Using the VXI-1394/G for Enhanced IEEE 1394 Control of ATE Systems

Introduction
The IEEE 1394 (Firewire) serial bus provides a fast and easy way of connecting computers to external peripherals by using a thin, very flexible, and inexpensive cable. This technology is increasingly being adopted by the consumer electronics industry especially for digital video applications. National Instruments recently introduced the VXI-1394 and the VXI-1394/G – two VXI Slot 0 controllers that use the IEEE 1394 serial bus as the connection between the PC and the VXI system. The VXI-1394/G controller also has a built-in GPIB port, which enables software-transparent control of GPIB instruments from a remote VXI chassis. In this application note, we discuss both the VXI-1394 and the VXI-1394/G controllers, with special emphasis on the VXI-1394/G and test system architectures where it can be used to great advantage.

VXI Control Options
Selecting your VXI controller is crucial to successful implementation of your project. The major issues to consider when choosing your controller are system size and performance. VXI performance depends heavily on all of the components that comprise a system; the VXI Slot 0 controller, software, and instruments are the core components that affect performance. Each component contributes to the overall time taken to perform a particular operation.

There are basically four types of VXI controller configurations (see Figure 1):
• GPIB-to-VXI translators
• MXI-2 interfaces
• Embedded controllers
• Recently introduced IEEE 1394-to-VXI controllers
Your VXI system configuration choice ultimately depends on the system requirements, the instruments, and, of course, cost. VXI controllers and instruments vary drastically in performance and cost, and these trade-offs must be weighed when designing a VXI system. In general, embedded and MXI-2 controllers will achieve the fastest performance, but at a premium cost. Although GPIB-VXI and VXI-1394 translators represent slower performance VXI controller options, they are much lower cost options.

VXI-1394 is ideal for systems that require fast block data transfers. The VXI-1394/G offers identical block transfer performance with the addition of a high-performance GPIB instrument controller.

**What Is the VXI-1394/G?**

The VXI-1394/G is a VXI Slot 0 controller from National Instruments that equips a desktop PC to interface with a VXI chassis using the high-speed IEEE 1394 serial link. In addition the VXI-1394/G Slot 0 controller has a GPIB port that can be controlled transparently by the PC – as though it were a GPIB interface board plugged into a PCI slot in the PC.
How Does the VXI-1394/G Achieve Both VXI and Transparent GPIB Control?

Figure 2 describes the working of the VXI-1394/G. The VXI-1394/G product uses several National Instruments ASICs to maximize the throughput – the MITE, the MiniMITE, and the Fire-PhiI. Firewire, a protocol originally devised by Apple Computer, has become popular in consumer electronics, specifically in digital video (DV). Because of that, Firewire is optimized for isochronous data transfers. Isochronous transfers guarantee bandwidth, but they do not guarantee data integrity. The transmitting device sends data, but the receiving device does not acknowledge. This protocol has the advantage of deterministic timing for each data packet or frame, which is needed in DV applications. However, this is not a good protocol for data acquisition and instrument control.

The National Instruments VXI-1394/G product uses asynchronous protocol. This protocol guarantees that the data will get there, and it will be correct. The protocol provides for hand shacking between devices, and retries if the receiver does not acknowledge receipt. Data throughput is not as high as isochronous, but data integrity is much higher.

Firewire is a serial bus, which interfaces to the PCI bus in the PC through the PCI-1394 host adapter card. On the VXI-1394/G board, the serial Firewire data is again translated to the PCI parallel bus, which is needed to interface to VXI and GPIB. Because of this need for parallel-to-serial-to-parallel conversion, National Instruments developed a protocol to run on top of the basic Firewire asynchronous protocol. Using this software layer, the user can program the VXI-1394/G in the same way one would program a VXI controller and a GPIB interface independently. That is, with the VXI-1394/G you transparently program the VXI portion and the GPIB portion of your test application as though you had the VXI-1394 or VXI-MXI interface and a separate PCI-GPIB interface board. However, because of the need to convert the parallel data to serial, and back to parallel, and because of the specific 1394 asynchronous protocol, the VXI-1394 implementation of Firewire has high first-byte latency. What this means for the system is that large block transfers will have a much better throughput than small transfers, because the setup overhead is small in proportion to the entire operation. To compensate for this performance issue, National Instruments uses the full power of the MITE ASIC to improve the performance across the VXI backplane. The VXI-1394/G uses the DMA engine in the MITE to speed up its transfers from VXI to its PCI bus, and the Fire-PhiI ASIC has buffers and a DMA engine for faster communication to the host computer.
In addition, there is the MiniMITE, which interfaces to GPIB with the power of the MITE. Because of the addition of the MiniMITE, GPIB and VXI are controlled by separate ASICs. This architecture is the reason the software can perform concurrent accesses to the VXI and GPIB buses. While each 1394 packet can address only one ASIC – either the MITE or the MiniMITE – these packets can be interspersed. For example, if the MITE was setup for a DMA transfer on the VXI backplane, and it was waiting for the VXI device to be ready for the transfer to begin, the VXI-1394/G could be performing GPIB accesses because the PCI bus would not be busy. Because both the MITE and the MiniMITE can take control of the PCI bus, no complicated arbitrating protocol is needed, and the performance of both is maximized.

Application Examples

In VXI-based test systems controlled by PCs, the PC normally has no more than three or four PCI slots. For example, a VXI-based cellular phone tester will have a VXI-Slot 0 controller and the following VXI modules:

- High-speed multichannel digitizer
- Digital multimeter
- Switches
- Digital I/O modules
- Arbitrary waveform generator

The system typically will also have PCI interface boards for functions such as

- Ethernet
- High-speed serial
- VXI (PCI-MXI or PCI-1394)
- GPIB

Often standard PCs will not have enough slots to house all the PCI boards. In such a case, you could use the VXI-1394/G as the Slot 0 controller, whereupon GPIB control would be available without the need for another slot in the PC. This option reduces costs and increases functionality by increasing the number of PCI slots available. Furthermore, by migrating the GPIB functionality into the VXI chassis and opening up a PCI slot, you could now add an advanced computer-based instrument to modernize your test systems – while preserving existing investments in expensive VXI instrumentation.

Another scenario, where the VXI-1394/G is increasingly popular is when the PC must be separated from the test system. When using the VXI-1394/G, the only interface to the test instruments is the 1394 link, while the VXI and GPIB components are together physically in a different location.

Conclusion

If IEEE-1394-based VXI control is your choice for your VXI/GPIB test system, consider using the VXI-1394/G with its several benefits:

- Integrated VXI and GPIB contro
- Isolation of the system from the PC
- Reduced cost (because a VXI-1394/G costs less than a VXI-1394 and a PCI-GPIB board)
- An additional open PCI slot in your PC