USER'S MANUAL
INTELLIGENT MOTOR CONTROLLERS
UMX FAMILY

OMS Motion, Inc
15201 NW Greenbrier Pkwy, B-1
BEAVERTON, OR 97006
PHONE 503-629-8081
FAX 503-629-0688
EMAIL: sales@omsmotion.com
http://www.omsmotion.com/

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Revision B

UMX Intelligent Motion Controls							
Model	Interface	Servo Axes	Stepper Axes (Open or Closed – loop)	Axes control I/O			User I/O
	Virtual COM over USB			Limits	Aux	Home	GPIO
UMX-25	Yes	2		4	2	2	8
UMX-45	Yes	4		8	4	4	8
UMX-26	Yes		2	4	2	2	8
UMX-46	Yes		4	8	4	4	8

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1. GENERAL DESCRIPTION

1.1. INTRODUCTION

The UMX family of motion controllers is a four axes motion controller that communicates through a USB 2.0 interface. The UMX is built on the successful PC78 architecture and shares the same command set and syntax and is compatible with other OMS motion controllers. (See list of UMX models.)

The UMX family of controllers has models that can manage up to four (4) stepper or four (4) servo axes with encoder feedback. For open loop stepper operation, the encoders are not connected. It can manage coordinated or independent motion of each or all of the axes simultaneously. With high level functionality, such as circular and linear interpolation, multi-tasking, custom profiling, etc., the UMX can satisfy most any motion control application. The UMX utilizes a 32-bit microprocessor and patented, proprietary technology to control the trajectory profile, acceleration, velocity, deceleration, and direction of selected axes. In response to commands from the host computer, the UMX controller will calculate the optimum velocity profile to reach the desired destination in the minimum time while conforming to the programmed acceleration and velocity parameters.

The stepper control of the UMX produces a 50% duty cycle square wave step pulse at velocities of 0 to 1,044,000 pulses per second and an acceleration of 0 to 8,000,000 pulses per second, per second. The encoder feedback control can be used as feedback or position maintenance for the stepper axes or as strictly a position feedback of any axis. The encoder input supports either differential or single-ended quadrature TTL signals at a rate of up to 12MHz and counts at a 4 times resolution. This means a 1000 line encoder will produce 4000 counts per revolution in the UMX controller.

The UMX is commanded using virtually any programming language to the pass simple ASCII command strings to the UMX through the USB interface. For a typical motion requirement of 1,000,000 counts at 400,000 counts/second and an acceleration of 500,000 counts/second/second the following string would be sent from the host computer to the UMX:

VL400000;

AC500000;

MR1000000;

GO

For additional command programming examples see Chapter 5.

1.2. SYSTEM OVERVIEW

The UMX circuit board is a compact 3.536” x 3.278”. As a stand-alone controller it communicates as a slave device through a USB interface. The UMX utilizes Flash Memory where programs (command sequences) can be stored permanently as macros.

The UMX utilizes the Motorola 68332 32-bit micro controller and FPGA technology for extensive logic integration and flexibility. The firmware, which resides in Flash Memory, can be upgraded through USB interface, without having to remove the controller from the system, if you have a 32-bit operating system such as Windows 2000 or XP. All signals to and from the UMX are buffered through TTL devices and are found on the shielded SCSI-3 type connector (J5). The IO68-M breakout can be used to route the signals of the UMX to individual screw terminal blocks, the UIO breakout can be used to route signals of the UMX to it’s 15-pin connectors. Both the UMX and IO68-M utilize a resettable fuse on the +5V on the SCSI-3 connectors for protection.

As a stand-alone controller the UMX obtains its power from connector J3 and the USB communication port connects to J4. At the computer operating system level the UMX looks like a serial port device thought the device driver directs the communications to the USB port. The UMX supports baud rates of 300 to 38.4K baud. With the ability to store macros into Flash Memory, the UMX could essentially be programmed once and then be embedded into a machine where it could run independently.

2. GETTING STARTED

2.1. PREPARE FOR INSTALLATION

There are two driver installation modes: (Decide before connecting the UMX to the host system!)

Option 1: UMX controller mapped to COM port (default USB behavior)
A UMX controller appears at the same COM port no matter which USB port the controller is connected. A UMX with a different serial number will require another driver installation and mapping to a different COM port.
On a virgin system no special preparation is needed, otherwise run AttachUsbToComPort.exe before connecting the UMX controller to the System.

Option 2: USB port mapped to COM port (recommended)
Any UMX controller plugged into a specific USB port is mapped to the same COM port each time. A UMX controller connected to a different USB port requires a reinstallation of the driver and mapping to a different COM port.
You need to run AttachUsbToComPort.exe before connecting a UMX controller to the System.

2.2. CONNECTING THE UMX FOR COMMUNICATION

The first requirement for communication through the USB interface is to ensure that the UMX is securely and safely mounted where damage is unlikely. This includes the exposure to possible static discharge, moisture, debris, etc. Special mounting efforts may be required to protect the extended pins on the bottom of the UMX.

CAUTION:

> The UMX is a static sensitive device and standard ESD (Electro Static Discharge) techniques are required when handling and installing the UMX.

Connect a +5VDC, 1 Amp power source to the power connector at J3. (See Table 2-1 for the connector pin-out) NOTE: +/- 12VDC is required only for servo operation.

Connect the USB cable to the Host Computer.

The Hardware setup wizard will appear. Choose the Advanced option and direct the wizard to the UMXDriver folder.

The wizard will display a warning that about an uncertified device description. It is safe to ignore it and continue.

Follow the same choices in the second wizard that maps the COM port.

For more detailed instruction read the UMXDriverInstallation.pdf in the Driver package.

TABLE 2-1 CONNECTOR J3

	PIN	PIN	
+5V DC	5	6	Digital Ground
-12V DC	3	4	No Connect
+12V DC	1	2	Analog Ground

Reference the support software disk to find a serial communications utility that will work with the UMX.

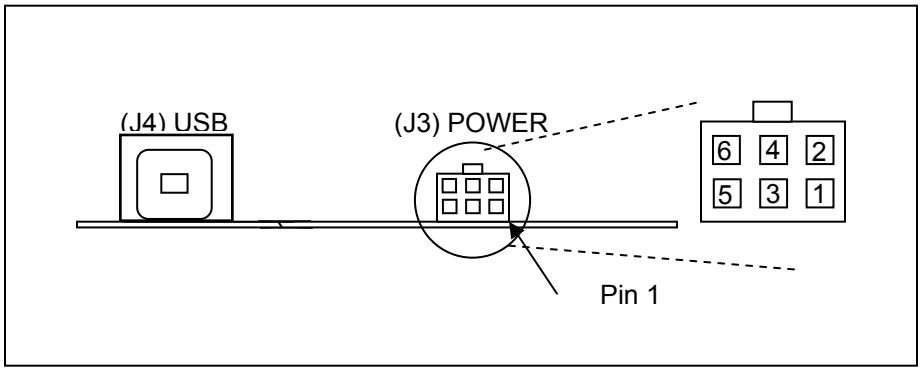

FIGURE 2-1 CONNECTOR CONFIGURATION

2.3. CONNECT AND CHECKOUT THE SERVO SYSTEM

Servo systems tend not to respond gracefully to connection errors. You can reduce the chance of making connection errors by following a step-by-step procedure:

Caution

The servo motor may jump or spin at a very high velocity during connection and configuration. The motor should be restrained via fastening to the physical system or by some other means before beginning this procedure. Keep hands and clothing clear of the motor and any mechanical assemblies while performing this procedure.

2.3.1. CONNECT AND CONFIGURE THE MOTOR\AMPLIFIER

1. Connect and configure your amplifier per the manufacturer's instructions (for "Torque" or "Open-Loop" mode).
2. With the motor and amplifier power turned off, connect the UMX to the amplifier. Do not connect the encoder yet.
3. Balance your motor:
   a. Using a voltage meter, verify that the command signal from the UMX is within +/-500mV. If it is not, send the command "DZ0"; to the UMX and recheck the voltage. If the voltage is still too high, contact OMS Motion, Inc. Technical Support department for guidance.
   b. Turn on power to the amplifier and then to the motor.
   c. Adjust the balance setting of your amplifier (if equipped) until the motor stops moving.
   d. If the motor continues to revolve or your amplifier has no balance adjustment:
      i. Send the command "DZ100;" to the UMX.
      ii. If the motor spins faster, reduce the command parameter and resend the command, e.g. "DZ50;"
      iii. If the motor spins slower but does not stop, increase the command parameter and resend the command, e.g. "DZ150;"
      iv. Continue adjusting and resending the DZ command until the motor comes to rest. Write down the final DZ value for later reference as your "zero" setting.
4. Maximize your system's usage of the UMX's DAC:
   a. Connect the servo encoder to the UMX.
   b. Set the signal/command gain of your amplifier to its minimum setting.
   c. Send the "DZ3277"; command to the UMX and observe the velocity of the motor. The output of UMX will be near 1VDC.
   d. If the motor does not move at all, your amplifier does not work well at a low velocity. In this case, adjust the signal/command gain of the amplifier to approximately 20% of maximum or until the motor begins to move.
   e. Using a frequency meter, measure the pulse rate of Phase A of the encoder. The frequency measured is ¼ of the actual pulse rate.
   f. Adjust the signal/command gain of the amplifier until the pulse rate of Phase A (4 is approximately 10% of your desired peak operational velocity. If the pulse rate is already greater than 10% of peak, your amplifier is not designed for low velocity motion and you will likely have some difficulty tuning your motors.
   g. Send the "DZ-3277;" command to the UMX and recheck the velocity. You may need to readjust your amplifier. If so, do not reduce the signal/command gain – only increase the setting as needed. Increasing the gain will not impair the forward peak velocity but reduction will.
   h. Send the DZ command with the "zero" value noted at the end of step 3d (iv) to the UMX. Send the same value using the KO command, e.g. "KO-175;"
5. Verify the direction of your servo encoder:
   a. Send the "LP0:DZ2000;" command to the UMX.

b. Send the "RE" command to the UMX and observe the response.

c. If the response is positive, no further action need be taken; go to step 6.

d. If the response is negative, your encoder must be reversed.

i. If your encoder produces a differential signal, swap Phase B with Phase B-not and repeat from step (a.) above.

ii. If your encoder produces a single-ended (or TTL) signal, swap Phase A with Phase B and repeat from step (a.) above.

e. If the RE response is still negative, contact OMS Technical Support for assistance.

6. Repeat from step 1 for the other servo axes.

7. Remember to set DZ and KO for each axis at every power-up unless you store the values in flash (see Section 5 COMMAND STRUCTURE)

NOTE: Most encoder problems are caused by lack of power or incorrect connections. If the encoder position changes by only 1 count, this is an indication that one of the phases is not connected.

Caution

Do not proceed until you perform all the steps in this procedure, ensure that the outputs of the UMX are as described, and ensure that the encoder is operating correctly

2.4. TUNE THE SYSTEM

2.4.1. INTRODUCTION

Tuning a servo system is the process of balancing the conflicting requirements to achieve optimum performance of a real world system.

The first of these requirements is that of accuracy. In a closed loop system, an error signal is derived, then amplified, then supplied to the motor to correct any error. Clearly, if a system is to compensate for infinitely small errors, the gain of the amplifier needs to be infinite. Real world amplifiers do not possess infinite gain; therefore, there is some minimal error which cannot be corrected. In order to have the greatest possible accuracy, the gain needs to be as high as possible. Unfortunately, other real world considerations limit the maximum gain of the system.

The second of the requirements is that of stability. The system must not be unstable, e.g. oscillate. The degree to which a system is stable affects its performance. The effects can be seen when looking at the system's response to a step change at the input. The step response falls into one of three categories: under damped, critically damped, over damped. Over damped systems are slow to reach their final value. Critically damped systems reach final value quickly, without overshoot. Under damped systems reach final value quickly, but have various degrees of "ringing" that decay to zero.

The third requirement is that of bandwidth. The system should respond to the highest input frequency possible. The motor/load combination is the predominant feature of the open loop bandwidth. In the closed loop situation, the amplifier attempts to compensate for the limited

response characteristics of the motor load. Increasing gain extends the closed loop bandwidth at the expense of stability.

2.4.2. MANUAL TUNING

In most all motion control applications the optimum tuning of the servo system is achieved through a manual tuning process. Auto-tuning algorithms typically can only get the system parameters close and require manual steps to fine tune the parameters. An empirical trial and error approach will be discussed first.

NOTE: You may want to use the OMS software to help during this process. It is capable of capturing the actual data and plotting it in reference to an ideal motion profile.

There are some system parameters that need to be defined to before attempting to tune a motor. The encoder resolution, counts per revolution, is one element to be determined. Another is the systems maximum velocity. Note that a motor should never exceed 90% of the motor's top rpm. If the system requirement is for a velocity higher than 90% of the motors top rpm, then another motor with higher rpm capability is to be used.

The system's maximum acceleration is determined a couple of different ways. The best method is to determine the system time constant, which includes "hitting" or "bumping" the motor under system load and measure the time from 0 rpm to maximum rpm and divide this value by 5. The maximum acceleration is either 2.5 times this value, or is based on the system requirements for handling the load as defined in the operating specifications of the system. This value is always lower than the calculated value and if this acceleration value is not high enough then a different motor/amplifier with more power or band-width should be utilized.

The UMX can control either current mode or voltage mode amplifiers. The servo update rate of the UMX is 488μs, for four axes. High following errors can be compensated for using the feedforward coefficients explained later in this section. There are some general formulas that have been developed to determine acceptable following error for both current and velocity mode systems:

Current mode following error for KP = (3°/360°) × (counts per revolution)

Voltage mode following error for KP = (90°/360°) × (counts per revolution)

It is obvious that the voltage mode allows for much greater following errors than the current mode. This value is the following error when the motor is at peak velocity and will be used when determining the proportional gain (KP).

The following error for the integral term (KI) or long-term gain value will follow the following guidelines:

Current Mode following error for KI = 0 counts

Voltage Mode following error for KI = 80° of 360° (expressed in motor counts)

While still in open-loop mode, hold off (HF use the DZ command to zero the motor. This variable is used to provide a constant output that will compensate for any torque offset from the load. So, when the system should be stationary, the necessary voltage will be sent to the amplifier to cause the motor to maintain position. With the correct DZ value, the motor should successfully maintain a zero position.

KO is the offset coefficient used while in closed-loop mode, hold on (HN). KO is essentially the same as DZ, but used for closed-loop operation. Once you have determined the correct value for DZ, this same value should be used for the KO variable before beginning to tune the PID filter

The values for DZ and KO range from –32767 to 32767.

Set the known values for velocity, acceleration and the move distance for a trapezoidal profile with at least a 20% flat spot at peak velocity. Formula:

Profile distance = ((peak velocity)^2/(2×acceleration))×2.4

Example: ((50,000)^2/(2×500,000))×2.4 = 6,000

Execute the move by sending the move commands to the UMX.

Example:
```
MR6000;
GO;
```

Adjust the KP term while repeating step 2 until the following error at the flat spot of the profile is acceptable. If the motor becomes unstable prior to obtaining the optimum KP term than increase the KD term until the motor stabilizes.

Example:
```
LP0;
KP3;
HN;
MR6000;
GO;
LP0;
KP10;
HN;
MR6000;
GO;
LP0;
KP25;
HN;
MR6000;
GO;
LP0;
KD100;
HN;
LP0;
KP35;
HN;
MR6000;
GO;
LP0;
KD125;
HN;
```

The values in the above example are totally arbitrary and may vary drastically with different systems. The LP0; command is used to set the position error to 0.

The values for KP range from 0 to 32767.

Once the KP term has been obtained, and then continues executing the motion while rising the KI term until the long-term following error is acceptable. This error can be measured at the two

knees of the motion profile. By increasing the KI term, the response time of your system will increase. The motion profile should have a steeper slope as KI increases.

However, as KI increases the system can also become unstable. If the instability becomes unacceptable increase the KD parameter. This will increase the dampening on the system's motion profile (therefore reducing oscillation, or "ringing"). Continue adjusting the KI and KD terms until the proper response time is obtained.

The values for KI range from 0 to 32767.

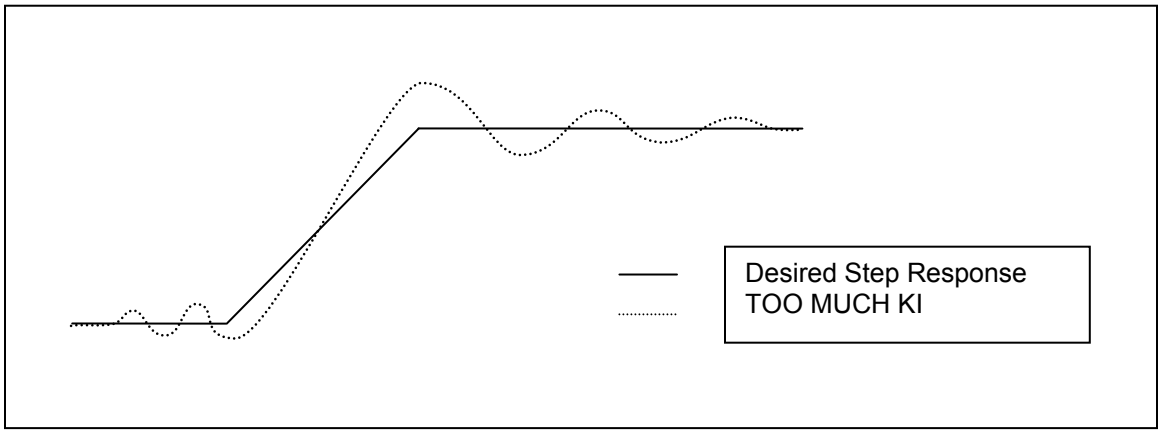

FIGURE 2-2

If you are getting too much "ringing" in the motion profile, then increase KD to help dampen the system's response. If, instead, the system is over-damped and is reaching the final velocity too slowly, then reduce the KD parameter. Optimally, the system's motion profile should show the motor reaching the desired velocity as quickly as possible without overshoot and oscillation ("ringing").

The values for KD range from 0 to 32767.

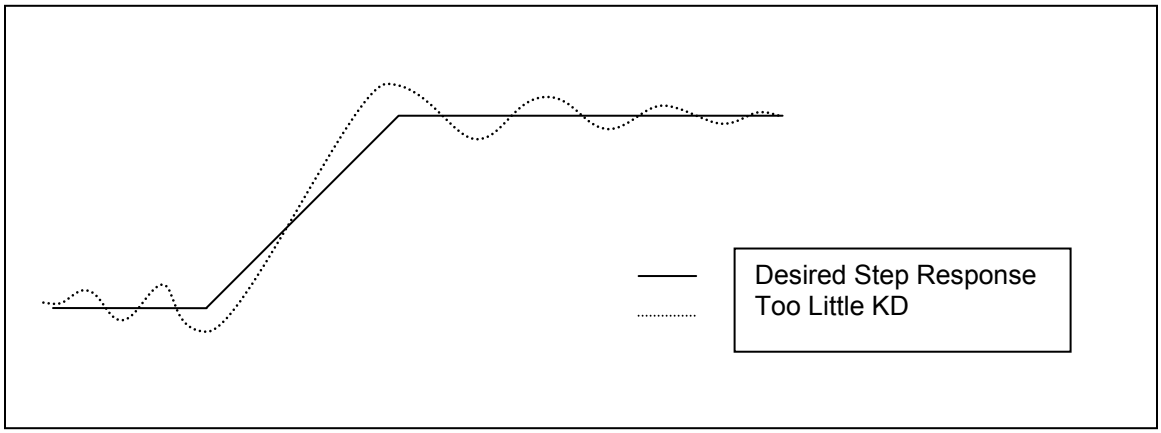

FIGURE 2-3

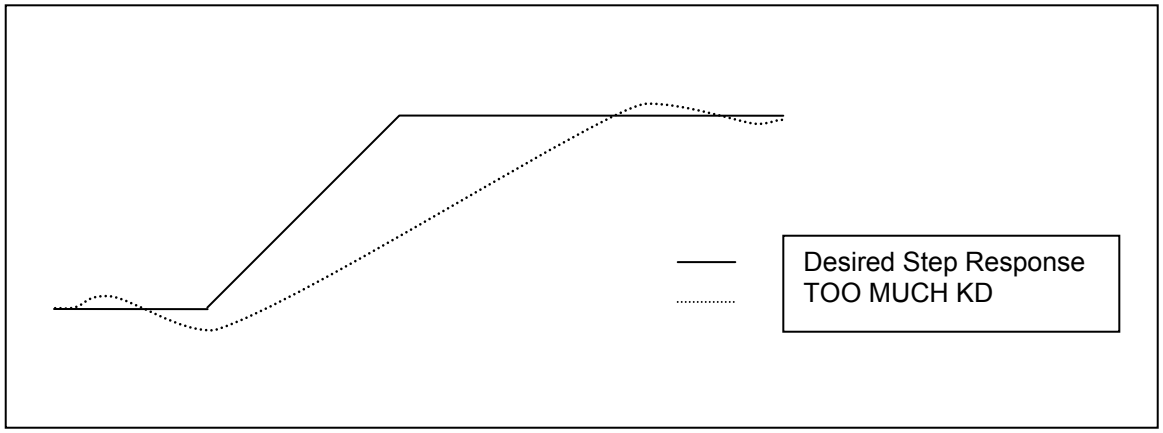

FIGURE 2-4

KP, KI and KD are the primary parameters of concern when tuning a servo system. Once the optimum values for these variables have been determined, then you can adjust some of the secondary parameters that will help fine tune your system's performance. These other variables are described in the subsequent steps.

The KV variable is used when tuning velocity controlled servos (voltage mode servo amplifiers). This is the velocity feedforward coefficient. KV determines how closely the system follows the desired constant velocity portion of the motion profile. By increasing this term, the following error of the system's response can be minimized. However, too large of a value may result in unstable behavior after command velocity changes.

The values for KV range from 0 to 32767.

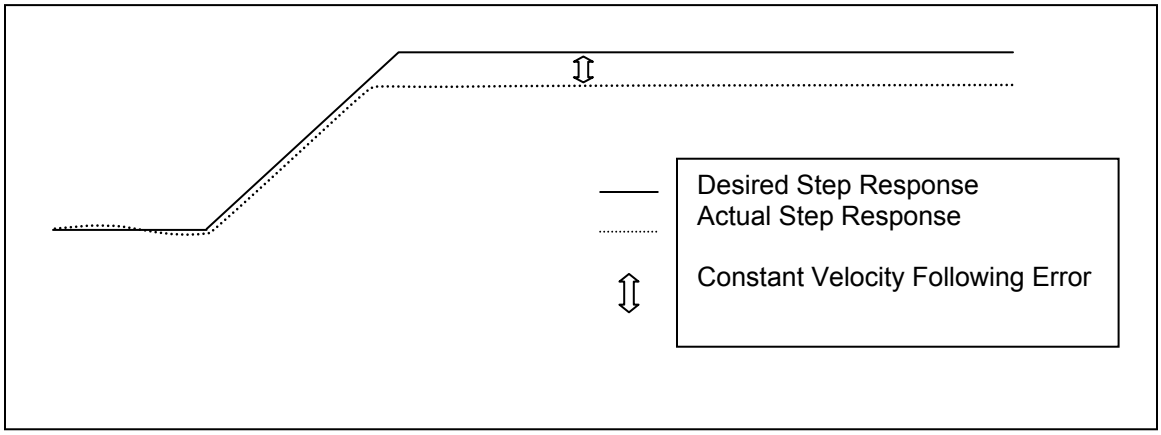

FIGURE 2-5

The KA variable is used when tuning torque controlled servos (current mode servo amplifiers). This is the acceleration feedforward coefficient. Systems with high inertial loads may require additional torque during acceleration or deceleration to achieve optimum performance. KA determines how closely the system follows the desired acceleration and deceleration portions of the motion profile. Increasing this term reduces the following error occurring during acceleration and deceleration of the system. Although, if KA is too large, instability may occur.

The values for KA range from 0 to 32767.

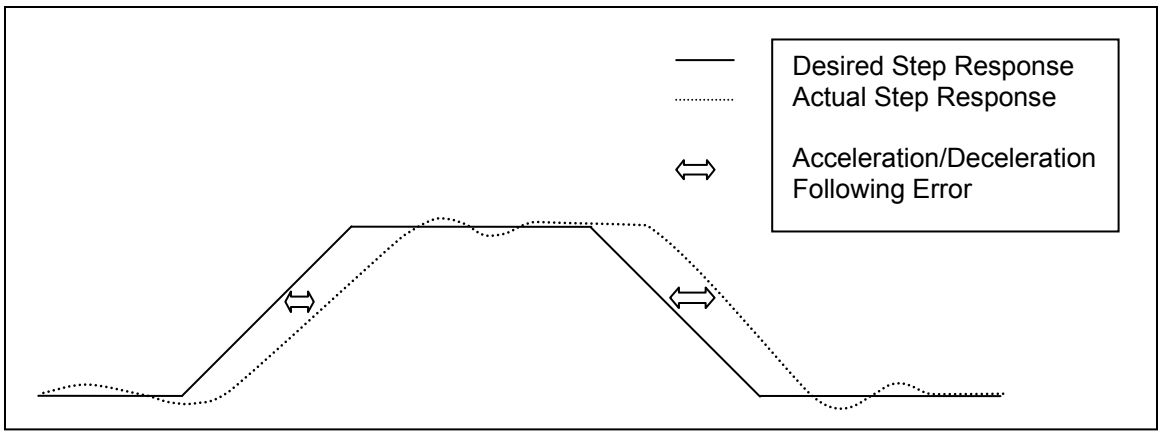

FIGURE 2-6

The block diagram below describes the feedback loop that is taking place in the servo system:

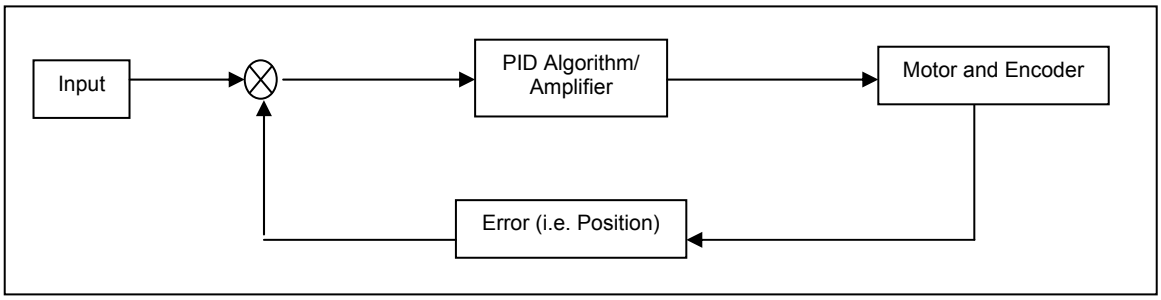

FIGURE 2-7 FEEDBACK LOOP

You may want to save the values for KP, KI, KD, etc., for future reference. These values can be saved in the board's Flash Memory, so they can be accessed easily on reset or power-up. The command AP will store your current parameter assignments, such as KP, KI, KD, etc., into flash memory. These saved parameters will then be used as the power up default set of values. Refer to page 5-33 for more detailed information regarding how to use the commands to save and load parameter sets from flash memory.

Once the KP term has been obtained, continue executing the motion while raising the KI term until the long-term following error is acceptable. This error is to be measured at the two knees of the profile. If the motor becomes unstable before obtaining the optimum following error than increase the KD term until the motor becomes stable.

To verify that your motor is tuned properly after you have completed the first 11 steps perform the following test to test the holding torque: Send LP0;HN commands and check the shaft of the motor to make sure it is stiff. If there is play in the motor shaft when you turn it then you may have to re-adjust your PID filter.

Once you are satisfied with the static holding torque you could check for position error. Send the command "AC100000;VL5000;MR64000;GO;". With an 8000 line encoder this move would be equivalent to 8 revolutions of the motor. After the move is complete check the position error by sending the RE and RP commands for the specific axis you are moving. Compare the difference in the two responses. If they are the same then you are on the right track, if the error was greater than 32768 than the controller will disable the PID so that you don't have a runaway motor and major changes to the PID parameters may be required. For minor differences in the encoder and the position reading you can fine-tune your PID filter according from the earlier steps.

2.5. SETTING THE USER DEFAULT CONFIGURATION

There are several parameters that can be defined by the user as default. These parameter values supersede the factory default values and are stored in Flash Memory for power-up configuration. Most of these parameters consist of axis specific values, i.e. velocity, acceleration, limit switch logic sense, etc. The configuration of the User I/O must be configured once the communication interface has been established.

2.5.1. SETTING THE USER I/O DEFAULTS

The factory default of these signals sets I/O bits 0 through 3 as inputs and 4 through 7 as outputs. If these signals are to be used in a configuration other than the factory defaults then they must be reconfigured before any hardware is connected. If an input device, such as a position sensor or limit switch, is attached to a User I/O signal configured as an output then the logic gate on the UMX may be destroyed and additional damage to the UMX could occur. The "IO" command is used to change the User I/O from input to output and visa-versa. User I/O bits are configured in blocks of four. The syntax for the IO command uses a 0 to set the corresponding four I/O bits to inputs and a 1 to set them to outputs.

Example: IO0,1;

This will set I/O bits 0 – 3 as inputs and 4 – 7 as outputs (factory default).

Example: IO1,1;

This will set all bits (0 – 7) to outputs.

Refer to page 5-102 for more on the IO command.

The "RB" Report Bits command is used to check the configuration of the I/O bits. This command should be executed to ensure that the configuration of the I/O bits is as required by the system. This should be performed PRIOR to connecting hardware to the User I/O signals of the UMX.

The eight User I/O bits all have a 2.2K Ohm pull-up resistor connected to them. By default, the active state of the inputs is a low true. When the I/O bits are configured as inputs it is only necessary to have a switch closure to ground to activate the input. The BX command is used to check the status of the input bits. The use of a 100-Ohm pull-down resistor can be used to change the state of the inputs for testing. Refer to page 5-42 for more on the BX command.

The "BH" Bit High and "BL" Bit Low commands are used to toggle the logic state of the User I/O bits. Before connecting the User I/O signals to exterior hardware, you should be certain that the bits are configured correctly. An LED connected through a 100 Ohm resistor to +5V can be used to test the I/O bits when toggling them. Refer to page 5-37 for more on the BH and page 5-39 for more on the BL commands.

2.5.2. OTHER USER DEFINABLE DEFAULT PARAMETERS

The UMX comes from the factory with default values for all parameters. For instance, the default value for the velocity of all axes is 100,000 counts per second. (A count is equivalent to a step pulse or one count of an encoder.) In a typical application, when the system is powered up, the main host computer would initialize all of the peripherals, such as the UMX, sending to each of the axes the peak velocity. When the User Definable Default Parameter value is defined for the velocity then the initialization of the system can skip initializing the velocities of the defined axes. This feature can greatly simplify the software and initialization process.

Once the values for all of the associated parameters are defined, i.e. velocity, acceleration, PID values, etc. then the "AP" Archive Parameters command is executed to place the values into Flash Memory. From this point forward these defined values will be used after reset or power-up. The individual parameters can be over-written at anytime by using the associated command, i.e. VL, AC, etc. To restore the factory defaults the command "RF" Restore Factory Defaults is executed. To restore the User Defined Default Parameters the command "RD" Restore Defaults is executed. Refer to Section 5 COMMAND STRUCTURE for more information on these commands.

The following is a list of parameters that can be defined as part of the User Definable Power-Up Default Parameters.

	Factory Default Settings
Baud Rate for serial communication (?SB)	9600
I/O bit configuration (BX)	00
Overtravel limit (soft limit or hard limit) (?SL)	sf
Overtravel limit (enabled or disabled)	enabled (0)
Overtravel limit polarity (active high or active low) (?LS)	ll
Software based overtravel for each axis (?TF)	tf
Direction bit polarity (?DB)	dbn
Acceleration value for each axis (?AC)	ac2000000
Trajectory profile for each axis (linear, parabolic, custom) (?RT)	la
Velocity Peak (?VL)	vl2000000
Velocity Base(?VB)	vb0
User Unit values for each axis (?UU)	uf
Auxiliary output settle time for each axis	0
Automatic auxiliary control axis by axis	disabled
Encoder Ratio for each axis (?ER)	1:0
Encoder Slip/stall tolerance for each axis (?ES)	es1
Position Maintenance Dead-Band, Hold Gain and Hold Velocity. (?HD)	hd0
Servo axis unipolar/bipolar output (?SO)	bi
Servo PID values: KP, KD, KI, KO, KV, KA, KF, KB, KU	10, 20, .04, 0, 0, 0, 0, 10, 200
Servo zero value: (?DZ)	dz0

NOTE: Use the AP command sparingly since it writes to Flash Memory. There is a finite number of times the Flash can be re-written (i.e. less than 10,000 times, typical.)

2.6. POWER SUPPLY REQUIREMENTS

The UMX is designed to operate from the power supplied by an external power supply which must be capable of supplying +5V at 1 amp (typical) to the UMX, J3. Servo models of the UMX require +/-12V at 0.1 amps (typical) and these voltages must be present for proper servo operation.

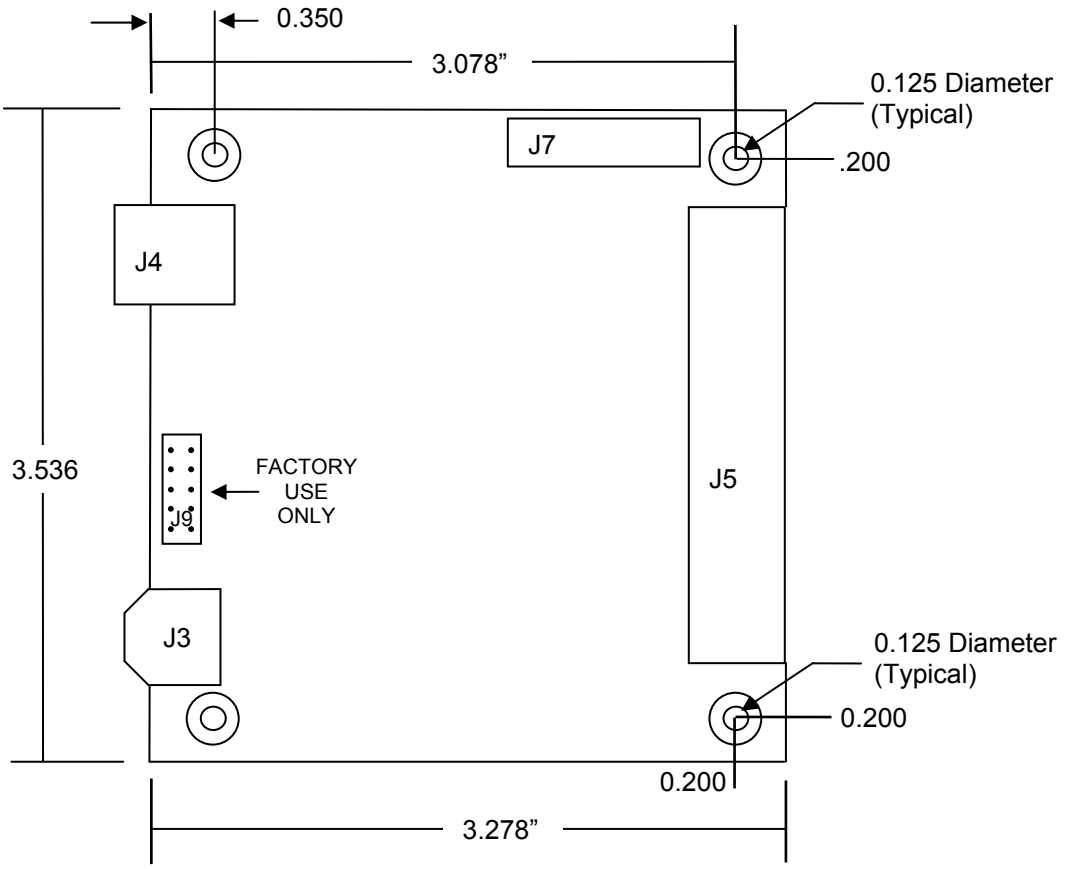

FIGURE 2-8 UMX DIMENSIONAL LAYOUT

* = NOTE: The UMX has a notched connector for J5 to better accommodate the SCSI3 connector.

3. COMMUNICATION INTERFACE

3.1. INTRODUCTION

The UMX is a compact multi-axis motion controller for Servo or Stepping motors or Stepping motors with encoders. The UMX communicates across a USB 2.0 interface. The software drivers are supplied with the controller and support most Windows operating systems. The UMX will appear as a serial device on a COMM port of the computer for a simple communications interface though the hardware is a USB port.

The UMX can control up to four (4) axis of motion that can be coordinated, independent or any combination of coordinated and independent axes. The UMX utilizes Flash memory technology that provides for the ability to store parameters and command macros for execution. The power-up default settings can even be customized and stored and the UMX can be programmed to execute the macros based on a general purpose input to provide for a completely stand-alone system. The stepper motor version requires a single +5VDC supply while the servo motor version requires an additional low power +/-12VDC supply for the control of the analog signals.

Along with a 32-bit microprocessor and patented, proprietary technology the UMX controls the trajectory profile, acceleration, velocity, deceleration, and direction of all selected axes. In response to commands from the host computer, the UMX controller will calculate the optimum velocity profile to reach the desired destination in the minimum time while conforming to the programmed acceleration and velocity parameters.

The stepper control of the UMX produces a 50% duty cycle square wave step pulse at velocities of 0 to 1,044,000 pulses per second and an acceleration of 0 to 8,000,000 pulses per second, per second. The encoder feedback control can be used as feedback or position maintenance for the stepper axes or as strictly a position feedback of any axis. The encoder input supports either differential or single-ended quadrature TTL signals at a rate of up to 12MHz and counts at a 4 times resolution. This means a 1000 line encoder will produce 4000 counts per revolution in the UMX controller.

The UMX is commanded using virtually any programming language to the pass simple ASCII command strings to the UMX through USB port. For a typical motion requirement of 1,000,000 counts at 400,000 counts/second and an acceleration of 500,000 counts/second/second the following string would be sent from the host computer to the UMX:

VL400000;

AC500000;

MR1000000;

GO

For additional command programming examples see Chapter 5.

The UMX returns status information to the host via special characters inserted into the response stream. If a “Done” or “Command Error” condition occurs, the UMX will send one or more of these characters to the host. These characters are:

#	Command Error
$	Motor Slip/stall (with encoders only)
@	Overtravel Limit
!	Done

These characters are not axis-specific. It is necessary for the host to query the UMX for that information if it is required.

4. CONTROL SIGNAL INTERFACE

4.1. INTRODUCTION

The UMX family contains a two or four axes stepper with encoder feedback motion controller or a two or four axis servo motion controller. A single 68- pin shielded SCSI-3 connector incorporates all the control signals of the UMX. The mating connector is an AMP, Inc. part number 749621-7 with a 749195-2 hood and strain relief. As a convenience in system integration, connections to the UMX for +5VDC power, +12 VDC, -12 VDC, digital ground and analog ground are provided at the output connector (J5).

The red LED is used to assist in fault diagnosis, and if it is “on” steady, a fault exists in the UMX.

4.2. LIMIT AND HOME INPUTS

To facilitate system implementation, limit and home inputs are provided for each axis. Limits may be activated by mechanical switches using contact closures or other suitable active switches, such as a Hall Effect switch or opto-isolator that connects to ground.

If the motor travels beyond its allowable limits and trips the switch, the limit switch closure removes the excitation from the affected axis. You can select the limit switch active signal state with the LH and LL command on an axis by axis basis. The behavior of the limit functionality can be controlled with the System Control Commands.

The home switch provides a means to synchronize the motor controller with the load at some home, or reference position. The home switch, when used with the software commands HM or HR, causes the motor to decelerate to a stop when the switch closes. On finding the home position, the position counters are initialized to the parameter supplied with the command. You can change the sense of the home switches to TRUE when open by use of the HH command (described on page 5-88).

4.3. CONTROL OUTPUT

The stepper version of the UMX is configured at the factory for control of stepper axes with encoder motors. The servo output may be either unipolar analog (0 to +10V) or bipolar analog (±10V). (See the UN and BI commands). Step pulse output is TTL open-collector which will wire directly into most driver inputs but may require a 2K Ohm pull-up resistor to +5 VDC to operate some other drives. See wiring diagrams that follow.

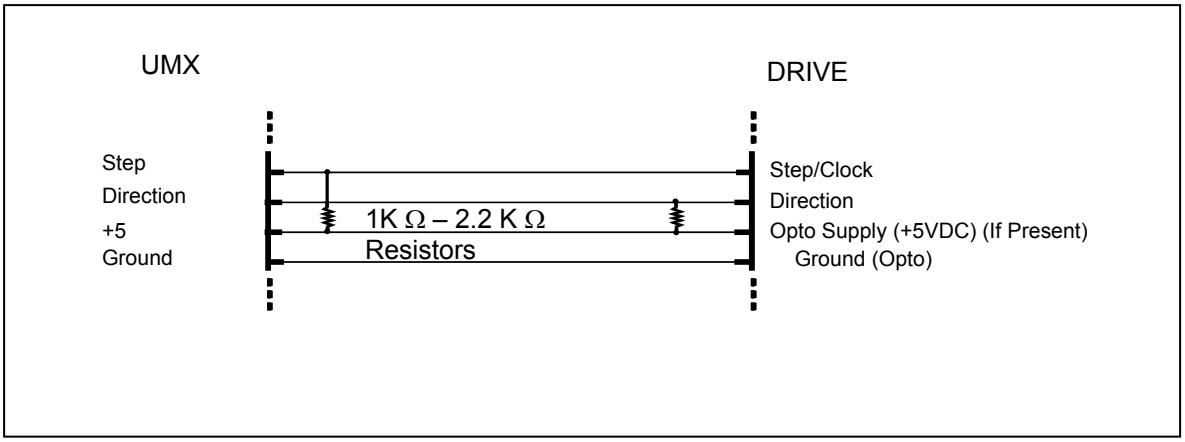

FIGURE 4-1 CONNECTION TO STEP DRIVES WITH INTERNAL PULL-UP RESISTORS AND OPTO-ISOLATION

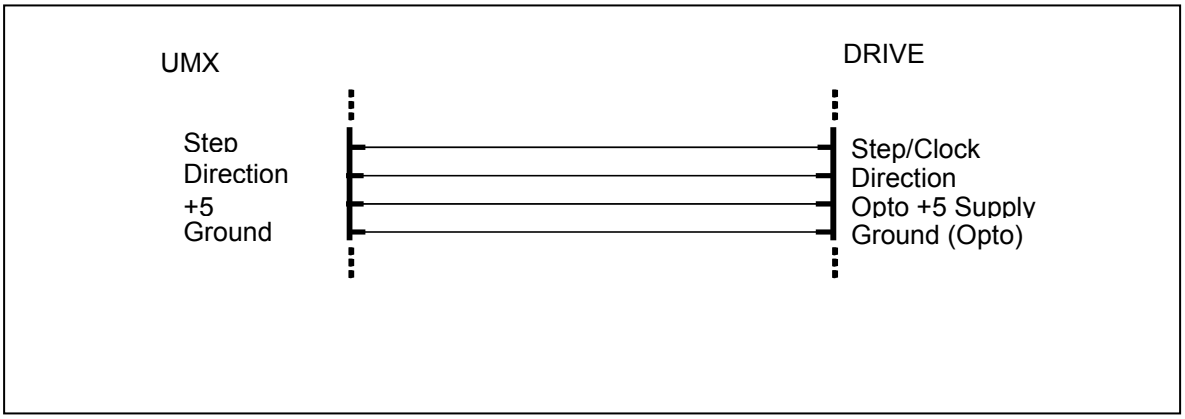

FIGURE 4-2 CONNECTION TO STEP DRIVES WITHOUT PULL-UP RESISTORS

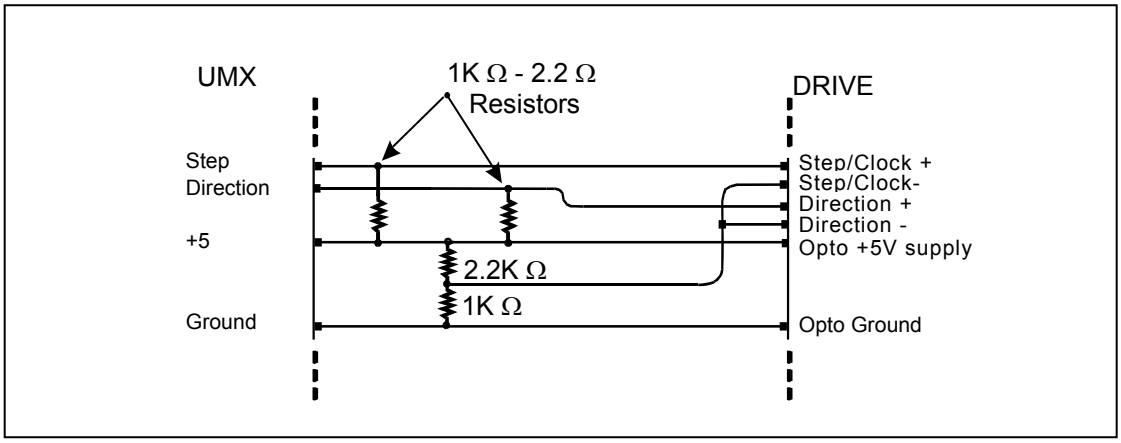

FIGURE 4-3 CONNECTION TO STEP DRIVES WITH DIFFERENTIAL INPUTS

TABLE 4-1 OUTPUT CONNECTOR PIN LIST (J5) (AT CIRCUIT BOARD)

SIGNAL CONNECTOR (J5)			
Pin#	**Description**	**Pin#**	**Description**
1	Digital Ground	35	+5VDC
2	I/O-1	36	I/O-0
3	I/O-3	37	I/O-2
4	I/O-5	38	I/O-4
5	I/O-7	39	I/O-6
6	Digital Ground	40	+5VDC
7	X Index +	41	X Servo
8	X Index -	42	X Step
9	X Phase A +	43	X Auxiliary
10	X Phase A -	44	X Direction
11	X Phase B +	45	X Limit +
12	X Phase B -	46	X Limit -
13	Y Servo	47	X Home
14	Y Index +	48	Y Step
15	Y Index -	49	Y Auxiliary
16	Y Phase A +	50	Y Direction
17	Y Phase A -	51	Y Limit +
18	Y Phase B +	52	Y Limit -
19	Y Phase B -	53	Y Home
20	Analog Ground	54	+5VDC
21	Z Index +	55	Z Servo
22	Z Index -	56	Z Step
23	Z Phase A +	57	Z Auxiliary
24	Z Phase A -	58	Z Direction
25	Z Phase B +	59	Z Limit +
26	Z Phase B -	60	Z Limit -
27	T Servo	61	Z Home
28	T Index +	62	T Step
29	T Index -	63	T Auxiliary
30	T Phase A +	64	T Direction
31	T Phase A -	65	T Limit +
32	T Phase B +	66	T Limit -
33	T Phase B -	67	T Home
34	Digital Ground	68	+5VDC

4.4. IO68 ADAPTER MODULE

The optional IO68-M is an adapter module designed to provide easy connection for each signal of the UMX. It incorporates a three row terminal block and some on-board filters for the limit inputs. A cable (CBL68-10) is available with the mating connector on each end to fit the UMX connector (J5). The +5VDC on the IO68-M is supplied by the UMX and is protected by a resettable fuse on the UMX. A green LED lights up when 5VDC is present.

This supply voltage is intended to be utilized with accessories used in conjunction with the UMX such as sensors, motor driver modules, etc., and is specified to supply a maximum current of 0.5 amps for these purposes.

If the fuse detects an over current situation (such as an external short circuit), the supply will shut down. It can be re-activated by powering down the UMX, ensuring the over current situation has been removed, and by powering the UMX up again after 3 seconds.

As the fuse is a semiconductor device, it never has to be replaced and requires no maintenance.

4.4.1. EXPLANATION OF ADDITIONAL CIRCUITRY ON THE IO68-M

The IO68-M board is to be used in conjunction with a UMX. The IO68-M board contains low-pass filtering circuitry for the positive and negative limit signals. The default values for the RC constants are 100Ω and 1.0μF. With these RC constants used the average cutoff frequency is 21.5 kHz, in a worse case scenario, where all other signals are left unterminated.

In addition to the above mentioned circuitry, there are also 2.2K pull-up resistors that have been added to the step output signals for each axis. These resistors have been added to the IO68-M to help reduce noise that may occur on the step output signals.

The resistors and capacitors are packaged as through hole devices. Should your particular application require different RC constants, these devices can be removed from the board and replaced with the appropriate components. When changing these components, use appropriate methods to desolder and solder the components to avoid causing damage to the board (i.e. lifting pads from the board).

There are two switches on the IO68-M (S43 and S45) that are used in regards to encoder signals. If your system uses differential encoders, then these switches should be in the OFF position (except where indicated). The switches are set to the OFF position as default from factory. If, however, your system employs single-ended encoders, then the negative encoder signals need to be fed a biasing voltage. Since a biasing voltage has been made available on the IO68-M, simply change the position of the switches to ON to tap into this voltage. Be sure to change the position of these switches only when power to the board is OFF (the green LED should be off).

TABLE 4-2

IO68-M ENCODER BIAS SWITCH (S43)

Switch Number	Signal Description
1	Y Phase B-
2	Y Phase A-
3	Y Index-
4	X Phase B-
5	X Phase A-
6	X Index-
7	(Leave ON)
8	(Leave ON)

IO68-M ENCODER BIAS SWITCH (S45)

Switch Number	Signal Description
1	T Phase B-
2	T Phase A-
3	T Index-
4	Z Phase B-
5	Z Phase A-
6	Z Index-
7	(Leave OFF)
8	(Leave OFF)

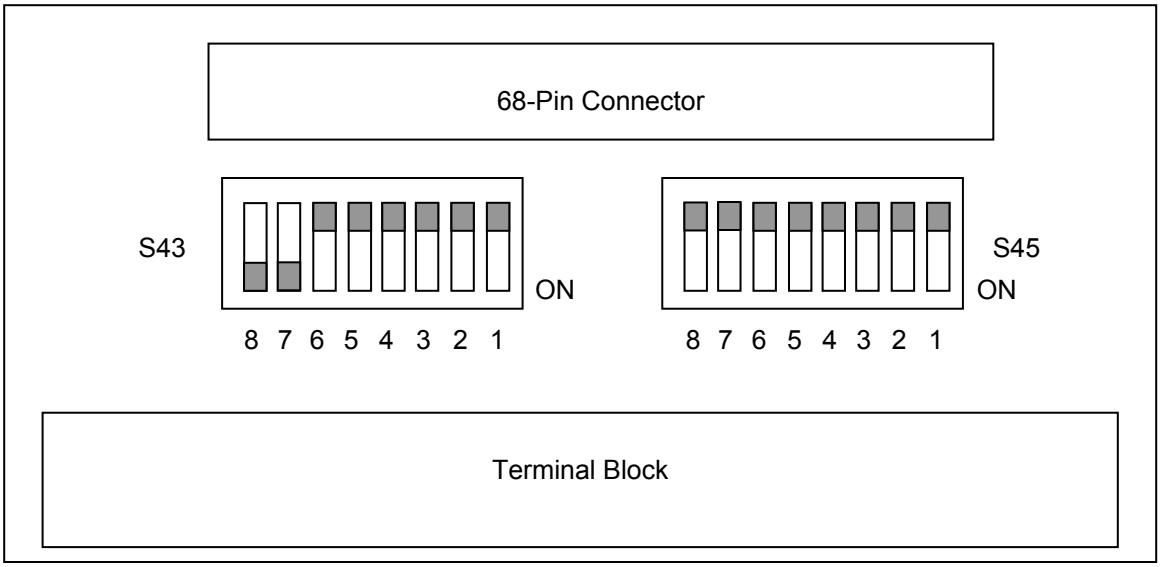

FIGURE 4-4 IO68-M DEFAULT SWITCH SETTING

If only one of the axes is using a single-ended encoder, while the others are using a differential encoder, you need only turn on the switch positions that relate to the axis with the single-ended encoder.

Besides biasing the negative encoder signals, these switches also configure the IO68-M. Placed in the position shown in Figure 4-4, the IO68-M is configured to work with the UMX. For the IO68-M, S43, switches 7 and 8 are to be ON, while S45, switches 7 and 8 are to be OFF.

All other signals on the IO68-M are straight through connections, with no additional circuitry added. Should you need filtering circuitry on any of these other signals, it would have to be added external to the IO68-M. See the OMS Motion, Inc. (http://www.omsmotion.com/) website if you need further instruction.

TABLE 4-3 IO68-M TERMINAL BLOCK PIN-OUT

Row 1	Description	Row 2	Description	Row 3	Description
1	X Step	24	X Direction	47	X Auxiliary
2	X Phase A+	25	X Phase B+	48	X Index +
3	X Phase A-	26	X Phase B-	49	X Index -
4	X Limit +	27	X Limit-	50	X Home
5	5VDC	28	X Servo	51	Digital GND
6	Y Step	29	Y Direction	52	Y Auxiliary
7	Y Phase A+	30	Y Phase B+	53	Y Index +
8	Y Phase A-	31	Y Phase B-	54	Y Index -
9	Y Limit +	32	Y Limit-	55	Y Home
10	5VDC	33	Y Servo	56	Digital GND
11	I/O-0	34	I/O-3	57	I/O-5
12	I/O-1	35	No Connect	58	I/O-6
13	I/O-2	36	I/O-4	59	I/O-7
14	5VDC	37	Z Servo	60	Analog GND
15	Z Step	38	Z Direction	61	Z Auxiliary
16	Z Phase A+	39	Z Phase B+	62	Z Index +
17	Z Phase A-	40	Z Phase B-	63	Z Index -
18	Z Limit +	41	Z Limit-	64	Z Home
19	5VDC	42	T Servo	65	T Auxiliary
20	T Step	43	T Direction	66	T Index +
21	T Phase A+	44	T Phase B+	67	T Index -
22	T Phase A-	45	T Phase B-	68	T Home
23	T Limit +	46	T Limit-	69	Digital GND

4.5. UIO ADAPTER MODULE

The optional UIO is an adapter module designed to provide easy connection for each signal of the UMX. It is the same size as the UMX and be attached to the UMX with the included hardware and cable. The UIO incorporates four 15-pin D-sub connectors, for each axis one, and an additional 15-pin Dsub for I/O signals. +5VDC is provided on each connector for powering accessories such as sensors, motor driver modules, encoders, etc. The supplied voltage is limited to 1.25 A overall by a resettable fuse on the UMX. A blue LED lights up when 5VDC is present.

The UIO can be used with CBL15-5, a mating cable to the 15-pin connectors.

TABLE 4-4 UIO 15-PIN CONNECTOR PIN OUT

J1 (X), J2 (Y), J3 (Z) , J4 (T) Connector pin outs	
Pin	**Signal**
1	GND
2	Phase B-
3	Phase B+
4	Index -
5	Index +
6	Phase A -
7	Phase A +
8	5V
9	Home
10	Limit -
11	Limit +
12	Servo
13	Auxiliary
14	Direction
15	Step

J8 (IO) Connector pin outs	
Pin	**Signal**
1	IO7
2	IO6
3	IO5
4	IO4
5	IO3
6	IO2
7	IO1
8	IO0
9	GND
10	5V
11	GND
12	5V
13	GND
14	5V
15	GND

TABLE 4-5 CBL15-5 WIRE COLOR TO PIN TABLE

Pin	Wire Color
1	Black
2	Brown
3	Red
4	Orange
5	Yellow
6	Dark Green
7	Blue
8	Purple
9	Grey
10	White
11	Pink
12	Light Green
13	Black/White
14	Brown/White
15	Red/White

TABLE 4-6 34-PIN CONNECTOR PIN OUTS

J5 Connector	
Pin	**End Signal**
1	GND
2	J8-Pin7 IO1
3	J8-Pin5 IO3
4	J8-Pin3 IO5
5	J8-Pin1 IO7
6	GND
7	J1-Pin5 X Index+
8	J1-Pin4 X Index-
9	J1-Pin7 X Phase A+
10	J1-Pin6 X Phase A-
11	J1-Pin3 X Phase B+
12	J1-Pin2 X Phase B-
13	J2-Pin12 Y Servo
14	J2-Pin5 Y Index+
15	J2-Pin4 Y Index-
16	J2-Pin7 Y Phase A+
17	J2-Pin6 Y Phase A-
18	J2-Pin3 Y Phase B+
19	J2-Pin2 Y Phase B-
20	GND
21	J3-Pin5 Z Index+
22	J3-Pin4 Z Index-
23	J3-Pin7 Z Phase A+
24	J3-Pin6 Z Phase A-
25	J3-Pin3 Z Phase B+
26	J3-Pin2 Z Phase B-
27	J4-Pin12 T Servo
28	J4-Pin5 T Index+
29	J4-Pin4 T Index-
30	J4-Pin7 T Phase A+
31	J4-Pin6 T Phase A-
32	J4-Pin3 T Phase B+
33	J4-Pin2 T Phase B-
34	GND

J6 Connector	
Pin	**End Signal**
1	5V
2	J8-Pin8 IO0
3	J8-Pin6 IO2
4	J8-Pin4 IO4
5	J8-Pin2 IO6
6	5V
7	J1-Pin12 X Servo
8	J1-Pin15 X Step
9	J1-Pin13 X Aux
10	J1-Pin14 X Dir
11	J1-Pin11 X Lmt+
12	J1-Pin10 X Lmt-
13	J1-Pin9 X Home
14	J2-Pin15 Y Step
15	J2-Pin13 Y Aux
16	J2-Pin14 Y Dir
17	J2-Pin11 Y Lmt+
18	J2-Pin10 Y Lmt-
19	J2-Pin9 Y Home
20	5V
21	J3-Pin12 Z Servo
22	J3-Pin15 Z Step
23	J3-Pin13 Z Aux
24	J3-Pin14 Z Dir
25	J3-Pin11 Z Lmt+
26	J3-Pin10 Z Lmt-
27	J3-Pin9 Z Home
28	J4-Pin15 T Step
29	J4-Pin13 T Aux
30	J4-Pin14 T Dir
31	J4-Pin11 T Lmt+
32	J4-Pin10 T Lmt-
33	J4-Pin9 T Home
34	5V

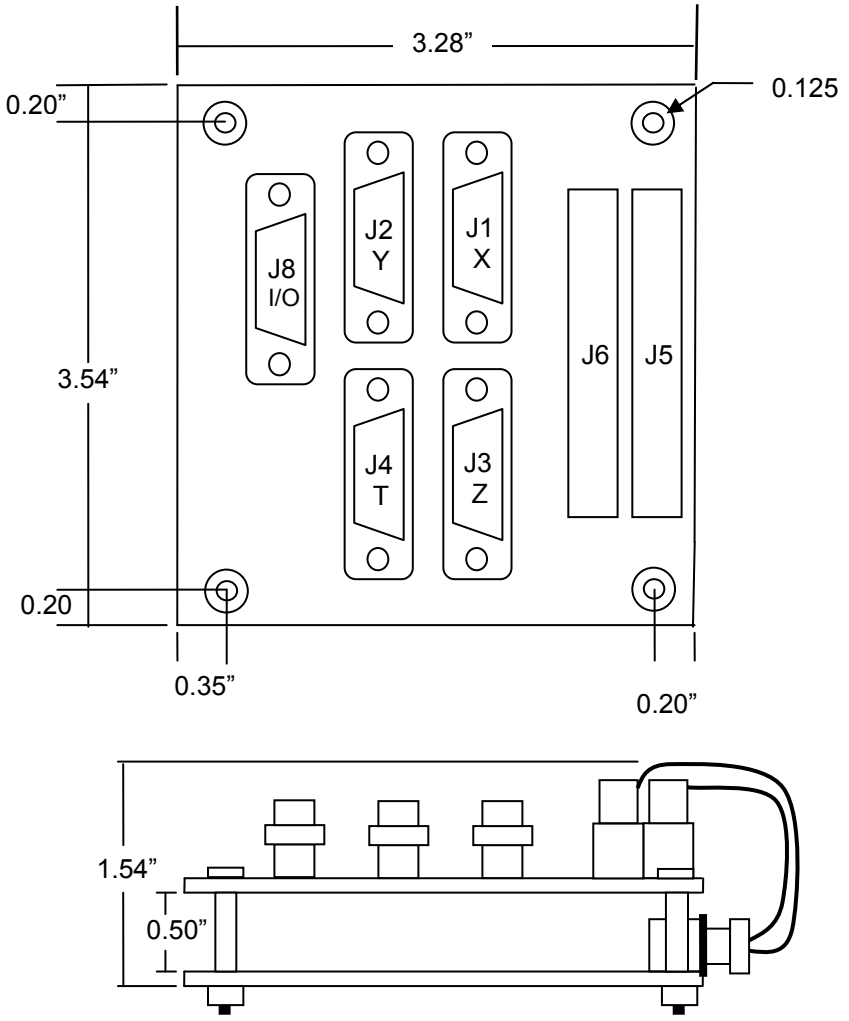

FIGURE 4-5 UIO DIMENSIONAL DRAWING

4.6. ENCODER FEEDBACK

Incremental encoder feedback is provided for each axis. The UMX encoder option accepts quadrature pulse inputs from high resolution encoders at rates up to 12 MHz (after quadrature detection). The encoder monitors actual position through the encoder pulse train. It then continuously calculates the position error on the servo axes and for servo axes the output based on that error through the PID filter. The stepper axes can monitor the error and correct the position after the move is finished. The encoder input can also be used as an independent feedback source. All modes are capable of slip/stall detection and encoder tracking with electronic gearing. These options are selectable by the user through software commands.

4.7. ENCODER SELECTION AND COMPATIBILTY

The UMX is compatible with virtually any incremental encoder which provides quadrature outputs. Times four quadrature detection is used to increase resolution. This means that an encoder rated for 1024 counts (or lines) per revolution will result in 4096 counts. The inputs are compatible with encoders, which have single ended or differential TTL outputs. The UMX inputs have built in hysteresis to minimize effects of noise pickup. The UMX has differential line receivers to accommodate encoders with differential line driver outputs.

4.8. HOME PROCEDURES

When single ended encoders are used the unused negative inputs, i.e. Phase A-, Phase B-, etc. must be biased at or near +1.5V. The IO68 provides convenient switches for this. Single ended encoders with long leads are not recommended.

Two modes are provided to synchronize the physical hardware with the UMX controller, i.e. put the controlled motor in the home position.

HS mode (factory default):

The home switch input is a TTL level input signal that can be used to physically home a mechanical stage. This signal can be either a logic HIGH or logic LOW true by using the HH and HL commands. The HM or HR commands are used after reducing the velocity to no more than 2048) pulses per second. This limit on velocity is necessary to avoid ambiguity of the home position if more than one pulse occurs per sample interval. When this functionality is used the axis position counter will be reset to a select value when the switch is activated. At this point the UMX can either ramp the axis to a stop or stop the axis immediately. The control of the direction of travel, the logic active state, and the response to the active switch are controlled through commands.

HE mode:
UMX home inputs can be used with encoders which provide one home pulse for the complete travel of the stage. The index input uses internal logic to establish the home position when used with the HE command mode. The default home position consists of the logical AND of the encoder index pulse, the home enable external input (LOW true only) and a single quadrant from the encoder logic. The home enable pulse must be true for less than one revolution of the encoder thus allowing only one home for the complete travel of the stage. The home logic expressed in Boolean terms is:

$$\text{Home} = \text{PhaseA} \times \overline{\text{PhaseB}} \times \text{Index} \times \overline{\text{Home Switch}}$$

It is necessary that the above quadrant occur within the index pulse as provided by the encoder for this logic to function properly. It may be necessary with some encoders to shift the phase of this quadrant by inverting one or both of the phases. Inverting one phase or swapping Phase A for Phase B will also reverse the direction. The encoder counter (read by a RE command) must increase for positive moves or the system will oscillate due to positive feedback. This is the default for the HE mode and is compatible with the PC68 family.
NOTE: The UMX has additional options for the HE mode. (See details in the HE command description.)

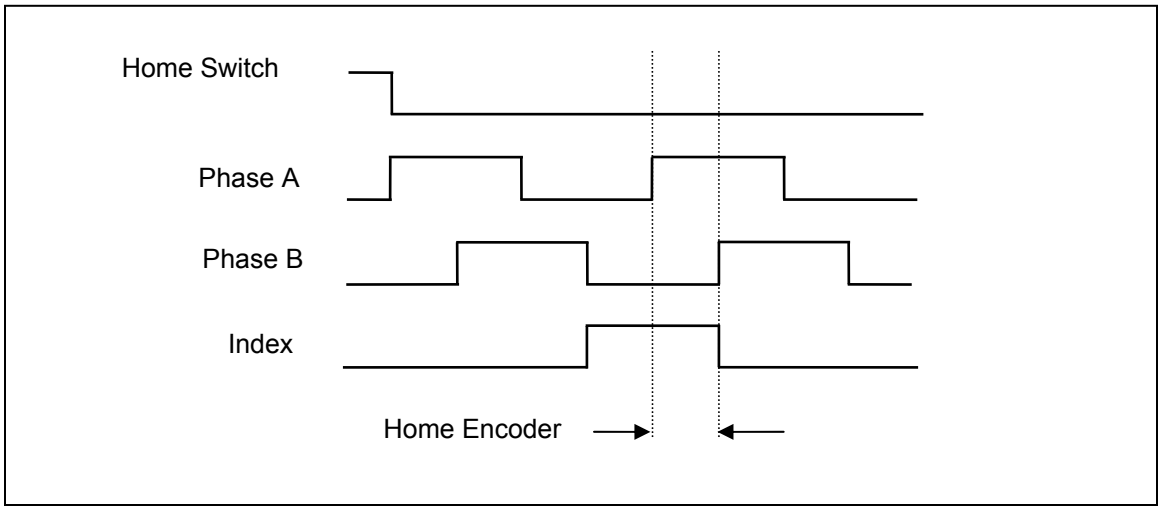

FIGURE 4-6 ENCODER HOMING STATE DETECTION (DEFAULT)

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5. COMMAND STRUCTURE

5.1. INTRODUCTION

An extensive command structure is built into the UMX family of intelligent motor controls. It includes over 200 commands, a parameter buffer for each axis, and a command loop counter which allows for multiple executions of almost any command string. Please visit the http://www.omsmotion.com/ website for the latest product releases.

The following commands in this section are included in the UMX family of controllers. Most of the commands are two ASCII characters and may be in upper or lower case. Some of the commands expect a numerical operand to follow. These commands are identified with "#" after the command. The operand must be terminated by a space, carriage return, or semi-colon to indicate the end of the number. No terminator is required on the other commands, but it is recommended to improve readability. Semi-colons are the preferred termination character because they are visible in your code. The operand must immediately follow the command with no space or separation character. The "#" indicates a signed integer input parameter or a signed fixed point number of the format ##.# when user units are enabled. With user units enabled distances, velocity and acceleration parameters may be input in inches, revolutions, etc.

Some commands that are usable in both single-axis and multi-axis modes do not take a parameter in single-axis mode. These commands require numeric parameters in multi-axis modes, and the parameters indicate whether of not to take action for each axis. If a parameter exists for an axis, then the command affects that axis and if the parameter does not exist for that axis, then the command has no affect on that axis. For example, the single-axis format of LN (Limits On) is simply "LN" without any parameters of any kind. The multi-axis format of LN is "LNb,b,b,b;" for 4-axis systems where 'b' represents the parameter for the corresponding axis. Like other multi-axis commands, a 'b' parameter may be omitted if that axis is to remain unchanged and the command may be prematurely terminated with a semicolon. Each 'b' position, if used, can be any numeric value. For example, to enable the Y and Z axes limit switches and leave the X and T axes unchanged, send the command "LN,1,100;". The 1 and 100 parameters could be any numeric value whatsoever, and the effect of the command would be the same. For example, the following commands are equivalent:

"LN,1,1;"

"LN,0,0;"

"LN,50,99;"

Synchronized moves may be made by entering the AA command. This command performs a context switch which allows entering the commands in the format MRx#,y#,z#,t#, Numbers are entered for each axis which is to be commanded to move. An axis may be skipped by entering a comma with no parameter. The command may be prematurely terminated with a ";", i.e. a move requiring only the X and Y axes would use the command MRx#,y#; followed by the GO command. Each axis programmed to move will start together upon executing the GO command. The UMX can be switched back to the unsynchronized mode by entering the desired single axis command such as AX.

The AM command is provided for complex applications where the host manages multiple motion processes by a multitasking operating system. This mode shares the same

instructions as the AA mode, but allows starting a task while some other task involving one or many axes is active. For example, the X and Y axes could be doing linear interpolation while the Z axis is making an unrelated move simultaneously.

Constant velocity contouring provides another mode wherein the move parameters are predefined by entering AA then CD. The UMX will then calculate the move profile in advance and move at constant velocity in the prescribed pattern. It can do linear interpolation on as many as 4 axes between the predefined points or it can do circular interpolation mixed with linear on two axes.

5.2. COMMAND QUEUES

The input characters are placed in a character buffer on input then removed and interpreted. The commands are then placed in separate command queues for each axis. As they are executed the space is reclaimed allowing the host to pass commands ahead of the moves actually being processed. Most of the commands are placed in the appropriate command queue for execution, while others are executed immediately allowing return of status information in a timely manner rather than when encountered in the command stream. This information is provided in a table for each command which shows the queue requirements, if any, and indicates immediate in those cases where the command is not queued. The queue requirements shown in the tables are typical. Depending on the circumstances in which the command is issued, the actual queue requirement may vary slightly. The single axis cases are indicated by the mode reference indicating the appropriate axis. The synchronized mode is indicated by the mode identifier AA or AM. The contouring case is indicated by AA/CD for multiple axes in contour definition mode. The RQ command may be used to determine the actual space available at any time. The queues operate independently allowing each axis to perform separate processes concurrently. The synchronized modes (AA) insert special wait op-codes which allow the axes to be synchronized in this mode. When the commands are nested within loops, the queue space is not reclaimed until after the loop has been executed the programmed number of times. For loops larger than the queue space, the loop may never be completed since it cannot reclaim the queue space and cannot accept the loop terminator. The RQ command may be used to examine the remaining queue space. A Control-D may clear this condition if the input character queue is not also filled since it bypasses the command interrupter.

Some commands are valid only for stepper axes, others for stepper axes with encoder feedback, and still others for servo axes. Most are valid for all three types or some combination of types. A set of symbols to the right of each command identifies which motor types with which each command may be used. The symbols' meanings are as follows:


Stepper motor with or without an encoder


Stepper motor with an encoder


Servo motor

If a command is usable with one of these motor types, the symbol will appear in black. If the command is not usable with a motor type, that motor symbol will be displayed in gray:


This command is not usable with servo motors


Indicates an example.

5.3. COMMAND SUMMARY

The following commands are included in the UMX family of motor controllers.

ALPHABETICAL COMMAND SUMMARY C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
AA	5-25	C	Any following commands are for the AA mode
AC	5-26	C	Set acceleration/deceleration register
?AC	5-27	Q	Report AC command
?AD	5-27	Q	Report default auxiliary bit state
ADH	5-28	C	Set auxiliary default to high
ADL	5-29	C	Set auxiliary default to low
AF	5-30	C	Auxiliary off
AM	5-31	C	Axes multitasking mode
AN	5-32	C	Auxiliary on
AP	5-33	C	Make the current parameter set the power up default values
?AQ	5-34	Q	Query current axis
AT	5-34	C	Any following commands are for the T axis
AX	5-35	C	Any following commands are for the X axis (default on reset)
AY	5-35	C	Any following commands are for the Y axis
AZ	5-36	C	Any following commands are for the Z axis
?BD	5-36	Q	Report the direction of a general purpose I/O
BH	5-37	C	Set selected I/O bit high (off)
BI	5-38	C	Bipolar, set the analog torque outputs to bipolar
BL	5-39	C	Set selected I/O bit low (on)
BS	5-40	C	Set all bits of the general purpose output port to the state specified by the hex argument
?BS	5-41	Q	Report the state of the specified I/O bit
BW	5-41	C	Wait for input to go low
BX	5-42	Q	Report bit status in hex format
CA	5-43	C	Clear done flag of currently addressed axis
CB	5-43	C	Clear all macro links to input bits
CD	5-44	C	Define a contour
CE	5-46	C	End contour definition, ramp to a stop
CG	5-47	C	Execute a constant velocity contour and prevent MT parsing
CK	5-49	C	End contour definition, immediately stop step pulses
CN	5-50	C	Cosine on, enable cosine velocity profiles
CR	5-51	C	Circular interpolation, move in a circle
CV	5-52	C	Contouring velocity, definition
CW	5-52	C	Clear while flag, i.e. terminate WH/WG loop
CX	5-53	C	Contour execute
?DA	5-54	Q	Report a custom ramp
DAB	5-55	C	Define custom ramp breakpoint

ALPHABETICAL COMMAND SUMMARY C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
DAE	5-55	C	End custom ramp definition
DAR	5-56	C	Begin custom ramp definition
?DB	5-57	Q	Report direction bit logic
DBI	5-58	C	Invert direction bit
DBN	5-59	C	Normalize direction bit
DC	5-60	C	Set the deceleration rate that will be used by the GU command
?DE	5-61	Q	Report an acceleration ramp definition table entry
?DS	5-62	Q	Report the size of a custom acceleration ramp table
DZ	5-63	C	Offset coefficient, used in open-loop mode
?DZ	5-64	Q	Report DAC open-loop offset
EA	5-65	Q	Report encoder status axis
EF	5-66	C	Echo off, (default at power up)
EH	5-67	C	Encoder home definition
?EH	5-68	Q	Report encoder home
EN	5-69	C	Echo on, turn on echo to host
ER	5-70	C	Set encoder count to motor count ratio
?ER	5-71	Q	Report motor:encoder ratio
ES	5-72	C	Encoder slip/stall tolerance
?ES	5-73	Q	Report encoder slip/stall tolerance
ET	5-74	C	Encoder tracking
FL	5-75	C	Flush an axis command queue
FP	5-76	Q	Force position, flush queue and attempt to stop
FX	5-77	C	Enable axis gantry mode
GD	5-78	C	Go and reset done flags
GN	5-80	C	Go and notify when done
GO	5-81	C	Go command, start execution of motion
GS	5-82	C	Go and use the home switch to monitor for motor slip/stall
GU	5-83	C	Go and use the AC values to accelerate and the DC values to decelerate
HD	5-84	C	Hold deadband, specify tolerance for position hold
?HD	5-84	Q	Report position maintenance deadband
HE	5-85	C	Encoder home mode, set home on encoder logic
HF	5-86	C	Hold off, disable position hold, slip/stall detection and tracking modes
HG	5-87	C	Hold gain, specify position hold gain parameter
?HG	5-87	Q	Report position maintenance gain
HH	5-88	C	Home high, home switches are active high
HL	5-89	C	Home low, home switches are active low
HM	5-90	C	Home, find home and initialize the position counter

ALPHABETICAL COMMAND SUMMARY C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
HN	5-92	C	Hold on, enable position correction after move
HR	5-93	C	Home reverse, find home in reverse direction and initialize position counter
HS	5-95	C	Home switch, enable home switch mode
HV	5-96	C	Hold velocity, specify maximum position hold correction velocity
?HV	5-97	Q	Report position maintenance velocity
IC	5-98	C	Interrupt clear, clear done interrupt status and error flags
ID	5-99	C	Interrupt host when done and set done flag
II	5-100	C	Interrupt independent
IN	5-101	C	Interrupt when nearly done
IO	5-102	C	Designates I/O bits as inputs or outputs
IP	5-103	C	Interrupt when in position
IS	5-104	C	Interrupt slip/stall, interrupts host on slip/stall detection
IX	5-105	C	Interrupt when done. Sends Hex character via RS-232
JF	5-106	C	Jog at fractional rates
JG	5-107	C	Jog command, run motor at specified velocity
KA	5-109	C	Acceleration feedforward coefficient, used in tuning servo systems
?KA	5-109	Q	Report acceleration feedforward
KB	5-110	C	PID upper bound limit coefficient
?KB	5-110	Q	Report axis PID upper bound limit
KD	5-111	C	Derivative gain coefficient, used for PID filter
?KD	5-111	Q	Report PID derivative gain
KF	5-112	C	Set servo axis PID friction coefficient
?KF	5-112	Q	Report servo axis friction offset
KI	5-113	C	Integral gain coefficient, used for PID filter
?KI	5-113	Q	Report PID integral gain
KL	5-114	C	Kill
KM	5-115	C	Home and kill pulse generation
KO	5-116	C	Offset coefficient, used in closed-loop mode
?KO	5-116	Q	Report PID closed-loop offset
KP	5-117	C	Proportional gain coefficient, used for PID filter
?KP	5-117	Q	Report PID proportional gain
KR	5-118	C	Home in reverse and kill pulse generation
KS	5-119	C	Kill selected axes
KU	5-120	C	PID integration sum upper limit
?KU	5-120	Q	Report PID integration sum upper limit
KV	5-121	C	Velocity feedforward coefficient, used in tuning servo systems
?KV	5-121	Q	Report velocity feedforward
LA	5-122	C	Linear ramp selection per axis
LE	5-123	C	Loop end, terminate most recent LS command
LF	5-124	C	Disable limit switches for selected axis

ALPHABETICAL COMMAND SUMMARY C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
LH	5-125	C	Limit high, limit switch is active high
LL	5-126	C	Limit low, limit switch is active low
LN	5-127	C	Enable limit switches for selected axis
LO	5-128	C	Load monitor position
LP	5-129	C	Load position
LS	5-130	C	Loop start
?LS	5-132	Q	Report limit active state
MA	5-133	C	Move absolute, move to absolute position
MD	5-135	C	Define a temporary macro
ML	5-136	C	Move linear
MM	5-137	C	Move minus
MP	5-137	C	Move plus
MR	5-138	C	Move relative
MT	5-140	C	Move to
MV	5-141	C	Move velocity
MX	5-143	C	Execute a macro command string
NV	5-143	C	Set a new contour velocity from with in a contour
PA	5-144	C	Power automatic
?PA	5-145	Q	Report power automatic state
PE	5-146	Q	Report encoder positions
PF	5-146	C	Parabolic off
PM	5-147	C	Print a macro command string
?PM	5-147	Q	Report PID state
PN	5-149	C	Parabolic on
PP	5-150	Q	Report motor positions of all axes
PR	5-151	C	Parabolic ramp selection per axis
PS	5-152	Q	Reports macro link to specified UMX input bit
PT	5-153	C	Preserve a temporary macro by copying it to non-volatile memory
QA	5-154	Q	Report status of switches and flags for addressed axis without affecting flags
QI	5-154	Q	Report status of switches and flags on all axes without affecting flags
QL	5-155	Q	Report the state of the limit sensor inputs
RA	5-156	Q	Report status of switches and flags and reset flags
RB	5-157	Q	Report programmed direction of I/O bits in hex format
RC	5-157	Q	Report current acceleration or deceleration of the current axis
RD	5-158	C	Restore the current parameter set to the power up default values
RE	5-158	Q	Request encoder position, return current encoder position
RF	5-159	C	Restore factory defaults
RI	5-159	Q	Report status of switches and flags for all axes and reset flags
RL	5-160	Q	Report slip/stall status of each axis

ALPHABETICAL COMMAND SUMMARY C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
RM	5-161	Q	Report remainder of position divided by parameter in position counter
RP	5-162	Q	Request position, returns current position
RQ	5-163	Q	Request queue status, return number of queue entries available
RS	5-163	C	Software reset of UMX
?RT	5-164	Q	Report ramp type
RU	5-165	Q	Return current position in user units
RV	5-166	Q	Return current velocity at which the axis is moving
SA	5-167	C	Stop all, flush queue and stops all axes with deceleration
SB	5-168	C	Sets the controller's serial communications baud rate
?SB	5-168	Q	Report current baud rate setting
SC	5-169	C	Cosine ramp selection per axis
SD	5-170	C	Stop all axes and clear any done flags
SE	5-171	C	Set settling time before power is reduced in PA mode
?SE	5-171	Q	Report settling time
SF	5-172	C	Soft limit off, restore normal overtravel operation
SI	5-173	C	Stop selected motors
SK	5-174	C	Links KILL function to specified UMX input bit
SL	5-175	C	Soft limit mode, allow pulse train to ramp down on overtravel
?SL	5-176	Q	Report soft limit status
SM	5-176	C	Enables/Disables stand-alone mode
SO	5-177	C	Stop at a designated position using a specified ramp down distance
?SO	5-178	Q	Report analog output mode
SP	5-178	C	Stop at position, stop at specified position if possible after all commands have been executed
SR	5-179	C	Selects custom ramp
ST	5-180	C	Stop, flush queue and decelerate to stop
?SV	5-181	Q	Report servo voltage inversion state
SVI	5-182	C	Invert servo voltage
SVN	5-182	C	Normalize servo voltage
SW	5-183	C	Sync wait, wait for the input bit to be released by other controllers
SX	5-185	C	Links macro to specified UMX input bit
TF	5-187	C	Turn encoder slip/stall kill off
TL	5-188	C	Set software travel limits
?TL	5-189	Q	Report software overtravel ranges
TM	5-190	C	Jog at the current velocity for the specified number of milliseconds
TN	5-191	C	Turn encoder slip/stall kill on
TX	5-192	C	Track the X axis

ALPHABETICAL COMMAND SUMMARY C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
UF	5-193	C	User units off, turn off user unit translation
UN	5-194	C	Unipolar, set the analog torque outputs to unipolar
UU	5-195	C	User units, multiply acceleration, velocity and distance parameters by specified parameter
?UU	5-196	Q	Report axis user units' axis assignment
VB	5-197	C	Base velocity, set base velocity
?VB	5-198	Q	Report axis base velocity
VL	5-199	C	Set maximum velocity to be used in profile
?VL	5-200	Q	Report axis velocity limit
VS	5-201	C	Velocity stream, slave velocity mode for profiling
WA	5-202	C	Wait until all moves on all axes are finished
WD	5-203	C	While end, WS loop terminator
WG	5-203	C	Terminate WH loop
WH	5-204	C	While, execute all commands until WG loop terminator, until flag cleared by CW command
WQ	5-206	C	Wait until current axis queue is empty
WS	5-207	C	While sync, execute while sync is true
WT	5-208	C	Wait, wait for specified number of milliseconds
WY	5-209	Q	Who are you, returns model and software revision

5.3.1. AXIS SPECIFICATION COMMANDS

The following commands set the context to direct the commands which follow to the appropriate axis. They remain in effect until superseded by another command of the same type, specifying a different axis.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
AA	5-25	C	Any following commands are for the AA (All Axes) mode
AM	5-31	C	Axes multitasking mode
AT	5-34	C	Any following commands are for the T axis
AX	5-35	C	Any following commands are for the X axis (default on reset)
AY	5-35	C	Any following commands are for the Y axis
AZ	5-36	C	Any following commands are for the Z axis
?AQ	5-34	Q	Query current axis

5.3.2. SYSTEM CONTROL COMMANDS

These commands allow control of various system parameters and operating modes to allow the user to optimize the response of the system for his/her application needs.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
AP	5-33	C	Make the current parameter set the power up default values
?DB	5-57	Q	Report motor direction bit logic
DBI	5-58	C	Invert motor direction bit
DBN	5-59	C	Normalize motor direction bit
EF	5-66	C	Echo off, turn off echo to host (default at power up)
EN	5-69	C	Echo on, turn on echo to host
HL	5-89	C	Home low, home switches are active low
HH	5-88	C	Home high, home switches are active high
LF	5-124	C	Disable limit switches for selected axis
LH	5-125	C	Limit high, limit switch is active high
LL	5-126	C	Limit low, limit switch is active low
LN	5-127	C	Enable limit switches for selected axis
?LS	5-132	Q	Report limit active state
PR	5-151	C	Parabolic ramp selection per axis
RD	5-158	C	Restore the current parameter set to the power up default values
RF	5-159	C	Restore the current parameter set to the factory default values
RS	5-163	C	Software reset of UMX
SF	5-172	C	Soft limit off, restore normal overtravel operation
SL	5-175	C	Soft limit mode, allow pulse train to ramp down on overtravel
?SL	5-176	Q	Report soft limit status
?SV	5-181	Q	Report servo voltage invert selection
SVI	5-182	C	Invert servo voltage
SVN	5-182	C	Normalize servo voltage
TL	5-188	C	Set software travel limits
?TL	5-189	Q	Report software overtravel ranges

5.3.3. ACCELERATION RAMP COMMANDS

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
CN	5-50	C	Cosine on, enable cosine velocity profiles
?DA	5-54	Q	Report a custom ramp
DAB	5-55	C	Define custom ramp breakpoint
DAE	5-55	C	End custom ramp definition
DAR	5-56	C	Begin custom ramp definition
?DE	5-61	Q	Report an acceleration ramp definition table entry
?DS	5-62	Q	Report the size of a custom acceleration ramp table
LA	5-122	C	Linear ramp selection per axis
PF	5-146	C	Parabolic off, disable parabolic ramps, i.e. linear ramps will be generated
PN	5-149	C	Parabolic on, enable parabolic ramps
?RT	5-164	Q	Report ramp type
RS	5-163	C	Software reset of UMX
SC	5-169	C	Cosine ramp selection per axis
SR	5-179	C	Selects custom ramp

5.3.4. USER I/O COMMANDS

The following commands are for accessing the bit I/O functions of the board. See also the SW (page 5-183) and WS (page 5-207) commands.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
?AD	5-27	Q	Report default auxiliary bit state
ADH	5-28	C	Set auxiliary default to high
ADL	5-29	C	Set auxiliary default to low
AF	5-30	C	Auxiliary off
AN	5-32	C	Auxiliary on
?BD	5-36	Q	Report the direction of a general purpose I/O
BH	5-37	C	Set selected I/O bit high (off)
BL	5-39	C	Set selected I/O bit low (on)
BS	5-40	C	Set all bits of the general purpose output port to the state specified by the hex argument
?BS	5-41	Q	Report the state of the specified I/O bit
BX	5-42	Q	Return bit status in hex format
IO	5-102	C	Designates I/O bits as inputs or outputs
PA	5-144	C	Power automatic
?PA	5-144	Q	Report power automatic state
RB	5-157	Q	Report programmed direction of I/O bits in hex format
SE	5-171	C	Set settling time before power is reduced in PA mode
?SE	5-171	Q	Report settling time

5.3.5. MOVE SPECIFICATION COMMANDS

These commands allow specification of move parameters. They allow move parameters to be tailored to the user's system requirements.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
AC	5-26	C	Acceleration, set acceleration/deceleration register
?AC	5-27	Q	Report AC command
DC	5-60	C	Set the deceleration rate that will be used by the GU command
LP	5-129	C	Load position, load position counter with parameter
MA	5-133	C	Move absolute, move to absolute position
ML	5-136	C	Move linear, move specified distance relative from current position
MR	5-138	C	Move relative, move specified distance from current position
MT	5-140	C	Move to, move to specified position
VB	5-197	C	Base velocity, set base velocity
?VB	5-198	Q	Report axis base velocity
VL	5-199	C	Set maximum velocity to be used in profile
?VL	5-200	Q	Report axis velocity limit

5.3.6. MOVE EXECUTION COMMANDS

These commands allow execution of the moves which have been previously specified.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
GD	5-78	C	Go and reset done flags
GN	5-80	C	Go and notify when done
GO	5-81	C	Go command, start execution of motion
GS	5-82	C	Go and use the home switch to monitor for motor slip/stall
GU	5-83	C	Go and use the AC values to accelerate and the DC values to decelerate
JG	5-107	C	Jog command, run motor at specified velocity until a new velocity command is sent or it is stopped by a stop or kill command
JF	5-106	C	Jog at fractional rates
TM	5-190	C	Jog at the current velocity for the specified number of milliseconds
VS	5-201	C	Velocity stream, slave velocity mode for profiling

5.3.7. MOVE TERMINATION COMMANDS

The following commands allow termination of move sequences in process.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
FL	5-75	C	Flush an axis command queue
KL	5-114	C	Kill, flush queue and terminate pulse generation immediately on all axes without decelerating
KS	5-119	C	Kill selected axes
SA	5-167	C	Stop all, flush queue and stops all axes with deceleration
SD	5-170	C	Stop all axes and clear any done flags
SI	5-173	C	Stop selected motors
SO	5-177	C	Stop at a designated position using a specified ramp down distance
ST	5-180	C	Stop, flush queue and decelerate to stop

5.3.8. LOOP CONTROL COMMANDS

These commands allow move sequences to be repeated within loops. Loops can be nested up to four levels deep on each axis.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
CW	5-52	C	Clear while flag, i.e. terminate WH/WG loop
LE	5-123	C	Loop end, terminate most recent LS command
LS	5-130	C	Loop start, set loop counter, from 1 to 32000 loops; (may be nested to 4 levels)
WD	5-203	C	While end, WS loop terminator
WG	5-203	C	Terminate WH loop
WH	5-204	C	While, execute all commands until WG loop terminator, until flag cleared by CW command
WS	5-207	C	While sync, execute while sync is true

5.3.9. INITIALIZATION AND HOME CONTROL COMMANDS

These commands allow the initialization of the physical stage with the controller.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
HM	5-90	C	Home, find home and initialize the position counter
HR	5-93	C	Home reverse, find home in reverse direction and initialize position counter
KM	5-115	C	Home and kill pulse generation
KR	5-118	C	Home in reverse and kill pulse generation

5.3.10. MOVE SYNCHRONIZATION COMMANDS

These commands allow the synchronization of moves with external events or multiple axis sequences.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
BW	5-41	C	Wait for input to go low
CA	5-43	C	Clear done flag of currently addressed axis
IC	5-98	C	Interrupt clear, clear done interrupt status and error flags
ID	5-99	C	Interrupt host when done and set done flag
II	5-100	C	Interrupt independent
IN	5-101	C	Interrupt when nearly done
IP	5-103	C	Interrupt when in position
IX	5-105	C	Interrupt when done. Sends Hex character via RS-232
SW	5-183	C	Sync wait, wait for the input bit to be released by other controllers
WA	5-202	C	Wait until all moves on all axes are finished
WQ	5-206	C	Wait until current axis queue is empty
WT	5-208	C	Wait, wait for specified number of milliseconds

5.3.11. SYSTEM STATUS REQUEST COMMANDS

These commands allow the host to request the status of various move parameters, including the status of limit and home switches.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
BX	5-42	Q	Return bit status in hex format
PE	5-146	Q	Report encoder positions of all encoder and servo axes
PP	5-150	Q	Report motor positions of all axes
QA	5-154	Q	Report status of switches and flags for addressed axis without affecting flags
QI	5-154	Q	Report status of switches and flags on all axes without affecting flags
QL	5-155	Q	Report the state of the Limit Sensor inputs
RA	5-156	Q	Report status of switches and flags and reset flags
RC	5-157	Q	Report current acceleration or deceleration of the current axis
RI	5-159	Q	Report status of switches and flags for all axes and reset flags
RM	5-161	Q	Report remainder of position divided by parameter in position counter
RP	5-162	Q	Request position, returns current position
RQ	5-163	Q	Request queue status, return number of queue entries available
RU	5-165	Q	Return current position in user units
RV	5-166	Q	Return current velocity at which the axis is moving
WY	5-209	Q	Who are you , returns model and software revision

5.3.12. AXIS SCALING COMMANDS

The following commands allow specification of move parameters in user defined units. The OMS controls will automatically convert all move parameters to these units once they have been initialized.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
ER	5-70	C	Encoder ratio, set encoder count to motor count ratio
?ER	5-71	Q	Report motor:encoder ratio
UF	5-193	C	User units off, turn off user unit translation
UU	5-195	C	User units, multiply acceleration, velocity and distance parameters by specified parameter
?UU	5-196	Q	Report axis user units' axis assignment

5.3.13. PID FILTER CONTROL COMMANDS

The following commands are valid only for servo axes and should never be executed while the specific axis is in motion.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
BI	5-38	C	Bipolar, set the analog torque outputs to bipolar
DZ	5-63	C	Offset coefficient, used in open-loop mode
?DZ	5-64	Q	Report DAC open-loop offset
HF	5-86	C	Hold off, disables PID filter
HN	5-92	C	Hold on, enables PID filter
KA	5-109	C	Acceleration feedforward coefficient, used in tuning servo systems
?KA	5-109	Q	Report acceleration feedforward
KB	5-110	C	PID Upper Bound Limit Coefficient
?KB	5-110	Q	Report AXIS PID upper Bound limit
KD	5-111	C	Derivative Gain coefficient, used for PID filter
?KD	5-111	Q	Report PID derivative gain
KF	5-112	C	Set Servo axis PID friction coefficient
?KF	5-112	Q	Report servo axis friction offset
KI	5-113	C	Integral Gain coefficient, used for PID filter
?KI	5-113	Q	Report PID integral gain
KO	5-116	C	Offset coefficient, used in closed-loop mode
?KO	5-116	Q	Report PID closed-loop offset
KP	5-117	C	Proportional Gain coefficient, used for PID filter
?KP	5-117	Q	Report PID proportional gain
KU	5-120	C	PID integration sum upper limit
?KU	5-120	Q	Report PID integration sum upper limit
KV	5-121	C	Velocity feedforward coefficient, used in tuning servo systems
?KV	5-121	Q	Report velocity feedforward
?PM	5-147	Q	Report PID state
?SO	5-178	Q	Report analog output mode
UN	5-194	C	Unipolar, set the analog torque outputs to unipolar

5.3.14. POSITION MAINTENANCE COMMANDS

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
FX	5-77	C	Enable axis gantry mode
HD	5-84	C	Hold deadband, specify deadband tolerance for position hold
?HD	5-84	Q	Report position maintenance deadband
HG	5-87	C	Hold gain, specify position hold gain parameter
?HG	5-87	Q	Report position maintenance gain
HF	5-86	C	Hold off, disable position hold, slip/stall detection and tracking modes
HN	5-92	C	Hold on, enable position correction after move
HV	5-96	C	Hold velocity, specify maximum position hold correction velocity
?HV	5-97	Q	Report position maintenance velocity
IP	5-103	C	Interrupt when in position
LO	5-128	C	Set axis motor position but not the encoder position
TX	5-192	C	Track the X axis

5.3.15. SLIP AND STALL DETECTION COMMANDS

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
ES	5-72	C	Encoder slip/stall tolerance, set tolerance before slip/stall is flagged
?ES	5-73	Q	Report encoder slip/stall tolerance
HF	5-86	C	Hold off, disable position hold, slip/stall detection and tracking modes
IS	5-104	C	Interrupt slip/stall, interrupts host on slip/stall detection
RL	5-160	Q	Report slip/stall status of each axis
TF	5-187	C	Turn encoder slip/stall kill off
TN	5-191	C	Turn encoder slip/stall kill on

5.3.16. ENCODER TRACKING COMMANDS

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
ET	5-74	C	Encoder tracking, set encoder tracking mode
HF	5-86	C	Hold off, disable position hold, slip/stall detection and tracking modes

5.3.17. ENCODER HOME CONTROL COMMANDS

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
EH	5-67	C	Encoder home definition
?EH	5-68	Q	Report encoder home
HE	5-85	C	Encoder home mode, set home on encoder logic
HS	5-95	C	Home switch, enable home switch mode

5.3.18. ENCODER STATUS REQUEST COMMANDS

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
EA	5-65	Q	Encoder status, return encoder status of currently addressed axis
PE	5-146	Q	Report encoder positions of all encoder and servo axes
RE	5-158	Q	Request encoder position, return current encoder position

5.3.19. VELOCITY STAIRCASE COMMANDS

The following commands describe the velocity staircase mode. This mode is useful in applications requiring a change in velocity at a prescribed position without stopping.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
FP	5-76	C	Force position, flush queue and attempt to stop at specified position
MM	5-137	C	Move minus, set minus direction for MV type move
MP	5-137	C	Move plus, set positive direction for MV type move
MV	5-141	C	Move velocity, move to first parameter (absolute position) at second parameter velocity without stopping at end of move
SP	5-178	C	Stop at position, stop at specified position if possible after all commands have been executed

5.3.20. CONSTANT VELOCITY CONTOURING COMMANDS

The UMX will attempt to generate any profile which it is asked to do. It is the responsibility of the host to be sure the acceleration required when generating a circle or any other change in direction is possible within the mechanical constraints of the system. All corners must be defined by arcs and tangents to those arcs, else the change in direction will be instantaneous and generate very large accelerations. The arc radius must be chosen so that the acceleration constraints of the system are met.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
CD	5-44	C	Define a contour
CE	5-46	C	End contour definition, ramp to a stop
CG	5-47	C	Execute a constant velocity contour and prevent MT parsing
CK	5-49	C	End contour definition, immediately stop step pulses
CR	5-51	C	Circular interpolation, move in a circle
CV	5-52	C	Contouring velocity, definition
CX	5-53	C	Contour execute
MT	5-140	C	Move to, move to specified position
NV	5-143	C	Set a new contour velocity from with in a contour
RQ	5-163	Q	Request queue status, return number of queue entries available

5.3.21. MACRO CONTROL COMMANDS

Macros are typically used as a shortcut to save some keystrokes. They can be used to save common parameter settings that may need to be recalled. They can also be used to store common command sequences that may be used for a particular process.

Once macros are defined, an entire command sequence can be sent to the controller through just executing the MX command and the appropriate macro number. As a result, sending a stream of frequently used commands to the controller is done simply through the use of one command. Detailed information regarding the macro commands is shown below.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
MD	5-135	C	Define a temporary macro
MX	5-143	C	Execute a macro command string
PM	5-147	Q	Print a macro command string
PT	5-153	C	Preserve a temporary macro by copying it to non-volatile memory

5.3.22. STAND-ALONE COMMANDS

The Stand-alone mode allows a UMX Motion Controller to run in a completely independent operation mode when powered by a separate +5 VDC power supply (for steppers) and ±12 VDC (for servos). This mode has several commands that can establish links to macros. When set up properly in this mode the UMX can scan for a predefined I/O Input bit, until it changes to the specified state Upon sensing that this condition has been met, it will execute the permanent Macro from Non-volatile flash memory that had been previously associated or linked with this I/O bit and its state.

A common application the stand-alone mode is to incorporate the KILL (KL) function. Reference the SK command. This will allow the user to stop motion of the device.

All of these selections are temporary. They can be made permanent by executing the AP command, which assigns the current parameter values as the Power Up defaults.

Note: The AP command should be used sparingly as it causes a write to the on board Flash Memory and there is a finite amount of times that it can be re-written to (i.e. less than 10,000 times, typical).

Application Overview:

The setup of the stand-alone mode is performed through the communication interface by the use of the commands. The user would define the required motion and processes and store them in a macro. Then, with the use of the commands below, the execution of the specific macros would be defined. Once all of the setup is completed the controller would be put in the stand-alone mode (SM) and the execution of the macros controlled by the defined input bits.

There are no queue requirements for these commands.

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
CB	5-43	C	Clear all macro links to input bits
PS	5-152	Q	Reports macro link to specified UMX input bit
SK	5-174	C	Links KILL function to specified UMX input bit
SM	5-176	C	Enables/Disables stand-alone mode
SX	5-185	C	Links macro to specified UMX input bit

5.3.23. SERIAL COMMUNICATION CONFIGURATION COMMANDS

COMMANDS SUMMARY BY SECTION			
C = COMMAND, Q = QUERY			
COMMAND	**PAGE #**	**TYPE**	**COMMAND DESCRIPTION**
SB	5-168	C	Sets the controller's serial communications baud rate
?SB	5-168	Q	Report current baud rate setting

5.3.24. COMMAND DEFINITIONS

AA ALL AXES

The AA command performs a context switch to multi-axis mode. All commands entered after this one will be treated as “all axes” commands which must be formatted for multi-axis use rather than single-axis use. Each command will be executed in the order in which it is received. This is true even if the second command affects axes other than those affected by the first command. For example, if AA mode is entered followed by a move of the X axis and then a move of the Y axis, the Y axis move will not begin until the X axis move has completed.

Example: Perform an absolute move using the X and Y axes. When this move is complete, perform a relative move using the Y, Z, and T axes.

Enter:
```
AA ;
MA12000,14000;
GO;
MR,5000,1500,100000;
GO;
```

Response: None

NOTE: This command changes the axis mode immediately, but has axis queue requirements because it places synchronization entries in all axis queues.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
AA;	AX - AT	1	1
AA;	AA-AM	1	1
-	AA/CD	Not Valid	

Related commands: AM, ?AQ, AT, AX, AY, AZ, CD

AC ACCELERATION

The AC command sets the acceleration/deceleration register to the operand which follows the command. The parameter must be greater than zero (zero is not valid) and less than 8,000,000, and the unit is in steps per second per second. All the following move commands for the axis being programmed will accelerate and decelerate at this rate until another AC command is entered. See the AP command, page 5-33 to preserve the AC settings as the power-up/reset values. The default value is 2,000,000.

RANGE: 1 ≤ AC ≤ 8000000

Note: The range denotes values after User Units have been applied. (See UU command.)

Example: In the single axis mode, set the Y axis acceleration to 200,000 counts per second per second.

Enter:
AY;
AC200000;

Response: None

Example: In the AA mode, set the acceleration of the X axis to 200,000 and the Z axis to 50,000 and leave the other axes with their previous values.

Enter:
AA ;
AC200000,,50000;

Response: None

QUEUE REQUIREMENTS				
FORMAT	**MODE**	**Axis Ramp Type**	**COMMAND**	**ARGUMENT**
AC#; or AC#,#,#,#;	AX-AT or AA-AM	Linear (LA or PF)	3	3
AC#; or AC#,#,#,#;	AX-AT or AA-AM	Short Parabolic (PN0; or PR0:)	3	5
AC#; or AC#,#,#,#;	AX-AT or AA-AM	All other parabolic forms	3	12
AC#; or AC#,#,#,#;	AX-AT or AA-AM	Custom Ramps (SR)	3	No. of ramp segments +12

Related commands: ?AC, DC, RC, VB, VL

?AC REPORT AC COMMAND

This command will reply with the current acceleration value for the selected axis.

Example: Report the current AC value for this axis.

Enter: ?AC

Response: ac200000<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?AC	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: AC

?AD REPORT DEFAULT AUXILIARY BIT STATE

This command reports the power up default selection for the axis aux bit.

Example: Report the power up state of the Y axis auxiliary bit

Enter: AY;
?AD

Response: adh<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?AD	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ADH, ADL

ADH SET AUXILIARY DEFAULT TO HIGH

The ADH command sets the default power up or reset state of the auxiliary line for the current axis to high. This change is stored as a power up parameter in flash automatically and need not be stored via the AP command. Since this command writes to non-volatile memory it should be used only when necessary and not in repeatedly called functions.

NOTE: This command will also archive all other parameter values as power up defaults.

Example: Set the power up state of the Z axis auxiliary line to high

Enter: AZ;
ADH;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
ADH;	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?AD, ADL

ADL SET AUXILIARY DEFAULT TO LOW

The ADL command sets the default power up or reset state of the auxiliary line for the current axis to low. This change is stored in nonvolatile memory automatically and need not be stored via the AP command. Since this command writes to non-volatile memory it should be used only when necessary and not in repeatedly called functions.

NOTE: This command will also archive all other parameter values as power up defaults.

Example: Set the power up state of the Y axis auxiliary line to low

Enter: AY;
ADL;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
ADL;	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?AD, ADH

AF AUXILIARY OFF

The AF command turns off the selected auxiliary outputs. That is, it causes the signal to be driven low. The AF command may be used to change power level on driver modules so equipped or as a user specified output. Note that this command will turn power automatic (PA) mode off.

Example: Turn off the Y axis auxiliary output in the single axis mode.

Enter:
AY;
AF;

Response: None

Example: Turn off the X and Z axes auxiliary outputs when in the AA command mode. The Y axis is unchanged in this example.

Enter:
AA;
AF1,,1;

Response: None

QUEUE REQUIREMENTS				
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**	**CONTOUR**
AF;	AX - AT	1	0	N/A
AFb,b,b,b;	AA-AM	1	0	N/A
AFb,b,b,b;	AA/CD	N/A	N/A	2*

*When AF is used in a contour definition the aux bits of all axes included in that definition will be turned off when the contour is executed.

Related commands: AN, BH, BL, BS, PA

AM AXES MULTITASKING

The AM mode allows several tasks to be managed simultaneously. This command changes the mode of all future commands to multi-axis mode. In this mode, a task may be performing coordination motion on 2 axes, while a second task is performing unrelated but simultaneous motion on another axis. All commands sent in this mode must be formatted for multi-axis mode rather than single-axis mode.

Example: Perform a coordinated relative move on the X and Y axes, while moving the T axis as a separate move at the same time.

Enter:
```
AM;
ML2000,3000;
GO;
MA,,,10000;
GO;
```

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
AM;	AX - AT	Immediate	
AM;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: AA, ?AQ, AT, AX, AY, AZ

AN AUXILIARY ON

The AN command turns on the selected auxiliary output ports. That is, it allows the signal to be pulled high. This is the default mode for the auxiliary line at power up or reset. The AN command may be used to change power level on driver modules so equipped, trigger another board's input or as a user specified output.

A parameter must be supplied for the desired axes when used in the AA mode so that the other axes are not affected. No parameter is required in a single axis mode. Note this command will turn power automatic (PA) mode off.

Example: Turn on the Y axis auxiliary output in the single axis mode.

Enter:
AY;
AN;

Response: None.

Example: Turn on the X and Z axes auxiliary outputs when in the AA command mode. The Y axis is unchanged in this example.

Enter:
AA;
AN1,,1;

Response: None.

QUEUE REQUIREMENTS				
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**	**CONTOUR**
AN;	AX - AT	1	0	N/A
ANb,b,b,b;	AA-AM	1	0	N/A
ANb,b,b,b;	AA/CD	N/A	N/A	2*

*When AN is used in a contour definition the Aux bits of all axes included in that definition will be turned on when the contour is executed.

Related commands: AF, BH, BL, BS, PA

AP ASSIGN CURRENT PARAMETERS AS POWER-UP DEFAULTS

The AP command stores the current parameter set as the power-up default set of values. This is done by writing the current parameter set to flash memory. The following list of parameters will have their values saved to flash memory when this command is used: AC, BI/UN, BR, EH, ER, ES, HD, HG, HH/HL, HV, KA, KB, KD, KF, KI, KO, KP, KU, KV, LA/SC/PR, LH/LL, LN/LF, PA0/PA1, SE, SF/SL, VB, VL, and UU,

Note: This command should not be issued when an axis is in motion and it should be used sparingly because the flash memory has a limited number of write cycles.

Example: Save the current parameter set to be the power up default set of values.

Enter: AP;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
AP;	AX - AT	Immediate	
AP;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: RF

?AQ QUERY CURRENT AXIS

The ?AQ command reports the mode that the current axis is in, i.e. AA mode, AM mode, etc.

Example: Determine the mode of the X axis.

Enter: AX;
?AQ

Response: ax<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?AQ	AX - AT	Immediate	
?AQ	AA-AM	Immediate	
?AQ	AA/CD	Immediate	

Related commands: AA, AM, AT, AX, AY, AZ

AT AXIS T

The AT command directs all following commands to the T axis. Commands sent in this mode will be executed in the order in which they are received (subject to queued versus immediate execution) and are expected to be formatted for single-axis use.

Example: Move the T axis to absolute position -2468.

Enter: AT;
MA-2468;
GO;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
AT;	AX - AT	Immediate	
AT;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: AA, AM, ?AQ, AX, AY, AZ

AX AXIS X

The AX command directs all following commands to the X axis. This is the default mode at power up or reset. Commands sent in this mode will be executed in the order in which they are received (subject to queued versus immediate execution) and are expected to be formatted for single-axis use.

Example: Make the X axis step at a rate of 5,000 steps/second.

Enter: AX;
JG5000;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
AX;	AX - AT	Immediate	
AX;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: AA, AM, ?AQ, AT, AY, AZ

AY AXIS Y

The AY command directs all following commands to the Y axis. Commands sent in this mode will be executed in the order in which they are received (subject to queued versus immediate execution) and are expected to be formatted for single-axis use.

Example: Examine the status of the Y axis.

Enter: AY;
RA

Response: PNNN<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
AY;	AX - AT	Immediate	
AY;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: AA, AM, ?AQ, AT, AX, AZ

AZ AXIS Z

The AZ command directs all following commands to the Z axis. Commands sent in this mode will be executed in the order in which they are received (subject to queued versus immediate execution) and are expected to be formatted for single-axis use.

Example: Move the Z axis 2,000 steps at a rate of 500 steps per second.

Enter:
AZ;
VL500;
MR2000;
GO;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
AZ;	AX - AT	Immediate	
AZ;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: AA, AM, ?AQ, AT, AX, AY

?BD REPORT BIT DIRECTION

The ?BD command reports if a general purpose I/O bit is an input or output.

Example: Find out whether I/O bit 2 is configured as an input or an output.

Enter: ?BD2;

Response: If the bit is an input the response will be: io0<LF>
An output bit response is: io1<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?BD	AX - AT	Immediate	
?BD	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: BH, BL, BX, IO, RB

BH BIT HIGH

The BH command turns the selected general purpose output off (i.e. logic high). The default state of general purpose outputs is off at power up or reset.

Note: Output bits should not be used as triggers for applying power to any device unless master power is applied separately and after the UMX is fully configured. The states of the outputs are unpredictable during power-up and reset and can toggle several times before settling at a high level.

Range: 0 ≤ bit number ≤ 7

Example: Set general purpose bits 4 and 5 to high.

Enter:
BH4;
BH5;

Response: None.

QUEUE REQUIREMENTS				
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**	**CONTOUR**
BH#;	AX - AT	1	1	N/A
BH#;	AA-AM	2	1	N/A
BH#;	AA/CD	N/A	N/A	2

Related commands: AF, AN, BL, BS, BX

BI BIPOLAR

The BI command sets the analog servo output of the current axis to bipolar. When bipolar is selected, a zero torque reference will result in a 0VDC output (+/- offset voltage). The analog output will range between +10VDC and -10VDC when bipolar is enabled. The BI command is valid only in the single axis mode and is the default mode at power up or reset.

Example: Set up servo axis X for bipolar operation.

Enter: AX;
BI;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
BI;	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: DBI, DBN, ?SO, SVI, SVN, UN

BL BIT LOW

The BL command turns the selected general purpose output line on (i.e. logic low). The default states of all output bits at power-up are logic high (off).The BS command can be used to set all outputs to a known state at once.

Note: Output bits should not be used as triggers for applying power to any device unless master power is applied separately and after the UMX is fully configured. The states of the outputs are unpredictable during power-up and reset and can toggle several times before settling at a high level.

RANGE: 0 < bit number < 7

Example: Turn on output bits 4 and 5 after a move. Note that this is only valid for output bits; input bits cannot be modified.

Enter:
```
AX;
MA1000;
GO;
BL4;
BL5;
```

Response: None.

QUEUE REQUIREMENTS				
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**	**CONTOUR**
BL#;	AX - AT	1	1	N/A
BL#;	AA-AM	2	1	N/A
BL#;	AA/CD	N/A	N/A	2

Related commands: AF, AN, BS, BX

BS BIT SET

Set all of the output bits to a known state at the same time. This command will affect all output bits, setting their states to the specified bit mask nearly simultaneously. The mask must be in ASCII hex format where the least significant bit (bit 0) is on the right. To set a line low, the corresponding bit in the hex mask must be a 0. A one (1) in any bit position will set the corresponding bit high.

Note: Output bits should not be used as triggers for applying power to any device unless master power is applied separately and after the UMX is fully configured. The states of the outputs are unpredictable during power-up and reset and can toggle several times before settling at a high level.

Range: 00 < Hex number < FF

Example: Assume I/O bit direction IO = FFFF, all outputs. Set output 0 high, 1-3 low, and 4-6 high (71 = (hex) 01110001)

Enter: BS71;

Response: None.

NOTE: Data written to input bits has no effect

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
BS#;	AX – AT	1	1
BS#;-	AA-AM	3	1
-	AA/CD	Not Valid	

Related commands: AF, AN, BH, BL, BX

?BS REPORT BIT STATE

The ?BS command reports the state of the specified general purpose I/O bit.

Example: Determine the state of I/O bit 6.

Enter: ?BS6;

Response: If the bit is set to a TTL high the response will be:
1<LF>
If the bit is set to a TTL low the response will be:
0<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?BS	AX - AT	Immediate	
-	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: BH, BL, BX

BW WAIT FOR INPUT TO GO LOW

The BW command is just like the SW command except that it waits for the input line to reach a TTL low rather than a TTL high. Refer to the SW command for more detail.

RANGE: 0 ≤ Bit Number ≤ 7

Example: See the examples for the SW (see page 5-183) command

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
BW#;	AX - AT	1	1
BW#;	AA-AM	3	1
-	AA/CD	Not Valid	

Related commands: SW, WA, WT, WQ

BX BIT REQUEST IN HEX

The BX command returns the states of the general purpose I/O bits in a hex format. The rightmost character represents the least-significant-nibble (4 bits) and, if the nibble is rewritten as bits, the rightmost bit is the least-significant bit. An input set low will be represented as a binary 0 and a high as binary 1, similarly for an output.

Example: Assuming the default I/O bit direction of IO = 00, bits 0-7 inputs
User input lines 0 and 2 are high and the remaining 6 inputs are low.
Use the BX commands to verify these states.

Enter: BX

Response: 05<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
BX	AX - AT	Immediate	
BX	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: BH, BL, BS

CA CLEAR AXIS DONE FLAG

The CA command operates like the IC command, except it clears the done flag of the addressed axis only. In multi-axis modes, the CA command clears the flags of all selected axes. Unlike the IC command, CA will not clear other error flags in the status register such as slip and limit.

Example: After a multi-axis move, clear the Z axis done flag only.

Enter:
```
AA;
MR1000,2000,3000,4000;
GO;
ID
AZ;
CA;
```

Response: None.

Example: After a multi-axis move, clear the Y and Z axis done flags only.

Enter:
```
AA;
MR1000,2000,3000,4000;
GO;
ID;
CA,1,1;
```

Response: None.

NOTE: In AA or AM mode, a null value in the argument list specifies the done bit of that axis is not to be cleared.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
CA;	AX - AT	Immediate	
CAb,b,b,b;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: GD, IC, ID, II, IN, IP

CB CLEAR MACRO LINKS

This command clears all macro links of input bits to macro executions and/or the KILL (KL) function.

Example: Clear all previously defined macro links to input bits.

Enter: CB;

Response: None

CD CONTOUR DEFINE

The CD command enters contour definition mode and defines a constant velocity contour. The only way to exit this mode is to issue a CE or CK command. Commands following the CD command must be in multi-axis format and be commands valid in CD mode. All multi-axis commands entered in CD mode can address only those axes assigned in the CD command. No commands entered will be executed until a CX command is received which must be issued outside of CD mode.

The CD command takes up to eight parameters. Each parameter specifies a starting point for each axis to be involved in the contour in absolute coordinates. If an axis is not to be involved in the contour, its parameter position should be skipped just as it would be in any other multi-axis command. Commands issued within CD mode must be formatted to include only those axes indicated in the CD command. Those that are not in the CD command simply do not exist in the formatting of commands entered in CD mode. For example, if a CD command is issued that uses the X, Y, and T axes (such as CD100,300,,400;), commands entered within CD mode will only consider the X, Y, and T axes. An MT command that moves X to 200, Y to 600, and T to 200 would take the form: MT200,600,200;. Note the lack of a placeholder comma for the Z axis.

Contours that will include circular interpolation (CR) must be defined for only 2 axes in the CD command. Contours involving more than 2 axes may not use the CR command. The size of the contour definition buffer for the UMX is 32,763 positions.

When the contour is executed, the UMX will use the distance between the current position and the contour starting point to linearly ramp up each axis such that all involved axes reach a combined, vectored velocity equal to the value set with the CV command. If this distance is zero, no ramp will be generated resulting in an instantaneous jump to contour velocity. Most stepper systems cannot achieve this and servos will tend to oscillate wildly before settling down if at all. Care should be taken to allow sufficient ramping distance between the contour starting position and the current position when the CX command is issued.

Once the contour is completely executed, the UMX will ramp the axes to a stop using the rate defined with the AC command. This ramp down will take each axis beyond the final point of the contour. Without manually calculating the ramp down distance for each axis, there is no way to force the contour to come to a complete stop at a predetermined point.

Example: The following demonstrates cutting a hole with a 10,000 count radius using constant velocity contouring and circular interpolation. The contouring velocity is set to 1000 pulses per second. A contour is then defined beginning at coordinates 0,0 on the X and Y axes. The auxiliary output of the Z axis is turned on, which could turn on the cutting torch or laser starting the cut at the center of the circle. A half circle is cut from the center to the outside of the hole, positioning the cutting tool at the start of the desired hole. The hole is then cut, the torch turned off, the stage stopped and the definition is complete. The stage is then positioned and the hole cut with the CX command. The AN and AF commands must have commas for all axes since they can all be addressed from within the contour definition.

Enter:

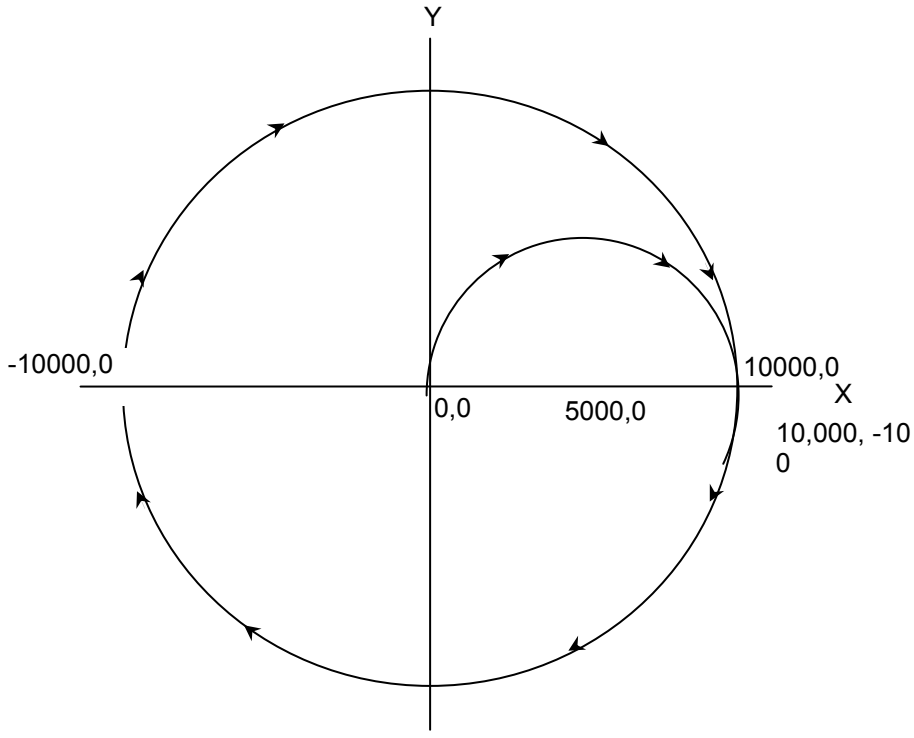
```
AA;
CV1000;
CD0,0;
```

```
AN,,1;
CR5000,0,-3.1415926;
CR0,0,-6.2831853;
AF,,0;
MT10000,-1000;
CE;
MT10000,0;
GO;
CX;
```

Response: None.

QUEUE REQUIREMENTS				
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**	**CONTOUR**
-	AX - AT	Not Valid		
CD#,#,#,#;	AA-AM	5 + number of axes in the contour		
-	AA/CD	N/A		

Related commands: AF, AN, BH, BL, CE, CK, CR, CV, CX, NV, MT



CE CONTOUR END

The CE command marks the end of the contour sequence. It will terminate the CD mode and, when executed, ramp to a stop and exit to the AA command mode. The end of the contour should contain at least a short linear segment just prior to the CE command to initialize the parameters for the deceleration of the stage.

Example: (see CD command on page 5-44)

QUEUE REQUIREMENTS				
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**	**CONTOUR**
-	AX – AT	Not Valid		
-	AA-AM	Not Valid		
CE;	AA/CD	N/A	N/A	2

Related commands: CD, CK

CG CONTOUR PRIORITY

The CG command is a form of the CX command, use if CE is followed by a MT command. When CG is used to execute the contour, the following MT commands will be on hold until the contour execution is complete. After the contour has been executed, the MT commands that follow can be parsed.

CG is preferred over the CX when the MT commands are issued after a contour is executed. The CG command ensures that the MT command that follows starts from a known position. This makes for a more accurate calculation of the MT move.

Example: See page 5-44 (CD), Make sure that the hole is completely cut before executing the move to the new command position.

Enter:
```
AA;
CV1000;
CD0,0;
AN,,1;
CR5000,0,-3.1415926;
CR0,0,6.2831853;
AF,,0;
MT10000,-1000;
CE;
MT-10000,0;
GO;
CG;
```

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
-	AX – AT	Not Valid	
CG;	AA-AM	7*	2*
CG;	AA/CD	Not Valid	

- If PA (power automatic) mode is selected add 2 to the command queue.
- If an aux bit settle time has been specified add 2 to the command queue and add 1 to the argument queue.
- If the axis is stepper and encoder or servo add 1 to the command queue.
- Add the following queue requirements for the ramp types listed.

QUEUE REQUIREMENTS		
Axis Ramp Type	**COMMAND QUEUE**	**ARGUMENT QUEUE**
Linear (PF, LA)	4	4
Short Form Parabolic (PN0, PR0)	4	8
All other Parabolic Forms (PN, PR)	4	22
Cosine (CN, SC)	4	22
Custom (SR)	4	(2*number of ramp segments) + 2

Related commands: AF, AN, BH, BL, CD, CK, CR, CV, CX, MT, NV

CK CONTOUR END AND KILL

The CK command will end the contour sequence, like the CE command, except there is no ramp down; i.e. motion will stop abruptly. It is used in place of the CE command.

NOTE: This command should be used with caution to prevent the stage from slipping or losing its correct position.

Example: Same scenario as CD command, but we want to end the contour with the minimum ramp down.

Enter:
```
AA;
CV1000;
CD0,0;
AN,,;
CR5000,0,-3.1415926;
CR0,0,-6.2831853;
AF,,0;
MT10000,-1000;
CK;
MT-1000,0;
GO;
CX
```

Response: None.

QUEUE REQUIREMENTS				
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**	**CONTOUR**
-	AX – AT	Not Valid		
-	AA-AM	Not Valid		
CK;	AA/CD	N/A	N/A	2

Related commands: CD, CE

CN COSINE ON

The CN command enables cosine velocity ramps; i.e. half sinusoid acceleration profiles, for all axes. The cosine profile is not truncated in moves cannot reach full velocity, but instead the velocity is reduced sufficiently to preserve the cosine profile. This command should not be given while an axis is in motion or the results may be unpredictable. This command affects all axes even if issued in the single axis mode. The PF command is used to return to linear motion profiles. See the AP command, page 5-33, to preserve the CN setting as the Power up/Reset ramp.

Example: Set the board to be in cosine mode.

Enter: CN;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
CN;	AX - AT	5	24
CN;	AA-AM	5	24
-	AA/CD	Not Valid	

Related commands: LA, PF, PN, PR, ?RT, SC, SR

CR CIRCULAR INTERPOLATION

The CR command defines a move in a circular pattern from the entry position. The first two parameters are the center of the circle in absolute units and the third parameter is the distance to move in radians. Positive radians equal counterclockwise movement. Negative radians equal counter clockwise movement. The radius of the circle is the linear distance between the current position and the first two parameters of the CR command.

The CR command generates a circle by breaking the circle into a series of linear segments. The number of segments will be equal to the total distance traveled divided by the contour velocity divided by the update rate. If finer resolution is required, the MT command may be used to produce smaller segments but the segments must be calculated by the user

RANGE:
Min Pos. Value ≤ Parameter 1 (First Coordinate for Center of Circle) ≤ Max Pos. Value
Min Pos. Value ≤ Parameter 2 (Second Coordinate for Center of Circle) ≤ Max Pos. Value

Note: The minimum and maximum position value depends on the settings used on UMX, see the specifications for more detail.

Example: (see CD command on page 5-44)

QUEUE REQUIREMENTS				
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**	**CONTOUR**
-	AX - AT	Not Valid		
-	AA-AM	Not Valid		
CR#,#,#;	AA/CD	N/A	N/A	8

Related commands: CD, MT

CV CONTOUR VELOCITY

The CV command allows specification of a contouring velocity. It is executed from the AA mode before a contour definition. A contour defined by a CD command cannot be executed if followed by a CV command. Changing this parameter will make any previously defined contours invalid. The contour velocity defaults to 1000 at power up or reset. Use WQ between contour definitions to avoid having a CV associated with a second contour definition affect a prior contour still in motion. A CV cannot be issued between a CD and CE command. To change the contour velocity within a contour definition, use the NV command.

RANGE: 1 ≤ CV ≤ 4,000,000

Example: (see CD command on page 5-44)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
-	AX - AT	Not Valid	
CV#;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: CD, NV

CW CLEAR WHILE

The CW command breaks the WH loop upon execution of the remaining commands in the loop; i.e. the current execution of the loop is finished. The WH loop is always executed at least one time since the test for the flag is at the bottom.

Example: (see WH command page 5-204)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
CW;	AX - AT	Immediate	
CW;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: WG, WH

CX CONTOUR EXECUTE

The CX command will execute the previously defined contour sequence. The stage must be positioned such that it can accelerate to speed by the absolute position specified by the CD command it is executing and must be traveling in the proper direction. Once a contour is defined it may be executed at any time by executing a CX command until it is replaced by another contour definition. The CX command cannot be placed within a loop or while construct.

Example: (see CD command on page 5-44)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
-	AX – AT	Not Valid	
CX;	AA-AM	6*	2*
-	AA/CD	Not Valid	

- If the axis is a stepper and encoder or servo add 1 to the command queue.
- If PA (power automatic) mode is active add 2 to the command queue.
- If an auxiliary output bit settle time has been specified add 2 to the command queue and add 1 to the argument queue.

QUEUE REQUIREMENTS		
Axis Ramp Type	**COMMAND QUEUE**	**ARGUMENT QUEUE**
Linear (PF, LA)	4	4
Short Form Parabolic (PN0, PR0)	4	8
All other Parabolic Forms (PN, PR)	4	22
Cosine (CN, SC)	4	22
Custom (SR)	4	(2*number of ramp segments) + 2

Related commands: CD, CE, CK, ID

?DA PRINT A CUSTOM RAMP

This command will report the entries of a previously defined custom ramp table.

RANGE: 1 ≤ Ramp Table Numbers ≤ 8

Example: Print out custom ramp table #2

Enter: ?DA2;

Response: DAR2<LF>
DAB0.10000000,0.20000000<LF>
DAB90000,0.80000000<LF>
DAB10000,1.00000000<LF>
DAE<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?DA#;	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: DAB, DAE, DAR, ?DE, ?DS

DAB DEFINE CUSTOM RAMP BREAKPOINT

The DAB command sets a breakpoint in a custom ramp table. This is the only command that should be used after DAR and before DAE. Each custom ramp may contain up to 25 breakpoints, each defined by a DAB command.

The DAB command takes two parameters; the first specifies the acceleration level that should be used to achieve the second parameter, velocity level. Both levels are expressed in terms of percentage in decimal format; i.e. 1.00 is 100%. At no time should a DAB command be entered in which the velocity parameter is less than the velocity parameter of the prior DAB. The UMX will not flag this as a command error but the results of such a ramp will be unpredictable. Each DAB command sent should be equal to or greater than the DAB command that preceded it. It is the user's responsibility to make sure this command is used properly.

RANGE:
0.0000000 ≤ Parameter 1 ≤ 1.00000000
0.0000000 ≤ Parameter 2 ≤ 1.00000000

Example: See the DAR command (page 5-56) for a complete example of a custom profile.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
DAB#,#;	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?DA, DAR, DAE, ?DS, ?DE, SR

DAE END CUSTOM RAMP DEFINITION

The DAE command terminates a custom ramp table definition initiated by the DAR command.

Example: See the DAR command (page 5-56) for a complete custom ramp table definition.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
DAE;	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?DA, DAR, DAB, ?DS, ?DE, SR

DAR BEGIN CUSTOM RAMP DEFINITION

The DAR command starts the definition of a custom ramp table. A parameter supplied with this command, from 1 to 8, specifies which ramp table to create. If a ramp table by that number has already been defined, it will be overwritten.

Once the DAR command has been issued, only the DAB and DAE commands will be valid. A series of ramp table breakpoints may be entered using the DAB command which define the profile breakpoints for this ramp table. Up to 25 breakpoints may be defined but a smaller number may be used. A ramp table containing no breakpoints is invalid and will result unpredictably if used.

RANGE: 1 ≤ DAR ≤ 8

Example: Create a ramp table definition resembling a jerk-limited linear profile.

Enter:	DAR3;	* Store as table #3
	DAB.1,.05;	* Ramp at 10% of AC until 5% of VL
	DAB.3,.1;	* Ramp at 30% of AC until 10% of VL
	DAB.9,.9;	* Ramp at 90% of AC until 90% of VL
	DAB.3,.95;	* Ramp at 30% of AC until 95% of VL
	DAB.1,1;	* Ramp at 10% of AC until 100% of VL
	DAE;	* End table definition

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
DAR#;	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?DA, DAB, DAE, ?DE, ?DS, SR

?DB REPORT DIRECTION BIT LOGIC

The ?DB command reports the direction bit logic: inverted or normal. If the direction bit is low when moving positive, this command will return 'normal'. If the direction bit has been inverted, this command will return inverted.

Example: Report whether the direction bit for the T axis is low or high when making positive moves

Enter: AT;
?DB

Response: dbi<LF> (The inverted result indicates the T axis direction bit is high for positive moves)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?DB	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: DBI, DBN, ?SV

DBI INVERT DIRECTION BIT

The DBI command inverts the logic of the direction control output of the addressed axis or axes. By default, the direction output of an axis is a TTL low when traveling in the positive direction and high when traveling negative. After using the DBI command, the direction bit will be high when traveling positive and low when traveling negative. This is useful for inverting the logical direction of a motor when the encoder counts opposite the motor direction. This command can be canceled using the DBN command. To make this the default at power up or reset, use the AP command.

Example: Set the direction outputs for axes Z and T to output high when traveling positive and low when traveling negative. Leaves X and Y as they are.

Enter:
AZ;
DBI;
AT;
DBI;
Or
AA;
DBI,,1,1;

Response: None.

Note: In AA or AM mode a null value in the argument list specifies that the sense of that direction bit is not to be changed.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
DBI;	AX - AT	1	0
DBIb,b,b,b;	AA-AM	1	0
-	AA/CD	Not Valid	

Related commands: BI, ?DB, DBN, SVI, SVN, UN

DBN NORMALIZE DIRECTION BIT

The DBN command normalizes the logic of the direction control output of the addressed axis or axes, returning their output logic to default; i.e. TTL low when traveling in the positive direction and high when traveling negative. This command negates the effect of the DBI command. To make this the default at power up or reset when DBI has already been made the default, use the AP command.

Example: Set the direction outputs for axes Z and T to default output logic; i.e. output high when traveling positive and low when traveling negative. Leave X and Y as they are.

Enter:
AZ;
DBN;
AT;
DBN;
Or
AA;
DBN,,1,1;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
DBN;	AX - AT	1	0
DBNb,b,b,b;	AA-AM	1	0
-	AA/CD	Not Valid	

Related commands: BI, ?DB, DBI, SVI, SVN, UN

DC DECELERATION

The DC command sets a deceleration rate overriding the AC parameter when the GU command is used to initiate a move. Only the GU command will use the DC value. The deceleration rate defaults to 200,000 and will take on whatever value is entered via the AC command. Therefore, the DC command must be reentered after using AC if a different deceleration rate is desired.

RANGE: 1 ≤ DC ≤ 1044000

Note: The range denotes values after User Units have been applied. (See UU command.)

Example: Send the Y axis on a 100,000 count move that accelerates at 100,000 counts per second per second up to 50,000 counts per second and decelerates at 20,000 counts per second per second.

Enter:
AY;
AC100000;
DC20000;
VL50000;
MR100000;
GU;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
DC#;	AX - AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: AC, GU, RC, VB, VL

?DE REPORT A CUSTOM RAMP TABLE ENTRY

The ?DE command will return a specific entry from a specific custom ramp table. The first parameter specifies the table to examine and the second parameter specifies the entry to return from the table.

RANGE:
1 ≤ Parameter1 ≤ 8
1 ≤ Parameter2 ≤ 25

Example: We can't remember what the 23rd breakpoint in table 4 was set to. Use the ?DE command to find out.

Enter: ?DE4,23;

Response: <LF> (there is no 23rd entry in table 4)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?DE#,#;	AX - AT	Immediate	
-	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: ?DA, DAB, DAE, DAR, ?DS

?DS REPORT THE SIZE OF A CUSTOM RAMP TABLE

The ?DS command returns the number of segments in the specified custom ramp table.

RANGE: 1 ≤ ?DS ≤ 8

Example: The 3rd custom ramp should be 17 breakpoints long. Make sure this is true.

Enter: ?DS3;

Response: 17<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?DS#;	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?DA, DAB, DAE, DAR, ?DE

DZ DEFINE ZERO POSITION IN OPEN-LOOP MODE

The DZ command defines the offset coefficient needed to produce a zero or stationary position by the servo motor. This command is used in the open-loop mode, hold off (HF). The factory default value is zero. See the AP Command on page 5-33 to preserve the DZ settings as the Power up/Reset values.

Power up/Reset values.

Value range: -32640 to +32640

Example: Define the offset coefficient to be 250 for the X axis.

Enter: AX;
DZ250;

Response: None

QUEUE REQUIREMENTS			
MODE	**Min (pf)**	**Max (pn/cn)**	**Custom ramp**
AY – AT	2	2	Not valid
AA-AM	Not Valid		
AA/CD	Not Valid		

Related commands: ?DZ, ?KO

?DZ REPORT DAC OPEN-LOOP OFFSET

The ?DZ command reports the current setting of the DZ command in DZ command format.

Example: The closed-loop offset needs to be set the same as the open-loop offset. We've already set the open-loop offset but forgot what value we used. Send the ?DZ command to find out.

Enter: ?DZ;

Response: dz28<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**Min**	**Max**
?DZ	AY – AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: DZ, ?KO

EA ENCODER STATUS

The EA command returns encoder status of the currently addressed axis or axes in the following format:

EA COMMAND RESPONSE DESCRIPTION		
CHAR	**SENT**	**DESCRIPTION**
1	LF	Line feed
2	CR	Carriage return
3	CR	Carriage return
4	E	Slip detection enabled
	D	Slip detection disabled
5	E	Position maintenance enabled
	D	Position maintenance disabled
6	S	Slip or stall detected (reset by execution of EA command)
	N	No slip or stall detected
7	P	Position Maintenance within deadband
	N	Position not within deadband
8	H	Axis is home
	N	Axis is not home
9	N	Unused/reserved
10	LF	Line feed
11	CR	Carriage return
12	CR	Carriage return

Example: Examine the status of the Y axis encoder.

Enter: AY;
EA

Response: DDNNNN<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
EA	AX - AT	Immediate	
EA	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: QA, QI, RA, RI

EF ECHO OFF

The EF command disables echoing from the UMX motion system. This is the default mode at power up or reset.

Example: Stop echoing to the host.

Enter: EF;

Response: None

QUEUE REQUIREMENTS			
MODE	**Min (pf)**	**Max (pn/cn)**	**Custom ramp**
AY – AT	Immediate		
AA-AM	Immediate		
AA/CD	Not Valid		

Related commands: EN

EH DEFINING ENCODER HOME

HH and HL commands are active in HE mode. This allows for an encoder home operation with the Home Switch being active HIGH. Previous OMS controllers required an active LOW Home Switch to do an encoder home operation, and this will be the "default" setting here as well. This command sets the true states of the A, B, and Index encoder signals and the true state of the Home Switch for the Encoder Home condition.

The new EHbbbb command provides variants that will completely determine the logic states of encoder signals A, B, Index, and Home Switch that make for a true encoder home event. This allows the user more flexibility to adapt to the schemes of most encoder manufacturers. All bbbb are ones (1) or zeros (0) representing the states of the Home Switch, Index, Phase B and Phase A, respectively, or X to indicate a “don’t care” condition.

Format: AX-AT: EHbbbb

All b’s are 0, 1, or X representing the states of Home Switch, Index, Phase B, and Phase A respectively. A 1 represents a high true state, a 0 represents a low true state, and an X represents a “don’t care” state.

Example: AX-AT: for the currently selected axis, the EH command: sets true states as follows:

EH1000; HomeHigh/Index low/PhaseB low/PhaseA low
EH0100; HomeLow/Index high/PhaseB low/PhaseA low
EH0010; HomeLow/Index low/PhaseB high/PhaseA low
EH0001; HomeLow/Index low/PhaseB low/PhaseA high
EH01XX; HomeLow/Index high/PhaseB “don’t care”/PhaseA “don’t care”

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
EHbbbb;	AX – AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?EH

?EH QUERY ENCODER HOME

The ?EH reports the state of the Home Switch, Index, Phase A and Phase B true states in both single axis and multi-axis modes. It is an immediate command and does not require any queue space.

Example: ?EH AX- AT Single axis mode

The controller's response to the ?EH command has the following meaning:

eh1000	HomeHigh/Index low/PhaseB low/PhaseA low
eh0100	HomeLow/Index high/PhaseB low/PhaseA low
eh0010	HomeLow/Index low/PhaseB high/PhaseA low
eh0001	HomeLow/Index low/PhaseB low/PhaseA high
eh01XX	HomeLow/Index high/PhaseB "don't care"/PhaseA "don't care"

NOTE: The encoder home pattern set by the EH command and the true logic state of the home switch as set by the HL or HH command are archived in the flash with the parameter archive commands.

The factory default encoder home pattern and home switch state would be the same as the current OMS standard home pattern, that is, Encoder Home pattern is Index HIGH, Phase A HIGH, Phase B LOW and the Home Switch is active LOW.

EN ECHO ON

The EN command enables echoing. All commands and parameters will be echoed to the host. This mode is useful for debugging command strings from a terminal. This mode also outputs an English readable error message to the host which may be echoed to the terminal or computer to aid in debugging.

Example: Enable echoing by the UMX so that commands are echoed and the error message is returned to the host as a readable ASCII string. This command would probably be the first command executed after turning on the system when this mode is desired.

Enter: EN;

Response: None

QUEUE REQUIREMENTS			
MODE	**Min (pf)**	**Max (pn/cn)**	**Custom ramp**
AX - AT	Immediate		
AA - AM	Immediate		
AA/CD	Not Valid		

Related commands: EF

ER ENCODER RATIO

The ER command allows specification of encoder:motor ratio for position maintenance mode. This command is not designed for use with servo motors. ER takes two arguments: encoder counts and motor counts. Both parameters must be integers unless user units (UU) are enabled. The ratio need not be per full revolution; reduce the fraction as far as possible and use those values.

The factory default ratio is 1:1. See the AP command, page 5-33, to preserve the ER settings as the Power up/Reset values.

NOTE: That if an encoder ratio has been defined by the ER command, then the slip tolerance defined by the ES command is defined in encoder units and not in motor units.

Parameter 1 = Encoder Count

Parameter 2 = Motor Counts

Example: You have an encoder connected to a stepper motor through a series of gears. When the motor steps 25,000 times, the encoder produces 10,000 counts. Set up an encoder ratio so hold mode will work correctly.

Enter:
ER10000,25000;
or
ER2,5;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
ER#,#;	AX - AT	1	0
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?ER

?ER REPORT MOTOR:ENCODER RATIO

The ?ER command reports the motor-to-encoder ratio as set with the ER command.

Example: Find out what the last ER command sent was.

Enter: ?ER

Response: er2.00000000<LF>
(The encoder produces 1 count for every 2 steps of the motor.)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?ER	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ER

ES ENCODER SLIP TOLERANCE

The ES command parameter specifies the slip detection tolerance before slip or stall is flagged in the status register and in the RL command response. The encoder may get off target by as much as this value before the UMX will consider the axis slipped. This mode must be turned on with an IS command and off with an HF command. The factory default value is 1. For servo motors, the default is 32,767. This value determines when the PID is disabled due typo excessive following error. See AP command (see page 5-33) to preserve the ES settings as the Power up/Reset values.

NOTE: If an encoder ratio is defined with the ER command, then the slip tolerance defined by the ES command is in encoder units and not in motor units.

NOTE: The GS command allows an open-loop stepper axis to perform a limited form of slip detection by using the home switch as a reference when executing a move command.

STEPPER RANGE: 0 ≤ ES ≤ 65,535

SERVO RANGE: 0 ≤ ES ≤ 327,670

Example: Your application can tolerate being up to 5 steps from the desired position before the controlling program should be notified of a slip condition.

Enter:
```
ES5;
IS;
```

Response: None.

NOTE: That if an encoder ratio has been defined by the ER command, then the slip tolerance defined by the ES command is defined in encoder units and not in motor units.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
ES#;	AX - AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?ES, IS, RL, TF, TN

?ES REPORT ENCODER SLIP TOLERANCE

The ?ES command reports the current value of the slip detect tolerance assigned to an axis.

Example: Report the current value for encoder slip detection tolerance

Enter: ?ES

Response: es15<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?ES	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ES

ET ENCODER TRACKING

The ET command turns on the encoder tracking mode. The axis will track its encoder input, thus allowing one axis to follow the activity of another or a thumbwheel for manual positioning or the movement of another device that produces a signal compatible to the encoder inputs. No acceleration or deceleration ramps are generated. The axis will duplicate the encoder input. The ER command allows the user to scale the motor's movements relative to the encoder. This command is intended to be used with stepper motors with encoders and not with servo motors.

Example: Set up the Y axis so it will follow its encoder input.

Enter: AY;
ET;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
ET;	AY – AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ER, HF

FL FLUSH

The FL command will flush an individual axis' queues. This command is similar in operation to the KL and ST commands except that current motion will remain unaffected by the FL command. All unexecuted commands remaining in the current axis queue will be flushed upon receipt of this command.

Example: Several motion commands have been sent to the X axis but a situation arose and now those commands must be cleared out. The currently executing motion must be allowed to complete to avoid damage to the product.

Enter:
AX;
FL;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
FL;	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: KL, KS, SA, ST

FP FORCE POSITION

The FP command will flush the command queue and attempt to stop at the specified position. The axis will overshoot if there is insufficient distance left to stop at the programmed acceleration. This command should not be given to a servo axis while it is in motion; the results may be unpredictable.

Example: Force axis to stop at 25,000.

Enter: FP25000;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
FP#;	AX - AT	2*	1*
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

— If PA (power automatic) mode is active add 1 to the command queue
— If an auxiliary output bit settle time has been specified add 2 to the command queue and add 1 to the argument queue

Related commands: MM, MP, MV, SP

FX ENABLE AXIS GANTRY MODE

The FX command pairs the current axis with the X axis to form a gantry crane. (i.e. the axis follows the X axis.)

Example: Pair the X and Y axis to form a gantry crane.

Enter: AY;
FX;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
FX;	AY – AT	1	0
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: None

GD GO AND RESET DONE

The GD command may be substituted for a GO command. It will reset the done flags and then initiate the move which has been previously programmed with such commands as MA, MR, MT, and ML just as the GO command does. In single axis mode, only the done flag for the selected axis will be reset.

In AA mode, all the done flags will be reset. In the AM mode, only the axes involved in the move will be reset. This allows the host to reset the interrupts on the axis involved in the next move without affecting other axes which may be still active. Note that this command is probably only useful in applications where commands are queued in advance since the interrupt may be reset before the host has the opportunity to service it if the GD command is waiting in the queue.

If this command is issued without having defined a move, the results are undefined. Issuing a GD command to execute an already-executed move also has undefined results. Only one GD command should be issued per defined move.

Example: In the single axis mode, move the Y axis 12345 counts in the negative direction and set the done flag when the move is completed. Then clear the done flag, move the motor 12345 counts in the positive direction, and set the done flag again when the move is completed.

Enter:
```
AY;
MR-12345;
GO;
ID;
MR12345;
GD;
ID;
```

Response: None.

Example: In AA mode, perform a linear absolute move with the X and Y axes to the position 10000, 20000 and set the done flag when the move is completed. Then clear the done flag, perform a linear relative move on both axes moving the X axis 10000 steps in the negative direction and the Y axis 20000 steps in the negative direction, and set the flag once again.

Enter:
```
AA;
MT10000,20000;
GO;
ID;
ML-10000,-20000;
GD;
ID;
```

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
GD;	AX - AT	6*	0*
GD;	AA-AM	8*	0*
-	AA/CD	Not Valid	

- If the axis is a stepper and encoder or servo axis add 1 to the command queue and add 2 to the argument queue.
- If PA (power automatic) mode is active add 2 to the command queue
- If an auxiliary output bit settle time has been specified add 2 to the command queue and add 1 to the argument queue

Related commands: GO, GN, GS, GU, MA, ML, MR, MT

GN GO AND NOTIFY WHEN DONE

The GN command will initiate a move which has been previously programmed with such commands as MA, MR, MT and ML and set the axis done flags when the move is complete. No operand is required with the GN command. If this command is issued without having defined a move, the results are undefined. Issuing a GN command to execute an already-executed move also has undefined results. Only one GN command should be issued per defined move.

Example: In the single axis mode, move the X axis to absolute position 12345.

Enter:
AX;
MA12345;
GN;

Response: None

Example: In the AA mode, move the X axis 2468 steps in the positive direction and the Y axis 2468 steps in the negative direction.

Enter:
AA;
MR2468,-2468;
GN;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
GN;	AX - AT	6*	0*
GN;	AA-AM	7*	0*
-	AA/CD	Not Valid	

- If the axis is a stepper and encoder or servo axis add 1 to the command queue and add 2 to the argument queue.
- If PA (power automatic) mode is active add 2 to the command queue
- If an auxiliary output bit settle time has been specified add 2 to the command queue and add 1 to the argument queue

Related commands: GD, GN, GS, GU, MA, ML, MR, MT

GO GO

The GO command will initiate a move which has been previously programmed with such commands as MA, MR, MT, and ML. No operand is required with the GO command. If this command is issued without having defined a move, the results are undefined. Issuing a GO command to execute an already-executed move also has undefined results. Only one GO command should be issued per defined move.

Example: In the single axis mode, move the X axis to absolute position 12345.

Enter:
AX;
MA12345;
GO;

Response: None

Example: In the AA mode, move the X axis 2468 steps in the positive direction and the Y axis 2468 steps in the negative direction.

Enter:
AA;
MR2468,-2468;
GO;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
GO;	AX - AT	5*	0*
GO;	AA-AM	7*	0*
-	AA/CD	Not Valid	

- If the axis is a stepper and encoder or servo axis add 1 to the command queue and add 2 to the argument queue.
- If PA (power automatic) mode is active add 2 to the command queue
- If an auxiliary output bit settle time has been specified add 2 to the command queue and add 1 to the argument queue

Related commands: GD, GN, GS, GU, MA, ML, MR, MT

GS GO AND MONITOR SLIP TRIGGER

The GS command works exactly like the GO command except that the home switch will be monitored during the motion. If the home switch becomes active the slip flag will be set for the axis. The host application can read the slip flag and see that the home switch was encountered during the move. This is useful in applications that register slip conditions by means other than encoder position verification; in fact, this command is not valid in controls with encoder feedback which includes servo motors.

If this command is issued without having defined a move, the results are undefined. Issuing a GD command to execute an already-executed move also has undefined results. Only one GD command should be issued per defined move.

Example: Move the X axis 50,000 counts in the positive direction. If the motor slips it will close a switch wired to the home input of the X axis. Monitor this switch during the move and set the slip flag for axis X if the switch becomes active.

Enter:
```
AX;
MR50000;
GS;
```

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
GS;	AX - AT	5*	0*
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

- If the axis is a stepper and encoder or servo axis add 1 to the command queue and add 2 to the argument queue.
- If PA (power automatic) mode is active add 2 to the command queue
- If an auxiliary output bit settle time has been specified add 2 to the command queue and add 1 to the argument queue

Related commands: GD, GN, GO, GU, MA, MR

GU GO ASYMMETRICAL

The GU command initiates a previously defined move using the AC value for acceleration and the DC value for deceleration. This command may be used with only one axis at a time; i.e. it is not valid with the ML and MT commands.

If this command is issued without having defined a move, the results are undefined. Issuing a GU command to execute an already-executed move also has undefined results. Only one GU command should be issued per defined move. GU is used only with linear acceleration ramps

Example: Move the Y axis to position 1,500 using the current acceleration and velocity and a deceleration of 5,000 counts per second per second.

Enter:
```
AY;
DC5000;
MA1500;
GU;
```

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
GU;	AX - AT	3*	0*
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

- If the axis is a stepper and encoder or servo axis add 1 to the command queue and add 2 to the argument queue.
- If PA (power automatic) mode is active add 2 to the command queue
- If an auxiliary output bit settle time has been specified add 2 to the command queue and add 1 to the argument queue

Related commands: AC, DC, GD, GN, GO, GS, MA, MR

HD HOLD DEADBAND

The HD command specifies dead band counts for position maintenance mode. If the encoder count is within this distance of target, it is considered in position and no further correction will be made. This parameter interacts with the HG and HV commands; i.e. a larger dead band will allow a larger gain parameter in many applications. This command is designed to work with stepper motor applications using encoders and is not designed for use with servo motors. The factory default value is zero. See the AP command command to preserve the HD settings as the Power up/Reset values.

RANGE: 0 ≤ HD ≤ 64,000

Example: (see HN command page 5-92)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
HD#;	AX - AT	1	1
HD#,#,#,#;	AA-AM	1	1
-	AA/CD	Not Valid	

Related commands: ?HD, HF, HG, HN, HV

?HD REPORT POSITION MAINTENANCE DEADBAND

The ?HD command reports the current setting of the HD command. This command will only work on stepper axes with encoders.

Example: Find out what HD was last set to.

Enter: ?HD

Response: hd5<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?HD	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: HD, ?HG, ?HV

HE HOME ENCODER

The HE command enables encoder index, and phase A and B signals to be considered in addition to the home switch input when an HM or HR command is executed. This command does not execute the home motion which must be initiated with an HM, HR, KM, or KR command. Default home behavior (considering only the home switch for home commands) may be reestablished via the HS command. In the HE mode, home is defined as the logical AND of the encoder index, the external home enable and the encoder quadrant where channel A is positive and channel B is negative. The default home logic expressed in Boolean terms is:

Home = Phase_A × / Phase_B ∗ Index × / Home_Switch

The default logic can be changed to any required combination with the use of HL and HH commands to set the true home switch state and the EH command to set the encoder signal (Index, PhaseA and PhaseB) states required for a true home condition.

Example: Set up the Y axis so it will use the encoder signals to recognize the home position.

Enter:
AY;
HE;
or
AA;
HE,1;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
HE;	AX - AT	Immediate	
HEb,b,b,b;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: EH, HH, HL, HM, HR, HS, KM, KR

HF HOLD OFF

The HF command disables position hold, stall detection and tracking modes, for stepper with an encoder axis. If the current axis is a servo, this command will open the loop and turn off the PID. If the current mode is multi-axis, all axes will go into open-loop mode. This is the default mode at power up or reset.

Example: Turn off encoder hold mode on the X axis.

Enter: AX;
HF;

Response: None

NOTE: In AA or AM mode, a null value in the argument list specifies feedback for that axis is not to be disabled.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
HF;	AX - AT	2*	0*
HF;	AA-AM	2*	0*
-	AA/CD	Not Valid	

*Values in table are for a stepper with encoder axis. For a servo axis the command queue requires 1, and the argument queue requires 1.

Related commands: HN, ?PM

HG HOLD GAIN

The HG command allows the user to specify the position hold gain parameter. This gain parameter is multiplied by the position error in determining the velocity during correction. The velocity used will not exceed the value set with the hold velocity (HV) command. This command is designed to work with stepper motor applications using encoders and is not designed for use with servo motors. The parameter should be set experimentally by increasing it until the system is unstable then reducing it slightly below the threshold of stability. The factory default value is 1. See the AP command, page 5-33, to preserve the HG settings as the Power up/Reset values.

RANGE: 1 ≤ HG ≤ 32,000

Example: (see HN command (page 5-92))

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
HG#;	AX - AT	1	1
HG#,#,#,#;	AA-AM	1	1
-	AA/CD	Not Valid	

Related commands: HD, HF, ?HG, HN, HV

?HG REPORT POSITION MAINTENANCE GAIN

The ?HG command reports the current setting of the position maintenance hold gain constant for the current axis. This command works only with stepper + encoder axes.

Example: Position corrections seem slow. Check the setting of HG to be sure it is correct.

Enter: ?HG

Response: hg100<LF >

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?HG	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?HD, HG, ?HV

HH HOME HIGH

The HH command sets the sense of the home switch on the current axis to active TTL high. This command allows TTL logic high to be treated as the “true” state for applications where this is more convenient. Once this command has been sent to the UMX, active high homes can be made the power-up default by using the AP command; refer to the AP command for details. This command sets the home switch “true” state to TTL logic high for both the HS and HE modes of the home operation.

Example: (see HL command on page 5-89)

Note: In AA or AM modes, a null argument in the parameter list specifies that axis home switch to be unchanged.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
HH;	AX - AT	1	0
HHb,b,b,b;	AA-AM	1	0
-	AA/CD	Not Valid	

Related commands: EH, HE, HL, HM, HR, HS, KM, KR

HL HOME LOW

The HL command sets the sense of the home switch on the current axis to active TTL low. This is the power-up and reset default “true” state unless HH has been saved as a user power-up default (See the AP command, page 5-33.). This command sets the “true” state of a home input to a TTL logic low.

This command sets the home switch “true” state to TTL logic low for both HS and HE modes of home operation.

Example: The stage is moved through home with the home switch set for active low at low speed to meet the less than 2048 steps per second requirement of the home command.

Enter:
AX;
VL2000;
HL;
HM0;

Response: None

Note: In AA or AM modes, a null argument in the parameter list specifies that axis home switch to be unchanged.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
HL;	AX - AT	1	0
HLb,b,b,b;	AA-AM	1	0
-	AA/CD	Not Valid	

Related commands: EH, HH, HE, HS, HM, HR, KM, KR

HM HOME

The HM command will cause the current axis or specified axes to move in the positive direction at the predefined velocity until the home is detected for each axis. The position counters will be initialized to the positions supplied as parameters.

How home is detected depends on whether the HS or HE modes has been selected. The default mode, HS, detects home based on an external home input only. The HE mode detects home based on the external home input and the encoder signals (Index, PhaseA and PhaseB).

The velocity should be less than the update rate to maintain accuracy of the home position loaded. A velocity set to less than or equal to the update rate will provide a homing accuracy of +/-0 counts. Every multiple of the update rate adds +/-1 count to the error range.

Each axis will, when home is detected, reset its position counter to the parameter specified in the HM command. Once the counter is reset, the axis will ramp to a stop at the rate specified previously via the AC command. This will result in the axis stopping beyond the home switch so care should be taken to ensure adequate stopping distance is available beyond the switches. The axis can be easily returned to the precise home position by using an MA command after the HM command.

If no parameter is specified in single axis modes, the HM command will use zero as a default value. Parameters must be specified in multi-axis modes to inform the UMX which axes are to be homed.

Example: Find the physical home position of the X axis of the stage. The motor runs until the home switch input is activated and then initializes the position counter to the parameter supplied. Since the motor decelerates to a stop after reaching home, it is necessary to do an MA to the same position as specified in the home command if it is desired to physically position the device at home. The following commands will find home, initialize it to 1000 counts, and then return to home. In many cases it will not be necessary to return home, only find the position and synchronize the controller to it.

Enter:
```
AX;
VL1000;
HM1000;
MA1000;
GO;
```

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
HM#;	AX - AT	3*	1*
HM#,#,#,#;	AA-AM	3*	11*
-	AA/CD	Not Valid	

Axis Ramp Type	Command queue	Argument queue
Linear (PF, LA)	4	4
Short Form Parabolic (PN0, PR0)	4	6
All other Parabolic forms (PN, PR)	4	22
Cosine (CN, SC)	4	22
Custom (SR)	4	(2 x number of ramp segments) +2

- If the axis is a stepper and encoder or servo axis add 2 to the argument queue.
- If PA (power automatic) mode is active add 2 to the command queue.
- If an auxiliary output bit settle time has been specified add 2 to the command queue and 1 to the argument queue.
- If the last profile move, just prior to this home command was either a MT or ML move then the axis acceleration and velocity values will be reset to the AC and VL values just prior to the execution of the home. This will add to the queue requirements under the following conditions:

Related commands: HE, HH, HL, HR, HS, KM, KR, LO, LP, RP

HN HOLD ON

For servo axes, the HN command closes the loop, enabling the PID. For servo axes, this mode is disabled when the HF command is entered, when the servo error becomes too large or a limit is encountered.

For stepper with encoder feedback axes, the HN command enables position correction after a move and activates the HV, HG and HD commands for stepper axes with encoders. For stepper exes with encoders, this mode will be cancelled (as though via an HF commands) is an CG. CX, HM, HR, LP, MV, SA, SO, SP, or ST commands is entered, if a limit is encountered or the minimum allowable position error is executed.

(Stepper)
Example: The following commands could be used to set up the position correction mode on a stepper axis. This sequence sets up a move velocity of 100,000 steps per second and an acceleration of 500,000 steps per second per second. The position correction velocity is set for 50,000 steps per second, a deadband of 10 steps and correction gain of 2,000. The correction is then enabled. A 200,000 step move is performed, then that position is maintained within the 10 step deadband until commanded to a new position.

Enter:
```
AX;
VL100000;
AC500000;
HV50000;
HD10;
HG2000;
HN;
MR200000;
GO;
```

Response: None

(Servo)
Example: Close PID loop or X axis after having modified one of the PID parameters

Enter:
```
AX;
HN;
```

Response: None.

QUEUE REQUIREMENTS			
MODE	**Min (pf)**	**Max (pn/cn)**	**Custom ramp**
AX - AT	1	3	3
AA	1	3	3
AM	1	3	1
AA/CD	Not Valid		

Related commands: HF

HR HOME REVERSE

The HR command will cause the current axis or specified axis to move in the negative direction at the predefined velocity, until the home is detected for each axis. When the home input is detected, the position and encoder counters are loaded with the parameter(s) supplied in the HR command. Then the axis is ramped to a stop. It behaves exactly like the HM command, except it travels in the reverse direction.

How home is detected depends on whether the HS or HE modes has been selected. The default mode, HS, detects home based on an external home input only. The HE mode detects home based on the external home input and the encoder signals (Index, Phase A and Phase B).

Example: In a long stage it may be awkward to travel the full distance to home at less than the update rate. The following will get close to home at higher speed, and then refine the position at lower speed in the reverse direction.

Enter:
```
AX;
VL100000;
HH;
HM;
VL1000;
HL;
HR;
```

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
HR#;	AX - AT	3*	1*
HR#,#,#,#;	AA-AM	3*	1*
-	AA/CD	Not Valid	

- If the axis is a stepper and encoder or servo axis add 2 to the argument queue.
- If PA (power automatic) mode is active add 2 to the command queue.
- If an auxiliary output bit settle time has been specified add 2 to the command queue and 1 to the argument queue.
- If the last profile move, just prior to this home command, was either a MT or ML move then the axis acceleration and velocity values will be reset to the AC and VL values just prior to the execution of the Home. This will add to the queue requirements under the following conditions:

Axis Ramp Type	Command queue	Argument queue
Linear (PF, LA)	4	4
Short Form Parabolic (PN0, PR0)	4	6
All other Parabolic forms (PN, PR)	4	22
Cosine (CN, SC)	4	22
Custom (SR)	4	(2 x number of ramp segments) +2

Related commands: HE, HH, HL, HM, HS, KM, KR, LO, LP

HS HOME SWITCH

The HS command disables HE mode and returns the UMX to the default home behavior. Default behavior defines a home state to be active when the home switch input is either low in default or HL mode or high when in HH mode. This mode can also be used with encoders which contain internal home logic by connecting their output to the UMX home input for the appropriate axis. The active level of this input may be controlled by the HH and HL commands.

Example: Set up the Y axis so it will ignore the encoder signals and only use the home input to recognize the home position.

Enter:
AY;
HS;

or

AM;
HS,1;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
HS;	AX - AT	Immediate	
HSb,b,b,b;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: HE, HH, HL, HM, HR, KM, KR

HV HOLD VELOCITY

The HV command specifies the maximum velocity to be used when correcting position error. The factory default setting is zero; some value must be set for position correction to occur at all. See the AP command, page 5-33, to preserve the HV settings as the Power up/Reset values. This command is not designed for use with servo motors.

Hold gain (HG) will be used to scale the HV value based on the total error that must be corrected. In most cases the HV value will never be reached unless the position error is very wide or the HG value is set very high.

RANGE: 1 ≤ HV ≤ 1,044,000

Example: (see HN command, see page 5-92)

NOTE: In AA or AM mode, a null value in the argument list specifies that the hold velocity parameter is not to be changed for that axis.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
HV#;	AX - AT	1	1
HV#,#,#,#;	AA-AM	1	1
-	AA/CD	Not Valid	

Related commands: HD, HF, HG, HN, ?HV

?HV REPORT POSITION MAINTENANCE VELOCITY

The ?HV command reports the current setting of the position maintenance hold velocity limits for the current axis. This command works only with stepper + encoder axes.

Example: Check the peak correction velocity for the T axis

Enter: AT;
?HV

Response: hv20000<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?HV	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?HD, ?HG, HV

IC INTERRUPT CLEAR

The IC command or the ASCII character Control-Y (hex 19) is used to clear the done and error flags in the status register and the done flag register on UMX, otherwise the axis would always appear to be “done”. This command will be executed immediately and will usually be placed in the done and error handler interrupt service routine to clear the interrupt and the associated flags. The flags may be polled by an RA or RI command which will also reset the flags.

Note: That this command is not recommended in Windows environments using OMS-supplied device drivers and DLLs. The preferred method is to use the device driver and DLL to handle the reporting and clearing status flags.

Example: Clear the flags after an X axis move relative of 5000 steps was flagged as done when an ID executes.

Enter:
AX;
MR5000;
GO;
ID; (done flag set)
IC; (done flag cleared on UMX)

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
IC;	AX - AT	Immediate	
IC;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: CA, GD, ID, II, IN, IP

ID INTERRUPT WHEN DONE

The ID command will set the done flag for the axis or axes to which the command was issued. An interrupt to the host will be generated if interrupts have been enabled in the UMX. In Windows environments, this interrupt is captured by the device driver which will store the flags to pass on to the host application when requested.

This command allows the UMX to signal the host when a string of commands has been completed. In AA mode, the done flag register bits will be set as each axis encounters the ID in its command stream, but the done flag in the status register will not be set until all axes have executed the ID command. In the AM mode, only the axes active in the most recent move will set their done flags.

Though move commands are most commonly used with the ID command, others may be used as well. The ID command may be sent to the UMX to tell it to set done flags whenever the host application could benefit from knowing an event or series of commands has completed.

Example: Interrupt the host CPU after the execution of Move Absolute is finished. When the move is finished the ID command will be encountered in the command queue and will set the done flags.

Enter:
```
AX;
MA100000;
GO;
ID;
```

Response: None

Example: Wait until an input line becomes false then notify the host that this occurred.

Enter:
```
SW2;
ID;
```

Response: None

QUEUE REQUIREMENTS				
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**	**CONTOUR**
ID;	AY – AT	1	0	N/A
ID;	AA-AM	1	0	N/A
ID;	AA/CD	1	0	1

Related commands: II, IN, IP

II INTERRUPT INDEPENDENT

Like the ID command, the II command tells the UMX to interrupt the host when each axis finishes a move. Unlike the ID command, only those axes which have been supplied parameters in the most recent move command will get their done flags set and cause interrupts.

Example: The following command sequence would cause interrupts when the Y and T axes finish. If they do not complete at the same time, two separate interrupts would be generated.

Enter:
```
AM;
MR,1000,,10000;
GO;
II;
```

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
-	AX - AT	Not Valid	
II;	AA - AM	1	0
-	AA/CD	Not Valid	

Related commands: ID, IN, IP

IN INTERRUPT NEARLY DONE

The IN command allows the UMX to interrupt the host when the axis or combination of axes is nearly complete. When used in an application involving probing a part after a move, the probes could start accelerating down while the stage is finishing its move, improving the overall system throughput. This command is valid in all modes. The IN command must be entered before the GO or GD command since it is executed before the move is complete. The test is only performed during deceleration. If the IN parameter is greater than the ramp down distance, the interrupt will be generated when the control starts decelerating.

RANGE:
Min Position Range ≤ Parameter (Distance Before the End of Move) ≤ MAX Position Range

NOTE: The position range depends on the settings used on UMX, see Specifications for details.

Example: The following sequence would interrupt the host when the X axis is complete and the Z axis is within 10,000 counts of being complete. The Y axis completion would be ignored in this example.

Enter:
```
AA;
IN0,,10000;
MR100000,100000;
GO;
MR,,50000;
GO;
```

Response: None

NOTE: In AA or AM mode, a null value in the argument list specifies the position tolerance for nearly done is not to be set for that axis.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
IN#;	AX - AT	1	2
IN#,#,#,#;	AA-AM	1	2
-	AA/CD	Not Valid	

Related commands: ID, II, IP

IO SET I/O BIT DIRECTION

The IO command defines the direction of the general purpose I/O bits 0 to 7 as inputs or outputs. The bit direction selection is made in groups of four bits. A null argument skips that bit group. A zero value sets that bit group to be inputs. A one value configures that bit group to be outputs. The factory default configuration is: bits 0-3 are inputs and bits 4-7 are outputs.

See the AP command on page 5-33 to preserve the IO setting as the Power up/Reset setting.

NOTE: Bits 8-15 are not configurable.

Example: Set bits 0-3 as output and bits 4-7 as inputs.

Enter: IO1,0;

Response: None

QUEUE REQUIREMENTS			
MODE	**Min (pf)**	**Max (pn/cn)**	**Custom ramp**
AX - AT	Immediate		
AA - AM	Immediate		
AA/CD	Not Valid		

Related commands: None

IP INTERRUPT WHEN IN POSITION

The IP command operates like the ID command except the interrupt is deferred until the stage is within the specified step encoder dead band. If the position hold (HN) is not enabled for an axis, the command will behave like an ID command for that axis.

Example: Set the done flag when axis is within its dead band.

Enter:
```
AX;
HV1000;
HG100;
HD10;
HN;
MR1000;
GO;
IP;
```

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
IP;	AX - AT	1	0
IP;	AA-AM	1	0
-	AA/CD	Not Valid	

Related commands: HN, ID, II, IN

IS INTERRUPT ON SLIP

The IS command enables the UMX to interrupt the host on slip or stall detection if the appropriate bit has been set in the interrupt control register. Slip detection are disabled if an ER, ET, HF, HM, HR, JG, LP, or TM command is entered or if a limit is encountered. If a slip occurs, slip detection must be re-enabled. The factory default slip tolerance (ES) value is 1. This command is intended to be used with stepper motors and not servo motors.

Example: (see ES command on page 5-72)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
IS;	AX - AT	1	0
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ES, RL, TF, TN

IX INTERRUPT WHEN AXES ARE DONE

The IX command is a special form of the ID command. It is intended for use by the serial communications version of the UMX. Each axis which has been supplied a position in the most recent move command will send a special done character to the host as they complete their move.

AXIS DONE INDICATOR CHARACTERS	
AXIS	**DONE CHARACTER IN HEX**
X	80
Y	81
Z	82
T	83

Example: The following command sequence would cause two characters to be sent to the host. An 81 hex character will be sent when the Y axis finishes and an 83 hex character when the T axis finishes.

Enter:
```
AM;
MR,1000,,10000;
GO;
IX;
```

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**Min**	**Max**
-	AY – AT	Not Valid	
IX;	AA-AM	1	1
-	AA/CD	Not Valid	

Related commands: ID, IN, IP

JF JOG FRACTIONAL VELOCITIES

The JF command will jog one or more axes at the velocities specified, like the JG command. The parameter may include a fractional part allowing better resolution at low speeds. The velocity set by this command will remain the default velocity until altered by a VL, JG or another JF command.

RANGE: -1,044,000 ≤ JF ≤ 1,044,000

Example: Jog the Y axis at 2 2/3 steps per second.

Enter:
AY;
JF2.667;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
JF#;	AX - AT	3*	0*
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

- If PA (power automatic) mode is active add 1 to the command queue
- If the axis is a stepper and encoder or servo axis add 1 to the command queue
- If the profile move, just prior to this home command was either a MT or ML move then the axis acceleration and velocity values will be reset to the AC and VL values just prior to the execution of the home. This adds to the queue requirements under the following conditions:

AXIS RAMP TYPE	COMMAND QUEUE	ARGUMENT QUEUE
Linear (PF, LA)	4	4
Short Form Parabolic (PN0, PR0)	4	6
All other Parabolic forms (PN, PR)	4	22
Cosine (CN, SC)	4	22
Custom (SR)	4	(2 x number of ramp segments) +2

Related commands: JG, SA, ST, TM

JG JOG

The JG command is a velocity mode and will move one or more axes at the velocities supplied as parameters. The JG command will accelerate to the programmed velocity at the current AC rate and run until altered by an ST, SA, KL, HF (servo models), another JG command, or a limit switch is encountered while limits are enabled.

The jog velocity may be changed by following the command with another JG command of a different velocity. A change in direction between two JG commands will cause an axis to ramp to a stop then back up in the opposite direction.

This command modifies the move velocity parameter (VL) for the affected axis or axes. The JG command does not require any other command to start the motion.

RANGE: -1,044,000≤ JG ≤ 1,044,000

Example: Jog the motor at 100,000 counts per second then change to 35,000 counts per second when the second JG is entered, stay at that velocity for 5 seconds, then stop by decelerating to a stop. Next, jog the motor at 5,000 counts per second in the negative direction.

Enter:
```
JG100000;
JG35000;
WT5000;
ST;
JG-5000;
```

Response: None

Note: Output events waiting for completion of JG will begin when JG is up to its requested velocity. In this case, the motor will ramp from zero to 100,000, ramp back down to 35,000, flatten out at 35,000 for 5 seconds, then ramp to a stop, before moving in the negative direction at a velocity of 5,000.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
JG#;	AX - AT	3*	1*
JG#,#,#,#;	AA-AM	3*	1*
-	AA/CD	Not Valid	

- If PA (power automatic) mode is active add 1 to the Command queue
- If the axis is a stepper encoder or servo axis add 1 to the Command queue
- If the profile move, just prior to this home command was either a MT or ML move then the axis acceleration and velocity values will be reset to the AC and VL values just prior to the execution of the home. This add to the queue requirements under the following conditions:

Axis Ramp Type	Command queue	Argument queue
Linear (PF, LA)	4	4
Short Form Parabolic (PN0, PR0)	4	6
All other Parabolic forms (PN, PR)	4	22
Cosine (CN, SC)	4	22
Custom (SR)	4	(2 x number of ramp segments) +2

Related commands: JF, SA, ST, TM

KA ACCELERATION FEEDFORWARD

KA is the acceleration feedforward gain coefficient used in the PID filter calculations. The factory default value is zero. See the AP command, page 5-33, to preserve the KA settings as the power up/reset values. The default value is 0.00

RANGE: 0.00 ≤ KA ≤ 32767.00

Example: Define KA to be 2 on the T axis.

Enter:
AT;
KA2;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
KA#;	AX - AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: HF, HN, ?KA, KD, KI, KP, KV

?KA REPORT ACCELERATION FEED FORWARD

The ?KA command reports the current setting of the acceleration feed-forward constant (KA) for the current servo axis. Default value is 0.00

Example: Find out what the current KA value is for servo axis Y

Enter:
AY;
?KA

Response: ka10.50<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?KA	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: KA, ?KV

KB PID UPPER BOUND LIMIT COEFFICIENT

The KB command sets the servo axis PID output value upper bound limit from DAC. (This can be useful in debugging servo drives.) The default value is 0.00

RANGE: 0.0 < KB < 10.0

Example: Limit the servo output from DAC to 9 max on Y axis. This is approximately half of its normal range.

Enter: AY;
KB9;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
KB#;	AX - AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?KB

?KB REPORT AXIS PID UPPER BOUND LIMIT

The ?KB command requests the value of the KB parameters for the upper bound limit to the DAC.

Example: Determine PID upper bound limit for X axis

Enter: AX;
?KB

Response: kb5.00<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?KB	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: DBI, DBN, ?SV

KD DERIVATIVE GAIN COEFFICIENT

KD is the derivative gain coefficient used in the PID filter calculations. See Section 2 for more information regarding this parameter. The factory default value is 20.00. See the AP command, page 5-33, to preserve the KD settings as the Power up/Reset values.

RANGE: 0.00 ≤ KD ≤ 32767.00

Example: Set KD to 56 on the Z axis.

Enter: AZ;
KD56;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
KD#;	AX - AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?KD, KI, KP, HF, HN

?KD REPORT PID DERIVATIVE GAIN

The ?KD command reports the current setting of the derivative gain coefficient (KD) in the PID of the current servo axis.

Example: Forgot to write down the Y axis KD setting which is working well. Report the setting so it can be recorded.

Enter: AY;
?KD

Response: kd5.12<LF >

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?KD	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: KD, ?KI, ?KP,

KF SET SERVO AXIS PID FRICTION COEFFICIENT

The KF command sets the friction offset coefficient of a servo axis PID. This assists in the smooth start up motion of the X axis, and compensates for friction. The default value is 0.

Range: 0 ≤ KF ≤ 32767

Example: Set the Y axis friction coefficient to 100.

Enter: AY;
KF100;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
KF#;	AX - AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?KF

?KF REPORT SERVO AXIS PID FRICTION COEFFICIENT

The ?KF command reports the value of the frictional offset coefficient.

Example: Verify Z axis friction offset coefficient is 12

Enter: AZ;
?KF

Response: kf12<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?KF	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: KD, ?KI, ?KP

KI INTEGRAL GAIN COEFFICIENT

KI is the integral gain coefficient used in the PID filter calculations. See the AP command, page 5-33, to preserve the KI settings as the power up/reset values. Default value is 0.04.

RANGE: 0.00 ≤ KI ≤ 32767.00

Example: Define KI to be 3.42 on the X axis.

Enter:
AX;
KI3.42;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
KI#;	AX - AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: HF, HN, KD, ?KI, KP

?KI REPORT PID INTEGRAL GAIN

The ?KI command reports the current setting of the integral gain constant (KI) in the PID of the current servo axis.

Example: Report the setting of the KI coefficient on the Z axis

Enter:
AZ;
?KI

Response: ki1.00<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?KI	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?KD, KI, ?KP

KL KILL

The KL command will flush the command queues and terminate pulse generation of all axes immediately. It is intended for emergency termination of any program and to reset the input queues to a known state.

Step motors may not stop immediately even though no more step pulses are delivered due to inertia of the motor and system load. This may result in slippage of the motor. Therefore, the position counter may not accurately reflect the true position of the motor following this command. All axes should be re-homed to return the position counters to a known state.

Due to the encoders used in servo systems, position will not be lost, so re-homing servo axes is unnecessary.

Example: Stop all previously defined movement and flush the queue of a partially entered incorrect move command (you wanted a negative move not a positive one), before GO is entered.

Enter:
```
AX;
MR5000; (oops!)
KL;
MR-5000;
GO;
```

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
KL;	AX - AT	1*	0*
KL;	AA-AM	1*	0*
-	AA/CD	Not Valid	

- If PA (power automatic) mode is active add 1 to the command queue
- If an auxiliary output bit settle time has been specified add 2 to the command queue and add 1 to the argument queue

Related commands: FL, KS, SA, SD, SI, SO, ST

KM HOME AND KILL

The KM command will move the current axis in the positive direction until home is detected and then kill motion immediately; i.e. without using a deceleration ramp. The position counter will not be reset or cleared. Due to motor and/or payload inertia, the motor may not stop immediately but slip some distance instead. This will result in inaccurate position counters. This command's primary purpose is to move an axis out of the way quickly or to get the axis near home rapidly to speed up the homing process.

Example: Move the Y axis in the positive direction to the home sensor and stop movement as quickly as possible.

Enter: AY;
KM;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
KM;	AX - AT	1*	1*
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

- If PA (power automatic) mode is active add 2 to the command queue.
- If an auxiliary output bit settle time has been specified add 2 to the command queue and 1 to the argument queue.
- If the last profile move, just prior to this home command, was either a MT or ML move then the axis acceleration and velocity values will be reset to the AC and VL values just prior to the execution of the Home. This will add to the queue requirements under the following conditions:

Axis Ramp Type	Command queue	Argument queue
Linear (PF, LA)	4	4
Short Form Parabolic (PN0, PR0)	4	6
All other Parabolic forms (PN, PR)	4	22
Cosine (CN, SC)	4	22
Custom (SR)	4	(2 x number of ramp segments) +2

Related commands: HE, HH, HL, HM, HR, HS, KR, LO, LP

KO OFFSET COEFFICIENT

The KO command defines the offset coefficient to cause the motor to remain stationary and compensate for additional torque on the motor from loading. The factory default value is zero. See the AP command, page 5-33, to preserve the KO settings as the power up/reset values.

The factory default value is zero. Full-scale, the KO command has a range of ±32,767 which corresponds directly to the 16-bit range of the DAC less a few counts as a buffer zone. Each increment/decrement of the KO value will result in an approximate change in the output voltage of 0.0003 volts.

RANGE: -32767 ≤ KO ≤ 32767

Example: Define the offset coefficient to be –2000 (≈ -610mV) on the Y axis.

Enter: AY;
KO-2000;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
KO#;	AX - AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: HF, HN, ?KO

?KO REPORT PID OFFSET COEFFICIENT

The ?KO command reports the voltage offset (KO) setting for the current servo axis.

Example: The open-loop offset is 218. Make sure the closed-loop offset is the same.

Enter: ?KO

Response: ko218<LF >

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?KO	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: KO

KP PROPORTIONAL GAIN COEFFICIENT

KP is the proportional gain coefficient used in the PID filter calculations. See the AP command, page 5-33, to preserve the KP settings as the power up/reset values. Default value is 10.00.

RANGE: 0.00 ≤ KP ≤ 32767.00

Example: Define KP to be 45.6 on the Z axis.

Enter: AZ;
KP45.6;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
KP#;	AX - AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: HF, HN, KD, KI, ?KP

?KP REPORT PROPORTIONAL GAIN COEFFICIENT

The ?KP command reports the current setting of the proportional gain coefficient (KP) in the PID of the current servo axis.

Example: Find out what the X axis proportional gain is set to.

Enter: AX;
?KP

Response: kp10.00<LF >

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?KP	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?KD, ?KI, KP

KR HOME REVERSE AND KILL

The KR command will find home by issuing a JG in reverse. When home is found, it will stop generating pulses immediately; i.e. no deceleration ramp will be generated. This command is identical to the KM command except that the direction of motion is reversed.

Example: Move the Y axis in a negative direction to the home sensor and stop movement as quickly as possible.

Enter:
AY;
KR;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
KR#;	AX - AT	1*	1*
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

- If PA (power automatic) mode is active add 2 to the command queue.
- If an auxiliary output bit settle time has been specified add 2 to the command queue and 1 to the argument queue.
- If the last profile move, just prior to this home command, was either a MT or ML move then the axis acceleration and velocity values will be reset to the AC and VL values just prior to the execution of the Home. This will add to the queue requirements under the following conditions:

QUEUE REQUIREMENTS		
Axis Ramp Type	**Command queue**	**Argument queue**
Linear (PF, LA)	4	4
Short Form Parabolic (PN0, PR0)	4	6
All other Parabolic forms (PN, PR)	4	22
Cosine (CN, SC)	4	22
Custom (SR)	4	(2 x number of ramp segments) +2

Related commands: HE, HH, HL, HM, HR, HS, KM, LO, LP

KS KILL SELECTED AXES

This command performs the same operation as the KL (kill) command except that individual axes can be killed without affecting others. KS will flush only the selected axes' command queues rather than the entire board. Refer to the KL command for more details.

Example: The Y axis has hit a limit switch and is now executing commands that were waiting in the queue. This axis must be reset but the other axes must be allowed to continue operation.

Enter:
AY;
KS;
or
AA;
KS,1;

Response: None

NOTE: In AA or AM modes, null values in the argument list specify that motion on that axis is not to be killed.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
KS;	AX - AT	1*	0*
KSb,b,b,b;	AA-AM	1*	0*
-	AA/CD	Not Valid	

— If PA (power automatic) mode is active add 1 to the command queue
— If an auxiliary output bit settle time has been specified add 2 to the command queue and add 1 to the argument queue

Related commands: FL, KL, SA, SD, SI, SO, ST

KU PID INTEGRATION SUM UPPER LIMIT

This command sets servo axis PID integration sum upper limit.

RANGE: 0 < KU < 32767

Example: Set the integration sum upper limit of X axis to 150

Enter:
AX;
KU150;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
KU#;	AX - AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?KU

?KU REPORT PID INTEGRATION SUM UPPER LIMIT

Report servo axis PID integration sum upper limit.

Example: Check to make sure the integration sum upper limit of X axis is less than 200.

Enter:
AX;
?KU

Response: ku150<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?KU	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: HF, HN, KD, KP, KU

KV VELOCITY FEEDFORWARD

KV is the velocity feedforward coefficient used in the PID filter calculations. The factory default value is zero. See the AP command, page 5-33, to preserve the KV settings as the power up/reset values.

RANGE: 0.00 ≤ KV ≤ 32767.00

Example: Set KV to 35.3 on the Y axis.

Enter: AY;
KV35.3;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
KV#;	AX - AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: HF, HN, KA, KD, KI, KP, ?KV

?KV REPORT VELOCITY FEED FORWARD

The ?KV command reports the current velocity feed forward coefficient (KV) of the current servo axis. Default value is 0.00

Example: Make sure the velocity feed-forward setting of axis T is zero

Enter: AT;
?KV

Response: kv0.00<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?KV	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?KA, KV

LA LINEAR RAMP PER AXIS

The LA command specifies that the linear acceleration ramp is to be used by the selected axes. This is the factory default for all axes. See the AP command, page 5-33, to preserve the LA settings as the power up/reset values. This command is similar to the PF command but can be used to switch a single axis rather than all axes at once.

Example: Select a linear ramp for the X axis.

Enter: AX;
LA;

Response: None

Example: Select the linear ramp for the Y and T axes.

Enter: AA ;
LA,1,,1;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
LA;	AX - AT	5	6
LAb,b,b,b;	AA-AM	5	6
-	AA/CD	Not Valid	

Related commands: CN, PF, PN, PR, ?RT, SC, SR

LE LOOP END

The LE command terminates the most recent LS command. The axis will loop back and repeat the commands within the loop the number of times specified in the LS command. The loop will start repeating as soon as this command is issued.

Example: Perform a relative move on axis Z five times. After each Z move, wiggle the T axis 20 times.

Enter:
AZ;
LS5;
MR5000;
GO;
AT;
LS20;
MR50;
GO;
MR-50;
GO;
LE; (terminates the LS20; command)
AZ;
LE; (terminates the LS5; command)

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
LE;	AX - AT	1	1
LE;	AA-AM	1	1
-	AA/CD	Not Valid	

Related commands: LS

LF LIMITS OFF

The LF command disables the limit switches for the addressed axis or axes. This allows the stage to move beyond the limit switches and should be used with caution. The UMX will still recognize that a limit switch has been closed if the stage runs into one and will report this information via the query commands (See the QA command). However, the limit switch closure will have no effect on motion; i.e. the axis will not be forced to stop as a result.

NOTE: In systems not designed to handle motion beyond the limit switch points, this can potentially cause damage to the system and/or persons operating the system. This command should be used with extreme caution.

Example: Set up a board to ignore the Y axis limit switches.

Enter:
```
AY;
 LF;
or
AA;
LF,1;
```

Response: None

Note: In AA or AM modes, a null argument in the parameter list specifies that axis home switch to be affected.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
LF;	AX - AT	1	0
LFb,b,b,b;	AA-AM	1	0
-	AA/CD	Not Valid	

Related commands: LH, LL, LN, SF, SL

LH LIMITS HIGH

The LH command sets the senses of the limit switches on the current axis to active high. The default “true” states of the limits are TTL logic low. This command allows TTL logic high to be treated as the “true” state for applications where this is more convenient. Through the execution of the AP command, limits can be made to default as active high on power-up or reset; see the AP command for details.

Example: Select the limit switch high true condition for the X axis.

Enter:
```
AX;
LH;
```

Response: None

Example: Select a high true limit condition for the Z and T axes.

Enter:
```
AA;
LH,,1,1;
```

Response: None

Note: In AA or AM modes, a null argument in the argument list specifies that axis is not to be affected.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
LH;	AX - AT	1	0
LHb,b,b,b;	AA-AM	1	0
-	AA/CD	Not Valid	

Related commands: LF, LL, LN, ?LS, SF, SL, TL

LL LIMITS LOW

The LL command specifies that over travel occurs when the limit input signal is low (active low). This is the factory default mode. See the AP command for information on how to preserve the LL settings as the power up/reset values.

Example: Select the limit switch low true condition for the X axis.

Enter: AX;
LL;

Response: None

Example: Select a low true limit condition for the Y and T axes.

Enter: AA;
LL,1,,1;

Response: None

Note: In AA or AM modes, a null argument in the argument list specifies that axis is not to be affected.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
LL;	AX - AT	1	0
LLb,b,b,b;	AA-AM	1	0
-	AA/CD	Not Valid	

Related commands: LF, LH, LN, ?LS, SF, SL, TL

LN LIMITS ON

The LN command restores the operation of the limit switches for the addressed axis or axes. This is the default mode at power up or reset. With limit switches enabled, if the axis encounters a limit switch in the course of executing any motion, the axis will be instructed to stop and the host will be notified of the event. Limit conditions are treated as critical errors and should not be used as simple positioning inputs to the UMX.

Example: Set up the Y and T axes to stop immediately when a limit switch is encountered.

Enter:
AA;
LN,1,,1;
or
AY;
LN;
AT;
LN;

Response: None

Note: In AA or AM modes, a null argument in the parameter list specifies that axis is not to be affected.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
LN;	AX - AT	1	0
LNb,b,b,b;	AA-AM	1	0
-	AA/CD	Not Valid	

Related commands: LF, LH, LL, SF, SL

LO LOAD MOTOR POSITION

The LO command sets the motor position independently of the encoder position unlike LP which sets both to the same supplied value. The LP command will override the LO command and reset the motor position. If the LP command is used and a different motor position value than the encoder position is desired, the LO command must be reentered. Any valid position within the allowable position range may be used.

Example: Set the motor position to 50,000 and the encoder position to 100,000 on the T axis

Enter:
AT;
LP100000;
LO50000;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
LO#;	AX - AT	1	1
LO#,#,#,#;	AA-AM	1	1
-	AA/CD	Not Valid	

NOTE: For AA and AM modes that any values in the argument list specify that axis is not to be affected.

Related commands: LP, RE, RM, RP, RU

LP LOAD POSITION

The LP command will immediately load the number supplied as a parameter in the absolute position registers of the axis. In models with the encoder option, the parameter will be loaded into the encoder position register and the parameter times the encoder ratio will be loaded into the position counter. If no parameter is supplied, the value of zero is used.

The LO command can be used after this command to set the motor position independently of the encoder position.

RANGE: Min. Position Value ≤ LP ≤ Max. Position Value

NOTE: The position value range varies with the specific settings used on UMX.

Example: The following would load the X axis position register with 1000, and the Z axis position register with 2000.

Enter:
AA;
LP1000,,2000;

Response: None

Example: The following would load the Y axis position register with 20,000 and the encoder position register with 30,000 counts, in encoder models.

Enter:
AY;
ER3,2;
LP30000;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
LP#;	AX - AT	1*	1*
LP#,#,#,#;	AA-AM	1*	1*
-	AA/CD	Not Valid	

— If the axis is a stepper and encoder or servo axis add 1 to the command queue and 1 to the argument queue.

Related commands: LO, RE, RM, RP, RU

LS LOOP START

The LS command sets the loop counter for the axis being programmed in the single axis mode and all axes in the AA mode. The command expects a loop counter operand following the command. The commands up to the LE loop terminator will be executed the number of times specified by the operand. Loops may be nested up to four levels deep on each axis. The parameter must be less than 32000.

The first loop of commands will occur immediately as they are entered. The remaining loops will be executed after the loop terminator (LE) has been entered.

The axis mode (e.g. AX, AY, and AA) must be the same when entering and exiting the loop, otherwise the matching loop termination command will not be found by the board's command processor. The axis mode may be switched within the loop provided the board is in the same mode when the LE command is sent as when the LS command was sent.

If you want one axis to wait for another in the loop, you must be in the AA mode throughout the loop. If you are in the single axis mode in the loop, each axis' commands will go into their separate queues and execute independently of each other.

If, when entering a looping sequence of commands, the command queue is filled before the LE loop terminator is entered, the board will hang. This is because there is no space for the LE command. When programming a loop of more than four or five moves, the queue size should be examined with the RQ command to see if it is nearing zero.

RANGE: 1 ≤ LS ≤ 32000

Example: Execute a 100,000 count relative move on the Z axis 5 times.

Enter:
```
AZ;
LS5;
MR100000;
GO;
LE;
```

Response: None

NOTE: The first move will occur immediately after entering the GO command. The remaining 4 moves will be executed after the loop terminator LE has been entered.

Example: Execute a 100,000 count move relative on the X axis together with a 100 count move on the T axis, followed by a move absolute to 100 counts on the X axis and 200 counts on the T axis, four times.

Enter:
AA;
LS4;
MR100000,,,100;
GO;
MA100,,,200;
GO;
LE;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
LS#;	AX - AT	1	1
LS#;	AA-AM	1	1
-	AA/CD	Not Valid	

Related commands: LE, WH, WS

?LS REPORT LIMIT ACTIVE STATE

The ?LS command reports the active state of the limits for the current axis. The LL and LH commands are used to set this value.

Example: Find out whether the Y axis limits are active high or active low.

Enter:
AY;
?LS

Response: ll<LF> or lh<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?LS	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: LH, LL

MA MOVE ABSOLUTE

The MA command will set up one or more axes to move to the absolute positions supplied as parameters. In AA mode, an axis may remain stationary by entering a comma but omitting the parameter. The move is actually initiated by a GO or GD command.

In AA mode all axes begin their move at the same time. Each axis will use its predefined acceleration and velocity values to move to the new absolute position. Each axis may or may not get to the destination at the same time because each axis utilizes individual velocities and accelerations. The MT command will ensure all axes reach their target positions simultaneously.

Example: In the single axis mode, move the X axis to absolute position 100,000 counts with the previously entered acceleration and velocity parameters.

Enter:
```
AX;
MA100000;
GO;
```

Response: None

Example: In the AA mode, move the Y axis to absolute position 10,000 counts and the T axis to absolute position 1,000 counts. The other axes will remain in their current positions.

Enter:
```
AA;
MA,10000,,1000;
GO;
```

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
MA#;	AX - AT	1*	1*
MA#,#,#,#;	AA-AM	1*	1*
-	AA/CD	Not Valid	

- If the axis is a stepper encoder or servo axis add 1 to both the command and argument queues.
- If the axis is using the cosine acceleration ramp, and velocity needs to be adjusted so the profile is not truncated, add 1 to the command queue and add 10 to the argument queue.
- If the acceleration and velocity values need to be reset to their AC and VL values because the last move just prior to this move was either a MT or ML move, add the following queue requirements:

QUEUE REQUIREMENTS		
Axis Ramp Type	**COMMAND QUEUE**	**ARGUMENT QUEUE**
Linear (PF, LA)	4	4
Short Form Parabolic (PN0, PR0)	4	8
All other Parabolic Forms (PN, PR)	4	22
Cosine (CN, SC)	4	22
Custom (SR)	4	(2*number of ramp segments) + 2

Related commands: GD, GN, GO, GS, GU, ML, MR, MT

MD TEMPORARY MACRO DEFINE

MD is used to begin defining a temporary macro. A macro can contain up to 250 characters. Macros 0 through 4 are temporary and they will be erased when the controller is reset or power is turned off. Macros 5 through 24 are stored in non-volatile memory and will be preserved when the controller is reset or powered off. This command cannot be used to define a macro directly into numbers 5 through 24. They must be defined with this command and then moved into the non-volatile space with the PT command.

Enter the macro number immediately after the MD command. The macro number must be between 0 and 4. Next enter the command string, which is made up of up to 250 ASCII characters. After entering the command string for the macro, enter a control Z to end the macro definition. The control Z may be ASCII value 26 or the string "^Z" (carat, shift 6 on a US keyboard, followed by a Z.)

Be careful not to exceed 250 ASCII characters or the size of the axis queue when working with macros.

RANGE: 0 ≤ MD ≤ 4

Example: Define macro 2 to set velocities to 20000 on all axes of a two axes board.

Enter:
MD2;
AA;
VL20000,20000;
^Z

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
MD#;	AX - AT	Immediate	
MD#;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: MX, PM

ML MOVE LINEAR

The ML command uses linear interpolation to perform a straight line relative move. Input parameters are relative distances for each axis involved in the move. The ML command should be followed by a GO or GD to start the axes together. The velocity and acceleration parameters are scaled to allow the axes to move and finish together. All axes are scaled to the axis with the longest move time (the master axis). At the end of the move, all involved velocities and accelerations will be restored to their pre-move values.

Example: In the AA mode, move the Y, Z and T axes 10000, 100 and 1000 counts respectively with all axes starting and finishing together. The other axes remain in their previous positions.

Enter:
```
AA;
ML,10000,100,1000;
GO;
```

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
-	AX - AT	Not Valid	
ML#,#,#,#;	AA-AM	2*	2*
-	AA/CD	Not Valid	

- If this is the master axis for this move and its acceleration and velocity values need to be reset to their original AC and VL values, because a previous move altered them, add the following queue requirements:
- If this is not the master axis, then the acceleration and velocity values will be modified, and the following queue requirements will be added:

QUEUE REQUIREMENTS		
Axis Ramp Type	**COMMAND QUEUE**	**ARGUMENT QUEUE**
Linear (PF, LA)	4	4
Short Form Parabolic (PN0, PR0)	4	8
All other Parabolic Forms (PN, PR)	4	22
Cosine (CN, SC)	4	22
Custom (SR)	4	(2*number of ramp segments) + 2

If the axis is using the cosine acceleration ramp, and velocity needs to be adjusted so the profile is not truncated, add 1 to the command queue and 10 to the argument queue:

Related commands: GD, GN, GO, MA, MR, MT

MM MOVE MINUS

The MM command sets the direction logic to move in the negative direction. The direction output for the current axis will change (if necessary) to reflect the new direction. All non-direction-specific move commands will now move in the negative direction.

Example: Set the direction line to move in the negative direction on the Y axis.

Enter: AY;
MM;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
MM;	AX - AT	1	0
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: FP, MO, MP, MV, SP

MP MOVE POSITIVE

The MP command sets the direction logic to move in the positive direction. The direction output for the current axis will change (if necessary) to reflect the new direction. All subsequent non-direction-specific motion commands will now move in the positive direction.

Example: Set the direction line to move in the positive direction on the Y axis.

Enter: AY;
MP;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
MP;	AX - AT	1	0
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: FP, MM, MV, SP

MR MOVE RELATIVE

The MR command will set up one or more axes to move relative from their current positions at the time the move is executed. In the AA mode, an axis may remain stationary by entering a comma but omitting the parameter. The move is actually initiated by a GO or GD command.

In AA mode all axes will start at the same time. Each axis will use its predefined acceleration and velocity values to move to the new position. Each axis may, or may not, get to the destination at the same time, because each axis utilizes individual velocities and accelerations. To ensure all axes reach their destinations simultaneously use the ML command.

Example: In the single axis mode, move the X axis 2468 steps in the negative direction.

Enter:
```
AX;
MR-2468;
GO;
```

Response: None

Example: In the AA mode, move the X axis 12345 steps in the positive direction and the Y axis 6789 steps in the positive direction. Both axes will start at the same time.

Enter:
```
AA;
MR12345,6789;
GO;
```

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
MR#;	AX - AT	1*	1*
MR#,#,#,#;	AA-AM	1*	1*
-	AA/CD	Not Valid	

— If the axis is a stepper encoder or servo axis add 1 to both the command and argument queues.
— If the axis is using the cosine acceleration ramp, and velocity needs to be adjusted so the profile is not truncated, add 1 to the command queue and add 10 to the argument queue.
— If the acceleration and velocity values need to be reset to their AC and VL values because the last move just prior to this move was either a MT or ML move, add the following queue requirements:

QUEUE REQUIREMENTS		
Axis Ramp Type	**COMMAND QUEUE**	**ARGUMENT QUEUE**
Linear (PF, LA)	4	4
Short Form Parabolic (PN0, PR0)	4	8
All other Parabolic Forms (PN, PR)	4	22
Cosine (CN, SC)	4	22
Custom (SR)	4	(2*number of ramp segments) + 2

Related commands: GO, GD, GN, GS, GU, MA, ML, MT

MT MOVE TO

The MT command uses linear interpolation to move two or more axes to the specified absolute positions. The syntax is similar to the ML command. This command is invalid if loops are being used due to the overhead involved. The command will become valid again after executing an ST or KL command. When used in the contour definition mode, only the axes being used in the contour must be provided for in the MT syntax. A GO or GD command initiates the move.

The axis that will reach its destination first (the master axis) is used as a gauge to modify the acceleration and velocity values of the other axes. This is done to ensure all involved axes arrive at their targets simultaneously. At the end of the move, any velocity or acceleration value that was modified is restored to its pre-move value.

Example: In the AA mode, move the X, Y and T axes to absolute positions 1000, 10000 and 100 counts, respectively, with each starting and finishing together. The unused axis remains in its previous position.

Enter:
```
AA;
MT1000,10000,,100;
GO;
```

Response: None.

QUEUE REQUIREMENTS				
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**	**CONTOUR**
-	AX - AT	Not Valid		
MT#,#,#,#;	AA-AM	2*	2*	N/A
MT#,#,#,#;	AA/CD	2*	2*	4 + (number of axes included in contour definition

— If this is not the master axis, then the acceleration and velocity values will be modified, and the following queue requirements will be added:

QUEUE REQUIREMENTS		
Axis Ramp Type	**COMMAND QUEUE**	**ARGUMENT QUEUE**
Linear (PF, LA)	4	4
Short Form Parabolic (PN0, PR0)	4	8
All other Parabolic Forms (PN, PR)	4	22
Cosine (CN, SC)	4	22
Custom (SR)	4	(2*number of ramp segments) + 2

— If the axis is using the cosine acceleration ramp, and velocity needs to be adjusted so the profile is not truncated, add 1 to the command queue and 10 to the argument queue:

Related commands: GD, GO, GN, MA, ML, MR

MV MOVE VELOCITY

The MV command causes the current axis to move to a new absolute position (parameter 1) at a new velocity (parameter 2). When the destination is reached control will be passed to the next command which should be another MV command or a SP command. If the command is not received in time the controller will continue to move at the specified velocity. Note that this is a slave mode and it is the responsibility of the user to provide the commands in time. They may be queued ahead of time. If a new MV command is sent after the controller has already passed the destination specified in the command, the controller will continue to move at the old velocity.

The UMX will ramp up or down as needed at the rate previously set with the AC command and travel at the new velocity until the new position is reached. The controller will not reverse direction if the position has already passed, but will behave as explained above. Thus the direction of the move must be specified before starting the move with the MP or MM commands. All destinations must be in absolute position; no position relative moves are allowed due to the nature of these commands. Cosine and parabolic acceleration will not apply.

RANGE:

Min Position Range ≤ Parameter 1 (Absolute Position) ≤ Max Position Range

1 ≤ Parameter 2 (Velocity) ≤ 1044000

NOTE: The position range depends on the settings used on UMX, see specifications for more details.

Example: Generate a velocity staircase with the breakpoints given in absolute position. Default acceleration (AC) of 200,000

Enter:
```
MP;
MV10000,30000;
MV20000,50000;
MV30000,10000;
SP35000;
```

Response: None

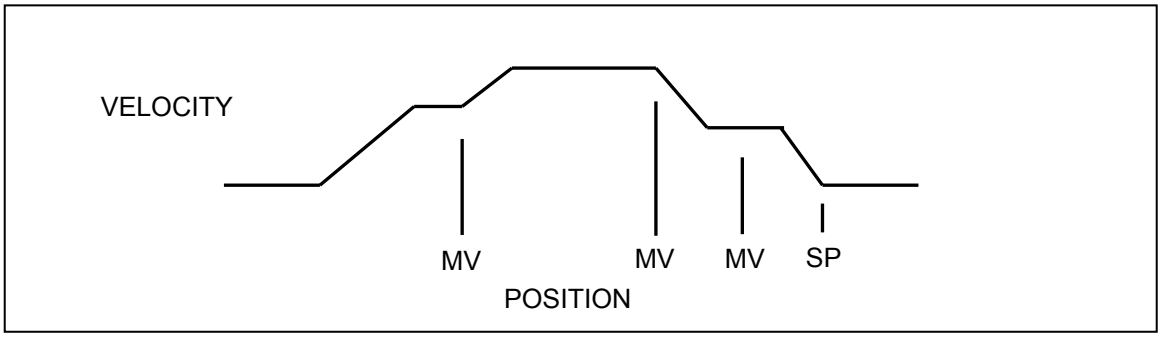


FIGURE 5-1 VELOCITY STAIRCASE PROFILE

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
MV#,#;	AX - AT	2*	2*
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

— If PA (power automatic) mode is active add 1 to the command queue
— If this axis is a stepper encoder or servo axis add 2 to the command queue

Related commands: FP, MM, MP, SP

MX MACRO EXECUTE

The MX command will execute the command string stored in the specified macro. The macro number that is entered as the argument of the command must be between 0 and 24.

RANGE: 0 ≤ MX ≤ 24

Example: Execute macro number 6.

Enter: MX6;

Response: None

NOTE: MX itself is an immediate command. However, the commands contained within the macro may have queue requirements.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
MX#;	AX - AT	Immediate	
MX#;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: MD, PM, PT

NV NEW CONTOUR VELOCITY

The NV command will set a new velocity for a contour currently in execution. When the velocity changes, the UMX will switch to the new velocity at the start of the next command in the contour queue without ramping. An NV command issued without a contour currently executing will have no effect.

RANGE: 1 ≤ NV ≤ 4,000,000

Example: The contour is executing at 25,000 counts per second. Change the velocity to 30,000 counts per second upon execution of the next command in the contour queue.

Enter: NV30000;

Response: None

QUEUE REQUIREMENTS				
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**	**CONTOUR**
-	AX - AT	Not Valid		
-	AA-AM	Not Valid		
NV#;	AA/CD	Immediate		

Related commands: CD, CV

PA POWER AUTOMATIC

The PA command will turn on or off the auxiliary outputs at the beginning of each GO or GD command execution and complement the outputs after the move is executed. The auxiliary will be turned on; i.e. pulled high, upon the execution of the GO or GD and off at the end of that move if the parameter is zero or not specified in the single axis mode. If the parameter is non-zero, the sense is reversed; i.e. the auxiliary output is turned off (driven low) upon the execution of the GO or GD command and on at the end of the move.

The SE command can be used to apply a settling time at the end of each move before complementing the auxiliary bit. This is useful for systems that need to retain torque for some specific amount of time before allowing the motor drive to reduce current output.

This mode need only be set once and can be turned off by using the AN or AF commands. Axes can be selectively affected in the AA mode. The values of the included parameters set the state of the auxiliary line during the move. The following queue requirements apply to each GO or GD command in the command stream in the AA and single axis modes. This mode is off by factory default. See the AP command to preserve the PA settings as the Power up/Reset values.

Example: Turn on the Y axis auxiliary output at the beginning of a move and turn the T axis output off at the beginning of a move, while in the AA command mode. (Note - the reversed logic; i.e. 0 = on, 1 = off. "On" pulls the signal line to ground. "Off" lets it rise to 5 volts or its pull-up reference voltage.)

Enter:
```
AA;
PA,0,,1;
```

Response: None

NOTE: PA selects the mode immediately but places entries in the axis command queue to set the state of the aux bit to the idle state.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
PAb;	AX - AT	1*	0
PAb,b,b,b;	AA-AM	1*	0
-	AA/CD	Not Valid	

*If an auxiliary output bit settle time has been specified add 2 to the command queue and add 1 to the argument queue.

Related commands: AF, AN, SE

?PA REPORT POWER AUTOMATIC STATE

The ?PA command reports whether the current axis has power automatic mode enabled. The PA command is used to set this value. If power automatic mode is enabled, it will report whether the aux bit goes high or low during a move. The axis is stationary if the aux bit is low.

Example: Determine if X axis power automatic is high or low.

Enter: AX;
?PA

Response: pa0<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?PA	AX – AS	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

*Power automatic mode is enabled for X axis such that the aux bit is high during a move.

Related commands: PA, ?SE

PE REPORT ENCODER POSITIONS

The PE command reports the encoder positions of all encoder and/or servo axes. All encoder positions will be reported even in single axis mode. (This is the same as AA;RE;.)

Example: Report the encoder positions of a four axis servo board.

Enter: PE

Response: 0,50,156,0<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
PE	AX - AT	Immediate	
PE	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: PP, RE, RP

PF LINEAR ON

The PF command restores all axes to linear acceleration and deceleration ramps. This command should not be given while an axis is in motion or the results may not be predictable. This command affects all axes even if issued in the single axis mode. PF is the factory default setting. See the AP command to restore the PF setting as the power up/reset mode.

Example: Turn off cosine or parabolic ramps, returning to linear.

Enter: PF;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
PF;	AX - AT	5	6
PF;	AA-AM	5	6
-	AA/CD	Not Valid	

Related commands: CN, LA, PN, PR, ?RT, SC, SR

PM PRINT MACRO

The PM command will return the command string stored in the specified macro number as a command response. The macro number entered as the argument for this command must be between 0 and 24.

RANGE: 0 ≤ PM ≤ 24

Example: Print the command string contained in macro 19.

Enter: PM19;

Response: If a macro string is defined for macro 19, the macro string will be the response. If no macro is defined there will be no response.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
PM#;	AX - AT	Immediate	
PM#;	AA-AM	Immediate	
-	AA/CD	Not Valid	

NOTE: Macros are stored as ASCII character strings. If <LF> character is used as command terminator it will be sent back to the host computer by the PM command. If the application software stops reading a character string first it will appear that the PM command did not return the macro contents. To avoid this issue, save macros without <LF> terminator. Use semi-colons instead to terminate commands

Related commands: MD, MX, PT

?PM REPORT HOLD STATE

The ?PM command reports whether the PID for the current servo axis is enabled.

Example: A limit switch was hit by servo axis Y. See if the PID is still enabled for that axis.

Enter: AY;
?PM

Response: hf<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?PM	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: HF, HN

PN PARABOLIC ON

The PN command sets all axes to truncated parabolic ramps. This acceleration profile starts at 100% of the programmed acceleration and decreases in steps of 10% of the initial acceleration down to as low as 10%. The parameter supplied selects the number of steps. It must be in the range of 3 to 10 corresponding to 70% and 10% acceleration at the peak respectively. A parameter out of this range or no parameter supplied defaults to 70% or 3 steps. Note that the parameter is the number of steps, not the acceleration values. The larger number is a lower acceleration at the peak. This command should not be given while an axis is in motion or the results may not be predictable. This command affects all axes even if issued in the single axis mode. The PF command is used to return to the default linear motion profiles. See the AP command to preserve the PN setting as the Power up/Reset ramp.

See PR for single axis.

RANGE: 3 ≤ PN ≤ 10

Example: Set the board to be in the smoothest parabolic acceleration ramp.

Enter: PN10;

Response: None

QUEUE REQUIREMENTS				
FORMAT	**MODE**	**AXIS RAMP TYPE**	**COMMAND**	**ARGUMENT**
PN#;	AX - AT	Short Form Parabolic (PN0;)	5	10
PN#;	AX - AT	All Other Parabolic (PN,PR)	5	24
PN#,#,#,#;	AA-AM	Short Form Parabolic (PN0;)	5	10

Related commands: CN, LA, PF, PR, ?RT, SC, SR

PP REPORT MOTOR POSITIONS

The PP command reports the motor positions of all axes in ASCII format. All axes will be reported even in single axis mode. (This is the same as AA; RP)

Example: Report the motor positions of a four axis controller.

Enter: PP;

Response: 0,0,0,125 <LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
PP;	AX - AT	Immediate	
PP;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: PE, RE, RP

PR PARABOLIC RAMP PER AXIS

The PR command defines parabolic acceleration/deceleration ramps for use with one or more axes. This command is similar to the PN command except that only the specified axes are affected. The AP command can be used to store the settings of PR as the power-up/reset defaults.

RANGE: 3 ≤ PR ≤ 10

Example: Select a 10 step parabolic ramp for the T axis.

Enter:
AT;
PR10;

Response: None

Example: Select a 10 step parabolic ramp for the Y axis and an 8 step parabolic ramp for the T axis and the R axis.

Enter:
AA;
PR,10,,8,,,8;

Response: None

QUEUE REQUIREMENTS				
FORMAT	**MODE**	**AXIS RAMP TYPE**	**COMMAND**	**ARGUMENT**
PR#;	AX - AT	Short Form Parabolic (PN0;)	5	10
PR#;	AX - AT	All Other Parabolic (PN,PR)	5	24
PR#,#,#,#;	AA-AM	Short Form Parabolic (PN0;)	5	10
PR#,#,#,#;	AA-AM	All Other Parabolic (PN,PR0)	5	24
-	AA/CD	Not Valid		

Related commands: CN, LA, PF, PN, ?RT, SC, SR

PS REPORT MACRO LINK

This command reports the macro link or KILL (KL) function link to the specified input bit and bit state.

First Parameter

This specifies the standard input bit number. The factory default bits are 0, 1, 2, and 3, but it can be configured by the user to be the I/O bits 0 to 7

Second Parameter

Valid bit states are 0 and 1

If the value of the selected bit state is ZERO, the selected macro will be executed if the selected bit changes from a TTL high to a TTL low.

If the bit state is ONE, then the selected macro will be executed when the selected bit changes from a TTL low to a TTL high.

NOTE: Each bit and state can be linked with a macro. So, up to two macros can be assigned to an input bit. For example, macro 15 could be executed when I/O 20 goes low, and macro 16 could be executed when I/O 20 goes high.

Output Formats:

If the bit is linked to the execution of a macro, the text response is the text of the SX command used to link the bit with the macro

Example: <LF><CR>SX1,0,23;<LF><CR>

If the bit is linked to the KL (KILL) function, the output will be the text response of the SK command used to link the bit with the kill function

Example: <LF><CR>SK1,0,1;<LF><CR>

If the bit is not linked the output will be: <LF><CR><LF><CR>

Example: This will report if there are any macro or KILL (KL) function links to input bit 2 when it goes from low to high.
Enter: PS2,1;

Response: None.

PT PRESERVE A TEMPORARY MACRO

Use PT to save a temporary macro permanently by copying it to non-volatile memory. The temporary macro number, which is entered as an argument for this command, must be between 0 and 4. The non-volatile macro number, which is also entered as an argument for this command, must be between 5 and 24.

RANGE:

0 ≤ Parameter 1 ≤ 4

5 ≤ Parameter 2 ≤ 24

Example: Copy temporary macro 3 to non-volatile macro 19.

Enter: PT3,19;

Response: None

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**Min**	**Max**
PT#,#;	AX – AT	Immediate	
PT#,#;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: MD, MX, PM

QA QUERY AXIS STATUS

The QA command returns the status of the single addressed axis like the RA command except the limit and done flags will not be cleared. Refer to the RA command for details.

Example: Check the status of the X axis.

Enter: AX;
QA

Response: PNNH<LF>

Refer to the table "Character Meaning" in the RA command on page 5-156.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
QA	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: EA, QI, RA, RI

QI QUERY INTERRUPT STATUS

The QI command returns the same information as the QA command but for all axes at once. The 4 character fields for each axis are separated by commas. The state of the status flags for all axes with out clearing the controller's copy of the done flags.

Example: Check the status of a four axis board.

Enter: AA;
QI

Response: PNNN,MNNN,PDNN,MNLN<LF>

Refer to the table "Character Meaning" in the RA command on page 5-156.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
-	AX - AT	Not Valid	
QI	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: EA, QA, RA, RI

QL QUERY ALL LIMIT SENSORS

QL is an immediate command and is valid in single axes, AA, and AM modes of operation.

The response of the QL command is a hexadecimal value representing the state of the response of the positive and negative limit sensors of each axis. A limit sensor in the TTL “High” state will have a value of ONE (1) and a limit sensor in a TLL “Low” state will have value of Zero (0). The order of the limit sensors is as follows:

0xf8f0	T Axis Positive Limit	0xf0f8	T Axis Negative Limit
0xf4f0	Z Axis Positive Limit	0xf0f4	Z Axis Negative Limit
0xf2f0	Y Axis Positive Limit	0xf0f2	Y Axis Negative Limit
0xf1f0	X Axis Positive Limit	0xf0f1	X Axis Negative Limit

Example: Query all limit sensors

Enter: AA;
QL

Response: ffff<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
QL	AX - AT	Immediate	
-	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: LH, LL, ?LS

RA REQUEST AXIS STATUS

The RA command returns the state of the limit and home switches and the done and direction flags for the currently addressed axis. The done flag register will be reset by this command.

See RI command for multi-axis mode.

The status is returned in the following format:

CHARACTER MEANING		
CHAR	**SENT**	**DESCRIPTION**
1	LF	Line feed
2	CR	Carriage return
3	CR	Carriage return
4	P	Moving in positive direction
	M	Moving in negative direction
5	D	Done (ID, II or IN command has been executed, set to N by this command or IC command)
	N	No ID executed yet
6	L	Axis in overtravel. Char 4 tells which direction. Set to N when limit switch is not active.
	N	Not in overtravel in this direction
7	H	Home switch active. Set to N when home switch is not active.
	N	Home switch not active
8	LF	Line feed
9	CR	Carriage return
10	CR	Carriage return

Example: The Y axis just encountered a limit, verify its status.

Enter: AY;
RA

Response: PNLN<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
RA	AX – AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: EA, QA, QI, RI

RB REPORT BIT DIRECTION

The RB command reports the bit direction of the general I/O bits.

Example: Report direction of all I/O's. In this example I/O bits 0-3 are set as outputs and I/O bits 4-7 are set as inputs.

Enter: RB

Response: 0f<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
-	AX - AT	Immediate	
RB	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: None

RC REQUEST ACCELERATION

The RC command will return the current acceleration rate of the current axis. This may differ from the programmed acceleration if a cosine (CN) or parabolic (PN) ramp is being generated. When the stage is stopped, the parameter returned will be zero (0). When the stage is running at programmed speed; i.e. not accelerating, the parameter returned will be zero (0). While a contour is executing, the value computed to generate the appropriate lead in will be returned. The response to the RC command is surrounded by linefeed + carriage return pairs.

Example: Display current acceleration values for all axes on a four axis board.

Enter: AA;
RC

Response: <LF><CR>2000000, 2000000, 2000000, 2000000<LF><CR>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
RC	AX - AT	Immediate	
RC	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: ?AC, AC, RV

RD RESTORE DEFAULT VALUES

RD assigns the current parameter set to be the default values that are in flash memory.

QUEUE REQUIREMENTS			
MODE	**Min (pf)**	**Max (pn/cn)**	**Custom ramp**
AX - AT	Immediate		
AA - AM	Immediate		
AA/CD	Not Valid		

Example: Assign the current parameter set to be the default values.

Enter: RD;

Response: None.

Related commands: AP, RF

RE REPORT ENCODER POSITION

The RE command returns the current encoder position of the currently addressed axis or axes in encoder counts.

Example: Examine the current encoder position of the Y axis.

Enter: AY;
RE

Response: 12345<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
RE	AX - AT	Immediate	
RE	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: PE, PP, RP

RF RESTORE FACTORY DEFAULT VALUES

RF assigns the current parameter set to be the factory default values.

Example: Assign the current parameter set to be the factory default values.

Enter: RF;

Response: None

QUEUE REQUIREMENTS			
MODE	**Min (pf)**	**Max (pn/cn)**	**Custom ramp**
AX - AT	Immediate		
AA - AM	Immediate		
AA/CD	Not Valid		

Related commands: None

RI REQUEST INTERRUPT STATUS

The RI command is a multi-axis mode command that returns the same status information for all axes as the RA command does in single axis mode. The 4 character fields for each axis are separated by commas. The done flag is reset by this command as it would be via the RA command.

Example: Check the status of a 4 axis board.

Enter: AA;
RI

Response: MDNN,MDNN,PNLN,PNNN<LF>

Refer to the table "Character Meaning" in the RA command on page 5-156.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
-	AX - AT	Not Valid	
RI	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: EA, QA, QI, RA

RL REPORT SLIP STATUS

The RL command returns the slip detection status of all axes. S is returned if a slip condition has occurred for that axis, or else an N is returned. The number of characters returned corresponds to the number of axes available on the board. This command is intended to be used with stepper motors with encoders and not with servo motors. Open-loop stepper always returns “n” and servo axes always returns “N” in their RL response.

Example: On a four axis board, see if any axis has slipped.

Enter: RL

Response: NNSN<LF> (The Z axis has slipped.)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
RL	AX - AT	Immediate	
RL	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: ES, IS, TF, TN

RM REMAINDER

The RM command divides the position counter by the parameter supplied and replaces the position counter with the resulting remainder. The parameter must be greater than zero and less than 32,000. This command is used in applications where the controller is managing the motion of a continuously rotating object. It allows the position counter to keep track of the absolute position without regard to the number of revolutions it may have rotated. This command has the same effect on the encoder position register on axes with the encoder feedback enabled.

RANGE: 0 < RM < 32,000

Example: The current position of a rotating stage with a full-revolution count of 6000 is needed. Since this stage has been rotated several times without regard for the position, the position counter has reached 163,279. Send an RM6000 command to find out what the real position of the axis is.

Enter: (Current position is 163,279)
RM6000;
(Current position is now 1,279)

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
RM#;	AX - AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: LO, LP, RE, RP, RU

RP REQUEST POSITION

The RP command returns the current position of the currently addressed axis in single axis mode or all positions separated by commas in AA or AM mode. The position will be returned to the host in ASCII format. This command is not queued; i.e. the current position will be returned immediately even if the axis is in motion.

Example: The current position on the Y axis is 12345. Use the RP command to verify the position.

Enter: AY;
RP

Response: 12345<LF>

Example: Verify the positions of all axes.

Enter: AA;
RP

Response: 100,200,300,400<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
RP	AX - AT	Immediate	
RP	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: RE, PE, PP

RQ REPORT QUEUE SIZE

The RQ command returns the number of entries available in the queue of the currently addressed axis in single axis mode or all axes separated by commas in multi-axis modes. The ASCII string is delimited by linefeed + carriage return pairs. The maximum available in each command queue is 800 except the contour queue which is 7160. The response is at a fixed length of 3 characters for all modes except contour mode which is fixed at 4 characters. For example, if the current free queue space is 67 in AM mode, the response from the controller to the RQ command is <LF><CR>067<LF><CR>.

Example: Report the command queue space remaining in contour mode.

Enter: RQ

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**MAX Value**
RQ	AX - AT	Immediate	200
RQ	AA-AM	Immediate	200
RQ	AA/CD	Immediate	7160

Related commands: None.

RS RESET

The RS command is a software reset which causes the local UMX microprocessor to reset. All previously entered data and commands are lost. All internal parameters are initialized to defaults. All interrupts are disabled. This command is intended for catastrophic failure recovery only. The KL command should be used to reset queues or return the system to a known state. Monitor the INIT flag in the status register for completion of the initialization process; see Table 3-4. The “Initializing” in process bit goes high during the initialization process. You should not try to communicate to the controller for approximately 5 seconds after issuing the RS command.

Example: Clear everything in the board and stop all movement. Reset all hardware registers.

Enter: RS;

Response: None

QUEUE REQUIREMENTS			
MODE	**Min (pf)**	**Max (pn/cn)**	**Custom ramp**
AY – AT	Immediate		
AA-AM	Immediate		
AA/CD	Not Valid		

Note: The Polling for the Dir Flag should be at a frequency of 1500ms or more.

Related commands: None.

?RT REPORT RAMP TYPE

The ?RT command reports the current acceleration ramp assigned to the active axis. Possible responses are:

la	Default linear ramp
prn	Parabolic where n specifies number of segments
sc	Cosine ramp
srn	Custom ramp where n specifies the table number
pr	Parabolic ramps

Example: Make sure custom ramp #3 was assigned to the Y axis

Enter: AY;
?RT

Response: sr3<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?RT	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: CN, LA, PF, PN, PR, SC, SR

RU REPORT POSITION IN USER UNITS

The RU command returns the current position in user units (see UU command on page 5-195). The format of the response is a floating-point number.

Example: One revolution of a motor is 2000 steps. Define user units so moves can be referenced in revolutions. Move the Z axis 3 1/2 revolutions. Use RU to display the position when the move is complete.

Enter:
```
AZ;
UU2000;
LP0;
MR3.5;
GO;      (Wait until move is complete.)
RU;
```

Response: 3.50000<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
RU;	AX - AT	Immediate	
RU;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: RE, RP, UU

NOTE: While the user units' mode provides a certain level of convenience to the user, it does so at a cost, namely accuracy and control. User unit conversions may cause round off error and may possibly truncate key information.

RV REQUEST VELOCITY

The RV command will return the current velocity at which the axis is moving. This may differ from the programmed maximum velocity if the axis is accelerating or decelerate. If the JF command is executing, the command only reports the integer part of the velocity.

Example: Jog the Y axis at 12345 steps per second.
Display the current velocity.

Enter:
AY;
JG12345;
RV

Response: 12345<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
RV	AX - AT	Immediate	
RV	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: RC, ?VL, VL

SA STOP ALL

The SA command flushes all queues and causes all axes to decelerate to a stop at the rate previously specified in an AC command. All status and position information is retained. Even when executed in a single axis mode, this command will cause all axes to stop.

Example: Send all axes on a move and then ramp them to a stop before they finish.

Enter:
```
AA;
VL100,100,100,100;
MR1000,2000,3000,4000;
GO;(wait awhile)
SA;
```

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
SA;	AX - AT	1*	0*
SA;	AA-AM	1*	0*
-	AA/CD	Not Valid	

Related commands: KL, KS, SD, SI, SO, ST

SB SET BAUD RATE

The SB command sets the controller's serial communications baud rate. Valid baud rates include 300, 600, 1200, 2400, 9600, 19200 and 38400. The factory default baud rate is 9600. See the AP Command to preserve the SB your baud rate as the Power up/Reset rate.

NOTE: The UMX uses CTS/DTR hardware handshake for flow control.

Example: Sets the serial communications baud rate to 19200.

Enter: SB19200;

Response: None.

QUEUE REQUIREMENTS			
MODE	**Min (pf)**	**Max (pn/cn)**	**Custom ramp**
AY – AT	Immediate		
AA - AM	Immediate		
AA/CD	Not Valid		

Related commands: ?SB

?SB QUERY THE BAUD RATE

The ?SB command queries the board to determine the current baud rate setting

Example: Query the board to determine its current baud rate setting.

Enter: ?SB

Response: If the board is set for 9600 baud rate: sb9600<LF>

QUEUE REQUIREMENTS			
MODE	**Min (pf)**	**Max (pn/cn)**	**Custom ramp**
AX - AT	Immediate		
AA - AM	Not Valid		
AA/CD	Not Valid		

Related commands: SB

SC COSINE RAMP PER AXIS

The SC command specifies that the standard cosine acceleration ramp is to be used by the selected axis/axes. This command is similar to the CN command except that only the selected axis or axes are affected. The AP command will store the settings of SC as the power-up/reset defaults.

Example: Select the cosine ramp for the X axis.

Enter:
AX;
SC;

Response: None.

Example: Select the cosine ramp for the Y and T axes.

Enter:
AA;
SC,1,,1;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
SC;	AY – AT	5	24
SCb,b,b,b;	AA-AM	5	24
-	AA/CD	Not Valid	

Related commands: CN, LA, PF, PN, PR, ?RT, SR

SD STOP AND RESET DONE

The SD command may be substituted for the SA command. It will reset the done flags for all axes, stop all axes at the rates previously specified via the AC command, and then flush all axis command queues. This allows the host to be interrupted when all axes have stopped by using the ID command after the SD. The SA ID combination may flag the completion early if one of the axes is already done from a previously executed ID.

Example: Stop all axes and reset all done flags. When all axes have stopped set all done flags.

Enter:
AA;
SD;
ID;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
SD;	AY – AT	2*	0*
SD;	AA-AM	2*	0*
-	AA/CD	Not Valid	

— If PA (power automatic) mode is active add 1 to the command queue.
— If an auxiliary output bit settle time has been specified add 2 to the command queue and add 1 to the argument queue.

Related commands: KL, KS, SA, SI, SO, ST

SE SETTLING TIME

The SE command allows specification of a settling time, in milliseconds, to be used before the auxiliary output is complemented when using PA mode. The parameter may be any value up to 1000 milliseconds. Specification of a parameter of zero disables SE mode.

The factory default settling time is zero. See the AP command to preserve the SE settings as the Power up/Reset values.

RANGE: 0 ≤ SE ≤ 1000

Example: Turn on the Z axis auxiliary output upon execution of a move and have it remain on for 500 milliseconds after the move is complete.

Enter:
AZ;
PA;
SE500;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
SE#;	AY – AT	Immediate	
SE#,#,#,#;	AA - AM	Immediate	
-	AA/CD	Not Valid	

Related commands: AF, AN, PA, ?SE

?SE REPORT SETTLING TIME

The ?SE command reports the settling time setting (SE) used with power automatic mode (PA) for the current axis.

Example: Report the current settling time for axis X

Enter:
AX;
?SE

Response: se250<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?SE	AY – AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?PA, SE

SF SOFT LIMITS OFF

The SF command restores the default operation of the limit switches; i.e. causes the affected axis or axes to abruptly halt when a limit switch is encountered. If soft limits have been made the power-up default, the AP command must be used to store hard limit operation as the default.

Example: Set up a board to make the X axis stop immediately when a limit is encountered.

Enter:
AX;
SF;

Response: None.

Example: Set up a board to make the Y and T axes to stop immediately when a limit is encountered.

Enter:
AA;
SF,1,,1;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
SF;	AX - AT	1	0
SFb,b,b,b;	AA-AM	1	0
-	AA/CD	Not Valid	

Related commands: LF, LH, LL, LN, ?SL, SL, TL

SI STOP INDIVIDUAL

This command can be used to stop only certain axes. In a single axis mode, the SI command behaves identically to ST. In a multi-axis mode, however, SI can be used to stop any number of axes and can be used in place of SA. Like SA, SI will ramp those axes to be stopped using the rate previously specified via the AC command. This command is useful for stopping a specific axis when the current axis mode is unknown and for stopping several axes without affecting current motion on other axes.

Each parameter represents an axis from X through S. Any non-zero value in a parameter will cause the corresponding axis to be stopped.

Example: Start a motion on all four axes. When input bit 1 becomes true, stop axes Y and T without affecting X and Z.

Enter:
```
AM;
MR15000,30000,20000,40000;
GO;
SW1;
SI,1,,1;
```

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
SI;	AX - AT	1*	0*
SIb,b,b,b;	AA-AM	1*	0*
-	AA/CD	Not Valid	

— If PA (power automatic) mode is active add 1 to the command queue.
— If an auxiliary output bit settle time has been specified add 2 to the command queue and add 1 to the argument queue.

Related commands: KL, KS, SA, SD, SO, ST

SK DEFINE KILL LINK ON UMX

The SK command links the execution of the KILL function (KL) to the defined change of state of the assigned input bit.

First Parameter

This specifies the standard input bit number. The factory default bits are 0, 1, 2, and 3, but it can be configured by the user to include bits 0 to 7

Second Parameter

Valid bit states are 0 and 1

If the value of the selected bit state is ZERO, the selected macro will be executed if the selected bit changes from a TTL high to a TTL low.

If the value of <Bit State> is ONE, then the selected Macro will be executed when the selected bit changes from a TTL low to a TTL high.

NOTE: Each bit state can be linked with a macro. So, up to two macros can be assigned to an input bit. For example, macro 10 could be executed when I/O 0 goes low and macro 11 could be executed when I/O 0 goes high.

Third Parameter

If the value is ZERO the KILL function linkage for the specified Bit State is deleted.

If the value is ONE, the KILL function linkage for the specified Bit State will replace the current linkage.

Example: The current macro linked to I/O bit 2 as it goes from high to low is to be replace with the KILL (KL) function.

Enter: SK2,0,1;

Response: None.

Related commands: None.

SL SOFT LIMITS ON

The SL command enables the UMX to ramp an axis to a stop rather than abruptly killing the motion when a limit switch is encountered on that axis. The output queue is not flushed except for the current move. This mode is effective for point to point and JG moves only. Soft limits can be made the power-up default via the AP command.

Example: Set up a board to allow the X axis to ramp to a stop when a limit is encountered.

Enter:
AX;
SL;

Response: None.

Example: Set up a board I/O to allow the Y and T axes to ramp to a stop when a limit is encountered.

Enter:
AA;
SL,1,,1;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
SL;	AX - AT	1	0
SLb,b,b,b;	AA-AM	1	0
-	AA/CD	Not Valid	

Related commands: LF, LH, LL, LN, SF, ?SL, TL

?SL REPORT SOFT LIMIT STATUS

The ?SL command reports whether soft limits are currently enabled for the active axis.

Example: Find out whether soft limits are enabled for axis Z

Enter: AZ;
?SL

Response: sl<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?SL	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: SF, SL

SM ENABLE/DISABLE STAND-ALONE MODE

This command enables or disables the SM mode (Stand-Alone Mode).

SM mode value of 1 enables the SM mode

A SM mode value of 0 disables the SM mode.

Example: Enable Stand-Alone Mode

Enter: SM1;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
SM#;	AX - AT	Immediate	
SM#,#,#,#;	AA-AM	Immediate	
SM#,#,#,#;	AA/CD	Immediate	

Related commands: CB, PS, SK, SX

SO STOP AT POSITION BY RAMPING FROM A DISTANCE

The SO command instructs the UMX to continue moving until reaching a specified distance (parameter 2) from a specified stop point (parameter 1). The axis will then ramp to a stop within the specified distance. This allows the user to control the point at which deceleration begins, the rate of deceleration, and the stop point, all with a single command.

RANGE:

Min. Position Range ≤ Parameter 1 (Stop Position) ≤ Max. Position Range
Min. Position Range ≤ Parameter 2 (Distance from Stop Position to Start Decelerating) ≤ Max. Position Range

NOTE: The position range is dependent on the UMX's settings, see Specifications for more detail.

Example: The X axis is jogging at 10,000 steps per second. We want the axis to stop at position 50,000 but it must not start ramping until reaching position 46,000.

Enter: SO50000,4000;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
SO#,#;	AY – AT	3*	2*
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

- If the axis is a stepper and encoder or servo axis, add 1 to the command queue
- If PA (power automatic) mode is active, add 1 to the command queue
- If an aux bit settling time has been specified, add 2 to the command queue and add 1 to the argument queue

Related commands: KL, KS, SA, SD, SI, ST

?SO REPORT ANALOG OUTPUT MODE

The ?SO command reports whether the analog output type for the current servo axis is bipolar or unipolar. The possible responses are BI and UN, the same commands used to set one mode or the other.

Example: The Y axis should be setup with unipolar outputs. Use ?SO to make sure.

Enter: AY;
?SO

Response: un<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?SO	AX - AT	Immediate	
-	AA - AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: BI, UN

SP STOP AT POSITION

The SP command will cause the controller to attempt to stop at the specified destination. If there is insufficient distance to stop at the previously specified deceleration when the command is received, the controller will stop as soon as possible at that deceleration. This command is not compatible with the JG command.

Example: (see MV command on page 5-141)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
SP#;	AY – AT	2*	1*
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

- If the axis is a stepper and encoder or servo axis add 1 to the command queue
- If PA (power automatic) mode is active add 1 to the command queue
- If an auxiliary output bit settle time has been specified add 2 to the command queue and add 1 to the argument queue

Related commands: FP, MM, MP, MV

SR SELECT CUSTOM RAMP

The SR command selects a previously defined custom ramp profile for use with a currently active axis. This command will override previous ramp type selection for the given axis such as PN and CN.

RANGE: 1 ≤ SR ≤ 8

Example: Select custom ramp number 4 for use with axis Y.

Enter:
AY;
SR4;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
SR#;	AY – AT	15	5 + (2* number of segments in ramp definition)
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: CN, DAB, DAE, DAR, LA, PF, PN, PR, ?RT, SC

ST STOP

The ST command flushes the queue for the current axis or axes only and causes the axis/axes to decelerate to a stop at the rate previously specified via the AC command. This command is used to stop one or more motors in a controlled manner from jog mode or an unfinished GO or GD command. This command is executed immediately upon receipt. All status and position information is retained. When executed in a multi-axis mode, the ST command is equivalent to the SA command.

Example: Move the Y axis for a while at 1200 steps/second and then ramp to a stop.

Enter:
AY;
JG1200;
(Wait awhile)
ST;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
ST;	AX - AT	1*	0*
ST;	AA-AM	9*	61*
-	AA/CD	Not Valid	

- If PA (power automatic) mode is active add 1 to the command queue.
- If an auxiliary output bit settle time has been specified add 2 to the command queue and add 1 to the argument queue.

Related commands: KL, KS, SA, SD, SI, SO

?SV REPORT SERVO VOLTAGE INVERSION STATE

The ?SV command reports the current logical direction for the current servo axis. The state is set with the SVI and SVN commands. The possible responses to the ?SV command are svn for normal and svi for inverted.

Example: Report whether servo voltage is positive for positive moves on axis X

Enter: AX;
?SV

Response: svn <LF> (voltage is normal; i.e. positive for positive moves)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?SV	AY – AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?DB, SVI, SVN

SVI INVERT SERVO VOLTAGE

The SVI command inverts the voltage output for the current axis. After receiving this command, the UMX will produce a negative voltage for positive motion and a positive voltage for negative motion. To cancel this command, issue an SVN command. To make inverted servo outputs the default at power up or reset, use the AP command.

Example: The Y axis encoder is counting opposite the expected direction. Setup the Y axis to produce a negative voltage when moving positive instead of a positive voltage to correct the problem.

Enter:
AY;
SVI;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
SVI;	AY – AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: BI, DBI, DBN, ?SV, SVN, UN

SVN NORMALIZE SERVO VOLTAGE

The SVN command normalizes the voltage output for the current axis, negating the effects of the SVI command. After receiving this command, the UMX will produce a positive voltage for positive motion and a negative voltage for negative motion, the default behavior. To make this the default behavior (if it has been changed via SVI/AP), use the AP command. (SVN is the factory default setting.)

Example: The Y axis encoder was rewired and now counts in the correct direction. Return the Y axis servo output to normal; i.e. output positive voltage for positive motion.

Enter:
AY;
SVN;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
SVN;	AY – AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: BI, DBI, DBN, ?SV, SVI, UN

SW SYNC WAIT

The SW command allows synchronization of multi-axis moves or other tasks on one or more UMX boards by using one of the general purpose input lines. This command causes the UMX to stop processing new commands until the general purpose input line has been released (allowed to go high) before proceeding with the next command.

The SW command can also be used to cause an axis to wait until the others are finished. To do this, wire-OR the auxiliary lines from several axes together and connect them to a general purpose input line. Use power automatic (PA) mode with the SW command on that line. All commands after that will wait until all axes release their auxiliary lines; i.e. come to a complete stop.

RANGE: 0 ≤ Bit Number ≤ 7

NOTE: The parameter used to specify Bit Number must be configured as an input. See, RB and IO.

Example: The following command sequence will cause the X axis move to wait until the Y axis has finished its move and turned off its auxiliary output which has been wired to the general purpose input 0 line.

Enter:
```
AY;
AN;
MR2000;
GO;
AF;
AX;
SW0;
MR10000;
GO;
```

Response: None.

The SW command provides a way to synchronize moves on two or more controllers. The following example shows one way to do this.

Example: You have 3 four axis controllers, for a total of 12 axes to move together. Call board 1 the “master” and boards 2 and 3 the “slaves”. Wire board 1’s X axis auxiliary line to the two slave boards’ general purpose input 0 line. Send to the master the command “AX PA0”, setting the master’s X axis auxiliary line low until its move starts. This also sets the slaves’ general purpose input 0 line low. Enter the “SW0” command to the two slaves, followed by the move and GO commands. On the master, enter the move command, followed by the GO command. When the master’s move starts, the PA command will set the auxiliary line high releasing the wait on the slave boards. All three boards will start their moves. This provides synchronization to within 480us of each board.

Procedure: Wire board 1’s X axis auxiliary line to board 2’s and board 3’s general purpose input 0 line.

Enter:
(Board 1) AX;
PA0;
(Board 2) AA;
SW0;
MR200,200,200,200;
GO;
(Board 3) AA;
SW0;
MR300,300,300,300;
GO;
(Board 1) AA;
MR100,100,100,100;
GO;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
SW#;	AX - AT	1	1
SW#;	AA-AM	1	1
-	AA/CD	Not Valid	

Related commands: BW, WA, WQ, WT

SX DEFINE MACRO LINK ON UMX

This command creates the link to execute the previously defined permanent macro when it senses the change in state of the defined standard input bit.

First Parameter

This specifies the standard input bit number. The factory default bits are 0, 1, 2, and 3, but it can be configured by the user to include bits 0 to 7.

Second Parameter

Valid bit states are 0 and 1

If the value of the selected bit state is ZERO, the selected macro will be executed if the selected bit changes from a TTL high to a TTL low.

If the value of <Bit State> is ONE, then the selected Macro will be executed when the selected bit changes from a TTL low to a TTL high.

NOTE: Each bit state can be linked with a macro. So, up to two macros can be assigned to an input bit. For example, macro 10 could be executed when I/O 0 goes low and macro 11 could be executed when I/O 0 goes high.

Third Parameter

Specifies the macro number (5-24) to be executed when the conditions are met. A macro link can be deleted by specifying the bit number and the bit state along with a macro number zero. The macro assigned to a given input bit and bit state can be changed by issuing the same SX command using a different macro number.

Example: When I/O bit 1 goes from low to high, macro 20 will be executed.

Enter: SX1,1,20;

Example: Upon Power-up, the user presses an “Activate Button-short to ground”, (linked to bit 1). This should cause the UMX to position the X-axis at a position 1000 steps from zero and the Y-axis at 2000 steps from zero. At that point, it should execute Macro 10. The stop button (short to ground) is linked to bit 2.

Enter:	MD0;	begin the definition of Macro #0
	AX; MA1000; GO;	move X-axis to position 1000
	AY; MA2000; GO;	move Y-axis to position 2000
	<control Z>	terminate the definition of macro #0
	PT0,10;	store macro #0 to non-volatile macro #10
	SX1,0,10;	define I/O bit #1, active low will execute macro #10
	MD1;	begin the definition of macro #1
	KL;	send a KILL to stop everything
	<control Z>	terminate the definition of Macro #1
	PT1,9;	store macro #1 to non-volatile macro #9
	SX2,0,9;	define I/O bit #2, active low will execute macro #9
	SM1;	enable the stand-alone mode
	AP;	set the current parameters to the power-up defaults

Related commands: CB, PS, SK, SM

TF TURN OFF SLIP KILL MODE

The TF command disables slip kill mode (enabled with TN.)

Example: Slip kill mode is enabled but a move needs to be performed where slip is likely and not important for this move. Disable slip kill mode.

Enter: TF;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
TF;	AY – AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ES, IS, RL TN

TL SET SOFTWARE OVERTRAVEL LIMITS

The TL command sets logical limits on the range of travel for an axis. Two parameters must be supplied; one for the upper travel limit and the other for the lower travel limit, both as absolute positions. If the axis reaches either of these logical limits, the UMX will flag a limit condition just as it would be using the physical limit switch inputs. Move Absolute (MA), Move Relative (MR), and Jog (JF,JG) commands are subject to software travel limits because the UMX checks an internal absolute position register.

Note: Software overtravel limits and physical limit switch inputs can be enabled at the same time.

RANGE: + Position Range

Note: The position range on UMX is dependent on the adder rate and update rate selection. See Specification section for more detail.

Example: Set logical position limits for the X axis of +/-1,000,000.

Enter: AX;
TL1000000,-1000000;

Response: None.

Note: TL0,0; Turns software limits off.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
TL#,#;	AY – AT	1	2
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: LF, LL, LH, LN, SF, SL, ?TL

?TL REPORT SOFTWARE OVERTRAVEL LIMITS

The ?TL command reports the software travel limits for the current axis assigned via the TL command. The first value returned is the upper (or "positive") limit and the second value is the lower (or "negative") limit. These are not physical limits but rather positional limits that an axis should not exceed. If one of these limits is exceeded, the UMX will set the current axis' limit flag and notify the host computer of the condition as though the axis encountered a hard limit.

Example: Find out what the software limits of the Y axis are currently set to.

Enter: AY;
?TL;

Response: tf<LF>

Example: Find out what the software limits of the T axis are currently set to.

Enter: AT;
?TL;

Response: tf<LF> (software limits for axis T are currently disabled)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?TL	AY – AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: TL

TM TIMED JOG

The TM command performs a jog at the current velocity limits defined for the axis/axes for the specified number of milliseconds. In multi-axis mode, all axes begin moving at the same time and ramp to a stop when their respective jog times have elapsed. The overall jog time will be the parameter passed to the TM command plus deceleration time and acceleration time.

RANGE: 0 ≤ TM ≤ 200,000

Example: Jog the X axis for 1000 milliseconds.

Enter: AX;
TM1000;

Response: None.

Example: Jog the X axis for 1000 milliseconds and the Z axis for 2000 milliseconds, starting both at the same time.

Enter: AA;
TM1000,,2000;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
TM#;	AX - AT	5*	1*
TM#,#,#,#;	AA-AM	5*	1*
-	AA/CD	Not Valid	

- If PA (power automatic) mode is active add 1 to the command queue
- If the axis is a stepper and encoder or servo axis add 1 to the command queue

Related commands: JF, JG, SA, ST

TN TURN ON SLIP KILL MODE

The TN command enables slip kill mode. In this mode, if the motor slips beyond the dead band set by the ES command, the UMX will kill motion on the axis that slipped as though a KL command had been issued to the axis. This mode can be disabled (default) with the TF command.

Example: X axis is sent on a move. Its encoder cable was not connected to the controller (oops!). The controller issues a KL (Kill) command to the X axis after receiving the slip interrupt. The slip interrupt is generated once the difference between the motor position counts and encoder counts exceed 20.

Enter:
```
AX;
ES20;
TN;
IS:
LP0;
MA30;
GO;
```

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
TN;	AY – AT	1	1
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ES, IS, RL, TF

TX TRACK THE X AXIS

Set up the current axis so that it tracks the X axis. The command argument is the tracking ratio specified as a floating point.

NOTE: If this is a negative, then the axis moves in the opposite direction of the X axis. The command is invalid for the X axis.

Example: Set the Z axis to track the X axis.

Enter: AZ;
TX;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
TX;	AY – AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related Commands: ET, HF

UF USER UNITS OFF

The UF command turns off user units returning all numeric commands and responses to their factory default raw representations. This command is equivalent to and preferred over UU1; since it turns off the mode thus minimizing unnecessary overhead. See the AP commands to preserve the UF settings to flash memory.

Example: Turn off user unit conversion on the X, Y, and Z axes.

Enter:
AX;
UF;
AY;
UF;
AZ;
UF;
Or
AA;
UF1,1,1;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
UF;	AX - AT	Immediate	
UFb,b,b,b;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: ?UU, UU

NOTE: While the user units' mode provides a certain level of convenience to the user, it does so at a cost, namely accuracy and control. User unit conversions may cause round off error and may possibly truncate key information.

UN UNIPOLAR

The UN command sets the analog torque outputs of servo axes to unipolar. The analog output will range between 0.0VDC and +10VDC when unipolar is enabled. At maximum positive velocity, the board outputs +10VDC. At maximum negative velocity, the board output approaches 0.0VDC. To maintain position the board outputs 5VDC. This command is valid only in single axis mode.

Example: Set up servo axis X for unipolar operation.

Enter: AX;
UN;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
UN;	AX - AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: BI, DBI, DBN, ?SO, SVI, SVN

UU USER UNITS

The UU command converts all move velocities, distances, etc. to user specified units by multiplying by the specified parameter. The UF command is used to terminate this mode. Factory default is with this command off. See the AP command on to preserve the UU settings to flash memory.

Example: The motor, driver, and gear ratio you are using requires 10,000 steps to move one inch. Set up the X, Y, and Z axes so you can enter move information in inches.

Enter:
AX;
UU10000;
AY;
UU10000;
AZ;
UU10000;
Or
AA;
UU10000,10000,10000;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
UU#;	AY – AT	Immediate	
UU#,#,#,#;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: RU, UF, ?UU

NOTE: While the user units' mode provides a certain level of convenience to the user, it does so at a cost, namely accuracy and control. User unit conversions may cause round off error and may possibly truncate key information.

?UU REPORT AXIS USER UNIT

This command returns the current user units' multiplier as set via the UU command. Factory default is UF.

Example: Make sure the UU512; command we sent earlier is still current. The command will return the UU value with six digits to the right of the decimal point. If the UU value exceeds six digits for the fractional value, the value will be rounded off to the sixth decimal place.

Enter: ?UU

Response: uu512.000000<LF>
If user units are turned off (UF) ?UU returns:
uf<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?UU	AY – AT	Immediate	
	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: UF, UU

NOTE: While the user units' mode provides a certain level of convenience to the user, it does so at a cost, namely accuracy and control. User unit conversions may cause round off error and may possibly truncate key information.

VB VELOCITY BASE

The VB command allows the acceleration ramp to start off at a specified velocity. This allows faster acceleration and the ability to pass through resonance quickly in some applications. The velocity jumps instantly to the specified velocity, and then accelerates as usual. The deceleration is the same in reverse. This mode is active only for linear ramps; it is ignored for cosine and parabolic ramps but not flagged as a command error. The parameter must be greater than zero and less than the programmed velocity, where the factory default is zero steps per second. This command is not valid with the JG command nor will it work in conjunction with the DC command. See the AP command to preserve the VB settings as the power-up/reset values.

If the VL command is used after the VB command and the velocity value set with VL is less than the previously set VB value, the initial velocity used at the start of a move will be the VL value minus one. This will result in a one-step acceleration ramp and must be taken into consideration in applications making use of the VB command.

RANGE: 0 ≤ VB < VL value

Example: In the single axis mode, set the Y axis velocity base to 200.

Enter:
AY;
VB200;

Response: None.

Example: In the AA mode, set the X and Y axes velocity bases to 200.

Enter:
AA;
VB200,200;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
VB#;	AY – AT	1	1
VB#,#,#,#;	AA-AM	1	1
-	AA/CD	Not Valid	

Related commands: AC, DC, ?VB, VL

?VB REPORT BASE VELOCITY

The ?VB command returns the base (starting) velocity setting for the current axis as set by the VB command. Note that the base velocity must be lower than the command velocity.

Example: The acceleration ramp should start at 0pps. Make sure we didn't leave it at some other value.

Enter: ?VB;

Response: vb1500<LF> (Oops! We forgot to set it back to zero)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?VB	AY – AT	Immediate	
	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: VB, ?VL

VL VELOCITY

The VL command sets the maximum velocity register of one or more axes to the operands which follow the command. The factory default is 200,000 steps per second. See the AP command to preserve the VL settings as the power-up/reset values.

RANGE: 1 ≤ VL ≤ 1044000

Example: In single axis mode, set the X axis velocity to 10,000 counts per second.

Enter:
AX;
VL10000;

Response: None.

Example: In the AA mode, set the peak velocities of the X and T axes to 5,000 and 50,000 respectively. Leave the other axes with their previous values.

Enter:
AA;
VL5000,,,50000;

Response: None.

QUEUE REQUIREMENTS				
Format	**Mode**	**Axis ramp type**	**Command**	**Argument**
VL#; or VL#,#,#,#;	AX-AT or AA-AM	Linear (LA or PF)	1	1
VL#; or VL#,#,#,#;	AX-AT or AA-AM	Short Parabolic (PN0; or PR0:)	2*	26*
VL#; or VL#,#,#,#;	AX-AT or AA-AM	All other Parabolic Forms	Not Valid	
VL#; or VL#,#,#,#;	AX-AT or AA-AM	Cosine (CN or SC)		
VL#; or VL#,#,#,#;	AX-AT or AA-AM	Custom Ramps (SR)		

Related commands: AC, DC, ?VB, VB, ?VL

?VL REPORT PEAK VELOCITY SETTING

The ?VL command returns the peak velocity setting for the current axis as set by the VL command.

Example: Make sure our "AX;VL50000;" command worked.

Enter: ?VL

Response: vl150000<LF>

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
?VL	AY – AT	Immediate	
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: ?VB, VB, VL

VS VELOCITY STREAMING

The VS command will generate a pulse train without acceleration or deceleration at the rates specified using the X and Y axes. The parameters are time in 1 update rate second sample intervals, X velocity, and Y velocity. This is a slave mode and cannot be mixed or queued with other commands; i.e. no other motions involving the X and Y axes or AA mode may be currently in execution when this command is issued. AX mode is the only valid mode for use with this command. The VS command does not require a GO command to start the motion; motion begins immediately upon receipt of the complete VS command.

RANGES:

1 ≤ Parameter 1 (Time in 1 update rate of a second) ≤ 200,000

0 ≤ Parameter 2 (X Axis Velocity) ≤ 1044000

0 ≤ Parameter 3 (Y Axis Velocity) ≤ 1044000

Example: Create a stair step profile on the X and Y axes, with the X axis moving in the negative direction and the Y axis in the positive direction. Make each step last 1 second long and increase velocity by 1,000 steps/second, until a velocity of 3,000 steps/second is reached, then step down to 0 steps/second. (Example assumes an update rate of 1024.)

Enter:
```
AX;
VS1024,-1000,1000;
VS1024,-2000,2000;
VS1024,-3000,3000;
VS1024,-2000,2000;
VS1024,-1000,1000;
VS1,0,0;
```

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
VS#,#,#,#;	AY – AT	2	3
-	AA-AM	Not Valid	
-	AA/CD	Not Valid	

Related commands: MV

WA WAIT FOR AXES

The WA command, valid only in AA mode, allows a command to wait until all moves on all axes are finished before executing any further commands. Some commands which can affect a non-moving axis, such as AN, AF and PA, may execute before a previous move on other axes has finished, especially while in a looping (LS-LE, WH-WG) mode. By preceding these commands with a WA, they will not execute until all previously defined moves have finished.

Example: The Z axis auxiliary line controls a laser beam that you only want on while the Z axis moves in a positive direction. The X and Y axes position the laser. You want to repeat the action 10 times.

Enter:

```
AA;
VL1000,1000,1000;
AC10000,10000,10000;
LS10;
MR1000,1000;
GO;
WA;
AN,,1;
MR,,500;
GO;
AF,,1;
MR,,-500;
GO;
LE;
```

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
-	AY – AT	Not Valid	
WA;	AA-AM	2*	0*
-	AA/CD	Not Valid	

* This command places entries in all axes' queues.

Related commands: BW, SW, WQ, WT

WD WHILE END

The WD command serves as the loop terminator for the WS command.

Example: (see WS command on page 5-207)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
WD;	AY – AT	1	1
WD;	AA-AM	1*	1*
-	AA/CD	Not Valid	

* In AA or AM mode, entries are made in all axes' queues.

Related commands: WS

WG WHILE FLAG

The WG command serves as the terminator for the WH command.

Example: (see WH command page 5-204)

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
WG;	AY – AT	1	1
WG;	AA-AM	2*	1*
-	AA/CD	Not Valid	

*In AA or AM mode, entries are made in all axes' queues.

Related commands: CW, WH

WH WHILE

The WH command will execute all commands between it and the terminating WG command as a loop until terminated by a CW command. This allows repeated execution of a command sequence which can be terminated by the host. These commands may not be nested but may be executed sequentially.

Example: You have a 3 axis platform that you use to drill holes in the center of a ¼ inch thick sheet of metal. The sheet is 6 inch square. The driver / motor / lead - screw pitch provide 10000 steps per inch. The operator must manually insert and remove the square from the platform. The X and Y axes move a drill into the desired position. The Z axis lifts and lowers the drill. The operator presses a switch which tells the motion controller that the square is in place and ready to be drilled. The operator will continuously remove and replace the squares until ready to take a break.

The following is a description of how to set up an OMS board to perform this task.

Procedure: Connect a normally closed momentary switch between user I/O input line 0 and ground. This will be the “Ready to Drill” switch.

Enter:

```
AX;
UU10000;        *set up user units so we can reference move to inches
AY;
UU10000;        *10000 steps = 1 inch
AZ;
UU10000;        *10000 steps = 1 inch
AX;
VL.1;
AC10;           *set up X axis homing velocity and acceleration
AY;
VL.1;
AC10;           *set up Y axis homing velocity and acceleration
AZ;
VL.1;
AC10;           *set up Z axis homing velocity and acceleration
AX;
HR;
AY;
HR;
AZ;
HR;             *send each axis to home
AA;
VL3,3,.5;       *set normal move velocity for X, Y and Z axes
WH;             *start of loop to drill squares indefinitely
SW0;            *(operator removes/replaces square into platform)
MA3,3;          *wait until operator presses switch
GO;             *move to center of square
MA,,.5;
GO;             *move the drill through the square (1/2 inch move on the
                 Z axis drill through the square)
MA,,0;
```

```
GO;             *lift the drill
MA0,0;
GO;             *move the platform to home position
WG;             *loop back to starting WH command
(CW;)           *operator wants a break so he/she sends CW from keyboard and presses
                 switch once more (since loop will most likely be waiting for the switch at
                 this point)
MA0,0,0;        *the loop ends and the following commands execute
GO;             *move to home position
```

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
WH;	AY – AT	1	1
WH;	AA-AM	2*	1*
-	AA/CD	Not Valid	

— In AA or AM mode, entries are made in all axes' queues.

Related commands: CW, LS, WG, WS

WQ WAIT FOR QUEUE TO EMPTY

The WQ command is a special command that stops the board from processing any new commands until the command queue for the current axis mode is empty; i.e. all previous moves have finished. This command is not valid in looping (LS-LE, WH-WG) modes.

Example: Move the Y axis 1,000 steps and wait until the move is complete before asking for the position.

Enter:
AY;
MR1000;
GO;
WQ
RP;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
WQ;	AY – AT	Immediate	
WQ;	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: BW, SW, WA, WT

WS WHILE SYNC

The WS command will execute the commands between the WS and WD commands as a loop while the specified general purpose input line is true; i.e. low (default). When the line goes high the UMX will exit the loop and execute the commands which follow the WD command. The test is at the bottom of the loop; i.e. the commands between WS and WD will always be executed at least once.

If the input line specified is already in the specified state to exit the loop when the WS/WD loop is issued to the UMX, those commands will be executed only once.

#RANGE: 0 ≤ Parameter ≤ 15

Example: Execute a continuous loop, moving the X axis 10,000 counts and then move the Y axis -1000 counts, until an external device terminates the loop by setting general purpose input 1 high.

Enter:
```
AA;
WS1;
MR10000;
GO;
MR,-1000;
GO;
WD;
```

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
WS#;	AY – AT	1	1
WS#;	AA-AM	1*	1*
-	AA/CD	Not Valid	

* In AA or AM mode, entries are made in all axes' queues

Related commands: LS, WD, WH

WT WAIT

The WT command will wait for a specified number of milliseconds before proceeding with the next command in the queue. In the AA mode, all axes will wait and entries are made in all axis queues. Immediate commands will not wait since they are not queued.

RANGE: 1 ≤ WT ≤ 200,000

Example: You want to produce pulses on the X axis at 5,000 steps/second for 2 seconds, then 10,000 pulses/second for 3 seconds, and then stop.

Enter:
AX;
JG5000;
WT2000;
JG10000;
WT3000;
ST;

Response: None.

QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
WT#;	AY – AT	2	1
WT#;	AA-AM	2	1
-	AA/CD	Not Valid	

Related commands: BW, SW, WA, WQ

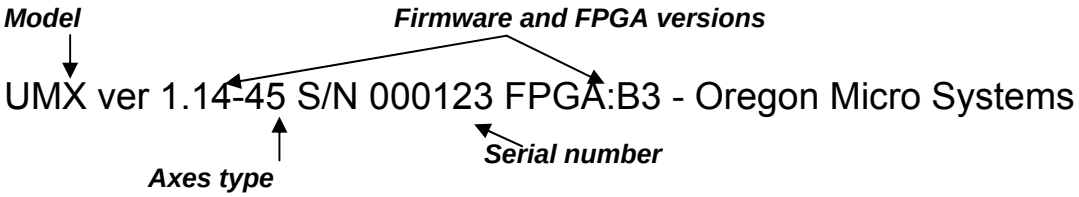
WY WHO ARE YOU

The WY command returns the model type, firmware revision number, and number of controlled axes of the board being addressed.

Example: You want to examine the board identification string.

Enter: WY;

Response:



QUEUE REQUIREMENTS			
FORMAT	**MODE**	**COMMAND**	**ARGUMENT**
WY	AY – AT	Immediate	
WY	AA-AM	Immediate	
-	AA/CD	Not Valid	

Related commands: None.

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6. HOST SOFTWARE

6.1. INTRODUCTION TO UMX SOFTWARE SUPPORT

A CD-ROM containing device drivers, application software, and demonstration code for OMS Motion, Inc. PC family controller is supplied with the initial purchase of an OMS UMX board. Reference the text files (i.e. README.TXT) on the disk for installation instructions and other information.

Some programs on the demo disk that include source code may be adapted for use in application programs that use OMS motion controls. No license is required.
An additional CD-ROM contains OMS User Manuals.

6.2. COMMUNICATION METHODS

There are two possible ports that may be used for communication on a UMX. They are virtual COM port and OmsUmxMC.dll.

6.2.1. VIRTUAL COM PORT COMMUNCIATION

The UMX driver offers a serial virtual COM port that can be accessed as a character device.
This way the application has to handle interrupt symbols itself (#, !, $, @, 0x80-0x83).

6.2.2. OMSUMXMC.DLL

The OmsUmxMC.dll eases the use by presenting a simple interface to the controller's virtual COM port. See the DLL and Example sections in the UMX software package for more information.

There are several example applications on the support disk shipped with your UMX. Reference the source code and "README" files on the support disk.

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7. SERVICE

7.1. USER SERVICE

The UMX family of controllers contains no user serviceable parts.

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APPENDIX A.

LIMITED WARRANTY

The Seller warrants that the articles furnished are free from defect in material and workmanship and perform to applicable, published OMS Motion, Inc. specifications for one year from date of shipment. This warranty is in lieu of any other warranty express or implied. In no event will Seller be liable for incidental or consequential damages as a result of an alleged breach of the warranty. The liability of Seller hereunder shall be limited to replacing or repairing, at its option, any defective units which are returned f.o.b. Seller's plant. Equipment or parts which have been subject to abuse, misuse, accident, alteration, neglect or unauthorized repair are not covered by warranty. Seller shall have the right of final determination as to the existence and cause of defect. As to items repaired or replaced, the warranty shall continue in effect for the remainder of the warranty period, or for 90 days following date of shipment by Seller of the repaired or replaced part whichever period is longer. No liability is assumed for expendable items such as lamps and fuses. No warranty is made with respect to custom equipment or products produced to Buyer's specifications except as specifically stated in writing by Seller and contained in the contract.

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APPENDIX B.

TECHNICAL SUPPORT

OMS Motion, Inc. can be reached for technical support by any of the following methods:

1. Email: support@omsmoton.com

2. Internet: http://www.omsmotion.com/

3. Telephone: 8:00 a.m. - 5:00 p.m. Pacific Standard Time
(503) 629-8081 or (800) 707-8111

4. Facsimile: 24 Hours
(503) 629-0688 or (877) 629-0688

5. USPS: OMS Motion, Inc.
15201 NW Greenbrier Pkwy, B-1
Beaverton OR 97006

RETURN FOR REPAIRS

Call OMS Motion, Inc. Customer Service at 503-629-8081 or (800) 707-8111 or email to: sales@omsmotion.com.

Explain the problem and we may be able to solve it on the phone. If not, we will give you a Return Materials Authorization (RMA) number.

Mark the RMA number on the shipping label, packing slip and other paper work accompanying the return. We cannot accept returns without an RMA number.

Please be sure to enclose a packing slip with the RMA number, serial number of the equipment, reason for return, and the name and telephone number of the person we should contact if we have further questions.

Pack the equipment in a solid cardboard box secured with packing material.

Ship prepaid and insured to:
OMS Motion, Inc.
15201 NW Greenbrier Pkwy, B1
Beaverton, OR 97006

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APPENDIX C.
SPECIFICATIONS

Velocity

0 to 1,044,000 counts per second simultaneous on each axis

Acceleration

0 to 8,000,000 counts per second per second

Position range

67,000,000 counts (±33,500,000)

Accuracy

Position accuracy and repeatability ±0 counts for point to point moves
Velocity accuracy ±0.01% for step pulse output
Environmental Operating temperature range: 0 to 50 degrees centigrade
Storage temperature range: -20 to 85 degrees centigrade
Humidity: 0 to 90% non-condensing

Power

+5VDC at 1 amp typical
+12VDC at 0.1 amp for servo model
-12VDC at 0.1 amp for servo model

Dimensions

3.278X3.536X0.5 inches high

Communication

USB 2.0

Update Rate

488 μs for UMX family

Limit switch inputs

TTL input levels with on board 2.2K pull up resistor, requires only external switch closure to ground or TTL level input signal. Input sense (low or high true) selectable by command input for each axis.

Home switch inputs

TTL input levels with on board 2.2K pull up resistor, requires only external switch closure to ground or TTL level input signal. Input sense (low or high true) selectable by command input for each axis.

User definable I/O

Up to 12 bits of user definable I/O on UMX models with 4 axes or less. 8 bits are user configurable as inputs or outputs. One auxiliary output per axis and these are fixed as outputs. Factory default is 4 inputs, 4 outputs and 1 auxiliary output per axis
TTL input levels with on board 2.2K pull up resistor, requires only external switch closure to ground or TTL level input signal.
The auxiliary outputs are TTL open collector outputs (7406, max 48mA). The other outputs are TTL totem pole outputs (74LS243, max 24mA).

Analog outputs

+/-10V and 0 to +10V (servo models only)

Step pulse output

Pulse width 50% duty cycle. Open collector TTL level signal (7406, max 48mA).

Direction output

Open collector TTL level signal (7406, max 48mA).

Encoder Feedback

Maximum 12 MHz after 4x quadrature detection
Differential TTL level signal MC26G32, max 150mA

UMX CONNECTOR (J5)			
Description	Pin#	Pin#	Description
Digital GND	1	35	+5VDC
I/O-1	2	36	I/O-0
I/O-3	3	37	I/O-2
I/O-5	4	38	I/O-4
I/O-7	5	39	I/O-6
Digital Ground	6	40	+5VDC
X Index +	7	41	X Servo
X Index -	8	42	X Step
X Phase A +	9	43	X Auxiliary
X Phase A -	10	44	X Direction
X Phase B +	11	45	X Limit +
X Phase B -	12	46	X Limit -
Y Servo	13	47	X Home
Y Index +	14	48	Y Step
Y Index -	15	49	Y Auxiliary
Y Phase A +	16	50	Y Direction
Y Phase A -	17	51	Y Limit +
Y Phase B +	18	52	Y Limit -
Y Phase B -	19	53	Y Home
Analog GND	20	54	+5VDC
Z Index +	21	55	Z Servo
Z Index -	22	56	Z Step
Z Phase A +	23	57	Z Auxiliary
Z Phase A -	24	58	Z Direction
Z Phase B +	25	59	Z Limit +
Z Phase B -	26	60	Z Limit -
T Servo	27	61	Z Home
T Index +	28	62	T Step
T Index -	29	63	T Auxiliary
T Phase A +	30	64	T Direction
T Phase A -	31	65	T Limit +
T Phase B +	32	66	T Limit -
T Phase B -	33	67	T Home
Digital GND	34	68	+5VDC

IO68-M TERMINAL BLOCK PIN-OUT					
Row 1	**Description**	**Row 2**	**Description**	**Row 3**	**Description**
1	X Step	24	X Direction	47	X Auxiliary
2	X Phase A+	25	X Phase B+	48	X Index +
3	X Phase A-	26	X Phase B-	49	X Index -
4	X Limit +	27	X Limit-	50	X Home
5	+5VDC	28	X Servo	51	Digital Ground
6	Y Step	29	Y Direction	52	Y Auxiliary
7	Y Phase A+	30	Y Phase B+	53	Y Index +
8	Y Phase A-	31	Y Phase B-	54	Y Index -
9	Y Limit +	32	Y Limit-	55	Y Home
10	+5VDC	33	Y Servo	56	Digital Ground
11	I/O-0	34	I/O-3	57	I/O-5
12	I/O-1	35	No Connect	58	I/O-6
13	I/O-2	36	I/O-4	59	I/O-7
14	+5VDC	37	Z Servo	60	Analog Ground
15	Z Step	38	Z Direction	61	Z Auxiliary
16	Z Phase A+	39	Z Phase B+	62	Z Index +
17	Z Phase A-	40	Z Phase B-	63	Z Index -
18	Z Limit +	41	Z Limit-	64	Z Home
19	+5VDC	42	T Servo	65	T Auxiliary
20	T Step	43	T Direction	66	T Index +
21	T Phase A+	44	T Phase B+	67	T Index -
22	T Phase A-	45	T Phase B-	68	T Home
23	T Limit +	46	T Limit-	69	Digital Ground

UIO J1 (X), J2 (Y), J3 (Z) , J4 (T) Connector pin outs	
Pin	**Signal**
1	GND
2	Phase B-
3	Phase B+
4	Index -
5	Index +
6	Phase A -
7	Phase A +
8	5V
9	Home
10	Limit -
11	Limit +
12	Servo
13	Auxiliary
14	Direction
15	Step

UIO J8 (IO) Connector pin outs	
Pin	**Signal**
1	IO7
2	IO6
3	IO5
4	IO4
5	IO3
6	IO2
7	IO1
8	IO0
9	GND
10	5V
11	GND
12	5V
13	GND
14	5V
15	GND

UIO J5 Connector	
Pin	**End Signal**
1	GND
2	J8-Pin7 IO1
3	J8-Pin5 IO3
4	J8-Pin3 IO5
5	J8-Pin1 IO7
6	GND
7	J1-Pin5 X Index+
8	J1-Pin4 X Index-
9	J1-Pin7 X Phase A+
10	J1-Pin6 X Phase A-
11	J1-Pin3 X Phase B+
12	J1-Pin2 X Phase B-
13	J2-Pin12 Y Servo
14	J2-Pin5 Y Index+
15	J2-Pin4 Y Index-
16	J2-Pin7 Y Phase A+
17	J2-Pin6 Y Phase A-
18	J2-Pin3 Y Phase B+
19	J2-Pin2 Y Phase B-
20	GND
21	J3-Pin5 Z Index+
22	J3-Pin4 Z Index-
23	J3-Pin7 Z Phase A+
24	J3-Pin6 Z Phase A-
25	J3-Pin3 Z Phase B+
26	J3-Pin2 Z Phase B-
27	J4-Pin12 T Servo
28	J4-Pin5 T Index+
29	J4-Pin4 T Index-
30	J4-Pin7 T Phase A+
31	J4-Pin6 T Phase A-
32	J4-Pin3 T Phase B+
33	J4-Pin2 T Phase B-
34	GND

UIO J6 Connector	
Pin	**End Signal**
1	5V
2	J8-Pin8 IO0
3	J8-Pin6 IO2
4	J8-Pin4 IO4
5	J8-Pin2 IO6
6	5V
7	J1-Pin12 X Servo
8	J1-Pin15 X Step
9	J1-Pin13 X Aux
10	J1-Pin14 X Dir
11	J1-Pin11 X Lmt+
12	J1-Pin10 X Lmt-
13	J1-Pin9 X Home
14	J2-Pin15 Y Step
15	J2-Pin13 Y Aux
16	J2-Pin14 Y Dir
17	J2-Pin11 Y Lmt+
18	J2-Pin10 Y Lmt-
19	J2-Pin9 Y Home
20	5V
21	J3-Pin12 Z Servo
22	J3-Pin15 Z Step
23	J3-Pin13 Z Aux
24	J3-Pin14 Z Dir
25	J3-Pin11 Z Lmt+
26	J3-Pin10 Z Lmt-
27	J3-Pin9 Z Home
28	J4-Pin15 T Step
29	J4-Pin13 T Aux
30	J4-Pin14 T Dir
31	J4-Pin11 T Lmt+
32	J4-Pin10 T Lmt-
33	J4-Pin9 T Home
34	5V

CBL15-5	
Pin	**Wire Color**
1	Black
2	Brown
3	Red
4	Orange
5	Yellow
6	Dark Green
7	Blue
8	Purple
9	Grey
10	White
11	Pink
12	Light Green
13	Black/White
14	Brown/White
15	Red/White

UMX Intelligent Motion Controls							
Model	Interface	Servo Axes	Stepper Axes (Open or Closed – loop)	Axes control I/O			User I/O
	Virtual COM over USB			Limits	Aux	Home	GPIO
UMX-25	Yes	2		4	2	2	8
UMX-45	Yes	4		8	4	4	8
UMX-26	Yes		2	4	2	2	8
UMX-46	Yes		4	8	4	4	8

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