

## Description

The EM1 is a transmissive optical encoder module designed to be an improved replacement for the HEDS-9000 series encoder module. This module is designed to detect rotary or linear position when used together with an encoder disk or linear strip. The EM1 consists of a lensed LED source and a monolithic detector IC enclosed in a small polymer package. The EM1 uses phased array detector technology to provide superior performance and greater tolerances over traditional aperture mask type encoders.

The EM1 provides digital A & B quadrature outputs with an optional third output index channel. Each EM1 module is resolution specific and is matched to the resolution of an encoder disk or linear strip. All standard resolutions offered by the HEDS-9000 series encoder module, as well as additional resolutions, are now supported by the EM1 module. The EM1 operates with a single 5V supply and provides single ended outputs which are capable of both sinking and sourcing 8mA. An internal 0.1 uF decoupling capacitor is designed into the EM1 to provide enhanced noise immunity over the HEDS-9000 series encoder modules.

For open collector and higher voltage applications, add the PC3 cable driver, or for differential cable driver outputs, add the PC4 cable driver. Encoder disks, linear strips, quadrature decoder chips, counter chips, computer interface boards, mating connectors and cables are also available.



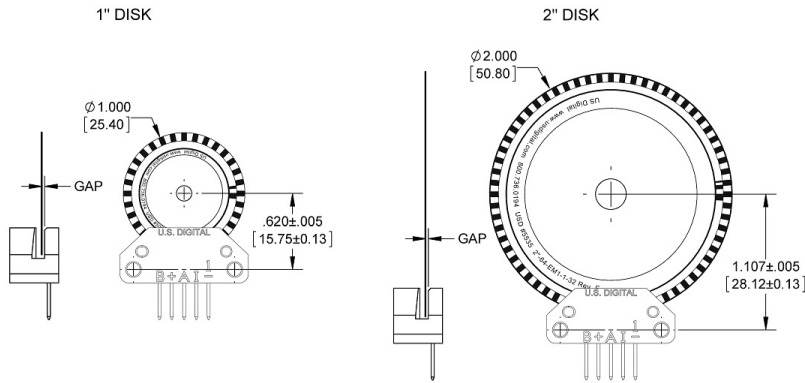
## Features

- ▶ Two channel quadrature with optional index
- ▶ Improved replacement for HEDS-9000 Series
- ▶ Single 5 VDC supply
- ▶ Resolutions from 32 to 2500 CPR
- ▶ Internal decoupling capacitor
- ▶ Sink/source 8mA outputs

Disk Alignment

EM1 Transmissive Optical Encoder Module  
Disk Alignment

RELEASE DATE: 04/05/2015



RECOMMENDED DISK GAP:  $.020^{+.005}_{-.010}$  [0.51<sup>+0.13</sup><sub>-0.25</sub>]  
(.020 ± .005 [0.51 ± 0.13] FOR 32 CPR 1" DISKS OR 64 CPR 2" DISKS)

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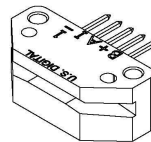
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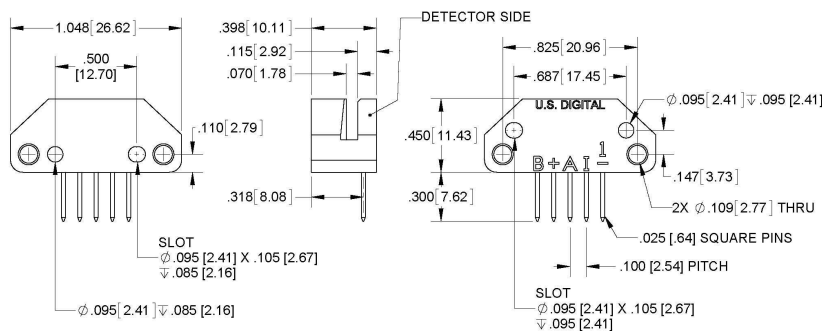
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Mechanical Drawing

EM1 Transmissive Optical Encoder Module



RELEASE DATE: 02/24/2011



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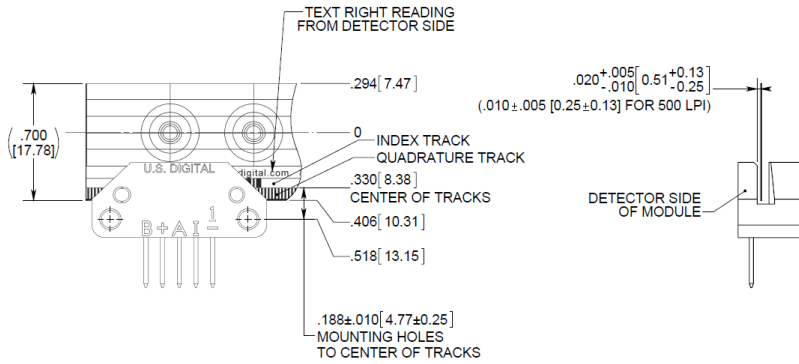
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Linear Alignment

EM1 Transmissive Optical Encoder Module  
Linear Strip Alignment

RELEASE DATE: 04/07/2015



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Available Resolutions

CPR /LPI	1" Disk Non-index	1" Disk Index	2" Disk Non-index	2" Disk Index	Linear Strip Non-index	Linear Strip Index
32	EM1-1-32-N					
50	EM1-1-50-N	EM1-1-50-I				
64			EM1-1-32-N			
96	EM1-1-100-N	EM1-1-100-I				
100	EM1-1-100-N	EM1-1-100-I	EM1-1-50-N	EM1-1-50-I		
120					EM1-0-120-N	EM1-0-120-I
125					EM1-0-127-N	EM1-0-127-I
127					EM1-0-127-N	EM1-0-127-I
192	EM1-1-200-N	EM1-1-200-I				
200	EM1-1-200-N	EM1-1-200-I	EM1-1-100-N	EM1-1-100-I	EM1-0-200-N	EM1-0-200-I

CPR /LPI	1" Disk Non-index	1" Disk Index	2" Disk Non-index	2" Disk Index	Linear Strip Non-index	Linear Strip Index
250	EM1-1-250-N	EM1-1-250-I			EM1-0-250-N	EM1-0-250-I
256	EM1-1-250-N	EM1-1-250-I				
300					EM1-0-300-N	EM1-0-300-I
360	EM1-1-360-N	EM1-1-360-I				
400	EM1-1-400-N	EM1-1-400-I	EM1-1-200-N	EM1-1-200-I		
500	EM1-1-500-N	EM1-1-500-I	EM1-2-500-N	EM1-2-500-I	EM1-0-500-N	EM1-0-500-I
512	EM1-1-512-N	EM1-1-512-I	EM1-2-500-N	EM1-2-500-I		
720	EM1-1-720-N	EM1-1-720-I				
800	EM1-1-800-N	EM1-1-800-I				
900	EM1-1-900-N	EM1-1-900-I				
1000	EM1-1-1000-N	EM1-1-1000-I	EM1-2-1000-N	EM1-2-1000-I		
1024	EM1-1-1024-N	EM1-1-1024-I	EM1-2-1024-N	EM1-2-1024-I		
1250	EM1-1-1250-N	EM1-1-1250-I				
1800			EM1-2-1800-N	EM1-2-1800-I		
2000			EM1-2-2000-N	EM1-2-2000-I		
2048			EM1-2-2048-N	EM1-2-2048-I		
2500			EM1-2-2500-N	EM1-2-2500-I		

For more information, see the EM1/HEDS Compatibility Guide.

*Other resolutions may be available upon request.*

### Operating Conditions

Parameter	Min.	Max.	Units	Notes
Temperature	-40	100	C	
A/B Output Frequency	0	300	kHz	
Disk RPM	0	$(18 \times 10^6) / \text{CPR}$	RPM	
Linear Strip Speed	0	$(3 \times 10^5) / \text{LPI}$	inches/sec.	
Disk Radial Position Tolerance	$\pm .005$		inch	with gap set by standard spacer tool

### Electrical Specifications

- Specifications apply over entire operating temperature range.
- Typical values are specified at  $V_{cc} = 5.0V$  and  $25C$ .

Parameter	Min.	Typ.	Max.	Units	Conditions
Supply Voltage	4.5	5.0	5.5	V	Ripple < 100 mVpp
Supply Current, EM1-0- (linear strip)		27	33	mA	LPI < 300, no load
		54	65	mA	LPI $\geq$ 300, no load
Supply Current, EM1-1- (1" disk)		27	33	mA	CPR < 500, no load
		54	65	mA	CPR $\geq$ 500, no load
Supply Current, EM1-2- (2" disk)		27	33	mA	CPR < 1000, no load
		54	65	mA	CPR $\geq$ 1000, no load
Low-level Output			0.5	V	IOL = 8mA max.
		0.05		V	No load
High-level Output	2.0			V	IOH = -8mA max.
		4.8		V	No load
Output Current Per Channel	-8		8	mA	
Load Capacitance			100	pF	
Output Rise Time		110		nS	
Output Fall Time		100		nS	
Electrostatic Discharge			$\pm 4$	kV	IEC 61000-4-2

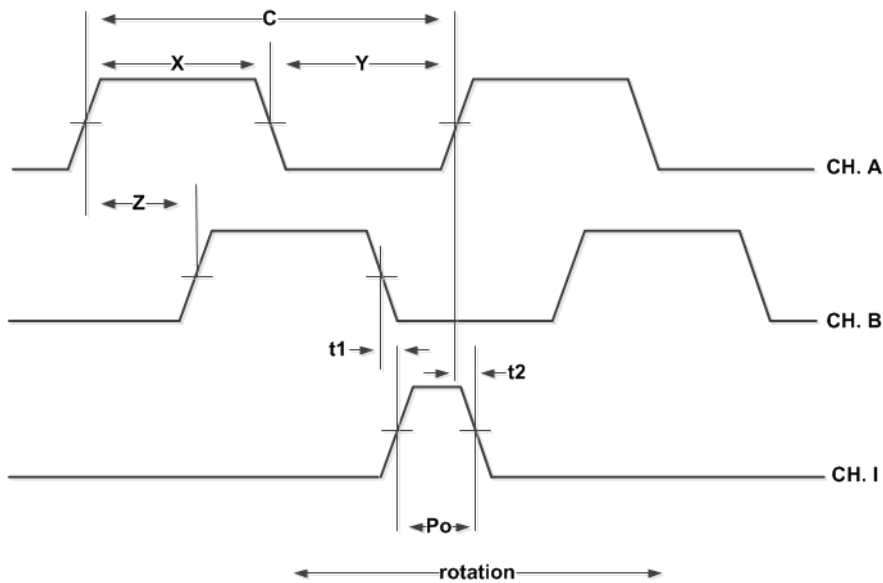
### Timing Characteristics

#### Encoding Characteristics:

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

Parameter	Symbol	Min.	Typ.	Max.	Units
Cycle Error	C		3.0	5.5	$^{\circ}e$
Symmetry	X, Y	150	180	210	$^{\circ}e$
Quadrature	Z	60	90	120	$^{\circ}e$
Index Pulse Width	Po	60	90	120	$^{\circ}e$
Ch. I Rise After Ch. B or Ch. A Fall	t1	50	100	200	ns
Ch. I Fall After Ch. B or Ch. A Rise	t2	-10	15	25	ns

#### Timing Diagram:



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

**Cycle Error:** An indication of cycle uniformity. The difference between an observed shaft angle which gives rise to one electrical cycle, and the nominal angular increment of  $1/CPR$  of a 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 ( $90^\circ e$ ).

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

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

**One Electrical Degree ( $^\circ e$ ):**  $1/360$ th of one cycle.

**One Cycle (C):** 360 electrical degrees ( $^\circ e$ ). 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  $90^\circ e$ .

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

## Installation Torque

Parameter	Torque
Mounting Screws	3.5-4 in-lbs

## EM1 / HEDS Comparison

US Digital is the designer and manufacturer of the **EM1** transmissive optical encoder module. The design of the **EM1** provides electrical and mechanical compatibility with **HEDS-9000**, **HEDS-9100**, **HEDS-9200**, **HEDS-9040**, and **HEDS-9140** series modules.

The process of switching from the **HEDS** to the **EM1** module should not require any mechanical or electrical changes. Simply use the **EM1** and matching codewheel in place of the **HEDS** module and codewheel. The **EM1** has a built-in index channel available on most resolutions, for both rotary disks and linear strips. The **EM1** uses a US Digital designed codewheel with 2 tracks rather than 3 tracks for index versions. The **EM1** offers improved output drive capability and will source and sink 8mA at TTL levels.

Physically, the **EM1** has no external wire loops which can interfere when mounting. The connector pins are 0.051" shorter than **HEDS** modules, while still providing .30" insertion depth. US Digital's **EM1** offers custom resolutions.

## Pin-outs

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

## Ordering Information

EM1 -  -  -

Native OD	Native LPI/CPR	Index
0Linear	32 =	I = <i>Index</i>
1 = <i>1in</i>	50 =	N = <i>No Index</i>
2 = <i>2in</i>	100 =	
	120 =	
	127 =	
	200 =	
	250 =	
	300 =	
	360 =	
	400 =	
	500 =	
	512 =	
	720 =	
	800 =	
	900 =	
	1000 =	
	1024 =	
	1250 =	
	1800 =	
	2000 =	
	2048 =	
	2500 =	

### Notes

- US Digital® warrants its products against defects in materials and workmanship for two years. See complete warranty for details.