

Motion Control

apt™ Motion Control Electronics

Thorlabs' engineers have worked closely with customers, system integrators, and leading researchers to better understand their requirements for sophisticated yet easy-to-use motion control electronics and software. The result is the highly flexible apt™ (Advanced Positioning Technology) controller family. In addition to a stepper motor, DC motor, piezo controllers, a strain gauge reader, and a solenoid driver, we offer sophisticated feedback controllers (Nanotrak™) that fully optimize coupled optical powers automatically in a variety of alignment scenarios. There are three formats of controller to meet the performance requirements for a range of applications and budgets:

- Compact, Table-Mounted T-Cube™ apt™ Controllers (Pages 348-363)
- High-Power apt™ Benchtop Controllers (Pages 364-373)
- Modular Rack-Based apt™ Control Systems (Pages 374-379)

All the controllers are USB interfaced and supported by unified PC-based user and programming utilities (the apt™ software pages 380-382). This enables higher level custom applications to be constructed effectively and quickly using any combination of the apt™ controllers.

Features

- Highly Flexible and Easy to Use
- Manual and Software Control
- Common Software Interfaces
- Setup With Minimal Effort – Plug-and-Play
- 3 Formats Available: Tabletop T-Cubes™, High-Power Benchtop, and Rack-Based Systems
- Stepper Motor, DC Motor Controllers, Open- and Closed-Loop Piezo Drivers, Strain Gauge Reader, Shutter Controller, Auto-Alignment Controllers
- All USB Interfaced – All Software Included

The apt™ system software is described in more detail on page 380.

The following pages describe the range of apt™ controllers:

- T-Cube™ Controllers – Pages 348-363
- Benchtop Controllers – Pages 364-373
- Rack-Based Controllers – Pages 374-379



TST001



TCH002



TPZ001



BPC203



MDT693A



BSC103



MNA601



MMR601



MPZ601

T-Cube™ apt™ USB Controllers

The T-Cube™ range of controllers provides a highly functional, flexible, and expandable electronics platform in a cost-effective and compact format. Their footprint measures just 60mm x 60mm x 47mm (2.4" x 2.4" x 1.8"), making them ideal for optomechanical applications where the controller is required to be in close proximity to the apparatus on the optical table. Each T-Cube™ is equipped with local controls to allow convenient manual operation, as well as a USB interface for automated PC control. The supplied apt™ software is easy to use and exposes the full motion control capabilities of the T-Cube™ controllers, including simultaneous command of multiple controllers. The optional T-Cube™ hub can provide both power distribution and USB communications for up to six controllers.



Stepper Motor Driver TST001
Page 350



DC Servo Driver TDC001
Page 352



Solenoid Controller TSC001
Page 354



Piezo Driver TPZ001
Page 356



Strain Gauge Reader TSG001
Page 358



**NanoTrak™ Auto-Alignment
Controller TNA001**
Page 360



T-Cube™ USB Controller Hub TCH002
Page 362

Single Axis Stages

Multi-Axis Stages

Flexure Stage
AccessoriesMotorized
Mirror Mounts

Rotation Stages

Drive Electronics
& Auto-AlignmentActuators &
Adjusters

Brief Tutorials

Motion Control

Single Axis Stages

Multi-Axis Stages

Flexure Stage
Accessories

Motorized
Mirror Mounts

Rotation Stages

Drive Electronics
& Auto-Alignment

Actuators &
Adjusters

Brief Tutorials

T-Cube™ apt™ USB NanoTrak™ Auto-Alignment Controller (Page 1 of 2)

The T-Cube™ NanoTrak™ Controller represents the latest developments in automated optical alignment technology. It is designed for use in entry-level lower bandwidth photonics devices and fiber alignment and is ideal for low-volume device assembly, characterization, and mapping. This auto-alignment T-Cube™ unit is used together with a pair of external piezo amplifier channels (TPZ001 T-Cube™ Piezo Drivers) to provide a complete solution for manipulating piezo-actuated nanopositioning stages to align devices to the 10nm regime. Equipped with a direct FC/PC optical PIN diode input fed to a high-gain multi-range transimpedance amplifier, this unit deploys the same advanced auto-alignment algorithms pioneered on our high-end, higher bandwidth, benchtop NanoTrak™ Controller (BNT001). For an explanation of NanoTrak™, please refer to the tutorial on page 378.

Operator interaction can be accomplished using either the manual control panel or via the intuitive software interface provided with the unit.

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"). It is also possible to mount the controller to the optical table directly so it is in close proximity to the device it controls. Tabletop operation also allows minimal drive cable lengths for easier cable management. All manual controls are located on the top face of the unit, making it convenient to adjust the piezo positions manually and to monitor the alignment via the easy-to-read target display.



TNA001

Optical Power Meters



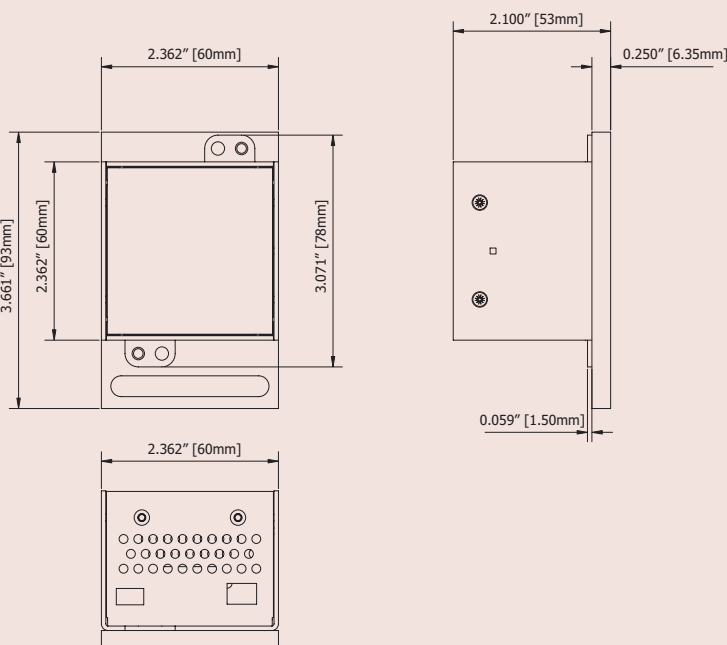
See Page 946

Features

- Compact Footprint
- Front Panel or PC Readout
- Active Fiber Alignment
- Maintain Optimum Power Throughput
- InGaAs or Si Detectors and Pin Current Options
- USB Plug-and-Play Connectivity
- Full Software Control Suite Included
- Extensive ActiveX® Programming Interfaces

Specifications

- **Optical Power Measurement:**
 - PIN Photodiode: FC/PC Fiber Input
 - Si or InGaAs Detector: 30nA to 10mA Photocurrent
 - Signal Phase Compensation: -180° to 180°
- **NanoTraking:**
 - Circle Scanning Frequency: 20-85Hz
 - Circle Dia Makes Adjustment: Automatic and Manual
- **Other Input/Output:**
 - Feedback Signal In: 0-10V (SMA)
 - Dual Piezo Position Demand Outputs: 0-10V (SMA)
 - USB Port: Version 1.1 (mini)
- **Input Power Requirements (DIN Connector):**
 - Voltages: +15V (100mA), -15V (100mA), or +5V (400mA)
- **Housing Dimensions (W x D x H):**
60 x 60 x 47mm (2.4" x 2.4" x 1.8")
- **Weight:** 160g (5.5oz)



T-Cube™ apt™ USB NanoTrak™ Auto-Alignment Controller (Page 2 of 2)

Power Supply options

The TNA001 T-Cube™ requires a +5V, +15V, or -15V, power supply. Thorlabs offers a compact, two-way power supply unit (TPS002), allowing up to two T-Cubes to be powered from a single main outlet.

Alternatively, the TCH002 USB Controller Hub provides power distribution for up to six T-Cubes. 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.



TNA001

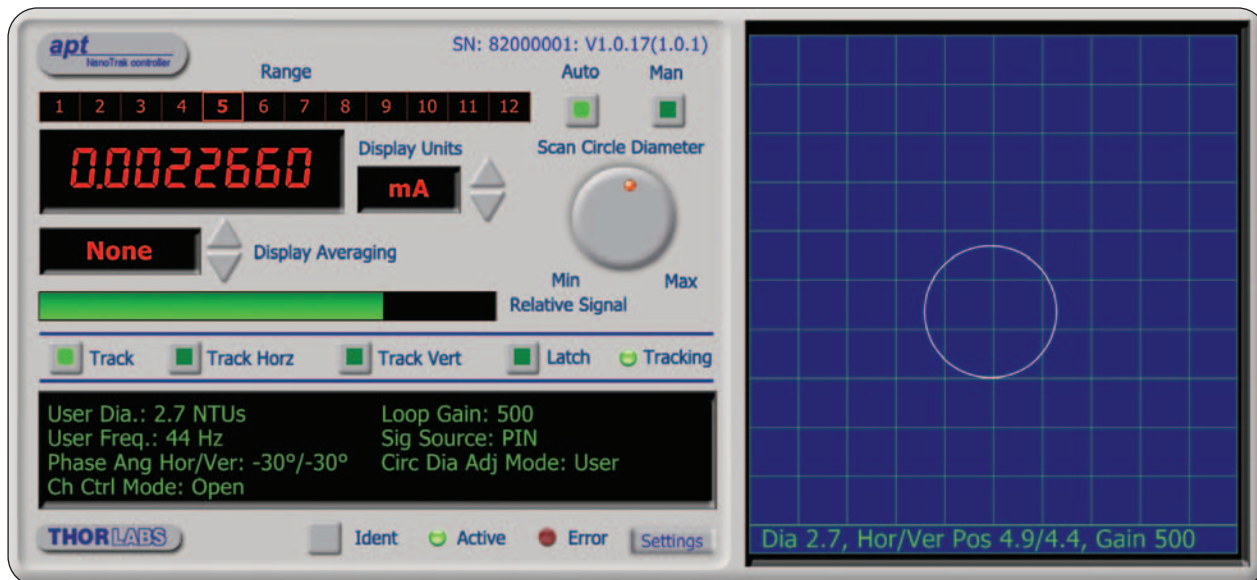
apt™ NanoTrak™ Controller



BNT001

For higher speed auto-alignment, please see our powerful benchtop NanoTrak™ unit. This controller combines an intelligent active feedback alignment control system and a two-channel, high-current piezoelectric controller into a single benchtop unit.

See Page 372



ITEM#	\$	£	€	RMB	DESCRIPTION
TNA001	\$ 1,690.00	£ 1,064.70	€ 1,571.70	¥ 16,139.50	T-Cube™ apt™ USB NanoTrak™ Auto-Alignment Controller
TNA001/VIS	\$ 1,995.00	£ 1,256.90	€ 1,855.40	¥ 19,052.30	T-Cube™ NanoTrak™ Controller With Silicon Detector
TNA001/IR	\$ 1,995.00	£ 1,256.90	€ 1,855.40	¥ 19,052.30	T-Cube™ NanoTrak™ Controller With InGaAs Detector
NTA007	\$ 314.50	£ 198.10	€ 292.50	¥ 3,003.50	InGaAs Detector for NanoTrak™
NTA009	\$ 314.50	£ 198.10	€ 292.50	¥ 3,003.50	Silicon Detector for NanoTrak™
TPS002	\$ 110.50	£ 69.60	€ 102.80	¥ 1,055.30	±15V/5V Power Supply Unit for up to 2 T-Cubes
TCH002	\$ 765.00	£ 482.00	€ 711.50	¥ 7,305.80	T-Cube™ Controller Hub and Power Supply Unit

Motion Control

apt™ Control Software Overview – Page 1 of 3

Single Axis Stages

Multi-Axis Stages

Flexure Stage Accessories

Motorized Mirror Mounts

Rotation Stages

Drive Electronics & Auto-Alignment

Actuators & Adjusters

Brief Tutorials

Constructing automated custom alignment and positioning solutions in a speedy and efficient manner is becoming increasingly important in today's competitive environment. Often timescales are short and yet the nature of the solutions, particularly at the software level, are becoming more complex and demanding. We have worked very closely with a large number of system engineers and research specialists in order to gain a detailed understanding of the specific requirements for sophisticated yet easy-to-use electronics and software controller products.

Out-of-the-Box Operation

When faced with an automated alignment project, the system engineer or researcher will often face a steep learning curve, and when the end requirement involves programming automative alignment sequences, learning how to operate the

equipment manually is an important first step. Every apt™ controller can be manually operated using the supplied 'APTUser' utility. This utility gives access to all settings, parameters, and operating modes. In this way most automated alignment sequences can be first tested and verified without writing a single line of custom software by first using APTUser.

Time Saving Speedy Pre-Configuration

In order to further reduce the time required to configure our range of apt™ controllers, an offline pre-configuration utility, APTConfig, is supplied with all units.

As an example, this utility can be used to associate Thorlabs' stages and actuators with individual motor drive channels, thus allowing the system to set automatically a large number of system parameter defaults. This offline configuration eliminates the need to write the large amounts of initialization code often required when using other control systems, greatly reducing the time taken when developing custom applications. Many other preconfigured settings can be made by using the APTConfig utility.

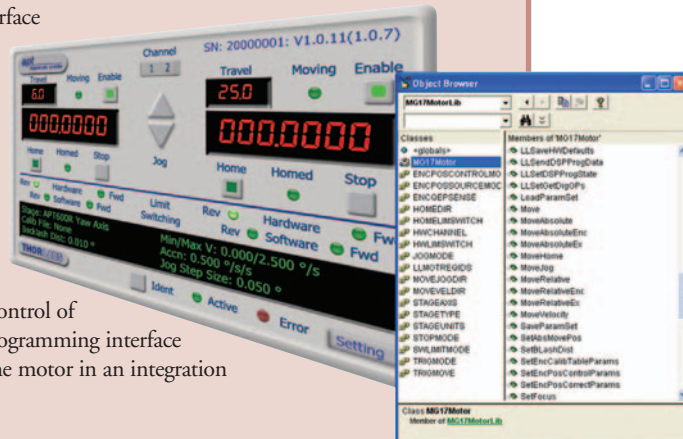
apt™ Server – The Engine for Integration Software Solutions

The apt™ Server lies at the heart of the apt™ system. This software engine sits underneath the operation of both APTUser and APTConfig and makes the functionality of both utilities easily accessible. The apt™ Server actually comprises a collection of cooperating ActiveX® Controls (see aside) and associated support libraries that provide a tool kit of graphical instrument panels and associated programming interfaces. It is this set of ActiveX® Controls that allow motion control and alignment functionality to be incorporated quickly and easily into custom applications.

Evaluation version available in the download section at www.thorlabs.com



ActiveX® Controls allow apt™ motion control and alignment functionality to be incorporated quickly and easily into custom applications. ActiveX® Controls are pre-compiled software functional blocks (or components) that typically include both a graphical user interface (GUI) and programming (software function) interface. There are many such ActiveX® Controls available to the Windows software developer providing an enormous range of pre-compiled functionality for use in their own custom (or client) applications. The ActiveX® Controls supplied with the apt™ system provide all of the GUI and programmability required to operate and control the full range of apt™ controllers (T-Cube, benchtop, and rack-based variants). For example, the Motor ActiveX® Control provides a complete instrument panel allowing full manual control of our stepper motor driver units. In addition, the associated programming interface allows the software developer to automate the operation of the motor in an integration application.



apt™ Control Software Overview – Page 2 of 3

Multiple Development Environment

Support – Your Choice

One of the first questions often posed by a system developer is that of language compatibility. We accept that our customers will want to use a wide variety of software development languages and tools when architecting their solutions, and it is for this very reason that we have engineered the apt™ Server to be ActiveX® compliant. ActiveX® is a language independent interfacing technology supported by a large number of Windows-based software development environments. Using our apt™ controllers, it is possible to create custom alignment applications with environments such as LabVIEW™, Visual Basic, Visual C++, Borland C++, HP VEE, Matlab, and even Microsoft Office via VBA (Visual Basic for Applications). Certain .NET environments (e.g. VB.NET, C#.NET) will also support ActiveX® through Microsoft interop technology.

motor control instrument panel can be incorporated into an end application literally within a minute with a single drag-and-drop operation, a single serial number setting, and a single line of code. Unlike many other motion control software libraries available, the apt™ system provides complete prewritten GUIs for use in custom applications. Consequently, a large amount of development time is saved by eliminating the need to write code to provide essential end user interface capability. These instrument panels can also be used during software development or when commissioning and configuring the system to alter essential settings. In the finished application, it is also very easy to hide these full parameter access graphical panels from the end user in order to prevent inadvertent changes to alignment parameters.

Comprehensive Programming Interfaces

We recognize that it is crucially important that the apt™ Server makes available all required parameters and operating modes through its programming interfaces.

We have taken every available system setting and command and exposed them to support the vast range of integrated software applications that can be built around the apt™ system. Hundreds of software commands and settings exist to ensure full flexibility and adaptability when automating the operation of our controllers.

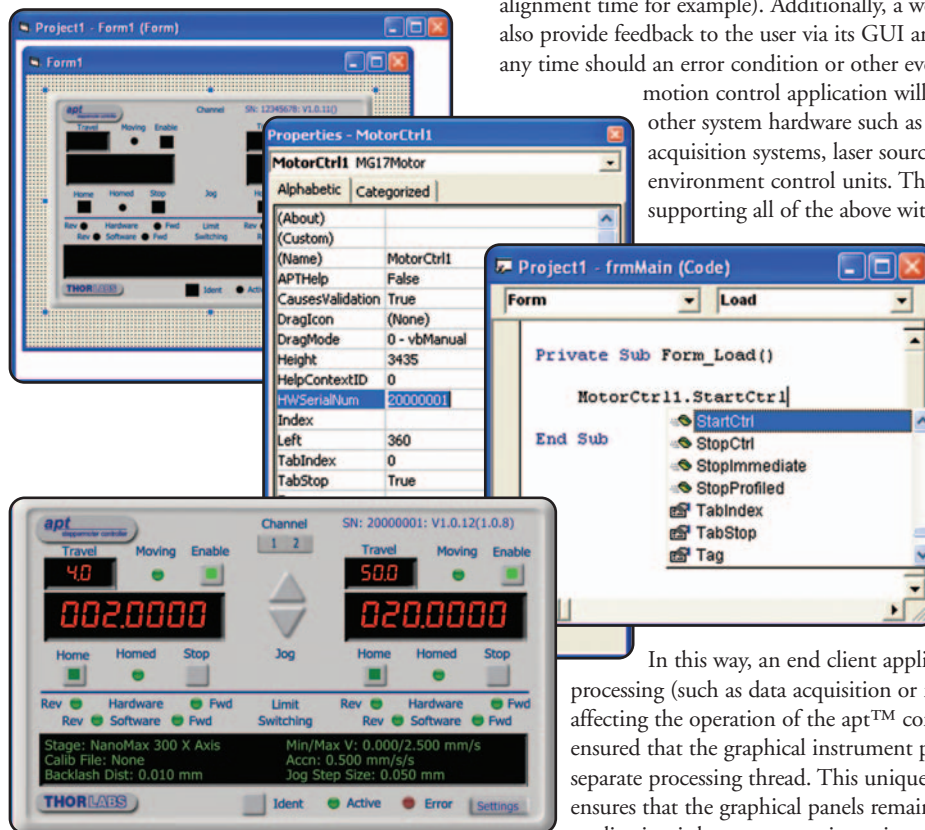
Multi-threading

When developing custom applications on a PC, it is important to ensure that the alignment process itself can execute without disruption (to maintain required alignment time for example). Additionally, a well-written client application will also provide feedback to the user via its GUI and allow operator intervention at any time should an error condition or other event occur. In many cases, a motion control application will also be required to interact with other system hardware such as device characterization and acquisition systems, laser sources, robotic units, and environment control units. The system engineer is faced with supporting all of the above within a single application while

also overcoming the consequent issues of software latency from the end user's perspective (e.g. due to polling of equipment).

To address these fundamental application issues, we have built full multi-threading and event "firing" capability into the apt™ Server. Multi-threading is deployed to isolate operation of the apt™ hardware completely from that of the end application.

In this way, an end client application can engage in intensive processing (such as data acquisition or number crunching) without affecting the operation of the apt™ controllers. Additionally, we have ensured that the graphical instrument panels are themselves executed in a separate processing thread. This unique approach taken in the apt™ Server ensures that the graphical panels remain fully responsive even when the end application is busy on some intensive processing activity. Always being able to access apt™ controller settings via their GUI panels is extremely useful when trying to optimise software routines, even if an alignment sequence is running. Event firing is the software mechanism by which an apt™ ActiveX® Control can inform the client application of some event or occurrence. In the apt™ system, this mechanism is effectively used to end motor movement and other lengthy operations. By responding to these events, a custom end application does not need to sit and poll for lengthy operations, which improves the overall system performance.



Rapid Application Development – Drag and Drop

One of the key benefits using the apt™ ActiveX® Controls is the speed with which the associated motion control functionality can be incorporated into a custom alignment application. Taking Visual Basic for example, a fully functional apt™

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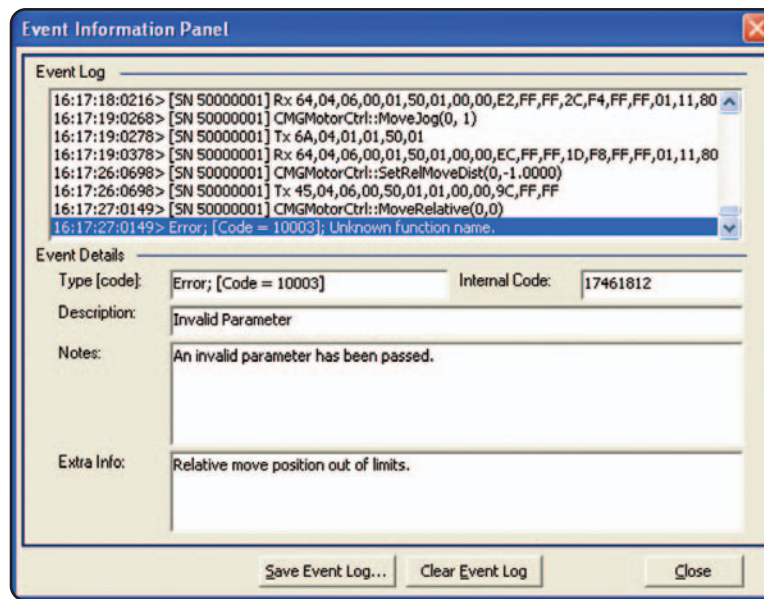
Actuators & Adjusters

Brief Tutorials

IR Cards & Alignment Disks



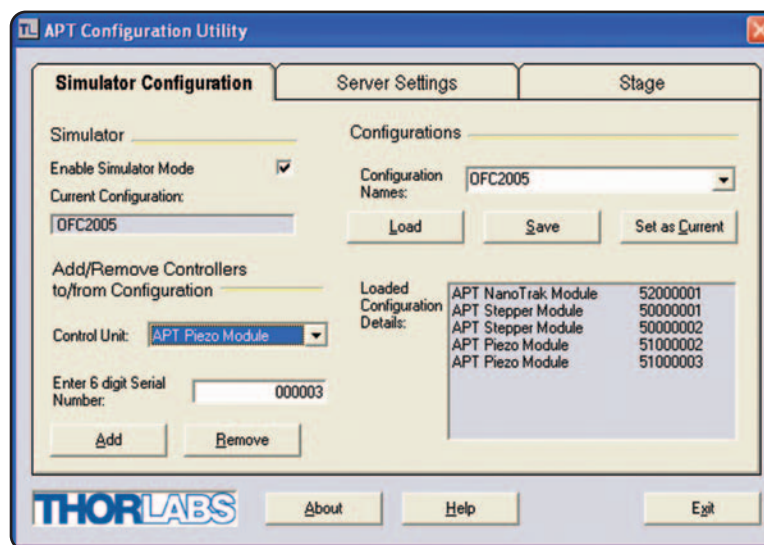
See Page 497



apt™ Hardware Emulator – Offline Application Development

For total convenience, the apt™ Server can be placed into a full hardware emulation mode (using the APTConfig utility), giving the freedom to run the software without connecting actual physical units.

This emulation support is useful for many reasons, including learning how to use and program the apt™ software without necessarily tying up real apt™ hardware, which is useful if multiple person teams are working on the same integration project.



It also gives the option of developing custom applications off-line if, for example, the apt™ hardware is unavailable or already being used. Moreover, after an apt™-based custom application has been developed and released, the actual physical apt™ hardware may no longer be accessible for software support and maintenance purposes, and so a simulator mode proves invaluable.

Debugging – apt™ System Logger

Software development, particularly of complex alignment and positioning systems, is a process that inevitably involves debugging and process optimization. Often

errors that occur during actual execution of the associated software (e.g. incorrectly calculated position parameter passed to the apt™ Server) are difficult to analyze after the event (and may not even occur when interactively debugging because of the difference in execution dynamics). To solve this issue, the apt™ software has a built-in system-wide event logging capability that records all function calls (and associated parameters). This chronological record of client application activity is invaluable in monitoring the sequence of events that lead up to a process failure, thereby helping the software developer to find and debug problems.

Developer Support CD

It is inevitable, even for relatively simple applications, that software programming support will be needed. Having recognized this and the wide range of software end applications that can be built around the apt™ system, we have brought together a comprehensive collection of programmer information and reference material and burned it onto a CD. A full set of sample applications written in Visual Basic and LabVIEW™ is included, together with various hints and tips. The programming samples themselves cover a varying degree of complexity, from basic to advanced examples. The advanced examples are working programs that can be used with the apt™ motion controllers and Thorlabs' positioning stages and actuators to perform optical alignments of real world multi-axis photonics. They form an excellent starting point for the system development and in many cases will provide the functionality required with only minor coding enhancements/changes.

Try the apt™ Software for Yourself

In the end, the best way to appreciate the power and flexibility of the apt™ system software is to try it yourself. You can obtain the latest shipping version of the apt™ software from the download section of the Thorlabs' website (www.thorlabs.com). After installation, it is possible to create a simulated configuration of apt™ controllers and then go on to explore all of the software commands and features described above, as well as experiment with writing custom motion control applications.

It is also useful to view the tutorial videos included. These cover all aspects of using the software, from overviews of the supplied user utilities to programming basics in Visual Basic, LabVIEW, and C++ environments.