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LightWave Computing Develops Innovative Fuel Cell Test Software

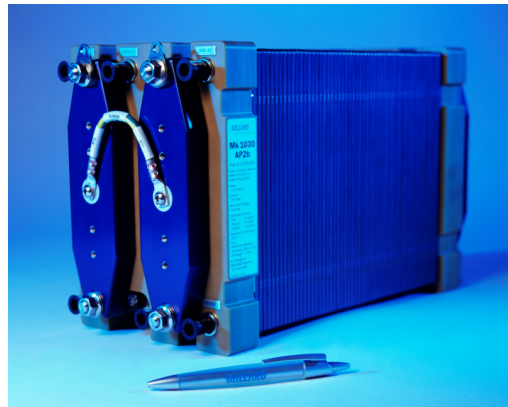
The Challenge: To build a highly responsive R&D Proton Exchange Membrane fuel cell testing system that has the capacity for various stack geometries and I/O requirements.

The Solution: Integration of LabVIEW, SCXI, GPIB, Fieldpoint, CAN and TCP/IP into a configurable high performance fuel cell testing environment.

Overview

Automotive Fuel Cell research is being carried out all over the world in an effort to deliver the next generation of vehicle power. A key requirement for an automotive fuel cell is its ability to operate under cold startup conditions, as well as delivering power instantly when required. Delivering instant power requires a test station with adequately responding mass flow controllers, and software that can respond quickly to stabilize pressures under these dynamic flow conditions.

In order to properly characterize fuel cell efficiencies, cell voltage (CV) measurements typically need to be taken on each individual fuel cell. The test stand requirements dictated software that could be scaled from single-cells to over 500 cells. Furthermore, while some tests required only stack testing, others required testing of complete fuel cell modules comprising the stack as well as ancillary CAN and TCP/IP based control systems. One unified testing environment was needed that allowed researchers to use the same test software with stations that could run all stack sizes and formats. This required an adaptable I/O architecture as well as a software model that allowed tuning tests with radically different flow, pressure, and loading requirements.



Lightwave Computing was asked to write a custom-built LabVIEW program comprising over 700 virtual instruments that enabled the adaptability of the test station to meet all these test requirements. The main program contains two main loops: one operates the test hardware and the other operates the user interface. This structure allows the potential to migrate the test hardware loop to a LabVIEW Real-Time target in the future for a more deterministic response. Splitting off the hardware control into a highly optimized timed loop along with the use of the National Instruments PID control toolkit enabled us to meet the requirements of fast, stable response under dynamic load conditions.

The system developed allows up to three SCXI 12 and 4-slot chassis' to be ganged together to access up to 512 CV measurements along with other signals for controlling pressure and test loads. For fuel cell module testing, the software can connect to a proprietary CAN or TCP/IP based module control system to read larger CV banks and allow ancillary control through the CAN bus. Cooling, heating and humidification controls are all selectable using SCXI and Fieldpoint I/O. A separate LabVIEW maintenance application is run on each test station that identifies the hardware capabilities of the station, which is saved in an ini format file for when the test station software is launched. The LabVIEW Enterprise connectivity toolkit was used to allow database tracking of the history and test parameters of the unit under test.

Automation

Also built into the LabVIEW software was the capability to record macros of a test in progress to allow the repeat of key test sequences. With one button the user can record subsequent control changes on the user interface, and save these test changes to a macro file. In playback mode, the user interface controls move in the same timed sequence as if an operator set the controls. While a macro is executing, the operator has the option of pausing the test and making adjustments before continuing. Multiple test sequences can be recorded as macros and then concatenated or arranged in complex loops to perform test sequences with many thousands of test steps. Additionally, if an event is detected during a test (for instance, a cell voltage drops below a minimum value) a special recovery macro can be executed. Researchers can edit these

macros later in Microsoft Excel, allowing them to better optimize fuel cell recovery routines. This rich automation functionality allows researchers to quickly identify strategies to improve fuel cell testing.

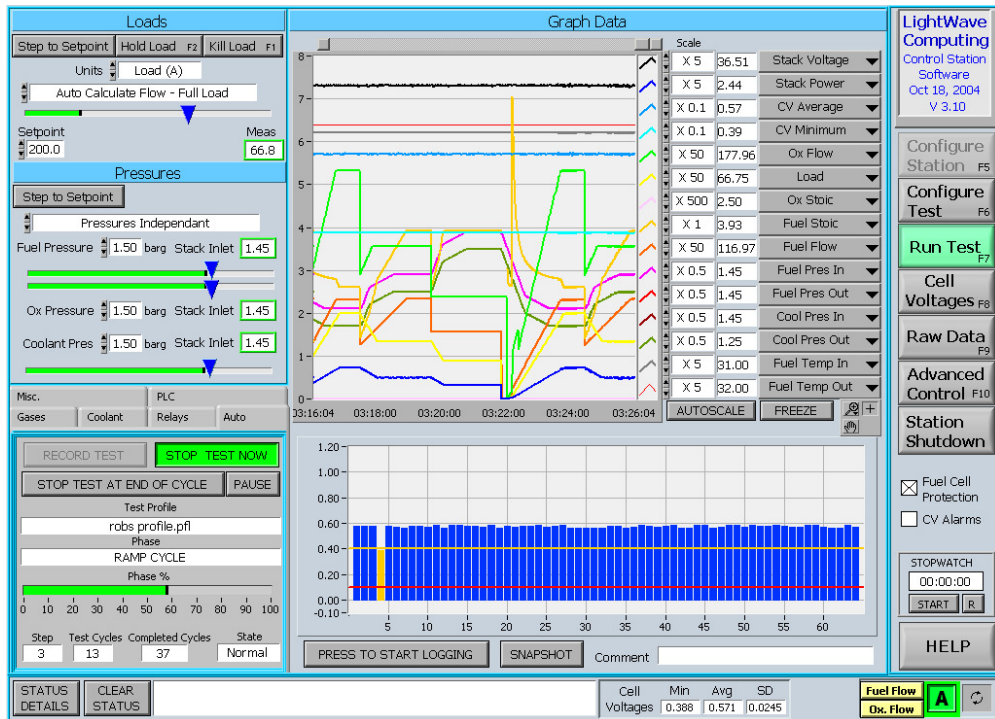
Data Retrieval

The researcher is also able to remotely monitor tests from anywhere on the network through a LabVIEW datasocket-based applet which tracks the "vital signs" of all running tests in the test lab. When test failures need to be tracked after a researcher has left the test facility, the software can e-mail specific failure information to a fan-out list of text pagars.

The user can log data either to an InSQL database or to a CSV formatted file which can be imported into Excel or National Instruments DIADEM for post-test analysis and reporting. The user can log data only when a low cell voltage event has occurred or by a fixed time interval.

Conclusion

LabVIEW's ability to provide a complete software solution to all these requirements and National Instruments wide array of I/O products provided the needed tools to build this flexible, responsive test system. The seamless integration of hardware devices enabled the development of this system in much less time and without the headaches often associated with developing multi vendor solutions. The end users benefit from an efficient, scalable testing environment that replicates the true operating conditions of an automotive fuel cell system.



Fuel Cell Test Simulation

For more information on this project or if you would like an assessment of your Testing or Machine Automation requirements, please contact Rob Taylor at LightWave Computing.



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