Bearing Briefs

EDUCATION

Bearing Specific Topics

Bearing Industry Information

Understanding Linear Actuators

Linear motion systems consist of a mechanical drive, a linear bearing, and a structural support. When a new linear motion axis is required, a customer has two choices. They can create the design, purchase the components, and assemble the components into a linear motion system or they can purchase a device that already includes this functionality. This type of device is called an actuator. The advantages of purchasing an actuator include reducing the time to market, consolidating suppliers, and reducing risk. For many applications this also leads to a lower overall cost.

Actuators can be driven pneumatically, hydraulically, or electrically. This discussion will focus on those driven electrically. Electrically driven actuators come in a variety of designs. The primary differences are found in the support structure, the drive, and the linear bearing. These three items will ultimately define the performance of the actuator including the velocity, acceleration, load capacity, length, precision, accuracy, and reliability.

Support Structure

The support structure refers to the main base that houses and supports the other components and provides structural integrity for the application. The two most common types of support structure are machined base plates and extruded aluminum profiles. The machined base plates can be made of aluminum, steel, or cast iron. Machined base plates are used when flatness and straightness are critical in the application or when higher rigidity is needed. Applications include measurement systems and grinding or machining systems.

Figure 1: Extruded Aluminum Acutator

Extruded aluminum profiles are the most common and are more economical than machined bases. Many of the features such as mounting slots and sealing can be incorporated into the shape of the profile. Applications include material handling, pick and place, and general automation.

Drive Systems

The three most common types of drive systems are direct drive, belt drive, and screw drive. Direct drive systems or linear motor systems drive the load without a mechanical drive system. The motor coils are embedded in the linear carriage and magnets are arranged in a linear pattern so that when the current is alternated through the different motor coils it induces linear motion. The advantage of this design is better dynamic response and higher speeds. Through the use of a linear encoder they also exhibit good accuracy capabilities. Applications include machine tool systems and high speed positioning systems.

Belt drives use a timing belt and pulley system to position the load. Advantages include long travel lengths, high speeds, and low cost. Applications include material handing, palletizing, and pick and place systems.

Screw drives (See Fig 2) use a threaded screw and a nut to position the load. There are leadscrews which rely on a solid nut and ballscrews which use a recirculating ballnut.

Leadscrews are often used as a low cost alternative for applications that have a low duty cycle and load. Ballscrews are used for higher loads and continuous operation. Ballscrews are also much more efficient than leadscrews. Advantages of using screw drives are high thrust capacity, high accuracy, and high mechanical advantage. Applications include vertical lifts, part assembly, Cartesian robots, and general automation.

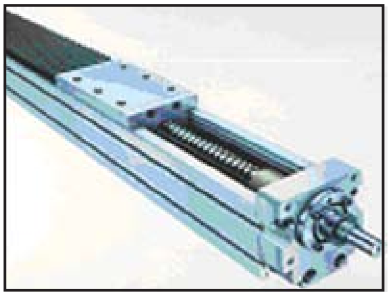

Figure 2: Screw driven Actuator

Linear Bearing Systems

The five most common types of linear bearing systems are plain bearings, track roller bearings, profiled rail bearings, ball bushings and non-recirculating ball or roller bearings

Bearing type	*Advantages*	*Applications*
Plain bearings	High resistance to contamination Low cost.	Automation systems with low duty cycles and low loads.
Track rollers	High speeds, low noise, medium cost Resistance to contamination Smooth motion.	Gantry robots, packaging mach Pick & place systems General material handling.
Profile rail linear	High accuracy, stiffness & load capacity Compact design.	Machine tool systems Cartesian robots, Transfer systems General automation.
Ball bushing	Low to medium cost Medium load capacity.	Pick & place systems (Fig. 4) Part assembly General automation.
Non-recirculating ball or roller bearings	Very high load capacity High accuracy, very smooth Low noise.	Precise positioning (Fig. 3) Part assembly Alignment & measuring system.

With demand for complete system solutions continuing to grow due to increased automation needs coupled with internal cost pressures and shorter lead-times, so will the demand for actuators continue to grow. Whether for simple material handling requirements or complex multi-axis Pick & Place applications (See Fig. 3 & 4), linear actuators continue to evolve into an ever broadening array of products to support the wide range of needs and devices.

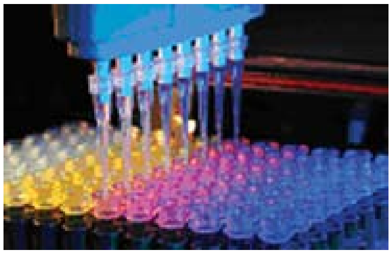

Figure 3: Positioning application

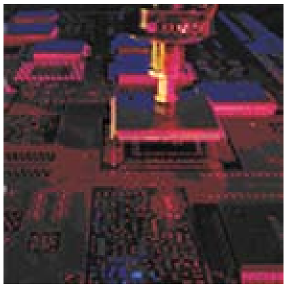

Figure 4: Pick & Place application

Quick Selection Guide	
Application	**Linear Actuator Type**
Slow movement of very heavy loads.	Hydraulic
Short stroke fast movement.	Pneumatic
Very accurate positioning.	Ball screw
Lower cost less accurate positioning.	Acme screw
Long travel with high speed.	Timing Belt
High speed very accurate repeatable positioning.	Linear motor
Short stroke, moderate to heavy load, repeatable positioning.	Rod-type cylinder
Very small movements, generally very light load.	Piezoelectric

Hydraulic	Payload: Pounds to tons. Stroke: Inches to 20 ft. Speed: Slow Accuracy: Poor Cost: High Disadvantage: Can be very messy	Timing Belt	Payload: Low to moderate. Stroke: 30 ft (10 meters). Speed: Fast. Accuracy: Low. Cost: Moderate. Disadvantage: Accuracy.
Pneumatic	Payload: Pounds Stroke: Less than 1 meter Speed: Fast Accuracy: Poor Cost: Low Disadvantage: Lack of accuracy	Linear Motor	Payload: Moderate Stroke: Unlimited Speed: High Accuracy: Very high Cost: High Disadvantage: Cost
Ball Screw	Payload: Light to heavy Stroke: 2 meters or less Speed: Moderate Accuracy: Very good Cost: High Disadvantage: Cost	Rod-type cylinder	Payload: Moderate to heavy. Stroke: Short to moderate. Speed: Slow. Accuracy: Good. Cost: Moderate. Disadvantage: Speed.
Acme Screw	Payload: Light to heavy Stroke: 2 meters or less Speed: Moderate Accuracy: Low Cost: Moderate Disadvantage: Wear	Piezoelectric	Payload: Light. Stroke: Short. Speed: High. Accuracy: Very high. Cost: Moderate. Disadvantage: Short Stroke

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