CURRENT MEASUREMENT SYSTEM MAKES ELECTRIC VEHICLES SAFER

The growing popularity of electric drives is changing a variety of automotive safety concerns. While leaking petrol may be a thing of the past, the need to more precisely control electric currents in a vehicle is on the rise. Isabellenhütte Heusler GmbH & Co. KG in Dillenburg, Germany, has unveiled a newly engineered high-precision sensor that meets the standards under rules and regulations worldwide.

The drive systems in electric vehicles require higher voltages and more electrical energy than in conventional cars with an internal combustion engine. As a result, the hazards caused by electric current increase, if the current flows are not precisely controlled. A battery management system that checks the state of charge and helps to prevent deep discharge or overload, either in the battery or in individual battery cells, provides monitoring, control and protection while also lowering the risk of battery fires.

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Precise monitoring of electricity flows in electric cars at all times

There are various ways of detecting deviations in desired electricity flows. Measuring current flow, power supply voltage and temperature – which also makes it possible to monitor insulation – plays an extremely important role. The growing number of complex and sensitive electronics systems in vehicles calls for a high-precision approach to measuring flows and currents that is engineered to keep up with today's standards.

Isabellenhütte engineered the IVT 3 Base current measurement sensor with precise current measurement in mind. Developed to meet the ISO 26262 Road Vehicles – Functional Safety standard, it fulfils the requirements of Automotive Safety Integrity Level (ASIL) C (on a scale of A to D). ASIL is a risk classification scheme for standards governing in-vehicle electric and electronic systems that have a relevant impact on safety. The classification level is the result of a hazard and risk analysis. Each level stipulates specific requirements for the development, validation, reliability and testing of a system.

Image 1: Precise electricity flow measurement, with a safe and reliable way of processing and providing data, plays a decisive role in optimising the efficiency and range of electric drives. The IVT 3 series measures the flow with a precision of 0.4 % across the life cycle and measurement range, meeting ASIL C functional safety requirements.
Image: ©Isabellenhütte Heusler GmbH & Co. KG

High safety integrity level meets automakers' standards

"By meeting the ASIL C standard, the IVT 3 Base provides safety for an absolutely essential component that the automotive industry demands," says Tom Hassel, Product Manager for Mobility & Motion at Isabellenhütte. "Our goal is for customers to be able to achieve ASIL D at system level with a single added redundancy." More and more automakers are demanding ASIL classifications, in part due to the advancements in autonomous driving. When it comes to electromagnetic compatibility (EMC), the current measurement system meets the requirements for level 3 of the CISPR25 standard, guaranteeing compliance with two requirements: First, the current measurement sensor's electromagnetic emissions are so low that they do not interfere with other electromagnetic components in the vehicle. And, second, the sensor itself is sturdy enough not to be disrupted by other electromagnetic waves.

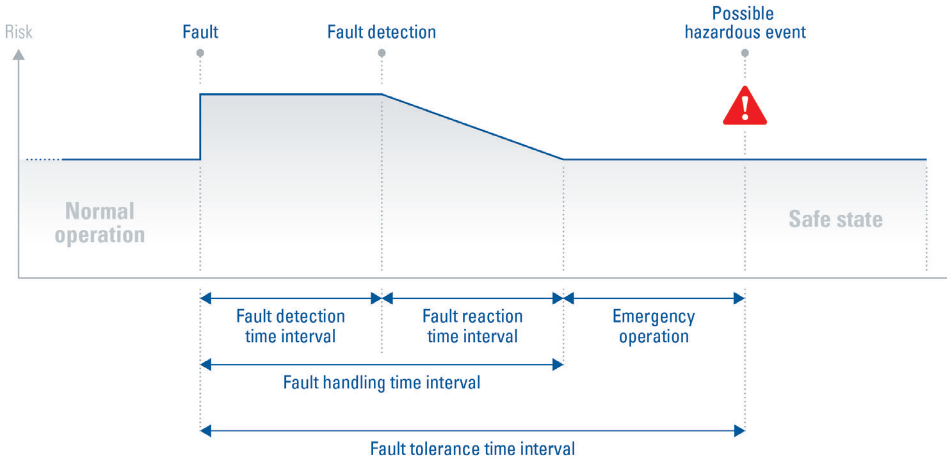

Image 2: Illustration of the fault tolerant time interval (FTTI). The IVT 3 series was developed in accordance with ISO 26262 and meets ASIL C current measurement standards. It detects faults and errors early on and reports them to the overall system, which can respond and restore safe conditions.

Besides monitoring electricity flows throughout the battery system, the IVT 3 Base current measurement sensor is also capable of recording the busbar’s temperature. The system additionally registers whether the vehicle is currently moving, charging or discharging. Accordingly, it recognises the necessary electricity flows at any given moment and transmits an error message in the event of deviations. No matter the process, the cause has to be identified quickly enough to take countermeasures before a dangerous situation arises.

Current measurement sensor works extremely precisely for years and years

Isabellenhütte current measurement sensors deliver especially stable and precise measurements throughout their life cycle of eight to ten years in ambient temperatures as low as -40 °C and as high as +105 °C. That sets them apart from current measurement sensors made by other manufacturers. “We guarantee a deviation of no more than 0.4 % across the entire life cycle,” Hassel explains. Keeping such deviations low poses a challenge, as products are exposed to the weather and the resulting temperature fluctuations, which can negatively affect the reliability of the sensors’ electricity flow measurements.

The manufacturer also performs tests to ensure functionality. During shock tests, for example, the products are cooled down as quickly as possible from an ambient temperature of +105 °C to -40 °C. “That allows us to guarantee that our sensors measure reliably,” Hassel says. “They work in vehicles in the desert and in northern Canada alike.”

Special alloys ensure precise measurement

The high precision of the current measurement sensors is attributable to the alloys that Isabellenhütte uses in its products and manufactures in-house. The IVT 3 Base is a shunt-based sensor, meaning that current flows through it during measurement. Although temperature changes and similar influences may alter the structure of the material over a product’s life cycle, which can also affect the flow of electrons or electrical resistance, Isabellenhütte’s materials remain stable over a long period of time. To make sure of this, the manufacturer performs certain heat treatment processes in order to artificially age the alloys. “After this heat treatment, the materials remain very stable,” according to Hassel. “That’s why we can guarantee that not much will change within the current measurement sensor over the life cycle of the alloys.”

The shunt-based technology also makes the IVT 3 Base particularly strong and durable in other ways. The busbar can handle currents of up to 12,000 A for a short period of time without damaging the sensor, with an extended measurement range of up to 4,000 A.

Design makes installation in electric cars easier

An additional advantage becomes apparent when installing the IVT 3 Base into an electric vehicle. In Hall effect sensors, which measure changes in the magnetic field, the component is shaped like a ring. As a result, the conductor that is to be used to perform the measurements has to be fed through this ring. By contrast, the IVT 3 Base is shunt-based and is easy to fasten to a flat copper busbar with four screws for use as a connector. Using screws to secure the sensor between two current-conducting bars is very easy, making it possible to channel the electricity flow through the bars and directly through the sensor.

"That lets you safely and directly measure the current flow," Hassel says. "Our sensor is directly integrated into the electricity flow."

The size and shape of the IVT 3 Base offer yet another advantage: Measuring 94 by 84 by 23 mm, and weighing in at just 150 grams, it is one of the smallest comparable ASIL C products on the market. With every cubic centimetre of the essence in battery packs, its compact size is an important argument in automotive engineering. Because every gram counts when it comes to optimising range, weight is a crucial factor in systems with multiple sensors.

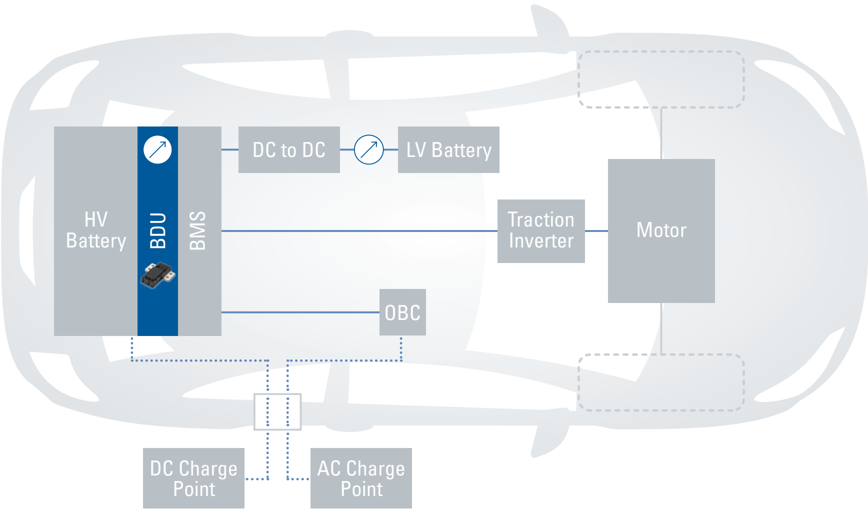

Image 3: Illustration of the main components of a battery electric vehicle (BEV). The IVT 3 measures currents with the utmost precision and transmits them to the battery management system (BMS).

CAN 2.0B, which is considered the gold standard (especially in the automotive industry), acts as the communication interface for the current measurement sensor. That enables onboard diagnosis and other functions for the component itself. In addition, the sensor is also capable of detecting and reporting errors in the system. Right now, Isabellenhütte is currently working on UDS update capabilities for the IVT 3 Base to eliminate the time and effort needed to remove the sensor for software updates.

Customers can define their own CAN IDs

One of the many other options is sleep mode, which reduces power consumption to less than 100 µA on average while still making it possible to reactivate the sensor in less than a second.

Customers can also customise their own CAN IDs. By adjusting the formula, Isabellenhütte can program a dedicated ID for a specific message. "That way, the customer doesn't need to change their system," Hassel explains. "Instead, they receive a software adaptation from us. Then they can install the sensor with all the right settings." The cycle times for transmitting recorded data can also be customised.

Current measurement sensor already in use

The IVT 3 Base is already being used in a battery management system made by Futavis GmbH, Aachen, Germany. The company offers modular battery systems and scalable modular kits for battery management. Futavis incorporates the IVT 3 Base into its switching boxes and builds on it to include the battery management system’s master unit, as well as functions for the shift lock, measuring voltage in individual battery cells, detecting thermal events, balancing out battery cells and pre-storing electricity during charging. The latter plays an important role in extending the life cycle of the electronics.
Ultimately, the automaker receives a safe, durable and certified battery management system for its electric vehicles that fully meets the safety demands for a high-voltage system, including international standards such as LV 123/124, DIN EN 60664-1 and ISO 26262. Thanks to its sophisticated engineering and the expertise of both companies, the system achieves an ASIL classification of C.

Larger model to complement IVT 3 platform concept

In order to round out the IVT 3 platform concept, Isabellenhütte plans to launch the expanded IVT 3 Pro model in the near future. Despite weighing more than the IVT 3 Base (250 grams), the current measurement sensor offers additional functions. Apart from current, the IVT 3 Pro will also be capable of measuring voltage through three or six channels, with a nominal voltage measurement range of 1,000 V and an overvoltage measurement range of up to 1,250 V.

The IVT 3 Pro will also feature isolation detection capabilities, which can be used to monitor defects throughout the battery management system.

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