Piezo • Nano • Positioning

P-561 • P-562 • P-563 PIMars™ XYZ Piezo System
High-Precision Nanopositioning Stage, 3 to 6 Axes

P-562 PIMars™ multi-axis, parallel-kinematics nanopositioning stages are available with up to 340 µm travel per axis. Custom versions to 6 DOF are available.

- Parallel-Kinematics / Metrology for Enhanced Responsiveness / Multi-Axis Precision
- Travel Ranges to 340 x 340 x 340 µm
- Capacitive Sensors for Highest Linearity
- Frictionless, High-Precision Flexure Guiding System
- Excellent Scanning Flatness
- High-Dynamics XYZ Version Available; Custom Versions to 6-DOF
- Clear Aperture 66 x 66 mm
- Outstanding Lifetime Due to PICMA® Piezo Actuators
- UHV Versions to 10⁻⁹ hPa

PIMars™ open-frame piezo stages are fast and highly accurate multi-axis scanning and nanopositioning systems with flatness and straightness in the nanometer range.

The 66 x 66 mm clear aperture is ideal for transmitted-light applications such as near-field scanning or confocal microscopy and mask positioning.

Large Variety of Models
PIMars™ multi-axis nanopositioners are offered in a large variety of configurations. Standard models include long-travel systems (to 300 x 300 x 300 µm), high-speed and vacuum versions. Custom six-axis designs with rotation to 6 mrad are available on request.

PI offers versions specially designed for applications in ultra-high vacuum with vacuum-qualified components only. The integrated ceramic-encapsulated PICMA® actuators allow high bakeout temperatures and assure minimal outgassing rates. A non-magnetizable version is available on request.

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

Direct Drive for Ultra-Fast Scanning and Positioning
The P-561.3DD versions have resonant frequencies to 1.0 kHz, enabling millisecond scanning rates with sub-nanometer resolution.

Capacitive Sensors for Highest Accuracy and Position Stability
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.

Active and Passive Guidance for Nanometer Flatness and Straightness
Wire-cut flexures optimized with Finite Element Analysis (FEA) are used to guide the stage. The FEA techniques give the design the highest possible stiffness and minimize linear and angular runout. Further enhancement is achieved by active trajectory control: multi-effect drive.

System properties
- System Configuration: P-561.3CD with E-710 digital controller, 330 g load
- Amplifier bandwidth, small signal: 25 Hz in X, Y; 35 Hz in Z
- Settling time (10 % step): 20 ms

Ordering Information

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-561.3CD</td>
<td>PIMars™ XYZ Piezo-Nanopositioning System, 100 x 100 x 100 µm, Parallel Metrology</td>
</tr>
<tr>
<td>P-562.3CD</td>
<td>PIMars™ XYZ Piezo-Nanopositioning System, 200 x 200 x 200 µm, Parallel Metrology</td>
</tr>
<tr>
<td>P-563.3CD</td>
<td>PIMars™ XYZ Piezo-Nanopositioning System, 300 x 300 x 300 µm, Parallel Metrology</td>
</tr>
<tr>
<td>P-561.3DD</td>
<td>PIMars™ High-Dynamics XYZ Nanopositioning System, 45 x 45 x 15 µm, Parallel Metrology, Direct Drive</td>
</tr>
</tbody>
</table>

Vacuum-compatible versions to 10⁻¹ hPa for the P-561.3CD, P-562.3CD and P-563.3CD models are available as P-561.3VD, P-562.3VD and P-563.3VD; versions to 10⁻⁹ hPa as P-561.3UD, P-562.3UD and P-563.3UD.

Super-invar & titanium versions are available, 6-DOF versions on request.
axis nanopositioning systems equipped with parallel metrology are able to measure platform position in all degrees of freedom against a common, fixed reference. In such systems, undesirable motion from one actuator in the direction of another (cross-talk) is detected immediately and actively compensated by the servo-loops. This can keep deviation from a trajectory to under a few nanometers, even in dynamic operation.

Technical Data

<table>
<thead>
<tr>
<th>Model</th>
<th>P-561.3CD</th>
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<th>P-563.3CD</th>
<th>P-561.3DD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active axes</td>
<td>X, Y, Z</td>
<td>X, Y, Z</td>
<td>X, Y, Z</td>
<td>X, Y, Z</td>
</tr>
<tr>
<td>Motion and positioning</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrated sensor</td>
<td>Capacitive</td>
<td>Capacitive</td>
<td>Capacitive</td>
<td>Capacitive</td>
</tr>
<tr>
<td>Open-loop travel, -20 to +120 V</td>
<td>150 x 150 x 150</td>
<td>300 x 300 x 300</td>
<td>340 x 340 x 340</td>
<td>58 x 58 x 18 µm</td>
</tr>
<tr>
<td>Closed-loop travel</td>
<td>100 x 100 x 100</td>
<td>200 x 200 x 200</td>
<td>300 x 300 x 300</td>
<td>45 x 45 x 15 µm</td>
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<tr>
<td>Open-loop travel</td>
<td>0.2</td>
<td>0.4</td>
<td>0.5</td>
<td>0.1</td>
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<tr>
<td>Closed-loop travel</td>
<td>0.8</td>
<td>1</td>
<td>2</td>
<td>0.2</td>
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<tr>
<td>Linearity</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.01%</td>
</tr>
<tr>
<td>Repeatability in X, Y, Z</td>
<td>±1</td>
<td>±2</td>
<td>±2</td>
<td>±3</td>
</tr>
<tr>
<td>Pitch in X, Y</td>
<td>±15</td>
<td>±20</td>
<td>±25</td>
<td>±3</td>
</tr>
<tr>
<td>Runout in X, Y, Z (motion)</td>
<td>±10</td>
<td>±10</td>
<td>±10</td>
<td>±3</td>
</tr>
<tr>
<td>Flatness in X, Y</td>
<td>±15</td>
<td>±20</td>
<td>±25</td>
<td>±10</td>
</tr>
<tr>
<td>CrossTalk X, Y (Z motion)</td>
<td>±30</td>
<td>±50</td>
<td>±50</td>
<td>±20</td>
</tr>
</tbody>
</table>

Mechanical properties

| Unloaded resonant frequency in X / Y / Z | 190 / 190 / 380 | 160 / 160 / 315 | 140 / 140 / 250 | 920 / 920 / 1050** Hz |
| Resonant frequency @ 100 g in X / Y / Z | 145 / 145 / 275 | 120 / 120 / 215 | 860 / 860 / 950 Hz | ±20% |
| Resonant frequency @ 330 g in X / Y / Z | 140 / 140 / 300 | 130 / 130 / 195 | 110 / 110 / 170 | 500 / 500 / 470 Hz | ±20% |
| Push force capacity in motion direction in X / Y | 200 / 200 / 50 | 120 / 120 / 50 | 100 / 100 / 50 | 200 / 200 / 50 N | N Max. |
| Pull force capacity in motion direction in X / Y | 30 / 30 / 30 | 30 / 30 / 30 | 30 / 30 / 30 | 30 / 30 / 30 |
| Load capacity | 50 | 50 | 50 | 50 |

Drive properties

| Ceramic type | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 | PICMA® P-885 in Z, P-888 in XY |
| Electrical capacitance in X / Y / Z | 5.2 / 5.2 / 10.4 | 7.4 / 7.4 / 14.8 | 7.4 / 7.4 / 14.8 | 38 / 38 / 6 µF | ±20% |
| Dynamic operating current coefficient (DOCC) in X / Y / Z | 6.5 / 6.5 / 13 | 4.6 / 4.6 / 9.25 | 3.1 / 3.1 / 6.1 | 106 / 106 / 50 µA/ (Hz • µm) | ±20% |

Miscellaneous

| Operating temperature range | -20 to 80 | -20 to 80 | -20 to 80 | -20 to 80 °C |
| Material | Aluminum | Aluminum | Aluminum | Aluminum |
| Mass | 1.45 | 1.45 | 1.45 | 1.55 kg | ±5% |
| Cable length | 1.5 | 1.5 | 1.5 | 1.5 m | ±10 mm |

Resolution of PI Piezo Nanopositioners is not limited by friction or stiction. Value given is noise equivalent motion with E-710 (p. 2-128) controller.

Recommended controller

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)
Piezo • Nano • Positioning

PIMars open-frame piezo stages are fast and highly accurate multi-axis scanning and nanopositioning systems with flatness and straightness in the nanometer range. Thanks to the parallel-kinematic design, where all piezo drives act on the same moving platform, and sophisticated digital control algorithms it is possible to achieve highly precise motion in all degrees of freedom: three linear axes and three rotary axes. The travel ranges amount to 200 μm in X, Y and Z, and the tilt angles are ±0.5 mrad about the respective axis. Systems with larger travel ranges or faster response are available on request. A six-axis system with 800 μm travel range in the X and Y axis is available as the P-587.6CD s.p. 2-76.

PIMars systems feature a large 66 x 66 mm clear aperture for transmitted-light applications such as near-field scanning or confocal microscopy and mask positioning. PIMars stages for ultra-high vacuum applications are also available. These versions contain vacuum-qualified components only. The integrated ceramic-encapsulated PICMA® actuators allow high bakeout temperatures and assure minimal outgassing rates. A non-magnetizable version is available on request.

Capacitive Sensors for Highest Accuracy and Stability
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. Further advantages of direct metrology with capacitive sensors are the excellent long-term stability, high phase fidelity and the high bandwidth of up to 10 kHz.

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Application Examples
- Scanning microscopy (SPM)
- Mask/wafer positioning
- Interferometry
- Metrology
- Biotechnology
- Micromanipulation

Ordering Information
P-562.6CD
PIMars 6-Axis Nanopositioning System, 200 μm, 1 mrad, Parallel Metrology
Other travel ranges on request!
Technical Data

<table>
<thead>
<tr>
<th>Model</th>
<th>P-562.6CD</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active axes</td>
<td>X, Y, Z, 6X, 6Y, 6Z</td>
<td></td>
</tr>
</tbody>
</table>

**Motion and Positioning**

- Integrated sensor: Capacitive
- Closed-loop travel X, Y, Z: 200 μm
- Closed-loop tip/tilt angle: ±0.5 mrad
- Closed-loop resolution X, Y, Z: 1 nm typ.
- Closed-loop tip/tilt resolution: 0.1 μrad typ.
- Linearity X, Y, Z: 0.01 % typ.
- Linearity 6X, 6Y, 6Z: 0.1 % typ.
- Repeatability in X, Y, Z: ±0.2 / ±0.2 / ±0.3 nm typ.
- Repeatability 6X / 6Y / 6Z: ±0.01 / ±0.01 / ±0.015 μrad typ.
- Flatness: < 15 nm typ.
- Unloaded resonant frequency in X / Y / Z: 110 / 110 / 190 Hz ±20%
- Load capacity: 50 N max.
- Push/pull force capacity in motion direction: 120 / 30 N max.

**Drive properties**

- Ceramic type: PICMA®
- Electrical capacitance in X / Y / Z: 7.4 / 7.4 / 14.8 μF ±20%
- Dynamic operating current coefficient in X, Y, Z: 4.6 / 4.6 / 9.2 μA/(Hz • μm) ±20%

**Miscellaneous**

- Operating temperature range: -20 to 80 °C
- Material: Aluminium
- Mass: 1.45 kg ±5%
- Cable length: 1.5 m ±10 mm
- Sensor / voltage connection: 2 x Sub-D Special

Recommended controller / amplifier:
E-710.6CD s.p. 2-128 or E-712.6CD digital controller s.p. 2-140