MA3 Miniature Absolute Magnetic Shaft Encoder

Description

The **MA3** is a miniature rotary absolute shaft encoder that reports the shaft position over 360 ° with no stops or gaps. The **MA3** is available with an analog or a pulse width modulated (PWM) digital output.

Analog output provides an analog voltage that is proportional to the absolute shaft position. Analog output is only available in 10-bit resolution.

PWM output provides a pulse width duty cycle that is proportional to the absolute shaft position. PWM output is available in 10-bit and 12-bit resolutions. While the accuracy is the same for both encoders, the 12-bit version provides higher resolution.

Three shaft torque versions are available. The standard torque version has a sleeve bushing lubricated with a viscous motion control gel to provide torque and feel that is ideal for front panel human interface applications.

The no torque added option has a sleeve bushing and a low viscosity lubricant (that does not intentionally add torque) for low RPM applications where a small amount of torque is acceptable.

The ball bearing version uses miniature precision ball bearings that are suitable for high speed and ultra low torque applications. The shaft diameter for ball bearing version option is 1/8" rather than 1/4".

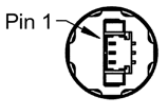
Connecting to the **MA3** is simple. The 3-pin high retention snap-in 1.25mm pitch polarized connector provides for +5V, output, and ground.

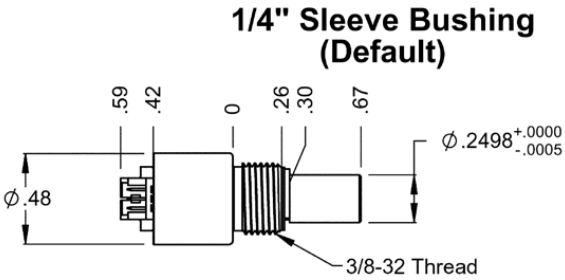
Features

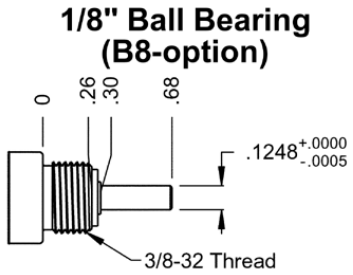
- **ROHS Compliant**
- Patent pending
- Miniature size (0.48" diameter)
- Non-contacting magnetic single chip sensing technology
- -40C to 125C. operating temperature range
- 10-bit Analog output - 2.6 kHz sampling rate
- 10-bit PWM output - 1024 positions per revolution, 1 kHz
- 12-bit PWM output - 4096 positions per revolution, 250 Hz

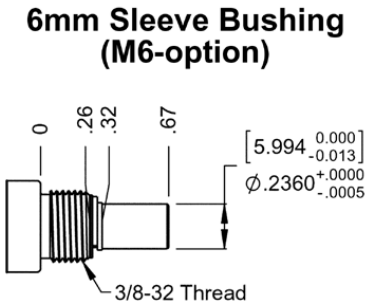
Mechanical Drawing

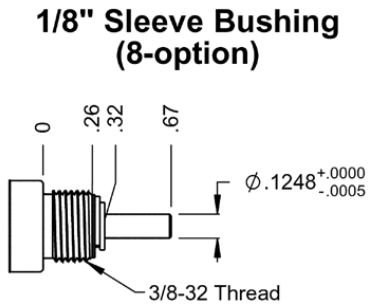
MA3 Miniature Absolute Magnetic Shaft Encoder











Mechanical

Specification	Sleeve Bushing	Ball Bearing
Moment of Inertia	4.1 x 10^-6 oz-in-s²	4.1 x 10^-6 oz-in-s²
Angular Accuracy	<0.5 deg. @ 25C	<0.5 deg. @ 25C
Angular Accuracy Over Temperature	<0.9 deg. @ -40 to 125C	<0.9 deg. @ -40 to 125C
Shaft Speed	100 RPM max. continuous	15,000 RPM max. continuous
Acceleration	10,000 rad/sec²	250,000 rad/sec²
Vibration	20G. 5Hz to 2kHz	20G. 5Hz to 2kHz
Shaft Torque	0.5 ± 0.2 in. oz. (**D** - torque option) 0.3 in. oz. max. (**N** - torque option)	0.05 in. oz. max.
Shaft Loading	2 lbs. max. dynamic* 20 lbs. max. static	1 lb. max.
Bearing Life	-	$(40/P)^3$ = life in millions of revs. where P = radial load in pounds
Weight	0.46 oz.	0.37 oz.
Shaft Runout	0.0015 T.I.R. max.	0.0015 T.I.R. max.

* When a pulley, gear, or friction wheel drives the shaft, the Ball Bearing option is recommended instead of the Sleeve Bushing.

Environmental

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Parameter	Value
Operating Temperature	-40C to +125C
Storage Temperature	-55C to +125C
ESD	± 2 kV max.
Humidity Non-condensing	5% to 85%

Mounting

Parameter	Value
Hole Diameter	0.375" +0.005 / -0.0
Panel Thickness	0.125" max.
Panel Nut Max. Torque	20 in.-lbs.

Materials

Parameter	Dimension
Shaft	Stainless
Bushing	Brass

Magnetic Field Crosstalk

The **MA3** absolute encoder contains a small internal magnet, mounted on the end of the shaft that generates a weak magnetic field extending outside the housing of each encoder. If two **MA3** units are to be installed closer than 1 inch apart (measured between the center of both shafts), a magnetic shield, such as a small steel plate should be installed in between to prevent one encoder from causing small changes in reported position through magnetic field cross-talk.

Electrical

Parameter	Min.	Typ.	Max.	Units
Power Supply	4.5	5.0	5.5	Volts
Supply Current	-	16	20	mA
Power-up Time	-	-	50	mS

Analog Output Operation

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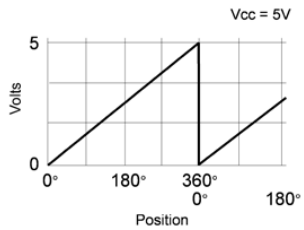
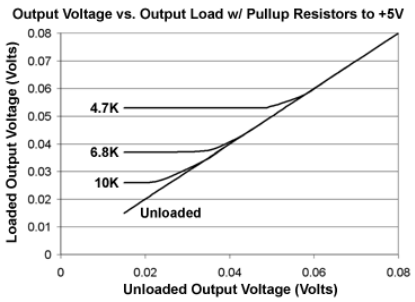


Analog output is only available in 10-bit resolution. The analog output voltage is ratiometric to the power supply voltage and will typically swing within 15 millivolts of the power supply rails with no output load. This non-linearity near the rails increases with increasing output loads. For this reason, the output load impedance should be $\geq$ 4.7kΩ and less than 100pF. The graphs below show the typical output levels for various output loads when powered by a 5V supply.

Parameter	Min.	Typ.	Max.	Units
Position Sampling Rate	2.35	2.61	2.87	kHz
Propagation Delay	-	-	384	?S
Analog Output Voltage Maximum	-	4.987	-	Volts*
Analog Output Voltage Minimum	-	0.015	-	Volts*
Output Short Circuit Sink Current	-	32	50	mA**
Output Short Circuit Source Current	-	36	66	mA**
Output Noise	160	220	490	Vrms**
Output Transition Noise	-	0.06	-	Degrees RMS***

* With no output load. See graphs below.
** Continuous short to +5V or ground will not damage the **MA3**.
*** Transition noise is defined as the jitter in the transition between two adjacent position steps.



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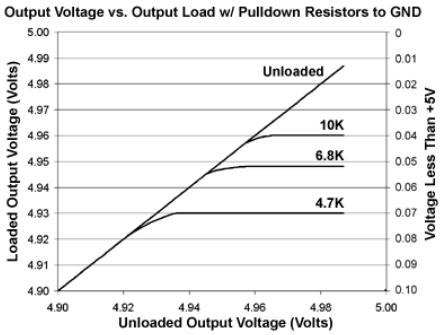

PWM Output Operation

The magnetic sensor chip in the **MA3** has an on-chip RC oscillator which is factory trimmed to 5% accuracy at room temperature (10% over full temperature range). This tolerance influences the sampling rate and the pulse width of the PWM output. If only the PWM pulse width t_{on} is used to measure the angle, the resulting value also has this timing tolerance. However, this tolerance can be cancelled by measuring both t_{on} and t_{off} and calculating the angle from the duty cycle. Angular accuracy including non-linearity is within 0.5 deg. at 25C, but may increase to 0.9 deg. at high temperatures.

Parameter	Min.	Typ.	Max.	Units
PWM Frequency (-40C to 125C)				
10-bit	0.877	0.975	1.072	kHz
12-bit	220	244	268	Hz
Minimum Pulse Width				
10-bit	0.95	1.00	1.05	?S
12-bit	0.95	1.00	1.05	?S
Maximum Pulse Width				
10-bit	974	1025	1076	?S
12-bit	3892	4097	4302	?S
Internal Sampling Rate				
10-bit	9.38	10.42	11.46	kHz
12-bit	2.35	2.61	2.87	kHz
Propagation				
10-bit	-	-	48	?S
12-bit	-	-	384	?S
High Level Output Voltage (V_{OH}: @4mA Source)	Vcc -0.5	-	-	V*
Low Level Output Voltage (V_{OL}: @4mA Sink)	-	-	0.4	V*

* Continuous short to +5V or ground will not damage the **MA3**.

10-bit PWM:

$x = ((t_{on} * 1026) / (t_{on} + t_{off})) - 1$

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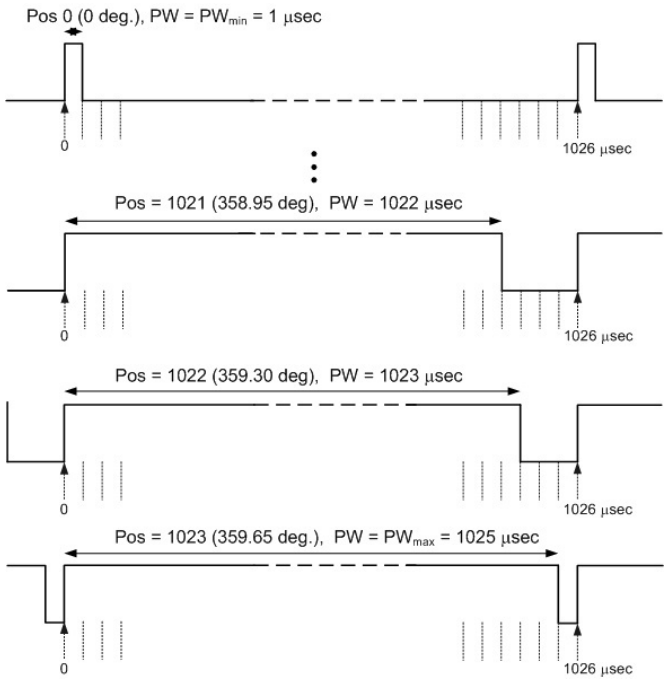
If x <= 1022, then Position = x

If x = 1024, then Position = 1023



12-bit PWM:

x = ((ton * 4098) / (t on+ t off)) -1

If x <= 4094, then Position = x

If x = 4096, then Position = 4095

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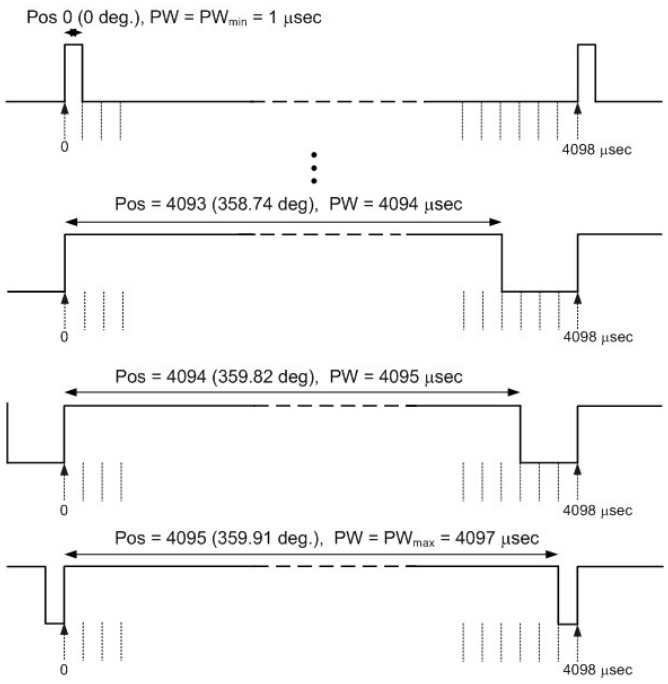

Pin-outs

Analog Output (MA3-A):

Pin	Name	Description
1	5	+5VDC power
2	A	Analog output
3	G	Ground

PWM Output (MA3-P10, MA3-P12):

Pin	Name	Description
1	5	+5VDC power
2	A	PWM output
3	G	Ground

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Ordering Information

MA3 - [ ] - [ ] - [ ]

Interface	Shaft Diameter	Torque
A10 =*10-Bit Analog*	125 =*1/8"*	D =*Sleeve Bushing, Most Drag*
P10 =*10-Bit PWM*	236 =*6mm*	N =*Sleeve Bushing, Somewhat Lighter Drag*
P12 =*12-Bit PWM*	250 =*1/4"*	B =*Ball Bearing, Free Spinning (Least Drag)*

Part Number Conditions

- Torque must be something other than B when Shaft Diameter is 125

Notes

- Cables and connectors are not included and must be ordered separately.
- This product is warranted against defects in materials and workmanship for two years.

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