

Appendices

Command Listing

#	Single Step	IN	Set Input Functions
A	Acceleration	INL	Set Active Input Level
B	Buffer Status Report	IO	Immediate Output
BCDB	Buffered Configure Dead Band	IS	Input Status Report
BCDG	Buffered Configure Differential Gain	JA	Jog Acceleration
BCDM	Buffered Configure Differential Maximum	JVL	Jog Velocity (Low)
BCIG	Buffered Configure Integral Gain	JVH	Jog Velocity (High)
BCIL	Buffered Configure Maximum Integral Sum Limit	K	Kill
BCIM	Buffered Configure Integral Maximum	L	Loop
BCPE	Buffered Configure Position Error	LA	Limit Acceleration
BCPG	Buffered Configure Proportional Gain	LD	Limit Disable
BCPM	Buffered Configure Proportional Maximum	LED	Illuminate Number on LED Display
BS	Buffer Status Report	LF	Line Feed
C	Continue	LRD	Read Loop Count via Parallel Input/Output
CDB	Configure Dead Band	MC	Mode Continuous
CDG	Configure Differential Gain	MN	Mode Normal
CDM	Configure Differential Maximum	MPA	Mode Position Absolute
CFB	Configure Feedback Device	MPI	Mode Position Incremental
CIG	Configure Integral Gain	N	End of Loop
CIL	Configure Integral Maximum Sum Limit	NIF	End of IF Commands
CIM	Configure Integral Maximum	O	Output
CMR	Configure Motion Resolution	OFF	Off
COCH	Configure Output as Current Source (High)	ON	On
COCL	Configure Output as Current Source (Low)	OS	Function Setup Report
COP	Configure Output Peak	OSB	Back up to Home Switch
COV	Configure Output as Voltage Source	OSC	Define Active State of Home Switch
CMR	Configure Motion Resolution	OSD	Enable Encoder Z Channel Input
CPB	Configure Push Button	OSE	Jog Enable
CPE	Configure Position Error	OSG	Final Homing Direction
CPG	Configure Proportional Gain	OSH	Reference Edge of Home Switch
CPM	Configure Proportional Maximum	OUT	Set Output Functions
CR	Carriage Return	OUTL	Set Active Output Level
D	Distance	OUTP	Output on Position
DAI	Display Analog Input	PR	Absolute Position Report
DCC	Display Current Control Configuration	PS	Pause
DFS	Display Flags for Servo Status	PZ	Set Absolute Counter to Zero
DFX	Display Flags for Indexer Status	"	Quote
DMO	Display Maximum Overshoot	Q0	Exit Velocity Profiling Mode
DOI	Display Output Instantaneous	Q1	Enter Velocity Profiling Mode
DPA	Display Position Actual	R	Indexer Status Report
DPE	Display Position Error	RA	Limit Switch Status Report
DPS	Display Setpoint Position	RB	Loop, Pause, Shutdown, Trigger Status Report
DRD	Read Distance via Parallel Input/Output	RFS	Return Drive Parameters to Factory Setting
DTP	Display Tuning Parameters	RG	Go Home Status Report
DVA	Display Velocity Actual	R1FS	Return Indexer to Factory Settings
DVS	Display Velocity Setpoint	RM	Rate Multiplier in Velocity Streaming Mode
E	Enable RS-232C Communication Interface	RS	Sequence Execution Report
F	Disable RS-232C Communication Interface	RSE	Report Servo Errors
G	Go	RV	Revision Level Report
GH	Go Home	S	Stop
GHA	Go Home Acceleration	SFL	Set User Flag
GHF	Go Home Final Velocity	SL	Software Limits
GHV	Go Home Velocity	SLD	Software Limit Disable
^H	Backspace	SN	Scan Delay Time
H	Set Direction	SP	Set Position Absolute
IFER	Compare Error Flag	SS	Function Setup Report
IFFL	Compare User Flag	SSA	RS-232C Echo Control
IFIN	Compare Input Status		

SSG	Clear/Save the Command Buffer on Limit
SSH	Clear/Save the Command Buffer on Stop
SSI	Enable/Disable Interactive Mode
SSJ	Enable/Disable Continuous Scan Mode
SSL	Enable/Disable Resume Execution
ST	Shutdown
STR	Set Strobe Output Delay Time
SV	Save Tuning Parameters
T	Time
TR	Wait for Trigger
TS	Trigger Input Status
U	Pause and Wait for Continue
V	Velocity
VRD	Read Velocity from Parallel Input/Output
W1	Signed Binary Position Report
W2	Hexadecimal Position Report
W3	Signed (+ or -) Position Report
XBS	Report Sequence Memory Available
XC	Sequence Checksum Report
XD	Sequence Definition
XDIR	Sequence Directory
XE	Sequence Erase
XFK	Set Fault or Kill Sequence
XG	Goto Sequence
XQ	Sequence Interrupted Run Mode
XR	Run Sequence
XRD	Read Sequence via Parallel Input/Output
XRP	Sequence Run with Pause
XSD	Sequence Status Definition Report
XSR	Sequence Status Run Report
XSS	Sequence Status Report
XST	Single Step Mode
XT	Sequence Termination
XTR	Set Trace Mode
XU	Upload Sequence
Y	Stop Loop
Z	Reset

Glossary

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 reference wherein all positions are specified relative to some reference, or *home* position. This is different from incremental programming, where distances are specified relative to the current position.

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.

Address

Multiple devices, each with a separate address or unit number, can be controlled on the same bus. The address allows the host to communicate individually to each device.

ASCII

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

Bandwidth

The frequency range in which the magnitude of the system gain expressed in dB is greater than -3 dB.

Baud Rate

The number of bits transmitted per second. Typical rates include 300, 600, 1200, 2400, 4800, 9600, 19,200. This means at 9,600 baud, one character can be sent nearly every millisecond.

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.

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.)

Byte

A group of 8 bits treated as a whole, with 256 possible combinations of ones and zeros, each combination representing a unique piece of information.

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 is used to describe a system wherein a velocity or position (or both) transducer is used to generate correction signals by comparison to desired parameters.

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.)

DAC

Digital-to-analog converter

Delay-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.

Data Bits

Since the ASCII character set consists of 128 characters, computers may transmit only seven bits of data. However, most computers support an eight bit extended ASCII character set.

DCE

Data Communications Equipment transmits on pin three and receives on pin two.

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 gain (ratio of output to input), then $20 \log G$ equals gain in decibels (dB).

Delimiter

A character (space or carriage return) used to separate fields in a command.

Drive

This is the electronics portion of the motion control system that controls power to the motor.

DTE

Data Communications Equipment transmits on pin two and receives on pin three.

Duty Cycle

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

Duty Cycle = $\frac{\text{On Time}}{\text{On Time} + \text{Off Time}}$

Efficiency

The ratio of power output to power input.

Encoder

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

Following

The ability to make one axis perform motion based on the motion of a second, or *master*, axis.

Friction

A resistance to motion caused by surfaces rubbing together. Friction can be constant with varying speed (Coulomb friction) or proportional to speed (viscous friction).

Full-Duplex

The terminal will display only received or echoed characters.

Gain

The ratio of system output signal to system input signal.

Half-Duplex

In half duplex mode, a terminal will display every character transmitted. It may also display the received character.

Hand Shaking Signals

RST: Request To Send
CTS: Clear To Send
DSR: Data Set Ready
DTR: Data Terminal Ready
IDB: Input Data Buffer
ODB: Output Data Buffer

Home

A reference position in a motion control system, usually derived from a mechanical datum. Often designated as the *zero* position.

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 is used to describe a device that produces one step of motion for each step command (usually a pulse) received.

Incremental Programming

A coordinated system where position 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.

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.

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.

Null Modem

A simple device or set of connectors which switches the receive and transmit lines of a three wire RS-232C connector.

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.

Parity

RS-232C error detection scheme that can detect an odd number of transmission errors.

PID Tuning

Refers to proportional, integral, and derivative gain tuning.

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.

Quadrature

A type of incremental encoder output in which the two square wave outputs are offset by 90°.

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.

Relative Accuracy

Also referred to as *Step-to-Step Accuracy*, this specification tells how microsteps can change in size. In a perfect system, microsteps would all be exactly the same size, but drive characteristics and the absolute accuracy of the motor cause the steps to expand and contract by an amount up to the relative accuracy figure. The error in not cumulative.

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.

RMS Torque

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

Where:

T_i = Torque during interval i
 t = 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 timing requirements so that different manufacturers' devices are compatible.

Sequence

A series of motion control commands. These commands are created, stored, and executed from the indexer's/controller's EEPROM memory.

Short-circuit

A defect in a winding that causes part of the normal electrical circuit to be bypassed. This frequently results in reducing the resistance or impedance to such an extent (near zero) as to cause overheating of the winding, and subsequent burnout.

Speed

Used to describe the linear or rotational velocity of a motor or other object in motion.

Start Bits

RS-232C character transmissions begin with a bit which signals the receiver that data is now being transmitted.

Static Torque

The maximum torque available at zero speed.

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.

Stop Bits

When using RS-232C, one or two bits are added to every character to signal the end of a character.

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. This condition is not damaging to a step motor.

Text/Echo (Off/On)

This setup allows received characters to be re-transmitted back to the original sending device. Echoing characters can be used to verify or *close the loop* on a transmission.

Torque

Force tending to produce rotation.

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.

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 0.8V and a logical *one* or *high* is represented by a voltage from 2.5 to 5V.

XON/XOFF

Two ASCII characters supported in some serial communication programs. If supported, the receiving device transmits an XOFF character to the host when its character buffer is full. The XOFF character directs the host to stop transmitting characters to the device. Once the buffer empties the device will transmit an XON character to signal the host to resume transmission.

Zero

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

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