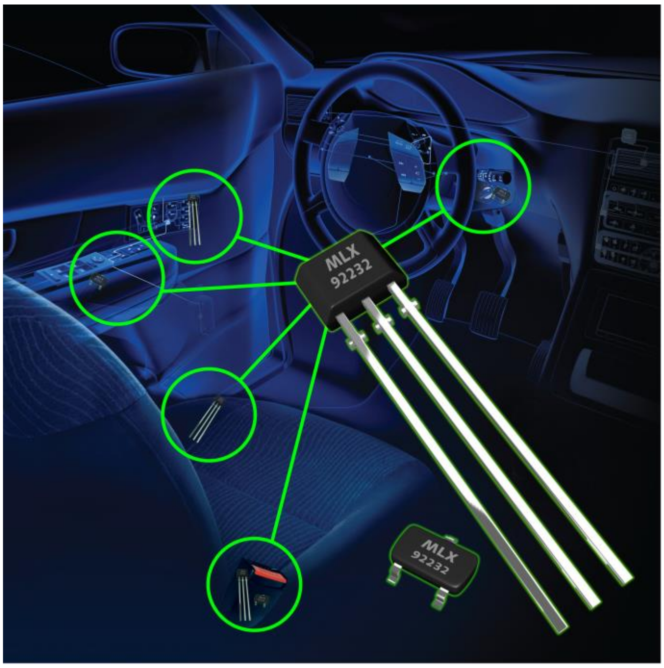
Programmable Digital Hall Effect Sensors Simplify Magnetic Sensor Design and Production

Magnetic Hall effect sensors prevail in position sensing applications across a variety of markets. This is a result of the robust, versatile, cost effective and non-contact performance of Hall effect sensors. Growth in the use of these sensors has been steady for several decades. The expected annual revenue generated by magnetic sensors within the automotive sector, a majority of which are Hall effect magnetic sensors, is expected to rise to $193.6 million by 2015 according to industry analysts IHS iSuppli. This works out to a compound annual growth rate that is above 16%. Today's Hall effect sensors solve ever more challenging sensing issues and do so with features that make design and manufacturability simpler and more cost competitive than ever. This whitepaper will detail the advances in Hall effect sensing which are simplifying the next generation of position sensing challenges.



Hall effect sensors divide into 2 basic classes, digital output devices and analog output devices. Analog Hall effect sensors have been using advanced digital controls and digital signal processing in cooperation with analog front ends, analog signal chains and analog outputs to optimize performance parameters in specific applications. These design trends in analog Hall sensors enabled the conversion of many passive sensor devices to active semiconductor sensors. The benefit to the designer from this trend comes in the ability to deliver error checking, self-diagnostics and mass customization at a very cost competitive price.

Digital Hall effect sensors have historically been built in strictly fixed circuit architectures. Some attempts to implement factory adjustable or very simple user programmable circuits have been offered. Typically these schemes allowed single use (one-time) programming with adjustable resistance values or fusible link schemes to change on chip resistance in the signal chain, especially in the switching threshold or Schmitt trigger circuit block found in most digital Hall effect sensors. More sophisticated programmable architectures were not economical for the typical applications served by such components.

In digital Hall sensor catalogs several magnetic functional ranges of devices exist. These are classified universally within the industry as; unipolar switches, bipolar switches, omnipolar switches and bipolar latches. Each class has a general range of magnetic switch threshold, or magnetic field, required to turn on or off the digital output of the Hall effect sensor. Typical position sensing applications can employ a variety of methods to actuate the sensor. These could include simple head-on magnet actuation, rotary multi-pole magnet actuation and metal vane or proximity actuation just to mention a few. It is from these different actuation methods that the Hall effect sensor type and its switch thresholds are determined by the design engineer. Further selection is often necessary to achieve the desired accuracy and precision of the sensing event under all operating conditions.

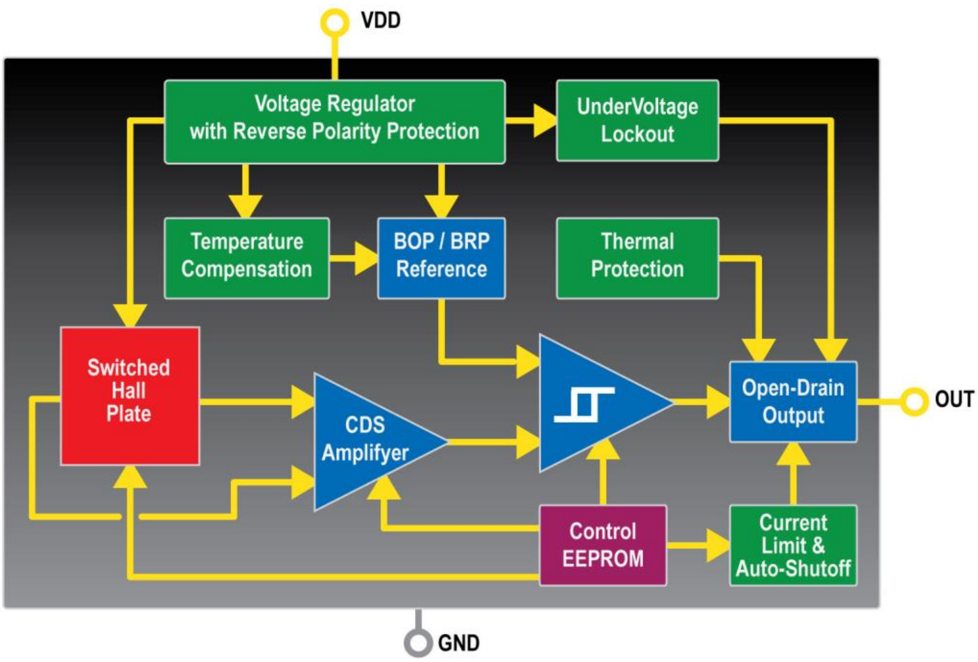
Presently a sensor module designer must account for many interdependent design choices when creating a sensor to meet system performance requirements. For a company with even a modest portfolio of sensor assemblies this can lead to many inventory items of different, but largely similar in function, Hall sensor IC. It can also lead to design compromises which place a priority on re-use of existing approved, in stock, components above meeting the maximum possible accuracy or precision specification.

A new class of magnetic Hall effect sensor now presents system designers with a truly no compromise solution. These devices implement state of the art fabrication processes to deliver fully programmable threshold levels. They do this by using proven automotive grade EEPROM technology to allow full user re-programmability. Along with the basic threshold programming these sensors have the capacity support thermal magnet material drift compensation and several other ancillary programmable features in order to enable high precision, high accuracy performance over extended operating temperature ranges. The programmable thresholds values include both the on/off levels and critically and most novel, the ability to set the hysteresis value over a very large range. This gives the sensors the option to meet nearly all functional classes, unipolar switch with high or low hysteresis; bipolar latch with high or low hysteresis.

The reprogrammable nature of the EEPROM devices offers benefits to both the designer and the manufacturer. To the designer it brings flexibility in a large variety of magnetic actuation schemes. This allows the same device to serve in speed sensing, timing sensing or proximity sensing applications. It can, as well, allow high performance results using cost effective magnet materials especially making it possible to avoid the use of rare earth materials in many applications.

At the manufacturing level operational advantages are immediately realized with lower inventory variation. This supports lean manufacturing goals resulting in direct bottom line savings and efficiencies. As important as reducing inventory variation might be the equally important result of this programmable architecture accrues from the end-of-line programming capability. The ability of each individual IC to be programmed after final assembly, with no extra dedicated programming pins needed, means true mass customization capability. Manufacturing variations and tolerance stack-ups can, in many instances, be compensated easily during a final programming step after assembly. This yields tighter statistical distributions for critical parameters and with clever design of modules even the ability to create multiple functional products from a common platform sensor assembly.

A prime example of this versatile architecture is the MLX92232 from Melexis. The MLX92232 has wide operational parameters, with an operating voltage range of 2.7V to 24V, a magnetic latch



range of ±0.4mT to ±80mT and a magnetic switch range of ±1.5mT to ±66mT and a programmable hysteresis range between 1mT and 36mT. The negative thermal coefficient can be adjusted in the range of 0 to -2000 ppm/°C to match all currently available permanent magnet materials or to use with electromagnet (current sensing) actuation. This device is fully AEC-Q100 qualified, with an operational temperature range spanning -40°C to +150°C, making it highly suited for use in demanding automotive or industrial) environments. Package options include industry standard 3-pin SIP and space saving TSOT23 variants.

The MLX92232 exhibits very low voltage capability allowing the device to interface with microcontrollers and other digital ICs placed on supply lines using 3V logic (or lower). This makes it more versatile and allows system designs that would not be possible for alternative solutions found on the market. A 32-bit unique ID code built in to each sensor enables lifetime traceability.
The growth in demand for high performance position sensors in physically harsh environments requires a new generation of sensor ICs. We have looked at how new architectures and technical capabilities are being deployed to meet these rising demands while simultaneously addressing the need goal of lean manufacturing practices.

To learn more about this next generation of magnetic Hall effect sensor technology visit www.melexis.com/calibrate.