6. Designing Accuracy

6.1 Accuracy Standards

The accuracy of the LM Guide is stipulated for each type with regard to dimensional tolerances for running parallelism, height, and width; height difference among LM blocks installed on the same plane; and differences in the rail-to-block lateral distance among LM blocks installed on the same rail. For details, see the standards tables for the models in question.

Running parallelism

When an LM block runs on an LM rail bolted to the reference base, if the LM-block reference surface is not fully parallel to the LM-rail reference surface over the entire length of the rail, the two members have insufficient running parallelism.

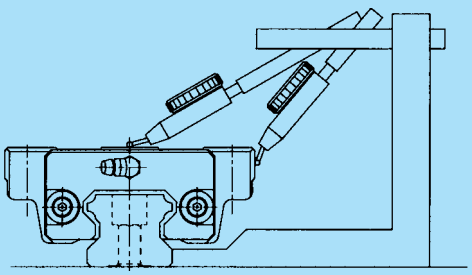


Fig. 43 Running Parallelism

Difference in height M among LM blocks

This refers to the difference between the maximum and minimum height (M) of by any LM block installed on the same plane.

Difference in rail-to-block lateral distance W_2 among LM blocks

This refers to the difference between the maximum and minimum rail-to-block lateral distance (W_2) of by any LM block installed on an LM rail.

Note 1: With two or more sets of LM Guides installed in parallel on the same plane, the tolerances for the rail-to-block lateral distance (W_2) and the differences therein among LM blocks apply to the master-rail side only. The serial number of a master LM rail is appended with "KB." This marking, however, is not provided on normal-grade models.

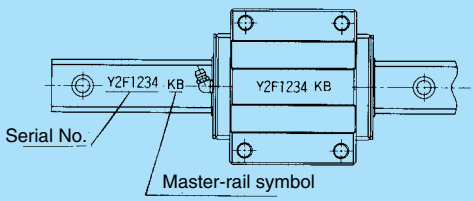


Fig. 44 Marking on the Master LM Rail

Note 2: Accuracy measurements indicate mean values of measurements taken at the center or central area of each LM block.

Note 3: LM rails are smoothly curved so that when they are installed on a machine they are easily straightened, and pressing them onto the machine reference base enables the design accuracy to be achieved.
If installed on a base lacking rigidity, such as an aluminum base, the bend of LM rails may affect machine precision. In such a case, the straightness should be set in advance.

6.2 Averaging Effect

The LM Guide incorporates precision balls with high sphericity, enabling a constrained structure to be created with no clearance. Moreover, in a multiple-axis configuration with the axes arranged in parallel to one another, the component LM Guides therein combine to form an entire constrained guideway. That is, the misalignment of the machine base on which the LM Guides are installed can be averaged and absorbed by the constrained structure, regardless of the misalignment - incomplete straightness, levelness, and parallelism due to errors in machining and assembly of the machine base.

The extent of the averaging effect varies with the degree of misalignment, i.e., errors in length and other dimensions, the magnitude of the LM-Guide preload, and the number of axes constrained. Fig. 46 shows measurements of the motion accuracy of the table shown in Fig. 45 (perpendicularity in the lateral direction), which were taken by performing arbitrary misalignment of either of the two rails of the table.

The averaging effect illustrated above makes it easier to create a guideway with a high degree of motion accuracy.

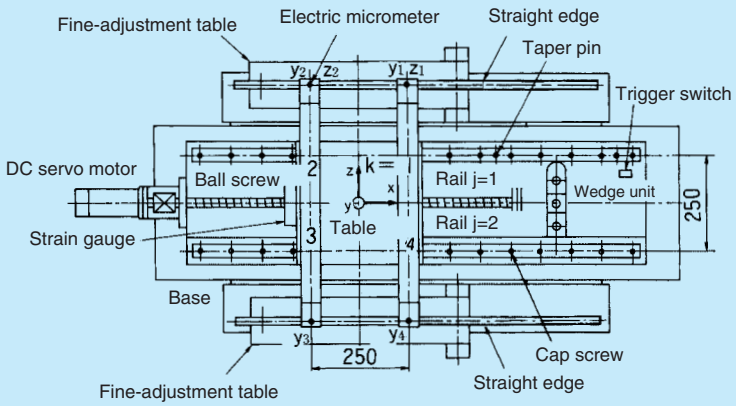
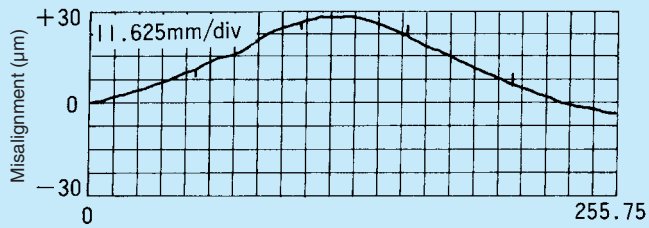
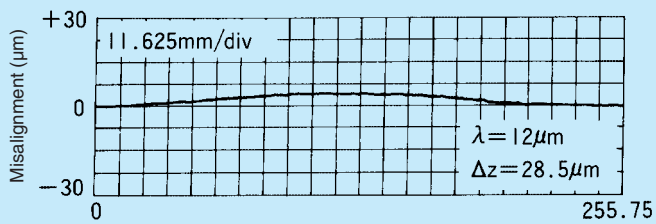


Fig. 45



Misalignment profile



Horizontal displacement of the table

Fig. 46

Source: Shigeo Shimizu: A Study on the Accuracy Averaging Effect of the Linear-Motion Ball-Guide System, Proceedings for the Academic Lecture Meeting at the 1990 Spring Convention, Precision Engineering Society (1990).

6.3 Equipment Applying the LM Guide and Accuracy Grade

Table 15 presents guidelines for selecting the correct accuracy grade of the LM Guide for your equipment.

Table 15 Guidelines for Selecting the Correct Accuracy Grade by Equipment Type

Equipment	Machine tool															
	Machining center	Lathe	Milling machine	Boring machine	Jig borer	Grinding machine	Electric discharge machine	Punching press	Laser-beam machine	Woodworking machine	NC drilling machine	Tapping center	Pallet changer	ATC	Wire cutter	Dresser
Accuracy grade: UP					○	○	○									○
SP	○	○	○	○	○	○	○		○						○	○
P	○	○	○	○			○	○	○	○	○	○			○	
H								○	○	○	○	○				
Normal										○			○	○		

Equipment	Industrial robot		Semiconductor manufacturing				Others									
	Cartesian coordinate robot	Cylindrical coordinate robot	Wire bonder	Prober	Electronic-component inserter	Printed-circuit-board drilling machine	Injection-molding machine	3D measuring instrument	Office equipment	Transfer equipment	XY table	Painting machine	Welding machine	Medical equipment	Digitizer	Inspection equipment
Accuracy grade: UP				○				○								○
SP			○	○		○		○			○				○	○
P	○		○		○	○					○				○	○
H	○	○			○	○	○		○	○	○	○	○	○	○	
Normal	○	○					○		○	○		○	○	○		