

## 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 longer cable lengths, adding a PC4 (<https://www.usdigital.com/pc4/>) / PC5 (<https://www.usdigital.com/pc5/>) differential line driver is recommended.

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.

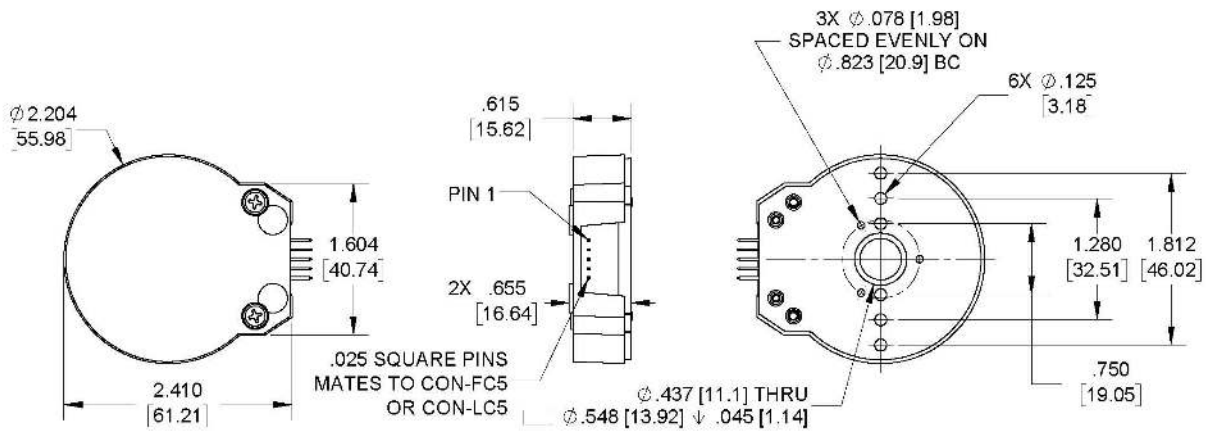
Connection to the E3 product is made through either a 5-pin locking or standard connector. The mating connectors are available from US Digital with several cable options and lengths.

## Mechanical Drawings

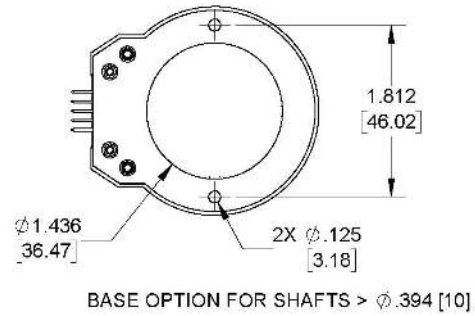
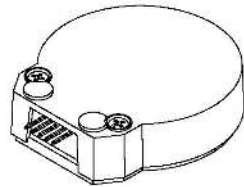
# US DIGITAL | E3 OPTICAL KIT ENCODER

## E3 Optical Kit Encoder (Default)

RELEASE DATE: 7/8/2019



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



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

**US DIGITAL** 1400 NE 136th Avenue  
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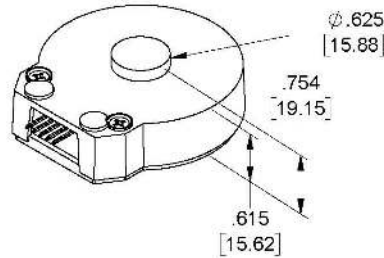
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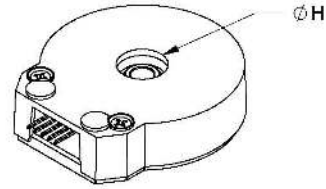
UNITS: INCHES [MM]  
METRIC SHOWN FOR REFERENCE ONLY

## E3 Optical Kit Encoder (Base & Cover Options)

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

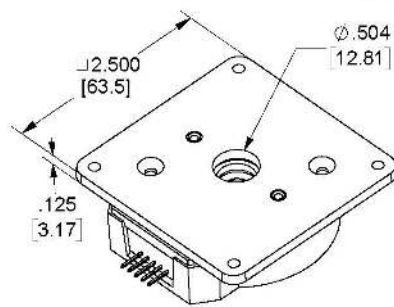


H-OPTION COVER (HOLE  
FOR SHAFT LENGTHS  
OVER .670 [17.02])

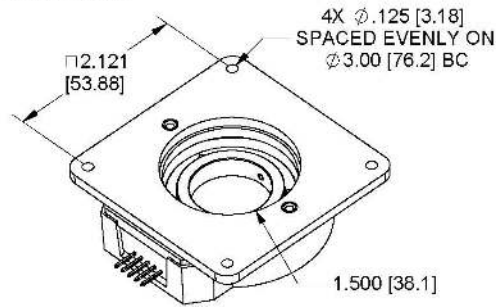


H = .550 [13.97] FOR SHAFT SIZES  $\leq \phi$  .500 [12.7]  
H = 1.050 [26.67] FOR SHAFT SIZES  $> \phi$  .500 [12.7]

M-OPTION BASE  
(MOUNTING PLATE)



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



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

REQUIRES AN ADDITIONAL .125 [3.18] SHAFT LENGTH



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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
Vibration (5Hz to 2kHz)	20	G
Electrostatic Discharge, IEC 61000-4-2	$\pm 4$	kV

### MECHANICAL

PARAMETER	VALUE	UNITS
Max. Shaft Axial Play	$\pm 0.010$	in.



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PARAMETER	VALUE	UNITS
Max. Shaft Runout	0.004 T.I.R.	in.
Max. Acceleration	250000	rad/sec <sup>2</sup>
Max. RPM (1) (CPR ≤ 2500) e.x. CPR=2500, max. rpm=7200 e.x. CPR=100, max. rpm=60000	minimum value of ((18 x 10 <sup>6</sup> ) / CPR) and (60000)	RPM
Max. RPM (1) (CPR > 2500 and ≤ 5000) e.x. CPR=4096, max. rpm=5273	(21.6 x 10 <sup>6</sup> ) / CPR	RPM
Max. RPM (1) (CPR > 5000) e.x. CPR=10000, max. rpm=4320	(43.2 x 10 <sup>6</sup> ) / CPR	RPM
Typical Product Weight	1.28	oz.
Codewheel Moment of Inertia	8.9 x 10 <sup>-5</sup> for bore < 12mm 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 Thickness	0.135	in.
3 Mounting Screw Size	#0-80	
3 Screw Bolt Circle Diameter (2)	0.823 ± 0.005	in.
2 Mounting Screw Size	#2-56 or #4-40	
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 (3) With E-option (2) With H-option	0.445 to 0.525 0.445 to 0.670 > 0.445	in. in. in.
Index alignment to hub set screw	180 ± Typical	degrees

PARAMETER	VALUE	UNITS
Technical Bulletin TB1001 - Shaft and Bore Tolerances		Download ( <a href="https://www.usdigital.com/support/resources/reference/technical-docs/technical-bulletins/shaft-and-bore-tolerances-tb1001/">https://www.usdigital.com/support/resources/reference/technical-docs/technical-bulletins/shaft-and-bore-tolerances-tb1001/</a> )

(1) 60000 rpm is the maximum rpm due to mechanical considerations. The maximum rpm due to the module's 300kHz maximum count frequency is  $(18 \times 10^6) / \text{CPR}$ .

(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

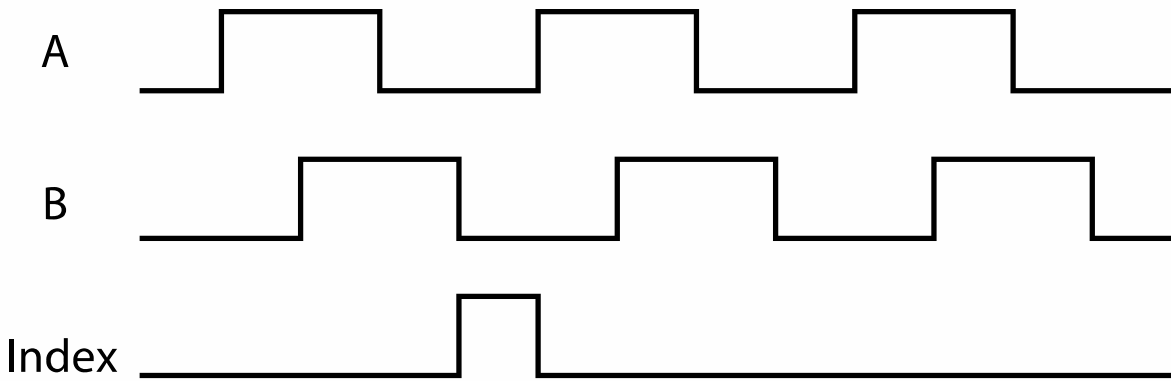
**Part #: SCREW-448-125-SS**

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



## PRODUCT CHANGE NOTIFICATIONS

Title	Date	Description	Download
E3 Base Mold Update - PCN 6804	1/24/2019	<p>As part of our ongoing continuous improvement efforts, and in order to enhance both function and appearance, multiple improvements are being incorporated into a plastic component redesign.</p> <p>The plastic base mounting holes and center hole counter-bore are increasing in size, and the four press-fit threaded inserts are being replaced with thread inserts that are over-molded into the base.</p> <p>With exception of the features outlined below, the new parts are dimensionally equivalent and will fit within the same envelope of the previous parts.</p>	<p>Download</p> <p>(<a href="https://www.usdigital.com/support/resources/product-change-notifications/pcn-6804-e3-base-mold-update/">https://www.usdigital.com/support/resources/product-change-notifications/pcn-6804-e3-base-mold-update/</a>)</p>
2" Hub/Disk Assembly Screw Change - PCN 6644	9/27/2018	<p>As part of our ongoing continuous improvement efforts, the screws used in the assembly of the 2" hub/disk assembly, that is with a bore of 12mm and larger, will be changed from a black oxide to a zinc plated screw.</p> <p>The zinc plating improves corrosion resistance as well as alleviates any potential for oil residue.</p> <p>The plating change has no effect on form, fit or function of our hubdisk assembly.</p>	<p>Download</p> <p>(<a href="https://www.usdigital.com/support/resources/product-change-notifications/pcn-6644-2-hub-disk-assembly-screw-change/">https://www.usdigital.com/support/resources/product-change-notifications/pcn-6644-2-hub-disk-assembly-screw-change/</a>)</p>

# E3 OPTICAL KIT ENCODER

Update to 1" and 2" Disks - PCN 6232	5/24/2018	<p>This notice is to inform our customers of a minor disk design modification that is being implemented for standard 1" and 2" disks. This is a continuation of a change that was implemented for our index disks in 2015.</p> <p>We are revising the text on the disk, adding the US Digital logo and a line that is used internally by our manufacturing group.</p> <p>The change does not affect the quadrature or index tracks; therefore, it has no impact on form, fit or function.</p>	<p>Download (<a href="https://www.usdigital.com/support/resources/product-change-notifications/pcn-6232-updated-1-and-2-inch-disks/">https://www.usdigital.com/support/resources/product-change-notifications/pcn-6232-updated-1-and-2-inch-disks/</a>)</p>
Hub Set Screw Production Change - PCN 5367	7/20/2015	<p>As part of our ongoing continuous improvement efforts, US Digital is implementing a change related to the production of our 5/16" (.313), 8mm (.315), 3/8" (.375), and 10mm (.394) HUBDISK assemblies. We are adding a low strength threadlocker to the set screw during our assembly process to assist in securing the set screw in the hub during transportation. This will aid in the set screw retention of these specific hub sizes; ensuring the retention is sufficient and avoid the potential of them backing out of the hub assembly during transit. This change does not affect form, fit or function.</p>	<p>Download (<a href="https://www.usdigital.com/support/resources/product-change-notifications/pcn-5367-hub-set-screw-production-change/">https://www.usdigital.com/support/resources/product-change-notifications/pcn-5367-hub-set-screw-production-change/</a>)</p>
Laser Marking - PCN 5253	6/17/2015	<p>As part of our ongoing continuous improvement efforts, US Digital is changing the labeling/marketing method for our E3, E6, H3, H6, S1, S2 and S6 products.</p>	<p>Download (<a href="https://www.usdigital.com/support/resources/product-change-notifications/pcn-5253-laser-marking/">https://www.usdigital.com/support/resources/product-change-notifications/pcn-5253-laser-marking/</a>)</p>
EM1 & EM2 Update - PCN 4199	1/14/2014	<p>Based on our continuous process improvement program, US Digital is changing the current marking method for our EM1 and EM2 encoder modules to a serialization method. This change will allow for each module to have a unique code; the current marking method is based on a date code system that includes all encoder modules produced within a specific week / year. The serialization system will be based on a hexadecimal system.</p>	<p>Download (<a href="https://www.usdigital.com/support/resources/product-change-notifications/pcn-4199-em1-em2-update/">https://www.usdigital.com/support/resources/product-change-notifications/pcn-4199-em1-em2-update/</a>)</p>
EM1 LED Die - PCN 1016	2/7/2013	<p>As part of US Digital's continual assurance of supply strategy, we have qualified additional sources for our LED die used in our EM1 encoder module, which in turn impacts all of the following products:</p> <p>EM1, E2, E3, E5, E6, H1, H15, H3, H5, H6, HB5M, HB6M, HD25, PE, S1, S2, S5, S6, T5 and T6</p> <p>The device specification will remain the same, i.e. there will be no change to form, fit or function of the product(s) as specified by US Digital. The appropriate quality and reliability testing has been performed on representative products to ensure normal parametric distribution, consistent with US Digital's quality and reliability standards.</p>	<p>Download (<a href="https://www.usdigital.com/support/resources/product-change-notifications/pcn-1016-em1-led-die/">https://www.usdigital.com/support/resources/product-change-notifications/pcn-1016-em1-led-die/</a>)</p>

## 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.

# | E3 OPTICAL KIT ENCODER

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