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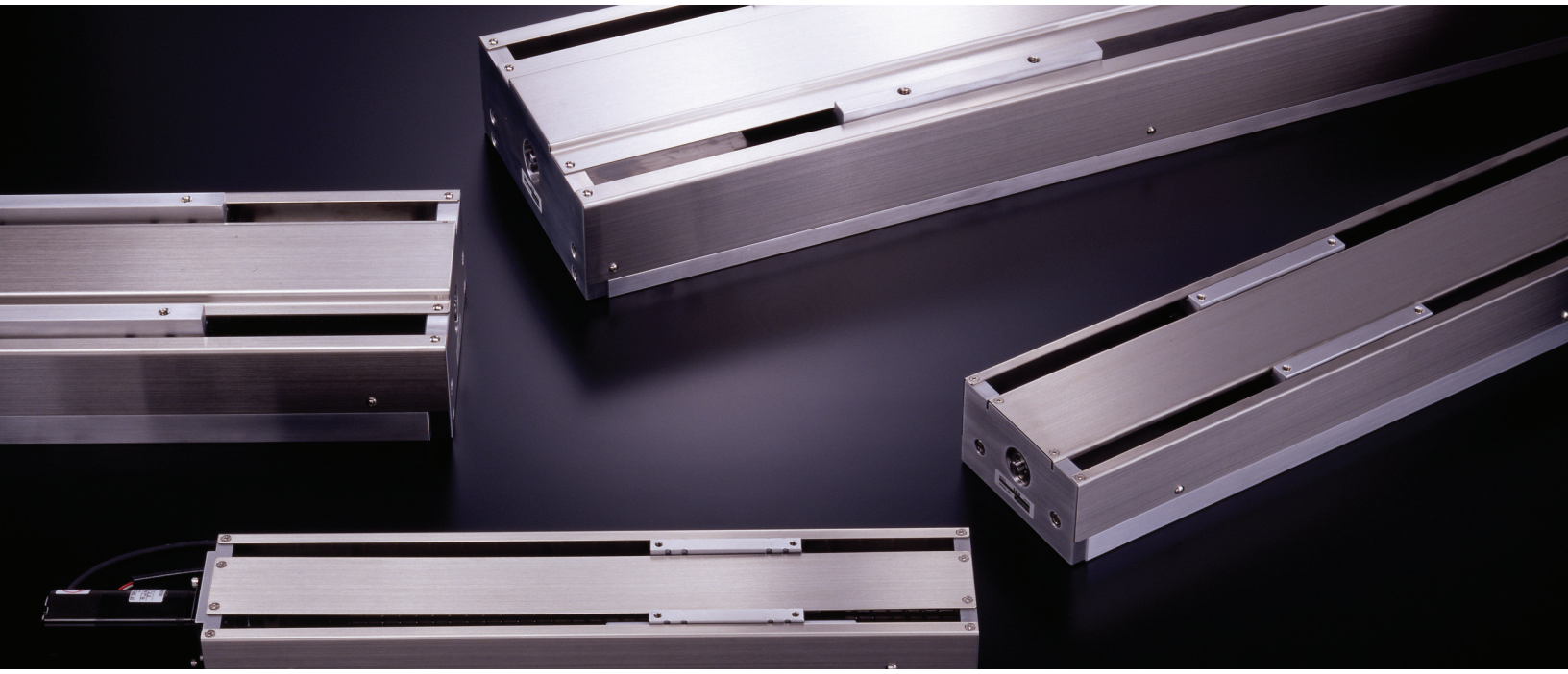
Precise Positioning: Choose the Ideal Linear Stage for Your Equipment

Linear stages with integrated precision machining technology and electronics can meet the needs of most any positioning application.



When your design or assembly requires a mechanism to guide or position a load, the positioning stages to choose from are as varied as the applications where they are used. While many linear stages are appropriate for a wide variety of industrial machinery, some may be more suited for high-speed applications while others offer more thrust to support heavy loads. In addition, some designs will call for a nano- or micro-sized linear stage, while others may need a linear stage to operate in a controlled setting with very stringent requirements for machines, such as inside a clean room.

Some of the best-performing linear stages available integrate precision machining technology and electronics. These devices incorporate a linear motion rolling guide and either a ball screw or motor between the bed and the slide stage, and they also include electrical control components within the same unit to help reduce the size of designs as well as simplify the assembly process. With careful selection, you can find a linear stage that will perform in your application for a long time. Here's an overview of the different types of linear stage and the typical selection criteria they satisfy so you can find a unit that meets and performs to your standards.

Linear Motor Drive Stages

These linear stages integrate an AC linear motor between the bed and the slide stage, and they are desirable for high-speed machinery such as pick-and-place and assembly systems used in electronics and semiconductor manufacturing. Linear motor drive stages offer high accuracy and fast response and are compact in size.

The integrated motor consists of a moving field coil and a C-shaped yoke set between two stator magnets. This arrangement follows Fleming's Left-Hand Rule, in which the magnetic flux vertically exerted by the magnet, and the rotational flux generated around the coil by the current, force the coil to move in a horizontal direction. The coil current is switched to a direction that corresponds to the flux direction, producing a continuous driving force that provides and maintains fast, precise motion. Integrated electronics control the current level, using feedback from a linear encoder, to ensure accurate travel and positioning. Some common requirements that machine designers often look for in a linear motor drive stage include:

- **Stability.** Some linear motor drive stages with advanced servo technology can achieve speed stability of ±1.78 percent at 10 mm/second and static stability of ±1 µm or less.
- **Long strokes.** Depending on the integrated linear motion rolling guide's track rail, super long strokes beyond 2,700 millimeters can be achieved.
- **High thrust and high loads.** When the moving field coils of a linear motor drive stage are densely arranged, the resulting magnetic fluxes can produce very high thrust forces to position heavy loads.
- **Compact size.** Many linear motor drive stages are available in a compact size. Integrated neodymium magnets help provide large thrust forces and high-speed response even in a small size. One such linear stage, IKO International's NT38V10 nano linear stage comes with an 11-millimeter in sectional height, 38-millimeter width and 62-millimeter length.

Ball Screw Drive Linear Stages

Stages driven by ball screws provide excellent thrust force plus high rigidity to provide accurate positioning for a wide variety of applications. They also exhibit good speed and low friction for efficient operation.

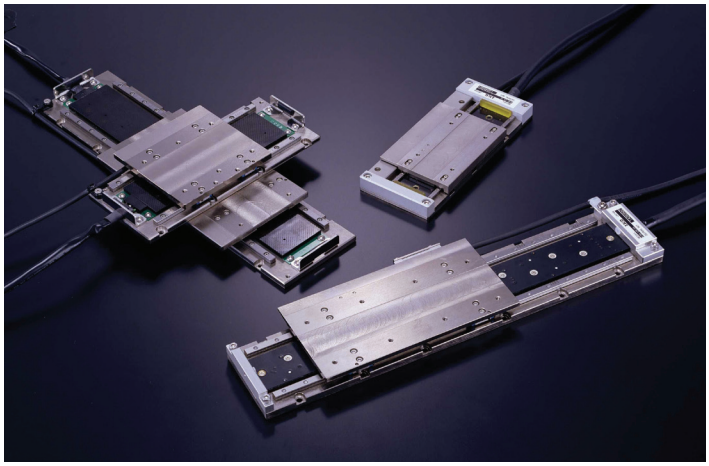


Figure 1. Ultra-compact linear motor-driven positioning stages can have dimensions as small as 11 millimeters sectional height, 38 millimeters width and 62 millimeters in length.

The slide stage gives ball screw drive linear stages their rigidity and thrust capabilities. Within the slide stage, large-diameter steel balls, arranged in two rows, make four-point contact with the raceways, allowing the unit to maintain high accuracy even under a fluctuating or complex load. For greater rigidity, two slide stages can be mounted on the track rail, depending on the applied load and the moment.

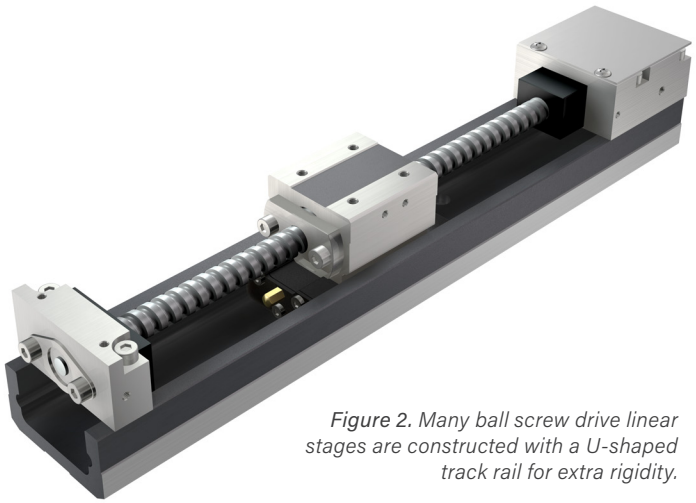


Figure 2. Many ball screw drive linear stages are constructed with a U-shaped track rail for extra rigidity.

Many ball screw drive linear stages have a U-shaped track rail, which under moment load and torsion bolsters rigidity. This track rail can be used as a structure beam for the machine it will be designed into to offer engineers greater flexibility. Some U-shaped linear stages come in lightweight, low-profile

models that still maintain high precision despite their small size thanks to high-strength materials and special grooves for mounting sensors on the bed without adding to the design size.

Ball screw drive linear stages come in many styles and options. Here are some typical requirements that can be satisfied with certain ball screw linear stages:

- **Long strokes.** Stage widths can range from 15 to 420 millimeters, and stroke lengths can reach up to 1,350 millimeters.
- **High accuracy and rigidity.** A stage bed made from a rugged material such as cast iron not only offers high rigidity, it also provides excellent vibration damping. For added stability, accuracy and load capacity, look for integrated linear guides arranged in parallel on the stage bed.
- **Compact size/micro positioning.** Small and ultra-small stages with low sectional heights and narrow widths can deliver high accuracy for applications requiring fast acceleration and deceleration as well as good anti-creep characteristics. Some micro-sized stages can accommodate tiny limit sensors without altering their outside dimensions.
- **Special environments.** Many linear stage manufacturers, including IKO International offer products specifically built for harsh environments such as those subject to washdowns. Major components are typically made from high-strength aluminum alloys and stainless steel. Certain stages are specifically designed to satisfy ISO Class 3 (U.S. Fed. Std. 209E Class 1) clean room requirements and can include a covering to prevent dust dispersion.
- **Custom units and additional options.** Depending on the accuracy requirement, designers can often customize their linear stage by specifying a particular stage length, motor or ball screw type and sensor mounting option. Additional customization options include flanges and bridge covers, motor fold-back to reduce the stage's overall length, bellows to prevent foreign matter from entering the stage, surface treatments and finishes such as black chrome to resist corrosion and brackets to make X-Y stage configuration easy.

VERIFY YOUR STAGE'S ACCURACY

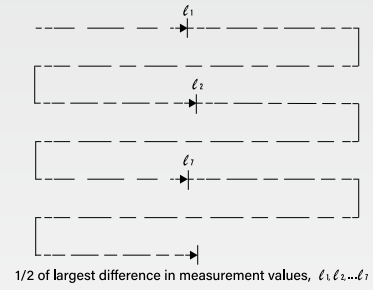
Because cutting-edge equipment places increasingly stringent accuracy requirements on linear stages, you want to be sure the device you choose has been tested by the supplier. Manufacturers like IKO include an inspection sheet or certificate of inspection for accuracy with the positioning unit. IKO can also perform model testing, according to use conditions, on request. Here is how you can test your unit for positioning repeatability and accuracy. Note that these tips may vary, depending on the model.

REPEATABILITY

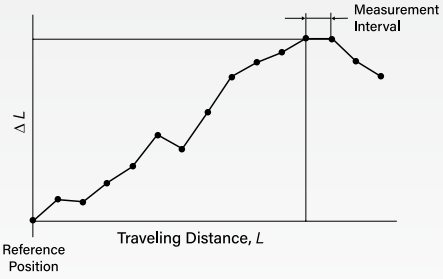
Repeat positioning to any one point from one direction seven times to measure the stop position and obtain half of the maximum reading difference. In principle, perform this measurement at the center and each end of the stroke length and take the maximum obtained value as the measurement value. Indicate the half of the maximum difference with ±.

ACCURACY

Perform positioning successively in the certain direction from the reference position, measure the difference between actual travel distance at each position and the theoretical travel distance, and indicate the maximum difference within the stroke length as an absolute value.



1/2 of largest difference in measurement values, $\ell_1, \ell_2 \ldots \ell_7$



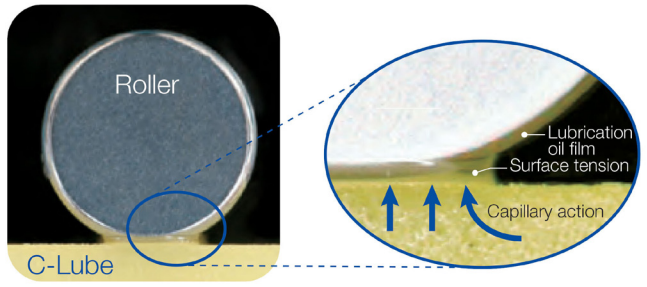
ΔL = (Distance actually traveled) - (Command value for traveling distance)

(Top) To test repeatability, measure the stop position by moving the guide to any one point from one direction seven times and obtain half of the maximum reading difference then indicate it with "+/-". (Bottom) To test positioning accuracy, perform positioning in a certain direction from a reference position, measure the actual travel distance, then compare it with the command distance to get maximum difference.

MAINTENANCE-FREE LINEAR STAGES STAY LUBRICATED

As with any device with rolling elements, lubrication is an important factor in the long operating life of linear stages. Regular maintenance intervals can be expensive: Machine downtime to allow workers access to the equipment, along with the associated personnel costs, impact the bottom line. Add to that, the cost of the lubricant itself. To keep maintenance costs in check, it pays to look for a linear stage with a lubrication system built into the unit.

For example, IKO's maintenance-free C-Lube technology uses capillary action to supply lubrication oil slowly through direct contact with the linear stage's rolling elements, which then carry the oil to the loading area. The result: continuous, adequate lubrication that lasts for a long period of time. In practice, it delivers maintenance-free performance that may even equate to the application's entire life. IKO offers C-Lube technology built into many linear motor drive and ball screw drive linear stages as well as select specialized stages.



C-Lube supplies lubrication oil through direct contact with the stage's rolling elements which carry the oil to the loading area.

Specialized Linear Stages

There are times when an application presents challenges that traditional linear stages may not address. Some machines must convert linear motion into rotary motion at a specific operating angle. Alignment stages can work with both stepper and AC servomotors and incorporate a crossed roller bearing to provide precise angular correction, and they can be mounted to a precision linear stage slide for multi-axis applications.

Alignment modules — which can mount to U-shaped linear stages — incorporate a rigid crossed roller bearing and linear guide to provide X, Y, X-Y, center reference angle compensation or randomly pivot for angle compensation. An alignment stage — another device that uses crossed roller bearings and linear guides — can provide X-Y-θ positioning with excellent resolution in a low-profile unit, and X-Y or X-Y-θ positioning is also possible. For precise up-and-down positioning, elevating stages do the job and, when used with a linear encoder, achieve high repeatability and accuracy thanks to closed loop control.

Another type of linear stage is driven by a stepper motor and incorporates a timing belt into the slide stage's feeding mechanism along with a pair of linear motion roller guides in parallel. Taken together, these components deliver stable and reliable performance for applications requiring high speed and accelerations plus a long stroke length.

There's a Linear Stage to Meet Your Application's Needs

When it comes to moving or guiding a load, the positioning mechanism you choose must perform with accuracy and precision while offering the right attributes for your specific application. Be sure to partner with a manufacturer that has a history of delivering motion components that exhibit high precision and can provide long-term, maintenance-free operation. IKO International offers a varied lineup of linear stages with precision machining technology and electronics to satisfy most any application. With careful selection and the right motion component supplier, there's a linear stage that will perform in your equipment for a long time.

For more information about IKO precision linear stages, visit www.ikont.com.