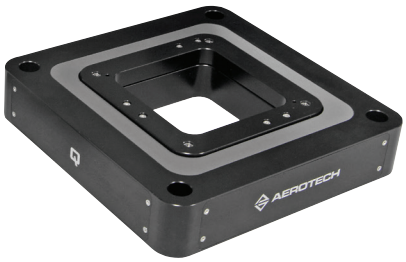
QNP3 Series

Three-Axis, Parallel Kinematic, XYZ Piezo Nanopositioning Stages

- Travels to 240 µm x 240 µm x 25 µm
- Large square clear aperture up to 66 mm x 66 mm
- Superior multi-axis accuracy via parallel kinematic design
- High stiffness and dynamics resulting in high process throughput
- High-precision, frictionless flexure guidance
- Patent-pending design provides unmatched geometric performance
- Long device lifetime
- Superior positioning resolution and linearity with direct-metrology capacitive sensor option
- Open-loop and vacuum versions

QNP3-100XYAZ-100-10



QNP3-150XYAZ-200-20

QNP3-100XYAZ-030-10

Aerotech's QNP3 Series of XYZ parallel kinematic piezo positioning stages combines sub-nanometer resolution, high dynamics, and excellent geometric performance in a compact low-profile package. The QNP3 series piezo stages come standard with a large, clear aperture with closed-loop travels up to 200 µm x 200 µm x 20 µm (open-loop travels to 240 µm x 240 µm x 25 µm). The design is ideal for optical and scanning probe microscopy or other inspection or manufacturing applications where two-sided part access is required with three DoF manipulation.

Precision Parallel-Kinematic Design

The QNP3 piezo stages employ a parallel-kinematic flexure and metrology design that ensures the highest levels of multi-axis accuracy. Guided by precision flexures which are FEA-optimized to ensure high stiffness and long device life, the QNP3 stages offer best-in-class stiffness and resonant frequency enabling high process throughput and fast closed-loop response.

Using a patent-pending drive design, X and Y yaw errors are minimized while still maintaining an Abbe-compliant metrology system. This design results in unmatched positioning performance over the entire XY travel space. Z-axis actuators and capacitive sensors are designed to provide Abbe-compliant feedback in the vertical direction with minimal geometric errors.

Sub-Nanometer Performance

All QNP3 piezo stages are available with closed-loop feedback (-C) or open-loop (no feedback). The unique capacitive sensor parallel-metrology design measures the output of the positioning carriage, directly enabling sub-nanometer resolution, linearity errors below 0.01%, and single-digit nanometer repeatability.

Ultra-Precision Control

When coupled with Aerotech's Q-series controllers and drives, the QNP3 stages demonstrate sub-nanometer positioning resolution, in-position stability (jitter), and high positioning bandwidth. Software options such as Aerotech's Dynamic Controls Toolbox and Motion Designer packages provide a host of advanced yet easy-to-use tools such as Learning Control, Harmonic Cancellation, and Command Shaping, providing improved tracking errors and faster step-and-settle times. OEM drive options are also available. Aerotech's controller architecture easily enables high-speed, tightly-controlled coordinated motion between piezo stages, servos, steppers, and galvos.

Design Options

An optional mounting plate provides direct mounting English or metric breadboard optical tables. A solid tabletop option is also available. QNP3 piezo stages are available in custom materials and vacuum-prepared versions upon request.

QNP3 Series SPECIFICATIONS

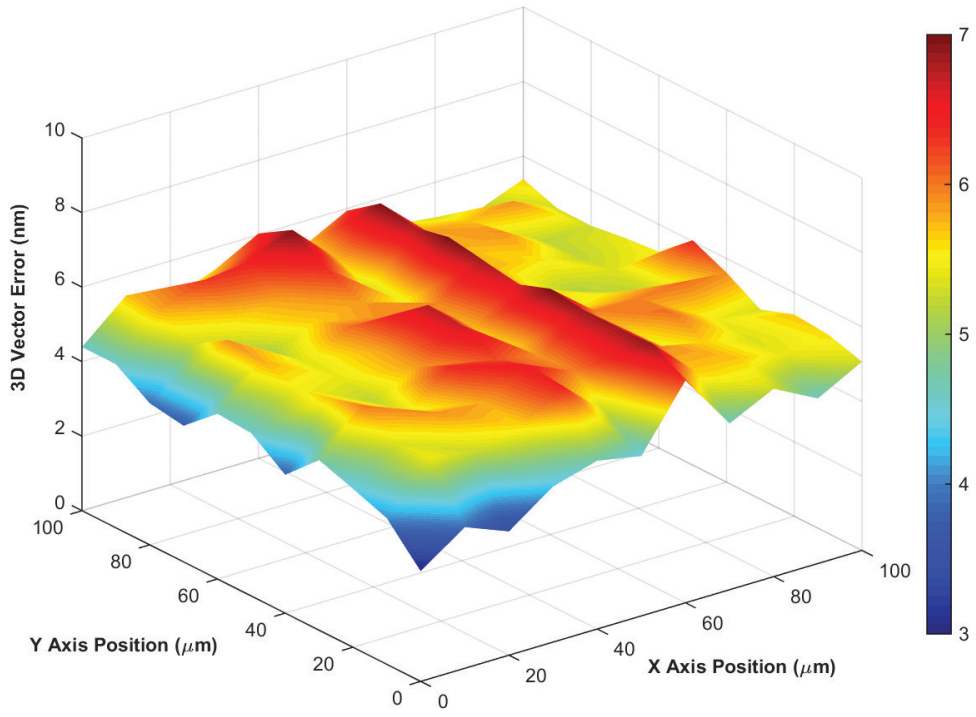
Mechanical Specifications		QNP3-100XYAZ-030-10	QNP3-100XYAZ-100-10	QNP3-150XYAZ-200-20
Closed-Loop Travel (X x Y x Z)		30 µm x 30 µm x 10 µm	100 µm x 100 µm x 10 µm	200 µm x 200 µm x 20 µm
Open-Loop Travel, -30 to +150 V(1)		36 µm x 36 µm x 12 µm	120 µm x 120 µm x 12 µm	240 µm x 240 µm x 25 µm
Resolution(2)	**Closed-Loop**	0.1 nm (XY); 0.15 nm (Z)	0.30 nm (XY); 0.15 nm (Z)	0.4 nm (XY), 0.15 nm (Z)
	Open-Loop	0.03 nm (XY); 0.05 nm (Z)	0.15 nm (XY); 0.05 nm (Z)	0.2 nm (XY), 0.1 nm (Z)
Linearity(3,4)		0.02% (XY); 0.04% (Z)	0.01% (XY); 0.02% (Z)	0.01% (XY); 0.02% (Z)
Bidirectional Repeatability(5)		4 nm (XY); 3 nm (Z)	2 nm (XY); 1 nm (Z)	2 nm (XY); 2 nm (Z)
Straightness		25 nm (XY); 50 nm (Z)	<10 nm (XY); <20 nm (Z)	10 nm (XY); 40 nm (Z)
2D Flatness (Over Full XY Travel)		10 nm	<5 nm	<10 nm
Pitch		10 µrad (2.1 arc sec) (XY) 6 µrad (1.2 arc sec) (Z)	2 µrad (0.4 arc sec) (XY); 6 µrad (1.2 arc sec) (Z)	2 urad (0.4 arc sec) (XY); 6 µrad (1.2 arc sec) (Z)
Yaw		5 µrad (1 arc sec) (XY) 5 µrad (1 arc sec) (Z)	10 µrad (2.1 arc sec) (XY); 5 µrad (1 arc sec) (Z)	20 urad (4 arc sec) (XY); 6 µrad (1.2 arc sec) (Z)
Stiffness (In Direction of Motion)(6)		10 N/µm (XY); 25 N/µm (Z)	1.9 N/µm (XY); 13 N/µm (Z)	1.3 N/µm (XY); 8.7 N/µm (Z)
Unloaded Resonant Frequency(6)		1850 Hz (XY); 2200 Hz (Z)	490 Hz (XY); 1425 Hz (Z)	330 Hz (XY); 910 Hz (Z)
Resonant Frequency (200 gram load)(6)		950 Hz (XY); 1390 Hz (Z)	350 Hz (XY); 910 Hz (Z)	260 Hz (XY); 670 Hz (Z)
Max Payload(7)		1 kg	1 kg	3 kg
Maximum Acceleration (Unloaded)(8)		400 m/s² (XY); 2000 m/s² (Z)	115 m/s² (XY); 2000 m/s² (Z)	35 m/s² (XY); 1000 m/s²
Moving Mass (Unloaded)		0.24 kg (XY); 0.05 kg (Z)	0.21 kg (XY); 0.05 kg (Z)	0.58 kg (XY); 0.10 kg
Stage Mass		0.53 kg	0.56 kg	1.3 kg
Material		Anodized Aluminum(9)	Anodized Aluminum(9)	Anodized Aluminum(9)
MTBF (Mean Time Between Failure)		30,000 Hours	30,000 Hours	30,000 Hours

Notes:
1. Value ±10%.
2. See Piezo Engineering Reference section 4.2 for description of resolution.
3. Certified with each stage (closed-loop feedback models only).
4. Measured approximately 15 mm above the carriage by an external metrology device. See Piezo Engineering Reference section 4.1 for description of linearity specifications.
5. Specified as a 1 sigma (standard deviation) value (closed-loop feedback models only). See Piezo Engineering Reference section 4.3 for description of bidirectional repeatability.
6. Values ±20%.
7. On-axis loading listed.
8. Max acceleration listed is the stage mechanical limitation. Achievable acceleration is a function of amplifier selection and move parameters.
9. External elements are anodized aluminum. Some stainless steel components are used in the internal construction. Other materials upon request.
10. Specifications listed are per axis unless specified.

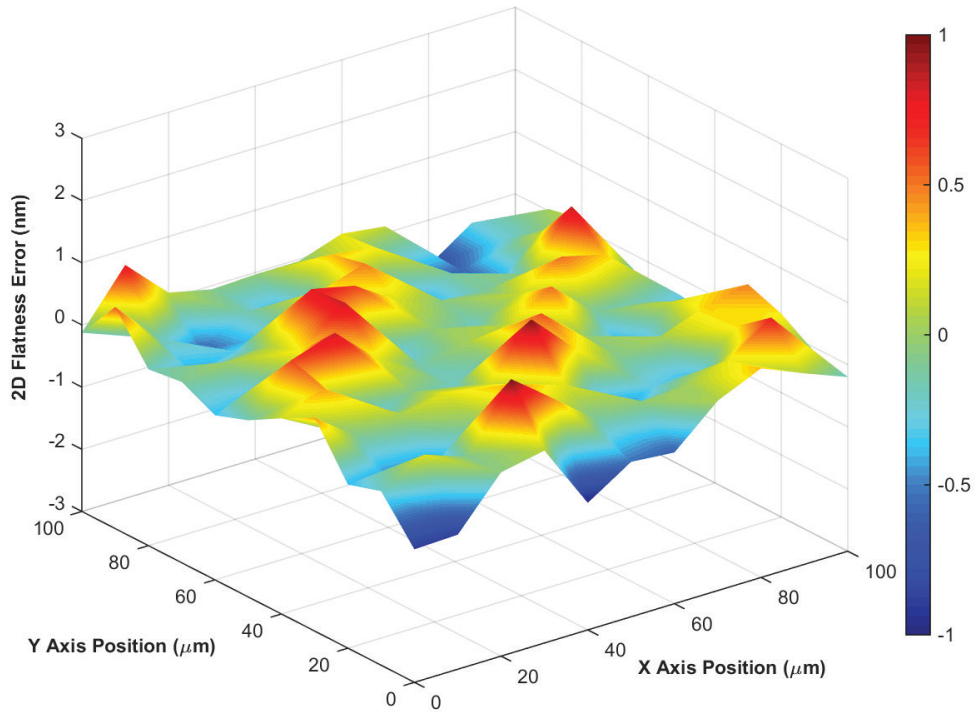
Electrical Specifications	QNP3-100XYAZ-030-10	QNP3-100XYAZ-100-10	QNP3-150XYAZ-200-20
Drive System	Piezo Multi-Layer Stack Actuator		
Feedback	CL: Capacitive Sensor OL: None		
Voltage Range	-30 V to +150 V		
Piezo Stack Capacitance(1)	4.6 µF (per axis) (XY); 2 µF (Z)	3.2 µF (XY, per axis); 2 µF (Z)	6.4 µF (XY, per axis); 4.8 µF (Z)

Note:
1. Value ±20%

QNP3 Series DESCRIPTION

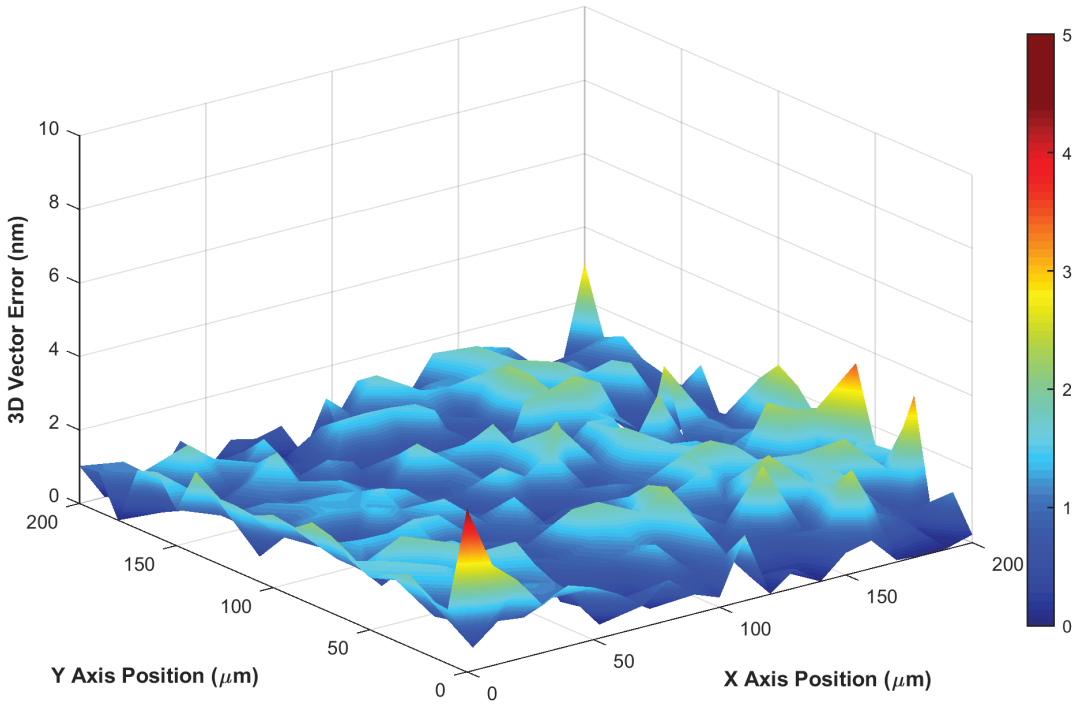


QNP3-100XYAZ-100-10-C three-dimensional vector accuracy error showing when commanded to move in the XY plane at a Z = 8 µm height. The results show the outstanding nm-level three-dimensional accuracy capability.

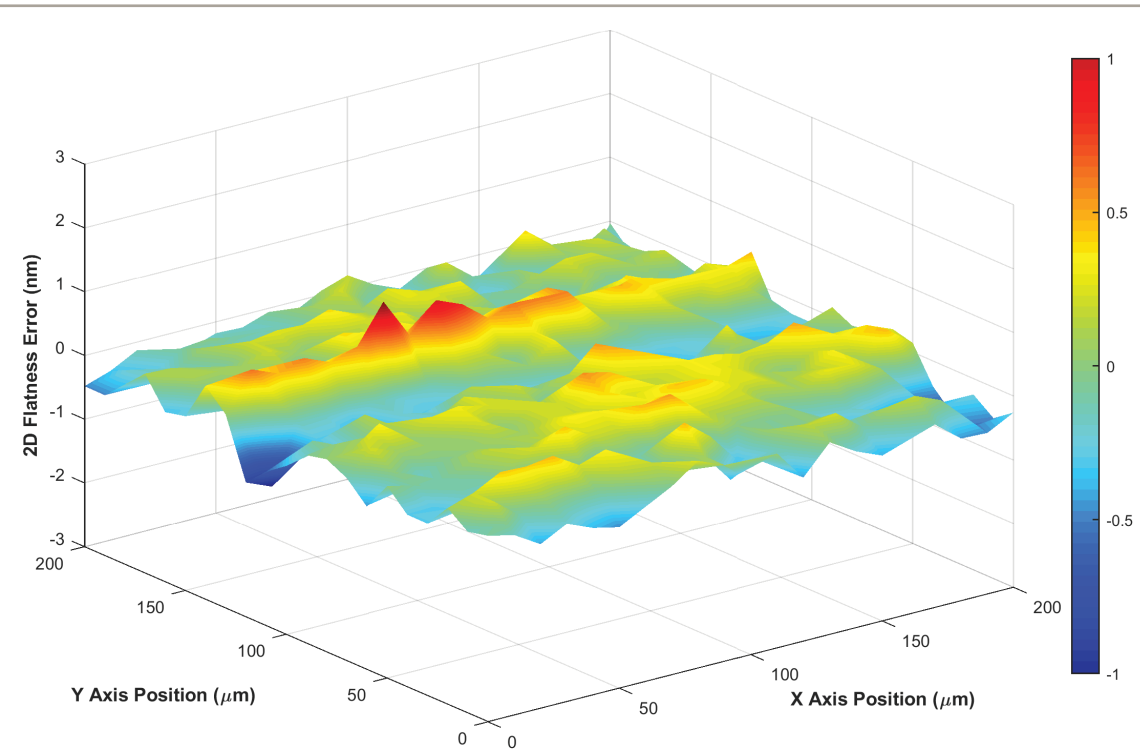


QNP3-100-100XYAZ-100-10-C two-dimensional flatness of <2 nm over the full XY travel. The results show the outstanding geometric performance capability of the QNP3 series.

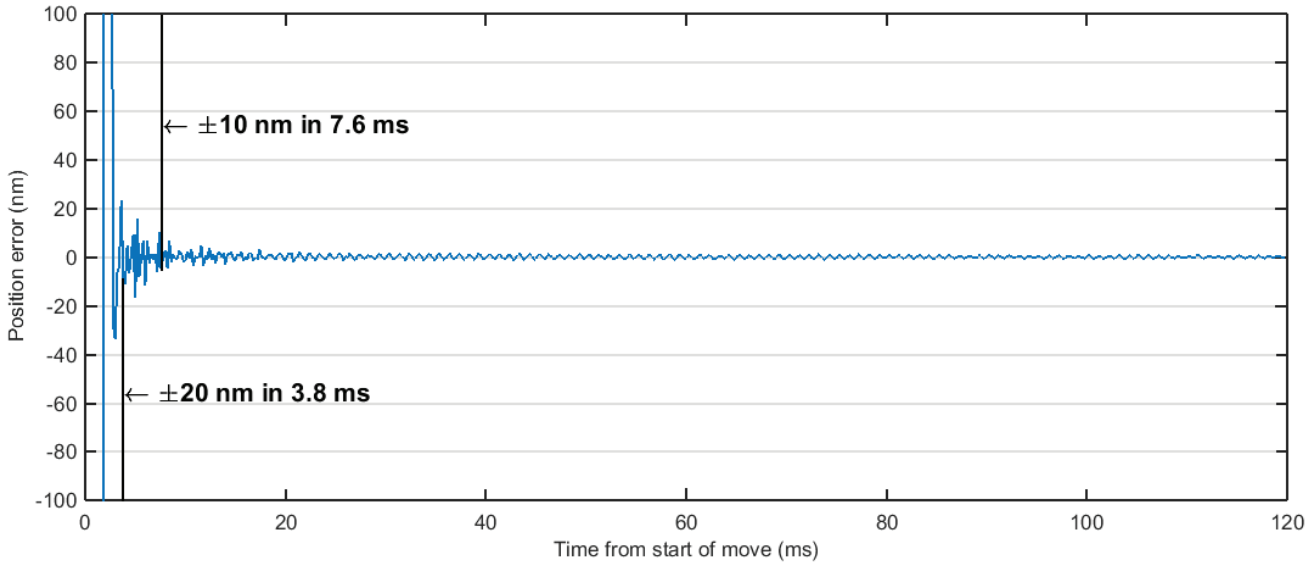
QNP3 Series DESCRIPTION



QNP3-150XYAZ-200-20-C three-dimensional vector accuracy error showing when commanded to move in the XY plane at a Z = 20 um height. The results show the outstanding nm-level three-dimensional accuracy capability.

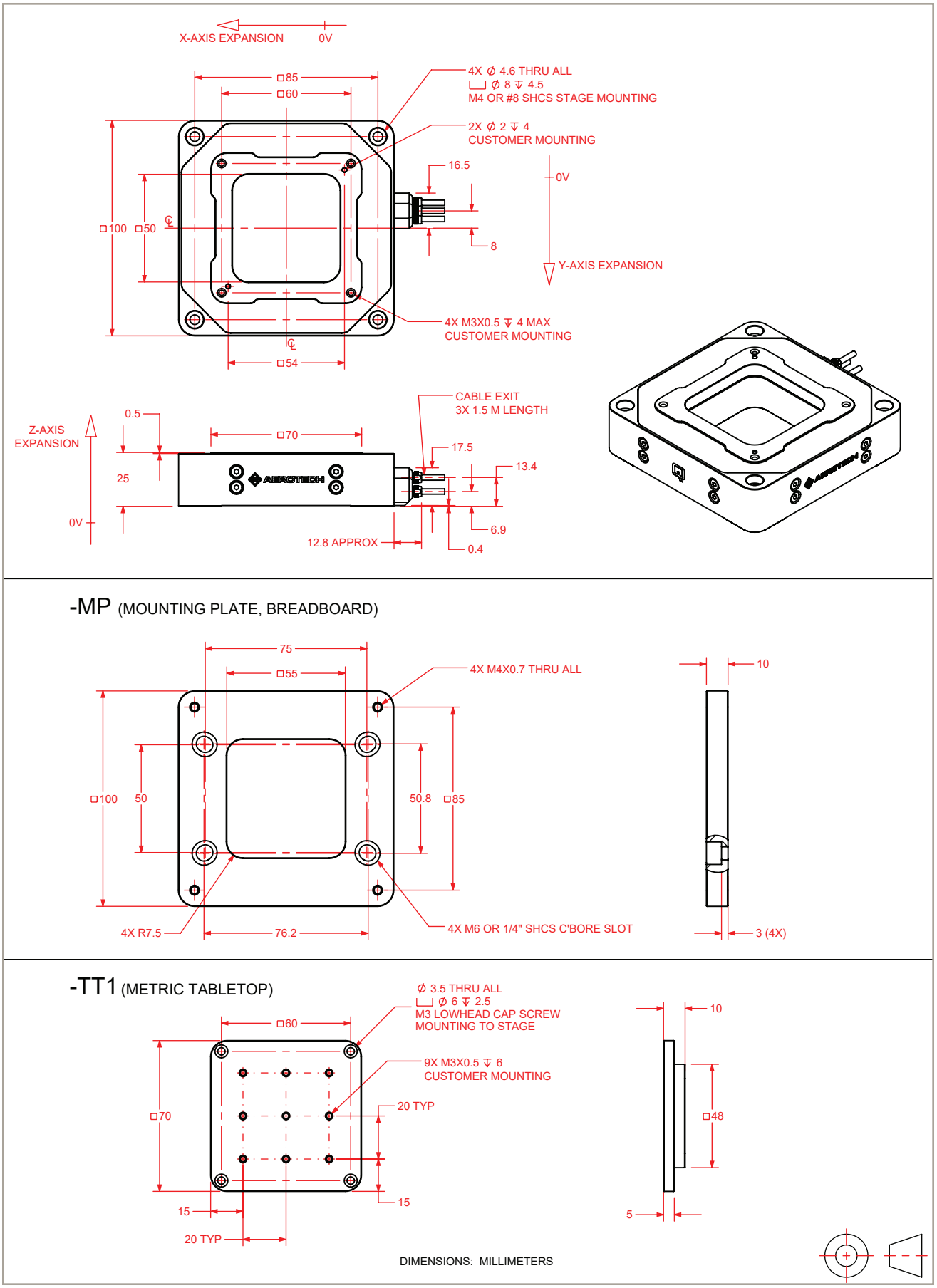


QNP3-150XYAZ-200-20-C two-dimensional flatness of < 2 nm over full XY travel. The results show the outstanding geometric performance capability of the QNP3 series.

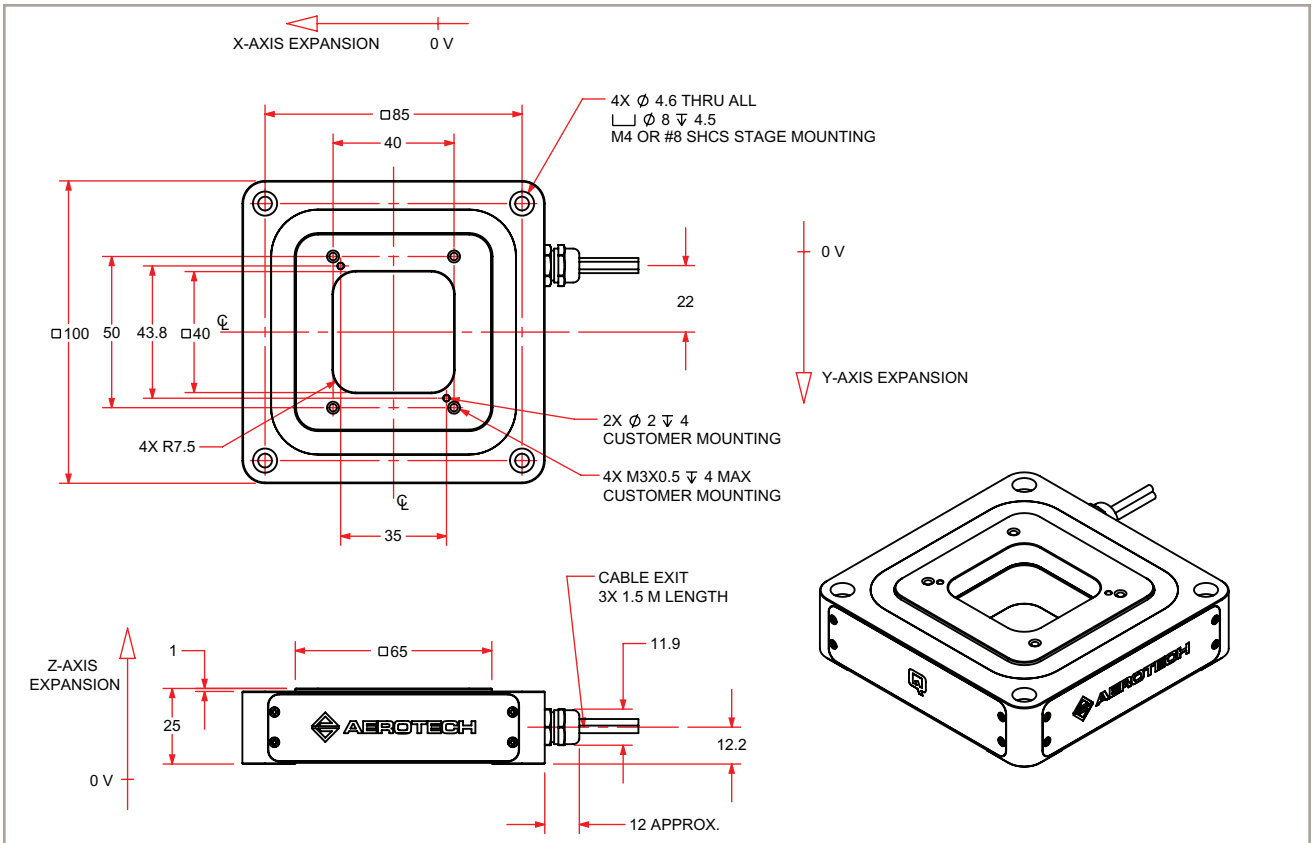


QNP3-100XYAZ-030-10 single-axis move-and-settle performance for a 10 um move (no-load condition), settling to within +/- 20 nm in 3.8 ms and to +/- 10 nm in 7.6 ms. This result illustrates the extreme dynamic performance capabilities of the QNP3.

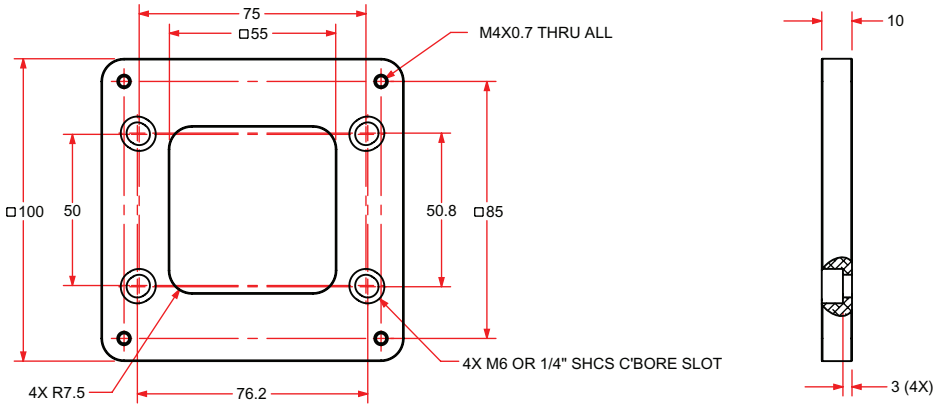
QNP3-100XYAZ-030-10 DIMENSIONS



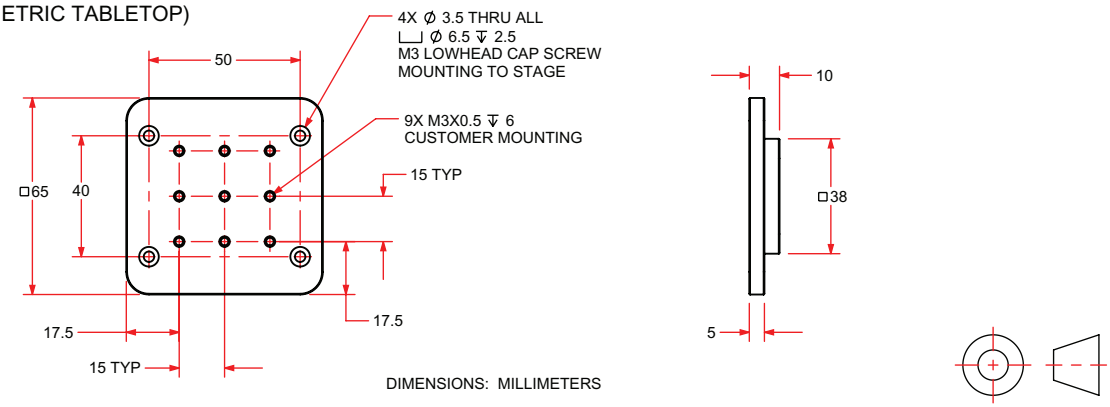
QNP3-100XYAZ-100-10 DIMENSIONS



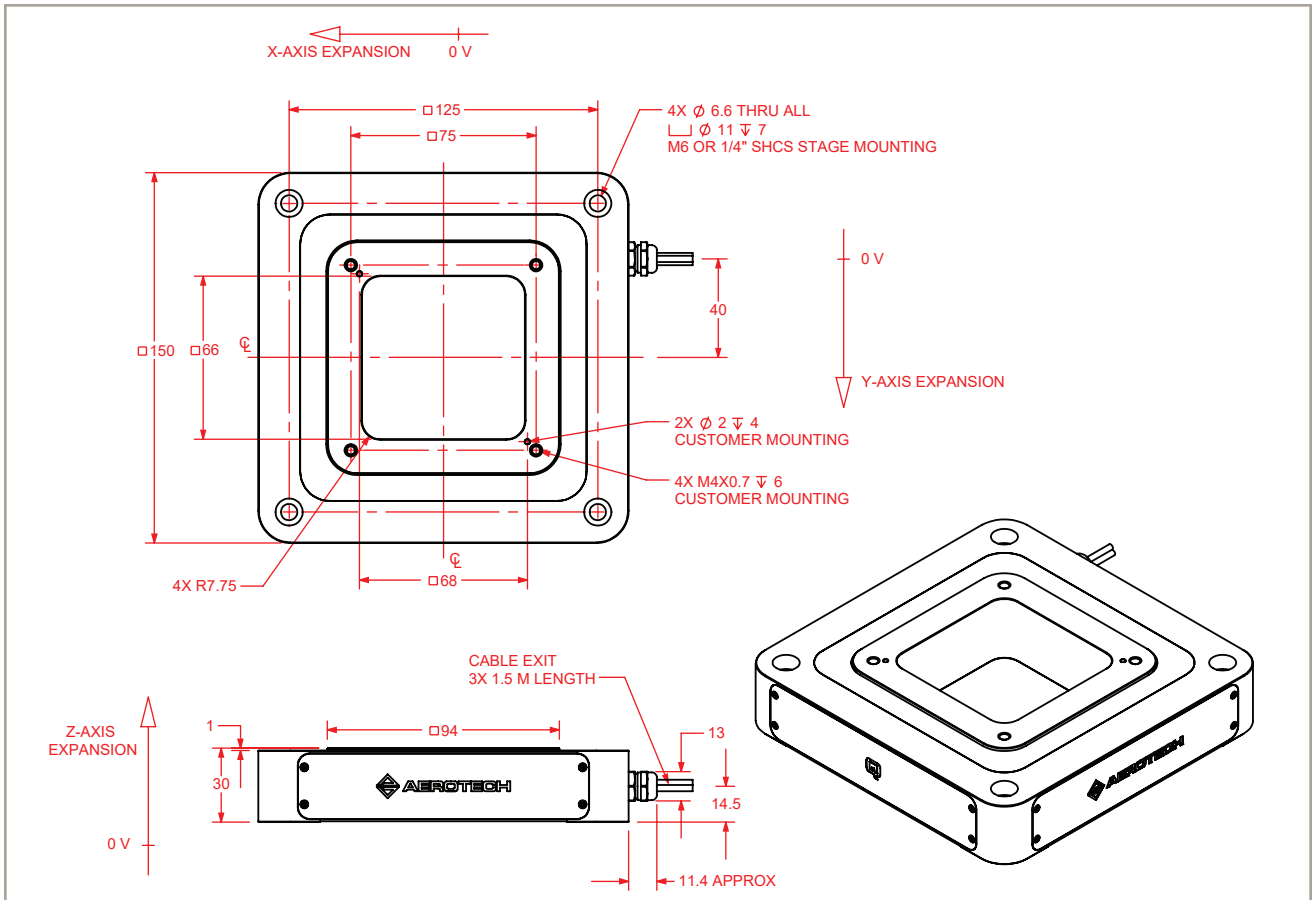
-MP (MOUNTING PLATE, BREADBOARD)



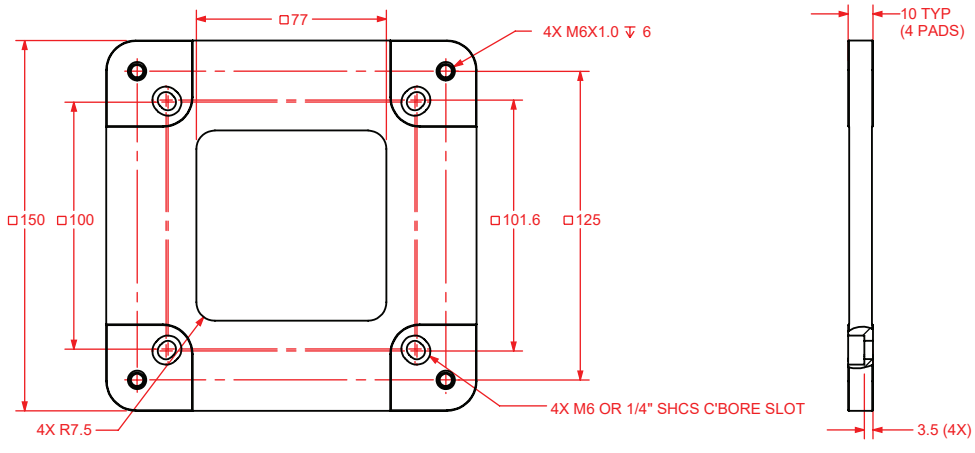
-TT1 (METRIC TABLETOP)



QNP3-150XYAZ-200-20 DIMENSIONS



-MP (MOUNTING PLATE, BREADBOARD)



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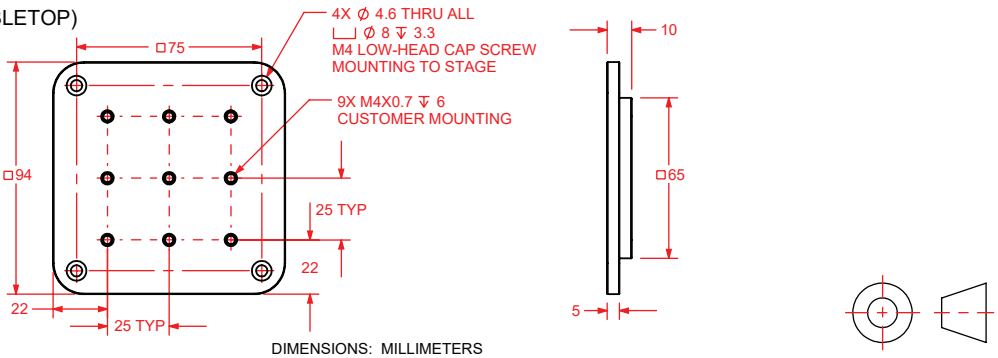

DIMENSIONS: MILLIMETERS

QNP3 Series ORDERING INFORMATION

QNP3 Series Three-Axis XYZ Piezo Nanopositioning Stage

QNP3-100XYAZ-030-10	QNP3 three-axis XYZ piezo nanopositioning stage, 30 µm x 30 µm x 10 µm closed-loop travel
QNP3-100XYAZ-100-10	QNP3 three-axis XYZ piezo nanopositioning stage, 100 µm x 100 µm x 10 µm closed-loop travel
QNP3-150XYAZ-200-20	QNP3 three-axis XYZ piezo nanopositioning stage, 200 µm x 200 µm x 20 µm closed-loop travel

Feedback (Optional)

-C	Capacitance sensor feedback

Mounting Plate (Optional)

-MP	Mounting plate for English and metric optical breadboard tables

Tabletop (Optional)

-TT1	Solid metric tabletop, covers aperture

Integration (Required)

Aerotech offers both standard and custom integration services to help you get your system fully operational as quickly as possible. The following standard integration options are available for this system. Please consult Aerotech if you are unsure what level of integration is required, or if you desire custom integration support with your system.

-TAS	**Integration - Test as system** Testing, integration, and documentation of a group of components as a complete system that will be used together (ex: drive, controller, and stage). This includes parameter file generation, system tuning, and documentation of the system configuration.
-TAC	**Integration - Test as components** Testing and integration of individual items as discrete components that ship together. This is typically used for spare parts, replacement parts, or items that will not be used together. These components may or may not be part of a larger system.