WINEMAN TECHNOLOGY INCORPORATED

EFFECTIVE SOLUTIONS FOR CONTROL SYSTEMS AND AUTOMATED TEST EQUIPMENT

Automating an Automotive Starter Durability Test Stand with LabVIEW

Category:
Automotive

Products Used:
LabVIEW™ Software
SCXI 1141 modules
SCXI 1000 four slot chassis
AT-MIO-16E-10 data acquisition board
PC-DIO-24 ISA plug-in board

The Challenge: Simulating an internal combustion automobile engine for performing accurate and repeatable durability testing of electric automotive starter motors.

The Solution: Using National Instruments' LabVIEW™ software, data acquisition (DAQ) and SCXI hardware to collect and analyze automotive starter data while controlling an electric motor to simulate an internal combustion (IC) engine.

Abstract/Introduction
When engineers at an automotive products company decided they needed a new Starter Durability Test Stand, WTI of Saginaw, Michigan teamed up with the customer to design a four-station test fixture with an automated Data Acquisition and Control system. The customer's existing Starter Durability Test Stands were run from DOS-based computers using custom signal conditioning and separate data acquisition (DAQ) cards for both control and data acquisition. The separate DAQ cards came from different manufacturers and were driven by separate programs written with different programming languages. The fixtures were loud and shook the entire test room. Using National Instruments' DAQ and SCXI hardware, the LabVIEW™ software, WTI created a single program to coordinate a powerful data acquisition and control system, while the customer constructed a sturdy, rigid fixture virtually free of vibrations.

Design Considerations
The most significant aspect of this data acquisition and control system was its ability to simulate an internal combustion (IC) automobile engine using an AC electric motor. The old programming was cumbersome and very difficult to troubleshoot, and the custom signal conditioning and separate DAQ hardware became issues when considering future stands and stand-to-stand repeatability. WTI answered the challenge and developed an automated data acquisition and control system using off-the-shelf components and one single program to supervise, coordinate, control, acquire data, analyze, and report all system operations. Figure 1 shows sample data and the user-friendliness for the graphical user interface. National Instruments' DAQ and SCXI hardware and LabVIEW™ software provided WTI with the power and flexibility to create a

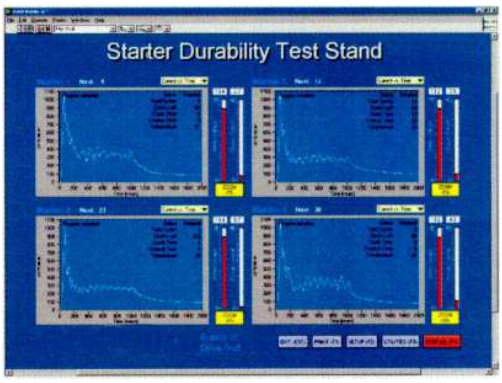

Figure 1: Starter durability test sample data

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cost effective solution while integrating a variety of components into one streamlined test system.

System Design

The test fixture consists of a four-station mounting plate, four automotive starters, batteries, battery chargers, cooling fans, and a flywheel coupled to an Allen Bradley 4O hp electric motor, which provides dynamic loading to the starters to simulate an automotive IC engine (Figure 2). An Allen Bradley 1336 ImpactrM Drive, fully automated and controlled by WTI's LabVIEW™ based data acquisition and control system program runs the motor. This data acquisition and control system uses a Micron Pentium 166 processor with 32 Mb RAM running the Windows NT operating system. Three National Instruments' SCXI 1141 modules, in a National Instruments' SCXI 1000 four slot chassis, provide elliptic filtering and multiplex twenty-four analog inputs into one National Instruments' AT-MIO-16E-10 DAQ board. The two analog outputs from the DAQ card control the speed and torque references to the drive, while three digital lines on the card monitor system inputs. A National Instruments' PC-DIO-24 ISA plug-in board energizes system relays for starters, cooling fans, etc., maintains a watchdog circuit, and controls the drive using five TTL signals. The system relays, the Drive, and many other hardware components (power distribution, fuses, etc.) are housed in the large electrical cabinet designed and built by WTI.

Figure 2: Starter durability test stand fixture

Software Design

The main screen displays the torque, current, or speed graphs for each station, as well as station status, cycle counters, fault information full-screen for any single station selected. At any time, the user can create new tests or edit existing test parameters with the Station setup screen. A built-in Log File Viewer lets the user browse through the DAQ event log file program without stopping the program. Another feature screen is the I/O status screen, giving the user full manual control over all system outputs while displaying the raw and scaled value of all system inputs.

The user can, from the Engine Editor screen, delete, copy, or create new simulated engines; edit the parameters that describe an engine; and single-cycle any starter to see how the new changes affect the starter data. This easy and straight-forward screen turns a simple 5 x 4 matrix of control parameters into a series of waveforms and runs the 40 hp motor in both open-loop and closed-loop control schemes to accurately simulate the actual crank and start cycles of a real IC engine. WTI also added two more engine parameters to compensate for the changing speed profiles of different automotive starters.

The system incorporates IsoCal™, WTI's standard sensor calibration routine, to provide a seamless transition from raw sensor voltage to useful engineering data. Each analog input to the system can be stored in a sensor library, and each sensor in the library can store coefficients for up to an 8^{th} order polynomial calibration curve. Calibration reports can be printed at any time for any sensor.

Conclusion

The Starter Durability Data Acquisition and Control system provides the customer with a seamless method of testing electric automotive starter motors, while simulating an IC motor during test sequence. All this was accomplished through the use of National Instruments' LabView™ and DAQ hardware

coupled with the period after fixture design. The system allows the customer to test their motors quickly, easily, and efficiently. It also produces data with increased accuracy and repeatability.