AUTOMOTIVE RESOURCE KIT

Hardware-in-the-Loop (HIL) Test System Architectures

Overview

HIL simulation is a powerful test method you can use to test embedded control systems more efficiently. When testing embedded control systems, safety, availability, or cost considerations can make it impractical to perform all of the necessary testing using the complete system. You can use HIL simulation to simulate the parts of the system that pose these challenges, which gives you the power to thoroughly test the embedded control device in a virtual environment before proceeding to real-world tests of the complete system. With this capability, you can maintain reliability and time-to-market requirements in a cost-effective manner even as the systems you are testing become more complex. To learn more about how HIL testing improves control system validation, watch the What Is HIL Testing [add hyperlink] webcast. This tutorial discusses a variety of HIL test system architectures and how to implement them.

Components of an HIL Test System

An HIL test system consists of three primary components: a real-time processor, I/O interfaces, and an operator interface. The real-time processor is the core of the HIL test system. It provides deterministic execution of most of the HIL test system components such as hardware I/O communication, data logging, stimulus generation, and model execution. A real-time system is typically necessary to provide an accurate simulation of the parts of the system that are not physically present as part of the test. The I/O interfaces are analog, digital, and bus signals that interact with the unit under test. You can use them to produce stimulus signals, acquire data for logging and analysis, and provide the sensor/actuator interactions between the electronic control unit (ECU) being tested and the virtual environment being simulated by the model. The operator interface communicates with the real-time processor to provide test commands and visualization. Often, this component also provides configuration management, test automation, analysis, and reporting tasks.

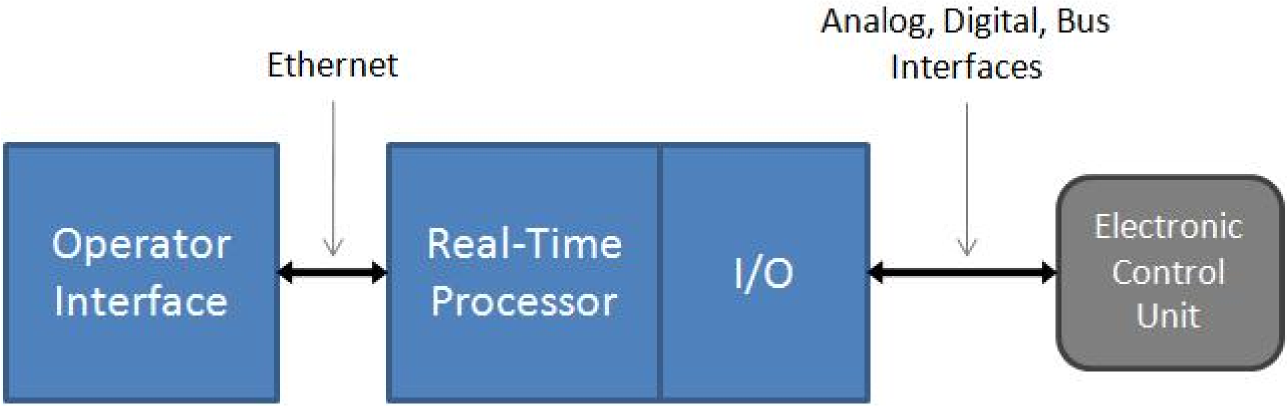


Figure 1. An HIL test system consists of three primary components: an operator interface, a real-time processor, and I/O interfaces.

Hardware Fault Insertion

Many HIL test systems use hardware fault insertion to create signal faults between the ECU and the rest of the system to test, characterize, or validate the behavior of the device under these conditions. To accomplish this, you can insert fault insertion units (FIUs) between the I/O interfaces and the ECU to allow the HIL test system to switch the interface signals between normal operation and fault conditions such as a short-to-ground or open circuit.

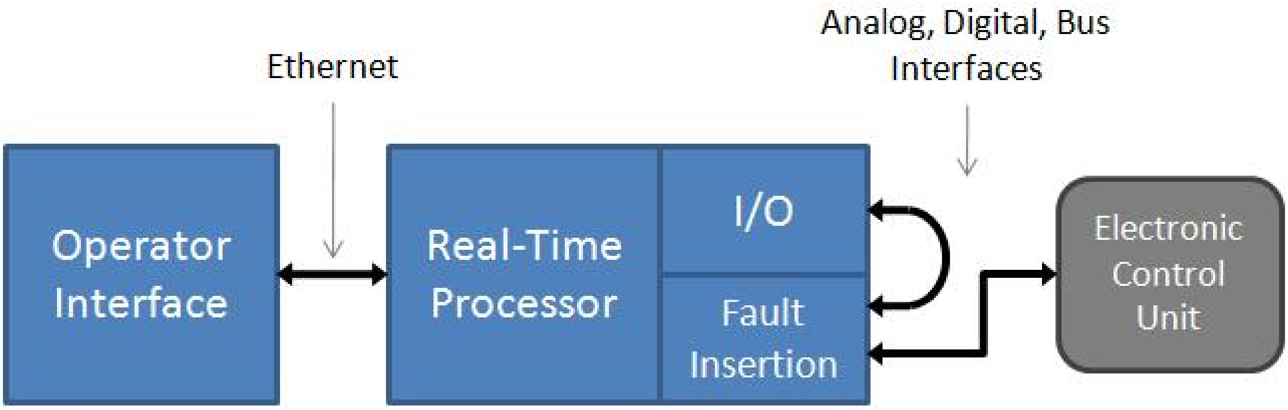


Figure 2. You can use hardware fault insertion to test the behavior of the ECU during signal faults.

Testing Multi-ECU Systems

Some embedded control systems, such as an automobile, aircraft, or wind farm, use multiple ECUs that are often networked together to function cohesively. Although each of these ECUs may initially be tested independently, a system's integration HIL test system, such as a full vehicle simulator or iron bird simulator, is often used to provide more complete virtual testing.

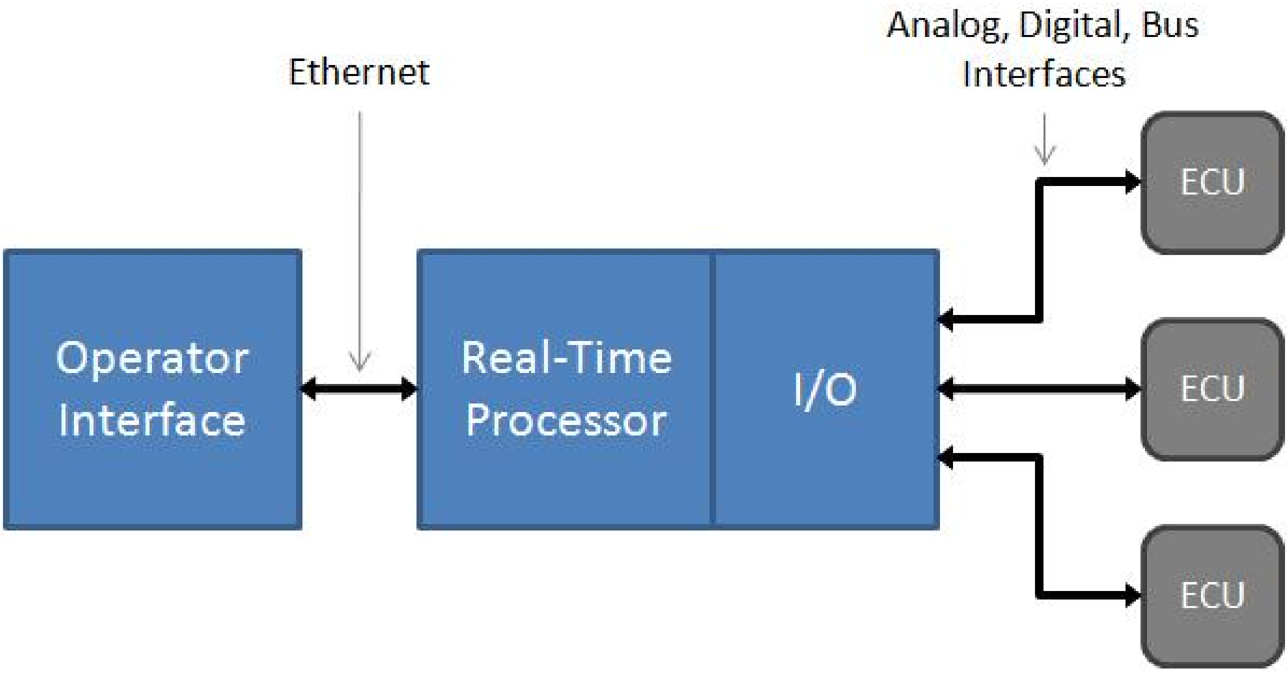


Figure 3. Automobiles, aircraft, and wind farms use multiple ECUs.

When testing a multi-ECU control system (and even some single ECU control systems), two needs often arise: additional processing power and simplified wiring.

Additional Processing Power – Distributed Processing

Even with the latest multicore processing power, some systems require more processing power than what is available in a single chassis. To address this challenge, you can use distributed processing techniques to meet the performance requirements of these systems. In very high-channel-count systems, the need is more than simply additional processing power, additional I/O is also necessary. In contrast, systems using large, processor-hungry models often use additional chassis only for the extra processing power, allowing those processors to remain dedicated to a single task for greater efficiency. Depending on how the simulator tasks are distributed, it may be necessary to provide shared trigger and timing signals between the chassis as well as deterministic data mirroring to allow them to operate cohesively.

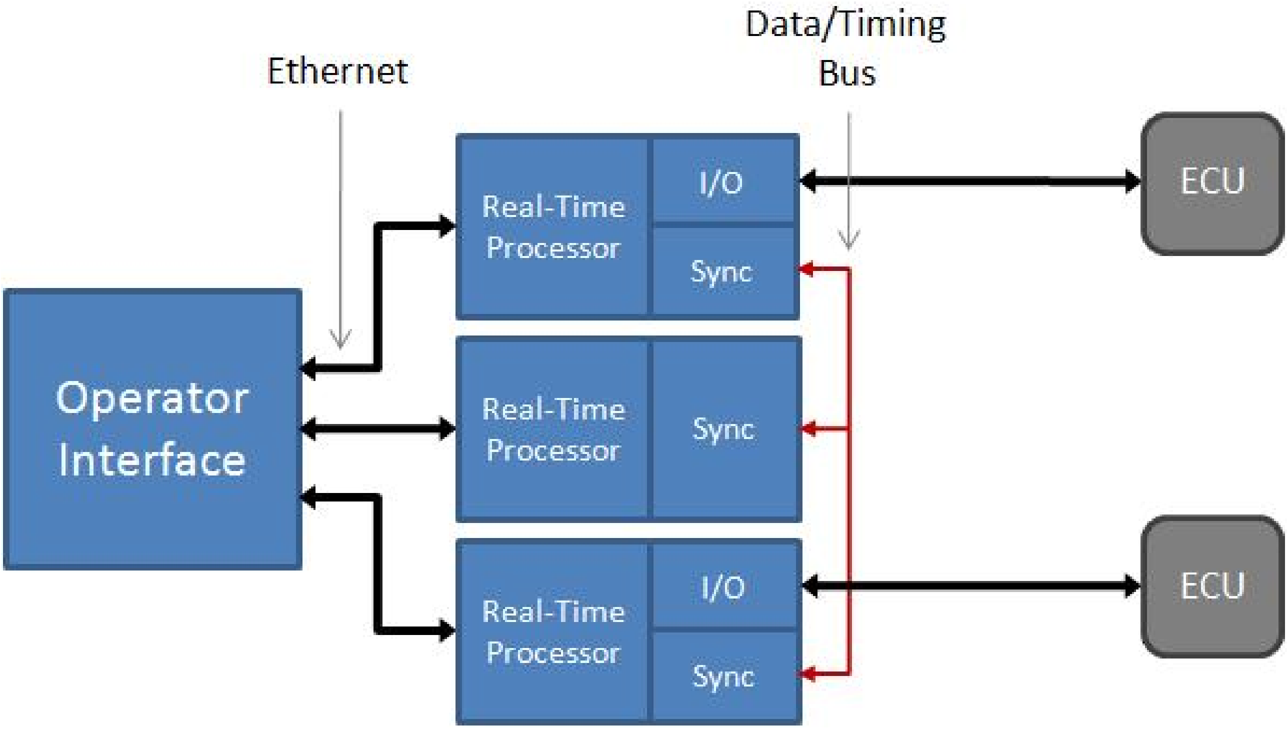


Figure 4. When using multiple chassis for additional processing power, it is often necessary to provide timing and data synchronization interfaces between them.

Simplified Wiring – Distributed I/O

Implementing and maintaining wiring for high-channel-count systems can pose costly and time-consuming challenges. These systems can require hundreds to thousands of signals be connected between the ECU and the HIL test system, often spanning many meters to compensate for space requirements.

Fortunately, deterministic distributed I/O technologies can help you tame these wiring complexities and provide modular connectivity to ECUs, which allows for efficient system configuration modifications. Instead of routing all connections back to a single rack containing one or more real-time processing chassis instrumented with I/O interfaces, you can use deterministic distributed I/O to provide modular I/O interfaces located in close proximity to each ECU without sacrificing the high-speed determinism necessary for accurate simulation of the virtual parts of the system.

This approach greatly reduces HIL test system wiring cost and complexity by making it possible for the connections between the ECU and the I/O interfaces to be made locally (spanning less than a meter) while a single bus cable is used to span the additional distance to the real-time processing chassis. Additionally, with the modular nature of this approach, HIL test systems can easily scale, incrementally, from a multi-ECU test system in which all but one of the ECUs are simulated to a complete systems integration HIL test system where none of the ECUs are simulated.

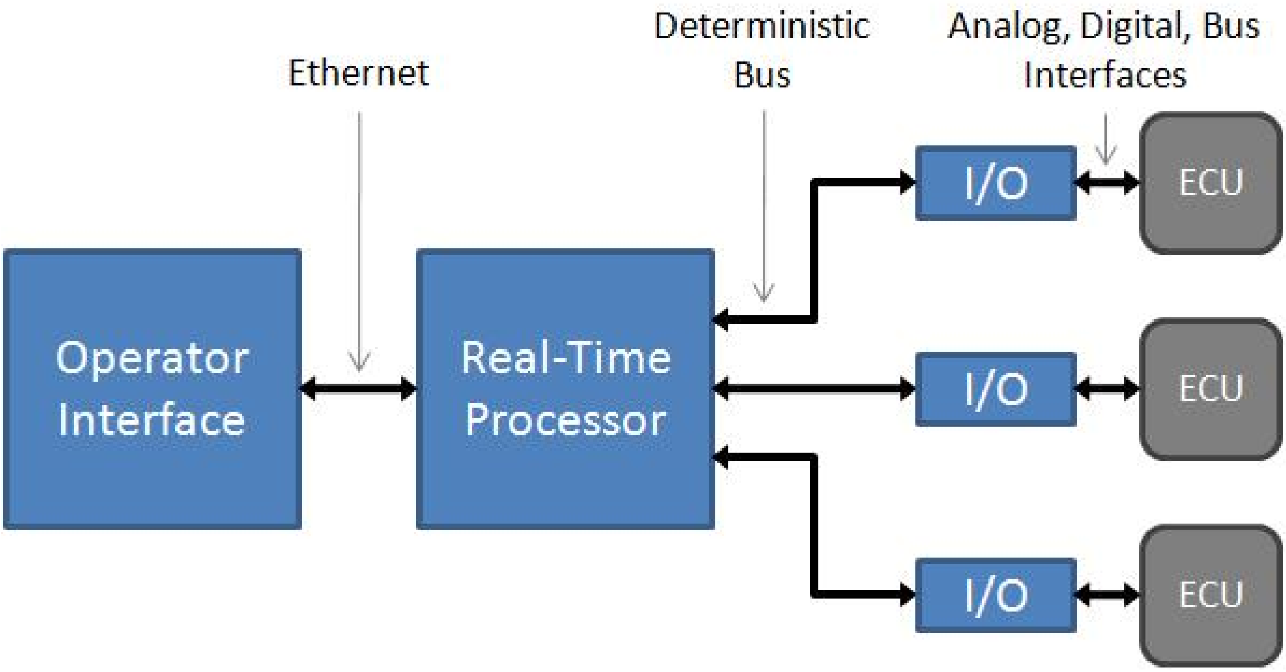
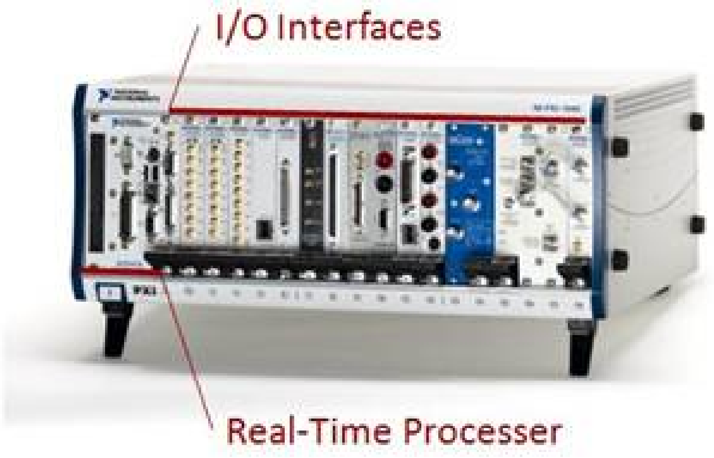


Figure 5. Deterministic distributed I/O interfaces greatly reduce HIL test system wiring cost and complexity because the connections between the ECU and the I/O interfaces can be made locally.

Implementing HIL Test Systems

Once you have selected the appropriate architecture for your HIL test system, the first step in creating a HIL test system is to select the real-time processing component(s) that best meets your development requirements. National Instruments provides a wide variety of real-time processing options for implementing HIL test systems. Because they are all based on open industry standards, you can be assured that they always deliver the latest advances in PC technology to your HIL test system and always meet future test system requirements.



PXI is an open, PC-based platform for test, measurement, and control. It offers a wide variety of real-time processor options including several high-performance dual- and quad-core processors. With more than 1,200 products from more than 70 vendors, PXI is the platform of choice for thousands of companies worldwide.

The PXI platform works with many synchronization technologies, including IRIG-B, IEEE 1588, SCRAMNet, and reflective memory for sharing timing, trigger, and data in multichassis HIL test systems.

National Instruments also provides several options for implementing minimal-cost, small-footprint HIL test systems. NI CompactRIO is a low-cost reconfigurable control and acquisition system. The system combines small size with an open embedded architecture powered by reconfigurable I/O (RIO) field-programmable gate array (FPGA) technology.

This technology combines a real-time processor with a user-programmable FPGA that you can use to create custom I/O personalities as well as to off-load model execution and signal processing from the real-time processor for increased HIL test system performance.

Summary

After determining and selecting the appropriate real-time processing component(s) necessary to meet your HIL test system needs, you need to select the I/O required to interface to your ECU(s). Read Selecting

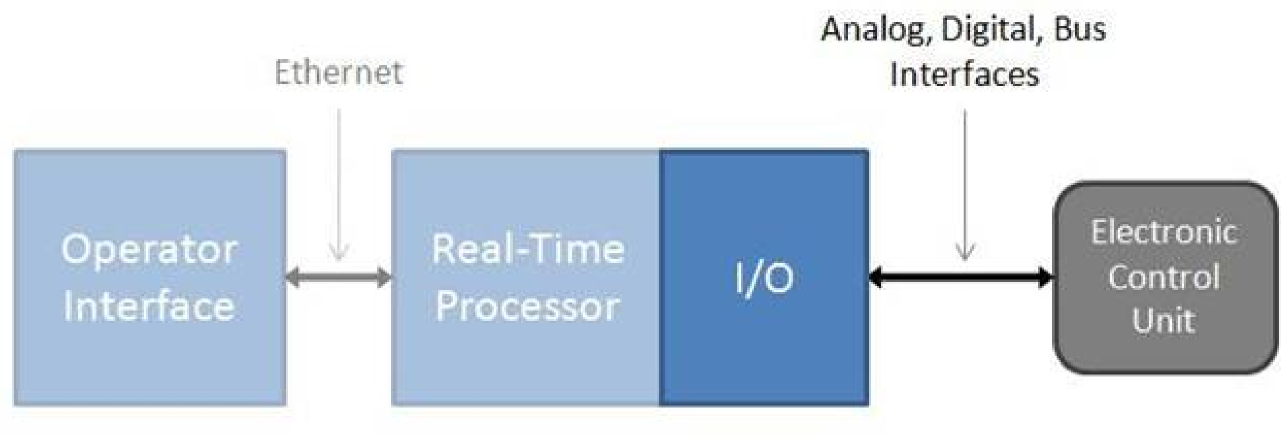
Hardware-in-the-Loop (HIL) Test System I/O Interfaces to learn more about the I/O interfaces available for your HIL test system.

Find additional resources to assist you with your HIL test system development or learn how others have achieved success with the NI HIL platform at ni.com/hil.

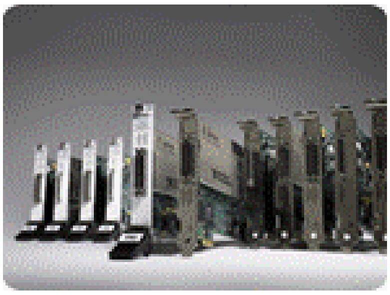
Selecting Hardware-in-the-Loop (HIL) Test System I/O Interfaces

Overview

High-performance, modular I/O interfaces are essential to building a successful HIL test system. The Hardware-in-the-Loop (HIL) Test System Architectures tutorial discussed several HIL test system architectures and the real-time processing technologies used to implement them. This tutorial discusses the variety of I/O interface options that can be used by the real-time processors when creating your HIL test system.



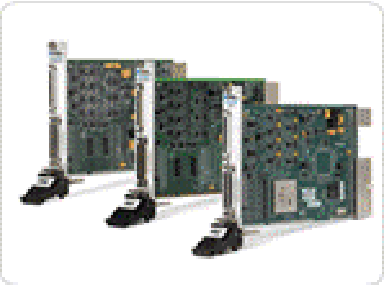
Multifunction I/O



HIL test systems require a variety of analog, digital, and counter/timer interfaces to interact with the electronic control unit (ECU) being tested. NI multifunction data acquisition products integrate all of this functionality on a single device, providing a high-value option for HIL test system I/O interfaces. High-performance analog-to-digital and digital-to-analog converters combined with onboard processing for counter/timer functionality and low-latency data transfers to the real-time processor make these interfaces ideal for HIL test system applications.

Browse NI multifunction data acquisition hardware

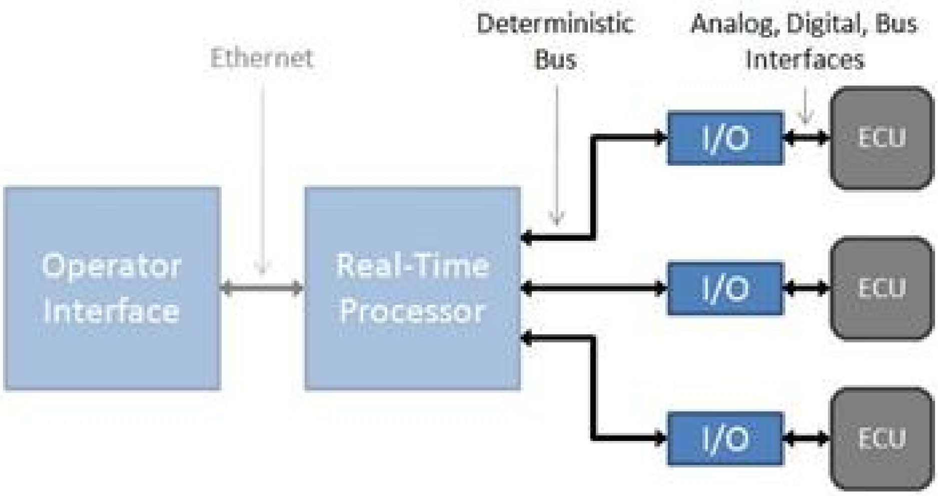
FPGA-Based I/O



NI field-programmable gate array (FPGA)-based I/O interfaces FPGA with analog and digital I/O into a single device. These devices are powered by NI reconfigurable I/O (RIO) FPGA technology, which provides a user-programmable FPGA that you can use to create custom I/O personalities as well as to off-load model execution and signal processing from the real-time processor for increased HIL test system performance. Using the NI LabVIEW FPGA Module, you can define your own hardware personality without in-depth knowledge of hardware description languages.

See how it works

Deterministic Distributed I/O



National Instruments offers a new class of deterministic distributed I/O products, which help you create distributed I/O-based HIL test systems to reduce wiring cost and complexity. Select from a variety of conditioned I/O modules to create distributed I/O interfaces that communicate with your real-time processor over deterministic Ethernet.

Learn more about real-time Ethernet I/O interfaces

Bus Interfaces

Many ECUs use communication bus interfaces to share information with other devices in the system. NI provides a wide variety of mil/aero, automotive, and industrial bus interfaces or you can use NI FPGA-based I/O interfaces to implement custom protocols for your HIL test system.

Browse NI mil/aero bus interfaces

Browse NI automotive and industrial network interfaces

Instrument-Grade I/O

NI modular instruments provide instrument grade measurement and signal generation in a modular form factor that you can integrate into your HIL test system. Choose from a wide variety of digital multimeters (DMMs), scopes, signal generators, and RF instruments and then configure them in software to meet your specific test system tasks.

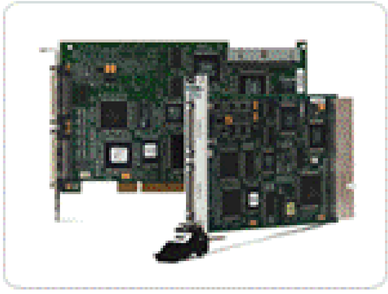
Browse NI modular instruments

Image Acquisition

With the family of NI Smart Cameras, which offers VGA (640 x 480 pixels) and SXGA (1280 x 1024 pixels) resolutions, add image analysis to your HIL test system to verify instrument panel displays or actuator response. Ensure minimal impact to your HIL test system by processing images directly on the onboard PowerPC and digital signal processing (DSP) coprocessors.

Browse NI Smart Cameras

Motion Control



National Instruments offers a variety of motion control solutions, which include high-performance controllers with full-feature capability for the most sophisticated requirements and low-cost motion controllers for point-to-point motion applications. NI motion control products provide high-level functions that help you to efficiently implement common tasks such as precise positioning, synchronization of multiple axes, and movement with defined velocity, acceleration, and deceleration.

Browse NI motion control products

Third-Party Hardware Support

Learn more about the multivendor PXI standard

Summary

If you plan to implement hardware fault insertion into your HIL test system, learn about the options on the NI HIL platform.

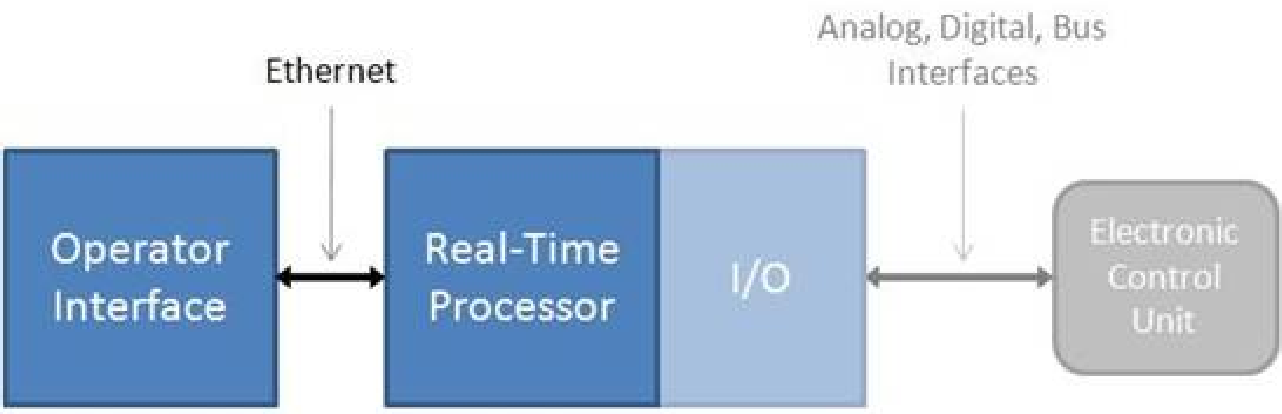
To complete your HIL test system, learn about the software technologies for HIL test system implementation, including test automation, requirements management, modeling, analysis, and reporting in Developing Hardware-in-the-Loop (HIL) Test System Applications.

Find additional resources to assist you with your HIL test system development or learn how others have achieved success with the NI HIL platform at ni.com/hil.

Creating Hardware-in-the-Loop (HIL) Test System Applications

Overview

The previous tutorials discussed the selection of I/O interfaces and how to use hardware fault insertion. HIL test applications use these interfaces to communicate with the electronic control unit (ECU) being tested and are composed of two primary execution systems: a deterministic, real-time application and a host application. This tutorial describes both the components and the tasks they perform.



Application Requirements

The deterministic, real-time application executes on the real-time processor to provide many services, including hardware I/O communication, data-logging services, stimulus generation, and model execution. The host application executes on the operator interface and communicates with the real-time processor via Ethernet to provide test command and visualization services as well as test automation and data analysis. Whether you want to configure, program, or simply turn on your HIL test system, National Instruments offers a variety of development and integration options.

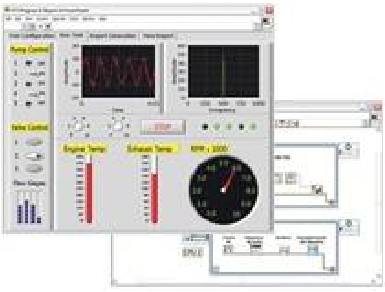
Configure

With NI VeriStand real-time testing and simulation software, you can quickly create your HIL test system application using a configuration-based approach, which reduces development cost and risk. NI VeriStand provides a flexible, multicore optimized application architecture ready to configure and use, ensuring successful HIL test system development. When necessary, you can customize and extend the open environment using NI LabVIEW, C/C++, and other environments providing assurance that NI VeriStand will always meet your future application requirements. By using NI VeriStand to build your real-time test systems, you benefit from reduced development time and application maintenance costs as well as the functionality and performance improvements implemented with each revision of the product.

Learn how to develop HIL test systems with NI VeriStand

Program

If you prefer to develop your own application architecture, National Instruments offers two programming tool chains designed to meet the specific needs of real-time test system application development.



The LabVIEW graphical programming environment provides the most efficient tool chain for developing real-time applications by combining the efficiency of graphical programming with engineering specific functions and tight coupling to real-time I/O interfaces. Quickly create host applications for your operator interface with drag-and-drop user-interface development and the power of graphically programed functionality. Then use the same graphical language to create multicore-ready, parallel applications for your real-time processor. To help you get started, use the NI Reference Design for Real-Time Testing Applications, which provides complete, documented source code for creating HIL test system applications with LabVIEW.

Learn how to develop HIL test systems with LabVIEW

LabWindows™/CVI is a proven ANSI C development environment that provides you with a comprehensive set of programming tools for creating HIL testing applications. LabWindows/CVI combines the longevity and reusability of ANSI C with engineering-specific functionality for real-time I/O interfaces, analysis, and user interface creation to provide an engineering-optizied environment for text-based application development.

Learn how to develop HIL test systems with LabWindows/CVI

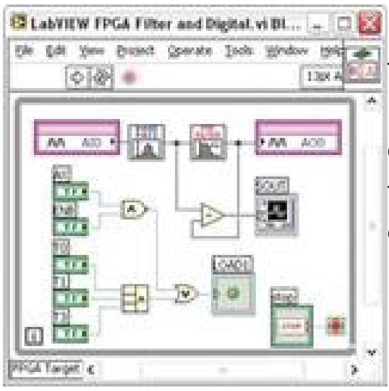
Turnkey System Integration

Receive an HIL test system built to your specification with turnkey system intergration. The National Instruments Alliance Partner program is a worldwide network of more than 600 certified system integrators who partner with NI to provide customers turnkey solutions. This partner approach to turnkey HIL test system development provides you with the highest quality HIL test solutions at the greatest value. You benefit from a product company with a focused investment in product development and technology innovation. Because of the product volumes NI produces with this business model, the company can offer the highest quality products at the lowest cost and with the greatest availability. Simultaneously you benefit from the deep domain expertise of certified integration partners whose business model helps them to provide superior system delivery times and on-site services.

To learn more about turnkey integration services contact your local NI field engineer

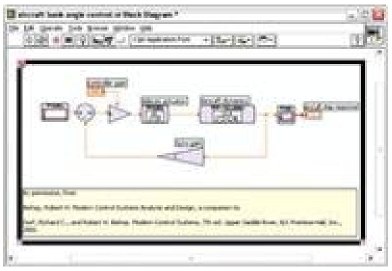
Other HIL Test System Application Tools

National Instruments provides many other tools for HIL test application development.



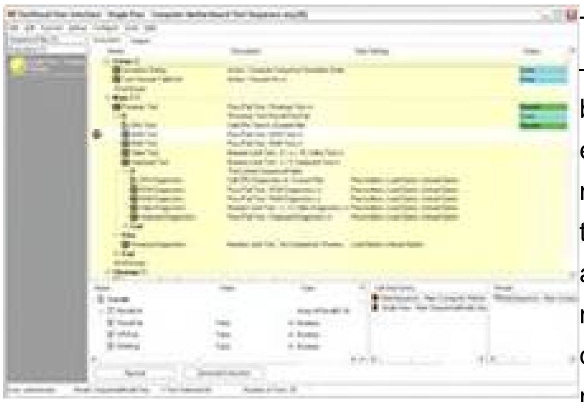
Reconfigurable I/O Customization Software – Use the LabVIEW graphical field-programmable gate array (FPGA) development tool chain with NI reconfigurable I/O (RIO) interfaces to easily create custom I/O personalities, deploy models for high-speed execution, and off-load signal processing tasks in your HIL test system. Using the LabVIEW FPGA Module, you can define your own hardware personality without in-depth knowledge of hardware description languages.

See how FPGA-based I/O can improve your HIL test system development



Creating and Using Models – Real-time system models are a crucial component of your HIL test system application. National Instruments offers a control design and simulation option for the LabVIEW development environment that combines high-level modeling components with the power of a complete programming language, which gives you the ability to produce multicore-optimized, real-time models that you can use with your NI VeriStand, LabVIEW, or LabWindows/CVI HIL applications. These development environments also support many third-party modeling environments as well C/C++ models and can combine models from different tools in the same HIL test application. You can also import models from a variety of 3rd party modeling environments.

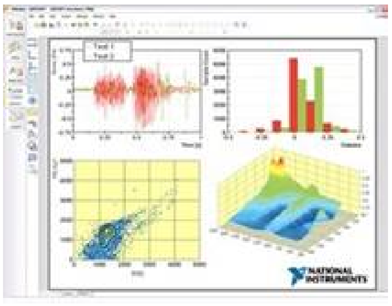
Explore LabVIEW for control design and simulation



Test Automation and Requirements Traceability Software – Increase the efficiency and quality of your HIL test system by adding test automation, requirements traceability, and enterprise connectivity. NI TestStand is a powerful ready-to-run test management environment that helps you to develop, manage, and execute test sequences written in any programming language. NI Requirements Gateway is a requirements traceability solution that links your development and verification documents with formal requirements. By organizing and managing requirements and the documents or applications that cover them, NI Requirements Gateway helps improve the quality and efficiency of your development process.

View how to add test automation to your HIL test system

Discover how NI Requirements Gateway can improve your development process



Analysis and Reporting Software (optional) – Accelerate your HIL test system analysis and reporting tasks with NI DIAdem software. Use NI DIAdem to interactively create reusable analysis scripts and report templates or implement automated analysis and report processes. With support for many third-party analysis packages, NI DIAdem can provide you with a unified process for quickly turning HIL test system data into results you can use to make decisions.

Use NI DIAdem to optimize your data analysis and reporting

Summary

National Instruments has been helping engineers achieve HIL test system success for more than a decade. To begin creating your NI HIL test system, view the reference systems or request a free consultation with your local NI field engineer to see additional product demonstrations or create a custom configuration for your HIL test system.

Find additional resources to assist you with your HIL test system development or learn how others have achieved success with the NI HIL platform at ni.com/hil.

Relevant Training Courses for Hardware-in-the-Loop Test Applications

Overview

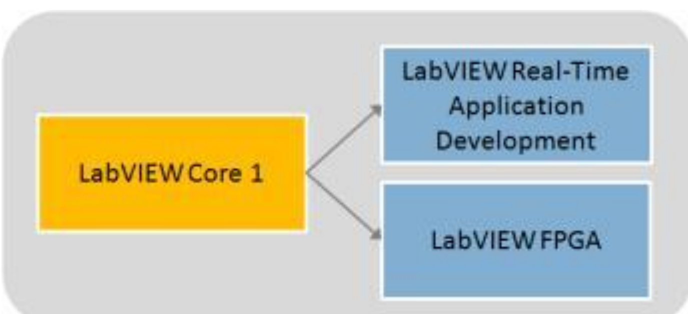
While NI does not offer courses specific hardware-in-the-loop (HIL) test application courses, NI LabVIEW and embedded hardware development courses provide the fundamental information you need to quickly design, prototype, and deploy reliable embedded control and acquisition systems for applications such as HIL test on NI Single-Board RIO, CompactRIO, and PXI/CompactPCI hardware.

Training Courses

Whether you use NI R Series hardware for PXI, NI CompactRIO modules, or NI Single-Board RIO devices to develop and deploy your HIL test applications, the training path starts in the same place. Specifically, all embedded system designers should start with:

- LabVIEW Core 1
  View Course Details | Review Sample Course Material | Test Your LabVIEW IQ

CompactRIO and NI Single-Board RIO Users



CompactRIO and NI Single-Board RIO users should progress from LabVIEW Core 1 to:

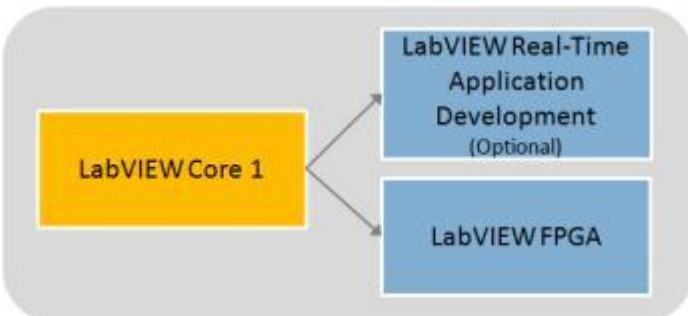
- LabVIEW Real-Time Application Development
  View Course Details | Review Sample Course Material | Test Your LabVIEW Real-Time IQ
- LabVIEW FPGA Module Course
  View Course Details | Review Sample Course Material | Test Your LabVIEW FPGA IQ

Building on information taught in LabVIEW Core 1, the LabVIEW Real-Time Application Development course teaches students how to develop the different elements of a real-time application using CompactRIO hardware.

Next, students take the LabVIEW FPGA Module course to explore how to design, debug, and implement applications using the LabVIEW FPGA Module and NI reconfigurable I/O (RIO) hardware.

Students can take the LabVIEW Real-Time Application Development and LabVIEW FPGA courses in any order.

R Series Users



R Series users should progress from LabVIEW Core 1 to:

- LabVIEW Real-Time Application Development (Optional)
  View Course Details | Review Sample Course Material | Test Your LabVIEW Real-Time IQ
- LabVIEW FPGA Module Course
  View Course Details | Review Sample Course Material | Test Your LabVIEW FPGA IQ

R Series users who are incorporating real-time PXI controllers in their applications should progress to the LabVIEW Real-Time Application Development course. Building on information taught in LabVIEW Core 1, this course covers powerful system architectures, real-time programming techniques, and time-saving development tips.

All R Series users should take the LabVIEW FPGA course to explore how to design, debug, and implement applications using the LabVIEW FPGA Module and NI RIO hardware.

Students can take the LabVIEW Real-Time Application Development and LabVIEW FPGA courses in any order.

Additional Training Resources

- Unsure about what you can gain from NI training? Learn how past NI training customers have benefited.

- View other LabVIEW training paths.

Using Fault Insertion Units (FIUs) for Electronic Testing

Overview

Hardware fault insertion (also known as fault injection) is a critical consideration in test systems that are responsible for the reliability of embedded control units. This tutorial describes the uses for fault insertion as well as how to incorporate fault insertion units (FIUs) into hardware-in-the-loop (HIL) test systems built with PXI hardware. For more information on NI products for fault insertion, visit the FIU selection page. For more information on the NI HIL platform, visit ni.com/hil.

Why Is Hardware Fault Insertion Needed?

In many hardware-in-the-loop (HIL) test systems, hardware fault insertion is used to create signal faults between the electronic control unit (ECU) and the rest of the system to test, characterize, or validate ECU behavior under specific failure conditions. Fault insertion is most commonly used when it is imperative for a specific ECU to have both a known and an acceptable response to fault conditions – examples include ECUs for vehicles, aircraft, spacecraft, and machinery. To accomplish this, fault insertion units (FIUs) are inserted between the I/O interfaces of a test system and the ECU so the test system can switch between normal operation and fault conditions such as a short to battery, short to ground, or open circuit.

The Figure 1 diagram shows how an FIU typically fits into an HIL test system. Notice that the fault insertion acts as a gate between the I/O and the ECU.

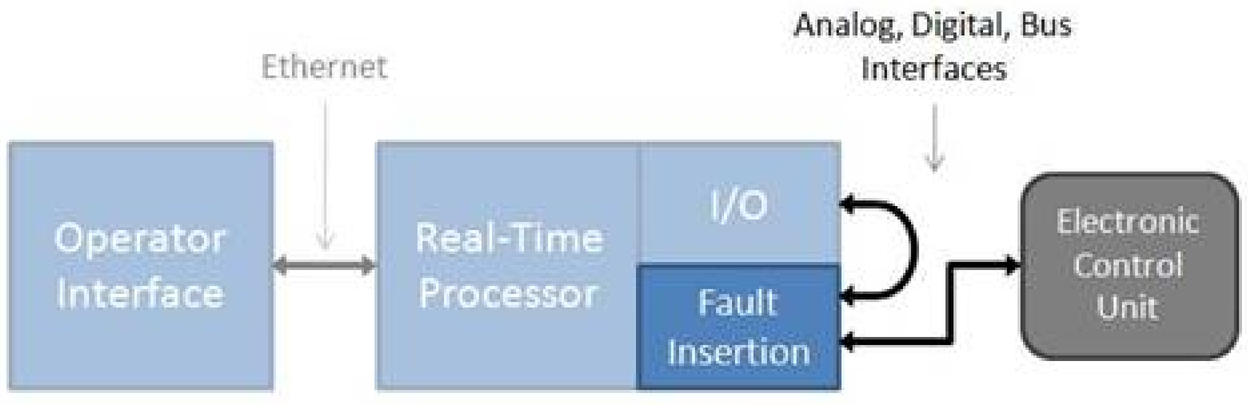


Figure 1. Typical Placement of a Fault Insertion Unit in a Dynamic Test System

Anatomy of a Fault Insertion Unit

A common configuration for an FIU is a “fault bus topology,” where you can open or short each channel to one or more fault buses. In this topology, each FIU channel consists of three single-pole-single-throw (SPST) relays. The first relay of the channel acts as a pass-through – during the default mode of operation, this relay is closed, and the FIU is transparent to both the ECU and the test system.

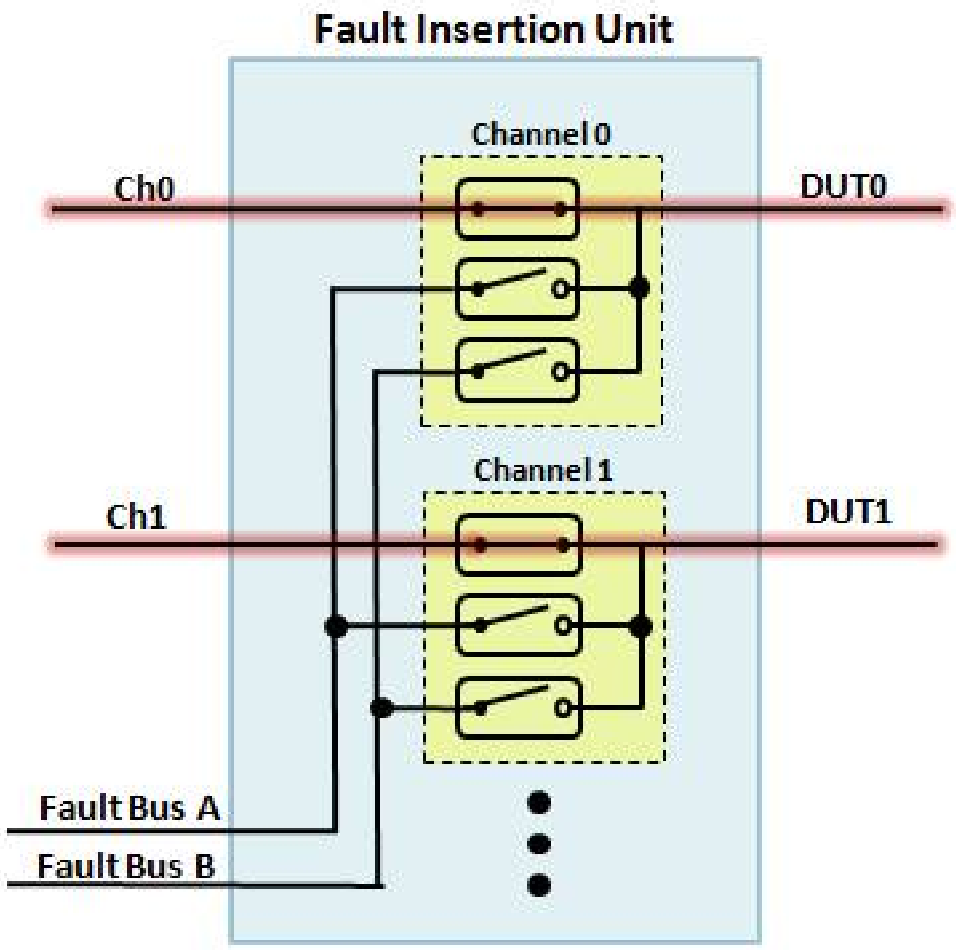


Figure 2. An FIU in the Default Mode of Operation – All Signals Are Passed Through

Open Circuit Faults

To simulate an open circuit or interrupt fault, the signal line between the test application and device under test (DUT) is left open to determine how the DUT behaves after a signal interruption. You can open this relay to simulate a hard break or open and close it at a specified time interval to simulate an intermittent connection or loose contacts.

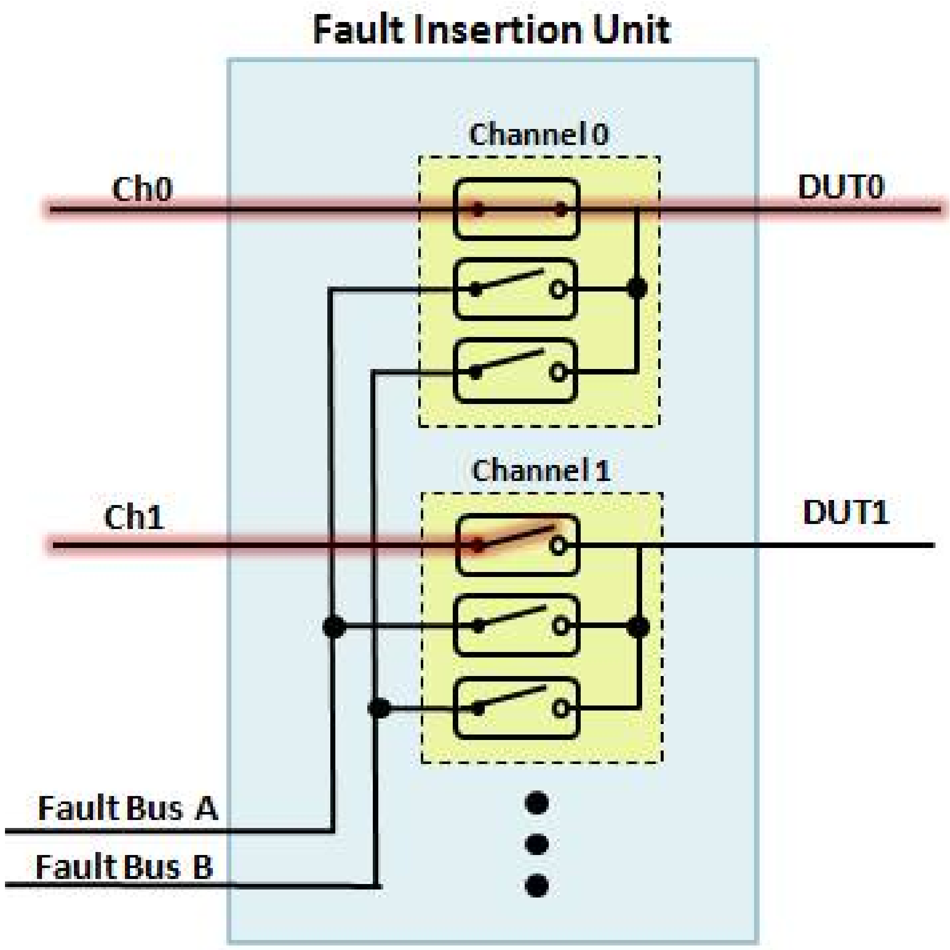


Figure 3. An FIU with an Open-Circuit Simulation on Channel 1

Short to Ground or Short to Power

To simulate shorts to ground or power, the signal line is connected from an external fault line or fault bus to the DUT. You can configure the fault buses to simulate power supply lines, system ground, or other power sources in the system.

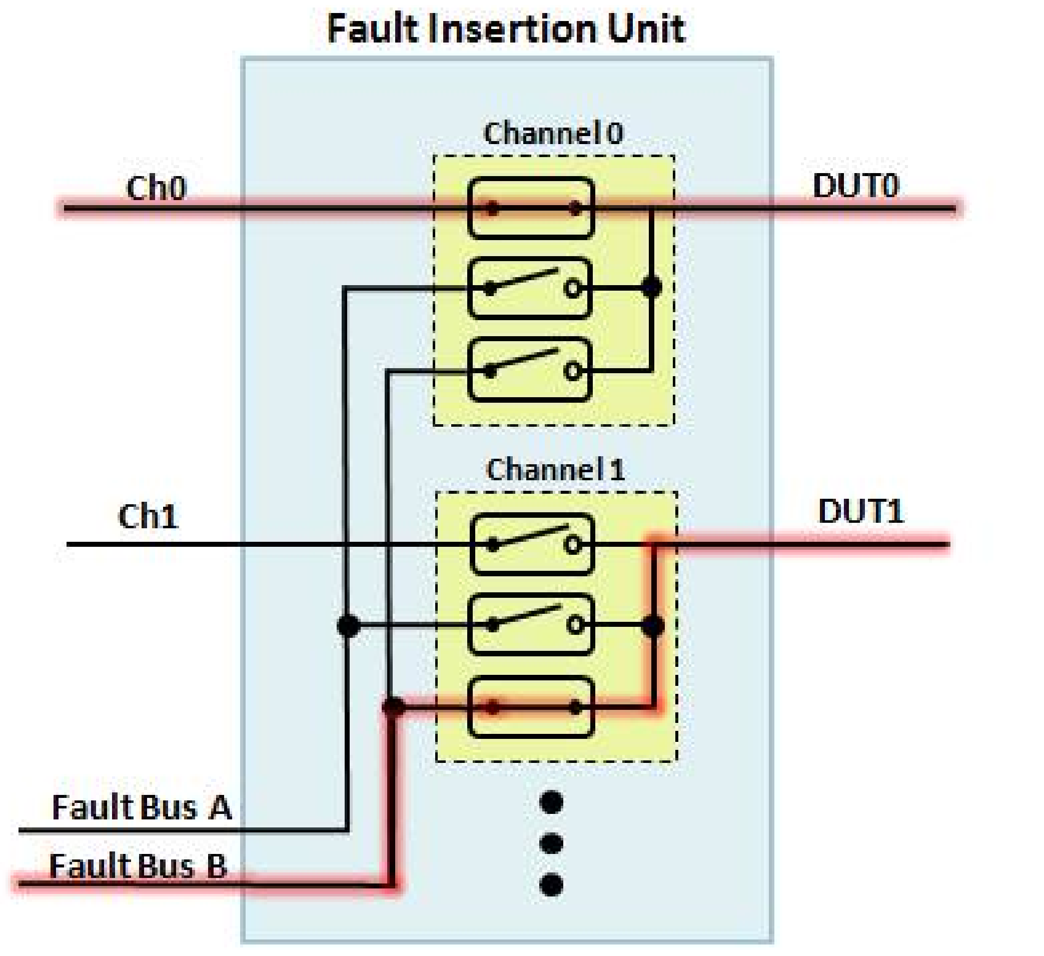


Figure 4. An FIU with a Short-to-Power Fault Simulation on Channel 1

Pin-to-Pin Shorts

Finally, to simulate a pin-to-pin short, the DUT signal line is connected to one or more additional DUT signal lines.

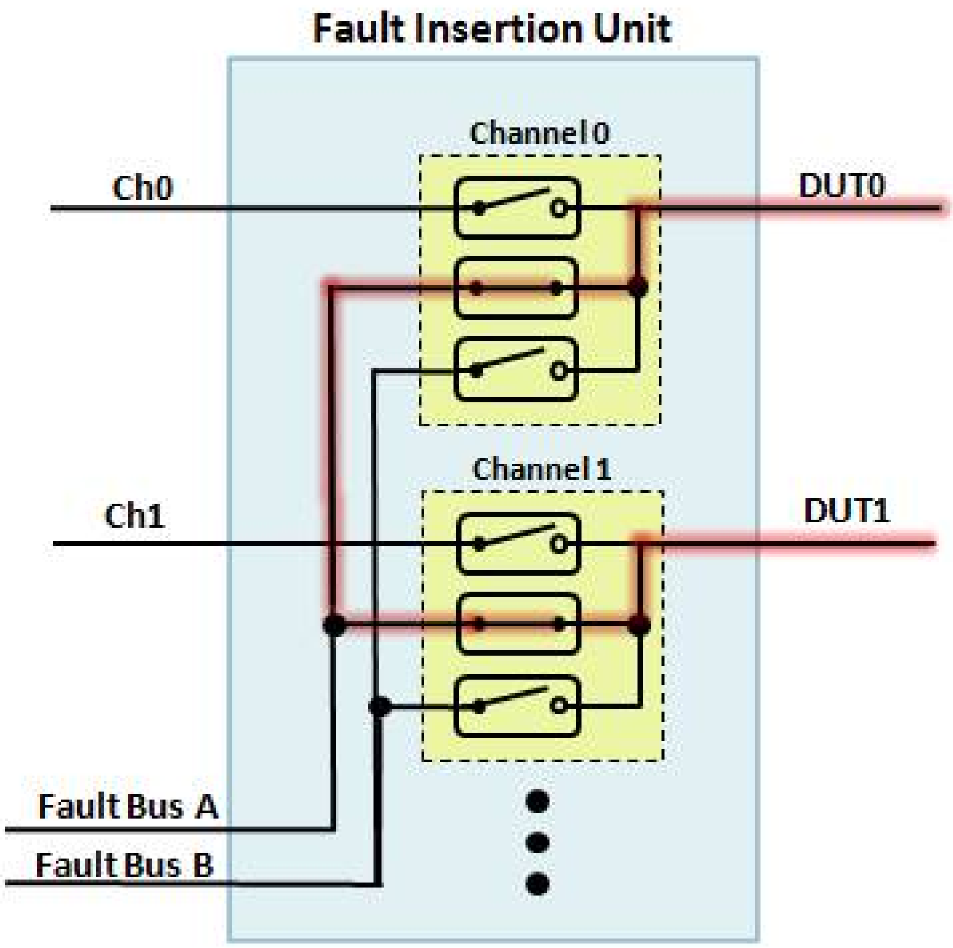


Figure 5. An FIU with a Pin-to-Pin Short between Channels 0 and 1

Benefits of PXI-Based FIUs

With its triggering and synchronization features, PXI provides an ideal environment for FIUs. And because HIL test systems are commonly architected with PXI-based I/O, PXI also offers close proximity to the signals you need to switch. Such systems are commonly controlled via embedded real-time processing software such as NI VeriStand, so having a PXI-based FIU makes it simple for engineers to programmatically select and control faults from the same interface that is running their model and test sequences.

National Instruments recently released its first FIU, the NI PXI-2510, a 68-channel, 150 V, 2 A FIU designed for use in HIL applications. Each module has 68 feedthrough channels that you can open or short to one or two fault buses. Additionally, each fault bus has a 4x1 input multiplexer, thereby allowing greater flexibility for both the type and number of faults that you can inject via software control.

Figure 6. NI PXI-2510 68-Channel 2 A FIU

In addition to easy integration with HIL test systems, NI PXI FIUs offer the hardware-related advantages of safety, reliability, and connectivity.

Safety

Because high voltages and currents are often associated with fault insertion, and reliability is essential for HIL applications, NI takes the utmost care with its FIUs when it comes to safety. Specifically, all NI FIUs are compliant with IEC 61010-1 international standards, and have had their designs verified through third-party agencies such as UL. Finally, each unit is tested prior to shipping to validate both functionality and safety.

Reliability

Similar to safety, reliability is a key concern for the integrity of long-term tests. Although rated for millions of cycles, electromechanical relays have a finite and relatively predictable lifetime under normal loading conditions. To allow for increased long-term reliability, the PXI-2510 incorporates onboard relay count tracking, which you can use to view the number of cycles each relay has undergone. This helps you determine your maintenance and replacement needs. The PXI-2510 features a user-replaceable relay kit in the event of normal relay failure at the end of its specified lifetime. NI also recognizes that through the course of usage, unforeseen circumstances can result in the accidental damage of relays by exposure to excessive voltages and currents, in which case the user-replaceable relay kit is also valuable. Finally, for mechanical reliability, each FIU design undergoes highly accelerated life test (HALT) screening to ensure mechanical soundness in high-vibration environments, which allows for sustained use in harsh field conditions.

Connectivity

Often overlooked, cabling and connectivity are major concerns for fault insertion applications due to the potentially large number of channels involved as well as the high voltages and currents that you can use. The PXI-2510 offers three connectivity options – screw terminal, bare wire, and DIN connector. Each of these options has been specifically designed to guarantee safety, reliability, and shielding all the way to the signal terminals to provide a full connectivity solution. The result is improved noise and crosstalk in addition to reduced system emissions.

To learn more about connectivity and cabling options for the PXI-2510, visit the “How to Connect Signals to the PXI-2510" tutorial.

In addition to products specifically designed for fault insertion, National Instruments offers a variety of general-purpose switching products that you can use to create custom fault insertion topologies. An example is the NI PXI-2586 10-channel, 12 A SPST module, which you can use to create multiple topologies for fault insertion, including a three-channel, two-bus FIU and a nine-channel, one-bus FIU, as shown in this tutorial. For a complete list of all NI switches that you can use for fault insertion applications, visit the NI Switch Selection Guide.

Integrating PXI FIUs into HIL Test Systems

System integration, including software, is a final key consideration when choosing an FIU. In the Windows environment, you can interactively configure and test PXI FIUs through the NI-SWITCH Soft Front Panel (SFP) – a graphical utility designed for switch debugging. For automated control, the included NI-DAQmx hardware driver provides programmatic access to the full functionality of the module through the LabVIEW Real-Time and Windows OSs.

Most commonly, HIL test systems are controlled via NI VeriStand, a ready-to-use software environment for configuring real-time testing applications. You can easily control NI PXI FIUs with NI VeriStand, which means you can manage them in the same environment that you use to configure real-time I/O, stimulus profiles, data logging, and alarming; implement control algorithms or system simulations; build test system interfaces for a run-time editable user interface; and more. For more information on configuring the PXI-2510 in NI VeriStand, visit the “Using the NI PXI-2510 in NI VeriStand" tutorial.

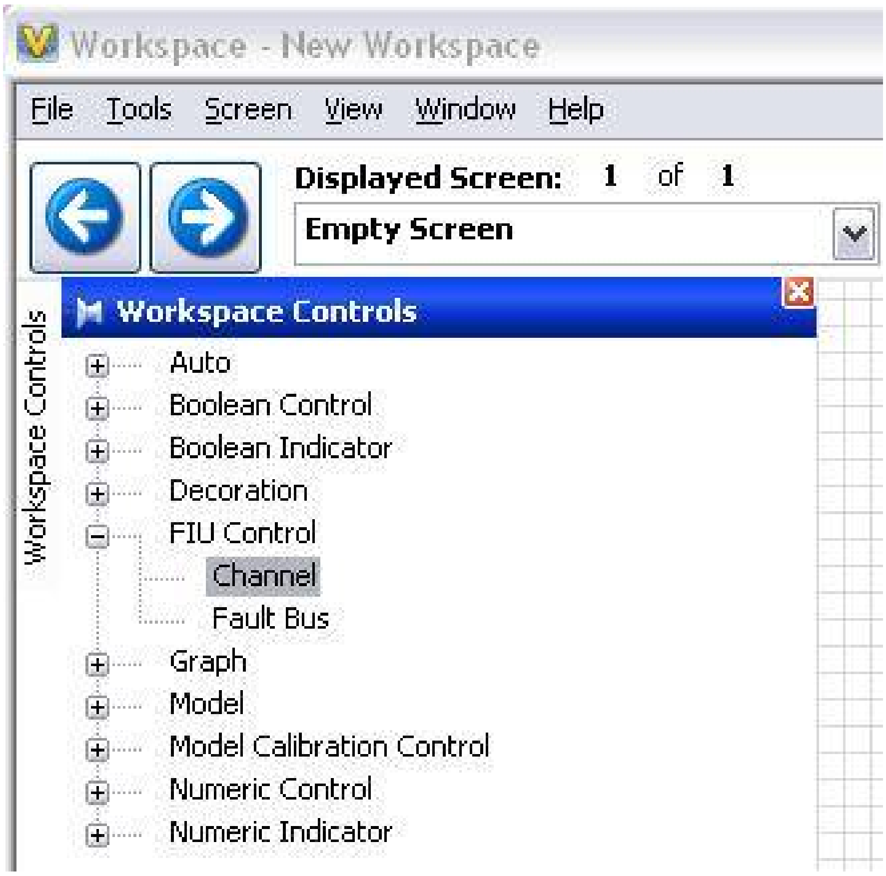


Figure 7. NI VeriStand Control of FIUs

For more advanced and time-sensitive control, each FIU module can send and receive triggers through the PXI backplane. Input triggers can advance the switch to the next fault location in a predefined list loaded onto the FIU hardware. You can use output triggers to initiate measurements on other instruments in the PXI system. You also can send triggers from real-time simulations to sequence through fault conditions for automated test coverage or, for applications requiring more complex sequencing and dynamic fault control, you can use a PXI field-programmable gate array (FPGA) module to send and receive triggers to one or more FIUs via the PXI backplane.

Conclusion

When ECU reliability is essential, you should consider FIUs. NI has created a hardware and software architecture you can use to integrate FIUs into HIL test systems in order to improve device safety and reliability.

Resources

Hardware-in-the-Loop Test

FIU Selection Guide

NI Switch Selection Guide

Using the NI PXI-2510 in NI VeriStand