Version: 2017

NAI | Motion Control Catalog

National Aperture Inc.

Miniature Positioners
Motion Control
Software

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ManualStage

Manual MicroMini™ Stage

MM-1 Series, Our Smallest Stages

General Data:

Moment Load Capacity:	3 - 8 oz-in
Body Height:	5 mm
Body Length:	26 mm
Body Width:	11mm and 14 mm
Travel Ranges:	3 mm and 5 mm
Thru Hole:	3.94 to 4.0 mm

General Precision:

Screw Pitch:	80 TPI (0.31725 mm/turn)
Adjustment Sensitivity:	0.5 µm
Wobble (max):	10 µrad
Backlash:	0
Runout (max.):	0.3 µm/mm

Model No.	MM-1CR	MM-1CR-EX	MM-1CRB
Top load:	0.17 kg (6 oz)	0.17 kg (6 oz)	0.17 kg (6 oz)
Pitch:	6 oz-in	6 oz-in	8 oz-in
Roll:	4 oz-in	4 oz-in	4 oz-in
Yaw:	3.5 oz-in	3.5 oz-in	6.5 oz-in
Travel:	3.1 mm	5.1 mm	3.1 mm
Return Force: (average)	8 - 16 oz	4 - 16 oz	8 - 16 oz
Thru Hole:	3.94 mm	4.0 mm	4.0 mm
Attributes:	safety braced 1 & 2 axis closely coupled to the load	longer trave,l less return force 1 & 2 axis closely coupled to the load	sturdier design ideal for 1 to 3 axis with load away from the stage

Moment load quick estimation:

Take the lowest moment value and apply that to the distance from the farthest stage slider.

Example: **MM-1CRB**; Absolute maximum = 4 oz-in for any one direction relative to farthest stage.
For best performance: 2 oz-in or less.

Dimensions: L x W x H, not including lead screw extension

Model No.	MM-1CR	MM-1CR-EX	MM-1CRB
-X Single Stage	26.2 x 11.2 x 5.1(mm)	26.2 x 14.2 x 5.1 (mm)	26.2 x14.2 x 5.1 (mm)
Weight	3 grams	5 grams	5.5 grams
-XY (2-axis)	26.2 x 26.2 x 10.2 (mm)	26.2 x 26.2 x 10.2 (mm)	26.2 x 26.2 x 10.2 (mm)
Weight	7 grams	10 grams	11 grams
-XZ (2-axis)	26.2 x 11.2 x 31.43 (mm)	26.2 x 14.2 x 31.43 (mm)	26.2 x 14.2 x 31.43 (mm)
Weight	9 grams	12 grams	13 grams
-XYZ (3-axis)	26.2 x 26.2 x 36.3 (mm)	26.2 x 26.2 x 36.3 (mm)	26.2 x 26.2 x 36.3 (mm)
Weight	13 grams	16 grams	17 grams

Features:

- 3D Models available on-line
- CR,and -EX, versions may be combined
- Constructible into over 16 different configurations
- Fully English/Metric Compatible
- Built-in Connectivity with all MM-1 manual MicroMini™ Stages

MM-1 Manual Stage

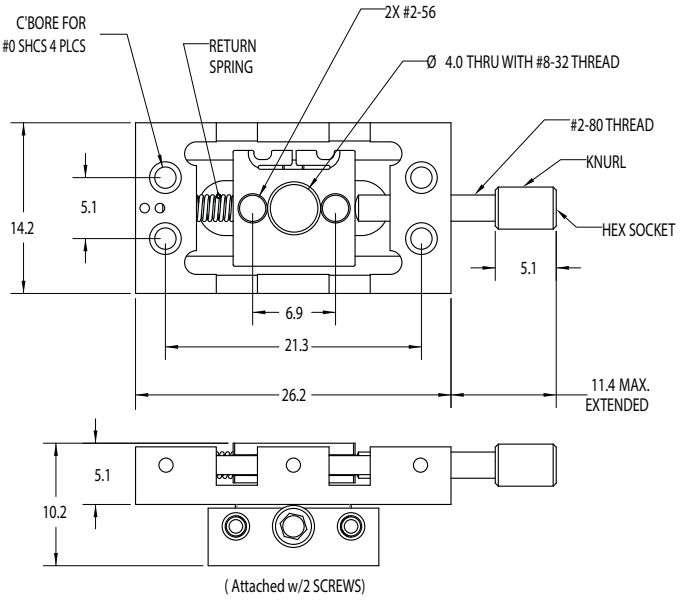
Part Number Key/Dimensional Data

Part Number Key, MM-1 series

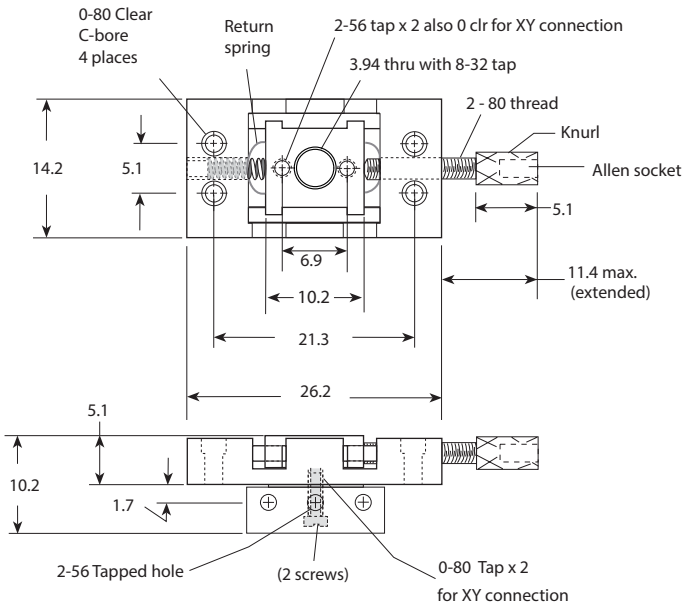
Example:

CR	XYZ	SS	V
configuration	**axes**	**actuation option**	**vacuum compatibility**
CR-EX: extended travel	X: single axis	blank: 80 TPI thumbscrew	blank: 10^{-3} Torr
CR: captive rail	XY: dual axis flat	SS: headless lead screw	V: 10^{-6} Torr
CRB: captive rail butterfly	XZ: dual axis, edge mount	TG: thumbscrew with thumb grip	
	XYZ: three axis		

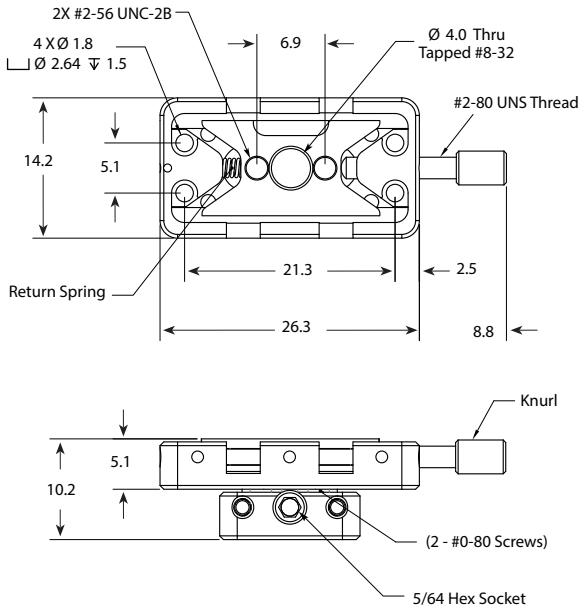
MM-1CR-EX (mm)
5 mm Travel



MM-1CR (mm)
3 mm Travel

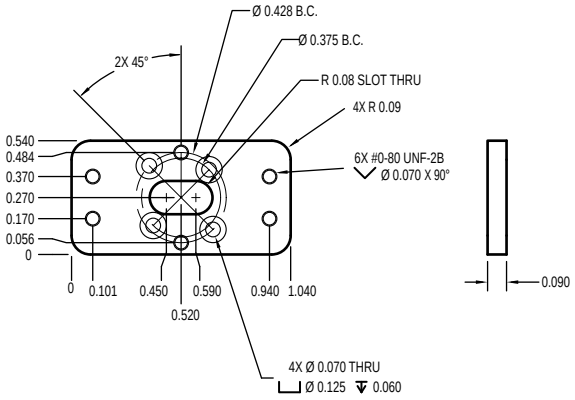


MM-1CRB (mm)
3 mm Travel



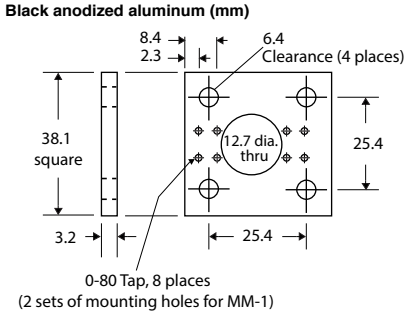
The information contained in this data sheet is subject to change without notice. Critical dimensions or specifications should be verified with our technical support staff.

ManualStage
MM-1
Accessories



AP1-3-XY

Adapter plate for mounting MM-1X on top of MM-1R, MM-2X & MM-3X (XY)

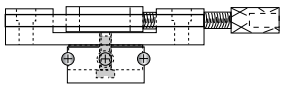


AP4-1, Adapter Plate

A multi-position mounting plate to interface with standard optical tables and accessories, or to stabilize free-standing stages.

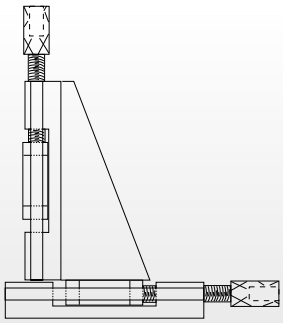
KIT-XY-1, MM-1-XY Screw Kit

Contains two, 0-80 connecting screws utilizing two tap clearance holes in slider to connect two MM-1 stages into an XY configuration.



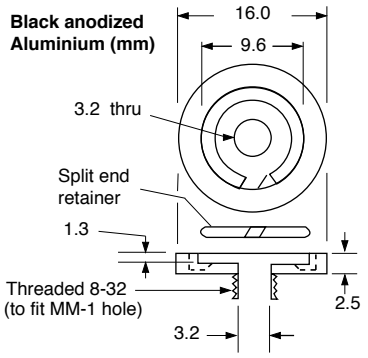
KIT-Z-1, Z-Brace and Screw Kit

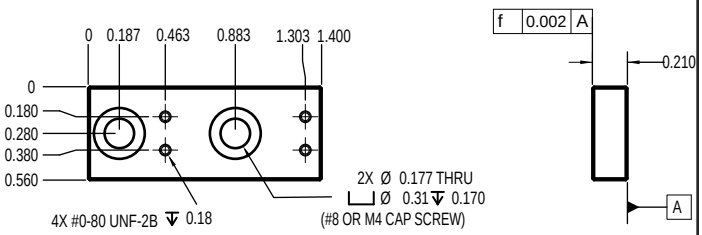
Contains two 0-80 x 3/16" long Socket Head Cap Screws, four 0-80 x 1/4" long Socket Head Cap Screws and one Z-brace to attach two MM-1 stages into an XZ configuration.



PA-1, Pinhole Adapter

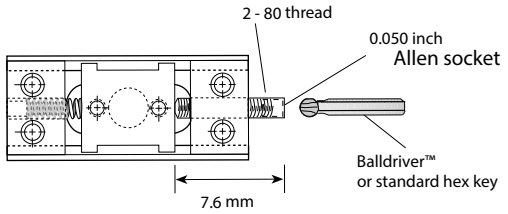
Adapter and hardware to mount 9.525 mm (0.375") dia. pinhole or slit substrates (or smaller) to stage. With the PA-1, apertures can be changed by replacing the entire adapter or by removing it and replacing the aperture only. A soft rubber washer can be used under the adapter for slit aperture orientation.





PM-1

Adapter plate to mount MM1 to breadboard post #8 or M4

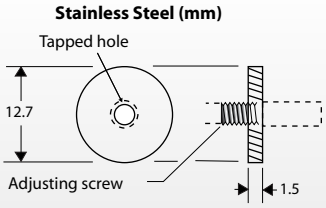


SS-1, Headless Adjusting Lead Screw

This custom designed lead screw replaces the standard thumb screw. It provides full linear travel while reducing the length of the stage by 0.4 inch (10.16 mm).

TG-1, Thumb Grip

Thumb grip for sensitive adjustment and may alternately be used as a locking nut.



ManualStage

Manual MicroMini™ Stage

MM-2 Series

General Data:

Moment Load Capacity:	6 to 11 oz-in
Body Height:	7.6 mm
Body Length:	36.5 mm and 31.8 mm
Body Width:	19 mm
Travel Range:	5.0 mm
Thru Hole:	7 mm

General Precision:

Screw Pitch:	80 TPI (0.3175mm per turn)
Adjustment Sensitivity:	0.5 µm
Wobble:	10 µrad
Backlash:	0
Runout:	1.5 and 0.6 µm

Model No.	MM-2CR	MM-2CRB
Top load:	0.23 kg (8 oz)	0.23 kg (8 oz)
Pitch:	9.5 oz-in	11 oz-in
Roll:	8 oz-in	8 oz-in
Yaw:	6.5 oz-in	9.5 oz-in
Travel	5.0 mm	5.0 mm
Return Force:	10 to 20 oz	10 to 20 oz
Thru Hole:	7 mm	7 mm

Notes: *Rule of thumb for moment loads;*

MM-2CR*: Absolute maximum of 6 oz-in single direction relative to farthest stage*
3 oz-in or less for best performance.

MM-2CRB*: Absolute maximum of 11 oz-in single direction relative to farthest stage;*
6 oz-in or less for best performance.

Dimensions: L x W x H, not including lead screw extension

Model No.	MM-2CR	MM-2CRB
-X Single Stage	36.5 x 19.0 x 7.6 (mm)	31.8 x 19.0 x 7.6 (mm)
Weight	14 grams	13 grams
-XY (2-axis)	36.5 x 36.5 x 15.2 (mm)	31.8 x 31.8 x 15.2 (mm)
Weight (g)	28 grams	26 grams
-XZ (2-axis)	36.5 x 19.0 x 44.1 (mm)	31.8 x 19.0 x 67.1 (mm)
Weight (g)	33 grams	30 grams
-XYZ (3-axis)	36.5 x 36.5 x 52.0 (mm)	31.8 x 31.8 x 69.9 (mm)
Weight (g)	47 grams	43 grams

Features:

- 3D models available on-line
- Built in Connectivity with all MM-2 manual MicroMini™ Stages
- Built in Connectivity with all MM-3 manual MicroMini™ Stages
- Built in Connectivity with all MM-3M motorized MicroMini™ Stages
- Fully English/Metric compatible (all taps and clearance holes)

MM-2CR and CRB Manual Linear Stage
Part Number Key/Dimensional Data

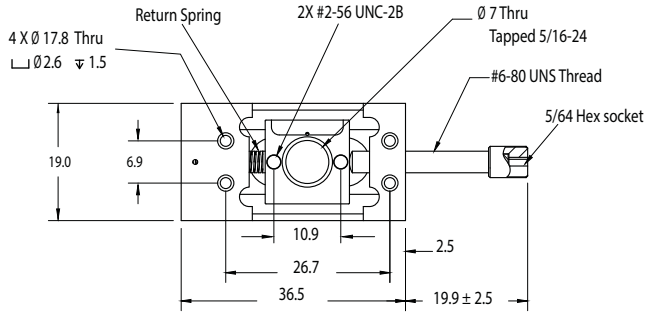
Part Number Key, MM-2 series

Example:

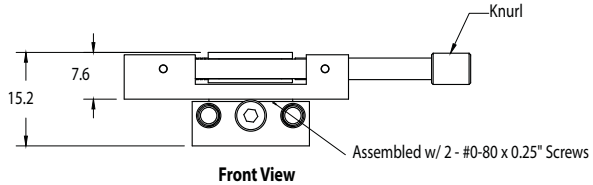
CR	XYZ	TG	V
configuration CR: captive rail CRB: captive rail butterfly	**axes** X: single axis XY: dual axis flat XZ: dual axis, edge mount XYZ: three axis	**actuation option** blank: thumbscrew for CR and CRB M: micrometer head for CRB optional SS: headless lead screw for CR TG: thumb grip for CR and CRB	**vacuum compatibility** blank: 10^{-3} Torr V: 10^{-6} Torr

Dimensional Data

MM-2CR (mm)

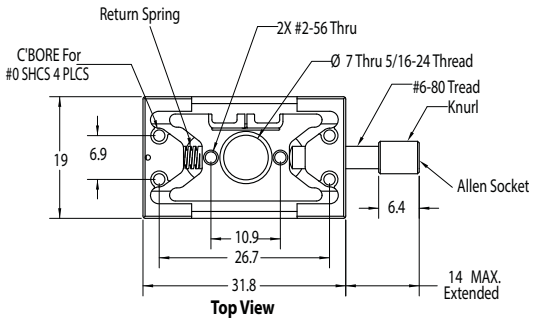


Top View
(X Axis Shown)

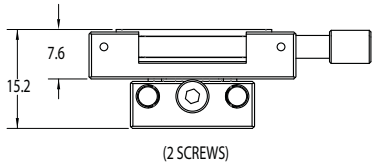


Front View
(X-Y Axis Configuration Shown)

MM-2CRB (mm)



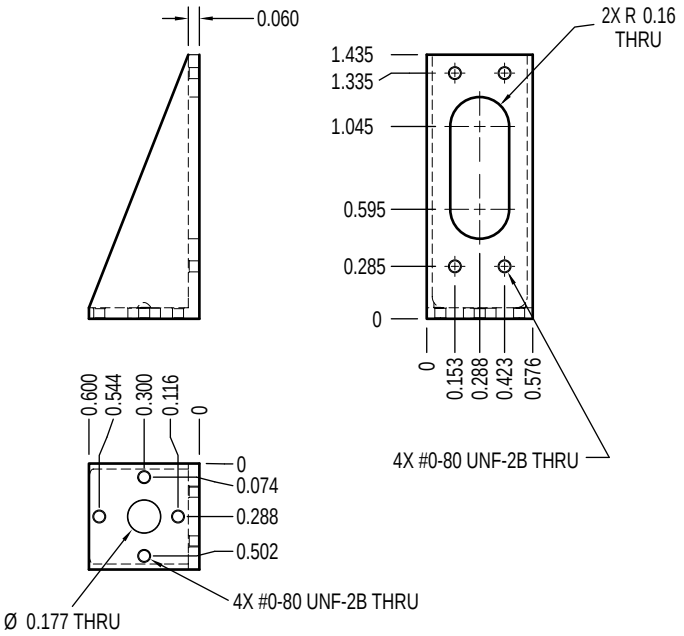
Top View
(X Axis Shown)



Front View
(X-Y Axis Configuration Shown)

ManualStage

MM-2
Accessories



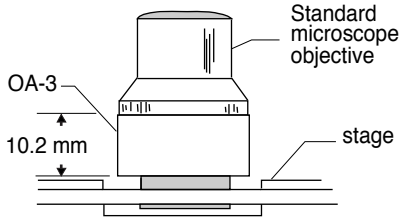
BR-Z-2, Z-Brace

Z-brace and Screw Kit to attach MM-2 stages into an -XZ configuration.

Black anodized aluminum

OA-3, Pinhole Adapter

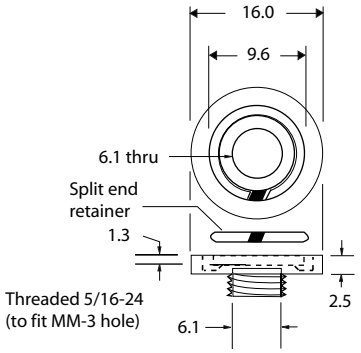
Adapter and Screw Kit to mount a standard microscope objective to a stage.

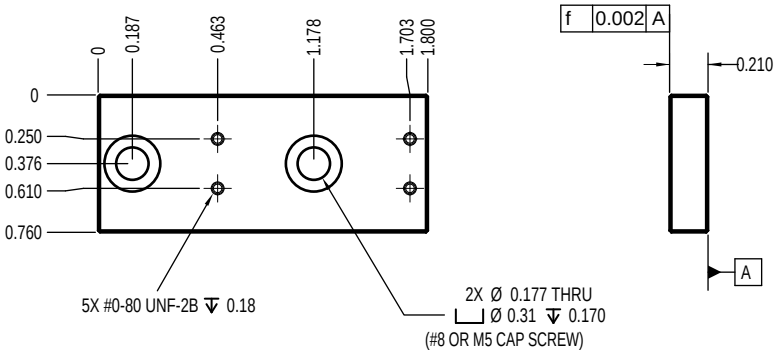


PA-3, Oinhole Adapter

Adapter and hardware to mount 9.525 mm (0.375") dia. pinhole or slit substrates to stage. With the PA-1, apertures can be changed by replacing the entire adapter or by removing it and replacing the aperture only. A soft rubber washer can be used under the adapter for slit aperture orientation.

Black Anodized Aluminum (mm)

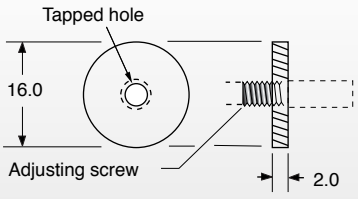




PM-2, Adapter Plate

Adapter Plate to mount MM-2 to breadboard post #8 or M4.

Stainless Steel (mm)



TG-3, Thumb Grip

Thumb grip for sensitive adjustment and may alternately be used as a locking nut.

Motion Control
catalog

ManualStage

MM-3 Series

General Data:

Moment Load Capacity:	6 to 15 oz-in
Body Height:	7.4 and 7.6 mm
Body Length:	44 mm
Body Width:	17 and 19 mm
Travel Range:	12.7 mm
Thru hole:	7.0 mm

General Precision:

Screw Pitch:	80 TPI (0.3175 mm/turn)
Adjustment Sensitivity:	0.5 µm
Wobble:	10 µrad
Backlash:	0
Runout:	1.5 and 0.6 µm

Model No.	MM-3ST	MM-3CR	MM-3CRB
Top load:	0.23 kg (8 oz)	0.23 kg (8 oz)	0.5 kg (18 oz)
Pitch:	9.5 oz-in	9.5 oz-in	15.5 oz-in
Roll:	8 oz-in	8 oz-in	8 oz-in
Yaw:	6.5 oz-in	6.5 oz-in	12.5 oz-in
Thru hole:	7.0 mm	7.0 mm	7.0 mm

Notes: *Rule of thumb for moment loads;*
MM-3ST, MM-3CR*; Absolute maximum of 6 oz-in single direction relative to farthest stage*
3 oz-in or less for best performance.

MM-3CRB*; Absolute maximum of 12 oz-in single direction relative to farthest stage;*
6 oz-in or less for best performance.

Travel :	12.7 mm	12.7 mm	12.7 mm
Runout: (maximum)	1.5 µm	1.5 µm	0.6 µm
Return Force: (extension-compression)	8 to 34 oz	8 to 34 oz	8 to 34 oz

Dimensions: L x W x H, (not including lead screw extension)

-X Single Stage	44.2 x 16.8 x 7.4 (mm)	44.2 x 19.1 x 7.4 (mm)	44.2 x 19.1 x 7.6 (mm)
Weight	15 grams	17 grams	17 grams
-XY (2-axis)	44.2 x 44.2 x 14.7 (mm)	44.2 x 44.2 x 14.7 (mm)	44.2 x 44.2 x 15.2 (mm)
Weight	29 grams	35 grams	34 grams
-XZ (2-axis)	44.2 x 16.8 x 51.85 (mm)	44.2 x 19.1 x 51.6 (mm)	44.2 x 19.1 x 51.6 (mm)
Weight	34 grams	39 grams	37 grams
-XYZ (3-axis)	44.2 x 44.2 x 58.9 (mm)	44.2 x 44.2 x 59.2 (mm)	44.2 x 44.2 x 59.2 (mm)
Weight	48 grams	54 grams	54 grams

Features:

- 3D models available on-line
- Built in Connectivity with all MM-3M motorized MicroMini™ Stages
- Fully English/Metric compatible (all taps and clearance holes)

MM-3 Manual Stage
Part Number Key/Dimensional Data

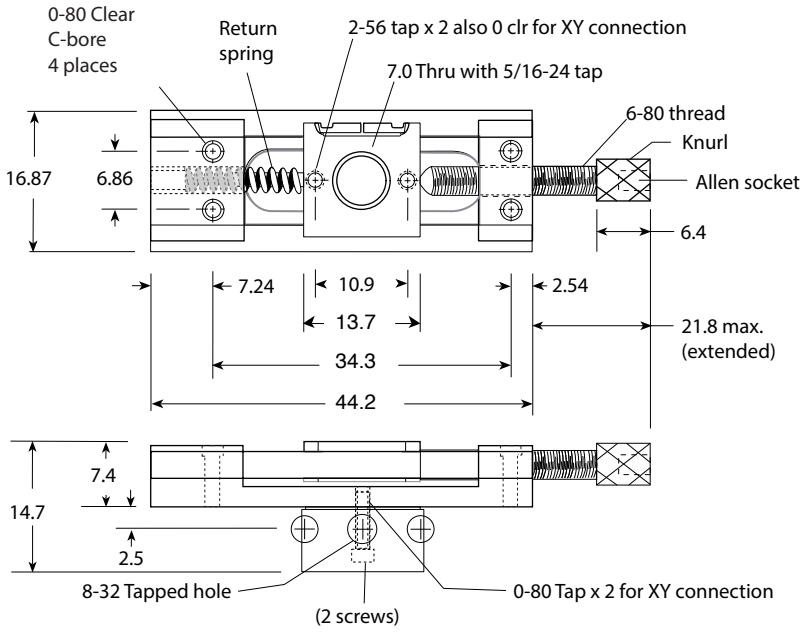
Part Number Key, MM-3 series

Example:

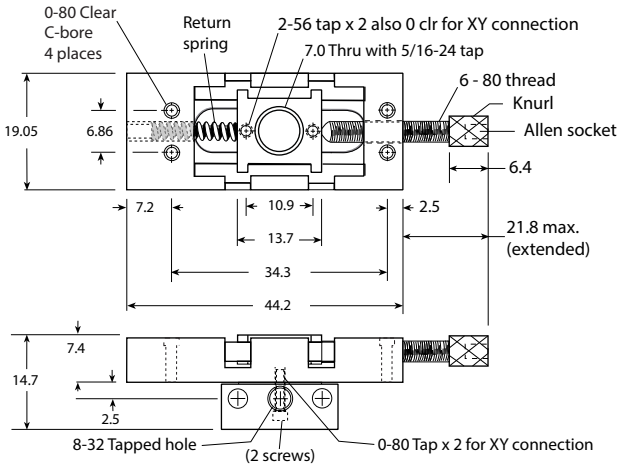
CR	XYZ	SS	V
configuration ST: standard CR: captive rail CRB: captive rail butterfly	**axes** X: single axis XY: dual axis flat XZ: dual axis, edge mount XYZ: three axis	**actuation option** blank: thumbscrew SS: headless lead screw TG: thumb grip	**vacuum compatibility** blank: 10^{-3} Torr V: 10^{-6} Torr

Dimensional Data

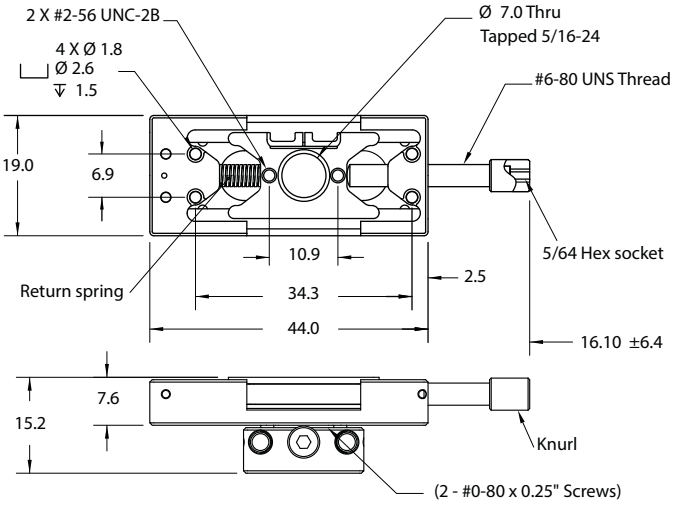
MM-3ST (mm)



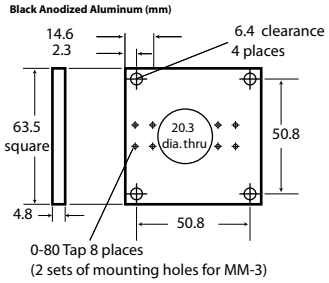
MM-3CR (mm)



MM-3CRB (mm)



ManualStage
MM-3
Accessories

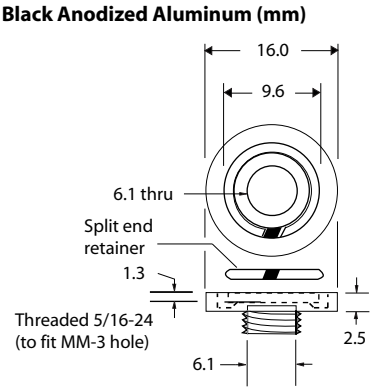


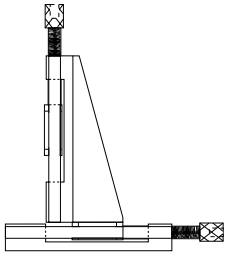
AP4-3, Adapter Plate

A multi-position mounting plate to interface with standard optical tables and accessories, or to stabilize free-standing stages.

PA-3, Pinhole Adapter

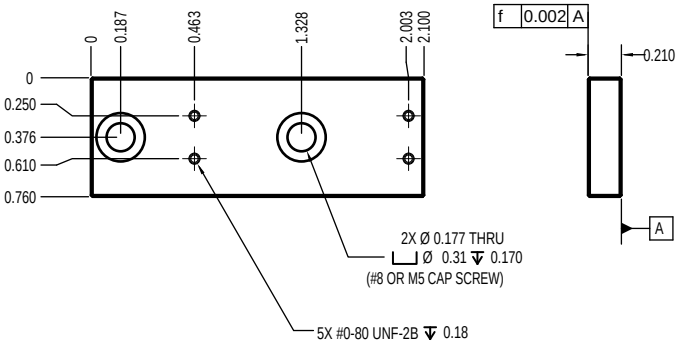
Adapter and hardware to mount 0.375" dia pinhole or slit substrate to stage. With the PA-3, apertures can be changed by replacing the entire adapter or by removing it and replacing the aperture only. A soft rubber washer can be used under the adapter for slit aperture orientation. (For use with standard 0.375 inch diameter substrates.





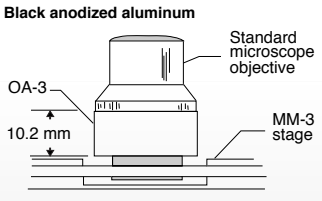
KIT-Z-3, Z-Brace and Screw Kit

Z-Brace to and Screw Kit for XZ configuration.



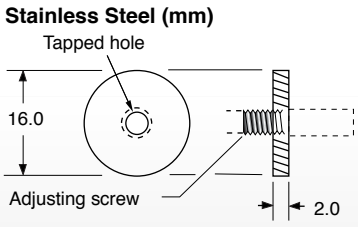
PM-3, Adapter Plate

Adapter Plate to mount MM-3 to breadboard post #8 or M4.



OA-3, Objective Adapter

Adapter and Screw Kit to mount a standard microscope objective to a stage.



TG-3, Thumb Grip

Thumb grip for sensitive adjustment and may alternately be used as a locking nut.

ManualStage

Manual MicroMini™ Stage

MM-1R

General Data:

Radial Load:	0.23 kg
Thrust Axial:	0.45 kg (Direct top load)
Body Size:	25.4 mm
Table Size:	19 mm
Travel Range:	360°
Weight:	10 grams
Thru hole:	7 mm

General Precision:

Table Travel:	360° (6.28 rad) Coarse, 17° (0.29 rad) Fine
Angular Travel:	36.7 µrad per lead screw turn
Moment Load:	3.97 oz-in (28 mNm)

Coarse adjustment tool included
Vacuum compatible to 10^{-6} Torr

Specifications:

Angular travel per lead screw turn:	36.7 µrad
Fine Adjustment Range:	0.29 rad Total
Coarse Adjust:	full circle continuous
Thrust "Axial":	0.45 kg
Radial Load:	0.23 kg
Torque:	3.97 oz-in (28 mNm)
Moment Load:	3.97 oz-in (28 mNm)
Weight:	10 grams
Thru Hole:	7 mm

Dimensions: (W x H)

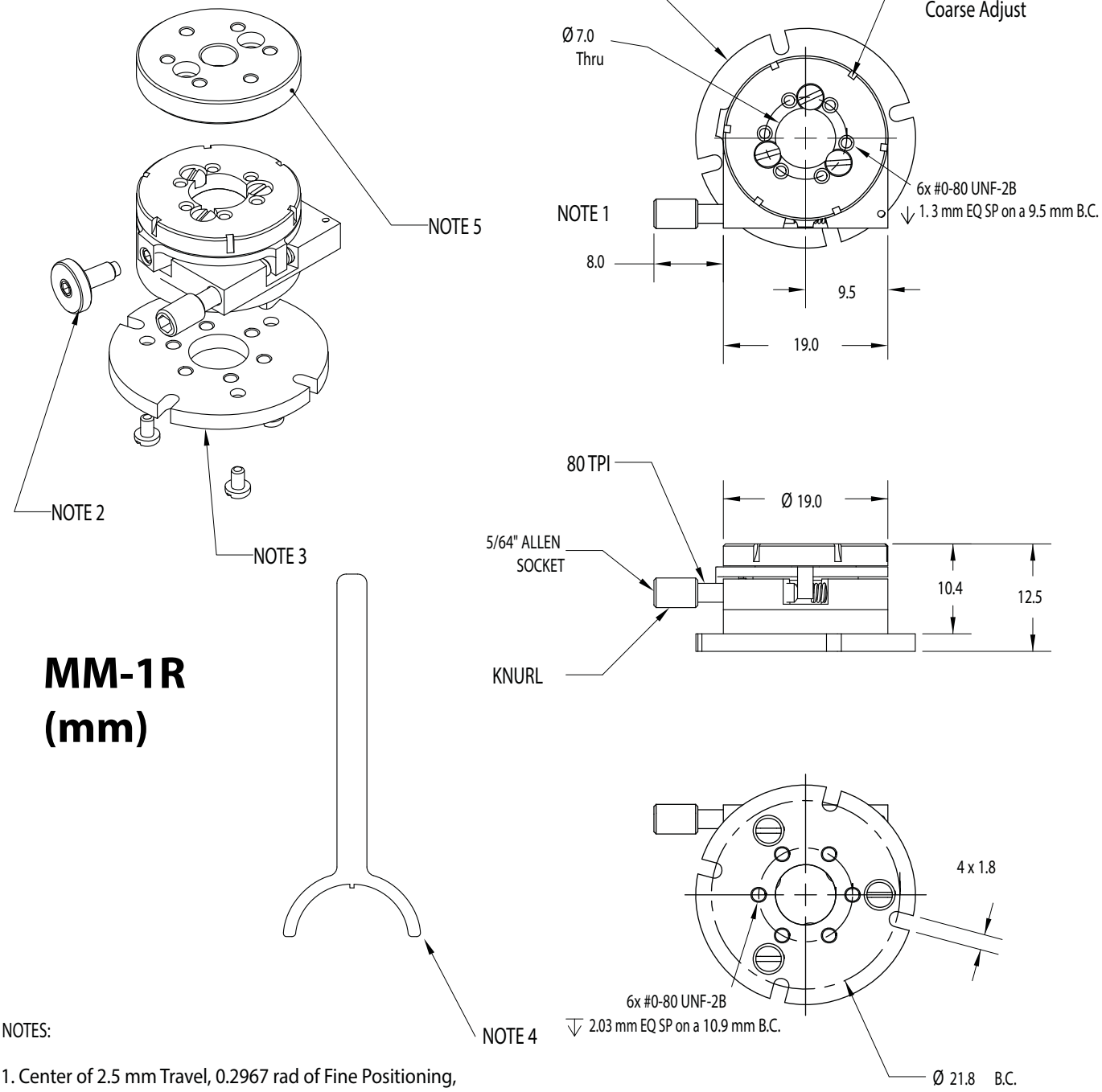
Model No.	Dimensions	Weight
MM-1R	25.44 x 12.5 (mm)	10 grams

Features:

- 3D models available on-line
- Micro-miniature Manual Rotary Stage
- Coarse full circle and fine 0.29 rad Total
- Coarse adjusting tool included with purchase
- 19 mm Rotation Table, 7mm Thru-hole
- Can be mounted to our MM-3X Manual Linear Stage (for X, XY, XYZ, plus rotary translation), while still retaining its thru-hole through both stages.
- Hex wrench accessibility for position and tension settings in hard to reach spaces.
- Black anodized stage body protects from damage and corrosion
- Stainless steel Thumb Screw for durability
- Vacuum compatibility (10^{-6} Torr)
- Bottom plate adapter available

Note: There are six 0-80 holes spaced 10.87 mm apart in the Base Plate of the MM-1R and four open-ended mounting slots. The Base Plate hole pattern matches the hole spacing on all manual MM-3 MicroMini™ Linear Stages, which allows the MM-1R to be mounted directly to any NAI Manual Linear Stage by using two 0-80 screws.

MM-1R Manual Rotary Stage
Dimensional Data

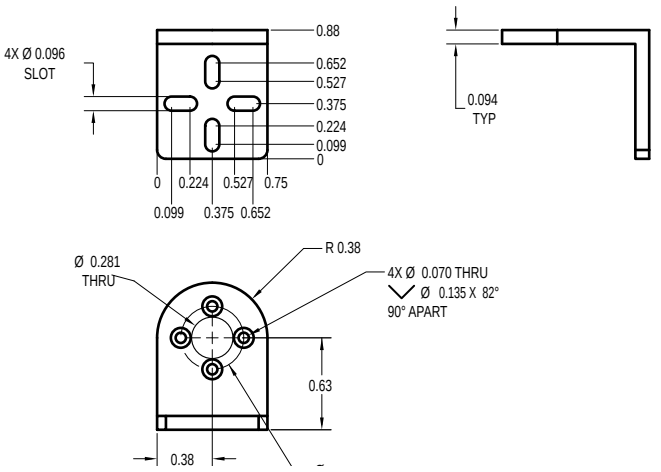


NOTES:

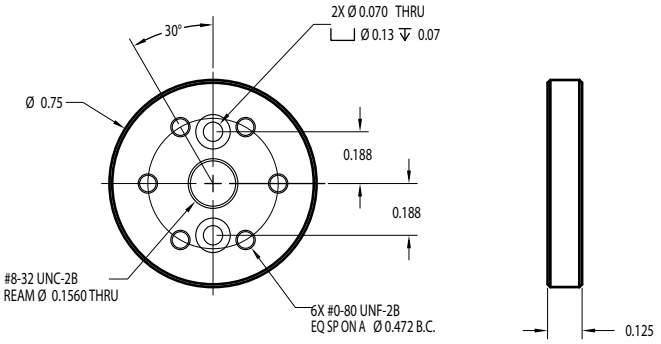
1. Center of 2.5 mm Travel, 0.2967 rad of Fine Positioning, 2 µrad of Coarse Positioning.
2. Optional Coarse Override Tension Thumbwheel.
3. Removable Base Plate.
4. Coarse Adjustment Tool Included.
5. Top Plate Adapter for 6x #0-80 on a 11.98 mm B.C. and Accepts PA-1 Adapter

ManualStage
MM-1R
Accessories

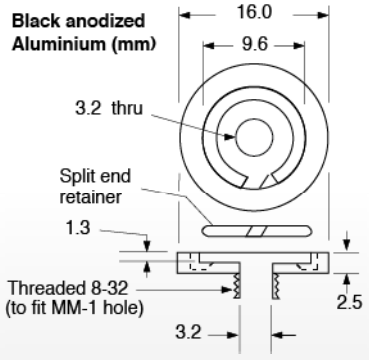
AP1R-3-90:
90˚ Adapter for mounting the MM-1R on top of MM-3X



AP1R-PA-1:
Adapter plate to mount PA-1 to MM-1R.
Note: the AP1R-PA-1 is part of the MM-1R stage package and is included in the total price.



PA-1:
Adapter and hardware to mount 0.375” dia. pinhole or slit substrates to stage.



Motion Control
catalog

ManualStage

Manual MicroMini™ Stage

MM-3GF

General Data:

Load Capacity:	0.45 kg (Direct top load)
Angular Travel:	±0.175 rad
Body Size:	66 x 19.1 x 21.6 (mm)
Table Radius:	25 mm & 42 mm
Center of Rotation:	14.2 mm & 32 mm
Weight:	38 grams

General Precision:

Sensitivity: 1 - 2 µrad (211 µrad per lead screw turn)
Zero-Backlash Drive System

Model No.	MM-3GF-25	MM-3GF-42
Radius:	25 mm	42 mm
Travel:	±0.175 rad nominal	±0.175 rad nominal
Sensitivity: (per lead screw rotation)	211.4 µrad	211.4 µrad
Center of Rotation: (from top surface)	14.2 mm	32 mm
Moment Load:	6 to 12 oz-in (42 to 84 mNm)	6 to 12 oz-in (42 to 84 mNm)
Load Capacity:		
Direct top load:	0.45 kg (16 oz)	0.45 kg (16 oz)
Pitch:	6 oz-in (42 mNm)	6 oz-in (42 mNm)
Roll:	6 oz-in (42 mNm)	6 oz-in (42 mNm)
Yaw:	12 oz-in (84 mNm)	12 oz-in (84 mNm)
Dimensions: (L x W x H)		
-X Single Stage:	66 x 19.1 x 21.6* (mm)	66 x 19.1 x 21.6* (mm)
Weight:	38 grams	38 grams
-XY (2 axis):	66 x 19.1 x 43.2* (mm)	66 x 19.1 x 43.2* (mm)
Weight:	77 grams	77 grams

**at full extended height*

Features:

- 3D models availableon line
- Anti-Backlash Lead Screw/Nut Assembly
- Supplied with hex wrench adjuster
- Precision 80 TPI (Threads Per Inch) Lead Screw Adjustment
- X-Y configuration uses 42 mm radius for X-axis and 25 mm radius for Y-axis
- Built in connectivity with all MM-3 MicroMini™ Stages
- Fully English/Metric compatible

Goniometers are used to achieve precision angular position of an object about a fixed point located above the center of the mounting surface.
Typical use would be for precision alignment of fiber optics and for beam steering applications.

MM-3GF Manual Angular Stage +/- 0.175 rad Fine Adjustment

Part Number Key/Dimensional Data

Part Number Key, MM-3GF series

Example:

XY

axes

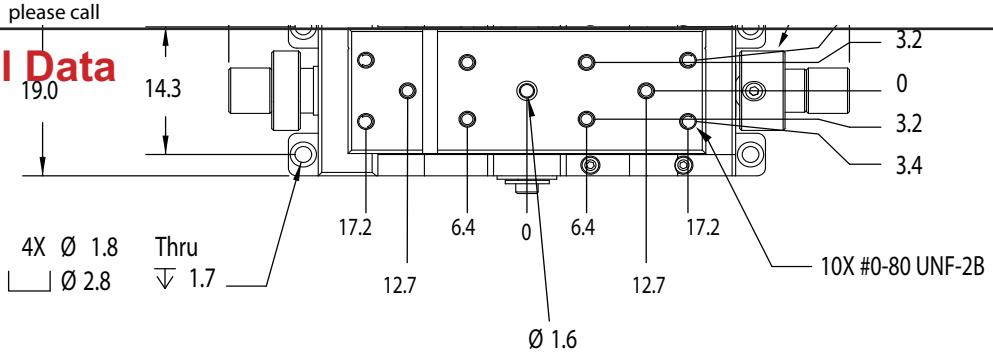
X: single axis

XY: dual axis flat

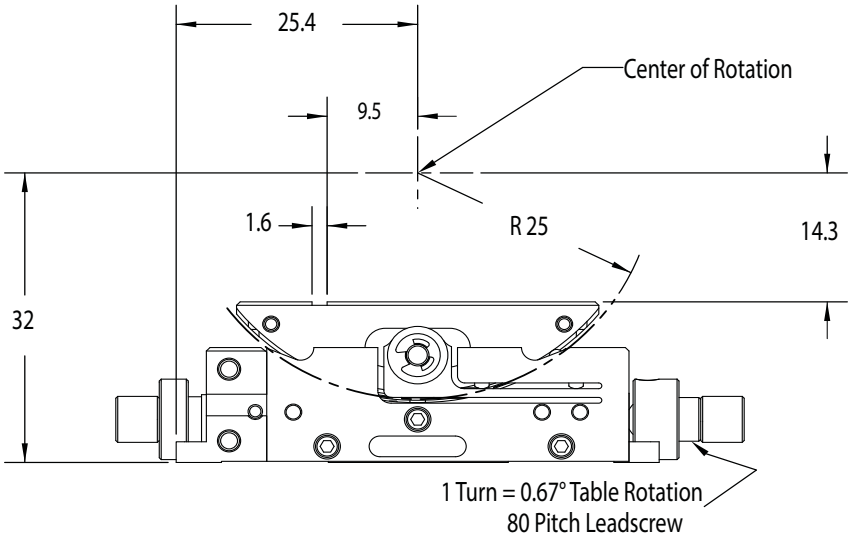
Note: Different radii can be combined in an XY configuration - please call

ıent Knob

Dimensional Data

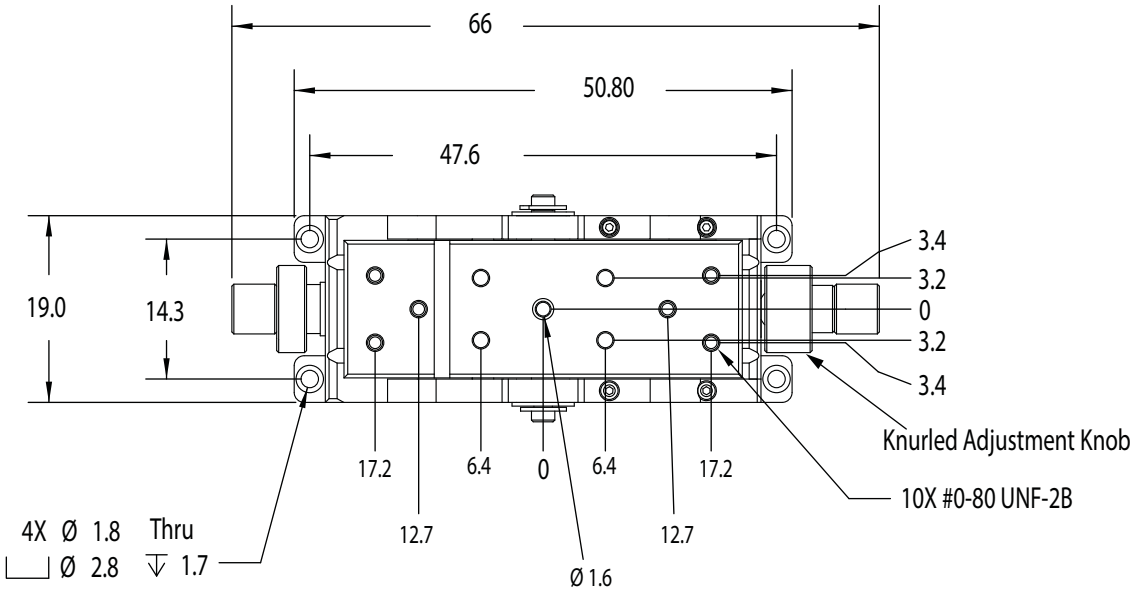


MM-3GF-25 (mm)

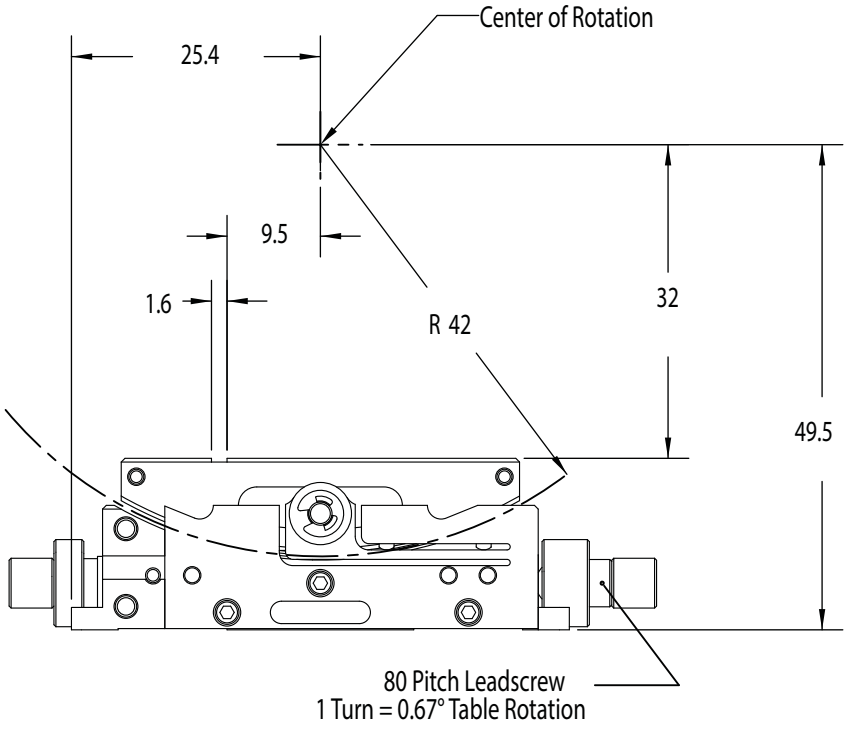


MM-3GF Manual Angular Stage +/- 0.175 rad Fine Adjustment

Dimensional Data



MM-3GF-42 (mm)



KIT-3MG-XY: XY Bracket and Screw Kit for XY configuration

Motorized Stages

MM-1M

Standard Motorized MicroMini™ Stages

General Data:

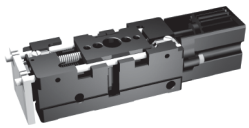
Moment Load Capacity:	3 oz-in
Linear Travel:	5.0 mm
Table Speed:	0.5 mm/sec and 1.1 mm/sec
Body Size :	60.8 x 14.2 x 12.5 (mm)
Weight:	28 grams

Not Vacuum compatible

General Precision:

Repeatability:	±2 µm
Accuracy:	±3 µm/25.4 mm
Slider Backlash:	<10 µm

***Repeatability:**	±2 µm
***Homing Repeatability:**	±2 µm
***Accuracy (linearity):**	±3 µm
Speed (with 64:1 gearhead):	0.5 mm/sec w/MC-CQ-STICK SRVO, 1.1 mm/sec



w/MC-CQ-B Controller

Slider Backlash:	<10 µm
Encoder Conversion (resolution):	0.01654 µm per count with 64:1 gearhead

**Encoder resolution must be added based on the gearhead ratio: 64:1 add ±0.0165µm*

Wobble (max.):	10 µrad (No ball bearings)
Screw Pitch:	0.3175 mm (80 TPI)
Linear motion per turn:	0.3175 mm
Runout (max.):	2 µm
Gearhead Backlash:	≤2.65 µm equivalent; can be compensated in software without overshoot
Motor:	6 mm diameter, 4.5 Vdc servo, brush type (MTR-6-50E-4.5v)

Load Capacity:

***Top or side load:**	0.25 kg (8.8 oz)
***Push:**	0.5 kg (17.6 oz)
****Return Force ext-comp.:**	0.23 (8 oz) to 0.45 kg (16 oz)
***Pitch:**	1.42 oz-in (10 mNm)
***Roll:**	2.97 oz-in (21 mNm)
***Yaw:**	1.42 oz-in (10 mNm)

**These stages may be run at twice the specified ratings without damage, but with a loss of accuracy and speed.*
***Retract is limited by the preload spring.*
Notes: A pinion gear with a gear ratio of 1.5 is included in the gear train. In combination with the motor gearhead, this results in an effective gearhead ratio of 96:1.

Travel Ranges and Dimensions:

Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-1M-X	5 mm	60.8 x 14.2 x 12.5 (mm)	28 grams
MM-1M-XY (2 axis)	5 mm	60.8 x 60.8 x 25 (mm)	57 grams
MM-1M-XZ (2 axis)	5 mm	60.8 x 14.2 x 70 (mm)	62 grams
MM-1M-XYZ (3 axis)	5 mm	60.8 x 60.8 x 82.7 (mm)	90 grams

Part Number Key, MM-1M series

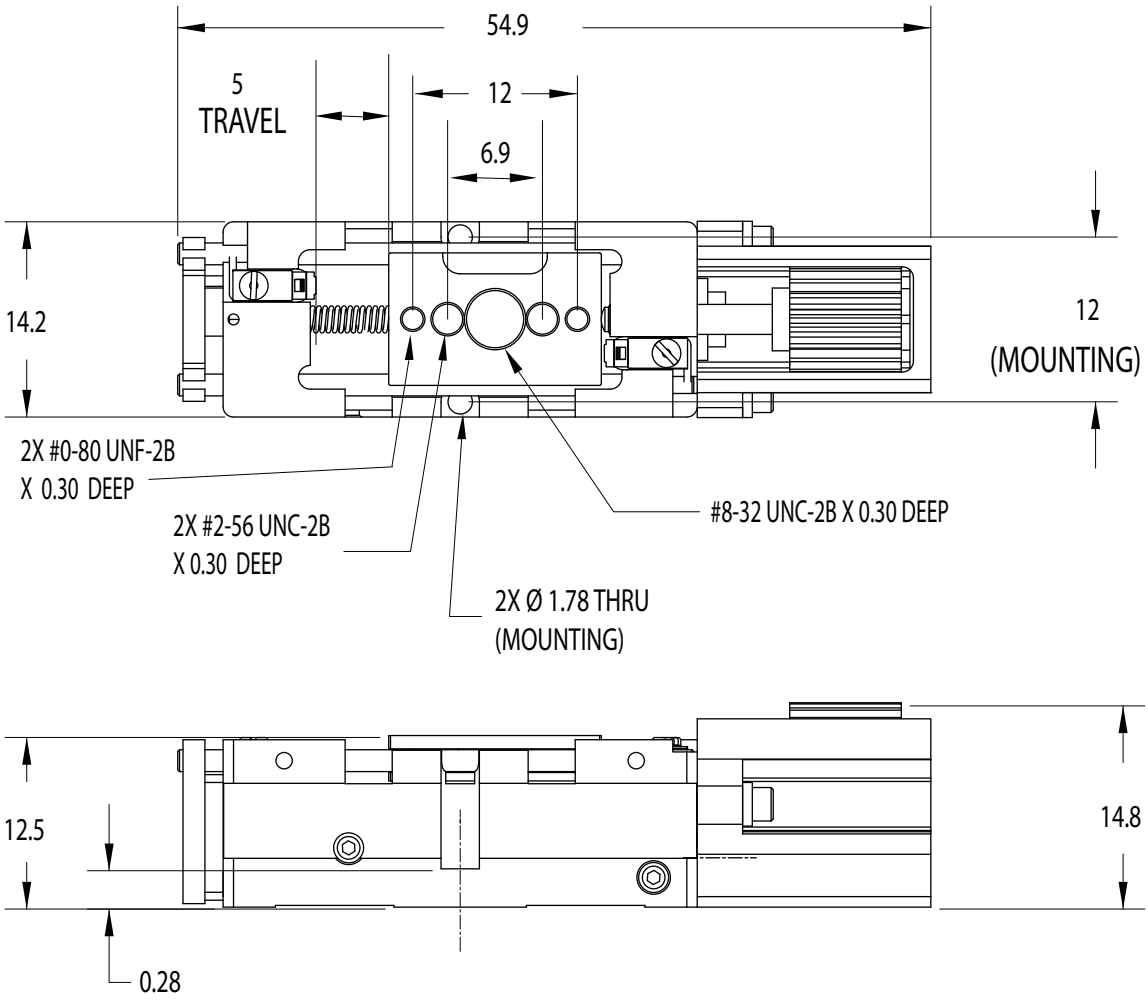
Example:

XYZ

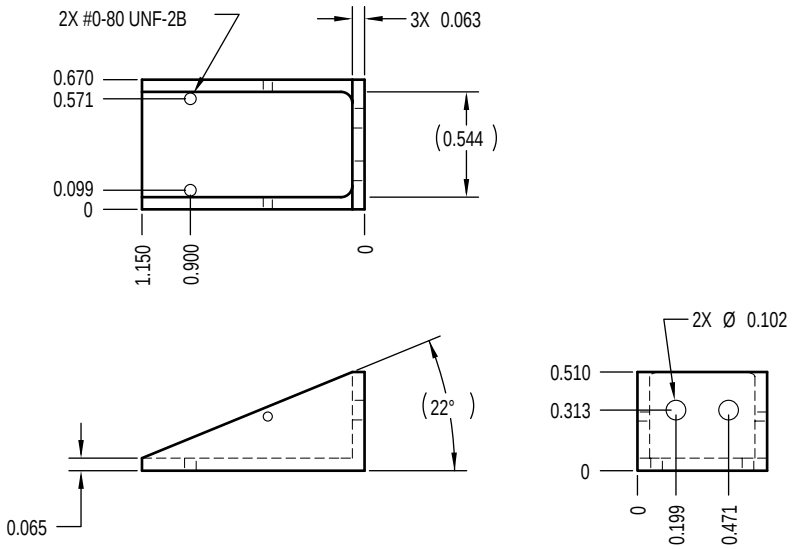
axes
X: single axis
XY: dual axis flat
XZ: dual axis, edge mount
XYZ: three axis

Dimensional Data

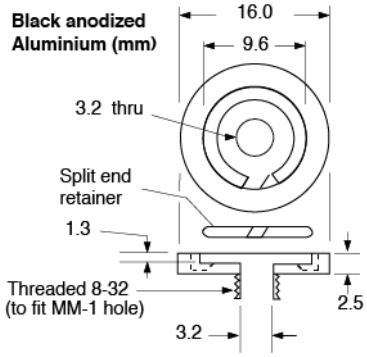
MM-1M-X (mm)



BR-1M-Z:
Z-Brace and Screw Kit for -XZ configuration



PA-1:
Adapter and hardware to mount 0.375” diameter pinhole or slit substrates to stage.



MM-3M-ST

Standard Motorized MicroMini™ Stages

General Data:

Moment Load Capacity:	6 to 9 oz-in
Linear Travel:	12.7 mm
Table Speed:	1.6 mm /second
Body Size:	113.8 x 19.1 x 9.1 (mm)
Weight:	50 grams

General Precision:

Repeatability:	4 µm
Accuracy:	6 µm/25.4 mm
Slider Backlash:	0 (spring preloaded)

***Repeatability:**	4 µm
***Homing Repeatability:**	4 µm
***Accuracy (linearity):**	6 µm/25.4 mm
Speed (max. for standard gearhead ratio):	1.6 mm/second @ 12 V with 64:1 gearhead
Slider Backlash:	0 (spring preloaded)
Encoder Conversion (resolution):	0.12406 µm per count with 64:1 gearhead (see Encoder resolution Data sheets)
Wobble (max.):	20 µrad
Screw Pitch:	0.3175 mm (80 TPI) or 0.635 mm (40 TPI)
Linear motion per turn:	0.3175 mm (80 TPI) or 0.635 mm (40 TPI)
Runout (max.):	2 µm
Gearhead Backlash:	1-2 µm equivalent; can be compensated in software without overshoot
Motor:	10 mm diameter, 6-12 Vdc servo, brush type (see Motor Specifications)

**Encoder resolution must be added to Repeatability and Accuracy.*

Load Capacity:

***Direct top or side load:**	0.23 kg (8 oz)
****Return:**	0.23 kg (8 oz) - 0.96 kg (34 oz)
***Pitch:**	9.5 oz-in (67 mNm)
***Roll:**	8 oz-in (56 mNm)
***Yaw:**	6.5 oz-in (45 mNm)

**These stages may be run at twice the specified ratings without damage, but with a loss of accuracy and speed.*
***Retract is limited by the preload spring.*

Travel Ranges and Dimensions:

Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-3M-ST-X-TR1	12.7 mm	113.8 x 19.1 x 9.1 (mm)	50 grams
MM-3M-ST-XY-TR1 (2 axis)	12.7 mm	113.8 x 113.8 x 18.3 (mm)	100 grams

Features:

- 3D models available on line
- Built in connectivity with all MM-3 MicroMini™ Stages
- Fully English/Metric compatible(all taps and clearance holes)
- Low Profile

Options:

- 64:1 gearhead with selection between 2 screw pitches (40 tpi or 80 tpi)

Standard MM-3M-ST Motorized MicroMini™ Stage - 12.7mm Travel

Part Number Key/Dimensional Data

Part Number Key, MM-3M-ST

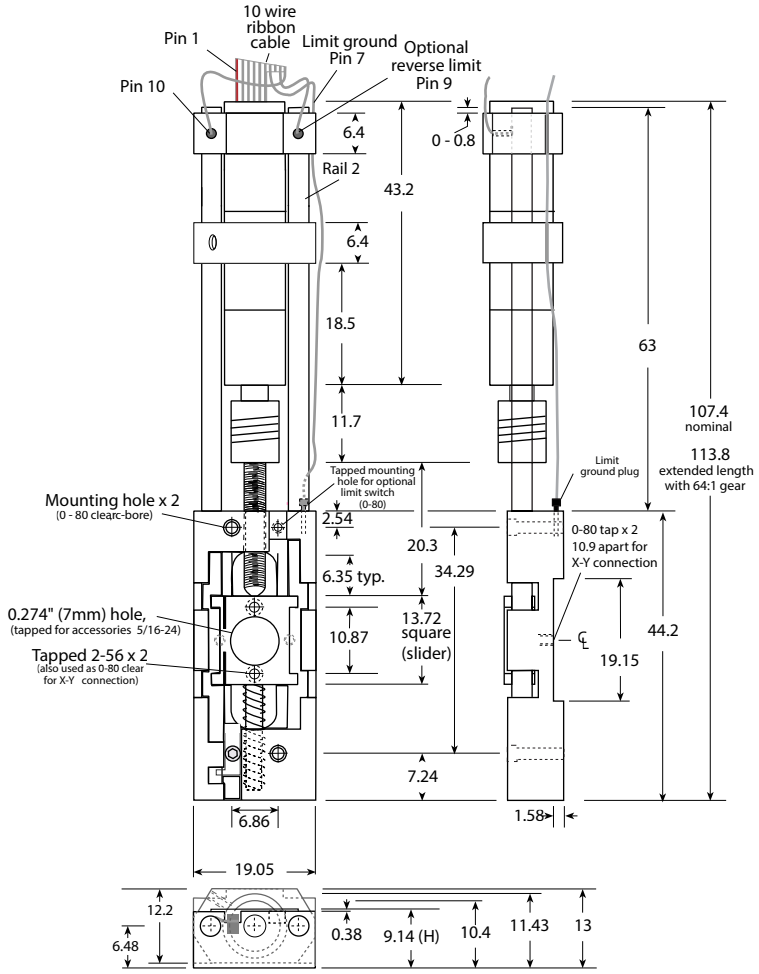
Example:

ST	XY	SPRS3	V
configuration ST: low profile	**axes** X: single axis XY: dual axis flat	**speed/resolution** SPRS3, SPRS4 (see table)	**vacuum compatibility** blank: 10^{-3} Torr V: 10^{-6} Torr

Speed/Resolution	Max Travel Rate (mm/sec)	Resolution (µm/count)	GH Ratio	TPI
SPRS3	3.3073	0.2481	64:1	40
SPRS4	1.6536	0.1240	64:1	80

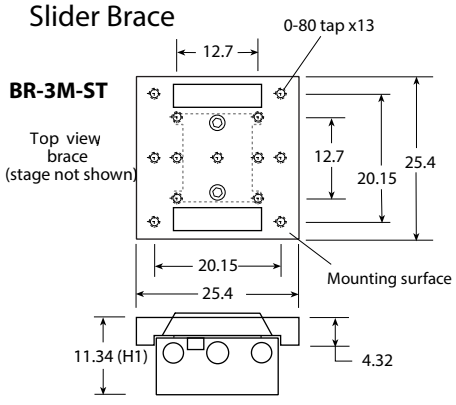
Dimensional Data

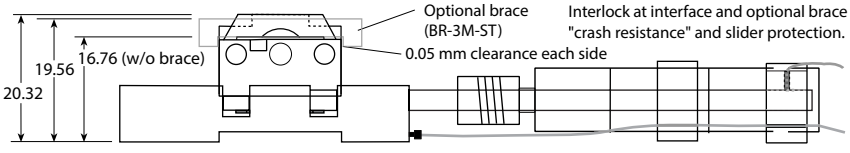
MM-3M-ST (mm)



Note: Symmetry is applicable wherever implied

Optional Crash Resistant Slider Brace





Note: Crash resistance is in XY plane only
Z axis is not recommended on this version.

The information contained in this data sheet is subject to change without notice. Critical dimensions or specifications should be verified with our technical support staff.

MM-3M-FOS

Folded Motorized MicroMini™ Stages

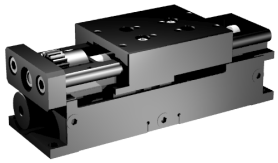
General Data:

Moment Load Capacity: 9 - 11 oz-in
Linear Travel: 25.4 to 63.5 mm
Table Speed: 6.5 mm/second
Weight: 60.5 to 72 (grams)
Anit-Backlash Optional

General Precision:

Repeatability: 4 µm
Accuracy: 6 µm/25.4mm
Slider Backlash: <50 µm
Optical Limits

***Repeatability:**	4 µm
***Homing Repeatability:**	4 µm
***Accuracy (linearity):**	6 µm/25.4 mm
Speed no load (max., for std. gearhead ratio):	6.5 mm/second (GH = 16:1, TPI = 80)
Slider Backlash (max. overshoot):	<50 µm
***Encoder Conversion (resolution):**	0.49609 µm per count (GH = 16:1, TPI = 80)



(See also: Gearhead Options)
**Encoder resolution must be added to Repeatability and Accuracy.*

Runout (max.):	3 µm per 25.4 mm of travel
Gearhead Backlash:	1-2 µm equivalent; can be compensated in software without overshoot
Motor:	10 mm diameter, 6-12 Vdc servo, brush type (see Motor Specifications)
Load Capacity:	
Direct Top Load:	0.34 kg (12 oz)
Push:	0.25 kg (9 oz)
Pull:	0.25 kg (9 oz)
Pitch:	11 oz-in (77 mNm)
Roll:	9 oz-in (63 mNm)
Yaw:	9.5 oz-in (67 mNm)

Note: These stages may be run at twice the specified ratings without damage, but with a loss of accuracy and speed.

Travel Ranges and Dimensions:

Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-3M-FOS-X-TR2	25.4 mm	62.7 x 19.1 x 18.5 (mm)	60.5 grams
MM-3M-FOS-XY-TR2 (2 axis)	25.4 mm	62.7 x 62.7 x 37.1 (mm)	126 grams
MM-3M-FOS-XZ-TR2 (2 axis)	25.4 mm	62.7 x 19.1 x 85.7 (mm)	128 grams
MM-3M-FOS-XYZ-TR2 (3 axis)	25.4 mm	62.7 x 19.1 x 105 (mm)	193 grams
MM-3M-FOS-X-TR3	38.1 mm	75.4 x 19.1 x 18.5 (mm)	65.3 grams
MM-3M-FOS-XY-TR3 (2 axis)	38.1 mm	75.4 x 75.4 x 37.1 (mm)	130.6 grams
MM-3M-FOS-XZ-TR3 (2 axis)	38.1 mm	75.4 x 19.1 x 94 (mm)	139 grams
MM-3M-FOS-XYZ-TR3 (3 axis)	38.1 mm	75.4 x 75.4 x 113 (mm)	208 grams
MM-3M-FOS-X-TR4	50.8 mm	88.1 x 19.1 x 18.5 (mm)	66 grams
MM-3M-FOS-XY-TR4 (2 axis)	50.8 mm	88.1 x 88.1 x 37.1 (mm)	137 grams
MM-3M-FOS-XZ-TR4 (2 axis)	50.8 mm	88.1 x 19.1 x 108 (mm)	139 grams
MM-3M-FOS-XYZ-TR4 (3 axis)	50.8 mm	88.1 x 88.1 x 127 (mm)	210 grams
MM-3M-FOS-X-TR5	63.5 mm	100.8 x 19.1 x 18.5 (mm)	72 grams
MM-3M-FOS-XY-TR5 (2 axis)	63.5 mm	100.8 x 100.8 x 37.1 (mm)	149 grams
MM-3M-FOS-XZ-TR5 (2 axis)	63.5 mm	100.8 x 19.1 x 120 (mm)	151 grams
MM-3M-FOS-XYZ-TR5 (3 axis)	63.5 mm	100.8 x 100.8 x 138 (mm)	228 grams

Features

- 3D models available on line
- Option among 4 gearhead ratios and two screw pitches
- Built in connectivity with all MM-3M MicroMini™ Stages
- Fully English/Metric compatible

Folded MM-3M-FOS Motorized MicroMini™ Stage™ 25.4 to 63.5 mm Travel

Part Number Key/Dimensional Data

Part Number Key, MM-3M-FOS

Example:

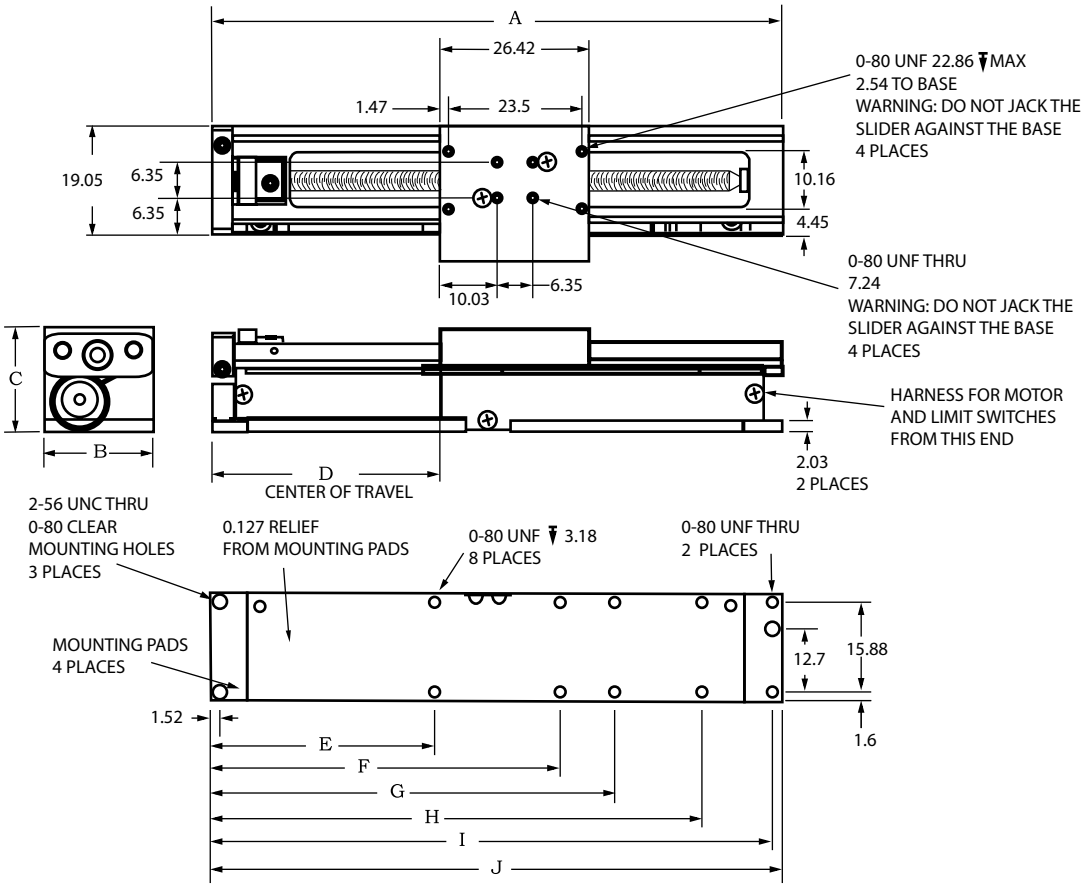
FOS	TR3	XYZ	SPRS1	AB	V
configuration FOS	**max travel** (options limited by configuration) TR2 - TR5 (see table, p. 25)	**axes** X: single axis XY: dual axis flat XZ: dual axis, edge mount XYZ: three axis	**speed/resolution** SPRS1 - SPRS8 (see table)	**anti-backlash option** blank: no anti-backlash AB: anti-backlash	**vacuum compatibility** blank: 10^{-3} Torr V: 10^{-6} Torr

Speed/Resolution	Max Travel Rate (mm/sec)	Resolution (µm/count)	GH Ratio	TPI
SPRS1	13.2291	0.9922	16:1	40
SPRS2	6.6145	0.4961	16:1	80
SPRS3	3.3073	0.2481	64:1	40
SPRS4	1.6536	0.1240	64:1	80
SPRS5	3.3073	0.0620	256:1	40
SPRS6	0.4134	0.0310	256:1	80
SPRS7	0.2067	0.0155	1024:1	40
SPRS8	0.1033	0.0078	1024:1	80

Dimensional Data

	A	B	C	D	E	F	G	H	I	J
MM-3M-FOS-X-TR2	62.74	19.05	18.54	23.11	20.45	23.62	48.64	52.20	61.21	62.74
MM-3M-FOS-X-TR3	75.44	19.05	18.54	29.46	26.80	36.32	58.55	61.34	93.91	75.44
MM-3M-FOS-X-TR4	88.14	19.05	18.54	35.81	33.15	49.02	64.9	74.04	86.61	88.14
MM-3M-FOS-X-TR5	100.84	19.05	18.54	40.49	39.50	61.72	71.25	86.74	99.31	100.84

MM-3M-FOS (mm)



The information contained in this data sheet is subject to change without notice. Critical dimensions or specifications should be verified with our technical support staff.

MM-3M-F

Folded Motorized MicroMini™ Stages

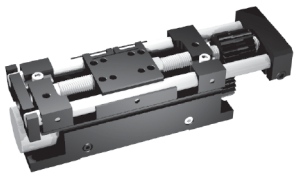
General Data:

Moment Load Capacity:	6 to 9 oz-in
Linear Travel:	12.7 to 63.5 mm
Table Speed:	1.65 to 12 mm/second
Weight:	53 to 73 grams

Anti-Backlash Optional

General Precision:

Repeatability:	4 µm standard, 1 µm with AB Slider
Accuracy:	6 µm/25.4 mm
Slider Backlash:	<50 µm



***Repeatability:**	4 µm	1 µm
***Homing Repeatability:**	4 µm	1 µm
***Accuracy (linearity):**	6 µm/25.4 mm	6 µm/25.4 mm
Speed @ 12V (max. for standard gearhead):	12 mm/sec	1.65 mm/sec.
Slider Backlash (max. overshoot)(GH = 16:1, TPI = 80):	<50 µm	3 µm
Encoder Conversion (resolution):	0.49609 µm/count	0.12406 µm/count
(See also: Gearhead Options)	w/16:1 GH	w/64:1 GH

**Encoder resolution must be added to Repeatability and Accuracy.*

Runout (max.):	3 µm per 25.4 mm travel
Gearhead Backlash:	1-2 µm equivalent; can be compensated in software without overshoot
Motor: (See Motor Specifications)	10 mm diameter, 6-12 Vdc servo, brush type
Load Capacity:	
Direct top or side load:	0.23 kg (8 oz)
Push:	0.5 kg (17 oz)
Pull:	0.5 kg (17 oz)
Pitch:	9.5 oz-in (67 mNm)
Roll:	8 oz-in (56 mNm)
Yaw:	6.5 oz-in (45 mNm)

Note: These stages may be run at twice the specified ratings without damage, but with a loss of accuracy and speed.

Travel Ranges and Dimensions:

Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-3M-F-X-TR1	12.7 mm	58.9 x 19.1 x 16.3 (mm)	53 grams
MM-3M-F-X-TR2	25.4 mm	71.6 x 19.1 x 16.3(mm)	58 grams
MM-3M-F-X-TR3	38.1 mm	84.3 x 19.1 x 16.3(mm)	63 grams
MM-3M-F-X-TR4	50.8 mm	97.0 x 19.1 x 16.3(mm)	68 grams
MM-3M-F-X-TR5	63.5 mm	109.7 x 19.1 x 16.3(mm)	73 grams

Features

- 3D models available on-line
- Option among 4 gearhead ratios and two screw pitches
- Built in connectivity with all MM-3M MicroMini™ Stages
- Fully English/Metric compatible
- Slider Brace is mainly used for larger loads. Use on X, Y, or Z axis
- The LS is available for larger loads but reduces travel by 0.5". The LS is not available for the TR1 Travel Range

Folded MM-3M-F Motorized MicroMini™ Stage - 12.7 to 63.5 mm Travel

Part Number Key/Dimensional Data

Part Number Key, MM-3M-F

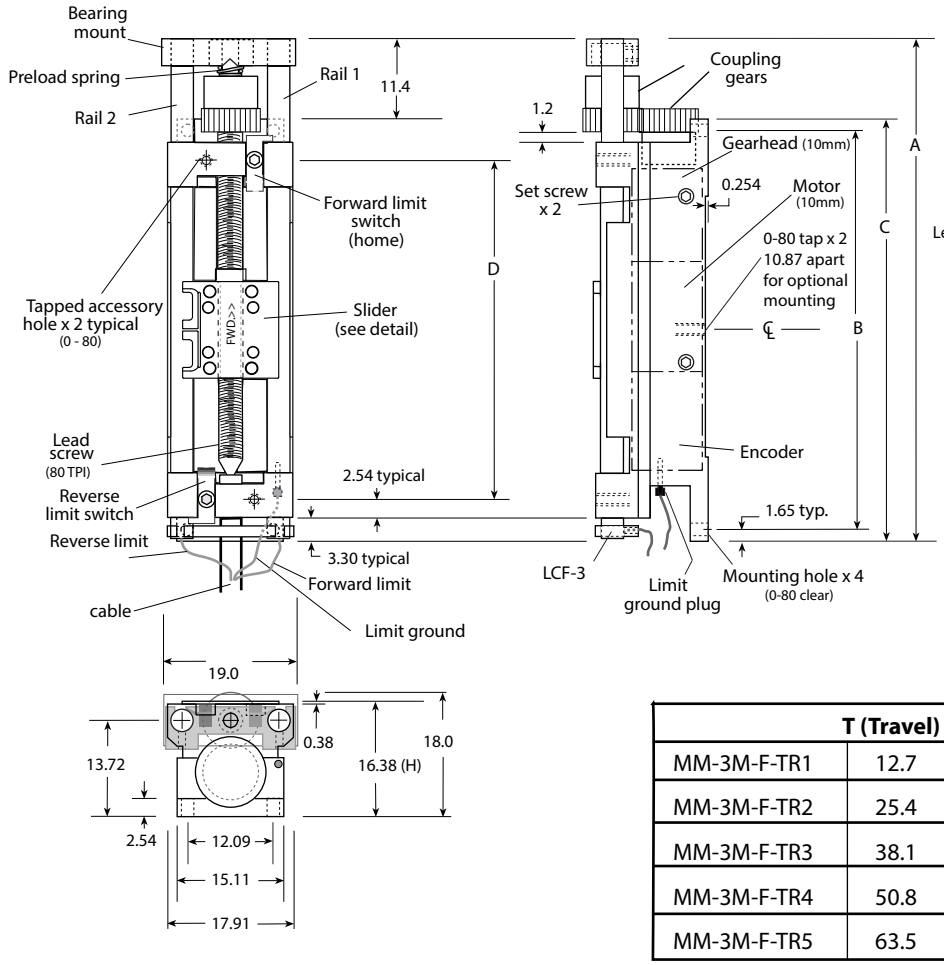
Example:

F TR3 XYZ SPRS1 LS AB SB V

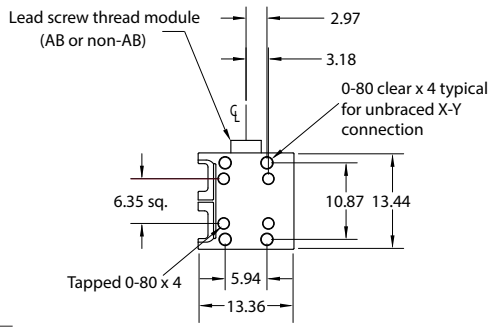
configuration	**max travel** (options limited by configuration)	**axes**	**speed/resolution**	**slider option**	**anti-backlash option**	**slider brace option**	**vacuum compatibility**
F: folded	TR1 - TR5 (see table)	X: single axis XY: dual axis flat XZ: dual axis, edge mount XYZ: three axis	SPRS1 - SPRS8 (see table)	blank: standard LS: long slider	blank: no anti-backlash AB: anti-backlash	blank: no slider brace SB: slider brace	blank: 10^{-3} Torr V: 10^{-6} Torr

Speed/Resolution	Max Travel Rate (mm/sec)	Resolution (µm/count)	GH Ratio	TPI
SPRS1	13.2291	0.9922	16:1	40
SPRS2	6.6145	0.4961	16:1	80
SPRS3	3.3073	0.2481	64:1	40
SPRS4	1.6536	0.1240	64:1	80
SPRS5	3.3073	0.0620	256:1	40
SPRS6	0.4134	0.0310	256:1	80
SPRS7	0.2067	0.0155	1024:1	40
SPRS8	0.1033	0.0078	1024:1	80

Dimensional Data



MM-3M-F (mm)



Slider detail

	T (Travel)	A	B	C	D (mm)
MM-3M-F-TR1	12.7	58.9	43.9	47.2	35.6
MM-3M-F-TR2	25.4	71.6	56.6	59.9	48.2
MM-3M-F-TR3	38.1	84.3	69.3	72.6	60.9
MM-3M-F-TR4	50.8	97.0	82.0	85.3	73.7
MM-3M-F-TR5	63.5	109.7	94.7	98.0	86.4

Note: Symmetry is applicable wherever implied

Note:
Single axis brace is essential where attachments are vulnerable to crash.

The information contained in this data sheet is subject to change without notice. Critical dimensions or specifications should be verified with our technical support staff.

Anti-Backlash (AB) Option For MM-3M-F and MM-3M-FOS Stages

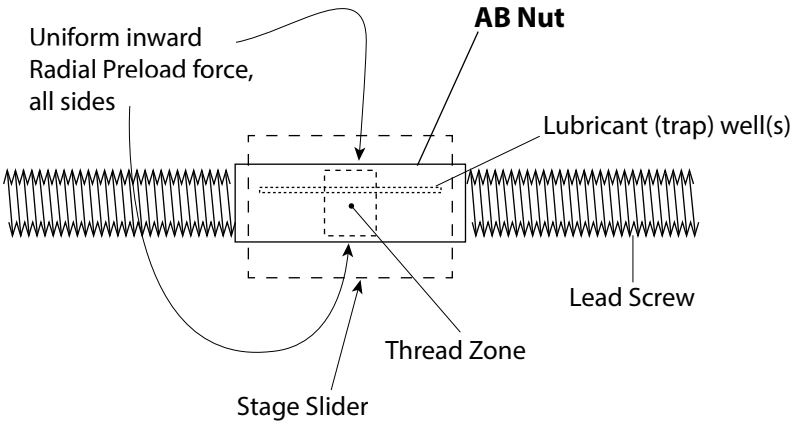
Overview

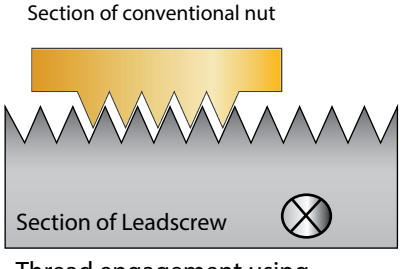
The AB version is not limited to just providing anti-backlash; the AB option provides many additional benefits that make it the preferred choice of users.

The following is a list of benefits that make the AB option significantly important.

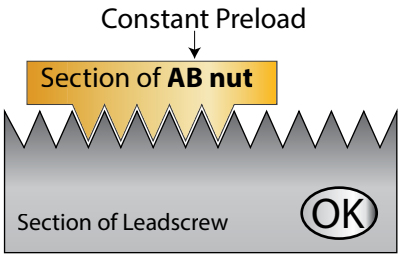
- **Reduces backlash** from standard 25-50 micrometer to 2-4 micrometer.
- **Reservoir of lubrication** for even distribution and long retention.
- **Perfect thread engagement** for uniform wear and wear-in.
- **Highest possible linearity;** true to lead screw thread accuracy (50µinch).
- **Uniform radial pressure** to eliminate tight spots that may cause servo interference.
- **Self-centering;** no lateral stresses to slider resulting from normal lead screw straightness error.
- **Wiper action** keeps threads clean and clear of dust and particles.

Regular stages *cannot* be upgraded to AB version
Price: $200 for option Delivery: 4-6 weeks or less





Thread engagement using
conventional anti-backlash



Thread engagement using NAI AB Nut
with uniform Radial Preload

MM-3M Accessories

Miscellaneous Adapters

Part Number	Description	For Stage
PA-3	Adapter and hardware to mount 0.375” pinhole or slit substrates to a stage	MM-3M-ST, MM-3M-F
OA-3	Adapter and Screw Kit to mount a standard microscope objective to a stage.	MM-3M-ST, MM-3M-F

Braces

Part Number	Description	
BR-3M-ST	Single or final axis slider brace	MM-3M-ST
BR-3M-X	Single or final axis slider brace	MM-3M-F
BR-XZ-FOS	Z brace and screw kit for MM-3M-FOS-XZ configuration	MM-3M-FOS
BR-XY-FOS	XY brace and screw kit for MM-3M-FOS-XY configuration	MM-3M-FOS

Adapter Plates

Part Number	Description	
AP4-3M	Stage-to-optical bench base adapter plate	MM-3M-F
AP4-3	A multi-position mounting plate to interace with standard optical tables and accessories, or to stabilize free-standing stages.	MM-3M-ST
AP4-3M-FOS	Stage-to-optical bench base adapter plate	MM-3M-FOS

Motorized Stages

MM-4M-F

Folded Motorized MicroMini™ Stages
(For heavier loads)

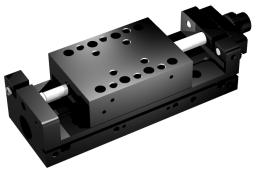
General Data:

Load Capacity: 3.0 kg Direct Top Load
Linear Travel: 25 and 50 mm
Table Speed: 1.6 to 7.6 mm/sec
Weight: 165 to 264 grams
Anti-Backlash Standard Feature

General Precision:

Repeatability: 1 µm
Accuracy: 2 µm/25.4 mm
Slider Backlash: 1 µm

***Repeatability:**	1 µm
***Homing Repeatability:**	1 µm
***Accuracy (linearity):**	2 µm/25 mm of travel
Straightness:	4 µm maximum deviation per 50 mm of travel
Speed (for std. gearhead ratio):	1.6 mm/second @12 V (GH = 64:1 TPI = 80)
Slider Backlash (max. overshoot):	1 µm
Gearhead Backlash:	<2 µm; can be compensated in software without overshoot
***Encoder Conversion (resolution):**	0.49609 µm per count, (GH = 64:1 TPI = 80) (see Resolution Data sheet)



**Encoder resolution must be added based on the gearhead (see Encoder Resolution Data sheet for MTR-10-10E)*

Motor:	10 mm diameter, 6-12 Vdc servo, brush type (see Motor Specifications sheet)
Slide:	Cross roller bearing
Load Capacity:	
Direct Top Load:	3.0 kg (106 oz)
Push:	1 kg (35 oz)
Vertically mounted:	1 kg (35 oz)
Side:	1.5 kg (53 oz)
Pitch:	58 oz-in, (410 mNm)
Roll:	73 oz-in, (515 mNm)
Yaw:	69 oz-in, (487 mNm)

Travel Ranges and Dimensions:

Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-4M-F-X-TR1	25 mm	96.4 x 31.5 x 23 (mm)	165 grams
MM-4M-F-XY-TR1 (2 axis)	25 mm	96.4 x 96.4 x 51.3 (mm)	366 grams
MM-4M-F-XZ-TR1 (2 axis)	25 mm	96.4 x 31.5 x 129.1 (mm)	380 grams
MM-4M-F-XYZ-TR1 (3 axis)	25 mm	96.4 x 96.4 x 157.2 (mm)	582 grams
MM-4M-F-X-TR3	50 mm	161.8 x 31.5 x 23 (mm)	264 grams
MM-4M-F-XY-TR3 (2 axis)	50 mm	161.8 x 161.8 x 51.3 (mm)	555 grams
MM-4M-F-XZ-TR3 (2 axis)	50 mm	161.8 x 31.5 x 193.4 (mm)	573 grams
MM-4M-F-XYZ-TR3 (3 axis)	50 mm	161.8 x 161.8 x 221.5 (mm)	883 grams

Features:

- 3D models available on-line
- Choose from 3 gearhead ratios
- The 25 mm carrier (TR1) may be used on the 50 mm travel stage (TR3) which would increase the travel of the TR3 by 40 mm.

MM-4M-F Motor Stage 25mm & 50mm Travel

Part Number Key/Dimensional Data

Part Number Key, MM-4M-F

Example:

F	TR3	XYZ	SPRS1	V
configuration F: folded	**max travel** : TR1, TR3	**axes:** X: single axis XY: dual axis flat XZ: dual axis, edge mount XYZ: three axis	**speed/resolution** SPRS1 - SPRS3 (see table)	**vacuum compatibility** blank: 10^{-3} Torr V: 10^{-6} Torr

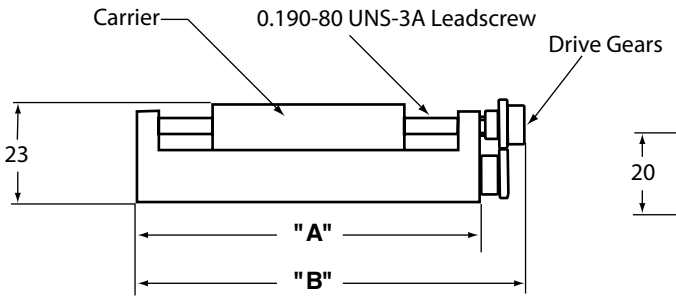
Speed/Resolution	Max Travel Rate (mm/sec)	Resolution (microns/count)	GH Ratio	TPI (turns per inch)
SPRS1	7.6714	0.3596	14:1	80
SPRS2	2.4658	0.1156	43:1	80
SPRS3	1.5982	0.0749	66:1	80

Higher Resolutions available via Custom Order with 6 weeks lead time.

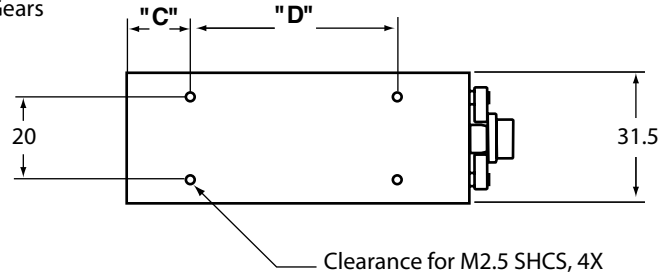
Dimensional Data

Tabulated Data for MM-4M-F Stages (mm)

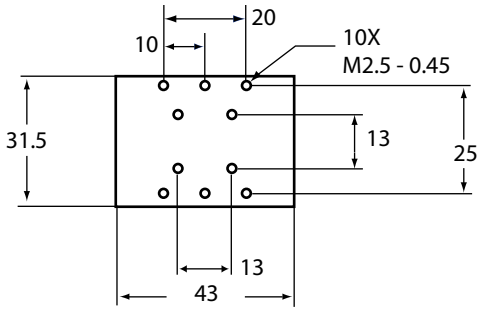
	Travel	"A"	"B"	"C"	"D"
TR1	25	82.7	96.4	16.3	50.0
TR3	50	148	161.80	24.0	100.0



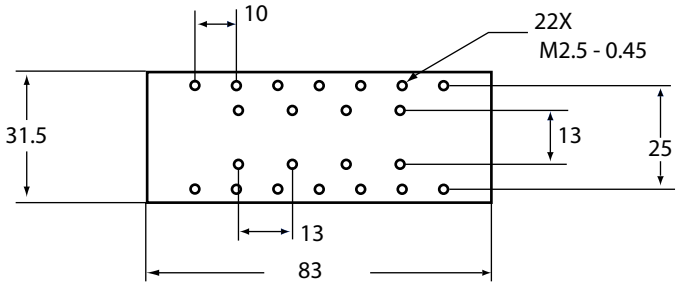
Side View



Bottom View



Top View (25 mm Carrier)



Top View (50 mm Carrier)

Motorized Stages

MM-4M-EX

Extended Motorized MicroMini™ Stages
(For heavier loads)

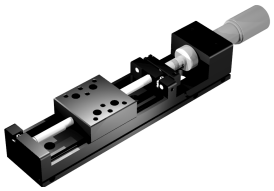
General Data:

Load Capacity: 3.0 kg Direct Top Load
Linear Travel: 48, 78, 108 and 138 mm
Table Speed: 7.6 mm/second @ 12 V
Weight: 330, 345, 360, and 375 (grams)
Anti-Backlash Standard Feature

General Precision:

Repeatability: 1 µm
Accuracy: 2 µm/25.4 mm
Slider Backlash: 1 µm

***Repeatability:**	1 µm
***Homing Repeatability:**	1 µm
***Accuracy (linearity):**	2 µm per 25 mm of travel
Straightness:	4 µm maximum deviation per 50 mm of travel
Speed, no load (max. for std gearhead ratio):	7.5 mm/second @ 12V (GH = 14:1, TPI = 80)
Slider Backlash:	1 µm
Gearhead Backlash:	<2 µm; can be compensated in software without overshoot
***Encoder Conversion (resolution):**	0.3596 µm per count, (GH = 14:1, TPI = 80)



**Encoder resolution must be added based on the gearhead (see Encoder Resolution Data sheet for MTR13-16E-HT)*
Note: Gearhead ratios of 66:1 incur a 6 to 8 week delivery.

Motor:	13 mm dia., 6-12 Vdc servo, brush type
Slide:	Recirculating ball bearings with four point contact, hardened stainless steel rails
Load Capacity:	
Direct Top Load:	3.0 kg (106 oz)
Push:	1.0 kg (35 oz)
Vertically mounted:	1.0 kg (35 oz)
Side:	1.5 kg (53 oz)
Pitch:	58 oz-in (410 mNm)
Roll:	73 oz-in, (515 mNm)
Yaw:	69 oz-in, (487 mNm)

Travel Ranges and Dimensions:

Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-4M-EX-X-TR2	48 mm	186.1 x 31.5 x 25.4 (mm)	330 grams
MM-4M-EX-XY-TR2 (2 axis)	48 mm	186.1 x 183.1 x 50.8(mm)	662 grams
MM-4M-EX-XZ-TR2 (2 axis)	48 mm	186.1 x 31.5 x 234.4(mm)	762 grams
MM-4M-EX-XYZ-TR2 (3 axis)	48 mm	186.1 x 183.1 x 259.8(mm)	1094 grams
MM-4M-EX-X-TR4	78 mm	216.1 x 31.5 x 25.4(mm)	345 grams
MM-4M-EX-XY-TR4 (2 axis)	78 mm	216.1 x 213.1 x 50.8(mm)	692 grams
MM-4M-EX-XZ-TR4 (2 axis)	78 mm	216.1 x 31.5 x 264.4(mm)	792 grams
MM-4M-EX-XYZ-TR4 (3 axis)	78 mm	216.1 x 213.1 x 298.8(mm)	1139 grams
MM-4M-EX-X-TR5	108 mm	246.1 x 31.5 x 25.4(mm)	360 grams
MM-4M-EX-XY-TR5 (2 axis)	108 mm	246.1 x 243.1 x 50.8(mm)	722 grams
MM-4M-EX-XZ-TR5 (2 axis)	108 mm	246.1 x 31.5 x 294.4(mm)	822 grams
MM-4M-EX-XYZ-TR5 (3 axis)	108 mm	246.1 x 243.1 x 319.8(mm)	1184 grams
MM-4M-EX-X-TR6	138 mm	276.1 x 31.5 x 25.4(mm)	375 grams
MM-4M-EX-XY-TR6 (2 axis)	138 mm	276.1 x 273.1 x 50.8(mm)	752 grams
MM-4M-EX-XZ-TR6 (2 axis)	138 mm	276.1 x 31.5 x 325.4(mm)	852 grams
MM-4M-EX-XYZ-TR6 (3 axis)	138 mm	276.1 x 273.1 x 350.8(mm)	1229 grams

Features:

- 3D models available on-line
- Dual Carriage available for increased top and moment loads, but reduces travel range by 32 mm.
- Choose from 3 gearhead ratios
- An optional Renishaw Absolute encoder is available for the MM-4M-EX stage

MM-4M-EX Motorized MicroMini™ Stage, 48 to 138 mm Travel

Dimensional Data

Part Number Key, MM-4M-EX

Example:

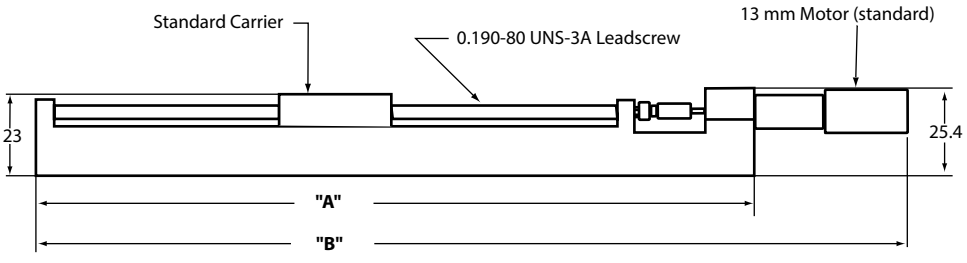
EX	TR3	XYZ	SPRS1	DC	V
configuration: EX: extended travel	**max travel:** TR2,TR4-TR6	**axes:** X: single axis XY: dual axis flat XZ: dual axis, edge mount XYZ: three axis	**speed/resolution:** SPRS1 - SPRS3 (see table)	**dual carriage option:** blank: standard carriage DC: dual carriage	**vacuum compatibility** blank: 10^{-3} Torr V: 10^{-6} Torr

Speed/Resolution	Max Travel Rate (mm/sec)	Resolution (microns/count)	GH Ratio	TPI (turns per inch)
SPRS1	7.6714	0.3596	14:1	80
SPRS2	2.4658	0.1156	43:1	80
SPRS3	1.5982	0.0749	66:1	80

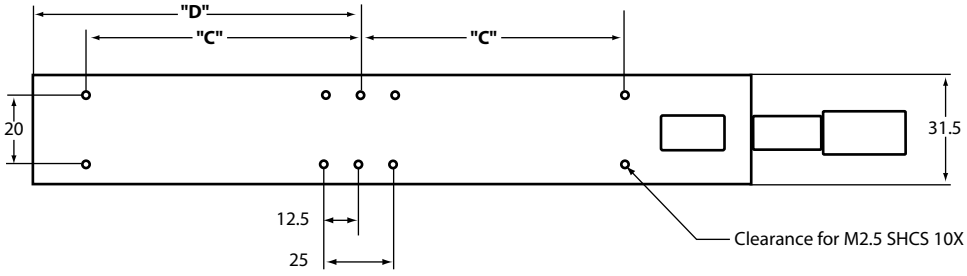
Higher Resolutions available via Custom Order with 6 weeks lead time.

Dimensional Data

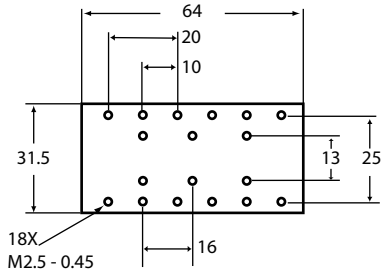
Tabulated Data for MM-4M-EX Stages (mm)					
	Travel	"A"	"B"	"C"	"D"
TR2	48	138.7	186.1	30	47.1
TR4	78	168.7	216.1	45	62.1
TR5	108	198.7	246.1	60	77.1
TR6	138	228.7	276.1	75	92.1



Side View

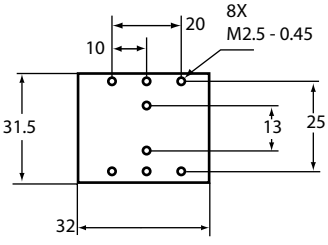


Bottom View



Extended Carrier for dual Carriage Option

Top View



Standard Carrier

Top View

The information contained in this data sheet is subject to change without notice. Critical dimensions or specifications should be verified with our technical support staff.

MM-4M-EX Accessories

Braces

Part Number	Description	Stages
BR-4M-EX-140	Z Brace for 140 mm travel	MM-4M-EX
BR-4M-F-25-Z	Z Brace for MM-4M-F-25	MM-4M-F
BR-4M-F-50-Z	Z Brace for MM-4M-F-50	MM-4M-F
BR-4M-F-25-XY	XY Brace for MM-4M-F-25	MM-4M-F
BR-4M-F-50-XY	XY Brace for MM-4M-F-50	MM-4M-F

Adapter Plates

Part Number	Description	
AP4-4M	Stage-to-optical bench base adapter plate for MM-4M-EX, -F.	MM-4M-EX, MM-4M-F
AP4-4M-EX	Stage-to-optical bench adapter plate for MM-4M-EX stages over 140 mm travel.	MM-4M-EX

Motorized Stages

MM-5M

Large Thru Hole Motorized MicroMini™ Stages
(For heavier loads)

General Data:

Load Capacity:	1.1 kg Direct Top Load
Linear Travel:	25.4 mm
Table Speed:	39 mm/second
Weight:	220 grams
Thru Hole:	54 x 29 (mm)

General Precision:

Repeatability:	± 0.5 µm
Accuracy:	± 3.0 µm/25.4 mm
Slider Backlash:	1 µm

***Repeatability:**	1 µm
***Homing Repeatability:**	1 µm
***Accuracy (linearity):**	± 3 µm per 25 mm of travel
Straightness:	4 µm maximum deviation per 25 mm of travel
Speed, no load (max. for std gearhead ratio):	39 mm/second
Slider Backlash:	1 µm
Gearhead Backlash:	<2 µm
Resolution:	1.56 µm/count
Gearhead Ratio:	16:1
TPI (turns per inch):	25.4
***Encoder Conversion (resolution):**	0.49609 µm/count

**Encoder resolution must be added based on the gearhead (see Encoder Resolution Data sheet for MTR10-10E)*
Note: Gearhead ratios of 66:1 incur a 6 to 8 week delivery.

Motor:	10 mm dia., 6-12 Vdc servo, brush type
Slide:	53.94 mm x 28.55 mm Thru Hole
Load Capacity:	
Direct Top Load:	1.1 kg (38.8 oz)
Push:	2.8 kg (98.8 oz)
Vertically mounted:	0.6 kg
Side Load:	1.1 kg
Pitch:	115 oz-in (800 mNm)
Roll:	38 oz-in, (270 mNm)
Yaw:	78 oz-in (556 mNm)

Travel Ranges and Dimensions:

Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-5M-X	25.4 mm	140 x 67 x 13 (mm)	220 grams
MM-5M-XY	25.4 mm	140 x 140 x 26 (mm)	440 grams
MM-5M-XZ	25.4 mm	140 x 67 x 156 (mm)	460 grams
MM-5M-XYZ	25.4 mm	140 x 140 x 170 (mm)	680 grams

Features:

- Ultra-Low Profile
- Large Thru-Hole
- 3 D models available on line

MM-5M Large Thru-Hole, Motorized MicroMini™ Stage, 25.4 mm Travel
Dimensional Data

Part Number Key, MM-5M-1.0

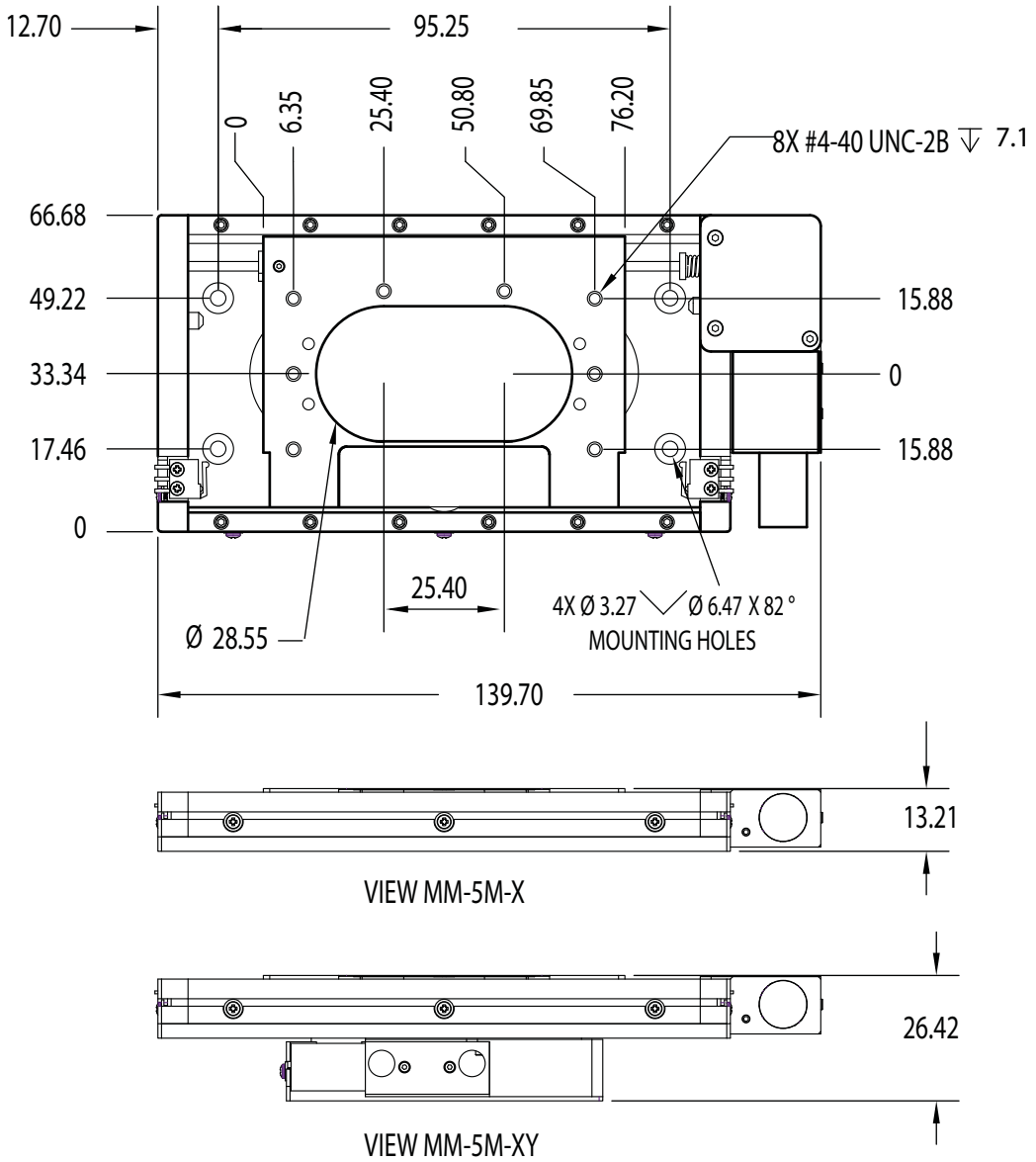
Example:

XYZ

axes:
X: single axis
XY: dual axis flat
XZ: dual axis, edge mount
XYZ: three axis

Dimensional Data

MM-5M-X (mm)



MotionControl catalog

MotorizedStages

MM-3M-R

Rotary Motorized MicroMini™ Stages

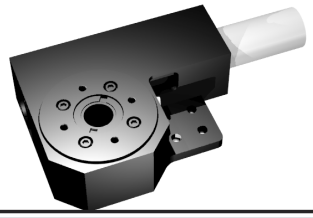
(For lighter loads)

General Data:

Load Capacity:	2 kg and 0.5 kg Direct Top Load
Rotary Travel:	360⁰
Table Speed:	0.409 rad/second
Weight:	76 grams

General Precision:

Repeatability:	70 µrad
Accuracy:	400 µrad
Axial Wobble:	291 µrad
Planar Shift:	1.2 µm
Eccentricity:	3 µm



	MM-3M-R-ST		MM-3M-R-A	MM-3M-R-B
Repeatability:	70 µrad*		same	same
Homing Repeatability:	300 µrad*		same	same
Accuracy: (linearity)	400 µrad*		same	same
A. Axial Wobble: (axial angular long range repeatability)	300 µrad		10 µrad	10 µrad
B. Axial angular deviation, total:	300 µrad		300 µrad	10 µrad
C. Planar shift, total:	1.2 µm		0	0
D. Eccentricity: (runout, including bearing mount)	3 µm		3 µm	3 µm
(See diagram on next page for an illustration of A.,B.,C.,D.)				
Direct top load:	2 kg axial		0.5 kg axial	0.5 kg axial
Moment Load:	500 mNm (70.8 oz-in)		90 mNm (12.7 oz-in)	90 mNm (12.7 oz-in)
Torque load:	80 mNm (11 oz-in)		40 mNm (5.6 oz-in)	40 mNm (5.6 oz-in)
Gearhead Ratio (with 80:1 worm ratio):	**64:1**(standard)	**16:1**	same	same
(see "Resolution Data Sheet")				
Speed (low load):	0.4091 rad/sec	1.57**rad/sec)	same	same
Encoder Conversion:	30.68 µrad/count	122.7 µrad/count	same	same
(see gearhead ratios, "Resolution Data Sheet")				
Gearhead Backlash:	~1 mrad†	~4 mrad†	same	same
Rotor Max Torque:	200 oz-in	50 oz-in	same	same
Rotor Backlash (preloaded):	0		same	same
Weight:	76 grams		same	same
Travel Range:	unlimited		same	same
Worm Ratio:	80:1		same	same
Stage Body with Motor Dimensions:	72.6 x 36.3 x 15 (L x W x H) (mm)		same	same
Motor:	10 mm diameter, 6-12 Vdc servo, brush type (see Motor Specifications)			

*Encoder resolution must be added based on the gearhead: 16:1 add ±122.72 µrad, 64:1 add ±30.68 µrad, 256:1 add ±7.67 µrad, , 1024:1 add ±1.92 µrad

**A higher gear reduction means a slower speed. Higher speeds (lower ratio) can be used, but at the expense of resolution and load/torque capacity.

†Dependent upon gearhead ratio, backlash can be compensated in software without overshoot.

Note: The MM-3M stages are designed for peak performance at low loads: ex; 60g, less than 50.8 mm off axis.

Features:

- 3D models available on-line
- Dual class 7 custom bearings for MM-3M-R
- Single class 7 custom bearing for MM-3M-R-A & B
- Multi-faceted connection interface
- Homing Switch

Options:

- Option among 4 gearhead ratios used with 80:1 worm drive ratio

MM-3M-R Rotary Stage

Part Number Key/Dimensional Data

Part Number Key, MM-3M-R series

Example:

A	SPRS1	V
configuration ST: standard A: low wobble B: low wobble & angular deviation	**max speed and corresponding resolution** SPRS1 - SPRS4 (see table)	**vacuum compatibility** blank: 10^{-3} Torr V: 10^{-6} Torr

Speed/Resolution	Max Travel Rate		Resolution			GH Ratio
	rad/sec	deg/sec	µrad/count	deg/count	arcsec/count	
SPRS1	1.6363	93.7531	122.7185	0.007031	25.312508	16:1
SPRS2	0.4091	23.4397	30.6796	0.001758	6.328122	64:1
SPRS3	0.1023	5.8614	7.6699	0.000439	1.582030	256:1
SPRS4	0.0256	1.4668	1.9175	0.000110	0.395513	1024:1

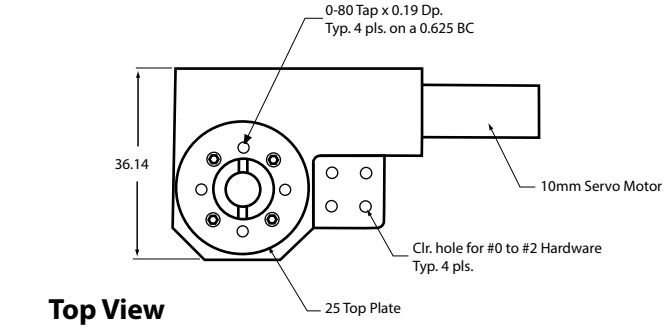
Description	MM-3M-R-ST	MM-3M-R-A	MM-3M-R-B
A. Axial wobble, (axial angular repeatability)	300 µrad	10 µrad	10 µrad
B. Axial angular deviation, total	300 µrad	300 µrad	10 µrad
C. Planar shift, total	1.2 µm	0	0
D. Eccentricity (runout)	3.0 µm	3.0 µm	3.0 µm
Direct Top Load, maximum:	2.0 kg	0.5 kg	0.5 kg
Moment load, maximum:	500 mNm	90 mNm	90 mNm

Note: The above specifications apply to horizontal mounting (load vertical).
For vertical mounting (load horizontal), the top load and moment load values are 1/2 the above.
Specifications apply to internal bearing. Rotary table is not aligned perfectly with bearing. Mounting of customer components will require adjustments to align with bearing.

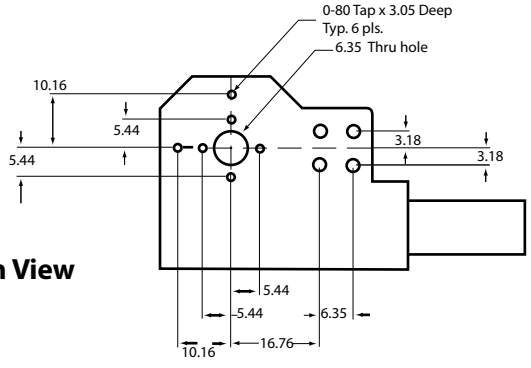
Dimensional Data

MM-3M-R (mm)

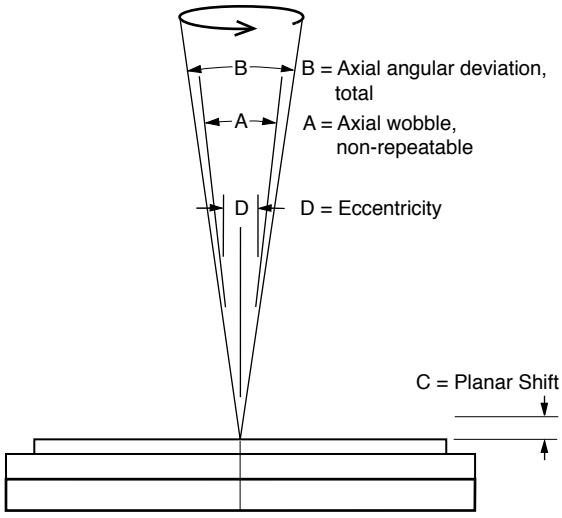
Gearhead Ratio	16:1	64:1	256:1	1024:1
Dimension E: (mm)	70.1	72.1	75.2	78.2
Resolution/Count (µrad/count)	122.7185	30.6796	7.6699	1.9175

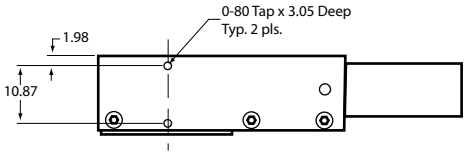


Top View

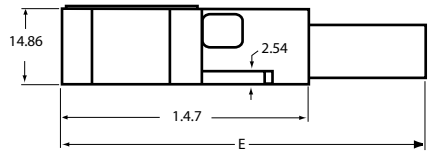


Bottom View





Back View



Front View

The information contained in this data sheet is subject to change without notice. Critical dimensions or specifications should be verified with our technical support staff.

MM-3M-R Accessories

Part Number	Description
AP3MR-4M	Adapter Plate to mount MM-3M-R on top of MM-4M-F/-EX stages as a z-axis stage
AP3MR	Stage to Optical bench adapter plate
AP3MR-90	Adapter Plate to Optical Bench 90º
TP3MR	MM-3M-R Top Plate 1/4 - 20 Hole

MotionControl catalog

MotorizedStages

MM-4M-R

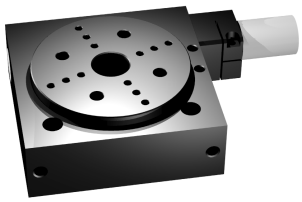
Rotary Motorized MicroMini™ Stages
(For heavier loads)

General Data:

Load Capacity:	4.5 kg Direct Top Load
Moment Load:	570 mNm
Rotary Travel:	360^0
Table Speed:	1.7 rad/second
Weight:	512 grams

General Precision:

Repeatability:	300 µrad
Accuracy:	1100 µrad (full travel)
Axial Wobble:	150 µrad
Planar Shift:	0.6 µm
Eccentricity :	2.5 µm



Repeatability:	300 µrad
Homing Repeatability:	300 µrad
Accuracy (linearity):	1100 µrad, full travel
A. Axial Wobble:	150 µrad
B. Axial angular deviation, total:	150 µrad
C. Planar Shift, total:	0.6 µm
D. Eccentricity:	2.5 µm
Max Speed[1]:	1.7 rad/sec (GH = 14:1, 90:1 worm ratio)
Encoder Conversion (resolution):	79.07 µrad/count, (GH = 14:1, 90:1 worm ratio)

(See Encoder Resolution Data sheet for MTR13-16E-HT)

[1]Max speed calculated with a maximum motor armature speed of 20,000 RPM

Load Capacity:	4.5 kg (159 oz)
Moment Load:	570 mNm (80.7 oz-in)
Torque Load:	285 mNm (40.3 oz-in)
Gearhead Backlash:	2.5 mrad
Bearing Runout at Table:	5 µm
Standard Gearhead:	14:1
Gearhead Options:	14:1, 43:1, 66:1
Worm Ratio:	90:1
Rotor Stall Torque:	1412 mNm
Motor:	13 mm diameter, 6-12 Vdc servo, brush type
Bearings:	Pre-loaded duplex angular contact
Base Material & Finish:	Aluminum, black anodized
Table Diameter:	60.45 mm

Travel Ranges and Dimensions:

Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-4M-R	Unlimited	136.4 x 73.2 x 28.6 (mm)	0.512 kg

Features:

- 3D models available on-line
- Ultra-low axial/angular runout
- Multi-faceted connection interface
- Anti-backlash worm drive system
- Option among 3 gearhead ratios used with 30:1 or 90:1 worm drive ratio

MM-4M-R Rotary Stage

Part Number Key/Dimensional Data

Part Number Key, MM-4M-R

Example:

SPRS1 **V**

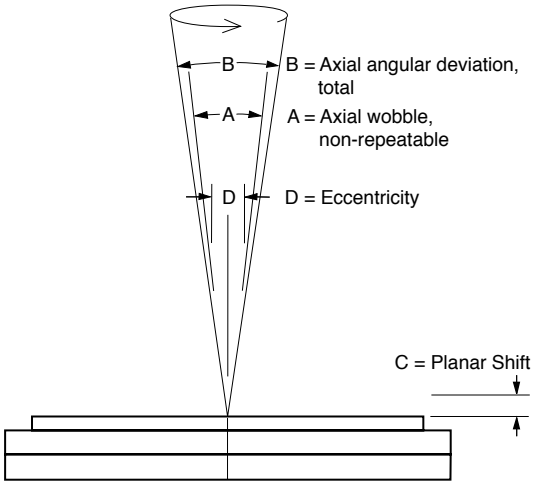
max speed and corresponding resolution
SPRS1 - SPRS6 (see table)

vacuum compatibility
blank: 10^{-3} Torr
V: 10^{-6} Torr

Speed/Resolution	Max Travel Rate		Resolution			GH Ratio	Worm Gear Ratio
	rad/sec	deg/sec	µrad/count	deg/count	arcsec/count		
SPRS1	5.0579	289.7963	237.2003	0.013591	48.926074	14:1	30:1
SPRS2	1.6868	96.6465	79.0691	0.004530	16.309173	14:1	90:1
SPRS3	1.6257	93.1457	76.2430	0.004368	15.726248	43:1	30:1
SPRS4	1.0537	60.3726	49.4167	0.002831	10.192926	66:1	30:1
SPRS5	0.5422	31.0658	25.4151	0.001456	5.242241	43:1	90:1
SPRS6	0.3154	20.1337	16.4727	0.000944	3.397738	66:1	90:1

Description	MM-4M-R
A. Axial wobble, (axial angular repeatability)	144 µrad
B. Axial angular deviation, Total	144 µrad
C. Planar shift, Total	0.6 µm
D. Eccentricity (runout)	2.5 µm
Direct Top Load, maximum:	4.5 kg
Moment load maximum:	570 mNm

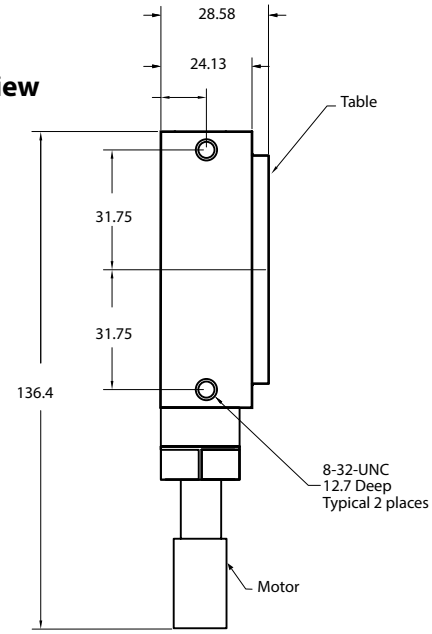
Note: The above specifications apply to horizontal mounting (load vertical
For vertical mounting (load horizontal), the top load and moment load values are 1/2 the above.
Specifications apply to internal bearing. Rotary table is not aligned perfectly with bearing. Mounting of customer components will require adjustments to align with bearing.



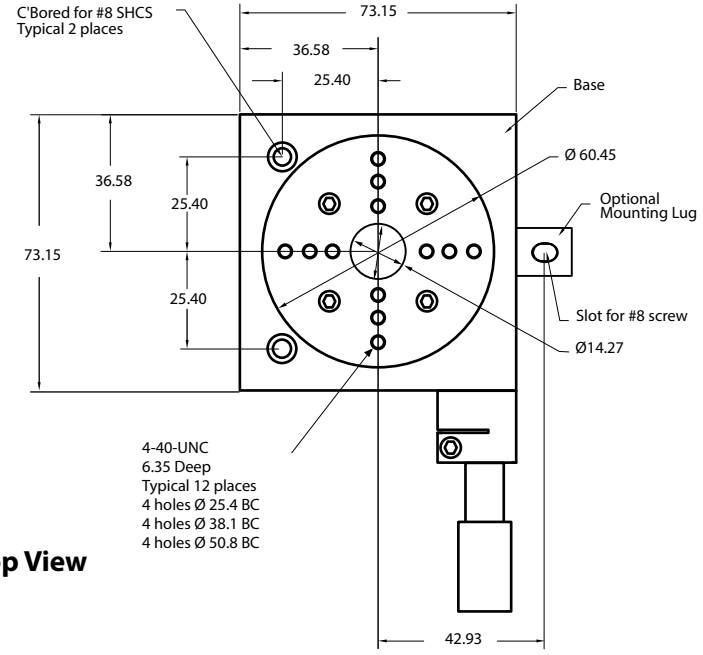
Dimensional Data

MM-4M-R (mm)

Side View



Top View



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MM-4M-R Accessories

Adapter Plates	
Part Number	**Description**
AP4MR	Adapter plate for MM-4M-R to optical bench

MotionControl catalog

MotorizedStages

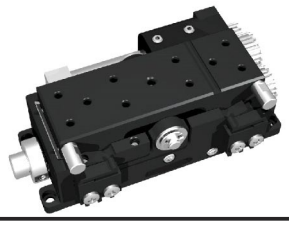
MM-3M-G Goniometer

General Data:

Load Capacity:	0.45 kg Direct Top Load
Angular Travel:	±0.175 rad
Body Size:	61.5 x 31.4 x 17.7 (mm)
Table Radius:	25 and 32 (mm)
Center of Rotation:	14.2 and 32 (mm)

General Precision:

Sensitivity: 0.6 µrad/encoder count at center



Specifications:

	MM-3M-G-25	MM-3M-G-42
Radius:	25 mm	42 mm
Repeatability:	<100 µrad	<100 µrad
Accuracy:	+0/-250 nm/10µm move	+0/-250 nm/10µm move
Backlash:	<150 µrad	<150 µrad
Moment Load:	6 to 12 oz-in (42 to 84 mNm)	6 to 12 oz-in (42 to 84 mNm)
Load Capacity:		
Direct top load:	0.45 kg (16 oz)	
Pitch:	6 oz-in (42 mNm)	
Roll:	6 oz-in (42 mNm)	
Yaw:	12 oz-in (84 mNm)	
Gearhead Ratio:	96:1	96:1
Max Speed @4.5 Vdc/no load:	40 mrad/sec	25 mrad/sec
Encoder conversion:	0.6 µrad/count at center	0.3 µrad/count at center
Resolution:	3.0 µrad	1.5 µrad
Gearhead backlash:	no load <3 deg	no load <3 deg
Motor:	dc Servo, brush type (MTR-6-50E-4.5v)	

Model No.	Radius	Travel	Center of Rotation (from top surface)
MM-3M-G-RD1	25 mm	±10°	14.2 mm
MM-3M-G-RD2	42 mm	±10°	32.0 mm

Dimensions: (L x W x H)

Model No.	-X Single Stage	Weight	-XY 2 axis	2 axis Weight
MM-3M-G-25	61.5 x 31.4 x 17.7 (mm)	50.8 g	61.5 x 61.5 x 35.5 (mm)	102 grams
MM-3M-G-42	61.5 x 31.4 x 17.7 (mm)	50.8 g	61.5 x 61.5 x 35.5 (mm)	102 grams

Features:

- 3D models available on line
- Gearhead ratio 96:1,
- Leadscrew TPI: 80:1
- Not vacuum compatible

MM-3M-G Motorized Goniometer

Dimensional Data (mm)

Part Number Key, MM-3GF series

Example:

XY

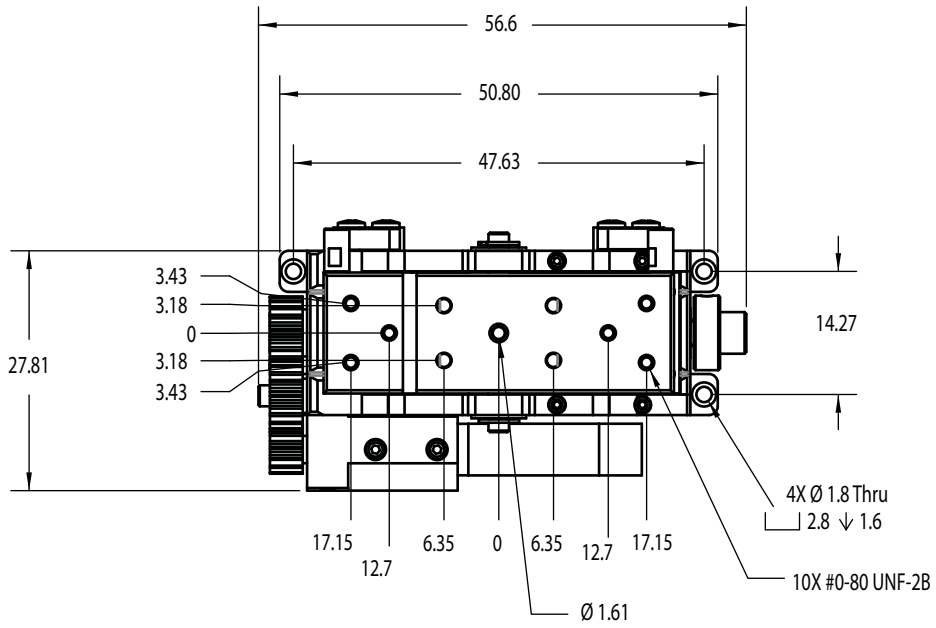
axes

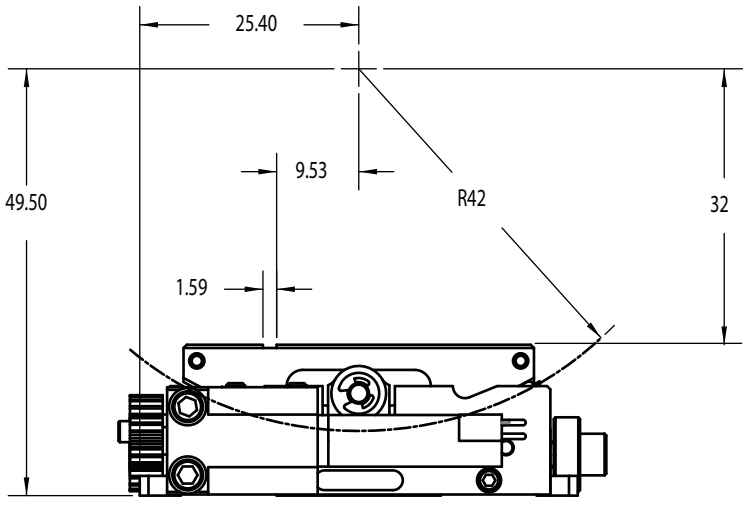
X: single axis

XY: dual axis flat

Note: Different radii can be combined in an XY configuration - please call

Radius (mm)	Max Speed		Resolution		
	(mrad/sec)	(deg/sec)	(μrad/count)	(deg/count)	(arcsecond/count)
25	40	2.5	0.6 avg.	3.5E-5	0.1
42	25	1.5	0.4 avg.	2.0E-5	0.07





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MM-3M-G Accessories

Bracket	
Part Number	**Description**
KIT-3MG-XY:	XY-Bracket and Screw Kit for XY configuration

MotionControl catalog

Motorized Stages

MM-4M-G Goniometer

	MM-4M-G-87	MM-4M-G-120
Radius:	87 mm	120 mm
Repeatability:	±12 µrad	±12 µrad
Accuracy:	±24 µrad	±24 µrad
Backlash:	<150 µrad	<150 µrad
Moment Load:	10 - 23.5 oz-in	10 - 23.5 oz-in
Gearhead Ratio:	64:1	64:1
Max Speed @4.5Vdc/no load:	21 mrad/sec	15 mrad/sec
Encoder conversion: (at center)	0.28 µrad/count	0.21 µrad/count
Gearhead backlash:	30 µrad	22 µrad
Motor:	6mm diameter, 4.5Vdc Servo, brush type	
Load Capacity:		
Direct top load:	6.8 kg (240 oz)	
Pitch:	23.5 oz-in (166 mNm)	
Roll:	18 oz-in (127 mNm)	
Yaw:	10 oz-in (71 mNm)	

Model No.	Radius	Travel	Center of Rotation (from top surface)	Weight
MM-4M-G-87	87 mm	±5°	72.5 mm	0.46 kg
MM-4M-G-120	120 mm	±5°	105.5 mm	0.46 kg

Dimensions : (L x W x H)

Model No.	-X Single Stage	-XY 2 axis	Weight
MM-4M-G-87	83 x 74 x 35.5 (mm)	83 x 83 x 70.8 (mm)	0.9 kg
MM-4M-G-120	87 x 78 x 35.5 (mm)	87 x 87 x 71.4 (mm)	1.07 kg

Features:

- 3D models available on-line
- Gearhead ratio 64:1, Leadscrew TPI: 80:1
- Linear Encoder Options

Part Number Key, MM-4M-G series

Example:

XY	EN
axes	**encoder**
X: single axis	blank: motor encoder
XY: dual axis	EN: absolute encoder

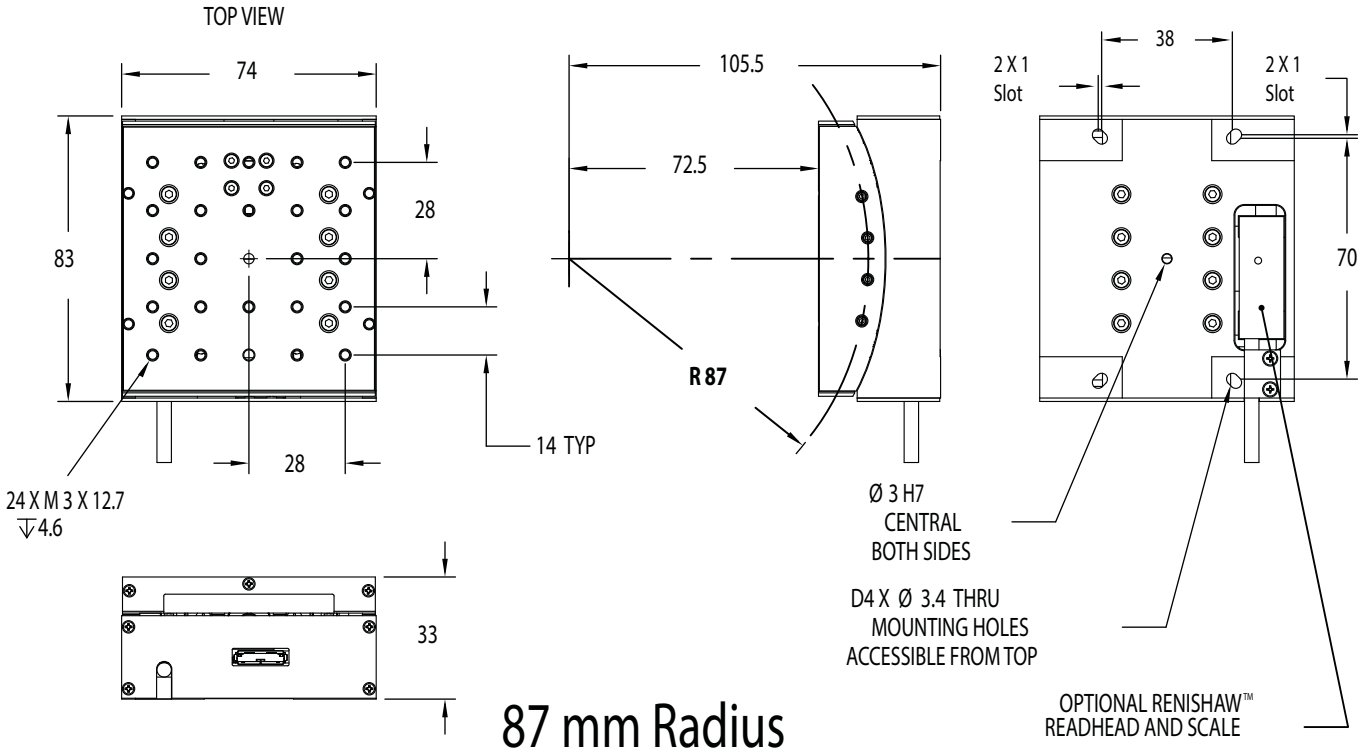
Note: Different radii can be combined in an XY configuration - please call

Radius (mm)	Max Speed		Resolution (angle per count)		
	mrad/sec	deg/sec	µrad/count	deg/count	arcsecond
87	21	1.2	0.25	1.6E-5	0.06
120	15	0.8	0.20	1.2E-5	0.04

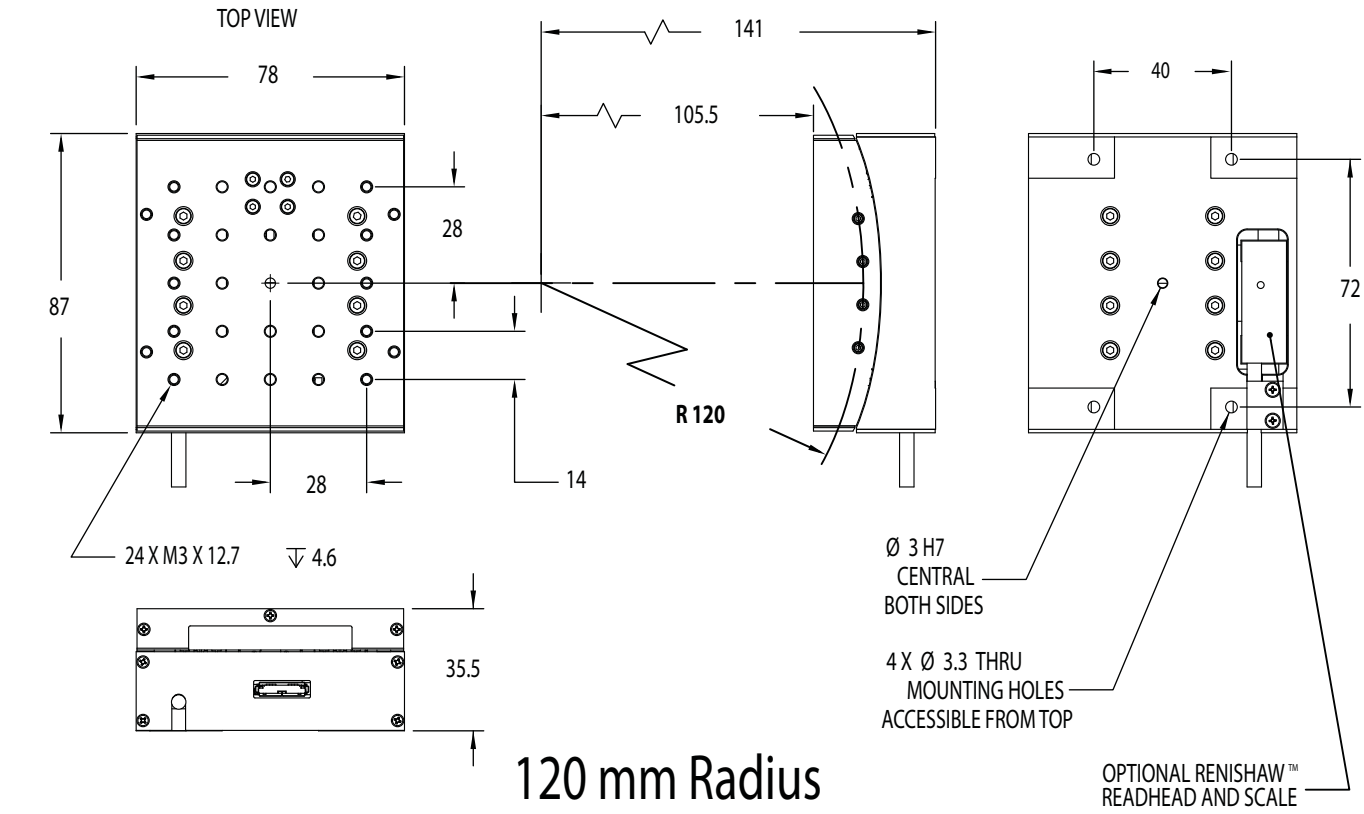
The information contained in this data sheet is subject to change without notice. Critical dimensions or specifications should be verified with our technical support staff.

MM-4M-G Motorized Goniometer +/- 87 mrad

Dimensional Data (mm)

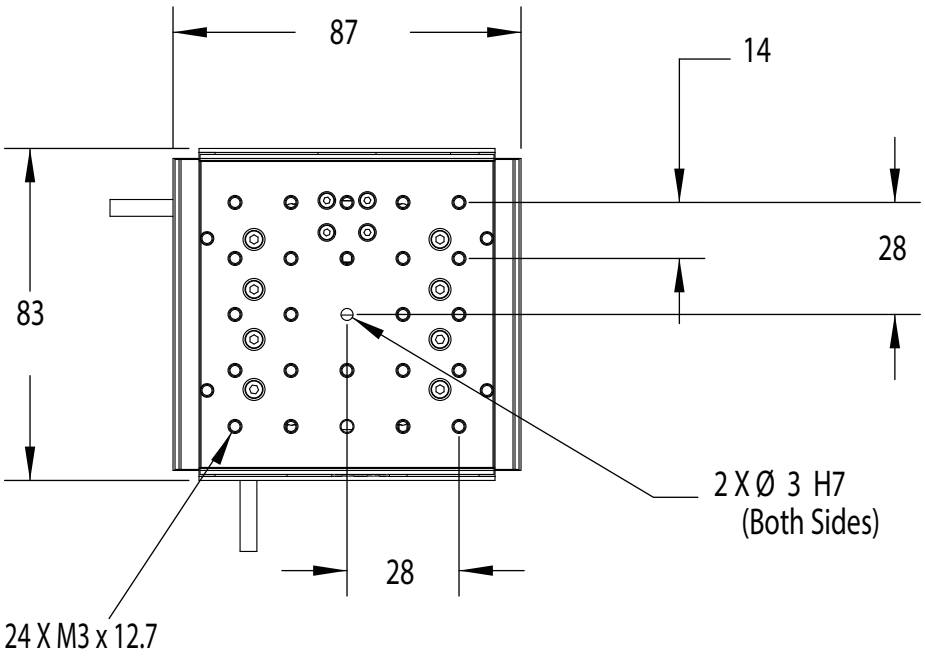


87 mm Radius

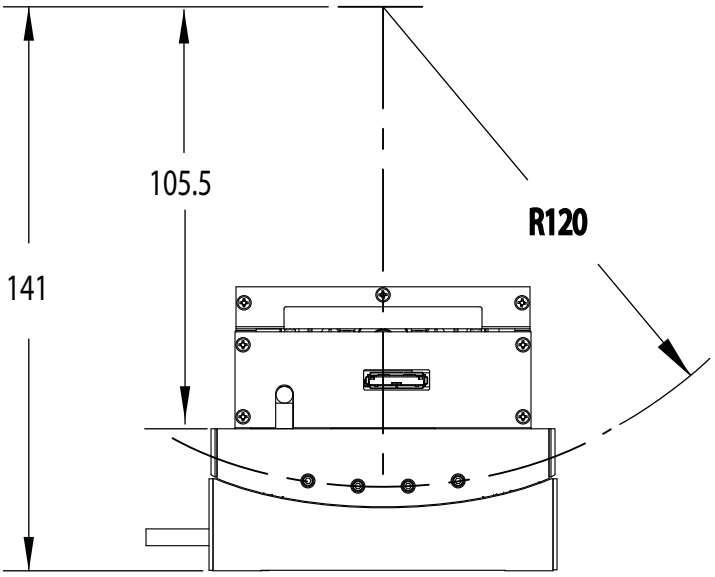


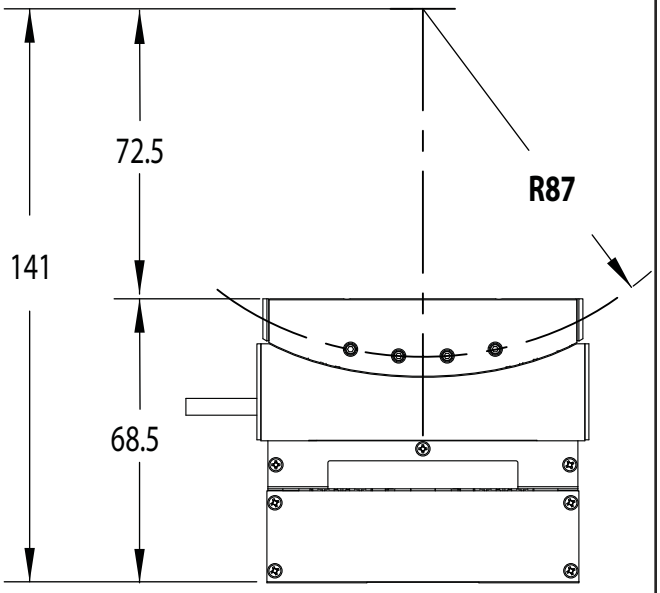
120 mm Radius

MM-4M-G-87/120 2-Axis Goniometer Stack
Dimensional Data (mm) Common Point Rotation



TOP VIEW





MotionControl catalog

Stage Controller

MC-5B

Single Axis Manual

Manually Programmed Position Control

The MC-5B Micro Positioning Controller from National Aperture, Inc. was designed for ease of use and effortless integration into any application. The MC-5B is a low-cost, quick-setup solution for those applications requiring precise position control of motorized stages. Incorporated into this all-in-one controller is a keypad/display interface, a 750mA 12V linear DC motor amplifier, single ended (TTL) A/B quadrature encoder inputs, 5 volt limit switch inputs and a serial communication interface.

The MC-5B functions seamlessly as a single axis, stand-alone system or as a multi-axis networked system, either with or without a PC. The peer to peer network architecture makes it possible for every MC-5B in a multi-axis system to control every axis in the motion system. No software development or complex wiring is required. The controllers themselves may be programmed to store and recall positions and to sequence through stored positions with looping, pausing and user/program interaction. Automation may also be driven serially from a PC or host processor.

Benefits:

- Instant "Out-of-the-Box" Motion Control
- A Low Cost, Integrated Motion Solution
- No need to write additional motion commands
- Perfect for Rapid Development, Prototyping, Bread Boarding, Proof-of-Concept,
- Small OEM lots where delivery is critical

Features:

- Compatible with all NAI motorized stages
- Communicate to any node on the system through your PC's Serial Port
- Up to 99 MC-5B controllers can be configured on a single motion system
- Control all nodes from any node on the motion network
- Original settings are retained
- Configure each unit as a node on the network with a unique node number
- Broadcast Single or Multiple Motion Commands to one node or all nodes at the same time;

Options:

MC-5B Encoder Wheel:

- Continuous bi-directional ultra-precision control.
- Detent value can be configured via the MC-5B menu selections.

MC-5B Joystick:

- 2-axis, 2-speed precision joystick manual control. High and low speed values configured via a simple jog rate control using the menu selection feature.

MC-5B

Manually Programmed Position Control

Specifications

MC-5B Controller	
Display:	Two Line, 20 character alphanumeric LCD
Control:	Keypad or PC
Optional Accessories:	Communication Kit Remote Dial Encoder Wheel Remote Joystick
Motor Load:	any 6-12 Vdc brush type motor (750 mA max.)
Encoder Interface:	Single ended, 5 Vdc TTL compatible A/B Quadrature Encoder Input
Remote Communication:	RS-232
Dimensions:	132.08 x 190.5 x 63.5 (mm)
Weight:	1.25 Kilograms
Operating Temperature:	20˚C (Ambient)
Fuse:	2 Amp Bussman model ABC-2 (or equivalent)

MC-5B Power Supply	
Input Voltage:	100 to approximately 240 Vac
Input Frequency:	47 to 63 Hz
Input Current:	0.6 A max
Output Voltage:	15 Vdc
Output Current:	1.4 A
Operating Temp:	20˚C (Ambient)
Dimensions:	108 x 49.53 x 30.48 (mm)
Weight:	22.7 grams

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MotionControl catalog

Stage Controller

MC-5B

Accessories

Model MC-5B Encoder Wheel
Single Axis Manual Positioning Control for the MC-5B Servo Controller

Features:

- Manually adjust Linear or Rotary position without writing any software
- Just plug it in and you are ready for precision positioning
- Each “click” of the Encoder Wheel generates motion in increments that you define.
- Easy to use remote control.
- Large velcro base for easy, stable surface placement
- Package includes all required cabling

Model MC-5B Joystick
Single or Dual Axis Manual Positioning Control for the MC-5B Servo Controller

Features:

- Manually adjust Linear or Rotary position without writing any software
- Just plug it in and you are ready for precision positioning
- Integrated 2-Speed Control; Standard Jog and Accelerated Jog
- Integrated Dual Axis Positioning System can be used on one or two MC-5B Servo Controllers.
- Easy to use remote control
- Large velcro base for easy, stable surface placement.
- Package includes all required cabling

MotionControl catalog

Stage Controller

MC-5CD

Multi-Axis

Servo Controller & Driver System

The MC-5CD is the newest addition to NAI's family of DC Servo Motor Motion Controllers and Amplifiers.

Applications include:

- Jogging point to point
- Positioning
- Vector positioning,
- Electronic gearing
- Multiple move sequences
- Contouring and PVT mode

The MC-5CD incorporates a Galil DMC-4143 Motor Controller providing four axes of closed Loop control for DC Brush type motors with AB quadrature encoders.

The MC-5CD is designed to be controlled via USB or high speed Ethernet.

The controller may be either bench/desktop or rack mounted and has a wide input range of 90-264 Vac, 47-63 Hz.

Each of the four axes includes both a 10 pin IDC and a 9 pin Mini DIN interface providing connectivity of motor drive, encoders, and limit switches for plug-in compatibility with National Aperture MicroMini™ stages.

Integrated Motion Controller and Amplifier utilizing the Galil software package.

MC-5CD is RoHS and CE compliant.

Purchase includes:

- MC-5CD Motion Controller
- Country specific Power Cord
- Extension Ribbon Cables
- USB Flash Drive
- MC-5CD User Manual
- Galil Tools Application
- DMC-4143 Instruction Manual
- DMC-4143 Command Reference

MC-5CD

Servo Controller & Driver System

Specifications:

Dimensions (W x H x D):	419.1 x 88.9 x 238.1 (mm) 19 inch Rack mountable or Desktop design
AC Supply:	90-264 Vac / 47-63 Hz ; Front Panel Power Switch
Power Supplies:	+5.1 Vdc @ 7 A; +15 Vdc @ 2.5 A; -15 Vdc @ 2.0 A Total power not to exceed 60W.+12 Vdc @ 1.25 A
Axis Status:	Front Panel Axis Enabled Status LED's
Maximum Continuous Motor Current:	1 A
Maximum Peak Motor Current:	1 A
5 Vdc Outputs- Max Combined Load:	1.1 A from Encoder and Limit Vcc
Limit Switch Configuration:	Switches to ground expected, controller incorporates 2.2 kΩ. Pull-up resistors to 5 Vdc
Limit Switch Logic Levels:	Low 0-0.5 V @ >1.5 mA, High 4.0-5.0 V @ <0.5 mA
Encoder Input Logic Levels:	Standard encoder voltage level is TTL (0-5 V). Voltage levels up to 12 V are acceptable, minimum voltage -12 V. Can accept Analog feedback ±10 V instead of an encoder for any axis.
Encoder Input Maximum Frequency:	15 MHz
Linear Encoder:	Linear (Differential) Encoder Inputs (4)
Serial Communication:	Serial Connector Provided for Messaging
Maximum Motor Velocity:	30,000 rpm (not to exceed stage speed rating)
Operating Systems:	Windows XP, Vista, and 7 (32 & 64 bit); Linux (32 & 64 bit)
Communications:	100 Base T Ether Net, USB
Non-Volatile Memory:	Flash EEPROM
I/O:	8 Opto-Isolated Digital Inputs 8 Opto-Isolated Outputs 8 Analog Inputs Dedicated Opto-Isolated Inputs for Limit Switches, Abort, Home and Input Interrupts
Baud Rate:	19,200 / 115,200
Operating Temperature:	0˚C to 70˚C
Storage Temperature:	-25˚C to +85˚C

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MotionControl catalog

Stage Controller

MC-4SA

Servo Amplifier System

Multi-Axis

Specifications:

AC power input (User-selectable):	110/220 VAC
Motor control input voltage:	±10 Vdc across 300 Kohms
Encoder supply voltage:	+5 Vdc
Max output power (Standard):	6 watts
Output voltage range:	±12 Vdc
Slew rate:	8 V/µS, max.
Voltage gain (Av):	1.2
Standard cabling:	**CA10-10-3:** 3 ft. motor extension cable
	CA10-10-6: 6 ft. motor extension cable
	CA10-10-9: 9 ft. motor extension cable
	186381-02: 6 ft controller amplifier interface cable
	Call for information on additional lengths

MULTI-AXIS|micropower

The MC-4SA is a multi-axis motor drive amplification system designed for use in systems where low power micro motors are required for a particular application.

The MC-4SA was designed for interfaceability to the National Instruments™ 7342 and 7344 series controllers. The MC-4SA interface connectors allow versatile connectivity based on the application and controller being used. All 4 axes may be accessed through a single cable.

Simple Connectivity

All of the difficult interfacing problems have been taken out of the hands of the user. For example, setup is simple; connect one end of the 68 conductor cable to the controller and the other to the MC-4SA, plug in your MicroMini™ stage and you are ready! No external power supply connections, no multi-wire motor connections.

The MC-4SA also features a number of built-in protective devices and signal enhancement circuits such as;

- Supply Rail Monitoring (SRM)
- System status monitoring
- Kickless Balanced Power Supply
- Encoder conditioning
- Reversible motor polarity

Features

- Fully compatible with all MicroMini™ stages
- Compatible with National Instruments 7342 & 7344 series controllers
- 110 VAC 60 Hz/220 VAC 50/60 Hz operation
- Built-in limit-sensing logic
- Front panel axis fault lights
- Axis enable switches with illuminated status lights
- Compact design
- Versatile multiple-controller interface
- On-board encoder conditioning
- Joystick Input
- Linear Encoder Inputs (Differential)
- Auxiliary I/O connector for ease of wiring
- Easily accessible rear panel mounted fuses
- 19” Rack Mountable or Desktop design
- ***Fully LabVIEW™ by National Instruments compatible.***

National Aperture, Inc. can provide custom electronic and mechanical design services in order to integrate the MC-4SA into your application.

Stage Controller

MC-4SA

Servo Amplifier System

Accessories

MC-4SA-Joystick-2
Single or Dual Axis Manual Positioning Control for the MC-4SA Amplifier

Features:

- Manually adjust linear or rotary position without writing any software
- Just plug it in and you are ready for precision positioning
- Integrated 2-speed control; standard jog and accelerated jog.
- Integrated Dual Axis Positioning System for use on the MC-4SA Amplifier
- Easy to use remote control
- Rubber “feet” on base for easy, stable surface placement.
- Package includes all cabling and sample joystick software for end user development

MotionControl catalog

Stage Controller

USB STICK DRIVE

Single Axis

Specifications:

Dimensions (mm):	51 x 19 x 10
Control loops:	P-term, I-term, D-term
Parameters Control:	Position, Velocity, Acceleration, and Torque
Computer Interface:	Standard USB
Resolution:	Down to 0.004 µm depending upon the encoder used
Networkable:	Optionally
Inputs and Outputs:	Digital and analog inputs and outputs for conversions and data acquisition. Maximum motor drive voltage is 4.5 V
Power Requirements:	No external power needed, use 5 V USB BUS
Software:	**Visual Basic™**, **LabVIEW™ Drivers**, and **DEMO** Software (all included)

The **MC-CQ-STICK-SRVO** USB Stick Servo controller is powered directly from the USB port with no additional power supply needed.

MC-CQ-STICK-SRVO miniaturized single axis USB stick controller for micro-positioning

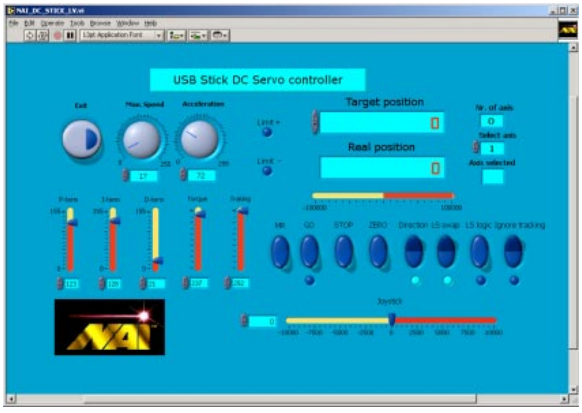
The **MC-CQ-STICK-SRVO USB** Stick Servo Controller is designed for use with the National Aperture MM-1M series miniature linear stages, and other low voltage servo motors. Its intended use is for motors up to 4.5 Vdc with maximum 200 mA current drain.

Plug and Go

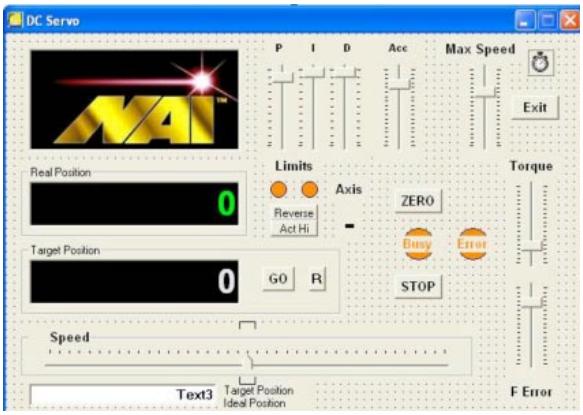
Just plug it in to the USB Port on your computer.

Stage Controller

USB STICK DRIVE Software



LabVIEW™ Driver Software Interface



Visual Basic Software Interface

These interfaces are included with the purchase of the MC-CQ-STICK-SRVO

MotionControl catalog

Stage Controller

MC-CQ-B

Motion Control/Amplifier System

Single Axis

SMALL BUT POWERFUL

The newest addition to National Aperture's family of electronics is the MC-CQ DC-Servo Motion Controller/Amplifier.

The MC-CQ is RoHS and CE compliant.

This small package contains not only a single-axis motion controller for use with our motorized stages, but also an amplifier and a user-friendly Serial Interface.
Each single-axis controller can be linked to multiple Control Units for an integrated multi-axis Motion Control system.

Your purchase will include an easy to use Software Application Development Interface, and an RS-232 serial cable.

- RoHS Compliant
- CE Marked
- Integrated Controller and Amplifier
- Small footprint
- Easy to use RS-232 Serial Interface
- Linkable to multiple Control Units
- Single-Axis becomes Multi-Axis
- Includes Software Application Development Interface
- DC power input with secure lock-on connection
- Easy access fuse
- Front access ON/OFF power switch
- Controller provides Velocity and Position Mode closed-loop control with programmable speed and acceleration and a rich Command-Set
- Clean-and-Simple-Connectivity facilitates Rapid Development
- Optional 2, 4, 8, or 16 port USB to RS-232 Expansion Module (Plug 'n Play)

Optional 2,4,8 or 16 port USB-to RS-232 Expansion Module (Plug 'n Play)

When combined with National Aperture's "IMS Motion Console Software" users receive a "no-development-required" complete Motion Control system for up to four axes.

MC-CQ-B

Motion Control/Amplifier System

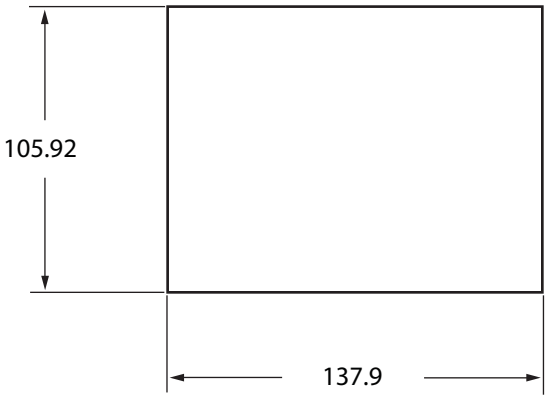
Specifications:

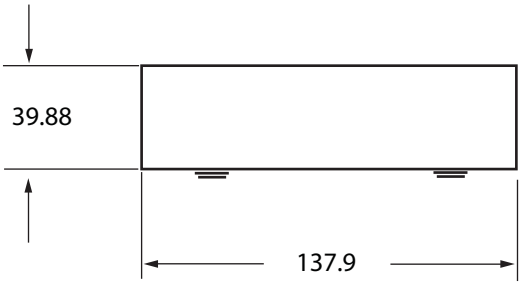
Supply voltage:	12-30 Vdc, (15 Vdc recommended for NAI stages)
PWM Switching Frequency:	78.12 Khz
Efficiency:	95%
Max Continuous Motor Current:	6A with sufficient conductors for motor connection 1 A with 28 gauge ribbon cable
Max Peak Motor Current:	10 A with sufficient conductors for motor connection and sufficient power supply current. 2 A with 28 gauge ribbon cable
Controller Current Consumption:	60 mA (w/no Motor, Encoder, or Limit Switch Current)
5 Volt Outputs:	50 mA (Max Combined Load from Encoder Vcc and Limit Vcc)
Limit Switch Configuration:	Switches to ground expected (Controller incorporates 1 K pull-up resistors to 5 V)
Limit Switch Logic Levels:	Low 0-0.5 V, High 4.0-5.0 V
Encoder Input Logic Levels:	Low 0-0.5 V, High 400 Hz
Encoder Input Max Frequency	400 Hz
Maximum Motor Velocity:	30,000 rpm (do not exceed stage speed rating)
Baud Rate:	600, 1200, 2400, 4800, 9600, 19,200, 38,400, 57,600,115,200
Serial EEPROM Program Memory:	6656 Bytes
Operating Temperature:	0º C to 70º C
Storage Temperature:	-25º to +85º C

MC-CQ-B

Motion Control/Amplifier System

Dimensional Data (mm):





MotionControl catalog

Stage Controller

MC-CQ 4X

Motion Control/Amplifier System

Multi-Axis

Front View

Rear View

The RoHS compliant MC-CQ-4X Motion Control System is a PWM motor controller designed to drive National Aperture, Inc. MM- series motorized stages and other systems utilizing DC brush type motors with single ended quadrature AB encoders.

The MC-CQ-4X incorporates four MCDC-series motor controllers and provides connectivity and packaging suitable for ease of use and rapid deployment in desktop, bench top and industrial automation applications.

Features:

- Unit includes both motion controller and amplifier (no external amplifier required)
- Programmable current limits
- RS-232 connectivity (direct or via available multiport USB to serial converter)
- RoHS compliant
- Package includes:
  - Easy-to-use configuration software with radio buttons and drop down selections
  - RS-232 null modem cable
  - Front panel On/Off switch, fuse, and power-on LED for each axis
  - Front panel accessible fuses for each axis
  - 19-Inch Rack-Mount Option available
  - Full support for NAI's "Motion Console" 4-axis "out-of-the-box" motion control software
  - Low-profile design
  - Shielded country-specific power cord
  - 15 V switching power supply
  - 3-foot extension ribbon cable (10-conductor) for attachment to NAI stages
  - Fuses: (2-each) 0.25 Amp, 0.5 Amp, 1 Amp, 2 Amp and 6 Amp
  - CD containing evaluation version of "IMS Motion Console" motion control software
  - CD including:
    - National Aperture, Inc. MC-CQ-4X User Manual
    - Motion Manager Configuration Software
    - MCDC Motion Controller Instruction Manual

The MC-CQ-B integrates seamlessly with IMS Motion Console software, eliminating the need for software development in many applications incorporating one to four axes of motion so your system is up and running in minutes.

Setting a new standard in automation interface software, IMS Motion Console gives you the power to command your system's operation instantly, with no programming. Whether you're pushing the frontiers of scientific research or integrating precision industrial systems, Motion Console delivers the features that get you effortlessly connected to your objectives.

For use with NAI MC-CQ motion controllers, the Motion Console architecture seamlessly integrates the motion controller and drive electronics, communication hardware, motors, stages, cameras and human machine interface devices that used to require weeks of integration effort.

With Motion Console, multi-axis position sequences may be executed directly from the embedded spreadsheet by entering position data and clicking the run button. Additional spreadsheet columns may be configured to hold sequence timing and flow control commands as well as serial communication transmission and response data, providing control not just of motion hardware but of a virtually unlimited range of RS-232 and RS-485 devices.

Motion Console includes a four axis wireless or wired joystick control interface, a video interface for DirectShow and DCAM compatible cameras, powerful and easy to use system configuration capabilities, an optional API and a variety of other features that come together to make system automation easier than you ever thought it could be.

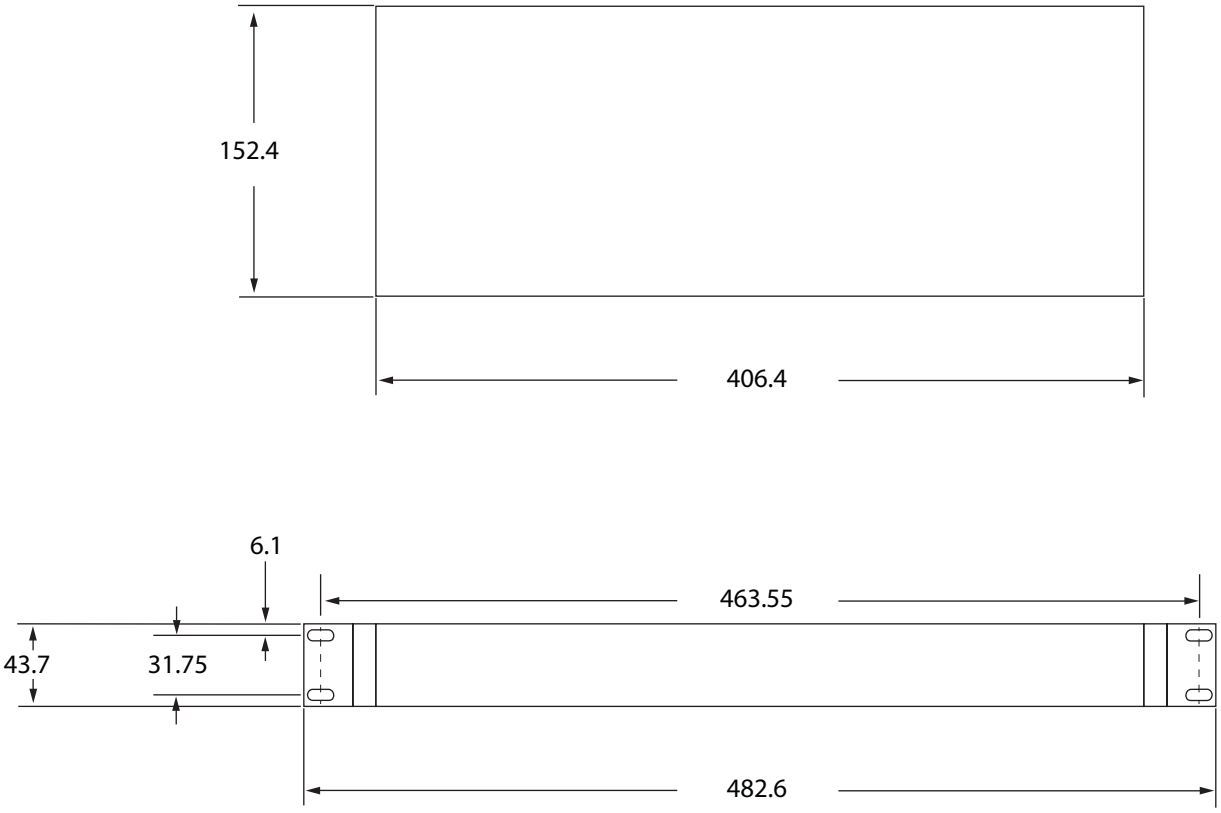
A fully functional 30 day trial version of Motion Console for Windows XP and 2000 is available for download and may be operated with motion controller hardware or without it using Motion Console's included and preconfigured motion controller simulators.

Plug and play wireless and wired USB control pads interface with IMS Motion Console software and provide configurable multi-range speed control and configurable joystick response curves for four axes of motion. Position storage and recall and spreadsheet navigation and execution are also available via control pads. Plug and play USB to serial converters provide additional RS-232 serial ports when needed for single or multi-axis applications. These converters provide easy setup and proven reliable performance.

MC-CQ 4X

Motion Control/Amplifier System

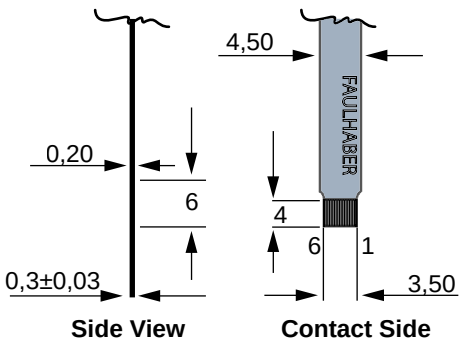
Dimensional Data (mm)



The information contained in this data sheet is subject to change without notice. Critical dimensions or specifications should be verified with our technical support staff.

MTR-6-50E-4.5 V MicroMini™ Motor (6 mm diameter, 4.5 Vdc, 50 position encoder)

Connection, Electrical, Mechanical and Encoder Specifications

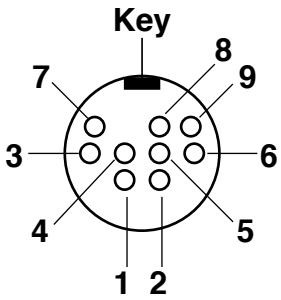


PIN	FUNCTION
1	Mot +
2	Vcc
3	Chan A
4	Chan B
5	Gnd
6	Mot -

Suggested Connector:
Molex 52745 series
Pitch 0.5mm
FPC/FFC, 6 circuits

Motor Connector

Pin #	Name
1	Motor (+)
2	Encoder Vcc
3	Encoder Ch A
4	Encoder Ch B
5	Encoder Ground
6	Motor (-)
7	Limit Ground Switch
8	Forward Limit
9	Reverse Limit



9 pin Mini-Din motor connector (front view)

Stage Connector

Electrical Specifications:

Supply Voltage Nom. (Volts):	4.5
Armature Resistance (Ohm) ±12%:	37.7
Maximum Power Output (watts)(2):	0.11
Maximum Efficiency (%)(2):	50
No Load Speed (RPM) ±12%(2):	19,500
No Load Current (mA) ±50%(3):	10
Stall Torque (mNm):	0.22
Velocity Constant (RPM/Volt):	4,727
Torque Constant (mNm/A):	2.02
Armature Inductance (mH):	0.095
Speed/Torque gradient (RPM/mNm):	88,229
Maximum permissible speed (RPM):	13,000
Maximum continuous current (mA):	110
Maximum continuous torque (mNm):	0.11

Encoder Specifications:

Supply Voltage:	2.7 to 3.3 Vdc
Operating Current Vcc = 3 Vdc:	8.5 mA
Signal Phase Shift:	90º ±45°
Maximum Signal Frequency:	35 Khz
Temperature Range:	-30ºC to +85ºC
Output Signal Type:	2 channel Square wave
Signal Rise Time:	0.3 µs:
Phase Relationship:	Channel B leads Channel A
Pulses per Revolution:	50
Quadrature:	200 encoder counts
Output signal:	CMOS and TTL compatible

Mechanical Specifications:

Mechanical Time Constant (ms)(2):	9
Armature Inertia (g cm²):	0.01
Rotor Temperature Range:	-30ºC to +85ºC
Axial Play :	0.15 mm
Maximum Shaft Load	
Radial 1.5mm from flange @3000RPM (N):	0.5
Axial @ standstill (N):	20
Weight :	2 g
Planetary Gearhead recommended input speed (max):	<8000 RPM

(1) Ratings are presented independent of each other
(2) Specified at nominal supply voltage
(3) Specified with shaft diameter = 0.8 mm at no load
*Mating connectors available through National Aperture, Inc.

50 Position Encoder Resolution Data Sheet

MTR-6-50E-4.5V

MM-1M			
80 TPI Lead Screw (0.3175 mm/turn)			50 position encoder[1]
	GH[2] Ratio (pinion gear ratio = 1.5)	Max Travel Rate[3,4] (mm/sec)	Resolution (µm/count)
	64:1	1.10	0.0165

MM-3M-G			
80 TPI Lead Screw (0.3175 mm/turn)			50 position encoder[1]
Model	GH[2] Ratio	Max Travel Rate[3,4] (rad/sec)	Resolution (µrad/count)
-25	64:1	0.044	0.6615
-42	64:1	0.026	0.3937

MM-4M-G			
80 TPI Lead Screw (0.3175 mm/turn)			50 position encoder[1]
Model	GH[2] Ratio	Max Travel Rate[3,4] (rad/sec)	Resolution (µrad/count)
-87	64:1	0.019	0.2851
-120	64:1	0.014	0.2067

Notes:

1. The 6mm motors incorporate dual channel, 50 position, optical encoders. The quadrature output is equivalent to 200 encoder counts per motor armature revolution.
2. Gearhead ratio is denoted by GH.
3. Maximum travel rate is calculated with the motor armature turning at a maximum rate of 20,000 RPM.
4. Maximum speed is measured at 4.5 VDC with 64:1 gearhead ratio.

Linear Travel

Travel rate calculations

For MM-1M and MM-3M-G[5]:

Lead screw RPM = (motor RPM)/[(gearhead ratio) x (pinion gear ratio)] = (motor RPM)/(64 x 1.5) =(motor RPM)/96

For MM-4M-G:

Lead screw RPM = (motor RPM)/(gearhead ratio) = (motor RPM)/64
Distance per minute = (lead screw RPM) x lead; (lead = 0.3175 mm for 80 TPI lead screw)
Distance per second = (distance per minute)/60
Distance in inches = (distance (mm))/(25.4)

Example calculation: with motor RPM = 20,000

For MM-1M and MM-3M-G:

Lead screw RPM = (20,000 motor RPM)/96 = 208.333 RPM
Lead screw RPS = 208.333/60 RPS = 3.4722 RPS
Distance per second = 3.4722 RPS x 0.3175 mm/revolution = 1.102 mm/sec

Encoder resolution calculations

For MM-1M and MM-3M-G:

Encoder counts per lead screw revolution = (encoder counts per motor revolution) x (gearhead ratio) x (pinion gear ratio)

For MM-4M-G:

Encoder counts per lead screw revolution = (encoder counts per motor revolution) x (gearhead ratio)
Distance per encoder count = lead/(encoder counts per lead screw revolution)

Example calculation: w/encoder counts (quadrature) per motor revolution = 200 and gearhead ratio = 64:1

For MM-1M and MM-3M-G:

Encoder counts per lead screw revolution = (200 counts per motor revolution) x (64 motor revolution per gearhead revolution) x (1.5 gearhead revolutions per pinion revolution) x (1 pinion revolution per lead screw revolution)
= 19,200 counts/(lead screw revolution)
Distance per encoder count = (0.3175 mm)/(19,200 counts) = 1.654E-5 mm/count = 1.654E-2 µm/count

For MM-4M-G:

Encoder counts per lead screw revolution = (200 counts per motor revolution) x (64 motor revolution per gearhead revolution)
= 12,800 counts
Distance per encoder count = (0.3175 mm)/(12,800 counts) = 2.48E-5 mm/count = 2.48E-2 µm/count

Note:

5. The MM-3M-G does not use a pinion gear but uses another gear train that results in an effective 96:1 composite gear ratio.

MTR-6-50E-4.5V

Goniometer Rotary Travel

Travel rate calculations

Lead screw travel rate = (motor RPM) x [min/(60 sec)] x (lead)/(gearhead ratio)
Angular travel rate = tan-1[(lead screw travel rate)/(stage radius)]
Example calculation: with motor RPM = 20,000; **MM-3M-G** total gear ratio = 96:1; **MM-4M-G** GH ratio = 64:1; lead = 0.3175 mm
For MM-3M-G stages:
Lead screw rate = (20,000 RPM) x [min/(60 sec)] x (0.3175 mm)/(96) = 1.10243 mm/sec
For 25 mm radius stage:
Angular travel rate = tan-1[(1.10243 mm/sec)/(25 mm)] = 0.04406 rad/sec
For 42 mm radius stage:
Angular travel rate = tan-1[(1.10243 mm/sec)/(42 mm)] = 0.02624 rad/sec
For MM-4M-G stages:
Lead screw rate = (20,000 RPM) x [min/(60 sec)] x (0.3175 mm)/(64) = 1.65365 mm/sec
For 87 mm radius stage:
Angular travel rate = tan-1[(1.65365 mm/sec)/(87 mm)] = 0.01901 rad/sec
For 120 mm radius stage
Angular travel rate = tan-1[(1.65365 mm/sec)/(120 mm)] = 0.01378 rad/sec

Encoder resolution calculations

Encoder counts per lead screw revolution = (encoder counts per motor revolution) x (gearhead ratio)
Distance per encoder count = lead/(encoder counts per lead screw revolution)
Angular resolution = tan-1[(distance per encoder count)/(stage radius)]
Example calculation: with encoder counts (quadrature) per motor revolution = 200
For MM-3M-G stages:
Encoder counts per lead screw revolution = [(200 counts)/(motor revolution)] x [(96 motor revolution)/(final gearhead revolution[5])] = 19,200
Distance per encoder count = (0.3175 mm)/(19,200 counts) = 1.65365E-5 mm/count
For 25 mm radius stage:
Angular travel rate = tan-1[(1.65365E-5 mm/count)/(25 mm)] = 0.66146 µrad/count
For 42 mm radius stage:
Angular travel rate = tan-1[(1.65365E-5 mm/count)/(42 mm)] = 0.39373 µrad/count
For MM-4M-G stages:
Encoder counts per lead screw revolution = [(200 counts)/(motor revolution)] x [(64 motor revolution)/(gearhead revolution)] = 12,800
Distance per encoder count = (0.3175 mm)/(12,800 counts) = 2.48E-5 mm/count
For 87 mm radius stage:
Angular resolution = tan-1[(2.48E-5 mm/count)/(87 mm)] = 0.285057 µrad/count
For 120 mm radius stage:
Angular resolution = tan-1[(2.48E-5 mm/count)/(120 mm)] = 0.206667 µrad/count

Note:

5. The MM-3M-G does not use a pinion gear but uses another gear train that results in an effective 96:1 composite gear ratio.

Conversion

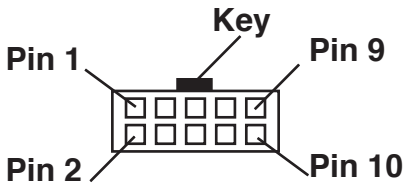
1 inch (in)	= 25.4 mm
1 inch	= 25,400 µm
1 millimeter (mm)	= 39.37E-3 inch
1 micron (µm)	= 39.37E-6 inch
1 deg	= 0.01745329252 rad

MTR-10-10E MicroMini™ Motor (10 mm diameter, 6 Vdc, 10 position encoder)

Linear 80 TPI/Rotary 80:1 Connection Specifications

Motor Type: MTR-10-10E
Connector type: Dual row IDC
***Mate Part# (male pin):**
Pancon part #057-010-115

Pin #	Name	Pin #	Name
1	Motor+	6	Motor -
2	Encoder+V	7	Limit ground
3	Encoder Ch A	8	No connection
4	Encoder Ch B	9	Reverse limit
5	Ground (case)	10	Forward limit



10 pin motor female connector (front view)

Electrical Specifications:

Supply Voltage Nom. (Volts):	6
Armature Resistance (Ohm)±12%:	20.1
Maximum power output (watts)(2):	0.42
Maximum Efficiency (%)(2):	67
No Load Speed (RPM) ±12%(2):	18,400
Friction Torque (@ no load speed) (mNm):	0.03
No Load Current (mA) ±50%(3):	10
Stall Torque (mNm)(2):	0.87
Velocity Constant (RPM/Volt):	3,173
Back EMF Constant (mV/RPM):	0.315
Torque Constant (mNm/A):	3.01
Armature Inductance (mH):	0.060
Speed/Torque Gradient(RPM/mNm):	21,185
Maximum permissible speed (RPM):	13,000
Maximum continuous current (mA):	170
Maximum continuous torque (mNm):	0.48

Encoder Specifications:

Supply Voltage:	5 Vdc Nom.
Maximum Voltage Supply:	15 Vdc
Operating Current:	5mA Nom. @ 5 Vdc
Signal Phase Shift	90º
Maximum Signal Frequency:	7.2 Khz
Temperature Range:	-30ºC to +85º C
Output Signal Type:	Square wave
Signal Rise Time:	Less than 5µs
Phase Relationship:	Ch A leads CH B when motor rotation is clockwise as seen from shaft end.
Pulses per Revolution:	10 (2 channels)
Quadrature:	40 encoder counts
Output signal:	CMOS and TTL compatible

Mechanical Specifications:

Mechanical Time Constant (ms)(2):	13
Armature Inertia (g cm²)(2):	0.06
Angular Acceleration (x 10³ rad/sec²)(2):	145
Rotor Temperature Range:	-30ºC to +85ºC
Axial Play:	0.2 mm
Shaft Play (measured @ bearing)	
Radial:	Less than 0.02mm
Axial:	Less than 0.2mm
Maximum Shaft Load	
Radial (@3,000 RPM) 1.5 mm from bearing (N):	5
Axial @ standstill (N):	5
Weight:	6.5 g
Planetary Gearhead recommendedmax continuous input speed:	5000 RPM

(1) Ratings are presented independent of each other
(2) Specified at nominal supply voltage
(3) Specified with shaft diameter = 0.8mm at no load
*Mating connectors available through National Aperture, Inc.

The information contained in this data sheet is subject to change without notice. Critical dimensions or specifications should be verified with our technical support staff.

10 Position Encoder Resolution Data Sheet

MTR-10-10E

MM-3M-ST, -F, -FOS, -EX, MM-4M-F		
80 TPI Lead Screw (0.3175 mm/turn)		10 position encoder[1]
GH[2] Ratio	Max Travel Rate[3] (mm/sec)	Resolution (µm/count)
16:1	6.614	0.4961
64:1	1.653	0.1240
256:1	0.413	0.0310
1024:1	0.103	0.0078
MM-3M-ST, -F, -EX, MM-4M-F		
40 TPI Lead Screw (0.635 mm/turn)		10 position encoder[1]
GH[2] Ratio	Max Travel Rate[3] (mm/sec)	Resolution (µm/count)
16:1	13.229	0.9922
64:1	3.307	0.2481
256:1	0.827	0.0620
1024:1	0.207	0.0155

Notes:

1. The 10mm motors used with both linear and rotary stages incorporate dual channel, 10 position, magnetic encoders. The quadrature output is equivalent to 40 encoder counts per motor armature revolution.
2. Gearhead ratio is denoted by GH.
3. Maximum travel rate is calculated with the motor armature turning at a maximum rate of 20,000 RPM.

Linear Travel

Travel rate calculations

Lead screw RPM = motor RPM)/(gearhead ratio)

Distance per minute = (lead screw RPM) x lead; (lead = 0.3175 mm for 80 TPI screw and 0.635 mm for 40 TPI screw)

Distance per second = (distance per minute)/60

Distance in inches = (distance (mm))/(25.4)

Example calculation: with motor RPM = 20,000; GH ratio = 16:1; lead = 0.3175 mm

Distance per second = [(20000 RPM)/(16)] x (0.3175 mm) x (min/60 sec)] = 6.6145 mm/sec

Encoder resolution calculations

Encoder counts per lead screw revolution = (encoder counts per motor revolution) x (gearhead ratio)

Distance per encoder count = lead/(encoder counts per lead screw revolution)

Example calculation: with motor GH ratio = 16:1; lead = 0.3175 mm; 40 encoder counts per motor revolution

Distance per encoder count = (0.3175 mm)/(40 x 16) = 0.4961 µm/count

10 Position Encoder Resolution Data Sheet (cont.)

MTR-10-10E

MM-3M-R			
80:1 Worm Drive Ratio			10 position encoder[1]
GH[2] Ratio	Final Output	Max Travel Rate[3] (rad/sec)	Resolution (µrad/count)
16:1	1,280:1	1.636	122.7185
64:1	5,120:1	0.409	30.6796
256:1	20,480:1	0.102	7.6699
1024:1	81,920:1	0.025	1.9175

Notes:

1. The 10mm motors used with both linear and rotary stages incorporate dual channel, 10 position, magnetic encoders. The quadrature output is equivalent to 40 encoder counts per motor armature revolution.
2. Gearhead ratio is denoted by GH.
3. Maximum travel rate is calculated with the motor armature turning at a maximum rate of 20,000 RPM.

Rotary Travel

Travel rate calculations

Rotor travel rate (RPM) = (motor RPM)/[gearhead ratio) x (worm drive ratio)]
Rotor travel rate (rad/sec) = [rotor travel rate (RPM)] x (min/60 sec) x (6.283185 rad/revolution)

Example calculation: with motor RPM = 20,000; GH ratio = 16:1; lead = 0.3175 mm
Rotor travel rate (rad/sec) = (20000 RPM)/(16 x 80) x (min/60 sec) x (6.283185 rad/revolution) = 1.63624 rad/sec

Encoder resolution calculations

Encoder counts per lead screw revolution = [(encoder counts per motor revolution)] x (gearhead ratio) x (worm drive ratio)
Angular resolution = (6.283185 rad/revolution)/ (encoder counts per lead screw revolution)

Example calculation: with motor GH ratio = 16:1; lead = 0.3175 mm; 40 encoder counts per motor revolution
Angular resolution = (6.283185 rad per lead screw revolution)/[(40 counts per motor revolution) x (16 motor revolutions per gearhead revolution) x (80 gearhead revolutions per lead screw revolution)]
= 122.718 µrad/count

Conversion:

1 inch (in) = 25.4 mm
1 inch = 25,400 µm
1 millimeter (mm) = 39.37E-3 inch
1 micron (µm) = 39.37E-6 inch
1 deg = 0.01745329252 rad

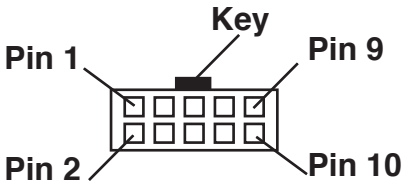
(This Motor is Special Order)

MTR-10-10E-HT MicroMini™ Motor (High Torque, 10 mm diameter, 6 Vdc, 10 position encoder)

Linear 80 TPI/Rotary 80:1 Connection Specifications

Motor Type: MTR-10-10E-HT with planetary gearhead and magnetic encoder
Connector type: Dual row IDC
***Mate Part #(male pins):**
Pancon Part #057-010-115

Pin #	Name	Pin #	Name
1	Motor+	6	Motor -
2	Encoder+V	7	Limit ground
3	Encoder Ch A	8	No connection
4	Encoder Ch B	9	Reverse limit
5	Ground (case)	10	Forward limit



10 pin motor female connector (front view)

Electrical Specifications:

Supply Voltage Nom. (Volts):	6
Armature Resistance (Ohm) ±12%:	10.8
Maximum power output (watts)(2):	0.81
Maximum Efficiency (%)(2):	78
No Load Speed (RPM) ±12%(2):	13,200
Friction Torque (at no-load speed)(mNm):	0.03
No Load Current (mA) ±50%(3):	8
Stall Torque (mNm):	2.34
Velocity Constant (RPM/Volt):	2,231
Back EMF Constant (mV/RPM):	0.448
Torque Constant (mNm/A):	4.28
Armature Inductance (mH):	0.100
Speed/Torque gradient (RPM/mNm):	5,630
Maximum permissible speed (RPM):	12,000
Maximum continuous current (mA):	291
Maximum continuous torque (mNm):	1.21

Mechanical Specifications:

Mechanical Time Constant (ms)(2):	7
Armature Inertia (g cm^2):	0.12
Angular Acceleration (x 10^3 rad/sec^2)(2) :	195
Rotor Temperature Range:	-30ºC to +85ºC
Axial Play :	0.2mm
Shaft Play (measured at bearing)	
Radial:	Less than 0.02mm
Axial:	Less than 0.2mm
Maximum Shaft Load	
Radial 1.5 mm from bearing (N):	0.5
Axial @ standstill (N:)	20
Weight	8.8 g
Planetary Gearhead recommended maximum continuous input speed:	5000 RPM

Encoder Specifications:

Supply Voltage:	5 Vdc Nominal
Maximum Voltage Supply:	15 Vdc
Operating Current:	5mA Nominal @5 Vdc
Signal Phase Shift:	90º
Maximum Signal Frequency:	7.2 Khz
Temperature Range:	-30ºC to +85º C
Output Signal Type:	Square wave
Signal Rise Time:	less than 5µs
Phase Relationship:	Ch A leads CH B when motor rotation is clockwise as seen from shaft end.
Pulses per Revolution:	10 (2 channels)
Quadrature:	40 encoder counts
Output signal:	CMOS and TTL compatible

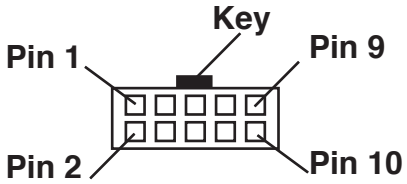
(1) Ratings are presented independent of each other
(2) Specified at nominal supply voltage
(3) Specified with shaft diameter = 0.8mm at no load
*Mating connectors available through National Aperture, Inc.

MTR-13-16E-HT MicroMini™ Motor (High Torque, 13 mm diameter, 6 Vdc, 16 position encoder)

Linear 80 TPI/Rotary 90:1 Connection Specifications

Motor Connector Pin Assignments:
Motor Type: MTR-13-16E
Connector Type: Dual Row IDC
***Mate Part # (Male Pin):**
Pancon Part #057-010-115

Pin #	Name	Pin #	Name
1	Motor+	6	Motor -
2	Encoder+V	7	Limit ground
3	Encoder Ch A	8	No connection**
4	Encoder Ch B	9	Reverse limit
5	Ground (case)	10	Forward limit



10 pin motor female connector (front view)

***Optional: +5V with Optical Limit Switches**

Electrical Specifications:

Supply Voltage Nom. (Volts)	6
Armature Resistance (Ohm) ±12%	2.83
Maximum Power Output (watts)(1)	3.11
Maximum Efficiency (%)(1)	81
No Load Speed (RPM) ±12%(1)	10,600
Friction Torque (at no-load speed)(mNm)	0.12
No Load Current (mA) ±50%(2)	22
Stall Torque (mNm.)(1)	11.2
Velocity Constant (RPM/Volt)	1,790
Back EMF Constant (mV/RPM)	0.560
Torque Constant (mNm/A)	5.35
Armature Inductance (mH)	0.07
Maximum permissible speed (RPM)	12,000
Maximum continuous current (mA)	810
Maximum continuous torque (mNm)	3.2

Encoder Specifications:

Supply Voltage	5 Vdc Nom.
Max Supply Voltage	5.5 Vdc
Operating Current	6 mA Nom. @ 5 Vdc
Signal Phase Shift	90˚
Maximum Signal Frequency	20 Khz
Operating Temperature Range	-30˚C to +85˚C
Signal Rise Time	0.1 µs max.
Phase Relationship	Ch. A leads Ch. B when motor rotation is clockwise as viewed from shaft end.
Pulses Per Revolution	16 (2 channels)
Quadrature	64 encoder counts
Output signal	CMOS and TTL compatible

Mechanical Specifications (Motor):

Mechanical Time Constant (ms)(1)	7
Armature Inertia (g cm^2)	0.71
Angular Acceleration (x 10^3 rad/sec^2)(1)	160
Rotor Temperature Range	-30ºC to +85ºC
Maximum Shaft Load	
Radial at 3,000 RPM 3 mm from bearing(N)	1.2
Axial @ standstill (N)	20
Weight	19 g
Maximum Rotor Temperature.	125˚C

(1) Specified at nominal supply voltage.
(2) Specified with shaft diameter = 1.5mm at no-load speed.
* Mating connectors may be purchased from National Aperture, Inc.

16 Position Encoder Resolution Data Sheet

MTR-13-16E-HT

MM-4M-EX

80 TPI Lead Screw (0.3175 mm/turn)			16 position encoder[1]
GH[2] Ratio	Actual Gear Ratio	Max Travel Rate[3] (mm/sec)	Resolution (µm/count)
14:1	13.795918367:1	7.671	0.3596
43:1	42.920634921:1	2.466	0.1156
66:1	66.220408163:1	1.598	0.0749
134:1	133.530864198:1	0.792	0.0372
159:1	159.419501134:1	0.664	0.0311
246:1	245.961516035:1	0.430	0.0202
415:1	415.429355281:1	0.255	0.0119
592:1	592.129575640:1	0.178	0.0084
989:1	988.891428571:1	0.107	0.0050
1526:1	1,525.718204082:1	0.069	0.0033
2608:1	2,625.740771277:1	0.040	0.0019
4365:1	4,385.142457309:1	0.024	0.0011
5647:1	5,666.953329446:1	0.018	0.0009
40 TPI Lead Screw (0.635 mm/turn)			16 position encoder[1]
GH[2] Ratio	Actual Gear Ratio	Max Travel Rate[3] (mm/sec)	Resolution (µm/count)
14:1	13.795918367:1	15.342	0.7192
43:1	42.920634921:1	4.931	0.2312
66:1	66.220408163:1	3.196	0.1498
134:1	133.530864198:1	1.585	0.0743
159:1	159.419501134:1	1.327	0.0622
246:1	245.961516035:1	0.860	0.0403
415:1	415.429355281:1	0.509	0.0239
592:1	592.129575640:1	0.357	0.0168
989:1	988.891428571:1	0.214	0.0100
1526:1	1,525.718204082:1	0.138	0.0065
2608:1	2,625.740771277:1	0.080	0.0038
4365:1	4,385.142457309:1	0.048	0.0023
5647:1	5,666.953329446:1	0.037	0.0018

Notes:

1. The 13 mm motors used with both linear and rotary stages incorporate dual channel, 16 position, optical encoders. The quadrature output is equivalent to 64 encoder counts per motor armature revolution.
2. Gearhead ratio is denoted by GH.
3. Maximum travel rate is calculated with the motor armature turning at a maximum rate of 20,000 RPM.

Linear Travel

Travel rate calculations

Lead screw RPM = (motor RPM)/(gearhead ratio)
Distance per minute = (lead screw RPM) x lead; (lead = 0.3175 mm for 80 TPI screw and 0.635 mm for 40 TPI screw)
Distance per second = (distance per minute)/60
Distance in inches = (distance (mm))/(25.4)

Example calculation: with motor RPM = 20,000; GH ratio = 13.795918367:1; lead = 0.3175 mm
Distance per second = [(20000 RPM)/13.795918367] x (0.3175 mm) x (min/60 sec)] = 7.6714 mm/sec

Encoder resolution calculations

Encoder counts per lead screw revolution = (encoder counts per motor revolution) x (gearhead ratio)
Distance per encoder count = lead/(encoder counts per lead screw revolution)

Example calculation: with motor GH ratio = 13.795918367:1; lead = 0.3175 mm; 64 encoder counts per motor revolution
Distance per encoder count = (0.3175 mm)/(64 x 13.795918367) = 0.3595945821096348 µm/count

16 Position Encoder Resolution Data Sheet (cont.)

MTR-13-16E-HT

MM-4M-R

90:1 Worm Drive Ratio			16 position encoder[1]
GH[2] Ratio	Actual Gear Ratio	Max Travel Rate[3] (rad/sec)	Resolution (µrad/count)
14:1	13.795918367:1	1.687	79.0691
43:1	42.920634921:1	0.542	25.4151
66:1	66.220408163:1	0.351	16.4727
134:1	133.530864198:1	0.174	8.1691
159:1	159.419501134:1	0.146	6.8425
246:1	245.961516035:1	0.094	4.4350
415:1	415.429355281:1	0.056	2.6258
592:1	592.129575640:1	0.039	1.8422
989:1	988.891428571:1	0.023	1.1031
1526:1	1,525.718204082:1	0.015	0.7150
2608:1	2,625.740771277:1	0.009	0.4154
4365:1	4,385.142457309:1	0.005	0.2488
5647:1	5,666.953329446:1	0.004	0.1925

Notes:

1. The 13 mm motors used with both linear and rotary stages incorporate dual channel, 16 position, optical encoders. The quadrature output is equivalent to 64 encoder counts per motor armature revolution.
2. Gearhead ratio is denoted by GH.
3. Maximum travel rate is calculated with the motor armature turning at a maximum rate of 20,000 RPM.

Rotary Travel

Travel rate calculations

Rotor travel rate (RPM) = (motor RPM)/[gearhead ratio) x (worm drive ratio)]
Rotor travel rate (rad/sec) = [rotor travel rate (RPM)] x (min/60 sec) x (6.283185 rad/revolution)
Example calculation: with motor RPM = 20,000; GH ratio = 13.795918367:1; lead = 0.3175 mm
Rotor travel rate (rad/sec) = (20000 RPM)/(13.795918367 x 90) x (min/60 sec) x (6.283185 rad/revolution) = 1.68680728 rad/sec

Encoder resolution calculations

Encoder counts per rotor revolution = [(encoder counts per motor revolution)] x (gearhead ratio) x (worm drive ratio)
Angular resolution = (6.283185 rad/revolution)/ (encoder counts per rotor revolution)
Example calculation: with motor GH ratio = 13.795918367:1; worm drive ratio = 90:1; lead = 0.3175 mm; 64 encoder counts per motor revolution
Angular resolution = (6.283185 rad per rotor revolution)/[(64 counts per motor revolution) x (13.795918367 motor revolutions per gearhead revolution) x (90 gearhead revolutions per rotor revolution)]
= 79.069 µrad/count

MicroMini™ Controller

Overview

TO THE MICRO-MOTION USER

National Aperture, Inc. is the leader in micro-automation. The MicroMini™ stages, along with our micro-motion control systems, have become the industry's best selling micro-automation tools.

The patented features of the MicroMini™ stage provide **high-precision micropositioning** at "breakthrough" prices.

Our new constraint-free design minimizes inherent error and provides linear and rotary motion in a unique, compact configuration. This small, compact design provides the user with the ultimate in accuracy, linearity, repeatability and speed. Our miniature servo-motor has advantages that far surpass any comparable stepper motor.

Our Controllers:
Now it is easy to integrate your total motion control solution. You can begin with confidence to replace your more critical hand operations in production and product development. National Aperture, Inc. Motion Controllers provide "plug in and go" solutions for both PC and Macintosh™. Our motion controllers provide real time, high speed, closed-loop control without sacrificing resolution or response time. With Windows™ and the additional support of LabVIEW™ by National Instruments Corp., custom software applications become simple and hardware headaches become a thing of the past!

All of our motion control products are not only user friendly and flexible, but they offer superior compatibility with other major servo systems.

National Aperture, Inc. is dedicated to bringing you into the world of motion control with the finest state of the art products.

Features of the MicroMini™ Stage

Overview

GENERAL APPLICATION

MANUAL LINEAR STAGES

The MM-1,-2,-3 manual linear stages are designed for top loads ranging from under 0.17 kg to 0.5 kg and moment loads under 15 oz-in.

SLIDE SYSTEM

Hardened precision dowels are preloaded against the slider. The load requirements of the stage allow a spring-action, preloaded, positive slider seating.

RETURN PRELOAD SPRING

The standard manual stages have a simple return spring and moving lead screw. Although limited in travel, there is the benefit of built in anti-backlash.

MOTORIZED LINEAR STAGES

-ST motor stages also have a simple return spring and moving lead screw. Although limited in travel, there is the benefit of built in anti-backlash.

FIXED LEAD SCREW THRU SLIDER

The Folded and Extended motor stages have a fixed lead screw passing through a tapped section in the slider.

BACKLASH

Clearance between the tapped hole and the lead screw gives a degree of backlash in slider motion. It also affects linearity of motion (in -F and -EX stages).

ANTI-BACKLASH HIGH LINEARITY

A radially preload-seating tapped lead hole module is provided for more stringent requirements. The effect of this system is near 0 backlash, along with maximum linearity, repeatability, and homing consistency.

LOAD BEARING CONSIDERATION

The amount of preload determines the load bearing capacity. When the preload is overcome by excessive load, the slider-rail seating is disturbed making overload errors easy to detect. Stage damage does not occur at this point. Simple formulae are provided for quick, or detailed load analysis. A larger MM-4M stage is provided as a base to better carry the weights of additional axes, thus improving the end load capacity.

VELOCITY

Slider velocity is determined by the torque and speed of the motor, along with the gearhead ratio. It is limited by the slider drag force along with the lead screw drag from an anti-backlash module (if used). In order to increase speed without violating accuracy, the “drag” forces may be reduced, but with a consequential decrease in load capacity.

BRACING

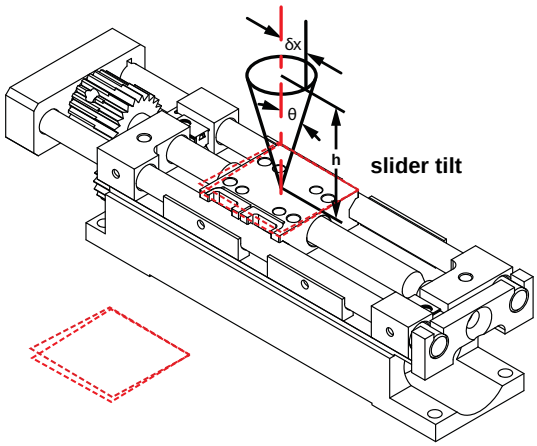
A selection of optional braces (BR) offers extra rigidity and crash protection for stages in vulnerable positions, as the slide elements are not designed to withstand pressure or twist. The cushioned “ears” on one side of the slider will begin to yield, then the brace will engage before damage takes place. Braces add some weight and must be counted as load.

MULTI-AXIS VERSATILITY

All similar series manual and motorized stages are compatible for quick, multi-axis connection using standard English screws.

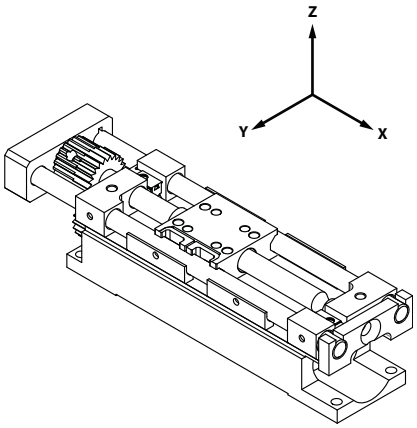
Glossary of Terms

Abbe Error - Abbe Error is the linear off-axis error introduced through the amplification of tilt by an Abbe offset moment arm (depicted as **h** in the figure below). This type of error increases with distance from the axis of motion.
For example, the Abbe error is approximately 0.01 µm of error based on a 10 mm moment arm and a tilt of 1 µradian.



Accuracy - Accuracy is the departure of the actual position from the commanded position (although, more precisely, it is the inaccuracy). Accuracy may be expressed per unit distance of travel or over the full travel of the stage.
For example, a linear stage may be specified as having an accuracy of 3 micrometers per inch of travel. This specification is sometimes considered the "linearity."

Axes - The convention used for NAI stages is the travel (longitudinal) axis is X, the cross-travel (lateral) axis is Y, and the vertical axis is Z as shown in the figure below.

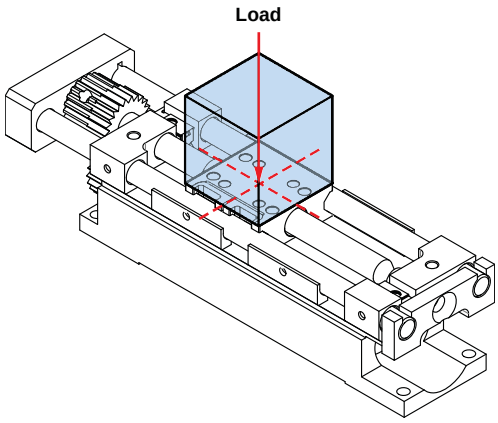


Axial thrust – For a rotary stage, the axial thrust refers to the hold-down strength of the rotor or the force required to release the rotor from its kinematic footing.

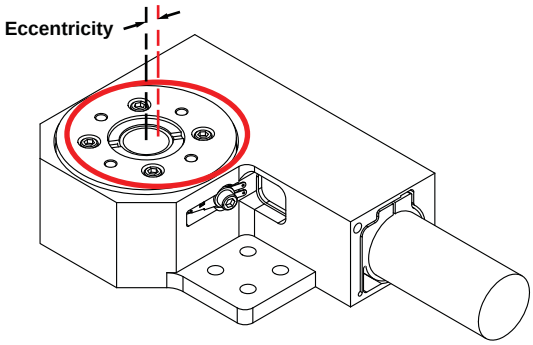
Axial wobble – For a rotary stage, axial wobble is the repeatable component of total axial angular deviation resulting from machining tolerances on mating surfaces.

Backlash - Backlash is an error in positioning experienced upon reversal of travel direction. Backlash is the portion of commanded motion that produces no change in position upon reversal of travel direction and is caused by clearance between elements in the drive train and mechanical deformation. Backlash also affects bidirectional repeatability. NAI manual stages do not exhibit measurable backlash because they are spring preloaded.

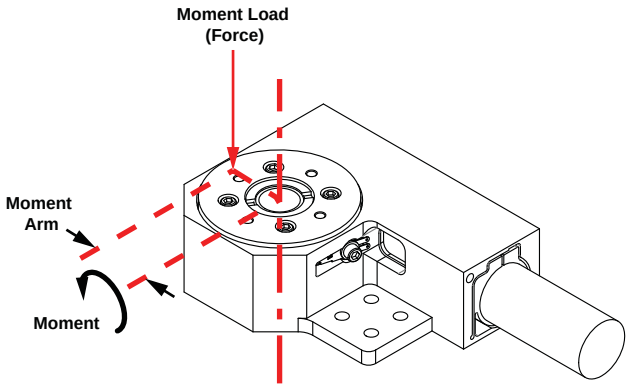
Direct Top Load – Direct top load is the maximum downward vertical load or force which can be applied to a stage slider perpendicular to the mounting surface (without deformation or associated motion error). If the force or center of gravity of the load is located off-center of the mounting surface, there will be an additional moment load (refer to moments).



Eccentricity – This is the radial (perpendicular to the axis of rotation) deviation of the center of rotation (lateral shift of the center of rotation) from its mean position as a stage rotates through one revolution.

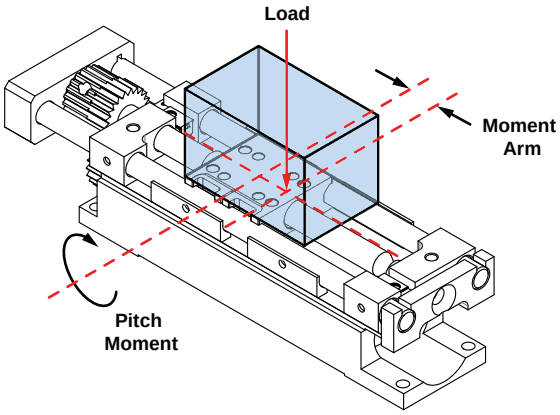


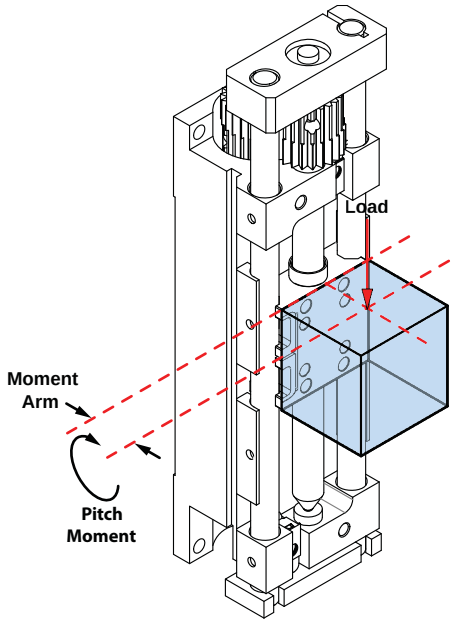
Moment load – Moment load is the maximum torque sustainable (without deformation or associated motion error) when a force is applied to a rotary table parallel to the rotation axis of a rotary table. The load therefore is applied at a moment arm (distance) from the table center of rotation. The torque moment is computed as the product of the applied load and the moment arm.



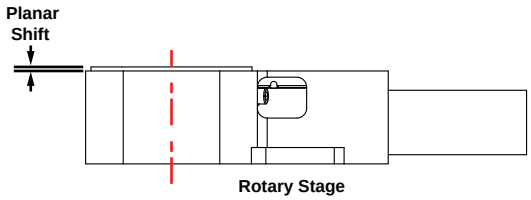
The information contained in this data sheet is subject to change without notice. Critical dimensions or specifications should be verified with our technical support staff.

Pitch (moment) Load – Pitch load is the maximum torque sustainable when the force or center of gravity of a vertically applied load is longitudinally offset from the center of the slider mounting surface (without deformation or associated motion error). The load therefore is applied at a longitudinal moment arm (distance) from the center of the mounting surface. The pitch moment is computed as the product of the applied load and the longitudinal moment arm.

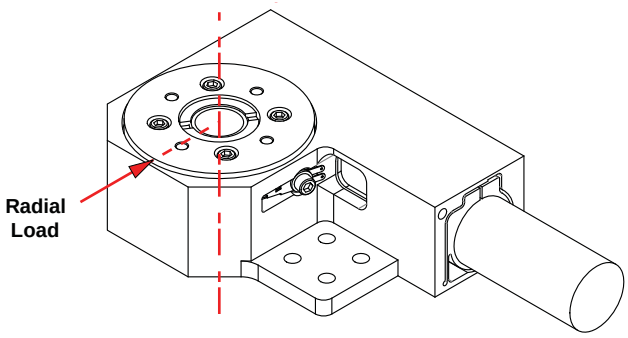




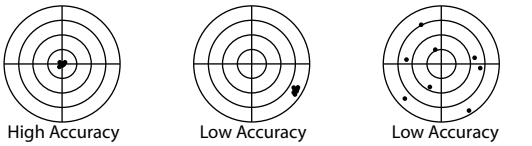
Planar shift – For a rotary stage table, planar shift is the maximum out of plane excursion of the table during rotation. This shift is partially correlated with wobble, but a component is due to local variation in table motion.



Radial load – Radial load is the maximum force sustainable (without deformation or associated motion error) when the force is applied radially to a rotary table.

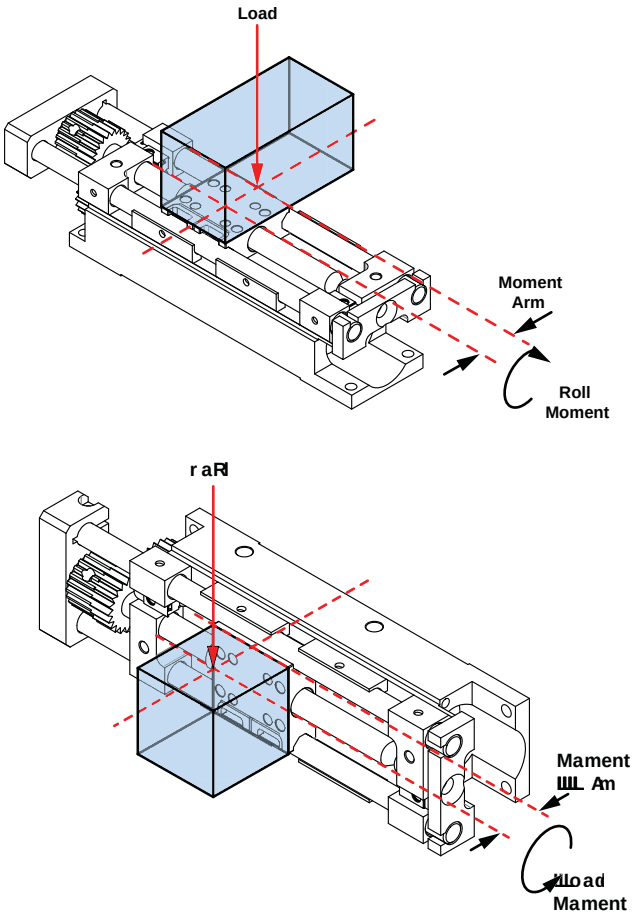


Repeatability - Repeatability represents the maximum difference between actual position values and commanded values, obtained in repetitive moves of a positioning stage to the commanded position. There are two types of repeatability: unidirectional and bidirectional. They are not the same as accuracy. Thus, a system may be very repeatable yet lack in accuracy. The distinction between accuracy and repeatability is illustrated in the figures below.



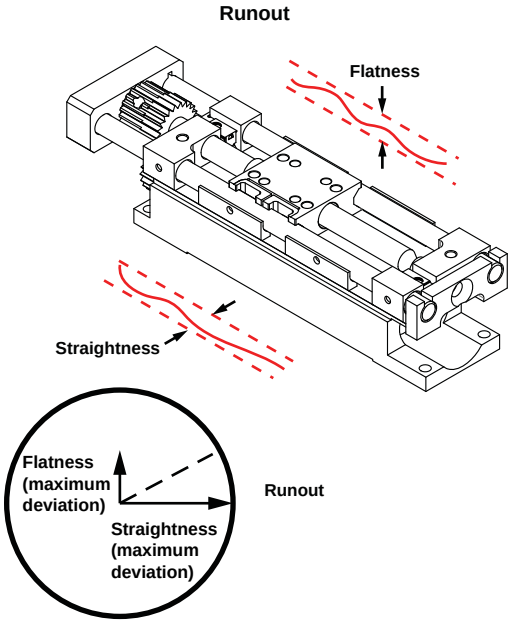
Return Force – Return force refers to manual stage preload spring force. It exhibits a maximum value at full compression and a minimum value at full extension positions of the slider. When a manual stage is mounted with the travel axis oriented vertically, these extreme values indicate what loads will remove the preload. The values correspond to the thumbscrew below the slider with the spring at full compression and the thumbscrew above the slider with the spring at full extension.

Roll (moment) Load – Roll load is the maximum torque sustainable (without deformation or associated motion error) when the force or center of gravity of a vertically applied load is laterally offset from the center of the slider mounting surface. The load therefore is applied at a lateral moment arm (distance) from the center of the mounting surface. The roll moment is computed as the product of the applied load and the lateral moment arm.

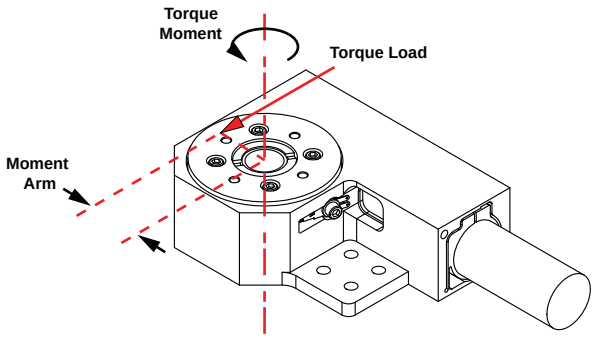


Rotor stall torque - The rotor stall torque corresponds to the stall (zero velocity) torque of the drive motor, modified by the gear ratios of the specific drive train connecting the motor to the rotor.

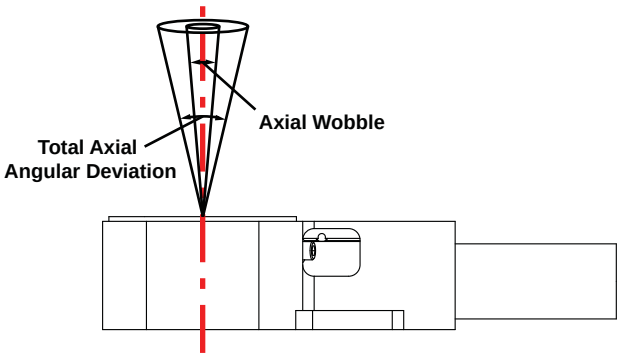
Runout – Runout pertains to the linear (as opposed to angular) portion of off-axis error present during slider translation. It is the maximum departure from desired, ideal straight line motion and consists of two orthogonal components, flatness and straightness. Runout is specified as the larger of the maxima of these two components.



Torque load – Torque load is the maximum torque sustainable (without deformation or associated motion error) when a force is applied tangentially to a rotary table (perpendicular to a radial from the center of rotation of a rotary table). The load therefore is applied at a moment arm (distance) from the table center of rotation. The torque moment is computed as the product of the applied load and the moment arm.

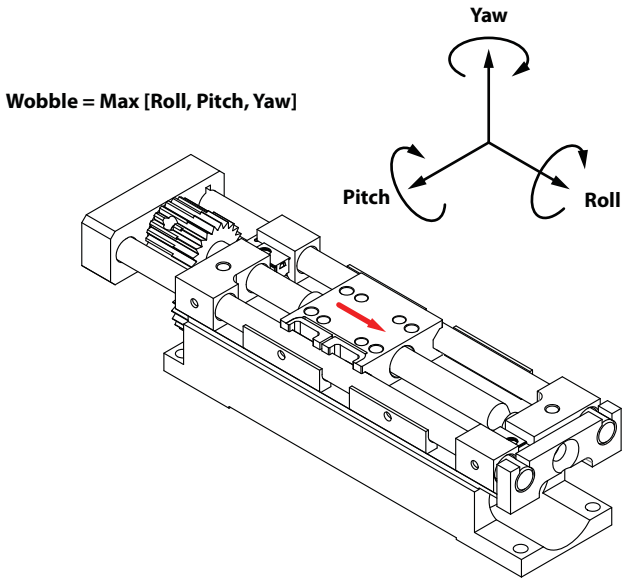


Total axial angular deviation – In addition to axial wobble, this includes non-repeatable (stochastic) axial deviation due to relative bearing motion and other mechanical contributions in the drive mechanism.



"Vacuum compatibility" – This refers to the ability of selected products to operate at 10^{-6} Torr pressure. This is achieved by selection of device materials and lubrication means that exhibit limited outgassing behavior.

Wobble (linear stage) – In the context of a linear stage, this refers to the larger of the maxima of slider roll, pitch, and yaw encountered during slider translation.



Yaw (moment) Load – Yaw load is the maximum torque sustainable (without deformation or associated motion error) when the force or center of gravity of a laterally applied load is longitudinally offset from the center of the slider mounting surface. The load therefore is applied at a longitudinal moment arm (distance) from the center of the mounting surface. The yaw moment is computed as the product of the applied load and the longitudinal moment arm.