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Multiturn Absolute Kit Encoders without Batteries or Gears: A Cost-Efficient Approach for Rotary Position Measurement in Servomotors, Stepper Motors and Rotating Equipment

POSITAL is offering a new set of component-level products that are designed to be built into servomotors or other types of equipment when real-time measurement of rotary position (angular displacement) or rotational speed is required. Based on POSITAL's well-proven magnetic rotary encoder technology, these new products provide manufacturers with a flexible and cost-effective way of incorporating rugged and precise rotation measurement capabilities directly into their devices.

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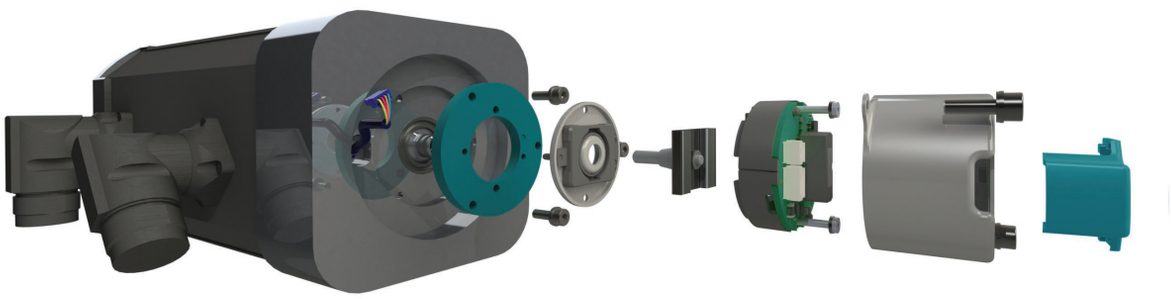


Closed-loop motion control systems, whether they are designed for production machinery, manufacturing robots, lifts and cranes, materials handling equipment or medical diagnostic systems, make use of feedback measurements to ensure the precise positioning of mechanical components. Stand-alone position sensors, such as rotary encoders, can do a good job of providing this feedback. In many cases though, it is technically and economically preferable to collect position measurement directly from a drive motor or other rotating component (such as a valve stem or cable drum) without the cost and complexity of extra measurement devices. POSITAL, a manufacturer of high-quality position and motion sensors has introduced new products designed to provide the manufacturers of servomotorsm stepper motors and rotating machinery with rugged, accurate and cost-effective tools for integrating position measurement functionality into their products. This new technology avoids many of the limitations and shortcomings of traditional measurement devices, such as the electromagnetic resolvers and optical encoders used in many servomotors. The new POSITAL rotation measurement tools share technology with the company's highly successful IXARC magnetic rotary encoders. Now however, POSITAL is offering a kit version that "unbundles" the core multi-turn absolute components used in these encoders.

The Secret is in the Software: High-Performance Signal Processing

The electronic components of these kits are contained in a compact electronics package mounted on a single 36mm diameter printed circuit board (PCB). This package includes four Hall-effect sensor elements and a powerful 32-bit microprocessor integrated into a single ASIC. The Hall-effect sensors respond to a rotating magnetic field created by permanent magnets mounted on the motor's shaft, producing analog output signals. Advanced signal processing software running on the microprocessor filters the input data and computes the rotational position of the shaft. This system delivers measurements that are accurate to within ☞✏✍ 0.1° with excellent dynamic response. The maximum electrical resolution of these devices is 17 bits for absolute measurements.

The microprocessor-centered approach allows for complete control over signal processing parameters, Application-specific parameters (e.g. range, resolution, rotational direction or zero position) can be modified by software updates, without the need for costly changes to hardware.

The electronics components are packaged together in a compact module that is 36mm in diameter and 24.2 mm deep.

Maintenance-Free Multi-Turn Measurements

For absolute measurement systems, POSITAL's new encoder kit components are available with multi-turn capabilities. This means that the devices can count the number of complete shaft revolutions, as well as reporting the precise angular position of the shaft within a single rotation. Multi-turn measurements are especially useful for monitoring the position of mechanical components

when a motor drives a screw shaft, cable drum or reduction gear system. Shaft position systems based on incremental encoder technologies depend on a PLC or control computer to keep track of the rotation count. A problem here is that if the shaft rotates while control system power is unavailable, the rotation counter may fail to record the change. The whole system might have to be “re-homed” by returning the entire machine to a known reference state and re-starting the rotation count. To avoid this problem, some encoder manufacturers have included a backup battery to keep the rotation counter energized when system power is not available. The rotation counter on the new POSITAL device is, however, self-powered and doesn’t rely on external power sources or backup batteries. Each time the shaft completes a rotation, a pulse of electricity created by a Wiegand wire system provides the energy needed to activate the rotation counter circuitry. This technology, which has been used successfully in POSITAL magnetic encoders since 2005, ensures that the rotation count is always accurate. The multi-turn counter has a 32-bit register, for a measurement range of over a million rotations.

A very important feature of the Wiegand wire energy harvesting system is that by eliminating the need for the backup batteries, it reduces downtime of production lines, maintenance costs and the need to dispose of spent batteries (which can contain hazardous materials).

Ruggedness and Reliability

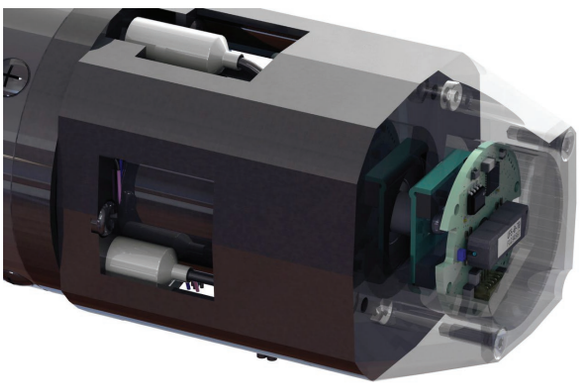
The magnetic rotary position measurement technologies used in POSITAL’s new product are based on solid state electronic devices that have no moving parts (aside from permanent magnets mounted on the rotating shaft). With no physical contact between rotating and static components, there is no component wear. The overall package can also tolerate high levels of shock and vibration. Compared to the optical encoder technologies that are sometimes used for rotation monitoring systems, magnetic technologies are relatively unaffected by dust, moisture or oil vapour. The operating temperature range is -40 to 105 degrees Celsius.

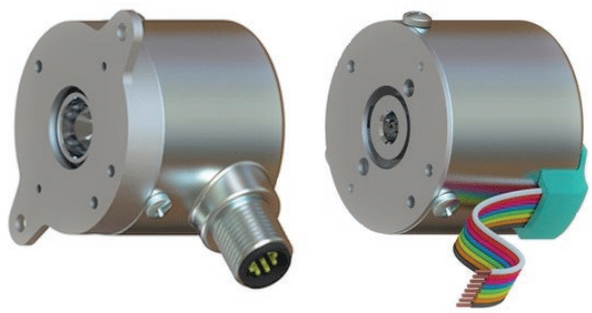
For servo motor applications with magnetic brakes, a special magnetic shield has been developed to isolate the magnetic pickups of the measurement system from the strong magnetic fields. With this in place, the accuracy of the rotary position measurements will not be significantly affected by application of a magnetic motor brake.

Onboard diagnostics help ensure reliable operations over the full life of the device.

Simplified Installation

These devices are highly compact and easy to build into motor casings or other devices. A built-in self-calibration capability can compensate for small sensor-to-shaft alignment errors, so that positional tolerances are compatible with normal motor assembly standards. This eliminates the need for special precision assembly techniques. And, because the magnetic measurement technology is less sensitive for dust or moisture than optical technologies, there is no need for clean-room standards on the production line.





POSITAL offers versions of the basic kit design that are designed to fit into the same installation footprint as popular incremental kit encoders such as US Digital or Broadcom (Avago). These enable manufacturers to upgrade their products to provide absolute position feedback (rather than incremental) without having to change physical designs or assembly procedures.

Communications Interfaces

The electronic interfaces for these encoders are based on non-proprietary BiSS C, BiSS Line or SSI communications standards. Unlike vendor-specific interfaces, these open-source standards are supported by many manufacturers of sensors and motion controllers, freeing users from a “locked-in” relationship with a single supplier. Standard 4-wire RS485 connections are supported, so that motor manufacturers who adopt POSITAL kit encoders can often make use of existing connectors and cables. IP core software is available for FPGAs widely used in motion controllers. This reduces the development effort required to make use of BiSS communications technologies.

The BiSS Line standards support a single cable approach to motor connections, with power and control wires combined in a single cable. Point-to-point or multi-slave network configurations are supported, simplifying wiring layouts in complex machines.

Compared to resolvers, the digital communications interface for POSITAL’s kit encoders helps reduce costs by eliminating the need for A/D conversion.

Economic Positioning

In terms of price and performance, the new POSITAL kit encoder components lie between optical systems and magnetic resolvers. Optical encoders still dominate the ultra-precision market, offering 20-bit or better resolution. However these are expensive and require meticulous assembly techniques. Multi-turn optical encoders typically use a set of secondary code wheels arranged in a gear train. This approach has been used successfully, but is mechanically complex and can be susceptible to damage from high shock or vibration loadings. At the other end of the market, magnetic resolvers are rugged and inexpensive, but not very accurate. Resolvers produce analog outputs and required the extra expense of A/D converters for digital control systems. Moreover, resolvers do not have multi-turn measurement ranges.

POSITAL’s new kit encoders offer 17 bit electrical resolution within each revolution and a reliable, maintenance-free multi-turn capability with a potential range of over a million revolutions. Based around digital microprocessor technology, they are capable of being adapted to a range of digital communications protocols and interfaces. The compact solid-state package is designed to be easily built into a wide variety of servomotors and machinery.

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	Resolver	POSITAL Kit Encoder	Optical Encoder Technology
Single-turn Measurement Technology	Magnetic induction between rotating and static coils	Hall-effect sensors measure field from rotating magnet	Rotating code disk and opto-electric sensor array
Multiturn Measurement Technology	N/A	Self-powered electronic counter	Typically geared code wheels or electronic counter with backup battery
Cost	$	$$	$$$
Size		36 mm ø., 24.2 mm deep	Typically >36mm ø
	No	Yes	Yes
Accuracy	Low: +/- 0.2°	Higher: +/- 0.1°	Highest: +/- 0.02°
Ruggedness	High	High	Code disks and sensors can be damaged by shock and vibration
Sensitivity to Moisture, Dust	Low	Low	High. Requires clear optical path across code disk
Output Signal	Analog – A/D conversion required for digital controllers	Digital	Digital
Maintenance Free	Yes	Yes	Cheaper versions include a backup battery that needs to be replaced every 2 years