MAE3 Features

- Quick, simple assembly, and disassembly
- -40C to +125C operating temperature
- 10-bit PWM output - 1,024 positions per revolution, 1 kHz
- Accepts +/- .025 in. axial shaft play
- Mounts to 0.750 in., 1.280 in. and 1.812 in. bolt circles
- Fits shaft diameters from .125 in. to .250 in. or 3mm to 6mm
- 10-bit Analog output - 2.6 kHz sampling rate
- 12-bit PWM output - 4,096 positions per revolution, 250 Hz

MAE3 Product Description

The MAE3 is an absolute magnetic kit encoder that provides shaft position information over 360° of rotation with no stops or gaps. This magnetic encoder is designed to easily mount to, and dismount from, an existing shaft to provide digital feedback information. The MAE3 is available with an analog or a pulse width modulated (PWM) digital output.

RoHS COMPLIANT

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

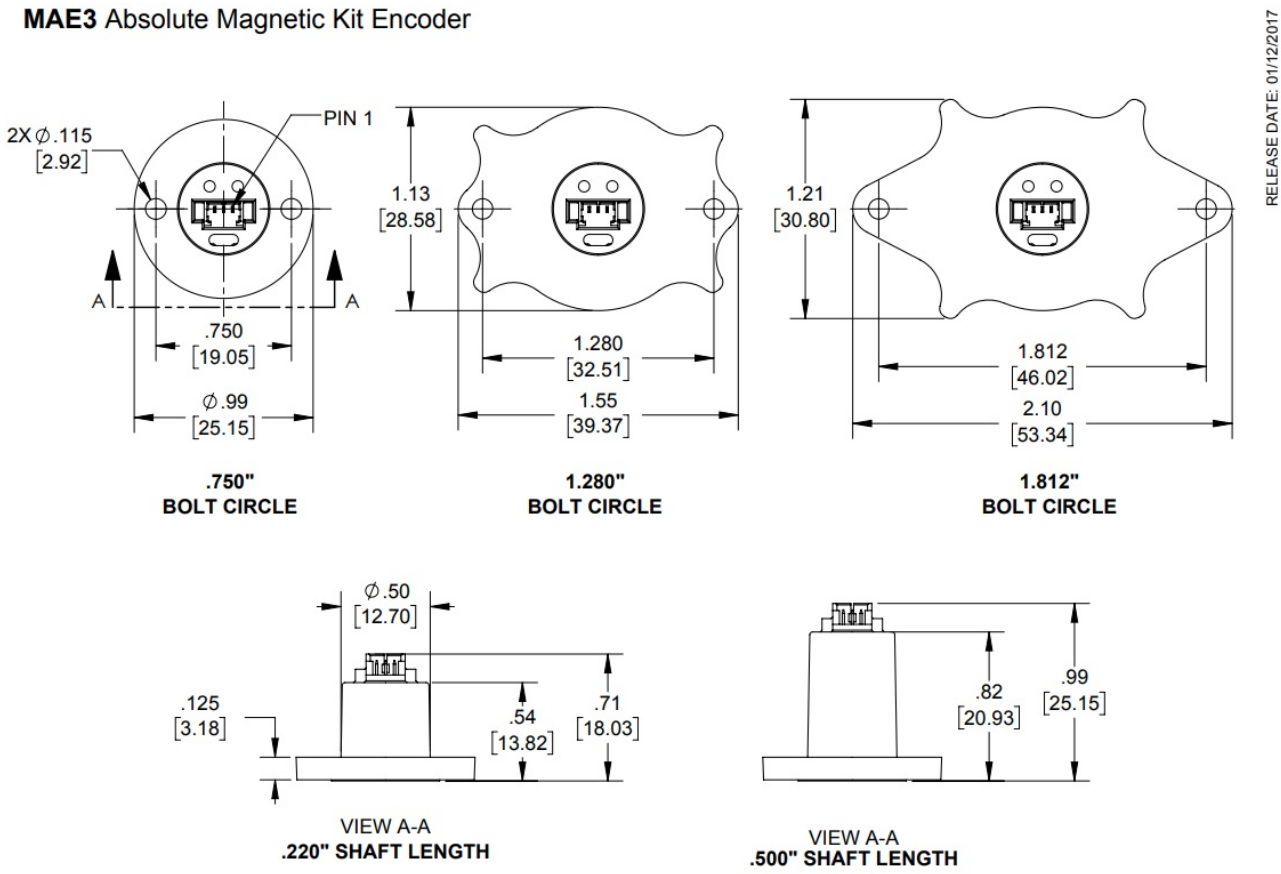
PWM output provides a pulse width duty cycle that is proportional to the absolute shaft position. PWM output is available in 10-bit and 12-bit resolutions. While the accuracy is the same for both encoders, the 12-bit version provides a higher resolution.

The MAE3 consists of three components: base, push-on magnetic hub, and encoder body. The base will accommodate 0.750 in., 1.280 in., and 1.812 in. mounting bolt circles. No tools are needed for the push-on, collet gripping hub. The hub mounts to a standard shaft in seconds and provides a simple and reliable means of securing the magnet to the shaft.

Two 4-40 pan head screws secure the base and encoder body to any flat surface. If desired, the encoder can be powered up and rotated by hand to any desired absolute position before the screws are tightened.

Connecting to the MAE3 is simple. The 3-pin, high retention, snap-in 1.25mm pitch polarized connector provides for +5V, output, and ground.

Mechanical Drawings



Specifications

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

PARAMETER	VALUE	UNITS
Max. Shaft Axial Play	±0.025	in.
Max. Shaft Runout (1)	0.004 T.I.R.	in.
Max. Acceleration	250000	rad/sec²
Max. Hub Moment of Inertia	9.42 x 10^-7	oz-in-s²
Mounting Screw Size	#4-40 x 1/4	in.
2 Screw Bolt Circle Diameter	0.750 ± 0.005	in.
2 Screw Bolt Circle Diameter	1.280 ± 0.005	in.
2 Screw Bolt Circle Diameter	1.812 ± 0.005	in.
Required Shaft Length, including axial play (1) Size 220 Shaft Length-option Size 500 Shaft Length-option	0.220 (+0.015 / -0.020) 0.500 (+0.015 / -0.020)	in. in.
Mounting Screw Torque	4 - 6	in-lbs
Technical Bulletin TB1001 - Shaft and Bore Tolerances		Download *(https://www.usdigital.com/support/resources/reference/technical-docs/technical-bulletins/shaft-and-bore-tolerances-tb1001/)*

(1) For optimum accuracy, the magnetic hub must be fully seated on the shaft and the shaft play must meet the specified axial and radial limits.

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

10-bit PWM:

n = 625200 / rpm

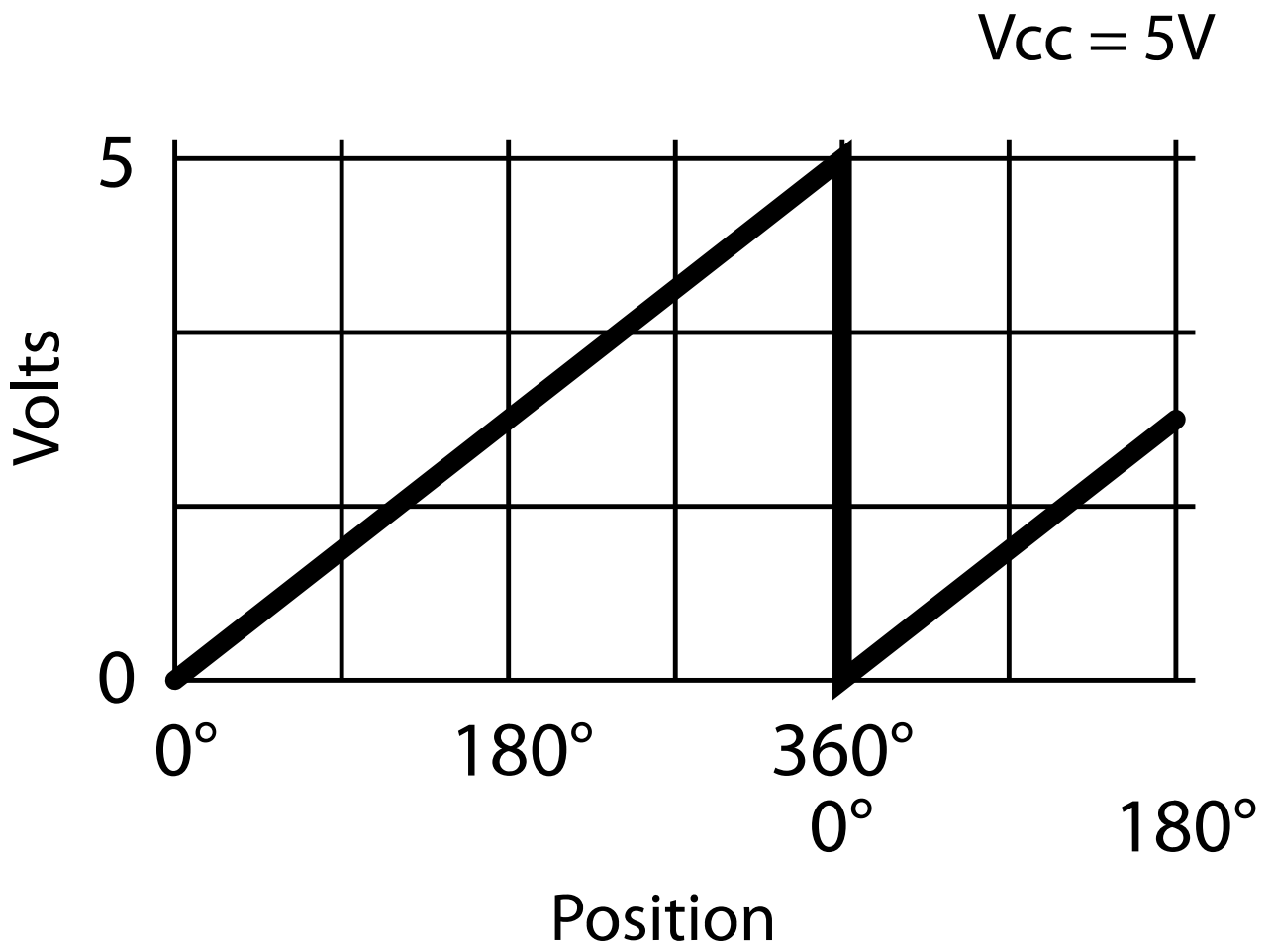
12-bit PWM / Analog:

n = 156600 / rpm

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	µS
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 (1-σ limit)		0.046		Deg. RMS

(1) With no output load. See graphs below.
(2) Continuous short to +5V or ground will not damage the MAE3.

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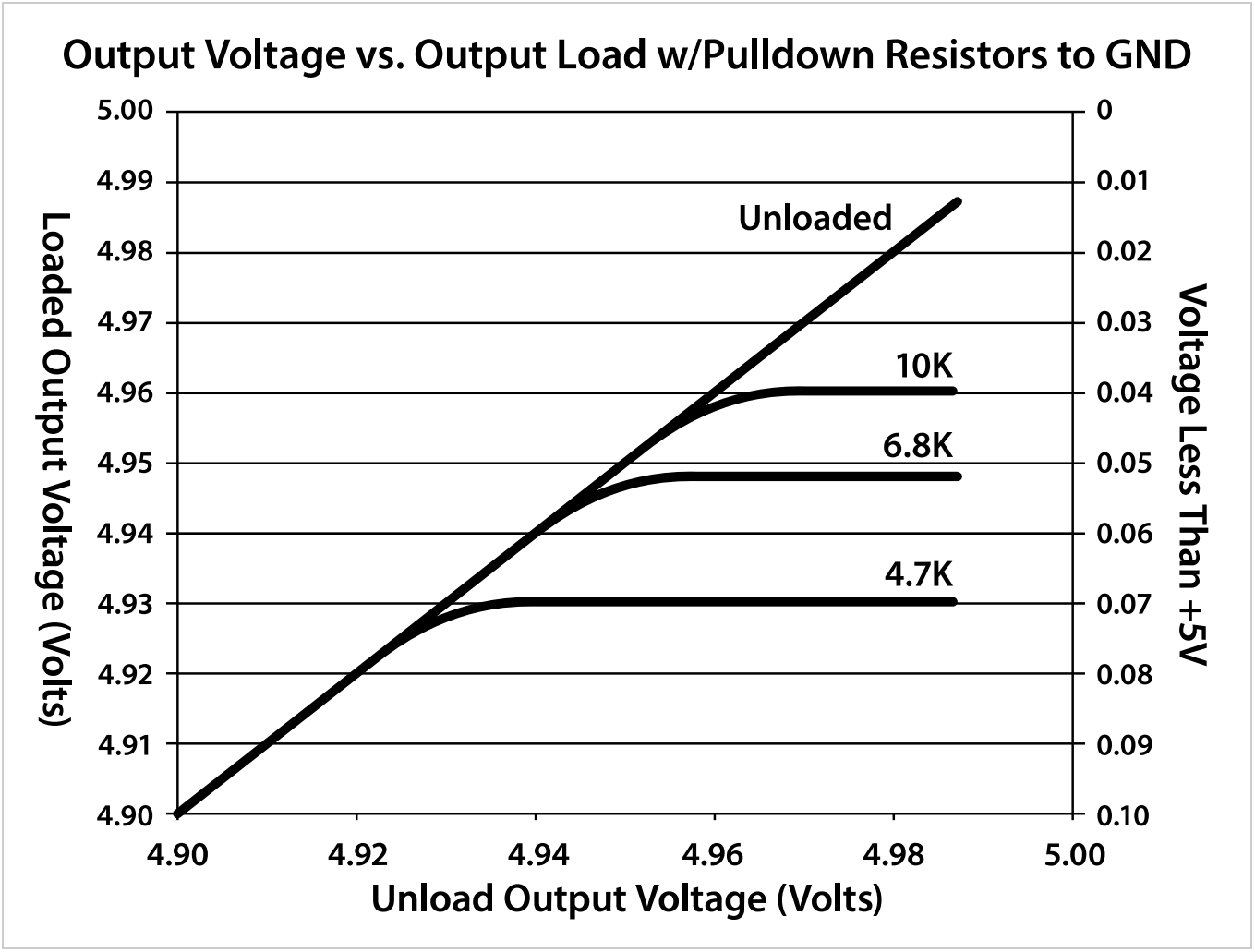
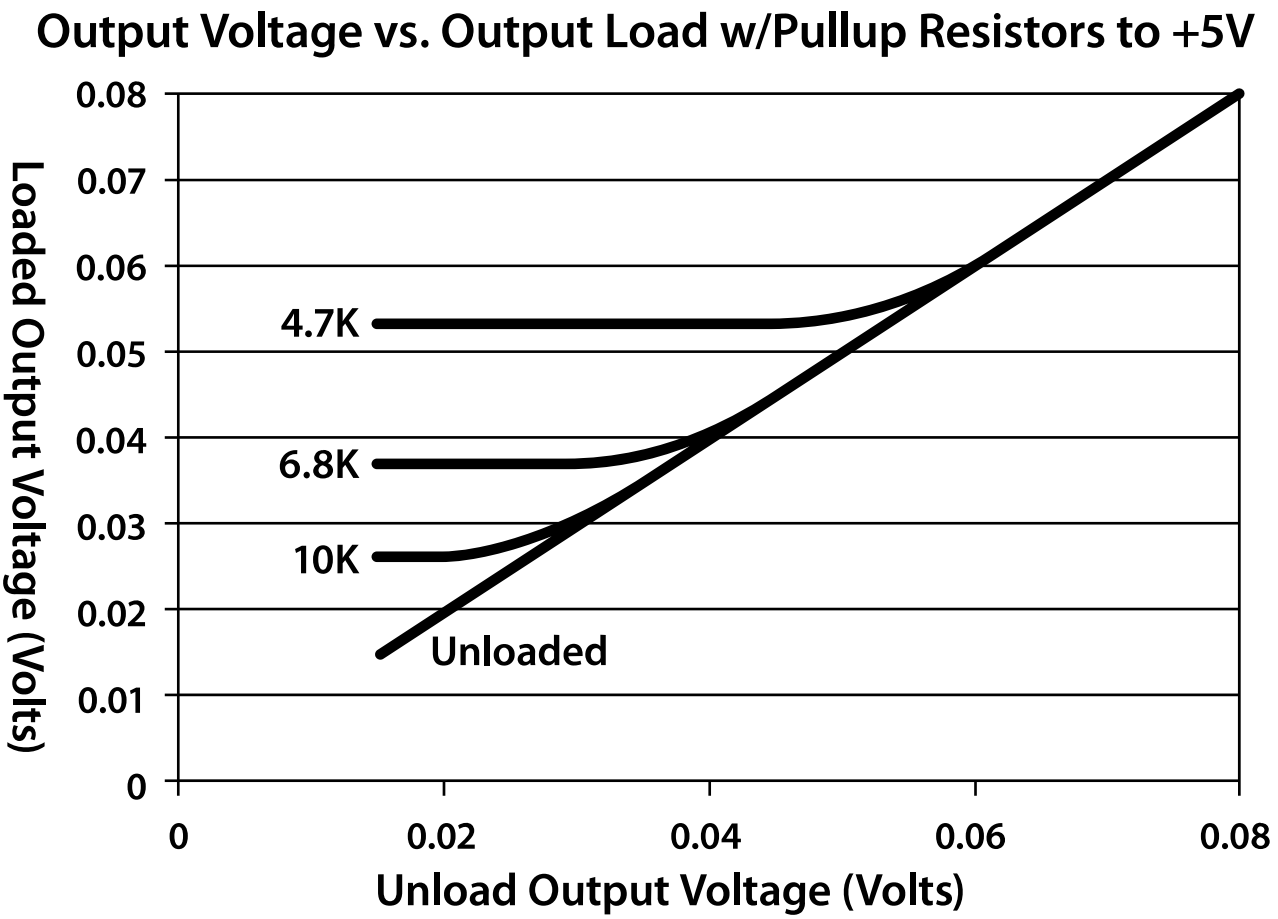

Output Voltage vs. Output Load w/Pulldown Resistors to GND
Loaded Output Voltage (Volts)
5.00
4.99
4.98
4.97
4.96
4.95
4.94
4.93
4.92
4.91
4.90
Voltage Less Than +5V
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
Unloaded
10K
6.8K
4.7K
4.90
4.92
4.94
4.96
4.98
5.00
Unload Output Voltage (Volts)



PWM OUTPUT OPERATION

The magnetic sensor chip in the MAE3 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 period of the PWM output. If only the PWM pulse width t_{on} and nominal pulse period are used to measure the angle, the resulting value also has this timing tolerance. However, this tolerance can be canceled by measuring both t_{on} and t_{off} 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	uS
12-bit	0.95	1.00	1.05	uS
Maximum Pulse Width				
10-bit	974	1025	1076	uS
12-bit	3892	4097	4302	uS
Internal Sampling Rate				
10-bit	9.38	10.42	11.46	kHz
12-bit	2.35	2.61	2.87	kHz
Propagation Delay				
10-bit			48	uS
12-bit			384	uS
Output Transition Noise, 12-bit version (1)		.03		Deg. RMS
Output Transition Noise, 10-bit version (1)		.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

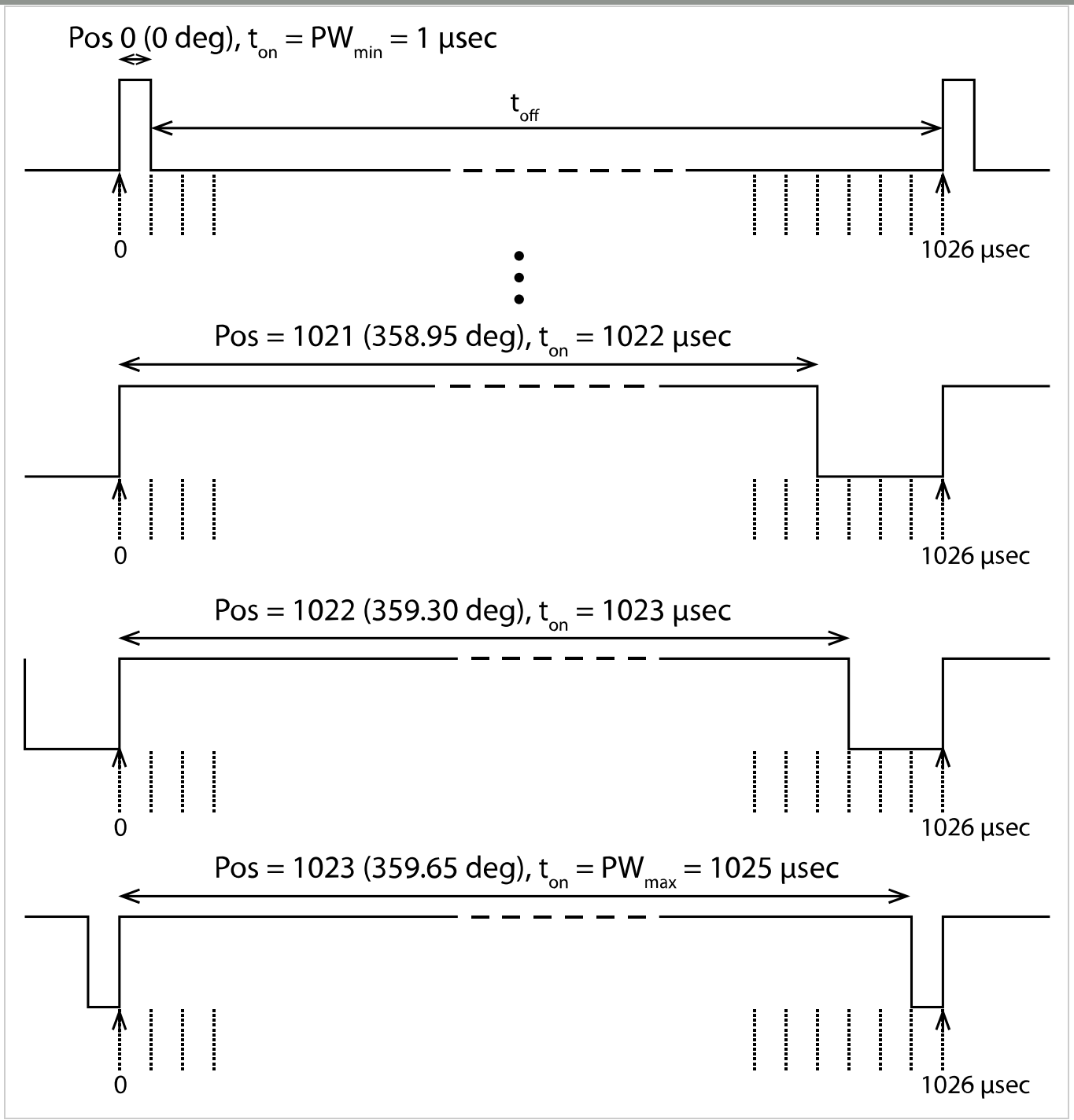
(1) Transition noise is the jitter in the transition between two adjacent position steps.
(2) Continuous short to +5V or ground will not damage the MAE3.

10-bit PWM:

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

If x <= 1022, then Position = x

If x = 1024 then Position = 1023

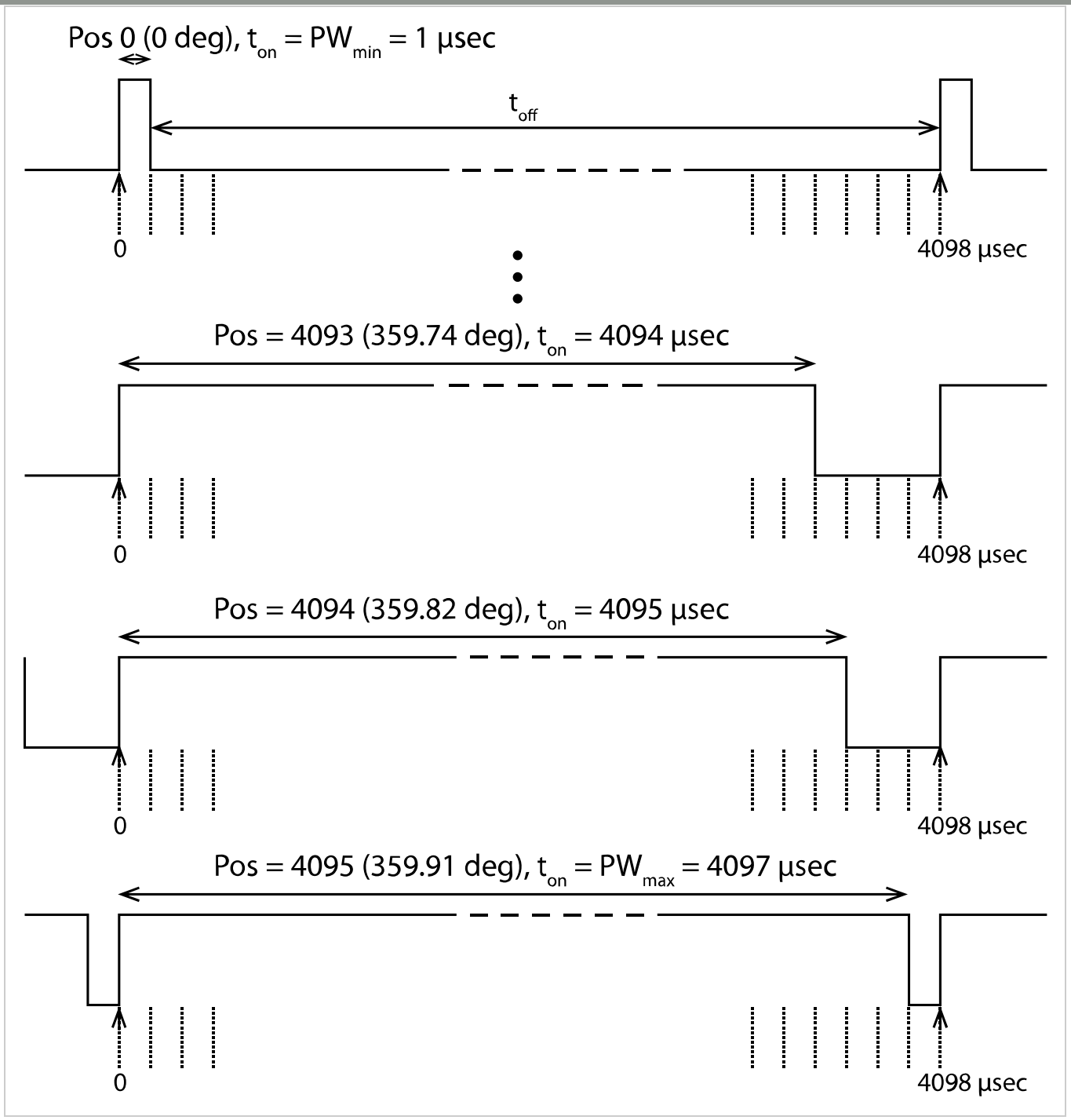


12-bit PWM:

$x = ((t_{on} * 4098) / (t_{on} + t_{off})) - 1$

If x <= 4094, then Position = x

If x = 4096 then Position = 4095


Pos 0 (0 deg), t_{on} = PW_{min} = 1 µsec
t_{off}
0
4098 µsec
Pos = 4093 (359.74 deg), t_{on} = 4094 µsec
0
4098 µsec
Pos = 4094 (359.82 deg), t_{on} = 4095 µsec
0
4098 µsec
Pos = 4095 (359.91 deg), t_{on} = PW_{max} = 4097 µsec
0
4098 µsec

PIN-OUTS

ANALOG OUTPUT (MAE3-A):

PIN	NAME	DESCRIPTION
1	5	+5VDC power
2	A	Analog output
3	G	Ground

PWM OUTPUT (MAE3-P10, MAE3-P12):

PIN	NAME	DESCRIPTION
1	5	+5VDC power
2	P	PWM output
3	G	Ground

ACCESSORIES

SCREWS

Part #:	SCREW-440-250-PH
Description:	4-40 x 1/4" Pan head screw
Quantity Required for Mounting	2 per encoder

CABLES / CONNECTORS

3-PIN MICRO:

PART #	DESCRIPTION
CON-MIC3 *(https://www.usdigital.com/products/accessories/connectors/con-mic3/)*	Connector
CA-MIC3-W3-NC *(https://www.usdigital.com/products/accessories/cables/3-pin/ca-mic3-w3-nc/)*	Connector on one end with 3 wires
CA-MIC3-SH-NC *(https://www.usdigital.com/products/accessories/cables/3-pin/ca-mic3-sh-nc/)*	Connector on one end with shielded cable

- Connector built into encoder: Molex# 53398-0371.
- Mating connector housing: Molex# 51021-0300.
- Mating connector individual crimp-on pins: Molex# 50079-8100.
- To install connector pins, a special crimp tool is needed: Molex# 50079.

Notes

- Cables and connectors are not included and must be ordered separately.
- US Digital® warrants its products against defects in materials and workmanship for two years. See complete warranty *(https://www.usdigital.com/company/warranty)* for details.

Configuration Options

MAE3	-	Output	-	Bore Size	-	Shaft Length	-	Bolt Circle	-	Packaging
		A10 (*Analog 10-Bit*)		118 (*3.0mm*)		220 (*.220"*)		7 (*0.750"*)		B (*Encoders packaged in bulk.*)
		P10 (*PWM 10-Bit*)		125 (*1/8"*)		500 (*.500"*)		12 (*1.280"*)		1 (*Encoders packaged individually.*)
		P12 (*PWM 12-Bit*)		157 (*4.0mm*)				18 (*1.812"*)		
				188 (*3/16"*)						
				197 (*5.0mm*)						
				236 (*6.0mm*)						
				250 (*1/4"*)						

PLEASE NOTE: This chart is for informational use only. Certain product configuration combinations are not available. Visit the MAE3 product page *(https://www.usdigital.com/products/MAE3)* for pricing and additional information.