MOTION & CONTROL
NSK

INSTALLATION OF NSK LINEAR GUIDES

NSK Ltd.

Linear Guide: Handling Precautions

NSK linear guides are 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 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

Handle with care.

Do not disassemble.

Do not drop.

Do not give impact.

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

Do not contaminate.

Do not hang upside down.

Temperature limitation.

a. Make every effort not to 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.

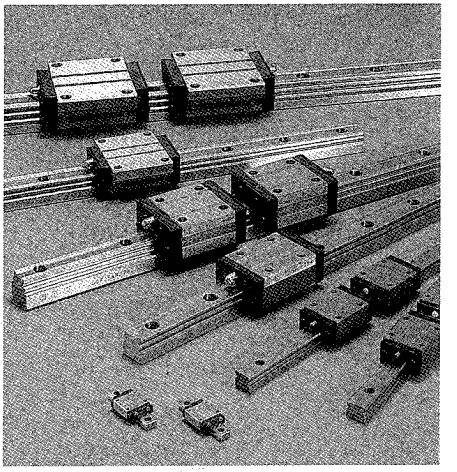
(4) Storage

Store in the correct position.

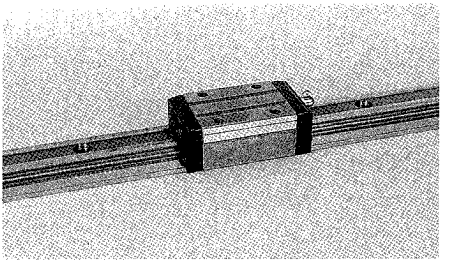
a. Linear guide may bend if the rail is stored in inappropriate position. Place it on a suitable surface, and store it in a flat position.

INSTALLATION OF NSK LINEAR GUIDES
[No.1 Machine Tools]

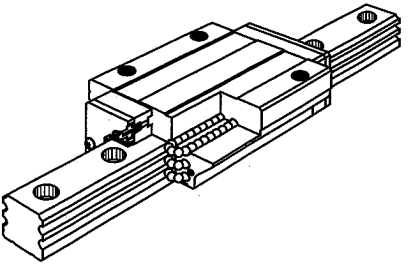
We thank you very much for your patronage of NSK linear guides. This manual describes the procedure for handling of NSK Linear Guides and installation in machine tools with the prescribed accuracy.



We recommend two types of NSK linear guides for the machine tools application. One is LA Series that offers high rigidity equivalent to roller type linear motion bearings, highly reliable durability and high impact load carrying capacity. The other is LY Series that has been widely accepted in the field.

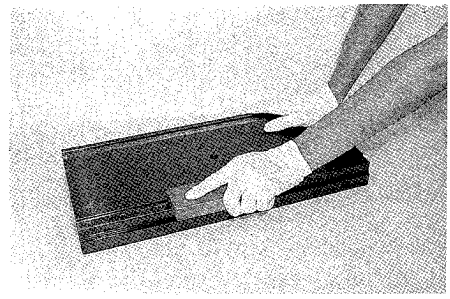


NSK Linear Guides are composed of a rail that governs linear motion of ball slides, and ball slides containing recirculating balls that allow smooth movement and retain rigidity of a machine's table or saddle.
Note: Be aware that balls of LA Series fall out a ball slide when it is removed from a rail.



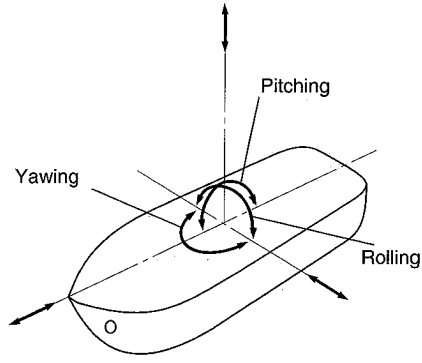
Before installing linear guides for the first time, we recommend a trial installation to gain experience with the procedure. In this trial installation, carefully measure the accuracy of the mounting surfaces on the machine and the accuracy of the linear guides to clarify the relation with the reqired table accuracy. This will enable you to judge the required accuracy of the machine base and accuracy grade of linear guides, as well as how and what degree you have to measure related accuracy, so that no problems will arise after the machines are finally put into massproduction. When installing linear guides for the first time, carefully follow the procedure in this manual.

Remove burrs and roughness on the machine bed mounting surfaces with an oil stone or other such stone. Then clean the surfaces with thinner or other volatile fluid.



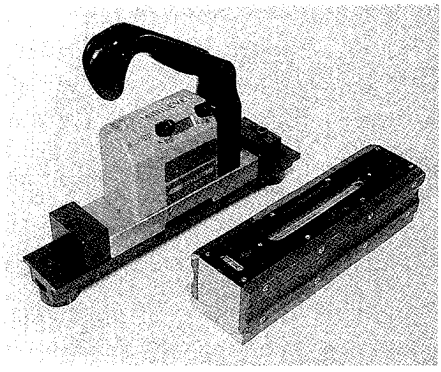
Highly precise measurements of the machine bed are necessary; therefore, appropriate instruments in good condition must be used.
Suitable instruments are described next.

The motion of any object can be separated into six "degrees of freedom": three angular movements (pitching, yawing, and rolling) and three linear movements (longitudinal, vertical, and lateral).

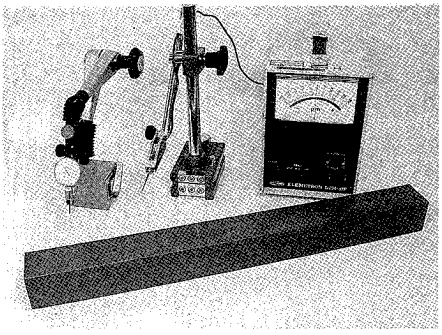


Instruments, which are suitable for only specific measurements, must be maintained and used properly.

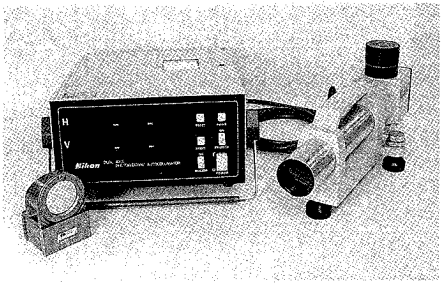
Most levels utilize bubbles in a fluid, but some are electric and have a digital indicator. Both types can measure angular wobble in pitching and rolling.



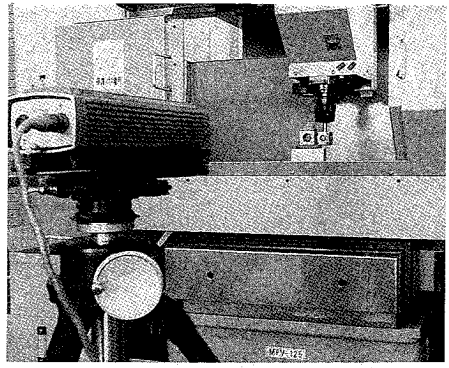
A good straightedge and a dial indicator or an electrical micrometer can be used under the ordinarily conditions to measure pitching, yawing, and rolling as well as vertical and lateral movements.



Autocollimators measure angular movement using reflected light, so they can measure pitching and yawing accurately.

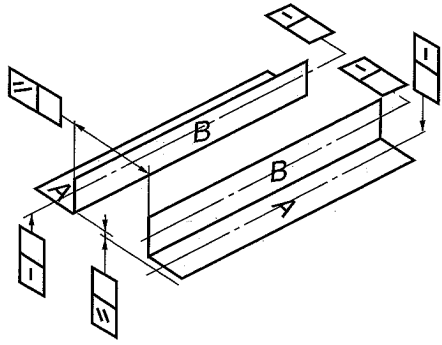


Laser interferometer can read pitching, yawing, and linear movement with high accuracy; however, it is not practical since it is hard to handle and requires much time for the setting.

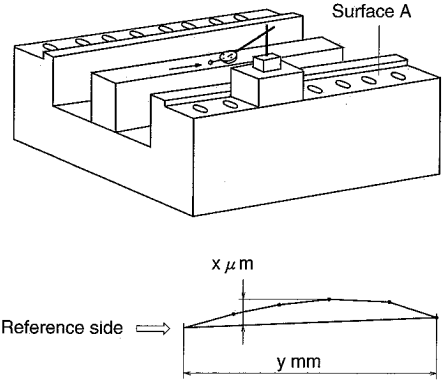


For the purposes of this manual, the combination of a straightedge and a dial indicator was chosen, with an autocollimator and a level used for reference.

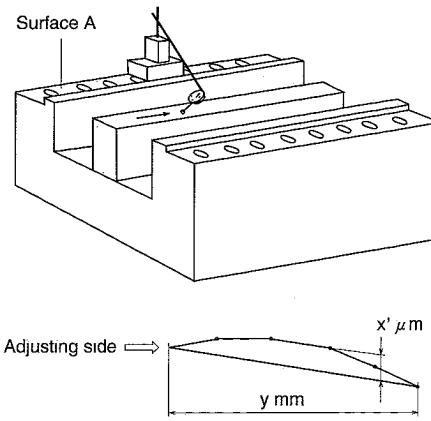
The machine bed mounting surfaces are designated here as "A" for the rail bottoms and "B" for the rail sides.
The linearity and parallelism of these surfaces are measured in the following manner.



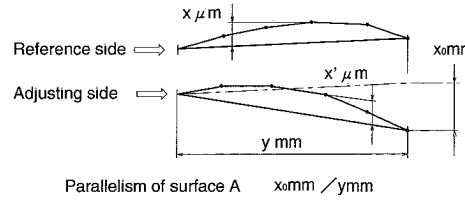
To measure the linearity of each A surface, place a suitable measuring block on one surface and attach a dial indicator to it with its stylus on a straightedge lying parallel to surface A. Holding the block firmly against surface B with both hands, slide the block along surface A for a specified step, record the measurement, then repeat the same to the end of the rail.



Then repeat the measurements for the other A surface. When doing this, it is important not to move the straightedge.

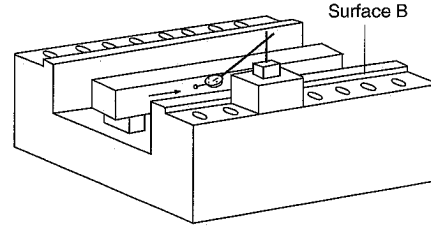


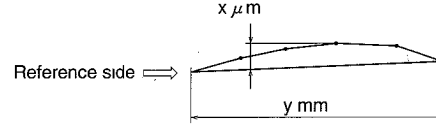
From the measurements of the two A surfaces, determine their parallelism.



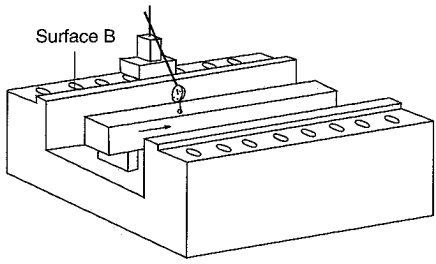
Parallelism of surface A $x_0$mm / ymm

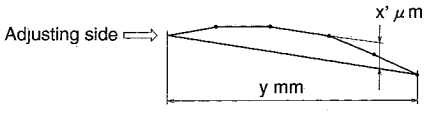
To measure the linearity of the two B surfaces of the machine bed, use an arrangement similar to that for the A surfaces but with the dial indicator stylus against the side of the straightedge.



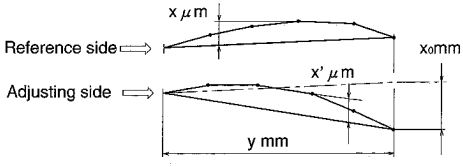


In this case also, the straightedge must not be moved. From the two measurements, determine their parallelism.





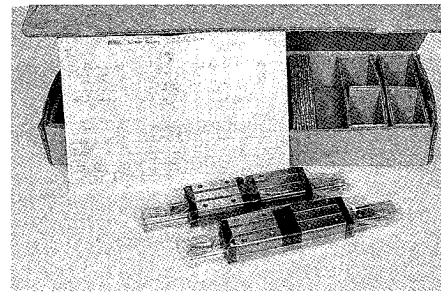
The measurements of the two B surfaces also determine their parallelism.



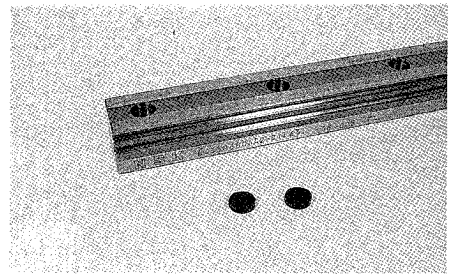
Parallelism of surface B $x_o$mm ／ymm

The accuracy measurement of the linear guide mounting surfaces is now complete. The linear guides should be carefully installed using the following procedure.

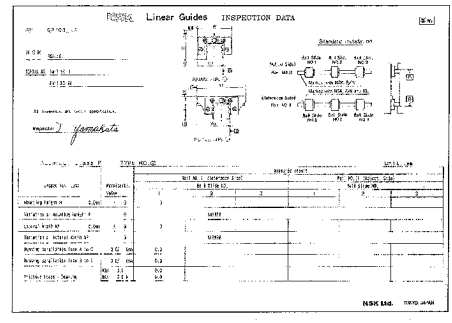
NSK linear guides are packed in high-grade corrugated cardboard boxes called Triwall. Generally we pack the linear guides for machine tools as a pair in the shipping container.
The linear guides are first wrapped in vinyl sheets and placed in their boxes together with an inspection sheet.



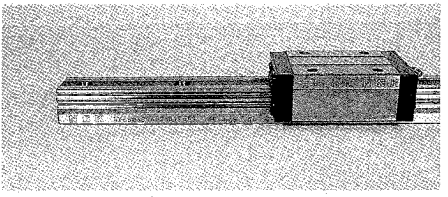
Caps for the rail mounting bolt holes are also included if requested by the customer.



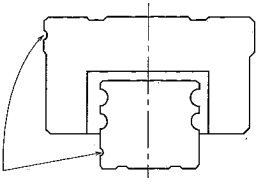
For the high-accuracy P3, P4 and P5 accuracy grades, actual inspection data are listed on the inspection sheets. For the P6 and PN accuracy grades, the inspection sheets are stamped to indicate compliance with the specifications.


Linear Guides INSPECTION DATA

Remove the vinyl wrapping and look for the reference and production numbers on the sides of the rails and ball slides.

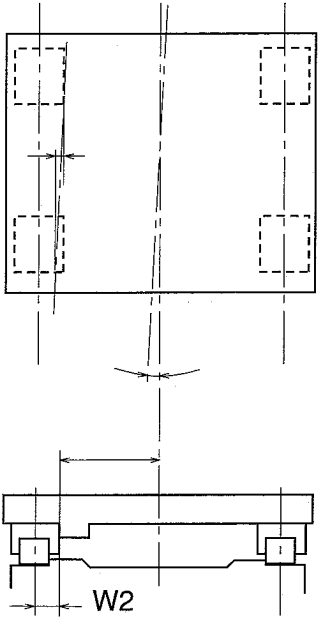


Both rails and all four ball slides are marked with lines that designate the datum face.

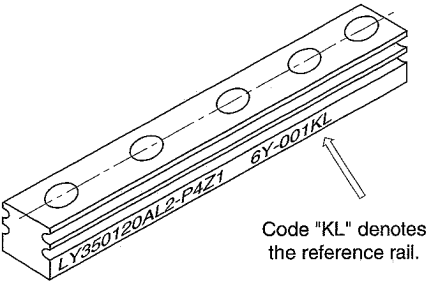


Groore mark indicates the datum face.

The two rails look similar but one of them is the reference rail that has controlled dimensional variation on the ball slide datum faces against that of the rail, that mate with corresponding surfaces on the table. If other ball slides are installed against the table's reference side surface, the table will be skewed as shown by the dotted lines in the figure. In the case of two-axis (Cartesian type) tables, accurate squareness of two-axis cannot be obtained.
Generally, no reference side face is provided on the table for the other rail; therefore, the ball slide face variation is not controlled so closely. This rail is called the "adjusting side rail."

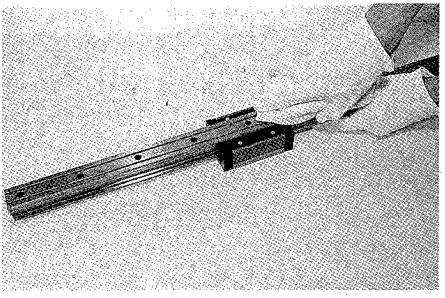


The reference rail is distinguished from the adjusting side rail by the letters KL following the production number on the rail side.



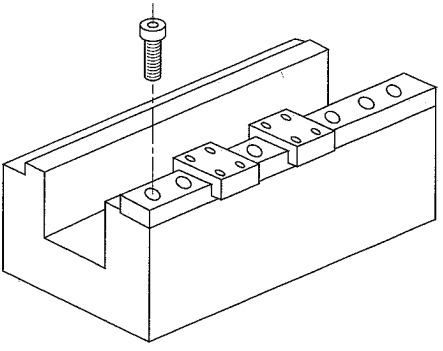
Code "KL" denotes the reference rail.

The bottoms of the rails have been coated with rust preventive oil, so wipe it off thoroughly.

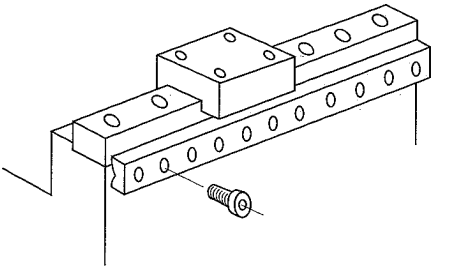


Place a linear guide on the machine bed as it is ready for installation.

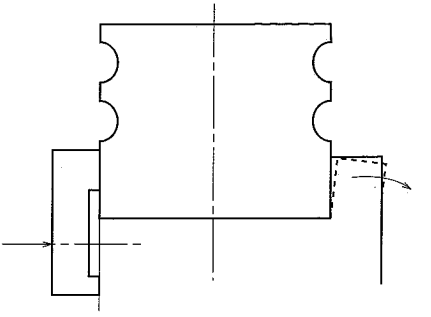
Temporarily tighten its mounting bolts lightly so that the rail's bottom is firmly against the bed.



Then install the shoulder plate to press the rail against the opposing surface and tighten the bolts firmly with a wrench. The tightening torque depends on the rigidity of the machine. In the case of high rigidity, tighten the bolts uniformly with the specified torque.



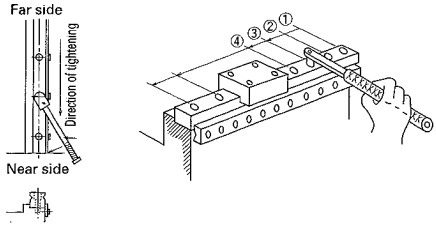
If the machine is not highly rigid, first tighten temporarily the bolts of shoulder plate so that the rail contacts closely to the datum side surface. Then tighten them again firmly after retightening the rail mounting bolts. Even if there is any bending of NSK linear guide rails, it is a simple curvature and the amount is small, so the bolts do not have to be too tight.



The main purpose of the shoulder plate is to prevent the rail from being disturbed in case of an accident or other troubles. Therefore, tighten the rail mounting bolts firmly and then, tighten the side plate bolts.

In NSK linear guides, the mounting bolt holes are processed after heat treatment using a precision machining center; therefore, the bolt hole pitch accuracy is as good as the positioning accuracy of the machine, which is considered very good.

When installing a linear guide rail against a reference side surface or on a flat surface with no rail shoulder plate, the rail may be slightly bent if the bolts are tightened indiscriminately starting near the middle. NSK recommends that the bolts be tightened starting at one end with the wrench seeing the datum reference surface of the bed on your left as shown in the figure. The rail will be pressed more firmly against the reference side surface if the bolts are tightened in this way.

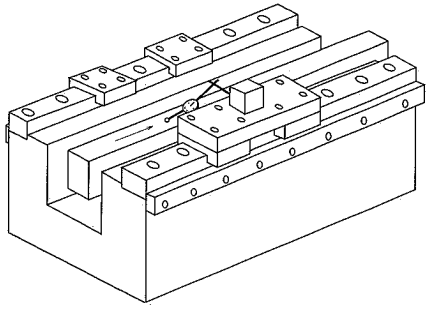


Tightening torque of bolts (Material: Chromium molybdenum steel)

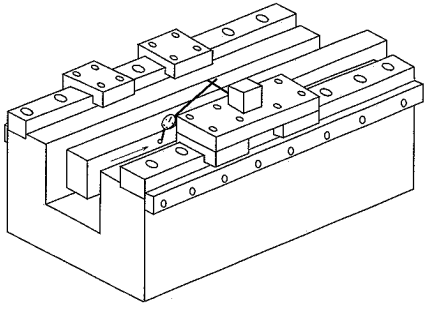
Unit : N• m

Nominal size	Tightening torque	Nominal size	Tightening torque
M2.3	0.38	M10	43
M2.5	0.58	M12	76
M3	1.06	M14	122
M4	2.5	M16	196
M5	5.1	M18	265
M6	8.6	M22	520
M8	22	—	—

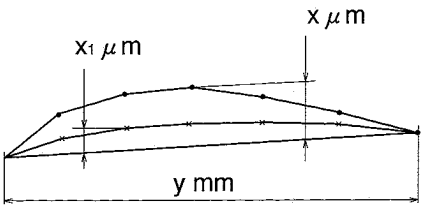
After installing the linear guides as explained above, mount a steel plate on the pair of ball slides on one rail and measure the pitching by following the same procedure used for inspecting the machine bed reference surfaces.



Measure the yawing in the same way and compare the data with that obtained for the machine bed reference surfaces to find the variation caused by the installation of the guides.

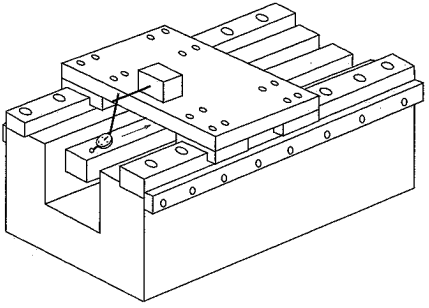


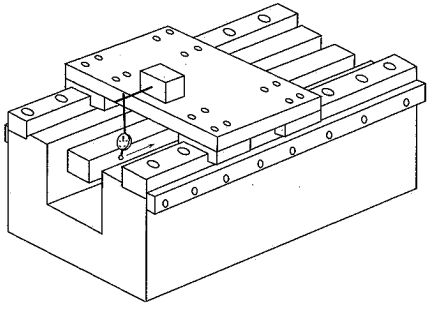
Rails of linear guides will deform to fit the contour of the machine bed; i.e., they will become concave if the bed is concave. If it is not attained, use care when taking measurements since vibration of the machine or floor will cause trouble.

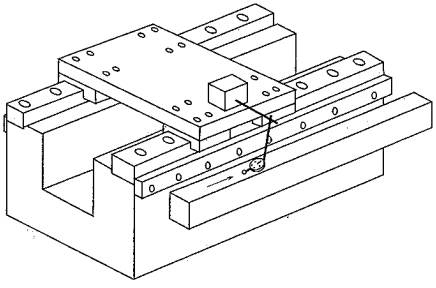


Finally, install the table, saddle, or interim table and check the accuracy of the entire assembly. The linearity of the completed assembly should be better than that for individual ball slides; however, this depends on the rigidity of the machine and the installing accuracy.

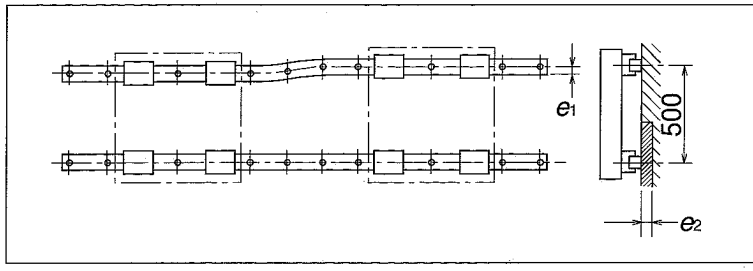
The measurements obtained are important characteristics of each machine built, and are essential data for your installation work instruction at the massproduction.







The installation of linear guides is easy if the instructions in this manual are followed carefully. If the accuracy is sufficiently poor to shorten the life of the linear guides, the frictional force will increase, which will serve as a warning. The allowable errors, which are shown below for the LA Series, consist of the error in parallelism (e_1) and error in height (e_2) of the two rails.



Recommended allowable installation error of the LA Series (Maximum) Unit: μm

Item	Preload code	Model number					
		LA25	LA30	LA35	LA45	LA55	LA65
Permissible values of parallelism in two rails e_1	Z3	15	17	20	25	30	40
	Z4	13	15	17	20	25	30
Permissible values of parallelism (height) in two rails e_2		185/500mm					

If the errors are smaller than the values in the preceding table, there should be no trouble. Naturally, errors should be as small as possible to achieve the highest performance and reliability of your products.

The procedure for installing linear guides is not too difficult, but care is required. In case of an improper installation, it is necessary to remove them and check all the related parts; however, we hope this will never be necessary. Many machine tool builders install linear guides regularly with no difficulty by following the procedure that is modified to meet their way of chekings based on this manual.

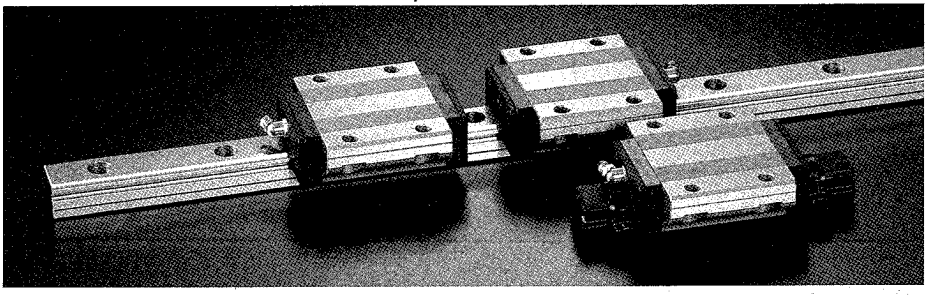
For assistance or more information, please contact an NSK branch office.

Assembly and Installation of NSK Linear Guides
(No. 2: General Industrial Machines)

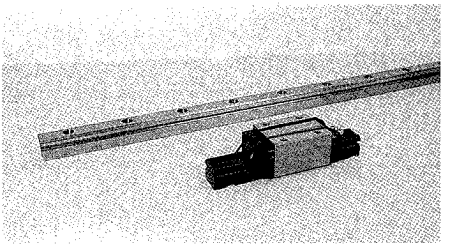
Thank you for choosing NSK linear guides. This manual briefly describes the recommended handling and installation of NSK linear guides for general industrial use.

There are two ways installing the linear guides into general industrial machines. One of them provides a datum shoulder on the mounting base of the machine for accurate horizontal alignment the same as the way for machine tools, while the other is not required a datum shoulder. Refer to "No.1 Machine Tools" for installation procedure that requires a datum shoulder for accurate horizontal alignment. The installation procedure described in this manual assumes that the datum shoulder is not required for horizontal alignment.

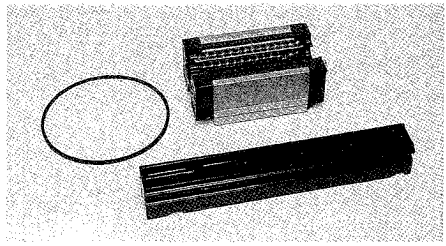
NSK recommends interchangeable LH and LS Series linear guides for general industrial application because they feature self-aligning capability better suited to tolerate some misalignment, interchangeability between the rails and ball slides for ease of addition of number of ball slides and their replacement, and standardized stock for short delivery times.



For interchangeable LH and LS Series linear guides, the ball slides and the rails are stocked separately. The ball slides are mounted on plastic provisional rails that allows for easy transfer of the ball slide to and from the steel rail.

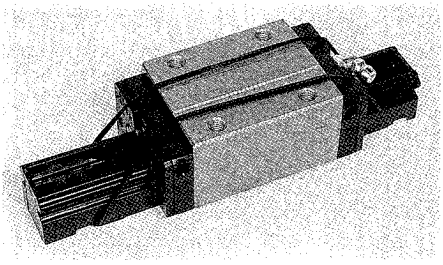


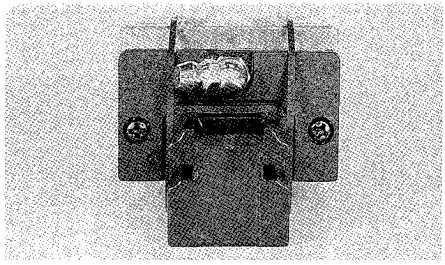
The ball slides are designed with retaining wires to prevent the balls from falling out when they are removed from the rail. However, NSK recommends that the ball slide should be stored on a provisional rail prior to installation to prevent contamination from dust and other foreign objects.



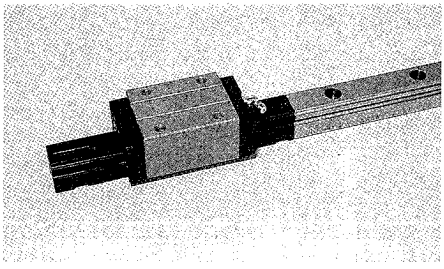
The following is a description of how the ball slide should be removed from and replaced on the linear guide rail.

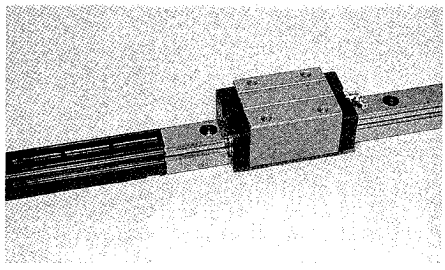
The ball slide is held on the provisional rail using a rubber band. The rubber band should catch the bottom channel in the provisonal rail and then twist around to secure the ball slide.



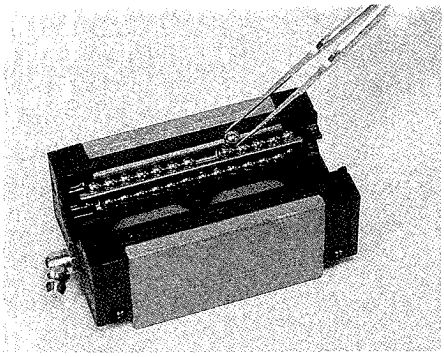


When transferring the ball slide from the provisional rail onto the rail, or vice versa, butt the provisional rail up against the rail and slide the ball slide directly from one onto the other. It is a good idea to secure the ball slide onto the provisional rail with a rubber band after removal from the rail.



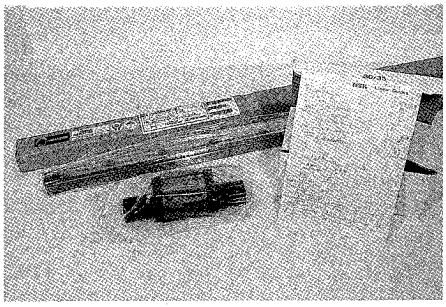


If a ball is accidentally dropped from the ball slide, it should be cleaned and replaced to the appropriate groove. The correct groove can be determined by the size of the clearance between the balls (the groove missing the ball will have greater clearance than the other grooves). It is normal to have a gap of 1.5 ball diameters in each groove.

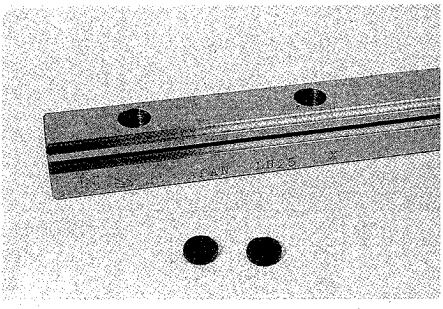


The following section describes how to install the linear guides on the machine.

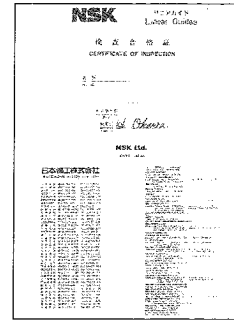
Ball slides and rails are supplied separately. Each is wrapped in vinyl sheet, and packed in a container. Each container has a certificate of inspection included.



Caps for rail mounting bolt holes are available upon request.



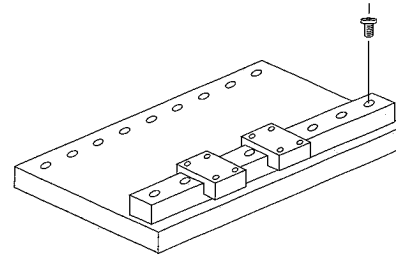
The certificate of inspection included with every rail and ball slide is NSK's guarantee of quality. If you should have any questions about the quality, please feel free to contact your local NSK representative.



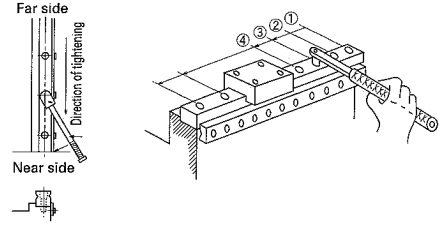
The rail is always shipped with rust preventive oil, which should be wiped off before applying grease to the rail. LH and LS Series ball slides are pre-packed with AV2 grease, so no cleaning is required prior to installation.

Now the linear guide is ready for installation. Put it on a mounting surface.

Snugly tighten its mounting bolts temporarily so that the rail's bottom is firmly against the bed.



Then tighten the bolts firmly with torque wrench to the specified torque starting from the one end.

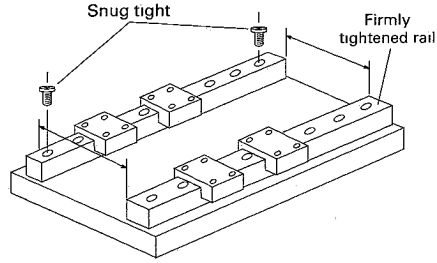


In NSK linear guides, the mounting bolt holes are processed after heat treatment using a precision machining center; therefore, the bolt hole pitch accuracy is as good as the positioning accuracy of the machine, which is considered very good.

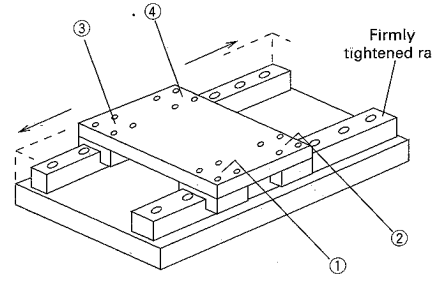
When installing a linear guide rail in a flat surface the same as this case, the rail tends to be slightly bent in the shape of S letter if the bolts are tightened indiscriminately starting near the middle because of friction at the seat of bolt head. NSK recommends that the bolts be tightened starting at one end with the wrench as shown in the above figure.

The rail that has been tightened can now be used as a reference rail. Using a vernier calipers or other accurate tool, measure the distance between the two rails, and adjust each end until they are the same. Tighten a bolt snugly at each end of the rail.

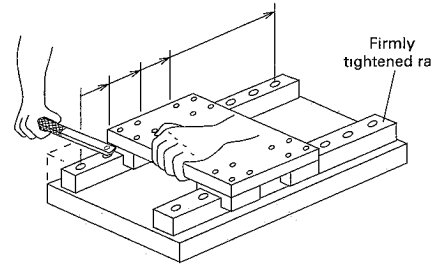
The next step is to install the table, and to use the table to align the rails.



Firmly bolt the table to ball slides 1 and 2 on the firmly secured rail as shown in the diagram. Then position ball slide 3 at the left end of the adjusting rail, and bolt the table to this ball slide. Move the ball slide 3 to right and bolt the table to the ball slide 4.



Move the table to one end of the rails, and start tightening the adjusting rail bolts sequentially to the specified torque while checking excessive friction of table movement. Continue moving the table down the rail tightening each adjacent bolt until they have all been tightened.



As described above, installation of the linear guides is not difficult work if you carefully follow the above procedure.

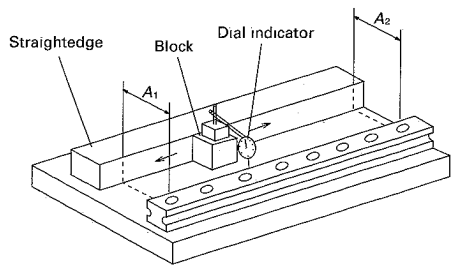
However, objective of the preceding procedure is only for an assembly of the table that moves smoothly. If you need to control motion accuracy of the table (linearity), it requires to add the following procedure.

When bolting the first rail on the machine base, align it straight using a straightedge and a dial indicator.

Bolt on the rail at the both ends lightly, and position a straightedge beside it. Set the straightedge parallel to the rail measuring distance A1 and A2 by a vernier calipers or some other accurate measuring tool.

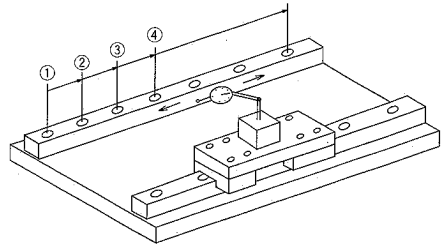
Move the dial indicator along the straightedge, and take readings at every bolt hole along the rail. Make fine adjustment of the rail to the straightedge until the desired reading is made, and tighten the bolt to the specified torque.

When all of the bolts have been tightened, slide the dial indicator from one end of the rail to the other to ensure that the desired straightness has been achieved.



Position the dial indicator on two ball slides on the reference rail as shown in the diagram. Tighten bolts of the adjusting side rail sequentially from the one end while noting the reading of the dial indicator.

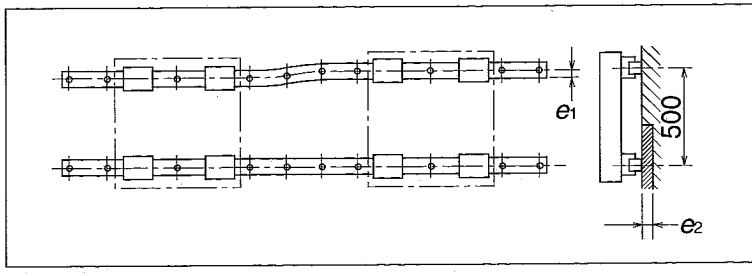
Straightness of NSK linear guides is controlled so that it can be easily adjusted manually for easy installation.



In order to maintain stable production of the tables, we recommend to install the linear guides while checking the alignment accuracy quantitatively even smooth operation is the least requirement.

As the final part of the manual, this section describes the allowable tolerances for installation in order to maximize the performance of NSK linear guides.

We recommend that the mounting errors e_1 and e_2 do not exceed the values shown in the table below.



Recommended allowable installation error of the LS Series (Maximum) Unit : μm

Item \ Model No.		15	20	25	30	35
Clearance Z0, ZT	Permissible values of parallelism in two rails : e_1	20	22	30	35	40
	Permissible values of parallelism (height) in two rails : e_2	375/500mm				
Preload Z1, ZZ	Permissible values of parallelism in two rails : e_1	15	17	20	25	30
	Permissible values of parallelism (height) in two rails : e_2	150/500mm				

Recommended allowable installation error of the LH Series (Maximum) Unit : μm

Item \ Model No.		20	25	30	35	45	55	65
Clearance Z0, ZT	Permissible values of parallelism in two rails : e_1	30	40	45	55	65	85	110
	Permissible values of parallelism (height) in two rails : e_2	375/500mm						
Preload Z1, ZZ	Permissible values of parallelism in two rails : e_1	20	25	30	35	45	55	70
	Permissible values of parallelism (height) in two rails : e_2	150/500mm						

If the errors are smaller than the values in the preceding tables, there should be no trouble. Naturally, errors should be as small as possible to achieve the highest performance and reliability of your products.

The procedure for installing linear guides is not too difficult, but care is required. In case of an improper installation, it is necessary to remove them and check all the related parts; however, we hope this will never be necessary.

Please contact your local NSK branch office for any questions regarding the installation of NSK linear guides.

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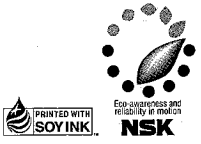

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CAT. No.E9008 2002 C-5 Printed in Japan