Accelerating Design Selection Testing Using LabVIEW, CompactDAQ and Third-Party Hardware

"Using LabVIEW, CompactDAQ and third-party hardware, Radius Teknologies, LLC helped our customer to fix their LabVIEW problems by refactoring their existing User Interface and code to deliver a reliable and easy-to-use control and measurement application."—Mark Ridgley, Radius Teknologies, LLC

Industry:
Industrial, commercial and consumer equipment

Application:
Equipment design selection testing

The Challenge:
Performing design selection testing on up to four equipment assemblies in parallel.

The Solution:
Using LabVIEW system design software, CompactDAQ and third-party hardware to develop the user interface, data acquisition, data analysis, and data presentation software needed to deliver a reliable, versatile, scalable, and modular control application that met all requirements of the design selection test system.

The Benefits:
Using LabVIEW, CompactDAQ and third-party hardware enabled Radius Teknologies, LLC to deliver a system that met or exceeded all customer needs. During the project, we discovered that CPU usage with the original code was at 100% with just the main VI running in the idle state. We were able to redesign the software such that we reduced the CPU usage to between 1% and 2% when the software was running the test process on all four test stations simultaneously. We also improved User Interface data presentation and messaging which made it easier for users to learn to operate the system and helped to reduce user errors. The customer estimated they would need to run each equipment assembly for 2035 hours to acquire the data necessary to determine which design should be selected for continued development and eventually moved into full production. As a result of our work, the customer was able to acquire the data necessary to make a decision in just 500 hours – a significant time savings of 75% that directly and positively impacts the customer's bottom line!

Author: Mark Ridgley, Radius Teknologies, LLC

Understanding Design Selection Testing
Design selection testing is used to help an organization test different designs by acquiring data under real-world operational conditions so that the best and most robust design can be selected for further development and production. In this case, the customer needed to perform life testing on two competing designs to validate which design provided the most longevity while maintaining assembly performance within specified design parameters.

The customer needed to run four complete equipment assemblies simultaneously for 2035 hours of total runtime. During operation, the four test stations needed to operate cooperatively regarding mode selection and power consumption to prevent system overload. The customer was evaluating two different hardware designs, so they set up two test stations to run one design and the other two test stations to run the second design at the same time. Unfortunately, their existing software was not capable of reliably running all four test stations simultaneously.

A design selection test system must be capable of simulating real-world operational conditions while simultaneously capturing, analyzing, and logging key unit under test (UUT) and system data, in addition to monitoring test system components for fault conditions.

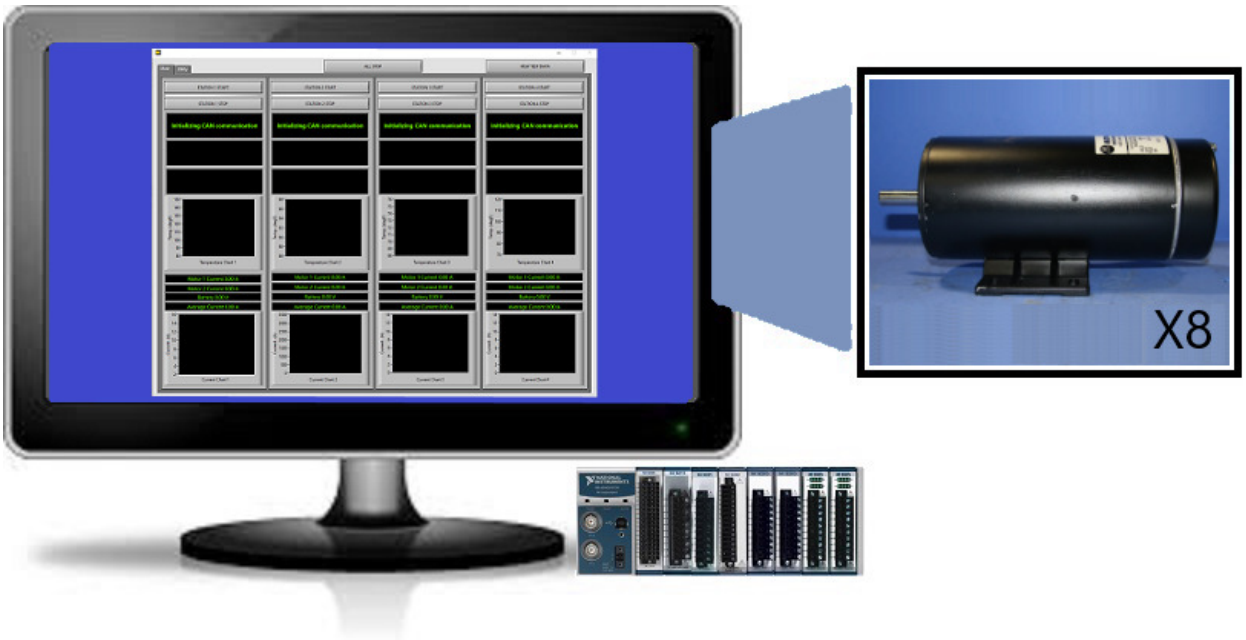

Figure 1. *Design Selection Test System User Interface*

Each assembly will be subjected to thousands of test cycles to verify the robustness and durability of a specific design. A single test cycle consists of five minutes operating with the motors running at a certain load as measured by the current draw of each motor, followed by a 10-second off time. This process is repeated at three different motor load values for up to three hours each. The system must also control the cycling of all four test stations among the various load levels so as to keep the system power supply from being overloaded. Because testing each assembly is a lengthy process, a design selection test system must be versatile, reliable, and easy to use. The test system must fully, reliably, and completely accomplish the following tasks within the test sequence:

- Establish CANOpen communication with each test station
- Command the test station to run the motors until the desired motor current is reached
- Ensure that the motor current is maintained within tolerance for the duration specified by the test requirements
- Capture and log all measurement data acquired each test station
    - Measurement timestamps
    - Cumulative run time
    - Motor temperatures (16x)
        - Motor shell temperature
        - Motor armature temperature
    - Motor voltage (8x)
    - Motor current (8x)
    - Supply voltage
- Repeat the process for all specified motor current values and time durations specified in the test requirements

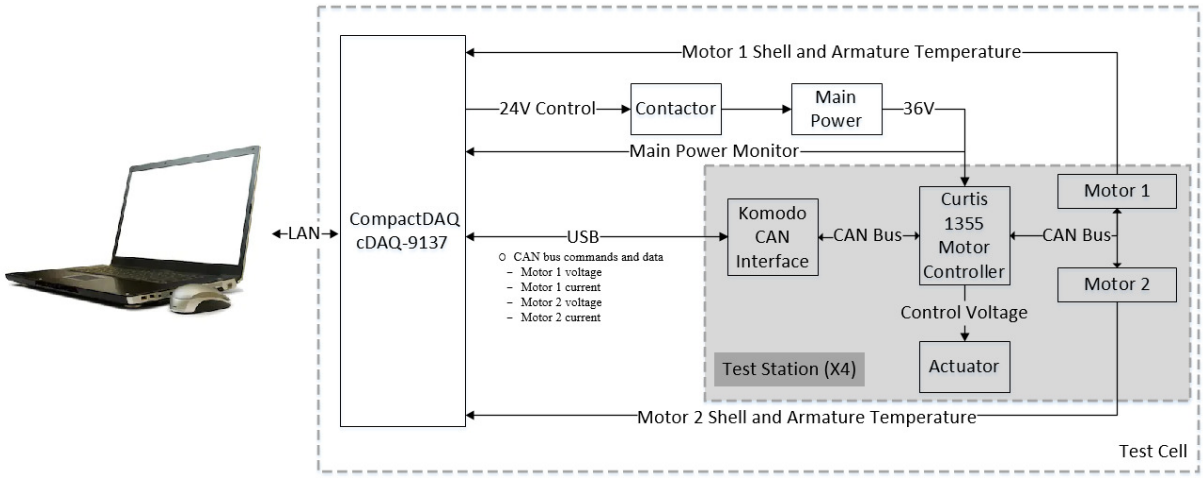

Figure 2. *Design Selection Test System Block Diagram*

The delivered test system consists of four separate test stations, controlled by a single CompactDAQ system. We implemented the capabilities listed below to meet customer requirements:

- Test station control software is designed so that each station runs independently of the others, controlled by the top-level application. Each test station can be started or stopped independently of the others and uses a distinct memory location to store its associated data— ensuring data segregation and integrity for all test stations.
- Because the system is required to run up to four test stations in parallel, it must share several key system resources, so the software is designed to prevent resource conflicts. When any test station is using a shared resource, all other test stations must wait until that resource is released.

Equipment Used

Equipment	Description	Function
cDAQ-9137	8-Slot USB Chassis	DAQ Measurement System Chassis
NI-9482	4-Channel, SPST Relay, 60 VDC (1 A)/250 VAC (1.5 A) C Series Relay Output Module	System Relay Control
NI-9214	16-Channel, 68 S/s Aggregate, ±78 mV, Isothermal C Series Temperature Input Module	Temperature Measurement
NI PS-15	24 VDC to 28 VDC, 5 A, 120 W, DIN-Mountable Industrial Power Supply	DAQ Measurement System Power Supply
Facility Power Supply	Rapid Power Technologies, Inc 40V, 200A, 8kW power supply	Main DC power
Main contactor	White-Rodgers 36VDC contactor	Main power control
Curtis 1355	5X high-current CANOpen slave programmable, solid-state soft-start module	Motor assembly control and monitoring
Komodo CAN Duo Interface	Two-channel USB-to-CAN adapter and analyzer	CAN bus interface
Motor Assemblies	Each equipment assembly contains two motor assemblies	Motors are used to drive the rotating system components
Actuator Assemblies	Each equipment assembly contains an actuator	Actuator is used to control the load applied to the motor assemblies

Table 1. *Design Selection Test System Key Components*

Company Background
Radius Teknologies, LLC was established as an NI Alliance Partner and independent LabVIEW consulting company in 2013. We are dedicated to helping our customers be successful using NI hardware and software to design, develop, and implement creative, versatile, and sustainable solutions to complex technical challenges in measurement, automation, and control. We have experience designing, developing, and implementing test systems based on NI hardware and software for the academic, consumer, medical, automotive, industrial, and aerospace/military markets.

Achieving Success with LabVIEW, CompactDAQ and third-party hardware
Radius Teknologies, LLC has more than 16 years experience developing applications based on LabVIEW. As an NI Alliance Partner, we are strong advocates of LabVIEW system design software. LabVIEW is a graphical programming environment with which we quickly produced the intuitive GUIs that this customer required. We were able to quickly prototype and refine the GUIs so that operators can execute tests quickly, with minimal user interaction and a reduced probability for errors.

CompactDAQ is a portable, rugged data acquisition platform that integrates connectivity and signal conditioning into modular I/O for directly interfacing to any sensor or signal. Using CompactDAQ with LabVIEW, developers can customize how measurement data is acquired, analyzed, presented, and managed to meet customer requirements.

LabVIEW and CompactDAQ provide a complete system development platform that provides for maximum reuse and unifies design, validation, and automated test. In addition, the ability to replicate real-world environments for individual test articles, coupled with a wide range of I/O and control options and flexible software, uniquely positioned LabVIEW and CompactDAQ as the best choice for this application.

Conclusion
With LabVIEW, CompactDAQ and third-party hardware, Radius Teknologies, LLC successfully developed a custom user interface, data acquisition, data analysis, and data presentation application needed to deliver a reliable and easy-to-use control and measurement application that met all customer requirements. The tight integration of NI hardware and software helped us meet all of the software design challenges presented by this demanding application.

The customer required minimum training on how to use the delivered software application, and was able to quickly put the system into service without any significant software issues or downtime. LabVIEW and CompactDAQ were undoubtedly the best choices to meet this customer's rigorous requirements.

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