Reflective Encoder

Increasing Demand for Low-Profile, High-Performance Encoders for Autonomous Guided Vehicles and Autonomous Mobile Robots

Abstract

In the mobile robotics world, autonomous guided vehicle (AGV) and autonomous mobile robots (AMR) technologies have evolved over the years. Today, there is increasing demand for high-performance feedback systems.

Multiple servo motors are needed to control robotic arms and drive mobility. A low-profile encoder is required to decrease the total size of the motor system.

Introduction

The Broadcom® portfolio of high-performance reflective encoders includes both the AR25 absolute encoders and the AEDR-98xx/99xx series incremental encoders.

The AR25 reflective encoder is an all-in-one encoder capable of providing absolute 15 bits to 25 bits and incremental outputs up to 2^{20} cycles per revolution (CPR). The AR25 offers various protocols, selectable by the user. Among the protocols available are Encoder Serial Link (ESL) or RS485 half-duplex protocol, SSI, BiSS-C, and SPI 4-wire. ESL and RS485 enable the multiple servo motor to communicate with the similar servo motor driver system that is suitable for AGV and robotic applications.

The AR25 encoder supports through-hole application up to 30 mm in diameter and the Broadcom proprietary battery-less Energy Harvesting Multi-Turn (EHMT) solution. Alternatively, other multiturn solutions like gear based and battery back-up are also supported via a dedicated MT interface port.

The AEDR-98xx/AEDR-99xx series encoders are high-resolution incremental encoders with state-of-the-art, built-in interpolators, which helps to decrease the overall cost of the system. The AEDR-98xxA series is automotive grade in compliance with IATF-16949 and qualified to Grade 1 AEC-Q100 automotive reliability up to 125°C.

Applications

- AGV/AMR
- Brushless DC motor and stepper motor
- Resolver and potentiometer replacement
- Industrial automation and robotics
- Industrial sewing machine and textiles equipment
- Light detection and range (LiDAR)
- Vending machines
- Liquid level monitoring

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Encoder Selection Principle

Using 5W 1H Principle to Determine Encoder Selection

Who to choose:

Broadcom is a global infrastructure technology leader built on 50 years of innovation, collaboration, and engineering excellence. With roots based in the rich technical heritage of AT&T/Bell Labs, Lucent, and Hewlett-Packard/Agilent, Broadcom focuses on technologies that connect our world. Through the combination of industry leaders Broadcom, LSI, Broadcom Corporation, Brocade, CA Technologies, and Symantec, the company has the size, scope, and engineering talent to lead the industry into the future.

Why choose Broadcom:

Broadcom is one of the leading encoder makers globally and has an extensive portfolio of encoder-related intellectual property, ranging from optical to magnetic encoders.

Where to find Broadcom encoder products:

Easy access to Broadcom encoder product details can be found at https://www.broadcom.com/products/motion-control-encoders/.

What types of encoder to choose:

Broadcom offers a wide range of motion control optical encoders and magnetic encoders:
- Optical Absolute encoder
- Optical Incremental encoder
- Optical Absolute with Incremental Output encoder
- Magnetic Absolute with Incremental Output encoder

When to choose:

Choose Broadcom encoders for new projects or on-going manufacturing products that required a better performance, safety requirements, consistent supply chain, and cost saving.
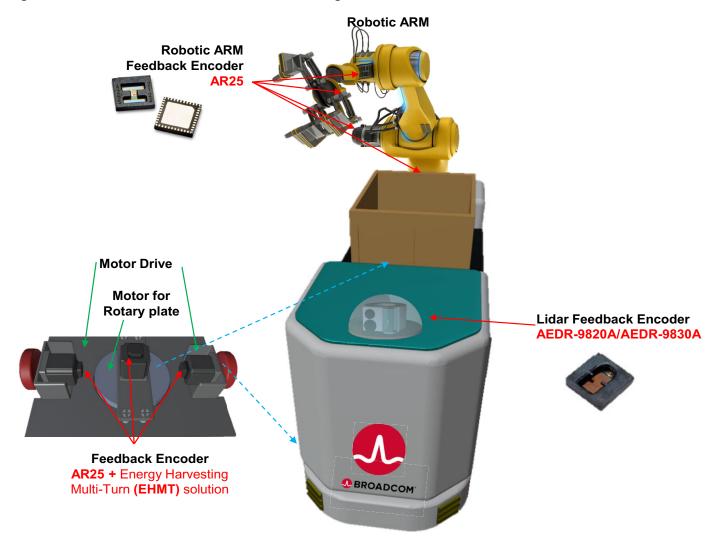
How to choose:

Examine your design requirements, and contact your Broadcom sales representative for recommendations.

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Autonomous Guided Vehicle/Mobile Robot

AGVs and AMRs are portable robots that follow along marked long lines or wires on the floor, or use radio waves, vision cameras, magnets, or lasers for navigation. They are often used in industrial applications to transport heavy materials around a large industrial building, such as a factory or warehouse. In the latest technology, an AGV/AMR is designed with LiDAR for collision avoidance, enhancing the safety for a next-level workplace.

Figure 1: Autonomous Guided Vehicle/Mobile Robot Integrated with Broadcom Encoders

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LiDAR Application Encoder Selection Guide

LiDAR applications provide speed control and live position feedback. The AEDR-9xxx series is suitable for this application because the initial position is not critical.

Automotive Grade

The AEDR-98xxA series encoders are automotive grade in compliance with IATF-16949 and are qualified to Grade 1 AEC-Q100 automotive reliability up to 125°C, a drop-in solution for an automotive/industrial part.

Cost and Temperature

The AEDR-98xx series provide a better cost and higher temperature rating up to 125°C with an automotive part number. The AEDR-9830 has a higher LPI compared to the AEDR-9820, meaning that with the same size, it will provide higher signal feedback frequency on the same movement speed.

Latency

The AEDR-98xx series has the lowest raw latency because it is a pure analog device while the AEDR-99xx series is a mix analog and digital devices. For applications that require live response and faster power-up timing, the AEDR-98xx series is the best choice. The shortest power-up timing for the AEDR-99xx series is ~110 ms.

Performance

For long-range LiDAR applications, the AEDR-99xx series is the preferred choice because it can generate higher resolution with a high interpolation factor.

Summary

Broadcom provides a full solution for the autonomous guided vehicle or autonomous mobile robot feedback system. The AR25 encoder enables you to reduce number of controllers because it allows up to seven peripherals with the ESL or RS485 protocol. The AR25 integrates with Energy Harvesting Multi-Turn (EHMT), allowing the AGV/AMR to be maintenance-free in comparison to battery back-up or gear-based encoders. The AEDR-98xxA series encoders are automotive grade in compliance with IATF-16949 and are qualified to Grade 1 AEC-Q100 automotive reliability up to 125°C, a drop-in solution for an automotive/industrial part.

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Product Summary

Parameter	AEDR-9820A	AEDR-9830A	Incremental Encoder AEDR-9920	AEDR-9930E2/E2L	AEDR-9940	Absolute Encoder AR25
Voltage	3.3V to 5.0V (±10%)					
Code Wheel Type	Dual Track		Single Track	Dual Track		
Base Cycle Per Revolution (CPR)	256	625	256	512	256	400 to 1024
LED Type	Infrared (840 nm ~ 860 nm)				Red ~660 nm	Infrared (840 nm ~ 860 nm)
Automotive Grade Qualified	√	√	X	X	X	X
Temperature Rating	−40°C to 125°C		−40°C to 115°C			−40°C to 125°C
Base Frequency (Hz)	200k				250k	128k
Maximum Frequency	2 MHz			4 MHz		
Line per Inch (LPI)	225	318	225	397	198.4375	NA
Resolution (Absolute)	NA					15 bits to 25 bits
Accuracy	NA					Reference Calibration: ±30 arcsec Speed Auto-Cal: ±120 arcsec Raw Accuracy: ±350 arcsec
Spatial Tolerance (Base CPR)	±200 µm		±500 µm	±300 µm (512 CPR) ±500 µm (1000 CPR and above)	128CPR ± 200 µm (Auto Cal) ≥512CPR ± 200 µm (No Cal) ≥625CPR ± 350 µm (Auto Cal)	±500 µm
Calibration Required	X	X	X	√	√	√
Maximum Digital Output (AB)	CPRs × 16x Interpolation		CPRs × 512x Interpolation	CPRs × 1024x Interpolation	CPRs × 1024x Interpolation	1x to 2^{20}CPRs