Industry: Aerospace/Defense

Products Used: LabVIEW™ 6.1 Professional Development System • GPIB • MXI™-3 • NI-DAQ™ • NI PXI

High-Speed Data Acquisition Vibration Test System for Re-Entry Vehicles Using LabVIEW and PXI

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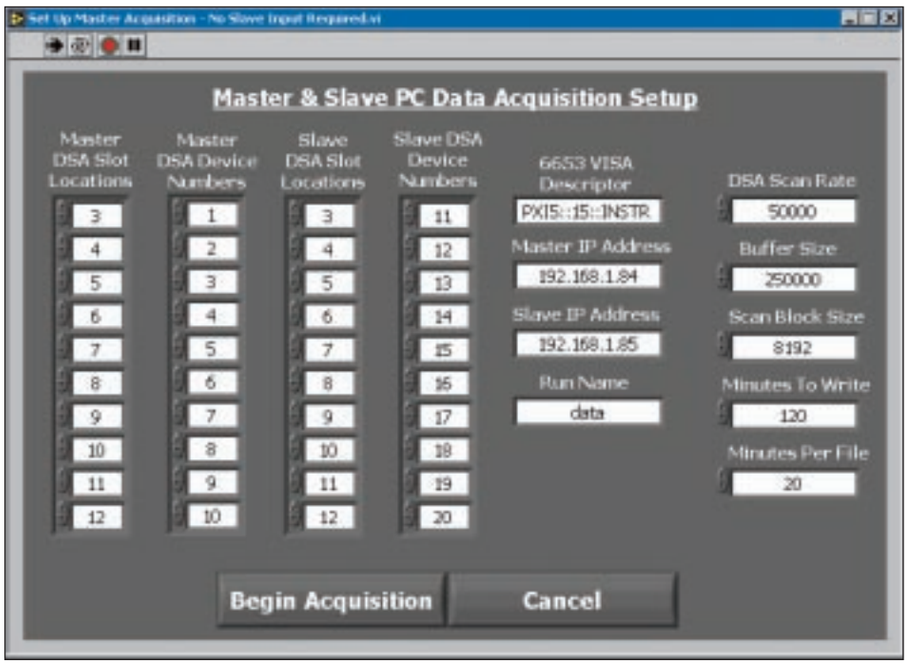
The Challenge: **Developing a system for Sandia National Laboratories (SNL) that can acquire and store up to 160 channels of vibration test data at speeds of up to 102.4 kHz for up to 120 minutes.**

The Solution: **Using National Instruments LabVIEW and hardware to create a measurement vibration test system capable of triggering, synchronizing, acquiring, displaying, and storing to disk all test data with local area network (LAN) connectivity.**

Introduction

Prior to this system, SNL could not synchronize, acquire, and digitally store the data from systems with high-channel counts and fast scan rates. Because card synchronization requires the use of the PXI star trigger lines, which only extend to slot 14, we built two chassis – each with 12 DSA cards plus a PXI-6653 timing module and a PXI-MXI-3 interface module. The PXI-6653 provides the scan clock and simultaneously triggers all of the DSA channels. With extensive testing, we found that the test requirements exceeded even the fastest computers bus and bandwidth limitations, resulting in the need for two workstations to handle the high-channel count and high scan rate scenarios. With a data throughput of 25 MB/s or 1.5 GB/minute per chassis, this dictated the use of Ultra 160 SCSI storage drives rather than Ultra ATA IDE hard disk drives.



Master and Slave Setup Screen for the Two Workstation, Two PXI Configuration

With the implementation of the easy-to-use, robust Vibration Test System, SNL can now confidently acquire, monitor, and digitally store accurate, synchronized vibration data from up to 160 channels at 102.4 kHz taken from a re-entry vehicle.

In the end, we presented three options to the customer to accommodate the wide variety of channel counts and scan rates, each of which provided LAN connectivity. The first option uses a single workstation connected through MXI-3 to a single chassis, which provides the scanning and storage of up to 80 channels at 102.4 kHz for up to 120 minutes. We found that the standard LabVIEW data acquisition (DAQ) functions were too memory and processor intensive, so we streamlined, customized, and implemented LabVIEW high-speed data logging (HSDL) utilities. With two identical computers and chassis, we gave SNL two complete, independent test systems for channel counts under 80.

The second option we presented to SNL uses one workstation connected to two PXI chassis piggy-backed together via MXI-3, which delivers scanning and storage of 160 channels at scan rates of up to 40 kHz for almost four hours. We also reduced the maximum throughput of this system to 19.2 MB/s as a result of the increased bus activity associated with the additional cards. We connected both chassis by the PXI-6653 devices with one chassis as the master responsible for setting up the triggering and clock synchronization.

Our third option uses both workstations, each connected to a PXI chassis via MXI-3 with both chassis connected by the PXI-6653 devices with one of the systems as the master. The LabVIEW software requires no slave system input because the master system performs all acquisition and trigger setup, and then transfers to the slave using VI server across Ethernet. On test completion, the system prompts the user to transfer any or all of the slave's acquired data to the master computer for further analysis.

Both of the dual PXI chassis configurations require extensive software setup to initialize and configure the triggering and clock

synchronization. The LabVIEW software only requires the input of the PXI-6653 VISA descriptors, master and slave IP addresses, acquisition parameters, and DSA slot locations and device numbers. Each system must issue commands in a specific order, with handshaking between master and slave workstations and devices to properly setup the synchronization.

Software System Functionality

The main panel can run software for all three configurations, a scope mode, and an extract channel. Once the user chooses a configuration, the system prompts them to perform a system setup, which requires specification of the PXI-6653 device's VISA descriptors, the master and slave IP addresses, if applicable, and the acquisition parameters, such as scan rate and test duration.

After pressing 'Begin Acquisition,' VI Server communication begins by rerouting scan clock and trigger signals to first set up the slave and then the master acquisition. The system saves the setup parameters to a text file and then sends them to the slave application, which does not require user interaction to execute slave and master triggers and timing. Once setup completes, the monitor window pops up on both systems (if applicable), so that the user can monitor four channels, which we can change any time in run-time mode. We can also perform and display an FFT of those channels.

During acquisition, data streams to disk using the LabVIEW HSDL utility, which eliminates the inconvenience of importing the data into LabVIEW and transferring it to a file. Because the data never goes into LabVIEW, the user must manipulate the AI Buffer Read to plot or analyze the data run-time. By reading from the end of data instead of the read marker, the programmer can read data from the buffer without interrupting the data flow to disk. With this technique, the user benefits from the high performance of streaming directly to disk and eliminates the risk of sacrificing the ability to monitor the run-time data.

Upon test completion, the program returns to the main panel where it can run another test or extract channels. When extracting a channel, the user selects the test to extract data and retrieves all test parameters from the text file. Then the user can specify the device, channel, start offset, and number of scans to extract.

Conclusion

With the implementation of the easy-to-use, robust Vibration Test System, SNL can now confidently acquire, monitor, and digitally store accurate, synchronized vibration data from up to 160 channels at 102.4 kHz taken from a re-entry vehicle. Furthermore, SNL can now maintain and archive digital test results, which they can retrieve any time for further analysis or review. ■

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