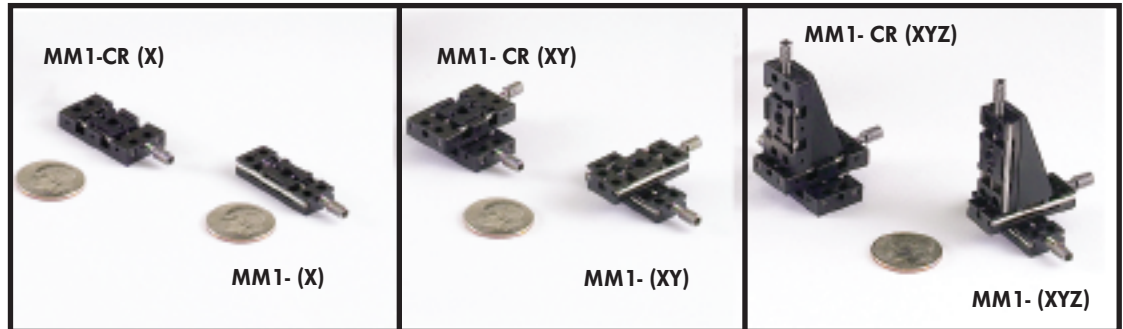




MM-1

Manual Stages



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

Specifications:

	Travel	Runout (max)	Return Force (ext.-comp.)	Weight
MM-1	3.175mm	1 μ m	113 - 312g	3g
MM-1-CR	3.175mm	1 μ m	113 - 312g	4g
MM-1-EX	5.715mm	1.5 μ m	170 - 510g	2.5g
MM-1-SPR-090	3.175mm	1 μ m	227 - 510g	3g

Wobble (max): 10 μ rad (2 arc sec) (no ball bearings)

Thermal Stability: 15° to 75°C

Screw Pitch: 80 TPI

Sensitivity: 0.5 μ m

Backlash: 0

Load Capacity:

Direct top or side load: 0.25 kg

Push: 0.5 kg

Retract ext-comp.: See return force above

Tilt: 3 in-oz (210 g-cm)

Twist: 1.5 in-oz (105 g-cm)

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

	-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)
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)
MM-1-EX	26.2 x 11.2 x 5.1 (mm)	26.2 x 26.2 x 10.2 (mm)	
MM-1-SPR-090	26.2 x 11.2 x 5.1 (mm)	26.2 x 26.2 x 10.2 (mm)	

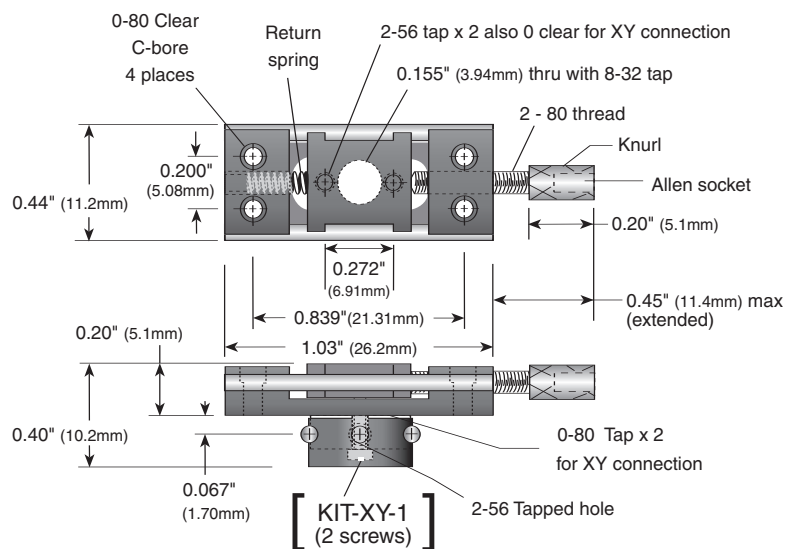
- -XZ configurations available
- -CR, -EX, and -090 versions may be combined
- Z axis must be a stage with Z connection enabled

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

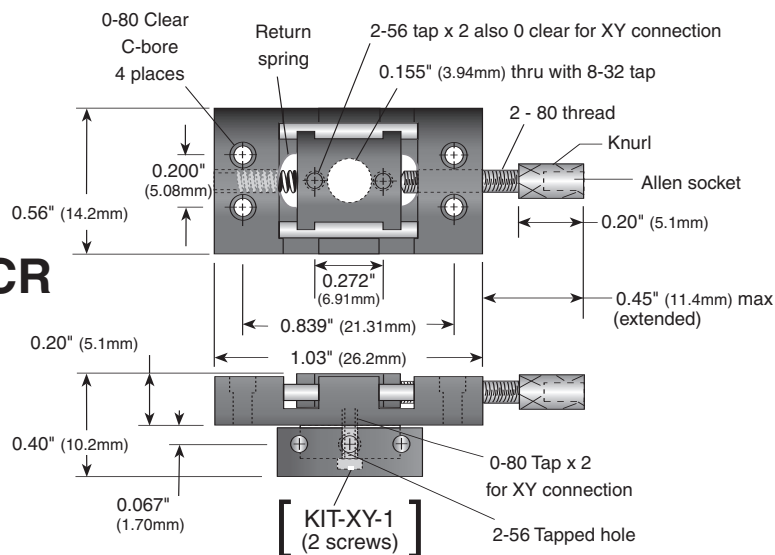
Dimensional Data

MM-1



Totally Metric/English Compatible

MM-1-CR



Totally Metric/English Compatible

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MM-1 Manual MicroMini™ Stage Accessories

Accessories

AP-1Adapter Plate

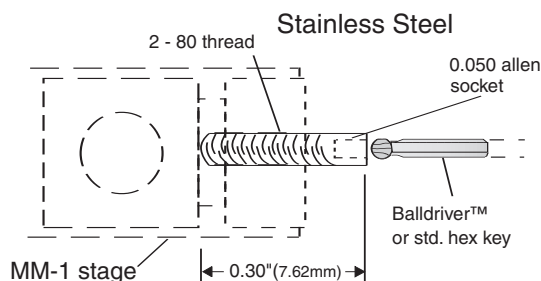
KIT-XY-1 . . .MM-1-XY connection screw kit.

KIT-Z-1 . . .MM-1-Z Connection with screws.

PA-1Pinhole Adapter

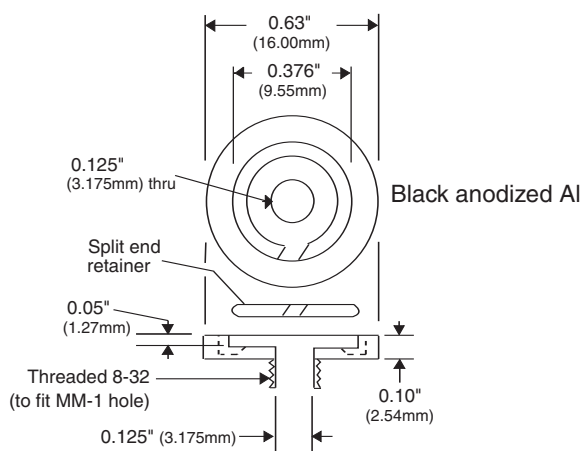
SS-1Headless Adjusting Screw

TG-1Thumb Grip



SS-1 Headless Adjusting 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).

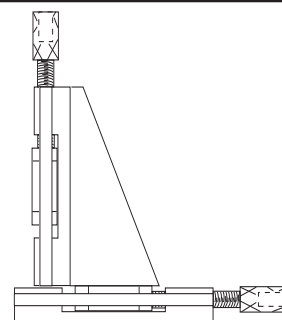


PA-1 Pinhole Adapter

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.]

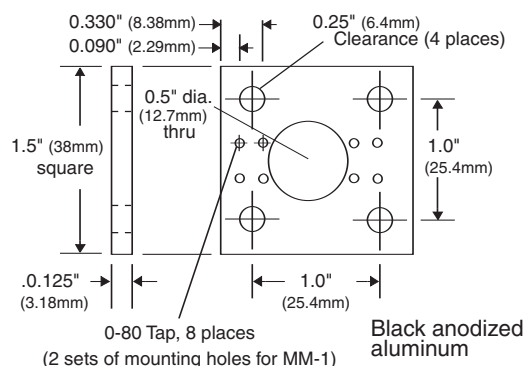
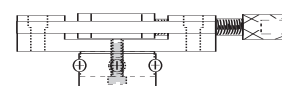
KIT-Z-1

Attaches 2 MM-1 stages into an XZ configuration.



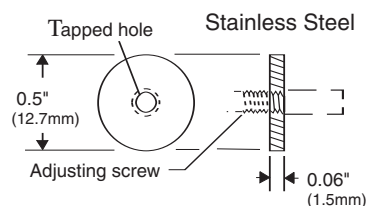
KIT-XY-1

Utilizes 2 tap holes in slider as clearance for 0-80 connecting screws.



AP-1 Adapter Plate

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



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.

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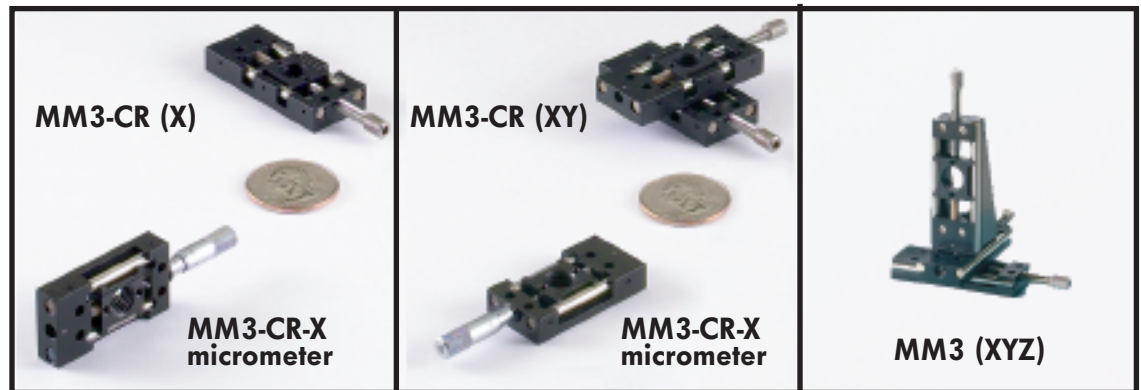
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MM-3

Manual Stages



The **larger** of the Manual stages, this unique micropositioner is also a dimensional breakthrough. The MM-3 manual MicroMini™ Stage is a precision instrument designed for space and weight limitations as well as higher loads and longer travel.

Constructible into **over 16 different configurations** (request “Basic Construction Diagrams”).

Specifications:

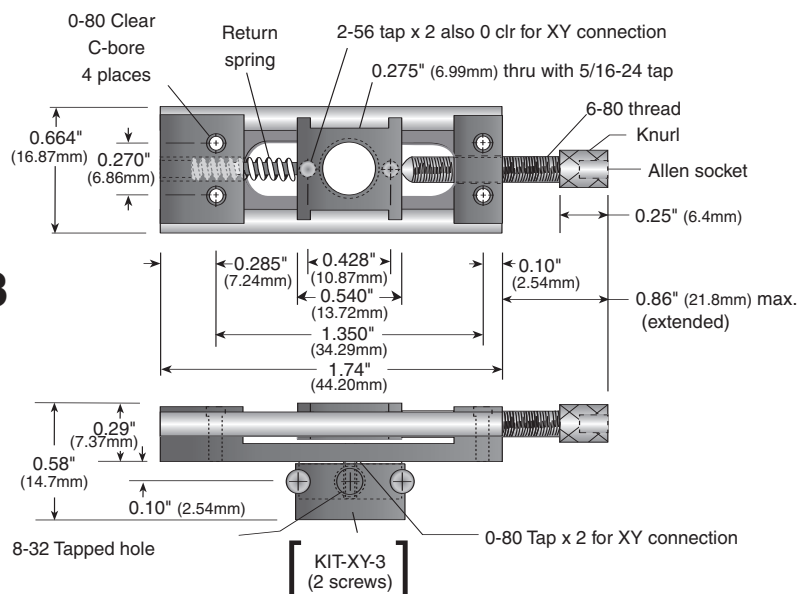
	MM-3	MM-3-CR	
Travel:	0.5 in. (12.7mm)	0.5 in. (12.7mm)	
Runout (max):	1.5µm	1.5µm	
Return Force ext.-comp.:	6-20oz(170-567g)	6-20oz (170-567g)	
Weight:	16g	20g	
Screw Pitch:	80 TPI		
Sensitivity:	0.5µm		
Backlash:	0 (no ball bearings)		
Wobble(max):	0.01mrad		
Thermal Stability:	15° to 75°C		
Load Capacity:			
Direct top or side load:	0.34 kg		
Push:	1 kg		
Retract ext-comp.:	See return force as specified above		
Tilt:	6 in-oz (420 g-cm)		
Twist:	3 in-oz (210 g-cm)		
Dimensions: (L x W x H, not including lead screw extension)			
	-X Single Stage	-XY (2- axis)	-XYZ (3-axis)
MM-3	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)
	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)
MM-3-CR	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)
	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)
•-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)			

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-3 Manual Stage

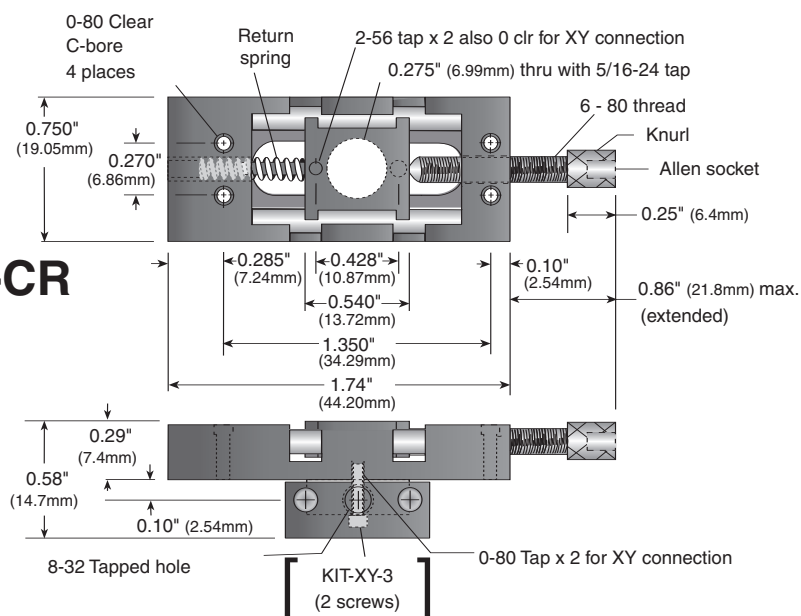
Dimensional Data

MM-3



Totally Metric/English Compatible

MM-3-CR



Totally Metric/English Compatible

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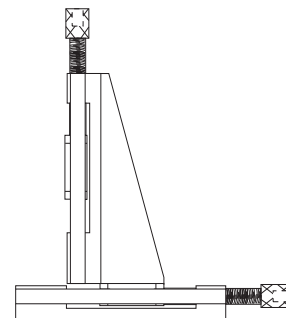
MM-3 Manual MicroMini™ Stage Accessories

Accessories

- AP-3** **Adapter Plate**
KIT-XY-3 **MM-3 XY connection screw kit.**
KIT-Z-3 **MM-3 Z brace/screw.**
OA-3 **Objective Adapter**
PA-3 **Pinhole Adapter**
SS-3 **Headless Adjusting Screw**
TG-3 **Thumb Grip**

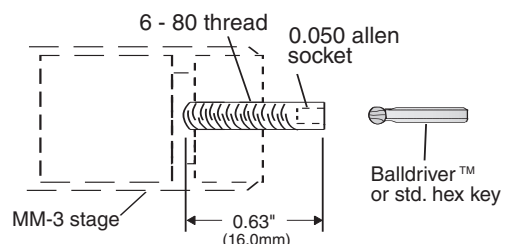
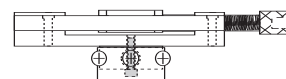
KIT-Z-3

Attaches 2 MM-3 stages into an XZ configuration.



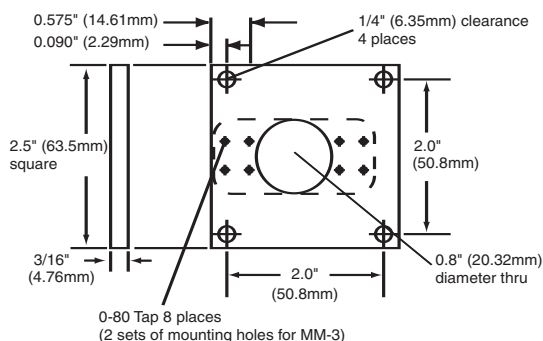
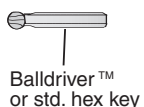
KIT-XY-3

Utilizes 2 tap holes in slider as clearance for 0-80 connecting screws.



SS-3 Headless Adjusting Screw

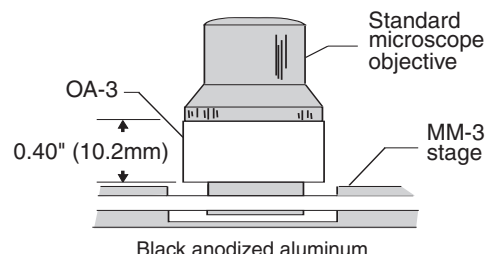
This custom designed stainless lead screw replaces the standard thumb screw, and provides full linear travel while reducing the overall length of the stage by 0.5 in.



AP-3 Adapter Plate

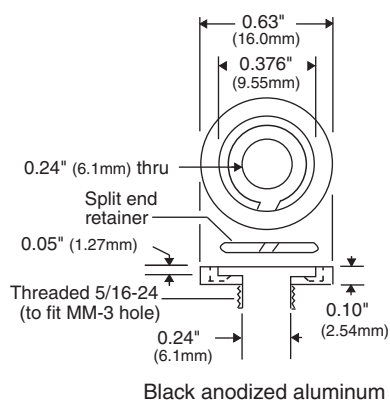
A multi-position mounting plate to interface with standard optical tables and accessories, or to stabilize free-standing stages.

Black anodized aluminum



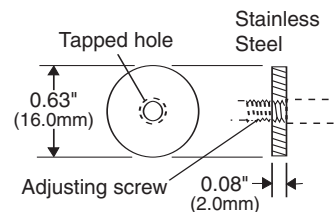
OA-3 Objective Adapter

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



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 in. diameter substrates, or smaller.)



TG-3 Thumb Grip

The knurled 5/8 in. 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.



MM-3M-ST

Standard Motorized MicroMini™ Stage



Specifications:

*Repeatability:	±0.002 mm
*Homing Repeatability:	±0.002 mm
*Accuracy (linearity):	±0.003 mm
Speed (max.):	4 mm/sec 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)
<i>*Encoder resolution must be added based on the gearhead: 16:1 add ±0.5µm, 64:1 add ±0.12µm</i>	
Wobble (max.):	0.02 mrad (~ 4 arc-sec)
Runout (max.):	0.002 mm
Gearhead Backlash:	1-2 µm equivalent; can be compensated in software without overshoot
Motor:	10 mm dia., 6-12 VDC servo, brush type (see motor specifications)
Vacuum compatibility:	10 ⁻³ Torr, standard, higher per request

Load Capacity:

*Direct top or side load:	0.34 kg
*Push:	0.5 kg
**Retract ext-comp.:	2oz-24oz (57g - 680g)
*Tilt:	6 in-oz (420 g-cm)
*Twist:	3 in-oz (210 g-cm)

**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 in.	4.48 x 0.75 x 0.36 (inch)	50g
	12.7mm	113.8 x 19.05 x 9.14 (mm)	50g

Accessories: See MM-3 manual stage accessories

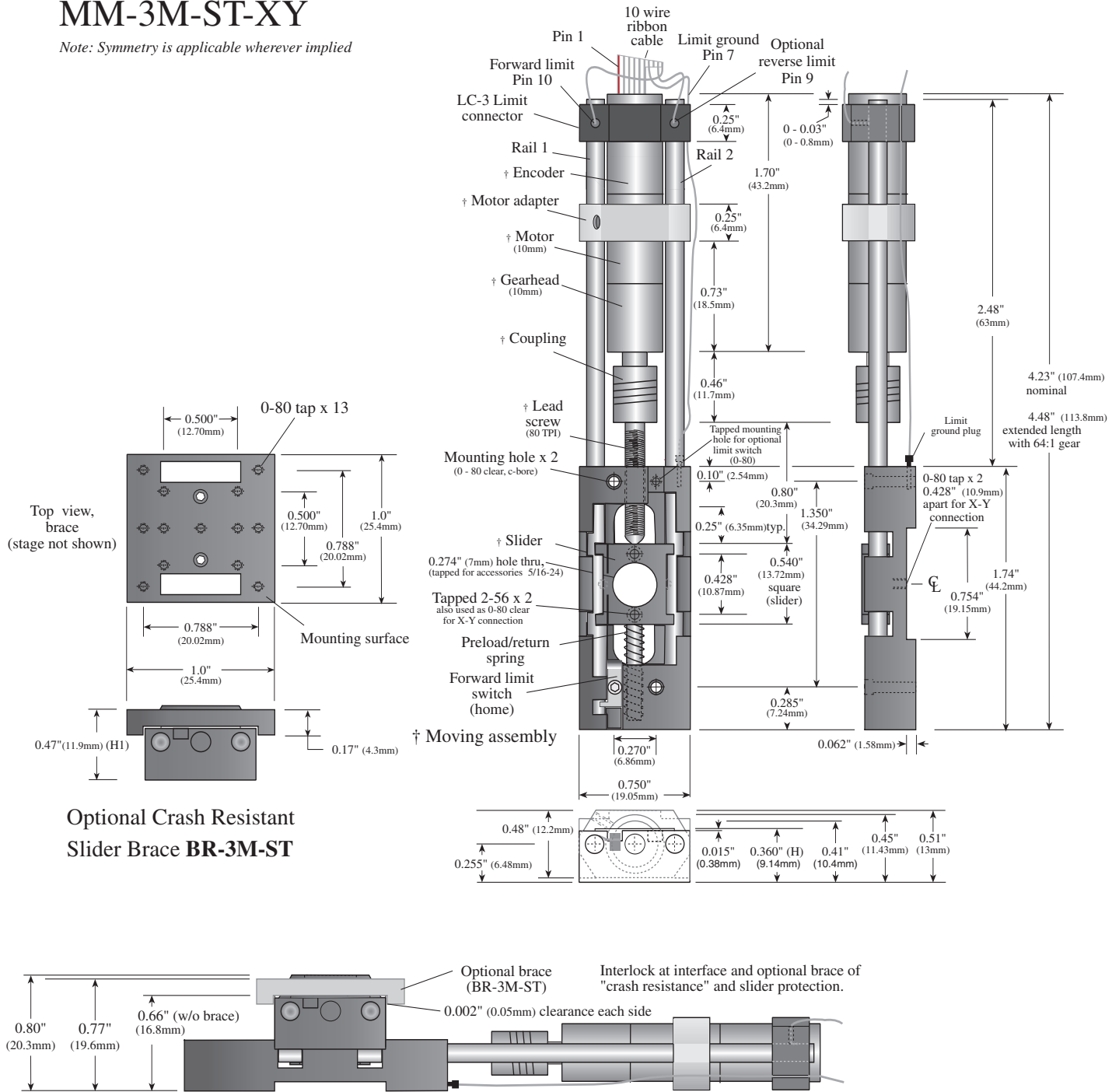
The information contained in this data sheet is subject to change without notice. Critical dimensions or specifications should be verified with our technical support staff.

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.

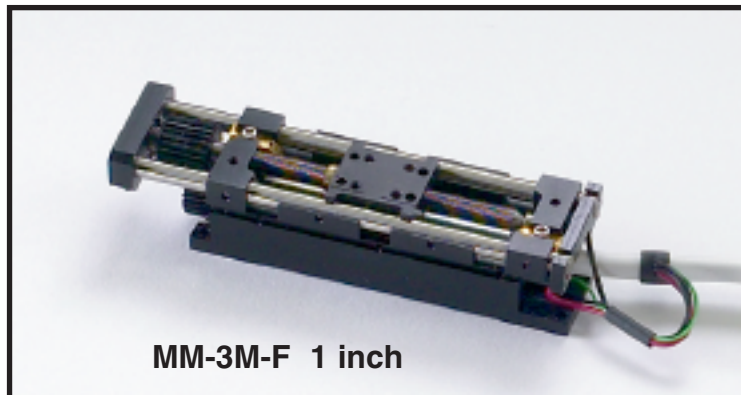
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MM-3M-F

Folded Motorized MicroMini™ Stage



MM-3M-F 1 inch

Specifications

	Standard Slider	AB Slider (anti-backlash)
*Repeatability:	±2µm	±0.5µm
*Homing Repeatability:	±2µm	±0.5µm
*Accuracy (linearity):	±3µm/per inch	±1.5µm/per inch
Speed (max.):	6mm/sec	4mm/sec
†Slider Backlash:	50µm	3µm
Encoder Conversion (resolution): (See also: gearhead options)	0.49609µm per count with 16:1 gearhead	0.12406µm per count 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 dia., 6-12 VDC servo, brush type (see motor specifications)	
Vacuum compatiblity:	10 ⁻³ Torr, standard, higher per request	
Load Capacity:		
Direct top or side load:	0.5 kg	
Push:	0.5 kg	
Pull:	0.5 kg	
Tilt:	8 in-oz (560 g-cm)	
Twist:	4 in-oz (280 g-cm)	
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:

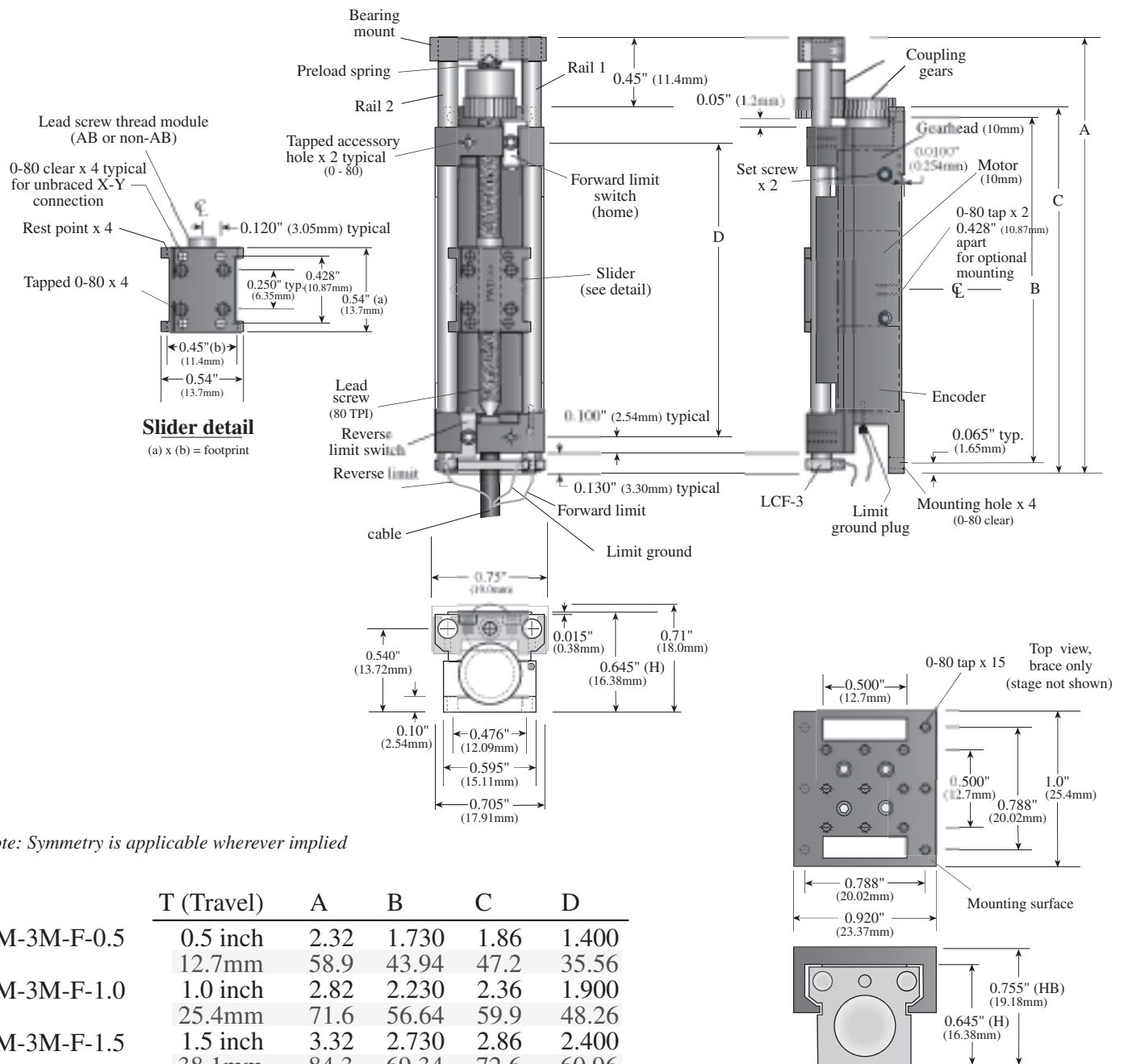
Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-3M-F-0.5	0.5 inch (12.7mm)	2.32 x .075 x 0.64 (inch) 58.9 x 19.1 x 16.3 (mm)	53g
MM-3M-F-1	1.0 inch (25.4mm)	2.82 x 0.75 x 0.64 (inch) 71.6 x 19.1 x 16.3 (mm)	58g
MM-3M-F-1.5	1.5 inch (38.1mm)	3.32 x 0.75 x 0.64 (inch) 84.3 x 19.1 x 16.3 (mm)	63g
MM-3M-F-2	2.0 inch (50.8mm)	3.82 x 0.75 x 0.64 (inch) 97.0 x 19.1 x 16.3 (mm)	68g
MM-3M-F-2.5	2.5 inch (63.5mm)	4.32 x 0.75 x 0.64 (inch) 109.7 x 19.1 x 16.3 (mm)	73g

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

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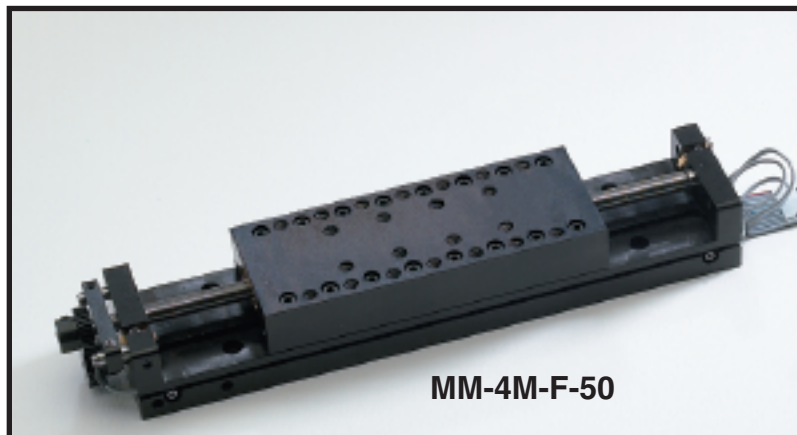
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MM-4M-F

Folded Motorized MicroMini™ Stage

(For heavier loads)



MM-4M-F-50

Specifications

*Repeatability:	±0.5 µm
*Homing Repeatability:	±0.5 µm
Accuracy:	±1.0 µm per 25mm of travel
Straightness:	±2.0 µm maximum deviation per 50mm of travel
Speed (max):	6mm/sec with 16:1 gearhead (other gearheads available)
†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 dia., 6-12 VDC servo, brush type
Slide:	Cross roller bearing
Vacuum Compatibility:	10 ⁻³ Torr, standard, higher per request
Load Capacity:	
Horizontal:	3.0 kg
Vertical:	1.0 kg
Side:	1.5 kg

Travel Ranges and Dimensions:

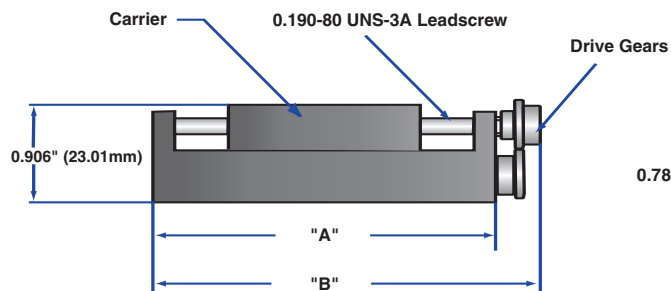
Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-4M-F-25	25mm	97mm x 31.5mm x 23mm	165g
MM-4M-F-50	50mm	162mm x 31.5mm x 23mm	246g

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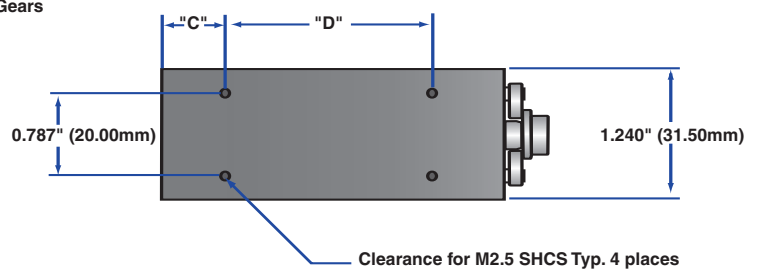
MM-4M-F Motor Stage 25mm & 50mm Travel

Dimensional Data

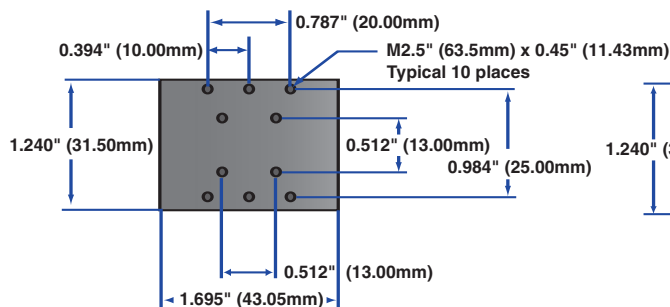
Tabulated Data for MM-4M-F Stages				
Travel	"A"	"B"	"C"	"D"
25mm	3.255" (82.68mm)	3.795" (96.39mm)	0.643" (16.34mm)	1.969" (50.00mm)
50mm	5.830" (148.02mm)	6.370" (161.80mm)	0.946" (24.04mm)	3.937" (100.00mm)



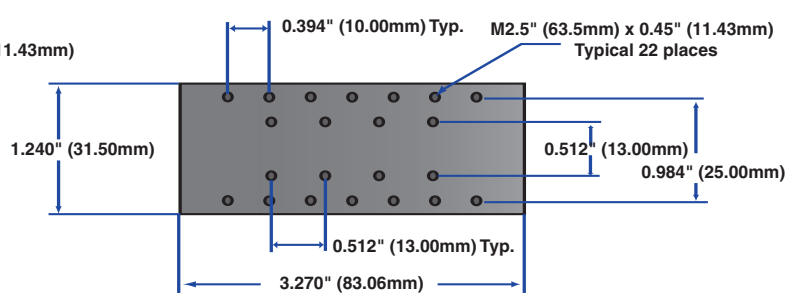
Side View



Bottom View



**25mm Carrier
Top View**



**50mm Carrier
Top View**

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MM-3M-EX

Extended Motorized MicroMini™ Stage

(For extended travel)



Specifications

	Standard Slider	AB Slider (anti-backlash)
*Repeatability:	$\pm 2 \mu\text{m}$	$\pm 0.5 \mu\text{m}$
*Homing Repeatability:	$\pm 2 \mu\text{m}$	$\pm 0.5 \mu\text{m}$
*Accuracy (linearity):	$\pm 3 \mu\text{m}$	$\pm 1.5 \mu\text{m}$
Speed (max.):	6 mm/sec	4 mm/sec
†Slider Backlash:	50 μm	3 μm
Encoder Conversion (resolution): (See also: gearhead options)	0.49609 μm per count w/16:1 gearhead	0.12406 μm per count w/64:1 gearhead
*Encoder resolution must be added, based on the gearhead: 16:1 add $\pm 0.5 \mu\text{m}$, 64:1 add $\pm 0.12 \mu\text{m}$		
†Slider backlash represents maximum overshoot		
Load Capacity:		
Direct top or side load:	0.5 kg	
Push:	0.5 kg	
Pull:	0.5 kg	
Tilt:	8 in.-oz. (560 g-cm)	
Twist:	4 in.-oz. (280 g-cm)	
<i>Note: These stages may be run at twice the specified ratings without damage, but with a loss of accuracy and speed.</i>		
Runout (max.):	3 μm per 25.4 mm (1 inch)	
Gearhead Backlash:	1-2 μm equivalent; can be compensated in software without overshoot	
Motor:	10 mm dia., 6-12 VDC servo, brush type (see motor specifications)	
Vacuum compatibility:	10^{-3} Torr, standard, higher per request	
Wobble (max.):	0.02 mrad (~ 4 arc-sec)	

Travel Ranges and Dimensions:

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

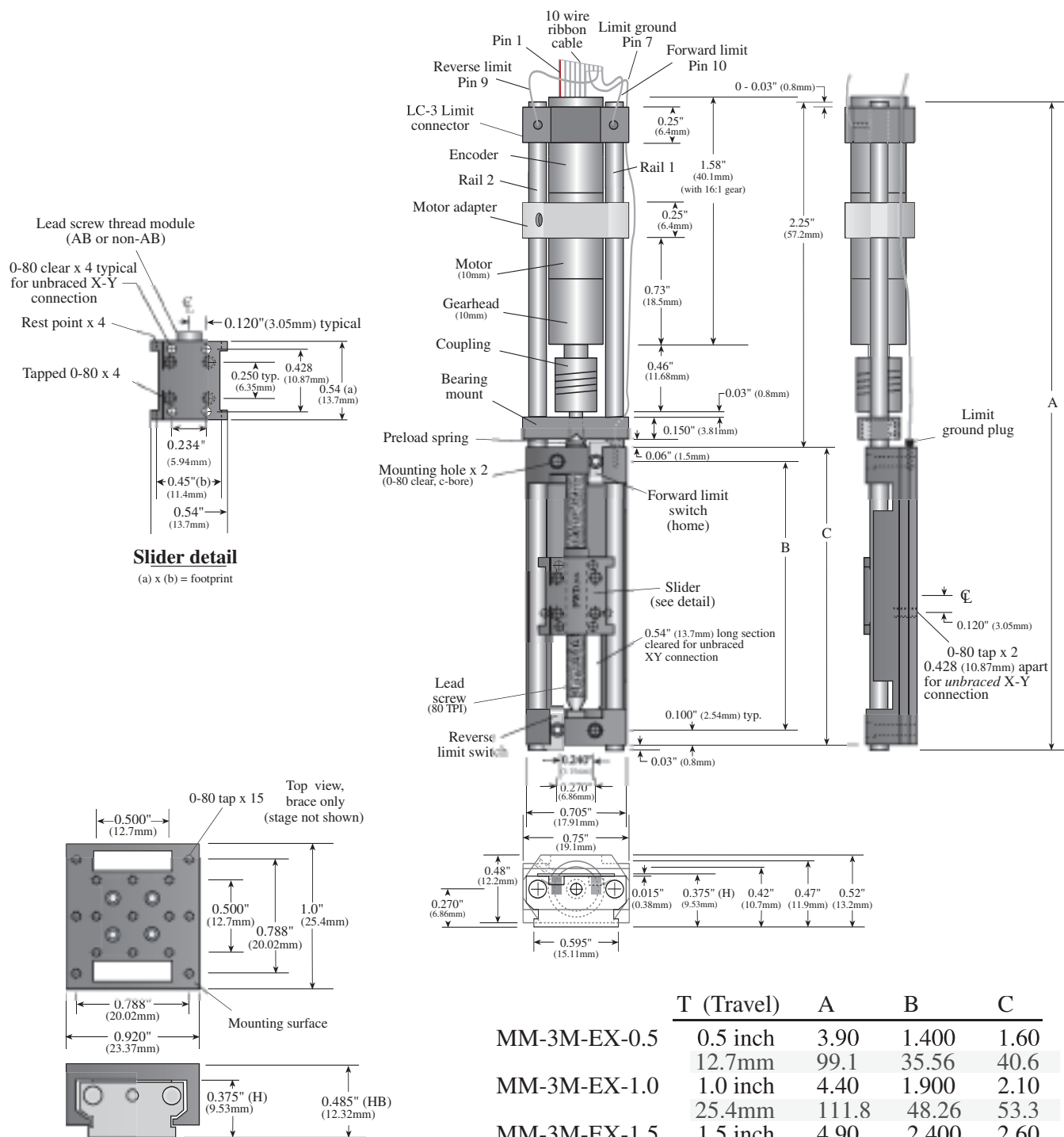
Specify -AB for Anti-Backlash

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



	T (Travel)	A	B	C
MM-3M-EX-0.5	0.5 inch	3.90	1.400	1.60
	12.7mm	99.1	35.56	40.6
MM-3M-EX-1.0	1.0 inch	4.40	1.900	2.10
	25.4mm	111.8	48.26	53.3
MM-3M-EX-1.5	1.5 inch	4.90	2.400	2.60
	38.1mm	124.5	60.96	66.0
MM-3M-EX-2.0	2.0 inch	5.40	2.900	3.10
	50.8 mm	137.2	73.66	78.7

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

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

Note: Symmetry is applicable wherever implied

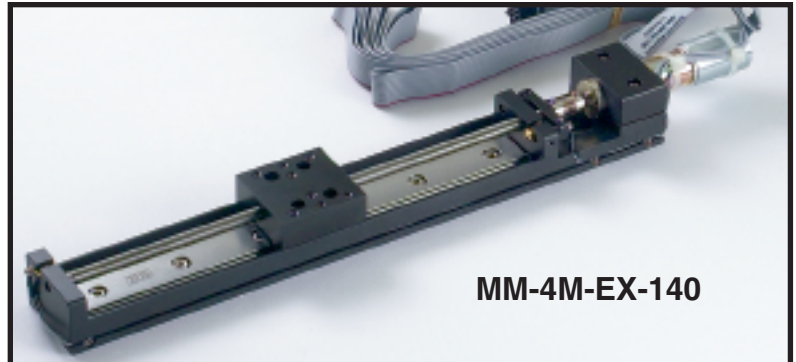
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MM-4M-EX

Extended Motorized MicroMini™ Stage

(For heavier loads)



MM-4M-EX-140

Specifications

*Repeatability:	±0.5 µm
*Homing Repeatability:	±0.5 µm
Accuracy:	±1.0 µm per 25mm of travel
Straightness:	±2.0µm maximum deviation per 200mm of travel
Speed (max):	7 mm/sec with 14:1 gearhead (other gearheads available)
†Slider Backlash:	1 µm
Gearhead Backlash:	<2.54 µm; can be compensated in software without overshoot
Encoder Conversion:	0.3595 µm per count, with 14:1 gearhead
*Encoder resolution must be added , based on the gearhead: 16:1 add ± 0.5 µm, 64:1 add ±0.12 µm	
†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, higher per request
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
MM-4M-EX-80	78 mm	168.68 x 31.5 x 25.4 (mm)	345g
MM-4M-EX-110	108 mm	198.68 x 31.5 x 25.4 (mm)	360g
MM-4M-EX-140	138 mm	228.68 x 31.5 x 25.4 (mm)	375g
MM-4M-EX-170 ¹	168 mm	258.68 x 31.5 x 25.4 (mm)	390g
MM-4M-EX-200 ¹	198 mm	288.68 x 31.5 x 25.4 (mm)	405g
MM-4M-EX-230 ¹	228 mm	318.68 x 31.5 x 25.4 (mm)	420g
MM-4M-EX-260 ¹	258 mm	348.68 x 31.5 x 25.4 (mm)	435g

¹Travel ranges from 168 mm to 260 mm are non-stock items; available on request.

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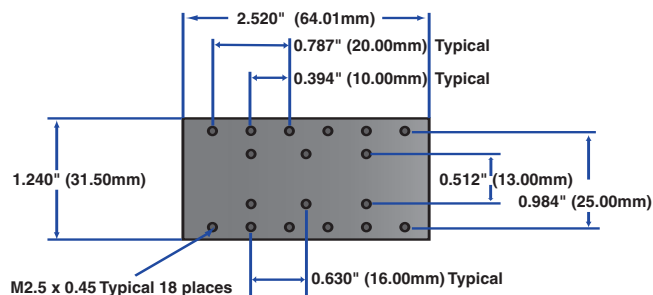
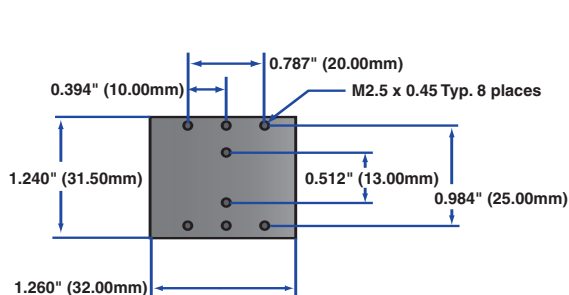
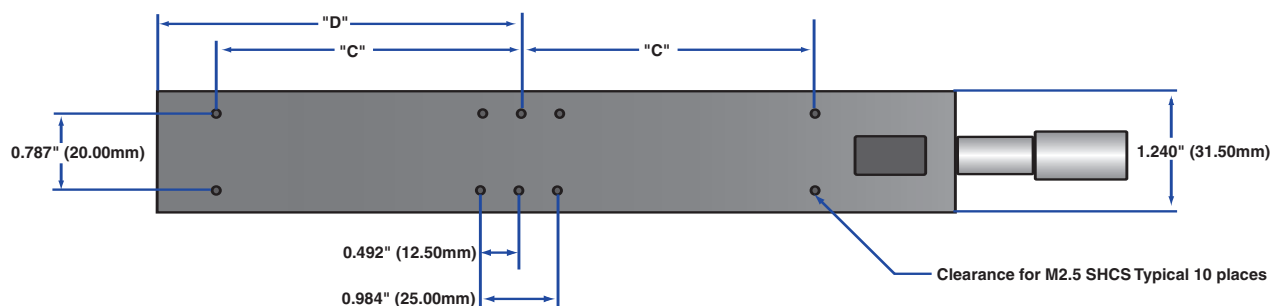
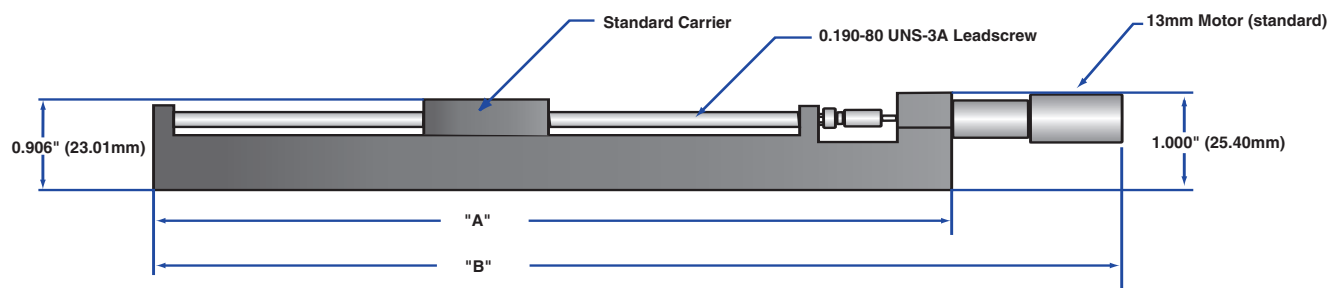
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MM-4M-EX Motor Stage

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)

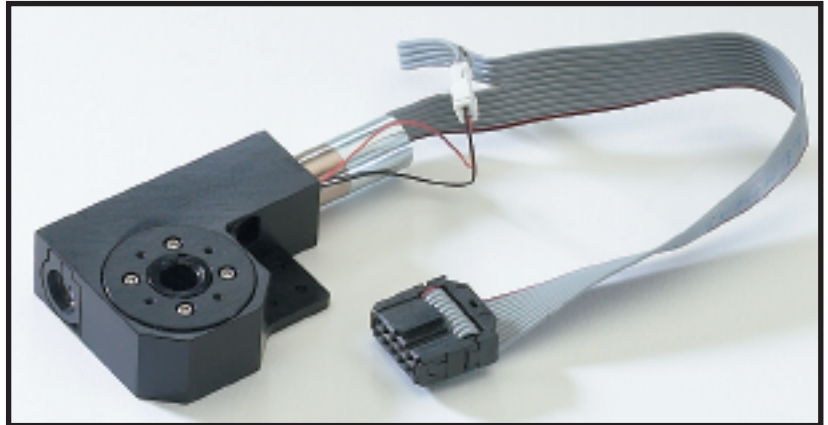


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MM-3M-R

Miniature Rotary Stage (For lighter loads)



Specifications

	MM-3M-R		MM-3M-RA	MM-3M-RA+
Repeatability:	15 arc-sec*		same	same
Homing Repeatability:	60 arc-sec*		same	same
Accuracy: (linearity)	80 arc-sec*		same	same
(See diagram on reverse of this sheet for an illustration of A.,B.,C.,D.)				
A. Axial Wobble (axial angular long range repeatability)	60 arc-sec		2 arc-sec	2 arc-sec
B. Axial angular deviation, total	60 arc-sec		60 arc-sec	2 arc-sec
C. Planar shift, total	1.2 μm		0	0
D. Eccentricity (runout, including bearing mount)	3μm		3μm	3μm
Direct top load:	2 kg axial		0.5 kg axial	0.5 kg axial
Tilt Load	5 kg-cm (70 in.-oz)		1.0 kg-cm (14 in.-oz)	1.0 kg-cm (14 in.-oz)
Torque load	850 g-cm (12 in.oz)		425g-cm (6 in.-oz)	425g-cm (6 in.-oz)
Gearhead Ratio:(see “Resolution Data Sheet”)	64:1 (standard)	16:1	same	same
Speed: (low load)	4 RPM	16 RPM**	same	same
Encoder Conversion: (arc-sec/count)	6.3281	25.3124	same	same
(see gearhead ratios, “Resolution Data Sheet”)				
Gearhead Backlash:	~1 mrad†	~4 mrad†	same	same
Rotor Stall Torque:	200 in-oz††	50 in-oz††	same	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 dia., 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 inches (50.8mm) off axis.

Special Features:

- Dual class 7 custom bearings for ultra-low axial/angular runout
- Multi-faceted connection interface
- Many other gearhead options, easy-change
- Homing switch

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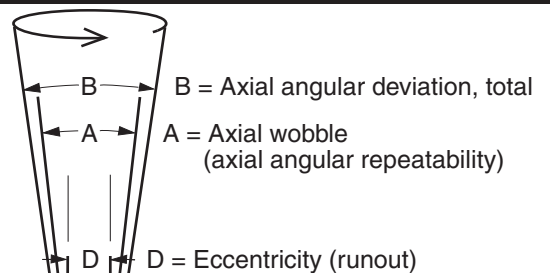
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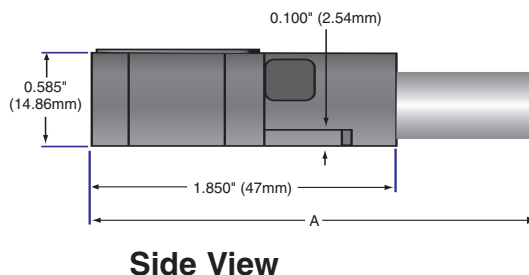
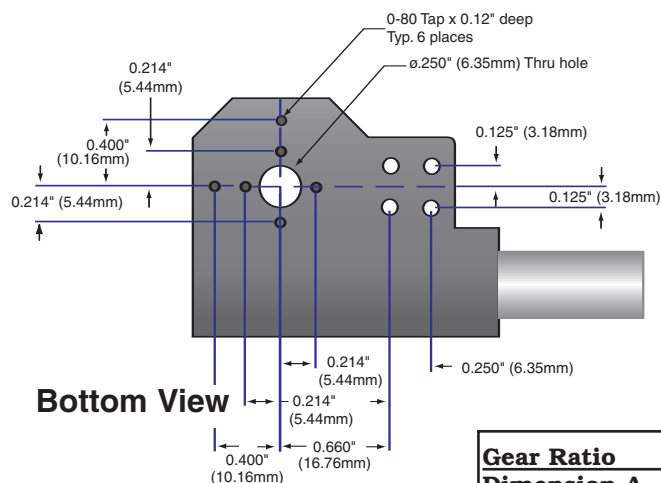
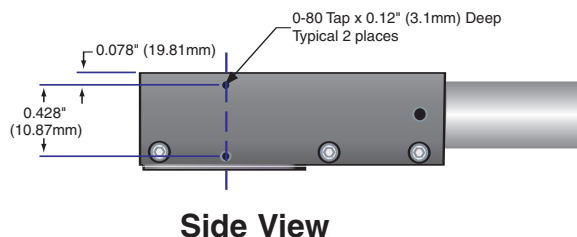
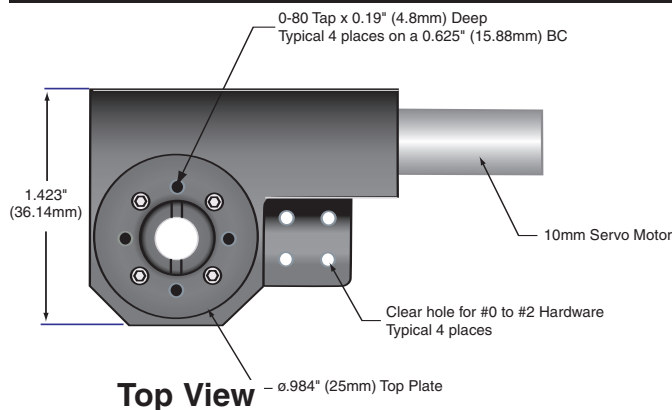
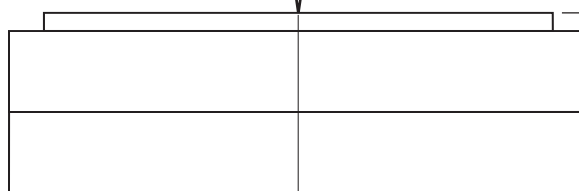
MM-3M-R Rotary Stage

Dimensional Data

Description	MM-3M-R	MM-3M-RA	MM-3M-RA+
A. Axial wobble, (axial angular long range repeatability)	60 arc-sec	2 arc-sec	2 arc-sec
B. Axial angular deviation, total	60 arc-sec	60 arc-sec	2 arc-sec
C. Planar shift, total	1.2 μ m	0	0
D. Eccentricity (runout, including bearing mount)	3 μ m	3 μ m	3 μ m
Direct top load	2 kg	0.5 kg	0.5 kg
Tilt load	5 kg-cm (70 in.-oz)	1.0 kg-cm(14 in.-oz)	1.0 kg-cm(14 in.-oz)



C = Planar shift, total



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 deg.	0.0017 deg.	0.00044 deg.	0.00011 deg.

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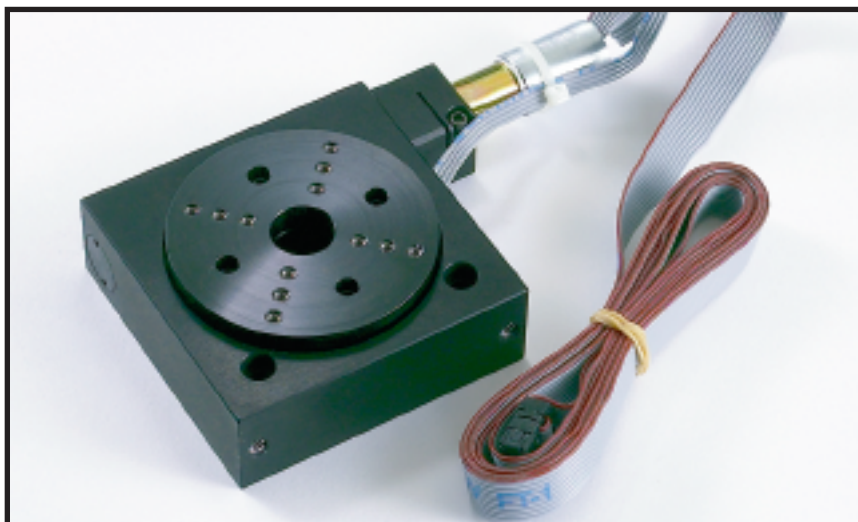
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MM-4M-R

Rotary Motorized MiniStage

(For heavier loads)



Specifications

Repeatability:	±30 arc-sec
Homing Repeatability:	±30 arc-sec
Accuracy (linearity):	±2 arc-min, full travel
Max Travel Rate ¹ :	96.63 deg/sec, w/14:1 gearhead
Encoder Conversion:	16.3091 arc-sec/count, w14:1 gearhead (See also MM-4M Resolution Sheet)

¹Max travel rate calculated with a maximum motor armature speed of 20,000 RPM

Load Capacity:	10 lbs (4.5 kg)
Table Runout:	±2.5µm
Standard Gearhead:	14:1
Gearhead Options:	3.71:1, 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 dia., 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)

Travel Ranges and Dimensions:

Model No.	Travel Range	Stage Body (L x W x H)	Weight
MM-4M-R	Unlimited	5.25 x 2.880 x 1.125 (inch)	1 lb.
		133.4 x 73.15 x 28.58 (mm)	0.454g

Special features:

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

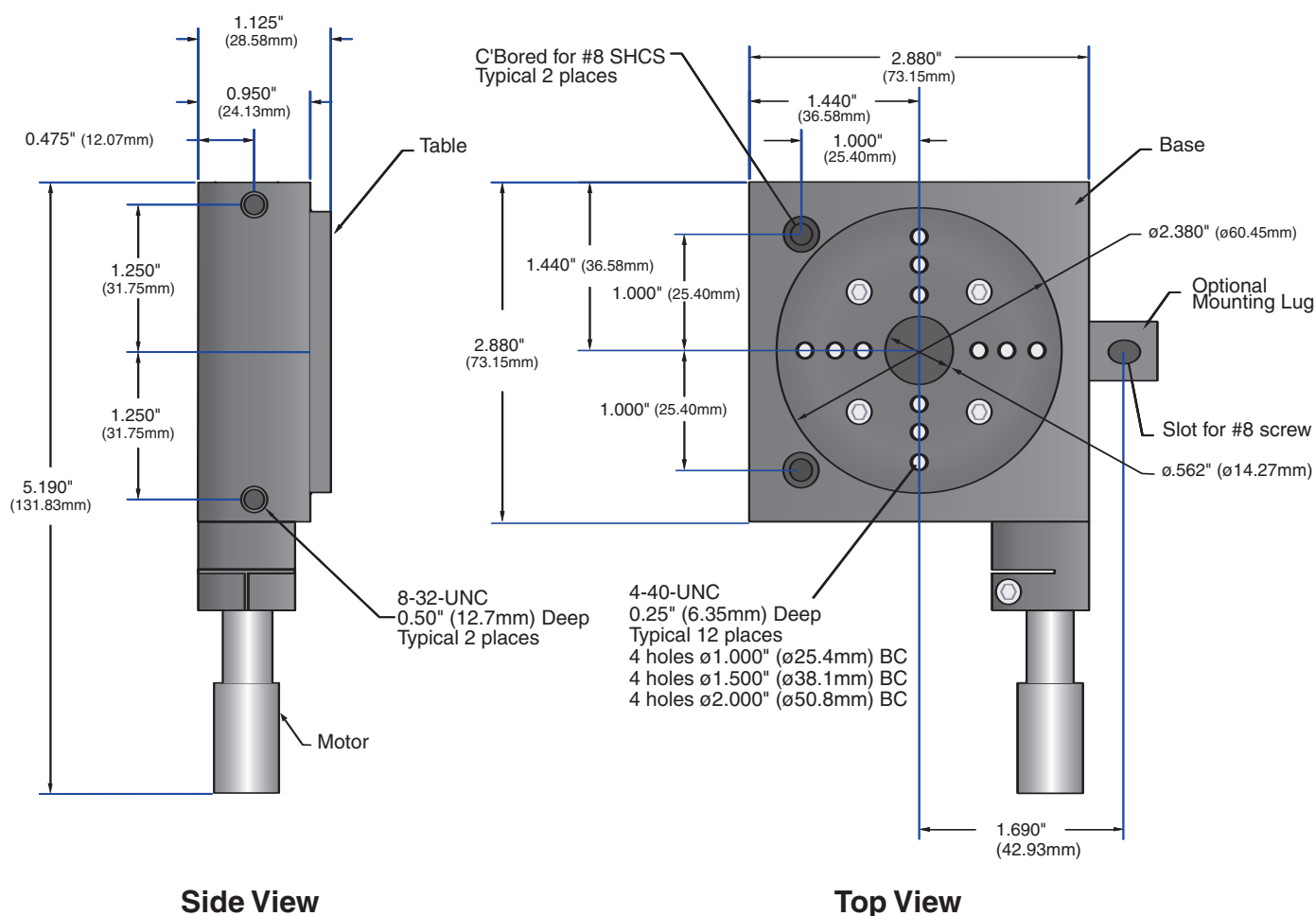
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MM-4M-R Rotary Stage

Dimensional Data



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MC-5B

Manual Position Controller

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;

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MC-4SA Multi-axis Servo Amplifier System

MULTI-AXIS Micro POWER

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



Fully LabVIEW™ by National Instruments compatible.

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
- Auxiliary I/O connector for ease of wiring
- Easily accessible rear panel mounted fuses
- Rack Mountable or Desktop design

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

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Specifications:

AC power input (User-selectable):	110/220VAC
Motor control input voltage:	$\pm 10\text{VDC}$ across 300 K ohms
Encoder supply voltage:	+5VDC
Max output power (Standard):	6 Watts
Output voltage range:	$\pm 12\text{VDC}$
Slew rate:	8V/ μS , max.
Voltage gain (A_v):	1.2

Standard cabling:

CA10-10-3	3 ft. motor extension cable
CA10-10-6	5 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

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MicroMini™ Controller

General Description

The MicroMini™ Controller is a low cost, miniature, single axis “intelligent drive” that provides speed and position control of DC motors with an on-board integrated amplifier. Up to 63 motor axes can be controlled using an RS-485 Multidrop interface or the DeviceNet™ protocol.

- Programmable Current Limit
- No external amplifier required
- RS-232, RS-485 Multidrop or DeviceNet™ (CAN) compatible interfaces
- Linear drive capable of 10 Watts continuous at 22°C ambient
- Local mode speed range up to 20,000:1
- Short Circuit Protection
- Accepts Step/Direction Input /Encoder Tracking (optional)
- Torque Limiting Capability
- Flash Based Parameter Storage/ EDS
- Indexing and Registration Support (Single, Continuous, Count, Absolute and Rel.)
- Position Capture (2)
- Macro Programming Support
- Custom Firmware Support for embedded OEM applications

Modes of Operation

Local/Stand alone (for speed/position control), or Remote via RS-232 or RS-485 , or DeviceNet™.

Performance (Remote Mode)

Position Range	±2,147,483,647 quadrature counts
Velocity Range	up to 2 million quadrature counts/sec
Velocity Accuracy	±0.1% of max. rate
Positional Accuracy	0.18° (with a 500 CPR encoder)
Servo Loop Update Time	1000µsec
Servo Tuning	Programmable PID filter
Acceleration Range	32,767 quadrature counts/sec/sec

Power Requirement

Single supply 24 VDC at 300mA, plus current to drive selected motor
Input voltage range Linear 18-40 VDC

Communication

RS-232, RS-485, Multidrop, DeviceNet™

Controller Inputs

Encoder	Two channel, Single-ended +5VDC TTL compatible 4 MHz maximum frequency, Optically isolated
Analog	One analog input (0-5 VDC, 10 bit)
General Purpose	Two external event inputs, Two hard limits, One emergency stop. All inputs are optically protected (except analog input)
Opto Coupler Power	Input to supply external Power to Opto Couplers

Controller Outputs

Sign Bit	One bit digital output (TTL) for external amplifier (direction)
Analog	One 12 bit signed output for external amplifier (± 10 VDC)
Analog	One 12 bit output (± 10 VDC)(Also used for programmable current limit.)

Drive Amplifier Specifications @ 22°C (72°F)

MicroMini™ Controller Linear Amplifier Outputs ±22 Volts DC at 1.0 Amp continuous; 3.5 Amps peak

Environmental

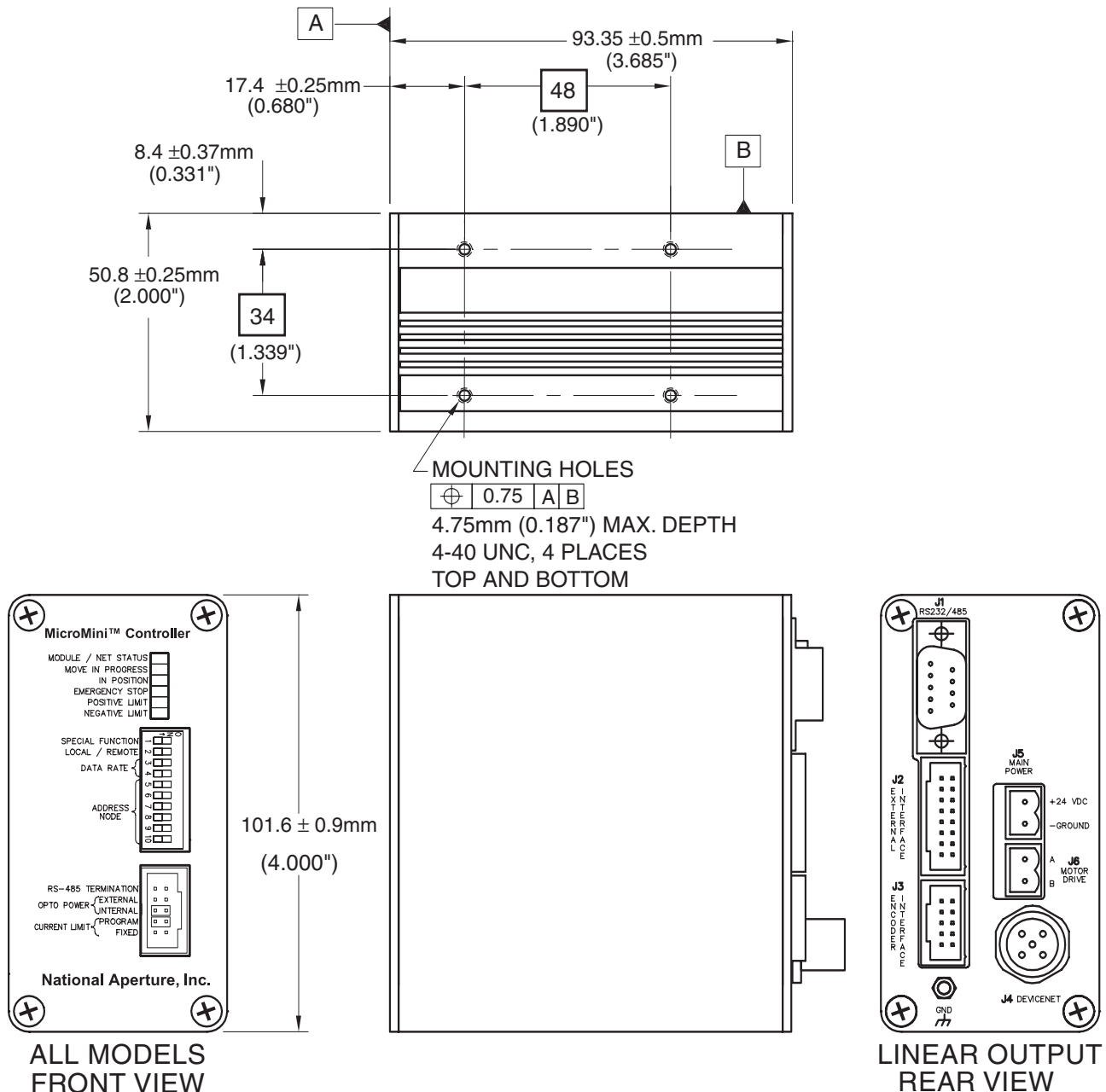
Controller Operating Temperature	0°C to 70°C (32°F to 158°F)
Ambient Operating Temperature (standard version)	0°C to 40°C (32°F to 104°F)
Ambient Storage Temperature (standard version)	-20°C to 85°C (-4°F to 185°F)
Humidity Tolerance (standard version)	80% Rh, non-condensing



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MicroMini™ Controller

Dimensional Outlines



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MM-3M-ST, -EX, -R Resolution Data Sheet

Linear Motion: 80 TPI Lead Screw

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

Rotary Motion: 80:1 Worm Drive Ratio

Gearhead Ratio	Final Output	Resolution ¹		Max Travel Rate ²
		Deg./count	(arc-sec)/count	Deg/sec
16:1	1,280:1	0.00703125	25.3125	93.74
64:1	5,120:1	0.00175781	6.3281	23.44
256:1	20,480:1	0.00043945	1.5820	5.86
1024:1	81,920:1	0.00010986	0.39550	1.46

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 millimeters	= inch/39.37 x 10 ⁻³
Distance in micrometers	= inch/39.37 x 10 ⁻⁶

Encoder resolution calculations:

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

Conversion:

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

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.

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MTR-10-E MicroMini™ Motor

Connection Specifications

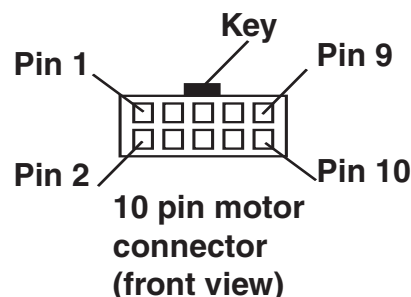
Motor Type: MTR-10-E

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⁾	0.46
Max. Efficiency (%) ⁽²⁾	68
No Load Speed (RPM) ±12% ⁽²⁾	17,600
Friction Torque (@ no load speed) (oz-in)	0.004
No Load Current (mA)±50% ⁽³⁾	10
Stall Torque(oz-in) ⁽²⁾	0.15
Velocity Constant (RPM/Volt)	2,854
Back EMF Constant (mV/RPM)	0.350
Torque Constant (oz-in/Amp)	0.48
Armature Inductance (mH)	0.060

Encoder Specifications:

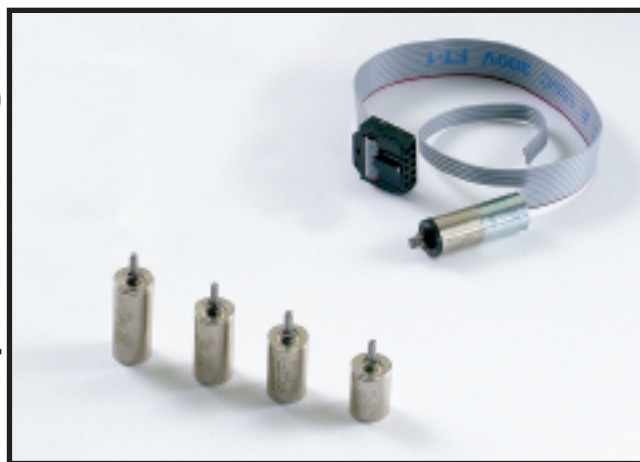
Supply Voltage	5 VDC Nom.
Max Voltage Supply	15 VDC
Operating Current	5mA Nom. @5VDC
Signal Phase Shift	90°
Max. Signal Freq.	7.2 KHz
Temperature Range	-20°C to +85° C
Storage Temp. Range	-40°C to +110°C
Assymetry Max.	10%
Output Signal Type	Square wave
Signal Rise Time	Less than 5µs
Phase Relationship	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⁾	9
Armature Inertia (x10 ⁻⁶ oz-in-sec ²) ⁽²⁾	0.85
Angular Acceleration (x 10 ³ Rad/sec ²) ⁽²⁾	193
Rotor Temperature Range	-30°C to +125°C (-22°F to +257°F)
Bearing Play (measured @ bearing)	
Radial	Less than 0.03mm (0.0012")
Axial	Less than 0.2mm (0.0079")
Thermal Resistance (°C/W)	
Rotor to Caszze	10
Case to Ambient	65
Maximum Shaft Load	
Radial (@3,000 RPM) 3mm from bearing	1.8 oz (51 grams)
Axial	72 oz(2,041.2 grams)
Weight	0.23 oz (6.5 grams)

- (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	Resolution ¹		Max Travel Rate	
	µInch/count	µm/count	Inch/sec	mm/sec
16:1	19.5313	0.4960	0.260	6.60
64:1	4.8828	0.1240	0.064	1.65
256:1	1.2207	0.0310	0.016	0.41
1024:1	0.3052	0.0077	0.004	0.10

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 millimeters	= inch/39.37 x 10 ⁻³
Distance in micrometers	= inch/39.37 x 10 ⁻⁶

Encoder resolution calculations:

Encoder counts per shaft revolution	= 40 encoder counts x Gearhead ratio
Minimum encoder count (inches)	= Lead (0.0125 in.)/Encoder counts per output shaft revolution
Minimum encoder count (millimeters)	= Minimum encoder count (inch)/39.37 x 10 ⁻³ in.
Minimum encoder count (micrometers)	= 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
1 micrometer (µ)	= 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.

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

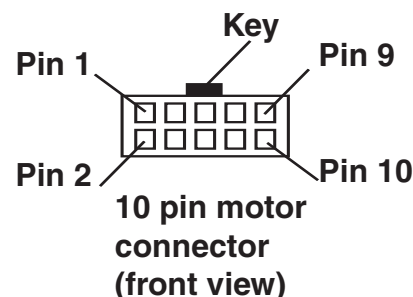
Motor Type: MTR-10-E

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)
Armature Resistance (Ohm)±12%
Max power output (Watts)⁽²⁾
Max. Efficiency (%)⁽²⁾
No Load Speed (RPM) ±12%⁽²⁾
Friction Torque (@ no load speed) (oz-in)
No Load Current (mA)±50%⁽³⁾
Stall Torque(oz-in)⁽²⁾
Velocity Constant (RPM/Volt)
Back EMF Constant (mV/RPM)
Torque Constant (oz-in/Amp)
Armature Inductance (mH)

6
20.1
0.46
68
17,600
0.004
10
0.15
2,854
0.350
0.48
0.060

Encoder Specifications:

Supply Voltage
Max Voltage Supply
Operating Current
Signal Phase Shift
Max. Signal Freq.
Temperature Range
Storage Temp. Range
Assymetry Max.
Output Signal Type
Signal Rise Time
Phase Relationship

5 VDC Nom.
15 VDC
5mA Nom. @5VDC
90°
7.2 KHz
-20°C to +85° C
-40°C to +110°C
10%
Square wave
Less than 5µs
Ch A leads CH B when motor rotation is clockwise as seen from shaft end.
10 (2 channels)
40

Pulses per Revolution
Quadrature

Mechanical Specifications:

Mechanical Time Constant (ms)⁽²⁾
Armature Inertia (x10⁻⁶ oz-in-sec²)⁽²⁾
Angular Acceleration (x 10³ Rad/sec²)⁽²⁾
Rotor Temperature Range
Bearing Play (measured @ bearing)
Radial
Axial
Thermal Resistance (°C/W)
Rotor to Case
Case to Ambient
Maximum Shaft Load
Radial (@3,000 RPM) 3mm from bearing
Axial
Weight

9
0.85
193
-30°C to +125°C (-22°F to +257°F)
Less than 0.03mm (0.0012")
Less than 0.2mm (0.0079")
10
65
1.8oz (51.03grams)
72oz (2,041.2grams)
0.23oz (6.5grams)



(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: 40 TPI Lead Screw

Gearhead Ratio	Resolution ¹		Max Travel Rate	
	µInch/count	µm/count	Inch/sec	mm/sec
16:1	39.0625	0.99219	0.5208	13.229

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 millimeters	= inch/39.37 x 10 ⁻³
Distance in micrometers	= inch/39.37 x 10 ⁻⁶

Encoder resolution calculations:

Encoder counts per shaft revolution	= 40 encoder counts x Gearhead ratio
Minimum encoder count (inches)	= Lead (0.025 in.)/Encoder counts per output shaft revolution
Minimum encoder count (millimeters)	= Minimum encoder count (inch)/39.37 x 10 ⁻³ in.
Minimum encoder count (micrometers)	= 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
1 micrometer (µ)	= 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 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.

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

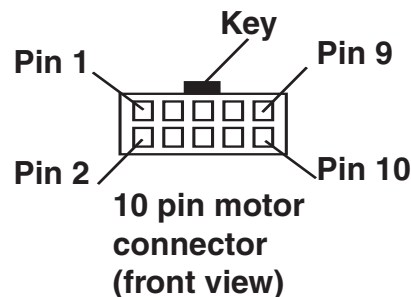
Motor Type: MTR-10-E

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⁾	0.46
Max. Efficiency (%) ⁽²⁾	68
No Load Speed (RPM) ±12% ⁽²⁾	17,600
Friction Torque (@ no load speed) (oz-in)	0.004
No Load Current (mA)±50% ⁽³⁾	10
Stall Torque(oz-in) ⁽²⁾	0.15
Velocity Constant (RPM/Volt)	2,854
Back EMF Constant (mV/RPM)	0.350
Torque Constant (oz-in/Amp)	0.48
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	-20°C to +85° C
Storage Temp. Range	-40°C to +110°C
Assymetry Max.	10%
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⁾	9
Armature Inertia (x10 ⁻⁶ oz-in-sec ²) ⁽²⁾	0.85
Angular Acceleration (x 10 ³ Rad/sec ²) ⁽²⁾	193
Rotor Temperature Range	-30°C to +125°C (-22°F to +257°F)
Bearing Play (measured @ bearing)	
Radial	Less than 0.03mm (0.0012")
Axial	Less than 0.2mm (0.0079")
Thermal Resistance (°C/W)	
Rotor to Case	10
Case to Ambient	65
Maximum Shaft Load	
Radial (@3,000 RPM) 3mm from bearing	1.8oz (51.03grams)
Axial	72oz (2,041.2grams)
Weight	0.23oz (6.5grams)

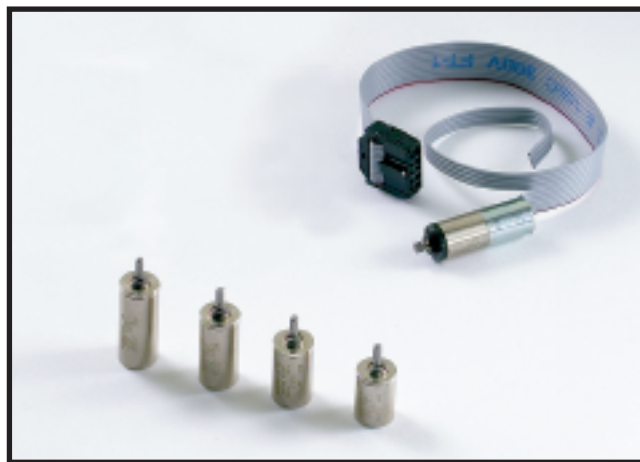
(1) Ratings are presented independent of each other

(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	Resolution ¹		Max Travel Rate	
	µInch/count	µm/count	Inch/sec	mm/sec
16:1	19.5313	0.4960	0.130	3.30
64:1	4.8828	0.1240	0.032	0.83
256:1	1.2207	0.0310	0.008	0.21
1024:1	0.3052	0.0077	0.002	0.05

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 millimeters	= inch/39.37 x 10 ⁻³
Distance in micrometers	= inch/39.37 x 10 ⁻⁶

Encoder resolution calculations:

Encoder counts per shaft revolution	= 40 encoder counts x Gearhead ratio
Minimum encoder count (inches)	= Lead (0.0125 in.)/Encoder counts per output shaft revolution
Minimum encoder count (millimeters)	= Minimum encoder count (inch)/39.37 x 10 ⁻³ in.
Minimum encoder count (micrometers)	= 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
1 micrometer (µ)	= 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 10,000 RPM (no load).
- 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.

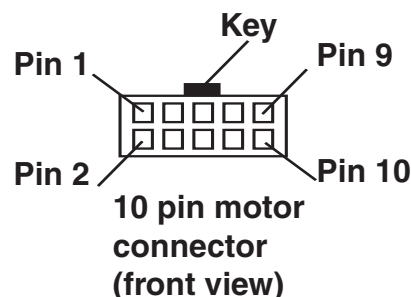


MTR-10-E-12V MicroMini™ Motor

Connection Specifications

Motor Type: MTR-10-E-12V
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)	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)	1,419
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	-20°C to +85° C
Storage Temp. Range	-40°C to +110°C
Assymetry Max.	10%
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	1.8oz (51.03grams)
Axial	18oz (2,041.2grams)
Weight	0.23oz (6.5grams)

- (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, 16 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	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
		Deg./count	arc-sec/count	Deg./sec
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
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) 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

*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 millimeters	= inch/39.37 X 10 ⁻³
Distance in micrometers	= 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 in.
1 micrometer (µm)	= 39.37 x 10 ⁻⁶ in.
1 degree (deg)	= 3,600 arc-sec
1 arc-sec	= 0.277 x 10 ⁻³ deg

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.



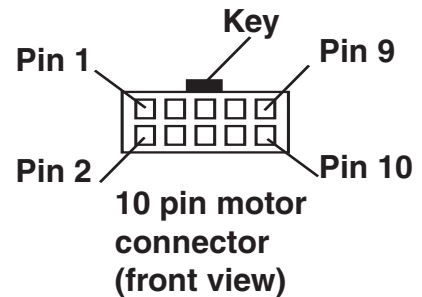
MTR-13-E MicroMini™ Motor Connection Specifications

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	15 VDC
Operating Current	5 mA Nom. @ 5VDC
Signal Phase Shift	90°
Max Signal Frequency	7.2 KHz
Operating Temp. Range	-40°C to +85°C (-40°F to +185°F)
Storage Temp. Range	-40°C to +110°C (-40°F to +257°C)
Max Asymmetry	10%
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)	4.3 oz (122 grams)
Axial (Static)	72 oz (2,014 grams)
Weight	0.71 oz (20 grams)
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	Resolution ¹		Max Travel Rate	
	µInch/count	µm/count	Inch/sec	mm/sec
16:1	16.276	0.41341	0.2604	6.6146

Rotary Motion: 80:1 Worm Drive Ratio

Gearhead Ratio	Final Output	Resolution ¹		Max Travel Rate ²
		Deg./count	(arc-sec)/count	Deg/sec
16:1	1,280:1	5.859375×10^{-3}	21.1530	93.75

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 millimeters	= inch/39.37 x 10^{-3}
Distance in micrometers	= inch/39.37 x 10^{-6}

Encoder resolution calculations:

Encoder counts per shaft revolution	= 48 encoder counts x Gearhead ratio
Minimum encoder count (inches)	= Lead (0.0125 inch)/ Encoder counts per output shaft revolution
Minimum encoder count (millimeters)	= Minimum encoder count (inch)/39.37 x 10^{-3} inch
Minimum encoder count (micrometers)	= 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)	= 39.37×10^{-3}
1 micrometer (µm)	= 39.37×10^{-6} inch
1 deg (deg)	= 3,600 arc-sec
1 arc-sec	= 0.277×10^{-3} deg.

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 MicroMini™ Motor

Connection Specifications

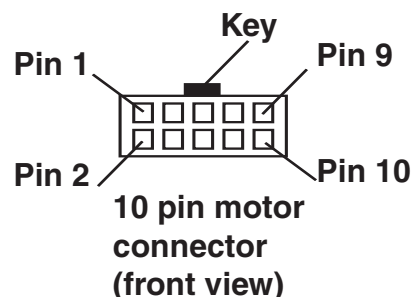
Motor Type: MTR-10-12E with 16:1 planetary gearhead and magnetic encoder

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⁾	1.5
Max. Efficiency (%) ⁽²⁾	76
No Load Speed (RPM) ±12% ⁽²⁾	12,400
No Load Current (mA) ±50% ⁽³⁾	11
Stall Torque (oz-in) ⁽²⁾ mNm	3.01
Velocity Constant (RPM/Volt)	2,100
Torque Constant (mNm/A)	4.56
Armature Inductance (mH)	0.08
Speed/torque gradient (rpm/mNm)	4180
Starting Current (mA)	660
Maximum permissible speed (rpm)	19,000
Maximum continuous current (mA)	339
Maximum continuous torque (mNm)	1.55
Maximum power output at nominal voltage (mW)	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⁾	4
Armature Inertia (g - cm ²)	0.098
Maximum rotor temperature	+85°C
Axial Play	0.02 - 0.10mm
Thermal Resistance (K/W)	
Rotor to Case	9
Case to Ambient	38
Maximum Shaft Load (N)	
Radial 5mm from flange	1
Axial	2
Weight	10 grams
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.

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

16 Position Encoder Resolution Data Sheet

Linear Motion: 80 TPI Lead Screw

Gearhead Ratio	Resolution ¹		Max Travel Rate	
	µInch/count	µm/count	Inch/sec	mm/sec
16:1	12.207	0.310	0.2604	6.6146

Rotary Motion: 80:1 Worm Drive Ratio

Gearhead Ratio	Final Output	Resolution ¹		Max Travel Rate ²
		Deg./count	(arc-sec)/count	Deg/sec
16:1	1,280:1	$4.39453125 \times 10^{-3}$	15.82031	93.75

note: for 16:1 gearhead there are 81,920 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 millimeters	= inch/39.37 x 10^{-3}
Distance in micrometers	= inch/39.37 x 10^{-6}

Encoder resolution calculations:

Encoder counts per shaft revolution	= 64 encoder counts x Gearhead ratio
Minimum encoder count (inches)	= Lead (0.0125 inch)/ Encoder counts per output shaft revolution
Minimum encoder count (millimeters)	= Minimum encoder count (inch)/39.37 x 10^{-3} inch
Minimum encoder count (micrometers)	= 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)	= 39.37×10^{-3}
1 micrometer (µm)	= 39.37×10^{-6} inch
1 deg (deg)	= 3,600 arc-sec
1 arc-sec	= 0.277×10^{-3} deg.

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, 16 position, magnetic encoders. The resultant quadrature output is equal to 64 encoder counts per motor armature revolution.

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MTR-10-16E MicroMini™ Motor

Connection Specifications

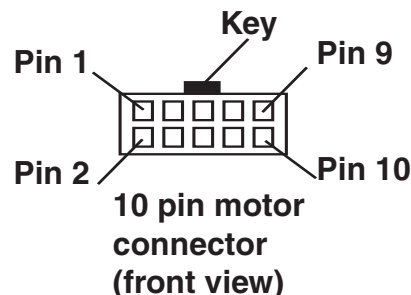
Motor Type: MTR-10-16E with 16:1 planetary gearhead and magnetic encoder

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*Mate Part# (male pin socket):

Panduit part #057-010-115

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MicroMini™ Stage

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 "breakthrough" 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. Standard "C" drivers and support libraries for use with Basic and Windows are included with our controllers. 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 systems.

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

FEATURES OF THE NATIONAL APERTURE MicroMini™ STAGE

- Hard treated surfaces for smooth, wear-resistant motion.
- No ball bearings, for wobble-free slide motion.
- Easy-change screw-on gearheads, for on-site modification.
- Gearhead options; multiple, broad range.
- Ultra low-backlash gearheads, 1µm- 2µm equivalent.
- Low inertia motors for maximum speed-to-resolution ratio
- Ultra-fine lead screw 80 TPI for minimal transmission error.
- Highly specialized limit switches, for error-free response.
- Superior homing repeatability, within 0.5 micrometers
- Easy-construction interfaces, for on-site modification.
- Easily and readily customized.

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HOW THE MicroMini™ STAGE WORKS

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 four-cornered 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 THRU SLIDER

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

BACKLASH

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

ANTI-BACKLASH, HIGH LINEARITY

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 possess full compatibility with English and Metric threaded fasteners.



Anti-Backlash Option for MM3M-EX and -F Stages

Date: April 22, 2000
From: George E. Mauro

SUBJECT: Anti-Backlash (A-B) Nut Introduction Flyer

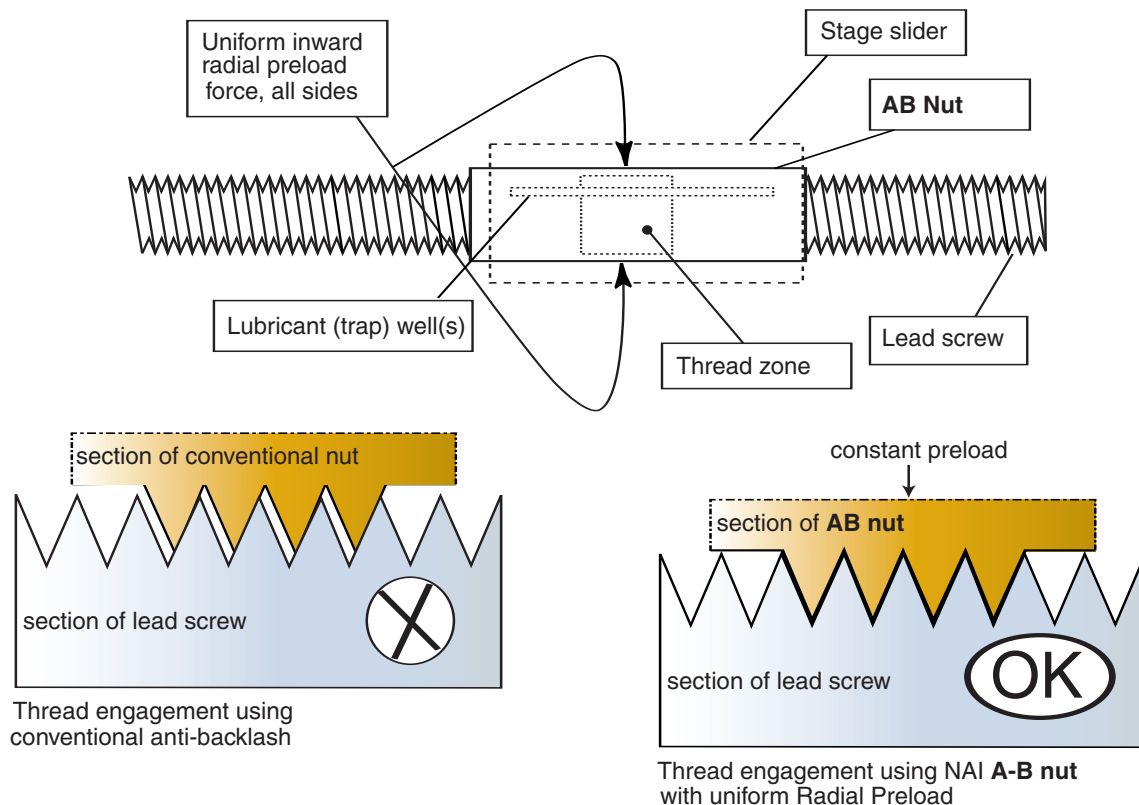
The AB version is not limited to anti-backlash, but contains features which may be equally or more important.

The following seven features are extremely significant:

- **Reduces backlash** from standard 25-50 micrometers to 2-4 micrometers.
- **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: \$150 for option Delivery: 4-6 weeks



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