

NanoCube[®] XYZ Stage with Piezo Flexure Drive

Long-Travel Multi-Axis Piezo Stage for Precision Alignment Applications



P-615NanoCube[®] XYZ Nanopositioning System provides up to 420 x 420 x 300 μ m travel range

- Up to 420 x 420 x 300 μ m Travel Range
- Resolution 1 nm
- Parallel-Kinematics / Metrology for Enhanced Responsiveness / Multi-Axis Precision
- Clear Aperture of 10 mm \varnothing , Ideal for Alignment and Photonics Packaging Applications
- Outstanding Lifetime Due to PICMA[®] Piezo Actuators
- Open- & Closed-Loop Versions
- Vacuum-Compatible Versions to 10⁻⁹ hPa
- Frictionless, High-Precision Flexure Guiding System

The P-615 NanoCube[®] is a multi-axis piezo nanopositioning and alignment system. Its 420 x 420 x 300 μ m, XYZ positioning and scanning range comes in a compact package. Equipped with a zero-stiction, zero-friction guidance system, this NanoCube[®] provides motion with ultra-high resolution and settling times of only a few milliseconds.

Fiber Positioning

The P-615 NanoCube[®] is equipped with a fiber adapter inter-

face similar to the P-611.3SF and accommodates all F-603-series fiber holders and accessories. Fiber optics handling is facilitated by the clear aperture.

Double Stiffness for Fast Response

The P-615's unique flexure design has double the stiffness in the vertical axis than in X and Y, providing faster response and higher operating frequencies under load. For example, the settling time to reach a commanded position with 1% accuracy is only 15 ms in the Z-axis with 100 g load (as opposed to 10 ms without load).

Open-Loop and Closed-Loop Operation

The open-loop basic model P-615.30L is ideal for appli-

ca- tions where fast response and very high resolution are essential but specifying or reporting absolute position values is either not required or is handled by external sensors, e. g. in tracking or fiber positioning tasks. In open-loop mode, the piezo displacement is roughly proportional to the applied voltage (see p. 2-184).

Capacitive Sensors for Highest Accuracy

The P-615.3C models are equipped with high-accuracy, capacitive 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.

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-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

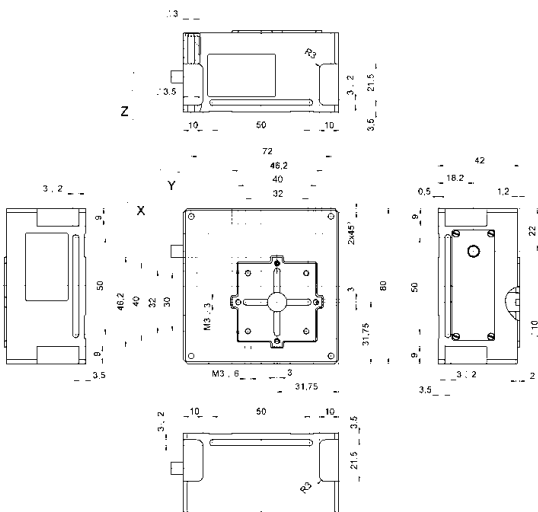
trajectory to under a few nanometers, even in dynamic operation.

Ceramic Insulated Piezo Actuators Provide Long Lifetime

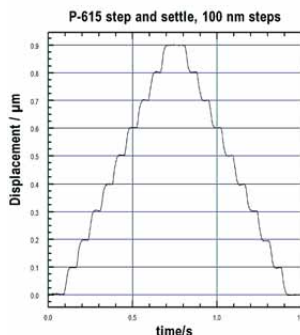
Highest possible reliability is assured by the use of award-winning PICMA[®] multilayer piezo actuators. PICMA[®] actuators are the only actuators on the market with ceramic-only insulation, which makes them resistant to ambient humidity and leakage-current failures. They are thus far superior to conventional actuators in reliability and lifetime.

Application Examples

- Micromanipulation
- Biotechnology
- Semiconductor testing
- Photonics / integrated optics



P-615 dimensions in mm.
The clear aperture has a diameter of 10 mm.



P-615, X-axis with 100 g load performing 100 nm steps in rapid sequence without overshoot. Settling time for the Z-axis to reach a commanded position with 1 % accuracy is only 15 ms.



P-615 with optional fiber holder F-603.22

Technical Data

Model	P-615.3CD / P-615.3CL	P-615.30L	Units	Tolerance
Active axes	X, Y, Z	X, Y, Z		
Motion and positioning				
Integrated sensor	Capacitive	–		
Open-loop travel in X/Y/Z, -20 to +120 V	420 / 420 / 300	420 / 420 / 300	µm	min. (+20 %/-0 %)
Closed-loop travel X/Y/Z	350 / 350 / 250	–	µm	
Open-loop resolution X/Y/Z	0.5	0.5	nm	typ.
Closed-loop resolution X/Y/Z	1	–	nm	typ.
Linearity X/Y/Z	0.02	–	%	typ.
Repeatability in X, Y, Z	±7.5 / ±7.5 / ±5	–	nm	typ.
Pitch in X,Y	100	100	µrad	typ.
Yaw in X, Y	50	50	µrad	typ.
Runout θ_x, θ_y (Z motion)	10	10	µrad	typ.
Mechanical properties				
Stiffness X / Y / Z	0.13 / 0.13 / 0.35	0.13 / 0.13 / 0.35	N/µm	±20 %
Unloaded resonant frequency in X / Y / Z	210 / 210 / 250	210 / 210 / 250	Hz	±20 %
Resonant frequency @ 100 g in X / Y / Z	125 / 125 / 200	125 / 125 / 200	Hz	±20 %
Push/pull force capacity in motion direction	20 / 10	20 / 10	N	Max.
Load capacity	20	20	N	Max.
Drive properties				
Ceramic type	PICMA® P-885	PICMA® P-885		
Electrical capacitance in X / Y / Z	3.7 / 3.7 / 6.2	3.7 / 3.7 / 6.2	µF	±20 %
Dynamic operating current coefficient (DOCC) in X / Y / Z	1.3 / 1.3 / 3.1	1.3 / 1.3 / 3.1	µA/(Hz·µm)	±20 %
Miscellaneous				
Operating temperature range	-20 to 80	-20 to 80	°C	
Material	Aluminum	Aluminum		
Mass	0.58	0.57	kg	±5 %
Cable length	1.5	1.5	m	±10 mm
Sensor / voltage connection	Sub-D special (CD-version); (no LEMO (CL-version)	LEMO sensor)		

Resolution of PI Piezo Nanopositioners is not limited by friction or stiction. Value given is noise equivalent motion with E-503 amplifier (p. 2-146).

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)

Multi-channel:
E-500 modular piezo controller system (p. 2-142) with E-509 servo-controller (p. 2-152) (optional) and as amplifier either E-503 (three channels) (p. 2-146) or E-505 (1 per axis, high-power, p. 2-147) modules P-615.30L (p. 2-68); E-610 controller / amplifier (p. 2-110) (1 per axis)