Developing a High-Voltage, Multi-Output Power Supply Test System with LabVIEW and PXI


The Challenge: Developing an automated test system for board level and fully-assembled functional testing of a multi-output, high-voltage power supply used in medical imaging equipment.

The Solution: Developing a robust and compact test system in eight weeks on the PXI platform using LabVIEW software and PXI instruments, such as DMM, scope, counter, and multiplexers.

Introduction
Our customer manufactures high-voltage power supplies used in medical imaging machines. These supplies provide 25 KW of power through 12 outputs, six of them being high voltage (up to 700 VDC) and the other six being low voltage (up to 150 VDC). These outputs drive the X, Y, and Z coils of scanning machines.

The testing requirements were elaborate and nontrivial to address different models of power supplies, and the delivery had to be within eight weeks. These test requirements called for board-level testing of the control driver boards used in the power supply and functional testing of the assembled power supply.

The customer was looking for a cost-effective test system that could meet the following requirements:
• Flexibility — The system should also be able to accommodate new power supply models introduced in the future
• Reliability — This was to run on a manufacturing line where uptime was critical

We successfully reduced the cycle time from more than one hour with the manual system to less than 10 minutes with the new PXI-based system.

Networking — The test results had to be accessible over the local network
Delivery — We had an extremely aggressive delivery schedule of eight weeks
Safety — Special consideration was to be given to safety due to the presence of voltages as high as 800 V
Compact footprint — The system demanded efficient utilization of valuable manufacturing floor space

The test requirements were met using two PXI systems with the results consolidated into one system using the LabVIEW Enterprise Connectivity Toolset.

We presented a solution using PXI and LabVIEW, and the customer evaluated another possibility with GPIB and traditional instruments. Our solution stood out in terms of cost-effectiveness, the ability to meet all the requirements, and finally our commitment to the eight-week delivery schedule proved that the NI-based system was the optimal choice.

Due to the assembly line setup, our client needed to perform the board-level testing and the functional testing at different physical locations. As a result, we developed two PXI-based test systems. We integrated the two test systems with the LabVIEW Enterprise Connectivity Toolset and shared across the local network.

Board-Level Test System
This system tests the functionality of the control board and the driver board. As the name implies, the control board is primarily responsible for providing the control signals for the switching devices in the power supply. It also checks for fault conditions and is responsible for performing load regulation.

The driver board amplifies and isolates the control signal from the control board before sending it to the gates of the switching device. The test requirements for the driver board and the control board called for applying various stimuli and measuring the electrical parameters of the response.

The 6602 counter generates a TTL level signal of the desired frequency. This converts to a bipolar square waveform with an H-Bridge circuit in the custom board, which is then sent to the driver board. Various measurements are made with a 5112 scope and 4060 DMM along with the 1127 multiplexer. The 6527 DIO card routes discrete TTL level signals through the custom board to test the control board.

The load test performs by switching a specified load to the appropriate outputs using the 6527 isolated DIO. The output voltages from the various outputs of the supply route to the 4060 DMM through the CYTEC Mux, the LEM Voltage Transducer and the 2503 low-voltage Mux. The CYTEC switch is rated at 3500V and is programmable through an RS-232 interface.

The customer completes the over voltage test by enabling the UUT and connecting the programmable power supply (PPS) to one of the outputs of the UUT through the CYTEC switch. In this mode, the CYTEC switch acts as a demultiplexer. For the PPS, we used a Bertan model 105R by programming it from the 6704 analog card.
routes through a reverse flow preventer (essentially a diode bank) to prevent current from flowing into its terminals. The PPS voltage increases until the UUT trips. This trip voltage is read from the voltage sensor and noted. This test then repeats for all the other outputs of the UUT. The customer can perform the under voltage tests in a similar way.

The input voltage tolerance test performs by reducing the supply voltage to the UUT until it trips.

**LabVIEW along with the PXI platform clearly was the main factor in the success of this test system.**

**System Benefits**

Since this test involves high voltages, safety was a primary concern, so we provided many interlocks both in software and hardware. The new PXI-based system provides numerous benefits over the manual system. We successfully reduced the cycle time from more than one hour with the manual system to less than 10 minutes with the new PXI-based system. With the manual system, the customer could not ensure integrity of manually collected data due to the lack of redundant safety mechanisms. The PXI-based system now provides reliable data collection, and interlocks provided in the software ensure safe operation. The customer now saves valuable time because the PXI-based system provides completely automated data collection and report generation by replacing the manual processes of the outdated test system. Finally, the PXI-based systems proved a compact, integrated architecture that replaces discrete test system components that occupied more space with the manual system.

**Conclusion**

A fully automated ATE was built for the high-voltage multi-output power supply using the latest in virtual instrumentation technology in a period of eight weeks. The system is compact, easy to use, more productive, improves overall test reliability, and has a high degree of built-in safety. LabVIEW along with the PXI platform clearly was the main factor in the success of this test system.

**For more information, contact**

Anand P. Chinnaswamy,
Soliton Automation
Classic Towers
1547 Trichy Road
Coimbatore – 641018, India
Tel: 91 (422) 302374 – 302371
Fax: 91 (422) 302375
E-Mail: achinna@solitonautomation.com

For worldwide contact information, please visit ni.com/niglobal

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