

PART 4
White Paper

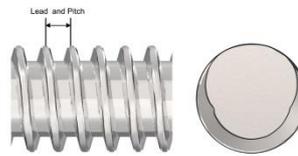
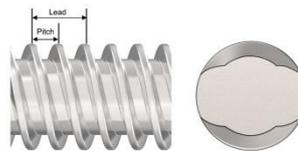
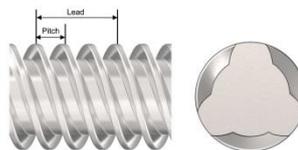
Load and Speed Characteristics of an Actuator

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Whether you are working on your company's next large project, or a DIY project at home, there are many factors to consider when choosing the correct electric linear actuator system for your application. By tailoring various combinations of spindle type, spindle specs, motor revolutions per minute (RPM), gear ratio, and the amount of power supplied to the actuator, TiMOTION is able to control the load and speed capabilities of the actuator. These characteristics are all dependent upon each other in order to operate a quality and durable linear actuator.

The **type of spindle** (or screw) is going to partly determine how fast the electric actuator moves, and also its load capability. TiMOTION produces electric actuators which feature one of two types of spindles, lead screws and ball screws. There are three thread types for a lead screw: a square thread, acme thread, and buttress thread. TiMOTION produces a lead screw with acme thread (to fit an acme nut). Acme threads have a high load capacity, but are not as fast as a ball screw due to increased friction caused between the nut and thread. However, the acme lead screw is a more economical, and highly reliable, solution which we are able to pass along to our customers. The majority of the electromechanical actuators that TiMOTION manufactures use the acme threaded lead screw as seen in our [TA1](#), [TA2](#), [TA4](#), [TA6](#) and many more models.

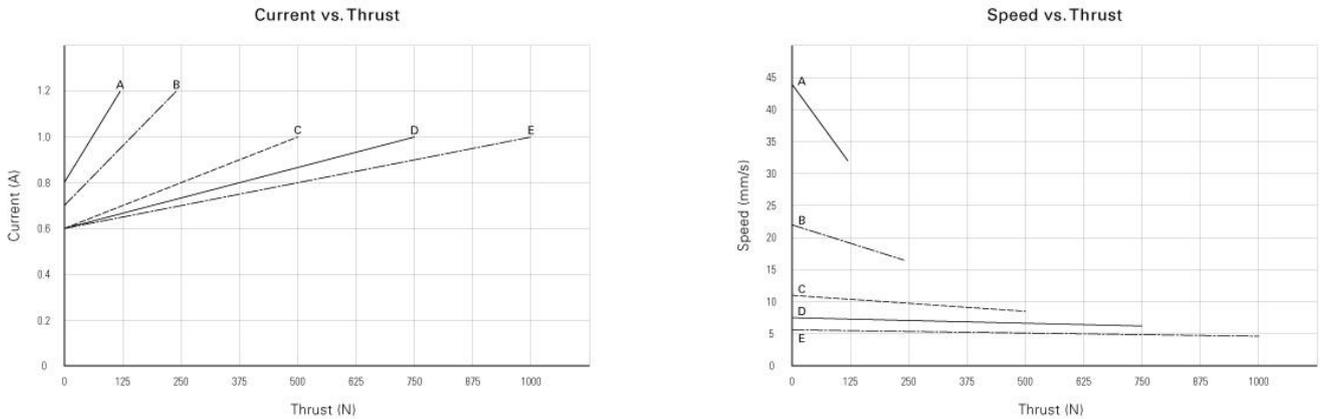
The other type of screw that TiMOTION utilizes within its electric linear actuators is the ball screw. The ball screw creates less friction than the acme screw because the threaded shaft provides a circular pathway for ball bearings (in a ball nut) which act in a more precise manner than the sliding friction caused on the acme nut. Because of this, the ball screw is more efficient and able to move at a higher speed. However, there is generally no self-locking force on a ball screw, so a brake mechanism can help with back drive and holding the load in place. The ball screw is an option used commonly in our [MA1](#) linear actuator model.

Single Start (Lead = Pitch)

Double Start (Lead = 2 x Pitch)

Three Start (Lead = 3 x Pitch)


The specifications on the spindle also have a large effect on how fast the actuator moves, but mostly how much load it is capable of holding. The specs on a spindle (or screw) include the pitch, lead, and number of starts. The pitch is the axial distance from a crest on a screw thread to the equivalent crest on an adjacent thread. The lead is the linear distance the screw travels in one complete turn (360 degrees) on the shaft. The start is the number of independent threads wrapped around the screw. What does all of this mean? The angle of the thread determines how fast the nut travels up and down the shaft. The steeper the angle, the faster it moves, and vice versa. The more starts there are on the spindle, the steeper the thread angle (as shown in the picture above). However, there is a trade-off between speed and self-locking ability. The faster the nut travels up and down the spindle, typically means that the self-locking force decreases (the natural ability to hold a load in place once the nut comes to a stop).

Another thing to take into consideration when controlling the speed and load of an actuator is adjusting the **RPM and gear ratio of the gear set**. The gear ratio is the ratio of number of revolutions per minute (RPM) of the driver vs. the revolutions per minute (RPM) of the driven gear. For example, if a driver spur gear has 12 teeth on it and the driven spur gear has 24 teeth on it, the driven spur gear is twice as big as the driver gear. Since the driver gear must turn two times for every one turn of the driven gear, it has a 2:1 gear ratio. There can also be additional gears added into the equation, depending on the trade-off between force and speed that is required, because force and speed are linked in an actuator by the formula "Mechanical Power = Force * Speed". So what does all of this mean? If the load required on a particular application is heavy, TiMOTION can add more gears and adjust the gear ratio to create more torque on the actuator which ultimately puts

more force on the spindle allowing it to travel.



When manipulating the load and speed of an actuator, one can also consider the **amount of mechanical power required** for the application (the power is measured in watts). The main idea to remember about current, speed and load in DC motors is that when the load increases, the current will increase and the speed will then tend to decrease (as shown in the charts above). Besides this main relationship, there are many other electro-mechanical parameters that influence load and speed like the kind of power supply used or the efficiency of the motor. The engineers of TiMOTION are in charge of selecting the right parameters in order to meet the application needs of our clients.

TiMOTION offers power supplies to support our 12V DC, 24V DC, or 36V DC linear actuators. Since most of TiMOTION's actuators run on direct current (DC) power, our control boxes can convert alternating current (AC) power to DC power so a customer's application can be plugged into the wall. TiMOTION can integrate SMPS transformers (switch mode power supply) and toroidal transformers into the control boxes. SMPS transformers support 110V AC and 220V AC inputs, allowing our customer's products to be plugged into different outlets around the world.

Below are three charts to help with term usage and conversions. The first is common voltage expressions that can be used interchangeably, the second is the conversion of Newton (N) to Pounds (Lbs.) and kilograms (kg), and the last is the conversion of Millimeters (mm) to Inches (In):

Voltage Expressions

12 Volts DC	12V DC	12 VDC
24 Volts DC	24V DC	24 VDC
36 Volts DC	36V DC	36 VDC
48 Volts DC	48V DC	48 VDC
110 Volts AC	110V AC	110 VAC
220 Volts AC	220V AC	220 VAC

Weight Conversion (N to lbs. and kgs)

1 Newton (N)	.22481 Pound (lbs)
1 Newton (N)	.1 kilogram (kg)

Distance (mm to in.)

1 Millimeter (mm)	.03937 Inch (in)
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We hope that this has helped you develop a better understanding and foundation for electric linear actuators. Next week, we will look at the levels of IP ratings for liquid and dust protection that can be added to an electric actuator as well as lubrication that goes into a linear actuator. If you have further questions and/or would like help with your next application, TiMOTION would be glad to assist you. We specialize in partnering with our clients while providing quality solutions for their linear motion system needs.