



# BMS Testing on a HiL System Using Cell Controller Simulation

Automotive supplier ElringKlinger is expanding its testing expertise for battery management systems (BMS), placing its trust in the solutions and expertise of MicroNova's testing specialists.

**TEXT: Abdülkerim Dagli (MicroNova AG), Dr. Pierre Freundt (ElringKlinger AG)**  
**PICTURE: © Herr Loeffler / Shutterstock.com**

2020 saw around 194,200 new all-electric vehicles registered in Germany – a new record, representing a three-fold increase over the previous year. A significant part of this trend towards low-emission mobility is also attributable to the steady advances in battery technology, which is playing a key role

in the transformation of the automotive industry.

Companies like ElringKlinger AG, based in Dettingen an der Erms in Baden-Württemberg, have made a significant contribution to this. The automotive supplier has been working on

battery technologies for vehicles for over 15 years and is a leading German player in this field. Having started out with battery-related components such as cell contacting systems, ElringKlinger has now secured orders for complete battery modules.

ElringKlinger is expanding its portfolio to include new products and solutions as part of its transformation from a component supplier to a systems partner. This includes, for example, the development of a battery management system (BMS), i.e. the electronic control unit for electric-vehicle batteries. ElringKlinger has chosen the software and systems vendor MicroNova as its partner for this project. With its measurement and simulation solutions specially developed for e-mobility, its hardware-in-the-loop (HiL) system "NovaCarts Battery" is ideal for testing battery control units.

#### **BMS: Multiple requirements for test systems**

The battery management system plays a central role in battery storage systems: besides monitoring the individual cells, it also assures functional safety by preventing overcharging or excessive discharging of the cells. The BMS also provides the main communication interface to other control units in the vehicle. For example, in addition to measuring battery voltages, it can also work together with the speedometer and navigation system to calculate range.

The requirements for appropriate test benches for their reliable validation are therefore just as varied as the battery management system functions: The HiL systems must simulate all conditions to which a BMS can be exposed in a realistic and reproducible manner. This is the only way of ensuring and proving that the system is functioning correctly.

One of the key challenges in developing BMS test systems is the high-precision simulation of individual cell voltages. While overall voltage is up to 1,000 volts, it is necessary to display differences in the millivolt range.

Another focus is the exact simulation of the charging and discharging current of the battery system as well as the intermediate circuit with the voltages occurring there. In addition, a test system should be able to accurately simulate the entire battery, including cell temperature and aging, and simulate special signals (e.g. pilot, crash).

NovaCarts test systems for BMS meet these requirements with the required accuracy through hardware and software-based simulations, thus enabling realistic testing at an early stage of development.

#### **Cell module controller simulation – a unique feature**

Safe operation of lithium-ion battery cells requires the continuous monitoring of cell voltage and temperature. To this end, each of the modules, each of which groups together several cells in a battery, has its own monitoring electronics unit. This consists of cell module controllers (CMC), also known as cell sensor circuits (CSC) or cell supervision electronics (CSE). Each cell is connected to such a monitoring

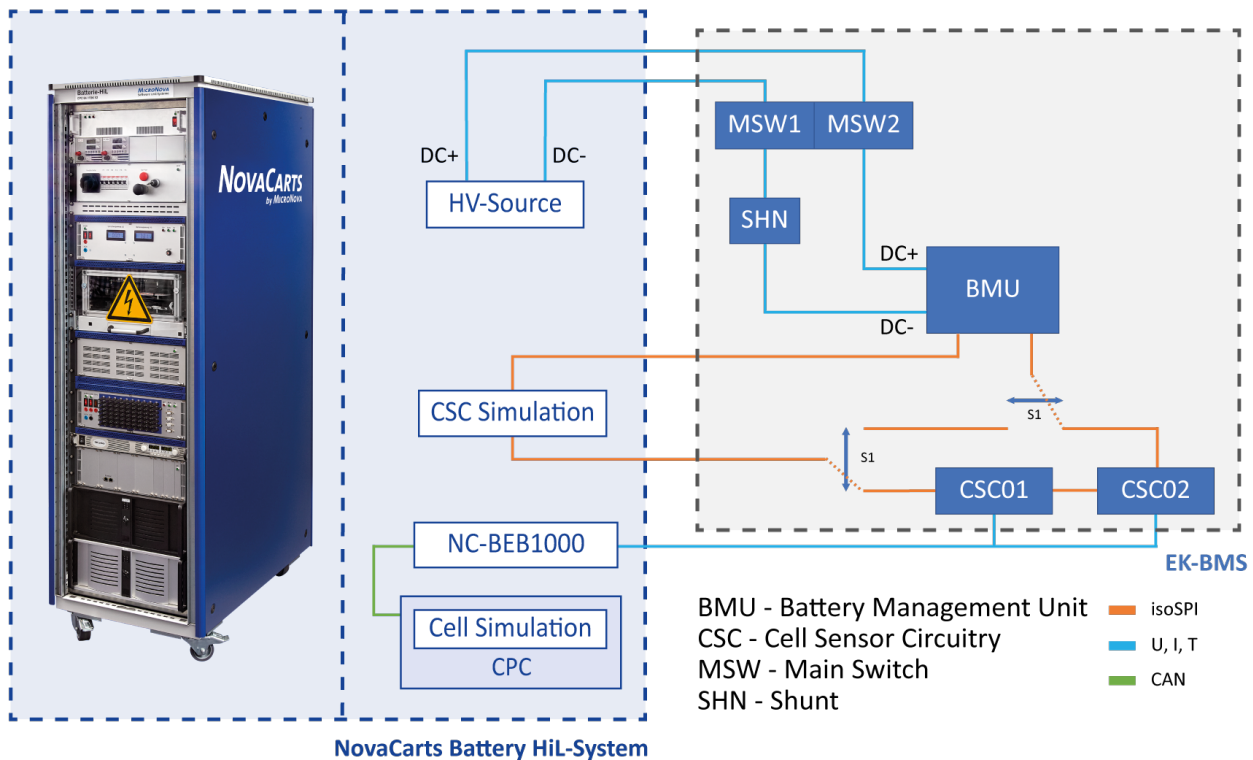
module, i.e. a CSC. CSCs constantly measure the voltage and temperature of the cells and pass this information to the BMS.

CSCs are primarily circuit boards with one or more microcontrollers, also known as ASICs (application-specific integrated circuits). These chips are specially designed for monitoring lithium-ion cells. The CSCs are connected electrically to the cell poles via "sense lines" in order to measure the voltage of the cells. Additional lines can also be used to connect temperature sensors, which are relevant for ensuring optimum use and load of the cells.

As central battery components, the cell module controllers supply the BMS with information about the current state of the cells. The BMS would not be able to collect any useful information on the state of the battery without them and pass it on, for example, to calculate the remaining range. CSCs therefore undergo repeated optimization in the course of the development of a BMS. ASICs are most frequently subject to modification, as the development process often involves the

#### **About ElringKlinger AG**

As a global, independent vendor, ElringKlinger is a strong and reliable partner for the automotive industry. The company offers innovative product solutions for all drive types – whether passenger cars or commercial vehicles, with combustion engines, hybrid technology or all-electric vehicles – thereby contributing to sustainable mobility. Lightweight design concepts reduce vehicle weight, which in turn reduces fuel consumption and CO<sub>2</sub> emissions in internal combustion engines and increases the range for alternative drive systems. ElringKlinger positioned itself early on as a specialist in electromobility with cutting-edge battery and fuel cell technology and electric drive units. The company is continuously developing its sealing technology for a wide range of applications. Its shielding systems ensure optimum temperature and acoustic management throughout the vehicle. Dynamic precision parts from ElringKlinger can be used with all drive types. Engineering services, tooling technology and products made of high-performance plastics – also for sectors outside the automotive industry – round off the portfolio. In total, around 10,000 employees at 44 locations worldwide work within the ElringKlinger Group.



**1** Functional scheme of the BMS HiL system used at ElringKlinger.

**Positive trend for e-cars**

At around 194,200, electric vehicles achieved a share of just under seven percent of total new registrations in 2020, while conventionally powered cars accounted for around 74 percent. Hybrid vehicles accounted for a further 18 percent and natural gas and liquefied petroleum gas for a further one percent.

The target set by the German government in 2013 of one million electric vehicles on Germany's roads by 2020 was therefore unfortunately not met. However, the latest registration figures indicate a clear trend in society and a rethink towards more environmentally friendly and sustainable mobility.

integration of chips that are more powerful and more suitable for the application in question. Replacing ASICs can be time-critical for development, as they also play an important role in communication with the BMS. This is because CSCs are not always available in time for validation tests when the new ASICs are introduced.

In this purpose, MicroNova offers a simulation solution that emulates ASICs and their function in the BMS-CSC network. This CSC simulation is based on an FPGA-based hardware solution that can be used both on the HiL system and as a desktop application. The associated software allows a choice between different ASICs for simulation. This approach allows validation tests for the BMS to be started at a very early stage, since no real CSC components are required. Moreover, CSCs from different manufacturers can

be easily tested in combination with the BMS – without significant change-over and downtime or conversion costs. MicroNova's CSC simulation currently supports chips from Texas Instruments, Analog Devices, Linear Technology, and MAXIM Integrated. Simulations for additional chips can be developed on demand.

**Trust and cooperation on eye level**

ElringKlinger's development and test engineers were able to draw on the decades of experience of MicroNova's consultants and project engineers in the fields of test & validation, simulation development and project management when establishing a test process for their own BMS development. Even the initial meeting and the joint preparation of specifications were characterized by a spirit of partner-

<sup>1</sup> <https://www.faz.net/aktuell/wirtschaft/wirtschaftspolitik/eine-million-elektroautos-bis-2020-merkel-haelt-an-absatz-ziel-fest-12196498.html>

ship and goal-oriented cooperation. Close contact was also maintained with those responsible at ElringKlinger during the implementation of the project. Regular updates on the status of the HiL setup and the implementation of the software elements meant that changes could be introduced at any time, even at short notice.

"We have expanded test capacities in the area of battery storage as well as module and cell testing in order to continuously broaden our e-mobility portfolio and have invested in corresponding test benches with climate function. A major factor in this is the ability to master the battery management system as well. In addition, the development and validation of key components such as the BMS form core elements of our develop-

ment and testing strategy," says Dr. Pierre Freundt, Head of Battery Testing & Validation at ElringKlinger, explaining the company's motivation. "The decisive factor in choosing MicroNova as a project partner in the field of HiL testing was, apart from its many years of experience in testing battery management systems, its high level of expertise in simulating cell module controllers."

The "NovaCarts Battery" BMS HiL system was commissioned on schedule. This was partly carried out on site at ElringKlinger, but for the most part remotely. In addition to a detailed briefing on the test system, training was also provided on how to operate the hardware and software. Both the HiL support engineers at MicroNova's corporate headquarters in Vierkirchen

and the engineers at the Leonberg site are available to assist in ongoing operations.

### Summary

The transformation in mobility is advancing, and battery technology has a central role to play in this. High-quality products and excellent cooperation have been impressive in the implementation of further tangible steps from the very outset. ElringKlinger AG has already embarked on the first enhancements to the CSC simulation, which will lead to even closer cooperation between the two companies. The focus is on further use cases in the context of electromobility.

# Red Hat Innovation Award

## MicroNova supplies key components for VW innovation project

**TEXT: Editorial staff**

Every year, the open source provider Red Hat honors five particularly innovative customer projects with the "Red Hat Innovation Awards". This year, one of the award winners is Volkswagen AG.

To improve the speed, scalability and consistency of testing ECUs for modern vehicles, VW Group used Red Hat technology to develop a test environment that combines virtual and real-

world testing. With this new environment and an architecture created with "Red Hat Open Innovation Labs", the VW Group's development division improved the integration of components, introduced self-service provisioning, and reduced system testing costs by 50 percent.

MicroNova congratulates VW on their success! We are proud to be able to help develop forward-looking stand-

ards such as the Connected Mixed Reality (CMR) environment and to contribute to the success of this project with some of our products. The MicroNova software "NovaCarts Virtual" for HiL systems, for example, is an important component for CMR as a simulation node.



# MicroNova Live!

Meet our experts here.

TEXT: Editorial staff PICTURE: © Brian A Jackson / Shutterstock.com

Events – the real ones, not virtual ones – have been rare in recent months for reasons we all know. However, there are now increasingly optimistic plans for some industry events. Our experts from the Testing Solutions division are already looking forward to two important dates in autumn. We hope to finally meet you in person again at 'f-cell Stuttgart' and the 'Battery Experts Forum'!

## **f-cell Stuttgart – Energizing Hydrogen Markets Haus der Wirtschaft, Stuttgart September 14.-15, 2021**

At the two-day event, international hydrogen and fuel cell experts will provide an extensive overview of relevant markets and industries as well as technological advances in alternative propulsion.

As part of the interactive format, MicroNova will be present together with its partner Smart Testsolutions. The companies will present their cooperation in the areas of fuel cell measurement technology, HiL testing & validation for ECUs and control elec-

tronics as well as monitoring of fuel cells and electrolyzers (Booth 23, List Hall).

## **Battery Experts Forum Messe Frankfurt, Hall 6.0 October 5.-7., 2021**

At the three-day Battery Experts Forum at the Congress Center of the Messe Frankfurt, MicroNova will provide information on how to validate battery management systems in a time and cost-effective manner.

Come and see our presentation "Simplification and cost reduction in testing Battery Management Systems" and learn more about the "NovaCarts Battery" HiL system.

### **Presentation times:**

- » Tuesday, 5 Oct. 2021, 3:20 pm – 3:35 pm, Business Presentation Lounge
- » Thursday, 7 Oct. 2021, 2:00 pm – 2:30 pm, Conclusion Room

Contact person and speaker:

**Abdülkerim Dagli**  
[sales-testing@micronova.de](mailto:sales-testing@micronova.de)  
 +49 8139 9300-0

## **Webinars**

In order to also keep you up to date virtually with the latest solutions and technologies, MicroNova offers free webinars. If you are unable to attend live or have missed a date, you can find the recordings here: [www.micronova.de/en/testing/videos](http://www.micronova.de/en/testing/videos)

Further events, webinars and presentations will be added to our schedule on an ongoing basis. Visit our website at [www.micronova.de/en/testing-events](http://www.micronova.de/en/testing-events).

## **Testing Solutions Newsletter**

Have you already subscribed to our newsletter? Sign up to receive regular updates on MicroNova's products, solutions, and services. You can of course choose your main areas of interest and your preferred language (DE/EN).

Sign up now at [www.micronova.de/en/newsletter](http://www.micronova.de/en/newsletter).