

Magnetic Encoders

Enhancing Robotics Applications with Broadcom[®] Magnetic Encoders

Abstract

The Broadcom magnetic encoder IC is a powerful, high-performance solution that addresses the precision, reliability, and versatility required in modern robotic applications. The Broadcom AEAT-9955/9966 series of magnetic encoders combine high accuracy, low power consumption and a compact design, making them ideal for the dynamic motion-control systems in robotics. This white paper highlights the key benefits and advantages of the AEAT-9955/9966 magnetic encoders in the context of robotic applications, showing how their features can elevate system performance while ensuring robustness and long-term reliability.

Introduction

The AEAT-9955/9966 series of programmable angular magnetic encoders is designed for high-resolution position feedback in a wide range of industrial and commercial applications. Their non-contact magnetic sensing technology ensures longevity and robustness in environments subject to shock, vibration, and temperature extremes. With a digital output and compact design, the encoders are an ideal choice for high-precision applications such as robotics, where performance, space constraints, and reliability are paramount.

The encoders are engineered to deliver precise feedback in real time, offering a resolution of up to 18 bits and a configurable output for incremental or absolute position sensing. This flexibility, combined with Broadcom advanced signal processing technology, allows these magnetic encoders to meet the demanding needs of robotic systems, whether they are used in industrial automation or the research of autonomous vehicles.

Applications

- Brushless DC motors and stepper motors
- Resolver and potentiometer replacement
- Industrial automation and robotics
- Industrial sewing machines and textile equipment
- Light detection and ranging (LiDAR)

Using the 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, VMware, 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 global encoder makers and has an extensive portfolio of encoder-related intellectual property ranging from optical encoders to magnetic encoders.

Where to find Broadcom encoder products:

Access Broadcom encoder product details at: www.broadcom.com/products/motion-control-encoders/.

What types of encoder to choose:

- Optical absolute encoders
- Optical incremental encoders
- Optical absolute encoders with incremental output
- Magnetic absolute encoders with incremental output

When to choose:

Choose encoders for new projects or the ongoing manufacture of products that require better performance, safety requirements, a consistent supply chain, and cost savings.

How to choose:

Know the design requirements and consult with a Broadcom sales representative for recommendations.

Key Benefits and Advantages for Robotic Applications

High Precision and Resolution

In robotic systems, precise position feedback is crucial for controlling motion accurately. The AEAT-9955/9966 series offers high-resolution position feedback of up to 18 bits (262,144 positions per revolution), ensuring that even small movements are detected and translated into real-time system control. With a high accuracy of $\pm 0.05^\circ$ (nominal), both the high-resolution and high-accuracy criteria of AEAT-9955/9966 series is particularly critical in applications like robotic arms, which require fine adjustments to maintain accuracy during manipulation tasks. The programmable resolution offers selectable absolute resolutions, which allow customers to choose the resolution that best suits their application needs, providing higher flexibility and precision.

Non-Contact Sensing for Reliability with Multiple Magnet Placements

Robots often operate in environments that expose sensors to dust, dirt, moisture, and other contaminants. The AEAT-9955/9966 series leverages non-contact magnetic sensing technology that eliminates the wear and tear associated with traditional optical encoders. This robust feature ensures that the encoders maintain high performance without degradation over time, even in harsh conditions, reducing downtime and maintenance costs.

The AEAT-9955/9966 series supports multiple magnet placement options, including on-axis (shaft end) and off-axis (side shaft, radial and axial). Accommodating various magnet placements provides flexibility in system design. Robotic applications often require unique configurations depending on the available space, the type of motion, or the specific mechanical setup of the robot. With multiple magnet placement options, designers can choose the best configuration for the application without being constrained by a single placement requirement.

Compact Form Factor and Easy Integration

The AEAT-9955/9966 series is designed to be compact and easy to integrate into robotic systems. A small form factor allows for flexible mounting in space-constrained robotic actuators, joints, and motors. Additionally, a digital output makes integration with motion controllers, microcontrollers, and PLCs straightforward, streamlining development cycles and reducing time to market for robotic solutions.

Wide Temperature Range for Harsh Environments

Robots are deployed in various industrial settings, including those that experience extreme temperatures. Whether in a factory, outdoors, or in an automotive environment, maintaining accurate position feedback is essential. The AEAT-9955/9966 series operates across a wide temperature range of -40°C to $+125^\circ\text{C}$, ensuring reliable performance in environments subject to temperature fluctuations.

Low Power Consumption

For mobile or battery-powered robotic systems, minimizing power consumption is a critical concern. The AEAT-9955/9966 series is designed with low power consumption in mind, helping extend the operational life of robotic systems, especially in autonomous robots that require long operational durations between charging cycles. This efficient design helps reduce the overall energy footprint of robotic platforms.

Versatile Output Configuration

The AEAT-9955/9966 series supports incremental and absolute position outputs, offering versatility in different robotic applications. Whether a robot requires absolute position feedback (ideal for restarting after power loss) or incremental feedback (for continuous tracking in motion), the AEAT-9955/9966 series can be configured to meet the needs of various systems. This flexibility enables the encoder to be used across a wide array of robotic tasks, from precise motion control in arms to angular sensing in wheels.

Robust Performance in Harsh Environments

In high-impact environments like manufacturing and outdoor robotics, shock and vibration can degrade traditional encoders. The AEAT-9955/9966 series' robust design ensures consistent performance, reducing maintenance and increasing uptime. Whether it's an industrial robotic arm in manufacturing or a mobile robot navigating outdoor terrain, the AEAT-9955/9966 series ensures reliable, consistent feedback even in the most challenging conditions.

Improved System Performance and Control






With the AEAT-9955/9966, robotic systems benefit from precise, real-time position feedback, which is essential for accurate motion control, path tracking, and speed regulation. The encoder's high accuracy directly impacts the robot's ability to execute precise movements, enabling more intricate tasks such as assembly, welding, and surgical procedures.

Applications in Robotic Systems

The AEAT-9955/9966 series of magnetic encoders is well-suited for a variety of robotic applications, including but not limited to the following:

- **Industrial Robots:** High-precision encoders like the AEAT-9955/9966 series enable robotic arms and manipulators to perform tasks such as assembly, packaging, and welding with remarkable accuracy and speed.
- **Autonomous Mobile Robots (AMRs):** In navigation and mapping systems, the AEAT-9955/9966 series provides reliable angular feedback for wheel rotation, ensuring that AMRs maintain proper positioning and orientation during autonomous operation.
- **Collaborative Robots (Cobots):** With a compact design, easy integration, and precise feedback, the AEAT-9955/9966 series helps cobots perform tasks in close proximity to humans while ensuring safety, accuracy, and fluid motion.
- **Medical Robotics:** Robotic surgery, prosthetics, and other medical applications benefit from the AEAT-9955/9966 series' precision, reliability, and non-contact sensing, which are crucial for performing delicate, high-stakes tasks.

Product Summary

Parameter	AEAT-8811	AEAT-9922	AEAT-9933	AEAT-9955	AEAT-9966	AEAT-9988	
Product Image							
Voltage	3.3V to 5V ($\pm 10\%$)					4.5V to 5V ($\pm 10\%$)	
Magnet Track Type	Single Track					Dual Track	
Package Size	5 mm \times 5 mm	4 mm \times 4 mm		5 mm \times 5 mm		8.2 mm \times 5 mm	
Automotive Ready ^a	X			√			
Temperature Rating	-40°C to 125°C						
ABI Output	√						
UVW Output	√						
ABI Differential Output				X			√
UVW Differential Output				X			√
PWM Output	√						
RS485 Protocol				X			√
BiSSC Protocol				X			√
SSI2 Protocol	X				√		
SSI3 Protocol	√						
SPI3 Protocol	√						
SSI4 Protocol				X			√
Standby Mode	X			√			
Resolution (Selectable)	10/12/14/16b	10b to 18b	10b to 14b	10b to 18b		16b to 23b	
Accuracy	± 0.35	± 0.10			± 0.015		
Latency (typical)	80 ns						
Spatial Tolerance	± 250 nm						
Calibration Required	√						
Maximum Digital Output (AB) Interpolation (Selectable)	32 to 4096	1 to 10,000	1 to 1024	1 to 20,000		1 to 65,536	
Maximum Digital Output (UVW) Pole-Pair (Selectable)	1 to 8	1 to 32					
Status Pin	X			√			

a. Manufacturing/Quality Management System compliant to automotive IATF-16949. AEAT-9955, AEAT-9966 (production status) qualified to Grade 1 AEC-Q100 automotive reliability 125°C.

Conclusion

The Broadcom AEAT-9955/9966 series of magnetic encoders is an exceptional solution for robotic applications, offering the precision, durability, and flexibility necessary to meet the demands of modern automation systems. High resolution, non-contact sensing, compact size, and low power consumption make these an ideal choice for industrial, mobile, and medical robots alike. By incorporating the AEAT-9955/9966 encoders, robotic systems can achieve superior motion control, increased uptime, and long-term reliability, ensuring that robots can perform with the accuracy and efficiency required for even the most complex tasks.

As robotics continues to advance, solutions like the AEAT-9955/9966 magnetic encoders will play a critical role in enabling robots to operate with greater precision, autonomy, and versatility. The Broadcom commitment to quality and innovation ensures that the AEAT-9955/9966 series remains a leading choice for robotic applications across industries.

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