
THORLABS

KDC101

DC Servo Motor Driver

APT 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.		

	Caution	
If your PC becomes unresponsive (e.g due to an operating system problem, entering a sleep state condition, or screen saver operation) for a prolonged period, this will interrupt communication between the APT Software and the hardware, and a communications error may be generated. To minimize the possibility of this happening it is strongly recommended that any such modes that result in prolonged unresponsiveness be disabled before the APT software is run. Please consult your system administrator or contact Thorlabs technical support for more details.		

Chapter 2 Introduction and Overview

2.1 Introduction

The K-Cube DC Servo Controller (KDC101) is a new very compact single channel controller/driver for easy manual and automatic control of DC Servo motors. This driver has been designed to operate with a variety of lower powered DC brushed motors (up to 15V/2.5W operation) equipped with encoder feedback. The KDC101 has been optimised for 'out of the box' operation with the Thorlabs range of Z8 DC motor equipped opto-mechanical products, however highly flexible software settings and closed loop tuning also supports operation with a wide range of third party DC Servo motors and associated stages/actuators.

Although compact in footprint, this unit offers a fully featured motion control capability including velocity profile settings, limit switch handling, "on the fly" changes in motor speed and direction, control over the closed loop PID parameters and, for more advanced operation, adjustment of settings such as lead screw pitch and gearbox ratio, allowing support for many different actuator configurations.

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



Fig. 2.1 K-Cube DC Servo Motor Driver

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 apt™ software (supplied) allows the user to very quickly get up and running with complex move sequences in a short space of time – for example all relevant operating parameters are set automatically by the software for Thorlabs stage/actuator products. Advanced custom motion control applications and sequences are also possible 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.

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.

2.2 Power Options

For power, a single way wall plug supply (KPS101) is available for powering a single K-Cube Driver.

As a further level of convenience when using the new 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 APT PC Software Overview

2.3.1 Introduction

As a member of the APT range of controllers, the K-Cube DC Driver shares many of the associated software benefits. This includes 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 APT software suite supplied with all APT controllers, including the DC Driver K-Cube, provides a flexible and powerful PC based control system both for users of the equipment, and software programmers aiming to automate its operation.

For users, the APTUser (see Section 2.3.2.) and APTConfig (see Section 2.3.3.) utilities allow full control of all settings and operating modes enabling complete 'out-of-box' operation without the need to develop any further custom software. Both utilities are built on top of a sophisticated, multi-threaded ActiveX 'engine' (called the APT server) which provides all of the necessary APT 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. It is this APT server 'engine' that is used by software developers to allow the creation of advanced automated positioning applications very rapidly and with great ease. The APT server is described in more detail in Section 2.3.4.



Caution



On start up, wait until the top panel display has stopped flashing before running the APT software.

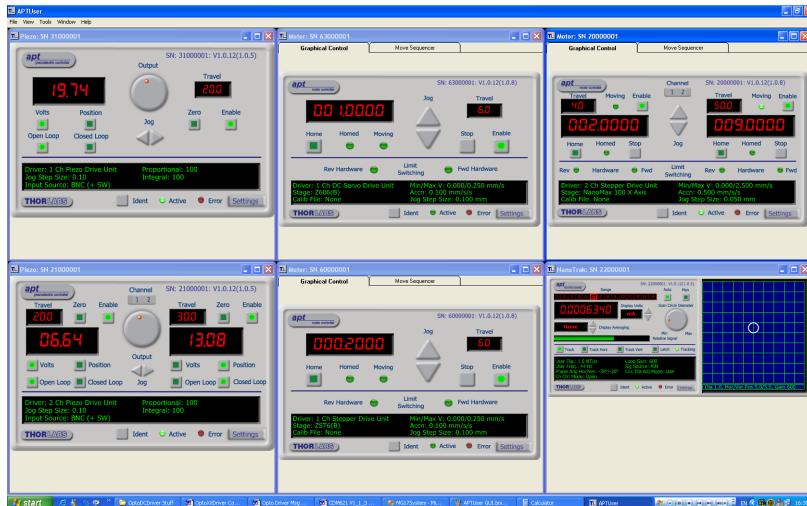
Aside

ActiveX®, a Windows®-based, language-independent technology, allows a user to quickly develop custom applications that automate the control of APT system hardware units. Development environments supported by ActiveX® technology include Visual Basic®, LabView™, Borland C++ Builder, Visual C++, Delphi™, and many others. ActiveX® technology is also supported by .NET development environments such as Visual Basic.NET and Visual C#.NET.

ActiveX controls are a specific form of ActiveX technology that provide both a user interface and a programming interface. An ActiveX control is supplied for each type of APT hardware unit to provide specific controller functionality to the software developer. See Section 2.3.4. for further details.

2.3.2 APTUser Utility

The APTUser application allows the user to interact with a number of APT hardware control units connected to the host PC. This program displays multiple graphical instrument panels to allow multiple APT units to be controlled simultaneously.



All basic operating parameters can be altered and, similarly, all operations (such as motor 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 APTUser application provides all of the functionality necessary to operate the APT hardware without the need to develop any further custom software. For those who do need to further customize and automate usage of the K-Cube DC Driver (e.g. to implement a positioning algorithm), this application illustrates how the rich functionality provided by the APT ActiveX server is exposed by a client application.

Use of the APT User utility is covered in the PC tutorial (Chapter 5) and in the APTUser online help file, accessed via the F1 key when using the APTUser utility.



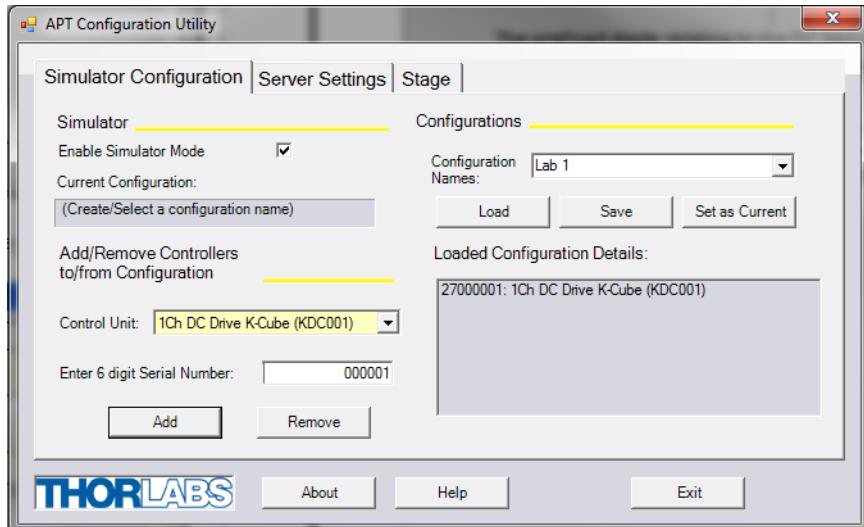
Caution



On start up, wait until the top panel POWER led is lit bright green before running the APT software.

2.3.3 APT Config Utility

There are many system parameters and configuration settings associated with the operation of the APT Server. Most can be directly accessed using the various graphical panels, however there are several system wide settings that can be made 'off-line' before running the APT software. These settings have global effect; such as switching between simulator and real operating mode, associating mechanical stages to specific motor actuators and incorporation of calibration data.



The APTConfig utility is provided as a convenient means for making these system wide settings and adjustments. Full details on using APTConfig are provided in the online help supplied with the utility.

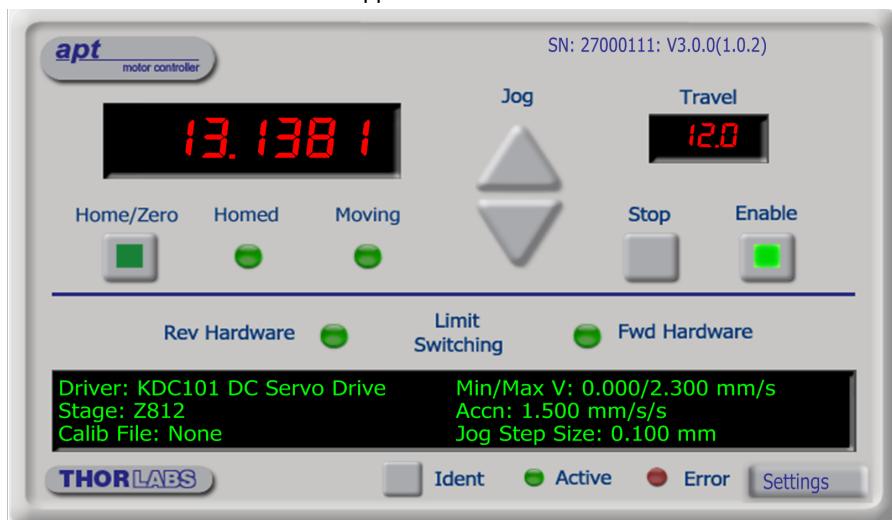
Use of the APT Config utility is covered in the PC tutorial (Chapter 5) and in the APTConfig online help file, accessed via the F1 key when using the APTConfig utility.

2.3.4 APT Server (ActiveX Controls)

ActiveX 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 APT system, ActiveX Controls are deployed to allow direct control over (and also reflect the status of) the range of electronic controller units, including the DC Driver K-Cube. Software applications that use ActiveX Controls are often referred to as 'client applications'. Based on ActiveX Interfacing technology, an ActiveX Control is a language independent software component. Consequently ActiveX 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 ActiveX Control supplied for the KDC101 DC servo driver unit.



This Control provides a complete user graphical instrument panel to allow the motor 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 motor 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 motor position). 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 DC servo motor Control to move a motor, the progress of that move is reflected automatically by changing position readouts on the graphical interface, without the need for further programming intervention.

The APT ActiveX Controls collection provides a rich set of graphical user panels and programmable interfaces allowing users and client application developers to interact seamlessly with the APT hardware. Each of the APT controllers has an associated ActiveX Control and these are described fully in system online help or the handbooks associated with the controllers. Note that the APTUser and APTConfig utilities take advantage of and are built on top of the powerful functionality provided by the APT ActiveX Server (as shown in Fig. 2.2).

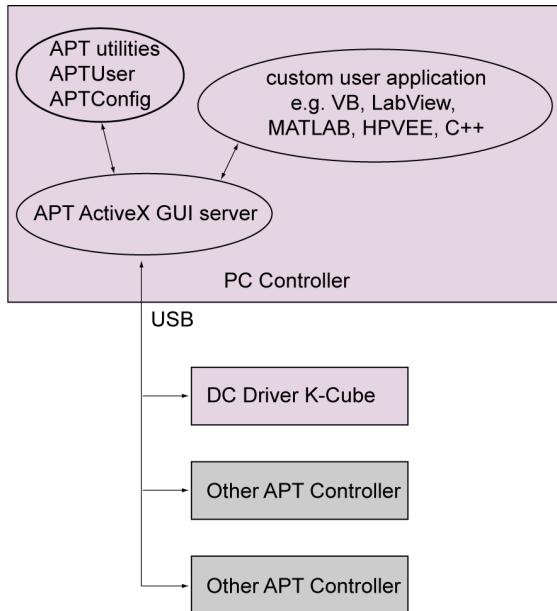


Fig. 2.2 System Architecture Diagram

Refer to the main APT Software online help file, for a complete programmers guide and reference material on using the APT ActiveX Controls collection. This is available either by pressing the F1 key when running the APT server, or via the Start menu, Start\Programs\Thorlabs\APT\APT Help.

2.3.5 Software Upgrades

Thorlabs operate a policy of continuous product development and may issue software upgrades as necessary.

Chapter 3 Getting Started

3.1 Install The Software



Caution



If your PC becomes unresponsive (e.g due to an operating system problem, entering a sleep state condition, or screen saver operation) for a prolonged period, this will interrupt communication between the APT Software and the hardware, and a communications error may be generated. To minimize the possibility of this happening it is strongly recommended that any such modes that result in prolonged unresponsiveness be disabled before the APT software is run. Please consult your system administrator or contact Thorlabs technical support for more details.



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 STAGE TO YOUR PC YET

- 1) Download the software from www.thorlabs.com.
- 2) Locate the downloaded setup.exe file and move to a suitable file location.
- 3) Double-click the setup.exe file and follow the on-screen instructions.

3.2 Mechanical Installation

3.2.1 Environmental Conditions



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 DC Driver is shipped with a baseplate, for use when fitting the unit to a breadboard, optical table or similar surface.

For multiple cube systems, a 3-channel and 6-channel K-Cube Controller Hub (KCH301 and KCH601).) are also available - see Section 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



3.2.3 Using the Baseplate

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

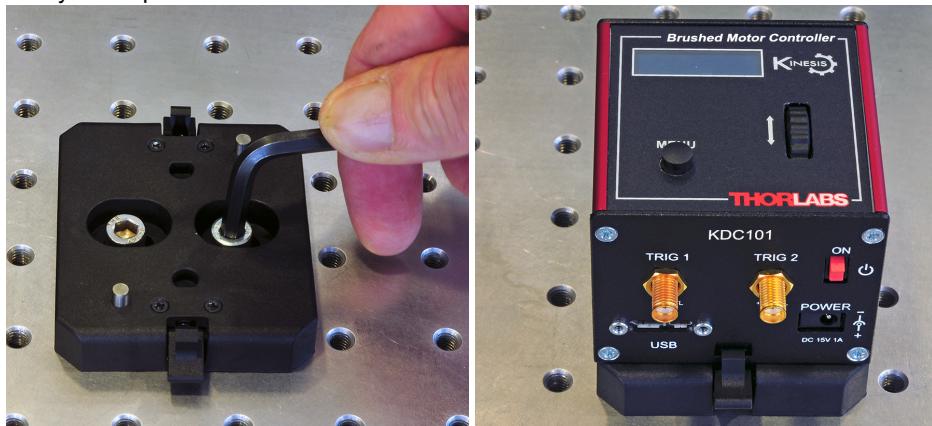


Fig. 3.1 Using The Baseplate

3.3 Electrical Installation

3.3.1 Rear Panel

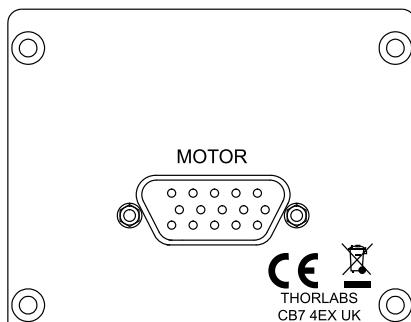


Fig. 3.2 Rear Panel Connections

The rear panel of the unit is fitted with a 15 pin D-type connector as shown above, which is compatible with Thorlabs DC servo motor actuators (refer to Appendix A for details of pin outs).

Caution

DO NOT connect a motor actuator while the K-Cube is powered up.
Only use motor drive cables supplied by Thorlabs, other cables may have incompatible wiring.

3.3.2 Front Panel

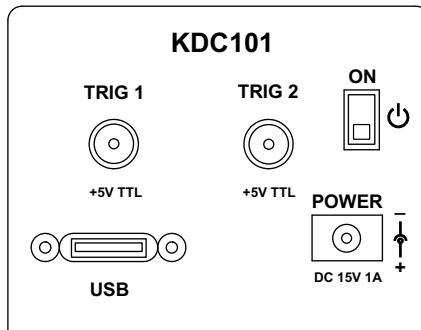


Fig. 3.3 Front Panel Connections



Shock Warning

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.

Thorlabs offers a compact, multi-way power supply unit (TPS008), allowing up to eight Driver K-Cubes to be powered from a single mains outlet. A single way wall plug supply (KPS101) for powering a single Driver K-Cube is also available.

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/Standy 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.

TRIG 1 and TRIG 2 - SMA connectors for use with external trigger input and output signals (5V TTL levels). The function is set to trigger IN or OUT via the settings panel - see Section 6.3.4.

3.4 Connect The Hardware

- 1) Perform the mechanical installation as detailed in Section 3.2.
- 2) Install the APT 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. DO NOT connect a motor actuator while the K-Cube is powered up.

- 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 DC servo motor actuator to the Controller unit - see Section 3.3.1.

Caution

During item (5) 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.

- 5) Connect the Controller unit to the power supply - see Section 3.3.2.
- 6) Connect the PSU to the main supply.

- 7) Switch 'ON' the unit using the switch on the front panel.

The unit takes about 5 seconds from power application until warm up is finished, during which time the following screens are displayed.

Thorlabs KDC101
SwRev 10002

Stage Connected:
Z812

At 0.000 mm
Stopped V

Fig. 3.4 Start up display

- 8) Windows™ should detect the new hardware. Wait while Windows™ installs the drivers for the new hardware.

Note

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

3.5 Stage identification

Most of the stages compatible with the KDC101 controller are fitted with an identification device. On power-up the KDC101 reads the stage identification and loads the correct operating parameters associated with the stage. When the controller is used with APT software, the type of stage is also reported to the GUI. However, some legacy stages are not fitted with an identification device. For correct operation these must be selected manually after power up.

If, on power-up, the controller is able to determine the type of the stage connected, it will load the operating parameters associated with that stage and the OLED display will show "Stage connected: <type of stage>", as shown in Fig. 3.4. In this scenario, no further action needs to be taken.

If, however, the stage is not fitted with an ID (e.g. Z825V, CR1-Z7) the user can manually select the correct stage and persist the setting. To facilitate this, the OLED display menu contains a menu option called "Select stage". For stages that are not fitted with an ID resistor, the user needs to use the "Select stage" menu option and manually identify the stage connected to the controller - see Section 4.4.11. for further details. This only needs to be done once: on subsequent power-ups the controller will assume that the stage type has not changed, unless it detects a stage that is fitted with an ID resistor. To indicate that the stage type is assumed rather than identified, the OLED power-up display screen will show "Stage persisted: <stage type> (No ID)" to warn the user that the type of the stage is only assumed and may not be correct..

Thorlabs KDC101
SwRev 020004

Stage persisted:
Z825 <no ID>

At 0.0000 mm
Stopped V

Fig. 3.5 Start up display - no stage ID

3.6 Verifying Software Operation

3.6.1 Initial Setup

- 1) Ensure power is applied to the unit, then switch the unit ON using the switch on the front panel.
- 2) Wait until the power up sequence is complete, then run the APTUser utility and check that the Graphical User Interface (GUI) panel appears and is active.



Fig. 3.6 Gui panel showing jog and ident buttons

- 3) Click the 'Ident' button. The digital 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.
- 4) Click the jog buttons on the GUI panel and check that the motor or axis connected to the DC Driver K-Cube moves. The position display for the associated GUI should increment and decrement accordingly.

Follow the tutorial steps described in Chapter 4 for further verification of operation.

Note

The 'APT Config' utility can be used to set up simulated hardware configurations and place the APT Server into simulator mode. In this way it is possible to create any number and type of simulated (virtual) hardware units in order to emulate a set of real hardware. This is a particularly useful feature, designed as an aid to application program development and testing. Any number of 'virtual' control units are combined to build a model of the real system, which can then be used to test the application software offline.

If using real hardware, ensure that Simulator Mode is disabled. If using a simulated setup, enable Simulator Mode and set up a 'Simulated Configuration' - see Section 5.8. or the *APTCConfig* helpfile for detailed instructions.

Chapter 4 Standalone Operation

4.1 Introduction

The DC Driver K-Cube has been designed specifically to operate with the extensive range of Thorlabs DC motorised opto-mechanical products. The unit offers a fully featured motion control capability including velocity profile settings, limit switch handling, homing sequences and, for more advanced operation, adjustment of settings such as lead screw pitch and gearbox ratio, allowing support for many different actuator configurations. These parameters can be set via the APT Server software - see Chapter 5. 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 to which it is associated - see Chapter 3 for more details.

4.2 Control Panel

4.2.1 Overview

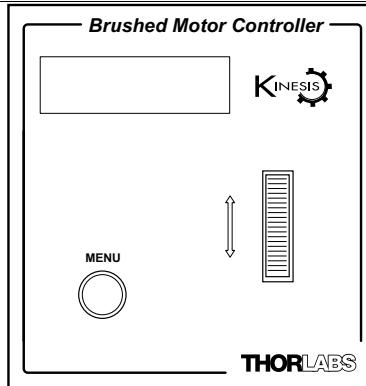


Fig. 4.1 Panel Controls and Indicators

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

Velocity Wheel - Used to drive the motor at a varying speed in either forward or reverse directions for full and easy motor control - see Section 4.3.

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

MENU - used to access the settings menu - see Section 4.4. Also used to stop a move when the stage is in motion.

4.2.2 Digital Display - Operating Mode

During normal operation, the digital display shows the current position (in millimeters or degrees) and the current state of the motor (Stopped or Moving). If the stage being driven has been homed, the display will also show 'Homed'.

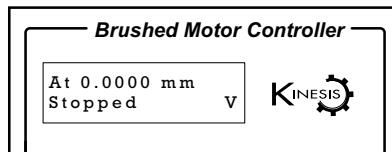


Fig. 4.2 Digital Display - Normal Operation

For rotation stages, the position display will be restricted to the "Equivalent Angle" display mode (see Section 6.3.6. for more details), so the position displayed will always be a positive number between 0 and 360 degrees. If set to Total Angle in the settings panel, the LED display will still show the equivalent 0 to 360° value but the GUI screen will show the total rotation.

4.3 Velocity Wheel Operation

The velocity wheel is a sprung potentiometer, such that when released it returns to its central position. In this central position the motor is stationary. Different types of move can be initiated by the wheel, depending on its mode setting. The mode can be set either via the GUI Settings panel, see Section 6.3.4. or via the top panel display menu, see Section 4.4. The various operating modes are described in Section 4.3.1. to Section 4.3.3.

4.3.1 Homing

A 'Home' move is performed to establish a datum from which subsequent absolute position moves can be measured (see Section 5.3. and Section E.2.2. for further information on the home position).

To initiate a 'Home' see Section 4.4.3.

4.3.2 Go to Position

In 'Go To Position' mode, two preset position values can be specified, such that the motor moves to position 1 when the wheel is moved down, and to position 2 when it is moved up. These 'taught' positions can be set through the software GUI - see Section 6.3.4. or via the display menu, see Section 4.4.7.

This mode of operation is enabled by setting the 'Wheel Mode' to 'Go To Position' through the software GUI - see Section 6.3.4. or via the display menu, see Section 4.4.5.

Note for Rotation Stage Users

If the current absolute position is outside the 0 to 360 degree range, then "go to position" will result in a move to the correct angular position within the same 0..360 degree full turn "segment". This means that the move will always stay in the current full turn segment, and from this point of view it is not always the quickest position move. For example, if you are at 350 degrees and you enter a "go to" position of 10 degrees, the stage will rotate anticlockwise 340 degrees and not clockwise 20 degrees.

4.3.3 Jogging

The top panel wheel can also be configured to 'jog' the motor. This mode of operation is enabled by setting the 'Wheel Mode' parameter to 'Jogging' through the software GUI - see Section 6.3.4. or via the display menu, see Section 4.4.5.

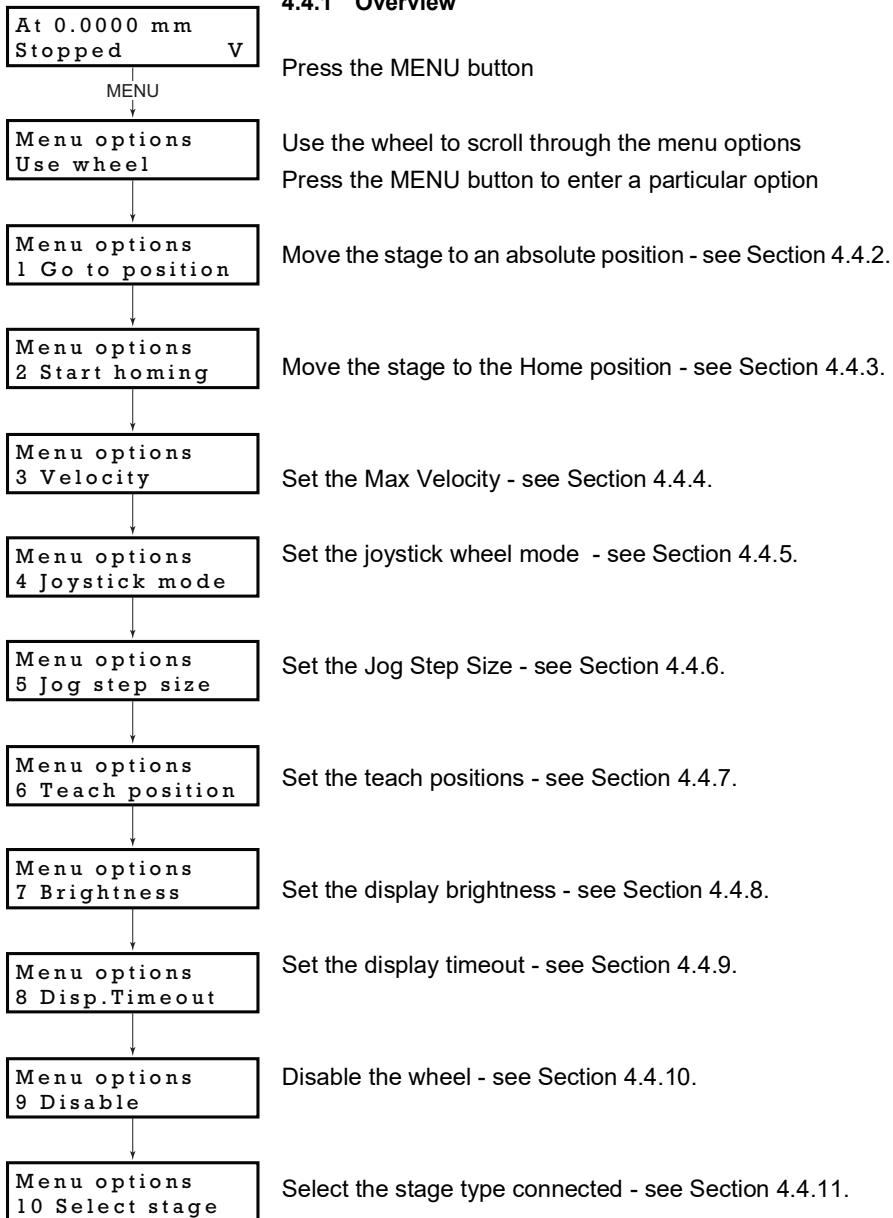
Once set to this mode, the jogging parameters for the wheels are taken from the 'Jog' parameters on the 'Move/Jogs' settings tab - see Section 6.3.1. or via the display menu, see Section 4.4.6.

4.3.4 Velocity Moves

The wheel can also be used to initiate a move at a specified velocity. As the wheel is moved away from the centre, the motor begins to move. Bidirectional control of the motor is possible by moving the wheel in both directions. The speed of the motor increases by discrete amounts as a function of wheel deflection, up to a maximum as set in through the software GUI - see Section 6.3.4. or via the display menu, see Section 4.4.4. The move stops when the wheel is returned to its centre position.

4.4 Settings Menu

4.4.1 Overview



4.4.2 Menu Option - Go to position

This mode is used to move to an absolute position.

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

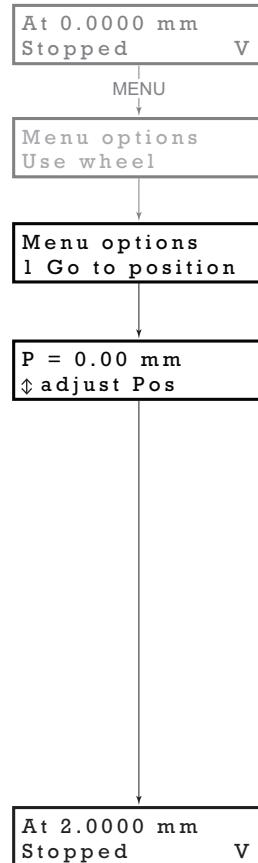
Press the MENU button to enter the Go to positions option.

Use the wheel to adjust the position value, (within the travel range for linear stages, or 0 to 360 ° for rotation stages) then press the MENU button to store the selection.

Note for rotation stages. If the current absolute position is outside the 0 to 360 degree range, then "go to position" will result in a move to the correct angular position within the same 0..360 degree full turn "segment". This means that the move will always stay in the current full turn segment, and from this point of view it is not always the quickest position move. For example, if the stage is at 350 degrees and you enter a "go to" position of 10 degrees, the stage will rotate anticlockwise 340 degrees and not clockwise 20 degrees.

The stage moves to the position entered, and the display shows the change in position.

To stop the move, press the MENU button.



At 2.0000 mm
Stopped V

MENU

↓
Menu options
Use wheel

↓
Menu options
2 Start homing

↓
At 2.0000 mm
Homing V

↓
At 0.0000 mm
Homed Stopped V

4.4.3 Menu Option - Start homing

This mode is used to home the stage.

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

Press the MENU button to enter the Start Homing option.

The display shows a decreasing position count while the stage is homing.

Once homing is complete, the display shows the position at 0.0000 mm and 'Homed' is displayed.

To stop the move, press the MENU button.

At 0.0000 mm
Homed Stopped V

MENU

↓
Menu options
Use wheel

↓
Menu options
3 Velocity

↓
1.680 mm/s
↓ adjust MaxVel

↓
At 0.0000 mm
Homed Stopped V

4.4.4 Menu Option - Velocity

This mode is used to move to set the max velocity.

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

Press the MENU button to enter the Velocity option.

Use the wheel to adjust the max velocity, e.g. 0.168 mm/s, then press the MENU button to store the setting.

Subsequent moves will be performed at the velocity entered.

4.4.5 Menu Option - Joystick Mode

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

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

Press the MENU button to enter the Joystick mode option. Use the wheel to scroll through the options, then press MENU when the required option is displayed.

In *Velocity control mode*, 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 joystick wheel) is set in the preceding 3 *Velocity* option. The move will stop when the wheel is released.

In *Jog to positions mode*, deflecting the wheel starts a move from the current position to one of the two predefined “teach” positions. The teach positions are specified in option 6 *Teach Position*.

In *Jog in steps mode*, deflecting the wheel initiates a jog move, using the parameters specified by the 3 *Velocity* and 5 *Jog step size* options. Keeping the wheel deflected repeats the move automatically after the current move has completed.

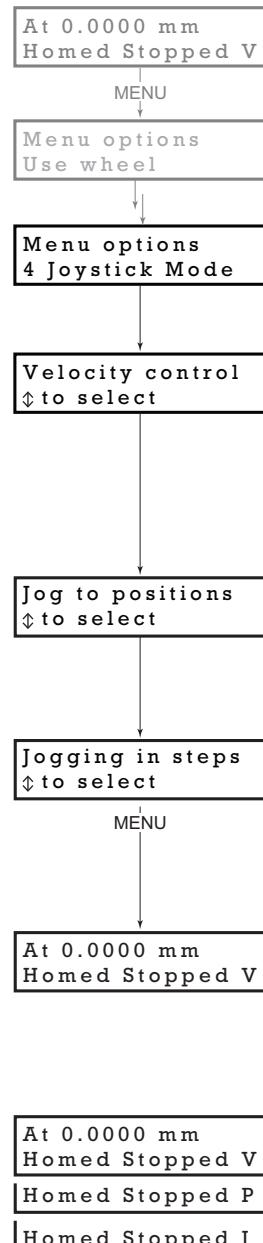
Use the wheel to display the required option, then press MENU to store the selection and return to the main display.

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

V = Velocity mode

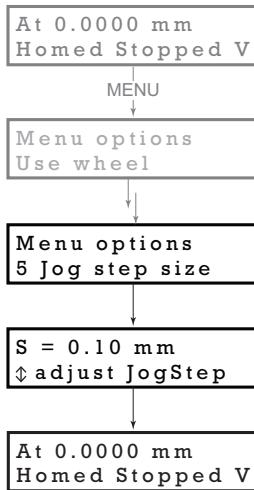
P = Jog to position mode

J = Jog in steps mode



4.4.6 Menu Option - Jog Step Size

This mode is used to set the jog step size.



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

Press the MENU button to enter the Jog step size option.

Use the wheel to adjust the step size, e.g. 0.10 mm, then press the MENU button to store the selection.

When *Jog in steps* mode is selected in the *Joystick mode* option (see Section 4.4.5.), subsequent moves will be performed at the step size entered.

4.4.7 Menu Option - Teach Position

This mode is used to set the teach positions, used when the *Joystick mode* option is set to *Jog to positions* mode - see Section 4.4.5.

To set Teach Position 1...

Move the stage to the position to use as teach position 1.

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

Press the MENU button to enter the Teach position option.

Use the wheel to select P1, then press the MENU button to store the current position as teach position 1 and return to the main display.

To set Teach Position 2...

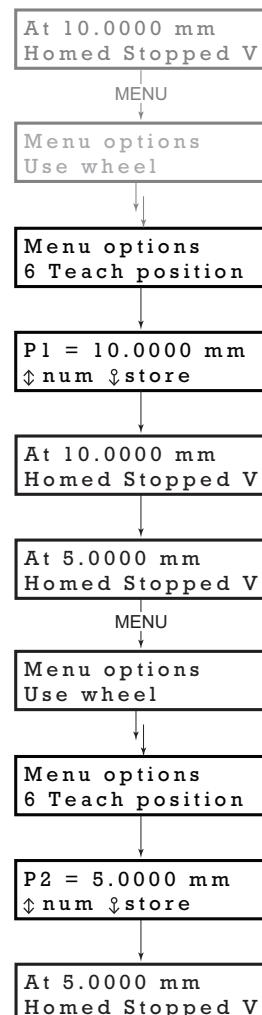
Move the stage to the position to use as teach position 2.

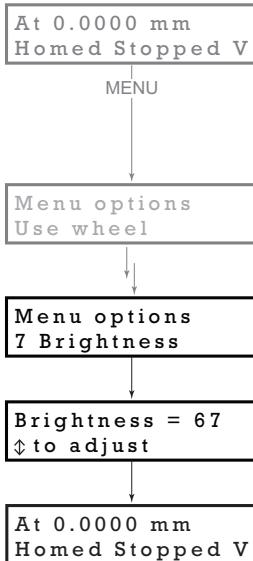
Press the MENU button, then use the wheel to scroll through the menu options.

Press the MENU button to enter the Teach position option.

Use the wheel to select P2, then press the MENU button to store the current position as teach position 2 and return to the main display.

When *Jog to position* mode is selected in the *Joystick mode* option (see Section 4.4.5.), a downwards deflection of the wheel moves the stage to position 1, and an upwards deflection moves to position 2.





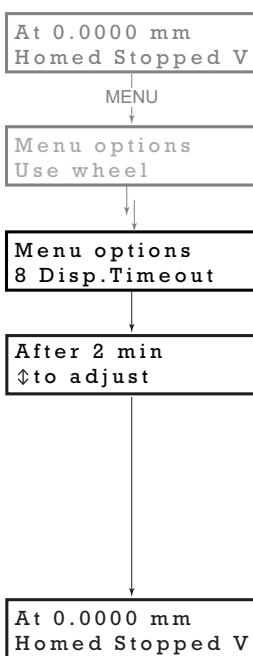
4.4.8 Menu Option - Brightness

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



4.4.9 Menu Option - Disp.Timeout

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

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

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

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

The dim level can only be adjusted via the Settings panel - see Section 6.3.4.

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

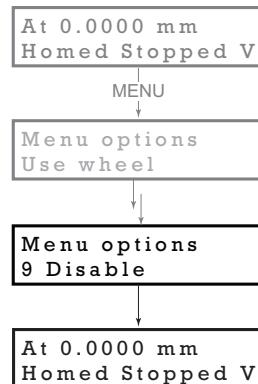
4.4.10 Menu Option - Disable

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

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

Press the MENU button to enter the Disable option.

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



4.4.11 Menu Option - Select Stage

Most of the stages compatible with the KDC101 controller are fitted with an identification device. On power-up the KDC101 reads the stage identification and loads the correct operating parameters associated with the stage. However, some legacy stages are not fitted with an identification device. For correct operation these must be selected manually after power up.

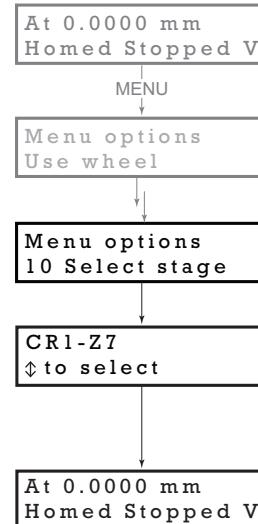
Press the MENU button, then use the wheel to scroll through the menu options.

Press the MENU button to enter the Select stage option.

Use the wheel to scroll to the required option:

CR1-Z7, Z806, Z812, Z825, MTS50-Z8, MTS25-Z8, PRM1-Z8, CR1-Z6, Z625, Z612 and Z606.

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



Chapter 5 PC Operation - Tutorial

5.1 Introduction

The following brief tutorial guides the user through a typical series of moves and parameter adjustments performed using the PC based APT software. It assumes that the unit is electrically connected as shown in Section 3.3.1. and that the APT Software is already installed - see Section 3.1. For illustration purposes, it also assumes that a Z812 motor is connected to the 'Motor' connector on the rear panel

Caution

If your PC becomes unresponsive (e.g due to an operating system problem, entering a sleep state condition, or screen saver operation) for a prolonged period, this will interrupt communication between the APT Software and the hardware, and a communications error may be generated. To minimize the possibility of this happening it is strongly recommended that any such modes that result in prolonged unresponsiveness be disabled before the APT software is run. Please consult your system administrator or contact Thorlabs technical support for more details.

5.2 Using the APT User Utility

The APT User.exe application allows the user to interact with any number of APT hardware control units connected to the PC USB Bus (or simulated via the APTConfig utility). This program allows multiple graphical instrument panels to be displayed so that multiple APT 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 APT User is run up.

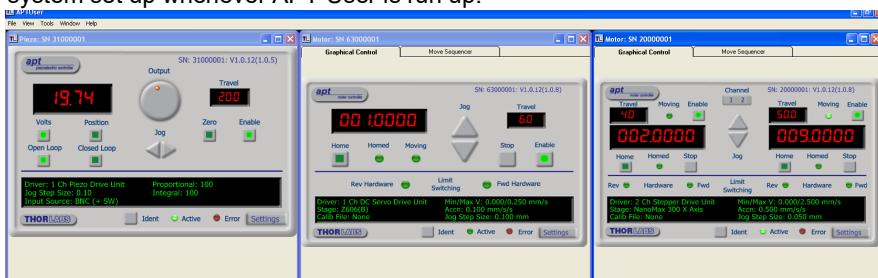


Fig. 5.1 Typical APT User Screen

- 1) Wait until the KDC101 has started, then run the APT User program - Start/Programs/Thorlabs/APT/APT User.

- 2) Notice how the actuator type is displayed in the 'Settings' window. See Section 5.11. and Section 6.3. for further details on the parameter values shown in the 'Settings' display.



Fig. 5.2 DC Driver K-CubeSoftware GUI

The APT User utility will be used throughout the rest of this tutorial to interface with the DC servo motor controller.

5.3 Homing Motors

Homing the motor moves the actuator to the home limit switch and resets the internal position counter to zero. The limit switch provides a fixed datum that can be found after the system has been powered up.



Fig. 5.3 DC Driver K-Cube Software GUI

- 1) Click the 'Home' button. Notice that the led in the button lights to indicate that homing is in progress and the displayed position counts down to 000.000, i.e the home position.

Note

After homing, shaft relaxation may cause a small position offset to be displayed. This relates only to one or two encoder counts and is not significant in terms of 'real world' positioning.

- 2) When homing is complete, the 'Homed' LED is lit as shown above.
See Appendix E Section E.2.2. for background information on the home position.

5.4 Moving to an Absolute Position

Absolute moves are measured in real world units (e.g. millimetres), relative to the Home position.

- 1) Click the position display.



Fig. 5.4 Absolute Position Popup Window

- 2) Enter 8.0 into the pop up window
- 3) Click 'OK'. Notice that the position display counts up to 8.000 to indicate a move to the absolute position 8.00mm.

5.5 Changing Motor Parameters

Moves are performed using a trapezoidal velocity profile (see Appendix E , Section E.1.3.). The velocity settings 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.

- 1) On the GUI panel, click the ‘Settings’ button (bottom right hand corner of the display) to show the Settings panel.

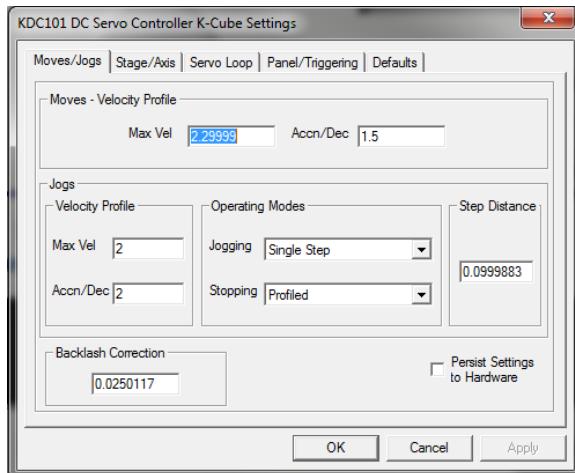


Fig. 5.5 Settings Panel - Move/Jogs Tab

- 2) Select the Move/Jogs tab as shown in Fig. 5.5.
- 3) In the ‘Moves’ field, enter parameter values as follows:
‘Max. Vel’ - ‘0.25’
‘Accn/Dec’ - ‘0.1’

Note

In current versions of software, the ‘Min Vel’ parameter is locked at zero and cannot be adjusted.

- 4) Click ‘OK’ to save the settings and close the window.
- 5) Any further moves initiated will now be performed at a maximum velocity of 0.25mm per second, with an acceleration of 0.1mm/sec/sec.

5.6 Jogging

During PC operation, the motor actuators are jogged using the GUI panel 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 Distance parameter. If the velocity wheel is turned and held, single step jogging is repeated until the wheel is released - see Fig. 6.3. In ‘Continuous’ mode, the motor actuator will accelerate and move at the jog velocity while the wheel is turned.

- 1) On the GUI panel, click the ‘Settings’ button to display the Settings panel.

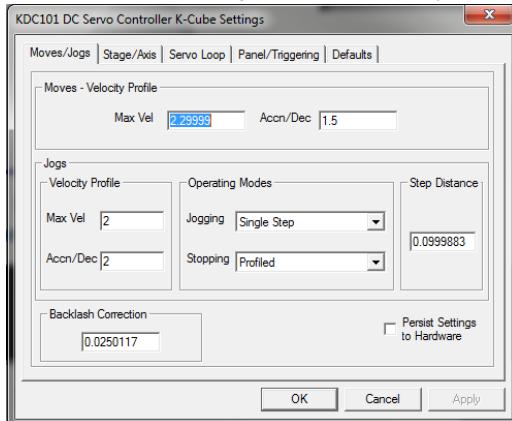


Fig. 5.6 Settings Panel - Move/Jogs Tab

- 2) Select the Move/Jogs tab as shown in Fig. 5.6.
- 3) In the ‘Jogs’ field, enter parameter values as follows:
Velocity Profile
 ‘Max. Vel’ - ‘0.25’
 ‘Accn/Dec’ - ‘0.1’

Note

In current versions of software, the ‘Min Vel’ parameter is locked at zero and cannot be adjusted.

Operating Modes

‘Jogging’ - ‘Single Step’
 ‘Stopping’ - ‘Profiled’

‘Step Distance’ - ‘0.1’

- 4) Click ‘OK’ to save the settings and close the window.
- 5) Click the Jog Arrows on the GUI panel to jog the motor. Notice that the position display increments 0.1 every time the button is clicked.

5.7 Stopping the Stage

The drive channel is enabled and disabled by clicking the ‘Enable’ button on the GUI panel. The green indicator in the button center is lit when the drive channel is enabled. Disabling the channel removes the drive power.

During operation, the stage can be stopped at any time by clicking the ‘Stop’ button on the GUI panel. Using this button does not remove power to the drive channel.



Fig. 5.7 APTUser GUI screen

5.8 Graphical Control Of Motor Positions (Point and Move)

The GUI panel display can be changed to a graphical display, showing the position of the motor channel(s). Moves to absolute positions can then be initiated by positioning the mouse within the display and clicking.

To change the panel view to graphical view, right click in the screen and select 'Graphical View'.



Fig. 5.8 DC Driver K-Cube GUI Panel - Graphical View

Consider the display shown above for a DC Driver K-Cube.

The right hand display shows the channel and motor unit parameters; i.e. controller unit type and serial number, associated stage and actuator type, minimum and maximum positions, current position, units per grid division and cursor position. All units are displayed in real world units, either millimetres or degrees.

Note

For single channel units such as the DC Driver K-Cube, the Channel 2 parameters are greyed out.

The left hand display shows a circle, which represents the current position of the motor associated with the specified controller (absolute position data is displayed in the 'Chan Pos' field).

The vertical divisions relate to the travel of the stage/actuator associated with the DC Driver K-Cube (the stage/actuator is selected in the 'APT Config' utility). For example, the screen shot above shows the parameters for a 50 mm travel MTS50-Z8 stage. The graph shows 10 divisions in the X axis, which relates to 5 mm of travel per division (50 mm in total).

The graphical panel has two modes of operation, 'Jog' and 'Move', which are selected by clicking the buttons at the bottom right of the screen.

Move Mode

When 'Move' is selected, the motors move to an absolute position which corresponds to the position of the cursor within the screen.

To specify a move:

- 1) Position the mouse within the window. For reference, the absolute motor position value associated with the mouse position is displayed in the 'Cursor Position' field.
- 2) Click the left hand mouse button to initiate the move.

Jog Mode

When 'Jogging' mode is selected, the motors are jogged each time the left mouse button is clicked.

The Jog direction corresponds to the position of the cursor relative to the circle (current motor position), e.g. if the cursor is to the left of the circle the motor will jog left. The Jog Step size is that selected in the Settings panel - see Section 6.3.

Stop

To stop the move at any time, click the 'Stop' button.

Returning to Panel View

To return to panel view, right click in the graphical panel and select 'Panel View'.

5.9 Setting Move Sequences

This section explains how to set move sequences, allowing several positions to be visited without user intervention.

For details on moving to absolute positions initiated by a mouse click – see Section 5.8.

- 1) From the Motor GUI Panel, select 'Move Sequencer' tab to display the Move Sequencer window.

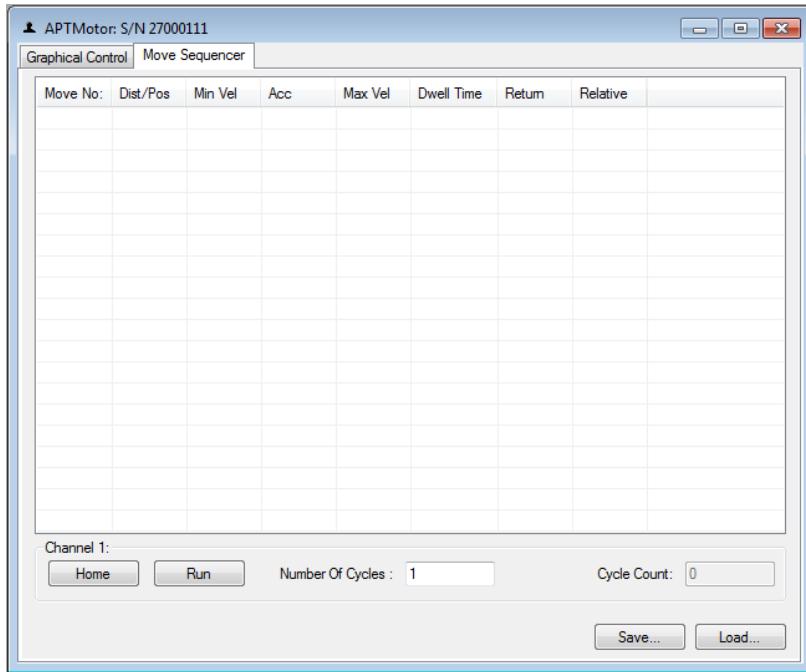


Fig. 5.9 Move Sequencer Window

- 2) Right click, in the move data field to display the pop up menu.

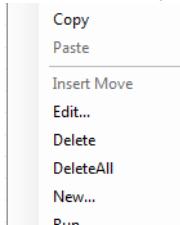


Fig. 5.10 Move Sequencer Pop Up Menu

- 3) Select 'New' to display the 'Move Editor' panel.

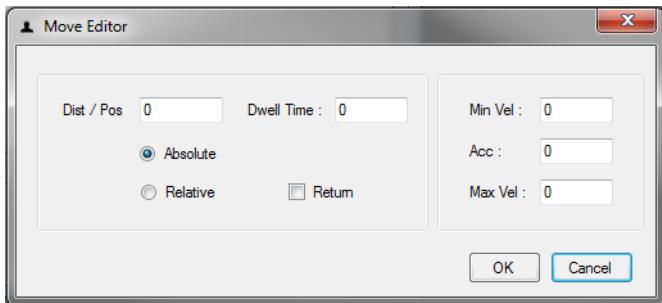


Fig. 5.11 Move Editor Window

Move data is entered/displayed as follows:

Dist/Pos: - the distance to move from the current position (if 'Relative' is selected) or the position to move to (if 'Absolute' is selected).

Dwell Time: - after the move is performed, the system can be set to wait for a specified time before performing the next move in the sequence. The Dwell time is the time to wait (in milliseconds).

Return - if checked, the system will move to the position specified in the Dist/Pos field, wait for the specified Dwell time, and then return to the original position.

- 4) **Min Vel: Acc: and Max Vel:** - the velocity profile parameters for the move.

Note

In current versions of software, the 'Min Vel' parameter is locked at zero and cannot be adjusted.

The motor accelerates at the rate set in the Acc field up to the speed set in the Max Vel field. As the destination approaches, the motor decelerates again to ensure that there is no overshoot of the position.

- 5) Enter the required move data into the Move Editor and click OK. The move data is displayed in the main window as shown below.

Move No:	Dist/Pos	Min Vel	Acc	Max Vel	Dwell Time	Return	Relative
1	1.5	0	0.5	1	100	False	False

Fig. 5.12 Main Window with Move Data

- 6) Repeat step 4 as necessary to build a sequence of moves. Move data can be copied, deleted, cut/pasted and edited by right clicking the data line(s) and selecting the appropriate option in the pop up menu (shown below).

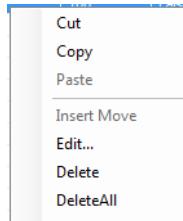


Fig. 5.13 Pop Up Options

- 7) To run a single line of data, right click the appropriate data and select 'Run' from the pop up menu (shown above).
 8) To run the entire sequence, click the 'Run' button (shown below). A Home move can also be performed from this panel by clicking the 'Home' button.

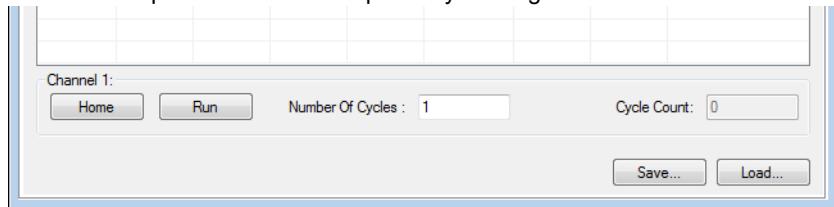


Fig. 5.14 Home and Run Buttons

- 9) To save data to a file, or load data from a previously saved file, click the 'Save' or 'Load' button and browse to the required location.

5.10 Creating a Simulated Configuration

The 'APT Config' utility can be used to set up simulated hardware configurations and place the APT Server into simulator mode. In this way it is possible to create any number and type of simulated (virtual) hardware units in order to emulate a set of real hardware. This is a particularly useful feature, designed as an aid learning how to use the APT software and as an aid to developing custom software applications 'offline'.

Any number of 'virtual' control units can be combined to emulate a collection of physical hardware units. For example, an application program can be written, then tested and debugged remotely, before running with the hardware.

To create a simulated configuration proceed as follows:

- 1) Run the APT Config utility - Start/Programs/Thorlabs/APT/APT Config.
- 2) Click the 'Simulator Configuration' tab.

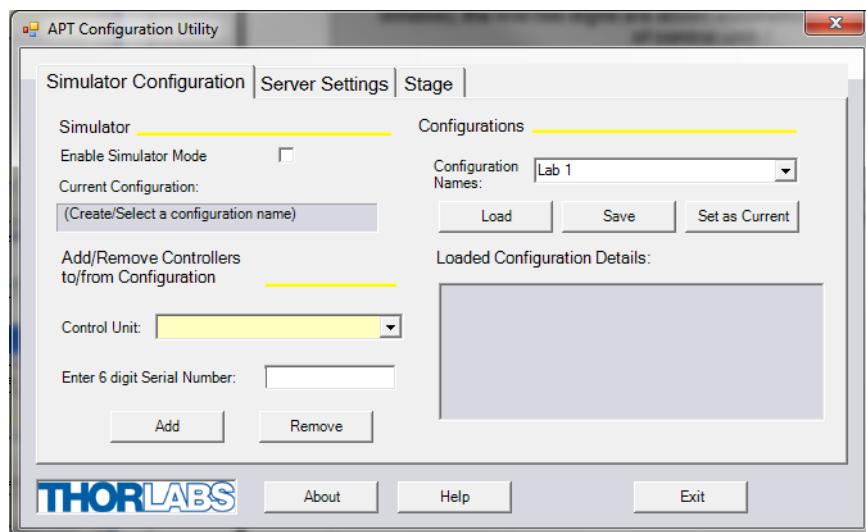
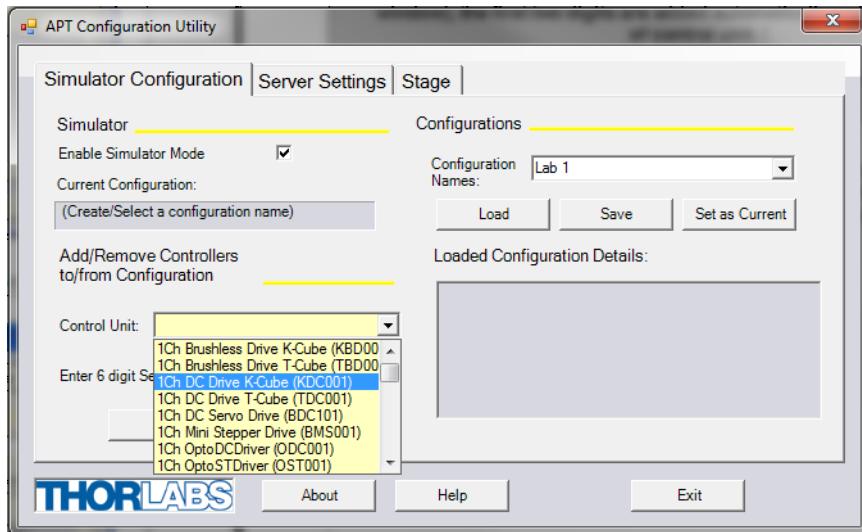


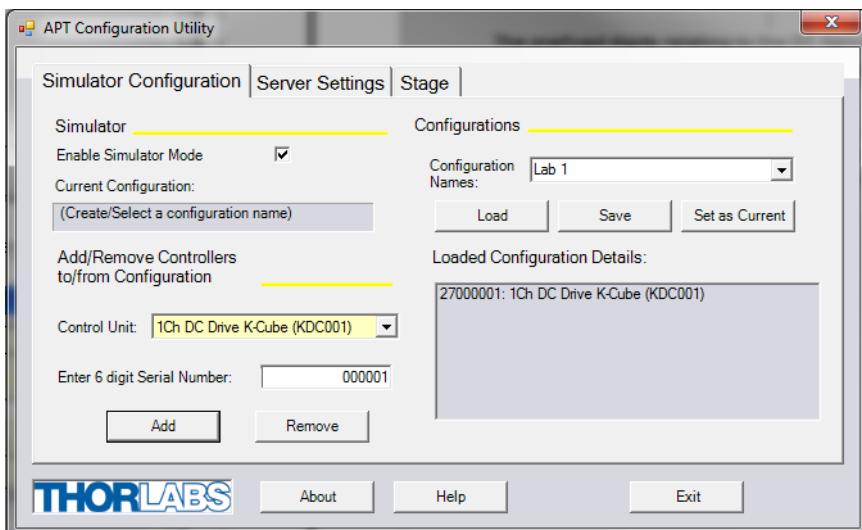
Fig. 5.15 APT Configuration Utility - Simulator Configuration Tab

- 3) Enter 'LAB 1' in the Configuration Names field.

- 4) In the 'Simulator' field, check the 'Enable Simulator Mode' box. The name of the most recently used configuration file is displayed in the 'Current Configuration' window.



- 5) In the 'Control Unit' field, select '1 Ch DC Driver K-Cube (KDC101)'.



- 6) In the 'Enter 6 digit serial number' field, enter a serial number for your KDC101 unit.

Note

Each physical APT hardware unit is factory programmed with a unique 8 digit serial number. In order to simulate a set of 'real' hardware the Config utility allows an 8 digit serial number to be associated with each simulated unit. It is good practice when creating simulated configurations for software development purposes to use the same serial numbers as any real hardware units that will be used. Although serial numbers are 8 digits (as displayed in the 'Load Configuration Details' window), the first two digits are added automatically and identify the type of control unit.

The prefixed digits relating to the DC Servo Driver K-Cube are:

27xxxxxx - 1 Ch DC Driver K-Cube

- 7) Click the 'Add' button.
- 8) Repeat items (1) to (7) as required. (A unit can be removed from the configuration by selecting it in the 'Loaded Configuration Details' window and clicking the 'Remove' button or by right clicking it and selecting the 'Remove' option from the pop up window).
- 9) Click 'Save'.
- 10) Click 'Set As Current' to use the configuration.

5.11 Stage/Axis Tab

This tab contains a number of parameters which are related to the physical characteristics of the particular stage or actuator being driven. They need to be set accordingly such that a particular stage is driven properly by the system.

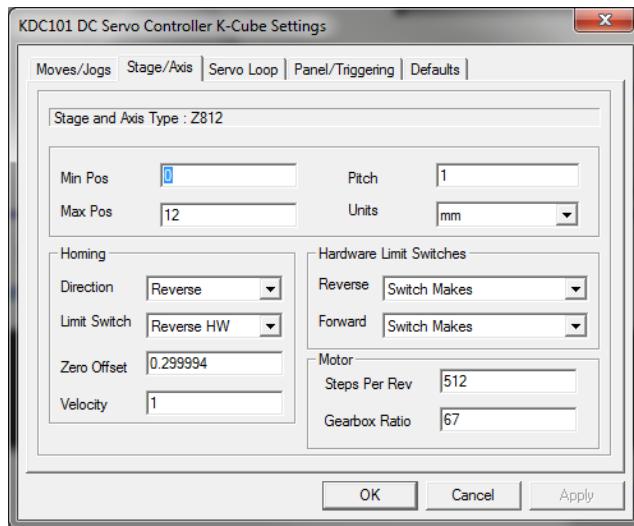


Fig. 5.16 Stage/Axis Tab

These parameters were set automatically when the actuator was connected. The APT server automatically applied suitable defaults for the parameters on this tab during boot up of APTUser. These parameters should not be altered for pre-defined Thorlabs stages and actuators selected using APT Config, as it may adversely affect the performance of the stage.

For third party stage types not available using the APT Config utility, these stage details must be entered manually.

Individual parameters are described in Section 6.3.

Chapter 6 Software Reference

6.1 Introduction

This chapter gives an explanation of the parameters and settings accessed from the APT software running on a PC. For information on the methods and properties which can be called via a programming interface, see Appendix D .

6.2 GUI Panel

The following screen shot shows the graphical user interface (GUI) displayed when accessing the DC Driver K-Cube using the APTUser utility.



Fig. 6.1 DC Driver K-Cube Software GUI

Note

The serial number of the DC Driver K-Cube associated with the GUI panel, the APT server version number, and the version number (in brackets) of the embedded software running on the unit, are displayed in the top right hand corner. This information should always be provided when requesting customer support.

Jog - 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.).

Travel - displays the range of travel (in millimeters or degrees) of the motor.

Moving - lit when the motor is in motion.

Enable - applies power to the motor. With the motor enabled, the LED in the button is lit.

Digital display - shows the position (in millimetres or degrees) of the motor. The motor must be 'Homed' before the display will show a meaningful value, (i.e. the displayed position is relative to a physical datum, the limit switch).

Home - sends the motor to its 'Home' position - see Appendix E Section E.2.2. The LED in the button is lit while the motor is homing.

Homed - lit when the motor has previously been 'Homed' (since power up).

Stop - halts the movement of the motor.

Limit switches - the LEDs are lit when the associated limit switch has been activated - see Appendix E Section E.2.3. for further details on limit switches.

Settings display - shows the following user specified settings:

Driver - the type of control unit associated with the specified channel.

Stage - the stage type and axis associated with the specified channel.

Calib File - the calibration file associated with the specified channel. See the APTConfig utility helpfile for more details on assigning and using calibration files.

Min/Max V - the minimum velocity at which a move is initiated, and the maximum velocity at which the move is performed. Values are displayed in real world units (mm/s or degrees/s), and can be set via the 'Settings' panel (see Section 6.3.).

Accn - the rate at which the velocity climbs to, and slows from, maximum velocity, displayed in real world units (mm/s/s or degrees/s/s). The acceleration can be set via the 'Settings' panel (see Section 6.3.) and is used in conjunction with the Min/Max velocity settings to determine the velocity profile of a motor move. See Appendix E Section E.1.3. for more information on velocity profiles.

Jog Step Size - the size of step (in mm or degrees) taken when the jog signal is initiated. The step size can be set either via the Settings panel or by calling the SetJogStepSize method.

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

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

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

Error - lit when a fault condition occurs. The Error LED is lit if the difference between the trajectory generator position (i.e. the demanded motor position) and the actual position, exceeds 10000 encoder pulses. Typically this can occur transiently if the maximum velocity specified for the move exceeds the maximum drive velocity of the motor being controlled.

6.3 Settings Panel

When the 'Settings' button on the GUI panel is clicked, the 'Settings' window is displayed. This panel allows motor operation parameters such as move/jog velocities, and stage/axis information to be modified. Note that all of these parameters have programmable equivalents accessible through the ActiveX methods and properties on this Control (refer to the *Programming Guide* in the *APT helpfile* for further details and to Section 2.3.4. for an overview of the APT ActiveX controls).

6.3.1 Moves/Jogs Tab

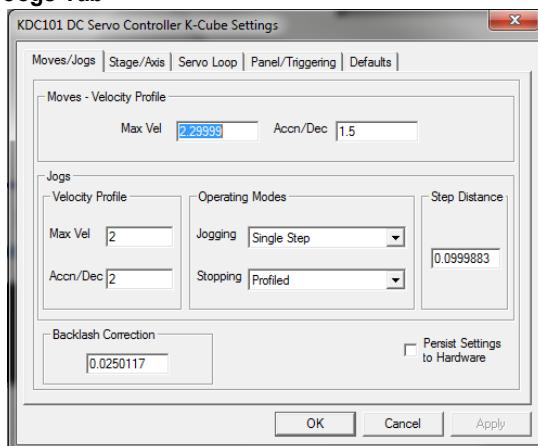


Fig. 6.2 DC Driver K-Cube - Move/Jog Settings

Moves - Velocity Profile

Moves can be initiated via the GUI panel, by using the velocity wheel (see Section 4.3.) or by entering a position value after clicking on the position display box (see Section 5.4.). The following settings determine the velocity profile of such moves, and are specified in real world units, millimetres or degrees.

Note

The minimum velocity is locked at zero and cannot be adjusted.

MaxVel - the maximum velocity at which to perform a move.

Accn/Dec - the rate at which the velocity climbs from minimum to maximum, and slows from maximum to minimum.

Note

Under certain velocity parameter and move distance conditions, the maximum velocity may never be reached (i.e. the move comprises an acceleration and deceleration phase only).

Jogs

Jogs are initiated by using the ‘Jog’ keys on the GUI panel (see Section 5.6.), or the Velocity Wheel on the top panel of the unit.

Velocity Profile (specified in real world units, millimetres or degrees)

MaxVel - the maximum velocity at which to perform a jog

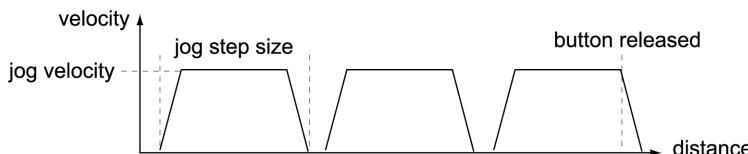
Accn/Dec - the rate at which the velocity climbs from minimum to maximum, and slows from maximum to minimum.

Operating Modes

Jogging - 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 Step’ and ‘Continuous’. In ‘Single Step’ mode, the motor moves by the step size specified in the Step Distance parameter. If the jog key is held down, single step jogging is repeated until the button is released - see Fig. 6.3. In ‘Continuous’ mode, the motor actuator will accelerate and move at the jog velocity while the button is held down..

Single Step mode (Channel 1)



Continuous mode (Channel 2)

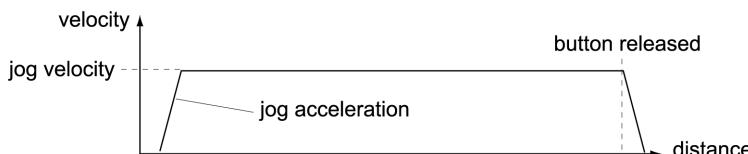


Fig. 6.3 Jog Modes

Single Step - the motor moves by the step size specified in the Step Distance parameter.

Continuous - the motor continues to move until the jog signal is removed (i.e. jog button is released).

Stopping - the way in which the jog motion stops when the demand is removed.

Immediate - the motor stops quickly, in a non-profiled manner

Profiled - the motor stops in a profiled manner using the jog Velocity Profile parameters set above.

Step Distance - The distance to move when a jog command is initiated. The step size is specified in real world units (mm or degrees dependent upon the stage).

Backlash Correction - The system compensates for lead screw backlash during reverse direction moves, by moving passed the demanded position by a specified amount, and then reversing. This ensures that positions are always approached in a forward direction. The Backlash Correction Distance is specified in real world units (millimeters or degrees). To remove backlash correction, this value should be set to zero.

Persist Settings to Hardware - Many of the parameters that can be set for the DC 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 Velocity Profile and Jogging 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.

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 APTUser, the default APTServer settings will be loaded at boot up, even if the 'Persist Settings' option has been checked.

6.3.2 Stage/Axis Tab

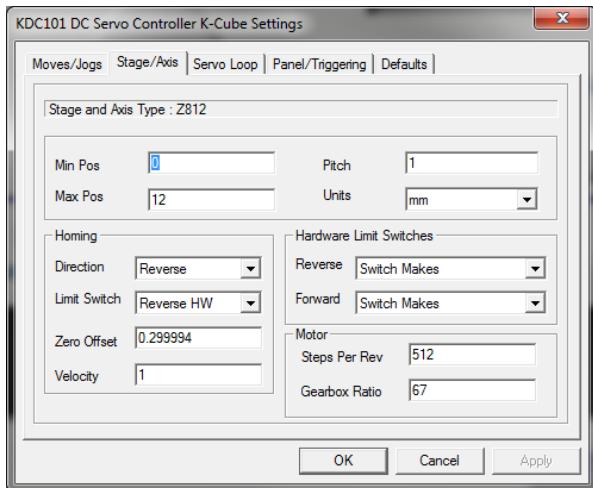


Fig. 6.4 DC Driver K-Cube - Stage/Axis Settings

Note

This tab contains a number of parameters which are related to the physical characteristics of the particular stage being driven. They need to be set accordingly such that a particular stage is driven properly by the system.

For Thorlabs stages, the system will recognise the stage and the APT server will automatically apply suitable defaults for the parameters on this tab during boot up of the software. These parameters should not be altered for pre-defined Thorlabs stages selected using APT Config, as it may adversely affect the performance of the stage.

For third party stage types not available using the APT Config utility, the stage details must be entered manually. Individual parameters are described in the following paragraphs.

Caution

Extreme care must be taken when modifying the stage related settings that follow. Some settings are self consistent with respect to each other, and illegal combinations of settings can result in incorrect operation of the physical motor/stage combination being driven. Consult Thorlabs for advice on settings for stage/actuator types that are not selectable via the APTConfig utility.

Stage and Axis Type - For Thorlabs stages, the stage type is displayed automatically once the axis has been associated using the APTConfig utility. For third party stages, the display shows '*Unknown*'.

Min Pos - the stage/actuator minimum position (typically zero).

Max Pos - the stage/actuator maximum position.

Pitch - the pitch of the motor lead screw (i.e. the distance travelled (in mm or degrees) per revolution of the leadscrew).

Units - the 'real world' positioning units (mm or degrees).

Homing

When homing, a stage typically moves in the reverse direction, (i.e. towards the reverse limit switch). The following settings allow support for stages with both Forward and Reverse limits.

Note

Typically, the following two parameters are set the same, i.e. both Forward or both Reverse.

Direction - the direction sense to move when homing, either *Forward* or *Reverse*.

Limit Switch - The hardware limit switch associated with the home position, either *Forward HW* or *Reverse HW*.

Zero Offset - the distance offset (in mm or degrees) from the limit switch to the Home position.

Velocity - the maximum velocity at which the motors move when Homing.

For further information on the home position, see Section E.2.2.

Hardware Limit Switches

Note

The minimum velocity and acceleration/deceleration parameters for a home move are taken from the existing move velocity profile parameters.

The operation of the limit switches is inherent in the design of the associated stage or actuator. The following parameters notify the system to the action of the switches when contact is made. Select Rev Switch or Fwd Switch as required, then select the relevant operation.

Switch Makes - The switch closes on contact

Switch Breaks - The switch opens on contact

Ignore/Absent - The switch is missing, or should be ignored.

Motor

These parameters are used to set the 'resolution' characteristics of the DC servo motor connected to the selected channel. The resolution of the motor, combined with other characteristics (such as lead screw pitch) of the associated actuator, determines the overall resolution.

Steps Per Rev - The number of encoder counts per revolution of the DC servo motor (minimum '1', maximum '1000').

Note

The Gearbox Ratio parameter is applicable only to motors fitted with a gearbox.

Gearbox Ratio - The ratio of the gearbox. For example, if the gearbox has a reduction ratio of X:1 (i.e. every 1 turn at the output of the gearbox requires X turns of the motor shaft) then the Gearbox Ratio value is set to X. (minimum '1', maximum '1000').

Note

The 'Steps Per Rev' and 'Gearbox Ratio' parameters, together with the 'Pitch' and 'Units' parameters are used to calculate the calibration factor for use when converting real world units to encoder counts.

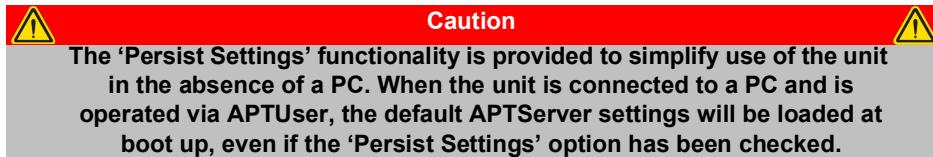
The Z800 series of DC servo motors have an encoder with 512 counts per rev and a 67:1 reduction gearbox. In this case, the Steps Per Rev and Gearbox Ratio should be set to '512' and '67' respectively. The equivalent calibration constant is calculated as:

$$512 \times 67 = 34,304 \text{ (encoder counts/mm)}$$

**512 counts per revolution
67:1 reduction gearbox
1.0 mm lead screw pitch**

The correct default values for Steps Per Rev and Gearbox Ratio are applied automatically at start up.

Persist Settings to Hardware - Many of the parameters that can be set for the DC 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 Stage and Homing 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.



6.3.3 Servo Loop Tab

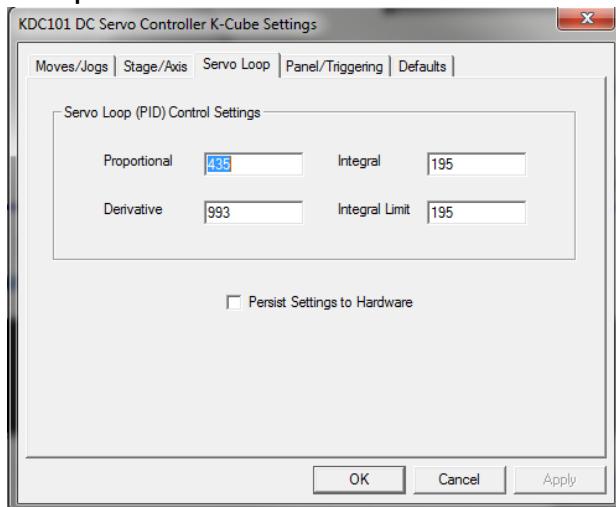


Fig. 6.5 DC Driver K-Cube - Advanced Settings

Servo Loop (PID) Control Settings

The DC Driver K-Cube implements a full servo control loop for motor velocity and position control. The loop response to demanded position moves is determined via Proportional, Integration and Derivative settings. These settings can be altered using the 'Servo Loop (PID) Control Settings' parameters.

Proportional – This parameter makes a change to the output which is proportional to the positional error value. A high proportional gain results in a large change in the output for a given error. It accepts values in the range 0 to 32767.

Integral – This parameter accelerates the process towards the demanded position, ensuring that the positional error is eventually reduced to zero. If set too high, the output can overshoot the demand value. Under a constant torque loading, the static position error is zero. It accepts values in the range 0 to 32767.

Derivative – This term provides the 'damping' force proportional to the rate of change of the position error, thereby decreasing the overshoot which may be caused by the integral term. However, the differential term also slows down system response.

It accepts values in the range 0 to 32767.

Integral Limit – This term sets a maximum limit for the integration term to prevent an excessive build up over time of the restoring force. It accepts values in the range 0 to 32767.

Note

The default values programmed into the APT software will give acceptable motor performance in most cases. These PID parameters are set according to the stage or actuator type associated with the driver using the APTConfig utility (see APTConfig helpfile or the handbook supplied with the unit). However, under extreme loading conditions it may be necessary to alter these factory default values.

6.3.4 Panel/Triggering Tab

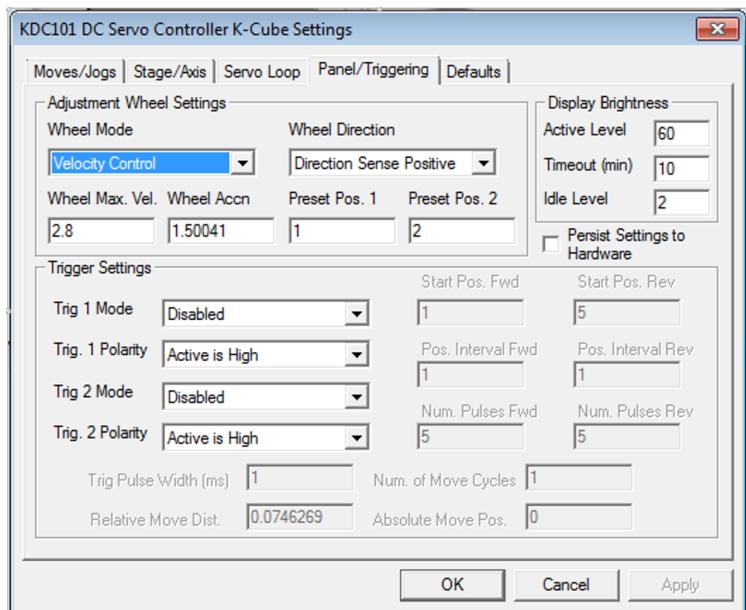


Fig. 6.6 DC Driver K-Cube - Panel/Triggering Settings

Adjustment Wheel Settings

The velocity wheel is sprung such that when released it returns to its 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 wheel deflection is increased. Bidirectional control of motor moves is possible by moving the wheel in both directions.

Wheel Mode

Velocity Control - 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 joystick wheel) and acceleration are set in the *Max Wheel Vel.* and *Wheel Accn.* parameters.

Position Jogging - Deflecting the wheel initiates a jog move, using the parameters specified by the Move/Jogs tab. Keeping the wheel deflected repeats the move automatically after the current move has completed.

Go To Position - Deflecting the wheel starts a move from the current position to one of the two predefined “teach” positions. The teach positions are specified in the *Preset Pos. 1* and *Preset Pos. 2* parameters, and are measured in number of steps from the home position.

Wheel Direction

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.

Direction Sense Positive - Upwards rotation 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.

Direction Sense Negative - Upwards rotation of the wheel results in a negative motion (i.e. decreased position count).

Display Brightness

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 *Active Level* 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 *Timeout (min)* parameter has elapsed. The time interval is specified in minutes in the range 0 (never dimmed) to 480. The dim level is set in the *Idle Level* parameter, as a value from 0 (Off) to 10 (brightest) but is also limited by the *Active Value* parameter if this is lower.

Persist Settings to Hardware - Many of the parameters that can be set for the DC 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, and trigger 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.



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 APTUser, the default APTServer settings will be loaded at boot up, even if the 'Persist Settings' option has been checked.

Triggering Introduction

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

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

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

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.

Input Trigger Modes

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

Trig In Rel. Move - Input trigger for relative move.

Trig In Abs. Move - Input trigger for absolute move.

Trig In Home - Input trigger for home move.

When the trigger mode is selected to *Trig In Rel Move* or *Trig In Abs Move*, the relative distance or absolute position to move, can be entered in the *Relative Move Dist* and *Absolute Move Pos.* parameters.

Output Trigger Modes

When the *Trig 1 Mode* and *Trig 2 Mode* parameters are configured as outputs, the TRIG ports can be used as a general purpose digital output, or to indicate motion status or to produce a trigger pulse at configurable positions as follows:

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

Trig Out In Motion - Trigger output active (level) when motor 'in motion'. The output trigger goes high (5V) or low (0V) (as set in the Trig 1. Polarity and Trig. 2 Polarity parameters) when the stage is in motion.

Trig Out Max Vel - Trigger output active (level) when motor at 'max velocity'.

Trig Out Pos. Steps Fwd - 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.

Trig Out Pos. Steps Rev - 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.

Trig Out Pos. Steps 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 be greyed out.

In the last three modes described above, the controller outputs a configurable number of pulses (set in the *Num. Pulses Fwd* and *Num. Pulses Rev* parameters), of configurable width (*Trig Pulse Width*), when the actual position of the stage matches the position values configured as the Start Position and Position Interval (*Start Pos. Fwd/Start Pos. Rev. and Pos Interval Fwd/Pos Interval Rev*). These modes allow external equipment to be triggered at exact position values.

The position pulses are generated by dedicated hardware, allowing a very low latency of less than 1 usec. The low latency of this triggering mode provides a very precise indication of a position match (assuming a stage velocity of 10 mm/sec, the less than 1 usec latency would in itself only result in a 10 nm position uncertainty, which is normally well below the accuracy limitations of the mechanics.)

Using the last three modes above, position triggering can be configured to be unidirectional (*Trig Out Pos. Steps Fwd* or *Trig Out Pos. Steps Rev*) or bidirectional (*Trig Out Pos. Steps Both*). In bidirectional mode the forward and reverse pulse sequences can be configured separately. A cycle count setting (*Num. of Move*

Cycles) allows the uni- or bidirectional position triggering sequence to be repeated a number of times.

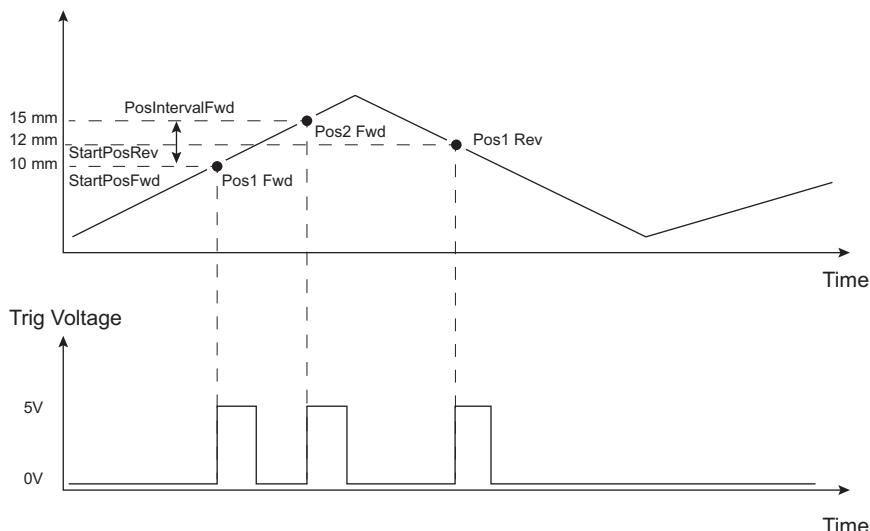


Fig. 6.7 Position Steps Triggering

Example for a move from 0 to 20 mm and back.

In forward direction: The first trigger pulse occurs at 10 mm (StartPosFwd), the next trigger pulse occurs after another 5 mm (PosIntervalFwd), the stage then moves to 20 mm.

In reverse direction: The next trigger occurs when the stage gets to 12 mm.

Note that position triggering can only be used on one TRIG port at a time, as there is only one set of position trigger parameters.

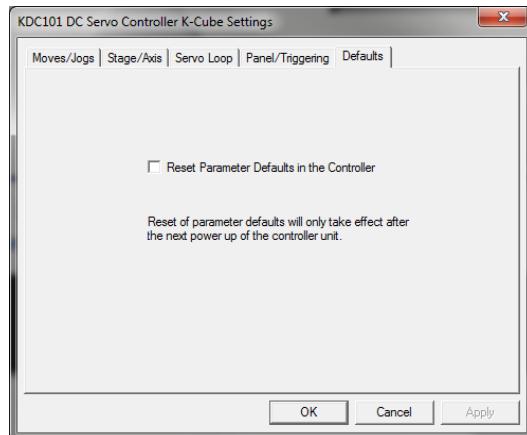
Triggering Polarity

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

6.3.5 Defaults Tab



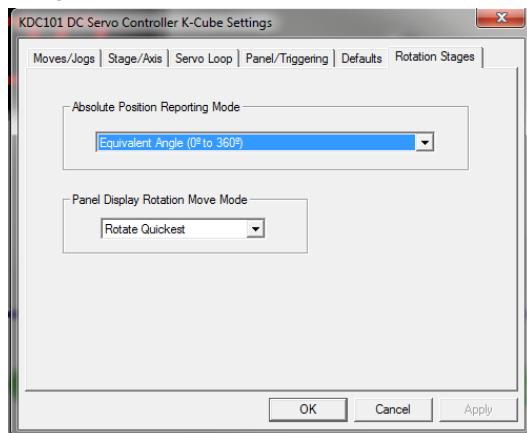
If adjustment of the parameter values previously described has resulted in unstable or unsatisfactory system response, this tab can be used to reset all parameter values to the factory default settings.

To restore the default values:

- 1) Click the 'Reset Parameter Defaults in the Controller' check box,
- 2) Click OK.

The driver must then be power cycled before the default values can take effect.

6.3.6 Rotation StagesTab



Absolute Position Reporting Mode

This setting relates to the way in which the angular position is displayed on the GUI panel. There are two options:

Equivalent Angle 0 to 360 degrees – The maximum displayed position is 359.99°. If a stage is driven past the 360° rotation point, the display reverts back to zero and counts up to 360° again.

Total Angle (360 x Num Revs + Angular Offset) – The total angular rotation is displayed, e.g. for a movement of two full rotations plus 10°, the display will show 730°.

Note. The following parameters are applicable only if the Absolute Position Reporting Mode is set to ‘Equivalent Angle 0 to 360 degrees’.

Panel Display Rotation Move Mode

This setting specifies the move direction. There are three options:

Rotate Positive – The move is performed in a positive direction

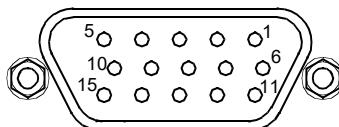
Rotate Negative - The move is performed in a negative direction

Rotate Quickest - The move is performed in the quickest direction

Appendix A Rear Panel Connector Pinout Detail

A.1 Rear Panel Motor Control Connector

The 'Motor' connector provides connection to the DC servo motor actuator. The pin functions are detailed in Fig. A.1



Pin	Description	Pin	Description
1	Ground	9	Ident In
2	Forward Limit Switch*	10	5V Encoder Supply
3	Reverse Limit Switch*	11	Encoder Channel A
4	Not Connected	12	Not Connected
5	Motor -	13	Encoder Channel B
6	Not Connected	14	Not Connected
7	Motor +	15	Not Connected
8	Not Connected		

* For third part actuators, the action of the limit switch on contact (i.e. switch open or switch close) is set in the settings panel, see Section 6.3.2.

Fig. A.1 MOTOR I/O Connector Pin Identification

Caution

DO NOT connect a motor actuator while the K-Cube is powered up.
Only use motor drive cables supplied by Thorlabs, other cables may have incompatible wiring.

Please contact tech support for details on use with Thorlabs legacy Z6 series DC Servo Motors.

Appendix B Preventive Maintenance



Warning



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

B.1 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



Warning



Disconnect the power supply before cleaning the unit.

Never allow water to get inside the case.

Do not saturate the unit.

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

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

Appendix C Specifications and Associated Products

C.1 Specifications

Parameter	Value
Motor Output	
Motor Drive Voltage	±12 to ±15V (Depending on Supply)
Motor Drive Current	150mA (Cont) >250 mA (peak)
Motor Drive Type	8-bit Sign/Magnitude PWM
Control Algorithm	Digital PID Filter (16bit)
Position Feedback: Quadrature Encoder (QEP) Input	5V Single Ended
Encoder Feedback Bandwidth	750 kHz
Position Counter	32-bit
Operating Modes	Position, Velocity
Velocity Profile	Trapezoidal
Motor Drive Connector (15 Way D-Type)	
Motor Drive Outputs	+ve & -ve
Quadrature Encoder (QEP) Input	Single Ended
Limit Switch Inputs	Forward, Reverse (+ Common Return)
Encoder Supply	5V
Front Panel Controls	
Sprung Potentiometer Wheel	Bidirectional Velocity Control, Forward/Reverse Jogging or Position Presets
Input Power Requirements	
Voltage	15V Regulated DC
Current	500mA (peak)
General Data	
Housing Dimensions (W x D x H) (excluding buttons and baseplate)	60 x 60 x 47mm (2.36" x 2.36" x 1.85")
USB Connector Type	USB 3.0
USB Connection Speed	USB 1.1 Full Speed (12 Mbps)
Weight	170g (6.0 oz)

Recommended Motor Requirements	
Peak Power	2.5W
Rated Current	10mA to 200mA (Nominal)
Motor Type	Brushed DC
Coil Resistance	5 to 50Ω
Position Control	Closed loop Encoder

C.2 Associated Products

Product Name	Part Number
6mm DC Servo Motor Actuator, 1/4"-80	Z806
6mm DC Servo Motor Actuator, 1/4"-80, Vacuum Rated	Z806V
12mm DC Servo Motor Actuator, 1/4"-80,	Z812
12mm DC Servo Motor Actuator, 3/8" Barrel Attachment	Z812B
12mm DC Servo Motor Actuator, 1/4"-80, Vaccuum Rated	Z812V
12mm DC Servo Motor Actuator, Vaccuum Rated, 3/8" Barrel Attachment	Z812BV
25mm DC Servo Motor Actuator, 3/8" Barrel Attachment,	Z825B
25mm DC Servo Motor Actuator, Vaccuum Rated, 3/8" Barrel Attachment	Z825BV
3-Channel K-Cube Controller USB Hub	KCH301
6-Channel K-Cube Controller USB Hub	KCH601
Single Way Power Supply	KPS101
8-way Power Supply	TPS008

Appendix D Motor Control Method Summary

The 'Motor' ActiveX Control provides the functionality required for a client application to control one or more of the APT series of motor controller units.

To specify the particular controller being addressed, every unit is factory programmed with a unique 8-digit serial number. This serial number is key to the operation of the APT Server software and is used by the Server to enumerate and communicate independently with multiple hardware units connected on the same USB bus. The serial number must be specified using the HWSerialNum property before an ActiveX control instance can communicate with the hardware unit. This can be done at design time or at run time. Note that the appearance of the ActiveX Control GUI (graphical user interface) will change to the required format when the serial number has been entered.

The Methods and Properties of the Motor ActiveX Control can be used to perform activities such as homing stages, absolute and relative moves, and changing velocity profile settings. A brief summary of each method and property is given below, for more detailed information and individual parameter descriptions please see the on-line help file supplied with the APT server.

Methods

DeleteParamSet	Deletes stored settings for specific controller.
DisableHWChannel	Disables the drive output.
DoEvents	Allows client application to process other activity.
EnableHWChannel	Enables the drive output.
GetAbsMovePos	Gets the absolute move position.
GetAbsMovePos_AbsPos	Gets the absolute move position (returned by value).
GetBLashDist	Gets the backlash distance.
GetBLashDist_BLashDist	Gets the backlash distance (returned by value).
GetButtonParams	Gets the front panel button settings.
GetCtrlStarted	Gets the ActiveX Control started flag.
GetDispMode	Gets the GUI display mode.
GetHomeParams	Gets the homing sequence parameters.
GetHomeParams_HomeVel	Gets the homing velocity parameter (returned by value).
GetHomeParams_ZeroOffset	Gets the homing zero offset parameter (returned by value).

GetHWCommsOK	Gets the hardware communications OK flag.
GetHWLimSwitches	Gets the limit switch configuration settings.
GetIndicatorLEDMode	Gets the front panel indication LED operating mode.
GetJogMode	Gets the jogging button operating modes.
GetJogMode_Mode	Get the jogging button operating mode (returned by value).
GetJogMode_StopMode	Gets the jogging button stopping mode (returned by value).
GetJogStepSize	Gets the jogging step size.
GetJogStepSize_StepSize	Gets the jogging step size (returned by value).
GetJogVelParams	Gets the jogging velocity profile parameters.
GetJogVelParams_Accn	Gets the jogging acceleration parameter (returned by value).
GetJogVelParams_MaxVel	Gets the jogging maximum velocity parameter (returned by value).
GetKCubePanelParams	Gets the operating parameters of the velocity wheel on the top panel
GetKCubePosTriggerParams	Gets operating parameters used when the triggering mode is set to a trigger out position steps mode
GetKCubeTriggerParams	Gets the operating parameters of the TRIG1 and TRIG2 connectors on the front panel.
GetMotorParams	Gets the motor gearing parameters.
GetPIDParams_Deriv	Gets the servo control loop derivative parameter (DC servo controllers - returned by value).
GetPIDParams_Int	Gets the servo control loop integration parameter (DC servo controllers - returned by value).
GetPIDParams_Prop	Gets the servo control loop proportional parameter (DC servo controllers - returned by value).
GetPosition	Gets the current motor position.
GetPosition_Position	Gets the current motor position (returned by value).
GetPositionEx	Gets the current motor position.
GetPositionEx_UncalibPosition	Gets the current uncalibrated motor position (returned by value).
GetPositionOffset	Gets the motor position offset.
GetPotParams	Gets the velocity control potentiometer parameters (Cube drivers).
GetRelMoveDist	Gets the relative move distance.
GetRelMoveDist_RelDist	Gets the relative move distance (returned by reference).

GetStageAxis	Gets the stage type information associated with the motor under control.
GetStageAxisInfo	Gets the stage axis parameters.
GetStageAxisInfo_MaxPos	Gets the stage maximum position (returned by value).
GetStageAxisInfo_MinPos	Gets the stage minimum position (returned by value).
GetStatusBits_Bits	Gets the controller status bits encoded in 32 bit integer (returned by value).
GetVelParamLimits	Gets the maximum velocity profile parameter limits.
GetVelParams	Gets the velocity profile parameters.
GetVelParams_Accn	Gets the move acceleration (returned by value).
GetVelParams_MaxVel	Gets the move maximum velocity (returned by value).
Identify	Identifies the controller by flashing unit LEDs.
LLGetStatusBits	Gets the controller status bits encoded in 32 bit integer.
LLSetGetPIDParams	Sets or Gets the servo control loop PID parameters (DC servo controllers).
LoadParamSet	Loads stored settings for specific controller.
MoveAbsolute	Initiates an absolute move.
MoveAbsoluteEnc	Initiates an absolute move with specified positions for encoder equipped stages.
MoveAbsoluteEx	Initiates an absolute move with specified positions.
MoveAbsoluteRot	Initiates an absolute move with specified positions for rotary stages.
MoveHome	Initiates a homing sequence.
MoveJog	Initiates a jog move.
MoveRelative	Initiates a relative move.
MoveRelativeEnc	Initiates a relative move with specified distances for encoder equipped stages.
MoveRelativeEx	Initiates a relative move with specified distances.
MoveVelocity	Initiates a move at constant velocity with no end point.
SaveParamSet	Saves settings for a specific controller.
SetAbsMovePos	Sets the absolute move position.
SetBLashDist	Sets the backlash distance.
SetButtonParams	Sets the front panel button settings (Cube drivers).

SetDispMode	Sets the GUI display mode.
SetHomeParams	Sets the homing sequence parameters.
SetHWLimSwitches	Sets the limit switch configuration settings.
SetIndicatorLEDMode	Sets the front panel indication LED operating modes (Cube drivers).
SetJogMode	Sets the jogging button operating modes.
SetJogStepSize	Sets the jogging step size.
SetJogVelParams	Sets the jogging velocity profile parameters.
SetKCubePanelParams	Sets the operating parameters of the velocity wheel on the top panel
SetKCubePosTriggerParams	Sets operating parameters used when the triggering mode is set to a trigger out position steps mode
SetKCubeTriggerParams	Sets the operating parameters of the TRIG1 and TRIG2 connectors on the front panel of the unit.
SetMotorParams	Sets the motor gearing parameters.
SetPositionOffset	Sets the motor position offset.
SetPotParams	Sets the velocity control potentiometer parameters
SetRelMoveDist	Sets the relative move distance.
SetStageAxisInfo	Sets the stage axis parameters.
SetVelParams	Sets the velocity profile parameters.
ShowSettingsDlg	Display the GUI Settings panel.
StartCtrl	Starts the ActiveX Control (starts communication with controller)
StopCtrl	Stops the ActiveX Control (stops communication with controller)
StopImmediate	Stops a motor move immediately.
StopProfiled	Stops a motor move in a profiled (deceleration) manner.

Properties

APTHelp	Specifies the help file that will be accessed when the user presses the F1 key. If APTHelp is set to 'True', the main server helpfile MG17Base will be launched.
DisplayMode	Allows the display mode of the virtual display panel to be set/read.
HWSerialNum	specifies the serial number of the hardware unit to be associated with an ActiveX control instance.

Appendix E DC Motor Operation - Background

E.1 How A DC Motor Works

E.1.1 General Principle

A DC motor works by converting electric power into mechanical energy (movement). This is achieved by forcing current through a coil and producing a magnetic field, which in turn, spins the motor.

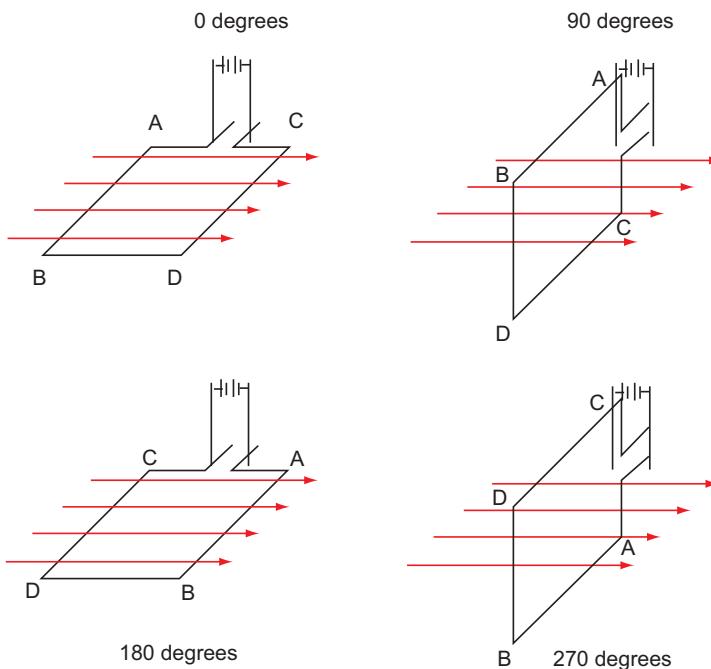


Fig. E.1 DC Motor Operation

To describe the operation of a DC motor, consider the single coil example shown above. In this diagram, current is forced through the coil via sliding contacts (brushes) that are connected to the voltage source. The brushes are located on the end of the coil wires and make a temporary electrical connection with the DC supply. When current is flowing, a magnetic field is set up as shown.

At 0° rotation, the brushes are in contact with the voltage source and current is flowing. The current that flows through the wire from A to B interacts with the magnetic field and produces an upward force. The current that flows from C to D has a similar effect, but because the flow is in the opposite direction with respect to the magnetic field, the force is in the downward direction.

Both forces are of equal magnitude. At 180°, the same phenomenon occurs, but segment A-B is forced down and C-D is forced up. In the 90° and 270° positions, the brushes are not in contact with the voltage source and no force is produced. In these two positions, the rotational kinetic energy of the motor keeps it spinning until the brushes regain contact. In reality, dc motors have several such coils, wound onto an armature, which produces a more even torque. The magnetic field is provided by an electromagnet.

E.1.2 Positive and Negative Moves

Positive and *negative* are used to describe the direction of a move. A positive move means a move from a smaller absolute position to a larger one, a negative move means the opposite.

In the case of a linear actuator, a positive move takes the platform of the stage further away from the motor.

In a rotational stage, a positive move turns the platform clockwise when viewed from above.

E.1.3 Velocity Profiles

To prevent the motor from stalling, it must be ramped up gradually to its maximum velocity. Certain limits to velocity and acceleration result from the torque and speed limits of the motor, and the inertia and friction of the parts it drives.

The motion employed is described by a trapezoidal velocity profile, reflecting the shape of the velocity vs. time graph (see Fig. E.2.), thereby driving the stage to its destination as quickly as possible, without causing it to stall or lose steps.

The stage is ramped at acceleration 'a' to a maximum velocity 'v'. As the destination is approached, the stage is decelerated at 'a' so that the final position is approached slowly in a controlled manner.

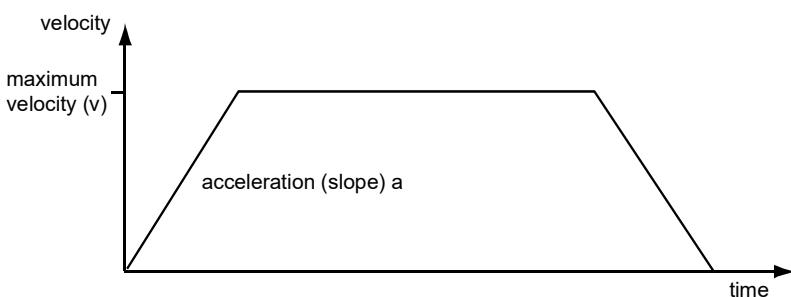


Fig. E.2 Graph of a trapezoidal velocity profile

E.2 Positioning a Stage

E.2.1 General

Whenever a command is received to move a stage, the movement is specified in motion units, (e.g. millimetres). This motion unit value is converted to encoder counts before it is sent to the stage by the APT software.

Each motor in the system has an associated electronic counter in the controller, which keeps a record of the net number of encoder counts moved. If a request is received to report the position, the value of this counter is converted back into motion units.

E.2.2 Home position

When the system is powered up, the position counters in the controller are all set to zero and consequently, the system has no way of knowing the position of the stage in relation to any physical datum.

A datum can be established by sending all the motors to their 'Home' positions. The 'Home' position is set during manufacture and is determined by driving the motor until the negative limit switch is reached and then driving positively a fixed distance (zero offset). When at the Home position, the counters are reset to zero thereby establishing a fixed datum that can be found even after the system has been switched off.

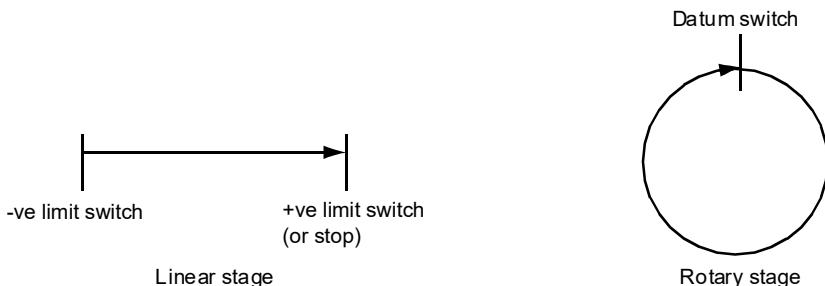
See Section 5.3. for details on performing a Home move.

E.2.3 Limit Switches

A linear stage moves between two stops, and movement outside these limits is physically impossible. Linear stages can include stages that control the angle of a platform within a certain range, although the movement of the platform is not really linear but angular. Rotary stages can rotate indefinitely, like a wheel.

Linear and rotary stages can contain microswitches that detect certain positions of the stage, but they differ in the way these switches are used.

All linear stages have a -ve limit switch, to prevent the stage from accidentally being moved too far in the -ve direction - see Fig. E.3. Once this switch is activated, movement stops. The switch also provides a physical datum used to find the Home position. Some linear stages and actuators also have a +ve limit switch (such as the ZST range of actuators), whereas others rely on a physical stop to halt the motion in the positive direction. A rotary stage has only one switch, used to provide a datum so that the Home position can be found. Movement is allowed right through the switch position in either direction

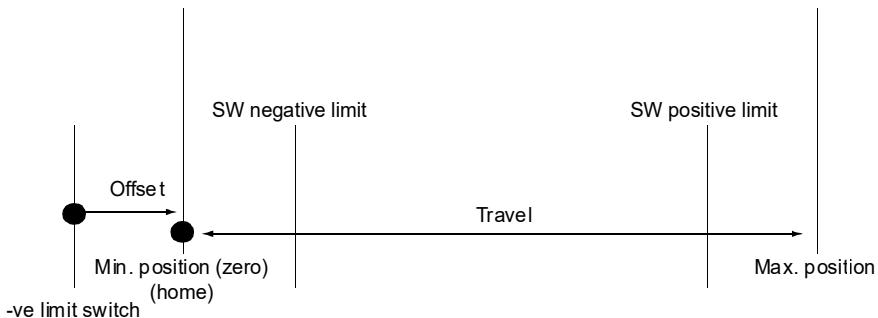
**Fig. E.3 Stage limit switches**

E.2.4 Minimum and Maximum Positions

These positions are dependent upon the stage or actuator to which the motors are fitted, and are defined as the minimum and maximum useful positions of the stage relative to the 'Home' position - see Fig. E.4.

The distance from the Minimum position to the Maximum position is the 'useful travel' of the stage. It is often the case that the Minimum position is zero. The Home and Minimum positions then coincide, with movement always occurring on the positive side of the Home position.

Rotary stages have effectively no limits of travel. The Minimum and Maximum positions are conventionally set to 0 and 360 degrees respectively. When the position of a rotary stage is requested, the answer will be reported as a number between 0 and 360 degrees, measured in the positive direction from the Home position.

**Fig. E.4 Minimum and Maximum Positions**

E.3 Error Correction

E.3.1 Backlash correction

The term *backlash* refers to the tendency of the stage to reach a different position depending on the direction of approach.

Backlash can be overcome by always making the last portion of a move in the same direction, conventionally the positive direction. Consider the situation in Fig. E.5, a *positive* move, from 10 to 20 mm, is carried out as one simple move, whereas a *negative* move, from 20 to 10 mm, first causes the stage to overshoot the target position and then move positively through a small amount.

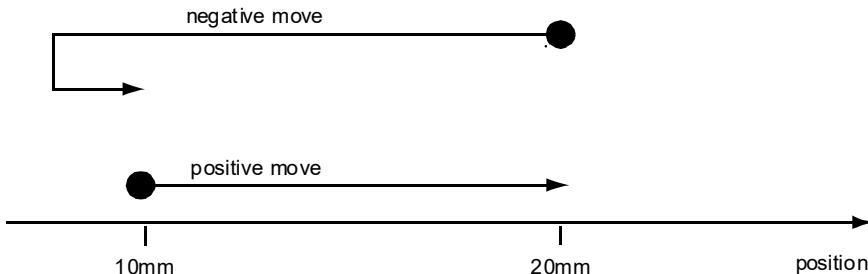


Fig. E.5 Backlash correction

The particular stage selection will usually have this type of ‘backlash correction’ enabled as its default mode of operation, but it can be overridden if the overshoot part of the move is unacceptable for a particular application.

See Chapter 6 Software Reference, Move/Jogs Tab for details on setting the backlash correction.

Appendix F Regulatory

F.1 Declarations Of Conformity

F.1.1 For Customers in Europe

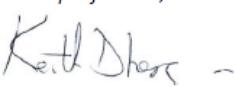
See Section F.2.

F.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.

F.2 Certificate of Conformity

 THORLABS www.thorlabs.com							
EU Declaration of Conformity <i>in accordance with EN ISO 17050-1:2010</i>							
<p>We: Thorlabs Ltd.</p> <p>Of: 1 St. Thomas Place, Ely, CB7 4EX, United Kingdom</p> <p><i>in accordance with the following Directive(s):</i></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">2004/108/EC</td> <td>Electromagnetic Compatibility (EMC) Directive</td> </tr> <tr> <td>2011/65/EU</td> <td>Restriction of Use of Certain Hazardous Substances (RoHS)</td> </tr> </table> <p><i>hereby declare that:</i></p> <p>Model: KDC101</p> <p>Equipment: Kinesis Brushed Motor Controller</p> <p><i>is in conformity with the applicable requirements of the following documents:</i></p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">EN 61326-1</td> <td>Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements</td> <td style="width: 30%; text-align: right;">2013</td> </tr> </table> <p><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></p> <p style="padding-left: 20px;">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</p> <p><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></p> <p>Signed: </p> <p>Name: Keith Dthese</p> <p>Position: General Manager</p> <p>On: 17 December 2015</p> <p>EDC - KDC101 -2015-12-17</p> <p style="text-align: right;">CE</p>	2004/108/EC	Electromagnetic Compatibility (EMC) Directive	2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)	EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013
2004/108/EC	Electromagnetic Compatibility (EMC) Directive						
2011/65/EU	Restriction of Use of Certain Hazardous Substances (RoHS)						
EN 61326-1	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements	2013					

Chapter 7 Thorlabs Worldwide Contacts

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



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



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