

KSG101 Strain Gauge Reader

Kinesis User Guide



Original Instructions

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Chapter 1 Safety

1.1 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.



	Shock Warning	
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.		

1.2 General Warnings

	Warnings	
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.		
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 2 Overview and Setup

2.1 Introduction

The K-Cube Strain Gauge Reader (KSG101) is a new very compact single channel reader, providing immediate 'out of the box' operation. For non-PC use the unit is equipped with an OLED Display to indicate position, together with a settings menu to change the display units and set the zero position point. The unit is also equipped with a SMA position monitor output generating an analog voltage (0-10V) proportional to the strain gauge signal.

Furthermore, when operated together with the new K-Cube Piezo Driver unit (KPZ101) on the K-Cube Controller Hub (see over), high precision closed loop positioning is possible using the complete range of feedback equipped piezo actuators available from Thorlabs.

The unit can also be placed into Force Sensing mode, to allow operation with Thorlabs Force Sensor products (FSC102 and FSC103). High sensitivity force sensing is possible down to mN levels.

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 monitoring positions using the easy to read display (with brightness adjustment).



Fig. 2.1 K-Cube Strain Gauge Reader (KSG101)

A low voltage output connector allows for easy monitoring of the strain gauge signal. Zero to 10V represents a Strain gauge signal (position or force) from 0 to full scale.

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 very user friendly Kinesis software (supplied) allows the user to very quickly get up and running in a short space of time. Custom automated strain gauge reader applications can be developed using the extensive ActiveX® programming environment also 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 2.3. for a full description of the Kinesis system software.

In the remainder of this handbook, the Tutorial section (Chapter 4) provides a good initial understanding on using the unit, and the reference section (Chapter 5) covers all operating modes and parameters in detail.

2.2 Power Options

For power, a compact two-way power supply unit (TPS002) is available from Thorlabs allowing up to 2 K-Cube Strain Gauge or Piezo Driver units 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.

2.3 Kinesis Software Overview

2.3.1 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.

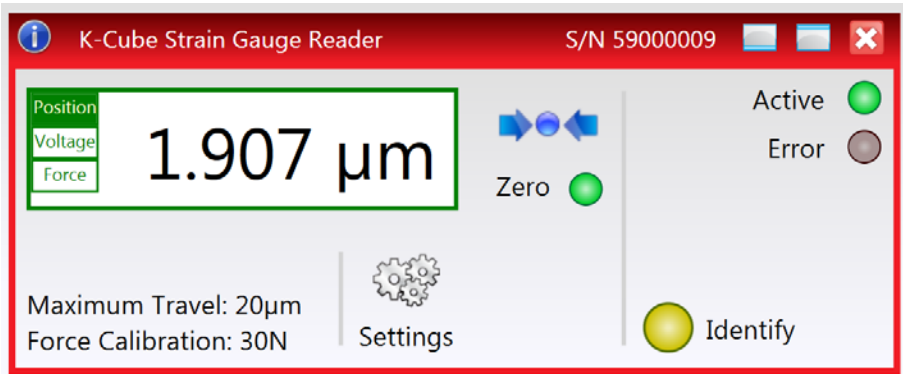
The User Interface allows full control of all settings and operating modes enabling complete 'out-of-box' operation without the need to develop any further custom software. It provides all of the necessary system software services such as generation of GUI panels, communications handling for multiple 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.

2.3.2 Kinesis Server

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, 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 a KSG101 Strain Gauge K-Cube unit.



This Control provides a complete user graphical instrument panel to allow the Strain Gauge unit to be manually operated, as well as a complete set of software functions (often called methods) to allow all parameters to be set and Strain Gauge control operations to be automated by a client application. The instrument panel reflects the current operating state of the controller unit to which it is associated (e.g. such as Strain Gauge reading). 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 Strain Gauge Control to zero the position sensor, progress is monitored automatically by changing position readout on the graphical interface, without the need for further programming intervention.

Note that the 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.

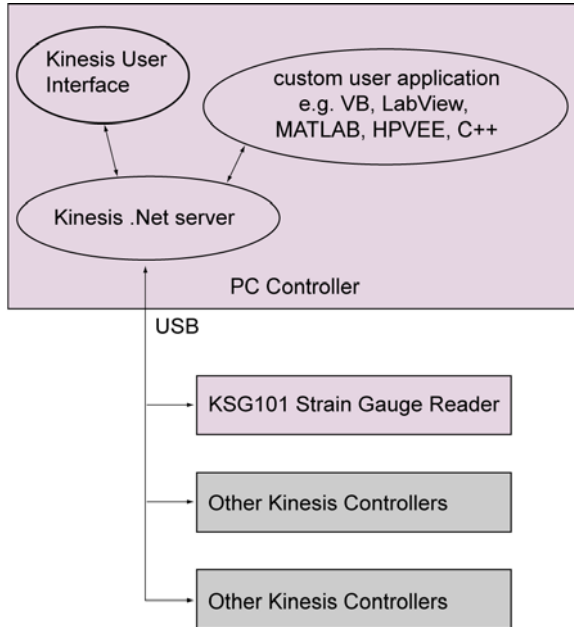


Fig. 2.2 System Architecture Diagram

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.

2.3.3 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' section of www.thorlabs.com.

2.4 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 Section 3.1.

When operating via a PC, direct user interaction with the strain gauge reader 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.

2.5 Mechanical Installation

2.5.1 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.

2.5.2 Mounting Options

The K-Cube Strain Gauge Reader 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 2.2. for further details. Full instructions on the fitting and use of the controller hub are contained in the handbook available at www.thorlabs.com



Cautions



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.

2.5.3 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. 2.3 Using The Baseplate

2.6 Electrical Installation

2.6.1 Connecting a Strain Gauge Signal

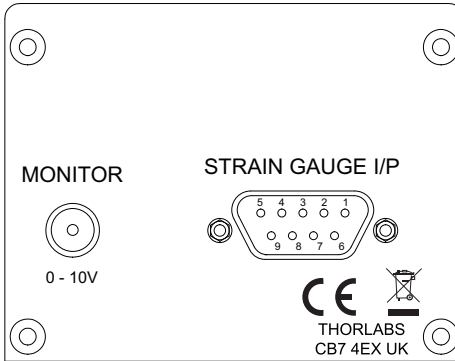


Fig. 2.4 Rear Panel Connections

STRAIN GAUGE I/P (9 Pin DIN connector) – This connector receives the signal from the strain gauge to provide the feedback for the control loop - see Section A.1. for pin out details. Thorlabs supply cabling to connect from this D-type connector to the full range of strain gauge equipped piezo actuators and force sensors.

MONITOR – This output can be connected to an oscilloscope, allowing the strain gauge output to be monitored.

Note

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

2.6.2 Strain Gauge - General Information

Typically, the KSG101 is used with strain gauges in a full bridge configuration (Wheatstone). The resistance of each arm of the bridge should be around 350 Ω , since there is a trade-off between resolution and heating of the gauges through too much current. The gauge factor should be about '2'.

A typical bridge circuit and strain gauge layout is shown below.

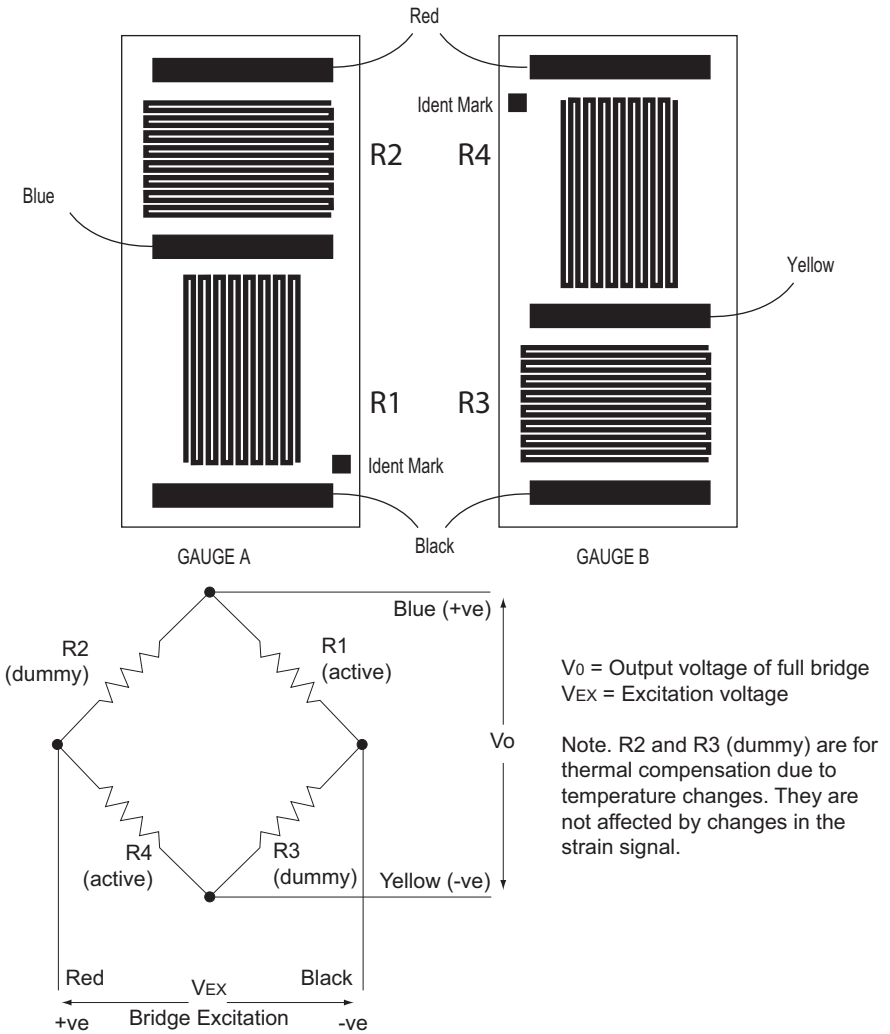


Fig. 2.5 Typical Circuit and Strain Gauge Layout

2.6.3 Supply Voltage and Current Requirements

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

2.6.4 Front Panel



Warning



The unit must be connected only to a DC supply as detailed in Section 2.6.3. 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.

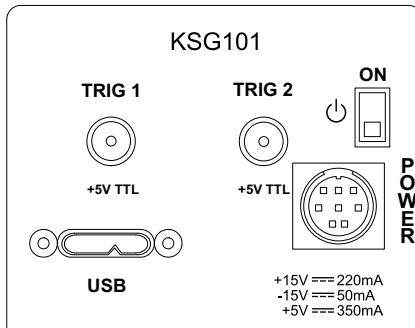


Fig. 2.6 Front Panel

POWER - Eight pin connector for connecting the unit to a regulated DC power supply of the rating detailed in Section 2.6.3.

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 - see Section 2.6.5.

TRIG 1 and TRIG 2 - SMA connectors for use with external trigger output signals (5V TTL levels). The function is set to trigger IN or OUT via the settings panel - see Section 5.2.3.

2.6.5 Powering Down The Unit



Warning



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.

2.6.6 Connecting To A Standalone Power Supply



Warning



The unit must be connected only to a DC supply of the rating detailed in Section 2.6.3. 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 2.6.3.
- 2) Switch on the Power Supply unit, then switch on the KSG101.
- 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 third party supply is to be used, see Appendix A.1 for power supply connector pin out details



Caution



If a third party 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 strain gauge cube showing an incorrect reading during subsequent operation.

2.7 Connect The Hardware

- 1) Perform the mechanical installation as detailed in Section 2.5.
- 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 supply from the mains before disconnecting the K-Cube unit.

- 4) Connect the strain gauge to the Controller unit - see Section 2.6.1.
- 5) Connect the Controller unit to the power supply - see Section 2.6.3.
- 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..

Thorlabs KSG101
SwRev 010001

Stage Travel:
100 μm

Note

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

2.8 Verifying Software Operation

The Software should be installed (Section 2.4.) and the hardware connected (Section 2.7.) before software operation can be verified.

Caution

In applications requiring the highest level of accuracy and repeatability, it is recommended that the controller unit is powered up approximately 30 minutes before use, in order to allow the internal temperature to stabilize.

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

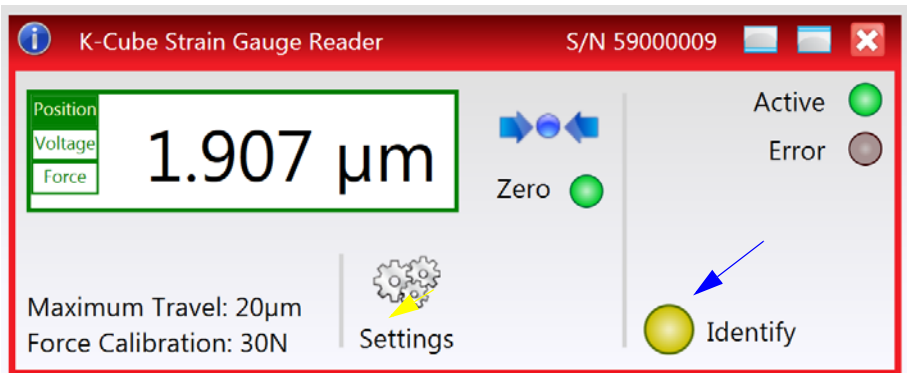


Fig. 2.7 Gui panel showing jog and ident buttons

- 2) Click the 'Ident' button. The digital display on the front panel of the associated controller flash for a short period. This is useful in multi-channel systems for identifying which channel is associated with which GUI.

Follow the tutorial described in Chapter 4 for further guidance on basic operation.

Chapter 3 Standalone Operation

3.1 Introduction

The Strain Gauge Reader K-Cube has been designed specifically to operate with the extensive range of Thorlabs piezo-actuated feedback equipped opto-mechanical products. It is also compatible with Thorlabs force sensor products, FSC102 and FSC103 providing high-sensitivity force and touch probe sensing.

For non-PC use the unit is equipped with an OLED Display to indicate position, together with a settings menu to change the display units and set the zero position point. These parameters can also be set via the Kinesis Server software - see Chapter 4. Parameters can be saved to the unit to allow “out of the box” operation with no further “set up” required.

The unit is also equipped with a SMA position monitor output generating an analogue voltage (0-10V) proportional to the strain gauge signal (position or force).

Furthermore, when operated together with the new K-Cube Piezo Driver unit (KPZ101) on the K-Cube Controller Hub, high precision closed loop positioning 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 operations.

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



Caution



The unit will always output the strain gauge feedback signal on the external SMA connector on the rear panel. This means that the unit can be used out-of-the-box, without any software setup. However, before the unit is operated it is advisable to read the section on Setting The Position Sensor Zero (Section 4.4.) and either Using with a Piezo Controller (Section 4.5.) or Using with a Force Sensor (Section 4.6.).

3.2 Control Panel

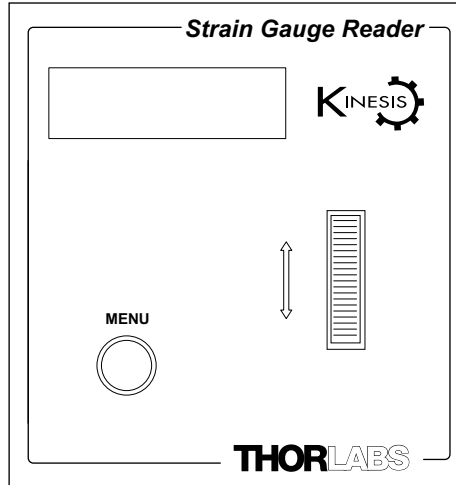


Fig. 3.1 Panel Controls and Indicators

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

Wheel - The wheel/joystick is an infinite turn potentiometer, which is used to select different parameters and values in the settings menu - see Section 4.4.

Digital Display - The display shows the menu options and settings, accessed via the menu button - see Section 3.3. 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 3.3.

3.2.1 Digital Display - Operating Mode

During normal operation, the top line of the digital display shows the current units applied, Voltage (V), Position (μm) or Force (N). The bottom line shows an indicator as to whether the unit has been zeroed (Z = Zeroed, N = Not Zeroed), the max travel of the piezo actuator connected, and the signal routing for the KCHxxx hub (Ch:1 or Ch:2)..

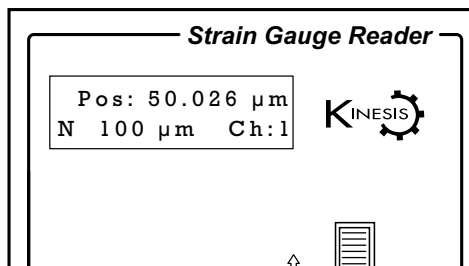


Fig. 3.2 Digital Display - Normal Operation

3.3 Settings Menu

3.3.1 Menu Overview

Press the MENU button

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

Zeroing the Position Sensor - see Section 3.3.2.

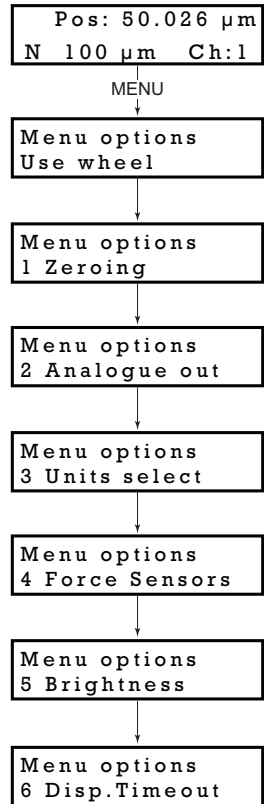
Set the KCHx01 hub comms channel - see Section 3.3.3.

Set the display units - see Section 3.3.4.

Set the type of force sensor used - see Section 3.3.5.

Set the display brightness - see Section 3.3.6.

Set the display timeout period - see Section 3.3.7.



3.3.2 Menu Option - Zeroing

The strain gauge or force sensor connected to the K-Cube may give a small signal when the device 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 device has a unique offset value. Therefore the offset should be adjusted whenever a device is replaced. Temperature and prolonged use can affect the performance of the device 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.

```
Pos: 50.026 µm
N 100 µm Ch:2
```

To zero the position sensor:

MENU

```
Menu options
Use wheel
```

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

```
Menu options
1 Zeroing
```

Press the MENU button to enter the 1 Zeroing option.

```
Zeroing
.....
```

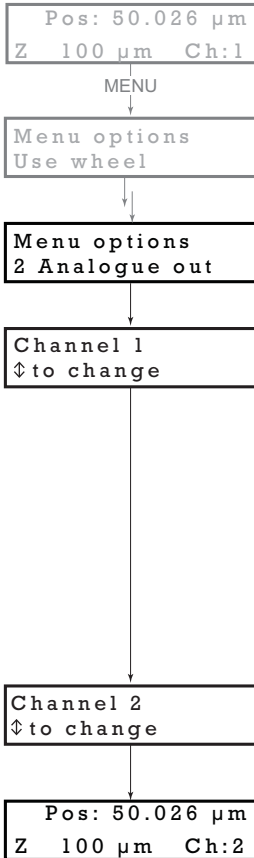
The unit will start the zeroing procedure automatically.

```
Pos: 50.026 µm
Z 100 µm Ch:2
```

When zeroing is complete, the unit reverts to the normal operating display, and a 'Z' is shown on the bottom line to indicate that the unit has been zeroed.

3.3.3 Menu Option - Analogue Out

When the K-Cube Strain Gauge Reader is used in conjunction with the K-Cube Piezo Driver unit (KPZ101) on the K-Cube Controller Hub, high precision closed loop operation is possible using the complete range of feedback equipped piezo actuators available from Thorlabs. This option allows the communication channel of the hub to be selected.



t

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

Press the MENU button to enter the 2 Analogue out option.

The display shows the current output setting.

If *Channel 1* is selected, the feedback signal runs through all the bays - see Fig. 5.3. 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. 5.3. This setting is useful when several pairs of cubes are being used on the same hub.

Note. *The rear panel MONITOR SMA connector is always active and cannot be turned off.*

Use the wheel to change to the required option.

Press the MENU button to save the setting and return to the operating screen. The selected option is displayed on the bottom line at the right hand side (Ch:1 or Ch:2).

3.3.4 Menu Option - Units Select

The display can be set to show the position (in microns) of the strain gauge, the voltage applied to the strain gauge, or the force (in N) detected.

```
Pos: 50.026 µm
Z 100 µm Ch:2
```

MENU

```
Menu options
Use wheel
```

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

```
Menu options
3 Units select
```

Press the MENU button to enter the 3 Units select option.

```
Position (µm)
↓ to change
```

Use the wheel to scroll through the options.

POSITION - This mode displays the position of the sensor in μm .

```
Voltage (V)
↓ to change
```

VOLTAGE - This mode displays a voltage proportional to the signal measured by the strain gauge, range 0 to 10V (10V is full scale deflection).

```
Force (N)
↓ to change
```

FORCE - In this mode, the strain gauge sensor signal is scaled to a force in N. Full scale deflection is set in the Setting panel - see Section 5.2.

See Section 3.3.5. for instructions on the nulling the position sensor.

```
Volt: 33.47 V
Z 100 µm Ch:2
```

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

3.3.5 Menu Option - Force Sensors

The Strain Gauge Reader unit can also be used to control a force sensor.

Pos: 50.026 μm
Z 100 μm Ch:2

MENU

Menu options
Use wheel

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

Menu options
4 Force sensors

Press the MENU button to enter the 4 Force sensors option.

FSC102 (30N)
⇅ to change

Use the wheel to select the type of sensor to be used (presently either FSC102 or FSC103). This will load the correct force calibration value.

FSC103 (30N)
⇅ to change

Volt: 33.47 V
Z 100 μm Ch:2

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

For best performance, wait approximately 30 mins for the unit to thermally stabilize to the environment. Failure to observe this delay could result in inaccurate readings.

The force sensor may display an offset when no contact is apparent. This latent offset must be removed, such that the sensor only detects a force when contact is experienced. To remove the offset proceed as follows.

- 1) Ensure that the force sensor is correctly orientated in the axis it is to be used.
- 2) Ensure that the force sensor is not in contact with any other equipment.
- 3) Null the force sensor - see Section 3.3.2.
- 4) The system is now ready for use.

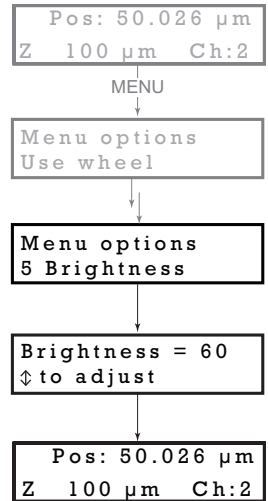
3.3.6 Menu Option - Brightness

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.



3.3.7 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.

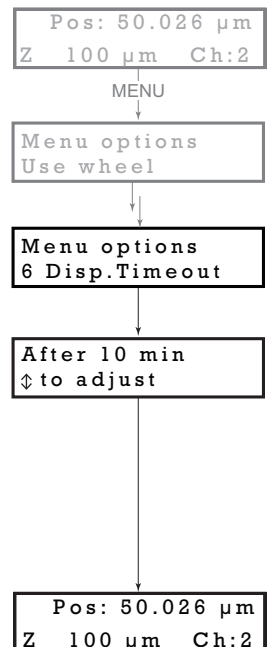
Press the MENU button, then use the wheel to scroll through the menu options.

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 5.2.2.

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



Chapter 4 Operation - Tutorial

4.1 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 2.6. and that the Kinesis Software is already installed - see Section 2.4. It also assumes that a Strain Gauge signal is connected to the 'STRAIN GAUGE I/P' connector on the rear panel.

4.2 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 KSG101 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 stabilize to the environment.

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

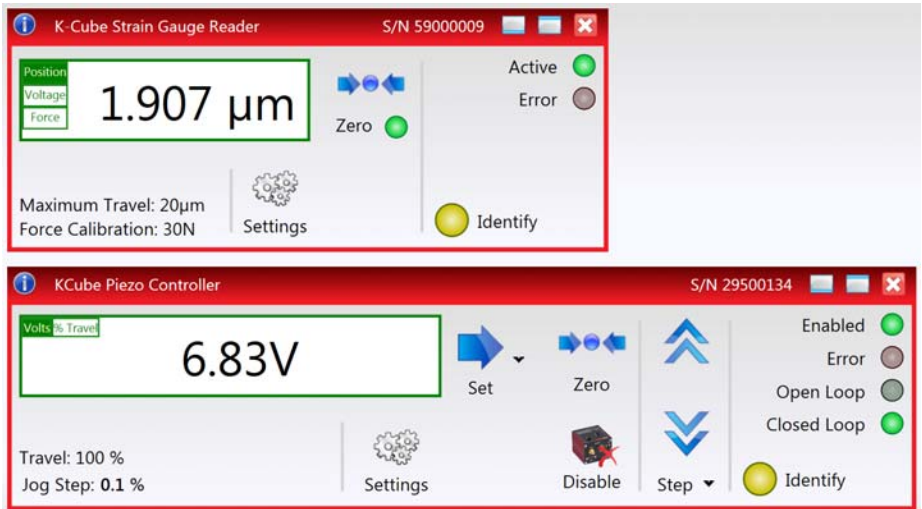


Fig. 4.1 Typical Software Screen Showing Piezo and Strain Gauge K-Cube GUI

2) The GUI panel for the Strain Gauge Reader K-Cube is displayed - see Fig. 4.2.

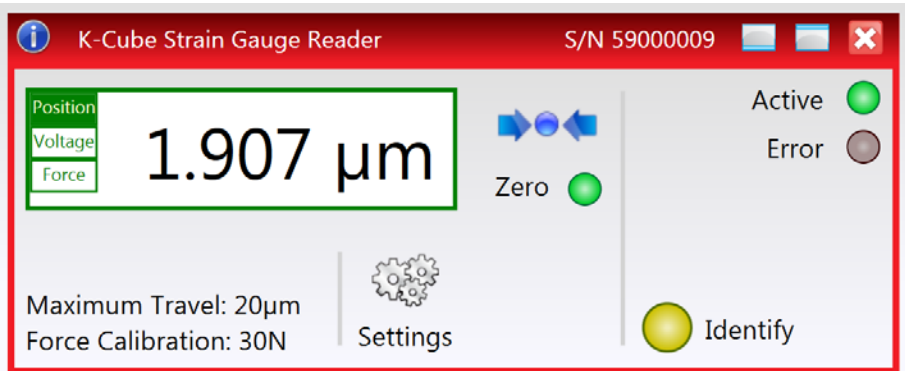


Fig. 4.2 Strain Gauge Reader Software GUI

4.3 Closed Loop Piezo 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 4.3.1.

explains operation on the KCHx01 USB Controller hub, while Section 4.3.2. explains use off the hub, with external wiring via the rear panel connections.

4.3.1 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 KCHx01 controller hub to drive a piezo actuated stage - see Fig. 4.3 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 5.2.2..

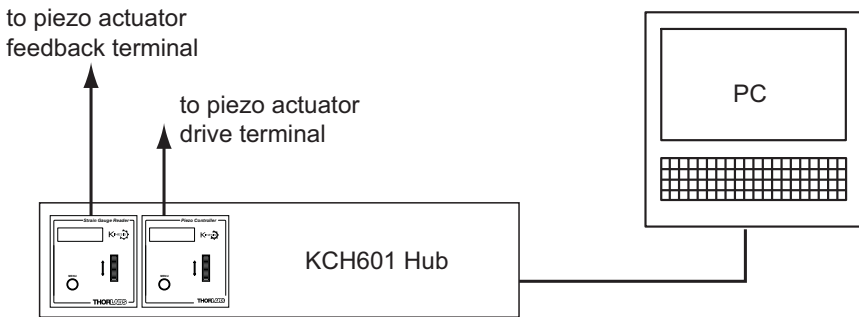


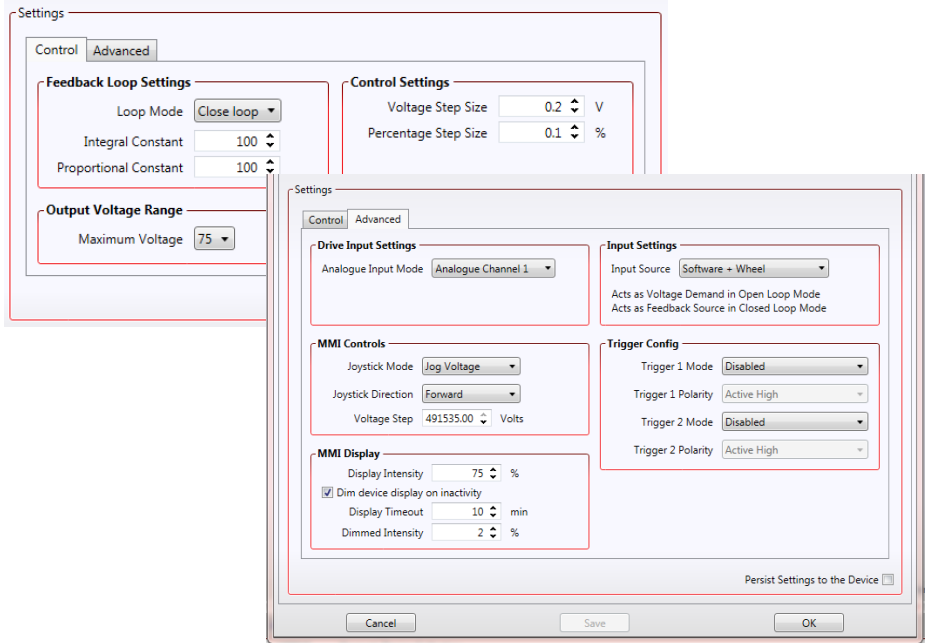
Fig. 4.3 Typical System Set Up - Hub Operation

- 1) Perform the mechanical installation as detailed in Section 2.5. of this manual and also in the manual supplied with the K-Cube Strain Gauge Reader.
- 2) Install the K-Cube units onto the controller hub. Fit the Piezo unit in bay 1, and the Strain Gauge Reader in bays 2 as shown in Fig. 4.3.
- 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 2.6.3.
- 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 OLED Display of the associated controller flashes for a short period.

Fig. 4.4 Piezo Driver Settings

- 11) Make the following parameter settings, as shown in Fig. 4.4

Control Tab

Loop Mode - Select Closed Loop

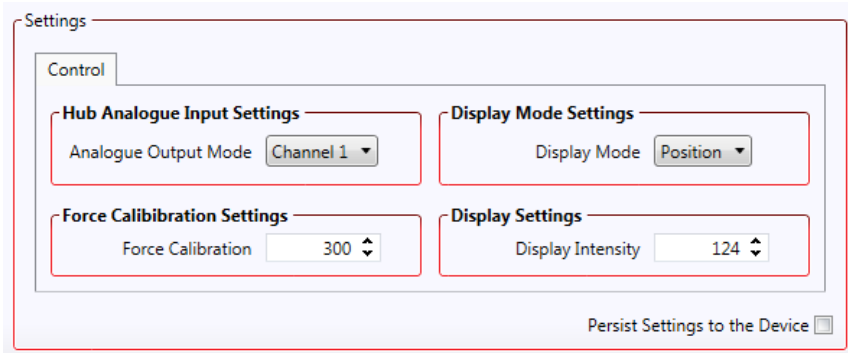
Maximum Voltage - Set the corresponding voltage for the piezo being driven, 75V, 100V or 150V.

Advanced Tab

Input Source - Select Software + Wheel

Analogue Input Mode - Select Analogue Channel 1

- 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) 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 OLED Display on the panel of the associated controller flashes for a short period

Fig. 4.5 Strain Gauge Reader Settings

- 15) Set the *Analogue Output Mode* parameter to *Channel 1*.
- 16) If desired, click the 'Persist Settings To Hardware' box. These settings will then be loaded on each power up cycle
- 17) Click 'OK' to save the settings.
- 18) Refer to Section 4.4. for instructions on setting the position sensor zero value.

4.3.2 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. 4.6 for a general system schematic diagram..

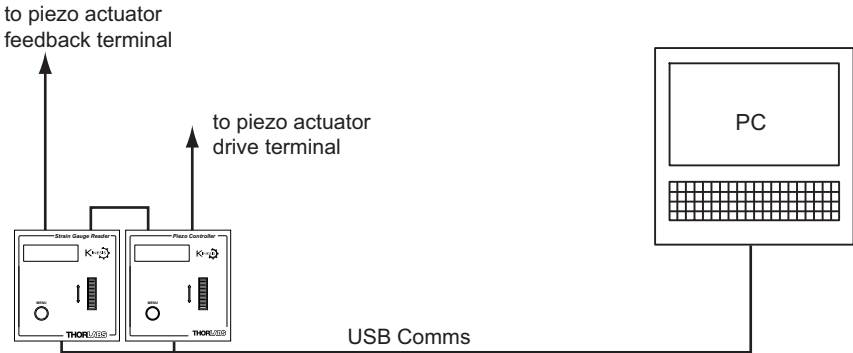


Fig. 4.6 Typical System Set Up - Off Hub (Hard Wired) Operation

- 1) Perform the mechanical installation as detailed in Section 2.5. 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 2.6. of this manual and also the manual for the Piezo Drivers.
- 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. 4.7 Piezo Driver Settings

- 11) Make the following parameter settings, as shown in Fig. 4.7

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 4.4. for instructions on setting the position sensor zero value.

4.4 Setting the Position Sensor Zero

The strain gauge or force sensor connected to the K-Cube may give a small signal when the device 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 device has a unique offset value. Therefore the offset should be adjusted whenever a device is replaced. Temperature and prolonged use can affect the performance of the device 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) If a Piezo Driver K-Cube is used in conjunction with the Strain Gauge Reader, ensure that the piezo drive output is zero. On the Piezo K-Cube control panel, turn the OUTPUT control to minimum and remove any input on the rear panel EXT IN connector.
- 2) Either select zeroing in the settings menu of the Strain Gauge K-Cube, click the 'Zero' button in the Strain Gauge K-Cube GUI panel, or call the ZeroPosition method in the application software.

During the nulling process, display on the Strain Gauge K-Cube shows 'Zeroing.....'. Once zeroing is complete, the display reverts to the normal operating screen.

4.5 Using The Strain Gauge Reader K-Cube with a Piezo Driver K-Cube

The following procedure explains the basic operation of the Strain Gauge Reader K-Cube when used in conjunction with a Piezo Driver K-Cube (KPZ101). It is assumed that the system is already connected and powered up, and that the various parameter settings have been made, as described in Section 4.3.1. and Section 4.3.2.

Note

The piezo position can be adjusted only when a Strain Gauge K-Cube (KSG101) is connected and when operating in 'Closed Loop' mode. The position of the actuator is relative to the minimum position set for the arrangement using the 'Null' facility, see Section 4.4. The extension of the actuator is displayed on the Strain Gauge K-Cube as a position in microns.

- 1) Zero the position sensor - see Section 4.4.
- 2) Set the Strain Gauge K-Cube to 'Position' mode - see Section 3.3.4.
- 3) Enable the output of the piezo K-Cube and set the wheel mode to Voltage Adjust.
- 4) Rotate the wheel on the Piezo Drive K-Cube upwards. 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).
- 5) Rotate the wheel on the Piezo Drive K-Cube downwards. 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).

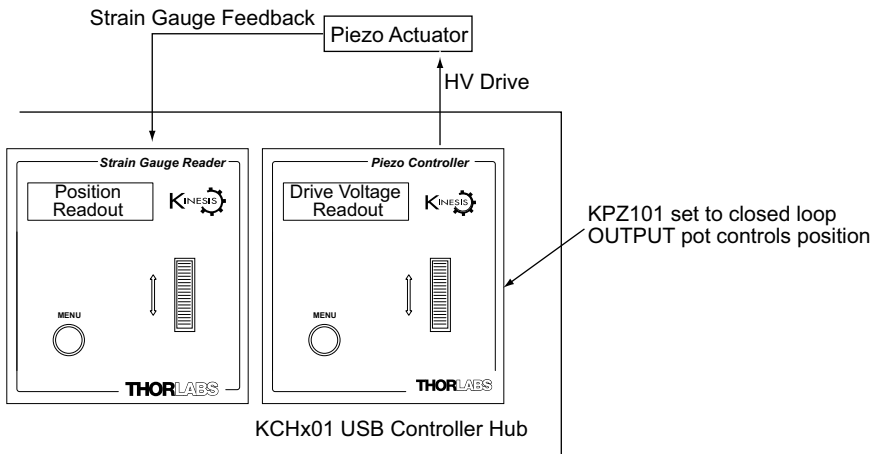
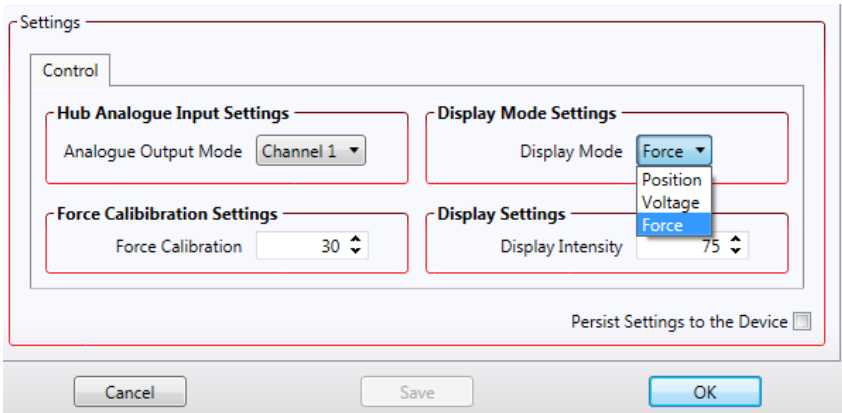


Fig. 4.8 Schematic Drawing of Piezo and Strain Gauge K-Cube Arrangement

4.6 Using the Controller with a Force Sensor

The Strain Gauge Reader unit can also be used to control a force sensor.

- 1) In the GUI panel, click the 'Settings' button to display the settings panel.



- 2) In the Display Mode field, select 'Force'.
- 3) In the 'Force Calibration Settings' field, enter the calibration factor for the type of force sensor being used. For example, if set to 20, the GUI digital display shows a detected force of 0 to 20N. The default setting for this parameter is 30, to be compatible with our FSC102 and FSC103 force sensors, which are specified to read forces up to 30N.
- 4) For best performance, wait approximately 30 mins for the unit to thermally stabilize to the environment. Failure to observe this delay could result in inaccurate readings..

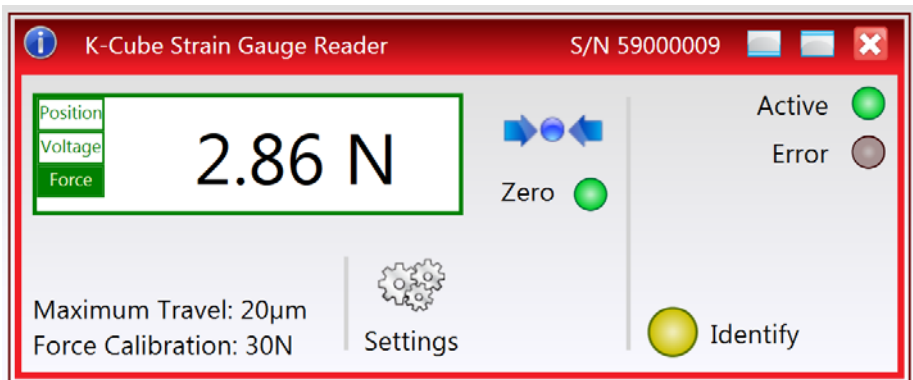


Fig. 4.9 Strain Gauge GUI Set to Force Mode

The force sensor may display an offset when no contact is apparent. This latent offset must be removed, such that the sensor only detects a force when contact is experienced. To remove the offset proceed as follows.

- 5) Ensure that the force sensor is correctly orientated in the axis it is to be used.
- 6) Ensure that the force sensor is not in contact with any other equipment.
- 7) Null the force sensor - see Section 4.4.
- 8) The system is now ready for use.

4.7 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*.

4.8 Changing and Saving Parameter Settings

During operation, certain settings (e.g. operating mode, 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 5 Software Reference

5.1 GUI Panel

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

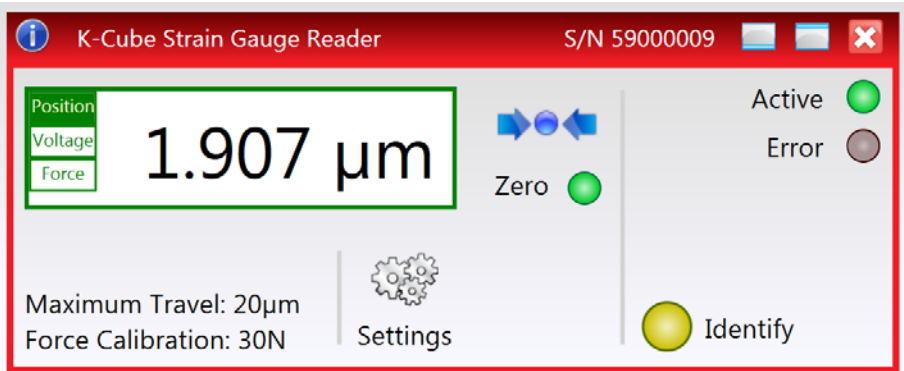
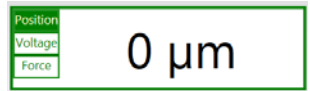


Fig. 5.1 KSG101 Strain Gauge Reader Software GUI

Note

The serial number of the KSG101 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 - shows the position (in microns) of the associated piezo, the voltage applied to the piezo, or the force (in N) detected. The display mode is selected by clicking on the required mode button. The selected mode is then highlighted.



Zero - used to zero the position sensor (strain gauge) - see Section 4.4. Setting The Position Sensor Zero. The associated is lit when the device has been zeroed.

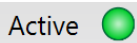


Settings display - shows the maximum position (range of travel) in microns, and the maximum operating force of the associated piezo actuator.

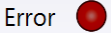
Maximum Travel: μm
Force Calibration: 30N

Settings button - Displays the 'Settings' panel, which allows the parameters to be set - see Section 5.2.





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



Error - lit when a fault condition occurs, e.g. the strain gauge unit is powered up without a feedback input connected.



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

5.2 Settings Panel

When the 'Settings' button on the GUI panel is clicked, the 'Settings' window is displayed. This panel allows data such as output modes and operating modes 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).

5.2.1 Persisting Settings to the Hardware

Many of the parameters that can be set for the Strain Gauge Reader 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 *Display Mode* 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.

5.2.2 Settings Tab.

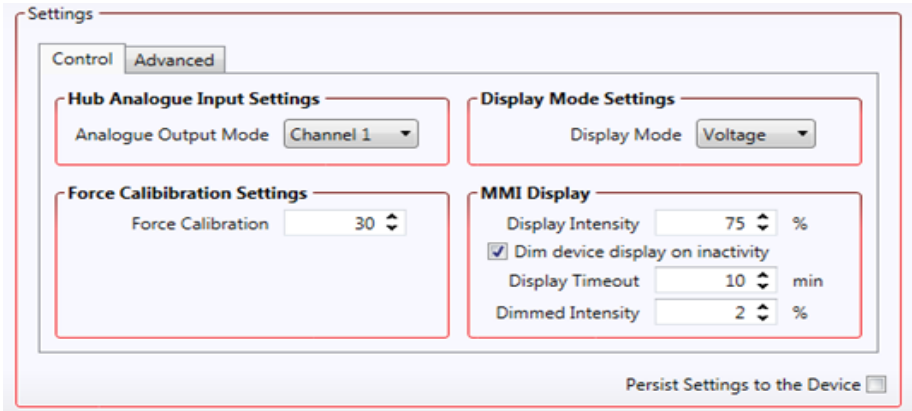


Fig. 5.2 Strain Gauge Reader Settings panel

Hub Analogue Input Settings - When the K-Cube Strain Gauge Reader is used in conjunction with the K-Cube Piezo Driver unit (KPZ101) on the K-Cube Controller Hub (KCHx01), high precision closed loop operation is possible using the complete range of feedback equipped piezo actuators available from Thorlabs.

If *Channel 1* is selected, the feedback signal runs through all the bays - see Fig. 5.3. 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. 5.3. This setting is useful when several pairs of cubes are being used on the same hub.

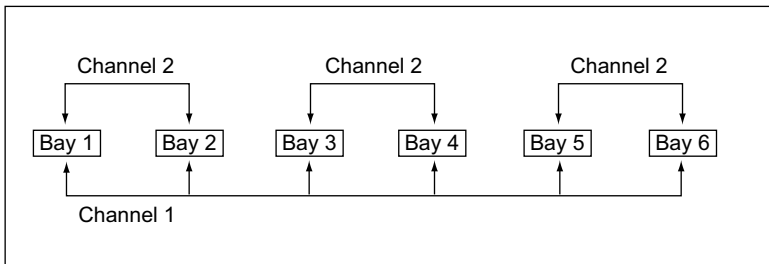


Fig. 5.3 Controller Hub Feedback Channels (KCH601 shown)

Only certain K-Cube arrangements allow the system to function correctly. Furthermore, the setting for the *Analogue Input Source (EXT IN)* parameter in the 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. 5.4 on the next page.



Caution



In general, when members of the K-Cube family are on the KCHx01 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.**

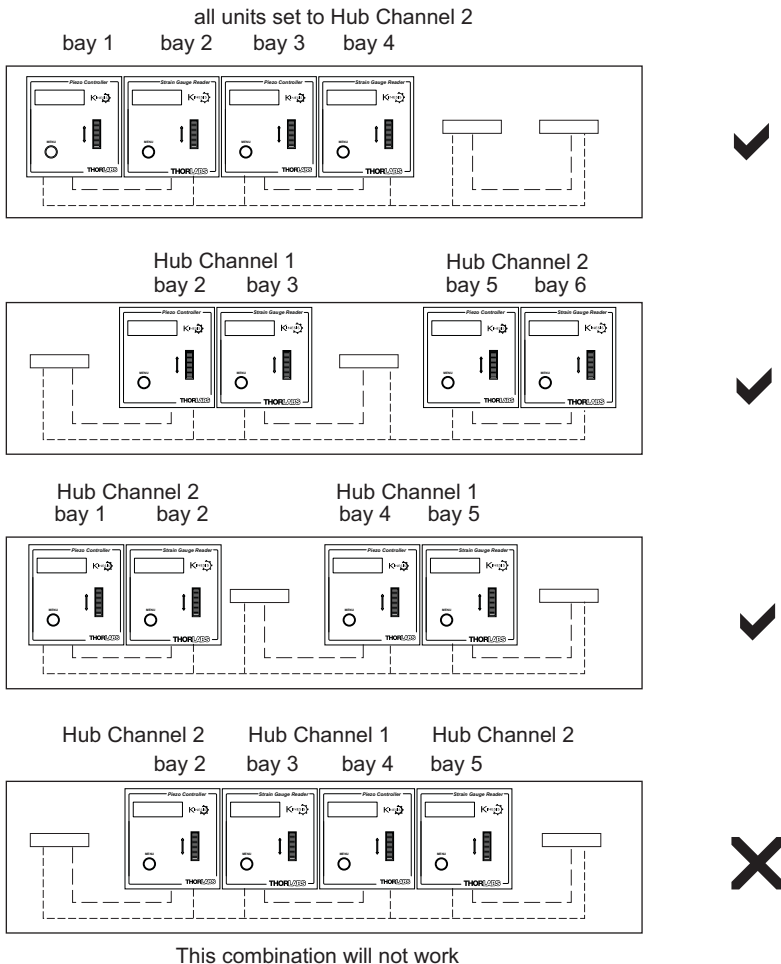


Fig. 5.4 Bay Options and Associated Analog Input Source Settings

Display Mode Settings - Specifies the operating mode and display mode of the unit.

If set to *Position*, the displays shows the present position in μm . If set to *Voltage*, the display shows the drive voltage applied to the piezo in Volts. If set to *Force*, the display shows the force detected by the force sensor in Newtons.

Force Calibration Settings - The Force Sensor connected to the Strain Gauge K-Cube has a specific maximum operating force.

Enter the calibration factor for the type of force sensor being used. For example, if set to 1, the GUI digital display shows a detected force of 0 to 1. The default setting for this parameter is 30, to be compatible with our FSC102 and FSC103 force sensors, which are specified to read forces up to 30N.

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.

5.2.3 Advanced tab

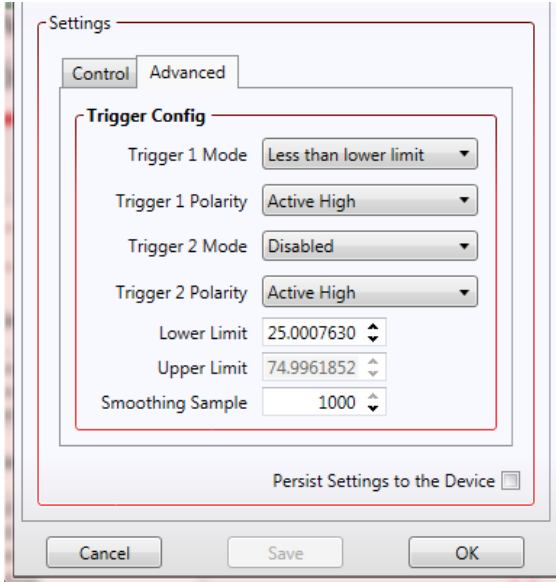


Fig. 5.5 Panel/Triggering tab

Triggering Introduction

The K-Cube strain gauge reader has two bidirectional trigger ports (TRIG1 and TRIG2) that can be used as a general purpose digital input/output, or can be configured to output a logic level to control external equipment.

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 circuitry. The active logic state can be selected High or Low to suit the requirements of the application. .



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.

The Trigger can be used to monitor a specific area, and output a signal when the devices moves away from this region of interest. This signal can then be used to give a warning by sounding a bell or turning on an LED. The triggers are set using a combination of the Trig 1 Mode and Trig 2 Mode parameters. and the Lower and Upper Limit parameters.

For example, consider the situation in Fig. 5.6, where a device is moving between two limits, and the trigger modes are set as shown.

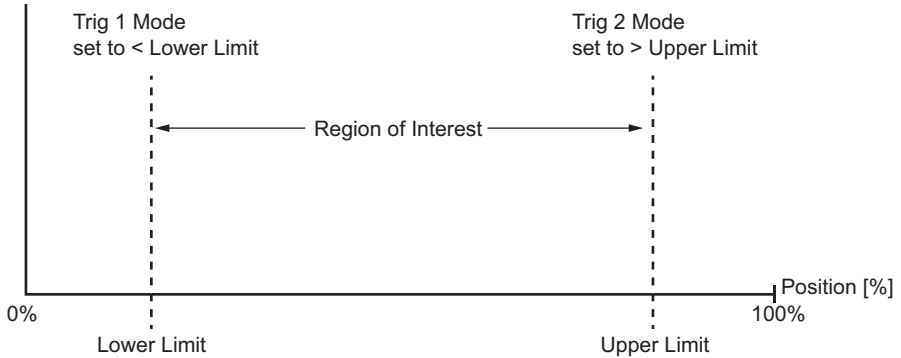


Fig. 5.6 Trigger Example

While the device is within the region of interest the triggers are inactive. If the device position was to move beyond the lower limit, Trig 1 would become active. Similarly, if the device were to move beyond the upper limit, Trig 2 would become active.

Trigger Config

The mode for each trigger port is set in the *Trig 1 Mode* and *Trig 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).

Digital Output - General purpose logic output (set using the `LLSetGetDigOPs` method).

Less than lower limit - The output trigger is active when the strain gauge input is less than the lower limit.

More than lower limit - The output trigger is active when the strain gauge input is greater than the lower limit.

Less than upper limit - The output trigger is active when the strain gauge input is less than the upper limit.

More than upper limit - The output trigger is active when the strain gauge input is greater than the upper limit.

Between Limits - The output trigger is active when the strain gauge input is between the two limits.

Outside Limits - The output trigger is active when the strain gauge input is outside either of the two limits.

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 output on a rising edge).

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

Lower Limit - The lower limit as a percentage of full scale deflection.

Upper Limit - The upper limit as a percentage of full scale deflection.

Smoothing Samples - The reading shown on the display is an average of the number of samples set in this parameter, between 1 and 1000. As a new sample is taken, the earliest sample is discarded.

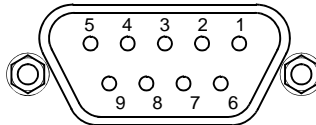
Display Intensity - In certain applications, it may be necessary to adjust the brightness of the OLED display. The brightness is set as a value from 0 (Off) to 100 (brightest).

Enter a value from 0 to 100.

Appendix A Connector Pinout Details

A.1 STRAIN GAUGE I/P Connector

This connector receives the signal from the position sensor (strain gauge) to provide the feedback for the control loop. The pin functions are detailed in Fig. A.1.



Pin	Description
1	Wheatstone Bridge Excitation
2	† +15V out
3	† -15V out
4	Ground
5	AC Feedback IN
6	Ground
7	* Actuator ID signal
8	Reserved for future use
9	Reserved for future use

Notes

† Power supply for the piezo actuator feedback circuit. It must not be used to drive any other circuits or devices.

* This signal is applicable to Thorlabs piezo actuators fitted with an ID resistor. It enables the system to identify the piezo extension associated with the actuator.

Fig. A.1 STRAIN GAUGE I/P Connector Pin Identification

A.2 POWER Connector

A.2.1 Pin Identification

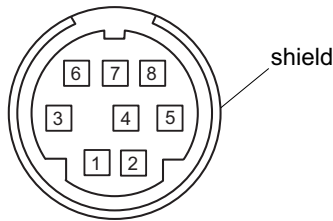
Thorlabs recommends that the Strain Gauge Reader K-Cube is operated with Thorlabs power supply TPS002, as it was specifically designed for use with this product. However, to enable customers to use the cube in installations where a $\pm 15V$ and 5V power is already available, the unit can be operated 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 is 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 K-Cube uses a standard “mini-DIN” type of input connector, the corresponding plug is available from most standard electronics suppliers.

The picture below 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

The pin functions are detailed in in Fig. A.2 .



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		

Fig. A.2 POWER Connector Pin Identification



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

Appendix B Preventive Maintenance



Warning



The equipment contains no user servicable parts. There is a risk of severe 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).



Caution



The instrument contains a power supply filter. Insulation testing of the power supply connector should be performed using a DC voltage.

B.2 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 Parts

C.1 Specifications

Parameter	Value
Strain Gauge Input (9-pin D-type)	
Bridge Type	AC
Excitation Frequency	18 kHz
Bandwidth	500 Hz
Supply	±15V +5V
Monitor Output	0-10V (SMA Connector)
Reading Resolution	Position mode 1 nm Force mode 1 mN Voltage mode 1 mV
Reading Display	OLED
USB Port	Version 3.0 (Micro B)
K-Cube Controller Hub Connector	26 way ERNI
Input Power Requirements (DIN Connector)	
Voltages:	+15V (220mA), -15V (50mA), +5V (350mA)
General Data	
Housing Dimensions (W x D x H)	60 x 60 x 47 mm (2.36" x 2.36" x 1.85")
Weight	160 g (5.5 oz)

C.2 Associated Products

Product Name	Part Number
Drive Cable for Piezoelectric Actuators (3.0 m)	PAA100
Drive Cable for Piezoelectric Actuators (1.5 m)	PAA101
K-Cube Piezo Driver	KPZ101
Piezoelectric Feedback Cable, Male D-type to Female LEMO converter (3.0 m)	PAA622
2-Way Power Supply Unit	TPS002
3-Channel K-Cube Controller Hub	KCH301
6-Channel K-Cube Controller Hub	KCH601
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 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 in the case of Thorlabs actuators).

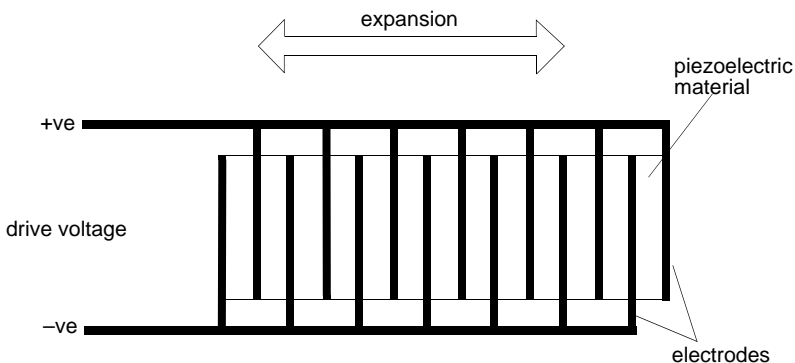


Fig. D.1 Piezo-electric actuator schematic diagram

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.

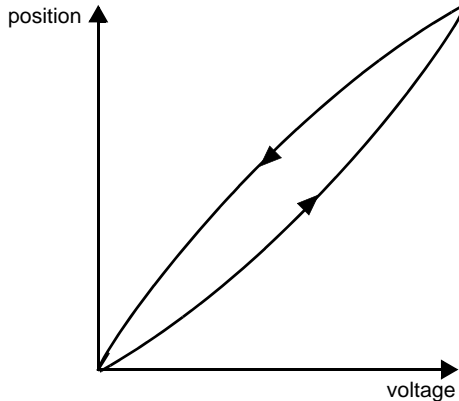


Fig. D.2 Piezo-electric hysteresis

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.

Notes

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.3.

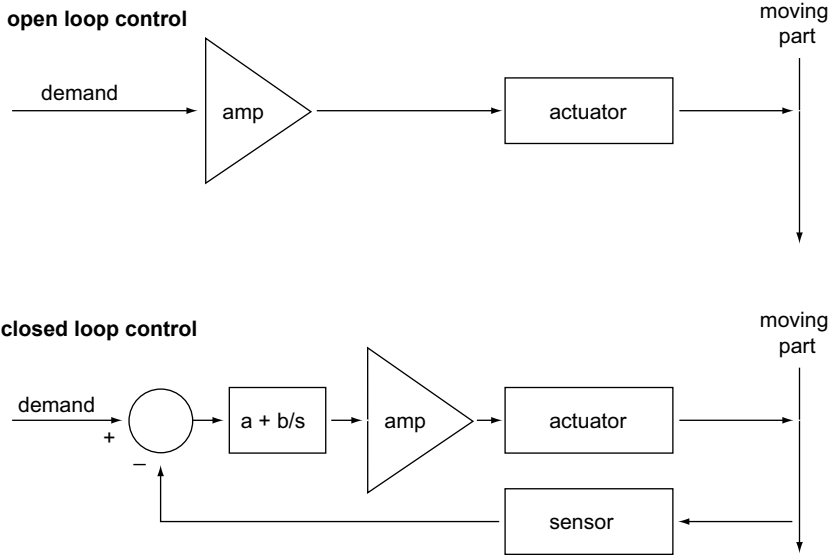


Fig. D.3 Open loop and closed loop control

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.

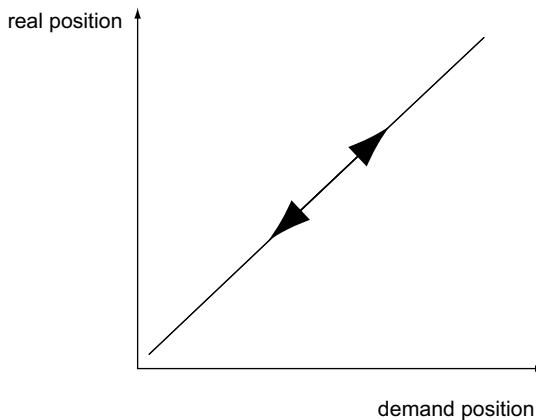





Fig. D.4 Closed loop response

Appendix E Regulatory

E.1 Declarations Of Conformity

E.1.1 For Customers in Europe

	THORLABS www.thorlabs.com	
EU Declaration of Conformity <i>in accordance with EN ISO 17050-1:2010</i>		
We:	Thorlabs Ltd.	
Of:	1 St. Thomas Place, Ely, CB7 4EX, United Kingdom	
<i>in accordance with the following Directive(s):</i>		
2014/30/EU	Electromagnetic Compatibility (EMC) Directive	
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)	
 <i>hereby declare that:</i>		
Model:	KSG101	
Equipment:	K-Cube Strain Gauge Reader	
<i>is in conformity with the applicable requirements of the following documents:</i>		
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013
 <i>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:</i>		
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>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.</i>		
Signed:		On: 13 October 2016
Name:	Keith Dhese	
Position:	General Manager	
		EDC - KSG101 - 2016-10-13

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 Waste Electrical and Electronic Equipment (WEEE) Directive

E.2.1 Compliance

As required by the Waste Electrical and Electronic Equipment (WEEE) Directive of the European Community and the corresponding national laws, we offer all end users in the EC the possibility to return "end of life" units without incurring disposal charges.

This offer is valid for electrical and electronic equipment

- sold after August 13th 2005
- marked correspondingly with the crossed out "wheelie bin" logo (see Fig. 1)
- sold to a company or institute within the EC
- currently owned by a company or institute within the EC
- still complete, not disassembled and not contaminated



Fig. 5.1 Crossed out "wheelie bin" symbol

As the WEEE directive applies to self contained operational electrical and electronic products, this "end of life" take back service does not refer to other products, such as

- pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM laser driver cards)
- components
- mechanics and optics
- left over parts of units disassembled by the user (PCB's, housings etc.).

If you wish to return a unit for waste recovery, please contact Thorlabs or your nearest dealer for further information.

E.2.2 Waste treatment on your own responsibility

If you do not return an "end of life" unit to the company, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

E.2.3 Ecological background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of life products will thereby avoid negative impacts on the environment.

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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