(6) Load and rating life when the preload is taken into account

It is necessary to consider preload for calculation of rating life, when the Z3 (medium preload) or the Z4 (heavy preload) preload code is specified. Please consult NSK.

(7) Calculating Friction Force by Preload

- Dynamic friction force per one slide of the ball guide can be calculated from preload value.
- The following is a simple calculation to obtain the criterion of dynamic friction force.
  For slight preload ZZ of random-matching 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).
SH, SS, LH, LS, LW, HS Series : 0.004
HA, LA Series : 0.010
PU, PE, LU, LE Series : 0.026

- The starting friction force when the 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) (refer to LH series preload)
$F = iP$
$= 0.004 \times 2350 = 9.4$ (N)
Therefore, the criteria of the dynamic friction force of LH35AN - Z3 is 9.4 N.

For seal friction, refer to seal friction of each Series.

A-3-4 Accuracy

(1) Accuracy standard

The accuracy characteristics of linear guide are specified to each series in the variations of assembled height, assembled width, and running parallelism. We also specify the mutual variation of a pair of linear guides in the assembled height and assembled width. The accuracy of the table equipped with a set of linear guides is depending on other accuracies and many factors besides the accuracy of linear guides. Those are the accuracy of the mounting surface of the machine, the mounting span between two linear guides, the span of ball slides, the number of ball slides, and the location of the point at where the accuracy is really required.

(2) Definition of Accuracy

- Table 4.1, Figure 4.1 and Figure 4.2 show accuracy characteristics.

Table 4.1 Definition of accuracy

Characteristics	Definition (Figures 4.1 and 4.2)
Mounting height H	Distance from A (rail bottom datum face) to C (slide top face)
Variation of H	Variation of H in slides assembled to the rails of a set of linear guides
Mounting width W_2 or W_3	Distance from B (rail side datum face) to D (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 slides which are installed in the same rail. Applicable only to the reference linear guide.
Running parallelism of slide, face C to face A	Variation of C (slide top face) to A (rail bottom datum face) when slide is moving.
Running parallelism of slide, face D to face B	Variation of D (slide side datum face) to B (rail side datum face) when a slide is moving.

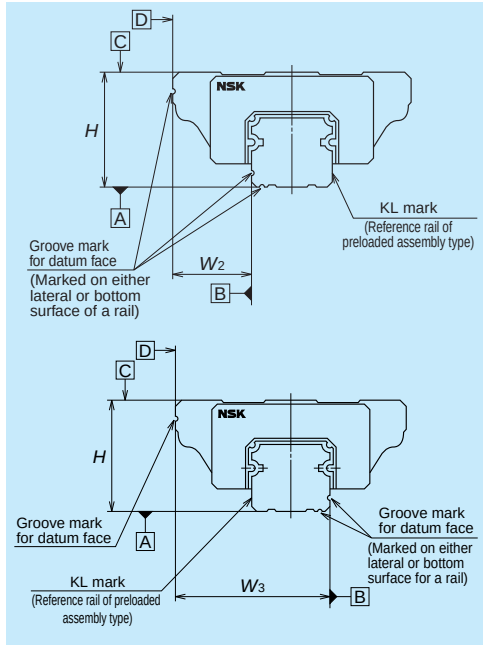


Fig. 4.1 Assembled dimensions

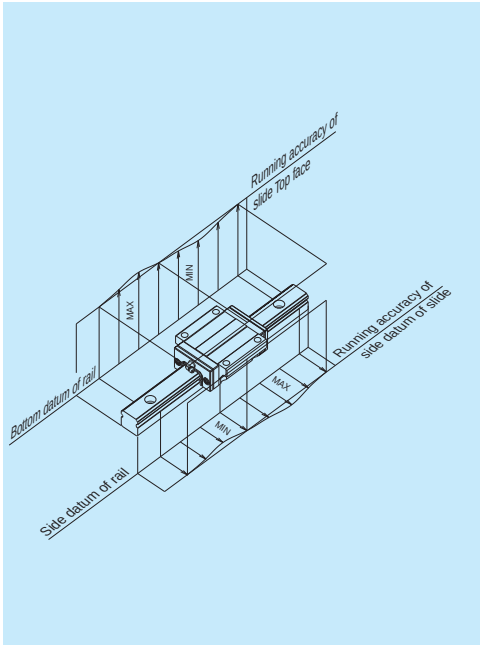


Fig. 4.2 Running parallelism of slide

Mounting width: W_2, and W_3

- Mounting width differs depending on the arrangement of the datum faces of the rail and slide on the reference linear guide (indicated as KL on the rail). (Fig. 4.3 and Fig. 4.4)

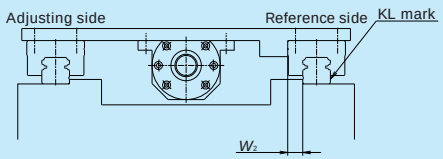


Fig. 4.3 Mounting width W_2

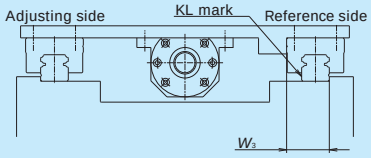


Fig. 4.4 Mounting width W_3

Running Parallelism of Ball Slide

- Running parallelism of slide is common in all series. Specifications of all accuracy grades are shown in Table 4.2. However, applicable accuracy grades differ by series. Please refer to "Table 4.4 Accuracy grade and applicable series" on page A35.

Table 4.2 Running parallelism of slide

Unit: µm

Rail over all length (mm) over	or less	Preloaded assembly (not random matching) Ultra precision P3	Super precision P4	High precision P5	Precision grade P6	Normal grade PN	Random-matching type Normal grade PC
–	50	2	2	2	4.5	6	6
50	80	2	2	3	5	6	6
80	125	2	2	3.5	5.5	6.5	6.5
125	200	2	2	4	6	7	7
200	250	2	2.5	5	7	8	8
250	315	2	2.5	5	8	9	9
315	400	2	3	6	9	11	11
400	500	2	3	6	10	12	12
500	630	2	3.5	7	12	14	14
630	800	2	4.5 (4)	8	14	16	16
800	1000	2.5	5 (4.5)	9	16	18	18
1000	1250	3	6 (5)	10	17	20	20
1250	1600	4	7 (6)	11	19	23	23
1600	2000	4.5	8 (7)	13	21	26	26
2000	2500	5	10 (8)	15	22	29	29
2500	3150	6	11 (9.5)	17	25	32	32
3150	4000	9	16	23	30	34	34

Note: Value of ( ) is the running parallelism of RA Series.

(3) Application examples of accuracy grade

Table 4.3 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.

Table 4.3 Application examples of accuracy grade and preload

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

Note: Only "slight preload (Z1, ZZ)" and "fine clearance (Z0, ZT)" are available for "normal grade (PN and PC)".
For random-matching type, only accuracy grade "PC," and preload "ZZ" and "ZT" are available.
For random-matching RA Series, only accuracy grade "P6" and preload "Z3" are avialable.

(4) Combination of accuracy grade and preload

① Accuracy grades

- The accuracy grade which matches the characteristic of each series is set for NSK linear guides.
- Table 4.4 shows accuracy grade set for each series.
- Refer to "**(3) Application examples of accuracy grade**" which shows cases of appropriate accuracy grade for specific purpose.

Table 4.4 Accuracy grades and applicable series

Series	Preloaded assembly (not random matching)					Random-matching type	
	Ultra precision	Super precision	High precision	Precision grade	Normal grade	Precision grade	Normal grade
	P3	P4	P5	P6	PN	P6	PC
LH, SH, VH	○	○	○	○	○		○
LS, SS	○	○	○	○	○		○
LA	○	○	○	○			
LW			○	○	○		○
LE, PE			○	○	○		○
LU, PU		○	○	○	○		○
LL					○		
HA	○	○	○				
HS	○	○	○				
RA	○	○	○	○		○*)	

*) Only RA25 to 65 are available in random matching.

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 4.5.
- Refer to characteristics of each series for details of radial clearance, preload, and rigidity.
- "**(3) Application examples of accuracy grade**" shows cases of appropriate preload and accuracy grades for specific purposes.

Table 4.5 Classification of preload

Series	Preloaded assembly (not random matching)				Random-matching type		
	Heavy preload	Medium preload	Slight preload	Fine clearance	Medium preload	Slight preload	Fine clearance
	Z4	Z3	Z1	Z0	Z3	ZZ	ZT
LH, LS, VH		○	○	○		○	○
SH, SS		○	○	○		○	
LA	○	○					
LW		(○)	○	○		○	○
LE, PE			○	○			○
LU, PU			○	○			○
LL				○			
HA		○	○				
HS		○	○				
RA		○			○		

Note : 1) Z3 preload types for LW Series are LW35 and 50 only.
2) "Z" is omitted from the specification number (refer to each series).

③ Combinations of accuracy grade and preload

• Combinations of accuracy grade and preload are shown in Table 4.6.

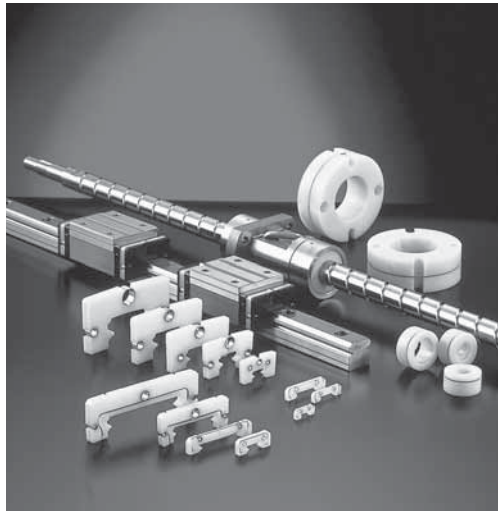
Table 4.6 Combinations of accuracy grade and preload type

	Accuracy grade	Preload
Preloaded assembly	P3 – P6	Z4 – Z0
	PN	Z1 – Z0
Random-matching type	PC, P6*)	ZZ – ZT

*) P6 grade is only for RA 25 to 65, and its preload is Z3. (Preload code is ZZ)

A-3-5 Lubrication

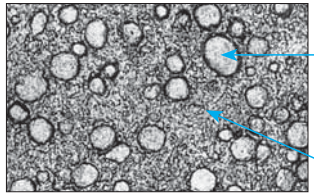
(1) NSK Linear Guides Equipped with "NSK K1™" Lubrication Unit.



"NSK K1™" lowers machine operation cost, and reduces impact on the environment.

What is "long-term, maintenance-free" operation?
Ball screws and linear guides which are equipped with "NSK K1™" do not require maintenance for five years or up to 10,000 km operational distance.

What is "NSK K1™" Lubrication Unit?
"NSK K1™" is a lubrication device which combines oil and resin in a single unit. The porous resin contains a large amount of lubrication oil. Equipped closely to the rail, "NSK K1™" constantly supplies fresh oil which seeps from the resin, lubricating the rail surface.



Enlarged surface of "NSK K1" Lubrication Unit

Polyolefin
Unlike vinyl chloride products, polyolefin does not produce dioxin. Polyolefin is also gaining use at supermarkets for food wrapping.

Lubrication oil
It is mineral oil-based. The oil has a viscosity of 100 cSt.

Remarkable capacity with new material: NSK K1™ Lubrication Unit information

- NSK K1 lubrication unit (referred to NSK K1 hereafter) to be equipped with NSK linear guide is outstanding new lubrication material.
- Newly developed "porous synthetic resin" contains large volume of lubricant oil, and it seeps out enhancing lubricating function.
- Simply install NSK K1 inside the standard end seal (rubber).
- We also provide NSK K1 lubrication unit for sanitary environments suited for food processing machinery, medical equipment and their ancillaries for the environment where hygiene control is essential. For details, refer to A-3-8 (3).

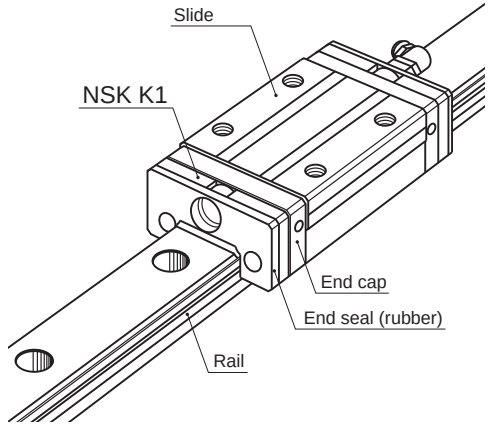


Fig. 5.1