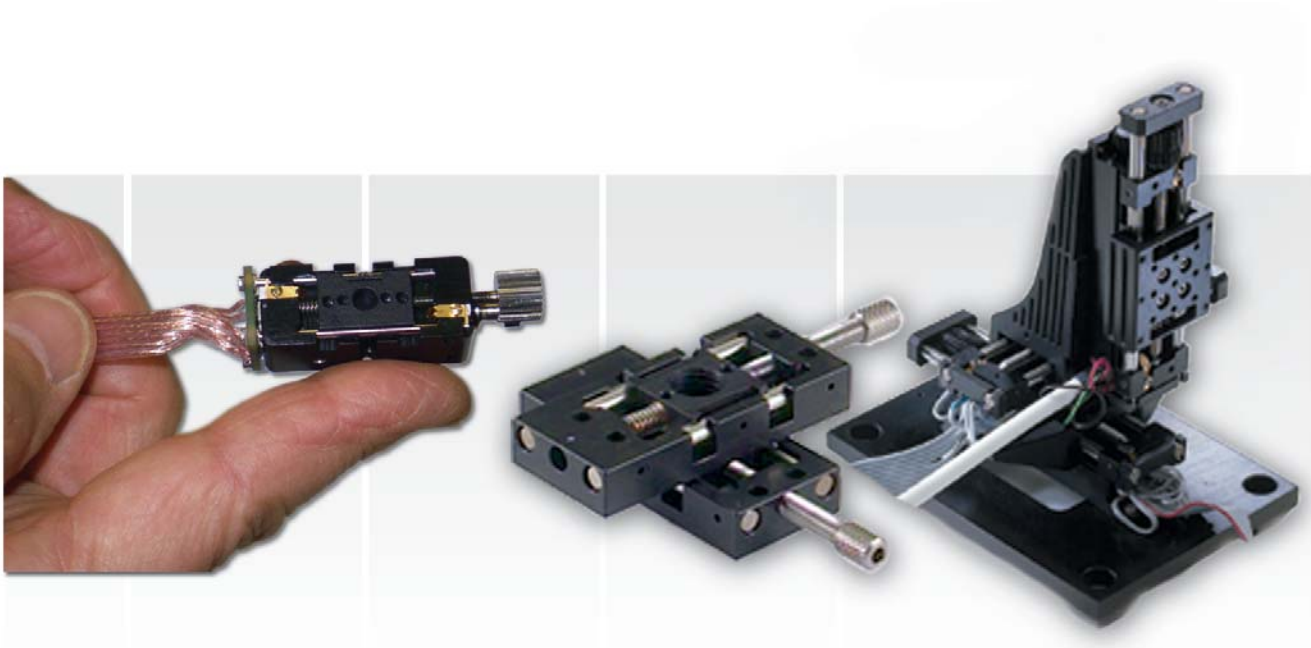


Motion Control Catalog



Miniature Positioners Motion Control Software

PLEASE CONTACT:

National Aperture, Inc.

Sales Department

TELEPHONE: (603) 893-7393, (800) 360-4598, Fax: (603) 893-7857

16 NORTHWESTERN DRIVE, SALEM, NH 03079-4810 • EMAIL: sales@naimotion.com • WEB SITE: <http://www.nationalaperture.com>

Constructible into **over 16 different configurations** (request 3 D Basic Construction Diagrams)

Specifications:

Wobble (max):	10 μ rad (2 arc-second) (no ball bearings)
Screw Pitch:	80 TPI
Sensitivity:	0.5 μ m
Backlash:	0
Load Capacity:	
Direct top or side load:	0.25 kg
Push:	0.05 kg
Retract ext-comp.:	See return force below
Tilt:	3.0 inch-ounce (210 gram-centimeter)
Twist:	1.5 inch-ounce (105 gram-centimeter)



Model No.	Travel	Runout (maximum)	Return Force (extension-compression)	Weight
MM-1	3.175mm	1.0 μ m	113 - 312g	3.0g
MM-1-CR	3.175mm	1.0 μ m	113 - 312g	4.0g
MM-1-EX	5.715mm	1.5 μ m	170 - 510g	2.5g

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

Model No.	-X Single Stage	-XY (2-axis)	-XYZ (3-axis)
MM-1	26.2 x 11.2 x 5.1 (mm)	26.2 x 26.2 x 10.2 (mm)	26.2 x 26.2 x 36.3 (mm)
	1.03 x 0.44 x 0.20 (inch)	1.03 x 1.03 x 0.40 (inch)	1.03 x 1.03 x 1.43 (inch)
MM-1-CR	26.2 x 14.2 x 5.1 (mm)	26.2 x 26.2 x 10.2 (mm)	26.2 x 26.2 x 36.3 (mm)
	1.03 x 0.56 x 0.20 (inch)	1.03 x 1.03 x 0.40 (inch)	1.03 x 1.03 x 1.43 (inch)
MM-1-EX	26.2 x 11.2 x 5.1 (mm)	26.2 x 26.2 x 10.2 (mm)	
	1.03 x 0.44 x 0.20 (inch)	1.03 x 1.03 x 0.40 (inch)	

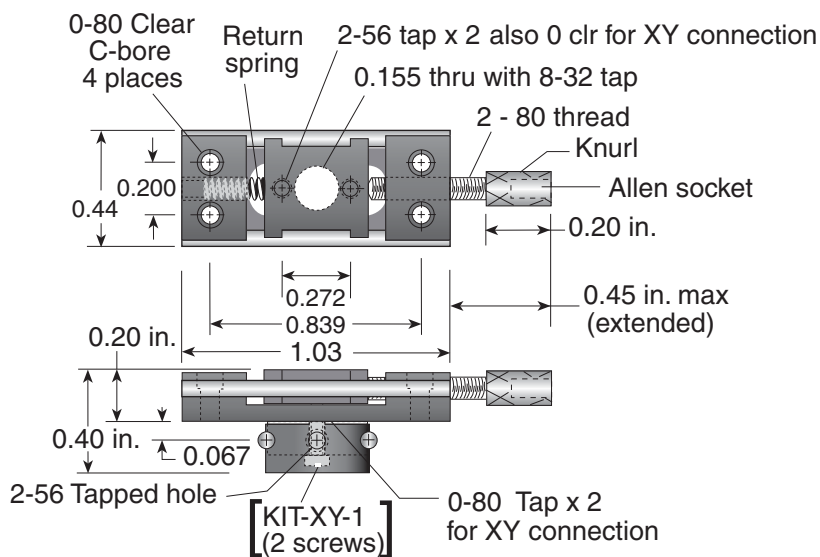
- XZ configurations available
- CR, -EX, and -090 versions may be combined
- Z axis must be a stage with Z connection enabled

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-1 Manual Stage

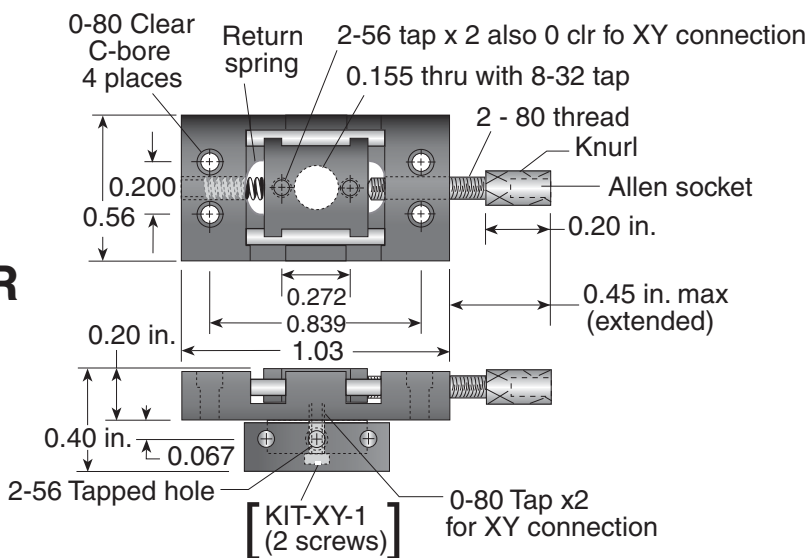
Dimensional Data

MM-1



Totally Metric Compatible

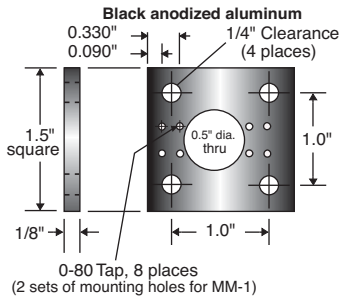
MM-1-CR



Totally Metric Compatible

Accessories

- AP4-1** Adapter Plate
- KIT-XY-1** MM-1-XY connection Screw Kit.
- KIT-Z-1** Z-Brace and Screw Kit
- PA-1** Pinhole Adapter
- SS-1** Headless Adjusting Lead Screw
- TG-1** Thumb Grip

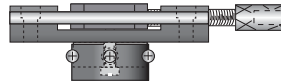


AP4-1, Adapter Plate

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

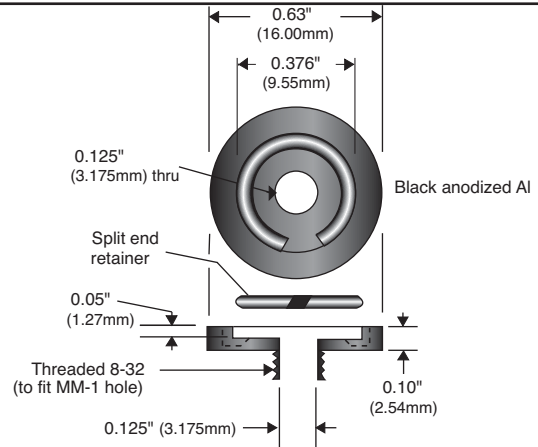
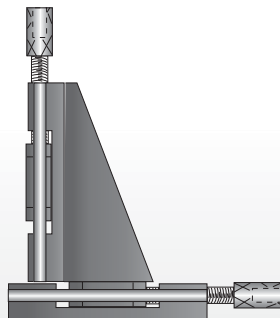
KIT-XY-1, Screw Kit

Contains two, 0-80 connecting screws utilizing two tap clearance holes in slider to connect two MM1 stages into an XY configuration.



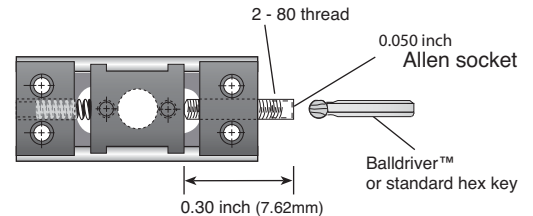
KIT-Z-1, Z-Brace and Screw Kit

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.



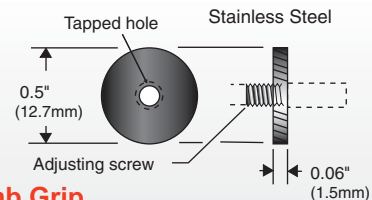
PA-1, Pinhole Adapter

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. [For use with standard 0.375 inch. (9.525mm) diameter substrates, or smaller.]



SS-1, Headless Adjusting Lead Screw

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



TG-1, Thumb Grip

The knurled 0.5 inch (12.7mm) diameter adjustment ring provides increased sensitivity. The TG-1 can be added to the standard MM-1 adjusting screw and may alternately be used as a locking nut.

Specifications:

Sensitivity:	75 μ rad
Fine Adjustment Range	17°
Coarse Adjust:	360° continuous
Thrust (centerline):	8 ounce
Radial Load:	6 ounce
Torque:	1 inch-ounce
Moment Load:	1.5 inch-ounce



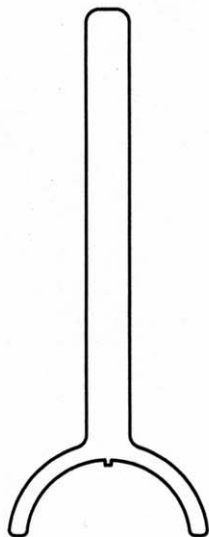
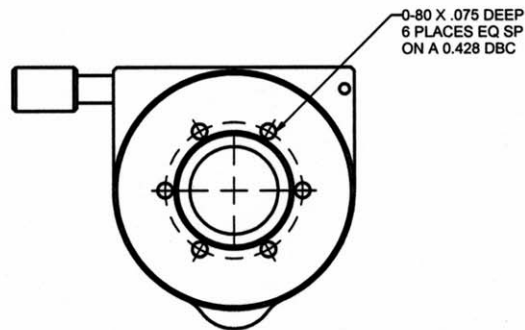
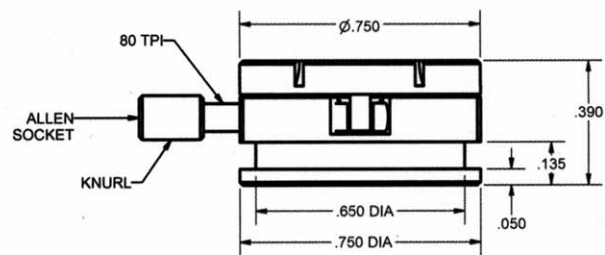
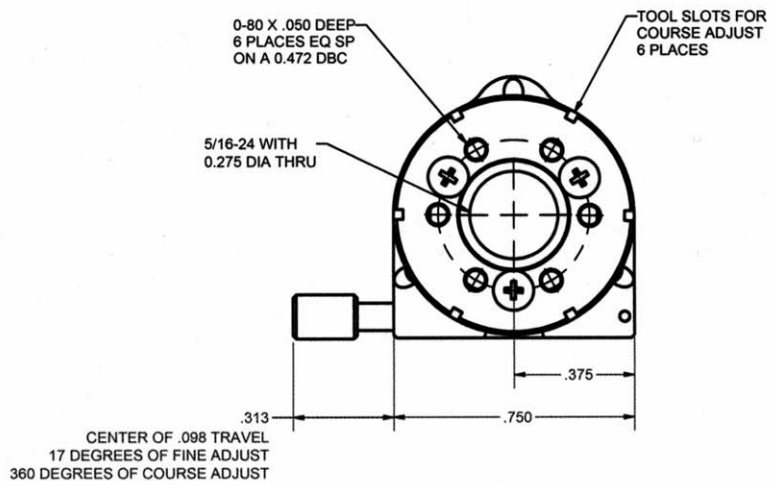
Special Features:

- Micro-miniature 360 degree Manual Rotary Stage
- Coarse (360 degree) and fine (17 degree) adjustment in either direction
- Coarse adjusting tool included with purchase
- 0.750 inch Rotating Table
- 5/16 -24 (0.275mm) thru-hole
- Accepts the optional PA-3 pinhole adaptor or your own mount
- 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.
- Use the Thumb Grip or insert a hex wrench into the Thumb Grip's shaft for simpler control in tight spaces.
- Vacuum compatible option available
- Black anodized stage body protects from damage and corrosion
- Stainless steel Thumb Screw for durability

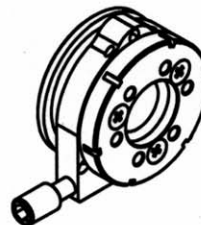
Note: There are six 0-80 holes spaced 0.428 inch apart in the base of the MM1-R. This matches the 0.428 spacing in all the Manual MM3 Linear stage family. This allows the MM1-R to be mounted directly to any Manual MM3 with two 0-80 screws.

MM-1R Manual Rotary Stage

Dimensional Data



COURSE ADJUSTMENT TOOL



MM1-R

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.

National Aperture, Inc. - 16 Northwestern Dr. - Salem, N.H. 03079-4810 - Tel. (800) 360-4598 - (603) 893-7393 - FAX (603) 893-7857 - www.nationalaperture.com/www.naimotion.com

Specifications:

Wobble (max):	0.01 mrad
Screw Pitch:	80 TPI
Sensitivity:	0.5µm
Backlash:	0 (no ball bearings)
Load Capacity:	
Direct top or side load:	0.34 kg
Push:	1 kg
Retract ext-comp.:	See return force as specified below
Tilt:	6 inch-ounce (420 gram-centimeter)
Twist:	3 inch-ounce (210 gram-centimeter)



Model Number	Travel	Runout (maximum)	Return Force (extension-compression)	Weight
MM-3	0.5 inch (12.7mm)	1.5µm	6-20oz (170-567g)	16g
MM-3-CR	0.5 inch (12.7mm)	1.5µm	6-20oz (170-567g)	20g

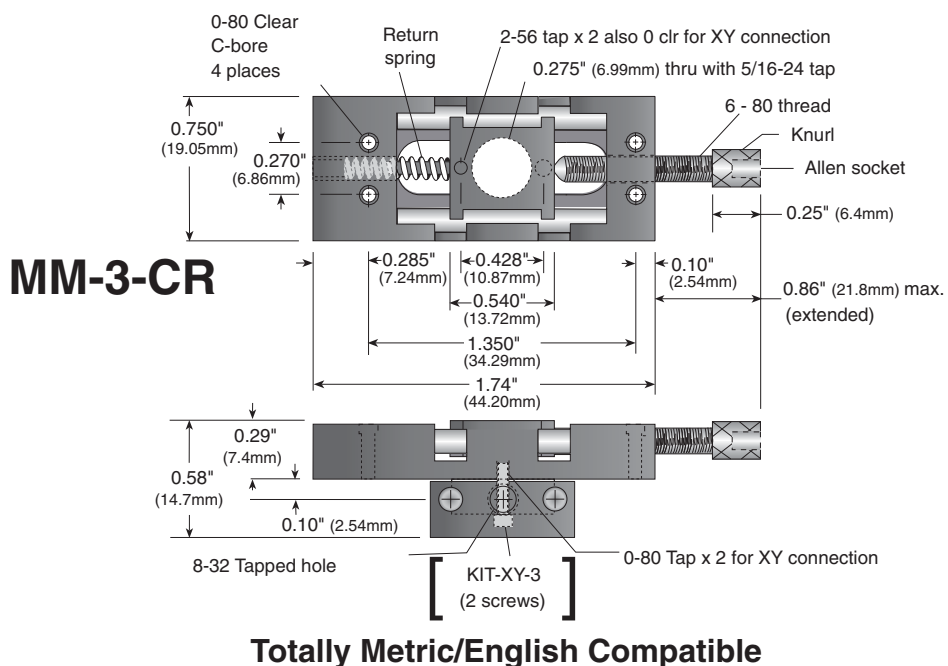
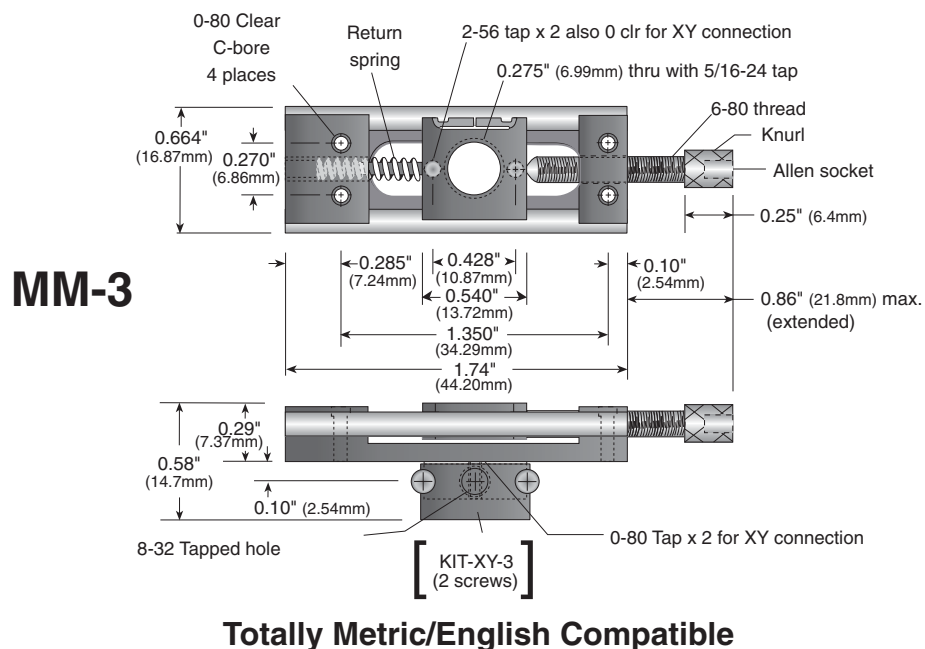
Dimensions:(L x W x H, not including lead screw extension)

Model No.	-X Single Stage	-XY (2-axis)	-XYZ (3-axis)
MM-3	44.2 x 16.8 x 7.4 (mm)	44.2 x 44.2 x 14.7 (mm)	44.2 x 44.2 x 58.9 (mm)
	1.74 x 0.66 x 0.29 (inch)	1.74 x 1.74 x 0.58 (inch)	1.74 x 1.74 x 2.32 (inch)
MM-3-CR	44.2 x 19.05 x 7.4 (mm)	44.2 x 44.2 x 14.7 (mm)	44.2 x 44.2 x 58.9 (mm)
	1.74 x 0.75 x 0.29 (inch)	1.74 x 1.74 x 0.58 (inch)	1.74 x 1.74 x 2.32 (inch)

- XZ configurations available
- Both Styles of MM-3 may be combined
- Compatible with all MM-3M motor stages
- **Fully metric compatible (all taps and clearance holes)**

MM-3 Manual Stage

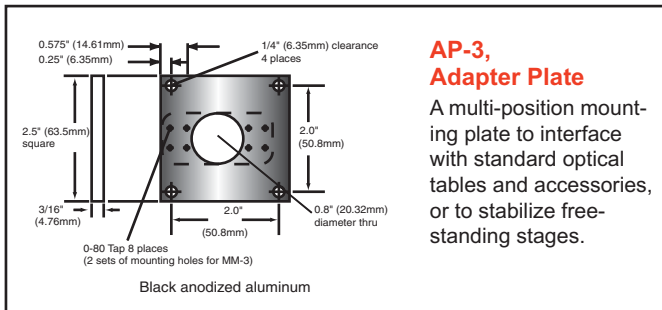
Dimensional Data



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.

Accessories

- AP-3 Adapter Plate
- KIT-XY-3 MM-1-XY connection screw kit.
- KIT-Z-3 MM-1-Z Connection with screws.
- OA-3 Objective Adapter
- PA-3 Pinhole Adapter
- SS-3 Headless Adjusting Screw
- TG-3 Thumb Grip
- ATK Assembly and Mounting Tool Kit
- JIG-XYZ-3 Alignment Fixture for 2-3 Axis System
- MM-3-MICROMETER . . . Micrometer Head

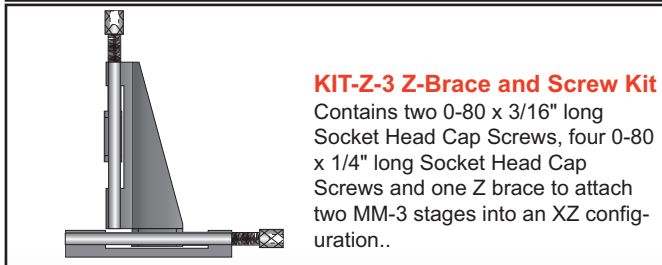


AP-3, Adapter Plate
A multi-position mounting plate to interface with standard optical tables and accessories, or to stabilize free-standing stages.

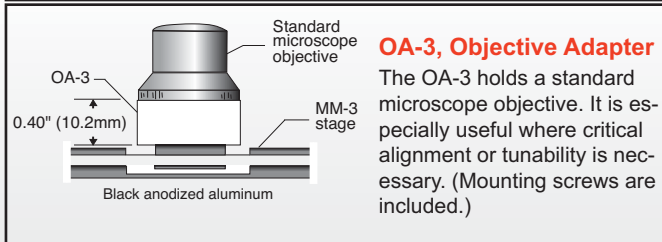
Black anodized aluminum



KIT-XY-3, Screw Kit
Utilizes 2 tap holes in slider as clearance for 0-80 connecting screws

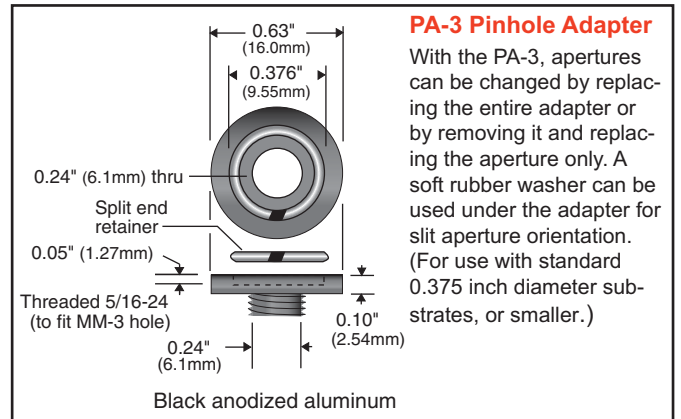


KIT-Z-3 Z-Brace and Screw Kit
Contains two 0-80 x 3/16\"



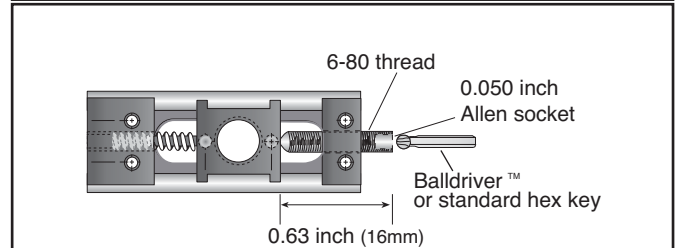
OA-3, Objective Adapter
The OA-3 holds a standard microscope objective. It is especially useful where critical alignment or tunability is necessary. (Mounting screws are included.)

Black anodized aluminum

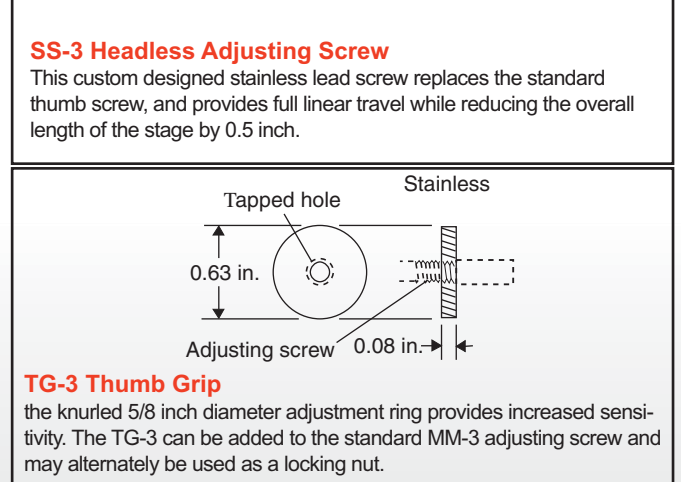


PA-3 Pinhole Adapter
With the PA-3, apertures can be changed by replacing the entire adapter or by removing it and replacing the aperture only. A soft rubber washer can be used under the adapter for slit aperture orientation. (For use with standard 0.375 inch diameter substrates, or smaller.)

Black anodized aluminum



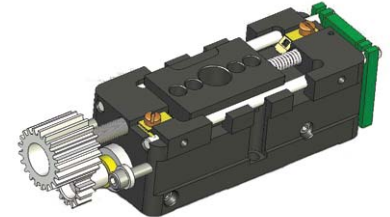
SS-3 Headless Adjusting Screw
This custom designed stainless lead screw replaces the standard thumb screw, and provides full linear travel while reducing the overall length of the stage by 0.5 inch.



TG-3 Thumb Grip
The knurled 5/8 inch diameter adjustment ring provides increased sensitivity. The TG-3 can be added to the standard MM-3 adjusting screw and may alternately be used as a locking nut.

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.

Specifications:



*Repeatability:	±2µm
*Homing Repeatability:	±2µm
*Accuracy (linearity):	±3µm
Speed (max.):	1.17mm/second @ 4.5 V with 64:1 gearhead
Slider Backlash:	<10µm
Encoder Conversion (resolution):	0.01654µm per count with 64:1 gearhead

*Encoder resolution must be added based on the gearhead: 16:1 add ±0.5µm, 64:1 add ±0.12µm

Wobble (max.):	0.01 mrad (~2 arc-second) (No ball bearings)
Runout (max.):	0.002 mm
Gearhead Backlash:	≤2.65 µm equivalent; can be compensated in software without overshoot
Motor:	6 mm diameter, 4.5 VDC servo, brush type (see motor specifications)
Vacuum compatibility:	TBD

Load Capacity:

*Direct top or side load:	0.25 kg (0.55 lb)
*Push:	0.5 kg (1.10 lb)
**Return Force ext-comp.:	5 ounce-23 ounce (1.39 gram - 6.39 gram)
*Tilt:	3 inch-ounce (2100 gram-centimeter)
*Twist:	1.5 inch-ounce (105 gram-centimeter)

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

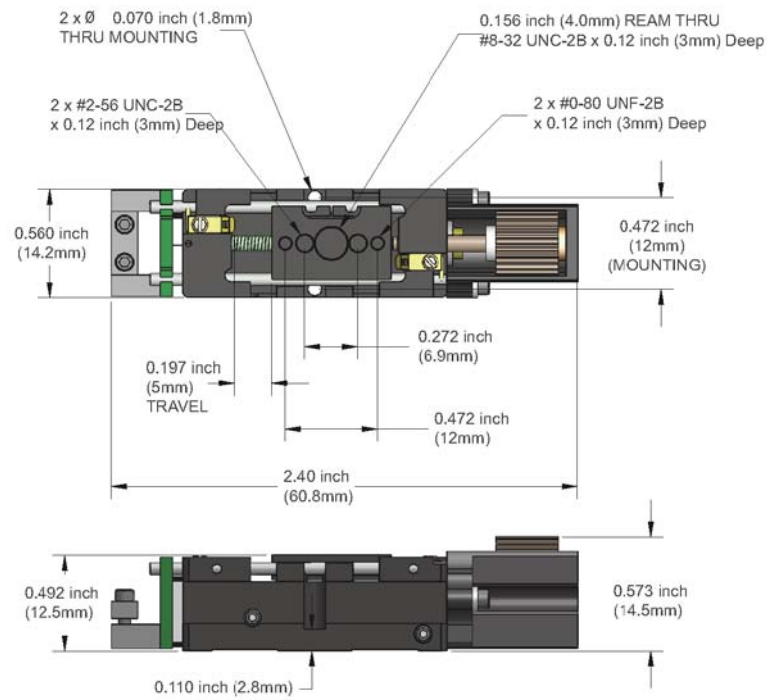
**Retract is limited by the preload spring.

Travel Ranges and Dimensions:

Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-1M	0.197 inch	4.48 x 0.75 x 0.36 (inch)	1 ounce
	5mm	113.8 x 19.05 x 9.14 (mm)	28 grams

MM-1M Motorized Stage

Dimensional Data



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.

Specifications:



*Repeatability:	±2µm
*Homing Repeatability:	±2µm
*Accuracy (linearity):	±3µm
Speed (max.):	1.65mm/second @ 12 V with 64:1 gearhead
Slider Backlash:	0 (spring preloaded)
Encoder Conversion (resolution):	0.12406µm per count with 64:1 gearhead (16:1, 64:1, 256:1, 1024:1 gearheads optional)

**Encoder resolution must be added based on the gearhead: 16:1 add ±0.5µm, 64:1 add ±0.12µm*

Wobble (max.):	0.02 mrad (~4 arc-second)
Runout (max.):	0.002 mm
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)
Vacuum compatibility:	10 ⁻³ Torr, standard, 10 ⁻⁶ Torr available

Load Capacity:

*Direct top or side load:	0.34 kg
*Push:	0.50 kg
**Retract ext-comp.:	2 ounce-24 ounce (57gram - 680 gram)
*Tilt:	6 inch-ounce (420 gram-centimeter)
*Twist:	3 inch-ounce (210 gram-centimeter)

**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:

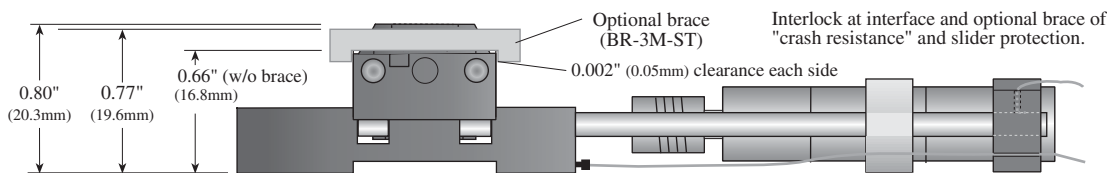
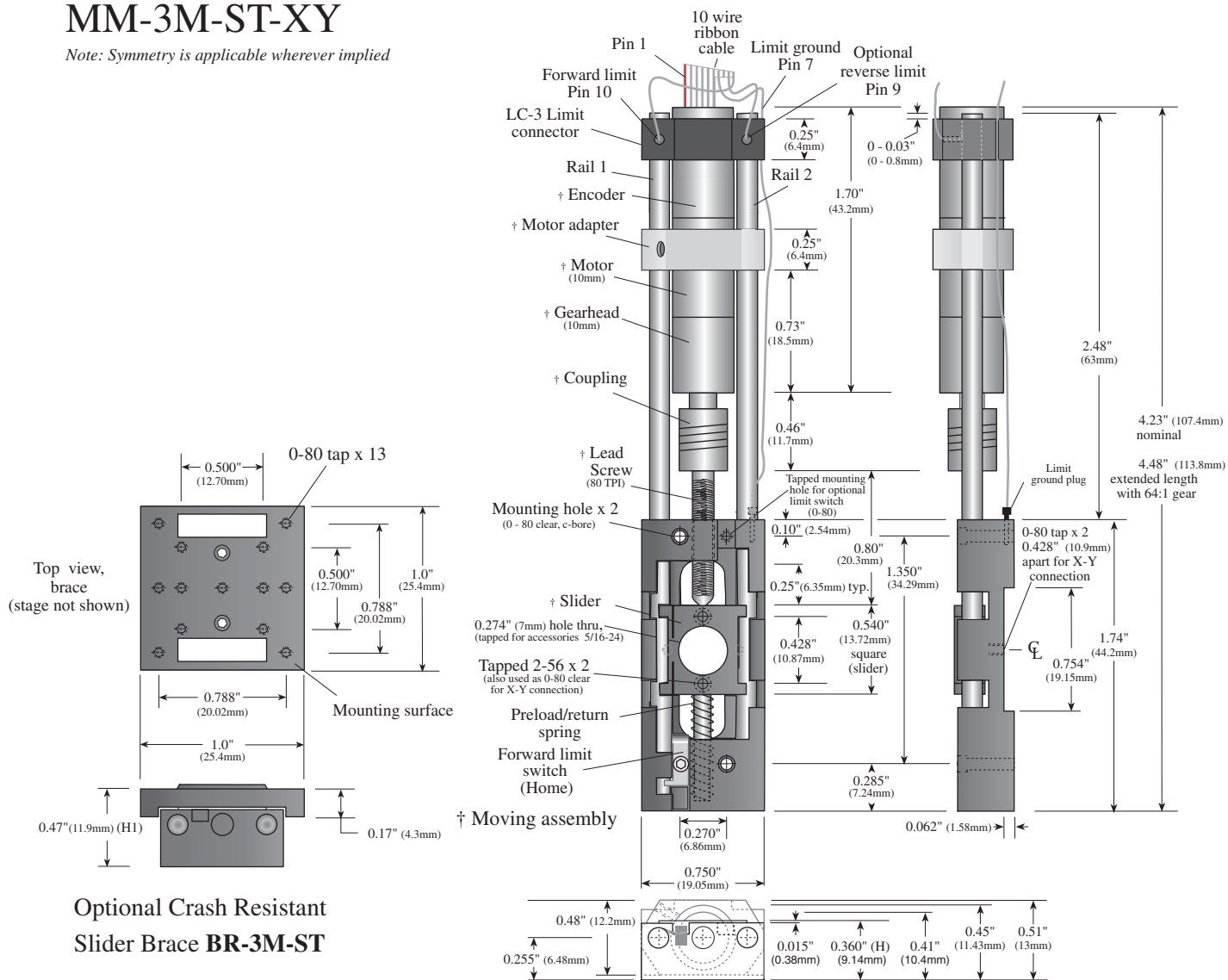
Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-3M-ST	0.5 inch	4.48 x 0.75 x 0.36 (inch)	50g
	12.7mm	113.8 x 19.05 x 9.14 (mm)	50g
MM-3M-ST-XY	0.5 inch	4.48 x 4.48 x 0.66 (inch)	100g
	12.7mm	113.8 x 113.8 x 18.28 (mm)	100g

Standard **MM-3M-ST** Motorized MicroMini™ Stage - 0.5 inch (12.7mm) Travel

Dimensional Data

MM-3M-ST-XY

Note: Symmetry is applicable wherever implied



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-F

Folded Motorized
MicroMini™ Stages



Specifications:

	Standard Slider	AB Slider (anti-backlash)
*Repeatability:	±2µm	±0.5µm
*Homing Repeatability:	±2µm	±0.5µm
*Accuracy (linearity):	±3µm/inch	±1.5µm/inch
Speed (max.):	12mm/second @ 12V	1.65mm/second @ 12V
†Slider Backlash:	50µm	3µm
Encoder Conversion (resolution):	0.49609µm/count	0.12406µm/count
(See also: gearhead options)	with 16:1 gearhead	with 64:1 gearhead

*Encoder resolution must be added, based on the gearhead: 16:1 add ± 0.5µm, 64:1 add ±0.12 µm

†Slider backlash represents maximum overshoot

Runout (max.):	3µm/25.4mm
Gearhead Backlash:	1-2µm equivalent; can be compensated in software without overshoot
Motor:	10 mm diameter, 6-12 VDC servo, brush type (see motor specifications)
Vacuum compatibility:	10 ⁻³ Torr, standard, 10 ⁻⁶ Torr available
Load Capacity:	
Direct top or side load:	0.5 kg
Push:	0.5 kg
Pull:	0.5 kg
Tilt:	8 inch-ounce (560 gram-centimeter)
Twist:	4 inch-ounce (280 gram-centimeter)

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-0.5	12.7mm (0.5 inch)	58.9 x 19.1 x 16.3 (mm)	53g
		2.32 x 0.75 x 0.64 (inch)	53g
MM-3M-F-1	25.4mm (1.0 inch)	71.6 x 19.1 x 16.3 (mm)	58g
		2.82 x 0.75 x 0.64 (inch)	58g
MM-3M-F-1.5	38.1mm (1.5 inch)	84.3 x 19.1 x 16.3 (mm)	63g
		3.32 x 0.75 x 0.64 (inch)	63g
MM-3M-F-2	50.8mm (2.0 inch)	97.0 x 19.1 x 16.3 (mm)	68g
		3.82 x 0.75 x 0.64 (inch)	68g
MM-3M-F-2.5	63.5mm (2.5 inch)	109.7 x 19.1 x 16.3 (mm)	73g
		4.32 x 0.75 x 0.64 (inch)	73g

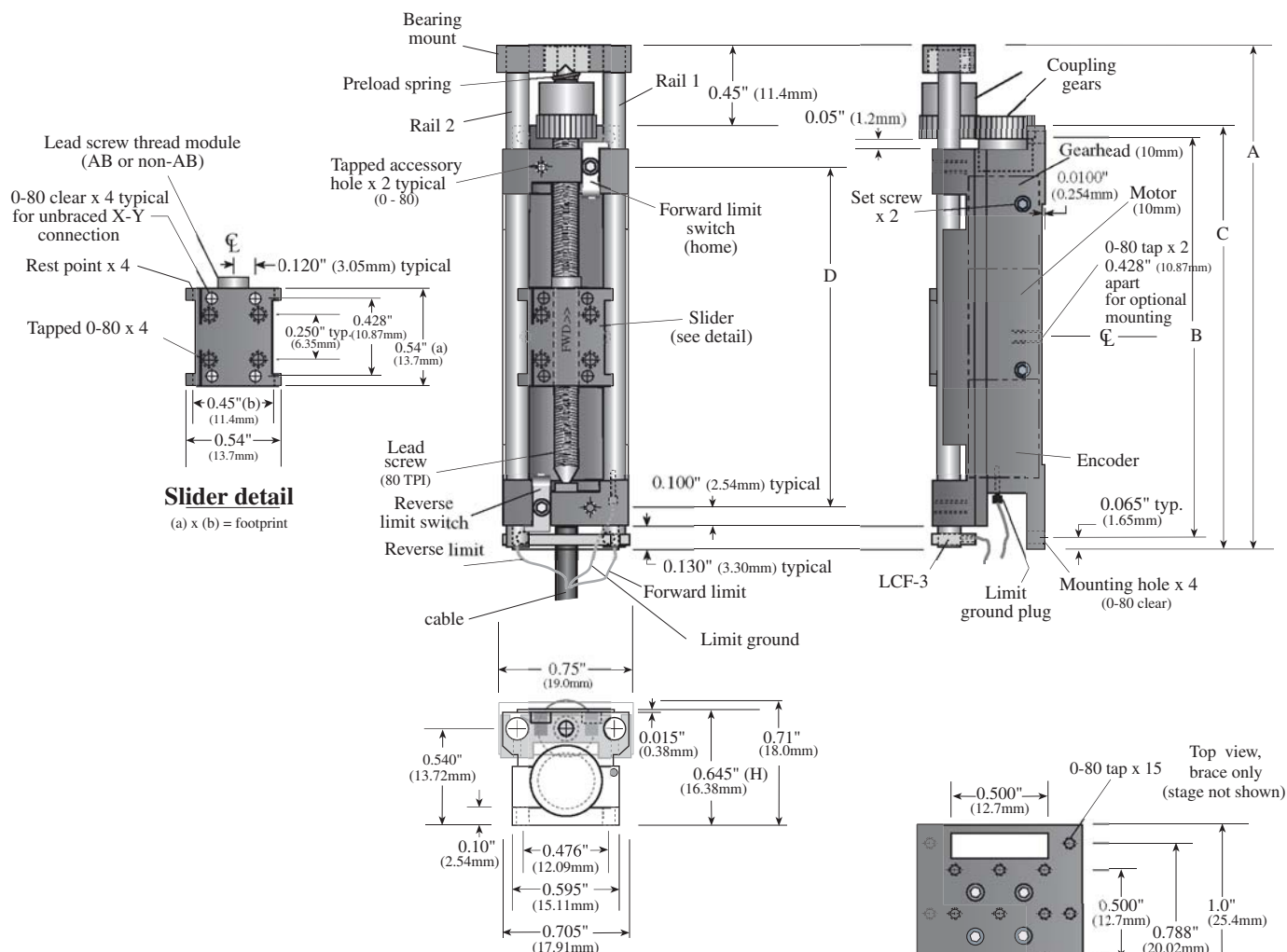
x, xy, xyz, xz configurations available

Specify -AB for Anti-Backlash

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.

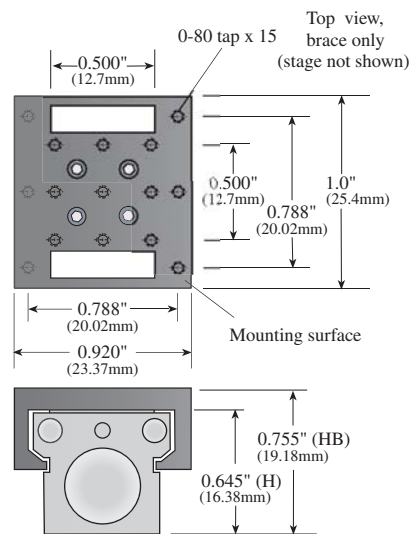
Folded **MM-3M-F** Motorized MicroMini™ Stage - 0.5 to 2.5 inch Travel

Dimensional Data



Note: Symmetry is applicable wherever implied

T (Travel)	A	B	C	D	
MM-3M-F-0.5	0.5 inch 12.7mm	2.32 58.9	1.730 43.94	1.86 47.2	1.400 35.56
MM-3M-F-1.0	1.0 inch 25.4mm	2.82 71.6	2.230 56.64	2.36 59.9	1.900 48.26
MM-3M-F-1.5	1.5 inch 38.1mm	3.32 84.3	2.730 69.34	2.86 72.6	2.400 60.96
MM-3M-F-2.0	2.0 inch 50.8 mm	3.82 97.0	3.230 82.04	3.36 85.3	2.900 73.66
MM-3M-F-2.5	2.5 inch 63.5 mm	4.32 109.7	3.730 94.74	3.86 98.0	3.400 86.36



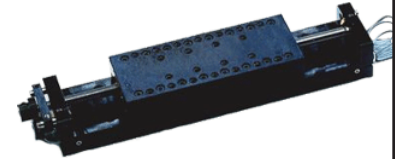
Note: Single axis brace is essential where attachments are vulnerable to crash.

BR-3M-X Optional Crash-resistant Slider Brace

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-F

Folded Motorized
MicroMini™ Stages
(For heavier loads)



Specifications:

*Repeatability:	±0.5µm
*Homing Repeatability:	±0.5µm
*Accuracy (linearity):	±1.0µm per 25mm of travel
Straightness:	±2.0µm maximum deviation per 50mm of travel
Speed (max.):	1.65mm/second @ 12 V with 64:1 gearhead
†Slider Backlash:	1µm
Gearhead Backlash:	<2.54µm; can be compensated in software without overshoot
Encoder Conversion(resolution):	0.49609µm per count, with 16:1 gearhead

*Encoder resolution must be added, based on the gearhead: 16:1 add ±0.0005mm, 64:1 add ±0.00012mm

†Slider backlash represents maximum overshoot

Motor:	10mm diameter, 6-12 VDC servo, brush type
Slide:	Cross roller bearing
Vacuum Compatibility:	10 ⁻³ Torr, standard, 10 ⁻⁶ Torr available
Load Capacity:	
Horizontal:	3.0 kg
Vertical:	1.0 kg
Side:	1.5 kg

Travel Ranges and Dimensions:

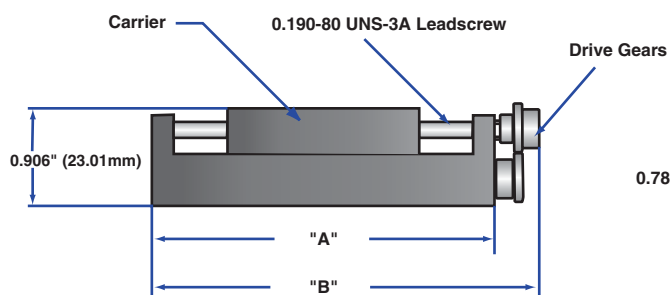
Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-4M-F-25	25mm	97 x 31.5 x 23 (mm)	165g
		3.82 x 1.24 x 0.905 (inch)	165g
MM-4M-F-50	50mm	162 x 31.5 x 23 (mm)	246g
		6.38 x 1.24 x 0.905 (inch)	246g

x, xy, xyz, xz configurations available

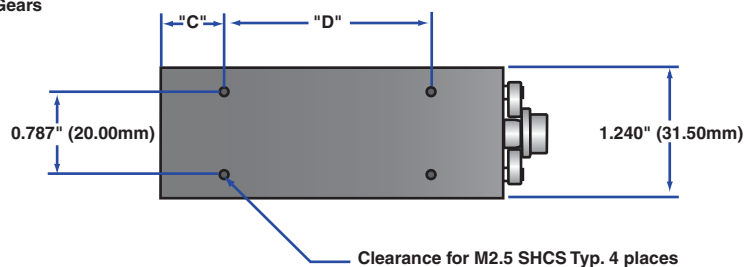
MM-4M-F Motor Stage 25mm & 50mm Travel

Dimensional Data

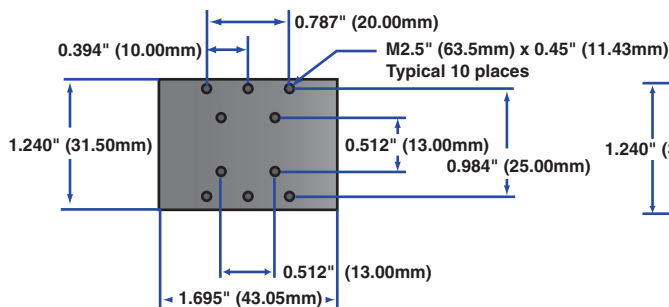
Tabulated Data for MM-4M-F Stages				
Travel	"A"	"B"	"C"	"D"
25mm	3.255" (82.68mm)	3.795" (96.39mm)	0.643" (16.34mm)	1.969" (50.00mm)
50mm	5.830" (148.02mm)	6.370" (161.80mm)	0.946" (24.04mm)	3.937" (100.00mm)



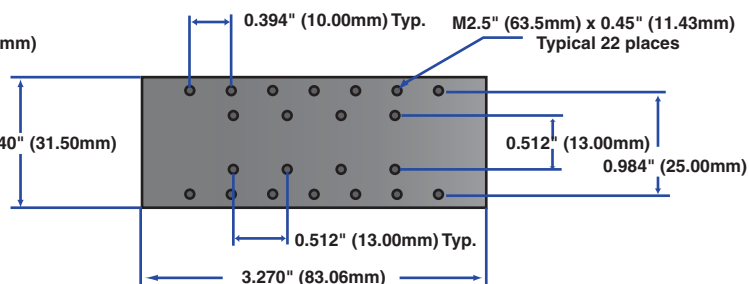
Side View



Bottom View



**25mm Carrier
Top View**



**50mm Carrier
Top View**



Specifications:

	Standard Slider
*Repeatability:	4µm + 1 count
*Homing Repeatability:	4µm + 1 count
*Accuracy (linearity):	6µm/inch + 1 count
Speed, no load (max.):	6mm/second
†Slider Backlash:	<50µm
Encoder Conversion (resolution):	0.49609µm per count with 16:1 gearhead (See also: gearhead options)

*Encoder resolution must be added based on the gearhead: 16:1 add ± 0.5µm, 64:1 add ±0.12 µm

†Slider backlash represents maximum overshoot

Runout (max.):	3µm/25.4mm (1 inch)
Gearhead Backlash:	1-2µm equivalent; can be compensated in software without overshoot
Motor:	10 mm diameter, 6-12 VDC servo, brush type (see motor specifications)
Vacuum Compatibility:	10 ⁻³ Torr, standard
Load Capacity:	
Direct Top Load	17.6 ounce (0.5 kg)
Push:	8.8 ounce (0.25 kg)
Pull:	8.8 ounce (0.25 kg)
Roll:	8 inch-ounce (576 gram-centimeter)
Pitch:	4 inch-ounce (288 gram-centimeter)
Yaw:	4 inch-ounce (288 gram-centimeter)

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

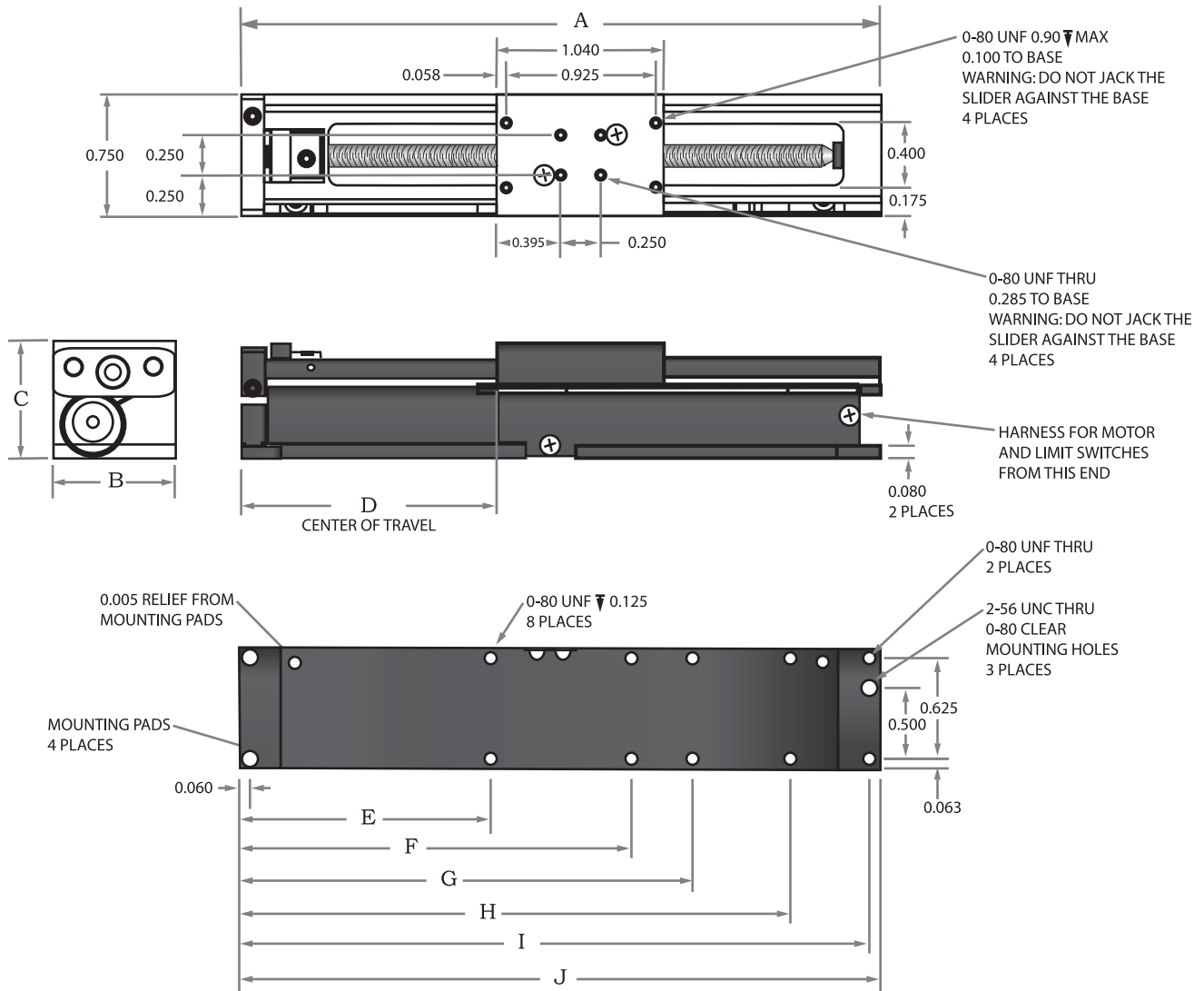
Travel Ranges and Dimensions:

Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-3M-FOS-2.0	50.8mm (2.0 inch)	88.14 x 19.1 x 18.54 (mm)	66g
		3.47 x 0.75 x 0.73 (inch)	66g
MM-3M-FOS-2.5	63.5mm (2.5 inch)	100.8 x 19.1 x 18.54 (mm)	72g
		3.97 x 0.75 x 0.73 (inch)	72g

*Additional sizes ranging from 0.75 to 4.0 inches are available upon request
All sizes are available in xy configuration*

Folded **MM-3M-FOS** Motorized MicroMini Stage™ 0.75 to 4 inch Travel

Dimensional Data



	A	B	C	D	E	F	G	H	I	J
MM-3M-FOS-2.0	3.470	0.750	0.730	1.410	1.305	1.930	2.555	2.915	3.410	3.470
MM-3M-FOS-2.5	3.970	0.750	0.730	1.594	1.555	2.430	2.805	3.415	3.910	3.970

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-EX

Extended Motorized
MicroMini™ Stages
(For extended travel)



Specifications:

	Standard Slider	AB Slider (anti-backlash)
*Repeatability:	±2µm	±0.5µm
*Homing Repeatability:	±2µm	±0.5µm
*Accuracy (linearity):	±3µm	±1.5µm
Speed, no load (max.):	12mm/second @ 12V	3mm/second @ 12V
†Slider Backlash:	50µm	3µm
Encoder Conversion (resolution):	0.49609µm per count	0.12406µm per count
(See also: gearhead options)	with 16:1 gearhead	with 64:1 gearhead

*Encoder resolution must be added, based on the gearhead: 16:1 add ± 0.5µm, 64:1 add ±0.12 µm

†Slider backlash represents maximum overshoot

Runout (max.):	3µm/25.4mm (1 inch)
Gearhead Backlash:	1-2µm equivalent; can be compensated in software without overshoot
Motor:	10 mm diameter, 6-12 VDC servo, brush type (see motor specifications)
Wobble (max.):	0.02 mrad (~ 4 arc-second)
Vacuum compatibility:	10 ⁻³ Torr, standard, 10 ⁻⁶ Torr available
Load Capacity:	
Direct top or side load:	0.5 kg
Push:	0.5 kg
Pull:	0.5 kg
Tilt:	8 inch-ounce (560 gram-centimeter)
Twist:	4 inch-ounce (280 gram-centimeter)

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:

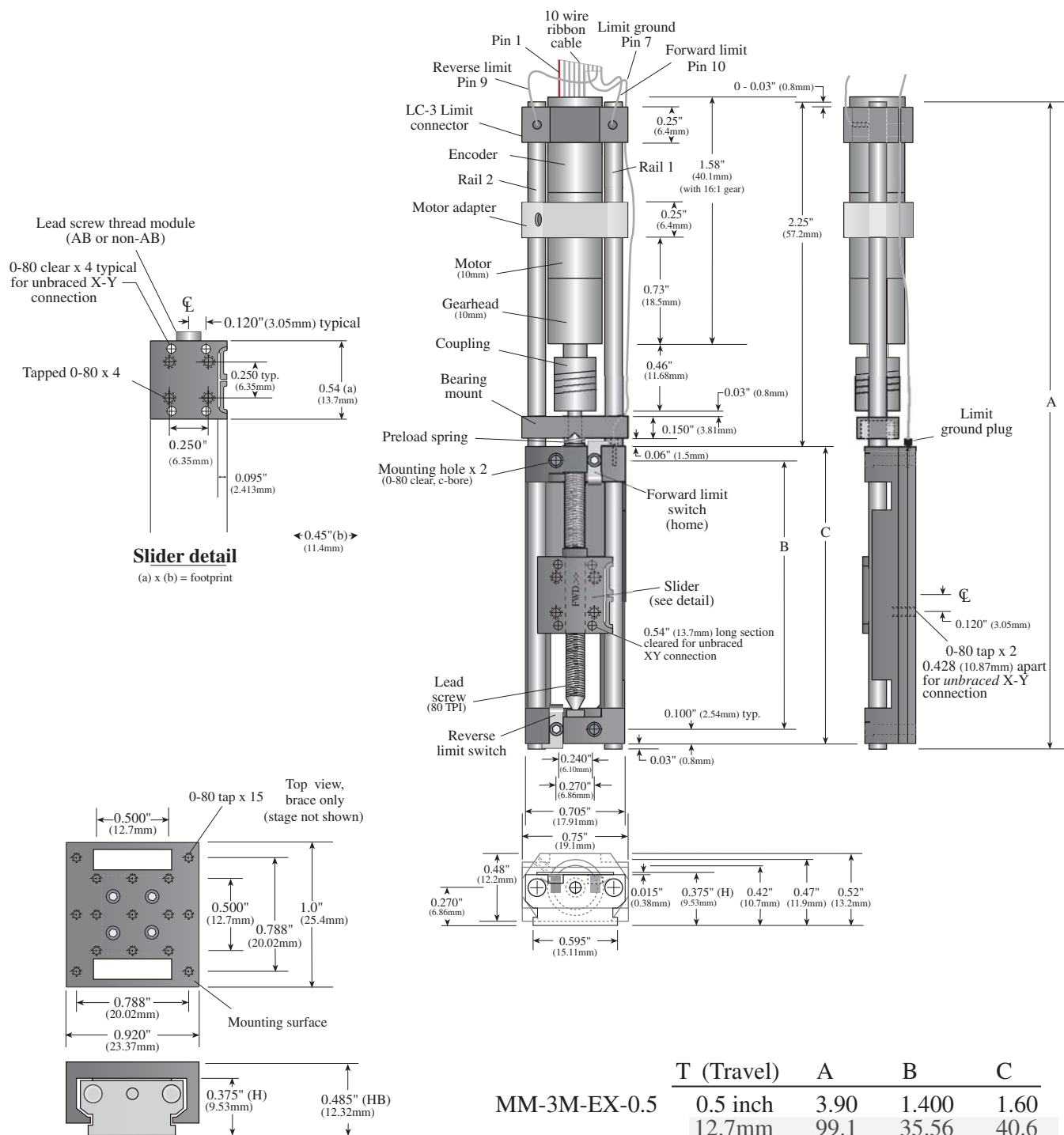
Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-3M-EX-0.5	12.7mm	99.1 x 19.1 x 9.1 (mm)	53g
	0.5 inch	3.90 x 0.75 x 0.36 (inch)	53g
MM-3M-EX-1	25.4mm	111.8 x 19.1 x 9.1 (mm)	58g
	1.0 inch	4.40 x 0.75 x 0.36 (inch)	58g
MM-3M-EX-1.5	38.1mm	124.5 x 19.1 x 9.1 (mm)	63g
	1.5 inch	4.90 x 0.75 x 0.36 (inch)	63g
MM-3M-EX-2	50.8 mm	137.2 x 19.1 x 9.1 (mm)	68g
	2.0 inch	5.40 x 0.75 x 0.36 (inch)	68g

Specify -AB for Anti-Backlash

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.

Folded **MM-3M-EX** Motorized MicroMini Stage™ - 0.5 to 2 inch Travel

Dimensional Data



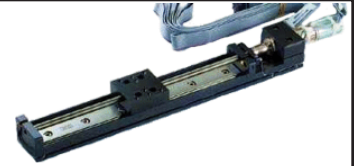
Note:
 Single axis brace is essential where attachments are vulnerable to crash.

BR-3M-X Optional Crash-resistant Slider Brace

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

Extended Motorized
MicroMini™ Stages
(For heavier loads)



Specifications:

*Repeatability:	±0.50 µm
*Homing Repeatability:	±0.50 µm
*Accuracy (linearity):	±1.00 µm per 25mm of travel
Straightness:	±2.00 µm maximum deviation per 50mm of travel
Speed, no load (max.):	7 mm/second @ 12V with 14:1 gearhead (other gearheads available)
†Slider Backlash:	1µm
Gearhead Backlash:	<2.54µm; can be compensated in software without overshoot
Encoder Conversion (resolution):	0.3595µm per count, with 14:1 gearhead

*Encoder resolution must be added, based on the gearhead: 16:1 add ±0.0005mm, 64:1 add ±0.00012mm

†Slider backlash represents maximum overshoot

Motor:	13 mm dia., 6-12 VDC servo, brush type
Slide:	Recirculating ball bearings with four point contact, hardened stainless steel rails
Vacuum compatibility:	10 ⁻³ Torr standard, 10 ⁻⁶ Torr available
Load Capacity:	
Horizontal:	3.0 kg
Vertical:	1.0 kg
Side:	1.0 kg

Travel Ranges and Dimensions:

Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-4M-EX-50	48 mm	138.68 x 31.5 x 25.4 (mm)	330g
	1.90 inch	5.46 x 1.24 x 1.0 (inch)	11.64oz
MM-4M-EX-80	78 mm	168.68 x 31.5 x 25.4 (mm)	345g
	3.07 inch	6.64 x 1.24 x 1.0 (inch)	12.49 oz
MM-4M-EX-110	108 mm	198.68 x 31.5 x 25.4 (mm)	360g
	4.25 inch	7.82 x 1.24 x 1.0 (inch)	12.70 oz
MM-4M-EX-140	138 mm	228.68 x 31.5 x 25.4 (mm)	375g
	5.43 inch	9.0 x 1.24 x 1.0 (inch)	13.23 oz
MM-4M-EX-170	168 mm	258.68 x 31.5 x 25.4 (mm)	390g
	6.61 inch	10.184 x 1.24 x 1.0 (inch)	13.76 oz
MM-4M-EX-200	198 mm	288.68 x 31.5 x 25.4 (mm)	405g
	7.79 inch	11.365 x 1.24 x 1.0 (inch)	14.29 oz
MM-4M-EX-230	228 mm	318.68 x 31.5 x 25.4 (mm)	420g
	8.97 inch	12.546 x 1.24 x 1.0 (inch)	14.82 oz
MM-4M-EX-260	258 mm	348.68 x 31.5 x 25.4 (mm)	435g
	10.15 inch	13.728 x 1.24 x 1.0 (inch)	15.35 oz

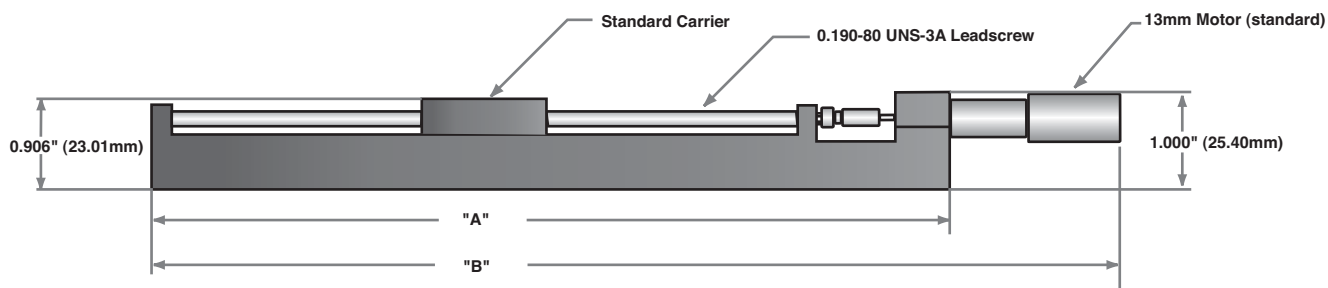
The information contained in this data sheet is subject to change without notice. Critical dimensions or specifications should be verified with our technical support staff.

MM-4M-EX Motor Stage

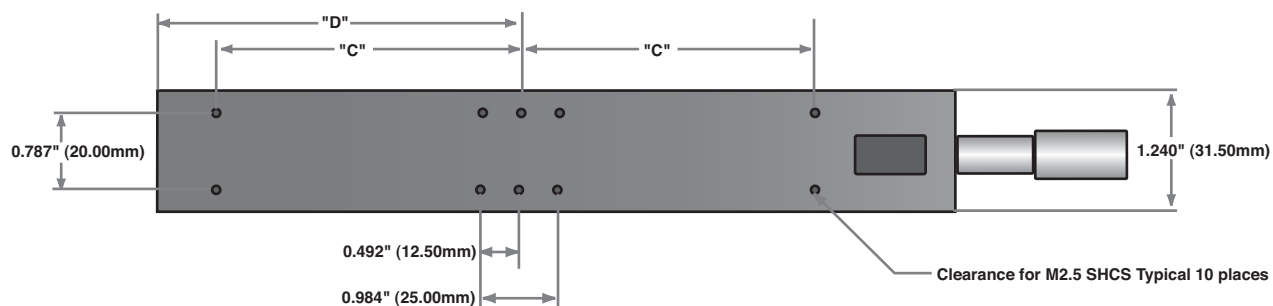
Dimensional Data

Tabulated Data for MM-4M-EX Stages

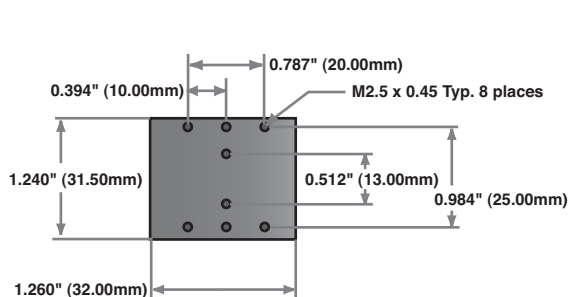
Travel	"A"	"B"	"C"	"D"
48mm	5.460" (138.68mm)	7.210" (183.13mm)	1.181" (30.00mm)	1.855" (47.12mm)
78mm	6.641" (168.68mm)	8.391" (213.13mm)	1.772" (45.00mm)	2.445" (62.12mm)
108mm	7.822" (198.68mm)	9.572" (243.13mm)	2.362" (60.00mm)	3.036" (77.12mm)
138mm	9.003" (228.68mm)	10.753" (273.13mm)	2.953" (75.00mm)	3.627" (92.12mm)
168mm	10.184" (258.68mm)	11.934" (303.13)	3.543" (90)	4.217" (107.12)
198mm	11.365" (288.68mm)	13.115" (333.13mm)	4.134" (105mm)	4.808" (122.12mm)
228mm	12.546" (318.68mm)	14.296" (363.13mm)	4.724" (120mm)	5.398" (137.12mm)
258mm	13.728" (348.68mm)	15.478" (393.13mm)	5.315" (135mm)	5.989" (152.12mm)



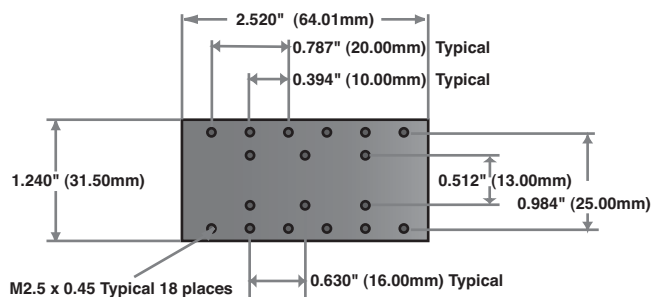
Side View



Bottom View



**Standard Carrier
Top View**



**Extended Carrier for dual Carriage Option
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-3M-R

Rotary Motorized
MicroMini™ Stages
(For lighter loads)



Specifications:

	MM-3M-R	MM-3M-RA	MM-3M-RA+
Repeatability:	15 arc-second*	same	same
Homing Repeatability:	60 arc-second*	same	same
Accuracy: (linearity)	80 arc-second*	same	same
A. Axial Wobble (axial angular long range repeatability)	60 arc-second	2 arc-second	2 arc-second
B. Axial angular deviation, total	60 arc-second	60 arc-second	2 arc-second
C. Planar shift, total	1.2 μm	0	0
D. Eccentricity (runout, including bearing mount)	3μm	3μm	3μm
(See diagram on reverse of this sheet for an illustration of A.,B.,C.,D.)			
Direct top load:	2 kg axial	0.5 kg axial	0.5 kg axial
Tilt Load	5 kg-cm (70 inch-ounce)	1.0 kg-cm (14 inch-ounce)	1.0 kg-cm (14 inch-ounce)
Torque load	850 g-cm (12 inch-ounce)	425g-cm (6 inch-ounce)	425g-cm (6 inch-ounce)
Gearhead Ratio: (see "Resolution Data Sheet")	64:1 (standard) 16:1	same	same
Speed: (low load)	4 RPM	16 RPM**	same
Encoder Conversion: (arc-second/count) (see gearhead ratios, "Resolution Data Sheet")	6.3281	25.3124	same
Gearhead Backlash:	~1 mrad†	~4 mrad†	same
Rotor Stall Torque:	200 inch-ounce††	50 inch-ounce††	same
Rotor Backlash: (preloaded)	0	same	same
Weight:	76g	same	same
Vacuum compatibility:	10 ⁻³ Torr, higher per request	same	same
Travel Range:	unlimited	same	same
Worm Ratio:	80:1	same	same
Stage Body Dimensions: (L x W x H)	2.86 x 1.43 x 0.59 (inch), 72.64 x 36.32 x 14.99 (mm)		
Motor:	10 mm diameter, 6-12 VDC servo, brush type (see motor specifications)		

*Encoder resolution must be added based on the gearhead: 64:1 add ±12 arc-sec 256:1 add ±3 arc-sec, 1024:1 add ±0.75 arc-sec (all approximated)

**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 gear ratio, and can be compensated in software without overshoot.

††Dependent upon gear ratio and worm ratio.

Note: The MM-3M stages are designed for peak performance at low loads: ex; 60g, less than 2 inch (50.8mm) off axis.

- Special Features:**
- Dual class 7 custom bearings for MM-3M-R
 - Single class 7 custom bearing for MM-3M-RA & RA Plus
 - Multi-faceted connection interface
 - Many other gearhead options
 - Homing Switch

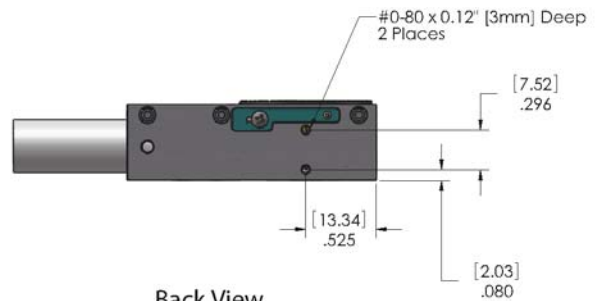
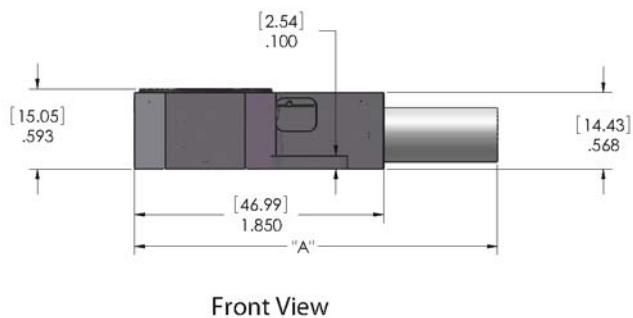
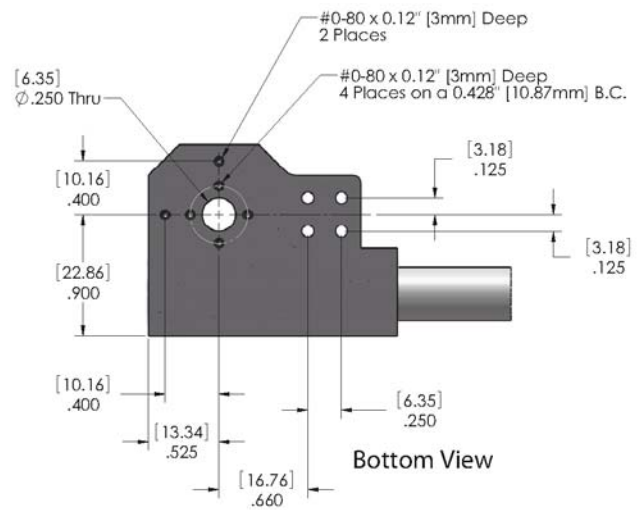
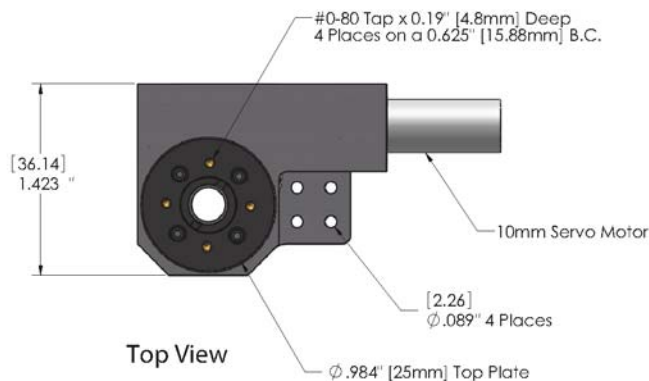
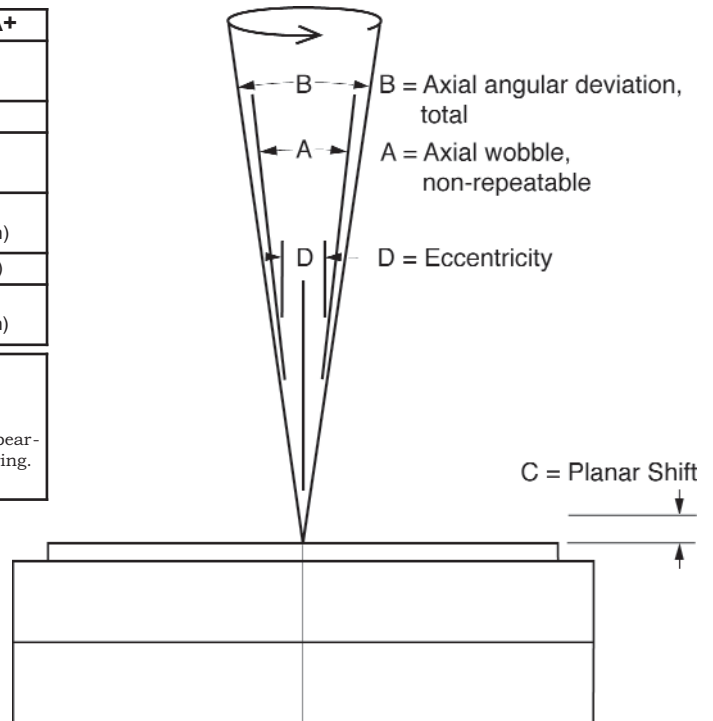
The information contained in this data sheet is subject to change without notice. Critical dimensions or specifications should be verified with our technical support staff.

MM-3M-R Rotary Stage

Dimensional Data

Description	MM-3M-R	MM-3M-RA	MM-3M-RA+
A. Axial wobble, (axial angular repeatability)	60 arc-second	2 arc-second	2 arc-second
B. Axial angular deviation, total	60 arc-second	60 arc-second	2 arc-second
C. Planar shift, total	1.2 μm (0.00005 inch)	0	0
D. Eccentricity (runout)	3.0 μm (0.000012 inch)	3.0 μm (0.000012 inch)	3.0 μm (0.000012 inch)
Direct Top Load, maximum:	2.0 kg (4.4 lbs)	0.5 kg (1.1 lbs)	0.5 kg (1.1 lbs)
Moment load, maximum:	28 N-cm (40 ounce-inch)	9.8 N-cm (14 ounce-inch)	9.8 N-cm (14 ounce-inch)

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.

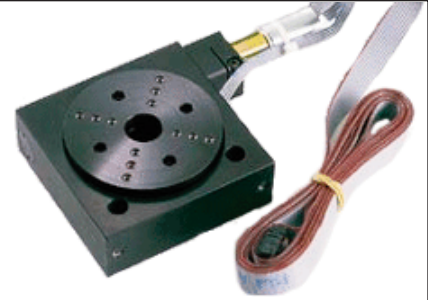


Gear Ratio	16:1	64:1	256:1	1024:1
Dimension A	2.76" (70.1mm)	2.84" (72.1mm)	2.96" (75.2mm)	3.08" (78.2mm)
Resolution/Count	0.0070 degree	0.0017 degree	0.00044 degree	0.00011 degree

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-R

Rotary Motorized
MicroMini™ Stages
(For heavier loads)



Specifications:

Repeatability:	±30 arc-second
Homing Repeatability:	±30 arc-second
Accuracy (linearity):	±2 arc-minute, full travel
Max Travel Rate¹:	96.63 degree/second, with 14:1 gearhead
Encoder Conversion(resolution):	16.3091 arc-second/count, with 14:1 gearhead
(See also MM-4M Resolution Sheet)	
¹ Max travel rate calculated with a maximum motor armature speed of 20,000 RPM	
Load Capacity:	10 lbs (4.5 kg)
Bearing Runout at Table:	±2.5µm
Standard Gearhead:	14:1
Gearhead Options:	14:1, 43:1, 66:1, 134:1, 159:1, 246:1, 415:1, 592:1, 989:1, 1,526:1, 2,608:1, 4,365:1 and 5,647:1
Worm Ratio:	90:1
Motor:	13mm diameter, 6-12 VDC servo, brush type
Bearings:	Pre-loaded duplex angular contact
Base Material & Finish:	Aluminum, black anodized
Vacuum compatibility:	10 ⁻³ Torr standard, higher per request
Table Diameter:	2.38 inch (60.45mm)

Special features:

- Ultra-low axial/angular runout
- Multi-faceted connection interface
- Anti-backlash worm drive system
- Black anodized finish

Travel Ranges and Dimensions:

Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-4M-R (with 14:1 gearhead)	Unlimited	133.4 x 73.15 x 28.58 (mm) 5.25 x 2.880 x 1.125 (inch)	0.512 kg 1.12 lb

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.

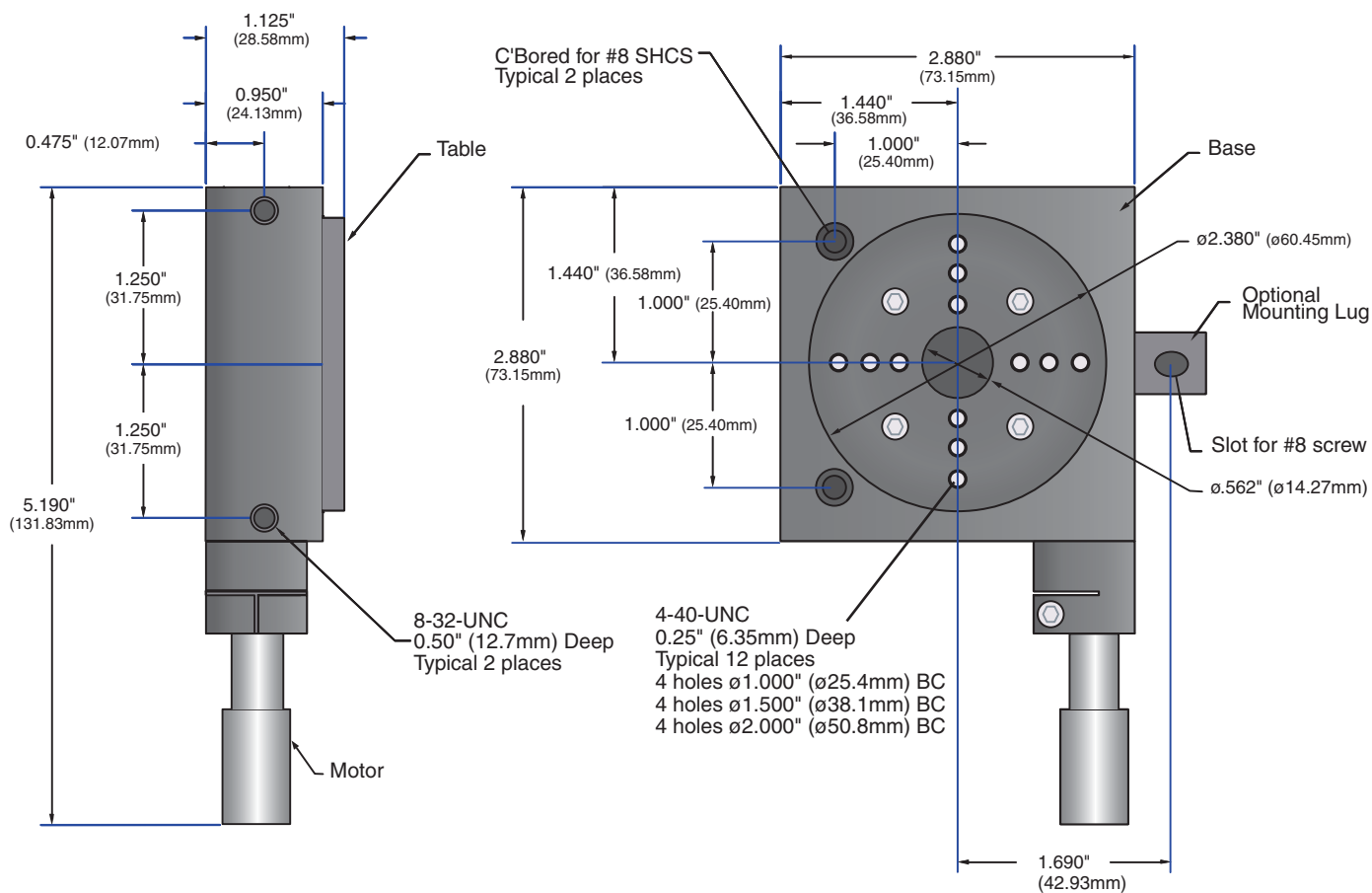
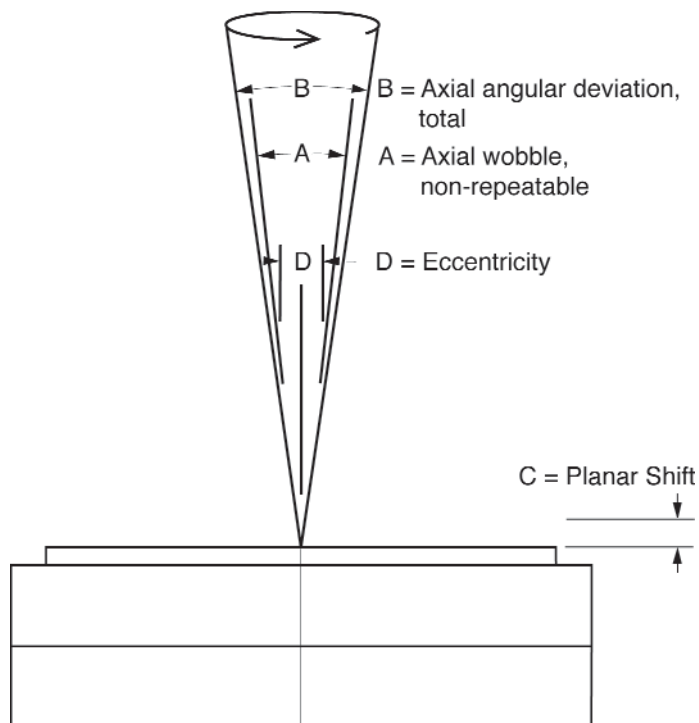
MM-4M-R Rotary Stage

Dimensional Data

Description	MM-4M-R
A. Axial wobble, (axial angular repeatability)	30 arc-second
B. Axial angular deviation, Total	30 arc-second
C. Planar shift, Total	0.6 μm (0.000024 inch)
D. Eccentricity (runout)	2.5 μm (0.000098 inch)
Direct Top Load, maximum:	4.5 kg (10 lbs)
Moment load maximum:	57 N-cm (80 ounce-inch)

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.



Side View

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.

Manual 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:

- 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.

Detant 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.



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 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

Stage Controller

MC-4SA MultiAxis

Servo Amplifier System



Specifications

AC power input (User-selectable):	110/220 VAC
Motor control input voltage:	±10 VDC across 300 K ohms
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 Instrument™ 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
- 110VAC 60Hz/220VAC 50/60Hz operation
- Built-in limit-sensing logic
- Front panel axis fault lights
- Axis enable switches w/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.

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.



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

Stage Controller

USB STICK DRIVE

SingleAxis



Specifications

Dimensions:	2" x 0.75" x 0.4"
Control loops:	P-term, I-term, D-term
Parameters Control:	Position, Velocity, Acceleration, and Torque.
Computer Interface:	Standard USB
Resolution:	Down to 0.004 μ m depending upon the encoder used.
Networkable:	Optionally.
Inputs and Outputs:	Digital and analog inputs and outputs for conversions and data acquisition.
Power Requirements:	No external power needed, use 5V USB BUS
Software:	Visual Basic, LabVIEW Drivers, and DEMO Software (all included)

The MC-CQ-STICK-SRVO 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

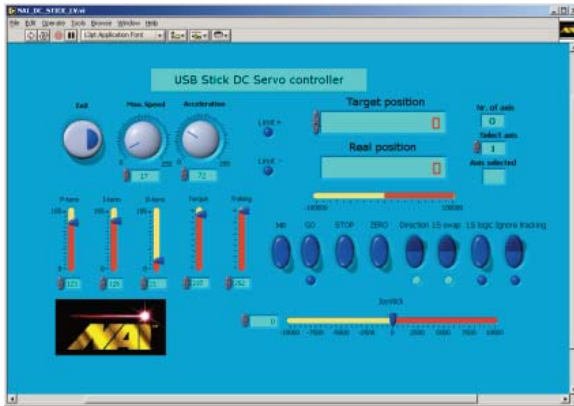
The MC-CQ-STICK-SRVO USB Stick Servo Controller was designed for use with the National Aperture MM-1M-F-0.125-SRVO miniature linear stage, and other servo motors. Its intended use is for 6V up to 12V DC motors with maximum 200mA consumption.

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

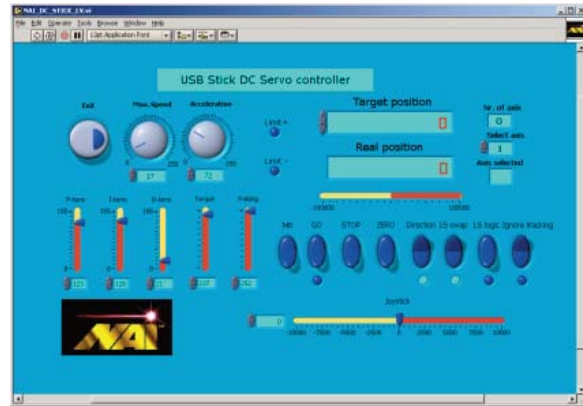
Stage Controller

USB STICK DRIVE

Software



LabVIEW Driver Software Interface



Visual Basic Demo Software

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

Single(multi)Axis MC-CQ

Motion Control/ Amplifier System



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, 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 w/programmable speed and acceleration and a rich Command-Set
- Clean-and-Simple-Connectivity facilitates Rapid Development

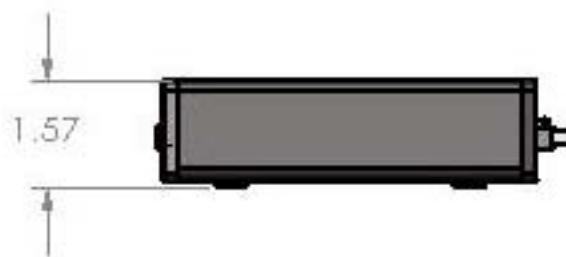
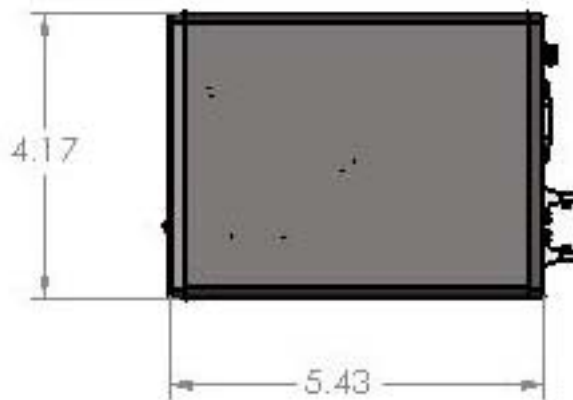
Optional 2,4,8 or 16 port RS-232-to-USB Expansion Module (Plug 'n Play)

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

Motion Control/Amplifier System

Dimensional Outlines



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.

MC-CQ

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 1A with 28 gauge ribbon cable
Max Peak Motor Current	10A with sufficient conductors for motor connection and sufficient power supply current. 2A with 28 gauge ribbon cable
Controller Current Consumption	60mA (w/no Motor, Encoder, or Limit Switch Current)
5 Volt Outputs	50mA (Max Combined Load from Encoder Vcc and Limit Vcc)
Limit Switch Configuration	Switches to ground expected (Controller incorporates 1K pullup resistors to 5V)
Limit Switch Logic Levels	low 0-0.5V, high 4.0-5.0V
Encoder Input Logic Levels	low 0-0.5V, high 4.0-5.0V
Encoder Input Max Frequency	400kHz
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	0 to 70° C
Storage Temperature	-25° to +85° C

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-1M-F-5mm

Resolution Data Sheet for 80 TPI Leadscrew

Linear Motion: 6mm Motors/w 50 position encoders

Gearhead Ratio	Max Travel Rate ²		Resolution ¹	
	Inch per second	mm per second	μinch per count	μm per count
64:1	0.046	1.17	0.6510416	0.01654

Travel rate calculations:

Leadscrew RPM = $\left[\frac{\text{RPM of motor}}{\text{Gearhead Ratio} \times \text{Pinion Gear Ratio}} \right] = \left[\frac{\text{Motor RPM}}{64 \times 1.5} \right] = \text{Motor RPM}/96$
Distance per minute = Output shaft RPM x Lead (0.025 inch, 0.635 mm)
Distance per second = Distance per minute/60
Distance in millimeter = inch/39.37 x 10⁻³
Distance in micrometer = inch/39.37 x 10⁻⁶

Encoder resolution calculations:

Encoder counts per shaft revolution = encoder counts x Gearhead ratio
Minimum encoder count (inch) = Lead (0.0125 inch)/ Encoder counts per output shaft revolution
Minimum encoder count (millimeter) = Minimum encoder count (inch)/39.37 x 10⁻³
Minimum encoder count (micrometer) = Minimum encoder count (inch)/39.37 x 10⁻⁶

Conversion:

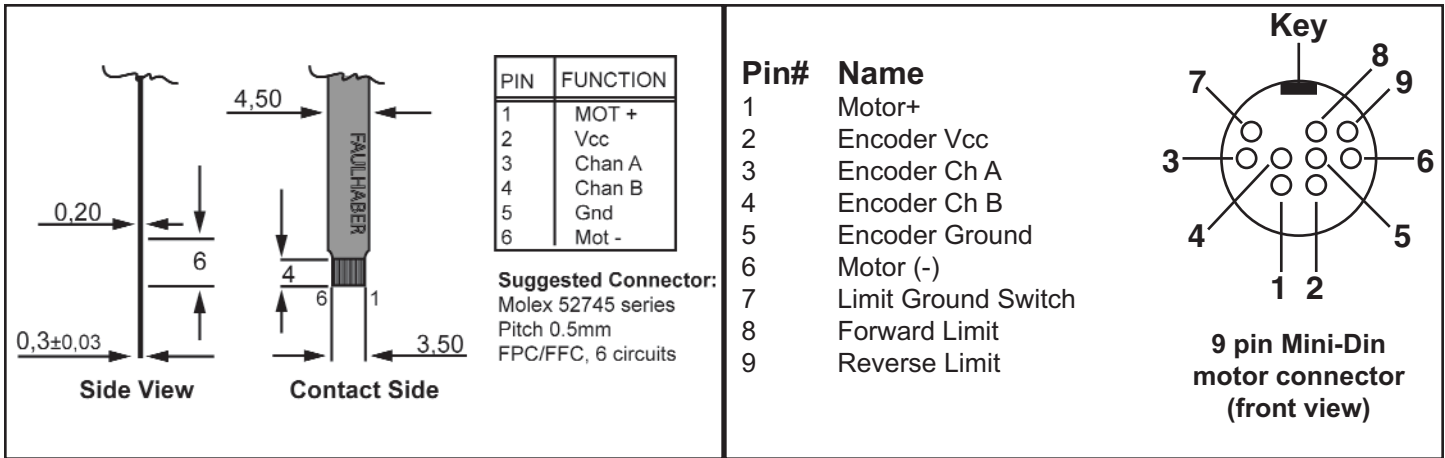
1 inch (in) = 25.4 mm
1 inch (in) = 25,400 μm
1 millimeter (mm) = 39.37 x 10⁻³ inch
1 micrometer (μm) = 39.37 x 10⁻⁶ inch
1 deg (deg) = 3,600 arc-second
1 arc-sec = 0.277 x 10⁻³ degree

Notes:

- 1) Max travel rate calculated with motor armature running at a maximum speed of 20,000 RPM.
- 2) The 6mm motors used with linear stages incorporate dual channel 50 position, optical encoders. The resultant quadrature output is equal to 200 encoder counts per motor armature revolution. speeds measured at 4.5VDC with 64:1 gearhead.
- 3) Minimum encoder count = (0.0125 inch) / (50 x 4 x 1.5 x 64) = 0.651μ inch/count
where 0.0125 is leadscrew pitch (1 inch/80 threads per inch),
and 50 x 4(=200) is quadrature counts per encoder revolution,
and 1.5 x 64(=96) is pinion gear ratio (21/14) times motor gearhead ratio.

MTR-6-50E-4.5v MicroMini™ Motor

Connection Specifications



Motor Connector

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 (µH)	95
Speed/Torque gradient (rpm/mNm)	88,229
Maximum permissible speed (rpm)	13,000
Maximum continuous current (mA)	110
Maximum continuous torque (mNm)	0.11
Maximum power output at nominal voltage (mW)	110

Encoder Specifications:

Supply Voltage	2.7 to 3.3 VDC
Operating Current Vcc=3 VDC	8.5mA
Signal Phase Shift	90° ± 45°
Maximum Signal Frequency	35 KHz
Temperature Range	-30°C to +85° C
Output Signal Type	2 channel Square wave
Phase Relationship	Channel B leads Channel A
Pulses per Revolution	50
Quadrature	200
Output signal TTL compatible	

Mechanical Specifications:

Mechanical Time Constant (ms) ⁽²⁾	9
Armature Inertia (g - cm ²)	0.01
Maximum rotor temperature	+85°C (+185°F)
Axial Play	0.15mm (0.0059 inches)
Thermal Resistance (C°/W)	
Rotor to Case	35
Case to Ambient	76
Maximum Shaft Load (N)	
Radial 1.5mm from flange @3000rpm	0.5 Newton
Axial @ standstill	20 Newton
Weight	2 gram (0.070547924 ounces)
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 = 0.8mm 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.

MM-3M-ST, -F, -EX, -R/MM-4M-F

Resolution Data Sheet

Linear Motion: 80 TPI Lead Screw

Gearhead Ratio	Max Travel Rate ²		Resolution ¹	
	Inch per second	mm per second	µinch per count	µm per count
16:1	0.260	6.60	19.5313	0.4960
64:1	0.064	1.65	4.8828	0.1240
256:1	0.016	0.41	1.2207	0.0310
1024:1	0.004	0.10	0.3052	0.0077

Rotary Motion: 80:1 Worm Drive Ratio

Gearhead Ratio	Final Output	Max Travel Rate ²		Resolution ¹	
		degree per second	degree per count	arc-second per count	
16:1	1,280:1	93.74	0.00703125	25.3125	
64:1	5,120:1	23.44	0.00175781	6.3281	
256:1	20,480:1	5.86	0.00043945	1.5820	
1024:1	81,920:1	1.46	0.00010986	0.3955	

Note: For 16:1 gearhead there are 51,220 counts for 360° rotation.

Travel rate calculations:

Output Shaft RPM = RPM of motor/Gearhead Ratio
Distance per minute = Output shaft RPM x Lead (0.0125 in., 0.3175 mm)
Distance per second = Distance per minute/60
Distance in millimeter = inch/39.37 x 10⁻³
Distance in micrometer = inch/39.37 x 10⁻⁶

Encoder resolution calculations:

Encoder counts per shaft revolution = 40 encoder counts x Gearhead ratio
Minimum encoder count (inch) = Lead (0.0125 inch)/ Encoder counts per output shaft revolution
Minimum encoder count (millimeter) = Minimum encoder count (inch)/39.37 x 10⁻³ in.
Minimum encoder count (micrometer) = Minimum encoder count (inch)/39.37 x 10⁻⁶

Conversion:

1 inch (in) = 25.4 mm
1 inch (in) = 25,400 µm
1 millimeter (mm) = 39.37 x 10⁻³ inch
1 micrometer (µm) = 39.37 x 10⁻⁶ inch
1 deg (deg) = 3,600 arc-second
1 arc-sec = 0.277 x 10⁻³ degree

Notes:

- 1) The lead values shown above in both travel rate and resolution calculations are for 80 (1/80) threads per Inch (TPI) leadscrews. For a 40 TPI leadscrew, substitute 0.025 inch lead.
- 2) Max travel rate calculated with motor armature running at a maximum speed of 20,000 RPM.
- 3) The 10 mm motors used with both the rotary and linear stages incorporate dual channel, 10 position, magnetic encoders. The resultant quadrature output is equal to 40 encoder counts per motor armature revolution.

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.

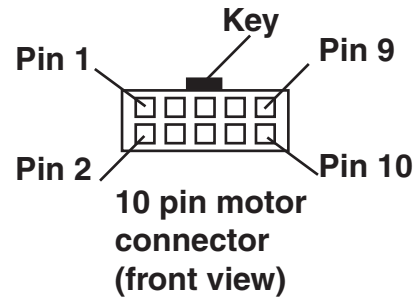
MTR-10-10E-HT MicroMini™ Motor

Connection Specifications

Motor Type: MTR-10-10E-HT with planetary gearhead and magnetic encoder

Connector type: Dual row IDC

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



Electrical Specifications:

Supply Voltage Nom. (Volts)	6
Armature Resistance (Ohm) $\pm 12\%$	10.8
Maximum power output (Watts) ⁽²⁾	0.81
Maximum Efficiency (%) ⁽²⁾	78
No Load Speed (RPM) $\pm 12\%$ ⁽²⁾	13,200
No Load Current (mA) $\pm 50\%$ ⁽³⁾	8
Stall Torque (oz-in) ⁽²⁾ mNm	2.34
Velocity Constant (RPM/Volt)	2,231
Torque Constant (mNm/A)	4.28
Armature Inductance (mH)	0.100
Speed/Torque gradient (rpm/mNm)	5630
Maximum permissible speed (rpm)	12,000
Maximum continuous current (mA)	291
Maximum continuous torque (mNm)	1.21
Maximum power output at nominal voltage (mW)	810

Encoder Specifications:

Supply Voltage	5 VDC Nominal
Max Voltage Supply	15 VDC
Operating Current	5mA Nominal @5 VDC
Signal Phase Shift	90°
Maximum Signal Frequency	7.2 KHz
Temperature Range	-40°C to +85° C
Output Signal Type	Square wave
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
Output signal TTL compatible	

Mechanical Specifications:

Mechanical Time Constant (ms) ⁽²⁾	7
Armature Inertia (g - cm ²)	0.12
Maximum rotor temperature	+85°C (+185°F)
Axial Play	0.2mm (0.0079 inches)
Thermal Resistance (C°/W)	
Rotor to Case	14
Case to Ambient	41
Maximum Shaft Load (N)	
Radial 1.5mm from flange	0.5
Axial @ standstill	20
Weight	8.8 gram (0.31041086 ounces)
Planetary Gearhead recommended input speed	<8000 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.

MM-3M-ST, -F, -EX/MM-4M-F

Resolution Data Sheet for 40 TPI Leadscrew

Linear Motion: 10mm Motors/w 10 position encoders

Gearhead Ratio	Max Travel Rate ²		Resolution ¹	
	Inch per second	mm per second	µinch per count	µm per count
16:1	0.5208	13.2292	39.0625	0.992189484379
64:1	0.1302	3.3073	9.765625	0.248047371095
256:1	0.0326	0.8268	2.44140625	0.0620118427737
1024:1	0.0081	0.2067	0.6103515625	0.0155029606934

Travel rate calculations:

- Output Shaft RPM = RPM of motor/Gearhead Ratio
Distance per minute = Output shaft RPM x Lead (0.025 inch, 0.635 mm)
Distance per second = Distance per minute/60
Distance in millimeter = inch/39.37 x 10⁻³
Distance in micrometer = inch/39.37 x 10⁻⁶

Encoder resolution calculations:

- Encoder counts per shaft revolution = 40 encoder counts x Gearhead ratio
Minimum encoder count (inch) = Lead (0.025 inch)/ Encoder counts per output shaft revolution
Minimum encoder count (millimeter) = Minimum encoder count (inch)/39.37 x 10⁻³ in.
Minimum encoder count (micrometer) = Minimum encoder count (inch)/39.37 x 10⁻⁶

Conversion:

- 1 inch (in) = 25.4 mm
1 inch (in) = 25,400 µm
1 millimeter (mm) = 39.37 x 10⁻³ inch
1 micrometer (µm) = 39.37 x 10⁻⁶ inch
1 deg (deg) = 3,600 arc-second
1 arc-sec = 0.277 x 10⁻³ degree

Notes:

- 1) The lead values shown above in both travel rate and resolution calculations are for 40 (1/40) threads per Inch (TPI) leadscrews. For an 80 TPI leadscrew, substitute 0.0125 inch lead.
- 2) Max travel rate calculated with motor armature running at a maximum speed of 20,000 RPM.
- 3) The 10 mm motors used with linear stages incorporate dual channel, 10 position, magnetic encoders. The resultant quadrature output is equal to 40 encoder counts per motor armature revolution.

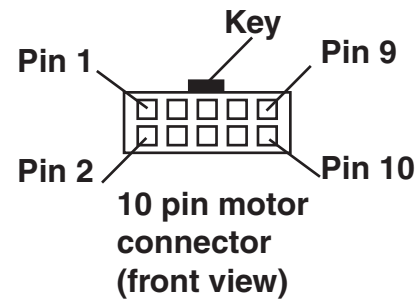
MTR-10-10E-HT MicroMini™ Motor

Connection Specifications

Motor Type: MTR-10-10E-HT with planetary gearhead and magnetic encoder

Connector type: Dual row IDC

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



Electrical Specifications:

Supply Voltage Nom. (Volts)	6
Armature Resistance (Ohm) $\pm 12\%$	10.8
Maximum power output (Watts) ⁽²⁾	0.81
Maximum Efficiency (%) ⁽²⁾	78
No Load Speed (RPM) $\pm 12\%$ ⁽²⁾	13,200
No Load Current (mA) $\pm 50\%$ ⁽³⁾	8
Stall Torque (oz-in) ⁽²⁾ mNm	2.34
Velocity Constant (RPM/Volt)	2,231
Torque Constant (mNm/A)	4.28
Armature Inductance (mH)	0.100
Speed/Torque gradient (rpm/mNm)	5630
Maximum permissible speed (rpm)	12,000
Maximum continuous current (mA)	291
Maximum continuous torque (mNm)	1.21
Maximum power output at nominal voltage (mW)	810

Encoder Specifications:

Supply Voltage	5 VDC Nominal
Max Voltage Supply	15 VDC
Operating Current	5mA Nominal @5 VDC
Signal Phase Shift	90°
Maximum Signal Frequency	7.2 KHz
Temperature Range	-40°C to +85° C
Output Signal Type	Square wave
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
Output signal TTL compatible	

Mechanical Specifications:

Mechanical Time Constant (ms) ⁽²⁾	7
Armature Inertia (g - cm ²)	0.12
Maximum rotor temperature	+85°C (+185°F)
Axial Play	0.2mm (0.0079 inches)
Thermal Resistance (C°/W)	
Rotor to Case	14
Case to Ambient	41
Maximum Shaft Load (N)	
Radial 1.5mm from flange	0.5
Axial @ standstill	20
Weight	8.8 gram (0.31041086 ounces)
Planetary Gearhead recommended input speed	<8000 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.

MM-3M-ST, -F, -EX, -R/MM-4M-F

Resolution Data Sheet

Linear Motion: 80 TPI Lead Screw

Gearhead Ratio	Max Travel Rate ²		Resolution ¹	
	Inch per second	mm per second	µinch per count	µm per count
16:1	0.260	6.60	19.5313	0.4960
64:1	0.064	1.65	4.8828	0.1240
256:1	0.016	0.41	1.2207	0.0310
1024:1	0.004	0.10	0.3052	0.0077

Rotary Motion: 80:1 Worm Drive Ratio

Gearhead Ratio	Final Output	Max Travel Rate ²		Resolution ¹	
		degree per second	degree per count	arc-second per count	
16:1	1,280:1	93.74	0.00703125	25.3125	
64:1	5,120:1	23.44	0.00175781	6.3281	
256:1	20,480:1	5.86	0.00043945	1.5820	
1024:1	81,920:1	1.46	0.00010986	0.3955	

Travel rate calculations:

- Output Shaft RPM = RPM of motor/Gearhead Ratio
- Distance per minute = Output shaft RPM x Lead (0.0125 in., 0.3175 mm)
- Distance per second = Distance per minute/60
- Distance in millimeter = inch/39.37 x 10⁻³
- Distance in micrometer = inch/39.37 x 10⁻⁶

Encoder resolution calculations:

- Encoder counts per shaft revolution = 40 encoder counts x Gearhead ratio
- Minimum encoder count (inch) = Lead (0.0125 in.) / Encoder counts per output shaft revolution
- Minimum encoder count (millimeter) = Minimum encoder count (inch)/39.37 x 10⁻³ in.
- Minimum encoder count (micrometer) = Minimum encoder count (inch)/39.37 x 10⁻⁶

Conversion:

- 1 inch (in) = 25.4 mm
- 1 inch (in) = 25,400 µm
- 1 millimeter (mm) = 39.37 x 10⁻³ inch
- 1 micrometer (µm) = 39.37 x 10⁻⁶ inch
- 1 deg (deg) = 3,600 arc-second
- 1 arc-sec = 0.277 x 10⁻³ degree

Notes:

- The lead values shown above in both travel rate and resolution calculations are for 80 (1/80) threads per Inch (TPI) leadscrews. For a 40 TPI leadscrew, substitute 0.025 inch lead.
- Max travel rate calculated with motor armature running at a maximum speed of 20,000 RPM.
- The 10 mm motors used with both the rotary and linear stages incorporate dual channel, 10 position, magnetic encoders. The resultant quadrature output is equal to 40 encoder counts per motor armature revolution.

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-10-E MicroMini™ Motor

Connection Specifications

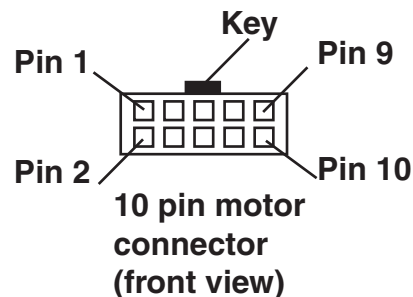
Motor Type: MTR-10-E

Connector type: Dual row IDC

***Mate Part# (male pin socket):**

Panduit 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



Electrical Specifications:

Supply Voltage Nom. (Volts)	6
Armature Resistance (Ohm)±12%	20.1
Max power output (Watts) ⁽²⁾	0.42
Max. Efficiency (%) ⁽²⁾	67
No Load Speed (RPM) ±12% ⁽²⁾	18,400
Friction Torque (@ no load speed) (oz-in)	0.004
No Load Current (mA)±50% ⁽³⁾	10
Stall Torque (oz-in) ⁽²⁾	0.123
Velocity Constant (RPM/Volt)	3,173
Back EMF Constant (mV/RPM)	0.315
Torque Constant (oz-in/Amp)	0.426
Armature Inductance (mH)	0.060

Encoder Specifications:

Supply Voltage	5 VDC Nom.
Max Voltage Supply	15 VDC
Operating Current	5mA Nom. @5VDC
Signal Phase Shift	90°
Max. Signal Freq.	7.2 KHz
Temperature Range	-40°C to +85° 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

Mechanical Specifications:

Mechanical Time Constant (ms) ⁽²⁾	13
Armature Inertia (x10 ⁻⁶ oz-in-sec ²) ⁽²⁾	0.85
Angular Acceleration (x 10 ³ Rad/sec ²) ⁽²⁾	145
Rotor Temperature Range	-30°C to +85°C (-22°F to +185°F)
Bearing Play (measured @ bearing)	
Radial	Less than 0.02mm (0.0008")
Axial	Less than 0.2mm (0.0079")
Thermal Resistance (°C/W)	
Rotor to Case	26
Case to Ambient	56
Maximum Shaft Load	
Radial (@3,000 RPM) 1.5mm from bearing	18 oz (510.3 gram)
Axial @ standstill	18 oz (510.3 gram)
Weight	0.23 oz (6.5 gram)

(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.

MM-3M-F/MM-4M-F

Resolution Data Sheet

Linear Motion: 80 TPI Lead Screw

Gearhead Ratio	Max Travel Rate ²		Resolution ¹	
	Inch per second	mm per second	µinch per count	µm per count
16:1	0.260	6.60	19.5313	0.4960
64:1	0.064	1.65	4.8828	0.1240
256:1	0.016	0.41	1.2207	0.0310
1024:1	0.004	0.10	0.3052	0.0077

Travel rate calculations:

- Output Shaft RPM = RPM of motor/Gearhead Ratio
- Distance per minute = Output shaft RPM x Lead (0.0125 in., 0.3175 mm)
- Distance per second = Distance per minute/60
- Distance in millimeter = inch/39.37 x 10⁻³
- Distance in micrometer = inch/39.37 x 10⁻⁶

Encoder resolution calculations:

- Encoder counts per shaft revolution = 40 encoder counts x Gearhead ratio
- Minimum encoder count (inch) = Lead (0.0125 in.) / Encoder counts per output shaft revolution
- Minimum encoder count (millimeter) = Minimum encoder count (inch) / 39.37 x 10⁻³ in.
- Minimum encoder count (micrometer) = Minimum encoder count (inch) / 39.37 x 10⁻⁶

Conversion:

- 1 inch (in) = 25.4mm
- 1 inch (in) = 25,400µm
- 1 millimeter (mm) = 39.37 x 10⁻³ inch
- 1 micrometer (µm) = 39.37 x 10⁻⁶ inch
- 1 deg (deg) = 3,600 arc-second
- 1 arc-sec = 0.277 x 10⁻³ degree

Notes:

- 1) The lead values shown above in both travel rate and resolution calculations are for 80 (1/80) threads per Inch (TPI) leadscrews. For a 40 TPI leadscrew, substitute 0.025 inch lead.
- 2) Max travel rate calculated with motor armature running at a maximum speed of 20,000 RPM.
- 3) The 10 mm motors used with both the rotary and linear stages incorporate dual channel, 10 position, magnetic encoders. The resultant quadrature output is equal to 40 encoder counts per motor armature revolution.

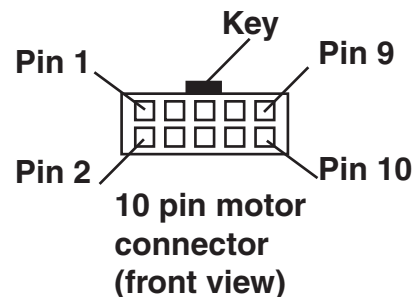
MTR-10-E-12V MicroMini™ Motor

Connection Specifications

Motor Type: MTR-10-E-12V

Connector type: Dual row IDC

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



Electrical Specifications:

Supply Voltage Nom. (Volts)	12
Armature Resistance (Ohm)±12%	95.0
Max power output (Watts) ⁽²⁾	0.36
Max. Efficiency (%) ⁽²⁾	68
No Load Speed (RPM) ±12% ⁽²⁾	16,500
Friction Torque (@ no load speed) (oz-in)	0.004
No Load Current (mA)±50% ⁽³⁾	4
Stall Torque(oz-in) ⁽²⁾	0.116
Velocity Constant (RPM/Volt)	1419
Back EMF Constant (mV/RPM)	0.705
Torque Constant (oz-in/Amp)	0.953
Armature Inductance (mH)	0.310

Encoder Specifications:

Supply Voltage	5 VDC Nom.
Max Voltage Supply	15 VDC
Operating Current	5mA Nom. @5VDC
Signal Phase Shift	90°
Max. Signal Freq.	7.2 KHz
Temperature Range	-40°C to +85° 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

Mechanical Specifications:

Mechanical Time Constant (ms) ⁽²⁾	10
Armature Inertia (x10 ⁻⁶ oz-in-sec ²) ⁽²⁾	0.7081
Angular Acceleration (x 10 ³ Rad/sec ²) ⁽²⁾	165
Rotor Temperature Range	-30°C to +85°C (-22°F to +185°F)
Bearing Play (measured @ bearing)	
Radial	Less than 0.02mm (0.0008")
Axial	Less than 0.2mm (0.0079")
Thermal Resistance (°C/W)	
Rotor to Case	26
Case to Ambient	56
Maximum Shaft Load	
Radial (@3,000 RPM) 3mm from bearing	18oz (510gram)
Axial @ standstill	18oz (510gram)
Weight	0.23oz (6.5gram)

(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.



MM-3M-ST, -F, -EX, -R/MM-4M-F, 12 Position Encoder Resolution Data Sheet

Linear Motion: 80 TPI Lead Screw

Gearhead Ratio	Max Travel Rate ²		Resolution ¹	
	Inch per second	mm per second	µinch per count	µm per count
16:1	0.2604	6.6146	16.276	0.41341

Rotary Motion: 80:1 Worm Drive Ratio

Gearhead Ratio	Final Output	Max Travel Rate ²		Resolution ¹	
		Degrees/Second	arc-seconds per count	degrees per count	
16:1	1,280:1	93.75	21.1530	5.859375 x 10 ⁻³	

Travel rate calculations:

- Output Shaft RPM = RPM of motor/Gearhead Ratio
- Distance per minute = Output shaft RPM x Lead (0.0125 in., 0.3175 mm)
- Distance per second = Distance per minute/60(sec/min)
- Distance in millimeter = inch/39.37 x 10⁻³ (in/mm)
- Distance in micrometer = inch/39.37 x 10⁻⁶ (in/µm)

Encoder resolution calculations:

- Encoder counts per shaft revolution = 48 encoder counts x Gearhead ratio
- Minimum encoder count (inch) = Lead (0.0125 in.) / Encoder counts per output shaft revolution
- Minimum encoder count (millimeter) = Minimum encoder count (inch)/39.37 x 10⁻³ (in/mm)
- Minimum encoder count (micrometer) = Minimum encoder count (inch)/39.37 x 10⁻⁶ (in/µm)

Conversion:

- 1 inch (in) = 25.4mm
- 1 inch (in) = 25,400µm
- 1 millimeter (mm) = 39.37 x 10⁻³ inch
- 1 micrometer (µm) = 39.37 x 10⁻⁶ inch
- 1 deg (deg) = 3,600 arc-second
- 1 arc-sec = 0.277 x 10⁻³ degree

Notes:

- 1) The lead values shown above in both travel rate and resolution calculations are for 80 (1/80) threads per Inch (TPI) leadscrews. For a 40 TPI leadscrew, substitute 0.025 inch lead.
- 2) Max travel rate calculated with motor armature running at a maximum speed of 20,000 RPM.
- 3) The 10 mm motors used with both the rotary and linear stages incorporate dual channel, 12 position, magnetic encoders. The resultant quadrature output is equal to 48 encoder counts per motor armature revolution.

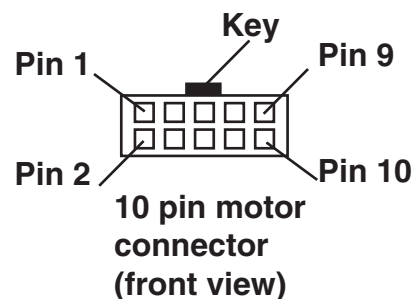
MTR-10-12E-HT MicroMini™ Motor

Connection Specifications

Motor Type: MTR-10-12E-HT with 16:1 planetary gearhead and magnetic encoder

Connector type: Dual row IDC

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



Electrical Specifications:

Supply Voltage Nom. (Volts)	6
Armature Resistance (Ohm)±12%	10.8
Max power output (Watts) ⁽²⁾	0.81
Max. Efficiency (%) ⁽²⁾	78
No Load Speed (RPM) ±12% ⁽²⁾	13,200
No Load Current (mA)±50% ⁽³⁾	8
Stall Torque (mNm) ⁽²⁾	2.34
Velocity Constant (RPM/Volt)	2,231
Torque Constant (oz-in/Amp)	4.28
Armature Inductance (mH)	0.100
Speed/Torque gradient (rpm/mNm)	5630
Maximum permissible speed (rpm)	12,000
Maximum continuous current (mA)	291
Maximum continuous torque (mNm)	1.21
Maximum power output at nominal voltage (mW)	0.81

Encoder Specifications:

Supply Voltage	5 VDC Nom.
Max Voltage Supply	15 VDC
Operating Current	5mA Nom. @5VDC
Signal Phase Shift	90°
Max. Signal Freq.	7.2 KHz
Temperature Range	-40°C to +85° C
Output Signal Type	Square wave
Phase Relationship	Ch A leads CH B when motor rotation is clockwise as seen from shaft end.
Pulses per Revolution	12 (2 channels)
Quadrature	48
Output signal TTL compatible	

Mechanical Specifications:

Mechanical Time Constant (ms) ⁽²⁾	7
Armature Inertia (x10 ⁻⁶ oz-in-sec ²) ⁽²⁾	0.12
Maximum rotor temperature	+85°
Axial Play	0.2mm
Thermal Resistance (°C/W)	
Rotor to Case	14
Case to Ambient	41
Maximum Shaft Load (N)	
Radial 1.5mm from bearing @3000 rpm	0.5
Axial @ standstill	20
Weight	8.8 grams

Planetary Gearhead recommended input speed <8000rpm

(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.

16 Northwestern Drive • Salem, NH 03079-4810 • 800-360-4598 • 603-893-7393 • Fax 603-893-7857 * www.nationalaperture.com/www.naimotion.com

MM-3M-F/MM-4M-F

Resolution Data Sheet

Linear Motion: 40 TPI Lead Screw

Gearhead Ratio	Max Travel Rate ²		Resolution ¹	
	Inch per second	mm per second	µinch per count	µm per count
16:1	0.5208	13.229	39.0625	0.99219

Travel rate calculations:

Output Shaft RPM = RPM of motor/Gearhead Ratio
Distance per minute = Output shaft RPM x Lead (0.025 in., 0.635 mm)
Distance per second = Distance per minute/60
Distance in millimeter = inch/39.37 x 10⁻³
Distance in micrometer = inch/39.37 x 10⁻⁶

Encoder resolution calculations:

Encoder counts per shaft revolution = 40 encoder counts x Gearhead ratio
Minimum encoder count (inch) = Lead (0.025 inch)/ Encoder counts per output shaft revolution
Minimum encoder count (millimeter) = Minimum encoder count (inch)/39.37 x 10⁻³ in.
Minimum encoder count (micrometer) = Minimum encoder count (inch)/39.37 x 10⁻⁶

Conversion:

1 inch (in) = 25.4mm
1 inch (in) = 25,400µm
1 millimeter (mm) = 39.37 x 10⁻³ inch
1 micrometer (µm) = 39.37 x 10⁻⁶ inch
1 deg (deg) = 3,600 arc-second
1 arc-sec = 0.277 x 10⁻³ degree

Notes:

- 1) The lead values shown above in both travel rate and resolution calculations, are for 40 (1/40) Threads per Inch (TPI) leadscrews. For an 80 TPI leadscrew, substitute 0.0125 inch lead.
- 2) Max travel rate calculated with motor armature running at a maximum speed of 20,000 RPM.
- 3) The 10 mm motors used with both the rotary and linear stages incorporate dual channel, 10 position, magnetic encoders. The resultant quadrature output is equal to 40 encoder counts per motor armature revolution.

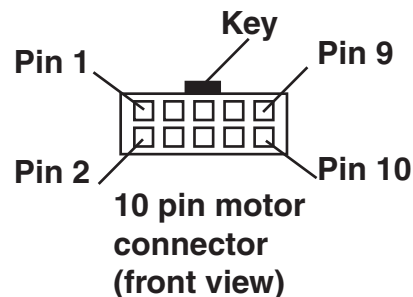
MTR-10-E MicroMini™ Motor

Connection Specifications

Motor Type: MTR-10-E

Connector type: Dual row IDC

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



Electrical Specifications:

Supply Voltage Nom. (Volts)	6
Armature Resistance (Ohm)±12%	20.1
Max power output (Watts) ⁽²⁾	0.42
Max. Efficiency (%) ⁽²⁾	67
No Load Speed (RPM) ±12% ⁽²⁾	18,400
Friction Torque (@ no load speed) (oz-in)	0.004
No Load Current (mA)±50% ⁽³⁾	10
Stall Torque(oz-in) ⁽²⁾	0.123
Velocity Constant (RPM/Volt)	3,173
Back EMF Constant (mV/RPM)	0.315
Torque Constant (oz-in/Amp)	0.426
Armature Inductance (mH)	0.060

Encoder Specifications:

Supply Voltage	5 VDC Nom.
Max Voltage Supply	15 VDC
Operating Current	5mA Nom. @5VDC
Signal Phase Shift	90°
Max. Signal Freq.	7.2 KHz
Temperature Range	-40°C to +85° 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

Mechanical Specifications:

Mechanical Time Constant (ms) ⁽²⁾	13
Armature Inertia (x 10 ⁻⁶ oz-in-sec ²) ⁽²⁾	0.85
Angular Acceleration (x 10 ³ Rad/sec ²) ⁽²⁾	145
Rotor Temperature Range	-30°C to +85°C (-22°F to +185°F)
Bearing Play (measured @ bearing)	
Radial	Less than 0.02mm (0.0008")
Axial	Less than 0.2mm (0.0079")
Thermal Resistance (°C/W)	
Rotor to Case	26
Case to Ambient	56
Maximum Shaft Load	
Radial (@3,000 RPM) 3 mm from bearing	18 oz (510 gram)
Axial @ standstill	18 oz (510 gram)
Weight	0.23 oz (6.5 gram)

(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.

MM-3M-F/MM-4M-F

Resolution Data Sheet

Linear Motion: 80 TPI Lead Screw

Gearhead Ratio	Max Travel Rate ²		Resolution ¹	
	Inch per second	mm per second	µinch per count	µm per count
16:1	0.260	6.60	19.5313	0.4960
64:1	0.064	1.65	4.8828	0.1240
256:1	0.016	0.41	1.2207	0.0310
1024:1	0.004	0.10	0.3052	0.0077

Travel rate calculations:

- Output Shaft RPM = RPM of motor/Gearhead Ratio
Distance per minute = Output shaft RPM x Lead (0.0125 in., 0.3175 mm)
Distance per second = Distance per minute/60
Distance in millimeter = inch/39.37 x 10⁻³
Distance in micrometer = inch/39.37 x 10⁻⁶

Encoder resolution calculations:

- Encoder counts per shaft revolution = 40 encoder counts x Gearhead ratio
Minimum encoder count (inch) = Lead (0.0125 in.) / Encoder counts per output shaft revolution
Minimum encoder count (millimeter) = Minimum encoder count (inch)/39.37 x 10⁻³ in.
Minimum encoder count (micrometer) = Minimum encoder count (inch)/39.37 x 10⁻⁶

Conversion:

- 1 inch (in) = 25.4mm
1 inch (in) = 25,400µm
1 millimeter (mm) = 39.37 x 10⁻³ inch
1 micrometer (µm) = 39.37 x 10⁻⁶ inch
1 deg (deg) = 3,600 arc-sec
1 arc-sec = 0.277 x 10⁻³ degree

Notes:

- 1) The lead values shown above in both travel rate and resolution calculations, are for 80 (1/80) Threads per Inch (TPI) leadscrews. For a 40 TPI leadscrew, substitute 0.025 inch lead.
- 2) Max travel rate calculated with motor armature running at a maximum speed of 20,000 RPM.
- 3) The 10 mm motors used with both the rotary and linear stages incorporate dual channel, 10 position, magnetic encoders. The resultant quadrature output is equal to 40 encoder counts per motor armature revolution.

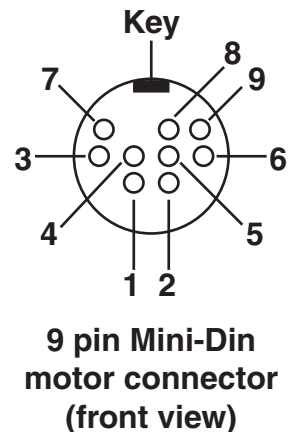
MTR-10-E MicroMini™ Motor

Connection Specifications

Motor Type: MTR-10-E

Connector type: 9 pin Mini-DIN

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



Electrical Specifications:

Supply Voltage Nom. (Volts)	6
Armature Resistance (Ohm)±12%	20.1
Max power output (Watts) ⁽²⁾	0.42
Max. Efficiency (%) ⁽²⁾	67
No Load Speed (RPM) ±12% ⁽²⁾	18,400
Friction Torque (@ no load speed) (oz-in)	0.004
No Load Current (mA)±50% ⁽³⁾	10
Stall Torque(oz-in) ⁽²⁾	0.123
Velocity Constant (RPM/Volt)	3,173
Back EMF Constant (mV/RPM)	0.315
Torque Constant (oz-in/Amp)	0.426
Armature Inductance (mH)	0.060

Encoder Specifications:

Supply Voltage	5 VDC Nom.
Max Voltage Supply	15 VDC
Operating Current	5mA Nom. @5VDC
Signal Phase Shift	90°
Max. Signal Freq.	7.2 KHz
Temperature Range	-40°C to +85° 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

Mechanical Specifications:

Mechanical Time Constant (ms) ⁽²⁾	13
Armature Inertia (x 10 ⁻⁶ ounce-inch-second ²) ⁽²⁾	0.85
Angular Acceleration (x 10 ³ Rad/second ²) ⁽²⁾	145
Rotor Temperature Range	-30°C to +85°C (-22°F to +185°F)
Bearing Play (measured @ bearing)	
Radial	Less than 0.02mm (0.0008")
Axial	Less than 0.2mm (0.0079")
Thermal Resistance (°C/W)	
Rotor to Case	26
Case to Ambient	56
Maximum Shaft Load	
Radial (@3,000 RPM) 3 mm from bearing	18 oz (510 gram)
Axial @ standstill	18 oz (510 gram)
Weight	0.23 oz (6.5 gram)

(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.

MM-4M-EX and MM-4M-R

Resolution Data Sheet

Linear Motion: MM-4M-EX, 80 TPI Lead Screw, 13mm mtr, 50 enc. *lines/mtr rev

Gearhead Ratio	Actual Gear Ratio	Resolution ¹		Max Travel Rate ²	
		Inch/count	mm/count	Inch/sec	mm/sec
14:1	13.795918367:1	4.5303 x 10 ⁻⁶	0.1151 x 10 ⁻³	0.302	7.67
43:1	42.920634921:1	1.4562 x 10 ⁻⁶	0.0370 x 10 ⁻³	0.097	2.4
66:1	66.220408163:1	0.9438 x 10 ⁻⁶	0.0240 x 10 ⁻³	0.062	1.5
134:1	133.530864198:1	0.4681 x 10 ⁻⁶	0.0119 x 10 ⁻³	0.030	0.78
159:1	159.419501134:1	0.3920 x 10 ⁻⁶	0.0096 x 10 ⁻³	0.025	0.64
246:1	245.961516035:1	0.2541 x 10 ⁻⁶	0.0065 x 10 ⁻³	0.016	0.41
415:1	415.429355281:1	0.1504 x 10 ⁻⁶	0.0038 x 10 ⁻³	0.010	0.25
592:1	592.129575640:1	0.1056 x 10 ⁻⁶	0.0027 x 10 ⁻³	0.006	0.16
989:1	988.891428571:1	0.0632 x 10 ⁻⁶	0.0016 x 10 ⁻³	0.0036	0.092
1,526:1	1,525.718204082:1	0.0410 x 10 ⁻⁶	0.0010 x 10 ⁻³	0.0027	0.069
2,608:1	2,625.740771277:1	0.0238 x 10 ⁻⁶	0.0006 x 10 ⁻³	0.0015	0.039
4,365:1	4,385.142457309:1	0.0143 x 10 ⁻⁶	0.0004 x 10 ⁻³	0.0009	0.023
5,647:1	5,666.953329446:1	0.0110 x 10 ⁻⁶	0.0003 x 10 ⁻³	0.0007	0.018

Rotary Motion: MM-4M-R, 90:1 Worm Drive Ratio 13mm mtr, 50 encoder* lines/motor revolution

Gearhead Ratio	Actual Gear Ratio	Resolution ¹		Max Travel Rate ²
		Degree/count	arc-sec/count	Degree/sec
14:1	13.795918367:1	1.44970 x 10 ⁻³	5.2189	96.63
43:1	42.920634921:1	0.46598 x 10 ⁻³	1.6775	31.00
66:1	66.220408163:1	0.30202 x 10 ⁻³	1.0873	20.09
134:1	133.530864198:1	0.14978 x 10 ⁻³	0.5392	9.90
159:1	159.419501134:1	0.12546 x 10 ⁻³	0.4516	8.36
246:1	245.961516035:1	0.08131 x 10 ⁻³	0.2927	5.36
415:1	415.429355281:1	0.04814 x 10 ⁻³	0.1733	3.18
592:1	592.129575640:1	0.03378 x 10 ⁻³	0.1216	2.18
989:1	988.891428571:1	0.02022 x 10 ⁻³	0.0728	1.361
1,526:1	1,525.718204082:1	0.01311 x 10 ⁻³	0.0472	0.90
2,608:1	2,625.740771277:1	0.00762 x 10 ⁻³	0.0274	0.54
4,365:1	4,385.142457309:1	0.00456 x 10 ⁻³	0.0164	0.27
5,647:1	5,666.953329446:1	0.00353 x 10 ⁻³	0.0127	0.23

Notes:

1) The lead values shown above in both travel rate and resolution calculations, are for 80 (1/80) thread per Inch (TPI) lead-screws. For a 40 TPI leadscrew, substitute 0.025 inch lead.

2) Max travel rate calculated with motor armature running at a maximum speed of 20,000 RPM

*The resultant quadrature output is equal to 64 encoder counts per motor armature revolution. (mtr rev)

Travel rate calculations:

Output Shaft RPM	= RPM of motor / Gearhead Ratio
Distance per minute	= Output shaft RPM x Lead (0.0125 inch, 0.03175mm)
Distance per second	= Distance per minute/60
Distance in millimeter	= inch/39.37 X 10 ⁻³
Distance in micrometer	= inch/39.37 x 10 ⁻⁶

Conversion:

1 inch (in.)	= 25.4 mm
1 inch (in.)	= 25,400µm
1 millimeter (mm)	= 39.37 x 10 ⁻³ inch
1 micrometer (µm)	= 39.37 x 10 ⁻⁶ inch
1 degree	= 3,600 arc-s
1 arc-s	= 0.277 x 10 ⁻³ degree

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-13-E-HT MicroMini™ Motor

Connection Specifications

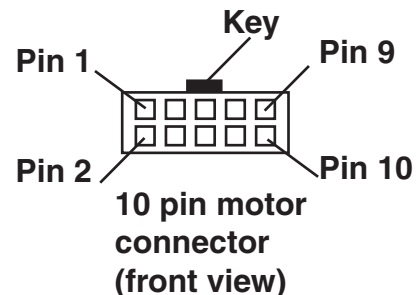
Motor Connector Pin Assignments:

Motor Type: MTR-13-E-HT

Connector Type: Dual Row IDC

Note: Mating connectors may be purchased from National Aperture, Inc.

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



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

Electrical Specifications:

Supply Voltage Nom. (Volts)	6
Armature Resistance (Ohm) $\pm 12\%$	2.83
Max Power Output (Watts) ¹	3.11
Max Efficiency (%) ¹	81
No-Load Speed (rpm) $\pm 12\%$ ¹	10,600
Friction Torque (at no-load speed)(oz-in)	0.017
No-Load Current (mA) $\pm 50\%$ ²	22
Stall Torque (oz-in.) ¹	1.59
Velocity Constant (rpm/Volt)	1,790
Back EMF Constant (mV/rpm)	0.560
Torque Constant (oz-in./Amp)	0.758
Armature Inductance (mH)	0.07

Encoder Specifications:

Supply Voltage	5 VDC Nom.
Max Supply Voltage	5.5 VDC
Operating Current	6 mA Nom. @ 5 VDC
Signal Phase Shift	90°
Max Signal Frequency	20 KHz
Operating Temp. Range	-25°C to +85°C (-13°F to +185°F)
Signal Rise Time	0.1µs max.
Phase Relationship	Ch. A leads Ch. B when motor rotation is clockwise as viewed from shaft end.
Pulses Per Revolution	50 (2 channels)
Quadrature	200 encoder counts

Mechanical Specifications (Motor):

Mechanical Time Constant (ms) ¹	7
Armature Inertia	0.71g-cm ²
Angular Acceleration (x 10 ³ rad/sec ²) ¹	160
Thermal Resistances (°C/W)	
Rotor to Case	6
Case to Ambient	25
Max Shaft Load	
Radial at 3,000 rpm (3mm from bearing)	1.2 N
Axial (Static)	20 N
Weight	0.71 oz (19 gram)
Max Operating Temp. Range	-30°C to +85°C (-22°F to +185°F)
Max Rotor Temp.	125°C (257°F)

(1) Specified at nominal supply voltage.

(2) Specified with shaft diameter = 1.5mm at no-load speed.

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 and MM-4M-R

Resolution Data Sheet

Linear Motion: MM-4M-EX, 80 TPI Lead Screw, 13mm mtr, 16 enc. *lines/mtr rev

Gearhead Ratio	Actual Gear Ratio	Resolution ¹		Max Travel Rate ²	
		Inch/count	mm/count	Inch/s	mm/s
14:1	13.795918367:1	14.1573 x 10 ⁻⁶	0.3595 x 10 ⁻³	0.30	7.6
43:1	42.920634921:1	4.5506 x 10 ⁻⁶	0.1155 x 10 ⁻³	0.096	2.4
66:1	66.220408163:1	2.9494 x 10 ⁻⁶	0.0749 x 10 ⁻³	0.062	1.5
134:1	133.530864198:1	1.4627 x 10 ⁻⁶	0.0371 x 10 ⁻³	0.030	0.78
159:1	159.419501134:1	1.2251 x 10 ⁻⁶	0.0311 x 10 ⁻³	0.025	0.64
246:1	245.961516035:1	0.7941 x 10 ⁻⁶	0.0201 x 10 ⁻³	0.016	0.41
415:1	415.429355281:1	0.4701 x 10 ⁻⁶	0.0119 x 10 ⁻³	0.010	0.25
592:1	592.129575640:1	0.3298 x 10 ⁻⁶	0.0083 x 10 ⁻³	0.006	0.16
989:1	988.891428571:1	0.1975 x 10 ⁻⁶	0.0050 x 10 ⁻³	0.0036	0.092
1,526:1	1,525.718204082:1	0.1280 x 10 ⁻⁶	0.0032 x 10 ⁻³	0.0027	0.069
2,608:1	2,625.740771277:1	0.0744 x 10 ⁻⁶	0.0018 x 10 ⁻³	0.0015	0.039
4,365:1	4,385.142457309:1	0.0445 x 10 ⁻⁶	0.0011 x 10 ⁻³	0.0009	0.023
5,647:1	5,666.953329446:1	0.0345 x 10 ⁻⁶	0.0008 x 10 ⁻³	0.0007	0.018

Rotary Motion: MM-4M-R, 90:1 Worm Drive Ratio 13mm mtr, 16 enc. *lines/mtr rev

Gearhead Ratio	Actual Gear Ratio	Resolution ¹		Max Travel Rate ²
		degree/count	arc-s/count	Degree/s
14:1	13.795918367:1	4.53032 x 10 ⁻³	16.3091	96.63
43:1	42.920634921:1	1.45617 x 10 ⁻³	5.2422	31.00
66:1	66.220408163:1	0.94381 x 10 ⁻³	3.3977	20.09
134:1	133.530864198:1	0.46805 x 10 ⁻³	1.6850	9.90
159:1	159.419501134:1	0.39204 x 10 ⁻³	1.4113	8.36
246:1	245.961516035:1	0.25410 x 10 ⁻³	0.9147	5.36
415:1	415.429355281:1	0.15044 x 10 ⁻³	0.5416	3.18
592:1	592.129575640:1	0.10555 x 10 ⁻³	0.3799	2.18
989:1	988.891428571:1	0.06320 x 10 ⁻³	0.2275	1.361
1,526:1	1,525.718204082:1	0.04096 x 10 ⁻³	0.1474	0.90
2,608:1	2,625.740771277:1	0.02380 x 10 ⁻³	0.0856	0.54
4,365:1	4,385.142457309:1	0.01425 x 10 ⁻³	0.0513	0.27
5,647:1	5,666.953329446:1	0.01102 x 10 ⁻³	0.0397	0.23

Notes:

1) The lead values shown above in both travel rate and resolution calculations, are for 80 (1/80) thread per Inch (TPI) lead-screws. For a 40 TPI leadscrew, substitute 0.025 inch lead.

2) Max travel rate calculated with motor armature running at a maximum speed of 20,000 RPM

*The resultant quadrature output is equal to 64 encoder counts per motor armature revolution. (mtr rev)

Travel rate calculations:

Output Shaft RPM	= RPM of motor / Gearhead Ratio
Distance per minute	= Output shaft RPM x Lead (0.0125 inch, 0.03175mm)
Distance per second	= Distance per minute/60
Distance in millimeter	= inch/39.37 X 10 ⁻³
Distance in micrometer	= inch/39.37 x 10 ⁻⁶

Conversion:

1 inch	= 25.4 mm
1 inch	= 25,400µm
1 millimeter (mm)	= 39.37 x 10 ⁻³ inch
1 micrometer (µm)	= 39.37 x 10 ⁻⁶ inch
1 degree	= 3,600 arc-s
1 arc-s	= 0.277 x 10 ⁻³ degree

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.

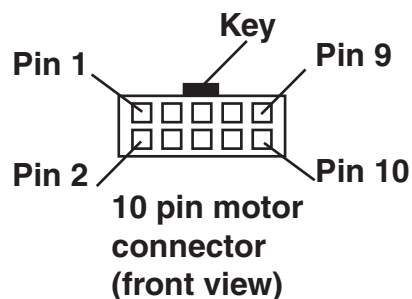
MTR-13E MicroMini™ Motor

Connection Specifications

Motor Connector Pin Assignments:

Motor Type: MTR-13-E
Connector Type: Dual Row IDC
Mating Part: Panduit P/N 057-010-115S
(male pin socket with mounting flange)

Note: Mating connectors may be purchased from National Aperture, Inc.



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

*Optional: +5V with Optical Limit Switches

Electrical Specifications:

Supply Voltage Nom. (Volts)	6
Armature Resistance (Ohm) $\pm 12\%$	3.6
Max Power Output (Watts) ¹	2.43
Max Efficiency (%) ¹	78
No-Load Speed (rpm) $\pm 12\%$ ¹	10,900
Friction Torque (at no-load speed)(oz-in)	0.018
No-Load Current (mA) $\pm 50\%$ ²	25
Stall Torque (oz-in.) ¹	1.20
Velocity Constant (rpm/Volt)	1,840
Back EMF Constant (mV/rpm)	0.542
Torque Constant (oz-in./Amp)	0.734
Armature Inductance (mH)	0.08

Encoder Specifications:

Supply Voltage	5 VDC Nom.
Max Supply Voltage	5.5 VDC
Operating Current	5 mA Nom. @ 5VDC
Signal Phase Shift	90°
Max Signal Frequency	20 KHz
Operating Temp. Range	-25°C to +85°C (-13°F to +185°F)
Signal Rise Time	Less than 5 μ s
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

Mechanical Specifications (Motor):

Mechanical Time Constant (ms) ¹	9
Armature Inertia (x 10 ⁻⁴ oz-in.-sec ²) ¹	0.095
Angular Acceleration (x 10 ³ rad/sec ²) ¹	130
Thermal Resistances (°C/W)	
Rotor to Case	8
Case to Ambient	40
Max Shaft Load	
Radial at 3,000 rpm (3mm from bearing)	18 oz (510 gram)
Axial (Static)	36 oz (1021 gram)
Weight	0.71 oz (20 gram)
Max Operating Temp. Range	-30°C to +85°C (-22°F to +185°F)
Max Rotor Temp.	100°C (212°F)

(1) Specified at nominal supply voltage.

(2) Specified with shaft diameter = 1.5mm at no-load speed.

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 / MM-4M-F

12 Position Encoder Resolution Data Sheet

Linear Motion: 80 TPI Lead Screw

Gearhead Ratio	Max Travel Rate ²		Resolution ¹	
	Inch per second	mm per second	µinch per count	µm per count
16:1	0.2604	6.6146	16.276	0.41341

Rotary Motion: 80:1 Worm Drive Ratio

Gearhead Ratio	Final Output	Max Travel Rate ²		Resolution ¹	
		degree per second	degree per count	arc-second per count	
16:1	1,280:1	93.75	5.859375×10^{-3}	21.1530	

note: for 16:1 gearhead there are 61,440 counts for 360° rotation.

Travel rate calculations:

Output Shaft RPM	=RPM of motor/Gearhead Ratio
Distance per minute	= Output shaft RPM x Lead (0.0125 inch, 0.3175 mm)
Distance per second	= Distance per minute/60
Distance in millimeter	= inch/39.37 x 10 ⁻³
Distance in micrometer	= inch/39.37 x 10 ⁻⁶

Encoder resolution calculations:

Encoder counts per shaft revolution	= 48 encoder counts x Gearhead ratio
Minimum encoder count (inch)	= Lead (0.0125 inch)/ Encoder counts per output shaft revolution
Minimum encoder count (millimeter)	= Minimum encoder count (inch)/39.37 x10 ⁻³ inch
Minimum encoder count (micrometer)	= Minimum encoder count (inch)/39.37 x 10 ⁻⁶

Conversion:

1 inch (in.)	= 25.4 mm
1 inch (in.)	= 25,400 µm
1 millimeter (mm)	= 39.37 x 10 ⁻³ inch
1 micrometer (µm)	= 39.37 x 10 ⁻⁶ inch
1 deg (deg)	= 3,600 arc-second
1 arc-sec	= 0.277 x 10 ⁻³ degree

Notes:

- 1) The lead values shown above in both travel rate and resolution calculations, are for 80 (1/80) Threads per Inch (TPI) leadscrews. For a 40 TPI leadscrew, substitute 0.025 inch lead.
- 2) Max travel rate calculated with motor armature running at a maximum speed of 20,000 RPM.
- 3) The 10 mm motors used with rotary stages incorporate dual channel, 12 position, magnetic encoders. The resultant quadrature output is equal to 48 encoder counts per motor armature revolution.

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-10-12E-HT MicroMini™ Motor

Connection Specifications

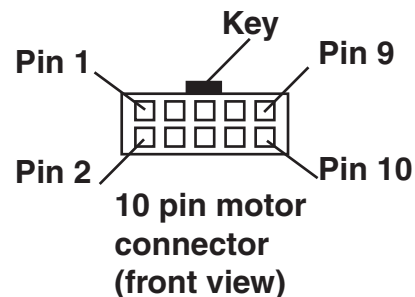
Motor Type: MTR-10-12E with 16:1 planetary gearhead and magnetic encoder

Connector type: Dual row IDC

*Mate Part# (male pin socket):

Panduit 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



Electrical Specifications:

Supply Voltage Nom. (Volts)	6
Armature Resistance (Ohm)±12%	9.09
Max. power output (Watts) ⁽²⁾	0.81
Max. Efficiency (%) ⁽²⁾	78
No Load Speed (RPM) ±12% ⁽²⁾	13,200
No Load Current (mA) ±50% ⁽³⁾	8
Stall Torque (oz-in) ⁽²⁾ mN	2.34
Velocity Constant (RPM/Volt)	2,231
Torque Constant (mN/A)	4.28
Armature Inductance (mH)	0.08
Speed/torque gradient (rpm/mN)	5630
Starting Current (mA)	660
Maximum permissible speed (rpm)	19,000
Maximum continuous current (mA)	291
Maximum continuous torque (mN)	1.28
Maximum power output at nominal voltage (mY)	962
Thermal time constant winding(s)	2

Encoder Specifications:

Supply Voltage	5 VDC Nom.
Max Voltage Supply	24 VDC
Operating Current	8mA Nom. @5 VDC
Signal Phase Shift	90°
Max. Signal Freq.	min. 20 KHz
Temperature Range	-20°C to +80° C
Output Signal Type	Square wave
Phase Relationship	Ch A leads CH B when motor rotation is clockwise as seen from shaft end.
Pulses per Revolution	12 (2 channels)
Quadrature	48
Output signal TTL compatible	

Mechanical Specifications:

Mechanical Time Constant (ms) ⁽²⁾	7
Armature Inertia (g - cm ²)	0.098
Maximum rotor temperature	+85°C
Axial Play	0.2mm
Thermal Resistance (K/W)	
Rotor to Case	9
Case to Ambient	38
Maximum Shaft Load (N)	
Radial 5mm from flange	0.5
Axial	2
Weight	10 gram
Planetary Gearhead recommended input speed <8000 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.

Resolution for 40 TPI Leadscrew

Data Sheet

Linear Motion: 10mm Motors/w 10 position encoders

Gearhead Ratio	Max Travel Rate ²		Resolution ¹	
	Inch per second	mm per second	μinch per count	μm per count
16:1	0.5208	13.2292	39.0625	0.992189484379
64:1	0.1302	3.3073	9.765625	0.248047371095
256:1	0.0326	0.8268	2.44140625	0.0620118427737
1024:1	0.0081	0.2067	0.6103515625	0.0155029606934

Linear Motion: 10mm Motors/w 12 position encoders

Gearhead Ratio	Max Travel Rate ²		Resolution ¹	
	Inch per second	mm per second	μinch per count	μm per count
16:1	0.5208	13.2292	32.552083	0.826824570315
64:1	0.1302	3.3073	8.13802083	0.206706142579
256:1	0.0326	0.8268	2.0345052083	0.051676535644
1024:1	0.0081	0.2067	0.508626302083	0.0129191339112

Linear Motion: 13mm Motors w/16 position encoders

Gearhead Ratio	Max Travel Rate ²		Resolution ¹	
	Inch per second	mm per second	μinch per count	μm per count
14:1	0.6040	15.3427	28.3145340244	0.719190602601
43:1	0.1942	4.9316	9.10110022182	0.231168407971
66:1	0.1258	3.1964	5.89886125495	0.149831375538
134:1	0.0624	1.5852	2.92535364274	0.0743041311339
159:1	0.0523	1.3277	2.45029621358	0.0622376483002
246:1	0.0339	0.8606	1.58815495325	0.040339216491
415:1	0.0201	0.5095	0.940292242313	0.0238834707217
592:1	0.0141	0.3575	0.659695134427	0.016756289927
989:1	0.0084	0.2140	0.395013030464	0.0100333510405
1526:1	0.0052	0.1387	0.25602696419	0.00650309789662
2608:1	0.0032	0.0806	0.14876754182	0.00377870311963
4365:1	0.0019	0.0483	0.0890792041086	0.00226261630959
5647:1	0.0015	0.0374	0.0689303365126	0.00175083404909

Encoder resolution calculations:

Encoder counts per leadscrew revolution (10 position encoder) = 40 encoder counts x Gearhead ratio
Encoder counts per leadscrew revolution (12 position encoder) = 48 encoder counts x Gearhead ratio
Encoder counts per leadscrew revolution (16 position encoder) = 64 encoder counts x Gearhead ratio
Resolution (inch) = Lead (0.0125 inch) / Encoder counts per leadscrew revolution
Resolution (micrometers) = Resolution (inch) / 39.37 x 10⁻⁶ inch/(μm)

Notes:

- 1) The lead values shown for travel rate and resolution calculations are for 40 Threads per Inch (TPI) leadscrews.
(1inch/40 threads = 0.025 inch/thread)
- 2) Max travel rate calculated with motor armature running at a maximum speed of 20,000 RPM.

Anti-Backlash Option For MM-3M-EX and -F Stages

overview

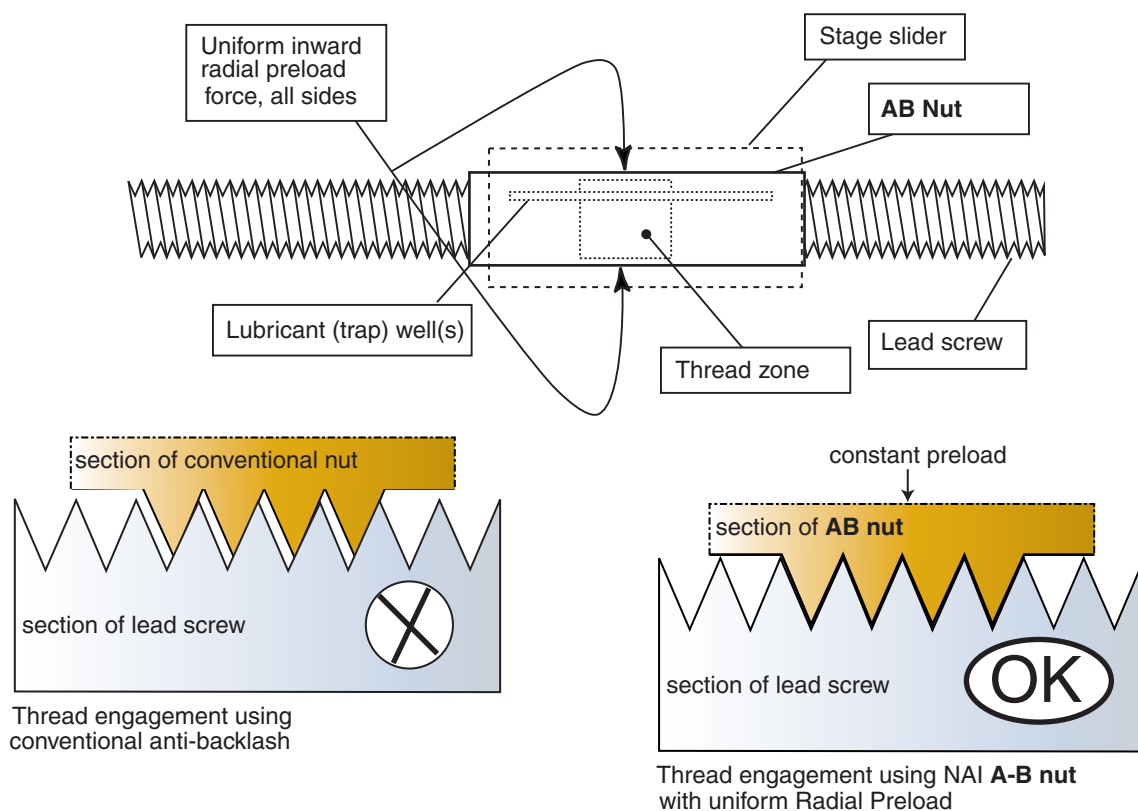
The AB version is not limited to just providing anti-backlash; the AB option provides many additional benefits that make it the preferred choice of users.

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 (50 μ inch).
- **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



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.

MicroMini™ Controller

Overview

TO THE MICRO-MOTION USER

National Aperture 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 “break-through” prices.

Our new constraint-free design minimizes inherent error and provides linear and rotary motion in a unique, compact configuration to give you the ultimate in accuracy, linearity, repeatability and speed in the smallest conceivable amount of space. Our miniature servo-motor has advantages that far surpass any comparable stepper motor.

Our Controllers:

Now it's easy to integrate your total motion control solution. You can begin with confidence to replace your more critical hand operations in production and laboratory. National Aperture provides “plug in and go” solutions for both PC and Macintosh™. Our motion control cards 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.

We are dedicated to bringing you into the world of motion control with the finest state of the art components.

How The MicroMini™ Stage Works

Overview

GENERAL APPLICATION

The MM stage is designed for loads under 6 ounces (170g) and low moments below 8 in.-oz.

SLIDE SYSTEM

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

RETURN PRELOAD SPRING

The standard manual stages and ST motor stages 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 THROUGH 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

Option 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 as demanded by the submicrometer resolution.

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-4 stage is provided as a base to better carry the weights of additional axes, thus improving the end load capacity by a pyramid effect.

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 consequent 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 (MM-3) manual and motor stages and some dissimilar (MM-, MM-1) series are compatible for quick, multi-axis connection using standard English screws.

ENGLISH-METRIC

All MM- stages can be manufactured to be compatible with English or Metric threaded fasteners.