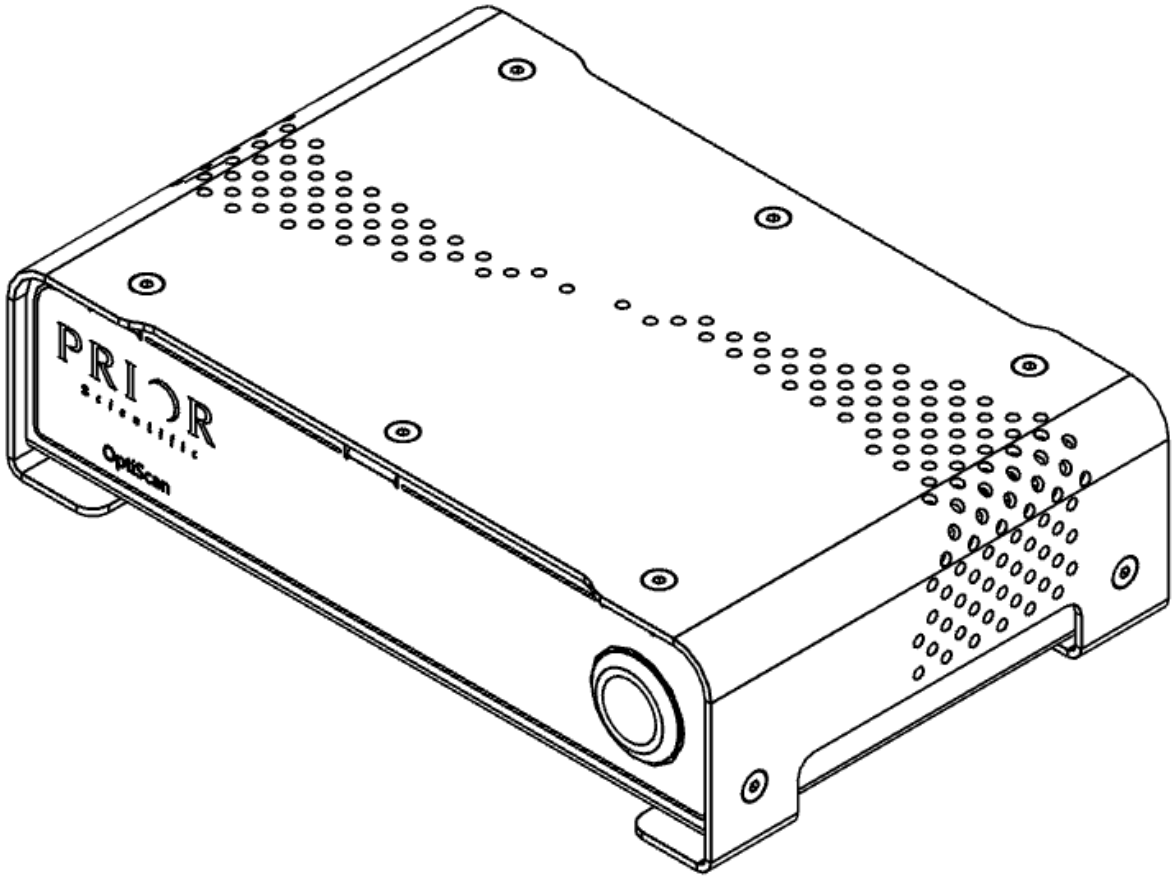
Installation and Handling Instructions

PRIOR Scientific

ES12ZETTL Operation Manual



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Contents

This manual covers the control, via ES12ZETTL, of any Prior product compatible with the ES12ZETTL, including the control digipot, filter wheels, filter turrets, focus motors, and encoders.

Note that in some cases, these products may also have their own installation manuals, installation guides, or quick start guides. In that case, all relevant literature should be read and understood before use.

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Important Safety Information

Only use the ES12ZETTL within the following parameters:-

- 5 to 40°C with relative humidity to 80% up to 31°C decreasing linearly to 50% RH at 40°C
- Not exposed to water or moisture
- Not exposed to extreme hot or cold temperatures
- Not exposed to open flames
- Not exposed to impacts or spills
- Make sure the electrical cord is in a place in cannot be damaged
- Only connect the AC power cord to designated power sources
- Before connecting any components, unplug the product from the power source
- Only the exterior of this product should be cleaned using a damp lint-free cloth
- Never alter the AC power cord or plug. The power cord set must be an appropriately rated and approved cord set in accordance with 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 ES12ZETTL is class 1 and must be only connected to a power outlet which provides a protective earth (ground). Some of our actuators are capable of producing forces in excess of 300N. During active use, ensure body parts are kept away from moving parts. Trap hazards may be formed between our actuators and other items in close proximity which are out of our control. Please be aware to minimize this risk during the installation of our equipment into your wider system.
- 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.

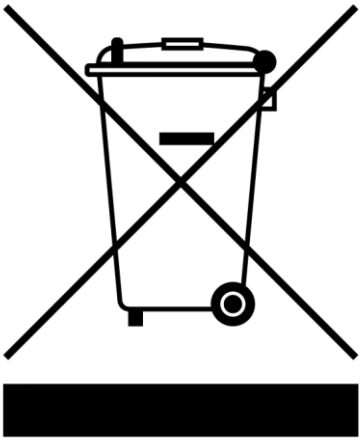
Risk of Injury or Damage

Strong Magnetic Field

High Voltage Danger

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.



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Basic Connections

The ES12ZETTL is a control system designed to control Prior products, including focus motors, filter wheels, filter turrets, and focus blocks.

The controller consists of

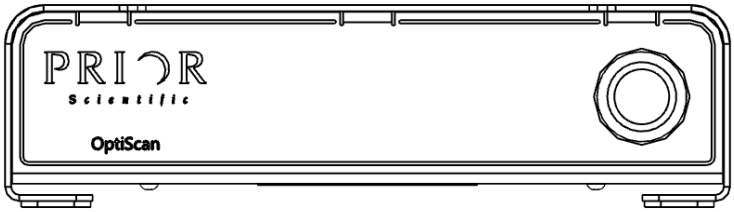
1x Controller Unit, 1x USB Cable, 1x Power Supply, 1x Power Cable for your region.

The rear of the controller unit has connections to integrate the controller with the power supply, accessories, and a controlling computer.

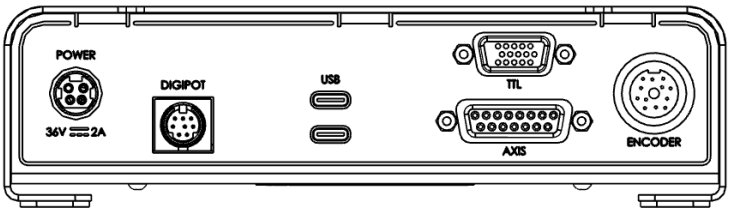
All connections on the controller are labelled on the controller itself.

The front of the controller has an on/off button with an LED ring that indicates a powered up system with a green light, or a powered down system with no LED illumination.

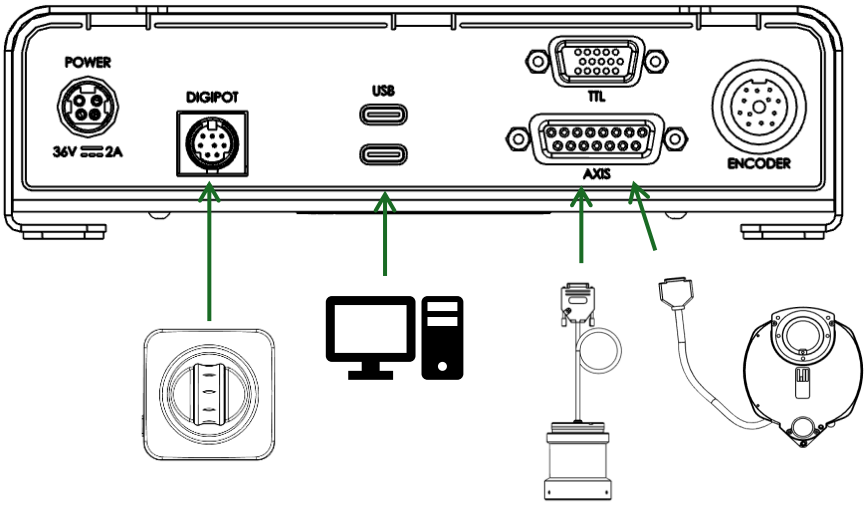
Front



Rear



Ensure that power is OFF before disconnecting or connecting anything to the control box.



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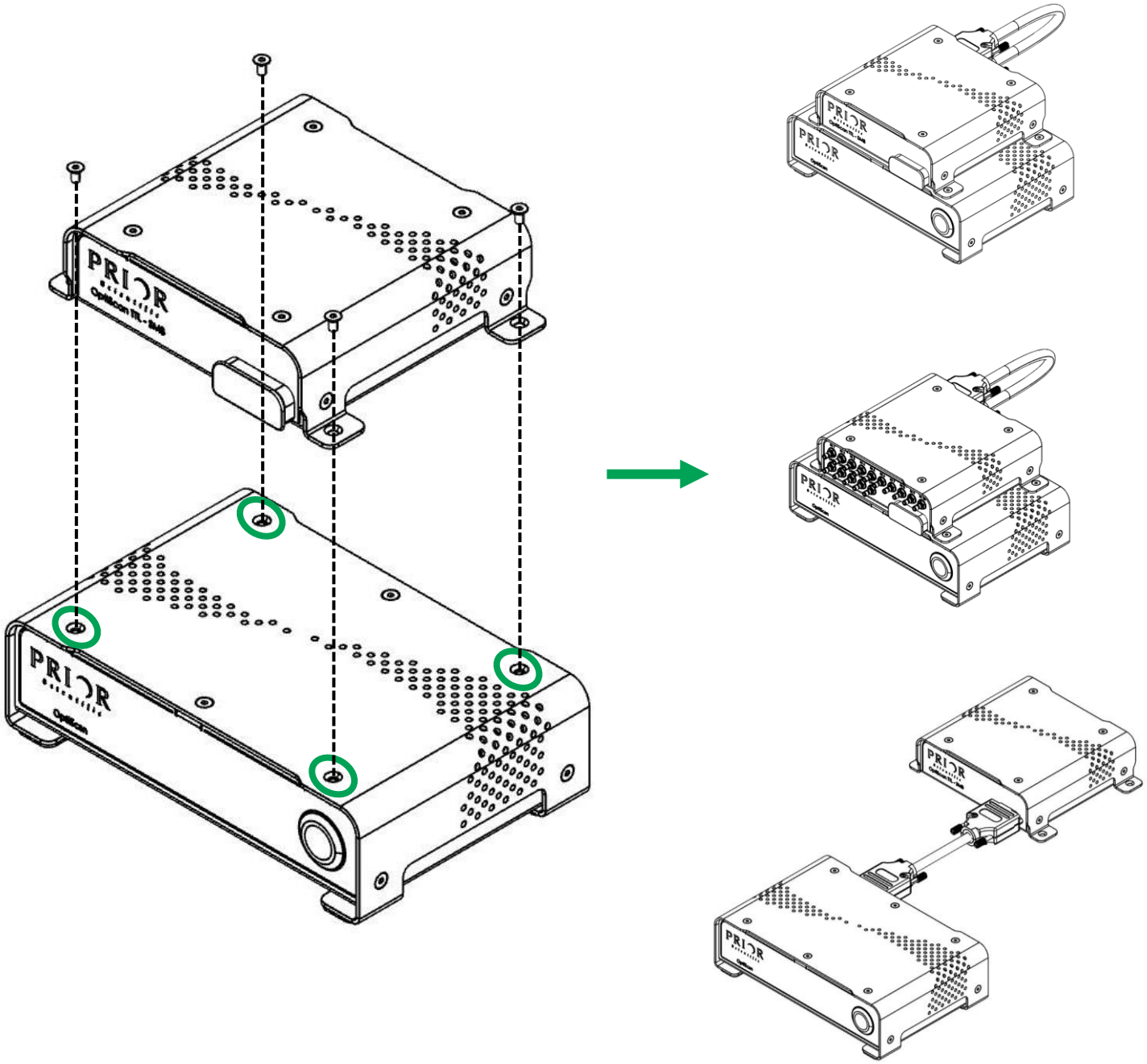
ES12ADTTL Installation

The ES12ADTTL add-on box converts the high-density 15-way D-sub connector into individual SMB connection. The ES12ZETTL and ES12ADTTL controller units can be combined together in several orientations, as mentioned previously.

The ES12ADTTL can be mounted onto the top of the ES12ZETTL with the SMB connections facing the rear or the front, as pictured below. This can be done by removing the four screws highlighted (green) from the ES12ZETTL, aligning the ES12ADTTL with the revealed holes, and using the included longer screws to attach the two together. Alternatively, the devices can be linked but not attached.



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Installing Prior Software

To complete installation of your ES12ZETTL, the Prior Scientific Software is required. This will allow you to change between modes, as well as provide a free software to control Prior equipment.

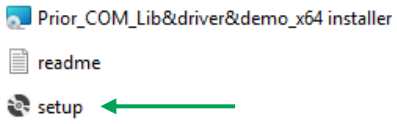
“Prior Test” allows control of the ES12ZETTL via a GUI

“Prior Terminal” is a terminal emulation program into which commands can be entered.

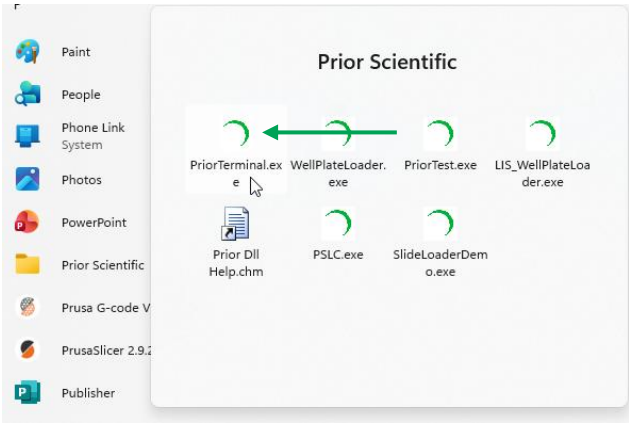
You can download the software from the Prior website https://www.prior.com/technical-support/downloads/software. Ensure you select the correct 32 or 64 bit version depending on your operating system.

Open the downloaded file and double-click Setup.exe

Proceed through the installation until it is complete.



To launch Prior Terminal, go to the Start Menu -> Prior Scientific -> PriorTerminal.exe

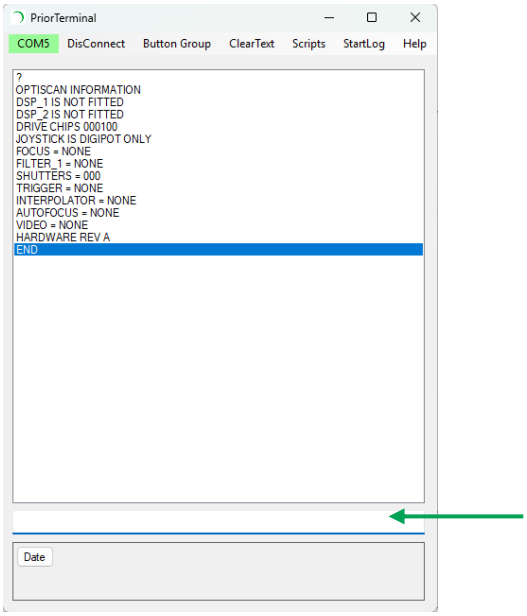


When Prior Terminal launches, you will be asked to enter a port number and a baud rate. Baud rate will, by default, stay at 9600. Port number is found in the Device Manager, under ‘Ports’ and labelled as “USB Serial Port”.

If you have multiple USB Serial Port COM ports, unplug the USB cable to the ES12ZETTL and note which COM number disappears. This is the correct port number.

When Prior Terminal opens, it will reveal a large white window with a smaller white bar below it. Enter a question mark (?) into the smaller white bar and press Enter/Return.

This will present a series of information about your Prior controller and system, as well as confirming you have connected correctly. It will look similar to the image on the right.



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Installing Z-axis Devices

Ensure that power is OFF before disconnecting or connecting anything to the control box.

This section of the manual will guide you through connecting your focus system to your ES12ZETTL controller. You will need the following items to complete this setup.

- ES12ZETTL controller + power adapter + cable
- Prior Focus Motor/Focus Block
- A Laptop or PC with Prior Software installed.
- The USB-C cable included with your controller.
- CS200 Z Digipot *(Optional but recommended)*

1) Connect the focus motor or focus block to the port labelled "AXIS". The 15-pin connector should slot in and has two thumb-screws on the side to secure the connection.

2) If your focus motor/block is encoded, connect the circular encoder connector to the port labelled "ENCODER". **Please note that there is a small notch on both port and connector to indicate the correct orientation. Do not force the connection.**

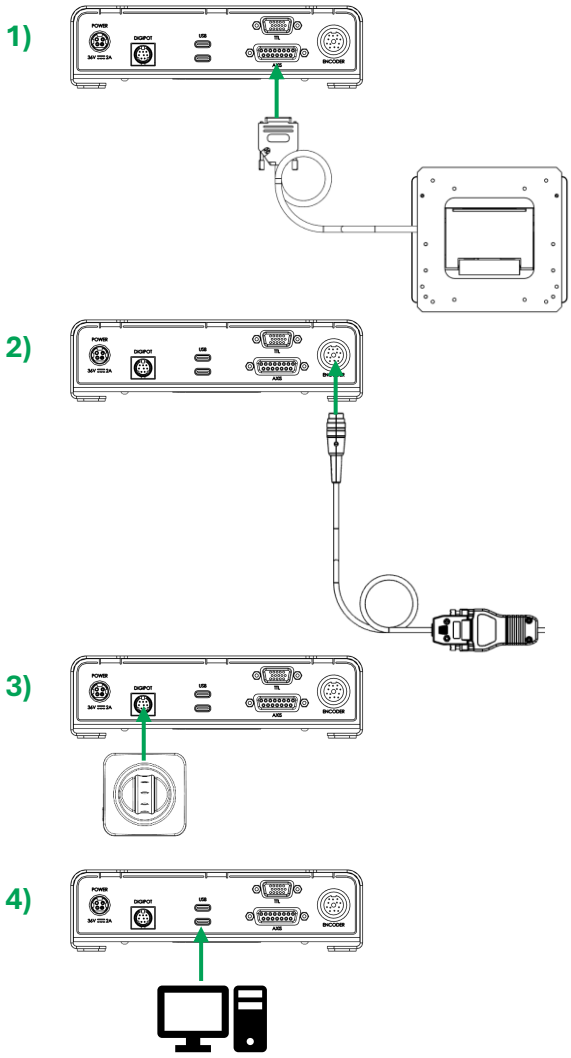
3) (Optional) Connect the CS200Z digipot to the controller with the included cable to the "DIGIPOT" port. **Please note that there is a small notch on both port and connector to indicate the correct orientation. Do not force the connection.**

4) Use the USB-C cable to connect the controller to your PC/Laptop.

5) Turn on the controller by pressing the large silver button on the front until it clicks. It should remain steady green to indicate it is ready for use. Ensure the system is connected to mains power.

6) Connect to Prior Terminal, as instructed in the installation section, and enter the command **MODE,0** to ensure your system is ready to operate your focus motor.

*7) (Optional) If your system is encoded, check that the encoders are operating with the command **ENCODER** in Prior Terminal. Response should be **Z**. A red flashing LED on the front indicates an encoder failure or error.*



Instructions for installing Prior accessories onto your specific microscope are available in the "Installation Guides and Help Sheets" section of Prior.com

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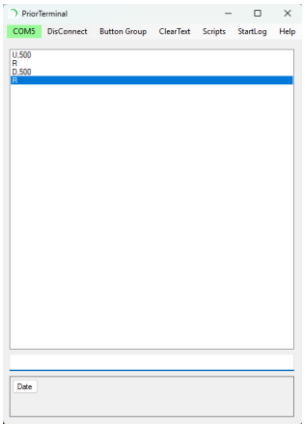
Using Prior Terminal (Z-axis)

Prior Terminal is the primary software that Prior Technicians will use when testing and troubleshooting systems, it has a powerful array of commands that can perform an impressive range of features.

The ES12ZETTL will need to be in Mode 0, which allows for control of Z-axis and linear drive devices

To demonstrate, we will control a focus block's operation with Prior Terminal commands. Begin by entering Mode 0 with the command **MODE,0** into the command line of Prior Terminal, then press enter. Confirm that your device has been recognised by using the **?** Command, and check that your **FOCUS** registers the correct device you have connected.

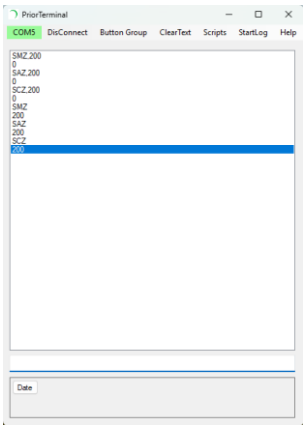
Prior Terminal commands are structured as [Command] [Argument/s] followed by an enter/return press, and a received command will always reply with the appropriate response.



The basic commands for controlling a focus block to move up and down are U and D.

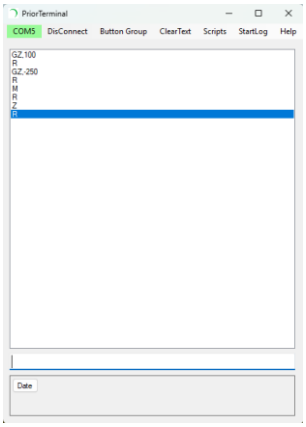
U,500	Will move your focus block up by 500 steps
D,500	Will move your focus block down by 500 steps

But say that we want our focus block to move faster than the default is set to, we have a few options. We can adjust the speed, acceleration, and curve of the focus block by relative amounts with SMZ, SAZ, and SCZ.



SMZ,200	Sets maximum speed to 200, making the focus block move faster but too fast can jam the ballscrew
SAZ,200	Sets acceleration to 200, making the focus block accelerate to maximum speed faster.
SCZ,200	Sets the curve to 200, making the time it takes to reach max acceleration much shorter.

If we don't have, or don't to want to use, a digipot, Prior Terminal can also command the focus block to a position with the GZ command, or can move the focus block back to it's preset origin with M.



GZ,100	Moves the focus block to Z=100
GZ,-250	Moves the focus block to Z=-250
M	Moves the focus block to Z=0

Or, if you have a focus plane you'd like to focus around, you can use Z to set that plane as zero.

Z	Sets the current focus position as Z=0

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Installing Filter Wheel / Turret / Nosepiece Devices

Ensure that power is OFF before disconnecting or connecting anything to the control box.

This section of the manual will guide you through connecting your filter or nosepiece device to your ES12ZETTL controller. You will need the following items to complete this setup.

- ES12ZETTL controller + power adapter + cable
- Prior Nosepiece / Filter Wheel / Turret
- A Laptop or PC with Prior Software installed.
- The USB-C cable included with your controller.
- CS200 Z Digipot *(Optional but recommended)*

1) Connect the OEM device to the port labelled “AXIS”. The 15-pin connector should slot in and has two thumb-screws on the side to secure the connection.

2) If your OEM Device is encoded, connect the circular encoder connector to the port labelled “ENCODER”. **Please note that there is a small notch on both port and connector to indicate the correct orientation. Do not force the connection.**

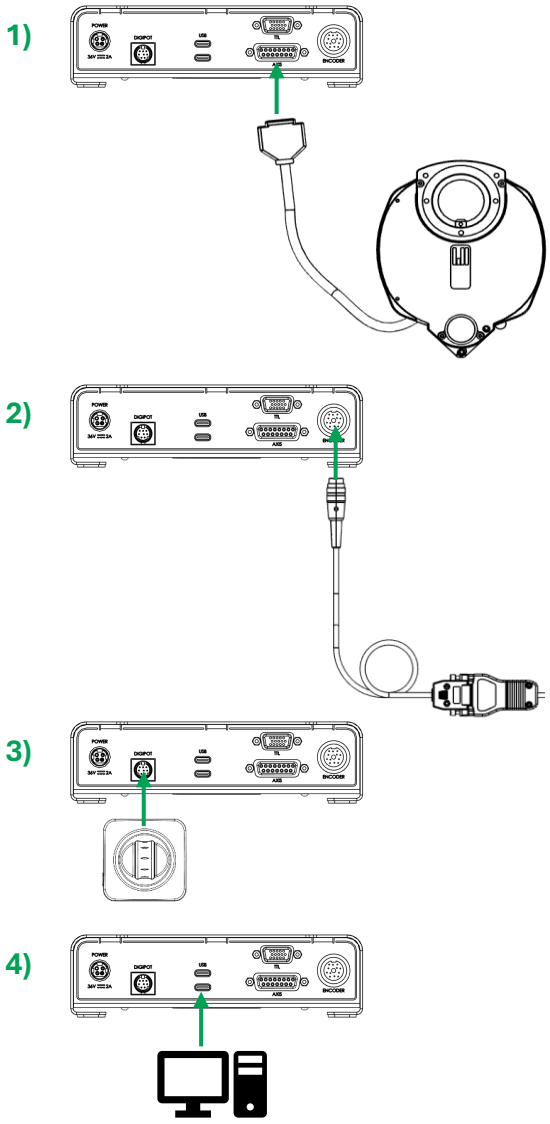
3) (Optional) Connect the CS200Z digipot to the controller with the included cable to the “DIGIPOT” port. **Please note that there is a small notch on both port and connector to indicate the correct orientation. Do not force the connection.**

4) Use the USB-C cable to connect the controller to your PC/Laptop.

5) Turn on the controller by pressing the large silver button on the front until it clicks. It should remain steady green to indicate it is ready for use. Ensure the system is connected to mains power.

6) Connect to Prior Terminal, as instructed in the installation section, and enter the command **MODE,1** to ensure your system is ready to setup your filter or nosepiece Device.

*7) (Optional) If your system is encoded, check that the encoders are operating with the command **ENCODER** in Prior Terminal. Response should be **A**.*



Instructions for installing Prior accessories onto your specific microscope are available in the “Installation Guides and Help Sheets” section of Prior.com

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Installing an OEM Device

The ES12ZETTL can support the operation of OEM devices that are not necessarily produced by Prior, provided that they are designed to connect to the Prior axis pinout. They can be configured to behave as stepper drives with normally closed or normally open limits switches.

Physically install the device as per the instructions for filter wheels/turrets/nosepieces, including setting the controller to Mode 1.

To set up an OEM device as a simple device that works in microsteps or encoder counts, with normally closed limits, you will need to enter the below command into Prior Terminal

OEM,1,CONFIG,OEMNC

You can check that your OEM axis has been accepted with the command below, which should respond with **1**.

OEM,1

When the OEM axis is confirmed to be connected, you can move your simple device with the below commands.

OEM,1,G,X	**Moves the axis to absolute position X**
OEM,1,GV,v	**Sets the axis moving at v steps/second**
OEM,1,GV,0	**Stops motion carefully (Soft Stop)**
OEM,1,K	**Stops motion immediately (Hard Stop)**

The movement profile, such as the speed and acceleration, of axis can be controlled with the below commands

OEM,1,SPEED,s	**Sets speed used in G movements in steps/s**
OEM,1,ACC,a	**Sets acceleration used in G movements in steps/s/s**

ES12ZETTL

Pin	Function
1	A+
2	B+
3	Limit +
4	GND
5	Sense
6	GND
7	Vshutter
8	VCC
9	A-
10	B-
11	Limit -
12	GND
13	n/c
14	Hall
15	Shutter Out

There is also the option to set the OEM to be a complex device. This can be used if your Prior devices plug and play resistor develops a fault or if it otherwise doesn't have a plug and play resistor.

For example, a HH215 2 position nosepiece can be programmed with the below command.

OEM,1,CONFIG,HH215

If you want to control an OEM axis with a PS3J100 right-hand digipot, or CS200Z, you can add a gain control to it with the below command.

OEM,1,VDR,500

To increase or decrease the rate of movement, the gain parameter (500) can be modified. This may need to be made higher to move certain devices.

If the complex device loses position, it can be homed according the programmed specification within the ES12ZETTL with the below command

OEM,1,HOME

A full list of commands available to OEM devices are available on pages 19-20.

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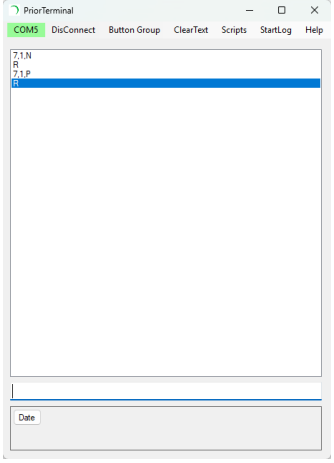
Using Prior Terminal (Mode 1)

The ES12ZETTL will need to be in Mode 1, which allows control of Filter wheel, turret, nosepiece, or other OEM devices.

To demonstrate, we will control a filter wheel's operation with Prior Terminal commands. Begin by entering Mode 1 with the command **MODE,1** into the command line of Prior Terminal, then press enter. Confirm that your device has been recognised by using the **?** Command, and check that your **FILTER_1** registers the correct device you have connected.

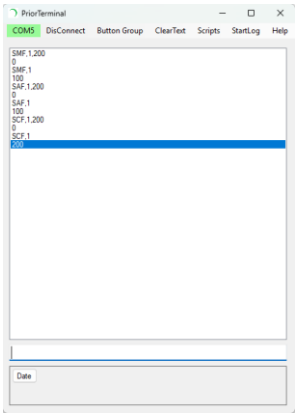


Prior Terminal commands are structured as [Command] [Argument/s] followed by an enter/return press, and a received command will always reply with the appropriate response.

The basic commands for controlling a filter wheel to move to the next or previous position is 7,1,N or 7,1,P

7,1,N Will move the filter wheel to the next position.

7,1,P Will move the filter wheel to the previous position

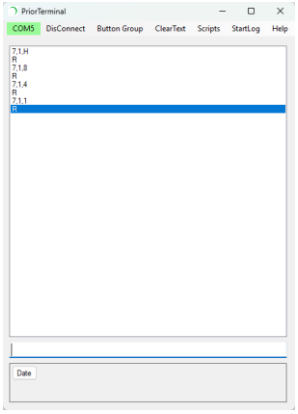


If you want your filter wheel to move faster than the default is set to, there area few options. You can adjust the speed, acceleration, and curve of the focus block by relative amounts with SMZ, SAZ, and SCZ.

SMF,1,200 Sets maximum speed to 200, making the filter wheel move faster but too fast can jam the motor

SAF,1, 200 Sets acceleration to 200, making the stage accelerate to maximum speed faster.

SCF,1,200 Sets the curve to 200, making the time it takes to reach max acceleration much shorter.



If the filter wheel loses position, or if a constant point is required for initialisation, the filterwheel can be homed with 7,1,H. The filter wheel can also be commanded to specific position X with the command 7,1,X

7,1,H Homes the filter wheel to position 1

7,1,X Moves the filter wheel to position X

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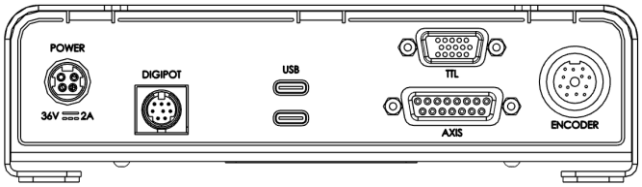
Axis/TTL Pinouts + Setup

The ES12ZETTL has a 15 pin female D-sub connector on its rear as it's axis connection port. This connects the controller to the focus devices for Mode 0, and the filter/nosepiece devices when in Mode 1.

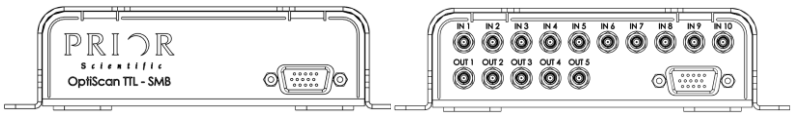
The ES12ZETTL also has a high density 15-pin D-sub connector on it's rear as it's TTL connection port. This TTL port can operate by itself, or it can be used in conjunction with the ES12ADTTL, an expansion module that converts the TTL inputs and outputs to 15 individual SMB connections.

The ES12ADTTL has two male HD-15 D-sub connectors, either one of which can connect to the ES12ZETTL female HD-15 D-sub connector in order to orient the SMB ports towards or away from the user as desired.

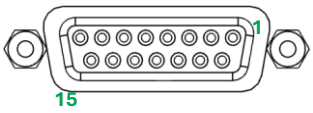
ES12ZETTL



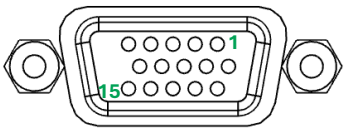
ES12ADTTL



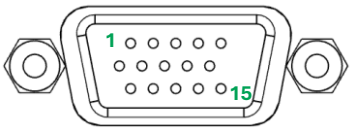
Female D-15



Female HD-15



Male HD-15



ES12ZETTL Axis Port

Pin	Function
1	A+
2	B+
3	Limit +
4	GND
5	Sense
6	GND
7	Vshutter
8	VCC
9	A-
10	B-
11	Limit -
12	GND
13	n/c
14	Hall
15	Shutter Out

HD-15 TTL Port(s) (Both Devices)

Pin	Function
1	TTL Out 1
2	TTL Out 2
3	TTL Out 3
4	TTL Out 4
5	TTL Out 5
6	TTL In 1
7	TTL In 2
8	TTL In 3
9	TTL In 4
10	TTL In 5
11	TTL In 6
12	TTL In 7
13	TTL In 8
14	TTL In 9
15	TTL In 10

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Axis/TTL Pinouts + Setup

Setting up TTL Ports using ASCII Commands

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/low or m = 1 rising edge/ 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 points and actions associated with TTL input n
TTLTRG	m where m = 0 Disarmed or m = 1 armed	0	Arms the global trigger flag
TTLMOT	n,m where n = TTL output 1,2,3, or 4 where m = 0 low, m = 1 high	0	Changes output n to level m while an axis is moving. When n = 0 function is disabled (default).

Example 1:
Create a Trigger that will advance a filter wheel position on the next rising edge of that input.

Commands	Description
TTLTP,1,1	Adds trigger point on TTL 1 on rising edge.
TTLACT,1,2,0,0,0	Add 'Filter 1 Next' to current trigger point on TTL 1
TTLTRG,1	Sets system ready.

Example 2:
Create a Trigger that will advance a filter wheel position when the Z focus stops moving

Commands	Description
TTLMOT,1,1	Changes TTL1 output to High when Z is moving
TTLTP,1,0	Adds trigger point on TTL 1 on falling edge
TTLACT,1,2,0,0,0	Add 'Filter 1 Next' to current trigger point on TTL 1
TTLTRG,1	Sets system ready.

Example 3:
Using ASCII commands in Prior Terminal, create an autoscan routine from bottom of the sample

EZ	Sets Z series origin to current position
U,5000	Move to top of sample
EE,10	Sets end position for Z series with 10 steps between images.
DZ,1	Sets Z series to go upwards
AZ,10,5,1,H	Sets autoscan with 10ms exposure and 5ms settle time with High TTL output on TTL Pin 1
AZ,1	Begin the Z autoscan routine.

TTL 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
Filter 3 Move	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
Stop All Movement	70	0	0	0

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ASCII Command Quick Reference

Below are some common commands that will likely be used or helpful during the day-to-day operation of your ES12ZETTL unit. They may not all be relevant to your specific setup, however these commands may be referenced when speaking to the Prior Technical Team.

Command	Arguments	Response	Description
?	None	Text String	Reports information about the peripherals currently connected to the controller. e.g. DRIVE CHIPS 10011 means Z and 4th axis chips missing, SHUTTERS = 110 means shutter 1 not connected. The final line of information is always a line saying END. This allows for the addition of extra fields of information without effecting application software. Users should always read lines in until the END is seen. A typical response is shown below: OPTISCAN INFORMATION DSP_1 IS NOT FITTED DPS_2 IS NOT FITTED DRIVE CHIPS 000100 JOYSTICK IS DIGIPOT ONLY FOCUS = NONE FILTER_1 = NONE SHUTTERS = 000 TRIGGER = NONE INTERPOLATOR = NONE AUTOFOCUS = NONE VIDEO = NONE HARDWARE REV A END
MODE	None	n	Reports current controller mode (0 or 1)
MODE	n	0	Sets controller mode to 0 or 1. **Mode 0 should only be used for FOCUS MOTORS, Mode 1 should only be used for OEM axes (Filters, Nosepiece, Turrets)**
RESET	None	0	Resets controller to default settings. This will wipe all customer settings from the controller.
VERSION	None	ddd	Reports the units software version number as a 3-figure number e.g. 100 is Version 1.00
U	z	R	Moves Focus Up by z steps.
D	z	R	Moves Focus down by z steps.
SMZ	m	0	Sets the current Z maximum speed to m. Range is 1 to 100
SAZ	a	0	Sets the current Z acceleration to a. Range is 1 to 100
SCZ	c	0	Sets the s-curve value for Z in units of % in the range 1 to 100.

Command	Arguments	Response	Description
7	1,H	R	Filter wheel performs a home routine and moves to position 1.
7	1,N	R	Filter wheel moves to the next position
7	1,P	R	Filter wheel moves to the previous position
7	1,X	R	Filter wheel moves to position X
SMF	1,m	0	Sets the current filter wheel 1 maximum speed to m in units of %. Range is 1 to 100
SAF	1,a	0	Sets the current filter wheel 1, acceleration to a in units of % Range is 1 to 100
SCF	1,c	0	Sets the current filter wheel 1 S-Curve setting. Range is 1 to 100
NP	?	f,n,s	Returns details of the nosepiece device fitted. f = fitted state [0|1] n = number of objectives s = description ie “HH215” e.g. “1,2,HH215”
NP	X	R	Request the nosepiece move to position X
NP	H	R	Request the nosepiece to home to position 1
NP	N	R	Request the nosepiece move to next position
NP	P	R	Request the nosepiece move to previous position.
ENCODER	b	0	b=0 Disables ALL encoders b=1 Enables ALL encoders.
ENCODER	n	0,1	Returns whether the individual axis have encoded enabled or disabled. n =Z,A.
ENCODER	n,b	0	b=0 Disables encoder specified by Axis b=1 Enables encoder specified by Axis.
ENCW	n,w	0	Sets the encoder window n for the Axis specified. This can prevent excessive ‘hunting’ as controller tries to close the position loop. n can be one of Z, A

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General ASCII Commands

General

Command	Arguments	Response	Description
?	None	Text String	Reports information about the peripherals currently connected to the controller. e.g. DRIVE CHIPS 10011 means Z and 4th axis chips missing, SHUTTERS = 110 means shutter 1 not connected. The final line of information is always a line saying END. This allows for the addition of extra fields of information without effecting application software. Users should always read lines in until the END is seen. A typical response is shown below: PROSCAN INFORMATION DSP_1 IS 3-AXIS STEPPER VERSION 0.0 DSP_2 IS 3-AXIS STEPPER VERSION 0.0 DRIVE CHIPS 111111 JOYSTICK ACTIVE STAGE = H138 FOCUS = OPENSTAND FOURTH=TWOPOSTURRET FILTER_1 = NONE FILTER_2 = NONE SHUTTERS = 001 LED = 0000 LED_MD = 00000000 TRIGGER = NONE INTERPOLATOR = NONE AUTOFOCUS = NONE VIDEO = NONE HARDWARE REV F END
=	None	n	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:- D07 D06 D05 D04 -A +A -Z +Z Reading this status clears it.
$	[a]	Decimal Number	Reports status as a decimal number and gives motion status of any axis of the controller. After binary conversion, convention is as follow:- D03 D02 F3/A Z A one in any bit location indicates the axis is moving. When used with the optional parameter [a], the moving status of the specified device is returned. Z Z Axis A A Axis
COMP	None	0 = STD 1 = COMP	Report the Command protocol (Compatibility mode (1) or Standard mode (0)) COMP,1 mode is default after a software upgrade or RESET of controller

General

Command	Arguments	Response	Description
COMP	M	0	Sets the controller compatibility mode for users who want to wait for 'R' at the end of the move. Compatibility is on if m = 1 and off if m = 0. Setting COMP, 1 will result in less flexibility. For example, SOAK cannot be used and commands sent while the joystick is active will be lost.
CURRENT	L	0	Reports active current (mA), standby current (mA), and time to switch between them (ms), for axis L
CURRENT	L,A,S,T	0	Sets the active current (A), standby current (S), and time to switch between them (T), for axis L
DATE	None	Text String	Reports Instrument name, version number and compile time. Note that the system description refers to the presence or absence of internal drivers NOT which peripherals are connected. E.g. Prior Scientific Instruments ProScan H31XYZEF controller Version 0.95 compiled Feb 16 2016 13:43:31
I	None	R	Stops movement in a controlled manner to reduce the risk of losing position. The command queue is also emptied.
K	None	R	Immediately stops movement in all axes. Mechanical inertia may result in the system continuing to move for a short period after the command is received. In this case, the controller position and mechanical position will no longer agree. The command queue is also emptied.. This command is normally treated as an emergency stop.
LMT	None	Nm	Reports whether any limit switch is currently active. A limit switch is active if the switch is in contact with the axis hardware. Nm is a two digit Hex number (one Byte) which when converted to binary is as follows:- e.g. 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).

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General/Z-axis ASCII Commands

General

Command	Arguments	Response	Description
MODE	None	n	Reports current controller mode (0 or 1)
MODE	n	0	Sets controller mode to 0 or 1. **Mode 0 should only be used for FOCUS MOTORS, Mode 1 should only be used for OEM axes (Filters, Nosepiece, Turrets)**
RESET	None	0	Resets controller to default settings. This will wipe all customer settings from the controller.
SERIAL	None	N	Reports the units' serial number n, if the serial number has not been set "0" is returned.
SOAK	None	0	Used to soak test the controller and peripherals. ONLY AVAILABLE IN STANDARD MODE.
VERSION	None	ddd	Reports the units software version number as a 3 figure number e.g 100 is Version 1.00
WAIT	t	0	Inserts a wait of t milliseconds in a macro/soak routine.

Z-Axis Commands (Mode 0)

Command	Arguments	Response	Description
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 of backlash compensation. There are 50,000 microsteps per revolution of the motor on a standard Prior 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	None	R	Moves down w steps defined by the 'C' command.
D	z	R	Moves down by z steps.
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
GZ	z	R	Move to absolute position z
JZD	None	d	Reads d.
JZD	d	0	Sets the direction of Z axis under digipot control. d = 1 or 1.
M	None	R	Moves stage and focus to zero (0,0,0)

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Z-axis ASCII Commands

Z-Axis Commands (Mode 0)

Command	Arguments	Response	Description
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)
OF	s	0	Sets the speed of the focus motor under joystick/digipot control. s is percentage in range 1 to 100.
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).
RES	Z	r	Returns resolution r for axis Z.
RES	Z,r	0	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.
U	None	R	Moves Up by w steps defined by the 'C' command.
U	z	R	Moves Up by z steps.
UPR	Z	n	Returns microns per revolution for the axis Z
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.
SAZ	None	a	Report the current Z acceleration setting, a.
SAZ	a	0	Sets the current Z acceleration to a. Range is 1 to 100

Z-Axis Commands (Mode 0)

Command	Arguments	Response	Description
SCZ	None	c	Returns the s-curve value, c
SCZ	c	0	Sets the s-curve value for Z in units of % in the range 1 to 100.
SIZ	None	R	Set Index of Z Stage. This command would normally only be used on first installation of the system. This command cannot be used on PS3H122R focus motor. 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
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
SSZ	None	s	Returns the current number of microsteps per user unit.
SSZ	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
V	z	R	Go to the absolute position z in the z-axis.
VZ	s	R	Sets the focus speed to s in microns per second. **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 position to ZERO (0,0,0).
ZD	None	d	Returns d
ZD	d	0	Sets direction of rotation of focus motor for commands sent via serial port. Defaults to d=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.
ZPLANE	None	a	Returns zplane enabled status 'a' [0|1]
ZPLANE	a	0	Defines a focus plane between three pairs of XY co-ordinates. Position at each of 3 XY points, focus at each point and issue ZPLANE,1 for 1st point; ZPLANE,2 and ZPLANE,3 for 2nd and 3rd points. ZPLANE,E then enables focus tracking across entire stage based on that plane. Move to any XY point and Z will move accordingly. ZPLANE,D disables focus tracking. Points must not be in a straight line.

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Filter Device/Nosepiece ASCII Commands

Filter Wheel Commands (Mode 1)

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	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.
FILTER	w	Text String	Prints information about filter wheel w. 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 in until the END is seen in order to maintain compatibility. Example FILTER_1 = HF110-10 TYPE = 3 PULSES PER REV = 262,500 FILTERS PER WHEEL = 10 OFFSET = 10080 HOME AT STARTUP = TRUE SHUTTERS CLOSED = FALSE END
FPW	w	N	Reports the number of filter positions for filter wheel w.

Filter Wheel Commands (Mode 1)

Command	Arguments	Response	Description
SAF	w	a	Reports the current filter wheel w acceleration setting.
SAF	w,a	0	Sets the current filter wheel w, acceleration to a in units of % Range is 1 to 100
SAF,i	w	a	Reports the current filter wheel w acceleration setting in intrinsic units /s/s
SAF,i	w,a	0	Sets the current filter wheel w, acceleration to a in intrinsic units /s/s
SAF,u	w	a	Reports the current filter wheel w acceleration setting in microns /s/s
SAF,u	w,a	0	Sets the current filter wheel w, acceleration to a in microns /s/s
SCF	w	c	Reports the current filter wheel w S-Curve setting c
SCF	w,c	0	Sets the current filter wheel w S-Curve setting. Range is 1 to 100
SCF,i	w	c	Reports the current filter wheel w S-curve setting in intrinsic units /s/s/s
SCF,i	w,c	0	Set the current filter wheel w S-curve setting in intrinsic units /s/s/s
SCF,u	w	c	Reports the current filter wheel w S-curve setting in microns /s/s/s
SCF,u	w,c	0	Set the current filter wheel w S-curve setting in microns /s/s/s
SMF	w	m	Reports the current filter wheel w maximum speed setting m
SMF	w,m	0	Sets the current filter wheel w maximum speed to m in units of %. Range is 1 to 100
SMF,i	w	m	Reports the current filter wheel w maximum speed setting m, in instrinsic units /s
SMF,i	w,m	0	Sets the current filter wheel w maximum speed to m in instrinsic units /s
SMF,u	w	m	Reports the current filter wheel w maximum speed setting m, in microns /s
SMF,u	w,m	0	Sets the current filter wheel w maximum speed to m in microns /s

Nosepiece Commands (Mode 1)

Command	Arguments	Response	Description
NP	None	n	Returns the value n, which represents the currently selected objective.
NP	?	f,n,s	Returns details of the nosepiece device fitted. f = fitted state [0|1] n = number of objectives s = description ie "HH215" e.g. "1,2,HH215"
NP	n	R	Request the nosepiece move to position n
NP	H	R	Request the nosepiece to home to position 1
NP	$	n	Return the nosepiece busy status n [0|1]

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OEM ASCII Commands

The ES12ZETTL supports Filter Wheels in Mode 1. These can be re-configured (by way of a plug and play resistor) to behave as OEM stepper drives with either normally closed (type 24 resistor, 3k3 ohm) or normally open (type 25 resistor, 3k9 ohm) limit switches. The command set is shown below.

Step resolution will be dependent on motor type and whether encoders are fitted. For a non-encoded OEM axis, this will typically be either 50,000 or 100,000 steps per revolution of the motor. For an encoded axis, this will be dependent on the nature of the encoder and driven axis.

OEM Commands (Mode 1)

Command	Arguments	Response	Description
OEM	n	f	Returns the fitted status f of axis n (1 to 6): 0 = not fitted 1 = fitted
OEM	n,$	m	Reports the motion status m of axis n: 0 = idle 1 = active
OEM	n,ACC	a	Returns acc a used in G movements in steps/s/s
OEM	n,ACC,a	0	Sets acc used in G movements in steps/s/s.
OEM	n,CONFIG, Name	0	These devices work in default units of microsteps or (if fitted) encoder counts.If your device has a plug and play then this command is not needed. If no plug and play is fitted the user has options to specify the device and its behavior where: n = OEM id [1..6] Name = the string id of the oem device Current known OEM devices are split into two groups : simple and complex: **Simple** "OEMNC" - as per type 24 "OEMNO" - as per type 25 "OEMNCLP" - as type 24 but with low currents (100,50,500) "OEMNOLP" - as type 25 but with low currents (100,50,500) **Complex** The following devices have positions based on their design and not pure step positions. For instance:- The MC12 has only two positions 1 and 2 that it can be moved to, whereas the HH339 has six. These devices may also have complex homing routines associated with them when calling the OEM,HOME command "MC12" - Inverted 2 position nosepiece "HH215" - Upright 2 position nosepiece "HH339" - 6 position nosepiece "HH313" - Cube Changer "MC11" - Mirror Changer
OEM	n,CURRENT	a,s,t	Returns the drive current settings for the axis n, Where: A = active current (mA) S = standby current (mA) T = Delay at the end of move before current switches from active to standby values (ms)

OEM Commands (Mode 1)

Command	Arguments	Response	Description
OEM	n,CURRENT, a,s,t	0	Sets the drive current settings for the axis n, Where: A = active current (mA) S = standby current (mA) T = Delay at the end of move before current switches from active to standby values (ms)
OEM	n,ENCRES	r	Returns the encoder resolution detected. If the OEM device is a named device or has a plug and play resistor then this is calculated automatically by the system. The value r is the number of microsteps per 4 encoder counts.
OEM	n,ENCRES,r	0	For non-standard prior motor/encoder combinations, the system may calculate r incorrectly. In such a case, the user must override the calculated value with their own. The value r is the number of microsteps per 4 encoder counts and must be a whole number. Setting resolution = 0 turns off the enforced encoder operation
OEM	n,ENCW	w	Returns the axis n encoder window count n. This is a +/- w counts around the target position within which the axis will accept as the target position. This can prevent excessive 'hunting' if your OEM axis has poor performance.
OEM	n,ENCW,w	0	Sets the axis n encoder window count w.
OEM	n,G,x	0	Drives the axis n to the absolute position x.
OEM	n,GV,v	0	Sets axis n moving at v steps per second.
OEM	n,HOME	0	The device will perform is specific homing routine. This may be as simple as moving to it lower limit switch or much more complicated (like a HH339). The device will remain busy (see OEM,$) until the homing is completed. The homing is available only for Complex OEM devices where n = OEM axis.
OEM	n,K	0	Stops motion immediately on axis n.
OEM	n,LMT	s	Reports the current limit switch state s: 0 = no active limit 1 = +ve limit active 2 = -ve limit active 3 = both limits active.

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OEM/Encoder/TTL ASCII Commands

TTL Commands

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 and 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
TTL	None	DCBA BA is actual status of 4 write bits. DC is TTL levels of 4 input bits (leading zeroes may be omitted)
TTL	n,m where n is number 0 to 3 and is the data bit number of TTL_OUT. m is 0 or 1 and sets the level of TTL_OUT. m = 0 is TTL low and 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.	Returns m, the TTL status of bit n. m = 0 is TTL low m = 1 is TTL high

OEM Commands (Mode 1)

Command	Arguments	Response	Description
OEM	n,P	x	Returns position x of axis n in steps
OEM	n,P,x	0	Sets position of axis n to x steps
OEM	n,SERVO	s	Return the axis n servo enabled status s [0|1]
OEM	n,SERVO,s	0	Sets the OEM axis n servo enabled status s [0|1]
OEM	n,SERW	w	Returns the axis n servo window count w. This is a +/- w counts around the target position within which the axis will not try to compensate for drift. E.g w+1 encoder counts drift from the original target position before the system will automatically correct.
OEM	n,SERW,w	0	Sets the servo window count w.
OEM	n,SPEED	s	Returns speed s used in G movements in steps/s.
OEM	n,SPEED,s	0	Sets the speed s used in G movements in steps/s.
OEM	n,VDR,g	0	Assigns the digipot of CS200Z to manually control the specified axis n. The g parameter is a simple gain control for the digipot demand.

Encoder Commands

Command	Arguments	Response	Description
ENCODER	none	n	Reports back as a decimal number the axes that are operating using the encoders.
ENCODER	b	0	b=0 Disables ALL encoders b=1 Enables ALL encoders.
ENCODER	n	0,1	Returns whether the individual axis have encoded enabled or disabled. n =Z,A.
ENCODER	n,b	0	b=0 Disables encoder specified by Axis b=1 Enables encoder specified by Axis.
ENCW	n,w	0	Sets the encoder window n for the Axis specified. This can prevent excessive 'hunting' as controller tries to close the position loop. n can be one of Z, A
ENCW			Returns the allowable encoder as a set of four numbers for axes XYZA e.g. 0 0 0 0
ENCW	n	w	Returns the encoder window for the axis given e.g ENCW,X
ENCW	n,w	0	Sets the encoder window w for the given axis n Eg ENCW,x,5
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
SENCODER	As ENCODER		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.
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	n	0,1	Returns whether the individual axis have servo enabled or disabled. n = Z,A
SERVO	n,b	0	b=0 Disables servo specified by n b=1 Enables servo specified by n.
SWZ	n	0	Sets a window of n encoder counts about the current Z position to prevent excessive hunting when servo enabled.

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TTL ASCII Commands

Advanced TTL Commands

Command	Arguments	Response	Description
TTLTP	n,m where n = TTL input 1,2,3, or 4 where m = 0 falling edge/low or m = 1 rising edge/ 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 points and actions associated with TTL input n
TTLTRG	m where m = 0 Disarmed or m = 1 armed	0	Arms the global trigger flag
TTLMOT	n,m where n = TTL output 1,2,3, or 4 where m = 0 low, m = 1 high	0	Changes output n to level m while an axis is moving. When n = 0 function is disabled (default).

TTL 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
Filter 3 Move	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
Stop All Movement	70	0	0	0

TTL Z Series Commands

Command	Arguments	Response	Description
AZ	E,S,P,T	0	AZ sets up a Z Autoscan procedure where E= Exposure time (ms) for camera (Time that TTL output is held in the triggered state. S = Settle time (ms) (Wait time after Z axis becomes idle before changing state of TTL output defined by P) P = TTL output pin (1-4) T = TTL trigger state, High (H) or Low (L)
AZ	0|1	0	AZ,1 will begin the setup Z autoscan procedure. AZ,0 will stop an in-progress Z autoscan procedure. **K will not stop an autoscan. AZ,0 MUST be used.**
C	None	0	Reports the distance between Z images
C	w	0	Defines the distance between Z images. This will purge EE when used.
DZ	d	0	Sets Z series direction. d = 0 goes down, d = 1 goes up
EE	?	0	Reports the current end position for the Z series
EE	c	0	Sets the end position for the Z series (c sets C, sets NZ to be [EE-EZ]/C, as an integer, rounding up. [] indicates magnitude, +/- does not matter.
EZ	None	0	Sets the origin for the Z series
EZ	?	0	Reports the current origin for the Z series
EZ	b	0	When b=0, system returns Z to Z origin after Z series. When b=1, system does not return Z to Z origin after series.
GEZ	None	R	Move to the origin for the Z series
NZ	None	x,y	Reports the number of positive steps (x) and negative steps (y) in Z series
NZ	x,y	0	Defines the number of positive steps (x) and negative steps (y) in Z series. Purges EE setting when used.
SZ	None	0	Reports current position in the Z series
SZ	n	R	Move to the nth position in the Z series (not used in AZ). If n=n, move to next position. If n=p, move to previous position.

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Prior Terminal Button Commands

The CS200Z digipot can be used to control Z-axis and OEM devices which do not have discrete positions. It is not recommended to use the digipot to control rotary or linear devices with discrete positions.

For applications requiring a second programmable button, a CS200XY joystick can be connected to the ES12ZETTL via the CS200Z. The joystick itself cannot be used.

The button on the side of the joystick can be used to quickly adjust the maximum speed of the stage by default but can be modified for other functions.

By default, pressing the buttons reduces the speed to 50% of maximum. A second press reduces the speed to 25% of maximum and a third press returns the speed to 100% of maximum speed.

This cycle can be repeated by continuing to press the buttons.

The ES12ZETTL controller offers a specific command ("BUTTON") which can be used to change the function of the buttons on CS200XY and CS200Z.

The command has the following format.

Command	Arguments	Response
BUTTON	b,f	0

There are three possible conditions identified by argument 'b'.

b = 0 – Button released (changing to a state where no button is pressed)
b = 1 – CS200Z button pressed
b = 2 – CS200XY button pressed

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

CS200 Button Examples

CS200Z button (b=1) pressed moves Z up at a constant velocity (f=2)
BUTTON,1,2

CS200XY button (b=2) pressed moves Z down at a constant velocity (f=3)
BUTTON,2,3

Release buttons (b=0) stops Z motor (f=1) (no buttons pressed)
BUTTON,0,1

CS200Z button (b=1) pressed implements TYA command
BUTTON,1,35,TYA

CS200XY button (b=2) pressed implements G,100,200,300
BUTTON,2,35,G,100,200,300

CS200Z button (b=1) pressed toggles XY joystick speed 100%/50%/25%
BUTTON,1,5

F, a number, defines what action the controller when it first detects a new state given by 'b' above. The table below shows which values of 'f' correspond to which actions.

F Argument	Description
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 (Z-motor) speed (100%/50%/25%)
8	Moves Z motor up by amount defined by C command
9	Moves Z motor down by amount defined by C command
16	Starts auto focus
23	Next point
24	Next wafer
25	Smooth stop (l)
26	Sudden stop (k)
35	Assigns any following text to the button. Hence any command may be assignable to a button. Commands that return information such as "?" or "STAGE" will have no effect.

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Prior Terminal ASCII Command Syntax

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

ES12ZETTL controllers can accept commands from either of its two USB-C ports. The ports default to a baud rate of 9600.

Commands and controller responses are terminated with a carriage return code <CR>.

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

- Comma (,)

- Space ( )

- Tab ( )

- Semicolon (;)

- Colon (:)

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

- GZ,100<CR>

- GZ 100<CR>

- GZ 100<CR>

- GZ;100<CR>

- GZ:,; 100<CR>

Soak

SOAK is an extension to the MACRO command enabling the testing of a controller without tying up a PC. The soak routine continually performs 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.

SOAK example

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

SOAK	0	Enter Macro Mode
8, A, 1	R	Close Shutter A
7, 1, 4	R	Move to Filter Position 4
WAIT 1000	R	Wait 1000 msecs
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)

There are two standard 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.

Property type commands that set or query certain statuses 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 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 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 queuing facility is useful in MACRO and SOAK modes but normally the controlling application would sequence the moves along with other external operations as image acquisition.

The default convention is that the controller will move each stage device by 1um per number entered, in other words a requested move of 1000,0 will result in the stage moving 1mm in the X axis.

If desired, this can be overridden 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. 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 user’s application code (assuming that the application software reads all text up to “END”.)

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

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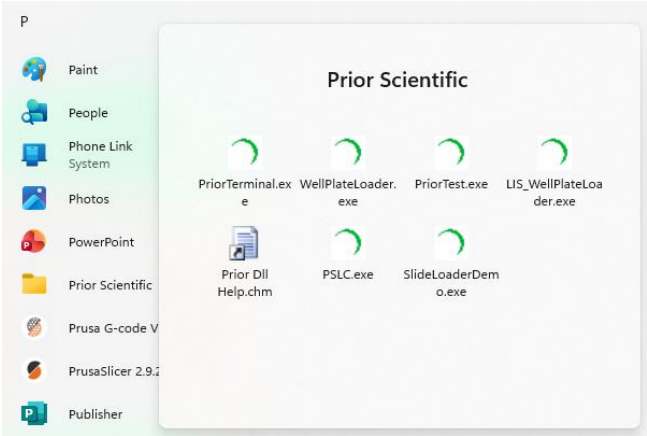
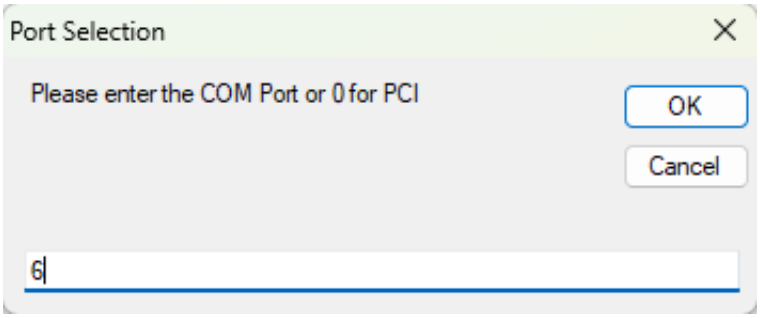
Using PriorTest Software

To launch Prior Test, go to the Start Menu > Prior Scientific > PriorTest.exe



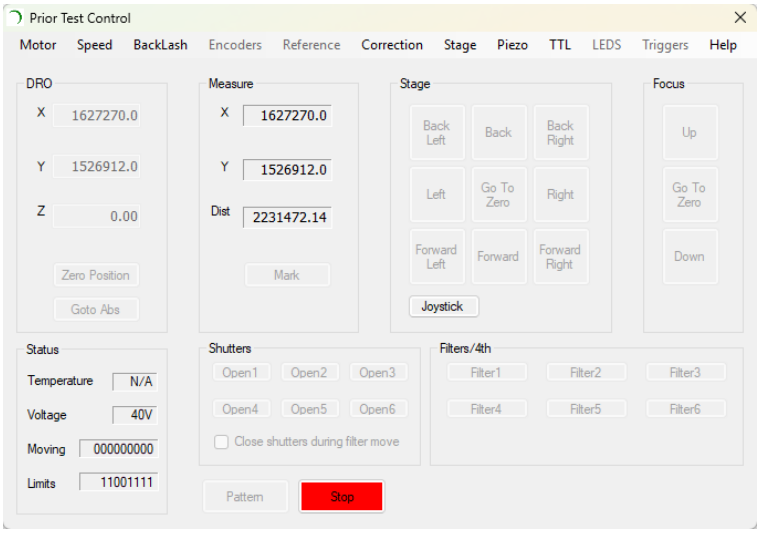
You will be asked to enter the correct port number. Open Windows Device Manager to identify the correct port. The port will be labelled as USB serial port. Ensure this is the port selected.

If you have multiple USB serial port COM ports, unplug the USB cable to the ES12ZETTL and note which number disappears. This is the correct port.



The screen to the right will be displayed once the correct port is entered.

Only the attached accessory sections will be active – E.g if a focus is plugged in instead of a filter wheel, the filter wheel area will be light grey and inactive.



The next few pages will offer information on how to use the relevant menus in Prior Test.

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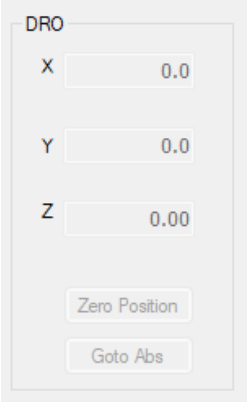
Digital Readout Area (DRO)



X is the X position (in microns) **[Unused]**

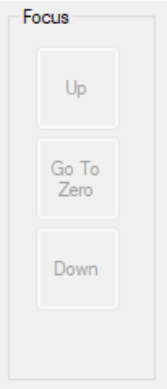
Y is the Y position (in microns) **[Unused]**

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

Zero Position Button: Zeros all three positions, all previous positional information is lost

Goto Abs Button: Brings up a window to type the X, Y, and Z position you require and press 'Goto'. This moves the X,Y, and Z, to the absolute X,Y, and Z position.

Focus Move Area (Mode 0)

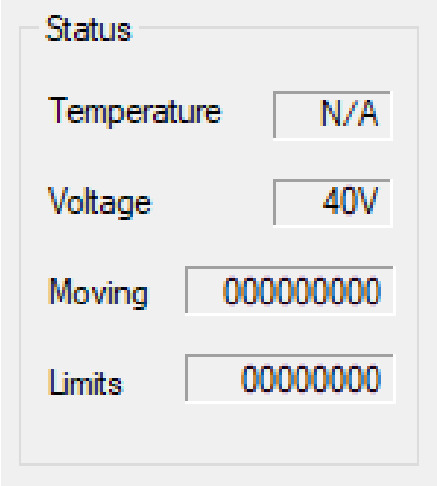


Click "Up" and "Down" to move focus set distances (default 10um).

Go To Zero: Move the focus to absolute zero.

Right click with the mouse on either "Up" or "Down" to set the distance the focus will travel. Type the step size (Z distance travelled) in microns into the box that appears, 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, 1 if it is moving.

All digits are always displayed in the following order:-

Filter 6, Filter 5, Filter 4, Filter 2, Filter 1, Filter 3/A-Axis, Z, Y, X.

0010011 indicates that 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+

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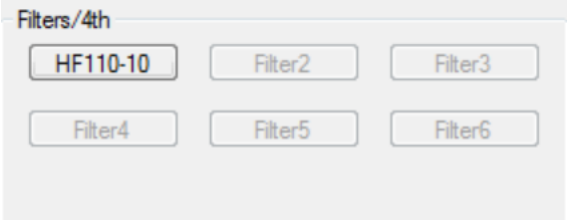
Filters / A Axis (Mode 1)

Click the appropriate button to open another window to access the Filter Wheel or A-Axis Accessory ('Theta').

Greyed out buttons show that no accessory is detected.



Filter Wheels (Mode 1)

Home: Homes the filter wheel to position 1.

Previous: Moves the filter wheel to the previous position

Next: Moves the filter wheel to the next position

Check *"Home on Start"* to activate the home on startup feature which will automatically home the filter wheel when the ES12ZETTL is powered on.

Stop Button

Click the "Stop" button to stop all axis movement immediately. This should be treated as an emergency stop

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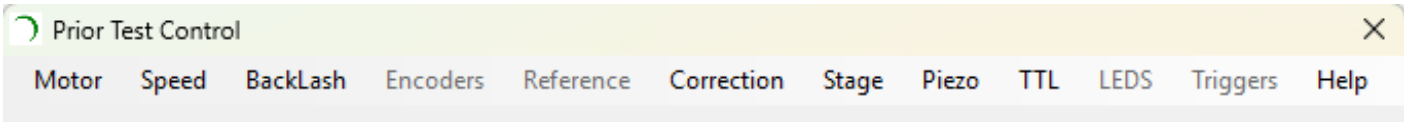
Menu Functions

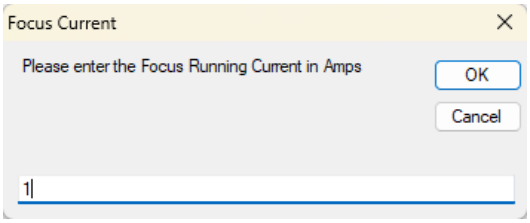
There are several menus available at the top of Prior Test, the next few sections will explain the features available within each Menu.



Motor Menu

Stage Current: **[Unused]**

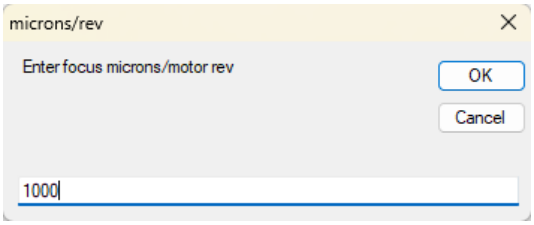
Focus Current: Sets the running current for the motors on the focus between 0 and 1.5 Amps



Changing this value may damage your motors.

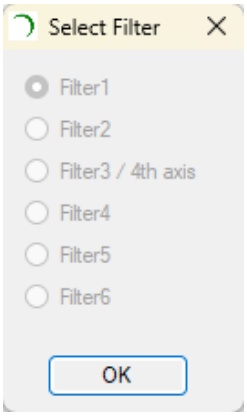
Focus microns/motor revolution: Enter the number of microns the microscope moves when the fine focus knob is rotated one revolution.

This enables the micron value in the display to be related correctly to the attached microscope.



Filter Current: This will open a new window to select a filter wheel to change the drive current of. Select Filter 3 (A-Axis) and click “OK”.

This then sets the running current for the motors on the filter wheel between 0 and 1.5 Amps



Changing this value may damage your motors.

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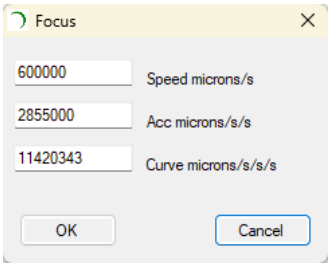
Speed Menu

Stage Speed: **[Unused]**

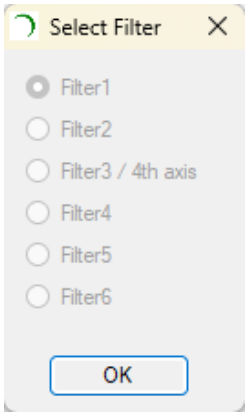
Focus Speed: Changes the intrinsic characteristics of the focus. Speed is in Microns per second. Acceleration is in Microns per second per second.

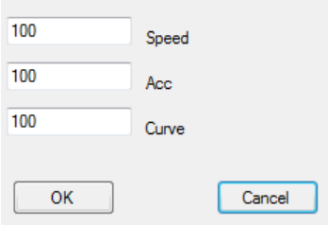


Focus may stall under certain conditions

Filter Speed: Select the filter axis you wish to change. Changes the characteristics of the selected filter axis.

Speed ranges from 1-100%, Acceleration ranges from 4-100%, and Curve ranges from 1-100%.



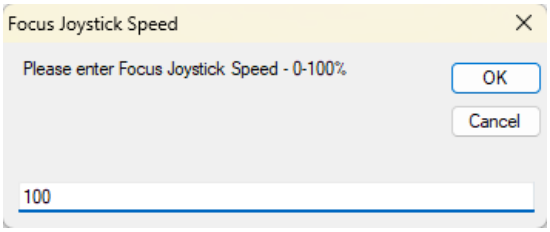


Filter Axis may stall under certain conditions

Joystick Enable: **[Unused]**

Stage Joystick Speed: **[Unused]**

Focus Joystick Speed: Enter the % speed from 0-100% for the digipot to move the focus.



Joy X Reverse: **[Unused]**

Joy Y Reverse: **[Unused]**

Host X Reverse: **[Unused]**

Host Y Reverse: **[Unused]**

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

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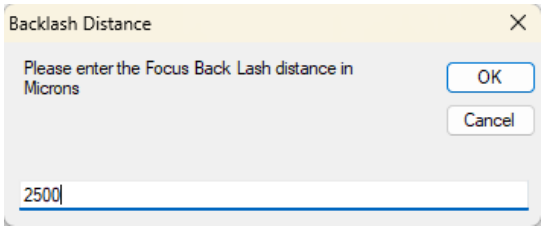
Backlash Menu

Stage Host Backlash Distance: **[Unused]**

Stage Host Backlash Enable: **[Unused]**

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: **[Unused]**

Stage Encoder Window: **[Unused]**

Stage Servo Enable: **[Unused]**

Stage Servo Window: **[Unused]**

Focus Encoders Enable: Check this to enable the encoder to function with the focus

Focus Encoder Window: If encoder is 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 system may move continually while searching for the exact position requested (Hunting).

Focus Servo Enable: Check this to enable focus servo. This makes 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 stage can move before the controller will respond and correct the position.

X Resolution: **[Unused]**

Y Resolution: **[Unused]**

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

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Reference Menu

Set Index of Stage: **[Unused]**

Restore Index of Stage: **[Unused]**

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

Restore Index Z: Completes a Set Index of Z then moves the focus to the position its original position.

Correction Menu

Full Stage Mapping: **[Unused]**

4-Point Stage Correction: **[Unused]**

Skew Correction: **[Unused]**

Skew Angle: **[Unused]**

Skew About: **[Unused]**

Stage Menu

All: **[Unused]**

Piezo Menu

All: **[Unused]**

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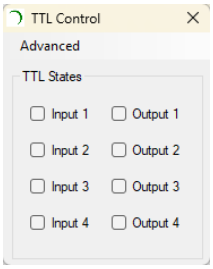
TTL Menu



For basic TTL control and indication, use the basic screen, an image of which is on the right.

Check the boxes to output high signals and uncheck them to output low signals.

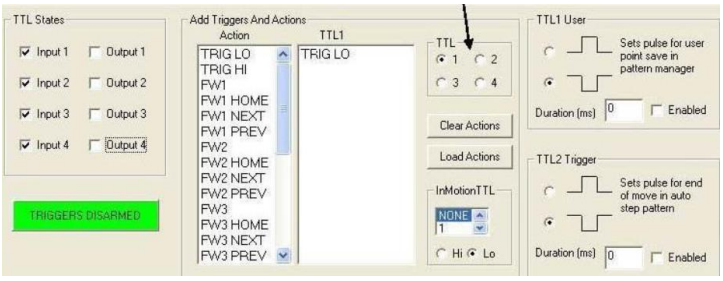
The inputs will indicate if the signal is high (checked) or low (unchecked)

Advanced TTL Control

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

Supported ES12ZETTL functions are:-

- **[Mode 0]** Z-Axis (Relative and Absolute Moves)
- **[Mode 1]** Filter Wheels (Move to Next, Previous, Home, and Move to Position)



- Ensure triggers are disarmed (Trigger arming button should be green)
- Clear actions using the “Clear Actions” button for each individual channel
- Select the TTL channel you would like to program (Only program the required TTL lines)

TTL can be used via the ES12ZETTL 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 action, a window is opened. Fill in the appropriate information to enable the assigned action and click “Add”

Click “TRIG HI” if an action is to be assigned to TTL High, then select the action to be assigned to TTL High

Click “Load Actions” to load the actions for that particular TTL to the ES12ZETTL controller. Repeat the process for each of the TTL channels required.

The “InMotionTTL” sets a TTL output (either high or low) when the axis is in motion. Select the TTL and check “High” 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 in the previous screenshot. Your system will now implement the TTL inputs as programmed.

TTL 1 – **[Unused]**

TTL 2 – **[Unused]**

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Troubleshooting

Power Button Status Light

The front LED of the ES12ZETTL controller can indicate errors with a combination of colour changes and timing changes, as noted in the below table.

Flashing LED Colour	LED Flash Interval	Error
Green	Flashing 1 Sec Interval	USB Timeout
Red and Green, alternating	Flashing 0.5 Sec Interval	Flash Memory Error
Orange and Green, alternating	Flashing 0.5 Sec Interval	Axis Comms Failed
Orange	Flashing 1 Sec Interval	Axis Drive Failed
Orange	Not Flashing	No Drive Found
Red	Flashing 0.5 Interval, then Pause	Axis Encoder Error
Red	Not Flashing	Encoder Failed

USB Timeout – If this issue occurs, try disconnecting the USB cable and reconnecting it. If this does not help, try a different USB cable.

Flash Memory Error – Unfortunately, this error cannot be resolved in the field. Please contact Prior to arrange an RMA.

Axis Comms Failed – If you encounter this error, connect the controller to a PC with Prior Terminal installed and use the RESET command.

Axis Drive Failed – If this issue occurs, connect the controller to a PC with Prior Terminal installed, use the ? Command and confirm that the drive chips display is not 000000. If your drive chips are 001000 or 000100, try using the RESET command and confirm if the issue continues. If so, please contact Prior.

No Drive Found – If this issue occurs, connect the controller to a PC with Prior Terminal installed, use the ? Command and confirm that the drive chips display is not 000000. If you find your drive chips are all zeroes, please contact Prior.

Axis encoder error – If your focus is stalling or struggling to identify/retain its location with an encoder attached, try to turn the controller off and then on, and reinitialise your system. If the issue persists, check your encoder readhead alignment. If this is not feasible, reach out to Prior for assistance

Encoder Failed – If you receive this error, there is a disconnect between the encoder and the axis device being used. Check your encoder cable to ensure no pins are broken or bent, and that the port is clear of debris.

As you cannot visually see the encoder readhead due to focus block design, the command **ENCODER** will report with **4** if the encoder is connected properly or **0** if it cannot detect the encoder.

You may also find this error if your axis device is not correctly plugged in. With the power turned off, unplug and securely reconnect the axis and encoder connectors.

Finally, check to ensure that your controller is operating on the appropriate mode (Mode 0 for focus, Mode 1 for OEM devices), by entering **MODE** as a command in Prior Terminal

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Controller fails to respond to computer

Verify that the controller is turned on by checking the power button for a status light.

- If the button is latched and no light is on, check the mains switch is turned on and that the power supply is connected to the mains and the controller correctly.

Verify that the controller is connected to the computer via USB.

- Ensure the USB cable is securely fitted at both ends.
- Try different USB ports on different cards. At minimum a desktop PC should have USB ports available on the front and rear. A USB card which is otherwise heavily used (e.g. for a microscopy camera) may not be able to handle all the communications traffic through a single card.

Verify the power button status light is green.

- If the button light is yellow, an action is being processed by the controller, and it will not process other commands until the action is completed. If the action fails to complete, power cycle the controller. If power cycling the controller fails to resolve the situation, rapidly turn the controller on and off 5 times to reset the controller. If the problem occurs repeatedly, record the sequence of events leading to a yellow light indicator and contact Prior for assistance.
- If the button light is flashing or another colour, review the 'Front LED is flashing' section in this manual.

Verify there are no COM port errors using Device Manager.

- Search Windows > open Device Manager.
- Locate Ports (COM & LPT).
- Identify any COM ports with errors and check that the affected port is the ES12ZETTL by unplugging the replugging the USB connection. Check that communication with the controller is being attempted via the correct COM port.
- If there is an error, review the 'Installing FTDI Drivers' section of this manual.

Verify the controller is in the correct mode.

- Some commands for Z-axis devices may not be accepted by the controller if in Mode 1, similarly commands for other devices may not be accepted if in Mode 0.

Verify the baud rate being used for communication is correct.

- Prior Terminal will accept 9600 baud rate by default.
- Third party software may change the baud rate requirements for Prior Terminal in a way that cannot easily be recovered. If in doubt, power cycle the controller and disconnect and reconnect the USB cable.
- Refer to third party software manuals for appropriate baud rates.

Verify that the controller is not communicating with another software instance.

- Shut down any other software that may be communicating with the ES12ZETTL.

Possible simple resolutions to communications problems.

- Disconnect and reconnect the USB cable.
- Power cycle the controller once or power cycle the controller 5 times to fully reset the controller without needing communication with the computer.
- If a communication connection can be made temporarily, send a reset command to the controller.
- Attempt to reinstall the controller firmware. Check the downloads section of prior.com or contact Prior for assistance.

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Device fails to respond to commands

If your controller is detected but your device isn't moving, the first step should be to check device manager. The controller may be detected but if the system is running old FTDI drivers, commands may not be processed correctly.

Please review the 'Installing FTDI drivers' section of this manual for further instruction.

Next, go to Prior Terminal and use the **?** Command to check for drive chips. You should see the line "DRIVE CHIPS 001000" or "DRIVE CHIPS 000100". If you see "DRIVE CHIPS 000000" then your axis drive has failed and you should contact Prior to arrange RMA.

If you see a drive chip, ensure that your mode is correct. **MODE,0** should be used if you are using a focus motor (PS3H122R) or focus block (FB203/FB210) variant, or **MODE,1** if you are using a filter wheel, filter turret, nosepiece, or other OEM device.

Finally, if your device is still not responding to any commands from Prior Terminal, but reports a command starting with E (E,2 / E,15), you should consult the error table below to identify the issue.

Error	Error Number
No Error	0
No Stage	1
Not Idle	2
No Drive	3
String Parse	4
Command Not Found	5
Invalid Shutter	6
No Focus	7
Value Out of Range	8
Invalid Wheel	9
Arg1 Out of Range	10
Arg2 Out of Range	11
Arg3 Out of Range	12
Arg4 Out of Range	13
Arg5 Out of Range	14
Arg6 Out of Range	15
Incorrect State	16
No Filter Wheel	17
Queue Full	18

Error	Error Number
Comp Mode Set	19
Shutter Not Fitted	20
Invalid Checksum	21
Not Rotary	22
No Fourth Axis	40
Autofocus in Progress	41
No Video	42
No Encoder	43
SIS Not Done	44
No Vacuum Detector	45
No Shuttle	46
Vacuum Queued	47
SIZ Not Done	48
Not Slide Loader	49
Already Preloaded	50
Stage Not Mapped	51
Trigger Not Fitted	52
Interpolator Not Fitted	53

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Encoder Errors

Encoder issues can be indicated by multiple different symptoms that may be noticed during usual operation of the ES12ZETTL. The easiest to identify is the front LED of the controller illuminating red, as indicated in the table below.

Flashing LED Colour	LED Flash Interval	Error
Red	Flashing 0.5 Interval, then Pause	Axis Encoder Error
Red	Not Flashing	Encoder Failed

If the light is indicating the axis encoder error, the first troubleshooting step should be to turn the system off, leave it for 60 seconds, and then turn the system back on again and reinitialize the setup if required.

If possible, the encoder readhead should be inspected while moving the device to ensure that the encoder light remains green except when it passes through the indicator mark when it should turn red.

If this isn't possible due to the location of the encoder readhead, reach out to Prior for additional assistance.

If the light is indicating that the encoder has failed, the first step should be to check all connections. Power down the system and remove all cables from the ES12ZETTL, checking each connector to ensure no pins have been bent, damaged, or snapped off. Once checked, securely reconnect each device.

Open Prior Terminal and use the command **MODE** to check that your system is in the correct usage mode. Mode 0 for focus devices and Mode 1 for filter, turret, nosepiece, and other OEM devices. If not in the correct mode, use **MODE,0** or **MODE,1** to switch to the correct mode.

If using an encoded focus device, the command **ENCODER** can also query the encoder to ensure it is responding as expected. A response of **4** indicates that the encoder is being recognised, while a response of **0** indicates that the encoder is not recognised and the issue is a physical fault.

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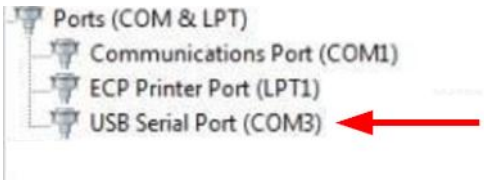
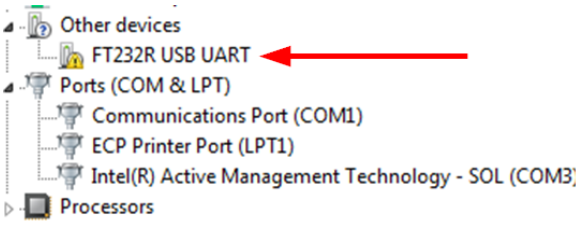
Installing FTDI Drivers

When a PC is not connected to the internet and an older or no FTDI driver is installed onto the PC there can be problems communicating via USB. The driver can appear to have installed correctly and yet not communicate.

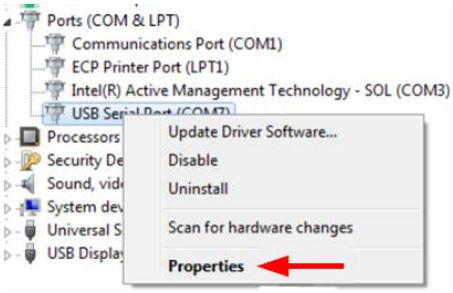
The image to the right is from the Device Manager of a PC where the Prior FTDI USB driver has set up COM3 on the PC, but USB communications is still unavailable.



Alternatively, on some installs, the USB connection can show up under “Other Devices” as “FT232R USB UART”



Right clicking on the Prior controller USB port in Device Manager will allow you to click on the “Properties” menu.



In the “Properties” window, click on the “Driver” tab and view the “Driver Date”. If it is older than 2016 or if the Driver Provider is not listed as FTDI, see the image to the right, a new driver needs to be installed.

If the PC does not have internet access, the files can be loaded onto the PC via a USB stick.

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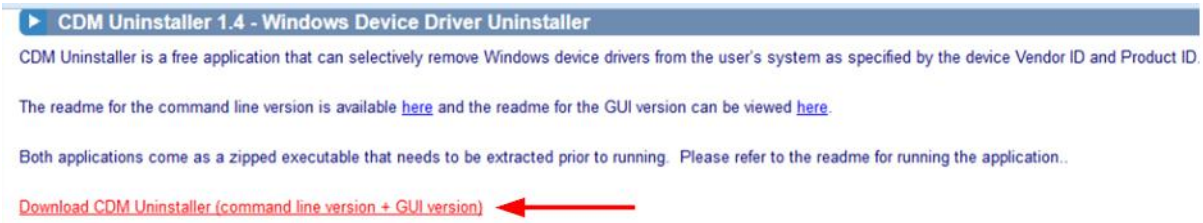
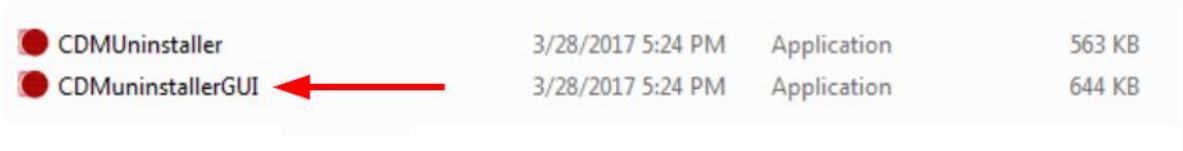
It is recommended to uninstall the existing FTDI drivers. There is an uninstaller tool that can be accessed from http://www.ftdichip.com/Support/Utilities.htm#CDMUninstaller

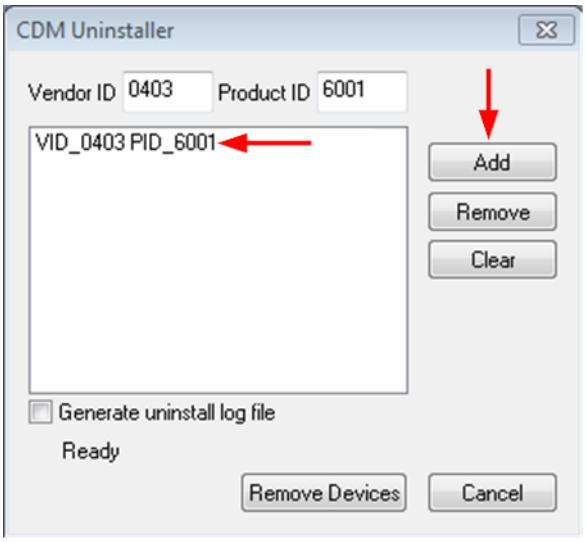
From the website download the “CDM Uninstaller” as shown below.

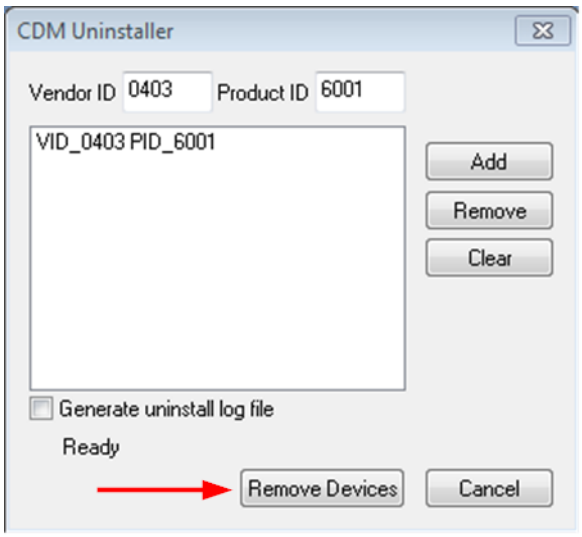


Extract all the files and run the CDMuninstallerGUI.exe



Click the “Add” button on the right and the Vendor ID and Product ID will be populated inside the blank area. When these are populated, click “Remove Devices”.





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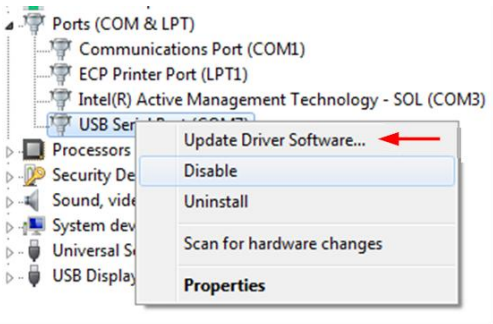
Download the latest USB Driver version from http://www.ftdichip.com/Drivers/VCP.htm

Download the appropriate 32 or 64 bit driver as shown below.

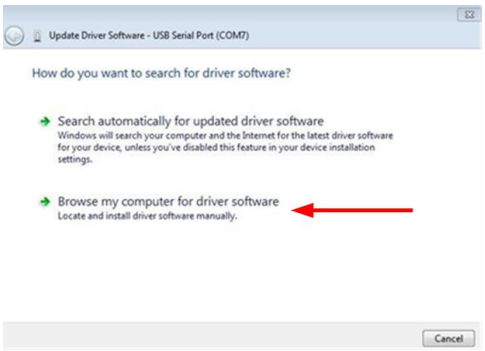
		Processor Architecture							
Operating System	Release Date	X86 (32-Bit)	X64 (64-Bit)	PPC	ARM	MIPSII	MIPSIV	SH4	Comments
Windows (Desktop)*	2025-03-04	2.12.36.20	2.12.36.20	–	2.12.36.20A*** *	–	–	–	WHQL Certified. Includes VCP and D2XX. Available as a setup executable (non-ARM64). Please read the Release Notes and Installation Guides.
Windows (Universal)***	2025-03-04	2.12.36.20U	2.12.36.20U	–	2.12.36.20UA	–	–	–	WHQL Certified. Includes VCP and D2XX.

Extract all of the files to the desktop or other download folder.

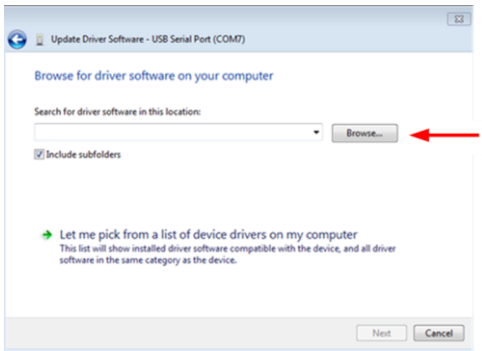
In Device Manager, right click on the USB Serial Port and choose “Update Driver Software”



Choose “Browse my computer for driver software”



Choose “Browse my computer for driver software”



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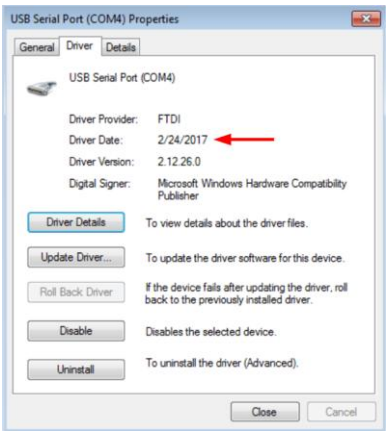
Windows will then update the Driver using the downloaded files.

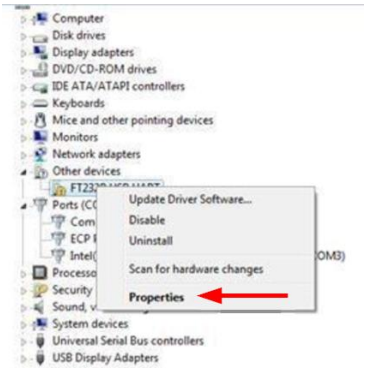
A successful installation will show a new date in the USB properties as shown below.

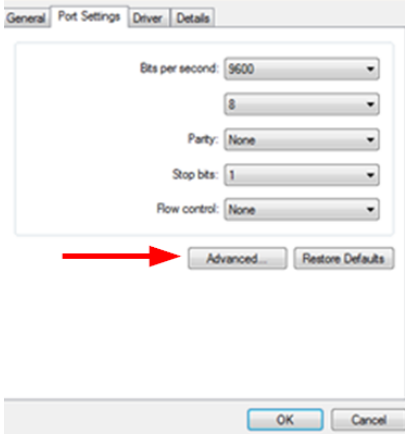


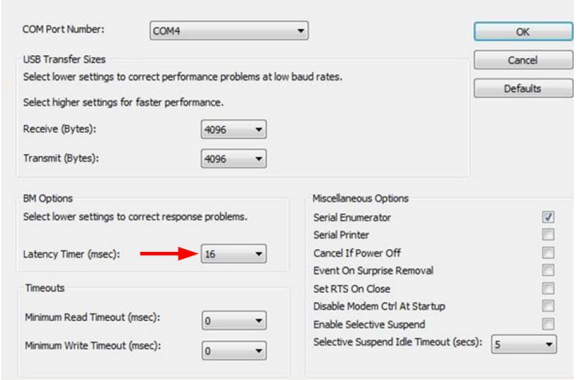
If at this point, a COM port has not been assigned to your USB connection, retry “Update Driver Software” as in some instances Windows will not assign a proper COM port the first time the driver is updated.

At this point, it is advisable to adjust the USB latency timer from the standard 16ms down to 2ms.

Right click on the new COM port and choose “Properties”. From the “Port Settings” tab, click on “Advanced”. In the “Advanced” tab, change the Latency Timer from 16 to 2.







Click OK twice to save the Latency Timer change.

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Additional Information

S-Curve vs Trapezoidal Acceleration

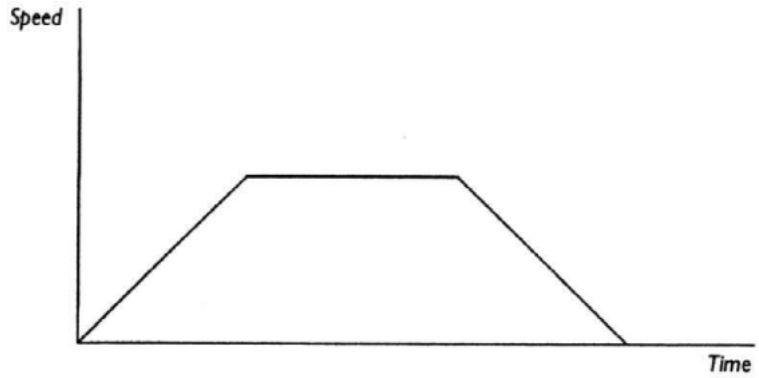
Step motors, for years, have been accelerated with a standard trapezoidal acceleration. An example of trapezoidal acceleration is shown to the right: This method of motor acceleration has a great impact on the performance of the system

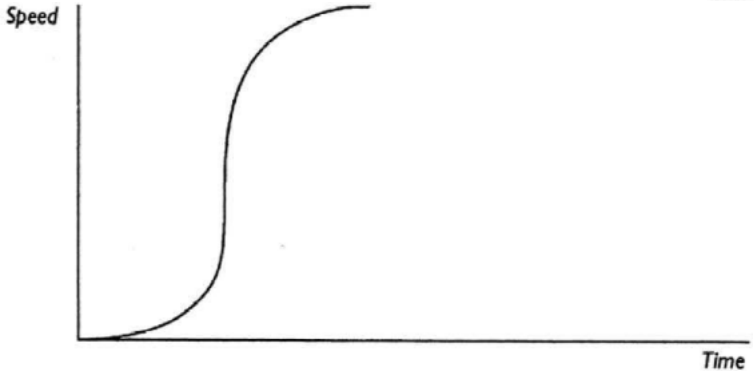
The trapezoidal acceleration causes the stage to jerk as it starts, switches from acceleration mode to maximum velocity mode, and switches from maximum velocity mode to deceleration mode. (Note the sharp corners on the graph). This can cause the stage to vibrate and that can increase stage settling time.

The ES12ZETTL controller accelerates the stage via the S-curve as shown to the right

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.





Information for Customers in China

The information in this section is only for the use of customers in China.

Name and Content of Hazardous Substances in Products						
Substances	Hazardous Substances					
	Lead and its compounds (Pb)	Mercury and its compounds (Hg)	Cadmium and its compounds (Cd)	Hexavalent Chromium and its compounds (Cr(VI))	PBB (PBB)	PBDE (PBDE)
Mechanical Components	X	O	O	O	O	O
Electrical Components	X	O	O	O	O	O

This table was prepared according to regulation SJ/T 11364

A 'O' indicates that the level of this substance is below the limit of GB/T26572 in all materials used in this component.

A 'X' indicates that the level is above the limit of GB/T26572 in all materials used in this component.

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Glossary Of Terms

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

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 ES12ZETTL controller to be backwards compatible with legacy controllers. See the “COMP” general command. Compatibility Mode is “COMP,1”

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

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

Encoder – A feedback device which provides positional information for a focus drive assembly. Encoders can be either 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 motorised 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 this is 100 microns per revolution of the fine focus knob.

Flash Memory Capability – The ability of the ES12ZETTL 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.

Imaging Packages – The general class of computer software including stereology and image analysis which utilize motorised stage and/or focus drives.

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

Legacy Commands – The set of serial commands that are common between older legacy controllers. See also: Compatibility Mode

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 number of pulses to the motor to achieve the required movement.

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

Prior Scientific Software – Term for the whole software package that is downloaded from the Prior website. Includes “Prior Terminal” and “Prior Test”.

Prior Terminal – Part of “Prior Scientific Software”, allows serial commands to be entered and acted upon.

Prior Test – GUI used to control the Prior controller and peripherals.

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 computers COM port travel to the controller via RS-232.

Serial Control – A typical 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.

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.

Standard Commands – The set of commands in the Prior controller 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 U or D command. This is also the movement of 1 pulse or the minimum focus movement.

Stepper Motor – A motor which when current is applied generates a holding torque. The motor is rotated by switching the coil 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).

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

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About Prior Scientific

Prior Scientific has manufactured precision optical and electromechanical equipment and instrumentation for over 100 years.

As the leader in the development of systems for precision motion control and microscope automation, we work closely with our partners and customers to develop customized optical and automation systems as well as providing a wide range of standard microscopy components.

We partner with system integrators and OEMs to develop prototypes, custom-built products, and complete imaging system solutions according to individual customer requirements for a variety of applications. Our integrated design and manufacturing facilities enable us to seamlessly transition from concepts to production systems.

Typical applications for our products are found in photonics, life science research, material science, nanotechnology, medical devices, metrology, and semiconductor manufacturing.

Our mission

We understand that every problem requires a unique approach. Our team works closely with customers and partners to identify their specific needs and design a cost-effective and tailored solution that meets their unique requirements. We continue to push scientific boundaries and constantly build on and improve our expertise in automated precision optical and mechanical systems.

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