How to Find the Ideal Sensor for Your Industrial Automation Application

Analog and digital sensors deliver long-term stability, precision and reliability

By

Ryan Sheahen, Global Product Manager, Magnetic Sensor Products,
Electronics Business Unit at Littelfuse

Motion control and industrial automation systems create numerous challenges for design engineers. For example, they must contend with the excessive dirt and dust found in factories settings. In addition, conveyors and pick-and-place systems can exhibit high vibration or spikes in shock force that threaten the stability of the circuit's sensors. The magnetic sensing system selected must provide exceptional durability to ensure the long-term accuracy and reliability within the application.

During project planning, the design engineer should conduct a thorough review of the industrial application's environmental, mechanical, electrical and magnetic parameters. The engineer should analyze the industrial application's full magnetic circuit—including the sensor and the magnetic actuator. With all key factors in mind, the engineer may recommend a robust custom sensor to meet the industrial automation system's unique requirements.

This article will discuss how to choose highly accurate and reliable sensors for industrial automation applications. After defining and describing the benefits of several analog and digital sensors, it will provide examples of industrial applications that utilize these devices.

Analog Rotary and Linear Hall Effect Sensors Provide Stability and Precision

Analog sensors allow the end user to get instantaneous feedback on the magnet's position in an industrial automation system. In the past, analog Hall effect sensors measured the flux density of the magnets and were greatly influenced by the temperature value of the application. Recent advancements in analog Hall effect technology allow the Hall effect chip to measure the angle of the flux field instead of the traditional amplitude, making it much less sensitive to temperature changes. Hall effect sensors now deliver a very stable analog output across a large temperature range.

The following Hall effect sensors are ideal for custom analog sensing applications:

Rotary Hall Effect Sensor Without using any moving parts, this semiconductor-based sensor combines a Hall effect sensing element with circuitry to provide an analog output signal that corresponds to the change in the rotating magnetic field. A rotary Hall effect sensor offers two output options: analog or pulse-width modulation (PWM). The device is programmable so that the engineer can associate a specific output voltage or PWM to a precise degree of rotation.

Multiple programming points are available up to 360 degrees of rotation. Each programming point represents a voltage or PWM output value that corresponds to a given angle of the magnetic field. This results in a high-accuracy, high-resolution ratiometric output signal relative to the degree of rotation.

Benefits	Applications
• Does not experience changing resistance values or mechanical wear like a mechanical rotary or resistive film rotary device • Provides exceptional stability over normal operating temperatures up to +105°C • Offers accuracy from 0–360 degrees rotation with 0.5 V–4.5 VDC output or 10–90% duty cycle for PWM	• Replacing the resistive film and potentiometer mechanical devices, which can experience wear and oxidation issues that lead to signal loss in the control unit • Motion control applications including measuring the angle of a flapper valve in a fluid flow system and precisely controlling the rate of flow • Detecting dial position in control circuits

Linear Hall Effect Sensor

The linear Hall effect sensor measures the linear movement of a magnetic field rather than the rotation. This sensor is programmable for a set output voltage that is ratiometric for a given travel distance. (Its output options are the same as the rotary Hall effect sensor.) The sensor measures the linear movement and relative flux angle of a magnetic actuator up to 30 mm of travel distance with a single Hall effect chip. This results in a ratiometric output signal relative to the precise movement of the sensor.

Benefits	Applications
• Sensor and actuator can be placed in their final mounting area within the application (including all magnetic influences from their nearby surroundings); this mounting placement allows the engineer to optimize the application's output signal since any shunting, mechanical tolerances or stack-up tolerances of the magnetic field will be included in	• Used as level sensors for monitoring fluid levels; sensor detects the location of the moving float, which has a magnet attached to it • Provides a very precise position tolerance for automatic pick-and-place systems

programming the output signal to correspond to the magnetic flux direction as the magnet rotates	

Reed and Hall Effect Deliver High-Reliability Digital Sensing

Industrial automation customers who want to verify that an object such as an elevator door is in its proper position prefer digital output. The following digital sensors deliver outstanding reliability in custom magnetic sensing applications:

Reed Switch

A reed switch has contacts that are hermetically sealed within a glass tube with precious metal contact material. This electrical switch does not require any power to operate.

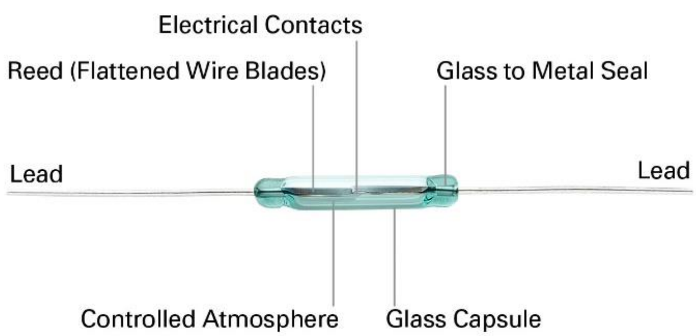

Figure 1: *Diagram of a reed switch*

Benefits	Applications
• Immunity to moisture and other environmental hazards enables reliable operation for millions of cycles	• Microprocessor-controlled, logic-level electrical loads • Digital on/off applications such as door closure or position detection systems in the industrial/motion control market (since they can switch AC or DC loads); see Figure 2 for an example of a freight or passenger elevator door using a reed switch for door closure detection

Figure 2: *Reed sensors used in an elevator door*

Digital Hall Effect Sensor

These sensors combine a Hall effect sensing element with circuitry to provide a digital on/off output signal that corresponds to a change in the magnetic field without using any moving parts. The Hall effect device's active circuitry draws a small amount of current at all times.

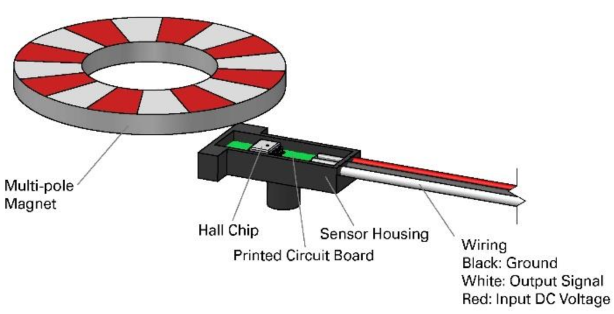

Figure 3: *Diagram of a digital Hall effect speed sensor*

Benefits	Applications

• Offers high reliability • Can be programmed to activate at a given magnetic field tolerance for precise sensing requirements	• Limited to industrial and motion control applications with low DC voltage and current values • Popular for high-speed sensing applications such as rotary speed sensing on conveyors; see Figure 4 for an example of a Hall effect speed sensor used to detect a rotating 16-pole ring magnet

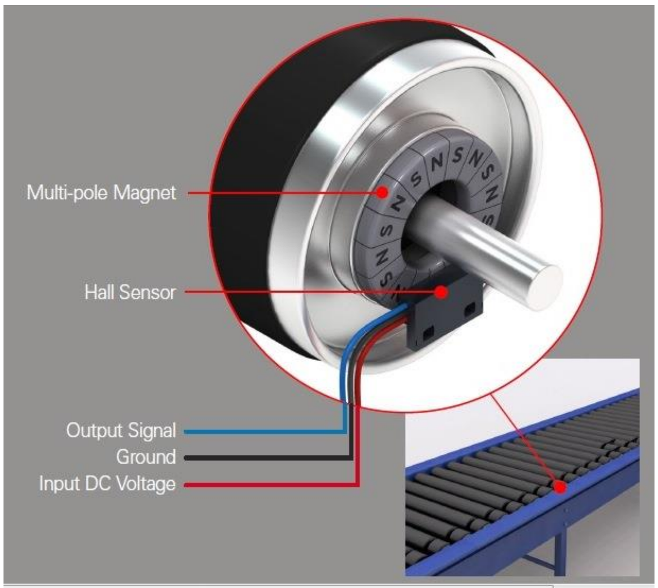

Figure 4: *Hall effect sensor used in a conveyor system*

Conclusion

Environmental hazards are abundant in industrial automation and motion control environments. Designing a magnetic circuit that incorporates a robust magnetic sensor is the key to delivering a precise, reliable industrial automation solution. For some industrial applications, a custom magnetic sensor may be needed for long-term reliability. Reed switches and Hall effect sensors are perfect for digital applications that require exceptional reliability such as elevator door closure detection systems. Rotary and linear Hall effect sensors enhance the stability and precision of custom analog applications such as fluid flow and automatic pick-and-place systems.

[Click here to learn more about Magnetic Sensors and Reed Switches.]

[Click here to download a complementary Sensing Products Selection Guide courtesy of Littelfuse.]

About the Author

Ryan Sheahen is the Global Product Manager for magnetic sensor products within the Electronics Business Unit at Littelfuse. Ryan joined Littelfuse in 2011. When Littelfuse acquired Hamlin in 2013 he worked on the integration team and has been involved in the magnetic sensor business ever since. Ryan earned his BS in Mechanical Engineering Technology from Purdue University.