AEDR-8300 Encoder

General Description and Typical Applications

Application Note 5246

Introduction

Avago Technologies' AEDR-8300 Encoder series is miniature incremental encoder incorporating leadless surface mount capability. Its miniature dimensions of 3.96mm × 5.12mm × 1.63mm make it the smallest optical encoder in the market. With both the LED light source and the photo detector IC in a single package, the encoder employs reflective technology to sense rotary or linear motions. The small size and reflective technology allow the AEDR-8300 Encoder series to be used in a wide range of commercial applications, particularly where space and weight are primary concerns. The AEDR-8300 Encoder series offers 75 lines per inch (LPI) resolution with options of either single or two-channel outputs. In addition, other resolutions such as 36, 150, 180 and 212LPI will also be available. The encoder is specified for operation over -20°C to 85°C temperature range and operates from a single 5-volt supply and operates from a single 5-volt supply (212LPI option could also operate at 3.3-volt supply).

Basic Operating Principle

The sensor consists of an LED light source and a photodetector IC in a single SO-6 surface mount leadless package. The sensor is mounted onto a PC board with a current-limiting resistor in series with the LED. Figure 1 shows the optical arrangement of AEDR-8300 Encoder series used with either a reflective codewheel or codestrip. Since sensing rotary and linear motion is based on the same concept, the operating principle of AEDR-8300 Encoder will henceforth be exemplified using codewheel only. The lens over the LED focuses the light onto the window and bar of the codewheel. Likewise, the detector lens focuses the reflected images of the window and bar to the photodiodes.

As the codewheel rotates, an alternating pattern of light and shadow cast by the window and bar, respectively, falls upon the photodiodes. The detector IC converts this pattern into digital outputs representing the codewheel rotary motion. An important parameter is *resolution*, which is defined as the density of window/bar in a unit distance and is typically defined as lines per inch (LPI) or lines per mm (LPmm). Higher resolution means 'finer' control of the rotary motion.

The AEDR-8300 Encoder is designed such that both the LED and detector IC of the encoder should be placed parallel to the window/bar orientation. As such, the encoder is robust against radial play. This concept is illustrated in Figure 2.

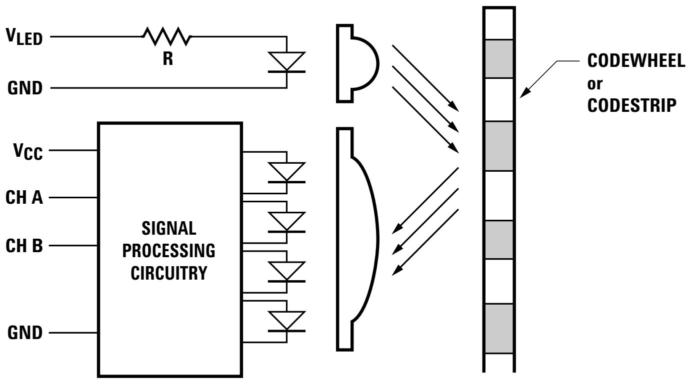


Figure 1. Optical arrangement of reflective encoder.

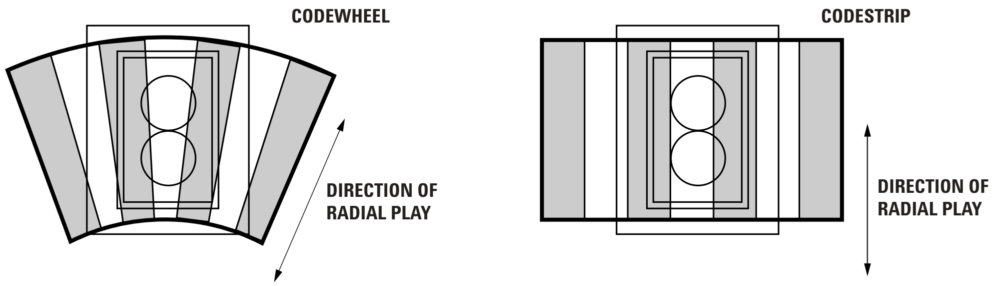


Figure 2. Optical alignment of emitter/detector with respect to window/bar, as viewed from top.

Using the Encoder Outputs

In the two channel outputs version, the outputs, namely Channel A and Channel B, are characterized by their quadrature relationship. As shown in Figure 3, there is a phase shift of 90 electrical degrees between the channels. In addition, the channels are also characterized by their 4 states, i.e. State 1 to State 4, each spanning a nominal 90 electrical degrees. Information about rotary motion, e.g. rotation speed and distance of rotation can be derived from the parameters of the output such as pulse period and number of pulses, whilst the direction of rotation is determined by the phase relationship between the two outputs. When the codewheel rotates in one direction, Channel A leads Channel B by 90 electrical degree. When the codewheel rotates in the other direction, Channel B leads Channel A by the same amount. This concept is illustrated in Figure 4.

Resolution higher than that of the codewheel is achievable via interpolation, where different levels of interpolation exist. Counting every rising edge of one channel (e.g. Channel A) is called 1X decoding, which basically equals the codewheel count per revolution (CPR). The codewheel resolution can be doubled by counting every rising and falling edge of one channel to further increase the resolution. This is called 2X decoding. When every transition of both Channel A and Channel B is utilized (or every logic state), 4X decoding is achievable.

The advantage of using encoder is that constant monitoring and feedback of motion data is made possible on a real-time basis. This allows the implementation of closed-loop control system or other design requirements aimed at preventing motion error in the system.

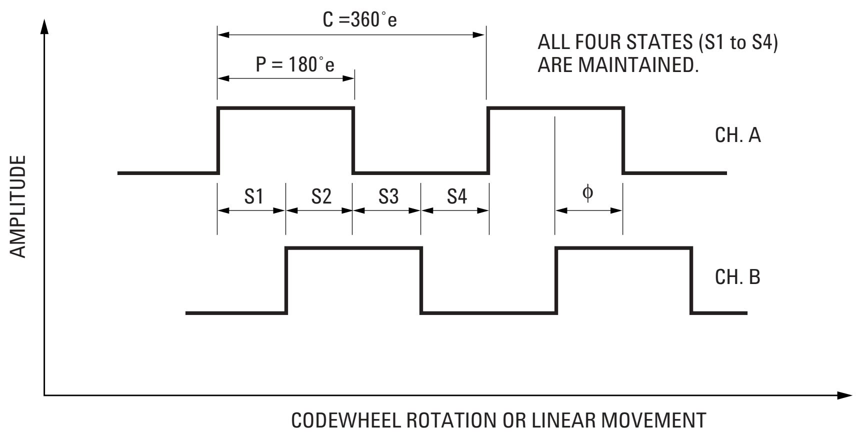


Figure 3. Quadrature characteristics of Channel A and B.

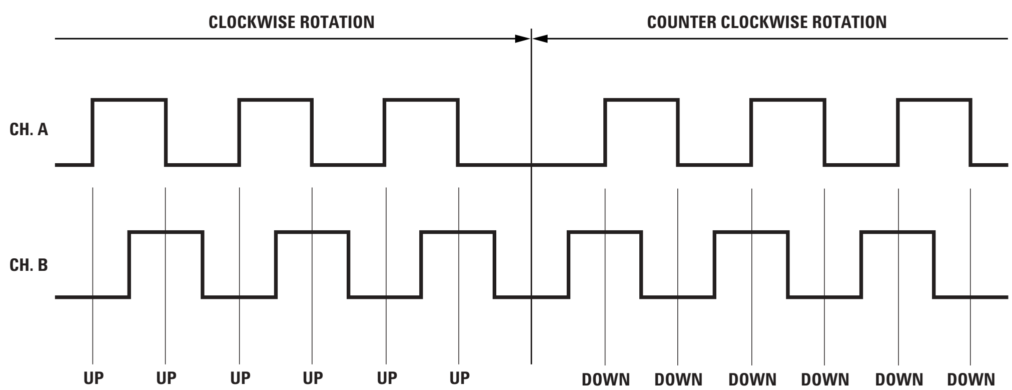


Figure 4. Phase lead and lag between Channel A and B indicates direction of rotation

Codewheels and Codestrips

The codewheel or codestrip surface must be both reflective and specular (mirror-like) so that the image of the pattern is reflected back onto the photo-diodes of the AEDR-8300 Encoder. Potential materials include metal and reflective film. One method to determine whether the codewheel or codestrip will work with the reflective optical encoder is using a Scatterometer.

Reflective surfaces with a specular reflectance of 60% or higher as measured by the device were compatible with the reflective encoder. The non-reflective areas should have a reflectance of less than 10%.

When testing for specular reflectance, testing should be done such that reflective surfaces are tested separately from non-reflective surfaces. Test the reflective surface by itself, then test the non-reflective surface. Do not perform tests on the patterned surface, as this will only give an average reflectance across the pattern.

Typical Applications

AEDR-8300 Encoder is used with codewheel or codestrip to sense rotary or linear motion, respectively. Figure 5 shows several ways to couple the encoder for motion control. In Figure 5(a), the encoder is integrated to a motor in order to detect motor rotation. Alternatively, the encoder is employed as a stand-alone unit to sense rotary and linear motion, as depicted in Figure 5(b) and (c), respectively.

The encoder easily fits various design requirements due to its miniature size. Hence, based on the above-mentioned mounting configurations, the encoder finds wide range of applications in different areas, some of which are shown in the following diagrams.

Consumer Electronics

- Digital camera - auto-zoom and auto-focus of camera lens.
- CD/DVD player - linear movement of laser head and rotation of disc.
- PC CD-ROM/DVD-ROM - linear movement of laser head and rotation of disc.
- Jukebox player - accurate disk selector and placement.
- Washing machine - motor.

Office Automation

- Inkjet printer -paper feed and print head.
- Laser printer - drum and roller.
- Scanner - linear movement of scan head.
- Tape drive -recording head, tape reel and roller.

Industrial Application

- Wafer Handling Machines - rotary and linear movement of the pick & place machinery arm.
- Vending Machines - to control card feeder movement and dispensing motor.
- ATM Machines - to control card feeder movement.
- Sewing Machines - provide accurate position of linear and rotary movement.
- Semi-automated wheelchairs - rotary movement of wheels

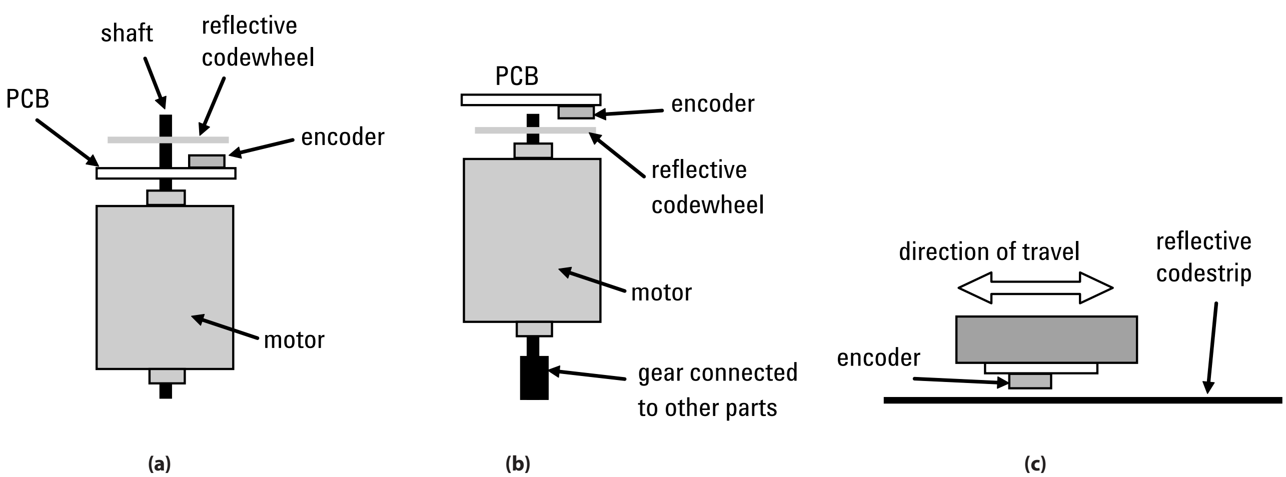
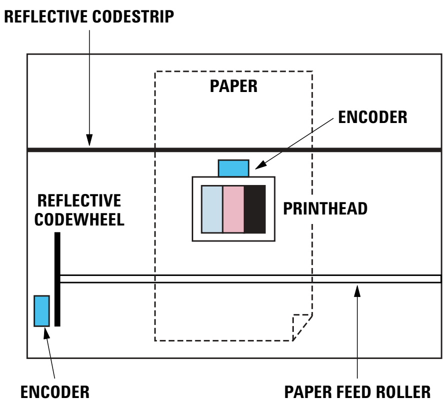
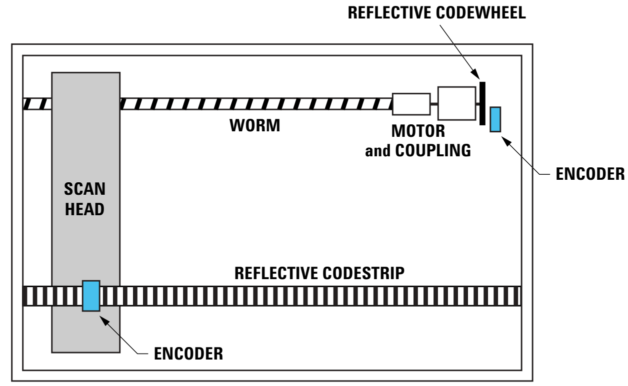


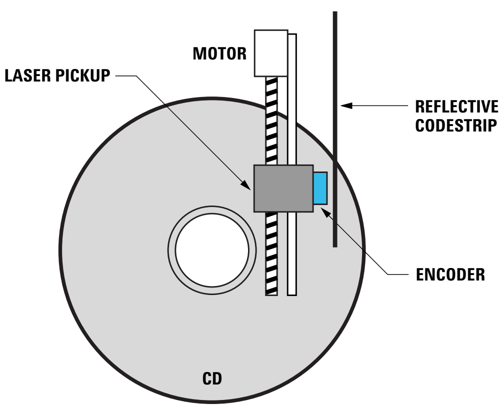
Figure 5. Different encoder mounting configurations to sense rotary and linear motion.



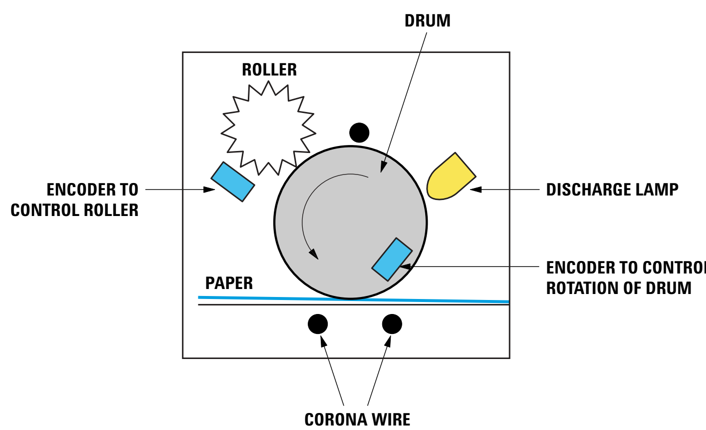
Inkjet Printer



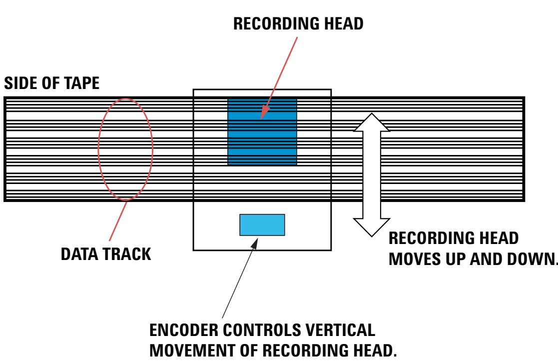
Scanner



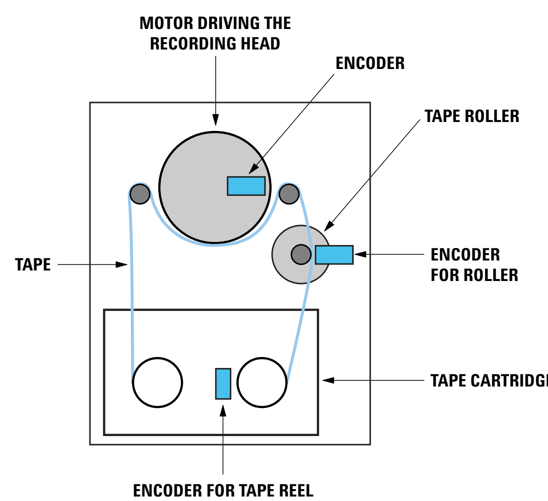
CD Player



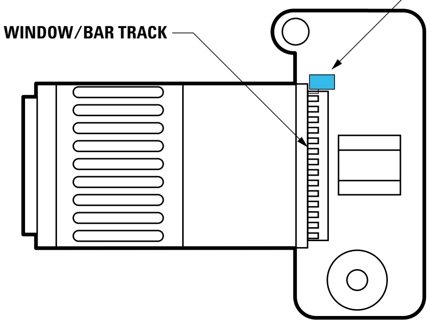
Laser Printer



Linear Type Tape Drive



Tape Drive



Camera

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