



## E6 Features

- Quick, simple assembly, and disassembly
- Rugged screw-together housing
- Positive latching connector
- Accepts .010 in. axial shaft play
- 64 to 10,000 cycles per revolution (CPR)
- 256 to 40,000 pulses per revolution (PPR)
- 2 channel quadrature with optional index
- Multiple Output Drive Options
- Fits shaft diameters from 2mm to 1 in.



## E6 Product Description

The E6 Series rotary encoder has a rugged glass-filled polymer enclosure that utilizes either a 5-pin or 10-pin latching 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 module contains a highly collimated solid-state light source and monolithic phased array sensor, which together provide a system extremely tolerant to mechanical misalignments.

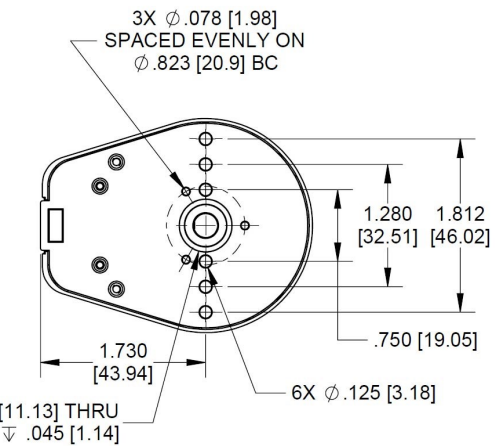
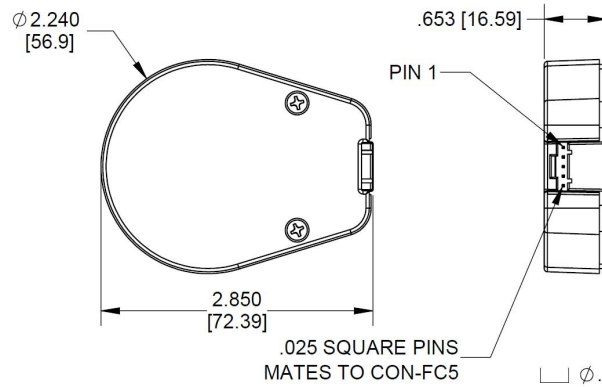
The single-ended output version (**S**-option) is typically used with cables of 10 feet or less. For longer cable lengths, the differential output version (**D**-option) is recommended.

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

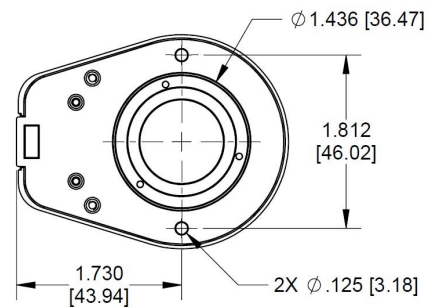
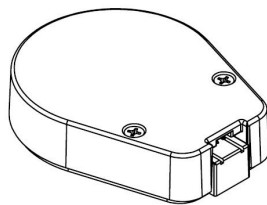
A secure connection to the E6 Series encoder is made through a 5-pin (single-ended versions) or 10-pin (differential, high-voltage or open-collector versions) latching connector. The mating connectors are available from US Digital with several cable options and lengths.

## Mechanical Drawings

### E6 Single-Ended Optical Kit Encoder (Default)



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



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



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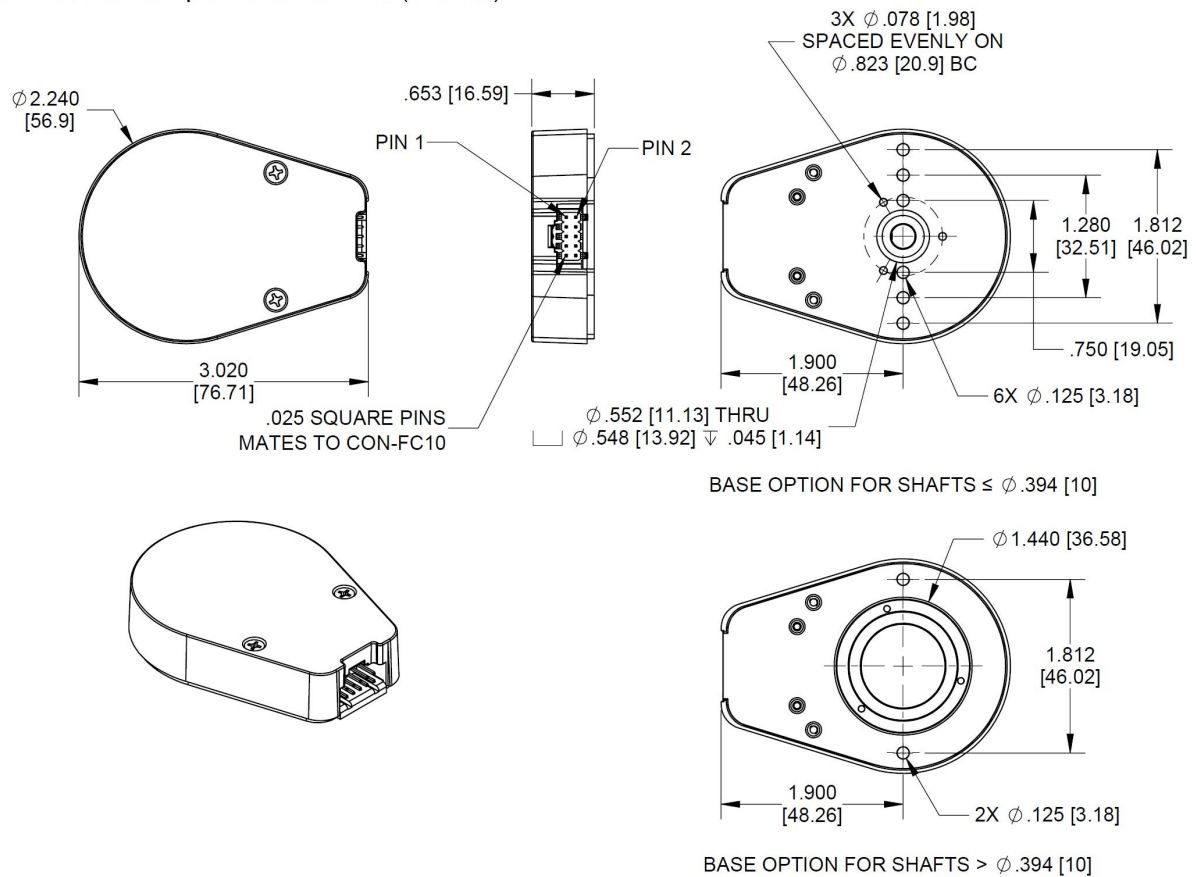
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RELEASE DATE: 05/19/2021

## E6 Differential Optical Kit Encoder (Default)



RELEASE DATE: 05/19/2021



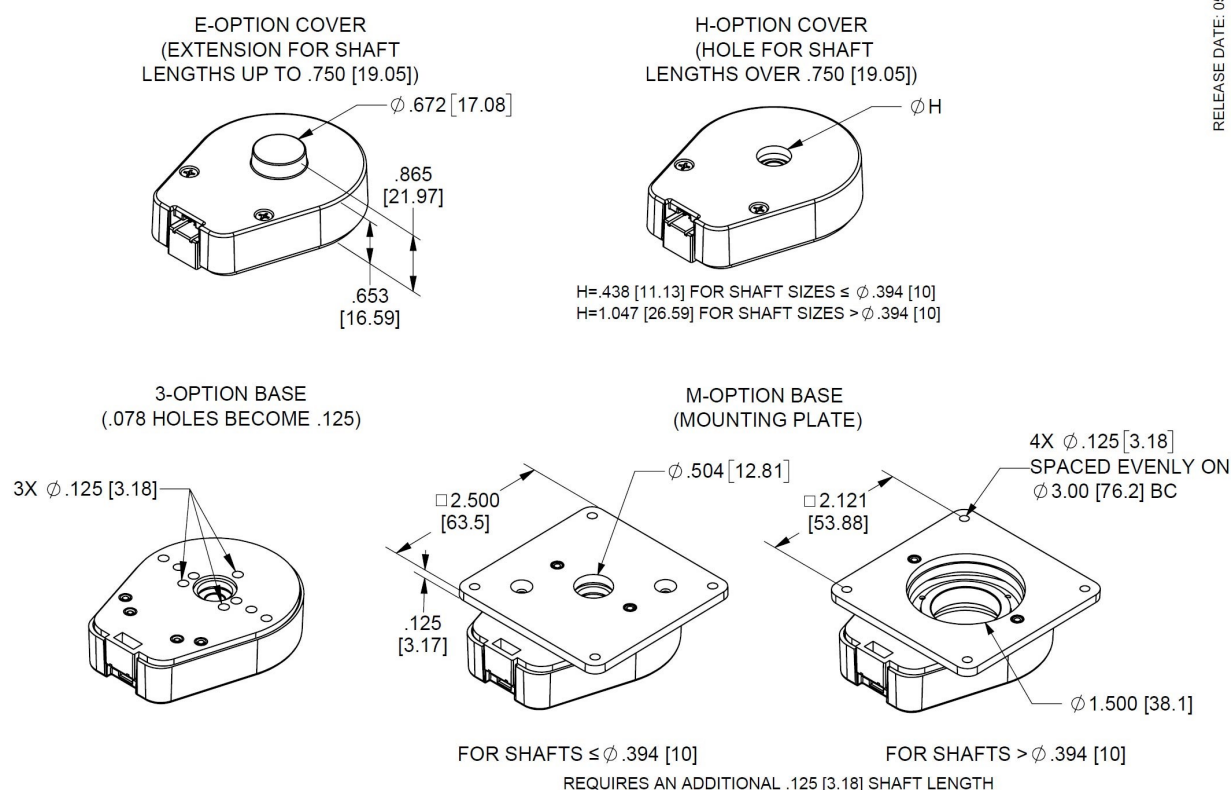
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## E6 Optical Kit Encoder (Base and Cover Options)



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## Specifications

### ENVIRONMENTAL

| PARAMETER   | VALUE      | UNITS |
|---|------------|-------|
| Operating Temperature (CPR < 3600)                        | -40 to 100 | C     |
| Operating Temperature (CPR $\geq$ 3600)                   | -25 to 100 | C     |
| Electrostatic Discharge                                   |            |       |
| Single-ended (-A, -S version), IEC 61000-4-2              | $\pm 4$    | kV    |
| Differential (-D, -L version), Human Body Model           | $\pm 2$    |       |
| High-Voltage, Open-collector (H, C option), IEC 61000-4-2 | $\pm 4$    |       |
| Vibration (10Hz to 2kHz, sinusoidal)                      | 20         | G     |
| Shock (6 milliseconds, half-sine)                         | 75         | G     |

## MECHANICAL

| PARAMETER   | VALUE  | UNITS                |
|---|--|----------------------|
| Max. Shaft Axial Play   | $\pm 0.010$  | in.                  |
| Max. Shaft Runout   | 0.004 T.I.R.   | in.                  |
| Max. Acceleration   | 250000   | rad/sec <sup>2</sup> |
| For CPR $\leq 2500$ :<br>Max. RPM (1)<br>Max. A/B Frequency<br>e.x. CPR=2500, Max. RPM=7200<br>e.x. CPR=100, Max. RPM=60000   | minimum value of $((18 \times 10^6) / \text{CPR})$ and (60000)<br>300                              | RPM<br>kHz           |
| For CPR = 3600, 4000, 4096, 5000:<br>Max. RPM (1)<br>Max. A/B Frequency   | $(21.6 \times 10^6) / \text{CPR}$<br>360   | RPM<br>kHz           |
| For CPR = 7200, 8000, 8192, 10000:<br>Max. RPM (1)<br>Max. A/B Frequency  | $(43.2 \times 10^6) / \text{CPR}$<br>720   | RPM<br>kHz           |
| Typical Product Weight<br>Single-Ended (S option)<br>Differential (D, L option)<br>High-Voltage, Open-Collector (H, C option) | 1.55<br>1.83<br>1.83   | oz.                  |
| Codewheel Moment of Inertia   | $8.9 \times 10^{-5}$ for bore $< 12\text{mm}$<br>$4.0 \times 10^{-4}$ for bore $\geq 12\text{ mm}$ | oz-in-s <sup>2</sup> |
| Hub Set Screw   | #3-48 or #4-48   |                      |
| Hex Wrench Size   | 0.050  | in.                  |
| Encoder Base Plate Thickness  | 0.135  | in.                  |
| 3 Mounting Screw Size   | #0-80  |                      |
| 2 Mounting Screw Size   | #2-56 or #4-40   |                      |
| 3 Screw Bolt Circle Diameter (2)  | $0.823 \pm 0.005$  | in.                  |
| 2 Screw Bolt Circle Diameter  | $0.750 \pm 0.005$  | in.                  |
| Required Shaft Length (3)<br>With E-option (2)<br>With H-option   | 0.445 to 0.570<br>0.445 to 0.750<br>> 0.445  | in.                  |
| Index Alignment to Hub 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

### SINGLE-ENDED (S) / DIFFERENTIAL (D) / HIGH-VOLTAGE (H) / OPEN-COLLECTOR (C) OPTION:

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

### BROADCOM / AVAGO COMPATIBLE PIN-OUT (A, L) OPTION:

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

## SINGLE-ENDED OPTION

- S option provides 5V TTL compatible outputs
- 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                            |
|----------------------------|------|------|------|-------|---------------------------------------|
| Supply Voltage             | 4.5  | 5.0  | 5.5  | V     |                                       |
| Supply Current             |      | 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              |
| Low-level Output           |      |      | 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              |
| High-level Output          | 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              |
| Output Current Per Channel | -8   |      | 8    | mA    | CPR < 3600                            |
|                            | -5   |      | 5    | mA    | CPR $\geq$ 3600                       |
| Output Rise Time           |      | 110  |      | nS    | CPR < 3600                            |
|                            |      | 50   |      | nS    | CPR $\geq$ 3600                       |
| Output Fall Time           |      | 35   |      | nS    | CPR < 3600                            |
|                            |      | 50   |      | nS    | CPR $\geq$ 3600                       |



## DIFFERENTIAL OPTION

- D Option provides differential line driver output
- 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                          |
|------------------------------------|------|------|------|-------|-------------------------------------|
| Supply Voltage                     | 4.5  | 5.0  | 5.5  | V     |                                     |
| Supply Current                     |      | 29   | 36   | mA    | CPR < 1000, no load                 |
|                                    |      | 56   | 65   | mA    | CPR $\geq$ 1000 and < 3600, no load |
|                                    |      | 74   | 88   | mA    | CPR $\geq$ 3600, no load            |
| Low-level Output                   |      | 0.2  | 0.4  | V     | $I_{OL} = 20mA$ max.                |
| High-level Output                  | 2.4  | 3.4  |      | V     | $I_{OH} = -20mA$ max.               |
| Differential Output Rise/Fall Time |      |      | 15   | nS    |                                     |

## HIGH-VOLTAGE OPTION

- H option uses a higher supply voltage and provides both single-ended and open-collector outputs
- Single-ended outputs are 5V TTL compatible (same as S option)
- Specifications apply over the entire operating temperature range
- For complete details, see the EM1 (<https://www.usdigital.com/products/encoders/incremental/modules/em1/>) or EM2 (<https://www.usdigital.com/products/encoders/incremental/modules/em2/>) product pages

| PARAMETER                      | MIN. | TYP. | MAX. | UNITS | CONDITIONS                         |
|--------------------------------|------|------|------|-------|------------------------------------|
| Supply Voltage                 | 7.5  |      | 30.0 | V     |                                    |
| Supply Current, 24V power      |      | 8    | 10   | mA    | CPR < 500, no load                 |
|                                |      | 16   | 19   | mA    | CPR $\geq$ 500 and < 2000, no load |
|                                |      | 22   | 25   | mA    | CPR $\geq$ 2000, no load           |
| Open Collector "On" Resistance |      | 2    |      | ohms  |                                    |
| Open Collector Sink Current    |      |      | 200  | mA    |                                    |
| Output Low Voltage             |      |      | 0.4  | V     | 200 mA sink current                |
| Open Collector Pullup Voltage  |      |      | 50   | V     |                                    |

## PIN-OUTS



| 5-PIN SINGLE-ENDED<br>S OPTION (1) |             | 10-PIN DIFFERENTIAL D<br>OPTION (2) |             | 10-PIN DIFFERENTIAL<br>L OPTION (2)(3) |               | 10-PIN SINGLE-ENDED<br>A-OPTION (2)(3) |               |
|------------------------------------|-------------|-------------------------------------|-------------|--|---------------|--|---------------|
| Pin                                | Description | Pin                                 | Description | Pin                                    | Description   | Pin                                    | Description   |
| 1                                  | Ground      | 1                                   | Ground      | 1                                      | No connection | 1                                      | A channel     |
| 2                                  | Index       | 2                                   | Ground      | 2                                      | +5VDC power   | 2                                      | +5VDC power   |
| 3                                  | A channel   | 3                                   | Index-      | 3                                      | Ground        | 3                                      | Ground        |
| 4                                  | +5VDC power | 4                                   | Index+      | 4                                      | No connection | 4                                      | No connection |
| 5                                  | B channel   | 5                                   | A- channel  | 5                                      | A- channel    | 5                                      | No connection |
|                                    |             | 6                                   | A+ channel  | 6                                      | A+ channel    | 6                                      | Ground        |
|                                    |             | 7                                   | +5VDC power | 7                                      | B- channel    | 7                                      | +5VDC power   |
|                                    |             | 8                                   | +5VDC power | 8                                      | B+ channel    | 8                                      | B+ channel    |
|                                    |             | 9                                   | B- channel  | 9                                      | Index-        | 9                                      | +5VDC power   |
|                                    |             | 10                                  | B+ channel  | 10                                     | Index+        | 10                                     | Index         |

| 10-PIN HIGH-VOLTAGE<br>H OPTION (2) |                             |
|-------------------------------------|-----------------------------|
| Pin                                 | Description                 |
| 1                                   | Ground                      |
| 2                                   | Ground                      |
| 3                                   | Index- (open collector)     |
| 4                                   | Index+ (single-ended)       |
| 5                                   | A- channel (open collector) |
| 6                                   | A+ channel (single-ended)   |
| 7                                   | 7.5-30V power               |
| 8                                   | 7.5-30V power               |
| 9                                   | B- channel (open collector) |
| 10                                  | B+ channel (single-ended)   |

(1) 5-pin single-ended mating connector is CON-FC5 (<https://www.usdigital.com/products/accessories/connectors/con-fc5/>).

(2) 10-pin differential mating connector is CON-FC10 (<https://www.usdigital.com/products/accessories/connectors/con-fc10/>).

(3) Broadcom / Avago compatible version.

## 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 **E6** base onto the shaft.

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.

## 2. Hex Tool

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

### Part #: HEXD-050

**Description:** Hex driver, .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, .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-E6S

**Description:** For shaft sizes < 0.472"

### Part #: SPACER-E6L

**Description:** For shaft sizes 12mm to 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, Philips #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, Philips #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"

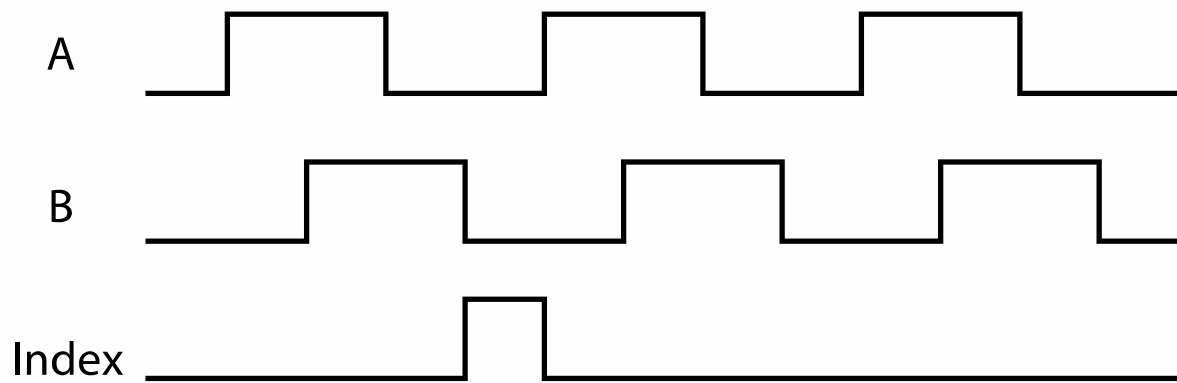
Use: Hub/Disk Mounting for 2mm - 1/4" Bore

Quantity Required: 1

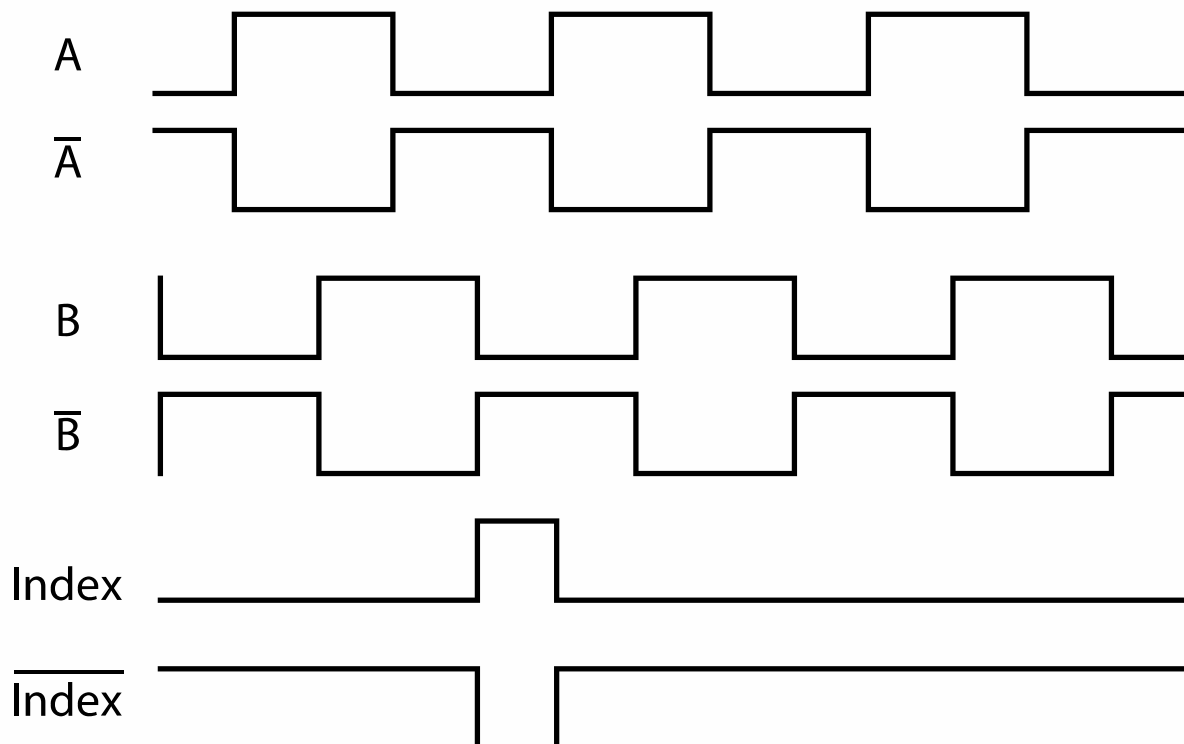
Screw is included

## OUTPUT WAVEFORMS

### SINGLE-ENDED



### DIFFERENTIAL





## 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

| E6    | CPR (Cycles Per Revolution) | Bore Size       | Index          | Output                        | Cover            | Base                        | Packaging  |
|-------|-----------------------------|-----------------|----------------|-------------------------------|------------------|-----------------------------|--|
|       |                             | 079 (2.0mm)     | IE (Index)     | S (Single-Ended)              | 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.)      |
|       |                             | 118 (3.0mm)     | NE (Non-Index) | H (Single-Ended High-Voltage) | E (Extended)     | 3 (1/8" Mounting Holes)     |  |
|       |                             | 125 (1/8")      |                |                               | H (Through-Hole) | M (3" Diameter Bolt Circle) |  |
| 64    |                             | 156 (5/32")     |                | D (Differential)              |                  |                             |  |
| 100   |                             | 157 (4.0mm)     |                | L (Avago 10-pin Differential) |                  |                             |  |
| 200   |                             | 188 (3/16")     |                |                               |                  |                             |  |
| 400   |                             | 197 (5.0mm)     |                | A (Avago 10-pin Single-Ended) |                  |                             |  |
| 500   |                             | 236 (6.0mm)     |                |                               |                  |                             |  |
| 512   |                             | 250 (1/4")      |                |                               |                  |                             | 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.) |
| 800   |                             | 313 (5/16")     |                |                               |                  |                             |  |
| 1000  |                             | 315 (8.0mm)     |                |                               |                  |                             |  |
| 1024  |                             | 375 (3/8")      |                |                               |                  |                             |  |
| 1800  |                             | 394 (10.0mm)    |                |                               |                  |                             |  |
| 2000  |                             | 472 (12.0mm)    |                |                               |                  |                             |  |
| 2048  |                             | 500 (1/2")      |                |                               |                  |                             |  |
| 2500  |                             | 551 (14.0mm)    |                |                               |                  |                             |  |
| 3600  |                             | 625 (5/8" Bore) |                |                               |                  |                             | 3 (Encoders packaged individually. Every order includes one centering tool, hex tool and spacer tool per encoder.)   |
| 4000  |                             | 750 (3/4" Bore) |                |                               |                  |                             |  |
| 4096  |                             | 787 (20.0mm)    |                |                               |                  |                             |  |
| 5000  |                             | 875 (7/8")      |                |                               |                  |                             |  |
| 7200  |                             | 984 (25.0mm)    |                |                               |                  |                             |  |
| 8000  |                             | 1000 (1")       |                |                               |                  |                             |  |
| 8192  |                             |                 |                |                               |                  |                             |  |
| 10000 |                             |                 |                |                               |                  |                             |  |

**PLEASE NOTE: This chart is for informational use only.** Certain product configuration combinations are not available. Visit the E6 product page (<https://www.usdigital.com/products/E6>) for pricing and additional information.