Scalable, Interchangeable PCB Test Platform for LED Lighting

Author(s):
Joseph F. Callaghan, Automation Systems Consultant, Data Science Automation, Inc.
Thomas R. Garvey, Manager, Project Engineering, Data Science Automation, Inc.

NI Product(s) Used:
CompactDAQ
LabVIEW

Category:
Advanced Manufacturing and Control
Transportation

The Challenge
Create a scalable electrical testing of multiple, panelized LED Lighting control boards with flexible, interchangeable test fixtures.

The Solution
Combine custom software developed in LabVIEW with NI CompactDAQ, bed-of nails test fixtures, custom DSA electronics, and a unique method of fixture auto-detection to produce a foolproof, accurate, scalable PCB test platform.

Introduction
Data Science Automation (DSA) is a premier National Instruments (NI) Alliance Partner that specializes in automating and educating the world leading companies. Clients choose DSA because of DSA's deep knowledge of National Instruments products, disciplined process of developing adaptive project solutions, staff of skilled Certified LabVIEW Architects and Certified Professional Instructors, and unique focus on empowerment through education and co-development.

A leading manufacturer of automotive lighting products was under pressure to launch production for a new series of lighting products, but needed to quickly test the printed circuit boards that formed the core of the LED lighting assembly. In addition, they needed a test platform that could seamlessly support multiple, panelized PCB designs without requiring personnel to modify software. Also, the risk of operators attaching the wrong fixture to the test system and damaging the unit under test needed to be mitigated.

The lighting manufacturer chose Data Science Automation, a premier NI Alliance Partner, to provide a turn-key solution for their lighting PCBs with a scalable LabVIEW-based software application and an interchangeable set of front-end test-fixtures. DSA was chosen based on reputation and a past history of providing successful test platforms to the client in question.

New Product Line in the Works
The client needed to commence production of a new series of automotive lighting products as soon as possible to meet market demand. However, they needed to perform production-level testing to measure current draw of every core lighting circuit produced and verify operation of the ultra-bright LEDs. This could not be reasonably done without some kind of automated test system using bed-of-nails PCB fixturing, and something needed to be provided in a short time frame to ensure production was not delayed.

The Case for LabVIEW
DSA had previously introduced this client to the LabVIEW environment and also empowered some of their engineering personnel with LabVIEW Core 1 and Core 2 classes. The use of LabVIEW with CompactDAQ hardware, as well as DSA's knowledge and expertise with the products, had already

proven itself on previous production test platforms at the client facility. This test platform needed to be as scalable as possible to allow for future expansion and modification. LabVIEW, as well as the expandable nature of the CompactDAQ platform, allowed DSA to deploy a system within a few weeks. As a result of prior empowerment by DSA the client's engineering staff felt comfortable maintaining the software on their own in the future.

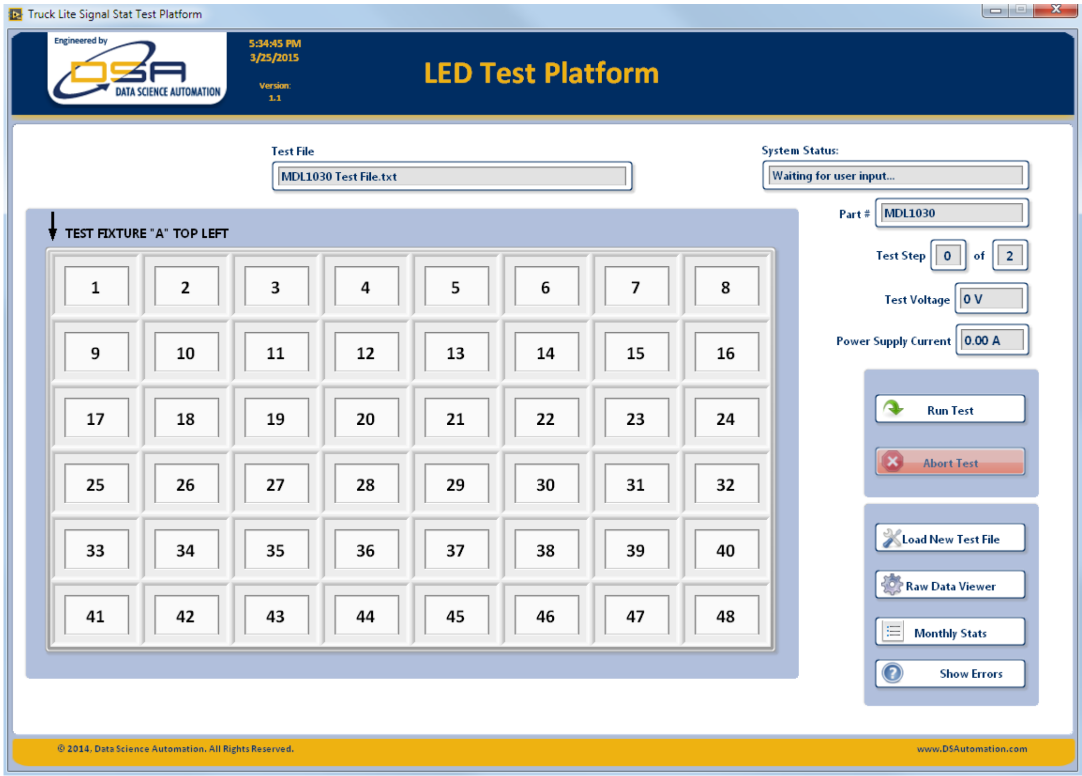

Figure 1: Main Screen of LED Test Application

The Challenge of Scalability

The new lighting product line included several different product sizes, each with different arrangements of LEDs and different circuits. Each PCB design, when produced, included varying numbers of individual circuits in a panelized layout, as is common in electronics production. For example, one board included only 4 individual circuits, while another included 48 circuits. At some point after testing but prior to final assembly, the panelized circuit board was "snapped" apart to separate each individual circuit, each of which would then be placed inside a housing and lens assembly for final production.

Each circuit needed to be tested for proper function and proper current draw by sourcing controlled levels of DC voltage to the circuit. Some PCB designs had multiple lamp functions on each circuit (for instance, a "bright" and "dim" mode) that required sourcing the voltage to different sets of leads. In addition, since each PCB design had a different size and number of test points, the physical test fixture with its associated probes needed to change as different production runs of the individual PCB designs were completed. The challenge was how to make the changing of test fixtures easy and seamless for the test operators, and minimize the chance of accidentally mismatching the fixture with the wrong test sequence in the software. As the test routines for each PCB sourced power through different wires to the fixture, mismatching the fixture to the test sequence could result in damage of the product under test.

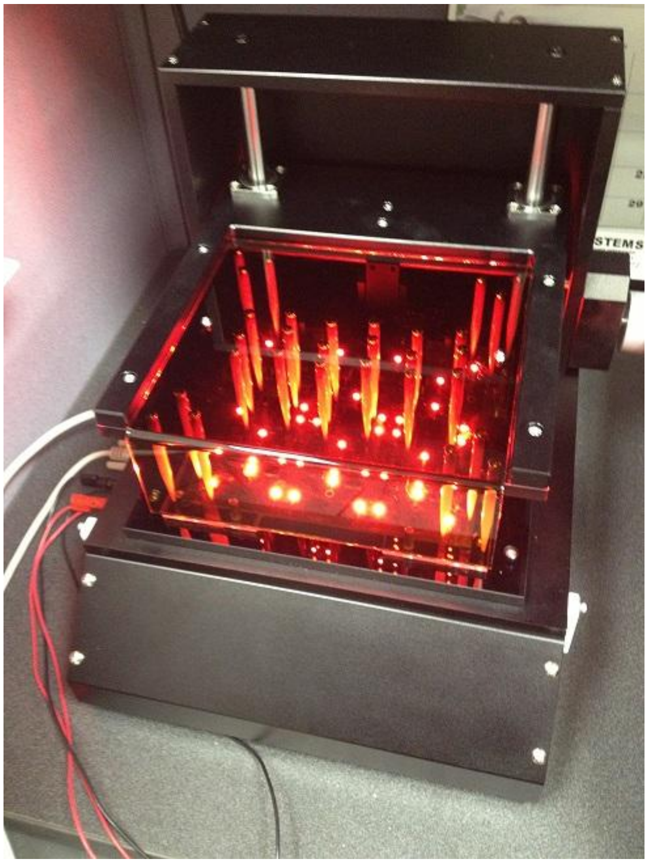
Figure 2: 48-Circuit LED Test Fixture

The Final Design

DSA produced a series of interchangeable test fixtures with common connectors, but different pin boards, for each separate PCB design tested. These test fixtures each contained their own individual custom current shunt circuits to convert current readings for each PCB circuit into voltages that could be easily measured by an NI CompactDAQ chassis. The custom current shunt circuits also contained relays (depending on the particular PCB test it was designed for) that would switch voltage to one part of the circuit vs. another when needed (for instance, to power the “bright” LEDs vs the “dim” LEDs on the circuit). These relays were controlled via a CompactDAQ digital output module. Power to the fixtures (to supply voltage to the circuits under test) was supplied by a programmable power supply controlled via the LabVIEW software application and a USB interface.

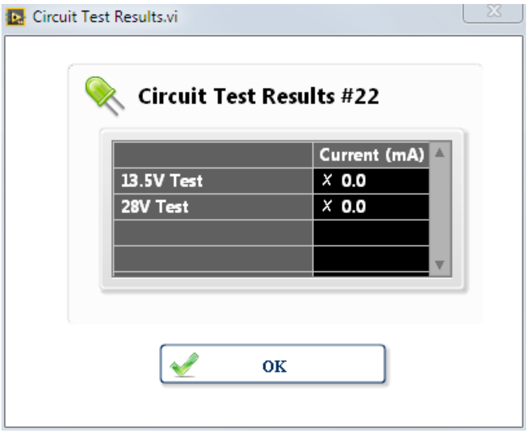

Figure 3: Circuit Test Results Popup

The typical test consisted of a sequence of steps to be performed on each circuit. The LabVIEW application written by DSA provided a visual grid on the user interface representing each individual circuit on the PCB. During and after testing the operator could click on each "circuit" on the user interface and bring up a window showing the test results for each test step on that circuit. The operator could load a spreadsheet-based series of steps designed for a particular model of PCB into the LabVIEW application, which would automatically drive the user interface grid shape, as well as which test fixture was expected to be plugged into the system. Monthly pass/fail statistics were also available for viewing as part of the system software.

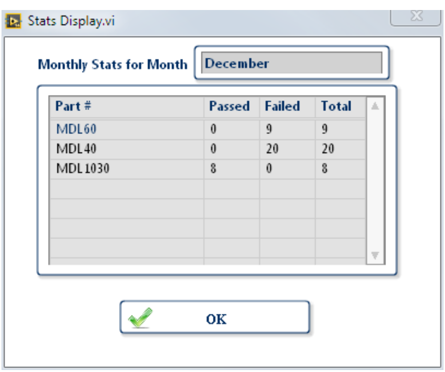

Figure 4: Monthly Statistics Display

To ensure that the wrong test fixture was not plugged in by the operator or left plugged in from a previous test, DSA designed into the test fixture an "ID" circuit that would complete a digital loop with the CompactDAQ system, allowing the LabVIEW software to detect which fixture was attached to the system. If the fixture did not match the test sequence that was loaded into the software, the user interface would display a dialog guiding the operator to attach the correct fixture. This prevented errors that could destroy a fixture or test unit inadvertently.

The Future

Following DSA's "adaptive automation" philosophy, the system was designed to be scalable, allowing operators to design additional test sequence files around existing PCB models or add new test fixtures in the future without requiring substantial re-design to the software or hardware platform.

Within days of system deployment, the client was already adding additional fixtures and expanding the DSA-provided system to accommodate new lighting products. Thanks to the expandable hardware platforms provided by NI and the Adaptive Automation techniques of DSA, lighting products can be tested faster and new designs can be deployed to production without waiting to design a new test bed each time.

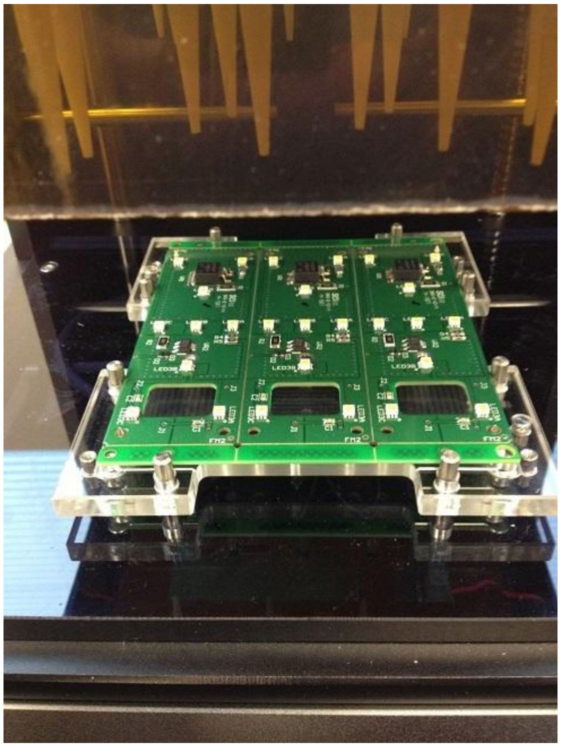

Figure 5: Test PCB in Fixture

Contact Information

Joseph F. Callaghan, info@DSAutomation.com
Data Science Automation, 375 Valley Brook Road, Suite 106, McMurray, PA 15317-3370
www.DSAutomation.com