# AEDR-8300 Series Encoders
## Reflective Surface Mount Optical Encoder

## Data Sheet

### Description

The AEDR-8300 series 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 AEDS-8300 series offers options of either single channel or two-channel quadrature digital outputs. Being TTL compatible, the outputs of the AEDR-8300 series 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 series is available in four resolutions, namely 36, 75, 150 and 180 lines per inch (LPI) (1.42, 2.95, 5.91 and 7.09 lines per mm respectively). This range of resolutions caters for different design and application needs.

### Applications

The AEDR-8300 series 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 printers, copiers, card readers and many consumer products, particularly where space and weigh are design constraint.

### Features

- Reflective technology
- Surface mount small outline leadless package
- Single channel incremental output
- Two channel quadrature outputs for direction sensing
- TTL compatible output
- Single 5V supply
- -20°C to 85°C absolute operating temperature
- Encoding resolution options:
  36, 75, 150, 180 (lines/inch) or 1.42, 2.95, 5.91, 7.09 (lines/mm)

Note: All specifications are subject to change without prior notification.

## Theory of Operation

The AEDR-8300 series 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 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.

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 diagram below, 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 is 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 (Δϕ)**: 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.

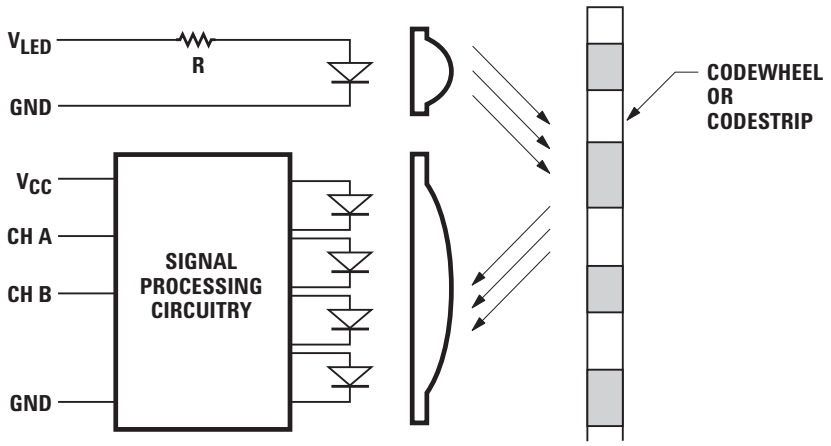



**Figure 1. Block Diagram of AEDR-8300.**

**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).

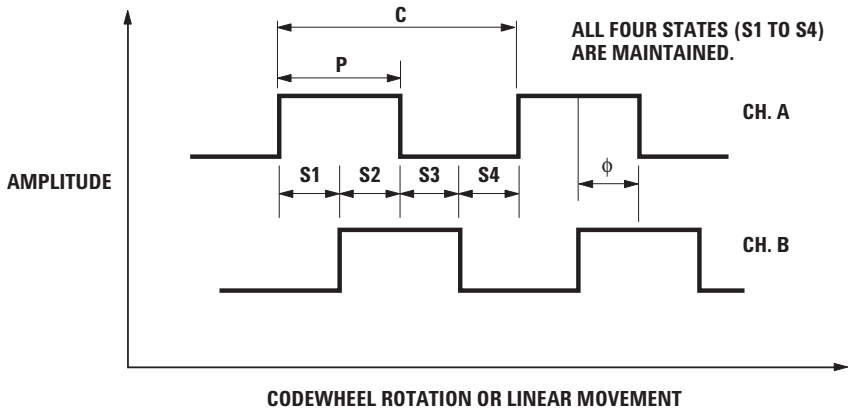
**Optical radius (Rop)**: The distance between the codewheel center and the centerline between the two domes of the encoder.

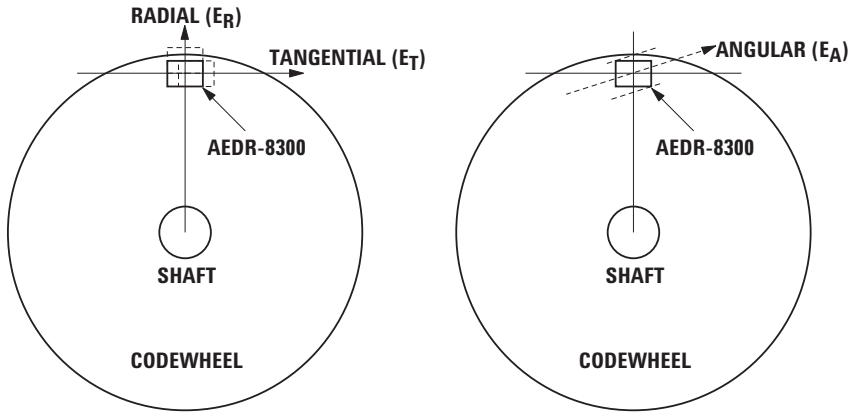
**Gap (G)**: The distance from surface of the encoder to the surface of codewheel or codestrip.

**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).

**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.



## AEDR-8300 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<br>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.

## AEDR-8300 Recommended Operating Conditions

| Parameter | Sym. | Min. | Typ. | Max. | Units | Notes |
|---|---|---|---|---|---|---|
| Temperature | $T_A$ | -20 | 25 | 85 | °C | |
| Supply Voltage | $V_{CC}$ | 4.5 | 5 | 5.5 | V | Ripple< 100mVp-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 | f | | | 30 | kHz | AEDR-83X0-K/P/Q<br>See Note 2 |
| Count Frequency | f | | | 15 | kHz | AEDR-8310-V |
| 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.) | |

Note:
1. Refer to "LED Current Limiting Resistor" in Page 6.
2. Count frequency = velocity(rpm)xN/60.

## AEDR-8300 Encoding Characteristics

Encoding characteristics over the recommended operating condition and mounting conditions.

| Parameter | Symbol | Typical | Maximum | Units | Notes |
|---|---|---|---|---|---|
| Pulse Width Error | ΔP | 15 | 55 | °e | AEDR-8310-K |
| | | 16 | 75 | °e | AEDR-8310-V |
| Pulse Width Error (Ch.A, Ch. B) | ΔP | 15, 25 | 55, 75 | °e | AEDR-8300-K |
| | ΔP | 16 | 75 | °e | AEDR-8300-P |
| | ΔP | 16 | 75 | °e | AEDR-8300-Q |
| Phase Error | Δφ | 12 | 60 | °e | AEDR-8300-K |
| | Δφ | 10 | 60 | °e | AEDR-8300-P |
| | Δφ | 10 | 60 | °e | AEDR-8300-Q |

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.

## AEDR-8300 Electrical Characteristics

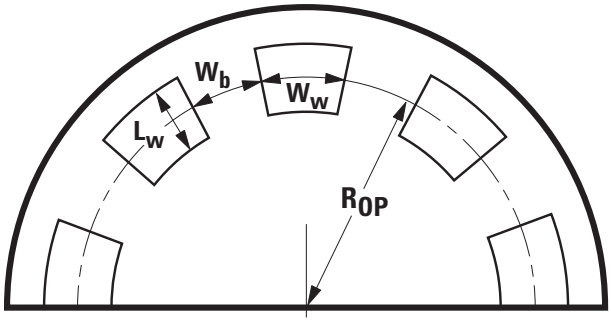
Characteristics over recommended operating conditions at 25°C.

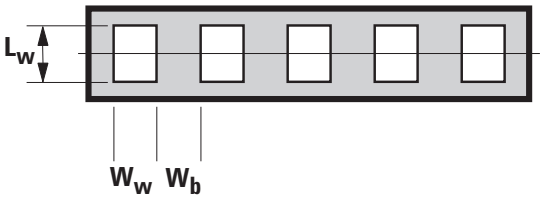
| Parameter | Sym. | Min. | Typ. | Max. | Units | Notes |
|---|---|---|---|---|---|---|
| Detector Supply Current | $I_{CC}$ | | 2.2 | 5.0 | mA | |
| High Level Output Voltage | $V_{OH}$ | 2.4 | | | V | $I_{OH} = -0.2$ mA |
| Low Level Output Voltage | $V_{OL}$ | | | 0.4 | V | $I_{OL} = 8.0$ mA |
| Rise Time | $t_r$ | | 500 | | ns | $C_L = 25$ pF, $R_L = 2.7$ kΩ |
| Fall Time | $t_f$ | | 100 | | ns | $C_L = 25$ pF, $R_L = 2.7$ kΩ |

## AEDR-8300 Encoder Pin Configuration

| Encoder option | Pin 1 | Pin 2 | Pin 3 | Pin 4 | Pin 5 | Pin 6 |
|---|---|---|---|---|---|---|
| AEDR-8310-K/V | NC | Gnd | $V_{LED}$ | Gnd | Ch A | $V_{cc}$ |
| AEDR-8300-K/P/Q | Ch B | Gnd | $V_{LED}$ | Gnd | Ch A | $V_{cc}$ |

## Recommended Codewheel and Codestrip Characteristics




| Parameter | Symbol | Min. | Max. | Unit | Notes |
|---|---|---|---|---|---|
| Window/bar Ratio | Ww/Wb | 0.9 | 1.1 | | |
| Window/bar Length | $L_w$ | 1.80 (0.071) | 2.31 (0.091) | mm (inches) | |
| Spectular Reflectance | $R_f$ | 60 | 85 | | Reflective area. See note 1. |
| | | — | 10 | | Non-reflective area |
| Line Density | LPmm (LPI) | 1.42 (36) | 1.42 (36) | lines/mm (inch) | AEDR-8310-V |
| | LPmm (LPI) | 2.95 (75) | 2.95 (75) | lines/mm (inch) | AEDR-8310-K, AEDR-8300-K |
| | LPmm (LPI) | 5.91 (150) | 5.91 (150) | lines/mm (inch) | AEDR-8300-P |
| | LPmm (LPI) | 7.09 (180) | 7.09 (180) | lines/mm (inch) | AEDR-8300-Q |
| Optical Radius | Rop | 11 | 11 | mm | Recommended value |

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

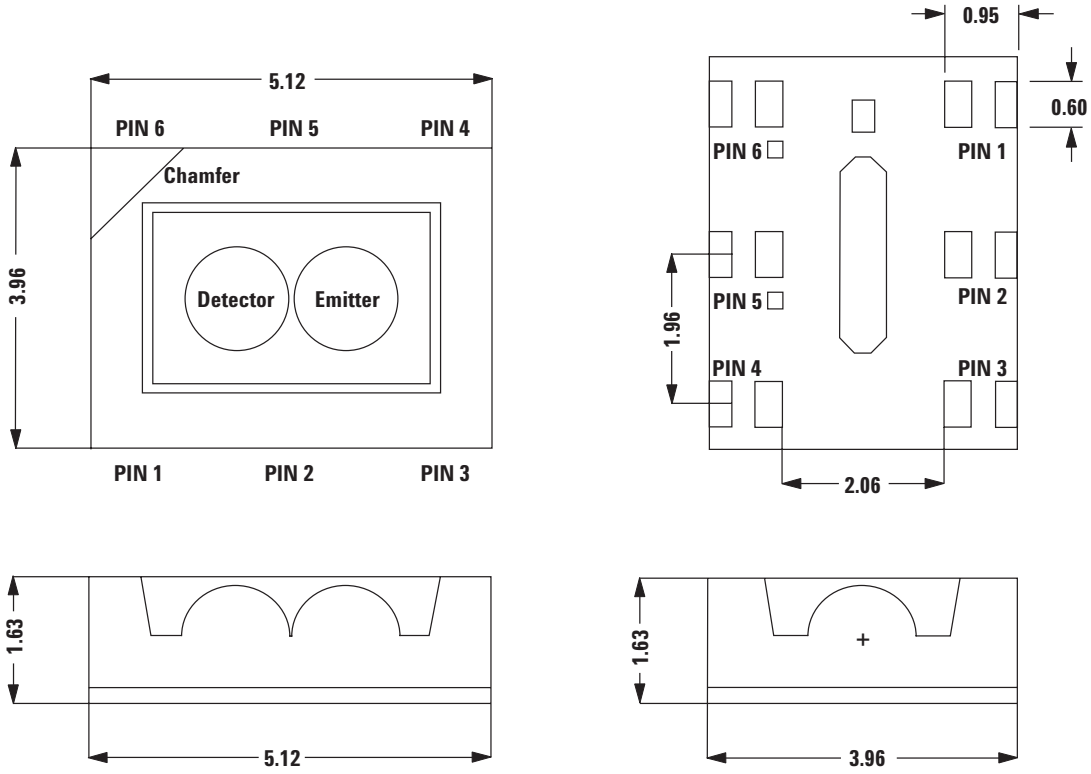
## LED Current Limiting Resistor

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

## Moisture Sensitive Level

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

## Outline Drawing

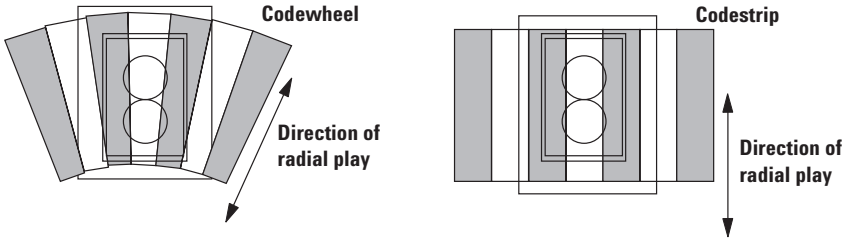



**All dimensions in millimeters.**
**Tolerance x.xx ± 0.15 mm.**

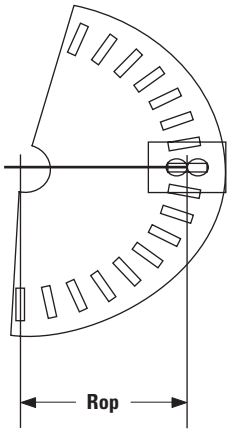
Note:
For ease of reference, a chamfer is marked on the detector side (pin 6), as shown in the above diagram.

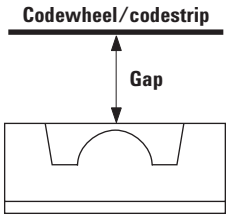
## Encoder Orientation

The AEDR-8300 series 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

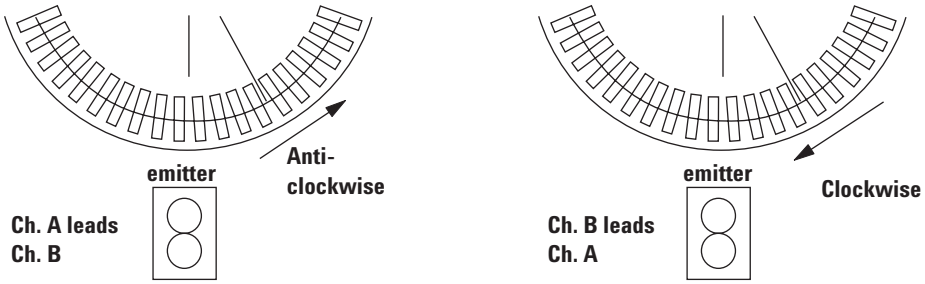



**11.00 mm (0.433 IN) < ROP < ∞**

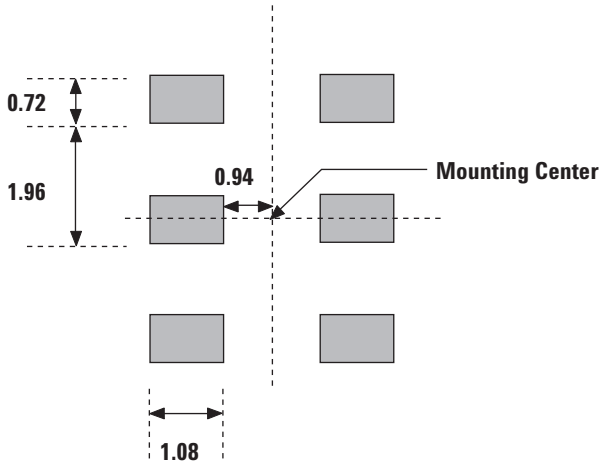
## Direction of Codewheel Rotation

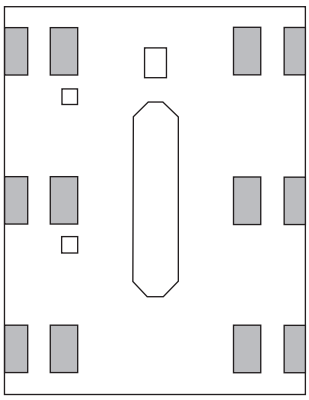
With the emitter side (pins 3 and 4) of the encoder placed closer to the codewheel centre, Channel A leads Channel B when the codewheel rotates anti-clockwise and vice versa.



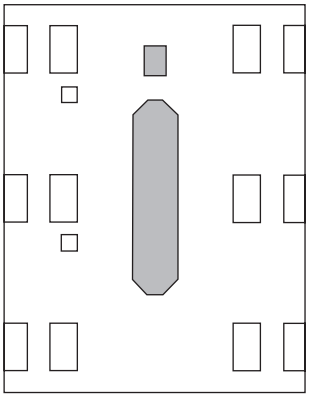

**Viewed from Top**

## Recommended Land Pattern for AEDR-8300 Series



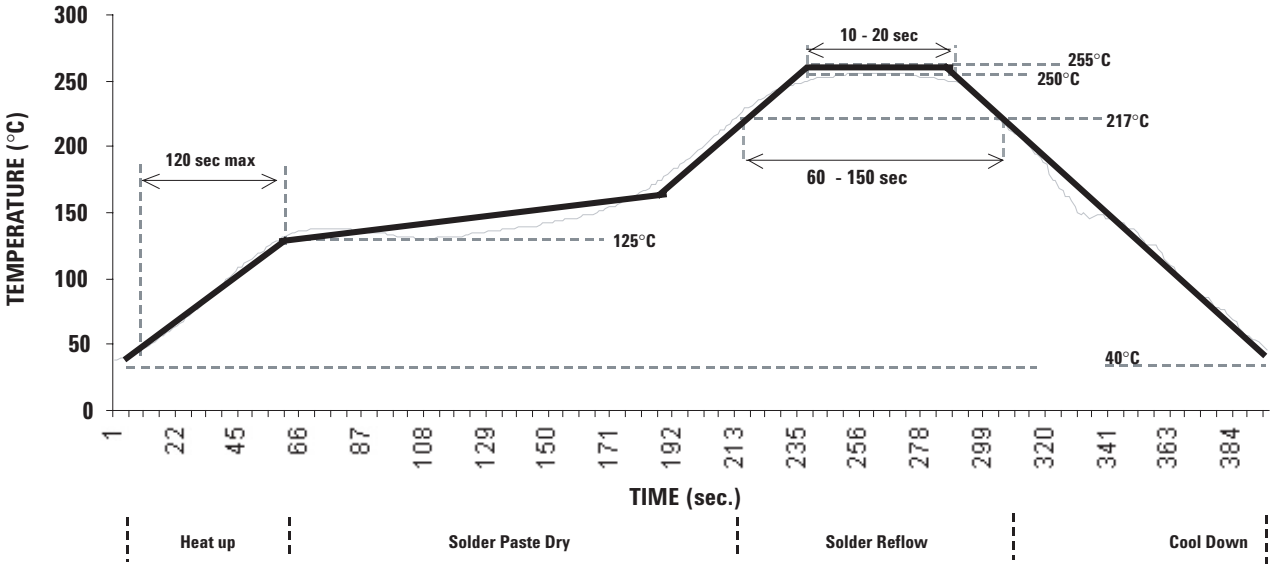



**Note:** The shaded areas are the leads for soldering.



**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 transparent compound is expected to turn 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. The details are:

36 LPI = Green package

75 LPI = Clear package

150LPI = Red package

180LPI = Amber package

## Ordering Information

AEDR-83 _ 0 Option _ _ _

**Number of Channel**

1 – One channel

0 – Two channels

**Packaging**

1 – Tape and Reel

**Lines per inch**

K – 75LPI

P – 150LPI [1]

Q - 180LPI [1]

V - 36LPI [2]

**Shipping Units**

0 – 1000 pcs

1 – 500 pcs

2 - 100 pcs

Note:
1. 150LPI and 180LPI resolutions are only available in two channel options
2. 36LPI resolution is only available in one channel option
3. Encoders are packed in tape quantities of 100, 500 or 1000 pieces.

## Summary of Product Availability

| Resolution Options | One Channel | Two Channel | Packing Quantity | | |
|---|---|---|---|---|---|
| | | | 1000 | 500 | 100 |
| 36LPI | ✓ | NA | ✓ | ✓ | ✓ |
| 75LPI | ✓ | ✓ | ✓ | ✓ | ✓ |
| 150LPI | NA | ✓ | ✓ | ✓ | ✓ |
| 180LPI | NA | ✓ | ✓ | ✓ | ✓ |

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

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