

APPENDICES

Command Listing

A	(Acceleration)	PX	(Report Absolute Encoder Position)
AC	(Acceleration Change)	PZ	(Position Zero)
B	(Buffer Status Report)	"	(Quote)
B S	(Buffer Size Status)	QØ	(Exit Velocity Profiling Mode)
C	(Continue)	Q1	(Enter Velocity Profiling Mode)
CA	(Change Acceleration)	R	(Request Indexer Status)
CBC	(Clear Buffered Commands)	RA	(Limit Switch Status Report)
CG	(Correction Gain)	RB	(Loop, Pause, Shutdown, Trigger Status Request)
CL	(Continuous Velocity Loop)	RC	(Closed Loop Status)
CN	(Continuous Mode End Loop)	RM	(Rate Multiplier in Velocity Streaming Mode)
CO	(Continuous Mode Output)	RS	(Status of Sequence Execution)
CR	(Carriage Return)	RV	(Revision)
CTM	(Continuous Mode Time Delay)	S	(Stop)
CTR	(Constant Velocity Wait for Trigger)	SC	(Standby Current)
CV	(Change Velocity)	SCA	(Standby Current Automatically)
D	(Distance)	SN	(Scan)
DB	(Dead Band)	SSA	(RS-232C Echo Control)
DW	(Dead Band Window)	SSD	(Stop on Limit Input)
E	(Enable Communications)	SSG	(Clear/Save the Command Buffer On Limit)
ER	(Encoder Resolution)	SSH	(Clear/Save the Command Buffer on Stop)
F	(Disable Communications)	ST	(Shutdown)
FR	(Encoder Functions Report)	SV	(Servoing Parameter)
FSA	(Set Indexer to Incremental/Absolute Mode)	T	(Time Delay)
FSB	(Set Indexer to Motor/Encoder Mode)	TEST	(System Test Routine)
FSC	(Enable/Disable Position Maintenance)	TR	(Wait for Trigger)
FSD	(Stop on Stall)	TS	(Trigger Input Status)
FSE	(Turn on Output 1 on Stall)	U	(Pause and Wait for Continue)
FSF	(Kill Motion on Trigger 3)	V	(Velocity)
FSG	(Turn on Output 2 when within Dead Band)	VC	(Change Velocity in Continuous Mode)
FSH	(Stall Detection)	W1	(Signed Binary Position Report)
G	(Go)	W3	(Hexadecimal Position Report)
GH	(Go Home)	WV	(Select Waveform)
H	(Delete)	XC	(Sequence Checksum)
H	(Set Direction)	XD	(Sequence Definition)
IS	(Input Status)	XE	(Sequence Erase)
K	(Kill)	XP	(Set Power-up Sequence Mode)
L	(Loop)	XQ	(Sequence Interrupted Run Mode)
LD	(Limit Disable)	XR	(Sequence Run)
LF	(Line Feed)	XRP	(Sequence Run with Pause)
MC	(Mode Continuous)	XSD	(Sequence Download Status)
MN	(Mode Normal)	XSP	(Sequence Status Power-up)
MPA	(Mode Position Absolute)	XSR	(Sequence Run Status)
MPI	(Mode Position Incremental)	XSS	(Sequence Status)
N	(End of Loop)	XT	(Sequence Termination)
O	(Output)	XU	(Sequence Upload)
OR	(Report Homing Function Set-up)	XZ	(Set power-up Sequence to Zero)
OSB	(Back up to Home Switch)	Y	(Stop Loop)
OSC	(Define Active State of Home)	Z	(Reset)
OSD	(Define Active State of Z Channel Input)		
OSH	(Reference Edge of Home Switch)		
PR	(Position Report)		
PS	(Pause)		

ASCII Table

DEC	HEX	GRAPHIC	DEC	HEX	GRAPHIC	DEC	HEX	GRAPHIC
000	00	NUL	058	3A	:	116	74	t
001	01	SOH	059	3B	;	117	75	u
002	02	STX	060	3C	<	118	76	v
003	03	ETX	061	3D	=	119	77	w
004	04	EOT	062	3E	>	120	78	x
005	05	ENQ	063	3F	?	121	79	y
006	06	ACK	064	40	@	122	7A	z
007	07	BEL	065	41	A	123	7B	{
008	08	BS	066	42	B	124	7C	
009	09	HT	067	43	C	125	7D	}
010	0A	LF	068	44	D	126	7E	~
011	0B	VT	069	45	E	127	7F	DEL
012	0C	FF	070	46	F			
013	0D	CR	071	47	G			
014	0E	SO	072	48	H			
015	0F	S1	073	49	I			
016	10	DLE	074	4A	J			
017	11	DC1	075	4B	K			
018	12	DC2	076	4C	L			
019	13	DC3	077	4D	M			
020	14	DC4	078	4E	N			
021	15	NAK	079	4F	O			
022	16	SYN	080	50	P			
023	17	ETB	081	51	Q			
024	18	CAN	082	52	R			
025	19	EM	083	53	S			
026	1A	SUB	084	54	T			
027	1B	ESC	085	55	U			
028	1C	FS	086	56	V			
029	1D	GS	087	57	W			
030	1E	RS	088	58	X			
031	1F	US	089	59	Y			
032	20	SPACE	090	5A	Z			
033	21	!	091	5B	[
034	22	"	092	5C	\			
035	23	#	093	5D]			
036	24	\$	094	5E	^			
037	25	%	095	5F	_			
038	26	&	096	60	`			
039	27	´	097	61	a			
040	28	(098	62	b			
041	29)	099	63	c			
042	2A	*	100	64	d			
043	2B	+	101	65	e			
044	2C	,	102	66	f			
045	2D	-	103	67	g			
046	2E	.	104	68	h			
047	2F	/	105	69	i			
048	30	0	106	6A	j			
049	31	1	107	6B	k			
050	32	2	108	6C	l			
051	33	3	109	6D	m			
052	34	4	110	6E	n			
053	35	5	111	6F	o			
054	36	6	112	70	p			
055	37	7	113	71	q			
056	38	8	114	72	r			
057	39	9	115	73	s			

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.

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 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 9600 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.

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.)

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.

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.

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.

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).

Detent Torque

The minimal torque present in an unenergized motor. The detent torque of a Compumotor or step motor is typically about one percent of its static energized torque.

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.

Encoder

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

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

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, usually derived from a mechanical datum. Often designated as the "zero" position.

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 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.

Micro-stepping

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

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

Phase Angle

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

Phase Margin

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

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.

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 is 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.

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

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.

Slew

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

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.

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.

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

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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