

Glossary of Terms

Absolute Positioning

Refers to a motion control system employing position feedback devices (absolute encoders) to maintain a given mechanical location.

Absolute Programming

A positioning coordinate referenced wherein all positions are specified relative to some reference, or "zero" position. This is different from incremental programming, where distances are specified relative to the current position.

AC Servo

A general term referring to a motor drive that generates sinusoidal shaped motor currents in a brushless motor wound as to generate sinusoidal back EMF.

Acceleration

The change in velocity as a function of time. Acceleration usually refers to increasing velocity and deceleration describes decreasing velocity.

Accuracy

A measure of the difference between expected position and actual position of a motor or mechanical system. Motor accuracy is usually specified as an angle representing the maximum deviation from expected position.

Ambient Temperature

The temperature of the cooling medium, usually air, immediately surrounding the motor or another device.

ASCII

American Standard Code for Information Interchange. This code assigns a number series of electrical signals to each numeral and letter of the alphabet. In this manner, information can be transmitted between machines as a series of binary numbers.

Bandwidth

A measure of system response. It is the frequency range that a control system can follow.

BCD

Binary Coded Decimal is an encoding technique used to describe the numbers 0 through 9 with four digital (on or off) signal lines. Popular in machine tool equipment, BCD interfaces are now giving way to interfaces requiring fewer wires – such as RS-232C.

Bit

Abbreviation of Binary Digit, the smallest unit of memory equal to 1 or 0.

Back EMF

The voltage produced across a winding of a motor due to the winding turns being cut by a magnetic field while the motor is operating. This voltage is directly proportional to rotor velocity and is opposite in polarity to the applied voltage. Sometimes referred to as *counter EMF*.

Block Diagram

A simplified schematic representing components and signal flow through a system.

Bode Plot

A graph of system gain and phase versus input frequency which graphically illustrates the steady state characteristics of the system.

Break Frequency

Frequency(ies) at which the gain changes slope on a Bode plot (break frequencies correspond to the poles and zeroes of the system).

Brushless DC Servo

A general term referring to a motor drive that generates trapezoidal shaped motor currents in a motor wound as to generate trapezoidal Back EMF.

Byte

A group of 8 bits treated as a whole, with 256 possible combinations of one's and zero's, each combination representing a unique piece of information.

Commutation

The switching sequence of drive voltage into motor phase windings necessary to assure continuous motor rotation. A brushed motor relies upon brush/bar contact to mechanically switch the windings. A brushless motor requires a device that senses rotor rotational position, feeds that information to a drive that determines the next switching sequence.

Closed Loop

A broadly applied term relating to any system where the output is measured and compared to the input. The output is then adjusted to reach the desired condition. In motion control, the term describes a system wherein a velocity or position (or both) transducer is used to generate correction signals by comparison to desired parameters.

Critical Damping

A system is critically damped when the response to a step change in desired velocity or position is achieved in the minimum possible time with little or no overshoot.

Crossover Frequency

The frequency at which the gain intercepts the 0 dB point on a Bode plot (used in reference to the open-loop gain plot).

Daisy-Chain

A term used to describe the linking of several RS-232C devices in sequence such that a single data stream flows through one device and on to the next. Daisy-chained devices usually are distinguished by device addresses, which serve to indicate the desired destination for data in the stream.

Damping

An indication of the rate of decay of a signal to its steady state value. Related to settling time.

Damping Ratio

Ratio of actual damping to critical damping. Less than one is an underdamped system and greater than one is an overdamped system.

Dead Band

A range of input signals for which there is no system response.

Decibel

A logarithmic measurement of gain. If G is a system's gain (ratio of output to input), then $20 \log G = \text{gain in decibels (dB)}$.

Detent Torque

The minimal torque present in an unenergized motor. The detent torque of a step motor is typically about 1% of its static energized torque.

Direct Drive Servo

A high-torque, low-speed servo motor with a high resolution encoder or resolver intended for direct connection to the load without going through a gearbox.

Duty Cycle

For a repetitive cycle, the ratio of on time to total cycle time.

$$\text{Duty cycle} = \frac{\text{On Time}}{(\text{On Time} + \text{Off Time})}$$

Efficiency

The ratio of power output to power input.

Electrical Time Constant

The ratio of armature inductance to armature resistance.

Encoder

A device that translates mechanical motion into electronic signals used for monitoring position or velocity.

Form Factor

The ratio of the RMS value of a harmonic signal to its average value in one half-wave.

Friction

A resistance to motion. Friction can be constant with varying speed (Coulomb friction) or proportional to speed (viscous friction).

Gain

The ratio of system output signal to system input signal.

Holding Torque

Sometimes called static torque, it specifies the maximum external force or torque that can be applied to a stopped, energized motor without causing the rotor to rotate continuously.

Home

A reference position in a motion control system derived from a mechanical datum or switch. Often designated as the “zero” position.

Hybrid Servo

A brushless servo motor based on a conventional hybrid stepper. It may use either a resolver or encoder for commutation feedback.

Hysteresis

The difference in response of a system to an increasing or a decreasing input signal.

IEEE-488

A digital data communications standard popular in instrumentation electronics. This parallel interface is also known as GPIB, or General Purpose Interface Bus.

Incremental Motion

A motion control term that describes a device that produces one step of motion for each step command (usually a pulse) received.

Incremental Programming

A coordinate system where positions or distances are specified relative to the current position.

Inertia

A measure of an object’s resistance to a change in velocity. The larger an object’s inertia, the larger the torque that is required to accelerate or decelerate it. Inertia is a function of an object’s mass and its shape.

Inertial Match

For most efficient operation, the system coupling ratio should be selected so that the reflected inertia of the load is equal to the rotor inertia of the motor.

Indexer

See PMC.

I/O

Abbreviation of input/output. Refers to input signals from switches or sensors and output signals to relays, solenoids etc.

Lead Compensation Algorithm

A mathematical equation implemented by a computer to decrease the delay between the input and output of a system.

Limits

Properly designed motion control systems have sensors called limits that alert the control electronics that the physical end of travel is being approached and that motion should stop.

Logic Ground

An electrical potential to which all control signals in a particular system are referenced.

Mechanical Time Constant

The time for an energized DC motor to reach 2/3rds of its set velocity. Based on a fixed voltage applied to the windings.

Mid-range Instability

Designates the condition resulting from energizing a motor at a multiple of its natural frequency (usually the third orders condition). Torque loss and oscillation can occur in underdamped open-loop systems.

Microstepping

An electronic control technique that proportions the current in a step motor’s windings to provide additional intermediate positions between poles. Produces smooth rotation over a wide speed range and high positional resolution.

Open Collector

A term used to describe a signal output that is performed with a transistor. An open collector output acts like a switch closure with one end of the switch at ground potential and the other end of the switch accessible.

Open Loop

Refers to a motion control system where no external sensors are used to provide position or velocity correction signals.

Opto-isolated

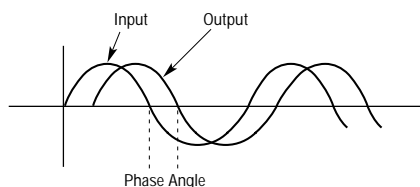
A method of sending a signal from one piece of equipment to another without the usual requirement of common ground potentials. The signal is transmitted optically with a light source (usually a Light Emitting Diode) and a light sensor (usually a photosensitive transistor). These optical components provide electrical isolation.

Parallel

Refers to a data communication format wherein many signal lines are used to communicate more than one piece of data at the same time.

Phase Angle

The angle at which the steady state input signal to a system leads the output signal.



Phase Margin

The difference between 180° and the phase angle of a system at its crossover frequency.

PLC

Programmable logic controller; a machine controller that activates relays and other I/O units from a stored program. Additional modules support motion control and other functions.

PMC

Programmable motion controller, primarily designed for single- or multi-axis motion control with I/O as an auxiliary function.

Pole

A frequency at which the transfer function of a system goes to infinity.

Pulse Rate

The frequency of the step pulses applied to a motor driver. The pulse rate multiplied by the resolution of the motor/drive combination (in steps per revolution) yields the rotational speed in revolutions per second.

PWM

Pulse Width Modulation. A method of controlling the average current in a motors phase windings by varying the on-time (duty cycle) of transistor switches.

Ramping

The acceleration and deceleration of a motor. May also refer to the change in frequency of the applied step pulse train.

Rated Torque

The torque producing capacity of a motor at a given speed. This is the maximum torque the motor can deliver to a load and is usually specified with a torque/speed curve.

Regeneration

Usually refers to a circuit in a drive amplifier that accepts and drains energy produced by a rotating motor either during deceleration or free-wheel shutdown.

Registration Move

Changing the predefined move profile that is being executed, to a different predefined move profile following receipt of an input or interrupt.

Repeatability

The degree to which the positioning accuracy for a given move performed repetitively can be duplicated.

Resolution

The smallest positioning increment that can be achieved. Frequently defined as the number of steps required for a motor’s shaft to rotate one complete revolution.

Resolver

A feedback device with a construction similar to a motor’s construction (stator and rotor). Provides velocity and position information to a drive’s microprocessor or DSP to electronically commutate the motor.

Resonance

Designates the condition resulting from energizing a motor at a frequency at or close to the motor's natural frequency. Lower resolution, open-loop systems will exhibit large oscillations from minimal input.

Ringing

Oscillation of a system following a sudden change in state.

RMS Torque

For an intermittent duty cycle application, the RMS Torque is equal to the steady- state torque that would produce the same amount of motor heating over long periods of time.

$$T_{\text{RMS}} = \sqrt{\frac{\sum (T_i^2 t_i)}{\sum t_i}}$$

Where: T_i = Torque during interval i
 t_i = Time of interval i

RS-232C

A data communications standard that encodes a string of information on a single line in a time sequential format. The standard specifies the proper voltage and time requirements so that different manufacturers devices are compatible.

Servo

A system consisting of several devices which continuously monitor actual information (position, velocity), compares those values to desired outcome and makes necessary corrections to minimize that difference.

Slew

In motion control, the portion of a move made at a constant non-zero velocity.

Static Torque

The maximum torque available at zero speed.

Step Angle

The angle the shaft rotates upon receipt of a single step command.

Stiffness

The ability to resist movement induced by an applied torque. Is often specified as a torque displacement curve, indicating the amount a motor shaft will rotate upon application of a known external force when stopped.

Synchronism

A motor rotating at a speed correctly corresponding to the applied step pulse frequency is said to be in synchronism. Load torques in excess of the motor's capacity (rated torque) will cause a loss of synchronism. The condition is not damaging to a step motor.

Torque

Force tending to produce rotation.

Torque Constant

K_T = The torque generated in a DC motor per unit Ampere applied to its windings.

$$K_T = \frac{\text{oz-in}}{\text{A amp}}$$

Simplified for a brushless motor at 90° commutation angle.

Torque Ripple

The cyclical variation of generated torque at a frequency given by the product of motor angular velocity and number of commutator segments or magnetic poles.

Torque-to-Inertia Ratio

Defined as a motor's holding torque divided by the inertia of its rotor. The higher the ratio, the higher a motor's maximum acceleration capability will be.

Transfer Function

A mathematical means of expressing the output to input relationship of a system. Expressed as a function of frequency.

Triggers

Inputs on a controller that initiate or "trigger" the next step in a program.

TTL

Transistor-Transistor Logic. Describes a common digital logic device family that is used in most modern digital electronics. TTL signals have two distinct states that are described with a voltage – a logical "zero" or "low" is represented by a voltage of less than 0.8 volts and a logical "one" or "high" is represented by a voltage from 2.5 to 5 volts.

Voltage Constant

K_E = The back EMF generated by a DC motor at a defined speed. Usually quoted in volts per 1000 rpm.

Zero

A frequency at which the transfer function of a system goes to zero.