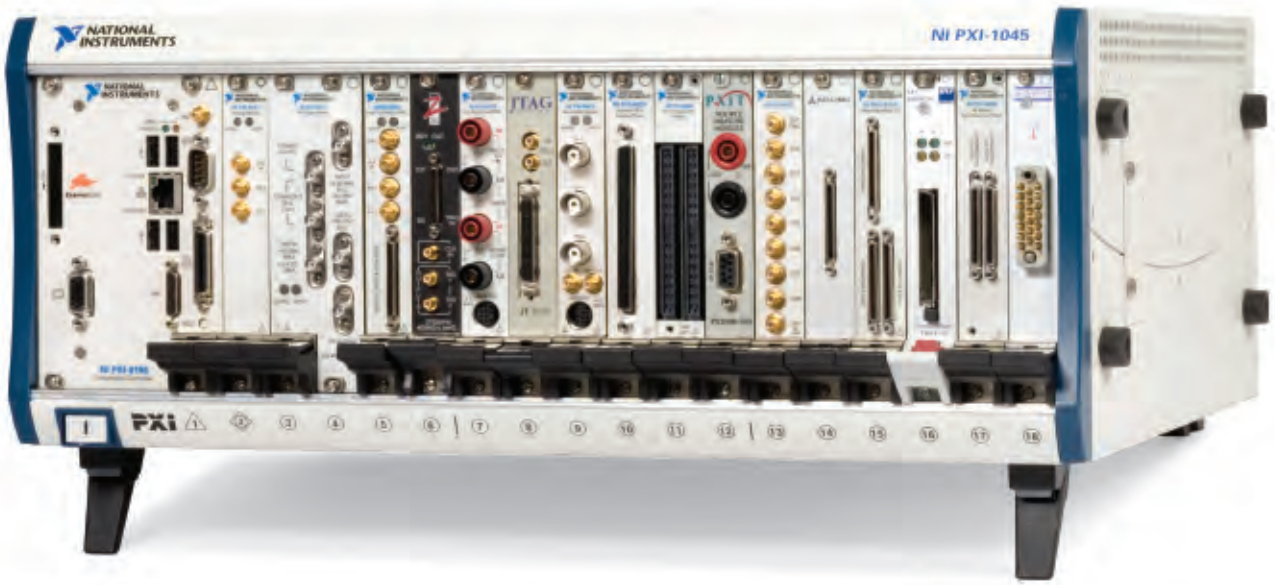
PXI

Rugged PC-Based Platform for Measurement and Automation

- Modular Instrumentation
- Automated Test Systems
- Data Acquisition Systems
- Real-Time Control Systems
- Vision and Motion Systems



ni.com/pxi

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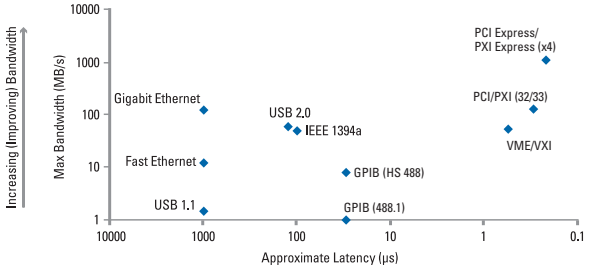
Benefits of PXI

Higher Throughput

Every application is unique and has very specific needs. However, bandwidth and latency are two important attributes of a platform for many applications. Latency tends to dominate single-point operations, such as digital multimeter/switch scanning, and bandwidth tends to dominate data streaming applications, such as waveform stimulus/response. PXI provides high speed for a wide range of applications with both high bandwidth and low latency via the PCI/PCI Express bus.



Bandwidth versus Latency

Timing and Synchronization

Many measurement and automation applications require advanced timing and synchronization capabilities that you cannot implement directly across PC standard I/O buses like PCI/PCI Express, Ethernet/LAN, USB, and so on. PXI offers advanced timing and synchronization features to meet your application needs:

- 100 MHz differential system reference clock
- 10 MHz reference clock signal
- Differential star trigger
- Star trigger bus with matched-length trigger traces to minimize intermodule delay and skew
- Trigger bus to send and receive high-speed timing and triggering signals
- Differential signals for multichassis synchronization

System Reliability

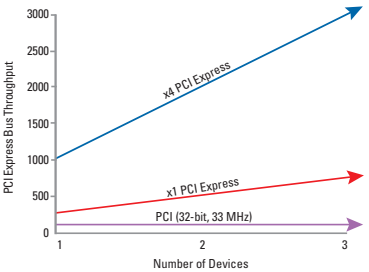
The PXI specification defines requirements that make PXI systems well-suited for harsh environments. PXI features the high-performance IEC (International Electrotechnical Commission) connectors and rugged Eurocard packaging system used by CompactPCI. The PXI specification also defines specific cooling and environmental requirements to ensure operation in industrial environments. Modularity makes it easy to configure, reconfigure, and repair your PXI systems, resulting in very low mean time to repair (MTTR). Because PXI is modular, you can update individual modules and components without replacing the entire system.

PXI Integrates PCI Express

PCI Express, the latest PC bus technology, delivers increased bandwidth and ease of use to enhance the widely adopted PCI bus. The PXI Systems Alliance (PXISA) updated the PXI specifications in August 2005 to incorporate PCI Express in PXI. National Instruments released the first PXI Express products in early 2006. PXI Express enhances existing PXI products and systems by providing increased dedicated per-slot bandwidth, industry-best device synchronization, and software and hardware compatibility with existing systems.

Increased Per-Slot Dedicated Bandwidth

Bandwidth is one of the most notable advancements with PCI Express. Unlike PCI, which divides bandwidth among all devices on the bus, PCI Express provides each device with its own dedicated bandwidth. Multiple x1 (read "by one") lanes can be grouped together into x4, x8, x16, and x32 configurations to increase bandwidth to every slot. The same technology applies to PXI Express to deliver up to 2 GB/s per-slot dedicated bandwidth, which significantly increases the overall system bandwidth.



Industry-Best Synchronization

In addition to increased throughput, the faster PCI Express I/O interconnect technology also enables industry-best device synchronization in PXI. PXI Express adds a 100 MHz differential system reference clock, differential star triggers, and differential signals for multichassis synchronization. The differential signaling helps you achieve very high data rates, reduced electromagnetic interference (EMI), and decreased jitter (<200 ps skew). These PXI Express synchronization features are provided in addition to the 10 MHz reference clock signal, trigger bus, and star trigger available in PXI today.

Software and Hardware Compatibility

PXI Express is software- and hardware-compatible with PXI modules and application software through specifications defined by PXISA and the PCI Special Interest Group (PCI-SIG). This ensures that your investment in any of the more than 1,000 PXI modules available today is preserved when you begin incorporating PXI Express into your future PXI-based measurement and automation systems.

PCI Express integration with PXI demonstrates the benefits of using standard PC technologies in your measurement and automation systems by delivering 45 times greater bandwidth performance and industry-best device synchronization while preserving your existing investment through software and hardware compatibility. With the PXI Express enhancements to PXI, you can meet practically all of your system needs, including high-channel-count, high-throughput, or multimodule applications featuring IF streaming, mixed-signal test, or high-speed image acquisition.

Overview

PXI (PCI eXtensions for Instrumentation) is a rugged, PC-based platform for measurement and automation systems. PXI integrates the speed and performance of the PCI bus with advanced timing and synchronization features in the rugged, modular, Eurocard packaging of CompactPCI. You can use PXI-based systems to realize all the benefits of computer-based systems and to achieve unparalleled integration in a mechanical package fit for industrial environments. Whether you are building an instrumentation platform, an automated test system, an industrial automation system, or a data acquisition system, PXI can help you reduce overall system cost, increase system performance, and develop your system faster.

PXI – Rugged PC-Based Platform for Measurement and Automation

PXI hardware is based on standard PC technologies, such as the high-speed PCI bus, standard CPUs, and peripherals. Because of this, you can use a standard I/O interface like Ethernet/LAN to control your PXI system over the network. PXI is built on the modular CompactPCI specification (which is based on PCI) so PXI products maintain complete interoperability with CompactPCI products.

The development and operation of a Windows-based PXI system is no different from that of a standard Windows-based PC. You can use common application software and programming interfaces such as National Instruments LabVIEW, NI LabWindows/CVI, C/C++, Visual Basic .NET, NI SignalExpress, and NI TestStand to control your PXI-based system. Additionally, because the PXI backplane uses the industry-standard PCI bus, you do not have to rewrite existing application software when transferring software between PCI- and PXI-based systems.

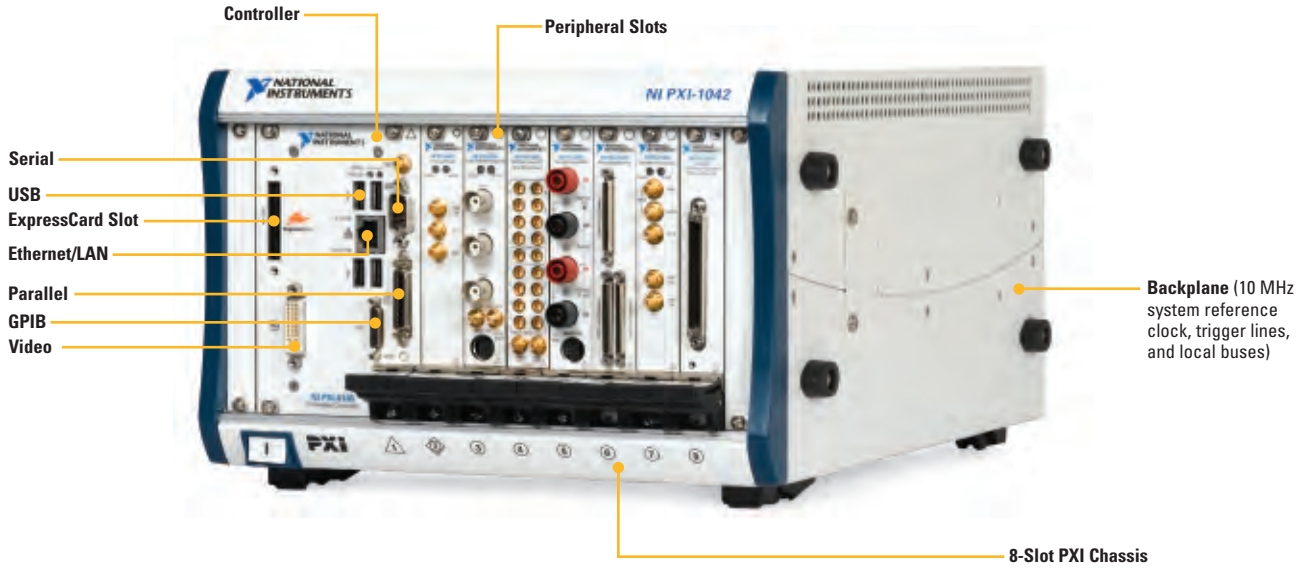
As an alternative to Windows-based systems, you can use a real-time software architecture for time-critical and reliable applications requiring deterministic loop rates and headless operation (no keyboard, mouse, or monitor). Additional information on using the NI LabVIEW Real-Time Module with PXI systems is available at **ni.com/realtime**.

PXI Systems Alliance

The PXI Systems Alliance is a group of more than 68 worldwide product manufacturers and system integrators who share a common commitment to user success with open, multivendor PXI systems. PXI-compliant products are defined by the PXI specification, which was developed by National Instruments and was announced in 1997 as an open industry standard. The overall goal of the PXI Systems Alliance is to increase the success of both users and vendors of PXI-compliant hardware and software for the benefit of the entire measurement and automation community. The charter of the PXI Systems Alliance supports this goal by:

- Promoting PXI as an open standard and encouraging multivendor support
- Ensuring multivendor interoperability of PXI products at the mechanical, electrical, and software levels
- Maintaining complete interoperability with CompactPCI
- Maintaining the PXI specification and making revisions when necessary, while keeping backward compatibility with products built to earlier revisions of the specification

For more information on the PXI Systems Alliance, visit **pxisa.org**.



PXI Controllers

National Instruments offers a wide variety of PXI controllers – from remote PC and laptop control of PXI to rugged embedded controllers and high-performance, rack-mount, server-class controllers.

Remote Control from Your PC

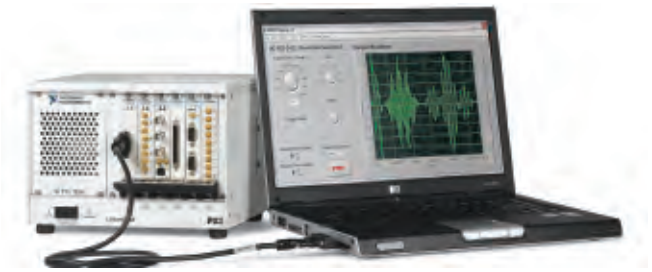
You can control your PXI system directly from a PC with a transparent, high-speed serial link to take advantage of the latest high-performance, low-cost desktop PCs, servers, and workstations. The MXI-Express link consists of a PCI Express board in your computer and a PXI or PXI Express module in slot 1 of your PXI or PXI Express system, respectively, connected by a copper cable. The MXI-4 link consists of a PCI board in your computer and a PXI module in slot 1 of your PXI system, connected by a copper or fiber-optic cable.

Model	NI PXIe-PCIe8361	NI PXIe-PCIe8362	NI PXI-PCIe8361	NI PXI-PCIe8362	PXI-PCI8331	PXI-PCI8336
Communication technology	MXI-Express	MXI-Express	MXI-Express	MXI-Express	MXI-4	MXI-4
Links per PCI Express or PCI board	1	2	1	2	1	1
Sustained throughput	192 MB/s	208 MB/s (1 and 2 chassis)	110 MB/s	160 MB/s (2 chassis) 110 MB/s (1 chassis)	78 MB/s	78 MB/s
Cable material	Copper	Copper	Copper	Copper	Copper	Fiber-optic
Maximum cable length	7 m	7 m	7 m	7 m	10 m	200 m
Electrical isolation	–	–	–	–	–	✓

Table 1. Selection Guide for Remote PC Control of PXI

Remote Control from Your Laptop

You can control your PXI system directly from a laptop computer using either an ExpressCard MXI or PCMCIA CardBus interface. The NI ExpressCard8360 kit consists of an ExpressCard device in your laptop and a PXI or PXI Express module in slot 1 of your PXI or PXI Express system, respectively, connected by a copper cable. The NI PXI-CardBus8310 kit consists of a PCMCIA CardBus device in your laptop and a PXI module in slot 1 of your PXI system, connected by a copper cable.



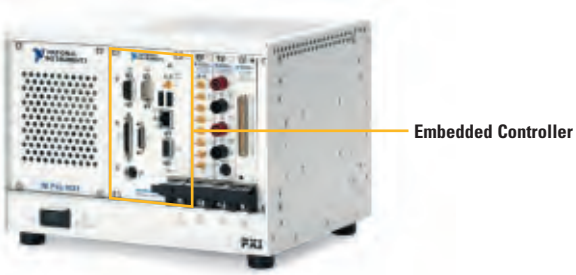
Model	NI PXIe-ExpressCard8360	NI PXI-ExpressCard8360	PXI-CardBus8310
Laptop interface	ExpressCard	ExpressCard	PCMCIA CardBus
Sustained throughput	214 MB/s	110 MB/s	50 MB/s
Cable material	Copper	Copper	Copper
Maximum cable length	7 m	7 m	14 m

Table 2. Selection Guide for Laptop Control of PXI

Embedded and Rack-Mount Control

Embedded and Rack-Mount Controllers – Windows OS

National Instruments PXI embedded and rack-mount controllers provide a high-performance yet compact embedded computer solution for your PXI measurement system. NI PXI and PXI Express embedded controllers come with standard features such as integrated CPU, hard drive, RAM, Ethernet/LAN, video, serial, USB, and other peripherals, as well as Microsoft Windows and all device drivers already installed.



Model	PXI-8350	PXI-8105	NI PXIe-8103	PXI-8196	PXI-8195
Packaging	1U rack-mount	Embedded	Embedded	Embedded	Embedded
Processor	3.0 GHz P4	2.0 GHz Core Duo	2.0 GHz P M760	2.0 GHz P M760	1.5 GHz Cel M370
Dual core	–	✓	–	–	–
System BW, max	132 MB/s	132 MB/s	1 GB/s	132 MB/s	132 MB/s
L2 cache	1024 KB	2048 KB	2048 KB	2048 KB	1024 KB
Front-side bus	800 MHz	667 MHz	533 MHz	533 MHz	400 MHz
RAM, standard	512 MB	512 MB	512 MB	512 MB	256 MB
RAM, maximum	4 GB	2 GB	2 GB	2 GB	2 GB
Hard drive (min)	80 GB	60 GB	40 GB	40 GB	40 GB
Video	VGA	DVI-I	VGA	VGA	VGA
GPIB port	–	✓	✓	✓	–
Ethernet/LAN ports	2 (10/100/1000)	1 (10/100/1000)	1 (10/100/1000)	1 (10/100/1000)	1 (10/100/1000)
USB 2.0 ports	4	4	4	4	4
Serial port (RS232)	✓	✓	✓	✓	✓
Windows OS	XP	2000/XP	XP	2000/XP	2000/XP
LabVIEW Real-Time	–	–	–	✓	✓
Dual-boot option	–	–	–	✓	✓

Table 3. Selection Guide for PXI Embedded and Rack-Mount Controllers

Embedded Controllers – LabVIEW Real-Time

National Instruments PXI real-time controllers deliver real-time, deterministic, and reliable I/O for measurement, automation, and control. Because you configure and program high-performance RT Series PXI controllers over the Ethernet/LAN, you can distribute and remotely monitor a real-time application across the network. You develop your LabVIEW application with the LabVIEW Real-Time Module on Windows and download the program to your embedded controller via Ethernet/LAN, while embedded code executes on a real-time OS. Thus, you can use all of the powerful, flexible development tools of LabVIEW to build reliable, real-time solutions.

Model	PXI-8196 RT	PXI-8195 RT	PXI-8184 RT	PXI-8145 RT
Processor	2.0 GHz P M760	1.5 GHz Cel M370	850 MHz Celeron	233 MHz P-MMX
Benchmark: single PID loop	57 kHz	48 kHz	23 kHz	6 kHz
RAM, standard	512 MB	256 MB	128 MB	64 MB
RAM, maximum	2 GB	2 GB	512 MB	128 MB
Hard drive (min)	40 GB	40 GB	40 GB	–
Storage, solid-state	–[1]	–[1]	–[1]	64 MB[2]
GPIB port	✓	–	–	–
Ethernet/LAN port	1 (10/100/1000)	1 (10/100/1000)	1 (10/100)	1 (10/100)
Serial port (RS232)	✓	✓	✓	✓
Watchdog/trigger SMB	✓	✓	✓	–

[1] Optional 128 MB or 512 MB solid-state drive can replace the hard drive. [2] Up to 512 MB CompactFlash optional.

Table 4. Selection Guide for PXI Real-Time Embedded Controllers

PXI Chassis

National Instruments has a variety of PXI chassis for measurement and automation applications. NI chassis feature high-performance backplanes and the rugged mechanical packaging of CompactPCI.

High-Performance Backplanes

All NI PXI chassis accept both PXI and CompactPCI modules. National Instruments PXI chassis – built on the high-speed PCI bus found in today's PCs – use CompactPCI packaging and advanced timing and synchronization features for demanding measurement and automation applications. In addition, the NI PXI Express chassis accept both PXI Express and CompactPCI Express modules and provide additional timing and synchronization features to these modules.

Cooling and Airflow

NI PXI chassis fans provide filtered forced-air cooling, strong enough to meet the cooling requirements of all PXI modules. NI uses sophisticated computer modeling to ensure that all PXI slots receive uniform airflow. Modeling results are validated through extensive thermal testing using full power load modules and PXI modules fitted with thermocouples. By designing and testing to ensure cooling, NI is able to guarantee uniform airflow and reduce operating temperatures, which in turn increases MTBF (mean time between failure) for both PXI modules and chassis power supplies.

A Chassis for Every Application

All NI PXI chassis include mounting points for attaching optional rack-mount kits. The PXI-1031, PXI-1036, PXI-1042Q, NI PXIe-1062, and PXI-1052 are ideally suited for benchtop or portable applications because of their quiet operation and compact size. For applications that require a DC power source, you can use a PXI-1031DC, PXI-1036DC, PXI-1000B DC, or an external DC-to-AC inverter. For high performance and bandwidth, PXI Express chassis – such as the NI PXIe-1062 – provide additional dedicated bandwidth. With the PXI Express specification, you can achieve up to 2 GB/s per-slot dedicated bandwidth.

	PXI-1031/1031DC	PXI-1036/1036DC	PXI-1042/1042Q	NI PXIe-1062	PXI-1044	PXI-1045	PXI-1000B DC	PXI-1050	PXI-1052
	Low-Cost, Compact Chassis	Low-Cost, Remote Control Chassis	High-Performance Chassis	High-Performance Chassis	High-Module-Count Chassis	High-Module-Count Chassis	AC/DC Chassis	PXI/SCXI Chassis	PXI/SCXI Chassis
PXI slots	4	6	8	8	14	18	8	8	4
Operating temperature	0 to 50 °C	0 to 50 °C	0 to 55 °C/0 to 40 °C	0 to 55 °C	0 to 55 °C	0 to 55 °C	0 to 50 °C	0 to 50 °C	0 to 55 °C
Integrated SCXI signal conditioning	–	–	–	–	–	–	–	4 SCXI slots	8 SCXI slots
AUTO/HIGH fan-speed selector	✓	✓	✓	✓	✓	✓	✓	–	✓
Noise – sound pressure level (dBA)	40.7/45.5	40.7/45.5	50.5/43.4	43.6	48.7	48.7	N/A	N/A	41.6
Remote power inhibit/monitoring	–	–	✓	✓	✓	✓	✓	–	–
DC input power supply	✓	✓	–[1]	–[1]	–[1]	–[1]	✓	–[1]	–[1]
Benchtop feet	Rubber	Rubber	Tilt and rubber	Tilt and rubber	Tilt and rubber	Tilt and rubber	Tilt and rubber	Rubber	Tilt and rubber
Rack-mount kit	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional	Optional

[1] Requires an external DC-to-AC power inverter for applications where only DC power is available.

Table 5. PXI Chassis Selection Guide

Customer Solution

ManTech Test Systems

U.S. Air Force Increases Mission-Capable Rates with PXI

The Challenge: Developing, producing, and supporting test equipment for LANTIRN systems on U.S. Air Force premier fighter aircrafts.
The Solution: Using NI PC-based software and hardware to lower costs and reduce the size of test systems by 50 percent.

The U.S. Air Force awarded ManTech Test Systems a multimillion dollar contract to develop, produce, and support test equipment for LANTIRN (Low Altitude Navigations and Targeting Infrared for Night) systems used on U.S. Air Force premier fighter aircraft, including the F-15E Eagle and F-16 C/D Fighting Falcon. LANTIRN significantly increases combat effectiveness, allowing these aircraft to fly at low altitudes, at night, and under weather to attack ground targets with a variety of precision-guided and unguided weapons.

Using PC-Based Software and Hardware to Lower Costs

The original LANTIRN test system dates back to the late 1980s, and was based on MicroVAX computers tied to stand-alone instrumentation. Not only was the system large, requiring seven complete racks of space, but the Air Force faced a host of reliability and maintenance problems from the growing obsolescence of test system components. A major requirement of the new system was to take advantage of new commercial off-the-shelf technology, such as industry-standard, PC-based hardware and software, to reduce the size and cost of the new test system.

Photograph courtesy of Lockheed Martin.

LANTIRN System on an F-16 on the Flight Line

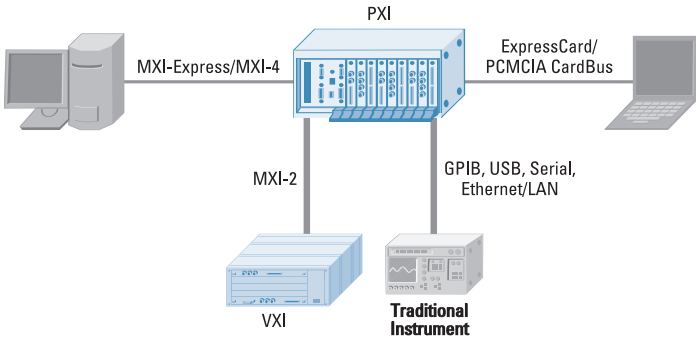
Reducing Test System Size by 50 Percent with PXI

ManTech selected PXI for a portion of the test system, largely because PXI provides the advantages of commercial off-the-shelf technology, while still meeting the needs of military specifications in test programs. For example, the specification required extended operating and nonoperating environmental conditions, which National Instruments met with the Intel Pentium 4-based PXI embedded controller. ManTech also was able to reduce the size of the test system from seven racks to three, a more than 50 percent reduction, due in large part to the incorporation of PXI instrumentation, which included up to 17 PXI instruments in just 4U of rack space.

John Abdale
ManTech Test Systems

PXI-Based Hybrid Systems

Because most test systems contain a variety of hardware platforms and bus requirements, PXI offers you software and hardware compatibility with all common measurement platforms and buses, including PXI, VXI, PCI, USB, Ethernet/LAN, and GPIB-based instrumentation. These hybrid systems require test engineers to select platforms for their systems that integrate well with current, legacy, and future systems and buses. With the ability to connect to VXI (via MXI-2 and USB) and traditional instruments (via GPIB, Ethernet/LAN, and USB), PXI-based systems can use legacy equipment from established equipment libraries to preserve existing investments.



Customer Solution

Tristan Technologies, Inc.
Using LabVIEW and PXI to Monitor Infant Brain Activity

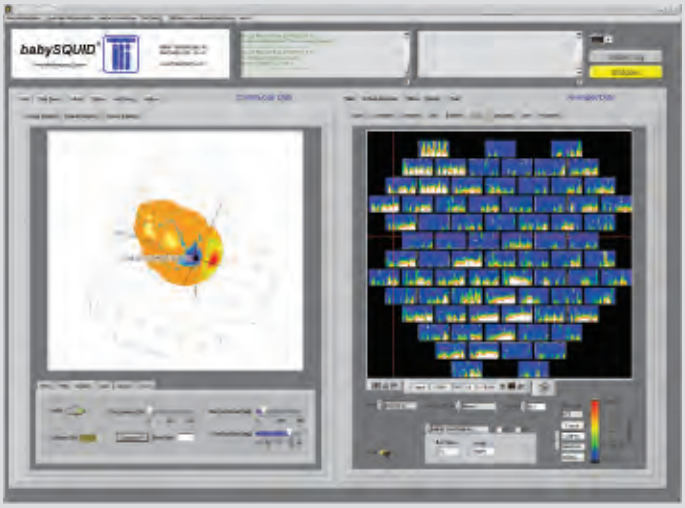
The Challenge: Developing a noninvasive magnetic imaging system to spatially and temporally map the magnetic fields generated by brain activity.

The Solution: Creating an adaptable, high-speed, high-channel-count National Instruments PXI data acquisition system; transferring the live data to the desktop computer with a PXI remote controller; and processing the data with LabVIEW.

Tristan Technologies, Inc., a leading manufacturer of custom systems using superconducting quantum interference devices (SQUIDs), developed a noninvasive magnetic imaging system to map the magnetic fields generated by brain activity in infants.

Easy-to-Configure National Instruments Hardware

Tristan mechanical engineers constructed an infant-sized headrest containing nearly 100 SQUID sensors cooled by liquid helium and insulated by a narrow vacuum gap. The engineers used National Instruments PXI-4472 high-speed, 24-bit dynamic signal acquisition modules to acquire data, and the acquired data was then continuously written to memory on a remote computer for data processing. Using the examples on ni.com, Tristan was able to configure the hardware and software to conduct basic acquisition in a matter of minutes.



Continuous Data Projected onto the Head Surface (left) and Averaged Data as Frequency versus Time for All Channels (right)

Tristan wrote noise-reduction algorithms using LabVIEW and directly incorporated graphical tools for conventional digital filtering, wavelet building, and joint time-frequency analysis. Using LabVIEW, doctors can stream raw data to disk, and, at a later time, simply switch the source of incoming data from live data to data from a saved file.

Christopher G. Atwood, Ph.D.
Tristan Technologies, Inc.

Revolutionizing Test, Control, and Design with Virtual Instrumentation

Virtual instrumentation uses mainstream computer technologies combined with innovative, flexible software such as LabVIEW and modular, high-performance hardware to create powerful computer-based instrumentation solutions. With this approach, engineers and scientists can capitalize on the ever-increasing performance of PCs and take advantage of the freedom to define measurement and automation solutions that meet their specific needs.

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