Inertia Research Develops Cost-Effective LabVIEW Real-Time Engine Dynamometer Controller

by Roy Krans, President, Inertia Research LLC

**The Challenge:** Developing a flexible, robust real-time engine dynamometer controller that is cost-effective, technologically advanced, based on off-the-shelf components, and capable of controlling a variety of engines and dynamometer types.

**The Solution:** Utilizing National Instruments PXI, SCXI, LabVIEW Real-Time 6.1, and Inertia engine dynamometer software to create this real-time engine dynamometer.

**Durability and Performance Testing**
A major spark plug manufacturer’s engine lab performs spark plug durability and performance testing on a variety of plug and engine configurations. The lab provides full engine cell testing on engines ranging from snowmobiles to supercharged luxury sedans. Testing generally involves long-term engine runs at varying throttle and load conditions with occasional complex test routines involving engine stops and restarts, coolant flushes, and other system variations.

The spark plug manufacturer contracted Inertia to satisfy the lab’s diverse testing requirements, which mandate a flexible control and measurement system capable of interfacing to their diverse dynamometer hardware, including various eddy current absorbers with and without their own PID controllers, a wide variety of feedback sensors, two-cycle engine compatibility, and numerous test cell safety systems.

**Developing a System Based on Off-the-Shelf Components**
To satisfy the flexibility, cost, and performance requirements, we selected an embedded LabVIEW Real-Time-based system. The system consisted of components, including an embedded LabVIEW PXI controller, PXI 16-bit multifunction I/O cards, SCXI signal conditioning, PXI chassis, our INERTIA engine dynamometer software, and a Windows PC with 10/100 Mbps Ethernet.

We selected the initial SCXI modules to satisfy current I/O requirements and provide additional space for expansion. These modules monitored all engine cell sensors, including engine RPM, load, oil pressure, fuel pressure, engine temperatures, and cell interlocks as well as controlling cooling water solenoids, fuel solenoids, and cell cooling. PXI cards with 16-bit analog output control each cell’s throttle actuator, dynamometer, engine water cooling and engine oil cooling.

We used our INERTIA real-time software application based on LabVIEW Real-Time to configure and control the National Instruments hardware.

The INERTIA system consisted of:
- INERTIA configuration – a configuration utility that allows our client to define a precise test procedure, channels, alarms, and custom functions.
- INERTIA engine – an embedded LabVIEW Real-Time application that acquires data, checks alarms, and executes test procedures in a deterministic real-time operating system.
- User interface – a standard LabVIEW VI that displays test information and allows the user to interact with the INERTIA engine.

**Providing Configuration Utility**
With our INERTIA configuration utility, our installers and our client can customize the real-time engine by defining channels, alarms, and test procedures.

Our INERTIA channels included analog and digital I/O, calculations, system variables, and user-defined variables. The flexibility of this configuration utility provides custom user test procedures, alarming, data logging, and channel management utilities.

We configured our INERTIA alarms to monitor cell safety inputs, such as cooling water flow and HVAC air flow, as well as engine operating safeties, such as oil pressures, engine temperatures, and speed. Each alarm featured many options,
Customer Solutions

including variable limits, delayed trips, and multiple priority settings.

Our INERTIA configurations defined the real-time engine’s various test and alarming procedures. By defining a number of standard tests along with alarming procedures for proper shutdown, idle states, and warning conditions, we created each procedure using our INERTIA simple pop-up dialog boxes. This allows complex procedures to be built from simple commands such as ramps, dwells, waveforms, conditionals, data playback, data logging, and high-performance, deterministic PID control loops ranging from 100 Hz to 2,000 Hz. The flexibility of the system along with off-the-shelf hardware, including National Instruments wide range of SCXI modules and PXI cards, allowed us to easily configure the system while providing our client with the option to later change or add configuration information.

LabVIEW provided an extensive and flexible interface for operation of the dynamometer, including:
- Manual control of any digital or analog control signal
- Display of acquired signals or user variables
- Strip charting and high-speed graphing of any INERTIA channel
- Profile generation, including road data playback
- Adjustment of data logging, channels, and rates
- Two bar graphs with green, yellow, and red zones, each displaying up to eight signals

Flexibility and Cost Effectiveness

We successfully updated our client’s engine cells for their diverse requirements using National Instruments software and hardware and our INERTIA software configuration utility. By combining the flexibility of the PXI/SCXI hardware and the power of LabVIEW Real-Time, we developed a single platform for handling our client’s multiple test cells.

By integrating similar hardware across multiple cells, we reduced maintenance and training costs. With the new controllers, we provided cost effective off-the-shelf hardware, saving tens of thousands of dollars.

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Engine Dynamometer Screen

Using NI software and hardware, a major manufacturer of spark plugs can support multiple test cells in a single platform.

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Inertia Configurator Screen

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