Automotive Guide

Better Product Quality Through Test

genuen

genuen.com

TABLE OF CONTENTS

INTRODUCTION

STATE-OF-THE-ART EQUIPMENT FOR THE
LATEST TRANSPORTATION TECHNOLOGY

TODD VANGILDER

Vice President of Sales

Providing Insight Through Electromechanical Test

As a leader in automotive test, Genuen combines dedicated engineers, the latest technology, and state-of-the art equipment to solve critical testing challenges across a spectrum of applications for motorized vehicles and equipment.

This brochure highlights the latest challenges in automotive technology and how innovative test systems are helping manufacturers like you get a better product to market faster. With open architecture solutions and deep industry experience, we come alongside your team to simulate real-world environments and get the data you need to make insightful decisions throughout product development.

LEADER IN AUTOMOTIVE TEST

As a leader in automotive test, Genuen combines dedicated engineers, the latest technology, and state-of-the art equipment to solve critical testing challenges across a spectrum of applications for motorized vehicles and equipment.

TRADITIONAL AUTOMOTIVE

Our engineering staff regularly deploys test solutions in all areas of development, from production equipment to systems for advanced research and development and functional test labs.

OFF-HIGHWAY VEHICLES

For construction, mining, agricultural, forestry, and other heavy-duty equipment, we create custom test solutions uniquely suited to your industry's needs.

MOTORCYCLES & RECREATIONAL VEHICLES

With years of experience in test equipment targeted for the ground transportation segment, we also specialize in state-of-the-art solutions for small engine vehicles and lawn and garden products.

ALTERNATIVE ENERGY VEHICLES

The move toward increased fuel efficiency and reduced emissions has led the automotive industry to develop alternative solutions, such as fuel cell, plug-in electric vehicles (PEV) and hybrid electric vehicles (HEV).

COMMERCIAL VEHICLES

Manfacturers and suppliers of trucks, vans, and other commercial vehicles trust Genuen to validate their products while saving overall costs.

POWER EQUIPMENT

Using the latest off-the-shelf technology measurement and control, we design and build turnkey systems to test generators, compressors, pumps, and similar power equipment.

FORD DEPLOYS FUEL CELL TEST SYSTEM USING *INERTIA* SOFTWARE

"NI VeriStand and the *INERTIA*™ add-on provided us with an easy-to-use tool for developing and deploying our HIL tests, and the NI VeriStand plugin architecture allowed us to customize the environment to meet our specific application needs."

THE CHALLENGE

Creating a hardware-in-the-loop (HIL) test stand to simulate, control, and monitor passenger vehicle fuel cells developed by Ford Motor Company.

THE SOLUTION

Using National Instruments (NI) VeriStand real-time test environment, Genuen *INERTIA*™ control software add-on, and NI PXI hardware to create a flexible, scalable solution for evaluating alternative fuel vehicle application systems.

PROJECT OVERVIEW

Ford Motor Company is pursuing fuel cells as an alternative energy source for powering passenger vehicles. Fuel cells require precise control of the incoming resources, as well as a tight balance of temperature, flow and pressure control of the coolant. In addition to these incoming resources, the fuel cells are designed to be commanded and controlled electronically by the vehicle engine control unit to provide the required vehicle performance dictated by the driver's input. As part of their research, they needed a test stand with the ability to:

Genuen created a hardware-in-the-loop (HIL) test stand to simulate, control, and monitor passenger vehicle fuel cells for Ford Motor Company.

- Simulate the vehicle inputs to the fuel cell
- Control and monitor the system around the fuel cell as well as the fuel cell itself
- Acquire the data for analysis
- Adapt easily to future fuel cell prototypes

BUILDING A COMPLETE HARDWARE AND SOFTWARE SOLUTION

As recommended by National Instruments, Ford Motor Company selected Wineman Technology to develop a standard software solution that provides the underlining system architecture for control, data acquisition, and monitoring of the required system parameters. For an easy-to-use test software environment, NI VeriStand and the *INERTIA* real-time control add-on were selected for development and deployment onto the real-time platform. NI VeriStand easily integrates with custom LabVIEW code for the user interface, CAN protocol databases, and vehicle models created in MATLAB or other development environments.

Wineman Technology built a complete turnkey solution that integrated NI VeriStand, INERTIA real-time control, PXI, SCXI, R-Series modules with FPGA, and EtherCAT distributed I/O.

The hardware equipment included the integration of PXI, SCXI, R-Series modules with field programmable gate arrays (FPGA), and an EtherCAT distributed I/O device to provide a robust and modular platform for the HIL system. Running NI VeriStand on a real-time PXI controller quickly gave us an application that could perform deterministic control with real-time data logging. Adding the INERTIA real-time control add-on to NI VeriStand provided multi-mode PID support that allows the control of a single loop to switch between temperature, pressure, or flow mode dynamically as the system calls for it. Also, using an EtherCAT distributed I/O chassis allows the different fuel cell's list of sensors to be quickly changed and wired to the chassis independently before the fuel cell prototype is brought into the test cell.

CONSISTENTLY DELIVERING COMPLEX TEST SOLUTIONS

In conclusion, the Genuen project development team, working closely with the NI VeriStand development team and Ford Motor Company, delivered a system that provided an intuitive solution for avery complex alternative fuel vehicle application system. Genuen's long history of developing high-performance real-time control and data acquisition systems enabled us to deliver a very advanced, robust, flexible, and user-friendly system that achieves all of Ford Motor Company's test system requirements.

A custom LabVIEW application was developed to programmatically display appropriate tools and I/O screens on demand.

IMPROVING AUTOMOTIVE BATTERY MANAGEMENT SYSTEMS USING HIL

THE CHALLENGE

Creating a hardware-in-the-loop (HIL) test stand to simulate, Simulating 12V and 48V lithium-ion starter batteries in various test scenarios to evaluate and improve BMS software.

THE SOLUTION

Delivering four full-height hardware-in-the-loop (HIL) systems capable of testing different BMS module types and adapting to future changes in test requirements.

A123 Systems is a global manufacturer and supplier of lithium-ion energy storage solutions, and they offer 12V and 48V lithium-ion starter batteries as a drop-in replacement for traditional lead-acid car batteries used in combustion vehicles. A starter battery consists of multiple rechargeable lithium-ion cells connected together as a single battery pack and controlled by a battery management system (BMS) thatmonitors and protects the health of the stack. A123 Systems wanted four HIL testers – two new stands and two stands retrofitted from existing equipment – capable of simulating the lithium-ion batteries while they evaluated and improved different firmware on the BMS modules. By modeling a variety of inputs from the vehicle battery pack, the software could be thoroughly tested for meeting the expected criteria.

Genuen delivered four full-height hardware-in-the-loop (HIL) systems.

TESTING BMS SOFTWARE WITH HIL SIMULATION

These four full-height HIL test systems were based on the Automotive HIL Reference Design that Genuen collaboratively created with Cummins and NI, and they included platform-based technology such as modular PXI hardware, NI TestStand and NI VeriStand test software, and a third-party mass interconnect panel. We also integrated an off-the-shelf battery cell simulator to produce different cell voltages for running test scenarios for the BMS. We chose a real-time PXI controller solution because of the tester's high performance, deterministic timing, and large sensor count requirements. We used VeriStand test application software to configure and control the hardware, and TestStand test management software to develop test profiles and sequences that automate the VeriStand software. The system also utilizes CAN communication via VeriStand to retrieve information from the BMS and monitor the cell levels.

SAVING TIME WITH OPEN TECHNOLOGY AND ENGINEERING SERVICES

A123 Systems was satisfied with the new HIL systems that have the flexibility to quickly change between testing a 12V or 48V starter battery BMS. The non-proprietary software automates the testing process and can easily adapt to changes in the testing requirements (since the end user has the ability to edit the test flow as needed). They also appreciated the quality of the final solution and beneficial features that protect the safety of the operators.

A123 Systems needed four full-height HIL systems to model various behaviors from the vehicle battery pack in order to measure proper responses from the BMS software.

A123 Systems originally ordered two new HIL systems and two retrofitted systems for testing and refining BMS firmware. Our electro-mechanical team designed and built the electrical design of the cabinet, while our software engineering team seamlessly collaborated with their internal staff to automate the system, thus expanding the group's overall bandwidth and capabilities. After we successfully delivered the first two testers, they were pleased with the installations and expanded their order to include a fifth system.

FLEXIBLE AUTOMOTIVE HIL SIMULATION FOR COMPLEX ACTIVE SUSPENSION

THE CHALLENGE

Simultaneously testing up to four active suspension electronic control units (ECUs) using a mix of real hardware components, control software, and simulated models.

THE SOLUTION

Creating an open, flexible HIL test system based on the NI technology platform that's capable of simulating ECUs and sensor data, as well as integrating with dynamometer test cells.

PROJECT OVERVIEW

Cutting-edge technology is constantly being introduced in the automotive industry, and it can be challenging to not only design but also test groundbreaking innovations. One of our clients designs high-end active suspension ECUs for luxury vehicles. One ECU was located in each corner of the car, and it had the ability to communicate with the other three ECUs and various sensors in the vehicle. The customer needed to test the ECU software to ensure the appropriate decisions were being made based on the available information – not just data from a single ECU and the sensors closest to it, but also simultaneous communications from all four ECUs.
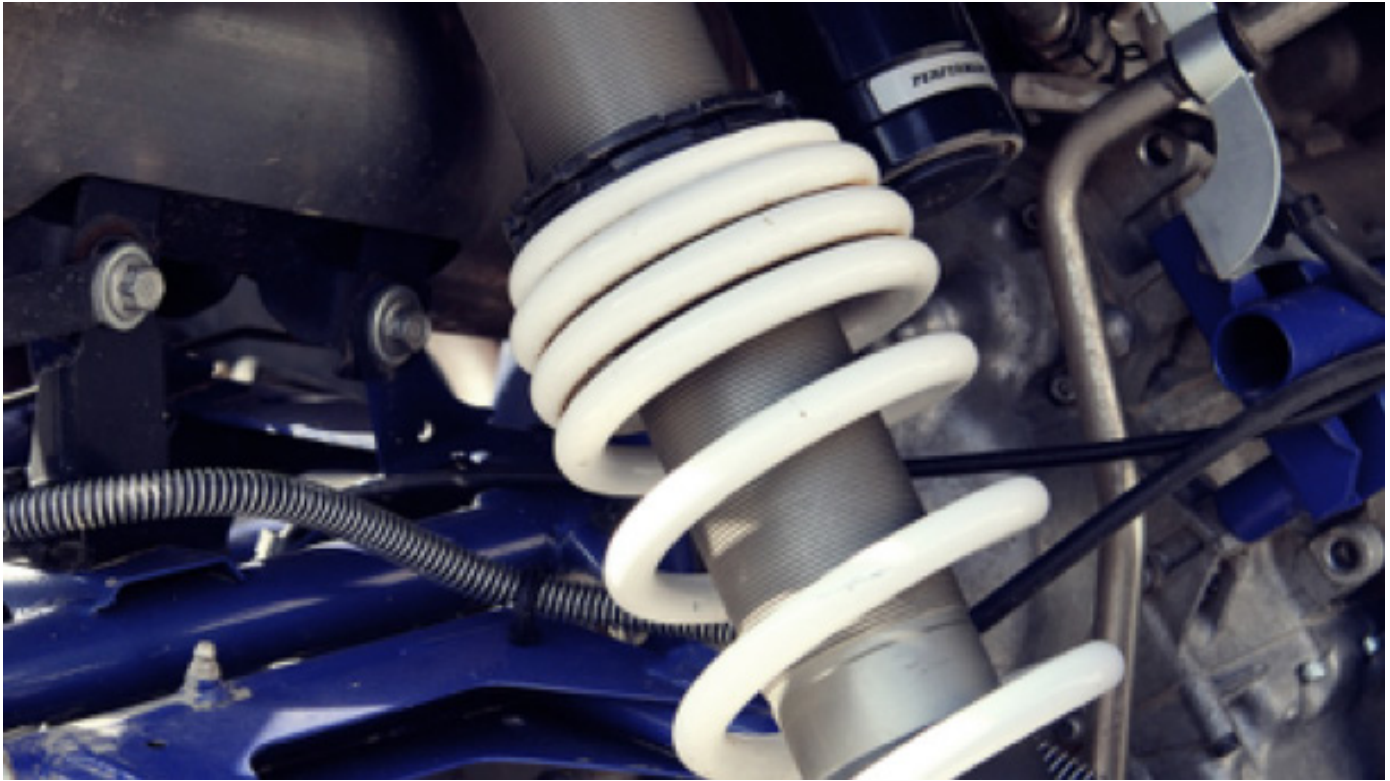
INTEGRATING HIL AND PHYSICAL TEST FOR ECUS

We worked closely with the client to deliver a full-height HIL system that simulated all the necessary vehicle sensors. The HIL system was based on the Automotive HIL Reference Design mentioned previously, and therefore incorporated modular PXI hardware, TestStand and VeriStand test software, and a third-party mass interconnect.

Based on the NI technology platform, this open, flexible HIL test system is capable of simulating ECUs and sensor data, as well as integrating with dynamometer test cells.

The system has the ability to do full software-in-the-loop (SIL) testing using HIL models to simulate all four ECUs against real or simulated sensor date. If only ECU is available, then the tester is capable of modeling the other three. Finally, the open platform of the simulation system has the ability to integrate with physical test like dynamometer test cells, allowing the designers making physical components to test their parts using the HIL models before the ECU is even complete. This parallel product development and ability to test earlier in the design cycle significantly speeds up time-to-market and reduces risk of finding design flaws late in the game.

The system had the ability to simultaneously test up to four active suspension ECUs, allowing the manufacturer to make intelligent decisions earlier in the development cycle.

COLLABORATIVELY DESIGNING A FULL-HEIGHT HIL TESTER

The HIL project was very collaborative, even throughout the quoting and system design process, since the customer wanted to take complete ownership of the tester after deployment and have the ability to fully customize its functionality as needed to adapt to future needs. They were very pleased with Genuen's ability to seamlessly join with their engineering team and share our years of engineering test expertise.

In the end, Genuen delivered a full-height HIL tester that not only modeled multiple ECUs and sensors, but also provided valuable data about how their overall active suspension system worked. The integrated testing allowed them to make intelligent decisions earlier in the development cycle and build a more robust product to deliver to customers.

ELECTRIC PARKING BRAKE HIL AND DURABILITY TESTING USING CANALYTICS SOFTWARE

THE CHALLENGE

Improving test automation and control functionality of an existing hybrid HIL test stand for electric parking brakes.

THE SOLUTION

Delivering a mid-height HIL tester with mechanical brake simulation and a full-height durability tester for 24-hour testing of multiple brakes.

PROJECT OVERVIEW

Akebono Brake Corporation is a global supplier of foundation brakes and brake friction materials, and one of the new technologies they are focused on is electric parking brakes – a type of electro-mechanical brake that uses traditional hydraulic actuation for braking while driving and then switches to an electro-mechanical actuator for braking when parking.

The HIL and durability testers were built on LabVIEW software, real-time CompactDAQ hardware, and mix-and-match C Series I/O modules because of their high-performance features and flexible use in different applications.

The HIL test stand runs in three modes: assembly mode and two simulation modes. In assembly mode, the entire mechanical test bench (with the motor gear unit (MGU), caliper, and servo actuators) provides real-world performance data. The ECU controller sends its estimated measurements and CompactDAQ sends its actual measurements for the host computer to evaluate how well the ECU software is performing and adjust as needed. In the two simulation modes, the CompactDAQ system runs the caliper profile or MGU profile, allowing the tester to push the boundaries in evaluating hypothetical conditions or worst-case scenarios.

CREATING A NEW FULL-HEIGHT DURABILITY TESTER

Due to the success of the HIL mid-height tester, Genuen was also called upon to create a brand-new full-height durability tester capable of testing three electric parking brake systems simultaneously, using three ECUs with six actuators. A typical test might include 150,000 cycles of applying and releasing the brake, while monitoring the internal software estimations and different benchmarks. The tester also has a built-in fail-safe functionality that gives Akebono the confidence to perform 24-hour, round-the-clock durability testing, increasing overall test efficiency of the lab.

Genuen successfully delivered a mid-height HIL tester for improving prototype ECU software and a full-height lifetime durability tester for verification and validation (V&V) testing.

SAVING TIME WITH CANALYTICS SOFTWARE FOR CAN COMMUNICATION

Both the retrofitted mid-height HIL tester and new ful-height durability tester use ECUs that communicate through the CAN bus. Genuen developed a CAN interface software called CANalytics that helps engineers to quickly and cost-effectively add CAN monitoring and communication capabilities without having to reinvent the wheel every time. Now Akebono can easily configure both their hardware and software components from a single development environment.

CONCLUSION

Building the stands with high performance real-time CompactDAQ controllers provided improved test functionality that ultimately decreases development time and speeds up time to market. Akebono also appreciated Genuen's smooth project management process and excellent engineering support. Pleased with the results, they have since ordered another test stand from Genuen to further the capabilities of their test laboratory.

Contact Us

WEBSITE
genuen.com

EMAIL
General Information: info@genuen.com
Sales: sales@genuen.com

PHONE AND FAX
General Inquiries: 989.771.3000
Fax number: 989.771.3010

HEADQUARTERS
1668 Champagne Drive North
Saginaw, MI 48604