Background

Designers of automotive systems have to validate the design reliability of their ECUs (Engine Control Units), also known as PCMs (Power-train Control Modules) or ECMs (Engine Control Modules). Rather than design proprietary systems, which are likely to be expensive to create if the investment in the design is accounted for and labor intensive in use, designers are increasingly turning to PXI based solutions.

HILS (Hardware In the Loop Solutions) are primarily used for NPI (New Product Introduction), they are used to verify that the key components all work as intended by including a mix of real products and simulated products. As well as verifying the operation of the system when everything is working as intended the user needs to verify that the system behaves correctly when simple faults are introduced. For example short circuits and open circuits in the parts that make up the system – a process commonly referred to as Fault Insertion (FI).

Proprietary FI systems typically use very manual methods of performing Fault Simulation. Basically, to insert a fault, the operator has to manually move cables on a patch panel to short pins together, force a stuck at Battery Voltage or Ground, or inject false sensor data. This method is slow, subject to human error, and is expensive. Issues of product liability when electronic systems fail and the continuous pressure to lower costs have forced a strategy change for many users.

Fault Insertion on an ECU

Fault simulation during the design and validation of ECUs is a method of establishing solid predictions for reliability and firmware verification, ultimately ensuring the safety of driver and passengers. An ECU relies on information from a set of sensors and controls and firmware instructions to decide what to do with the device it is managing. These sensors are themselves often working in extremely hostile environments (such as within a car in this application) and predictably failures can occur in the sensors or their interconnections. The ECU has to respond appropriately to these component failures, as well as to genuine system faults. The idea of testing for system failures is not new – it is an important aspect of ECU validation and involves the introduction of electrical faults into a system. The test process typically duplicates various conditions that could occur because of corrosion, short/open circuits and other electrical failures caused by infant mortality, age, damage or even faulty installation. The concept is to ensure that the ECU will do its best to function, even with bad data present, to either protect the passengers and allow them to get to a repair facility safely.
PXI Solutions

PXI provides an open platform for HILS requirements. Combining this with the large range of hardware, available from Pickering Interfaces and many other vendors, enables the most flexible and cost-effective alternatives to proprietary systems. The modularity and openness of PXI enables the integrator to design a highly scalable solution with plenty of potential for evolution.

There is a wide range of PXI FI modules to aid the reliability testing of safety critical controllers. These switching modules are designed to route various fault conditions between a test fixture and the UUT. This includes open circuits, short circuit between UUT connections, and short circuits to other signals such as power, ignition, and ground. Faulty serial busses can be injected into the circuit as well using PXI modules such as Pickering Interfaces newly released Differential PXI Fault Insertion Switching (models 40-200 and 40-201).

A key advantage of using PXI is that elements of the test system can come from different PXI vendors, allowing integrators or users to choose the most appropriate modules for their test system. The PXI standard ensures that these modules will work together in any PXI vendor's chassis.

Another key requirement for HILS is that they require vendors to support RTOS (Real Time Operating Systems) to ensure a deterministic response for the system. Events have to happen at specific times, to emulate the connections to the ECU. Market pressures ensure that vendors, such as Pickering Interfaces, support users of RTOS.
FI systems also need to have a wide variety of modules supporting different levels of voltage and current to match the paths in the ECU connections. Some may require high current capacity, but designs capable of this occupy more space than those with lower capacities. Therefore, fulfilling requirements with modules matched to the highest performance requirements will occupy more space and slots in a PXI chassis, and that in turn impacts costs. For that reason, it is important to offer a wide range of both FI architectures (to match connection types) and capacity (voltage or current). Pickering Interfaces offer the widest range of FI modules available in PXI. The introduction of their models 40-200 and 40-201 also allows the simple creation of faults on the commonly used automotive serial interfaces, such as CAN and Ethernet, while preserving the integrity of the serial interface in no fault condition.

**Summary**

PXI is an ideal platform for creating HILS systems and the addition of Fault Insertion paths. It allows users and integrators to create flexible multi-vendor solutions based on an open hardware platform.

For more information on Pickering Interfaces range of FI modules see: