THORLABS

TSC001
T-Cube Solenoid Controller

User Guide

Contents

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 absorbent tissue. Do not allow spilled fluid to enter the internal mechanism.

Chapter 2   Overview and Setup

2.1   Introduction

The T-Cube Solenoid Controller (TSC001) is a new very compact single channel controller for easy manual and automated control of solenoid operated shutters, and other such devices. Designed to operate 15V solenoid actuated devices, this mini controller is fully featured, possessing an embedded DSP processor to provide a multitude of flexible operating modes.

Embedded software functionality allow this unit to be used to control solenoid devices manually (using panel buttons), automatically with DSP timed operation, or via external trigger signals for operation with third party equipment. A trigger out connection allows multiple T-Cube controllers to be connected together for multi-channel 'synchronised' operation.

For convenience the footprint of this unit has been kept to a minimum, measuring only 60mm x 60mm x 47mm (2.4" x 2.4" x 1.8") and with the facility to directly mount to the optical table. The manual controls for this unit are conveniently located on the upper surface such as the 'Mode' and 'Enable' buttons. The Mode button allows the various operating modes to be selected easily and the Enable button is used to initiate manual or automatic operation of the solenoid controller output. There is also a safety key switch and interlock plug fitted to this compact unit for use in laser safety applications .

Fig. 2.1   T-Cube Solenoid Controller

USB connectivity provides easy 'Plug and Play' PC controlled operation - multiple units can be connected to a single PC via standard USB hub technology or by using the new T-Cube Controller Hub (see Section 2.2.) 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 operating sequences in a short space of time. Custom 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.

For power, a compact multi-way power supply unit (TPS008) is available from Thorlabs allowing up to 8 T-Cube Drivers to be powered from a single mains outlet. This power supply unit is also designed to take up minimal space and can be mounted to the optical table in close proximity to the driver units, connected via short power leads. A single way wall plug supply (OPS001) is also available for powering a single T-Cube Driver.

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   T-Cube Controller Hub

As a further level of convenience when using the new T-Cube Controllers Thorlabs also offers the new T-Cube Controller Hub (TCH002). This product has been designed specifically with multiple T-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 T-Cube Controller Hub comprises a slim base-plate type carrier (375mm x 86mm x 21.5mm, 14.75" x 3.4" x 0.85") with electrical connections located on the upper surface to accept up to six T-Cubes.

Internally the Controller Hub contains a fully compliant USB 2.0 hub circuit to provide communications for all six T-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 up to six T-Cubes, requiring only a single power connection (from a separate supply unit TPS006 supplied by Thorlabs).

2.3   APT PC Software Overview

2.3.1   Introduction

As a member of the APT range of controllers, the TSC001 Solenoid Driver T-Cube 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 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.

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.

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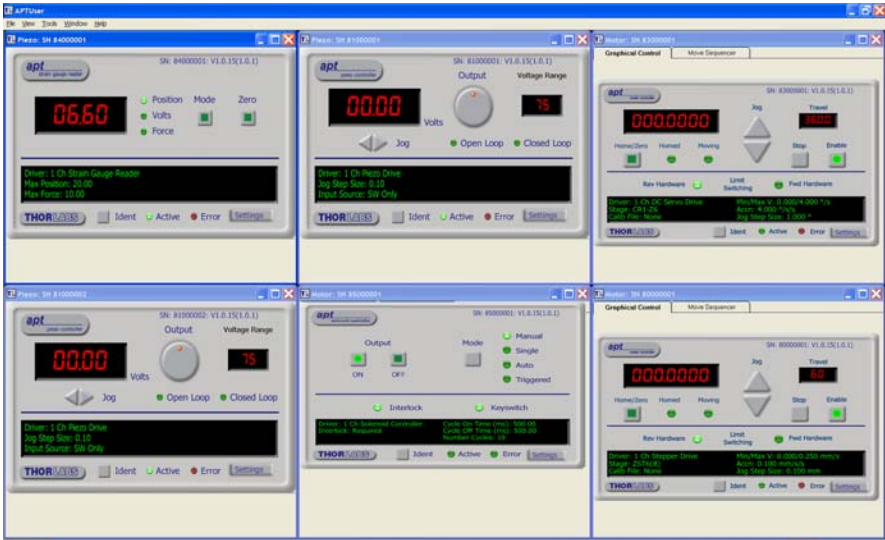
All basic operating parameters can be altered and, similarly, all operations (such as manual or automatic solenoid operation) can be initiated. Settings and parameter changes can be saved and loaded to allow multiple operating configurations to be created and easily applied.

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 customise and automate usage of the Solenoid Controller T-Cube, 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.

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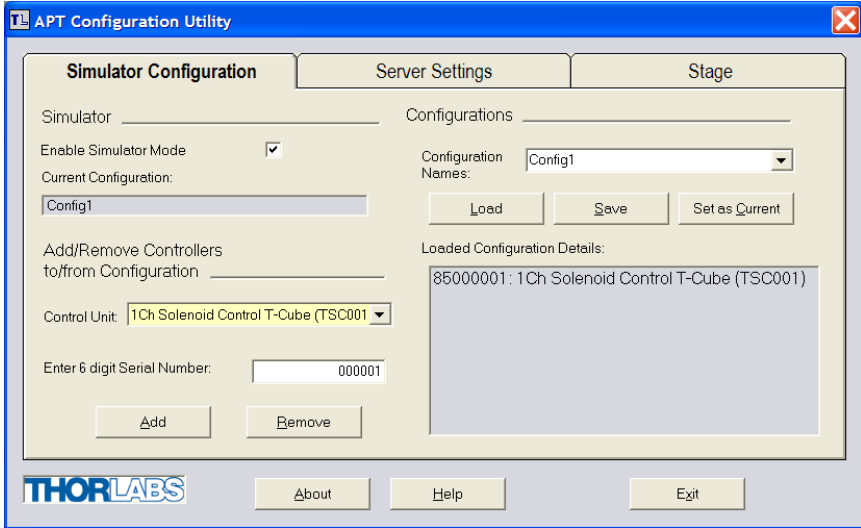
The APTConfig utility is provided as a convenient means for making these system wide settings and adjustments. Full details on using APTConfig are provided in the online help supplied with the utility.

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 Solenoid Driver T-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 T-Cube Solenoid Controller unit.

This Control provides a complete user graphical instrument panel to allow the 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 operation to be automated by a client application. The instrument panel reflects the current operating state of the controller unit to which it is associated (such as Interlock state). Updates to the panel take place automatically when a user is operating the unit manually.

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).
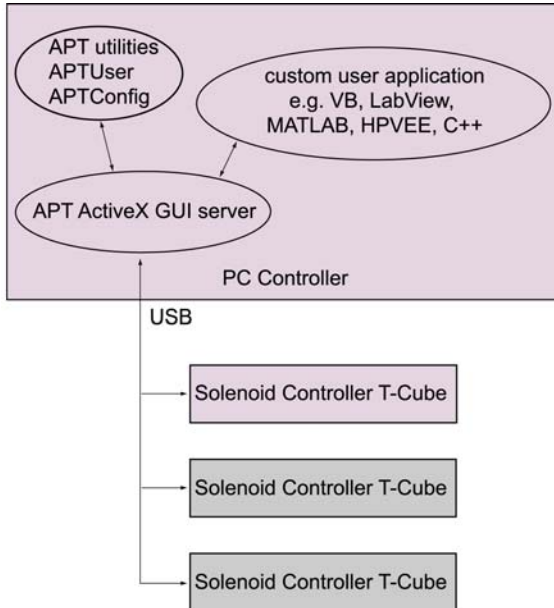
Fig. 2.2 System Architecture Diagram

Refer to the main APT Software online help file, APTServer.hlp, 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.

Additional software developer support is provided by the APT Support CD supplied with every APT controller. This CD contains a complete range of tutorial samples and coding hints and tips, together with handbooks for all the APT controllers.

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

Note
This section is applicable only if the T-Cube is to be used with a PC. If your application consists only of local operation via the T-Cube front face, proceed to Section 3.4. **When operating via a PC, direct user interaction with the solenoid controller is accomplished through intuitive graphical user interface panels (GUIs), which expose all key operating parameters and modes. The multitasking software architecture ensures that the graphical control panels always remain live, showing all current hardware activity.**

⚠ Caution ⚠
Some PCs may have been configured to restrict the users ability to load software, and on these systems the software may not install/run. If you are in any doubt about your rights to install/run software, please consult your system administrator before attempting to install.
If you experience any problems when installing software, contact Thorlabs on +44 (0)1353 654440 and ask for Technical Support.

DO NOT CONNECT THE CONTROLLER TO YOUR PC YET

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

3.2 Mechanical Installation

3.2.1 Environmental Conditions

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

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

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

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

3.2.2 Mounting Options

The T-Cube Solenoid Controller is shipped with a baseplate fitted, ready to be bolted to a breadboard, optical table or similar surface.

If desired, the baseplate can be removed and the unit can be stood on rubber feet - see Section 3.2.3.

For multiple cube systems, a USB controller hub (TCH002) is available - see Section 2.2. for further details. Full instructions on the fitting and use of the controller hub are contained in handbook *ha0146 T-Cube Controller Hub*, available from www.thorlabs.com.

⚠	**Caution**	⚠
	When siting the unit, it should be positioned so as not to impede the operation of the control panel buttons.	
	Ensure that proper airflow is maintained to the rear of the unit.	

3.2.3   Removing the Baseplate

The baseplate must be removed before the rubber feet (supplied) can be fitted, or the unit is connected to the USB controller hub..

Detail A
Baseplate attachment screws

Detail B
Baseplate removed and rubber feet fitted

Fig. 3.1   Removing The Baseplate

Using a hexagon key, remove the bolts securing the unit to the baseplate. Retain the bolts for future use if the baseplate is refitted.

4) Invert the unit.

5) Remove the backing paper from the rubber feet (supplied) taking care not to touch the exposed adhesive surface.

6) Position the feet as desired, then press and hold for a few seconds until the adhesive has bonded.

7) The unit may now be used freestanding, sitting on its rubber feet.

3.3   Electrical Installation

3.3.1   Supply Voltage and Current Requirements
Power supply requirements are detailed in the table below.

Supply	Minimum	Maximum	Max Operating Current
15V	+14.5V	+15.5V	1 A

3.3.2   Connecting a Solenoid
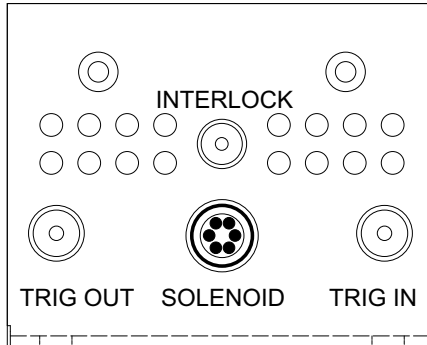
Fig. 3.2   Rear Panel Connections

The solenoid is connected via the 6-way HiRose connector, which is compatible with all Thorlabs solenoid-actuated shutters (refer to Appendix A   for details of pin outs)**.**

Two SMA connectors provide connection to Trigger In and Trigger Out signals. The TRIG IN is a 5V TTL type input. The TRIG OUT is an open collector pulled up to 5V.

The unit also features an Interlock connector, for use in laser safety applications - see Section 3.4.2.

3.3.3   Using The TCH002 Controller Hub
The TCH002 USB Controller Hub provides power distribution for up to six T-Cubes, and requires only a single power connection (from a separate supply unit TPS006 supplied by Thorlabs). Further details are contained in handbook *ha0146T   T-Cube Controller Hub*, available from www.thorlabs.com.

⚠	**Shock Warning**	⚠
	DO NOT PLUG A POWERED UP T-CUBE INTO THE TCH002 USB CONTROLLER HUB. Always ensure that all power is disconnected from the Solenoid Driver T-Cube AND the hub before the T-Cube is plugged into the hub. Failure to observe this precaution will seriously damage the T-Cube unit and could result in personal injury.	

3.3.4   Connecting To A Standalone Power Supply

Warning

The unit must be connected only to a DC supply of the rating detailed in Section 3.3.1. Connection to a supply of a different rating may cause damage to the unit and could result in injury to the operator. Thorlabs offers a compact, multi-way power supply unit (TPS008), allowing up to eight T-Cube Controllers to be powered from a single mains outlet. A single way wall plug supply (TPS001) for powering a single Driver T-Cube is also available.

Caution

The Solenoid Controller unit should not be connected to a 'live' external power supply. Always power up the unit by connecting its power supply to the mains. Similarly, to power down the unit, disconnect the power supply from the mains before disconnecting the unit.
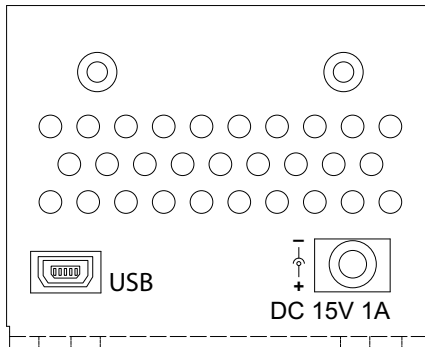
Fig. 3.3   Front Panel Power Supply Connector

1) Using the front panel connector as shown above, connect the unit to a regulated DC power supply of the rating detailed in Section 3.3.1.
2) Switch on the Power Supply unit.

3.4 Connect The Hardware

1) Perform the mechanical installation as detailed in Section 3.2.
2) Connect the solenoid to the Controller unit - see Section 3.3.2.

⚠️	**Warning**	⚠️
	IF USING THE TCH002 CONTROLLER HUB. During item (3), do not plug a the T-Cube unit into a powered up controller hub. Always ensure that all power is disconnected from the Solenoid Controller T-Cube AND the hub before the T-Cube is plugged into the hub. Failure to observe this precaution will seriously damage the T-Cube unit and could result in personal injury.	

3) Connect the Controller unit to the power supply - see Section 3.3.
4) Connect the INTERLOCK jack plug - seeSection 3.4.2.
5) Connect the PSU to the main supply and switch 'ON'.
6) Turn ON the key switch.
7) 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).

8) Windows^{TM} should detect the new hardware. Wait while Windows^{TM} installs the drivers for the new hardware - see the Getting Started guide for more information.
9) Run the APTUser utility
   Start/All Programs/Thorlabs/APT/APT User.
10) Your T-Cube Solenoid Controller is now ready for use.

3.4.1   Using an External Trigger

To use the external trigger, the unit must be set to *Triggered* mode - see Section 4.3.

In Triggered mode, a rising edge (logic high) on rear panel TRIG IN BNC input will open the shutter, which will remain open until a falling edge (logic low) is detected. In this way, the shutter can be opened and closed in relation to the duty cycle of the trigger input signal. The unit must be primed (i.e. the ENABLE button has been pressed) before the unit can respond to the external trigger.

> ⚠️ **Warning** ⚠️
>
> **In external triggering mode, the shutter is opened and closed under control of an external logic signal, connected to the SMA input marked "TRIG IN" on the rear panel. The way in which the unit responds when the 'TRIG IN' connector is open circuit differs between early and later models. This is particularly important in applications where a shutter is used to enable or disable a laser light source.**
>
> **Below serial number 85810830: the 'TRIG IN' SMA defaults to logic HIGH when there is nothing driving this input, i.e. if the TSC001 unit is enabled, the shutter will open.**
>
> **Serial number 85810830 and above: the 'TRIG IN' SMA defaults to logic LOW, so the trigger is disabled when the external input is open circuit (disconnected), i.e. the solenoid is disabled/closed.**
> **The ENABLE button must be pressed for the shutter opening to be enabled, so a disconnected input in itself cannot cause the shutter to open. However, understanding this feature of the TSC001 is particularly important for customers using the TSC001 cube in an application where the shutter opening due to a disconnected EXT TRIG input can have safety implications.**

3.4.2   Using the Safety Interlock

To comply with laser safety regulations, the Solenoid Controller T-Cube is fitted with a remote INTERLOCK connector located on the rear panel (see Fig. 3.2). A short circuit must be applied across the terminals of this connector before the unit can be enabled.

> ⚠️ **Caution** ⚠️
>
> **If it is controlled externally, the INTERLOCK contact is taking solenoid-type currents. This current is dependent upon the solenoid being driven but could as high as 2A peak.**

An INTERLOCK jack plug is supplied with the unit to close this connection. Alternatively, the contact can be controlled externally; the user can use a custom

3.5mm jackplug connected to a remote actuated (normally open) switch (e.g. an open door indicator), which must be closed before the unit can operate.

⚠	**Caution**	⚠

If the unit is being operated in a trigger mode, the interlock controls the output of the master unit in the normal way. However, if the interlock is removed from the master unit, the slave unit will still function unless its interlock is also removed.

3.5   Verifying Software Operation

3.5.1   Initial Setup

1) Install the APT software as detailed in Section 3.1.

2) Connect the Controller to the solenoid (see Section 3.3.) and the PC, then switch ON. Wait several seconds for the system to settle.

3) Run the APTUser utility and check that the Graphical User Interface (GUI) panel appears and is active.
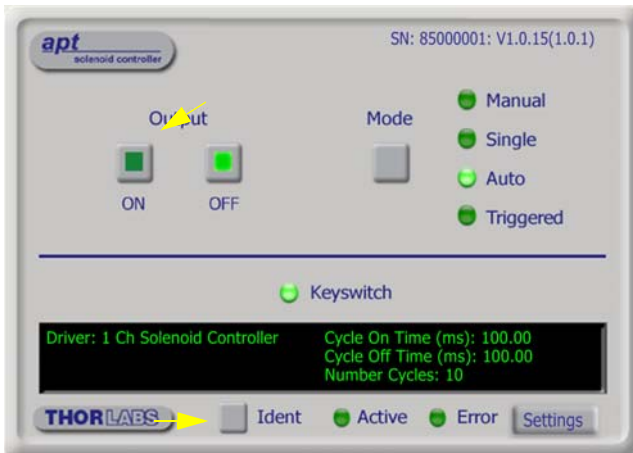
Fig. 3.4   Gui panel showing jog and ident buttons

4) Click the 'Ident' button. The Power LED on the control panel of the associated controller flashes. This is useful in multi-channel systems for identifying which channel is associated with which GUI.

5) Click the 'Mode' button until the 'Manual' LED is lit, then Click the ON and OFF Output buttons and check that the solenoid connected to the Solenoid Controller T-Cube responds.

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 5.3. or the *APTConfig* helpfile for detailed instructions.

Chapter 4 Standalone Operation

4.1 Introduction

The T-Cube Solenoid Controller (TSC001) is a new very compact single channel controller for easy manual and automated control of solenoid operated shutters, and other such devices. Designed to operate 15V solenoid actuated devices, this mini controller is fully featured, possessing an embedded DSP processor to provide a multitude of flexible operating modes.

Embedded software functionality allows this unit to be used to control solenoid devices manually (using panel buttons), automatically with DSP timed operation, or via external trigger signals for operation with third party equipment. A trigger out connection allows multiple T-Cube controllers to be connected together for multi-channel 'synchronised' operation.

The following brief overview explains how the front panel controls can be used.

4.2 Front Panel Controls and Indicators
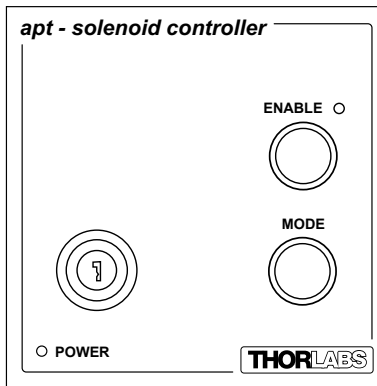
Fig. 4.1   Front Panel Controls and Indicators

Enable Button - Used to initiate manual or automatic operation of the solenoid controller output.

Enable LED - Lit when the unit is active or waiting for a trigger event.

Mode Button - Used to select the various operating modes - see Section 4.3.

Key Switch - A key-operated power switch.

POWER LED - Lit when power is applied to the unit.

Note
The ENABLE and POWER LEDs will flash when the 'Ident' button is clicked on the APT Software GUI panel - see Section 6.2. for further details.

4.3   Using the Front Panel Buttons

The buttons on the front of the unit are used to operate the solenoid-actuated device and to switch between operating modes as follows.

4.4   Mode Button

Press and release to switch between modes. The 'ENABLE LED flashes to indicate the selected mode as described below.

Manual - Indicated by one flash of the ENABLE LED. In this mode, operation of the solenoid is via the front panel 'Enable' button, (or by the 'Output' buttons on the GUI panel).

Single - Indicated by two flashes of the ENABLE LED. In this mode, the solenoid will open and close each time the front panel 'Enable' button is pressed, (or the 'Output ON' button on the GUI panel is clicked). The ON and OFF times are entered in the 'Settings' panel - see Section 6.3.

Auto - Indicated by three flashes of the ENABLE LED. In this mode, the solenoid will open and close continuously after the front panel 'Enable' button is pressed, (or the 'Output ON' button on the GUI panel is clicked). The ON and OFF times, and the number of cycles performed, are those entered in the 'Settings' panel - see Section 6.3.

Triggered - Indicated by four flashes of the ENABLE LED. In Triggered mode, a rising edge (logic high) on rear panel TRIG IN BNC input will open the shutter, which will remain open until a falling edge (logic low) is detected. In this way, the shutter can be opened and closed in relation to the duty cycle of the trigger input signal. The unit must be primed (i.e. the ENABLE button has been pressed) before the unit can respond to the external trigger.

⚠	**Caution**	⚠
	The operating mode cannot be switched when the Trigger port is primed. When operating in Trigger mode, the unit must be unprimed by pressing the enable button before the operating mode can be switched. Failure to follow this procedure will cause the unit to crash and a power cycle will be required.	

In all modes of operation, pressing the ENABLE button while the unit is "enabled" will disable the solenoid.

⚠	Caution	⚠

The way in which the MODE setting is saved between power cycles differs between early and later models.

Below serial number 85810830, the MODE setting (e.g. Manual, Auto, Triggered) can only be persisted via the 'Settings' panel in the GUI - see Section 6.3.1.

Serial number 85810830 and above, the last used MODE setting is remembered automatically between power cycles and the unit powers up automatically in the last used operating mode

4.4.1 Changing the Output Trigger Sense

Note

The default mode of trigger operation is that the trigger input and trigger output have opposite senses, i.e. when the trigger input goes high, the trigger output goes low and vise versa.

The output trigger sense can be changed at power up by holding down the MODE button until the green POWER LED is lit, which will toggle the sense of the output trigger.

To toggle the sense again, power cycle the unit and hold down the MODE button until the POWER LED is lit.

To save the trigger sense when the unit is power cycled, click the Persist Settings checkbox in the settings panel - see Section 6.3.1.

4.5 Enable button

Press and release to toggle the output between ON and OFF.

4.6 Operation From The Front Panel

The following brief tutorial guides the user through a typical series of operations.

4.6.1 Preparation

1) Connect a solenoid actuated device (e.g. a Thorlabs SH05 Shutter) to the 'SOLENOID' connector on the rear panel of the unit.
2) Connect the INTERLOCK jack plug - see Section 3.4.2.
3) Connect the unit to a +15V DC power supply unit (PSU) - see Section 3.3.4.
4) Connect the unit to the PC USB bus - see Fig. 3.3
5) Switch ON the power to the PSU.
6) Turn ON the keyswitch.

4.6.2 Manual Mode

1) Press the Mode button to select Manual mode, i.e. the ENABLED LED flashes once.
2) Press the ENABLE button. The ENABLED LED is lit and the SH05 shutter opens.
3) Press the ENABLE button again. The ENABLED LED is extinguished and the SH05 shutter closes.

4.6.3 Auto Mode

1) Press the Mode button to select AUTO mode, i.e. the ENABLED LED flashes three times.
2) Press the ENABLE button. The ENABLED LED is lit and the SH05 shutter begins to open and close. Unless the default settings have been changed, the following settings apply:

   ON (Open) time: 1s

   OFF (Closed time: 1s

   Number of Cycles: 0 (i.e. infinite)

   See Section 6.3.1. for more information on these settings.
3) Press the ENABLE button again. The ENABLED LED is extinguished and the SH05 shutter closes.
4) Turn OFF the keyswitch.
5) Switch OFF the power to the PSU.

Chapter 5 PC Operation - Tutorial

The following brief tutorial guides the user through a typical series of moves and parameter adjustments performed using the PC based APT software.

5.1 Preparation

1) Connect a solenoid actuated device (e.g. a Thorlabs SH05 Shutter) to the 'SOLENOID' connector on the rear panel of the unit.
2) Connect the INTERLOCK jack plug - see Section 3.4.2..
3) Connect the unit to a +15V DC power supply unit (PSU) - see Section 3.3.4.
4) Connect the unit to the PC USB bus - see Fig. 3.3
5) Switch ON the power to the PSU.
6) Turn ON the keyswitch.

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 operating the solenoid/ shutter) can be initiated. Hardware configurations and parameter settings can be saved, which simplifies system set up whenever APT User is run up.
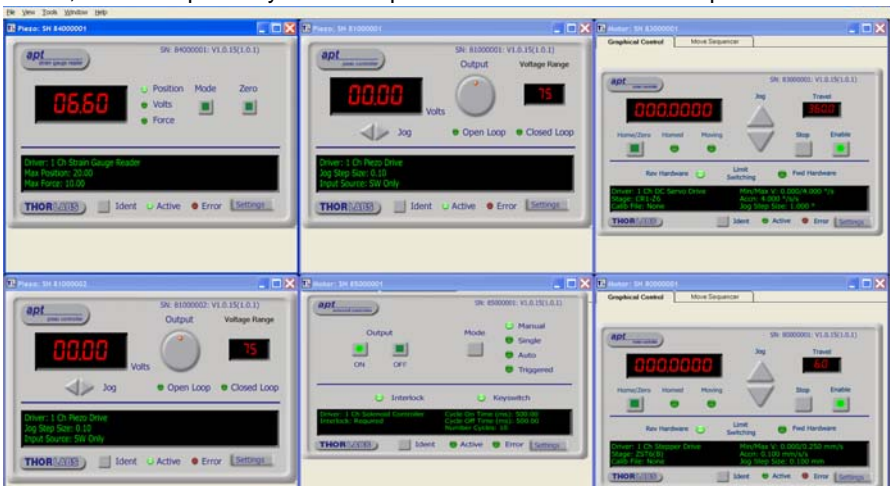

Fig. 5.1   Typical APT User Screen

1) Run the APT User program - Start/Programs/Thorlabs/APT/APT User.

2) The PC detects the hardware connected to the USB bus and the GUI panel for the Solenoid Controller is displayed. For an explanation of the GUI panel - see Section 6.2. For further details on the parameter values shown in the 'Settings' display - see Section 6.3..

Fig. 5.2   Solenoid Controller T-Cube Software GUI

The APT User utility will be used throughout the rest of this tutorial to interface with the Solenoid Controller T-Cube.

5.2.1   Setting Manual Mode
1) Press the Mode button until the Manual LED is lit.
2) Press the ON button. The SH05 shutter opens.
3) Press the OFF button. The SH05 shutter closes.

5.2.2   Setting Auto Mode
1) Press the Mode button to until the Auto LED is lit.
2) Press the ON button. The SH05 shutter begins to open and close. Unless the default settings have been changed, the following settings apply:

   ON (Open) time: 1s

   OFF (Closed) time: 1s

   Number of Cycles: 0 (i.e. infinite)

   See Section 6.3.1. for more information on these settings.
3) Press the OFF button. The SH05 shutter closes.

5.3   Creating a Simulated Configuration Using APT Config

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 colection 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/All Programs/Thorlabs/APT/APT Config.

2) Click the 'Simulator Configuration' tab.

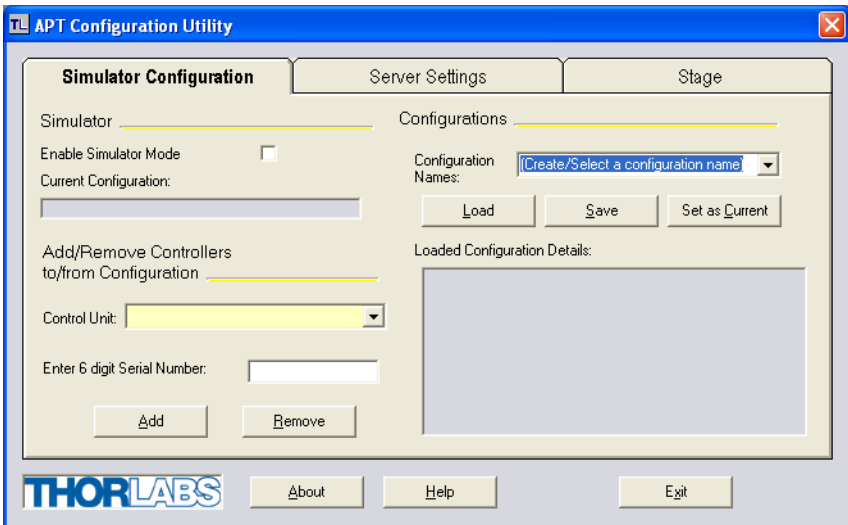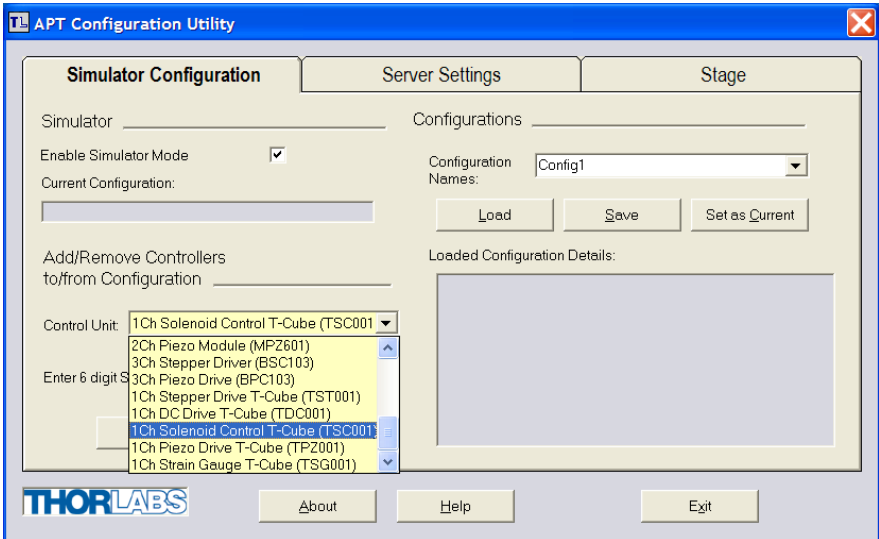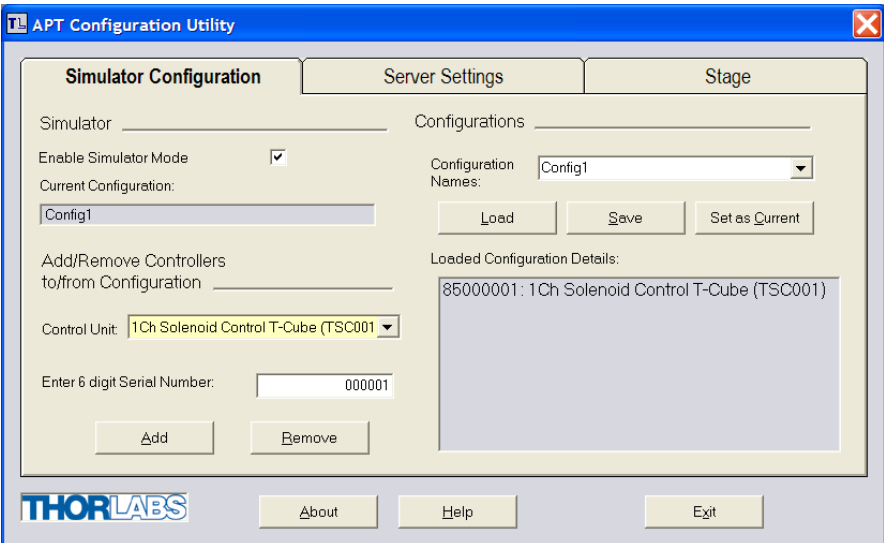**Fig. 5.3   APT Configuration Utility - Simulator Configuration Tab**

3) Enter 'Config1' 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 Solenoid Controller T-Cube (TSC001)'.

6) In the 'Enter 6 digit serial number' field, enter the serial number of your T-Cube Solenoid Controller.

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 Solenoid Controller T-Cube are:**   **85xxxxxx - 1 Ch Solenoid Controller T-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.

5.4 Introduction To Solenoid Controller Programming

The ActiveX functionality for the Solenoid Controller T-Cube is accessed via the APTMotor Control Object, and provides the functionality required for a client application to control a number of T-Cube Solenoid Controller units.

Every hardware unit is factory programmed with a unique 8-digit serial number. This serial number is key to 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 allocated using the *HWSerialNum* property, before an ActiveX control can communicate with the hardware unit. This can be done at design time or at run time.

The methods for the T-Cube Solenoid Controller unit can then be used to operate the solenoid device, and perform activities such as switching between operating modes.

Please see the *APTServer* Helpfile for more information

Chapter 6   Software Reference

6.1   Introduction

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

6.2   GUI Panel

The following screen shot shows the graphical user interface (GUI) displayed when accessing the Solenoid Controller T-Cube using the APTUser utility.

Fig. 6.1   Solenoid Controller T-Cube Software GUI

Note
The serial number of the Solenoid Controller T-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.

Output - these buttons are used to open and close the solenoid-actuated device. The action of these buttons is dependent upon the operating mode selected - see 'Mode'.

Mode - this button sets the operating mode of the unit as follows:

Manual - In this mode, operation of the solenoid is via the front panel 'Enable' button, or by the 'Output' buttons on the GUI panel.

Single - In this mode, the solenoid will open and close each time the front panel 'Enable' button is pressed, or the 'Output ON' button on the GUI panel is clicked. The ON and OFF times are entered in the 'Settings' panel - see Section 6.3.

Auto - In this mode, the solenoid will open and close continuously after the front panel 'Enable' button is pressed, or the 'Output ON' button on the GUI panel is clicked. The ON and OFF times, and the number of cycles performed, are those entered in the 'Settings' panel - see Section 6.3.

Triggered - In Triggered mode, a rising edge (logic high) on rear panel TRIG IN BNC input will open the shutter, which will remain open until a falling edge (logic low) is detected. In this way, the shutter can be opened and closed in relation to the duty cycle of the trigger input signal. The unit must be primed (i.e. the ENABLE button has been pressed) before the unit can respond to the external trigger.

In all modes of operation, pressing the ENABLE button (or GUI panel OFF button) while the unit is "enabled" will disable the solenoid.

Keyswitch LED - Lit when the key-operated power switch is turned on.

Settings display - shows the name of the associated T-Cube together with the following user specified settings:

Cycle On Time (ms) - The time which the solenoid is activated (i.e. the shutter/solenoid is open) 100ms to 100s

Cycle Off Time (ms) - The time which the solenoid is de-activated (i.e. the shutter/solenoid is closed) 100ms to 100s.

Number Cycles - The number of Open/Close cycles to perform when the unit is operating in 'Auto' mode 1 to 1,000,000. If set to '0' the unit cycles indefinately.

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

Ident - when this button is pressed, the ENABLE and POWER LEDs 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.

6.3   Settings Panel

When the 'Settings' button on the GUI panel is clicked, the 'Settings' window is displayed. This panel allows operating parameters, e.g. On and OFF times, to be modified. Note that these parameters also have programmable equivalents accessible through the ActiveX methods and properties on this Control (refer to the *Programming Guide* in the *APTServer helpfile* for further details and to Section 2.3.4. for an overview of the APT ActiveX controls).
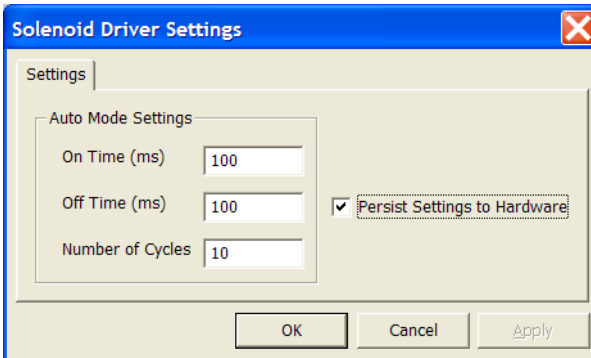
6.3.1   Settings Tab

Fig. 6.2   Solenoid Controller - Settings

Auto Mode Settings

On Time (ms) - The time which the solenoid is activated (i.e. the shutter/ solenoid is open) 100ms to 100s in 250μs steps.

Off Time (ms) - The time which the solenoid is de-activated (i.e. the shutter/ solenoid is closed) 100ms to 100s in 250μs steps.

Number of Cycles - The number of Open/Close cycles (0 to 1,000,000) to perform when the unit is operating in 'Auto' mode . If set to '0' the unit cycles indefinitely.

Note
If operating in 'Triggered' mode with the *Number of Cycles* parameter set to '0', then the solenoid ON and OFF times are defined respectively by the HIGH and LOW values of the trigger pulse.

Persist Settings to Hardware

The parameters described above, together with the 'Mode' parameter set via the GUI panel, 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 unit is being used manually in the absence of a PC and USB link. To save the settings to hardware, check the 'Persist Settings to Hardware' checkbox before clicking the 'OK button.

Appendix A   Rear Panel Connector Pinout Details

A.1   Rear Panel SOLENOID Connector

The 'SOLENOID' connector provides connection to the shutter, or other solenoid actuated device. The pin functions are detailed in Fig. A.1.

Pin	Description
1	Opto Anode (12V limited to 20mA)
2	Shutter Coil 15V Pulse, 10V steady state (0.4A max)
3	Shutter Coil Ground (When ON) Open CCT (When OFF)
4	Opto Cathode Ground
5	Opto Emitter Ground
6	Opto Collector (2.5V)

Fig. A.1 SOLENOID Connector Pin Identification

A.2   TRIG IN and TRIG OUT Connectors

The rear panel provides two SMA outputs for use in triggering applications. The TRIG IN is a 5V TTL type input. The TRIG OUT is an open collector, pulled up to 5V.

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 Parts

C.1   Specifications

Parameter	Value
Timing Resolution	250µs
Trigger Input/Output	TTL
On/Off Times	100ms to 10s
Maximum Repetition Rate	Up to 10Hz
Output Enable	Key Switch and Interlock Jack Plug
Operating Modes	
Manual	User Controlled On/Off
Single	DSP Controlled Single On/Off Cycle
Auto	DSP Controlled Multiple On/Off Cycles
Triggered	ExternallyTriggered On/Off
TRIG IN	SMA TTL Type 5V
TRIG OUT	SMA, Open Collector 5 V
Output (6 Way HiRose)	
Solenoid Drive	15V Pulse (10V Hold)
Position Sensor Feedback	Photodiode
Input Power Requirements	
Voltage	14.5 - 15.5 V Regulated DC
Current	1A Peak, 300mA Steady State
General	
Housing Dimensions (W x D x H)	60 x 60 x 47 mm (2.4" x 2.4" x 1.8")
Instrument Weight	160 g (5.5 oz)

C.2   Associated Products

Product Name	Part Number
T-Cube Controller USB Hub and Power Supply	TCH002
Single Way Power Supply	TPS001
8-way Power Supply	TPS008
1/2" Shutter	SH05

Appendix D   Motor Control Method Summary

In addition to providing the functionality required for a client application to control one or more of the APT series of motor controller units, the 'Motor' ActiveX Control also provides the functionality for the TSC001 T-Cube Solenoid Controller.

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.

A brief summary of the methods and properties applicable to the TSC001 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.
GetCtrlStarted	Gets the ActiveX Control started flag.
SC_Disable	Disables (turns off) the solenoid.
SC_Enable	Enables (turns on) the solenoid.
SC_GetCycleParams	Gets solenoid parameters for automated on/off operation.
SC_GetOperatingMode	Gets the solenoid operating mode.
SC_GetOPState	Gets the activity state of the solenoid.
SC_SetCycleParams	Sets solenoid parameters for automated on/off operation.
SC_SetOperatingMode	Sets the solenoid operating mode.
ShowSettingsDlg	Display the GUI Settings panel.
StartCtrl	Starts the ActiveX Control (starts communication with controller)
StopCtrl	Stops the ActiveX Control (stops communication with controller)

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.
HWSerialNum	specifies the serial number of the hardware unit to be associated with an ActiveX control instance.

Appendix E   Regulatory

E.1   Declarations Of Conformity

E.1.1   For Customers in Europe
See Section E.3.

E.1.2   For Customers In The USA
This equipment has been tested and found to comply with the limits for a Class A digital device, persuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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

E.2   Waste Electrical and Electronic Equipment (WEEE) Directive

E.2.1   Compliance
As required by the Waste Electrical and Electronic Equipment (WEEE) Directive of the European Community and the corresponding national laws, we offer all end users in the EC the possibility to return "end of life" units without incurring disposal charges.

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

Fig. 5.1   Crossed out "wheelie bin" symbol

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

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

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

E.2.2   Waste treatment on your own responsibility
If you do not return an "end of life" unit to the company, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

E.2.3   Ecological background
It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

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

E.3 CE Certificate

THORLABS
www.thorlabs.com

EU Declaration of Conformity

in accordance with EN ISO 17050-1:2010

We: Thorlabs Ltd.

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

in accordance with the following Directive(s):

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

hereby declare that:

Model: **TSC001**

Equipment: **T-Cube Solenoid Contoller**

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

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

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

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

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

Signed: On: 02 November 2015

Name: Keith Dhese

Position: General Manager   EDC - TSC001 -2015-11-02

$C\epsilon^{15}$

THORLABS

Appendix F   Thorlabs Worldwide Contacts

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

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