Glossary

Absolute Move: A move referenced from a fixed zero position.
Acceleration: Change in velocity as a function of time, going from slower to faster.
Accuracy: Difference between expected position and achieved position.
Back EMF: The peak phase-to-phase voltage generated when the motor is traveling at a velocity of 1m/s.
Backlash: The non-responsive lost motion between a drive screw and its nut that occurs at the point of change in rotation direction.
Brushless Servomotor: A class of servomotors, which operates using electronic commutation of phase currents rather than electromechanical (brushes) commutation.
Cantilevered Load: A load that has its center of mass offset from the balance point of a bearing system.
Closed Loop: Implementing feedback to regulated position and/or velocity with respect to commanded.
Cogging: A term used to describe non-uniform angular velocity. Cogging appears as jerkiness, especially at low speeds. Changes in force at low velocity, caused by magnetic “detenting” forces created by relative motion between a motor's permanent magnets and its ferrous core coil windings.
Commutation: The switching sequence of drive voltage into motor phase windings necessary to ensure continuous motor movement. A brushed motor relies upon brush/bar contact to switch the windings mechanically. A brushless Linear Motor requires a device that senses forcer position information relative to the shaft, and then feeds that data to a drive, which determines the next switching sequence.
Commutation, Sinusoidal : The three phase currents applied to a motor closely follow the sine wave shape of the motor's natural back emf waves, thereby providing the lowest velocity ripple and the smoothest possible motion. This is a very important factor for scanning applications. Sinusoidal commutation is electronically generated at the servo controller.
Commutation, Trapezoidal: The three phase currents applied to a motor resemble a trapezoidal profile. Slight force ripple is present due
to the mismatch between the three phase trapezoidal shape and the motor's back emf sinewave profile. Trapezoidal commutation is typically generated by Hall effect sensors secured near the motor's moving coils. Trapezoidal commutation is suitable for most high-speed motion applications.
Continuous Current: The current required to heat the motor phases to their maximum operating temperature when the ambient temperature is 25°C, the motor is not moving, and there is no cooling.
Continuous Force: Continuous force is the force produced when the continuous current is applied to the motor. It is the product of Force constant X Continuous current. The motor is not moving and there is no cooling.
Continuous Working Voltage: The maximum allowable continuous voltage between any two phases or between any phase and the motor safety earth.
Counts per Meter: Counts per Meter is equal to1 divided by resolution on encoder.
Coefficient of Kinetic Friction (**µk**): It is the proportional value of the force required to maintain motion to the normal force of the mass being moved.
Coefficient of Static Friction (**µs**): It is the proportional value of the force required to overcome static friction, to the normal force of the mass to be moved.
Cosine Error: Results from a parallel misalignment between a linear bearing system and the linear feedback element.
Current: The value of current when two motor phases are joined, and a current is passed between those two phases and the third. Example, a current of 1 ampere means that 1 ampere will be flowing in one phase and 0.5 ampere in each of the other two phases.

Current/Torque Amplifiers: Current/Torque amplifiers produce a force proportional to the command signal. The speed with which the motor will move is therefore controlled entirely by the external servo controller. The most common type of programmable digital servo controller used with current amplifiers employs a PIDF algorithm to control the position of the motor.
Deceleration: Change in velocity as a function of time, going from faster to slower.
Duty Cycle, **Motion**: The percentage of the time in motion to the total time (motion time ÷ total time) x 100%.
Duty Motor Power: The percentage of the application process power to a motor's continuous power limits [(IRMS ÷ ICont)2 x 100%]. This value should not exceed 100% for a prolonged period of time.
Electrical Time Constant: The time taken for a step current input to the motor to reach 63.2% of its value.
Encoder: A position-sensing device that translates mechanical motion into electronic signals used for monitoring
position or velocity.

Flatness

The deviation from the theoretically perfect line of travel, and is measured as displacement in the vertical plane. Note that the frame or mounting surface to which the module or gantry system is fixed will affect the flatness of the system.

Friction

Resistance to motion of two surfaces that touch.

Force Constant

Force constant is the k force produced when 1 ampere flows into one phase and 0.5 ampere flows out of the remaining two phases

Forcer

The coil assembly of the Linear Shaft Motor. It is typically available in one of five configurations: D, two sets Of windings; T, three sets of windings; Q, four sets of windings; H, six sets of windings, S, one sets of windings, or X, eight sets of windings.

Hall Sensors

A feedback device, which is used in some brushless servo systems to provide information for the amplifier to electronically commutate the motor. In a Linear Shaft Motor, the hall sensors sense the position of the forcer and send a signal to the driver to switch on the next sequential winding (the process of commutation) in the Forcer, which causes linear movement.

Hysteresis

The non-responsive lost motion which may occur at the point of change in direction. The composite error results from many contributing factors (backlash, elasticity of structure, etc.).

Incremental Move

A move referenced from the current position.

Inductance

The property of an electric circuit by which an electromotive force is induced in it as the result of a changing magnetic flux. This electrical characteristic is an indicator of how fast the current can rise and fall when voltage is applied to the windings.

Inertia

The property of an element's mass and shape that resists changes in velocity when exposed to an outside force. The larger an object's mass, the greater its inertia and the greater the magnitude of force required to accelerate it at a given rate.

Intelligent Amplifiers

Servo amplifiers do not require external control signals in order to position the motor. Depending on the unit, they can perform very simple point to point moves up to very sophisticated moves with external synchronization and I/O handling. Generally, they can operate in either position/velocity, or force control modes.

Limits or Limit Switches

Properly designed motion control systems have sensors called limits, or limit switches, which alert the control electronics that the physical end of travel is being approached and that motion should stop. These are safety devices at each end of the movement to prevent damage due to over travel of the forcer.

Linear Bearing
A support device that allows a smooth, low friction motion between two surfaces loaded against each other.

Magnetic Pitch (**Pole Pitch**)
The distance in millimeters for one complete electrical cycle (between like magnetic poles). Example: North
to North.

Maximum Phase Temperature
The maximum operating temperature for the motor phases. It is limited to provide a safe operating temperature for the coil.

Open Loop
A motion system which does not utilize a feedback element.

Orthogonality
The degree to which stages are aligned with their motion at right angles to one another. Motion of an X-Y system is typically 90° apart in a single plane. X-Y-Z systems are all mutually at a 90° relationship in a 3D space. The specification is typically the angle measured between the best-fit-straight-line of X-axis motion and the best-fit-straight-line of Y-axis motion.

Parallelism
The deviation between the perpendicular distance between axes (with one being the reference axis).

Peak Current
The current that can be applied for short periods of time for accelerating or decelerating. The peak current can be safely applied the Linear Motor for a maximum of 40 seconds, before the motor phases reach their maximum operating temperature when the ambient temperature is 25°C, the motor is not moving, there is no and no additional heat sinking.

Peak Force
The force produced when the peak current is applied to the Linear Shaft Motor. It is the product of Force
constant X Peak current. The motor is not moving, there is no cooling and no additional heat sinking.

Pole Pitch
See Magnetic Pitch.

Pulses per Meter
Pulses per Meter is equal to 1 divided by resolution on encoder divided by 4.

Repeatability, **Bi-directional**
The error from nominal when repeatedly approaching a position from opposite directions.

Repeatability, **Uni-directional**
The error from nominal when repeatedly approaching a position from the same direction.

Resistance
The opposition to the flow of charge through a conductor.

Resonance
Oscillatory behavior in a mechanical body when subjected to a periodic force occurring at its natural frequency.

Resolution, **Electrical**
The smallest increment that can be commanded by a servo system. The value results from the feedback's precision (encoder, laser, etc.) and the controller's logic multiplication factor.

Resolution, **Mechanical**
The smallest increment that can be controlled by a motion system. The value is affected by friction,

static friction, driving mechanism precision, etc.

Scale Error

Errors associated with the precision of the feedback elements.

Settling Time

The time it takes after a move completes to settle to within a specified tolerance band (i.e.: to within ± 1µm).

Servo Driver

A three phase brushless DC servomotor driver used to drive and control the position of a servo motor. It is comprised of a servo controller and amplifier combination. There are many different makes and models of amplifiers available, but they tend to fall into one of three possible categories:

1. Intelligent amplifiers that have built in servo controllers
2. Velocity amplifiers capable of controlling only the velocity of the motor
3. Current/Torque amplifiers that control only the force of a linear motor (torque in a rotary motor)

Shaft

The magnetic assembly of the Linear Motor. It is typically is a stainless steel shaft and not designed to be load bearing.

Straightness

The deviation from the theoretical perfect line of travel, and is measured as displacement in the horizontal plane.

Stiction

Frictional resistance to initial motion.

Thermal Resistance

The equivalent thermal resistance of the motor, determined by the ratio of coil temperature rise to the total power motor losses in the three phases.

Velocity

A change in position as a function of time (speed).

Velocity amplifiers

Servo amplifiers are used to move the motor at a velocity determined by an analog command. The unit requires an external servo controller to determine the move profiles. In addition, some are available where the command can be input to the drive through a serial link. Units of this nature can sometimes be given a position set point that can be used to move the motor to a defined position. The motor will move towards the required position at a predefined velocity and acceleration. Encoder feedback is required to calculate the motor’s velocity. The advantages of using such a system is that the processing by the main controller is reduced, and the update time within the amp for the velocity loop can usually be much higher than the servo Controller.

Weight

The force of gravity acting on a body. Weight equals mass x acceleration due to gravity.

Working Envelope

The effective area available for the system to operate, without interfering with other parts of the system.

Yaw

Angular motion of a linear stage, about an axis which is between to the bearing system and which is at right angles to the direction of travel.