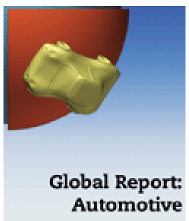
Feature

Invisible sensors permeate car control

Modern autos bristle with sensors that contribute to everything from engine control to passenger safety. Sensor technologies are evolving to deliver ease of design, higher reliability, and more functions.

By Bill Schweber, Executive Editor, EDN North America -- EDN, 6/23/2005



Sensors and processors, like alien creatures in science-fiction movies, really have taken over today's cars. They're not only in visible areas, such as the passenger compartment (see "**Extra sensor(y) perception**"), but also in every nook of the car, including the power train and chassis, monitoring and controlling performance, safety, and basic operations.

The demand for greater fuel economy, reduced emissions, decreased likelihood of an accident, and increased post-crash safety largely drive the impetus for this sensored vehicle. New sensor technologies both improve on existing sensors and provide sensing that was previously impractical in mass-produced consumer products. Sensors extend from the engine, to the exhaust, to even the fuel tank: Freescale Semiconductor supplies a low-pressure differential sensor that detects gas-tank leakage.

Taking the pressure

The power train of a car is a complex electrical, mechanical, and chemical system, and improved performance requires pressure sensing at many points. Gasoline engines need the MAP (manifold absolute pressure) from a sensor that must unavoidably reside in an area that exposes it to gas. Increasingly, these fuel systems are also measuring air flow, which a rugged version of the well-established hot-wire technique (with no moving parts) must sense. Diesel engines, in contrast, use the BAP (barometric absolute pressure); their requisite sensor can reside in a control module, which is a less hostile environment.

MEMS process technology has changed the approach to the sensor and signal conditioner, always key parts of the sensor signal chain. Freescale is migrating pressure sensors from bulk micromachined devices to surface micromachined units. Steve Hendry, **automotive** product-marketing manager for Freescale's Sensor and Analog Division, notes, "[These units] have less area and lower cost by using capacitance techniques and allow 1 to 2% tolerance." The next-generation devices, he adds, may be two-chip devices combining a sensor with a separate CMOS signal conditioner, in which the sensor is smaller than a wire-bond pad; overall, this combination may yield the best cost and performance pairing.

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The ubiquitous Hall-effect sensor has found a welcome home in rotary, linear, and on/off position sensing in cars (see sidebar "**Who's in the Hall?**"). Due to their inherent ruggedness, encapsulation, and nondegradation over time, Hall-effect devices have established a strong position in diverse automotive-power-train niches as on/off and linear sensors. For example, engineers now use linear Hall-effect devices for sensing critical valve position.

According to Melexis Inc's Vincent Hiligsmann, application and marketing manager for engine management/Hall sensors, "Many automakers have decided that the future will be contactless," thus driving design-in of sensors based on the Hall-effect, optical, and pressure technologies. Contactless sensing allows component designs to encapsulate and protect the sensing element, enhancing reliability and reducing long-term problems with dirt, corrosion, and liquids. According to Hiligsmann, the benefits of such sensors are so dramatic that they are pushing aside the historic guideline of the auto business: that new generations must be compatible with previous ones. He notes, "There is no

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