CAN Newsletter Online

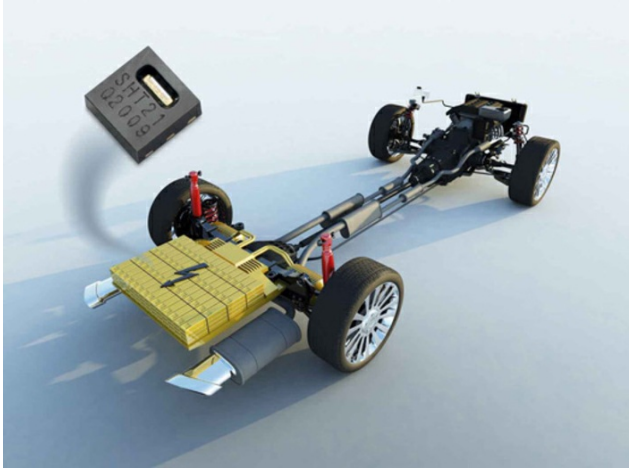
HUMIDITY MONITORING

Increasing the safety of electric vehicles

The safety of electric vehicles and hybrid electric vehicles is highly dependent on the battery. The lithium-ion batteries predominantly used in such vehicles are a source of various potential hazards for the occupants. A sophisticated battery management system is necessary to address these hazards.

AMONG OTHER TASKS, IT MANAGES AMBIENT CONDITIONS for the battery and ensures proper battery maintenance and replacement. This considerably reduces the risk of malfunction and overheating. Overheating during battery charging or operation under diverse ambient conditions, proper maintenance, secure replacement, preventing malfunctions, and the risk of electric shock in the event of an accident are among the factors addressed by a properly designed battery management system.

For this reason, vehicle batteries have developed into diagnostic systems equipped with sensors for the constant monitoring of battery voltage, current, temperature and internal pressure. Other sensors detect factors such as acceleration, the ground orientation of the vehicle, and humidity. When specific sensors detect that a monitored value is outside specified limits, the battery is immediately disconnected from the vehicle to ensure safety.



Humidity monitoring for safety of electric vehicles (Photo: Sensirion)

The proper use of humidity sensors in green cars can increase the safety of vehicle batteries, reduce their power consumption and increase their lifetime. Modern humidity and temperature sensors are based on proprietary CMO-Sens technology, which combines the sensor element and signal processing circuitry on a single semiconductor chip. The Swiss company Sensirion produces sensors of this sort. According to the manufacturer the advantages of CMO-Sens humidity and temperature sensors are the direct and economical integration into the battery management system, a digital interface for effective data transmission on the CAN network and communication diagnostics to ensure operation.

Avoiding short circuits and saving energy

The battery is actively cooled by air or water to prevent battery overheating during the vehicle's operation. If an electric vehicle is operated under humid conditions in tropical regions or on rainy days, a considerable amount of humidity can accumulate inside the battery. If the temperature of the air inside the cooled battery reaches the dew point, moisture condenses on the inside of the battery. This water film increases the risk of short circuits, which can lead to battery shutdown and potential damage to the battery. Humidity accumulation can easily be prevented by ventilating the battery housing with dry air from the vehicle's air conditioning system.

To avoid constant battery ventilation and the unnecessary use of energy, the humidity of the air inside the battery can be monitored, so that the ventilation process is only initiated when the humidity exceeds a specified critical value and condensation is possible. This strategy minimizes the power consumption of the air conditioning system and improves the overall efficiency of the vehicle while increasing battery safety.

Excessive humidity accelerates the corrosion of various electrical contacts and connectors in the battery. These parts are especially prone to corrosion because they are heated during operation by the high current load. To reduce the risk of corrosion damage to electrical parts, a humidity-controlled ventilation strategy with dry air can be implemented as previously described. This allows a reduction in maintenance effort and expense by avoiding excessive humidity in the battery.

Monitoring battery aging

Another issue in battery management is battery aging due to moisture penetration. Vehicle battery cases may be fitted with vents to equalize variations in atmospheric pressure. These vents are usually made from water-repellent fabric. Although this is essentially watertight, in the course of time a small amount of moisture penetrates the fabric and enters the battery. Due to the long service life of a vehicle, the amount of moisture penetration can lead to problems because the water reacts with the electrolyte and lithium electrodes. This chemical interaction results in gases inside the battery cells, which degrade the characteristics of the electrolyte. The end result is reduced cell capacity and lifetime.

Timely battery maintenance is therefore important for secure vehicle operation over the entire useful life of the battery. Battery depletion is faster when the vehicle is used in hot, moist regions than in dry environments because more moisture penetrates into the battery. Accordingly, the maintenance interval depends on the weather conditions to which the vehicle is exposed. By sensing the humidity level of the battery, the vehicle can tell the driver when battery maintenance is necessary.

CMO-Sens technology
The company's sensor products are all based on the CMO-Sens technology, which enables the sensor component to be combined with the analog and digital signal processing circuitry on a CMOS silicon chip. This is implemented in the semiconductor technology, using microsystem processing steps to produce the microsensor structures on specially developed and patented semiconductor parts. The resulting sensor chips enable sensing of the desired physical parameters, such as relative humidity, temperature, or mass flow.

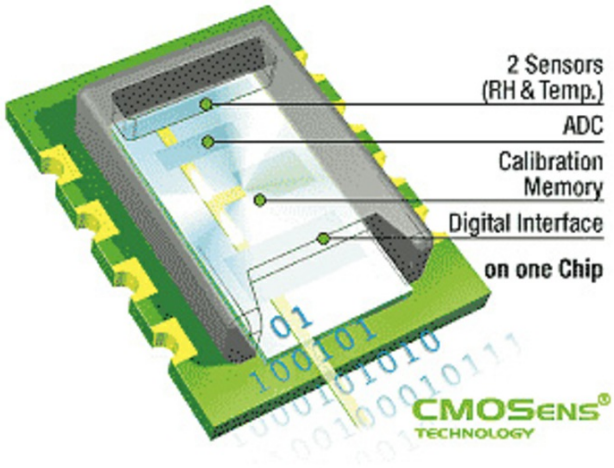
“Capactive humidity sensor principle”

For this principle, the sensor element is built out of a capacitor. The dielectric is a polymer which absorbs or releases water proportional to the relative environmental humidity, and thus changes the capacitance of the capacitor. This change in capacitance can be measured by an electronic circuit. This allows the relative air humidity to be determined. For humidity sensors with CMO-Sens technology, a "micro-machined" finger electrode system with different protective and polymer cover layers forms the capacitance for the sensor chip, and, in addition to providing the sensor property, simultaneously protects the sensor from interference in ways previously not achieved.

Humidity, temperature and dew point

The temperature sensor and the humidity sensor together form a single unit. This also enables a determination of the dew point, without incurring errors due to temperature gradients between the humidity and the temperature sensors. Through the linkage of these sensor elements with the signal amplifier unit, the analog-to-digital converter, the calibration data memory, as well as the digital, bus-ready interface, all on a surface area of a few square millimeters.

The analog-to-digital conversion without CAN connectivity, which is performed "in place," makes the signal insensitive to noise. A checksum generated by the chip itself is used. Other advantages are the response times of 4 sec at 1/e, the precision of ±2 % to ±5 % according to configuration, as well as the power consumption of < 3 mA standby. According to the company, the humidity and temperature sensors can be connected directly to any microprocessor system by means of the digital 2-wire interface.



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