

## HEDR-5300 Series

Quick Assembly Small Diameter Two Channel  
Optical Encoder



## Data Sheet



### Description

The HEDR-5300 is a low cost, two channel optical incremental encoder. This encoder emphasizes small size, high reliability, and easy assembly.

Each encoder contains a LED source, an integrated circuit with detectors and output circuitry, and a reflective codewheel. The LED and detector are mounted in a single IC package with two lenses molded into the top. Light is focused onto a reflective code-wheel that rotates above the emitter and detector and reflects light back onto the detector IC. The outputs of the HEDR-5300 are two square waves in quadrature.

The HEDR-5300 encoder may be quickly and easily mounted to a motor.

Power and signal connections are made through a standard 4 pin Molex connector located on the top face of the cylindrical housing.

The HEDR-5300 module available has a resolution of 160 counts per revolution and mates with a 1.5 mm diameter motor shaft. Consult local Avago Technologies sales representatives for other resolutions and shaft sizes.

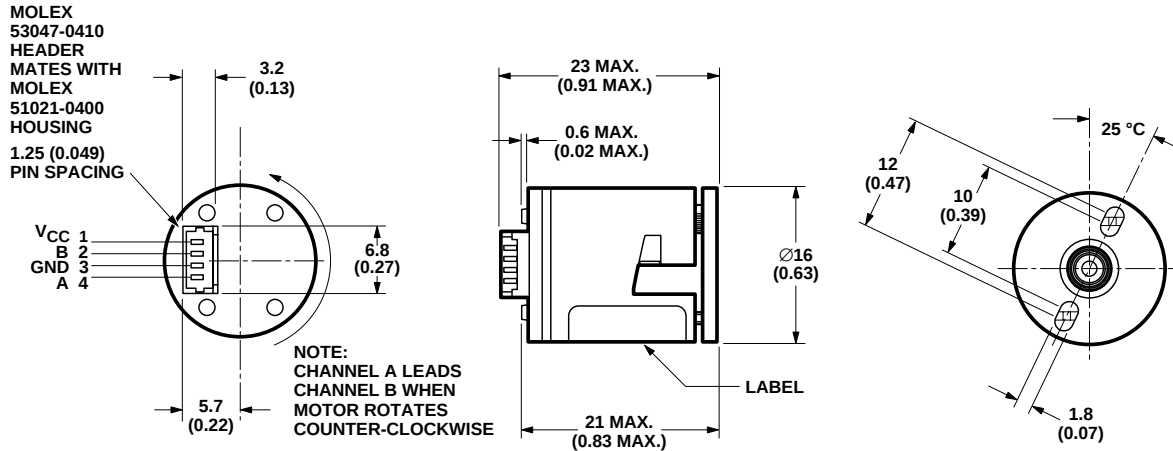
See the Avago web site at <http://www.Avago.com/view/motion> for the latest information about the HEDR-5300 and other Avago encoder products. Available information includes technical data, application notes, and reliability information.

### Features

- Extremely small size
- Low cost
- Quick and easy assembly
- Two channel quadrature output
- No signal adjustment required
- TTL compatible
- Single 5 V supply

*ESD WARNING: Normal handling precautions should be taken to avoid static discharge.*

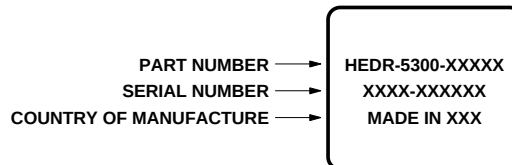
## Package Dimensions



## Applications

The HEDR-5300 provides pre-packaged motion detection in a small package and at a low cost, making it ideal for high volume applications. Typical applications include printers, plotters, tape drives, positioning tables, automatic handlers, and any other motion control system where space is constrained.

## Device Marking



**Note:** Avago Technologies encoders are not recommended for use in safety critical applications. Eg. ABS braking systems, power steering, life support systems and critical care medical equipment. Please contact sales representative if more clarification is needed.

## Theory of Operation

The HEDR-5300 translates rotary motion of a shaft into a two channel digital output.

As seen in the block diagram, the HEDR-5300 series has four key parts: a single light emitting diode (LED) light source, a

photodetector IC with a set of uniquely configured photodiodes, a pair of lenses, and a codewheel. The lens over the LED focuses light onto the codewheel. Light is either reflected or not reflected back to the lens over the photodetector IC.

As the codewheel rotates an alternating pattern of light and dark corresponding to the pattern of the codewheel falls upon the photodiodes. This light is used to produce internal signals A and  $\bar{A}$ , and B and  $\bar{B}$ . As part of this “push-pull” detector system, these signals are fed through comparators that are part of the signal processing circuitry to produce the final outputs for channels A and B.

## Definitions

**Count (N):** The number of bar and window pairs or counts per revolution (CPR) of the codewheel.

**One Cycle (C):** 360 electrical degrees ( $^{\circ}e$ ), 1 bar and window pair.

**Cycle Error ( $\Delta C$ ):** 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.

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

**Position Error ( $\Delta\Theta$ ):** The normalized angular difference between the actual shaft position and the position indicated by the encoder cycle count.

**Pulse Width (P):** The number of electrical degrees that an output is high during one cycle, nominally  $180^{\circ}e$  or  $1/2$  a cycle.

**Pulse Width Error ( $\Delta P$ ):** The deviation in electrical degrees of the pulse width from its ideal value of  $180^{\circ}e$ .

**State Width (S):** The number of electrical degrees between a transition in the output of channel A and the neighboring transition in the output of channel B. There are 4 states per cycle, each nominally  $90^{\circ}e$ .

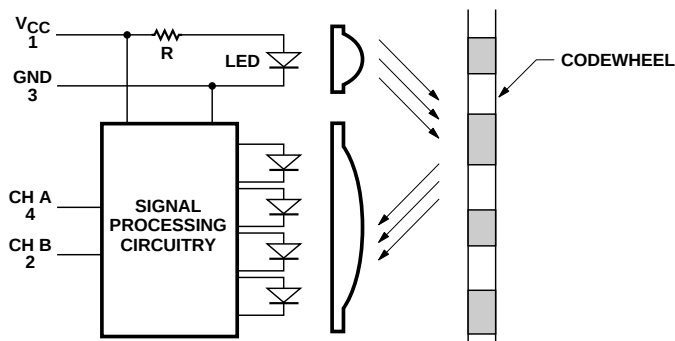
**State Width Error ( $\Delta S$ ):** The deviation in electrical degrees of each state width from its ideal value of  $90^{\circ}e$ .

**Phase ( $\phi$ ):** The number of electrical degrees between the center of the high state on channel A and the center of the high state on channel B. This value is nominally  $90^{\circ}e$  for quadrature output.

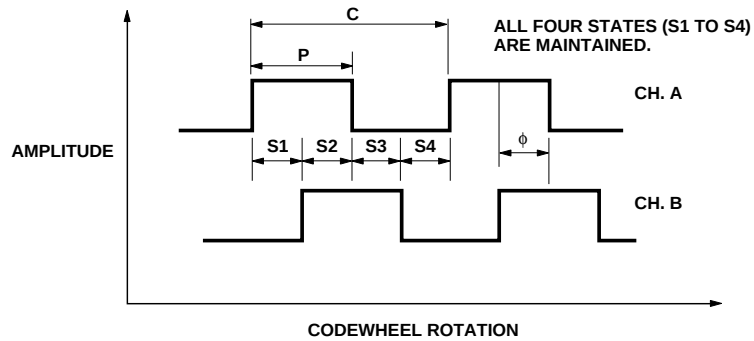
**Phase Error ( $\Delta\phi$ ):** The deviation in electrical degrees of the phase from its ideal value of  $90^{\circ}e$ .

**Direction of Rotation:** When the codewheel rotates in the counter-clockwise direction (as viewed from the encoder end of the motor), channel A will lead channel B. If the codewheel rotates in the clockwise direction, channel B will lead channel A.

## Block Diagram



## Output Waveforms



## Absolute Maximum Ratings

| Parameter                  | Symbol    | Min. | Typ. | Max.     | Units             | Notes |
|----------------------------|-----------|------|------|----------|-------------------|-------|
| Storage Temperature        | $T_S$     | -40  |      | 85       | °C                |       |
| Humidity Exposure          |           |      |      | 90%      | Relative Humidity | 60°C  |
| Supply Voltage             | $V_{CC}$  | -.5  |      | 7        | Volts             |       |
| Output Voltage             | $V_O$     | -.5  |      | $V_{CC}$ | Volts             |       |
| Output Current per Channel | $I_{OUT}$ | -1.0 |      | 5        | mA                |       |
| Vibration                  |           |      |      | 2000     | Hz                | 20g   |

## Recommended Operating Conditions

| Parameter                                                     | Symbol   | Min. | Typ. | Max.                         | Units        | Notes                  |
|---------------------------------------------------------------|----------|------|------|------------------------------|--------------|------------------------|
| Temperature                                                   | $T_A$    | -10  |      | 85                           | °C           |                        |
| Supply Voltage                                                | $V_{CC}$ | 4.5  | 5    | 5.5                          | Volts        |                        |
| Load Capacitance                                              | $C_L$    |      |      | 100                          | pF           | 2.7 k $\Omega$ Pull-UP |
| Count Frequency                                               |          |      |      | 15                           | kHz          | Velocity (rpm) x N/60  |
| Concentricity Tolerance between Motor Shaft and Mounting Boss |          |      |      | .25<br>(.010)                | mm<br>(inch) |                        |
| Shaft Eccentricity Plus Radial Play                           |          |      |      | $\pm .025$<br>( $\pm .001$ ) | mm<br>(inch) |                        |

## Encoding Characteristics

Encoding Characteristics over the Recommended Operating Conditions and Mounting Conditions.

| Parameter         | Symbol             | Typ. | Max. | Units       |
|-------------------|--------------------|------|------|-------------|
| Pulse Width Error | $\Delta P$         | 15   | 75   | $^{\circ}e$ |
| State Width Error | $\Delta S$         | 15   | 60   | $^{\circ}e$ |
| Phase Error       | $\Delta \emptyset$ | 8    | 60   | $^{\circ}e$ |
| Position Error    | $\Delta \Theta$    | 25   | 120  | arc min.    |
| Cycle Error       | $\Delta C$         | 10   | 75   | $^{\circ}e$ |

## Electrical Characteristics

Electrical Characteristics over the Recommended Operating Conditions. Typical Values at 25°C and  $V_{CC} = 5\text{ V}$ .

| Parameter                 | Symbol   | Min. | Typ. | Max. | Units | Notes                                              |
|---------------------------|----------|------|------|------|-------|----------------------------------------------------|
| Supply Current            | $I_{CC}$ |      | 18   |      | mA    |                                                    |
| High Level Output Voltage | $V_{OH}$ | 2.4  |      |      | Volts | $I_{OH} = -40\text{ }\mu\text{A min.}$             |
| Low Level Output Voltage  | $V_{OL}$ |      |      | 0.4  | Volts | $I_{OL} = 3.86\text{ mA}$                          |
| Rise Time                 | $t_r$    |      | 150  | 200  | ns    | $C_L = 25\text{ pF}$<br>$R_L = 2.7\text{ k}\Omega$ |
| Fall Time                 | $t_f$    |      | 50   | 60   | ns    |                                                    |

## Electrical Interface

To ensure reliable encoding performance, the HEDR-5300 encoder requires 2.7 k $\Omega$  ( $\pm 10\%$ ) pull-up resistors on output pins 2 and 4 (Channels A and B) as shown in Figure 1. These pull-up

resistors should be located as close to the encoder as possible (within 4 feet). Each of the encoder outputs can drive a single TTL load in this configuration.

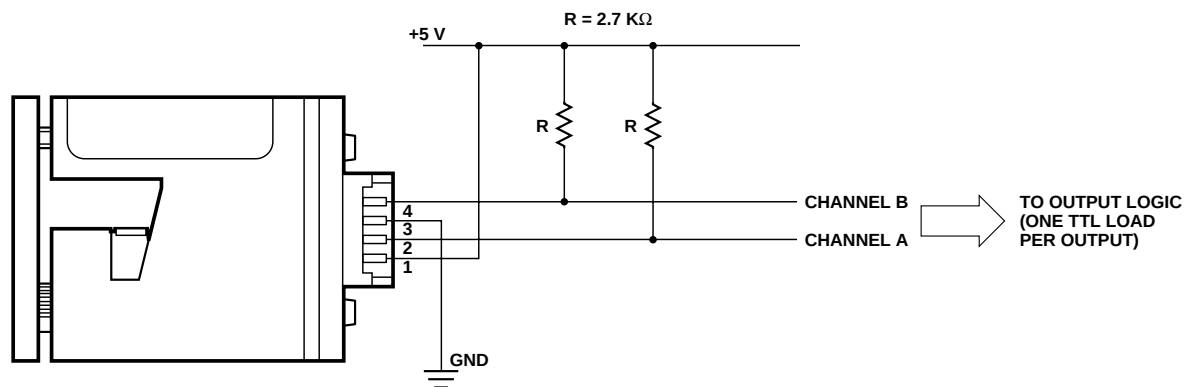


Figure 1. Pull-up Resistors on HEDR-5300 Encoder Outputs.

## Mechanical Characteristics

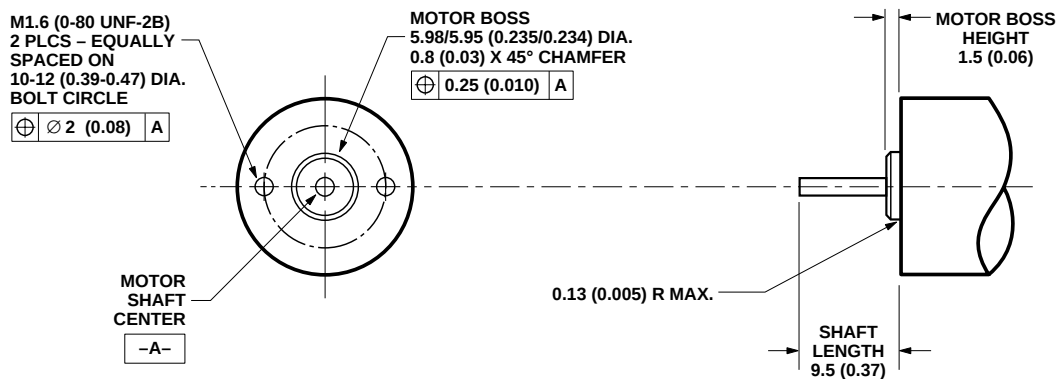
| Parameter                                   | Dimension            | Tolerance <sup>[1]</sup>           | Units        |
|---------------------------------------------|----------------------|------------------------------------|--------------|
| Shaft Diameter                              | 1.500<br>(0.0591)    | -0.005/-0.010<br>(-0.0002/-0.0004) | mm<br>(inch) |
| Required Shaft Length                       | 9.5<br>(0.37)        | $\pm 0.5$<br>( $\pm 0.02$ )        | mm<br>(inch) |
| Bolt Circle (2 Screws)                      | 10-12<br>(0.39-0.47) | $\pm 1$<br>( $\pm 0.04$ )          | mm<br>(inch) |
| Mounting Screw Size                         | M1.6 or (0-80)       |                                    |              |
| Mounting Boss Diameter <sup>[2]</sup>       | 6.00<br>(0.236)      | -0.02/-0.05<br>(-0.001/-0.002)     | mm<br>(inch) |
| Maximum Mounting Boss Height <sup>[2]</sup> | 1.5<br>(0.06)        |                                    | mm<br>(inch) |
| Mating Connector                            | MOLEX 51021-0400     |                                    |              |

### Notes:

1. These are tolerances required of the user.
2. The HEDR-5300 must be aligned with a mounting boss on the motor endplate as discussed in “Mounting Considerations” and “Mounting Instructions.”

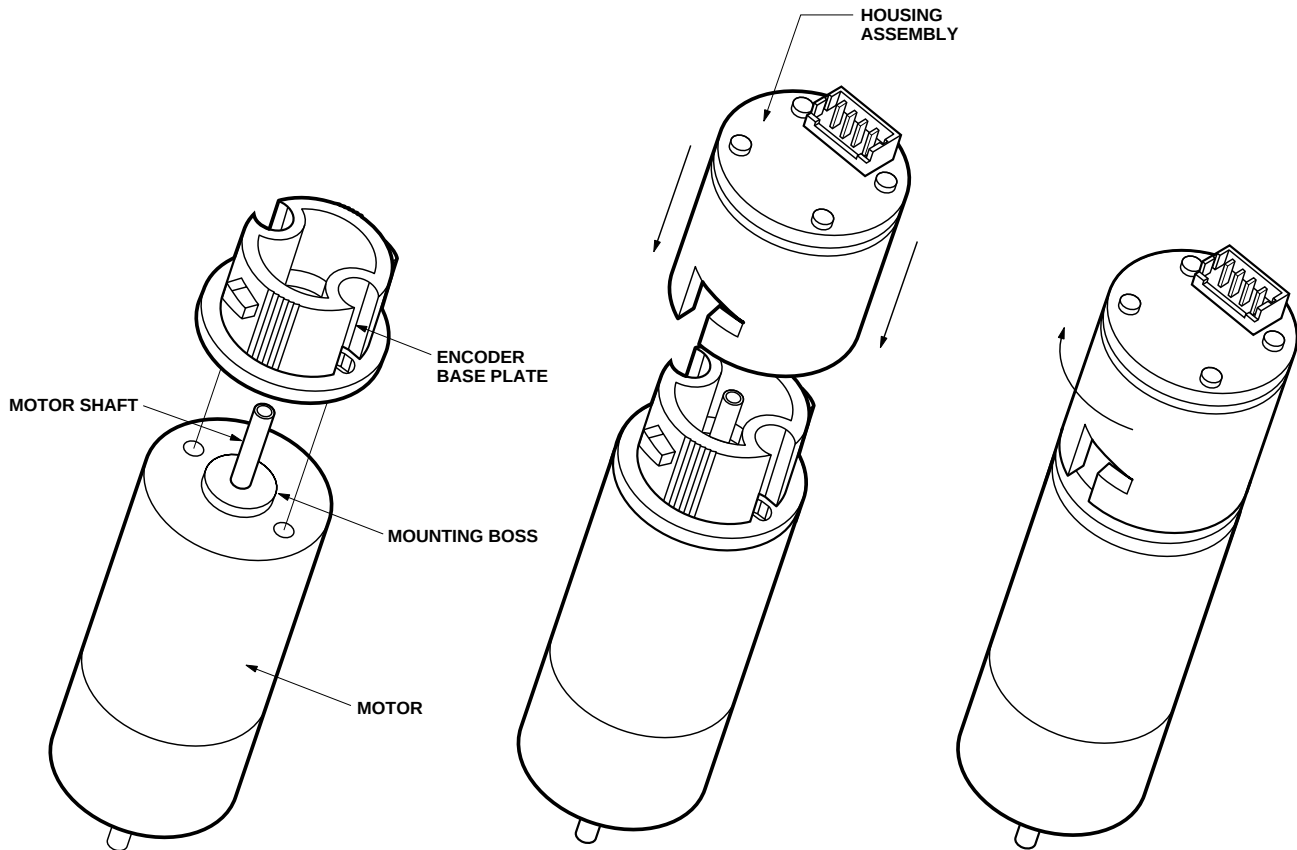
## Mounting Considerations

The HEDR-5300 encoder is designed to self align using a mounting boss. Figure 2 shows the configuration of the mounting boss along with the location of the mounting screw holes. Shaft diameter and tolerances are given in the Mechanical Characteristics section.



**Figure 2. Mounting Holes and Mounting Aids.**

## Mounting Instructions



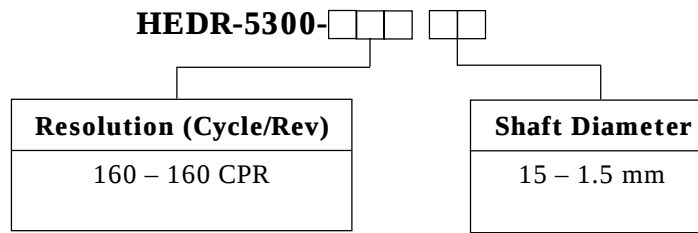
1. Fasten the encoder base plate on the motor using two M1.6 or 0-80 screws. The base plate should be located concentrically to the motor shaft by using a motor with a mounting boss having dimensions described in the Mounting Considerations section.

2. Slide the encoder housing assembly axially over the base plate, simultaneously pressing the hub inside of the housing onto the motor shaft. Continue to press the housing onto the base plate until the housing rim contacts the base plate, and it cannot be pushed on any farther.

3. Twist the housing clockwise on the base plate as far as possible. Cams on the base plate will raise the housing, and the housing will be locked in place. Once the housing has been locked in place, it should not be unlocked and reused.

4. Make necessary electrical connections using the connector on the top of the encoder.

## Ordering Information



For product information and a complete list of distributors, please go to our website: [www.avagotech.com](http://www.avagotech.com)

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