AEDR-8300-1Wx Encoders

Reflective Surface Mount Optical Encoder

Data Sheet

Description

The AEDR-8300-1Wx is the smallest optical encoder employing reflective technology for motion control purposes. The encoder houses an LED light source and a photo-detecting circuitry in a single package.

The AEDR-8300-1Wx offers two-channel quadrature digital outputs. Being TTL compatible, the outputs of the AEDR-8300-1Wx can be interfaced directly with most of the signal processing circuitries. Hence the encoder provides great design-in flexibility and easy integration into existing systems. The AEDR-8300-1Wx could yields encoding resolution at 212 lines per inch (LPI) which is 8.35 lines per mm.

The AEDR-8300-1Wx provides motion sensing at a competitive cost, making it ideal for high volume applications. Its small size and surface mount package make it ideal for many consumer products, particularly where space and weigh are primary design constraint.

Features

- Reflective technology
- Surface mount leadless package
- Two channel quadrature outputs for direction sensing
- TTL compatible output
- Single 3.3 V to 5 V supply
- -20° C to 85° C absolute operating temperature
- Encoding resolution: 212 (lines/inch) or 8.35 (lines/mm)

Applications

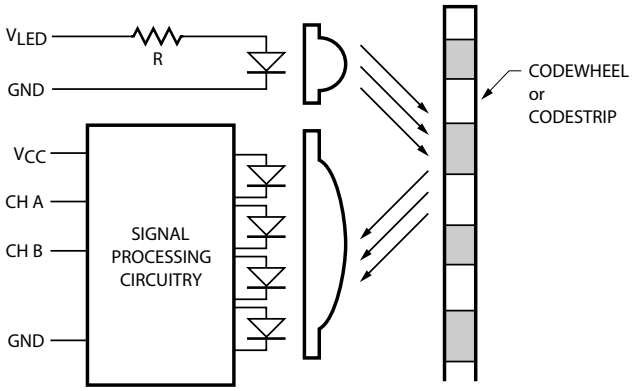
Ideal for high volume applications:

- Printers
- Copiers
- Card readers
- Scanners
- Cameras
- Motor Solutions
- Automated Wheel-chair
- Vending Machines
- Low Servo Systems
- ATM Machines
- Textile Machines
- Industrial Sewing Machines
- Consumer Product Applications

Theory of Operation

The AEDR-8300-1Wx combines an emitter and a detector in a single surface mount leadless package. When used with a codewheel or linear codestrip, the encoder translates rotary or linear motion into digital outputs. As seen in the block diagram, the AEDR-8300-1Wx consists of three major components: a light emitting diode (LED) light source, a detector IC consisting photodiodes and lens to focus light beam from the emitter as well as light falling on the detector.

Block Diagram of AEDR-8300-1Wx



The operation of the encoder is based on the principle of optics where the detector photodiodes sense the absence and presence of light. In this case, the rotary/linear motion of an object being monitored is converted to equivalent light pattern via the use of codewheel/codestrip. As shown in the above diagram, the reflective area (window) of the codewheel (or codestrip) reflects light back to the photodetector IC, whereas no light is reflected by the non-reflective area (bar). An alternating light and dark patterns corresponding to the window and bar fall on the photodiodes as the codewheel rotates. The moving light pattern is exploited by the detector circuitry to produce digital outputs representing the rotation of the codewheel. When the codewheel is coupled to a motor, the encoder outputs are then a direct representation of the motor rotation. The same concept applies to the use of a codestrip to detect linear motion.

Definitions

State Width (S): The number of electrical degrees between a transition in Channel A and the neighboring transition in Channel B. There are 4 states per cycle, each nominally 90°e.

State Width Error (ΔS): The deviation of state width, in electrical degree, from its ideal value of 90°e.

Phase (ϕ): The number of electrical degrees between the center of high state of Channel A and the center of high state of Channel B. Nominally 90°e.

Phase Error ($\Delta\phi$): The deviation of phase, in electrical degree, from its ideal value of 90°e.

Pulse Width (P): The duration of high state of the output, in electrical degree, within one cycle. Nominally 180°e or half a cycle.

Pulse Width Error (ΔP): The deviation of pulse width, in electrical degree, from its ideal value of 180°e.

Count (N): The number of window and bar pair per revolution (CPR) of codewheel. For linear codestrip, defined as the number of window and bar pair per unit length (lines per inch [LPI] or lines per mm [LPmm]).

One Cycle (C): 360 electrical degrees (°e). Equivalent to one window and bar pair.

One Shaft Rotation: 360 mechanical degrees. Also equivalent to N counts (codewheel only).

Line Density: The number of window and bar pair per unit length, expressed in either lines per inch (LPI) or lines per mm (LPmm).

Optical radius (Rop): The distance between the codewheel center and the centerline between the two domes of the encoder.

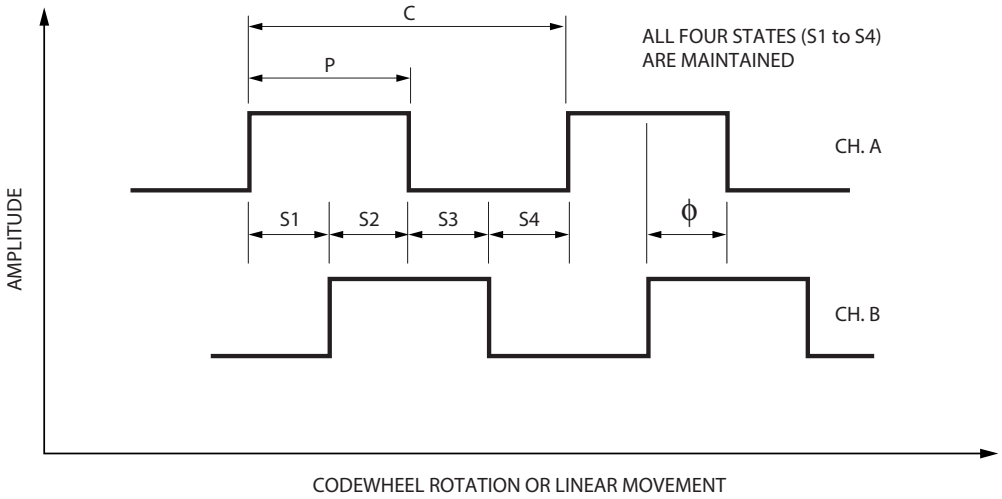
Gap (G): The distance from surface of the encoder to the surface of codewheel or codestrip.

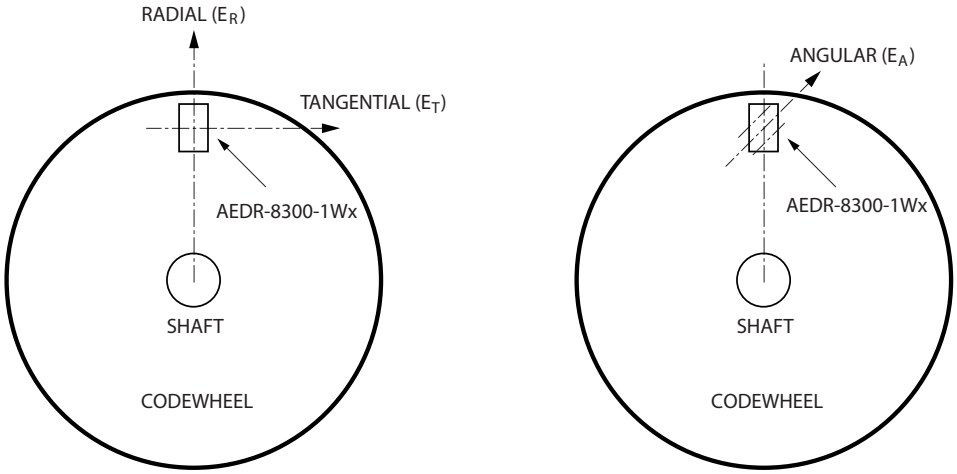
Radial and Tangential Misalignment Error (E_R, E_T): For rotary motion, mechanical displacement in the radial and tangential directions relative to the nominal alignment.

Angular Misalignment Error (E_A): Angular displacement of the encoder relative to the tangential line.

Specular Reflectance (R_f): The amount of incident light reflected by a surface. Quantified in terms of the percentage of incident light. A spectrometer can be used to measure specular reflectance of a surface (contact factory for more information).

Output waveform





Absolute Maximum Ratings

Storage Temperature, T_S	-40° C to 85° C
Operating Temperature, T_A	-20° C to 85° C
Supply Voltage, V_{CC}	-0.5 V to 7 V
Output Voltage, V_O	-0.5 V to V_{CC}
Output Current per Channel, I_{OUT}	-1.0 mA to 8 mA
ESD	Human Body Model JESD22-A114-A Class 2
	Machine Model JESD22-A115-A Class B

Notes:
1. Exposure to extreme light intensity (such as from flashbulbs or spotlights) may cause permanent damage to the device.
2. CAUTION: It is advised that normal static precautions should be taken when handling the encoder in order to avoid damage and/or degradation induced by ESD.
3. Proper operation of the encoder cannot be guaranteed if the maximum ratings are exceeded.

Recommended Operating Conditions

Parameter	Symbol	Minimum	Typical	Maximum	Units	Notes
Temperature	T_A	-20	25	85	°C	
Supply Voltage	V_{CC}	3.0	3.3 / 5.0	5.5	V	Ripple < 100 mVp-p
LED Current	I_{LED}	13	15	18	mA	See Note 1
Load Capacitance	C_L			100	pF	2.7 kΩ Pull-Up
Count Frequency[2]	F	0.3		60	kHz	See Note 3
Radial Misalignment	E_R			±0.38 (±0.015)	mm (in.)	
Tangential Misalignment	E_T			±0.38 (±0.015)	mm (in.)	
Angular Misalignment	E_A		0	±1.5	deg.	
Codewheel/strip tilt	C_T		0	1	deg.	
Codewheel/strip Gap	G	1.0 (0.04)	2.0 (0.08)	2.5 (0.10)	mm (in.)	

Notes:
1. LED Current Limiting Resistor:
   For Vcc = 5.0 V, recommended series resistor = 220 Ω (±10 %)
   For Vcc = 3.3 V, recommended series resistor = 110 Ω (± 10 %)
2. Count frequency = velocity (rpm) x N / 60.
3. Data collected based on Avago production characterization.

Encoding Characteristics

Encoding characteristics over the recommended operating condition and mounting conditions.

Parameter	Symbol	Typical	Maximum	Unit
Pulse Width Error (Ch.A, Ch.B)	ΔP	16	75	°e
Phase Error	Δϕ	10	60	°e

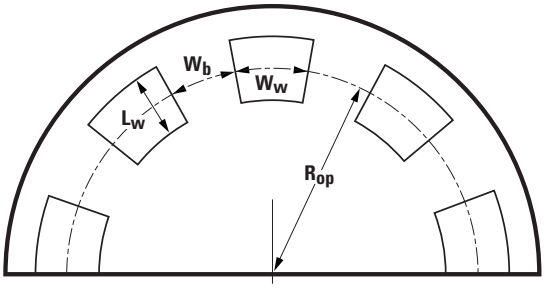
Note:
1. Typical values represent the encoder performance at typical mounting alignment, whereas the maximum values represent the encoder performance across the range of recommended mounting tolerance.

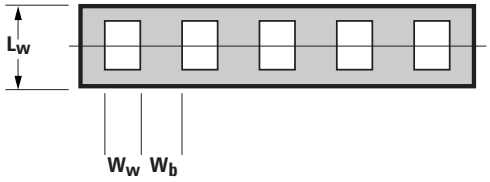
Electrical Characteristics

Characteristics over recommended operating conditions at 25° C.

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
Detector Supply Current	I_{CC}		4.8	6.0	mA	Vcc = 5 V
			3.9	4.1		Vcc = 3.3 V
High Level Output Voltage	V_{OH}	2.4			V	I_{OH} = -0.2 mA
Low Level Output Voltage	V_{OL}			0.4	V	I_{OL} = 8.0 mA
Rise Time	t_r		500		ns	C_L = 25 pF R_L = 2.7 kΩ
Fall Time	t_f		100		ns	

Recommended Codewheel and Codestrip Characteristics





Parameter	Symbol	Minimum	Maximum	Unit	Notes
Window/bar Ratio	Ww/Wb	0.9	1.1		
Window/bar Length	LW	1.80 (0.071)	2.31 (0.091)	mm (inches)	
Specular Reflectance	Rf	60	85		Reflective area. See note 1.
		–	10		Non reflective area
Line Density	LPmm (LPI)	8.35 (212)	8.35 (212)	lines/mm (lines/inch)	
Optical radius	Rop	11		mm	Recommended value

Notes:
1. Measurements from TMA µScan meter. Contact factory for more information.
2. Contact factory for more information on compatibility of codewheel/strip.

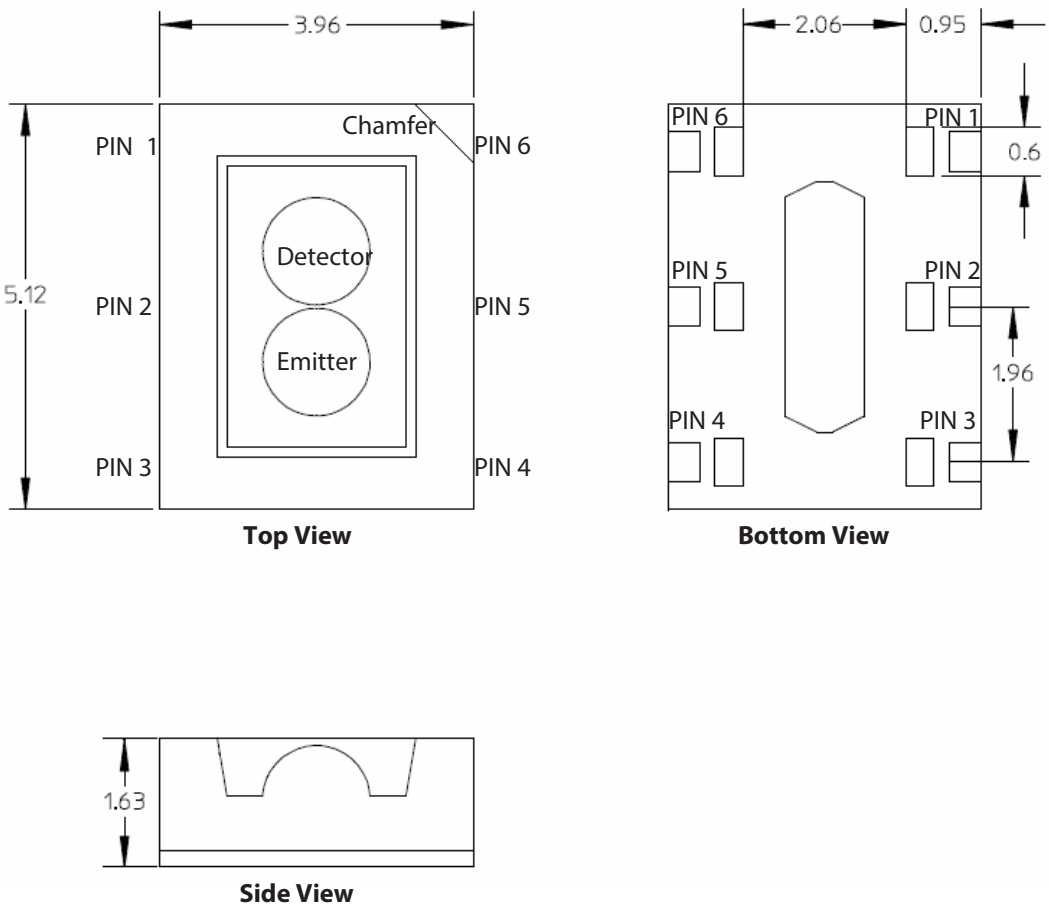
LED Current Limiting Resistor

A resistor to limit current to the LED is required. The recommended value is 220 Ω (± 10%) and the resistor should be placed in series between the 5 V supply and pin 3 of the device (V_{LED}). This will result in an LED current of approximately 15 mA. If 3.3 V voltage supply is used, the corresponded resistance would be 110 Ω (± 10%).

Moisture Sensitive Level

The AEDR-8300-1Wx is specified to moisture sensitive level (MSL) 3.

Outline Drawing



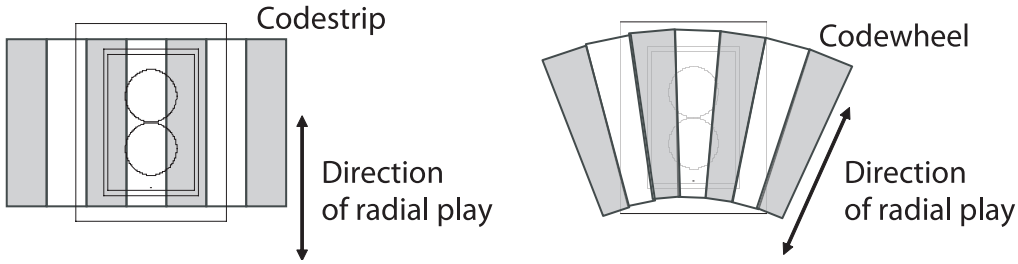
Notes:
1. All dimensions in millimeter.
2. Tolerance X.XX ± 0.15mm.
3. For ease of reference, a chamfer is incorporated on the detector side (pin 6), as shown in the above diagram.

Encoder Pin Configuration

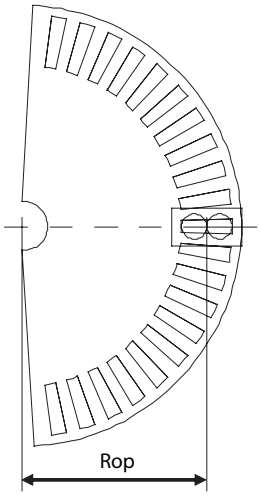
Encoder option	Pin 1	Pin2	Pin3	Pin4	Pin5	Pin6
AEDR-8300-1Wx	Ch B	Gnd	V_{LED}	Gnd	Ch A	Vcc

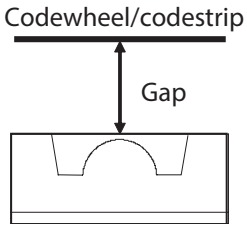
Encoder Orientation

The AEDR-8300-1Wx is designed such that both the LED and detector IC should be placed parallel to the window/bar orientation, as shown. As such, the encoder is tolerant against radial play of ± 0.38 mm. The emitter side (pins 3 and 4) should be placed closer to the rotating shaft.



Mounting Consideration

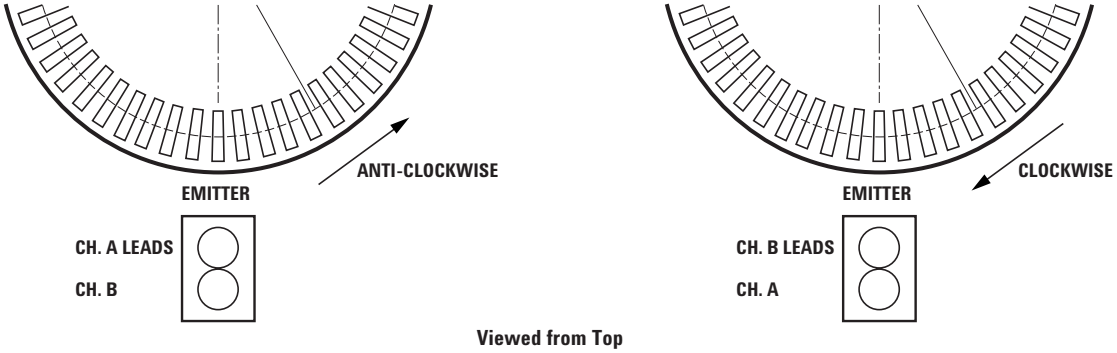




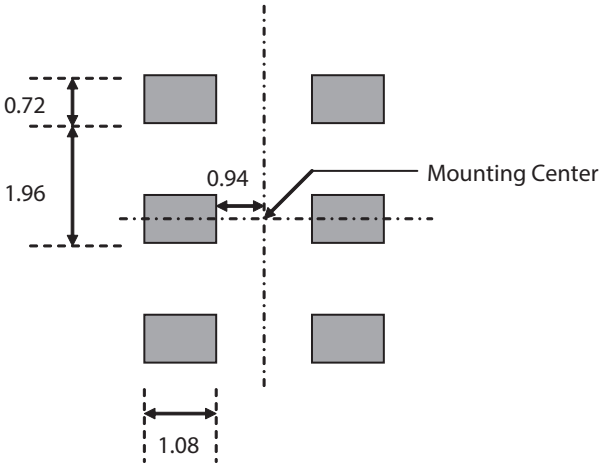
11.00 mm (0.433 IN) < Rop < ∝

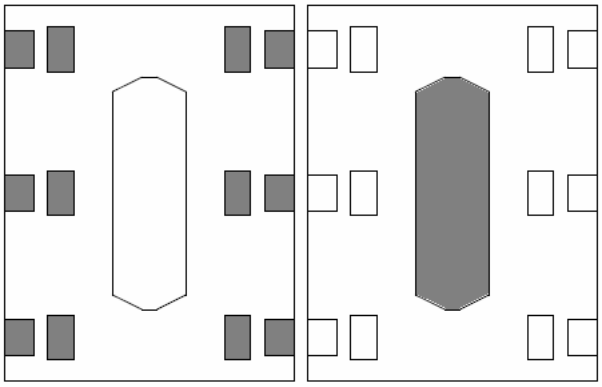
Direction of Codewheel Rotation

With the emitter side (pins 3 and 4) of the encoder placed closer to the codewheel centre, Channel A leads Channel B when the codewheel rotates anti-clockwise and vice versa.



Recommended Land Pattern for AEDR-8300-1Wx

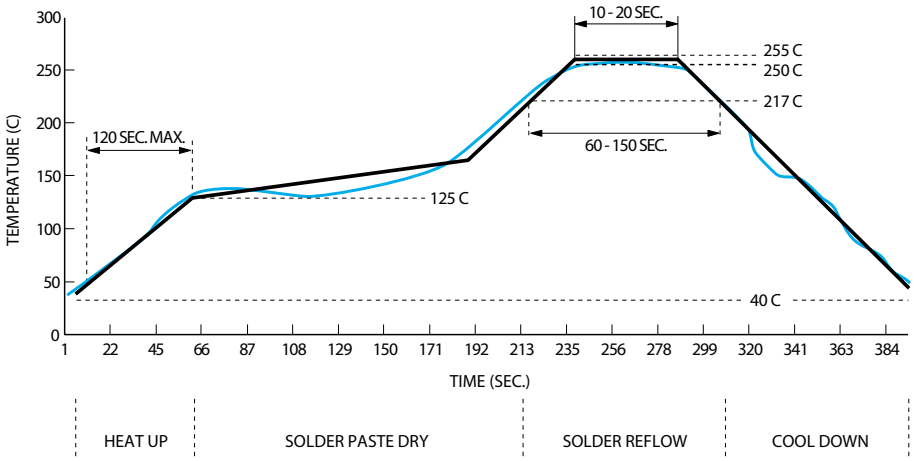




Note: The shaded areas are the leads for soldering.

Note: The shaded areas are not encoder pin-outs. They are electrically grounded and physically exposed. PCB layout with tracks running across these areas should be avoided.

Recommended Lead-free Reflow Soldering Temperature Profile



Preheat Temperature 40° C to 125° C = 120 sec max

Temperature maintain above 217° C = 60 – 150 sec

Peak Temperature = 255 ± 5° C

Time above 250° C = 10 – 20 sec

Note: Due to treatment of high temperature, AEDR-8300-1Wx compound may turn to yellow after IR reflow.

Resolution Indicator

Since the encoder is too small to imprint resolution marking on its package, color-coding the package is employed to differentiate resolutions.

Resolution (LPI)	**212**
Color	Light Amber

Ordering Information

AEDR-8300 Option 1W ☐

Shipping Units
0 – 1000 pcs
1 – 500 pcs
2 – 100 pcs

Note: Encoders are packed in tape of quantity 1000 pcs, 500 pcs or 100 pcs.

For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**

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