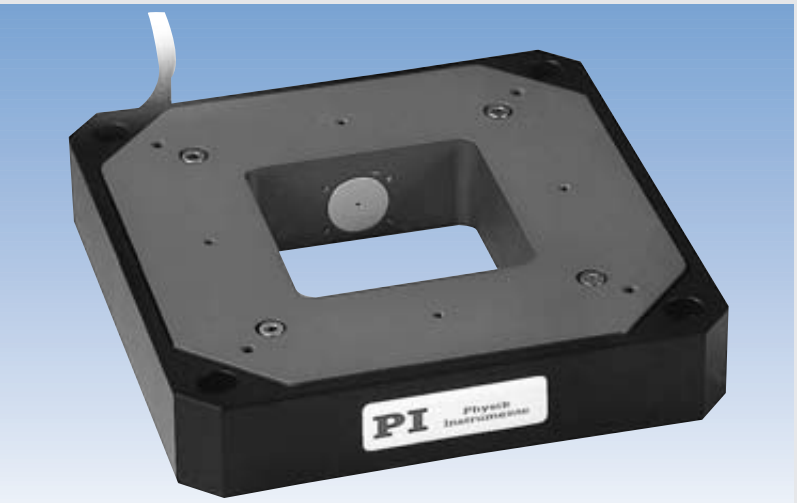
P-500

Multi-Axis, Single-Module Piezo Flexure NanoPositioners and Scanners



P-527.2CL
Single-module Flexure NanoPositioner

Ordering Information

P-558.ZCD
Z Piezo Flexure Stage, 50 µm, Capacitive Sensor, Sub-D Connector

P-518.ZCD
Z Piezo Flexure Stage, 100 µm, Capacitive Sensor, Sub-D Connector

P-528.ZCD
Z Piezo Flexure Stage, 200 µm, Capacitive Sensor, Sub-D Connector

P-558.ZCL
Z Piezo Flexure Stage, 50 µm, Capacitive Sensor, LEMO Connectors

P-518.ZCL
Z Piezo Flexure Stage, 100 µm, Capacitive Sensor, LEMO Connectors

P-528.ZCL
Z Piezo Flexure Stage, 200 µm, Capacitive Sensor, LEMO Connectors

P-558.TCD
Z, θ_x, θ_y Piezo Flexure Stage, 50 µm, ±025 mrad, Capacitive Sensor, Sub-D Connector

P-518.TCD
Z, θ_x, θ_y Piezo Flexure Stage, 100 µm, ±0.5 mrad, Capacitive Sensor, Sub-D Connector

P-528.TCD
Z, θ_x, θ_y Piezo Flexure Stage, 200 µm, ±1 mrad, Capacitive Sensor, Sub-D Connector

Continued on p. 2-34

Custom Designs for Volume Buyers

Application Examples

- Metrology
- Lithography
- Nanopositioning
- Scanning microscopy
- Disk-drive testing
- Optics
- Laser technology
- Micromanufacturing

- **Precision Trajectory Control**
- **Single-Module, Parallel-Kinematics Design Features Enhanced Responsiveness and Automatic Runout Compensation**
- **1- to 6-Axis Versions**
- **Travel Ranges to 200 µm**
- **Clear Aperture to 66 x 66 mm**
- **Integrated Capacitive Displacement Sensors**
- **Optional Active Error Compensation for Enhanced Trajectory Control**

P-500 series NanoPositioners are low-profile, high-resolution, piezoelectrically driven, multi-axis flexure stages providing motion with up to 6 degrees of freedom. Linear travel ranges to 200 × 200 × 20 µm and rotation ranges to ±2 mrad are available. The 66 x 66 mm clear aperture is ideal for transmitted-light applications.

Parallel Kinematics, Versatility

The low cost and versatility of the P-500 stages are made possible by their unique single-module multi-axis design. Another advantage of the single-module parallel-kinematics design is that there are no moving cables and no cable management issues to be resolved when integrating the unit. This design increases reliability enhances responsiveness and also increases repeatability and accuracy at the nanometer level, because the friction and force exerted by a moving cable are eliminated (see the "Tutorial" section, page 4-1 *ff.* for further details).

State-of-the-art trajectory control is achieved in a special 6D version of the P-500. This stage incorporates 6-axis active error compensation to force sub-nm and sub-µrad straightness and flatness (ask for separate information).

For longer travel ranges see the P-587 six-axis NanoPositioning system on page 2-35.

Working Principle

Low-voltage PZTs (0 to 100 V) and flexures are employed as the drive and guiding system. The flexures provide zero stiction/friction, ultra-high resolution and exceptional guiding precision. Integrated capacitive position feedback sensors provide sub-nanometer resolution and stability in closed-loop operation (with PI electronics).

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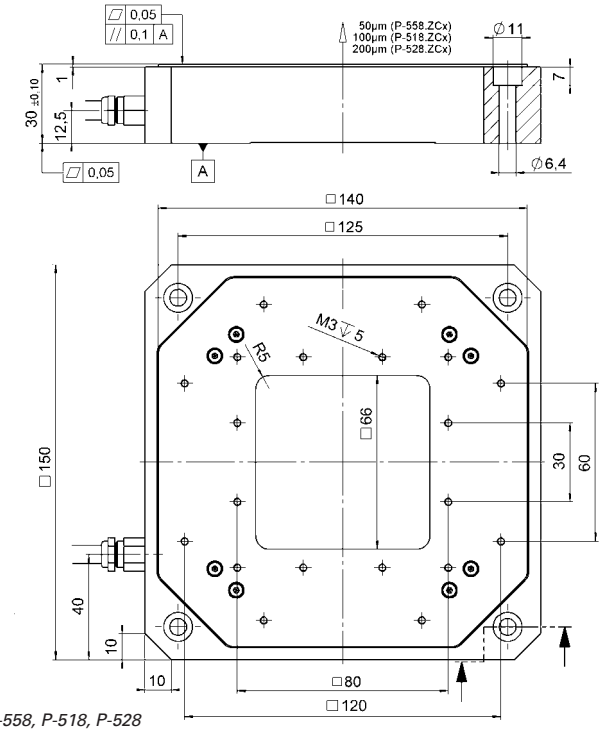


P-558, P-518, P-528 dimensions (in mm)

Technical Data P-500-Series (Z and Z/Tip/Tilt Stages)

Models	P-558.ZCD	P-518.ZCD	P-528.ZCD	P-558.ZCL	P-518.ZCL	P-528.ZCL	P-558.TCD	P-518.TCD	P-528.TCD	Units	Notes see p. 2-44
Active axes	Z	Z	Z	Z	Z	Z	Z, θ_x, θ_y	Z, θ_x, θ_y	Z, θ_x, θ_y		
Open-loop travel @ 0 to 100 V	50	100	200	50	100	200	50 (±0.28 mrad)	100 (±0.56 mrad)	200 (±1.13 mrad)	µm ±20%	A2
Closed-loop travel ≥	50	100	200	50	100	200	50 (±0.25 mrad)	100 (±0.5 mrad)	200 (±1.0 mrad)	µm	A5
Integrated feedback sensor	1 x capacitive	1 x capacitive	1 x capacitive	1 x capacitive	1 x capacitive	1 x capacitive	3 x capacitive	3 x capacitive	3 x capacitive		B
Closed-loop / open-loop * resolution ≤	0.5	0.5	1	0.5	0.5	1	0.5 (50 nrad)	0.5 (50 nrad)	1 (100 nrad)	nm	C1
Closed-loop linearity (typ.)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	%	
Full-range repeatability (typ.)	±5	±5	±10	±5	±5	±10	±5 (±0.1 µrad)	±5 (±0.1 µrad)	±10 (±0.1 µrad)	nm	C3
Stiffness	Z: 4.0	Z: 2.7	Z: 1.5	Z: 4.0	Z: 2.7	Z: 1.5	Z: 4.0	Z: 2.7	Z: 1.5	N/µm ±20%	D1
Push/pull force capacity (in operating direction)	Z: 100/50	Z: 100/50	Z: 100/50	Z: 100/50	Z: 100/50	Z: 100/50	Z: 100/50	Z: 100/50	Z: 100/50	N	D3
Max. (+/-) normal load	5	5	5	5	5	5	5	5	5	kg	D4
** Electrical capacitance	8	11	15	8	11	15	Z: 8	Z: 11	Z: 15	µF ±20%	F1
** Dynamic operating current coefficient (DOCC)	20	13.7	9.5	20	13.7	9.5	Z: 20	Z: 13.7	Z: 9.5	µA/ (Hz x µm)	F2
Unloaded resonant frequency	570	500	350	570	500	350	Z: 570 θ_x, θ_y: 610	Z: 500 θ_x, θ_y: 530	Z: 350 θ_x, θ_y: 390	Hz ±20%	G2
Resonant frequency load @ 500 g	410	350	210	410	350	210	Z: 410 θ_x, θ_y: 430	Z: 350 θ_x, θ_y:370	Z: 210 θ_x, θ_y: 250	Hz ±20%	G3
Resonant frequency @ 2500 g load	240	190	115	240	190	115	Z: 240 θ_x, θ_y: 245	Z: 190 θ_x, θ_y:200	Z: 115 θ_x, θ_y: 130	Hz ±20%	G3
Operating temperature range	- 20 to 80	- 20 to 80	- 20 to 80	- 20 to 80	- 20 to 80	- 20 to 80	- 20 to 80	- 20 to 80	- 20 to 80	°C	H2
Voltage connection	D ***	D ***	D ***	VL	VL	VL	D ***	D ***	D ***		J1
Sensor connection	D***	D ***	D ***	2 x C	2 x C	2 x C	D ***	D ***	D ***		J2
Weight (with cables)	1380	1400	1420	1380	1400	1420	1380	1400	1420	g ±5%	
Body material	Al	Al	Al	Al	Al	Al	Al	Al	Al		L
Recommended Amplifier/ Controller (codes explained p. 6-46)	M	M	M	H, F, L	H, F, L	H, F, L	K	K	K		

** Resolution of PZT NanoPositioners is not limited by friction or stiction. Noise equivalent motion with E-710, E-750, E-503 amplifiers.*

*** Capacitance and DOCC of rotational axes cannot be stated because uZ is based on differential X and Y motion rather than on motion of a dedicated rotational drive. Dynamic Operating Current Coefficient of linear axes is in µA per hertz and µm. Example P-558.CZL: Sinusoidal scan of 10 µm at 10 Hz requires approximately 2 mA drive current.*

**** Cable length: 1.5 m. One Sub-D special connector only (sensor and operating voltage).*

Ordering Information (cont.)

P-517.2CL
XY Piezo Flexure Stage, 100 × 100 µm, Capacitive Sensor, LEMO Connectors

P-527.2CL
XY Piezo Flexure Stage, 200 × 200 µm, Capacitive Sensor, LEMO Connectors

P-517.3CL
XYZ Piezo Flexure Stage, 100 × 100 × 20 µm, Capacitive Sensor, LEMO Connectors

P-527.3CL
XYZ Piezo Flexure Stage, 200 × 200 × 20 µm, Capacitive Sensor, LEMO Connectors

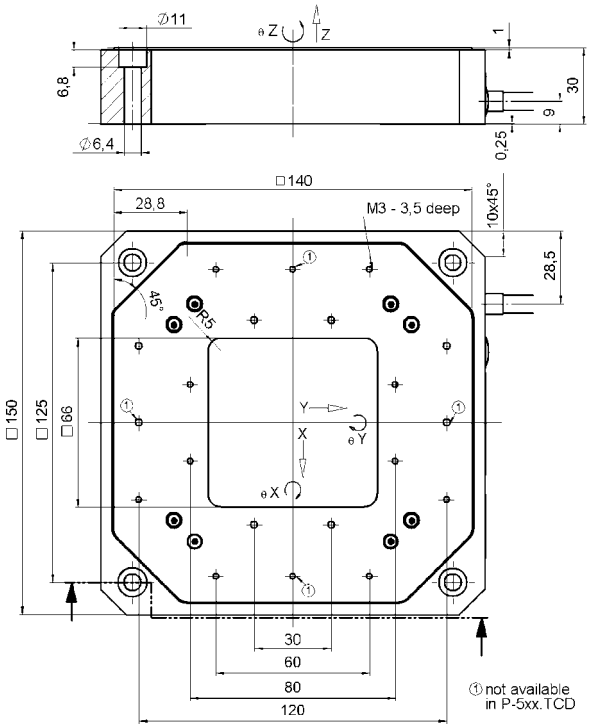
P-517.3CD
XYZ Piezo Flexure Stage, 100 × 100 × 20 µm, Capacitive Sensor, Sub-D Connector

P-527.3CD
XYZ Piezo Flexure Stage, 200 × 200 × 20 µm, Capacitive Sensor, Sub-D Connector

P-517.RCD
X,Y, θ_z Piezo Flexure Stage, 100 × 100 µm, ±1 mrad, Capacitive Sensor, Sub-D Connector

P-527.RCD
X,Y, θ_z Piezo Flexure Stage, 200 × 200 µm, ±2 mrad, Capacitive Sensor, Sub-D Connector

Custom Designs for Volume Buyers



P-517, P-527 dimensions (in mm)

Technical Data P-500-Series (XYZ and X,Y, θ_z Stages)

Models	P-517.2CL	P-527.2CL	P-517.3CL	P-527.3CL	P-517.3CD	P-527.3CD	P-517.RCD	P-527.RCD	Units	Notes see p. 2-44
Active axes	X,Y	X,Y	X,Y,Z	X,Y,Z	X,Y,Z	X,Y,Z	X,Y, θ_z	X,Y, θ_z		
Open-loop travel @ 0 to 100 V	100 × 100	200 × 200	100 × 100 × 20	200 × 200 × 20	100 × 100 × 20	200 × 200 × 20	100 × 100 × ± 1 mrad	200 × 200 × ±2 mrad	µm ±20%	A2
Closed-loop travel ≥	100 × 100	200 × 200	100 × 100 × 20	200 × 200 × 20	100 × 100 × 20	200 × 200 × 20	100 × 100 × ±1 mrad	200 × 200 × ±2 mrad	µm	A5
Integrated feedback sensor	2 x capacitive	2 x capacitive	3 x capacitive	3 x capacitive	3 x capacitive	3 x capacitive	3 x capacitive	3 x capacitive		B
Closed- / open-loop*** resolution ≤	1	2	X,Y: 1; Z: 0.1	X,Y: 2; Z: 0.1	X,Y: 1; Z: 0.1	X,Y: 2; Z: 0.1	X,Y: 1; θ_z: 0.3 µrad	X,Y: 2; θ_z: 0.3 µrad	nm	C1
Closed-loop linearity (typ.)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	%	
Full-range repeatability (typ.)	±5	±10	X,Y: ±5; Z: ±1	X,Y:±10; Z: ±1	X,Y: ±5; Z: ±1	X,Y:±10; Z: ±1	X,Y: ±5; θ_z: ±0.5 µrad	X,Y: ±10; θ_z: ±1 µrad	nm	C3
Stiffness	2	1	X,Y: 2; Z: 15	X,Y: 1; Z: 15	X,Y: 2; Z: 15	X,Y: 1; Z: 15	2	1	N/µm ±20%	D1
Push/pull force capacity (in operating direction)	200 / 30	200 / 30	200 / 30; Z: 50 / 30	200 / 30; Z: 50 / 30	200 / 30; Z: 50 / 30	200 / 30; Z: 50 / 30	200 / 30	200 / 30	N	D3
Max. (+/-) normal load	5	5	5	5	5	5	5	5	kg	D4
* Electrical capacitance	11 / axis	11 / axis	X,Y: 11; Z: 7.2	X,Y: 11; Z: 7.2	X,Y: 11; Z: 7.2	X,Y: 11; Z: 7.2	X,Y: 11	X,Y: 11	µF ±20%	F1
* Dynamic operating current coefficient (DOCC)	13.7 / axis	6.9 / axis	X,Y: 13.7; :Z: 75	X,Y: 6.9; :Z: 75	X,Y: 13.7; :Z: 75	X,Y: 6.9; :Z: 75	X,Y: 13.7	X,Y: 6.9	µA/(Hz x µm)	F2
Unloaded resonant frequency	450	350	450; Z: 1100	350; Z: 1100	450; Z: 1100	350; Z: 1100	X,Y: 450; θ_z: 400	X,Y: 350; θ_z: 300	Hz ±20%	G2
Resonant frequency @ 500 g load	250	190	X, Y: 250	X, Y: 190	X, Y: 250	X, Y: 190	X,Y 250	X, Y: 190	Hz ±20%	G3
Resonant frequency @ 2500 g load	140	110	X, Y: 140	X, Y: 110	X, Y: 140	X, Y: 110	X,Y 140	X, Y: 110	Hz ±20%	G3
Operating temperature range	- 20 to 80	- 20 to 80	- 20 to 80	- 20 to 80	- 20 to 80	- 20 to 80	- 20 to 80	- 20 to 80	°C	H2
** Voltage connection	2 x VL	2 x VL	3 x VL	3 x VL	D	D	D	D		J1
** Sensor connection	4 x C	4 x C	6 x C	6 x C	D	D	D	D	J2	
Weight (with cables)	1400	1400	1450	1450	1460	1460	1400	1400	g ±5%	
Body material	Al	Al	Al	Al	Al	Al	Al	Al		L
Recommended Amplifier/Controller (codes explained p. 6-46)	H, F, L, K	H, F, L, K	H, F, L	H, F, L	K	K	K	K		

** Capacitance and DOCC of rotational axes cannot be stated because θ_z is based on differential X and Y motion rather than on motion of a dedicated rotational drive. Dynamic Operating Current Coefficient of linear axes is in µA per hertz and µm. Example P-527.2xx: Sinusoidal scan of 30 µm at 10 Hz requires approximately 2.1 mA drive current.*

*** Cable length: 1.5 m. Versions P-5xx.xxD with one Sub-D special connector for sensor and operating voltage. Versions P-5xx.xxL with LEMO connectors.*

**** Resolution of PZT NanoPositioners is not limited by friction or stiction. Noise equivalent motion with E-710, E-503.*