

P-010.xxH – P-025.xxH PICA™ Thru Actuator

High-Load Piezo Stack Actuators with Aperture



PICA™ Thru piezo stack actuators with clear aperture

- Clear Aperture for Transmitted-Light Applications for Mechanical Preloading
- Extreme Reliability $>10^9$ Cycles
- Large Cross Sections to 56 mm Diameter
- Variety of Shapes
- Sub-Millisecond Response, Sub-Nanometer Resolution
- Vacuum-Compatible Versions

PICA™ Thru actuators are hollow piezo stack actuators, offered in a large variety of standard shapes and sizes with additional custom designs to meet all customer requirements. They combine the advantage of a clear aperture with the strength and force generation of stack actuators. These tubular devices are high-resolution linear actuators for static and dynamic applications. The clear aperture facilitates

transmitted-light applications. Furthermore the electrical consumption is reduced due to the decreased electrical capacitance.

Ultra-High Reliability, High Displacement, Low Power Requirements

PICA™ piezo actuators are specifically designed for high-duty-cycle applications. With our extensive applications knowledge, gained over several decades, we know how to build performance that does not come at the price of reliability. All materials used are specifically matched for robustness and lifetime. Endurance tests on PICA™ actuators prove consistent performance, even after billions (1,000,000,000) of cycles. The combination of high displacement and low electrical capacitance provides for excellent dynamic behavior with re-

duced driving power requirements.

Flexibility / Short Leadtimes

All manufacturing processes at PI Ceramic are set up for flexibility. Should our standard actuators not fit your application, let us provide you with a custom design. Our engineers will work with you to find the optimum solution at a very attractive price, even for small quantities. Some of our custom capabilities are listed below:

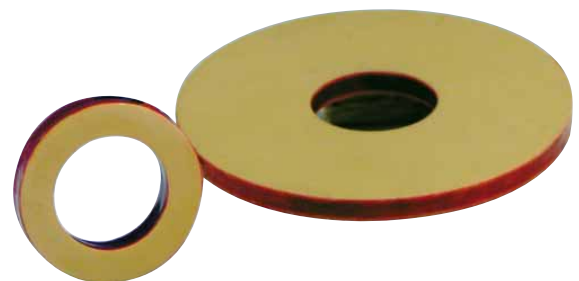
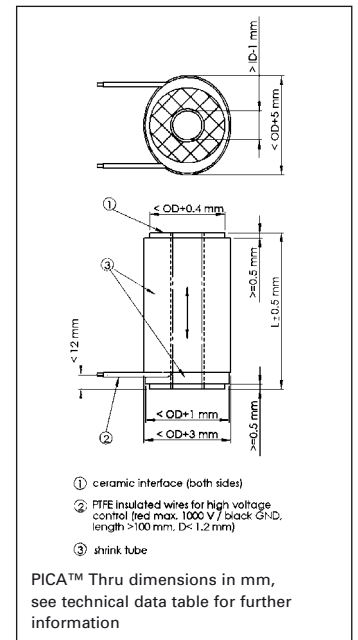
- Custom Materials
- Custom Voltage Ranges
- Custom Geometries (Circular, Rectangular, Triangular, Layer Thickness ...)
- Custom Load / Force Ranges
- Custom Flat or Spherical Endplates (Alumina, Glass, Sapphire, ...)
- Extra-Tight Length Tolerances
- Integrated Piezoelectric Sensor Discs
- Special High / Low Temperature Versions
- Vacuum Compatible Versions

Because all piezoelectric materials used in PICA™ actuators are manufactured at PI Ceram-

ic, leadtimes are short and quality is outstanding. All standard and custom actuators are delivered with performance test sheets.

Piezo Drivers, Controllers & High-Voltage Amplifiers

High-resolution amplifiers and servo-control electronics, both digital and analog, are described in the "Piezo Drivers / Servo Controllers" section.



Customized PICA™ Thru actuator discs

Application Examples

- Optics
- Image stabilization
- Laser tuning
- Laser treatment
- Precision mechanics / -machining
- Confocal microscopy
- Nanopositioning

Standard actuators are delivered with black heat shrink tube (shown here is the model P-010.20H)



Custom PICA™ Thru piezo actuator with 56 mm outside diameter, 8 mm inner diameter, 250 μ m displacement. Pen for size comparison

Technical Data / Product Order Numbers

Order numbers	Displacement [μ m] -10/+20 %	Diameter OD [mm]	Diameter ID [mm]	Length L [mm] \pm 0.5	Blocking force [N]	Stiffness [N/ μ m]	Capacitance [nF] \pm 20 %	Resonant frequency [kHz]
P-010.00H	5	10	5	7	1200	230	15	144
P-010.05H	10	10	5	12	1300	130	29	84
P-010.10H	15	10	5	15	1700	110	40	67
P-010.15H	20	10	5	21	1500	76	59	48
P-010.20H	30	10	5	27	1800	59	82	39
P-010.30H	40	10	5	40	1600	40	120	28
P-010.40H	60	10	5	54	1800	29	180	21
P-016.00H	5	16	8	7	2900	580	42	144
P-016.05H	10	16	8	12	3400	340	83	84
P-016.10H	15	16	8	15	4100	270	120	67
P-016.15H	20	16	8	21	3800	190	170	48
P-016.20H	30	16	8	27	4500	150	230	39
P-016.30H	40	16	8	40	4000	100	340	28
P-016.40H	60	16	8	52	4700	78	490	21
P-025.10H	15	25	16	16	7400	490	220	63
P-025.20H	30	25	16	27	8700	290	430	39
P-025.40H	60	25	16	51	9000	150	920	22
P-025.50H	80	25	16	66	9600	120	1200	17

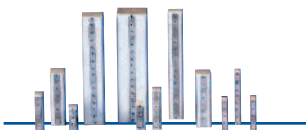
Piezo ceramic type PIC 151
 Recommended preload for dynamic operation: 15 MPa
 Maximum preload for constant force: 30 MPa
 Resonant frequency at 1 V_{pp} , unloaded, free at both sides. The value is halved for unilateral clamping
 Capacitance at 1 V_{pp} , 1 kHz
 Blocking force at 1000 V
 Operating voltage range: 0 to 1000 V
 Operating temperature range: -20 to +85 °C
 Standard mechanical interface (top & bottom): ceramic, 0.5-2 mm thick (depends on model)
 Standard electrical interface: two PTFE-insulated wires, pigtail length 100 mm
 Available options: integrated force piezo sensor or strain gauge sensors, non-magnetic, vacuum compatible, etc.
 Ask about custom designs and further specifications.

Low-cost Piezo Systems with Various Levels of Integration

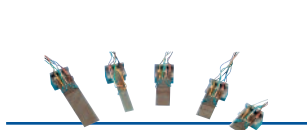
For more information visit <http://www.pi.ws>

Piezo Actuator / Stage	Description	Travel Range up to	Guiding System	Mechanical Levels of Integrations	Positioning Sensor	Stiffness
P-882 - P-888	PICMA® Multilayer Piezo Stack Actuators	30 µm	-	-	optional SGS	up to 200 N/µm
P-871	PICMA® Piezo Bender Actuator	1600 µm	-	-	optional SGS	0.02 N/µm
P-842 - P-845	Preloaded Piezo 90 µm Actuators		-	case, mechanically preloaded	optional SGS	up to 200 N/µm
P-601	PiezoMove Linear Actuator	400 µm	flexure guiding system prevents tip and tilt	motion amplifier, mechanically preloaded	optional SGS	up to 0.8 N/µm
P-602	PiezoMove Flexure Actuator with High Stiffness	1000 µm	flexure guiding system provides straight motion with no tip and minimum tilt	motion amplifier, mechanically preloaded	optional SGS	up to 2.3 N/µm
P-603	PiezoMove Linear Actuator	500 µm	flexure guiding system prevents tip and tilt	motion amplifier, mechanically preloaded	optional SGS	up to 0.36 N/µm
P-712, P-713	Low-Profile Piezo Scanner	30 µm in X, XY	flexure guiding system provides straight motion with no tip and minimum tilt	motion amplifier, mechanically preloaded, P-713 parallel-kinematics	optional SGS	up to 0.8 N/µm
P-611	NanoCube® XYZ Piezo Stage	100 µm in XYZ up to 3 axes	flexure guiding system provides straight motion with no tip and minimum tilt	motion amplifier, mechanically preloaded, serial kinematics	optional SGS	up to 0.8 N/µm

Controller	Function	Positioning Sensor	Number of Channels	Peak Output Current	Peak Output Power
E-831	Piezo Amplifier	-	1	100 mA (< 8 ms)	2 W without heat sink, 5 W with additional heat sink
E-610.00	Piezo Amplifier	-	1	180 mA (< 15 ms)	18 W (< 15 ms)
E-610.S0	Motion Controller	SGS	1	180 mA (< 15 ms)	18 W (< 15 ms)
E-621.SR	Networkable Motion Controller Module	SGS	1, networkable up to 16	120 mA (< 5 ms)	12 W (< 5 ms)



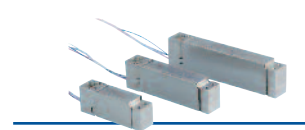
P-882 - P-888 PICMA® Multilayer Piezo Stack Actuators



P-871 PICMA® Piezo Bender Actuator



P-842 - P-845 Preloaded Piezo Actuators



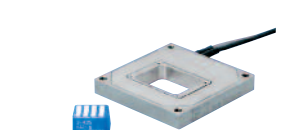
P-601 PiezoMove Linear Actuator



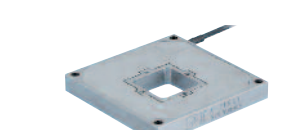
P-602 PiezoMove Flexure Actuator with High Stiffness



P-603 PiezoMove Linear Actuator



P-712 Low-Profile Piezo Scanner



P-713 Low-Profile Piezo Scanner



P-611 NanoCube® XYZ Piezo Stage



E-831 Piezo Amplifier



E-610 Piezo Amplifier/Motion Controller



E-621.SR Motion Controller Module

PiezoMove: Moving, Positioning, Scanning

Microfluidics, Biotechnology, Medical Engineering, Adaptronics

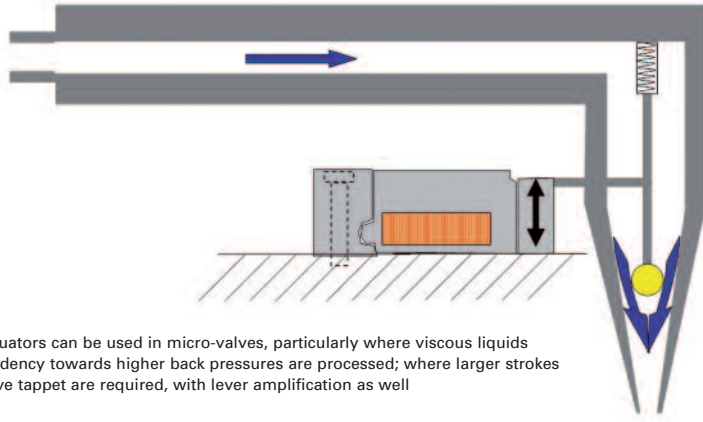
Piezo = nano = expensive?

Piezo actuators can do a lot more than “just” precision. Their excellent dynamics and high force play a crucial role in many areas, while the (nanometer) precision is of lesser importance: e.g. for fast switching, vibration cancellation, or to adjust tools in machines.

In these applications the piezo actuator is one – if not the only – solution and in the case of the new PiezoMove OEM actuators, at a very attractive price.

PiezoMove OEM actuators: Apply motion, how and where it is required

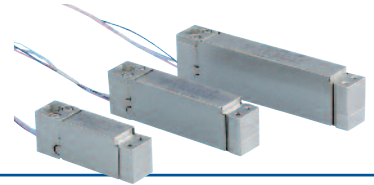
PiezoMove actuators combine guided motion and long travel ranges up to 1 mm and provide precision in the 10 nm range if ordered with the position sensor option. They are very compact, easy to integrate, require no maintenance and provide service life of Billions (10^9) of cycles.



Linear actuators can be used in micro-valves, particularly where viscous liquids with a tendency towards higher back pressures are processed; where larger strokes of the valve tappet are required, with lever amplification as well

PI supplies a variety of standard integration levels and also customized versions: From simple piezo stack components and preloaded linear actuators through to 6-axis positioning systems with sub-nanometer precision.

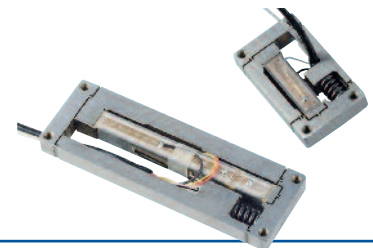
3 Actuator Families



P-601: Travel ranges to 400 μm , slight tilt



P-602: Travel ranges to 1000 μm , slight tip and tilt, high stiffness



P-603: Travel ranges to 500 μm , slight tilt, cost-optimized for high quantities

For more information visit <http://www.pi.ws>

Application fields

Microfluidics:

Valves, pumps, microliter and nanoliter dosing

Biotechnology:

Cell manipulation, patch-clamp, microarrays, nanoliter dosing, dispensers, microstructuring with imprint processes

Medical engineering:

Diaphragm pumps, valves, dosing, injection, sample handling

Mechatronics, adaptronics:

Active structures, vibration isolation, active tools, structure deformation

Laser technology, metrology:

Cavity tuning, adjustment of optics or slit widths, sample positioning, beam control

PiezoMove: Travel Ranges to 1 mm

Easy Integration and Adaptation

Systems Thinking

PI provides a range of different control electronics for PiezoMove actuators.

These range from solderable OEM piezo driver modules to advanced digital motion controllers.

PI's wide range of actuators and control electronics allows for an optimum match of performance and cost for any application.

In addition to standard products, modified or completely custom engineered solutions are available at competitive prices. The following parameters can be modified to suit an application:

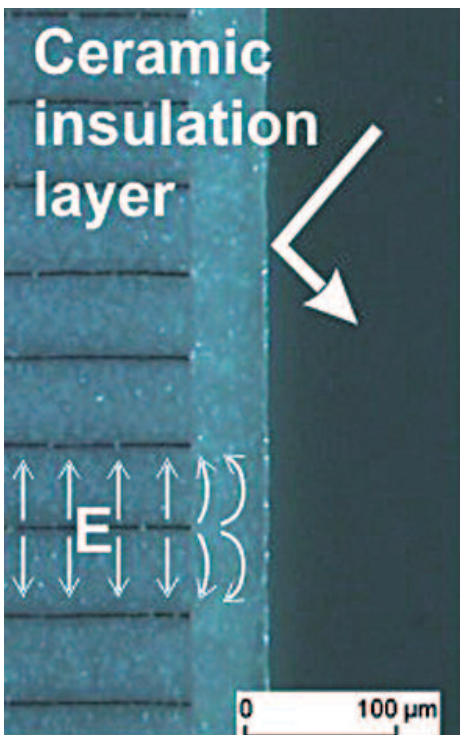
- Travel range
- Dynamics
- Force
- Precision



Levels of Integration: From Stack Actuator to 6-Axis Stage

	Stack actuators	Lever-amplified actuators	Positioning systems
Travel ranges	up to approx. 150 μm	up to 1 mm	up to 2 mm
Axes moved	one	one	up to three linear axes and three tip/tilt axes
Sensors	SGS optional	SGS optional	SGS or direct measuring capacitive sensors
Linearity	up to 99.8 %	up to 99.8 %	over 99.9 %
Guidance	none	flexures for rotations <10"	flexures for rotations <2"
Space required	low	low	depends on features
Price	low	low	depends on features
Integration effort	high	low	low

PI Actuators Offer Longer Service Life



The ceramic insulating layer prevents the penetration of water molecules and reliably protects the sensitive internal electrodes from mechanical damage and dirt

Different Piezo Solutions: Simple Piezo Components to Complex (Nano) Positioning Systems

Actuator: Piezo ceramic stack actuators are the driving force in many of PI's motion systems. Piezo actuators can move very rapidly due to their high stiffness; response times are as short as microseconds and scan frequencies up to several tens of kilohertz are feasible. The resolution is virtually unlimited, depending only on the electrical noise of the driver, making piezo actuators predestined for precision motion applications. The displacement of basic actuators is limited to a few tens of micrometers, however, and they need to be handled with care.

Preloading and Decoupling Against Lateral Forces: Encased piezo stacks can handle higher forces. The housing can decouple the piezo ceramics from lateral forces. Integrated mechanical preloading allows dynamic operation with higher loads.

Guiding System: Piezo ceramic stacks do not move in perfectly straight lines. For precise linear motion, a guiding system is required. Flexures guarantee the best performance because they provide frictionless, backlash-free motion and unlimited lifetime. If designed well, preloading and decoupling of unwanted forces can also be integrated without negative effects on the system stiffness.

Lever Amplification for Longer Travel Ranges:

The guiding system can be designed in such a way that it acts like a mechanical lever and increases the displacement of the piezo ceramic stack. Lever amplifiers reduce the system stiffness and this is where experience pays off. PI uses CAD modeling, FEA analysis and laser vibrometry for design optimization and testing. Based on 3 decades of experience with piezo flexure design PI actuators provide the best combination of lifetime, stiffness, precision and size.

Sensor: Position feedback sensors are available when absolute position information is required. Strain gauge sensors (lower cost, accuracy to 0.5%) and capacitive sensors (higher precision to 0.01 %) are available.

Controller: The higher the demands placed on the system precision, the larger the role played by the motion controller. Open-loop actuators can be controlled directly via a voltage amplifier. To achieve maximum positional accuracy and scanning linearity, however, closed-loop control and digital control algorithms are indispensable.

Multi-Axis Positioners are constructed as parallel-kinematic systems for the highest possible precision, and controlled by advanced digital nanopositioning controllers.