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KPZ101
Piezo Driver

Kinesis User Guide



Original Instructions

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Chapter 1 Overview

1.1 Introduction

The K-Cube Piezo Controller (KPZ101) is a compact single channel controller/driver for easy manual and automatic control of a wide range of piezo stacks and actuators. This driver is capable of delivering up to 150V of drive voltage at 7.5mA - allowing operating bandwidths up to 1kHz (see specs). The KPZ101 provides immediate 'out of the box' operation with the Thorlabs complete range of bare piezo stacks, piezo equipped actuators and piezo driven mirror mounts.

Furthermore, when operated together with the K-Cube Strain Gauge Reader unit (KSG101), high precision closed loop operation is possible using the complete range of feedback equipped piezo actuators available from Thorlabs.

For convenience the footprint of this unit has been kept to a minimum, measuring only 60mm x 60mm x 47mm (2.36” x 2.36 x 1.85”) and with the facility to directly mount to the optical table close to the device under control. Table top operation also allows minimal drive cable lengths for easier cable management. All manual controls are located on the top face of the unit – very convenient when manually adjusting piezo positions using the digitally encoded adjustment pot and easy to read voltage display (with brightness adjustment).



Fig. 1.1 K-Cube Piezo Driver (KPZ101)

Although compact in footprint, this unit offers a fully featured piezo control capability. To support a wide variety of piezo devices the output range can be user selected to 75V, 100V or 150V. The resolution of the digitally encoded adjustment pot is easily altered to provide very accurate positioning control. Direct hardware control of the high voltage output can be facilitated using the low voltage input connector.

A low voltage output connector allows for easy monitoring of the HV output (using a scope for example). Open or closed loop operation is a simple button click.

USB connectivity provides easy 'Plug and Play' PC controlled operation - multiple units can be connected to a single PC via standard USB hub technology or by using the new K-Cube Controller Hub (see over) for multi-axis motion control applications. Coupling this with the user friendly Kinesissoftware (supplied) allows the user to get up and running in a short space of time. Advanced custom motion control applications and sequences are also possible using the programming environment supplied. This programming library is compatible with many development tools such as LabView, Visual Basic, Visual C++, C++ Builder, LabWindows/CVI, Matlab and Delphi.

See Section 1.3. for a full description of the Kinesis system software.

In the remainder of this handbook, the Tutorial section (Chapter 5) provides a good initial understanding on using the unit, and the reference section (Chapter 6) covers all operating modes and parameters in detail.

1.2 Power Options

For power, a compact two-way power supply unit (TPS002) is available from Thorlabs allowing up to 2 K-Cube Piezo Drivers to be powered from a single mains outlet. This power supply unit is also designed to take up minimal space and can be mounted to the optical table in close proximity to the driver units, connected via short power leads.

As a further level of convenience when using the K-Cube Controllers Thorlabs also offers the 3-channel and 6-channel K-Cube Controller Hubs (KCH301 and KCH601). These products have been designed specifically with multiple K-Cube operation in

mind in order to simplify issues such as cable management, power supply routing, multiple USB device communications and different optical table mounting scenarios.

The K-Cube Controller Hub comprises a slim base-plate type carrier with electrical connections located on the upper surface to accept the K-Cubes.

Internally the Controller Hub contains a fully compliant USB 2.0 hub circuit to provide communications for all K-Cubes – a single USB connection to the Controller Hub is all that is required for PC control. The Controller Hub also provides power distribution for the K-Cubes, requiring only a single power connection.

1.3 Kinesis PC Software Overview

1.3.1 Introduction

The K-Cube range of controllers share many of the benefits. These include USB connectivity (allowing multiple units to be used together on a single PC), fully featured Graphical User Interface (GUI) panels, and extensive software function libraries for custom application development.

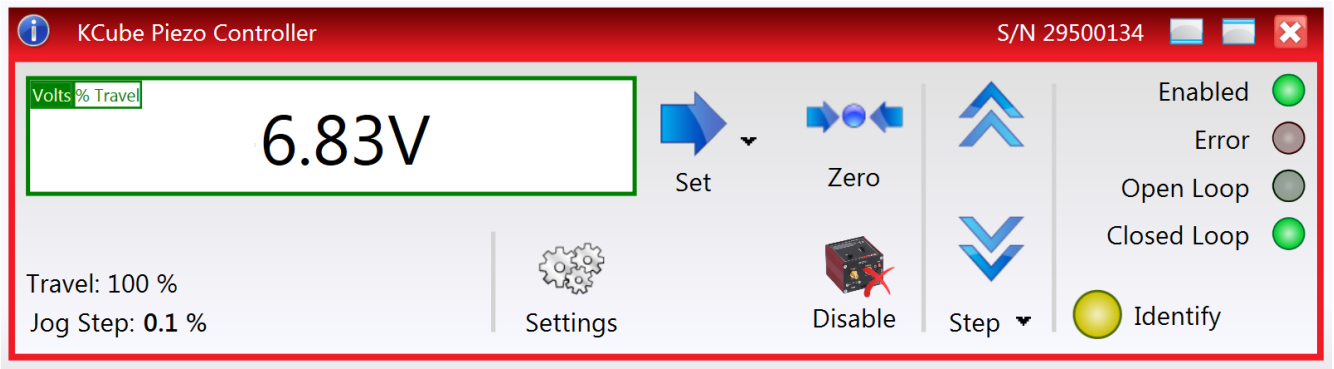
The Kinesis software suite provides a flexible and powerful PC based control system both for users of the equipment, and software programmers aiming to automate its operation.

The User Interface allows full control of all settings and operating modes enabling complete 'out-of-box' operation without the need to develop any further custom software. It provides all of the necessary system software services such as generation of GUI panels, communications handling for multiple USB units, and logging of all system activity to assist in hardware trouble shooting. The Kinesis server is also used by software developers to allow the creation of advanced automated positioning applications very rapidly and with great ease. The server is described in more detail in the following section.

1.3.2 Kinesis Server

With the Kinesis system, .Net Controls are deployed to allow direct control over (and also reflect the status of) the range of electronic controller units, including the Piezo K-Cube. Software applications that use .Net Controls are often referred to as 'client applications'. A .Net Control is a language independent software component. Consequently the controls can be incorporated into a wide range of software development environments for use by client application developers. Development environments supported include Visual Basic, Labview, Visual C++, C++ Builder, HPVEE, Matlab, VB.NET, C#.NET and, via VBA, Microsoft Office applications such as Excel and Word.

Consider the control supplied for the KPZ101 Piezo driver unit.



This Control provides a complete user graphical instrument panel to allow the piezo unit to be manually operated, as well as a complete set of software functions to allow all parameters to be set and operations to be automated by a client application. The instrument panel reflects the current operating state of the driver unit to which it is associated (e.g. such as piezo drive voltage). Updates to the panel take place automatically when a user (client) application is making software calls into the same Control. For example, if a client application instructs the associated Piezo Control to move an actuator, the progress of that move is reflected automatically by changing position readouts on the graphical interface, without the need for further programming intervention.

The Kinesis Controls collection provides a rich set of graphical user panels and programmable interfaces allowing users and client application developers to interact seamlessly with the Kinesis hardware. Each of the Kinesis controllers has an associated .Net Control and these are described fully in the handbooks associated with the controllers.

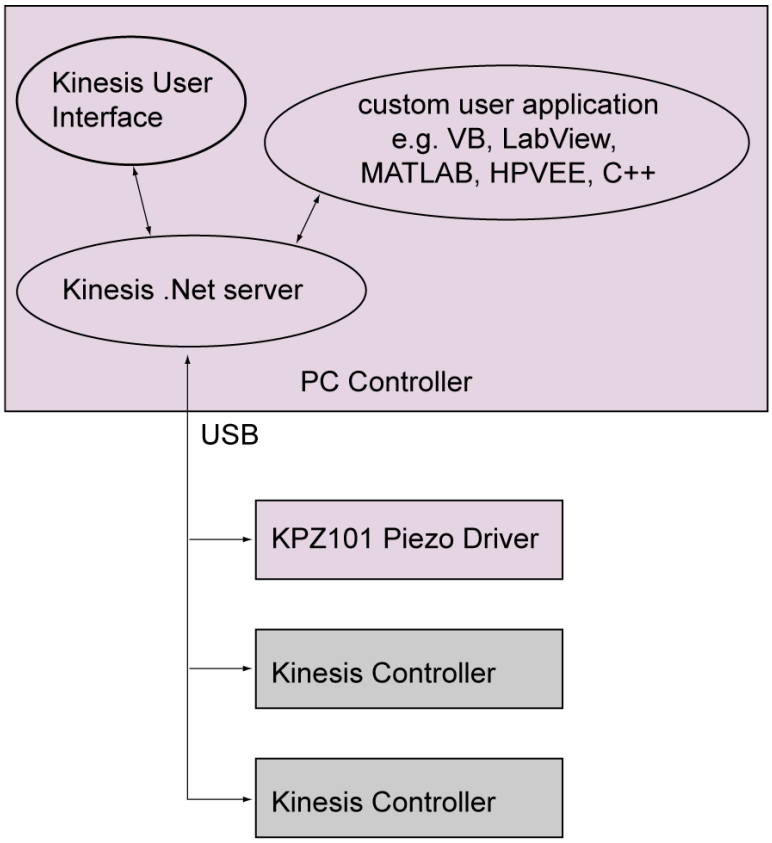


Fig. 1.2 System Architecture Diagram

Refer to the main Kinesis Software online help file, for a complete programmers guide. This is available either by pressing the F1 key when running the Kinesis server, or via the Start menu, Start\Programs\Thorlabs\Kinesis\Kinesis Help.

1.3.3 Software Upgrades

Thorlabs often releases updated firmware for bug fixes and support for new features. We recommend all users to download the latest version of software and use the included firmware update utility. Failure to do this could result in stages not being recognized by the latest controllers.

Chapter 2 Safety

2.1 Safety Information

For the continuing safety of the operators of this equipment, and the protection of the equipment itself, the operator should take note of the **Warnings, Cautions,** and **Notes** throughout this handbook and, where visible, on the product itself.

The following safety symbols may be used throughout the handbook and on the equipment itself.



Warning: Risk of Electrical Shock

Given when there is a risk of injury from electrical shock.



Warning

Given when there is a risk of injury to users.



Caution

Given when there is a risk of damage to the product.

Note

Clarification of an instruction or additional information.

2.2 General Warnings



Warning

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. In particular, excessive moisture may impair operation.

This product generates, uses and outputs high voltages from the SMC connector (HV Output) that are hazardous and can cause serious injury. In any installation that uses the KPZ101 it is the user's responsibility to ensure adequate insulation and precautions are taken to avoid shock risk. Cables for HV Out must be rated for 250 V RMS.

Spillage of fluid, such as sample solutions, should be avoided. If spillage does occur, clean up immediately using absorbant tissue. Do not allow spilled fluid to enter the internal mechanism.

Chapter 3 Getting Started

3.1 Install The Software.

Caution

Some PCs may have been configured to restrict the users ability to load software, and on these systems the software may not install/run. If you are in any doubt about your rights to install/run software, please consult your system administrator before attempting to install.

If you experience any problems when installing software, contact Thorlabs on +44 (0)1353 654440 and ask for Technical Support.

Note

This section is applicable only if the K-Cube is to be used with a PC. If your application consists only of local operation via the K-Cube front face, proceed to Section 3.2.

When operating via a PC, direct user interaction with the Piezo driver is accomplished through intuitive graphical user interface panels (GUIs), which expose all key operating parameters and modes. The user can select multiple panel views displaying different information about a particular hardware unit. The multitasking architecture ensures that the graphical control panels always remain live, showing all current hardware activity.

DO NOT CONNECT THE CONTROLLER TO YOUR PC YET

1) Go to Services/Downloads at www.thorlabs.com and download the software.
2) Run the .exe file and follow the on-screen instructions.

3.2 Mechanical Installation

Warning

The safety of any system incorporating this equipment is the responsibility of the person performing the installation.

3.2.1 Environmental Conditions

Warning

Operation outside the following environmental limits may adversely affect operator safety.

Location	Indoor use only
Maximum altitude	2000 m
Temperature range	5°C to 40°C
Maximum Humidity	Less than 80% RH (non-condensing) at 31°C

To ensure reliable operation the unit should not be exposed to corrosive agents or excessive moisture, heat or dust.

If the unit has been stored at a low temperature or in an environment of high humidity, it must be allowed to reach ambient conditions before being powered up.

3.2.2 Mounting Options

The K-Cube Piezo Driver is shipped with a baseplate, for use when fitting the unit to a breadboard, optical table or similar surface.

For multiple cube systems, a 3-channel and 6-channel K-Cube Controller Hub (KCH301 and KCH601).) are also available - see Section 1.2. for further details. Full instructions on the fitting and use of the controller hub are contained in the handbook available at www.thorlabs.com

Caution

When siting the unit, it should be positioned so as not to impede the operation of the control panel buttons.

Ensure that proper airflow is maintained to the rear of the unit

3.2.3 Using the Baseplate

The baseplate must be bolted to the worksurface before the K-Cube is fitted, as shown below. The K-cube is then located on two dowels in the baseplate and secured by two clips.

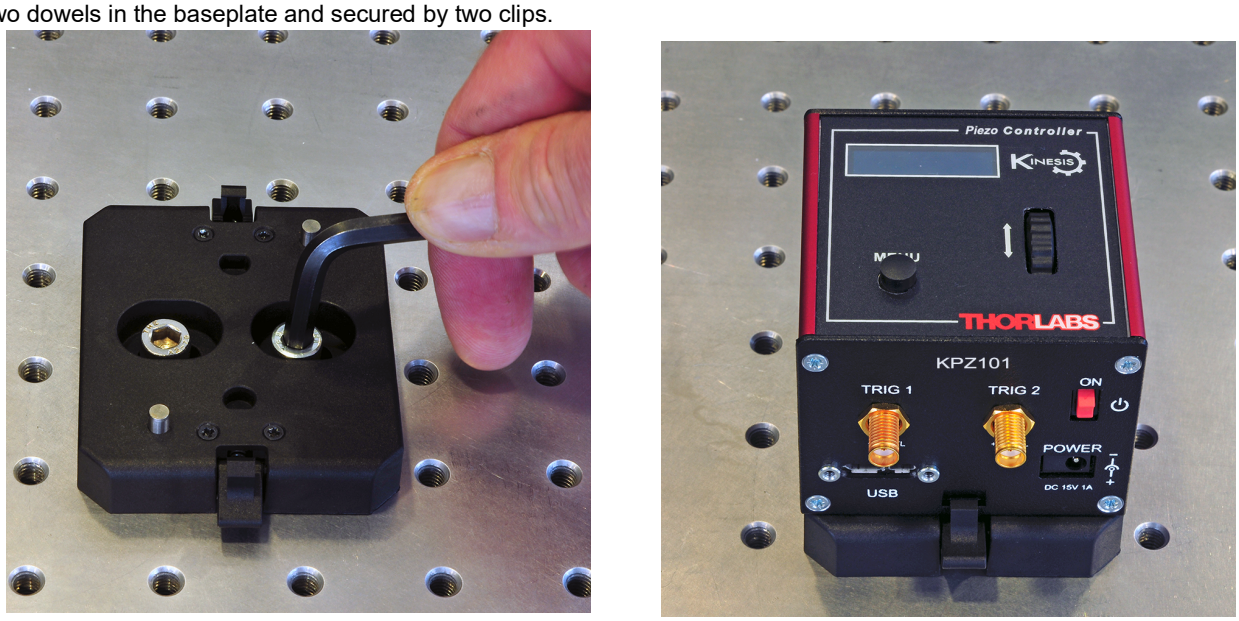


Fig. 3.1 Using The Baseplate

3.3 Electrical Installation

3.3.1 Rear Panel

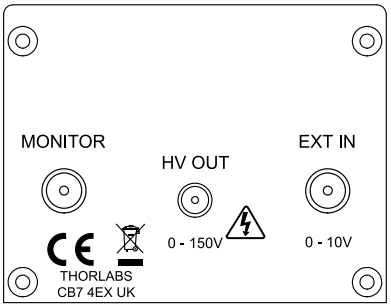


Fig. 3.2 Rear Panel Connections

HV OUT (SMC connector) – 0 to 150V, 0 to 7.5mA. Provides the drive signal to the piezo actuator. The maximum voltage (75V, 100V or 150V) is set via the top panel (see Section 4.4.3.) or via the APTsoftware 'Settings' panel (see Section 6.2.).

EXT IN (SMA connector) – Used to connect an external analogue signal source to control the operation of the cube. The input voltage range is 0 to +10V and the input impedance is 12 kΩ.

The way the signal driving the EXT IN input controls the unit depends on the operating mode. In *open loop* mode, the voltage on the EXT IN input can be used to drive the high voltage amplifier directly and the output voltage is proportional to the driving voltage. In *closed loop* mode, EXT IN can be used as a position feedback input, designed to be driven by an external position reader (such as the KSG101 Strain Gauge Reader). These operating modes are detailed in Section 5.3. to Section 5.6.

Caution

In open loop mode, the EXT IN connector drives the HV amplifier circuit directly. If an external input is used, the output voltage limits (i.e. 75V, 100V or 150V) can be exceeded.

MONITOR (SMA connector) – This low-voltage (0 to +10V), output can be used to monitor the signal at the HV OUT high voltage output. In its most common use, it can be connected directly to an oscilloscope to observe the waveforms or voltage levels present at the high voltage output.

Note

The KPZ101 has two main, selectable output voltage ranges of 0 to 75V or 0 to 150V, to allow driving piezo actuators with different drive requirements. (In addition, there is a 100V limit for operation under software control). Regardless of which range is selected, the input and output voltage range on the EXT IN and MONITOR connectors is always 0 to +10V full scale.

Note

Thorlabs supply a variety of SMA to BNC and SMC to BNC adaptor and extension cables. Please see our catalog, or visit www.Thorlabs.com for further details.

3.3.2 Supply Voltage and Current Requirements

Supply	Minimum	Maximum	Max Operating Current
+5V	+4.9V	+5.1V	350 mA
+15V	+14.5V	+15.5V	220 mA
-15V	-14.5V	-15.5V	50 mA

3.3.3 Front Panel

Warning

The unit must be connected only to a DC supply as detailed in Section 3.3. Connection to a supply of a different rating may cause damage to the unit and could result in injury to the operator.

Caution

Ensure the power switch on the front panel of the unit is switched off before connecting power to the K-Cube. Always power up the K-Cube unit by its ON switch. DO NOT connect the K-Cube unit to a 'live' external power supply. Doing so (i.e. “hot plugging”) carries the risk of PERMANENT damage to the unit. Similarly, to power down the unit, turn the power switch off before disconnecting the power supply.

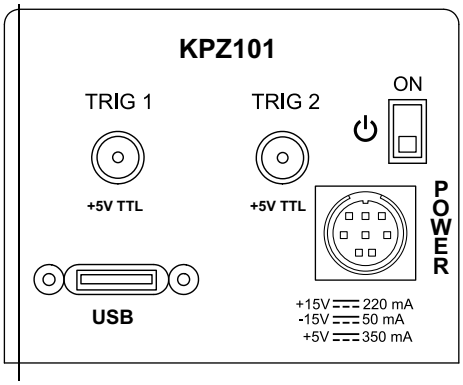


Fig. 3.3 Front Panel

POWER - Eight pin connector for connecting the unit to a regulated DC power supply of the rating detailed in Section 3.3.

USB - USB port for system communications.

Note

The USB cable length should be no more than 3 metres unless a powered USB hub is being used.

ON - Power ON/Standby switch - seeSection 3.3.5.

TRIG 1 and TRIG 2 - SMA connectors for use with external trigger input and output signals (5V TTL levels). The function is set to trigger IN or OUT via the settings panel - see Section 6.2.3.

3.3.4 Connecting to a Power Supply

Warning

The unit must be connected only to a DC supply as detailed in Section 3.3. Connection to a supply of a different rating may cause damage to the unit and could result in injury to the operator.

Caution

Ensure the power switch on the front panel of the unit is switched off before connecting power to the K-Cube. Always power up the K-Cube unit by its ON switch. DO NOT connect the K-Cube unit to a 'live' external power supply. Doing so (i.e. “hot plugging”) carries the risk of PERMANENT damage to the unit. Similarly, to power down the unit, turn the power switch off before disconnecting the power supply.

1) Using the front panel connector as shown above, connect the unit to a regulated DC power supply of the rating detailed in Section 3.3.
2) Switch on the Power Supply unit, then switch on the KPZ101.
3) The Version number of the embedded software is displayed for a few seconds.

Thorlabs offers a compact, two-way power supply unit (TPS002), allowing up to two piezo driver K-Cubes to be powered from a single mains outlet. However, if an external supply is to be used, see Appendix A.1 for power supply connector pin out details.

Caution

If an external power supply is used, ensure that the 3 supply voltages are turned on and off simultaneously. Applying the supply voltages with a large (more than 1 second) time delay between them can result in the piezo cube showing an incorrect reading.

3.3.5 Powering Down The Unit

Warning

The controller may cause drive voltage spikes on power down. In applications requiring the highest sensitivity, the piezo drive voltage should be set to zero, and the HV cable disconnected before the unit is powered down.

Always be use the front panel ON switch to power down the unit. When in the ON position, the unit is fully powered up. When the switch is turned to the Standby position, the unit initiates a controlled power down sequence, saving all user-adjustable parameters to non-volatile memory before turning off the power. For the first few seconds, the shutdown can be cancelled by turning the switch on again, in which case the unit will save the parameters but will remain powered up. In a powered down (Standby) state, the logic circuits are powered off and the unit will draw only a small quiescent current.

3.4 Connect The Hardware

1) Perform the mechanical installation as detailed in Section 3.2.
2) Install the Kinesis Software.

Caution

During items (3) to (6) the instructions should be followed strictly in the order stated. Problems may occur if the process is not performed in the correct sequence.

3) Connect the Controller unit to your PC.
(**Note**. The USB cable should be no more than 3 metres in length. Communication lengths in excess of 3 metres can be achieved by using a powered USB hub).

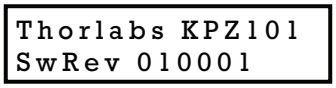
Caution

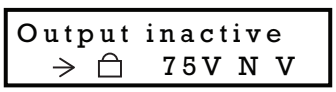
During item (4) ensure the power supply unit is isolated from the mains before connecting to the K-Cube unit. Always power up the K-Cube unit by connecting its power supply to the mains. DO NOT connect the K-Cube unit to a 'live' external power supply. Doing so (i.e. “hot plugging”) carries the risk of PERMANENT damage to the unit. Similarly, to power down the unit, disconnect the power suply from the mains before disconnecting the K-Cube unit.

4) Connect the piezo actuator to the Controller unit - see Section 3.3.1.
5) Connect the Controller unit to the power supply - see Section 3.3.2.
6) Connect the PSU to the main supply.
7) Switch ‘ON’ the unit using the switch on the front panel.

The unit takes about 5 seconds from power application until warm up is finished, during which time the software revision is displayed. Windows™ should detect the new hardware. Wait while Windows™ installs the drivers for the new hardware.

8) The unit starts up with the HV output disabled. This must be enabled before any further settings can be adjusted - see Section 4.4.2..





Note

If any problems are encountered during the connection and power up process, power cycle the unit, which should clear the error.

Chapter 4 Standalone Operation

Warning: Risk of Electrical Shock

Persons using the KPZ101 controller must understand the hazards associated with using high voltages and the steps necessary to avoid risk of electrical shock. If the KPZ101 is used in a manner not specified by Thorlabs, the protective features provided by the product may be impaired.

4.1 Introduction

The Piezo Driver K-Cube has been designed specifically to operate with the extensive range of Thorlabs piezo-actuated opto-mechanical products. The unit offers a fully featured open loop control capability, including piezo drive voltage adjustment and input source selection. These parameters can be set via the Kinesis software - see Chapter 5. Furthermore, many of these parameters are automatically set to allow “out of the box” operation with no further “tuning” required.

When the K-Cube Piezo Driver is used in conjunction with the K-Cube Strain Gauge Reader unit (KSG101), high precision closed loop operation is possible using the complete range of feedback equipped piezo actuators available from Thorlabs.

The following brief overview explains how the front panel controls can be used to perform a typical series of piezo moves.

In conjunction with this chapter, it also may be useful to read the background on piezo operation contained in Appendix D.

4.2 Control Panel

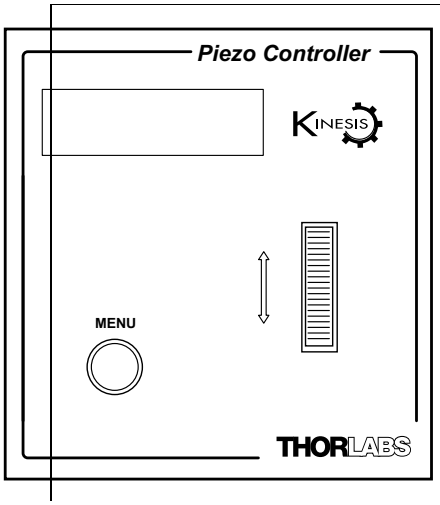


Fig. 4.1 Panel Controls and Indicators

MOVE Controls - These controls allow all motor moves to be initiated.

Velocity Wheel - Used to drive the motor at a varying speed in either forward or reverse directions for full and easy motor control - see Section 4.3.1.

Digital Display - The display shows the menu options and settings, accessed via the menu button - see Section 4.4. When the Ident button on the associated GUI panel is clicked, the display will flash for a short period.

MENU - used to access the settings menu - see Section 4.4.

4.2.1 Digital Display - Operating Mode

During normal operation, the top line of the digital display shows the current drive voltage applied. The bottom line shows various icons which indicate the operating state of the device, i.e. the hazardous voltage warning arrow, the feedback loop mode (see Section 4.4.4.), the unlocked symbol to show the output is enabled (see Section 4.4.2.), the maximum drive voltage of the device being driven (see Section 4.4.3.), the analog input mode (see Section 4.4.5.) and the Joystick mode (see Section 4.4.7.).

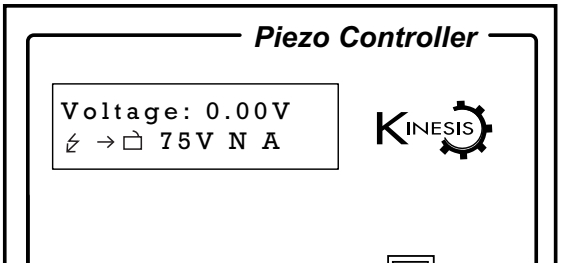


Fig. 4.2 Digital Display - Normal Operation

4.3 Velocity Wheel Operation

The velocity wheel/joystick is an infinite turn potentiometer, which is used to initiate different types of move depending on its mode setting. The mode can be set either via the GUI Settings panel, see Section 6.2.3. or via the top panel display menu, see Section 4.4.

4.3.1 Voltage Adjust Mode

In voltage mode, the wheel can be used to increase and decrease the drive voltage. The voltage change is proportional to the deflection of the wheel - see Section 4.4.7. The rate of change is adjusted in the Joystick Menu parameter - see Section 4.4.8.

4.3.2 Go to Voltage

In ‘Go To Voltage’ mode, two preset voltage values can be specified, such that the drive voltage is set to voltage 1 when the wheel is moved down, and to voltage 2 when it is moved up. These ‘taught’ voltages can be set through the software GUI - see Section 6.2.3. or via the display menu, see Section 4.4.7.

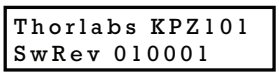
This mode of operation is enabled by setting the ‘Wheel Mode’ to ‘Go to voltage’ through the software GUI - see Section 6.2.3. or via the display menu, see Section 4.4.7.

4.3.3 Jog to voltages

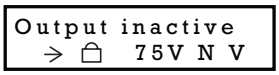
The top panel wheel can also be configured to ‘jog’ the drive voltage. This mode of operation is enabled by setting the ‘Wheel Mode’ parameter to ‘Jog to voltage’ through the software GUI - see Section 6.2.3. or via the display menu, see Section 4.4.7.

4.4 Settings Menu

Before the settings menu can be accessed, the drive output must be enabled as follows..



Press the MENU button

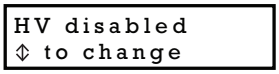




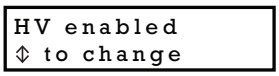
Use the wheel to scroll to the 1 HV output option.



Press the MENU button to enter the option



Use the wheel to scroll to the HV enabled option.



Press the MENU button to save and exit.

4.4.1 Menu Overview

Press the MENU button

Use the wheel to scroll through the menu options
Press the MENU button to enter a particular option

Enable/disable the drive output - see Section 4.4.2.

Set the max drive voltage - see Section 4.4.3.

Set open loop or closed loop mode - see Section 4.4.4.

Set the analogue input source - see Section 4.4.5.

Set the wheel/joystick mode - see Section 4.4.7.

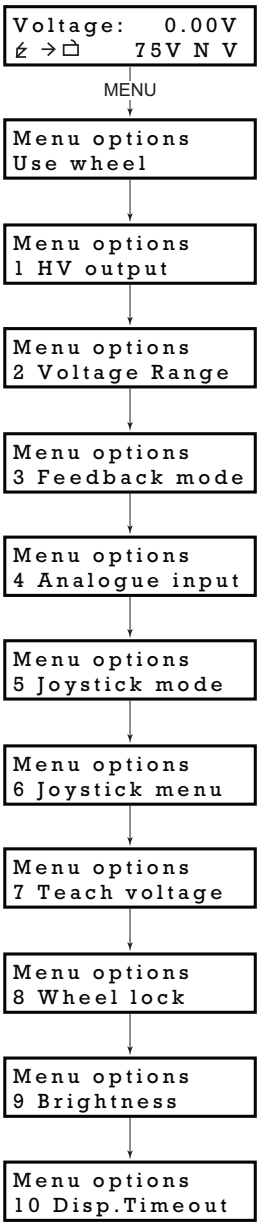
Set the wheel/joystick parameters - see Section 4.4.8.

Set the teach voltages - see Section 4.4.9.

Disable the wheel - see Section 4.4.10.

Set the display brightness - see Section 4.4.11.

Set the display timeout period - see Section 4.4.12.



4.4.2 Menu Option - HV output

This mode is used to enable or disable the drive output.

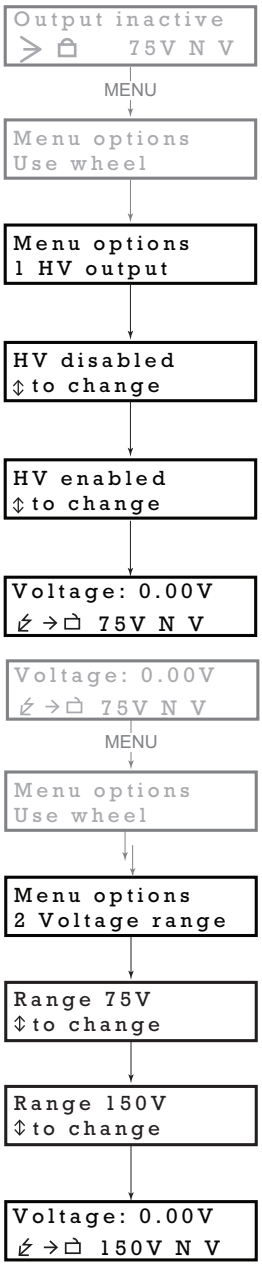
Press the MENU button, then use the wheel to scroll through the menu options.

Press the MENU button to enter the 1 HV output option.

The display shows the current setting.

Use the wheel to enable/disable the output.

Press the MENU button to store the selection and return to the operating screen.



4.4.3 Menu Option - Voltage range

The piezo actuator connected to the cube has a specific maximum operating voltage range. This mode is used to set the maximum drive voltage for the actuator connected to the unit.

Press the MENU button, then use the wheel to scroll through the menu options.

Press the MENU button to enter the 2 Voltage range option.

The display shows the current setting.

Use the wheel to set the voltage associated with your piezo actuator, 75V, 100V or 150V.

Press the MENU button to save the setting and return to the operating screen.

4.4.4 Menu Option - Feedback mode

When the K-Cube Piezo Driver is used in conjunction with the K-Cube Strain Gauge Reader unit (KSG101), high precision closed loop operation is possible using the complete range of feedback equipped piezo actuators available from Thorlabs - see Section 5.3.1. for schematic diagrams of open and closed loop operation.

This mode is used to set the feedback mode.

Press the MENU button, then use the wheel to scroll through the menu options.

Press the MENU button to enter the 3 Feedback mode option.

The display shows the current setting.

Use the wheel to change to the required mode, e.g. Loop closed.

Note. *This setting cannot be saved (persisted), i.e. at subsequent power-up cycles the unit always defaults to open loop mode.*

Caution. *If the Piezo Driver is switch to closed loop mode without being connected to a Strain Gauge Reader, the piezo driver will expect a feedback signal and the piezo drive voltage will ramp up to the maximum limit, either 75V or 150V, whichever is set in software (see Section 6.2.). The 100V limit is only a software setting and in this case, the output will still ramp to 150V.*

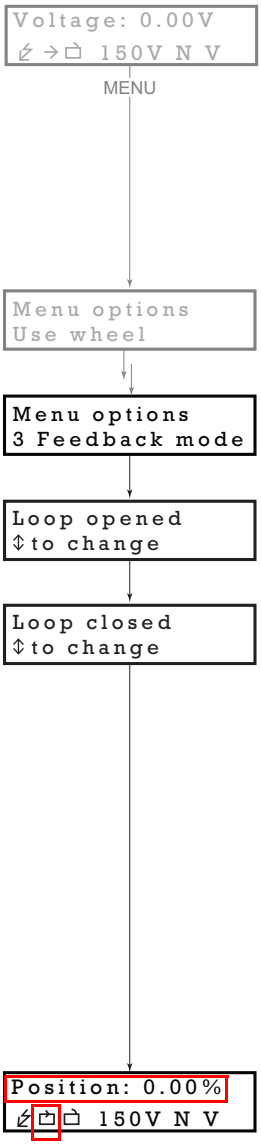
Press the MENU button to save the setting and return to the operating screen.

The selected mode is indicated on the lower line of the display as follows:

Open loop mode →

Closed loop mode

Note that in closed loop, the display shows position as a percentage of the piezo travel range.



4.4.5 Menu Option - Analogue input

The K-Cube piezo driver has 3 external inputs whose function depends on whether the cube is used in open or closed loop mode - see Section 4.4.6.

Press the MENU button, then use the wheel to scroll through the menu options.

Press the MENU button to enter the 4 Analogue input option.

The display shows the current input setting.

If A*nlg Input SMA* is selected, the signal is routed via the Ext IN SMA connector on the rear panel.

If *Anlg In hub(Ch1)* is selected, the feedback signal runs through all the bays - see Fig. 4.3. This setting is useful in applications where a master cube is controlling several slave cubes

If *Anlg In hub(Ch2)* is selected, the feedback signals run between adjacent pairs of K-Cube bays (i.e. 1 and 2, 3 and 4, 5 and 6) - see Fig. 4.3. This setting is useful when several pairs of cubes are being used on the same hub.

If A*nlg Input off* is selected, the analogue input is disabled. In open loop mode, the external input (Ch1, Ch2 or SMA) is used to control the high voltage amplifier.

Note. *This setting applies only to open loop mode, where using an external signal to control the KPZ101 is optional. Closed loop operation is only possible if there is an external feedback signal connected to the unit, so the selected external input is always assumed to have a signal source driving it. Therefore in closed loop mode these settings are ignored.*

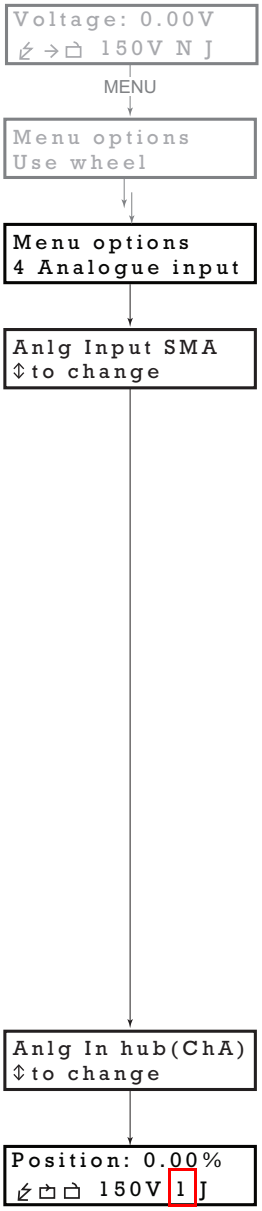
Use the wheel to change to the required input mode.

Press the MENU button to save the setting and return to the operating screen.

The selected mode is indicated on the lower line of the display as follows:

S - Anlg Input SMA *1 - Anlg In hub(Ch1)*

2 - Anlg In hub(Ch1) *N - Anlg Input off*



4.4.6 External Inputs

The K-Cube piezo driver has 3 external inputs whose function depends on whether the cube is used in open or closed loop mode. In open loop mode, the selected input drives the high voltage amplifier directly, whilst in closed loop mode the selected input receives the feedback position signal from the external position reader (such as the KSG101 Strain Gauge Reader).

Of these 3 external inputs, Ch 1 and Ch 2 are routed via the TCH002 K-Cube controller hub, allowing the KPZ101 to be controlled by other cubes on the hub. For example, a combination of a KPZ101 unit with a KSG101 Strain Gauge Reader allows closed loop operation, or two KPZ101 units with a TNA001 NanoTrak cube allows optical beam alignment. As the hub also provides power to the units and USB communications as well as signal routing, there is no need for separate USB leads, power supplies or external cable connection between units.

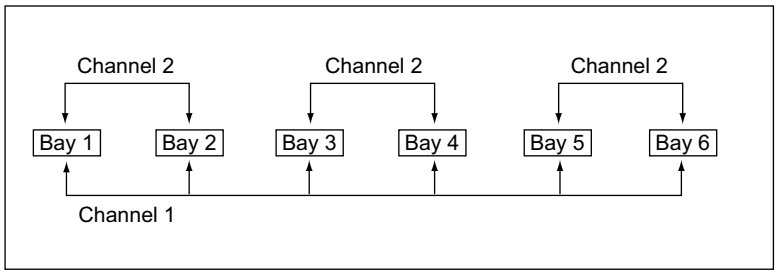


Fig. 4.3 Controller Hub Feedback Channels

If *Channel 1* is selected, the feedback signal runs through all the bays - see Fig. 4.3. This setting is useful in applications where a master cube is controlling several slave cubes.

If *Channel 2* is selected, the feedback signals run between adjacent pairs of K-Cube bays (i.e. 1 and 2, 3 and 4, 5 and 6) - see Fig. 4.3. This setting is useful when several pairs of cubes are being used on the same hub.

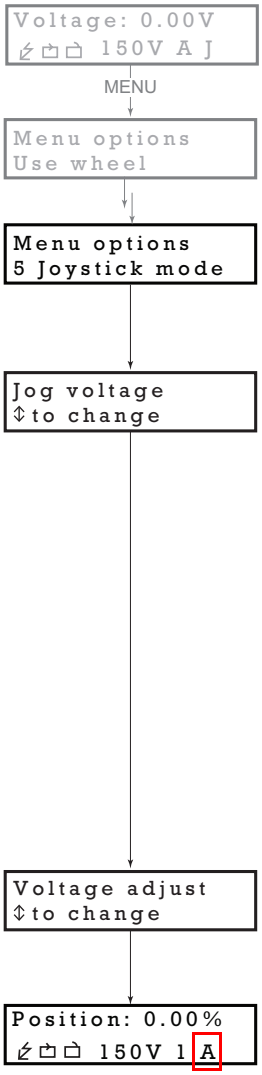
The third input is the EXT IN SMA connector on the rear panel, which can be used if a hub is not available or the controlling signal source is not a member of the K-Cube family of products. For example, even if a hub is not available, the combination of a KPZ101 unit with a KSG101 Strain Gauge Reader described above can still be used for closed loop control but in this case the KSG101 MONITOR output must be connected to the KPZ101 EXT IN input using an external SMA to SMA cable.

Note

When the KPZ101 is used in closed loop mode with the KSG101 Strain Gauge Reader, it is not possible to modulate the KPZ101.

4.4.7 Menu Option - Joystick mode

This mode is used to set the operating mode of the joystick wheel.



Press the MENU button, then use the wheel to scroll through the menu options

Press the MENU button to enter the 5 Joystick mode option. Use the wheel to scroll through the options.

The display shows the current setting.

In *Jog voltage* mode, deflecting the wheel initiates a change in the drive voltage, using the parameters specified by the *Step* parameter in the *6 Joystick menu* option - see Section 4.4.8. The voltage is increased or decreased by one step per click of the wheel.

In *Voltage adjust* mode, the wheel can be used to increase and decrease the drive voltage. The voltage change is proportional to the deflection of the wheel according to the setting in the *Speed* parameter in the
6 Joystick menu option - see Section 4.4.8.

In *Go to voltage mode*, deflecting the wheel changes the voltage from the current value to one of the two predefined “teach voltage” values. The teach voltages are specified in option *7 Teach voltage - see* Section 4.4.9.

Use the wheel to display the required option, then press MENU to store the selection and return to the main display.

The selected mode is indicated at the right hand side of the bottom line:

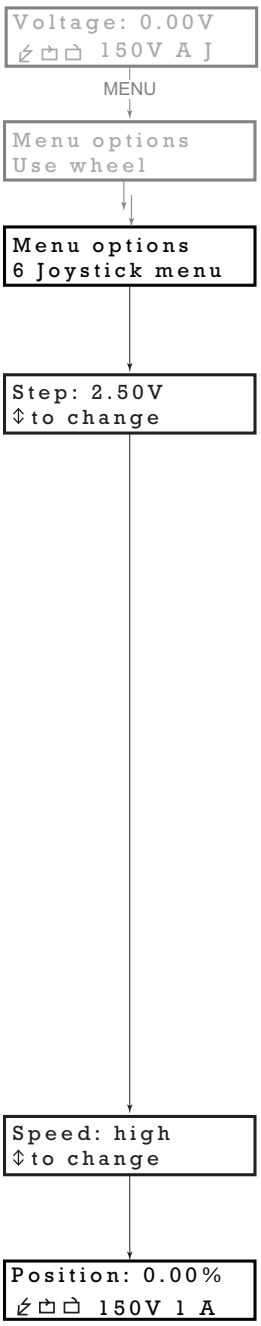
A = Voltage adjust mode

J = Jog to voltage mode

G = Go to voltage

4.4.8 Menu Option - Joystick menu

This mode is used to set various parameters depending on the Joystick mode setting - see Section 4.4.7.



Press the MENU button, then use the wheel to scroll through the menu options.

Press the MENU button to enter the 6 Joystick menu option.

The display shows the current setting.

If *Jog voltage* Joystick mode is selected in the previous section, deflecting the wheel initiates a change in the drive voltage, using the parameters specified by the *Step* parameter. To change the step size, click the MENU button when this option is displayed, then turn the wheel to adjust the step size.

Press MENU to store the selection and return to the main display.

If *Voltage adjust* Joystick mode is selected in the previous section, the wheel can be used to increase and decrease the drive voltage. The voltage change is proportional to the deflection of the wheel according to the setting in the *Speed* parameter as follows:

Speed: high - Voltage adjusts at a high rate,
i.e. 1 V per detent/click.

Speed: medium - Voltage adjusts at a medium rate, i.e. 100 mV per detent/click.

Speed: low - Voltage adjusts at a low rate,
i.e. 10 mV per detent/click.

The size of the step is as set in the *Step* parameter above.

To change the adjustment rate, click the MENU button when the *Speed:* option is displayed, then turn the wheel to adjust the step size.

Press MENU to store the selection and return to the main display.

4.4.9 Menu Option - Teach voltage

This mode is used to set the teach positions, used when the *Joystick mode* option is set to *Go to voltages* mode - see Section 4.4.7.

To set Teach Voltage 1...

Using the method described in Section 4.4.7. and Section 4.4.8. set the drive voltage to the value required as teach voltage 1, then...

press the MENU button, and use the wheel to scroll through the menu options.

Press the MENU button to enter the 7 Teach voltage option.

Use the wheel to select V1, then press the MENU button to store the present voltage setting as teach voltage 1 and return to the main display.

When *Go to voltages* mode is selected in the *Joystick mode* option (see Section 4.4.7.), an upwards deflection of the wheel changes the drive voltage to V1, and an downwards deflection changes the drive voltage to V2.

To set Teach Voltage 2...

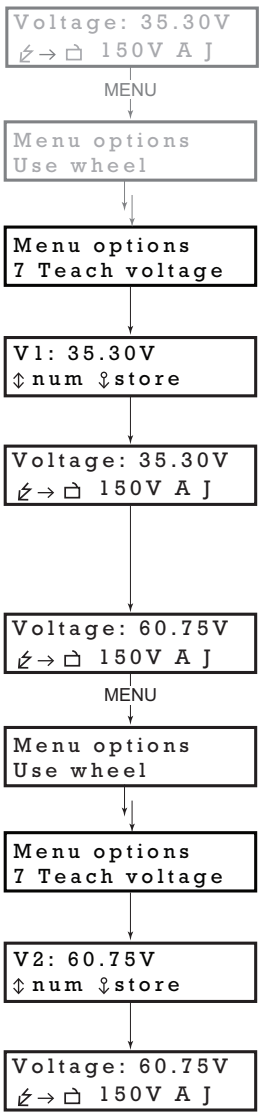
Using the method described in Section 4.4.7. and Section 4.4.8. set the drive voltage to the value required as teach voltage 2, then...

press the MENU button, and use the wheel to scroll through the menu options.

Press the MENU button to enter the 7 Teach voltage option.

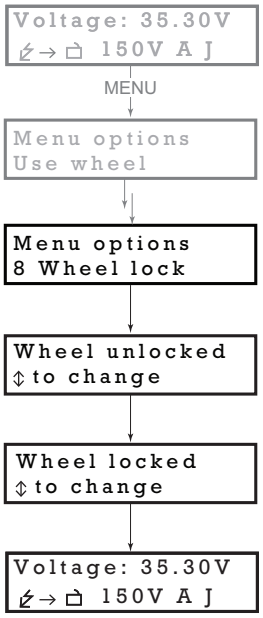
Use the wheel to select V2, then press the MENU button to store the present voltage setting as teach voltage 2 and return to the main display.

When *Go to voltages* mode is selected in the *Joystick mode* option (see Section 4.4.7.), an upwards deflection of the wheel changes the drive voltage to V1, and an downwards deflection changes the drive voltage to V2.



4.4.10 Menu Option - 8 Wheel lock

In certain applications, it may be advantageous to disable the wheel to remove the possibility of unwanted motion due to accidental movement of the wheel.



Press the MENU button, then use the wheel to scroll through the menu options.

Press the MENU button to enter the 8 Wheel lock option.

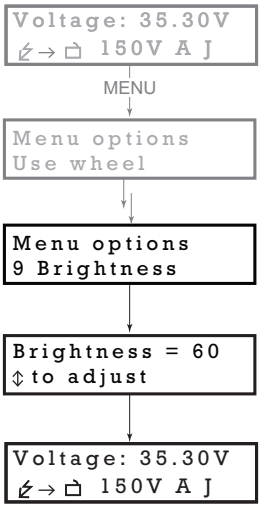
The display shows the current setting.

Use the wheel to select 'Wheel locked' or 'Wheel unlocked' as required.

Press the MENU button to store the selection and return to the main display.

4.4.11 Menu Option - Brightness

In certain applications, it may be necessary to adjust the brightness of the LED display. The brightness is set as a value from 0 (Off) to 100 (brightest). The display can be turned off completely by entering a setting of zero, however, pressing the MENU button on the top panel will temporarily illuminate the display at its lowest brightness setting to allow adjustments. When the display returns to its default operating display mode, it will turn off again.



Press the MENU button, then use the wheel to scroll through the menu options.

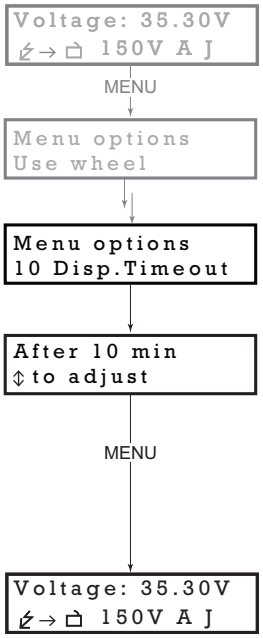
Press the MENU button to enter the 9 Brightness option.

Use the wheel to adjust the brightness, then press the MENU button to store the selection and return to the main display.

4.4.12 Menu Option - Disp.Timeout

'Burn In' of the display can occur if it remains static for a long time. To prevent this, the display is automatically dimmed after a specified time interval.

Press the MENU button, then use the wheel to scroll through the menu options.



Press the MENU button to enter the Disp.Timeout option.

The time out interval is specified in minutes in the range 1 to 480. The adjustment is done in steps of 1 minute if the timeout is between 1 to 10 minutes, 10 minute steps between 10 minutes and 1 hour, and 30 minute steps above, up to a maximum of 480 minutes. After 480 minutes there is an option for Never.

The dim level can only be adjusted via the Settings panel - see Section 6.2.3.

Press the MENU button to store the selection and return to the main display.

Chapter 5 PC Operation - Tutorial

5.1 Introduction

The following brief tutorial guides the user through a typical series of actions and parameter adjustments performed using the Kinesis software. It assumes that the unit is electrically connected as shown in Section 3.3. and that the software is already installed - see Section 3.1. It also assumes that a piezo actuator is connected to the 'HV OUT connector on the rear panel.

5.2 Using the Kinesis Software

The Kinesis application allows the user to interact with any number of hardware control units connected to the PC USB Bus. This program allows multiple graphical instrument panels to be displayed so that multiple units can be controlled. All basic operating parameters can be set through this program, and all basic operations (such as piezo moves) can be initiated.

This tutorial shows how the Kinesis application provides all of the functionality necessary to operate the hardware.

1) Power up the hardware, and wait until the KPZ101 has finished booting up, then run the Kinesis software - Start/All Programs/Thorlabs/Kinesis/Kinesis.

Note

For maximum accuracy, wait approximately 30 mins for the unit to thermally stabalize to the environment.

The server registers automatically the units connected on the USB bus and displays the associated GUI panels as shown in Fig. 5.1

.

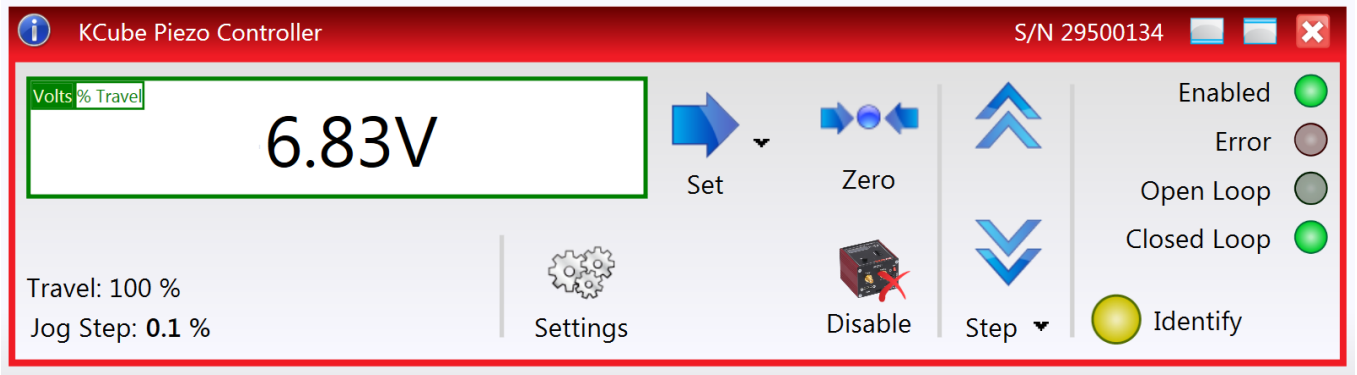


Fig. 5.1 Piezo Controller Software GUI

Notice how the maximum voltage for the associated piezo is displayed at the bottom left of the display.

5.3 Introduction to Open and Closed Loop Operation

The KPZ101 Piezo Controller has two distinct modes of operation: open and closed loop mode. In open loop mode, the output voltage is controlled directly, using the potentiometer, one of the external inputs, the GUI or a combination of these three. The output voltage is proportional to the controlling source. This voltage controls the expansion of the piezo actuator, turning the voltage into a certain amount of displacement.

The need for a closed loop mode of operation arises from the fact that the displacement produced by the piezo actuator is not a linear function of the driving voltage. All piezo actuators show a certain amount of nonlinearity, hysteresis, temperature dependence and aging - see Appendix D for more details.

In precision positioning applications this can seriously limit the accuracy and repeatability of the system. This problem can however be eliminated when closed loop control is used. Closed loop mode assumes that the piezo actuator is fitted with a position sensor, usually a strain gauge, that is capable of reading the actual position and this signal is fed back to the piezo controller. Rather than outputting a constant voltage, the piezo controller continuously monitors the position signal and, if necessary, adjusts the output voltage to maintain the required position.

Closed loop operation is only possible if an external position signal is available to control the piezo cube. For the Thorlabs range of piezo actuators, the KSG101 strain gauge reader is a fully self contained unit that is designed to work with the KPZ101 in closed loop mode, providing the feedback signal necessary for closed loop operation.

5.3.1 Description of Open Loop Mode

Fig. 5.2 shows a simplified block diagram of the piezo controller in open loop mode.

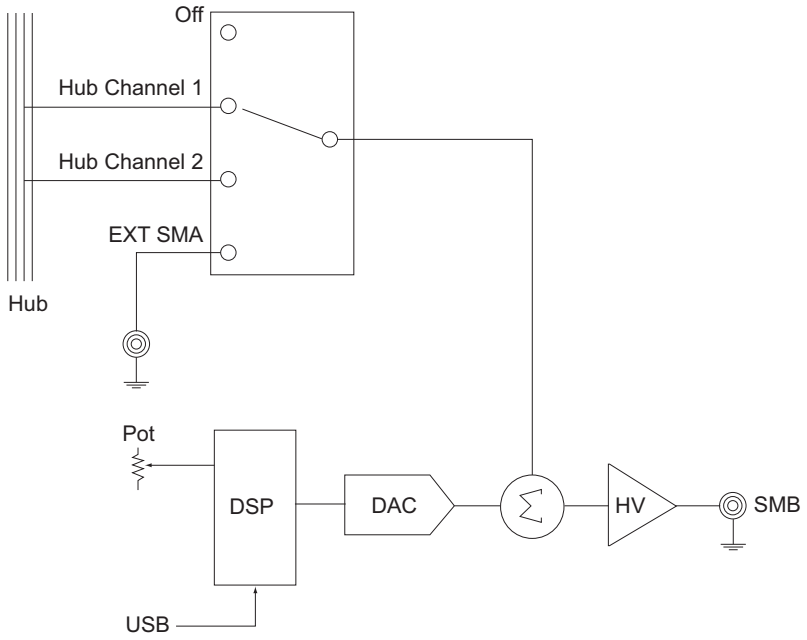


Fig. 5.2 Open Loop Schematic Diagram

The output voltage is controlled by the DSP, allowing the Kinesis server to set the output voltage. The output voltage can also be controlled by the top panel potentiometer. In addition, one of the 3 possible external inputs (SMA input, Hub Channel 1 or Hub Channel 2) can also be added to the signal that controls the output voltage.

5.3.2 Description of Closed Loop Mode

Fig. 5.3 shows a simplified block diagram of the piezo controller in closed loop mode (with the rear panel EXT IN terminal used for feedback)..

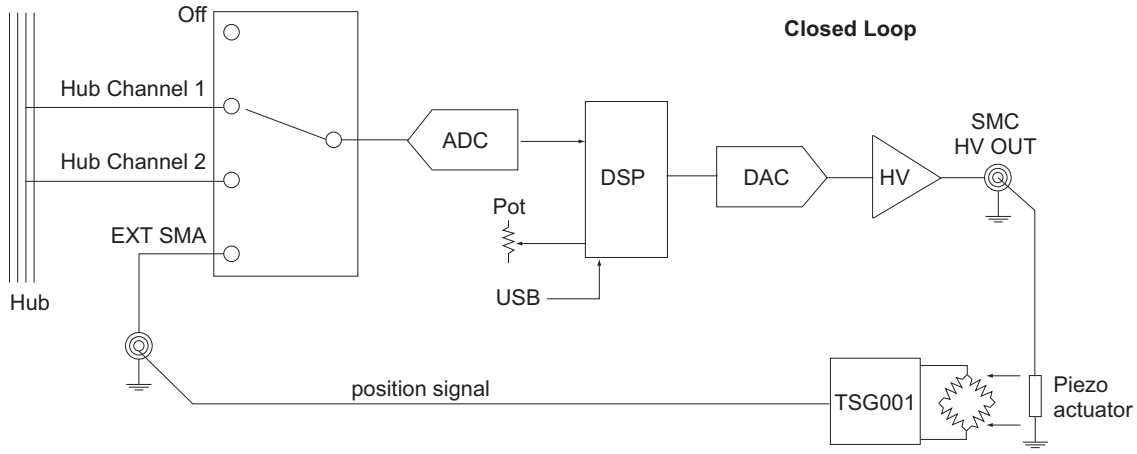


Fig. 5.3 Closed Loop Schematic Diagram

In closed loop, the role of the external inputs changes, and the selected input receives the position signal from the external position reader. The DSP now implements a digital PI (proportional-integral) control feedback loop. This control loop monitors the actual position reading and adjusts the high voltage output to maintain a constant position (set point). This set point can be varied by adjsuting the OUTPUT pot on the front panel or the Output control on the GUI.

5.4 Open Loop Operation

The following procedures explain how the piezo actuator is driven. In open loop mode, the piezo can be positioned in three ways: by entering a voltage, by using the 'Output' potentiometer or by clicking the 'Jog' buttons.

5.4.1 Entering the piezo voltage

1) Click the Set Arrow  to display the Target window..

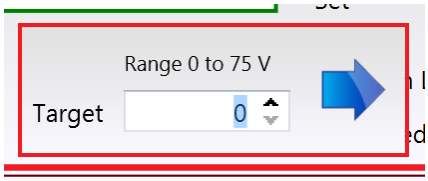


Fig. 5.4 Target Voltage Popup Window

2) Enter a voltage into the pop up window. This can be entered directly into the field, or by clicking on the up/down arrows.
3) When finished, click the Set Target Output arrow to the right of the window. The main GUI display counts up to the value entered.

5.4.2 Jogging the Piezos

When the jog buttons are pressed, the piezo moves by the voltage step specified in the Jog Step Size parameter.

1) Click the Step Button  to display the Step Size window..

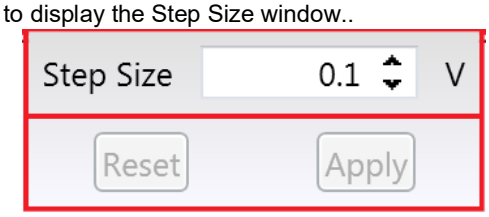


Fig. 5.5 Target Voltage Popup Window

2) In the 'Step Size' field, enter a step size in the range 0.1 V to 10 V. This can be entered directly into the field, or by clicking on the up/down arrows.
3) Click 'Apply' to save the settings and close the window. To cancel the change click Reset.
4) Click the upper Jog arrow on the GUI panel to jog the piezo. Notice that the voltage display increments by the value entered every time the button is clicked.
5) Click the lower Jog arrow on the GUI panel. Notice that the voltage display decrements by the value entered every time the button is clicked.

5.4.3 Using the Controller as a Piezo Amplifier

Certain applications may require the piezo to be driven by a voltage generated from an external source (e.g. a signal generator). The piezo K-Cube is designed to accept an external 0 to 10V signal and handle the amplification from 10V to 75 or 150V.

As an example, the following procedure explains how to configure the unit as a piezo amplifier.

1) Connect a 0 - 10V external source to the EXT IN connector on the rear panel.
2) In the GUI panel, click the 'Settings button to display the settings panel, then select the 'Advanced' tab.

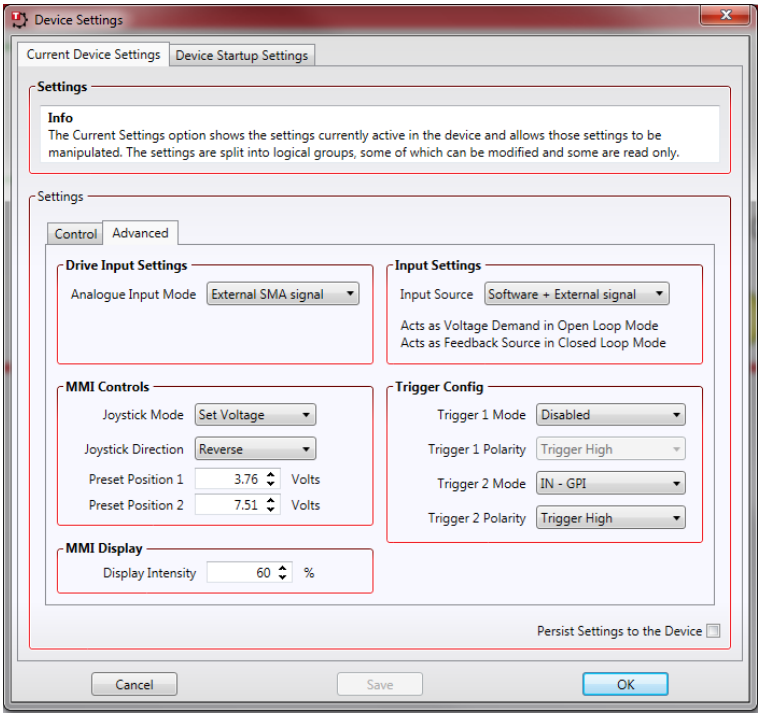


Fig. 5.6 Piezo settings panel

3) In the 'Input Source' field, select *Software + External signal*.
4) In the 'Analogue Input Mode' field, select *External SMA signal*.
5) Click 'OK' to save the settings and close the window.

Any voltage on the rear panel SMA connector is now amplified by the unit and presented at the HV OUT (piezo drive) connector and the position of the piezo actuator can be controlled by varying the 0-10V external source.

If required, the contribution of the potentiometer on the top panle of the unit can also be added by selecting the appropriate option in the 'Input Source' field. In this way it is possible to adjust the DC level on the output whilst adding an AC signal to this DC level via the external SMA terminal.

5.5 Operation with Other Members of the K-Cube Family

5.5.1 Introduction

The operation of the KPZ101 piezo controller can be extended when the unit is used in conjunction with other members of the K-Cube family. Specifically, 2 other controllers have been designed to work closely with the KPZ101 piezo unit; the KSG101 strain gauge reader and the TNA001 NanoTrak autoalignment controller. When the KPZ101 piezo controller is used with a KSG101 strain gauge reader, closed loop operation is possible, which allows more stable and precise position control than open loop - see Section 5.6.

When used with the TNA001 NanoTrak controller and a laser light source such as the TLS001 laser source cube, automatic fiber alignment systems can be built - see the handbook supplied with the NanoTrak unit for more information.

With both the KSG101 and the TNA001 it is possible to build a system without the TCH002 USB controller hub, however, in this case individual power supply and USB connections are required for each controller in addition to the external signal cables between the controllers. Using the TCH002 hub greatly simplifies the system because the hub provides all the necessary power, signal and USB connections to all the controller cubes.

5.6 Closed Loop Operation

The following procedures explain the basic operation of the Piezo Driver K-Cube when used in conjunction with a Strain Gauge Reader K-Cube. Section 5.6.1. explains operation on the TCH002 USB Controller hub, while Section 5.6.2. explains the various bay mounting options and the associated software settings.
Section 5.6.3. explains use off the hub, with external wiring via the rear panel connections.

Note

When the KPZ101 is used in closed loop mode with the KSG101 Strain Gauge Reader, it is not possible to modulate the KPZ101.

5.6.1 Electrical Connections and Software Settings - Hub Operation

The following procedure describes a typical set up, when a KPZ101 piezo driver cube and a KSG101 Strain Gauge Reader are used on the TCH002 controller hub to drive a piezo actuated stage - see Fig. 5.7 for a general system schematic diagram.

The K-Cube positions on the hub and associated parameter settings described are by no means the only possible options. For further information, see Section 5.6.2..

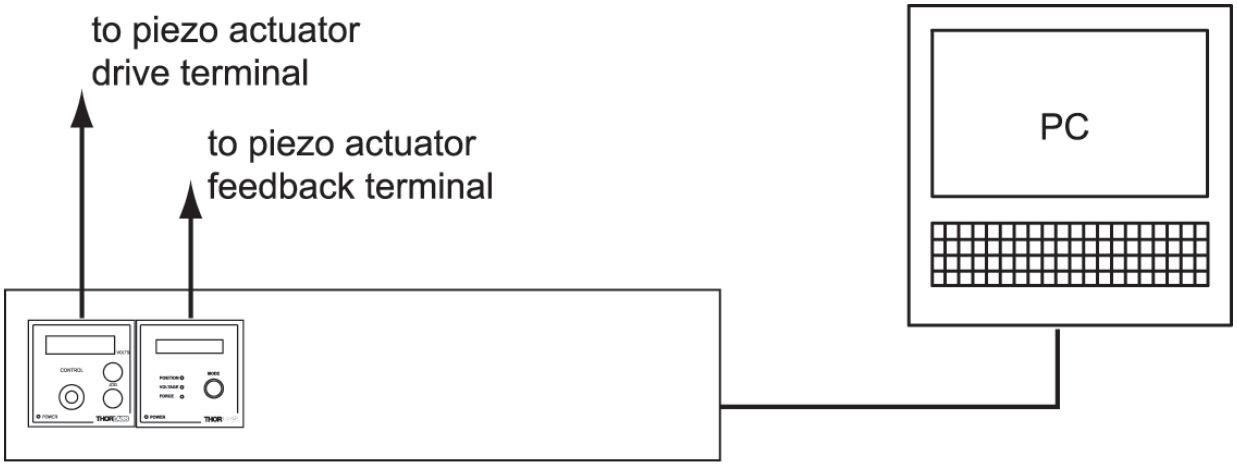


Fig. 5.7 Typical System Set Up - Hub Operation

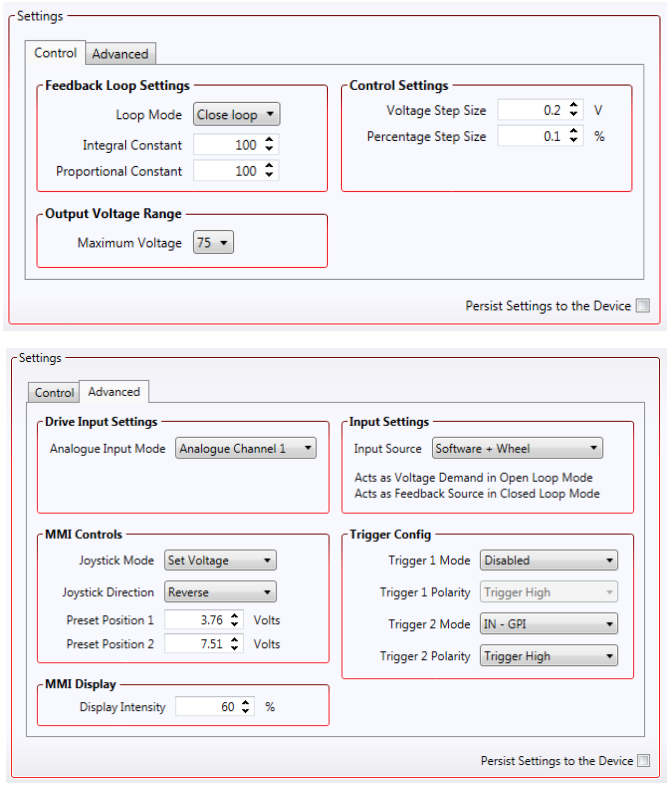
1) Perform the mechanical installation as detailed in Section 3.2. of this manual and also in the manual supplied with the K-Cube Strain Gauge Reader.
2) Install the units onto the controller hub. Fit the Piezo unit in bay 1, and the Strain Gauge Reader in bays 2 as shown in Fig. 5.7.
3) Connect the HV OUT terminal on the rear of the Piezo driver to the associated piezo actuator.
4) Connect the STRAIN GAUGE I/P terminal on the rear panel of the strain gauge unit to the Feedback connector on the piezo actuator.
5) Connect the controller hub to the power supply - see Section 3.3.2.
6) Connect the PSU to the main supply and switch ‘ON’. The version number of the embedded software is displayed on the Piezo unit during boot up. The software version is useful when requesting technical support. The ident number of the associated K-Cube bay on the hub is also displayed.
7) Connect the controller hub to your PC.

Note

The USB cable should be no more than 3 metres in length. Communication lengths in excess of 3 metres can be achieved by using a powered USB hub).

8) Windows™ should detect the new hardware. Wait while Windows™ installs the drivers for the new hardware.
9) Run the Kinesis software - Start/All Programs/Thorlabs/Kinesis/Kinesis.
10) Click the ‘Settings’ button on GUI of the Piezo Driver to display the Settings panel (shown below).

.



Note

To identify the piezo unit associated with the GUI panel, click the 'Ident' button; the Power LED and the Display of the asssociated controller flashes for a short period.

Fig. 5.8 Piezo Driver Settings

Note

The following parameter settings are shown for example only, and are by no means the only possible setting combinations.

11) Make the following parameter settings, as shown in Fig. 5.8

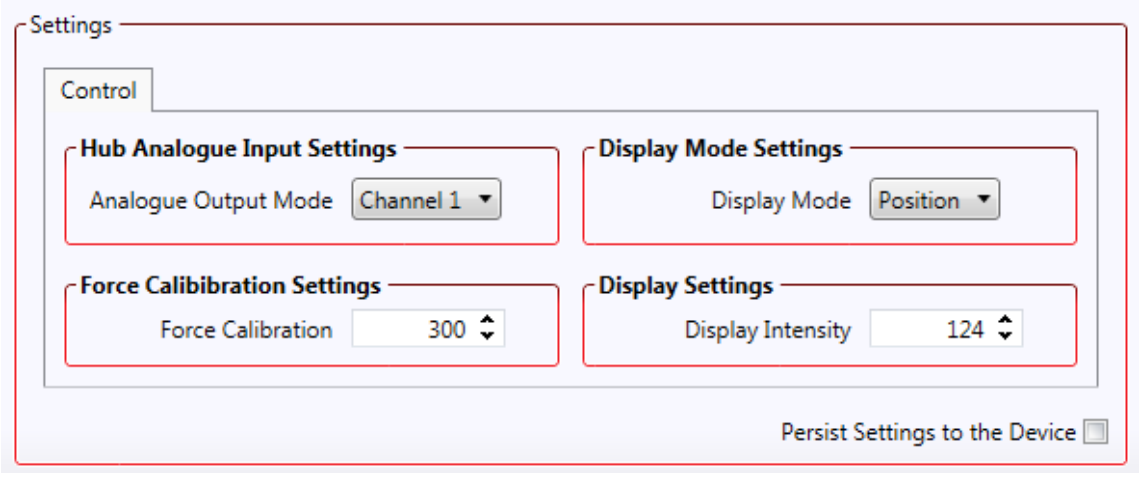
Control Tab
Loop Mode - Select Closed Loop
Maximum Voltage - Set the corresponding voltage for the piezo being driven, *75V, 100V or 150V.*

Advanced Tab
Input Source - Select *Software + Wheel*
Analogue Input Mode - Select *Analogue Channel 1*
If desired, click the 'Persist Settings To Hardware' box. These settings will then be loaded on each power up cycle.

12) Click 'OK to save the settings.

13) Click the ‘Settings’ button on GUI of the Strain Gauge Reader fitted in bay 2, to display the Settings panel (shown below).

..



Note

To identify the strain gauge unit associated with a GUI panel, click the ‘Ident’ button; the Power LED on the panel of the asssociated controller flashes for a short period

Fig. 5.9 Strain Gauge Reader Settings

Note

The following parameter settings are shown for example only, and are by no means the only possible setting combinations.

14) Set the *Analogue Output Mode* parameter to *Channel 1.*

15) If desired, click the ‘Persist Settings To Hardware’ box. These settings will then be loaded on each power up cycle

16) Click ‘OK to save the settings.

17) Refer to Section 5.6.5. for instructions on setting the position sensor zero value.

5.6.2 Piezo Driver Hub Mounting Options.

When the K-Cube piezo driver is used on the hub, together with the KSG101 strain gauge unit, signals can be routed via dedicated internal communication channels. These channels are selected via the piezo unit settings panel, or via the ‘MODE’ button on the top panel of the unit.

If *Channel 1* is selected, the feedback signal runs through all the bays - see Fig. 5.10. If *Channel 2* is selected, the feedback signals run between adjacent pairs of K-Cube bays (i.e. 1 and 2, 3 and 4, 5 and 6) - see Fig. 5.10.

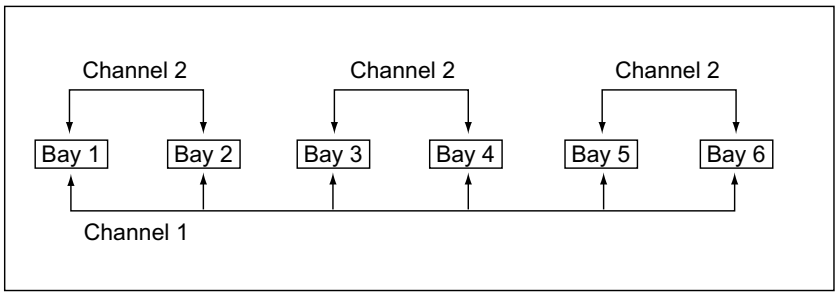


Fig. 5.10 Hub Analog Input Channels

Only certain K-Cube arrangements allow the system to function correctly. Furthermore, the setting for the *Analogue Input Source (EXT IN)* parameter in the piezo settings panel, depends on the bays in which the K-Cube units are fitted. The various bay options, and their associated *Analogue Input Source (EXT IN)* settings are described in Fig. 5.11.

Caution

In general, when members of the K-Cube family are on the TCH002 controller hub, using the signal channels (Channel 1 and Channel 2), users must ensure that:

The individual cubes are set up to use the intended signal channel.

Only one cube is driving the intended signal channel.

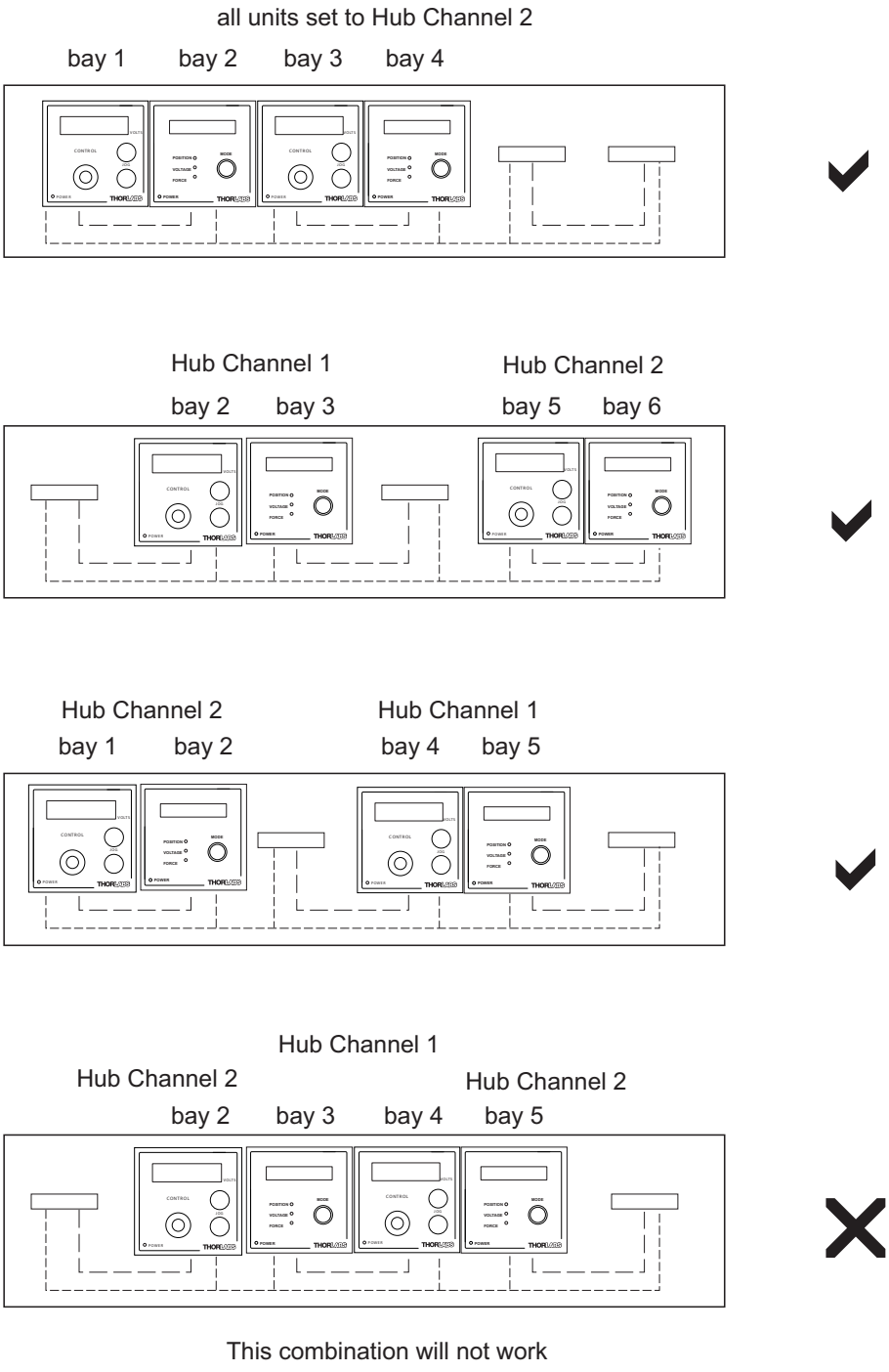


Fig. 5.11 Bay Options and Associated Analog Input Source Settings

5.6.3 Electrical Connections and Software Settings - Off Hub (Hard Wired) Operation

The following procedure describes a typical set up, when a KPZ101 piezo driver cube and a KSG101 Strain Gauge Reader are used to control a piezo actuated stage - see Fig. 5.12 for a general system schematic diagram..

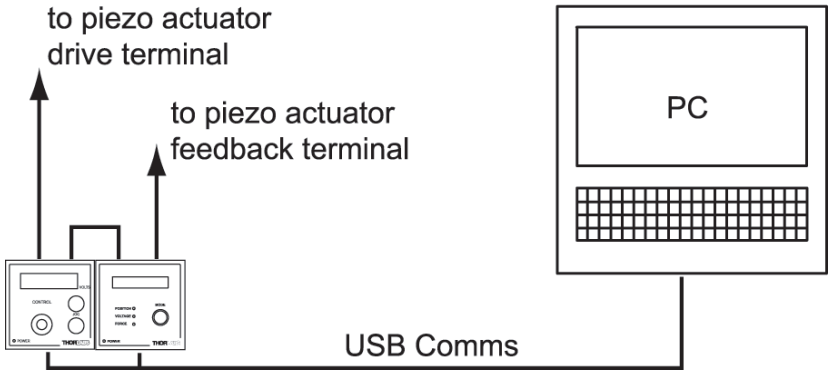


Fig. 5.12 Typical System Set Up - Off Hub (Hard Wired) Operation

1) Perform the mechanical installation as detailed in Section 3.2. of this manual and also in the manual supplied with the K-Cube Strain Gauge Reader.
2) Connect the MONITOR terminal on the rear panel of the strain gauge unit to the EXT IN terminal on the rear panel of the piezo unit.
3) Connect the STRAIN GAUGE I/P terminal on the rear panel of the strain gauge unit to the Feedback connector on the piezo actuator.
4) Connect the HV OUT terminal on the rear of the Piezo driver to the associated piezo actuator.
5) Connect the units to their power supplies - see Section 3.3.4. of this manual and also the manual supplied with the Strain Gauge Readers.
6) Connect the PSU to the main supply and switch 'ON'. The version number of the embedded software is displayed on the Piezo unit during boot up. The software version is useful when requesting technical support.
7) Connect each controller unit to your PC.

Note

The USB cable should be no more than 3 metres in length. Communication lengths in excess of 3 metres can be achieved by using a powered USB hub).

8) Windows™ should detect the new hardware. Wait while Windows™ installs the drivers for the new hardware.
9) Run the Kinesis software - Start/All Programs/Thorlabs/Kinesis/Kinesis.
10) Click the 'Settings' button on the GUI panel of the Piezo Driver to display the Settings panel (shown below). .

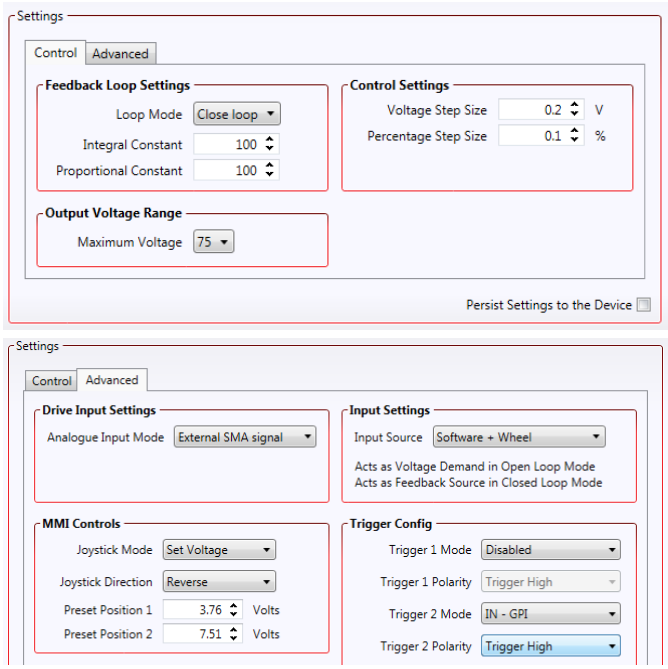


Fig. 5.13 Piezo Driver Settings

11) Make the following parameter settings, as shown in Fig. 5.8

Control Tab
Loop Mode - Select *Closed Loop*
Maximum Voltage - Set the corresponding voltage for the piezo being driven, *75V, 100V or 150V.*

Advanced Tab
Input Source - Select *Software + Wheel*
Analogue Input Mode - Select *External SMA Input*

12) If desired, click the 'Persist Settings To Hardware' box. These settings will then be loaded on each power up cycle
13) Click 'OK to save the settings.
14) Refer to Section 5.6.5. for instructions on setting the position sensor zero value.

5.6.4 Entering the piezo percentage position

1) Click the Set Arrow  to display the Target window..

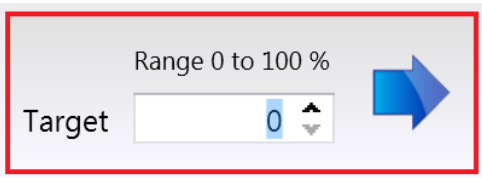


Fig. 5.14 Target Position Popup Window

2) Enter a position as a percentage of total piezo travel. This can be entered directly into the field, or by clicking on the up/ down arrows.

5.6.5 Setting the Position Sensor Zero

On actuators with position feedback, the position sensor is a strain gauge fitted to the piezo actuator. The strain gauge may give a small signal when the actuator is at zero position with zero volts applied (due to limitations in manufacture, or temperature fluctuations). This 'offset' signal must be removed before the position attained by a specific applied voltage and the position attained by a corresponding specified distance can be rationalized.

Each actuator has a unique offset value. Therefore the offset should be adjusted whenever an actuator is replaced. Temperature and prolonged use can affect the performance of the strain gauge and therefore the offset value.

Each time the Strain Gauge K-Cube is powered up, the display will flash a default reading until the position sensor is zeroed.

To zero the position sensor:

1) Ensure that the Piezo Driver K-Cube output is zero. Turn the OUTPUT control to minimum and remove any input on the rear panel EXT IN connector.
2) Either press and hold the button on the Strain Gauge K-Cube, click the 'Zero' button in the Strain Gauge K-Cube GUI panel, or call the 'SG_ZeroPosition' method in the application software.
3) The display on the Strain Gauge K-Cube shows 'nULL' and counts down to zero.

5.7 Adjusting the Piezo Position

Note

The position of the actuator is relative to the minimum position set for the arrangement using the 'Null' facility, see Section 5.6.5. The extension of the actuator is displayed on the Strain Gauge K-Cube as a position in microns.

1) Make connections as detailed in Section 5.6.1. or Section 5.6.3.
2) Set the Strain Gauge K-Cube to 'Position' mode - see handbook *ha0144 Strain Gauge K-Cube*.
3) Rotate the Piezo Drive K-Cube 'Output' control clockwise. Notice how the voltage display increments to show the increasing voltage applied to the piezo. The Position display on the Strain Gauge Reader K-Cube shows a proportional increase in position (in microns).
4) Rotate the 'Output' control anticlockwise. Notice how the voltage display decrements to show the decreasing voltage applied to the piezo. The Position display on the Strain Gauge Reader K-Cube shows a proportional decrease in position (in microns).

5.8 Load Response

The response of the KPZ101 to varying load and frequencies is shown below.

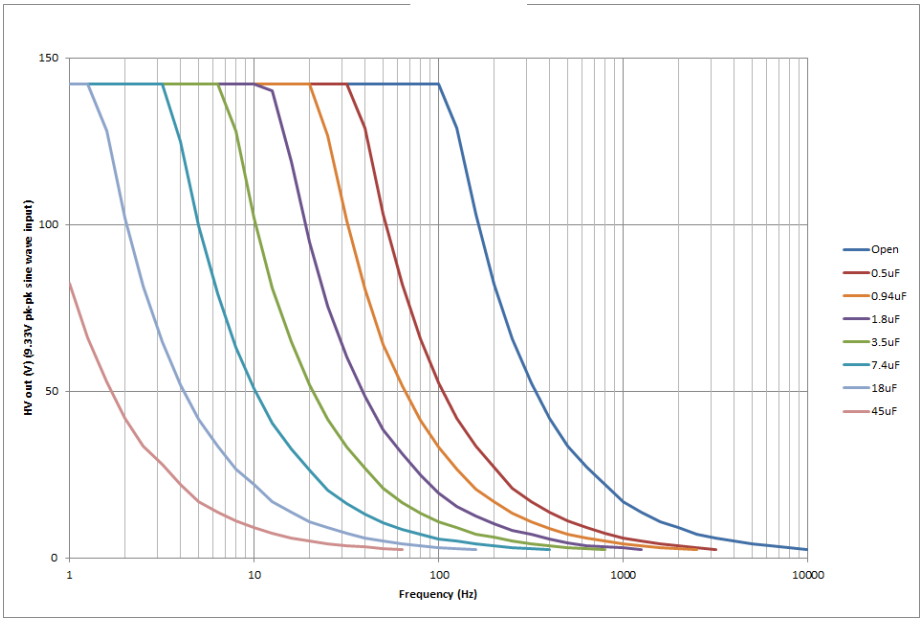


Fig. 5.15 Response of KPZ101 to Varying Loads and Frequencies

5.9 Setting Move Sequences

The Kinesis software allows move sequences to be programmed, allowing several positions to be visited without user intervention. For more details and instructions on setting move sequences, please see the *Kinesis Helpfile*.

5.10 Changing and Saving Parameter Settings

During operation, certain settings (e.g. loop mode, maximum voltage etc) can be changed as required and saved to the device for use in the absence of a PC. However, when the device is next connected to a PC and the Kinesis Server is run up, these settings will be overwritten by the default settings. These values have been chosen to provide safe performance in the majority of applications. For applications where these settings need to be changed, a new set of Device Start Up settings', must be created which can then be applied and/or uploaded on subsequent start up. See the *Kinesis Helpfile* for more details.

Chapter 6 Software Reference

6.1 GUI Panel

The following screen shot shows the graphical user interface (GUI) displayed when accessing the controller using the Kinesis software.

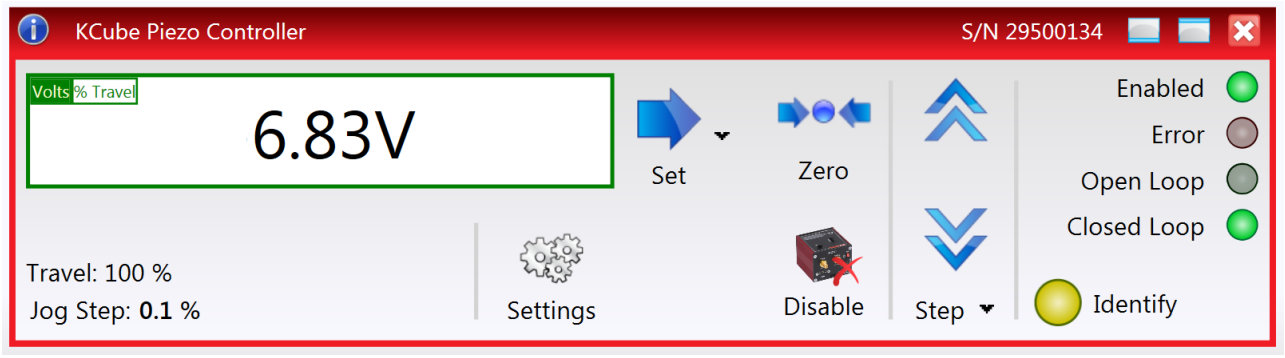


Fig. 6.1 KPZ101 Piezo Driver Software GUI

Note

The serial number of the KPZ101 unit associated with the GUI panel, is displayed in the top right hand corner. This information should always be provided when requesting customer support.

Main Display - In open loop, the display shows the voltage applied to the piezo. In closed loop, it shows the position as a percentage of total travel.



Set Arrow - Opens the settings window, so that the target drive voltage or position can be entered - see Section 5.4.1.



Zero - Sets the piezo drive voltage to zero.

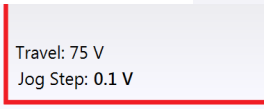


Step Arrows - used to increment or decrement the output voltage or position. When the buttons are clicked, the piezo is driven in the selected direction, one step per click. The step size is set by clicking the Step Button 

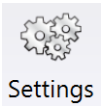
- see Section 5.4.2.



Parameters Display - shows the maximum working voltage of the associated piezo actuator and the present setting for the step size



Settings - Displays the 'Settings' panel, which allows the operating parameters to be entered for the motor drive - see Section 6.2.

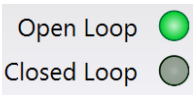


Active - lit when the unit is operating normally and no error condition exists.

Error - lit when a fault condition occurs.



Open Loop and Closed Loop LEDs - When Open Loop or Closed Loop mode is selected, the corresponding LED is lit.



Identify - when this button is pressed, the POWER LED and the main display on the front panel of the associated hardware unit will flash for a short period.



6.2 Settings Panel

When the 'Settings' button on the GUI panel is clicked, the 'Settings' window is displayed. This panel allows data such as jog step size and input sources to be entered. Note that all of these parameters have programmable equivalents accessible through the functions on this Control (refer to the *Kinesis API helpfile* for further details.

6.2.1 Persisting Settings to the Hardware

Many of the parameters that can be set for the Piezo Driver K-Cube can be stored (persisted) within the unit itself, such that when the unit is next powered up these settings are applied automatically. This is particularly important when the driver is being used manually in the absence of a PC and USB link. The *Analogue Input Channel* and *Closed Loop Operation* parameters are good examples of settings that can be altered and then persisted in the driver for use in absence of a PC.

To save the settings to hardware, check the ‘Persist Settings to Hardware’ checkbox before clicking the ‘OK button.



Caution

The ‘Persist Settings’ functionality is provided to simplify use of the unit in the absence of a PC. When the unit is connected to a PC and is operated via the Kinesis software, the default settings will be loaded at boot up, even if the ‘Persist Settings’ option has been checked.

6.2.2 Control Tab

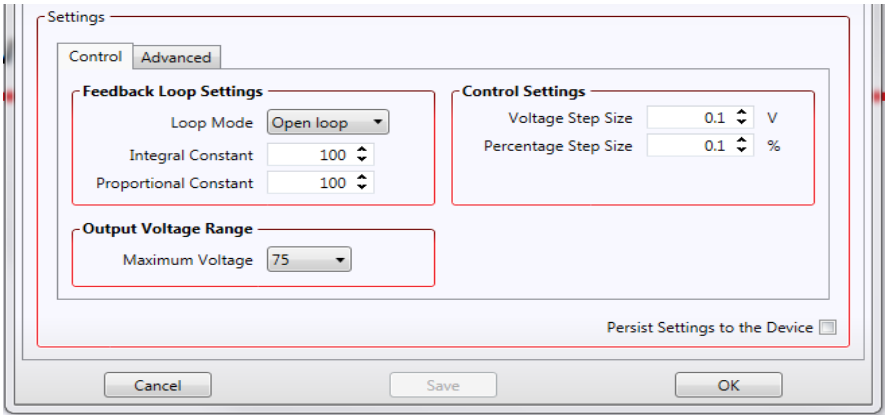


Fig. 6.1 Piezo Settings panel

Feedback Loop Settings

Loop mode - This panel can be used to select between the two distinct operating modes: open loop and closed loop. Note that closed loop operation is only possible if an external position reader (such as the TGS001 Strain Gauge Reader) is used in conjunction with the piezo cube.

Caution

If the Piezo Driver is switch to closed loop mode without being connected to a Strain Gauge Reader, the piezo driver will expect a feedback signal and the piezo drive voltage will ramp up to the maximum limit. If the limit is set to 75V, a protective circuit limits the voltage to 75V. If 100V or 150V is selected, the output will ramp to 150V.

When the K-Cube Piezo Driver is used in conjunction with the K-Cube Strain Gauge Reader unit (KSG101) on the K-Cube Controller Hub (TCH002), high precision closed loop operation is possible using the complete range of feedback equipped piezo actuators available from Thorlabs.

Select Open Loop or Closed Loop as required.

Note

When the KPZ101 and KSG101 are used in closed loop, the joystick wheel on the top panel of the unit controls the position setpoint rather than voltage. This position setpoint is a percentage (0-100%) reflecting min-max piezo extension, e.g. for a 30 micron piezo stack, a position setpoint of 50% equates to 15 micron. Further, when operating in closed loop mode, if you click the 'Set' button on the GUI of the KPZ101 you are prompted to enter a 'Position Setpoint [0-100%] - see Fig. 6.2 below.

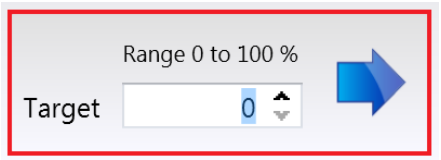


Fig. 6.2 Position Setpoint Window

Loop Constants - When operating in Closed Loop mode, the proportional and integral (PI) constants can be used to fine tune the behaviour of the feedback loop to changes in the output voltage or position. While closed loop operation allows more precise control of the output position, feedback loops need to be adjusted to suit the different types of piezo actuator that can be connected to the system. The default values of 100 (proportional) and 100 (integral) have been optimized to work with most Thorlabs piezo actuators, so usually these values can be left unchanged.

Integral Constant - sets the integral feedback loop constant for the selected channel (0 to 255).

Proportional Constant - sets the proportional feedback loop constant for the selected channel (0 to 255).

Control Settings

Voltage Step Size - Only applicable in open loop mode. This parameter specifies the amount by which the piezo drive voltage is incremented or decremented, each time the 'Step' button is clicked on the GUI panel.

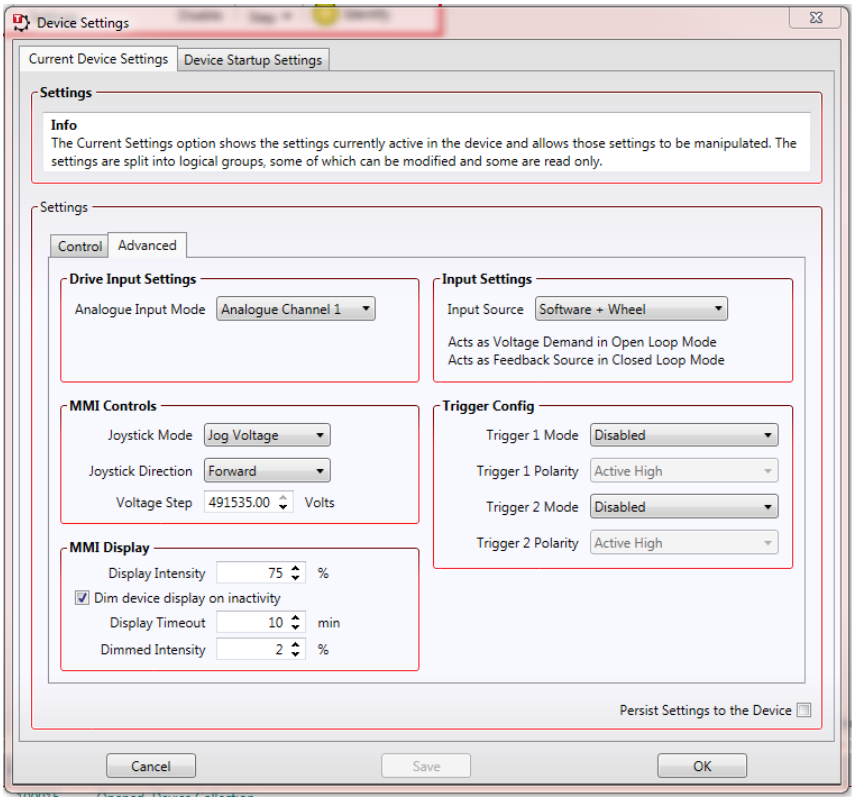
Percentage Step Size - Only applicable in closed loop mode. This parameter specifies the distance to move, each time the 'Step' button is clicked on the GUI panel, as a percentage of the full travel range.

Output Voltage Range

Maximum Voltage - used to set the maximum output voltage of the piezo controller. This must be set up to suit the maximum specified operating voltage of the piezo actuator connected to the unit. Most Thorlabs piezo actuators are specified for either 75V or 150V maximum operation. In general, the maximum voltage should not be exceeded because it can cause damage to the piezo actuator.

The output voltage range can be selected from 75V, 100V or 150V. Of these 3 settings, 75V and 150V are hardware limits: the piezo unit contains an internal clamping circuit that limits the output voltage to approximately 10% above these values. (Piezo actuators can tolerate a 10% overvoltage without damage.) The 100V limit is a software limit: under software control (for example, by turning the 'Output' control knob) it is not possible to exceed this limit but using the external inputs (SMA, Hub channel 1 or Hub channel 2) the limit can be exceeded. Therefore exercise care when 100V piezo actuators are driven under external input control.

6.2.3 Advanced Tab



Drive Input Settings

Analogue Input Mode - This field allows the user to select the analogue input source, which can be one of 3 inputs:

If *Analogue Channel 1* is selected, the feedback signal runs through all the bays - see Fig. 6.3. This setting is useful in applications where a master cube is controlling several slave cubes.

If *Analogue Channel 2* is selected, the feedback signals run between adjacent pairs of K-Cube bays (i.e. 1 and 2, 3 and 4, 5 and 6) - see Fig. 6.3. This setting is useful when several pairs of cubes are being used on the same hub.

If *External SMA signal* is selected, the signal runs through external connections via the rear panel EXT IN SMA terminal. This option is useful if a hub is not available or the controlling signal source is not a member of the K-Cube family of products. For example, even if a hub is not available, the combination of a KPZ101 unit with a KSG101 Strain Gauge

Reader described above can still be used for closed loop control but in this case the KSG101 MONITOR output must be connected to the KPZ101 EXT IN input using an external SMA to SMA cable.

Note

As mentioned in the previous section, the function of the analogue input source depends on whether the cube is used in open or closed loop mode. In open loop mode, the input selected here will be added to the Drive Input Source if the 'External Input' is enabled in this panel. In closed loop mode, the input selected here expects to see the feedback input from the external position reader.

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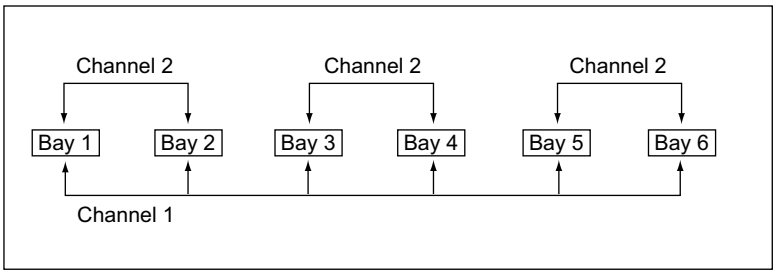


Fig. 6.3 Controller Hub Feedback Channels

Input Settings

Input Source - the voltage output of the unit is a sum of up to 3 contributing sources: the software (GUI) 'Output Voltage' setting, the front panel potentiometer and the external input source, which in turn can be set to Hub Channel 1, Hub Channel 2 or 'EXT IN' SMA connector - see *Analogue Input Source* parameter.

Of these 3 contributing sources, software control is always on (since whenever the GUI panel is displayed, the software is controlling the piezo cube), whilst the contribution of the front panel pot and the external input can be individually enabled or disabled as follows:

If *Software only* is selected, the unit responds only to software inputs and the HV amp output is that set using the SetVoltOutput method (or the GUI panel 'Output' control).

If *Software + External Signal* is selected, the unit sums the signal on the rear panel 'EXT IN' SMC connector with the voltage set using the SetVoltOutput method (or the GUI panel 'Output' control).

If *Software + Wheel* is selected, the unit sums the voltage set using the top panel joystick wheel with the voltage set using the SetVoltOutput method (or the GUI panel 'Output' control).

MMI Controls

The voltage wheel/joystick is an infinite turn potentiometer, which is used to initiate different types of move depending on its mode setting. The mode can be set either via the GUI Settings panel as follows or via the top panel display menu, see Section 4.4.

Joystick Mode

The parameters displayed are dependent upon the Feedback Loop Settings selected on the Control tab. If Open Loop is selected, the parameters are displayed in Voltage, if Closed Loop is sleected the parameters are displayed in Position.

Adjust Voltage/Position - The wheel can be used to increase and decrease the drive voltage/position. The voltage change is proportional to the deflection of the wheel according to the setting in the *Voltage Adjust Rate* parameter as follows:

High - Voltage adjusts at a high rate, i.e. 1 V per click

Medium - Voltage adjusts at a medium rate, i.e. 100 mV per click

Low - Voltage adjusts at a low rate, i.e. 10 mV per click

Jog Voltage/Position - Deflecting the wheel initiates a change in the drive voltage, using the parameters specified by the *Voltage Step* parameter. The voltage changes by one step for each click of the wheel.

Set Voltage/Position - Deflecting the wheel changes the drive voltage to one of the two predefined "teach" voltages or positions. The teach voltages are specified in the *Preset Volts/Position 1* and *Preset Volts/Position 2* parameters.

Joystick Direction

The direction of a voltage change initiated by the velocity wheel is specified as follows:

Direction Sense Positive - Upwards rotation of the wheel results in a positive change (i.e. increased voltage).

Direction Sense Negative - Upwards rotation of the wheel results in a negative change (i.e. decreased voltage).

MMI Display

In certain applications, it may be necessary to adjust the brightness of the LED display on the top of the unit. The brightness is set in the *Display Intensity* parameter, as a value from 0 (Off) to 100 (brightest). The display can be turned off completely by entering a setting of zero, however, pressing the MENU button on the top panel will temporarily illuminate the display at its lowest brightness setting to allow adjustments. When the display returns to its default position display mode, it will turn off again.

Furthermore, 'Burn In' of the display can occur if it remains static for a long time. To prevent this, the display is automatically dimmed after the time interval specified in the *Display Timeout* parameter has elapsed. The time interval is specified in minutes in the range 1 to 480. The dim level is set in the *Dimmed Intensity* parameter, as a percentage of full brightness from 0 (Off) to 10 (brightest) but is also limited by the *Display Intensity* parameter if this is lower. These settings are only visible and active if the *Dim device display on inactivity* box is checked.

Triggering Introduction

The K-Cube piezo controller has two bidirectional trigger ports (TRIG1 and TRIG2) that can be used to read an external logic signal or output a logic level to control external equipment. Either of them can be independently configured as an input or an output and the active logic state can be selected High or Low to suit the requirements of the application. Electrically the ports output 5 Volt logic signals and are designed to be driven from a 5 Volt logic.

When the port is used in the input mode, the logic levels are TTL compatible, i.e. a voltage level less than 0.8 Volt will be recognised as a logic LOW and a level greater than 2.4 Volt as a logic HIGH. The input contains a weak pull-up, so the state of the input with nothing connected will default to a logic HIGH. The weak pull-up feature allows a passive device, such as a mechanical switch to be connected directly to the input.

When the port is used as an output it provides a push-pull drive of 5 Volts, with the maximum current limited to approximately 8 mA. The current limit prevents damage when the output is accidentally shorted to ground or driven to the opposite logic state by external circuity.

Warning: do not drive the TRIG ports from any voltage source that can produce an output in excess of the normal 0 to 5 Volt logic level range. In any case the voltage at the TRIG ports must be limited to -0.25 to +5.25 Volts.

Trigger Config

When configured as an input, the TRIG ports can be used as a general purpose digital input, or for triggering a relative, absolute or home move. When used for triggering a move, the port is edge sensitive. In other words, it has to see a transition from the inactive to the active logic state (Low->High or High->Low) for the trigger input to be recognized. For the same reason a sustained logic level will not trigger repeated moves. The trigger input has to return to its inactive state first in order to start the next trigger. The mode is set in the *Trigger 1 Mode* and *Trigger 2 Mode* parameters as follows:

Disabled - The trigger IO is disabled

Digital Input - General purpose logic input (read through status bits using the LLGetStatusBits method).

Trigger Input Jog Up - Input trigger for voltage step up. On receipt of the trigger, the drive voltage increases by the value set in the *Voltage Step* parameter.

Trigger Input Jog Down - Input trigger for absolute move. On receipt of the trigger, the drive voltage decreases by the value set in the *Voltage Step* parameter.

When the *Trig 1 Mode* and *Trig 2 Mode* parameters are configured as outputs, the TRIG ports can be used as a general purpose digital output as follows:

Digital Output - General purpose logic output (set using the SetKCubeTriggerConfigParams() message).

Triggering Polarity

The polarity of the trigger pulse is specified in the *Trig. 1 Polarity* and *Trig 2 Polarity*

parameters as follows:

Active High - The active state of the trigger port is logic HIGH 5V (trigger input and output on a rising edge).

Active Low - The active state of the trigger port is logic LOW 0V (trigger input and output on a falling edge).

Appendix A Connector Pinout Details

A.1 Power Connector

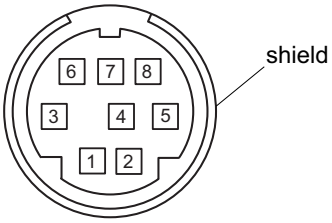
A.1.1 Pin Identification

Thorlabs recommends that the piezo cube is operated with Thorlabs power supply TPS002, as it was specifically designed for use with this product. However, to enable customers to use the cube in installations where a ±15V and 5V power is already available, the piezo cube can be operated with a different external power supply, such as a bench or lab supply.

In this case however, extreme care must be taken to ensure that it meets the specifications and connected to the cube correctly. Out of tolerance supply voltages or incorrect connection, applied even momentarily, can result in the sensitive electronic inside the cube getting damaged, invalidating warranty.

The cube uses a standard “mini-DIN” type of input connector, the corresponding plug is available from most standard electronics suppliers.

Fig. A.1 shows the mini-DIN socket as viewed by looking at the rear panel of the cube. The pin numbering follows the standard for mini-DIN connectors.



Pin	Description	Pin	Description
1	+5V	6	Common Ground
2	+5V	7	Common Ground
3	-15V	8	Common Ground
4	+15V	Shield	Common Ground
5	+5V		

Warning

When wiring the mini-DIN plug, ensure that all the ground pins are used and the shield is connected to common ground. This provides a level of protection against overvoltages due to loss of ground. A “loss of ground” condition can seriously damage the electronics inside the cube.

Fig. A.1 POWER Connector Pin Identification

Appendix B Preventive Maintenance

Warning: Risk of Electrical Shock

The equipment contains no user servicable parts. There is a risk of electrical shock if the equipment is operated with the covers removed. Only personnel authorized by Thorlabs Ltd and trained in the maintenance of this equipment should remove its covers or attempt any repairs or adjustments. Maintenance is limited to safety testing and cleaning as described in the following sections.

B.1 Cleaning

Warning

Disconnect the power supply before cleaning the unit.

Never allow water to get inside the case.

Do not saturate the unit.

Do not use any type of abrasive pad, scouring powder or solvent, e.g. alcohol or benzene.

The fascia may be cleaned with a soft cloth, lightly dampened with water or a mild detergent.

Appendix C Specifications and Associated Products

C.1 Specifications

Parameter	Value
Piezoelectric Output	
Piezo Drive Voltage	0 - 150V max. (SMC Connector)
Piezo Drive Current	7.5mA max. continuous
User Voltage Control	Digital Potentiometer (Resolution Selectable)
Output Noise	No Load Condition: < 5mV rms With 3.6 µF Load: < 3mV rms
Typical Piezo Capacitance	1µF to 10µF
Unit Internal Capacitance	220 nF
Output Impedance	10 Ω
Drive Bandwidth	1kHz (1µF Load, 1V p-p)
Drive Input	0-10V (SMA Connector)
Output Monitor	0-10V (SMA Connector)
K-Cube Controller Hub Connector	26-way ERNI
Closed Loop Operation	with K-Cube Strain Gauge Reader (KSG101)
Input Power Requirements (DIN Connector)	
Voltages	+15V (220 mA), -15V (50 mA), +5V (350 mA)
General Data	
Housing Dimensions (W x D x H) Excluding Buttons and Baseplate	60 x 60 x 47mm (2.36" x 2.36" x 1.85")
USB Connector Type	USB 3.0
USB Connection Speed	USB 1.1 Full Speed (12 Mbps)
Weight:	140g (5.0 oz)

C.2 Associated Products

Product Name	Part Number
Drive Cable for Piezoelectric Actuators (3.0 m)	PAA100
Drive Cable Extension for Piezo Actuators (3.0 m)	PAA100A
Drive Cable for Piezoelectric Actuators (1.5 m)	PAA101
Drive Cable Extension for Piezo Actuators (1.5 m)	PAA101A
K-Cube Strain Gauge Reader	KSG101
2-Way Power Supply Unit	TPS002
K-Cube 6-Channel Controller Hub	KCH601
K-Cube 3-Channel Controller Hub	KCH301
SMA to BNC Converter Cable 6”	CA2806
SMA Female to BNC Male Converter	T4289
SMA Male to BNC Female Converter	T4290

Appendix D Piezo Operation - Background

D.1 The Piezoelectric Effect

Piezoelectricity is the effect whereby certain types of crystal expand reversibly when subjected to an electric field.

Although the amount of expansion is usually very small (corresponding to less than 1% strain in the material) it can be controlled extremely finely by varying the strength of the electric field. Piezoelectric materials therefore form the basis of very high precision actuators. The resolution of these actuators is effectively only limited by the noise and stability of the drive electronics. Moreover, the force generated by the expanding piezo is very large, typically hundreds of newtons.

Perhaps the most useful property of these actuators is their ability to produce oscillating motion at considerable frequencies, usually limited by the mechanical system driven rather than by the piezo actuator itself. This ability is used to advantage in the NanoTrak control system, for example.

The electric field gradient needed to produce a useful amount of expansion is quite large. Thus to avoid excessive drive voltages, the actuator is constructed as a stack, consisting of lamina of active material sandwiched among electrodes – see Fig. D.1. In this way, the distance from positive to negative electrodes is very small. A large field gradient can therefore be obtained with a modest drive voltage (75 V in the case of most Thorlabs actuators).

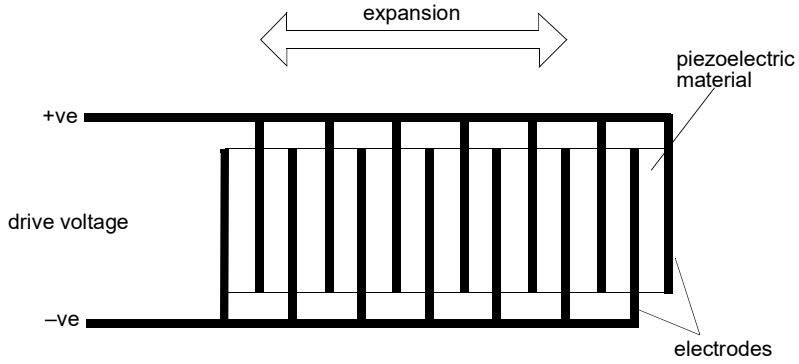


Fig. D.1 Piezo-electric actuator schematic diagram

D.2 Hysteresis

Despite the very high resolution of piezoelectric actuators, an inherent problem is the significant amount of hysteresis they exhibit, (i.e., the tendency of the actuator to reach a final position that lags behind the demand position).

If a cyclic voltage is applied to the actuator the positions reached on the upward sweep are smaller than those achieved on the downward sweep. If position is plotted against voltage, the graph describes a hysteresis loop – see Fig. D.2.

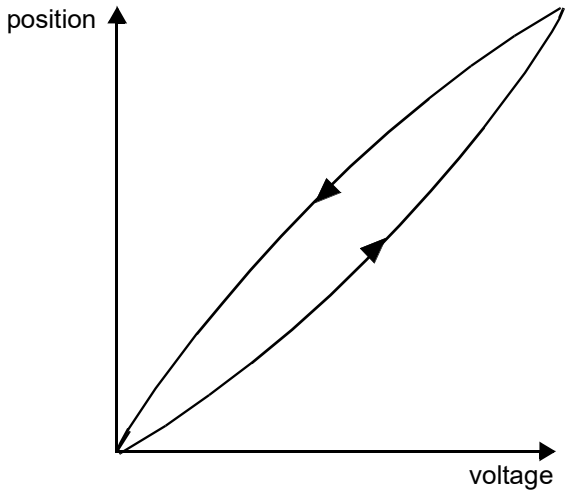


Fig. D.2 Piezo-electric hysteresis

D.3 Position Sensing and Feedback Control

Hysteresis can be eliminated by using a position sensor and feedback loop, i.e., the sensor measures the position, the circuit subtracts the measured position from the demand position to get the error, and a proportional-integral feedback loop adjusts the voltage to the actuator until the error is virtually zero.

Some Thorlabs nanopositioning actuators have position sensing, others do not. The Piezoelectric control module allows both types to be controlled.

To control an actuator with position sensing, the Piezoelectric control module should be set to closed-loop mode. To control an actuator without position sensing, the Piezoelectric Control module should be set to open-loop mode.

Note

An actuator with position sensing can also be driven in open-loop mode if desired, since the feedback part of the circuit can be switched off. An advantage of open-loop mode is the greater bandwidth of the system.

Block diagrams for both modes of operation are shown in Fig. D.1.

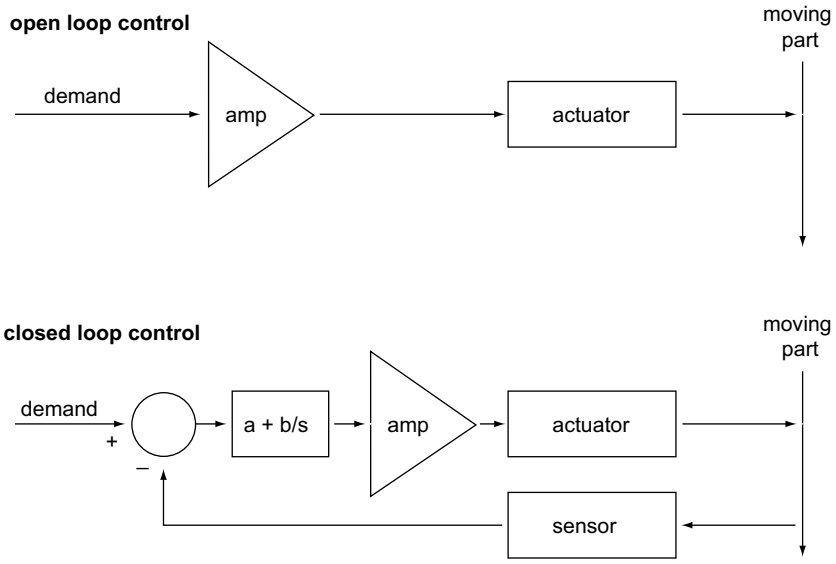


Fig. D.3 Open loop and closed loop control

The result of using closed-loop control is a linear relationship between demand (voltage) and measured position – see Fig. D.4, in contrast to open loop control – see Fig. D.2.

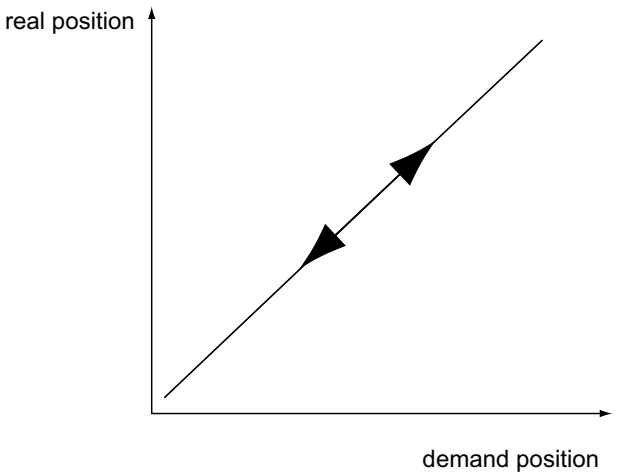


Fig. D.4 Closed loop response

Appendix E Regulatory

E.1 Declarations Of Conformity

E.1.1 For Customers in Europe

See Section E.2.

E.1.2 For Customers In The USA

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Changes or modifications not expressly approved by the company could void the user's authority to operate the equipment.

E.2 CE Certificate



EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs Ltd.

Of: 1 St. Thomas Place, Ely, CB7 4EX, United Kingdom

in accordance with the following Directive(s):

2006/95/EC	Low Voltage Directive (LVD)
2004/108/EC	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)

hereby declare that:

Model: ***KPZ101***

Equipment: ***Kinesis Piezo Motor Controller***

is in conformity with the applicable requirements of the following documents:

EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.	2010
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013

and which, issued under the sole responsibility of Thorlabs, is in conformity with Directive 2011/65/EU of the European Parliament and of the Council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment, for the reason stated below:

does not contain substances in excess of the maximum concentration values tolerated by weight in homogenous materials as listed in Annex II of the Directive

I hereby declare that the equipment named has been designed to comply with the relevant sections of the above referenced specifications, and complies with all applicable Essential Requirements of the Directives.

Signed: Keith Dhese *On:* 28 January 2016

Name: Keith Dhese

Position: General Manager

EDC - KPZ101 -2016-01-28

CE 16

Chapter 6 Thorlabs Worldwide Contacts

For technical support or sales inquiries, please visit us at www.thorlabs.com/contact for our most up-to-date contact information.



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Thorlabs verifies our compliance with the WEEE (Waste Electrical and Electronic Equipment) directive of the European Community and the corresponding national laws. Accordingly, all end users in the EC may return "end of life" Annex I category electrical and electronic equipment sold after August 13, 2005 to Thorlabs, without incurring disposal charges. Eligible units are marked with the crossed out "wheelie bin" logo (see right), were sold to and are currently owned by a company or institute within the EC, and are not dissembled or contaminated. Contact Thorlabs for more information. Waste treatment is your own responsibility. "End of life" units must be returned to Thorlabs or handed to a company specializing in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site





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