

P-313 PicoCube™ XY(Z) Piezo Scanner

Picometer Precision, High Bandwidth, No Servo Lag, for Scanning Probe Microscopy



A new drive concept allows high-linearity positioning in open-loop operation

- Ultra-High-Performance Scanner for AFM/SPM
- 20 Picometers Resolution, <1 nm Hysteresis
- Very High Bandwidth with no Servo Lag Due to New Drive Concept
- Compact Manipulation Tool for Bio-/Nanotechnology
- Resonant Frequency 4.0 kHz (X, Y), 11 kHz (Z)
- 1 x 1 x 0.8 μm Travel Range

Model	Travel range (±250 V)	Resolution	Dimensions
P-313.30	1 x 1 μm (X,Y)	0.02 nm (X, Y)	30 x 30 x 29.4 mm
PicoCube™ XYZ Scanner	0.8 μm (Z)	0.14 nm (Z)	Moved platform 20 x 20 mm

P-915K XY-Theta-Z Piezo Stage

3 Degrees of Freedom in the XY Plane

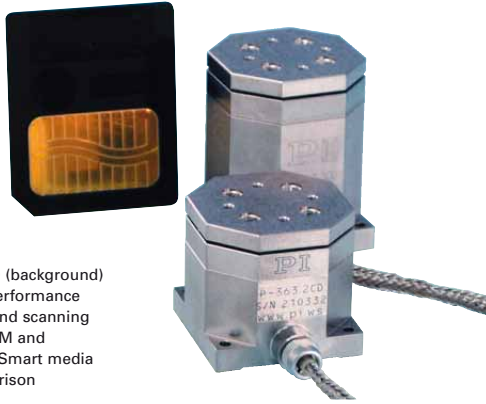


- Travel Ranges 250 x 250 μm, 16 mrad
- Frictionless, High-Precision Flexure Guiding System
- High Stiffness >1 N/μm
- Outstanding Lifetime Due to PICMA® Piezo Actuators

Model	Travel	Resolution	Load capacity	Settling (system combination with E-621)	Dimensions
P-915KPPS XY-Rot-Z Piezo Stage	250 x 250 μm ±8 mrad	3 nm 15 μrad	2 kg	45 ms (250 μm) 28 ms (16 mrad)	60 x 60 x 100 mm

P-363 PicoCube™ XY(Z) Piezo Scanner

High-Dynamics Nanoscanner for Scanning Probe Microscopy



P-363.2CD and .3CD (background) PicoCube™, high-performance piezo positioning- and scanning systems or AFM/STM and nanomanipulation. Smart media card for size comparison

- Ultra-High-Performance Closed-Loop Scanner for AFM/SPM
- Compact Manipulation Tool for Bio/Nanotechnology
- Resonant Frequency 9.8 kHz
- Capacitive Sensors for Highest Accuracy
- Parallel-Motion Metrology for Automated Compensation of Guiding Errors
- 50 Picometer Resolution
- 5 x 5 x 5 µm Travel Range
- Vacuum-Compatible Versions

The P-363 PicoCube™ XY/XYZ is an ultra-high-performance closed-loop piezo scanning system. Designed for AFM, SPM and nanomanipulation applications, it combines an ultra-low inertia, high-speed XY/XYZ piezo scanner with non-contact, direct-measuring, parallel-metrology capacitive feedback capable of 50 picometers resolution. On top of being extremely precise, the PicoCube™ system is also very small and rugged. Measuring

only 30 x 30 x 40 mm (with removable top plate, 30 x 30 x 28 mm for XY version), it is easy to integrate in any scanning apparatus.

SPM, AFM, STM, Nano-lithography, Nanoimprinting, Nanometrology

The PicoCube™ was specifically developed to overcome the limitations of the open-loop scanners currently available for SPM, AFM and STM. In addition to these applications, the PicoCube™ is also the ideal scanning and manipulation tool for nanoimprinting, nanolithography, ultra-high-resolution, near-field, scanning optical microscopy and nano-surface-metrology applications.

Higher Precision Through Parallel-Motion Metrology w/ Capacitive Sensors

The PicoCube™ is based on a proprietary, ultra-fast, piezo-driven scanner design equip-

ped with direct-measuring, capacitive position sensors (parallel metrology). Unlike conventional sensors, they measure the actual distance between the fixed frame and the moving part of the stage. This results in higher-motion linearity, long-term stability, phase fidelity, and—because external disturbances are seen by the sensor immediately—a stiffer, faster-responding servo-loop.

Multi-axis nanopositioning systems equipped with parallel direct metrology are able to measure the platform position in all degrees of freedom against one fixed reference. In such systems, undesirable motion from one actuator in the direction of another (crosstalk) is detected immediately and actively compensated by the servo-loops. This Active Trajectory Control Concept can keep deviation from a trajectory to under a few nanometers, even in dynamic operation.

Ordering Information

P-363.3CD
PicoCube™ High-Precision XYZ Nanopositioning System, 5 x 5 x 5 µm, Parallel Metrology, Capacitive Sensors, Sub-D Connector

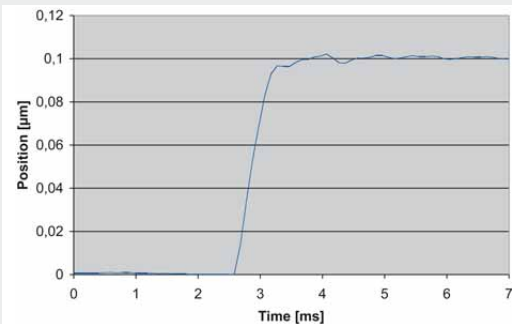
P-363.3UD
PicoCube™ High-Precision XYZ Nanopositioning System, 5 x 5 x 5 µm, Parallel Metrology, Capacitive Sensors, Sub-D Connector, Vacuum Compatible to 10⁻⁹ hPa

P-363.2CD
PicoCube™ High-Precision XY Nanopositioning System, 5 x 5 µm, Parallel Metrology, Capacitive Sensors, Sub-D Connector

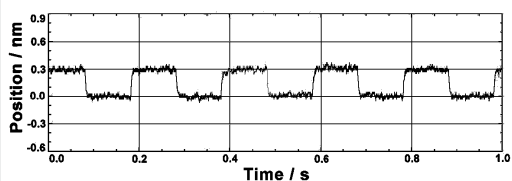
P-363.2UD
PicoCube™ High-Precision XY Nanopositioning System, 5 x 5 µm, Parallel Metrology, Capacitive Sensors, Sub-D Connector, Vacuum Compatible to 10⁻⁹ hPa

P-363.3CL
PicoCube™ High-Precision XYZ Nanopositioning System, 5 x 5 x 5 µm, Parallel Metrology, Capacitive Sensors, LEMO Connector

P-363.2CL
PicoCube™ High-Precision XY Nanopositioning System, 5 x 5 µm, Parallel Metrology, Capacitive Sensors, LEMO Connector



The P-363 settles to within 1 nm in 1 ms (100 nm step, X and Y motion; faster response in Z)



300 picometer steps (0.3 nm) performed with the P-363, measured with an external high-resolution, capacitive measurement system

Nanometer Accuracy in 1 Millisecond with 30-Picometer Resolution

PicoCube™ systems provide resolution of 30 picometers and below. The ultra-fast XY/XYZ piezo drives offer resonant frequencies of 9.8 kHz in Z and >3 kHz in X and Y! The high resonant frequency and high-bandwidth capacitive feedback allow step and settle to 1% accuracy in as little as one millisecond.

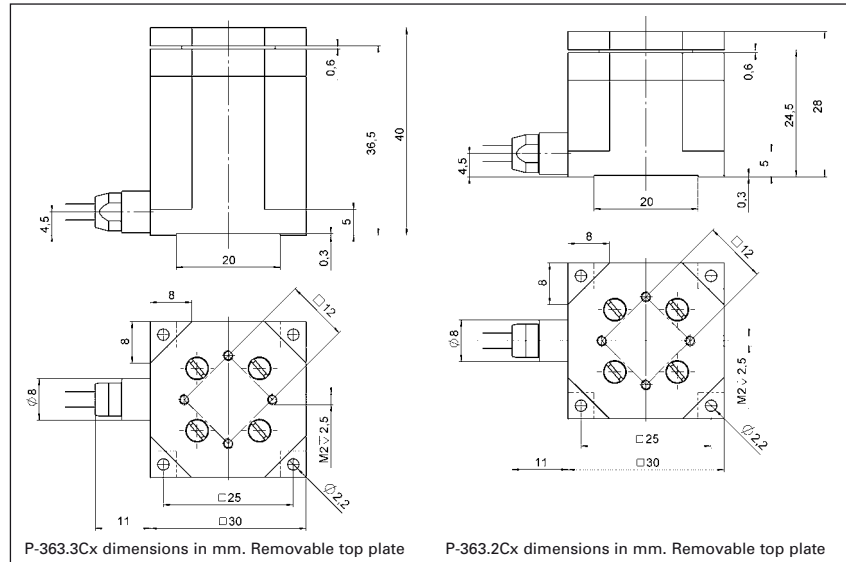
Rugged Design

In spite of its ability to move and position on an atomic scale, the PicoCube™ boasts a rugged design for real-world applications. For extra-high stability and reduced mass, the body is precision machined from heat-treated and stress-relieved titanium. The sophisticated frictionless design also ensures that the (moving) top plate protects the internal actuator/sensor unit from contamination.

Controller

For dynamic scanning operation the E-725.3CM high-power digital controller offers advanced linearization algorithms for sub-nanometer precision (see p. 2-126).

Alternatively the analog E-536 PicoCube™ controller (see p. 2-134) comes in different versions optimized for resolution or power. An optional E-517 24-bit interface module is also available (see p. 2-156).



Technical Data

Model	P-363.3CD	P-363.2CD	Units
Active axes	X, Y, Z	X, Y	
Motion and positioning			
Integrated sensor	Capacitive	Capacitive	
Open-loop travel X, Y, -250 to +250 V	±3	±3	µm
Open-loop travel, -250 to +250 V	±2.7	–	µm
Closed-loop travel X, Y	±2.5	±2.5	µm
Closed-loop travel	±2.5	–	µm
Open-loop resolution	0.03*	0.03*	nm
Closed-loop resolution	0.1	0.1nm	
Linearity	0.05	0.05	%
Repeatability	1**	1**	nm
Pitch / yaw in X, Y	0.5	0.5	µrad
Runout X, Y (Z motion)	0.2	–	µrad
Straightness in X, Y	3	3	nm
Flatness in X, Y	<10	<10	nm
Crosstalk X, Y (Z motion)	5	–	nm
Mechanical properties			
Unloaded resonant frequency in X, Y	3.1	4.2	kHz
Unloaded resonant frequency (Z)	9.8	–	kHz
Resonant frequency in X, Y	1.5 (20 g)	2.1 (20 g)	kHz
Load capacity	10	10	N
Ceramic type	PICA™, PICA™ Shear	PICA™ Shear	
Miscellaneous			
Operating temperature range	-20 to 80	-20 to 80	°C
Material	Titanium	Titanium	
Dimensions	30 x 30 x 40	30 x 30 x 28	mm
Mass	225	190	g
Cable length	1.5	1.5	m
Sensor / voltage connection***	Sub-D connector PicoCube™	Sub-D connector PicoCube™	
Recommended controller	E-536 PicoCube™ Controller	E-536 PicoCube™ Controller	

Resolution of PI Piezo Nanopositioners is not limited by friction or stiction. Value given is noise equivalent motion with E-536 controller (p. 2-134)

*With E-536.3xH Controller

**for 10% travel in Z; 50 nm for 100% travel in Z

***P-363.xCL versions with LEMO connectors

System properties

System configuration	P-363.3CD (Z-axis) with 20 g load and E-536 servo controller
Settling time	(10% step width) 1 ms

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

Single-Channel

Multi-Channel

Modular

Accessories

Piezoelectrics in Positioning

Nanometrology

Micropositioning

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