PRIOR®
Scientific

ProScan® III

Universal Microscope Automation Controller

Manual Version 1.10

PRIOR®
Scientific

bsi. ISO 9001 Quality Management
FM 61600

Worldwide distribution

Prior Scientific, Ltd
Cambridge, UK
T. +44 (0) 1223 881711
E. uksales@prior.com

Prior Scientific, Inc
Rockland, MA. USA
T. +1 781-878-8442
E. info@prior.com

Prior Scientific, GmbH
Jena, Germany
T. +49 (0) 3641 675 650
E. jena@prior.com

Prior Scientific KK
Tokyo, Japan
T. +81-3-5652-8831
E. info-japan@prior.com

Contents

Thank you for purchasing a ProScan III system – we hope and expect that it will be a reliable and useful part of your microscopy set up. Please take the time to thoroughly read this manual before installing and using the ProScan III as it contains both important safety information and how to use the device effectively. Do not hesitate to contact Prior Scientific if you have any questions or comments. *Note that this manual DOES NOT cover products controlled by the ProScan III – for such products, refer to their own manuals, or to the Installation and Help Sheets on the Prior website. Ensure that you read and understand ALL relevant material before setting up a system.*

IMPORTANT SAFETY INFORMATION
SECTION 1

- Save this manual as it contains important safety information and operating instructions.
- Use only as specified by these operating instructions or the intrinsic protection provided by the unit may be impaired.
- Before using the stage system, please follow and adhere to all warnings, safety and operating instructions located on the product and in this user manual.
- It is safe for use in an ambient temperature from 5 to 40°C with relative humidity to 80% up to 31°C decreasing linearly to 50% RH at 40°C.
- **Do not** expose the product to water or moisture while switched on.
- **Do not** expose the product to extreme hot or cold temperatures.
- **Do not** expose the product to open flames.
- **Do not** allow objects to fall on or liquids to spill on the product.
- Connect the AC power cord only to designated power sources as marked on the product.
- Make sure the electrical cord is located so that it will not be subject to damage.
- Make sure the system in installed so that the front panel power switch is easily accessible.
- For use in a manner not specified in this manual contact Prior before any work is done.
- To reduce the risk of damage, unplug the product from the power source before connecting the components together.
- **DANGER – Never alter the AC cord or plug. The power cord set must be an appropriately rated and approved cord set in accordance in the regulations of the country it is used in. If the supplied plug adapter is not the correct fitting for your geographic area or if you are unsure about the relevant regulations, please contact your supplier for advice**

- The ProScan III is class I and must be only connected to a power outlet which provides a protective earth (ground).
- **Do not** attempt to disassemble the product. Doing so will void the warranty. This product does not contain consumer serviceable components. Servicing should only be performed by Prior or a Prior approved agent.
- Only the exterior of this product should be cleaned using a damp lint-free cloth.
- This warning symbol indicates that there is a high voltage danger.

- This warning symbol indicates that there is a strong magnetic field

This sign means – "Warning! Potential risk of damage to unit

– read instructions carefully before proceeding".

In accordance with The Waste Electrical and Electronic Equipment Regulations, this symbol indicates that the product must not be disposed of as unsorted municipal waste but should be collected separately.

Refer to your local authority in the EU for return and/or collection systems available in your country.

IDENTIFYING AND CONNECTING YOUR SYSTEM

SECTION 2

2.1 Identifying the parts of the ProScan III controller

The ProScan III is a control system designed to control Prior products, including stages, focus motors, shutters, filter wheels and illumination. The modular design of the ProScan III controller allows the functionality of the system to be altered to match your requirements. The same modular approach allows an easy upgrade path should additional functionality be required.

The controller consists of:
1 controller box.
1 RS232 Cable.
1 USB cable.
1 Power cable, supplied suitable for your geographical area.
Quick Start Guide for your specific controller.

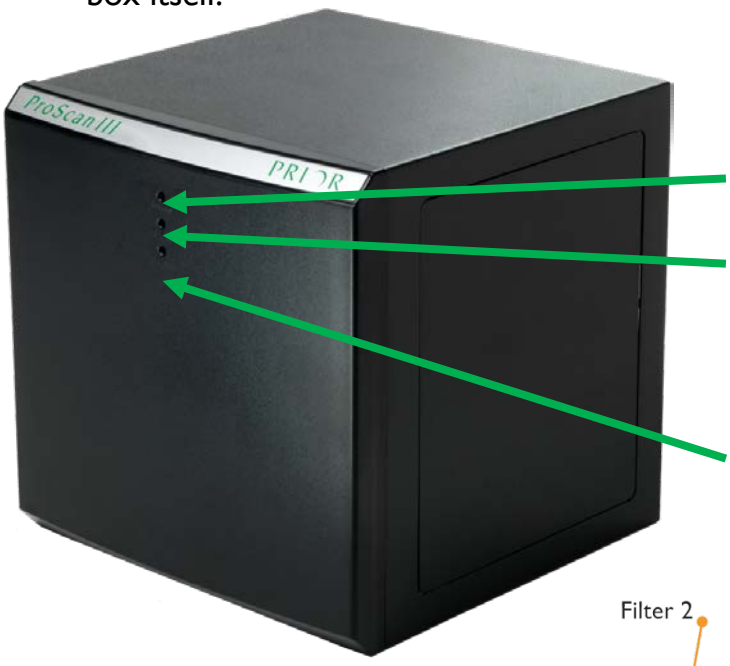
Contact Prior Scientific immediately if any parts are making.

It is likely that you will also receive a PS3J100 Interactive Control Centre; a joystick allowing control of the system. The operation of this device is not covered in this manual so please consult the PS3J100 Interactive Control Centre manual for advice and support.

The controller box will be one of two variants, either the vertical stacking (left) option or the horizontal stacking (right) option. For the purposes of this manual we will use the vertical version in pictures and instructions below; however the instructions apply equally to the horizontal version. The large, square box is the main ProScan III unit, whilst the smaller box is an ancillary box for added functionality.

2.2 Connections and Indicators

The rear of the box has the connections to integrate the control box with power supplies, accessories and a controlling computer. All connections on the box are labelled on the box itself.

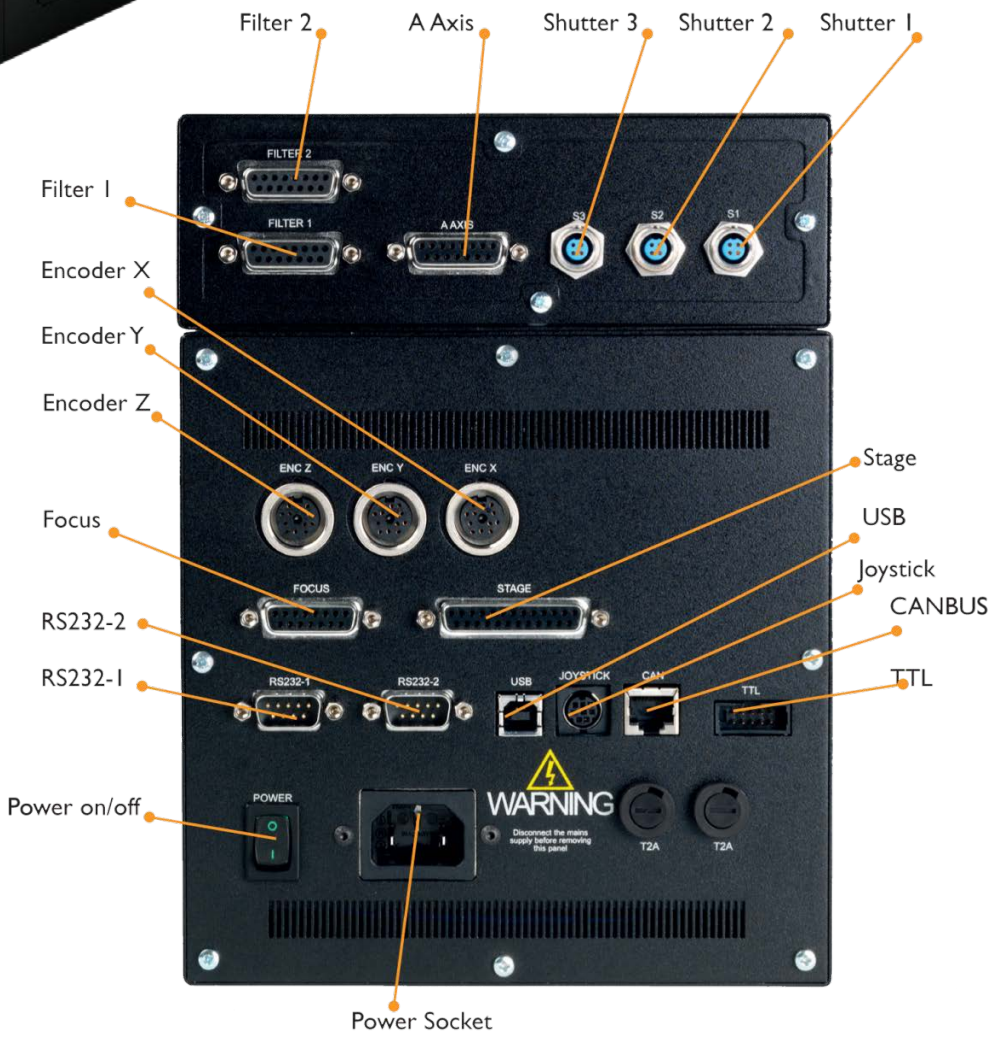


The controller front face has 3 LEDs.

1. POWER: Green illuminated: Power On

2. TX RX: Two Colour LED, RX (receive) and TX (transmit) communications
   a. RX Amber illuminated
   b. TX Green illuminated

3. STATUS: Red illuminated: Fault in system.



2.3 Installing accessories.

ENSURE THAT THE POWER IS OFF BEFORE DECONNECTING OR CONNECTING ANYTHING TO THE CONTROL BOX.

All connectors on the rear of the box are labelled. See the included 'Quick Start Guide' (also available on the Prior UK website) for further details regarding connections. In the Appendices you will find connection diagrams for the V31F and the linear stage controllers.

2.31 Installing stages

Installing the stages on specific microscopes is not covered in this manual. If unsure how to proceed please contact Prior Scientific.

To avoid damage to the optics when removing an existing stage, ensure that the distance between the objectives and stage is maximised, and that the condenser is clear of the stage.

All stepper motor stages connect to the 25 way connector labelled "STAGE". The linear motor stages use a 26 way HD connector. Switch off the power using the power switch. Connect and firmly and screw in the cable both at the controller and stage. The ProScan will now auto detect the stage and setup the features associated with that stage in its software.

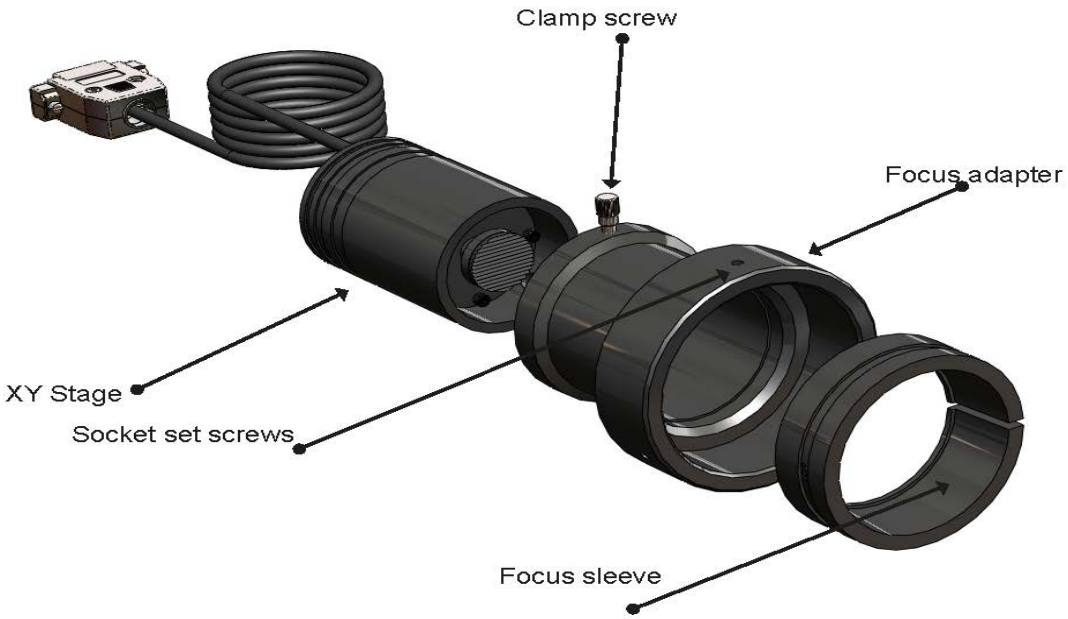
If you have an encoded stage, plug and screw in the encoder cables, these are labelled X and Y. Ensure the X cable is plugged into the connector on the ProScan III labelled X and ensure the Y cable is plugged into the Y labelled connector. Power on the ProScan III. The ProScan III will now auto detect the stage and setup the features associated with that stage in its software.

If you have a linear stage, the same process as for encoded stages applies.

Linear stages contain an Eeprom with tuning information for that stage. When a new linear stage is connected to the PS3 the tuning parameters are uploaded from the stage to the controller. This may take a few minutes, during which time the green and red status LEDs will be flashing alternately on the controller. When completed the red led will be left flashing on its own, the controller must be power cycled to finish the upgrade after which normal control is resumed.

2.32 Installing focus

All stepper motor based focus systems connect to the 15 way connector labelled "FOCUS". Switch off the power using the power switch. Connect and firmly screw in the cable to the controller.



The following instructions refer to the standard split sleeve mounting. Refer to the Prior Website, 'Installation and help sheets' section, to find instructions for specific mounts and microscopes, or contact Prior Scientific.

1. Loosen the clamp screw on the focus motor assembly and remove the focus motor from the focus adapter.

2. Loosen the 3 socket set screws around the periphery of the focus adapter using a 2mm hex key until the focus sleeve is able to fit inside the adapter. Note that it is important to insert the sleeve in the correct orientation with the lip furthest inside the adapter (the chamfered edge of the sleeve will be inserted first). Note the orientation of the sleeve as it has a recess around its outer surface, which will hold the sleeve in when the setscrews are tightened. This recess must line up with the tips of the socket set screws.

3. With the sleeve in place, tighten the 3 socket set screws in sequence until they all just touch the sleeve, ensuring that the split in the sleeve does not line up with any of the set screw positions. **DO NOT TIGHTEN UP ANY OF THE SETSCREWS AT THIS STAGE.**

4. Push the adapter onto the preferred coarse knob of the microscope as far as it will go.

5. The inside fitting diameter of the sleeve is designed to be slightly larger than the coarse knob, provided the setscrews have not been tightened and are compressing the sleeve.

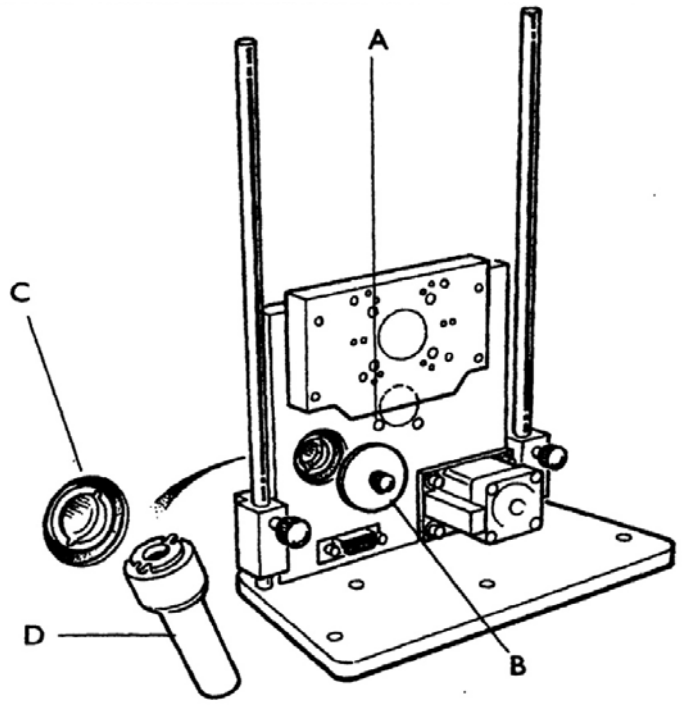
6. While holding the adapter in place, tighten the set screws in sequence only enough to secure the unit onto the coarse focus knob. The focus knob will have to be rotated to gain access to all of the screws.

7. Check that the unit has been tightened sufficiently by taking hold of it and turning it. If the adapter is correctly fitted it will stay attached to the coarse knob.

8. Slide the focus motor into the adapter as far as it will go and while applying gentle pressure to the motor tighten the clamp screw. This will hold the motor in place.
   The rubber drive bush on the end of the motor spindle should now be pressing against the end surface of the fine focus control knob. This can be confirmed by manually rotating the exposed fine focus knob on the opposite side of the microscope and feeling for the resistance caused by the detent positions of the stepper motor as it rotates. This will not cause any damage to the focus motor.

9. Confirm that the controller is switched off before connecting the 15 way D type plug on the focus motor lead to the socket on the rear of the controller as shown on page 10.

On power up the system auto detects the focus motor and the controller configures the system to drive the focus motor in the correct direction when mounted to the right hand side of an upright microscope. If the left hand coarse control knob is preferred by the user or the focus drive is to be mounted on an inverted microscope, the motor direction can be reversed either in the Interactive Control Centre settings menu or by using Prior Terminal and changing the settings of the ZD command via RS232 or USB communication.



2.33 Installing filter wheels and shutters
It is recommended that filters be installed **before** mounting the filter wheel to a microscope.

1 Select filter position required for loading, by checking the number displayed in the load position indicator window (**A**)

2 Remove the magnetic covers (**B**) from the load port.

3 Remove lock ring (**C**) by unscrewing from the filter holder cell with the tool (**D**) provided.

4 Insert desired filter and replace lock ring.

5 Repeat this process for all the desired filter positions.

6 Replace magnetic covers.

All Filter wheels connect to the 15way connector. It can be labelled "FILTER" or "AXIS A", you can select FILTER 1, FILTER 2 or Axis A .Switch off the power using the power switch. Connect and firmly and screw in the cable both at the controller and Filter wheel. All shutters connect to the round connector labelled "S". You can select S1, S2 or S3. Switch off the power using the power switch. Connect and firmly and screw in the cable to the controller.

Prior Filter Wheels and Shutters are supplied with the correct adapter flanges fitted, for the specified microscope stand. Therefore the mounting of this equipment uses exactly the same procedure used when fitting the microscopes lamp-house. All Prior Filter Wheels and Shutters are manufactured with C mount threads. The addition of a male to male C mount adapter (Part No. HF207) allows these units to be mounted to a microscope camera port, if required.

Note: Shutters should always be installed with the silvered face facing the lamp-house.

For more information on installation, please refer to the 'Installation Guides and Help Sheets' section on the Prior website.

NOTE: SHUTTERS MUST ONLY BE RUN AT A MAXIMUM OF 10 HZ

2.34 Fourth Axis or Auxiliary Axis equipment.

Fourth Axis or Auxiliary Axis equipment connects to the 15 way connector, labelled "AXIS A". Switch off the power using the power switch. Connect and firmly and screw in the cable both at the controller and the equipment.

The controller will automatically detect Prior accessories and set them up for use. For non-standard user equipment use the FOURTH commands in the Appendix.

2.35 Connecting the Interactive Control Centre.

Ensure the system is switched off. Plug in the 9 way connector to either the RS232-1 (preferable option) or the RS232-2 connector. Power on the system. The Interactive Control Centre will detect the ProScan III controller and automatically configure the internal software. See the Interactive Control Centre manual for further details.

2.36 Installing a Lumen 200Pro

The Lumen 200Pro uses 2 15-way connectors and a round "shutter" connector. The two 15 way connectors should be connected to "FILTER 1" and "FILTER 2"; "AXIS A" can also be used if necessary. Switch off the power using the power switch. Connect and firmly screw in the cables for both at the controller and two Lumen 15 way connectors. The shutter connector is optional and should be connected to the ProScan III "S1, S2 or S3". Switch off the power using the power switch. Connect and firmly and screw in the cable both at the controller and Lumen 200Pro connector.

Note: If connected the default for the Lumen200 Pro is OFF. The system must be activated via software – you cannot just switch on the device itself.

2.4 Expanding the ProScan III.

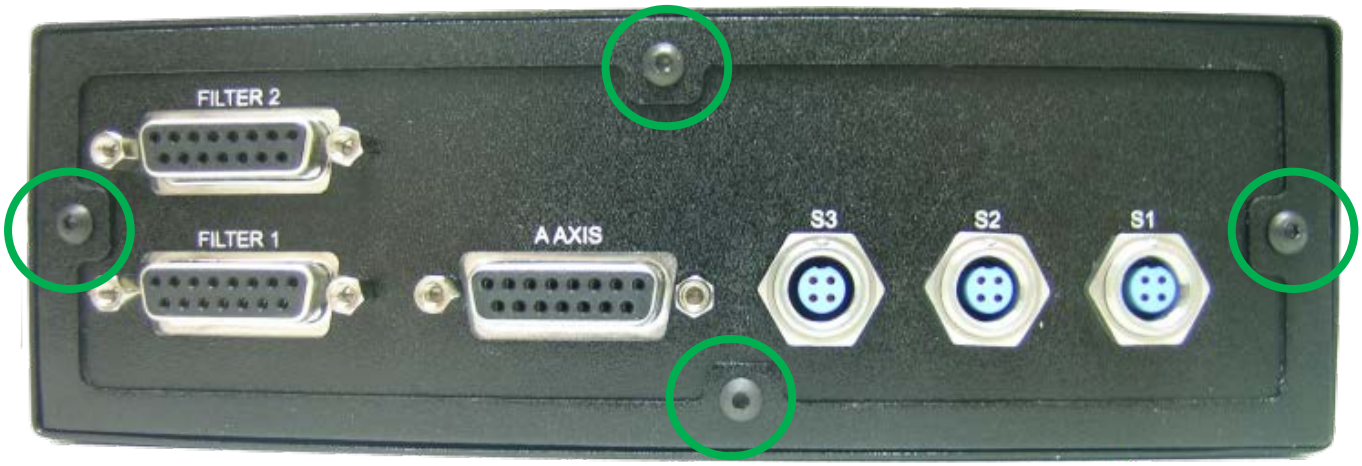
Only perform this operation if you have read and understood the instructions.

Note: The following instructions should only be followed by either Prior trained and authorized personnel, or a qualified electrical engineer. Contact Prior if you are unsure about any aspect of this procedure.

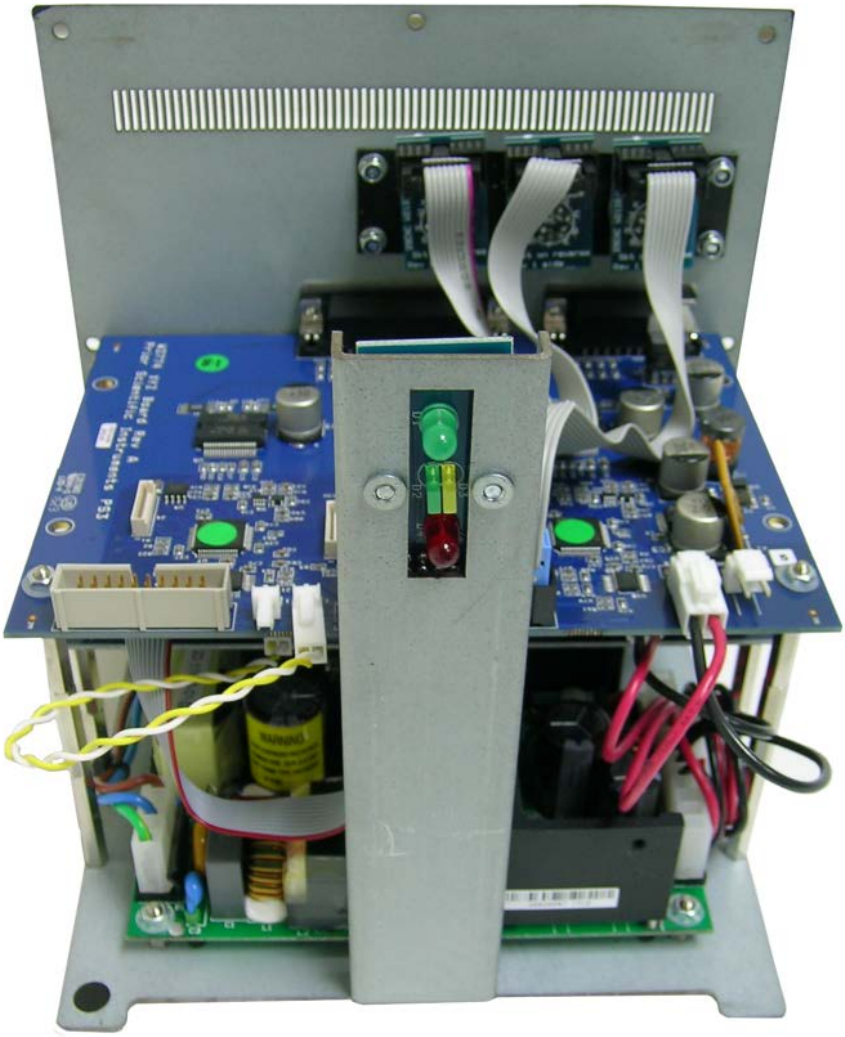
CAUTION: DISCONNECT ALL POWER SUPPLIES BEFORE STARTING THIS PROCEDURE

Adding the ancillary box to the ProScan III control is a relatively simple task that will substantially increase the versatility of the ProScan system. Generally, the ancillary box will control filters and shutters whilst the main control box provides the connections such as USB, power and RS232, in addition to controlling the stage and focus. However, main boxes which control filter wheels and shutters are also available. Note that the ancillary box is not a standalone unit. Depending on whether a V- or H- type ProScan III was purchased, the ancillary box is added to the top or the side respectively of the main box.

In this guide, 'case' will mean the cases that cover that circuit boards in the boxes, 'box' will mean either the entire main unit or the entire ancillary unit, 'front' will refer to the front of the unit displaying the ProScan logo and 'back' will refer to the side with the connectors. 'Right' and 'left' refer to the side of the unit when viewed from the back. The exact procedure detailed here is for attaching an ancillary box to the left of a horizontal ProScan III, however the procedure is functionally identical for the other configurations.

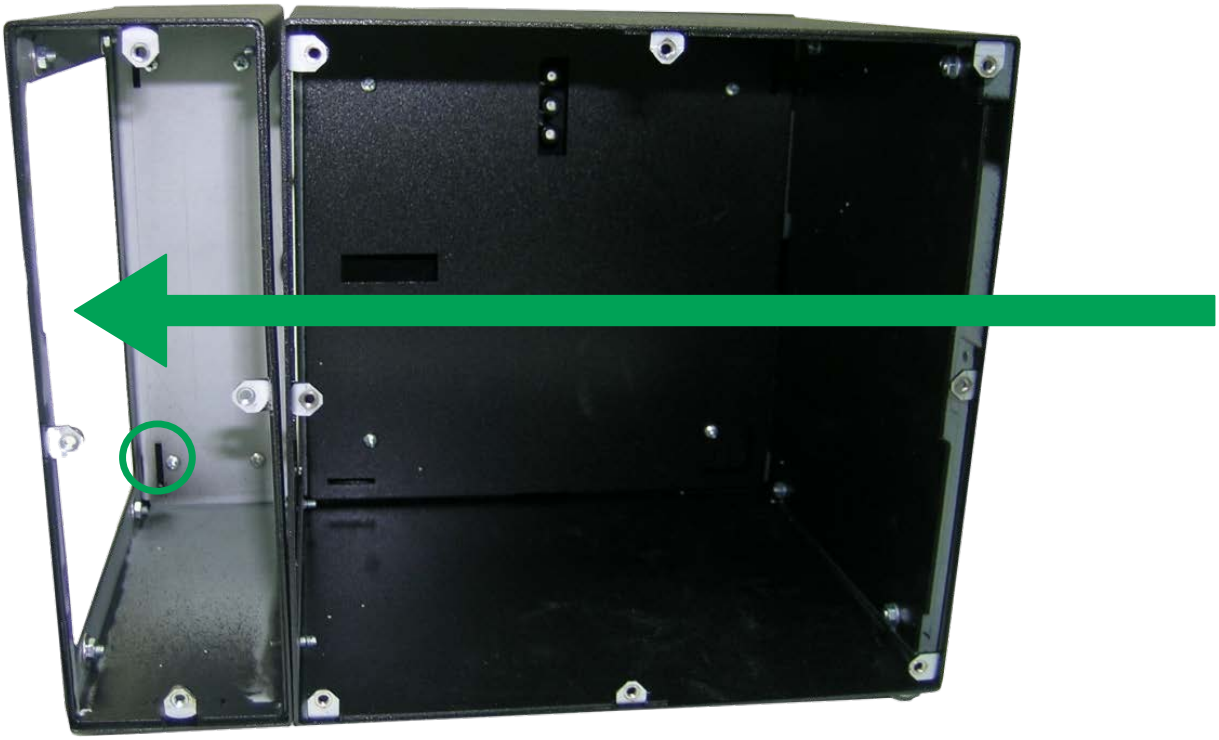

FILTER 2
FILTER 1
A AXIS
S3
S2
S1


ENC Z
ENC Y
ENC X
PRIOR
www.prior.com
MODEL TYPE
SERIAL No.
HLD31XYZ
1197104/a
FOCUS
STAGE
RS232-1
RS232-2
USB
JOYSTICK
CAN
POWER
WARNING
100-240v 50/60Hz 150W
T2AH240V
T2AH240V

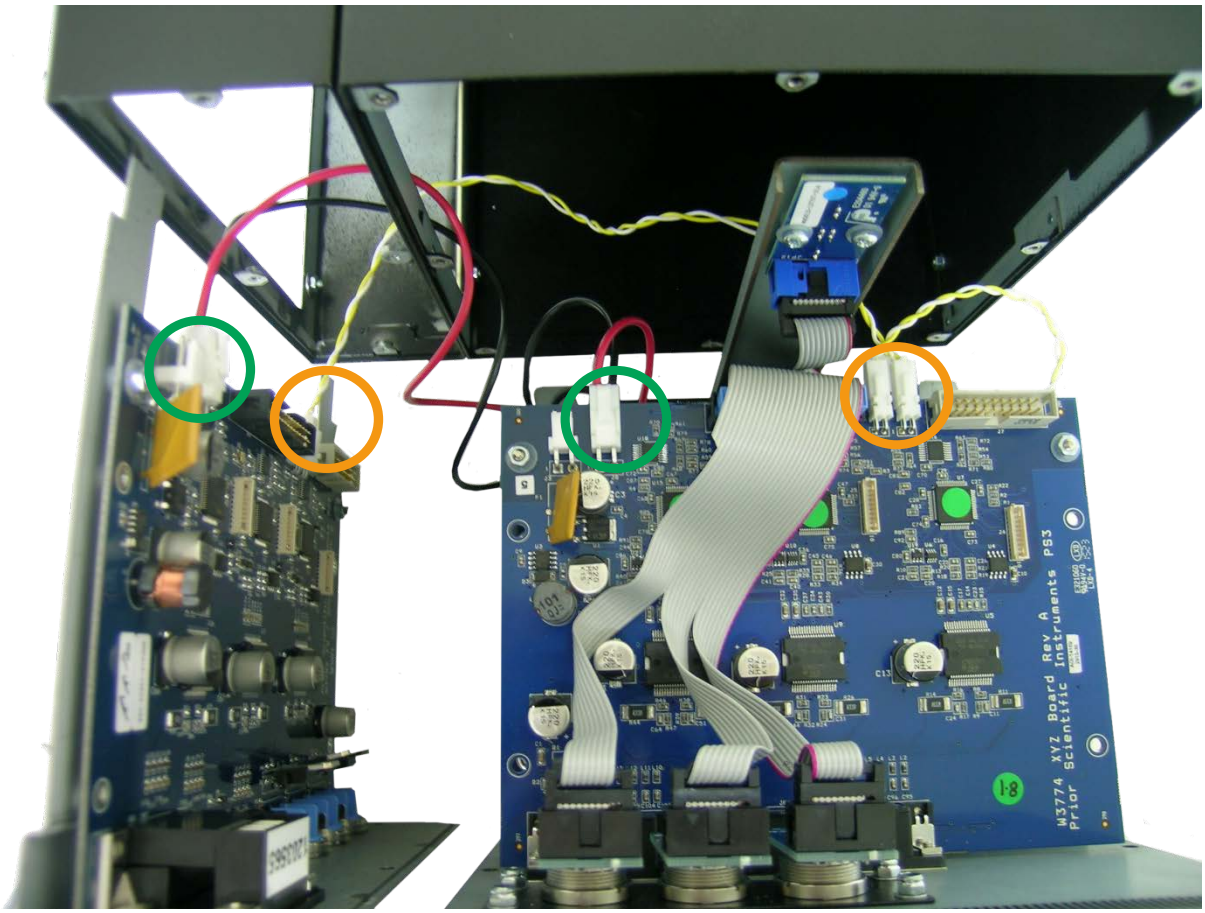


Leave the ancillary box as it is. Slide the case of the main box away from the interior which will expose the inner circuit boards.

Identify where the ancillary box will be controlled. Ensure that the ancillary unit will be facing in the same direction as the main control box. Remove the appropriate panel using a wrench. Slide the case of the ancillary box away from the interior, and place it next to the main box in the position where it will be installed. You can ensure that the orientation is correct by noting the position of the slots. If you are installing it to the LEFT or BOTTOM of the main box, the slots (circled in green) should be on the side opposite to the main case. If to the RIGHT or TOP, the slots should be adjacent to the main case. The image below shows the main and ancillary cases correctly orientated for an installation on the left. Use the U-clamps provided to fasten the cases together – note that these may be attached to the ancillary box casing. Then install the panel you removed from the main casing onto the appropriate open side of the ancillary casing.



Connect the two internal components. From the main control box extract a power cable (red and black) which is attached at one end. Plug the other end into the ancillary board (see green circles on the next page). It can go into either one of the sockets than will accept it. On the ancillary board there is a yellow and white cable, connected at both ends. Undo one of these connectors (it does not matter which) and connect it to the spare connector next to the white and yellow cable on the main box (see orange circles on the next page). Ensure that the cables are threaded through the opening between the two cases; otherwise it will not be possible to place the boards back into their cases.



The exploded view above shows cable connections.

Slide circuit boards back into their cases – ensure that they go all the way back in (the prongs at the end should enter the slots at the back of the cases). Then redo the screws. Your ProScan III is now ready for use.

INSTALLING AND USING THE SOFTWARE SECTION 3

3.1 Installing and Opening Software.

Prior supplies free software which can be used to control the ProScan III system. It is available in either 32 or 64 bit versions. It can be downloaded by going to the 'Downloads' section of the Prior website. For more information on the software please see our Quick Start Guide 'Installing and Using Prior Software'.

'Prior Demo Software' refers to the whole package downloaded from www.prior.com.

'Prior Terminal' is a terminal emulation program into which commands can be entered via a USB or RS232 connection. Such commands are discussed in Section 5 and guidance is provided in Appendix A.

'Controller Demo' allows control of the ProScan III via a GUI and is discussed in this section.

'Prior Demo Software' is downloaded from www.prior.com in the 'Downloads' section. Open the downloaded file and double click in setup. Ignore any warning messages and follow the onscreen instructions. The software should install automatically.

To launch the 'Controller Demo' go to the Start Menu > Prior Scientific > Visual Basic > Controller Demo.

You will be asked to enter the correct port number.

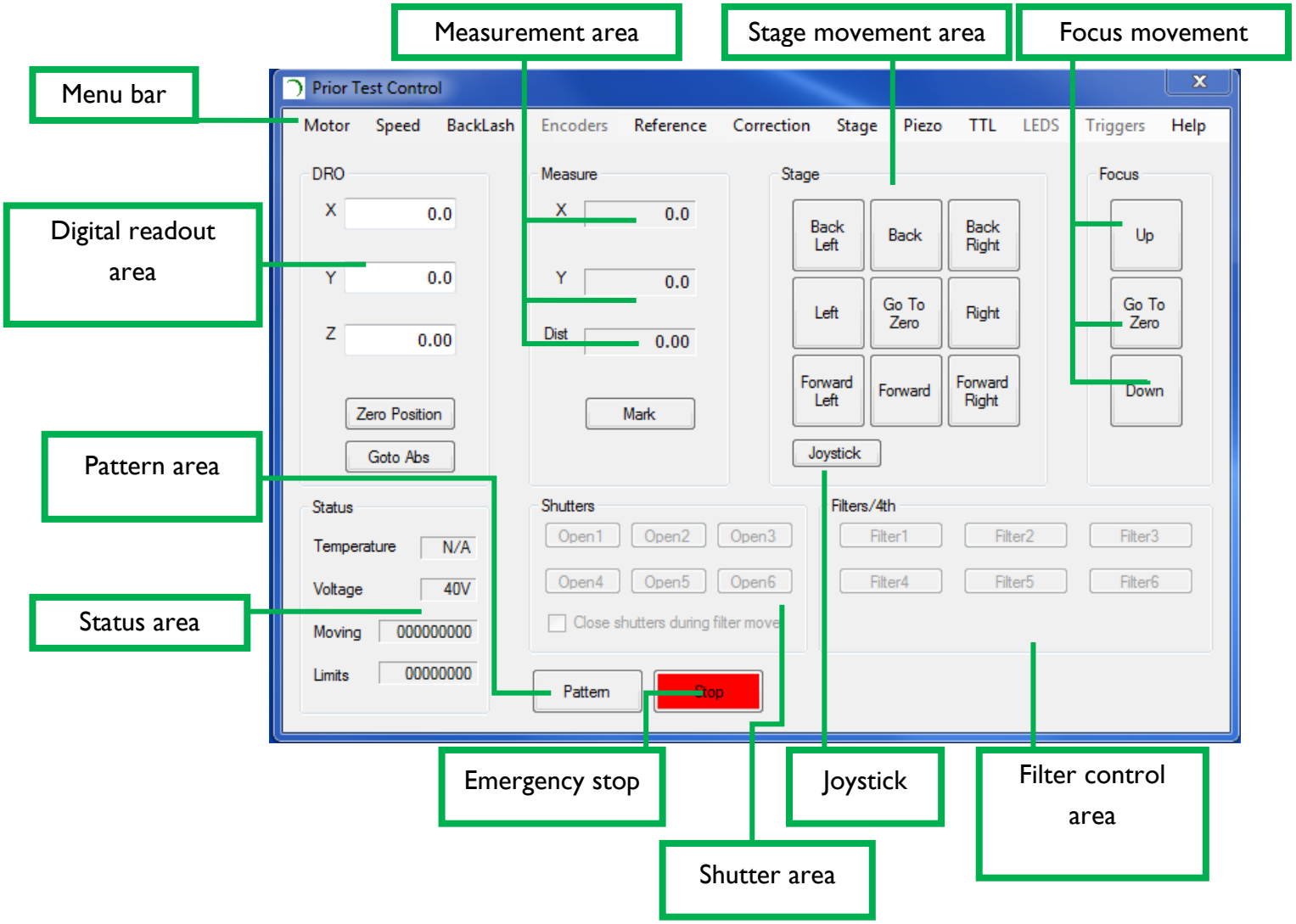
Open Windows Device Manager to identify the correct port.

For older ProScan devices, the correct port should be labelled 'Prior Communications Port'. For more recent PS3 or ES11 devices equipped with FTDI, or connections via a RS232 to USB convertor, the port will be labelled as 'USB Serial Port'. Ensure that this is the port selected.

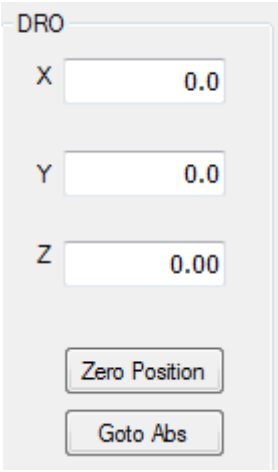
3.2 Using the Program

The following screen will be displayed once the correct Port is entered.

Only attached accessory sections will be active, e.g., if there are no shutters all of the Shutter buttons in the Shutter area will be light grey and inactive.



See below for information on how to use the different menus in this software.



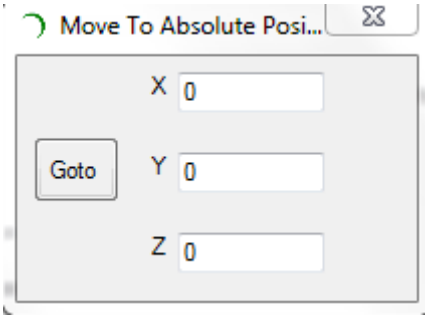
X is the X position (in microns)

Y is the Y position (in microns)

Z is the Z position (in microns, if the UPR is set correctly for the microscope)

Zero Position Button: Zero's all three positions, all previous positional information is lost.

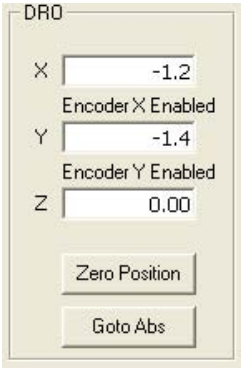
Go to Abs Button:



Type the X Y and Z position you require and Press 'Goto'.

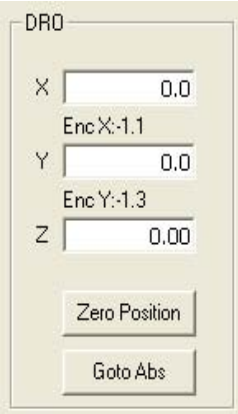
Moves the X Y and Z to the absolute X Y and Z position.

Digital Readout with Encoders:



X value using encoder (Based on the encoder settings)
Y value using encoder (Based on the encoder settings)
No z-encoder fitted, Z position. (in microns, if the UPR is set correctly for the microcope).

Digital Readout with encoder fitted but disabled:



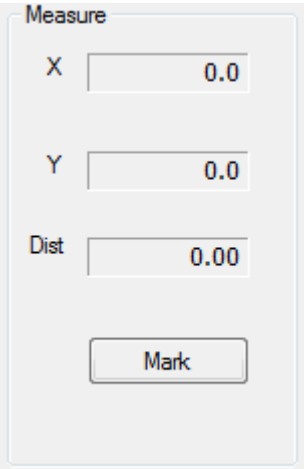
X is the X position (in microns)

EncX: X encoder position

Y is the Y position (in microns)

Enc Y: Y encoder position

Z is the Z position (in microns, if the UPR is set correctly for the microscope)



Measurement Area:

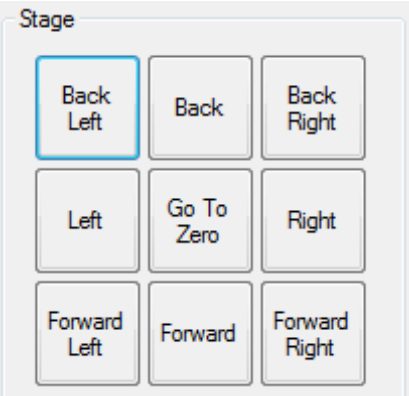
X distance from marked position to current position.

Y distance from marked position to current position.

Diagonal distance from marked position to current position.

Click 'Mark' to make current position marked position.

Stage move area:



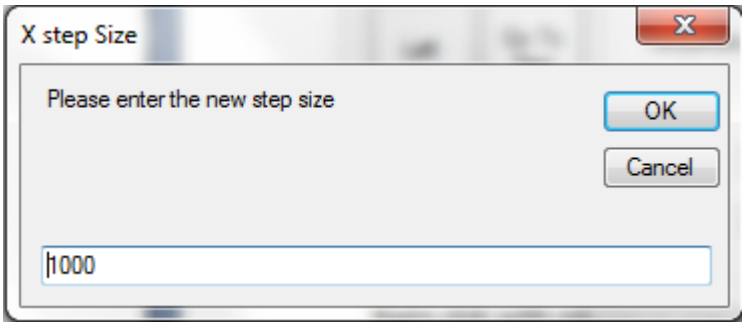
Click buttons to move stage set distances (default 1000um).

Back, Forward (Y)

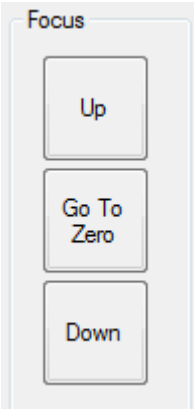
Left, right (X)

Right click with mouse on one of the buttons to set the distance travelled.

Type in the step size (distance travelled) in microns and click ok.



Focus Move Area:

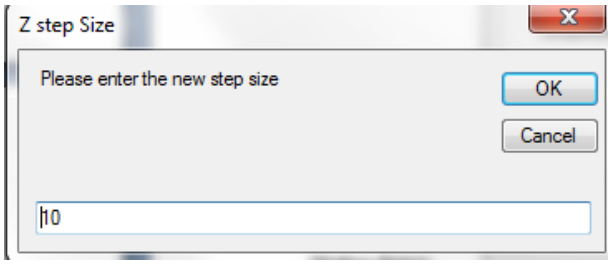


Click buttons to move focus set distances (default 10µm).

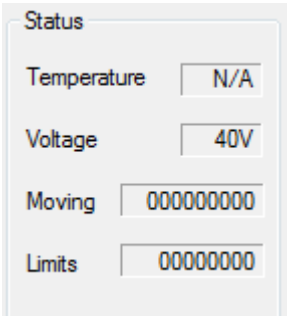
Go To Zero: move the focus to absolute zero.

Right click with mouse on either 'up' or 'down' to set the distance the focus will travel.

Type in the step size (distance travelled) in microns and click ok.



Status Area:



Temperature: Chip temperature is displayed if available.

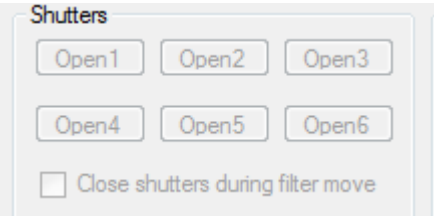
Voltage: Drive voltage is displayed.

Moving: Displays nine digits, one for each axis, 0 if the axis is stationary and 1 if it is moving.

All digits are always displayed in the following order: F6,F5,F4,F2,F1,F3/A,Z,Y,X. 0010011 indicates the Filter 1, X and Y are moving, for example.

Limits: Displays eight digits, one for each end of each axis, 0 is not active 1 is limit active. All digits are always displayed in the following order: A-, A+, Z-,Z+,Y-,Y+, X-,X+.

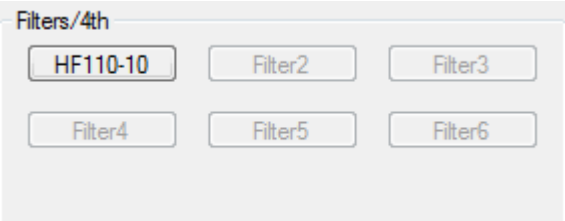
Shutters Area:



Click the appropriate button to Open or Close an attached shutter. If the button is greyed out the shutter is not detected.

Check the Close shutter during filter move to close all shutter when any attached filter wheel is moved.

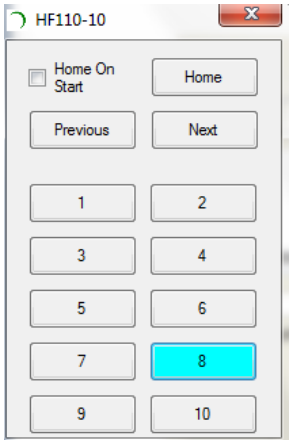
Filters/4th Area:



Click the appropriate button to open another window to access the Filter Wheel, Lumen Attenuator ('LLG Shutter'), or 4th Axis Accessory ('Theta').

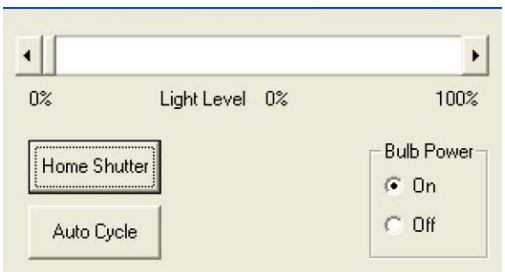
Greyed out buttons show that no accessory is detected.

Filter Wheels:



Click 'Next' to move the next filter wheel position. Click 'Previous' to move the previous filter wheel position. Click 'Home' to home the Filter wheel. Check the 'Home on start', to activate the home on startup feature which will automatically home the filter wheel when the ProScan unit is powered on.

Lumen Attenuator:

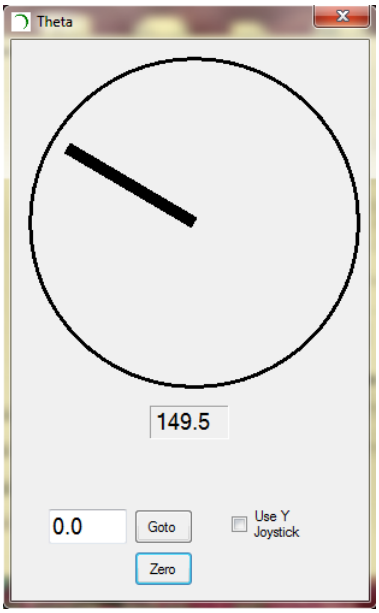


Use the scroll bar to set the light output level from 0 to 100%.

Click the 'Home Shutter' to home the shutter; this should be done on start-up.

'Auto Cycle', click to automatically cycle the unit through 0-100% light output, Click

cancel to stop.
Bulb Power: Switches entire Lumen On/Off



4th Axis – Theta:
Displays the position of the theta insert or stage axis.

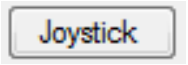
Type a angle position 0-360 degrees into the Goto box and click Goto to move the axis to that angle.

* Check the 'Use Y Joystick box' to enable the Y axis of the Joystick to be used as the Theta controller.

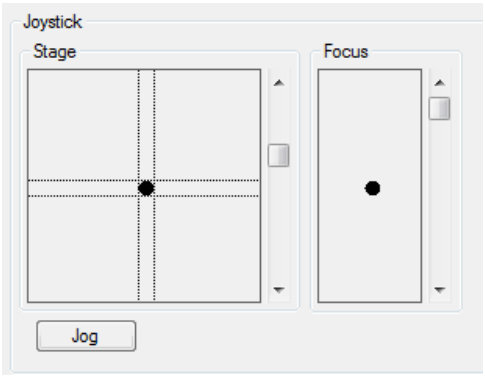
Buttons:

Stop: Press this button to stop all axis movement immediately.

Pattern: Click the 'Pattern' button the launch Pattern Manager.

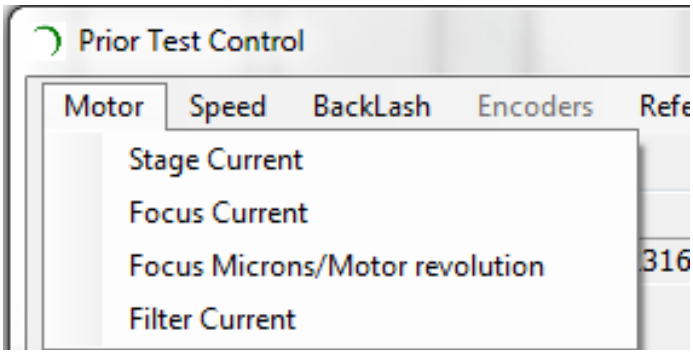


Joystick: Click Joystick to launch the Joystick windows.

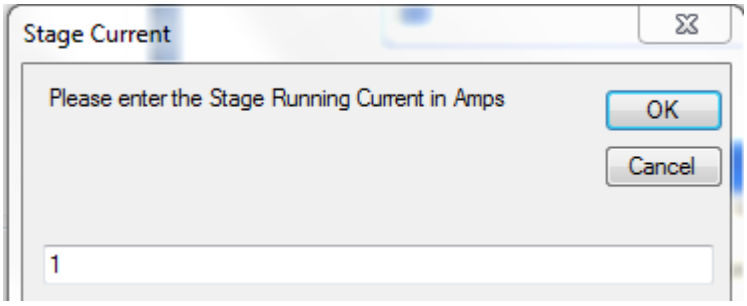


Drag the black ball to make the axis move.

Menu Functions:



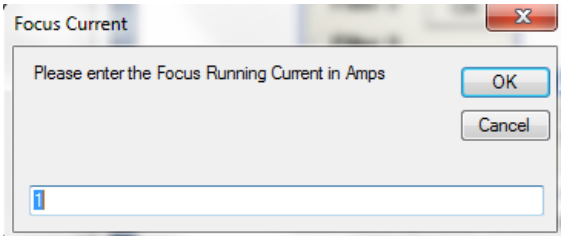
Stage Current:



Sets the running current for the motors on the stage between 0 and 1.5Amps.

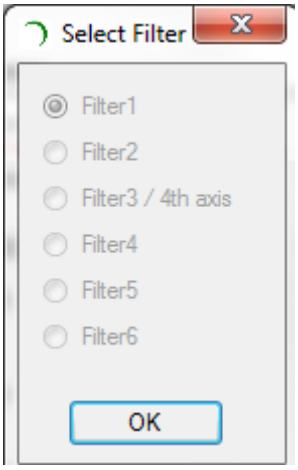
WARNING: Changing this value may damage your motors.

Focus Current:



Sets the running current for the motors on the focus between 0 and 1.5Amps. **WARNING**: Changing this value may damage your motors.

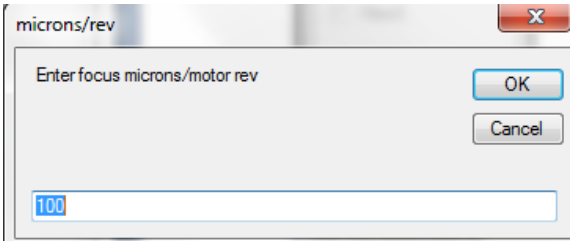
Filter Current:



Select the filter wheel axis you would like to change the drive current for and click OK.

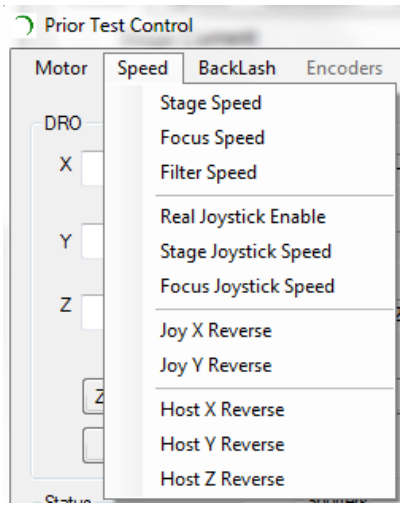
Sets the running current for the motors on the filter wheel axis between 0 and 1.5Amps

WARNING: Changing this value may damage your motors.

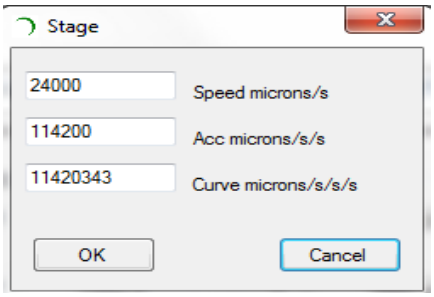


Focus microns/motor revolution:
Enter here the number of microns the microscope focus moves when the fine focus knob is rotated 1 revolution.This enables the micron value in the display to be related correctly to the attached microscope.

Speed Menu:



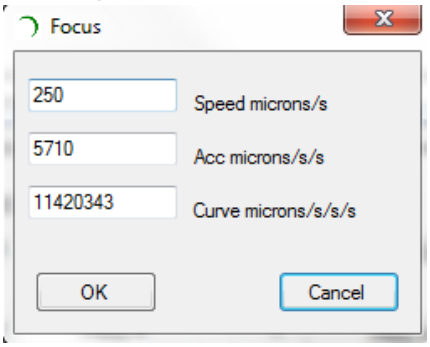
Stage Speed:



Changes the intrinsic characteristics of the stage. Speed is in micro steps per second. Acceleration in micro steps per second per second

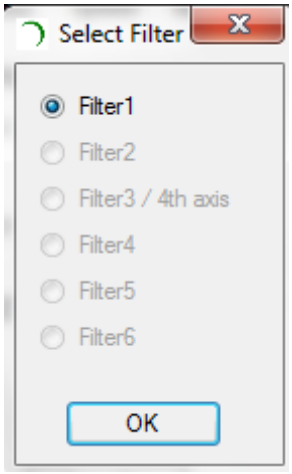
WARNING: Stage may stall under certain settings.

Focus Speed:



Changes the intrinsic characteristics of the focus. Speed in micro steps per second. Acceleration in micro steps per second per second

WARNING: Focus may stall under certain settings.



Filter Speed:

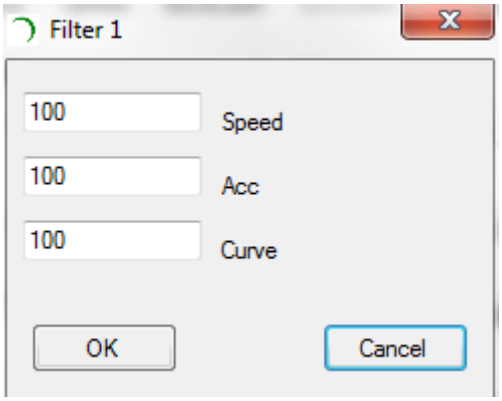
Select the filter axis you wish to change.

Changes the characteristics of the selected filter axis. Speed, 1-100%.

Acceleration 4-100%

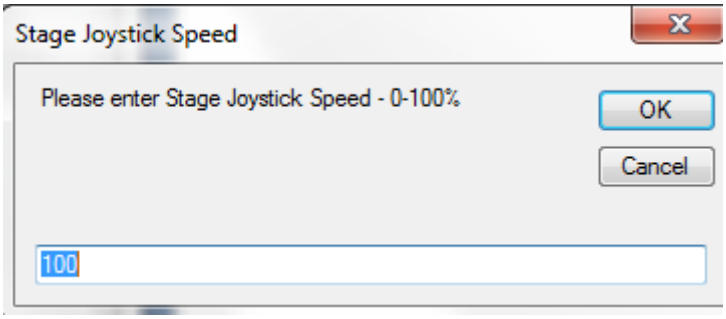
Curve (See S-Curve in Appendix D) 1-100%

WARNING: Filter axis may stall under certain settings.



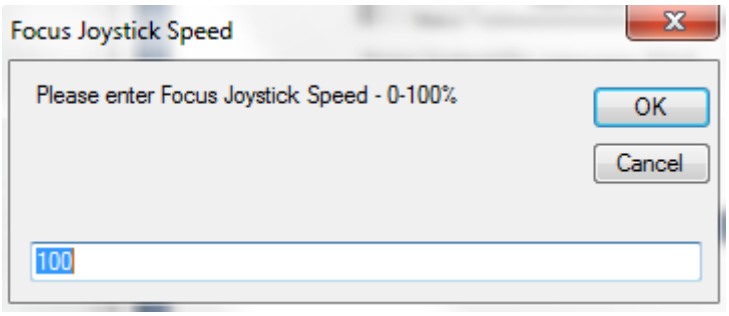
Joystick Enable: Enables or Disables Joystick, check to enable.

Stage Joystick Speed:



Enter the % speed from 0-100% for the joystick to move the stage.

Focus Joystick Speed:



Enter the % speed from 0-100% for the joystick to move the focus.

Joy X reverse: Check to reverse the direction of the X axis under joystick control.

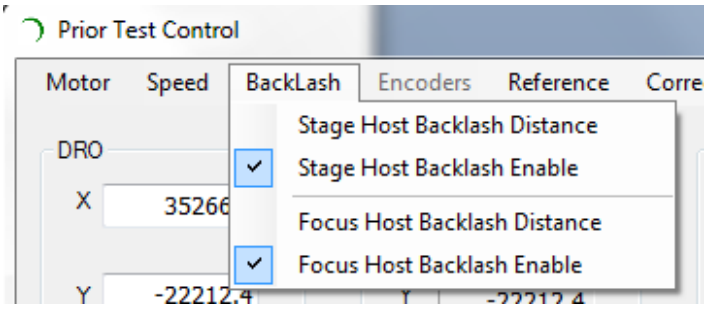
Joy Y reverse: Check to reverse the direction of the Y axis under joystick control.

Host X reverse: Check to reverse the direction of the X axis under computer control.

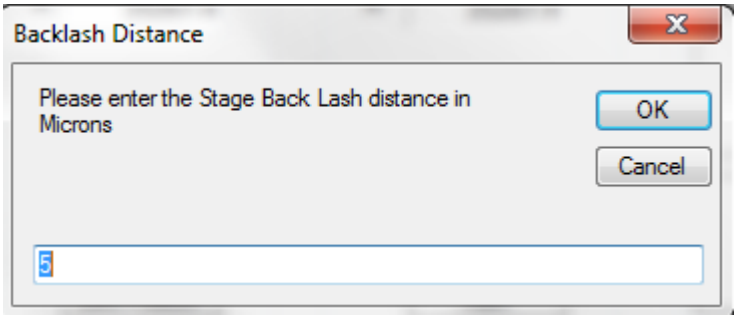
Host Y reverse: Check to reverse the direction of the Y axis under computer control.

Host Z reverse (Focus): Check to reverse the direction of the Z (Focus) axis under computer control.

Backlash Menu:



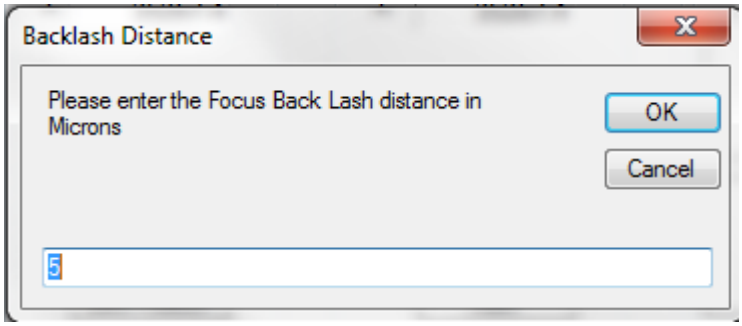
Stage Host Backlash Distance:



Sets the distance the stage will move when under computer control and performing the backlash correction. Input the number of microns required.

Stage Host Backlash Enable: Check this to enable the backlash feature for computer control on the stage.

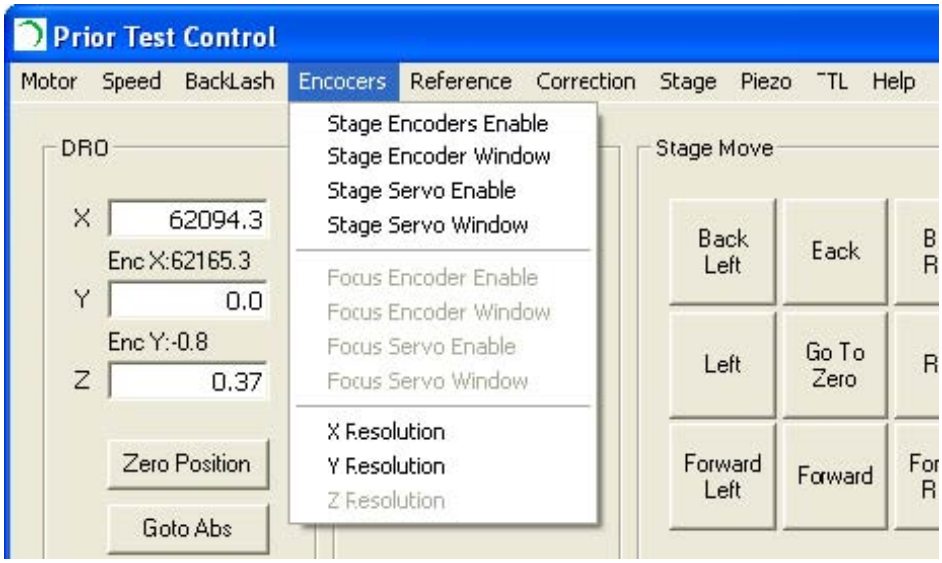
Focus Host Backlash Distance:



Sets the distance the focus will move when under computer control and performing the backlash correction. Input the number of microns required.

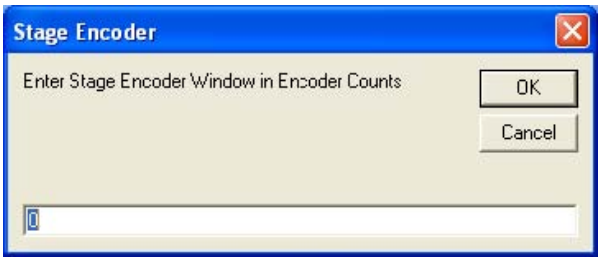
Focus Host Backlash Enable: Check this to enable the backlash feature for computer control on the focus axis.

Encoder Menu:



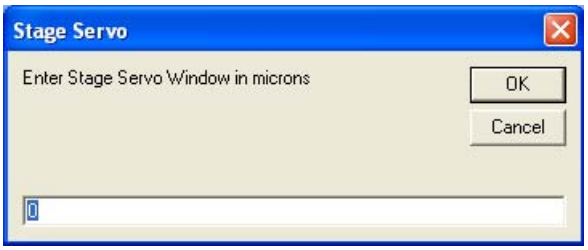
Stage Encoders Enable: Check this to enable the encoders to function with the stage.

Stage Encoder Window:
If encoders are enabled the controller will move the stage to an encoder position. The encoder window is the number of encoder counts away from this position the system can be. If the encoder window is set too small the system may move continually while searching the exact position requested.



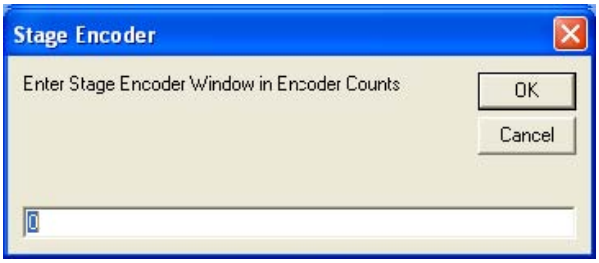
Stage Servo Enable: Check this to enable stage servo. This makes the stage attempt to stay at the programmed position. Use this function to overcome drift in time-lapse experiments.

Stage Servo Window:



When in servo mode the controller will attempt to keep the stage at a particular position. The servo window is the number of encoder counts the stage can move before the controller will respond and correct the position.

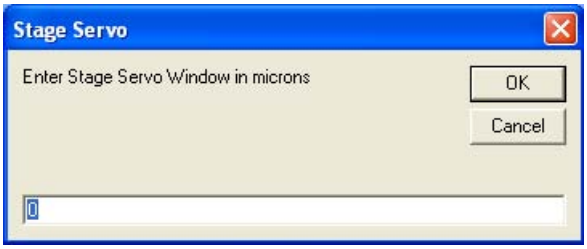
Encoders Enable: Check this to enable the encoders to function with the focus.



Encoder window: If encoders are enabled the controller will move the focus to an encoder position. The encoder window is the number of encoder counts away from this position the system can be. If the encoder window is set too small the focus may move continually while searching the exact position requested.

Focus Servo Enable: Check this to enable focus servo. This is make the focus attempt to stay at the programmed position. Use this function to overcome drift in time-lapse experiments.

Focus Servo Window:



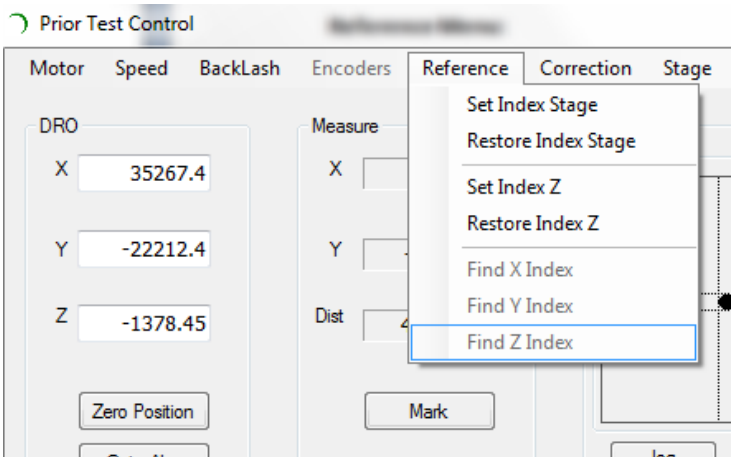
When in servo mode the controller will attempt to keep the focus at a particular position. The servo window is the number of encoder counts the focus can move before the controller will respond and correct the position.

X Resolution: Sets the encoder resolution for the X axis to determine the micron number displayed in the DRO. Use negative number to reverse the direction if the encoder is reversed.

Y Resolution: Sets the encoder resolution for the Y axis, this determines the micron number
displayed in the DRO. Use negative number to reverse the direction if encoder reversed.

Z Resolution: Sets the encoder resolution for the Z axis, this determines the micron number displayed in the DRO. Use negative number to reverse the direction if encoder reversed.

Reference Menu:



Set Index of Stage: Unencoded: Moves stage to X+ and Y+ limits (Forward and right) and sets position as 0,0.

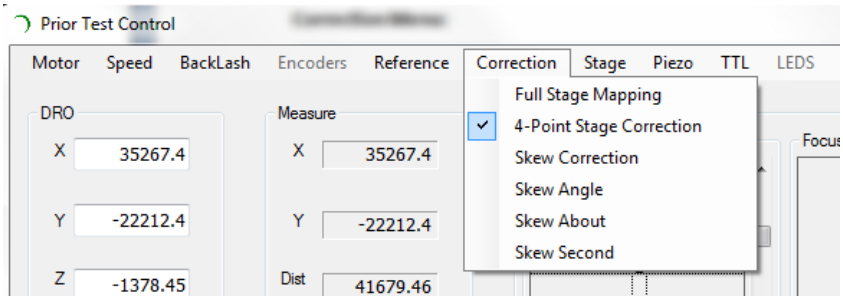
Encoded: Moves stage to X+ and Y+ limits, (Forward and right) and sets motor count to 0, then returns the stage to reference points on encoders and set position 0.

Restore Index of stage: Completes a Set Index of Stage move then returns the stage to the position it was originally at.

Set Index Z (Requires Z limits): Moves the focus to Z+ limit and sets motor count to 0.

Restore Index of Z: Completes a Set Index of Z then moves the focus to the position it was originally at.

Correction Menu:



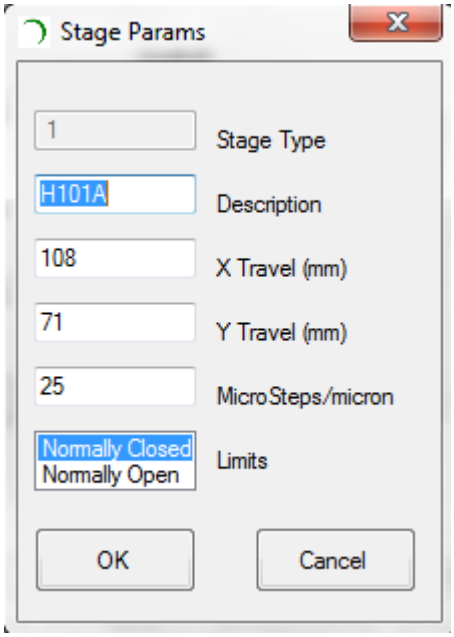
Full Stage Mapping: Check to enable Full stage mapping. (Set Stage Index must be complete on startup and stage must be enabled with All point mapping).

4-point Stage Correction: Check to enable IST stage correction.

Skew Correction: Enables Basic Skew correction using the parameters from Skew Angle, Skew About and Skew Second.

Skew Angle: Skew the stage by the angle inputted.
Skew About: Skews the stage between about this point with the above angle.

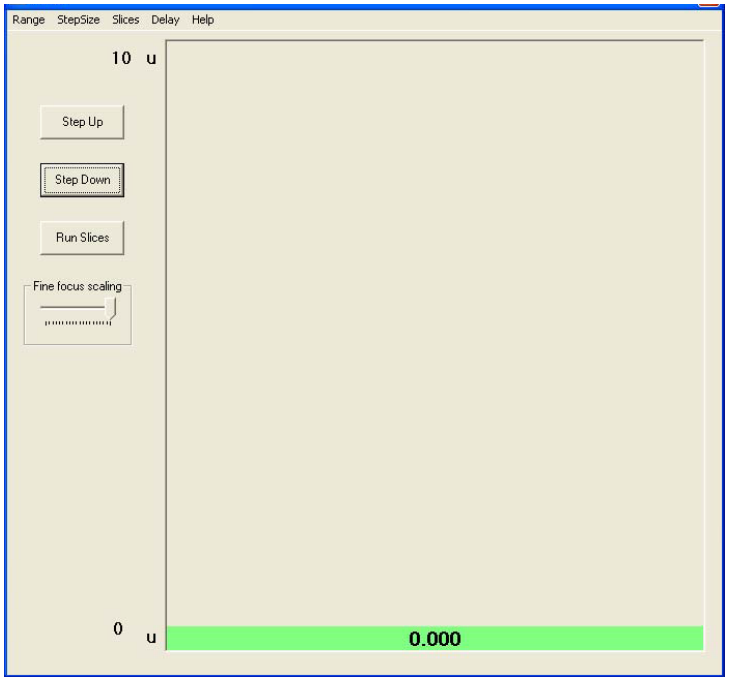
Stage menu:



Displays information about the stage attached.

Piezo Menu:
This launches the piezo menu.
If the Piezo drive is daisy chained from the PS3 controller then it will be connected to immediately. If it is attatched to the computer via another COM port, click 'Yes'.

Range: Reports the Range of the Piezo.

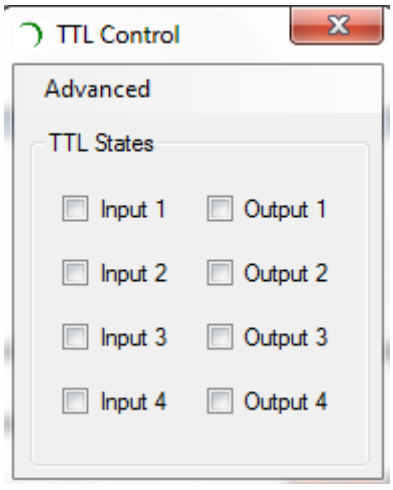


Step Size: Sets the step size for the Step up and Step down buttons.

Slices: Set the number of slices for the run slices button.

Delays: Sets the delay between the slices for the run slices button.

Run Slices: Runs a program stepping though a number of equal slices between the position the stage is at to zero. Click into the area above the green banner and drag to mouse to make the piezo stage move. Use the Fine Focus scaling to increase and decrease movement speed.



TTL Control Menu:

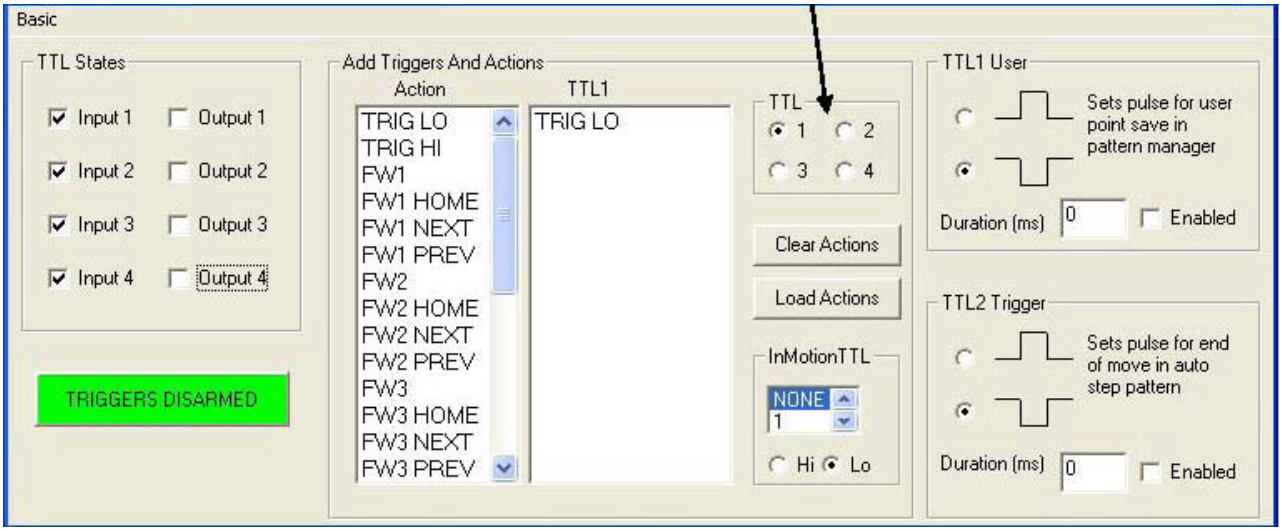
For basic TTL control and indication use the basic screen, check the boxes to output high signals and uncheck them to output low signals. The inputs will indicate if the signal is high (checked) or low (unchecked).

Advanced TTL control:

This allows the programming of the auto response TTL system. Use this to trigger events via TTL.

Supported Functions are:
Lumen Attenuator, move to % open.
Filter wheels: move to Next, Previous, Home and Move to position.
Shutter: Open and Close.
XYZ axis: Relative and Absolute Moves.

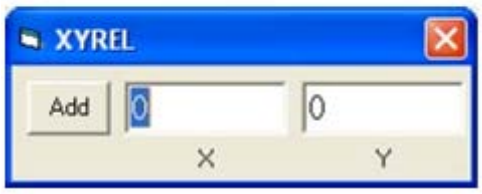
NanoScanZ (Piezo): Relative and Absolute Moves



Ensure triggers are disarmed. (Button should be green). Clear actions using Clear Actions button for each individual TTL channel. Select the TTL channel you would like to program (only program the TTL lines required). TTL can be used via the ProScan either via two modes – a 'High' TTL pulse or a 'Low' TTL pulse. . This allows more precise ordering of events than just associating a particular action with a TTL pulse. By default, TRIG LO (TTL Low) is displayed in the TTL window. If you want TTL High select TRIG HI.

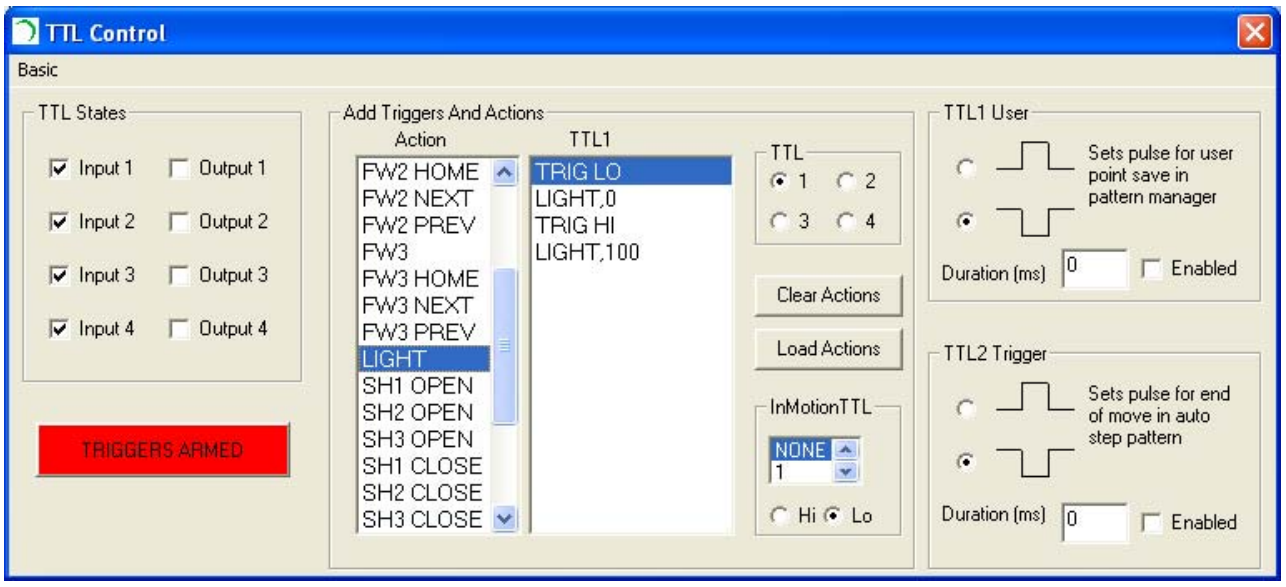
For some actions a window is opened, fill in the appropriate information to enable the assigned action.

e.g., Type in the % of light you would like the lumen attenuator to allow through.



e.g., Type in the relative move you would like the stage to make and then click add.

Click TRIG HI, if an action is to be assigned to TTL Hi. Select the action to be assigned to



TTL Hi.

Click Load Actions to load the actions for that particular TTL to the ProScan Controller. Repeat the process for each of the TTL channels required.

The In motion TTL sets a TTL output (either high or low) when any axis is in motion.

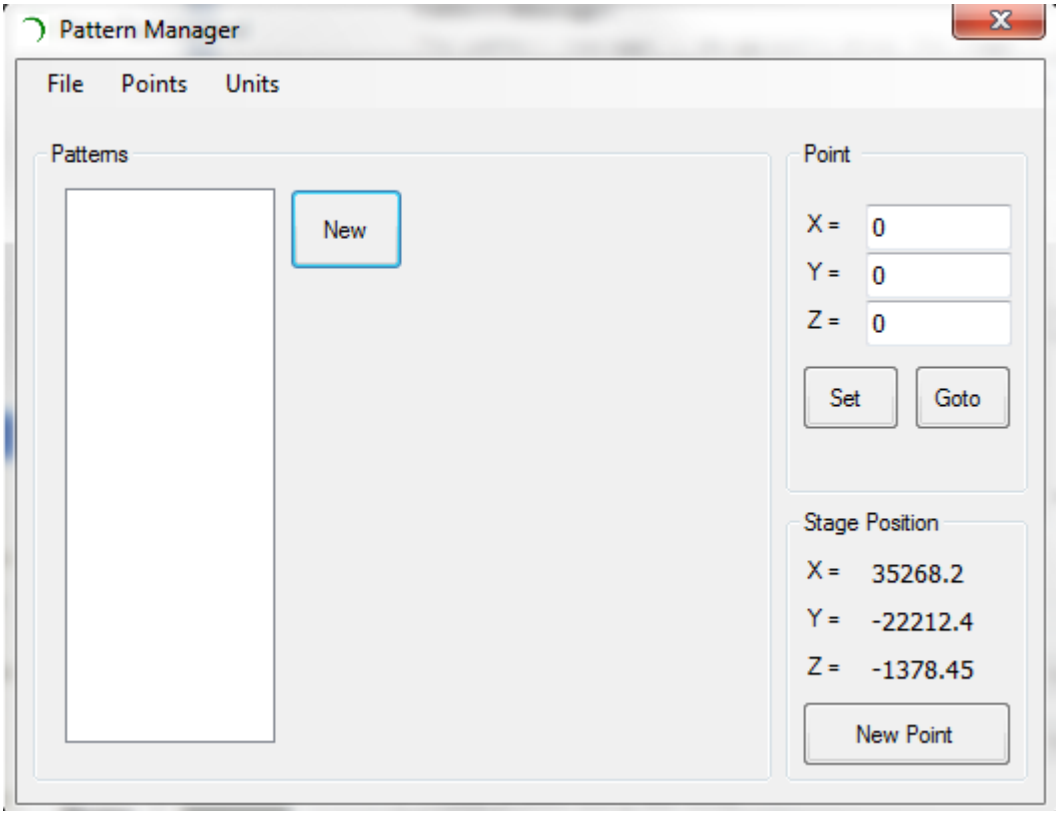
Select the TTL and check Hi or Low as required and then click 'Load Actions'.

To arm the system and make it respond to TTL inputs and outputs click the 'Triggers Disarmed' button, this will change colour to red and display Triggers Armed as above. Your system will now implement the TTL inputs as programmed.

TTL 1 User sets the length in ms and orientation, high-low-high or low-high-low of a TTL trigger pulse outputted via TTL 1, when a point is saved at the end of each move of a pattern (see 'Patten Manager'). Enable the feature by checking the Enable box.
TTL 2 Trigger sets the length in ms and orientation, high-low-high or low-high-low of a TTL trigger pulse outputted on TTL 2 at the end of each move of a pattern (see 'Pattern Manager'). Enable the feature by checking the Enable box.

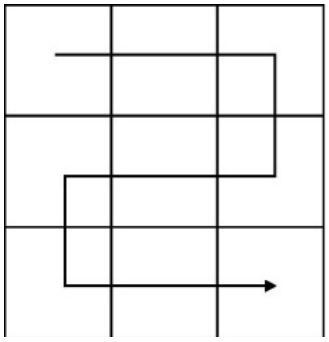
Pattern Manager:
The pattern manager is designed to drive the stage in various patterns, with the TTL trigger functions enabled this can be used to automatically gather images for tilling or stitching.

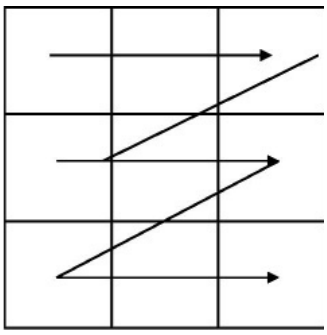
Click the 'Pattern Button' on the main screen of the program.



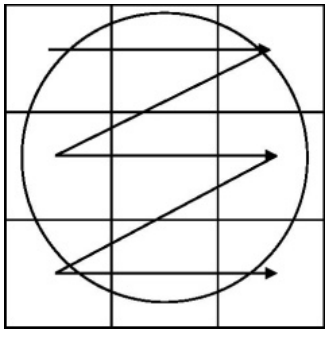
You can open a previous saved pattern or save a pattern using the File menu.

Click 'New' to create a new pattern. Select the type of Pattern Type in a name for the pattern, and select a type. The four choices determine how the stage moves through the pattern.

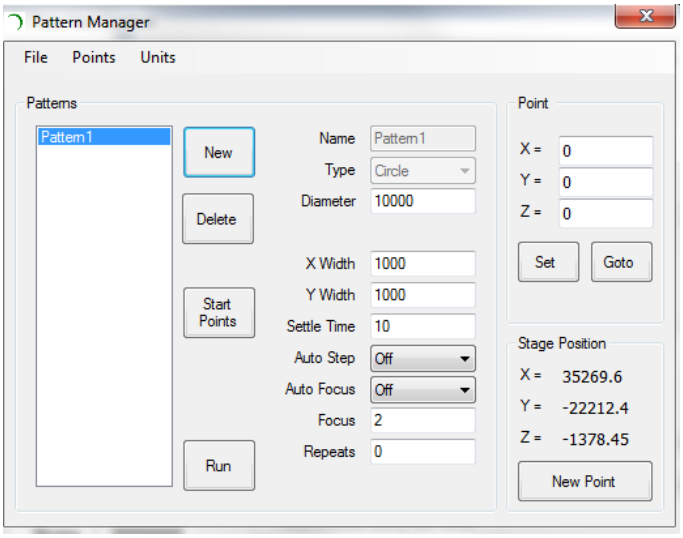




Top – Snake
Middle – Raster
Bottom - Circle
(Not shown): User, where user pattern is defined as a number of user points which are followed in order.



Setup the characteristic of the pattern:
Circle:



Select the diameter of the circle, the X width, Y width and the (FOV) fields of view, in microns The settle time is the number of ms the stage will remain at each point.

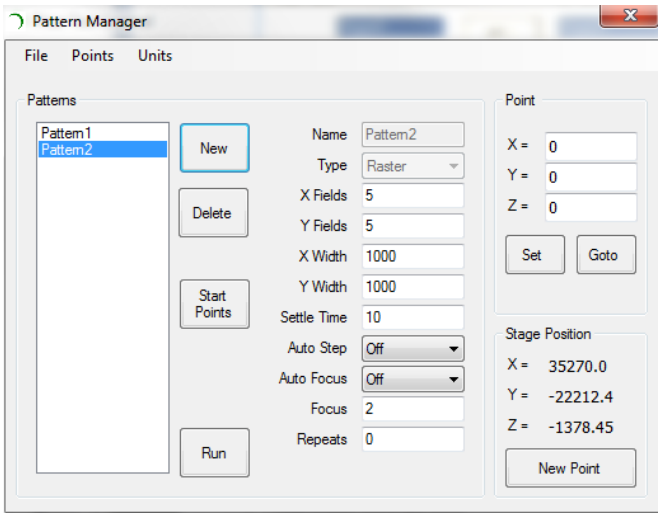
Autostep: will automatically move to the next point after the settle time is complete, select off to manually click though the points.

Autofocus: the function is not available.

Focus Range: the function is not available.

Repeats: The number of times the pattern should be repeated.

Raster:



Select the number of X Fields and Y Fields. Select the X width Y width and the (FOV) fields of view, in microns.

The settle time is the number of ms the stage will remain at each point.

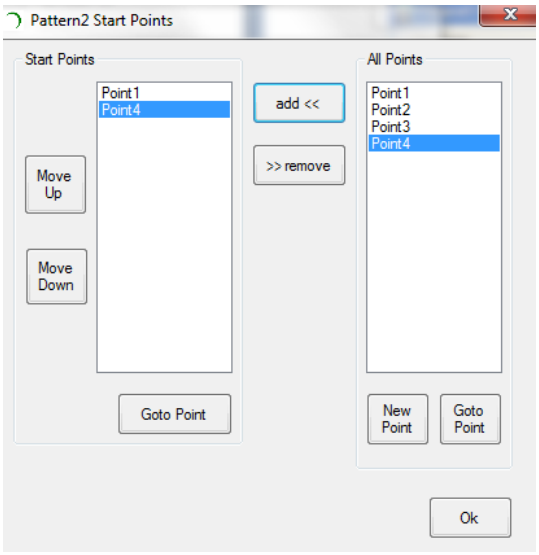
Autostep: will automatically move to the next point after the settle time is complete, select off to manually click though the points.

Autofocus: the function is not available. Focus Range: the function is not available.

Repeats: The number of times the pattern should be repeated.

Snake: The Snake has the same characteristic as the Raster above.

Adding start points to Snake Raster and Circle patterns:



Every time the pattern is run it will start at the start point, if no start point is set the pattern will run from the current position.

Move to the start point and click new point.

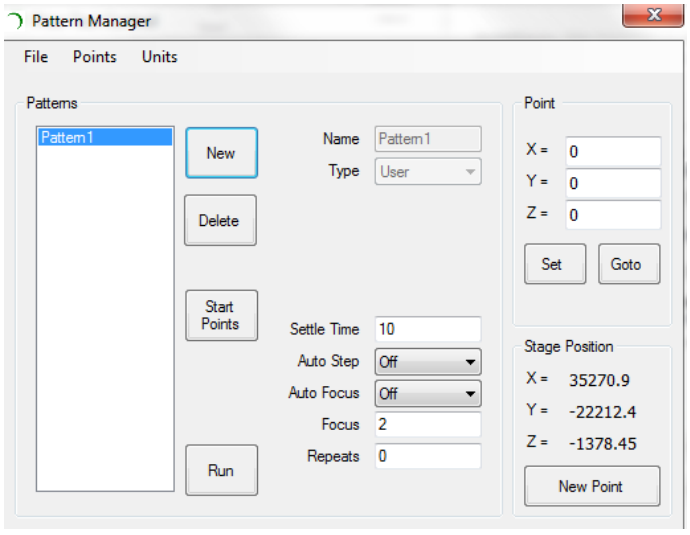
Name the point and click ok.

Click 'Start points'

Move the named point to Start points.

Click OK.

User:



The settle time is the number of ms the stage will remain at each point.

Autostep: will automatically move to the next point after the settle time is complete, select off to manually click though the points.

Autofocus: will automatically move to the next focus point after the settle time is complete.

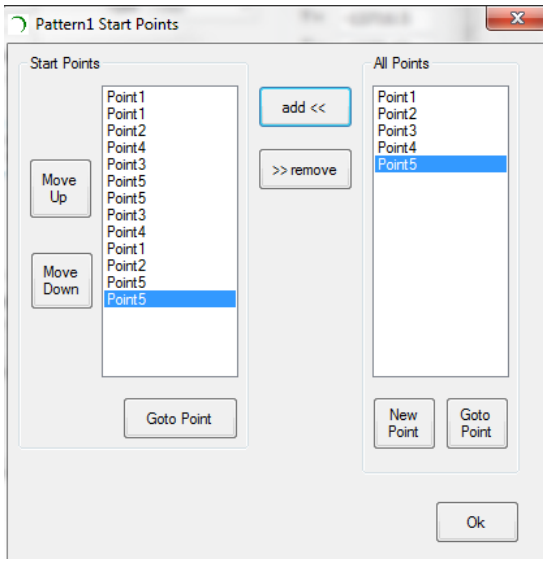
Repeats: The number of times the pattern should be repeated.

For the User pattern you must now add the points. Move to the location of a point you require for the user pattern and click New Point.

Give the point a name and click ok.

Repeat this for each user point.

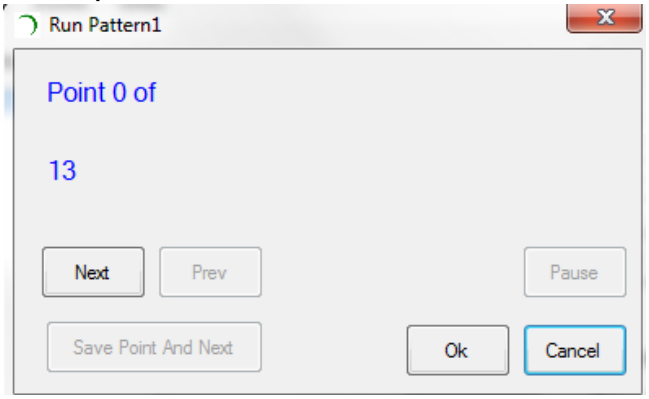
Click Start Points



Add the points and order them in the pattern required. You can add or remove points from the User pattern. Only point in the Start points will be used in the pattern.

Click OK once complete.

On all patterns now click Run.



If auto step off click 'Next' to move through the positions.
If autostep on click 'Next' to start pattern.
Click 'Save Point' and 'Next' to store the current point.

When exiting you will be prompted to save any unsaved patterns.

To enable the TTL pulse on pattern move or to have a TTL signal while the stage is moving, see the TTL section above.

SOFTWARE COMMANDS
SECTION 4

4.1 ASCII commands for RS232 or Virtual COM control

Software commands can be directly entered into Prior Terminal to control the system.

ProScan controllers can accept commands from either of the two serial ports or its USB port. The ports default to a baud rate of 9600. (see BAUD command below).

Commands and controller responses are terminated with a Carriage Return code <CR>. Use of 'I', 'K', and '#' in compatibility mode without <CR> is now deprecated, <CR> must follow these commands.

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

- COMMA
- SPACE
- TAB
- SEMICOLON
- COLON

KI;
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 legacy customers who do not wish to re-port their existing H128 application code. .
Property type commands that set or query certain status respond immediately. Movement commands respond with an R at the end of move. Once a movement command is issued the application should wait until the end of move R response is received before sending any further commands.

In Standard Mode up to 100 movement commands may be queued in the f the controller. If a movement 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 re-sent when the queue is no longer full. It is desirable to read back each individual command response (R<cr>) before sending any further commands. Sending

I<cr> aborts the current move and empties the queue. This queueing facility is useful in MACRO and SOAK modes, but normally the controlling application would sequence the moves along with such other external operations as image acquisition.

The default convention is that the controller will move each stage device by 1µm 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. The stage scale is determined by the model of stage in use. A stage with a 2mm ball screw and a 200 step motor has an SS value of 25. See Appendix B for full explanation of microsteping calculations. Changing SS value to 100 and requesting a move of 1000,0 will now result in the stage moving 4mm in the x axis.

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

MACRO and SOAK - 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)

4.1.1 Axis Identification

Axis Name	Axis Number
X	1
Y	2
Z	3
A/F3	4
F1	5
F2	6
F4	7
F5	8
F6	9

4.2 General Commands

<table>
<tr><th>Command</th><th>Arguments</th><th>Response</th><th>Description</th></tr>
<tr><td>?</td><td>None</td><td>Text string</td><td>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 3-AXIS STEPPER VERSION 0.0
DSP_2 IS 3-AXIS STEPPER VERSION 0.0
DRIVE CHIPS 111111
JOYSTICK NOT FITTED
STAGE = H101AENC
FOCUS = FB20X
FOURTH = NONE
FILTER_1 = NONE
FILTER_2 = NONE
SHUTTERS = 001
LED = 0000
TRIGGER = NONE
INTERPOLATOR = NONE
AUTOFOCUS = NONE
VIDEO = NONE
HARDWARE REV F
END</td></tr>
<tr><td>=</td><td>None</td><td>n</td><td>Reports whether any limit switch has been hit since the last call of the command.

n is a decimal value which when converted to binary is as follows:-

<table><tr><td>D07</td><td>D06</td><td>D05</td><td>D04</td><td>D03</td><td>D02</td><td>D0</td><td>D00</td></tr><tr><td>-4th</td><td>+4th</td><td>-Z</td><td>+Z</td><td>-Y</td><td>+Y</td><td>-X</td><td>+X</td></tr></table>
eg 05 means +Y and +X have been hit. Reading this status clears it.</td></tr>
</table>

<table>
<tr><th>Command</th><th>Arguments</th><th>Response</th><th>Description</th></tr>
<tr><td>$</td><td>[a]</td><td>Decimal number</td><td>Reports status as a decimal number and gives motion status of any axis of the controller. After binary conversion convention is as follows:-

<table>
<tr><td>F2</td><td>F1</td><td>A</td><td>Z</td><td>Y</td><td>X</td></tr>
<tr><td>D05</td><td>D04</td><td>D03</td><td>D02</td><td>D01</td><td>D00</td></tr>
</table>

Optional parameters “$,a” where a is the axis or resource

<table>
<tr><td>X</td><td>X Axis</td></tr>
<tr><td>Y</td><td>Y Axis</td></tr>
<tr><td>S</td><td>X and Y axis</td></tr>
<tr><td>Z</td><td>Z Axis</td></tr>
<tr><td>A</td><td>A Axis</td></tr>
<tr><td>F</td><td>Filter wheels</td></tr>
<tr><td>F1</td><td>Filter wheel 1</td></tr>
<tr><td>F2</td><td>Filter wheel 2</td></tr>
</table>

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.</td></tr>
<tr><td>BAUD</td><td>b</td><td>0</td><td>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) and 115400 (115).

  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.</td></tr>
<tr><td>COMP</td><td>None</td><td>0 = Std
1 = Comp</td><td>Report the Command protocol (Compatibility mode (1) or Standard mode (0))
COMP,1 mode is default after a software upgrade or RESET of controller.</td></tr>
</table>

<table>
<tr><th>Command</th><th>Arguments</th><th>Response</th><th>Description</th></tr>
<tr><td>COMP</td><td>m</td><td>0</td><td>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.</td></tr>
<tr><td>DATE</td><td>None</td><td>Text string</td><td>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 H31XYZEF can drive XY stage with possible encoder and 3 filter wheel and 3 shutters capability.

E.g.
Prior Scientific Instruments ProScan H31XYZEF controller
Version 0.95 compiled Feb 16 2016 13:43:31</td></tr>
<tr><td>ERROR</td><td>h</td><td>0</td><td>Sets the reporting of error to ‘Human’ if h is 1 (readable text) else error codes are returned (see Error Description Table)</td></tr>
<tr><td>I</td><td>None</td><td>R</td><td>Stops movement in a controlled manner to reduce the risk of losing position. The command queue is also emptied.</td></tr>
<tr><td>K</td><td>None</td><td>R</td><td>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. The command queue is also emptied..

This command is normally treated as an emergency stop.</td></tr>
<tr><td>MACRO</td><td>None</td><td>0</td><td>Used to enter and leave the Macro Mode. ONLY AVAILABLE IN STANDARD MODE.</td></tr>
<tr><td>SERIAL</td><td>None</td><td>n</td><td>Reports the units’ serial number n, if the serial number has not been set “0” is returned.</td></tr>
<tr><td>LMT</td><td>None</td><td>Nm</td><td>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:-
<table>
<tr><td>D07</td><td>D06</td><td>D05</td><td>D04</td><td>D03</td><td>D02</td><td>D01</td><td>D00</td></tr>
<tr><td>-4th</td><td>+4th</td><td>-Z</td><td>+Z</td><td>-Y</td><td>+Y</td><td>-X</td><td>+X</td></tr>
</table>
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).</td></tr>
<tr><td>SOAK</td><td>None</td><td>0</td><td>Used to soak test the controller and peripherals. ONLY AVAILABLE IN STANDARD MODE.</td></tr>
<tr><td>VERSION</td><td>None</td><td>ddd</td><td>Reports the units software version number as a 3 figure number eg 100 is Version 1.00</td></tr>
<tr><td>WAIT</td><td>t</td><td>0</td><td>Inserts a wait of t milliseconds in a macro/soak routine.</td></tr>
</table>

4.3 Stage Commands

Command	Arguments	Response	Description
X	None	u,v	Reports the current step size (u and v) in x and y for the stage in user units. From here on steps refers to user units
X	u,v	0	Sets the current step size in x and y for the stage when used in conjunction with B.L,R,F type commands
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. H — Joystick disabled H,0 — Joystick enabled H,1 — Joystick disabled H,2 — XY disabled H,3 — Z disabled
J	None	0	Turns ON the joystick (Stage and Z axes). This command is acted upon immediately.
JXD	d	0	Sets the direction of X axis under joystick control. d = 1 Joystick right, moves stage mechanically right d = -1 Joystick right, moves stage mechanically left.
JXD	None	d	Reads d.
JYD	d	0	Sets the direction of Y axis under joystick control d = 1 Joystick forward, moves stage mechanically forward. d = -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.

Command	Arguments	Response	Description
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> 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
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.
SS	s	0	Sets the user unit step size in microsteps for the stage. By default this value is the number of microsteps/micron as detailed in the STAGE command. This value is linked with RES,S and XD/YD values
SS	None	s	Returns the current number of microsteps per user unit. NOTE: in COMPATABILITY mode this value is based on the older 100 microsteps/fullstep of H127/128 systems!
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 Not all resolutions are achievable accurately. Only those that are direct multiples of the base microstep resolution. See Appendix B and SS commands.
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.
SAS	a	0	Sets the maximum stage acceleration to a. Range is 1 to 1000. Default setting is 100 and used by Prior during long life testing. Higher values are allowed but their efficacy is constrained by varying factors such as stage type, users stage payload motor type etc.
SAS	None	a	Report current stage acceleration
SAS,i	None	n	n=number of intrinsic units/s/s the stage current stage acceleration is set to. Intrinsic units would be microsteps for stepper stages and encoder counts for linear stages.
SAS,n,i	n	0	Sets the current stage acceleration to n intrinsic units/s/s
SAS,u	None	n	n=number microns per second the stage current stage acceleration is set to.
SAS,n,u	n	0	Sets the current stage acceleration to n microns per second.
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 1000. Prior chooses to express curve in time units rather than units/s/s/s. So at default 100 setting curve time = 13ms. At 200 curve time = 6.5ms

Command	Arguments	Response	Description
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 1000. Default setting is 100 and used by Prior during long life testing. Higher values are allowed but their efficacy is constrained by varying factors such as stage type, users stage payload motor type etc.
SMS	None	m	Report the current Stage (x, y) maximum speed setting m
SMS,i	None	n	n=number of intrinsic units per second the stage current stage speed is set to. Intrinsic units would be microsteps for stepper stages and encoder counts for linear stages.
SMS,n,i	n	0	Sets the current stage speed to n. n is the number of intrinsic units per second.
SMS,u	None	n	n=number microns per second the stage current stage speed is set to.
SMS,n,u	n	0	Sets the current stage speed to n. microns per second.
STAGE	None	Text string	Prints information about the currently connected stage. 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 The sizes are approximate based on the original stage designate and are variable as limit switches can be mechanically adjusted by users. Prior recommendation is to measure the stage from software by moving between back and left and front right limits and calculating the travel from the returned XY positions.
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.
XD	d	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. d=1 or –1.
YD	d	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. d=1 or –1.
Z	None	0	Sets the stage and focus position to ZERO (0,0,0).
MOTOR	a,b	0	Turn the given axis a to motor state b. E.g. MOTOR, X, 1 turns X motor on. MOTOR, 2, 1=0 turns Y motor off. Axes are identified by their number or character: NOTE: for stepper stages, turning motors off then on may result in a small position error

Command	Arguments	Response	Description
SWLL	a	0	From the users POV sets the axis a current position to the numerically lowest value, acting as a software settable limit switch. E.g. SWLL, Z sets current Z position as lowest numerical point for Z Axes are identified as: 1 or 'X' = X axis 2 or 'Y' = Y axis 3 or 'Z' = Z axis 4 or 'A' = fourth axis (linear type only) NOTES: setting of software limits must be done following a power on and are set with respect to current XD/YD/ZD settings
SWLH	a	0	From the users POV sets the axis a current position to the numerically highest value, acting as a software settable limit switch. E.g. SWLH, Z sets highest numerical point for Z Axes are identified as describe above:
SWLC	a	0	Clears all soft limits on axis a

4.4 Z-Axis Commands

Command	Arguments	Response	Description
GZ	z	R	Move to absolute position z
BLZH	s,b	0	Sets the z-axis backlash value for z-axis move commands sent via the serial port (not joystick moves) to b. s = 1 enables backlash s = 0 disables backlash. b is the number of microsteps per motor. There are 50,000 microsteps per revolution of the motor on a standard ProScan focus system.
BLZH	s	0	Enables / Disables the z-axis backlash. s = 1 enables backlash s = 0 disables backlash.
BLZH	None	s,b	Reports back s and b values for z-axis moves sent via the serial port (see above). In compatibility mode only s returned
BLZJ	s,b	0	Sets the z-axis backlash value for joystick/digipot moves to b in microsteps. s = 1 enables backlash s = 0 disables backlash.
BLZJ	s	0	Enables / Disables the z-axis backlash for joystick/digipot control. s = 1 enables backlash s = 0 disables backlash.
BLZJ	None	s,b	Reports s and b values for z-axis (see above). In compatibility mode only s returned
C	None	w	Reports the current step size for the z-axis focus motor.
C	w	0	Sets the current step size for the z-axis focus motor to w.
D	z	R	Moves down by z steps.
D	None	R	Moves down w steps defined by the 'C' command.
U	z	R	Moves Up by z steps.
U	None	R	Moves Up by w steps defined by the 'C' command.
V	z	R	Go to the absolute position z in the z-axis.
FOCUS	None	Text string	Prints information about z-axis focus unit. The information end is always a line saying END. This allows for the addition of extra fields of information without affecting application software. Users should always read lines in until the END is seen to keep in sync. Example FOCUS = NORMAL TYPE = 0 MICRONS/REV = 100 END
Z	None	0	Sets the stage and focus position to ZERO (0,0,0).
GZ	z	R	Move to absolute position z
BLZH	s,b	0	Sets the z-axis backlash value for z-axis move commands sent via the serial port (not joystick moves) to b. s = 1 enables backlash s = 0 disables backlash. b is the number of microsteps per motor. There are 50,000 microsteps per revolution of the motor on a standard ProScan focus system.
JZD	d	0	Sets the direction of Z axis under digipot control. d = 1 or -1.
JZD	None	d	Reads d.
M	None	R	Moves stage and focus to zero (0,0,0)
OF	S	0	Sets the speed of the focus motor under joystick/digipot control. s is percentage in range 1 to 100.
OF	None	S	Reports value of OF allowing for joystick speed buttons effect (if the button speed is ½ and OF is set to 50 the returned value will be 25)
PZ	None	Z	Reports position of z only.
PZ	z	0	Sets absolute position of z axis. No axis can be moving for this command to work. If an encoder is present on the Z axis, the position is only set when the current position is in the encoder range (it must have been further down than it is currently).

Command	Arguments	Response	Description
VZ	s,u	R	Sets the focus speed to s in units specified by u. u = u Units are microns per second. u is the default unit and can be omitted. To stop a virtual focus move use VZ,0 Note that UPR must be set to achieve correct linear focus speed.
Z	None	0	Sets the stage and focus absolute position to zero (0,0,0).
ZD	d	0	d=1 Sets direction of rotation of focus motor for commands sent via serial port. Defaults to 1 and is correct for motor fitted on right hand side of the microscope. d=-1 Direction of rotation of focus motor opposite to above.
ZD	None	d	Returns d
0	s	0	Sets the user unit step size in microsteps for the Z. By default this value is the number of microsteps/0.1microns. This value is linked with RES,Z and ZD values
SSZ	None	s	Returns the current number of microsteps per user unit. NOTE: in COMPATABILITY mode this value is based on the older 100 microsteps/fullstep of H127/128 systems!
RES	Z,r		Sets the desired resolution for the axis Z, r can be a non-integer number setting the resolution for the axis in units of microns. UPR command must be implemented before using this command for Z axis. e.g UPR,z,400 RES,z,0.1 Resolution set to 0.1 micron for a focus mechanism of 400 microns per revolution of the motor.
RES	Z		Returns resolution for axis Z.
SAZ	a	0	Sets the current Z acceleration to a. Range is 1 to 100
SAZ	None	a	Report the current Z acceleration setting.
SCZ	c	0	Sets the s-curve value for Z in units of % in the range 1 to 100.
SCZ	None	c	Returns the s-curve value.
SMZ	None	m	Report the current Z maximum speed setting m
SMZ	m	0	Sets the current Z maximum speed to m. Range is 1 to 100
UPR	Z,n	0	Sets the number of microns (n) linear movement per revolution of the motor for the axis a. E.g. UPR,Z,100 is set for a motor fitted to the fine focus knob with 100 microns focus movement per revolution. Default UPR setting is dependent on the device fitted, ie 100 for normal focus motor, 1000 for FB20x focus blocks. The UPR command always sets RES,Z back to 0.1 microns.
UPR	Z	n	Returns microns per revolution for the axis Z

4.5 Filter Wheel Commands

Command	Arguments	Response	Description
7	w, f	R or a number. If no wheel is fitted E,17 will be returned.	w defines the filter wheel number 1,2 or3. f is defined below. If f is a number, command moves filter wheel w to filter position f. If f is 'N', command moves filter wheel w to next filter. If f is 'P', command moves filter wheel w to previous filter. If f is 'F', command reports current filter position on filter wheel w. If f is 'H', command performs a home routine. If f is 'A' wheel will auto home on controller startup If f is 'D' wheel will NOT auto home on startup (default)
7	0,f1,f2,f3	R	The first parameter (zero) indicates all filters; the three subsequent parameters f1 f2 and f3 are the target positions for filter1, 2 and 3 respectively. Filters not fitted or invalid filter wheel positions are ignored. This feature is only available in COMP 0 mode.
7	C	0	Enables automatic shutter closure during any filter move and then re-assert initial shutter state at end of move
7	D	0	Disables automatic shutter closure
7	W,T,P	Text	Displays tag text for filter wheel w at position p. 7,1,T,3 will respond with text for filter wheel 1 position 3.
7	W,T,P, text	R	Writes text to memory for filter wheel W and Position P. 7,1,T,3,Dapi will set the tag for filter wheel 1 position 3 to "Dapi" Tags are 6 characters log and are displayed in control centre display.

4.6 Shutter Commands

Command	Arguments	Response	Description
8	s,c[,t]	R If shutter s is not fitted E,20 will be returned	Opens or closes the shutter s (value '1' '2' or '3'), if c is 0 the shutter is opened, 1 it is closed. The optional argument t is used to open/close the shutter for a time t milliseconds.
8	0,s1,s2,s3	0	First parameter is a zero. Subsequent parameters define the startup state of shutters s1,s2 and s3 respectively. if s1 is 0 then shutter1 is opened, 1 it is closed etc. Default state is all shutters closed.
8	s	c If shutter s is not fitted E,20 will be returned	Returns status c of shutter s
Shutter	s	Text string	Prints information about shutter's' (s is a value between 1 and 3). The information end 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 until the END is seen in order to maintain compatibility. Example SHUTTER_1 = NORMAL DEFAULT_STATE=CLOSED END

4.7 Lumen Pro Commands

Command	Arguments	Response	Description
LIGHT		a	Reports the output of light from the shutter in %. The command automatically locates LGG_SHUTTER. Error 20 reported if no shutter detected.
LIGHT	n	0	Sets the output from the shutter to n, where n can be set between 1-100%. The command automatically locates LGG_SHUTTER. If n is "h" the shutter will perform a home routine.
LIGHT	P,n	0	Sets the filter wheel position P to n % light output. i.e., LIGHT,4,45 Sets position 4 to 45% light output. Use 7,n,4 to move filter to position 4, where n is the Filter Wheel port which the shutter is attached. STANDARD 10 Position Shutter settings are: Position % Light output 0,11, 22, 33, 44, 55, 66, 77, 88, 100
LIGHT	P, ?	n	Reports n, the %output of position p.
LIGHT	POWER , n	R	Switches on or off the Lumen 200PRO unit, if n is 1 the unit is on, 0 it is off, e.g. "LIGHT, POWER, 0" would switch the unit off. Sending "LIGHT, POWER" without 0 or 1 will report the current status. The Lumen 200PRO unit must be connected to the plug and play shutter output of a ProScan III. The Lumen will default to state 1, Lumen on, if no cable connected.

4.8 Pattern Commands

These commands control the internal patterns available in the ProScan controller Firmware.

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 nth cell in X and mth 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 nth cell in X and mth 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.)
CC	d, r, s		Where d=diameter (in user units), 100 to 100000 r=number of revolutions, 1 to 1000 s=number of sides to polygon, 1 to 360 The stage then moves backwards to the top of the polygon and proceeds to move around the side of the polygon sides until all sides are done.

Command	Arguments	Response	Description
AS	E,S,P,T,R	0	Sets up an AutoScan function for stage. Where: **E** = camera exposure time (ms) **S** = stage settle time (ms). If the stage vibrates due to high accelerations you may need to have a settling time before triggering the camera) **P** = TTL out pin (1 of 4) **T** = TTL trigger state (high or low) **R** = raster type : 'R' = raster, 'S' = snake E.g. AS,10,0,1,H,R Exposure time: 10ms Settle time: 0ms TTL output pin: 1 TTL trigger state: High to trigger camera Pattern type: A standard Raster. Example usage: 1. Set raster size e.g. "N,99,99" to give a 100x100 raster 2. Set step size e.g. "X,1,1" to give 1u steps size in both X and Y travel 3. Set raster parameters with AS command: 4. Move to desired start position (this will be the first image collected) 5. Send "AS,1" to start the raster. It will run raster without further commands from the PC. 6. To query when the raster has finished, send "AS" command. A response of "1" indicates raster still running, a response of "0" indicates raster has finished.
AS	None	n	Where n =0 indicating idle, n=1 indicating raster active

4.9 *Stage mapping commands*

Command	Arguments	Response	Description
CORRECT	None	N	N=0 no correction enabled N=1 4pt correction enabled N='M' full stage mapping enabled
CORRECT	?	S,a,b,c,d	Returns 4pt correction state S plus the four correction values Eg 1 0.999851 0.000034 0.0 1.000184
CORRECT	E	0	All ProScan III stages come fitted with 4pt correction enabled a standard
CORRECT	D	0	Disable all forms of IST : both 4pt and full stage mapping
CORRECT	M	N	If the stage has full mapping this command will enable it. User must use SIS command to send the stage to the limits and establish the absolute coordinate system. When a new stage is first attached to the controller or a RESET command or software update has occurred, it should be noted that loading the full mapping from the stage to controller takes about 20 seconds, the controller will be unresponsive until this data is loaded. N=0 Ok N=E,44 SIS not done N=E,51 stage not mapped NOTE: if a stage leaves production with encoders fitted then the correction only applies to that stage when the encoders are enabled. Turning encoders off, or adding encoders retrospectively to a non-encoded stage will invalidate the stated correction capabilities of the stage

4.10 *Error Codes and Error Tracking Commands*

To track physical errors in the ProScan III use the following command.

Command	Arguments	Response	Description
ERRORSTAT	None	Text String	Reports any errors with the system. 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. Responses: "NONE" : No Error "AXIS 1 COMMS FAILED" : Communications failure with axis n. "AXIS 1 DRIVE FAILED" : Drive chip on axis n has failed. n is the axis number

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	ARG 1 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

4.11 CS152 (Joystick Configuration backwards compatibility)

These commands are only applicable to CS152 Joysticks and **not for the PS3J100 Interactive Control Centre.**
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.

0	Default Button Function
1	Z motor velocity stop (only used with f=2/3 below)
2	Z motor constant velocity up
3	Z motor constant velocity down
4	Toggles digipot speed (100%/50%/25%)
5	Toggles XY joystick speed (100%/50%/25%)
6	Toggles joystick speed (100%/10%)
7	Toggles joystick speed (100%/2%)
8	Moves Z motor up by amount defined by C command
9	Moves Z motor down by amount defined by C command
10	Moves stage left defined by X command
11	Moves stage right defined by X command
12	Moves stage back defined by X command
13	Moves stage front by amount defined by X command
14	Toggles digipot speed (100%/10%)
15	Toggles digipot speed (100%/2%)
16	Starts auto focus
23	Next point
24	Next wafer
25	Smooth stop (I)
26	Sudden stop (k)
28	Toggle shutter 1
29	Toggle shutter 2
30	Toggle shutter 3
35	Assigns any following txt to the button. Hence any command may be assignable to a button).

4.12 Examples for the CS152 Joystick Buttons

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

4.13 Add-on Trigger Board Commands

These commands are only available if the trigger board is fitted.

Command	Arguments	Response	Description
TRIGGERRES	[X|Y|Z]	n	Reports n, the number of encoder counts/ micron for the axis. Axis may be X,Y or Z
TRIGGER	F,D,A,N,P,W	0 E,n	F = First trigger position in encoder counts D= Distance between triggers in encoder counts A = Axis to trigger from X, Y or Z N = Number of triggers in chord P = trigger pulse polarity 'P' or 'N' W = trigger pulse in **microseconds** **(ENSURE IT IS IN MICROSECONDS – 1 millionth of a second- not milliseconds).** Example: A single chord in X with first trigger at 0, followed by 19 triggers every +100 counts, -ve trigger pulse of 1 ms (**millisecond**). Step 1: Position the stage before the first intended trigger point. Step 2: Send 'TRIGGER 0,100,X,20,N,1000'to arm trigger mechanism. Step 3: Move stage over intended triggers (any command or even joystick movement). The triggers will output when X = 0, 100, 200....1800, 1900 encoder counts. The trigger mechanism is automatically disarmed after all specified triggers have been output. Negating the sign of D can be used to trigger in reverse direction. The user application should convert local stage position to encoder counts when using the TRIGGER function. By default the PS3 XY position is reported in microns, the Z position is 100nm steps. In COMP,0 mode an E,n response indicates error. See Error Codes.
TRIGGER	none	F,D,A,N,P,W	Report current trigger settings

4.14 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 50 nanometres (for the linear stages). This superior performance is extremely critical in many industrial and bio-science applications such as the performance of time-lapse photography studies.

An encoded 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. Axis can be one of S, X, Y, Z, A
ENCW			Returns the allowable encoder as a set of four numbers for axis XYZA Ie. 0 0 0 0
ENCW	Axis	N	Returns the encoder window for the axis given Eg ENCW,X
ENCW	Axis,n	0	Sets the encoder wind n for the given axis Eg ENCW,x,5
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.
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.

4.15 TTL input/output signals

The ProScan III 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).

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

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

4.16 TTL 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.	
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 compatibility with H129

4.17 TTL Programming Advanced Features

More complex features are available that provide the user with the ability to construct lists of actions to be executed when TTL input lines change state. There is one list per TTL input. Each list contains one or more trigger points and each trigger point has associated with it one or more actions. A trigger can be activated by a rising or falling edge of the TTL input.

Command	Arguments	Response	Description
TTLTP	n,m where n = TTL input 1,2,3 or 4 where m = 0 falling edge or low m = 1 rising edge or high	0	Adds a trigger point to the TTL input n, activated by a change in the level m
TTLACT	n,action,data1,data2,data3	0	Add an action to the current trigger point for the TTL input n. See table following for full list of actions.
TTLDEL	n where n = TTL input 1,2,3 or 4	0	Deletes all the trigger points and actions associated with TTL input n
TTLRES	n where n = TTL input 1,2,3 or 4	0	Resets the Trigger list for input n back to the start.
TTLTRG	M where m = 0 Disarmed, 1 Armed	0	Arms the global trigger flag
TTLMOT	n,m where n = TTL output 1,2,3 or 4 where m = 0 low, 1 high	0	Changes output n to level m while stage is moving. When n=0 function disabled (default)

Table of Actions:

Description	Action	Data1	Data2	Data3
Filter 1 Move	1	Filter pos	0	0
Filter 1 next	2	0	0	0
Filter 1 previous	3	0	0	0
Filter 1 Home	4	0	0	0
Filter 2 Move	5	Filter pos	0	0
Filter 2 next	6	0	0	0
Filter 2 previous	7	0	0	0
Filter 2 Home	8	0	0	0
Move Filter 3	9	Filter pos	0	0
Filter 3 next	10	0	0	0
Filter 3 previous	11	0	0	0
Filter 3 Home	12	0	0	0
Lumen Light Level	20	0-100	0	0
Move Z Relative	30	Z pos	0	0
Move Z Absolute	31	Z pos	0	0
Move XY Relative	40	X pos	Y pos	0
Move XY Absolute	41	X pos	Y pos	0
Move XYZ Relative	50	X pos	Y pos	Z pos
Move XYZ Absolute	51	X pos	Y pos	Z pos
Open Shutter 1	60	0	0	0
Close Shutter 1	61	0	0	0
Open Shutter 2	62	0	0	0
Close Shutter 2	63	0	0	0
Open Shutter 3	64	0	0	0
Close Shutter 3	65	0	0	0
Stop All Movement	70	0	0	0

Example 1:

Create a Trigger that will be activated when TTL1 goes low and moves the stage and then open shutter1 on the next rising edge of that input.

TTLTP,1,0	Adds trigger point on TTL 1 on falling edge.
TTLACT,1,40,5000,4000,0	Adds stage movement to current trigger point on TTL 1.
TTLTP,1,1	Adds a new trigger point TTL 1 on rising edge.
TTLACT,1,60,0,0,0	Add open shutter to current trigger point on TTL 1.
TTLTRG,1	Sets system ready.

First falling edge detected will execute the stage command, the next rising edge of TTL1 causes the shutter to open.

Example 2:

The opening of the shutter can be automated by wiring the output of the TTLMOT to another TTL input.

TTLTP,1,0	Adds trigger point on TTL 1 on falling edge.
TTLACT,1,40,5000,4000,0	Adds stage movement to current trigger point on
TTL 1. TTLTP,2,1	Adds new trigger point on TTL 2 rising edge
TTLACT,2,60,0,0,0	Add open shutter to current trigger point on TTL 2.
TTLMOT,2,1	Set the TTL output on TTL 2 to high when stage moving
TTLTRG,1	Set system ready.

GLOSSARY OF TERMS
SECTION 5

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.
Controller Demo – GUI used to control the ProScan III controller and peripherals.
Demo Software – Term for the whole software package that is downloaded from the Prior website. Includes 'Prior Terminal' and 'Controller Demo'.
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 ProScan III 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 – An old program allowing control of Prior devices via computer. Now replaced with 'Prior Terminal'.
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.
Prior Terminal – Part of the 'Demo Software'. Allows commands to be entered and acted upon. A replacement for Hyperterminal.
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).

RETURNS AND REPAIRS
SECTION 6

Should you experience problems with your ProScan System and want to send it back for service, warranty or otherwise, a Return Material Authorisation (RMA) number must be obtained from the appropriate Prior Scientific office before returning any equipment. For North and South America contact Prior Scientific Inc. and for the rest of the world contact Prior Scientific Instruments Limited.

Prior Scientific Instruments Ltd,
Unit 4,
Wilbraham Road,
Fulbourn,
Cambridge,
ENGLAND,
CB1 5ET
Tel: 01223 881711
Fax: 01223 881710
email: uksales@prior.com

Prior Scientific Inc.
80 Reservoir Park Drive,
Rockland,
MA 02370-1062
USA
Tel: 781 878 8442
Fax: 781 878 8736
email: info@prior.com

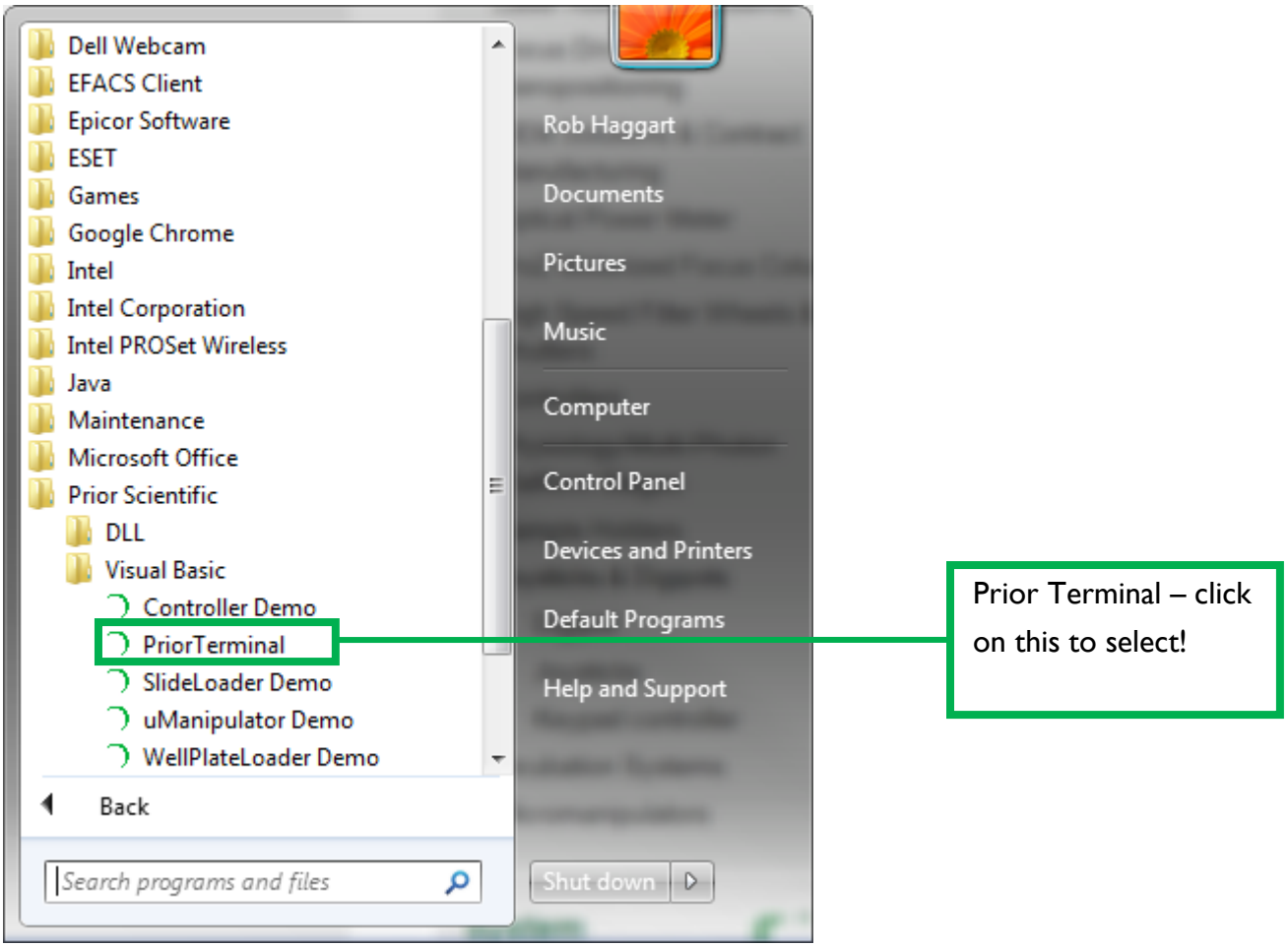
Prior Scientific GmbH
Wildenbruchstr. 15
D-07745
Jena
GERMANY
Tel: +49 (0)3641 675 650
Fax: +44 (0)3641 675 651
email: jena@prior.com

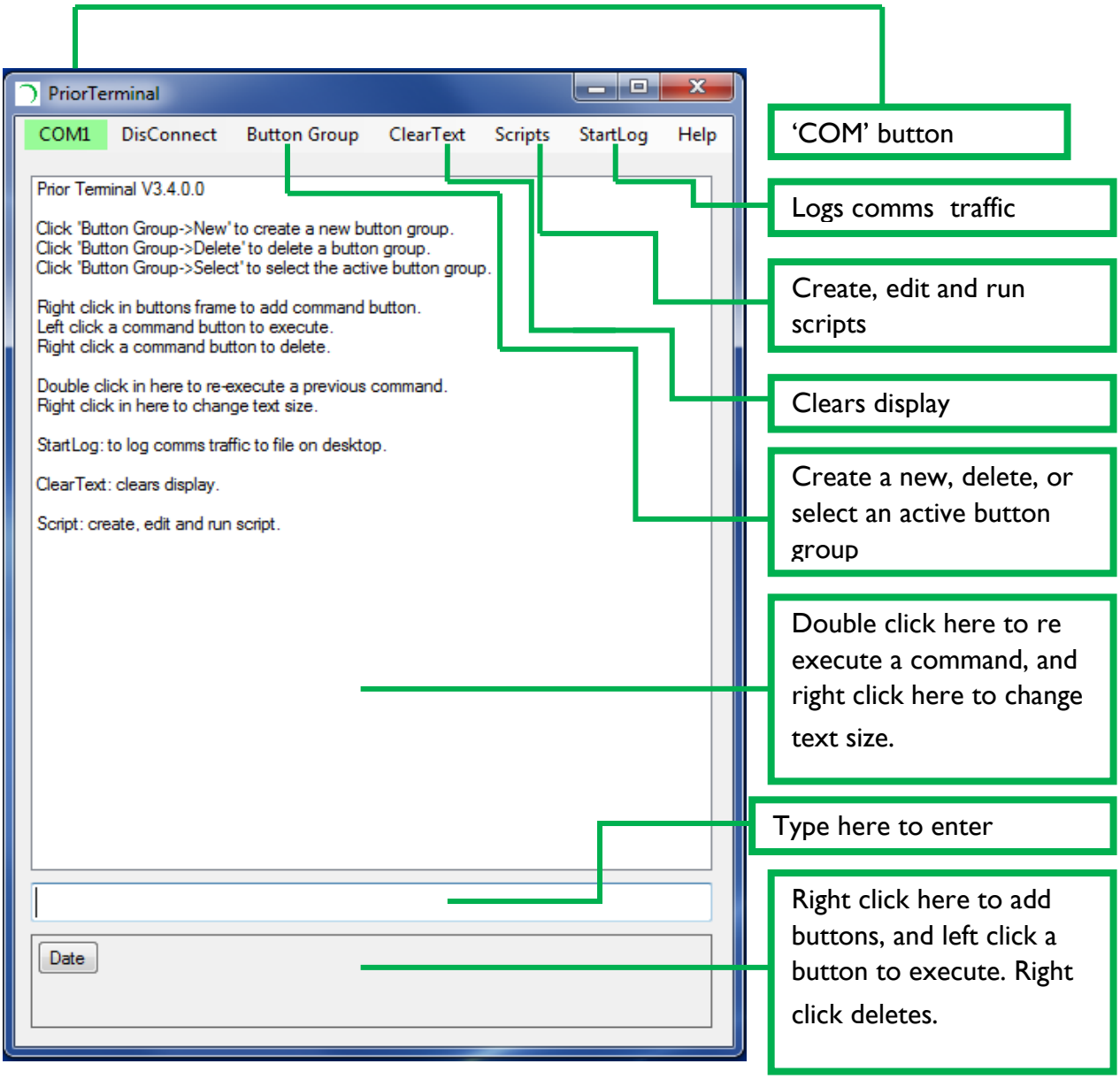
Prior Scientific KK
Kayabacho 3rd Nagaoka Bldg. 10F
2-7-10
Nihonbashi Kayabacho,
Chuo-Ku
Tokyo
103-0025
JAPAN
Tel: +81 (0) 3 5652 8831
Fax: +81 (0) 3 5652 8832
email: info-japan@prior.com

APPENDICES

Appendix A: Using Prior Terminal

Click on the Windows Start menu and go to 'All Programs'. Go to 'Prior Scientific' and select 'Visual Basic'. From this, go to 'Prior Terminal' and open that program. Other programs are also available. The 'Controller Demo' will be covered later in this guide. Since the other programs are specific to a particular product, instructions for these are covered in the respective manuals.





It is important to select the correct COM Port to allow the system to function. This is done by clicking 'Com', which also allows the baud rate to be changed. The default setting of the controllers is 9600; however some software can change this. Once Prior Terminal is open, to list what hardware is connected type '?'. From the product manual you should see the correct response this should generate. For example, from the ProScan III one might get the response:

PROSCAN INFORMATION
DSP_1 IS 3-AXIS STEPPER VERSION 0.0
DSP_2 IS 3-AXIS STEPPER VERSION 0.0
DRIVE CHIPS 111111
JOYSTICK NOT FITTED
STAGE = H101AENC
FOCUS = FB20X
FOURTH = NONE

```
FILTER_1 = NONE
FILTER_2 = NONE
SHUTTERS = 001
LED = 0000
TRIGGER = NONE
INTERPOLATOR = NONE
AUTOFOCUS = NONE
VIDEO = NONE
HARDWARE REV F
END
```

All commands must be terminated with a carriage return e.g the ENTER key .
If this generates the correct response everything is connected properly. If not, try the following.
Ensure that the product is on, and that the connections between the computer and product are secure.
Try changing the baud rate.
You might be able to swiftly resolve the problem by clicking 'Com' and altering the port. If there are a large number of ports, go to Start Menu > Control Panel > System. Open Windows Device Manager to identify the correct port.

For older ProScan devices, the correct port should be labelled 'Prior Communications Port'. For more recent PS3 or ES11 devices equipped with FTDI, or connections via a RS232 to USB convertor, the port will be labelled as 'USB Serial Port'. Ensure that this is the port selected.

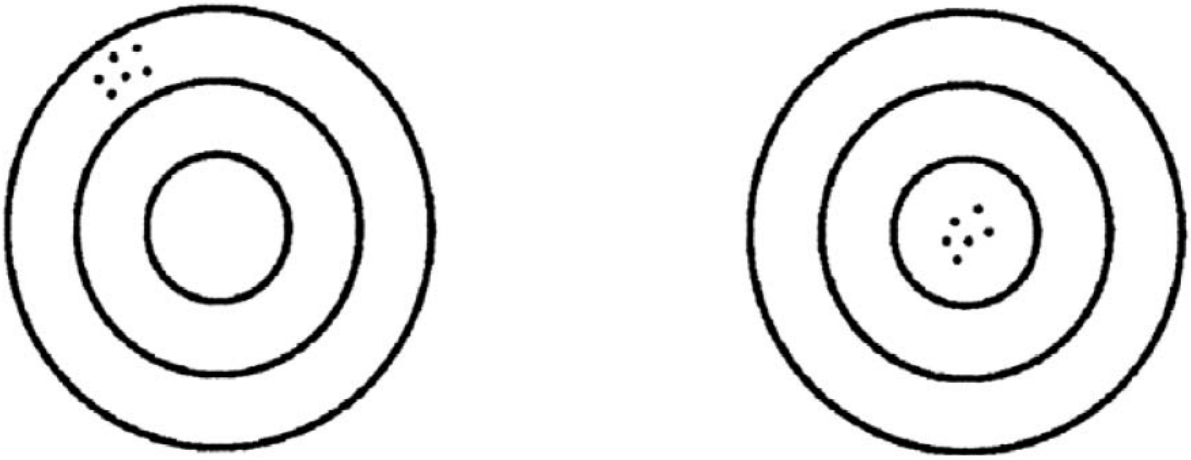
For older ProScan devices, a cause of a failure to connect could be the drivers not being installed. When first connecting, Windows Device Manager may prompt for the driver. Go to Control Panel > Systems > > Device Manager. Scan for hardware changes, select 'Prior Virtual COM port'. Right click 'Update driver' and select the correct driver. The driver will be located in the 'Prior Scientific' program files as it is automatically included in the Prior Terminal download (C:\Program Files\Prior Scientific\Prior Software (assuming the program is in the C Drive)). Generally, the driver to be selected is the driver for that product, e.g. a ProScan III driver.

(Note that newer versions of the ProScan III should not have this problem as the drivers are bundled with Windows. In the unlikely event that the drivers do not install automatically go to *http://www.ftdichip.com/Drivers/VCP.htm* ***to download.)***

Ensure that this is the port selected by Prior Terminal by clicking the 'Com' button. If this fails to resolve the problem then it is probably the case that the driver is not installed properly. Repeat the above process. If this fails, then please contact Prior Scientific.
Note that Legacy ES9/ES10/PS2 controllers use a Cypress USB chip set that is no longer supported by Windows. It is recommended in this case to use an off the shelf USB-to-RS232 adapter cable.

Appendix B – Principles of operation

Repeatability and Accuracy are important considerations when evaluating stage performance. Metric 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 to a given position. 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 metric 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.

The Prior ProScan stages and focus drives use high precision step motors. Generally, the step motors used in Prior stages products are either 1.8 degree (200 steps per revolution) motors or 0.9 degree (400 steps per revolution). The ProScan controllers provide a bipolar chopper drive to the motors which allow for maximum torque, stabilization, smoothness, and performance. As a simple example the motors receive pulses from the controller which in turn causes them to rotate. Theoretically 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 (1/400 for the 0.9 degree motors). The example below uses the 0.9 degree motor; it is applicable to both motors. 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 (0.9 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 (1.8 degree 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 (0.9 degree motor) with a 1mm pitch screw (1mm per rev or 1000 µm per rev), the stage has a resolution as shown below: (400 step/rev) x (250 micro-steps/step) = 100,000 micro-steps/rev Hence, (1000 µm/rev) / (100,000 micro-steps/rev) = 0.01 µm/micro-step

For a typical stage (1.8 degree motor) 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 (1.8 degree motor) 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

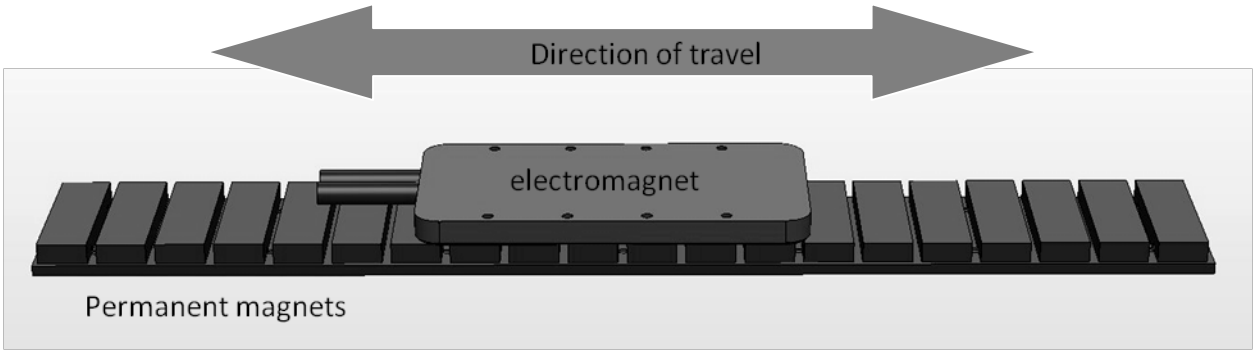
In all cases the minimum user step size will be when SS=1 or SSZ=1 and will be equivalent to 1 microstep. As an example we use the 1.8 motor with 2mm pitch:

With SS=1, minimum step size is 0.04u, so RES,S = 0.04
With SS=25 minimum steps size is 1, so RES,S = 1

However setting RES,S,0.1 is not accurately achievable on this stage as 0.1 cannot be divided wholly by 0.04.

Linear Motor Stages

Linear motor stages do not have ball screws and stepper motors to provide the stage movement. Instead they use an induction motor that produces motion in a straight line.

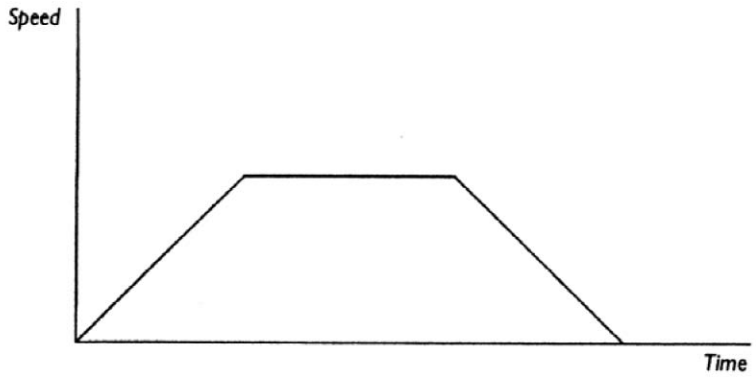


Applying a current to the electromagnet produces a magnetic field which interacts with the magnetic field of the permanent magnets and propels the stage along guided precision rails.

Linear motor stages offer high levels of acceleration and velocity together with excellent repeatability, accuracy and resolution.

S curve vs. Trapezoidal Accelerations

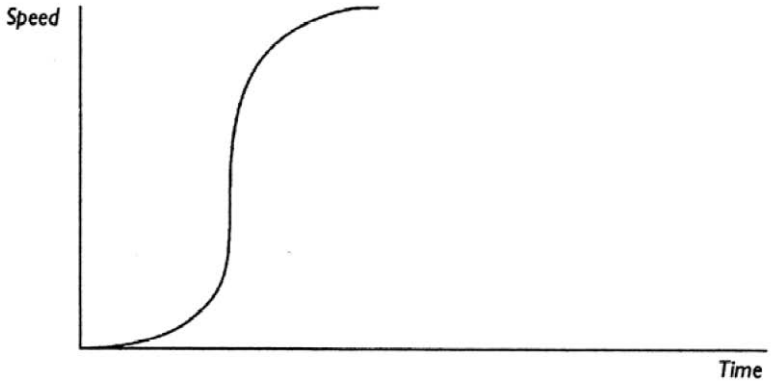
Step motors for years have been accelerated with a standard trapezoidal acceleration. An example of a trapezoidal acceleration is shown below: This method of motor acceleration has a great impact on the performance of the system.



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.

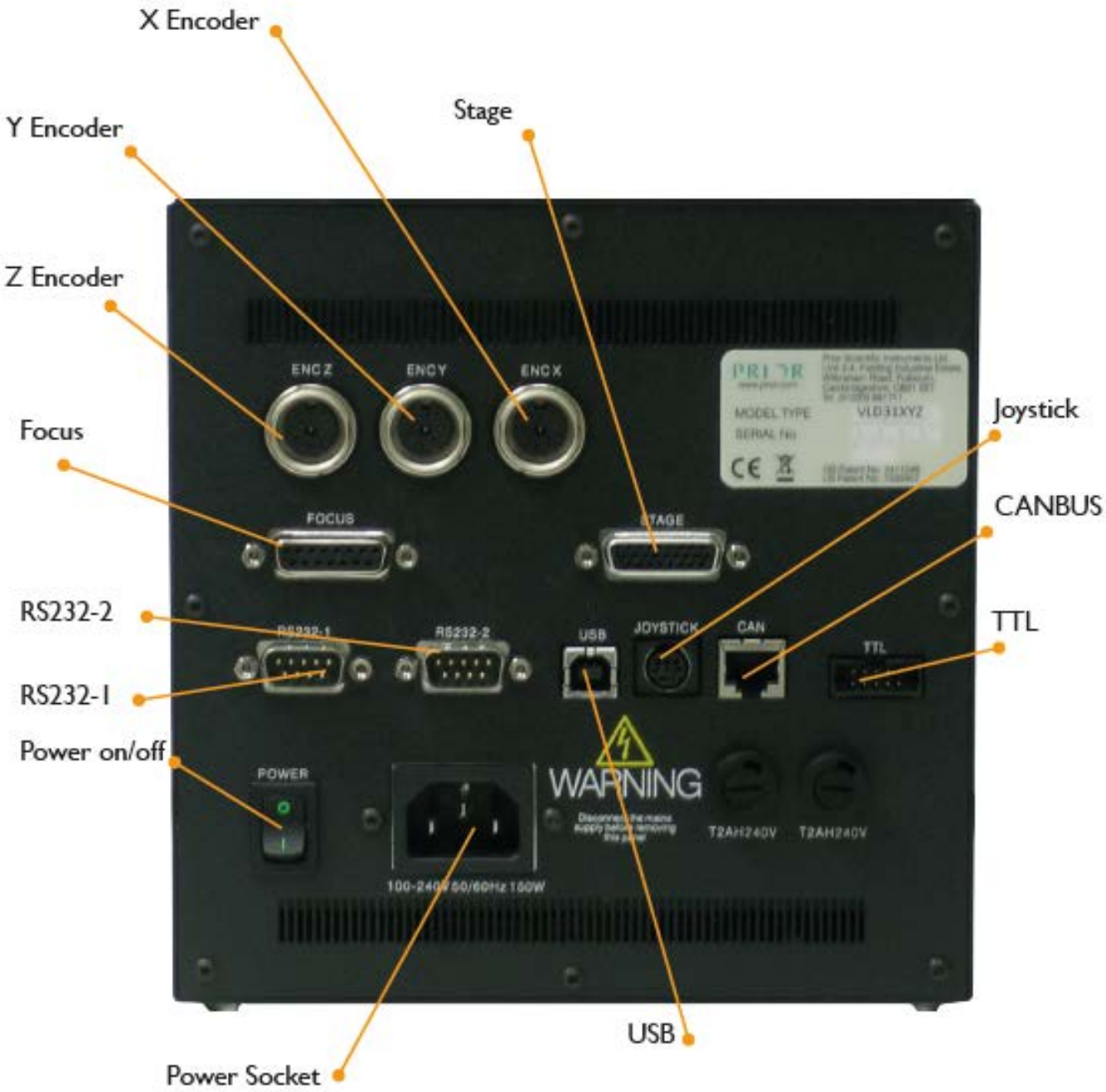


IST is a system where the stage movement is analysed during the production process and errors in metric accuracy recorded. Metric errors in stages tend to be linear in form, so the metric error is mapped to a straight line. The description of the straight line, the gradient and offset is stored on a chip on the stage itself. This is done for both axes creating four numbers, hence the common description 4 point mapping. Prior products are Plug and Play, i.e., any product can be attached to any controller and the information about the stage is loaded into the controller. This makes Prior systems very flexible, and easy to set up.

Stage Mapping takes the IST one step further and does not assume that any errors in the stage are linear. The mapping is in 1mm square grid pattern, i.e., it generates 4 numbers for each 1mm square of the stage. The significantly enhances metric accuracy.

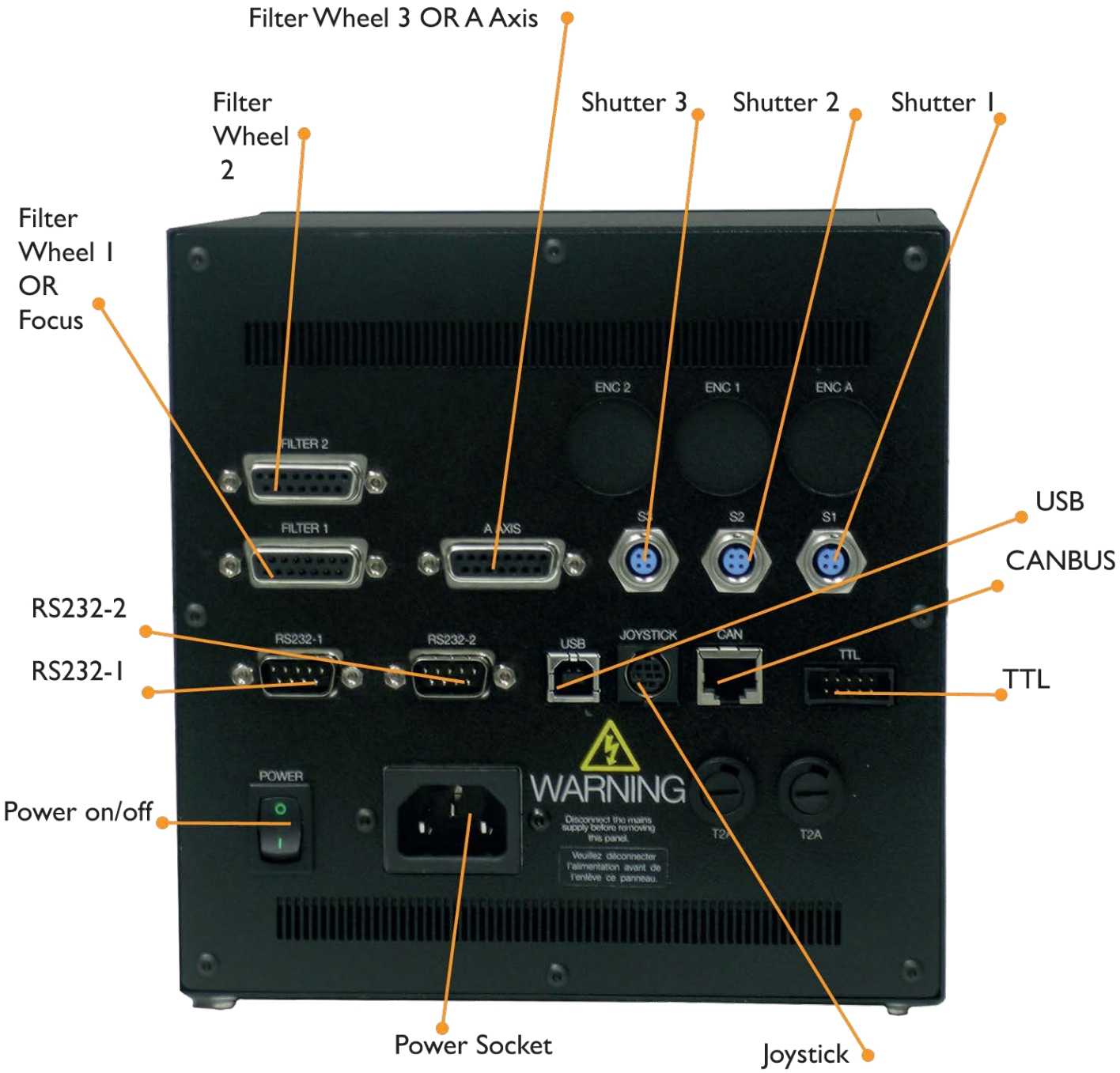
Appendix C – Connections for the VLD

The VLD31F is a variant on the ProScan III controlling shutters, filter wheels and a linear stage. Although it looks similar to a controller for a stepper motor stage, stepper motor stages cannot be controlled by linear stage controllers, and vice versa. Connections for a main control box controlling stages and focussing mechanisms, and an auxiliary box controlling filter wheels and shutters, are shown on page 6.



Appendix D – Connections for the V31F

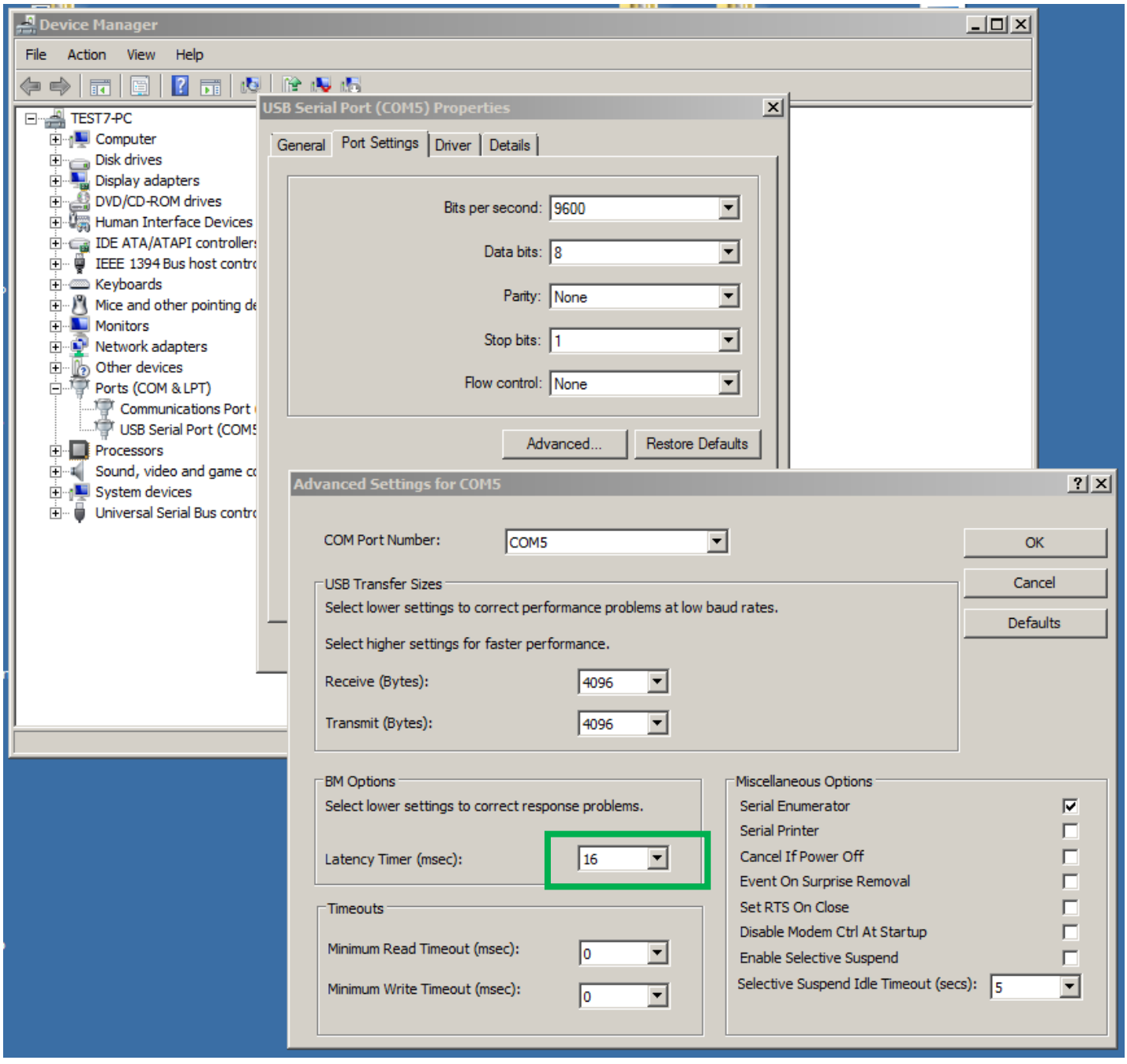
The V31F is a variant of the ProScan III which controls shutters, filter wheels, and a focussing device. If wished, an auxiliary box allowing control of a stage could be added. Connections for a main control box controlling stages and focussing mechanisms, and an auxiliary box controlling filter wheels and shutters, are shown on page 6.



Appendix E – FTDI Speed Adjustments

More recent ProScan III controllers have FTDI boards inserted to increase their functionality and allow control via USB from Windows 8 and above operating systems. Some users have reported very minor differences in speed and response time when using these new controllers.

The response time can be altered in order to increase the speed of response. The default is 16 ms which may lead to slightly delayed responses. Right click on the appropriate port and select Port Settings > Advanced Settings. Select a lower latency time (e.g. 2 ms) to reduce any delay observed.



Appendix F – Fourth Axis Commands

Fourth axis commands can be delivered the same as the others. Fourth axis commands are now less widely used and are mostly for OEM customers.

Command	Arguments	Response	Description
SMA	n	0	Set Maximum Speed for 4th axis (A axis)
SAA	n	0	Set Acceleration for 4th axis.
SCA	n	0	Set S-Curve for 4th axis.
SSA	n	0	Sets the step size. User Units are multiplied by this number to convert to microsteps.
PA	none	p	Returns position (in User Units)
ZA	none	0	Set current position to zero.
GA	p		Goes to absolute position (User Units)
CW	d	R	Moves Clockwise by distance d (User Units) Note that device should be Rotary NOT Linear.
ACW	d	R	Moves Clockwise by distance d (User Units) Note that device should be Rotary NOT Linear.
TYA	None	0	Toggles Y axis of joystick between controlling Y axis and 4th axis. An error is returned if the Y axis is moving. The controller reverts to Y axis control after a power cycle.
VA	v	R	Sets the axis moving at velocity v.
FOURTH	Ra,b,c,d/La,b,c,d	0	R is typed and defines fourth axis to be Rotary. a defines the microstepping resolution (64,250 or 256). b is number of microsteps per complete revolution of the wheel, nosepiece or turntable. c is number of positions per rev (eg filter wheel or nosepiece) d is the offset distance (in microsteps) of limit switch/home sensor from position 1. eg FOURTH,R250,2516789,10,35467 As above only used when 4th axis is operating a linear device (identified by typing L a is microstep resolution as before. b is linear distance (in microsteps) between first and last positions.
FOURTH	La,b,c,d	0	c is (number of positions-1) ie number of movements between first and last position eg c=3 is 4 positions, 3 movements. d is as above. A device is Rotary if it has unlimited rotary travel (no limits). Position will default to 0.1 degree user units and be reset after exceeding 360 degrees WARNING A nosepiece is considered linear is it has hardware limit switches

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For more assistance, please do not hesitate to contact Prior Scientific

Visit Prior online at www.prior.com

Prior Scientific Ltd
Cambridge, UK
T. +44 (0) 1223 881 711
E. uksales@prior.com

Prior Scientific Inc
MA USA
T. +1 781-878-8442
E. info@prior.com

Prior Scientific GmbH
Jena, Germany
T. +49 (0) 3641 675 650
E. jena@prior.com

Prior Scientific KK
Tokyo, Japan
T. +81-3-5652-8831
E. info-japan@prior.com