Fire-Fighting Apparatus Testing
using the DaqBook

Safety

Application Note #103

Application Summary

All automotive manufacturers claim that they have the most reliable and trouble-free vehicles on the road, and we can believe them or not. In the end, we must rely on our own experience with their products to furnish us the truth. But the kinds of manufacturers that must back up such assertions – unconditionally- are those in the fire fighting and other emergency-vehicle businesses. When they declare that they have a safe, reliable, and durable vehicle, they have the test results to prove it. High-quality fire truck manufacturers cannot afford to compromise on the value of the components they select. Too many lives depend on the reliability of their vehicles.

The engineers and technicians who design and test fire apparatus must have up-to-date tools to do their jobs most effectively. Among the most important are data acquisition systems that are small, portable, and reliable, and can handle numerous channels. During design and development just about every variable that can be imagined is measured, including temperature, strain, pressure, flow, speed, and displacement. In addition, many of these vehicles are tested in extreme environments such as low temperatures in Minnesota during the winter and exceedingly high temperatures in Death Valley. Consequently, their test equipment must hold up to these rigors as well as the product being tested.

Potential Solution

One company that designs and manufactures such custom fire-fighting apparatus is Pierce Manufacturing located in Appleton, Wisconsin. It claims to be the largest North American manufacturer of custom fire apparatus: Pierce trucks are largely designed and built from the ground up, which means its engineers design the cab, chassis, frame rails, and all other major components.

Chad Radtke, Project Engineer, and Paul Piechowski, Development Engineer, both work in the Research and Development Department in Appleton, and are responsible for much of the vehicle and component testing that takes place in the facility. They have equipment that allows them to perform component durability testing, full vehicle structural testing, and ride and handling testing at the Appleton facilities. They also perform on-site testing on vehicles across the country. The bulky test equipment they employed in the past was not convenient to lug to their customers' facilities, so the engineers decided to purchase an extremely portable IOtech DaqBook that can be used in the lab as well.

IOtech's Solution

"Before we purchased the IOtech equipment, we used various other data acquisition systems, but the type of testing we now do is relatively new, and the IOtech equipment does the job much better," says Radtke. "The DaqBook® is straightforward and easy to learn. It did not require two months of training, only a couple of days in the shop and we all got going with it," says Radtke. "Moreover, the DaqBook is very compact, easy to use, and sets up quickly, especially when we need from 80 to 100 channels. Being able to view our data in semi-real time is a pretty valuable feature. The speed of acquisition and accuracy have been great for us with the new DaqBook," says Radtke.

"For example, a large part of the work we do is product validation testing which involves a wide range of activities. It may require as little as placing a single strain gage on a
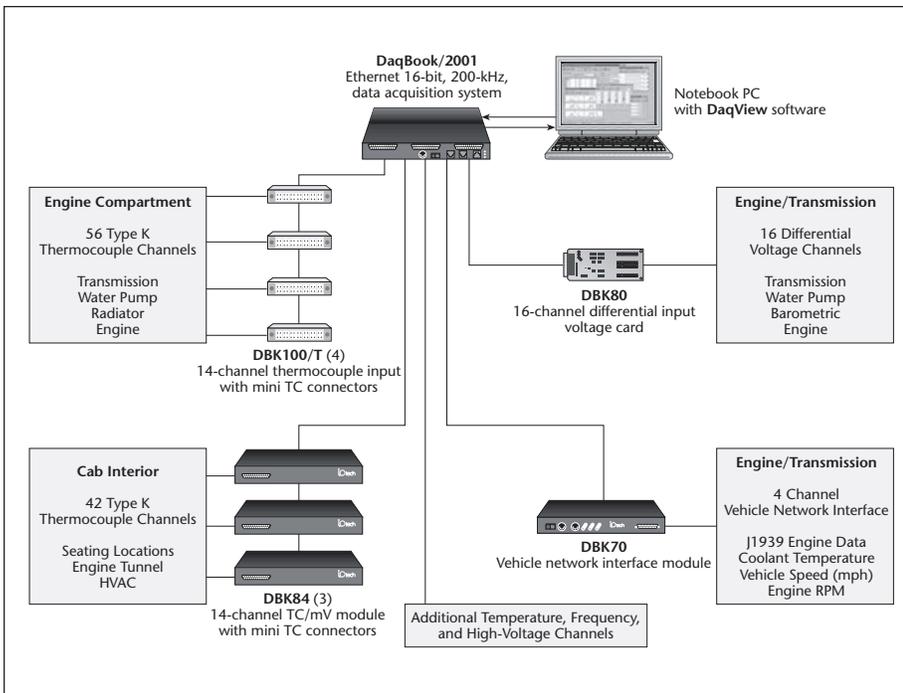
This diagram illustrates a high channel-count, engine-cooling test with additional thermocouples installed in the cab to track the performance of the HVAC system. A notebook computer controls the hardware through DaqView™ software. This software allows the user to configure each channel based on the sensor, view real-time results, and log data to an organized Excel® spreadsheet.

component to instrumenting a full vehicle that requires hundreds of channels," continues Radtke.

As part of the certification process, Pierce engineers need to provide data to their engine manufacturer to verify that they have adequate cooling capacity in the system. "We must certify that the system will work well, and cool the engine efficiently," says Radtke. The tests involve measuring temperatures, wind speeds, pressures, and flows. Temperature is usually measured with K-type thermocouples. Previously, they measured speed with a 5th wheel, which contained a reluctor pickup. "Now, we use the SAE J1939 signal obtained from the vehicle computer with the IOtech DBK70™ vehicle network interface," says Radtke. "And we use GPS-based speed and distance measuring equipment that outputs a 0 to 5V signal, which we bring directly into the IOtech DaqBook."

"We also measure the engine's water pump output flow and pressure, as well as those variables in the engine block, radiator, coolant tubes, transmission cooler, and transmission itself using the DBK80™ 16-channel voltage input card," says Piechowski. Engine coolant runs at about 120 gpm, while the transmission coolant delivers about 40 to 50 gpm. "We also use accelerometers for ride and handling tests according to ISO STD 204 and SAE requirements."

"Whether we test components or full vehicles depends on the specific application," says Piechowski. "We test a lot of hardware, from small relays to full vehicles. For example we often design a new cab using 3D modeling software. We build at least one prototype, apply strain gages, install additional test equipment, and test for long-term durability. By structuring our test program in this fashion, we are able to modify our designs accordingly, before going to a pilot build," says Piechowski.

"An average test, such as a cabin interior temperature test, consumes about 20 to 30 channels on our DaqBook," says Piechowski. "We can measure 200 channels now," offers Radtke. "We purchased a DBK101™ TC measurement pod for future

engine cooling tests because it will eliminate numerous thermocouple links." In the past they used the DBK84™ TC expansion module and ran the 80 thermocouple channels through the firewall or the bottom of the vehicle. "We recently purchased a USB-based Personal Daq/56™, so we might measure 120 to 150 channels more often now," concludes Radtke.

Conclusion

Engineers at Pierce Manufacturing, suppliers of fire fighting apparatus and vehicles, purchased an IOtech DaqBook data acquisition system to use both in their lab and at customers' sites. The DaqBook was selected for its small size, accuracy, durability, and speed of measurement. The engineers measure and analyze numerous variables during design and development and for testing prototypes. The variables include voltage, speed, pressure, flow, and temperature. The collected data ensures that the vehicle and its components can withstand the rigors of rough handling during emergency and hazardous conditions.

DaqBook/2000 Series

The DaqBook/2000® series of portable data acquisition devices can synchronously measure analog inputs, frequency inputs, and digital inputs. The 16-bit/200-kHz DaqBooks come equipped with built-in signal I/O capability, which can be further expanded and enhanced with over 40 DBK series expansion and signal conditioning options.

The DaqBook/2000 series includes a built-in 10/100BaseT Ethernet interface capable of transferring acquired data back to the PC at the full 200 Kreading/s measurement rate of the DaqBook. Multiple DaqBooks can be attached to a single PC via an Ethernet hub or switch, and are capable of being synchronized and of transferring data continuously at full speed into the PC. Up to 10 DaqBooks can be transferring 200 Kreading/s back to a PC concurrently, with no loss in data.

Features
- Analog input, analog output, frequency input, timer output, and digital I/O; all in one compact and portable enclosure
- Built-in Ethernet connection provides continuous streaming to the PC with no data loss
- 16-bit, 200-kHz A/D converter
- Operates from -30˚ to +70˚C
- Powerable from 10 to 30 VDC, or with included AC adapter
- Synchronous analog, digital, and frequency measurements
- Trigger modes include analog, digital, frequency, and software
- Virtually infinite pre-trigger buffer
- 4 channels of 16-bit, 100-kHz analog output (models /2001 and /2020)
- DaqBook/2020 offers convenient front panel connectors for thermocouple, voltage and frequency measurements all in one box
- DaqBooks attach to over 40 DBK signal conditioning options to assemble a low-cost system, customized to your particular application

Signal Conditioning Options
- Signal conditioning and expansion options for thermocouples, strain gages, accelerometers, isolation, RTDs, etc. — over 40 DBK I/O expansion options are available

Software
- DaqView™ *Out-of-the-Box*™ software for effortless data logging and analysis
- Support for Visual Studio® and Visual Studio® .NET, including examples for Visual C++®, Visual C#®, Visual Basic®, and Visual Basic® .NET
- Comprehensive drivers for DASYLab®, MATLAB®, and LabVIEW®
- DaqCal™ software application for easy user calibration