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 the expected position and the achieved position.
Back EMF: The peak phase-to-phase voltage generated when the motor is traveling at a velocity of 1 m/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 that operates using electronic commutation of phase currents rather than electromechanical (brushes) commutation.
Cantilevered Load: A load whose center of mass is offset from the balance point of a bearing system.
Closed Loop: A control scheme that uses feedback to regulate position and/or velocity relative to the commanded (reference) value.
Cogging: A term used to describe non-uniform angular velocity. Cogging appears as jerkiness, especially at low speeds, caused by changes in force at low velocity due to 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 the motor phase windings, necessary to ensure continuous motor movement. A brushed motor relies on brush/bar contact to switch the windings mechanically. A brushless linear motor requires a device that senses forcer position relative to the shaft and 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, thereby providing the lowest velocity ripple and the smoothest possible motion. This is a very important factor for scanning applications. Sinusoidal commutation is generated electronically 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 sine-wave profile. Trapezoidal commutation is typically generated by Hall effect sensors secured near the motor's moving coils. It 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: The force produced when the continuous current is applied to the motor. It is the product of the force constant and the 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: Equal to 1 divided by the encoder resolution.
Coefficient of Kinetic Friction (µk): The proportional value of the force required to maintain motion relative to the normal force of the mass being moved.
Coefficient of Static Friction (µs): The proportional value of the force required to overcome static friction, relative 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 motors phases are joined and a current is passed between those two phases and the third. For example, a current of 1 ampere means that 1 ampere will flow in one phase and 0.5 ampere in each of the other two phases.

Current/Torque Amplifiers: Amplifiers that produce a force proportional to the command signal. The speed at which the motor moves 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 relative to the total time: (motion time ÷ total time) × 100%.
Duty Motor Power: The ratio of the application process power to the motor's continuous power limit, expressed as [(IRMS ÷ ICont)² × 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, 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 between two surfaces that touch.
Force Constant: The 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 set of windings), or X (eight sets of windings).
Hall Sensors: A feedback device 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), which causes linear movement.
Hysteresis: The non-responsive lost motion that 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 a result of a changing magnetic flux. This electrical characteristic indicates 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 that 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 overtravel of the forcer.
Linear Bearing: A support device that allows 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 that 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 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 distances between axes (with one axis 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 to 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, and there is no cooling 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 the force constant and the peak current. The motor is not moving, there is no cooling, and there is no additional heat sinking.
Pole Pitch: See Magnetic Pitch.
Pulses per Meter: Equal to 1 divided by the encoder resolution, divided by 4.
Repeatability, Bidirectional: The error from nominal when repeatedly approaching a position from opposite directions.
Repeatability, Unidirectional: 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, stiction, drive-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 within a specified tolerance band (for example, within ±1 µm).
Servo Driver: A three phase brushless DC servomotor driver used to drive and control the position of a servo motor. It consists of a servo controller and an amplifier combination. Many different makes and models of amplifiers are available, but they tend to fall into one of three 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 a stainless steel shaft and is not designed to be load-bearing.
Straightness: The deviation from the theoretical perfect line of travel, 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 losses in the three phases.
Velocity: A change in position as a function of time (speed).
Velocity Amplifiers: Servo amplifiers 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 models allow the command to be input to the drive through a serial link. Units of this nature can sometimes be given a position setpoint 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 are that

the processing by the main controller is reduced, and the update time within the amplifier for the velocity loop can usually be much higher than that of the servo controller.
Weight: The force of gravity acting on a body. Weight equals mass × 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 that is between the bearing system and at right angles to the direction of travel.

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