The testing of wireless networking designs has been getting simpler as companies have begun offering specialized test equipment for the task. Wireless standards are still evolving, however, which makes it challenging for test equipment vendors to keep pace. One recent entry into the market, from National Instruments, uses a PXI-based approach that can evolve to match changes in the standards.

The NI setup handles two wireless standards: IEEE 802.11 (WiFi) and IEEE 802.15.4 (ZigBee). The hardware consists of a PCI chassis, an NI PXI-5660 vector signal analyzer, and an NI PXI-5670/1 vector signal generator. The core of the design is not the hardware, however. It’s the software.

To meet the needs of wireless networking test, NI joined forces with software developer SeaSolve Software. The SeaSolve WiPAN and WiLANTA software includes compliance test packages for both WiFi and ZigBee as well as software packages for implementing the protocols in chip designs. The SeaSolve software, combined with NI's LabView graphical development tool and NI's Modulation Toolkit, gives developers a suite of tools for developing customized wireless measurement systems.

“As product technology evolves, so does test,” said Darcy Dement, product marketing manager for NI's modular test instrument team. “Often the product is software driven to enable upgrades, so the test has to be software driven, too.” Dement also pointed out that the wireless networking products are evolving rapidly and that software-driven testing is the only way to keep up.

Software keeps things flexible

The open nature of LabView-based software is a key component of NI's product offering, said Dement. “The open architecture allows you to get into the parameters so that you can do something out of the norm that standards-based testing won’t.” She noted that traditional instruments use firmware, so if standards change, developers must wait for the instrument maker to offer a new firmware release.

The foundation hardware, being PXI-based, is able to handle the needs of wireless testing, said NI's RF product marketing manager Joseph E. Kovacs. “These products lend themselves to test because of PXI's speed—132 Mbps. It's much faster than the 1 to 3 Mbps available over GPIB.” The PXI and LabView base also means that developers will be able to use any other test software developed by members of the NI Alliance program.

The open and modular nature of the platform was a significant factor in SeaSolve's decision to port its test software to the NI system, according to SeaSolve's business development manager Nadeem Sayed. “We chose to develop this solution on the NI platform because of PXI's inherent speed advantage as well as the short time to market that the platform offers as a whole.”

The modular nature also means that the hardware platform's utility is readily extended with software. For example, developers can compensate for frequency deviations in the device under test by using the Modulation Toolkit software rather than having to adjust the hardware. They also can change the filters used in the simulation of channel fading, choosing Rayleigh and Gaussian filters as well as custom ones.

The software-based platform also leaves the door open to adding other wireless system tests. One such test currently under development at SeaSolve would handle testing for the IEEE 802.16 WiMax standard. Other Alliance members are investigating GSM test using the platform.
**Editor's Note**

What will you do with the bandwidth?

Richard A. Quinnell, Technical Editor

Just before this issue went to press, the PCI Industrial Computer Manufacturer’s Group (PICMG) released the CompactPCI Express (EXP.0) specification. This spec provides a means of adding the high-bandwidth capacity of PCI Express to the CompactPCI (cPCI) form factor while maintaining compatibility with existing cPCI hardware. Depending on the type of board used, this gives equipment developers, including PXI users, access to data pipes running as fast as 6 Gbytes/s in each direction.

The spec defines several types of boards and backplane slots, including a Hybrid Slot that supports CompactPCI, PXI, and Compact PCI Express peripheral boards. The board definitions include System Boards, Type 1 Peripheral Boards, Type 2 Peripheral Boards, and Switch Boards. Type 1 Peripheral Boards share the same pin definitions as System Boards, so a CPU board could be designed to work in both slot types. Type 2 Peripheral Boards can be used in Type 1, Type 2, and Hybrid Slots.

The specification defines the System slot and board to have up to 24 lanes and up to four links of PCI Express for up to 6 Gbytes/s of system bandwidth per direction. Type 1 peripheral slots and boards can have up to 16 lanes of PCI Express for up to 4 Gbytes/s bandwidth per direction and Type 2 peripheral slots can have up to 8 lanes of PCI Express for up to 2 Gbytes/s bandwidth per direction.

So the question is: With bandwidth no longer a limiting factor, what are the possibilities?

Contact Richard A. Quinnell at richquinnell@att.net.

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**NEWS**

**PXI Express debuts**

In mid-August, the PXI Systems Alliance (PXISA) released the PXI Express specification, which integrates PCI Express and CompactPCI technology into the PXI standard. With PXI Express, engineers and scientists can achieve bandwidth of up to 6 Gbytes/s per system (a reported 45 times improvement over traditional PXI systems) while preserving both software and hardware compatibility with existing PXI products.

PXI Express makes use of the electrical features defined by the PCI Express specification, and PXI Express modules are compatible with the new CompactPCI Express (EXP.0) specification from the PCI Industrial Computer Manufacturers Group (PICMG) (see “Editor’s note” at left). Thus, a single measurement system will be able to support both PXI Express and CompactPCI Express modules.

“PXI has always incorporated CompactPCI, and the PXI Systems Alliance has been working within the PICMG technical committees since early 2004 to ensure compatibility with PXI,” said Loofie Gutterman, president of the PXI Systems Alliance. “PXI Express products will provide engineers with the bandwidth and performance required by tomorrow’s applications while maintaining compatibility and interoperability with today’s PXI products and applications.”

“Both CompactPCI Express and PXI Express use a new Advanced Differential Fabric connector,” said Mark Wetzel, technical chair of the PXI Systems Alliance. “Using this new ADF connector, we can bring PCI Express to PXI, incorporate advanced synchronization signals, and create hybrid slots that accept both PXI and PXI Express signaling.”

The PXI Systems Alliance anticipates its members will pass the PXI Express specification in the fourth quarter of this year, with vendors beginning to supply products in 2006. www.pxisa.org.

**Boundary-scan controllers unveiled at NIWeek**

During NIWeek 2005 (August 16–18, Austin, TX), Göpel electronic introduced a new family of PXI-based boundary-scan controllers for its Scanflex boundary-scan hardware. Like the company’s PCI- and USB 2.0-based controllers introduced earlier this year, the PXI modules are available in three performance classes that differ in the upper TCK frequency limit (maximum of 20, 50, or 80 MHz, respectively) as well as the level of implementation of the enhanced SPACE II chip set for high-performance scan operations.

The new SFX/PXI1149-(x) controllers support all trigger features provided by the PXI specification. www.goepel.com.

**Geotest awarded contract for PXI missile field test sets**

Raytheon Missile Systems will be purchasing four MTS-206 Maverick Missile field test sets from Geotest. Raytheon has been awarded a contract from the UK Ministry of Defense for the test sets. The MTS-206 performs parametric functional tests on Raytheon’s AGM-65 and other Maverick missile system components and will be used by the Royal Air Force to maintain the Maverick missile system.

The MTS-206 uses a modular chassis secured via five shock absorbers to enable the unit to meet stringent shock, vibration, and other environmental requirements. www.geotestinc.com.
A Visionary Alliance

High-speed digitizers with GHz performance, now available in single-slot 3U PXI format.

Acqiris, the reference for high-speed data conversion, introduces single-slot high-speed PXI digitizers with unprecedented performance, size and power consumption. Using large-scale IC technology, the DC140 and DC135 deliver synchronous dual-channel or interleaved single-channel acquisition at up to 2 GS/s, with up to 16 Mpoints of on-board memory, in a unit that consumes less than 16 W.

With its cutting-edge PXI technology, Acqiris is changing the face of data conversion in measurement and automation.

See Us at AUTOTESTCON, Booth # 715

For more information on PXI, PCI and CompactPCI modules, call us at 1 877 227 4747 or visit our website at www.acqiris.com
You need 'em. We got 'em.

And even if we don't have exactly what you need, we probably have something pretty close. Our engineering staff does a little redesign, creates a few extra lines of code for the driver and you have it – problem solved. That's what ASCOR has been doing for the last fifteen years. Our switches are in systems that test Hot Tub Controllers and Satellites...Pacemakers and Rockets...the B1B and the 747. We have the widest range of VXI and PXI Switches and Instrumentation. We build GPIB controlled Microwave and Optical Switch Modules. We even build Turnkey Systems. We are the engineering company who actually listens to what you want and then provides you with the solution in an economical and timely manner. Want to know more about ASCOR?

Please call Bill Nicklin at 510-490-2300 x216 or send an e-mail at bnicklin@ascor.com or check out our web site at www.ascor.com.

Because Your System Deserves It
A rising application for PXI systems is the creation of virtual instruments, a collection of hardware elements that can be linked in software to perform the function of many different desktop instruments. A core element of such virtual instruments is the high-speed digitizer. Recently, the PXI Systems Alliance (PXISA) released a Web seminar that can help test engineers choose a digitizer for virtual instrumentation.

The seminar, “PXI Instrumentation and Replacement of Conventional Instruments,” originally broadcast on June 28, 2005, and now archived on the PXISA Web site, has two parts. The first is a brief introduction to virtual instrumentation using PXI. The second provides a more in-depth discussion on choosing a digitizer; it is presented by Richard Soden, product manager at instrument maker Acqiris.

The basic idea behind virtual instrumentation is simple. Most bench instruments have many hardware elements in common, such as displays, control panels, power supplies, and signal-processing stages. A virtual instrument would have one of each hardware element (Figure 1) and would route data through the hardware set under software control to duplicate the function of a bench instrument. Different combinations of hardware elements and data paths would allow the single hardware set to function as any of an entire suite of test instruments.

**Banner specs: Good start but not enough**

A key hardware component for making measurements is a high-speed digitizer. Soden cautions test engineers to look beyond what he calls “banner specs” when choosing a digitizer to ensure that the component will perform as expected. Banner specs are performance specifications that serve as a quick guide to choosing a product, but if you limit your evaluation to only those specs, you will get a false sense of the product’s capabilities.

Three banner specs that Soden identifies for high-speed digitizers are resolution, sampling rate, and bandwidth. These specifications are useful as a pre-filter when selecting a digitizer, and if a product’s banner specs do not meet or exceed application requirements, then no further evaluation is needed. If the banner specs do meet requirements, though, you will need to perform further investigation before making a final choice.

The resolution banner spec, for instance, is an indication of a digitizer’s accuracy. Soden notes, however, that the presence of noise and distortion in the conversion process can erode accuracy, so he suggests that you examine the effective number of bits (ENOB) that the digitizer provides. You can calculate the ENOB with the equation below (Ref. 1); the signal-to-noise-plus-distortion (SINAD) ratio is generally a function of frequency and signal strength presented as a graph:

\[
\text{ENOB} = \frac{\text{SINAD} - 1.76}{6.02}
\]

Another banner spec is the digitizer’s sample rate, which is an indication of its timing accuracy. But knowing the sample rate alone is not enough. To fully understand a digitizer’s timing accuracy, especially if it uses a built-in clock, you also must study its clock accuracy and clock jitter.

The clock accuracy, or frequency drift, will limit the accuracy of frequency measurements the digitizer can provide. Clock jitter will disperse the incoming signal’s energy randomly throughout the spectrum, where it will be manifested as noise, reducing the ENOB.

Another important sampling parameter is the time to conversion. If a
Choosing a PXI digitizer  from page P5

sample is assumed to be instantaneously captured, then there will be a phase error in the reconstructed waveform. By knowing the time to conversion, you can correct the phase information.

Bandwidth is the third banner spec that Soden notes is often misinterpreted. When the spec is provided as simply the 3-dB point, you might assume that the gain curve is flat and then falls off linearly. As shown in Figure 2, though, the gain curve of a digitizer may not be flat, but it can have the same 3-dB point, and hence the same bandwidth banner spec, as another digitizer with higher gain fidelity.

Looking beyond banner specs

The key to making an accurate evaluation of a digitizer, therefore, is to look deeper than the banner specs. As a starting point, Soden recommends that you evaluate several secondary specifications. These secondary specs are direct measures of signal integrity and measurement fidelity, both of which will affect the accuracy of the digitizer’s final output.

Along with ENOB, clock accuracy, and clock jitter, the secondary specifications include:

- **Time-to-digital conversion (TDC).** Knowing when the sampling trigger occurs relative to the sample clock helps reduce phase-measurement errors.
- **Gain flatness.** Examining the digitizer’s Bode plot gives you a much better measurement of the digitizer’s useful bandwidth than the bandwidth banner spec.
- **Signal-to-noise ratio (SNR).** To be useful, the SNR should always be quoted with the input frequency range for which it is valid, the digitizer’s full-scale voltage range, and the input signal voltage.
- **Spurious free dynamic range (SFDR).** SFDR is a measure of the strength of the first spurious signal that the digitizer generates, relative to the input signal. As with SNR, this specification should include the input frequency and full-scale voltage ranges along with the input signal voltage.
- **Total harmonic distortion (THD).** THD tells you the relative strength of the signal and the first several harmonics that the digitizer generates. Unlike many analog systems, however, the higher order harmonics in digitizers may be stronger than lower order ones. Look to see how many harmonics are included in the calculation when making comparisons.
- **Differential nonlinearity (DNL).** The DNL indicates the input signal

Enlist PXI for Field Test

Geotest’s MTS-207 is a state-of-the-art portable PXI platform for field and flight-line test and data acquisition applications. Its architecture is based on the MTS-206 Maverick Field Test -- the first PXI-based system to be qualified and certified by the United States Air Force for munitions testing. The MTS-207 combines the power of PXI in a compact, rugged, flight-line qualified enclosure. The MTS-207 can operate in virtually any environmental condition from rough terrain to extreme temperatures and meets the requirements for MIL-STD-810 and MIL-STD-461.

FEATURES INCLUDE:

- Ultra-rugged portable PXI platform for field and flight-line applications
- Meets MIL-STD-810E requirement for harsh environmental conditions
- Built-in, shock-mounted 14-slot PXI chassis (seven 3U and seven 6U slots)
- A wide range of PXI modules available to tackle any test or data acquisition application
- Optional touch-screen display (can be operated up to 25 ft from MTS-207)
difference that results in the output moving between two adjacent bit codes.

- **Integral nonlinearity (INL).** INL is a measure of the difference between the input signal that produces an output code and the idealized interpretation of that code. Both INL and DNL represent deviations from the assumed ideal mapping between the digital output value and the input signal. Errors here can affect measurements of signal gain and offset. Matching the INL and DNL of digitizers is particularly important when using multiple digitizers with interleaved outputs to sample high-frequency signals.

A more in-depth discussion of these secondary specifications and of high-speed digitizers in general can be found at the PXISA Web site (www.pxisa.org). A recorded version of the Webcast is available to registered users (registration is free) along with Webcasts on other topics.

Reference
PXI control

Using National Instrument's MXI-Express kits, engineers can now control PXI and CompactPCI systems over the PCI Express bus. Based on PCI Express, MXI-Express delivers bandwidth of up to 110 Mbytes/s to PXI systems, making it appropriate for mixed-signal test for the manufacturing, communications, consumer electronics, and military/aerospace industries.

MXI-Express is available in two configurations. The NI PXI-PCIe8361 kit includes a PCI Express board with one x1 cabled PCI Express link. The NI PXI-PCIe8362 kit provides two x1 PCI Express links from the host PC, each of which can cable to individual PXI chassis, letting engineers control two PXI systems from one PCI Express slot in the PC. National Instruments, www.ni.com.

RF signal generator

Building on the success of the company's PXI 3000 series RF test systems, Aeroflex has unveiled the 3020A 2.7-GHz digital RF signal generator, the 3030A 3-GHz RF digitizer with 33 MHz bandwidth, and a cdma2000 reverse link software measurement library. Together with the Aeroflex 3010 RF synthesizer, the 3020A (pictured) forms a compact 3U-high precision digital RF signal generator (complete with integrated dual-channel arbitrary waveform generation) that occupies just three PXI slots. Similarly, the 3010 RF synthesizer and 3030A digitizer combine to make a compact 3U-high precision RF digitizer that also occupies just three PXI slots. The measurement software for the Aeroflex 3000 series, the cdma2000 measurement suite, is an ActiveX control software measurement library that provides measurement functions for power, spectrum, and modulation analysis of cdmaOne and cdma2000 reverse link transmissions. Aeroflex, www.aeroflexstore.com.

Portable instrument chassis

ADLINK Technology has unveiled the PXIS-2680P, a portable 3U PXI instrument chassis. The PXIS-2680P provides an eight-slot capacity for PXI/CompactPCI modules. The unit includes a keyboard, touch-pad, and touch-sensitive LCD monitor. A built-in DVD combo drive is suitable for high-speed recording or backup of data. A 300-W + 300-W mini-redundant power module is included with the chassis and reduces mean time to repair. The temperature and power-supply status are monitored by an alarm module integral to the chassis. When a failure is detected, an LED and buzzer will be actuated. ADLINK Technology, www.adlinktech.com.

Modular oscilloscopes

Z-Tec has expanded its ZT450 modular instrument family with six 8-bit digital storage oscilloscopes in PXI, VXI, and PCI formats. The expanded family offers sample rates up to 2.5 Gsamples/s and bandwidth options up to 1 GHz for high-end ATE applications. The ZT450 product family provides capabilities such as deep onboard sample memory (up to 32 Msamples for PCI/PXI and 64 Msamples for VXI). Multiple DSOs as well as other bus board products can be synchronized using the local timing and trigger bus. The ZScope soft front-panel software provides complete interactive instrument control. The instruments also come with plug-and-play instrument drivers for LabView, LabWindows/CVI, Visual Basic, and C/C++.