EM1 & HEDS Transmissive Optical Encoder Module

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 4-40 machine screws. 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.

Features:

- Two channel quadrature output with index pulse
- No signal adjustment
- TTL Compatible
- Single +5V supply
- US Digital warrants its products against defects in materials and workmanship for two years. See complete warranty for details.

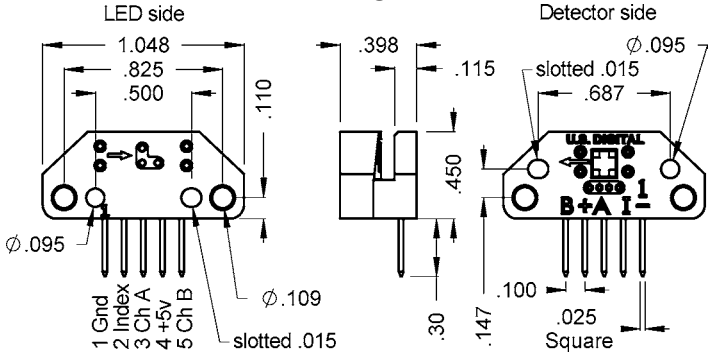
EM1:

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

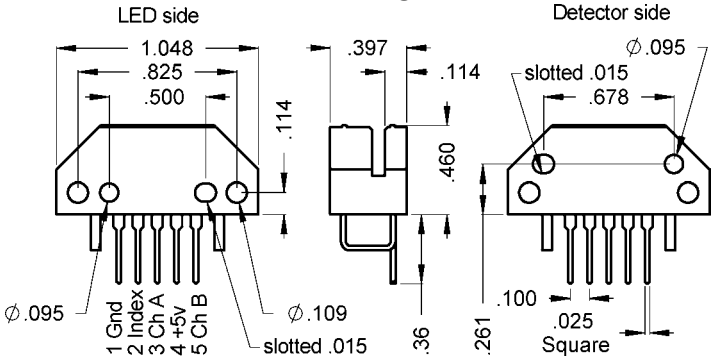
HEDS:

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

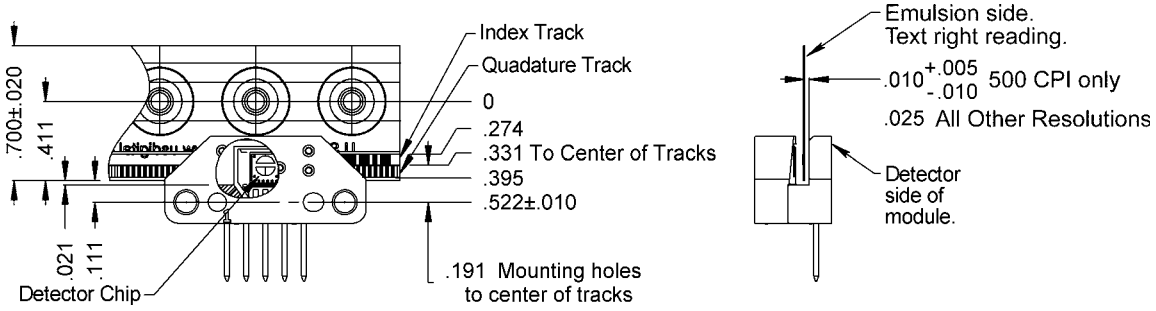
EM1 Mechanical Drawing:



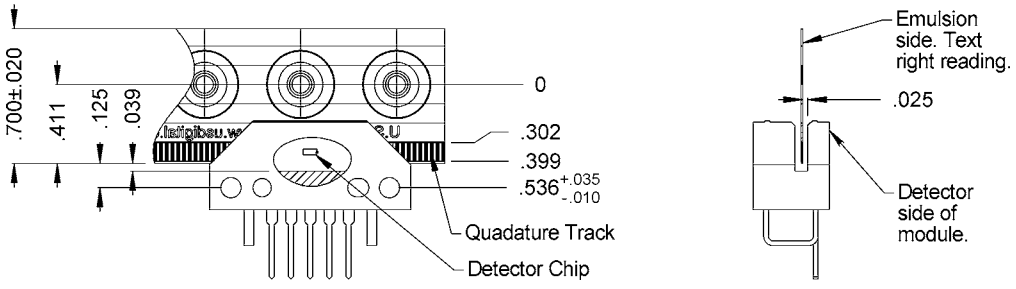
HEDS Mechanical Drawing:



EM1 Module & Linear Strip Mechanical Alignment:



HEDS Module & Linear Strip Mechanical Alignment:



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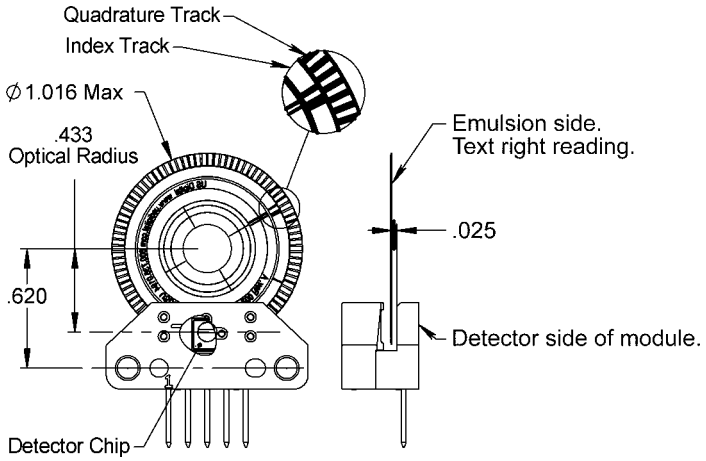
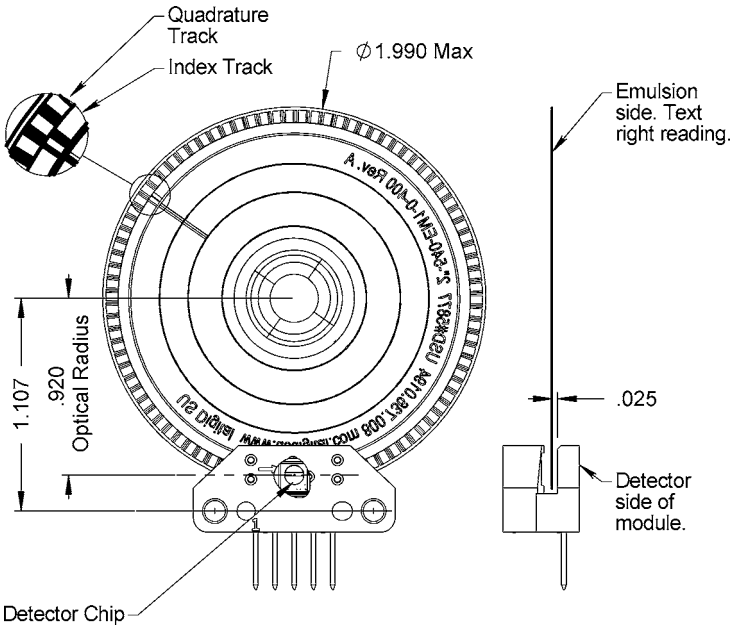
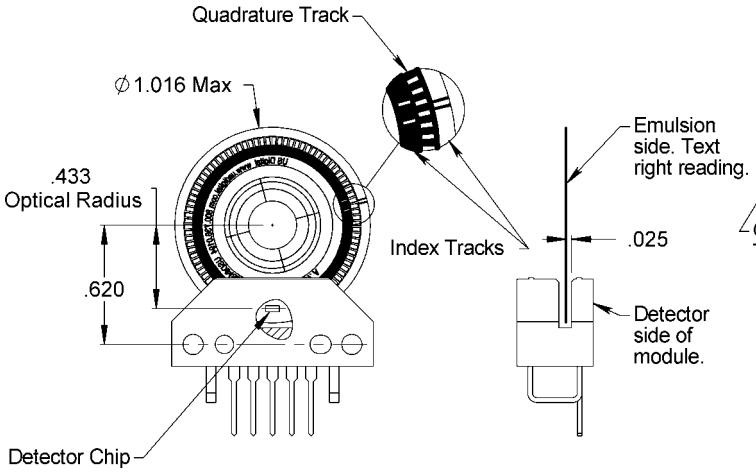
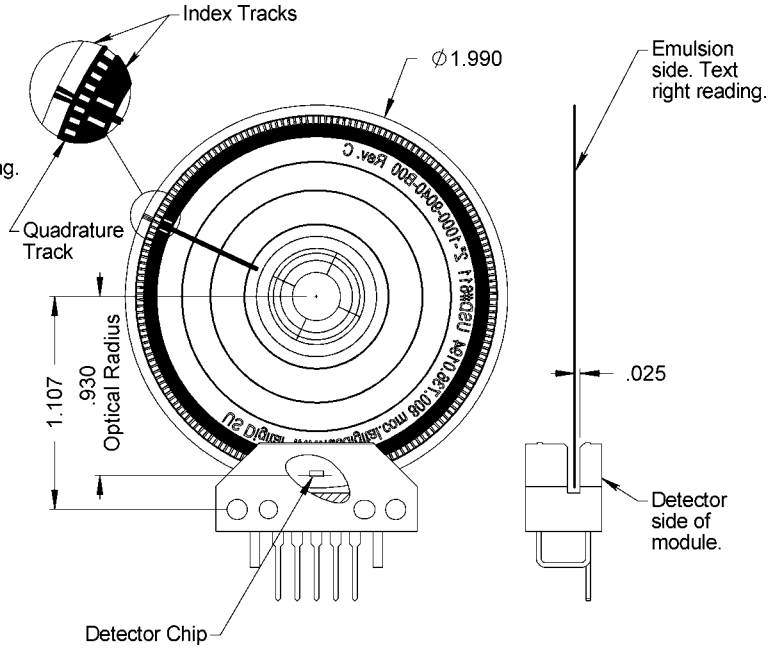
EM1 Module & Disk Mechanical Alignment:





HEDS Module & Disk Mechanical Alignment:





Recommended Operating Conditions:

Parameter	Min.	Max.	Units	Notes
Temperature				
EM1	-55	125	℃	
HEDS	-40	100	℃	
Supply Voltage	4.5	5.5	Volts	Ripple <100mV$_{P-P}$
Load Capacitance	-	100	pF	
Count Frequency	-	100	kHz	rpm/60 x cycles/rev.

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
Cycle Error					
HEDS (2000 or 2048 CPR only)		-	3.0	7.5	°e
EM1 & HEDS (All Other Resolutions)		-	3.0	5.5	°e
Symmetry					
HEDS (2000 or 2048 CPR only)		130	180	230	°e
EM1 & HEDS (All Other Resolutions)		150	180	210	°e
Quadrature					
HEDS (2000 or 2048 CPR only)		40	90	140	°e
EM1 & HEDS (All Other Resolutions)		60	90	120	°e
Index Pulse Width					
HEDS (2000 or 2048 CPR only)	Po	40	90	140	°e
EM1 & HEDS (All Other Resolutions)	Po	60	90	120	°e
Ch. I Rise After Ch. B or Ch. A Fall					
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
Ch. I Fall After Ch. A or Ch. B Rise					
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

Electrical Specifications:

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

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

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

Phase Relationship:

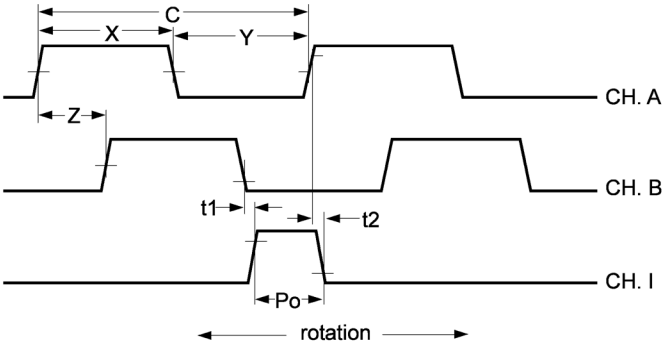
Shaft Rotation For Shaft Encoders: (View the encoder so the shaft / bushing side is facing up.)

- 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 counterclockwse rotation for the following products: **H15D, H15S, H3, H5D, H5S, H6D, H6S, HD25, S1, S2, S5D, S5S, S6D, S6S** and **SP-16.**

Shaft Rotation 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, E5D, E5M, E5S, E6D, E6M** and **E6S.**
- B leads A in a clockwise rotation; A leads B in a counterclockwise rotation for the following products: **E2.**

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 interchangable 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*).

Modules for 1" Disks:

CPR	Non-Index Part Number	Pricing Level	With Index 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

Modules for 2" Disks:

CPR	Non-Index Part Number	Pricing Level	With Index 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	3

Modules for Linear Strips:

CPR	Non-Index Part Number	Pricing Level	With Index 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

Prices:

Level 1:
$25.00 / 1
$22.24 / 10
$18.97 / 50
$16.81 / 100
$14.92 / 500
$13.36 / 1K

Level 2:
$28.00 / 1
$24.91 / 10
$21.24 / 50
$18.62 / 100
$16.71 / 500
$14.96 / 1K

Level 3:
$31.00 / 1
$27.58 / 10
$23.52 / 50
$20.84 / 100
$18.50 / 500
$16.57 / 1K

Level 4:
$34.00 / 1
$30.25 / 10
$25.80 / 50
$22.86 / 100
$20.29 / 500
$18.17 / 1K

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