P-733.2DD · P-733.3DD

Ultra-High-Speed, XY / XYZ Scanning Microscopy Stages with Parallel Metrology

P-733.3DD (left side) and P-733.2DD, high-speed, direct drive XY(Z) scanning stages are the fastest scanning stages with large aperture currently available (2.2 kHz resonant frequency!). Both units feature a footprint of only 100 x 100 mm. Compact disc for size comparison.

- **Higher Speed Through Direct Drive**
- **Up to 2.2 kHz Resonant Frequency in X and Y**
- **30 x 30 or 30 x 30 x 10 µm Travel Range**
- **100 Picometers Resolution**
- **Capacitive Sensors for Highest Linearity**
- **Parallel-Kinematics/Metrology for Enhanced Responsiveness / Multi-Axis Precision**
- **Active Runout Compensation**
- **50 x 50 mm Clear Aperture**
- **Frictionless Precision Flexure Guiding System**
- **PICMA® High-Performance Piezo Drives**

Fastest Multi-Axis Systems w/Large Apertures

P-733.2DD / .3DD multi-axis piezo nanopositioning systems are the fastest ultra-high-precision, open-frame stages for microscopy. They provide a positioning and scanning range of 30 x 30 (x10) µm and are equipped with parallel-metrology capacitive position feedback for superior multi-axis linearity and repeatability.

The novel, high-stiffness, direct drive gives the systems resonant frequencies as high as 2.2 kHz (4 x that of other comparable systems), enabling millisecond scanning rates with sub-nanometer resolution.

Application Examples

- Optical trapping
- Imaging (resolution enhancement)
- Scanning microscopy
- Surface structure analysis
- Biotechnology
- Atomic force microscopy
- Semiconductor test equipment
- Precision mask and wafer alignment
- Scanning interferometry
- Nanomanipulation
- Biophysics

Low-Profile and Clear Aperture—Ideal for Microscopy

P-733 nanopositioning and scanning stages are designed for easy integration into high-resolution microscopes. They feature very low profiles, as low as 20 mm (0.8 inch), a 50 x 50 mm aperture, and offer highly accurate motion with sub-nanometer resolution.

Higher Precision Through Parallel Kinematics/Metrology

P-733 piezo scanning stages feature a parallel-kinematics design with direct-measuring, non-contact capacitive position sensors (parallel, direct metrology).
These sensors make possible motion linearity to 0.03% with effective resolution in the sub-nanometer range. PI capacitive sensors are absolute-measuring, direct-metrology devices that boast very high bandwidth and exhibit no periodic errors.

Unlike conventional sensors, capacitive sensors measure the actual distance between the fixed frame and the moving part of the stage. They detect errors contributed by all components in the drive train—from the actuator through the flexures to the platform. 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. See p. 2-4 *ff.* and p. 5-2 *ff.* for more information.

Parallel kinematics means that all actuators act directly on the same moving platform leading to reduced size, inertia and the elimination of microfriction caused by moving cables. The advantages are enhanced dynamics, higher scanning rates, and better reproducibility.

Ordering Information

P-733.2DD
XY High-Speed Direct Drive Piezo Scanning Stage, 30 x 30 µm, Parallel Metrology, Sub-D Connector

P-733.3DD
XYZ High-Speed Direct Drive Piezo Scanning Stage, 30 x 30 x 10 µm, Parallel Metrology, Sub-D Connector

Vacuum Versions Available

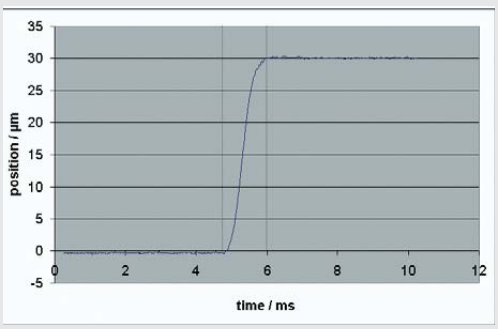
With parallel metrology, all sensors measure the position of the same moving platform against the same stationary reference (the fixed frame). This means that—in contrast to serial metrology—all motion is inside the servo-loop, no matter which actuator may have caused it, resulting in superior multi-axis precision (Active Trajectory Control).

Dynamic Digital Control for Best Scanning Linearity

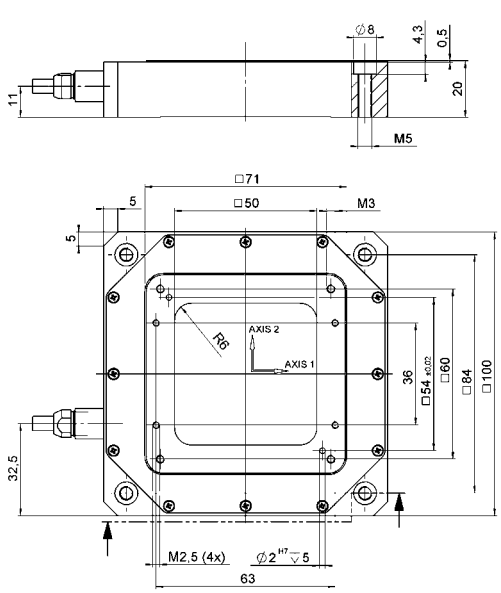
Use our new digital control electronics with DDL (Dynamic Digital Linearization) to increase linearity and effective bandwidth in scanning applications by up to 1000-fold (see p. 6-16). By virtually eliminating tracking errors, DDL also increases the usable travel range.

Working Principle / Reliability

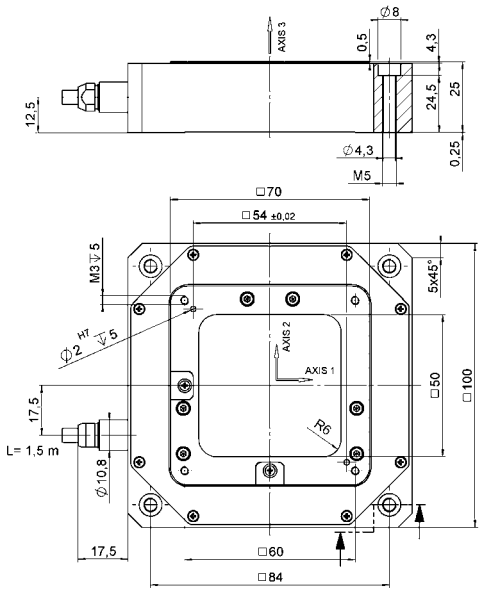
P-733 nanopositioning stages are equipped with the award winning PICMA® piezo drives,



0 to 100 % travel in 1.36 msec, without overshoot. The P-733.2DD is the fastest, highest precision closed-loop XY scanning stage with large aperture currently available.



Dimensions of P-733.2DD in mm.



Dimensions of P-733.3DD in mm.

integrated into a sophisticated, single-module, parallel-kinematics, flexure guiding system. The wire-EDM-cut flexures are FEA modeled for zero stiction, zero friction and exceptional guiding precision. The ceramic-encapsulated PICMA® drives are more robust than conventional piezo actuators, featuring superior lifetime and performance in both dynamic and static applications.

Because guidance, actuators and sensors are all frictionless and maintenance-free, these nanopositioning systems achieve outstanding levels of reliability.

Vacuum Applications

PI offers versions specially designed for applications in ultra-high vacuum (see p. 2-66). A non-magnetizable version is available on request.

Notes

See the "Selection Guide" on p. 2-14 *ff.* for comparison with other nanopositioning systems.

Technical Data

Models	P-733.2DD	P-733.3DD	Units	Notes see p. 2-84
Active axes	X,Y	X,Y,Z		
Min. open-loop travel @ -20 to 120 V	33 x 33	33 x 33 x 14	µm ±20%	A2
Closed-loop travel	30 x 30	30 x 30 x 10	µm	A5
Integrated feedback sensor	capacitive	capacitive		B
* Closed-loop / open-loop resolution	0.1 / 0.1	0.1 / 0.1	nm	C1
Closed-loop linearity (typ.)	0.03	0.03	%	
Full-range repeatability (typ.)	±1.0	±1.0	nm	C3
Stiffness (X,Y,Z)	20, 20, -	4, 4, 10	N/µm ±20%	D1
Push / pull force capacity (in operating direction)	300 / 100	300 / 100	N	D3
Max. (±) normal load	20	20	N	D4
Tilt θ_x, θ_z (typ.)	3	3	µrad	E1
Electrical capacitance (X, Y, Z)	6.0, 6.0, -	6.0, 6.0, 4.4	µF ±20%	F1
** Dynamic operating current (X, Y, Z) coefficient (DOCC)	25, 25,-	25, 25, 50	µA/(Hz x µm)	F2
Unloaded resonant frequency (X, Y, Z)	2230, 2230, -	1200, 1200, 1200	Hz ±20%	G2
Resonant frequency @ 50 g load (X, Y, Z)	1800, 1800, -		Hz ±20%	G3
Resonant frequency @ 200 g load (X, Y, Z)		530, 530, 635	Hz ±20%	G3
Operating temperature range	-20 to 80	-20 to 80	°C	H2
Voltage connection	sub-D, special	sub-D, special		J1
Sensor connection	sub-D, special	sub-D, special		J2
Weight (with cables)	525	635	g ±5%	
Body material	Al	Al		L
Recommended amplifier/controller (codes explained p. 2-17)	H, F, L	H, F, L		

* For calibration information see p. 2-8. Resolution of PI piezo nanopositioners is not limited by friction or stiction. The value given is noise equivalent motion with E-503 amplifier.

** Dynamic Operating Current Coefficient in µA per Hz and µm. Example: Sinusoidal scan of 10 µm at 100 Hz requires approximately 25 mA drive current.