Electric Car Battery Testing
using the DaqBook®

Automotive

Application Note #30

An electric utility company was interested in using electric vehicles for its meter readers and other customer service personnel. In order to determine the feasibility of this idea, engineers needed to evaluate the vehicle's operating parameters during operation and measure what effect they would have on its electrical requirements. In other words, they needed to determine how long the batteries would be able to power the vehicle under normal operating conditions.

Application Summary

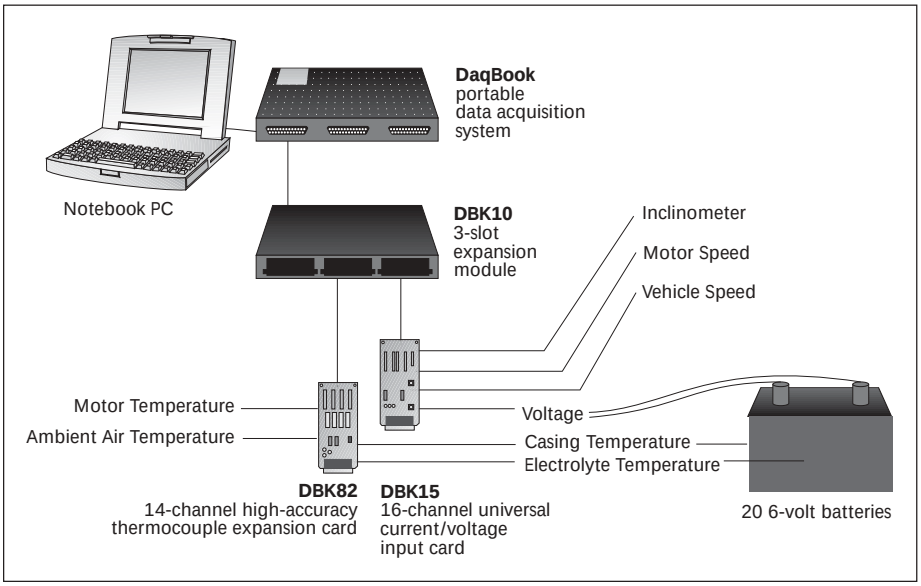
After an electrical propulsion system was installed in a small pickup truck, the engineers began to research methods for increasing the truck's operating efficiency and its operating range between battery chargings. Some initial possibilities they considered were: solar panels to extend the battery life, regenerative braking to recover kinetic energy, lighter plastic components replacing the heavier stock vehicle components, and low-resistance tires. All of these methods would extend the range of the vehicle; however, the relative merits of each needed to be quantified so that the value of each modification in terms of performance could be compared to the cost of its implementation. To obtain this data, the vehicle's operation needed to be measured both before and after each modification.

To make the measurements, the researchers needed a data acquisition system able to meet a demanding set of performance criteria. These criteria included portability, operability from a battery, ability to accommodate mixed analog signals, a high channel count, and expandability. The system needed to run unattended after a relatively simple setup procedure. Furthermore, the system's sampling rate, resolution, accuracy, and data transfer speed needed to be sufficient.

IOtech's Solution

The data acquisition system that best met these criteria was IOtech's PC-based DaqBook data acquisition system. The DaqBook system was equipped with IOtech's thermocouple card and universal voltage and current card. The thermocouple card provided auto zero, cold-junction compensation, and programmable gain for a variety of temperature measurements. The signal conditioning card accommodated analog signals from transducers placed on the vehicle to measure voltage, current, temperature, and other variables. The data acquisition was controlled by a notebook PC using a custom software program; the PC's hard drive provided data storage.

The DaqBook data acquisition system provided the accuracy needed to capture even the most rapidly changing variables. It also provided sufficient channels in the form of 8 differential or 16 single-ended analog inputs, plus many additional output and digital input channels. Expandable to 256 analog-input channels, the DaqBook system was capable of multiplexing all channels with individual gains for each channel.



The electric vehicle test set-up

The DaqBook's rugged metal enclosure is roughly the same form factor (8 1/2" x 11" x 1 3/8") as the notebook PC, as is the optional expansion card enclosure and battery pack. The system was installed behind the driver's seat, and combined with the PC, weighed no more than 35 pounds, of which 15 pounds was mounting hardware.

Data Acquisition System Measurements

Battery charge and discharge characteristics were perhaps the most important variables measured on the electric vehicle, which used 20 six-volt lead/acid batteries connected in series to drive a 120 VDC motor. A voltage divider was used to scale down the aggregate voltage to 5 VDC for input into the data acquisition system. A clamp-on current sensor measured battery charge and discharge current, up to a maximum of

the smart approach to instrumentation™

400A. The sensor output was set up for ±5 VDC for 500A full-scale current flow in either direction. Voltage and current were also measured on a 12 VDC accessory battery used to operate windshield wipers and lights.

To help determine the effects of charge and discharge characteristics on the batteries, temperatures were measured in various locations. Thermocouple probes were installed in selected cells to measure electrolyte temperatures inside the front and rear battery assemblies. Flush mount thermocouples measured the batteries' casing temperatures. Other temperature measurements included a flush mount thermocouple on the drive motor, and a thermocouple probe in the bed of the truck for ambient air temperature.

Charge/discharge data was correlated with truck loading. Although the truck load itself was virtually constant, terrain affected both motor load and speed. Terrain was measured with an inclinometer installed behind the truck's seat in the center of the cab. The output was scaled 0 to 3.6 VDC for 0 to 360° of rotation (incline). Vehicle speed was measured by attaching a pulse generator to the speedometer cable. The DaqBook data acquisition system's counter timer created the appropriate speed scale. The output from an electronic tachometer connected to the motor was used in a similar fashion to obtain motor speed.

Conclusion

Using a single portable PC-based data acquisition system, the researchers quickly and easily acquired many channels of data of mixed signal types. IOtech's DaqBook data acquisition system worked so well that the utility is considering alternative uses for it. One use would be to add a GPS (Global Positioning Satellite) system that would determine the vehicle's coordinates and those of its proposed destination. This information, combined with terrain data and battery-charge data, would allow the driver to decide whether the truck could make a trip of a certain distance on its current charge.

DaqBook/2000 Series

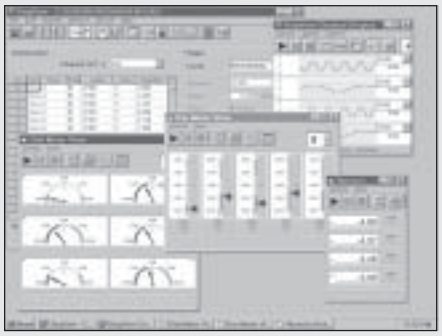
The DaqBook/2000® series of portable data acquisition devices are available with either a built-in Ethernet interface (model /2000E), or a parallel-port interface (model /2000A or /2000X). The Ethernet-based DaqBook/2000E can attach directly to the Ethernet port of a PC, or to an installed Ethernet network. The DaqBook/2000E also contains three parallel expansion ports, which can attach to an additional three parallel DaqBooks, thereby quadrupling the channel capacity of a single Ethernet link to the PC.

Features

- Analog input, frequency input, timer output, digital I/O, and analog output; all in one compact and portable enclosure
- Available with either an Ethernet PC connection, or a parallel port which can link directly to a PC parallel port, or with an interface to PCI bus, PC-Card slot, or ISA slot
- 16-bit, 200-kHz A/D converter
- Synchronous analog, digital, and frequency measurements
- 8 differential or 16 single-ended analog inputs (software selectable per channel)
- Expandable up to 256 analog input channels, while maintaining 200-kHz (5 µs per channel) scan rate
- Expandable up to 1024 analog inputs with DaqBook/2000E plus three slave parallel DaqBooks
- 512 location channel/gain FIFO, capable of scanning all channels, including expansion channels and digital/counter channels, at 5 µs per channel
- Trigger modes include analog, digital, & software, with <5 µs latency
- Virtually infinite pre-trigger buffer
- Optional four channel, 16-bit, 100-kHz analog output card installs internally
- 40 digital I/O lines scanned synchronously or asynchronously with analog inputs
- Digital I/O is expandable up to 272 lines, including isolation and relay closure options
- Four cascadable counter/pulse input channels scanned synchronously or asynchronously with analog inputs
- Two timer/pulse output channels
- Digital calibration — no potentiometers
- Multi-unit scan synchronization
- Vehicle network interface option

Signal Conditioning Options

- Signal conditioning and expansion options for thermocouples, strain gages, accelerometers, isolation, RTDs, etc.—over 40 DBK I/O expansion options in all



Software

- DaqView™ software with eZ-PostView™
- Included drivers for Visual Basic®, Delphi™ and C++ for Windows®; DASYLab®, TestPoint®, and LabVIEW®

IOtech, Inc. ▲ 25971 Cannon Road ▲ Cleveland, Ohio 44146 ▲ (440) 439-4091 ▲ Fax (440) 439-4093