PT120 - PT140
Piezoceramic Tubes (HVPZT)

Selection of PT piezoceramic tubes.

PT-series piezoceramic tubes are used in a wide range of applications from microdispensing to scanning microscopy. These monolithic components contract laterally (radially) and longitudinally when a voltage is applied between their inner and outer electrodes. Multi-electrode tubes are available to provide XYZ motion for use in manipulation and scanning microscopy applications. PI also provides ultra-high-linearity, closed-loop scanning stages for SPM and nanomanipulation.

**Application Examples**
- Micropositioning
- Scanning microscopy (STM, AFM, etc.)
- Fiber stretching / modulation of optical path length
- Micro pumps / ink-jet printing
- Micromanipulators
- Ultrasonic and sonar applications

**Precision and Flexibility: PI Ceramic’s Strength**
PT piezo tubes are manufactured to the tightest tolerances. We can provide tubes with diameters as small as 0.8 mm and tolerances as tight as 0.025 mm.

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
- Custom Displacement
- Extra-Tight Tolerances
- Applied Sensors
- Special High / Low Temperature Versions
- Ultra-High-Vacuum Versions

**Design**
Dimensions: max. L: 50 mm max. OD: 80 mm min. wall thickness: 0.30 mm

**Electrodes:** fired silver-plated inside and outside as standard; thin film electrodes (e.g. copper-nickel or gold) as outer electrodes optional

**Options:** single or double wrapped, circumferential bands or quartered outer electrodes

**Polarization:** inner electrode positive potential

Tube actuators are not designed to withstand large forces (see PICA-Thru actuators), but their high resonant frequencies make them especially suitable for dynamic operation with light loads.

**Amplifiers, Drivers & Controllers**
PI offers a wide range of control electronics for piezo actuators from low power drivers to multi-channel, closed-loop, digital controllers.

**Short Leadtime for Standard & Custom Designs**
Because all piezoelectric materials used in PT tube actuators are manufactured at PI Ceramic, leadtimes are short and quality is outstanding. All standard and custom actuators are delivered with performance test sheets.

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Useful Equations
Axial contraction and radial displacement of piezo tube actuators can be estimated by the following equations:

\[ (\text{Equation 1}) \]
\[
\Delta L = d_{31} \cdot L \cdot \frac{U}{d}
\]

where:
\( d_{31} \) = strain coefficient (displacement normal to polarization direction) \([m/V]\)
\( L \) = length of the ceramic tube \([m]\)
\( U \) = operating voltage \([V]\)
\( d \) = wall thickness \([m]\)

\[ (\text{Equation 2}) \]
\[
\Delta d = d_{33} \cdot U
\]

where:
\( \Delta d \) = change in wall thickness \([m]\)
\( d_{33} \) = strain coefficient (field and displacement in polarization direction) \([m/V]\)
\( U \) = operating voltage \([V]\)

Typical values for \( d_{31} \) and \( d_{33} \) are \(-200\) pm/V and \(500\) pm/V, respectively.

The radial contraction is the superposition of the increase in wall thickness and the tangential contraction; it can be estimated by the following equation:

\[ (\text{Equation 3}) \]
\[
\Delta r = d_{31} \cdot \frac{U}{d}
\]

where:
\( r \) = tube radius
\( d_{31} \) = strain coefficient (displacement normal to polarization direction) \([m/V]\)
\( U \) = operating voltage \([V]\)
\( d \) = wall thickness \([m]\)

The quartered electrodes option makes XY scanning possible. These scanner tubes, which flex in X and Y, are widely used in scanning-probe microscopes. The scan range of these components is estimated by:

\[ (\text{Equation 4}) \]
\[
\Delta x = \frac{2 \sqrt{2} \cdot d_{31} \cdot L^2 \cdot U}{\pi \cdot ID \cdot d}
\]

where:
\( \Delta x \) = scan range in X and Y (for symmetrical electrodes) \([m]\)
\( d_{31} \) = strain coefficient (displacement normal to polarization direction) \([m/V]\)
\( U \) = symmetric operating voltage \([V]\)
\( L \) = length \([m]\)
\( ID \) = inner diameter \([m]\)
\( d \) = wall thickness \([m]\)

Technical Data / Product Order Numbers

<table>
<thead>
<tr>
<th>Order number</th>
<th>Dimensions [L x OD x ID]**</th>
<th>Max. operating voltage [V]</th>
<th>Electrical capacitance [nF ±20%]</th>
<th>Axial contraction [µm @ max. V]</th>
<th>Radial contraction [µm @ max. V]</th>
<th>XY deflection [µm]</th>
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</thead>
<tbody>
<tr>
<td>PT120.00</td>
<td>20 x 2.2 x 1.0</td>
<td>500</td>
<td>3</td>
<td>4</td>
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<tr>
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<td>15</td>
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</table>

All models available with 40 mm length, except PT120.00
* Quartered electrodes for XY deflection
** OD, ID ±0.05 mm all models except PT120 / PT 130.00 (±0.1 mm)