

## New M-500 Generation of Translation Stages

Higher Speed & Accuracy, Lower Cost: Translation Stages Provide 102 to 306 mm Travel

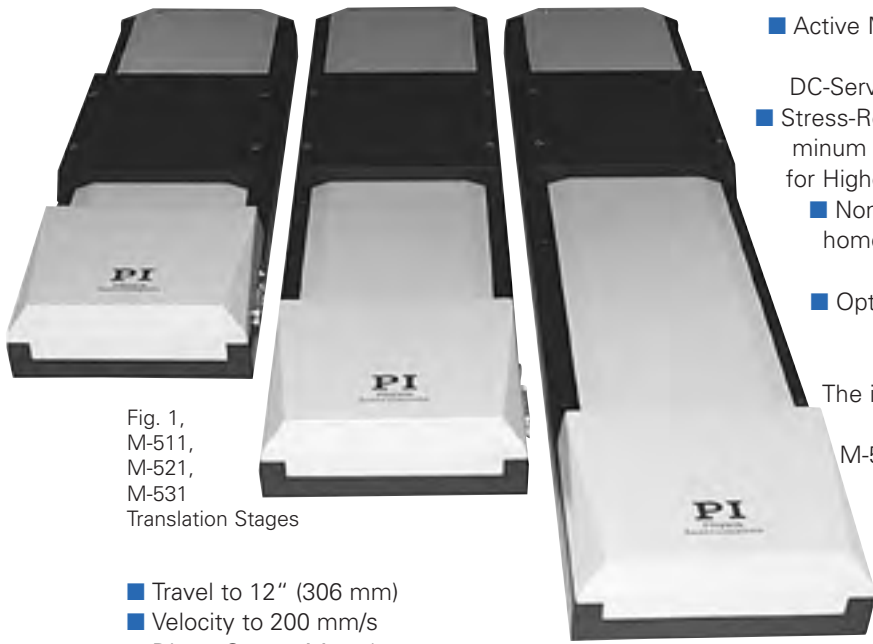


Fig. 1, M-511, M-521, M-531 Translation Stages

- Travel to 12" (306 mm)
- Velocity to 200 mm/s
- Direct Output Metrology: 0.1  $\mu\text{m}$  Resolution
- Zero-Backlash, Recirculating Ball-Screw

- Active Motor Drive (integrated DC-Servo-amplifier)
- Stress-Relieved Aluminum Stage Base for Highest Stability
  - Non-contacting home- and limit-switches
  - Optional motor brake

The introduction of PI's new M-500 generation at LASER 99 in Munich was a great success.

Small wonder, considering all the improvements over the predecessor (M-5x5 Series) at lower cost.

external power amplifier between the motor controller and the stage. With the new generation, we shrunk the amplifier and installed it inside the stage (**Active Drive**). Why? No power loss, higher dynamics, less cables, lower costs. Now, one C-842 PC-Motor Controller Board is sufficient to drive 4 fast stages.

**3.** High velocity and resolution are available **at the same time:** 50 mm/sec and 0.1  $\mu\text{m}$ . Velocity of 200 mm/sec can be achieved at 0.5  $\mu\text{m}$  resolution.

**4.** Travel ranges were increased from 100, 200 and 300 mm, to 102, 204 and 306 mm (4", 8", 12").

**5.** Double limit switches provide improved protection from overtravel and damage.

**6.** Integrated non-contacting, Hall-effect origin switches with left/right-of-switch position-detection allow fast and precise homing procedures, a time saving feature in industrial applications.

### Improvements

**1.** Integrated linear encoders (direct output metrology) are now standard in all DC direct drive versions. The stage position is measured by a non-contacting read head **directly at the moving platform**, providing improved resolution (0.1  $\mu\text{m}$ ) and repeatability (0.2  $\mu\text{m}$ ) close to one order of magnitude over the previous models.

**2.** The last generation M-500 stages required an

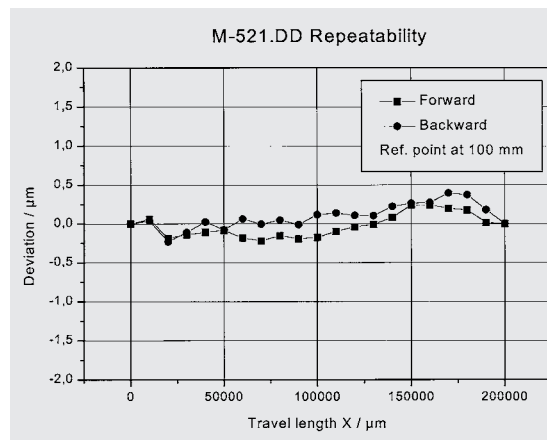


Fig. 2, Interferometer Test Sheet

### PI continues Growth

PI continues double-digit growth in the first two quarters of 1999. The growth also causes the continuing investment in new equipment and highly qualified people who help us meet our customers' needs. Here's an example of the importance of metrology test equipment in our quality control system: to date a total of six high resolution laser interferometers have been put to work at our headquarters in Waldbronn (plus a variety of other sophisticated optical and electrical instruments).

## Ultra-Flat Linear Stages feature 50 to 150 mm Travel

Another highlight at LASER 99 was the introduction of the Active Drive option for the new M-400 Series of Translation Stages which replace the M-150 and M-155 stages (50 and 100 mm travel).

- New Active Drive featuring 0.125  $\mu\text{m}$  resolution and 15 mm/s velocity
- Travel Ranges 50, 100 and 150 mm
- Stress-Relieved Aluminum Stage Base with integrated thermal Compensation for Highest Stability
- Crossed Roller Bearings
- High Resolution DC-Motor Drives
- Manual Knob for Convenient Position Adjustment
- Standard Origin and Limit Switches

These compact micropositioning stages are equipped with 0.5 mm pitch lead screws and crossed roller be-

arings providing high load capacity and excellent guiding accuracy. Two motorized versions are available: Models M-4xx.DG utilize closed loop DC motors with shaft mounted position encoders and backlash-free gearheads providing < 0.1  $\mu\text{m}$  minimum incremental motion. Models M-4xx.PD are equipped with 30 W att Active Drive DC motors providing 0.125  $\mu\text{m}$  resolution and velocity up to 15 mm/sec. The novel Active Drive concept features an integrated, high efficiency power amplifier and reduces overall system cost, because the stage can be driven directly from a PC motor controller card (e.g. C-842).

Ask for your copy of the PI Nano Positioning catalog or check out our web site at:

<http://www.physikinstrumente.com>



M-405.DG, M-410.DG, M-415.DG Micropositioning Stages

## CONTENTS

### New Translation Stages

Ultra-Fast, Digital Piezo Controller

LabView Driver for E-710 Piezo Controller

New Voice-Coil Scanner

PI and Polytec at LASER 99

Piezo Bender Actuators Provide 2 mm Travel

PIFOCs® for Confocal Microscopy

LabView Driver for C-842 Motor Controller

Hexapod for Satellite-Antenna-Testing

Fiber-Chip-Coupler

Interferometric Telescopes

**7.** An optional motor brake locks the stage in case of power loss or whenever a position has to be maintained without drive power to the motor.

All these benefits are available under the following part numbers: M-511.DD (102 mm), M-521.DD (204 mm) and M-531.DD (306 mm). Need more details? Ask for your copy of the PI Nano-Positioning catalog or check out our web site at:

<http://www.physikinstrumente.com>

## E-750 Piezo Controller: Ultra-Fast and Digital, perfect Solution for OEMs!

### New Controller allows Sub-Angstrom Resolution

- Ultra-fast Servo: 90 µsec
- Optical FiberLink-Interface: 1 Mbit/s
- DSP-based Real Time Operating System
- Additional High-Speed-Analog Input
- Integrated MACH™ - Algorithm for Input Shaping™ (Optional)
- AutoCalibration Function for NanoPositioning Systems
- All Servo Parameters internally stored in Flash ROM
- For head test, track profiling, scanned-probe microscopy...

The new E-750.CP Digital Piezo-Controller offers unmatched responsiveness and precision for the most demanding OEM applications. Driving the ultra-fast P-752- and P-753 Series NanoStages, the E-750 provides sub-msec step times and Sub-Angstrom resolution.

Apart from the fast servo, the integrated, low noise power amplifier and patented vibration killing MACH™-Algorithm for Input Shaping™, the E-750 offers further advantages: The AutoCalibration function and the FiberLink interface.

Long distances between the controlling computer and the piezo controller? EMI? High communication rates? No problem for the FiberLink interface. The optical data transmission isolates the controller from the environment and guarantees communication rates of 1 Mbit/sec at distances up to 50 m. OEM customers will appreciate the AutoCalibration function, allowing random combination (and easy interchangeability) of controllers and NanoPositioning systems with factory default configuration. Calibration data, linearization data and optimized servo parameters are stored in each Nano-

Positioning system and read by the controller upon power up. The controller is equipped with a wide range power supply for use throughout the world.



Fig. 2, FiberLink Interface



Fig. 1, E-750.CP Digital Piezo Controller with P-752 NanoPositioning Stage

## New High Resolution Micropositioning Stage Provides 25 mm Travel

- Resolution 0.125 µm and 50 nm
  - Velocity up to 15 mm/sec
  - Manual, DC/Gearhead and Active DC Motor Drive
  - Crossed Roller Bearings for excellent Guiding Accuracy
  - Manual Knob for Convenient Position Adjustment
- The M-126 Translation Stage Family is based on the successful M-125 Series

which it replaces. High strength aluminum profiles for reduced weight, crossed roller bearings for superior straightness and high resolution DC-Motor drives are but a few keywords characterizing these new precision stages. For more information, request our datasheet or check out our internet site at:

<http://www.physikinstrumente.com>



Four M-126.DG MicroPositioning Stages and C-842 Motor Controller Board

## Fiber-Chip-Couplers

for Telecommunication. PI PiezoMikes used in alignment unit patented by Heinrich-Hertz-Institut, Germany

Researchers at the Heinrich-Hertz-Institut, Berlin, Germany have developed a new compound system (consisting of an adjusting bench and module) for the implementation of high precision fiber-to-chip couplings. The new patented solution (DE 19536 185 AI, DE 19536 173 AI) targets customers who need better performance in terms of damping than standard industrial systems provide today.

Fig. 1 shows the thermally controllable module for coupling of optical fibers to



Fig. 2, Adjusting bench for fiber-to-chip mounting. Courtesy of HHI

This device is based on three PI model P-853 and P-854 PiezoMike drives providing coarse travel to 18 mm and resolution on the order of 1 nm. Single mode fibers and polarization preserving fibers (e.g. Panda fibers) can be coupled with an angular accuracy of 0.5°.

If you need more information on this subject, talk to your local PI representative.

Special thanks U. H. P. Fischer of Heinrich-Hertz-Institut für Nachrichtentechnik Berlin GmbH for the technical and graphical information.



Fig. 1, Laser amplifier module with two optical inputs. Courtesy of HHI

optoelectronic components such as laser amplifiers, laser diodes and optical modulators. Coupling losses are as low as 3 dB typical.

For coupling and adjusting an optical fiber to a chip, the specially designed adjustment bench is required (Fig. 2).

## Scanning: Faster & more accurate!

### Fast scanning stages for OEM applications

- Scan Frequency up to 30 Hz
- Travel Range 2 mm
- Zero-friction, Zero-backlash Guiding System
- Integrated LVDT Sensor for Closed Loop Operation
- Compact Design

The latest PI Voice-Coil Scanner fills a gap in the market for high precision micro-scanners.



Voice-Coil Scanner with Controller Card

Combining our experience in designing piezoelectric nanopositioners and "classical" micropositioning stages with the advantage of frictionless voice-coil drives resulted in a unique product: A scanner featuring 2 mm displacement with sub-µm resolution at frequencies up to 30 Hz.

Position feedback is via an integrated, high resolution LVDT sensor. Equipped with a frictionless flexure guiding system, the stage provides sub-µm reproducibility in closed loop operation. A compact Euro-card controller board is available to drive the stage. This voice-coil scanner is a unique and cost effective solution for OEM applications in the field of life-science, optics and image processing. If you need to scan fast, talk to PI.

## LASER 99 Great Success for PI and Polytec

LASER 99, the world's leading international trade fair for lasers, electro-optics and related components was a great success for PI and sister company Polytec. According to the officials, this year more than 15,000 people

from 61 countries visited, many of whom stopped by the PI and Polytec booths.

The large halls of the new trade-fair center at the former Munich Airport were the ideal stage for the new PI Polytec booth design. Both companies proved their leadership in the industry with a variety of novel products displayed on more than 400 m<sup>2</sup>. With the optimistic atmosphere in the industry, PI and Polytec expect considerable business from this year's LASER and look forward to the next exhibition, June 18 - 22, 2001.



Customers at PI's LASER 99 booth learning about M-850 and F-206 Hexapods.

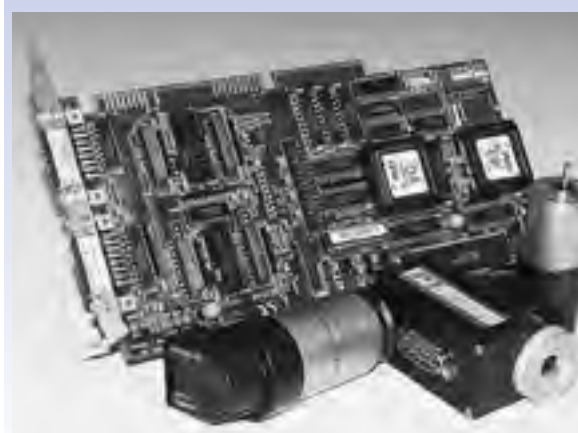
## LabView™ Driver for C-842 Motor Controller Card

### New Drivers for Windows NT™

The protection mechanisms of the NT operating system don't allow direct hardware access and therefore impede direct programming of ISA bus cards such as the C-842 motor controller.

PI now offers a new system driver for Windows NT™. After installation in the operating system the driver allows operation of the board via the included DLLs. For LabView™ programmers, new NT drivers (VIs) are available, too. They allow access to all commands and functions of the C-842 motor controller.

The drivers and documentation are available at no charge. Please contact your PI distributor for more information.



C-842 Motor Controller Card with several DC motors

# Satellite Dishes, Hexapods & More

ALCATEL SPACE, Cannes (France) has developed an innovative system for satellite antenna optimization at its Compact Range Facility. A satellite antenna basically consists of a reflector and a feed. The reflector (dish) and the corresponding feed are built with respect to the specifications. Due to manufacturing tolerances the theoretical position of the feed does not completely fulfill the specifications. So relative movements of the feeds with respect to the reflector are necessary.

Alcatel Space has developed a new process for this optimization, called „Pathfinder System“. After testing the feeds with their theoretical position, deviations are analyzed by software and hardware and the new optimized position for the feeds is determined. Pathfinder is fully automated. It controls two Physik Instrumente M-850 Hexapods to reach the optimized position of the feeds. The M-850 Hexapod is a complex six-degrees-of-freedom micropositioning system featuring better than 1 µm linear resolution and better than 5 µrad angular resolution in all axes. It also allows the user to define the pivot point any-

where inside or outside the system's envelope. Pathfinder drastically reduces testing time and increases performance, correcting deviations in pointing and



Fig. 1, Two M-850 Hexapods at Alcatel Space, Compact Antenna Test Range. This example shows optimization of the Eutelsat W4 Africa Antenna. Courtesy of Alcatel Space.



Fig. 2, M-850 Hexapod

gain with an accuracy of better than 0.01 mm and 0.001 deg. The new system has already demonstrated its full efficiency. More than 15 antennas have been optimized to date (1999).



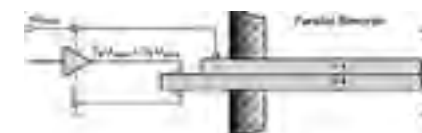
Fig. 3, Alcatel Space Compact Antenna Test Range. Courtesy of Alcatel Space

## High Resolution Multilayer Benders New PI Ceramic Piezo Actuators work under extreme conditions.

- Ideal for OEM Applications
  - Positioning Range up to 2 mm
  - Fast Response ( $\leq 10$  msec)
  - Nanometer Scale Resolution
  - Low Operating Voltage (0 to 60 V)
  - Low Temperature Compatibility
- The new line of Piezo Multilayer Bender Actuators from PI Ceramic now travels up to 2 mm and provides improved material characteristics (e.g. temperature range, protection from humidity etc.). Apart from standard models, custom sizes are available for volume buyers. OEMs will also appreciate the low operating voltage of only 60 V.

Recent tests at an Italian research institute have shown that the new

actuators operate at temperatures as low as 4 Kelvin. The researchers who design a novel Magnetic Microscope found that the actuators worked reliably and would still provide sufficient travel under these extreme conditions. **Target Applications:** Wire Bonding, fiber-optic switches, beam deflection, (pneumatic) valves, nanopositioning. Request our datasheet!



Principle design of the PI Ceramic multilayer bender

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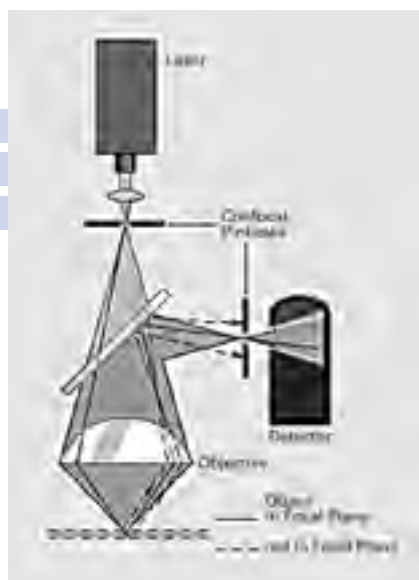


Fig. 1, Principle design of a confocal microscope

# Confocal Microscopy:

Nanometer Precision in Milliseconds: Ideal Application Field for Piezo NanoPositioners

Confocal microscopes provide significantly higher resolution than conventional microscopes. They also allow imaging of living cells (unlike



Fig. 2, P-527.ZC, 200 µm NanoScanning Stage

electron microscopes) and are widely used in the fields of semiconductor testing, materials research and biology. Confocal microscopy is based on scanning the specimen in X, Y and Z direction and capturing images at each individual XYZ coordinate. For high throughput and quality, the motion between the individual positions has to be fast and precise at the same time. Both requirements are met by PI Piezo NanoPositioning Systems as indicated in the examples which follow.

P-720 through P-723 PIFOC® Microscope Objective-Scanners are simply screwed between the microscope and the objective. A variety of thread options allows adaptation to all standard microscopes. PIFOCs® are available with scanning ranges of 100 - 350 µm providing resolution of better than 1 nm.

POWFOC™ Turret-Scanners provide scanning ranges of 100 µm and 200 µm and sufficient force for scanning the complete turret with several objectives (Fig. 3).

For scanning the sample, the new P-500 stages are recommended (Fig. 2). They provide scanning ranges to 200 µm and resolution of better than 1 nm (integrated capacitive position sensors).

## Interferometric Telescopes

Alenia Aerospazio, Italy, designs Mirror Stabilization with PI Piezo Actuators

The Global Astrometric Interferometer for Astrophysics (GAIA) is one of ESA's (European Space Agency) cornerstone missions in the Horizon 2000 Plus long-term scientific program. GAIA's objective is to determine star positions and motions with an accuracy of 10 micro-arcsec. This accuracy can only be realized with sophisticated interferometric measurements where distance variations as small as a few picometers between individual optical



Fig. 1, „Optics Active Control Experiment“ Prototype. Courtesy of Alenia Aerospazio

components in the interferometer can be detrimental.

For nullification of these variations Alenia Aerospazio, Italy, designed an active tip-tilt mechanism based on three PI Piezo Actuators (model P-844.20, Fig.2). The following tests proved the active control system to be capable of ensuring the ultra-high stability requirements fundamental for the achievement of the GAIA mission goals.

Need more information? Talk to your local PI representative.



Fig. 2, Enlargement showing the P-844.20 Piezo Actuator. Courtesy of Alenia Aerospazio

Fig. 1 shows the principle of a confocal microscope. The specimen is illuminated by a laser beam. Due to the small dimension of the illuminating light spot in the focal plane, stray light is minimized. Reflected light from all structures being out of focus is suppressed by a pinhole before reaching the detector. Only light returning from an exact plane passes through. For a complete 3 D image many slices have to be taken and superimposed by software. The depth of the focal plane is typically on the order of several 100 nanometers. For imaging small structures with optimal contrast, scanners (nanopositioners) with resolution of better than 20 nm should be used. Confocal microscopes use different types of scanning techniques: a) scanning the objective and b) scanning the sample. PI offers a variety of solutions for both versions:



Fig. 3, POWFOC™ Turret-NanoScanner with microscope turret and P-500 XY scanning-stage

## LabView™ Driver for E-710 Digital Piezo Controller

New LabView™ drivers are now available for the E-710 Three- and Four Channel Digital Piezo Controllers.

The drivers support both IEEE488.2 and RS-232 communication (COM 1 through 4). A variety of virtual instruments allow easy access to the functions and features of the E-710 controllers and facilitate individual programming.

The drivers and documentation are available at no charge. Please contact your PI distributor for more information.



E-710 Digital Piezo Controller

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