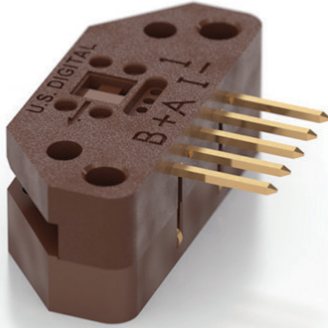




Features of the EM1 Transmissive Optical Encoder Module

- Encoder module for measuring linear or rotary movement
- Two-channel quadrature with optional index channel
- 21 Rotary Resolutions from 32 to 2,500 CPR (128 to 10,000 PPR)
- 9 Linear Resolutions from 120 to 500 LPI (x1 quadrature decoding)
- Sink/source 8 mA outputs
- Internal decoupling capacitor for enhanced noise immunity
- Single 5 VDC supply
- Improved replacement for HEDS-9000 Series

Description

The EM1 is a transmissive optical encoder module designed to measure rotary or linear motion when paired 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, allowing for a wider gap tolerance and reliable performance even with some disk contamination.



The EM1 encoder module provides digital A & B quadrature outputs with an optional index channel. Each EM1 module is resolution-specific and is matched to the resolution of an encoder disk or linear strip. The EM1 module supports 21 different resolutions. The EM1 operates with a single 5V supply and provides single-ended outputs capable of sinking and sourcing 8mA. An internal 0.1 μ F decoupling capacitor provides enhanced noise immunity.

For open collector and higher voltage applications, add the PC3⁽¹⁾ cable driver, or for differential cable driver outputs, add the PC4⁽²⁾ cable driver.

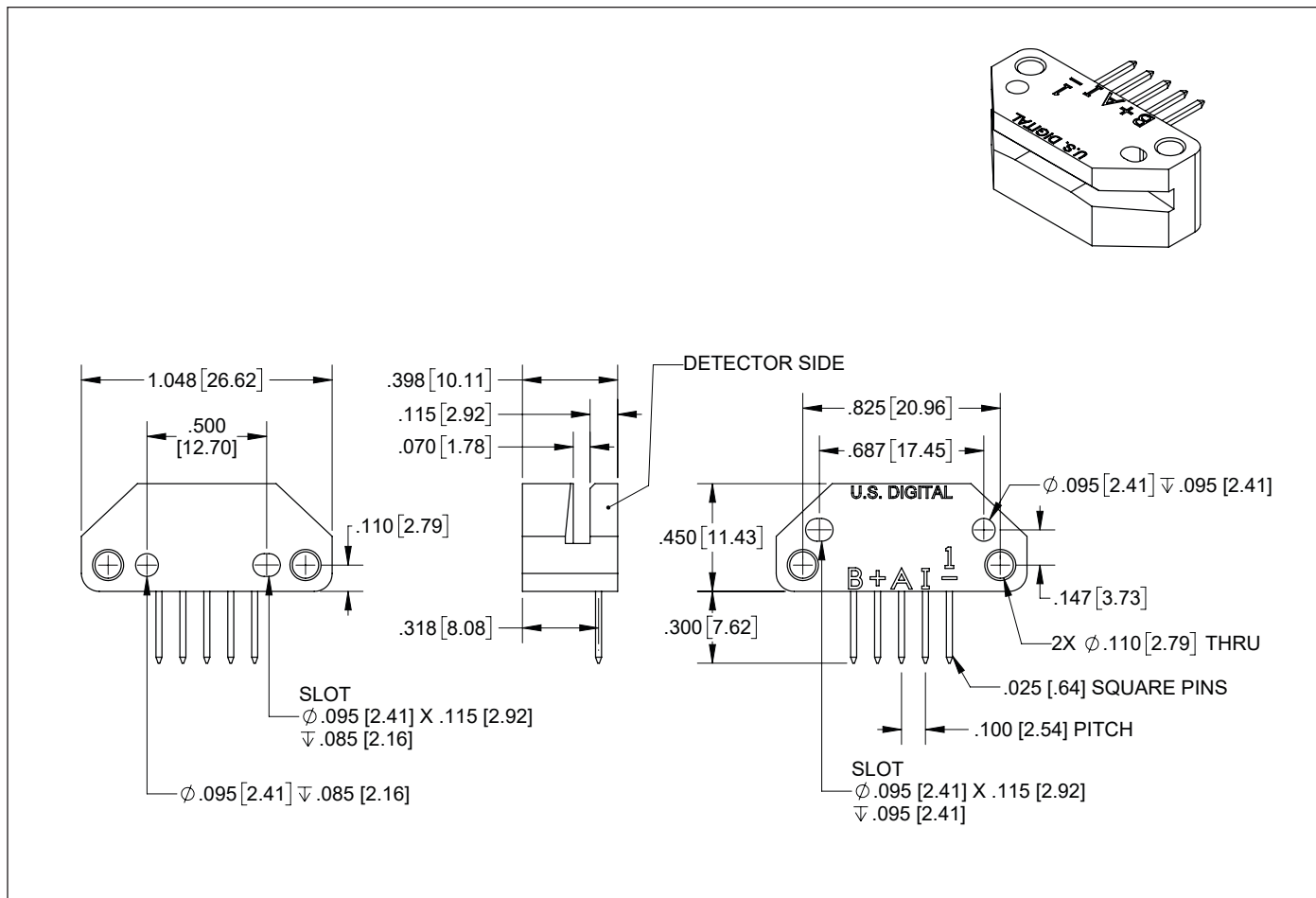
Accessories such as encoder disks, linear strips, mating connectors and cables are also available.

Transmissive Optical Encoder Module

Product ID | EM1



Mechanical Drawings



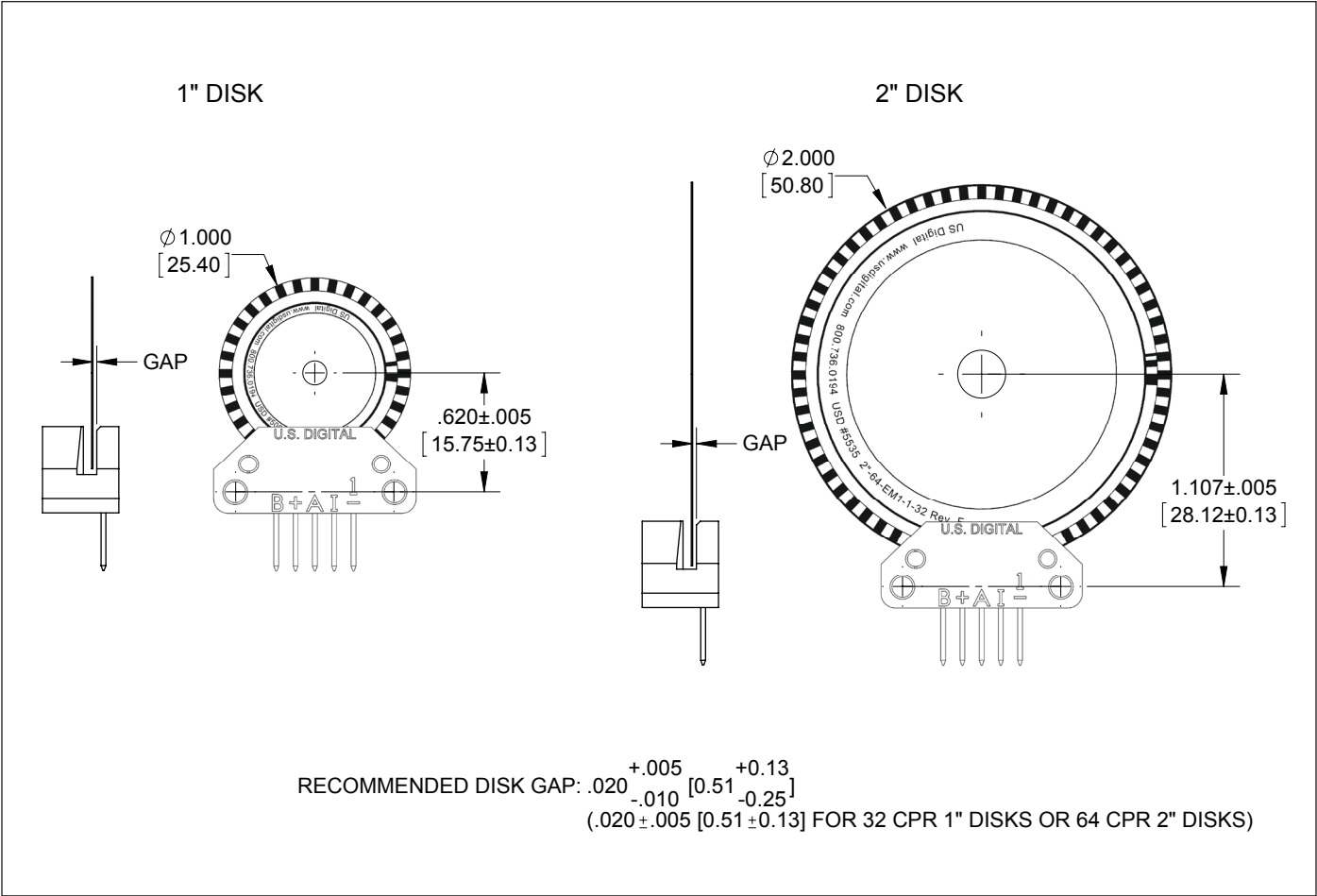
EM1 Transmissive Optical Encoder Module

Transmissive Optical Encoder Module

Product ID | EM1

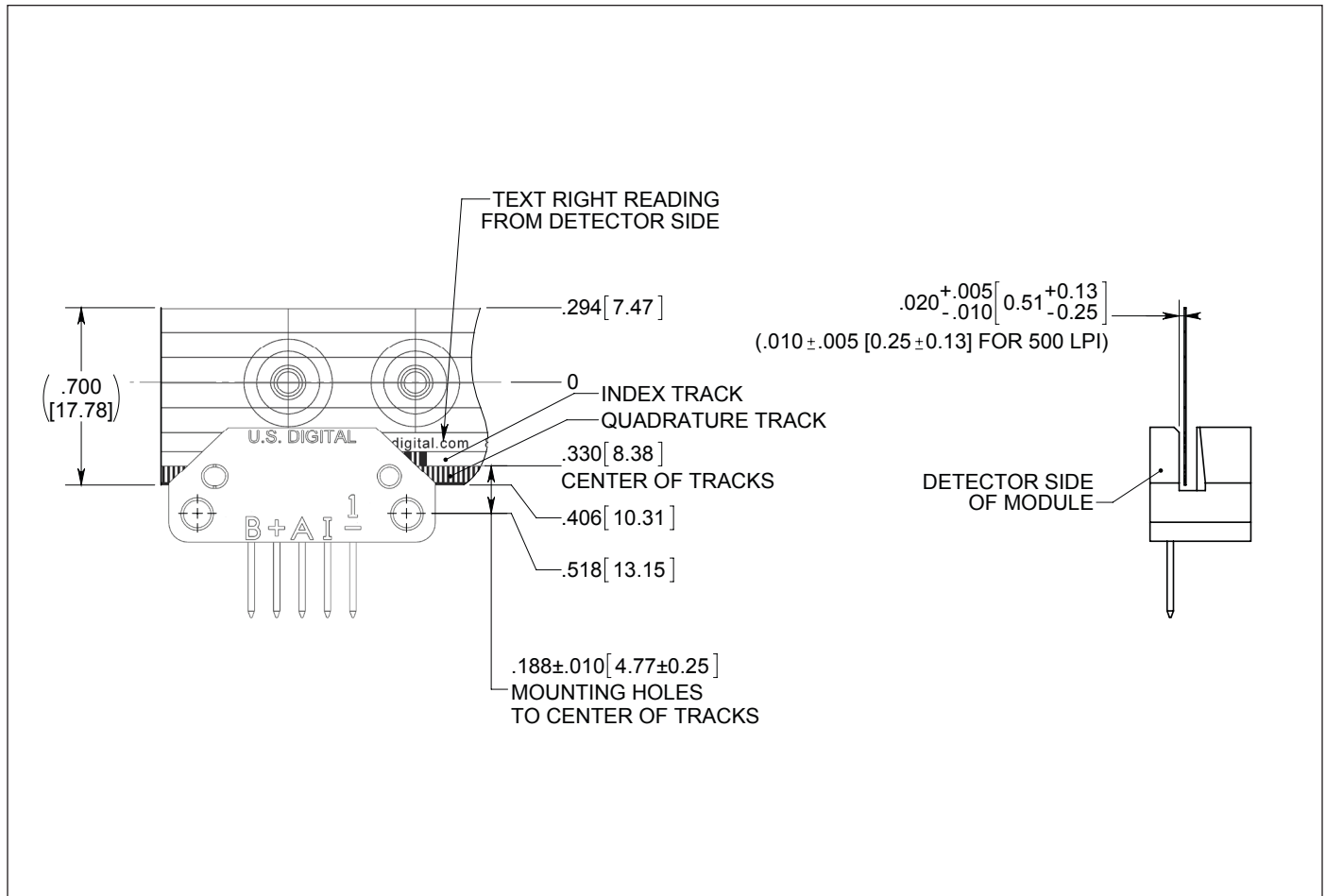


Mechanical Drawings



EM1 Transmissive Optical Encoder Module - Disk Alignment

Mechanical Drawings



EM1 Transmissive Optical Encoder Module - Linear Strip Alignment

Transmissive Optical Encoder Module

Product ID | EM1



Specifications

Compatible 1 in. and 2 in. Disks

1 in. Disks

CPR	Module Non-Index	1 in. Disk Non-Index	Module Index	1 in. Disk Index
32	EM1-1-32-N	DISK-1-32-*-NE		
50	EM1-1-50-N	DISK-1-50-*-NE	EM1-1-50-I	DISK-1-50-*-IE
96	EM1-1-100-N	DISK-1-96-*-NE	EM1-1-100-I	DISK-1-96-*-IE
100	EM1-1-100-N	DISK-1-100-*-NE	EM1-1-100-I	DISK-1-100-*-IE
120	EM1-1-100-N	DISK-1-120-*-NE		
192	EM1-1-200-N	DISK-1-192-*-NE	EM1-1-200-I	DISK-1-192-*-IE
200	EM1-1-200-N	DISK-1-200-*-NE	EM1-1-200-I	DISK-1-200-*-IE
250	EM1-1-250-N	DISK-1-250-*-NE	EM1-1-250-I	DISK-1-250-*-IE
256	EM1-1-250-N	DISK-1-256-*-NE	EM1-1-250-I	DISK-1-256-*-IE
360	EM1-1-360-N	DISK-1-360-*-NE	EM1-1-360-I	DISK-1-360-*-IE
400	EM1-1-400-N	DISK-1-400-*-NE	EM1-1-400-I	DISK-1-400-*-IE
500	EM1-1-500-N	DISK-1-500-*-NE	EM1-1-500-I	DISK-1-500-*-IE
512	EM1-1-512-N	DISK-1-512-*-NE	EM1-1-512-I	DISK-1-512-*-IE
540	EM1-1-540-N	DISK-1-540-*-NE	EM1-1-540-I	DISK-1-540-*-IE
720	EM1-1-720-N	DISK-1-720-*-NE	EM1-1-720-I	DISK-1-720-*-IE
800	EM1-1-800-N	DISK-1-800-*-NE	EM1-1-800-I	DISK-1-800-*-IE
1000	EM1-1-1000-N	DISK-1-1000-*-NE	EM1-1-1000-I	DISK-1-1000-*-IE
1024	EM1-1-1024-N	DISK-1-1024-*-NE	EM1-1-1024-I	DISK-1-1024-*-IE
1250	EM1-1-1250-N	DISK-1-1250-*-NE	EM1-1-1250-I	DISK-1-1250-*-IE

*Represents the bore size.

Transmissive Optical Encoder Module

Product ID | EM1



Specifications

Compatible 1 in. and 2 in. Disks

2 in. Disks

CPR	Module Non-Index	2 in. Disk Non-Index	Module Index	2 in. Disk Index
64	EM1-1-32-N	DISK-2-64-*-NE		
100	EM1-1-50-N	DISK-2-100-*-NE	EM1-1-50-I	DISK-2-100-*-IE
200	EM1-1-100-N	DISK-2-200-*-NE	EM1-1-100-I	DISK-2-200-*-IE
400	EM1-1-200-N	DISK-2-400-*-NE	EM1-1-200-I	DISK-2-400-*-IE
500	EM1-2-500-N	DISK-2-500-*-NE	EM1-2-500-I	DISK-2-500-*-IE
512	EM1-2-500-N	DISK-2-512-*-NE	EM1-2-500-I	DISK-2-512-*-IE
800	EM1-1-400-N	DISK-2-800-*-NE	EM1-1-400-I	DISK-2-800-*-IE
1000	EM1-2-1000-N	DISK-2-1000-*-NE	EM1-2-1000-I	DISK-2-1000-*-IE
1024	EM1-2-1024-N	DISK-2-1024-*-NE	EM1-2-1024-I	DISK-2-1024-*-IE
1800	EM1-2-1800-N	DISK-2-1800-*-NE	EM1-2-1800-I	DISK-2-1800-*-IE
2000	EM1-2-2000-N	DISK-2-2000-*-NE	EM1-2-2000-I	DISK-2-2000-*-IE
2048	EM1-2-2048-N	DISK-2-2048-*-NE	EM1-2-2048-I	DISK-2-2048-*-IE
2500	EM1-2-2500-N	DISK-2-2500-*-NE	EM1-2-2500-I	DISK-2-2500-*-IE

*Represents the bore size.

Transmissive Optical Encoder Module

Product ID | EM1



Specifications

Compatible 1 in. and 2 in. Hubdisks

1 in. Hubdisks

CPR	Module Non-Index	1 in. Hubdisk Non-Index	Module Index	1 in. Hubdisk Index
32	EM1-1-32-N	HUBDISK-1-32-*-NE		
50	EM1-1-50-N	HUBDISK-1-50-*-NE	EM1-1-50-I	HUBDISK-1-50-*-IE
96	EM1-1-100-N	HUBDISK-1-96-*-NE	EM1-1-100-I	HUBDISK-1-96-*-IE
100	EM1-1-100-N	HUBDISK-1-100-*-NE	EM1-1-100-I	HUBDISK-1-100-*-IE
120	EM1-1-100-N	HUBDISK-1-120-*-NE		
192	EM1-1-200-N	HUBDISK-1-192-*-NE	EM1-1-200-I	HUBDISK-1-192-*-IE
200	EM1-1-200-N	HUBDISK-1-200-*-NE	EM1-1-200-I	HUBDISK-1-200-*-IE
250	EM1-1-250-N	HUBDISK-1-250-*-NE	EM1-1-250-I	HUBDISK-1-250-*-IE
256	EM1-1-250-N	HUBDISK-1-256-*-NE	EM1-1-250-I	HUBDISK-1-256-*-IE
360	EM1-1-360-N	HUBDISK-1-360-*-NE	EM1-1-360-I	HUBDISK-1-360-*-IE
400	EM1-1-400-N	HUBDISK-1-400-*-NE	EM1-1-400-I	HUBDISK-1-400-*-IE
500	EM1-1-500-N	HUBDISK-1-500-*-NE	EM1-1-500-I	HUBDISK-1-500-*-IE
512	EM1-1-512-N	HUBDISK-1-512-*-NE	EM1-1-512-I	HUBDISK-1-512-*-IE
540	EM1-1-540-N	HUBDISK-1-540-*-NE	EM1-1-540-I	HUBDISK-1-540-*-IE
720	EM1-1-720-N	HUBDISK-1-720-*-NE	EM1-1-720-I	HUBDISK-1-720-*-IE
800	EM1-1-800-N	HUBDISK-1-800-*-NE	EM1-1-800-I	HUBDISK-1-800-*-IE
1000	EM1-1-1000-N	HUBDISK-1-1000-*-NE	EM1-1-1000-I	HUBDISK-1-1000-*-IE
1024	EM1-1-1024-N	HUBDISK-1-1024-*-NE	EM1-1-1024-I	HUBDISK-1-1024-*-IE
1250	EM1-1-1250-N	HUBDISK-1-1250-*-NE	EM1-1-1250-I	HUBDISK-1-1250-*-IE

*Represnets the bore size.

Transmissive Optical Encoder Module

Product ID | EM1



Specifications

Compatible 1 in. and 2 in. Hubdisks

2 in. Hubdisks

CPR	Module Non-Index	2 in. Hubdisk Non-Index	Module Index	2 in. Hubdisk Index
64	EM1-1-32-N	HUBDISK-2-64-*-NE		
100	EM1-1-50-N	HUBDISK-2-100-*-NE	EM1-1-50-I	HUBDISK-2-100-*-IE
200	EM1-1-100-N	HUBDISK-2-200-*-NE	EM1-1-100-I	HUBDISK-2-200-*-IE
400	EM1-1-200-N	HUBDISK-2-400-*-NE	EM1-1-200-I	HUBDISK-2-400-*-IE
500	EM1-2-500-N	HUBDISK-2-500-*-NE	EM1-2-500-I	HUBDISK-2-500-*-IE
512	EM1-2-500-N	HUBDISK-2-512-*-NE	EM1-2-500-I	HUBDISK-2-512-*-IE
800	EM1-1-400-N	HUBDISK-2-800-*-NE	EM1-1-400-I	HUBDISK-2-800-*-IE
1000	EM1-2-1000-N	HUBDISK-2-1000-*-NE	EM1-2-1000-I	HUBDISK-2-1000-*-IE
1024	EM1-2-1024-N	HUBDISK-2-1024-*-NE	EM1-2-1024-I	HUBDISK-2-1024-*-IE
1800	EM1-2-1800-N	HUBDISK-2-1800-*-NE	EM1-2-1800-I	HUBDISK-2-1800-*-IE
2000	EM1-2-2000-N	HUBDISK-2-2000-*-NE	EM1-2-2000-I	HUBDISK-2-2000-*-IE
2048	EM1-2-2048-N	HUBDISK-2-2048-*-NE	EM1-2-2048-I	HUBDISK-2-2048-*-IE
2500	EM1-2-2500-N	HUBDISK-2-2500-*-NE	EM1-2-2500-I	HUBDISK-2-2500-*-IE

*Represents the bore size.

Transmissive Optical Encoder Module

Product ID | EM1



Specifications

Compatible Linear Strips

LPI	Module Non-Index	Linear Strip Non-Index	Module Index	Linear Strip Index
120	EM1-0-120-N	LIN-120-*-N	EM1-0-120-I	LIN-120-*-#
125	EM1-0-127-N	LIN-125-*-N	EM1-0-127-I	LIN-125-*-#
127	EM1-0-127-N	LIN-127-*-N	EM1-0-127-I	LIN-127-*-#
150	EM1-0-150-N	LIN-150-*-N	EM1-0-150-I	LIN-150-*-#
180	EM1-0-180-N	LIN-180-*-N	EM1-0-180-I	LIN-180-*-#
200	EM1-0-200-N	LIN-200-*-N	EM1-0-200-I	LIN-200-*-#
250	EM1-0-250-N	LIN-250-*-N	EM1-0-250-I	LIN-250-*-#
360	EM1-0-360-N	LIN-360-*-N	EM1-0-360-I	LIN-360-*-#
500	EM1-0-500-N	LIN-500-*-N	EM1-0-500-I	LIN-500-*-#
		* Represents length of Linear Strip		
			* Represents length of Linear Strip	# Represents location of Index

Environmental

Parameter	Value	Units
Operating Temperature	-40 to 100	C
Electrostatic Discharge, IEC 61000-4-2	± 4	kV
Vibration (10Hz to 2kHz, sinusoidal)	20	G
Shock (6 milliseconds, half-sine)	75	G

Operating Conditions

Parameter	Min.	Max.	Units
A/B Output Frequency	0	300	kHz
Disk RPM	0	(18 x 10 ⁶) / CPR	RPM
Linear Strip Speed	0	(3 x 10 ⁵) / LPI	inches/sec.
Disk/Linear Strip Radial Position Tolerance	±.005		inch

Specifications

Electrical

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

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 54	33 65	mA mA	LPI < 250, no load LPI $\geq$ 360, no load
Supply Current, EM1-1- (1 in. disk)		27 54	33 65	mA mA	CPR < 500, no load CPR $\geq$ 500, no load
Supply Current, EM1-2- (2 in. disk)		27 54	33 65	mA mA	CPR < 1000, no load CPR $\geq$ 1000, no load
Low-level Output		0.05	0.5	V V	$I_{OL} = 8mA$ max. No load
High-level Output	2.0	4.8		V V	$I_{OH} = -8mA$ max. No load
Output Current Per Channel	-8		8	mA	
Load Capacitance			100	pF	
Output Rise Time		110		nS	
Output Fall Time		100		nS	

Timing Characteristics

Encoding Characteristics

- Specifications apply over the entire operating temperature 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	150	180	210	$^{\circ}e$
Quadrature	Z	60	90	120	$^{\circ}e$
Index Pulse Width	Po	40	90	120	$^{\circ}e$

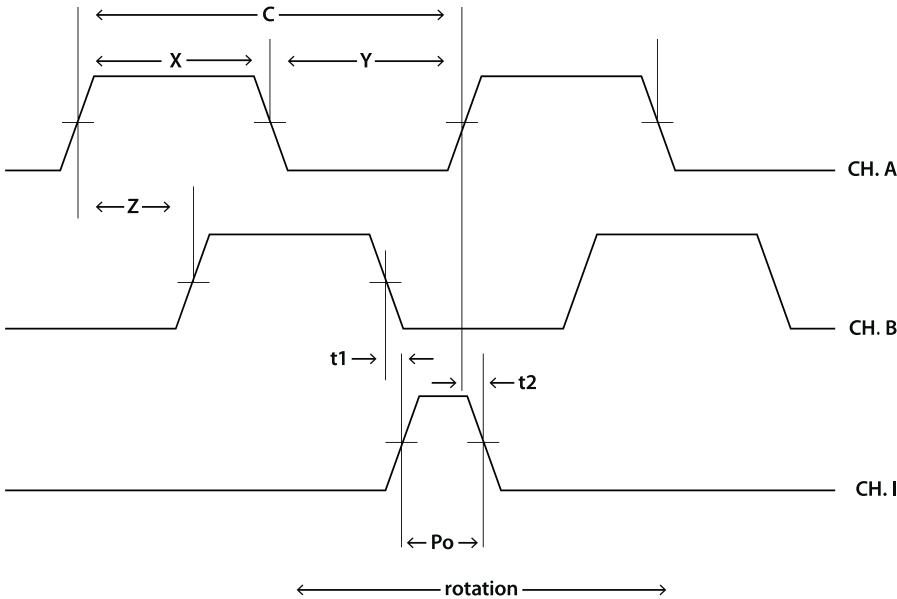
Specifications

Timing Characteristics

Encoding Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units
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 °e).

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

Specifications

Timing Characteristics

One Shaft Rotation: 360 mechanical degrees.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 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

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 0.05 1 in. shorter than HEDS modules, while still providing .30 in. insertion depth. US Digital’s EM1 offers custom resolutions.

Specifications

Pin-Outs

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

Notes

- Cables and connectors are not included and must be ordered separately.
- US Digital® warrants its products against defects in materials and workmanship for two years. See complete warranty⁽³⁾ for details.

Part Number Guide and Configuration Options

Product ID - ? - ???? - ?			
EM1	Type	Resolution	Index
	0 (Linear Strip)	120 LPI	I (Index)
	1 (1 in. Disk)	125 LPI	N (Non-Index)
	2 (2 in. Disk)	127 LPI	
		150 LPI	
		180 LPI	
		200 LPI	
		250 LPI	
		300 LPI	
		360 LPI	
		500 LPI	
		32 CPR	
		50 CPR	
		64 CPR	
		100 CPR	
		100 CPR	
		200 CPR	
		200 CPR	
		250 CPR	
		360 CPR	
		400 CPR	
		400 CPR	
		500 CPR	
		500 CPR	
		512 CPR	
		540 CPR	
		720 CPR	
		800 CPR	
		800 CPR	
		900 CPR	
		1000 CPR	
		1024 CPR	
		1250 CPR	
		1000 CPR	
		1024 CPR	
		1800 CPR	
		2000 CPR	
		2048 CPR	
		2500 CPR	

PLEASE NOTE: This chart is for informational use only. Certain product configuration combinations are not available. Visit the [EM1^{\(4\)}](#) product page for pricing and additional information.

Transmissive Optical Encoder Module

Product ID | EM1



Reference Links



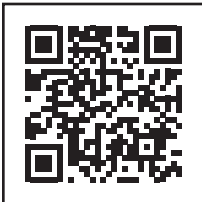
(1) PC3 Encoder
Open Collector
Cable Driver



(2) PC4 Incre-
mental Encoder
Cable Driver



(3) Legal Terms
and Conditions,
Warranty



(4) EM1 Trans-
missive Optical
Encoder Module