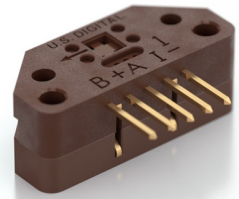## EM2 Features

- Two-channel quadrature with index
- High-resolution version of EM1
- Single 5V supply
- Rotary versions up to 10,000 CPR
- Linear versions up to 2,000 CPI
- Internal decoupling capacitor
- Outputs source/sink 5 mA

## EM2 Product Description

The **EM2** is a transmissive optical encoder module designed to offer 2x or 4x higher resolution than the **EM1** encoder module. This module is designed to detect rotary position when used with a US Digital encoder disk. The **EM2** consists of a lensed LED source and a monolithic detector IC enclosed in a small polymer package identical to the **EM1**. The **EM2** uses phased array detector technology to provide superior performance and greater tolerances over traditional aperture mask-type encoders.

The **EM2** provides digital A & B quadrature outputs with a third output index channel. Each **EM2** module is resolution-specific and is matched to the resolution of an encoder disk. The **EM2** operates with a single 5V supply and provides single-ended outputs capable of sinking and sourcing 5mA. An internal 0.1 µF decoupling capacitor is designed into the **EM2** to provide enhanced noise immunity.
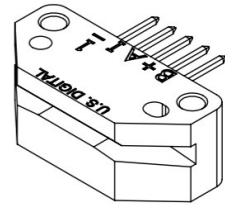
For open collector and higher voltage applications, add the PC3 *(https://www.usdigital.com/products/accessories/interfaces/cable-drivers/pc3/)* cable driver, or for differential cable driver outputs, add the PC4 *(https://www.usdigital.com/products/accessories/interfaces/cable-drivers/pc4/)* cable driver. Encoder disks, quadrature decoder chips, counter chips, computer interface boards, mating connectors, and cables are also available.

Download *(https://www.usdigital.com/media/4tvlnrwp/em2-em1-comparison.pdf)* the EM2/EM1 comparison chart.

## Mechanical Drawings

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Page: 1 of 9
2/7/2022 55126
EM2

**EM2** Transmissive Optical Encoder Module

RELEASE DATE: 02/07/2022

1.048 [26.62]

.500 [12.70]

.110 [2.79]

.398 [10.11]

.115 [2.92]

.070 [1.78]

DETECTOR SIDE

.318 [8.08]

SLOT
⌀ .095 [2.41] X .115 [2.92]
▽ .085 [2.16]

⌀ .095 [2.41] ▽ .085 [2.16]

.825 [20.96]

.687 [17.45]

.450 [11.43]

.300 [7.62]

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B + A I 1

⌀ .095 [2.41] ▽ .095 [2.41]

.147 [3.73]

2X ⌀ .110 [2.79] THRU

.025 [.64] SQUARE PINS

.100 [2.54] PITCH

SLOT
⌀ .095 [2.41] X .115 [2.92]
▽ .095 [2.41]

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Page: 2 of 9
2/7/2022 55126
EM2

**EM2** Transmissive Optical Encoder Module
Linear Strip Alignment

TEXT RIGHT READING
FROM DETECTOR SIDE

.294[7.47]

0 — INDEX TRACK
QUADRATURE TRACK

.700
[17.78]

U.S. DIGITAL    ...digital.com

.330[8.38]
CENTER OF TRACKS

.406[10.31]

.518[13.15]

B + A I 1 −

.188±.010[4.77±0.25]
MOUNTING HOLES
TO CENTER OF TRACKS

$.020^{+.005}_{-.010}$[$0.51^{+0.13}_{-0.25}$]

DETECTOR SIDE
OF MODULE
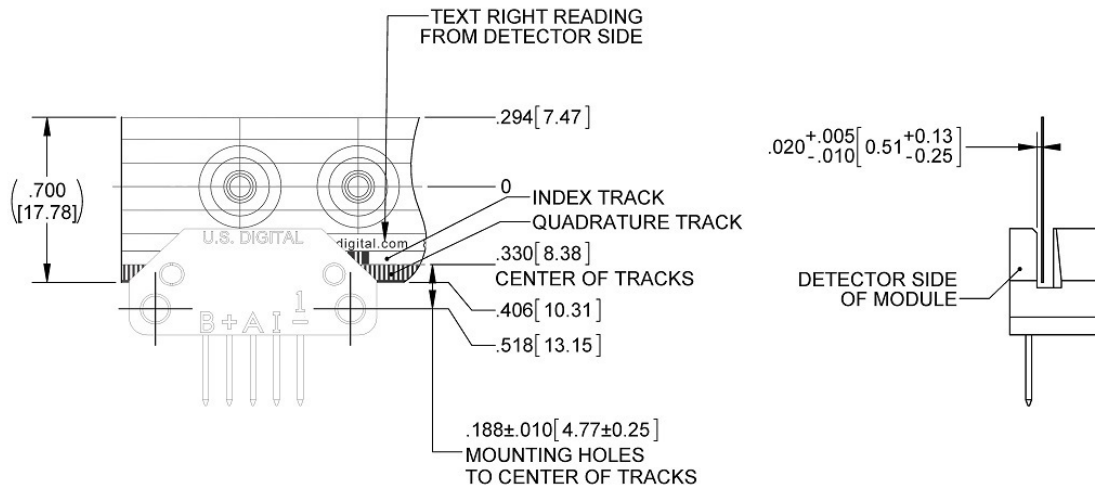
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UNITS: INCHES [MM]
METRIC SHOWN FOR REFERENCE ONLY

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Page: 3 of 9
2/7/2022 55126
EM2

**EM2** Transmissive Optical Encoder Module
Disk Alignment

1" DISK

2" DISK

⌀ 1.000
[25.40]

⌀ 2.000
[50.80]

GAP

GAP

.620±.005
[15.75±0.13]

1.107±.005
[28.12±0.13]

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B + A I 1

B + A I 1
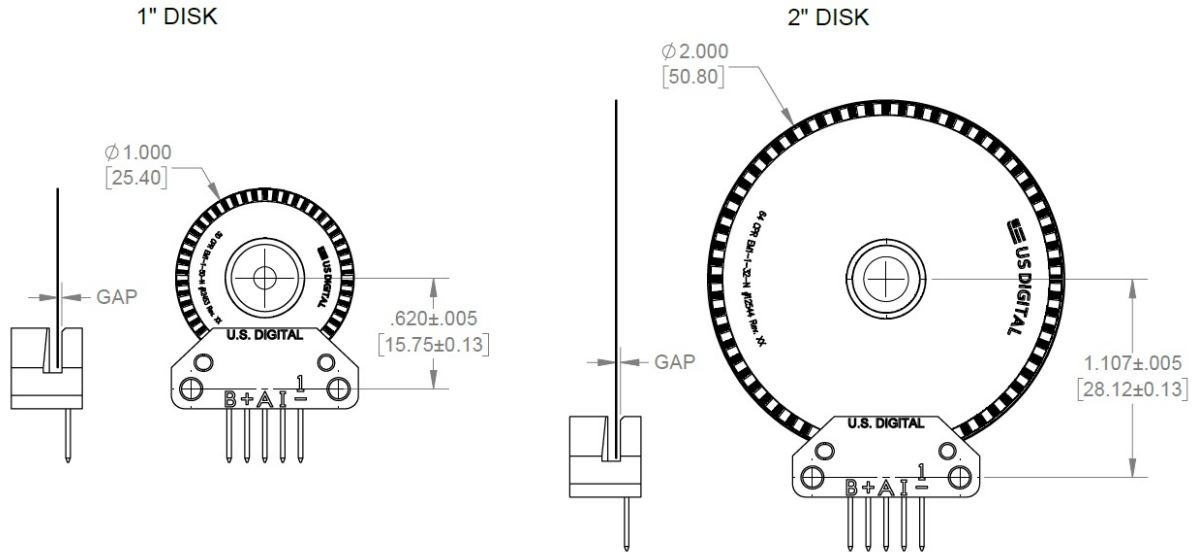
RECOMMENDED DISK GAP: .020±.005 [0.51±0.13]

# Specifications

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## AVAILABLE RESOLUTIONS

| CPR/CPI | EM2 | HUBDISK-1 | HUBDISK-2 | LIN |
|---|---|---|---|---|
| 1000 | EM2-0-1000-* | - | - | LIN-1000-*-* |
| 2000 | EM2-1-2000-I (1") / EM2-0-2000-I / EM2-0-2000-N (LIN) | HUBDISK-1-2000-*-IE | - | LIN-2000-*-* |
| 2048 | EM2-1-2048-I | HUBDISK-1-2048-*-IE | - | - |
| 2500 | EM2-1-2500-I | HUBDISK-1-2500-*-IE | - | - |
| 3600 | EM2-2-3600-I | - | HUBDISK-2-3600-*-IE | - |
| 4000 | EM2-1-4000-I (1") / EM2-2-4000-I (2") | HUBDISK-1-4000-*-IE | HUBDISK-2-4000-*-IE | - |
| 4096 | EM2-1-4096-I (1") / EM2-2-4096-I (2") | HUBDISK-1-4096-*-IE | HUBDISK-2-4096-*-IE | - |
| 5000 | EM2-1-5000-I (1") / EM2-2-5000-I (2") | HUBDISK-1-5000-*-IE | HUBDISK-2-5000-*-IE | - |
| 7200 | EM2-2-7200-I | - | HUBDISK-2-7200-*-IE | - |
| 8000 | EM2-2-8000-I | - | HUBDISK-2-8000-*-IE | - |
| 8192 | EM2-2-8192-I | - | HUBDISK-2-8192-*-IE | - |
| 10000 | EM2-2-10000-I | - | HUBDISK-2-10000-*-IE | - |

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Page: 5 of 9
2/7/2022 55126
EM2

## OPERATING CONDITIONS

| PARAMETER | MIN. | MAX. | UNITS | NOTES |
|---|---|---|---|---|
| Temperature | -25 | 100 | C | |
| A/B Output Frequency | 0 | 360 | kHz | 2000, 2048, 2500 CPR (1")<br>3600, 4000, 4096, 5000 CPR (2")<br>1000 CPI (Linear) |
| | 0 | 720 | kHz | 4000, 4096, 5000 CPR (1")<br>7200, 8000, 8192, 10000 CPR (2")<br>2000 CPI (Linear) |
| Disk RPM | 0 | $(21.6 \times 10^6) / CPR$ | RPM | 2000, 2048, 2500 CPR (1")<br>3600, 4000, 4096, 5000 CPR (2") |
| | 0 | $(43.2 \times 10^6) / CPR$ | RPM | 4000, 4096, 5000 CPR (1")<br>7200, 8000, 8192, 10000 CPR (2") |
| Linear Strip Speed | 0 | 360 | in./sec. | 1000, 2000 CPI (Linear) |
| Disk/Linear Strip Radial Position Tolerance | ± .005 | | inch | |

## ELECTRICAL SPECIFICATIONS

- Specifications apply over the entire operating temperature/voltage range.
- Typical values are specified at Vcc = 5.0V and 25C.

| PARAMETER | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|---|---|---|---|---|---|
| Supply Voltage | 4.5 | 5.0 | 5.5 | V | Ripple < 100 mVpp |
| Supply Current | | 72 | 85 | mA | no load |
| Low-level Output | | | 0.5 | V | $I_{OL}$ = 5 mA |
| | | 0.25 | | V | no load |
| High-level Output | 2.0 | | | V | $I_{OH}$ = -5 mA |
| | | 4.0 | | V | no load |
| Output Current Per Channel | -5 | | 5 | mA | |
| Load Capacitance | | | 100 | pF | |
| Output Rise Time | | 50 | | nS | ± 5 mA load |
| Output Fall Time | | 50 | | nS | ± 5 mA load |
| Electrostatic Discharge | | | ± 4 | kV | IEC 61000-4-2 |

## TIMING CHARACTERISTICS

## ENCODING CHARACTERISTICS:

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Page: 6 of 9
2/7/2022 55126
EM2

- Specifications apply over the entire operating temperature/voltage range.
- Values are for the worst error over full rotation.
- Refer to the timing diagram below.

| PARAMETER | SYMBOL | MIN. | TYP. | MAX. | UNITS |
|---|---|---|---|---|---|
| Symmetry | X, Y | 108 | 190 | 252 | °e *(https://www.usdigital.com/support/resources/glossary/#glossary_e)* |
| Quadrature | Z | 45 | 90 | 135 | °e *(https://www.usdigital.com/support/resources/glossary/#glossary_e)* |
| Index Pulse Width | Po | 45 | 90 | 135 | °e *(https://www.usdigital.com/support/resources/glossary/#glossary_e)* |
| Ch. I Rise After Ch. B or Ch. A Fall | t1 | | -40 | | ns |
| Ch. I Fall After Ch. B or Ch. A Rise | t2 | | 25 | | ns |

**TIMING DIAGRAM:**
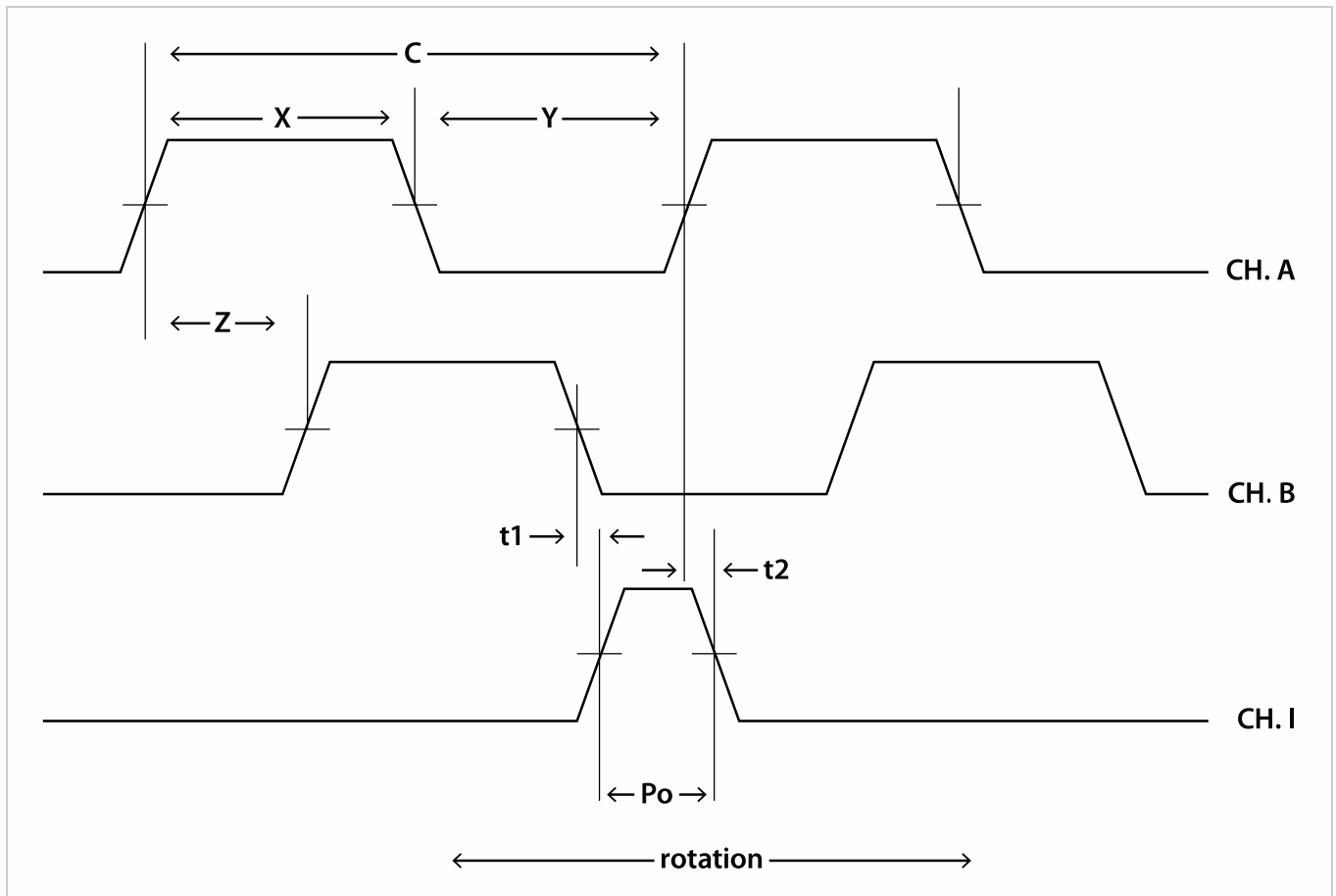


**CPI**: The number of Cycles (C) of the A or B output Per Inch of linear strip movement.

**CPR**: The number of Cycles (C) of the A or B outputs Per Revolution.

**Index (I):** The index output goes high once per revolution, coincident with the low states of channels A and B, nominally 1/4 of one cycle

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Page: 7 of 9
2/7/2022 55126
EM2

(90 °e).

**One Shaft Rotation:** 360 mechanical degrees.

**One Electrical Degree (°e):** 1/360th of one cycle.

**One Cycle:** 360 electrical degrees (°e). Each cycle can be decoded into 1 or 4 states, referred to as X1 or X4 resolution multiplication.

**PPR**: The number of resolvable Positions Per Revolution of the encoder disk with x4 quadrature decoding.

**Quadrature (Z):** The phase lag or lead between channels A and B in electrical degrees, nominally 90 °e.

**Symmetry:** A measure of the relationship between (X) and (Y) in electrical degrees, nominally 180 °e.

## INSTALLATION TORQUE

| PARAMETER | TORQUE |
|---|---|
| Mounting Screws | 3.5-4 in-lbs |

## PIN-OUTS

| Pin | Description |
|---|---|
| 1 | Ground |
| 2 | Index |
| 3 | A channel |
| 4 | +5VDC power |
| 5 | B channel |

## PRODUCT CHANGE NOTIFICATIONS

| Title | Date | Description | Download |
|---|---|---|---|
| EM1 & EM2 Update - PCN 4199 | 1/14/2014 | 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. | Download *(https://www.usdigital.com/support/resources/product-change-notifications/pcn-4199-em1-em2-update/)* |

# 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.

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Page: 8 of 9
2/7/2022 55126
EM2

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Page: 9 of 9
2/7/2022 55126
EM2