

## E3 Features

- Quick, simple assembly, and disassembly
- Rugged screw-together housing
- Accepts .010 in. axial shaft play
- Small size
- 64 to 10,000 cycles per revolution (CPR)
- 256 to 40,000 pulses per revolution (PPR)
- 2 channel quadrature TTL squarewave outputs
- Optional index (3rd channel)



## E3 Product Description

The E3 is a high-resolution rotary encoder with a rugged glass-filled polymer enclosure, which utilizes either a 5-pin locking or standard connector. This optical incremental encoder is designed to easily mount to and dismount from an existing shaft to provide digital feedback information.



The internal components consist of a mylar disk mounted to a precision machined aluminum hub and an encoder module. The hub is available for diameters up to 1 in. The module contains a highly collimated solid-state light source and monolithic phased array sensor, which together provide a system extremely tolerant to mechanical misalignments.

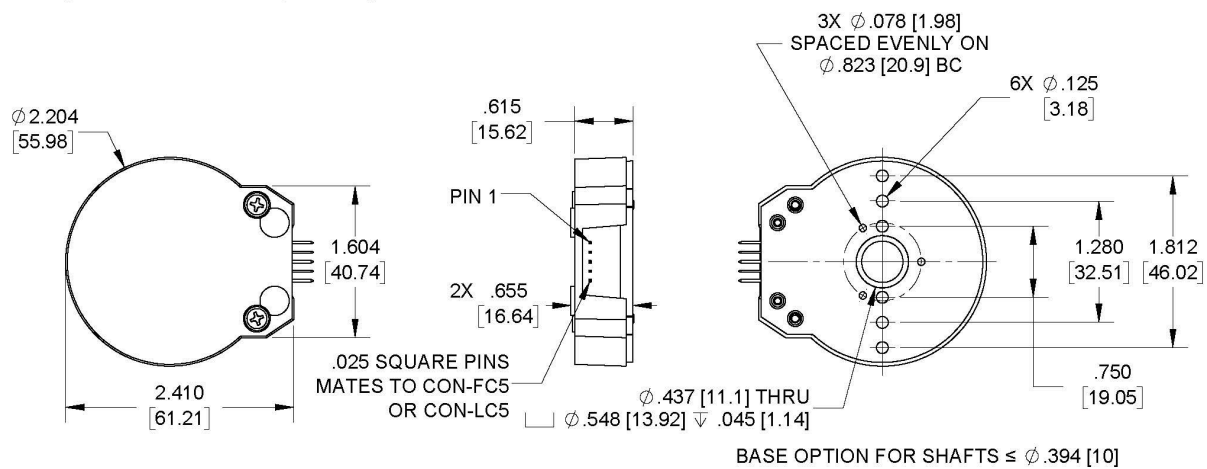
The E3 is normally designed for applications of 10 feet or less. For applications requiring longer cable lengths, we recommend adding a PC4 (<https://www.usdigital.com/pc4/>) / PC5 (<https://www.usdigital.com/pc5/>) differential line driver or check out our E6 (<https://www.usdigital.com/products/encoders/incremental/kit/e6/>) which has an optional differential output.

Attachment of the base to a surface may be accomplished by utilizing one of several machine screw bolt circle options. Positioning of the base to the centerline of a shaft is ensured by use of a centering tool. The cover is securely attached to the base with two 4-40 flat head screws to provide a resilient package protecting the internal components.

Connection to the E3 product is made through either a 5-pin locking or standard connector. The mating connectors are available from US Digital with several cable options and lengths.

## Mechanical Drawings

## E3 Optical Kit Encoder (Default)



RELEASE DATE: 7/18/2019

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Vancouver, Washington 98684, USA

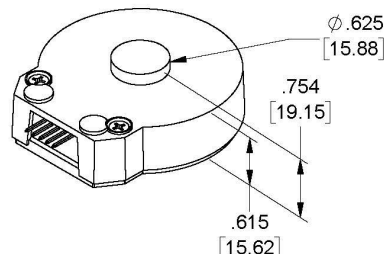
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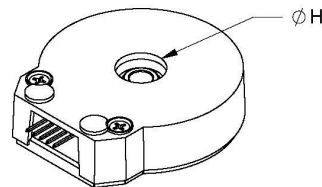
UNITS: INCHES [MM]  
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## E3 Optical Kit Encoder (Base & Cover Options)

E-OPTION COVER  
(EXTENSION FOR SHAFT  
LENGTHS UP TO .670 [17.02])

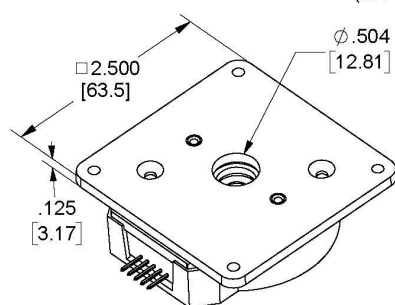


H-OPTION COVER (HOLE  
FOR SHAFT LENGTHS  
OVER .670 [17.02])



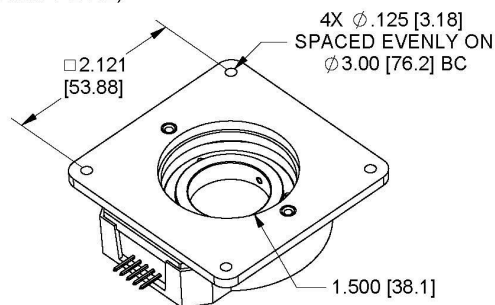
H = .550 [13.97] FOR SHAFT SIZES  $\leq \phi .500$  [12.7]  
H = 1.050 [26.67] FOR SHAFT SIZES  $> \phi .500$  [12.7]

M-OPTION BASE  
(MOUNTING PLATE)



FOR SHAFTS  $\leq \phi .394$  [10]

REQUIRES AN ADDITIONAL .125 [3.18] SHAFT LENGTH



FOR SHAFTS  $> \phi .394$  [10]



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UNITS: INCHES [MM]  
METRIC SHOWN FOR REFERENCE ONLY

RELEASE DATE: 7/8/2019

## Specifications

### ENVIRONMENTAL

| PARAMETER                              | VALUE      | UNITS |
|----------------------------------------|------------|-------|
| Operating Temperature, CPR < 2000      | -40 to 100 | C     |
| Operating Temperature, CPR $\geq$ 2000 | -25 to 100 | C     |
| Electrostatic Discharge, IEC 61000-4-2 | $\pm 4$    | kV    |
| Vibration (10Hz to 2kHz, sinusoidal)   | 20         | G     |
| Shock (6 milliseconds, half-sine)      | 75         | G     |

### MECHANICAL

| PARAMETER | VALUE | UNITS |
|-----------|-------|-------|
|-----------|-------|-------|



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E3

# | E3 Optical Kit Encoder

|                                                                                                                             |                                                                                   |                      |
|-----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------|
| Max. Shaft Axial Play                                                                                                       | ±0.010                                                                            | in.                  |
| Max. Shaft Runout                                                                                                           | 0.004 T.I.R.                                                                      | in.                  |
| Max. Acceleration                                                                                                           | 250000                                                                            | rad/sec <sup>2</sup> |
| For CPR ≤ 2500:<br>Max. RPM (1)<br>Max. A/B Frequency<br>e.x. CPR=2500, Max.<br>RPM=7200<br>e.x. CPR=100, Max.<br>RPM=60000 | minimum value of ((18 x 10 <sup>6</sup> ) /<br>CPR) and (60000)<br>300            | RPM<br>kHz           |
| For CPR = 3600, 4000,<br>4096, 5000:<br>Max. RPM (1)<br>Max. A/B Frequency                                                  | (21.6 x 10 <sup>6</sup> ) / CPR<br>360                                            | RPM<br>kHz           |
| For CPR = 7200, 8000,<br>8192, 10000:<br>Max. RPM (1)<br>Max. A/B Frequency                                                 | (43.2 x 10 <sup>6</sup> ) / CPR<br>720                                            | RPM<br>kHz           |
| Typical Product Weight                                                                                                      | 1.28                                                                              | oz.                  |
| Codewheel Moment of<br>Inertia                                                                                              | 8.9 x 10 <sup>-5</sup> for bore < 12mm<br>4.0 x 10 <sup>-4</sup> for bore ≥ 12 mm | oz-in-s <sup>2</sup> |
| Hub Set Screw                                                                                                               | #3-48 or #4-48                                                                    |                      |
| Hex Wrench Size                                                                                                             | 0.050                                                                             | in.                  |
| Encoder Base Plate<br>Thickness                                                                                             | 0.135                                                                             | in.                  |
| 3 Mounting Screw Size                                                                                                       | #0-80                                                                             |                      |
| 3 Screw Bolt Circle<br>Diameter (2)                                                                                         | 0.823 ± 0.005                                                                     | in.                  |
| 2 Mounting Screw Size                                                                                                       | #2-56 or #4-40                                                                    |                      |
| 2 Screw Bolt Circle<br>Diameter                                                                                             | 0.750 ± 0.005                                                                     | in.                  |
| 2 Screw Bolt Circle<br>Diameter                                                                                             | 1.280 ± 0.005                                                                     | in.                  |
| 2 Screw Bolt Circle<br>Diameter                                                                                             | 1.812 ± 0.005                                                                     | in.                  |
| Required Shaft Length<br>(3)<br>With E-option (2)<br>With H-option                                                          | 0.445 to 0.525<br>0.445 to 0.670<br>> 0.445                                       | in.<br>in.<br>in.    |
| Index alignment to hub<br>set screw                                                                                         | 180 ± Typical                                                                     | degrees              |

(1) 60000 RPM is the maximum rpm due to mechanical considerations. The maximum RPM due to the module's maximum frequency response is dependent upon the module's resolution (CPR).

(2) Only for shaft diameters < 0.472".

(3) Add 0.125" to all required shaft lengths when using M-option.

## TORQUE SPECIFICATIONS

| PARAMETER                                     | VALUE | TORQUE |
|-----------------------------------------------|-------|--------|
| Hub Set Screw                                 | 2-3   | in-lbs |
| Cover Screw                                   | 2-4   | in-lbs |
| Base Mounting Screw (#0-80)                   | 1-2   | in-lbs |
| Base Mounting Screw (#2-56)                   | 2-3   | in-lbs |
| Base Mounting Screw (#4-40)                   | 4-6   | in-lbs |
| Adapter Plate Mounting Surface (#2-56 screws) | 2-3   | in-lbs |
| Adapter Plate Mounting Surface (#4-40 screws) | 4-6   | in-lbs |
| Module Mounting Screw                         | 3.5-4 | in-lbs |

## PHASE RELATIONSHIP

A leads B for clockwise shaft rotation, and B leads A for counterclockwise rotation viewed from the cover side of the encoder.

## ELECTRICAL

- Specifications apply over the entire operating temperature range.
- Typical values are specified at  $V_{CC} = 5.0V_{DC}$  and  $25^{\circ}C$ .
- For complete details, see the EM1 (<https://www.usdigital.com/products/encoders/incremental/modules/em1/>) and EM2 (<https://www.usdigital.com/products/encoders/incremental/modules/em2/>) product pages.

| PARAMETER                         | MIN. | TYP. | MAX. | UNITS | CONDITIONS                            |
|-----------------------------------|------|------|------|-------|---------------------------------------|
| <b>Supply Voltage</b>             | 4.5  | 5.0  | 5.5  | V     |                                       |
| <b>Supply Current</b>             |      | 27   | 33   | mA    | CPR < 1000, no load                   |
|                                   |      | 54   | 62   | mA    | CPR $\geq$ 1000 and < 3600, no load   |
|                                   |      | 72   | 85   | mA    | CPR $\geq$ 3600, no load              |
| <b>Low-level Output</b>           |      |      | 0.5  | V     | $I_{OL} = 8mA$ max., CPR < 3600       |
|                                   |      |      | 0.5  | mA    | $I_{OL} = 5mA$ max., CPR $\geq$ 3600  |
|                                   |      | 0.05 |      | mA    | no load, CPR < 3600                   |
|                                   |      | 0.25 |      | mA    | no load, CPR $\geq$ 3600              |
| <b>High-level Output</b>          | 2.0  |      |      | V     | $I_{OH} = -8mA$ max., CPR < 3600      |
|                                   | 2.0  |      |      | V     | $I_{OH} = -5mA$ max., CPR $\geq$ 3600 |
|                                   |      | 4.8  |      | V     | no load, CPR < 3600                   |
|                                   |      | 3.5  |      | V     | no load, CPR $\geq$ 3600              |
| <b>Output Current Per Channel</b> | -8   |      | 8    | mA    | CPR < 3600                            |
|                                   | -5   |      | 5    | mA    | CPR $\geq$ 3600                       |
| <b>Output Rise Time</b>           |      | 110  |      | nS    | CPR < 3600                            |
|                                   |      | 50   |      | nS    | CPR $\geq$ 3600                       |
| <b>Output Fall Time</b>           |      | 35   |      | nS    | CPR < 3600                            |
|                                   |      | 50   |      | nS    | CPR $\geq$ 3600                       |



## PIN-OUT

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | Ground      |
| 2   | Index       |
| 3   | A channel   |
| 4   | +5VDC power |
| 5   | B channel   |

**Note:** 5-pin single-ended mating connector is CON-C5 (<https://www.usdigital.com/products/accessories/connectors/con-c5/>) or CON-LC5 (<https://www.usdigital.com/products/accessories/connectors/con-lc5/>)

## ACCESSORIES

### 1. Centering Tool

The centering tool is only included with the **-3** packaging option. It has to be ordered separately for other packaging options.

#### Part #: CTOOL - (Shaft Diameter)

**Description:** This reusable tool provides a simple method for accurately centering the E3 base onto the shaft in order to promote concentricity and thus, higher accuracy. It is recommended for the following situations:

- When using mounting screws smaller than #4-40.
- When the position of the mounting holes is in question.
- When using the 3-hole mounting pattern.
- When using the T-option transfer adhesive.

**Instructions:** When mounting encoder base, slide centering tool down shaft until it slips into centering hole of encoder base. Tighten mounting screws, then remove centering tool.

### 2. Hex Tool

Depending on the order packaging option, either a hex driver or hex wrench is included.

#### Part #: HEXD-050

**Description:** Hex driver, 0.050" flat-to-flat for #3-48 or #4-48 set screws. Only included with **-B** or **-1** packaging options.

#### Part #: HEXW-050

**Description:** Hex wrench, 0.050" flat-to-flat for #3-48 or #4-48 set screws. Only included with **-2** or **-3** packaging options.

### 3. Spacer Tool

A spacer tool is included for all packaging options.

#### Part #: SPACER-E3S

**Description:** For shafts  $\leq 0.394$ "

#### Part #: SPACER-E3L

**Description:** For shafts 12mm - 1"

### 4. Screws

#### Part #: SCREW-080-250-PH

**Description:** Pan Head, Philips #0-80 UNF x 1/4"

**Use:** Base Mounting

Quantity Required: 3  
Screws are not included

**Part #: SCREW-256-250-PH**

Description: Pan Head, Phillips #2-56 UNC x 1/4"  
Use: Base Mounting  
Quantity Required: 2  
Screws are not included

**Part #: SCREW-348-125-SS**

Description: Socket Head Set Screw, 3-48 UNC x 1/8"  
Use: Hub/Disk Mounting for 12mm - 1" Bore  
Quantity Required: 2  
Screws are included

**Part #: SCREW-440-250-PH**

Description: Pan Head, Phillips #4-40 UNC x 1/4"  
Use: Base Mounting  
Quantity Required: 2  
Screws are not included

**Part #: SCREW-440-500-PH**

Description: Pan Head, Phillips #4-40 UNC x 1/2"  
Use: Module Mounting  
Quantity Required: 2  
Screws are included

**Part #: SCREW-440-625-FH**

Description: Flat Head, Phillips 4-40 UNC x 5/8"  
Use: Cover Mounting  
Quantity Required: 2  
Screws are included

**Part #: SCREW-448-063-SS**

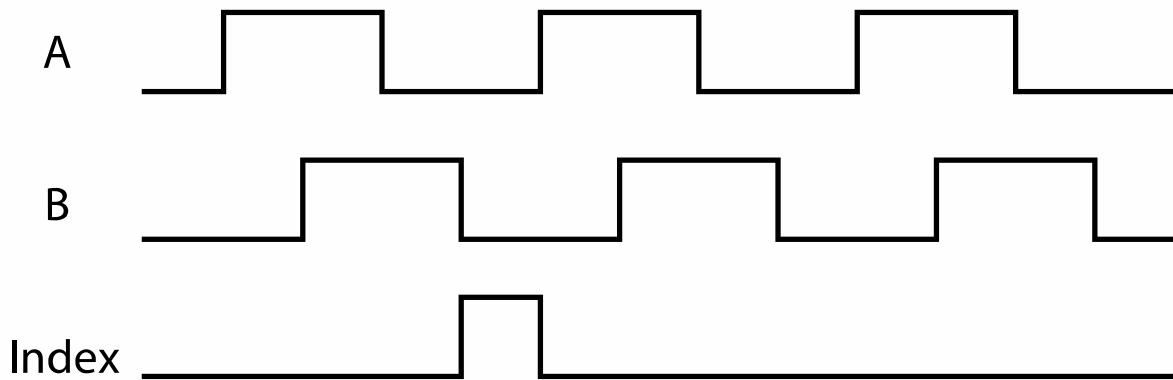
Description: Socket Head Set Screw, 4-48 UNC x 1/16"  
Use: Hub/Disk Mounting for 5/16" - 10mm Bore  
Quantity Required: 1  
Screw is included

**Part #: SCREW-448-125-SS**

Description: Socket Head Set Screw, 4-48 UNC x 1/8"  
Use: Hub/Disk Mounting for 2mm - 1/4" Bore  
Quantity Required: 1  
Screw is included

## OUTPUT WAVEFORMS

### SINGLE-ENDED



## Notes

- 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.
- Cables and connectors are not included and must be ordered separately.

## Configuration Options

| E3 | CPR (Cycles Per Revolution) | Bore Size       | Index          | Cover            | Base                        | Packaging                                                                                                                                                                    |
|----|-----------------------------|-----------------|----------------|------------------|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | 64                          | 079 (2.0mm)     | IE (Index)     | D (Default)      | D (Default)                 | B (Encoders packaged in bulk. Every order includes one centering tool, hex tool and spacer tool. An additional set of tools is included for each 100 encoders ordered.)      |
|    | 100                         | 118 (3.0mm)     | NE (Non-Index) | E (Extended)     | M (3" Diameter Bolt Circle) | 1 (Encoders packaged individually. Every order includes one centering tool, hex tool and spacer tool. An additional set of tools is included for each 100 encoders ordered.) |
|    | 200                         | 125 (1/8")      |                | H (Through-Hole) |                             | 3 (Encoders packaged individually. Every order includes one centering tool, hex tool and spacer tool per encoder.)                                                           |
|    | 400                         | 156 (5/32")     |                |                  |                             |                                                                                                                                                                              |
|    | 500                         | 157 (4.0mm)     |                |                  |                             |                                                                                                                                                                              |
|    | 512                         | 188 (3/16")     |                |                  |                             |                                                                                                                                                                              |
|    | 1000                        | 197 (5.0mm)     |                |                  |                             |                                                                                                                                                                              |
|    | 1024                        | 236 (6.0mm)     |                |                  |                             |                                                                                                                                                                              |
|    | 1800                        | 250 (1/4")      |                |                  |                             |                                                                                                                                                                              |
|    | 2000                        | 313 (5/16")     |                |                  |                             |                                                                                                                                                                              |
|    | 2048                        | 315 (8.0mm)     |                |                  |                             |                                                                                                                                                                              |
|    | 2500                        | 375 (3/8")      |                |                  |                             |                                                                                                                                                                              |
|    | 3600                        | 394 (10.0mm)    |                |                  |                             |                                                                                                                                                                              |
|    | 4000                        | 472 (12.0mm)    |                |                  |                             |                                                                                                                                                                              |
|    | 4096                        | 500 (1/2")      |                |                  |                             |                                                                                                                                                                              |
|    | 5000                        | 551 (14.0mm)    |                |                  |                             |                                                                                                                                                                              |
|    | 7200                        | 625 (5/8" Bore) |                |                  |                             |                                                                                                                                                                              |
|    | 8000                        | 750 (3/4" Bore) |                |                  |                             |                                                                                                                                                                              |
|    | 8192                        | 787 (20.0mm)    |                |                  |                             |                                                                                                                                                                              |
|    | 10000                       | 875 (7/8")      |                |                  |                             |                                                                                                                                                                              |
|    |                             | 984 (25.0mm)    |                |                  |                             |                                                                                                                                                                              |
|    |                             | 1000 (1")       |                |                  |                             |                                                                                                                                                                              |

**PLEASE NOTE: This chart is for informational use only.** Certain product configuration combinations are not available. Visit the E3 product page (<https://www.usdigital.com/products/E3>) for pricing and additional information.