Busting three myths of chopper stabilization

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Brushless DC (BLDC) motor manufacturers often think they need a chopper-stabilized magnetic sensor, but what they actually require is a high-sensitivity part. Joshua and Fred bust the three myths that have led designers to request latching sensors with chopper stabilization and explain why a high-sensitivity bipolar latching Hall effect sensor can increase BLDC motor efficiency.

Sensor manufacturers have historically achieved high sensitivity in bipolar latching Hall effect sensors for BLDC motor applications by using chopper stabilization, a technique used to mitigate sensitivity and stability over temperature for a Hall element. As a result, chopper stabilization has become synonymous with high sensitivity and stability in Hall effect sensors.

Today, with new technologies and processes, magnetic sensor manufacturers can achieve high sensitivity and magnetic stability without using chopper stabilization. This translates into improved sensor performance in terms of faster response time and better repeatability from the sensor.

BLDC motors are highly efficient, delivering more energy per unit compared to brush-type DC motors. These motors are growing in popularity due to the world's need for greater energy efficiency. BLDC motors use electronic commutation versus mechanical commutation in brush-type DC motors to control power distribution to the motor. Latching Hall effect sensors measure the motor's position, which is communicated to the electronic controller to apply energy to the motor at the right time and right orientation (see Figure 1). BLDC motors can be used in any application that needs an efficient and quiet motor, ranging from robotics and portable medical equipment to HVAC fans and appliances.

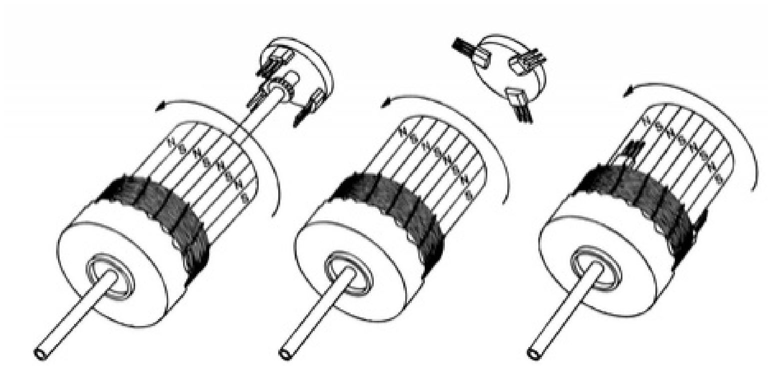

Figure 1: Latching Hall effect sensors can be placed directly inside the motor, at the end of a motor's shaft, or around a ring magnet attached to the rotor shaft.

(click graphic to zoom by 1.9x)

BLDC motor manufacturers have moved toward using chopper-stabilized latching sensors for electronic commutation, but what is actually required is a high-sensitivity part that is stable over its specified temperature range. The following discussion will bust three myths that have led designers to request chopper-stabilized bipolar latching Hall effect sensors instead of choosing several other options that can more efficiently commutate the motor.

Myth #1: Chopper stabilization is an ideal technology for latching sensors in BLDC motors

Truth: Although chopper stabilization can offer high sensitivity and more magnetic stability, it has several drawbacks including slower response time, accuracy error (due to sampling), and electrical noise generation.

Hall effect sensors are operated by a magnetic field from a permanent magnet or an electromagnet responding to North and South Poles. These magnetic sensors measure the change in magnetic field and communicate the position of the motor shaft to a logic unit, which uses this information to determine when the current should be applied to the motor coils to make the magnets rotate at the correct orientation.

To ensure the motor is operating as efficiently as possible, this mechanism must be able to determine the rotor's position as accurately as possible. The longer it takes the sensor to respond to changes in magnetic field, the less accurate this position is, resulting in lower motor efficiency and issues commutating the motor at higher frequencies.

Chopper stabilization, which is continually averaging the induced voltage across the Hall elements to determine the output signal, slows down how fast a sensor switches. As a result, a chopper-stabilized part typically switches at a delayed magnetic field level due to the slower response. As the motor spins faster, the chopper-stabilized device's delay time results in more accuracy errors.

In addition to slower response time, chopper stabilization adds electrical noise to the circuit each time the switches used for this technique open and close. This translates into additional design time, the need for more filtering, and higher cost.

By eliminating the need for chopper stabilization, the latching sensor has a faster response time. This means the motor is commuted at or closer to the correct time, translating into higher accuracy, which ultimately leads to a more efficient motor. Another benefit of a non-chopper-stabilized sensor is that it does not generate additional electric noise, thus eliminating the need for extra filtering and simplifying the design.

Myth #2: Chopper stabilization is the only way to achieve stability over the operating temperature range for a Hall effect sensor

Truth: Many designers believe the misconception that non-chopper-stabilized parts are not stable. In reality, one of the most important factors contributing to the sensor's stability starts with the Hall element used by the manufacturer.

Many sensors today utilize single and dual Hall effect elements, which are susceptible to wide ranges of magnetic performance due to packaging stresses. To mitigate these stresses, most manufacturers use an averaging process (chopper stabilization) to provide a more stable operation over voltage and temperature.

Another way to realize stability is to start with a more stable Hall effect element. A quad Hall element is less susceptible to stress-induced error because voltage is measured in four directions, cancelling the offsets in each element to provide stable operation over the operating temperature range. A quad Hall element offers more stable sensor performance, requiring less averaging correction than what chopper stabilization provides. In addition, Hall sensors utilizing this technology are not larger than their single or dual Hall element counterparts using chopper stabilization.

Myth #3: Chopper stabilization is required to achieve high sensitivity in latching Hall effect sensors for BLDC motor commutation

Truth: Chopper stabilization is not the only way to achieve high sensitivity. Other technologies and processes are available to manufacturers for high-sensitivity magnetic sensing.

As an alternative to chopper stabilization, Honeywell Sensing and Control has developed a high-sensitivity bipolar latching sensor by combining a quad Hall element and proprietary programming without chopper stabilization (see Figure 2). This programming adjusts the magnetics to account for the effects of packaging stresses, thus contributing to the sensor's high sensitivity. This design offers the required high sensitivity and stable magnetics for BLDC motors, along with the additional benefits of faster response time, repeatability, improved jitter performance (which is critical for BLDC efficiency), and no additional electric noise generation.

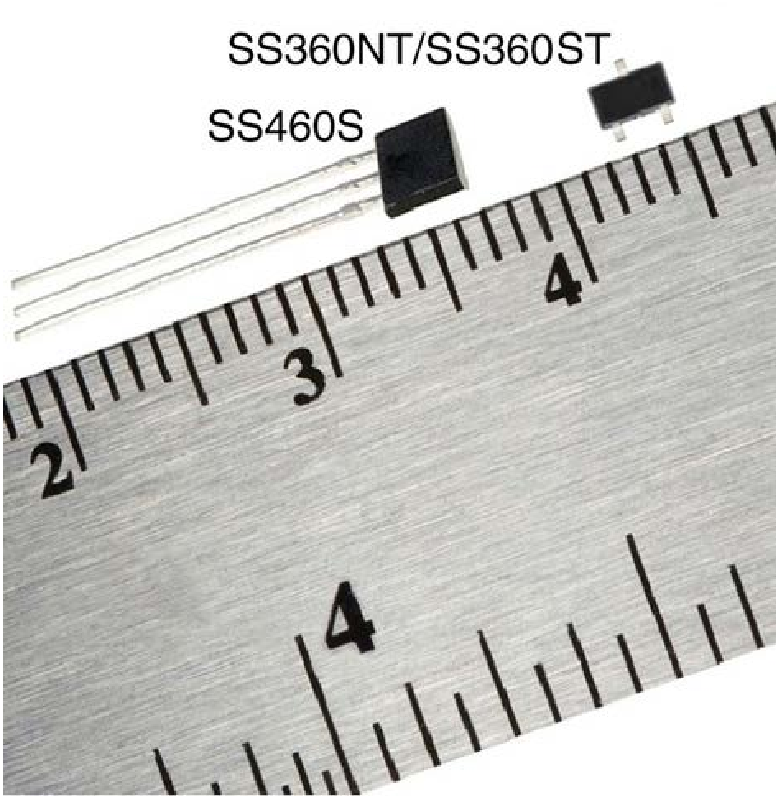

Figure 2: Honeywell bipolar latching Hall effect sensors provide the precise motor shaft positioning data needed by BLDC motors.

(click graphic to zoom)

The Honeywell SS360NT/SS360ST/SS460S bipolar latching Hall effect sensors provide high magnetic sensitivity of 30 Gauss (G) typical (55 G maximum) over the entire temperature range of -40 °C to +150 °C without chopper stabilization of the Hall element. Combined with faster latch response time and the capability to handle higher frequencies, these latching Hall effect sensors can significantly boost motor efficiency. Initial customer feedback indicates a 5 percent increase in motor efficiency compared to a competitive chopper-stabilized part.

Technology has come a long way to make a highly sensitive latching Hall effect sensor that is stable over the wide temperature range needed for BLDC motors. When deciding on the right technology, design engineers need to understand both the positives as well as the drawbacks of chopper stabilization and take these into consideration to design the most efficient motor for their customers.

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