

PT120 · PT140 PT Piezo Tube Actuators

Piezoceramic Tube Actuators with Small Tolerances and Various Options



- Standard & Custom Sizes
- Optional Quartered Electrodes for XYZ-Positioning & Scanning
- Sub-Nanometer Resolution
- Ideal for OEM-Applications

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.

Precision and Flexibility

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 0.05 mm. All manufacturing processes at PI Ceramic are set up for maximum 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 / Displacement
- Custom Geometries
- Extra-Tight Tolerances
- Applied Sensors
- Special High / Low Temperature Versions

Application Examples

- Micropositioning
- Scanning microscopy (AFM, STM, etc.)
- Fiber stretching / modulation
- Micropumps
- Micromanipulation
- Ultrasonic and sonar applications

Short Leadtime

Because all piezoelectric materials used in PT tube actuators are manufactured at PI Ceramic, leadtimes are short and quality is outstanding.

Dimensions

max. L: 50 mm
max. OD: 80 mm
min. d: 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 p. 1-90), but their high resonant frequencies make them especially suitable for dynamic operation with light loads.

Application examples are micro pumps, scanning microscopy, ink-jet printing, ultrasonic and sonar applications.

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.

Equations

The axial contraction and radial displacement of piezo tubes can be calculated as follows:

(Equation 1)

$$\Delta L \approx d_{31} \cdot L \cdot \frac{U}{d}$$

where:

d_{31} = strain coefficient (displacement normal to polarization direction) [m/V]

L = length of ceramic tube [m]

U = operating voltage [V]

d = wall thickness [m]

(Equation 2)

$$\Delta d \approx d_{33} \cdot U$$

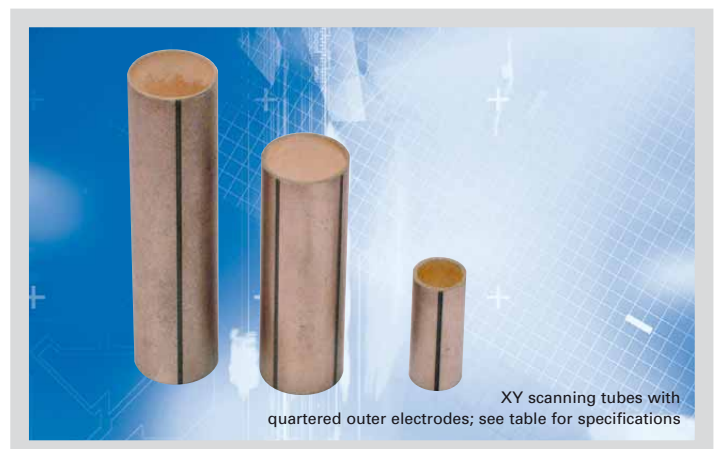
where:

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:

(Equation 3)

$$\frac{\Delta r}{r} \approx d_{31} \frac{U}{d}$$

where:

r = radius of piezo tube

d_{31} = strain coefficient (displacement normal to polarization direction) [m/V]

U = operating voltage [V]

d = wall thickness [m]

For a given division of the outer electrode of a piezo tube into four 90° sections the differential control ($\pm U$) of opposing electrodes results in bending of one of the ends, due to super-

position of radial and axial contraction. Such tubes are applied as XY scanner in scanning-probe microscopes such as atomic force microscopes. The scanning range can be evaluated as follows:

(Equation 4)

$$\Delta x \approx \frac{2\sqrt{2} \cdot d_{31} \cdot L^2 \cdot U}{\pi \cdot ID \cdot d}$$

where:

Δx = scanning range in X and Y (for symmetrical electrodes) [m]

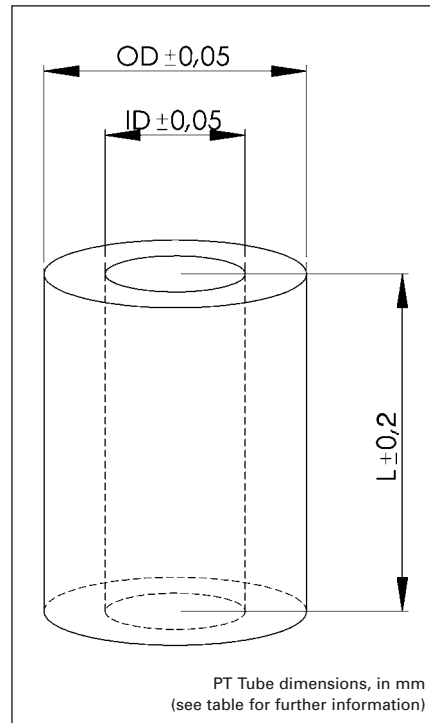
d_{31} = strain coefficient (displacement normal to polarization direction) [m/V]

U = operating voltage [V]

L = length [m]

ID = inner diameter [m]

d = wall thickness [m]



Linear Actuators & Motors

PiezoWalk® Motors / Actuators

PILine® Ultrasonic Motors

DC-Servo & 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 | Dimensions [mm] L x OD x ID** | Max. operating voltage [V] | Electrical capacitance [nF] ±20% | Axial contraction [µm] @ max. V | Radial contraction [µm] @ max. voltage | XY deflection [µm] @ ±200 V |
|--------------|----------------------------------|----------------------------|----------------------------------|---------------------------------|--|-----------------------------|
| PT120.00 | 20 x 2.2 x 1.0 | 500 | 3 | 5 | 0.7 | - |
| PT130.00 | 30 x 3.2 x 2.2 | 500 | 10 | 9 | 0.9 | - |
| PT130.90 | 30 x 3.2 x 2.2 | 500 | 12 | 9 | 0.9 | - |
| PT130.94* | 30 x 3.2 x 2.2 | ±200 | 4 x 2.4 | 9 | 0.9 | ±35 |
| PT130.10 | 30 x 6.35 x 5.35 | 500 | 18 | 9 | 1.8 | - |
| PT130.14* | 30 x 6.35 x 5.35 | ±200 | 4 x 3.8 | 9 | 1.8 | ±16 |
| PT130.20 | 30 x 10.0 x 9.0 | 500 | 36 | 9 | 3 | - |
| PT130.24* | 30 x 10.0 x 9.0 | ±200 | 4 x 8.5 | 9 | 3 | ±10 |
| PT130.30 | 30 x 10.0 x 8.0 | 1000 | 18 | 9 | 3 | - |
| PT130.40 | 30 x 20.0 x 18.0 | 1000 | 35 | 9 | 6 | - |
| PT140.70 | 40 x 40.0 x 38.0 | 1000 | 70 | 15 | 12 | - |

*Quartered electrodes for XY deflection

**OD (outer diameter), ID (inner diameter) ±0.05 mm. PT120 / PT130.00: ID ±0.1 mm

Other specifications on request.