The NanoTrak™ auto-alignment controller combines an intelligent active feedback alignment control system and a two channel piezoelectric controller into a single benchtop unit. As part of the apt™ series, this unit represents the latest developments in automated optical alignment technologies. This system is a basic building block from which advanced alignment systems can be quickly configured. It can be fully integrated with our extensive selection of motorized positioning systems found in the early chapters of this Motion Control section.

Although used primarily for aligning optical fibers and integrated optical devices, the NanoTrak™ is ideal for automating just about any labor intensive alignment tasks such as waveguide characterization, fiber pigtailling of active and passive devices, as well as a multitude of other R&D applications.

Auto-Alignment
When combined with a positioning stage outfitted with at least two piezoelectric actuators, the NanoTrak™ auto-alignment system is designed to optimize the coupling through an optical assembly. Refer to the NanoTrak™ tutorial (page 344) for a more detailed explanation of the principle of operation of this unit when operated with piezo actuated alignment stages. The NanoTrak™ is compatible with a wide range of Thorlabs piezo actuated stages and assemblies (see our NanoMax stages on page 275).

In a typical automated alignment set up it is common to align for initial 'first light' detection using motor control, before then allowing the NanoTrak to take over and achieve optimal alignment via piezo actuation. Many of the Thorlabs piezo actuated stages can also be motorised to support this initial first alignment step (e.g. see our NanoMax™ or apt™ stages on page 275). The initial coupling of light from one device (e.g. fiber) to another involves searching a multidimensional space until a signal is detected. The NanoTrak™ support software offers a series of motor search algorithms for this first light detection; ranging from a simple 2-D raster scan, to a highly efficient hyperspiral search that starts with the point of highest detection probability and then progressively spirals out to more remote points of lower probability (see software support CD page 354).

Once first light detection is accomplished, the NanoTrak™ system begins its alignment process using advanced phase sensitive detection and digital filtering techniques to generate correction voltages which are then directly applied to the piezoelectric actuators in order to achieve optimal alignment performance (see NanoTrak™ tutorial page 344). These features are found to significantly improve the speed and accuracy with which the system operates by compensating for the inherent limitation of piezoelectric elements (these limitations are covered on page 339).

Highly Adaptable Operation
There are an infinite variety of optical device alignment scenarios, each with potentially different optical and physical characteristics; half widths, coupled peak...
powers, misalignment power response, and mechanical phase lags. Given the range of applications, it is important that NanoTrak™ be easily “tuned” for a specific alignment task.

In order to achieve this adaptability, NanoTrak’s operation is fully configurable with many of the operational parameters of the system accessible through easy-to-use graphical software panels. This “parameterization” of the key settings, with predetermined defaults makes the system highly adaptable.

For example, when operating in “Tracking Mode”, the system applies a small sinusoidal dither to the piezoelectric actuators as part of the alignment process (see NanoTrak™ tutorial page 344). To accommodate the specific optical characteristics of the elements in the system as well as the characteristics of the optical source, the dithering amplitude and frequency can be adjusted via the “Circle Diameter” and “Circle Frequency” settings respectively. Additionally, to deal with a potentially wide range of optical signal levels and sensitivities the overall closed loop gain can be adjusted via a “Gain” parameter. While all of these parameters are accessible on an individual basis, the system is also capable of automatically optimizing such settings. Features like this provide out-of-the-box operation while preserving the ability of the operator to achieve ultimate performance through manual control of the individual parameters.

A few other critical parameters are also worth covering in this brief summary of the NanoTrak™ system. The electro-mechanical phase lags associated with any moving device under piezoelectric control can be compensated by using phase correction parameters. A wide range of feedback signal (coupled power) levels and sensitivities the overall closed loop gain can be adjusted via a “Gain” parameter. While all of these parameters are accessible on an individual basis, the system is also capable of automatically optimizing such settings. Features like this provide out-of-the-box operation while preserving the ability of the operator to achieve ultimate performance through manual control of the individual parameters.

For convenience and to further enhance the ease of use, adjustment of all key parameters is possible through direct interaction with a software generated graphical panel. For example, the “Circle Diameter” previously defined, can be adjusted by using your mouse to rotate a simple computer generated knob. All such settings and parameters are also accessible through the ActiveX® programmable interfaces for automated alignment sequences. See page 354 to 356 for a full description of the apt™ system software.

Ease of Use
For convenience and to further enhance the ease of use, adjustment of all key parameters is possible through direct interaction with a software generated graphical panel. For example, the “Circle Diameter” previously defined, can be adjusted by using your mouse to rotate a simple computer generated knob. All such settings and parameters are also accessible through the ActiveX® programmable interfaces for automated alignment sequences. See page 354 to 356 for a full description of the apt™ system software.
**Motion Control**

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**High Density 19” Rack System**

A module version of the apt™, NanoTrak™ is also available for use with the new apt™ rack system (see page 352 for details). The module version is functionally identical to the benchtop unit, and provides a more compact implementation for multi-channel applications such as fully automated control systems that require multiple auto-alignments (multiple NanoTrak™ systems can be used even on the same optical path, this is achieved by using unique dither frequencies). Please call Thorlabs to speak with a nanopositioning expert if you would like more information on this or any other feature of the NanoTrak™ system.

The sophisticated ActiveX® apt™ software shipped with the bench top NanoTrak™ unit is also compatible with rack based modules. This allows seamless mixing of both the bench top and rack based systems in a single application.

**Extensive Software Support Tools**

The apt™ software library contains a number of optional features, with many different graphical user interfaces, operational parameters and programming functions. To assist using the software, a comprehensive, fully context sensitive on-line help is provided throughout. Whether using the fully functional utilities or programming custom applications with the apt™ ActiveX® Controls, detailed help is usually a single key stroke away.

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**Tools of the Trade**

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**6-Axis NanoPositioning Stages**

For Full Details See Page 309

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**ITEM#** | **$** | **£** | **€** | **¥** | **DESCRIPTION**
---|---|---|---|---|---
BNT001 | $6,800.00 | £4,000.00 | €6,000.00 | ¥1,120,000 | apt™ NanoTrak™ Controller with Voltage Input Only
BNT001/HR | $7,114.50 | £4,185.00 | €6,277.50 | ¥1,171,800 | apt™ NanoTrak™ Controller with InGaAs Detector
BNT001/VIS | $7,114.50 | £4,185.00 | €6,277.50 | ¥1,171,800 | apt™ NanoTrak™ Controller with Silicon Detector
NTA007 | $314.50 | £185.00 | €277.50 | ¥51,800 | InGaAs Detector for NanoTrak™
NTA009 | $314.50 | £185.00 | €277.50 | ¥51,800 | Silicon Detector NanoTrak™

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**Front view of the 19” rack based apt™ NanoTrak™ system, the system can accept a mixture of up to 6 plug-ins. Each one supporting two channels of motion control.**

The back view of the 19” apt™ system, all plug-ins and cables connections are accessed via the back panel.