

Inductive encoders: a robust solution for precise motion feedback

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An inductive sensor, also known as an inductive encoder, provides fast and precise feedback of motor speed and position. Compared to optical and magnetic encoders, they can optimize the reliability of feedback for miniature motion applications. However, their specification for motion design requires careful consideration, especially for different operational and environmental conditions.

Sayali Shinde, Design Engineer at Portescap, discusses the technology behind inductive sensors.

In a medical operating theatre, a hand-held surgical device, powered by a miniature BLDC motor, needs precise control to optimize the success of the procedure. Alternatively, a robot handling a tool for precision manufacturing needs accurate control to achieve micron-level position adjustment.

In both these examples, an encoder is an essential feedback device that measures the speed or position of the shaft of an electric motor. The encoder communicates this information to the controller, which calculates the discrepancy between the setpoint and the actual speed or position. The controller then sends a corresponding signal back to the motor to correct any error. With this process operating continually at high speeds, this creates a closed loop system essential to precise speed or position control.

Encoders can operate on an optical principle, using a disk with patterns and optical sensors to detect position or rotation, yet dirt or dust can impact the reading. Alternatively, magnetic encoders, which rely on a magnetized disk and magneto

resistive sensors to detect magnetic field changes can be used. However, these devices are more affected by stray magnetic fields, leading to errors in environments with high electromagnetic interference (EMI).

Electromagnetic principle

Other options include encoders based on electromagnetic induction, which are impervious to contamination but also less susceptible to magnetic fields. Unlike magnetic encoders, the performance of an inductive encoder doesn't diminish over time.

An inductive sensor operates on an electromagnetic principle, and signals speed and position changes by utilizing the interaction between its electromagnetic field and a motor shaft. An inductive coil is the main sensing element of an inductive sensor, and when an alternating current (AC) flows through it, the coil generates an electromagnetic field. A motor shaft within the proximity disturbs the field, which induces eddy currents, which are loops of current induced within a conductor when exposed to a changing magnetic field. These eddy currents create a secondary magnetic field, which interacts with the primary field of the sensor, and this interaction alters the inductance of the sensor's coil, causing a change in its output signal. As the motor shaft rotates, the inductance changes periodically, and the frequency of these changes corresponds to its speed. Alternatively, the sensor can determine its precise angular position by tracking the exact phase of the inductance variations as the shaft rotates.

Advantages of inductive sensors

Typically, adding an encoder adds length to the motor, and for flat or pancake-style BLDC motors, this extended length may negatively impact the motor-encoder assembly. However, inductive encoder technology also proves advantageous as the encoder elements and the commutation Hall sensor are situated on the same printed circuit board (PCB), maintaining the overall motor length compared to a standard encoder setup.

Inductive sensors achieve fast response times. Changes in position or speed cause immediate alterations in the induced eddy currents, which directly affect the inductance of the sensor coil. This direct interaction between the field and the object enables real-time detection and feedback.

These devices also enable high precision sensing, and inductive encoders can achieve high resolution due to their ability to detect even small variations in the inductive signal. As the motor shaft rotates, its interaction with the sensor's electromagnetic field causes measurable changes in the inductance of the coil, which are directly proportional to the position or speed of the object. Accurate measurement of these variations provides precise motion feedback.

With inherently robust features, integration within the motor housing, and lack of mechanical components, this gives inductive encoders a long service life. Free of mechanical components such as optical disks, inductive encoders can also achieve a more compact design. These devices also typically have low power consumption, making them energy-efficient and suitable for battery-powered or portable power tool applications. Their relative simplicity also makes them easier to install and set-up, and for control system integration they can output various signal options such as PNP, NPN, or analog.

Support in specification

An inductive sensor can still be affected by magnetic interference, and the presence of nearby metallic objects can interfere with the accuracy and reliability of inductive sensors, leading to false readings or inconsistent performance. Inductive sensor operation can also be compromised by EMI generated by nearby electrical devices or equipment. Some inductive encoders may also be unsuitable for sterilization environments, such as surgical applications, as they can suffer damage.

While the integration of inductive sensors into miniature motion systems can be advantageous, their use requires appropriate specification according to operational and environmental considerations. Expert support in the selection of the right

feedback sensor technology is useful to achieve long-term application success, as well as faster speed of development.

Image captions:

Image 1: In a medical operating theatre, a hand-held surgical device, powered by a miniature BLDC motor, needs precise control to optimize the success of the procedure.

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About Portescap

Portescap, a proud member of Regal Rexnord, excels in addressing critical motion challenges with premium miniature electronic motors and components. For over 70 years, our extensive product range – including coreless brush DC, brushless DC, stepper, gearhead, encoder, and controller technologies – has powered applications across the aerospace and defense, automation, industrial power tools, medical, robotics, and surgical hand tool industries. Expert engineers collaborate with you from prototype to production, ensuring exceptional performance tailored to your specific needs.

As part of Regal Rexnord, customers benefit from seamless access to a vast brand portfolio and a robust global manufacturing and sourcing network. Dedication to innovation and sustainability drives us to design products that significantly impact daily life. Leveraging Regal Rexnord's broader expertise and resources, we aim to deliver sustainable solutions that power, transmit, and control motion, helping to create a better tomorrow.

For more information, visit www.portescap.com

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