New E-500 PZT Electronics

In January, PI introduced new PZT electronics. The new electronics comply with the 1996 EMI European Community regulations and offer a number of additional advantages. The new E-500 19" rack mount units now allow operation of High Voltage PZTs and Low Voltage PZTs from one device plus a variety of other options.

E-500 features:

- 19 inch rack mount, modular design
- High and/or Low Voltage PZT drivers can be installed in one unit
- Operation without display module possible (saves OEMs money)
- LVDT, Strain Gage & Capacitive Gage position sensor electronics
- Optional intelligent multi-function-computer interface with 4 1/2 digit graphical display
- Universal wide-band power supply (90- 260 VAC)
- Improved S:N ratio for optimum position stability.

E-500 basic units consist of a 19 inch chassis, an intelligent motherboard and a universal wide band power supply. Amplifier-, position servo control- and interface/display modules are optional. Up to 3 independent channels can be installed in one chassis. More information about new PZT electronics will follow in the next issue of M&P.

Caption
E-500 with 2 x E-507 HVPZT amplifier, 1 x E-505 LVPZT amplifier, E-509 sensor/servo controller and E-515 display/interface

Microscope Objective Positioner with Nanometer Resolution

The new P-915.748 PIFOC completes the PI family of high resolution, piezoelectric, Microscope Objective Positioners. The new P-915.748 positioner is equipped with capacitive gage feedback and allows position repeatability in the low nanometer range.

Features:

- Travel range 100 µm
- Resolution <1 nm
- Repeatability ≤ 2 nm (closed loop)
- Straightness of travel ≤ 5 arcsec
- Settling time 10 - 20 ms
- Compatible with standard microscope objectives
- Compatible with E-610.C0 OEM control module (p. 4)

Mounting: PIFOC Microscope Objective Positioners can be mounted on almost any microscope. The units are screwed between the turret and the objective, extending the optical path by only 13 mm (infinite path length microscope required). Standard threads are W 0.8x1/36", other threads are available on request.

Application examples: Scanning interferometry, surface structure analysis, confocal microscopy, bio-technology, semiconductor test equipment.

Caption
PIFOC with integrated capacitive sensor

M-038 Rotary Stages with new DC-Motor Drive and Reference Hall-effect Sensor

PI introduces the new M-900.916, a special version of the M-038 Precision Rotary Stage (360° range, 100 mm diameter, 40 kg load capacity). M-900.916 is equipped with a Hall-effect homing sensor and a DC servo motor drive with anti-backlash gear head. The new drive features higher velocity, better resolution and repeatability for an extended application range.

The rotary stage is equipped with a 180:1 worm-wheel drive spring-preloaded for zero backlash. Resolution is up to 1 arc second and velocity up to 6°/sec. Optical, motor shaft mounted rotary encoders provide position feedback for operation with DC-Servo motor controllers. The new stage also features a rotary-platform mounted Hall-effect sensor for home positioning with ±5 arc seconds repeatability.

The M-038 versions with standard DC servo motors and 5 phase stepper motors remain available.

Caption
Rotary stage with reference Hall-effect sensor

Trade Shows

Come see us at:

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Micro 96, July 2-4

Australia
XX International Quantum Electronics Conference, July 14-19

USA
SEMICON WEST, July 16-18

Taiwan
OE-EXPO, July 25-28

Novel bending tester for highly flexible materials employs PI precision positioners.

The "Institut für Materialforschung 1" at the "Forschungszentrum Karlsruhe" has developed a new test system for material bending and fatigue testing. The system is particularly well suited for highly flexible materials such as polymers, carbon- and glass fiber composites, metal film and other materials that are important for microsystem technology. The new testing process allows for bending angles to ±90 ° and radii < 1 micron while maintaining pure bending deformation as well as "zero-lateral force" materials testing that would not be possible with traditional test methods.

The test stand consists of three principal components:

- motorized X-Y-θ_z positioning system
- sensor unit
- control computer (PC)

The positioning system consists of two PI M-500 linear stages and a rotational stage. A sample holder mounted on the rotary stage holds one end of the bending sample, while the other end is mounted on a fixed clamp that also incorporates the bending sensor.

Trajectory control was implemented by software and two PI C-832 motor controller boards. The control software synchronizes the motion of the positioning system in a way that the sensor mounted end of the sample moves on a path free of disturbing lateral forces. This ensures constant bending moment distribution over the entire sample length.

The sensor feeds the bending moment information into the serial port of the PC via a digital amplifier. Resolution is up to 20 bit at 600 Hz bandwidth. Position encoders on the positioners provide exact information about angle (1/100°) and linear position (1 micron).

The program "FATIBEND" (written in C) controls the complete measuring cycle for unidirectional and reverse bending and fatigue tests. Before a test cycle starts, all X-Y target positions are calculated to ensure bending with zero lateral forces. During the motion, velocity and position data are processed in real-time "in the background". The test stand was set up in April 1995 and has been utilized continuously since then. Current memory alloy fatigue tests prove the system to be ideal for long term tests.

Thanks to Dipl.-Phys. R. Plietsch from IMF 1, FZ Karlsruhe for the information and photo.

Caption: Bending tester with motorized positioners and bending sensor

New LabViewä Drivers for C-832 and C-842 DC Motor Controllers

PI offers new LabView drivers for C-832 and C-842 DC motor controller boards. LabView was introduced by National Instruments several years ago and finds more and more users each year, world-wide. LabView facilitates control of multiple devices (of various manufacturers) from one software package. It allows data acquisition, analysis and control of IEEE 488, RS-232 and PC bus devices via graphical, object oriented commands. Each basic function of a device (e.g. on, off, run, stop etc.) can be defined as a virtual instrument (VI) for later use as a sub-routine.

An example of a VI is given in the illustration. The C-842 motor controller LabView demo software is equipped with (virtual) knobs, buttons and switches. Velocity e.g. can be set by a mouse click on the velocity control knob. Positions are entered in the corresponding "Move" fields and a click on the Move Relative (+/-) or Move Absolute buttons will determine which way to go. Flipping the Run switch will start the motion.

VIs can also perform complex functions (combinations of basic functions).

Example: How to automatically couple a fiber to a laser diode with a positioner, a motor controller and an optical power meter? If LabView drivers are supplied with the units, it is a simple job for a LabView programmer to combine the functions of the power meter and the motor controller. He will not have to worry about implementation of the commands and addressing of the interfaces. LabView will acquire data from the power meter and cause the motor controller to change the position until maximum power is coupled into the fiber.

PI already provides LabView drivers for most of its controllers and instruments.

Caption
Operating elements of a VI for C-842 motor controllers

Piezo Ceramics for Adaptive Structures

Piezo ceramics from PI Ceramics play an important role in the development process of adaptive structures at the German DLR "Institut für Strukturmechanik" (Society for Aeronautics Research, Institute for Structural Mechanics). Close cooperation and custom piezo actuator design by PI fostered the R&D work at the DLR.

Adaptive structure systems automatically adapt to varying external conditions via integrated actuators, sensors and controllers. The controller acquires system information from the sensors and calculates the required control output to the actuators by comparing the actual data with the target data.

R&D on adaptive structures began world-wide in the late 80s and, in Germany, was substantially supported by the DLR's "Institut für Strukturmechanik", right from the start. Today this institute has extraordinary experience in adaptive materials systems.

The following key projects are currently being worked on:
- adaptive rotor blades for helicopters
- adaptive engine suspension for turbo-prop aircraft
- adaptive wing (fixed wing aircraft)

PZT actuators and ceramics are employed for all these projects.

The objective of the adaptive rotor development is reduction of vibration and noise propagation of helicopters by individual control of each rotor blade. At the same time the aerodynamic efficiency will be improved. The DLR plans on influencing blade dynamics by twisting the outer blade parts (maximum aerodynamic efficiency) synchronously with the azimuth angle. A combination of PZT ceramics and struts made of composite fiber materials, integral to the blade convert lateral piezo motion into torsional motion. Initial tests on deformation kinematics and actuator requirements were successfully completed. The principle actuator design developed for helicopters can be applied to other rotor systems, as well.

The idea of the adaptive engine suspension (see fig. 1) is to suppress vibration transmission from the engine to the wing and the rest of the aircraft. A scaled test version is currently being developed at the DLR. It consists of a fiber composite space frame with integrated PZT stack actuators. PI Ceramic provided custom actuators (∅ 45 x 60 mm) for future tests with real world airplanes.

The DLR has a long track record of integrating PZT ceramics into fiber composite structures. A truss structure with integrated off-the-shelf PZT actuators was successfully used as a suspension for a satellite antenna. Integrated preload

allows operation of the actuators in push-pull mode. The graph in figure 2 shows a significant reduction of external vibration when operated in closed loop mode.

Other projects at the DLR deal with active noise abatement (noise radiation and conduction) by combining PZT ceramic plates and fiber to form composite material plates and dishes. Thanks to Prof. Dr.- Ing. Breitenbach, Dr. Lammering and Dipl.-Ing. Goetting (all DLR) for the information and illustrations.

Caption
Fig. 1: Model of a space frame engine suspension; active CFK rod with integrated PZT ceramics

Fig. 2: Suppression of truss vibrations

C-842.20 Two-Channel DC-Motor Controller Board

PI introduces the new C-842.20 Two-Channel DC Motor Controller board for IBM compatible PCs. The new board is compatible to the C-842.40 four axis version, introduced in 1995. It offers the same performance at significantly reduced price and is the optimal solution for applications where two motors have to be controlled by a PC.

The C-842. 20 features:

- Simultaneous control of 2 DC servo-motors
- Digital PID (Proportional, Integral, Derivative) gain control with software setting of all parameters
- Integrated amplifiers for motors up to 5 Watts
- PC bus compatible, less costly than bench-top controllers
- Extensive, easy-to-use programming language
- Powerful software with drivers for C, PASCAL and LabView™
- Hardware interrupts for process control
- Integrated I/O lines for flexible automation

C-842.20 will be available in June.

Caption
C-842.20 Motor controller

Versatile Power Source from GSG Elektronik.

The PI affiliated GSG Elektronik GmbH introduces a new AC power source. The galvanically isolated unit provides an output voltage of 0 to 320 VAC and power of 2 and 4 kW, respectively. The basic version comes with 10-turn potentiometers for voltage and current control and 3 1/2 digit displays for readout. The actual waveform is available via 2 BNC outputs, potential free. The power source can be controlled by an analog input signal (0 to 10 V) or an optional computer interface (RS-232 or IEEE 488). An optional keyboard allows programming and recall of up to 10 different parameter settings. A multi function LCD displays control conditions, real power output as well as target and actual values for voltage and current.

OEM PZT Controller provides Sub-Nanometer Resolution

PI introduces the new E-610.C0 Piezo-Amplifier & Position Servo Controller Module for capacitive displacement sensors. The module provides position control for low voltage PZT positioners to nanometer accuracy at a very attractive price. It is targeted for the OEM market and can be easily integrated into control units.

The E-610.C0 processes the feedback of high-resolution capacitve gages and regulates position of PZT precision positioners through a control input signal in the range of 1 to 10 volts.

Positioning accuracy is on the order of 1 nm, bandwidth is up to 1 kHz. The integrated amplifier provides 6 watts of power with an output voltage range of -20 to 120 volts.

Application examples: Micropositioning, semiconductor technology, micro-manufacturing, optics, laser-technology.

Caption
E-610.C0 with capacitive sensors

Low Voltage Piezos for High Vacuum Applications

Piezoelectric translators (PZTs) are ceramic actuators with sub-nanometer resolution and sub-millisecond response time. PI offers a new P-703.20 Ultra High Vacuum (UHV) option for their line of preloaded Low Voltage Piezos (LVPZTs). LVPZTs operate at 0 to 100 Volts and extend up to 90 microns with pushing forces up to 3000 N (660 lb.). The UHV option utilizes extremely low outgassing materials and a ceramic material that can withstand baking temperatures up to 150 °C. Additional vent holes in the PZT's steel case eliminate the potential for virtual leaks.

UHV versions of High Voltage PZTs (HVPZTs, 0 to 1000 V) have been available for several years. In addition to the reduced operating voltage, LVPZTs also offer reduced costs and more compact drive electronics over HVPZTs.

Application Examples: X-Ray crystallography, beam steering of synchrotron radiation, electron beam monochromators, STM, AFM.

Caption
UHV LVPZT translator

Focus Measurement of High Resolution Objectives with PI Precision Positioner

Even in the ages of SEM, ATM and AFM, light microscopes are not outdated. Actually they are gaining in importance, especially for non-destructive testing of sub-cellular structures and other biological imaging applications. The reason for this trend lies in the progress of optical scanning technology over the recent years. One of the new developments in this field is the modification of the illumination intensity distribution in the focus (point spread function engineering) to overcome the classical diffraction limited resolution. For this modification exact knowledge of the 3-D intensity distribution is required. The illustration shows the cross section (at the optical axis) of a commercially available, high numerical aperture objective (1.4 oil). The wavelength of the focused light is λ = 780 nm. Lateral distribution (point spread function) determines the lateral resolution of a light microscope, axial distribution determines the axial resolution (depth of focus). The illustration shows a small spherical aberration of the focused wavefront, appearing as an asymmetry regarding the focal plane. The accurate measurement of the focus was realized by detection of light scattered at a 30 nm gold particle. The particle was applied to a glass plate and piezoelectrically scanned through the focus in steps of 10 nm by means of a PI F-603 LightLine precision positioning system.

Caption
Intensity distribution in the focus
(Thanks to Priv. Doz. Dr. Stefan W. Hell, Turku /Heidelberg; see also: Hell, Soukka, Hänninen, Bioimaging, 3, 64, 1995.)

Optek Technology uses PI LightLine to Reduce Production Cycle Times and for Device Characterization

Optek Technology, Inc. (Carrollton, TX) produces optoelectronic, Hall-effect, and fiberoptic transmitters and receivers for commercial and aerospace applications. Until they introduced LightLine into their production process, they were taking up to twenty minutes to align an emitter/fiber package using conventional, manually operated stages. With LightLine, the alignment process is completed in less than 60 seconds and the parts are held in place while the adhesive cures. The production line system has been operating 10 hours a day for almost a year without a problem. A second LightLine system is used for research and quality evaluations of components.

Caption
LightLine fiber alignment system

PI opens new Sales Office in Japan

PI has opened a second sales office in Japan. The office is located in Osaka and will relieve the recently expanded PI office in Tokyo. It will provide customers in the technology centers around Osaka with technical support on PI's high-tech product lines. Most important for the Japanese market are the computer controlled PZT positioning systems with sub-nanometer resolution. They are the key to developing and producing smaller and smaller structures on semiconductors. Apart from the PI micropositioning product lines, the Osaka office will handle Polytec's lines of laser based measurement equipment.

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Editorial staff: Stefan Vorndran
Total Production: Druckerei Widmann, Karlsruhe

PI International:

GERMANY (D) (Headquarters)
Physik Instrumente (PI) GmbH & Co
Polytec-Platz 1-7
D-76337 Waldbronn
Tel: (07243) 604-100
Fax: (07243) 604-145

GERMANY (D)
PI Ceramic GmbH
Lindenstrasse
D-07589 Lederhose
Tel: (036604) 882-0
Fax: (036604) 882-25

FRANCE (F)
Polytec PI S.A.
32 Rue Delizy
F-93500 Pantin
Tel: (01) 48 10 39 30
Fax: (01) 48 10 08 03

ITALY (I)
Physik Instrumente (PI) Ufficio di Rappresentanza per l'Italia
Via E. De Amicis, 2
I-20091 Bresso (MI)
Tel: (02) 665 011 01
Fax: (02) 665 014 56

GREAT BRITAIN (GB)
Lambda Photometrics Ltd.
Lambda House
Batford Mill
GB-Harpenden, Herts AL5 5BZ
Tel: (01582) 76 43 34
Fax: (01582) 71 20 84

USA West/MEXICO
Polytec PI, Inc.
3152 Redhill Ave.
Suite 110
USA-Costa Mesa, CA 92626
Tel: (714) 850 1835
Fax: (714) 850 1831
Email: info@PolytecPi.com
web page: www.PolytecPi.com

USA East/CANADA
Polytec PI, Inc.
23 Midstate Drive
Suite 212
USA-Auburn, MA 01501
Tel: (508) 832 3456
Fax: (508) 832 0506
Email: info@PolytecPi.com
web page: www.PolytecPi.com

JAPAN (J)
PI Polytec KK
Akebono-cho 2-38-5
Tachikawa-shi
J-Tokyo 190
Tel: (0425) 26 73 00
Fax: (0425) 26 73 01

JAPAN (J)
PI Polytec KK
Hanahara Dai-ni Bld. #703
4-11-27 Nishinakajima,
Yodogawa-ku
Osaka-shi
J-Osaka 532
Tel: (06) 304 56 05
Fax: (06) 304 56 06

Representations

SWITZERLAND (CH)
GMP S.A.
Electro-optics/Laser/Telecom
19, avenue des Baumettes
Case Postale
CH-1020 Renens 1 / Lausanne
Tel: (021) 634 81 81
Fax: (021) 635 32 95

BENELUX (NL/B/L)
Applied Laser Technology BV
De Dintel 2
NL-5684 PS Best
Tel: (0499) 37 53 75
Fax: (0499) 37 53 73

SWEDEN/NORWAY (S/N)
Parameter AB
P.O.B. 27186
S-10252 Stockholm
Sehlstedtsgatan 9
S-11528 Stockholm
Tel: (08) 459 11 20
Fax: (08) 663 40 26

DENMARK (DK)
Unit One Electronics
Sandholmgardsvej 38
DK-3460 Birkerod
Tel: 48 14 16 70
Fax: 48 14 16 80

SPAIN (E)
Optilas Iberica S.A
c/Maria Tubau, 5
E-28050 Madrid
Tel: (01) 358 86 11
Fax: (01) 358 92 71

ISRAEL (IL)
Landseas (Israel) Ltd.
3 Yehonathan Nethanyahu St.
P.O.B. 676
IL-OR Yehuda 60 256

Tel: (03) 533 30 33
Fax: (03) 533 30 52

KOREA (ROK)
Woojoo Hi-Tech Corp.
Sinkwang Bldg.
160-8 Karak 2-Dong
Songpa-Ku
ROK-Seoul 138-162
Tel: (02) 449 54 72
Fax: (02) 449 54 75

TAIWAN (ROC)
Superbin Company Ltd.
3F, 339 Sec. 2
Ho Ping E. Rd.
ROC-Taipei, Taiwan
Republic of China
Tel: (02) 701 36 26
Fax: (02) 701 35 31

HONG KONG (HK)
Superbin Company Ltd.
Unit 1, 1/F
Kam Hon Industrial Bldg.
8 Wang Kwun Road
Kowloon Bay
HK-Kowloon
Tel: (02) 755 65 78
Fax: (02) 755 45 49

SINGAPORE (SGP)
Millice Private Ltd.
Techplace 1, #05-09
BLK 4012 Ang Mo Kio Ave. 10
SGP-2056 Singapore
Tel: 552 72 11
Fax: 552 73 11

CHINA (TJ)
Superbin Company Ltd.
R.M. 1302 Zhong Ke Office Bldg.
Haidian Rd. 80
Zhong Guan Cun, 100080
TJ-Beijing, P.R.CHINA
Tel: (10) 262 80 35
Fax: (10) 262 80 34

ARGENTINIA (RA)
Eliovac S.A
Av. Coronel Uzal 4223/35
RA-1636 Olivos-Rep. Arg.
Tel: (01) 798 52 95
Fax: (01) 799 95 75

AUSTRALIA (AUS)
Warsash Pty. Ltd.
P.O.B. 16 85
AUS-Strawberry Hills
N.S.W. 2012
Tel: (02) 319 01 22
Fax: (02) 318 21 92

