

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



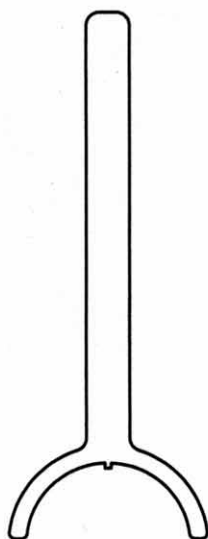
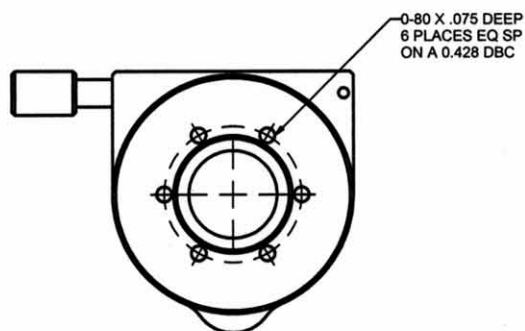
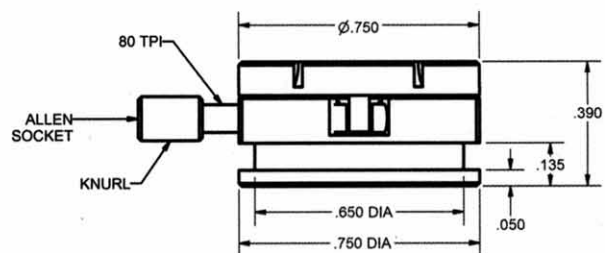
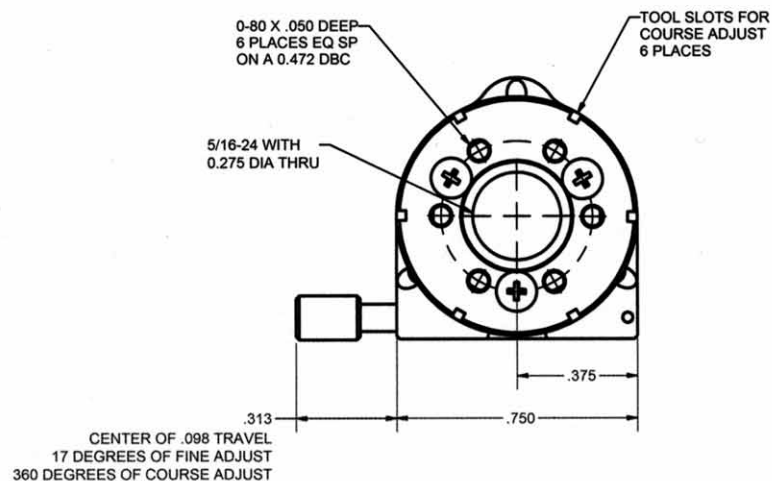
Special Features:

- 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 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

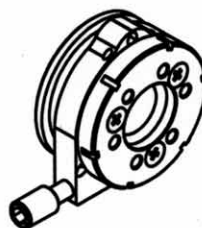
Note: There are six 0-80 holes spaced 0.428 inch apart in the base of the MM1-R. This matches the 0.428 spacing in all the Manual MM3 Linear stage family. This allows the MM1-R to be mounted directly to any Manual MM3 with two 0-80 screws.

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:



	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 μ m	0	0
D. Eccentricity (runout, including bearing mount)	3 μ m	3 μ m	3 μ m
(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
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.

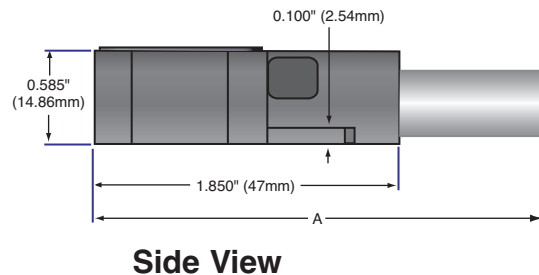
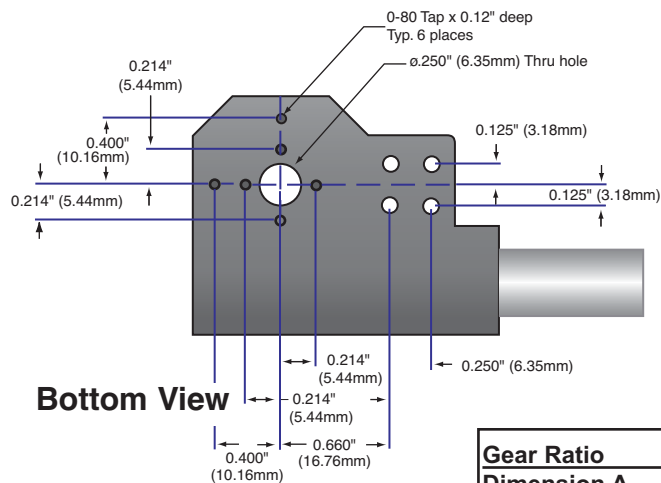
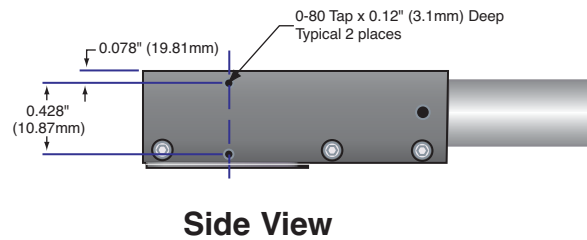
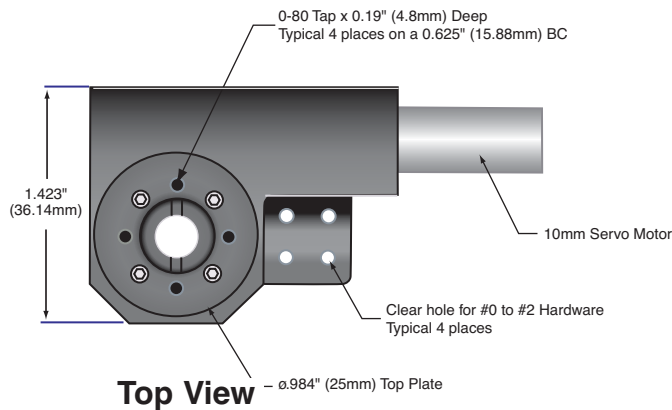
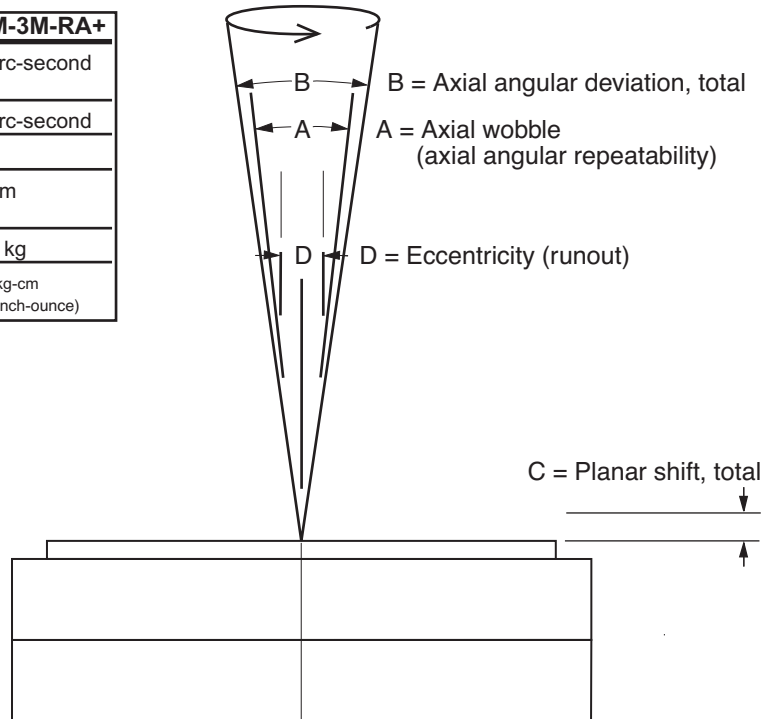
- Special Features:**
- Dual class 7 custom bearings for MM-3M-R
 - Single class 7 custom bearing for MM-3M-RA & RA Plus
 - Multi-faceted connection interface
 - Many other gearhead options
 - Homing Switch

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 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 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 inch-ounce)	1.0 kg-cm (14 inch-ounce)	1.0 kg-cm (14 inch-ounce)



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.



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:

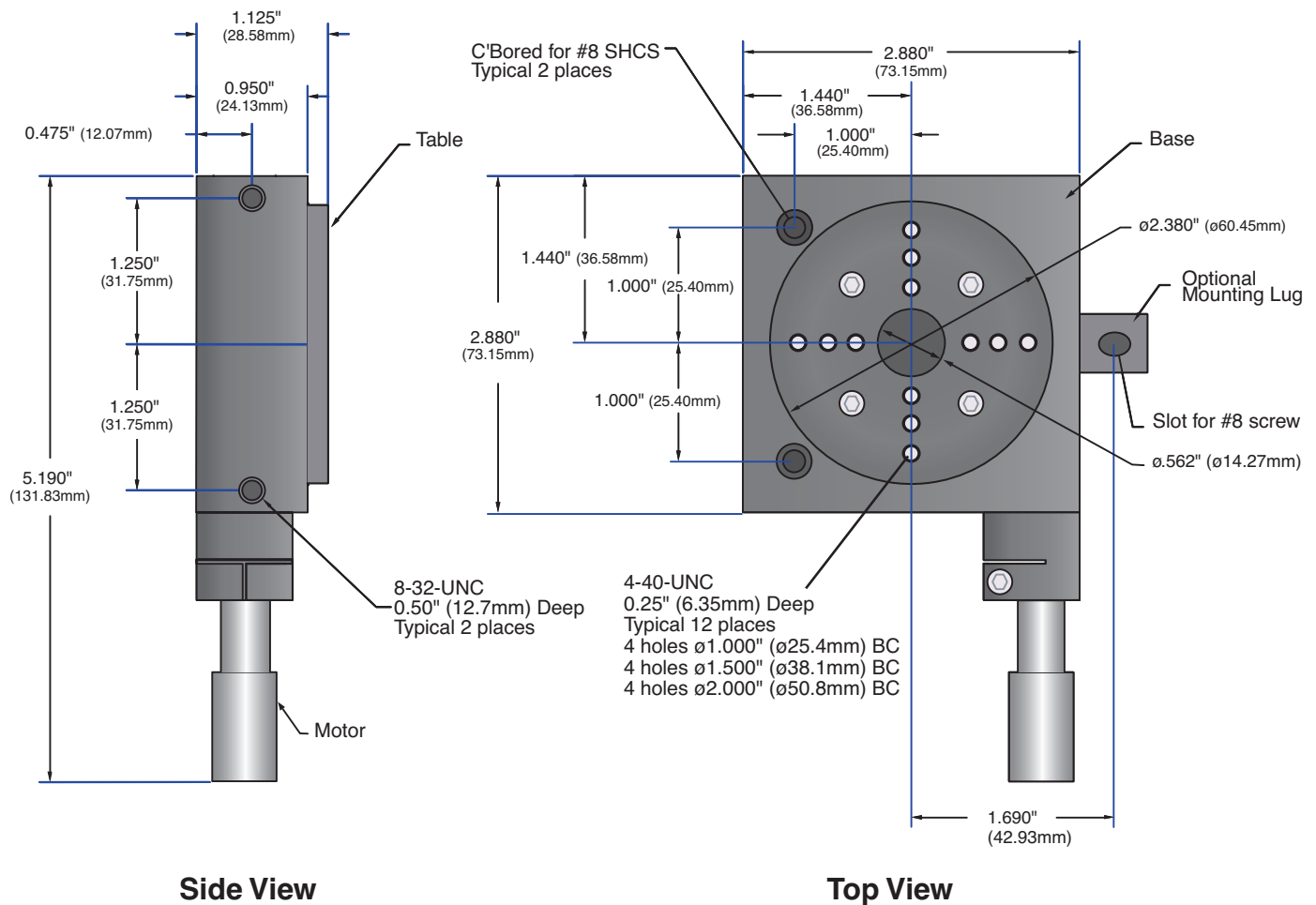
- Ultra-low axial/angular runout
- Multi-faceted connection interface
- Anti-backlash worm drive system
- Black anodized finish

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

MM-4M-R Rotary 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.

MM-3M-ST, -EX, -R

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

		Max Travel Rate ²	Resolution ¹	
Gearhead Ratio	Final Output	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:

- 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

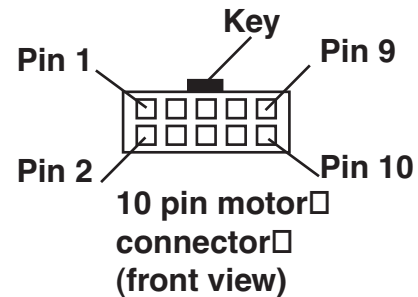
Motor Type: MTR-10-E

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)	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.

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

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

		Max Travel Rate ²	Resolution ¹	
Gearhead Ratio	Final Output	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.

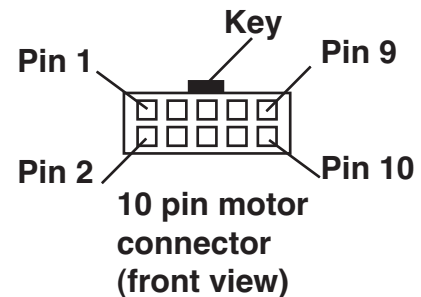
MTR-10-12E-HT MicroMini™ Motor

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

Rotary Motion: MM-4M-R, 90:1 Worm Drive Ratio 13mm mtr, 50enc. *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	1.44970×10^{-3}	5.2189	96.63	
43:1	42.920634921:1	0.46598×10^{-3}	1.6775	31.00	
66:1	66.220408163:1	0.30202×10^{-3}	1.0873	20.09	
134:1	133.530864198:1	0.14978×10^{-3}	0.5392	9.90	
159:1	159.419501134:1	0.12546×10^{-3}	0.4516	8.36	
246:1	245.961516035:1	0.08131×10^{-3}	0.2927	5.36	
415:1	415.429355281:1	0.04814×10^{-3}	0.1733	3.18	
592:1	592.129575640:1	0.03378×10^{-3}	0.1216	2.18	
989:1	988.891428571:1	0.02022×10^{-3}	0.0728	1.361	
1,526:1	1,525.718204082:1	0.01311×10^{-3}	0.0472	0.90	
2,608:1	2,625.740771277:1	0.00762×10^{-3}	0.0274	0.54	
4,365:1	4,385.142457309:1	0.00456×10^{-3}	0.0164	0.27	
5,647:1	5,666.953329446:1	0.00353×10^{-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) 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 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)	= 39.37×10^{-3} inch
1 micrometer (µm)	= 39.37×10^{-6} inch
1 degree	= 3,600 arc-s
1 arc-s	= 0.277×10^{-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

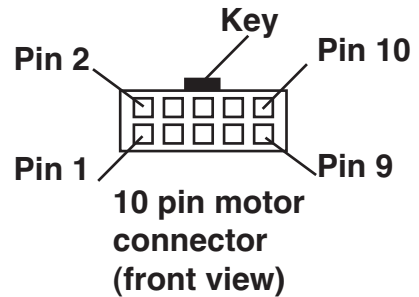
Motor Connector Pin Assignments:

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	0.71 g-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.

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

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) 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 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

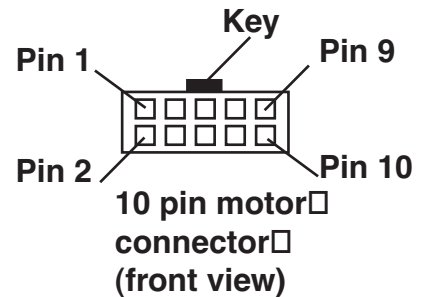
Connection Specifications

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 5μs
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 ($\times 10^{-4}$ oz-in.-sec ²) ¹	0.095
Angular Acceleration ($\times 10^3$ 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.

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

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

		Max Travel Rate ²	Resolution ¹	
Gearhead Ratio	Final Output	degree per second	degree per count	arc-second per count
16:1	1,280:1	93.75	5.859375 x 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 x 10^{-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)	= 39.37×10^{-3} inch
1 micrometer (μm)	= 39.37×10^{-6} inch
1 deg (deg)	= 3,600 arc-second
1 arc-sec	= 0.277×10^{-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.

MTR-10-12E-HT MicroMini™ Motor

Connection Specifications

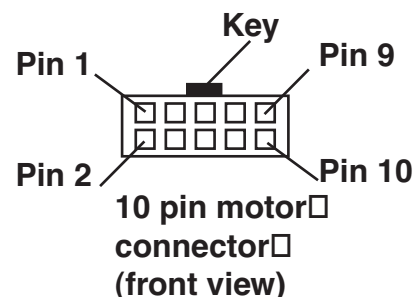
Motor Type: MTR-10-12E with 16:1 planetary gearhead and magnetic encoder

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 (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⁾	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.

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