KIM001

1-Channel Inertia Piezo Motor Controller

Kinesis User Guide



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Chapter 1 Introduction

1.1 Introduction

The KIM001 Piezo Inertia Motor Controller is designed to control our series of piezo inertia-driven actuators and positioning stages. It offers 1 channel of stand-alone manual control for continuous movement/jogging and also remote PC control via USB. The product will support multiple external trigger functions, including position count and motion activity, as well as general purpose I/O.

Although compact in footprint, this unit offers a fully featured control capability including jog settings, “on the fly” changes in move direction, and, for more advanced operation, control over the number of steps performed.

The footprint of this unit has been kept to a minimum, measuring only 60 mm x 60 mm x 47 mm (2.36" x 2.36" x 1.85") and with the facility to directly mount to the optical table close to the devices being driven - convenient when manually adjusting positions using the top panel controls. Table top operation also allows minimal drive cable lengths for easier cable management.



Fig. 1.1 K-Cube Piezo Inertia Motor Controller

USB connectivity provides easy 'Plug and Play' PC controlled operation - multiple units can be connected to a single PC via standard USB hub technology. Coupling this with the user friendly Kinesis software (supplied) allows the user to very quickly get up and running with complex move sequences in a short space of time. Advanced custom motion control applications and sequences are also possible using the

extensive .Net programming environment also supplied. This programming library is compatible with many development tools such as LabView, Visual Basic, Visual C++, C++ Builder, LabWindows/CVI, and Delphi.

In the remainder of this handbook, operation of the unit is described for both front panel and PC operation. Tutorial sections (Chapter 4 and Chapter 5) provide a good initial understanding on using the unit and reference section (Chapter 6) covers all operating modes and parameters in detail.

1.2 Power Options

A single way wall plug KPS201* supply for powering a single K-Cube Driver is available.

* The previous-generation KPS101 power supply is also compatible and can be used to power a single K-Cube Driver.

For multiple cube systems, a 3-channel (KEH3) or 6-channel (KEH6) K-Cube Controller Hub are offered..



Caution

Due to the nature of its design, and its non-linear high frequency switching, the KIM001 unit is not compatible with the previous-generation KCH301 and KCH601 hubs. Use either the KPS201 power supply unit or the KEH3/KEH6 Controller Hubs. The previous-generation KPS101 is also compatible.



Caution

Do not use a power supply with damaged, cracked or split wires. In such cases, the supply could still power up the cube, but the integrity of the ground return may be compromised. This could result in a hazardous live voltage being generated.

Any obvious signs of damage to the power supply lead should result in immediate replacement of the PSU.

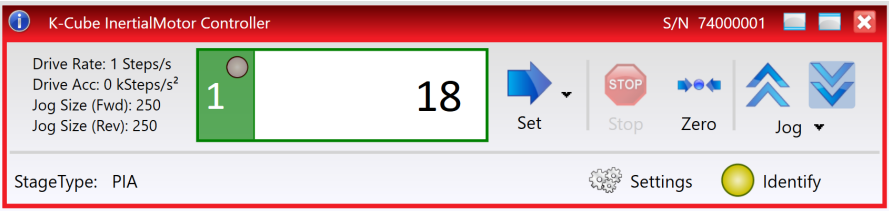
1.3 Software Overview

1.3.1 Introduction

Kinesis controls are re-usable compiled software components that supply both a graphical user interface and a programmable interface. Many such Controls are available for Windows applications development, providing a large range of re-usable functionality. For example, there are Controls available that can be used to manipulate image files, connect to the internet or simply provide user interface components such as buttons and list boxes.

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. 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, VB.NET, C#.NET and, via VBA, Microsoft Office applications such as Excel and Word.

Consider the control supplied with the KIM001 Inertial Piezo Driver K-Cube.



All basic operating parameters can be altered and, similarly, all operations (such as jog moves) can be initiated. Settings and parameter changes can be saved and loaded to allow multiple operating configurations to be created and easily applied.

For many users, the GUI application provides all of the functionality necessary to operate the hardware without the need to develop any further custom software. For those who do need to further customize and automate usage of the controller, this application illustrates how the rich functionality provided by the Kinesis server is exposed by a client application.

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

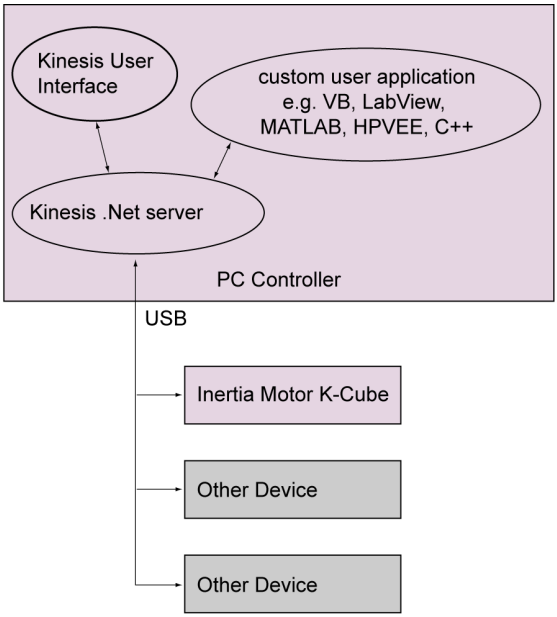


Fig. 1.2 System Architecture Diagram

Refer to the main Kinesis Software online help file, for a complete programmers guide and reference material on using the Kinesis Controls collection. 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.

This controller is fully compatible with Thorlabs' Kinesis® and XA software applications. This manual describes use of the KIM001 controller with Thorlabs' Kinesis software. For information about operation using Thorlabs' XA software, refer to the XA User Guide.

1.3.2 Software Upgrades

Thorlabs operate a policy of continuous product development and may issue software upgrades as necessary. The latest software can be downloaded from the 'Services/ Software Downloads/Motion Controllers' section of www.thorlabs.com. A utility is provided with the Software to assist in firmware upgrades

Note

When the firmware is updated, the cooling fan may increase in speed while the unit is reprogrammed.

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 (MOTOR) that are hazardous and can cause serious injury. In any installation that uses the KIM001 it is the user's responsibility to ensure adequate insulation and precautions are taken to avoid shock risk. Cables for MOTOR 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 absorbent tissue. Do not allow spilled fluid to enter the internal mechanism.

Chapter 3 Installation

3.1 Install The Software

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 Chapter 4.

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.



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.

DO NOT CONNECT THE CONTROLLER TO YOUR PC YET

1) Go to Services/Downloads at www.thorlabs.com and download the Kinesis 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 Motor Controller 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 (KEH3) or 6-channel (KEH6) K-Cube Controller Hub are offered. Due to the nature of its design, and its non-linear high frequency switching, the KIM001 unit is not compatible with the previous generation KCH301 and KCH601 hubs.

Caution

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

To help minimize the risk of overheating, ensure that proper airflow is maintained to the front, rear and sides of the unit.

3.2.3 Using the Baseplate

The baseplate is supplied with magnets for quick positioning on an optical worksurface. For more secure positioning, it can 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.

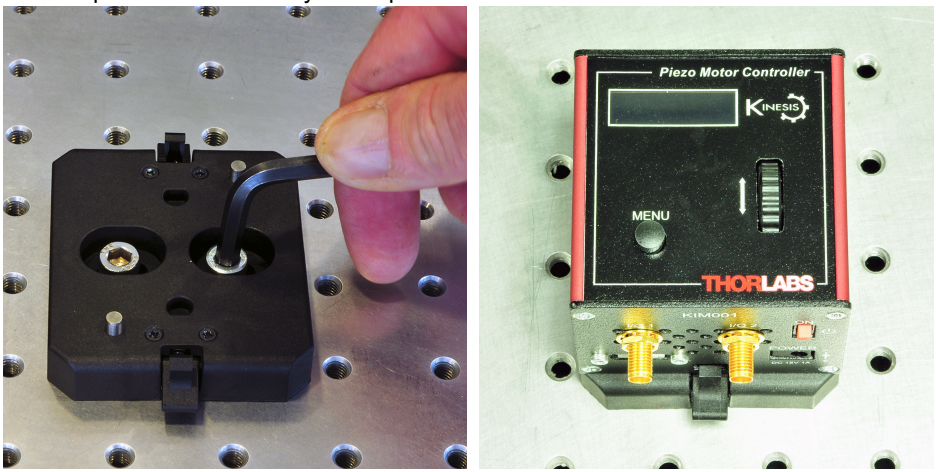


Fig. 3.1 Using The Baseplate

3.3 Electrical Installation

Caution

Ensure that all USB and electrical cables are positively connected and all joints tightened. Loose connections can cause noise and interference problems due to transients from the high switching frequencies within the unit

3.3.1 Front Panel Connections

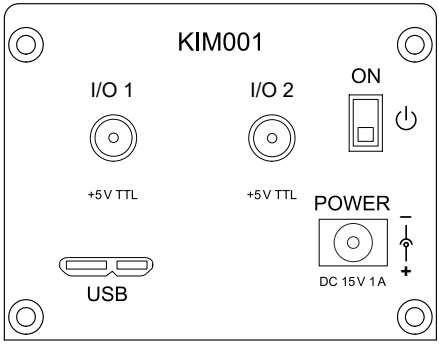


Fig. 3.2 Front Panel



Warning: Risk of Electrical Shock

The unit must be connected only to a DC supply of 15V, 1A regulated. Connection to a supply of a different rating may cause damage to the unit and could result in injury to the operator.

POWER - A Standard 3.5 mm front panel jack connector for connecting the unit to a regulated DC power supply of 15 V, 1A - 2.66A. See Section 1.2. for details on power supply options.



Caution

Do not use a power supply with damaged, cracked or split wires. In such cases, the supply could still power up the cube, but the integrity of the ground return may be compromised. This could result in a hazardous live voltage being generated.

Any obvious signs of damage to the power supply lead should result in immediate replacement of the PSU.

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. 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. The switch should always be used to power down the unit.

I/O 1 and I/O 2 - SMA connectors for use with external trigger input and output signals (5V TTL levels). Units are shipped with I/O functionality disabled. The function is set to trigger IN or OUT via the GUI settings panel - see Section 6.3.4.



Caution

Do not connect the piezo unit to a 'live' external power supply. Doing so (i.e. “hot plugging”) carries the risk of PERMANENT damage to the unit. Always ensure the power supply unit is isolated from the mains and the front panel switch turn OFF before connecting to the piezo unit.

Always power up the piezo unit by connecting its power supply to the mains then switch ON using the front panel switch. Similarly, to power down the unit, turn the front panel switch OFF, then disconnect the power supply from the mains before disconnecting the piezo unit.

Caution

To avoid overheating the unit, do not turn off the power until the fan has stopped. This can take several minutes if high frequency stage moves have been performed.

3.3.2 Rear Panel Connections

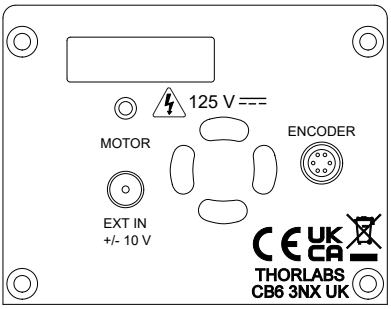


Fig. 3.3 Rear Panel Connections

EXT IN - (SMA Connector) Analog input, used to control the velocity of the piezo actuator from an external source. This input allows an external signal to drive the output to its full scale velocity in either direction. A -10V input gives max velocity in the reverse direction, whereas +10V input gives max velocity forwards; a 0V input results in no movement.

See Section 4.6. for information on how to enable control via these analog inputs.

MOTOR - (SMC Connector) Drive connector compatible with all Thorlabs inertial piezo motor driven positioning stages and actuators (PIA series)**.**

Caution

When making connections to the MOTOR terminal, take care to ensure proper alignment of the connectors before tightening. If resistance is felt the pins may be misaligned and could bend/break if the connection is forced.

The PIA series piezo inertia actuators are shipped with 1.1 m (3.3') of cable. Thorlabs offer 1.5 m extension cables (PAA101) and male adapters (T5026) to extend the drive cable length to 2.5 m, see www.thorlabs.com.

Due to the capacitance of the cables, do not use cables longer than 2.5 m in total.

ENCODER - (6-Pin Hi-Rose Connector Female) For future use.

3.3.3 Powering Down The Unit

Caution

To avoid overheating the unit, do not turn off the power until the fan has stopped.

3.4 Connect The Hardware

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

4) Connect the Piezo motor stage to the Controller unit - see Section 3.3.2.

Caution

During item (5) 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 supply from the mains before disconnecting the K-Cube unit.

5) Connect the Controller unit to the power supply - see Section 3.3.1.
6) Connect the PSU to the main supply and switch ‘ON’.

Caution

During initialization at power up, checks are carried out on any actuators connected to the controller. If any faults are detected an error message is indicated on the LCD screen and the unit should be powered down immediately.

7) Switch ‘ON’ the unit using the switch on the front panel.
8) Windows® should detect the new hardware. Wait while Windows® installs the drivers for the new hardware.

The unit takes about 5 seconds from power application until initialization is finished, during which time the firmware revision and the stage type last selected are displayed.

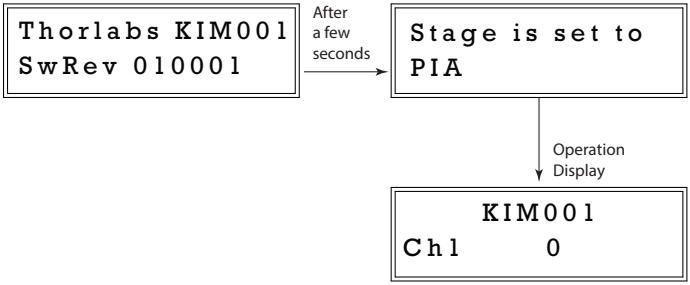


Fig. 3.4 KIM001 start up screen

After initialization, the displays shows the device part number (KIM001) and the position is steps from the zero position.

3.5 Selecting the Stage Type

To ensure that a particular stage is driven properly by the system, a number of parameters must first be set. These parameters relate to the physical characteristics of the stage/ actuator being driven (e.g. min and max positions, leadscrew pitch, homing direction etc.).

To assist in setting these parameters correctly, it is possible to associate a specific stage type with the motor controller. Once this association has been made, the server automatically applies suitable default parameter values on boot up of the software.

Note

To ensure correct operation, it is important to select the correct stage and axis type as described above. Selecting an incompatible stage/axis type could result in reduced velocity and/or resolution, and in the worst case could cause the stage to run into the end stops.

The stage type can only be selected from the top panel settings menu - see Section 4.5.11. for more details.

3.6 Verifying Software Operation

The Kinesis Software should be installed (Section 3.1.) and the controller connected to the actuators (see Section 3.4.) and the PC, before verifying software operation.

1) Run the Kinesis software and check that the Graphical User Interface (GUI) panel appears and is active.

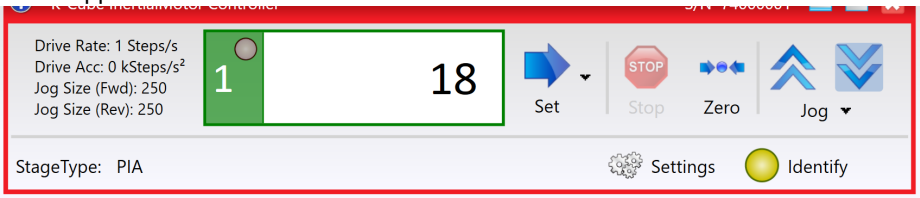


Fig. 3.5 GUI panel showing jog and ident buttons

2) Click the 'Ident' button. The display on the top panel of the associated controller flashes. This is useful in multi-channel systems for identifying which channel is associated with which GUI.
3) Click the channel number to enable the channel. The number is highlighted in green as shown above. The LED adjacent to the channel number is lit when the channel is in motion.
4) Click the jog buttons on the GUI panel to move the actuator associated with the selected channel. The step count display for the associated GUI should increment and decrement accordingly.

Follow the tutorial described in Chapter 5 for further guidance on basic operation.

3.7 Automatic Temperature Control During High Frequency Operation

Caution

During high frequency operation over a prolonged period of time, the unit can become quite hot. During this operation, the unit temperature is continually monitored by an internal sensor circuit. If the heat generated becomes excessive, the internal circuit may trip and reduce the drive frequency until the unit has cooled down. In extreme operating conditions the unit may be disabled and an error message generated on the top panel.

Chapter 4 Standalone Operation



Warning: Risk of Electrical Shock

Persons using the KIM001 controller must understand the hazards associated with using high voltages and the steps necessary to avoid risk of electrical shock. If the KIM001 is used in a manner not specified by Thorlabs, the protective features provided by the product may be impaired.

4.1 Introduction

The K-Cube Piezo Inertia Motor Driver has been designed specifically to operate with the latest range of Thorlabs piezo inertia motor driven products. The unit offers a fully featured control capability including max drive voltage settings, step rate and step acceleration, allowing support for many different actuator configurations. These parameters can be set via the Kinesis software - see Chapter 6. Furthermore, many of these parameters are automatically set to allow “out of the box” operation with no further “tuning” required.

The following brief overview explains how the front panel controls can be used to perform a typical series of motor moves. It is assumed that the unit has already been installed and configured for the particular actuator or stage connected - see Chapter 3 for more details.

4.2 Control Panel Buttons and Indicators

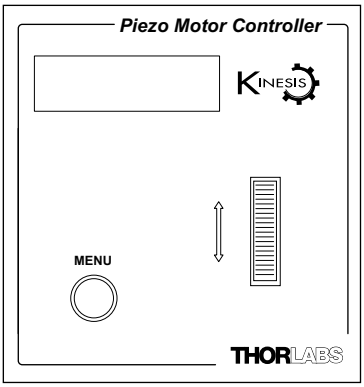


Fig. 4.1 Panel Controls and Indicators

These controls allow all operations to be initiated.

Wheel - Used to move the piezo motor - see Section 4.4. Also used to move through the various set up menu options - see Section 4.5.

Digital Display - Under normal operation, the display shows the step count of the motor, together with the motor channel currently selected. It also shows the menu options and settings, accessed via the menu button - see Section 4.5. When the Ident button on the associated GUI panel is clicked, the display text 'KIM001' at the top of the display will flash for a short period.

MENU - used to access the settings menu - see Section 4.5.

4.3 Zeroing

To establish a datum from which subsequent moves can be measured, move the motor to the required zero position. The position count can then be zeroed in the Zero Axis option in the Settings Menu - see Section 4.5.3.

The counter can also be zeroed by clicking the ZERO button on the GUI panel (see Section 5.3.), or by calling the appropriate message in the Kinesis software).

4.4 Wheel Operation

The wheel on top of the unit provides multi-function operation. In normal use the wheel is used to move the motor, at a velocity that is proportional to its deflection from the central position. In this central position the piezo inertia motor is stationary. As the wheel is moved away from the center, the motor begins to move. Directional control of the motor is achieved by moving the wheel up and down.

The wheel can be used to control the motor in a number of ways as follows, depending on the mode selected in the wheel Mode menu option - see Section 4.5.6.



Caution

If the actuator is driven into its physical end stops, the motor may stick and may not respond to subsequent motion demands. If this is the case, turn the adjustment knob of the actuator manually to move the device away from its end stop, then the motor should move normally.

4.4.1 Jog to Count

In 'Jog to Count' mode, the wheel can be programmed with two position values, one for each direction of deflection, such that the controller will move the motor to that position when the wheel is moved. In this mode, move the wheel up to go to position 1, and down to go to position 2.

These 'taught' positions can be set through the Teach Position option in the settings menu - see Section 4.5.7. or through the software GUI - see Section 6.3.1.

This mode of operation is enabled in the Settings Menu by setting the 'wheel Mode' option to 'Jog to Count' - see Section 4.5.6. It can also be selected in the wheel Mode parameter on the Device tab in the GUI Settings panel - see Section 6.3.1. for further information.

4.4.2 Jogging

The top panel wheel can also be configured to 'jog' the motor. This mode of operation is enabled by setting the wheel Mode menu option to 'Jogging in Steps - see Section 4.5.6. or by setting the 'wheel Mode' parameter to 'Jog' on the 'Device' settings tab - see Section 6.3.1.

Once set to this mode, the jogging parameters (step size, step rate etc) are taken from the 'Jog Settings' parameters on the individual Channel settings tabs - see Section 6.3.3. or from the Jog Step Size option in the panel settings menu.

4.4.3 Velocity Control

When Velocity Control mode is selected, the speed of the motor increases as a function of deflection. The maximum speed is entered in the 'Max Step Rate' parameter in the 'Device Control Options' parameters on the Device settings tabs - see Section 6.3.3.

4.5 Settings Menu

4.5.1 Overview

After the power up sequence is complete, the normal operating screen is displayed.

Press the MENU button to enter the settings mode.

Use the wheel to scroll through the menu options

Press the MENU button to enter a particular option

Go to position count - see Section 4.5.2.

Zero the selected axis - see Section 4.5.3.

Set the move velocity- see Section 4.5.4.

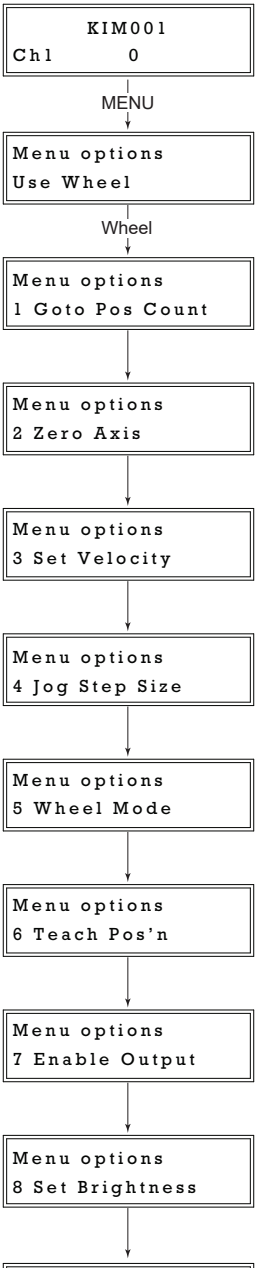
Set the jog step size- see Section 4.5.5.

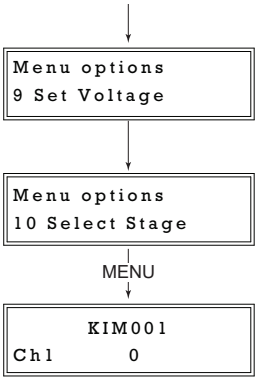
Set the wheel mode - see Section 4.5.6.

Teach the go to positions - see Section 4.5.7.

Enable or disable the drive axis - see Section 4.5.8.

Set the display brightness - see Section 4.5.9.





Overview (Cont)...

Set the voltage - see Section 4.5.10.

Select the stage - see Section 4.5.11.

Press MENU to return to the operating screen

4.5.2 Menu Option - Go to position count

This option is used to move the motor associated with the selected channel to a specific position. The position is measured in cycles (pulses) relative to the zero position, in the range -100000 to 100000.

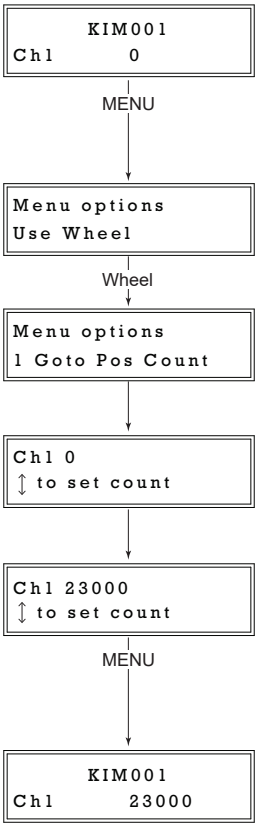
Press the MENU button, then use the wheel to scroll through the menu options.

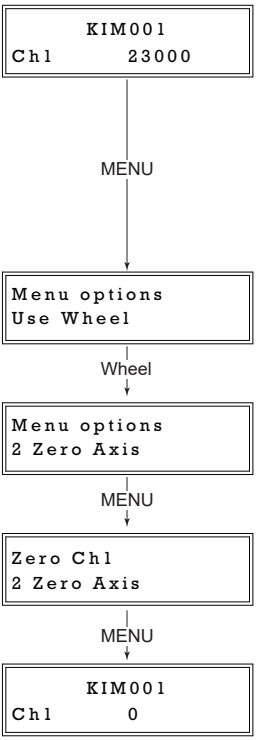
Press the MENU button to enter the *Go to Pos Count* option.

Use the wheel to set the required position count, in the range -100000 to +100000.

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

The display shows position count, which counts up or down until the target is reached.





4.5.3 Menu Option - Zero Axis

Zeroing is equivalent to homing in a stepper or DC motor in that it establishes a datum from which subsequent position moves can be measured. Unlike these other motors however, the piezo motor can be zeroed anywhere along its travel.

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

Press the MENU button to enter the Zero Axis option.

Press the MENU button to zero the channel and return to the main display.

The display shows the zeroed position count.

4.5.4 Menu Option - Set Velocity

This option is used to set the max velocity when a move command is initiated via the GUI panel or via software. It is not applicable to moves initiated by the wheel (see Section 6.3.3.).

The piezo motor moves by ramping up the drive voltage to the value set in the Peak Voltage parameter (see Section 4.5.10.) and then dropping quickly to zero. This cycle is then repeated (see Fig. 6.3).

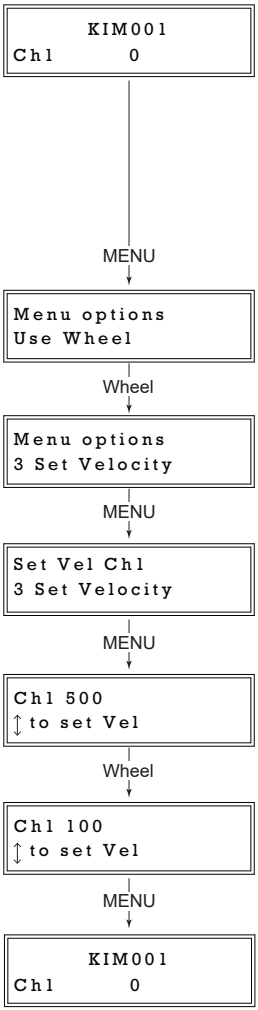
The velocity is specified in cycles/sec, in the range 1 to 2,000.

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

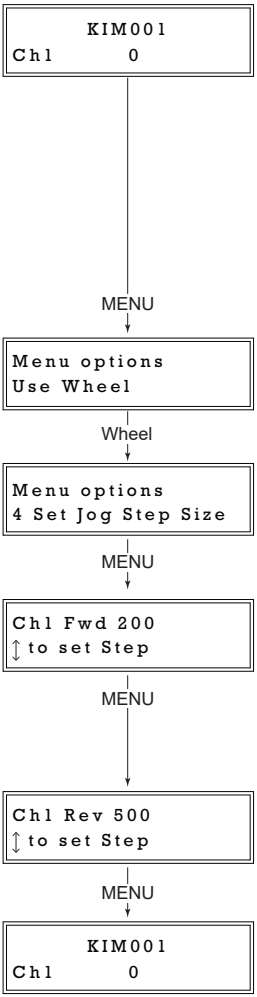
Press the MENU button to enter the Set Velocity option.

Use the wheel to adjust the velocity, in the range 1 to 2,000 cycles/sec.

Press the MENU button to save the setting and return to the main operating display.



4.5.5 Menu Option - Set Jog Step Size



This option is used to set the distance moved when a jog command is initiated. The step size is specified by the 'number of cycles' (or pulses)' (see Section 6.3.3.), in the range 1 to 2,000.

The optimum step size depends on several parameters including the resistive torque against which the actuator tip is pushing, the drive voltage, the step rate, active preload, variance in the frictional behaviour of assembly components, the direction of actuation and the condition of the actuator.

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

Press the MENU button to enter the Set Jog Step Size option.

Use the wheel to adjust the forward jog step size, in the range 0 to 2,000 cycles.

Press the MENU button to save the setting.

Use the wheel to adjust the reverse jog step size, in the range 0 to 2,000 cycles.

Press the MENU button to save the setting and return to the main operating display.

4.5.6 Menu Option - Wheel Mode

This option is used to set the operating mode of the top panel wheel, as detailed in Section 4.4.

In all modes, directional control of the motor is achieved by moving the wheel up and down.

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

Press the MENU button to enter the Wheel Mode option.

Use the wheel to select the required mode.

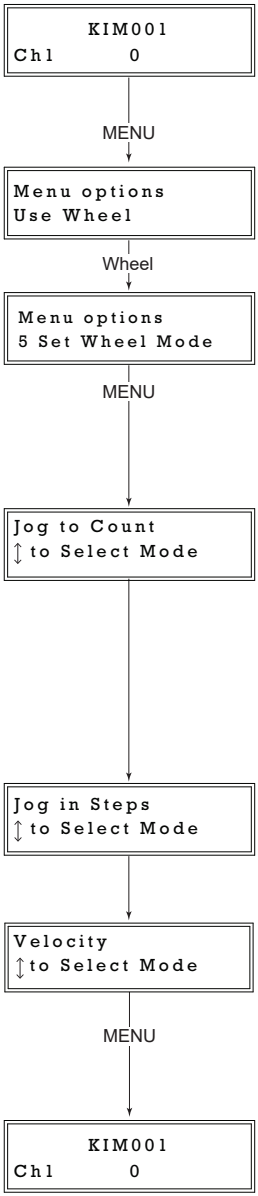
In '*Jog to Count*' mode, the wheel can be programmed with two position values, one for each direction of deflection, such that the controller will move the motor to that position when the wheel is moved. In this mode, move the wheel up to go to position 1, and down to go to position 2.

These 'taught' positions are set through the Teach Position option - see Section 4.5.7.

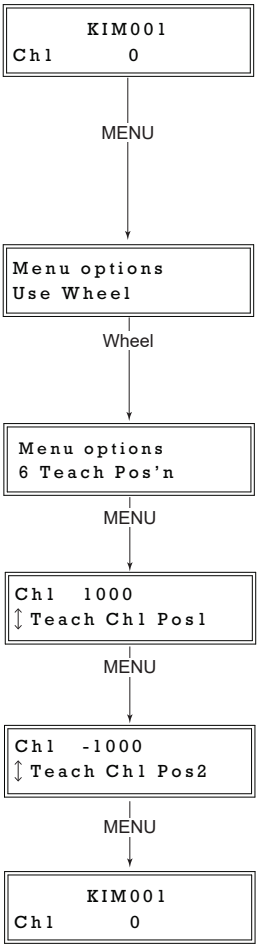
In *Jog in Steps* mode, the motor moves one jog step for each deflection of the wheel. The jog step size is set in the Set Jog Step Size menu option - see Section 4.5.5. or in the 'Channel' settings tab - see Section 6.3.3.

When *Velocity* mode is selected, the speed of the motor increases as a function of deflection. The maximum speed is entered as a Step Rate value in the 'Max Step Rate' parameter in the 'Device Control Options' parameters on the Device settings tabs - see Section 6.3.3.

Press the MENU button to save the mode selected and return to the operating screen.



4.5.7 Menu Option - Teach Positions



This option is used to set the move positions, when the wheel mode is set to 'Jog to Count' mode (see Section 4.5.6.).

Positions are measured in cycles' (or pulses)' from the zero position (see Section 6.3.3.).

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

Press the MENU button to enter the Teach Pos'n option.

Use the wheel to set Pos1 (in steps from the zero position), then press the MENU button to save. The motor will move to this position when the wheel is moved Up.

Use the wheel to set Pos2 (in steps from the zero position), then press the MENU button to save. The motor will move to this position when the wheel is moved Down.

Press MENU to save the settings and return to the operating screen.

4.5.8 Menu Option - Enable Output

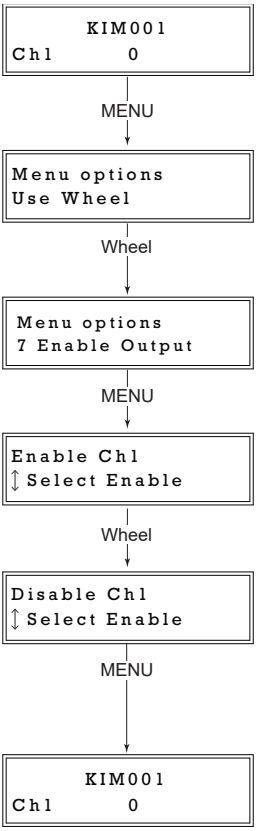
This option is used to enable and disable the motor axis from the top panel.

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

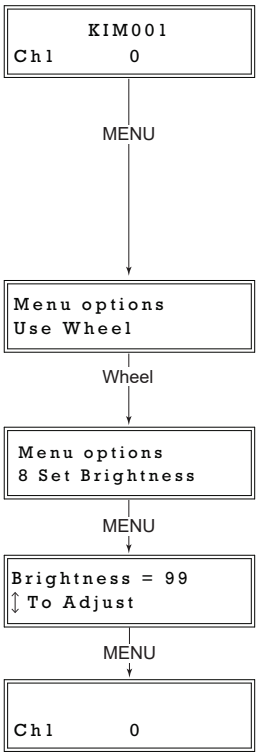
Press the MENU button to enter the Enable Output Mode option.

Use the wheel to select *Enable Ch1* or *Disable Ch1* as required.

Press the MENU button to save the selection and return to the operating mode.



4.5.9 Menu Option - Set Brightness



In certain applications, it may be necessary to adjust the brightness of the LCD display. The brightness is set as a value from 0 (Off) to 99 (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.

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

Press the MENU button to enter the Brightness option.

Use the wheel to adjust the brightness, in the range 0 (off) to 99 (brightest).

Then press the MENU button to store the selection and return to the main display.

4.5.10 Menu Option - Set Voltage

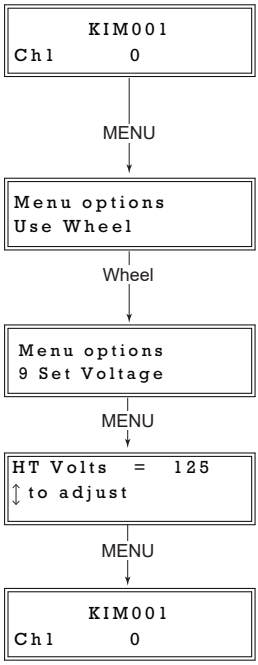
This option is used to set the maximum piezo drive voltage applied to the actuators in the range 85 V to 125 V.

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

Press the MENU button to enter the Set Voltage option.

Use the wheel to adjust the max drive voltage, in the range 85 to 125 V.

Then press the MENU button to store the selection and return to the main display.



4.5.11 Menu Option - Select Stage

This option allows the type of stage/actuator being driven to be selected. Once this selection has been made, the server automatically applies suitable default parameter values on boot up of the software

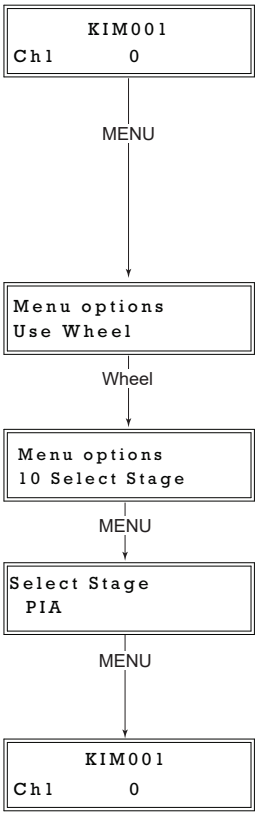
It is important to select the correct stage and axis type. Selecting an incompatible stage/axis type could result in reduced velocity and/or resolution, and in the worst case could cause the stage to run into the end stops.

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

Press the MENU button to enter the Select Stage option.

Use the wheel to select the stage being driven, either 'PIA' for our PIA series Inertial Piezo Actuators, or PD(R) for one of our PD series Inertial Piezo Stages. The stage type selected is displayed on start up - see Fig. 3.4.

Then press the MENU button to store the selection and return to the main display.



4.6 Using the External Inputs

The EXT IN connector on the rear panel (see Fig. 3.3) can be used to control the velocity of the piezo actuator by using a voltage input from an external source.

A -10 V input gives max velocity in the reverse direction, whereas +10 V input gives max velocity forwards; a 0 V input results in no movement.

To use the external inputs, the user should apply a signal of 0 V ±0.25 V to the connector and wait 10 to 12 seconds for the unit to recognize a steady 0V input. After this time, the drive channel can be controlled by varying the voltage from -10V (max velocity reverse) to 10 V (max velocity forwards). A 0 V input results in no movement.

Note

The external inputs cannot be used in conjunction with the wheel or GUI panels.

If the unit recognizes a 0 V signal on the EXT IN connector for around 12 seconds it will accept this as the controlling input. If subsequently, a move is performed via the GUI panel or wheel, this will inhibit the analog input. However, if the 0V signal remains, and no further GUI or wheel moves are performed, the external analog input will again become active after 12 secs.

To disable completely the analog control, disable the relevant axis, then remove the analog input, then re-enable the axis.

Chapter 5 PC Operation - Tutorial

5.1 Introduction

The following brief tutorial guides the user through a typical series of moves and parameter adjustments performed using the Kinesis software. It assumes that the unit is electrically connected as shown in Section 3.3.2. and that the Software is already installed - see Section 3.1.

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 motor moves) can be initiated. Hardware configurations and parameter settings can be saved, which simplifies system set up whenever the software is run up.

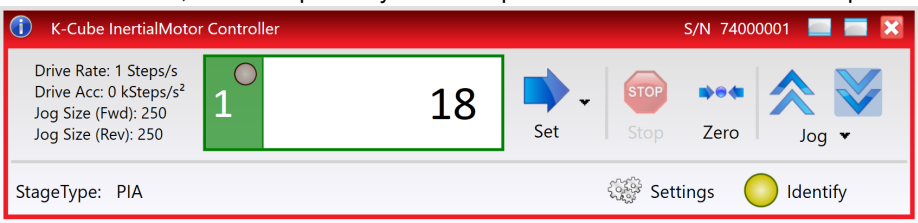


Fig. 5.1 Typical User Screen

1) Run the Kinesis program - Start/Programs/Thorlabs/Kinesis/Kinesis.
2) The GUI panel shown above is displayed.
3) The number of the channel currently enabled is highlighted in green as shown above. The LED adjacent to the channel number is lit when the channel is in motion.

The Kinesis software will be used throughout the rest of this tutorial to interface with the piezo inertia motor controller.

5.3 Zeroing

To establish a datum from which subsequent position moves can be measured, move the motor to the required zero position, and then click the ZERO button on the GUI panel. The motor can also be zeroed from the hardware unit by using the Zero Axis menu option (see Section 4.5.3.).

5.4 Moving to a Position

Moves are measured in the number of steps, relative to the zero position.

1) Click the 'Set' arrow, next to the position display for the required channel.

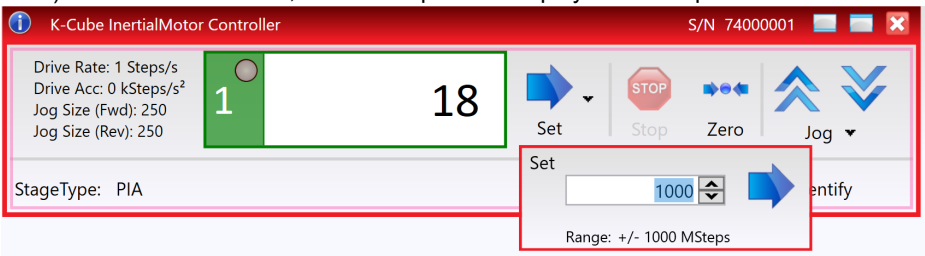


Fig. 5.2 Position Popup Window

2) Enter the required number of steps into the pop up window, e.g. 128
3) Click the arrow button . Notice that the position display counts up to 128 to indicate a move to the absolute position commanded.

5.5 Changing Motor Parameters

The velocity settings shown to the left of the main display relate to the maximum velocities at which a move is performed, and the acceleration at which the motor speeds up from zero to maximum velocity. The values are entered for each channel in the Drive Settings entered in the Settings panel (see Section 6.3.3.).

5.6 Jogging

During PC operation, the motor actuators are jogged using the GUI panel 'Jog' arrow keys .



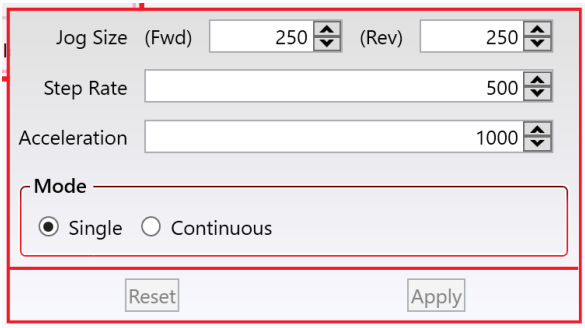
There are two jogging modes available, 'Single Step' and 'Continuous'. In 'Single Step' mode, the motor moves by the step size specified in the Step Size parameter each time the jog key is pressed and released. The jog key must be released and pressed again for jogging to be repeated - see Fig. 6.2.

In 'Continuous' mode, the motor actuator will accelerate and move at the jog velocity while the button is held down.

Caution

If the actuator is driven into its end stops, the motor may stick and may not respond to subsequent motion demands. If this is the case, turn the adjustment knob on the actuator manually to move the device away from its end stop, then the motor should move normally.

1) To adjust the Jog parameters, click the Jog button to display the Jog Parameters popup window.



2) Enter the parameters values as required, then click Apply to save the settings. These parameters can also be set/saved in the settings panel for each channel - see Section 6.3.3. for more details on these parameters.

Chapter 6 Software Reference

6.1 Introduction

This chapter gives an explanation of the parameters and settings accessed from the software running on a PC.

6.2 GUI Panel

The following screen shot shows the graphical user interface (GUI) displayed when accessing the Piezo Motor Driver K-Cube using the Kinesis software.

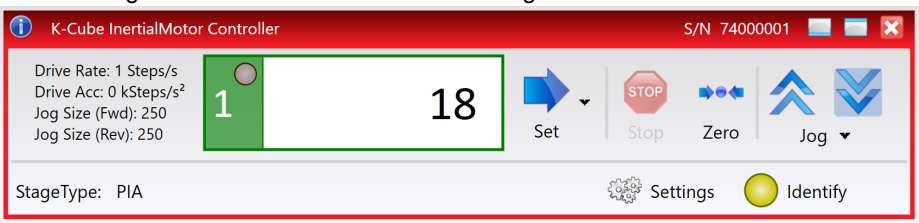


Fig. 6.1 Piezo Motor Driver K-Cube Software GUI

Note. The serial number of the Piezo Motor Driver K-Cube associated with the GUI panel is displayed in the top right hand corner. This information should always be provided when requesting customer support.

Digital display - Shows the position (drive pulses) of the motor associated with the drive channel. The motor must be 'zeroed' before the display will show a meaningful value, (i.e. the displayed position is relative to a physical datum). The channel can be enabled and disabled by clicking the channel number which is lit green as shown above when enabled. The adjacent LED is lit when the associated motor is in motion.

Set Arrow - Used to move the motor to a specified position (see Section 5.4.).

Jog Arrows- used to increment or decrement the motor position. When the button is clicked, the motor is driven in the selected direction at the jog velocity one step per click. The step size and jog velocity parameters are set in the 'Settings' panel (see Section 6.3.) or by clicking the Jog button (see Section 5.6.).

Zero - Zeroes the position counter at the current motor position. Subsequent moves are then measured from the current position.

Stop - halts the movement of the motor.

Settings display - shows the following user specified settings:

Drive Rate - The velocity to move when a move command is initiated. It is specified in drive pulses/sec, in the range 1 to 2,000.

Drive Acc - The acceleration up to the drive rate. It is specified in pulses/sec/sec in the range 1 to 100,000.

Jog Size (Fwd) and (Rev) - the size of step (ie. number of drive pulses) taken when the jog signal is initiated (1 to 1000000).

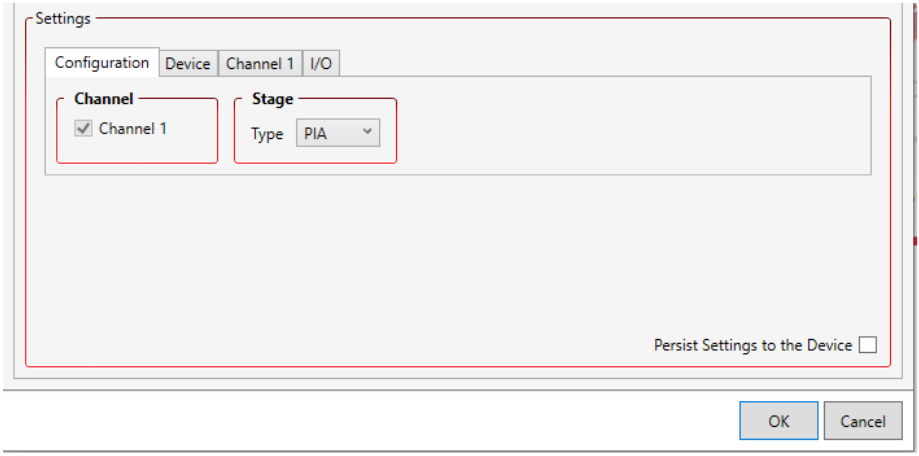
Identify - when this button is pressed, the text 'KIM001' on the top panel display of the associated hardware unit will flash for a short period.

Settings button - Displays the 'Settings' panel, which allows the operating parameters to be entered for the motor drive - see Section 6.3.

6.3 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 (refer to the *Kinesis Server helpfile* for further details.

6.3.1 Configuration Tab



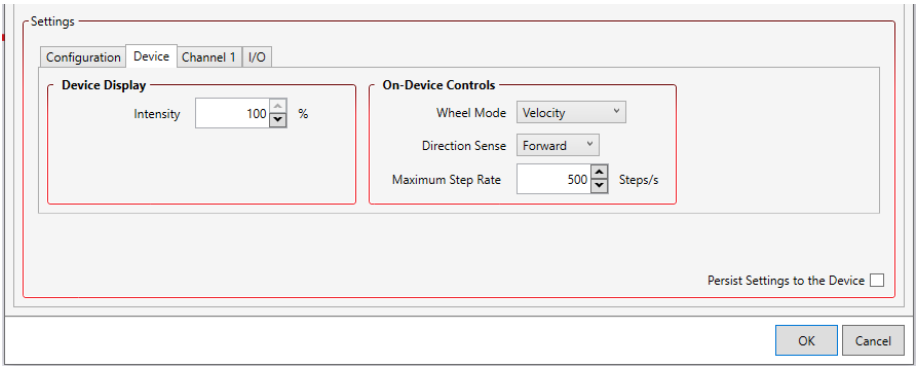
Channel - This parameter is always checked and is not adjustable by the user.

Stage - This parameter allows the type of stage/actuator being driven to be selected. Once this selection has been made, the server automatically applies suitable default parameter values on boot up of the software

It is important to select the correct stage and axis type. Selecting an incompatible stage/axis type could result in reduced velocity and/or resolution, and in the worst case could cause the stage to run into the end stops.

Select either PIA or PD(R) as appropriate.

6.3.2 Device Tab



Device Display

In certain applications, it may be necessary to adjust the brightness of the LCD display on the top of the unit. The brightness is set in the *Intensity* parameter, as a value from 1% (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.

On-Device Controls

These parameters

The wheel is sprung such that when released it returns to it's central position. In this central position the motor is stationary. As the wheel is moved away from the center, the motor begins to move; the speed of this movement increases as the deflection is increased. Bidirectional control of motor moves is possible by moving the wheel in both directions.

Wheel Mode

Velocity - Deflecting the wheel starts a move with the velocity proportional to the deflection. The maximum velocity (i.e. velocity corresponding to the full deflection of the wheel) and acceleration are set in the *Channel tab Drive Settings*. parameters.

Jog - Deflecting the wheel initiates a jog move, using the parameters specified by the *Channel tab Jog Settings*. The wheel must be released before another jog move can be initiated.

Go To Position - Deflecting the wheel starts a move from the current position to one of the two predefined "go to" positions. These positions are specified in the *Preset Position 1* and *Preset Position 2* parameters displayed for each channel when the Go To Position mode is selected, and are measured in number of steps from the zero position. In this mode, move the wheel up to go to position 1, and down to go to position 2.

Note. The following parameters are applicable only if 'Go to Position' is selected in the '*Wheel Mode*' field.

Preset Position 1: The position to which the motor will move when the top panel wheel is moved upwards. The position is entered in 'Steps, measured from the Zero position.

Preset Position 2: The position to which the motor will move when the top panel wheel is moved downwards.

Note. The motor can be zeroed by clicking the 'Zero' button on the GUI panel. Doing this will zero the position counter, and subsequent moves will be measured from the position the motor was at when the counter was zeroed.

Direction Sense

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

Disabled - The wheel is disabled to remove any unwanted motion due to accidental movement of the wheel.

Forward - Upwards movement of the wheel results in a positive motion (i.e. increased position count).

Note. The following option applies only when the Wheel Mode is set to Velocity Control. If set to Position Jogging or Go to Position Mode, the following option is ignored.

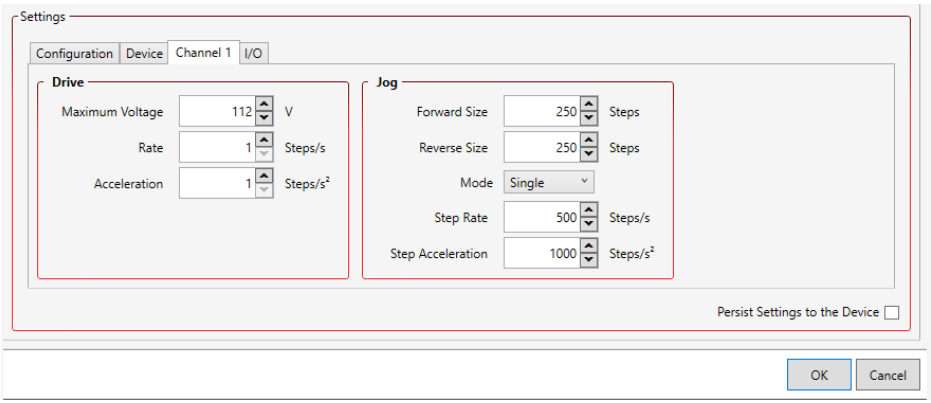
Reverse - Upwards movement of the wheel results in a negative motion (i.e. decreased position count).

Maximum Step Rate

This parameter specifies the maximum velocity (step rate) used when moves are instigated via the wheel, in the range 1 to 1,000 steps per second.

Persist Settings to Hardware - Many of the parameters that can be set for the Inertia 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 wheel parameters described here 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.

6.3.3 Channel 1 Tab



Drive Settings

These parameters define the speed and acceleration of moves initiated by clicking in the position display, or via the wheel when 'Go To Position' mode is selected.

Maximum Voltage - the maximum piezo drive voltage. Set in the range 85V to 125V.

Rate - The piezo motor moves by ramping up the drive voltage to the value set in the *Maximum Voltage* parameter and then dropping quickly to zero, then repeating (see Fig. 6.2). One cycle is termed a step. The Step Rate is the velocity to move when a command is initiated. It is specified in steps/sec, in the range 1 to 2,000.

Acceleration - The acceleration up to the step rate. It is specified in steps/sec/sec in the range 1 to 100,000.

Note

The step size is defined as the distance moved in one step or pulse. This distance can be adjusted up to about 30% by changing the piezo drive voltage. The actual step size achieved for a given drive voltage will be dependent on application.

Jog Settings

These parameters define the speed and acceleration of moves by jog command, either from the wheel, GUI panel or via software.

Forward and Reverse Size - The distance to move when a jog command is initiated. The step size is specified by the 'number of steps' (or pulses)', in a jog step, in the range 1 to 1,000,000.

The optimum step size depends on several parameters including the resistive torque against which the actuator tip is pushing, the drive voltage, the step rate, active

preload, variance in the frictional behavior of assembly components, the direction of actuation and the condition of the actuator.

Mode - The way in which the motor moves when a jog command is received (i.e. front panel button pressed or GUI panel button clicked).

There are two jogging modes available, '*Single*' and '*Continuous*'. In 'Single' mode, the motor moves by the distance specified in the Step Size parameter. The jog key must be released and pressed again for jogging to be repeated - see Fig. 6.2.

In 'Continuous' mode, the motor actuator will accelerate at the Step Accn value and move at the Step Rate while the button is held down..

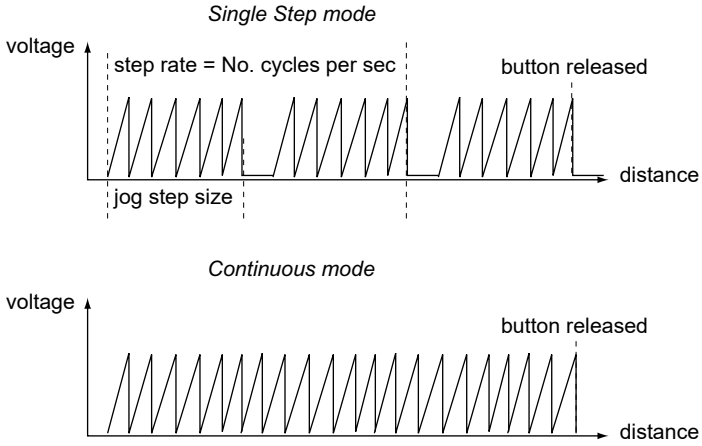


Fig. 6.2 Jog Modes

Step Rate - The velocity to move when a jog command is initiated. The step rate is specified in pulses per second, in the range 1 to 2,000.

Step Acceleration - The acceleration up to the step rate. It is specified in pulses/sec/sec in the range 1 to 100,000.

Persist Settings to 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 Drive and Jog Setting parameters described previously 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.

Settings are always saved to the unit on power down.

6.3.4 I/O Tab

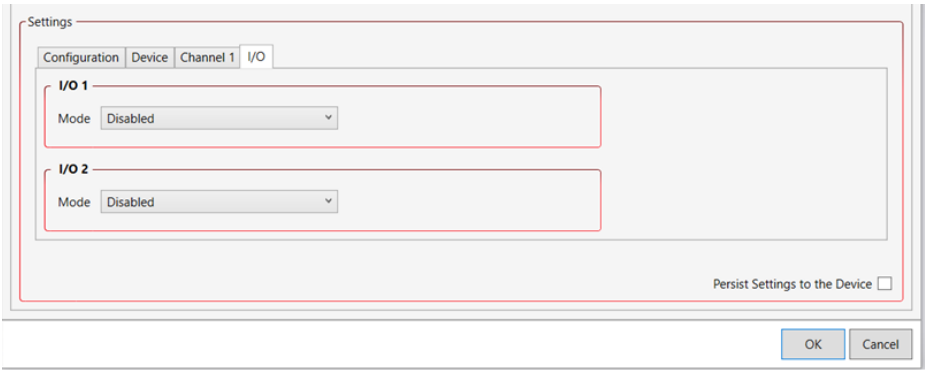


Fig. 6.3 IO Settings

Triggering (IO) Introduction

The K-Cube piezo motor controllers have two bidirectional trigger ports (I/O1 and I/O2) 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 recognized as a logic LOW and a level greater than 2.4 Volt as a logic HIGH.

Note

Although the inputs are TTL compatible, the input circuitry used will allow a logic high at voltages lower than 2.4 V.

The input contains a weak pull-up, so the state of the input with nothing connected will default to a logic HIGH. This means that +5 V can be measured on the port with negligible supply current. 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.

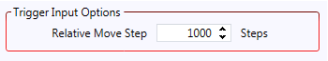
Warning: do not drive the IO ports from any voltage source that can produce an output in excess of the normal 0 to 5 Volt logic level range. In any case the voltage at the IO ports must be limited to -0.25 to +5.25 Volts.

Input Trigger Modes

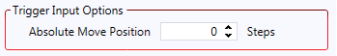
When configured as an input, the IO ports can be used as a general purpose digital input, or for triggering a relative or absolute move. When used for triggering a move, the port is edge sensitive. In other words, it has to see a transition from the inactive to the active logic state (Low->High or High->Low) 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 Mode* parameter for each trigger as follows:

Disabled - The trigger IO is disabled

General Purpose Input - General purpose logic input (read through status bits using the associated server message).

Trigger In - Relative Move - Input trigger for relative move. On receipt of the trigger, the motor will move by the number of position steps entered in the *Trigger Input Options - Relative Move Step* parameter in the range 1 to 100000000 steps. 

.

Trigger In - Absolute Move - Input trigger for absolute move. On receipt of the trigger, the motor will move to the position entered in the *Trigger Input Options - Absolute Move Position* parameter in the range -2000000000 to 2000000000. 

.

Trigger In - Reset Count - Input trigger for Encoder Count Reset. On receipt of the trigger, the counter will reset and all subsequent moves will be measured from the current position.

Output Trigger Modes

When the *Trigger Mode* parameters are configured as outputs, the IO ports can be used as a general purpose digital output, or to indicate motion status or to produce a trigger pulse at configurable positions as follows:

General Purpose Output - General purpose logic output (set using the associated server message).

Trigger Out - In Motion - Trigger output active (level) when motor 'in motion'. The output trigger goes high (5 V) or low (0 V) (as set in the Trigger Polarity parameters) when the stage is in motion.

Trigger Out - At Max Rate - Trigger output active (level) when motor is at 'max rate (velocity)'. The max rate limit that generates the trigger is dependent on the type of move being performed, e.g. jog move, wheel move etc.

Note

The following output modes can be set to only one trigger at a time.

Trigger Out - Position Step Forward - Trigger output active (pulsed) at pre-defined positions moving forward. Only one Trigger port at a time can be set to this mode. See Trigger Out Position Steps for further details.

Trigger Out - Position Step Backward - Trigger output active (pulsed) at pre-defined positions moving backwards. Only one Trigger port at a time can be set to this mode. See Trigger Out Position Steps for further details.

Trigger Out Position Step Both - Trigger output active (pulsed) at pre-defined positions moving forwards and backward. Only one Trigger port at a time can be set to this mode. See Trigger Out Position Steps for further details.

Trigger Out Position Steps

Note

If the trigger mode is not set to one of the three position modes described previously, then the following parameters are not applicable and will not be displayed.

In the Position Step modes described previously, the controller outputs a configurable number of pulses (set in the *Number of forward steps* and *Number of reverse steps* parameters), of configurable width (*Pulse Width*), when the actual position of the stage matches the position values configured as the Start Position and Position Interval (*Forward Start Position/Reverse Start Position and Forward Interval /Reverse Interval*). These modes allow external equipment to be triggered at exact position values.

Using these Position Step modes, position triggering can be configured to be unidirectional (*Out - Position Step Forward* or *Out - Position Step Reverse*) or bidirectional (*Out - Position Step Both*). In bidirectional mode the forward and reverse pulse sequences can be configured separately.

A cycle count setting (*Number of cycles*) allows the uni- or bidirectional position triggering sequence to be repeated a number of times.

Note

In the *Trig Out Pos. Steps Fwd* mode, the *StartPos. Fwd* value must be reached in the forward direction for the subsequent trigger sequence to be performed correctly. If *StartPos. Fwd* is reached in the reverse direction, the initial trigger will still be activated, but any subsequent sequence could be corrupted. Similarly, *StartPosRev* must be reached in reverse direction for the sequence to work correctly.

In the event of incorrect trigger set up or if a sequence is only partially completed, set the trigger mode to ‘Disable’ for both I/O 1 and I/O 2 save the setting, then start the set up again. This ensures that a new set of trigger parameters is set and minimizes the possibility of unforseen position trigger behavior.

Example referring to Fig. 6.4 for a move from 0 to 2000 steps and back.

In forward direction: The first trigger pulse occurs at 1000 steps (StartPosFwd), the next trigger pulse occurs after another 500 steps (PosIntervalFwd), the stage then moves to 2000 steps.

In reverse direction: The next trigger occurs when the stage gets to 1200 steps.

Note that position triggering can only be used on one TRIG port at a time.

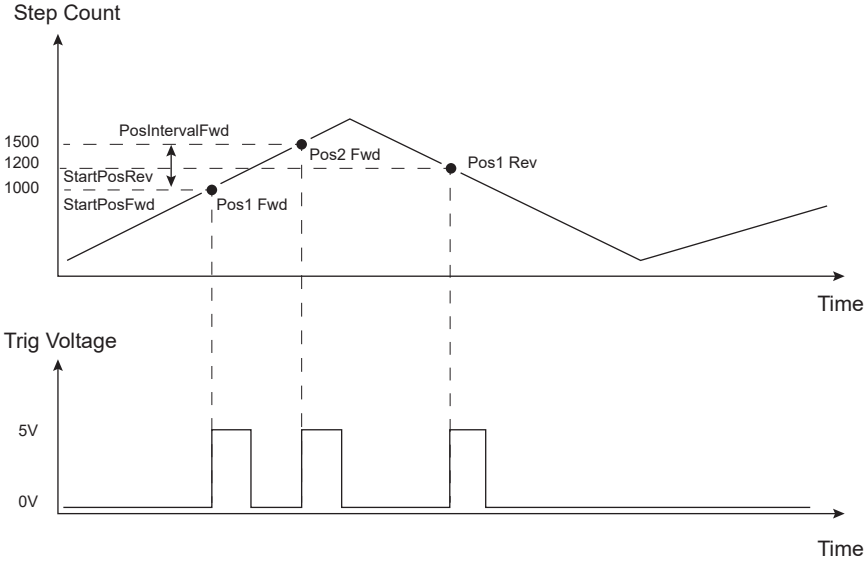


Fig. 6.4 Position Steps Triggering

Triggering Polarity - The polarity of the trigger pulse is specified in the Trigger Polarity parameters for each trigger as follows:

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

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

Caution

Due to the weak pull up on the I/O ports (see Triggering (I/O) Introduction) if a trigger input mode is selected, and the triggering polarity is set to Active High, then a trigger will be generated when the device is first powered up, or when the user leaves the Settings dialog in the Kinesis software.

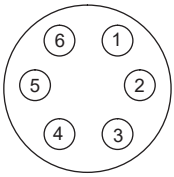
Trigger Channel - The channel to which the trigger is associated.

Appendix A Rear Panel Connector Pinout Details

A.1 Rear Panel ENCODER Connector

FOR FUTURE USE. THE FUNCTIONALITY FOR THIS CONNECTOR IS NOT IMPLEMENTED AT THIS TIME.

The 'ENCODER' connector is for future use in closed loop applications and provides a means of supplying feedback from an eternal source. The pin out, when viewed from the front, is described below.



Pin	Description	Pin	Description
1	+5 V	4	Encoder 2A
2	Encoder 1A	5	Encoder 2B
3	Encoder 1B	6	0 V

Fig. A.1 ENCODER Connector Pin Identification

Appendix B Preventive Maintenance



Warning: Risk of Electrical Shock

The equipment contains no user serviceable 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 Safety Testing

PAT testing in accordance with local regulations, should be performed on a regular basis, (typically annually for an instrument in daily use).

B.2 Cleaning



Caution

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 Parts

C.1 Specifications

Parameter	Value
Piezoelectric Output (SMC)	
Voltage Output	85 to 125 V DC
External Input (SMA EXT IN)	
Input Type	Single Ended, Analog
Input Voltage	-10 to 10 V ±2% -10 V gives nominally 2kHz pulses backwards 10 V gives nominally 2 kHz pulses forwards 0 V gives zero movement
Output Pulses	Frequency: 1 Hz to 2 kHz Voltage: Peak 85 to 125 V Adjustable
Operating Display	128 x 32 LCD Mono
I/O 1 and I/O 2 Connectors	TTL Input, TTL Output, 5 V Level
Wheel	Spring-loaded, Center return Velocity Control, Menu Control in Setup Mode
ENCODER Connector	6 Pin HiRose For Future Use
USB Connector	The USB 3.0 (left hand side of the connector is compatible with a USB 2.0 Micro B) Communication speed USB 1.1
Input Power Requirements	
Voltage	15 VDC
Current	1 A
General Data	
Operating Temperature Range	5 ° to 40 °C
Housing Dimensions Excluding Baseplate (W x D x H)	60 mm x 60 mm x 47 mm (2.36" x 2.36" x 1.85")
Weight:	200 g

C.2 Associated Products

Product Name	Part Number
Piezo Inertia Motor Actuator, 13 mm Travel	PIA13
Piezo Inertia Motor Actuator, 25 mm Travel	PIA25
Piezo Inertia Motor Actuator, 50 mm Travel,	PIA50
Piezo Inertia Motor Actuator, 10 mm Travel, Kinematic Mounting	PIAK10
Single Way Power Supply	KPS201[a]
20 mm Linear Stage with Piezoelectric Inertia Drive	PD1

a. The previous-generation KPS101 power supply is also compatible.

Appendix D Piezo Operation - Background

D.1 Piezoelectric Controller

D.1.1 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 or 150 V in the case of Thorlabs actuators).

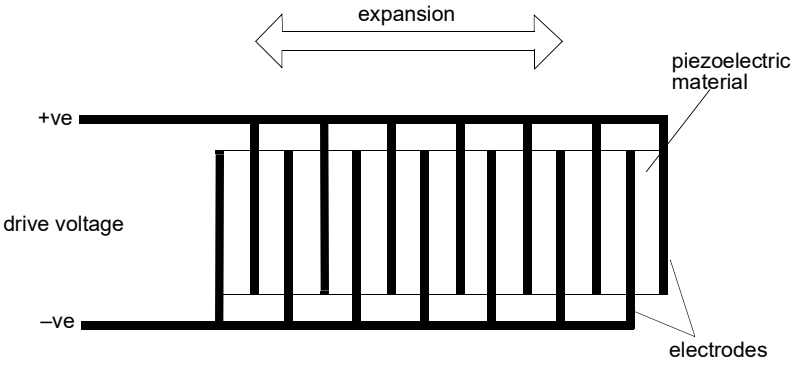


Fig. D.1 Piezo-electric Actuator Schematic Diagram

D.1.2 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.

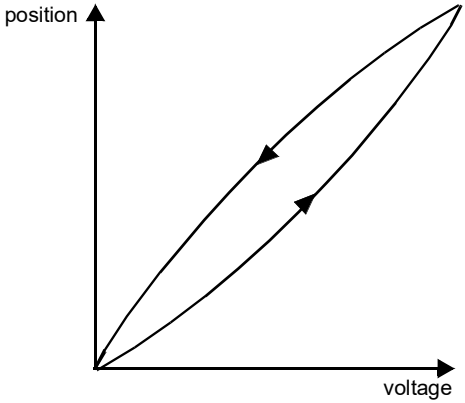


Fig. D.2 Piezo-electric hysteresis

D.1.3 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.

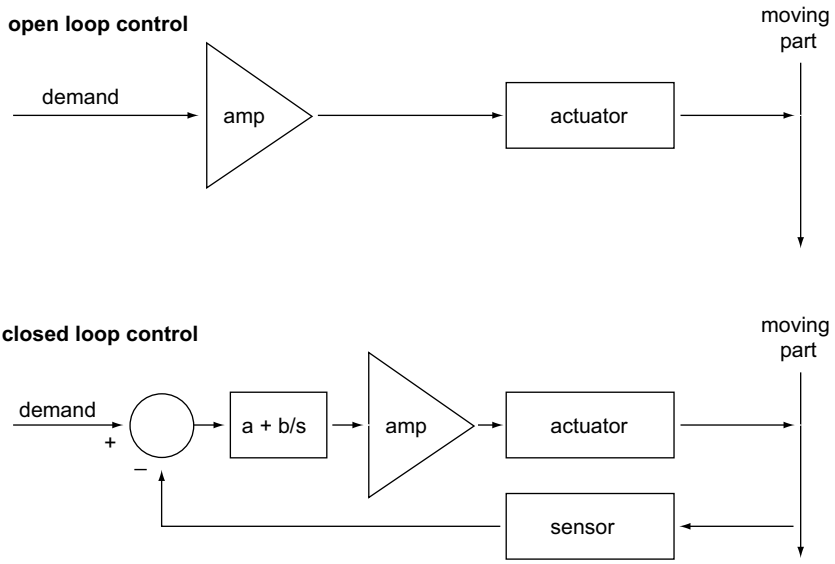


Fig. D.3 Open loop and Closed Loop Control

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.

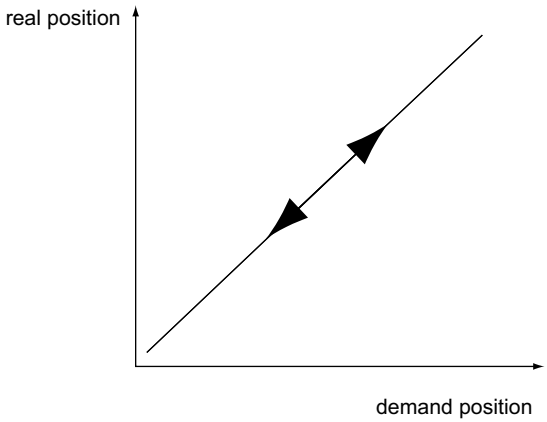


Fig. D.4 Closed Loop Response

Appendix E Regulatory

E.1 Declarations Of Conformity

5.1.1 For Customers in Europe

See Section E.2.

5.1.2 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

Manufacturer: Thorlabs LTD

Address: 204 Lancaster Way, Ely, CB6 3NX

We hereby declare under our sole responsibility that:

Product: **KIM001**

Product description: **1-Channel Inertial Piezo Motor Driver**

is/are in conformity with the following directive(s):

2014/30/EU	Electromagnetic Compatibility (EMC) Directive
2014/35/EU	Low Voltage Directive (LVD)
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS), including 2015/863

and (harmonized) standards / technical specifications :

EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013
EN 61010-1	Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use.	2010 + A1:2019 + AC:2019
EN IEC 63000	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances	2018

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

Name: Keith Dhese *On:* 12/7/2023

Position: General Manager

CE

Appendix F 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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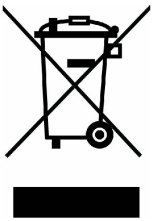
sales.de@thorlabs.com
europe@thorlabs.com

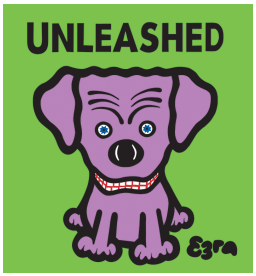
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Thorlabs verifies our compliance with the WEEE (Waste Electrical and Electronic Equipment) directive of the European Community and the corresponding national laws. Accordingly, all end users in the EC may return "end of life" Annex I category electrical 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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