



Hydraulic Component Testing using the WaveBook™

Off-Road Vehicle

Application Note #74

Application Summary

Hydraulic components intended for OEM off-highway vehicles are typically designed for the maximum level of efficiency and reliability. Replacing failed components in the field is not as convenient as replacing them in the factory. Because low maintenance is critical to off-highway vehicles, hydraulic component makers continually improve existing products and systems, as well as manufacturing processes to improve the current standards of efficiency and durability. And the components' robust performance is maintained with on-going testing programs.

Eaton Hydraulics, Eden Prairie, Minn., routinely develops new products and systems using three types of tests to guarantee high quality: performance testing and endurance testing on test stands, and vehicle testing on-site and in the field. Performance testing ensures that the components meet their functional specifications, while endurance testing validates the component life under temperature, pressure, and vibration extremes. These tests ensure that the components and systems will stand up to the real-world rigors of off-road use and abuse. In

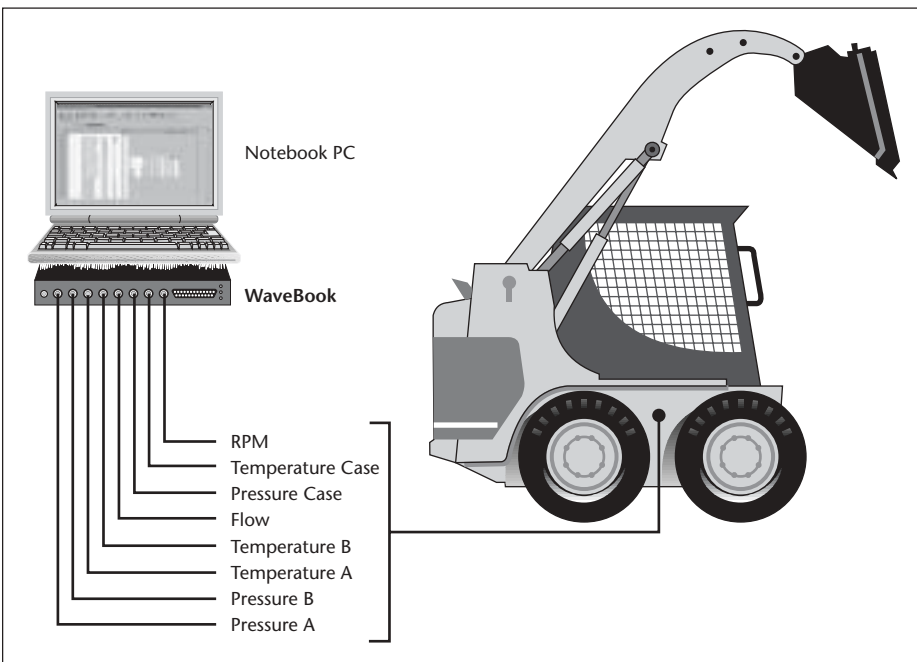
addition, vehicle testing provides a system analysis that ensures a component or system will perform well in a specific application. Vince Duray, Eaton test lab manager, has the responsibility to make certain that the testing programs for nine major hydraulic product lines designed at the division are up to Eaton's high performance standards. Part of the program requires collecting large amounts of data in real time and storing them for post processing, which is especially critical for off-road vehicle testing.

Potential Solution

Not long ago, the hydraulics division had numerous individual groups reporting to different managers, and all were running various tests simultaneously. They did not share common test stands nor use a uniform set of instrumentation. Everyone was operating on behalf of the individual product group, doing what was best at the time for the individual product. They used a variety of well-known black boxes, computer-based plug-in cards, and some customized equipment. Much of the computer equipment was DOS based and not kept up to date. When Duray was brought in as the manager, he realized that the lab needed a common direction and his first step was to purchase a common data acquisition system. This change was especially needed for endurance testing to replace antiquated strip-chart recorders for measuring test setups. All data were analyzed manually, and with the increase in testing programs, it became necessary to purchase more automated and functional test equipment.

IOtech's Solution

Duray established a cross-functional team that investigated and evaluated several data acquisition systems that were available. The systems had to be practical to handle the wide variety of performance and endurance tests needed for all products and systems. The team decided upon an IOtech WaveBook™ that previously had been brought into some of the test groups. As a result, Duray has a format for presenting data that he is proud to turn over to his customer, no cumbersome strip-chart recorder paper. "Now we are using WaveBook data acquisition systems all over the lab," says Duray. "Whether it's performance testing or endurance testing, we can get the results we need with simple setup requirements and less post processing."



Component testing requirements at the Eaton Hydraulics, Eden Prairie, Minn. test lab vary considerably among nine major product groups. In addition to qualifying a component on a test stand, instrumentation is continually analyzing entire systems on customer vehicles. A skid-steer system, for example, is typically instrumented to measure internal oil pressure and temperature in the hydraulic circuit, but other variables often requested to be measured during vehicle analysis include oil flow, shaft rpm, and vehicle acceleration.



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An endurance test requires an accurate test setup and continuous monitoring of test parameters to ensure the accelerated test conditions provide an effective life estimate. These parameters include steady state and peak pressures, pressure rise rate, cycle frequency, oil temperature, and rotational speed.

Eaton has also continued to develop electronic units to improve hydraulic systems control. Electronic units control hydraulic valves more efficiently, and adjust the response of a customer's vehicle more simply. Eaton also has developed software to make customer response adjustments within a fraction of the time that the changes previously required. Adjustments are made based on the vehicle's driving feel and data collected with the WaveBook. Different customers expect different results, so the data acquisition can be tracked and recorded for a particular customer's vehicle for future reference.

"The WaveBooks have helped so much that we now have ten units at our hydraulics division headquarters alone," says Duray, "and they are used in other hydraulics locations that manage engineering testing. WaveBooks have a tremendous amount of flexibility to cover a broad range of testing." The Eden Prairie test lab contains approximately 80 test stands that vary from a 50-hp small endurance test stand for the steering and motors group, to a 600-hp test stand for the vane and piston products group.

"We typically measure eight to ten channels," says Duray, "and because we need 16 channels once in a while, we purchased the IOtech expansion modules." Usually, 8 channels are sufficient for road tests, but occasionally on a skid-steer vehicle or tractor, more complex tests require the 16-channel capability. "The DASyLab® software is easy to use and set up, so the combination of DASyLab® and the IOtech WaveBook give us quality data acquisition with quick uptime and a small requirement for training. When used together, they give us the simplicity we need for a great variety of tests, as opposed to other software packages that would require a lot longer time to set up," says Duray.

Conclusion

Numerous WaveBooks collect data on hydraulic component test stands for performance and durability analysis at Eaton Hydraulics in Eden Prairie, Minn. And because the WaveBooks operate from battery voltage, engineers can run real-world

component tests on off-road vehicles in the field. The combination of DASyLab® software and the WaveBook flexibility let engineers run a wide variety of tests that otherwise would have taken much longer because of setup time.

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 an Ethernet connection to a PC.

Features

- PC connection via Ethernet
- 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

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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