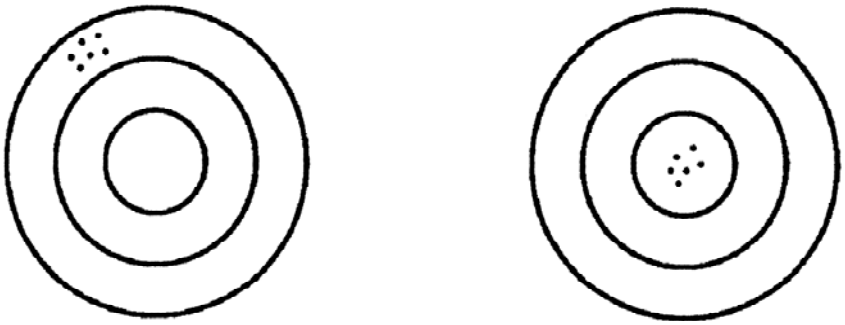
Repeatability and Accuracy

Accuracy, Repeatability and Resolution are important considerations when evaluating stage performance. *Accuracy* is simply defined as the difference between the requested and the actual motion performed by a linear motion device. *Repeatability* is defined as the ability of a device to reproduce a given linear motion. *Resolution* is then defined as the smallest movement or step size the device is capable of.

Note: The resolution of the X and Y axes are usually different from that of the Z axis or focus resolution.

The Marksman Analogy shown below attempts to pictorially demonstrate the difference between accuracy and repeatability. The target on the left shows a cluster of shots that are all in the same basic location, yet not in the desired location (the centre of the target). The marksman was repeatable, but not accurate. The target on the right has all of the shots close together and at the centre of the target. The marksman that took these shots is both accurate and repeatable.



Some motorized stage manufacturers overstate their stage accuracy by using the Root Mean Square (RMS) definition of accuracy. Prior Scientific uses the Standard Deviation Method. When Prior Scientific quotes stage accuracy, 3 sigma accuracy (+/- 3 Standard Deviations) is used. This means that 99.74% of all movements made by our stage will be within our stated accuracy or repeatability range. The following example compares RMS and 3 Sigma Accuracy.

Consider a stage at the 'Home' position which is 1 micron in the X axis away from the stage zero position. The stage can be cycled through a series of moves which take the stage away from 'Home' and then return to 'Home' at which point the actual position in the X axis is measured. After 14 cycles, the following data may be collected;

1.8, 1.5, 0.1, 1.7, 1.8, 1.1, 1.8, 0.9, 1.8, 2.0, 0.0, 1.5, 0.9, 1.8.

The 3 sigma accuracy for these moves is +/-1.0 microns, while the RMS accuracy is

+\-0.7 microns! The stage can be shown mathematically to have 2 different accuracies. However, the data shows that 1/2 of the measured values fall outside the 0.7 RMS accuracy range, while all the data fall within the 3 Sigma accuracy range. Calculating accuracy using the RMS method exaggerates the accuracy of a stage.

2.1 Step Motors and Resolution

The Prior ProScan stages and focus drives use high precision step motors. Generally, the step motors used in Prior stages products are 1.8 degree (200 steps per revolution) motors.

The ProScan controllers provide a bipolar chopper drive to the motors which allow for maximum torque, stabilization, smoothness, and performance.

The motors receive pulses from the controller which in turn causes them to rotate. If the motors are operated in a "full step" mode, one pulse from the controller will rotate the motor 1.8 degrees or 1/200 of a revolution.

The ProScan controller microstep the motors, this is a technique whereby the coil current in the motor is precisely controlled to sub-divide the fundamental step angle (1.8 degrees) of the motor into a series of smaller sub-steps called microsteps or pulses. The ProScan controller is capable of creating 250 microsteps per full step of the motor.

Thus, for a focus motor attached to a microscope that has a fine focus mechanism with 100 µm per revolution of the fine focus shaft, the system can achieve the following resolution:

(200 step/rev) x (250 micro-steps/step) = 50,000 micro-steps/rev

Hence, (100 µm/rev) / (50,000 micro-steps/rev) = 0.002 µm/micro-step

Therefore, the theoretical resolution of the focus drive motor is 0.002 µm/pulse

For a typical stage with a 2mm pitch screw (2mm per rev or 2000 µm per rev), the stage has a resolution as shown below:

(200 step/rev) x (250 micro-steps/step) = 50,000 micro-steps/rev

Hence, (2000 µm/rev) / (50,000 micro-steps/rev) = 0.04 µm/micro-step

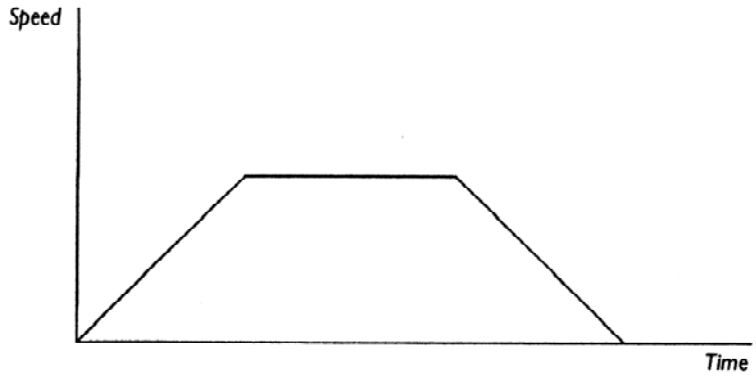
For a typical stage with a 5mm pitch screw (5mm per rev or 5000 µm per rev), the stage has a resolution as shown below:

(200 step/rev) x (250 micro-steps/step) = 50,000 micro-steps/rev

Hence, (5000 µm/rev) / (50,000 micro-steps/rev) = 0.1 µm/micro-step

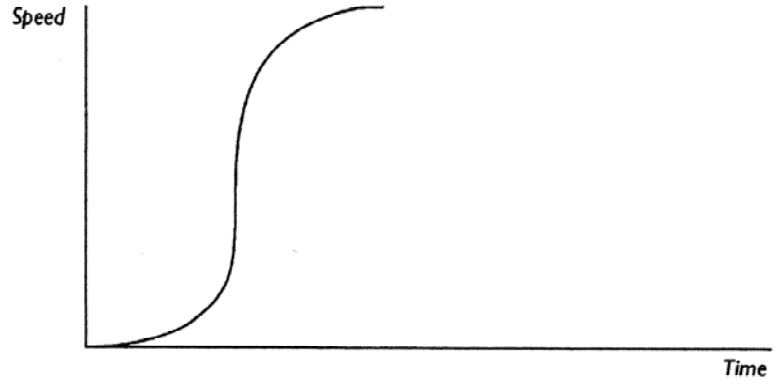
2.2 S curve vs. Trapezoidal Accelerations

Step motors for years have been accelerated with a standard trapezoidal acceleration. An example of a trapezoidal acceleration is shown below:



This method of motor acceleration has a great impact on the performance of the system. The trapezoidal acceleration causes the stage to jerk as it starts, switches from acceleration mode to maximum velocity mode, and switches from maximum velocity mode to deceleration mode. (Note all of the sharp corners on the graph). This can cause the stage to vibrate and it can increase stage settling time.

The ProScan controller accelerates the stage via the S-curve as shown below:

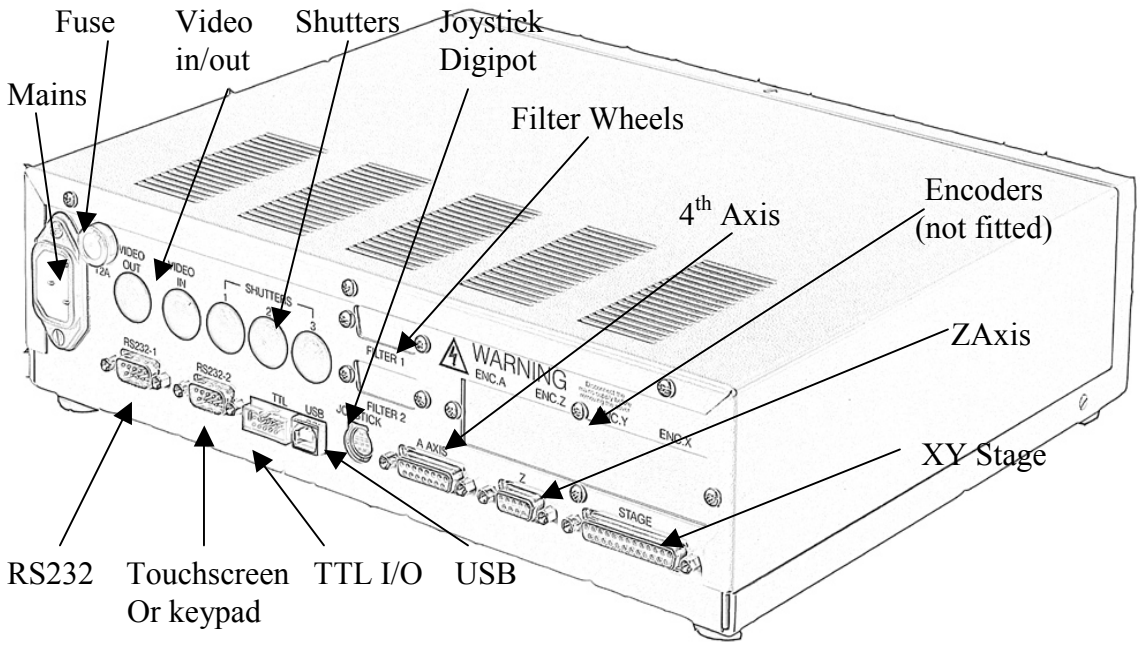


The S-curve acceleration transitions from starts to stops with smooth accelerations and decelerations thereby resulting in faster, quiet, and vibration free performance. The stage can actually be moved faster due to the ramp characteristics of the S-curve. Settling time is greatly reduced and overall stage performance is enhanced.

4.3 Cable Connections

The cable connections to the ProScan controller are located on the rear panel of the control box, as shown in the illustration below. Before making any of these connections, ensure that the ProScan controller is switched off. Each connection is well labelled but great care should be taken not to try and connect your computer's serial port cable to the `Z' axis connector on the controller.

The RS232 connection from your computer should be made to the RS232-1 port on the controller. For USB connection to your computer see separate section on this subject.



USB Operation

To use the ProScan II controller (H130 series) via the USB connection the user will need to install the USB connection software. This can be found in the USB folder on the CD.

Installing USB software on a PC running Microsoft Window98/2000.

1) WARNING. Do not connect ProScan II to PC at this point.

2) Insert CD, open USB folder and run HidComInst.exe

WARNING. The only indication that the utility has installed correctly is the momentary appearance of the hourglass. There is no message indicating successful completion.

3) Connect ProScan II to PC using supplied USB cable.

4) Switch power to ProScan II on.

5) Select My Computer, Control panel, System, Hardware, Device Manager.

6) Expand Ports (COM & LPT) to see list of ports.

7) USB-HID->COM n will now be added. Make a note of the COM port number. Select this port when writing applications or running a terminal emulation application, such as HyperTerminal. This will enable communication between the PC and ProScan II via the USB port.

If HyperTerminal is used, none of the default settings within this application will need to be modified.

Installing USB software on PC running Microsoft XP Professional

This does not install automatically. Extra care must be taken.

1) WARNING. Do not connect ProScan II to PC at this point.

2) Insert CD, Open USB folder and run HidComInst.exe

WARNING. The only indication that it has installed correctly is the momentary appearance of the hourglass. There is no message indicating successful completion.

3) Connect ProScan II to PC using USB cable provided.

4) Switch ProScan II on.

5) Select My Computer, Control panel, System, Hardware, Device Manager.

6) Expand Ports(COM &LPT) to see list of ports

7) If USB-HID->COM n is listed (where n is number of COM port), then installation is complete. If not continue as follows:-

8) Select Human Interface Device in USB list, right click, select Properties, select update driver, select “Install” from a list or specific location. Click Next, select “Don't search I will choose the driver to install”, Click Next, Select Cyprus USB-HID->COM device, Click Next. Ignore warning message and click continue then select Finish.

9) Cyprus USB-HID->COM n will now have been added to the list of Ports (COM and LPT). Note; this will only be the case if the ProScan II is still connected to USB and switched on.

Getting Started

Switch the ProScan controller unit on using the on/off rocker switch located on the front panel. There are three LED's on the bottom left of the front panel. The 'running' LED should be illuminated to indicate correct operation. If this is not the case refer to section 7. The 'TX' (transmit) LED will flash rapidly when data is being transmitted by the controller and 'RX' (receive) LED flashes rapidly when receiving data from computer RS232.

The ProScan system can be computer controlled via the RS232 serial port or stand alone using the optional accessories available. The ProScan controller provides a 'plug and play' facility meaning that all correctly connected peripheral devices will be automatically configured for use when the system is powered up.

Older ProScan stages are not 'plug and play' compatible. If you are upgrading an existing stage system with a new ProScan controller you may need to have the stage upgraded to ensure 'plug and play' compatibility. Contact your local Prior dealer for further advice.

Control via RS232 will be considered further in Section 6. Control via other system accessories including joysticks, Z axis digipot, filter wheel keypad and touch screen keypad will be described here.

5.1 Using Joysticks

Four joysticks are available as part of the ProScan system; a two axis joystick (CS152V2) and three axis joysticks (CS152V3, CS152DP, CS152EF). The joystick units are used to control the motorized stage and the focus motor. Only three axis systems will control both the stage and the focus motor.

Standard Features

All the joysticks feature an X,Y joystick, two sliding tensioners and two ‘Hot Keys’.

Ensure the sliding tensioners are fully home and latched to hold the joystick vertically in the ‘off’ position. In this position there is no power to the stage motors and the stage does not move. Deflecting the joystick left or right from the central position will cause the stage to move in the X axis. Deflecting the joystick backwards or forwards from the central position will cause the stage to move in the Y axis. Deflecting the joystick diagonally will cause the stage to vector in 2 axes providing a corresponding diagonal movement.

The joystick provides proportional control. The further the joystick is deflected from the central position, the faster the stage will move. Deflecting the unit to its extreme limit provides the fastest stage movement.

The CS152V3 joystick is equipped with a twist action, proportional control knob for focus control on top of the joystick shaft.

The ‘Hot Key’ to the left of the joystick can be used to quickly adjust the maximum speed of the stage. This affects both X and Y axes equally. The key to the right of the joystick provides an identical function for the focus motor (3 axis joystick only).

Pressing these buttons once reduces the speed to 25% of maximum. Pressing a second time increases the speed to 50% of maximum and a third press of the button returns to 100% of maximum speed. This cycle can be repeated by continuing to press the buttons.

The action of the ‘Hot Keys’ can be reprogrammed using RS232 commands (See Section 6).

CS152DP and CS152EF

In addition to the standard features described earlier, the CS152DP and the CS152EF provide a digipot control mounted to the side of the joystick unit. This device controls the focus motor on a 3 axis system. It is not proportional, but is designed to closely match the normal response of the fine focus knob on a microscope.

The CS152EF is also equipped with an autofocus button on top of the joystick shaft.

Advanced Operation

6.1 RS232 Command Set

ProScan controllers can accept commands from either serial port. The port defaults to a baud rate of 9600. This can be increased to 38400 if desired (see BAUD below).

Commands and controller responses are terminated with a Carriage Return code <CR> with the exceptions of 'I', 'K', and '#' in compatibility mode.

Commands are separated from arguments by one or more of the following delimiters.

COMMA
SPACE
TAB
EQUALS
SEMICOLON
COLON

To move a stage to a position of (100,200) the user could enter any of the following

G,100,200<CR>
G 100 200<CR>
G 100 200<CR>
G, 100, 200<CR>
G,,100,200<CR>

There are two modes of operation; **Standard Mode** and **Compatibility Mode.**

Standard mode is the recommended mode for new software as it offers more features. Compatibility mode is supported for existing customers who do not wish to re-port their existing application code. All communication is non-blocking meaning that commands can always be sent even though there may be a delay prior to their execution.

In Standard Mode up to 100 commands may be queued in the serial buffer of the controller. If a command is sent and there is insufficient space to accept it an error (E18 – Queue Full) will be returned. This indicates that the command has not been accepted and must be resent when the queue is no longer full. It is desirable to read back each command (R<cr>) before sending any further commands. Sending I<cr> aborts the current move and empties the queue.

The default convention is that the controller will move each device by 1um per number entered, in other words a requested move of 1000,0 will result in the stage moving 1mm in the X axis. If desired this can be over-ridden by using the scale stage (SS) command. If the stage scale is changed the resultant movements are determined by the model of stage in use. The controller is fixed at 250 micro-steps per full motor revolution and by setting SS,1 each requested move will be in micro-steps. A requested move of 1000,0 will now result in the stage moving by 4 (1000/250) complete motor revolutions. The actual distance moved by the stage will depend upon the pitch of the ball screw fitted to the stage. A stage with a 2mm ball screw pitch will move 8mm in the X axis while a unit with 5mm pitch screws would move 20mm.

The commands STAGE, FILTER, FOCUS and SHUTTER return a text description the last line of which is always "END". The allows Prior to add supplementary text information without resulting in changes to the users application code (assuming that the application software reads al text up to "END".)

Macro and Soak

MACRO - a set of commands can be entered and started in a block by the use of the MACRO command.

Example of MACRO

If you wish to close a shutter, move the filter wheel to a new position then open the shutter.

MACRO	0	enter macro mode
8,A,1	R	close shutter A
7,1,4	R	move to filter position 4
8,A,0	R	open shutter A
WAIT 1000	R	wait 1000 msecs
MACRO	0	start the macro

SOAK - this is an extension to the MACRO command enabling the testing of a controller without tying up a PC. The soak routine continually performs the instructions entered in a loop, reporting the number of complete cycles on each pass. To stop the soak test enter an action and the unit will complete the current cycle and then stop.

Example of SOAK

If you wish to test a shutter, and filter wheel you could use the following routine.

SOAK	0	enter soak mode
8,A,1	R	close shutter A
7,1,4	R	move to filter position 4
WAIT	500	wait 500msecs.
8,A,0	R	open shutter A
7,1,1	R	move to filter position 1
SOAK	0	start the soak

Note MACRO and SOAK can only be used in Standard Mode (COMP,0)

6.2 General Commands

Command	Arguments	Response	Description
?	None	Text string	Reports information about the peripherals currently connected to the controller. e.g. DRIVE CHIPS 10011 means Z and 4th axis chips missing, SHUTTERS = 110 means shutter 1 not connected. The final line of information is always a line saying END. This allows for the addition of extra fields of information without effecting application software. Users should always read lines in until the END is seen. A typical response is shown below; PROSCAN INFORMATION DSP_1 IS 4-AXIS STEPPER VERSION 2.7 DSP_2 IS 2-AXIS STEPPER VERSION 2.7 DRIVE CHIPS 010111 (F2 F1 A Z Y X) 0 = Not Fitted JOYSTICK ACTIVE STAGE = H101/2 FOCUS = NORMAL FILTER_1 = NONE FILTER_2 = HF110-10 SHUTTERS = 001 (S3 S2 S1) 0 = Not Fitted AUTOFOCUS = FITTED VIDEO = NONE END
=	None	Nm	Reports whether any limit switch has been hit since the last call of the command. Nm is a two digit Hex number (one Byte) which converted to binary is as follows:- D07 D06 D05 D04 D03 D02 D01 D00 -4th +4th -Z +Z -Y +Y -X +X eg 05 means +Y and +X have been hit. Reading this status clears it.

Command	Arguments	Response	Description
$	[a]	Decimal number	Reports status as a decimal number and gives motion status of any axis of the controller. After binary conversion convention is as follows:- F2 F1 Z Y X D04 D03 D02 D01 D00 Optional parameters "$,a" where a is the axis or resource X - X axis Y - Y axis S - X and Y axis Z - Z axis A - A axis (not present on Optiscan) F - Filter wheels F1 - Filter wheel 1 F2 - Filter wheel 2 when the optional parameter is used the binary word is just for the axis requested. Stage is for x, y axis, F is for filters and would return 0 to 3 depending on if they are in use.
BAUD	b	0	Sets the baud rate of the port issuing the command to the value specified by b. As a protection measure, if no command is sent to the port while the controller is switched on, the baud rate will revert to 9600 after switching off and back on again twice. Allowable values for baud rate are 9600 (argument 96), 19200 (argument 19) and 38400 (argument 38) **WARNING** **If the baud rate of ProScan is changed it is important for the application software to check communication with ProScan by scanning the baud rate on initialisation. This will avoid a permanent communication failure should the PC Port and ProScan port be set at different bauds.**
COMP	None	0 = Std 1 = Comp	Report the Command protocol (Compatibility mode (1) or Standard mode (0))

Command	Arguments	Response	Description
COMP	m	0	Sets the controller compatibility mode for users who want to wait for 'R' at the end of the move. Compatibility is on if m = 1 and off if m = 0. Setting COMP,1 will result in less flexibility. For example, SOAK cannot be used and commands sent while the joystick is active will be lost. Compatibility mode is offered for users who wish the Commands to be compatible with earlier H127/H128 Prior Controllers.
DATE	None	Text string	Reports Instrument name, version number and compile time. Note that the system description refers to the presence or absence of internal drivers NOT which peripherals are connected. E.g H29XY1 can drive XY stage and 1 filter wheel only.
ERROR	h	0	Sets the reporting of error to 'Human' if h is 1 (readable text) else error codes are returned (see Error Description Table)
I	None	R	Stops movement in a controlled manner to reduce the risk of losing position. In compatibility mode this command is acted on immediately i.e. there is no need for a <CR>. The command queue is also emptied. In Standard Mode a <CR> must be used.
K	None	R	Immediately stops movement in all axes. Mechanical inertia may result in the system continuing to move for a short period after the command is received. In this case, the controller position and mechanical position will no longer agree. In compatibility mode this command is acted on immediately i.e. there is no need for a <CR>. The command queue is also emptied. In Standard Mode a <CR> must be used. This command is normally treated as an emergency stop.
MACRO	None	0	Used to enter and leave the Macro Mode. ONLY AVAILABLE IN STANDARD MODE.
SERIAL	None	nnnnn	Reports the units' serial number nnnnn, if the serial number has not been set "00000" is returned.

Command	Arguments	Response	Description
LMT	None	Nm	Reports whether any limit switch is currently active. A limit switch is active if the switch is in contact with the axis hardware. Nm is a two digit Hex number (one Byte) which when converted to binary is as follows:- to binary is as follows:- D07 D06 D05 D04 D03 D02 D01 D00 -4^{th} $+4^{th}$ -Z +Z -Y +Y -X +X eg 05 means stage is in contact with +X and +Y limit switches, 0A indicates contact with both -X and –Y limits. 00 means all axes are not in contact with any limit switch. (Note that the controller knows whether the limit switch is normally low or normally high and corrects accordingly. This does **not** return the hardware signal level of the limit switch (see STAGE command).
SOAK	None	0	Used to soak test the controller and peripherals. ONLY AVAILABLE IN STANDARD MODE.
VERSION	None	ddd	Reports the units software version number as a 3 figure number eg 100 is Version 1.00
WAIT	t	0	Inserts a wait of t milliseconds in a macro/soak routine.

Stage Commands

Command	Arguments	Response	Description
B	None	R	Moves Back by v steps as defined by the 'X' command below.
B	y	R	Moves Back by y steps.
BLSH	s,b	0	Sets the stage backlash value for stage move commands sent via the serial port (not joystick moves) to b. s = 1 enables backlash s = 0 disables backlash. B is a number of microsteps of the motor. There are 50,000 microsteps per revolution of the motor on a standard ProScan system.
BLSH	s	0	Enables / Disables the Stage (XY) backlash. S = 1 enables backlash s=0 disables backlash.
BLSH	None	s,b	Reports back s and b values for stage moves sent via the serial port (see above). In COMP 1 mode only s returned.
BLSJ	s,b	0	Sets the stage backlash value for joystick moves to b in microsteps. s = 1 enables backlash s = 0 disables backlash.
BLSJ	s	0	Enables / Disables the stage backlash for joystick moves. S = 1 enables backlash s = 0 disables backlash.
BLSJ	None	s,b	Reports back s and b for Stage (see above). In COMP 1 mode only s returned
F	None	R	Moves Forward by the v step size defined by the 'X' command
F	y	R	Moves Forward by y steps.
G	x, y, z	R	Go to the absolute position x, y, z. Z is optional.
GR	x, y,z	R	(Go Relative) Moves by the amount specified by x, y, z. Z is optional.
GX	x	R	Move to absolute position x (y position remains unchanged)
GY	y	R	Move to absolute position y (x position remains unchanged)
H	None	0	Turns OFF the joystick (Stage and Z axes) after completion of any current joystick move. The joystick is re-enabled using 'J' Command (see below) The joystick is always enabled on power up.
J	None	0	Turns ON the joystick (Stage and Z axes). This command is acted upon immediately.

Command	Arguments	Response	Description
JXD	c	0	Sets the direction of X axis under joystick control. c = 1 Joystick right, moves stage mechanically right c = -1 Joystick right, moves stage mechanically left.
JXD	None	c	Reads c.
JYD	d	0	Sets the direction of Y axis under joystick control c = 1 Joystick forward, moves stage mechanically forward. c = -1 Joystick forward, moves stage mechanically back.
JYD	None	d	Reads d.
L	None	R	Moves Left by u steps as defined by the 'X' command.
L	x	R	Moves Left by x steps.
M	None	R	Moves stage and focus to zero (0,0,0)
O	s	0	Sets the speed of the stage under joystick control. s is percentage in range 1 to 100.
O	None	s	Reports value of O allowing for joystick speed buttons effect (if the button speed is ½ and O is set to 50 the returned value will be 25)
P	None	x,y,z	Reports absolute position of x,y and z axes. This can be used whilst any axis is moving to give 'position on the fly' Note <CR> (Carriage return) only will also return position.
P	x, y, z	0	Sets absolute position of x, y, and z axis. No axis can be moving for this command to work. If there is a linear encoder fitted on the Z axis the position can only be set when the current position is within the encoder range and it has previously been at some lower position. If neither of these conditions has been met an error will be reported.

Command	Arguments	Response	Description
PS	None	x,y	Reports position of Stage only (x, and y).
PS	x, y	0	Sets Absolute position of x, and y axis. No axis can be moving for this command to work.
PX	None	x	Reports position of x only.
PX	x	0	Sets Absolute position of x axis. No axis can be moving for this command to work.
PY	None	y	Reports position of y only.
PY	y	0	Sets Absolute position of y axis. No axis can be moving for this command to work.
R	None	R	Moves Right by u steps as defined by 'X' command.
R	x	R	Moves Right by x steps.
RES	s,r		Sets the desired resolution for the stage, s is X and Y axes, r can be a non integer number setting the resolution for the axis in units of microns. e.g. RES,s,1.0 Resolution set to 1.0 micron
RES	a		Returns resolution for axis a.
RIS		R	Restore Index of Stage. This command is only effective if the SIS command has been used on installation. This Command can be used at any time and will re synchronise the stage and controller position should the stage have been manually moved when the controller was off. The stage will hit limits and then return to the position stored by the controller prior to the last power down. If the stage has not been manually moved this command will not normally be needed.

Command	Arguments	Response	Description
SAS	a	0	Sets the maximum stage acceleration to a. Range is 1 to 100.
SAS	None	a	Report current stage acceleration
SCS	c	0	Sets the current stage S-curve value. This is the rate of change of acceleration during the transition from stationary until the stage reaches the full acceleration set by SAS. Range of c is 1 to 100.
SCS	None	c	Report current stage S-curve setting.
SIS		R	Set Index of Stage. This command would normally only be used on first installation of the system. The stage moves to limits and sets absolute position to 0,0. The controller will always remember this internally as zero even with subsequent uses of Z and P, x , y command.
SMS	m	0	Sets the current Stage (x, y) maximum speed to m. Range is 1 to 100.
SMS	None	m	Report the current Stage (x, y) maximum speed setting m
STAGE	None	Text string	Prints information about the currently connected stage. There are 250 microsteps per full step of the motor. The final line of information is always a line saying END. This allows for the addition of extra fields of information without effecting application software. Users should always read lines in until the END is seen. Example STAGE = H101/2 TYPE = 1 SIZE_X = 108 MM SIZE_Y = 71 MM MICROSTEPS/MICRON = 25 LIMITS = NORMALLY CLOSED END
SKEW	None	a	Returns the skew angle a, in degrees, that had previously been set by the SKEW,A and SKEW,S commands or the SKEW,A command.

Command	Arguments	Response	Description
SKEW	A	0	Skew About command, when used in conjunction with SWEW S, can re-align samples which are not perfectly aligned to the XY motion of the stage. Use this command to skew the XY stage movement About this point. The SKEW S command must also be executed to complete this operation.
SKEW	S	0	Use this command after the SKEW A command AND moving a distance in X and Y axis to define the skew angle. This is equivalent to twisting the stage.
SKEW	a	0	Sets the skew angle a. IE SKEW 0.5 will skew the stage through 0.5 degrees. SKEW 0 disables skew function
TYA	None	0	Toggles Y axis of joystick between Y and A axis control
VS	x,y,u		Sets the stage speed to x, y for the X and Y axes respectively in units specified by u. u = values in microns linear travel per second. This is default if u is omitted, therefore VS,500,500 would set 500um/s in both X & Y. u = p are values in microsteps per second based on 250 microsteps per full step of motor. VS,500,500,p would set 2 full steps per second. To stop this 'virtual joystick' move use VS,0,0. If limits are hit the speed will be set to zero for the appropriate axis.
X	None	u,v	Reports the current step size (u and v) in x and y for the stage
X	u,v	0	Sets the current step size for the stage.
XD	C	0	Sets the direction of the X axis move (mechanical) with respect to the software move. Use this command if 'L' command moves stage mechanically right. C=1 or –1.
YD	C	0	Sets the direction of the Y axis move (mechanical) with respect to the software move. Use this command if 'F' command moves the stage mechanically backwards. C=1 or –1.
Z	None	0	Sets the stage and focus position to ZERO (0,0,0).

6.7 Pattern Commands

Command	Arguments	Response	Description
E	None	R	Sets the origin for the pattern to the current position. Zeros the pattern X and Y counter.
E	b	0	If b = 0 the stage returns to the origin after completing the final move of the pattern (default setting upon power up). If b = 1 the stage will stay at the final pattern position.
N	n,m	0	Defines the number n of X and number m of Y steps for the pattern.
N	None	n,m	Reports number of X and Y steps.
S	None	R	Move to next position in Rectangular Raster.
S	?	s	Step number of scan.
S	n,m	R	Moves to n^{th} cell in X and m^{th} cell in Y in rectangular raster.
X	x,y	0	Sets the step size in X and Y
X	None	x,y	Reports step size in X and Y.
Y	None	R	Move to next position of Rectangular Snake.
Y	?	s	Step number of scan.
Y	n,m	R	Moves to n^{th} cell in X and m^{th} cell in Y in rectangular snake.
Q	None	0	Sets the origin of the disc grid equal to the current position. Zeros the disc grid X and Y counter.
T	None	R	Move to next field of Disc Raster Scan.
T	?	s	Step number s of circular scan
W	d	0 in compatibility mode. Number of fields in standard mode.	Sets the diameter in mm of a circular disc (Range 1 to 327mm) The parameter X defining the step sizes in x and y should be defined before setting the W value.
W	None	d	Reports the disc diameter (in mm.)

6.9 Error Codes

If a command is not valid a response of "E,n" is returned. The n specifies an error type as listed below.

Machine or human readable messages are chosen using the ERROR Command.

ERROR CODE	ERROR DESCRIPTION
1	NO STAGE
2	NOT IDLE
3	NO DRIVE
4	STRING PARSE
5	COMMAND NOT FOUND
6	INVALID SHUTTER
7	NO FOCUS
8	VALUE OUT OF RANGE
9	INVALID WHEEL
10	ARG1 OUT OF RANGE
11	ARG2 OUT OF RANGE
12	ARG3 OUT OF RANGE
13	ARG4 OUT OF RANGE
14	ARG5 OUT OF RANGE
15	ARG6 OUT OF RANGE
16	INCORRECT STATE
17	WHEEL NOT FITTED
18	QUEUE FULL
19	COMPATIBILITY MODE SET
20	SHUTTER NOT FITTED
21	INVALID CHECKSUM
60	ENCODER ERROR
61	ENCODER RUN OFF

6.10 CS152 (Joystick Configuration)

The CS152 range of joysticks is compatible with the ProScan system and any one can be used depending on the system configuration as follows;

CS152Z Z only digipot
CS152V2 2 axis joystick
CS152V3 3 axis joystick
CS152DP 2 axis joystick with digipot for Z axis.
CS152EF 2 axis joystick with digipot for Z axis with 'fire' button.

The CS152Z is used for the control of a system equipped with only a Z-axis. It has a large round digipot control which provides fine control of the focus motor. A button is provided to change the focus motor speed range and there are two further buttons which can be used for coarse focus control by driving the focus up or down while the button is pressed.

Joysticks may be fitted with up to 3 buttons, 2 long 'hot keys' on either side of the joystick and a 'fire' button on top of the joystick. In addition, there are 2 small sliding buttons, one to the side and one below the joystick. These provide spring loaded tension to the joystick which ensures it always returns to its vertical 'off' position. Ensure these sliding buttons are fully home and the joystick is held vertically before turning the system on.

The joystick can be used to control the speed and direction of the stage. A small deflection of the joystick results in slow stage movement while a large deflection provides high speed movement. The direction of movement of the joystick normally produces a corresponding movement of the stage. For example, moving the joystick to the left will move the stage left. Please note however, that there are commands available to reverse the direction of the stage on one or both axes (see Advanced Operation).

The CS152DP and CS152EF joysticks are fitted with a round digipot control on the side of the joystick box. This is used for fine focus control. The digipot is a rotary encoder which comprises a disc with radial lines and 2 LED detectors. As the disc is rotated by the knob, the encoder generates two square wave signals. One controls the amount of movement while the other monitors the direction of movement. This provides precise positioning of the fine focus knob on the microscope while the system continuously keeps track of the actual position.

The ProScan controller offers a specific command which can be used to change the function of any of the buttons on the joystick.

The command has the following format:

Command	Arguments	Response (including <cr>)
BUTTON	b,f	0

There are 4 possible conditions identified by b

b=0 Button released.(i.e. changing to a state where no button is pressed)

b=1 Right button pressed

b=2 Left button pressed

b=3 *'Fire'* button pressed.(on top of joystick).

(Pressing more than one button simultaneously will not register a command.)

f defines what action the controller does when it first detects a new state given by b above.

f= 0 Default Button Function

f= 1 Z motor velocity stop (only used in conjunction with f=2 and f=3 below)

f= 2 Z motor constant velocity up

f= 3 Z motor constant velocity down.

f= 4 Toggles digipot speed 100% 50% 25%

f= 5 Toggles X/Y joystick speed 100%, 50%, 25%

f= 6 Toggles joystick speed 100% 10%

f= 7 Toggles joystick speed 100% 2%

f= 8 Moves Z motor up by amount defined by C Command

f= 9 Moves Z motor down by amount defined by C Command

f=10 Moves stage left defined by X Command

f=11 Moves stage right defined by X Command

f=12 Moves stage back defined by X Command

f=13 Moves stage front by amount defined by X Command

f=14 Toggles Digipot Speed 100% 10%

f=15 Toggles Digipot Speed 100% 2%

f=16 Starts Auto Focus

f=23 Next Point

f=24 Next Wafer

f=25 Smooth Stop (I)

f=26 Sudden Stop (K)

f=28 Toggle Shutter 1

f=29 Toggle Shutter 2

f=30 Toggle Shutter 3

f=35 assigns any following text to the button. Hence any command may be assignable to a button.

Examples

Right button (b=1) being pressed moves Z up at constant velocity
Left button (b=2) being pressed moves Z down at constant velocity
Release buttons (b=0) stops Z motor (no buttons being pressed)
BUTTON,1,2
BUTTON,2,3
BUTTON,0,1
BUTTON 1,35,TYA (assigns the TYA command to button 1)
BUTTON 1,35,G,100,200,300 (executes a G,100,200,300 command)

Right button (b=1) toggles joystick speed 100%-2%
A momentary press of Left button (b=2) starts Z motor moving down with constant velocity.
Pressing 'Fire' button (b=3) stops Z motor.
BUTTON,1,7
BUTTON,2,3
BUTTON,3,1

Normal Joystick operation i.e.
Left button (b=2) toggles Stage speed 100% 50% 25%
Right button (b=1) toggles Z motor speed 100% 50% 25%
BUTTON,3,0
BUTTON,2,0
BUTTON,1,0
BUTTON,0,0
BUTTON,2,5
BUTTON,1,4
BUTTON,0,0

6.12 Encoders

Prior stages can be equipped with either linear or rotary encoders for higher positioning repeatability and accuracy.

A linear encoder is an optical system that reflects light off a graduated scale through a grating and onto photo sensors. These sensors generate electrical currents. The electrical currents generated are used to determine distance and direction the stage has travelled. Unlike rotary encoders which imply a distance travelled by measuring the rotation of the motor, linear encoders/scales are actually mounted to the moving plates of a stage and therefore directly measure stage movement.

Linear Encoders benefit the stage user by providing:

- The ability to use a Digital Read Out (DRO)
- The ability to provide closed loop "servo" control
- Superior precision and finer resolution.

Linear scales mounted on Prior stages now provide repeatability to +/- 0.3 microns and resolution (step size) as small as 0.1 microns. This superior performance is extremely critical in many Industrial and Bio-Science applications such as the performance of time-lapse photography studies.

H130 Controller with the 'E' option enables rotary or linear encoder with RS485 differential quadrature square wave outputs to be inputted to all or any of the 4 axes. This controller will have 3 or 4 round 12 pin connectors on the back of the control box labelled, "X Axis", "Y Axis", etc. Turn the controller off and plug in the appropriate encoder or scale that corresponds with the appropriate axis.

The linear scales also have a home or reference position. This is a specific mark on the scale that is read by the controller and it can be used to establish the same reference position at any time. To use this feature, see the commands SIS and RIS described below.

When an encoder is fitted and enabled (the default condition) the controller uses the position measured by the encoder as the true position and not the number of pulses sent to the stepper motor.

The controller will sense which encoder input has an encoder fitted. It will control the individual axis using motor pulses or encoder pulses depending on whether that axis has an encoder fitted (and enabled).

When the controller identifies an encoder fitted to any axis for the first power-up this prompts a small motion to be initiated (two full steps of the motor). The controller will use the number and sign of the counts from the encoder to establish the correct ratio between encoder pulses and motor pulses.

The stage can be sent to a position using internal stepper position or encoders using the ENCODER Command. If the stage is fitted with encoders which are disabled the 'P,s' and 'P,e' Command can be used to compare the stepper and encoder position. This facility may be useful for application software where stage calibration is required.

Stepper moves will be faster than moves under encoder control due to the feedback, checking, and adjusting required for the closed loop system.

The SERVO,b command gives the option for the controller to constantly read the encoder position (when stationary) and correct for any position drift.

b=1 SERVO on
b=0 SERVO off.

This is a global command that affects all axes fitted with encoders.

With SERVO off, the axis still moves to its destination positions measured by the encoder but will not correct for any drift once the destination has been reached.

This command refers to **ALL** axes which have encoders fitted (and enabled)

Command	Arguments	Response	Description
ENCODER	none	n	Reports back as a decimal number the axes that are operating using the encoders. For example, 3 means X and Y axes are using the encoders.
ENCODER	b	0	b=0 Disables ALL encoders b=1 Enables ALL encoders.
ENCODER	Axis	0,1	Returns whether the individual axis have encoder enabled or disabled. Axis = S,X,Y,Z,A.
ENCODER	Axis,b	0	b=0 Disables encoder specified by Axis b=1 Enables encoder specified by Axis.
SENCODER	As above		Behaves like the ENCODER commands above except that it forces the encoder and motor positions to be the same when enabling and disabling encoder function.

Command	Arguments	Response	Description
ENCW	Axis,n	0	Sets the encoder window n for the Axis specified. This can prevent excessive 'hunting' as controller tries to close the position loop.
ENCW	Axis	n	Returns the allowable encoder window for the Axis in encoder counts. for determining when position acquired.
SERVO	none	n	Reports back as a decimal number the axes that have servo operation enabled. For example, 4 means Z axis servo enabled, others disabled.
SERVO	b	0	b = 0 stage moves to destination position (as read from encoders) and stops. There is no servo action therefore the stage can drift from destination position due to external mechanical and thermal forces. b = 1 Stage continuously reads position from encoders (even when stationary) and corrects for any drift.
SERVO	Axis	0,1	Returns whether the individual axis have servo enabled or disabled. Axis = S,X,Y,Z,A
SERVO	Axis,b	0	b=0 Disables servo specified by Axis b=1 Enables servo specified by Axis.
SWS	n	o	Sets a window of n encoder counts about the current stage position to prevent excessive hunting when servo enabled.
SWZ	n	o	Sets a window of n encoder counts about the current Z position to prevent excessive hunting when servo enabled.
P	e	x,y,z	Argument 'e' indicates encoder position. If ENCODER,0 returns encoder position at present stepper position (Use P Command) If ENCODER,1 Returns encoder position. This is the same as 'P' Command
SIS	none	R	Set Index of stage. The stage will find the encoder Index signal, stop and set absolute position to 0,0 Used only when the mechanical position of the stage bears no relationship to controller position; i.e. when the stage has been mechanically moved during power off. THIS COMMAND MUST BE DONE ONCE AT INITIAL CONNECTION OF STAGE TO CONTROLLER IN ORDER TO ESTABLISH A UNIQUE REFERENCE POSITION WHICH IS PERMANENTLY REMEMBERED BY THE CONTROLLER.

Command	Arguments	Response	Description
RIS	none	R	Restore Index of Stage. Used to restore accurate mechanical position by seeking Index signal and returning back to controller position. This is used to re-establish mechanical accuracy by referencing back to the encoder index signal.

6.13 TTL input/output signals

The H130 controller has the capability of reading and sending signals to and from other external equipment through its standard TTL port. This powerful capability allows the controller to process data and make decisions based on other external sources such as pressure switches, line scan cameras, and relays.

The ProScan controller has a 10 way boxed header (male). Four pins are assigned to TTL output (one Byte) from the Controller and Four pins to TTL inputs (one Byte).

The matching female part to be used with this header is an Industry standard ribbon cable socket with centre bump polarisation (to ensure correct orientation) manufactured by 3M (part number 3421-6620), Thomas and Betts (part number 609 2041) etc.

The TTL outputs use a 74HCT374 buffer IC and the TTL inputs input to a 74HCT541

+5 Volts is available from pins 1 and 2 (shorted together to share the current) for TTL power to a limited amount of circuitry. Maximum current 100mA.

0V is the zero volts of the electronics inside the controller, which is also chassis ground.

K2 Pin allocation

Pin number	Signal
1	+5V_OUT
2	0v (Ground)
3	TTL_OUT 0
4	TTL_OUT 1
5	TTL_OUT 2
6	TTL_OUT 3
7	TTL_IN 0
8	TTL_IN 1
9	TTL_IN 2
10	TTL_IN 3

Command set

Command	Arguments	Response
TTL	Writes to TTL port. DCBA where DCBA are Hexadecimal numbers assigned as follows:- A TTL_OUT least significant 4 bits B TTL_OUT most significant 4 bits C TTL_IN least significant 4 bits D TTL_IN most significant 4 bits Since TTL_IN are inputs to the controller only i.e. cannot be written to, C and D should both be 0 (any other value is ignored) Acceptable formats are TTL,000E writes TTL high to all 4 TTL_OUT bits except TTL_OUT 0 TTL,E (as above)	0<cr> H129 had 8 TTL IN/OUT bits H130 only has 4 TTL IN/OUT bits (B and D are ignored)
TTL	None	DCBA BA is actual status of 4 Write Bits DC is TTL levels of 4 Input bits. (leading zeros may be omitted)
TTL	n,m Where n is number 0 to 3 and is the data bit number of TTL_OUT (see table above) m is 0 or 1 and sets the level of TTL_OUT m=0 is TTL low m=1 is TTL high. Note that it is important not to omit m or it will be assumed by the controller that n is a Hexadecimal number.	

Command	Arguments	Response
TTL	n,? where n is the data bit number of the TTL TTL_OUT has n between 0 and 3 TTL_IN has n between 8 and 11 (See Hexadecimal nomenclature above)	Returns m the TTL status of bit n m=0 is TTL low m=1 is TTL high for backwards compatability with H129

Troubleshooting

Problem:

Stage will not respond to Joystick or RS232 commands

Suggestions:

Check that the system is properly installed and that there is proper power to the controller. For Installation see section 4.

Check that the controller is switched on.

Check that the green “Running” light is on. If it is not, return unit to your local Prior Scientific dealer for servicing. There is no external fuse that can be replaced.

Set up and run HyperTerminal (Windows Users) see Appendix C and send the `?' command via RS232-1. The controller should report with information about the peripherals currently connected, as shown in section 6 of this manual.

If the controller does not acknowledge the presence of any of the connected peripherals return that peripheral to your local Prior dealer.

Problem:

In one axis (X or Y) the stage will only move in one direction.

Suggestions:

There is an internal switch failure. Return the stage to your local Prior Dealer for servicing

Problem:

The stage will not respond to my Image Analysis Software.

Suggestions:

Check that the Image Analysis Software Program has drivers for Prior systems. If not, consult the software dealer.

Check communication by monitoring the 'TX' (transmit) LED (this will flash rapidly when data is being transmitted by the controller) and the 'RX' (receive) LED (this flashes rapidly when receiving data from computer).

Close down the Image Analysis Software.

Set up and run HyperTerminal (Windows Users) see Appendix C.

Try several basic commands while in HyperTerminal to determine if the stage responds correctly, if so the controller is functioning properly. At this point consult the supplier of the Image Analysis Software. If the stage does not respond to the commands, contact your local Prior dealer for further advice.

Note: Before running commands using HyperTerminal make sure that your microscope objectives and any other objects that may impede the motion of the stage are moved out of the way, to avoid damage.

Problem:

System will not respond to remote RS232 commands

Suggestions:

Set Up HyperTerminal (see Appendix C). Check that the RS232 cable is plugged into the RS232-1 port in the back panel of the ProScan Controller. Press "Enter" on your computer keyboard several times. If the "TX" and "RX" lights on the front of the controller blink and the system does not respond, then there is an internal problem with the controller. Return the unit to your local Prior Dealer.

If the "TX" and "RX" lights do not blink on and off, then there is a problem with the computer sending the commands.

Problem:

My stage will execute the first command sent, but for each subsequent command the controller returns an error message "E, 5".

Suggestions:

Make sure that your computer is not sending an extra line feed command at the end of each command being sent. If you are using HyperTerminal, check that the set up is correct using Appendix C.

Problem:

The focus motor turns but the microscope fine focus knob does not.

Suggestions:

The focus drive may not be properly positioned against the fine focus knob.

Loosen the knurled screw that holds the focus motor and press it gently against the fine focus knob. While pressing re-tighten the knurled screw. Note: If the fine focus knob on the microscope is difficult to turn or the movement rough, then the focus drive may not function until the microscope is properly adjusted.

Problem:

The focus drive does not repeat to the same "Z" position every time.

Suggestions:

Check that the "Z" backlash routine is turned on. Refer to the Command Set for command "BLZH"

For upright microscopes check that the focus motor is mounted on the right.

For inverted microscopes check that the focus motor is mounted on the left.

If the focus drive cannot be mounted on the correct side of the microscope, refer to the command set and use command "ZD" to reverse the rotation of the motor.

Problem:

Filter Wheel will not operate

Suggestions:

Make sure that the controller is switched on.

Check that the filter wheel cable is properly connected.

If using the Filter Wheel Keypad check that the filter wheel cable is properly connected and that the LED's on the keypad flash momentarily when turning on the controller. This will confirm power is being provided to the keypad. If the LED's do not flash contact your local Prior representative.

If using the RS232 commands ensure that the filter wheel cable is connected to the correct connector on the back of the ProScan controller.

Ensure the correct commands are being used for the appropriate filter wheel 1 or 2.

Problem:

The filter wheel is noisy when rotating.

Suggestions:

Tighten all the filter locking rings with the tool provided.

Problem:

The Shutter will not operate

Suggestions:

Make sure that the controller is switched on.

Check that the shutter cable is properly connected.

If using the Filter Wheel Keypad, check that the cable for the keypad is properly connected.

If using the RS232 commands, determine which connector the shutter cable is plugged into. There are 3 shutter connections in the back of the ProScan Controller labelled Shutter ‘S1’, ‘S2’ and ‘S3’. Ensure you are sending the correct commands for the connection being used.

System Specifications

(All Dimensions in mm)

PART No.	DESCRIPTION	DIMENSIONS (L x W x D)	WEIGHT
H101	Upright Stage 112 x 73mm Travel	342 x 249 x 71	3.0Kg
H105	Upright Stage 153 x 153mm Travel	400 x 353 x 82	5.0Kg
H107	Inverted Stage 112 x 73mm Travel	316 x 314 x 63	3.5Kg
H117	Flat Top Inverted Stage		
H112	Upright Stage 300 x 300mm Travel	548 x 548 x 100	14.5Kg
H116	Upright Stage 255 x 215mm Travel	500 x 408 x 82	7.7Kg
H138	Upright Stage for 8 3"x1" Slides	426 x 290 x 71	4.0Kg
H30	ProScan II Controller	355 x 270 x 100	3.8Kg
CS100K	Filter Wheel Keypad	150 x 125 x 30	0.35Kg
CS152DP	2 Axis Joystick With Remote Focus	200 x 120 x 45	0.5Kg
CS152EF	2 Axis Joystick With Remote Focus and Autofocus Button	200 x 120 x 45	0.5Kg
CS152KB	Touch Screen Keypad	230 x 180 x 75	1.6Kg
CS152V2	2 Axis Joystick	200 x 120 x 45	0.35Kg
CS152V3	3 Axis Joystick	200 x 120 x 45	0.45Kg
CS152Z	Digipot (Z Axis Only)	130 x 100 x 55	0.7Kg
HF200	Shutter (25mm)	100 x 85 x 25	0.3Kg
HF201	Shutter (32mm)	112 x 92 x 28	0.5kg
HF108	8 Position Filter Wheel (32mm)	160 x 178 x 27	1.4kg
HF110	10 Position Filter Wheel (25mm)	140 x 168 x 27	1.2kg

Max. Speeds

Stage	Up to 100mm/sec
Focus Drive	20 revs/sec
Filter Wheel	55 msec (Position to Position)
Shutter	14 msec (for open/close cycle)

Power

Universal integral power supply
Input: 90 - 265V 110 - 240V, 50/60Hz 60W
Output: 24VDC 2.5A

Specifications subject to change without notice.

Glossary of Terms

Aperture - The area which is available for the passage of light

Autofocus - The ability of a Z focus system to automatically find the correct focus when initiated by either an RS-232 command or the fire button on a joystick.

Autofocus Score - The relative number that represents the contrast for the best image the Autofocus routine has captured.

Autofocus Range - A number from zero to five that represents the relative distance the Z focus drive will travel when trying to maximize the Autofocus Score

Closed Loop Control - A control system whereby the controller adjusts the motor position based on the measurement provided by an electronic linear scale or rotary encoder

Coarse Focus Knob - The large knob on the side of a microscope that moves the stage up and down large distances with relatively small motion.

Compatibility Mode - The serial communication status which allows the H130 Controller to be backwards compatible with the H127 and H128 controllers. See the "COMP" command. Compatibility mode is "COMP,1".

Controller - The device which provides positional control to the stage, focus drive, filter wheel, or shutter.

Digipot - A circular device/encoder, typically mounted on a joystick used to manually rotate the fine focus knob. The digipot rotates the focus knob at an angle relative to the angular movement of the rotation of the digipot.

Encoder - A feedback device which provides positional information for either an XY stage or the focus drive assembly. Encoders can either be rotary or linear.

Encoder Feedback - The signal given from an encoder. This signal can be displayed as in an open loop encoder system or fed back through the controller to provide closed loop control.

Filter - A device typically made of glass or plastic and mounted in a filter wheel that is used to alter the properties of light emitted from a microscope's light source.

Filter Wheel - A motorized turret that holds and positions optical filters in the light path of a microscope

Fine Focus Knob - The small knob on the side of the microscope that moves the stage up and down small amounts with relatively large movements. Typically 100 microns per revolution of the fine focus knob.

Flash Memory Capability - The ability of the Prior H130 controller to download new software without requiring an EPROM change. This ability is analogous to that of a solid state hard drive.

Focus Drive - A motor and adapter assembly that typically mounts to the coarse focus knob of a microscope and drives the fine focus knob.

Hyperterminal - A terminal emulation program provided with Windows Operating Systems. Instructions for setting up Hyperterminal to communicate with the Prior controller are located in the appendices.

Imaging Packages - The general class of computer software including stereology and image analysis which utilize motorized stages and/or focus drives.

Incident Illumination - Light which falls on the object from any direction (typically refers to reflected light applications).

Inverted Microscope - A microscope that views the object from below. The objectives are underneath the stage.

Joystick - A device which allows manual movement of a motorized stage and focus without using RS232 commands.

Legacy Commands - The set of RS232 commands that are common between the H127, H128 and H130 Prior Motor Controllers. See also compatibility commands.

Linear Scales- See Encoders

MACRO - A set of commands that can be entered and started in a block by the use of the MACRO command.

Mechanical Stage - The manually operated X,Y positioning table that comes as standard with most microscopes.

Motorized Stage - An XY positioning table, typically mounted on a microscope that is moved via stepper or servo motors and their corresponding controller.

Open Frame Stage - A stage that allows for transmitted illumination via holes in the X and Y plates.

Open Loop System - A control system that has no means of comparing the output with the input for control purposes. Open loop stage systems rely on the controller to send the proper amount of pulses to the motor to achieve the required movement.

Plug & Play Facility - The ability of the Prior Scientific controller to recognize which components/accessories are connected and to auto-configure itself to work when powered up.

Raster Pattern - A programmed movement where the stage moves a set number of steps across a sample in the X axis and then moves back to its starting position before moving in the Y axis.

RS-232 - A communication standard which specifies electrical, mechanical and functional characteristics for serial binary communication circuits in a point to point link. Commands from a computer's COM port travel to the controller via RS-232.

Serial Control - A type of information transfer where the bits are handled sequentially

Servo Motor - A motor that rotates due to the interaction of the stator field and armature field. Servo motors require feedback loops, i.e. encoders.

Shutter - A device which can be opened or closed to enable or prevent the passage of light between an illumination device and the microscope or between the microscope and a detector such as a camera.

Snake Pattern - A programmed movement where the stage moves a set number of steps across in the X axis and then moves in the Y axis. The stage then moves back to its original X position. This movement is repeated until the complete area of interest has been scanned, creating a snake-like pattern across the sample.

SOAK command - A set of commands which can be entered and started in a block. These commands will be continuously performed in a loop until the "i" or "k" command is entered or the power is cycled.

Solid Frame Stage - A stage where there is no path for transmitted illumination. i.e. the stage plates are solid without holes in them.

Stage Travel - The overall length in X and Y that a stage can move.

Standard Commands - The set of commands in the Prior Scientific H130 which the controller is allowed to queue. These commands are enabled by the "Comp,0" command.

Step Size - The movement in microns initiated by either the L,R,F,B,U or D command. This is also the movement of 1 pulse or the minimum stage movement.

Stepper Motor - A motor which when current is applied generates a holding torque. The motor is rotated by switching the coils on and off. The stepper motors in Prior stages and focus motors generally have 200 steps per revolution, which is then micro-stepped to 50,000 micro-steps per revolution.

TTL – Transistor to Transistor Logic. An integrated circuit with its inputs and outputs directly tied to transistors. Inputs and outputs are low voltage (<1 VDC) and high voltage (>3 VDC).

Transmitted Illumination - Light which passes through the object.

Upright Microscope - A microscope that views the object from above.

X-Theta Stage - A stage with motion in both the X direction and Rotational or Theta Direction.

XYZ - The term used to describe the axes of a microscope that move left/right(X), front/back(Y) and up/down(Z).

Appendices

Appendix A

12.1 How to Run HyperTerminal

Instructions for using Windows Terminal Emulation Program (Windows 3.1) for communication with a ProScan Controller.

1) Double-click the ACCESSORIES Group symbol in WINDOWS 3.11
2) Double-click the TERMINAL Icon.
3) From the SETTINGS menu select COMMUNICATIONS.
   Choose: -

Baud Rate	9600
Data Bits	8
Stop Bits	1
Parity	None
Flow Control	None
Connector	Com1 or Com2 depending on which port is required to be used.
Parity Check	Off
Carrier Detect	Off

   Press OK button.

4) From SETTINGS menu select TERMINAL PREFERENCES
   Choose: -

Line Wrap	On
Local Echo	On
Sound	Off
cr-cr/lf Inbound	On
cr-cr/lf Outbound	Off
Columns	80
Translations	United Kingdom
IBM to ANSI	Off
Buffer Lines	100

   Press OK

5) From SETTINGS menu select TERMINAL EMULATION
6) Choose: - DECVT-100 (ANSI)
7) Choose OK
8) Select SAVE AS --- from FILE menu and save settings as PRIOR
9) These settings can be retrieved at any time by selecting it from FILE menu at start of a new session.

Instructions for using Windows HyperTerminal Emulation Program (Windows 95/98) for communication with a ProScan Controller.

5) Click Start, then Programs, then Accessories, then HyperTerminal.
6) Double-click the the "Hypertrm" icon.
7) Enter filename eg priorterm, select an icon and press OK.
8) For the "Connect using..." option, select COM1 or COM2 as appropriate
9) Press OK.
10) Enter the following parameters in the Port Setting Box,

Bits per second	9600
Data bits	8
Parity	None
Stop bits	1
Flow control	None

11) Press OK.
12) From the menu bar select File and then Properties.
13) In the Properties dialogue box select the Settings tab.
14) Press ASCII Setup...
15) Select "Echo typed characters locally" and "Append line feeds to incoming line ends". Then click OK twice.

Instructions for using Windows HyperTerminal Emulation Program (Windows NT)for communication with a ProScan Controller.

1) Click Start, then Programs, then Accessories, then HyperTerminal.
2) Select the "HyperTerminal" icon.
3) In the "Connection description" dialog box enter filename e.g. prior, select an icon and press OK.

4) In the “Connect to” dialog box enter Phone Number (if required) and Select COM1 or COM2 as appropriate and press OK.
5) Enter the following parameters in the Port Settings box ;

Bits per second	9600
Data bits	8
Parity	None
Stop bits	1
Flow control	None

6) Press OK button.
7) Select File, Properties and Settings tab.
8) Press ASCII Setup...
9) Select “Echo typed characters locally” and “Append line feeds to incoming line ends” (you should find that “Wrap lines that exceed terminal width” has already been selected).
10) Press OK
11) Press OK

Instructions for using Windows HyperTerminal Emulation Program (Windows 2000) for communication with a ProScan Controller.

1) Click Start, then Programs, then Accessories, then Communications and finally HyperTerminal.
2) A window called ‘Location Information’ will appear, press cancel. The ‘Confirm Cancel’ window will appear, press yes. This will be followed by another window ‘HyperTerminal’ press OK.
3) Enter filename e.g. priorterm, select an icon and press OK.
4) A window called ‘Location Information’ will appear, press cancel. The ‘Confirm Cancel’ window will appear, press yes. This will be followed by another window ‘HyperTerminal’ press OK.
5) For the "Connect using" option, select COM1 or COM2 as appropriate.
6) Press OK.
7) Enter the following parameters in the Port Setting Box,

Bits per second	9600
Data bits	8
Parity	None
Stop bits	1

Flow control	None

8) Press OK.
9) From the menu bar select File and then Properties.
10) In the Properties dialogue box select the Settings tab.
11) Press ASCII Setup.
12) Select "Echo typed characters locally" and "Append line feeds to incoming line ends". (You will also notice that “Wrap lines that exceed terminal width” will already be selected).
13) Press OK.
14) Press OK.

Instructions for using Windows HyperTerminal Emulation Program (Windows XP) for communication with a ProScan Controller.

1) Click Start, then Programs, then Accessories, then Communications and finally HyperTerminal.
2) A window called ‘Default Telnet Program’ will appear, close the box and ignore.
3) Enter filename e.g. priorterm, select an icon and press OK.
4) For the "Connect using" option, select COM1 or COM2 as appropriate.
5) Press OK.
6) Enter the following parameters in the Port Setting Box,

Bits per second	9600
Data bits	8
Parity	None
Stop bits	1
Flow control	None

7) Press OK.
8) From the menu bar select File and then Properties.
9) In the Properties dialogue box select the Settings tab.
10) Press ASCII Setup.
11) Select "Echo typed characters locally" and "Append line feeds to incoming line ends". (You will also notice that “Wrap lines that exceed terminal width” will already be selected).
12) Press OK.
13) Press OK.