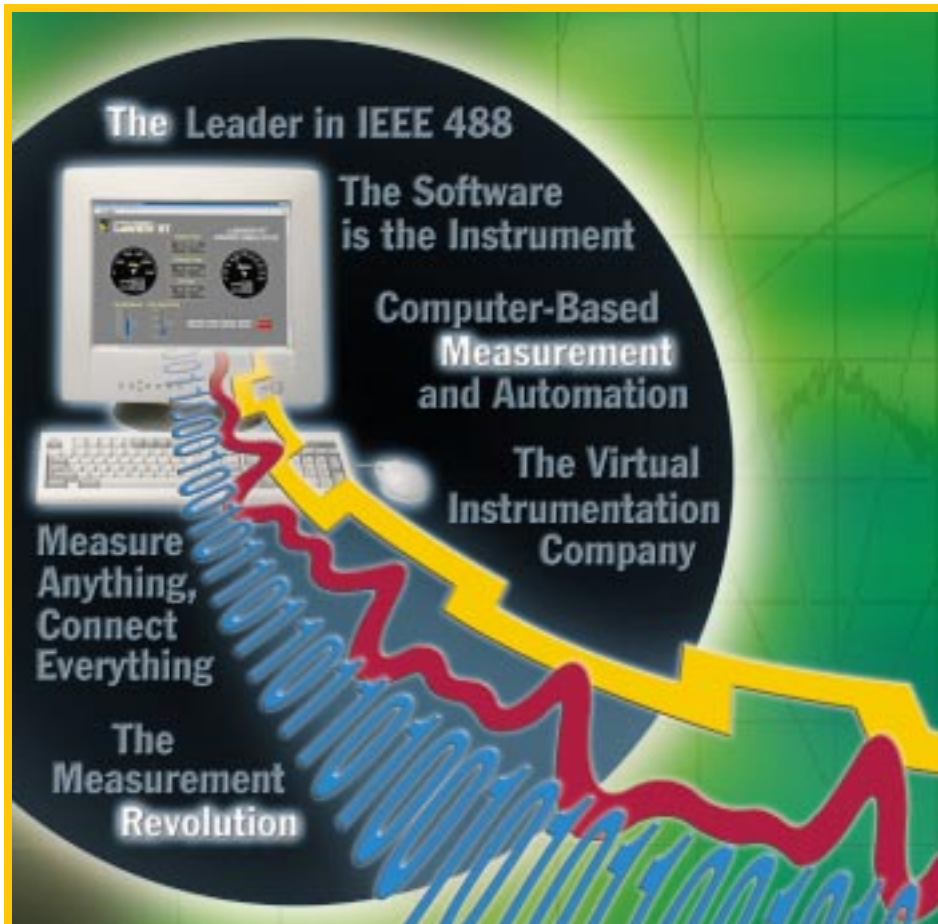


Instrumentation newsletter™

Technical News from National Instruments

Third Quarter 1999



The Measurement Revolution Transforms Test and Measurement

The computer, along with the technological innovations that have driven the computer industry, has literally revolutionized the markets and processes by which companies conduct their business. While measurement technology has improved over the same time period, the computer itself has had more impact on how we measure today than any other technology.

Most of the advances have occurred in high-density and high-speed logic driven by computer memory, audio, and video display. During the past 20 years, the computer has supplied the core platform for a "measurement revolution," transforming test and measurement as well as industrial automation systems from loosely coupled, and often incompatible, stand-alone instruments to tightly integrated, high-performance measurement and automation systems.

continued on page 4

Design Architecture for Measurement and Automation Applications

Engineers often believe in building applications from the ground up. However, as more technologies evolve into mainstream applications, the ground-up design architecture is proving far too expensive and time consuming. Component-based architectures represent a paradigm shift from individual



continued on page 6

Network Measurements – The Next Generation of Measurement Solutions



The Internet is changing the way you work. As a technology, you are adopting use of the Internet more quickly than any previous technology in our history, including the PC itself. The universal presence of the Internet and PC

continued on page 8



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Here's What You Missed...

- Learning more about signal processing and analysis
- Discovering how to ready your systems for Windows 2000
- Comparing multifunction data acquisition (DAQ) systems to digital multimeter (DMM) systems

...If You Missed the Last Issue.

For more information, check the appropriate past newsletter issue on the reply card.

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10 Years of Innovation and Improvement



This issue marks the 10th anniversary of *Instrumentation Newsletter*. Much has changed in these 10 years – including our newsletter design – but more importantly, your approach to measurement and automation. To help you understand the revolutionary advances in technology, we have continued to bring you the latest news in measurement and automation. In this issue, you read about how the line between computers and measurements has blurred, leading to dramatic performance improvements, cost savings, higher quality products, and faster time-to-market.

Below we share some of the products, technology, and news that we covered during the past 10 years. You can be sure that things have changed quickly and will continue to do so.

We thank all of you who have been readers from the very first issue. We welcome those of you receiving your very first issue. You are all part of a measurement community reaching hundreds of thousands of engineers and scientists worldwide. ▶

John Graff, VP Marketing

10 Years of Measurement News

Fall 1989	Programming GPIB instruments with NI-488 and QuickBASIC for DOS
Spring 1990	LabVIEW™ 2 introduces first graphical language compiler
Summer 1990	National Instruments introduces NAT4882 chip offering IEEE 488.2 compatibility
Fall 1991	SCXI™ signal conditioning platform introduced
Winter 1992	Windows 3.1 for data acquisition and instrument control
Summer 1992	Windows 3.1 versus OS/2 2.0 versus Mac System 7
Fall 1992	LabVIEW for Windows and Sun
Spring 1993	Gabor Spectrogram for joint-time frequency analysis wins EDN Innovation Award
Fall 1993	LabWindows™/CVI introduced for Windows
Winter 1993/94	The Virtual Instrument Revolution
Spring 1994	PCMCIA data acquisition cards for notebook PCs
Summer 1994	VXIplug&play introduces software frameworks
Fall 1994	E Series DAQ brings switchless/jumperless data acquisition
Spring 1995	National Instruments launches initial Web site
Summer 1995	National Instruments goes public
Winter 1995/96	ComponentWorks™ adds virtual instrumentation to Visual Basic
Spring 1996	PCI data acquisition boards offer new levels of performance
Winter 1996/97	Imaging products bring vision to virtual instrumentation
Spring 1997	Computer-based scope and DMM expand possibilities of plug-in boards
Autumn 1997	HS488™ boosts GPIB transfer rates to 8 Mbytes/s
Winter 1997/98	PXI™ – the new platform for measurement and automation
Spring 1998	LabVIEW 5.0 delivers multithreading, ActiveX, and more
Summer 1998	FireWire (IEEE 1394); IVI™ interchangeable instrument drivers
Winter 1998/99	DataSocket™ provides simple data publishing to the Internet
Summer 1999	Full-featured arbitrary waveform generator for PCI and PXI

MXI™-3 Gives PCs Direct Control of PXI/CompactPCI®

MXI-3, the fastest and most flexible PC extension technology, gives PCs direct control of PXI/CompactPCI via a software and hardware transparent link with speeds approaching 100 Mbytes/s over distances up to 200 m. The same technology extends existing PXI/CompactPCI systems to secondary chassis with more available slots for I/O.

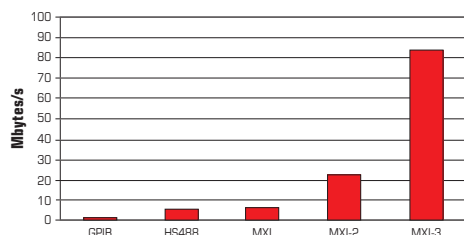
Computer-Based Measurement and Automation

The link between standard PCs and instrumentation equipment is critical to computer-based measurement and automation. GPIB, an early link from PCs to instruments, ushered in the virtual instrumentation age. High-speed 488 (HS488) extended the standard 1 Mbyte/s GPIB architecture to 8 Mbytes/s for

MXI-3 uses the latest technology available to deliver a 10X performance increase over the original MXIbus and a 100X increase over the original GPIB bus.

connections to box instruments. With the advent of VXI in 1987, users needed a new technology for PC control of VXI modular instruments. This new multisystem extension interface (MXI) technology linked PCs to VXI at rates of more than 10X faster than the original GPIB link. The second generation MXI-2 further increased the speed of the link to VXI.

Modular instrumentation took on a smaller and less costly form in 1997 with the introduction of PXI. PXI uses the



Successive MXI technologies offer dramatic performance improvements for sustained data transfers.

CompactPCI architecture to bring the high-performance PCIbus to modular instruments. Until now, the only choice for controlling PXI and CompactPCI was an embedded controller. Today, MXI-3 gives you direct control of PXI from PCs without the need for an embedded controller. MXI-3 uses the latest technology available to deliver a 10X performance increase over the original MXIbus and a 100X increase over the original GPIBbus.

MXI-3 Architecture

MXI-3 extension technology is built on the standard PCI-PCI bridging architecture. Widely used to provide more PCI slots in industrial computers, servers, and other monolithic PCI-based systems, a PCI-PCI bridge is simply a device for transparent expansion of one PCIbus to another. The benefits of this standard architecture

include complete software and hardware transparency, high bandwidth, and flexible configurations. However, because PCI-PCI bridges are designed for monolithic (single box) systems and are implemented as a single chip mounted on a PC motherboard, standard PCI-PCI bridges do not provide a ready link to external systems.

MXI-3 innovates on the standard PCI-PCI bridge architecture by splitting the bridge in two and connecting the two halves through a 1.5 Gigabit/s serial link. The system interfaces with the MXI-3 link exactly as it would with a standard PCI-PCI bridge, so MXI-3 benefits fully from all the capabilities of PCI-PCI bridging.

MXI-3 Configurations

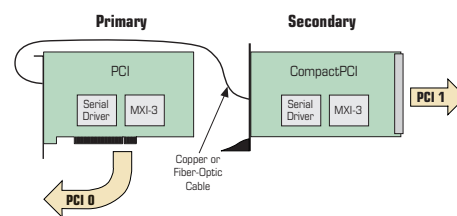
The circuitry required for each half of the PCI-PCI bridge is contained within the MXI-3 ASIC developed by National Instruments. The high-speed serial link is



National Instruments MXI-3 is a high-speed serial link for adding more I/O slots to PCs and PXI/CompactPCI systems.

implemented with standard driver components, connectors, and cables for both copper and fiber optic interconnects. Copper links are the least expensive interconnect for short distances between systems. Fiber optic links offer connections between systems separated by up to 200 m without repeaters. The figure below shows a typical MXI-3 interface kit for connecting a PC to a PXI/CompactPCI system.

Every MXI-3 link consists of a primary and secondary MXI-3 card and a copper or fiber optic cable connecting the two cards. By plugging a PCI MXI-3 card into a desktop PC, a PXI MXI-3 module into

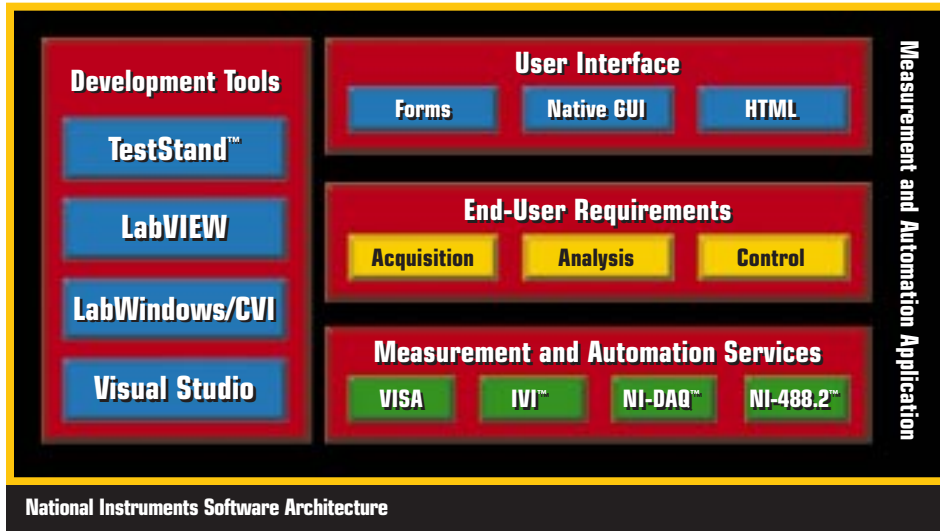


Typical MXI-3 Extension Kit

slot 1 of a PXI/CompactPCI chassis, and connecting the two cards with a cable, you can transparently link the PXI/CompactPCI chassis to the PC. The application and driver software run unmodified on the PC as if the PC were embedded in slot 1 of the PXI/CompactPCI chassis. Similarly, you expand one chassis to two or more using several MXI-3 board pairs.

Continued on page 7

The Measurement Revolution Transforms Test



Continued from page 1

In effect, the computer industry has helped create the digital measurement system.

Digital Measurement System

A digital measurement system is built on extremely powerful, low-cost computing platforms. Measurement components, typically consisting of a digitizing element with a maximum sample rate and frequency

The computer, along with the technological innovations that have driven the computer industry, has literally revolutionized the markets and processes by which companies conduct their business.

resolution, rather than specific instruments, supply the core measurement technology. The chart to the right shows the broad spectrum of frequency ranges and resolution across which measurement components are available. The chart also shows the capabilities of the more specialized, proprietary instruments. Over the past 10 years, the measurement capabilities of computer-based measurement components, including bandwidth, accuracy, and resolution, have increased dramatically. Now, you can make virtually all the most common measurements with higher performance, lower cost measurement components.

To integrate the computer with the measurement components, you need highly productive software development tools. The basic elements include the Measurement and Automation services supplying all the high-speed I/O services to move measured data into the computer. You also need software development tools so you can create your own user-defined instrument systems. Today's software development environments,

such as LabVIEW, have the critical tools for acquiring, analyzing, and displaying data, as well as publishing data over the Internet, storing and retrieving information in databases, and

integrating with other industry-standard software such as Excel, MatLab, and TestStand.

The Need for Better Performance

When considering the processing power of today's computers as well as their incredibly low cost, you can ask why the test, measurement, or industrial automation industry has not produced the same large-scale improvements in performance and reductions in price. The answer – these industries are just now beginning to embrace computer-based measurement and automation on an industry-wide

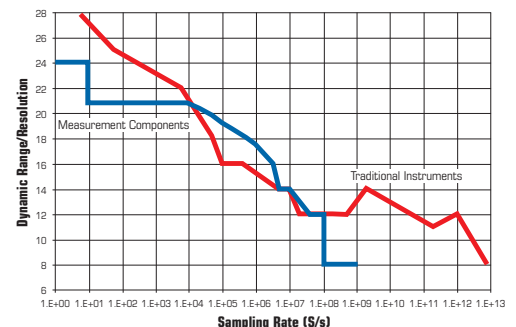
scale. Performance is the most obvious benefit because the computer itself is more than 1,000 times faster than it was 10 years ago. Measurement systems, however, that do not fully integrate the computer have not improved in system performance over the past decade. The reason is simple – stand-alone instruments cannot use the processing power, nor the enterprise-wide connectivity of today's PC.

Cost is the other compelling reason to build a digital measurement system. Typically, a computer-based measurement and automation system costs ½ to ⅓ of the stand-alone equivalent. In addition, the cost to upgrade to a higher performance model in the future is either negligible or even zero. You can make the same argument for the networking capabilities found on today's computers.

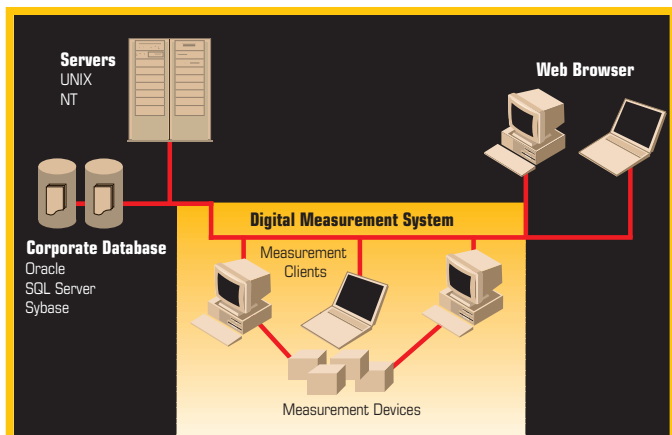
Evolving from Virtual Instrumentation

Over 10 years ago, the LabVIEW community pioneered the use of virtual instrumentation. At that time, the term suggested that software – not hardware – should define the operation of an instrument or other measurement devices. With virtual instrumentation, anyone could easily connect disparate instruments together across many different communication interfaces and program them all in the same manner. The development productivity gains were enormous. Virtual instrumentation essentially made it possible for anyone, regardless of their computer expertise, to develop sophisticated instrumentation systems.

Virtual instrumentation has now grown to include more than just integrating GPIB instruments and plug-in DAQ boards.



Use measurement components to make most measurements for which you use traditional instruments.



Today, measurements can be made through distributed networks, high-speed computer buses, and directly in the sensors themselves. The introduction of so many new measurement components and the evolution of the software development tools that can control and communicate with these components make all this possible. A typical measurement system today consists of electronic measurement devices, such as scopes, digital multimeters (DMMs), analyzers, and DAQ devices, image acquisition and machine vision devices, motion control, and the software to integrate all of these devices. You can connect today's systems to networks, publish data via Web browsers, and communicate via modems and RF links. You have the control to create an exact measurement system to fit your needs.

Creating Your Own Measurement Device

The benefits of the digital measurement system are simple:

- Higher performance
- Lower cost
- Better systems integration
- Increased developer productivity

With the recent introduction of LabVIEW RT, you can use the technologies of a digital measurement system to create embedded and real-time devices with a

Windows PC. LabVIEW RT creates real-time programs that run on embedded processors on RT Series plug-in DAQ boards for applications such as dynamometer control and machine monitoring and control. Now you can create custom real-time applications with off-the-shelf computing technology.

With LabVIEW RT

and the RT Series hardware, you can download the graphical diagrams to an independent processor to implement the logic required to monitor and control a real-time process. With this architecture, you can offload time-critical real-time tasks to the embedded processor on the RT Series board

current products offer, then you could develop applications with the most productive user friendly computer-based measurement and automation tools. You would have the flexibility to target various hardware to achieve the needed system performance. For example, if LabVIEW RT could run inside a FieldPoint controller, you could create a low-cost, rugged, real-time distributed monitoring and control system. If you could run LabVIEW RT code on a PXI controller, you could control the entire PXI system with deterministic real-time performance to create custom measurement systems. In short, with LabVIEW RT you have the key to a vision of running LabVIEW everywhere to take measurements anywhere. This vision can even extend to the chip itself, such as a FPGA, or into the sensor itself.

The development of embedded and real-time systems using low-cost, easy-to-use

Measurement Revolution

and use the host PC for tasks such as user interface display, networking, and file I/O. You can easily develop this system with the same process as LabVIEW. With LabVIEW RT, you simply download the graphical program into the RT Series embedded processor. Download occurs automatically at runtime, or you can manually select a menu item in your LabVIEW RT development system.

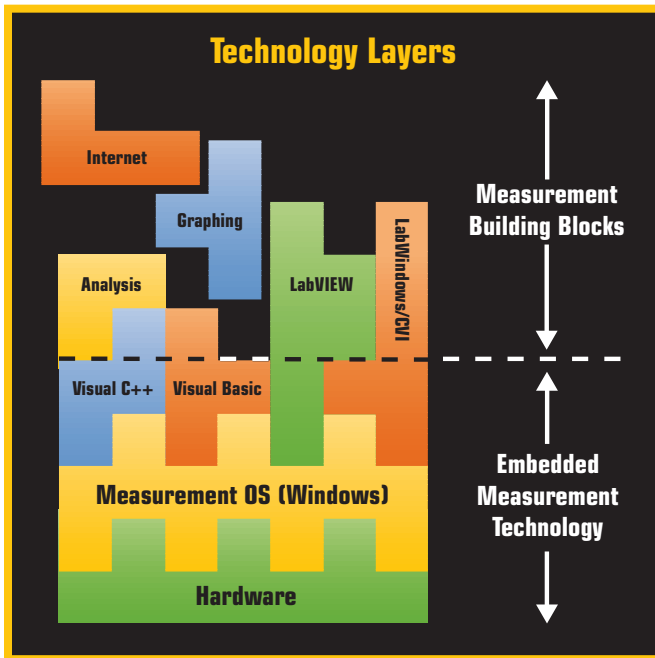
Simply, the RT Series boards are a single board computer with integrated data acquisition. So the question presents itself – “What if LabVIEW RT could target ANY processor-based system – local or distributed?” If LabVIEW RT could target any processor system with the ease that

tools, such as LabVIEW, plug-in DAQ boards, PXI modular instrumentation, and more sophisticated use of computers is part of the future of the measurement revolution. Real-time and embedded systems no longer need to be independent and isolated systems. You can develop and seamlessly integrate these systems with standard computer-based systems – forming a unified digital measurement system. ✎

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Design Architecture for Measurement Applications



longer limited to displaying waveforms on a monitor when presenting data. As more and more measurement systems are connecting to the Internet, programmers are distributing data to other computers, connecting to local and remote databases, and presenting data in many different formats such as HTML. Because of the complexity involved with data presentation and analysis, engineers should not and cannot be responsible for developing the building blocks of a measurement system.

displays, and stores the information so that programmers can make intelligent decisions.

Development tools play a fundamental role in the effective creation of component-based architectures. For LabVIEW and LabWindows/CVI programmers, the notion of measurement components is not new. By design, LabVIEW programs (VIs) are completely modular and extensible, and all the component building blocks for acquisition, analysis, and presentation are readily available. For Visual Basic and Visual C++ programmers, the three basic building blocks of a measurement system do not exist natively in the environment. However, with off-the-shelf components, such as National Instruments ComponentWorks, programmers can integrate and customize the core building blocks into the Visual Studio development package. Without these drop-and-go component tools, Visual Studio programmers would need to develop every aspect of a measurement system.

The building blocks of a measurement component are just the beginning. A programmer can use each application he/she creates as a component within a larger measurement system, a valuable element to development teams. The following example details the benefits of code reuse through a component-based architecture. It facilitates larger development teams, fosters cooperation, and permits the creation of enterprise-wide solutions.

Continued from page 1

monolithic applications to high-level building blocks which programmers use for measurement design. Components deliver a foundation for incorporating new technologies without losing design efficiency.

The complexity of measurement systems forces engineers to become software architects. While the basic building blocks of a measurement system are simple – acquisition, analysis, and presentation – technology has added extra layers of sophistication to the programming experience. This poses a challenge to the measurement and automation software development community. When developing a measurement application, programmers can interface computers with one of many sources of data including stand-alone instruments, plug-in instruments, data acquisition boards, motion and vision boards, and distributed I/O across a network. Ideally, creating a hardware-independent measurement system can eliminate dependence on a specific acquisition device and prolong the life of your test system. However, hardware independence requires a significant amount of software design when programming from scratch.

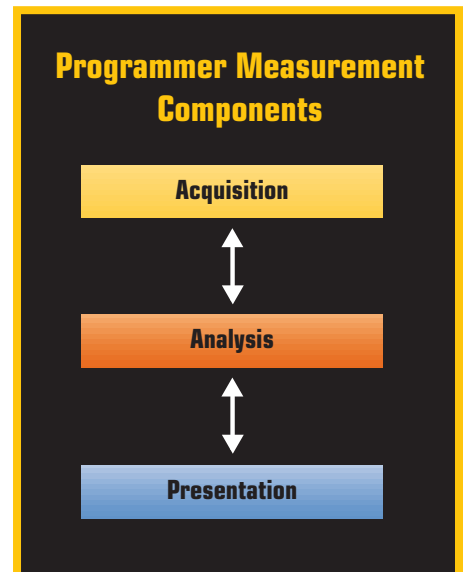
In addition, programmers are challenged by data presentation. Using a component-based architecture, programmers are no

Measurement Building Blocks

As a foundation for incorporating new technologies, component-based architecture represents an evolution in measurement systems. Components are the base on which programmers can build their applications. Programmers can adapt components to different technologies based on a standard application programming interface (API), resulting in a far richer measurement system design. In addition, programmers save time with this method through greater code reuse. By using components that are native to the development environment, programmers can shorten the learning curve and take advantage of easier debugging.

Designing Measurement Components

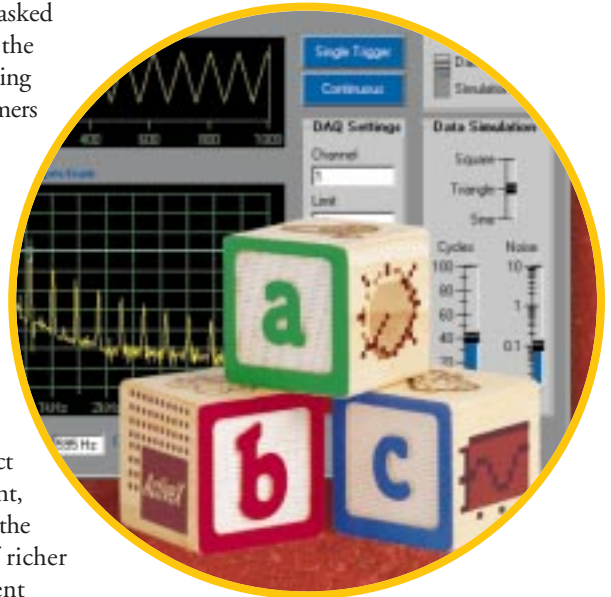
Implementing a component-based architecture extends from the core building blocks to the highest level of your measurement system. Each of the building blocks is present in every measurement component. The acquisition block integrates into the operating system to create a highly intelligent path for delivering information to your measurement application. The analysis block converts the raw data returned from your acquisition device into meaningful information. The presentation distributes,



Component-Based Architecture Example

Component-based design architectures take the programmer a step away from both the hardware and the programming language – which gives him/her an application completely focused on the device under test (DUT). Let us begin with a programmer (Jack) tasked with acquiring, analyzing, displaying, and distributing the sound of some physical phenomena over the Internet. Jack chooses Visual Basic as his development environment. Without using any available plug-in components, Jack must interface to the low-level driver for his acquisition device, create a numerical algorithm to analyze his input

Jane is another programmer tasked with monitoring and controlling the environment of Jack's DUT test using LabVIEW. Because both programmers have written their tests using a component-based architecture, they can use them as components in a larger measurement system. In fact, integrating both tests into a larger test system is as easy as calling the test from National Instruments TestStand either remotely over the network or directly from one computer. TestStand is a revolutionary product that delivers a language-independent, plug-in architecture that facilitates the



creation of richer measurement applications.

Programmers can build their own measurement components that

plug into higher level systems – saving development time and money with an enterprise-wide solution.

Components deliver a foundation for incorporating new technologies without losing design efficiency.

signal, create a specialized graph to display the data, and learn TCP/IP or HTML to distribute the data over the Internet. By using the measurement components available to him (ComponentWorks ActiveX components), Jack can cut his development time by more than a factor of four. He no longer needs to create any special tools or learn a new protocol (TCP/IP) or programming language (HTML). Almost every aspect of the measurement system is encapsulated within the ComponentWorks plug-in components.

Component-Based Architecture Roadmap

The measurement revolution represents a dramatic shift in the way programmers develop measurement systems and therefore a paradigm shift in the purpose of software from individual ground-up design to high-level building blocks used in measurement applications. Soon everyone will have the

opportunity to develop high-level, reusable measurement components in any language in a simple and consistent form, creating enterprise-wide solutions and benefiting from native development environment tools and code reuse. ▶

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For more information, check ComponentWorks brochure and Software Showcase CD on the reply card.

www.natinst.com/cworks

MXI-3 Gives PCs Direct Control of PXI/CompactPCI

Continued from page 3 System Performance

Because MXI-3 is based on the PCI-PCI bridge architecture, its peak performance reaches 132 Mbytes/s. As with single-chip versions of PCI-PCI bridges, MXI-3 links are characterized by sustained transfer rates somewhat lower than the peak rate. Sustained transfer rates for MXI-3 reach over 80 Mbytes/s. This performance is heavily dependent on the

host processor and the I/O card with which it communicates.

MXI-3 expands the range of possible applications for PCs and PXI/CompactPCI by giving the end-user more I/O slots with which to work. It offers both copper interfaces for short distances and fiber optic interfaces for long distance connections. By providing a high-speed, software and hardware-transparent link, MXI-3 gives users an easy way to expand

their test, measurement, data acquisition, and industrial automation systems. ▶

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For more information, check MXI-3 kit on the reply card or visit www.natinst.com/info/news

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Network Measurements, The Next Generation of Measurement

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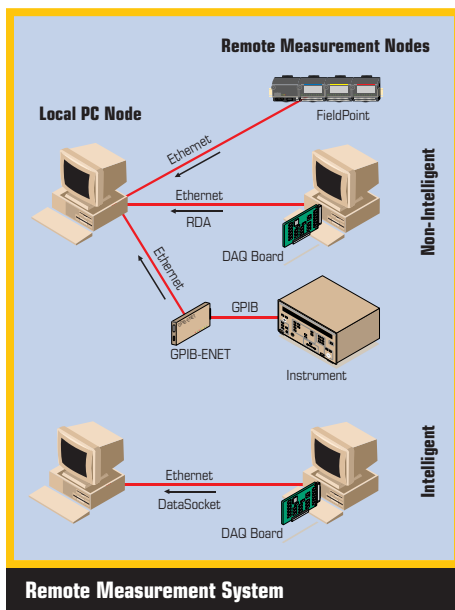
networks ushers in a new age of information connectivity and data sharing that delivers innovative ways to acquire, analyze, and present measurements.

Networks are inherently flexible, and therefore, the possible permutations for creating a network measurement solution are seemingly endless. Below, we simplify potential network measurement solutions into three basic types and recommend the technologies most ideally suited for creating each solution:

- Remote measurement system – a PC node that retrieves measurements over a network from one or more remote measurement nodes
- Measurement publishing system – a measurement node that publishes data over a network to one or more remote PC nodes
- Enterprise measurement system – multiple remote measurement and PC nodes that all share information over a network

Remote Measurement System

In this case, the goal is to deploy one or more remote measurement nodes that send measurements back to a local PC node. The remote nodes are either intelligent or non-intelligent. Example applications include distributing I/O throughout a plant floor or providing remote log-in capabilities for controlling or troubleshooting your



measurement system. Four National Instruments technologies make this task simple to accomplish.

DataSocket is a software technology that makes sharing your measurements across a network as easy as writing information to a file. You can use DataSocket to create an

The universal presence of the Internet and PC networks ushers in a new age of information connectivity and data sharing that delivers new ways to acquire, analyze, and present your measurements.

intelligent remote measurement node. You create the measurement and control application for the remote measurement node, including any analysis, and use DataSocket functions to publish your measurements to your local PC node. DataSocket is included with both LabVIEW and ComponentWorks and is ideal when you want complete control over the distribution of your measurements but do not want to learn the intricacies of the TCP/IP data transfer protocols.

FieldPoint, a modular distributed I/O system, provides economical solutions for industrial measurement and control applications. The FieldPoint system includes a variety of analog and digital I/O modules for taking remote measurements. With the FP-1600 Ethernet interface module, you can deploy several non-intelligent measurement nodes, each with up to nine FieldPoint I/O modules. You need FieldPoint when you are performing single-point measurements on a variety of signal types.

Remote device access (RDA) makes any National Instruments DAQ device located in a remote computer available to any other PC on the network. With RDA, your remote measurement node is a PC equipped with one or more DAQ devices. Your application runs on your local PC node, but the measurements are taken at the remote measurement node. In this case, the remote measurement node is non-intelligent. Choose RDA when it is advantageous to have a PC or CompactPCI/PXI computer at the

remote location, you need acquisition rates greater than 1 kHz, or you need several DAQ devices. Every National Instruments DAQ device includes RDA.

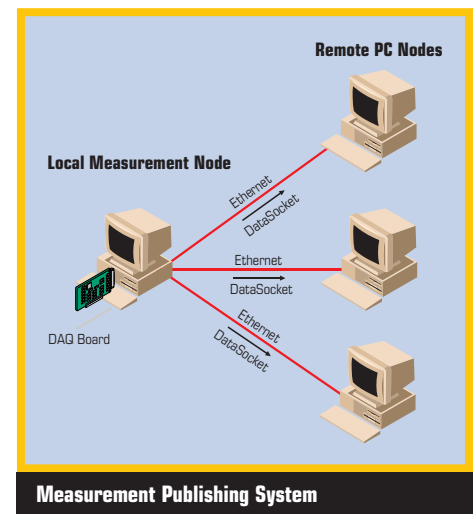
GPIB-ENET is an Ethernet-to-GPIB controller that turns any GPIB instrument into a remote measurement node. As with RDA and FieldPoint solutions, your application runs on your local PC node but takes measurements from the remote measurement node – in this case, your GPIB instrument.

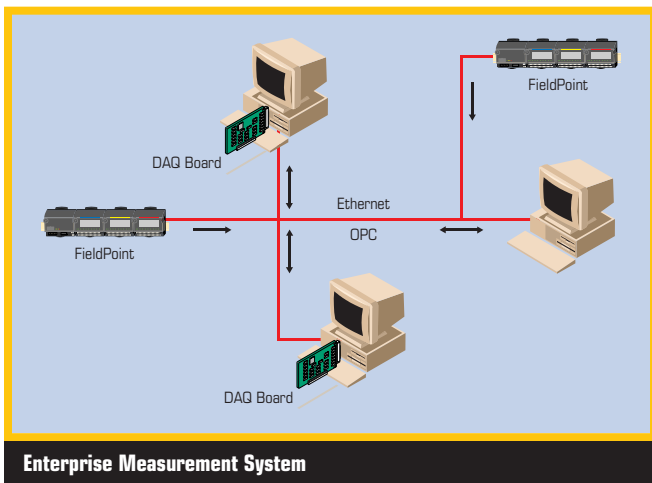
With GPIB-ENET, the remote measurement node is intelligent or non-intelligent depending on the capabilities of your specific GPIB instrument.

Measurement Publishing System

This scenario is almost the opposite of the previous one. Now, the goal is to have a local measurement node that distributes measurements to one or more remote PC nodes. Examples of applications include distributing measurements throughout your enterprise or implementing a distance learning laboratory at a university.

DataSocket is the ideal technology for this application. With DataSocket, you have complete flexibility to define what information travels to the remote PC. You can send raw measurements for remote





analysis or live processed data to colleagues on the other side of the world. We have already discussed the basics of DataSocket in the preceding section, but there is one additional benefit of DataSocket for this application – your remote PC nodes do not need to have an application development environment installed. Instead, you can create a Web interface to receive information from your measurement node and use a standard Web browser on the remote node.

Enterprise Measurement System

This scenario is a combination of the first two. In this case, the goal is to provide access to any given measurement from any PC or measurement node. The measurement nodes can be a combination

of intelligent or non-intelligent nodes. The most common application for this model is an industrial DAQ and control system on a plant floor that integrates your measurement hardware with human-machine interface (HMI)/SCADA and other industrial software packages.

OLE for process control (OPC) is an industry standard that defines an interapplication communication mechanism for device servers to connect to factory automation and process control software systems. OPC spans several hardware and software vendors, making connectivity between your measurement hardware and automation software easier to implement. All National Instruments DAQ devices include OPC Servers.

You can also implement this model using a combination of the technologies mentioned in the first two scenarios.

Distribute More than Your Measurements

When you create a network measurement solution, you may want to distribute executable code to several PC nodes to increase processing power or speed analysis

time. With VI Server, a software technology included with LabVIEW, you can easily execute any LabVIEW function (VI) on another PC node. This technology, coupled with the network measurement technologies, is a powerful tool for creating large-scale network measurement solutions that fully use the power and benefits of PC networks.

Network Measurements Made Easy

At National Instruments, we identify PC technologies that bring benefits to PC-based measurement solutions. National Instruments technologies make it easy to create network measurement solutions by handling the intricacies of TCP/IP communication protocols for you. No matter which type of network measurement solution you need to create, our tools complete the difficult tasks so you can focus on what you do best – taking measurements.✔

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www.natinst.com/daq

Measurement Terminology

To introduce you to the National Instruments technologies that bring the benefits of PC networks and the Internet to your measurement solutions, we define the terms used throughout this article.

Measurement Capturing a signal of any kind – also called input.

Control Changing a signal of any kind – also called output.

Network A collection of PCs or measurement devices connected via Ethernet – includes internal networks (intranet) and external networks (Internet).

Measurement Node Any device or collection of devices on a network with measurement and/or control capabilities. The devices may connect directly to the network or are located inside a computer connected to the network.

PC Node A computer connected to a network with no measurement and/or control capabilities.

Remote An attribute of the distance between your location and the location of a measurement node. As a general rule, if you cannot see the measurement node or it takes more than about five seconds to walk to the measurement node, then you can consider that node remote.

Intelligent A measurement node that can execute a program developed by an end-user is intelligent.

Non-Intelligent A measurement node with fixed functionality is non-intelligent. The fixed functionality might include predefined analysis routines.✔

Understanding How Switching Fits into Your Application



Have you ever wanted to use your scope to analyze 20 signals, but you did not want to manually change the probe location? Or have you had one arbitrary function generator and wanted to stimulate several points on the circuits? Knowing the basics of switching can help you determine a cost-effective solution for distributing and routing signals inside your measurement system.

Three Types of Switches

We can categorize switching devices into three main families.

General purpose – you use these switches to turn motors, lights, and fans on and off. Typical applications involve high power. Therefore, when judging the quality of general-purpose switches, consider parameters

such as maximum voltage, and current/switching capacity for both AC and DC, as well as the life expectancy of the components. National Instruments offers a complete range of general-purpose switches.

Multiplexers – you use multiplexer switches to route several signals to one common terminal and vice versa. A typical application involves connecting several testing points to one oscilloscope channel or to

distribute a source signal to several test points. In this case, watch for the maximum switching voltage and current to compute the maximum power you can handle, the transfer characteristic to evaluate the bandwidth of the signal you can route, and the maximum operating speed to understand how fast you can scan between different channels. While specifying the characteristics of a multiplexer, the number of “wires” represents the number of signals physically routed for any given channel. National Instruments has a wide array of products in this category.

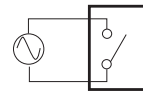
Matrix – a matrix takes the multiplexer idea one step further. The switches inside a matrix make

it possible to route any input signal coming from the N rows to any of the M output columns.

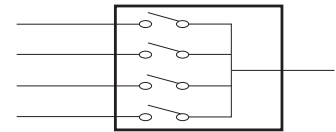
Often, you can build a matrix from multiple multiplexers. Therefore, the same parameters that help determine the quality of the multiplexer apply to the matrix. In addition, it is important to estimate how difficult it is to create the overall wiring architecture – when you are designing your system with switching cards, using terminal blocks or accessories designed to implement all the necessary wiring for a given matrix configuration can easily pay for itself with the saved labor cost.

You can use any of the National Instruments multiplexers as a

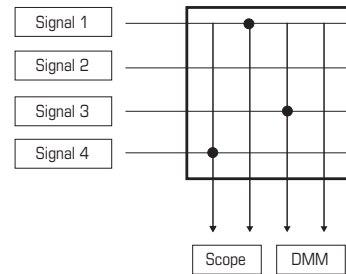
General Purpose



Multiplexer



Matrix



Schematics for Various Types of Switches

matrix with the appropriate external cabling. You can also rely on terminal blocks specifically designed to implement certain

Switching helps you implement a high-channel count system while continuing to keep a firm control on cost.

types of matrix wiring schemes. The TBX-2606 for PXI, together with a PXI-2501 or PXI-2503 module, is a 6x4, two-wire matrix that requires no extra wiring. The SCXI-1127, coupled with the terminal block SCXI-1132 is an 8x4, two-wire matrix ready to accept connections from the field.

Using switching technology can reduce the number of instruments you need in your system, thereby helping you implement a high-channel count system while continuing to keep a firm control on cost. ✎

Maurizio Basso
Computer-Based Instruments
Product Manager
E-mail maurizio.basso@natinst.com

General-Purpose Switches	
Product Name	Description
SSR modules	8 to 32 solid-state switches
ER-8 and ER-16	8 or 16 electromechanical switches
SCXI-1160	16 electromechanical switches
SCXI-1161	8 electromechanical switches
FieldPoint FP-RLY-420	8 electromechanical switches
SC-2062	8 electromechanical switches
NI 2565 for PXI	16 electromechanical switches

Multiplexers and Matrices	
Product Name	Description
SCXI-1127	32x1, two wires, electromechanical switches
PXI-2501	24x1, two wires, solid-state switches
PXI-2503	24x1, one wire, electromechanical switches
PXI-2590	4x1, 50 Ω, 1.3 GHz, switches
SCXI-1163R	Four groups of 8x1, one wire, electromechanical switches

www.natinst.com/instruments

MiniDAT – a Platform for Wireless and Networked DAQ



ViaSat, Inc. is offering its second generation Miniature Data Acquisition Transceiver (MiniDAT), a compact platform for wireless and networked data acquisition. Designed specifically for use with National Instruments LabVIEW or BridgeVIEW™ and DAQCards™, the MiniDAT includes all the software you need for full compatibility with your existing VIs.

Weighing in at 24 oz and filling fewer than 50 in.³, these units are appropriate in

many situations where small size and ruggedness are necessary. The MiniDAT rugged design makes it suitable for outdoor or harsh industrial environments. An optional battery pack provides eight hours of operation.

Use the ViaSat MiniDAT to perform remote data acquisition over any standard Ethernet LAN, or eliminate the cables with a robust spread-spectrum digital wireless transceiver. Perform the right tradeoff between range and sample rate

using a variety of wireless options. At ranges of under 1,000 ft, sample rates in the tens of kHz are obtained. For fixed-site applications requiring ranges of a few miles, add an external antenna. For longer range applications, cellular and satellite connectivity are options.

The typical MiniDAT model runs LabVIEW or BridgeVIEW on a local PC base station. The base station links to one or more remote MiniDAT units wirelessly or

over Ethernet. Each remote MiniDAT unit includes an onboard processor and two PCMCIA slots. A National Instruments DAQCard populates slot 1, while slot 2 is used to provide the communications link. The PC base station must have one free PCMCIA or PCI slot, available for the local end of the link. The MiniDAT software approach makes the communications link transparent by using NI-DAQ remote device access (RDA) technology. LabVIEW or BridgeVIEW operate as if the DAQCard populates the local machine.

ViaSat is currently shipping second generation units. In its standard configuration, ViaSat equips each unit with the National Instruments DAQCard-A1-16XE-50 and your choice of an Ethernet card or spread-spectrum transceiver card. Ask about additional configurations. ▶

For more information, contact Troy Tom, ViaSat, Inc., Carlsbad, CA, tel (760) 431-3590 ext. 2089, fax (760) 431-3636, e-mail minidat@viasat.com, Web www.viasat.com/advanced

www.natinst.com/daq

More I/O Options for FieldPoint Distributed I/O

FieldPoint, a modular I/O system for distributed data acquisition and control applications, can now generate pulse trains, provide protected digital outputs, and deliver even more accurate thermocouple measurements with an isothermal terminal base.

The FP-PG-522 is an eight-channel pulse-generator module for outputting finite or continuous pulse trains. You can programmatically control the FP-PG-522 module to generate output pulses with a frequency up to 5 kHz. The outputs of the FP-PG-522 are rated to drive up to 2 A and are compatible with 24 VDC as well as TTL/CMOS devices.

The FP-DO-410 is an eight-channel digital output module with an electronic overcurrent protection circuit on each

output. In the case of a wiring or device fault such as a short circuit, which causes the output current to exceed 1 A, the protection circuit automatically deactivates the output, limiting the current and preventing possible damage. The protection circuitry also activates the appropriate status LED indicator on the FP-DO-410 and returns the status condition to the software. When the wiring fault is removed, the output channel returns to its normal state. Another addition to the discrete I/O family of modules is the FP-DO-403, a 16-channel discrete module with 5-30 VDC, sinking outputs that are also compatible with TTL/CMOS devices.

The FP-TB-3 is an isothermal terminal base designed to deliver maximum accuracy when you use the FP-TC-120 to measure thermocouple inputs. Accurate

thermocouple readings require a reliable, stable measurement of the temperature of the terminal connections, referred to as cold junction. Similar in functionality to the universal FP-TB-1 and FP-TB-2 terminal bases, the FP-TB-3 provides an increased thermal mass to stabilize the temperature of the terminals and minimize temperature gradients across the terminal base. This is especially useful if the FP-TC-120 thermocouple module is located directly adjacent to a heat source, such as relays or a high-power network module. ▶

For more information, check FieldPoint brochure on the reply card.

www.natinst.com/fieldpoint

New Color and Digital IMAQ™ Boards for Image Measurements



Two new boards expand National Instruments IMAQ offerings for industrial inspection and scientific imaging.

Two new boards open up new application opportunities for industrial inspection and scientific imaging. The IMAQ PCI-1411 board acquires images from S-Video, NTSC, and PAL color cameras. The PCI-1411 is the first color board for machine vision offering on-the-fly color conversion to the hue, saturation, and luminance (HSL) image planes and partial image acquisition with programmable region of interest.

The on-the-fly HSL conversion is critical in color applications that need high-speed color matching. The PCI-1411 is a unique color frame grabber, speeding color processes by converting images to a common format called HSL. Color frame grabbers in the past acquired 24- or 32-bit color images to PC

memory. Now you can configure the PCI-1411 to acquire 8-bit images of the hue plane to PC memory. Color information is retained because in the HSL format the hue plane contains the image color information. Less image data means faster transfer times to PC memory and faster image processing. Effective for automotive, semiconductor, electronics, food, and pharmaceutical applications, you can use the PCI-1411 to precisely judge the quality of automotive paints, inspect fruits and vegetables, and inspect for color electronic components.

The PCI-1411 color conversion feature is optimized in hardware and runs at up to 30 frames/s. In addition, the hue plane is not affected by poor lighting, reflections, and shadows in the field of view. Therefore, you can have varying illumination and still inspect for color. The PCI-1411 board also acquires gray-scale images from RS-170 and CCIR monochrome cameras.

The new IMAQ PCI-1422 board takes advantage of the latest technological revolution in the imaging industry – digital cameras. For scientific and industrial inspection applications, digital cameras offer several advanced features over traditional analog cameras, such as fast image acquisition rates (2,500 frames/s, for example), high spatial resolution (4,096

horizontal pixels by 4,096 vertical pixels in one image with at least 16,000,000 pixels!), and greater pixel depth (12 bits per pixel or more and 4,096 gray-scale levels).

Typical analog cameras are only 8-bit or 256 gray-scale levels. Plus, many digital cameras offer advanced features such as exposure control and the ability to read CCD pixels in parallel. These advanced features make digital cameras the choice for many semiconductor and electronic packaging inspection, microscopy, fluoroscopy, and high-speed printing inspection applications. The new IMAQ PCI-1422 works with a wide range of digital cameras from vendors such as Basler, Cohu, DALSA, EG&G, Hamamatsu, Kodak, and SMD. The IMAQ PCI-1422 has advanced features, such as a 16-bit interface for acquisition from 8, 10, 12, 14, and 16-bit cameras. In addition, the PCI-1422 includes a 40 MHz pixel clock for fast image acquisition and has 16 MB of onboard memory for buffering large images. Use the onboard counter/timers and digital I/O for precise image capturing, triggering, and timing. ▶

For more information, check the PCI-1411 or PCI-1422 data sheets on the reply card, or visit www.natinst.com/info/news

www.natinst.com/vision

New Signal Conditioning Solutions Deliver Ease of Use

National Instruments offers four new SCXI modules and five new SCC modules. The new SCXI modules give SCXI users more options as well as increased ease of use. The SCXI-1112 is an 8-channel thermocouple module with mini-thermocouple connectors built in. The SCXI-1125 is a fully programmable, 8-channel, isolated analog input module. It is functionally compatible to the SCXI-1120, except it has fully programmable input ranges, filter settings, improved accuracy, and enhanced calibration capabilities. Finally, the SCXI-1142 and SCXI-1143 are fully programmable, 8-pole, low-pass filter



modules with Bessel and Butterworth filtering, respectively. We recommend Bessel filters for maintaining signal phase

relationships between channels, while Butterworth filters offer a flat pass-band.

We also offer strain gauge signal conditioning for the low-channel count, modular SCC signal conditioning system. New SCC-SG0x Series dual-channel modules are available for 120 Ω quarter-bridge, 350 Ω quarter-bridge, half-bridge, and full-bridge strain gauges. By adding the SCC-SG11 module to each SCC-SG0x module, you can perform shunt calibration programmatically. ▶

www.natinst.com/sigcon

PXI – The Platform for Data Acquisition

PXI/CompactPCI is becoming a widely used platform for data acquisition. Its high performance, tight integration, and industrial compact packaging are among the features you can use to create solutions. Along with these features, a wide variety of modules perform I/O at all rates and degrees of accuracy. Combined with signal conditioning, PXI is becoming a favorite choice for DAQ systems.

Develop with Standard Components

A PXI system has the same look and feel as a standard Windows desktop system. In fact, at the heart of the system is a high-performance Windows-based computer. Therefore, you can write code and experience the same programming benefits of a PC, such as taking advantage of productive development environments, realizing faster time to market, and lowering costs.

Use the High-Performance PCIbus

PXI uses the PCIbus with data transfers and throughput rates up to 132 Mbytes/s. PXI also has built-in timing and triggering lines and a 10 MHz system reference clock for synchronization. DAQ modules

boards and LabVIEW RT. An RT Series board has its own independent processor capable of running embedded LabVIEW RT code in real time. If you add RT Series DAQ boards to your PXI system, you create a high-performance system that uses many independent real-time controllers to give you more processing power.

Use Modularity for Best Expansion Capability

PXI packaging offers superior mechanical integrity and easy installation and removal of hardware components. With the modular approach, you can easily mix and match DAQ components to construct a custom application and add in new components as your application grows. PXI does not have the slot and resource limits of a standard desktop computer. You can even choose one with built-in SCXI slots for signal conditioning or one with a display and keyboard permanently installed.

Use a Rugged and Compact Platform

Unlike a standard desktop PC, PXI can handle difficult environmental conditions and is rated for temperature, humidity, vibration, and shock extremes. It uses the standard Eurocard packaging system and high-performance IEC connectors. You can use the compact and rugged chassis in a wider range of applications such as industrial data acquisition, monitoring, and control.

Use Ethernet for Remote Operation

You can use the Ethernet port on the PXI embedded controllers for communication providing distributed and remote operation.



PXI packaging offers superior mechanical integrity and easy installation and removal of hardware components.

use the PXI trigger lines to route RTSI™ signals for multimodule timing, triggering, and synchronization.

Take Advantage of Proven DAQ Technologies

We create PXI DAQ boards from the same high-performance technologies we developed for our PCI DAQ boards. You program PXI DAQ boards identically to current plug-in DAQ boards and use the same high-performance A/Ds, timing and triggering ASICs, and RTSI bus.

Achieve Real-Time Performance

When DAQ and PXI technologies are not real time enough for specific applications, you can use our new real-time RT Series

Because of the Windows platform, networking is simple. With other high-level protocols, such as the VI Server technology in LabVIEW, RDA, and DataSocket, easy remote software control and data passing is possible.

Use the Online PXI Configurator

Configuring your PXI DAQ system is now easier than ever with the new PXI Configurator. Simply point your Web browser to www.natinst.com/pxiconfig and then choose your chassis, controller, and plug-in modules. You can configure a virtual PXI system online to see what your final solution will look like. Then simply click to order the complete system online. ✎

For more information, check LabVIEW RT kit or PXI brochure on the reply card or visit www.natinst.com/info/news

www.natinst.com/pxi

GenRad and NI Partner with Revolutionary Technology

by Bob Stasonis, GenRad

The Challenge: Developing a low-cost, functional test solution for automotive ECU testing in a high-volume manufacturing environment.

The Solution: Teaming with National Instruments to create a new test platform for a compact, tightly integrated product that builds on available instrumentation technology, such as PXI, MXI-3, TestStand, LabVIEW, and LabWindows/CVI.

GenRad has developed functional test solutions for industries as diverse as military, medical, and telecom for more than 30 years. Based on our research of the automotive ECU test market – which included automotive manufacturers, contract manufacturers, and systems integrators – we realized that we needed to create a new test platform.

The new test platform needed to address requirements such as high beat rate, multiple UUT panels, quality reporting, repeatability, and global outsourcing issues, while lowering the entry price point.

We needed to develop a new, compact, tightly integrated test platform that builds on available instrumentation technology.

Using revolutionary technology, such as National Instruments MXI-3, TestStand, LabVIEW, and LabWindows/CVI, customers who want a single chassis test solution now have an option.

National Instruments and GenRad worked together to create a system, the GR Versa automotive test (AT), to address these requirements:

- Speed – concurrent testing of multiple units under test (UUTs)
- Multiple analog and digital I/O – replacing the previous systems with a single system to solve cost and space issues
- Switching – a matrix solution handles the large number of test points and instruments without additional wiring or complicated cabling

- Active and passive loads – a small, easily integrated system incorporates loads internally to simulate various portions of the automobile
- Multiple communications protocols – communication to various manufacturer protocols
- Controller – an alternative to the embedded controllers that take up space in the chassis and make upgrades difficult
- Ergonomics – simple interface and minimal cabling
- Price – a cost-effective, modular solution with just enough components for test

Our Answer

We introduced the GR Versa AT test system, which uses National Instruments PXI, MXI-3, TestStand, LabVIEW, and LabWindows/CVI. The core of the system is a rack-mountable PXI chassis that handles more instruments and resources than any other PXI chassis available today.

By implementing this PXI system, we gain many advantages, including GenRad-designed plug-in PXIscan™ switching cards that work with custom loads. The GR Versa can dissipate up to 50 W per slot of cooling capacity, dissipating more heat than a standard PXI chassis. When the cards do not provide enough cooling, or the physical size of the loads precludes mounting in the chassis, the GR Versa has access panels for routing external load boxes to the system.

With a unique dual-level bridging scheme, we can place up to 19 CompactPCI and PXI instruments in a single chassis. In addition, we used 6U instrument slots to take advantage of minimal space requirements. The automotive communications protocol (ACP) card can handle several independent ports of automotive network protocol in addition to addressing several vendor requirements.



The GR Versa AT combines the GenRad patented PXIscan switching technology with low-cost PXI instruments.

MXI-3 was the key to using the maximum number of instruments in a single chassis. The unit is a complete PCI-to-PCI bridge in a single instrument width, and it works with most commercial PCs by connecting it to the GR Versa AT chassis. Therefore, the customer benefits from lower costs, additional instrument slots in the chassis, the ability to use PC plug-in cards, and an easy upgrade path for the PC.

We combined the powerful multithreaded test engine of TestStand with our ENCOMPASS Test Management software suite. Advantages include point and click switching, calibration control, automatic data logging, password security, and a tightly coupled development environment. GR Versa AT works with both LabVIEW and LabWindows/CVI.

The Result

Because of the flexibility of the hardware design and the powerful software tools, GR Versa AT is an easy-to-integrate system for the automotive industry. Using revolutionary technology, such as National Instruments MXI-3, TestStand, LabVIEW, and LabWindows/CVI, customers who want a single chassis test solution now have an option. ▶

For more information, contact Bob Stasonis, GenRad, Inc., 7 Technology Park Drive, Westford, MA 01886-0033, tel (978) 589-7000, fax (978) 589-2060, e-mail stasonisb@genrad.com

New 1.3 GHz Module Offers Switching for PXI/CompactPCI

National Instruments announced the availability of the NI 2590 for PXI/CompactPCI, a 4x1 reflective switch with 1.3 GHz bandwidth and 50 Ω characteristic impedance. Easy connectivity is ensured by SMB connectors conveniently placed in front of the module.

RF Routing Capabilities

This module is a 4x1 multiplexer capable of routing high-frequency signals with minimal loss. It features insertion loss of less than 1.5 dB and return loss of less than 1.4 dB. These characteristics, matched with the 50 Ω impedance, ensure that the switch

presence is minimal for frequencies more than 1 GHz in a 50 Ω circuit.

This module is ideal for routing several high-frequency signals to a scope/digitizer, such as the NI 5911 or NI 5102, or for routing the signals generated from an arbitrary waveform generator, such as the NI 5411, NI 5401, or NI 5431.

The lifecycle of NI 2590 is five million switches in the no-load condition. The NI 2590 consists of a control board and a switching module that you can replace once the lifecycle of the switches has been reached.

The NI 2590 handles PXI triggering so you can synchronize the operation of this

module with other modules in a very precise and controlled way. It works in CompactPCI systems as well.

With the NI 2590, you have an integrated PXI solution for the high-frequency domain, creating applications, such as automated test solutions for wireless components and accessories, antennas, cellular base stations, and other high-frequency products. ▶

For more information, check the NI 2590 data sheet on the reply card or visit www.natinst.com/info/news

www.natinst.com/instruments

PXI Module Offering Continues to Expand

The latest additions to the National Instruments PXI product line include two new E Series multifunction I/O modules, a high-resolution analog output module, and a digital image acquisition module.

The first new multifunction I/O module is the PXI-6052E, which has 16 single-ended, 16-bit inputs and acquires data at 333 kS/s. Its two 16-bit analog output channels generate output signals at 333 kS/s. The combination of rapid signal acquisition and generation at high resolution places the PXI-6052E at the forefront of our high-performance, 16-bit E Series boards, regardless of bus interface. Furthermore, the PXI-6052E has eight digital I/O lines and two 24-bit counter/timers, as well as both analog and digital triggering.

The second new E Series multifunction I/O module is the PXI-6025E. It has 16 single-ended, 12-bit inputs and acquires data at 200 kS/s. Eight digital I/O lines and two 24-bit counter/timers accompany the 12-bit analog output channels. It has 24 additional digital I/O lines capable of handshaking with other digital devices according to the 8255 protocol. The combined capabilities of the PXI-6025E – analog and digital – make it the best value of any PXI DAQ board available.

The PXI-6704 is a high-resolution analog output source that provides 16-bit resolution on 32 analog output channels – 16 current and 16 voltage. You can use these current and voltage channels concurrently and independently to provide 0 to 20 mA current output, accurate to ±2 µA without

external excitation and ±10 V voltage output, accurate to ±1 mV.

Digital image acquisition from National Instruments is now available for the PXI platform with the introduction of the PXI-1422. The PXI-1422 captures 16 bits of data at a clock speed of 40 MHz for a total acquisition rate of 80 Mbytes/s. With the 16 MB of onboard memory, you can capture large images and sustain real-time throughput. The board also features four general-purpose, bi-directional TTL lines for controlling and triggering and can handle the full line of cameras that work with the PCI-1424. ▶

For more information, check PXI-1422, PXI-6052E, PXI-6025E, or PXI-6704 data sheets on the reply card or visit www.natinst.com/catalog to view online.

www.natinst.com/pxi

Digital Camera Image Acquisition Hardware

Module	Spatial Resolution	Pixel Depth	Video Input	Memory	Pixel Clock	Digital I/O
PXI-1422	No limit	8-, 10-, 12-, 16-bit	Digital (RS-422 or TTL)	16 MB	40MHz	4

General-Purpose Data Acquisition Hardware

Module	Analog Inputs	Resolution	Sampling Rate	Input Range	Analog Outputs	Resolution	Output Rate	Output Range	Digital I/O	Counter/Timers	Triggers
PXI-6052E	16 SE/8 DI	16 bits	333 kS/s	±0.05 to ±10 V	2	16 bits	333 kS/s	±10 V	8	2, 24-bit	Analog/Digital
PXI-6025E	16 SE/8 DI	12 bits	200 kS/s	±0.05 to ±10 V	2	12 bits	10 kS/s*	±10 V	32	2, 24-bit	Digital
PXI-6704	–	–	–	–	16 voltage, 16 current	16 bits	–	±10 V 0 to 20 mA	8	–	–

*10 kS/s when using DMA for analog output. 1 kS/s when using interrupts for analog output.

LabVIEW-Based DAQ System Offers Hardware Flexibility

by Ted White, Engineering Manager,
Datepli, Inc.

The Challenge: Developing a long-term, portable monitoring system for industrial-size trucks in which the user can edit and add mathematical functions as the system acquires data.

The Solution: Using the LabVIEW 5.0 development environment and the extensive capabilities of the VI Server, we developed a software system that consists of an executable with two distinct types of plug-in modules – one for the DAQ system and the other for the mathematical functions performed on the data.

Introduction

We needed to build a new thermal test cell and upgrade the existing one. We decided to upgrade the old cell with a VXI-based DAQ system because of the high channel

system. The main application detects installed functions and makes them available to the user.

Software Architecture

At startup, the system reads an INI file. This file determines the name of the system, the DAQ system used, the number of DAQ channels, and the number of pseudo-channels (additional data calculated from real DAQ channels). This information is propagated through the main application so that the proper information is used and displayed on each user-interface screen.

The DAQ system entry determines which virtual instrument (VI) is dynamically loaded by the system whenever the DAQ VI is called. By changing this single entry, the same software can run with both hardware systems. The system also provides a demo mode, which gives the user a working version of the software prior to final delivery, offering valuable feedback during software development.

Mathematical functions are available in a defined directory. Any subVIs required by the functions are also placed in this directory. Users can add new functions to the system simply by adding them to this directory.

Data Acquisition

The DAQ module is called during calibration and test. During calibration, data acquisition is a single shot acquisition. For this reason, the call by reference node function is used. With this function, users can call any VI with a defined connector pane with this function. Inputs and outputs are wired with a regular VI, making implementation simple and increasing flexibility by changing the called VI without recompiling the executable.

During testing, users call the DAQ VI only once, then it runs for an extended period of time. To accomplish this, the VI had to launch without stopping the execution of the calling VI – this requires the



use of LabVIEW methods and properties. The main executable can now continue running without interference from the DAQ VI, but can still interact with the it.

Mathematical Functions

Mathematical functions are used in two places in the software – the test design and the DAQ portions. On launch of the test design screen, all filenames in the directory containing the functions are read. A common extension is given to each top-level function so the user can easily identify each one. When the test design is saved, the function name is saved, not the menu ring index. The function VIs are never loaded during the test design; only the names are read.

Conclusion

We provided the customer with a flexible software system – they can upgrade the software as their testing requirements change. With minimum LabVIEW knowledge, users can make the system work with a variety of DAQ systems from a PCMCIA plug-in card to a remote SCXI chassis. Users can add functions as new tests are developed. By using the existing plug-in modules as templates, the customer can reduce software development time and cost. ▶

For more information, contact Jim Coons, Datepli Inc., 2783 Thames Gate Dr., Mississauga, ON Canada L4T 1G5, tel (905) 672-0352 x103, fax (905) 672-0353, Web www.datepli.com

We chose LabVIEW as the development environment for its speed of development and ease of maintainability.

count capability of VXI and the expandability to other instrument types. The new cell would use the existing DAQ system until the budget provided for an upgrade. We chose LabVIEW as the development environment for its speed of development and ease of maintainability.

In the software design stage, we had to consider several requirements:

- Identical operator interface for the two systems
- Easy-to-upgrade DAQ system in the new test cell
- Math functions performed on data as acquired
- New functions easy to add

The software consists of a main executable that calibrates the sensors, enters test parameters, initiates a test, and displays the data. Dynamically loaded plug-in modules handle the DAQ and mathematical functions. An entry in a configuration file read at startup chooses the proper DAQ

GPIB Converters Deliver Flexibility

Have you thought about how to take advantage of Ethernet or USB in your test system? Are you running short on PCI, ISA, or PCMCIA slots in your computer? Most likely, you cannot find the right test instrument with these interfaces onboard. With a GPIB converter, you can control IEEE 488 (GPIB) instruments directly from many of the interfaces already installed in your PC without rewriting any of your GPIB source code.

Desktop Systems

Today, PCI has become the *de facto* peripheral interface standard for desktop computers. However, when you see standard off-the-shelf computers, you are generally limited to three or four PCI slots for adding measurement and control capabilities. Many solve this problem using industrial computers or PXI, with PCI bridges that handle more than four PCI slots. However, if low cost is a key factor and you want to stick with a standard desktop computer, consider using a GPIB converter interface. Today, Ethernet, USB, and serial are readily available interfaces you can use to control GPIB instruments. Under Windows 98, you have a plug-in interface such as the PCI-GPIB installed in your computer, in addition to the GPIB-ENET and GPIB-USB. For Windows 95, you use a plug-in interface such as the PCI-GPIB with the GPIB-ENET. We are working to provide this capability on other platforms as well.

Today, PC Cards (PCMCIA) are the standard for adding measurement and control capability to your notebook computer.

Portable Applications

Today, PC Cards (PCMCIA) are the standard for adding measurement and control capability to your notebook computer. Combined with powerful ASIC technologies for acquiring and moving data, PCMCIA provides adequate performance for most portable test applications. Many have been evaluating USB for portable applications because some USB devices can draw power directly from the USB port.



GPIB Converter Family

This offers advantages when you are testing on the go. The speed at which data transfers over USB is much slower than PCMCIA, but the GPIB-USB provides a convenient control solution if performance is not the main concern.

Controlling Racks of Instruments

Large test system configuration is challenging. When you have several racks of instruments you need to control, you do not want the burden of high cost and maintenance caused by putting a computer in each and every test rack. On the other hand, trying to control all the test racks from a single computer is a cabling nightmare. Ethernet and GPIB-ENET offer a practical

solution to this problem. You can place GPIB-ENET in each rack containing GPIB instruments. GPIB cabling is then localized to the rack. You can use Ethernet cables and an Ethernet hub to route an easy-to-manage Ethernet cable back to the computer. Our NI-488.2 software works with different GPIB-ENET interfaces to control hundreds of GPIB instruments. Because you are using Ethernet, you gain the advantages it offers for spanning large distances.

Direct Connect to Instruments

Historically, successful control interfaces have relied on standards for interoperability and ease of use to become mainstream. GPIB and serial are two excellent examples. Although some proprietary implementations are available from instrument vendors today, you must meet certain milestones before direct connect becomes more popular:

- Standard that ensures multivendor interoperability
- Readily available, easy-to-configure, and easy-to-use system
- Wide instrumentation selection

As you are investigating alternative interfaces, remember to ask vendors what they are doing to ensure interoperability and ease of use. In the meantime, you can rely on GPIB converter products to provide the extensibility you require in using other existing and emerging communications interfaces. ▶

Vanessa Trujillo, GPIB Product Manager
E-mail vanessa.trujillo@natinst.com

For more information, check GPIB brochure on the reply card or visit www.natinst.com/info/news

www.natinst.com/gpib

LabVIEW Toolset Improves Sound and Vibration Analysis

National Instruments Sound and Vibration Toolset extends LabVIEW and BridgeVIEW with functions and user interface objects for calibration, frequency analysis, transient analysis, sound level measurements, and new fractional-octave analysis. Coded entirely in LabVIEW G (source code included), the toolset works with both Windows and Macintosh.

Analysis of sound and vibration plays a role in product design, production test, architecture, and process control. For instance, measurement of sounds early in a product design cycle could lead to improvements in the initial design to ensure compliance with standards. You can also use sound and vibration analysis to meet market expectations. Examples include fine tuning an automobile door latching mechanism to impress a consumer with a satisfying click or modifying an exhaust system to change the tone of an engine.

Equally important is the role sound and vibration analysis plays in improving machine performance and reliability. When used during the design process, you can reduce vibration and reap such benefits as higher operating speeds, greater precision, extended component life, reduction of thermal effects, and energy savings.

Sound and Vibration Analysis

Sound and vibration analysis often begins with signal acquisition using microphones, accelerometers, tachometers, or displacement probes. To capture data from one of these sensors, you can deploy any of our plug-in DAQ devices or a GPIB or serial-connected instrument because the toolset is not hardware dependent and can work with an arbitrary sampling frequency. Nonetheless, for standards compliance, a National Instruments Series PCI-445x or 95 kHz dynamic signal analyzer (DSA) board is a good choice. When used with this toolset, these PCI plug-in boards offer compliance with numerous standards, including ANSI S1.11, Order 3, Type 1-D, optional range; IEC 1260: 1995, Class 1, ANSI S1.4-1983; and ANSI S1.42-1986.

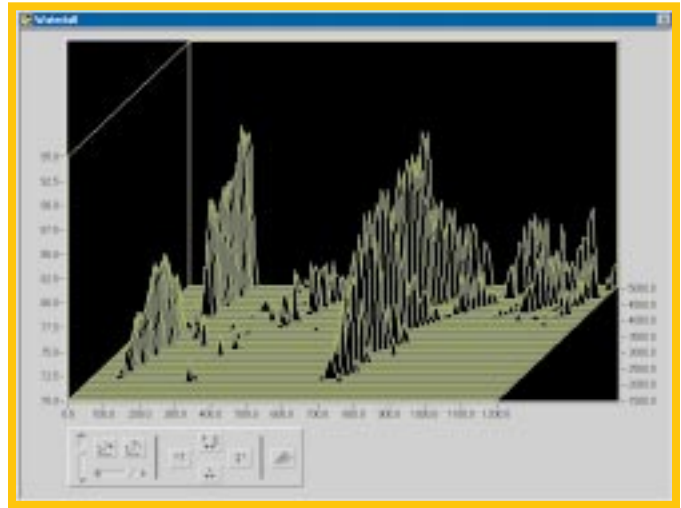
Following acquisition, you want to associate the incoming signal with such characteristics as sensor sensitivity, an

engineering unit, and a dB reference. The analysis routines of this toolset track these and other parameters and produce properly labeled, scaled, and calibrated results. In addition, you can apply a standard A, B, or C weighting filter to your time-domain signal.

For frequency-domain analysis, this toolset includes averaged and non-averaged routines based on the Fast Fourier Transform (FFT). With the non-averaged variety, you measure FFT, power, and cross-power spectra of a single block of data. Averaged measurements include FFT, power spectrum, cross-power spectrum, frequency response function (H1, H2, or H3), coherence, and coherent output power. Averaged transforms accept multiple blocks of data and calculate measurements based on contiguous or non-contiguous (such as overlapping) data blocks. Available averaging modes include RMS, vector, and peak hold. You can often reduce signal fluctuations and increase the signal-to-noise ratio by invoking an appropriate averaging measurement.

Fractional-Octave Analysis

Averaging is also a feature of the toolset's fractional-octave analysis and sound level measurement routines. You can perform fractional-octave analysis with any number of bands using bandwidths that include $\frac{1}{3}$, $\frac{1}{6}$, $\frac{1}{12}$, and $\frac{1}{24}$ octave. These routines can accommodate any sampling frequency and work with averaging modes that include linear averaging, exponential averaging, equal confidence, and peak hold. The sound level measurement functions include high-level tools for linear averaging (equivalent continuous level or L_{eq}), exponential averaging, and peak hold. For nonstationary signal analysis, the toolset also ships with transient analysis routines based on the Short-Time Fourier Transform (STFT). You can call



With the Sound and Vibration Toolset waterfall display, you can quickly display the results of a Short-Time Fourier Transform (STFT) as a function of engine speed.

these routines with a time-domain signal to obtain the frequency content versus time or with a tachometer signal to find frequency content as a function of rotational speed.

Display of Results

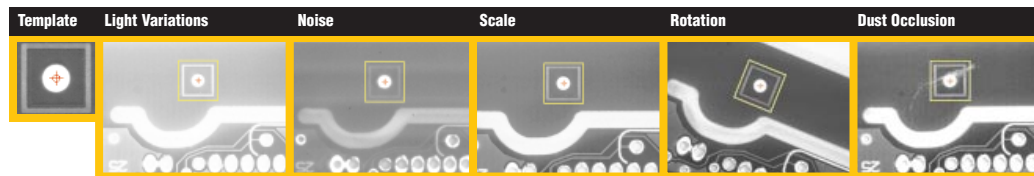
The results of any of the toolset analysis functions are available as standard LabVIEW or BridgeVIEW datatypes you can display or save to disk. The toolset also offers several enhanced display tools and functions fine-tuned for sound and vibration analysis. Examples include the octave bargraph and linegraph, which display on a log scale single or multiple octave spectra. In addition, a colormap control depicts the 3D result of a transient analysis with an intensity graph using colors to show the intensity levels of the third dimension. To display the results of a frequency or octave analysis, you can invoke a 3D waterfall graph that offers control over the view, orientation, autoscaling, storing/restoring a specific view, and transparency.✎

Sam Shearman, Product Manager
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For more information about the Sound and Vibration Toolset and signal processing analysis software, visit www.natinst.com/analysis

www.natinst.com/analysis

Vision Software Upgrade Locates Objects Quickly



Use IMAQ Vision 5.0 to inspect a wide range of processes.

Scientists and engineers who take measurements with National Instruments LabVIEW or BridgeVIEW can now add high-speed machine vision pattern and color matching to their repertoire. In addition, the Vision Development Software comes with IMAQ Vision Builder. Users can create advanced vision applications, perform “what-if” testing, develop inspection strategies, and output vision recipes that LabVIEW uses.

With the addition of the National Instruments Vision Development Software upgrade, including the new IMAQ Vision 5.0 and IMAQ Vision Builder 5.0, LabVIEW users can automate object location quickly and accurately regardless of size, orientation, focus, or lighting.

Pattern matching is key in most inspection and guidance applications, such as locating alignment markers on semiconductor wafers, guiding motion control, and inspecting the quality of manufactured parts. IMAQ pattern

matching locates objects quickly and accurately even when objects are out of focus, at various angles, partially hidden, and scaled (varying in size by ± 10 percent). IMAQ also matches patterns even when focus or lighting is poor.

Pattern matching occurs quickly because IMAQ “learns” the pattern from a sample image, or “golden template,” and then uses a speedy algorithm to search for every occurrence of the template in each new image. National Instruments vision software employs a revolutionary patent-pending search method that requires only one percent of the pixels from the template and a subset of pixels from the target image to perform a match. A correlation algorithm then checks for accuracy. For applications where the object is rotated, IMAQ pattern matching locates the object with a typical angle accuracy of 0.1 degrees. The new IMAQ pattern-matching software is more than 100 times faster than the

computationally intensive technique based on traditional, normalized gray-scale correlation.

Finding a template object with the gray-scale correlation is slow because millions of calculations are necessary to locate rotated and scaled objects in an image. By

contrast, test cases of IMAQ pattern-matching software using a 100x100 pixel template on a full-frame image (640x480 pixels) located objects in less than 40 ms.

The vision software upgrade also includes advanced color analysis functions to measure, compare, and match colors. Users can use it with National Instruments new IMAQ PCI-1411 color board, which offers real-time color conversion, to judge color quality, important in automotive, pharmaceutical, food, and printing applications. Real-time color conversion reduces problems associated with poor illumination, shadows, and lighting gradients across the image. ▶

For more information on the Vision Development Software upgrade, visit www.natinst.com/vision

www.natinst.com/vision

Pioneering FireWire Data Acquisition

National Instruments has broken new ground with the introduction of the DAQPad™-6070E, the world's first DAQ device for the FireWire serial bus. IEEE 1394 – also known as FireWire – features Plug and Play configuration and throughput rates up to 400 Mbits/s. (In addition, revisions are already underway to improve the rates to 3.2 Mbits/s.) While the maximum distance between devices is limited to 4.5 m, you can daisy-chain up to 16 devices with the thin, flexible IEEE 1394 cable. The DAQPad-6070E works with the Windows 98 operating system, which handles IEEE 1394 natively, although most computers do not yet have built-in hardware ports.

The DAQPad-6070E for IEEE 1394 takes full advantage of the bus capabilities –

the DAQPad is portable, easily configured, and can acquire data continuously at 1.25 MS/s. It has 16 single-ended (or eight differential) 12-bit analog input channels, two 12-bit analog output channels, two 24-bit counter/timers, eight digital I/O lines, and both analog and digital triggering.

In addition to the indispensable E Series characteristics, the DAQPad-6070E for IEEE 1394 features 250 V functional isolation from the PC and either BNC or mass termination connector configurations. Any nine to 25 VDC power supply or the optional BP-1 rechargeable battery pack can power the DAQPad.

National Instruments has once again demonstrated its leadership in the field of data acquisition by not only being the first

to produce an IEEE 1394 DAQ device, but by making that device easy to use and integrating it seamlessly with existing products. You can count on National Instruments to always provide the latest in computer-based measurement solutions. ▶

For more information, check DAQPad-6070E for IEEE 1394 data sheet on the reply card or visit www.natinst.com/info/news. For more information on IEEE 1394, visit www.natinst.com/tech2000

www.natinst.com/daq

New Developer Suite™ Software Streamlines Development

The new National Instruments Developer Suite Software bundles help you save thousands of dollars in software and development costs. Developer Suite combines our most productive development and add-on software for LabVIEW, LabWindows/CVI, and ComponentWorks so you can simplify your development. Now you can upgrade to a single, easy-to-maintain software package for tremendous savings over the cost of the individual tools.



If you use LabVIEW, Developer Suite Professional Edition offers a great value for the add-on tools you need. Developer Suite Professional Edition includes the LabVIEW Professional Development System, with source code control, an application builder for creating stand-alone executables, graphical differencing, and more. It also includes our most popular LabVIEW add-on toolsets including Enterprise Connectivity, PID, Systems Design and

Simulation, and Signal Processing, plus IVI™ high-performance, hardware-independent instrument driver libraries.

For those who use LabWindows/CVI, we recommend the Developer Suite Professional Edition, which includes the most popular LabWindows/CVI add-on software, plus IVI instrument drivers, ComponentWorks, ActiveX controls, and more. Developer Suite Professional Edition provides

your choice of National Instruments software tools to solve any measurement and automation application with the best software available for the job.

We recommend the Developer Suite Test Edition for automated test applications. Developer Suite Test Edition includes TestStand, a ready-to-run test executive and sophisticated test development environment.

Developer Suite offers tremendous value – from your initial investment through the entire development cycle – as you take advantage of the array of tools now available in a single package. Not only do you save money up front with either a new package or an upgrade, but you also save in total development costs by having all the software available when you need it. In addition, Developer Suite is easy to maintain as a single package. You can obtain a yearly subscription service to receive all add-on software or development system updates automatically for one year.

You no longer have to worry about individual software packages and deciding on toolsets – Developer Suite delivers the tools you need for huge savings over the cost of the individual packages. ▶

www.natinst.com/suite

New LabVIEW Instrument Control Course

Do you feel overwhelmed by the many options and combinations of hardware and software in today's measurement systems? With ever-expanding functionality and speed, learning new integration tools and techniques is frustrating and costly.

National Instruments Customer Education courses, such as the LabVIEW Instrument Control Course, cover the basic and advanced concepts you need to create and maintain a successful test and measurement system.

This course teaches you test and measurement concepts from an application perspective. The courses cover GPIB, serial, and stand-alone and computer-based instruments. We discuss

instrument drivers, IVI, and TestStand to teach you how to create a fast, efficient measurement system. We carefully design exercises to teach you the basic concepts you need to make your application a success! ▶

Visit the Customer Education Web site, www.natinst.com/custed, for a detailed outline in addition to the next LabVIEW Instrument Control Course that meets your schedule needs.

www.natinst.com/custed

National Instruments Partners with Amazon.com

The National Instruments Online Library, located at www.natinst.com/library, is now available for your use. It features a selection of books pertaining to computer-based measurement and automation, including:

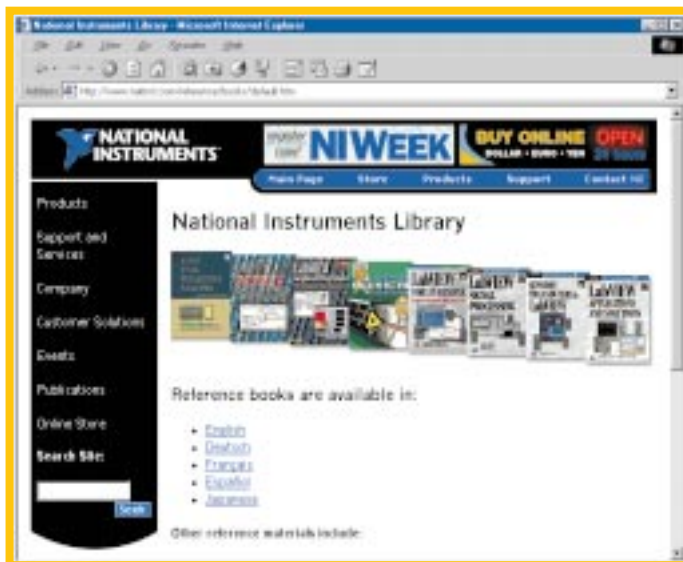
- LabVIEW
- Instrumentation and control
- Sensors and transducers
- Analog and digital electronics
- Electronic noise reduction
- Signal processing and analysis
- Computer vision
- Languages, application software, and operating systems

The library also features listings of computer-based measurement and automation books available in Japanese, French, German, and Spanish, as well as direct links to online application notes and product manuals.

Coinciding with the development of the National Instruments Online Library, National Instruments has joined the Amazon.com Associates Program in the United States, United Kingdom, and Germany. Visitors to the National

Instruments Web site, www.natinst.com, can now purchase reference material from the world's leading online book vendor at www.amazon.com, www.amazon.co.uk, and www.amazon.de

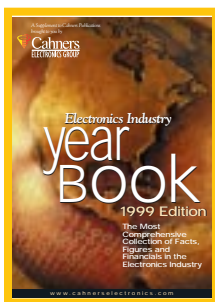
We have a wide variety of materials available on our Web site to help engineers and scientists learn more about computer-based measurement and automation, including information on products, measurement techniques, and integration partners. Providing an online library of resources and books is an obvious extension to our Web site that helps users educate themselves on how to use PCs more effectively in test, measurement, and automation applications. Make sure to



visit www.natinst.com as your resource for computer-based measurement and automation applications.✎

www.natinst.com/library

Three National Instruments Innovations Named Among the Top Ten Products



Cahners Electronics Group, in its 1999 Electronics Industry Yearbook, named three National Instruments innovations among the Top Ten T&M Products of 1998.

In selecting the winners, Cahners Electronics Group created a diverse panel of technical editors who serve the electronics community and assigned them the task of naming the 10 most notable developments of 1998. The National Instruments innovations included:

- IVI software
- GPIB-1394 FireWire-to-IEEE 488 converter
- NI 5911 Flexible Resolution A/D converter

“National Instruments is very pleased to be recognized as having three of the top 10 products for 1998,” said James Truchard, President and CEO of National Instruments. “We feel this achievement demonstrates more than the company’s dedication to building innovative, high-quality software and hardware products. This achievement reflects our leadership in redefining a new age in test and measurement – the revolutionary age of computer-based measurement and automation.”✎

www.natinst.com

Windows 2000 Online Seminar



Join us for Windows 2000, our next topic in the Technology 2000 Online Seminar

Series. During this seminar, we explore the new features of Windows 2000 and demonstrate how they can impact the measurement and automation industry.

September 15, 1999
10:30 a.m. CST, 15:03 UTC

Register at www.natinst.com/webevents

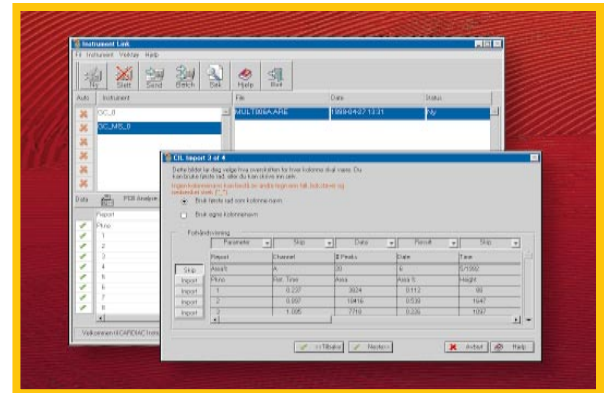
NI-Based System for Laboratory Information Management

CARDIAC, a Norwegian Alliance Program member, has created the IMATIS for LIMS, a modularized system suitable for both small and large laboratories. Programmed in LabVIEW 5.1 on either an Oracle or Microsoft SQL Server, IMATIS uses the latest computer technologies to optimize performance and flexibility.

The system connects simple laboratory instruments and larger instruments such as gas chromatographs or spectrometers through easy configuration methods. In addition, the system includes a LabVIEW template so you can incorporate additional devices. You start with a single DAQ module and expand the system to collect data from all the instruments in your laboratory. For larger process applications,

IMATIS incorporates OPC, fieldbus, and standardized tools for industrial devices.

CARDIAC designed IMATIS for integration between administrative and technical systems in an organization. IMATIS uses the latest standardized technologies – such as ActiveX components and Web and e-mail integration, including dynamic HTML reports – to ensure that data is accessible to decision-makers as well as to technicians and workers. IMATIS also uses barcode information to track the sample flow in laboratories. ✎



For more information, contact CARDIAC, Vipeveien 51, Porsgrunn 3917 Norway, tel +47 3593 0600, fax +47 3593 0666, e-mail cardiac@cardiac.no, Web www.cardiac.no

NI-Based Systems for Occupant Safety Testing



Microsys offers several National Instruments-based systems for occupant safety testing. The systems test air bags, seatbelts, and other interior items commonly found in automobiles and other passenger vehicles using a combination of National Instruments FieldPoint, SCXI, and GPIB hardware as well as LabVIEW software.

Static Air Bag Deployment System

The Microsys Static Air Bag Deployment System is a complete, highly integrated solution for testing air bags or product

interaction with air bags. The system includes high-speed video imaging, squib power supplies, safety interlocks, configurable deployment software, and advanced analysis capabilities. In the engineering environment, the Microsys system provides flexibility beyond the deployment method and in-depth analysis capabilities of sensor and video imaging data. On the

production floor, the system offers an easy-to-use and fully automated performance of lot acceptance testing.

Air Bag Burst Test System

For designers and manufacturers of air bags needing to test the quality of the fabric or stitching, the Microsys Air Bag Burst Test System is a complete, highly integrated solution. The Microsys system feeds compressed air into an air bag, inflating and normally bursting the bag. During this operation, the test system monitors the

internal air bag pressure and uses a high-speed digital video imaging system to obtain a visual record of the bag burst. Video imaging is necessary to ascertain the bag tear location because the time duration from tear onset to complete disintegration of the bag is only milliseconds.

Seatbelt Pretensioner Test System

The Microsys Seatbelt Pretensioner Test System is ideal for designers and manufacturers of seat belt pyrotechnic pretensioners who need to perform conformance testing. The Microsys system fires the pretensioner within a safe and controlled environment. As the pretensioner moves the seat belt webbing, the test system reads seat belt linear displacement, belt load, and anchor load. After the test, belt velocity and acceleration data are calculated and available for analysis. ✎

For more information, contact Microsys Technologies Inc., 3100 Steeles Ave West, Suite 205, Concord, ON L4K 3R1 Canada, tel (905) 761-5250, fax (905) 761-5244, e-mail coreym@micro-sys.com, Web www.micro-sys.com

Developers and Users Are Building the Future Today!

From August 18-20, more than 1,200 people from around the world gathered in Austin, Texas, for NIWeek™ 99, the Worldwide Conference on Measurement and Automation. The conference expanded to five primary tracks, each with two to four concurrent sessions, totaling more than 100 presentations during the week. In particular, the number of hands-on and advanced track sessions doubled since last year. Attendees learned how to squeeze the most out of their systems, saw previews of the most innovative emerging hardware and software technologies, and met with National Instruments management and engineers.

During the keynote presentation, “Building Your Future, Today,” Dr. James Truchard, President and CEO of National Instruments, and Neil Gershenfeld, Director of the Physics and Media Group, MIT Media Lab, discussed the impact of emerging technologies. On Thursday, August 19, Tim Dehne, Vice President of Engineering

at National Instruments, gave attendees a glimpse of how our engineers are using these technologies to develop solutions for the new millennium.

The NIWeek Exhibition housed more than 100 booths demonstrating the products discussed at the conference. In addition, attendees visited the poster session highlighting the entries for our Best Applications in Measurement and Automation Contest, gaining application knowledge from colleagues who have been successful with computer-based measurement and automation.

At night, attendees also enjoyed a variety of meals and activities. For instance, National Instruments hosted “Meet the Expert” night in the NIWeek 99 exhibition area, giving attendees additional time to network with exhibitors, our engineers, and application experts in the Poster Session. On Thursday night, National Instruments held “The

Future’s So Bright” extravaganza celebrating three decades of life-changing computer technology – attendees played games ranging from Pong and Pac-Man to virtual reality.

Make Plans to Join Us Next Year

Make plans now to attend NIWeek 2000! Find out about the latest developments in computer-based measurement and automation while enjoying the festivities surrounding this noted conference. In the meantime, join us for NIDays – one-day events held regionally around the world. ✎

For more information, check NIWeek Proceedings CD on the reply card.

www.natinst.com/niweek

Best Applications in Measurement and Automation Contest Winners

This year, 120 end users participated in the NIWeek 99 Best Applications in Measurement and Automation Contest. Criteria for the contest included technical challenge, innovation, and cost-effectiveness of the solutions. National Instruments recognizes the following people for their winning papers:

Best in Category Awards

Research and Development – Richard Jennings from Sandia National Laboratories for his paper, “Optimizing the Execution of Multithreaded LabVIEW 5.0 with Dual Processors and Windows NT 4”

Industrial Automation – Dirk De Mol from Honeywell-Measurex for his paper, “Honeywell-Measurex Develops Large Industrial Control Applications Using National Instruments LabVIEW Software”

Production Test – Craig Rupp from Alliance Technologies Group, Inc. for his paper, “High Current Fault Handling Module Test System”

Maintenance/Field Test – Lance Butler from B&B Technologies for his paper, “LabVIEW Tests M1A1 Ammunition”

Automotive – Russell Watts from Fleetguard, Inc. for his paper, “Reducing Time and Cost of Vibration Analysis and Reproduction”

Semiconductor – Sergey Liberman from Solidus Integration, Inc. for his paper, “Control System for X-Ray Photolithography Tool”

Biomedical – Keita Ikeda from Digital Instruments for his paper, “Cutting Latency on Assessing Heart Period Variability Studies”

Academic – Lambertus Hesselink from Stanford University for his paper, “Cyberlab, A New Paradigm in Distance Learning” ✎

www.natinst.com/niweek

References

“FireWire in Instrumentation Applications,” by Amar Patel, Real-Time Computing, February 1999. **A1598**

“LabVIEW 5.1: The Newest Version of National Instruments Graphical Programming Environment Offers an Array of Internet Tools and Integrates the Power of MATLAB,” by Norma Dorst, Sensors, February 1999. **A1596**

MXI-3 Technology Gives PCs Direct Control of PXI/CompactPCI



Use MXI-3 as a high-speed link between standard PCs and instrument equipment. Read more on page 3.

NIDays – One Day Technical Conferences on Measurement and Automation

A revolution is underway in how you develop your computer-based measurement and automation systems. The NIDays one-day technical sessions include in-depth training on our hardware and software products and give you critical information for your current and future applications so you can build the future today!

We hold NIDays Worldwide across the Americas, Asia, and Europe throughout Autumn 1999*. ✈

To find out dates and locations nearest you, visit www.natinst.com/nidays

*Not available in all locations



This newsletter represents a commitment from National Instruments to the environment.

Printed in the USA

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Look for the National Instruments booth at these upcoming trade shows:

AutoTestCon – San Antonio, TX	Aug 31-Sept 2	System Control Fair – Tokyo, Japan	Oct 6
Messcomp – Germany	Sept 7-9	TEST – United Kingdom	Oct 6-7
SAE Off-Highway – Indianapolis, IN	Sept 13-15	ECH&S – Australia	Oct 14-15
Sensors (DAQ focus) – Cleveland, OH	Sept 14-16	Interkama – Germany	Oct 18-23
Photonics (vision focus) – Boston, MA	Sept 20-22	INTERMAC – Tokyo, Japan	Oct 19-22
Elektrotechnik – Netherlands	Sept 27-Oct 1	Wescon – San Jose, CA	Oct 19-21
Embedded System Conf. – San Jose, CA	Sept 28-30	Nepcon – Dallas, TX	Oct 27-28
Int'l Test Conf. – Atlantic City, NJ	Sept 28-30	Mexitronica – Guadalajara, Mexico	Oct 29-31
High Technology – Toronto, Ontario, Canada	Oct 5-6	Outside Plant Show – Fort Worth, TX	Nov 10-11
SEP – Paris, France	Oct 5-7	Seoul Instruments – Korea	Nov 19-22
Vision Show – San Jose, CA	Oct 5-7	CIA – Singapore	Nov 30-Dec 3



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