



EFFECTIVE SOLUTIONS FOR CONTROL SYSTEMS AND AUTOMATED TEST EQUIPMENT

CCRD Dynamometer

Category
R & D

Products Used:
LabVIEW™ Software
PCI-MIO-16E-4
SCXI-1000
SCXI-1102
SCXI-1121
SCXI-1162
PID Toolkit

The Challenge: Control the operation of a dynamometer and monitor the status of the engine during a test.

The Solution: Provide a LabVIEW™ software based system that monitors the engine and provides set point information to control the speed and load of the engine during testing.

Abstract/Introduction

A method was developed to improve the performance of a diesel engine by dynamically adjusting the camshaft to modify valve timing, and required a dynamometer control system for testing the performance of the engine at various loads and speeds.

The system developed uses two computers. The main computer is used for monitoring the engine conditions and controlling the engine using set points generated from a profile. The secondary computer is used to measure the angular difference between the camshaft and the cam pinion gear and control the position of the camshaft. It uses PID control algorithms to adjust the phase to match the current set point.

Main Computer

The control system on the main computer uses an SCXI system for input of approximately seventy channels of temperature and pressure data. Figure 1 is a sample screen of data. The sensors are calibrated using IsoCal true-through calibration utility. Each sensor can be calibrated using a ninth order polynomial.

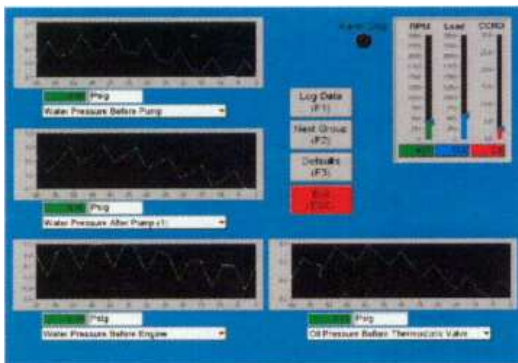


Figure 1: Data Screen

The data from the SCXI system is acquired, averaged, and stored in a five-minute FIFO buffer. At user defined intervals, a data set is logged to disk. There are also several screens that allow the user to view data from the buffer using history charts, digital displays, or dials.

The setup routine allows the user to define a profile which either ramps or steps the engine to a new speed and load over a specified time interval. The user can also define alarms for each channel. Figure 2 illustrates the screen the operator uses to define the alarm limits. If the channel exceeds the first set of limits, only a warning is issued. If the second set of limits is exceeded, the system will shut down the engine automatically.



Channel	Description	Units	Low	High	Low	High
28	Water Flowrate LP	Gal/min	10	10	10	10
29	Water Flowrate HP	Gal/min	10	10	10	10
30	Air Flow	in ³ /ft ³	10	10	10	10
31	Air Temperature in Test Cell	Deg C	75	60	0	10
32	Air Humidity in Test Cell	%RH	100	80	25	0
33	Air Temperature in Control Room	Volt	10	10	10	10
34	Air Humidity in Control Room	Volt	10	10	10	10
35	Engine Torque	ft-lb	10	10	10	10
36	Engine Speed	RPM	2000	1850	500	0
37	LP Turbo Speed	Volt	10	10	10	10
38	HP Turbo Speed	Volt	10	10	10	10
39	Atmospheric Pressure	KPa	300	110	100	0

Figure 2: Setting alarm limits

A second data acquisition card is used to obtain high-speed data. An encoder is used to provide the sampling clock to acquire high-resolution data for two full revolutions of the crankshaft. The data acquired is used to calculate the efficiency of the engine. The results are plotted several times per second.

PID Computer

On the second computer, a high-speed data acquisition card is used to control the phase of the camshaft. The phase is measured by inputting two pulsating signals, which correspond to the positions and speeds of the inner and outer rings. The current phase delay between the signals is calculated. The current phase delay is compared to the current set point and adjusted using PID algorithms from National Instruments' PID control toolkit.

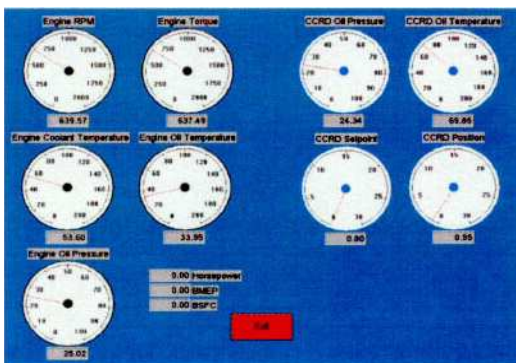


Figure 3: Screen showing critical engine parameters

The screen on the PID control computer is also used as a permanent display of critical engine parameters (Figure 3). TCP/IP communication between the computers is used to continuously update the values displayed on the screen. This way, the user can change between displays on the main control computer and select any channels of interest to monitor. Meanwhile, all of the critical values are displayed on the secondary computer.

Conclusion

A cost effective system for testing engine performance was created using National Instruments' hardware and software platforms. The system allows the operator to effectively evaluate the changes in engine performance as the camshaft, and therefore timing and compression, are dynamically changed.