

Encoder Selection for Motion Control Systems

A Practical Guide to Choosing the Right Feedback Technology

Abstract

In industrial automation, robotics, and precision manufacturing, motion controls rely on accurate feedback to execute exact movements. The encoder serves as the critical link in this process, converting mechanical motion into the electrical signals that a controller uses to manage position, velocity, and direction.

Choosing the right encoder is a foundational engineering decision. The specific technology selected directly influences how a machine behaves at startup, the smoothness of its motion, its long-term durability, and the required maintenance schedule. Engineers must weigh different sensing approaches such as optical, magnetic, capacitive, and inductive while also making basic architectural choices such as whether the system needs absolute or incremental tracking.

This white paper provides a practical framework for navigating encoder selection. It breaks down the differences between measurement architectures, explores the real-world trade-offs of various sensing technologies, and offers grounded advice for matching encoder capabilities to the actual needs of the desired applications.

Why Encoder Selection Matters in Motion Control

A typical closed-loop motion system consists of a controller, a motor drive, a motor, and a feedback sensor. Although a great deal of engineering effort usually goes into sizing the motor and tuning the control algorithm, the system's performance ceiling is ultimately dictated by the quality of the feedback sensor. If an encoder provides noisy, inaccurate, or delayed data, the controller will struggle to correct the motion, regardless of its processing power.

One critical factor in this loop is latency. Latency is the slight delay between a physical movement occurring and the controller receiving the updated position data. In highly dynamic applications, low latency is essential. It allows for tighter tuning and more responsive control. On the other hand, excessive latency can force the controller to rely on outdated information, potentially causing overshoot, instability, or vibration.

Beyond pure dynamic performance, real-world reliability depends heavily on how the encoder interacts with its environment and how well it is installed. An encoder must be able to maintain signal integrity despite any hazards such as dust, oil, mechanical shock, electrical noise, or electromagnetic field interference. Therefore, selecting an encoder is not just about choosing specifications from a data sheet, but also about ensuring that the technology can survive the daily realities of the application.

Industrial and Automotive Functional Safety in Encoder Selection

In some encoder applications, performance alone is not enough. As part of the selection process, functional safety and automotive quality requirements might also need to be considered, especially when the encoder is used in safety-related motion, steering, braking, traction, or other high-reliability systems.

Functional safety is defined as the system's ability to maintain safe operation despite internal failures or external disturbances. This means that if a part fails, the system is built to go into a safe state instead of letting the problem turn into a real accident, keeping people safe.

Industrial and Automotive Safety Standard

Industrial and automotive applications follow different functional safety standards based on their operating environments.

Industrial Safety Standards:

- **IEC 61508:** General functional safety standard for electrical, electronic, and programmable systems, defining Safety Integrity Levels (SIL1 to SIL3).
- **ISO 13849-1:** Standard for safety-related parts of machine control systems, defining Performance Levels (PLa to PLe) and Categories (Cat 1 to 4).
- **IEC 61800-5-2:** Functional safety requirements and safety functions for adjustable-speed electrical power drive systems.
- **IEC 61800-5-3:** Functional, electrical, mechanical, and environmental safety requirements for encoders used in related drive systems.
- **IEC 62061:** Functional safety standard for electrical and electronic control systems used in machinery.

Automotive Safety Standard:

- **ISO 26262:** Functional safety standard for electrical and electronic systems in road vehicles. Defines Automotive Safety Integrity Levels (ASIL A to ASIL D).

Why Safety Encoders Differ from Standard Encoders

A standard encoder has only one sensing channel. If it fails, the controller cannot tell and just keeps using the last value, even if it is wrong. Safety encoders overcome this limitation by a specific fundamental architecture:

- **Dual-channel redundancy:** Safety encoders use two independent sensing channels combined within a single housing, or two internal readings from the same sensing element, that are continuously checked against each other.
- **Safe mechanical connection:** Mechanical interfaces such as keyways, clamping hubs, tapered shafts, or press-fit couplings reduce the risk of shaft slippage that could cause errors in position feedback.
- **Continuous self-diagnostics:** Safety encoders continuously monitor internal functions including the optical signal quality, LED condition, supply voltage, memory, and processing circuits. Detected faults are reported immediately to prevent invalid feedback.

Common Safety Functions Enabled by a Safety Encoder

SLS Safety-Limited Speed Keeps the motor within a controlled speed range during operation	SDI Safe Direction Confirms that the motor turns only in the permitted direction of rotation	SLI Safe Limited Increment Limits motion to a small, defined increment for safe jogging or setup	SOS Safe Operating Stop Holds the motor at a known standstill while still under power
SS1/SS2 Safe Stop 1 & 2 Brings the motor to a controlled stop and then removes or holds torque	SSM Safe Speed Monitoring Reports the actual speed for external monitoring, without enforcing a limit itself	SLP Safety-Limited Position Keeps the axis inside a defined position range, such as near a hard stop	SCA Safe Cam Issues a safe signal when the shaft passes a defined position window

All functions rely on continuous, validated position, speed, and direction feedback from the safety encoder.

Communication Protocols

Safety communication protocols ensure the integrity of position data exchanged between the encoder, drive, and safety controller.

Application Type	Common Safety Protocols
Point to Point (Direct Drive)	BiSS Safety, Hiperface DSL Safety, EnDAT Safety, ESL Safety
Fieldbus (Networked)	PROFIsafe (PROFINET), FSoE (EtherCAT), CANopen Safety

Choosing the Right Measurement Architecture

Before selecting a sensor technology, it is important to first understand what kind of position feedback and what application environment that the machine actually needs. The right measurement architecture depends on the system's movement, the level of precision required, safe operation during startup and use, and the conditions of the application's environment.

Incremental vs. Absolute Encoders

Incremental encoders measure relative movement. As the shaft rotates or the readhead moves, the encoder generates electrical pulses. The controller counts these pulses to calculate how far the system has moved from a starting reference point. Incremental encoders are commonly used because they are simple, reliable, and cost-effective. They work well in applications such as conveyor systems, pump motors, and general speed control, especially when the machine can safely perform a homing routine each time it powers up.

Absolute encoders, on the other hand, provide a unique digital value for every position. This allows the system to know its exact location immediately after power is restored, without needing to move to a reference point first. Absolute encoders are preferred in applications where homing would be unsafe, impractical, or time-consuming. Common examples include robotic arms, multi-axis machine tools, and servo systems that require immediate position awareness before motion begins.

Single-Turn (ST) vs. Multi-Turn (MT)

Single-turn encoders measure position within one full 360-degree rotation. Once the shaft completes a full revolution, the position value resets back to zero. Single-turn encoders are commonly used in systems that have a limited range of motion, such as steering systems, rotary knobs, or positioning joints that move only within a fixed range.

Multi-turn encoders work similarly but also keep count of how many full revolutions the shaft has made, not just the position within a single rotation. This difference makes them a better fit for applications where rotary motion drives long linear travel, such as ballscrew drives, elevators, belt actuators, or gantry systems. Multi-turn encoders are also used in higher-resolution applications where more precise position tracking is needed across multiple revolutions. Another advantage is that even after a power loss, the encoder can still report the correct position of the moving stage or carriage.

Rotary vs. Linear Measurement

Rotary encoders are mounted directly to a rotating shaft to measure angular movement. In many machines, this rotary information is mathematically converted by the controller into linear position. This approach is widely used because it is practical and cost-efficient. However, the position feedback reflects movement only at the motor shaft, which means it cannot fully compensate for mechanical errors such as backlash, belt stretch, or drivetrain looseness occurring further along the motion system.

Linear encoders measure movement directly at the point of motion using a readhead and a fixed linear scale. Because the feedback is taken directly from the moving axis, mechanical transmission errors are largely eliminated. Linear encoders are commonly selected for high-precision applications where accuracy at the working point is critical, such as semiconductor equipment, precision assembly systems, micro/nano stages, and coordinate-measuring machines.

Encoder Technology Overview

Each technology uses different physical principles to detect motion, carrying unique trade-offs.

Optical Encoders

Optical encoders typically use an LED light source, a patterned scale or code wheel, and a photodetector array. As the target moves, the light pattern changes and is converted into position data. Optical technology is frequently chosen when high resolution, high accuracy, and very fast response time are required. Because the measurement relies on light rather than magnetism, the optical sensing is naturally immune to magnetic interference. The primary trade-off is environmental sensitivity: unsealed optical sensors can be disrupted by dust, condensation, or oil, meaning that they require appropriate packaging (dust-proof/liquid-proof) and clean installation practices.

Magnetic Encoders

Magnetic encoders track the rotation of a magnetized target (often a small disc or ring) using a sensor chip. Because magnetic fields easily pass through nonmagnetic contaminants such as dirt, water, and oil, these encoders are generally very robust in harsh, dirty environments. Their trade-offs still matter: performance can depend on magnet quality, air-gap control, and mechanical alignment, and some designs may need attention to stray magnetic fields if they are installed near motors, brakes, or high-current conductors. Within the magnetic category, there are several distinct sensing approaches:

- **Hall effect:** A mature, cost-effective, and widely used magnetic sensing method. While very reliable, Hall-based designs typically offer lower sensitivity and resolution compared to newer magnetoresistive approaches.
- **AMR (anisotropic magnetoresistance):** AMR provides higher sensitivity than basic Hall sensing. It is often selected when a system requires better angle accuracy and more stable performance across changing temperatures.
- **GMR (giant magnetoresistance):** GMR can provide even higher sensitivity than AMR and can often support larger physical air gaps between the sensor and the magnet. System designers must still be careful to shield GMR sensors from strong external stray magnetic fields.
- **TMR (tunnel magnetoresistance):** TMR is one of the highest-sensitivity magnetic sensing technologies in current use. It can provide strong signal quality and low power consumption, helping some magnetic encoder designs reach significantly higher performance than traditional Hall-based solutions.

Capacitive Encoders

Capacitive encoders operate by detecting changes in electrical capacitance as a patterned rotor moves between a transmitter and a receiver board. These encoders are typically very compact, draw minimal power, and are immune to magnetic fields. They offer a practical middle ground: they are generally more tolerant of dry dust than unsealed optical encoders, though they can sometimes be affected by severe condensation or conductive fluids if not properly protected.

Inductive Encoders

Inductive encoders use printed circuit board coils to induce currents in a passive, metallic target. As the target moves, it alters the electromagnetic coupling between the coils, which is then decoded into position information. Inductive technology is exceptionally rugged and handles heavy vibration, shock, dust, and magnetic interference very well. Because the moving rotor usually contains no active electronics, these encoders are highly durable. Trade-offs can include a larger physical footprint and the need for relatively precise parallel mounting during integration.

Technology Comparison

The following table provides a general comparison of the four primary encoder technologies.

Parameter	Optical	Magnetic	Capacitive	Inductive
Strengths	High accuracy potential, very high resolution, low response delay	High tolerance to dirt, oil, and shock Very compact sizes available	Low power consumption, magnetic field immunity	Extreme environmental tolerance
Limitations	Sensitive to dust and condensation unless properly sealed	Can be susceptible to strong external stray magnetic fields	Can be sensitive to conductive fluids or humidity	Often requires a larger footprint, mounting alignment can be critical
Resolution	High	Medium to high (especially with TMR)	Medium to high	Medium to high
Accuracy	Excellent in well-designed systems	Good	Good	Very good
Latency/Response	Very low (direct light detection)	Medium (requires signal processing)	Medium	Medium to high (due to coil processing)
Contamination Resistance	Low	Excellent against dust and oil	Good against dust, fair against liquids	Excellent

Multi-Turn Absolute Methods Comparison

If the design requires an absolute multi-turn encoder, the method that the encoder uses to remember the turn count during a power loss is a very important detail. Common approaches include battery-backed electronic memory, physical mechanical gears, and patented Wiegand energy-harvesting technology.

Parameter	Battery-Backed Electronic	Mechanical Gear-Based	Patented Wiegand Energy-Harvesting (EHMT)
Power-Loss Position Retention	Uses an active battery to keep the memory and sensor powered	Turn count is physically stored in the position of mechanical gears	Generates its own power pulse from motion to record turns to nonvolatile memory
Maintenance	High (Batteries must be monitored and eventually replaced)	None (Purely mechanical)	None (Solid-state, wear-free)
Lifespan	Limited by battery shelf/operational life (3–5 years)	Limited by gear teeth and bearing wear	Exceptionally long (No moving parts/batteries)
Size and Profile	Small encoder (Requires physical space for a battery replacement)	Large and heavy (Needs physical space for gear trains)	Highly compact and lightweight
Cold-Start Readiness	Excellent (Position data is immediately available)	Excellent (Position data is immediately available)	Excellent (Position is retained in nonvolatile memory)

Why Optical Remains the Preferred Choice for High-Performance Systems

In demanding applications, optical technology is often specified for several practical reasons:

- **Lower Latency:** Light-based detection provides extremely fast signal updates. Compared to technologies that require heavier signal demodulation or filtering, optical systems often support minimal response delays, allowing for tighter control-loop tuning and smoother motor performance.
- **Higher Accuracy Potential:** Optical code wheels and scales can be printed with microscopic precision. In a well-designed system, this allows optical encoders to natively support excellent accuracy and repeatability.
- **Reduced Magnetic Interference Concerns:** Because the fundamental sensing principle relies on photons rather than magnetic fields, the measurement mechanism is not disrupted by nearby motors, magnetic brakes, or high-current cables. Good overall electrical shielding is still necessary, but the core sensor is magnetically immune.
- **Programmable Resolution:** Many modern optical encoder designs feature advanced interpolators that allow the output resolution to be configured via software or hardware pin selection. This feature gives machine builders the flexibility to standardize on a single encoder model across different machine variants.
- **Calibration and Alignment Support:** Historically, optical encoders required painstaking manual alignment. Today, many optical platforms include software tools that help calibrate the sensor and electronically compensate for minor mechanical misalignments during installation, saving time and preserving accuracy.

It is important to note, however, that utilizing these optical benefits in an industrial setting requires proper environmental protection. If the sensing area is exposed to severe dust or fluids, the light path can be blocked, making protective housings and seals a necessary part of the system design.

Application Guidance

Matching the encoder to the realities of the application is a cornerstone of good system design. Here is how different technologies typically map to common use cases.

Robotics

Robotics is a diverse field, and optical, magnetic, and inductive encoders can all be suitable depending on the specific priorities of the encoder's joints. Optical encoders are often used on primary axes where high precision and low latency are needed to ensure smooth, accurate motion at the tool center point. Magnetic encoders (especially compact AMR or TMR designs) are frequently favored in tight joints or end effectors where space is limited and absolute multi-turn capabilities are helpful. Inductive encoders can be an excellent fit for heavy-duty robots exposed to welding environments or heavy vibration, thanks to their rugged hollow-shaft designs.

Factory Automation

In clean manufacturing settings, such as semiconductor or electronics assembly equipment, optical encoders are often chosen because these machines demand very high precision and fast feedback. In contrast, harsher settings like metal machining or woodworking often rely on magnetic or inductive encoders, which can more easily tolerate ambient dust, coolant spray, and routine vibration.

Automated Guided Vehicles (AGVs) and Autonomous Mobile Robots (AMRs)

Mobile robots rely on encoders for wheel odometry and steering angle feedback. These vehicles frequently deal with floor shocks, warehouse dust, tight packaging constraints, and cost pressures. Magnetic encoders are commonly selected for these drivetrains because they are compact, durable, and practical for volume manufacturing.

Linear Actuation and Positioning

High-speed, high-accuracy linear stages, such as those found in precision pick-and-place machines, often rely on linear optical encoders. By measuring position directly along the axis of movement, these encoders avoid mechanical backlash and provide the fast, direct feedback that the controller needs to settle quickly into position.

Light Detection and Ranging (LiDAR) and Precision Scanning

Precision scanning platforms require highly smooth rotational feedback and very low signal jitter to generate clean, accurate spatial data. Optical encoders are frequently chosen for these applications because they typically offer the low latency, high resolution, and strong repeatability required to prevent distortion in the scan.

General Industrial Motion

In broad industrial applications like conveyors, packaging lines, and process pumps, the best encoder is usually the one that meets the requirement without unnecessary overspecification. Incremental optical encoders are often a practical fit for cost-effective speed control in moderately protected areas. Absolute magnetic encoders work well when the system needs to restart without homing and contamination is a concern. In this segment, the smartest approach is to balance uptime, maintenance needs, and installed cost rather than chasing the highest possible specification.

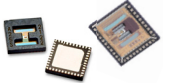
What Broadcom Motion Control Products Offer

To help users select the right encoder based on applications needs, a comparison of key solutions follows. Start by identifying what the system needs in terms of positioning, environment, and cost. These solutions can be grouped into five main categories:

- **Absolute transmissive and absolute reflective encoders:** Used in applications where the system must know its position as soon as power is applied, without performing a homing sequence. Commonly found in servo motors and precision motor control systems. Reflective encoders are well suited for compact/miniature designs, whereas transmissive encoders are often preferred for higher resolution applications.
- **Incremental reflective encoders:** A good fit for compact and cost-sensitive designs. Common in robotics, factory automation, and smaller motor systems where relative position tracking is sufficient.
- **Absolute magnetic encoder ICs:** Designed for harsh environments with dust, oil, or vibration. Suitable for industrial systems, AGVs, and applications where optical solutions might not be reliable.
- **Energy-harvesting multi-turn (EHMT) magnetic and EHMT optical encoders:** Designed for applications that need absolute multi-turn position feedback without battery maintenance. The Broadcom energy-harvesting multi-turn technology uses a patented Wiegand energy-harvesting approach to retain the turn count during power loss, helping deliver compact, batteryless multi-turn solutions. EHMT optical encoders are well suited for systems that also need high accuracy, fast response, and compact integration, whereas EHMT magnetic encoders are a strong fit for applications that combine multi-turn absolute feedback with better tolerance to dust, oil, vibration, and other harsh operating conditions.
- **Incremental transmissive encoders:** A good fit for applications that need reliable incremental feedback using transmissive optical sensing. Commonly used in motor feedback, industrial automation, and motion control systems where relative position, speed, and direction information are sufficient. They are usually preferred over reflective solutions when signal quality, resolution, and stable performance are the priority.

As safety requirements continue to evolve in industrial and automotive applications, encoder selection extends beyond motion performance alone. Functional safety should be considered alongside performance, accuracy, and environmental requirements when selecting an encoder. Choosing an encoder with the appropriate safety features and reliability helps support safe and dependable operation in both industrial and automotive systems.

Absolute Transmissive and Absolute Reflective Encoders: Quick Selection Guide

Parameter	AR18	AR25/AR25DP	AR55	QS35	AR49	AS20-M42M	AS33-M42M	AS38-H39E
Product Image								
Type	Optical Reflective	Optical Reflective	Optical Reflective	Optical Transmissive	Optical Reflective	Magnetic	Magnetic	Optical Transmissive
Operating Voltage	3.3V and 5V	3.3V and 5V	3.3V and 5V	5V	5V	5V	5V or 7V–12V	5V
Operating Temperature	–40°C to 115°C	–40°C to 125°C	–40°C to 125°C	–40°C to 105°C/115°C	–40°C to 115°C	–40°C to 115°C	–40°C to 115°C	–20°C to 105°C
Package Size in mm (W × L × H) or (OD × H)	9.1 × 10.9 × 1.5	6 × 6 × 1.05 6 × 6 × 0.7 (DP)	6 × 6 × 0.7	35 × 21	35 × 17.5	20 × 22.5	33 × 20	38 × 40
Applications	■ Robotic automation ■ Factory automation and drones ■ Miniature motors, servo motors, linear actuators ■ Medical devices	■ Robotic automation ■ Factory automation and drones ■ Miniature motors, servo motors, and linear actuators ■ Through-shaft motors, gear motors, and speed reducers ■ Medical devices	■ Housed encoder makers ■ Linear motor applications ■ Robotic automation ■ Hollow-shaft servo motors ■ Factory automation ■ Medical devices	■ Servo motors ■ SCARA or multi-axis robots ■ Factory automation ■ Linear positioning systems ■ CNC machine tools ■ Medical devices	■ AC/DC servo motor feedback ■ SCARA or multi-axis robots ■ Robotics ■ CNC machine tools ■ Factory automation ■ Medical devices	■ Miniature servo motors and drives ■ Linear actuators ■ Robotics ■ Automated guided vehicles (AGVs) ■ Factory automation ■ Medical devices	■ Robotic automation ■ Small motors and linear actuators ■ Drones and automated guided vehicles (AGVs) ■ DC and AC servo motors	■ Robotics ■ Factory automation ■ Linear positioning systems ■ CNC machine tools ■ Medical devices

Incremental Reflective Encoders: Quick Selection Guide

Parameter	AEDR-9820/9820A	AEDR-9830/9830A/9830DP	AEDR-9920	AEDR-9930E/9930E2/ 9930E2L/9930EA	AEDR-9940/9940ER/9940A
Product Image					
Type	Optical Reflective				
Operating Voltage	3.3V or 5V				
Operating Temperature	-40°C to 115°C -40°C to 125°C (AEDR-9820A)	-40°C to 115°C -40°C to 125°C (AEDR-9830A)	-40°C to 115°C	-40°C to 115°C -40°C to 125°C (AEDR-9930EA)	-40°C to 115°C -40°C to 125°C (AEDR-9940A)
Package Size in mm (W × L × H) or (OD × H)	4 × 4			5 × 5	4 × 4
Applications	■ Closed-loop stepper motors ■ Small motors ■ Industrial printers ■ Robotics ■ Card readers ■ Pan-tilt-zoom cameras ■ Portable medical equipment ■ Optometric equipment ■ Linear stages	■ Closed-loop stepper motors ■ Small motors ■ Industrial printers ■ Robotics ■ Card readers ■ Pan-tilt-zoom cameras ■ Portable medical equipment ■ Optometric equipment ■ Linear stages	■ Closed-loop stepper motors ■ Small motors ■ Industrial printers ■ Robotics ■ Card readers ■ Pan-tilt-zoom cameras ■ Portable medical equipment ■ Optometric equipment ■ Linear stages ■ LiDAR	■ Closed-loop stepper motors ■ Small motors ■ Industrial printers ■ Robotics ■ Card readers ■ Pan-tilt-zoom cameras ■ Portable medical equipment ■ Optometric equipment ■ Linear stages ■ LiDAR	■ Closed-loop stepper motors ■ Small motors ■ Industrial printers ■ Robotics ■ Card readers ■ Pan-tilt-zoom cameras ■ Portable medical equipment ■ Optometric equipment ■ Linear stages ■ LiDAR

Absolute Magnetic Encoder ICs: Quick Selection Guide

Parameter	AEAT-9922/9933	AEAT-9955	AEAT-9966	AEAT-9988M
Product Image				
Type	Magnetic Absolute			
Operating Voltage	3.0V to 5.5V			
Operating Temperature	–40°C to 125°C			
Package Size in mm (W × L × H) or (OD × H)	4 × 4	5 × 5	5 × 5	4.2 × 5
Applications	■ Brushless DC motors and stepper motors ■ Resolver and potentiometer replacement ■ Industrial automation and robotics ■ Industrial sewing machines and textile equipment	■ Brushless DC motors and stepper motors ■ Resolver and potentiometer replacement ■ Industrial automation and robotics ■ Industrial sewing machines and textile equipment ■ LiDAR	■ Brushless DC motors and stepper motors ■ Resolver and potentiometer replacement ■ Industrial automation and robotics ■ Industrial sewing machines and textile equipment ■ LiDAR	■ Industrial automation ■ Hollow-shaft servo motors ■ SCARA or multi-axis robots

EHMT Magnetic and EHMT Optical Encoders: Quick Selection Guide

Parameter	AR49	AS20-M42M	AS33-M42M	AS38-H39E	QP39
Product Image					
Type	EHMT Optical	EHMT Magnetic	EHMT Magnetic	EHMT Optical	Multi-Turn Only
Operating Voltage	5V	5V	5V or 7V–12V	5V	5V
Operating Temperature	–40°C to 115°C	–40°C to 115°C	–40°C to 115°C	–20°C to 105°C	–40°C to 115°C
Package Size in mm (W × L × H) or (OD × H)	35 × 17.5	20 × 22.5	33 × 20	38 × 40	15 × 15 25 × 15
Applications	■ AC/DC servo motor feedback ■ SCARA or multi-axis robots ■ Medical devices ■ Robotics ■ CNC machine tools ■ Factory automation	■ Miniature servo motors and drives ■ Linear actuators ■ Medical devices ■ Robotics ■ Automated guided vehicles (AGVs) ■ Factory automation	■ Small motors and linear actuators ■ Robotic automation ■ Drones and automated guided vehicles (AGVs) ■ DC and AC servo motors	■ Robotics ■ Factory automation ■ Linear positioning systems ■ CNC machine tools ■ Medical devices	■ Robotics ■ Machine tools ■ Semiconductor machinery ■ Factory and industrial automation

Conclusion

Selecting the right encoder requires understanding the trade-offs between different technologies and application environments. There is no single solution that fits all applications. When making a decision, engineers must consider resolution, environment, mechanical design, and cost. Different applications prioritize different factors, which leads to different encoder choices.

By understanding these trade-offs and using the right technology for the right application, engineers can design motion control systems that are both accurate and reliable. Broadcom provides encoder solutions that support key application needs, helping engineers implement effective motion sensing in a wide range of systems.

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