

## **Comparing Speed Sensor Technologies: Hall and VR**

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There are many technologies available on the market to measure the speed of a rotating object. For many applications, especially those that operate in extreme environments, the choice often comes down to either Hall effect or Variable Reluctance (VR) speed sensors. Speed sensors based on either of these technologies can be applied in situations of extreme heat and cold, and can function in the presence of dirt, grease, and other contaminants that can render sensors based on other technologies inoperative. Which technology makes sense for your application?

In order to make an informed decision one way or another, it is important to understand how both Hall effect and VR speed sensors work. While both technologies operate by sensing perturbations in a magnetic field, this is where the similarity ends.

In its most basic form, a VR sensor consists of a coil of wire wrapped around a magnet. As gear teeth (or other target features) pass by the face of the magnet, they cause the amount of magnetic flux passing through the magnet, and consequently the coil, to vary. When a target feature (such as a gear tooth) is moved close to the sensor, the flux is at a maximum. When the target is further away, the flux drops off. As the target moves, this results in a time-varying flux that induces a proportional voltage in the coil. Subsequent

electronics are then used to massage this signal to get a digital waveform that can be more readily counted and timed.

Although VR sensors are based on very mature technology, they still offer a number of significant advantages. The first is cost; wire and magnets are pretty inexpensive. Unfortunately, the low cost of the transducer is frequently offset by the cost of the additional signal processing circuitry needed to recover a useful signal. And because the magnitude of the signal developed by the VR sensor is proportional to target speed, it is difficult to design circuitry to accommodate very low speed signals. For a given VR sensing system there is a definite limit as to how slow the target can move and still develop a usable signal.

One area in which VR sensors excel, however, is in high-temperature applications. Because operating temperature is limited by the characteristics of the materials used in the device, with appropriate construction VR sensors can be made to operate at temperatures in excess of 300°C. An example of such an extreme application is sensing the turbine speed of a jet engine.

In a Hall effect speed sensor, the Hall effect transducer element is situated between the magnet and the target, and detects target-induced flux changes from this point. Unlike a VR sensor, however, a Hall transducer is sensitive to the magnitude of flux, not its rate of change. This technology feature allows one to make speed sensors that can detect targets moving at arbitrarily slow speeds, or even the presence or absence of non-moving targets.

For applications where one must keep track of total revolutions (such as in an odometer), zero-speed sensing is important because it guarantees one will not lose count when the target moves slowly.

Another important feature of Hall effect speed sensors is that the signal processing electronics is often integrated into the same package as the transducer, providing several tangible benefits. The first of these is that little or no additional signal processing circuitry is required - most Hall effect speed sensors directly provide a digital output signal that is directly compatible with digital logic, microcontrollers, and PLC's. Another benefit is that the signals from the transducer don't have to go very far to get to the signal processing electronics; often merely a few mils. This reduces the amount of pickup from interference sources, and makes Hall effect speed sensors highly immune to Electromagnetic Interference (EMI) induced malfunctions and failures. While Hall effect speed sensors can't quite survive the environmental extremes of their VR counterparts, they come in a close second; many available devices sport operating temperature ranges of  $-40^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$ . Because of integral signal processing, near-zero-speed capabilities, and digital outputs, Hall effect speed sensors are a designer's best choice for most speed sensing applications.