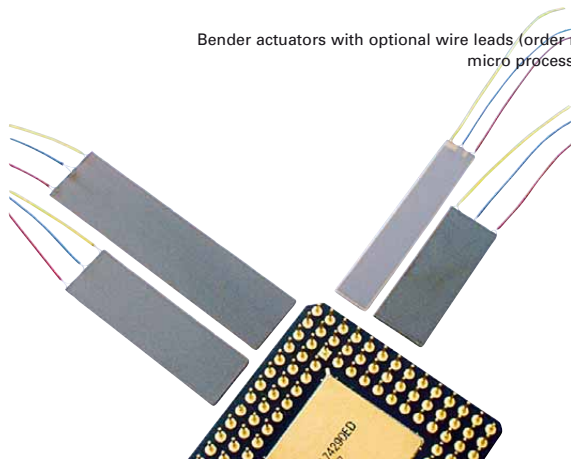


## PL112 · PL140 PICMA® Bender Actuators

### Multilayer Piezo Bender Actuators with High Travel and Low Operating Voltage

Bender actuators with optional wire leads (order number extension .x1); micro processor for size comparison



- Ceramic Encapsulation for Better Protection and Longer Lifetime
- Positioning Range up to 2 mm
- Fast Response (10 msec)
- Nanometer-Range Resolution
- Low Operating Voltage
- Vacuum-Compatible Versions to 10<sup>-9</sup> hPa
- Available with Integrated Position Sensor
- Special OEM- and Bench-Top Amplifiers Available

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).

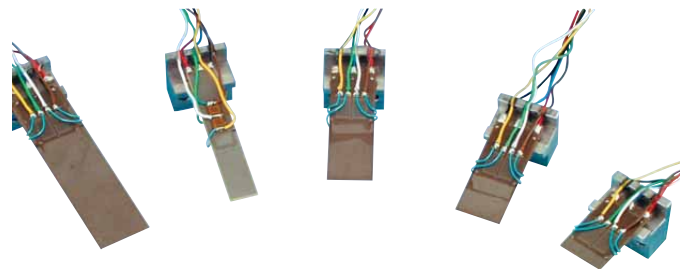
#### Closed-Loop Version

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.

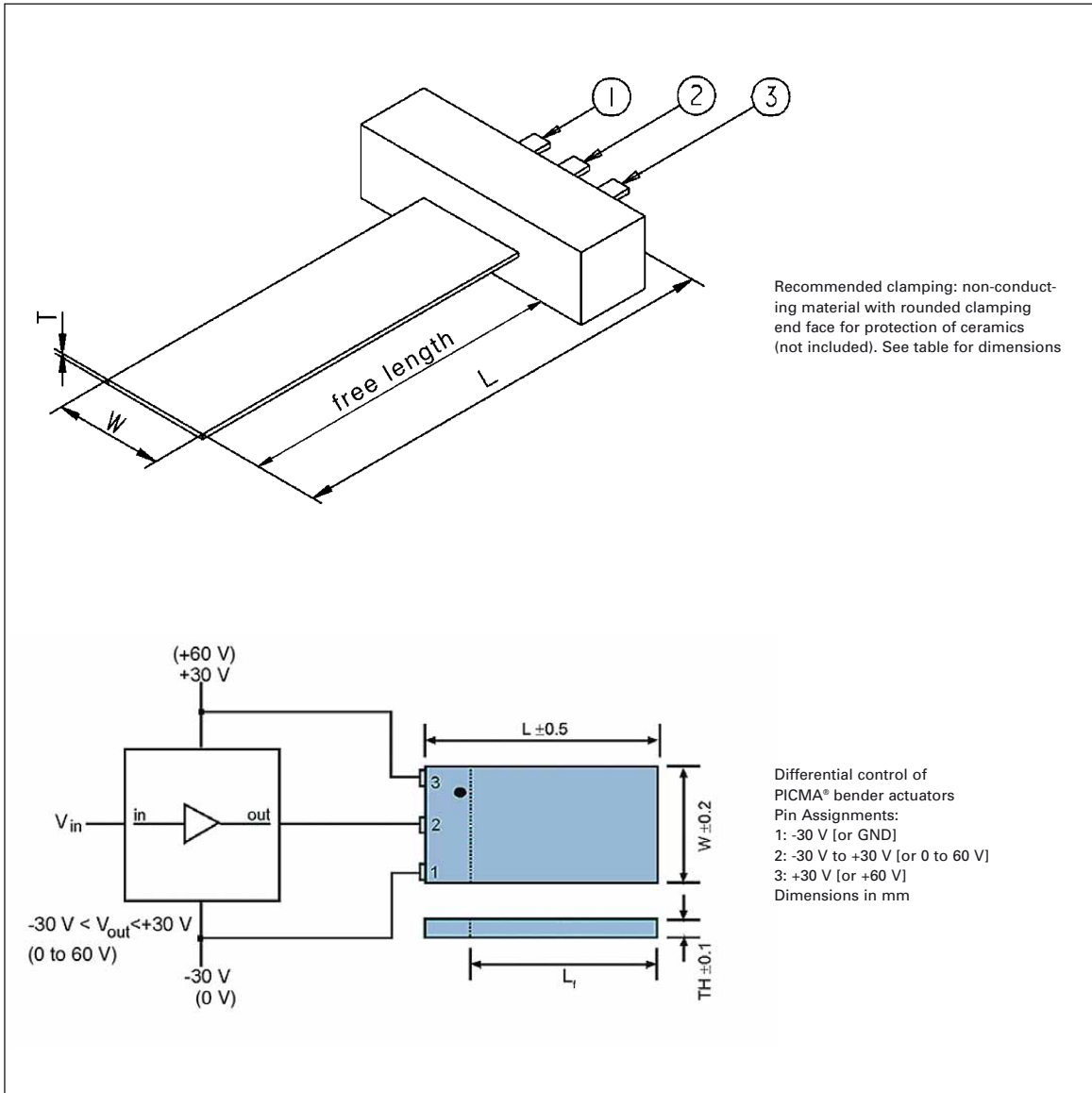
The E-650.00 and E-650.0E piezo amplifiers ( see p. 2-122) are especially designed for operating the PICMA® bender actuators.



Bender actuators with strain gauge positioning sensors are available with product number P-871

#### Application Examples

- Wire bonding
- Pneumatic valves
- Fiber optic switches
- (Laser)-Beam steering
- Micropositioning
- Acceleration sensors



### Linear Actuators & Motors

PiezoWalk® Motors / Actuators

PLine® Ultrasonic Motors

DC-Servo &amp; Stepper Actuators

### Piezo Actuators & Components

Guided / Preloaded Actuators

Unpackaged stack Actuators

Patches/Benders/Tubes/Shear..

Nanopositioning / Piezoelectrics

Nanometrology

Micropositioning

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### Technical Data / Product Order Numbers

Order number*	Operating voltage [V]	Nominal displacement [ $\mu\text{m}$ ] $\pm 20\%$	Free length [mm]	Dimensions L x W x T [mm]	Blocking force [N]	Electrical capacitance [ $\mu\text{F}$ ] $\pm 20\%$	Resonant frequency [Hz] $\pm 20\%$
PL112.10**	0 - 60 ( $\pm 30$ )	$\pm 80$	12	17.8 x 9.6 x 0.65	$\pm 2.0$	2 x 1.1	>1000
PL122.10	0 - 60 ( $\pm 30$ )	$\pm 250$	22	25.0 x 9.6 x 0.65	$\pm 1.1$	2 x 2.4	660
PL127.10	0 - 60 ( $\pm 30$ )	$\pm 450$	27	31.0 x 9.6 x 0.65	$\pm 1.0$	2 x 3.4	380
PL128.10**	0 - 60 ( $\pm 30$ )	$\pm 450$	28	35.5 x 6.3 x 0.75	$\pm 0.5$	2 x 1.2	360
PL140.10	0 - 60 ( $\pm 30$ )	$\pm 1000$	40	45.0 x 11.0 x 0.60	$\pm 0.5$	2 x 4.0	160

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

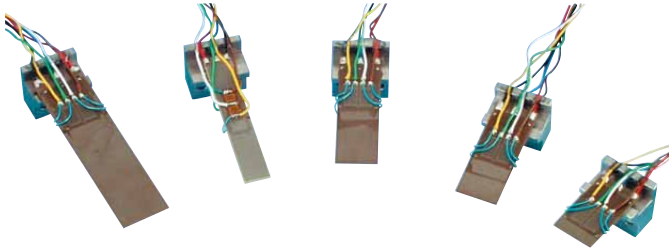
Operating temperature range: -20 to +85 °C;

\*\*to +150 °C Resonant frequency at 1  $V_{pp}$ , capacitance at 1  $V_{pp}$ , 1 kHz

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

## P-871 PICMA® Piezo Bender Actuators

### Low-Voltage Multilayer Piezo Bender Actuators with Position Sensor



P-871.140, P-871.128, P-871.122 and P-871.112 closed-loop bender actuators (from left to right)

- 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.

#### Closed-Loop Position Control for Higher Accuracy

P-871s are ideal devices for scanning, positioning and beam deflection applications and provide much better accu-

racy, stability and repeatability than conventional open-loop actuators. The special bender design allows the direct application of a strain gauge sensor to the surface without the need for a polymer insulation layer in between. The advantages are faster response, reduced phase lag and precise position control with non-linearity of <0.5%. The settling time for a small-signal step (up to 1% nominal travel) to an accuracy of better than 1% is between 10 ms (P-871.112) and 30 ms (P-871.140).

#### 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-

#### 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

vacuum compatibility (no outgassing / high bakeout temperatures, up to 150 °C).

#### Amplifiers, Drivers & Controllers

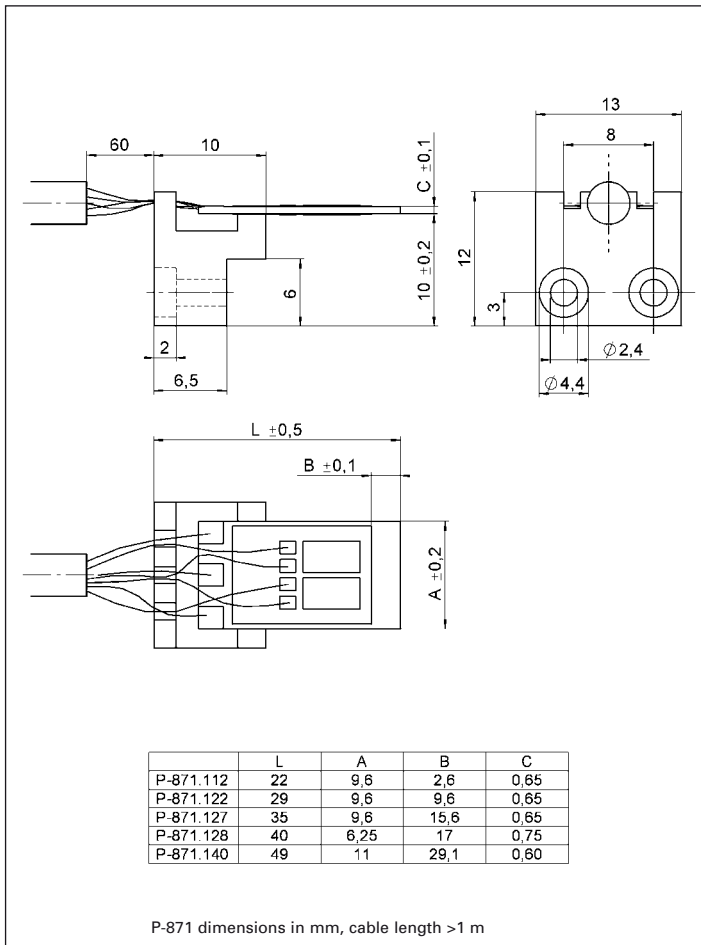
PI offers a wide range of standard amplifiers and controllers for piezo actuators. The E-651.1S and E-651.2S desktop controllers and the OEM board E-614.2BS (see p. 2-123) are specifically designed to operate P-871 bender actuators.



E-651 2-channel and 1-channel controllers with P-871 bender actuators

#### Application Examples

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



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### Technical Data

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

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 V<sub>pp</sub>, capacitance at 1 V<sub>pp</sub>, 1 kHz

All specifications depend on the real clamping conditions and on the applied mechanical load.

Other specifications on request.