



MMR601, MMR602 Modular Rack

User Guide



Original Instructions

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Chapter 1 Introduction

Thorlabs has an extensive range of one-, two- and three-axis controllers for stepper motor and piezo actuator control. Increasingly, production of optoelectronic components requires fully automated or semiautomated control of a large number of mechanical stages. In such applications, it is often more convenient to use a modular system of controllers to drive a modular system.

The Thorlabs Modular Motion Control System has been developed to meet the challenges of the modern optoelectronic production environment and provides unsurpassed ease of installation, reconfiguration, flexibility and upgradability.

The modular rack system provides a highly functional 12 channel platform within the 'footprint' of a 4U high, 19" wide enclosure. With a unified power supply and a USB communications interface, the rack system is easily incorporated into larger custom applications. The MMR601 Rack is supplied without a cover, ready for installation into a standard 19 in. frame. The MMR602 is supplied with a cover and rubber feet for benchtop use.

Chapter 2 Safety

2.1 Safety Information

For the continuing safety of the operators of this equipment, and the protection of the equipment itself, the operator should take note of the **Warnings, Cautions** and **Notes** throughout this handbook and, where visible, on the product itself.

The following safety symbols may be used throughout the handbook and on the equipment itself.

The following safety symbols may be used throughout the handbook and on the equipment itself.



Warning: Risk of Electrical Shock

Given when there is a risk of injury from electrical shock.



Warning

Given when there is a risk of injury to users.



Caution

Given when there is a risk of damage to the product.

Note

Clarification of an instruction or additional information.

2.2 General Warnings



Warning

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. In particular, excessive moisture may impair operation.

Spillage of fluid, such as sample solutions, should be avoided. If spillage does occur, clean up immediately using absorbant tissue. Do not allow spilled fluid to enter the internal mechanism.

Chapter 3 Overview

3.1 Rack System Description

3.1.1 Building Larger Scale Systems

The unrestricted configuration flexibility offered by the rack allows any combination of the 2-channel stepper motor controller, piezoelectric driver and NanoTrak control modules to be fitted for specific nanopositioning and alignment applications. For example, a system configured to operate our MAX683 6-axis nanopositioning stage, which has six stepper motors and six piezoelectric actuators with displacement sensors, would require 12 channels of motion control. Using three stepper motor modules, each with two channels, provides the motor control; using two piezoelectric controller modules and one NanoTrak controller module would power all 6 of the piezoelectric actuators while also taking advantage of the position sensors. Additionally, the NanoTrak module provides the full range of features offered by a fully operational auto-alignment system. All this functionality fits into the single chassis that measures just 4U in height.

Please see the documentation supplied with the various module products for further details.

3.1.2 Ease of Use

The rack system architecture, hardware and software has been skilfully engineered to provide an efficient and effective solution to complex high channel count applications.

The rack presents a clean, uncluttered front panel, with six rear mounting bays for the plug-in modules. The backplane of the rack connects all modules and the control PC via a standard USB bus. This arrangement greatly simplifies the cable management issues that arise as the number of channels expands.

A flexible and energy efficient integral power supply powers all of the modules allowing for an adaptable, “mix-and-match” choice of module type, location and combination. These features greatly enhance ease-of-use, and provide an unparalleled flexibility for future system upgrades or reconfigurations. Each module is equipped with an on-board DSP embedded processor; as modules (channels of operation) are added, processing power is also added, hence the system is able to maintain maximum operating efficiency even when fully loaded.

Due to the inherent architecture of the system, additional racks can be added to the USB bus as required, thus allowing multiple, fully automated 6-axis positioning stages to be combined into a single unified motion control system.

The PC based software that is used to drive the system operates from the same multithreaded server code and associated suite of high level user applications used to drive our range of stand-alone bench top controllers. This makes it possible to offer effortless code-porting and concurrent control of bench top and rack controllers.

The software is rigorously engineered using modern object oriented techniques, ensuring programming environment independence and compatibility with a large number of third party development tools. All key high level commands, settings and system parameters are exposed through a set of software functions. These exposed functions allow the modular electronics system to be 'driven' from applications written by the user without the need to understand or alter the core system software.

The following sections detail the operation of the rack using of the Kinesis software. For details using the legacy APT software please see Appendix A.

3.2 Kinesis Software Overview

3.2.1 Introduction

The controllers fitted in the MMR601 rack share many of the benefits of the Thorlabs range of motor, piezo and auto-alignment controllers. These include USB connectivity (allowing multiple units to be used together on a single PC), fully featured Graphical User Interface (GUI) panels, and extensive software function libraries for custom application development.

The Kinesis software suite provides a flexible and powerful PC based control system both for users of the equipment, and software programmers aiming to automate its operation.

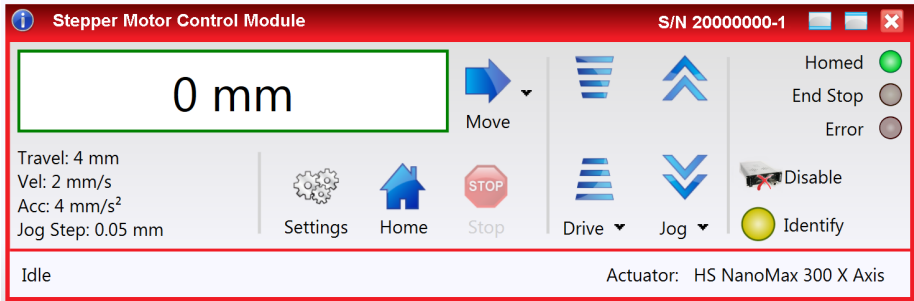
The User Interface allows full control of all settings and operating modes enabling complete 'out-of-box' operation without the need to develop any further custom software. It provides all of the necessary system software services such as generation of GUI panels, communications handling for multiple USB units, and logging of all system activity to assist in hardware trouble shooting. The Kinesis server is also used by software developers to allow the creation of advanced automated positioning applications very rapidly and with great ease.

3.2.2 Kinesis Server

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

With the Kinesis system, .Net Controls are deployed to allow direct control over (and also reflect the status of) the range of electronic controller units, including the BSC201 series controllers. Software applications that use .Net Controls are often referred to as 'client applications'. A .Net Control is a language independent software component. Consequently the controls can be incorporated into a wide range of software development environments for use by client application developers. Development environments supported include Visual Basic, Labview, Visual C++, C++ Builder, HPVEE, Matlab, VB.NET, C#.NET and, via VBA, Microsoft Office applications such as Excel and Word.

Consider the control supplied for the MST602 stepper motor control module.



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

The Kinesis Controls collection provides a rich set of graphical user panels and programmable interfaces allowing users and client application developers to interact seamlessly with the Kinesis hardware. Each of the Kinesis controllers has an associated .Net Control and these are described fully in the handbooks associated with the controllers.

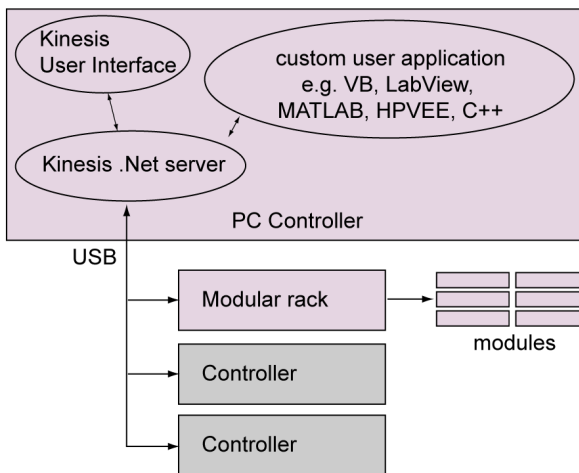


Fig. 3.1 System Architecture Diagram

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

3.2.3 Software Upgrades

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

3.3 Front Panel Controls

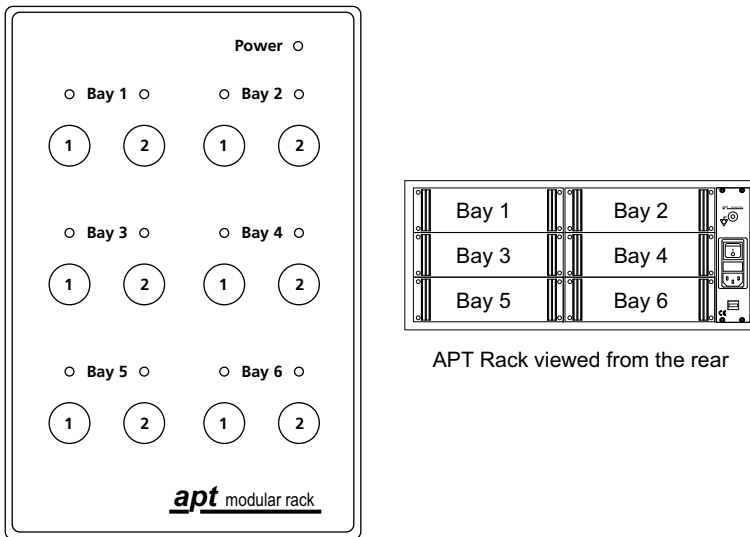


Fig. 3.2 Modular rack front panel

Power LED - Indicates that power is applied to the unit.

Channel Keys - Used to enable/disable channels of the modules fitted in Bays 1 to 6. The associated LED is lit when the channel is enabled. In the case of the motor controllers, disabling the channel allows the motor actuator to be operated manually. Disabling channels on piezo and NanoTrak controllers sends their respective HV outputs to zero volts. See Fig. 3.2 for information on associating channel keys with bay locations.

3.4 Rear Panel Controls

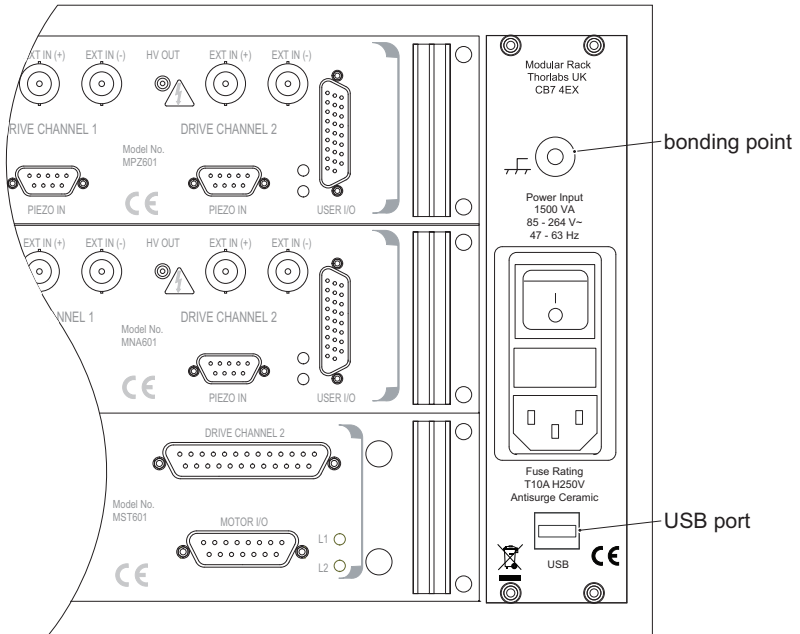


Fig. 3.3 Modular rack rear panel

Bonding Point - used to electrically bond one or more racks together (or with other equipment) to eliminate circulating earth (ground) currents. Do not connect to the main power supply ground.

USB - USB port for system communications with a host control PC.

Chapter 4 Installation and Set Up

4.1 Installing 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 may interrupt communication between the 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 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.

4.2 General Precautions

4.2.1 Siting

The Modular Rack is designed to be used in a horizontal position..



Caution

When lifting the unit, use both handles on the front panel. Do not lift the unit using only one handle.

When siting the unit, it should be positioned so as not to impede the operation of the rear panel power supply switch which is the main power disconnect.

To maintain cooling, ensure that proper airflow is maintained to the sides of the unit, particularly if mounted in a 19" rack.

4.2.2 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.



Caution

The host PC controlling the unit must be protected against humidity and/or liquid spillage.

4.3 Mechanical Installation

4.3.1 Mounting

The MMR601 Rack is supplied without a cover, ready for installation into a standard 19 in. frame. The MMR602 is supplied with a cover and rubber feet for benchtop use. It is possible to convert a rack from frame mount to benchtop (or vice versa), please contact the factory for details.



Caution

When mounting the benchtop version, ensure adequate air flow is maintained; do not obscure the ventilation holes on the left- and right-hand sides of the unit. When mounting in a 19 in. frame, ensure there is sufficient air gap at the sides of the enclosure.

4.3.2 Blanking plates



Warning

Unoccupied module slots in the rack must always be covered by the purpose made blanking plates provided. Do not operate the equipment with the blanking plates removed.

4.3.3 Fitting a module



Warning

Ensure that all power to the rack is disconnected before fitting or removing a module.

To fit a module into the rack, refer to Fig. 4.1 and proceed as follows;

- 1) Ensure the rack is the right way up, with the feet at the bottom.
- 2) Undo the securing screws in the module front panel such that the screws are held in the panel by their threads.

Note

During item (3) ensure that the fins on the module are correctly located in the left hand and right hand guide rails.

- 3) Gently slide the module into the guide rails until it engages with the back plane connector. If the module does not go in easily, check it lines up with the connector and that the guide rails are positioned correctly. Firm pressure is required to seat the module correctly.
- 4) Tighten the four securing screws on the module front panel.

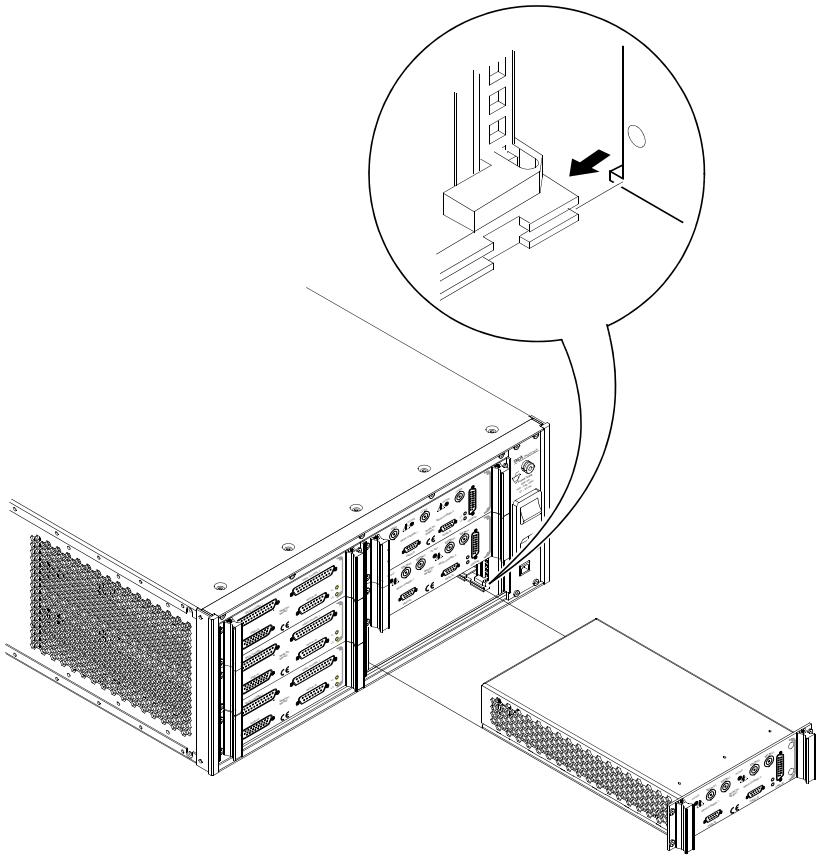


Fig. 4.1 Fitting a module into the rack

4.3.4 Removing a module

- 1) Switch off and disconnect all power.
- 2) Undo the securing screws in the module front panel such that the screws are held in the panel by their threads.



Caution

During item (3), take care not to damage the spring bonding strip along the top and bottom edges of the front panel.

- 3) Pull the module from its bay, ensuring an even pulling force on both handles to prevent the module sticking in its rails.

4.4 Electrical Installation

4.4.1 Connecting the Rack and Controller

The Control PC should be connected to the rack using a spare USB connector, according to the PC manufacturers instruction manual.

Additional racks can be added as required, via spare USB sockets or a standard USB hub.

4.4.2 Connecting To The Supply



Warning

The unit must be connected only to an earthed fused supply of 110 to 230V.

Use only power supply cables supplied by Thorlabs, other cables may not be rated to the same current. The unit is shipped with appropriate power cables for use in the UK, Europe and the USA. When shipped to other territories the appropriate power plug must be fitted by the user. Cable identification is as follows:

Brown Live

Blue Neutral

Green/Yellow Earth/Ground

4.4.3 Bonding



Warning

Do not connect this terminal to the power supply ground.

To eliminate circulating earth (ground) currents, units in the same system should be bonded using the rear panel terminal.

4.4.4 Fuses

Two T 10A/250V a.c. antisurge ceramic fuses are located on the back panel, one for the live feed and one for the neutral as follows:

Fuse	Rating	Type	Fused Line
F1	T 10A	ceramic; antisurge; 20mm	Live feed
F2	T 10A	ceramic; antisurge; 20mm	Neutral feed

When replacing fuses:

- 1) Switch off the power and disconnect the power cord before removing the fuse cover.
- 2) Always replace broken fuses with a fuse of the same rating and type.

4.5 Selecting the Stage Type

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

To assist in setting these parameters correctly, a stage association can be made which enables the Kinesis server to apply automatically, suitable default parameter values on boot up of the software. With some Thorlabs stages, the controller will recognise the stage at switch on, and no further action is required; for others, it is necessary to tell the controller which stage is connected as follows.

Note

Even if a stage type and axis has been associated with the controller, it is still possible to alter these parameters if required, (e.g. for a custom stage type not selectable using the Kinesis software) - see Section 5.3.4.

Note

To use the increased resolution and velocity functionality offered by these controllers, the stage types prefixed by 'HS' (e.g. HS NanoMax 300 X Axis) must be selected. Failure to select the correct stage type will result in reduced velocity and resolution.

- 1) Install the software as detailed in Section 4.1.
- 2) Install the electronic hardware and connect the modules to the relevant axes of the associated stages (see Section 4.3.3. of this handbook, and also the handbooks supplied with the control modules).
- 3) For each Stepper Motor Control module in your system, fit the interlock plug (supplied) to the MOTOR CONTROL connector on the rear panel (see the handbook supplied with the motor control module).
- 4) Connect the rack to the PC then switch ON.
- 5) Run the Kinesis software - Start/All Programs/Thorlabs/Kinesis/Kinesis.
- 6) The 'Actuator/Startup Settings' window is displayed.

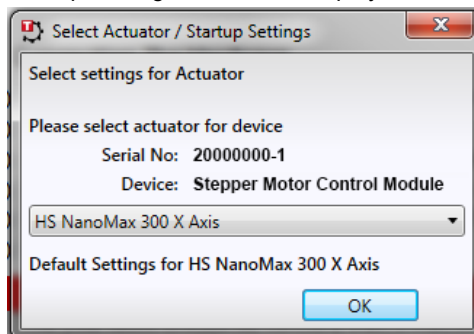


Fig. 4.2 Stage Configuration Window

7) Select your actuator type (e.g. HS NanoMax 300 X-Axis) from the list displayed.

Note

To use the increased resolution and velocity functionality offered by these controllers, the stage types prefixed by 'HS' (e.g. HS NanoMax 300) must be selected. Selecting a stage/actuator type without the 'HS' prefix will result in reduced velocity and resolution.

8) Click OK.

9) The server reads in the stage and controller information automatically. See the handbook supplied with the relevant control module for further information.

Chapter 5 Preventive Maintenance



Warning

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

5.1 Safety Testing

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



Caution

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

Repeated application of 'flash' test may damage the insulation.

5.2 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.

Chapter 6 Specifications and Associated Products

6.1 Specifications

Power Supply	
Voltage	100 to 240 VAC
Frequency	50-60 Hz
Power	800 VA
Fuse	10A
Dimensions (W x D x H)	480 x 448 x 183 mm (19.0 x 17.6 x 7.0 in.)

6.2 Associated Products

Description	Part number
APT Modular Rack (no cover)	MMR601
APT Modular Rack (with cover)	MMR602
Piezoelectric Control Module	MPZ601
Stepper Motor Control Module	MST601
NanoTrak Autoalignment Module	MNA601
Blanking plate	

Appendix A Using the APT Software

A.1 Introduction

A common requirement in many optoelectronic alignment and characterization applications concerns the implementation of automated positioning sequences. Typically, such positioning sequences require a series of discrete movements and measurements to implement an overall solution

The mechanical stage options and drive electronics offered by Thorlabs are ideally suited to performing all of these individual steps in a variety of different ways.

The key to the APT range of controllers (and associated mechanical products) concerns the ease and speed with which complete automated alignment systems can be engineered at the software level. All controllers in the APT range are equipped with USB connectivity. The 'multi-drop' USB bus allows multiple APT units to be connected to a single controller PC using simple USB hubs and cables.

The USB connection flexibility offered by the APT controllers is matched by the associated product software. All APT controllers are shipped with a sophisticated multithreaded ActiveX based software control suite. This suite comprises the main ActiveX based APT Server with a number of utilities including APTUser and APTConfig. APT Server is the main software 'engine' that runs on the host PC to provide all necessary APT services such as generation of sophisticated graphical instrument panels, multiple unit USB communications and multithreaded execution to enhance system operation and prevent GUI deadlock. Rather than a single monolithic entity, the APT Server is actually an interoperating collection of ActiveX Controls (or simply Controls) together with associated support files and libraries. These ActiveX Controls, developed using leading edge object oriented coding techniques, are the key to the powerful, flexible and yet extremely easy to use APT control software.

A.1.1 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. 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.

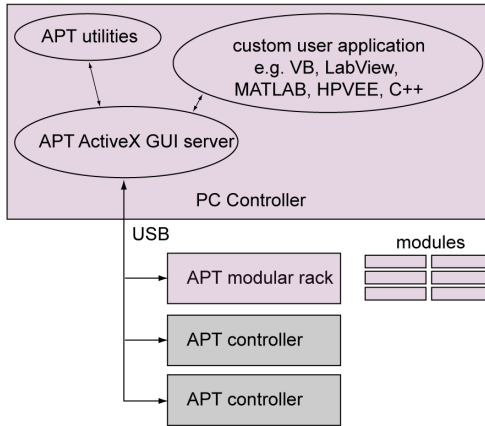
Consider the ActiveX Control supplied for the APT stepper controller module.



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 stepper 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.

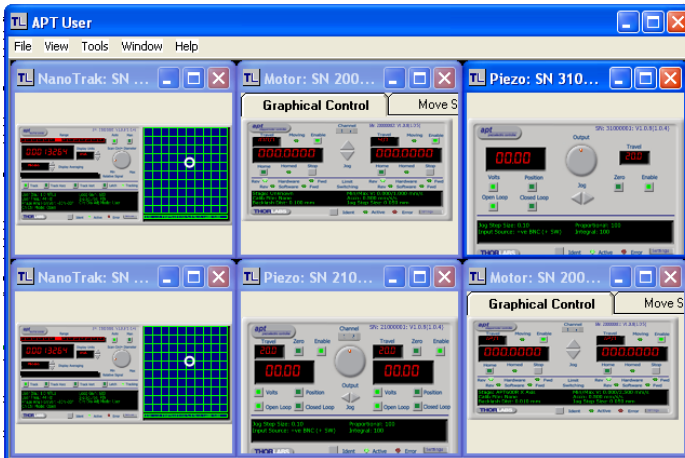
The APT ActiveX Controls collection provides a rich set of graphical user panels and programmable interfaces allowing users and client application developers to interact seamlessly with the APT hardware. Each of the APT controller modules has an associated ActiveX Control and these are described fully in system online help or the handbooks associated with the controllers. In addition to the main ActiveX Server, a number of other utilities are supplied with the APT system, most notably APTUser and APTConfig. Note that these utilities themselves take advantage of and are built on top

of the powerful functionality provided by the APT ActiveX Server (as illustrated in the system architecture diagram below).



A.1.2 APT User.exe

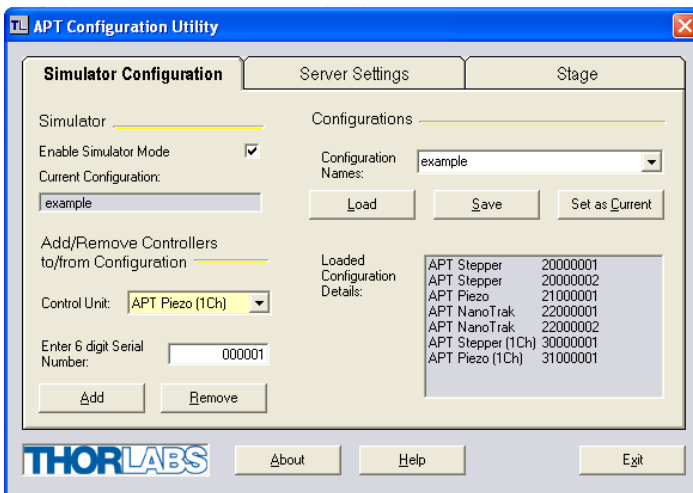
The APTUser application allows the user to interact with any of the modules connected, via rack units, to the host PC. This program displays multiple graphical instrument panels to allow multiple APT modules to be controlled simultaneously.



All basic operating parameters can be altered and, similarly, all operations (such as motor moves) can be initiated. 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 APT modules (e.g. to implement an alignment algorithm), this application illustrates clearly how the rich functionality provided by the APT ActiveX Controls are used by a client application. The complete Visual Basic source project is provided as a useful aid to software developers.

A.1.3 APT Config Utility

There are many system parameters and configuration settings associated with the operation of the APT Server (ActiveX Controls). Most can be directly accessed using the various graphical panels and their associated programmable interfaces. 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.

A.1.4 Software Upgrades

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

A.2 APT System Setup

- 1) Install the software as detailed in Section 4.1.
- 2) Install the electronic hardware and connect the modules to the relevant axes of the associated stages (see Section 4.3.3. of this handbook, and also the handbooks supplied with the control modules).
- 3) For each Stepper Motor Control module in your system, fit the interlock plug (supplied) to the MOTOR CONTROL connector on the rear panel (see the handbook supplied with the motor control module).

Note

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

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

- 4) Run the APTConfig utility and associate each motor channel with its stage and axis - see the *APTConfig* helpfile for detailed instructions.

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 the APTConfig helpfile for detailed instructions..

- 5) Begin using the APT hardware - see the APTUser helpfile for further details.

Appendix B Regulatory

B.1 Declarations of Conformity

B.1.1 For Customers in Europe

Thorlabs declares that the MMR series Modular Rack is in conformity with the applicable requirements of the following directives:

EN61010-1 Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use (2010)

EN6136-1 Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements (2013)

and has been tested or assessed in accordance with the following directives:

2014/35/EU Low Voltage Directive (LVD)

2014/30/EU Electromagnetic Compatibility (EMC) Directive

2011/65/EU Restriction of Use of Certain Hazardous Substances (RoHS).

B.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.

Appendix C 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.



USA, Canada, and South America

Thorlabs, Inc.
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UK and Ireland

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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 disassembled 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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