NATIONAL INSTRUMENTS™

HIL Testing: A Methodology That Spans Industries

Contents

HIL Defined

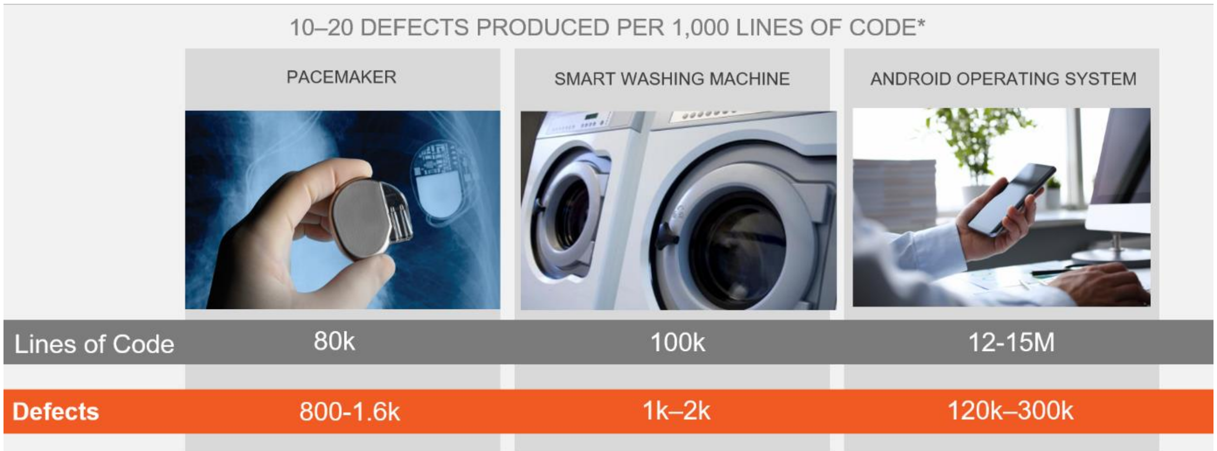
HIL is an embedded software test technique during which real signals from a controller are connected to a test system that simulates reality using a software model. This tricks the controller into thinking it is installed in the assembled product. Test and design iteration take place as though the real-world system is being used. This way, engineers can easily run through thousands of possible scenarios to properly exercise a controller without the cost and time associated with physical tests.

The Case for HIL

Companies use HIL to test embedded software, helping avoid production failures such as a loss of $1M a day from a broken downhole tool on an oil well, the recall of thousands of smart washing machines, or a defective pacemaker that has already been implanted in patients. These are disastrous situations for both users and the engineering teams that create these products. Financial penalties, brand reputation, ethical concerns, and more are at stake for the companies associated with these potential product failures. Hardware-in-the-loop (HIL) testing is a preventive test methodology that allows software engineers and test engineers to assess corner cases that are not practical in the field. Companies can also save money and time by testing earlier in the design cycle and iterating quickly instead of waiting for production test.

Why HIL outside of Aerospace and Automotive

HIL testing was first conducted in the aerospace industry during the Apollo missions by cutting-edge thinkers seeking to send humans into the unknown of space. The only way to test this scenario was with simulation. In the 50 years since, the benefit of testing embedded software early and often before deployment to costly production systems has appealed to a number of industries including aerospace, automotive, oil and gas, medical devices, white goods, and more. As devices become “smarter” with more onboard computing, the opportunity - and payoff - for iterative testing grows. Because of this, HIL is seeing increased adoption in all industries releasing products that rely on embedded software.



* "Tech.View: Cars and software bugs," *The Economist,* May 16, 2010, economist.com

Figure 1. The rise of onboard software heightens the need for more sophisticated testing earlier in the design cycle. Leading design and test organizations are using HIL to answer this call.

Benefit to Users: More Than Failure Detection, A Means to Innovation

The word "test" often defines the final steps needed to move a design to production and ultimately to market. Depending on the industry, test might be a valued part of an organization or it might be a painful afterthought that engineers must begrudgingly conduct to mark a project as complete. At face value, testing provides a final check to ensure everything is working as expected and generates reasonable confidence that a product will be successful in the field.

HIL elevates testing to more than a checkbox on a project plan. It becomes an integral part of the innovation that makes a design and company successful.

Forward-thinking companies are use HIL outside of the traditional road-to-market testing. Though the long-term goal of HIL is to prevent a costly mistake in an expensive program, it's also a design tool that software engineers can use to iteratively test and tweak their software designs. This improves product quality before formal testing even begins. Additionally, software engineers can conceive of and test new ideas quickly, which helps them maximize innovation through timely feedback.

Elements of an HIL System: Software and Hardware Combination

The core elements of an HIL system are the device under test (DUT), data acquisition, and the model that receives processes and sends signals that mimic real-world scenarios. Additional elements may include test case automation, data management, custom communication protocols, fault insertion, and loads.

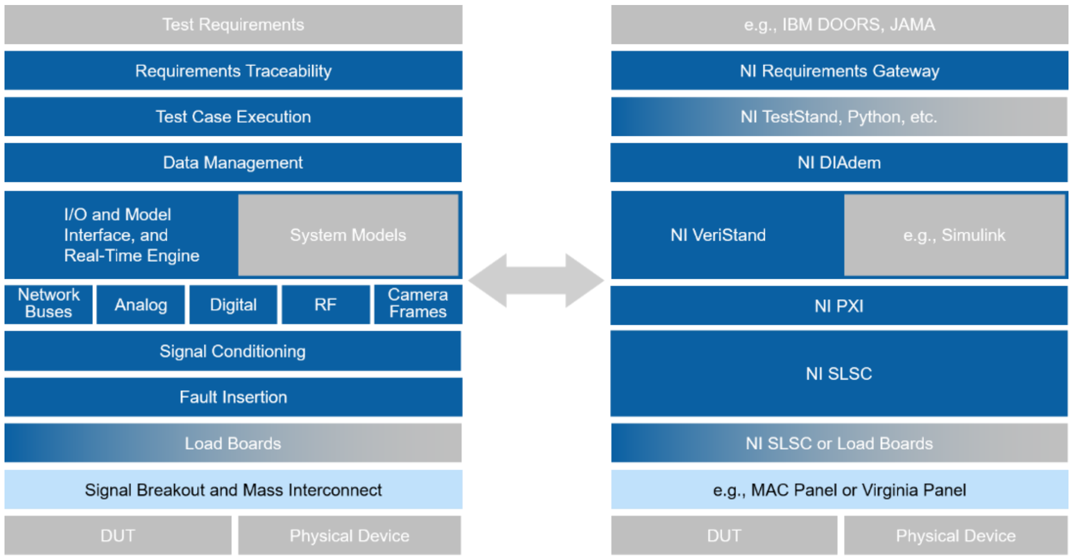


Figure 2. Typical HIL System Requirements Mapped to the NI Platform

Building an HIL Test Rig: NI's Open Approach to HIL

NI's software-defined platform maximizes the potential of already powerful hardware by allowing user customization through FPGA programming for custom signals and faster processing speeds, model integration, and seamless driver integration. With VeriStand, NI's configuration-based real-time test software, test engineers can incorporate models from over 20 different environments including MathWorks Simulink®. SLSC hardware acts as a modular interface between the DUT and the measurement hardware (PXI or CompactRIO) and provides signal conditioning, fault insertion, and loading. Supported by NI's community of domain-expert partners, SLSC boasts a growing portfolio of modules and allows users to create their own as needed. This approach greatly reduces cabling issues, eases troubleshooting, and maximizes reuse from system to system and test to test.

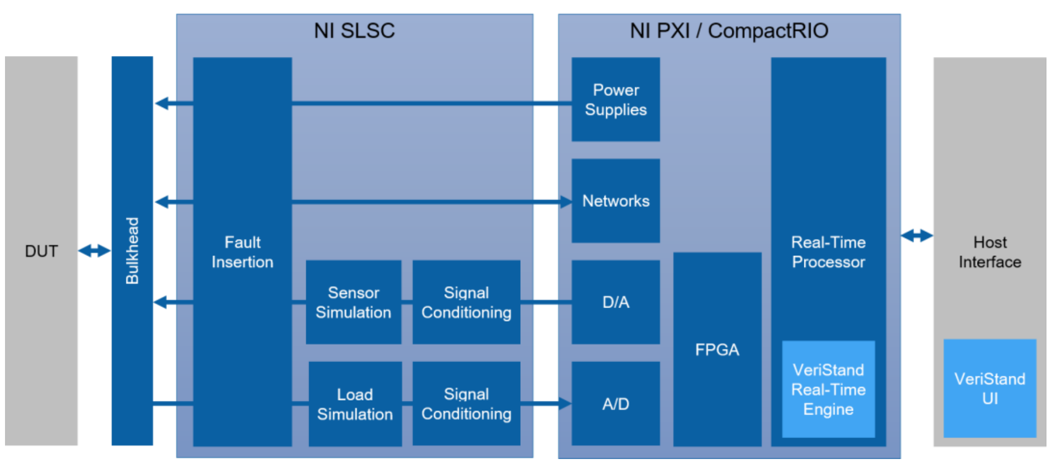


Figure 3. Typical HIL System Built on NI's Open Platform

Unlike black box, closed solutions from other vendors, NI’s HIL offering is open to customization as needed. It is built on the latest industry-proven, commercial off-the-shelf components that have published life cycles, so users can plan accordingly for test rigs that need to last decades or longer. With the openness of NI’s platform, engineers can incorporate test hardware and software that they already use, which reduces the burden of migrating to a new solution.

> "The powerful combination of the NI VeriStand platform, LabVIEW FPGA, the real-time PXI module, and years of fast prototype development and experience with NI products helped us quickly and easily design and develop the whole HIL system."
>
> — G. Paviglianiti, Whirlpool Fabric Care, Advanced Development

Launching a new test system can be overwhelming, especially when test system changes can impact in-flight projects. NI’s worldwide community of partners provides the level of customization users need, from completely turnkey solutions to specific points of integration assistance. Additionally, NI’s support engineers worldwide can troubleshoot and offer guidance in the language and time zone customers need to make them successful.

Conclusion

NI’s 40-year history as an automated test and automated measurement technology provider can help HIL test engineers who need comprehensive I/O, high-end instrumentation, and an open platform to modify and reuse test rig parts as their test requirements change over time.

Next Steps

Read how Whirlpool is making washing machines more reliable with HIL

See how Siemens uses HIL for wind turbine testing

Learn how NI tools are used to control a heart simulator

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