In-Vehicle Data Acquisition System for Ford Motor Proving Grounds

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The Challenge: Providing Ford Motor Proving Grounds (Ford) with a compact, portable, user-friendly method of recording and alarming 400 channels of data in a moving vehicle. The system tests vehicle temperatures to assure that they do not exceed design limitations in extreme conditions.

The Solution: Using the power of the modern PC with the power of open architecture instrumentation buses to couple all of the features of the old systems with the power of new technology.

Introduction

The in-vehicle data acquisition system (IVDAS) was designed to address the data logging needs of Ford. Traditionally, Ford used proprietary, standalone data loggers that were built to allow general data logging and some alarming. These systems were text based, large, and difficult to work with.

The power of the modern PC coupled with the power of open architecture instrumentation buses has opened the door for a much more powerful and flexible solution. IVDAS uses these new paradigms to couple all of the features of the old systems with the power of new technology.

System Hardware

National Instruments products were chosen for the new application based on their modularity, flexibility, and reliability. The heart of IVDAS is a National Instruments PXI chassis linked to four SCXI mainframes filled with thermocouple conditioning modules. The SCXI chassis can be populated with various signal conditioning modules tailored for the signals that need to be acquired. The chassis can handle about 400 channels of thermocouple input, as well as extra channels for signals such as velocity and oil pressure. The LabVIEW application ties these channels together creating a more user friendly system than before and giving the user the opportunity to receive readings during the testing as well as adjust the on-screen view.

System Software

IVDAS software is first set up by defining the channels. This is accomplished in one of three ways:

- A user interface panel that allows the user to define channel count, names, and scaling. Conditioning and alarming can be used if the channel list has not been created.
- A text file that can be created with a separate package such as Microsoft Excel can be imported.
- A company-specific file type can be read into the system to generate a channel list.

Specific setup files can be saved to disk in order to recall them for similar tests. After setup, the user can test run the software to look for open or shorted circuits wired to the SCXI chassis. Once setup and initial checkout are complete, the system is ready to be used by the driver.
Data Logging and Alarming
With the driver panel, the test driver starts the data logging and alarming process with the touch of a button. No mouse interaction is necessary for the driver for safety reasons. While the driver can pause acquisition during the test, alarming is always running.

Three types of alarms are available at the setup stage – max, min, and warning. Each of these alarms, when triggered, changes the color of the digital readout for the given channel to a color corresponding to the type of alarm, and emits a tone specific to the alarm type.

The driver can adjust the on-screen view between the following channel sets:
- Critical – channels with defined alarms
- Alarm – channels that are currently in the alarm state
- All – all channels
- User – a user-defined set of channels

Within each of the channel lists, the driver can scroll through each page of displayed data with the page-up, page-down keys. Data for all channels is logged to disk and can be converted to a text format for easy data manipulation in almost any software package.

System Options
The real strength of IVDAS is its flexibility and upgradeability. By using PXI and SCXI, additional options are almost unlimited. A few examples of some of the upgrades available will help make this point clear.
- Touch screen upgrade – A touch screen can be added to allow the driver more flexibility and control while driving. This would only require changing the standard flat panel monitor with a touch screen monitor and installing the driver software. Because the software is already mouse and keyboard driven, no changes to the IVDAS software would be required.
- Voice synthesis upgrade – Voice synthesis would be useful to notify the driver of potential problems in a more detailed manner than simple beeps. This would only require changes to the software (since the system already includes sound) to use a toolkit that BBT uses on other projects.
- Voice recognition upgrade – Voice recognition would also help the driver maintain focus on the road. Commands that are given to the computer through voice rather than keystrokes would fit into the basic IVDAS architecture easily. The system would require the addition of a microphone and an adaptation of a voice recognition toolkit into LabVIEW.
- Machine vision upgrade – Machine vision would be a very useful add-on to the system. It can either be used to visually monitor positions of various components, or to monitor temperature of an entire surface. By using a spray on coating that changes color with temperature, various surfaces can be monitored in much more detail than a thermocouple can give.
- Other options – Motion control, GPS, telemetry, control of safety equipment such as fire extinguishers, and communications with the automobile’s onboard computer are just a few more features than can easily be added to this system. The flexibility of these add-on features is the key reason that IVDAS is the logical replacement for traditional data loggers previously used by Ford.

Results
With the use of the IVDAS system, development time has been cut in half. The space required for the IVDAS system is significantly less than the previous system, giving the driver greater freedom of movement during testing. The increased flexibility and ease of use has combined to make a technologically advanced, yet user simplified system, providing Ford with the reliable data feedback it has been seeking.

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