Automating Steering Column Linkage Performance Measurements

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The Challenge: Automating data acquisition and data reduction for a steering column linkage torsional compliance test.

The Solution: Incorporating a computer-based measurement and analysis system into the existing test system.

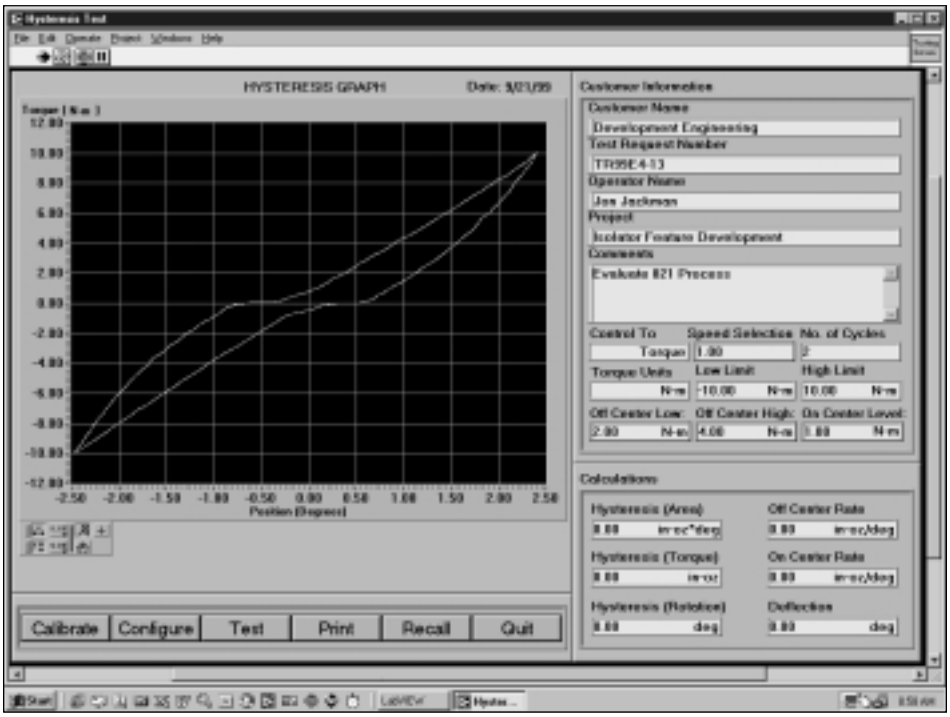
Introduction

The Torrington Co., a subsidiary of Ingersoll-Rand, is a leading producer of precision bearings and motion control products. Torrington's automotive components facility in Watertown, CT, generates performance curves to check the torsional compliance characteristics of steering column linkage assemblies. Their original test system used discrete torque and quadrature encoder readouts with an X-Y pen plotter to graph torque versus deflection and measure linkage performance characteristics. This setup required an engineer to graphically interpret the plotted data and perform manual calculations. Torrington recognized that the elimination of manual calculations would quickly yield improvements.

To assist in the upgrade of their test system, Torrington contracted Bloomy Controls Inc., a National Instruments Select Integrator. Bloomy Controls recommended a powerful and flexible LabVIEW-based system to address Torrington's needs:

- Improved control over the load and deflection application
- Improved data acquisition and display
- Flexibility of matching customer needs to capabilities
- Freedom to export data to a spreadsheet file for supplemental data analysis

Bloomy Controls also recommended National Instruments data acquisition (DAQ) products for their specific capabilities and compatibility with LabVIEW.



Torsional Compliance Test System User Interface

While testing the software on site, LabVIEW gave Bloomy Controls the versatility to make changes as needed. The graphical nature and ease of use provided by LabVIEW, coupled with its built-in debugging tools, made it relatively easy to discover exactly what parts of the code were causing problems.

System Description

To upgrade the torsional compliance test setup, Bloomy Controls developed a system to acquire and display torque and position measurements, perform various calculations, and store and retrieve data. The system stores the acquired data and calculations in tab delimited, ASCII formatted files for easy import into other programs. The system can also store and retrieve unit under test (UUT) information, including customer and project names, test request numbers, and test variables.

With the graphical user interface (GUI), the user can enter UUT information, display calculation results and graphs of acquired data, and execute password-protected calibration of analog inputs. The system performs data acquisition by taking buffered analog and position readings. Software triggers start the two buffered acquisition operations at the same time and maintain synchronization by sharing a sampling rate. After the acquisition finishes, the system creates a performance characteristic curve and completes calculations. The main screen then displays the items and prompts the user to save the data from this test run.

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graphical nature and ease of use provided by LabVIEW, coupled with its built-in debugging tools, made it relatively easy to discover exactly what parts of the code were causing problems. These tools also revealed when the problem was not with the code at all. To solve one such problem, we added a solid state relay to enable the motor before the test and disable it afterward. LabVIEW and the PCI-6602 TIO board made this a simple and straightforward addition.

Since the system's upgrade, Torrington has seen wholesale timesaving benefits. The measurement equipment can be set up, data acquired, graphical results displayed, calculations performed, results displayed, and raw data sent to a file in about three minutes per sample.

Software

The software development effort for this project included the following tasks:

- Create a front panel to enter UUT information, operator's name, and selection of Metric or English units
- Create VIs to store and retrieve UUT information and test variables, acquire torque measurements, send the speed command from the PCI-6024E to the servo drive, and acquire the quadrature signal
- Create additional VIs to display a graph of the acquired data and calculation results, set the servo speed, select the type of acquisition to perform, and store the acquired data and calculations in ASCII formatted files
- Create a VI to retrieve previously acquired data and calculations saved in ASCII formatted files

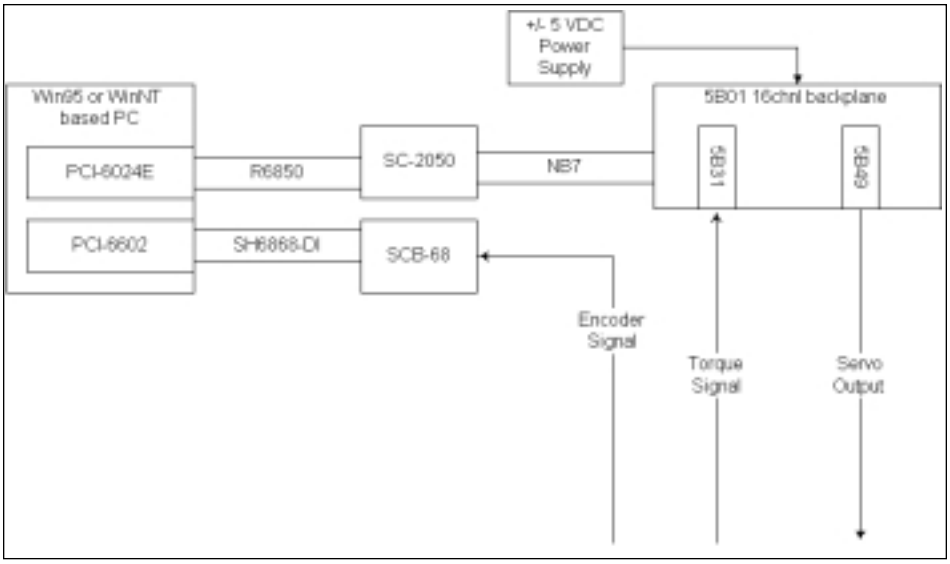

Figure 1. System Hardware

Hardware

Bloomy Controls selected National Instruments 5B modules for the 1,500 Vrms of common voltage isolation and 240 Vrms of normal mode input protection for the computer. With the 5B hardware, low-cost future expansion for a variety of signals that require conditioning before being connected to the PCI-6024E is easily accommodated. Figure 1 shows a block diagram of the hardware design.

Results

Since the system's upgrade, Torrington has seen wholesale timesaving benefits. The measurement equipment is set up; data is acquired; graphical results are displayed; calculations are performed; results displayed, and raw data is sent to a file in about three minutes per sample. This is a 4X improvement over the 12 minutes previously required. The added ability to retrieve and easily compare historical data has also proven valuable.

Ease and repeatability of calculations are other key improvements provided by the upgraded LabVIEW system. The system produces a more detailed graph where exact values are pinpointed with higher precision than on a pen-plotted graph. This results in improvement of accuracy and consistency of data analysis. The ability to store test data on the local computer or on the company network is another valuable addition. Furthermore, the system generates professional, report-ready data sheets that display the graph side-by-side with calculations for customer review.

Based on the success of this project, Torrington plans to apply similar upgrades to other mature test and measurement equipment at its Watertown, CT, facility, under the direction of Test Development Engineer Jon Jackman and Product Development Engineer Jay Files. In addition, they require LabVIEW drivers as a part of the basic equipment package on most new purchases.[1]

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