Analog sensors for current and temperature monitoring in one component

# Reducing development costs with a plug & play solution

*Electrification in the automotive sector is progrssing - andwith it many challenges for manufacturers and OEMs. Ever shorter development cycles require rapid, cost-effective, and technically superior solutions. There is a demand for standard multi-functional components which relieves suppliers of design and development work. The analog sensors from Isabellenhütte offer precise current shunt monitoring for battery management and simultaneous monitoring of the busbar shunt temperature.The measurement and calibration data are provided directly by the soldered circuit board and the data matrix code on the shunt - a plug-and-playsolution for simple integration. Isabellenhütte also provides comprehensive support during implementation.*

*In battery management, the key parameters of state-of-health (SoH), state-of-charge (SoC) and state-of-power (SoP) need to be recorded. Isabellenhütte's analog sensors, which consist of a busbar shunt and a soldered-on printed circuit board (PCB), can be used to precisely monitor the incoming and outgoing currents in the battery pack as well as the temperature development. This allows the battery's state of charge to be reliably recorded and the battery's service life to be extended through optimized charging processes.*

## Plug-and-play reduces development steps

Depending on the configuration of the application, the main electronic functions are often located in a different place than the busbar shunt. Accordingly, OEMs need a simple solution to bridge the distance between the main electronics and the shunt. A small circuit board with a connector soldered onto the busbar shunt is ideal for this purpose. With suitable cabling, analog sensors are therefore a simple plug-and-play solution. Several development steps are eliminated for the user: determining the solder pad design, determining the best position for the measurement tap on the shunt and calibration. In addition, there is no need to record the initial resistance value and the temperature curve (TCR) of each component, as this data is provided directly on a data matrix code. This reduces the internal measurement effort and the necessary software programming.

## Shunt expertise brings the advantage

Manuel Dietermann, Business Development Manager at Isabellenhütte, explains the stumbling blocks in designing the solder pads: "A customer requested a component design for a busbar shunt that was to be used in four different applications. The respective circuit boards were developed by four different engineers. As a result, no solution represented the ideal configuration and the same component delivered four different measurement results. Thanks to our expertise in shunt and PCB design, the voltage taps on the analog sensors are optimally designed to achieve precise and comparable measurement results. The customer then does not need detailed knowledge about the influence of the temperature coefficient when designing the solder pads of the PCB, but instead installs the finished analog sensors."

## Analog sensors BSL, BSX, BSS and BSN

The analog sensors from Isabellenhütte differ primarily in the maximum continuous current, which is influenced by the geometry and resistance value of the sensor. The smallest sensor BSL with a resistance value of 100 µOhm and a maximum continuous current of approx. 310 A is very well suited for 12 V applications. The BSX with a resistance value of 25 µOhm is designed for continuous loads of 1,340 A, which makes it ideal for use in a 400 V or 800 V battery pack. If a customer wants to a smaller sensor and has slightly lower continuous current loads of up to 1,100 A, the BSN with a slightly different cross-section is an alternative.

The pulse loads vary accordingly. For example, the BSL can be subjected to up to 800 A with a current pulse of 1 s, while the BSX can easily handle 3,400 A with the same pulse load of 1 s. The larger cross-section and thus the greater mass of the component ensure better absorption of the thermal energy generated by the voltage drop at the shunt.

While the components mentioned are currently available as B and C samples, the BSS is already in use as a series product in various applications. With R-values of either 100 µOhm or 50 µOhm, it is suitable for monitoring SoC, SoH and SoP in battery packs of heavy-duty vehicles, electric forklifts, excavators or trucks.

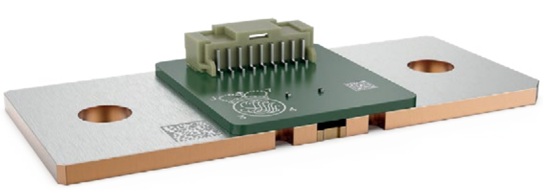

Fig. 1) Current and temperature measurement for battery management in a single component: Isabellenhütte's analog sensors with soldered circuit board offer an easy-to-integrate plug-and-play solution. The picture shows the BSN for use in 400 or 800 V battery packs and a continuous load of 1,100 A.

## Industrial application: energy storage systems

The BSS is also in demand in the industrial sector: for mobile and stationary energy storage systems. The integrated battery management systems temporarily store surplus energy (from solar or wind power, for example) to release it again when required. Analog sensors with their precise current and temperature measurement provide valuable support for the efficient energy management of these storage systems.

## Overcurrent detection as a safety factor

Current measurement can also be used for fault monitoring within the system and, in the event of a fault, the battery can be disconnected from the load by a fuse. The analog sensors detect very precise overcurrents, which are transmitted to a microcontroller. This triggers a Pyro-Fuse or an eFuse to safely disconnect the battery from connected components or the vehicle chassis. Conventional fuses are often no longer sufficient due to their inherent tripping delay, among other things.

## A special feature: Data matrix code

What sets Isabellenhütte's analog sensors apart is the data matrix code (DMC) applied to each component, which contains the sensor's individual measurement data. This includes the initial resistance value and the temperature coefficient. Both parameters must be considered individually for each sensor, as they are influenced by manufacturing fluctuations within the tolerance limits. Although the initial resistance value is usually also specified on the market, only the batch average value of the temperature coefficient is given. This makes the measurement less accurate.

Fig. 2) Users no longer need to record the initial resistance value and the temperature curve (TCR) of each component, as this data is provided directly on a data matrix code.

## Isabellenhütte assists with implementation

Apart from the fact that the analog sensors already offer simplified integration options for customers, Isabellenhütte provides intensive support with the technical implementation of the sensors. The service includes thermal simulation of the sensors and complete assembly with connected busbars in advance. This makes it possible to assess whether, for example, a slightly higher resistance might be suitable in the respective application in order to achieve a better measurement signal. The experts also provide support when reading out and using the data matrix code. Based on the customer's so-called "mission profile", Isabellenhütte can carry out simulations on the ageing of the sensors over their service life on request, which is relevant for energy storage systems, for example, as these are usually in use for 10 to 15 years and must deliver good results in the long term. Isabellenhütte also helps with the connection to the customer's busbars.

## Alternative measurement options: bare shunts or pins

If the main board and shunt are close together, a bare bus bar shunt is a good alternative to the analog sensor. The advantage of this is that no extra plug connection or an additional cable has to be assembled, instead the shunt is soldered on directly. However, this also has the disadvantage that the placement of the solder pads has a decisive influence on the measurement result and deviations can occur. As the trend in battery packs is increasingly moving towards placing the main board and shunt separately from each other, the analog sensor is the more convenient alternative.

Another more highly integrated measurement solution compared to the bare shunt is a busbar shunt with welded pins onto which customers can press or solder their own circuit board. With shunts of this type at Isabellenhütte, the pins are positioned in such a way that good acquisition of the measured values can be guaranteed. However, the distance between the circuit board and the shunt means that exact temperature measurement and compensation of the temperature coefficient is no longer possible. Reliable temperature measurement is essential, especially in the high-voltage range, so analog sensors are the better choice.

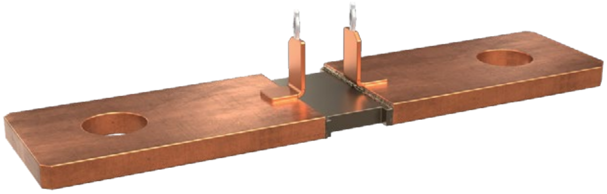

Fig. 3) The BAV allows current monitoring without a soldered circuit board. Thanks to the press-fit pin design, more than two pins per shunt are possible.

## Availability of the analog sensors

The BSS is already in production and can be purchased with values of 100 and 50 µOhm. For the BSX, C samples will be available in the third quarter of 2025 and the SOP is planned for the first quarter of 2026; the same applies to the BSN: C samples in Q3 2025 and the SOP at the end of Q4 2025. For the BSL, C samples can be supplied on request. For customer-specific adaptations, the delivery time for B samples is usually four to six weeks after technical clarification of the details. As a general rule, the smaller the deviations from the standard, the shorter the delivery times. The respective shunt design has the greatest influence here.

| **BSX/BSN**<br>Samples on request | **BSN**<br>Serial Production Part | **BSX**<br>Serial Production Part | **BSL**<br>Samples on request |
|---|---|---|---|
| **Q3 2025** | **Q4 2025** | **Q1 2026** | **on request** |

Fig. 4) Availability of the analog sensors