MCL®

MAD CITY LABS INC.

Piezo Nanopositioning Systems
Vacuum Nanopositioning
Microscope Stages & Micropositioners

Atomic Force Microscopes
Near Field Scanning Optical Microscopes
Single Molecule Microscopes

picoQ® Sensor Technology

Product Catalog 800A

www.madcitylabs.com

Mad City Labs, Inc.

Superior Technical Support

No voicemail. At Mad City Labs, Inc. you will immediately speak to a real person. Our sales and technical staff are experienced scientists and engineers with extensive experience in many facets of R&D, not just our product line.

Got a question?

Pick up the phone and talk to our friendly support staff.

High Performance Nanopositioning Systems

Since 1999, Mad City Labs has been the innovation leader in piezo nanopositioning systems. Our broad range of products and continuous development of new designs makes Mad City Labs the preferred choice for exacting research and industrial applications.

Proprietary PicoQ® sensors

Ultra low noise, high stability PicoQ sensors are exclusive to Mad City Labs piezo nanopositioning systems.

Integrated Instrument Solutions

Our high resolution nanopositioning systems provide the basis for high resolution atomic force microscopes (AFM) and single molecule microscopes.

Custom Design and OEM Partnerships

Our R&D center has provided many unique, innovative nanopositioner and instrument designs for specialized applications and custom requirements. Call us with your requirements.

Competitive Pricing

Complete in-house design and manufacturing provides a level of flexibility and control which enables Mad City Labs to compete successfully on a worldwide basis. This vertical integration allows for streamlined design and manufacturing resulting in very competitive pricing.

Ready to Order?

Contact your local representative or one of our direct offices to request a formal price quotation. Purchase orders are accepted by email. See the end of this catalog for a list of our offices and authorized distributors.

Think Nano®! Think Mad CIty Labs!

Main Office

United States & all countries without representation

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Important Note to Purchaser

All technical information and recommendations related to Mad City Labs, Inc. products made in this catalog are based on information believed to be reliable. Before utilizing the product, the users should determine the suitability of the product for its intended use. The user assumes all risks and liability whatsoever in connection with such use.

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Product Selection Tables

Single X-Axis Nanopositioners

Range of Motion	Aperture	Overall Dimensions	Special Features	Model
50 µm, 100 µm, 200 µm	No	6.0" x 4.5" x 1.96"	Heavy load capability	Nano-HL Series
200 µm	No	4.25" x 3.0" x 0.7"	Lowest out of plane motion	Nano-LR200
10 µm, 20 µm	No	1.77" x 1.77" x 0.59"	Smallest 1-axis stage	Nano-MET10/20
10 µm	No	1.5" x 1.0" x 0.375"	Smallest 1-axis stage	Nano-Mini
30 µm, 65 µm, 100 µm	No	2.0" x 0.5" x 2.75" to 4.8"	Fast, small, versatile	Nano-OP Series
30 µm, 50 µm, 100 µm	1.3" diameter	2.5" x 0.5" x 3.5" to 6"	Fast with aperture	Nano-OPH Series
30 µm, 65 µm, 100 µm	No	65mm x 65mm x 13mm	Fast, compact, metric	Nano-OPM
500 µm	0.39" x 2.56"	3.39" x 4.72" x 0.6"	Long range motion	Nano-YT500

Single Z-Axis Nanopositioners

Range of Motion	Aperture	Overall Dimensions (inches)	Special Features	Model
100 µm, 200 µm	3.76" x 2.38"	6.28" x 4.31" x 0.59"	Best fit for microscopy	Nano-Z Series
50 µm	1.75" diameter	5" x 4" x 0.77"	High speed	Nano-Z50HS
100 µm, 200 µm	2.6" x 2.6"	5.25" x 5.0" x 0.8"	Large aperture for microscopy	Nano-ZS Series
100 µm, 500 µm	4.0" x 6.0"	8.25" x 7.0" x 0.75"	Holds multiwell plates	Nano-ZL Series
200 µm	No	2.5" x 2.5" x 1.06"	Long range motion	Nano-CZ200
500 µm	0.5" diameter	5" x 5" x 1.285"	Long range motion	Nano-CZ500
5 µm	No	1.32" x 1.32" x 0.95"	Highest speed, low noise	Nano-METZ
25 µm	0.25" diameter	2.5" x 2.2" x 0.8"	Compact size with aperture	Nano-MZ

XY-Axis Nanopositioners

Range of Motion	Aperture	Overall Dimensions (inches)	Special Features	Model
100 µm, 200 µm, 300 µm (XY)	2.6" x 2.6"	6.0" x 6.0" x 0.6"	Low profile with large aperture	Nano-Bio Series
100 µm, 200 µm, 300 µm (XY)	3.3" x 2.1"	6.0" x 8.0" x 0.6"	Low profile, aperture for 3" slides	Nano-BioS Series
50 µm (XY)	1.8" x 1.8"	4.75" x 4.75" x 0.5"	Low profile, aperture, Invar or Ti	Nano-Bio2M
50 µm, 100 µm (XY)	2.0" x 2.0"	4.0" x 4.0" x 1.28"	Compact size with aperture	Nano-H Series
50 µm (XY)	3.5" x 3.5"	8.9" x 8.9" x 1.25"	Large load capacity (5 kg)	Nano-Max50
10 µm (XY)	No	2.0" x 2.0" x1.15"	Compact size, high speed	Nano-HS2
50 µm (XY)	No	2.1" x 2.1" x 1.1"	Smallest 2-axis stage with aperture	Nano-M250
75 µm (XY)	No	4.92" x 4.92" x 1.08"	High speed, low noise	Nano-MET2
200 µm (XY)	No	2.5" x 2.5" x 1.2"	Designed specifically for SPM	Nano-SPM200

XY or XYZ-Axis Nanopositioners

Range of Motion	Aperture	Overall Dimensions (inches)	Special Features	Model
50 µm (XY) x 50 µm (Z) 75 µm (XY) x 50 µm (Z)	2.6" x 2.6"	6.25" x 4.5" x 1.35"	High speed, large aperture	Nano-PDQ Series
100 µm (XY) x 20 µm (Z) 200 µm (XY) x 50 µm (Z)	2.6" x 2.6"	6.5" x 5.0" x 1.5"	Economical with large aperture	Nano-T Series

XYZ-Axis Nanopositioners

Range of Motion	Aperture	Overall Dimensions (inches)	Special Features	Model
100 µm, 200 µm, 300 µm (XYZ)	2.6" x 2.6"	7.5" x 6.0" x 0.8"	Low profile with large aperture	Nano-LP Series
100 µm, 200 µm, 300 µm (XYZ)	3.3" x 2.1	6.0" x 8.7" x 0.8"	Low profile, aperture for 3" slides	Nano-LPS Series
75 µm (XY) x 50 µm (Z)	2.6" x 2.6"	6.0" x 7.5" x 0.865"	High speed, low profile	Nano-LPQ
200 µm (XYZ)	6.61" x 4.65"	10.24" x 7.09" x 1.29"	Only XYZ for multiwell plates	Nano-LPMW
10 µm (XY) x 5 µm (Z)	No	2" x 2" x 1.95"	High speed, picometer precision	Nano-HS3M
50 µm (XY) x 20 µm (Z)	No	2.5" x 2.2" x 1.9"	Compact, sub-nm precision	Nano-M350
75 µm (XY) x 5 µm (Z)	No	4.92" x 4.92" x 1.53"	Ultra-low noise performance	Nano-MET3
200 µm (XYZ)	No	2.5" x 2.5" x 2.05"	Compact, long range, low cost	Nano-3D200
500 µm (XYZ)	0.5" dia.	5.125" x 5.0" x 2.21"	Compact, very long range	Nano-3D500

Objective Lens Nanopositioners

Range of Motion	Resolution	Overall Dimensions (inches)	Applications	Model
100 µm	0.2 nm	1.7" (height)	Objective lens focusing element	Nano-F Series
25 µm	0.05 nm	1.7" x 2.0" x 2.77"	High speed objective lens focusing element	Nano-F25HS
450 µm	0.9 nm	2.55" x 4.46" x 1.0"	Objective lens focusing element	Nano-F450
100 µm (XYZ)	0.2 nm	4.45" x 2.76" x 1.44"	3-axis objective lens motion	Nano-F3D
100 µm	0.2 nm	NA	Automatic microscope focus drift correction	C-Focus™

Tip/Tilt (θ_x, θ_y) and Rotational (θ_z) Nanopositioners

Range of Motion	Aperture	Overall Dimensions (inches)	Special Features	Model
2 mrad, 5 mrad, 10 mrad	No	variable depending on range	High speed beam steering, one and two axis available	Nano-MTA Series
2 mrad, 5 mrad, 10 mrad	No	variable depending on range	Compatible with cage mount, single axis only	Nano-MTA/VSM Nano-MTA/HSM
2 mrad	No	2.0" x 1.25" x 0.5"	Small, accessible rotation axis	Nano-Theta
5 mrad	1.378" diameter	5.0" x 5.0" x 0.5"	Low profile, large aperture	Nano-ThetaH

Product Selection Tables

Z-Axis, θ_X, θ_Y Nanopositioners (Z-axis Linear + Tip + Tilt)				
Range of Motion	*Aperture*	*Overall Dimensions (inches)*	*Special Features*	*Model*
100 µm x 2 mrad x 2 mrad	2.6" x 2.6"	5.25" x 5.0" x 0.8"	Low profile, large aperture	Nano-Align3-100
200 µm x 4 mrad x 4 mrad	2.6" x 2.6"	5.25" x 5.0" x 0.8"	Low profile, large aperture	Nano-Align3-200
25 µm x 1 mrad x 1 mrad	No	2.5" x 2.5" x 0.76"	Smallest Z, θ_X , θ_Y stage	Nano-M3Z

XYZ-Axis, θ_X, θ_Y Nanopositioners (3-axis Linear + Tip + Tilt)				
Range of Motion	*Aperture*	*Overall Dimensions (inches)*	*Special Features*	*Model*
100 µm (XYZ) x 1.1 mrad x 1.5 mrad	2.6" x 2.6"	6.0" x 7.5" x 0.8"	Large aperture, low profile	Nano-Align5-100
200 µm (XYZ) x 2.3 mrad x 3.0 mrad	2.6" x 2.6"	6.0" x 7.5" x 0.8"	Large aperture, low profile	Nano-Align5-200
300 µm (XYZ) x 3.5 mrad x 4.3 mrad	2.6" x 2.6"	6.0" x 7.5" x 0.8"	Large aperture, low profile	Nano-Align5-300
50 µm (XY) x 25 µm (Z) x 1 mrad x 1 mrad	No	2.5" x 2.5" x 1.75"	Smallest X, Y, Z, θ_X , θ_Y stage	Nano-Man5

XYZ-Axis, θ_X, θ_Y, θ_Z Nanopositioners (3-axis Linear + Tip + Tilt + Rotation)				
Range of Motion	*Aperture*	*Overall Dimensions (inches)*	*Special Features*	*Model*
100 µm (XYZ) x 1.2 mrad x 1.5 mrad x 5mrad	1.378" diameter	6.0" x 7.5" x 1.3"	6 axis motion with aperture	Nano-Align6-100
200 µm (XYZ) x 2.3 mrad x 3.0 mrad x 5mrad	1.378" diameter	6.0" x 7.5" x 1.3"	6 axis motion with aperture	Nano-Align6-200

UHV (bakeable) Nanopositioners Note: Nearly all standard systems can be modified for vacuum applications to 10^{-8} Torr if baking is not necessary.				
Range of Motion	*Aperture*	*Overall Dimensions (inches)*	*Special Features*	*Model*
50 µm (XY)	1" diameter	2.5" x 2.5" x 1.29"	Vacuums to 10^{-10} Torr, bakeable to 120° C.	Nano-UHV50
100 µm (XY)	2.6" x 2.6"	5.5" x 5.5" x 1.12"	Vacuums to 10^{-10} Torr, bakeable to 120° C.	Nano-UHV100
200 µm (XYZ)	2.0" x 2.0"	5.3" x 7.5" x 1.4"	Vacuums to 10^{-10} Torr, bakeable to 100° C.	Nano-UHV200

OUR PRODUCTS

Mad City Labs nanopositioning systems and micropositioning systems comprise a stage paired with an electronic controller. This approach greatly simplifies the pricing and decision process of purchasing our products. Of course, a wide range of options and upgrades are available - and our sales engineers are ready to help tailor your system to your application needs. Call or email us to discuss your specific needs.

Micropositioning Stages - XY Axis				
Range of Motion	*Step Size*	*Linear Encoder Resolution*	*Special Features*	*Model*
up to 50mm (XY)	NA	NA	Allows rotation of microscope nosepiece, inverted optical microscopes	Manual MicroStage-LT
25mm (XY)	NA	NA	Designed for upright optical microscopes	Manual MicroStage-UP
25 mm (XY)	95 nm (XY)	50 nm	Integrated high resolution linear encoder, upright and inverted optical microscopes	MicroStage
25 mm	95 nm	50 nm	Compact, low cost modular platforms	MMP Series
25 mm	95 nm	50nm	Precision aligned, motorized approach for SPM	SPM-MZ

RM21® Single Molecule Microscopes							
Models \ *Methods*	*Epi-Fluorescence*	*Single Molecule Localization*	*MicroMirror TIRF*	*Dichroic TIRF*	*Multi-color imaging*	*Z Drift correction*	*3D Drift correction*
RM21® Versa	●	●		○	○	○	
RM21® Classic	●	●		○	○	○	○
RM21® Advanced	●	●	●	●	○	○	○
RM21® MicroMirror TIRF		●	●	○	○	○	○

○ Requires additional RM21® microscope options

NEED HELP?

Contact Mad City Labs technical sales engineers at 608-298-0855 or sales@madcitylabs.com for help choosing the best nanopositioner or instrument solution for your application. They can also provide advice on customizing a design to better suit your needs. Sales offices outside the United States, including our direct office in Europe, are listed at the end of this catalog.

What we don't have:

No voice mail - you will immediately talk to a real person!
No "please wait to hear all the options" phone tree - we hate those things!
No long waits for email responses - emails are read and answered immediately by real people!

What we do have:

Experienced physicists and engineers who are more than happy to help!

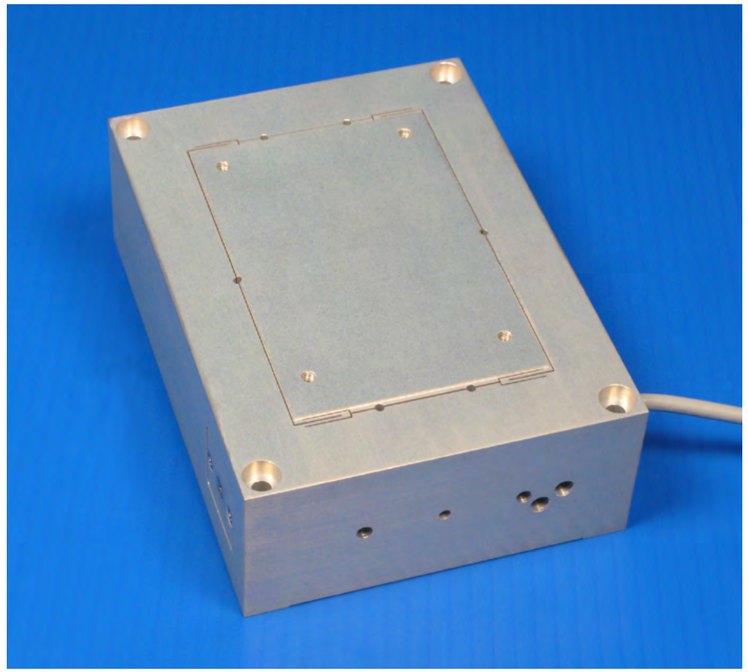
Nano-HL Series

Features

- *Heavy load capacity - up to 10kg*
- *Single axis motion*
- *Long range motion - up to 200µm*
- *Closed loop control*
- *picoQ sensor technology*

Typical Applications

- *Precise positioning of heavy optics or sensor assemblies*
- *Off-axis loading with high positional stability*



Nano-HL200 constructed from aluminum.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

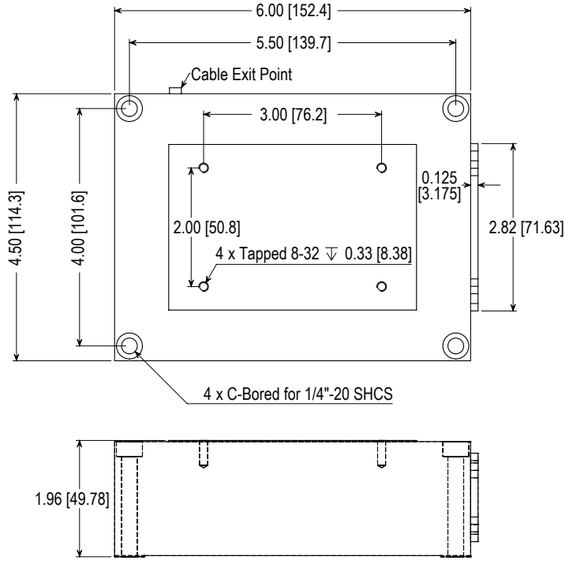
Product Description

The Nano-HL Series single axis stages are heavy duty, piezo nanopositioners designed to carry loads weighing up to 10kg. Build from a single block of aluminum nearly 2 inches (50mm) thick, the Nano-HL has enough physical rigidity to counteract large off-axis loads while continuing to produce precise, high resolution movements. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with sub-nanometer resolution under closed loop control. The Nano-HL Series stages can be operated in any orientation and may be customized to fit specific installations and special mounting requirements.

Technical Specifications

Range of motion (Nano-HL50) ..... 50 µm
Range of motion (Nano-HL100) ..... 100 µm
Range of motion (Nano-HL200) ..... 200 µm
Resolution (50/100/200 µm) ..... 0.1/0.2/0.4 nm
Resonant Frequency ..... 450 Hz ±20%
Stiffness ..... 1.0 N/µm
Recommended max. load (horizontal)* ..... 10 kg
Recommended max. load (vertical)* ..... 10 kg
Body Material ..... Aluminum
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Note: All Dimensions in Inches [millimeters]

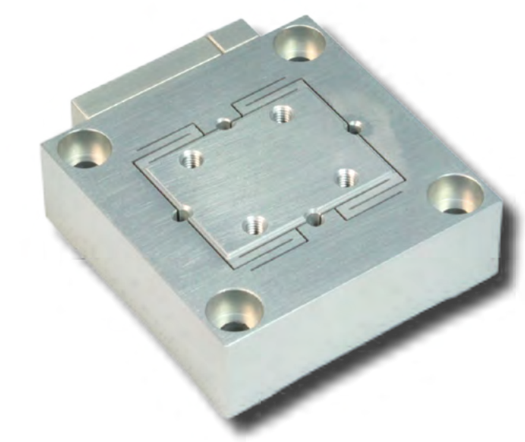
Nano-MET10 & Nano-MET20

Features

- *Compact footprint*
- *Single axis - 10 microns or 20 microns*
- *Closed loop control*
- *Ultra-low noise performance*
- *Picometer positioning resolution*
- *High speed*
- pico *sensor technology*

Typical Applications

- *High speed, high resolution positioning*
- *Metrology*
- *AFM*
- *SPM*



Related products

- Nano-METZ
- Nano-MET2
- Nano-MET3

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

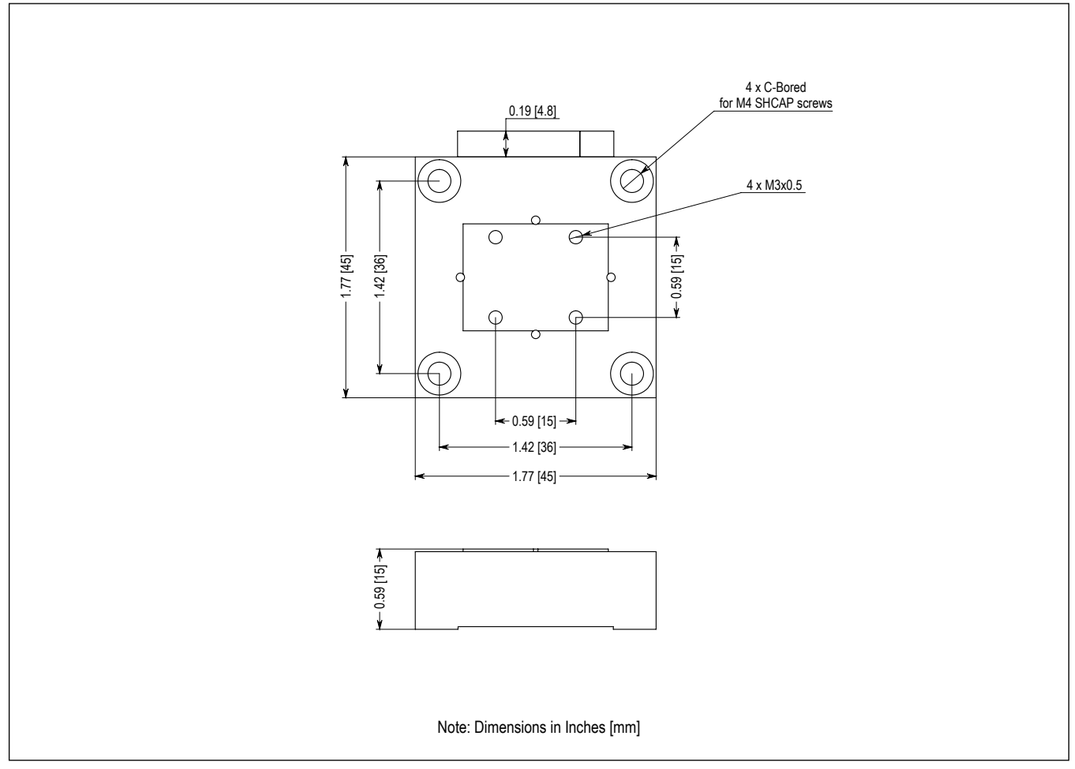
Product Description

The Nano-MET10 and Nano-MET20 are compact, single axis piezo nanopositioning systems with exceptional resonant frequency and low noise characteristics. The Nano-MET10 and Nano-MET20 have picometer positioning resolution. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement under closed loop control. The low noise characteristics and high resonant frequencies make it ideal for demanding metrology applications that require noise floors less than 10 picometers/√Hz and high speed performance. Related products include the Nano-MET2, Nano-MET3 and Nano-METZ nanopositioning systems.

Technical Specifications

Range of motion (MET10)	10 µm
Range of motion (MET20)	20 µm
Resolution (Nano-MET10)	0.01 nm
Resolution (Nano-MET20)	0.02 nm
Resonant Frequency	4.6 kHz
Resonant Frequency (30g)	2.8 kHz
Recommended max. load (horizontal)*	100 g
Recommended max. load (vertical)*	100 g
Body Material	Aluminum
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Note: Dimensions in Inches [mm]

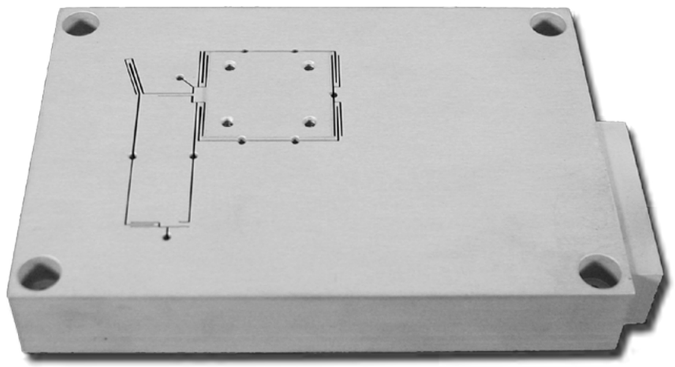
Nano-LR200

Features

- *Long range single axis motion: 200 µm*
- *Less than 5 nm out of plane motion*
- *Low profile design*
- *Closed loop control*
- *picoQ sensor technology*

Typical Applications

- *Surface metrology*
- *Wafer scanning and alignment*
- *Optical alignment*



Nano-LR200 (1-axis) constructed from aluminum.

Product Description

The Nano-LR200 is designed to provide long range, single axis translation with an absolute minimum of out-of-axis motion. The unique design of the piezoactuated Nano-LR200 stage produces less than 5 nm of out-of-plane motion; measured over the entire moving platform throughout the 200 µm range of motion. The Nano-LR200 sets the highest level of single axis precision and positioning performance. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with sub-nanometer accuracy under closed loop control. The Nano-LR200 is ideally suited for applications that require extreme parallelism, such as metrology, AFM and MEMS.

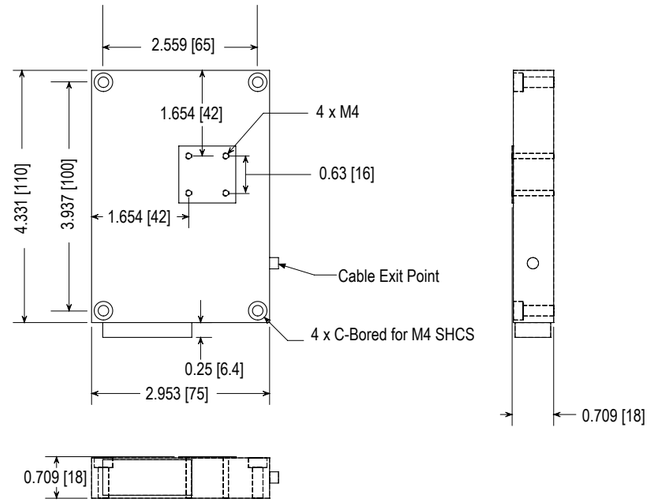
Technical Specifications

Range of motion (X)	200 µm
Resolution	0.4 nm
Resonant Frequency	690 Hz ±20%
Stiffness	0.2 N/µm
θ_{roll} , θ_{pitch} (typical)	≤0.3 µrad
θ_{yaw} (typical)	≤0.3 µrad
Recommended max. load (horizontal)*	0.5 kg
Recommended max. load (vertical)*	0.2 kg
Body Material	Al
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.



Note: All Dimensions in Inches [millimeters]

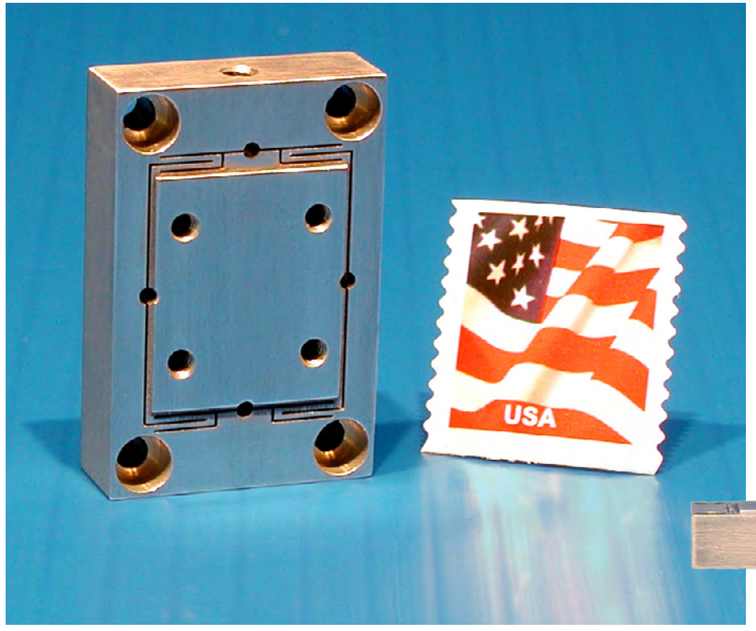
Nano-Mini

Features

- *Ultra small footprint: 1" × 1.5"*
- *Stackable for XY motion*
- *Closed loop control*
- *Titanium or invar construction*
- *picoQ® sensor technology*

Typical Applications

- *Optical fiber alignment*
- *Optical positioning*
- *Interferometry*



Actual Size

Nano-Mini constructed from titanium.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

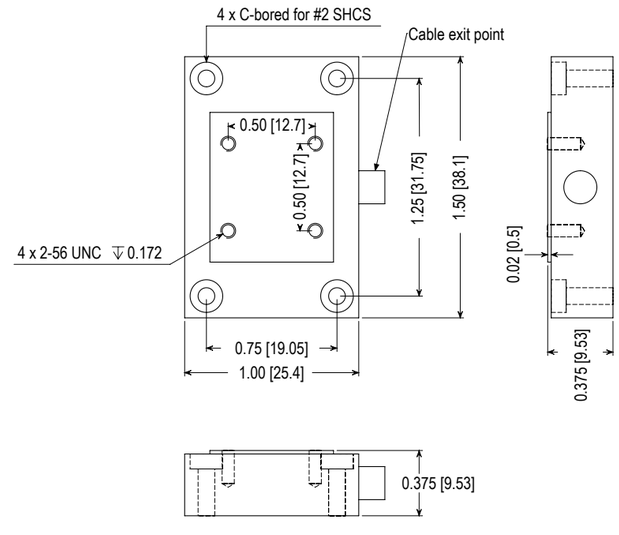
Product Description

The Nano-Mini is one of the smallest flexure guided piezo nanopositioning stages available. Designed for optimum performance on a small footprint, this stage uses an innovative mini-cross section multilayer piezo ceramic which allows for a stiff stage to translate 10 microns with picometer precision. This unique design makes it ideal for applications in precision metrology and microscopy. Internal position sensors utilizing proprietary PicoQ® sensor technology provide absolute, repeatable position measurement with picometer accuracy under closed loop control. Available in titanium or invar.

Technical Specifications

Range of motion ..... 10 µm
Resolution ..... 0.02 nm
Resonant Frequency ..... 1.5 kHz ±20%
Resonant Frequency (50g load) ..... 650 Hz ±20%
Stiffness ..... 1.0 N/µm ±20%
θ_{roll} , θ_{pitch} (typical) ..... ≤1 µrad
θ_{yaw} (typical) ..... ≤2 µrad
Recommended max. load (horizontal)* ..... 0.5 kg
Recommended max. load (vertical)* ..... 0.15 kg
Body Material ..... Titanium or Invar
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Note: All Dimensions in Inches [millimeters]

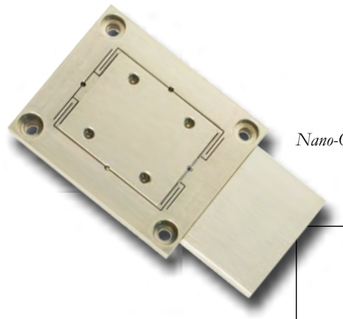
Nano-OP Series

Features

- *High speed, direct drive*
- *Modular and versatile*
- *30, 65, and 100 µm ranges of motion*
- *PicoQ® sensor technology*
- *Closed loop control*

Typical Applications

- *Interferometry*
- *Nanomanipulation*
- *High speed lens focusing*
- *Fiber optics*
- *NSOM/AFM*



Nano-OP65 (1-axis) constructed from aluminum.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Nano-OP30 (1-axis) constructed from aluminum.

Stacked Nano-OP30's (2-axis) constructed from aluminum.

Product Description

The Nano-OP Series is a versatile group of compact piezo nanopositioners which can be configured as stand-alone single axis nanopositioners or multi-axis positioners. The Nano-OP Series are available with standard travel ranges of 30, 65, and 100 microns and can be constructed from aluminum, invar, or titanium. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with picometer resolution under closed loop control. PicoQ® sensors combined with direct drive design means that the Nano-OP series has exceptional low noise performance and high scanning speeds.

Nano-OP nanopositioning systems can be used in a wide variety of applications such as lithography, interferomentry, optical microscopy and atomic force microscopy.

Related products include the Nano-OPM, with metric dimensions, and the Nano-OPH for applications that require an aperture for transmitted light.

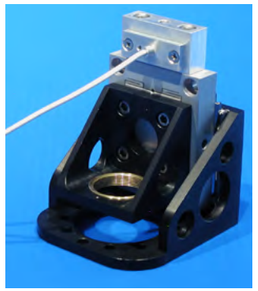
The Nano-OP series can be customized for a variety of applications and environmental conditons such as ultra-high vacuum.

Technical Specifications

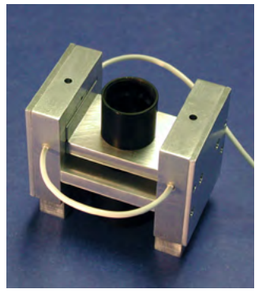
Range of motion (Nano-OP30)	30 µm
Range of motion (Nano-OP65)	65 µm
Range of motion (Nano-OP100)	100 µm
Resolution (30/65/100 µm)	0.06/0.13/0.2 nm
Resonant Frequency	4.0/3.0/2.8 kHz ±20%
Stiffness	3.0 N/µm ±20%
θ_{roll} , θ_{pitch} (typical)	≤1 µrad
θ_{yaw} (typical)	≤2 µrad
Recommended max. load (horizontal)*	1.0 kg
Recommended max. load (vertical)*	0.5 kg
Body Material	Al, Invar or Titanium
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

Application: High speed lens positioning

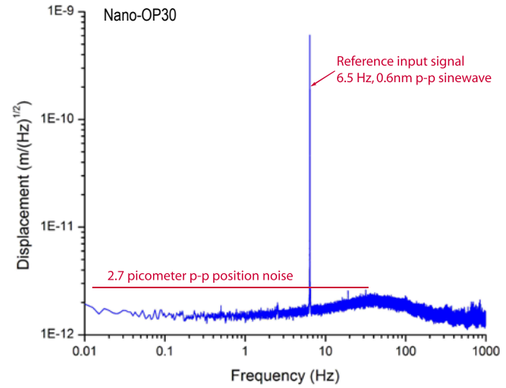


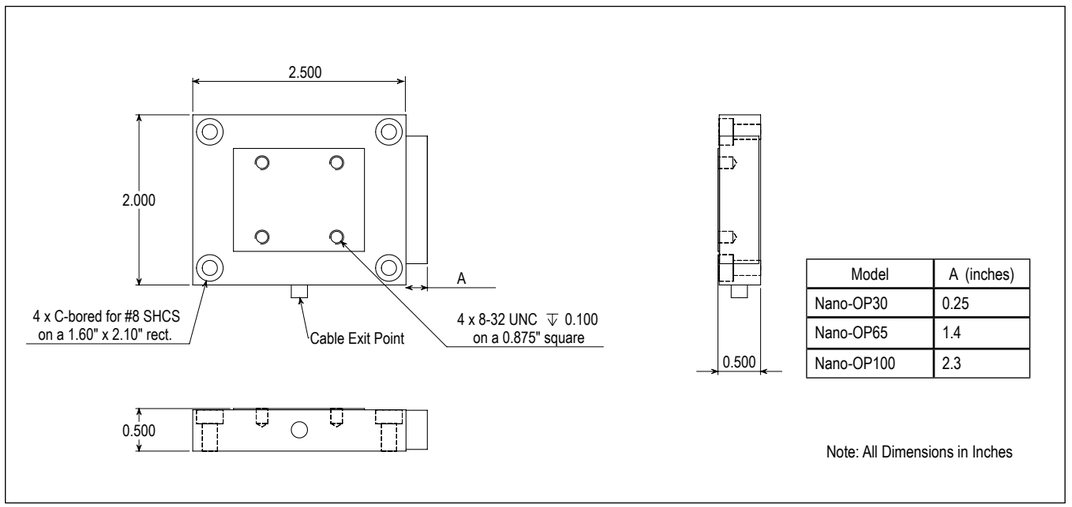
High speed focusing device composed of a Nano-OP30 with objective lens brackets and integrated manual coarse positioning.



Two Nano-OP25's combined to form an ultra high speed objective lens focusing device.

Low Position Noise





Model	A (inches)
Nano-OP30	0.25
Nano-OP65	1.4
Nano-OP100	2.3

Note: All Dimensions in Inches

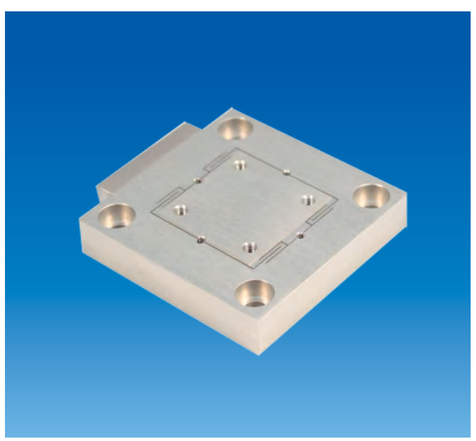
Nano-OPM Series

Features

- *High speed, direct drive*
- *Metric dimensions*
- *30, 65, and 100 µm ranges of motion*
- *PicoQ® sensor technology*
- *Closed loop control*

Typical Applications

- *Interferometry*
- *Nanomanipulation*
- *High speed lens focusing*
- *Optical microscopy*
- *NSOM/AFM*



Nano-OP30 with M6 mounting holes on a 50mm square.
Designed to mount directly to a metric optical table.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products

- Nano-OP series
- Nano-OPH series

Product Description

The Nano-OPM Series of compact piezo nanopositioning stages is a sister product to the Nano-OP series that is compatible with metric optical tables. The Nano-OPM can be used as a stand-alone single axis nanopositioners or configured as a multi-axis positioner in any orientation. The Nano-OPM Series are available with standard travel ranges of 30, 65, and 100 microns and can be constructed from aluminum, invar, or titanium. Integrated proprietary PicoQ® sensors provide absolute, repeatable position measurement with picometer resolution under closed loop control. PicoQ® sensors combined with direct drive design means that the Nano-OPM series has low noise and high speed performance. The low noise performance is comparable to the Nano-OP series.

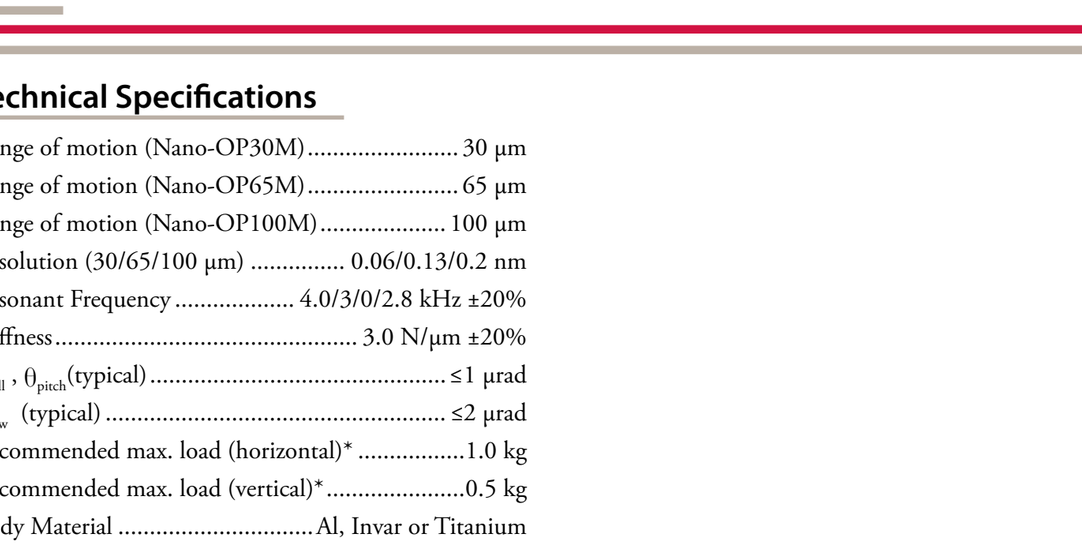
Nano-OPM nanopositioning systems can be used in a applications such as lithography, interferomentry, optical microscopy and atomic force microscopy. Related products include the Nano-OP, with imperial dimensions, and the Nano-OPH for applications that require an aperture for transmitted light.

The Nano-OPM series can be adapted for a variety of applications and environmental conditons such as ultra-high vacuum. Contact our engineers for more information on custom solutions.

Technical Specifications

Range of motion (Nano-OP30M) ..... 30 µm
Range of motion (Nano-OP65M) ..... 65 µm
Range of motion (Nano-OP100M) ..... 100 µm
Resolution (30/65/100 µm) ..... 0.06/0.13/0.2 nm
Resonant Frequency ..... 4.0/3/0/2.8 kHz ±20%
Stiffness ..... 3.0 N/µm ±20%
θ_{roll} , θ_{pitch} (typical) ..... ≤1 µrad
θ_{yaw} (typical) ..... ≤2 µrad
Recommended max. load (horizontal)* ..... 1.0 kg
Recommended max. load (vertical)* ..... 0.5 kg
Body Material ..... Al, Invar or Titanium
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Model	A (millimeters)
Nano-OP30M	6.35
Nano-OP65M	35.56
Nano-OP100M	58.42

Note: All Dimensions in millimeters

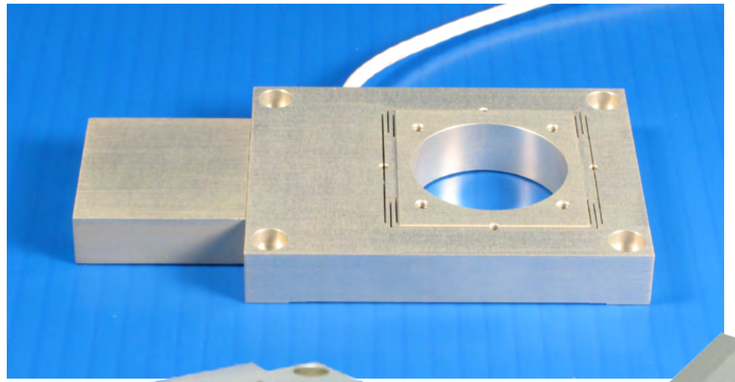
Nano-OPH Series

Features

- *High speed, direct drive*
- *Stackable for multi-axis motion*
- *30, 50, and 100 µm ranges of motion*
- *PicoQ® sensor technology*
- *Closed loop control*

Typical Applications

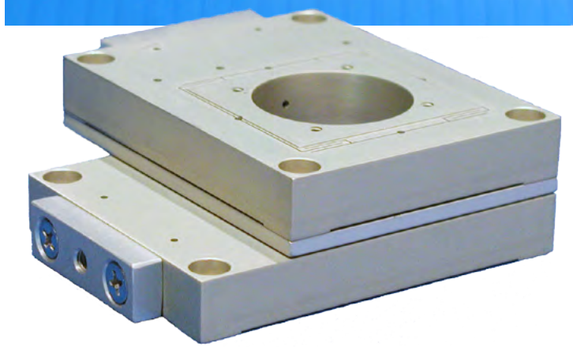
- *Interferometry*
- *Nanomanipulation*
- *High speed lens focusing*
- *Fiber optics*
- *NSOM*



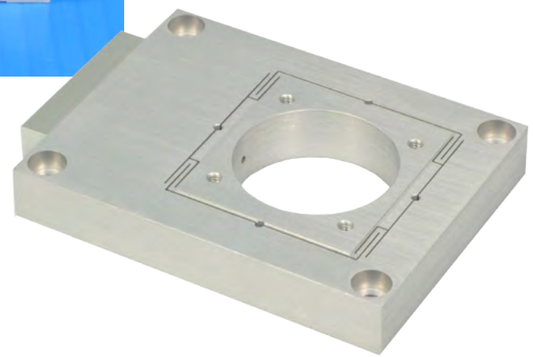
LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Nano-OPH50 with 1.3 inch diameter aperture



Stacked Nano-OPH30's (2-axis) constructed from aluminum.



Nano-OPH30 (1-axis) constructed from aluminum.

Product Description

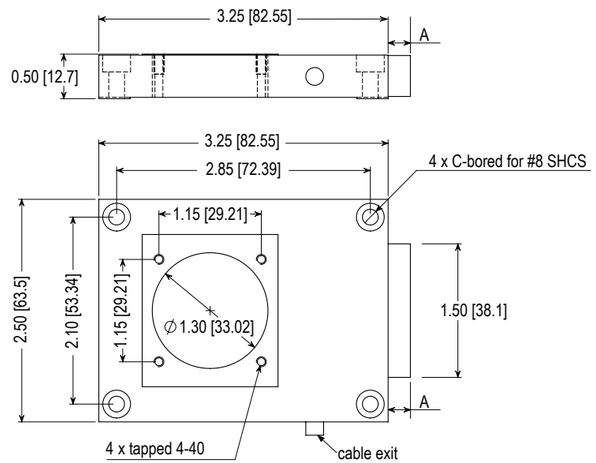
Like the Nano-OP Series, the Nano-OPH Series is a versatile group of compact single axis piezo nanopositioners which can be configured to fit into a wide variety of applications. The addition of a 1.3 inch diameter aperture through the stage makes the Nano-OPH especially useful for precise motion in optical experiments. Individual, single axis stages may be combined to form multi-axis systems. The Nano-OPH Series are available with 30, 50, and 100 micron ranges of motion. The Nano-OPH Series has similar performance to the Nano-OP Series of nanopositioning systems. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with picometer resolution under closed loop control.

Technical Specifications

Range of motion (Nano-OPH30)	30 µm
Range of motion (Nano-OPH50)	50 µm
Range of motion (Nano-OPH100)	100 µm
Resolution (30/50/100 µm)	0.06/0.1/0.2 nm
Resonant Frequency	3.5 kHz ±20%
Resonant Frequency (100g load)	1.5 kHz ±20%
Stiffness	3.0 N/µm ±20%
θ_{roll} , θ_{pitch} (typical)	≤1 µrad
θ_{yaw} (typical)	≤2 µrad
Recommended max. load (horizontal)*	1.0 kg
Recommended max. load (vertical)*	0.5 kg
Body Material	Al
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

Related products
- Nano-OP series
- Nano-OPM series



Model	A
Nano-OPH30	0.25 [6.35]
Nano-OPH65	1.40 [35.56]
Nano-OPH100	2.8 [71.12]

Note: All Dimensions in Inches [millimeters]

Nano-YT Series

Features

- *Single axis motion*
- *Long range - up to 500µm*
- *Compact size*
- *Rectangular aperture*
- *Closed loop control*
- *PicoQ® sensor technology*

Typical Applications

- *Long range scanning*
- *Inspection, quality control*

Nano-YT500 constructed from aluminum.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

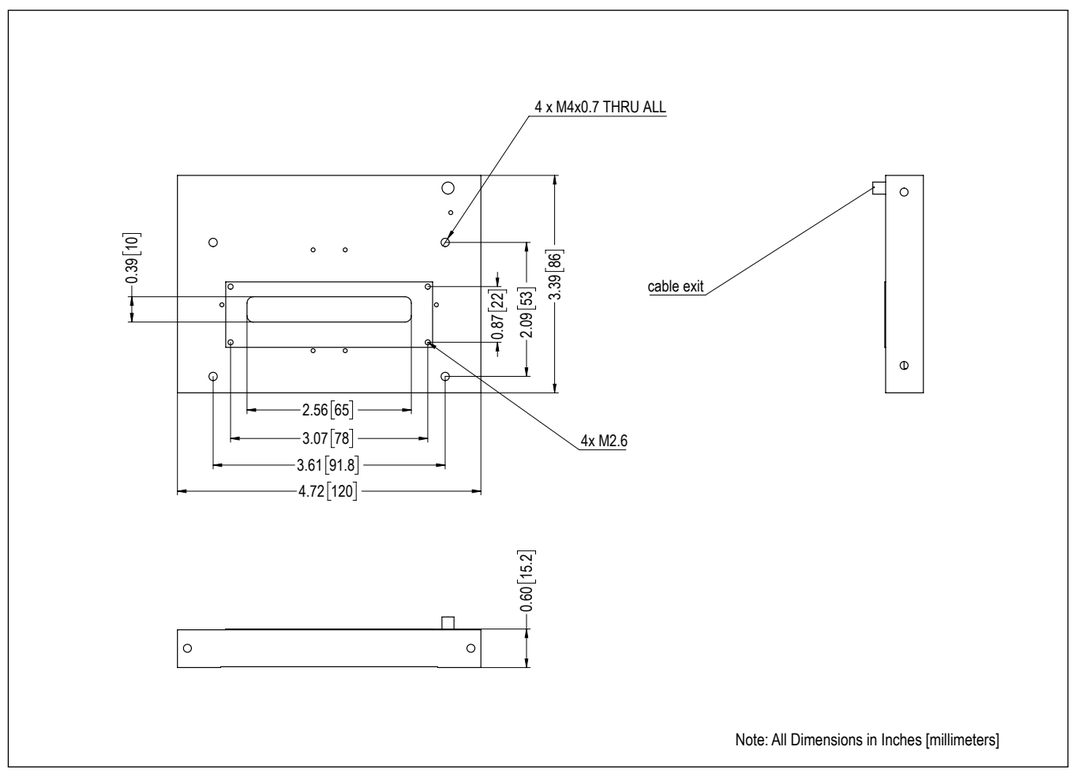
Product Description

The Nano-YT Series is a long range, single axis, piezo nanopositioning system with a central aperture well suited for optical scanning of samples. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with nanometer resolution under closed loop control. True flexure guided motion of the Nano-YT Series minimizes the end-to-end differences in travel across the aperture to less than 1µm over 500µm range of motion (0.2%). The Nano-YT500 can be operated in any orientation and has been tested for reliability over 1,000,000 full cycles (1000µm total travel per cycle).

Technical Specifications

Range of motion (Nano-YT200)	200 µm
Range of motion (Nano-YT500)	500 µm
Resolution	1.0 nm
Resonant Frequency	425/150 Hz ±20%
Stiffness	0.8 N/µm
Recommended max. load (horizontal)*	0.5 kg
Recommended max. load (vertical)*	0.1 kg
Body Material	Aluminum
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Nano-Z Series

Features

- *Ultra-low profile*
- *Closed loop control*
- *Easy sample holder exchange*
- *Compatible with many microscope stages*
- *picoQ® sensor technology*

Typical Applications

- *High speed confocal microscopy*
- *High throughput fluorescence microscopy*
- *Super resolution microscopy*

Related products
- Nano-Z50HS
- Nano-ZL Series

Sample holders for the Nano-Z seriess.

Product Description

The Nano-Z Series are high precision Z-axis piezo nanopositioners specifically designed to hold slides, chambered slides, cover slips and 35mm petri dishes. The Nano-Z series nanopositioning systems are ideal for single cell fluorescence microscopy, super resolution microscopy and high resolution confocal imaging. The nanopositioning stages have true flexure guided motion and contains internal position sensing. Utilizing proprietary PicoQ® technology, the position sensors provide absolute, repeatable position measurement for closed loop control with sub-nanometer resolution. The Nano-Z series offers smooth, continuous travel with superior resolution and stability for advanced microscopy techniques. The Nano-Z series is compatible with LabVIEW based software and other major 3rd party microscopy software packages.

Technical Specifications

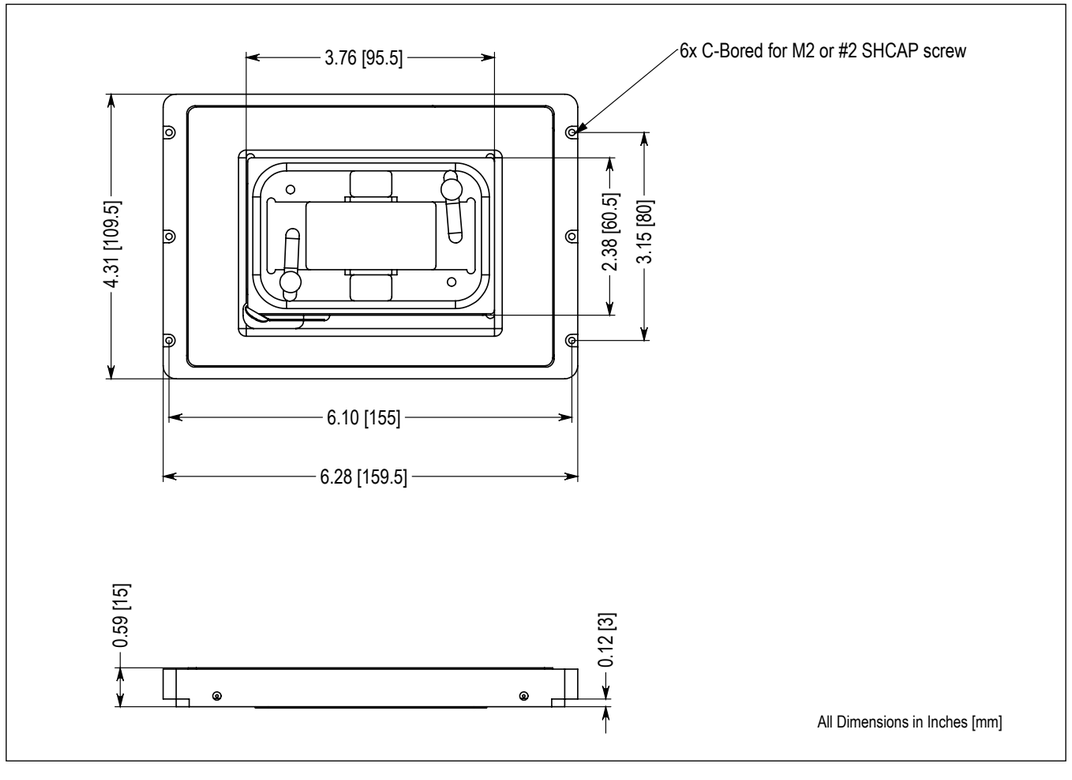
Range of motion (Z100) ..... 100 µm
Resonant Frequency ..... 425 Hz ± 20%
Range of motion (Z200) ..... 200 µm
Resonant Frequency ..... 210 Hz ±20%
Resolution (100/200) 0.2/0.4nm
Recommended max. load (horizontal)* .....0.5 kg
Body Material ..... Aluminum
Controller ..... Nano-Drive®
75mm slide sample holder ..... AC-ZS
35mm Petri dish holder .....AC-ZP

* Larger load requirements should be discussed with our engineering staff.

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph, NIS-Elements, Image-Pro Plus, SlideBook 6, µManager (Open Source Microscopy Software)



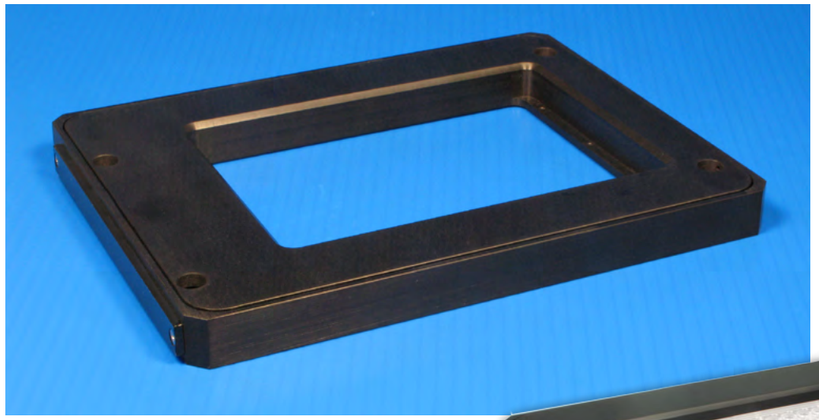
Nano-ZL Series

Features

- *500 µm or 100 µm Z-axis motion*
- *Multiwell plate sized aperture (4.3" × 6.3")*
- *Closed loop control*
- *Low profile, easy to retrofit*
- *pico sensor technology*

Typical Applications

- *High speed confocal microscopy*
- *High throughput fluorescence microscopy*
- *Super resolution microscopy*



Nano-ZL Series with multi-well plate.

Related products
- Nano-Z50HS
- Nano-Z Series
- Nano-LPMW

Product Description

The Nano-ZL Series are long range, piezo z-axis nanopositioners specifically designed to hold multiwell plates used in biomedical research. High-throughput single cell fluorescence microscopy and high speed, high resolution confocal imaging can be accomplished while simultaneously adjusting the Z-axis position to remove the effects of multiwell plate irregularities. The Nano-ZL Series has true flexure guided motion and contains internal position sensing. Utilizing proprietary PicoQ® technology, the position sensors provide absolute, repeatable position measurement for closed loop control with a resolution of better than 1 nm over the full 500 micron travel range and sub-nanometer for the shorter 100 micron travel range. In addition to high resolution spatial imaging, the Nano-ZL step response allows entire Z-section acquisitions with minimal photo bleaching.

Technical Specifications

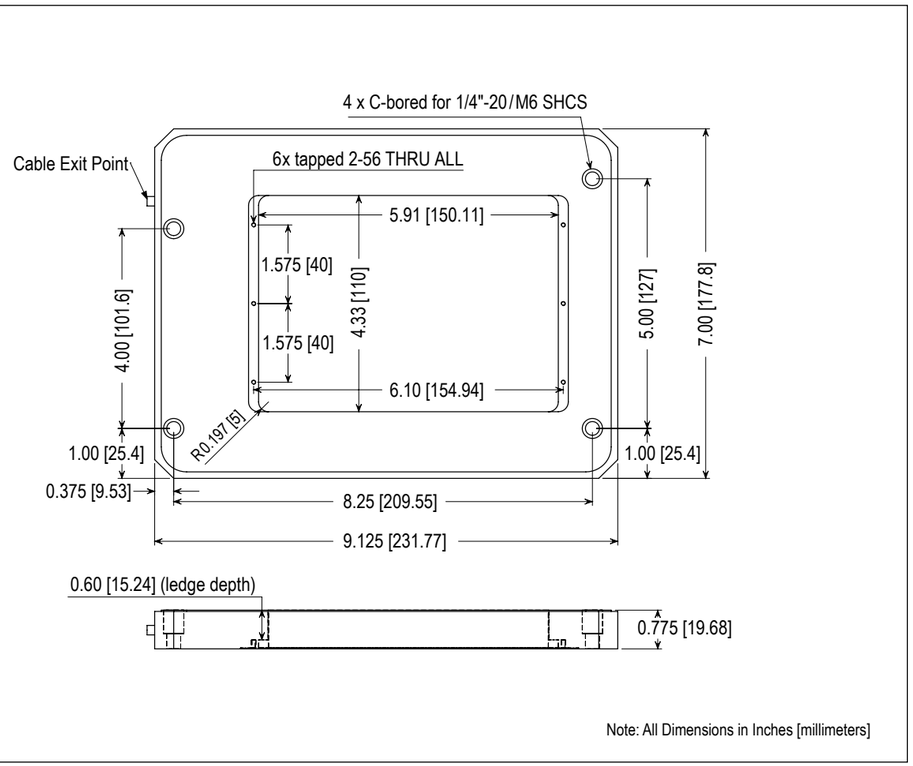
Range of motion (ZL100)	100 µm
Resolution	0.2 nm
Range of motion (ZL500)	500 µm
Resolution	1 nm
Resonant Frequency	200 Hz
Recommended max. load (horizontal)*	0.5 kg
Body Material	Aluminum
Controller	Nano-Drive®
75mm slide sample holder	AC-ZLS
35mm Petri dish holder	AC-ZLP

* Larger load requirements should be discussed with our engineering staff.

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph®, NIS-Elements, Image-Pro® PLUS, SlideBook 6, µManager Open Source Microscopy Software



Note: All Dimensions in Inches [millimeters]

Z-Axis Piezo Nanopositioners

Features

- *Compatible with many microscope stages*
- *Fully removeable from microscope*
- *Low profile designs*
- *Compatible with slides, petri dishes, multi-well plates and selected incubators*
- *Analog or digital USB control*
- *3rd party software compatible*
- *Sample holders available*

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW · MetaMorph · NIS-Elements · Image-Pro Plus · SlideBook 6 · µManager (Open Source Microscopy Software)

Advantages

- *Smooth, continuous z-axis motion*
- *Repeatable motion with nanometer precision*
- *Closed loop flexure guided motion*
- *Moves the sample, not the objective lens*
- *High resolution and stability*

Typical Applications

- *Super resolution microscopy*
- *High content imaging*
- *Confocal Microscopy*

Sample holders for 35mm petri dishes and 75mm slides

Model Name \ Features	Travel range (µm)	75mm slides	35mm petri	multi-well plates	incubator compatibility	Stage compatibility
Nano-Z100	100	●	●		●	Mad City Labs MicroStages
Nano-Z200	200	●	●		●	Mad City Labs MicroStages
Nano-ZL100	100	●	●	●	●	Mad City Labs MicroStages
Nano-ZL500	500	●	●	●	●	Mad City Labs MicroStages
Nano-Z100-PS	100	●	●		●	Prior Scientific H107/H117/HLD117
Nano-Z200-PS	200	●	●		●	Prior Scientific H107/H117/HLD117
PSZ200-S*	200	●	●	●	●	Prior Scientific H117/HLD117
PSZ400-S*	400	●	●	●	●	Prior Scientific H117/HLD117
PSZ200-U*	200	●				Prior Scientific H101F
Nano-Z200-OSSU†	200	●	●	●	●	Olympus IX3-SSU/SVR/SVL
Nano-ZL100-OSSU†	100	●	●	●	●	Olympus IX3-SSU/SVR/SVL
Nano-ZL400-OSSU†	400	●	●	●	●	Olympus IX3-SSU/SVR/SVL
Nano-Z100-N2	100	●	●	●	●	Available exclusively through Nikon Instruments
Nano-Z200-N2	200	●	●	●	●	
Nano-Z500-N2	500	●	●	●	●	
Nano-Z100-M	100	●	●		●	Marzhauser Scan IM
Nano-Z200-M	200	●	●		●	Marzhauser Scan IM
Nano-ZL300-M	300	●	●	●	●	Marzhauser Scan IM
PSZ100-ZM*	100	●	●	●	●	Marzhauser Scan IM
Nano-Z100-LA	100	●	●		●	Ludl BioPrecision, ASI MS2000
Nano-Z200-LA	200	●	●		●	Ludl BioPrecision, ASI MS2000

* Models previously sold by Prior Scientific

† Models also available from Olympus

Z-axis piezo nanopositioners can be custom modified.
Please call or email for more information on custom modifications.

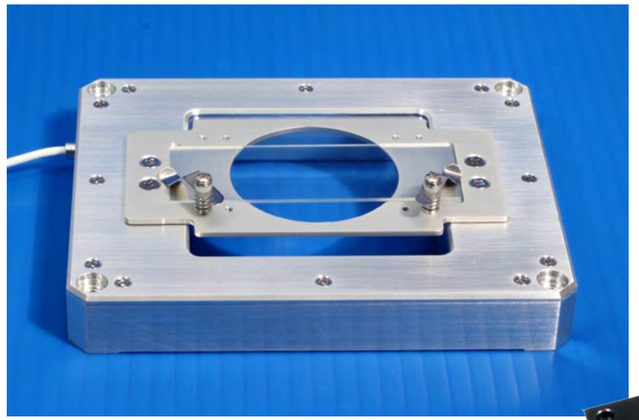
Nano-Z50HS

Features

- *High speed Z-axis motion*
- *Low profile: 0.77"*
- *Integrated sample holder*
- *50 µm motion*
- *Closed loop control*
- *PicoQ sensor technology*

Typical Applications

- *Optical microscopy*
- *High speed confocal imaging*
- *Up to 150Hz sinewave motion*



Nano-Z50HS-T cwith integrated top mounted 3 inch slide holder.

Related products
- Nano-Z Series
- Nano-ZL Series
- Nano-LPQ

Nano-Z50HS-B with bottom mounted 3 inch slide holder.

Product Description

The Nano-Z50HS is a single axis (Z-axis) piezo nanopositioning system designed to move a microscopy sample up to 50 microns at the fastest possible positioning speeds. The Nano-Z50HS is a sister product to the 3-axis, high speed, Nano-LPQ piezo nanopositioning system. The compact size allows the Nano-Z50HS to easily retrofit onto existing microscopes or fit into custom experimental setups. Since the only moving part is the integated sample holder, moving mass is minimized to ensure high speed performance. Two models are available: top mounted samples or bottom mounted samples. The model and type of sample media must be specified at time of order. Custom sample holders can also be quoted. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with picometer resolution under closed loop control.

Technical Specifications

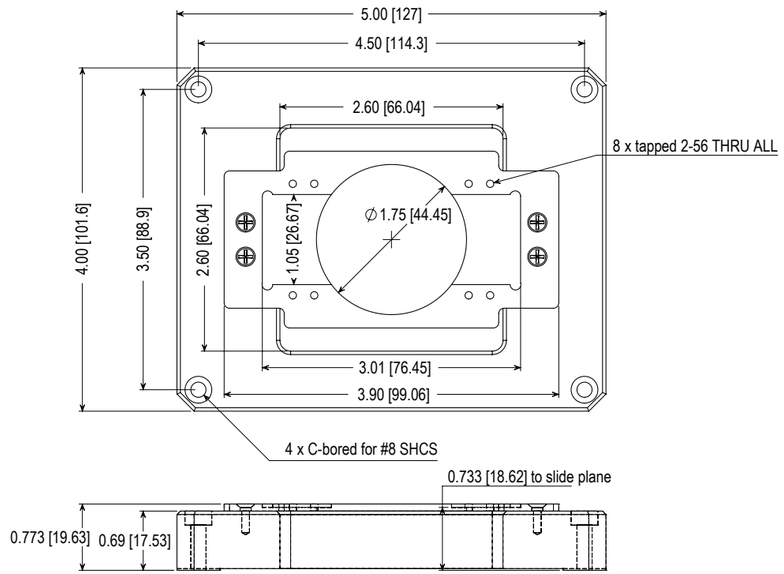
Range of motion	50 µm
Resolution	0.1 nm
Resonant Frequency	830 Hz ±20%
Stiffness	1.0 N/µm
Recommended max. load (horizontal)*	200 g
Body Material	Aluminum
Controller	Nano-Drive®45
Models	Nano-Z50HS-T
	Nano-Z50HS-B

* Larger load requirements should be discussed with our engineering staff.

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph, NIS-Elements, Image-Pro Plus, SlideBook 6, µManager Open Source Microscopy Software



Note: All Dimensions in Inches [millimeters]

Nano-ZS Series

Features

- *Engineered to retrofit to most microscopes*
- *Low profile: 0.8"*
- *Large aperture: 2.6" x 2.6"*
- *Long range motion: 100 µm or 200 µm*
- *Closed loop control*
- *pico sensor technology*

Typical Applications

- *Optical microscopy*
- *High speed confocal imaging*
- *High speed auto focus*
- *Super resolution microscopy*

Related products

- Nano-Z Series
- Nano-ZL Series
- Nano-Z50HS

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph®, NIS-Elements, Image-Pro® PLUS, SlideBook 6, µManager Open Source Microscopy Software

Product Description

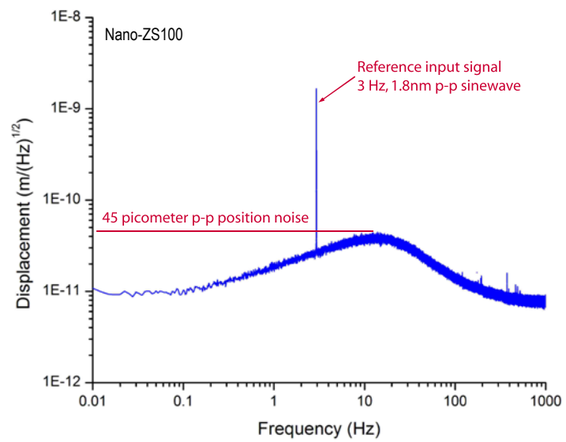
The Nano-ZS Series are z- axis piezo nanopositioning systems with a low profile design, allowing it to be easily retrofit into existing instrumentation where space is restricted. With a large center aperture, the Nano-ZS Series is ideal for confocal imaging and microscopy applications which require long range travel and fast, repeatable positioning. Combined with the high output power Nano-Drive® controllers, the Nano-ZS Series is ideal for high speed, high precision applications. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with picometer resolution under closed loop control. Nano-ZS Series stage dimensions can be customized to fit into OEM applications.

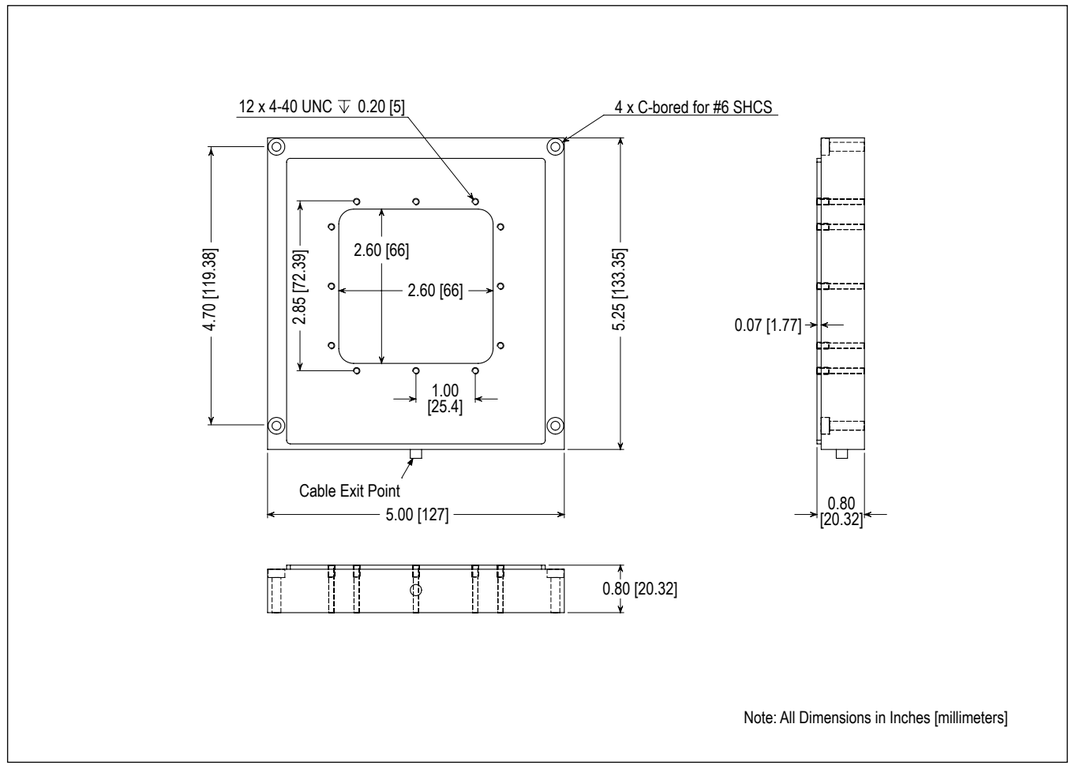
Technical Specifications

Range of motion (Nano-ZS100)	100 µm
Range of motion (Nano-ZS200)	200 µm
Resolution (100/200 µm)	0.2/0.4 nm
Resonant Frequency (100 µm)	450 Hz
Resonant Frequency (200 µm)	250 Hz
Stiffness	1.0 N/µm
Recommended max. load (horizontal)*	0.5 kg
Body Material	Aluminum or invar
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

Low Position Noise





Nano-CZ200

Features

- *Single axis (Z) motion*
- *Long range motion - 200µm*
- *Compact size*
- *Closed loop control*
- *picoQ sensor technology*

Typical Applications

- *Precision optical alignment and mirror positioning*
- *High resolution probe positioning*
- *Metrology*

Nano-CZ200 constructed from aluminum.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products

- Nano-CZ500

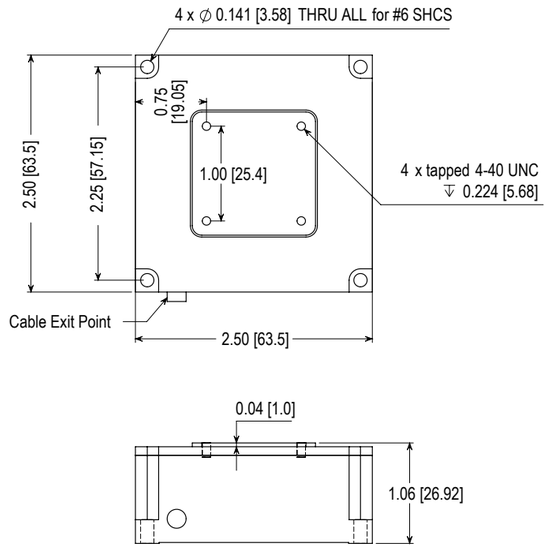
Product Description

The Nano-CZ200 is a compact, long range, single axis (Z-axis) precision nanopositioning system. Our piezo flexure guided stage with internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with sub-nanometer resolution under closed loop control.
The Nano-CZ200 can be operated in any orientation and is ideally suited for precision alignment of optical elements or other components with limited size and weight.

Technical Specifications

Range of motion (Z) ..... 200 µm
Resolution ..... 0.4 nm
Resonant Frequency ..... 700 Hz ±20%
Stiffness ..... 1.0 N/µm
Recommended max. load (horizontal)* ..... 0.5 kg
Recommended max. load (vertical)* ..... 0.1 kg
Body Material ..... Aluminum
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Note: All Dimensions in Inches [millimeters]

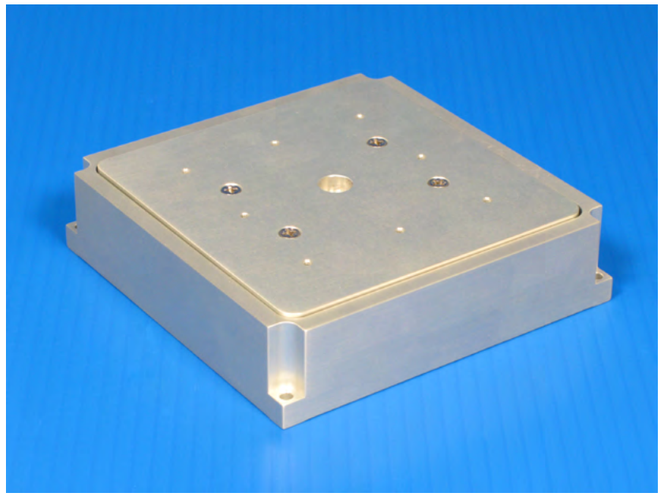
Nano-CZ500

Features

- *Single axis (Z) motion*
- *Long range motion - 500µm*
- *Compact size*
- *Closed loop control*
- *PicoQ® sensor technology*

Typical Applications

- *Precision optical alignment and mirror positioning*
- *High resolution probe positioning*
- *Metrology*



Nano-CZ500 constructed from aluminum.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products
- Nano-CZ200

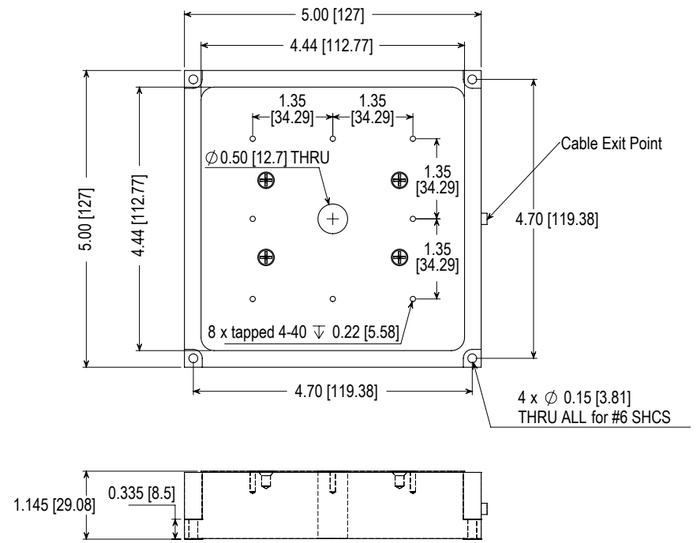
Product Description

The Nano-CZ500 is a compact, long range, single axis (Z-axis) precision nanopositioning system. The piezo flexure guided design combined with proprietary PicoQ® sensor technology provide absolute, repeatable position measurement with nanometer resolution under closed loop control. A center aperture (up to 1.25" diameter) may be requested as a custom modification to provide an optical pathway through the stage. The Nano-CZ500 can be operated in any orientation and is well suited for static alignment and moderate speed, long range scanning applications.

Technical Specifications

Range of motion (Z) ..... 500 µm
Resolution ..... 1.0 nm
Resonant Frequency ..... 140 Hz ±20%
Stiffness ..... 1.0 N/µm
Recommended max. load (horizontal)* ..... 0.5 kg
Recommended max. load (vertical)* ..... 0.1 kg
Body Material ..... Aluminum
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Note: All Dimensions in Inches [millimeters]

Nano-METZ

Features

- *Ultra-fast response*
- *Femtometer noise floor*
- *High stability*
- *Closed loop control*
- *Compact size*
- *Picometer positioning resolution*
- *PicoQ® sensor technology*

Typical Applications

- *High speed, high resolution positioning*
- *Extreme Metrology*
- *AFM*
- *SPM*
- *Picometer positioning*

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products

- Nano-MET10/20
- Nano-MET2
- Nano-MET3

Product Description

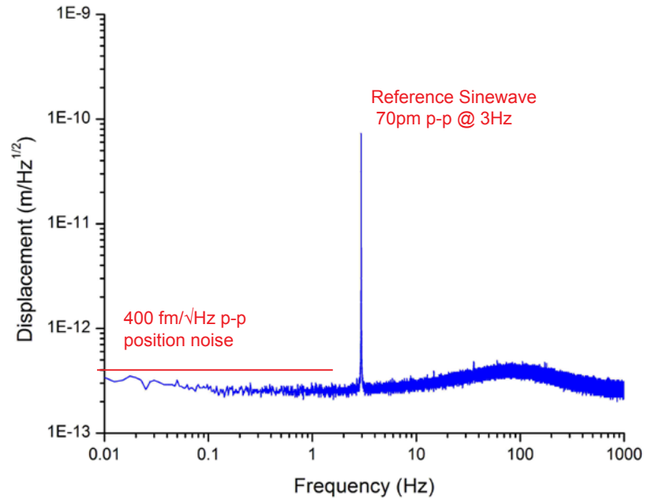
The Nano-METZ is a compact z-axis piezo nanopositioning system designed for high speed scanning and ultra-low noise characteristics for demanding AFM and metrology applications. The innovative design of the Nano-METZ coupled with our proprietary PicoQ® sensor technology yields a resonant frequency of 14.5kHz and a noise floor of 400 femtometers/√Hz. The result: unparalled speed, response and precision for the most demanding and extreme metrology applications. Related products include the Nano-MET2, Nano-MET3, Nano-MET10 and Nano-MET20 nanopositioning systems.

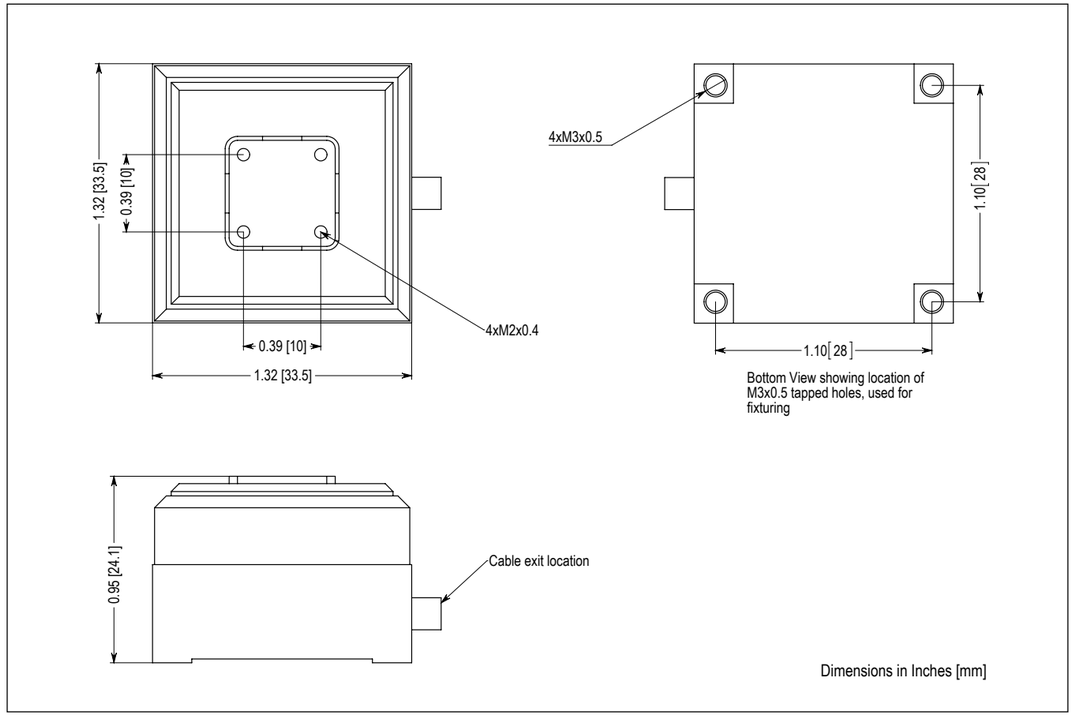
Technical Specifications

Range of motion	5 µm
Resolution	0.005 nm
Resonant Frequency	14.5 kHz
Recommended max. load (horizontal)*	0.1 kg
Recommended max. load (vertical)*	0.1 kg
Body Material	Al or Titanium
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

Ultra-Low Position Noise





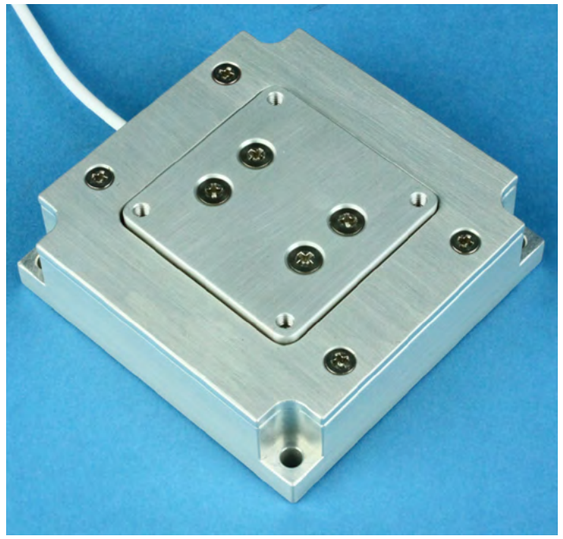
Nano-MZ

Features

- *Compact design*
- *Low profile: 0.76" [19.4mm]*
- *Closed loop control*
- *Custom travel ranges available*
- *picoQ® sensor technology*

Typical Applications

- *High resolution Z-axis alignment*
- *AFM*
- *Metrology*



LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products

- Nano-M3Z
- Nano-M250
- Nano-M350

Product Description

The Nano-MZ is a compact Z-axis piezo nanopositioning system designed to be easily integrated into existing instrumentation where space is restricted. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with picometer accuracy under closed loop control. The Nano-MZ has the same footprint as other models within the Nano-M Series - see the Nano-M350 and the Nano-Man5.

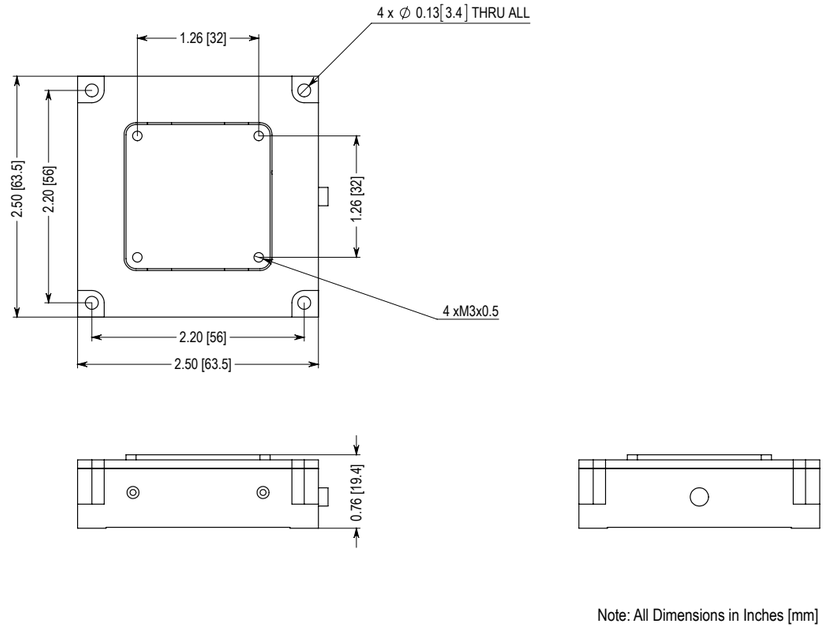
A related model, the Nano-M3Z, includes additional "tip" and "tilt" motions (θ_X ,θ_Y) to the linear motion in the Z-axis.

The Nano-MZ can be customized for longer ranges of motion (up to 100 microns) and a center aperture (up to 0.25" diameter) can also be incorporated for transmission of light.

Technical Specifications

Range of motion (Z) ..... 25 µm
Resolution ..... 0.05 nm
Resonant Frequency ..... 1180 Hz ±20%
Stiffness ..... 1.0 N/µm
Recommended max. load (horizontal)* ..... 0.5 kg
Body Material ..... Aluminum
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Note: All Dimensions in Inches [mm]

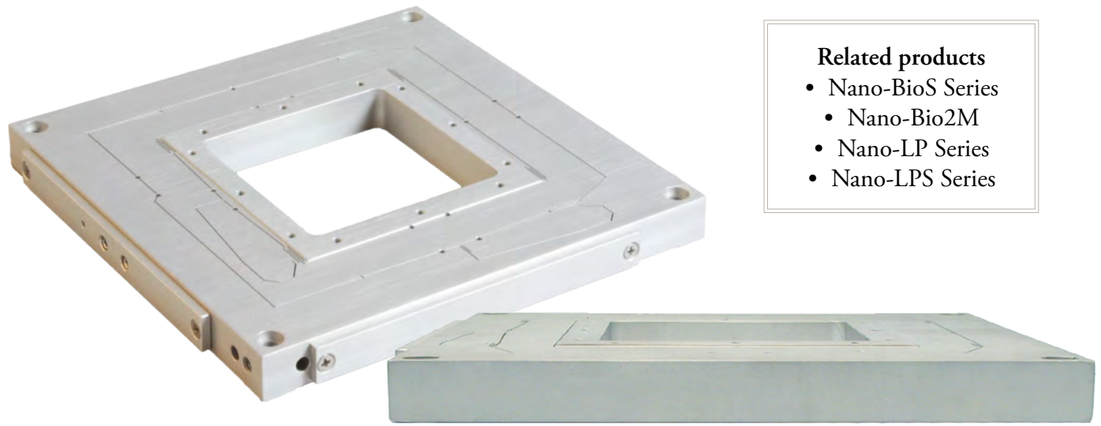
Nano-Bio Series

Features

- *Lowest profile 2-axis nanopositioner available*
- *Large aperture*
- *100 µm, 200 µm, or 300 µm ranges of motion*
- *pico sensor technology*
- *Closed loop control, high stability*

Typical Applications

- *Optical microscopy, easy to retrofit*
- *Fluorescence imaging*
- *Closed-loop AFM scanner*
- *Nanolithography*
- *Optical tweezers*
- *Super resolution microscopy*



Low profile (0.6") of the Nano-Bio200.

Related products
- Nano-BioS Series
- Nano-Bio2M
- Nano-LP Series
- Nano-LPS Series

Product Description

The Nano-Bio Series are ultra low profile, two axis piezo nanopositioning systems. The low profile design allows the Nano-Bio Series to be easily integrated into existing inverted microscopes, AFM's and other instrumentation where space is limited. The large center aperture allows the Nano-Bio to accommodate the lenses of all major microscope manufacturers. The Nano-Bio Series includes internal position sensors with proprietary PicoQ® technology to provide absolute, repeatable position measurement and picometer accuracy under closed loop feedback control. The Nano-Bio100, Nano-Bio200, and Nano-Bio300 are constructed from aluminum and are ideal for optical microscopy. A related product, the Nano-Bio2M has increased thermal stability, reduced overall size, and is an easily implemented closed-loop scanner upgrade for commercial AFM instruments.

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

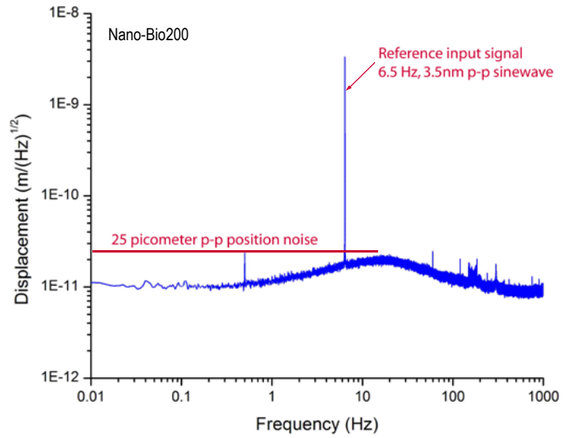
LabVIEW, MetaMorph, NIS-Elements, Image-Pro Plus, SlideBook 6, µManager

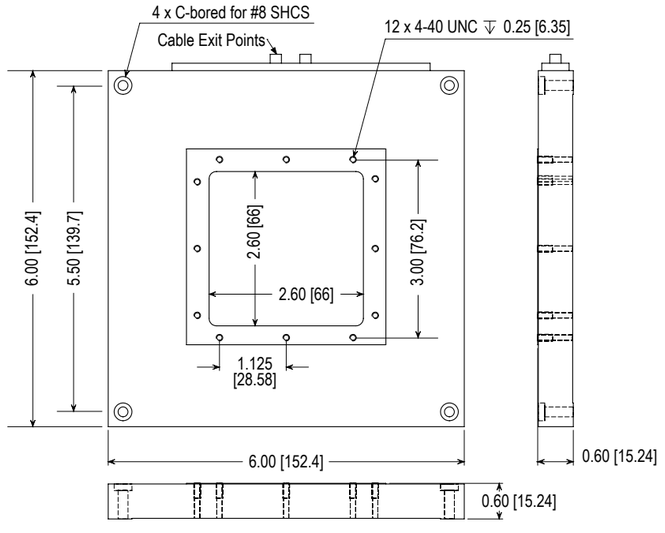
Technical Specifications

Range of motion (Nano-Bio100)..... 100 µm x 100 µm
Range of motion (Nano-Bio200)..... 200 µm x 200 µm
Range of motion (Nano-Bio300)..... 300 µm x 300 µm
Resolution (100/200/300 µm) ..... 0.2/0.4/0.6 nm
Resonant Frequencies
X axis (100/200/300 µm).....300/300/260 Hz ±20%
Y axis (100/200/300 µm).....250/170/170 Hz ±20%
Stiffness.....1.0 N/µm
θ_{roll} , θ_{pitch}(typical) ..... ≤1 µrad
θ_{yaw} (typical) ..... ≤3 µrad
Recommended max. load (horizontal)* .....0.5 kg
Recommended max. load (vertical)*.....0.2 kg
Body Material** .....Al, Invar or Titanium
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.
** Material is aluminum for Nano-Bio300.

Low Position Noise





Note: All Dimensions in Inches [millimeters]

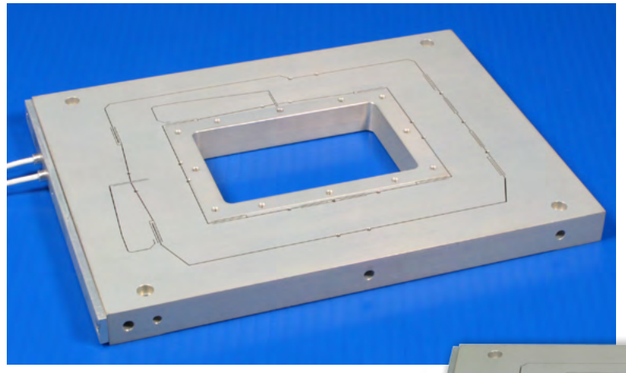
Nano-BioS Series

Features

- *Lowest profile 2-axis nanopositioner available*
- *Large rectangular aperture for slides*
- *100 µm, 200 µm, or 300 µm ranges of motion*
- *PicoQ sensor technology*
- *Closed loop control, high stability*
- *Aperture sized for 3"/75mm slides*

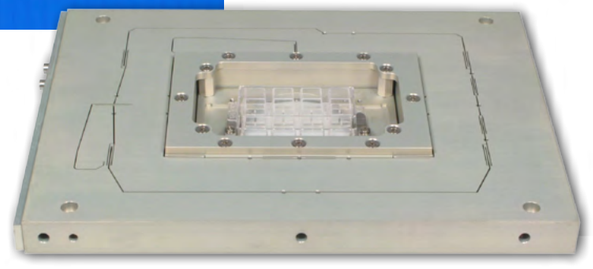
Typical Applications

- *Optical microscopy, easy to retrofit*
- *Fluorescence imaging*
- *Closed-loop AFM scanner*
- *Nanolithography*
- *Optical tweezers*
- *Super resolution microscopy*



Re-entrant petri dish holder.

Re-entrant coverslip holder.



Nano-BioS300 with re-entrant slide holder (shown with Lab-Tek chamber slide).

Product Description

The Nano-BioS Series are ultra low profile, two axis piezo nanopositioning systems designed to be easily integrated into existing inverted microscopes, AFM's and other instrumentation where space is limited. The large, rectangular center aperture allows the Nano-BioS to hold re-entrant sample holders for standard 3"/75mm slides and other similar sized biological samples such as Lab-Tek chamber slides. The Nano-BioS Series stages include internal position sensors with proprietary PicoQ® technology to provide absolute, repeatable position measurement and picometer resolution under closed loop feedback control. The noise performance is similar to the Nano-Bio Series. The Nano-BioS stages are constructed from anodized aluminum and are offered in three ranges of motion: 100µm, 200µm, and 300µm. If motion in all three axes is needed, the Nano-LPS Series is a similar sized microscopy stage which is also able to move in the Z-axis for focusing operations.

Technical Specifications

Range of motion (Nano-BioS100)..... 100 µm x 100 µm
Range of motion (Nano-BioS200)..... 200 µm x 200 µm
Range of motion (Nano-BioS300)..... 300 µm x 300 µm
Resolution (100/200/300 µm) ..... 0.2/0.4/0.6 nm
Resonant Frequencies
X axis (100/200/300 µm).....365/305/270 Hz ±20%
Y axis (100/200/300 µm) .....220/185/165 Hz ±20%
Stiffness.....1.0 N/µm
θ_{roll} , θ_{pitch}(typical) ..... ≤1 µrad
θ_{yaw} (typical) ..... ≤3 µrad
Recommended max. load (horizontal)* .....0.5 kg
Recommended max. load (vertical)*.....0.2 kg
Body Material** .....Al, Invar or Titanium
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.
** Material is aluminum for Nano-BioS300.

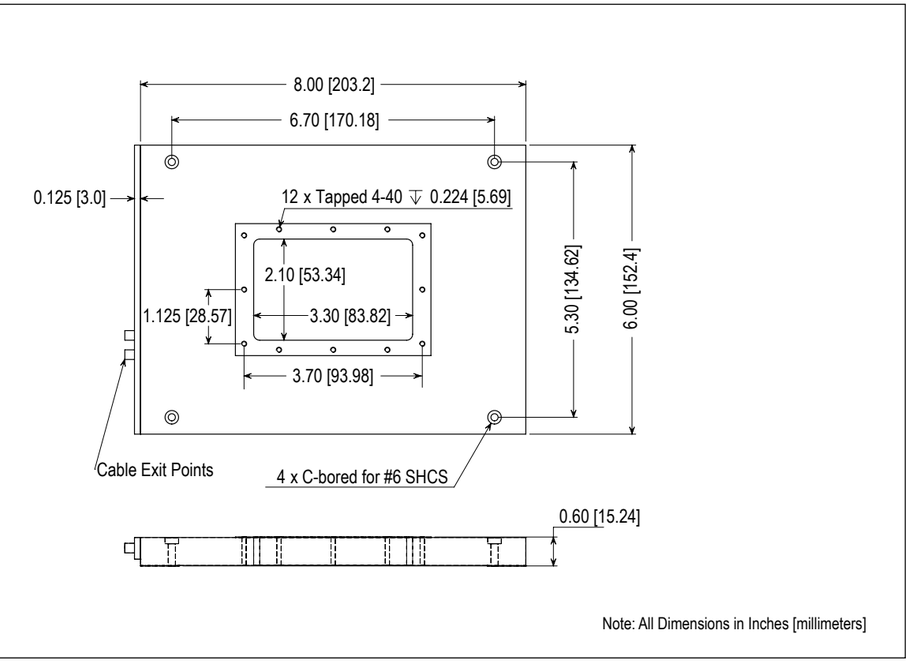
Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph, NIS-Elements, Image-Pro Plus, SlideBook 6, µManager

Related products

- Nano-Bio Series
- Nano-Bio2M
- Nano-LP Series
- Nano-LPS Series



Nano-Bio2M

Features

- *Lowest profile 2-axis nanopositioner available*
- *Large aperture*
- *50 µm range of motion*
- *pico sensor technology*
- *Closed loop control, high stability*

Typical Applications

- *Optical microscopy, easy to retrofit*
- *Fluorescence imaging*
- *Closed-loop AFM scanner*
- *Nanolithography*
- *Optical tweezers*
- *Super resolution microscopy*

Nano-Bio2M constructed from invar

Related products

- Nano-Bio Series
- Nano-BioS Series
- Nano-LP Series
- Nano-LPS Series

Product Description

The Nano-Bio2M is an ultra low profile, two axis piezo nanopositioning system designed for integration in to commercial AFM instruments. The low profile design and use of low thermal expansion materials makes it the ideal choice for applications where thermal stability is key and space is limited. The large center aperture allows the Nano-Bio2M to accommodate the lenses of all major microscope manufacturers. The Nano-Bio2M includes proprietary PicoQ® position sensors to provide absolute, repeatable position measurement and picometer accuracy under closed loop feedback control. For more information on the low noise performance please see the related product, Nano-Bio Series. The Nano-Bio2M may be customized for vacuum applications and custom travel ranges.

Technical Specifications

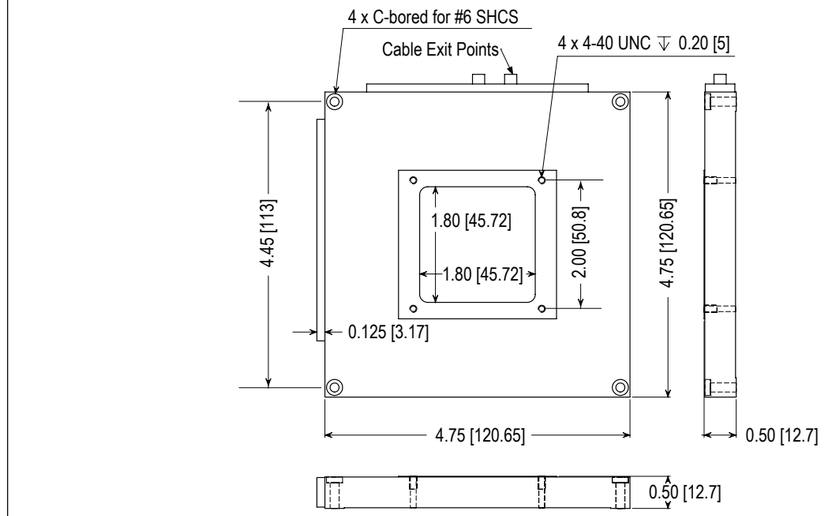
Range of motion ..... 50 µm x 50 µm
Resolution ..... 0.1 nm
Resonant Frequencies
X axis ..... 500 Hz ±20%
Y axis ..... 400 Hz ±20%
Stiffness ..... 1.0 N/µm
θ_{roll} , θ_{pitch} (typical) ..... ≤1 µrad
θ_{yaw} (typical) ..... ≤3 µrad
Recommended max. load (horizontal)* ..... 0.5 kg
Recommended max. load (vertical)* ..... 0.2 kg
Body Material* ..... Invar or Titanium
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph, NIS-Elements, Image-Pro Plus, SlideBook 6, µManager



Note: All Dimensions in Inches [millimeters]

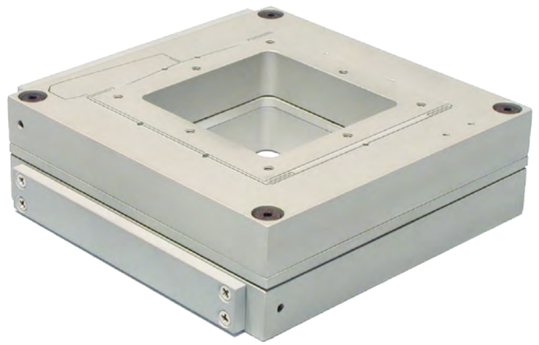
Nano-H Series

Features

- *Aperture for microscopy: 2" x 2"*
- *Two axis piezo motion*
- *100 µm or 50 µm ranges of motion*
- *Compact size*
- *Economical*
- *PicoQ® sensor technology*
- *Closed loop control*

Typical Applications

- *Optical microscopy*
- *AFM*
- *Fluorescence imaging*
- *Optical trapping*



Related products

- Nano-T Series
- Nano-Max50
- Nano-PDQ Series
- Nano-Bio Series
- Nano-BioS Series

Product Description

The Nano-H Series is a compact, XY piezo nanopositioning system which provides excellent positioning performance at an economical price. The large center aperture makes the Nano-H Series ideal for applications requiring transmitted beams, or the mounting of bulky components such as multiple fibers, optics, and metrology probes. Internal PicoQ® position sensors provide absolute, repeatable position measurement and picometer resolution when operated with the Nano-Drive® controller. The Nano-H Series is available in custom ranges of motion and can be constructed from aluminum, invar or titanium.

Compatible Software Packages

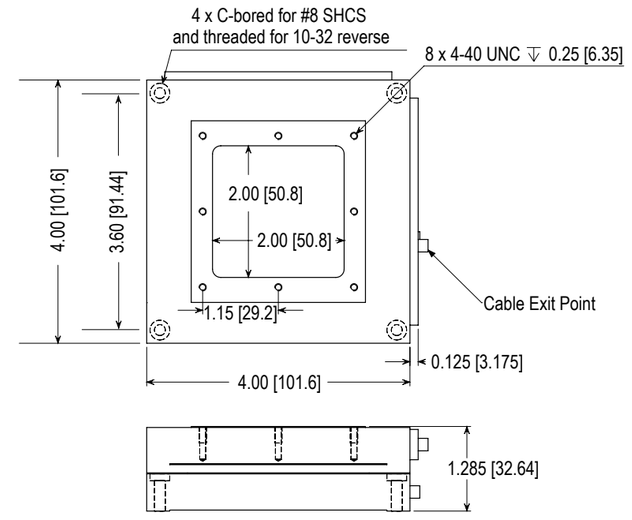
Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW · MetaMorph · NIS-Elements · Image-Pro Plus · SlideBook 6 · µManager

Technical Specifications

Range of motion (Nano-H50)..... 50 µm x 50 µm
Range of motion (Nano-H100)..... 100 µm x 100 µm
Resolution (Nano-H50) ..... 0.1 nm
Resolution (Nano-H100) ..... 0.2 nm
Resonant Frequency (X) ..... 560/400 Hz ±20%
Resonant Frequency (Y) ..... 195/225 Hz ±20%
Stiffness ..... 1.0 N/µm
θ_{roll} , θ_{pitch} (typical) ..... ≤1 µrad
θ_{yaw} (typical) ..... ≤3 µrad
Recommended max. load (horizontal)* ..... 0.5 kg
Recommended max. load (vertical)* ..... 0.2 kg
Body Material ..... Al, Invar or Titanium
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Note: All Dimensions in Inches [millimeters]

Nano-Max50

Features

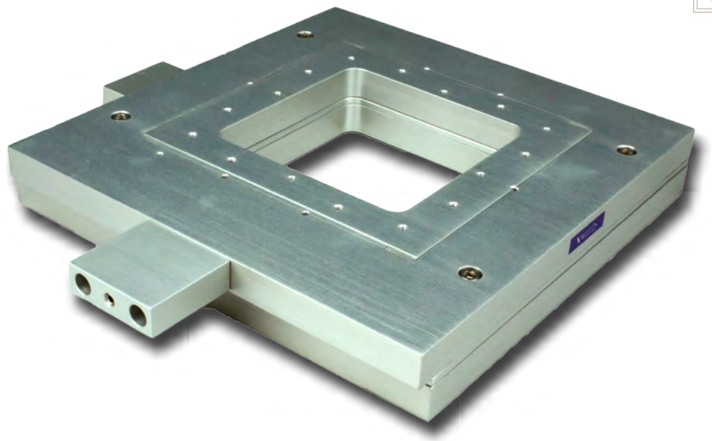
- *Large load capacity*
- *Two axis piezo motion*
- *50 µm x 50 µm ranges of motion*
- *Extra large aperture*
- *Closed loop control*
- *pico sensor technology*

Typical Applications

- *Precision cryostat positioning*
- *Low temperature optical microscopy*
- *Quantum dot research*
- *High load positioning*

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.



Nano-Max50 (2-axis) constructed from aluminum.

Product Description

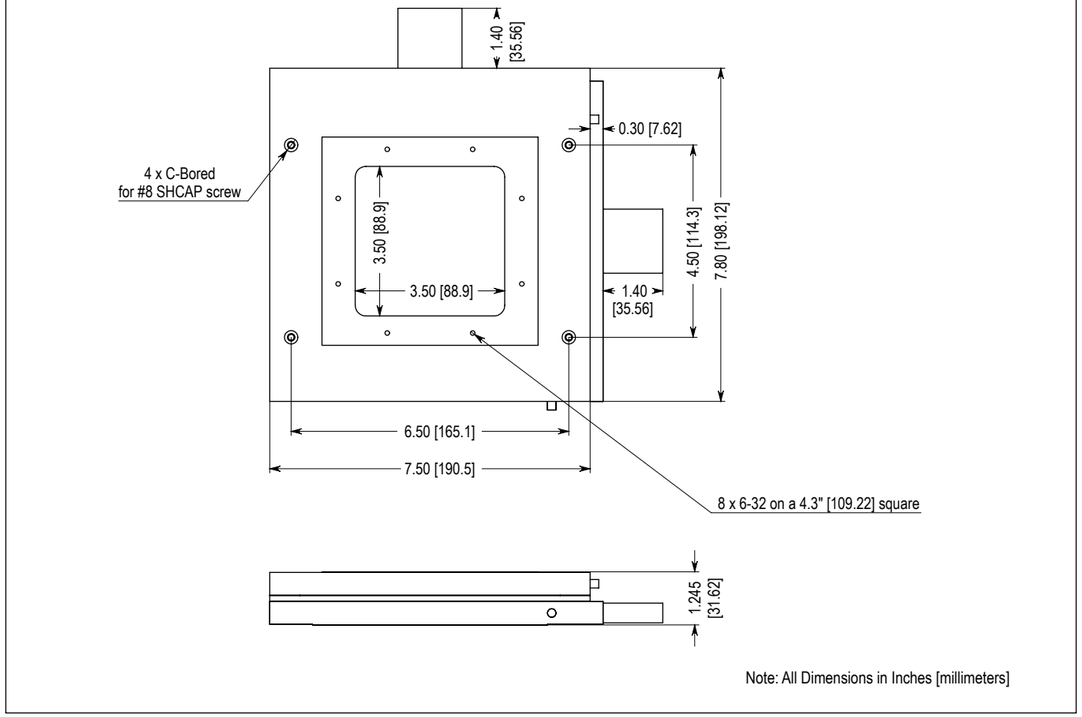
The Nano-Max50 is a heavy duty, two axis piezo nanopositioning stage designed to carry heavy experimental assemblies. With a load capacity of 5 kg, the Nano-Max50 to be used in applications such as precision positioning of cryostats for low temperature optical microscopy. The low profile and extra large aperture allows the Nano-Max50 to be integrated into existing optical microscopes. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with picometer accuracy under closed loop control. Special Nano-Max systems can be built with ranges of motion that exceed the standard 50 microns.

Technical Specifications

Range of motion (X)	50 µm
Range of motion (Y)	50 µm
Resolution	0.1 nm
Resonant Frequency (X)	860 Hz ±20%
Resonant Frequency (Y)	465 Hz ±20%
Stiffness	4.0 N/µm
θ_{roll} , θ_{pitch} (typical)	≤1 µrad
θ_{yaw} (typical)	≤3 µrad
Recommended max. load (horizontal)*	5 kg
Body Material	Al
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

Related products
- Nano-H Series
- Nano-T Series
- Nano-PDQ Series
- Nano-HL



Nano-HS2

Features

- *High speed, two-axis*
- *Closed loop control*
- *Picometer positioning resolution*
- *High stability*
- *picoQ® sensor technology*

Typical Applications

- *High speed, high resolution positioning*
- *Metrology*
- *AFM*
- *SPM*

Related products
- Nano-HS3M
- Nano-M250
- Nano-M350
- SPM-M kit

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Product Description

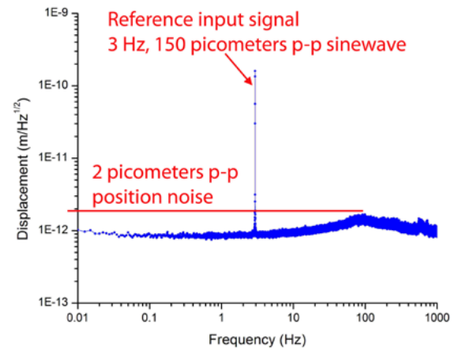
The Nano-HS2 is a high speed, XY piezo nanopositioning system with picometer positioning resolution. Offering maximum versatility, the Nano-HS can be configured to provide XY or XYZ motion. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement under closed loop control. The compact footprint, ultra-low noise characteristics, and a Z-axis resonant frequency of 5kHz make it ideal for metrology applications that require noise floors less than 10 picometers and/or high speed performance.
The Nano-HS series are compatible with the MadPLL® phase lock loop controller and Mad City Labs SPM instruments.

Technical Specifications

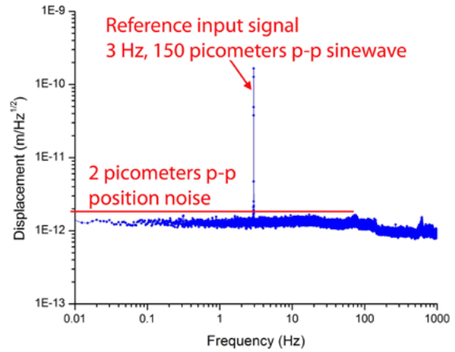
Range of motion (XY)	10 µm
Resolution	0.01 nm
Resonant Frequency (X)	2.1 kHz±20%
Resonant Frequency (Y)	1.9 kHz ±20%
Scanning Speed	up to 300 Hz
Stiffness (Z-axis)	8 N/µm
Recommended max. load (horizontal)*	0.1 kg
Recommended max. load (vertical)*	0.1 kg
Body Material	Al, Invar or Titanium
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

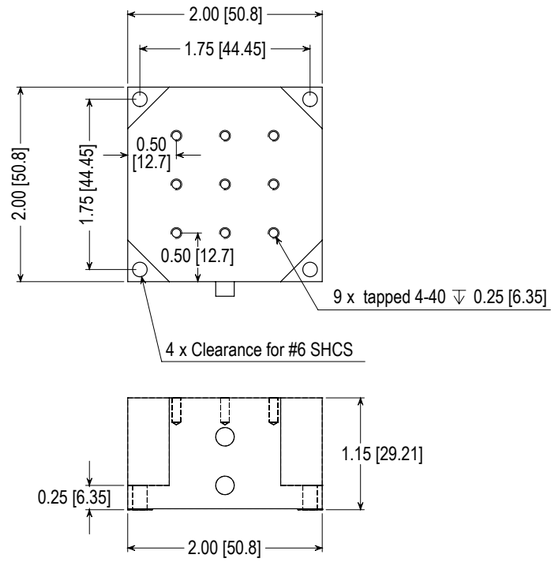
Low Position Noise



X Axis



Y Axis



Note: All Dimensions in Inches [mm]

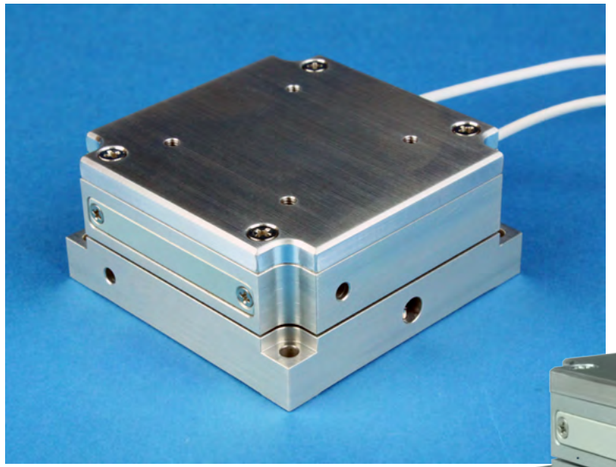
Nano-M250

Features

- *Compact size*
- *Two axis motion*
- *50 µm x 50 µm ranges of motion*
- *Closed loop control*
- *PicoQ® sensor technology*
- *Modular design*

Typical Applications

- *Alignment*
- *Nanolithography*
- *Scanning microscopy*



Product Description

The Nano-M250 is a compact, two axis piezo nanopositioning system constructed from aluminum The small dimensions of the Nano-M250 allow it to be easily integrated into existing instrumentation for applications such as nanolithography and SEM. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with picometer accuracy under closed loop control. The Nano-M250 can be combined with the Nano-MZ to form a 3 axis nanoposiitoning system. The Nano-M250 is also available in high vacuum and ultra high vacuum compatible models. Custom modifications, including range of motion, are available. Contact your local sales office for more information.

Technical Specifications

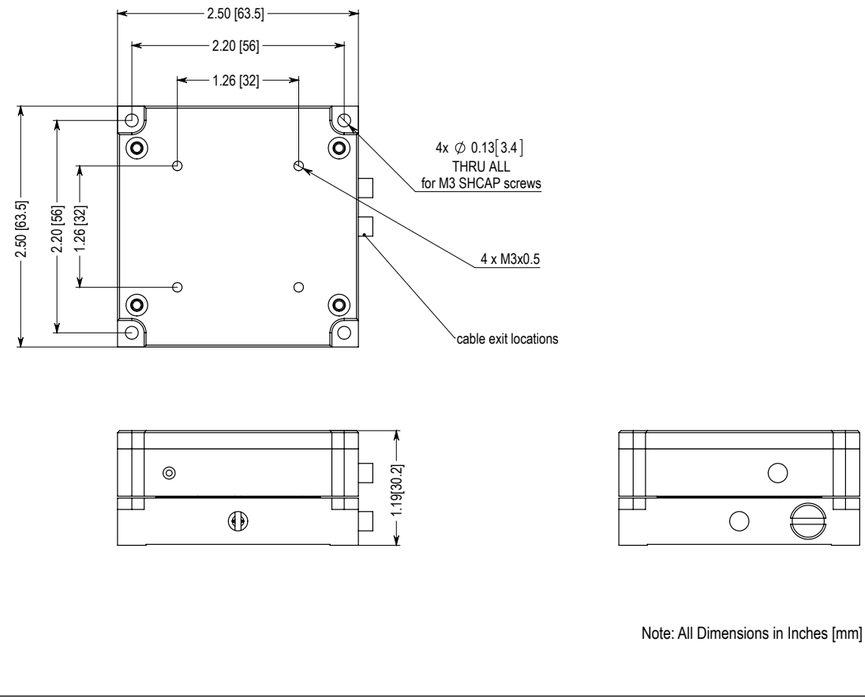
Range of motion (XY)	50 µm x 50 µm
Resolution	0.1 nm
Resonant Frequency (X)	420 Hz ±20%
Resonant Frequency (Y)	400 Hz ±20%
Stiffness	1.0 N/µm
θ_{roll} , θ_{pitch} (typical)	≤1 µrad
θ_{yaw} (typical)	≤3 µrad
Recommended max. load (horizontal)*	0.5 kg
Recommended max. load (vertical)*	0.2 kg
Body Material	Aluminum
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

Related products
- Nano-M3Z
- Nano-MZ
- Nano-M350

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.



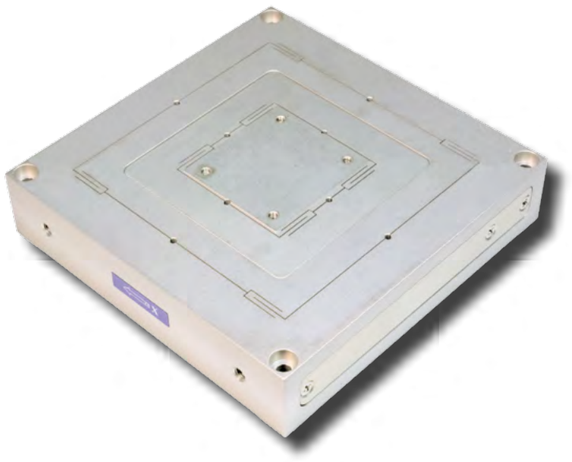
Nano-MET2

Features

- *High speed, multi-axis*
- *2 axis motion (XY)*
- *Closed loop control*
- *Ultra-low noise performance*
- *Picometer positioning resolution*
- *High stability*
- *picoQ® sensor technology*

Typical Applications

- *High speed, high resolution positioning*
- *Extreme Metrology*
- *AFM*
- *SPM*



LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products

- Nano-METZ
- Nano-MET10/20
- Nano-MET3
- SPM-M kit

Product Description

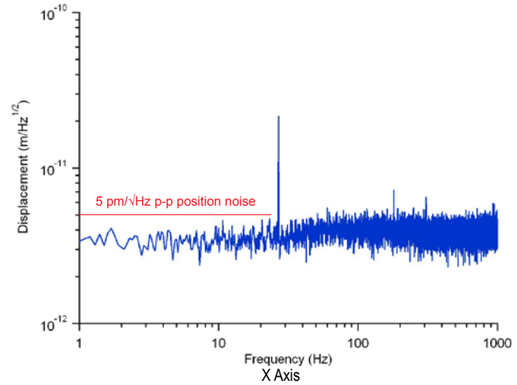
The Nano-MET2 is an ultra-low noise, high precision piezo nanopositioning systems with picometer positioning resolution. True flexure guided motion with internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement under closed loop control. The exceptionally low position noise in XY of this nanopositioning system makes it ideal for extreme metrology applications. Related products include the Nano-MET3, Nano-METZ, Nano-MET10 and Nano-MET20 nanopositioning systems.

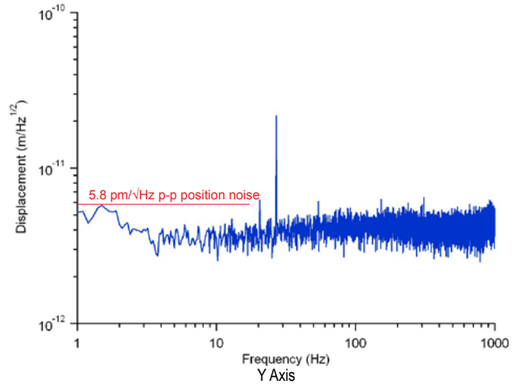
Technical Specifications

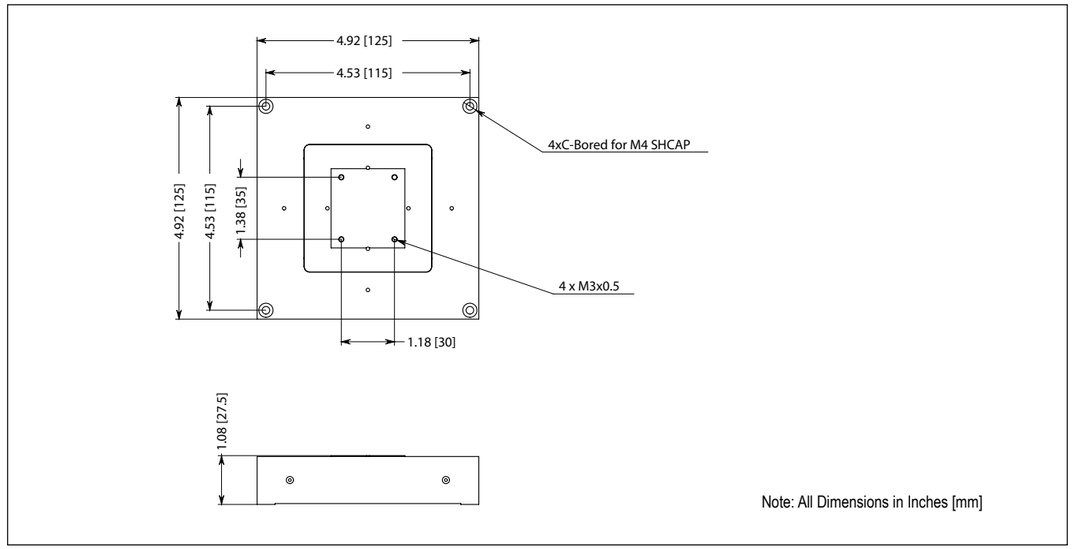
Range of motion (XY)	75 µm
Resolution (XY)	0.15 nm
Resonant Frequency X	1.4 kHz
Resonant Frequency Y	610 Hz
Recommended max. load (horizontal)*	100 g
Recommended max. load (vertical)*	100 g
Body Material	Aluminum
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

Low Position Noise







Nano-SPM200

Features

- *Compact size*
- *200 µm two axis motion (XY)*
- *Closed loop control*
- *True flexure guided motion*
- *Large sample mounting area*
- *picoQ sensor technology*

Typical Applications

- *AFM, NSOM and other types of scanning probe microscopy*
- *XY precision alignment*
- *Nanofabrication*

The Nano-SPM200 incorporated as part of an atomic step resolution AFM. For more information about SPM instruments using Mad Ctiy Labs products see the Scanning Probe Microscope section of our catalog

Product Description

The Nano-SPM200 is a compact XY piezo nanopositioning system constructed from aluminum. The compact design combined with a 200µm × 200µm range of motion makes it ideal for integration into scanning probe microscopy systems. Proprietary PicoQ® sensors combined with the closed loop Nano-Drive® controller provide sub-nanometer positioning resolution and long term stability. Independent flexure guided motion for each axis provides mechanical isolation and ensures minimum cross-talk between axes. Samples can be mounted in any location on the flat top surface and secured with the four threaded mounting holes.

The SPM-M atomic force microscope kit (see Scanning Probe Microscope section of our catalog) incorporates the Nano-SPM200. Atomic force microscopes based on the SPM-M kit have achieved atomic step resolution.

Technical Specifications

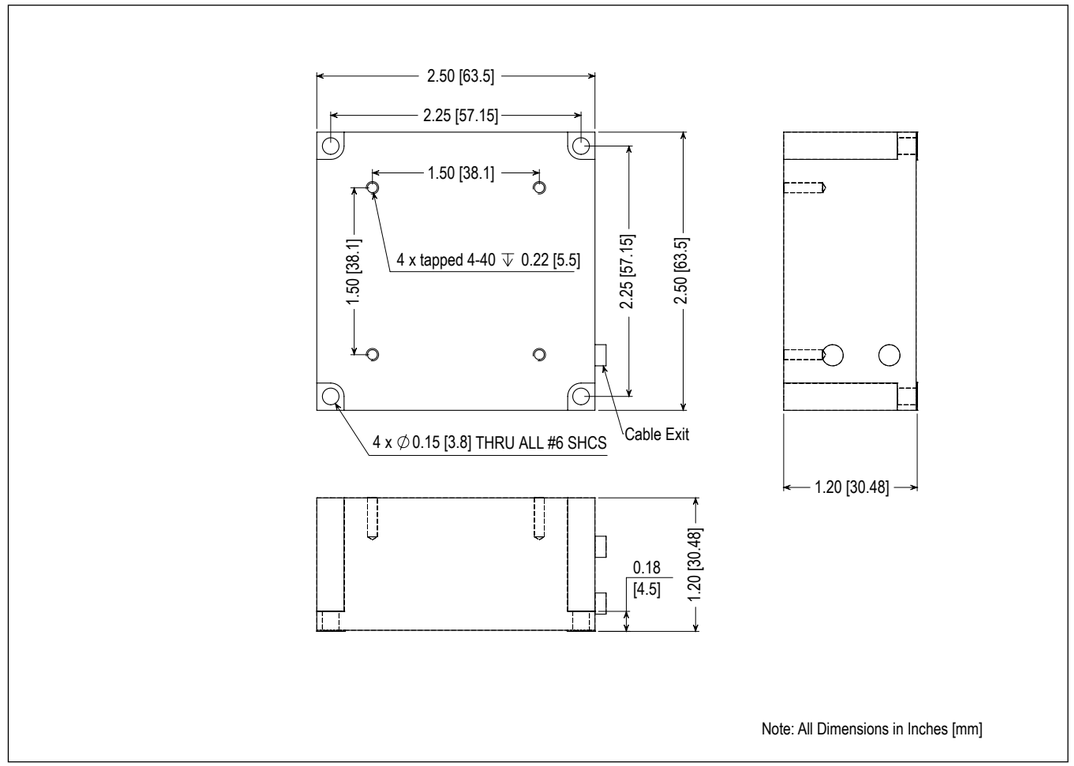
Ranges of motion (XY)	200 µm
Resolution	0.4 nm
Resonant Frequency (X)	300 Hz ±20%
Resonant Frequency (Y)	300 Hz ±20%
Stiffness	1.0 N/µm
Recommended max. load (horizontal)*	0.5 kg
Recommended max. load (vertical)*	0.2 kg
Body Material	Aluminum
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

Related products
- Nano-M250
- Nano-OP Series
- MadPLL®
- SPM-M kit

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.



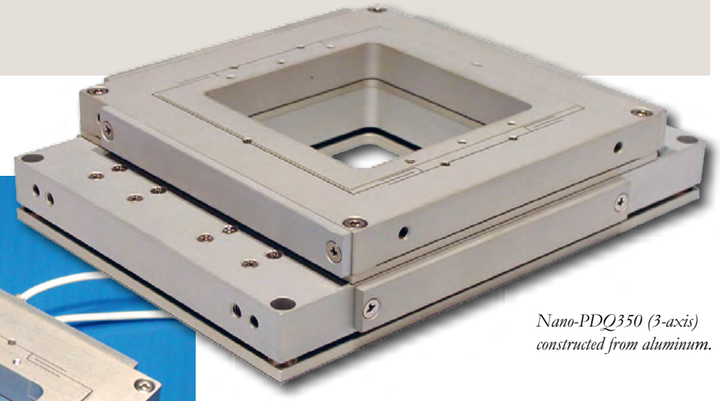
Nano-PDQ Series

Features

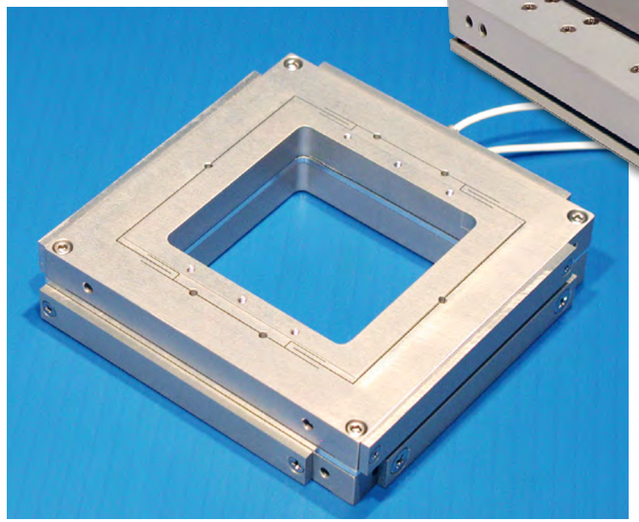
- *High speed, direct drive*
- *Two or three axis motion*
- *50 µm or 75 µm ranges of motion*
- *Large aperture*
- *Large load capacity*
- *pico sensor technology*
- *Closed loop control*

Typical Applications

- *Fast multi-axis scanning*
- *Optical trap calibration*
- *Particle tracking*



Nano-PDQ350 (3-axis) constructed from aluminum.



Nano-PDQ250 (2-axis) constructed from aluminum.

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW · MetaMorph · NIS-Elements · Image-Pro Plus · SlideBook 6 · µManager Open Source Microscopy Software

Product Description

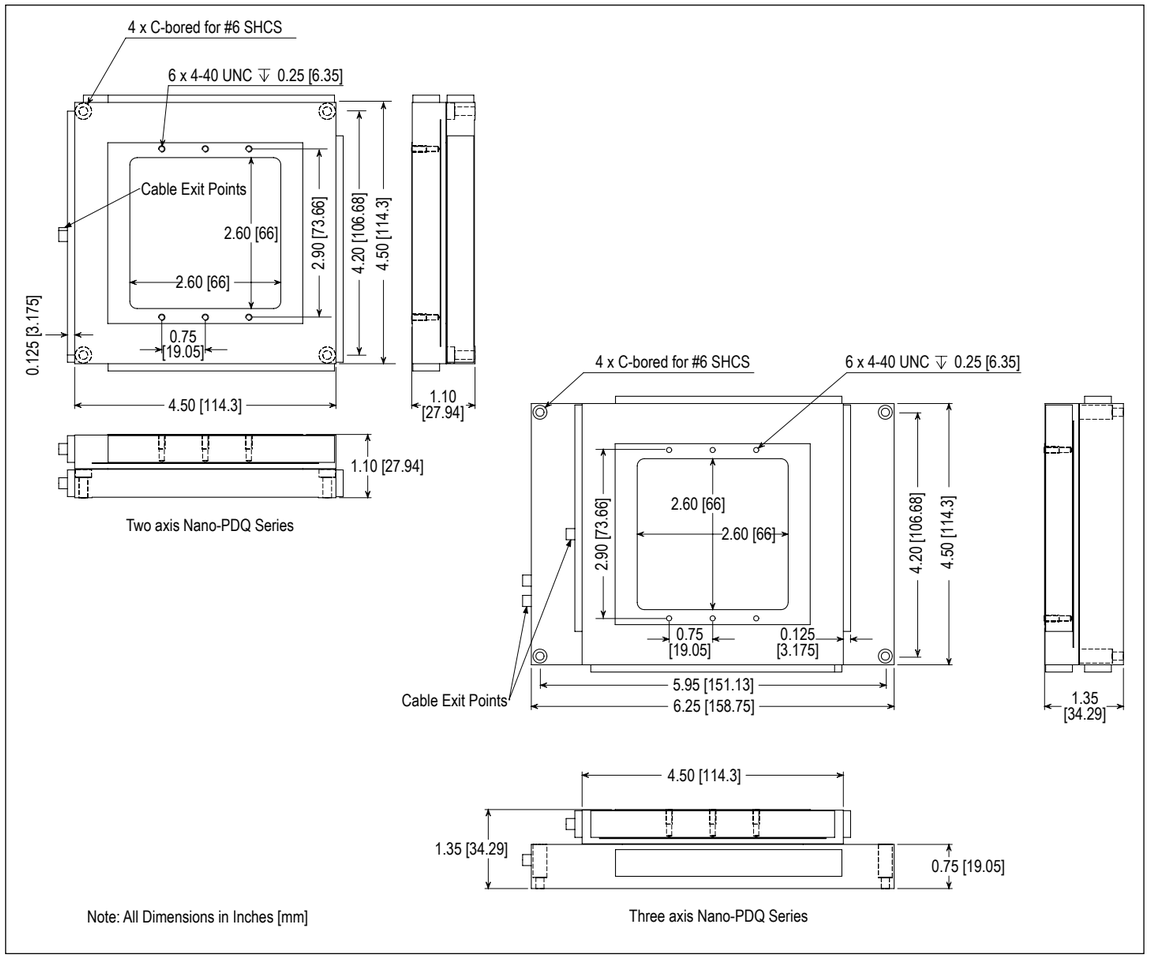
The Nano-PDQ Series are high speed, multi-axis piezo nanopositioning systems. The Nano-PDQ Series offers a compact footprint with a large center aperture while still offering fast response and sub-nm precision The Nano-PDQ Series are ideal for applications that demand high scan rates or large load capacities. The Nano-PDQ series may be ordered with the standard Nano-Drive® or higher power Nano-Drive® controllers to match to your application speed requirements. The Nano-PDQ Series features parallel, uncoupled motion in up to three axes and fully integrated position sensors utilizing proprietary PicoQ® technology to provide absolute, repeatable position measurement and picometer accuracy under closed loop control.

Another system to consider: the low profile Nano-LPQ has similar 3-axis, high speed positioning performance but is sized to be more convenient when used on inverted research microscopes.

Technical Specifications

Range of motion (X)	50 µm/75 µm
Range of motion (Y)	50 µm/75 µm
Range of motion (Z)	50 µm
Resolution (50/75 µm)	0.1/0.15 nm
Resonant Frequency (X)	2.7/1.0 kHz ±20%
Resonant Frequency (Y)	1.6/0.4 kHz ±20%
Resonant Frequency (Z)	275 Hz ±20%
Scanning Speed†	up to 400 Hz
Stiffness	3.0 N/µm
θ_{roll} , θ_{pitch} (typical)	≤1 µrad
θ_{yaw} (typical)	≤3 µrad
Recommended max. load (horizontal)*	0.5 kg
Recommended max. load (vertical)*	0.2 kg
Body Material	Al, Invar or Titanium
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.
† Using a Nano-Drive®85 controller.



Nano-T Series

Features

- *Economical multi-axis nanopositioner*
- *Two or three axis motion*
- *100 µm or 200 µm XY ranges of motion*
- *20 µm or 50 µm Z range of motion*
- *Large aperture*
- *picoQ sensor technology*
- *Closed loop control*

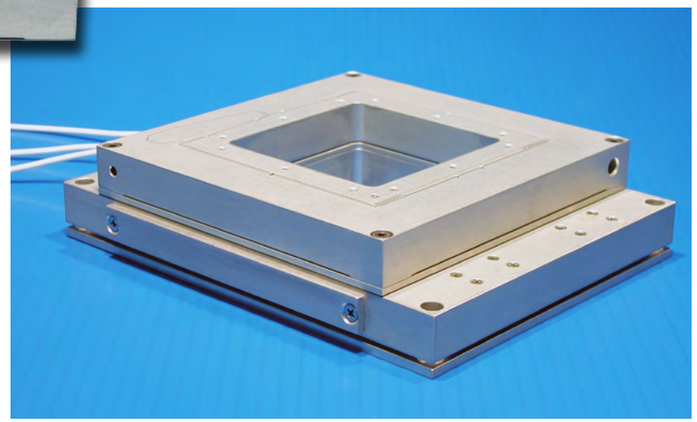
Typical Applications

- *Multi-axis alignment*
- *Fluorescence imaging*
- *Closed-loop AFM scanner*
- *Super resolution microscopy*

Related products
- Nano-H Series
- Nano-PDQ Series

◀ *Nano-T11 (2-axis) constructed from aluminum.*

▼ *Nano-T115 (3-axis) constructed from aluminum*



Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW · MetaMorph · NIS-Elements · Image-Pro Plus · SlideBook 6 · µManager Open Source Microscopy Software

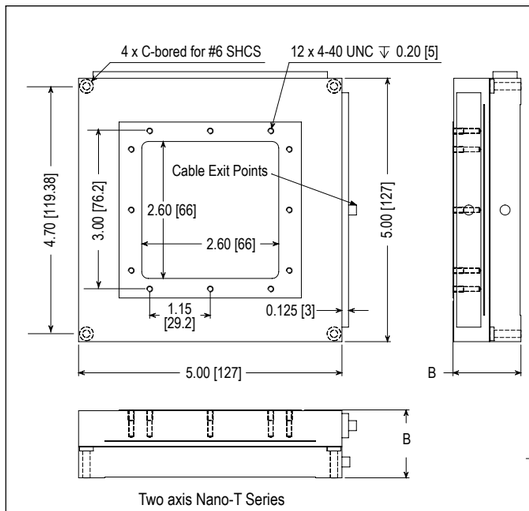
Product Description

The Nano-T Series are economical, multi-axis piezo nanopositioning systems which are available in XY and XYZ configurations. The Nano-T Series have up to 200 microns range of motion in X and Y, and up to 50 microns in Z. The large center aperture accomodates lenses and probes without compromising performance. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement and picometer resolution under closed loop control. The Nano-T Series is well suited to applications in which precise positioning is required but the overall stage height is not critical. If extremely low profile systems are required, the Nano-Bio Series and Nano-BioS Series (XY) or the Nano-LP Series and Nano-LPS Series (XYZ) should be considered.

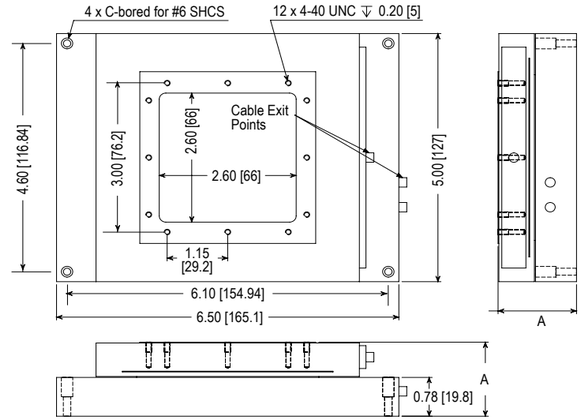
Technical Specifications

Range of motion (X, Y)	100 µm/200 µm
Range of motion (Z)	20 µm/50 µm
Resolution XY (100/200 µm)	0.2/0.4 nm
Resolution Z (20/50 µm)	0.04/0.1 nm
Resonant Frequencies	
X axis (100/200 µm)	425/345 Hz ±20%
Y axis (100/200 µm)	150/140 Hz ±20%
Z axis	160 Hz ±20%
Stiffness	1.0 N/µm
θ_{roll} , θ_{pitch} (typical)	≤1 µrad
θ_{yaw} (typical)	≤3 µrad
Recommended max. load (horizontal)*	0.5 kg
Recommended max. load (vertical)*	0.2 kg
Body Material	Al or Invar
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Two axis Nano-T Series



Three axis Nano-T Series

Material	A	B
Aluminum	1.50 [38.1]	1.30 [33.02]
Invar	1.30 [33.02]	1.10 [27.94]

Note: All Dimensions in Inches [mm]

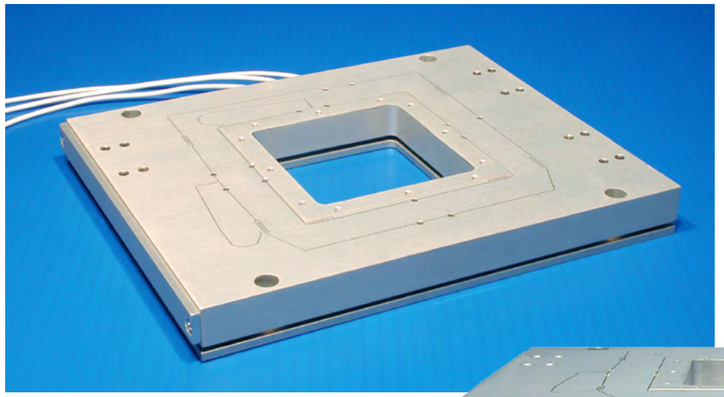
Nano-LP Series

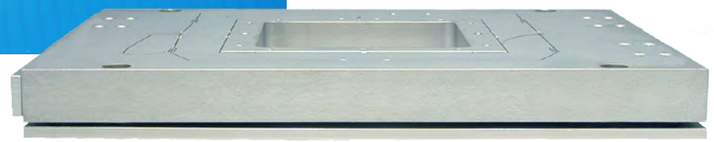
Features

- *Lowest profile 3-axis nanopositioner available*
- *Large aperture*
- *100 µm, 200 µm, and 300 µm ranges of motion*
- *picoQ® sensor technology*
- *Closed loop control*
- *High stability*

Typical Applications

- *Optical microscopy, easy to retrofit*
- *Optical trapping experiments*
- *Fluorescence imaging*
- *Alignment*
- *Single molecule spectroscopy*
- *Super resolution microscopy*





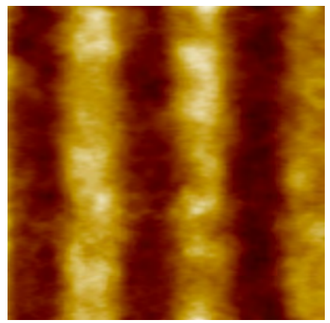
Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW · MetaMorph · NIS-Elements · Image-Pro PLUS · SlideBook 6 · µManager Open Source Microscopy Software

Product Description

The Nano-LP Series are the industry standard for ultra-low profile, three axis piezo nanopositioning systems. The low height of the Nano-LP Series allows it to be easily integrated into existing inverted optical microscopes. With its extended ranges of motion, up to 300 microns in XYZ, the Nano-LP Series is ideal for demanding microscopy applications. The Nano-LP Series' internal position sensors utilize proprietary PicoQ® technology to provide absolute, repeatable position measurement with picometer accuracy under closed loop control. The low noise capabilities of the PicoQ® sensors enable extremely high resolution performance as verified by AFM data (at right).
A sister product is the Nano-LPS Series which accomodates 3" (75mm) slides with similar performance characteristics.



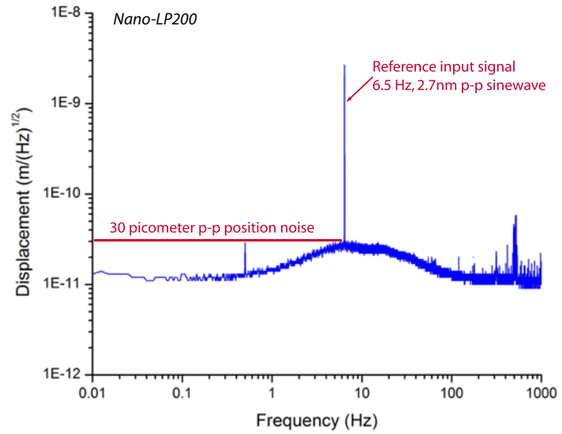
Low noise PicoQ® sensors enable 95 picometer steps. The Z-axis of the Nano-LP100 was commanded in 95 pm square wave moving the silicon substrate. Using Mad City Labs resonant probe AFM in constant force mode, the probe position was measured and recorded. The colors in the image represent the z-axis displacement of the probe.

Technical Specifications

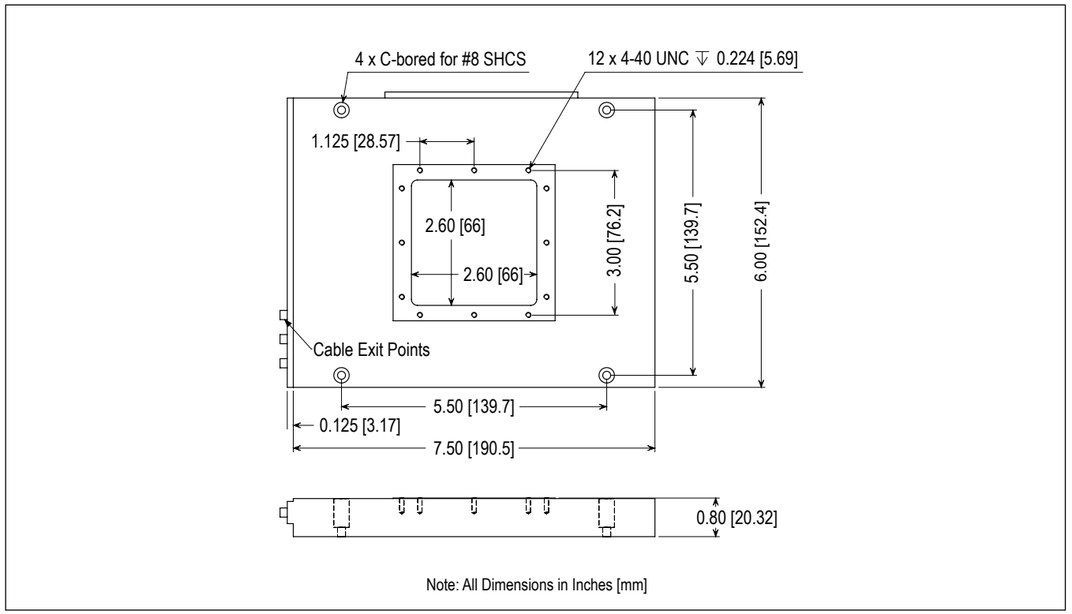
Range of motion (Nano-LP100) .....100 x 100 x 100 µm
Range of motion (Nano-LP200) .....200 x 200 x 200 µm
Range of motion (Nano-LP300) .....300 x 300 x 300 µm
Resolution (100/200/300 µm) ..... 0.2/0.4/0.6 nm
Resonant Frequencies
X axis (100/200/300 µm).....355/270/265 Hz ±20%
Y axis (100/200/300 µm).....205/185/140 Hz ±20%
Z axis (100/200/300 µm).....195/110/110 Hz ±20%
Stiffness.....1.0 N/µm
θ_{roll} , θ_{pitch}(typical) ..... ≤1 µrad
θ_{yaw} (typical) ..... ≤3 µrad
Recommended max. load (horizontal)* .....0.5 kg
Recommended max. load (vertical)*.....0.2 kg
Body Material** .....Al, Invar or Titanium
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.
** Nano-LP300 is available in Aluminum only.

Low Position Noise



Related products
- Nano-LPS Series
- Nano-Bio Series



Note: All Dimensions in Inches [mm]

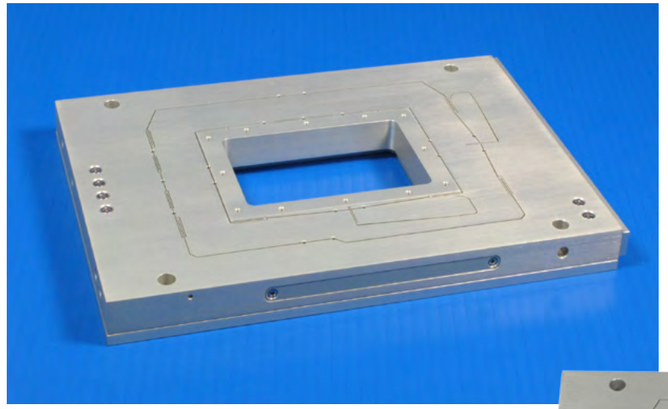
Nano-LPS Series

Features

- *Lowest profile 3-axis nanopositioner available*
- *Large aperture for standard 3" slides*
- *100 µm, 200 µm, and 300 µm ranges of motion*
- *PicoQ® sensor technology*
- *Closed loop control*
- *High stability*

Typical Applications

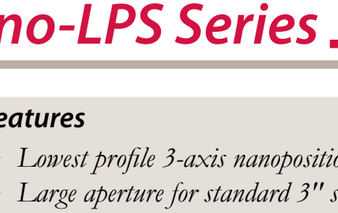
- *Super resolution microscopy*
- *Single molecule spectroscopy*
- *Optical trapping*
- *Optical microscopy, easy to retrofit*
- *Fluorescence imaging*
- *Alignment*



Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph®, NIS-Elements, Image-Pro® Plus, SlideBook 6, µManager Open Source Microscopy Software



Re-entrant slide holder with coverslip adapter.

Nano-LPS100 with re-entrant slide holder.

Product Description

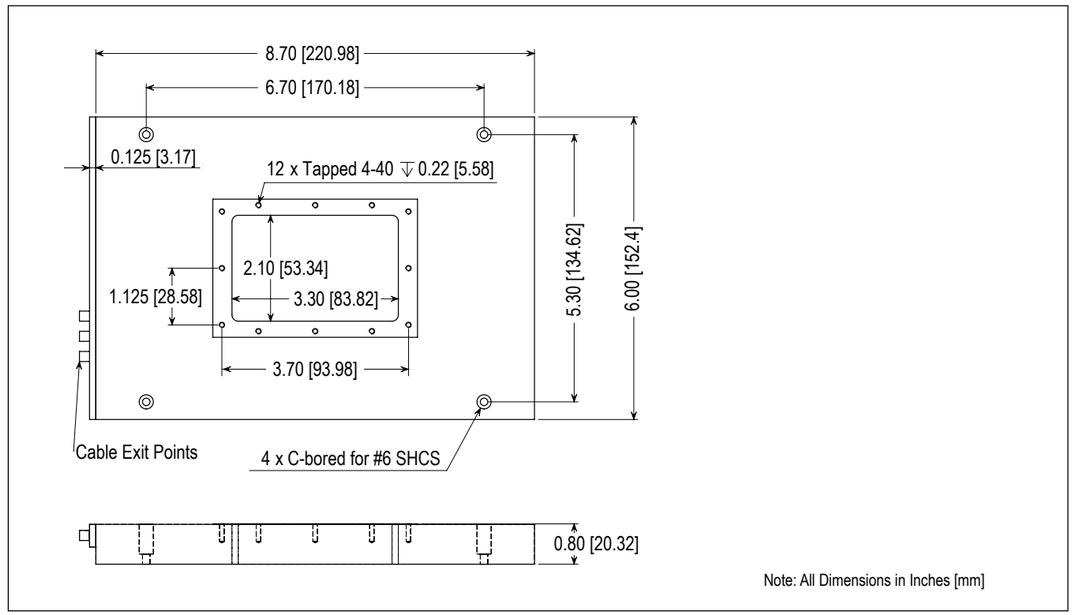
The Nano-LPS Series are ultra-low profile, three axis piezo nanopositioning systems with up to 300 micron ranges of motion in all three axes. The low height of the Nano-LPS Series allows it to be easily integrated into existing inverted optical microscopes. With comparable performance to the Nano-LP Series, the Nano-LPS Series is ideal for demanding microscopy applications which require long range travel and three axes of motion. Uniquely suited for biological samples, the Nano-LPS has a large center aperture which is large enough to hold full size 3 inch (75mm) standard slides. Precise and repeatable motion is made possible through closed loop control combined with proprietary PicoQ® position sensors. The low noise floor of PicoQ sensors enables high resolution and high stability performance essential to advanced nanoscopy and metrology applications.

Technical Specifications

Range of motion (Nano-LPS100) ...100 x 100 x 100 µm
Range of motion (Nano-LPS200) ...200 x 200 x 200 µm
Range of motion (Nano-LPS300) ...300 x 300 x 300 µm
Resolution (100/200/300 µm) ..... 0.2/0.4/0.6 nm
Resonant Frequencies
X axis (100/200/300 µm).....365/250/250 Hz ±20%
Y axis (100/200/300 µm).....285/150/125 Hz ±20%
Z axis (100/200/300 µm).....150/115/110 Hz ±20%
Stiffness.....1.0 N/µm
θ_{roll} , θ_{pitch}(typical) ..... ≤1 µrad
θ_{yaw} (typical) ..... ≤3 µrad
Recommended max. load (horizontal)* .....0.5 kg
Recommended max. load (vertical)*.....0.2 kg
Body Material** .....Al, Invar or Titanium
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.
** Nano-LPS300 is available in Aluminum only.

Related products
- Nano-LP Series
- Nano-LPQ
- Nano-Bio Series
- Nano-BioS Series
- RM21® Microscopes



Nano-LPQ

Features

- *Low profile, high speed, XYZ motion*
- *Built-in sample holders*
- *Equal speeds on all three axes*
- *PicoQ® sensor technology*
- *Closed loop control*
- *High stability*

Typical Applications

- *Particle tracking*
- *Single molecule spectroscopy*
- *Optical microscopy, easy to retrofit*
- *Optical trapping experiments*
- *Fluorescence imaging*

Related products
- Nano-LPS Series
- Nano-LP Series
- Nano-PDQ Series

Product Description

The Nano-LPQ is an ultra-low profile, high speed, XYZ piezo nanopositioning system with 75 microns of travel in XY and 50 microns in Z. Designed to minimize the moving mass, lightweight sample holders are integrated into the stage and represent the only moving component. This unusual design allows the three axes of motion to have high resonant frequencies and matched step response times. Equal 3-axis speed is particularly useful for applications like 3D particle tracking. The Nano-LPQ uses internal position sensors utilizing proprietary PicoQ® technology to provide absolute, repeatable position measurement with sub-nanometer resolution under closed loop control.

Other nanopositioning systems to consider: The Nano-PDQ Series stages offer similar high speed positioning performance with a larger sample mounting area and higher load capacity. The Nano-LPS Series has a similar ultra-low profile with high stability and low noise performance but with up to 300 microns travel range per axis.

Technical Specifications

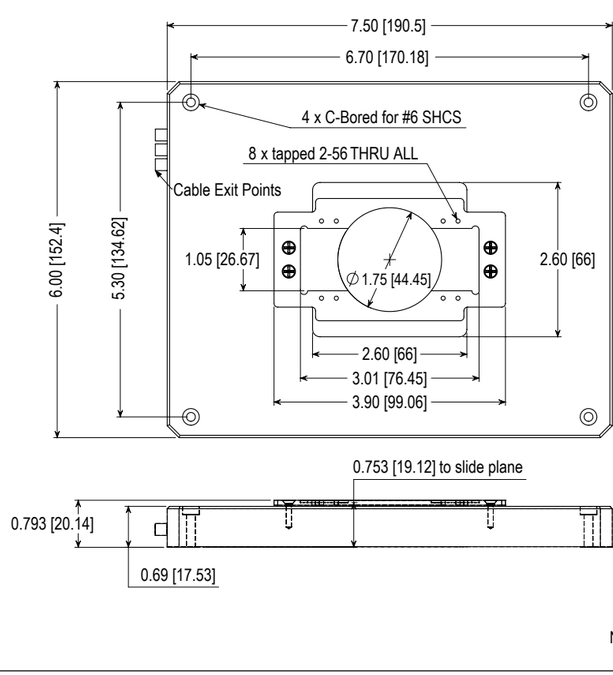
Range of motion (XYZ)	75 x 75 x 50 µm
Resolution (X/Y/Z)	0.2/0.2/0.1 nm
Resonant Frequency (X)	1000 Hz ±20%
Resonant Frequency (Y)	850 Hz ±20%
Resonant Frequency (Z)	750 Hz ±20%
Stiffness	1.0 N/µm
θ_{roll} , θ_{pitch} (typical)	≤1 µrad
θ_{yaw} (typical)	≤3 µrad
Recommended max. load (horizontal)*	100 g
Recommended max. load (vertical)*	100 g
Body Material	Aluminum
Controller	Nano-Drive®85

* Larger load requirements should be discussed with our engineering staff.

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph, NIS-Elements, Image-Pro Plus, SlideBook 6, µManager



Note: All Dimensions in Inches [mm]

Nano-LPMW

Features

- *Unique XYZ piezo nanopositioner*
- *Only design to accomodate multiwell plates and incubators*
- *200 µm range of motion (XYZ)*
- *PicoQ sensor technology*
- *Closed loop control*
- *High stability, parallel motion*

Typical Applications

- *Single molecule spectroscopy*
- *Super resolution microscopy*
- *Optical microscopy, easy to retrofit*
- *Optical trapping experiments*
- *Fluorescence imaging*
- *Alignment*

Nano-LPMW designed to accomodate multiwell plates, incubators, chambers and slides

Product Description

The Nano-LPMW is a unique 3 axis piezo nanopositioning system designed to hold multiwell plates, slides, dishes and environmental chambers. The Nano-LPMW has a low profile and extra-large center aperture with 200 micron range of motion in XYZ axes. The Nano-LPMW design accomodates high load, long range travel and highly parallel motion in XYZ with sub-nanometer precision. It is the only 3 axis closed loop nanopositioner designed to hold incubators and chambers. The low height of the Nano-LPMW allows it to be integrated into existing inverted optical microscopes and is compatible with a range of microscope stages. Like the related Nano-LPS Series, the Nano-LPMW is ideal for demanding microscopy applications. Precise and repeatable motion is made possible through closed loop control combined with Mad City Labs proprietary PicoQ® position sensors.

Technical Specifications

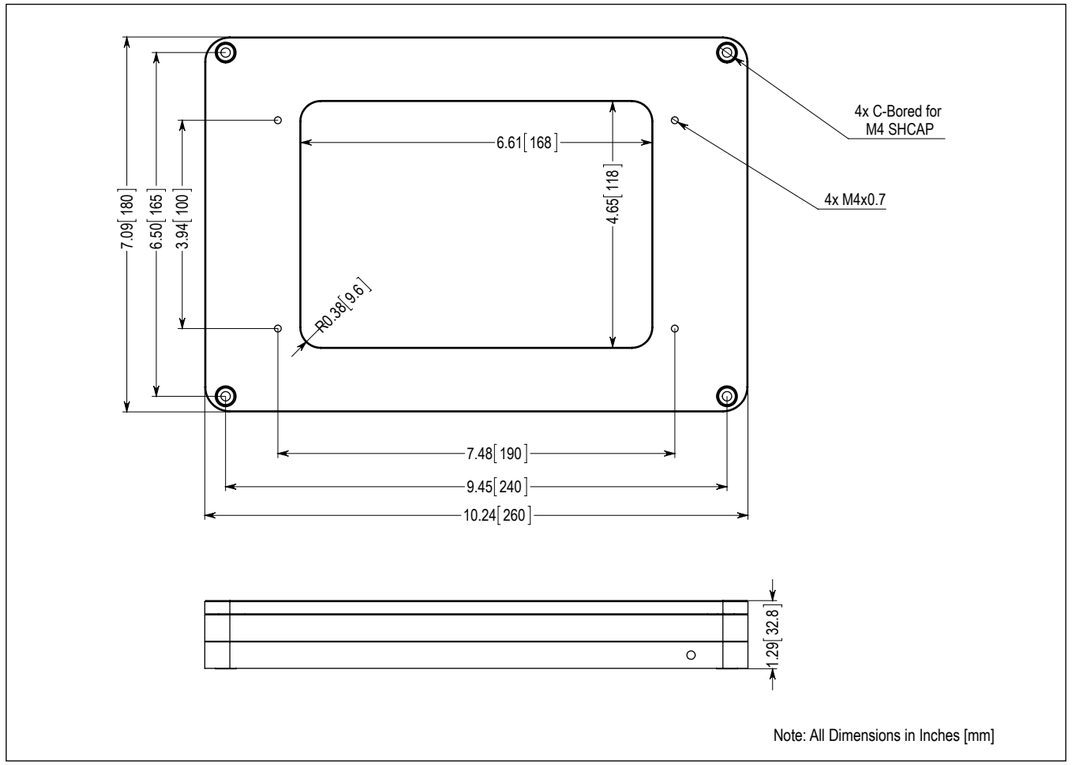
Range of motion	200 x 200 x 200 µm
Resolution	0.4 nm
Resonant Frequency (X)	105 Hz ±20%
Resonant Frequency (Y)	90 Hz ±20%
Resonant Frequency (Z)	195 Hz ±20%
θ_x , θ_y (typical)	≤40 µrad
θ_z (typical)	≤20 µrad
Recommended max. load (horizontal)*	0.5 kg
Recommended max. load (vertical)*	0.2 kg
Body Material	Aluminum
Controller	Nano-Drive®
Accessories	Adapter plate to Ti-S-E/ER
Slide Sample holder	AC-LPMWS

* Larger load requirements should be discussed with our engineering staff.

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph, NIS-Elements, Image-Pro Plus, SlideBook 6, µManager



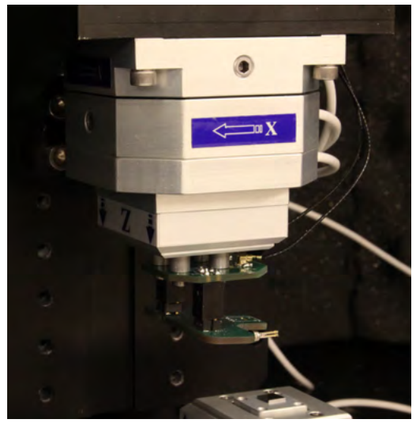
Nano-HS3M

Features

- *High speed*
- *Low noise floor*
- *Closed loop control*
- *Picometer positioning resolution*
- *High stability*
- *Compact design*
- PicoQ® *sensor technology*

Typical Applications

- *High speed, high resolution positioning*
- *Metrology*
- *AFM*
- *Tip Scanning SPM*



Nano-HS3 shown as part of Mad City Labs resonant probe AFM. The Nano-HS3M controls the probe motion (XYZ). The sample nanopositioner (bottom of image) is a Nano-METZ.

Product Description

The Nano-HS3M is a high speed, XYZ piezo nanopositioning system with picometer positioning resolution. Offering maximum versatility, the Nano-HS3M is designed for demanding metrology applications. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement under closed loop control. The compact footprint, ultra-low noise characteristics, and a Z-axis resonant frequency of 13.5kHz make it ideal for applications that require picometer noise floors and high speed performance. The Nano-HS3M can be combined with the MadPLL® phase lock loop controller and our other AFM related instruments to form a high precision resonant probe AFM.

Related products
- Nano-MET3
  Nano-M350
- Nano-HS Series
- SPM-M kit

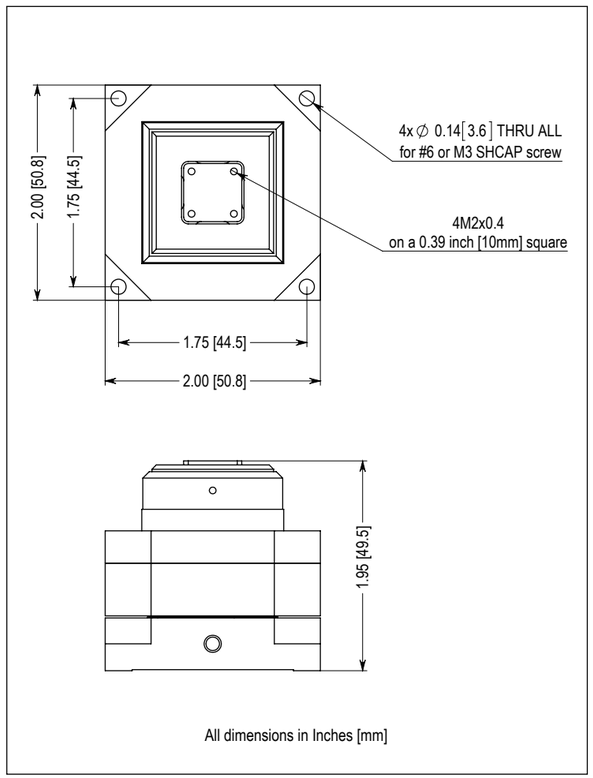
LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

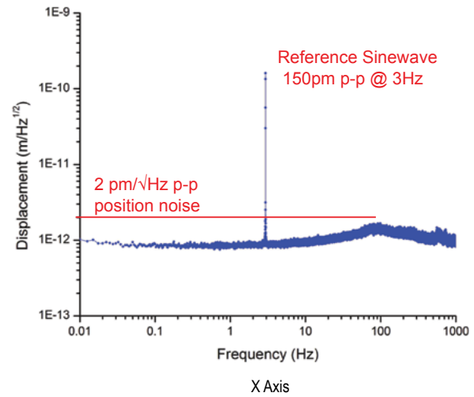
Technical Specifications

Range of motion (XY)	10 µm
Range of motion (Z)	5 µm
Resolution	0.01 nm
Resonant Frequency (X)	2.0 kHz ±20%
Resonant Frequency (Y)	1.8 kHz ±20%
Resonant Frequency (Z)	13.5 kHz ±20%
Recommended max. load (horizontal)*	0.1 kg
Recommended max. load (vertical)*	0.1 kg
Body Material	Al or Titanium
Controller	Nano-Drive®

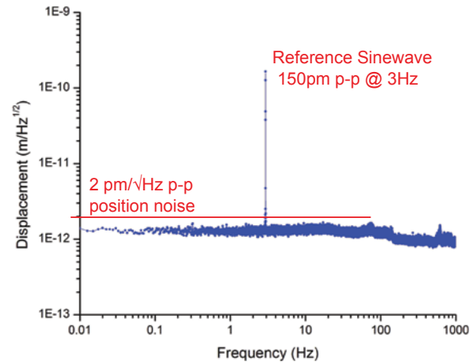
* Larger load requirements should be discussed with our engineering staff.



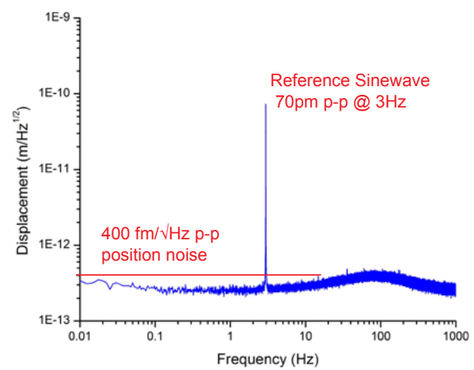
Ultra-Low Position Noise



X Axis



Y Axis



Z Axis

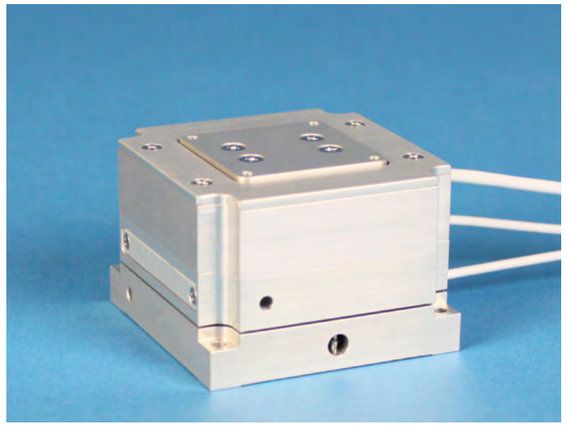
Nano-M350

Features

- *Compact size*
- *Three axis motion (XYZ)*
- *50 µm x 50 µm x 20 µm ranges of motion*
- *Closed loop control*
- *picoQ sensor technology*
- *Vacuum compatible models available*

Typical Applications

- *Alignment*
- *MEMS*
- *Nanolithography*
- *SEM*



Related products

- Nano-MET3
- Nano-HS2
- Nano-HS3M
- Nano-M250

Product Description

The Nano-M350 is a compact three axis piezo nanopositioning system constructed from aluminum. The XY travel range is 50 µm and 20 µm in the Z axis under closed loop control. The compact design of the Nano-M350 allows it to be easily integrated into existing instrumentation for applications such as nanolithography, and SEM. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with picometer accuracy under closed loop control. The Nano-M350 has been designed for high speed performance in the Z-axis while maintaining high precision motion. The Nano-M350 is also available in high vacuum (non-bakeable) compatible models.

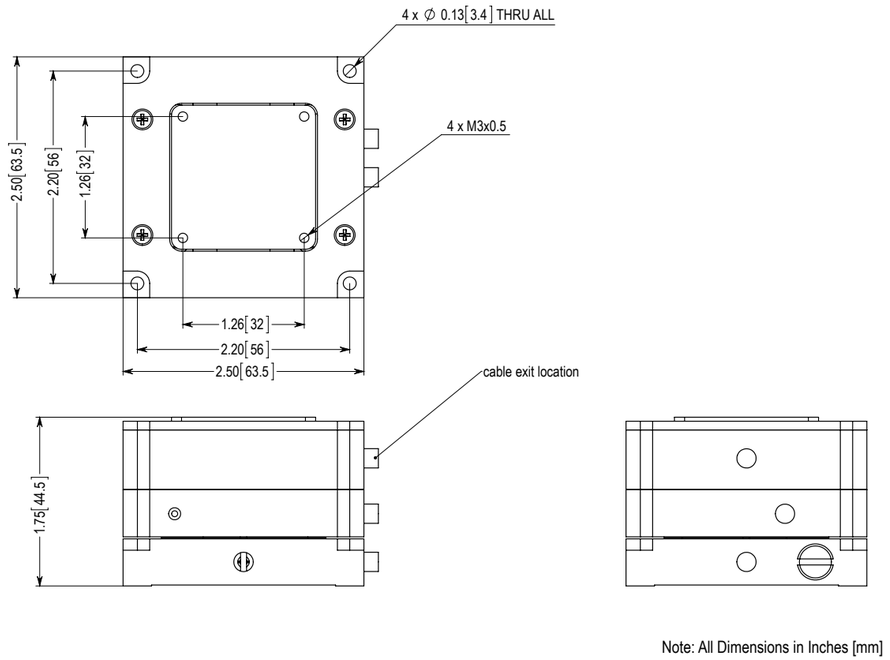
Technical Specifications

Range of motion (X) ..... 50 µm
Range of motion (Y) ..... 50 µm
Range of motion (Z) ..... 20 µm
Resolution ..... 0.1 nm/0.04 nm
Resonant Frequency (X) ..... 285 Hz ±20%
Resonant Frequency (Y) ..... 235 Hz ±20%
Resonant Frequency (Z) ..... 1580 Hz ±20%
θ_{roll} , θ_{pitch}(typical) ..... ≤1 µrad
θ_{yaw} (typical) ..... ≤3 µrad
Recommended max. load (horizontal)* .....0.5 kg
Recommended max. load (vertical)* .....0.2 kg
Body Material ..... Aluminum
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route®3D supplied with Nano-Drive® USB interfaces.



Note: All Dimensions in Inches [mm]

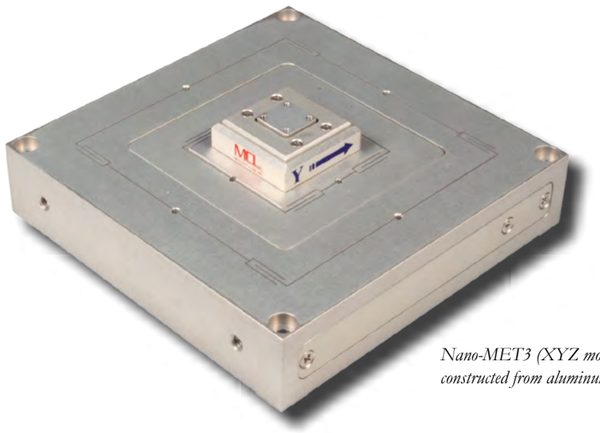
Nano-MET3

Features

- *High speed, multi-axis*
- *3 axis configuration*
- *Closed loop control*
- *Ultra-low noise performance*
- *Picometer positioning resolution*
- *High stability*
- *picoQ® sensor technology*

Typical Applications

- *High speed, high resolution positioning*
- *Metrology*
- *AFM*
- *SPM*



Nano-MET3 (XYZ motion) constructed from aluminum.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products

- Nano-METZ
- Nano-MET10/20
- Nano-MET2
- Nano-HS3M
- SPM-M kit

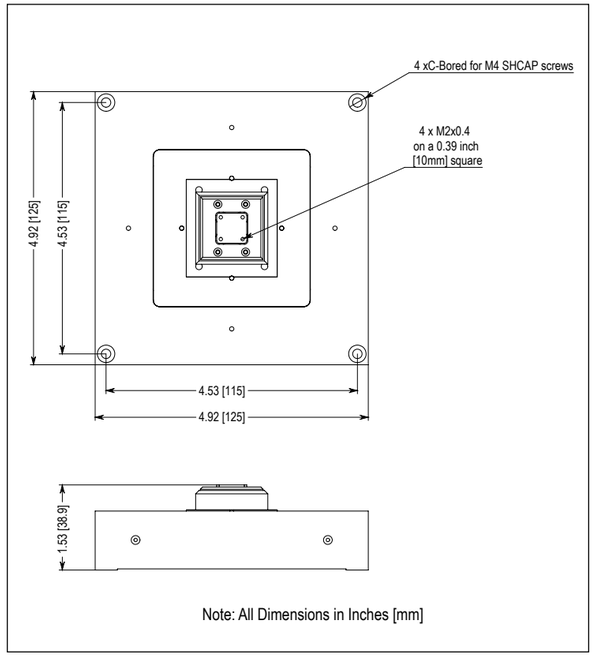
Product Description

The Nano-MET3 is an ultra-low noise, piezo nanopositioning systems with picometer positioning resolution. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement under closed loop control. The ultra-low position noise (4 picometers/√Hz in XY and 400 femtometers/√Hz in Z) of these nanopositioning systems make them ideal for demanding metrology applications. With a resonant frequency of 10kHz, the z-axis of the Nano-MET3 offers ultra-fast response needed for demanding AFM applications. Related products include the Nano-METZ, Nano-MET10, Nano-MET20, and Nano-MET2 nanopositioning systems.

Technical Specifications

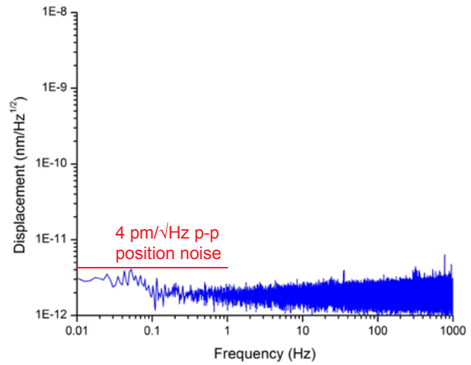
Range of motion (XY)	75 µm
Range of motion (Z)	5 µm
Resolution (XY)	0.15 nm
Resolution (Z)	0.005 nm
Resonant Frequency X	850 Hz ±20%
Resonant Frequency Y	750 Hz ±20%
Resonant Frequency Z	10 kHz ±20%
Recommended max. load (horizontal)*	100 g
Recommended max. load (vertical)*	100 g
Body Material	Aluminum
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

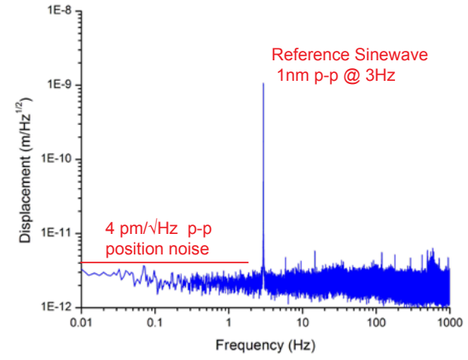


Note: All Dimensions in Inches [mm]

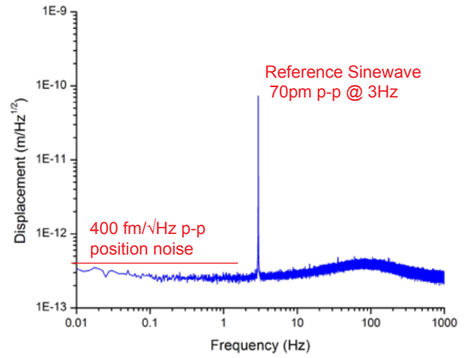
Ultra-Low Position Noise



X Axis



Y Axis



Z Axis

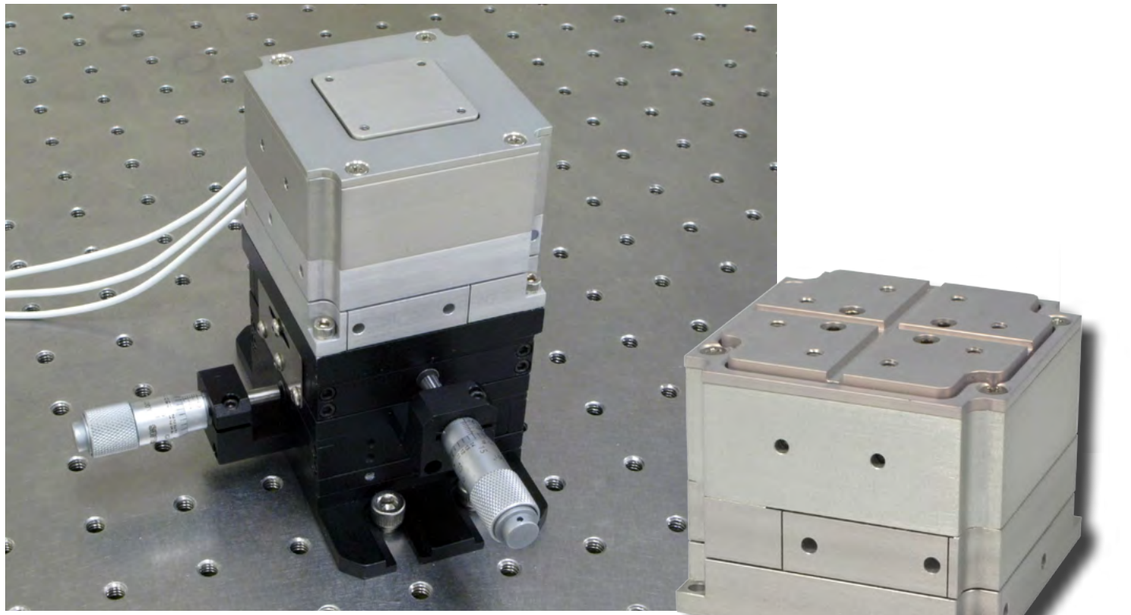
Nano-3D200

Features

- *Compact size*
- *Low cost*
- *200 µm three axis motion (XYZ)*
- *Closed loop control*
- *True flexure guided motion*

Typical Applications

- *Optical fiber alignment*
- *Hybrid positioning systems*
- *Nanofabrication*



Nano-3D200FT combined with a coarse XY positioner is ideal for optical alignment applications.

Nano-3D200GT constructed from aluminum with top surface alignment grooves for optical accessories.

Product Description

The Nano-3D200 is a compact three axis (XYZ) piezo nanopositioning system constructed from aluminum. The compact design of the Nano-3D200 allows it to be easily integrated with coarse positioning stages and standard optical fixturing accessories. Internal position sensors combine with the closed loop controller to provide absolute, repeatable position measurement and long term stability. Independent flexure guided motion for each axis provides mechanical isolation and ensures that alignment adjustments can be done with minimum cross-talk between axes. A wireless 3-axis gamepad controller is available as a convenience for fast, precise manual alignment without computer programming.

Technical Specifications

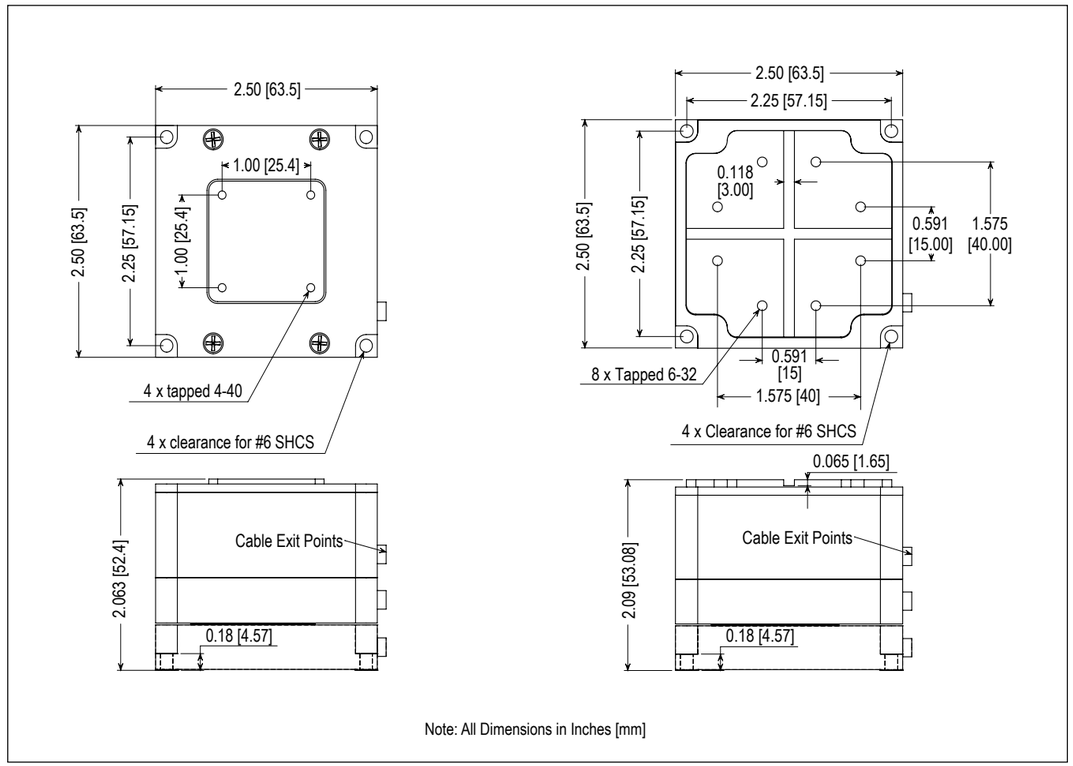
Ranges of motion (XYZ)	200 µm
Resolution	1 nm
Resonant Frequency (X)	160 Hz ±20%
Resonant Frequency (Y)	160 Hz ±20%
Resonant Frequency (Z)	320 Hz ±20%
Recommended max. load (horizontal)*	0.5 kg
Recommended max. load (vertical)*	0.2 kg
Body Material	Aluminum
Controller	Nano-Drive®
Models	Nano-3D200FT
	Nano-3D200GT

* Larger load requirements should be discussed with our engineering staff.

Related products
- Nano-3D500
- Nano-M350

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.



Note: All Dimensions in Inches [mm]

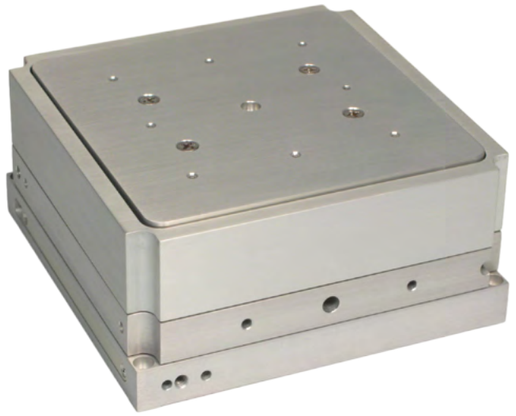
Nano-3D500

Features

- *Compact size*
- *500 µm three axis motion (XYZ)*
- *Closed loop control*
- *True flexure guided motion*

Typical Applications

- *Optical fiber alignment*
- *Hybrid positioning systems*
- *Micromachining*
- *Micromanipulation*



LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products
- Nano-3D200

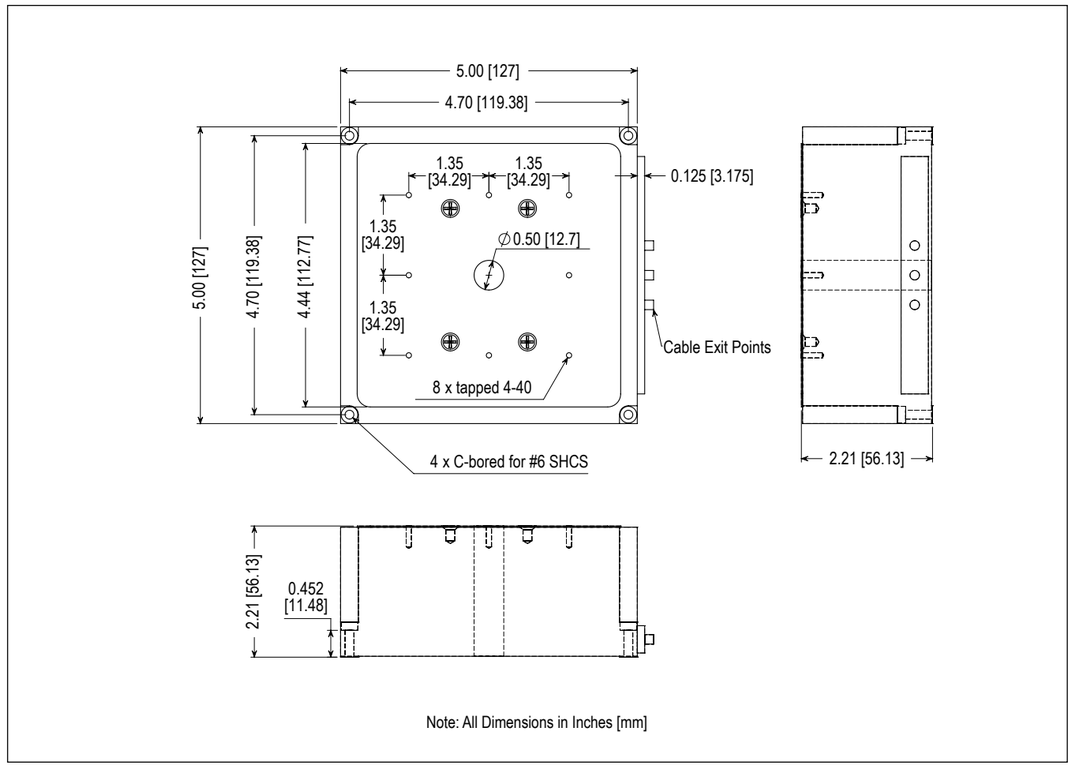
Product Description

The Nano-3D500 is a long range, three axis (XYZ) piezo nanopositioning system constructed from aluminum. Ideally suited for optical alignment applications and high precision static positioning, the Nano-3D500 uses unique internal flexures to produce independent, isolated movement in all axes. High resolution position sensors combine with the closed loop controller to provide absolute, repeatable position measurement and long term stability. The 0.5 inch diameter center aperture provides a potentially useful optical path through the stage. A wireless 3-axis gamepad controller is available as a convenience for fast, precise manual alignment without computer programming.

Technical Specifications

Ranges of motion (XYZ) ..... 500 µm
Resolution ..... 1 nm
Resonant Frequency (X) ..... 150 Hz ±20%
Resonant Frequency (Y) ..... 150 Hz ±20%
Resonant Frequency (Z) ..... 200 Hz ±20%
Recommended max. load (horizontal)* .....0.5 kg
Recommended max. load (vertical)* .....0.2 kg
Body Material ..... Aluminum
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Nano-F Series

Features

- *Compact, piezo lens nanopositioner*
- *Interchangeable, quick mount adapters*
- *100 µm or 200 µm ranges of motion*
- *Compatible with all microscopes*
- *Closed loop control*
- pico *sensor technology*

Typical Applications

- *Microscope focusing element*
- *Confocal imaging*
- *Auto focus*
- *Super resolution microscopy*

Nano-F200S constructed from aluminum.

Quick mount adapters allow the Nano-F Series to be used with a variety of microscopes and lenses. Threaded adapters include RMS, M25, M26, M27 and M32 (Nano-F100W and F200W for M27 and M32).

Product Description

The Nano-F Series are piezo lens nanopositioners with 100 or 200 microns of travel. Internal position sensors utilizing proprietary PicoQ®technology provide absolute, repeatable position measurement for precise closed loop control. Extensive computer modeling (FEA) of the Nano-F Series mechanical structures has resulted in designs with very low off-axis motion (see runout specifications) - which means that microscope images will remain stable throughout the entire range of motion. The Nano-F Series can be used as stand-alone systems or in conjunction with other Mad City Labs nanopositioning stages. Quick mount adapters thread directly into the microscope turret and the nanopositioner can then be clamped onto the adapter without having to rotate the entire assembly with the attached cable. A variety of quick mount adapter threads allow the Nano-F Series to be used on all microscopes. The desired threads on the quick mount adapter are specified for each system when it is ordered. Extra adapters can be ordered separately.

Technical Specifications

Range of motion (Nano-F100S and F100W)	100 µm
Range of motion (Nano-F200S and F200W)	200 µm
Resolution (100/200 µm)	0.2 / 0.4 nm
Resonant Frequency	500 Hz ±20%
Runout (θ_X)	6 µrad (100 and 200 µm ranges)
Runout (θ_Y)	10 µrad (100 µm), 25 µrad (200 µm)
Stiffness	1.0 N/µm
Recommended max. load*	0.5 kg
Body Material	Al and Brass
Threaded Adapters	
Nano-F100S/F200S	RMS, M25, M26
Nano-F100W/F200W	M27, M32
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

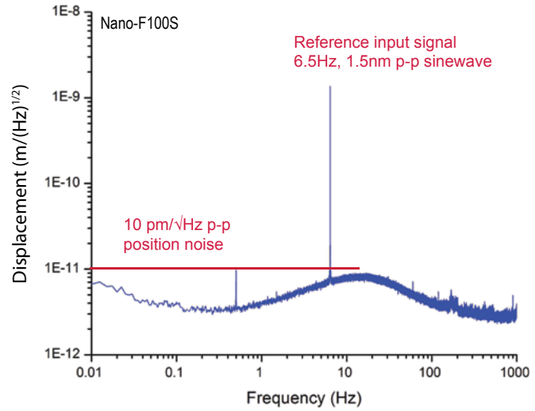
Related products
- Nano-F25HS
- Nano-F450
- Nano-F3D
- Nano-OP Series

Compatible Software Packages

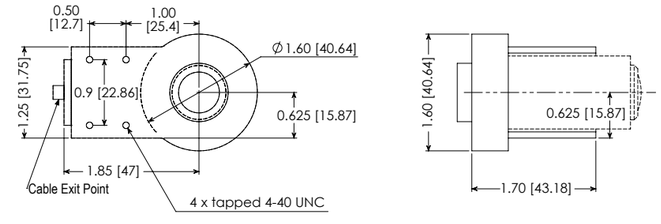
Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

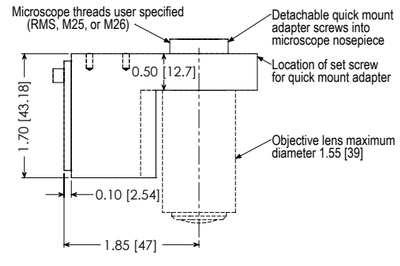
LabVIEW, MetaMorph®, NIS-Elements, Image-Pro® PLUS, SlideBook 6, µManager Open Source Microscopy Software

Low Position Noise



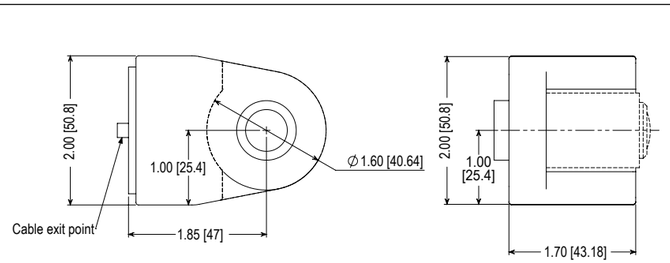
Nano-F100S

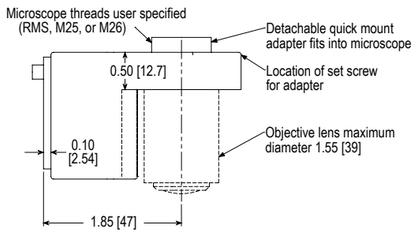




Note: All Dimensions in Inches [mm]

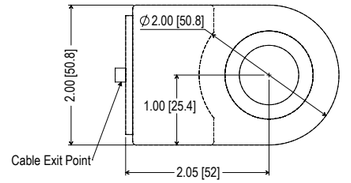
Nano-F200S

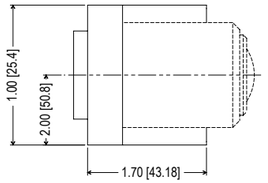


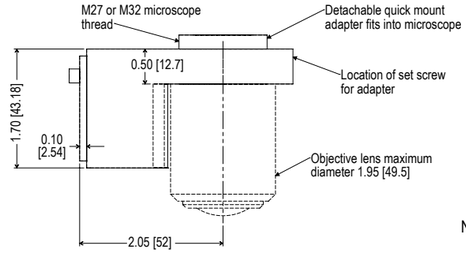


Note: All Dimensions in Inches [mm]

Nano-F100W/F200W







Note: All Dimensions in Inches [mm]

Nano-F25HS

Features

- *High speed objective lens nanopositioner*
- *Interchangeable, quick mount adapters*
- *25 µm range of motion*
- *Compatible with all microscopes*
- *Closed loop control*
- *pico sensor technology*

Typical Applications

- *Microscope focusing element*
- *Confocal imaging*
- *Auto focus*

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph, NIS-Elements, Image-Pro PLUS, SlideBook 6, µManager

Related products

- Nano-F Series
- Nano-F450
- Nano-F3D
- Nano-OP Series

Product Description

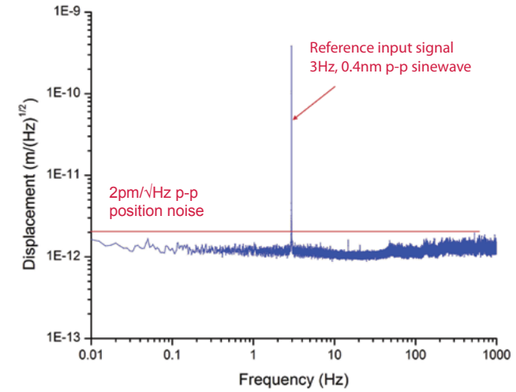
The Nano-F25HS is a high speed piezo nanopositioner for objective lenses with 25 microns of travel. Twice as fast as standard longer range objective lens nanopositioners, the Nano-F25HS uses a compact direct drive flexure design to reduce the step response time while maintaining a size that easily adapts to microscopes or other optical systems. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement for precise closed loop control. The Nano-F25HS can be used as stand-alone system or in conjunction with other Mad City Labs nanopositioning stages. Quick mount threaded adapters are available for RMS, M25, and M26 lens threads. Adapter threads are specified when the system is ordered. Customized mounting arrangements can also be provided for non-microscope installations.

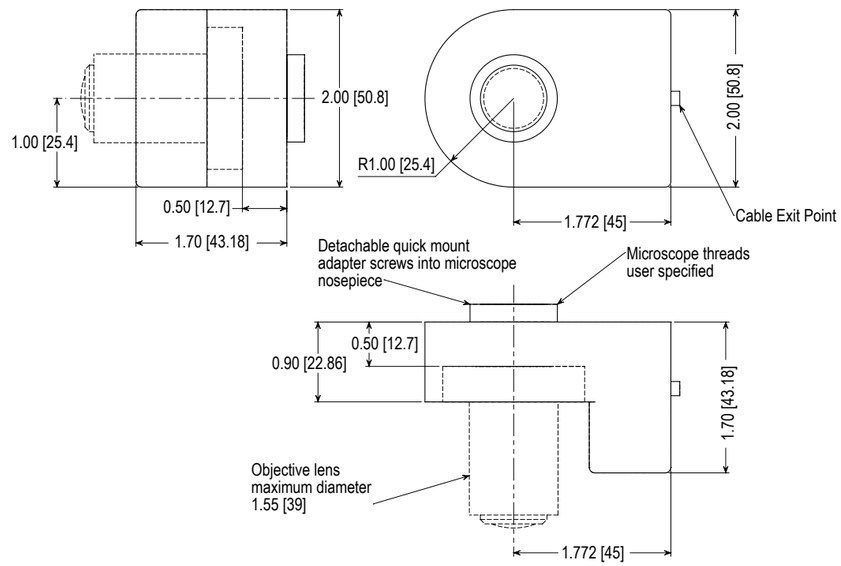
Technical Specifications

Range of motion	25 µm
Resolution	0.05 nm
Resonant Frequency	
Unloaded	1.2 kHz ±20%
Loaded with 200g lens	450 Hz ±20%
Runout (θ_X)	2 µrad
Runout (θ_Y)	2 µrad
Stiffness	1.5 N/µm
Recommended max. load*	0.5 kg
Body Material	Al and Brass
Threaded Adapters	RMS, M25, M26
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

Low Position Noise





Note: All Dimensions in Inches [mm]

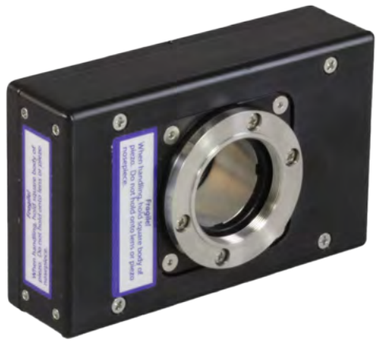
Nano-F450

Features

- *450 µm travel*
- *Objective lens piezo nanopositioner*
- *Interchangeable, quick mount adapters*
- *Compatible with all microscopes*
- *Closed loop control*
- pico *sensor technology*

Typical Applications

- *Microscope focusing element*
- *Confocal imaging*
- *Auto focus*
- *STORM and PALM imaging*



Nano-F450, objective lens side, constructed from aluminum.

Quick mount threaded adapters allow the Nano-F450 to be used with RMS, M25, M26, and M32 lens threads.

Product Description

The Nano-F450 is the longest travel range piezo focussing element available for research microscopy. Ideally suited to high speed, long range confocal imaging, the Nano-F450 utilizes proprietary PicoQ® position sensor technology for absolute, repeatable position measurement and precise closed loop control. The Nano-F450 can be used as stand-alone system or in conjunction with other Mad City Labs nanopositioning stages. Quick mount adapters thread directly into the microscope turret, allowing the lens nanopositioner to be clamped onto the adapter without having to rotate the entire assembly with the attached cable. Compatible with RMS, M25, M26, and M32 quick mount threaded adapters, the Nano-F450 can be used on many different microscopes. The desired threads on the quick mount adapter are specified for each system when it is ordered. Extra adapters can be ordered separately.

Technical Specifications

Range of motion	450 µm
Resolution	0.9 nm
Resonant Frequency (no load)	194 Hz ±20%
Resonant Frequency (with 175 g lens)	128 Hz ±20%
Stiffness	1.0 N/µm
Recommended max. load*	0.5 kg
Body Material	Al and Brass
Threaded Adapters	RMS, M25, M26, M32
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

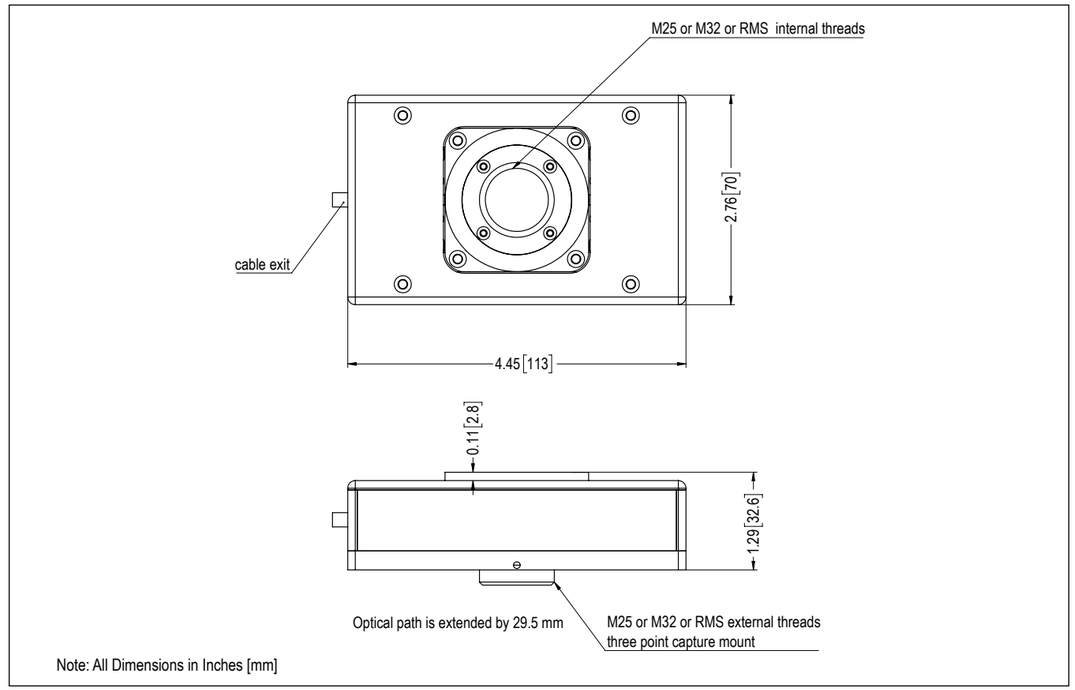
Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph, NIS-Elements, Image-Pro Plus, SlideBook 6, µManager

Related products

- Nano-F Series
- Nano-F3D
- Nano-ZL Series
- Nano-OP Series



Note: All Dimensions in Inches [mm]

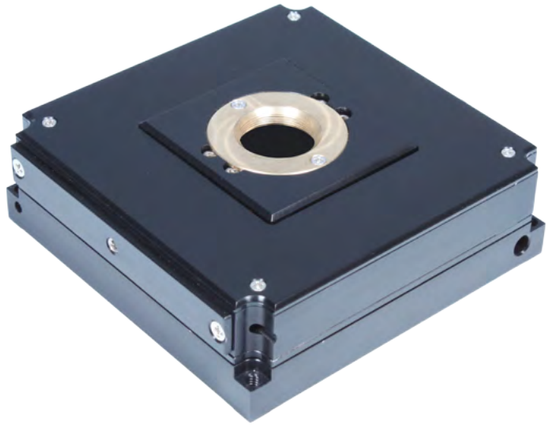
Nano-F3D

Features

- *XYZ objective lens positioning*
- *100 µm range of motion in all 3 axes*
- *Interchangeable threaded lens adapters*
- *Closed loop control*
- *picoQ sensor technology*

Typical Applications

- *Lens positioning*
- *Custom microscope scanning*
- *4Pi microscopy*
- *Optical inspection*



Nano-F3D with M25 objective lens threaded adapter. Adapters for RMS and M26 lens threads are also available.

Related products
- Nano-F Series
- Nano-T Series
- Nano-LP Series

Product Description

The Nano-F3D is a piezo objective lens nanopositioner designed to provide the unique capability of moving a lens in all three axes (XYZ). Simultaneous, three axis motions of up to 100 microns can be accomplished with sub-nanometer positioning resolution. As with all Mad City Labs nanopositioning systems, the Nano-F3D uses proprietary PicoQ® position sensors on each axis to provide feedback for closed loop control. Compatible with RMS, M25, M26, and M27 lens threads, the Nano-F3D can be used with most commercially available objective lenses. Threaded adapters are specified for each system when it is ordered. Extra adapters can be ordered separately. Customized mounting adapters can also be manufactured to your specifications.

Technical Specifications

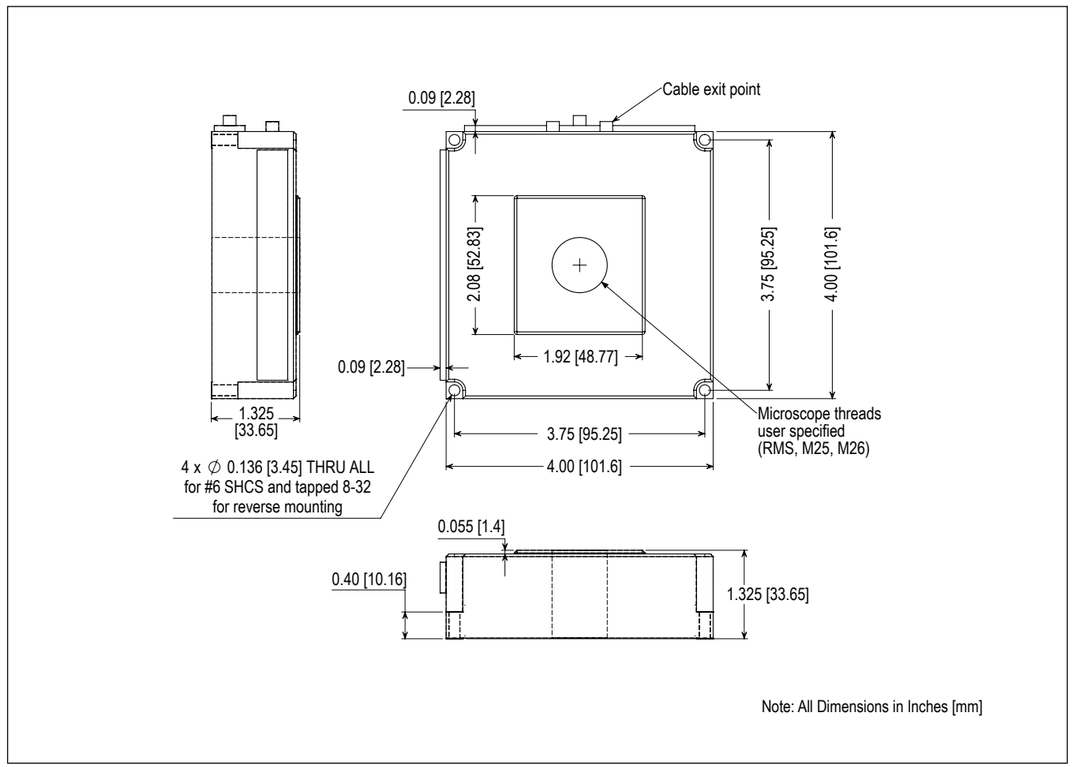
Ranges of motion (X,Y,Z)	100 µm
Resolution	0.2 nm
Resonant Frequencies (X)	240 Hz ±20%
Resonant Frequencies (Y)	160 Hz ±20%
Resonant Frequencies (Z)	460 Hz ±20%
Stiffness	1.0 N/µm
Recommended max. load*	0.5 kg
Body Material	Al and Brass
Threaded Adapters	RMS, M25, M26
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph, NIS-Elements, Image-Pro Plus, SlideBook 6, µManager



C-Focus™ System

Features

- *Microscope automatic focus drift correction*
- *Includes lens nanopositioner, sensor & manual microstage*
- *Compatible with inverted microscopes*
- *Closed loop control*
- pico *sensor technology*

Typical Applications

- *Maintain constant microscope focus*
- *High speed confocal imaging*
- *Ultra-fine focus adjustments*
- *Drift correction*

Nano-F100S objective lens nanopositioner is included with the C-Focus™ system.

C-Focus™ nanopositioner with 5nm optical sensor system removes the effects of microscope focus drift.

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW · MetaMorph · NIS-Elements · Image-Pro Plus · SlideBook 6 · µManager Open Source Microscopy Software

Single button to maintain focus.

Single button to move lens into the starting position.

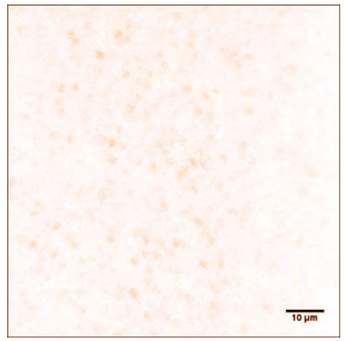
Product Description

C-Focus™ systems provide an automatic means to correct microscope focus drift over long time periods. Unlike autofocus systems which require use of advanced microscopes with internal focus correction or external devices which track video signals or introduce additional light sources, the C-Focus™ simply corrects for microscope focus drift via a high resolution sensor system fitted to the included low drift manual microstage. The sensor system measures the lens to stage plane spacing and makes the necessary adjustments using the piezo lens positioner. The C-Focus™ system has no effect on standard manual focusing and can be retrofit to any microscope. After focus is established, simply pushing the "focus lock" button starts the C-Focus™ operation. Objective lens motions are accomplished with a lens nanopositioner (the Nano-F100S) fitted to the nosepiece via a quick mount adapter. In addition to the unique C-Focus™ operation, lens nanopositioner motion can also be directly commanded by digital (16-bit USB) or analog signals and can be used for high speed, high resolution confocal imaging and other imaging tasks with demanding focus requirements. The C-Focus™ lens positioning system contains our proprietary, low noise PicoQ®position sensors and is capable of sub-nanometer positioning resolution. The 16-bit USB digital computer interface is included with all C-Focus™ controllers.

Technical Specifications

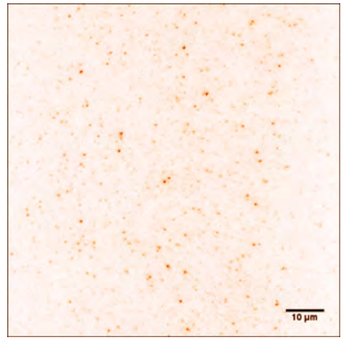
Range of motion (Nano-F100S)	100 µm
Resolution	0.2 nm
Resonant Frequency	500 Hz ±20%
Stiffness	1.0 N/µm
Recommended max. load*	0.5 kg
Body Material	Al and Brass
Controller	C-Focus™
Range of motion (MicroStage - XY)	25 mm
Vernier graduations	1 µm
C-Focus™ sensor resolution	5 µm

* Larger load requirements should be discussed with our engineering staff.



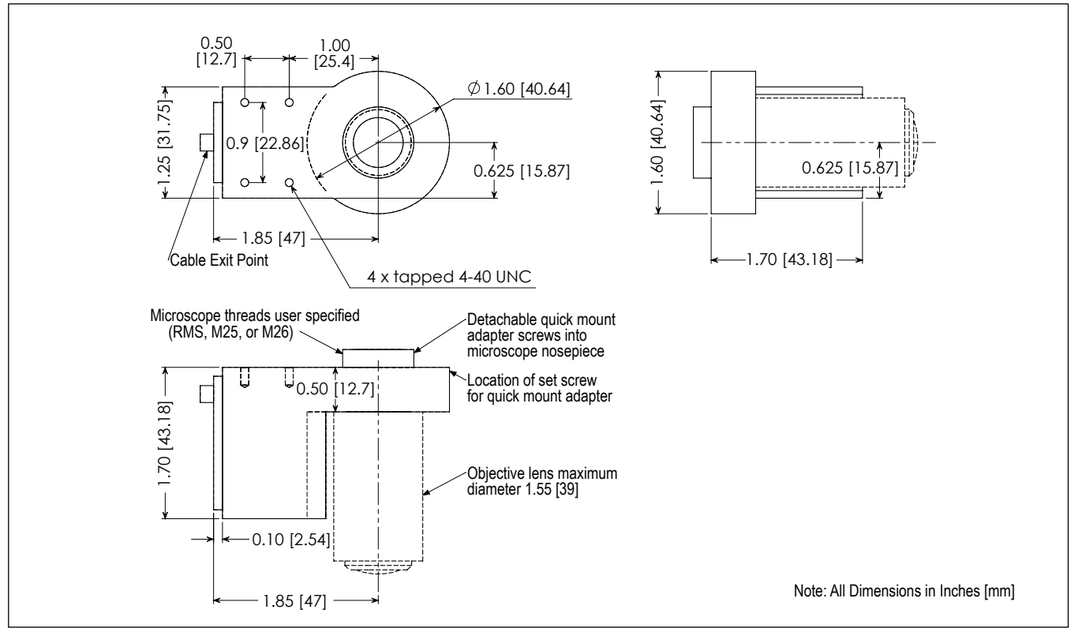
MutS protein imaged with Cy3 via Prism TIRF. Olympus IX71, 60x 1.45NA Oil, 1.6x magnification

◀ *20 minute exposure without C-Focus™.*



◀ *20 minute exposure with C-Focus™.*

Images courtesy of Biomolecular & Cellular Dynamics Lab, Dept of Physics/IBIO, POSTECH South Korea



Nano-MTA Series

Features

- *400 Hz high speed scans*
- *Sub-nanoradian stability*
- *One or two axis tip/tilt piezo nanopositioner*
- *2, 5 or 10 mrad ranges of motion*
- *picoQ® sensor technology*
- *Mount in any orientation*
- *Closed loop control*

Typical Applications

- *High speed, high accuracy beam steering*
- *Astronomy*
- *Interferometry*
- *Optical trapping*
- *FBG writing*
- *Optical disk manufacturing*
- *Active optics*

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Nano-MTA2X (extended range) constructed from aluminum.

Product Description

The Nano-MTA Series are one and two axis piezo tip/tilt nanopositioners. Designed to hold mirrors and with nanoradian resolution under closed loop control, the Nano-MTA Series is ideal for beam steering, tracking, and scanning. Position sensors utilizing proprietary PicoQ® technology provide high stability and low noise performance. The exceptional performance of PicoQ® sensors enable high resolution step performance†. The Nano-MTA Series is capable of continuous, high speed scans at 400 Hz and step response times down to 2 milliseconds. Included Nano-Drive® electronic controllers include sensor electronics, proportional integral feedback control, and 150V amplifiers. The high resolution, high stability performance of the Nano-MTA2 has been employed in the Advanced LIGO experiment and other highly sensitive interferometry and optical experiments. It is ideal for extreme metrology applications.

† Technical Note T-003 "High resolution steps for angular displacement using the Nano-MTA2"

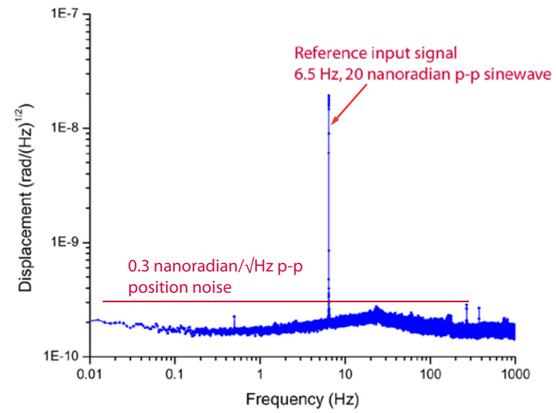
Technical Specifications

Range of motion (Nano-MTA) ..... 2.0 mradian
Resolution..... 4.0 nradian
Range of motion (Nano-MTAX)..... 5.0 mradian
Resolution..... 10 nradian
Range of motion (Nano-MTAX10)..... 10.0 mradian
Resolution..... 20 nradian
Resonant Frequency - Nano-MTA2/2X
X axis (2mrad/5mrad) ..... 3.2kHz/2.8kHz ±20%
Y axis (2mrad/5mrad) ..... 1.25kHz/800Hz ±20%
Resonant Frequency - Nano-MTA2X10
X axis ..... 1.6kHz ±20%
Y axis..... 435Hz ±20%
Scanning Speed ..... up to 400 Hz
Optics ..... 25mm diameter mirror mounting area*
Body Material ..... Al or Invar and Titanium
Controller .....Nano-Drive® Series

Nano-MTA2/2X resonant frequency is with a 25mm diameter x 3mm glass mirror.

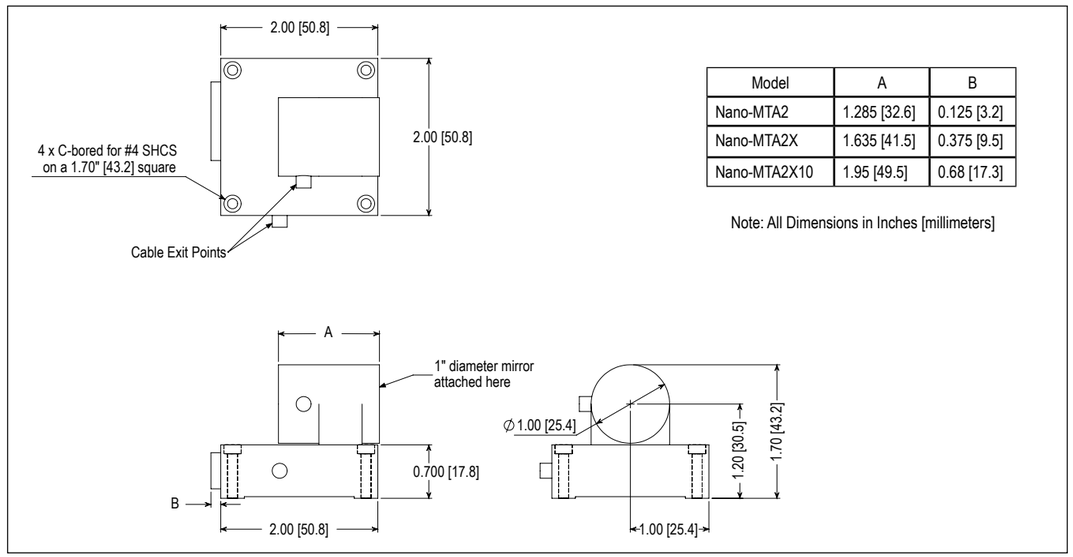
* Mirrors can be attached to the Nano-MTA2 using Milbond adhesive available from Edmund Optics - stock number NT53-288.

Ultra Low Position Noise



Measured position noise of the Nano-MTA2 shows the system's exceptional stability.

Related products
- Nano-MTA Cage Mount
- Nano-MTA/CP
- Nano-Theta



Model	A	B
Nano-MTA2	1.285 [32.6]	0.125 [3.2]
Nano-MTA2X	1.635 [41.5]	0.375 [9.5]
Nano-MTA2X10	1.95 [49.5]	0.68 [17.3]

Note: All Dimensions in Inches [millimeters]

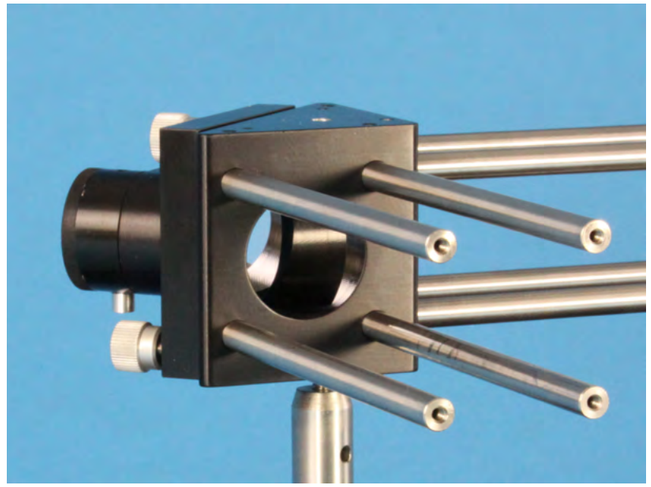
Nano-MTA: Cage mount models

Features

- *400 Hz high speed scans*
- *Single axis with integrated 30mm cage mount*
- *2, 5 or 10 mrad ranges of motion*
- *picoQ sensor technology*
- *Closed loop control*
- *High Stability*
- *Compatible with optical components*

Typical Applications

- *High speed laser beam steering*
- *Astronomy*
- *Fluorescence microscopy*
- *Optical trapping*
- *Interferometry*
- *Optical microscopy*
- *Active optics*



Nano-MTA/HSM shown with cage rods and post

Product Description

The Nano-MTA cage mount models are single axis piezo tip/tilt nanopositioning systems. They have been designed for compatibility with cage mount systems to allow easier integration with standard optomechanical parts and Mad City Labs RM21™ microscopes. Two orientations are available, horizontal scanning and vertical scanning.

With nanoradian resolution, the Nano-MTA Series is ideal for applications involving high precision beam steering, tracking, and scanning. Proprietary PicoQ® position sensors provide absolute, repeatable position measurement under closed loop control with low noise performance. The nanopositioner system is completed with the Nano-Drive® controller with upgrades available to higher power controllers. All controllers include sensor electronics, feedback control, and high voltage amplifiers and ensure optimum performance.

Technical Specifications

Range of motion (Nano-MTA) ..... 2.0 mradian
Resolution ..... 4.0 nradian
Resonant Frequency ..... 3.2kHz±20%

Range of motion (Nano-MTAX) ..... 5.0 mradian
Resolution ..... 10 nradian
Resonant Frequency ..... 3.3kHz ±20%

Range of motion (Nano-MTAX10) ..... 10.0 mradian
Resolution ..... 20 nradian
Resonant Frequency ..... 1.2kHz ±20%

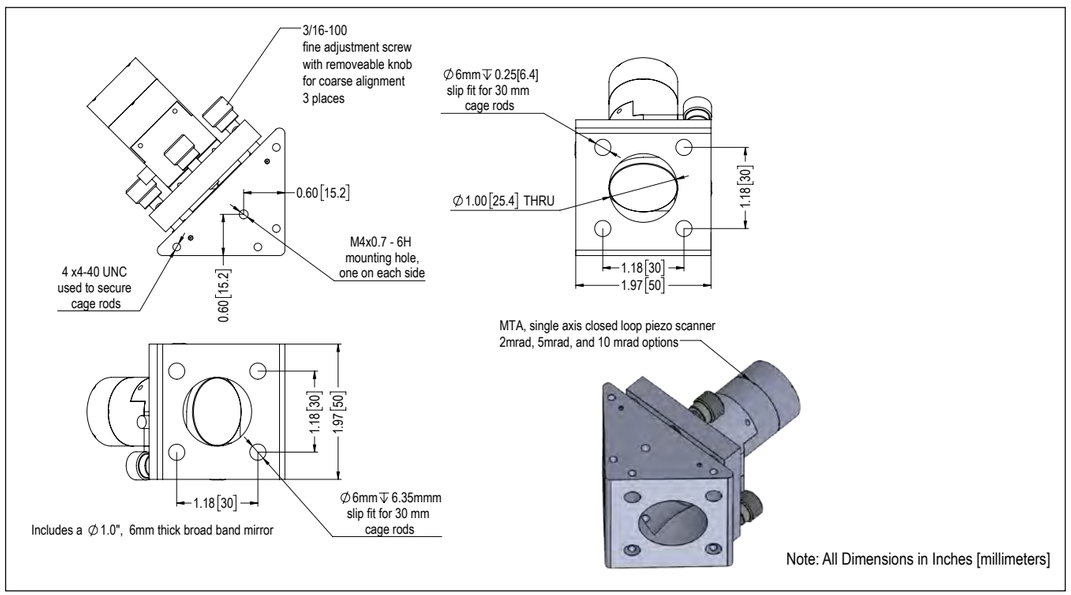
Scanning Speed ..... up to 400 Hz
Optics ..... 25mm diameter broadband mirror*
Body Material ..... Al or Invar and Titanium
Controller ..... Nano-Drive®
Models ..... Nano-MTA/VSM
Nano-MTA/HSM

Nano-MTA2/2X resonant frequency is with a 25mm diameter x 3mm glass mirror.

* Mirrors must be attached at the factory.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.



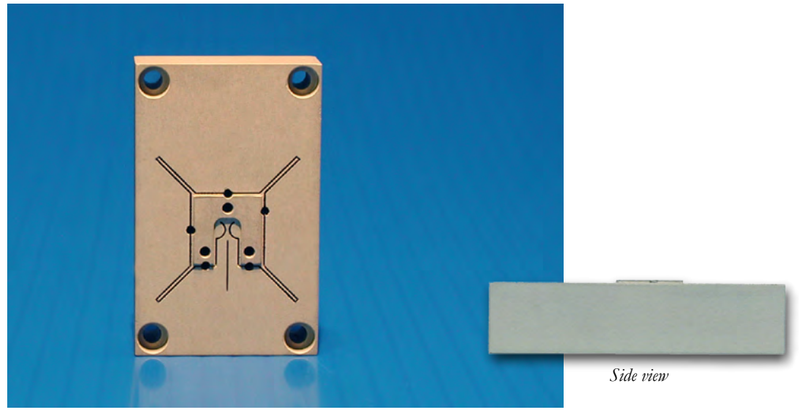
Nano-Theta

Features

- *Precision rotation: 2 mradians range*
- *Accessible and well defined axis of rotation*
- *Mount in any orientation*
- *High resolution: 4 nanoradians*
- *picoQ® sensor technology*
- *Closed loop control*

Typical Applications

- *Laser beam scanning*
- *Lithography*
- *FBG writing*
- *Interferometry*



Side view

Nano-Theta (actual size) constructed from aluminum.

Product Description

The Nano-Theta is a unique piezo-actuated nanopositioning stage having 2 milliradians of total rotational motion. With nanoradian resolution, the Nano-Theta is designed for applications in lithography, optical disk manufacturing, and laser beam tracking or scanning. The innovative design of the Nano-Theta incorporates a readily accessible and well-defined axis of rotation which allows a mirror to be mounted so that it is co-planar with the axis of rotation. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with nanoradian accuracy under closed loop control.

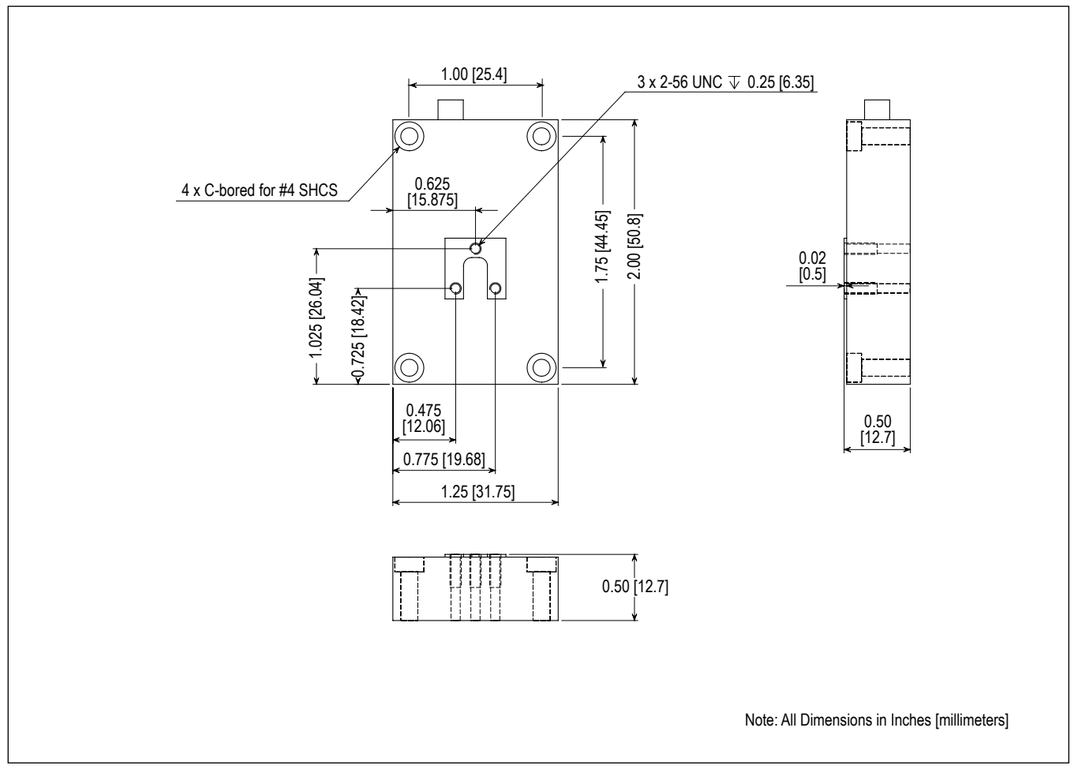
Related products
- Nano-MTA Series
- Nano-Theta/H

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Technical Specifications

Range of motion ..... 2.0 mradians
Resolution ..... 4 nradians
Resonant Frequency (unloaded) ..... 2 kHz ±20%
Body Material ..... Al or Invar
Controller ..... Nano-Drive®



Note: All Dimensions in Inches [millimeters]

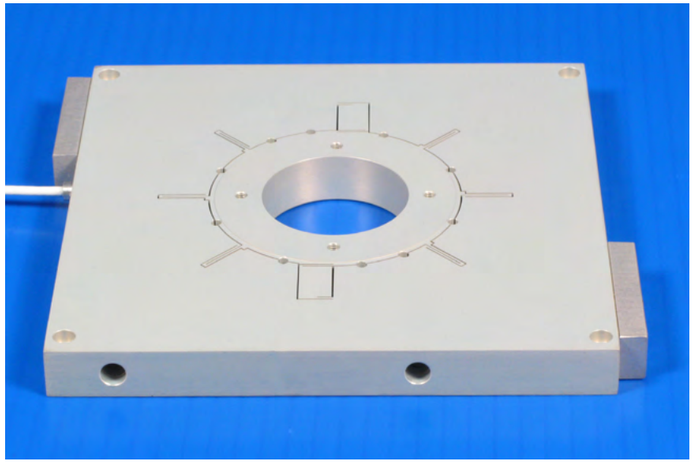
Nano-Theta/H

Features

- *Precision rotation: 5 mradians range*
- *Large center aperture*
- *Mount in any orientation*
- *High resolution: 10 nanoradians*
- *pico sensor technology*
- *Closed loop control*

Typical Applications

- *Precision alignment*
- *Lithography*
- *FBG writing*
- *Polarized nanoscopy*



Related products

- Nano-MTA Series
- Nano-Theta
- Nano-Align6

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

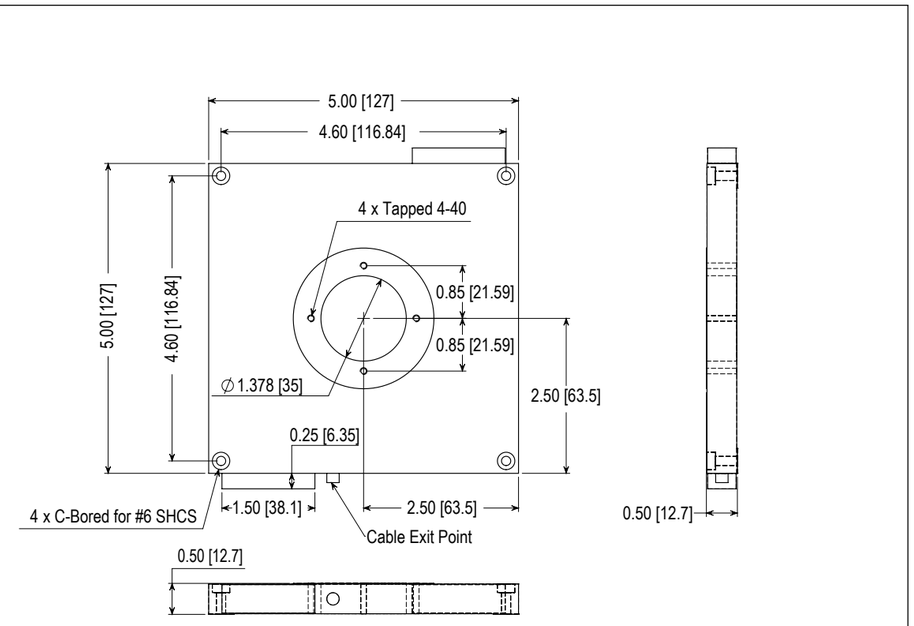
Product Description

The Nano-Theta/H is a unique, high precision piezo nanopositioning system. It is a rotational stage which provides 5 milliradians of total motion and a large center aperture for optical access. The innovative design of the Nano-Theta/H allows it to be combined with our other multi-axis nanopositioning stages for the ultimate flexibility in sample alignment - see the Nano-Align6 Series. Internal position sensors utilizing the proprietary PicoQ® technology provide absolute, repeatable position measurement with nanoradian resolution under closed loop control.
As with all Mad City Labs nanopositioning systems, the Nano-Theta/H is paired with our low noise, high stability Nano-Drive® controllers. Nano-Drive® controllers have a wide range of options, including USB 2.0 digital interface with LabVIEW based software, and third party software compatibility.
Related products include the Nano-Theta and the Nano-MTA Series.

Technical Specifications

Range of motion ..... 5.0 mradians
Resolution ..... 10 nradians
Resonant Frequency (unloaded) ..... 870 Hz ±20%
Recommended max. load (horizontal)* .....0.5 kg
Recommended max. load (vertical)* .....0.2 kg
Body Material .....Al, Invar or Titanium
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Note: All Dimensions in Inches [mm]

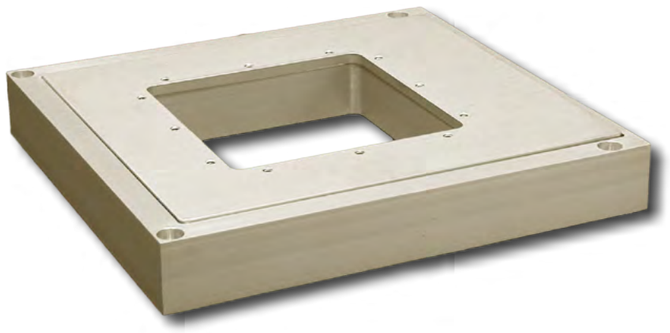
Nano-Align3 Series

Features

- *Low profile: 0.8"*
- *Three axis motion (Z θ_X θ_Y)*
- *Large center aperture: 2.6" x 2.6"*
- *Long range: 100 µm or 200 µm (Z), 2mradians or 4mradians (θ_X θ_Y)*
- *pico sensor technology*
- *Closed loop control*

Typical Applications

- *Z-axis plus tip/tilt alignment*
- *Nanolithography*
- *Microscopy*
- *MEMS*



LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products
- Nano-Align5
- Nano-M3Z

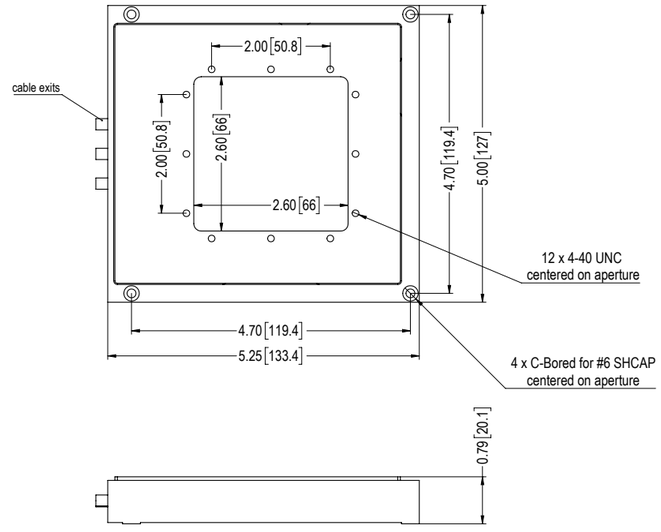
Product Description

The Nano-Align3 is a three axis (Z, θ_X, θ_Y) piezo nanopositioning system with a large center aperture. The Nano-Align3 allows for precise linear positioning in the z-axis while also allowing for precision tip/tilt positioning. The low profile design of the Nano-Align3 allows it to be integrated into existing instrumentation where space is restricted. The center aperture makes the Nano-Align3 ideal for demanding microscopy alignment applications.
Internal position sensors utilizing proprietary PicoQ® technology provide picometer and nanoradian precision under closed loop control. The Nano-Align3, like all Mad City Labs nanopositioning systems, is accompanied by our low noise, closed loop Nano-Drive® controller. Nano-Drive® controllers are available with a range of options including USB 2.0 digital interfaces and software compatibility.

Technical Specifications

Ranges of motion (Nano-Align3-100)
Z axis ..... 100 µm
θ_X and θ_Y .....2 mradian
Ranges of motion (Nano-Align3-200)
Z axis ..... 200 µm
θ_X and θ_Y .....4 mradian
Resolution (Nano-Align3-100).....0.2nm/ 4 nradian
Resolution (Nano-Align3-200).....0.4nm/ 8 nradian
Resonant Frequency (Nano-Align3-100) ..... 425 Hz ±20%
Resonant Frequency (Nano-Align3-200) ..... 230 Hz ±20%
Recommended max. load (horizontal)* .....0.5 kg
Recommended max. load (vertical)*.....0.2 kg
Body Material .....Aluminum, Titanium, or Invar
Controller .....Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



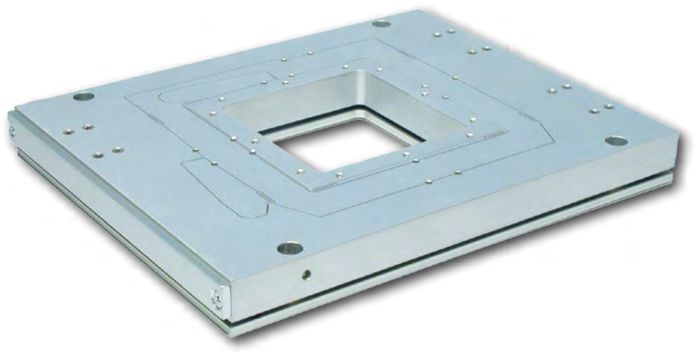
Nano-Align5 Series

Features

- *Low profile*
- *Five axis motion (XYZ θ_X θ_Y)*
- *100 µm, 200 µm, or 300 µm motion in XYZ*
- *Up to 3.5mrad motion in θ_X, and up to 4.3 mrad motion in θ_Y*
- *Center aperture: 2.6" x 2.6"*
- *Closed loop control*
- *picoQ sensor technology*

Typical Applications

- *Alignment*
- *MEMS*
- *Nanolithography*
- *Metrology*



LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products

- Nano-Align6
- Nano-LP Series
- Nano-Align3

Product Description

The Nano-Align5 is a five axis closed loop, piezo nanopositioning system with a large center aperture. The Nano-Align5 is ideal for alignment applications which require three linear axes of motion (X, Y, Z) combined with "tip" and "tilt" ($\theta_X\theta_Y$). The large center aperture provides excellent access for microscopy optics, sample holders, and probe placement. The Nano-Align5 includes internal sensors with proprietary PicoQ® technology for absolute position measurement and picometer/nanoradian accuracy under closed loop control.

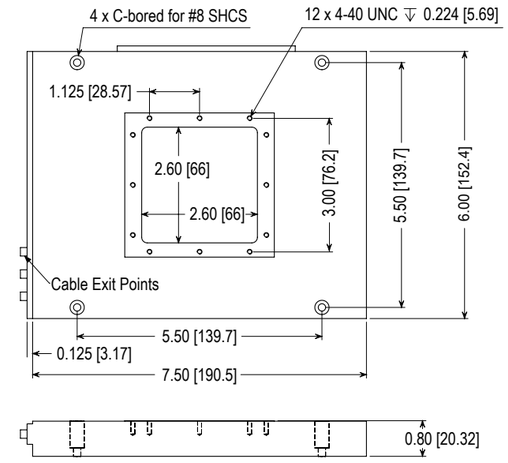
The Nano-Align5, like all Mad City Labs nanopositioning systems, is accompanied by our low noise, closed loop Nano-Drive® controller. Nano-Drive® controllers are available with a range of options including USB 2.0 digital interfaces and software compatibility.

The Nano-Align5 can be combined with the MicroStage and Manual MicroStage for long range micropositioning.

Technical Specifications

Ranges of motion (Nano-Align5-100)	100 x 100 x 100 µm x 1.1 mrad (θ_X) x 1.5 mrad (θ_Y)
Ranges of motion (Nano-Align5-200)	200 x 200 x 200 µm x 2.3 mrad (θ_X) x 3.0 mrad (θ_Y)
Ranges of motion (Nano-Align5-300)	300 x 300 x 300 µm x 3.5 mrad (θ_X) x 4.3 mrad (θ_Y)
Resolution (Nano-Align5-100)	0.2 nm (XYZ), 2.2 nrad (θ_X), 3.0 nrad (θ_Y)
Resolution (Nano-Align5-200)	0.4 nm (XYZ), 4.6 nrad (θ_X), 6.0 nrad (θ_Y)
Resolution (Nano-Align5-300)	0.6 nm (XYZ), 6.6 nrad (θ_X), 9.0 nrad (θ_Y)
Resonant Frequencies	
X axis (100/200/300 µm)	360/270/265 Hz ±20%
Y axis (100/200/300 µm)	205/185/140 Hz ±20%
Z axis (100/200/300 µm)	200/115/110 Hz ±20%
Stiffness	1.0 N/µm
Recommended max. load (horizontal)*	0.5 kg
Recommended max. load (vertical)*	0.2 kg
Body Material	Al or Invar
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Note: All Dimensions in Inches [mm]

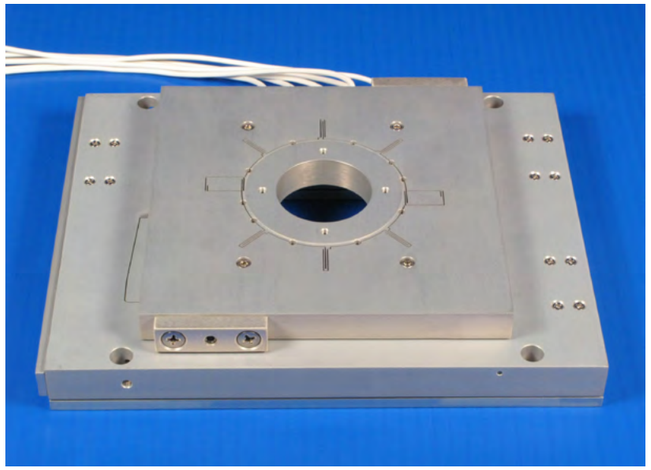
Nano-Align6 Series

Features

- *Low profile*
- *Six axis motion (XYZ θ_X θ_Y θ_Z)*
- *100 µm x 100 µm x 100 µm x 1.1 mrad x 1.5 mrad x 5 mrad ranges of motion*
- *200 µm x 200 µm x 200 µm x 2.3 mrad x 3.0 mrad x 5 mrad ranges of motion*
- *Center aperture: 35mm diameter*
- *Closed loop control*
- *picoQ® sensor technology*

Typical Applications

- *Alignment*
- *MEMS*
- *Nanolithography*
- *Metrology*



Nano-Align6 constructed from aluminum.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products

- Nano-Align5
- Nano-Theta/H
- Nano-Align3

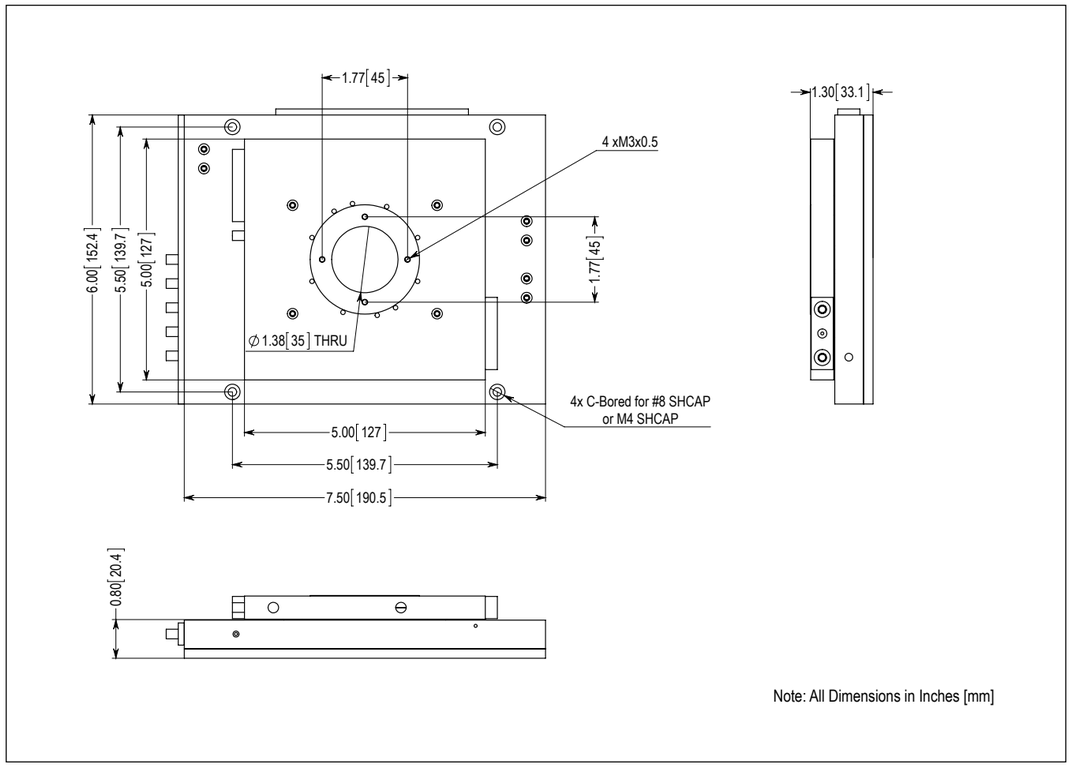
Product Description

The Nano-Align6 is a six axis closed loop, piezo nanopositioning system with a large center aperture. The Nano-Align6 is ideal for alignment applications which require three linear axes of motion (X, Y, Z) combined with rotational motion about each axis. The large aperture provides excellent access for microscopy optics, sample holders, and probe placement. The Nano-Align6 includes internal position sensors on every axis using Mad City Labs' proprietary PicoQ® technology for absolute position measurement and picometer/nanoradian accuracy under closed loop control.
The Nano-Align6 is a unique product combining linear motion with precision rotational motion.

Technical Specifications

Ranges of motion (Nano-Align6-100) ..... 100 x 100 x 100 µm x 1.1 mrad (θ_X) x 1.5 mrad (θ_Y) x 5 mrad (θ_Z)
Ranges of motion (Nano-Align6-200) ..... 200 x 200 x 200 µm x 2.3 mrad (θ_X) x 3.0 mrad (θ_Y) x 5 mrad (θ_Z)
Resolution (Nano-Align6-100) ..... 0.2 nm (XYZ), 2.2 nrad (θ_X), 3.0 nrad (θ_Y), 10 nrad (θ_Z)
Resolution (Nano-Align6-200) ..... 0.4 nm (XYZ), 4.6 nrad (θ_X), 6.0 nrad (θ_Y), 10 nrad (θ_Z)
Resonant Frequencies
X axis (Nano-Align6-100/Nano-Align6-200) ..... 200/135 Hz ±20%
Y axis (Nano-Align6-100/Nano-Align6-200) ..... 110/95 Hz ±20%
Z axis (Nano-Align6-100/Nano-Align6-200) ..... 130/100 Hz ±20%
θ_Z axis ..... 870 Hz ±20%
Recommended max. load (horizontal)* ..... 0.5 kg
Recommended max. load (vertical)* ..... 0.2 kg
Body Material ..... Aluminum, Titanium, or Invar
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Note: All Dimensions in Inches [mm]

Nano-M3Z

Features

- *Compact design*
- *Three axis motion (Z θ_X θ_Y)*
- *Low profile: 0.76"*
- *pico sensor technology*
- *Closed loop control*

Typical Applications

- *Z-axis plus tip/tilt alignment*
- *Nanolithography*
- *Metrology*
- *Nano-alignment*

Nano-M3Z constructed from aluminum.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products

- Nano-Align3
- Nano-MZ
- Nano-Man5

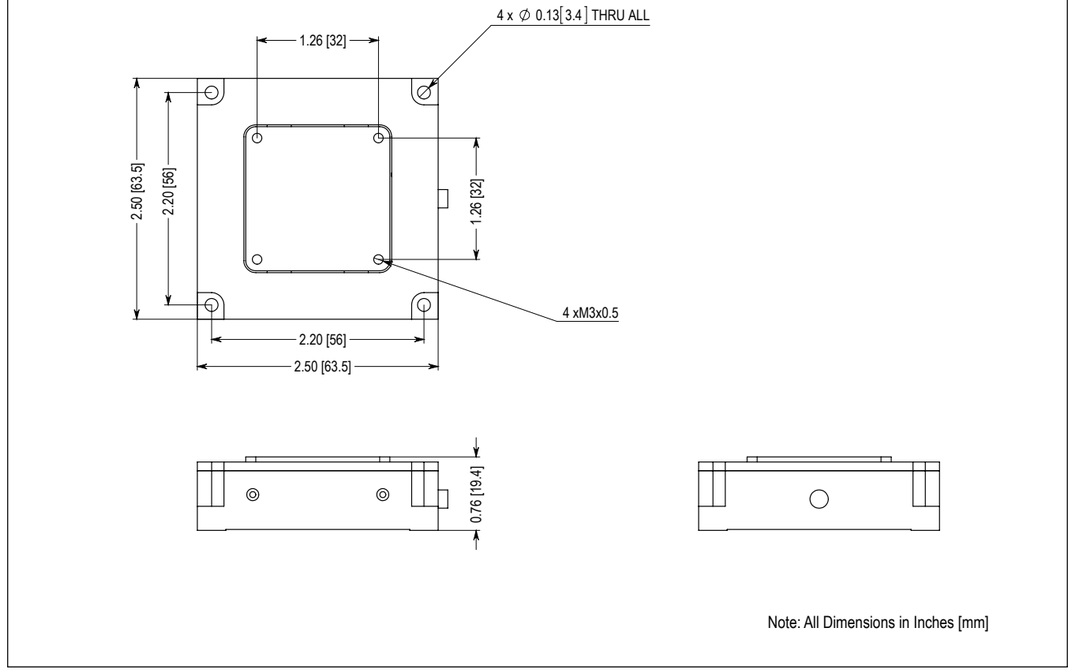
Product Description

The Nano-M3Z is a compact, three axis piezo nanopositioning system constructed from aluminum. The nanopositioner is ideal for alignment applications with motion in Z, θ_X, θ_Y. The compact design of the Nano-M3Z allows it to be integrated into existing instrumentation where space is restricted. The Nano-M3Z is ideal for demanding applications which require precise alignment capabilities. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with picometer and nanoradian accuracy under closed loop control. A related model, the Nano-Man5, incorporates linear X and Y motion to the the capabilities of the Nano-M3Z.

Technical Specifications

Range of motion (Z) ..... 25 µm
Range of motion (θ_X) ..... 1 mradian
Range of motion (θ_Y) ..... 1 mradian
Resolution (Z) ..... 0.05 nm
Resolution (θ_X) ..... 2 nradian
Resolution (θ_Y) ..... 2 nradian
Resonant Frequency ..... 500 Hz ±20%
Stiffness ..... 1.0 N/µm
Recommended max. load (horizontal)* ..... 0.5 kg
Recommended max. load (vertical)* ..... 0.2 kg
Body Material ..... Aluminum
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Nano-Man5

Features

- *Compact size*
- *Five axis motion (XYZ θ_X θ_Y)*
- *50 µm x 50 µm x 25 µm x 1mrad x 1mrad*
- *Closed loop control*
- *PicoQ sensor technology*
- *Vacuum compatible models available*

Typical Applications

- *Alignment*
- *MEMS*
- *Nanolithography*
- *SEM*

The Nano-Man5 is a 5 axis closed loop nanopositioning system constructed from aluminum.

Related products

- Nano-Align5
- Nano-Align6
- Nano-M3Z

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

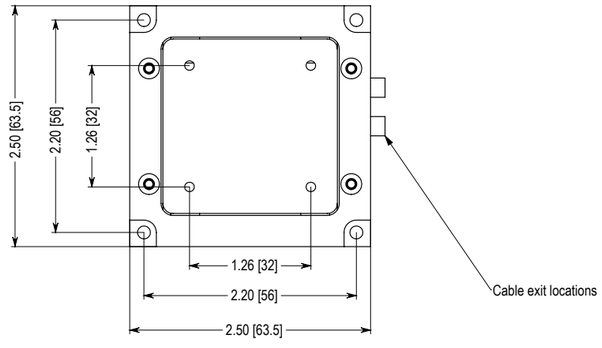
Product Description

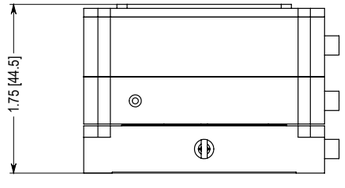
The Nano-Man5 is a five axis piezo nanopositioning system with closed loop feedback control for absolute position measurement. The compact design of the Nano-Man5 allows it to be easily integrated into existing instrumentation for applications such as nanolithography and SEM. The Nano-Man5 is ideal for alignment applications which require three linear axes of motion (X, Y, Z) combined with "tip" and "tilt" ($\theta_X\theta_Y$). Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with picometer and nanoradian accuracy under closed loop control. The Nano-Man5 is also available in high vacuum (non-bakeable) compatible models. Similar to the Nano-Man5, the Nano-M350 shares the same physical dimensions but has only three axes (XYZ) of motion.

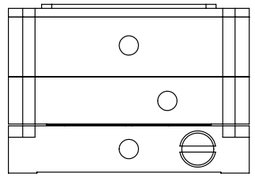
Technical Specifications

Range of motion (X)	50 µm
Range of motion (Y)	50 µm
Range of motion (Z)	25 µm
Range of motion (θ_X)	1 mradian
Range of motion (θ_Y)	1 mradian
Resolution (X)	0.1 nm
Resolution (Y)	0.1 nm
Resolution (Z)	0.05 nm
Resolution (θ_X)	2 nradian
Resolution (θ_Y)	2 nradian
Resonant Frequency (X)	285 Hz ±20%
Resonant Frequency (Y)	235 Hz ±20%
Resonant Frequency (Z)	1580 Hz ±20%
Recommended max. load (horizontal)*	0.2 kg
Recommended max. load (vertical)*	0.2 kg
Body Material	Aluminum
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.







Note: All Dimensions in Inches [mm]

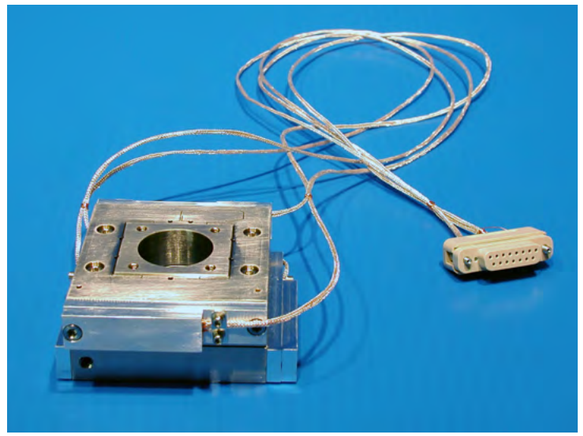
Nano-UHV50

Features

- *UHV compatible construction*
- *Two axis (XY)*
- *50 µm x 50 µm ranges of motion*
- *Bakeable to 100° C*
- *Titanium or invar construction*
- *pico sensor technology*
- *Closed loop control*

Typical Applications

- *X-ray, VUV, and optical microscopy*
- *Surface metrology*
- *UHV atomic scale microscopy*
- *Custom designs - just contact us with your requirements*



Nano-UHV50 constructed from titanium. Shown with custom Kapton cables and silver plated copper shielding. The 15-pin, sub-D, vacuum compatible PEEK connector is wired to be compatible with vacuum feedthrough flanges.

Product Description

The Nano-UHV50 is a two axis ultra-high vacuum (UHV) compatible nanopositioning system constructed from titanium or invar. Made entirely from UHV compatible materials, the Nano-UHV50 is bakeable to 100°C for vacuum applications in the 10^{-10} Torr range. A 1 inch (25mm) center aperture provides an optical pathway or access for sample holders.
Proprietary PicoQ® sensor technology provide absolute, repeatable position measurement with picometer accuracy. PicoQ® sensors are fully UHV compatible and are not affected by cable length, unlike capacitive sensor systems which suffer from 60% increased position noise for every meter of UHV cable added. Mad City Labs nanopositioning systems can be ordered with custom UHV cable lengths, and air side cables can easily be extended by adding standard, well-shielded extension cables without performance loss. Mad City Labs nanopositioning systems with PicoQ® sensor technology also do not require costly signal conditioning boxes. Connector wiring is compatible with Accu-Glass Products electrical feedthrough flanges - compatibility with other types of flanges may be requested.

Technical Specifications

Range of motion (X)	50 µm
Range of motion (Y)	50 µm
Resolution (XY)	0.1 nm
Resonant Frequency (X)	500 Hz ±20%
Resonant Frequency (Y)	250 Hz ±20%
Stiffness	0.5 N/µm
θ_{roll} , θ_{pitch} (typical)	≤1 µrad
θ_{yaw} (typical)	≤3 µrad
Recommended max. load (horizontal)*	0.5 kg
Recommended max. load (vertical)*	0.2 kg
Body Material	Invar or Titanium
Controller	Nano-Drive®

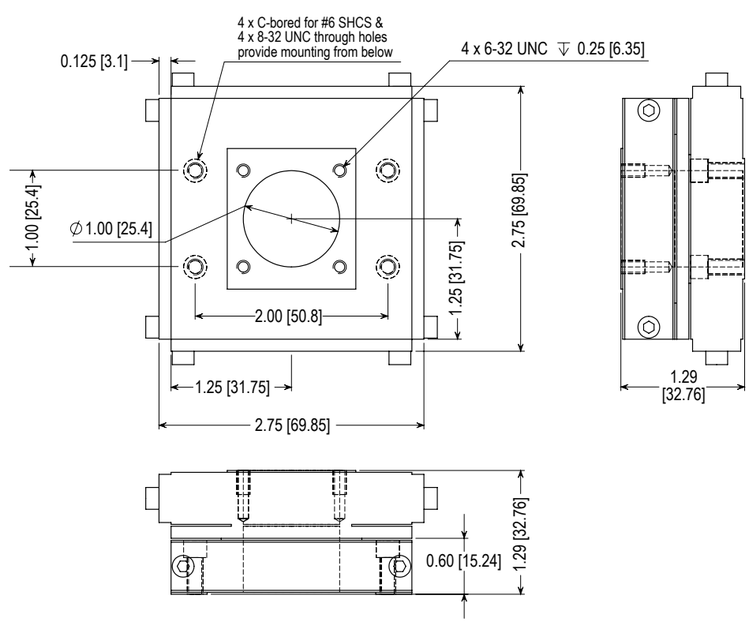
* Larger load requirements should be discussed with our engineering staff.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products

- Nano-UHV100
- Nano-UHV200
- MadMotor®
- Custom Design



Note: All Dimensions in Inches [mm]

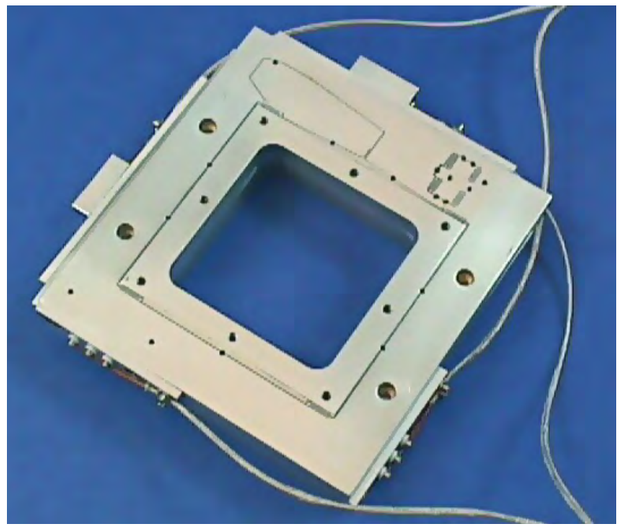
Nano-UHV100

Features

- *UHV compatible construction*
- *Two axis (XY), large aperture*
- *100 µm x 100 µm ranges of motion*
- *Bakeable to 100° C*
- *Titanium or invar construction*
- *PicoQ® sensor technology*
- *Closed loop control*

Typical Applications

- *X-ray, VUV, and optical microscopy*
- *Surface metrology*
- *UHV atomic scale microscopy*
- *Custom designs - just contact us with your requirements*



Nano-UHV100 constructed from titanium. Integrated PicoQ® position sensors are fully UHV compatible and are unaffected by cable length. Custom cables have Kapton insulation and silver plated copper shielding. The 15-pin, sub-D, vacuum compatible PEEK connector is wired to be compatible with vacuum feedthrough flanges.

Product Description

The Nano-UHV100 is a two axis ultra-high vacuum (UHV) compatible nanopositioning stage constructed from either titanium or invar. Made entirely from UHV compatible materials, the Nano-UHV100 can be baked to 100°C for vacuum applications in the 10^{-10} Torr range. The large center aperture makes the Nano-UHV100 ideal for vacuum microscopy applications. Proprietary PicoQ® sensor technology provide absolute, repeatable position measurement with picometer accuracy. PicoQ® sensors are fully UHV compatible and are not affected by cable length, unlike capacitive sensor systems which suffer from 60% increased position noise for every meter of UHV cable added. Mad City Labs nanopositioning systems can be ordered with custom UHV cable lengths, and air side cables can easily be extended by adding standard, well-shielded extension cables without performance loss. Mad City Labs nanopositioning systems with PicoQ® sensor technology also do not require costly signal conditioning boxes. Connector wiring is compatible with Accu-Glass Products electrical feedthrough flanges - compatibility with other types of flanges may be requested.

Technical Specifications

Range of motion (X)	100 µm
Range of motion (Y)	100 µm
Resolution (XY)	0.2 nm
Resonant Frequency (X)	500 Hz ±20%
Resonant Frequency (Y)	250 Hz ±20%
Stiffness	1.0 N/µm
θ_{roll} , θ_{pitch} (typical)	≤1 µrad
θ_{yaw} (typical)	≤3 µrad
Recommended max. load (horizontal)*	0.5 kg
Recommended max. load (vertical)*	0.2 kg
Body Material	Invar or Titanium
Controller	Nano-Drive®

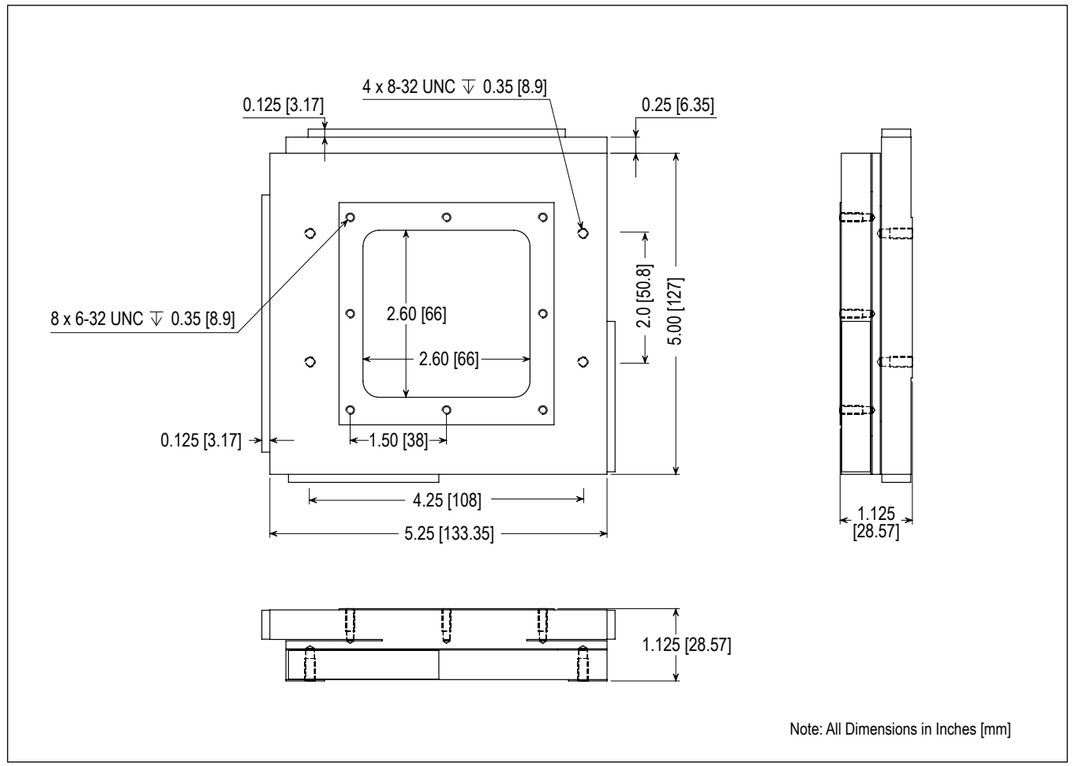
* Larger load requirements should be discussed with our engineering staff.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products

- Nano-UHV50
- Nano-UHV200
- MadMotor®
- Custom Design



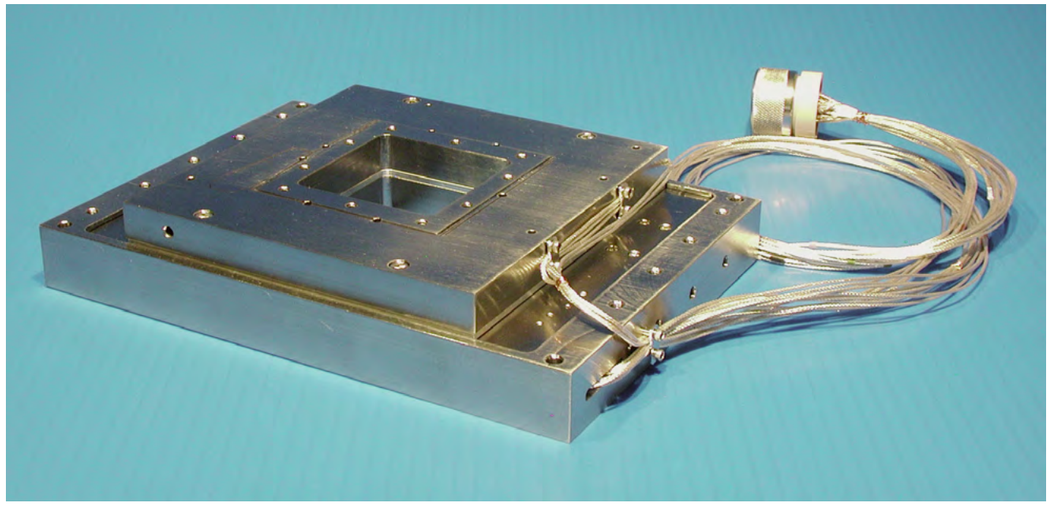
Nano-UHV200

Features

- *UHV compatible construction*
- *Three axis (XYZ)*
- *200 µm x 200 µm x 200 µm motion*
- *Bakeable to 100° C*
- *Titanium and 316SS construction*
- *PicoQ® sensor technology*
- *Closed loop control*

Typical Applications

- *X-ray, VUV, and optical microscopy*
- *Surface metrology*
- *UHV atomic scale microscopy*
- *Special designs - just contact us with your requirements*



Nano-UHV200 constructed from titanium and 316SS. Custom cables have Kapton insulation and silver plated copper shielding terminated with a 19-pin, MIL-C-26482, vacuum compatible PEEK connector. PicoQ® position sensors deliver the same low noise performance irrespective of the cabling length.

Product Description

The Nano-UHV200 is a three axis ultra-high vacuum (UHV) piezo nanopositioning system constructed from titanium and 316 stainless steel. Made entirely from non-magnetic UHV compatible materials, the Nano-UHV200 is bakeable to 100°C for vacuum applications in the 10^{-10} Torr range. A center aperture provides an optical pathway or access for sample holders. Proprietary PicoQ® sensor technology provide absolute, repeatable position measurement with picometer accuracy. PicoQ® sensors are fully UHV compatible and are not affected by cable length, unlike capacitive sensor systems which suffer from 60% increased position noise for every meter of UHV cable added. Mad City Labs nanopositioning systems can be ordered with custom UHV cable lengths, and air side cables can easily be extended by adding standard, well-shielded extension cables without performance loss. Mad City Labs nanopositioning systems with PicoQ® sensor technology also do not require costly signal conditioning boxes. Connector wiring is compatible with Accu-Glass Products electrical feedthrough flanges - compatibility with other types of flanges may be requested.

Technical Specifications

Range of motion (X)	200 µm
Range of motion (Y)	200 µm
Range of motion (Z)	200 µm
Resolution (XYZ)	0.4 nm
Resonant Frequency (X)	300 Hz ±20%
Resonant Frequency (Y)	150 Hz ±20%
Resonant Frequency (Z)	175 Hz ±20%
Stiffness	2 N/µm
θ_{roll} , θ_{pitch} (typical)	≤1 µrad
θ_{yaw} (typical)	≤3 µrad
Recommended max. load (horizontal)*	0.5 kg
Recommended max. load (vertical)*	0.2 kg
Body Material	Titanium and 316 SS
Controller	Nano-Drive®

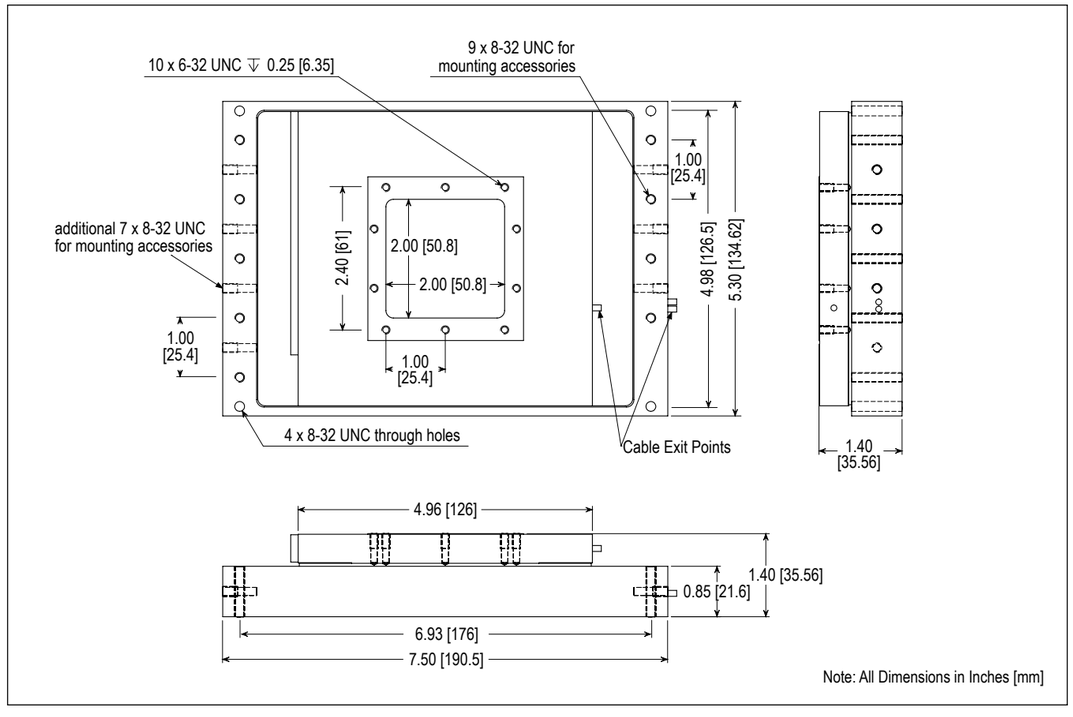
* Larger load requirements should be discussed with our engineering staff.

LabVIEW Compatible USB Interfaces

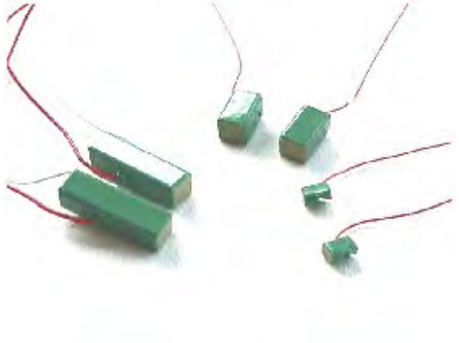
Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Related products

- Nano-UHV50
- Nano-UHV100
- MadMotor®
- Custom Designs



Piezoactuators



Related products
- PA3 power amplifier
- PA25 power amplifier

Product Description

Mad City Labs offers a range of coated, multilayer piezoactuators for applications that do not require a flexure guided stage. These high performance multilayer piezoactuators are typically in stock for immediate shipment. These low voltage multilayer piezoactuators have variable cross sections and displacements up to 18µm. These actuators can be easily bonded together in larger stacks for greater displacement. For nanopositioning applications that require the integration of multilayer piezoactuators into flexure guided motion stages, please see our Nanopositioning product range.
The multilayer piezoactuators can be driven using either the PA3 power amplifier or the PA25 power amplifier.

Technical Specifications

Model	PZT1	PZT2	PZT3	PZT4
Length (mm)	*5 ± 0.1*	*10 ± 0.1*	*20 ± 0.1*	*10 ±0.1*
Max. Cross Section (mm)	*3.5×4.5*	*3.5×4.5*	*3.5×4.5*	*3.5×4.5*
Max. voltage (VDC)	*150*	*150*	*150*	*150*
Max. Displacement (µm)	*4.6 ± 1.5*	*9.1 ± 1.5*	*17.4 ± 1.5*	*9.1 ± 1.5*
Capacitance (µF ± 20%)	*0.10*	*0.18*	*0.35*	*0.75*
Unloaded resonant frequency (kHz)	*261*	*138*	*69*	*138*
Generated Force (N)	*200*	*200*	*200*	*850*
Tensile Strength (N/m^2)	*20*	*20*	*20*	*85*
Young's Modulus (N/m^2)	4.4×10^{10}	4.4×10^{10}	4.4×10^{10}	4.4×10^{10}
Temperature Range (°C)	*-25 to +85*	*-25 to +85*	*-25 to +85*	*-25 to +85*

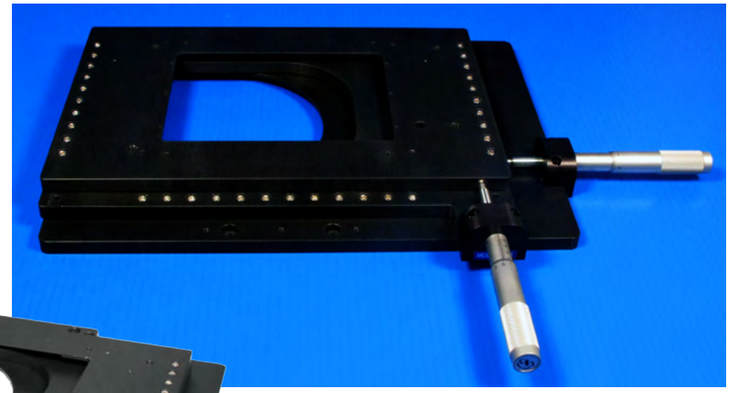
Manual MicroStage-LT Series

Features

- *Up to 50mm total motion on XY axes*
- *Highly stable - nanopositioner compatible*
- *Allows objective nosepiece rotation*
- *Manual micrometer position adjustment*
- *1 µm vernier scales*
- *Integrated, continuous position locking*
- *Compatible with inverted microscopes and optical tables*

Typical Applications

- *Coarse positioning for high resolution nanopositioning stages*
- *Direct replacement for standard, non-locking microscopy stages*



Manual MicroStage-LT2x2 with 50mm travel per axis constructed from aluminum.

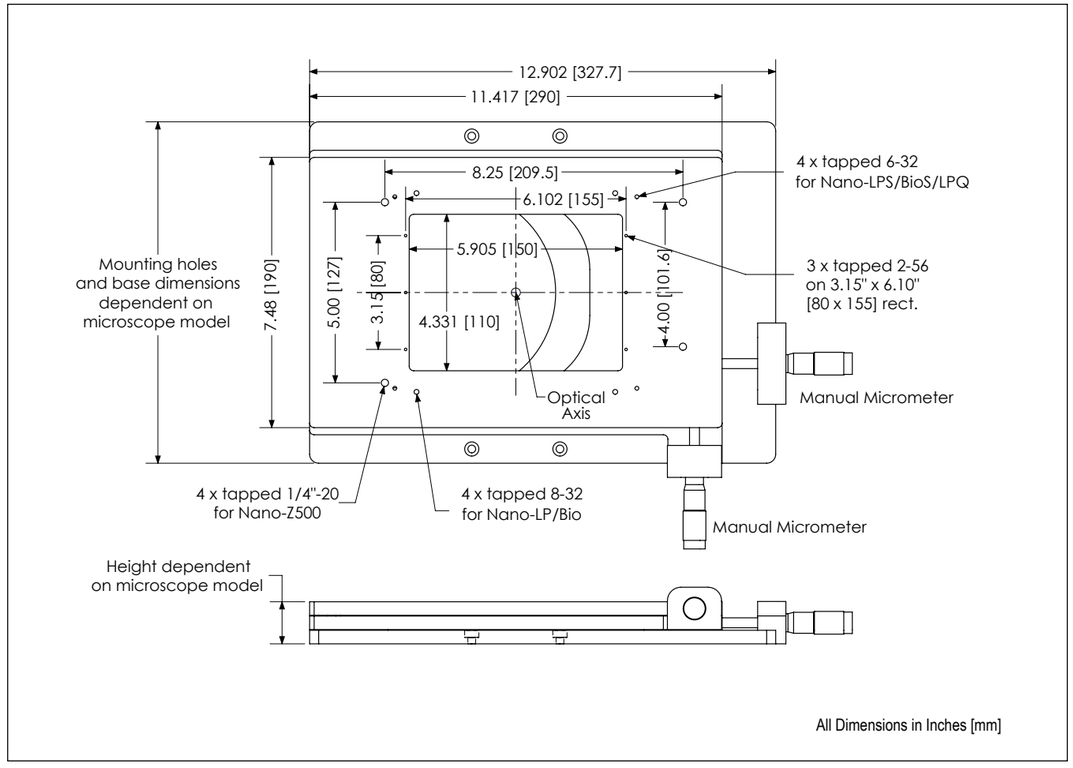
Manual MicroStage-LT1x1 with 25mm of travel in XY is shown with optional adjustable breadboard.

Product Description

The Manual MicroStage-LT is Mad City Labs' popular micrometer driven microscope stage developed for use with high resolution nanopositioners. The Manual MicroStage-LT offers travel up to 50mm and an aperture design which allows rotation of the microscope's objective nosepiece. The Manual MicroStage-LT continuous internal position locking combined with excellent stability makes this stage an ideal base for high resolution nanopositioning stages.
The microscope stage has been carefully dimensioned to locate the top surface of the stage within the microscope's focal range. Nanopositioning stages with re-entrant sample holders can be used on top of the Manual MicroStage-LT while maintaining the ability to change objective lenses. Models compatible with inverted optical microscope models and optical tables are available. For versions compatible with select upright microscopes please see Manual MicroStage-UP Series.

Technical Specifications

Axes of motion	XY
Ranges of motion (XY)	up to 50mm
Graduations	10 µm
Vernier graduations	1 µm
Body Material	Aluminum
Models	LT1x1
	LT2x2
Compatibilty	Optical Table (imperial/metric)
	Nikon Ti microscopes
	Olympus IX microscopes
	Zeiss Axiovert
Options	Adjustable breadboard



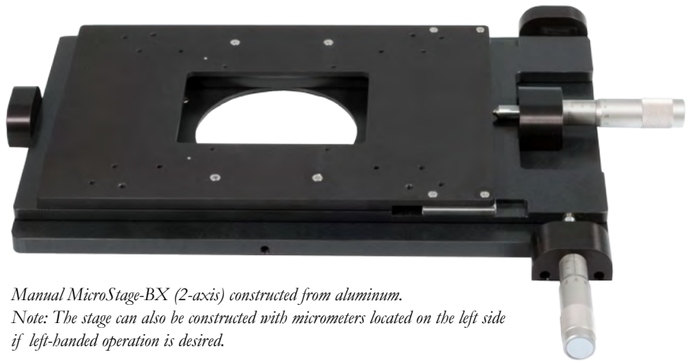
Manual MicroStage-UP Series

Features

- *25mm travel on XY axes*
- *Manual micrometer position adjustment*
- *1 μm vernier scales*
- *Integrated, continuous position locking*
- *Compatible with select upright microscopes*
- *Highly stable - nanopositioner ready*

Typical Applications

- *Coarse positioning for high resolution nanopositioning stages*
- *Direct replacement for standard, non-locking microscopy stages*



Manual MicroStage-BX (2-axis) constructed from aluminum.
Note: The stage can also be constructed with micrometers located on the left side if left-handed operation is desired.

Sub-stage mounting surface compatible with Manual MicroStage-BX
Olympus part number: AV619700

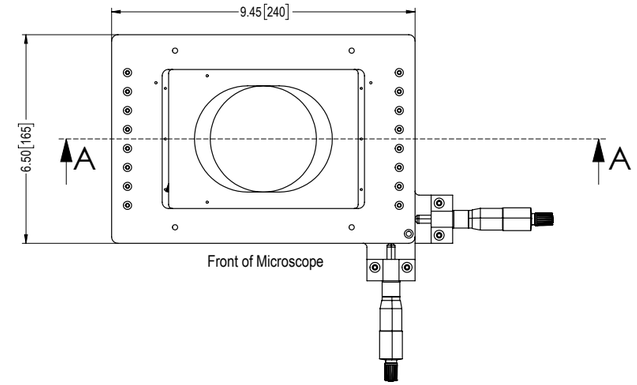
Product Description

The Manual MicroStage-UP Series fits select upright optical microscopes and uses manual micrometers to control XY motion. Total XY range of motion is 25mm. Continuous internal position locking combined with excellent stability makes this stage an ideal base for Mad City Labs' high resolution Z-axis nanopositioning stages. Standard, non-locking, manual microscope stages suffer from position drift if used as a coarse positioner for a fast moving nanopositioning stage. Constructed from anodized aluminum, the Manual MicroStage-UP has a specialized mounting arrangement which mates directly with selected upright microscope models. No additional hardware or brackets are necessary.

Technical Specifications

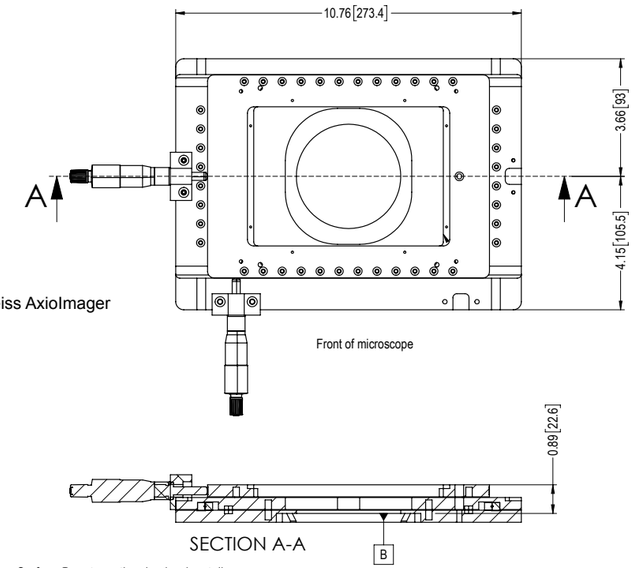
Axes of motion ..... XY
Ranges of motion (XY) ..... 25 mm
Graduations ..... 10 μm
Vernier graduations ..... 1 μm
Body Material ..... Aluminum
Compatibilty ..... Nikon Eclipse 80i
Olympus BX
Zeiss AxioImager
Options ..... Left/Right mount micrometers

Nikon Eclipse 80i



Surface B rests on the circular dovetail of the Nikon 80i microscope, the microstage is locked onto the the cirular dovetail be a set screw from the front.

Olympus BX53/Zeiss AxioImager



Surface B rests on the circular dovetail of the Olympus BX53 microscope, the microstage is locked onto the circular dovetail by a set screw from the front.

All Dimensions in Inches [mm]

MicroStage Series

Features

- *XY motion: 25mm*
- *Proprietary intelligent control for stability*
- *High native precision & accuracy*
- *Nanopositioner compatible*
- *Fits inverted microscopes, custom available*
- *Optional encoders: 50 nm resolution*

Typical Applications

- *Single Molecule Microscopy*
- *Complex, programmed motion control*
- *High stability microscopy*
- *Automation*

MicroStage with optional breadboards for mounting probes or other accessories. Breadboard position is easily adjusted and breadboards can be removed if not needed.

Compatible Software Packages

LabVIEW

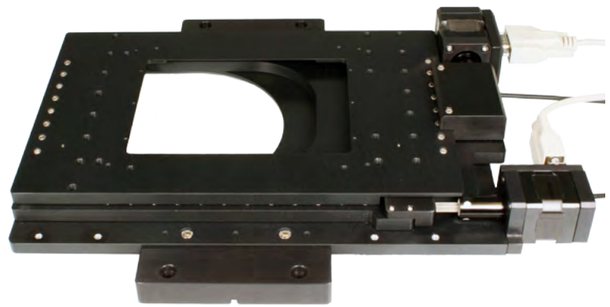
µManager Open Source Microscopy Software — *USB motion control*

MetaMorph — *USB motion control*

Examples supplied for the Micro-Drive™ controller

SlideBook 6 Digital Microscopy Software

Slide holder with coverslip/ petri dish adapter.



MicroStage (2-axis) constructed from aluminum.

Product Description

The MicroStage is a precision, stepper motor driven, micropositioning system for microscopy applications. Long range (25 mm) linear positioning is provided in X and Y with high resolution and excellent repeatability. Employing proprietary intelligent control results in exceptional stability with high native precision making our MicroStages the ideal choice for demanding microscopy and nanoscopy. The MicroStage is compatible with a range of Mad City Labs nanopositioning systems. The addition of optional high resolution linear encoders provide real-time feedback of the actual stage position.

The included Micro-Drive™ controller connects to a PC via a USB port and can be controlled with the supplied LabVIEW based software. Complex motion profiles can be programmed and sophisticated control parameters such as automatic acceleration and deceleration is employed to achieve high stability and native accuracy. Optional wireless gamepad control is also available. MicroStages are offered for the following inverted microscopes: Olympus IX Series, Nikon TE/Ti Series, Leica DMI Series, and Zeiss Axiovert/Axio Observer Series. MicroStages designed for optical tables and select upright optical microscopes are also available.

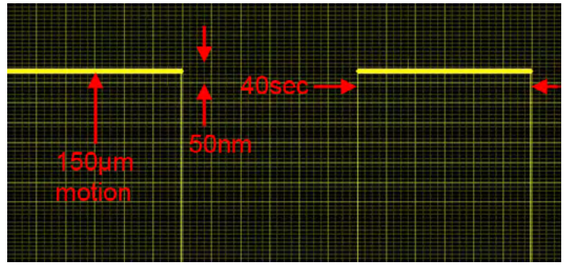
Technical Specifications

Range of motion (X)	25 mm
Range of motion (Y)	25 mm
Encoder Resolution (optional)	50 nm
Step Size	95 nm
Maximum Speed	2 mm/sec†
Native Accuracy	< 1 µm
Native Repeatability	< 100 nm
Recommended max. load*	5 kg
Body Material	Aluminum
Controller	Micro-Drive™2

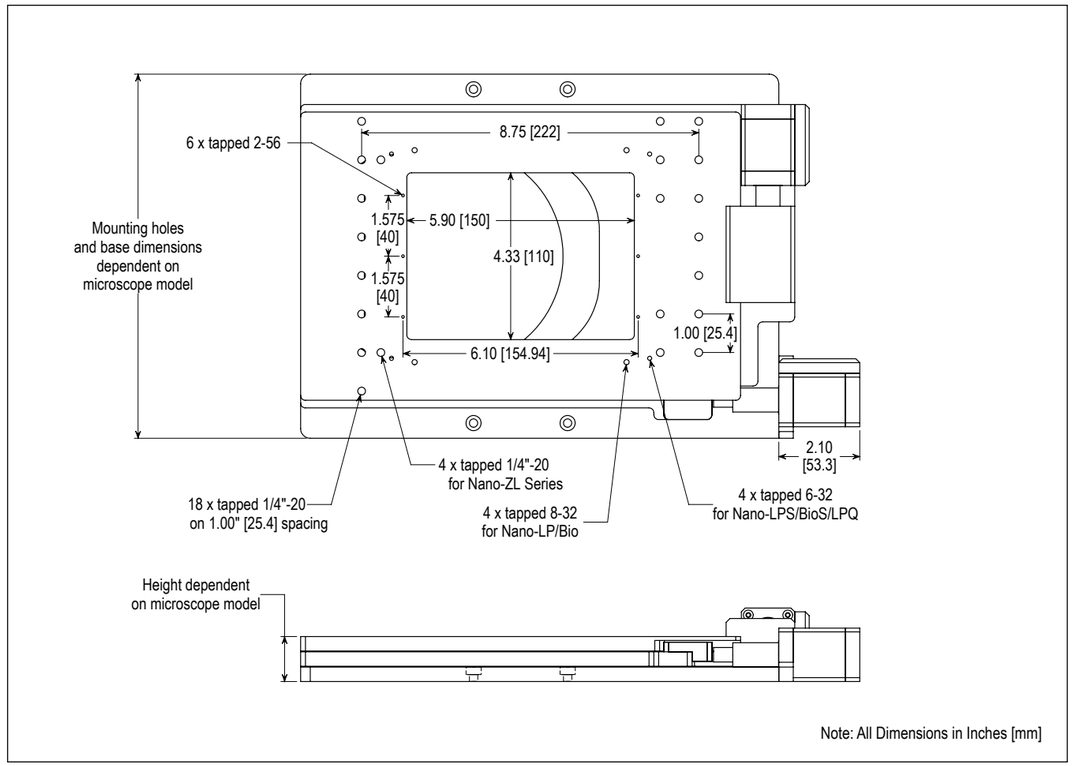
† Higher speed stages also available by custom request.

* Larger load requirements should be discussed with our engineering staff.

Three axis Micro-Drive™3 controller includes a USB port for direct connection of the Micro-Drive™ controller to a PC. LabVIEW and 3rd party software compatible.



MicroStage stability after two 150µm motions.



MMP Series

Features

- *1,2, or 3 axis configurations*
- *Range of motion: 25mm*
- *Optional encoders: 50 nm resolution*
- *Proprietary intelligent control for stability*
- *High native precision & accuracy*
- *Nanopositioner compatible*

Typical Applications

- *Complex, programmed motion control*
- *High precision positioning*
- *Automation*

The MMP Series with optional encoders for high precision motion control. L-R: MMP3V, MMP2-50E, MMP3H, and MMP1.

Product Description

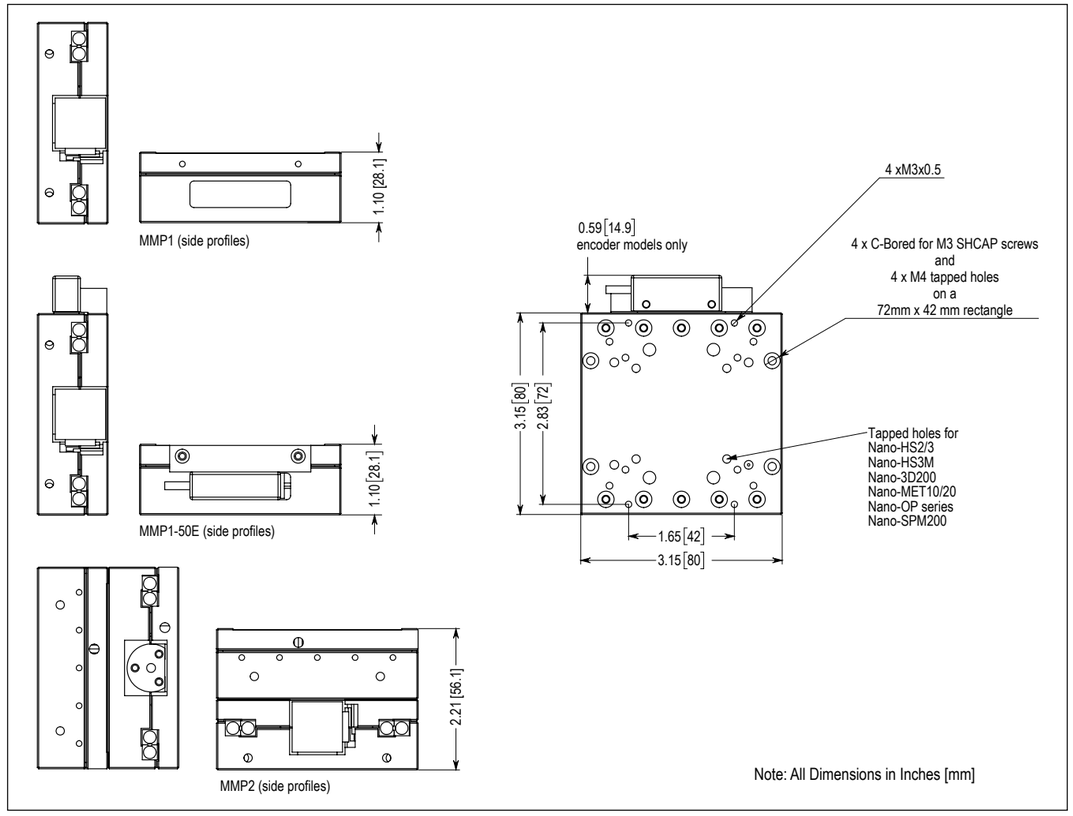
The MMP Series are a precision, stepper motor driven, micropositioning system for high precision positioning for a variety of applications. Long range linear positioning is provided in one, two or three axis configurations with high resolution and excellent repeatability. Employing our proprietary intelligent control scheme results in exceptional stability with high native precision making our MMP Series the ideal choice for demanding motion control applications. Optional high resolution (50nm) linear encoders provide real-time feedback of the actual stage position. The included Micro-Drive™ controller connects to a PC via a standard USB port and can be controlled via the supplied LabVIEW based software. Complex motion profiles can be programmed and sophisticated control parameters such as automatic acceleration and deceleration is employed to achieve high stability and native accuracy. Optional wireless gamepad control is also available. The MMP Series is compatible with a wide range of our nanopositioning systems and can be customized to your requirements.

Technical Specifications

Range of motion (X,Y, Z)	25 mm
Encoder Resolution (optional)	50 nm
Step Size	95 nm
Maximum Speed	4 mm/sec
Native Accuracy	< 4 µm
Native Repeatability	< 100 nm
Recommended max. load (horizontal)*	10 kg
Recommended max. load (vertical)*	2 kg
Body Material	Aluminum
Controller	Micro-Drive™

* Larger load requirements should be discussed with our engineering staff.

Three axis Micro-Drive™3 controller includes a USB port for direct connection of the Micro-Drive™ controller to a PC. LabVIEW and 3rd party software compatible.



MMP Series

Available models

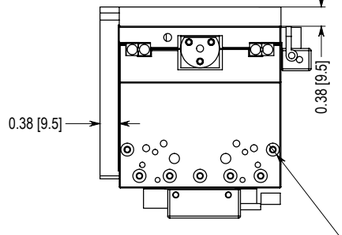
Model	No. of Axes	50nm encoders
MMP1	1	—
MMP1-50E	1	yes
MMP2	2	—
MMP2-50E	2	yes
MMP3V	3	—
MMP3V-50E	3	yes
MMP3H	3	—
MMP3H-50E	3	yes

Compatible Software Packages

LabVIEW — *Examples supplied for the Micro-Drive™ controller*

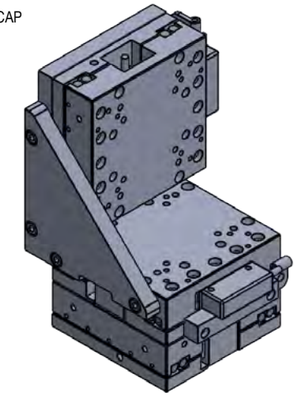
µManager (Open Source Microscopy Software) — *USB motion control*

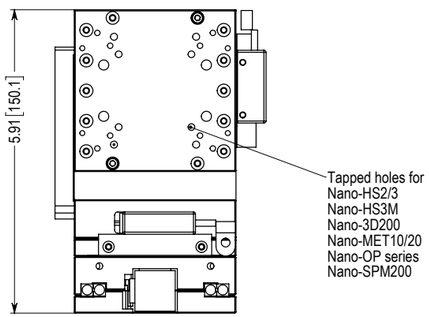
MetaMorph — *USB motion control*



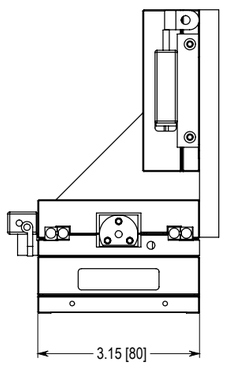
The MMP3V can be secured from the top using four M3 SHCAP screws, or from the bottom using the four M4 tapped hole.

4 x C-Bored for M3 SHCAP screws
and
4 x M4 tapped holes
on a
72mm x 42 mm rectangle

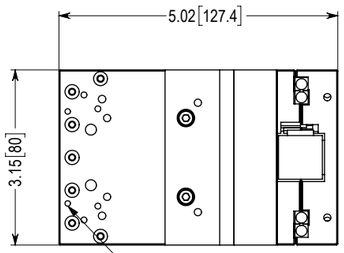




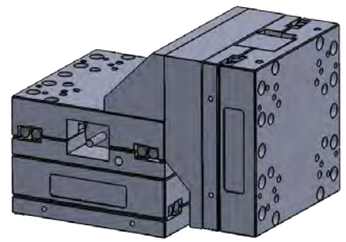
Tapped holes for
Nano-HS2/3
Nano-HS3M
Nano-3D200
Nano-MET10/20
Nano-OP series
Nano-SPM200

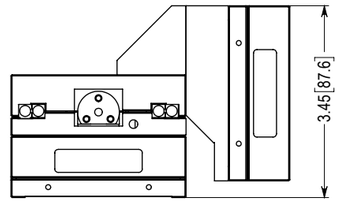


Note: All Dimensions in Inches [mm]

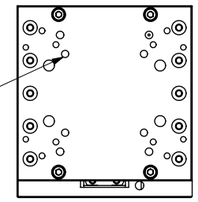


4 x C-Bored for M3 SHCAP screws
and
4 x M4 tapped holes
on a
72mm x 42 mm rectangle





Tapped holes for
Nano-HS2/3
Nano-HS3M
Nano-3D200
Nano-MET 10/20
Nano-OP series
Nano-SPM200



The MMP3H can be secured from the top using four M3 SHCAP screws, or from the bottom using the four M4 tapped hole.

Note: All Dimensions in Inches [mm]

SPM-MZ

Features

- *Single axis micropositioning*
- *High stability, precision aligned with built-in right angle mount*
- *Low drift, intelligent motor control*
- *25mm travel with 95nm step*
- *Compatible with Nano-OP30*

Typical Applications

- *Scanning Probe microscopy*
- *Fluorescence microscopy*
- *Nanomanipulation*

SPM-MZ shown in a vertical orientation and with a Nano-OP30 nanopositioner.

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.

Product Description

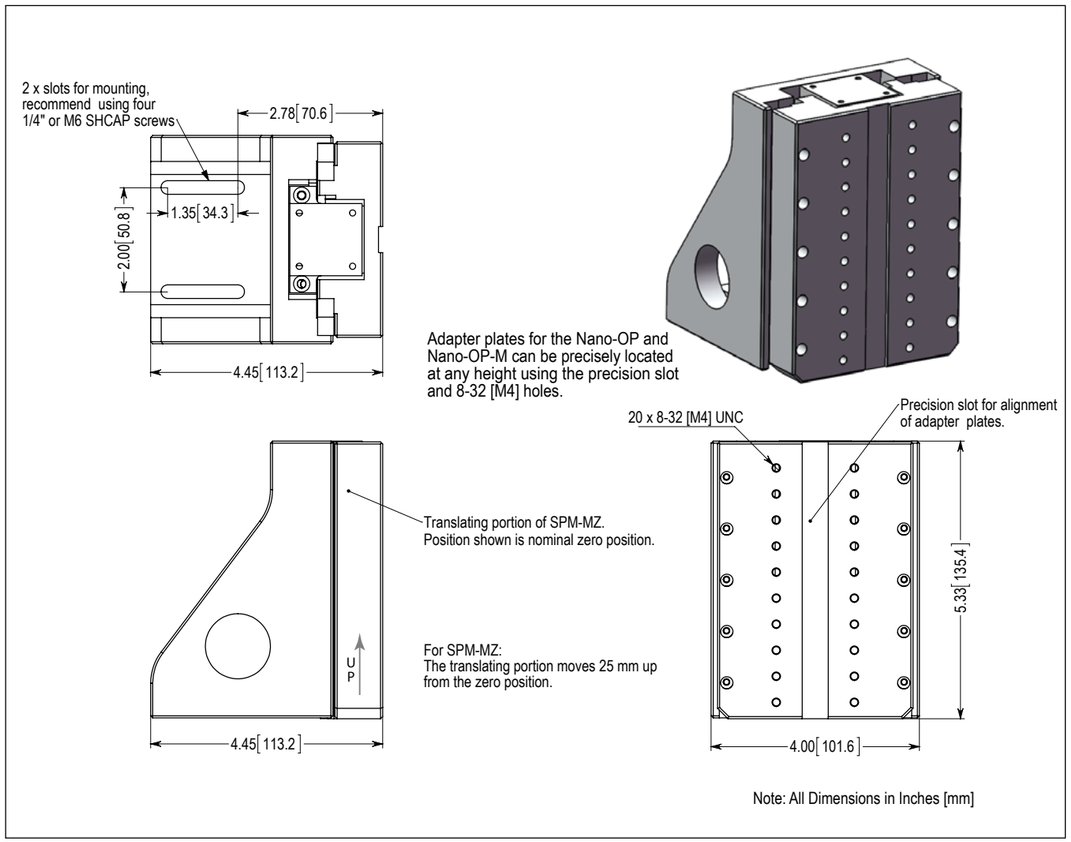
The SPM-MZ is a precision aligned, highly stable single axis micropositioner designed as a Z-axis approach for scanning probe microscopes. The SPM-MZ employs our proprietary intelligent motor control for low drift performance and incorporates a built-in right angle bracket to ensure high stability. The total travel range of the SPM-MZ is 25mm with a minimum step size of 95nm. An optional high resolution linear encoder may be ordered to continuously monitor positions down to 50nm. The USB digital interface provides direct PC control of the micropositioner as well as access to the linear encoder.

The SPM-MZ is compatible with standard opto-mechanical components, including tables, and Mad City Labs Nano-OP30 nanopositioners. Combining the SPM-MZ with the Nano-OP30 offers the user an integrated Z-axis approach with both long range travel and closed loop sub-nanometer precision making it ideal high resolution probe microscopy.
The SPM-MZ is recommended as a high stability automated Z-approach upgrade for our SPM-M kit.

Technical Specifications

Range of motion (micropositioner)	25 mm
Micropositioning step size	95 nm
Maximum speed	2 mm/sec
Motion Profile	
Motion >500 steps	Automatic accel/decel control
Motion ≤500 steps	Constant 1 step/ms
Linear encoder resolution	50 nm
Body Material	Aluminum
Controller	Micro-Drive™
Computer interface	Bidirectional USB

Related products
- SPM-M kit
- MadPLL®
- Nano-OP Series
- MMP Series



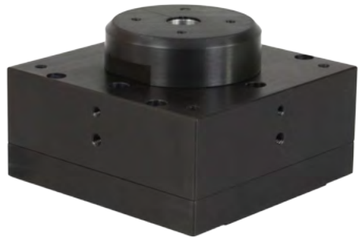
Mad360™

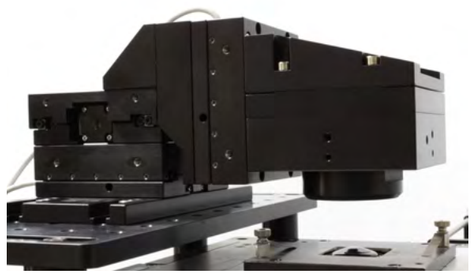
Features

- *Continuous 360° rotation*
- *Bidirectional rotation*
- *High precision & accuracy*
- *High speed or High precision modes*
- *Compatible with MMP micropositioners*

Typical Applications

- *Alignment*
- *Tracking*
- *Automation*





The Mad360™ shwon attached to a MMP3H micropositioning system for use in an optical microscopy instrument.

Product Description

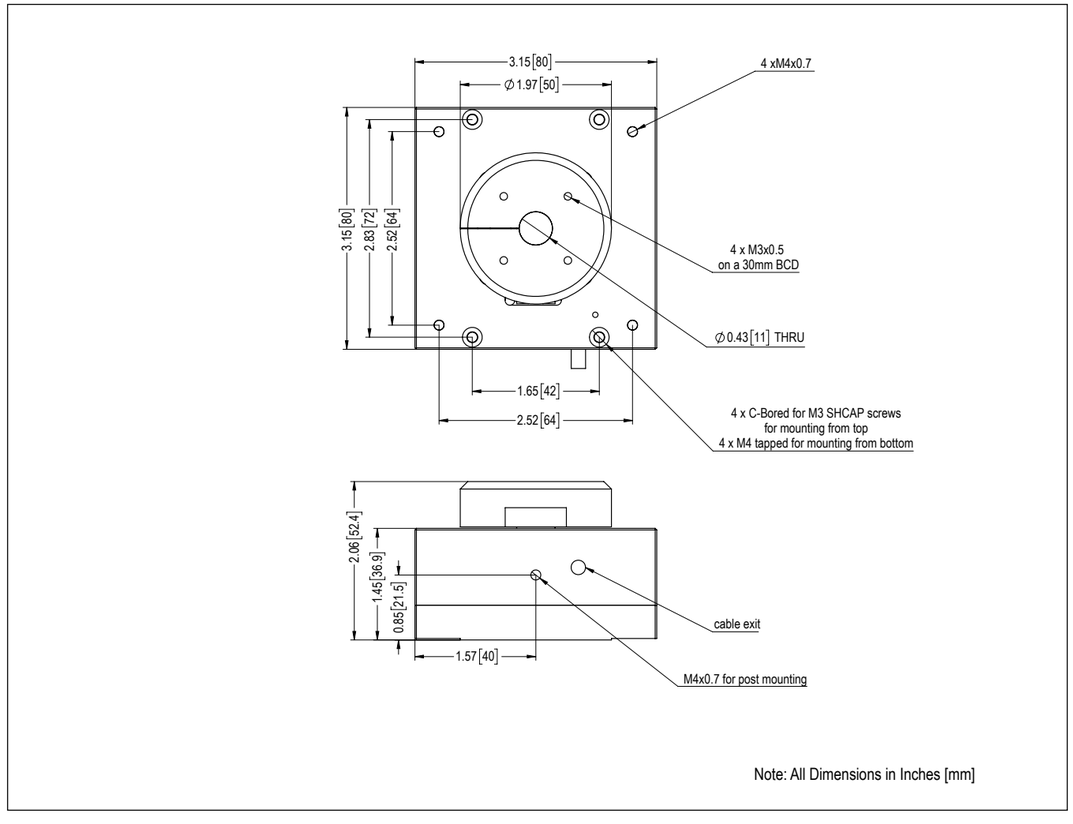
The Mad360™ is a direct drive stepper motor driven, rotational system. Ideal for high speed rotational positioning or high precision rotational positioning. The Mad360™ has bidirectional, continuous 360° rotation. Designed for compatibility with Mad City Labs MMP linear micropositioning systems the Mad360™ can be used in a variety of alignment or tracking applications. Due to the direct drive mechanism, the Mad360 has a minimum step size of 1 milliradian (17 mrad = 1°) and a repeatability of 1 milliradian. The maximum speed of the Mad360™ is 20 rotations/sec (1200 rpm). The included controller connects to a PC via a standard USB port and can be controlled via the supplied LabVIEW based software. The supplied software allows the user to select between high speed mode or a high precision mode.

Technical Specifications

Rotational motion (continuous) ..... 360°
Step Size ..... 1 mrad
Repeatability (@ 2 rotations/s) ..... 1 mrad
Maximum Speed ..... 20 rotations/sec
Holding torque ..... 0.12 Nm
Modes ..... High Speed/Precision
Body Material ..... Anodized Aluminum
Controller ..... Mad360 ™

LabVIEW Compatible USB Interfaces

Examples, tutorial, and Nano-Route® 3D supplied with Nano-Drive® USB interfaces.



Nano-Gauge™ Series

Features

- *1.5nm or 5nm linear displacement measurement*
- *25mm total range of measurement*
- *USB output to PC*
- *Optional probe types*
- *Compact sensor head*
- *Easy to use*

Typical Applications

- *Nanopositioner calibration*
- *Transducer calibration*
- *Alignment*
- *Position creep measurements*

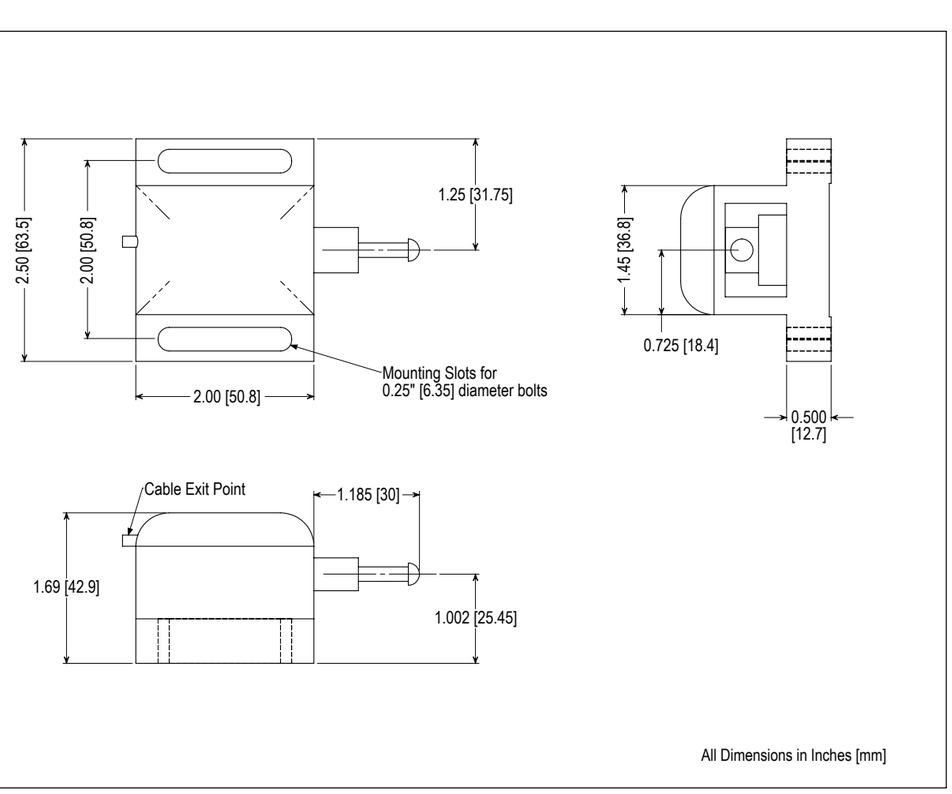
Product Description

The Nano-Gauge™ is an ultra high precision, single axis, displacement measuring instrument capable of resolving dimensions down to 1.5 nanometers (0.06 microinches) over a full scale range of 25mm (1 inch). Combining ease-of-use and small physical size, the Nano-Gauge™ can be quickly adapted to a wide variety of precision measurement situations without lengthy or complex setup procedures. A standard USB "Plug & Play" digital interface connects the Nano-Gauge™ controller to a PC for a real-time display of measurement values. Laptop PC's with USB ports can be used to bring the Nano-Gauge™ into the field for on-site measurements. An on-screen zeroing button provides a simple means to accomplish relative measurements and makes the Nano-Gauge™ as easy to use as standard machinist's digital calipers. A displayed "up/down" measurement rate selector determines the data acquisition time spacing. Measurement rates range from 50 ms/data value to 1 minute/data value. Available probe tips include hardened steel, sapphire, and silicon nitride balls. Probes can also be provided with threaded holes for direct connection to moving components or customized for specific applications. The pictured Nano-Gauge™ mounting is designed to fit standard optical table breadboards - custom mounting for unique applications may be specified. Probe tip loading is user adjustable via internal springs. Probe loading may be eliminated by use of magnetically coupled steel tipped probes. The extreme precision and resolution of the Nano-Gauge™ makes it ideal for transducer design and calibration, development of nanoindentation systems, and materials testing.

Technical Specifications

Range of measurement ..... 25mm (1 inch)
Measurement resolution (Nano-Gauge™1) ..... 1.5 nm
Measurement resolution (Nano-Gauge™5) ..... 5.0 nm
Measurement rate ..... 50 ms to 1 minute
Probe loading ..... 1 lb/in to 10 lb/in
Probe diameter ..... 0.25 mm to 8 mm
Probe tip ..... hardened steel ball or optional sapphire or silicon nitride precision balls
Body Material ..... Aluminum
Stage Dimensions ..... 2.50" x 3.12" x 1.69"
Controller ..... Nano-Gauge™

LabVIEW Compatible USB Interface



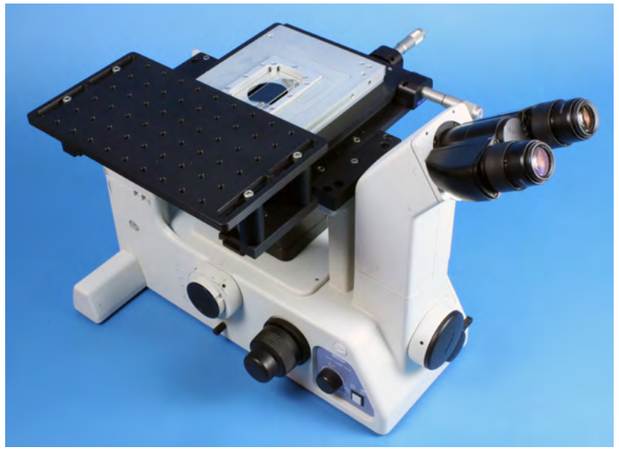
Nano-View®/M Series

Features

- *Manual micropositioning with nanopositioning*
- *1" (25mm) 2-axis manual positioning*
- *2-axis or 3-axis piezo nanopositioning*
- *pico sensor technology*
- *Closed loop control*
- *Compatible with inverted optical microscopes*

Typical Applications

- *Optical microscopy, easy to retrofit*
- *Confocal imaging*
- *Fluorescence microscopy*
- *Single molecule spectroscopy*
- *Particle tracking*
- *Nanomanipulation*
- *STORM and PALM*



Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW · MetaMorph® · NIS-Elements · Image-Pro® PLUS · SlideBook 6 · µManager Open Source Microscopy Software

◀ *Nano-View®/M 100-3 System with optional breadboard assembly.*

Product Description

The Nano-View®/M is a fully integrated positioning system for use with inverted optical microscopes. Easy to operate and affordable, the Nano-View®/M combines a manual micrometer driven, two axis stage with high resolution, long range piezo nanopositioners. A stable blocking force of 10 N built into each axis of the coarse positioning stage provides a secure base for precision nanopositioning. The overall height of the Nano-View®/M with the low profile nanopositioners is only slightly more than standard manual XY stages. An optional breadboard assembly with threaded mounting holes (1/4-20 on a 1 inch pattern or M6 on a 25mm pattern) is a convenient mounting surface for probes.

Nanopositioner ranges of motion extend up to 300 microns per axis (X,Y and Z). Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement. The Nano-View®/M system includes the Nano-Drive® controller and is compatible with user written LabVIEW software. Standard Nano-View®/M systems are offered for the following inverted microscopes: Olympus IX Series, Nikon TE2000/Ti Series, Leica DMI Series, and Zeiss Axiovert/Axio Observer Series. Nano-View®/M systems designed to fit other setups, including direct mounting to optical tables, may also be requested.

Technical Specifications

Low Profile Nanopositioners

Axes of motion	XY or XYZ
Ranges of motion (XY or XYZ)	100/200/300 µm
Resolution (100/200/300 µm)	0.2/0.4/0.6 nm
Resonant Frequencies	
X axis (100/200/300 µm)	365/250/250 Hz ±20%
Y axis (100/200/300 µm)	285/150/125 Hz ±20%
Z axis (100/200/300 µm)	150/115/110 Hz ±20%
Body Material**	Al, Invar or Titanium
Controller	Nano-Drive®

Micropositioning Stage

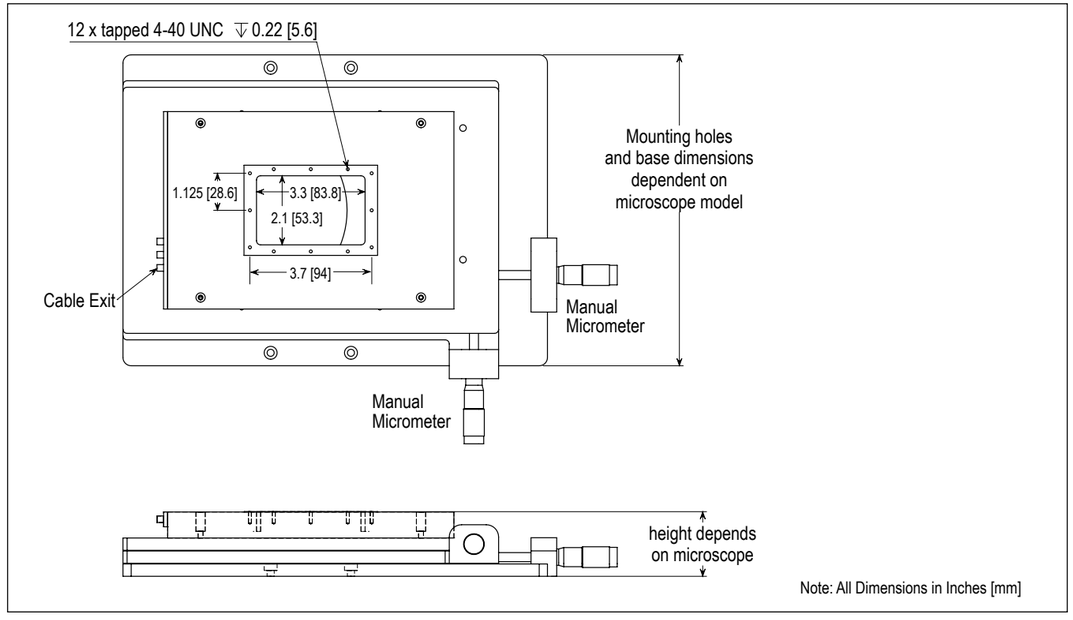
Axes of motion	XY
Ranges of motion (XY)	25mm
Graduations	10 µm
Vernier graduations	1 µm
Body Material	Aluminum

** Nanopositioners with 300 microns of motion available in Aluminum only.

High Speed Nanopositioner

Axes of motion	XYZ
Ranges of motion (XY)	75 µm
Range of motion (Z)	50 µm
Resolution (50/75 µm)	0.1/0.15 nm
Resonant Frequency (X)	1000 Hz ±20%
Resonant Frequency (Y)	850 Hz ±20%
Resonant Frequency (Z)	750 Hz ± 20%
Body Material	Aluminum
Controller	Nano-Drive®85

Available options
- Breadboard
- Sample holders
- Customization



Nano-View® Series

Features

- *Integrated micropositioning and nanopositioning*
- *1" (25mm) 2-axis micropositioning with encoders*
- *2-axis or 3-axis nanopositioning up to 300 µm*
- *Compatible with optical inverted microscopes*
- *PicoQ® sensor technology*
- *Closed loop control*

Typical Applications

- *STORM and PALM*
- *Single molecule spectroscopy*
- *Optical microscopy, easy to retrofit*
- *Confocal imaging*
- *Fluorescence imaging*
- *Nanomanipulation*

Product Description

The Nano-View® is an integrated positioning system for use with inverted optical microscopes. The Nano-View® combines a long range, motor driven, XY microscope stage with an ultra-low profile, high resolution piezo nanopositioning system.

The micropositioning stage has 25 mm of travel per axis and employs our proprietary intelligent control scheme resulting in exceptional stability with high native precision. Optional linear encoders with resolution of 50 nm are available. The minimum step size is 95 nm with a native step repeatability of 50 nm. The piezo nanopositioning systems have the lowest profile available and have ranges of motion extending up to 300 microns per axis (X,Y,Z). Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with sub-nanometer resolution under closed loop control.

A Nano-View® system includes the Nano-Drive® controller and the Micro-Drive™ controller which connects to a PC using a standard USB computer interface. The Micro-Drive™ is fully compatible with user written LabVIEW software and a variety of third party software packages. Optional wireless gamepad control is also available.

The Nano-View® is the complete nanometer positioning system for single molecule spectroscopy and high resolution microscopy applications. Standard Nano-View® systems are offered for the following inverted microscopes: Olympus IX Series, Nikon TE2000/Ti Series, Leica DMI Series, and Zeiss Axiovert/Axio Observer Series. Nano-View® systems designed to fit other setups, such as direct mounting to optical tables, may also be requested.

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW · MetaMorph · NIS-Elements · Image-Pro PLUS · SlideBook 6 · µManager Open Source Microscopy Software

Technical Specifications

Low Profile Nanopositioners

Axes of motion	XY or XYZ
Ranges of motion (XY or XYZ)	100/200/300 µm
Resolution (100/200/300 µm)	0.2/0.4/0.6 nm
Resonant Frequencies	
X axis (100/200/300 µm)	365/250/250 Hz ±20%
Y axis (100/200/300 µm)	285/150/125 Hz ±20%
Z axis (100/200/300 µm)	150/115/110 Hz ±20%
Body Material**	Al, Invar or Titanium
Controller	Nano-Drive®

** Nanopositioners with 300 micron travel range available in Aluminum only.

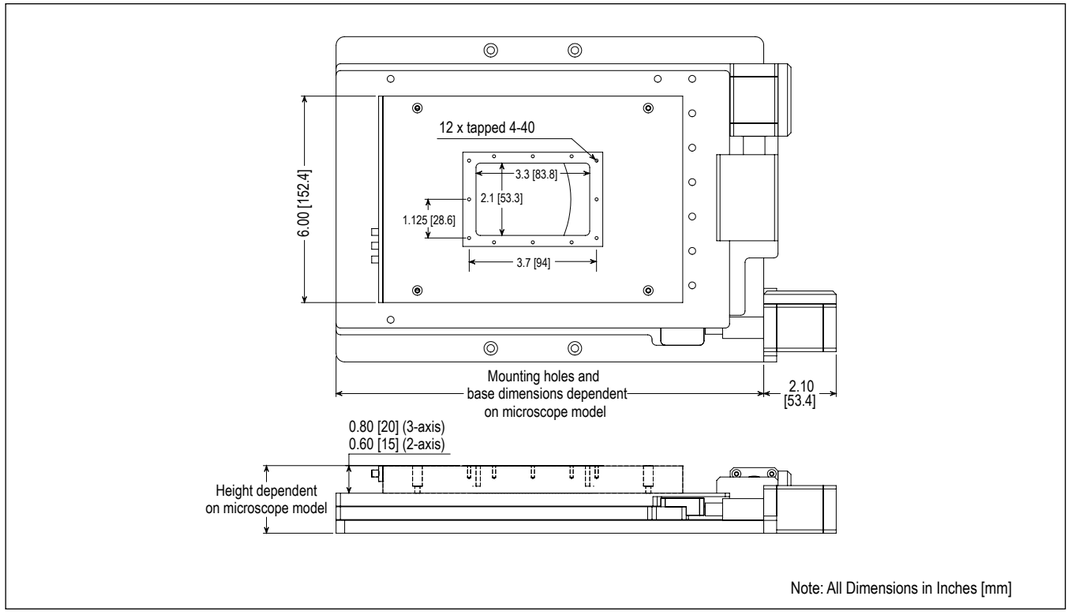
Available options
- Optical encoders for microscope stage
- Breadboard
- Sample holders
- Customization

High Speed Nanopositioner

Axes of motion	XYZ
Ranges of motion (XY)	75 µm
Range of motion (Z)	50 µm
Resolution (50/75 µm)	0.1/0.15 nm
Resonant Frequency (XYZ)	1000/850/750 Hz
Body Material	Aluminum
Controller	Nano-Drive®

Micropositioner

Axes of motion	XY
Range of motion (XY)	25mm
Step repeatability	50 nm
Step size	95 nm
Encoder resolution (option)	50 nm
Body Material	Aluminum
Controller	Micro-Drive™



Note: All Dimensions in Inches [mm]

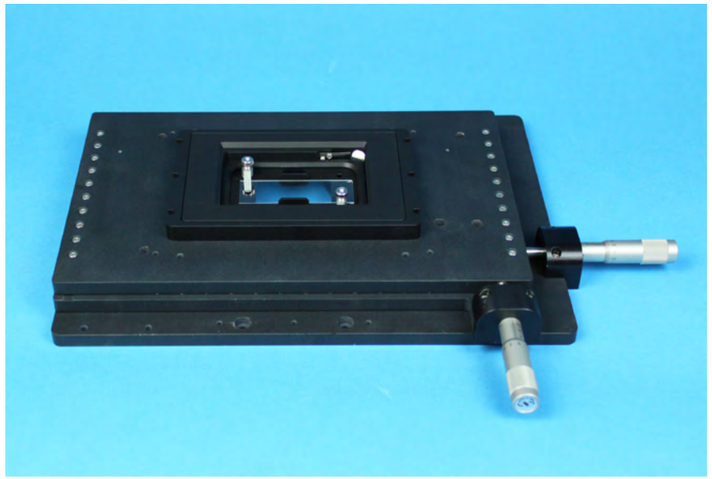
MCL-MANNZ

Features

- *Manual micropositioning with nanopositioning*
- *Z-axis piezo nanopositioning, manual XY*
- *Fits 3" (75mm) slides and 35mm petri dishes*
- *For inverted and upright optical microscopes*
- *picoQ sensor technology*
- *Closed loop control*
- *Very affordable*

Typical Applications

- *Optical microscopy, easy to retrofit*
- *Confocal imaging*
- *Fluorescence imaging*
- *Single molecule spectroscopy*
- *Nanomanipulation*
- *STORM and PALM imaging*



MCL-MANNZ (inverted microscope model) shown with 75mm slide holder

Slide holder

35mm petri dishes

Available sample holders for inverted optical microscope models of the MCL-MANNZ

Product Description

The MCL-MANNZ is an integrated micro-nano positioning system for use with inverted and upright optical microscopes. Easy to operate and affordable, the MCL-MANNZ combines a manual micrometer driven, two axis, linear motion stage with a high resolution Z-axis piezo nanopositioner. A stable blocking force of 10 N built into each axis of the coarse positioning stage provides a secure base for precision nanopositioning. The overall design of the MCL-MANNZ ensures that the sample height remains within the proper focal range of the microscope. The z-axis nanopositioner has a range of motion of 200 microns. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement. The MCL-MANNZ system includes the compact version of the Nano-Drive® controller and it is compatible with user written LabVIEW software.

MCL-MANNZ systems are offered for the following inverted microscopes: Olympus IX Series, Nikon TE/Ti Series, Leica DMI Series, and Zeiss Axiovert/Axio Observer Series.

MCL-MANNZ systems are also offered for the following upright microscopes: Olympus BX, Nikon 80i, and Zeiss AxioImager.

Technical Specifications

Micropositioning Stage

Axes of motion	XY
Ranges of motion (XY)	25mm
Graduations	10 µm
Vernier graduations	1 µm
Body Material	Aluminum

Nanopositioner

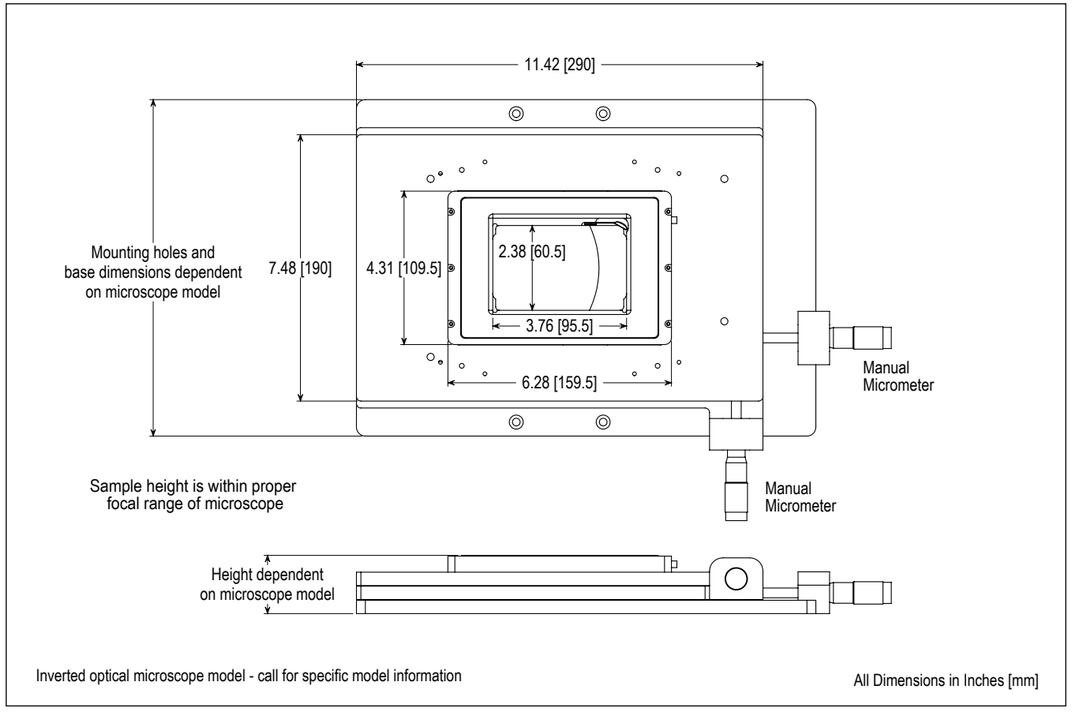
Axis of motion	Z
Range of motion	200 µm
Resolution	0.4 nm
Resonant Frequency	230 Hz ±20%
Recommended max. load (horizontal)*	0.5 kg
Body Material	Aluminum
Controller†	Nano-Drive®C
Digital Interface	USB 2.0
Analog Input	0V to 10V

* Larger load requirements should be discussed with our engineering staff.
† Compact series of controllers.

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph®, NIS-Elements, Image-Pro® Plus, SlideBook 6, µManager Open Source Microscopy Software



Inverted optical microscope model - call for specific model information

All Dimensions in Inches [mm]

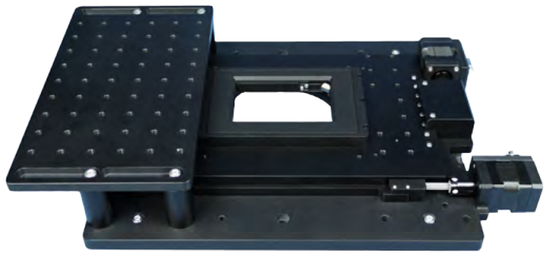
MCL-MOTNZ

Features

- *Ultra-stable positioning*
- *Integrated micro- and nanopositioning*
- *Z-axis closed loop nanopositioning*
- *Holders for 75mm slides & 35mm petri dishes*
- *Models for inverted and upright microscopes*
- *picoQ sensor technology*
- *Very affordable high precision positioning*

Typical Applications

- *Optical microscopy, easy to retrofit*
- *Confocal imaging*
- *Fluorescence imaging*
- *Single molecule spectroscopy*
- *Nanomanipulation*
- *STORM and PALM imaging*



Optical table compatible MCL-MOTNZ with an optional breadboard. Compact controllers for the MCL-MOTNZ

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW · MetaMorph · NIS-Elements · Image-Pro PLUS · SlideBook 6 · µManager Open Source Microscopy Software

Product Description

The MCL-MOTNZ is a value priced positioning system for use with inverted optical microscopes. The MCL-MOTNZ combines a stepper motor XY microscope stage with a closed loop, high resolution Z-axis piezo nanopositioning system. The micropositioning stage provides 25 mm of travel per axis with a minimum step size of 95 nm. The use of high precision components and our proprietary intelligent control technique results in an ultra-stable microscope platform with excellent native precision without the addition of costly encoders. The MCL-MOTNZ z-axis piezo nanopositioner has a travel range of 200 microns and integrates into the nano-qualified microstage. Internal position sensors utilizing proprietary PicoQ® technology provide absolute, repeatable position measurement with sub-nanometer resolution under closed loop control.

The MCL-MOTNZ system includes our compact, USB enabled Nano-Drive®C and Micro-Drive™C controllers. These controllers are fully compatible with user written LabVIEW software and other third party software packages. Optional wireless gamepad control is also available.

The MCL-MOTNZ is the complete nanometer positioning system for single molecule spectroscopy and high resolution microscopy applications. The MCL-MOTNZ is compatible with the following inverted optical microscopes: Olympus IX Series, Nikon TE/Ti Series, Leica DMI Series, and Zeiss Axiovert/Axio Observer Series. Models compatible with Olympus BX and Zeiss AxioImager upright microscopes available. Available options: sample holders, breadboard (metric or imperial).

Technical Specifications

Micropositioner

Axes of motion	XY
Range of motion (XY)	25mm
Minimum step size	95 nm
Repeatability	<100 nm
Speed	2 mm/sec
Body Material	Aluminum
Controller†	Micro-Drive™C
Digital Interface	USB 2.0

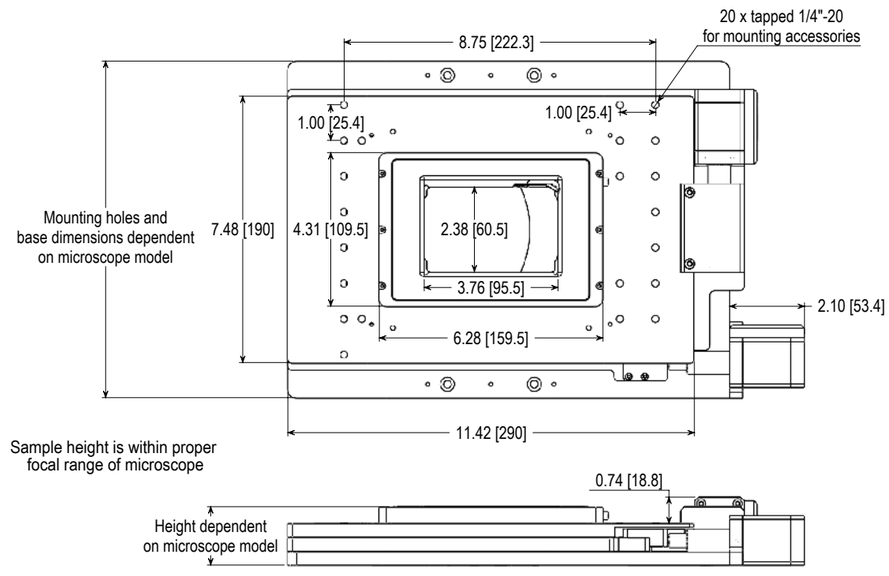
Nanopositioner

Axis of motion	Z
Ranges of motion	200 µm
Resolution	0.4 nm
Resonant Frequency	230 Hz ±20%
Recommended max. load (horizontal)*	0.5 kg
Body Material	Aluminum
Controller†	Nano-Drive®C
Digital Interface	USB 2.0
Analog Input	0V to 10V

* Larger load requirements should be discussed with our engineering staff.
† Compact series of controllers.

35mm petri dish holder

75mm slide holder



Inverted optical microscope model - call for specific model information

All Dimensions in Inches [mm]

MadPLL®

Features

- *Low Cost*
- *Software, sensor amplifier, probe boards included*
- *Two additional ADC connections*
- *Low noise, atomic step performance*
- *Automated software control*
- *Auto PCC control*
- *High resolution Auto Q calculation*
- *High resolution resonant frequency detection*
- *Integrated Z axis PI control loop*
- *Fully compatible with Mad City Labs nanopositioning systems*

▲ *MadPLL® digital phase lock loop controller*
Sensor amplifier with probe boards shown at right. ►

Product Description

MadPLL® is an integrated solution that includes the digital phase lock loop (PLL) controller, software, sensor amplifier, probe board mount, and resonant probe mounting board. Simply add your Akiyama probe or tuning fork to the probe board to create a powerful force sensor for scanning probe measurements with no optics required. The PLL controller contains a digitally controlled proportional integral (PI) loop designed to work seamlessly with Mad City Labs' nanopositioning systems. The addition of closed loop nanopositioners adds to the high performance of MadPLL®. Additional options are available for multi-axis closed loop nanopositioning control.

The PLL controller has three operational modes: self oscillation, PLL driven, and lock-in/DDS driven. The probe can be controlled in constant excitation or constant signal mode. Measured outputs from the controller include changes in frequency, amplitude or phase shift.

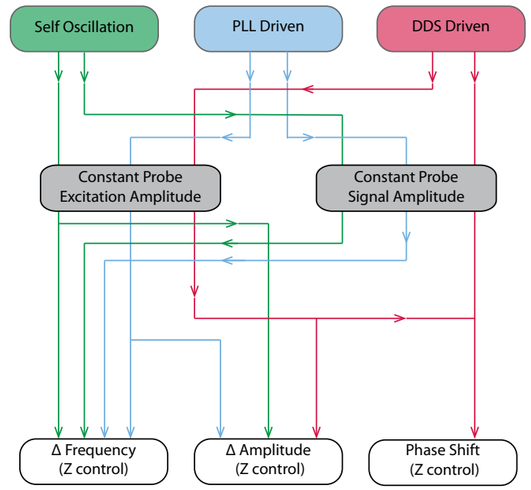
The sensor amplifier is the interface between the MadPLL® controller and the probe. The sensor amplifier contains a preamplifier, an excitation signal attenuator, and a parasistic capacitance compensation (PCC) circuit. The probe board mount and probe board assemblies are compact and can be fitted to existing instrumentation. The probe board simply plugs into the probe board mount. The mount can be fixed to a precision nanopositioning system. The probe board has been designed for use with tuning forks and Akiyama probes. These probes are easy to mount and alignment free.

MadPLL® software simplifies the control of your scanning probe microscope. All of the functions of MadPLL® are fully automated but accessible via individual software control. Among the software features are automated setup, configuration control, auto-Q calculation and automatic parasitic capacitance compensation (PCC) control. These included features are designed to simplify setup and accelerate the data acquisition process. MadPLL® software integrates seamlessly with Mad City Labs' AFMView™2 software. AFMView™2 software is part of our complete SPM product suite.

Technical Specifications

Lock-In Amplifier	
Phase Shifter	0° - 360°
Demodulation Bandwidth	3 kHz
Phase Lock Loop	
Auto Range Selection	YES
Measurement Range	± 500 Hz
Measurement Resolution (rms)	50 mHz
Preamplifier	
Input Gain (Attenuator)	0x - 1x (16 bit internal DAC)
Parasitic Capacitance Compensation (PCC)	YES (16 bit internal DAC)
Automatic PCC	YES
Probe Oscillation Loop	
Operating Modes	self oscillation
	PLL driven
	lock-in/DDS driven
Amplitude Control Modes	constant excitation
	constant signal
Probe DDS resolution	92 mHz
Amplitude Setpoint	16 bit internal DAC
Amplitude Control	YES, adjustable PI loop filter
Input Voltage Range	± 10 V (peak)
Input Voltage Gain	2x - 40x
Frequency Range	10 kHz - 100 kHz
Output Voltage Range	± 10 V (peak)
PI Loop Filter (Z-Axis)	
Integration Time Constant	digitally controlled
Digitally Set Parameters	YES
Error Signal Inversion Capability	YES
Sensor Signals	frequency
	phase
	excitation amplitude
	signal amplitude
Command Signal	16 bit internal DAC
Automatic Loop Filter Setup	YES, after initialization.
Loop Output	0 - 14 V

General		
Spectrum Analysis		amplitude
		phase
Feedback Monitor BNC		frequency
		phase
		excitation amplitude
		signal amplitude
ADC input (2 x BNC)		0 - 10V input range, 16 bit
Probe Signal Monitor (BNC)		sinewave amplitude probe (diagnostic)
Power Supply		90 - 260 VAC (50/60 Hz)
Controller Dimensions		16.75" x 14" x 1.75" (1U) (42.55cm x 35.56cm x 4.45 cm)
PC Connection		USB 2.0
Operating System	32 bit	Windows Vista/7/8/10
	64 bit	Windows Vista/7/8/10



The digital MadPLL® controller has three operational modes: self oscillation, PLL driven, and DDS driven. The probe can be controlled in constant excitation amplitude or constant signal amplitude. Changes in frequency, amplitude, or phase are measured for Z control.

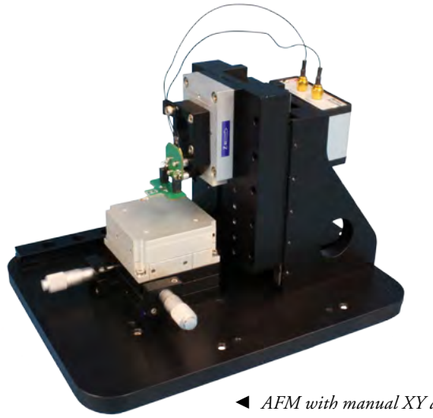
SPM-M Kit

Features

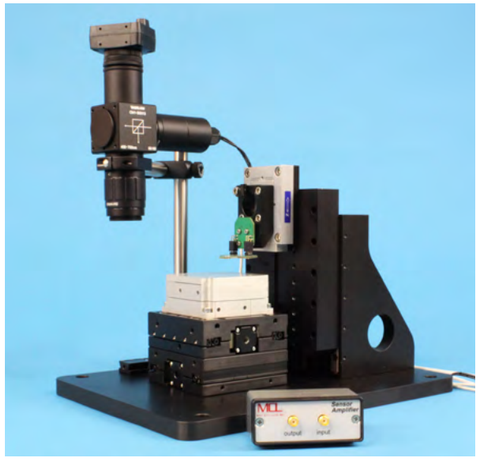
- *Low cost AFM*
- *Atomic Step Resolution*
- *MadPLL® low noise controller*
- *Integrated closed loop piezo nanopositioners*
- *Compatible wth resonant and Akiyama probes*
- *Automated hardware and software control*
- *Custom configurations*

Typical Applications

- *Metrology*
- *AFM*
- *SPM*
- *Combined light microscopy/AFM*



◄ *AFM with manual XY approach and motorized Z approach*



▲ *AFM with motorized XYZ approach, video optical microscope, and coaxial illuminator*

Product Description

Mad City Labs' SPM-M kit is suitable for both research and teaching environments. The assembled SPM is a high performance, closed loop scanning resonant probe microscope.

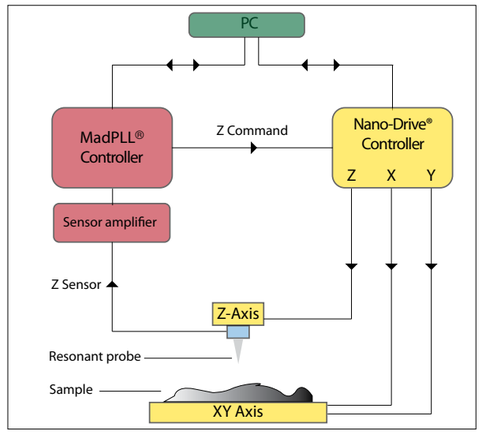
The SPM-M kit includes:

- MadPLL®
- Nano-SPM200 nanopositioning stage (XY)
- Nano-OP30 nanopositioning stage (Z)
- 3 axis closed loop Nano-Drive® controller
- OCL option (Z axis only)
- AFMView™2 software and tutorial
- Probe starter package
- Adapter plate between probe mount board and Nano-OP30
- Application note: "AFM kit with manual positioning"

MadPLL® is an integrated solution that includes the digital phase lock loop (PLL) controller, software, sensor amplifier, probe mounting board, and probe boards. MadPLL® includes five (5) each of the vertical, horizontal, Akiyama and blank probe boards. In addition each unit is shipped with 5 tuning forks. Additional probe boards and tuning forks can be purchased separately. The advantage of the MadPLL® controller is its seamless operation with all Mad City Labs nanopositioning systems.
Mad City Labs nanopositioning systems have low noise PicoQ® sensors and closed loop feedback control yielding high resolution closed loop SPM performance.
Our nanopositioners plus a wide range of SPM accessories makes it simple to create inexpensive, customized atomic force microscopes.

Custom SPM

The SPM-M kit may be customized by substituting any of our wide range of nanopositioners and picopositioners and including additional options. The schematic, below, shows the typical AFM instrument layout.



Schematic of a typical AFM instrument

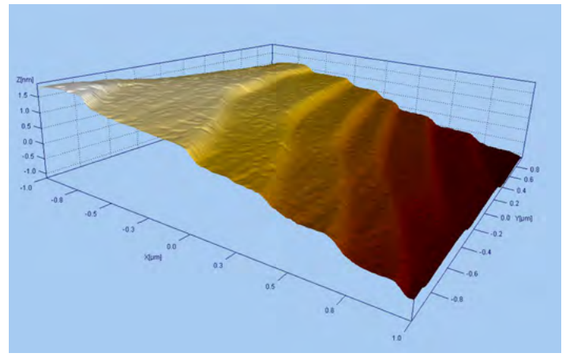
Our resonant probe SPM instruments are ideal for both materials research and biophysical research and are fully compatible with our RM21® microscopes.
On the following pages are examples of SPM-M kit customizations. These examples have been used for a wide variety of applications from material science to life sciences.

SPM Accessories

- Tuning Forks
- Motorized XY or Z-axis approach
- Manual XY or Z-axis approach
- SPM baseplate
- Coaxial Illuminator
- Video optical microscope
- Isolation enclosure
- SPM tip etch kit
- Probe starter package

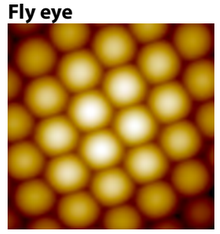
Images

Atomic steps on Si(111)



2 µm x 2 µm
Self oscillation mode, constant probe signal
Z force feedback: frequency
312 pm atomic steps on Si(111). Data taken using MadPLL® with Nano-HS3 XYZ nanopositioning system with an etched tungsten tip on a quartz tuning fork.

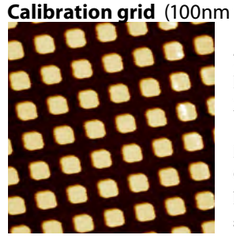
Fly eye



100 µm x 100 µm
Bidirectional scan
PLL mode, constant probe signal
Z force feedback: frequency

Data taken using MadPLL® with Nano-OP30 nanopositioning system (Z-axis), Nano-OP100 nanopositioning system (XY axes)

Calibration grid (100nm tall, 10 µm pitch)



70 µm x 70 µm, Unidirectional scan
PLL mode, constant probe signal
Z force feedback: frequency

Data taken using MadPLL® with Nano-OP30 nanopositioning system (Z-axis), Nano-OP100 nanopositioning system (XY axes)

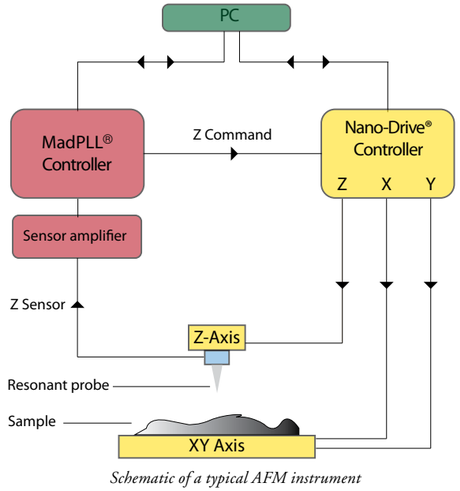
* The following items are described in the application note "AFM Kit with manual positioning" and are listed in the bill of materials (BOM) but not included with the SPM-M kit.

- Manual micropositioners for XY, Z axes.
- SPM Baseplate
- L-Bracket
- Fasteners or clamps

SPM-M kit Customization

The SPM-M kit may be customized to your application by substituting different nanopositioning systems and adding in automated micropositioning. A range of accessories, including probes and isolation enclosures, are described in a separate brochure. The schematic, shown at left, is a typical AFM instrument layout.

The motion control components can be divided into two categories: probe positioning and sample positioning. In all applications, it is necessary to have at least a single axis of nanopositioning and an automated approach for the probe. Examples of stand-alone probe positioning and combination probe and sample positioning configurations are shown below.
All configurations shown are compatible with the MadPLL® phase lock loop controller and included AFMView™2 software.



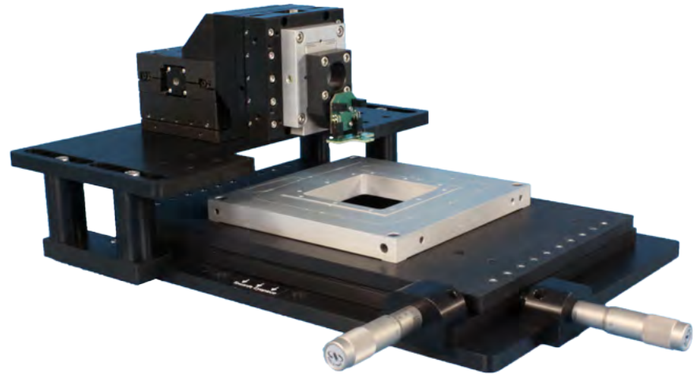
Schematic of a typical AFM instrument

Examples

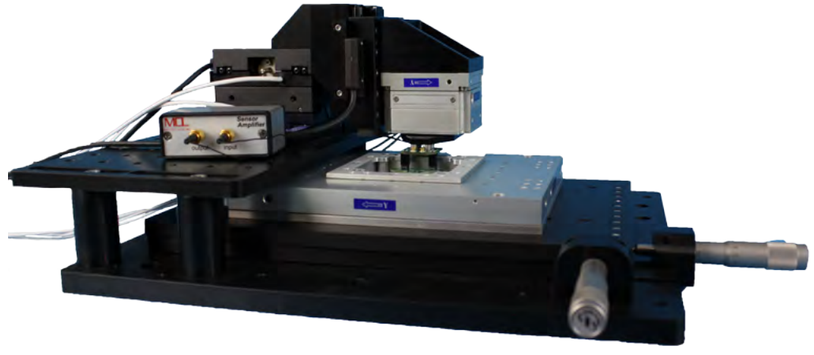
▲ *A three axis high resolution tip scanner. A single axis motorized approach is provided by the SPM-MZ. The high resolution tip scanner is the Nano-HS3M with 10 × 10 × 5 μm of motion. This example is designed for users who require picometer precision.*

◀ *A simple probe positioning configuration. This probe positioner uses an MMP1 automated positioner for the z-axis approach and a Nano-OP30 nanoposiitoning system for the high resolution probe positioning and feedback. The adapter for the probe mounting board is included with the MadPLL® controller.*

▲ *Three axis probe positioner with three axis micropositioning of the probe head. Ideal for use on optical tables when mounted on an optional platform (as shown). The probe nanopositioner is a compact custom nanopositioner with 100 × 100 × 20 μm of travel. The probe head micropositioning is the MMP3H micropositioning system.*



Combined probe positioner and sample positioner for an AFM for use on an inverted optical microscope. The probe positioner comprises a 3 axis motorized positioner with a high resolution Nano-OP30 to hold the probe mounting board.
The sample is positioned using the Nano-View® 100-2/M system. This sample positioner comprises a high resolution 100 × 100 μm nanopositioning stage paired with a high stability manual microscope stage.



Combined probe positioner and sample positioner for an AFM or NSOM for use on an inverted optical microscope. The probe positioner comprises a 3 axis motorized positioning with a custom three axis nanopositioner with 100 × 100 × 20 μm travel range. The probe positioner is designed for automation and high precision. The sample is positioned using the Nano-View® 100-3/M system. This sample positioner comprises a high stability 100 × 100 × 100 μm nanopositioning stage paired with a manual microscope stage.

Related products
- SPM-M kit
- MadPLL®
- SPM Accessories

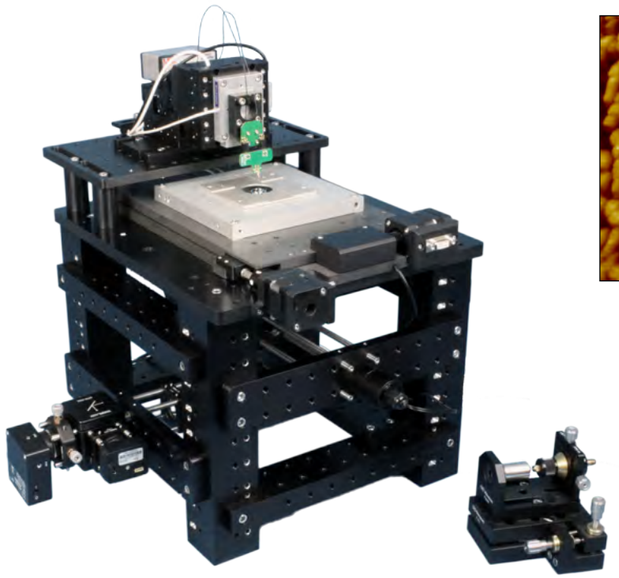
MCL-NSOM

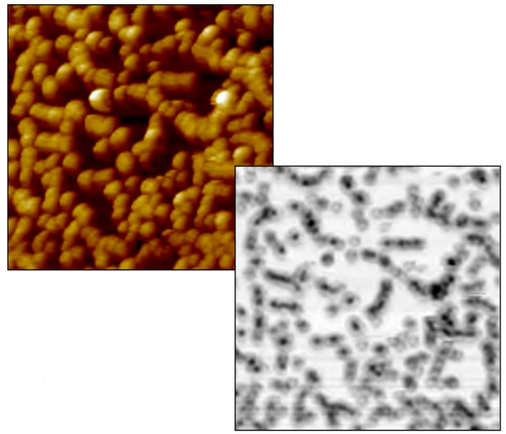
Features

- *Complete inverted optical microscope*
- *Six axes of motorized control*
- *Closed loop nanopositioning in XYZ*
- *Independent automation for fiber alignment to optical axis*
- *Alignment camera and detection APD included*
- *Software included*

Other Applications

- *Aperture-less NSOM*
- *Resonant probe AFM*
- *Near field spectroscopy*
- *Fluorescence & epifluorescence microscopy*





▲ *50 µm x 50 µm images of 500nm diameter polystyrene beads on a glass coverslip.*
Images taken using Mad City Labs AFM (left) and NSOM (below). NSOM: Transmission mode using 640nm light with 100x, 1.25 N.A. objective lens and avalanche photodiode.

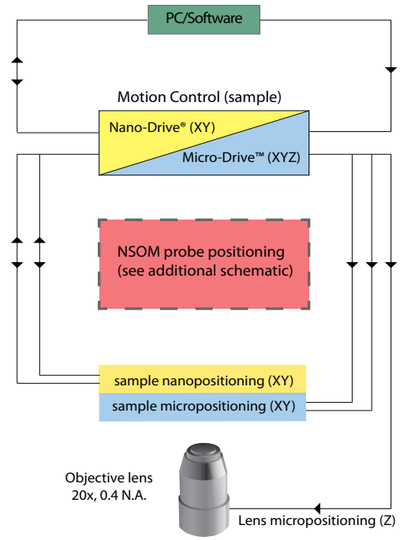
Product Description

The MCL-NSOM is a fully operational near field scanning optical microscope. It has been built on Mad City Labs versatile RM21™ microscope which allows users to convert between NSOM, SPM, and fluorescence optical microscopy techniques.
The MCL-NSOM builds on our successful resonant probe SPM and incorporates common elements such as the MadPLL® phase lock loop controller. The NSOM also exploits our expertise in precision motion control by including six axes of motorized positioning, for the sample and NSOM probe, and three axes of closed loop nanopositioning to provide exceptional position resolution and accuracy.

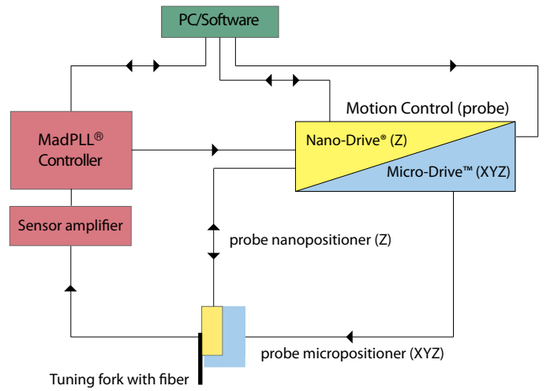
The MCL-NSOM also includes a 635nm laser excitation source, fiber launch, objective lens (20x, 0.4 N.A.), CMOS alignment camera and avalanche photodiode detector. The microscope configurable design allows researchers to tailor the instrument for many different optical microscopy techniques including near field spectroscopy.
The MCL-NSOM is operated in aperture mode with shear force feedback. The standard 5 NSOM modes are supported: illumination, collection, illumination and collection, reflection and reflection collection.

Technical Specifications

Motion Control	
Sample micropositioning (XY)	25 mm
Lens micropositioning (Z)	50 mm
Fiber micropositioning (XYZ)	25 mm
Micropositioning step size	95 nm
Micropositioning controller	Micro-Drive™
Nanopositioning range of motion (XYZ)	200 µm × 200 µm × 30 µm
Resolution	0.4 nm (XY), 0.06 nm (Z)
Step size	0.2 nm (XY), 0.03 nm (Z)
Nanopositioning controller	Nano-Drive®
Communication	USB 2.0
DAC/ADC	20 bit
NSOM	
NSOM operation	Aperture
Feedback	Shear Force
Phase lock loop controller	MadPLL®
Software	AFMView™2
Software compatibility	C#
Objective lens	20x, 0.4 N.A. (Infinity corrected)
Excitation and detection	635nm, 4.5mW laser diode with fiber launch
	0.3MP fiber alignment CMOS camera
	Avalanche photodiode (200nm-1000nm, 1mm active area)
Supplied accessories	Coaxial illuminator (LED)
	Tuning fork with attached single mode fiber for NSOM
	Tuning forks with etched tungsten tips (3)
	Tuning forks (10)
	Fiber launch
	Instrument enclosure
Power supply	90 - 260 VAC (50/60Hz)
Operating system	Windows Vista/7/8/10



Instrument overview of MCL-NSOM hardware



Schematic of the probe positioning element

SPM Accessories

Available Accessories

- *Tuning Forks (with and without tips)*
- *SPM Baseplate*
- *Double Insulated Enclosure*
- *Video Optical Microscope*
- *Coaxial Illuminator*
- *SPM Etch Kit*
- *Probe Starter Package*
- *SPM-MZ*
- *MMP Series*
- *SPM XY Manual Micropositioner*

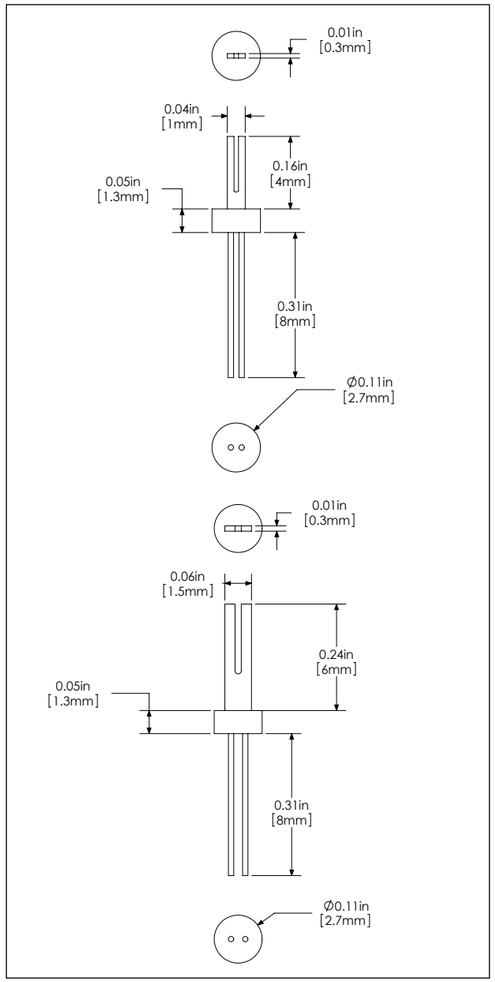
Mad City Labs offers an extensive range of accessories to complement our SPM-M kit and MadPLL® digital controller. These accessories combined with our nanopositioning systems allow users to build customized, high resolution atomic force and scanning probe microscopes.

Tuning Forks

Mad City Labs offers quartz crystal tuning forks for scanning probe microscopy applications such as atomic force microscopy (AFM) and near field scanning optical microscopy (NSOM). Each tuning fork has two electrical leads for connection to a driving oscillator such as the Mad City Labs MadPLL® phase lock loop controller. Our tuning forks are available in two sizes, and are shipped to you conveniently ready to use - "out of the can" - with the typical cylindrical housing removed. Bare tuning forks available in boxes of 20. Tuning forks with tungsten tips available in boxes of 8.

Technical Specifications

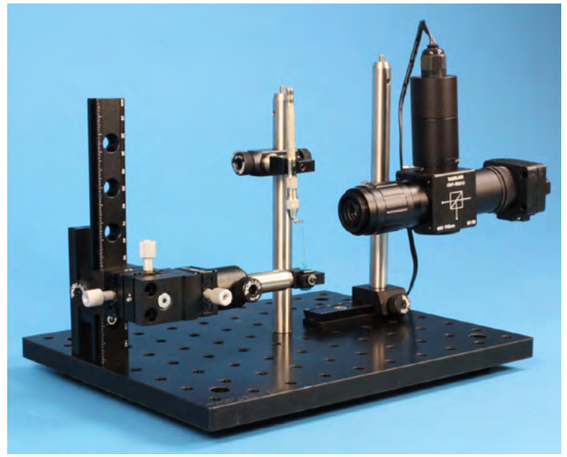
Center Frequency	32.768 kHz
Oscillation Mode	Fundamental
Series Resistance (max.)	30 kΩ
Tolerance (@25°C)	±18 ppm
Operating Temperature Range	-10°C to +60°C
Frequency Stability over Temperature	-0.038 ppm/°C
Drive level	10 µW
Shunt Capacitance (max.)	1.7 pF
Motional Capacitance	2.5 fF
Load Capacitance	12.5 pF
Aging (max.)	± 3 ppm/year



Tuning fork dimensions. Medium (top), large (bottom)

SPM Etch Kit

The Mad City Labs SPM etch kit is designed to allow users to create a sharp tungsten tip suiable for scanning probe microscopy. The instrumentation allows the user to attach a tungsten wire to a quartz tuning fork and electrochemically etch the wire. The attachment of the wire is done with the assistance of a three axis manual micropositioner and video optical microscope.
The etching process uses the lamella method where the wire passes thorugh a thin lamella and into a bath of potassium hydroxide (KOH) or sodium hydroxide (NaOH). A bias voltage is applied to the electrodes in the film and bath which causes the tungsten wire to be etched by the film. When the wire is completely etched, the bottom portion of the wire falls, the etching process is complete, and remaining portion of wire attached to the tuning fork is left with a very sharp tip.



Included in the etch kit

- Coaxial illuminator
- Video optical microscope (1x, 50mm)
- Tip etching station controller
- LabVIEW based software
- Baseplate
- Three axis manipulator, fixturing rails and posts
- Wire holder
- Five large tuning forks

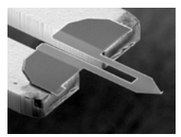
Not included

- Potassium hydroxide
- Sodium hydroxide
- Glassware
- Tungsten
- Screen for video optical microscope

Tip Etching Station controller

Tuning Fork with etched tungsten tip

Akiyama Probes



Akiyama-Probe is based on a quartz tuning fork combined with a micro-machined cantilever. The great advantage of this novel probe is that one can benefit from both the tuning fork's extremely stable oscillation and the silicon cantilever's reasonable spring constant with one probe.
Available from www.akiyamaprobe.com

Probe Starter Package

Starter package for SPM probes. Recommended for new users of resonant probe AFMs. Includes calibration sample and easy-to-use probes. The package includes (1) box of Akiyama Probes, (1) 100nm height calibration grating, (2) tuning forks with silicon shards attached, (1) 15mL bottle of First Contact cleaning solution.

SPM Accessories

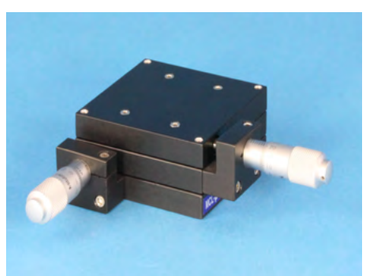
SPM-MZ

The SPM-MZ is a precision aligned, highly stable single axis micropositioner designed as a high stability, Z-axis approach for scanning probe microscopes. The SPM-MZ employs our proprietary intelligent motor control for low drift performance and incorporates a built-in right angle bracket to ensure high stability. The total travel range of the SPM-MZ is 25mm with a minimum step size of 95nm. An optional high resolution linear encoder may be ordered to continuously monitor positions down to 20nm. The USB digital interface provides direct PC control of the micropositioner as well as access to the linear encoder.
The SPM-MZ is compatible with standard optomechanical components, including tables, and Mad City Labs Nano-OP30 nanopositioners. Combining the SPM-MZ with the Nano-OP30 offers the user an integrated Z-axis approach with both long range travel and closed loop sub-nanometer precision making it ideal high resolution probe microscopy.

MMP Series

The MMP Series are a precision, stepper motor driven, micropositioning system for high precision positioning suitable for SPM/AFM applications. Long range linear positioning is provided in one, two or three axis configurations with high resolution and excellent repeatability. Employing our proprietary intelligent control scheme results in exceptional stability with high native precision. Optional high resolution (50nm) linear encoders provide real-time feedback of the actual stage position. The included Micro-Drive™ controller connects to a PC via a standard USB port and can be controlled via the supplied LabVIEW based software. Complex motion profiles can be programmed and sophisticated control parameters such as automatic acceleration and deceleration is employed to achieve high stability and native accuracy. Optional wireless gamepad control is also available.

SPM XY Manual Positioner



An XY manual micropositioning stage with 12.5mm/0.5" travel per axis. Constructed from aluminum. The stage is designed with integrated preloading making it suitable for nanopositioning. The XY manual micropositioner is suitable for positioning samples in areas of interest. The micrometers have 10 micrometer graduations. Compatible with the Nano-SPM200 and other nanopositioning stages with 2.25" x 2.25" hole pattern. Compatible with the SPM baseplate.

Coaxial Illuminator

Coaxial illuminator designed for use with the video optical microscope to view the probe approach to the surface. The illuminator assembly includes the LED with a pre-calibrated collimating lens housed in a 1" diameter lens tube, terminated with an iris. The brightness of the illuminator is controlled via a dial on the controller. The easy to use LED light source fits directly to the port of the video optical microscope.
Technical Specifications
Power supply: 12V/3.0A
Color temperature: 3000-9000K (min-max)
Axial intensity: 30lm
Cable length: 6'

Video Optical Microscope 2x, 100mm

Video optical microscope designed for viewing the probe approach to the sample surface. Manual XYZ positioning included. Recommended for use with the coaxial illuminator.
Technical specifications
2x magnification
100mm focal length
USB 2.0 output. Screen not included.

Double Insulated Enclosure

A double insulated enclosure for use with the SPM-M kit or any of our SPM products. This enclosure fits on most vibration isolation tables, offers a hinged front viewing window, and rear cable exit.
Dimensions
Exterior: 17" x 20" x 20"
Interior: 12" x 16" x 11.5"

SPM baseplate

Black anodized aluminum plate compatible with Mad City Labs manual and motorized micropositioning XY stages for SPM as well as the SPM-MZ. Baseplate includes additional 1/4-20 tapped holes on 1 inch spacing for accessories.
Dimensions
10.75" x 8" x 0.5"

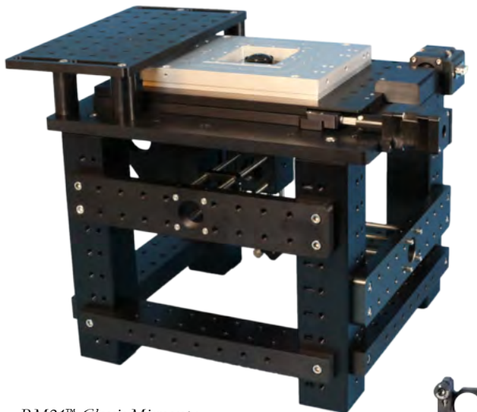
RM21® Microscopes

Applications

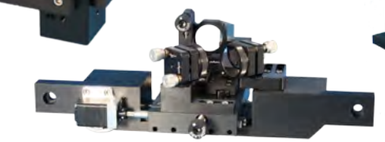
- *Fluorescence Microscopy*
- *Single Molecule Localization Microscopy*
- *MicroMirror TIRF Microscopy*
- *AFM*
- *Magnetic Tweezers*

Advantages

- *Direct optical access*
- *Integrated nanopositioning systems*
- *High stability microscope with precision alignment*
- *Designed for nanoscopy and light microscopy*
- *Future versatility*



RM21™ Classic Microscope



Motorized TIRF Module option

RM21™ Advanced Microscope

Product Overview

The RM21® is a versatile microscope suitable for a variety of advanced microscopy and nanoscopy methods. The RM21® is available in four standard models (see table) to satisfy a wide range of applications and budgets. All RM21® microscopes have been engineered for precision alignment and stability, essential elements for advanced microscopy techniques. The targeted microscopy methods routinely employ closed loop nanopositioning systems and all RM21® microscopes include Mad City Labs industry leading nanopositioning systems. Unlike conventional optical microscopes, RM21® microscopes allow direct access to the optical pathway. This access enables users to employ a variety of microscopy methods using the same central instrument. RM21® microscopes are compatible with 30mm and 60mm cage systems and are designed for use on a standard optical table. This feature makes it convenient to use a variety of off-the-shelf optical components. The RM21® microscope is not only suitable for advanced microscopy methods but also complementary techniques such as AFM and magnetic tweezers. Options to implement these techniques and multi-view imaging are available. Please contact our sales engineers to fully explore the possibilities of the RM21® microscopes.

Universal Features

- *Precision aligned three dimensional grid*
- *Adjustable, precision aligned shelves and breadboards*
- *Compatible with SM1/30mm and 60mm‡ cage system*
- *Vibration damping feet with removeable foot brackets*
- *Imperial or metric models available*

Models \ Methods	Epi-Fluorescence	Single Molecule Localization	MicroMirror TIRF	Dichroic TIRF	Magnetic Tweezers	Atomic Force Microscopy	Z Drift correction	3D Drift correction	Multi-View Imaging
RM21® Versa	●	●		○			○		○
RM21® Classic	●	●		○	○	○	○	○	○
RM21® Advanced	●	●	●	●	○	○	○	○	○
RM21® MicroMirror TIRF		●	●	○	○		○	○	○

Models \ Included Features	Manual XY	Motorized XY	Automated Objective	Fixed Objective	MicroMirror TIRF	Dichroic TIRF Module	Nanopositioning Axes
RM21® Versa	●			●			Z
RM21® Classic		●	●				XYZ
RM21® Advanced		●		●	●	●	XYZ
RM21® MicroMirror TIRF	●			●	●		XYZ

‡ Compatibility with 60mm cage system should be discussed with a sales engineer.
○ Requires additional RM21® microscope options

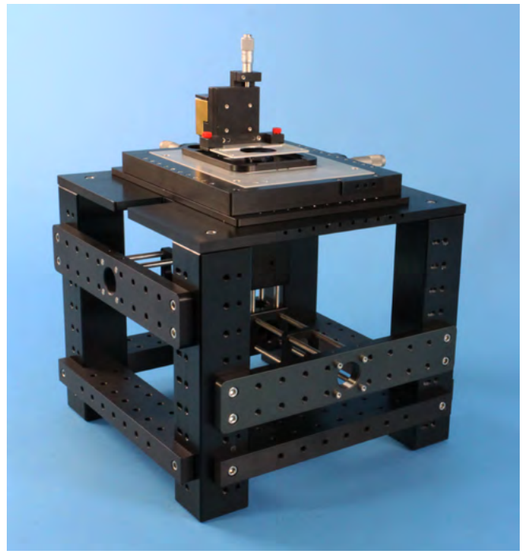
RM21® Versa Microscope

Supported Methods

- *Epi-fluorescence microscopy*
- *Single Molecule Localization Microscopy*
- *Dichroic TIRF †*
- *Z-axis focus correction †*

Microscope Advantages

- *Direct optical access*
- *Integrated Z-axis piezo nanopositioning*
- *Fixed objective lens for maximum stability*
- *High stability microscope designed for nanoscopy*
- *Manual XY microscope stage*
- *Simple to use*



Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW

MetaMorph®

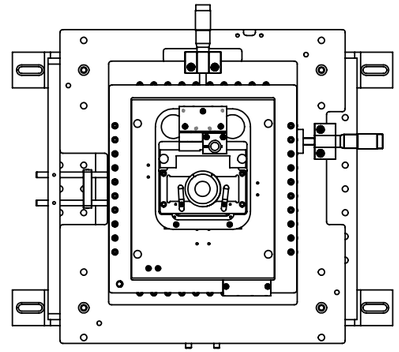
µManager Open Source Microscopy Software

Image-Pro® PLUS

SlideBook 6

Product Description

The RM21® Versa Microscope is an inverted optical microscope with a fixed objective lens position for maximum stability. The RM21® Versa microscope is ideal for single molecule localization microscopy and epifluorescence microscopy where sub-nanometer precision is only required in the Z-axis.
In common with all RM21® microscopes, there is direct access to the optical pathway and the microscope has been engineered for precision alignment and nanoscale stability in all three axes. All RM21® microscopes are compatible with 30mm and 60mm‡ cage systems and are designed to be mounted on standard optical tables.
The RM21® Versa Microscope includes a sub-nanometer precision, Z-axis closed loop piezo nanopositioning system designed to meet the requirements of super resolution microscopy. The objective lens position is fixed and precision aligned with the optical axis of the microscope and accomodates one lens. The position of the lens is fixed to maximize the stability of the microscope. The manual XY microscope stage has been specifically designed for use with closed loop nanopositioners and travels 25mm per axis. An adjustable, top mounted sample holder is included.
The RM21® Versa microscope use can be extended to additional techniques by simply adding standard options. In addition to the supported methods listed above, this microscope is also suitable for applications such as magnetic tweezers and AFM integration.



Top View

Above: Dimensions (in inches) of the RM21® Versa Microscope. Dimensions of the metric model are shown in [ ].

RM21® Versa Microscope

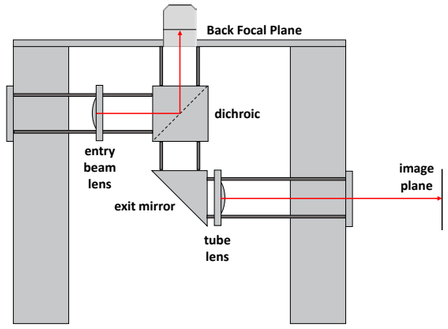
Microscope Specifications

Micropositioning Axes ..... X, Y
Range of motion (XY) ..... 25 mm
Threaded hole size ..... 1/4"-20 or M6
Threaded hole spacing ..... 1" or 25mm
Precision aligned shelves 4
Side breadboards 2
Foot brackets 4
Body Material ..... Anodized Aluminum

Nanopositioning Specifications

Range of motion ..... 200 µm
Resolution ..... 0.4 nm
Resonant Frequencies
Z axis ..... 110 Hz ±20%
Stiffness ..... 1.0 N/µm
θ_{roll} , θ_{pitch} (typical) ..... ≤1 µrad
θ_{yaw} (typical) ..... ≤3 µrad
Recommended max. load (horizontal)* ..... 0.5 kg
Recommended max. load (vertical)* ..... 0.2 kg
Body Material ..... Anodized Aluminum
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.



Above: Optical pathway of the RM21® Versa Microscope

Additional Notes

All models available in imperial (-I) or metric (-M).
Supported lens threads: RMS, M25, M26, M27, M32. Please specify at time of order.
Side breadboards compatible with SM1/30mm. ‡Compatibility with 60mm cage system available.
Due to the multiplicity of supported methods, user specific optics are not included.
User must specify parfocal distance of objective lens at time of order.
† Applications require additional options.

Available options

- TIRF Module - manual or motorized
- TIRF Lock

www.madcitylabs.com sales@madcitylabs.com MCL phone: 608-298-0855 fax: 608-298-9525

RM21® Classic Microscope

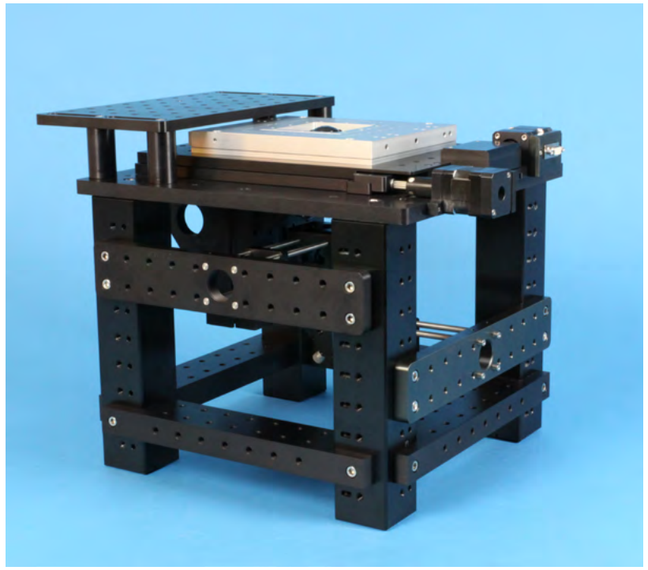
Supported Methods

- *Epi-fluorescence microscopy*
- *Single Molecule Localization Microscopy*
- *Dichroic TIRF †*
- *AFM/NSOM†*
- *Z-axis focus correction †*
- *Active 3D correction †*

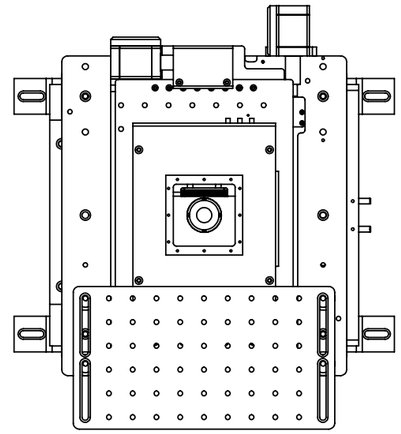
Microscope Advantages

- *Direct optical access*
- *Integrated XYZ piezo nanopositioning*
- *High stability microscope designed for nanoscopy*
- *Automated objective lens positioning*
- *Automated XY long range travel*
- *Multiple microscopy methods supported*

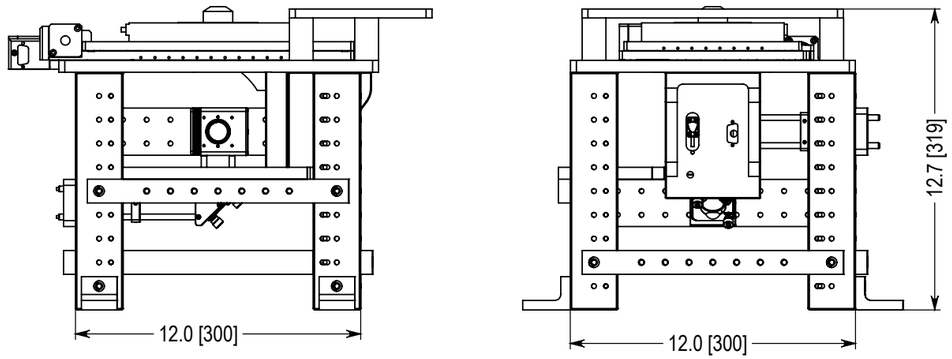
Product Description



The RM21® Classic Microscope is an inverted optical microscope that has been specifically designed for nanometer scale microscopy.
The RM21® Classic microscope is ideal for single molecule localization microscopy and epifluorescence microscopy but can be extended to other microscopy methods.
In common with all RM21® microscopes, there is direct access to the optical pathway and the microscope has been engineered for precision alignment and nanoscale stability in all three axes. All RM21® microscopes are compatible with 30mm and 60mm‡ cage systems and are designed to be mounted on standard optical tables.
The RM21® Classic Microscope includes a sub-nanometer precision, XYZ closed loop piezo nanopositioning system designed to meet the requirements of super resolution microscopy. In addition to the nanopositioning stage are three axes of precision stepper motor control for millimeter range motion. All micropositioning axes use our proprietary intelligent control for low drift and high performance with 95nm step size.
The z- axis objective lens holder is precision aligned with the optical axis of the microscope and accomodates one objective lens. Unlike other inverted optical microscopes, the total range of motion is 50mm. The XY microscope stage travels 25mm per axis and has been engineered for nanopositioning use. All automated axes may be ordered with optional position encoders to provide relative displacement readouts.
In addition to the supported optical microscopy methods listed above, the RM21® Classic microscope is also well suited for magnetic tweezers and atomic force microscopy.



Top View



Above: Dimensions (in inches) of the RM21® Classic Microscope. Dimensions of the metric model shown in [ ].

RM21® Classic Microscope

Microscope Specifications

Micropositioning Axes ..... X, Y, Z
Range of motion (XY) ..... 25 mm
Range of motion (Z) ..... 50 mm
Step Size (motor) ..... 95 nm
Micropositioning Controller ..... Micro-Drive™
Digital Interface ..... USB 2.0
Threaded hole size ..... 1/4"-20 or M6
Threaded hole spacing ..... 1" or 25mm
Precision aligned shelves 4
Side breadboards 2
Sliding breadboard 1
Foot brackets 4
Vertical Cage Plate 1
Body Material ..... Anodized Aluminum

Nanopositioning Specifications

Range of motion ..... 200 x 200 x 200 µm
Resolution ..... 0.4 nm
Resonant Frequencies
X axis ..... 270 Hz ±20%
Y axis ..... 185 Hz ±20%
Z axis ..... 110 Hz ±20%
Stiffness ..... 1.0 N/µm
θ_{roll} , θ_{pitch} (typical) ..... ≤1 µrad
θ_{yaw} (typical) ..... ≤3 µrad
Recommended max. load (horizontal)* ..... 0.5 kg
Recommended max. load (vertical)* ..... 0.2 kg
Body Material ..... Anodized Aluminum
Controller ..... Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

Additional Notes

All models available in imperial (-I) or metric (-M).
Supported lens threads: RMS, M25, M26, M27, M32.
Due to the multiplicity of supported methods, user specific optics are not included.
Side breadboards compatible with SM1/30mm cage systems.
‡Compatibility with 60mm cage system available.
† Applications require additional options.

Available options

- TIRF Module - manual or motorized
- TIRF Lock
- Magnetic Tweezers
- Nano-Cyte®
- Atomic Force Microscopy (AFM)
- Near Field Scanning Optical Microscopy (NSOM)

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph®, µManager Open Source Microscopy Software, Image-Pro PLUS, SlideBook 6

Models \ Methods	Epi-Fluorescence	Sinlge Molecule Localization	MicroMirror TIRF	Dichroic TIRF	Magnetic Tweezers	Atomic Force Microscopy	Z Drift correction	3D Drift correction	Multi-View Imaging
RM21® Versa	●	●		○			○		○
RM21® Classic	●	●		○	○	○	○	○	○
RM21® Advanced	●	●	●	●	○	○	○	○	○
RM21® MicroMirror TIRF		●	●	○	○		○	○	○

Models \ Included Features	Manual XY	Motorized XY	Automated Objective	Fixed Objective	MicroMirror TIRF	Dichroic TIRF Module	Nanopositioning Axes
RM21® Versa	●			●			Z
RM21® Classic		●	●				XYZ
RM21® Advanced		●		●	●	●	XYZ
RM21® MicroMirror TIRF	●			●	●		XYZ

‡ Compatibility with 60mm cage system available as an option.
○ Requires additional RM21™ microscope options

RM21® Advanced Microscope

Supported Methods

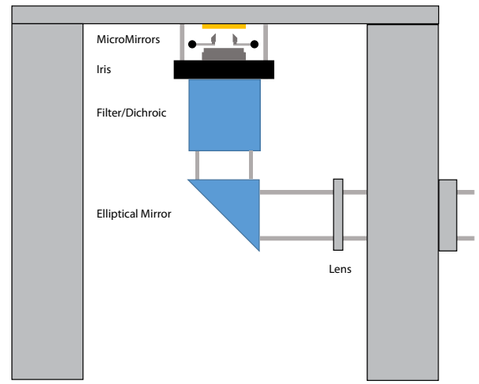
- *Epi-fluorescence microscopy*
- *Single Molecule Localization Microscopy*
- *MicroMirror TIRF*
- *Dichroic TIRF*
- *Atomic Force Microscopy †*
- *Magnetic Tweezers †*
- *Focus correction †*

Product Description

The RM21® Advanced Microscope is an inverted optical microscope with a fixed objective lens position for maximum stability. The RM21® Advanced microscope is our most versatile inverted optical microscope capable of supporting MicroMirror TIRF, single molecule localization microscopy, and other microscopy methods.
In common with all RM21® microscopes, there is direct access to the optical pathway and the microscope has been engineered for precision alignment and nanoscale stability in all three axes. All RM21® microscopes are compatible with 30mm and 60mm‡ cage systems and are designed for use with standard optical tables.
The RM21® Advanced Microscope includes a sub-nanometer precision, XYZ closed loop piezo nanopositioning system designed to meet the requirements of super resolution microscopy. The objective lens position is fixed and precision aligned with the optical axis of the microscope and accomodates one lens. The position of the lens is fixed to maximize the stability of the microscope. In addition to the nanopositioning stage are two axes of precision stepper motor control for millimeter range motion. All micropositioning axes use our proprietary intelligent control for low drift and high performance with 95nm step size. An adjustable height sample holder is included.
The RM21®Advanced microscope use can be extended to additional techniques by simply adding standard options. In addition to the supported methods listed above, this microscope is also suitable for applications such as magnetic tweezers and AFM integration.

Microscope Advantages

- *Direct optical access*
- *Fixed objective lens for maximum stability*
- *Integrated XYZ piezo nanopositioning*
- *Automated XY microscope stage*
- *Includes Unique MicroMirror TIRF*
- *High stability microscope designed for nanoscopy*
- *Most versatile microscope*



Above: RM21™ Advanced Microscope optical pathway for CoSMoS method

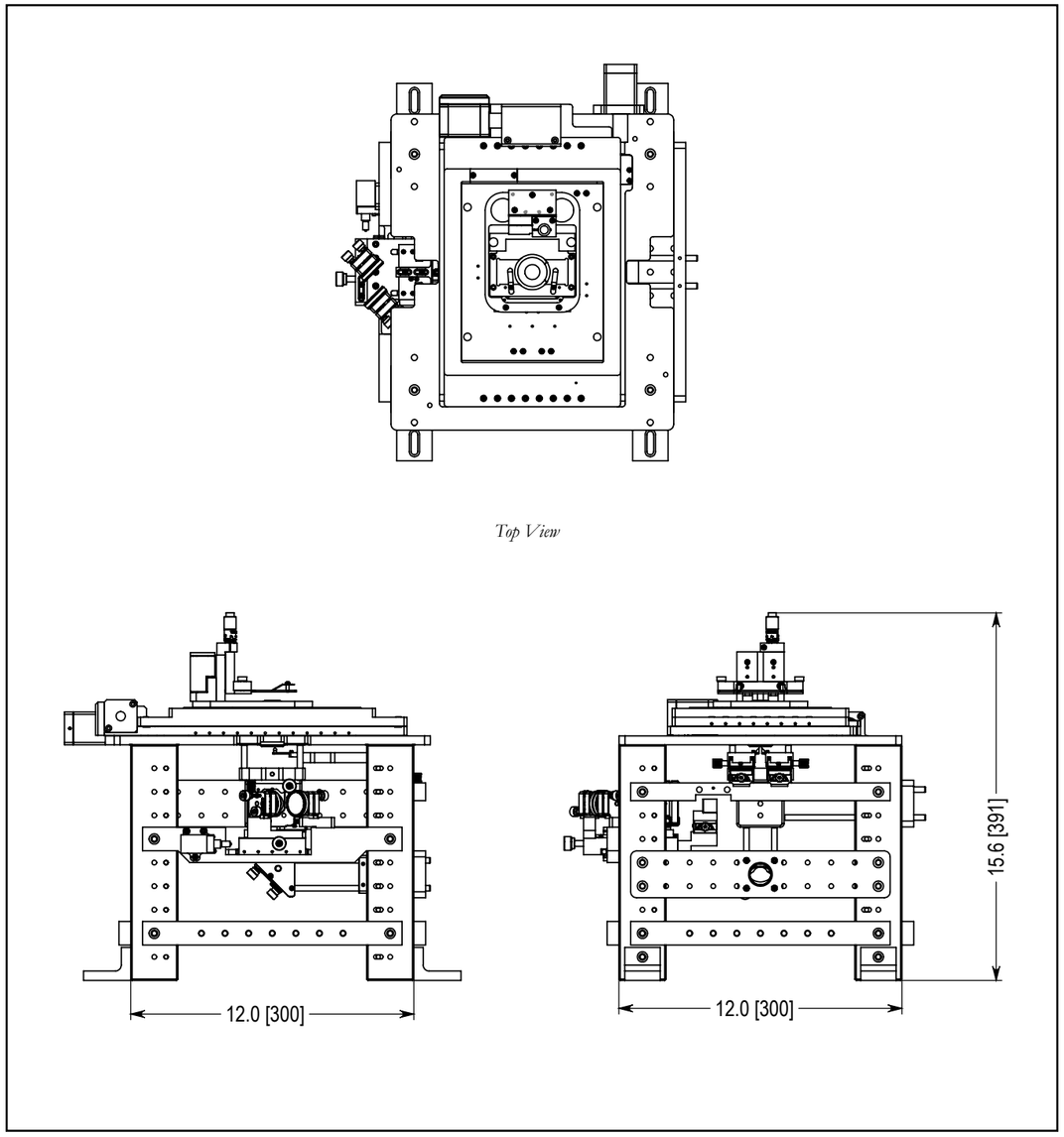
Additional Notes

All models available in imperial (-I) or metric (-M).
Supported lens threads: RMS, M25, M26, M27, M32
Side breadboards compatible with SM1/30mm. ‡Compatibility with 60mm cage system available as an option.
Due to the multiplicity of supported methods, user specific optics are not included.
User must specify parfocal distance of lens at time of order.
† Applications require additional options.

Available options

- TIRF Lock
- Nano-Cyte®
- Magnetic Tweezers

RM21® Advanced Microscope



Dimensions (in inches) of the RM21® Advanced Microscope. Dimensions of the metric models shown in [ ].

Microscope Specifications

Micropositioning Axes	X, Y
Range of motion (XY)	25 mm
Step Size (motor)	95 nm
Micropositioning Controller	Micro-Drive™
Digital Interface	USB 2.0
Threaded hole size	1/4"-20 or M6
Threaded hole spacing	1" or 25mm
Precision aligned shelves	4
Side breadboards	2
Foot brackets	4
Body Material	Anodized Aluminum

Nanopositioning Specifications

Range of motion	200 x 200 x 200 µm
Resolution	0.4 nm
Resonant Frequencies	
X axis	270 Hz ±20%
Y axis	185 Hz ±20%
Z axis	110 Hz ±20%
Stiffness	1.0 N/µm
θ_{roll} , θ_{pitch} (typical)	≤1 µrad
θ_{yaw} (typical)	≤3 µrad
Recommended max. load (horizontal)*	0.5 kg
Recommended max. load (vertical)*	0.2 kg
Body Material	Anodized Aluminum
Controller	Nano-Drive®

* Larger load requirements should be discussed with our engineering staff.

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW · MetaMorph® · µManager Open Source Microscopy Software · Image-Pro® PLUS · SlideBook 6

Models \ Methods	Epi-Fluorescence	Sinlge Molecule Localization	MicroMirror TIRF	Dichroic TIRF	Magnetic Tweezers	Atomic Force Microscopy	Z Drift correction	3D Drift correction	Multi-View Imaging
RM21® Versa	●	●		○			○		○
RM21® Classic	●	●		○	○	○	○	○	○
RM21® Advanced	●	●	●	●	○	○	○	○	○
RM21® MicroMirror TIRF		●	●	○	○		○	○	○

RM21® MicroMirror TIRF

Features

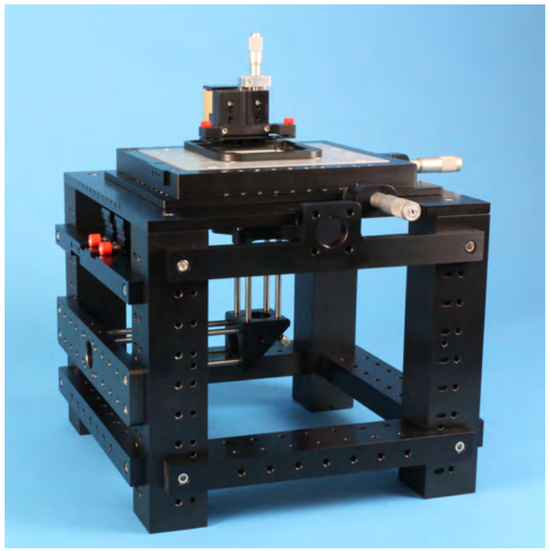
- *Integrated piezo nanopositioning*
- *Spatially separated excitation & emission beams*
- *MicroMirror TIRF*
- *Open access to optical pathways*
- *Highly stable, yet flexible, platform*
- *Integrated slide holder*
- *TIRF lock feedback control†*

Advantages

- *Unique MicroMirror TIRF Microscope*
- *Superior signal-to-noise ratio*
- *Eliminates dichroic mirrors*
- *Optical pathway accessibility*
- *Facilitates multi-spectral microscopy*
- *Proven design*

Product Description

The microscopy technique of colocalization single molecule spectroscopy (CoSMoS) is the only proven method to study the ordered assembly and function of multi-component biomolecular machines. The MicroMirror TIRF microscope is a proven design and is the only commercially available CoSMoS microscope.
The MicroMirror TIRF microscope is part of our RM21® microscope family and draws on our expertise with high precision, high stability nanopositioning systems and microscopy solutions. The MicroMirror TIRF microscope uses through-the-objective excitation, but replaces the dichroic used in conventional TIRF systems with two broadband micro-mirrors positioned at the back aperture of the objective lens. Spatially separating the excitation and emission beams and eliminating the dichroic mirror leads to superior signal-to-noise ratios and simplifies the introduction of multiple spectral lines to your experiment. Typical biomolecular systems studied using micro-mirror TIRF incorporate 3 or more laser lines which can be difficult to accomodate in conventional dichroic TIRF instruments.

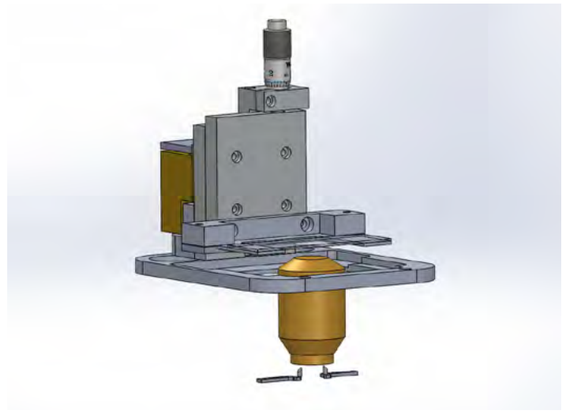


MicroMirror TIRF microscope showing the integrated nanopositoning with multi-axis adjustable micromirror mount. The red adjustment screws are the entry point for the micromirrors.

Each micro-mirror is mounted to a multi-axis precision manipulator allowing the user to make fine adjustments to the optical pathway. As with all RM21® microscopes it is designed to maximize optical pathway accessibility and flexibility, while also simplifying the optical alignment. A compelling advantage of our MicroMirror TIRF microscope is open access to the entry and exit optical pathways, and integrated XYZ closed loop piezo nanopositioning. The XYZ closed loop nanopositioning uses proprietary PicoQ® sensors for sub-nanometer precision and high stability. A manual adjustable sample holder is mounted above the nanopositioning system. Completing our MicroMirror TIRF microscope is the optional TIRF Lock feedback control consisting of a QPD sensor, TIRF Lock controller and software. The TIRF Lock module maintains the TIR signal through software feedback to the nanopositioner.

Technical Specifications

Micropositioning motion	X, Y, Z
Range of motion (XY)	25mm
Range of motion (Z)	10mm
Body Material	Anodized Aluminum
Nanopositioning motion	X, Y, Z
Ranges of motion	200 µm
Resolution	0.4 nm
Recommended max. load (horizontal)*	0.5 kg
Body Material	Aluminum
Controller	Nano-Drive®
Digital Interface	USB 2.0
Analog Input	0V to 10V
Synchronization outputs	TTL (4)
Nanopositioner software	Nano-Route®3D
Micro-Mirror diameter	3 mm



Above: Rendering of the MicroMirror TIRF microscope showing the relation between the micro-mirrors, fixed objective lens and z-axis sample positioner. For illustration purposes only.

* Larger load requirements should be discussed with our engineering staff.

† Applications require additional options.

Models \ Methods	Epi-Fluorescence	Sinlge Molecule Localization	MicroMirror TIRF	Dichroic TIRF	Magnetic Tweezers	Atomic Force Microscopy	Z Drift correction	3D Drift correction	Multi-View Imaging
RM21® Versa	●	●		○			○		○
RM21® Classic	●	●		○	○	○	○	○	○
RM21® Advanced	●	●	●	●	○	○	○	○	○
RM21® MicroMirror TIRF		●	●	○	○		○	○	○

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

Nano-Cyte®

Features

- *3D stabilization within 3 nanometers*
- *Active positional control over days*
- *Corrects for temperature gradients and drift*
- *Particle tracking capability*
- *Simultaneous image acquisition and stabilization*
- *Particle localization analysis*
- *Particle position rendering*

Product Description

The Nano-Cyte® single molecule imaging system* eliminates the microscope drift that limits advanced fluorescence imaging methods. With Nano-Cyte® you no longer need to be concerned with temperature gradients, sample drift, and microscope drift. Unprecedented stability in the nanometer regime allows long term experiments as never before.

The Nano-Cyte® works by using the image of fluorescent fiduciary references, sparsely distributed within the sample, to localize these emitters in all three dimensions. The Nano-Cyte® uses this 3D localization information to provide active position adjustments to the sample, thus eliminating drift in the experiment.

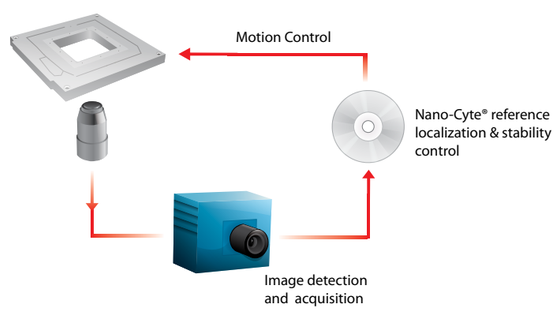
Nano-Cyte® is the complete stabilization and image acquisition instrument for advanced fluorescence microscopy. Our integrated approach to 3D stabilization yields image stability up to 3nm in X,Y and Z axes. Nano-Cyte® has proven stability over days and is a unique offering that promises to revolutionize advanced microscopy methods.

Hardware

The Nano-Cyte® is comprised of a high performance three axis nanopositioning system coupled with a two axis motorized micropositioning stage. These precision motion capabilities enable the active positional control and particle tracking features of the Nano-Cyte®. The nanopositioner is a flexure guided piezoactuated design with integrated PicoQ® sensors for absolute position sensing and nanometer precision under closed loop control. The micropositioning stage enables the user to have a large range of travel for surveying samples prior to engaging the active stabilization. All motion devices are controlled by the Nano-Cyte® controller via USB 2.0 interface.

The Nano-Cyte® is compatible with the Mad City Labs RM21™ Classic Microscope and most models of inverted optical microscopes.

Method



The Nano-Cyte® feedback control system. Stabilization is based on the imaging pathway. Once a fiduciary reference is selected, and localized, the Nano-Cyte® makes active positional changes to maintain focus. Mad City Labs high stability nanopositioners are integrated into the Nano-Cyte®.

* US Patent no. 9,019,363

Software

The native Nano-Cyte® software performs 6 important functions

- Stabilization
- Image acquisition
- Device control
- Particle localization analysis
- Rendering of particle position
- Tracking over multiple fields-of-view (FOV)

The Nano-Cyte® 3D stabilization occurs simultaneously with image acquistiion and incorporates reference selection, reference localization, and calibration statistics. Acquired images are saved in TIFF format and can be exported to ImageJ and other 3rd party software for post-acquisition processing.

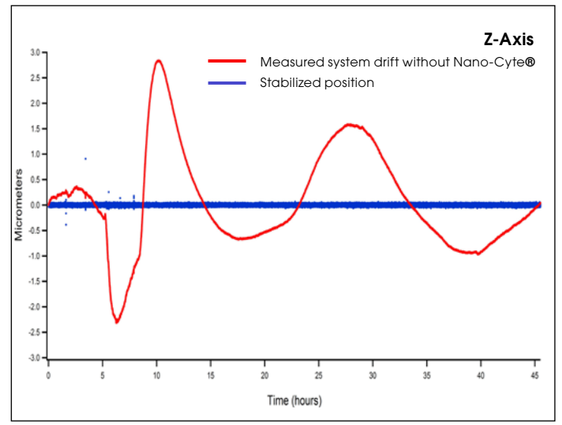
Nano-Cyte® device control ensures precision motion control and the ability to incorporate a variety of external user devices such as EMCCD cameras, shutters and light sources. Compatibility with LabVIEW™ and µManager facilitates even greater user device control and flexibility.

Post-acquisition features of Nano-Cyte® enable the localization of particles within an image and the three dimensional rendering of particle positions.

Nano-Cyte® is compatible with LabVIEW™, µManager, and rapidSTORM. In addition, Nano-Cyte® has an exportable DLL to allow wider functionality with 3rd party software platforms.

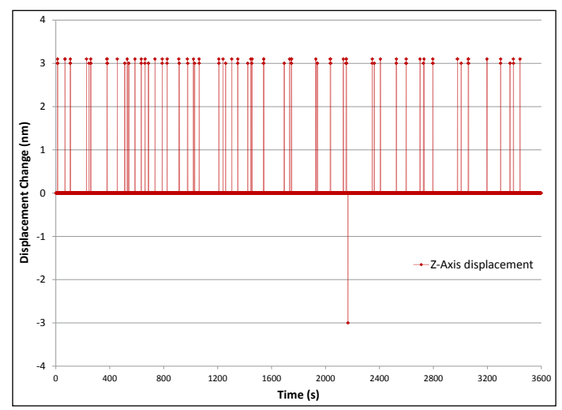
Nanometer stability over days

Stability data measured over 44 hours for the z-axis. The red line indicates the measured drift. The blue line indicates the stabilized position when using the Nano-Cyte®. Similar results were observed simultaneously for the x- and y-axis. These data below demonstrate the efficacy of the Nano-Cyte® under non-monotonic drift conditions.



Effective stabiliity using Nano-Cyte®

The Nano-Cyte® data below shows position changes performed on the z-axis over a period of 1 hour. These data demonstrate that the Nano-Cyte® effective stability is 3nm.



Technical Specifications

Nano-Cyte® specifications	
Stability (x,y, z-axis)	3nm
Drift rate compensation (typical)	10nm/sec
Stabilization rate (typical)	1 frame/second
Maximum data acquisition rate	Camera dependent
Measurement Resolution (rms)	50 mHz
Nanopositioning System specifications	
Range of motion	200µm × 200µm × 200µm
Position noise (total)	0.4 nm
Step size	3nm
Micropositioning specifications	
Range of motion	25mm × 25mm
Encoder resolution	20nm
Minimum step size	95nm
Controller & Software	
Controller	Nano-Cyte®
Communication	USB 2.0
TTL outputs	4 channels
Output image format	TIFF
Software	Nano-Cyte®
Software compatibility	LabVIEW
	µManager
	ImageJ
	Exportable DLL
	RapidSTORM
Microscope compatibility	RM21®
	Nikon Ti, TE series
	Olympus IX series
	Zeiss Axio Series
Supported EMCCD camera types	Andor
	Photometrics
	Hamamatsu
Power supply	12VDC/5A
Operating System	Windows Vista/7/8/10

Additional Documentation

Application Notes

- NC-001: Slide and coverslip cleaning for single molecule fluorescence microscopy.
- NC-002: Selecting fluorescent fiduciary reference beads.
- NC-003: Adsorbing PS-Speck beads onto slides and coverslips.
- NC-004: Adjusting optics to improve z-axis localization.

Software Note

- NC-005: Interfacing to the Nano-Cyte® DLL.

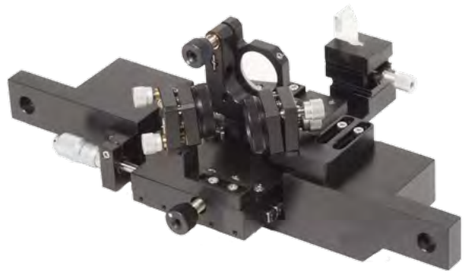
RM21® Options

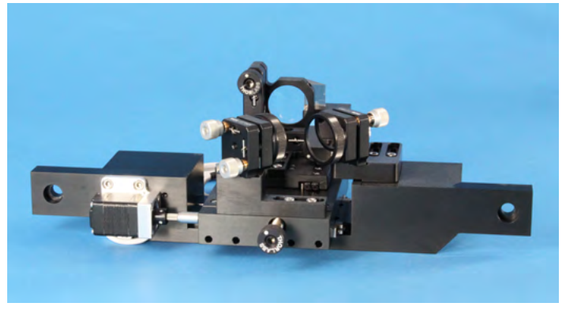
Available Options

- *Dichroic TIRF module - manual or motororized*
- *TIRF lock*
- *Coaxial Illuminator*
- *Magnetic Tweezer Module*
- *MadView™ multiview image splitter*
- *Nano-Cyte® 3D image stabilization*
- *Atomic Force Microscope*

TIRF Modules - Manual and Motorized

A typical application for the RM21® microscope are single molecule fluorescence microscopy.
A standard option available for the RM21® microscopes are TIRF Modules, which provides simple adjustment of the total internal reflection (TIR) excitation beam to achieve epifluorescence or TIR illumination of the sample and all angles in between (HILO). Both the manual and motorized versions of the TIRF Module control the angle of illumination and the focusing of the excitation beam onto the back focal plane of the objective lens. The motorized TIRF module is software controlled via a LabVIEW VI which allows the user to program up to five setpoints for angle of illumination. The LabVIEW VI can be incorporated as a sub-routine in user written LabVIEW programs.
TIRF Modules are fully compatible with all models of the RM21® and may be used in conjunction with Mad City Labs nanopositioning systems. We recommend using the TIRF module with the TIRF Lock option for maximum stability





Specifications

Motor step size (minimum) 95nm
Programmable set points 5
Software .....LabVIEW VI
Controller .....Micro-Drive™
Controller power..... 12V/3.0A

TIRF Lock

The TIRF Lock option comprises a quadrant photodetector (QPD), TIRF lock controller and LabVIEW based software. The TIRF Lock maintains the user desired TIR signal via software feedback control to the z-axis of the closed loop nanopositioning system. It is extremely useful for long term TIRF experiments and is compatible with both dichroic based and micromirror TIRF methods.
Two models of TIRF Lock are available. The standard model, pictured right, which is compatible with Mad City Labs RM21® Microscopes and selected external instrumentation. The advanced TIRF Lock model includes focussing lenses and is designed specifically for use on the RM21® Microscopes for ease of alignment and use.

Specifications

QPD Wavelength range .....400 nm - 1100 nm
Sensor size.....2.4 mm × 2.4 mm
Incident beam size (recommended) .....300 µm to 1.5 mm
Controller ..... TIRF-Lock™
Software ..... LabVIEW VI
Operating system .....Windows Vista/7/8/10
Controller power.....12V/5.0A
Controller dimensions..... 8.375” × 3.5” × 12”

RM21®Coaxial Illuminator

Coaxial LED illuminator with easy flip mount for use with RM21® Microscopes. Requires an RM21® breadboard (not included). Compatible with fixed objective RM21® microscopes.
The illuminator assembly includes the LED with a pre-calibrated collimating lens housed in a 1” diameter lens tube, terminated with an iris. The brightness of the illuminator is controlled via a dial on the controller.

<u>Technical Specifications</u>
Power supply: 12V/3.0A
Color temperature: 3000-9000K (min-max)
Axial intensity: 30lm
Cable length: 6’

RM21® Options

Magnetic Tweezer Module

The Mad City Labs, Inc. Magnetic Tweezer Module has been designed for use with RM21® single molecule microscopes. It comprises motion control hardware to facilitate magnetic tweezer implementations and a precision engineered magnet cartridge. It does not include analysis software.
The magnetic tweezer module comprises two axes (XY) manual control, one axis of motorized Z-axis approach and a bidirectional rotational stage which holds the detachable magnet cartridge. The rotational stage incorporates a clear aperture for light transmission.
The magnetic tweezer module uses two different controllers; the Micro-Drive™ for z-axis control and the Mad360™ for rotational control. Both controllers implement our proprietary intelligent control system. Our proprietary control scheme ensures excellent native stability and accuracy. The controllers interfaces to a PC via a USB port and separate LabView based motion control software.

Specifications

XY motion	25 mm
Z motion	50 mm
Z Step size (nominal)	95 nm
Z Encoder resolution	50 nm
Z-axis speed	4mm/sec
Z-axis native accuracy	<4 µm
Z-axis Controller	Micro-Drive™
Rotational Motion	360°
Motion	Bidirectional
Step size (nominal)	1 milliradian
Repeatability (@ 2 rotations/sec)	1 milliradian
Angular velocity (maximum)	6.28 radians/sec
	1 rotation/sec
Rotational Controller	Mad360™
Digital Interface	USB 2.0
Software	LabVIEW VI
Operating system	Windows Vista/7/8/10

Image Stabilization

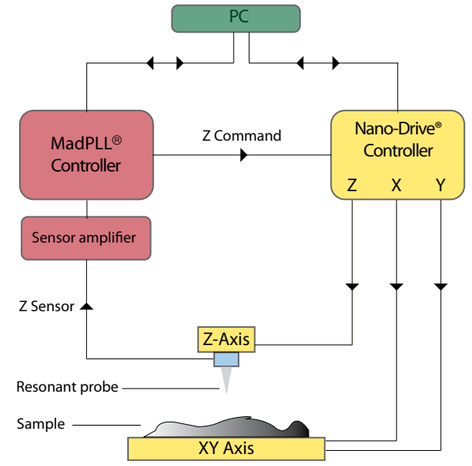
The Nano-Cyte® (US Patent no. 9,019,363) eliminates the microscope drift that limits advanced fluorescence imaging methods. With Nano-Cyte® you no longer need to be concerned with temperature gradients, sample drift, and microscope drift. Unprecedented stability in the nanometer regime allows long term experiments as never before.
The Nano-Cyte® works by using the image of fluorescent fiduciary references, sparsely distributed within the sample, to localize these emitters in all three dimensions. The Nano-Cyte® uses this 3D localization information to provide active position adjustments to the sample, thus eliminating drift in the experiment.
Nano-Cyte® is the complete stabilization and image acquisition instrument for advanced fluorescence microscopy. Our integrated approach to 3D stabilization yields image stability up to 3nm in X,Y and Z axes. Nano-Cyte® has proven stability over days and is a unique offering that promises to revolutionize advanced microscopy methods.
Additional information regarding Nano-Cyte®can be found in this catalog on page 174.

Multi-View Imaging

The MadView™ is a adaptable beam-splitting system designed for multi-color Single Molecule Microscopy imaging. It is capable of splitting the microscope image into Mono-, Dual-, Tri-, and Quad-View modes with the ability to switch between these imaging modes as required.
The MadView™ design allows for future customization in the field to suit particular experimental needs. This customizable approach permits the user to order the specific dichroic mirrors and final imaging lens as needed for their application.
More information regarding MadView™ can be found on page 182.

Atomic Force Microscopy

Mad City Labs' atomic force microscopes (AFM) are suitable for both research and teaching environments. The assembled AFM is a high performance, closed loop scanning resonant probe microscope with atomic step resolution. The AFM combines our low noise, high stability nanopositioners and micropositioners with our digital phase lock loop controller (see page 146).
Our AFMs are customizable and compatible with RM21® single molecule microscopes making them an excellent complementary technique for fluorescence microscopy. Our technical sales staff can assist with developing an AFM instrument to meet your application needs.
More information about our AFM products can be found on page 148.
Examples of AFM customizations can be found on page 154.



RM21® Options: MadView™

Features

- *Mono-to-Quad View Imaging*
- *Fully Customizable in the field*
- *Easy Filter Exchange*
- *Independent Beam Steering*
- *Independent Chromatic/Focal Control*
- *Magnification and FOV Control*

Product Overview

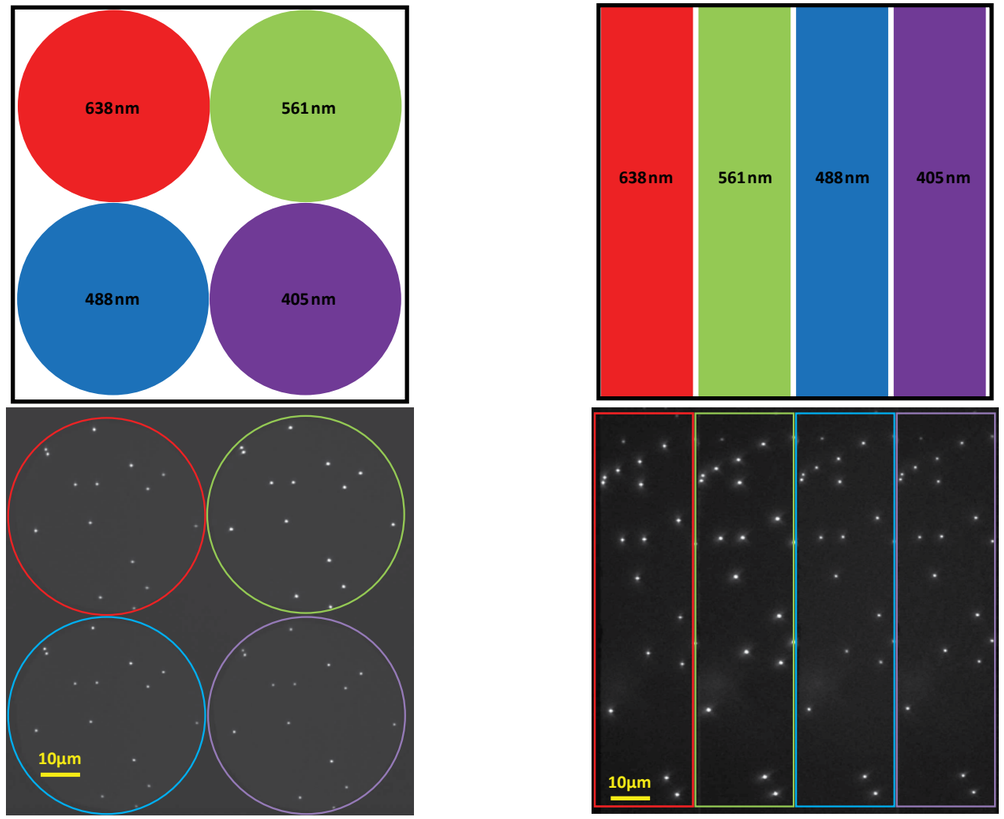
The MadView™ is a adaptable beam-splitting system designed for multi-color Single Molecule Microscopy imaging. It is capable of splitting the microscope image into Mono-, Dual-, Tri-, and Quad-View modes with the ability to switch between these imaging modes as required. The MadView™ is an available option for all current models of Mad City Labs RM21® Single Molecule Microscope. The compact design mounts directly to an optical table. Imperial and Metric models are available. Due to installation requirements, we recommend purchasing this option with the initial RM21® microscope purchase.

The MadView™ is designed to use 25mm x 36mm x 3mm "ultra-flat" dichroics (0.25λ/inch Peak-to-Valley flatness) to minimize Reflected Wave Distortion (RFW) and produce the highest quality images. The dichroics are held in precision magnetic mounts, making for easy filter exchange. This design also allows for future customization in the field to suit particular experimental needs. This customizable approach permits the user to order the specific dichroic mirrors and final imaging lens as needed for their application. Each chromatic channel of the MadView™ is the same optical length and has independent directional and focal control to steer and focus each separated color onto the camera as desired.

The MadView™ is compatible with most EMCCD and sCMOS cameras commonly used for Single Molecule Imaging. A unique feature of the MadView™ is that the overall magnification and Field-Of-View (FOV) is adjustable to achieve the desired pixel size and image registration on the camera. This feature allows the user to maximize the use of their imaging sensor.

Applications

- *Fluorescence Microscopy*
- *Single Molecule Imaging*
- *Super Resolution Microscopy*
- *Optical and Magnetic Tweezers*
- *Single Molecule FRET*



Above: Quad-view images of 0.5µm TetraSpeck™ beads, 107nm pixel representation, 1002 x 1004 pixel array

Nano-Drive® Series

Features

- *Nano-Drive® controller included with every Mad City Lab nanopositioning system*
- *Only controller that is PicoQ® sensor compatible for high stability and resolution*
- *Calibrated controller optimized for application specific performance*
- *Low noise performance*
- *Proportional integral feedback with closed loop control*
- *True USB 2.0 digital interface for positioning control*
- *High power models available for continuous high speed scanning*
- *CE compliant*

Nano-Drive®1 and Nano-Drive®3 controllers. Nano-Drive® controllers are shipped with every nanopositioning system fully calibrated and optimized for each system. Single axis Nano-Drive®C controllers are shipped with selected nanopositioning systems.

Product Description

Every Mad City Labs nanopositioning system includes our calibrated, closed loop Nano-Drive® controller. The Nano-Drive® Series of controllers are complete electronic packages for sub-nanometer positioning and are optimized for your piezo nanopositioning stage.

All Nano-Drive® controllers include low noise, low drift amplifiers, absolute position control, PicoQ® sensor electronics, and closed loop feedback. Closed loop feedback ensures that the displacement as a function of input voltage is highly linear and free of positioning errors caused by inherent creep and hysteresis in the piezo actuators. Piezo nanopositioners combined with a Nano-Drive® controller form a calibrated nanopositioning system which is individually adjusted and optimized for the specific performance requested by the customer. Factors such as load (sample mass), type of motion (steps, scanning, etc.), and required positioning speed are all factored into the customized setup and is at no additional charge.

All Nano-Drive® controllers provide standard analog control inputs (0-10V) via front panel BNC's. Optional 16-bit or 20-bit USB digital control interfaces may also be included to provide true "Plug & Play" connectivity. Front panel output BNC's provide access to the real-time position sensor signal and the actuator drive signal (HV/10). A variety of options (see table) are available to enhance the control of the nanopositioning system and integration with existing instrumentation. Upgrades to higher powered versions, the Nano-Drive®45 and Nano-Drive®85, for applications which demand continuous, high speed scanning and fast step response motions are also available.

Consult with your local Mad City Labs sales engineers for more information.
Select single axis nanopositioning systems include the Nano-Drive®C compact controller. This compact version of the Nano-Drive® controller provides the same performance as single axis Nano-Drive® controllers with an included 16 bit digital interface. Compact Nano-Drive®C controllers are not compatible with additional Nano-Drive® options.
The Nano-Drive® is also available for OEM customers. Contact our technical sales engineers for further information about partnering with us for your precision motion needs.

Nano-Drive® Specifications

Analog Input	0V to +10V
Input Connector	BNC
Command Signal Input Impedence	10 kΩ
Output Short Circuit Protection	YES
Output Signals	Sensor HV/10
Output Connectors	BNC
Operating Temperature	5°C to 40°C
Options	See table

Maximum Drive Current (continuous)

Nano-Drive®	50 mA
Nano-Drive®45	225 mA
Nano-Drive®85	425 mA

Power Output (continuous)

Nano-Drive®	10 W
Nano-Drive®45	45 W
Nano-Drive®85	85 W

Compatible Software Packages

Examples, tutorial, and Mad City Labs Nano-Route® 3D motion control software

LabVIEW, MetaMorph, NIS-Elements, Image-Pro Plus, SlideBook 6, µManager

Nano-Drive® Options

Option	Description
ND45-x	Upgrade to higher powered Nano-Drive®45 controller (x = number of axes). Consult technical sales to determine suitability.
NS85-x	Upgrade to higher powered Nano-Drive®85 controller (x = number of axes). Consult with technical sales to determine suitability.
USB16x	16 bit USB interface (x = number of axes). Features USB 2.0, 16 bit DAC/ADC for user friendly plug and play control. Supplied with Nano-Route®3D software.
USB20x	20 bit USB interface (x = number of axes). Features USB 2.0, 20 bit DAC/ADC for user friendly plug and play control. Supplied with Nano-Route®3D software.
AR-10	Analog input voltage range, -10V to +10V. Compatible with USB20x interface. Suitable for use with 3rd party data acquisition boards.
AR-6	Analog input voltage range, -6V to +6V. Compatible with USB20x interface. Suitable for use with 3rd party data acquisition boards.
AR-5	Analog input voltage range, -5V to +5V. Compatible with USB20x interface. Suitable for use with 3rd party data acquisition boards.
ISS	Image Scan Synchronization provides TTL compatible pixel clock, line clock, and frame clock. Compatible with both Becker and Hickl and PicoQuant TCSPC products. The ISS option requres Nano-Drive® controllers installed with either USB16x or USB20x options.
SO	Scan offset potentiometer for Nano-Drive®.
OCL	Front panel open loop/closed loop switch per axis.
RM	Rack mount hardware for Nano-Drive®.
PicoBOB	Breakout box to connect PicoQuant PicoHarp to Nano-Drive® controller with ISS option.

USB Computer Interfaces

- "Plug & Play" 16-bit and 20-bit digital USB 2.0 interfaces are Windows Vista, 7, 8, and 10 compatible (32-bit and 64-bit). USB drivers are included. 20 bit resolution is required to access the maximum available resolution of the nanopositioner. 16-bit resolution is sufficient for most optical microscopy applications
- LabVIEW compatible. Every USB enabled Nano-Drive® is supplied with Mad City Labs Nano-Route®3D motion control program, example VI's, and an extensive LabVIEW based tutorial. Nano-Route®3D is open source, LabView based motion control software.
- DLL file supplied for compatiblity with other programming languages, e.g. C#, Matlab
- Easily synchronize the nanopositioning system with other external instrumentation.
- Computer waveform generation and position data logging with internal memory for up to 10,000 positions.
- Custom firmware available upon request.

PA3 Amplifier

Features

- *Open Loop Control*
- *Low Noise, High Stability*
- *Multiple control methods*
- *Digital voltage readback via USB 2.0*
- *Output Voltage: 0 - 150V*
- *Compatible with Mad City Labs piezo actuators*

PA3 front panel (above)
PA3 rear panel (right)

Specifications	
Analog Input	*0 V to +10 V*
Command Signal Input Impedance	*10 kΩ*
Gain (0 - 10V input)	*15 $V_{out}/1V_{in}$*
Amplifier Output Voltage	*0 V to +150 V*
Maximum Drive Current (continuous)	*50 mA*
Power Output (continuous)	*10 W*
Output Impedance	*10 Ω*
Output Noise	*< 50 μV_{rms} (1 - 100Hz)*
Output Short Circuit Protection	*YES*
Steady State Power Consumption	*< 0.5 W*
General	
DC Input Voltage	*12 V*
Input Current	*5 A*
Power Supply	*100-240VAC, 50-60Hz*
Analog Input (per axis)	*BNC*
Manual Input (per axis)	*10 turn potentiometer*
Digital Input	*USB 2.0 (16 bit DAC)*
Digital Output	*USB 2.0 (16 bit ADC)*
High Voltage Output Display	*Front panel screen/USB 2.0*
High Voltage Output	*BNC (rear panel)*
Operating Temperature	*5°C to 40°C*
Dimensions	*10" × 8.375" × 3.5" (254 × 213 × 89 mm)*

Product Description

The PA3 is a three channel amplifier suitable for driving low voltage (150V) piezo actuators. The PA3 amplifier combines low noise and outstanding stability with high power output making it ideal for open loop, high resolution control of piezos. The PA3 includes adjustable feet for desktop use, a rack mount option is also available.
The PA3 requires a user supplied 0-10V input signal. The high voltage output is via BNC connections on the rear panel of the PA3. The output voltage for each axis is conveniently displayed on the front panel display.
The PA3 has three available input methods to maximize the compatibility with user instrumentation: analog input (BNC), front panel potentiometer, and 16 bit DAC input via the included USB 2.0 interface.
The USB 2.0 interface not only permits the user to command the input voltage with 16 bit precision but also allows the user to read back the high voltage output via the 16 bit ADC. The PA3 is shipped with LabVIEW based software to enable users to integrate the amplifier operation directly into their own LabVIEW based control software.

PA25 Amplifier

Features

- *Open Loop Control*
- *Low Noise*
- *High Stability*
- *High Power*
- *Output Voltage: 0 - 150V*
- *Compatible with Mad City Labs piezo actuators*

Product Description

The PA25 is a single channel amplifier suitable for driving low voltage (150V) piezo actuators. The PA25 amplifier combines low noise and outstanding stability with high power output making it ideal for open loop, high resolution control of piezos. The PA25 is equipped with a front panel analog input BNC for high precision command voltage control. A single channel high voltage (0 - 150V) output is conveniently located on the front panel This high voltage BNC connector can be interfaced to our bare piezoactuators for precision motion applications.

Specifications	
Analog Input	*0 V to +10 V*
Command Signal Input Impedance	*10 kΩ*
Gain (0 - 10V input)	*15 $V_{our}/1V_{in}$*
Amplifier Output Voltage	*0 V to +150 V*
Maximum Drive Current (continuous)	*160 mA*
Power Output (continuous)	*25 W*
Output Impedance	*10 Ω*
Output Noise	*< 50 μV_{rms} (1 - 100Hz)*
Output Short Circuit Protection	*YES*
Steady State Power Consumption	*10 W*
Current Consumption (max.)	*5 A*
-3 dB Bandwidth	
No Load (200 mV_{p-p} input)	*27 kHz*
No Load (10 V_{p-p} input)	*27 kHz*
1.0 µF load, current limited	*1240 Hz*
Stability	*< 0.01% over 16 hours*
General	
DC Input Voltage	*12V*
Input Current	*5A*
Analog Input	*BNC*
High Voltage Output	*BNC*
Operating Temperature	*5°C to 40°C*
Dimensions	*10" × 8.375" × 3.5" (254 × 213 × 89 mm)*

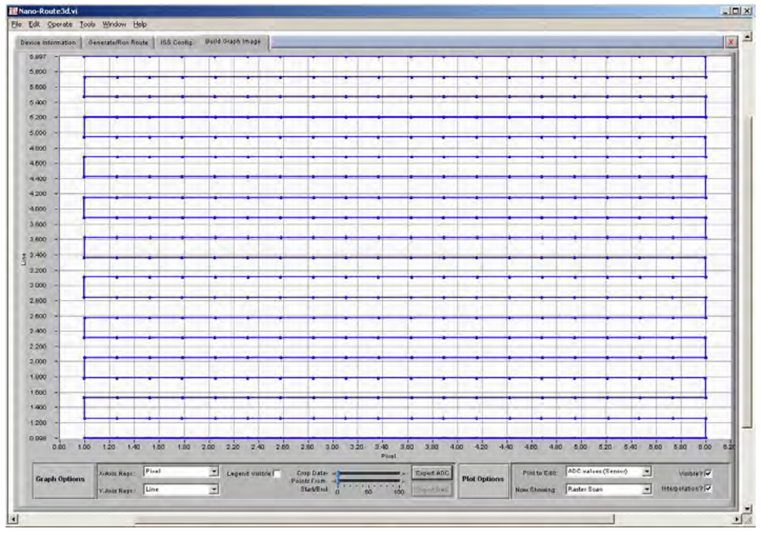
Software: Nano-Route®3D

Features

- *LabVIEW based - open source*
- *Easy to use graphical interface*
- *Live position tracking*
- *Point and time based functions*
- *Complex multi-axis route creation*
- *Control of pixel, line, and frame clock*
- *Route preview window*
- *Graphical display of executed route*
- *Position sensor data fully exportable*

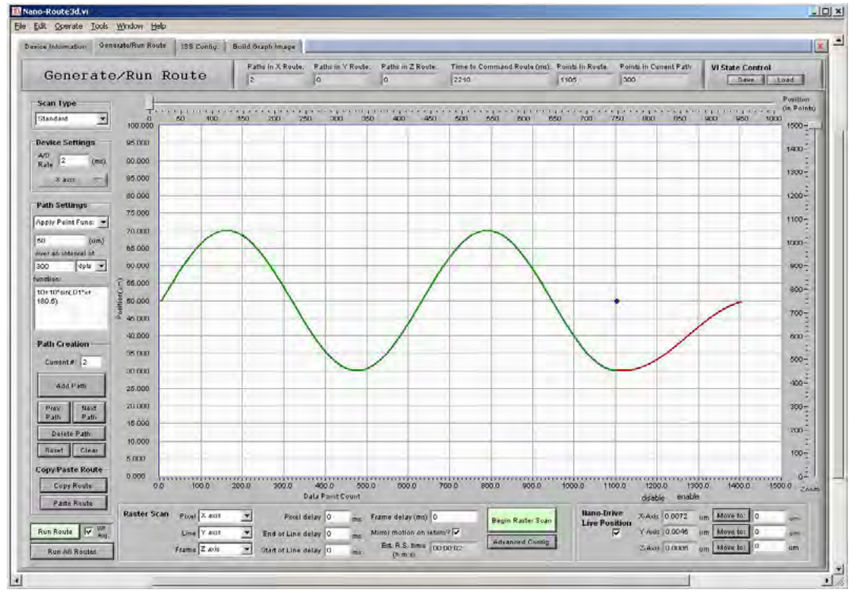
Mad City Labs' Nano-Route®3D is a LabVIEW based program designed to direct the motion of nanopositioning stages with minimal programming input. Nano-Route®3D is provided at no charge with all USB interface enabled nanopositioning systems. Programming details associated with control of a nanopositioner are handled internally and the on-screen displays are used to set the essential parameters which define the desired motion - including complex multi-axis routines. Routes can be generated via simple "go to" commands or more sophisticated point or time based functions. Motion commands to the Nano-Drive® contoller can be issued via the single point write mode or the waveform generation mode (single download and storage of all data points) depending on application requirements. A graphical display previews the generated command route and may be edited before the route is run. During execution of a route, Nano-Route®3D retains position sensor data retrieved from the Nano-Drive® controller and displays this data graphically in a separate window. The graphical representation can be customized and the data can be exported for further analysis. For experienced LabVIEW programmers, Nano-Route®3D can be used as a starting point for specialized control requirements. Mad City Labs' programming staff is also available to provide modified versions of Nano-Route®3D - contact sales@madcitylabs.com for further information and pricing estimates. Nano-Route®3D is compatible with Windows based PC's (Vista, 7, 8, 10) and requires a USB interface on the Nano-Drive® controller.

Nano-Route®3D Examples

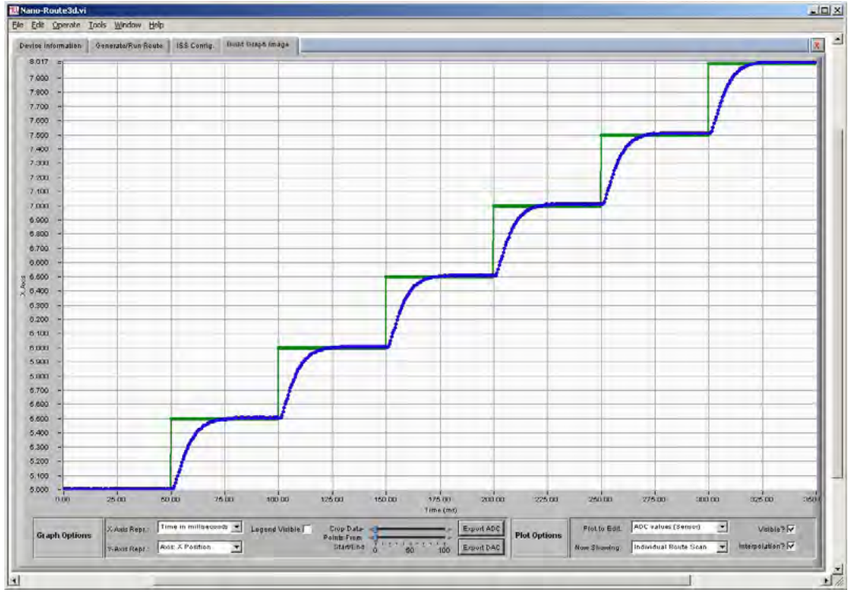


Nano-Route®3D is included free of charge with every USB enabled Nano-Drive® controller.

◀ *5μm x 6μm XY raster scan. XY plot shows the actual travel path of the nanopositioning stage in which a single scan line increments in Y axis position after each scan across the X axis.*



Path generation screen showing accepted path definition (green), path preview (red), and current boundary between accepted and preview portions of the path (dot).



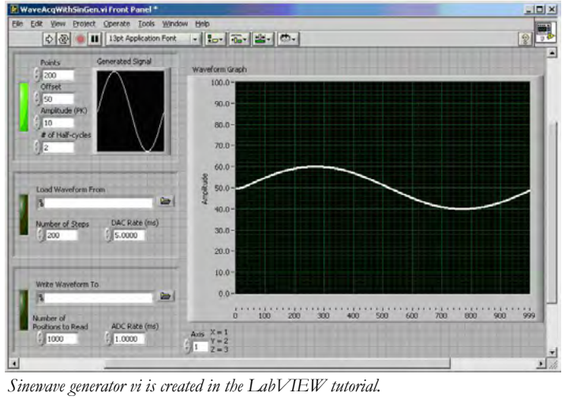
Path run screen showing the commanded path (green) and the actual path (blue) for a nanopositioner doing a high speed step followed by a pause at each new position.

3rd Party Software

LabVIEW - Examples and Tutorial

National Instruments' LabVIEW is an established graphical programming language specifically designed for scientific measurement and control applications. Mad City Labs' USB computer interfaces are LabVIEW compatible and come with examples which illustrate the operation of nanopositioning stages under computer control. Often, the LabVIEW examples are enough to allow experienced programmers to move ahead into more complex control schemes for specific nanopositioning applications. First time and infrequent users of LabVIEW will find Mad City Labs' LabVIEW tutorial a very helpful resource to quickly understand the essential concepts and start creating useful control software. Both the LabVIEW examples and tutorial are provided free of charge with every USB enabled nanopositioning system.

Mad City Labs' programmers are available to write custom LabVIEW vi's for specific applications. Contact our sales engineers to discuss the technical requirements of your ideal nanopositioning control software.



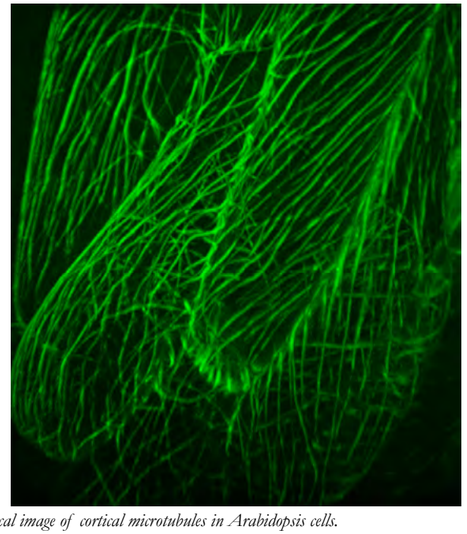
Sinewave generator vi is created in the LabVIEW tutorial.

LabVIEW examples and tutorial included free of charge with every USB enabled Nano-Drive® and Micro-Drive™ controllers.

MetaMorph®

Molecular Devices' MetaMorph is an industry standard software package for microscope automation and image analysis. MetaMorph provides direct control of Mad City Labs' nanopositioning stages using Mad City Labs' digital USB computer interface in addition to the standard analog control signals. MetaMorph integrates high resolution nanopositioning with image acquisition and analysis. Direct programming control of the nanopositioning stage is handled in MetaMorph - making knowledge of specific nanopositioning control commands unnecessary.

Mad City Labs MicroStages with encoders paired with Micro-Drive™ controllers are also supported under Metamorph software yielding high precision performance for mosaic imaging.



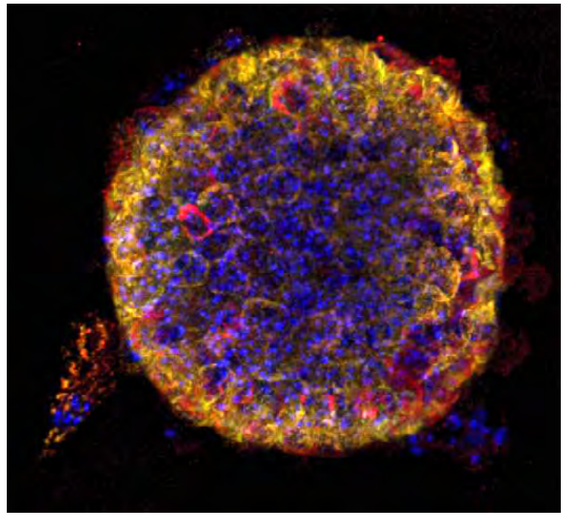
Confocal image of cortical microtubules in Arabidopsis cells.
Image courtesy of Dr. Sidney L. Shaw, IUB Light Microscopy Imaging Center

Mad City Labs nanopositioning and micropositioning systems also supported by:

NIS-Elements

Image-Pro

MediaCybernetics' Image Pro Plus software controls image acquistion and analysis software to form an integrated microscopy software package. Image Pro Plus directly controls Mad City Labs nanopositioning systems through standard analog control signals as well as the optional Nano-Drive® USB digital computer interfaces.



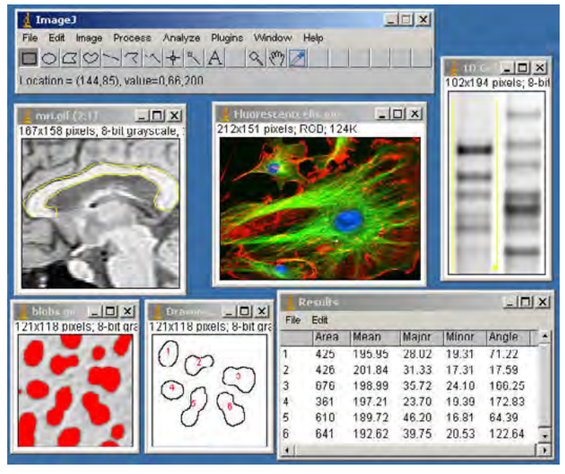
Confocal image of pancreatic islet cell.
Image courtesy of Dr. David Piston and Dr. Steven Head, Vanderbilt University

C Based Programming Support

With all USB enabled Nano-Drive controllers, Mad City Labs provides full access to Madlib.dll, a language independent DLL which implements an API for communicating with all Nano-Drive® products. It may be used by any programming environment that has support for importing C functions; e.g. C++, C#, Matlab, Python; and gives the user the ability to customize their instrumentation control. A basic example is provided which demonstrates how to access Madlib.dll.

µManager & ImageJ

µManager is a widely accepted open source software package for controlling microscopes and for image acquisition. µManager combined with ImageJ, a popular open source image processing and analysis package, forms a powerful and adaptable research tool with an active community of users. Mad City Labs contributed adapters (specialized control software) to µManager to provide direct control of Mad City Labs nanopositioning and micropositioning stages. All software can be downloaded directly from the µManager and ImageJ websites:
http://www.micro-manager.org/
http://rsbweb.nih.gov/ij/



Slidebook 6.0

SlideBook 6

Intelligent Imaging Innovations (3i) latest digital microscopy software, Slidebook 6.0, provides analog motion control and digital USB control for single axis and XYZ-axis nanopositioning systems. Support for XYstepper motor driven stages.

Accessories

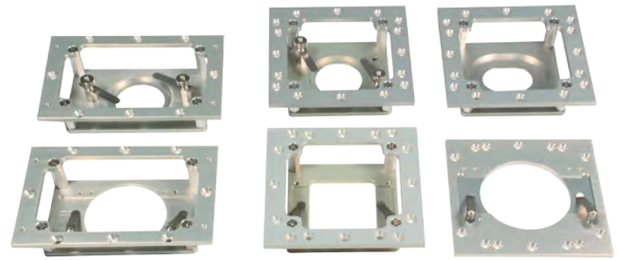
- *Sample holders - standard models for typical biological samples or custom designed for unique applications.*
- *Nanopositioning accessories including covers, extension cables, and adapter plates*
- *Adapter plates*
- *Wireless gamepad control of nanopositioners and micropositioners*
- *Lens extender tubes and adapters*
- *AFM accessories*

Sample Holders for Nanopositioners and Microscope Stages

Sample holder suitable for a variety of sample media

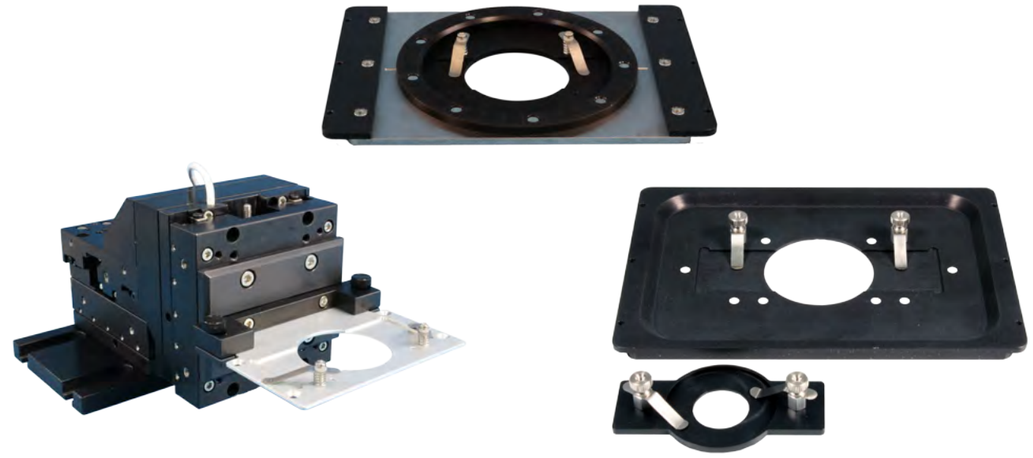
Mad City Labs offers a wide range of standard sample holders for their nanopositioning systems. Re-entrant and top-mounted sample holders are available. The table below indicates the availability of sample holders for various media types. Custom sample holders can be manufactured - please call our technical sales team for consultation on any of our sample holders and specific model numbers compatible with your nanopositioning system.

Nanopositioner Model	Media					
	50mm slide	75mm slide	35mm Petri	Coverslip	Multiwell plates	8 chamber
Nano-H Series	•	•	•	•		
Nano-Bio, Nano-LP, Nano-T, Nano-PDQ Series	•	•	•	•		
Nano-BioS, Nano-LPS Series		•	•	•		•
Nano-Z Series (not -OSSU)		•	•			
Nano-Zxxx-OSSU, Nano-ZLxxx-M	•	•	•	•	—	
Nano-ZL Series (not -M)	•	•	•	•	•	•
Nano-LPMW		•	•		—	



Sample holders suitable for nanopositioning stages to support a variety of sample media. The photo shows examples of re-entrant and top-mounted sample holders.

Mad City Labs microscope stages and micropositioners are essential elements in precision motion control. We offer a range of sample holders suitable for use with our microscope stages. In addition custom fabrication is available for those specialist applications. Please contact our technical sales group for more information.



Sample holders suitable for micropositioning stages and microscope stgaes. Slide holder for a 3 axis module motion control system (left), rotational sample positioner for microscope stage (center), and slide holder and coverslip holder for microscope stage (right).

Nanopositioning Accessories

In addition to sample holders, Mad City Labs offers other accessories for our nanopositioning systems.

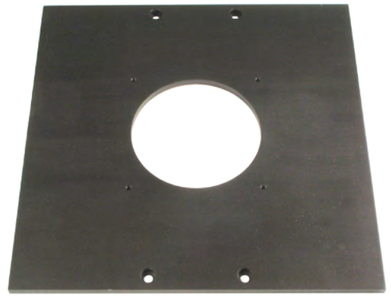
- Nanopositioning stage covers
- Extension cables - Mad City Labs nanopositioners with PicoQ® sensors are the only nanopositioning systems that can use extension cables without degradation of performance.
- Breakout boxes to interface between Nano-Drive® controllers and other instrumentation.
- Tool kit for use with Nano-Drive® controllers

Accessories

Microscope Adapter Plates

Nanopositioning systems are frequently used with inverted or optical microscopes. We offer a variety of adapter plates that allow our nanopositioners to be mounted directly to a microscope, or adapter plates to mount the nanopositioner to existing microscope stages. Please call our technical sales for more information.

Olympus IX inverted microscope series mount for the Nano-LP Series and Nano-Bio Series



Olympus IX inverted microscope series mount for the Nano-H Series

Objective Lens Extender Tubes & Adapters

The position of the microscope objective lens relative to the sample is quite important. Adding a nanopositioning stage to an existing microscope may raise the sample location if a re-entrant sample holder is not used (see Nanopositioner sample holders). In some situations it may be preferable to raise the objective lens to match the new sample location. Mad City Labs offers standard lens extender tubes with RMS, M25-0.75, and M27 threads. Standard lengths are 0.25" (6.34mm) and 0.5" (12.67mm). Lens extender tubes can be threaded together to make longer lengths.

M25-0.75 threaded lens extender tubes.

RMS threaded lens extender tubes.

A range of lens thread adapters to facilitate the use of objective lenses on different microscopes is available. All lens thread adapters are constructed from brass.

- M25(male) - M27 (female)
- M27 (male) - RMS (female)
- M32 (male) - M25 (female)
- RMS (male) - M27 (female)

The Nano-F Series of objective lens nanopositioners have interchangeable lens threads. These lens threads can be ordered separately. The interchangeable lens threads comprise the male piece to fit to the microscope nosepiece and the female piece for the lens. Please call our technical support to ensure that your nanopositioner can be fitted with an interchangeable thread before ordering.

Nano-Drive® and Micro-Drive™ Rack Mount

Nano-Drive® and Micro-Drive™ controllers can be mounted into standard equipment racks by attaching optional rack mount kits. All Mad City Labs controllers fit into the industry standard "2U" height (3.47 inches). Multi-axis Nano-Drive® controllers and the Micro-Drive™ controllers are the full rack width and can be mounted with narrow brackets. Single axis Nano-Drive® controllers are one half rack width and use extended mounting brackets. Rack mount kits are optional accessories that can be ordered with complete systems or purchased separately by contacting Mad City Labs.

Wireless Gamepad Control

Mad City Labs nanopositioning and micropositioning systems can be controlled via wireless Logitech gamepads. All USB enabled Nano-Drive and Micro-Drive controllers are supplied with the executable LabVIEW based gamepad programs.

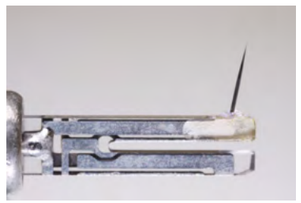
The nanopositioner's rate of acceleration is easily set with an on-screen control knob. On-screen position readouts show the stage location in every axis of motion.

For micropositioners, the wireless gamepad is a substitute for the hardware joystick traditionally available with microscope stages.

The gamepad program includes an on-screen control panel which displays the stage position as measured by the MicroStage high resolution linear encoders. Stage speed of motion can also be easily set with the MicroControl displayed parameters. For precise displacements, specific stage motions can also be input numerically - bypassing the joystick controller. MicroControl source code is provided for experienced LabVIEW programmers who may wish to modify the VI code.

SPM Accessories

Mad City Labs offers a wide range of accessories for their SPM instrumentation. A more complete description can be found at "SPM Accessories" on page 154.

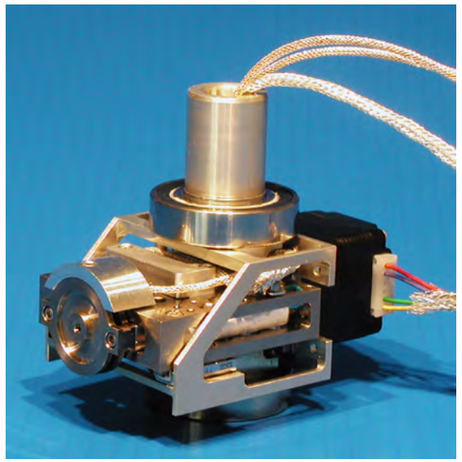


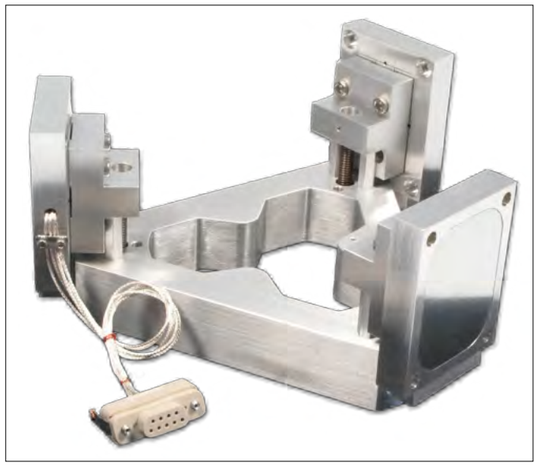
Available accessories:

- Tuning forks (medium and large)
- Video Optical Microscope, 2x, 100mm
- Coaxial illuminator (shown above)
- SPM etch kit
- SPM-MZ motorized approach (see page 132)
- Tuning forks with tungsten tips (shown above)
- Double insulated enclosure
- SPM baseplate
- SPM XY manual positioner
- MMP micropositioners (see page 128)

Custom Solutions

- *Fast delivery*
- *Experienced scientists with direct research experience*
- *In-house CNC fabrication and electronics manufacturing*
- *Specialty material expertise*
- *UHV expertise*
- *OEM partnerships welcomed*





Custom Systems

From simple modifications of existing designs to completely custom projects, Mad City Labs' engineering team has the capability to quickly provide unique nanopositioning systems for specialized requirements. In-house research scientists with extensive experience in UHV instrumentation, optical spectroscopy, and nanotechnology can provide the real-world advice and assistance to move a project from concept to reality. Generally, this work is done with minimum added charges and without any requirements for multiple unit orders. Whether you need a special physical configuration, expanded or reduced range of motion, compatibility with environmental conditions, or special materials, a short discussion with our technical sales staff and engineers will quickly reveal the feasibility of a custom solution.

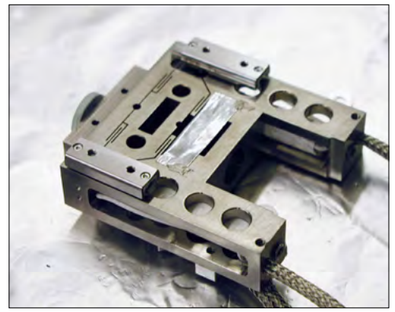
Custom Design Checklist

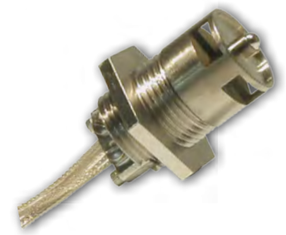
- How many axes of motion?
- Range of motion for each axis?
- What is the required speed of motion?
- What are the minimum and maximum dimensions?
- Center aperture?
- Environmental conditions (e.g. UHV, etc.)?
- USB computer interface needed?
- Coarse positioning needed?
- What is the maximum load on the positioners?
- Does the finished design need to interface to other instrumentation?

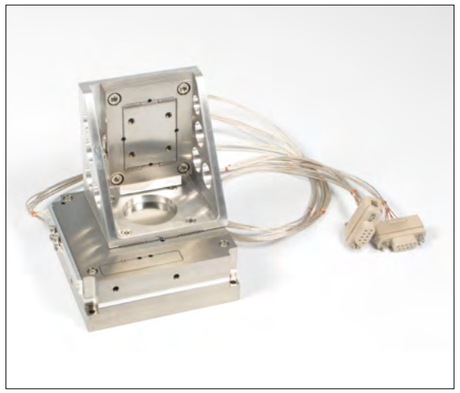
Need to discuss a custom design?
Call or email our engineers.
sales@madcitylabs.com
+1 608 298-0855

Custom
Instrumentation Development Process

1. CUSTOMER AND MCL REPRESENTATIVES DISCUSS APPLICATION AND CUSTOM INSTRUMENT'S EXPECTED PERFORMANCE CRITERIA
2. MAD CITY LABS INQUIRES ABOUT BUDGET AND TIMELINES
3. UNWORKABLE CRITERIA FLAGGED AND EXPECTATIONS ARE RESET
4. MCL PROVIDES FEEDBACK REGARDING TRADE-OFFS BETWEEN PRAGMATIC (MUST-HAVE) SOLUTION AND IDEAL (WISH LIST) SOLUTION
5. INITIAL DESIGN DEVELOPED IN ONE TO TWO WEEKS
6. CUSTOMER DECIDES WHETHER THE PRODUCT MEETS THEIR NEEDS; FEEDBACK DELIVERED TO MAD CITY LABS
7. CHANGES ARE INCORPORATED INTO FINAL DESIGN AND SENT TO CUSTOMER FOR APPROVAL
8. ONCE THE FINAL DESIGN IS APPROVED, FORMAL QUOTATION IS SENT TO CUSTOMER ALONG WITH PROJECTED LEAD TIMES FOR MANUFACTURE AND DELIVERY
9. FORMAL QUOTATION IS APPROVED AND THE ORDER IS PLACED AND READIED FOR DELIVERY BY THE AGREED-UPON DATES







OEM Partnerships

Mad City Labs Advantages

- *Innovative designs with industry leading performance*
- *Proven track record with startup companies and global companies*
- *Single site engineering design, manufacturing and assembly*
- *Quick turnaround*
- *Excellent reliability and reputation*
- *Prototype systems available for performance testing*
- *Unique performance characteristics*
- *Tailored hardware and software solutions*
- *Brand labeling and custom controller packaging available*
- *Board level OEM controllers available for integration into larger systems*
- *Annual blanket order pricing with scheduled monthly deliveries*
- *Expertise in a wide range of industries, including life sciences, aerospace, and photonics*

Mad City Labs welcomes the opportunity to partner with companies who require precision motion in their products.

Mad City Labs has proven expertise in designing and producing custom nanopositioning systems and precision micropositioning for integration into a wide variety of products. Our products are utilized in a number of industries including aerospace, metrology, life sciences, and photonics.

In-house design engineers and scientists work with your product team to provide practical and efficient positioning solutions. Mad City Labs in-house machining and electronic manufacturing allows products to move from concept to production within a short time. With our design, manufacturing and assembly located at a single site we are able to exert a high level of control over all aspects of production resulting in enhanced turnaround times and responsiveness to market changes.

Mad City Labs can also offer additional services such as firmware and software engineering, accessory design, and technical support and documentation.

Whether you have an annual requirement for hundreds of systems or only a few, Mad City Labs welcomes the opportunity to partner with your company.

Some examples

- High speed, high resolution laser scanners
- Lens nanopositioners
- Heavy duty nanopositioners for optics assemblies
- Long range multi-axis nanopositioning for microscopy
- Z-axis scanning nanopositioners
- Long range positioners for precision inspection

Our Custom Solutions page shows the range of our engineering capabilities.

MCL
THINK NANO

Need Nano in your product? Mad City Labs is the right OEM partner for you whether you are a small business or a Fortune 500 company. We work with you to manufacture reliable high precision motion control units for integration into your products. Contact our US or European office to begin your partnership today!

Notes on Nanopositioning

General Application

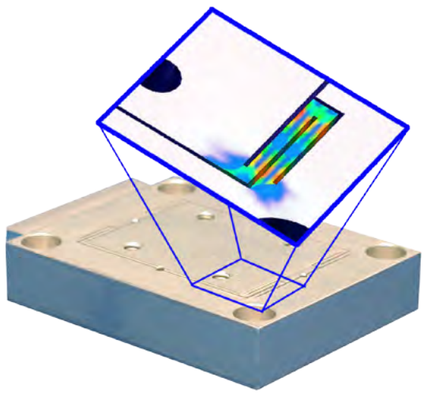
Nanopositioning systems are useful for any application which demands precision and reproducibility at the **single nanometer** or even **sub-nanometer** level. These applications include numerous types of microscopy, nano-alignment, and optical positioning. Nanopositioners can be generally categorized as bare piezoactuators, open loop stages, and closed loop flexure guided stages. The best performance is expected from closed loop, flexure guided systems.

Piezo Actuator

Nanopositioning can be achieved by simply using bare piezoactuators. Multilayer piezoactuators are made from PZT ceramic which expands in proportion to the applied voltage. The expansion is nearly linear, but hysteresis (~8%) and creep (~1%) are problems. As the PZT expands, it also twists and corkscrews. For these reasons, bare piezoactuators have a limited range of uses for nanopositioning. These sources of positioning errors must be eliminated by use of flexure stages, integrated position sensors and closed loop control systems. All Mad City Labs nanopositioning systems are flexure guided, closed loop control systems.

True Flexure Guided Motion

To overcome the problems associated with PZT actuators, all Mad City Labs nanopositioning systems use electrical discharge machined flexure stages. Flexure stages are unique in that they provide frictionless motion restricted to a single axis. This effectively decouples the unwanted motions in the PZT actuators and results in a pure linear translation. Mad City Labs uses finite element analysis in the design process to ensure proper flexure performance.



Finite element analysis of a basic flexure design showing areas of high stress during stage motion.

Response and Speed

Mad City Labs nanopositioning systems are designed to operate at a variety of speeds. The usable bandpass is typically 1/10 of the stage's specified resonant frequency.

Load Capacity

The load capacities listed in the catalog are conservative. Much larger loads can be moved but special care must be taken since the added moving mass effectively lowers the resonant frequency of the stage. If your application requires a large moving load it would be beneficial to discuss the details with our engineering staff.

Closed Loop vs. Open Loop

In open loop mode, the driver determines the motion of the nanopositioner simply by amplifying the input voltage. The position of the nanopositioning stage includes errors due to creep and hysteresis. In closed loop mode, the input voltage is compared to the output voltage from a position sensor. Using a proportional-integral feedback loop, the driver output is continuously adjusted so that the sensor signal matches the input signal to the driver. Since the sensor signal is proportional to the absolute position, the position of the stage is linear with respect to the driver input voltage. The effects of creep and hysteresis are eliminated. Mad City Labs employs proprietary PicoQ® sensors as part of their closed loop nanopositioning systems.

Resolution

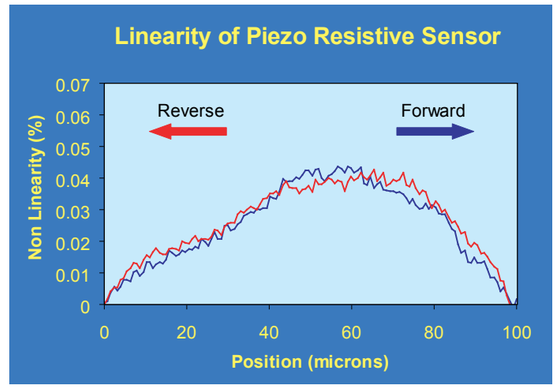
Since there is no quantum principle affecting the lattice spacing in PZT actuators, the step resolution of our nanopositioning stages is dependent only on the resolution of the input voltage to the Nano-Drive® limited by the combined position sensor and driver electronics noise level. For more information about position noise of our nanopositioning systems see the PicoQ® Precision section.

PicoQ® Sensors - Proprietary Technology

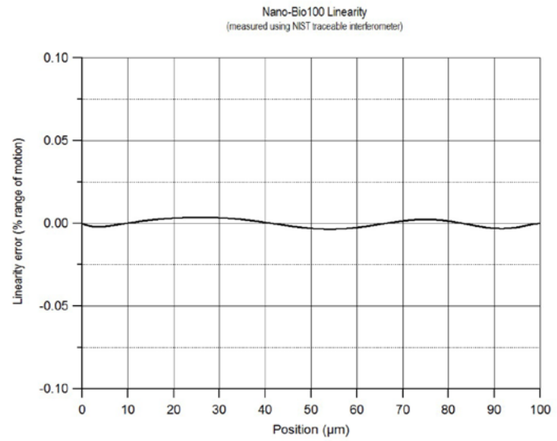
All Mad City Labs nanopositioning systems use ultra sensitive, temperature compensated, piezoresistive networks for position measurement. Called the Mad City Labs picoQ® sensor technology, this proprietary design provides extremely low noise floors, step resolutions down to 0.01nm and a positioning linearity of better than 0.05% without corrections. PicoQ® sensors are inherently linear and achieve performance superior to capacitive sensors without the need for higher order corrections or specialized controllers. For more information about the performance of our sensors see the PicoQ® Precision section.

Linearity

The accuracy and reproducibility of any piezo actuator driven nanopositioning stage depends primarily on the linearity and sensitivity of the stage. The linearity and sensitivity of a stage are different depending on the operation mode, open or closed loop. When operated in the open loop mode, the hysteresis and creep of the piezo actuator determine the non-linearity, which is typically 8% or more. This non-linearity is due to uncorrected hysteresis in the piezoactuator. Linearity is greatly improved when operating in the closed loop mode. In closed loop operation, a control circuit compares the input signal to a signal from a position sensitive detector. The control circuit continuously adjusts the driver voltage to ensure that the input signal matches the position signal. The linearity of a nanopositioning stage, when operated in closed loop mode depends on the linearity of the position sensitive detector - not the piezo actuator. Mad City Labs nanopositioning stages use PicoQ® sensors for position sensing. These sensors have a linearity of better than 0.05%. The closed loop linearity of a Mad City Labs nanopositioning stage is shown below.



Measured non-linearity is less than 0.05%. Nonlinearity correction techniques such as look up tables and high order polynomial fits are not needed to produce highly linear motion with Mad City Labs systems.



Exceptional linearity of PicoQ® sensors. The linearity of the Nano-Bio100 nanopositioning system was measured with a NIST-traceable interferometer. The linearity error of the system is measured as lower than 0.01% over the full range of motion of 100 microns.

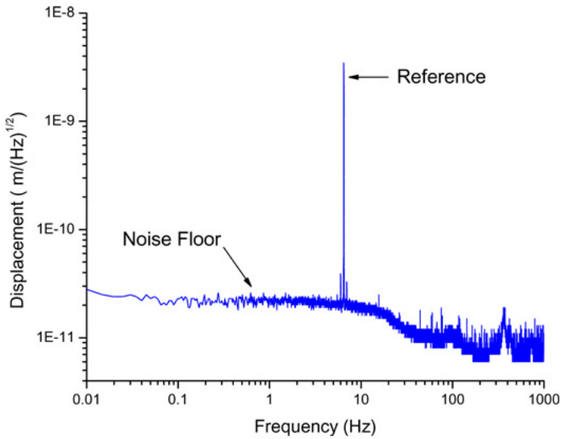
Need More Information?

Mad City Labs has an extensive library of introductory texts and videos, application notes, and technical notes. Visit our website or email us.

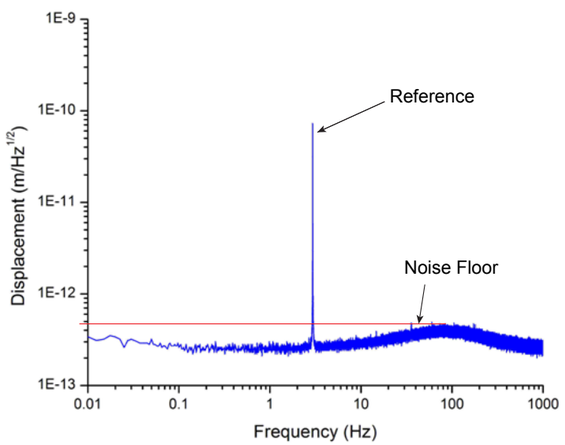
Notes on Nanopositioning

PicoQ® Precision

Mad City Labs closed loop nanopositioning systems are capable of providing picometer level positioning. Position noise, the lower limit on controllable motions, can be thought of as the true positioning resolution of a nanopositioning system. Position noise is the sum of all unwanted (but unavoidable) noise in the complete system - the electronic control system as well as the position sensors inside the stage. While the overall concept is simple, actual experimental determination of picometer level position noise requires an indirect approach. Mad City Labs' test procedure uses the nanopositioner's own internal position sensors to provide the necessary noise data. Since the internal position sensors provide analog signals which track the real-time position of the stage, it is possible to compare a calibrated motion created by a reference signal to the general background resulting from system noise. A fast fourier transform (FFT) plot of the position sensor signal clearly shows a spike which matches the frequency of the sinewave reference input and low amplitude background noise which is the summation of all system noise sources. Since the amplitude of the reference signal is known, the amplitude of the position noise can be easily computed.



Position noise plot for the X-axis of a Nano-LP100 nanopositioning system. The reference sinewave input is 3.5nm peak-to-peak at 7 Hz, the noise floor is 0.03nm/√Hz (30 picometers/√Hz).

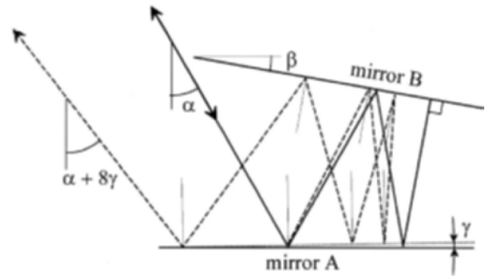


Position noise plot for the Z-axis of a Nano-HS3M nanopositioning system. The reference sinewave input is 70pm peak-to-peak at 3.5 Hz, the noise floor is 0.0004nm/√Hz (400 femtometers/√Hz).

Resolvable Steps and Stability

Nanopositioners with PicoQ® sensor technology have lower position noise than capacitive sensor systems and exhibit better inherent long time-scale stability. The inherent low noise properties of the PicoQ® sensor enabled nanopositioners also leads to high-resolution step capabilities.

The low-noise performance and high-resolution capabilities of our angular nanopositioning systems are demonstrated below. The measurements were conducted in the laboratory of Dr. Marco Pisani, Isituto Nazionale di Recerca Metrologica in Torino, Italy[1].

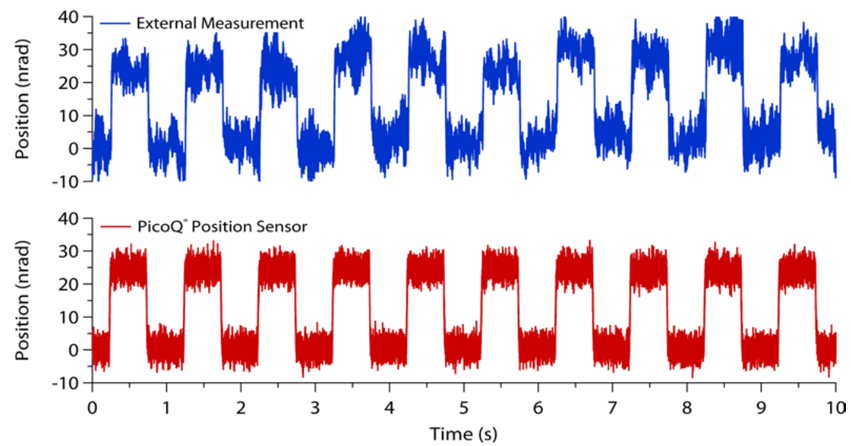


The measurement principle combines the effect of the optical lever and the reflection law, in a multiple reflection setup. A laser beam is sent towards a pair of quasi-parallel mirrors and after N reflections exits from the same direction (solid line).

Mirror A was glued to the Nano-MTA2 nanopositioning stage while mirror B was kept fixed. When Mirror A is rotated, the exiting mirror is rotated and translated proportionally to the distance between the two mirrors and N (dashed line). A position sensitive detector measures the displacement of the output laser beam and converts it to an electric signal.

The Nano-MTA2 is a two axis, tip/tilt closed loop nanopositioning system with a total range of motion per axis of 2 milliradians . The Nano-MTA2 nanopositioning system is commanded with a 25 nano-radian peak-to-peak square wave at 1Hz frequency. The position is measured by two methods: PicoQ® position sensor output voltage and the external angular displacement measurement described above. The PicoQ® sensor output is an analog voltage signal available from the front panel of the Nano-Drive® controller.

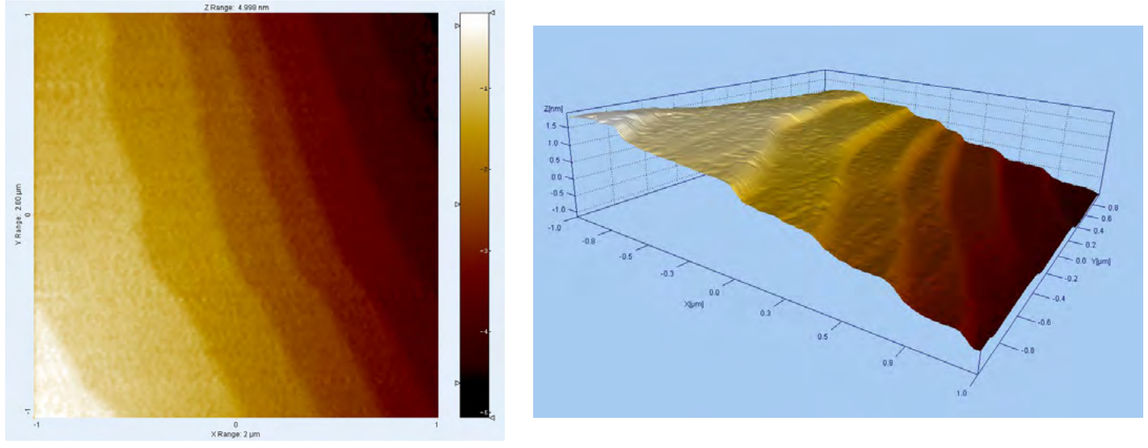
The results of the external angular measurement (blue, top) correlate closely with the data obtained from the PicoQ® sensor output (red, bottom). Both position measurements demonstrate the ultra-low noise and high-resolution



capabilities of Mad City Labs nanopositioning systems using PicoQ® sensor technology.
These data demonstrate the capability to take extremely small steps of 25 nanoradians using the Nano-MTA2 and for these steps to be discerned by an external measurement. These data also demonstrate the low noise floor and overall stability of the nanopositioning system.
[1] *M. Pisani, M. Astrua, "Angle amplification for nanoradian measurements," Appl. Opt. 45, 1725-1729 (2006) https://doi.org/10.1364/AO.45.001725*

Application: Atomic Force Microscopy

The following test demonstrates that a nanopositioning system with PicoQ® sensor technology (model Nano-HS3) has sufficiently low position noise and high accuracy to resolve single atomic steps in Silicon (0.312 nm). This is further validation that Mad City labs piezo nanopositioners with PicoQ® sensor technology set the standard for high accuracy and lowest position noise.
In the following test, the AFM instrument consisted of a Nano-HS3 with PicoQ® sensor technology for XYZ probe motion mounted on a SPM-MZ for Z axis coarse approach. A MadPLL® was used for closed loop feedback to maintain probe position in Z and an etched Tungsten tip attached to a quartz tuning fork was used as the imaging probe. Data were acquired using AFMView™ software, and analyzed and presented using SPIP® software.
A Silicon (111) substrate of single atomic layer steps was placed underneath the AFM described above. Silicon (111) has a stated monatomic layer thickness of 0.312 nm. Using such a well-known and well-defined physical sample allows for accurate characterization of the AFM's accuracy and resolution, and therefore the accuracy and resolution of the nanopositioning system that is part of the AFM. This Silicon substrate has been previously confirmed to be an excellent AFM calibration sample, see M. Suzuki et al. Standardized procedure for calibrating height scales in atomic force microscopy on the order of 1 nm. J. Vac. Sci. Technol. A 14, 1228 (1996).
The demonstrated low-noise properties of piezo nanopositioning systems with PicoQ® sensor technology allow for precise surface height measurement at the picometer scale when used as part of an AFM instrument. A lateral XY scan of the sample with simultaneous Z-axis position sensor measurements yields the topographic structure of the sample.
The resulting data clearly demonstrate that the individual atomic layers can be resolved using the Nano-HS3. Based

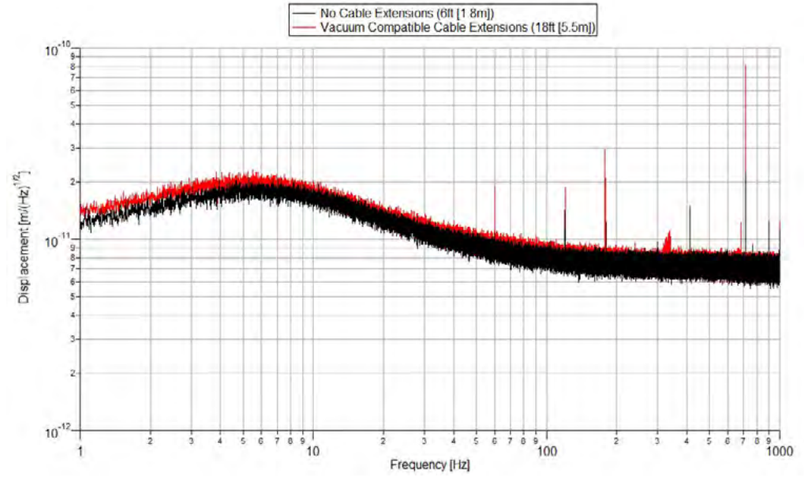


Individual 312 pm atomic layers on Si (111) detected using Nano-HS3 nanopositioner with PicoQ® sensors, measured by AFM. Left, 2D representation where each color change represents an atomic step. Right, 3D representation of these data.

on these measurements, the average step height was calculated as 311 pm with a standard deviation of 3 pm. Orji, et al derived an accepted value of 312 ±12 pm. These data externally verify the position resolution and low noise of Mad City Labs piezo nanopositioners with PicoQ® sensor technology in a relevant, real world application. The data also verify the accuracy of PicoQ® sensor technology, which were independently calibrated using NIST-traceable interferometry. The Si (111) atomic step-height measured by the position sensor is consistent with the previously derived accepted value.
Orji, et al. Traceable pico-meter level step height metrology. Wear 257:12, 1264-1269 (2004)]

Application: Ultra High Vacuum Compatibility

Designs for ultra high vacuum compatibility are our specialty. Most of our nanopositioning products can be upgraded for UHV environments. Our product engineers and technicians have extensive experience with vacuum instrumentation. In particular, Mad City Labs PicoQ® sensors offer significant advantages in the UHV environment ; the sensor material is vacuum compatible and the sensor performance remains unchanged irrespective of cable length. By contrast capacitive sensor performance degrades with added cable length (in air or vacuum), with 60% increased position noise for every meter of UHV cable added. This problem limits the versatility of any piezo nanopositioner that uses a capacitive sensor for position feedback, and can be a major drawback for both research and OEM applications.
Mad City Labs piezo nanopositioning systems can have custom UHV cable lengths and air side cables can easily be extended by adding standard, well-shielded extension cables without performance loss. Mad City Labs piezo nanopositioning systems with PicoQ® sensor technology also do not require costly signal conditioning boxes.



These data confirm that piezo nanopositioning systems with PicoQ® sensor technology maintain low position noise after the addition of UHV cables. In the experiment, the position noise of the piezo nanopositioning system was measured with the standard cable length of 6 feet [1.8 m]. Noise measurements were repeated after adding 18 foot [5.5 m] UHV compatible cables. The difference between the measurements at different cable lengths was negligible, showing that UHV cables and cable length do not affect the performance of piezo nanopositoining systems with PicoQ® sensor technology.

Notes on Micropositioning

General Application

Micropositioning stages are a practical addition to nanopositioning systems as they allow larger travel ranges, millimeters compared to micrometers. For microscopy applications it allows users to locate an area of interest for a higher resolution nanopositioning scan. Mad City Labs micropositioning stages are designed to be nanoposiitoning compatible with particular emphasis on positional stability, accuracy and repeatability performance. These are critical parameters when considering their use in conjunction with sub-nanometer accuracy devices. Mad City Labs offers both manual and motorized micropositioners.

Motorized Micropositioners

Mad City Labs micropositioning systems are designed to minimize the amount of power dissipated in the stage. The use of high precision, high force stepper motors allow the power dissipation to be reduced to zero when not in motion. This coupled with proprietary intelligent control results in exceptional positional stability beginning immediately after a move has been made. This is in contrast to micropositioners that use servo motors. Servo motors necessarily alway supply power to the motors and thereby continuously dissipate heat into the stage. As such, we do not recommend the use of servo motor stages with nanopositioning systems. Mad City Labs micropositioning systems have high native accuracy and repeatability.

Native Accuracy

The stepper motors used in Mad City Labs micropositioning systems allow for a high degree of native accuracy. Native accuracy is the absolute accuracy obtained when operated in open loop and the size of the microstep is used to calculate any change in commanded position. Native accuracy values are obtained by commanding the stage to move 100 micrometers and 1000 micrometers without reversing direction. Values reported are RMS errors in accuracy and obtained using an interferometric sensor, calibrated with an interferometer.

Native Repeatability

The stepper motors used in Mad City Labs micropositioning systems allow for a very high degree of native repeatability. Native repeatability is the absolute repeatability obstained when operated in open loop and the size of the microstep is used to calculate any change in commanded position. The native repeatability values were obtained by commanding the stage to move back and forth in a square wave fashion while the stage position was sequentially measured at each extremity. The values reported are the RMS error about the average position at either extremity. As with native accuracy, the measurements were made using an interferometric external sensor, calibrated with an interferometer.

Worldwide Sales

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For technical support and sales please contact our direct offices listed above or contact your local representative. Mad City Labs products and technical support are only available through our authorized sales offices. For the most current information regarding our sales network please visit www.madcitylabs.com/international.html.

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Terms and Conditions of Sale

1. Price. Quoted prices on the products are exclusive of all sales, excise and other taxes, and exclusive of freight, installation, handling and storage charges, any or all of which, as applicable will be added to the invoice as a separate charges to be paid by the Buyer or otherwise charged as indicated in these Terms and Conditions. Prices are effective for all purchase orders received from Buyer within 30 days of the date of Mad City Labs, Inc.'s formal price quotation, and thereafter subject to changes. Mad City Labs, Inc. reserves the right to increase prices in cases where modifications requested by the Buyer give rise to additional costs. Verbal price estimates are not binding.

2. Payment Terms. Buyer agrees to pay the total amount shown as due on each invoice within 30 days after the date of such invoice notwithstanding any repairs, corrections or adjustments that may have to be made. Special (custom) orders for products pursuant to Buyer specifications, are subject to payment of 50% of quoted price at time of acceptance of purchase order. Invoices will be dated as of date of shipment except if products are stored at Buyers request for more than 30 days beyond completion of their manufacture, in which case, invoices will be dated as of the date of product completion. Mad City Labs, Inc. shall reserve the right to charge interest at a rate not in excess of 18% per annum (but in no event more than the amount permitted by applicable law) upon any sum not paid by the due date. Mad City Labs, Inc. shall be entitled to collect from Buyer for all expenses of collection, including attorneys' fees.

3. Delivery. Terms shall be FCA Mad City Labs, Inc. premises, Madison, Wisconsin, for delivery by Federal Express (or similar carrier) with all freight charges, including special handling charges of carrier, paid by Buyer. Buyer shall bear all risk or loss or damage upon delivery of products to carrier at point of shipment, Madison Wisconsin.

4. Delays. Mad City Labs, Inc. is not liable for any delay in the performance of orders or contracts, or in the delivery or shipment of products, or any damages suffered by Buyer by reason of such delay, when such delay is , directly or indirectly, caused by or in any manner arises from, fires, floods, earthquakes, accidents, Acts of God, governmental interference or embargoes, strikes, labor difficulties, shortage of labor, fuel, power, materials or supplies, transportation delays or any other cause or caused beyond its control. All orders or contracts are given and accepted with the understanding that they are subject to Mad City Labs, Inc.'s ability to obtain materials from manufacturers and suppliers and are subject to manufacturing schedules and government regulations that may be in effect from time to time. Failure to meet a delivery date shall not give cause to either cancellation of the order, or liability on the part of Mad City Labs, Inc. Mad City Labs, Inc. may elect to make partial shipments.

5. Title. Upon issuance of Buyer's purchase order and Mad City Labs, Inc. acceptance thereof, Buyer thereby shall be considered to have granted to Mad City Labs, Inc. a security interest in all products delivered to secure the payment of invoiced amounts due. Buyer agrees to execute and deliver to Mad City Labs, Inc., upon request, UCC financing statements and other documents reasonably requested by Mad City Labs, Inc. to perfect its security interest in the products.

6. Cancellations and Change Orders. Accepted purchase orders can be cancelled or changed only with Mad City Labs, Inc.'s written consent and upon terms that will indemnify Mad City Labs, Inc. against all losses, costs and damages it sustains directly or indirectly related to the cancellation or change. All special orders are non-cancellable and non-changeable. A restocking fee of 100% of the purchase price is applicable to all invoiced orders.

7. Inspection and Rejection. All products shall be examined by Buyer upon receipt of Buyer. If products are damaged upon receipt or do not conform to agreed specifications, products shall not be moved from point of delivery, and a written claim must be filed with Mad City Labs, Inc. within 5 business days of date of delivery. Upon receipt of a written claim for damaged or nonconforming products, Mad City Labs, Inc. will notify Buyer in writing if products are to be returned, or if products will be repaired or if a credit will be issued. Whether products are returned or repaired or whether a credit is issued, is within Mad City Labs, Inc.'s full and complete discretion, subject to the limited warranty set forth below, and shall be Buyer's sole remedy at law or equity.

8. Limited Warranty: Disclaimer. Mad City Labs, Inc. warrants that for a period of 1 year following the date of delivery to Buyer Mad City Labs, Inc. products shall conform to the specifications, drawings or other written descriptions contained in any purchase order and shall be free from defects in material and workmanship. This limited warranty applies to the initial purchaser only and may be acted upon only by the initial purchaser. Buyer's sole remedy and Mad City Labs, Inc.'s exclusive liability for a breach of this limited warranty shall be, at Mad City Labs, Inc.'s option, the repair or replacement of the nonconforming product or part thereof. This limited warranty does not cover normal wear and tear and shall not apply to any product which has been damaged or misused or modified, altered or repaired by any party other than an authorized representative of Mad City Labs, Inc.

THE FOREGOING LIMITED WARRANTY IS IN LIEU OF ANY OTHER WARRANTY, WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL (INCLUDING ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, TITLE OR NON-INFRINGEMENT.)

9. IN NO EVENT SHALL MAD CITY LABS, INC. BE LIABLE TO BUYER FOR SPECIAL, INCIDENTAL, CONSEQUENTIAL, EXEMPLARY, PUNITIVE, OR OTHER INDIRECT DAMAGES, OR FOR LOSS OF PROFITS, LOSS OF DATA OR LOSS OF USE DAMAGES, ARISING OUT OF THE MANUFACTURE, SALE, SUPPLYING OR FAILURE OR DELAY IN SUPPLYING OF THE PRODUCTS OR THE SERVICES RELATED THERETO, WHETHER BASED UPON WARRANTY, CONTRACT, TORT, STRICT LIABILITY OR OTHERWISE, SHALL NOT EXCEED THE PRICE PAID FOR THE PRODUCT.

10. Controlling Provisions. To the extent there is a conflict between these Terms and Conditions of Sale and Buyer's purchase order, these Terms and Conditions of Sale shall be controlling.

11. Termination. Each purchase order issued by Buyer in connection with Mad City Labs, Inc.'s quotation is subject to acceptance by Mad City Labs, Inc. If Buyer defaults in the payment of any sum due Mad City Labs, Inc. or commits any other breach of any of the terms or conditions herein or if there is a material change in the ownership or financial conditions of the Buyer which is considered unsatisfactory to Mad City Labs, Inc., then Mad City Labs, Inc. may, without prejudice to any other rights which may have accrued or which may accrue to it, whether under contract or at law or equity, refuse to accept any purchase order and may terminate any order immediately.

12. Governing Law. Any contract between the parties shall be construed and governed in accordance with the laws of the State of Wisconsin.

13. Mad City Labs, Inc.'s Property. All specifications, drawings, tools, jigs, dies, fixtures, materials, equipment and other items furnished by Mad City Labs, Inc., or the cost of which is charged against this order shall be confidential and shall be and remain the property of Mad City Labs, Inc.. The sale of products by Mad City Labs, Inc. to Buyer shall not be construed as a license of any trade secret right, trademark, patent or copyright.

14. Patents. The Buyer agrees to defend, indemnify and hold Mad City Labs, Inc. and its distributors and dealers in, and users of the products of Mad City Labs, Inc. harmless against any and all losses, damages or liabilities arising out of any demand, claim, action, litigation or judgement (each, a "Claim") involving infringement or alleged infringement of the U.S. and/or foreign patent by any product furnished hereunder.

15. Patent Rights. Patent rights to all improvements embodied in products, designs, tools, patterns, drawings, information and equipment supplied by Mad City Labs, Inc. under this contract and exclusive rights for the use and reproduction thereof are reserved by Mad City Labs, Inc.

16. Confidential Information. Buyer agrees to treat the products supplied by Mad City Labs, Inc., related documentation, specifications and any other papers accompanying purchase orders as the confidential information ("Confidential Information") of Mad City Labs, Inc. and shall not disclose such Confidential Information other than to its employees and agents who need to know such information and who are informed of the confidential nature of such information. In addition, Buyer agrees not to incorporate or permit its' affiliates to incorporate any features of design or construction peculiar to the products supplied by Mad City Labs, Inc. into any other product.

17. Indemnification. Buyer will indemnify, defend and hold harmless (including paying reasonable attorneys' fees) Mad City Labs, Inc. and its employees, agents and permitted assigns against all liability to third parties that: (1) arises from Buyer's negligence or willfully wrongful, wanton or reckless conduct that results in death or bodily injury or damage to real or tangible personal property; or (2) arises from or in connection with Buyer's use or resale of any product furnished under this Agreement that violates any third party's trade secrets, proprietary information, trademark, copyright or patent rights.

18. Errors. Any stenographic or clerical errors contained on the face hereof are subject to correction by Buyer.