

Automated Test System for Remanufactured Truck Transmissions

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Category:

Test and Quality

Products Used:

LabVIEW™ Version 5.1f1
TestStand™ Version 1.0.2
PCI 6024E Series DAQ card
PCI 6503 Digital Output Card

The Challenge:

To create automated test stands for end of the line production testing of remanufactured truck transmissions. The test stands had to perform a variety of tests required to ensure the proper operation and quality of remanufactured transmissions, while minimizing the need for operator input, and meeting strict cycle time requirements. Also, the test stand needed to automatically detect shift points in the transmission accurately and reliably, though it was unclear as to how this could be accomplished. Furthermore, the test stands must meet or exceed the capabilities of an existing PLC controlled test system at the OEM manufacturer - at a significantly reduced cost.

The Solution:

Create a PC based dynamometer control and test system using National Instrument's TestStand and LabVIEW software together with National Instrument's low cost PCI data acquisition hardware. The PC used is an off the shelf Compaq 400 MHz PIII running on the Windows 98™ Operating System.

Abstract

Using National Instruments TestStand and LabVIEW software along with National Instruments Data Acquisition hardware, a world class remanufacturer of automotive transmissions and Life Cycle Engineering (LCE) created an automated control and test system capable of controlling transmission dynamometers, while simultaneously measuring all test parameters, and calculating shift points. Five complete test systems were built, tested, and integrated into end of line testing for a less than the cost of the one PLC based test stand used by the OEM manufacturer.



An operator mounts transmissions to be tested, provides input such as manually shifting the unit, and monitors the test status.

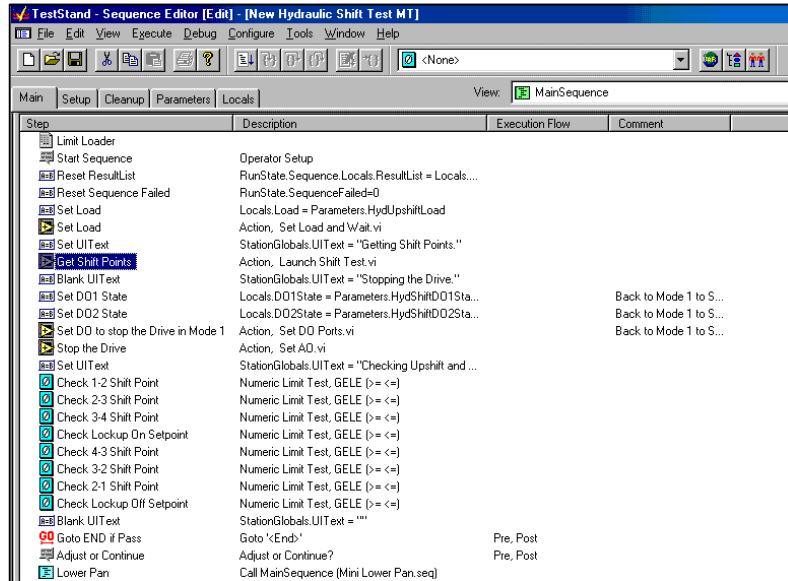
Introduction

A world class manufacturer of automotive transmissions for a variety of OEM manufacturers such as Ford, GM, Nissan, and Hyundai recently constructed a new facility for re-manufacturing truck transmissions and needed 5 dynamometer test stands to perform end of the line testing. They chose TestStand software from National Instruments as the primary test executive for several reasons:

- A large number and variety of tests were required.
- The development time is shortened since the sequence editor can call programs written in other languages such as LabVIEW, Visual Basic, and DLL's.
- The sequence editor allows fast and easy editing or the addition of new tests to the test sequence.
- Tests are easily defined and test results can be written to any SQL compatible database.

The test sequence was developed in TestStand in just a few days. The test sequence is made up of tests defined in TestStand and LabVIEW. During each test step, the transmission input speed is controlled by supplying a 0-10 volt

signal to the dynamometer controller via the analog output capability of the PCI 6024E card. A PCI 6503 digital output card controls discrete devices such as the power enable, E-stop enable, and the transmission modulator (a device which supplies vacuum to simulate a driver applying pressure to the vehicle accelerator). Analog signals such as the transmission and cooler fluid pressures, temperatures, as well as input and output speed are acquired using the PCI-6024E analog input card.



LabVIEW, LabWindows/CVI, C/C++, and Visual Basic.

sequence. This method lacked the reproducibility of automated shift detection and caused undo strain on the operators. Life Cycle Engineering, Inc. (LCE), a National Instruments alliance member, was asked to develop an automated shift detect program which could be called by TestStand. LCE chose LabVIEW 5.1 as the programming language because of the easy to use graphical programming environment, fast development time, advanced math capabilities, and the ease in which it can be integrated into the TestStand environment.

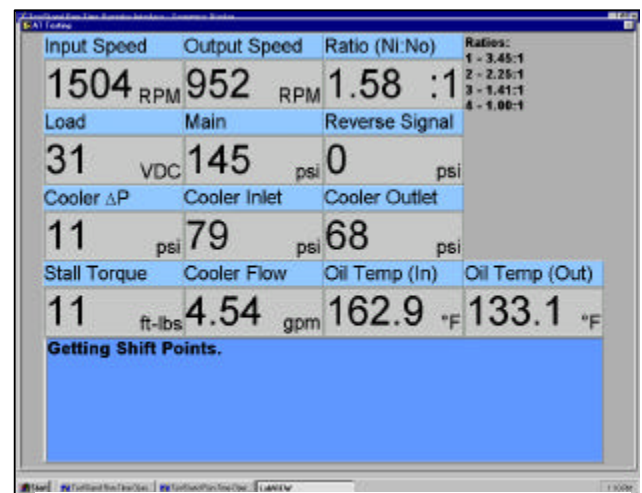
Developing an Automated Test while Maintaining Production

In addition to the main challenge of developing an automatic shift detection program, there was the requirement that the impact on current production be minimized. To do this, LCE created a LabVIEW Virtual Instrument (VI) which controlled the dynamometer during the hydraulic shift test, and recorded all acquired analog signals to disk. This allowed the operators to continue production as usual, while at the same time acquiring test data for the full variety of transmission models being tested.

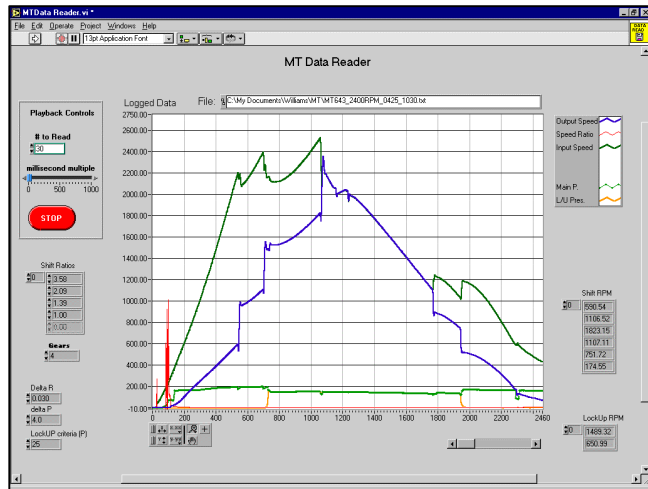
In parallel, LCE developed another LabVIEW VI to read previously recorded data, plot it in a chart, and analyze it to determine which signals could be used to reliably detect UUT shifts. Using the advanced math functions contained in LabVIEW 5.1, LCE developed a method of analyzing pressure and gear ratio (input speed ÷ output speed) to detect a shift. When a shift event occurred, LabVIEW's array and shift register functions allowed us to "step through" the data and correlate the event to the instantaneous UUT output speed in RPM.

One of the most critical tests to be performed on the re-manufactured transmissions is the hydraulic shift test. In this test, the input speed is slowly ramped up from engine idle speed, through the design range of the unit, then ramped back down to idle speed. As the input speed is ramped up and down the transmission shifts up through the gears and back down to first gear.

When the TestStand system was first developed, shift detection was done manually by the operator who observed the unit's fluid pressure and output speed signals via a Human Machine Interface (HMI) written in LabVIEW 5.1. The operator would record the shift points (in output speed RPM's) into a dialog box at the end of the hydraulic shift detection



A LabVIEW panel shows the current values for each of the measured signals and indicates the test status.



A LabVIEW Virtual Instrument (VI) was used to playback data acquired in production, and to test different shift detection methods in the development stages – this approach minimized the impact on production testing.

Integration

After developing and testing the LabVIEW shift detection program offline, the program was easily integrated into production by incorporating it into the previously written LabVIEW hydraulic shift test control VI. TestStand calls the VI when the hydraulic shift test begins. Instead of manual entry of the shift points, however, the values are passed from the LabVIEW shift detect program, to TestStand, through local and global variables defined in the TestStand Sequence Editor.

A minimal amount of testing was required after integration into the production test area. Controls affecting the sensitivity of the shift detection VI were added to the front panel of the controlling VI so that adjustments could be made quickly if needed.

Conclusion

Using National Instruments' hardware and software, a leading re-manufacturer and Life Cycle Engineering developed 5 automated vehicle transmission test stands in a short period of time for less than the cost of an existing test stand used by the OEM manufacturer. The dynamometer test stands perform the full range of tests required by the OEM manufacturer, and detect shifts in the UUT automatically without the need for operator input. The automatic shift detection program, developed in LabVIEW, resulted in very reproducible measurements and reduced test cycle times. In addition, the LabVIEW VI's were easily and seamlessly integrated into the existing TestStand test sequence.

The shift detection program was almost entirely developed and tested offline using the data reader while the end of the line dynamometer testing continued uninterrupted. The offline development also allowed us to test the program with data from the full range of units to be tested before the program was ever introduced to the factory floor.



A LabVIEW VI controls the dynamometer during the hydraulic shift test.