

# P-212, P-216 PICA™ Power Piezo Stack Actuators

## Preloaded Piezo Actuators (HVPZT) w/ Sensor Option



From left:  
P-212.1S and .8S, P-216.9S,  
.4S and .1S piezo actuators  
(CD for size comparison)

- Travel Range to 180  $\mu\text{m}$
- Pushing Forces to 4500 N
- Pulling Forces to 500 N
- Sub-millisecond Response
- Sub-nanometer Resolution
- Options: Vacuum, High- and Low-Temperature

The P-212 and P-216 series are high-resolution linear piezo actuators (translators) for static and dynamic applications. They provide sub-millisecond

### Application Examples

- Optics
- Metrology / interferometry
- Adaptronics
- Precision engineering / micromechanics
- Adaptive mechanics
- Active vibration damping
- Switches
- Laser tuning
- Force generation / materials testing
- Nanotechnology

response and sub-nanometer resolution.

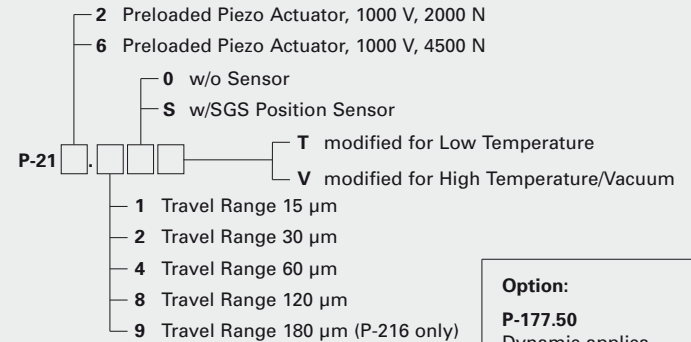
These actuators have the friction-free, preloaded PICA™ Power actuators inside. The preload makes them ideal for dynamic applications like precision machining or active damping.

### High Displacement with Ultra-High Reliability

PICA™ Power actuators are optimized for high-temperature working conditions and high-duty-cycle dynamic applications.

All PICA™ piezo ceramics are specifically designed for high-duty-cycle applications. With PI's extensive applications knowledge, gained over several decades, performance does

### Ordering Information



Please read "Options and Accessories" (page 1-102 ff) for further information.  
 Extensions cables, adapters & connectors: see in "Accessories" in the "Piezo Drivers / Servo Controllers" (see p. 2-168 ff) section.

### Option:

**P-177.50**  
 Dynamic applications (with E-481):  
 temperature sensor and protective air for PICA™ HVPZT

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.

### Open- and Closed-Loop Models for Optimum Dynamics and Linearity

The standard models are ideal for open loop positioning applications. In this mode the actuator displacement is roughly proportional to the applied voltage.

Open-loop operation is ideal for applications where fast response and very high resolution with maximum bandwidth are essential. Here, commanding and reading the target position in absolute values is either not important or carried out by external position sensors (see p. 2-104).

For highest positioning accuracy and repeatability, select the factory installed closed-loop option with integrated ultra-high-resolution strain gauge position sensors and operate with PI servo-control electronics. For more information, read the tutorial "Piezo-

electrics in Positioning" (see p. 2-169 ff).

### Mechanical Mounting

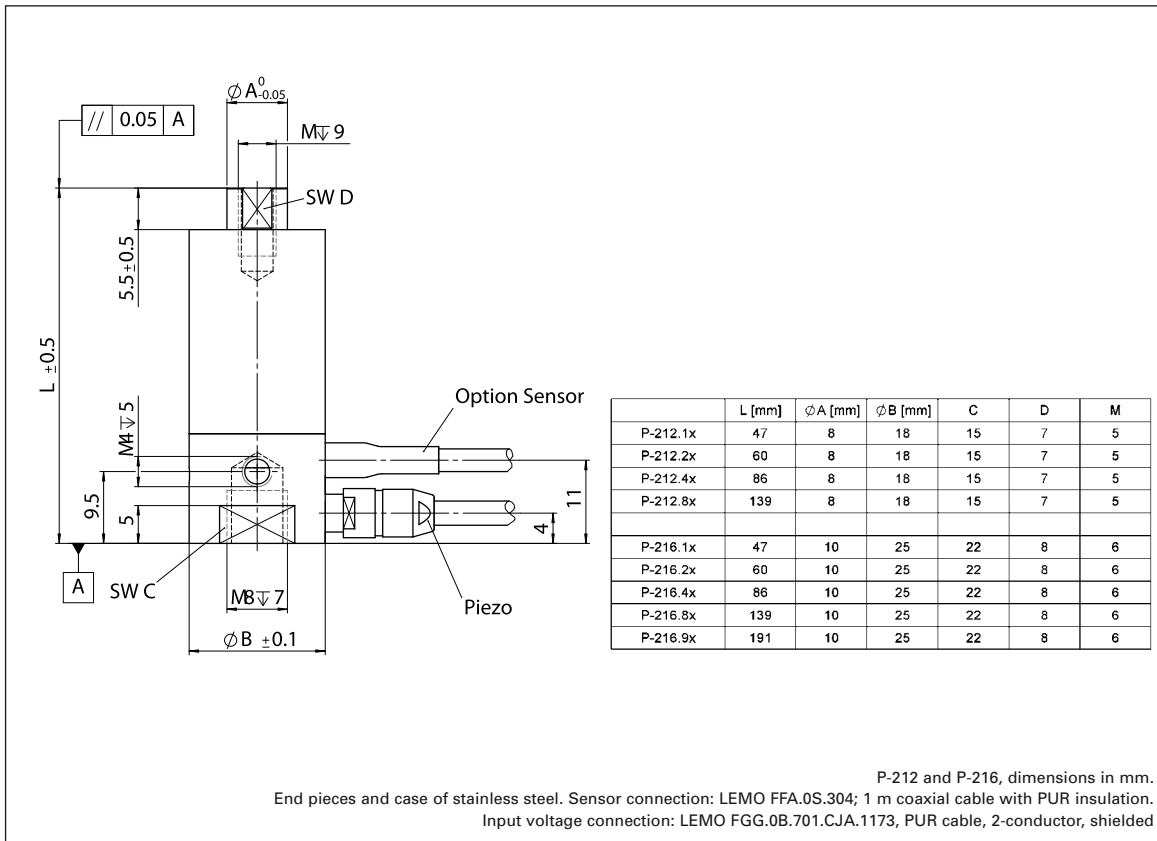
Mounting is at the foot, with push/pull forces of less than 5 N, the actuator can be held by clamping the case. The optional ball tip is intended to decouple torque and off-center forces from the translator. Read details in Mounting and Handling Guidelines (p. 1-67).

### High Flexibility with PI Amplifiers, Drivers & Controllers

PI offers a wide range of control electronics for piezo actuators from low-power drivers to the high-performance amplifier / controller E-481.

For closed-loop operation PI offers a wide variety of analog and digital controllers. The E-500 modular system can be easily upgraded from an amplifier to a servo controller, including different interface / display modules.

High-resolution amplifiers and servo-control electronics, both digital and analog, see selection guide in the "Piezo Drivers / Servo Controllers" section (see p. 2-99 ff).



### Linear Actuators & Motors

PiezoWalk® Motors / Actuators

PILine® 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

	P-212.10	P-212.20	P-212.40	P-212.80	P-216.10	P-216.20	P-216.40	P-216.80	P-216.90	Unit	Tolerance
Operating voltage	0 to 1000	0 to 1000	0 to 1000	0 to 1000	0 to 1000	0 to 1000	0 to 1000	0 to 1000	0 to 1000	V	
<b>Motion and positioning</b>											
Closed-loop travel*	15	30	60	120	15	30	60	120	180	μm	
Closed-loop resolution*/**	0.3	0.6	1.2	2.4	0.3	0.6	1.2	2.4	3.6	nm	typ.
Open-open resolution**	0.15	0.3	0.6	1.2	0.15	0.3	0.6	1.2	1.8	nm	typ.
Linearity*	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	%	typ.
<b>Mechanical properties</b>											
Static large-signal stiffness***	90	60	34	18	210	140	80	50	32	N/μm	±20%
Unloaded resonant frequency	17	12	7	4.5	17	12	7	4.5	3	kHz	±20%
Push/pull force capacity	2000/300	2000/300	2000/300	2000/300	4500/500	4500/500	4500/500	4500/500	4500/500	N	Max.
Shear force limit	15	10	10	10	60	36	23	23	23	N	
Torque limit (on tip)	0.5	0.5	0.5	0.5	1	1	1	1	1	Nm	
<b>Drive properties</b>											
Electrical capacitance	47	90	180	370	130	250	500	1000	1500	nF	±20%
Dynamic operating current coefficient	5	5	5	5	13	13	13	13	13	μA/(Hz • μm)	±20%
<b>Miscellaneous</b>											
Mass (with cable)	110	120	150	210	170	200	250	370	480	g	±5%

\* Requires SGS sensor. SGS versions are shipped with performance reports

\*\* Measured with an Interferometer. The resolution of piezo actuators is not limited by stiction or friction

\*\*\* Dynamic small-signal stiffness is ~50% higher

Piezo ceramic type: PICA™ Power

Operating temperature range: -40 to +80 °C

Recommended controller/driver see p. 2-100 ff

For maximum lifetime, voltages in excess of 750 V should be applied only for short durations

See Notes (Technical Data) for further information (p. 1-106 ff)

# P-225, P-235 PICA™ Power Piezo Stack Actuators

## Preloaded High-Load Piezo Actuators (HVPZT) w/ Sensor Option



High-load piezo actuators P-235.1S, .4S and .9S, P-225.8S and .1S (from left) with CD for size comparison

- **Extremely High Stiffness**
- **Pushing Forces to 30,000 N**
- **Pulling Forces to 3500 N**
- **Travel Ranges to 180 µm**
- **Options: Versions for Vacuum, High- and Low-Temperatures and with Water-Resistant Case**

P-225 and P-235 are preloaded, high-load piezo actuators (translators) for static and dynamic applications. They provide sub-millisecond re-sponse and sub-nanometer resolution.

These ultra-high-force linear

### Application Examples

- Precision engineering / micromechanics
- Adaptive mechanics
- Active vibration damping
- Adaptronics
- Static and dynamic precision positioning
- Force generation / materials testing

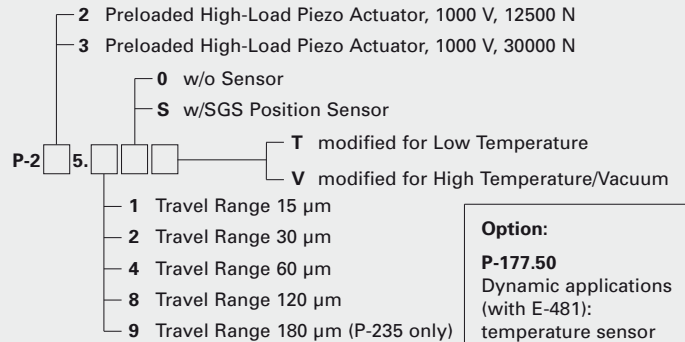
actuators consist of PICA™ Power piezoelectric ceramic-stacks encapsulated in a stainless steel case with stainless steel end pieces and a frictionless internal spring preload. The high load capacity and preload makes them ideal for machining applications and active vibration cancellation.

### High Displacement with Ultra-High Reliability

PICA™ Power actuators are optimized for high-temperature working conditions and high-duty-cycle dynamic applications.

All PICA™ piezo ceramics are specifically designed for high-duty-cycle applications. With PI's extensive applications knowledge, gained over sever-

### Ordering Information



Please read "Options and Accessories" (page 1-102 ff) for further information.

Extensions cables, adapters & connectors: "Accessories" in the "Piezo Drivers / Servo Controllers" (see p. 2-168 ff) section.

al decades, performance 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.

### Open- and Closed-Loop Models for Optimum Dynamics and Linearity

The standard models are ideal for open loop positioning applications. In this mode the actuator displacement is roughly proportional to the applied voltage.

Open-loop operation is ideal for applications where the fastest response and the highest bandwidth are essential. Here, commanding and reading the target position in absolute values is either not important or carried out by an external feedback loop.

For highest positioning accuracy and repeatability, select the factory installed closed-loop option with integrated ultra-high-resolution strain gauge position sensors and operate with PI servo-control electronics. For more information, read

the tutorial "Piezoelectrics in Positioning" (see p. 2-169 ff).

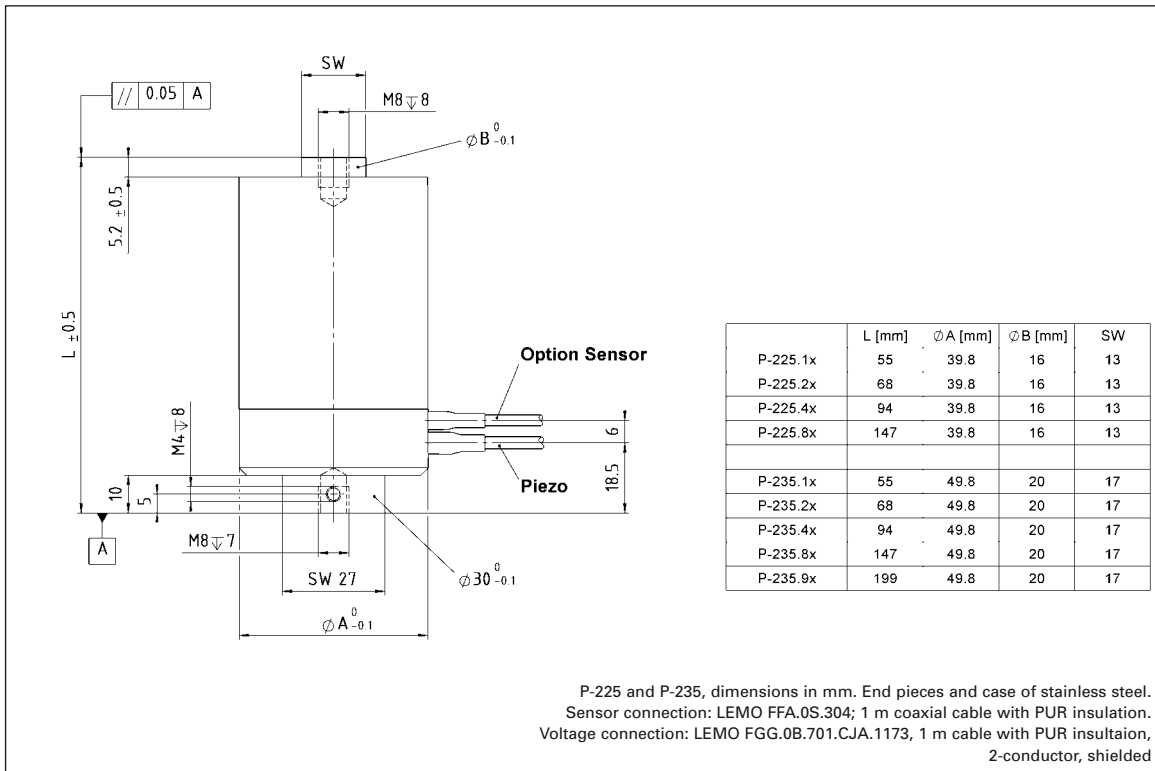
### High Flexibility with PI Amplifiers, Drivers & Controllers

PI offers a wide range of control electronics for piezo actuators from economical, low-power piezo drivers to the E-481 high-performance amplifier / controller providing 2000 W of dynamic power.

For closed-loop operation a wide variety of analog and digital controllers is available. The E-500 modular system can be easily upgraded from an amplifier to a servo controller, including different interface / display modules.

Read details in Mounting and Handling Guidelines (p. 1-67).

High-resolution amplifiers and servo-control electronics, both digital and analog, see selection guide in the "Piezo Drivers / Servo Controllers" section (see p. 2-99 ff).



### Linear Actuators & Motors

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### Technical Data

Model	P-225.10	P-225.20	P-225.40	P-225.80	P-235.10	P-235.20	P-235.40	P-235.80	P-235.90	Unit	Tolerance
Operating voltage	0 to 1000	0 to 1000	0 to 1000	0 to 1000	0 to 1000	0 to 1000	0 to 1000	0 to 1000	0 to 1000	V	
<b>Motion and positioning</b>											
Closed-loop travel*	15	30	60	120	15	30	60	120	180	µm	
Closed-loop resolution*/**	0.3	0.6	1.2	2.4	0.3	0.6	1.2	2.4	3.6	nm	typ.
Open-loop resolution**	0.15	0.3	0.6	1.2	0.15	0.3	0.6	1.2	1.8	nm	typ.
Linearity*	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	%	typ.
<b>Mechanical properties</b>											
Static large-signal stiffness***	480	330	200	110	860	600	380	210	150	N/µm	±20
Unloaded resonant frequency	14	10	7	4	14	10	7	3,9	2,8	kHz	±20%
Push/pull force capacity	12500 / 2000	12500 / 2000	12500 / 2000	12500 / 2000	30000 / 3500	30000 / 3500	30000 / 3500	30000 / 3500	30000 / 3500	N	Max.
Shear force limit	255	152	84	73	707	420	232	147	147	N	
Torque limit (on tip)	1,5	1,5	1,5	1,5	2	2	2	2	2	Nm	
<b>Drive properties</b>											
El. capacitance	320	630	1300	2600	550	1100	2400	5100	7800	nF	±20%
Dynamic operating current coefficient	33	33	33	33	65	65	65	65	65	µA/(Hz • µm)	±20%
<b>Miscellaneous</b>											
Mass (with cable)	410	470	610	900	580	690	940	1400	1900	g	±5%

\*Requires SGS sensor. SGS versions are shipped with performance reports

\*\*Measured with an interferometer. The resolution of piezo actuators is not limited by stiction or friction

\*\*\*Dynamic small-signal stiffness is ~50% higher

Piezo ceramic type: PICA™ Power

Operating temperature range: -40 to +80 °C

Recommended controller/driver see p. 2-100 ff

For maximum lifetime, voltages in excess of 750 V should be applied only for short durations

See Notes (Technical Data) for further information (see p. 1-106 ff)