



GO for Quality

Ford's electrical/electronics system validation group turns to 'lights out testing' to maximize test coverage

The North American Electrical & Electronics System Validation group at Ford Motor Company has nearly tripled its automated testing capability, adding momentum to the automaker's resolve to strengthen its global market position by producing the highest level of quality cars and trucks, while reducing its overall cost structure.



HIL Simulation Lab

Recently Ford's Electrical/Electronics System Validation Group acquired eight, full-size hardware-in-the-loop (HIL) simulators from dSPACE. The group's state-of-the-art testing lab is now equipped with a total of 13 full-size dSPACE HIL simulators all dedicated to developing and testing embedded systems associated with Ford's electric/electronic (E/E) architecture for future vehicle models. Similar dSPACE HIL systems are applied at Ford facilities in Cologne, Germany, and at its flagship technical center in Dunton, UK.

Automated Test Runs

With the addition of automated test scripts, written with dSPACE AutomationDesk® software, the Electrical Validation Group is now equipped to perform "lights out testing." This means the group has the capability to test E/E systems around the clock, running tests nights and weekends with minimal supervision.

"This capability enables the Electrical/Electronics System Validation Group to conduct more thorough and

in-depth testing, while dramatically minimizing its manual testing costs," says Jace Allen, Manager HIL Engineering at dSPACE, Inc. "It will also improve the quality of the modules and electronic systems in the vehicle, which directly leads to better vehicle quality and greater customer satisfaction."

The Benefits of Automated Testing

"The number of distributed functionality across ECUs in vehicle electronics is rapidly growing. Automated testing at the subsystem and vehicle system level is absolutely essential and has become an integral part of the Ford development process," says EESE Global Embedded Software Manager, Florian Frischmuth. "Automated software testing including the real ECU real hardware gives us the ability to cover significantly more conditions and scenarios than manually ever possible."

Smart Power Testing

HIL simulation testing has long been a proven test method to the Electrical/





“Our ability to automate and execute testing 24/7 has been a key contributor to the success and expansion of our HIL testing activity.”

Florian Frischmuth, Ford

the ECU around-the-clock, 24/7, utilizing a full-size dSPACE HIL Simulator and dSPACE's Automation-Desk test automation and test management tool.

Flawless Execution and Launch

“The SPDJB is a highly complex module and is being used across numerous vehicle lines,” says Wajjha Chahine, EE Validation Group Supervisor. “Our hardware-in-the-loop validation effort was extremely critical to its flawless execution and launch. We have worked very closely with our supplier to validate the ECU software and its functionality. Our response time to identifying, reporting and fixing issues was virtually instantaneous and very effective given the numerous software drops that we had to iterate through. We are extremely pleased with the results.”

Testing the E/E System

As part of its expanded automated testing capability, the eight simulators are being used to test E/E components associated with 2011 vehicle model programs. This includes the following ECUs:

- Restraints Control Module / Occupant Classification System (RCM/OCS). With the use of electronic sensors placed around the vehicle, the RCM automatically detects crashes and deploys safety features, such as safety belt pretension and air bag deployment, to protect passengers. The OCS uses classification sensing to determine how to deploy or suppress airbags,

depending on the size of passenger(s) in the front seat.

- Infotainment Cluster Module (ICM) fully integrates infotainment customer interaction, with devices such as stereo CD/radios, MP3 players, and DVD entertainment systems, into the vehicle.
- Driver Seat Module
- Remote Climate Control Module
- Smart Power Distribution Junction Box
- Anti-lock Brake System (ABS)
- Adaptive Cruise Control (ACC)
- Audio Control System / Smart Display Module
- Ford Sync™ – Ford's industry-exclusive, voice-activated hands-free in-car communications and entertainment system

The cross-functionality of these consumer-desired technologies poses a much larger challenge to auto companies today – the need to perform systems integration testing across the entire realm of the vehicle electrical and electronics (EE) system.

Understanding the Impacts of Converging Technologies

Most electronic devices are real-time in nature, and thus have to conform to strict timing requirements. Moreover, these devices are typically self-reliant in that they function on their own resources and power. When these devices are integrated into a vehicle, their functionality is dependent on communication and interaction with other technologies in the vehicle (e.g. data, communication and power).

Electronics System Validation Group. For the past several years, this progressive engineering team has been performing simulation testing for its “Smart Power Distribution Junction Box (SPDJB)” – an electronic control unit (ECU) that analyzes and disseminates many of the car's electronic functions, and thus serves as one of the core components to Ford's E/E architecture.

The smart junction box not only distributes electrical power throughout the vehicle, but it single-handedly manages and monitors loads of electronic functions for powertrain, safety, traction, security, consumer infotainment, remote keyless entry, and other features.

Over 4000 Test Runs

To ensure that this powerful ECU is functioning properly, the Electrical/Electronics System Validation Group put the smart junction box through a rigorous validation process. More than 4000 tests were performed on

The convergence of these technologies makes systems integration testing critical to ensure proper functionality at both the component level and across the greater E/E architecture.

System and Component Testing

With the use of an HIL simulator, a virtual real-time test environment is established. This environment is scalable. Each HIL simulator can be configured to act as an independent unit to test specific modules, or any number of them can be hooked together to work as a system tester.

"The complete CAN network and all of the power systems in the vehicle need to be managed properly – primarily to optimize power usage and to ensure effective ECU interaction," says Allen.

"These HIL systems provide accurate

"Our HIL validation effort was extremely critical to the flawless execution and launch of the controllers. We are extremely pleased with the results."

Wajiha Chahine, Ford

ECU power measurement, dynamic simulation and control of the CAN network to support system integration testing. Ford has been implementing this cutting-edge testing capability and is able to leverage this in future programs as well."

Automated Diagnostics Process

In addition to performing HIL simulation, the testing environment for the Systems Integration Group will also feature an automated diagnostics process. Using a CAN and Simulink® interface, test engineers will be able to read the ECUs to determine whether diagnostic trouble codes, programmed into the test process, are being detected.



Ford installed eight HIL simulators for automated ECU testing.

Vehicle Dynamics Testing

Additionally, the test environment includes a vehicle dynamics model from dSPACE Automotive Simulation Models (ASM) that will allow the group to perform full-vehicle dynamics simulation on virtual drive courses and test conditions.

"In combination, these tools will

help the Ford Systems Integration Group deal more effectively with engineering resources by lowering testing resource costs and improving timing capabilities," says Allen. "The increase in vehicle electrical content and complexity and the need to develop and validate faster, more robustly and efficiently have proven to be a strong driver for HIL testing," added Frischmuth. "Our ability to automate and execute testing 24/7, and to accurately simulate the vehicle and its operating environment, have been a key contributor to the success and expansion of our HIL testing activity." ■

Wajiha Chahine

Wajiha Chahine is EE Validation Group Supervisor at Ford in Dearborn, USA.



Florian Frischmuth

Florian Frischmuth is Electrical/Electronic Systems Engineering (E/ESE) Global Embedded Software Manager at Ford in Dearborn, USA.

