



USE CASE: LHP INTEGRATES HIL TEST SYSTEMS TO PROVIDE AN AUTOMATED METHOD FOR FUNCTIONAL SAFETY TESTING

CASE STUDY



CHALLENGES

The existing customer-built HILs only tested Electronic Control Units (ECUs) individually, and they lacked fault insertion capability, preventing the customer from properly testing the Functional Safety requirements they had written. The customer wanted to provide the software and wanted LHP to design and implement the architecture.

The customer-built HILs required extensive hard wiring between the HIL and the DUTs. Hard wiring the DUTs was complex and time-consuming. The process involved a large quantity of different connectors that must be connected manually without error.

The process was communication-centric, for a very specific type of architecture.

THE SERVICES DELIVERED

LHP provided a blend of hardware solutions, software innovations, and expertise in functional safety, testing, and systems engineering. Drawing on these capabilities enabled LHP to tailor their solutions to the exact needs of the customer.

LHP built two types of HILs: one large hybrid system for both their internal combustion-type vehicles and their electric vehicles, and another smaller and more portable system specifically targeted toward their electric vehicles. This empowered the OEM to plan around which system would best meet their testing needs at a given point in time.

LHP also delivered modular architecture via the Mass Interconnect Receiver, enabling efficient and

ABOUT THE PROJECT

Industry

- American motorcycle manufacturing

Company

- North American motorcycle OEM

Tools/Technologies/Skills

- **Hardware-in-the-loop (HIL) Automated Test Equipment (ATE):** Custom HIL Test System running a software model of an environment, using modular architecture to run tests automatically and meet the customer's system-level Functional Safety testing requirements.
- **Mass Interconnect Receiver:** Connects the ATE to the customer's Device Under Test (DUT).
- **Fault Insertion Unit (FIU):** Accommodates the hardware-based simulation of faulty open circuits, circuits shorted to neighboring signals or busses, and circuits shorted to power or ground.
- **Testing as a service:** Simulates real-world testing environments utilizing LHP HIL assets that are using the same architecture, to test elements such as load and stress tests, and other factors.

Goals of the Project

- Allow the customer to easily scale testing capability by offloading verification/validation tasks to LHP personnel and LHP assets.
- Allow the customer to easily test multiple vehicle platforms with minimal downtime.
- Utilize reusable and reconfigurable modular architecture to increase the return on investment.
- Utilize a process and hardware that is scalable.

Application Area

- Functional testing
- Functional Safety testing

reconfigurable connectivity to the customer-built test fixture or directly to the test article. That modularity extends to all levels of the system.

The LHP HIL systems included a Fault Insertion Unit, which accommodates the hardware-based simulation of faulty open circuits, circuits shorted to neighboring signals or busses, and circuits shorted to power or ground. This enables the testing of safety-critical inputs and outputs at the vehicle level across multiple ECUs and provides real-world hardware fault conditions, an essential capability for properly testing and achieving functional safety requirements.

The most significantly challenging and time-consuming aspects of this process to learn, systems engineering and writing proper requirements, were provided by LHP's experienced assets. LHP provided a path for the OEM to expand their testing capability quickly.

PROJECT OUTCOMES

The LHP Application Lifecycle Management (ALM) interface solution provides the ability to gather test case data and apply it to the ATE environment. Results are then added back to the ALM environment to close the gap between test cases and test results, providing a controlled and automated method for regression testing.

The customer had a history of building their own test equipment but needed an entirely new system that would meet Functional Safety requirements. Not only did they need the system itself, but they also needed access to the knowledge and expertise required to

define, design, and test a Functional Safety-compliant system. Moving the customer to a new system was the most efficient way to approach functional safety compliance.

LHP's services have helped in additional ways:

- The test equipment has only had to be installed at one site.
- The architecture accommodates multiple test devices. To add additional test articles, only additional fixtures with their own sets of devices need to be built, and those can be connected to and share the existing test equipment.
- The ATE provides the automatic execution of test procedures.
- LHP provided direct access to the experts. The customer had worked a lot with National Instruments (NI) in the past. LHP is an Alliance Partner with NI. LHP's team used to work for NI and wrote the book on these systems. Partnering with LHP empowered the customer to really pick the brains of the people who authored these systems, enabling the asking of very detailed questions, and reassuring our customer that the systems and processes would be implemented the right way.
- LHP provided testing as a service. When the customer suddenly introduced a new vehicle that strained their existing engineering capacity, LHP provided the second HIL hardware and on-site assets at no additional cost in exchange for earning the testing business, empowering the OEM to drive forward with their new product without a negative impact on their existing production.

RESULTS, ROI, & FUTURE PLANS

The customer found LHP's process to be an efficient approach, enabling them to leverage advanced technology in a robust way at a favorable cost. Both the HIL hardware and software-as-a-service paths are scalable; this enables swift implementation to meet immediate business needs, while introducing less-experienced talent to the real-world experience of creating and implementing a robust testing requirement. These engagements will only strengthen the in-house engineering team as time goes by.

The LHP HIL system eliminated the need to build an expensive custom rack and install hundreds of labor-intensive hard-wired connections for each specific type or variant of a product.

The customer was able to use LHP's ALM as a model for their own ALM verification, enabling them to standardize their ALM system with LHP's system and broadening their capacity for additional tests without having to buy additional systems. Now, when the customer comes to LHP for additional test services, this compatibility gives them more options.

With both LHP and the customer possessing a strong culture of safety, and having staff who are Functional Safety Certified, this provided important common ground that helped expedite our working together in an efficient manner.

LHP's portion of the system is highly reusable, resulting in a higher return on investment.

LHP's approach focuses heavily on the use of off-the-shelf components, enabling a high confidence in the test equipment. In this case, no custom circuits were required, and only a few custom cables had to be fabricated.

LHP's standard turn-around for a typical HIL system is 16 weeks.