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VXI Technology™

MTS2000
Automotive Test Subsystem



- Electronic Engine Control Modules
- Intermittent Wiper Modules
- Suspension Testing
- Powertrain Control Modules
- ABS Controller
- Airbag Testing
- Automotive Relay Testing

Overview

Use of electronics in the automotive industry has been rapidly increasing. This creates more challenges for the automotive test engineer, since complete functional testing of these devices must be performed. Because the automotive industry is highly competitive, cost of testing is of utmost interest. In order to lower the cost of test plans, development, hardware and floor space must be minimized. The mass production needs of the automotive industry demand simple and cost-effective test stations. Modular instruments and switching systems manufactured by VXI Technology, Inc. focus on optimizing size, density and price, and are increasingly being utilized in the automotive industry to test automotive electronics. Applications include Electronic Engine Control Units (EECs), Intermittent Wiper Modules, suspension testing, powertrain control modules, ABS controllers, sensing and diagnostic modules for airbags, and automotive relay testing.

High Performance - Testing of the EEC

Objective

To provide a cost-effective test solution with simulated inputs and outputs to be used in production test of the EEC, as well as calibrate and adjust it for different engines and automobiles. Additionally, it is desirable to take the same solution with minor modifications and use it in road test to monitor the EEC and other devices.

Unit Under Test

The EEC is directly responsible for the most important parameters in the automobile: speed, power, fuel and efficiency. Typically, the EEC device has a microcontroller unit and memory, as well as built-in input/output controllers to take inputs from various sensors and switches and output to various coils and valves. This particular EEC consists of 8 digital/pulse inputs, 12 analog inputs, 12 digital/relay outputs and 8 analog outputs driving inductive loads. Among the responsibilities of the EEC are:

- **Basic functions of ignition**
- **Canister purge control**
- **Air compressor control**
- **Automatic idle speed**
- **Transmission control interface**
- **Monitor various voltage and battery conditions**

Various inputs to the device, such as engine temperature, speed, and battery supply need to be simulated, while the timing and angles are to be measured by the test system. For example, a major activity of the EEC is the ignition control. Ignition control inputs to the EEC are engine load (proportional to air quantity), speed, engine temperature and throttle position. The output drives two successive ignitions at a computed time interval. The ignition is always driven with reference to piston position, which is given by the crankshaft position sensor.

A test plan was developed to simulate different input conditions for the EEC and measure the variation in ignition timing with reference to the crankshaft position. It was determined that the variation in timing intervals needed to be precisely measured with a time stamp card. By varying the

output coil conditions using a programmable active load, the test could be carried out for different engine and vehicle conditions. Test plans for other functions of the EEC were developed in a similar manner.

Hardware Solution

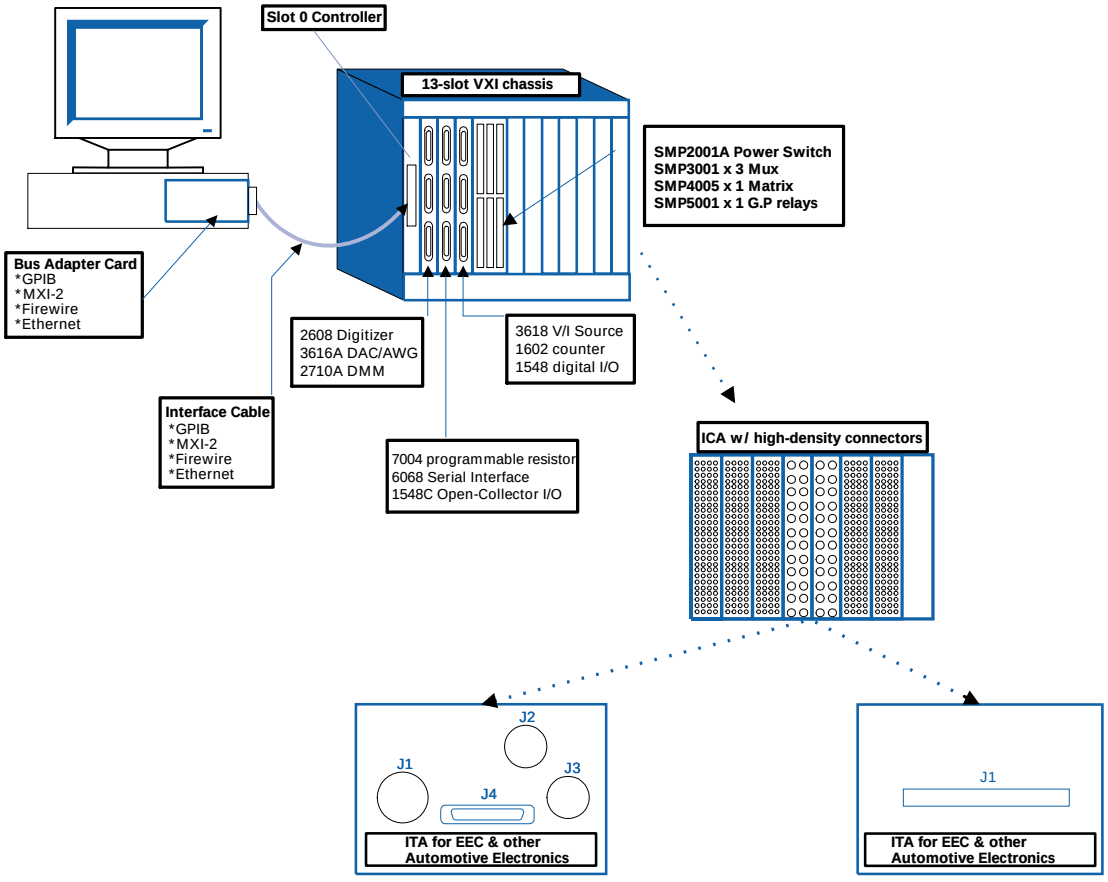
VXI Technology's VMIP™ family of products was chosen for the bulk of test instrumentation because it allowed the system to be contained within one small, portable 5-slot VXI chassis. By replacing the modular AC power supply with a DC version and using an embedded slot 0 PC, the EEC was also monitored under actual vehicle condition in road test. Figure 1 provides a basic system diagram of the test station.

- **VM3618 –** 8-channel D/A converter providing current and voltage source
- **VM1548 –** 48-channel digital I/O for digital control
- **VM3616A -** 100kHz, 16-channel AWG simulates engine speed, crankshaft angle and reference markers
- **VM7004 –** 4-channel programmable resistor load
- **VM1602 –** 32-channel time stamp/time interval analyzer measures response timing, 1ms resolution
- **VM2608 –** 8-channel digitizer records time/angle at which ignition occurs in relation to crankshaft position
- **VM1548C –** 48-channel open-collector digital I/O
- **VM2710 –** 6.5 digit multimeter, current, voltage and four-wire ohm measurements
- **VM6068 –** 4-channel high-speed serial interface
- **Signal Switching –** Example shows 182 channels of 2A muxing, 12 x 12 2A matrix, 80 2A SPSTs and 20 channels of power switching

Suspension Testing Through Road Simulation

Introduction

Automotive suspensions are subjected to extreme conditions as they travel the roads. Potholes and other unwanted disturbances can do extensive damage. Manufacturers must perform rigorous testing to ensure that their designs can withstand whatever the road may have to offer. Actual road tests are impractical because test results are often inaccurate, and costly to obtain. Stationary test systems that utilize servo-hydraulic-based road simulators are routinely used in suspension tests. A car is attached to a test frame at each of its four wheels. The four mounting points are driven by three actuators (x,y,z axes).



Objective

The objective is to develop a VXI-based test system to drive the road simulator. A common way to create the road simulation waveforms is to drive instrumented test vehicles over various road conditions and record the wheel movements. These waveforms are then played back through the test system, and the vehicle can be tested without driving the car. In the past, the control loops were entirely analog. The error signal of the control loop was sent to the valve driver which, in turn, controlled the actuator motion. Systems are now using digital control in all areas except the valve driver which remains analog. A drive waveform resides in memory as digital data. DSP algorithms create a digital error signal, which is output through a DAC to the corresponding valve driver. A tightly integrated test architecture is desirable, making the VXIbus platform a viable candidate.

Hardware Solution

One of the modules in VXI Technology's VMIP™ platform is the VM3616A, a high density D/A converter. The card has 16 independent DAC channels and occupies one-third of a VXI slot. The VM3616A can operate in a FIFO or arbitrary waveform mode, making it the ideal selection for outputting the digital data fed to it by the DSP. Since there are four mounting points and three axes per point, one VM3616A can provide all of the analog output requirements. The VM3616A and a high-speed DSP module can easily fit into a five-slot VXI chassis with room for expansion for instruments such as a DMM and signal switching for monitoring various voltage points.

Testing Wiper Modules

Introduction

Automotive electronic modules have specific functions. One of these functions is the operation of the wiper blade as it goes across the windshield. As the driver operates the wiper control, a load is applied to the wiper control module. Different settings of the control will apply different loads to the unit. These loads affect the RC time constant of the wiper module causing the wiper delay to vary (in intermittent load).

Objective

The automotive industry produces components in high volumes. Testing of these components must be performed in as little time as possible to reduce overall cycle time. Test floor space is also limited, so the overall size of the system must be kept to a minimum. Because of the volume, cost of the systems is of utmost importance.

Hardware Solution

A simplified block diagram of a test system for the wiper module is shown in figure 2.

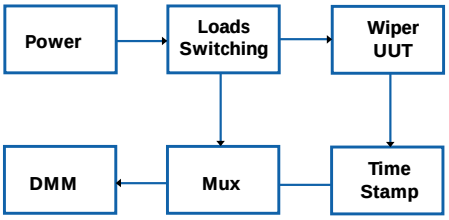


Figure 2

Time Stamping - VM1602

32 event monitor with time stamp recording
1 ms resolution for precision time stamping
Message-based control or register access
Triggering from any of three inputs, adjacent channels, front panel inputs or TTL triggers

Digital Multimeter - VM2710A

DCV, ACV, ACI, 2- and 4-wire ohms
2000 readings/sec over the backplane
Up to 256k readings of on-board memory
Message and register data access, fastest DMM on the market

Switching - SMP2001A, SMP3001, SMP4001

Modular platform for greatest flexibility
Highest density for VXI switching on the market
16A power switch modules (SPST), up to 120 in two slots
64 x 1 multiplexer card, up to 384 x 1 in two slots
4 x 32 matrix module, up to 4 x 192 in two slots (or any combination of 4 x 8)

Summary

Modular instruments and switching systems manufactured by VTI, are helping automotive test engineers reduce test system size and cost. The instrumentation necessary to test an EEC can now be contained in a six-slot VXIbus chassis (with one spare slot for expansion). The size of an equivalent GPIB system would make it difficult, if not impossible, to perform road tests. Furthermore, the VXIbus architecture greatly enhances test efficiency and times.

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