The Basics of Linear Slide Tables

Off-the-shelf, one-piece, design solutions

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Pre-assembled linear slide tables' time and resource saving one-piece designs are available for countless applications. They allow design engineers and manufacturers to eliminate the need to research suppliers and products, design and draw custom assemblies, purchase and assemble these systems. Additionally, many linear companies manufacture a wide variety of linear slide tables with geometries and configurations to fit almost any application, both for slow speed positioning and high-cycle applications. They can be used in many environments including laboratory settings or in food-processing equipment.

There are 2 common types of linear slide tables, lead screw driven, and belt driven. Lead screw systems are able to generate a great amount of torque, and are ideal for high load applications. However, due to frictional heat buildup in the nut, may be limited to lower speed applications. Belt driven systems, on the other hand, are ideal for positioning low to medium loads at high speeds, and at high cycles. Engineers can motorize these tables or operate them using a hand wheel or thumbscrew. Stepper motors allow engineers to program and implement a range of motion profiles, and DC motors are available for simpler motions controlled by limit switches.

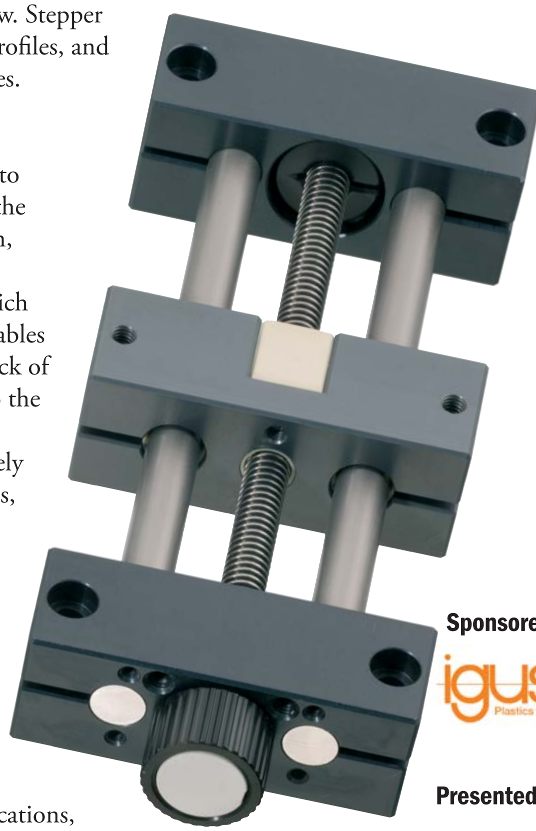
Lead screw tables

Linear slide tables that use lead screw nuts convert rotary motion into linear motion. The screw can turn clockwise, or counterclockwise, and the nut correspondingly moves the bearing carriage assembly back and forth, respectively.

Some companies, such as igus®, use nuts made of special plastic, which eliminates the need for oil of any other lubricants. This lets lead screw tables operate reliably in sterile or sensitive environments. Furthermore, the lack of lubricant means dust and debris are not attracted to the nut or screw, so the tables are able to withstand dirty, corrosive environments.

Positional accuracy for lead screw tables is usually rated approximately between 0.1 and 0.35mm when new, however, in high cycle applications, engineers must account for wear in the lead screw, as well as anywhere in the thrust bearings. This can increase backlash and clearance, and reduces precision. To counter this, some manufacturers offer anti-backlash nuts that continuously self adjust to mechanically reduce the clearance.

Lead screw tables have strokes limited to about 3.28 ft (1m), depending on the their diameter. Lengthier lead screws may be prone to deflection, increasing friction forces and torque, and may lead to unwanted resonance and noise. This may not be critical for hand applications, however it could be problematic for motorized applications,



Linear slide tables can use lead screws that are motor or manually moved in low- to moderate-speed positioning applications.

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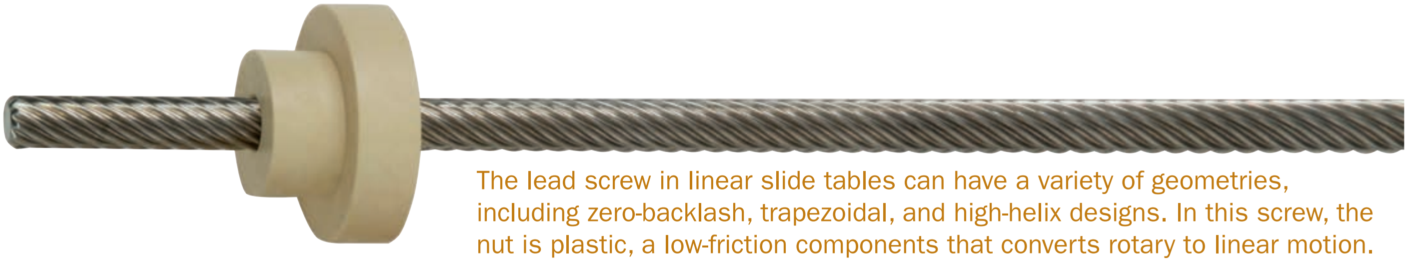


The lead screw in linear slide tables can have a variety of geometries, including zero-backlash, trapezoidal, and high-helix designs. In this screw, the nut is plastic, a low-friction components that converts rotary to linear motion.

particularly with high RPMs. Lead screw tables, it should be noted, may be prone to generating unwanted noise when mounted vertically in combination with motors in high speed, long stroke applications. Belt driven systems may be more optimal for these applications. Lead screw geometries, including ACME and trapezoidal, which have tighter pitches, are limited to speeds of about 3.28 ft (1m) per minute at maximum load, however high helix or speedy lead screws are available for high speed applications. Generally speaking, belt driven systems are better suited for higher speeds.

Lead screw sliding tables are best used to position hardware, such as sensors or for format adjustments for conveyer guides. For example, if a bottle-filling line handles several different sized bottles and uses machine vision to ensure bottles are properly filled, the camera could be mounted on a slide table that allows the camera to move up and down. Technicians could change the camera position to pre-set heights that correspond to the size of the bottles currently being filled. Position indicators or counters can be assembled to help the operator position the carriage in the correct position. Lead screw tables are not well suited to moving items quickly on a continuous basis.

Belt driven tables

Like lead screw tables, belt driven linear slide tables are based on a linear guide system with a moving carriage, as well as end blocks which enable customers to easily mount their equipment. Unlike lead screw driven tables, however, they are driven by a belt.

The timing belt is generally operated around a pulley mechanism that is guided by deep groove ball bearings. These ball bearings operate quietly and are generally sealed to retain any oil. The linear slides can be made of a wear resistant polymer material or possibly recirculating ball bearings. As long as the manufacturers catalog specifications are followed, stretching of the belt should not be a concern.

Unlike lead screw nuts, in which friction may cause heat buildup, there are no thermal issues with belts, so they are able to handle applications with high speeds and cycles.

Belt driven systems can be used in many applications, ranging from lab automation, vending machines and kiosks, film and studio equipment, and testing machines. They are also ideal for factory automation, since non-aggressive dust will not affect their environment. Belt drives are also optimal for vertical applications, where lead screws tend to resonate and have issues with noise.

Materials

There are several different materials that make up lead screw and belt driven systems. If you are looking at the bearing carriage assemble itself, it can either be single piece extruded aluminum, typically hard anodized or clear anodized for corrosion resistance. There are also several types of systems that might incorporate linear bearings made of plastic materials, which are housed by zinc carriages. Zinc carriages may not be suitable for all types of environments, and many suppliers offer aluminum and stainless steel options as well.

Lead screws in linear slides can be made of several materials. The most common material is mild steel. It works in most applications and it the most cost effective. Stainless steel screws resist corrosion and are specified for tables that will operate in chemically aggressive environments. Aluminum lead screws are sometimes chosen for their low weight. They are also used when magnetic interference in applications would be problematic. For example, a slide table used with an MRI machine would need to be nonmagnetic, thus using an aluminum screw.

Linear slide tables are often modular and come in a variety of configurations. For example, self-centering versions feature two tables that move on a lead screw that has left-handed threads on 1 end, and right-handed threads on the other. This lets the tables move together or apart in unison, both maintaining the same distance from the center of the device. Users can also combine slide tables, mounting one atop the table of another perpendicularly, to get x-y directions.

Belt driven systems typically use belts made of either polyethylene or neoprene, with added strength from steel belts or glass fibers. If used within the published specifications of the manufacturers catalog, any small amount of stretching should not affect the customer's application. Although ball bearings used in pulley systems are sealed, they can be also be made from stainless steel or plastic ball bearings for extreme applications, including underwater.

Bearings

In both belt driven and lead screw sliding devices, the linear bearing carriage, or table, is supported by one or two guide rails or shafts. Some companies use recirculating metal ball bearings in their tables. While these serve the purpose, they also increase the maintenance workload. Technicians may need to re-lubricate the ball bearings periodically to ensure proper performance and friction. If this does not occur, the shafting may become damaged and ultimately the bearings system may fail. This is particularly of concern in wash-down applications where lubricants are leeched from bearings during the caustic wash-down process. The oil is also a concern in dirty and dusty environments, as it may attract dirt and dust and lead to bearing failure. An alternative to metal ball bearings are wear resistant plastic linear bearing liners, which as stated before, may be placed in a variety of housing materials such as zinc, hard anodized aluminum, or stainless steel. Since there are no moving parts, they cannot damage the shafting and may also be used on softer, less expensive shafts or rails. There are no races, guideways, or individual ball bearings, which cuts down on complexity and the number of failure points. Because linear bearings use sliding rather than rolling motion, they cannot lead to galling or other damage to the rails, which helps reduce machinery downtime.

igus® for example, provides liners made of DryLin® (iglide® or J200), a proprietary thermoplastic with reinforcing compounds and dry lubricants. These run dry liners are pre-lubricated for life, and work well in most environments, even underwater.

The lack of lubricants makes these run dry liners an ideal component for sensitive lab and hospital environments. Lubricants can attract dirt and dust which interferes with tapered and ball bearings, changing their frictional characteristics. Linear bearings also have no problem working on dirty factory floors or in machine shops. If dust and dirt somehow get onto the liner material, it becomes imbedded in the material and does not significantly change friction.

Bearing liners from igus® have high wear resistance, which allows them to move at speeds up to 49.2 feet (15m) per second when used with hard anodized rails. The liner bearings withstand temperatures from –40° to 194°F (-40° to 90°C). igus® also has a high temperature bearing material, T500, that handles temperatures from –148° to 482°F (-100° to 250°C).

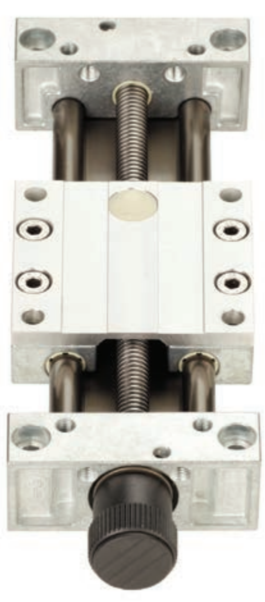
Engineers at igus® are constantly looking for new linear bearing materials, and carry out 5,000 tests on hundreds of materials each year, seeking plastics with even lower friction rates and lower wear resistance that currently exist.

Applications

To help engineers and designers looking for a linear slide table that meets their needs, companies have developed online configurators. These let designers plug in the parameters of their proposed application – payload size, weight, length of stroke, desired speed, and duty cycle – and the configurator suggests components and assemblies that should meet their needs. This gives designers the benefit of the manufacturer's experience in dealing with potential problems.

For example, the payload's center of gravity should be taken into consideration when sizing the linear table, specifically the distance between bearings on one rail. The accepted rule of thumb, known as the 2-to-1 rule, says that the distance between the load's center of gravity and the dive force should be no more than twice the distance between the bearings. If you ignore this rule, the table will likely chatter or bind as it moves. This is especially true of belt driven systems with their higher speeds and acceleration because the effect is the result of friction and inertia.

With so many types of linear slide tables available in such a wide variety of materials and designs, there are options for an endless array of practical applications. These one piece design solutions give engineers and designers the ability to more easily create and put into place the most effective solution best suited to their application.



Lead screw and belt-driven slide tables can use linear bearings that mount inside the table or platform and reduce friction when it moves along the guide rails. In these tables form igus, the bearings are made of DryLin, a wear-resistant, low friction tribopolymer.