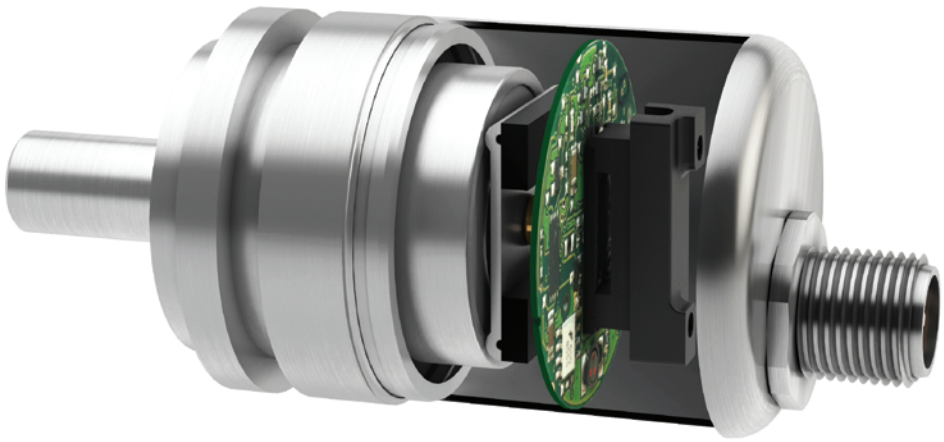
POSITAL
FRABA

WHITE PAPER

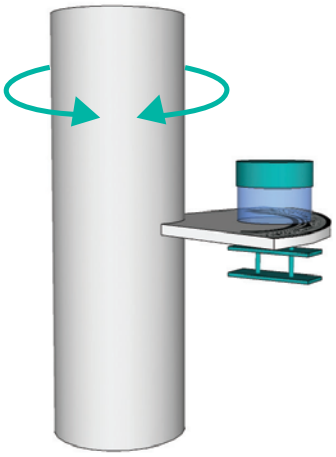


Re-Inventing the Rotary Encoder: The No-Compromise IXARC from POSITAL

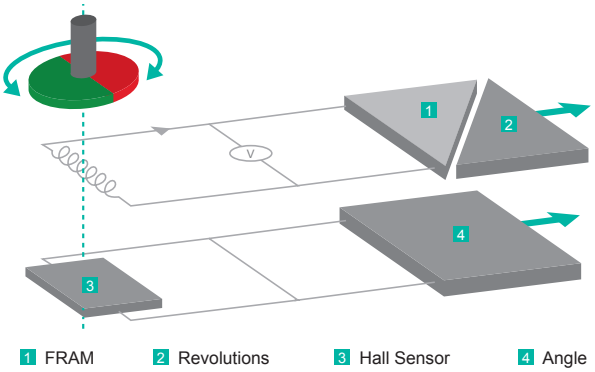
Designers of motion control or industrial automation systems who need to measure the rotation of shafts or other mechanical components have had two types of rotary encoders to choose from. Encoders based on optical measurement techniques can provide high levels of precision and dynamic response, but are relatively bulky and can be unreliable in damp or dusty conditions. Magnetic encoders are typically more compact and rugged, but until now, have offered lower levels of precision and dynamic response. POSITAL has eliminated the need for compromise by developing a new generation of magnetic absolute and incremental encoders that match the performance of optical shaft-mounted encoders in all but the most demanding applications. The new magnetic IXARC encoders are compact, accurate, fast and tough enough for challenging environmental conditions.

IXARC ROTARY ENCODERS
16 BIT
Absolute & Incremental

www.posital.com



Measuring rotation angle with an optoelectronic encoder



Magnetic measuring principle for the revolution counter

Technology IXARC Rotary Encoders

Optical encoders have been the traditional choice for applications requiring very precise measurement or high levels of dynamic response. A key component of optical rotary encoders is a code disk mounted on the encoder shaft. This is a disk made of transparent material that carries a concentric pattern of transparent and opaque areas. The disk sits between an LED light source and an array of photoreceptors, so that the pattern of light falling on the photoreceptors will be determined by the rotational angle of the disk. While this approach offers good accuracy and dynamic response, the code disks can become contaminated by dust, humidity and condensation. Moreover, glass disks can be broken by severe shocks or vibrations. Code disks must also have relatively large diameters – up to 50mm – in order to achieve high resolutions. This means that these instruments must be relatively large.

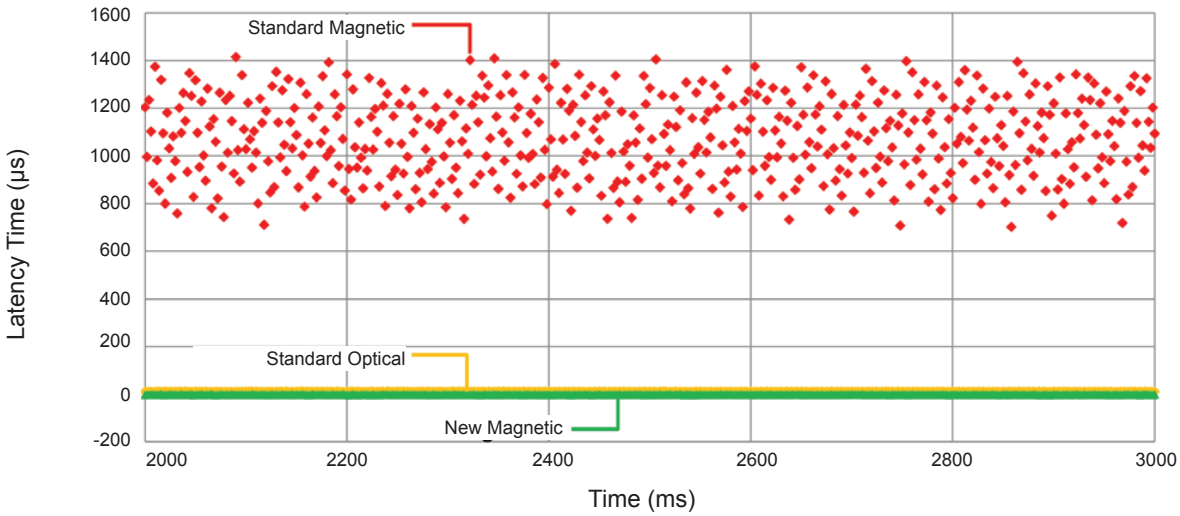
Magnetic encoders are based on an array of Hall-effect sensors that measure the orientation of the magnetic field created by a permanent magnet fastened to the encoder's shaft. A microprocessor interprets the signals from the Hall-effect sensors and calculate the rotational angle of the permanent magnet (and hence the encoder shaft). Because of the mechanical simplicity of this measuring system, a magnetic encoder can be significantly smaller and more robust than its optical counterpart. However, magnetic encoders built around traditional Hall-effect sensor arrays with integrated signal processing circuits have had lower levels of precision, accuracy and dynamic response than high-quality optical encoders.

Taking Magnetic Encoder Technology to a New Level

The core element of POSITAL`s new series of magnetic encoders is an advanced Hall-effect sensor system, combined with a powerful 32-bit microprocessor and carefully optimized signal processing software. This combination results in levels of resolution, accuracy and dynamic response that rival the performance level of optical encoders.

High-Performance Signal Processing

An essential element of the new system was the development of suitable signal processing software. The Hall-effect sensor chip which forms the basis of POSITAL's new magnetic encoders contains four Hall-effect elements that generate four analog output signals each. These raw signals are fed to fast analog-to-digital converters and interpretted by sophisticated signal processing software running on a powerful 32-bit microprocessor. Developing signal processing software that would combine high precision with extremely fast processing was a significant challenge for POSITAL. Through extensive testing and meticulous optimization of filter and velocity compensation algorithms, the develop-



ment team were able to achieve an accuracy of 12 bits (<0.1 degree) and 16-bit resolution. This represents a 4-fold improvement over previous generation-encoders with integrated signal processing. Latency-was also substantially reduced. Temperature compensation has been built into the signal processing algorithm, reducing measurement errors due to thermal drift. Moreover, the separation of sensors and signal processing allows for complete control over signal processing parameters. Application-specific parameter changes (e.g.-rotational direction, number of pulses, zero pulse position, hysteresis or filter settings) can be implemented without costly changes to hardware.

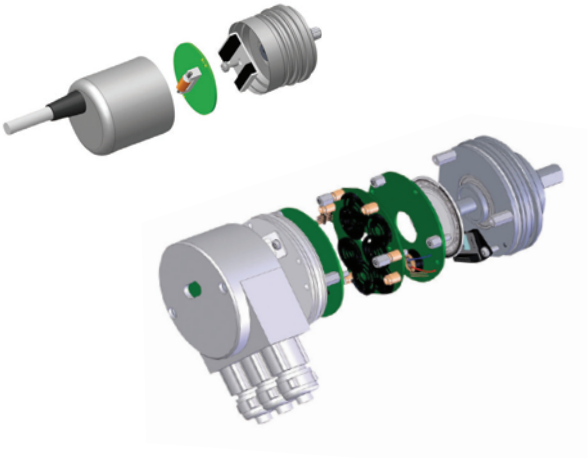
Faster Results for Incremental Encoders

Previous generation magnetic encoders had the disadvantage of relatively long latency (the period between the time when a measurement was triggered and the time when the result became available). As shown in the accompanying graph, this could be in the range of 700 to 1400 microseconds. With the new microprocessor-based solution, latency has been reduced by a factor of one hundred. Thanks to this technological advance, users in the automation industry now have new options, especially where powerful, robust solutions with a small footprint are needed. Even motor feedback applications – where fast dynamic response is essential – can now make use of magnetic systems.

A Reliable Revolution Counter

The Hall-effect sensor system measures rotations over a 0-360° range. However, it does not enable the encoder to keep track of multiple revolutions if this occurs when no external power is available. POSITAL solves this problem by means of a digital revolution counter circuit that is powered by an energy harvesting system based on the Wiegand effect. This solution has a number of advantages over systems powered by back-up batteries: batteries have a limited lifespan, add extra weight, and contain harmful substances which make them difficult to dispose of after they have been been replaced. The POSITAL all-digital energy-harvesting system also eliminates the need for gear systems (such as are used in most optical encoders). Gear-train systems are usually bulky, difficult to scale and costly to build. The energy harvesting system generates short, powerful voltage pulses sufficient to power the rotation-counting electronic circuit, even when the speed of rotation is very low. This solution, which has proven itself since 2005, enables the reliable measurement of multi-turn absolute positions without requiring access to an external power supply. Normally, the counting electronics are in a dormant state. When the shaft moves, they are activated for a short time by a voltage pulse and analyze the rotating direction. A register recording the number of revolutions is then incremented or decremented accordingly. Disturbances (e.g. electromagnetic pulses) occurring during the dormant state will not cause measurement errors.

POSITAL magnetic encoders are available in many different versions



Rotation counter technologies: magnetic (top) and optical

Enlarging the Product Range

With the introduction of high performance, durable magnetic incremental encoders with a magnetic measuring principle for the revolution counter pulse rate of up to 16,384 pulses per rotation (14-bit), POSITAL can now offer both absolute and incremental encoders based on a common platform. For all encoder types, a wide range of mechanical options is available to simplify the mechanical integration of these devices into new or existing machinery systems. A variety of shaft configurations (blind hollow shafts and solid shafts of various diameters) can be combined with different flange and housing sizes. Users can choose standard aluminum housings and flanges, or upgrade to stainless steel (types 304 and 312) for more challenging operating environments. SSI (serial) communications inter-faces are currently available. Analog, CANopen, DeviceNet, J1939, PROFIBUS and several varieties of industrial Ethernet will be introduced in the near future. The architecture also means that a single model can be easily programmed to take on the performance characteristics of conventional encoders or to meet special requirements. This is of benefit to users and system integrators, since they can “tune” the encoders to meet specific system requirements. It is also useful for retail distributors, since they can offer a wide range of operating characteristics without having to stock a large number of different models.

Modularization for Maximum Versatility

In addition to developing this exciting new technology, POSITAL has also reorganized their business model: the whole range of shaftmounted encoders can now be explored online, worldwide, through a new product finder tool. The introduction of “industrial customization” puts POSITAL in a unique position: technicians and international distribution partners can easily and quickly configure exactly the product required by potential customers. The new database contains current versions of all data sheets and technical drawings. By comparison, the old system of ordering by type code required additional knowledge from the sales agent, since not all combinations of components would be viable. Often, the question whether an encoder could actually be manufactured as specified could only be settled by a call to the manufacturer. The new product finder has all of this know-how built in and only displays viable combinations. Since the entire encoder product portfolio is designed to be modular, POSITAL can generate a multitude of unique products by assembling appropriate combinations of components. Currently, more than 50,000 absolute rotary encoders configurations, are available. With the new absolute magnetic encoders and incremental encoders, the product portfolio will include approximately 100,000 types.

POSITAL
FRABA

POSITAL is a specialized manufacturer of rotary encoders and inclinometers. The company belongs to the FRABA group which dates back to 1918, when its predecessor Franz Baumgartner elektrische Apparate GmbH, a producer of relays, was established. In 1963, the original company introduced the first magnetic brush-based absolute rotary encoders. Optical absolute encoders were introduced inthe 1970s. Reorganized as the FRABA Group in the 1980s, the company's encoder division established itself as a successful supplier for the machine building industry. In 1993, the management consultant Christian Leeser, his brother Dr. Achim Leeser, and Axel Wiemann, head of the encoder division, acquired the company and restructured it with a new management. Today, the group consists of independent companies that employ a staff of 120 at locations in Germany, Singapore, and the USA, and operate a state-of-the-art production plant in Poland. Over the last few years, POSITAL has developed various innovative products, including optical and magnetic safety encoders as well as high-resolution magnetic multiturn encoders.

IXARC ROTARY ENCODERS
16 BIT
Absolute & Incremental

www.posital.com

AMERICA
FRABA Inc.
1800 East State Street, Suite 148,
Hamilton NJ 08609-2020, USA
T +1 609 750-8705, F +1 609 750-8703
www.posital.com, info@posital.com

EUROPE
FRABA AG
Carlswerkstrasse 13c
D-51063 Cologne, GERMANY
T +49 221 96213-0, F +49 221 96213-20
www.posital.com, info@posital.eu

ASIA
FRABA Pte. Ltd.
20 Kallang Ave #01-00
Pico Creative Centre, SINGAPORE 339411
T +65 6514 8880, F +65 6271 1792
www.posital.com, info@posital.sg