Cover Story: The PXI Bus Hits its Stride

Jon Titus, Senior Technical Editor

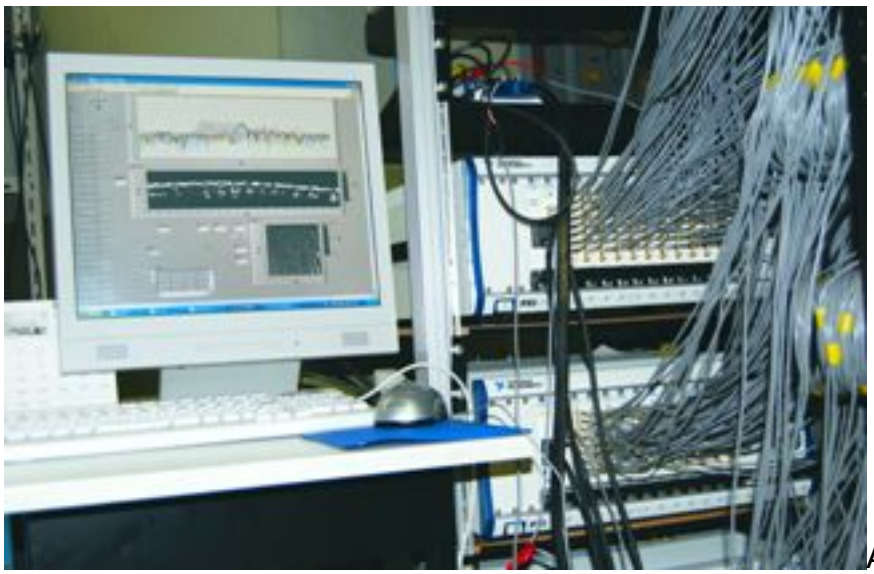
The PXI Bus Hits its Stride

PXI test systems show good things really do come in small packages.

by Jon Titus, Senior Technical Editor

 As you might guess from its name, the PCI eXtensions for Instrumentation bus, or PXI bus, takes advantage of the Peripheral Component Interconnect (PCI) technology developed for personal computers. Just as the original PCI bus lets users add cards to a PC motherboard, the PXI bus lets instrument-system developers connect measurement and control modules through a standard backplane.

The PXI bus adds a few extra signals for triggering and synchronization, but for the most part it relies on standard PCI chipsets in plug-in modules for bus-related operations. The PXI Systems Alliance (www.pxisa.org [1]) oversees the related open hardware and software standards and makes them readily available. In the opinion of Bob Stasonis, sales and marketing manager for Pickering Interfaces, and a member of the board of Directors of the PXISA, the use of standard PCI-bus technology and Windows-based software offers developers a measure of comfort when they design PXI-based test systems.



At present, about 60 vendors of PXI equipment and software offer over 1200 products, so engineers have a wide variety of modules, chassis, cables, software, and accessories from which to assemble test systems. "For the most part, you can choose PXI modules equivalent to rack-and-stack bench instruments," noted Tim Carey, PXI product manager at Aeroflex, a supplier of PXI RF instruments. "The nice thing about PXI is that it provides central power, an embedded computer, and a communication-and-control bus that instruments share. Thus PXI modules share those functions so users can design a lower-cost test system that offers high-speed testing capabilities."

"The increased speed of making tests attracted us to the PXI bus," said Carey. "Communications between box instruments can cause bottlenecks in an instrument system. The PXI bus offers a shared bandwidth of 132 Mbytes/sec., which goes beyond the bandwidths available from IEEE 488, USB, and older VXI products. When you must synchronize instruments you could use a logic signal from one instrument to the others, but the PXI standard provides much greater capabilities to accurately trigger instruments so they can make synchronous measurements."

The PXI approach lets manufacturers concentrate

on the design of signal-creation and -measurement hardware on each module, and move their software to the PXI embedded computer or controller. That software can change a card's functions so it can operate as an oscilloscope, spectrum analyzer, power meter, or data logger, depending on the application and the software driver in use. Many developers use LabVIEW to program a PXI test system, but they can use other languages and tools such as C, Visual C, ATEasy, LabWindows/CVI (an ANSI C IDE), and others. PXI modules come with LabVIEW drivers, dynamic-link libraries (DLs), and other software. Some modules also come with Interchangeable Virtual Instruments, or IVI, drivers.

In addition to looking at programming languages, system designers must consider legacy code, particularly if they plan to move from an existing rack-and-stack, VXI, or other instrument setup. Legacy software can become a problem, according to Mike Dewey, senior marketing manager at Geotest--Marvin Test Systems. "In some cases you might write a 'wrapper' for new functions or drivers so they look like your old ones, but most of the time you have to start over with new software. For some time people have talked about using IVI drivers, but we haven't seen that many companies adopt the IVI standard." Some buyers might like IVI drivers, but it's not usually a requirement.

Software-development tools can extend developers' creativity beyond traditional test-and-measurement tasks. The adoption of multi-core CPUs in PXI controllers and the use of FPGAs in PXI systems offer new capabilities. "We let engineers take advantage of FPGAs so they can design complex

operations that exist in real high-speed logic," explained Matthew Friedman, PXI platform manager at National Instruments. "Now, scientists--who don't want second careers as VHDL or Verilog programmers--can use LabVIEW FPGA, a visual programming language, to create FPGA 'programs' that customize a PXI test system for custom protocols and measurements."

To some, the 3U-size PXI modules may look small, but don't let size fool you. Pickering Interfaces' Bob Stasonis noted that his company can now put eighteen 40-amp MOSFET switches in a two-slot 3U PXI module, something older technologies would not allow. This type of high-current switch appeals to test engineers in automotive and aerospace businesses. "The 3U-size modules still let us

provide a variety of special switch configurations with controlled impedances, for example, used in software-defined-radio testers and equipment for HDTV testing," said Stasonis. "Many instruments such as function generators and DMMs fit nicely into single slot 3U modules."

In some cases, one PXI module can occupy two or three contiguous slots in a PXI card frame. "Basically, the PXI standard was designed for non-RF instruments," noted Carey of Aeroflex. "The pitch and space between modules is not ideal for efficient compact RF design. There is insufficient space to design a RF screened PCB with components mounted on both sides. Our HF to UHF PXI modules generally occupy more than one slot. In one slot space--not connected to the PXI bus--we put all the RF components in a shielded environment. They connect to control circuits on a second board that does connect to the PXI backplane. That board communicates between the backplane and the RF parts of the instrument module."

Developers may not realize the PXI specification includes 6U-size modules. "We started with 6U modules because we have a lot of experience with large systems and we didn't want multiple PXI chassis," explained Dewey of Geotest. "More than one chassis can complicate a test system. Customers ask, 'How do I control two chassis?' and 'If I have a mass-termination interface, how do I interconnect two chassis and their instrument resources?' So a majority of the systems we build, particularly for military and aerospace customers, use the 6U platform. Some of these systems require many I/O connections and we get more than a two-fold increase in board space on 6U modules. We also mix 3U and 6U cards in many test setups. Often, you need a DMM or a MIL STD 1553 channel and you can find one in a 3U PXI module."

If you must connect two or more PXI chassis, you can use the multi-platform extension for instrumentation (MXI) bus from National Instruments. A MXI connection can link a computer to a PXI chassis or it can link multiple PXI chassis.

A Need for Speed

The PXI standard now includes specifications that adopt the PC industry's PCI Express technology and bus components to yield PXI Express modules. The PXI Express specification allows for a "lane" bandwidth of up to 6 Gbytes/sec. So, PXI instruments will not run out of "bandwidth" for some time. And don't worry about PXI boards becoming obsolete. PXI chassis can mix PXI and PXI-Express cards and a backplane can include PXI-only, PXI-Express-only, and PXI-Hybrid slots. A hybrid slot will accept either type of board.

The PXI bus offers a shared bandwidth of 132 Mbytes/sec so an instrument can quickly cut into--and reduce--the bandwidth available to other modules. The PXI-Express bus, though does not share bandwidth and instead uses a point-to-point bus topology. Thus, each module has its own dedicated PXI Express "lane" for high-speed data transfers to and from the embedded PXI controller. If you plan to use PXI Express modules, you will need a PXI-Express-compatible controller, too.

The PXI Express bus will handle transfers to and from high-speed digitizers, arbitrary waveform generators, pattern generators, and other instruments. However, for the majority of applications, the 32-bit, 33 MHz conventional PXI bus offers more than adequate bandwidth and continues to be the principle "Say you plan to use a DMM and several switch modules to handle an array of sensors," noted Stasonis. "The DMM has its own measurement sampling rate and it will take relays on a switch module several milliseconds to open or close, so you don't need PXI Express for those modules."

Friedman of National Instruments stressed that application software developed for a PXI system will work right away with PXI-Express modules. "The software doesn't change just because the bus structure does. There's a separation between the application software and how the bus operates."

For further reading

"PXI Express Specification Tutorial," National Instruments.
http://zone.ni.com/devzone/cda/tut/p/id/2876 [2].

Links:
[1] http://www.pxisa.org/
[2] http://zone.ni.com/devzone/cda/tut/p/id/2876