

# EM1 / HEDS

# Transmissive Optical Encoder Module

## Start Here:

➤ Use charts below to determine which module family your application uses (based on CPR/CPI).

### 1" Resolutions:

CPR	Non-Index	With Index
32	n/a	EM1
50	HEDS	HEDS
96	HEDS	HEDS
100	HEDS	HEDS
110	HEDS	n/a
120	HEDS	n/a
192	HEDS	HEDS
200	HEDS	HEDS
250	HEDS	HEDS
256	HEDS	HEDS
360	HEDS	HEDS
400	HEDS	HEDS
500	HEDS	HEDS
512	HEDS	HEDS
540	HEDS	n/a
720	n/a	EM1
900	n/a	EM1
1000	HEDS	EM1
1016	HEDS	n/a
1024	HEDS	EM1
1250	n/a	EM1

### 2" Resolutions:

CPR	Non-Index	With Index
64	n/a	EM1
100	HEDS	HEDS
200	HEDS	HEDS
400	HEDS	HEDS
500	HEDS	HEDS
512	HEDS	n/a
1000	HEDS	HEDS
1024	HEDS	HEDS
1800	n/a	EM1
2000	HEDS	HEDS
2048	HEDS	HEDS
2500	EM1	EM1

### Linear Strip Resolutions:

CPI	Non-Index	With Index
120	n/a	EM1
125	n/a	EM1
127	n/a	EM1
150	n/a	EM1
180	HEDS	n/a
200	n/a	EM1
250	n/a	EM1
300	HEDS	n/a
360	HEDS	n/a
500	n/a	EM1

## Features:

- Two channel quadrature output with index pulse
- No signal adjustment
- TTL Compatible
- Single +5V supply
- The **EM1** and **HEDS** are both RoHS compliant
- US Digital warrants its products against defects and workmanship for two years. See complete warranty for details.

### EM1:

- Resolutions up to 2500 CPR (10,000 PPR)
- Internal 0.1 ufd bypass capacitor
- -55°C to 125°C operating temperature

### HEDS:

- Resolutions up to 2048 CPR (8192 PPR)
- -40°C to 100°C operating temperature

## Description:

The **EM1** and **HEDS** products are transmissive optical encoder modules. These modules are designed to detect rotary or linear position when used together with a codewheel or linear strip. The **EM1** and **HEDS** modules consist of a lensed LED source and a monolithic detector IC enclosed in a small polymer package. These modules use phased array detector technology to provide superior performance and greater tolerances over traditional aperture mask type encoders.

Both the **EM1** and **HEDS** module provide digital quadrature outputs. The **EM1** comes standard with a third index channel output on all resolutions. The **HEDS** is available with a third index channel output on only some resolutions.

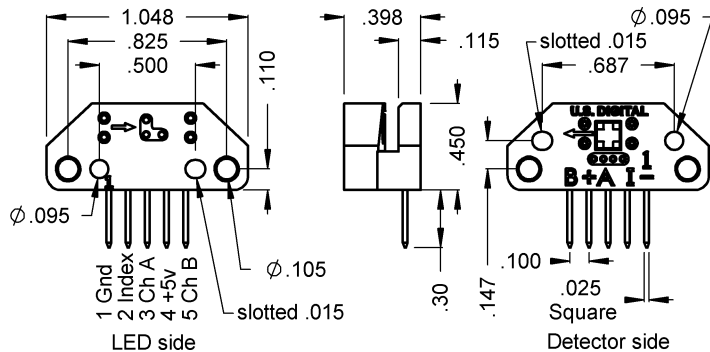
The **EM1** and **HEDS** transmissive optical encoder modules are powered from a single +5VDC power supply. Additional power supply voltages for the **EM1** will be available in the near future. The **EM1** single-ended outputs are capable of sinking or sourcing 8mA each.

The resolution of the modules and encoder disks or linear strips must match. Two mounting holes are provided to accept screws up to .105" dia. Both the **EM1** and **HEDS** have identical mounting and pin-out configurations.

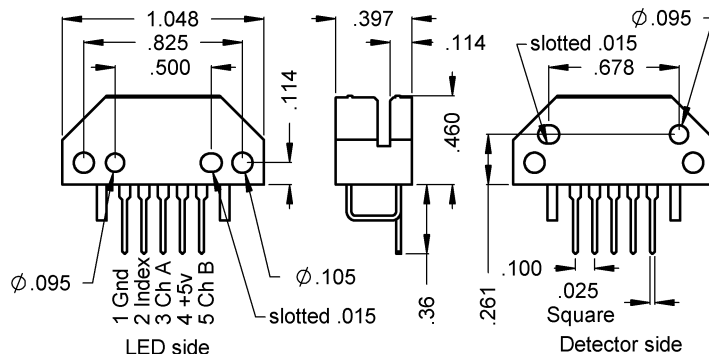
For open collector and higher voltage applications, add the **PC3** device (see the **PC3 data sheet**), or for differential cable driver outputs, add the **PC4** device (see the **PC4 data sheet**). Encoder disks, linear strips, quadrature decoder chips, counter chips, computer interface boards, mating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

The **EM1** and **HEDS** are both RoHS compliant.

## EM1 Mechanical Drawing:



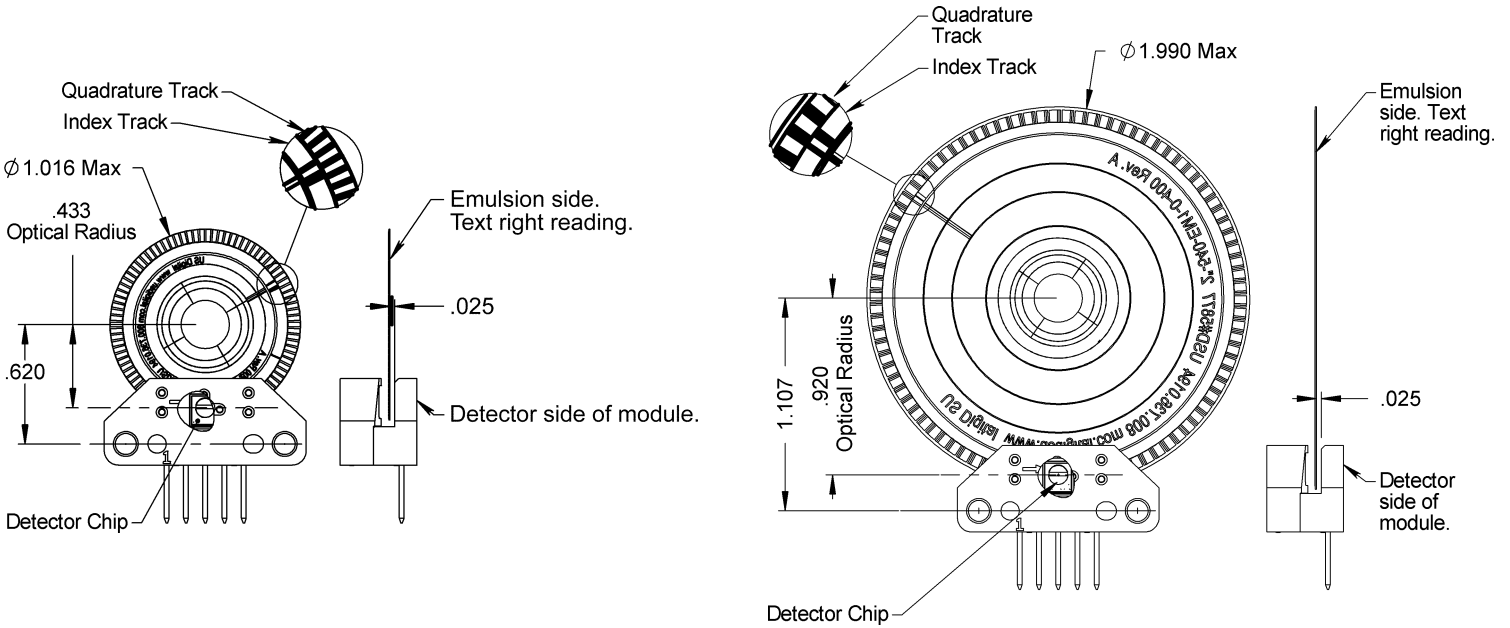
## HEDS Mechanical Drawing:



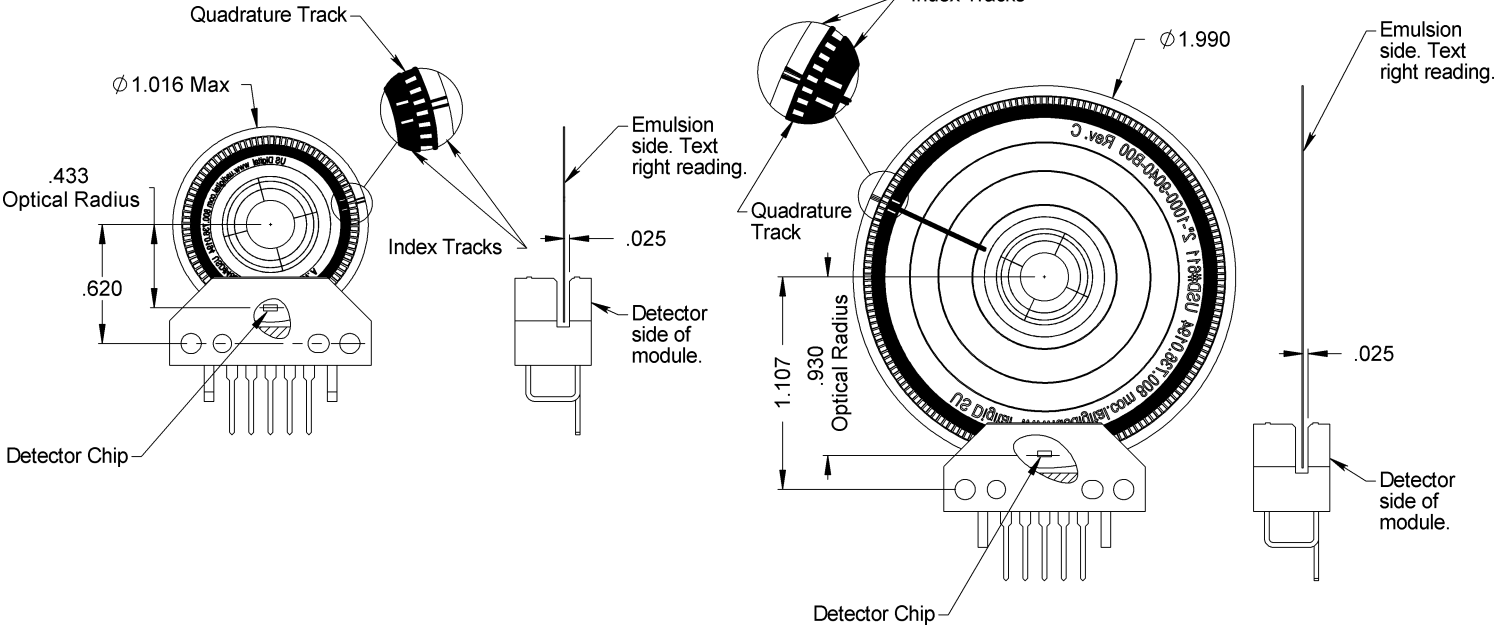
# EM1 / HEDS

# Transmissive Optical Encoder Module

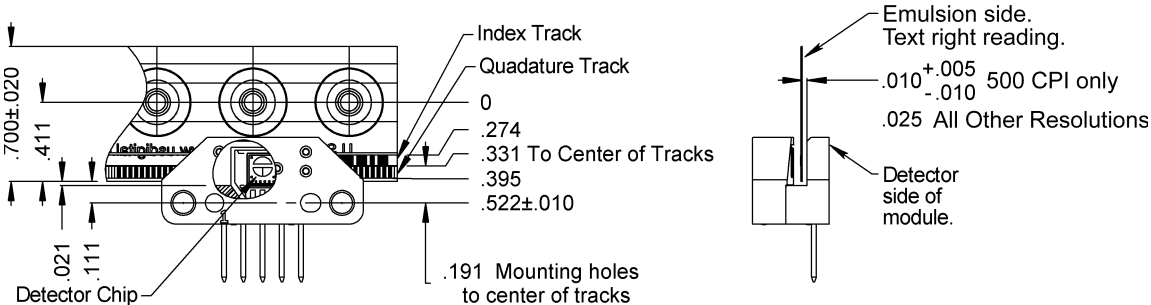
## EM1 Module & Disk Mechanical Alignment:



## HEDS Module & Disk Mechanical Alignment:



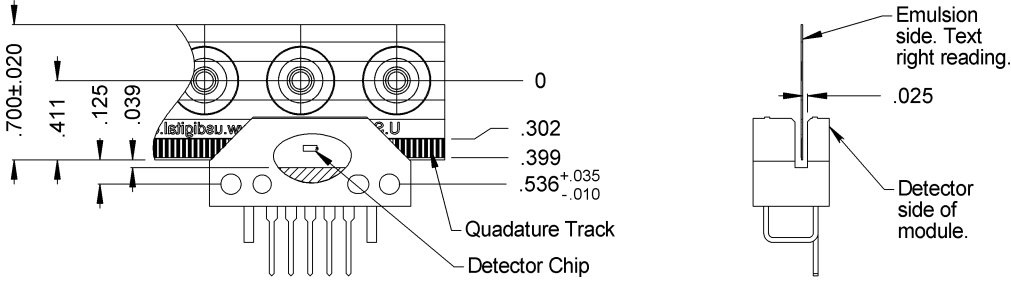
## EM1 Module & Linear Strip Mechanical Alignment:



# EM1 / HEDS

# Transmissive Optical Encoder Module

## HEDS Module & Linear Strip Mechanical Alignment:



## Encoding Characteristics:

- > Specifications apply over entire operating temperature range.  
Values are for the worst error over a full rotation.
- > Refer to Timing Diagram on next page.

Parameter	Symbol	Min.	Typ.	Max.	Units
<b>Cycle Error</b>					
HEDS (2000 or 2048 CPR only)		-	3.0	7.5	°e
EM1 & HEDS (All Other Resolutions)		-	3.0	5.5	°e
<b>Symmetry</b>					
HEDS (2000 or 2048 CPR only)		130	180	230	°e
EM1 & HEDS (All Other Resolutions)		150	180	210	°e
<b>Quadrature</b>					
HEDS (2000 or 2048 CPR only)		40	90	140	°e
EM1 & HEDS (All Other Resolutions)		60	90	120	°e
<b>Index Pulse Width</b>					
HEDS (2000 or 2048 CPR only)	Po	40	90	140	°e
EM1 & HEDS (All Other Resolutions)	Po	60	90	120	°e
<b>Ch. I Rise After Ch. B or Ch. A Fall</b>					
EM1	t1	10	100	250	ns
HEDS (2000 or 2048 CPR only)	t1	10	450	1500	ns
HEDS (All Other Resolutions)	t1	-300	100	250	ns
<b>Ch. I Fall After Ch. A or Ch. B Rise</b>					
EM1	t2	70	150	300	ns
HEDS (2000 or 2048 CPR only)	t2	10	250	1500	ns
HEDS (All Other Resolutions)	t2	70	150	1000	ns

## Recommended Operating Conditions:

Parameter	Min.	Max.	Units	Notes
<b>Temperature</b>				
EM1	-55	125	°C	
HEDS	-40	100	°C	
<b>Supply Voltage</b>	4.5	5.5	Volts	Ripple < 100mV <sub>p-p</sub>
<b>Load Capacitance</b>	-	100	pF	
<b>Count Frequency</b>	-	100	kHz	rpm/60 x cycles/rev.

## Electrical Specifications:

- > Specifications apply over entire operating temperature range.  
Typical values are specified at V<sub>cc</sub> = 5.0V and 25°C.
- > Refer to Timing Diagram on next page.

Parameter	Min.	Typ.	Max.	Units	Notes
<b>Output Voltage</b>	-0.5	-	V <sub>cc</sub>	Volts	
<b>Supply Current</b>					
EM1 (32, 64 CPR, 500 CPI only)	-	27	30	mA	
EM1 (All Other Resolutions)	-	55	57	mA	
HEDS (Index or 1" >=1000 CPR or 2" >=2000 CPR only)	30	57	85	mA	
HEDS (Non-index or All Other Resolutions)	-	17	40	mA	
<b>Output Low*</b>					
EM1	-	-	0.5	Volts	I <sub>OL</sub> = 8.0mA max.
HEDS (Index or 1" >=1000 CPR or 2" >=2000 CPR only)	-	-	0.4	Volts	I <sub>OL</sub> = 3.86mA max.
HEDS (Non-index or All Other Resolutions)	-	-	0.4	Volts	I <sub>OL</sub> = 3.2mA max.
<b>Output High*</b>					
EM1	2.0	-	-	Volts	I <sub>OH</sub> = -8.0mA max.
HEDS (Index or 1" >=1000 CPR or 2" >=2000 CPR only)	2.4	-	-	Volts	I <sub>OH</sub> = -200µA max.
HEDS (Non-index or All Other Resolutions)	2.4	-	-	Volts	I <sub>OH</sub> = -40µA max.
<b>Output Current Per Channel</b>					
EM1	-8.0	-	8.0	mA	
HEDS	-1.0	-	5.0	mA	

\* Unloaded high level output voltage is 4.80V typically, 4.2V minimum.



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## Phase Relationship:

**For Shaft Encoders:** (View the encoder so the shaft / bushing side is facing up.)

➤ A leads B in a clockwise rotation; B leads A in a counterclockwise rotation for the following products:

**H1.**

➤ B leads A in a clockwise rotation; A leads B in a counterclockwise rotation for the following products:

**H15, H3, H5, H6, HB5M, HB6M, HD25, S1, S2, S5, S6 and SP-16.**

**For Kit Encoders:** (View the encoder so the cover side is facing up.)

➤ A leads B in a clockwise rotation; B leads A in a counterclockwise rotation for the following products:

**E3, E5 and E6.**

➤ B leads A in a clockwise rotation; A leads B in a counterclockwise rotation for the following products:

**E2.**

**For Probe Encoders:**

➤ A leads B in inward plunger motion; B leads A in outward plunger motion for the following products:

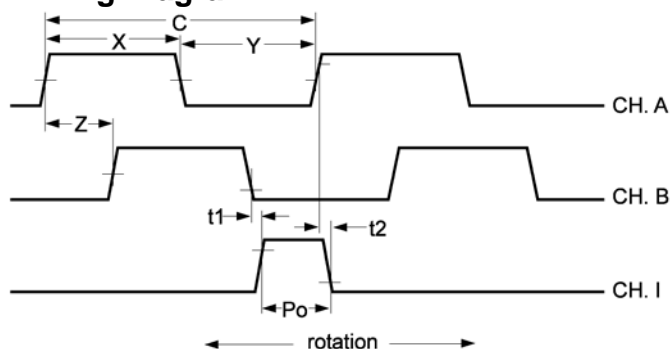
**PE.**

**For Inclinometers:** (View the inclinometer so the cover side is facing up.)

➤ A leads B in a clockwise rotation; B leads A in a counterclockwise rotation for the following products:

**T5 and T6.**

## Timing Diagram:



**CPR (N):** The number of Cycles Per Revolution.

**One Shaft Rotation:** 360 mechanical degrees, N cycles.

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

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

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

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

**Index (CH. 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°e).

**Position Error:** The difference between the actual shaft position and the position indicated by the encoder cycle count.

**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/N of a revolution.

## EM1 / HEDS Encoder Module Differences:

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 the Agilent **HEDS-9000, HEDS-9100, HEDS-9200, HEDS-9040, and HEDS-9140** series modules. Non-index codewheels are interchangeable between the **EM1** and **HEDS** 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 and is available on all resolutions, for both rotary disks and linear strips. The **EM1** offers improved output drive capability and will source and sink 8mA at TTL levels. The current consumption is reduced over Agilent index versions (27mA vs. 57mA typical). Physically the **EM1** has no external wire loops which interfere when mounting. The connector pins are 0.051" shorter than Agilent, while still providing .30" insertion depth. The **EM1** uses a US Digital designed codewheel with 2 tracks rather than 3 tracks for index versions. US Digital's **EM1** offers custom and special resolutions.

## Ordering Information:

- The part numbers below do not include optical encoder disks or linear strips.
- Disks and linear strips must be ordered separately (see the *DISK* or *LIN* data sheet).

### Pricing Levels per Module for 1" Disks:

CPR	Non-Index		With Index	
	Part Number	Pricing Level	Part Number	Pricing Level
32	-	-	EM1-1-32	2
50	HEDS-9100-S00	1	HEDS-9140-S00	2
96	HEDS-9100-C00	1	HEDS-9140-C00	2
100	HEDS-9100-C00	1	HEDS-9140-C00	2
110	HEDS-9100-C00	1	-	-
120	HEDS-9100-C00	1	-	-
192	HEDS-9100-E00	1	HEDS-9140-E00	2
200	HEDS-9100-E00	1	HEDS-9140-E00	2
250	HEDS-9100-F00	1	HEDS-9140-F00	2
256	HEDS-9100-F00	1	HEDS-9140-F00	2
360	HEDS-9100-G00	1	HEDS-9140-G00	2
400	HEDS-9100-H00	1	HEDS-9140-H00	2
500	HEDS-9100-A00	1	HEDS-9140-A00	2
512	HEDS-9100-I00	1	HEDS-9140-I00	2
540	HEDS-9100-I00	1	-	-
720	-	-	EM1-1-720	3
900	-	-	EM1-1-900	3
1000	HEDS-9100-B00	2	EM1-1-1000	3
1016	HEDS-9100-J00	2	-	-
1024	HEDS-9100-J00	2	EM1-1-1024	3
1250	-	-	EM1-1-1250	3

### Prices:

#### Level 1:

\$26.25 / 1  
 \$23.35 / 10  
 \$19.92 / 50  
 \$17.65 / 100

#### Level 2:

\$29.40 / 1  
 \$26.16 / 10  
 \$22.30 / 50  
 \$19.76 / 100

#### Level 3:

\$32.55 / 1  
 \$28.96 / 10  
 \$24.70 / 50  
 \$21.88 / 100

#### Level 4:

\$35.70 / 1  
 \$31.76 / 10  
 \$27.09 / 50  
 \$24.00 / 100

### Pricing Levels per Module for 2" Disks:

CPR	Non-Index		With Index	
	Part Number	Pricing Level	Part Number	Pricing Level
64	-	-	EM1-2-64	2
100	HEDS-9100-S00	1	HEDS-9140-S00	2
200	HEDS-9100-C00	1	HEDS-9140-C00	2
400	HEDS-9100-E00	1	HEDS-9140-E00	2
500	HEDS-9000-A00	1	HEDS-9140-F00	2
512	HEDS-9000-A00	1	-	-
1000	HEDS-9000-B00	1	HEDS-9040-B00	2
1024	HEDS-9000-J00	1	HEDS-9040-J00	2
1800	-	-	EM1-2-1800	3
2000	HEDS-9000-T00	2	HEDS-9040-T00	2
2048	HEDS-9000-U00	2	HEDS-9040-T00	2
2500	EM1-2-2500-N	3	EM1-2-2500	3

### Pricing Levels per Module for Linear Strips:

CPR	Non-Index		With Index	
	Part Number	Pricing Level	Part Number	Pricing Level
120	-	-	EM1-0-120	2
125	-	-	EM1-0-125	2
127	-	-	EM1-0-127	2
150	-	-	EM1-0-150	2
180	HEDS-9200-Q00	2	-	-
200	-	-	EM1-0-200	2
250	-	-	EM1-0-250	2
300	HEDS-9200-300	2	-	-
360	HEDS-9200-360	2	-	-
500	-	-	EM1-0-500	4

Technical Data, Rev. 01.15.07, January 2007  
 All information subject to change without notice.