MA3 Miniature Absolute Magnetic Shaft Encoder

RoHS COMPLIANT

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 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: high torque (-D option), low torque (-N) and ball-bearing (-B). The high and low torque versions have a stainless steel shaft and brass bushing lubricated with grease to provide ideal torque for panel mount, human-interface applications. The ball-bearing version has a brass shaft and miniature precision ball bearings suitable for high speed and ultra low torque applications. The ball-bearing version is only available with a 1/8" shaft diameter.

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

- 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

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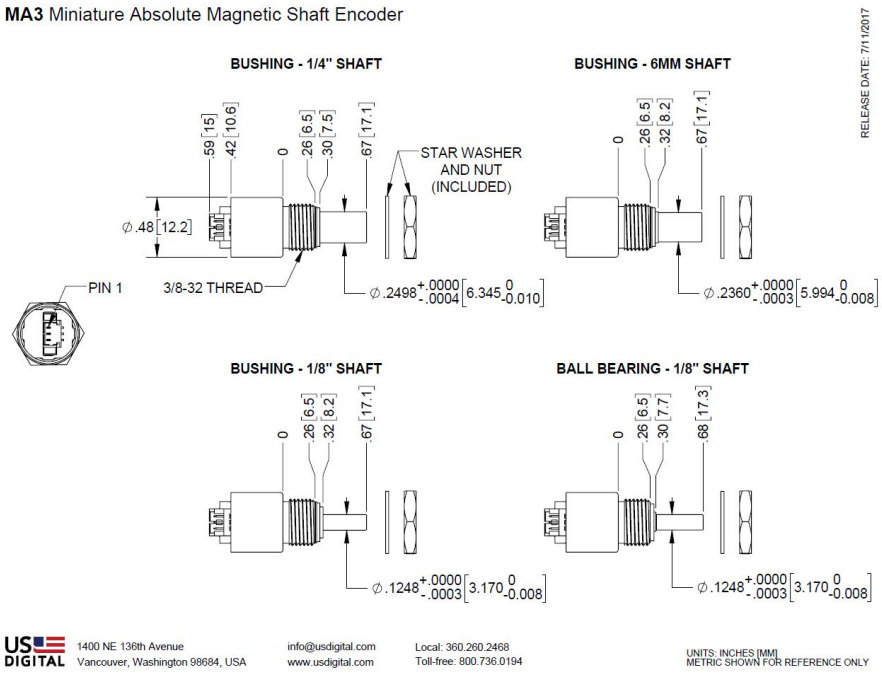


Environmental

Parameter	Value	Units
Operating Temperature	-40 to +125	C
Vibration (5Hz to 2kHz)	20	G
Electrostatic Discharge, Human Body Model MIL-STD-883E, Method 3015.7	± 2	kV

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
Max. Shaft Speed (1)	100 RPM	15000 RPM
Max. Acceleration	10000 rad/sec²	250000 rad/sec²
Max. Shaft Torque	0.5 ± 0.2 in-oz (D - torque option) 0.3 in-oz (N- torque option)	0.05 in-oz
Max. Shaft Loading	2 lb. dynamic 20 lb. static	1 lb.
Bearing Life (2)	> 1,000,000 revolutions	$L10 = (18.3/Fr)^3$ Where $L10$ = bearing life in millions of revs, and Fr = radial shaft loading in pounds

Specification	Sleeve Bushing	Ball Bearing
Weight	0.46 oz.	0.37 oz.
Max. Shaft Total Indicated Runout	0.0015 in.	0.0015 in.
Technical Bulletin TB1001 - Shaft and Bore Tolerances		Download

(1) The chip that decodes position uses sampled data. There will be fewer readings per revolution as the speed increases. The formula f or number of readings per revolution is given by:

10-bit PWM:

n = 625200 / rpm

12-bit PWM / Analog:

n = 156600 / rpm

(2) only valid with negligible axial shaft loading

Mounting

Parameter	Value	Units
Hole Diameter	0.375 +0.005 / -0.0	in.
Panel Thickness	0.125 max.	in.
Panel Nut Max. Torque	20.0	in-lbs

Materials

Component	Material	Torque Option(s)
Shaft	Stainless	Sleeve Bushing (-D and -N options)
	Brass	Ball Bearing (-B option only)
Bushing	Brass	-

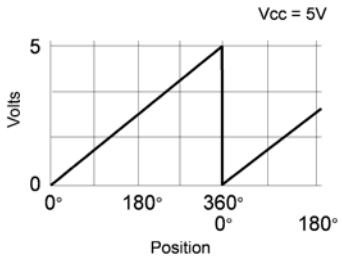
Magnetic Field Crosstalk

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

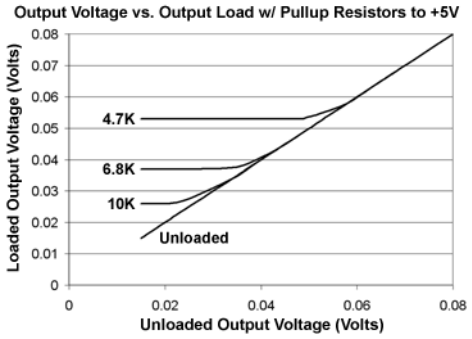
Analog Output Operation

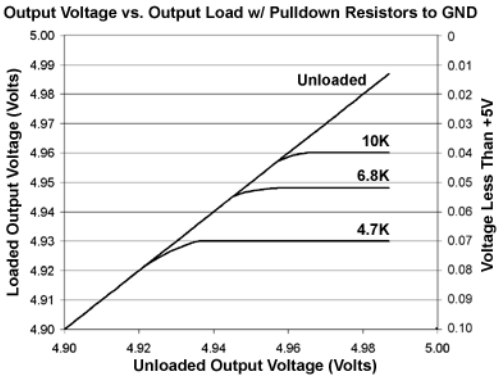


Analog output is only available in 10-bit resolution. The analog output voltage is ratiometric to the power supply voltage and will typically swing within 15 millivolts of the power supply rails with no output load. This non-linearity near the rails increases with increasing output loads. For this reason, the output load impedance should be ≥ 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 (1)	-	4.987	-	Volts
Analog Output Voltage Minimum (1)	-	0.015	-	Volts
Output Short Circuit Sink Current (2)	-	32	50	mA
Output Short Circuit Source Current (2)	-	36	66	mA
Output Noise (2)	160	220	490	μ Vrms
Output Transition Noise (3)	-	0.03	-	Deg. RMS

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





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 pulse period of the PWM output. If only the PWM pulse w idth ton and the nominal pulse period is used to measure the angle, the resulting value also has this timing tolerance. However, this to lerance can be cancelled by measuring both ton and toff and calculating the angle from the duty cycle.

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

Parameter	Min.	Typ.	Max.	Units
Propagation				
10-bit	-	-	48	?S
12-bit	-	-	384	?S
Output Transition Noise, 12-bit version (1)		0.03		Deg. RMS
Output Transition Noise, 10-bit version (1)		0.12		Deg. RMS
Output High Voltage (V OH: @4mA Source) (2)	Vcc -0.5	-	-	V
Output Low Voltage (V OL: @4mA Sink) (2)	-	-	0.4	V

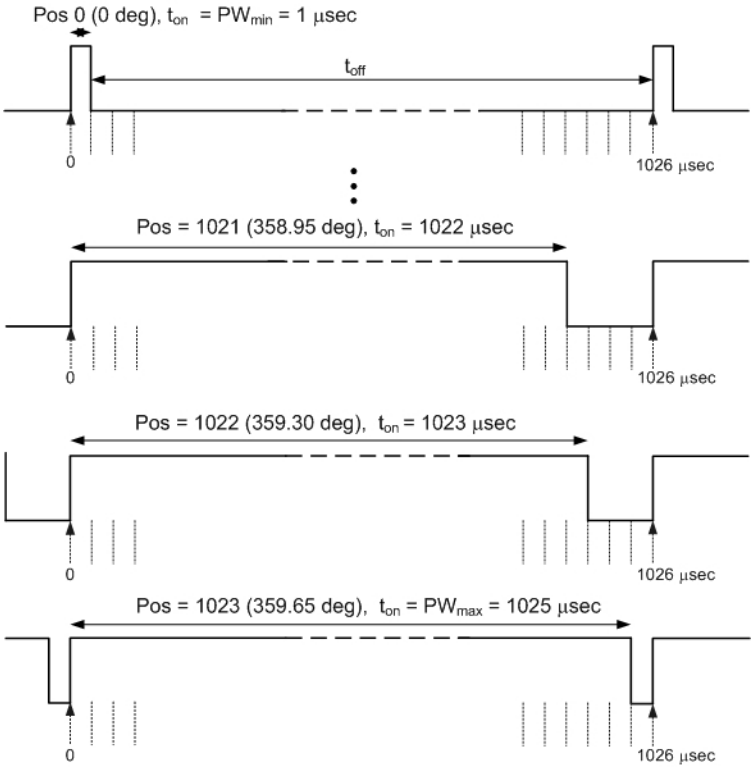
(1) Transition noise is the jitter in the transition between two adjacent position steps.
(2) Continuous short to +5V or ground will not damage the MA3.

10-bit PWM:

x = ((ton * 1026) / (t on+ t off)) -1

If x <= 1022, then Position = x

If x = 1024, then Position = 1023

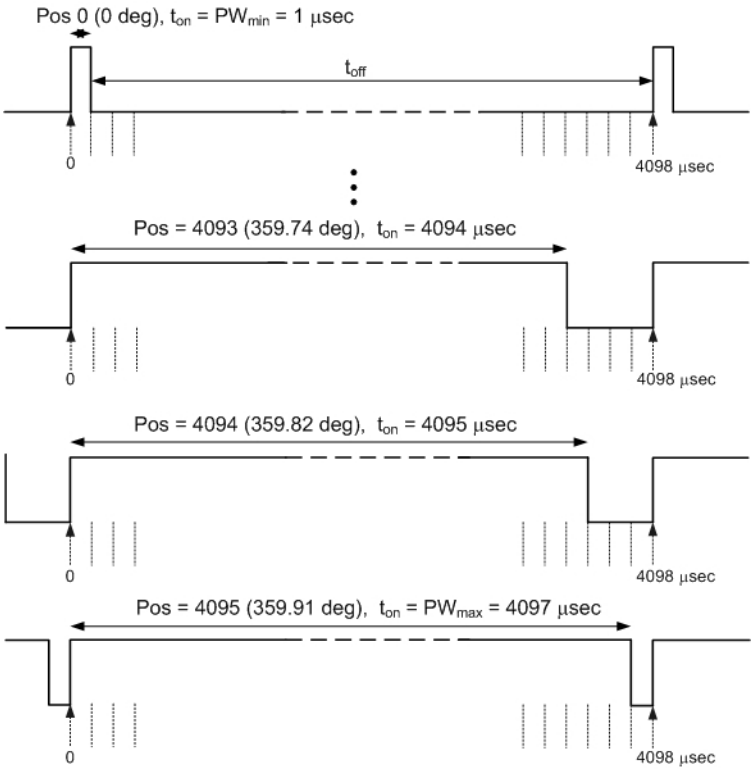


12-bit PWM:

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

If x <= 4094, then Position = x

If x = 4096, then Position = 4095



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

Ordering Information

MA3 - [ ] - [ ] - [ ]

Interface	Shaft Diameter	Torque	Notes
A10 =*10-Bit Analog*	125 =*1/8"*	D =*Sleeve Bushing, Most Drag*	‣ Cables and connectors are not included and must be ordered separately.
P10 =*10-Bit PWM*	236 =*6mm*	N =*Sleeve Bushing, Somewhat Lighter Drag*	‣ US Digital® warrants its products against d efects in materials and workmanship for two years. See complete warranty for details.
P12 =*12-Bit PWM*	250 =*1/4"*	B =*Ball Bearing, Free Spinning (Least Drag)*	

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