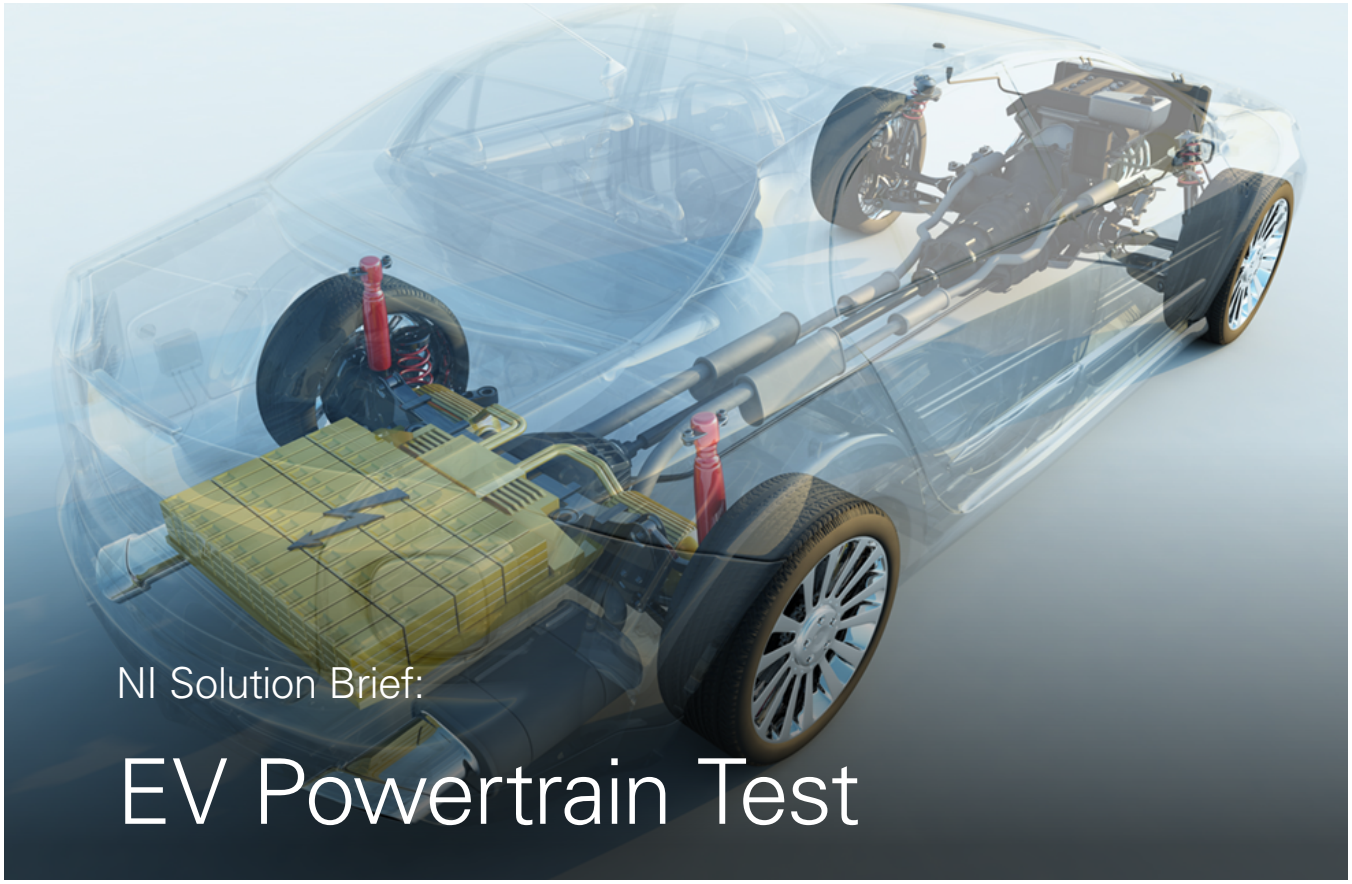


NI Solution Brief:

EV Powertrain Test

Electric vehicle (EV) powertrain components and systems are rapidly evolving and test teams must keep pace. NI offers a highly adaptable, platform-based test approach that you can use across the product development process to accelerate test development, expand test coverage, and efficiently manage data and systems.

Signal-Level HIL Inverter Test 2

EV Battery Pack/Module Test 4

Battery Management System (BMS) Test 6

NATIONAL INSTRUMENTS

Signal-Level HIL Inverter Test

You can test hybrid and electric vehicle inverters for software and electrical functionality at the signal level with a closed-loop simulator. By using a simulator instead of a dynamometer, you can test sooner in the design process, test cheaper, and achieve greater test coverage because of the physical limitations of dynamometers. You need to iterate on systems quickly to manage rapidly evolving DUTs and meet time-to-market requirements.

Application Requirements

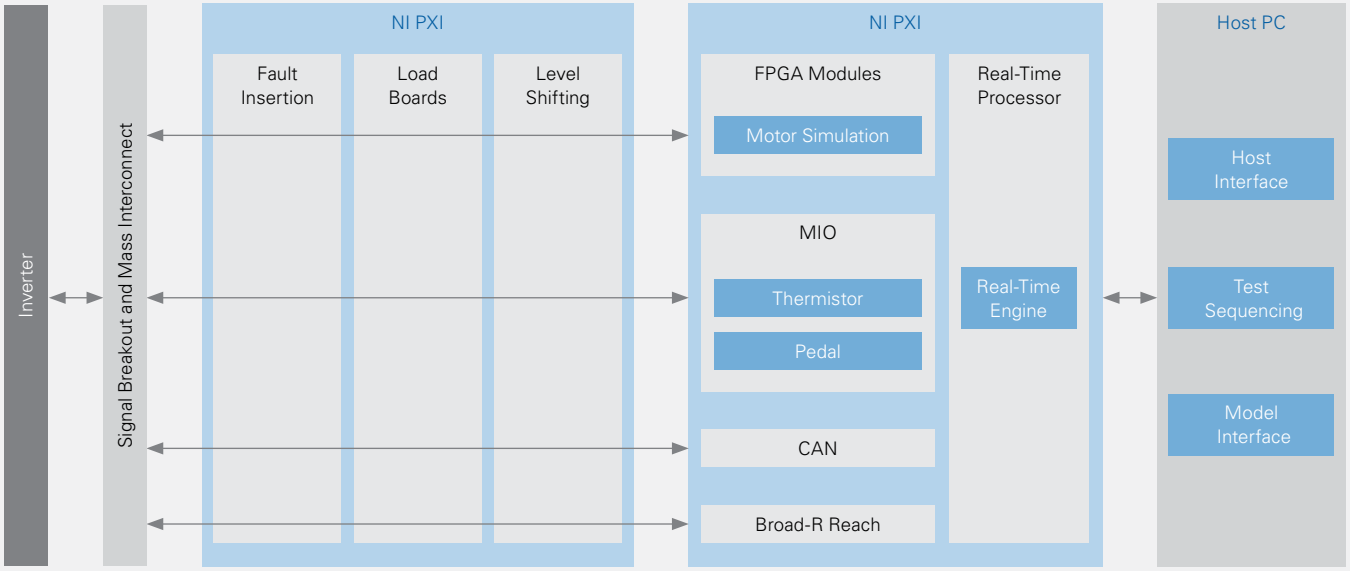
- Run motor and electrical models at 100 kHz or faster loop rates to achieve sufficient model accuracy for testing the inverter in simulation.
- Deploy quickly using existing models, tools, and workflows. Test systems need to be up and running quickly with fast delivery schedules.
- Use fault insertion in hardware for opens and shorts and software for network messages.

NI Solution

NI PXI and CompactRIO hardware incorporates the latest commercial off-the-shelf (COTS) FPGA technology from Xilinx and provides I/O interfaces to the DUT.

NI is collaborating with OPAL-RT to readily deploy models from a variety of electrical modeling environments like swMATH SimPowerSystems, Powersim PSIM, and NI Multisim directly to NI FPGA PXI modules.

You can implement open, short, and ground hardware fault insertion with NI switch, load, and signal conditioning (SLSC) hardware, and you can implement software faults directly in the FPGA.



In partnership with OPAL-RT TECHNOLOGIES

The NI Advantage

NI systems can be integrated and delivered by our industry-leading partners like OPAL-RT to help you get up and running quickly.

NI's open and flexible platform-based approach means you can own the test system IP and make changes quickly rather than solely relying on a third-party vendor.

"By adopting FPGA-based simulation using the NI hardware and software platforms, we achieved the simulation speed and model fidelity required for verification of an electric motor ECU. We reduced test time to 1/20 of the estimated time for equivalent testing on a dynamometer."

Tomohiro Morita, Subaru

EV Battery Pack/Module Test

Cycle power from a battery pack according to profiles such as drive cycles across a variety of temperatures to determine key performance and durability characteristics related to cycle life, efficiency, and safety.

Application Requirements

- Time-intensive tests require managing long-term tests in multiple parallel testers.
- EV power levels need a specialized source/load (battery cycler) with regeneration and safety features.
- Battery temperature dependence requires thermal chambers and heater/chiller control.

NI Solution

Battery Test Software

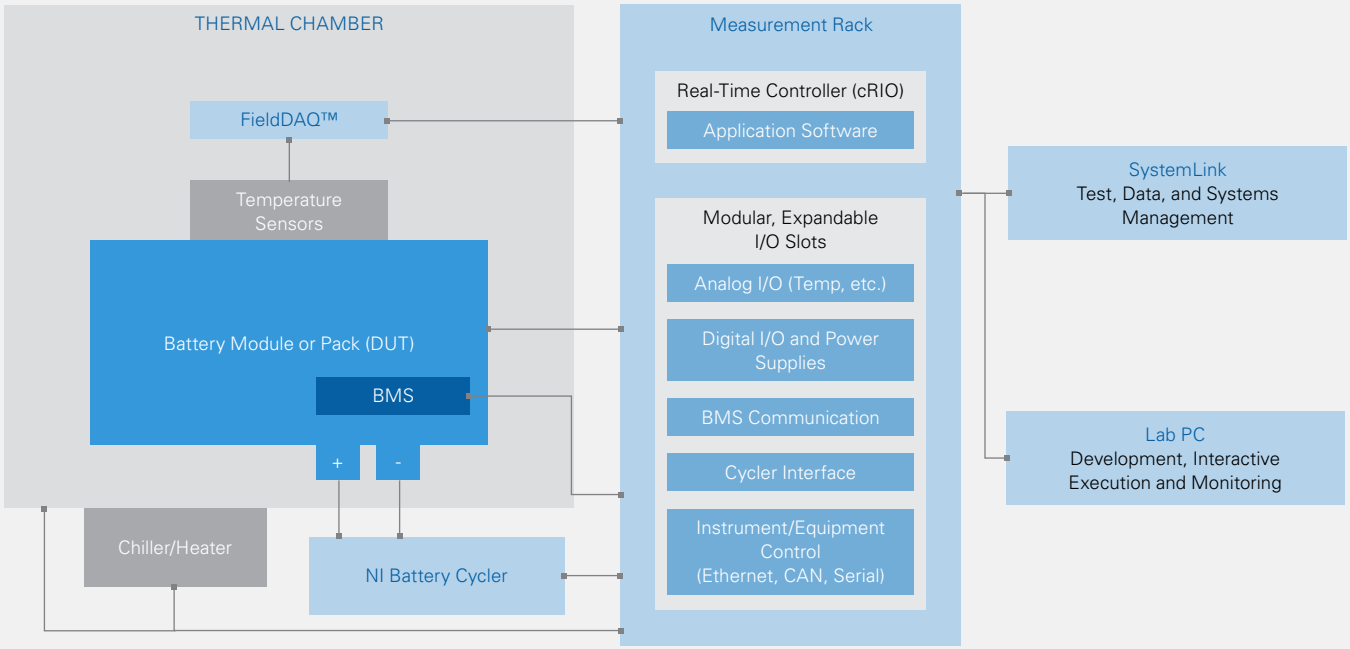
Manage test execution and quickly set up test sequences with pre-defined configurations and equipment drivers.

Power Electronics

Take control with flexible power cycling for simple loading to drive cycle simulation with regeneration.

Enterprise Test Management Software

Increase efficiency in test, data, and systems management of distributed systems from anywhere with SystemLink™ Software.



The NI Advantage

NI data and systems management capabilities maximize the uptime of expensive test resources and ensure you have complete visibility and control of your tests no matter where you and your test assets are in the world.

NI systems provide seamless integration of advanced control, measurement, and third-party equipment to help you minimize the time required to build and maintain heterogeneous test setups for a variety of components and programs.

Key Specifications	
Equipment Integration	Integration of any third-party environmental chambers or control/measurement devices and easy management of a heterogeneous fleet of equipment
Flexible Control	Sequencing, alarms, fully definable profiles, and variable/PID/custom thermal setpoints and profiles
Data and Systems Management	Scalable enterprise-ready tools for data organization and storage, interactive data exploration/visualization, custom automated reporting and analytics, software versioning and remote deployment, and so on
Charge/Discharge Mode	CC/CV/CP/Waveform
Voltage Range (Cycler)	0–1200 V
Current Range (Cycler)	±1600 A
Power Range	Up to 1.2 MW
Power Regeneration	Ability to recycle energy back to the DC bus or to the grid (utility)
High-Precision Measurements	Easy addition of any NI I/O library to scale the test system from a few to hundreds of I/O channels (temperature, thermal cameras, DIO, stress/strain, vibration, and so on) to meet test requirements now and in the future
Cell Voltage	±10 V, 24-bit, 1 kS/s/ch simultaneous, 250 Vrms, CAT II, channel-to-channel isolation
Cell Temperature	J, K, T, E, N, B, R, and S thermocouple types (24-bit, simultaneous sampling)
Digital Input/Output	30 V DC, 7 µs sinking DI, 500 µs sourcing DO, 60 V DC, CAT I, channel-to-earth isolation, with PWM support

Battery Management System (BMS) Test

Verify your battery management system (BMS) function with HIL testing by emulating battery cells and simulating sensors, I/O, and communication to other ECUs. Ensure that your communication, safety functions, cell balancing, and fault monitoring algorithms are working properly.

Application Requirements

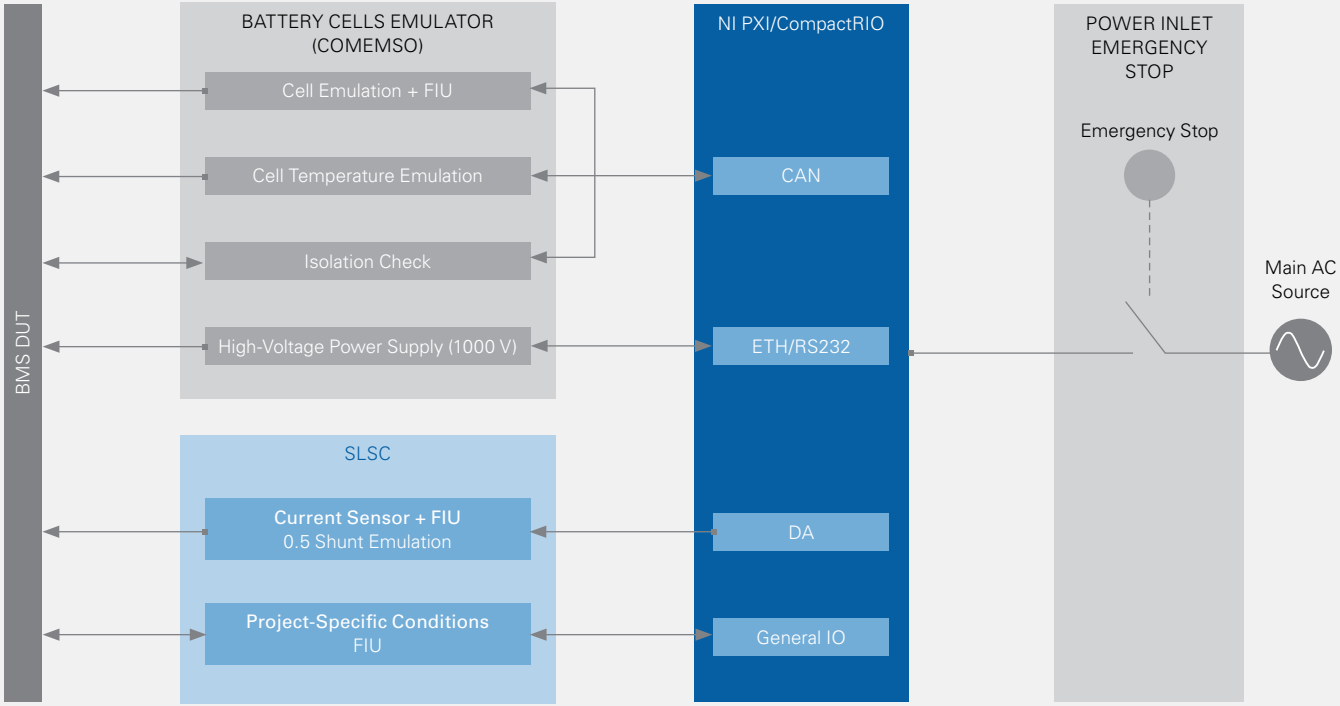
- Emulate cells on battery models.
- Conduct fault insertion and signal conditioning on BMSs.
- Implement ECU communications and sensor simulation on BMSs.

OPAL-RT Solution

Emulate 12 battery cells with a Comemso high-precision BCS unit connected to the system through a PXI CAN interface module. Easily add more channels.

Integrate battery models configured to simulate most battery types (NiMH,LiON, and so on) with different discharge characteristics, connect to third-party equipment, and execute real-time tests with VeriStand.

Take advantage of integration expertise and custom engineering for extra protection, shunt emulation, breakout boxes, and the incorporation of other controls and systems.



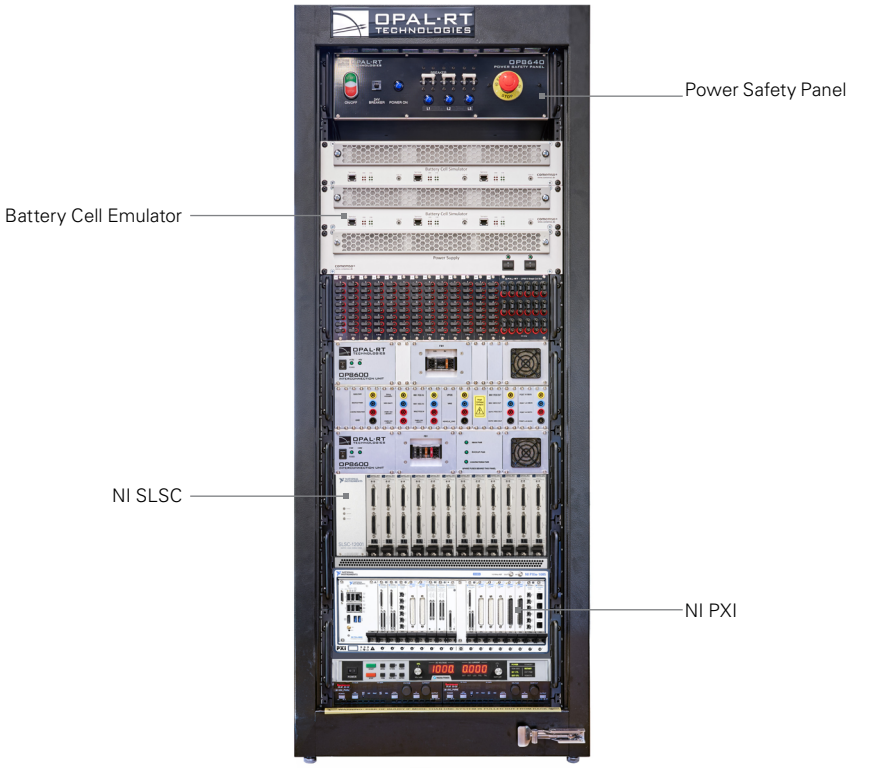
OPAL-RT TECHNOLOGIES BMS test solutions on the NI platform are delivered by OPAL-RT and other NI Alliance Partners.

The NI and OPAL-RT Advantage

NI for hardware and VeriStand software, OPAL-RT for integration and models, and Comemso for battery emulation add up to the BMS leadership triumvirate.

The NI real-time simulation system helps you develop and test products and designs in a safe environment.

NI and OPAL-RT combined technologies help you to simulate models of batteries, high-fidelity power electronics and motors, and cooling or visual control units in real time.



Key Specifications, Comemso Battery Emulator	
Number of Cells per Emulator	12
Voltage Range	0.01…8 V
Nominal Current	0…4.9 A
DC Accuracy	±0.5 mV
Ripple	±3 mV
Communication with NI PXI	CAN/Ethernet
Electrical Failure Simulation	Broken wire, short circuit, polarity reversal; up to 144 cells per rack, 200 cells total

"Testing a BMS in real time is not a very high technical challenge in terms of real-time simulation, but the safety and reliability, repeatability of tests, flexibility, and openness of the solution made the full difference for us."

Julie Darrah, Senior Engineer, IAV Automotive Engineering

System Integration on Your Terms

NI offers a variety of solution integration options customized to your application-specific requirements. You can use your own internal integration teams for full system control or leverage the expertise of our worldwide network of Alliance Partners to obtain a turnkey system.

Contact your account manager or call or email us to learn more about how NI can help you increase product quality and accelerate test timelines at **(888) 280-7645** or info@ni.com

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- Turnkey Solution Delivery and Support
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- Global Support
- Prototyping and Feasibility Analysis
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