P-871 PICMA® Piezo Bender Actuators
Low-Voltage Multilayer Piezo Bender Actuators with Position Sensor

Closed-Loop Operation for Superior Accuracy
Nanometer-Resolution
Displacement to 1.6 mm
Ceramic Encapsulation for Extended Lifetime
Ideal for Scanning Applications
Vacuum-Compatible Versions
Low Operating Voltage
Mounting Hardware Included
Special OEM- and Bench-Top Amplifiers Available

P-871 transducers are unique closed-loop piezo benders based on the open-loop PL 122 to PL 140 PICMA®-series multilayer actuators p. 1-94. Equipped with high-resolution position feedback sensors they provide better linearity, accuracy and repeatability than other piezo benders on the market. P-871 bender actuators achieve longer positioning ranges than typical piezo stack actuators, up to 1.6 mm, while still providing fast response times in the millisecond range.

Design
These multilayer piezoelectric components are manufactured from ceramic layers of only about 50 µm thickness. They feature internal silver-palladium electrodes and ceramic insulation applied in a cofiring process. Due to the thin layers the operating voltage is significantly lower than for classical parallel bimorph bender elements. For ease of installation, the units come complete with the mounting hardware, cables and connectors.

Application Examples
- Wire bonders
- Pneumatic valves
- Fiber optic positioning & switches
- (Laser)- Beam steering
- Micropositioning
- Acceleration sensors
- Nanotechnology

Ceramic Insulated Piezo Actuators Provide Long Lifetime
Highest possible reliability is assured by the use of award-winning PICMA® multilayer piezo actuators. PICMA® actuators are the only actuators on the market with ceramic-only insulation, which makes them resistant to ambient humidity and leakage-current failures. They are thus far superior to conventional actuators in reliability and lifetime.

Optimum UHV Compatibility - Minimum Outgassing
The lack of polymer insulation and the high Curie temperature make for optimal ultra-high-vacuum compatibility (no outgassing / high bakeout temperatures, up to 150 °C).

Amplifiers, Drivers & Controllers
PI offers a wide range of standard amplifiers and controllers for piezo actuators. The E-651.1S and E-651.2S desktop controllers and the OEM board E-614.2BS (see p. 2-123) are specifically designed to operate P-871 bender actuators.

Ordering Information
P-871.112
PICMA® Multilayer Piezo Bender Actuator, 160 µm, 9.6 mm Width, SGS-Sensor
P-871.122
PICMA® Multilayer Piezo Bender Actuator, 400 µm, 9.6 mm Width, SGS-Sensor
P-871.127
PICMA® Multilayer Piezo Bender Actuator, 720 µm, 9.6 mm Width, SGS-Sensor
P-871.128
PICMA® Multilayer Piezo Bender Actuator, 720 µm, 6.3 mm Width, SGS-Sensor
P-871.140
PICMA® Multilayer Piezo Bender Actuator, 1600 µm, 11 mm Width, SGS-Sensor

Ask about custom designs
Technical Data

<table>
<thead>
<tr>
<th>Model</th>
<th>P-871.112*</th>
<th>P-871.122</th>
<th>P-871.127</th>
<th>P-871.128*</th>
<th>P-871.140</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed-loop travel</td>
<td>±80</td>
<td>±200</td>
<td>±360</td>
<td>±360</td>
<td>±800</td>
<td>µm</td>
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<tr>
<td>Integrated feedback sensor</td>
<td>SGS</td>
<td>SGS</td>
<td>SGS</td>
<td>SGS</td>
<td>SGS</td>
<td>%</td>
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<tr>
<td>Closed-loop linearity</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>N/µm</td>
</tr>
<tr>
<td>Static large-signal stiffness</td>
<td>0.02</td>
<td>0.01</td>
<td>0.003</td>
<td>0.002</td>
<td>0.0007</td>
<td></td>
</tr>
<tr>
<td>Blocking force</td>
<td>±2.0</td>
<td>±1.1</td>
<td>±1.0</td>
<td>±0.5</td>
<td>±0.5</td>
<td>N ±20%</td>
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<tr>
<td>Electrical capacitance</td>
<td>2 x 1.1</td>
<td>2 x 2.4</td>
<td>2 x 3.4</td>
<td>2 x 1.2</td>
<td>2 x 4.0</td>
<td>µF ±20%</td>
</tr>
<tr>
<td>Unloaded resonant frequency</td>
<td>2540</td>
<td>1010</td>
<td>560</td>
<td>340</td>
<td>195</td>
<td>Hz ±20%</td>
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<tr>
<td>Resonant frequency @ 6.5 g load</td>
<td>480</td>
<td>220</td>
<td>145</td>
<td>100</td>
<td>60</td>
<td>Hz ±20%</td>
</tr>
</tbody>
</table>

Operating voltage: 0 to 60 V (±30 V)
Recommended driver / controller: E-651 bench top / E-614 PCI card (p. 2-123)
Connector: 1 LEMO connector for both sensor and voltage supply
Operating temperature range: -20 to +85 °C; ** to +150 °C
Resonant frequency at 1 Vpp, capacitance at 1 Vpp, 1 kHz
All specifications depend on the real clamping conditions and on the applied mechanical load.
Other specifications on request.
PICMA® multilayer bender piezo actuators provide a deflection of up to 2 mm, forces up to 2 N and response times in the millisecond range. These multilayer piezoelectric components are manufactured from ceramic layers of only about 50 µm thickness. They feature internal silver-palladium electrodes and ceramic insulation applied in a cofiring process. The benders have two outer active areas and one central electrode network dividing the actuator in two segments of equal capacitance, similar to a classical parallel bimorph.

Advantages
PICMA® Bender piezo actuators offer several advantages over classic bimorph components manufactured by gluing together two ceramic plates (0.1 to 1 mm thick): faster response time and higher stiffness. The main advantage, however, is the drastically reduced (by a factor of 3 to 10) operating voltage of only 60 V. The reduced voltage allows smaller drive electronics and new applications, such as in medical equipment. Additionally, these devices offer improved humidity resistance due to the ceramic encapsulation.

Increased Lifetime Through Humidity Resistance
The monolithic ceramic-encapsulated design provides better humidity protection than polymer-film insulation. Diffusion of water molecules into the insulation layer is greatly reduced by the use of cofired, outer ceramic encapsulation. Due to their high resonant frequency the actuators are suitable for highly dynamic applications with small loads; depending on the load an external preload for dynamic applications is recommended. The high Curie temperature of 320 °C gives PICMA® actuators a usable temperature range extending up to 150 °C, far beyond 80 °C as is common for conventional multilayer actuators. With conventional multilayer actuators, heat generation – which is proportional to operating frequency – either limits the operating frequency or duty cycle in dynamic operation, or makes ungainly cooling provisions necessary. At the low end, operation down to a few Kelvin is possible (with reduction in performance specifications).

Optimum UHV Compatibility – Minimum Outgassing
The lack of polymer insulation and the high Curie temperature make for optimal ultra-high-vacuum compatibility (high bakeout temperatures, up to 150 °C).

Closed-Loop Version
For closed-loop positioning the versions P-871 with integrated strain gauge sensors are available (see p. 1-84).

Drivers and Controllers
PI offers a wide selection of low noise amplifiers and controllers for piezo actuators (see section „Piezo Electronics“). Customized piezo electronics are developed on request.

The E-650.00 and E-650.0E piezo amplifiers (see p. 2-122) are especially designed for operating the PICMA® bender actuators.
Recommended clamping: non-conducting material with rounded clamping end face for protection of ceramics (not included). See table for dimensions.

Differential control of PICMA® bender actuators
Pin Assignments:
1: -30 V (or GND)
2: -30 V to +30 V (or 0 to 60 V)
3: +30 V (or +60 V)
Dimensions in mm

Technical Data / Product Order Numbers

<table>
<thead>
<tr>
<th>Order number*</th>
<th>Operating voltage [V]</th>
<th>Nominal displacement [µm] ±20%</th>
<th>Free length [mm]</th>
<th>Dimensions L x W x T [mm]</th>
<th>Blocking force [N]</th>
<th>Electrical capacitance [µF] ±20%</th>
<th>Resonant frequency [Hz] ±20%</th>
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</thead>
<tbody>
<tr>
<td>PL112.10**</td>
<td>0 - 60 (±30)</td>
<td>±80</td>
<td>12</td>
<td>17.8 x 9.6 x 0.65</td>
<td>±2.0</td>
<td>2 x 1.1</td>
<td>&gt;1000</td>
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<td>PL122.10</td>
<td>0 - 60 (±30)</td>
<td>±250</td>
<td>22</td>
<td>25.0 x 9.6 x 0.85</td>
<td>±1.1</td>
<td>2 x 2.4</td>
<td>660</td>
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<tr>
<td>PL127.10</td>
<td>0 - 60 (±30)</td>
<td>±450</td>
<td>27</td>
<td>31.0 x 9.6 x 0.65</td>
<td>±1.0</td>
<td>2 x 3.4</td>
<td>380</td>
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<tr>
<td>PL128.10**</td>
<td>0 - 60 (±30)</td>
<td>±450</td>
<td>28</td>
<td>35.5 x 6.3 x 0.75</td>
<td>±0.5</td>
<td>2 x 1.2</td>
<td>360</td>
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<tr>
<td>PL140.10</td>
<td>0 - 60 (±30)</td>
<td>±1000</td>
<td>40</td>
<td>45.0 x 11.0 x 0.60</td>
<td>±0.5</td>
<td>2 x 4.0</td>
<td>160</td>
</tr>
</tbody>
</table>

*For optional PTFE insulated wire leads change order number extension to .x 1 (e.g. PL112.11)

Operating temperature range: -20 to +85 °C
**to +150 °C Resonant frequency at V_rms capacitance at 1 V_rms, 1 kHz

All parameters depend on actual clamping conditions and applied load. Ask about custom designs and further specifications.