Industry: Automotive
Products Used: PXI • LabVIEW™ • LabVIEW Real-Time

Redesigning and Implementing an Engine Exhaust Simulator with National Instruments LabVIEW and PXI

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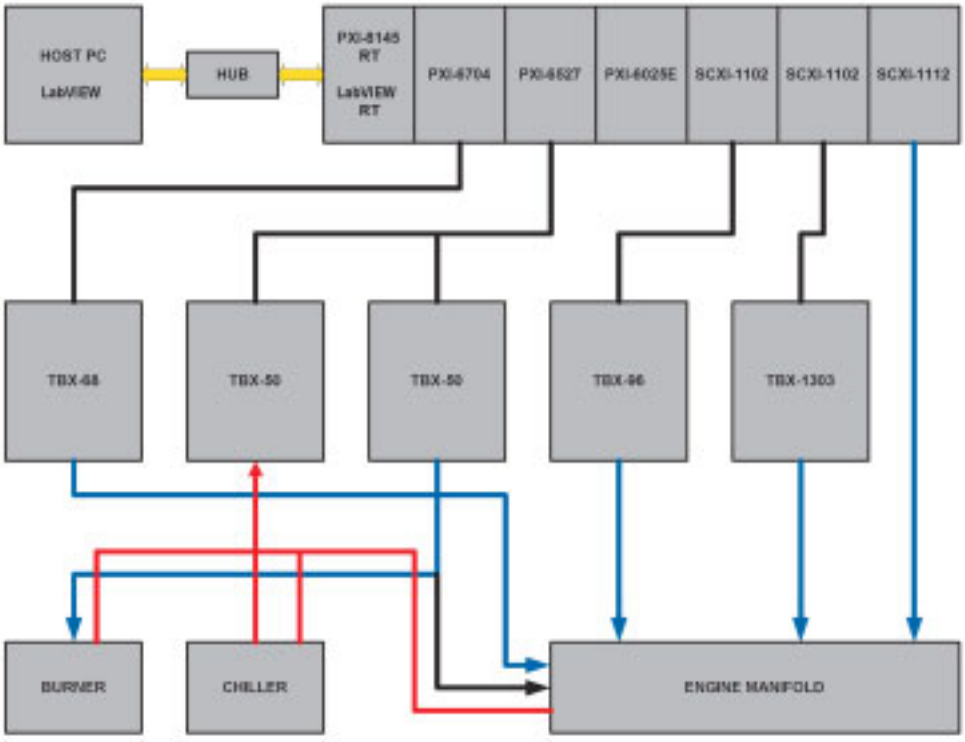
The Challenge: **Redesigning and implementing an engine exhaust simulator system that is modular, flexible, reliable, and automated into a single program that allows both manual and automatic control of the system.**

The Solution: **Using National Instruments LabVIEW Real-Time and a PXI based-system, we developed an engine exhaust simulator system that can simultaneously control and monitor three independent subsystems and two engine manifolds.**

Simultaneous, Independent Tests on Two Engine Manifolds

The engine exhaust simulator system is an upgrade from a previous version. In the older version of the system, we had to manually program the burner and the cooler sub-system parameters and then run a dummy test to verify that the system would use the desired cycle profile. This sometimes required several iterations before the system achieved the desired profile; a time-consuming and arduous process. The original software monitored, but did not control, the individual subsystems. Also, the system supported only a limited number of channels.



Block Diagram of Engine Exhaust Simulator

By using National Instruments products for all functions in the system, integration was smooth and efficient.

E-JAZ Test and Measurement was contracted to make an engine exhaust simulator system that could perform simultaneous, independent tests on two engine manifolds. We used the system to measure the exhaust gas temperature (EGT), the coolant temperature, and up to 32 skin temperatures, while accommodating up to eight additional sensors. The system also needed to control three subsystems: the gas burner, the cooler, and the building's exhaust system.

From a software point of view, the system must allow an operator to define a test profile that is composed of a heat time, a cool time, the number of cycles in the test, and the PID parameters for the heat and cool periods. The software must control the amount of heat and coolant flow and there must be a simple method to verify the PID parameters. Once this information is defined, the software must display the acquired data and allow the operator to view and export it in various ways. Finally, the main system must have a fail-safe method to prevent damage to the operator and equipment.

Critical Reliability

To have deterministic control over two independent tests, we implemented a PXI-based system using the PXI-8145 controller. Required measurements include the EGT, the heat and coolant flow, the skin temperature, and other sensors. The system controls the burner and cooler by applying two independent 0-20 mA signals. These signals control the gas and airflow of the burner and cooler, respectively. The system also controls the test room's exhaust system using digital outputs.

The system monitors potential failures of any of the six burners through digital inputs. If any burners fail, the system must react to prevent a failed burner from causing abnormal measurements in the final data analysis. The system also uses digital inputs to monitor the cooler to see if it fails. This is very important because if there is no coolant flow, the burners must shut off or the engine manifold will be severely damaged. Finally, the system monitors the test room's exhaust subsystem using digital inputs. When the main system asks the subsystem to open the exhaust, the subsystem must acknowledge that it has actually opened them fully. This is important because if the mechanism fails, the emissions in the room cause a health

Front Panel of the Host Software

hazard to operators in the area; also, the contaminated air could yield abnormal results.

Full Flexibility

The software of the engine exhaust simulator system is divided into two separate sections: the embedded software and the host software. The embedded software runs on the PXI-RT controller. This portion of the software is responsible for collecting the data and sending it to the host software via a TCP connection. The host software takes the collected data and displays it for the operator. To start a test, the operator defines or loads a pre-existing configuration and the configuration is downloaded to the embedded software. The embedded software continues to take measurements until an error occurs or the predetermined numbers of cycles have been completed. While configuring a test, the operator has full flexibility to define, configure, and test the PID parameters. This is a vast improvement over its predecessor.

The host software is not only a tool to view the current data, it also has the ability to view previous data, analyze data, and export data to Microsoft Excel spreadsheets. One of the powerful features of the new software is the ability to view the current tests data history. In the standard data window, the view is limited to a maximum of two hours. The system was coded this way to prevent the program from slowing down because of memory constraints. To view data previous to those two hours, a view data screen can be opened to allow scrolling through the entire timeframe of available data. Also, the software can analyze the data, export the existing data to an Excel spreadsheet, and export the raw data. Since the system was programmed for flexibility, new analysis routines can be added by simply creating a sub-VI and adding it to the system. The host application required no changes or recompilation. Because the files are already in Excel, you can easily run analysis on the data as well.

A Timely, Cost-Effective Solution

Using National Instruments software and hardware platform, we met our customer's requirements in a timely and cost effective manner. Because the system runs on LabVIEW Real-Time and PXI, we were able to readily achieve the deterministic control of the engine manifold. We easily accomplished the control and monitoring of the sub-systems as well. By making use of the LabVIEW Report Generation Toolkit, we easily performed the export and analysis of the data files. The LabVIEW PID Control Toolset saved us time by removing the need to program the PID algorithms. Finally, by using National Instruments products for all system functions, integration was smooth and efficient. ■

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