TOPICS

PIEZO NANO POSITIONING

PI

ISSUE 43

Piezo Actuators Are the Driving Force:

Nanoliter Dosing for Biotechnology, Diagnostics and Industry

Microdispensers for nanoliter dosing are used in the manufacture of microarrays and lab-on-a-chip systems as well as in researching active agents. They must be able to generate perfect droplets, taking into account the viscosity and surface tension of the media and the dosing speed. Misting, satellite formation on impact or dripping must be reliably prevented.

Piezo-Driven Direct Displacement: PipeJet Technology

The best conditions for this are provided by the PipeJet™ technology developed by Biofluidix, which uses piezo-driven direct displacement for the dosing. The nanodispensers allow non-contact and flexible dosing of liquids in the volume range from a few nanoliters to several microliters per second.

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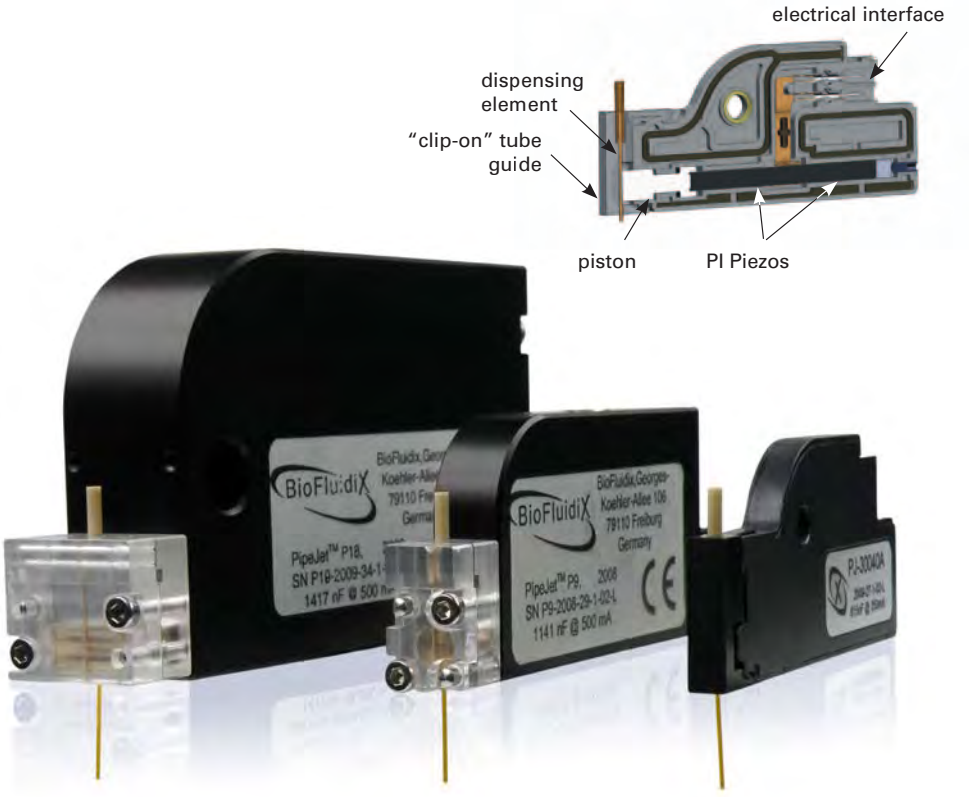


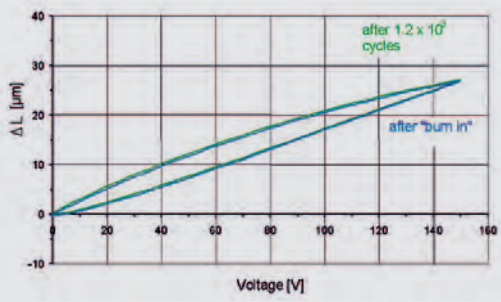
The piezo-driven direct displacement method of the PipeJet™ dispenser uses a fluid line made from an elastic polymer tube with a well-defined internal diameter which is not firmly attached to a piezo actuator. In order to provide sufficient force for force for the precise dosing of difficult media, Biofluidix employs a PI Ceramic multilayer PICMA® piezo stack compressing the polymer tube via a piston with 100 times the force of the conventional ring actuators. The particular volume is controlled via the amplitude of the piezo actuator. The dispenser is used in clinical diagnostics in Lateral Flow Assays, which are test strips requiring a specific dosage of fluids.

Fast, Precise and Durable: PICMA®

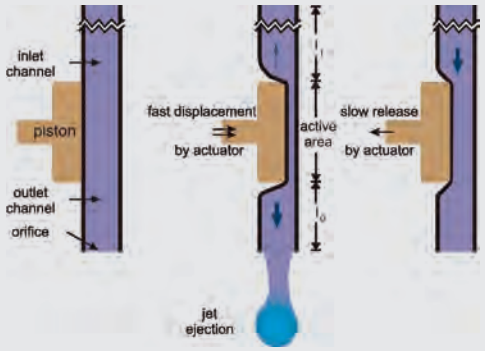
One of the key components in the dispenser is the P-885 PICMA® piezo stack, because of its high force, precise displacement controllability (to nanometers) and fast response. Its effect on the fluid-filled dosing tube causes the droplet to break away determining the properties of the drop. The actuators can also be used in multi-channel applications, where every channel can be controlled individually and the separation between the dispensing points is at least 9 mm. The modules are suitable for droplet volumes between 5 nL (nanoliters) and 60 nL with a dosing frequency of up to 100 hertz.

The high repetition rate puts extra high demands on the reliability of the actuators. PICMA® stack actuators were designed for consistent performance over billions of cycles. Long term results are shown in. They meet and exceed all the requirements of microdosing or pumping applications and operate with short response times down to the microsecond range and sub-nanometer resolution. Both the response and stroke can be controlled with extreme precision allowing for highly random motion profiles. The fast response makes it possible to implement short dosing cycles. The dosing processes can be precisely controlled by the variable stroke.

PICMA®: Patented, fully ceramic encapsulated multilayer piezo stack design provides maximum operating life: (Photo: PI)



PI piezo actuators have gone through several billion cycles in endurance tests without measurable changes in their behavior (Photo PI)



The PipeJet dosing principle: The valveless method is based on the piezo-driven direct displacement of the liquid by an elastic polymer tube with a well-defined internal diameter (Photo: Biofluidix)

The price is right!

Compact, Digital Motion Controller for Piezo Nanopositioning Systems

The new, E-709 digital piezo controller combines performance, compactness and cost-effectiveness.

Earlier this year PI introduced the E-709 digital piezo controller with sensor circuitry for piezoresistive and film strain gauge sensors. These sensors are typically used in entry-level nanopositioning systems. Now, a new version of this compact, affordable controller can also operate piezo positioning systems of the highest accuracy class, equipped with capacitive feedback sensors. Since the majority of the PI's nanopositioning stages employ such sensors, the E-709 significantly reduces system costs if digital control is desired.

Digital Signal Processing:

The main difference between analog and digital servo control from a user point-of-view is the ability to change servo parameters on-the-fly, by software commands, without physically touching the controller. In addition, digital servos allow for improved motion linearization and precise synchronization with external events via trigger functions. See table below for further information on digital and analog servo controllers.

How to choose an analog or digital servo controller for piezo positioning

If you care about ...	then choose...
Software settable parameters	Any PI digital including E-609-based
Price	Digital: E-709 or E-609 or Analog: E-610, E-625, E-621
Resolution	High-end PI digital, or analog
Real-time Command	Digital with PIO option (or SPI, standard on E-709!); or analog I/O with any controller
Linearity/Accuracy	Any PI digital including E-709 (5th-order linearization)
Long Term Stability	Any PI digital
Best Dynamic Linearity	High-end digital (E-753, E-712, E-725) with DDL option
High Speed Tracking Servo	E-712
Virtual Axes and Tight Multi-Axis Synchonization	Multi-axis digital (E-712, E-725)
Position Control with Analog Signal	Any analog or E-709, E-609, E-753 or E-712 with analog in option

	E-625.C0	E-625.CR	E-709.CRG	E-753.1CD
Number of axis	1	1	1	1
Supported sensor for the version considered	Capacitive sensors	Capacitive sensors	Capacitive sensors	Capacitive sensors
Control/Interfaces	Analog	Analog, RS-232, USB	Analog (16-bit ADC), RS-232, USB, SPI	RS-232, Ethernet
Digital parameter setting	None	Motion command	Motion, control, ID chip	Motion, control, ID chip
Digital functions	None	Function table (255 points of data)	Digital linearization, wave generator, data recorder	Digital linearization, digital dynamic linearization, Wave generator, data recorder
Resolution controlled with PIHera® P-621.1CD, 100 µm, capacitive sensors	1 nm	1 nm	1 nm	0.5 nm
Servo-update rate	Real time (analog)	Real time (analog)	10 kHz	25 kHz
Price bracket	0.8	1	1	1.5
Recommended applications	With analog control	Standard application	Standard application with changing operational conditions	Highest precision, even during dynamic scans

The amplifier of the E-709 is designed so that nanopositioning systems such as the P-620 PIHera linear stage and the P-721 and P-725 objective scanners of the PIFOC® series can be operated in almost every application.

New Interface for Real-Time Commands

The serial SPI interface with up to 25MBit/s is a new feature of the E-709. The high-througput of the SPI interface allows new position commands to be provided in real-time for each servo cycle.Two data formats are available: Floating-point and fixed-point with a variable bit width. The E-709 is supported by a variety of software packages such as PIMikroMove, NanoCapture as well as LabVIEW drivers and DLLs for Windows or LINUX.

The controller is also compatible to popular software platforms such as Metamorph and µManager (microscopy applications) and MATLAB.

Piezomotors: Self-locking, Non-Magnetic and Easy to Integrate

Linear Drive for Automation Technology

Self-locking at rest, very fast and easy to integrate: Piezo-based PILine® linear drive for automation technology (photo: Physik Instrumente (PI))

Physik Instrumente (PI), Karlsruhe, has paid heed to the requirements of modern automation technology and has now developed a versatile, scalable piezo-based linear actuator which provides drive forces up to 10 N, velocities up to 0.5 m/s and travel ranges of several tens of 10 mm. An piezo ceramic plate generating minute oscillations at ultrasonic frequencies - serves as the drive. The ceramic is preloaded against the linearly guided rod clamping it tightly when powered down or at the end of a motion command (self inhibition). Unlike electromagnetic linear motors, the piezo-based drive does not require any energy for holding a position, and no heat is dissipated. An integrated optical linear encoder provides 5 µm resolution and accuracy in the range of 0,01 mm (10 µm). Higher accuracies down to the submicrometer range are feasible with different encoders.

A matching motion controller with integrated driver electronics to generate the ultrasonic oscillations in the piezo actuator is also available; both controller and linear drive are designed for easy integration in industrial applications, and priced accordingly. The controller is based on a eurocard (160 x 100 mm) with a 32pin spring loaded-connector and provides several standard interfaces: CAN, RS-232 and analog inputs (for joystick or velocity control).

For Highest Reliablilty and Dynamics

System Compatibility with Brushless Motors

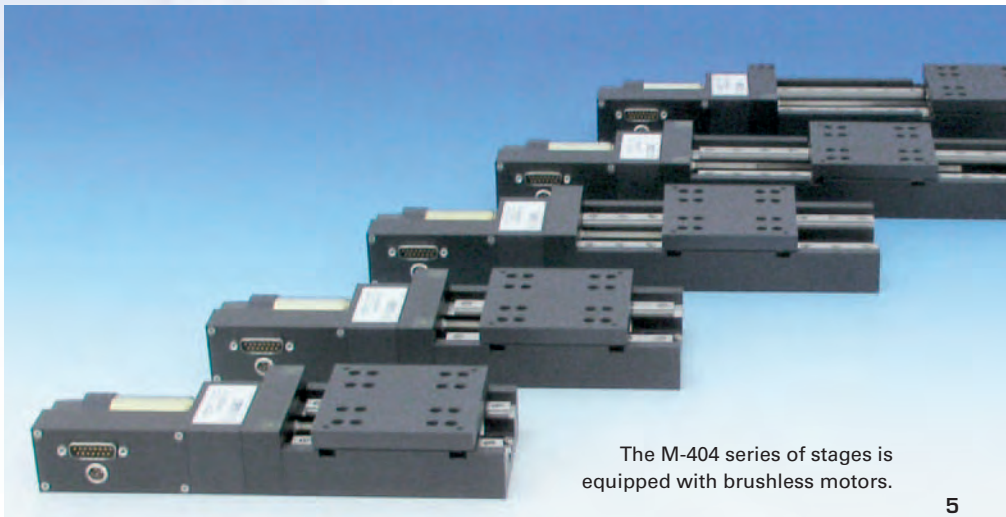
The M-810 miniature hexapod is a prominent example of a PI positioner driven by a brushless torque motor. The compact size and high power of the motors clinched matters for the choice of drive. PI will also offer EC motors in the translation stages of the M-404 and M-511/M-521/M-531 series in the near future covering travel ranges from 25 mm to 300 mm.

To ensure full compatibility with all existing PI servo motor controllers, the commutation electronics are integrated inside the positioning systems, basically becoming part of the motor.

The datasheets will be continuously expanded; if you are interested, please contact PI.

Brushless torque motors drive the M-810 miniature hexapod.

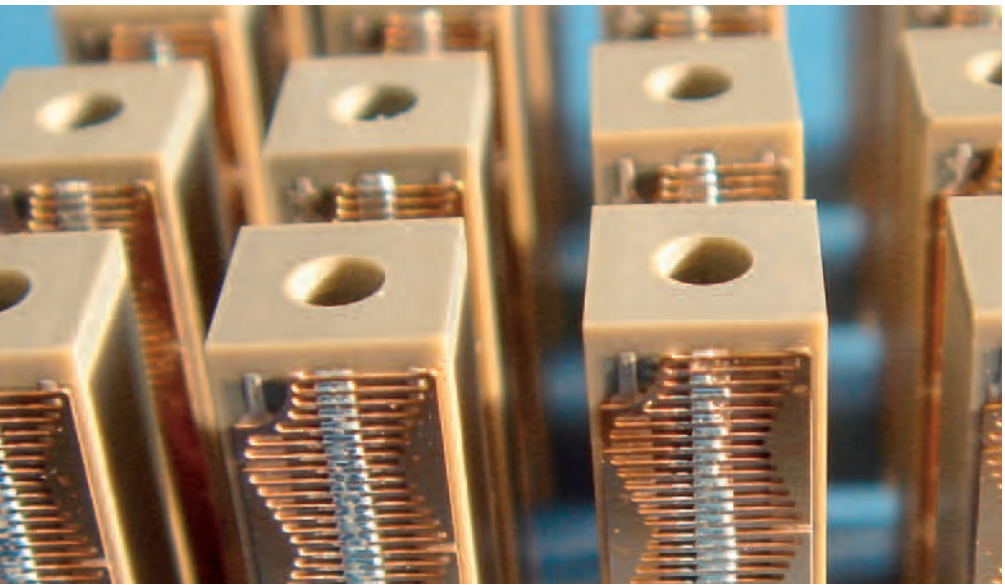
Brushless DC motors have two significant advantages over conventional DC motors with slip rings: They suffer less wear and tear and do not cause electric interferences. This explains why motors with higher power or speed are often brushless. They are used in automation, and also in micropositioning and nanopositioning systems. The absence of slip rings means an electronic commutation (EC) is necessary, which is why these motors cannot be operated with the simple controls for conventional DC motors.



The M-404 series of stages is equipped with brushless motors.

High-Tech Production Technology at PI Ceramic

More Freedom for PICMA®



PI Ceramic has developed a new production technology which enables it to manufacture multilayer piezo actuators with central apertures or other complex shapes and form factors. The new technology can produce tiny holes, structured ceramic surfaces and almost any type of contour – even three-dimensional ones. It is available for stack actuators and piezo bender elements as well.

Special milling machines work the sensitive ceramic films in the green state, i.e. before sintering. The individual layers are then equipped with electrodes and laminated. The co-firing process is used to sinter the ceramic with the internal electrodes, as happens with PICMA® standard actuators.

The result is a continuous insulating ceramic layer with all its familiar advantages: The piezo actuator is protected against humidity and has a high dielectric strength, which significantly increases the lifetime when compared to conventional polymer-insulated actuators.

Key Component Software

Version Check and Downloads Made Easy

Good software is the key to the functionality of many instruments. PI delivers it with the versatile PIMikroMove user interface and software drivers to link each product to its own application: PI puts great importance on the support of current operating systems and the continuous improvement of device functions when developing its products. For many years, the trendsetting philosophy of the universal PI General Command Set (GCS) has been to provide maximum compatibility of all products with minimum programming effort.

PI has now improved the method for downloading its software components even further. A new automatic feature allows you to compare the status of your existing installations with the availability of new versions at any time.

All you need is an Internet connection for the PC which operates the PI controllers. The free service tool "PI Update Finder" identifies PI software components and sends version information to a script, which automatically compares the versions and offers new components for download.

From 2011 on, the "PI Update Finder" will be supplied as part of the software package on the product CD. It will also be available as a free download with documentation, via a link on the PI homepage.

New software versions can also be downloaded easily and free of charge. They often coincide with advanced features or bug fixes so that it is always worthwhile using the "PI Update Finder" to search for news.

Update Finder – start page

A further upgrade of the service tool will allow connected PI hardware to be automatically identified, and not only a software but also a firmware update will be offered.

Ready to Face the Future:

Heading for Growth

PI wants to continue to live up to the expectations placed on the technology leader in piezo technology and ultra-precision motion control. In May 2010, PI purchased the lot adjacent to the company site from the city of Karlsruhe to facilitate the expansions planned for the next few years. This increased the land available from 17,000 to more than 44,000 m².

„The staff of 280 currently employed in Karlsruhe presently already have the excellent working conditions in our building. We presume that the current upswing will continue, after all, we had annual double-digit growth rates on average over the last 10 years. This is why we want to be ready for the future" explains Dr. Karl Spanner, Associate and President of PI. „The chances are high, especially since accuracy requirements far below one thousandth of a millimeter are moving into industrial processes. We develop all key technologies in-house. This means that we can control every phase from the design right down to the shipment: Precision mechanics, control electronics as well as the position metrology, piezo ceramics and actuators. The latter are produced by our subsidiary PI Ceramic."

Dr. Karl Spanner, President of PI

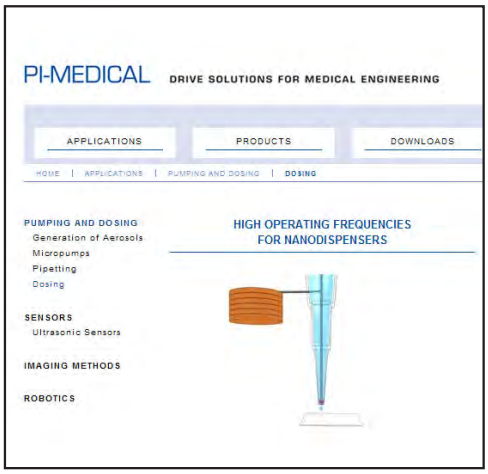
PI is conveniently situated directly on the A8 autobahn at the Karlsbad exit, right next to the 'Dreieck Karlsruhe' autobahn junction. The purchase of the neighboring lot allows the company to continue its growth.

PI Ceramic: New Website with More Information

The redesigned PI Ceramic website [www.piceramic.com] provides more information and a more user friendly navigation. In addition to product datasheets, applications & tips, a number of tutorials on piezo technology, piezoelectric materials, and piezocomposite transducers for Energy Harvesting and Structural Health Monitoring are accessible online and can be downloaded as well.

New Website on Medical Technology

PI-Medical



Medical engineering and related life science disciplines need two types of system – high-precision positioning systems and less accurate systems which are nevertheless small, fast, reliable and energy saving.

Piezoelectric components and drives from PI Ceramic and Physik Instrumente (PI) perfectly meet these requirements. They are successfully employed in various medical applications today. The spectrum hereby covers the entire product range of PI, from basic piezo transducers for generating ultrasound to six-axis positioning systems.

On www.pi-medical.ws, you can find an overview of applications and suitable products. Animations and related texts describe the way piezo elements work. Currently, the main focus is on microdosing and pipetting, micro pumps and nebulizing as well as the use of sensors such as air-bubble sensors. Product overviews, a download area and contact details complete the website.

The website will be expanded gradually to include further fields of application.

Tradeshows 2010/2011

Jan, 22–23	San Francisco Moscone Center	SPIE	Biomedical Optics (BIOS) Booth #8700
Jan, 25–27	San Francisco Moscone Center	SPIE	Photonics West Booth #4807 North Hall
Feb 8–10	Anaheim Anaheim Convention Center	Canon Communication	ATX West (MD&M West) Booth 4361
March 5–9	San Francisco Moscone Center		BioPhysical Society Booth #246
April 26–28	Orlando Marriott World Center	SPIE	Defense & Security Booth #1201

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