

CUSTOMER CASE STUDY

HIL System for Electric & Hybrid Vehicle VCU Validation

Application Summary

TMCS developed a **Hardware-in-the-Loop (HIL)** system to validate **Vehicle Control Units (VCUs)** for **electric and hybrid vehicles**. Built with **NI PXIe**, **LabVIEW** and **NI VeriStand** for **real-time simulation**, the system performs **CAN**, **I/O**, **load** and **calibration** tests under automated control, ensuring reliable, high-performance VCU validation under simulated conditions.

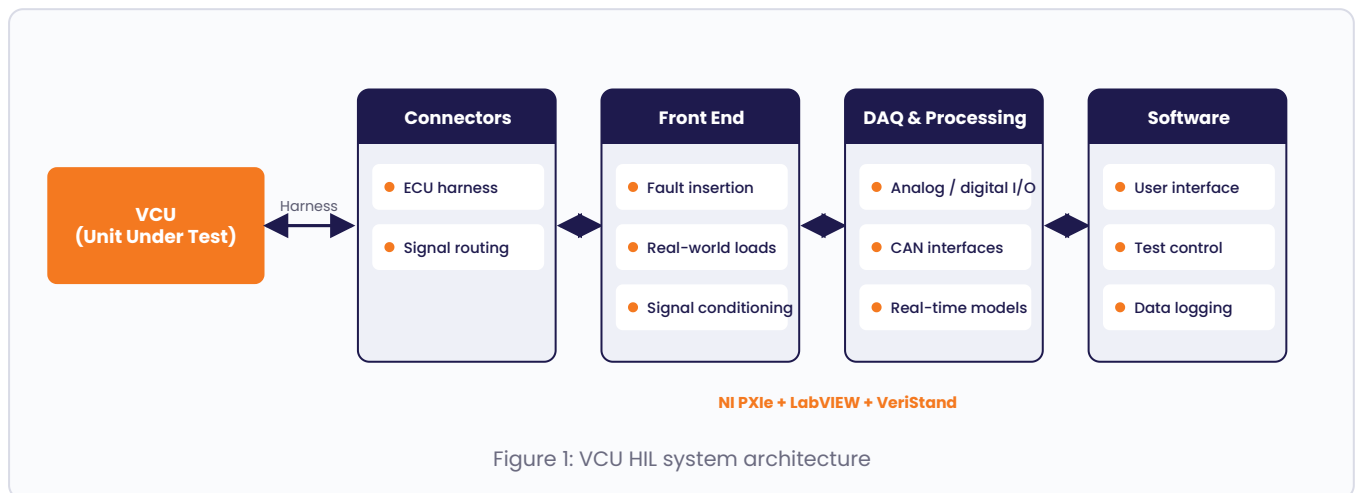
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Challenges

The VCU coordinates the powertrain, energy management and driver commands, so a fault in its software or I/O affects the whole vehicle. Testing it on prototypes is expensive and late in the program, and many conditions are hard or unsafe to create on a real vehicle. The challenge was to give the VCU a realistic electrical and network environment, with real-world loads and controlled faults, and to run the tests automatically and repeatably.

The Solution

TMCS built a layered **VCU HIL system**. The VCU connects through its harness to a **front end** that provides **fault insertion**, **loads that simulate real-world conditions** and **signal conditioning**. **NI PXIe DAQ** hardware handles analog, digital and **CAN I/O** while **real-time models** in **NI VeriStand** simulate the vehicle. The **LabVIEW** software layer provides the user interface, automated test control and data logging.



Test Types / Parameters Monitored

Test Type	Description
CAN Communication	Verifies VCU messages, signals and timing on the vehicle network
I/O Validation	Checks analog and digital inputs and outputs against expected behaviour
Load Testing	Validates VCU outputs while driving simulated real-world loads
Calibration Testing	Verifies calibration parameters and their effect on VCU behaviour
Fault Handling	Confirms VCU response to inserted electrical faults

Specifications & Features

Feature	Description
Real-Time Simulation	Vehicle and powertrain models executed in NI VeriStand
Fault Insertion	Controlled electrical faults on VCU lines
Real-World Loads	Load simulation with front-end signal conditioning
Automated Control	Test execution and sequencing under software control
Data Logging	Structured logging for traceability and analysis

Technology Used

The system uses **NI PXIe** hardware for high-speed I/O and **CAN** interfacing. **NI VeriStand** runs the real-time vehicle models and **LabVIEW** provides the user interface, test control and data logging. Fault insertion, load simulation and signal conditioning in the front end connect the hardware safely to the VCU.

Advantage / Benefit

- **Early validation:** VCU software and hardware are tested before vehicles are available.
- **Realistic conditions:** real-world loads and network traffic exercise the VCU as in the vehicle.
- **Safe fault testing:** electrical faults are injected without risk to vehicles or people.
- **Automated and repeatable:** consistent regression testing with full data logging.
- **Supports EV and hybrid platforms:** one architecture serves both.

Conclusion and Future Plan

The HIL system gives the customer a reliable, high-performance platform for VCU validation under simulated conditions. Future enhancements may include expanded fault scenarios, additional vehicle networks and closer integration with model-based development tools.

Need a HIL system for your VCU?

Talk to TMCS engineers about your validation requirements.

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