

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.

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.

The **MAE3** consists of three components: base, push-on magnetic hub, and encoder body. The base will accommodate 0.750", 1.280" and 1.812" 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.

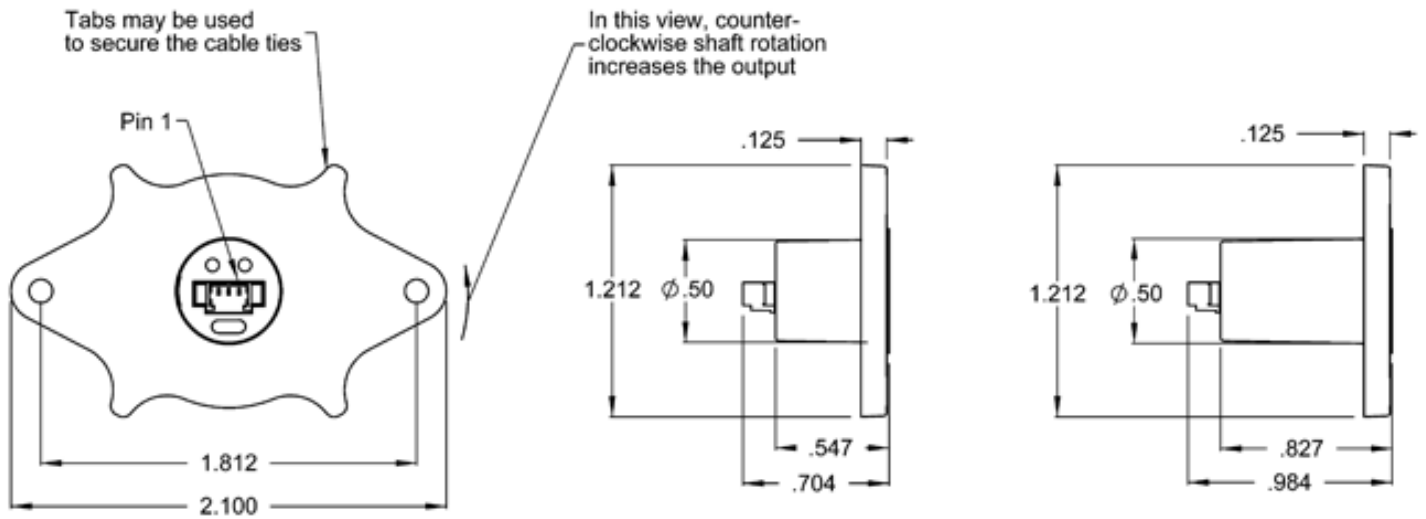
Connecting to the **MAE3** is simple. The 3-pin, high retention, snap-in 1.25mm pitch polarized connector provides for +5V, output, and ground.



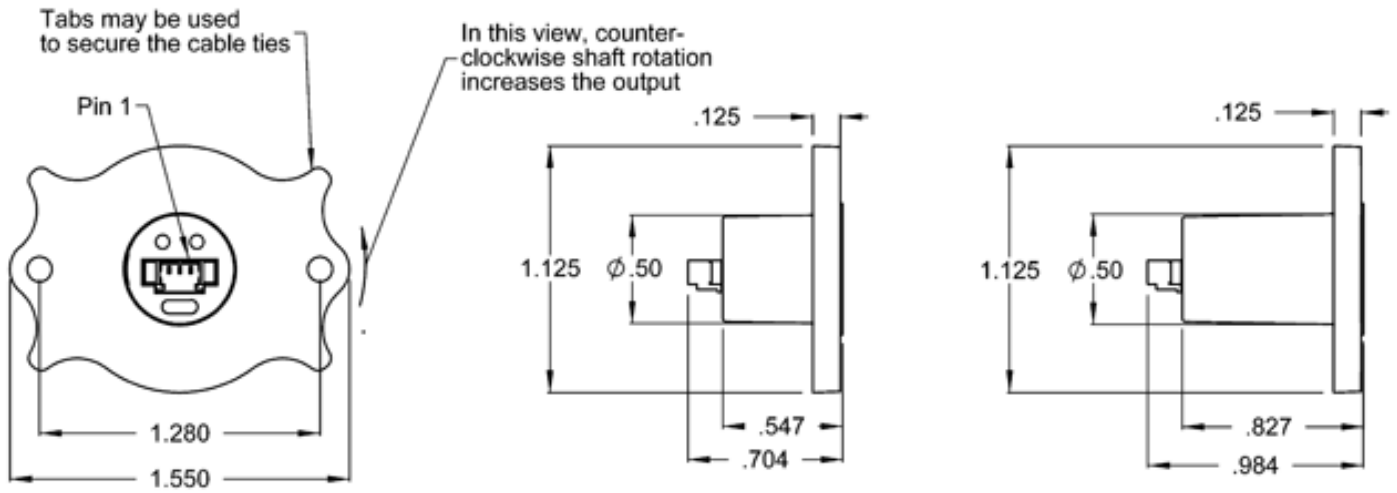
Features

- ▶ Quick, simple assembly and disassembly
- ▶ -40C to +125C operating temperature
- ▶ Accepts .010" axial shaft play
- ▶ Mounts to 0.750", 1.280" and 1.812" bolt circles
- ▶ Fits shaft diameters from .125" to .250" or 2mm to 6mm
- ▶ 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

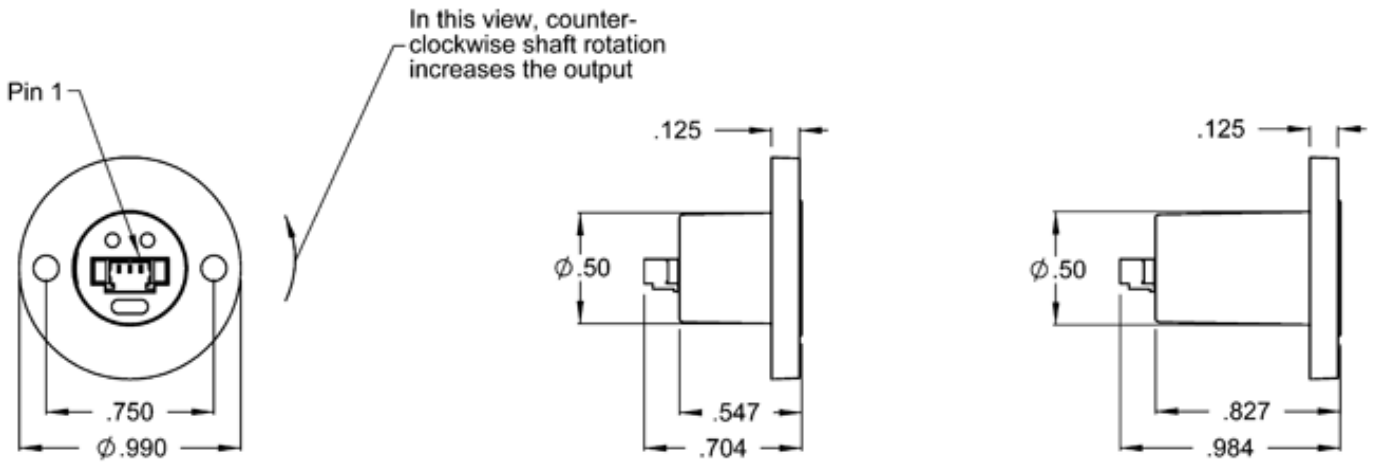
Size 18 Bolt Circle



Size 12 Bolt Circle



Size 7 Bolt Circle



Mechanical

| Parameter | Dimension | Units |
|---|-------------------------|----------------------|
| Moment of Inertia | 8.49 x 10 ⁻⁷ | oz-in-s ² |
| Mounting Screw Size (pan head) | 4-40 x 1/4" | - |
| Required Shaft Length | | |
| Size 220 Shaft Length -option | 0.220 (+0.04 / -0.02) | in. |
| Size 500 Shaft Length -option | 0.500 (+0.04 / -0.02) | in. |
| Base to Mounting Surface Torque | 4 - 6 | in.-lbs. |
| Shaft diameter tolerance, relative to nominal | -0.0001 to -0.0006 | in. |

Absolute Maximum Ratings

| Parameter | Max. | Units |
|-------------------------------------|---------|----------------------|
| Vibration (5Hz to 2kHz) | 20 | G |
| Shaft Axial Play | ±0.025 | in. |
| Shaft Eccentricity Plus Radial Play | 0.004 | in. |
| Acceleration | 250,000 | rad/sec ² |

Note that radial play translates directly to position inaccuracy.

Electrical

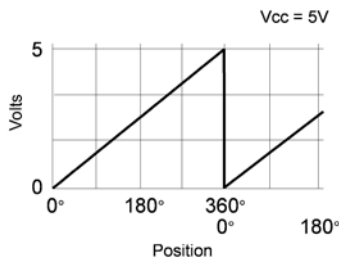
| Parameter | Min. | Typ | Max. | Units |
|-----------|------|-----|------|-------|
|-----------|------|-----|------|-------|

| | | | | |
|----------------|-----|-----|-----|-------|
| Power Supply | 4.5 | 5.0 | 5.5 | Volts |
| Supply Current | - | 16 | 20 | mA |
| Power-up Time | - | - | 50 | mS |

Environmental

| Parameter | Dimension |
|-------------------------|---------------|
| Operating Temperature | -40C to +125C |
| Storage Temperature | -55C to +125C |
| ESD | 2 kV minimum |
| Humidity Non-condensing | 5% to 85% |

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 $\geq 4.7k\Omega$ and less than 100pF. The graphs below show the typical output levels for various output loads when powered by a 5V supply.

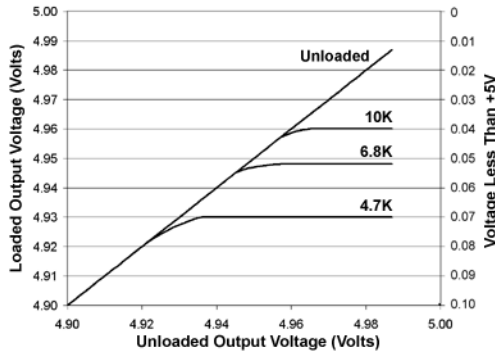
| Parameter | Min. | Typ. | Max. | Units |
|-------------------------------------|------|-------|------|----------------|
| Position Sampling Rate | 2.35 | 2.61 | 2.87 | kHz |
| Propagation Delay | - | - | 384 | ?S |
| Analog Output Voltage Maximum | - | 4.987 | - | Volts* |
| Analog Output Voltage Minimum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

* With no output load. See graphs below.

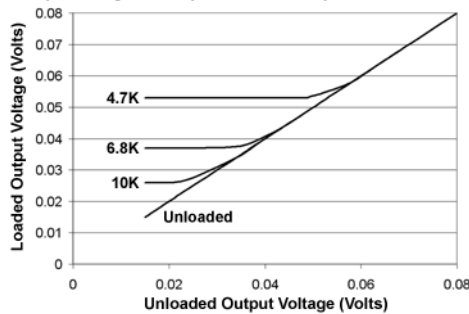
** Continuous short to +5V or ground will not damage the MAE3.

*** Transition noise is defined as the jitter in the transition between two adjacent position steps.

Output Voltage vs. Output Load w/ Pulldown Resistors to GND



Output Voltage vs. Output Load w/ Pullup Resistors to +5V



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 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. Accuracy including non-linearity is within 0.5 deg. at 25C, but may increase to 0.9 deg. at high temperatures.

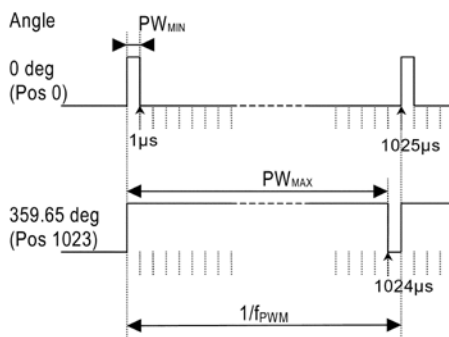
| Parameter | Min. | Typ. | Max. | Units |
|------------------------------|-------|-------|-------|-------|
| PWM Frequency (-40C to 125C) | | | | |
| 10-bit | 0.878 | 0.976 | 1.074 | kHz |
| 12-bit | 220 | 244 | 268 | Hz |
| Minimum Pulse Width | | | | |
| 10-bit | 0.95 | 1.00 | 1.05 | ?S |
| 12-bit | 0.95 | 1.00 | 1.05 | ?S |
| Maximum Pulse Width | | | | |
| 10-bit | 973 | 1024 | 1075 | ?S |
| 12-bit | 3891 | 4096 | 4301 | ?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 Delay | | | | |
| 10-bit | - | - | 48 | ?S |
| 12-bit | - | - | 384 | ?S |
| High Level Output Voltage (VOH: @4mA Source) | V _{cc} -0.5 | - | - | V* |
| Low Level Output Voltage (VOL: @4mA Sink) | - | - | 0.4 | V* |

* Continuous short to +5V or ground will not damage the MAE3.

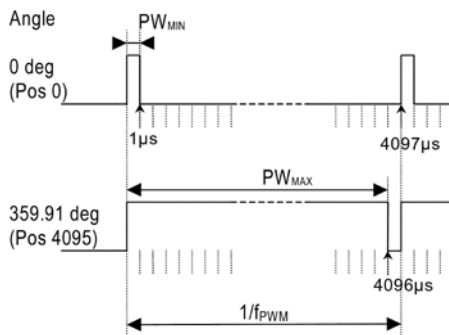
10-bit PWM:

$$\text{Position} = ((t_{\text{on}}/1025) / (t_{\text{on}} + t_{\text{off}})) - 1$$



12-bit PWM:

$$\text{Position} = ((t_{\text{on}}/4097) / (t_{\text{on}} + t_{\text{off}})) - 1$$



Pin-outs

Analog Output (MAE3-A):

| Pin | Name | Description |
|-----|------|---------------|
| 1 | 5 | +5VDC power |
| 2 | A | Analog output |

| Pin | Name | Description |
|-----|------|-------------|
| 3 | G | Ground |

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

| Pin | Name | Description |
|-----|------|-------------|
| 1 | 5 | +5VDC power |
| 2 | A | 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 |

Ordering Information

| | | | | | | | | | |
|---------------|----------------------|---|----------------------|---|----------------------|---|----------------------|---|--|
| MAE3 - | <input type="text"/> | - | <input type="text"/> | - | <input type="text"/> | - | <input type="text"/> | - | <input type="text"/> |
| | Interface | | Bore | | Shaft Length | | Bolt Circle | | Packaging |
| | A10 = 10-Bit Analog | | 079 = 2mm | | 220 = 0.220" | | 7 = 0.750" | | B = Encoder components packaged in bulk. |
| | P10 = 10-Bit PWM | | 091 = 2.3mm | | 500 = 0.500" | | 12 = 1.280" | | 1 = Each encoder packaged individually |
| | P12 = 12-Bit PWM | | 098 = 2.5mm | | | | 18 = 1.812" | | |
| | | | 118 = 3mm | | | | | | |
| | | | 125 = 1/8" | | | | | | |
| | | | 156 = 5/32" | | | | | | |
| | | | 157 = 4mm | | | | | | |
| | | | 188 = 3/16" | | | | | | |
| | | | 197 = 5mm | | | | | | |
| | | | 236 = 6mm | | | | | | |
| | | | 250 = 1/4" | | | | | | |

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 for details.

Pricing

| Quantity | Price |
|----------|---------|
| 1 | \$43.50 |
| 10 | \$32.85 |
| 50 | \$20.13 |
| 100 | \$16.40 |

- Add 17% per unit for **Interface** of 12-Bit PWM
- Add \$3.00 per unit for **Packaging** of Each encoder packaged individually