Enabling Dynamic Vehicle Life Testing Using LabVIEW, CompactRIO and FPGA

"Using LabVIEW, CompactRIO and FPGA, Radius Teknologies, LLC helped our customer to fully automate their dynamic vehicle life testing system – enabling them to validate the durability of the vehicle when subjected to the dynamic loads anticipated during the vehicle's service life."—Mark Ridgley, Radius Teknologies, LLC

Industry:
Industrial, commercial and consumer equipment

Application:
Dynamic vehicle life testing

Figure 1. *Dynamic Vehicle Life Test System User Interface*

The Challenge:
Fully automating the performance of dynamic vehicle life testing.

The Solution:
Using LabVIEW system design software, CompactRIO and FPGA to develop a fully automated dynamic vehicle life test system including the user interface, machine control, data acquisition, and data presentation software needed to deliver a reliable, versatile, scalable, and modular machine control and measurement application to meet demanding customer requirements.

The Benefits:
Using LabVIEW, CompactRIO and FPGA enabled Radius Teknologies, LLC to deliver a system that met or exceeded all customer requirements. During initial discussions with the customer, we learned that the current test process was accomplished manually. Each day, the customer assigns a Technician resource to drive the vehicle under test (VUT) around the vehicle test area for the duration of their shift. This diverts a resource from performing other tasks, results in variations in the test process and increases the time required to complete the testing. Physical inputs from the operator of the vehicle are transferred to onboard vehicle systems using the CANopen communication protocol. The delivered system uses the NI-9881 1-Port C Series CANopen interface module to inject CANopen messages onto the onboard vehicle CANopen communication bus enabling the test system to simulate any physical input supplied by the operator of the vehicle. The system is capable of operating unattended for the extended periods of time required to meet company objectives – which frees the Technician resource to work on other critical tasks. As a result of our work, the customer was able to utilize their limited Technician resources more efficiently while simultaneously improving the reliability and repeatability of their test process and reducing test time – significant benefits that directly and positively impact the customer's bottom line.

Author: Mark Ridgley, Radius Teknologies, LLC

Understanding Dynamic Vehicle Life Testing
Dynamic vehicle life testing is used to help an organization test the long-term durability of a vehicle. Testing may involve driving the vehicle over a test track or in a lab 24 hours a day, seven days a week for an extended period of time. The goal is to simulate every real life challenge the vehicle could face while in use. The test process repeatedly executes a series of maneuvers thousands of times to compress the lifetime of the vehicle into a shorter timeframe that is a reflection of a real-time equivalent expected vehicle lifetime. In this case, the customer needed to perform dynamic vehicle life testing to validate that in-service vehicle longevity met documented design goals.

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

Each vehicle will be subjected to thousands of test cycles to verify the robustness and durability of critical vehicle subsystems. Because dynamic vehicle life testing is a lengthy process, the 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 while simultaneously monitoring vehicle safety systems and logging key system parameters:

- Command vehicle to the forward operating mode
- Command full throttle
- Continue operating in this mode for 10 minutes
- Command throttle to stop
- Pause for 3 seconds
- Command vehicle to the reverse operating mode
- Command full throttle for 3 seconds
- Command throttle to stop
- Command vehicle to the forward operating mode
- Command full throttle
- Wait 10 seconds
- Command vehicle to continue in the forward direction while performing no other vehicle functions
- Continue operating in this mode for 30 seconds
- Command throttle to stop
- Wait 15 seconds
- Repeat the sequence

The delivered test system consists of the vehicle under test connected to a rotary electrical contact via a swingarm. The system is controlled by a single CompactRIO controller and host computer.

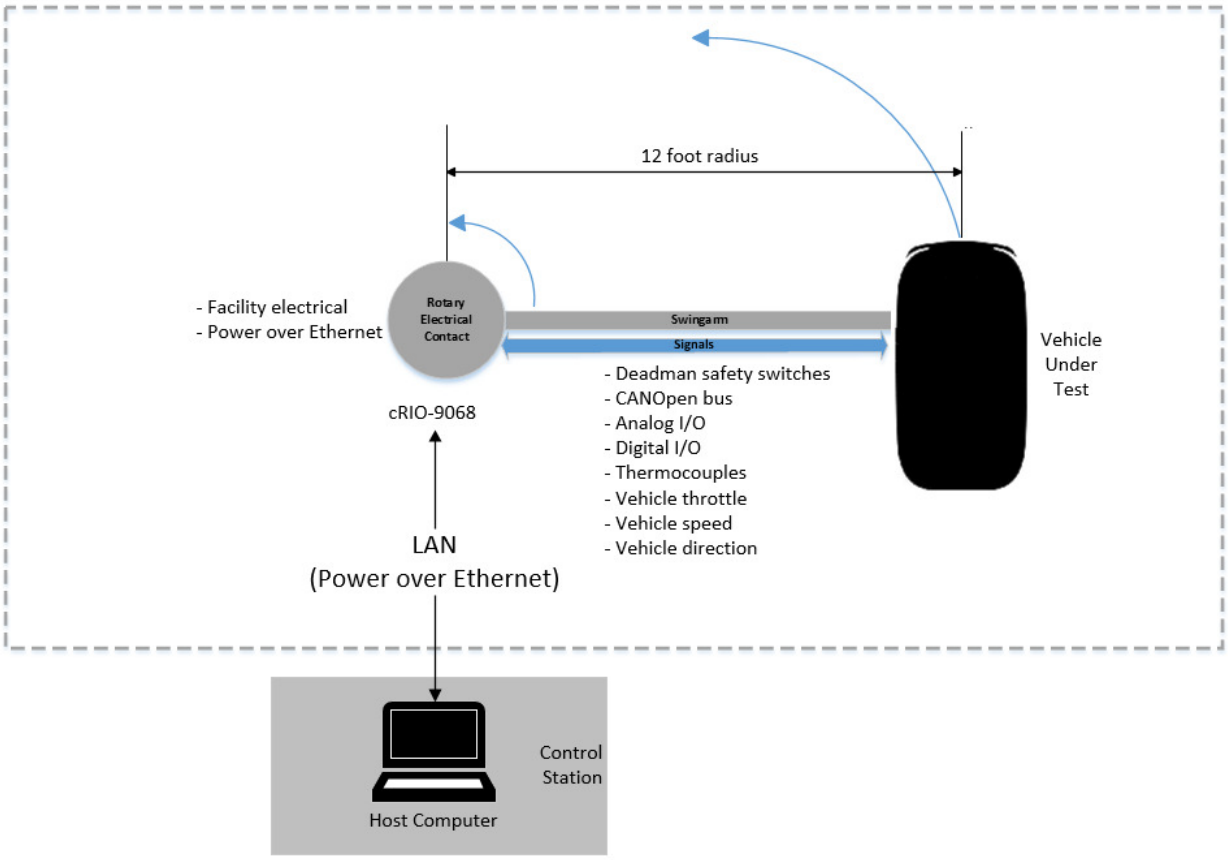

Figure 2. *Dynamic Vehicle Life Test System Diagram*

Equipment Used

Equipment	Description	Function
cRIO-9068	8-Slot CompactRIO Controller	DAQ Measurement System Chassis
NI-9411	±5 V to 24 V, 6 Differential/Single-Ended Channels, 500 ns C Series Digital Module	Digital I/O
NI-9881	1-Port C Series CANopen Interface Module	CANopen bus interface
NI-9482	4-Channel, SPST Relay, 60 VDC (1 A)/250 VAC (1.5 A) C Series Relay Output Module	Relay Output
NI-9214	16-Channel, 68 S/s Aggregate, ±78 mV, Isothermal C Series Temperature Input Module	Temperature Measurement
NI-9205	±10 V, 250 kS/s, 16-Bit, 32-Channel C Series Voltage Input Module	Analog Input
NI-9264	25 kS/s/ch Simultaneous, ±10 V, 16-Channel C Series Voltage Output Module	Analog Output
Zyxel PLA5256	1000 Mbps Powerline Pass-Thru 2-Port Gigabit Ethernet Adapter	Ethernet Adapter
Honeywell	Magnetic switch	Revolution Counting

Table 1. *Dynamic Vehicle Life 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, CompactRIO and FPGA
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 run the system with minimal user interaction and a reduced probability for errors.

CompactRIO is a portable, rugged data acquisition platform that integrates a real-time embedded industrial controller, reconfigurable IO Modules (RIO) and an FPGA module. Using CompactRIO with LabVIEW, developers can customize how measurement data is acquired, analyzed, presented, and managed to meet customer requirements.

LabVIEW and CompactRIO 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 CompactRIO as the best choice for this application.

Conclusion
With LabVIEW, CompactRIO and FPGA, Radius Teknologies, LLC successfully developed a custom user interface, machine control, data acquisition, data analysis, and data presentation application needed to deliver a reliable and easy-to-use machine 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, CompactRIO and FPGA were undoubtedly the best choices to meet this customer's rigorous requirements.

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