

OPERATION

Front Panel Controls

XY Joystick

The XY Joystick is spring loaded to return to a zero movement center when not in use. The speed at which the stage moves is linear function of the degree to which the joystick is pushed away from the center. The direction of deflection can be controlled by the settings of the DIP switches on the back panel of the box (see *Back Panel Controls*). Depressing the button on top of the joystick will toggle the speed range of the joystick. In the high-speed range, the stage will travel up to the maximum speed of the motors; in the low-speed range, the speed for maximum deflection is reduced to 5 – 10% of maximum speed. The speed settings for the joystick may be programmed and saved in firmware. See the JSSPD command.

Command Encoder Knob

The Command Encoder Knob is usually used to control the Z-axis stage. The relative speed of the knob can be set with the JSSPD command and saved in firmware. The command knob can be attached to any axis by using the JS command.

Zero Button

The Zero Button allows the user to set all three axes coordinates to zero. Upon pressing the button, the LCD will display the change. Pressing the button also cancels any and all serial-controlled movement commands. The zero button also acts as a HALT button to stop undesired motion. Pressing the zero button briefly will halt motion and zero the coordinates; pressing and holding down the zero button for more than 1 second will halt motion, but not alter the coordinate settings.

Home Button

The Home Button sends the stage back to the zero coordinates.

@ Button

The @ Button is programmed for special functions. On most controllers this button is used with the Multi-Point Save/Move feature (see *Special Functions* below).

Rocker Switch - Clutch Enable

The Clutch Enable Switch allows the user to disconnect the Z-Axis motor from the microscope's fine focus knob by setting the switch to "Disengaged" (no dot on switch). When switching from "Disengaged" to "Engaged" (white dot on switch), the current position of the Z-Axis is locked-in, canceling any previously given Move commands. When the drive is "Disengaged," the feedback encoder still provides position information for the Z-axis LCD display. In some system configurations, the rocker switch is not used, or used for other special purposes.

LCD Screen

The Liquid Crystal Display (LCD) screen shows the current position coordinates of the axes with status information displayed to the right. A dim back illumination allows users to clearly view the screen even in a darkened room without causing light pollution.

The LCD display has four display modes selected by DIP switches 1 & 2 on the back panel. The display modes have the following characteristics:

Mode 1 - SW 1 & 2 DOWN Normal Display with Controller Firmware Version Line Shown

```
X: 23.12345 mm : fB
Y: -3.12345 mm : UM
Z:  1.12345 mm : E
      MS2000 v8.8d
```

This display shows the stage position in millimeters with five digits of precision with the status indicators on the right side.

Mode 2 - SW 1 DOWN & SW 2 UP Normal Display with Status Line Shown

```
X: 23.12345 mm : S
Y: -3.12345 mm : U
Z:  1.12345 mm : E
HRR 001:003 00:23:05
```

The status line at the bottom of the display indicates the command set (H high or L low), the XY encoder mode (R rotary or L linear), and the Z encoder mode (R rotary or L linear). The next two numbers show the next position to move-to for ring buffer, and the number of positions stored, respectively, separated by a colon (:). Controllers with the Auto-Focus option display the focus value on this line as well. On the right side is a time clock. Some error codes are displayed in place of the clock for a few seconds after they occur.

Mode 3 - SW 1 & 2 UP Dual Display with Status Line Shown

```
X23.12342>23.12345s
Y-3.12340>-3.12345U
Z 1.12345> 1.12345E
HRR 002:003 COD: 22
```

In this mode, two sets of number are shown for each axis. The number on the left is the current position reported by the axis encoders. The number on the right is the target position that the controller is trying to achieve.

Mode 4 - SW 1 UP & 2 DOWN Dual Display with Firmware Version Line Shown

There are several status indicators that may appear on the right side of the axis line display (in display columns 19 or 20). The meaning of these indicators is listed in the table below.

Table 1: Status Indicators in Order of Priority per Column

Status Letter	Meaning	Column	Priority	Comments
D	Disabled / Disengaged	19	highest	Axis is disabled if run-away error condition is detected
L	Lower Limit Engaged	19	mid	
U	Upper Limit Engaged	19	mid	
s	Slow Joystick Control	19	lower	
f	Fast Joystick Control	19	lower	
E	Clutch Engaged	19	lowest	Microscope Z-drive only
P	Axis in PAUSE state	20	highest	Axis is BUSY while paused.
B	Axis BUSY	20	high	
M	Motor Active	20	mid	Servos are turned on.
W	Command Wheel	20	lowest	Used on controllers where the command wheel may be switched between axes with the '@' button.

The status indicators can help you understand how the controller is set up and working.

The f, s, & W indicators tell you which axes are being controlled by the manual control devices as well as the speed range for the devices. Momentarily depressing the joystick button will switch the speed indicator from 's' to 'f' or vice versa.

Should the stage be moved into either a hardware or software limit switch, the 'U' or 'L' indicators will appear. Further movement into the limit is prohibited.

When a commanded move is issued to an axis via a computer command, the 'B' indicator will appear until the axis reaches target to the accuracy specified by the PC error variable. Should the stage drift further from the current target by more than the E drift error variable, the motors will re-engage and the 'M' will appear as the right status indicator. The 'M' will disappear when the stage is again within the PC error variable of the target. When using manual input devices (joystick or knob), the 'M' will appear as the motors attempt to keep the XY stage and Z drive at the location specified by the input devices.

If excessive servo errors are encountered, the axis will be disabled and the 'D' will appear. This is a safety feature to limit motion under run-away conditions or in the event of a stage crash.

Back Panel

USB Port

To use the USB port, you need to install the necessary drivers onto your computer. The drivers are furnished on a CD shipped with the controller and are available for download from <http://www.asiimaging.com/support/downloads/usb-support-on-ms-2000-wk-controllers/>.

To obtain and install the drivers and associated files from the CD, open ...\\CP2101 USB-Serial\\MS2000X\\Host Driver Installation Files\\WK_USB.zip.

Create a temporary folder on your computer and extract all 20 files from WK_USB.zip into that folder. Run PreInstaller.exe. This application will step you through two separate installations: one for the USB low-level driver, and the other for the virtual serial port driver.

With these drivers installed, you can test for correct operation by using your computer's Control Panel and its subfunctions System/Hardware/Device Manager/Ports (COM & LPT). Before you connect and power up your ASI controller, expand the Ports (COM & LPT) listing and note any COMx devices present. When you power up the connected controller, you will see a new COMx+1 appear. For example, if you see COM1 before powering up the controller, then after powering it up you will see COM1 and COM2.

(If you do not see "Ports (COM & LPT)" when the drivers are installed and the controller connected and powered up, then the computer may not fully support USB and RS-232. Certain inexpensive laptops have been observed with this defect. The workaround solution for this problem is to use a Serial Port PCI Card. Alternately, your computer may work with a Keyspan USA19HS High Speed USB / Serial Adapter. This device, a cable with two connectors, plugs into your USB port, and the other end is a serial port connector. With either the Keyspan or the Serial Card, you connect the device to the controller via a serial null modem cable. A serial null modem cable is furnished with each ASI controller and widely available at computer stores. Note that if the words "NULL MODEM" are not stamped on the connectors of a serial cable, it is probably not a null modem cable.)

The USB drivers on your computer will create a virtual serial port whenever the computer is connected to a powered-up controller. This virtual serial port operates like an RS-232 port as described below.

RS-232 Ports

The two 9-pin RS-232 ports allow serial commands to talk to and through the MS-2000. The IN port attaches to the PC computer via a null modem RS-232 Serial Cable to allow serial commands to control and get information from the MS-2000. The null modem cable switches the RX and TX lines and terminates possible PC handshaking lines allowing for asynchronous communication without handshaking. The OUT port is controlled by a second UART on the microcontroller. As a default it is configured as a "pass through" so serial traffic sent to the controller from the PC is echoed directly on the OUT port. Special functions are supported that use this port for dedicated purposes (e.g. triggered encoder reporting).

Fuse

The MS-2000 uses a 1A, 250V, fast blow, 5x20mm standard fuse.

Power Input

The MS-2000 uses a 24V 1.25A universal input, switching DC power supply. The power supply is connected and disconnected from the circuits via the ON/OFF power switch.

X-Y Stage Connector

This DB-25 connector is used to connect the MS-2000 to the X/Y stage via a four-foot cable.

Z-Axis Connector

This DB-15 connector is used to connect the MS-2000 to the Z-Axis drive assembly via a four-foot cable.

Linear Encoder Connectors

X, Y & Z linear encoder connectors are located on the back panel. Heidenhain encoders utilize labeled DB-15F connectors. If the encoders are cross connected, the affected axes will behave erratically.

BNC Connectors

Two BNC connectors are provided, labeled IN and OUT. The connectors are wired to the internal board connector SV1. The IN connector is usually wired to IN0, the buffered TTL input channel. On piezo Z-axis systems, the OUT connector is connected to the analog DAC output that is used for control of the piezo system. On non-piezo systems, the OUT connector is usually wired to OUT0, the buffered TTL output channel.

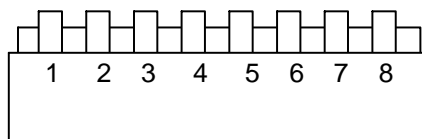
Reset Button

The reset button causes a hardware-level reboot of the microprocessor, which re-initializes the MS-2000 system.

Dip-Switches

The Dip-Switches allow the user to modify the configuration of the MS-2000's input and output devices. Switches 1-2 select the LCD screen options. Switches 4 and 5 set up the serial baud rate for the RS-232 and USB interfaces. Switches 3 & 6 select between linear and rotary encoders for the XY and Z axes, respectively. Switches 7-8 adjust the deflection of the joystick. The controller must be reset for most new DIP switch settings to take effect.

Dip Switch Settings



SWITCH	DOWN	UP	COMMENT
DIP SW 1	LCD Show Actual Position Only (normal)	Displays Position Actual > Target	
DIP SW 2	LCD 4 th line: Firmware Version	LCD 4 th line: config / status / clock	4 th line format depends on specific firmware build
DIP SW 3	XY Linear Encoder	XY Rotary Encoder	Reset controller after changing switch
DIP SW 4	Baud Rate Selector – see chart below		Reset controller after changing switch
DIP SW 5			
DIP SW 6	Z Linear Encoder	Z Rotary Encoder	Reset controller after changing switch
DIP SW 7	Joystick Y deflection Reversed	Joystick Y deflection Normal	Reset controller after changing switch
DIP SW 8	Joystick X deflection Reversed	Joystick X deflection Normal	

Switch 4	Switch 5	Baud Rate
UP	UP	9600
UP	DOWN	19200
DOWN	UP	28800
DOWN	DOWN	115200

Special Functions and Features

Several special features have been incorporated into the stage control firmware beginning with version 6.0a. Several of these functions are standard on every controller, others are only supported with special hardware modifications or options; each are discussed in turn.

Configuration Flags

Beginning with firmware version 8.0, a set of configuration flags are read upon startup which determines the axis profiles for standard build firmware. These flags determine whether linear or rotary encoders are to be used, and the type of motor / lead screw combination used for the various axes. The configuration flags may be changed using the “CCA X” commands or by switching the encoder DIP switches. When a configuration flag is changed for an axis, new default parameter settings are used for that axis. On most controllers the “CCA X?” command will show the existing configuration and show the other configurations available in the firmware.

Build Configuration

Users often request special features for their systems. Often there are special firmware modules that are included to provide custom functionality. The BUILD X [BU X] command lists the firmware basic build flavor and all of the special firmware modules that are included in the controller. The following list describes some of these modules that may be present in your controller.

LL COMMANDS *	Low Level Command set is included
RING BUFFER *	Internal 50 position Ring Buffer is supported
SEARCH INDEX *	Supports ability to search for the index on linear encoders
TRACKING	Firmware module to support PhotoTrack system
AUTOFOCUS	Video autofocus scanning firmware module
SCAN MODULE	Supports 1-d and 2-d programmable scan patterns.
ARRAY MODULE	Firmware module for x,y moves in array pattern.
SPEED TRUTH	Query on SPEED command returns internal calculated speed used.
CRIFF	Firmware for the CRIFF focus system.
DAC OUT	WRDAC command sends specified voltage to SV1-Pin 5.
PREPULSE	Module to add predictive TTL output trigger pulse
PEDALS	Support for foot pedals to control Z-axis and Zoom systems
MULTIAXIS MOVES	Supports circular and spiral moves directly from the controller
CLOCKED POSITIONS	Supports motorized objective turrets, filter turrets & filter wheels
TTL_REPORT_INT	TTL IN0 used for interrupt-driven encoder position reporting
ENC_INT	Interrupt line is used for encoder pulse counting with the SCAN MODULE

INO_INT * TTL IN0 used for a variety of interrupt driven functions selected using the TTL command.

* These modules are often included in standard builds.
If you see something you want but don't have, contact ASI.

Power Down Coordinate Save

Beginning with firmware version 8.1, powering down the MS-2000 controller will automatically cause the current positions to be saved to non-volatile memory so they can be restored upon startup. The shutdown procedure watches for power failure and immediately turns off the motor drivers before saving the position coordinates. Any power interruption will shut down operation. The user can always reset the stage coordinate origin using the ZERO button, however the actual position of the preset firmware limits remain unchanged with this operation. To reset the controller with default firmware limits and with zero stage coordinates, press the RESET button on the back of the controller. With the RESET operation, the current stage position will be lost.

Upon loss of power, the controller will send the character 'O' out the serial port. After successfully saving positions, the controller will send the character 'K'.

Save Settings to Non-Volatile Memory

The MS-2000 controller allows the user to customize various parameter settings and then save the settings to non-volatile memory to be used on subsequent power-ups. The controller is shipped with general purpose default setting suitable for most users. The user can always return to the default settings unsuitable parameters are saved. See the SAVESET command in the Programming section of the manual.

Post-Move Control Options

The behavior of the stage and controller at the completion of a move can be controlled with several programmable parameters. The best method can depend upon the particular application, the thermal and vibration environment, whether linear encoders are used, speed required, etc. The various options are set using the MAINTAIN [MA] command codes for each axis. The Finish Error and Drift Error tolerances are set with the PCROS [PC] and ERROR [E] commands respectively. The WAIT [WT] command can be used to enter a PAUSE state or control the motor drivers following a move. The table below shows how the various command options can be used.

MAINTAIN code [MA]	Description	Axis STATUS changes at end of move		Consequence of setting a WAIT time [WT]
		NOT BUSY	BUSY	
0	Default – HYSTERESIS Motor and servo turns off when position error is less than the <i>Finish Error</i> . Motor turns on again when error is more than the <i>Drift Error</i> . Drift-out and re-correct can occur 18 times per 0.5 sec. before fatal position error is set	$\epsilon < \textit{Finish Error}$ [PC] LCD shows 'B' until $\epsilon < \textit{Finish Error}$	$\epsilon > \textit{Drift Error}$ [E] LCD shows 'M'	PAUSE state is entered at end of move trajectory. BUSY state is not cleared until the WAIT expires.

	and motion is halted.			
1	UNLIMITED_TRIES: Like HYSTERESOUS above, but drift and re-correction can occur indefinitely without error.	$\epsilon < \text{Finish Error [PC]}$	$\epsilon > \text{Drift Error [E]}$	Same as above.
2	SERVOS_ON: Servo remains active and correcting errors until HALT command is received. Leaving the servos on indefinitely will cause the controller to run warm.	$\epsilon < \text{Finish Error [PC]}$	Never	Same as above
3	SERVOS_WAIT: Servo remains active and correcting errors for the time set by the WAIT command following the move completion.	$\epsilon < \text{Finish Error [PC]}$	Never	Motor driver and servo remain active for the WAIT time following completion of the move – then turn off.

ϵ is the final position error

Leaving the servos on can improve the positioning, especially on some linear encoded stages, and especially when a second axis remains in motion after one axis has finished moving. Turning the drivers off and using error threshold hysteresis means that most of the time there is no power applied to the motors so they cannot move. This is also the most power efficient mode.

Multi-Point Save/Move

Often there is a need to mark several positions to later revisit. The MS-2000 controller has a ring-buffer with up to 50 locations that the user can load with position information and then visit sequentially. The current stage position can be saved to the buffer by depressing the button on top of the joystick and holding it for longer than one second. (A short tap of the button toggles the joystick speed) You can move to the next position of interest and again save the position in the buffer by holding down the joystick button. Continue this procedure to save all positions of interest.

Save locations can be revisited by pressing the @ button briefly. Each press of the @ button advances to the next position. When you reach the last position, the next press of the @ button will take you back to the first position.

Holding the HOME button down for longer than one second will clear all the stored positions in the ring buffer.

The ring buffer may be preloaded with values via the serial command LOAD. Serial commands can also be used to advance to the next position as well as to control which axes will be affected by the move commands. See LOAD, RBMODE, and TTL commands in the Programming section of this manual. Contact ASI for details.

Constant Velocity Moves – (with firmware Version 8.1+)

The MS-2000 controller now uses a full closed-loop trajectory-driven algorithm for all commanded moves. This means that the move velocity is controlled as part of the digital feedback loop. Many users need to have high precision slow speed control. The MS-2000 now

provides the smoothest control possible in a motorized stage. To achieve this unsurpassed control, we have had to impose some small restrictions in terms of the acceptable velocity values. The controller has a minimum controlled speed of one encoder count per sixteen servo cycles. The table below shows the slowest controlled speed for various stage configurations:

	6.35 mm Pitch Lead-screw Stage	1.59 mm Pitch Lead-screw Stage	Linear Encoder equipped Stage
XY Stage: 2 ms servo loop	0.69 $\mu\text{m/sec}$	0.17 $\mu\text{m/sec}$	0.63 $\mu\text{m/sec}$
XYZ Stage: 3 ms servo loop	0.46 $\mu\text{m/sec}$	0.12 $\mu\text{m/sec}$	0.42 $\mu\text{m/sec}$

The controlled stage speed must be an integer-multiple of the minimum speed. For example, an XYZ stage with 6.35 mm pitch lead-screw could be programmed to move 0.46 $\mu\text{m/s}$, 0.92 $\mu\text{m/s}$, 1.38 $\mu\text{m/s}$, etc., but not values between the integer-multiple of the slowest speed. Be aware that at the very slowest speeds, the condition and cleanliness of the stage, and the calibration of the analog stage driver circuitry can have a dramatic effect on the smoothness of operation. Please request tech note *TN120 Slow Speed Considerations* for further information.

TTL Controlled I/O Functions

Buffered TTL input (IN0) and output (OUT0) are available on internal connector SV1 pins 1 & 2 respectively. These lines may be connected to the IN and OUT BNC connectors on the MS-2000 back panel. The TTL command allows the user to select which functions are active for the IN0 and OUT0 lines. Various functions supported by the TTL command include:

- Triggered moves or Z-stack acquisitions
- Triggered asynchronous serial stage position reporting
- Output pulses upon move completion
- Output gated during constant speed motion.

The TTL input functions require the **INO_INT** firmware module. The output functions are available in all builds.

Automated 1-D or 2-D Scanning

Systems the with **SCAN_MODULE** firmware addition have some special commands that make raster scanning very easy and well controlled. With the SCAN, SCANR, and SCANV commands, you can define a raster area and the number of raster lines. The stage will scan each line at constant speed, followed by rapid retrace. Hardware line sync signals available on SV1 pin 7 for the X or Y axis, as selected by internal jumper JP1 (1&2 X-axis; 2&3 Y-axis). With the **ENC_INT** firmware module encoder transitions can be counted to provide a “pixel” clock for an external recording device.

Synchronous Encoder Reporting

The **TTL_REPORT_INT** firmware module allow for external TTL synchronized position reporting. The position reports are sent to the auxiliary serial port on the MS-2000-WK in a binary format so that rapid, low jitter position reporting is possible for real-time positioning tasks. Contact ASI for details.

Tracking Features

ASI's PhotoTrack system uses the **TRACKING** firmware module along with hardware available from ASI that allows the stage to latch on and track spots of fluorescent illumination from labeled organisms. A quadrant PMT is used to provide sensitive and rapid position feed back information from the illuminated target. Contact ASI for details.

Safety, Diagnostic and Alignment Features

Motor-driver current-limits prevent the motors from fully powering into hard stops. In addition, the MS-2000 controller is constantly monitoring the positions of the motors under its control. Situations that may result in run-away conditions (such as reversed polarity motors or encoders), or situations where the motor is not able to follow the desired move trajectory (e.g., when mechanical interference limits the motion), cause the controller to detect an error condition. The motors are immediately turned off and the offending axis is disabled. If this happens, a 'D' character is displayed as the status indicator on the LCD display. The user should correct the problem and then reset the controller to regain control of the disabled axis.

Controllers using firmware Version 6.0 and newer utilize a motor driver circuit where all analog circuit alignment is done either automatically in firmware, or via serial commands. The user need not open the case to adjust the drive-circuit feedback and zeroing levels.

The firmware also keeps track of any internal error conditions that may arise during operation and saves the last 255 error codes in a buffer that may be read out for diagnostic purposes (see the serial DUMP command). The controller also has a built-in "move buffer" that holds move dynamic information for up to 200 servo cycles. The user may utilize this buffer to attempt advanced tuning of the controller for special applications or extremely fast or slow moves. Please see the section *MS-2000 Optimal Alignment Procedures* for a full discussion of these issues.

Clocked Devices

The MS-2000 controller supports clocked rotational devices, such as motorized objective nosepiece turrets, filter cube turrets, and filter wheels. These devices move to discrete clocked positions. Manual control is usually via the @ button to advance to the next position. The serial MOVE command is used to move the devices to a specific integer-value clocked position. The current position is reported using the WHERE command.

Default Settings, Saved Parameters, Configuration Flags, Limits and Positions

The controller keeps track of several sets of flags, parameters and other saved configuration variables. It is important to understand how changing some of these parameters affect the other sets. The parameter sets are discussed below, starting with the most permanent settings and continuing to the least permanent settings.

Motor Driver Alignment Parameters

The motor driver alignment parameters are set with the AA and AZ commands. These commands set nonvolatile digital potentiometers located in the driver circuitry. These settings are independent of the other parameters settings and are immediately saved on the digital pots themselves.

Configuration Flags

The configuration flags are set with the “CCA X=n” command, and by the position of DIP Switches #3 and #6 (the DIP switches change between linear and rotary mode for the XY stage and Z-axis drive respectively). The configuration flags allow the loaded firmware to work with a variety of specific hardware configurations. Specific lead screw pitch, linear encoder resolution, encoder type, and piezo Z-axis range are some examples of the configurations settings that can be changed. (See the CCA command for details). The configuration flags are usually only changed when the controller is first set up for a particular set of hardware, when new firmware is loaded using the ASI Updater, or when changing between linear and rotary encoder for the stage. When a configuration flag is changed, it is immediately saved in nonvolatile memory; the controller must be restarted for the new configuration to be implemented. *Whenever any configuration flag is changed, the controller restores any Saved Parameter settings back to the Factory Defaults settings.*

Saved Parameters

There are many operating parameters that can be changed in the controller. These include such things as error tolerances (E and PC commands), speed and acceleration times (S and AC commands), servo parameters settings (KP, KI, and KD commands), and many others. All of these operating parameters have Factory Default settings that have been determined to be appropriate for most typical situations. A user may find that a change to some parameter value will improve the performance of the system for their application. When parameter values are changed using a serial command, the new parameter immediately becomes active in the controller. Third party software vendors can change parameter settings “on the fly” using their software and the changes will remain active as long as the controller remains powered on and not RESET. Parameter changes can be made persistent using the “SS Z” command, which saves all parameter settings to nonvolatile flash memory. Users wishing to make a one-time permanent change to a parameter setting can use a terminal program to communicate with the controller, make the parameter change, and then make the change persistent with the “SS Z” command. The new parameters will be used on subsequent power down/up or controller RESET. The user can restore the Factory Default parameter settings any time using the serial command “SS X”.

Saved Stage Positions, Limit and Home Positions

The controller watches the power line voltage so that it can detect when the controller is being turned off. There is sufficient stored charge in the controller's power supply to allow the controller to save the stage position and a few other variables as power is being shut down. The variables that are saved are the Stage Axis positions, the programmable Upper and Lower limit locations, and the Home location all expressed in the current coordinated reference system.

When power is restored, the controller loads the saved information into its working memory and clears the data from the Saved Position nonvolatile memory locations to ready those storage locations for when power is again shut off. *If the controller is RESET (without turning off the power) current locations are NOT saved, and the controller will come up with axis positions at zero and default Limit and Home positions; the Saved Position information will be lost.*

Successful shutdown is indicated by “OK” broadcast on the serial port upon power-off.

Internal I/O connector details

Special user requirements often require custom external wiring. The MS-2000-WK controller has an internal board connector with several I/O lines that are often wired to the external BNC connectors for user connections. There may be occasions where the functions required are not wired to external connectors. The table below shows the connector wiring and the firmware modules that are required to take advantage of the I/O functions. The BU X command will list which modules are present in the loaded firmware. On most controllers the IN BNC is connected to TTL IN0.

EXT I/O – SV1

PIN	DESCRIPTION	FUNCTION	FIRMWARE Modules
1	TTL IN0	INPUT –TTL input w/ processor interrupt <i>(Usually wired to the IN BNC)</i>	INO_INT used for external TTL triggered tasks – see TTL command for specific functions.
			ENC_INT use to count encoder pulses (selected with JP2) in conjunction with SCAN firmware.
			TTL_REPORT_INT used for triggered position reporting.
2	TTL OUT0	TTL OUTPUT – <i>(Usually wire to the OUT BNC on systems without PIEZO)</i>	All builds – see TTL command for specific functions.
3	GND	Ground for all I/O	
4	TTL IN0 - OUT	OUTPUT – IN0 buffered and inverted	Can be used as buffered encoder pulses OUTPUT with ENC_INT .
5	PZ-DAC OUT	ANALOG OUTPUT from 16 bit DAC <i>(Wire to OUT BNC on PIEZO systems)</i>	On systems with a PIEZO axis this is the control voltage.
			DAC_OUT with WRDAC command, provides external analog output.
6	TTL IN1	INPUT – Auxiliary TTL input	
7	SCAN SYNC	OUTPUT for SCAN MODULE SYNC pulse	SCAN MODULE - selects sync source from JP1 to clock the sync flip-flop.

Internal Jumper JP1 selects the encoder flag signal that is used for the SYNC flip-flop. JP1 1-2 selects the X-axis; JP1 2-3 selects the Y-axis.

Internal Jumper JP2 selects the encoder signals that are counted during scanning. JP2 1-2 selects the X-axis; JP2 2-3 selects the Y-axis.

Please contact ASI if you need assistance configuring the controller for special functions.