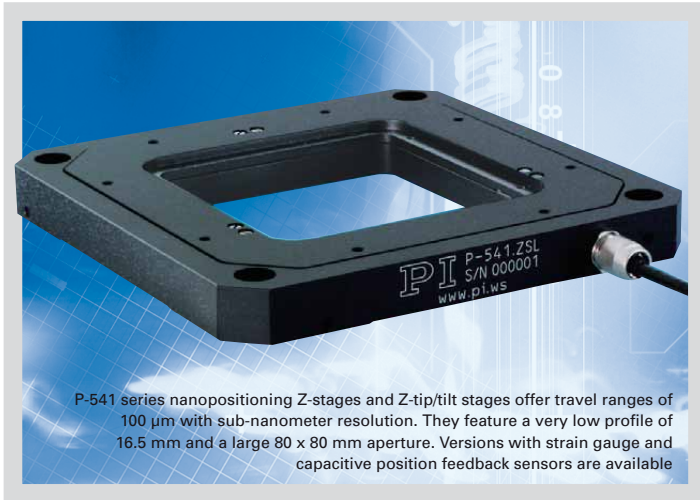


P-541.Z Piezo Z and Z/Tip/Tilt Stages

Low Profile, Large Aperture



P-541 series nanopositioning Z-stages and Z-tip/tilt stages offer travel ranges of 100 μm with sub-nanometer resolution. They feature a very low profile of 16.5 mm and a large 80 x 80 mm aperture. Versions with strain gauge and capacitive position feedback sensors are available

- **Low Profile for Easy Integration: 16.5 mm; 80 x 80 mm Clear Aperture**
- **Vertical and Z/Tip/Tilt Stages**
- **100 μm Travel Range, 1 mrad Tilt**
- **Parallel-Kinematics / Metrology for Enhanced Responsiveness / Multi-Axis Precision**
- **Choice of Sensors: Strain Gauge (Lower Cost) or Capacitive Sensors (Higher Performance)**
- **Outstanding Lifetime Due to PICMA® Piezo Actuators**
- **Combination with Long-Travel M-686 Microscopy Stages**

Low Profile, Optimized for Microscopy Applications

The P-541 Z stages and Z/tip/tilt stages are for ideal alignment, nano-focusing or metrology tasks in the nanometer range. They feature a very low profile of 16.5 mm, a large 80 x 80 mm aperture, and offer highly accurate motion with sub-nanometer resolution.

Application Examples

- Scanning microscopy
- Mask / wafer positioning
- Interferometry
- Metrology
- Biotechnology
- Micromanipulation

A variety of P-541 XY scanning stages with the same footprint are also available (see p. 2-60). Due to the low-profile design, the stages can easily be integrated in high-resolution microscopes.

Choice of Position Sensors

PI's proprietary capacitive sensors measure position directly and without physical contact. They are free of friction and hysteresis, a fact which, in combination with the positioning resolution of well under 1 nm, makes it possible to achieve very high levels of linearity. A further advantage of direct metrology with capacitive sensors is the high phase fidelity and the high bandwidth of up to 10 kHz.

Alternatively, economical strain gauge sensors are available. PI uses a bridge configuration to eliminate thermal drift, and assure optimal position stability in the nanometer range.

Active and Passive Guidance for Nanometer Flatness and Straightness

Flexures optimized with Finite Element Analysis (FEA) are completely free of play and friction to allow extremely high-precision motion. The FEA techniques also optimize straightness and flatness and provide for the highest possible stiffness in, and perpendicular to, the direction of motion.

Due to the parallel-kinematics design there is only one common moving platform for all axes, minimizing mass, enabling identical dynamic behaviour and eliminating cumulative errors. Parallel kinematics also allows for a more compact construction and faster response compared to stacked or nested designs.

Ordering Information

P-541.ZCD

Vertical Nanopositioning Stage with Large Aperture, 100 μm , Direct Metrology, Capacitive Sensors

P-541.TCD

Vertical Tip / Tilt Nanopositioning Stage with Large Aperture, 100 μm / 1 mrad, Parallel Metrology, Capacitive Sensors

P-541.ZSL

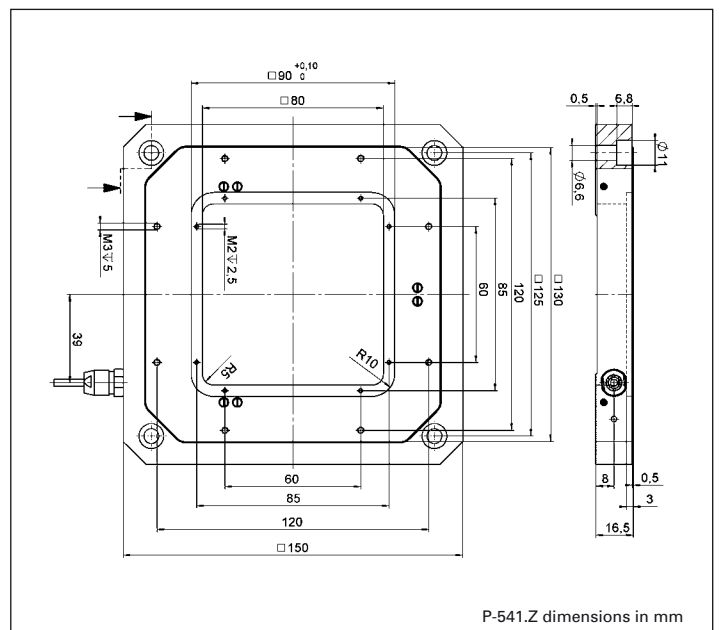
Vertical Nanopositioning Stage with Large Aperture, 100 μm , Strain Gauge Sensors

P-541.TSL

Vertical Tip / Tilt Nanopositioning Stage with large Aperture, 100 μm , Strain Gauge Sensors

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.



P-541.Z dimensions in mm



System properties

| | |
|-----------------------------------|--|
| System configuration | P-541.ZCD and E-500 modular system with E-503 amplifier and E-509 sensor module, 20 g load |
| Amplifier bandwidth, small signal | 60 Hz |
| Settling time (10 % step width) | 9 ms |

Technical Data

| Models | P-541.ZCD | P-541.TCD* | P-541.ZSL | P-541.TSL | P-541.T0L* | P-541.Z0L | Units | Tolerance |
|---|------------------|----------------------------|-----------|----------------------------|------------|----------------------------|---|--------------------|
| Active axes | Z | Z, θ_x , θ_y | Z | Z, θ_x , θ_y | Z | Z, θ_x , θ_y | | |
| Motion and positioning | | | | | | | | |
| Integrated sensor | Capacitive | Capacitive | SGS | SGS | Open-loop | Open-loop | | |
| Open-loop Z-travel, -20 to +120 V | 150 | 150 | 150 | 150 | 150 | 150 | μm | min. (+20%/0%) |
| Open-loop tip/tilt angle, -20 to +120 V | – | ± 0.6 | – | ± 0.6 | – | ± 0.6 | mrad | min. (+20%/0%) |
| Closed-loop Z-travel | 100 | 100 | 100 | 100 | – | – | μm | |
| Closed-loop tip/tilt angle | – | ± 0.4 | – | ± 0.4 | – | – | mrad | |
| Open-loop Z-resolution | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | nm | typ. |
| Open-loop tip/tilt angle resolution | – | 0.02 | – | 0.02 | – | 0.02 | μrad | typ. |
| Closed-loop Z-resolution | 0.5 | 0.5 | 2.5 | 2.5 | – | – | nm | typ. |
| Closed-loop tip/tilt resolution | – | 0.08 | – | 0.25 | – | – | μrad | typ. |
| Linearity Z, θ_x , θ_y | 0.03 | 0.03 | 0.2 | 0.2 | – | – | % | typ. |
| Repeatability Z | <2 | <2 | <10 | <10 | – | – | nm | typ. |
| Repeatability θ_x , θ_y | – | 0.01 | – | 0.05 | – | – | μrad | typ. |
| Runout θ_x , θ_y | ± 15 | ± 15 | ± 15 | ± 15 | ± 15 | ± 15 | μrad | typ. |
| Mechanical properties | | | | | | | | |
| Stiffness Z | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | N/ μm | $\pm 20\%$ |
| Unloaded resonant frequency (Z) | 410 | 410 | 410 | 410 | 410 | 410 | Hz | $\pm 20\%$ |
| Unloaded resonant frequency (θ_x , θ_y) | – | 330 | – | 330 | – | 330 | Hz | $\pm 20\%$ |
| Resonant frequency @ 200 g (Z) | 250 | 250 | 250 | 250 | 250 | 250 | Hz | $\pm 20\%$ |
| Resonant frequency @ 200 g (θ_x , θ_y) | – | 270 | – | 270 | – | 270 | Hz | $\pm 20\%$ |
| Push/pull force capacity | 50 / 20 | 50 / 20 | 50 / 20 | 50 / 20 | 50 / 20 | 50 / 20 | N | Max. |
| Drive properties | | | | | | | | |
| Ceramic type | PICMA® | PICMA® | PICMA® | PICMA® | PICMA® | PICMA® | | |
| | P-885 | P-885 | P-885 | P-885 | P-885 | P-885 | | |
| Electrical capacitance | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | μF | $\pm 20\%$ |
| Dynamic operating current coefficient | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 | $\mu\text{A} / (\text{Hz} \cdot \mu\text{m})$ | $\pm 20\%$ |
| Miscellaneous | | | | | | | | |
| Operating temperature range | 20 to 80 | 20 to 80 | 20 to 80 | 20 to 80 | 20 to 80 | 20 to 80 | $^{\circ}\text{C}$ | |
| Material | Aluminum | Aluminum | Aluminum | Aluminum | Aluminum | Aluminum | | |
| Mass | 750 | 750 | 730 | 730 | 700 | 700 | g | $\pm 5\%$ |
| Cable length | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | m | $\pm 10\text{ mm}$ |
| Sensoranschluss | Sub-D Special | Sub-D Special | LEMO | 3 x LEMO | – | – | | |
| Voltage connection | Sub-D Special | Sub-D Special | LEMO | 3 x LEMO | LEMO | 3 x LEMO | | |

*Parallel kinematics design; the maximum displacement for translation and tilt motion cannot be achieved at the same time
Resolution of PI Piezo Nanopositioners is not limited by friction or stiction. Value given is noise equivalent motion with E-503 (p. 2-146) or E-710 controller (p. 2-128).
Recommended controller / amplifier

Single-channel (1 per axis): E-610 servo controller / amplifier (p. 2-110), E-625 servo controller, bench-top (p. 2-114), E-621 controller module (p. 2-160)

Multi-channel: modular piezo controller system E-500 (p. 2-142) with amplifier module E-503 (three channels) (p. 2-146) or E-505 (1 per axis, high-power) (p. 2-147) and E-509 controller (p. 2-152)

Single-channel digital controller: E-753 (bench-top) (p. 2-108)

Multi-channel digital controllers: E-710 bench-top (p. 2-128), E-712 modular (p. 2-140), E-725 high-power (p. 2-126), E-761 PCI board (p. 2-130)

Linear Actuators & Motors

Nanopositioning/Piezoelectrics

Piezo Flexure Stages / High-Speed Scanning Systems

Linear

Vertical & Tip/Tilt

2- and 3-Axis

6-Axis

Fast Steering Mirrors / Active Optics

Piezo Drivers / Servo Controllers

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