Piezo · Nano · Positioning

news

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Small but Power-Packed – NEXACT® Piezo-Walk® Drives for Micro- & Nanopositioning

PI's third line of piezo linear motor drives combines unlimited travel range, sub-nanometer resolution and high dynamics in a very compact package

Precision motion over several millimeters with high position resolution places great demands on drive hardware. Not only do dynamic performance and generated force requirements have to be considered for each application, but also available space.

Three Systems: One Solution for Every Application

PI has been providing two types of piezo linear motors for many years. The new and cost-effective NEXACT® piezo linear drives now fill the niche between the fast, flat PILine® drives (50 nm resolution, up to 800 mm/sec) and the heavy-duty, ultra-precise NEXLINE® drives (up to 600 N, sub-nanometer resolution). The outstanding features of the NEXACT® OEM stepping drives include virtually unlimited travel range, very high positioning resolution in the sub-nanometer range and highly compact design – the N-310 is only 25 x 25 x 12 mm (1" x 1" x 5/16") – not to mention the vacuum-compatible and non-magnetic operating principle.

Steps in the Right Direction

The decision to use piezo stepping drives to combine long travel ranges with the high resolution typical of piezo positioners was confirmed by the great success of the NEXLINE® product line. The high-end NEXLINE® stepping drive was specially designed for use in semiconductor production with extreme stability, dynamics and load requirements. The new N-310 NEXACT® drives with 20 mm travel range are suited for applications which also need picometer resolution, but require lower forces (10 N or less) and smaller size.

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N-310 NEXACT® compact piezo motor linear drives, sub-nanometer resolution, 20 mm travel range, 25 x 25 x 12 mm small

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Small but Power-Packed – NEXACT® Piezo-Walk Drives for Micro- & Nanopositioning

NEXACT® technology uses the PiezoWalk® drive principle that combines two operating modes: step motion for unlimited travel range and a highly-dynamic linear (analog) mode for sub-nanometer resolution within a step. The runner of the linear drive is moved forward or backward by piezoelectric actuators, which alternately clamp and drive it. In the ultra-high-resolution linear mode, all the piezo actuators clamp and drive the runner together, without stepping. NEXACT® differs from NEXLINE® in its smaller size, lower force generation and lower operating voltage of less than 50 V. In summary, NEXACT® OEM drives are, with 10 mm/s, faster, smaller and more cost-effective than NEXLINE® actuators, but less powerful. Compared to PILine® ultrasonic drives, NEXACT® stepping drives are more powerful and more precise, but not as fast.

Micro or Nano: The Electronics Make the Difference

NEXACT® actuators are basically two drives in one. For applications where compact design, high driving force and velocity are crucial, yet micrometer resolution is sufficient, special cost-effective drive electronics supporting only the stepping mode are available. For ultra-precision nanopositioning applications, the highly sophisticated E-860-series NEXACT® driver/controller series supports both stepping and linear modes in open- and closed-loop operation.

Properties of NEXACT® Features:

- High-Resolution PiezoWalk® Drive with Basically Unlimited Travel
- Compact Dimensions
- Cost Effective
- Resolution < 100 Picometers
- Velocity 10 mm/s
- Push/Pull Force 10 N
- Vacuum Compatible and Non-Magnetic Drive Principle

Single-Probe Capacitive Gauge for Nanometrology Applications

PISeca™ Capacitive Displacement Sensors measure with high bandwidth and sub-nanometer precision against any kind of electrically conductive target.

Capacitive displacement sensors measure the shortest of distances with highest precision and reliability. The new PISeca™ single electrode sensors are based on PI's 15 years of experience with nanomeasuring systems. Together with the ultra-low noise E-852 signal conditioning electronics, PISeca™ sensors provide linearity to 20 nm (< 0.1% range) and bandwidth to 6.6 kHz. These single-probe nanometrology sensors are easy to integrate and are ideally suited for measuring:

- Displacement to 1 mm
- Vibration, Flatness, Thickness
- Layer Thickness
- Tip / Tilt
- Straightness & Flatness
- Cross-Talk
- Out-of-Plane/Out-of-Round Motion
- Micro Newton Forces

In addition to the E-852 single-channel electronics, a number of modular, 3-channel controllers are now also available.

Request the New Capacitive Sensors Brochure!

24-Bit Resolution for NEXLINE® Drives

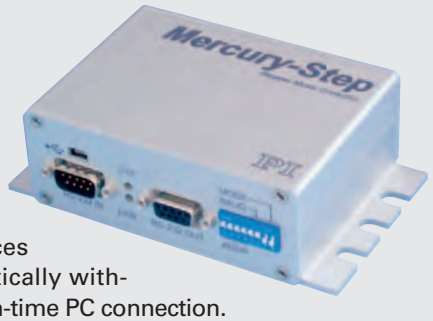
The new E-755 controller for NEXLINE® linear drives enables the combination of long travel ranges and picometer resolution

NEXLINE® is a patented high-force, ultra-high-precision linear motor actuator developed to bridge the gap between micro- and nanopositioning technology. The highly reliable, all-ceramic NEXLINE® drives have won a technology award from the semiconductor community and are ideally suited for static and dynamic high-precision positioning of high loads. PI currently offers 3 standard NEXLINE® actuators (N-110, N-214, N-215) for closed- and open-loop operation with maximum loads of 6 and 60 kg.

New Controller Features Digital Linearization, Linear Encoders, 24 Bits, Picometer Resolution

The new E-755 NEXLINE® motion controller combines sophisticated control algorithms, high-end 32-bit digital filters and output channels with extremely low-noise, 24-bit D/A converters. In closed-loop operation, outstanding linearity, within 0.001 % over the full travel range, is achieved by polynomial linearization. Standard N-214 NEXLINE® nanopositioning drives are equipped with 10 nm linear encoders for long-range position control (higher resolution encoders can be handled by the controller as well). Due to its low-noise, 24 bit D/A converters, the E-755 can provide picometer level resolution in the highly-dynamic short-range/dithering mode. E-755 controllers come with an extensive software package including LabVIEW drivers for simple and flexible automation of nanopositioning tasks.

Stepper Motor Controller for Cost-Sensitive Applications



The Mercury™ Step stepper motor controller is the perfect solution for cost-effective, modular and flexible motion control applications. Its high-resolution microstepping mode with 6400 steps/rev. provides for ultra-smooth motion.

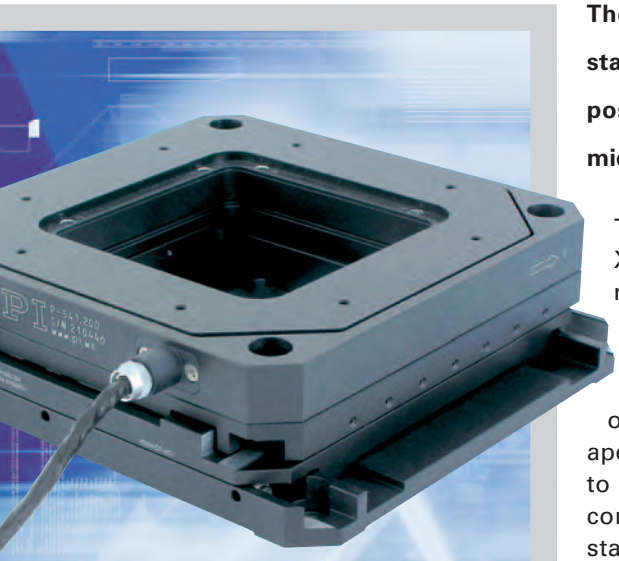
Modular Multi-Axis Control, Combination of DC & Stepper Motors

The networking feature allows the user to start out with one Mercury™ controller and add more units later for multiaxis setups. The Mercury™ Step stepper motor controller shares its programming language with the well-established Mercury™ DC-motor controller. Up to 16 Mercury™ controllers (DC and stepper) can be daisy-chained and operated from one computer. Micropositioning systems with stepper motors and Mercury™ Step controller (C-663) are ideally suited for cost-effective automation systems.

Flexible Operation: Stand-Alone or Control by USB, RS-232, Joystick or Push-Buttons

The C-663 provides a number of operating modes. For computer control it is equipped with both USB and RS-232 interfaces. In stand-alone mode Mercury™ Step controllers can execute predetermined command sequences automatically without a run-time PC connection. These sequences are conveniently generated with the host software macro editor and then stored directly in the C-663 controller. 4+4 I/O lines (8 bit resolution on the inputs) are also available for flexible automation such as synchronization with external events or manual control. For operational safety, Mercury™ Step controllers support reference and limit switches. Manual control is supported with an optional joystick and a push-button pad.

Low-Profile XY Open-Frame Piezo Motor Stage with Linear Encoders



P-541 piezo scanner (Z or XY) mounted on top of the new M-686 XY piezo motor stage. The low profile height of only 43 mm (combined) makes for a compact, easy to integrate system.

The M-686 low-profile piezo motor stages are designed for fast sample positioning in applications such as microscopy.

This newly designed closed-loop XY stage is equipped with 0.1 µm resolution linear encoders and provides high-speed to 100 mm/sec over travel ranges of 25 x 25 mm. The low profile height of 27 mm and large 78 x 76 mm aperture makes for a compact, easy to integrate system. Compared to conventional motorized translation stages, the M-686 provides smaller footprint and a lower profile because the integrated PILine® piezoelectric linear motors make both the lead-screw/duct and bulky motors obsolete. In addition, the piezo motors are self locking at rest and hold the stage in a stable position.

Controller for Fast Response and Excellent Velocity Control

M-686 stages are driven the new C-866.164 PILine® controller. Equipped with a number of special features, such as dynamic control parameter adaptation it can support the extremely fast settling times and high speeds of ultrasonic piezomotor stages.

Compatible with Scanning Microscopy Piezo Stages

A number of standard PI piezo flexure stages (150 x 150 mm footprint) can be mounted directly on the M-686. Depending on the application, these highly specialized nanopositioning systems are available as fast, XY scanners (for fluorescence microscopy), as vertical, Z positioners (3D imaging), or with up to 6 degrees of freedom.

High-Dynamics Nanopositioning Stages add up to 100 µm Z-Travel

Successful P-733 stage family now features new XYZ-version and 100 µm Z-version

P-733 series piezo driven stages are fast and highly accurate nanopositioning and scanning systems. The 50 x 50 mm clear aperture is ideal for transmitted-light applications such as confocal and near-field scanning microscopy. In addition to the 100 x 100 µm XY versions, a new 100 µm Z-stage (P-733.ZCD) and a 100 x 100 x 10 µm XYZ stage (P-733.3CD) are now available.

The high-speed Z-axis of the P-733.3CD provides step and settle times of 10 msec and can also be used to actively compensate unwanted out-of-plane motion in XY scanning applications. Due to the parallel-kinematics layout (all actuators drive a single moving platform) both the X and Y axis achieve identical dynamic performance, a prerequisite for improved imaging speed and linearity.

Capacitive Feeback for Sub-Nanometer Precision

All stages are equipped with direct-measuring, capacitive sensors, providing a closed-loop resolution of 0.3 nm (0.2 nm for the 10 µm Z-axis) and negligible linearity errors of < 0.03 %.

OEM-PZT-Actuator & Driver Modules

PiezoMove® Lever Amplified Actuators and E-831 Amplifier Modules: Compact, Cost-Effective, Long Travel Ranges.

The combination of the compact P-601 PiezoMove® actuators and E-831 driver modules is the ideal solution for OEM applications where space is at a premium and long travel ranges and high dynamics are of the essence.

PiezoMove® vs. Conventional Lever Amplified Actuators

Lever amplified piezo actuators provide significantly longer travel ranges than piezo stack actuators. What sets PiezoMove® actuators apart are the internal frictionless flexure-guides, making additional bearings or guiding mechanisms obsolete when integrating the actuators into a positioning system. Three versions providing up to 480 µm travel and resolution to 0.2 nm are available.

Stiff Design With Millisecond Response Times

The stiff design with high resonant frequencies to 750 Hz allows settling times of only a few milliseconds, ideal for highly dynamic applications.

Compact E-831 Driver Provides 100 mA/120 V

The minute driver module (50 x 30 x 14 mm) is a high-precision 4-quadrant amplifier and provides peak curents of 100 mA and 12 W peak power for dynamic linear operation or fast switching applications. The E-831 amplifier is well protected by two current limiters and a temperature sensor.

PIHera® Piezo Stages Feature Record Travel Ranges

Compact Nanopositionig Stage Series extended by four new X and YX models featureing up to 1.5 mm Travel.

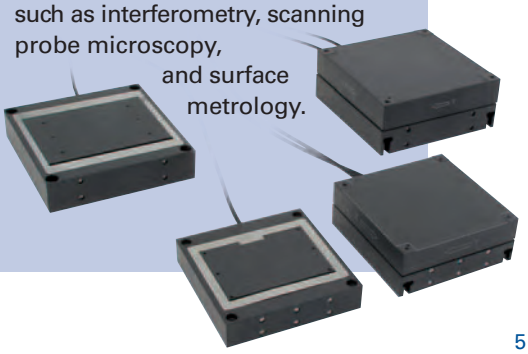
PIHera® closed-loop piezo flexure stages combine the longest travel ranges and highest precision in the industry at a very affordable price. The long travel ranges to 1500 µm are achieved with a newly designed, friction-free and extremely stiff flexure system, which also offers rapid response and excellent guiding accuracy with trajectory precision typically in the low-nanometer range. High acceleration forces are provided by multiple, high-force multilayer piezo stack actuators.

Large Family of Compact X, XY, Z Stages

PIHera® stages are available as X, XY and Z positioners with travel ranges from 60 µm bis 1500 µm. The new P-628 (1000 µm) and P-629 (1500) µm stages are currently offered in X and XY configurations for open- and closed-loop control. All PIHera® stages are very compact compared to their travel range and measure between 30 x 30 x 12 mm (60 µm version) and 100 x 100 x 22 mm (1.5 mm version).

Nanometer Precision for QA Applications

Most PIHera versions provide sub-nanometer resolution and even the 1.5 mm versions achieve 5 nm resolution in closed-loop operation. The ability to control motion with nanometer precision over long travel ranges makes PIHera® stages ideal for measuring and QA applications such as interferometry, scanning probe microscopy, and surface metrology.



Parallel-Kinematics 6-Axis Positioning System:

Ultra-Precise Measuring System for Optical Surfaces

Inserts for precision optical molds make high demands on the testing process. Today, such testing can easily be automated with the help of interferometric measuring devices. Parallel-kinematics Hexapod 6-axis alignment systems even make it possible to integrate testing directly in the manufacturing process.

Fig. 1: The tighter the tolerances required for a product, the higher the precision required of the testing equipment. The optical mold inserts for production of plastic or glass lenses have especially high precision requirements.
(Illustration: Fraunhofer Institute for Production Technology, IPT)

The integration of testing equipment for optical mold inserts (Fig. 1) directly into the manufacturing cell avoids complex and time-consuming setup steps and completely eliminates rechucking errors. The new testing unit developed by the Fraunhofer Institute for Production Technology (IPT) in Aachen, Germany tests the optical mold inserts directly in-line, on the production machine. Discrepancies are calculated and the error is fed back into the process where it can, if necessary, trigger automatic reworking of the optical surface. Automated interferometric surface testing is the key to the system.

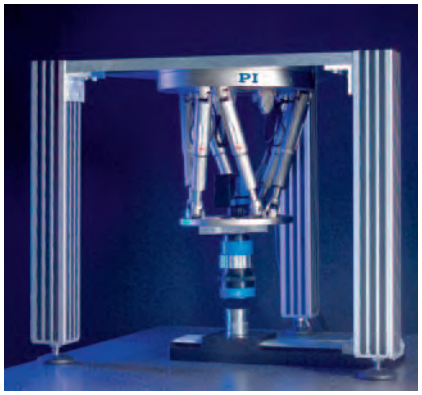


Fig. 2: The Hexapod is mounted on a 20 mm thick aluminum plate. The parallel-kinematic design and large aperture allow for the interferometer to be integrated into the Hexapod. Images are captured by a CCD camera and evaluated in real time. A MATLAB program, controls the position of the Hexapod.
(Photo: Physik Instrumente, PI / Fraunhofer Institute for Production Technology, IPT)

Interferometric testing: non-contact, fast and extremely precise

Interferometric optical mold testing uses the interference pattern (fringe pattern) which gives information about the topography of the test sample. Image processing algorithms automatically recognize and evaluate shape deviations with nanometer accuracy. The interferometer must, of course, be positioned very precisely relative to the optical surface.

First, coarse adjustment aligns the beam reflected off the test surface with the CCD sensor. Then, with the fine adjustment, a well-defined interference pattern is created. The automated fine-adjustment algorithm uses the Fast Fourier Transformation (FFT) technique to analyze the fringe pattern. The adjustment strategy is based on an evaluation system newly developed at the Fraunhofer IPT, which determines the topology from a single interference pattern.

In order to test both spherical and aspherical elements, motion in six degrees of freedom is required (Fig.3). For this purpose, a PI parallel-kinematics positioning system is used. In addition to very high accuracy, it offers further advantages such as low inertia, uniformly high dynamic performance for all motion axes, and a compact design with a large aperture.

Hexapod: Six Degrees of Freedom and Freely Definable Pivot Point

The PI M-840 Hexapod chosen also provides rapid settling after a move, a linear travel range of up to 100 mm and a rotational travel range up to 60°. The large working space makes it possible to measure spherical surfaces with a radius of up to 100 mm. Also important for both the coarse and fine alignment process is the

freely definable pivot point, which is not affected by motion. The optical mold testing interferometer system achieves impressive values: 3 µm accuracy in X and Y, 1 µm in Z – with repeatabilities also of 3 µm and 1 µm, respectively. The rotational minimum incremental motion of only 0.017 arc minutes (5 µrad) is over an order of magnitude better than the required 1 arc minute.

Simple Integration

It was surprisingly easy to integrate the Hexapod into the application's automation environment. Control is simplified by the Hexapod controller's open interface architecture, which facilitates programming with high-level commands using any of a variety of included drivers (COM Object or DLL). The Hexapod controller can thus be operated by external programs, such as the MATLAB programs employed for image processing and analysis in the testing interferometer. The flexibility of the Hexapod system played an important part in making possible the first fully integrated automated testing device for optical components with complex geometries. The new interferometer will significantly simplify quality control while providing higher precision than otherwise possible.

Karl Vielhaber, MSc, scientific assistant at the Fraunhofer Institute for Production Technology (IPT) in Aachen, Germany and Ellen-Christine Reiff, M.A., Editorial Service Stutensee

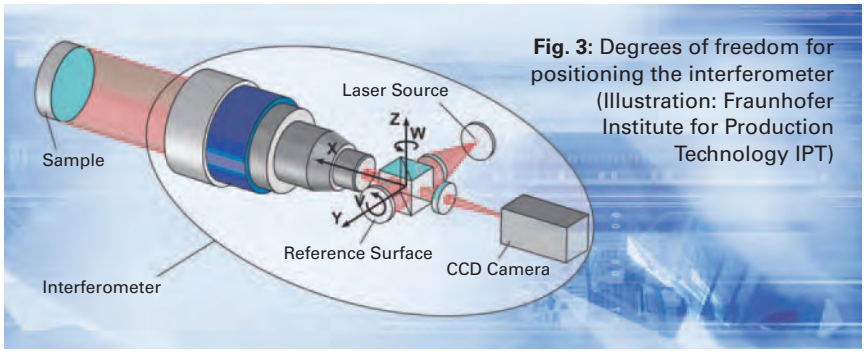


Fig. 3: Degrees of freedom for positioning the interferometer (Illustration: Fraunhofer Institute for Production Technology IPT)

New High-Performance Piezo Actuators and High-Voltage Amplifiers

Successful high-force piezo actuator series updated with PICA™ Power PZT ceramics; new line of high-voltage drivers also available

PI is the leading manufacturer of piezo actuators and offers the largest product variety in terms of load capacity, travel range, temperature range and dynamics. While most medium and low force actuator applications are covered by PI's patented PICMA® multilayer technology, the classical PICA™ actuator technology enables applications where extremely high forces are required or high levels of customization are needed.

Lower Power Consumption, Forces to 30,000 N, Amplifier Power from 1 to 2000 W

Four newly developed, preloaded HVPZT actuator series (P-212, P-216, P-225 and P-235) are now equipped with the advanced PIC 255 PICA Power piezoceramic stacks. They feature load capacities from 2,000 N to 30,000 N, travel ranges from 15 µm up to 180 µm and standardized dimensions. The integrated preload makes these actuators ideal for dynamic applications (e.g. precision machining, active vibration damping, etc.) and push-pull applications. In contrast to HVPZT actuators of older design, they have positive polarity and a different connector. The low-capacitance, piezo ceramics require less electric power – a special advantage for high dynamics applications. Five RoHS compliant high-voltage amplifiers ranging from 1 to 2000 watts of power are available to drive the new HVPZT actuators. All models (E-462, E-464, E-508, E-421 / E-470 / E-471 / E-472, E-481) are delivered preset to provide positive output voltages and otherwise improved in many details compared to their predecessors.

DuraAct – Piezoelectric Transducers for Industrial High-Volume Applications

Used either as actuators or sensors, DuraAct transducers offer an outstanding combination of precision, reliability, flexibility and variety

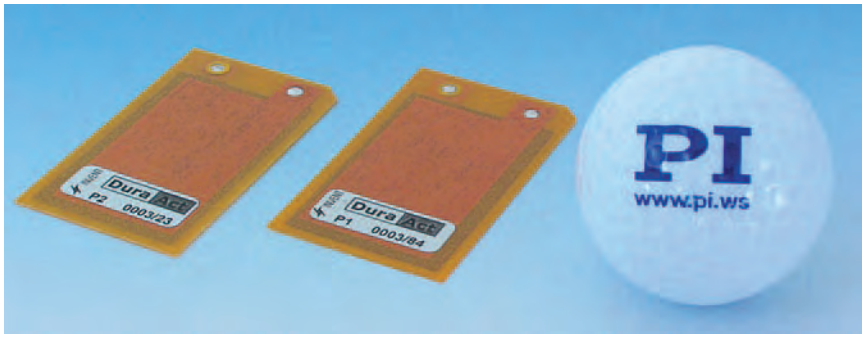
The P-876 DuraAct combines the functionality of the piezoceramic material as sensors or actuators, both for electrical charge generation and storage. As an actuator, it can be used as a bending element or as a precision positioner. Other possible uses for DuraAct are as high-dynamics sensor or for energy harvesting. P-876 DuraAct transducers have commercial application in mechanical and plant engineering, aviation, in the automobile industry as well as sporting goods and building automation.

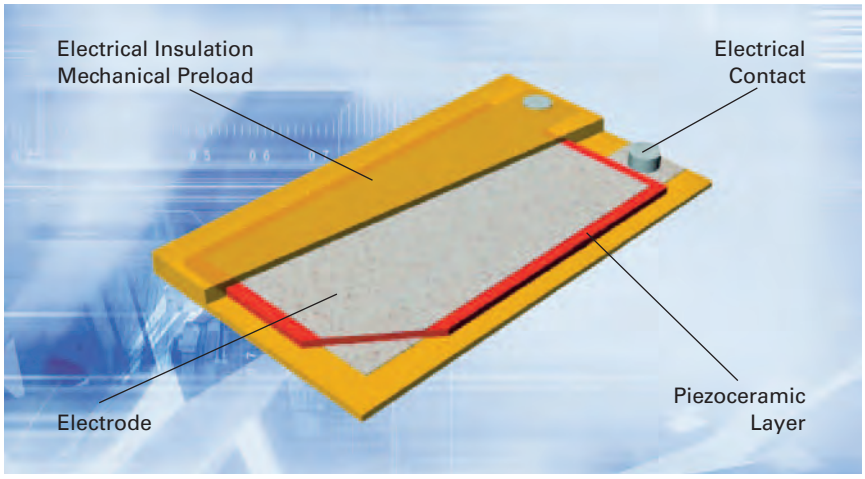
DuraAct transducers are ideally suited for active and adaptive systems. Embedded in a servo-control loop, vibrations of parts can be reduced and contours can be controlled in the nanometer range.

The P-876 patch actuator features a rugged design with the mechanical stability of a structural material. With their compact design, DuraAct transducers can be applied to structure areas where deformations are to be generated or detected. For this purpose, the transducers can be affixed to the surfaces of structures or integrated as structural elements themselves.

DuraAct patch transducers have the following main application areas:

- Noise cancellation
- Vibration cancellation
- Adaptive surface control, structural deformation and stabilization
- Energy harvesting
- High-dynamics positioning and precision motion control
- Structural health monitoring





INVENT GmbH and PI sign cooperation contract

During the Adaptronic Congress 23 and 24 March 2007, the DLR (German Aerospace Center), INVENT GmbH and PI GmbH & Co. KG signed a cooperation agreement for focusing their know-how on the acclaimed DuraAct transducer.

The accord specifies that the DLR-developed transducers will be manufactured at INVENT. PI Ceramic will provide the piezoceramics and take delivery of all units in an exclusive marketing arrangement. "We are convinced that the DuraAct working principle is viable," said Norbert Ludwig, Vice President Sales and Marketing of PI, who sees for DuraAct good success prospects in established sales channels.

More information about DuraAct: ISPA 2007 – International Symposium on Piezocomposite Applications, 27 – 28 September 2007 in Dresden, Germany.

New LabVIEW® Drivers for Analog Piezocontrollers

LabVIEW® drivers simplify control of analog piezo controllers. HyperBit™ increases resolution by up to 11 bits.

The integration and control of PI piezo controllers under LabVIEW® has long been made easy by the provision of comprehensive LabVIEW® libraries (VI) for digital interfaces such as USB and RS-232. The VIs allow the flexible programming of closed-loop and open-loop piezo controllers. In addition to standard LV drivers for voltage and position, a set of complex VIs for step response, velocity control and function generation are now also available.

New Drivers for Controllers w/o Digital Interfaces

The same functions that are supported for PI digital controllers can now also be used on PI controllers with analog inputs. Also, all customers who prefer to generate control signals with a D/A card will benefit from these drivers. The new E-500.ACD software drivers are free of charge and support most National Instruments D/A cards.

HyperBit™ Technology for Even Higher Resolution

The patented HyperBit™ technology allows attaining position resolution many times better than the resolution of the DAQ board used. Depending on the model, improvements of up 400% (2-bit) to 12,800% (7-bit) are feasible. Lately an improvement of 11 bits was realized with a 16-bit card! The E-500.HCD HyperBit™ drivers are available as an option to the E-500.ACD analog LabVIEW® drivers. The standard E-500.ACD drivers can be downloaded from the PI Website free of charge.

For more information, request or download the PI Software Brochure

PicoCube®: Reference-Class System for Nanotechnology

New E-536 controllers enable even higher resolution and bandwidth with the minute P-363 PicoCube® piezo stages.

The minute P-363 PicoCube®, together with its reference-class, ultra-low-noise E-536 driver/controller, are ideally suited for nanotechnology applications. They provide significantly higher dynamics, resolution and positional stability than previous multi-axis scanning stages. Nano-imprint lithography, scanning microscopy and biotechnology benefit from the extremely high resolution of up to 25 picometers over travel ranges of 5 µm per axis.

Controllers: Optimized for Highest Resolution / Bandwidth

Two controller versions are available. For high-speed scanning applications the E-536.3C high-power models featuring 100 watts per channel are recommended. The E-536.3CH ultra-low noise versions are optimized for highest positioning accuracy and resolution in the picometer range.

Compact 2-Axis and 3-Axis Stages

The compact PicoCube® is available as XY and XYZ system. It is based on exceptionally robust, high-stiffness shear piezo drives and employs non-contact, direct-measuring, parallel-metrology capacitive sensors for position feedback.

The low-inertia drives allow for a resonant frequency of 10 kHz, important for high speed scanning applications. Measuring only 30 x 30 x 26 mm (XY version), it is easy to integrate in any scanning apparatus.

Tradeshows

June			
18 – 21	Laser	München, Germany	Hall B1-457
July			
17 – 19	Semicon West	San Francisco (CA), USA	Booth 6149
August			
28 – 30	Optics & Photonics	San Diego (CA), USA	Booth 820
September			
11 – 12	Optics East	Boston (MA), USA	
16 – 20	ECOC	Berlin, Germany	Booth 12, 12045
19 – 20	Diskcon	Santa Clara (CA), USA	Booth 119
October			
09 – 11	Semicon Europe	Stuttgart, Germany	
17 – 19	Opto Paris	Paris, France	
November			
13 – 16	Productronica	München, Germany	
14 – 16	ComPaMED	Düsseldorf, Germany	
19 – 23	CEMOI	France	
27 – 29	SPS/IPC/Drives	Nürnberg, Germany	

Growth Needs Room: 97,000 ft²

Continuing growth has made production-area expansion necessary

It was only 2001 when PI moved into the current company building, with what was then a considerably larger production area. Thanks to continuing growth – sales were doubled in three years – the Production Dept. has had its hands full. Finally, more capacity and more space was necessary, and the previously unused area on Level 4 of the building was appropriately remodeled this year. This results in an expansion of the production area of 2800 square meters (30,100 sq. ft.), to a total of 9000 square meters (97,000 square feet) PI is now primed for future challenges and more growth. The new facilities can be visited during PI's open house day on 8 July 2007.

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