Military Vehicle Off-Road Testing
using the WaveBook

Military and civilian drivers with a wide range of driving skills are using sport-utility and multi-purpose vehicles in extreme off-road environments. To assure vehicle quality, vehicle manufacturers are adopting portable PC-based data acquisition systems to perform innovative field tests.

Application Summary

The maker of a popular multiple-purpose military vehicle learned that some inexperienced operators were not maneuvering vehicles through obstacles correctly, causing tremendous stress on driveline components. In rare situations, the drivers compromised performance by putting excessive torque on transmissions, transfer cases, and differentials. To better understand this phenomenon, the manufacturer's engineering team needed to identify the combined effects of engine torque, speed, and controlled brake activation on components during the worst possible operating scenarios. This would require simultaneous, multiple-channel data acquisition during torturous field testing.
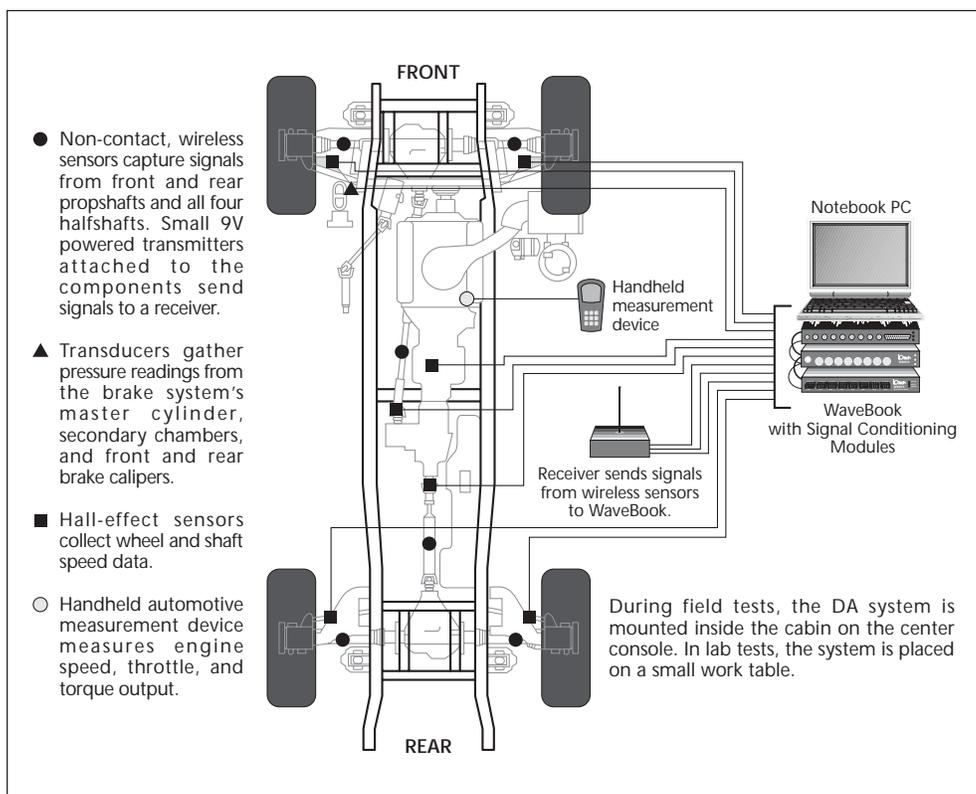
Potential Solution

Initially, the engineers used traditional measurement equipment, such as dedicated instruments and rack-mounted systems. This equipment had major drawbacks. Only a few of the bulky instruments fit inside the vehicle's cabin, and tests had to be repeated numerous times to capture readings. Once the data was gathered, the measurements were put through exhaustive calculations to evaluate vehicle performance. The process was costly, time-consuming, and it compromised data accuracy.

IOtech's Solution

After considering their options, the engineers decided to use a portable PC-based system that easily mounted inside the vehicle's cabin on the center console during field tests. At the heart of this compact system was IOtech's WaveBook, a 1-MHz system designed for high-speed, multi-channel data acquisition. The WaveBook included IOtech's WaveView™ *Out-of-the-Box*™ software, which allowed engineers to take measurements without the complicated setup and programming often associated with typical data acquisition programs.

The WaveBook system transferred data to a notebook computer. This combination allowed up to two full days of measurements to be saved to disk or the PC's hard drive. Using an IOtech WBK10 8-channel analog expansion module and a WBK15 8-channel multi-purpose isolated signal conditioning module, the WaveBook acquired data from 16 sensors attached to various vehicle components.

Speed sensors were easily mounted to front and rear propshafts and halfshafts, and four transducers were attached to brake lines to collect pressure readings. Measuring torque on front and rear propshafts and all four halfshafts presented a challenge. Because shafts move during testing, traditional wired sensors were not an option. To solve the problem, the engineers custom-fit the shafts with non-contact, wireless sensors. These sensors were

● Non-contact, wireless sensors capture signals from front and rear propshafts and all four halfshafts. Small 9V powered transmitters attached to the components send signals to a receiver.

▲ Transducers gather pressure readings from the brake system's master cylinder, secondary chambers, and front and rear brake calipers.

■ Hall-effect sensors collect wheel and shaft speed data.

○ Handheld automotive measurement device measures engine speed, throttle, and torque output.

FRONT

Notebook PC

Handheld measurement device

WaveBook with Signal Conditioning Modules

Receiver sends signals from wireless sensors to WaveBook.

During field tests, the DA system is mounted inside the cabin on the center console. In lab tests, the system is placed on a small work table.

REAR

Equipped with IOtech's WaveBook, a laptop PC and non-contact wireless sensors, engineers put the military vehicle through a series of rigorous field tests, challenging the vehicle's powertrain and drive-line

supported by small 9V-battery-powered transmitters that sent readings to a receiver/signal conditioner mounted in the vehicle's cabin.

With the system in place, engineers put the vehicle through a host of field applications designed to challenge the transmission, transfer case, and differential. During field tests, the vehicle made its way through water and mud up to 28-inches deep, VW-Bug-sized snow piles, and bumpy terrain that often limited it to two-wheel ground contact. For skid-torque testing, the vehicle was nudged against a concrete wall, and the vehicle's gas pedal was depressed until all wheels started to skid. In all, these tests generated more abuse than most off-road vehicles will ever have to endure.

With the acquired data, test conditions were replicated in a lab by mounting the vehicle on a bed-plate and four electric absorption dynamometers (one for each wheel). Loads for each dynamometer were controlled individually to replicate exact field conditions. The WaveBook was used to validate conditions and to further evaluate performance. Using analytical software, engineers conducted real-time, post-experiment analysis to make direct correlations between test data and component performance. Engineers used their findings to make the driveline components "user-proof."

Conclusion

The WaveBook's performance capabilities, compact size, and mobility helped engineers to quickly accomplish field tests that would have been impossible with dedicated test-and-measurement instruments only a few years ago. As the manufacturer's director of product assurance put it, "With traditional equipment, there were many exhausting steps to acquiring measurements. We had to wait days, even weeks, for results. Now, with portable PC-based systems, data collection is easy and results are instantaneous."

WaveBook Series

The WaveBook™ series of portable and desktop digitizers offer multi-channel waveform acquisition and analysis for portable or laboratory applications. All WaveBook models include 8 built-in channels expandable up to 72 channels of voltage, accelerometer, microphone, strain gage, thermocouple, position encoder, frequency, high voltage, and other signal types. For applications beyond 72 channels, up to four WaveBooks can be combined within one measurement system, for a total capacity of 288 channels. WaveBooks are available with either an Ethernet or parallel connection to a PC.

Features

- PC connection via Ethernet, parallel, PC-Card, or PCI card
- 1 µs/channel scanning of any combination of channels
- Expandable up to 288 high-speed channels
- SYNC connection allows multiple units to measure synchronously
- Add up to 224 lower-speed thermocouple channels
- DSP-based design provides real-time digital calibration on all channels
- Single and multichannel analog triggering with programmable level and slope
- Digital TTL-level and pattern triggering
- Pulse trigger and external clock
- Programmable pre- and post-trigger sampling rates
- Sixteen 1-MHz digital inputs
- Operable from AC line, a 10 to 30 VDC source, such as a car battery, or optional compact rechargeable battery module
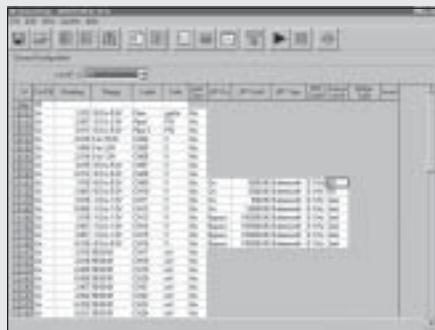
Using WaveView software's spreadsheet-style interface, you can easily set up your application and begin taking data within minutes of connecting your hardware, with no programming required.

Included Software

- WaveView™ for *Out-of-the-Box*™ setup, acquisition, and real-time display*:*
  - Scope mode for real-time waveform display
  - Logger mode for continuous streaming to disk
- eZ-Analyst™ for real-time spectrum analysis
- Export data in third-party formats
- Includes drivers for Visual Basic®, Delphi™, C++ for Windows®; DASYLab®, and LabVIEW®
- ActiveX/COM development tools

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