MicroNova
Software and Systems

NovaCarts Fuel Cell featuring SMART-TS MCM

SMART
TESTSOLUTIONS

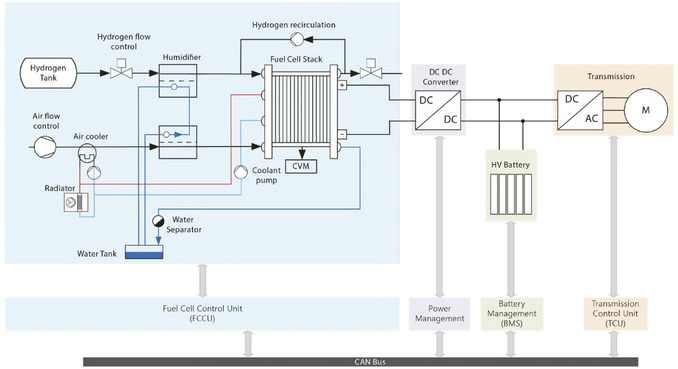
Platform for validating fuel cell control units (FCCUs)

- **Powerful real-time platform for comprehensive, ASPICE-compliant validation of electronic control units (ECUs)**
- **High-precision mapping of individual cells, compact design, and high insulation voltage for large numbers of channels**
- **Scalable, flexible architecture from single-component to integrated HiL systems**
- **End-to-end X-in-the-loop (XiL) test environment**
- **Comprehensive advice during design, implementation, and operation**

Efficient Test Technology for Fuel Cell Controllers

A broad performance range between partial and full load, transient processes, and changing ambient conditions combine to make the control of a fuel cell system (FCS) in vehicles a complex task. The fuel cell control unit (FCCU) is critical for high reliability and efficiency as well as a long service life for fuel cell systems. Validating this control unit is therefore important.

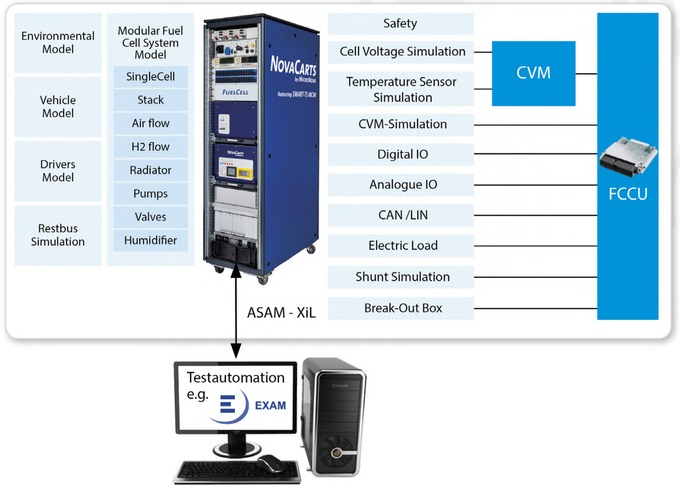
MicroNova and SMART TESTSOLUTIONS have pooled their expertise in fuel cell measurement engineering and HiL applications to provide automotive manufacturers and suppliers with time- and cost-efficient as well as comprehensive test solutions for FCCU validation.



Benefits of Hardware-in-the-Loop Testing compared to Validation on the Fuel Cell System Test Bench:

- Significantly lower costs of acquisition and operation due to faster changeover
- No requirement to handle hydrogen with the associated safety regulations and risks
- High flexibility – from single component HiL system (e.g. stack only) to system HiL test and integrated HiL system
- Faster changeover and start-up
- Time savings and quality assurance thanks to easy reproducibility of tests
- Straightforward error testing and critical state testing

When combined with the "NovaCarts Battery" HiL system, it is also possible to simulate functions of a connected battery, such as state-of-charge (SoC) and state-of-health (SoH) control, and cell balancing. The „NovaCarts eEngine" HiL simulator also enables validation of the entire control unit network of fuel cell electric vehicles (FCEVs).



Structure and Operation of the HiL System NovaCarts Fuel Cell featuring SMART-TS MCM

NovaCarts Real-Time Suite Platform:
The NovaCarts Real-Time software for the H2 HiL test bench runs on a special industrial PC with a Linux operating system for real-time applications. This setup ensures a processing frequency of up to 1 kHz in harsh real time, meaning that the defined response time is never exceeded.
Test automation solutions such as EXAM can be integrated via an ASAM-standardized XiL interface.

System Characteristics:
The HiL system concept is adapted to specific test tasks. For example, different electrical loads can be used depending on test requirements.
The modular design and the systematic networking of the individual components over real-time Ethernet make subsequent adaptations easier. I/O modules from MicroNova and SMART TESTSOLUTIONS can be used equally to provide optimum results in terms of performance and price sensitivity.

I/O Modules

SMART MCM I/O and IntelliSim Cell Voltage Simulation:
The key feature of SMART TESTSOLUTIONS' multi-channel MCM I/O modules is their ability to process multiple I/O signals in parallel and completely synchronously. The modules are inexpensive, easily scalable and cover all necessary I/O requirements for a device under test. The simulation modules of the MCM IntelliSim series, when used in conjunction with a master module, make it possible to actively simulate each cell of a fuel cell stack without having to integrate a real stack into the test environment. They follow the successful modular design principle of the MCM IntelliProbe product family for single cell voltage measurement, which is used by fuel cell vehicle manufacturers and their suppliers around the world.

IntelliSim modules are very compact and robust and can be easily combined to form a multi-cell stack. Up to 50 modules allow the simulation of a maximum of 500 (single-cell simulation) or 1,000 cells (double-cell simulation). Cascading makes 1,000 or 2,000 simulation channels possible. The master module guarantees the integration of simulation over Ethernet or EtherCAT and consequently real-time operation. Operation over CAN without a master module may be sufficient for less dynamic applications.

IntelliSIM Technical Data	
Dimensions of each module	100 x 10,5 x 30 mm
Simulation channels per module	10
Simulation range per channel	-3 to +3 V
Accuracy	Max. ± 6 mV
Output rate	≤ 1.000 Hz
Permanent galvanic isolation	1.400 V DC

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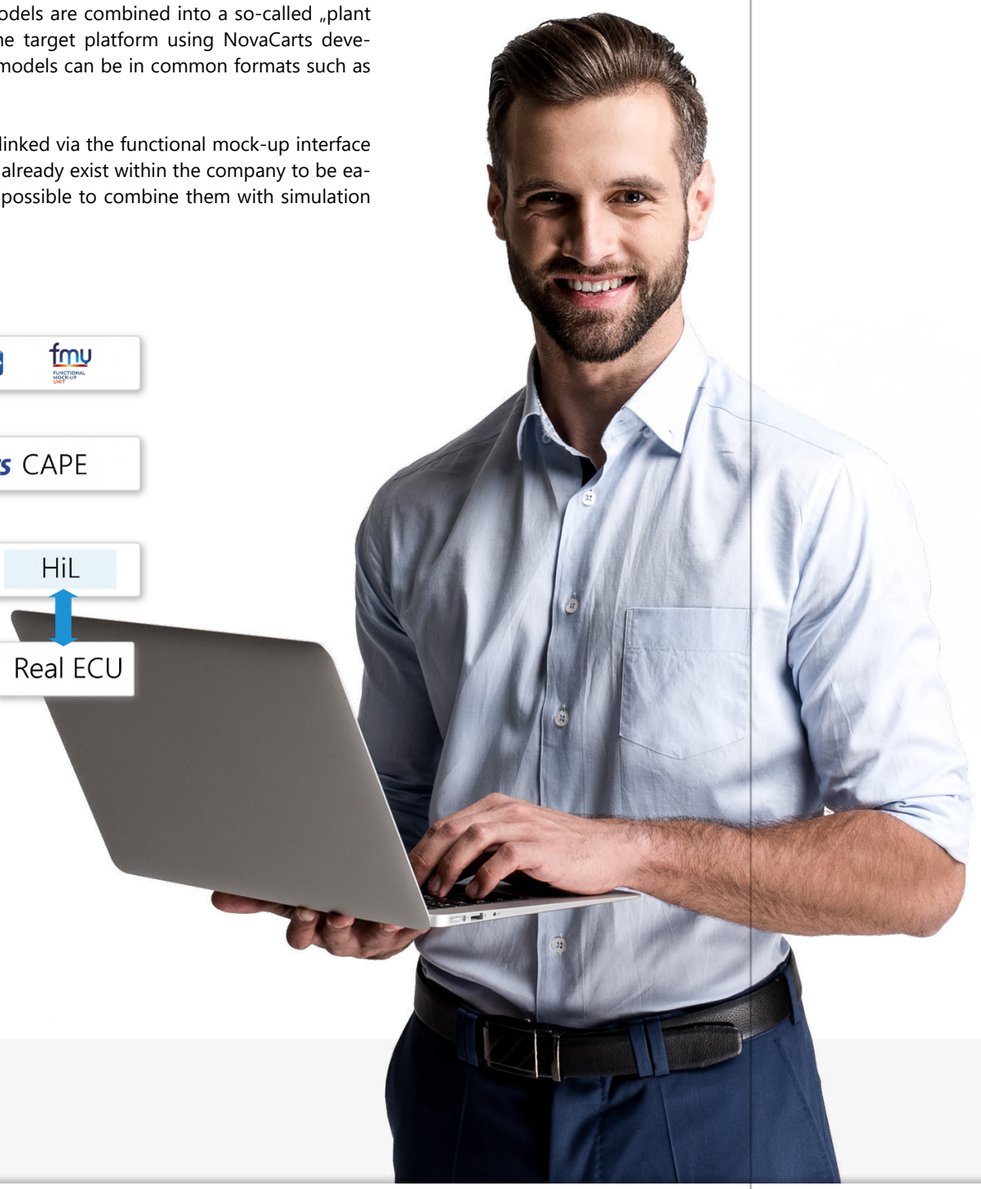
Simulation Models: Architecture and Integration Options

Simulating a fuel cell system is a complex, multi-domain task. In order to meet all requirements, individual sub models are combined into a so-called „plant model“ and made available on the target platform using NovaCarts development tools (CAPE). Simulation models can be in common formats such as MATLAB/SIMULINK or C / C++.

In addition, partial models can be linked via the functional mock-up interface (FMU / FMI), allowing models that already exist within the company to be easily integrated. It is also generally possible to combine them with simulation models from other suppliers.



Competence and Experience for Your Success

Fuel cell systems and their control units are modules that are critical to function and safety. The demands on the development and validation of the FCCU are correspondingly stringent.

SMART TESTSOLUTIONS has been active in the fuel cell measurement and simulation market for more than 20 years and is the market leader in cell voltage monitoring.

MicroNova’s testing experts have more than 30 years of experience in HiL simulation and ECU testing. Their expertise also includes modeling, virtualization of ECUs, test automation, and functional safety. Our specialists provide comprehensive support for the introduction and operation of an ASPICE-compliant test environment for fuel cell control units:

- Requirement analysis, preparation of requirement specifications
- Design specifications
- On-site setup of NovaCarts Fuel Cell featuring SMART-TS MCM
- Ramp-up and optimization
- Staff training
- Safety gap analysis
- Tool qualification for ISO 26262, preparation for assessments

You can find more information at: www.micronova.de/en/NovaCartsFuelCell

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