In-Vehicle Seat Suspension Testing
using the DaqBook®

Automotive

Application Note #18

A manufacturer of vibration and shock control products needed to develop a seat suspension system that would maximize the comfort and safety of operators of heavy-duty, on- and off-road construction equipment. This required the manufacturer's engineers to conduct in-vehicle development and testing. This in-vehicle testing required a lightweight, portable data acquisition system capable of displaying data in real-time. The engineers chose IOtech's DaqBook, a portable data acquisition system that fits neatly beneath a notebook PC.

Performance Criteria

Because of space limitations in the testing environment, the engineers decided to employ a notebook PC in their data acquisition system. Since an AC power source was not readily available, the fully configured system had to be able to draw sufficient power from its own battery or from a standard car battery. The selected data acquisition system needed to provide a sampling rate and resolution high enough for a vibration application, as well as voltage outputs that could be used to adjust the seat's suspension. Furthermore, it had to be able to withstand the hostile environment in which heavy-duty over-the-road trucks and off-highway construction equipment generally operate.

IOtech's DaqBook met all of these performance criteria. The DaqBook is a portable data acquisition system that can be connected to a notebook PC via a standard or enhanced parallel port. In addition to meeting all of the required performance specifications, the DaqBook was easy to set up and use.

The DaqBook ships with Windows-based setup, acquisition, and data-display applications, and drivers for third-party graphical acquisition packages. The DaqBook also provides Windows drivers, which allowed the engineers to write their own data acquisition software.

Application Summary

Each seat under test required a controllable fluid damper adjusted for the particular vehicle model in which it would be used. During the tests, which were conducted on an outdoor test track that duplicated common road conditions for heavy-duty trucks and construction equipment, the seats were secured in either a test stand or a test vehicle. The design engineers configured the test setup by connecting the notebook PC and the DaqBook to a sensor, the controllable fluid damper, and the seat's air-spring suspension mechanism. The controllable fluid damper was then attached to the air spring

DaqBook Seat-Suspension Test
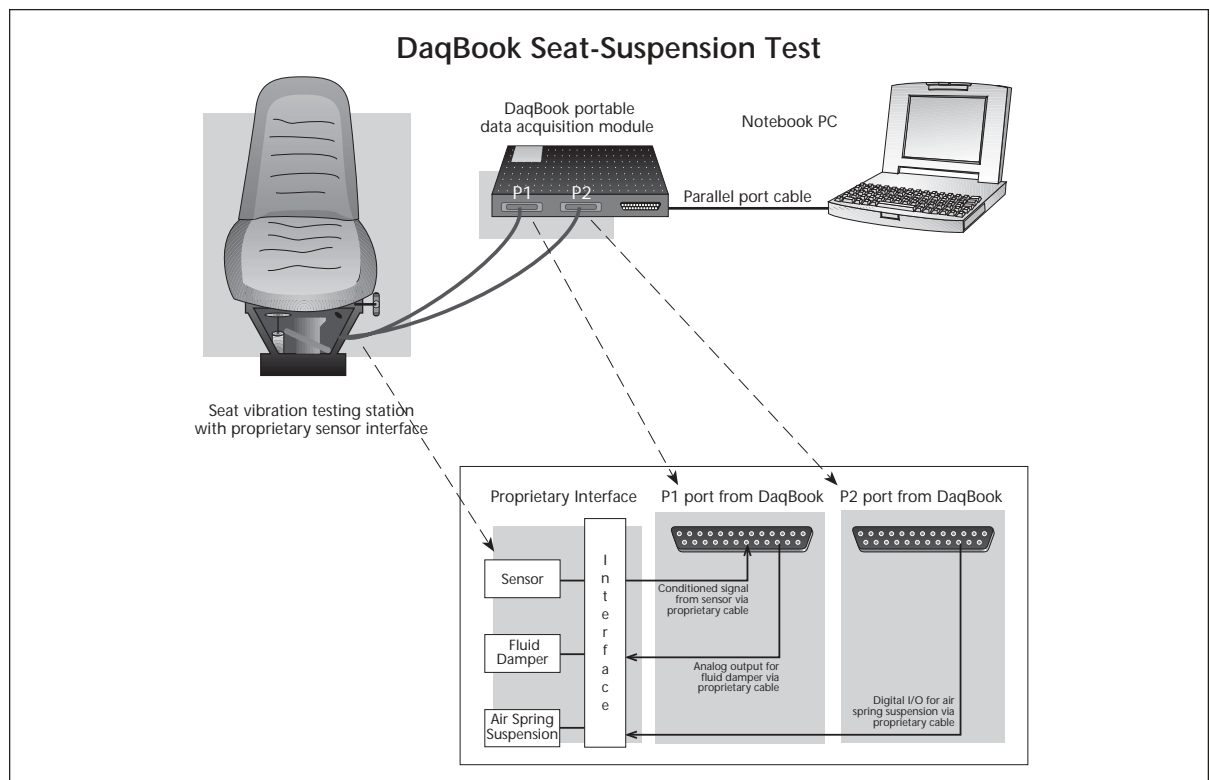
suspension. A proprietary interface was used for power and signal conditioning. In order to electronically adjust the damping characteristics of each fluid damper, the data acquisition system needed to be able to acquire data in real time. A closed control loop, in which the DaqBook generated an electrical output based on the acquired vibration data, was used to adjust the controllable fluid damper.

To conduct the test, the engineers electronically tuned the fluid damper to the structure (either a test stand or vehicle) to which it was attached. The DaqBook received an analog signal input from the sensor, which was attached to the seat, indicating the position of the seat. This analog signal was sent to the notebook PC via the DaqBook's A/D converter. The notebook PC used this signal to determine the seat's gross motion and vibration. This motion was then reduced by varying the current (via the DaqBook's D/A converters) through the electronically controlled damper, which in turn leveled the seat's air spring suspension so that the seat provided the best operator support. The seat's air spring suspension was also adjusted directly by the DaqBook's 24 general-purpose digital I/O lines.

Conclusion

The tests conducted using IOtech's DaqBook portable data acquisition system proved very effective. The semi-active seat suspension system that the DaqBook helped to develop is currently in use in many heavy-duty, off-road trucks and in construction equipment. The vibration- and shock-control product manufacturer foresees additional applications in equipment and vehicles used in aerospace, agriculture, construction, logging, mining, and transportation.

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®

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