

PXI-based, multipurpose, mobile DAQ station

By Robert Gough

The United Technologies Research Center (UTRC), which supports all of United Technologies Corporation's business units and their products, from elevators and fuel cells to helicopters and jet engines, required a DAQ system capable of logging 160 channels of synchronized data to disk at high and low speeds. Because UTRC works on a wide range of projects, the system also must be able to measure a variety of data and be portable and rugged so it can be transported and used by numerous groups within the research center.

By combining LabVIEW, PXI, SCXI, and MXI-3, National Instruments Select Integrator Bloomy Controls created a multipurpose, mobile DAQ station that meets UTRC's comprehensive measurement needs.

Hardware

The DAQ station measures three main signals – pressure, temperature, and voltage/current. Up to 32 strain gauge pressure sensors, 64 thermocouples, and 64 generic voltage/current inputs can be attached to the station at any time.

The station hardware (Figure 1) was chosen according to signal types, number of signals, maximum required sampling rates, and synchronization. An SCXI-1520 module provides strain gauge measurement, supporting up to eight channels. Four modules are used to measure all 32 pressure inputs. The station must measure frequencies as high as 10 KHz, requiring a minimum sampling rate of 20 KHz for any of the pressure inputs. Each SCXI-1520 connects to its own DAQ board and runs in parallel mode on the SCXI chassis. Signals connect to the SCXI-1520 through an SCXI-1320 strain gauge terminal block.

Temperature measurements are piped into two SCXI-1102B modules through TC-2095 terminal blocks, enabling easy connection and removal of up to 64 thermocouples. Two SCXI-1102C

modules measure voltage through a BNC-2095 terminal block and current through an SCXI-1302 module, which contains a precision resistor for current measurement. Because voltage and temperature measurements may require higher sampling rates, the SCXI-1102 modules are multiplexed onto two DAQ cards. A total of six DAQ cards are used in the station.

All of the hardware is combined into a PXI-1010 chassis with an external controller and an SCXI-1001 chassis (Figure 2). The PXI-1010 provides mobility, PC control with ample slots for six DAQ cards in addition to other hardware not built-in to the station, and an SCXI backplane. The SCXI-1001 chassis houses four SCXI-1520 modules, operating in parallel mode, and two SCXI-1102C modules for voltage/current input, which are multiplexed onto a fifth DAQ board. Two SCXI-1102B modules for temperature measurement are located in the PXI-1010 SCXI chassis multiplexed onto the sixth DAQ board through the SCXI backplane. Six PXI-6052E DAQ boards allow the maximum possible sampling rate on all SCXI channels. The external controller was chosen over an embedded controller because of the sheer amount of data being written to disk, in the case that all channels are being logged at maximum sampling rates. The external controller has an 80 Gbyte SCSI hard drive, 512 Mbyte RAM, and a 1.8 GHz Pentium IV processor to store data, which is transferred from the PXI chassis to the controller through a high-speed, fiber optic MXI-3 link.

Synchronization is a non-issue as PXI has a built-in RTSI backplane that synchronizes the DAQ boards. The sample and hold technology of the SCXI-1520 modules further enhance synchronization.

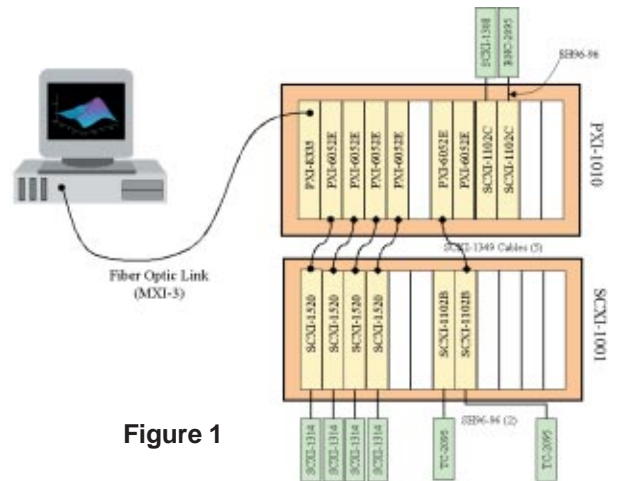


Figure 1

Software

Bloomy Controls developed the DAQ station software using LabVIEW (Figure 3) because of its seamless integration with the station hardware. LabVIEW configures and acquires data from the DAQ boards, streams data to disk, and provides a user interface that reflects the flexibility of the station. The tight integration between LabVIEW and NI-DAQ makes DAQ control inherent. LabVIEW code efficiently streams large amounts of data to disk and provides user interface tools that, in a simple way, present the user with the vast choices he or she is given in this application.

With data being acquired on so many channels at high channel rates, it is important to ensure that processor utilization is



Figure 2

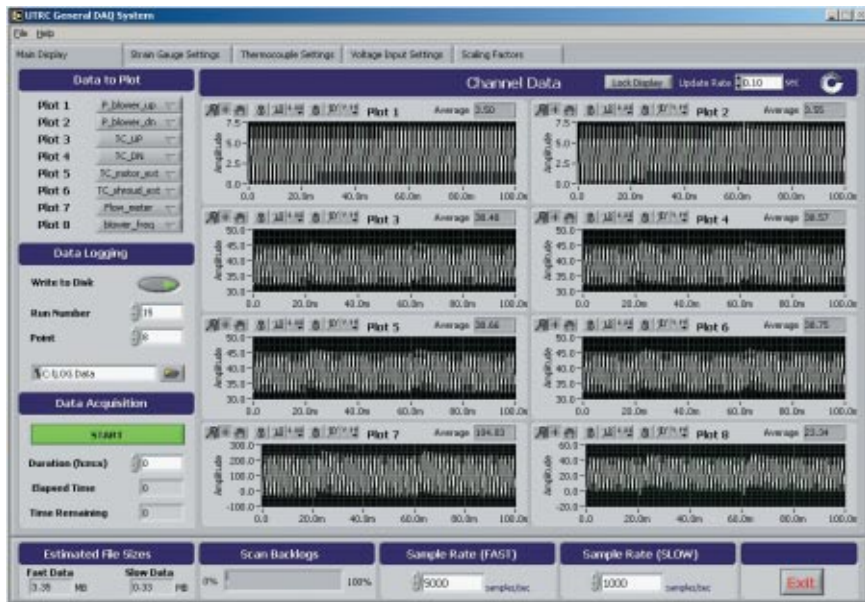


Figure 3

Results

The PXI-based DAQ station created by Bloomy Controls gives UTRC an extremely powerful, mobile measurement station. The station achieves seamless integration among signal conditioning, data acquisition, and synchronization that bench top instruments would not have achieved. By choosing this flexible, PXI-based DAQ station, over using bench top instruments, UTRC saved hundreds of thousands of dollars.



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kept to a minimum, while simultaneously acquiring data, updating graphs, and logging data to disk. This is achieved through multiple loop architecture, where two independent parallel-running state machines acquire data from fast and slow channels separately and a third parallel state machine provides user interface updates. The user interface state machine loops at a slower rate than the DAQ loops, giving the DAQ loops a higher priority and preventing any buffer under-run issues. Occurrences control timing in the DAQ loops, where data is transferred to disk only when a certain number of scans is placed into the DAQ buffer. This frees computer resources to complete user interface updates and data logging while the DAQ buffer is filling. Logging data to disk in binary format reduces overall file

size and frees computer resources because smaller data chunks are written to disk. Combining these additions allow the program to be responsive and efficient.

The hardware used in the DAQ station presents many configuration options, which must be changeable to reflect the user's specific measurement needs. LabVIEW is used to present the user with configuration options and dynamically configure channels. This allows the user to configure all channels and change and test hardware settings very quickly. The adjustable settings include excitation voltage, gain, and thermocouple type. In order to display all key parameters on the user interface, a series of tab controls is used.