Benefits of Combining ICT & Functional Test for a High Volume Automotive Dashboard Application

How one company used a Teradyne TestStation system equipped with a PXI Expansion Board to improve test quality, cut test acquisition costs, and lower operational expenses

Summary

This case study describes the benefits that were realized by a manufacturer of high volume automotive dashboard units when they replaced a functional test system with a standard TestStation In-Circuit tester equipped with a PXI Expansion Board. Benefits included 60% lower acquisition costs, higher test coverage, faster test throughput, reduced equipment floor space, and lower operational costs.

Background

A successful manufacturer of automotive dashboards needed to update their test strategy to keep up with the demands of increasing production volumes.

Their existing test strategy consisted of a comprehensive functional test running on a commercial functional test system that had become increasingly unsupportable ever since it had been discontinued by the tester manufacturer.

The goal was to find an alternate test solution with equivalent or better test coverage; faster test throughput, and lower operational costs.

Test Requirements

The manufacturer's Dashboard Controller is a medium complexity board with 500 components; including 100 LEDs, passive analog components, stepper motors, push buttons, a speaker, phototransistors, EEPROMs, Mux, and LCD drivers.

Figure 1: Dashboard Controller

The basic test requirements for the automotive dashboard specified that the solution be able to ensure that all components have been properly placed and that the board is free of short and open defects.

Functional test requirements included communication with the CAN bus after power up, upload of dedicated firmware to the FLASH to perform self test procedures, storage of calibration data in an EEPROM, simulating loads, measuring very precise time intervals, verifying audio levels, and measuring LED colors and intensity.

Test Solution Options

The manufacturer examined three options for satisfying their Dashboard Controller test requirements:

1. Replicate their current functional test strategy the best they can by integrating off-the-shelf PXI instruments in a custom functional rack system.
2. Deploy a two-stage test strategy, where the first stage performed traditional ICT testing and the second stage would perform defined functional testing.
3. Replace their current functional test system with an ICT system that could be extended to support their functional test requirements in a single test stage.

The first option had the benefit of most closely matching their current test strategy and it would allow them to directly transfer existing tests in the fastest amount of time. However, this option also came with the same weaknesses as their current test solution; which were high support costs, indeterminate fault coverage, limited diagnostic accuracy, and slow throughput.

By adding traditional ICT to the mix, the second option would improve fault coverage and diagnostic accuracy, as well as simplify functional test requirements. However this option would increase both acquisition and operational costs because it would require two test systems, two test fixtures, and additional product handling

The third option was perceived as ideal as it would eliminate the weaknesses that were identified in both options 1 and 2. The challenge was to find the in-circuit tester that could be extended to best support their functional test requirements.

Selected Test Solution

After researching various solutions in the market, the manufacturer selected Teradyne's TestStation LH tester as the best solution for their test requirements.

In addition to the high performance in-circuit test capabilities of the TestStation LH, the manufacturer found the TestStation's ***PXI Functional Expansion Board*** capabilities to be unique among all the in-circuit test systems that they researched.

The board supports the installation of PXI instruments in a chassis attached to a low profile board that plugs directly into an Accessory slot of the TestStation backplane. It's innovative and compact design simplifies adding functional test capabilities to the system without expanding equipment floor space or complicating fixture tooling.

The bottom of the board supports the addition of 4 industry standard 3U PXI instruments, while the top half of the board is a signal distribution hub that supports routing of the PXI instrument signals directly to the Unit-Under-Test, to external GPIB instrument ports, or to the system analog bus (where they can be further routed to any pin in the system).

Additional signals are provided to connect the TestStation's Arbitrary Waveform Generator and to synchronize the PXI instruments with the tester's standard DMM instrument.

Figure 2: TestStation PXI Expansion Board

Application programs to communicate and control the PXI instruments can be developed using popular and intuitive graphical programming environments like Labview, LabWindows/CVI, or Visual Studio.

Once created, the PXI functional test procedures can be tightly integrated with the in-circuit program using TestStation's ***Dynamic Programming Extension*** feature. This feature provides a mechanism to link the tester run-time executable directly with external Dynamic Link Library routines (DLLs). Program status and measurement variables can be easily passed between the tester and external software applications providing maximum flexibility for test program developers.

Implementation

The process for implementing the combined TestStation ICT/Functional test solution for the Dashboard Controller board involved the following steps.

1. **Generation of the in-circuit test** - This was done in a matter of hours using TestStation device library models and automatic test generators. The in-circuit tests provide certainty that structural and assembly faults in the Dashboard Controller will be detected quickly and accurately. The original test solution relied on more complex functional tests to detect these defects.

2. **Identify required functional tests** – this step involved reviewing the existing functional tests and identifying those that were still required. Any functional tests that provided overlapping test coverage with the ICT tests were targeted for removal while those that provided supplemental coverage were targeted for integration with the ICT tests.

   Many of the existing functional tests could be migrated easily and re-used because of the TestStation software support for external program DLL routines and the built-in hardware support for the industry standard PXI and GPIB instrumentation buses.

3. **Install required functional instruments** – once the functional tests were identified, the manufacturer was able to select the instruments that would be needed to execute these tests.

   For the Dashboard Controller application it was determined that 3 PXI instruments (a CAN Commmunication Controller, a High Density Resistor Simulator card, and a high accuracy Counter/Timer) were needed.

4. **Fabricate test fixture** – this step involved communicating to the fixture fabricator the fixture requirements for both the in-circuit and functional portions of the test program.

   The in-circuit fixture wiring instruction were generated automatically as part of the in-circuit test program development; however additional instructions had to be created by the manufacturer to account for the addition of an optical camera box for measuring LED luminosity and intensity, pneumatic pushers to test switches, a microphone to measure audio, and a PCB board marker.

5. **Integrate and debug in-circuit and functional tests** – this last step included qualification of the program and the fixture and verifying that the tests were reliable and repeatable for production testing. This step also gave the manufacturer the opportunity to compare and contrast the new combined ICT/Functional test solution with the original functional test solution.

Results

The table below compares the results of the two solutions along the dimensions that mattered most to the manufacturer.

	Original Functional Solution	ICT w/ PXI Expansion Board
Acquisition Price	$190K	$180K
Fixture Cost	$60K	$20K
Tester Floorspace	25 ft^2	16 ft^2
Test Coverage	Lower	Higher
Dev Time	Slower	Faster
Test Time	90 seconds	45 seconds
Repair Time	Slower	Faster
Support Costs	More expensive	Less expensive
Testers Needed	6	3

The benefits of the combined approach won out easily in the eyes of the manufacturer because it significantly lowered both their acquisition and operational costs.

Lower acquisition costs were achieved because the TestStation solution cost 20% less than the original functional test system and it was twice as fast. Calculations showed that the manufacturer saved 60% ($300K) for every two functional test systems that were replaced with a single TestStation system – those savings were achieved without sacrificing any reduction in test capacity.

Lower operational costs were achieved from less expensive fixture kit pricing, reduced factory floorspace, faster program development times, less defect escapes, faster repair times (due to more accurate ICT diagnostics), and lower support costs.