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Automobile Torque Converter Testing

Automotive

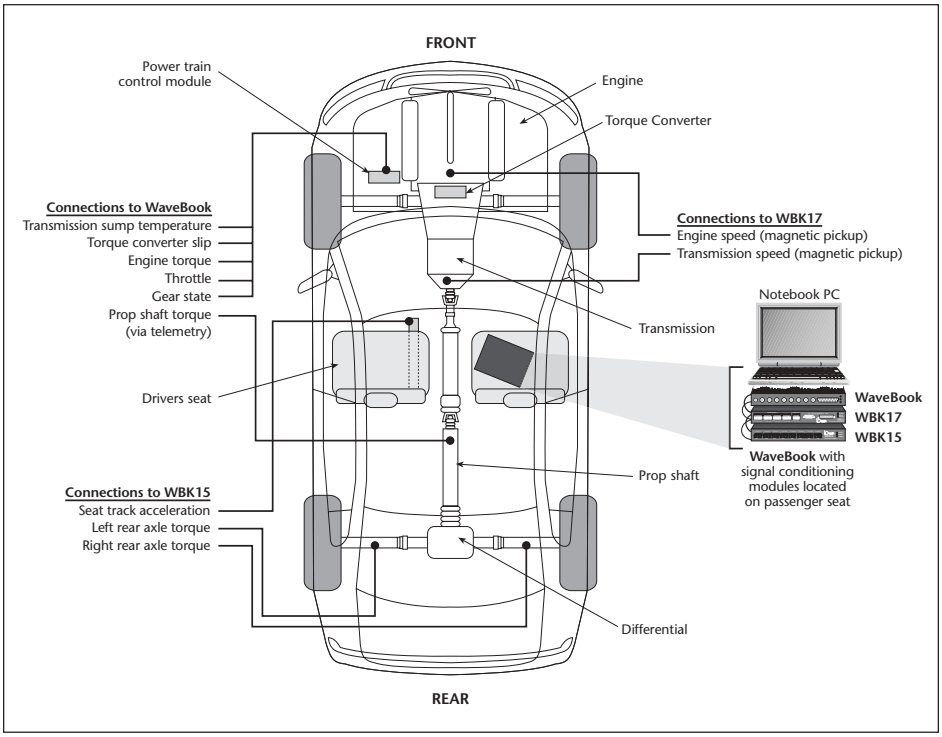
using the WaveBook™

Application Note #73

Application Summary

Torque converters are at the heart of all conventional automatic transmissions. Engine torque powers the converter pump, which in turn, sends fluid to the turbine. The turbine then transmits the torque to the transmission through a splined coupling. Torque converters must be well designed and manufactured to prevent excessive slip, operate for thousands of miles without maintenance or repair, and generate minimal noise, vibration, and harshness. And to ensure that the converters measure up to the companies' highest standards, engineers continually collect data on performance and durability tests carried out during design and development.

The General Motors Transmission Engineering Center, Ypsilanti, Mich., employs two large groups of engineers who design and release future transmissions for all the GM product lines. David Paladino, an engineer in the design group, develops torque converter clutch plates for every GM transmission. His task includes collecting data for temperature, fluid flow, and vibration on new torque converter models and delivers his findings to the design-release engineering group. He summarizes and transforms the information and data into useful metrics and graphical plots that are necessary for determining converter life, durability, vibration, and fuel economy. For his reports, Paladino relies on his data acquisition systems to collect multiple channels of accurate and reliable information in real time.



The Powertrain Div. of General Motors records and analyzes test data collected from torque converters during on-vehicle tests and engine test stands. Engineers use the data to characterize high-performance cars and fuel-efficient commuters to achieve optimum durability and drivability. The WaveBook's portability, compact size, and intuitive interface allow the engineers to change easily from instrumenting a vehicle to setting up a test stand or changing acquisition structure.

Potential Solution

Paladino didn't always have a reliable and easy-to-use data acquisition system. "We used customized equipment for each application," says Paladino. "We might have used an expensive oscilloscope for some accelerometer or noise measurements, but more often we used customized hardware, such as frequency-to-voltage converters, for measuring speeds. We didn't have a single, compact instrument that could to do it all." Moreover, Paladino didn't have sufficient instrumentation to record much data, not even strip-chart recorders. He used digital oscilloscopes that hosted a small hard drive, but the data were difficult to reach. "Sometimes the oscilloscopes had an SCSI port that could attach to your computer," says Paladino, "but it was touchy. You could also save data to floppies, but if you had a large data set, forget it. It's obvious that diskettes would be difficult to use."

IOtech's Solution

The day of reckoning came when the design group needed a better system to test and characterize new torque converters for the parallel hybrid truck that's scheduled for release this year. So Paladino evaluated a few widely known electronic data acquisition systems. As a result, he purchased the IOtech WaveBook™ because it appeared to be the most versatile data acquisition system available for his work. "It does everything that I thought it would in terms of sample rates and versatility," says Paladino. "In addition, we really appreciated the technical support we received from IOtech to help us get up to speed."

"The data acquisition system plays a critical role in helping us analyze a couple of factors that are always in dynamic tension," says Paladino. "One concerns the driver, especially in a sports car or high-performance muscle car." The design group strives to make the driver feel like the engine has a lot

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of power and response. But that demands higher fluid flows and more durable parts, so they have to know the torque, flow, and temperature rise inside the transmission during those maneuvers in detail. And the WaveBook keeps them well informed. It measures the engine torque and speed, transmission input and output speed, and throttle position. It also measures transmission sump temperature, torque converter clutch interface temperature, propeller shaft torque and speed, and wheel speed. The temperatures typically range from -40 to 140˚C, torque from 5 to 400 nm, and speed from 10 to 4,000 rpm. Paladino even measures the seat-track vibration and interior noise level, because vibration can be transmitted from the power train through the floor and into the seat track.

In addition to collecting data for high-performance cars, the WaveBook plays a key role in collecting data for improving commuter cars. Drivers don't expect these vehicles to be exceptionally responsive but they do want higher fuel economy. Fluid flows are fine-tuned to provide a smooth ride and tempered with just enough transmission slip for optimal performance, but not so much slip that it sacrifices fuel economy. "Optimizing the performance doesn't mean we can use less expensive components;" says Paladino, "that would just increase vibration." And although the systems are fine-tuned, rarely does it affect fuel economy more than about 5%. The task is to balance performance and economy with city and highway driving.

Paladino also likes the WaveBook's portability, compact size, and intuitive interface. It allows him to change easily from instrumenting a vehicle to setting up a test stand or changing acquisition structure. Also, the software and hardware combination, such as the DASYLab® software package makes it easy to learn and use.

Conclusion

The General Motors Powertrain Division uses IOtech WaveBooks to record and analyze test data collected from torque converters during on-vehicle tests and engine test stands. The data acquisition systems monitor transmission fluid flow, engine torque and speed, transmission input and output speed, and throttle position. They also measure transmission sump temperature, torque converter clutch interface temperature, propeller shaft torque and speed, and wheel speed. The data helps engineers characterize high-performance cars as well as fuel-efficient commuters to achieve optimum durability and drivability.

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