Instrumentation newsletter

Technical News from National Instruments

Second Quarter 2000

Real-Time Control Systems – From Design to Deployment

Real-time control systems, with reliable deterministic control operation, are required across the enterprise for research and development, production test and manufacturing, and machine monitoring and control.

However, traditional real-time control systems can be difficult to develop because the tools available include disparate components such as chips and boards, C, assembly or proprietary software environments, single board computers, I/O cards, and so on. For solutions, companies invest in internal real-time and embedded development groups, or purchase expensive custom systems from suppliers. These systems may not scale well to future needs, and often rely on maintenance and support from third-party companies.

With productivity increases every year fueled by technologies from the evolution of the Internet and the personal computer, real-time control systems are one of the last bottlenecks

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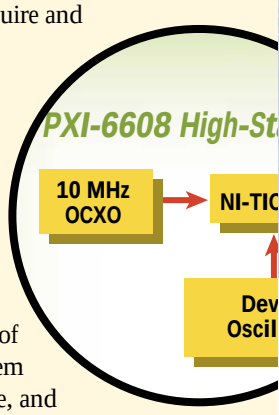
Using Stable Timing and PXI™ Phase-Locking Technology to Take Better Measurements

The timing oscillartor is the heart of your measurement hardware. Precise, stable timing provides the healthy pulse on which you can acquire and output data samples. However, when your system is comprised of multiple devices, each device operates by referencing a different pulse. The ideal solution would be to have an oscillator at the heart of your multidevice system that was stable, precise, and could provide timing for all the components in your system. PXI



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NI Developer Zone™ – The Essential Technical Source for Measurement and Automation

Where do you turn for technical advice on your measurement and automation challenges? Who can help when you are looking for a proven technique for acquiring or analyzing a particular type of signal? How do you learn about the latest development tools? The NI Developer Zone is a new Web-based resource that provides a central repository for technical tips and techniques for computer-based measurement and automation system development. At zone.ni.com, you can exchange ideas, access extensive libraries

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NATIONAL INSTRUMENTS™

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Here's What You Missed...

- Learning about Measurement Studio™, revolutionizing text-based programming with a complete set of the most productive tools for industry-standard programming languages
- Discovering the improvement to LabWindows™/CVI Version 5.5
- Knowing how digitizer technology is having a direct impact on measurement and automation approach

...If You Missed the Last Issue.

ni.com/reference

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Thomas Edison and Internet Appliances

TIME Magazine called the last 100 years, the century of science and technology. The 20th century began with Thomas Edison and his small laboratory team inventing innumerable useful devices to simplify our daily lives. As the century progressed, many companies relied on small armies of engineers for typical product design. Each engineer specializes in a specific aspect of the project and performs all calculations manually. As we start the next 100 years, measurement and automation technology is returning to the philosophy of Edison – the power of the personal computer and the Internet, the versatility of hardware, and the productivity of graphical software make it possible for a designer or a small team of designers to unleash their creativity and build innovative systems for diverse applications. We see that innovation in the exciting solutions you are developing every day to improve all our lives.

We invented National Instruments LabVIEW graphical programming more than 12 years ago. Our vision was to create software that was as productive and easy to use for engineers as the spreadsheet was to accountants. This intuitive, logical flow diagramming software would integrate tightly with hardware making it easy to automate measurements and control, while taking advantage of the personal computer for processing, display, and so on. Engineers could concentrate on their designing strength and use software tools, such as LabVIEW, to rapidly prototype, test, and deploy advanced systems.

Small teams of engineers are bringing about the integration of manufacturing and test to optimize production. Because these engineers know what it takes to run the line, they can make it work better by building scalable, integrated systems using intuitive software. At National Instruments, we are committed to providing computer-based measurement and automation tools and technologies that energize the individual designer and enable small teams to create sophisticated solutions.

Build Your Own Appliance

Imagine a modular measurement system, running a real-time operating system with deterministic control, communicating results over Ethernet to a host, a Web server, or directly into a corporate database. Imagine developing the system yourself. Imagine doing all this in LabVIEW. Today it is possible, and is just one example of the power of LabVIEW RT running on the PXI platform. With distributed virtual instrumentation, you can build a virtual instrumentation system around a single PC and create a truly distributed measurement system.

The start of the new century finds the technology industry talking more about Internet appliances, and less about the personal computer. While we believe in the PC platform, we are also quite excited about the possibilities of a new genre of computing devices. The idea of creating Internet appliances is also appealing to many traditional instrument and data acquisition companies. While we see promise for an expanding range of applications for these new devices, we also see some limitations. Virtual instrumentation is based on the premise that you should have the most flexibility in defining the instrument or system requirements. While some vendors replace traditional serial and GPIB interfaces with Ethernet connections and built-in Web servers, these devices are still vendor-defined. The communication functionality is new, but the measurement functionality is limited by the vendor-built device. Distributed virtual instrumentation, on the other hand, takes full advantage of Ethernet, the Web, wireless technologies, and more to truly deliver new measurement functionality that is ultimately defined by you.

At the beginning of this new century, we look forward to the challenges and opportunities that we will experience in the measurement and automation business. The miniaturization of the powerful computer, the connectivity of the Internet, and the continuing advances in software technologies will have a tremendous impact on all of us. We look forward to your inventions and innovations in the 21st century.

John Graff, VP Marketing

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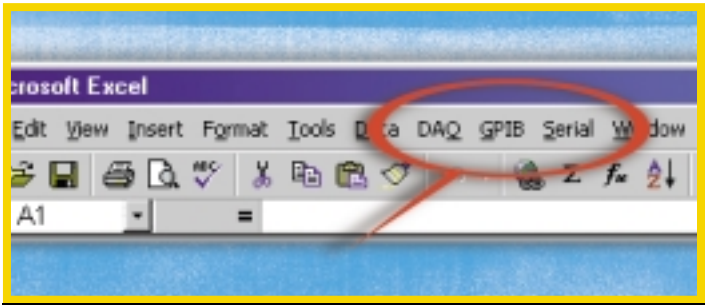
Measurements Made Simple with National Instruments Tools

With National Instruments Measure™, LabVIEW, and Measurement Studio™, you can extend Microsoft Excel for measurement and automation.

For formatting, processing, charting, printing, and other tasks, many engineers and scientists turn to Microsoft Excel. Because the spreadsheet focuses on business applications, it is not a complete, out-of-the-box solution for measurement and automation. By itself, Excel lacks tools for instrument control, data acquisition, and other engineering-specific applications.

Automate Measurements in Excel

You can fill these gaps with National Instruments Measure, LabVIEW, and Measurement Studio software designed to easily work with Microsoft Excel. Measure is a configuration tool for quick setup of simple Excel-based measurement systems. LabVIEW and Measurement Studio give you the flexibility you need for any job and offer a variety of Excel links – Excel-compatible file export/import, ActiveX client/server, and dynamic data exchange (DDE) for example. For simple measurement tasks that do not require sequencing or a custom user interface, use National Instruments Measure. Measure plugs directly into Microsoft Excel 2000/9x, giving you access to data acquisition (DAQ), serial, and GPIB tasks from added pull-down menus. Using simple dialog boxes accessed from these menus, you can quickly configure and automate measurements from the Microsoft Excel environment. Measure automatically stores results in one or more specified Excel cells.



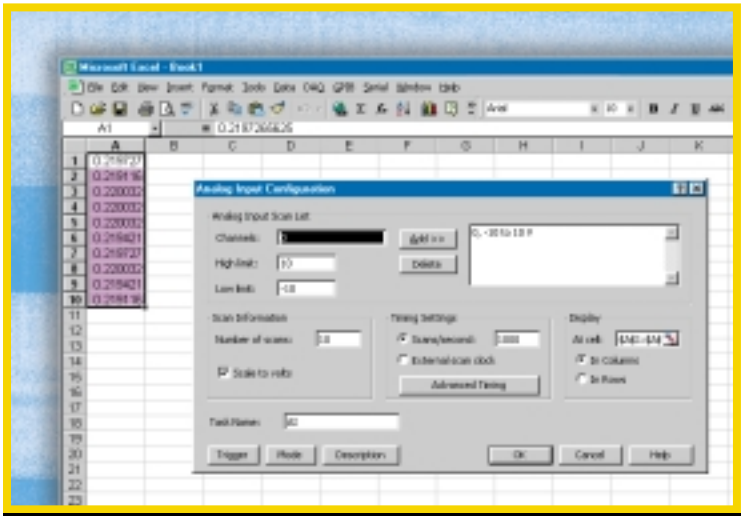
National Instruments Measure adds menu items to the standard Excel toolbar for data acquisition, serial instrument control, and GPIB instrument control.

Measure Excels at Simple Tasks

Consider a case in which you want to automatically record a series of weight measurements with a computer-connected balance. To automate the process, you first connect and configure the communication device. This configuration is a simple, two-step process that is similar for both serial and GPIB-connected balances.

First, you set up communication with one or more instruments. A dialog box guides you through this setup, which features automatic detection of most GPIB devices and the ability to type device commands and immediately see the device response.

Second, you associate measurement tasks with the instrument. Dialog boxes help you set up the measurement particulars, such as the command to request a measurement and the Excel cell destination for the measurement. With each task, you can have single or multiple measurements that fill a single cell or a cell range, respectively. In this example, you might set up a task to take five measurements from the balance, and fill a range of five cells with the results.



The Measure dialog boxes guide you through configuration of measurements, so you can set such parameters as ranges, triggers, and cell destinations.

Automate Your Configuration

After configuration, you can quickly start tasks by adding a menu item or button to Excel. Such simple configuration-based measurements are only the starting point for measurement automation with Measure and other National Instruments software. For more complex applications, you can also call up tasks from Visual Basic for Applications (VBA), the Microsoft Excel scripting language. Measure also has a conversion utility that can automatically build VBA code based on your tasks.

By combining Microsoft Excel and National Instruments software, you can address everything from quick configuration of simple measurement and automation tasks to more complex, involved tasks.

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For more details, read "Tech Tips – Integrate Microsoft Excel with National Instruments Software" on zone.ni.com Resource Library. Enter the title in the search field.

ni.com/measure

Real-Time Control Systems – From Design to Deployment

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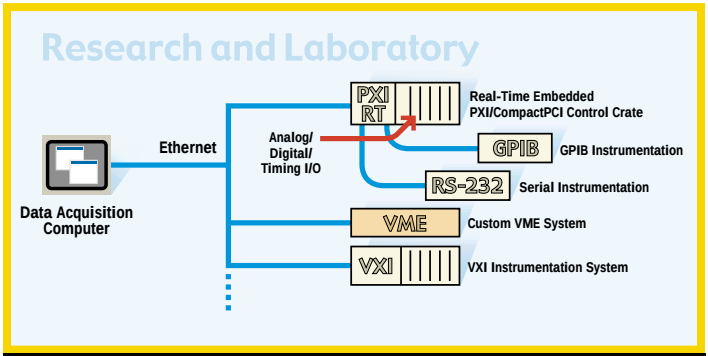
for faster time to market. In order to overcome development time issues, you need easy-to-use, industry-standard tools that can quickly take you from the design stage to final deployment. With National Instruments LabVIEW RT and RT Series hardware, you can now scale your system from the desktop to real time, without learning new tools or programming. With industry-standard LabVIEW, data acquisition (DAQ), and now the PXI system platform, you can attain hard real-time control with deterministic properties in the microsecond to nanosecond range, without giving up the ease of use and connectivity of the Windows environment. This hardware and software combination has flexibility and ease of use for research and design; power and performance for production test and manufacturing; and reliability and integration for machine monitoring and control. With these off-the-shelf tools, you now have unified development tools across your enterprise that can speed time to market and eliminate the productivity bottleneck for deterministic real-time control solutions.

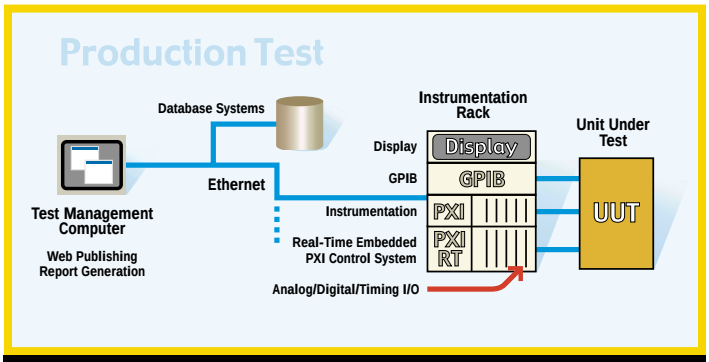
LabVIEW RT Software and RT Series Hardware

With LabVIEW RT, you develop with easy-to-use graphical programming in Windows, then download and run real-time code on a hardware target. The target is either an intelligent data acquisition board, or the PXI-8156B RT controller that can control a chassis of any data acquisition I/O in real-time.



Combine off-the-shelf RT systems and custom VME crates for real-time control while monitoring via Ethernet from your PC.

The RT Series DAQ board easily adds a real-time component to an existing Windows system – it continues to run your custom LabVIEW real-time control code even if you reboot Windows. In addition, you can reconnect seamlessly back to the uninterrupted control process as soon as the Windows system reboots.



Use RT to control the test that is integrated with other instrumentation in the rack. Use one software development environment for test, measurement, and real-time control.

You can also download LabVIEW RT code via Ethernet to run in real-time on the PXI-8156, a PXI/CompactPCI controller. The controller, running the RT engine using a real-time operating system kernel, can run more control loops in the chassis faster, with determinism in microseconds or nanoseconds, depending on the code. With the controller, you can build a complete real-time system.

Research and Design

In the prototyping stage, you need flexibility in your real-time control system to easily adapt to changing code. As you design a new wing for a jet or an engine for an automobile, you need real-time control performance and the ability to debug and adapt code quickly for new enhancements. With LabVIEW RT, you have a complete compiled programming language with built-in functionality such as PID and fuzzy logic design tools. You have signal processing functions, the ability to define mathematics, simulation, and logic, and most importantly, strong integration with real-time I/O for realistic prototyping. With the RT Series real-time PXI controller, you can design on your workstation or laptop, and download, debug, and run in real-time on a crate of off-the-shelf analog, digital, and timing I/O. Not only is the code deterministic, but you can also take advantage of the real-time system integration bus (RTSI™) built into National Instruments DAQ hardware for additional timing, synchronization, and triggering. In addition, you have connectivity to other instrumentation via the onboard Ethernet port, the two onboard serial RS-232 ports, and the onboard GPIB port.

Production Test and Manufacturing

After you design and prototype your product, you need to test and manufacture it. In automated test, you need real-time performance for speed and reliability. With PXI, a standard CompactPCI platform for automated test, you can now mount real-time systems alongside Windows-based systems using the same software tools for both. Again, the onboard GPIB and RS-232 ports on the RT controller make it possible to connect to other instruments and hardware in the rack. The RT system can control the unit under test (UUT) as the instrumentation systems test it. You can also place the UUT in a constrained environment, where the real-time system can monitor and control environmental conditions. Because test engineers can scale their knowledge of LabVIEW, PXI, and other automated test tools to the real-time control arena, companies save orders of magnitude on development time, training costs, and maintenance costs in both software and hardware.

Real-time PXI systems make it easier to integrate automated test directly into the manufacturing process. Instead of test and quality control occurring only at the end of the line, these systems are now reliable enough to function within the manufacturing process. This integration of test and manufacturing results in better quality throughout the process, and ultimately in reduced time to market.

One area the real-time PXI solution excels in is short life-cycle testing or lower unit volume under test. You may need to test a product that obsoletes within a year and require shorter test development times, or you may need a test system that can run a small batch test for a series of low quantity custom products in minimal time and can be reconfigured for the next batch. For both these situations, the flexibility and ease of use of the LabVIEW RT and RT PXI solution can create a complete solution that is easy to customize. In addition, you can deploy several real-time systems using stand-alone executables just as you can with LabVIEW. Because you use standard, off-the-shelf hardware it is easier to reproduce and maintain the systems you build.

Machine Monitoring and Control

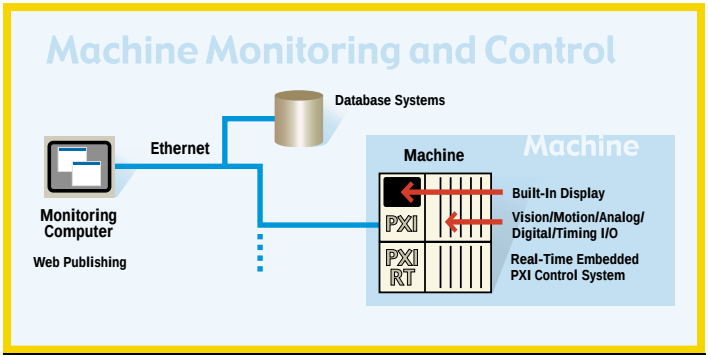
Machine monitoring and control, especially in the manufacturing process, requires reliability and deterministic on-time performance. The consequences of a system crash or a system that misses a timing requirement can be catastrophic. In controlling machines, parts may be made incorrectly, resulting in scrap or time to market losses. Even worse, hazardous conditions could develop, making an area dangerous to operators and other personnel on the floor. With these safety issues, companies need to use reliable systems.

With LabVIEW RT and PXI, you now have a reliable headless embedded system created with industry-standard tools you can easily maintain. It connects via Ethernet, RS-232, or even GPIB – or stands by itself.

However, new requirements in next generation manufacturing processes are outdating technology that has been a standard for the past 20 years. Software and connectivity are more important than ever. Machines today can interface to a database to download requirements for different jobs, or upload statistical information for quality control. Remote monitoring and control of machines also contributes to preventative maintenance. You could need stand-alone systems to communicate or integrate to other systems. When maintaining or reconfiguring systems, using off-the-shelf hardware and software is easier than trying to find replacement parts or reprogramming custom equipment. Companies faced with these issues have started to explore new ways to build a more efficient, integrated, control system that still meets the stringent requirements of reliability and real-time performance. National Instruments real-time products solve these issues with embedded control in a PC-based environment.

With LabVIEW RT and PXI, you now have a reliable headless embedded system created with easy-to-maintain, industry-standard tools. You can connect this system via Ethernet, RS-232, or GPIB to solve your stand-alone needs. You can program in a familiar Windows environment, and execute your real-time code on an independent system running on a real-time operating system kernel. Based on the standard CompactPCI bus, it is rugged, compact, reduces development and maintenance costs, and trims down floor space. Most importantly, you have systems integrators, developers, and National Instruments worldwide for training, support, and service.

National Instruments real-time development tools scale across an enterprise from design to test to manufacturing. The developer who uses LabVIEW on the desktop can apply those skills to development of real-time systems with LabVIEW RT for all areas of enterprise. With demand now ramping up for more sophisticated real-time control systems requiring shorter development cycles, real-time control systems development is positioned to grow. To take advantage of this in the fastest, most cost effective way, design laboratories, test departments, and manufacturing groups need to standardize on tools that help small teams of engineers develop systems quickly and maintain and modify systems easily. With LabVIEW RT and integrated real-time hardware, these companies now gain the competitive advantage.



For inspection machines, use integrated vision, motion, and real-time hardware. For rotating machines, integrate RT and high-speed data acquisition for vibration monitoring, control, and safety/shut-down systems.

Norma Dorst
Embedded and Real-Time Product Manager
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For more information, check LabVIEW RT brochure and white paper on the reply card or visit ni.com/info/news

ni.com/labviewrt

Using Stable Timing and PXI Phase-Locking Technology to Take Better Measurements

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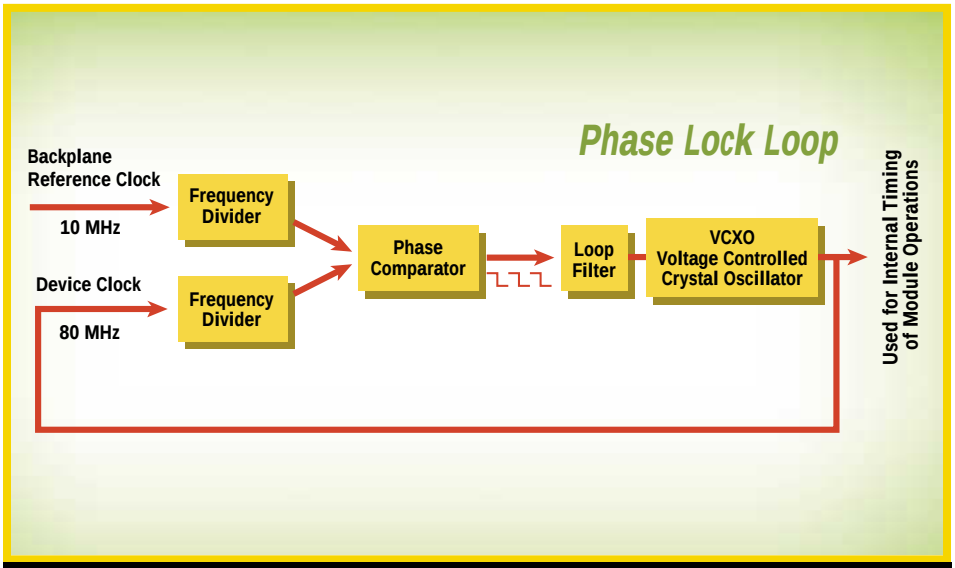
backplane phase-lock loop (PLL) technology gives you just that. By default, PLL technology synchronizes modules to the PXI backplane clock. By plugging in a PXI-6608 high-stability counter/timer module into slot two of a PXI chassis, you can use its highly stable and precise oven-controlled crystal oscillator (OCXO) in lieu of the standard backplane clock to improve the timing stability of your PXI system. While traditional off-the-shelf oscillators provide timing precision and stability on the order of 50 parts per million (ppm), this oscillator stays precise to within 75 parts per billion (ppb) over the period of one year. PLL technology then automates module synchronization of this common OCXO timing lock to improve the timing stability and precision of your measurements as well as ensuring that all timing operations are synchronized off of the same timebase.

Using an OCXO clock that can calibrate its frequency to a precise value and exhibit stable timing over time improves the accuracy of this period measurement and guarantees that measuring the same period in a number of years yields the same result

Using the Phase-Lock Loop

The control loop with PLL architecture works to synchronize the internal clock of a module with the 10 MHz clock coming from the PXI backplane. In step one, we divide the frequency of the module's own onboard clock to match the 10 MHz frequency of the PXI backplane clock. In step two, we compare the resulting phases of the two clocks with a phase comparator. The goal here is to drive the phase difference between the two clocks to zero, at which point the output of the comparator becomes a zero voltage steady state value. In step three, we filter the output pulse train from the comparator; and in step four, we stimulate the voltage controlled crystal oscillator (VCXO), causing it to adjust the phase of its own internal clock and minimize its phase-difference with the backplane clock. The resulting outcome of this ongoing control loop is two synchronized clocks. This technology can guarantee that all PLL-enabled modules in a PXI chassis perform synchronized operations that are at the same phase, limited only by the jitter, precision, and stability of the clock that is active on the PXI backplane.



Phase Lock Loop

Bringing High Stability and Precision to the PLL

The PLL and the NI-TIO™ timing ASIC on the PXI-6608 counter module work together to drive the OCXO clock to the PXI backplane star trigger line. Once this highly stable and precise clock is driven to the PXI backplane, we use phase locking to stabilize the internal 80 MHz clock of the NI 6608 counter module. The PLL synchronizes every eighth edge of the internal 80 MHz clock with an edge of the OCXO clock. The PXI-6608 counter module drives the OCXO clock to the PXI backplane through the NI-TIO timing ASIC, for other modules in the chassis to use their PLL circuitry to synchronize to it. With the OCXO operating as the PXI backplane clock, you can use a lower-cost PXI-6602 advanced counter module in additional slots and its performance increases to that of the OCXO-based module. This dramatically reduces the cost of a PXI high channel count, high stability counter/timer system. As a testament to the value of PLL technology, the PXI-6608 high stability module delivers impressive timing precision and stability, using phase locking internally to implement the stability of its built-in OCXO.

Timing Precision and Stability as a Component of Measurement Quality

Parts per billion timing precision and stability directly translate to better measurement accuracy and consistency when the measurement in question directly involves time or when you are interested in the frequency component of your data. Period measurement is a basic example of such a measurement. Because of synchronization between the internal time

base of the counter timer and the source signal whose period is measured, the measurement can be off by a single cycle of the time base. In addition to this error of a single cycle, the measurement of the period assumes a known frequency of the internal time base. The uncertainty of this period measurement is a direct result of the time base reference that you use, as well as the single cycle error. Using an OCXO clock that can calibrate its frequency to a precise value and exhibit stable timing over time improves the accuracy of this period measurement and guarantees that measuring the same period in a number of years yields the same result. Measuring duty cycle, pulse width, time, two signal edge separation, and phase with a counter-timer device, as well as generating pulses and pulse-trains with high-confidence in frequency, are operations that rely heavily on the precision and stability of the reference timebase. High-speed analog operations typical of scopes, high-speed simultaneous sampling modules, and arbitrary waveform generators also benefit from synchronizing to a common stable and precise clock source. For high-speed operations, a small timing discrepancy between modules can result in large phase errors.

With the ability to guarantee the timing precision of your measurements to ppb accuracy, you can reduce the timing uncertainty of your entire PXI system.

Use RTSI™ to Benefi from OCXO Timing

Many computer-based instruments and advanced counter timer devices for PXI from National Instruments have PLL circuitry built in and can take advantage of phase locking. For the modules that don't come with phase-locking technology built-in, you can use the real-time system integration bus (RTSI) built into the PXI backplane and used by National Instruments PXI modules to share the OCXO clock of the PXI-6608 advanced counter module. This means that analog input, analog output, and counter operations on an E Series multifunction device can use RTSI to benefit from the precise timing of the OCXO.

You can build a better system with precise timing if you use PXI phase-locking technology to take advantage of the precise timing and stability of the PXI-6608 high-stability counter module. With the ability to guarantee the timing precision of your measurements to ppb accuracy, you can reduce the timing uncertainty of your entire PXI system. When referenced to a time-base that is synchronized to an OCXO, most counter operations, together with many analog operations, are more precise and consistent. Using phase-locking technology across several PXI modules, you can create a tightly integrated, high-performance system without sacrificing cost.

Yiannis Pavlou, Product Manager
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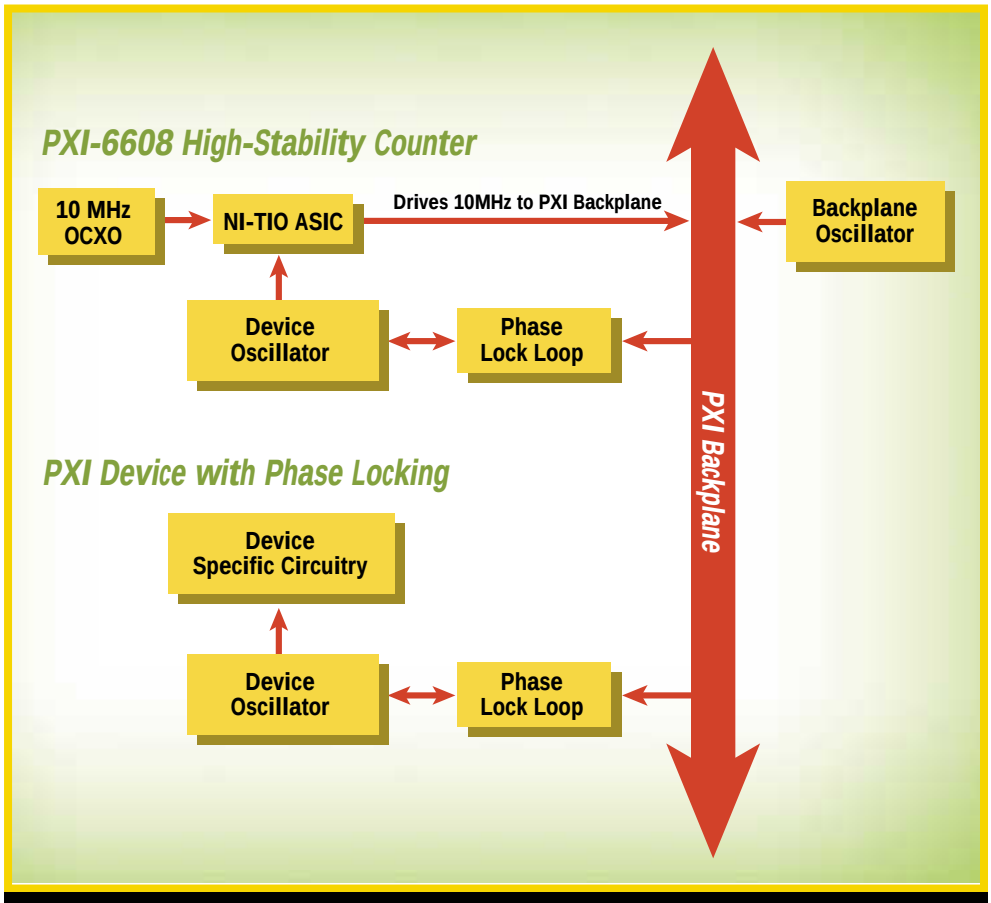
For more information watch the PXI-6608 video at ni.com/info/news

ni.com/daq



The PLL architecture that is used to synchronize a module's reference clock with the PXI backplane clock shown on page 6.

NI Developer Zone™ – The Essential Technical Source for Measurement and Automation

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of technical resources, and search for products based on technical specifications. As a member of the NI Developer Zone, you can access hundreds of example programs, application notes, technical articles, presentations, seminars, and code samples.

Providing additional technical content to the NI Developer Zone are Prentice Hall Professional Technical Reference, GlobalSpec.com, and *LabVIEW Technical Resource (LTR)* publishing. Prentice Hall PTR, a leading publisher of professional and academic references and textbooks, is supplying technical content from their huge catalog of titles. GlobalSpec.com provides technical specifications for more than 180,000 products to complete your systems, such as sensors, transducers, and motors. *LTR*, the largest independent technical newsletter for LabVIEW users, is providing monthly technical columns on LabVIEW development techniques.

More Than Technical Support – Technical Know-How

The National Instruments technical support Web pages have always been a resource in helping you solve problems encountered when building a system. Through the technical support section, you can download product manuals, new versions of drivers, or patches to get around specific problems. In addition, you can run wizards on the Web that show you how to install and configure your hardware, or search our Knowledge Base to learn how to handle specific compatibility issues or error codes. The NI Developer Zone builds on this technical support information with in-depth descriptions and recipes for solving specific applications and development tasks. The Product Resource Library contains more than 2,000 example programs, technical presentations, and tutorials to guide you through your development challenges.

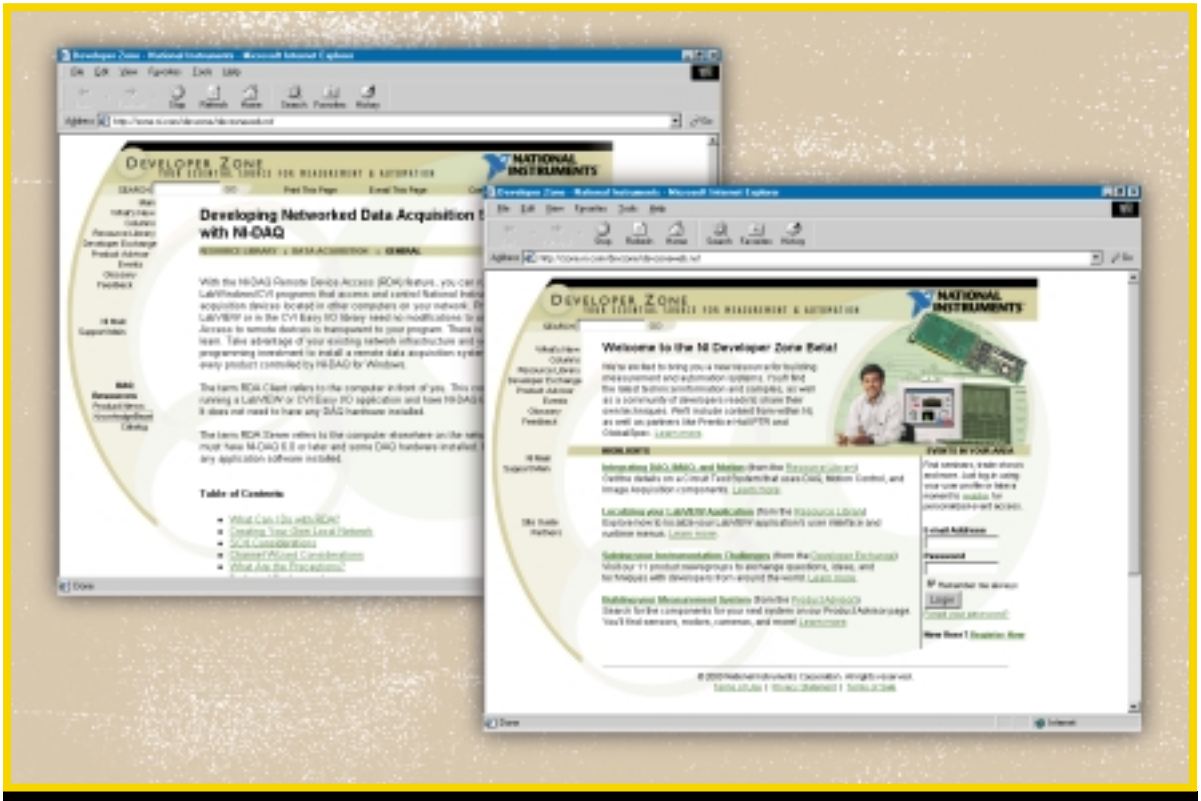
The Developer Exchange – 100,000 Heads are Better than One

The NI Developer Zone is more than just a technical resource for our users. We have designed this site to unlock the collective knowledge of the user community.

The NI Developer Zone is the definitive source for measurement and automation with thousands of example programs, presentations, and in-depth tutorials to help users solve specific applications and evaluate new technologies.

In the Developer Exchange area, you can trade ideas or questions with other users who may have experience solving the same applications on which you are working. You can post questions on the 11 product-specific newsgroups, browse through libraries of sample code provided by other users, or find information on User Group meetings in your area.

Just as NIWeek brings the virtual instrumentation community together in an exciting environment where users can share development techniques and success stories among themselves and National Instruments engineers for an entire week, the



NI Developer Zone puts the technical know-how back in the engineer's hands.

NI Developer Zone extends this environment to the Web for a non-stop virtual NIWeek experience. For the growing community of virtual instrument developers around the world, the NI Developer Zone is the home base for sharing knowledge and development techniques.

In addition, when you read an article online about a particular measurement technique, you can post additional thoughts or alternative techniques for getting the job done. You can rank the article's value. User comments and ranking are made available to others browsing the site, so you can quickly determine the helpfulness of each document.

The NI Developer Zone Product Resource Library

The NI Developer Zone core resides in the Product Resource Library, an extensive catalog of technical articles and example code that illustrate how to solve specific tasks for your measurement and automation system. The resource library includes information to help you specify and develop your system from sensor to solution. You can find information in the library that covers sensors, signal conditioning, wiring techniques, acquisition options, analysis algorithms, user interface techniques, and everything in between. The information ranges from sample code for making the simplest measurements with a DAQ board, to discussions of advanced timing and triggering approaches using the RTSI bus or backplane signals. This information comes directly from our product development engineers and technical support experts, as well as through our partnership with Prentice Hall PTR for excerpts from its extensive library of professional and academic titles.

Through the NI Developer Zone, you can tap into the huge community of virtual instrumentation developers around the world to exchange questions, techniques, and ideas.

The resource library also includes all of our technical presentations from our technical seminar series, NIWeek, and special product events, ranging from measurement techniques, product developments, and general computer technologies.

You can browse through the product categories to discover what is available, or you can use the advanced search pages in the NI Developer Zone to quickly find specific documents. When searching through the site, you can select from the specific databases to include in your search, such as example programs, presentations, and tutorials, as well as include resources from our technical support site on ni.com™ in your NI Developer Zone search.

The Measurement Glossary

In addition to development techniques and code, the NI Developer Zone also includes a Measurement Glossary with more than 2,000 terms and definitions. Definitions include common acronyms, instruments, measurements, PC technical terms, sensors, hardware and software technologies, and signals. For each term, you find a short definition and links to other topics either within the NI Developer Zone or on external sites.

Product Advisor – Find the Right Sensor for the Job

In the Product Advisor area of NI Developer Zone, you can search and compare thousands of products from hundreds of vendors to find the right component to complete your system. We have more than 100 categories of products, such as accelerometers, thermocouples, remote terminal units (RTUs), encoders, position sensors, proximity sensors, valves, pumps, level sensors, and motors. The product categories represent more than 180,000 products from more than 450 vendors. For each category, you can set parameters to match the specifications you need to find exactly which products are available to meet your system needs. You can then contact the vendor directly for a quote. The Product Advisor is powered by SpecSearch℠ from GlobablSpec.com, the leaders in parametric product search.

You can research and compare thousands of components in the Product Advisor area to find the right sensor, transducers, camera, motors, pumps, or switches to complete your system.

Sign Up Now

Access to the NI Developer Zone is free of charge. You sign up as a member of the NI Developer Zone by simply creating a user profile on our Web site. By providing your address, we can present you with the latest information about upcoming events in your area. In the future, we can further personalize the information and how it is presented to you based on your profile.

The NI Developer Zone is a site designed for you – the virtual instrument development community. The technical information available in the NI Developer Zone is growing and changing as the technologies and products change. The NI Developer Zone is a direct link between you, the virtual instrumentation developers around the world, and the engineers who design and build our products.

John Pasquarette, ni.com Web Team
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zone.ni.com

New Acceleration, Position, and High-Voltage Measurement Solutions in SCXI™

National Instruments introduces four new measurement solutions for SCXI, the proven signal conditioning and expansion platform for high-channel count data acquisition systems.

The SCXI-1530 and SCXI-1531 ICP® modules are 4-channel and 8-channel input modules for sound and vibration applications with accelerometers. First, each channel has an independently programmable amplifier, filter, and ICP excitation source for accelerometers. The amplifier provides gains from 1 to 100. The 4-pole Bessel filtering circuitry maintains a signal's phase relationship while removing unwanted noise. Possible filter cutoff frequencies range from 2.5 to 20 kHz. The ICP excitation source is a 4 mA current source that meets 24 V compliance. You can programmatically disable this excitation source on a per-channel basis, which is very useful for "noise floor" measurements or using input channels for non-ICP signals. These modules offer simultaneous sampling, which is critical for "cause and effect" vibration applications. Finally, these modules offer BNC connectors along the front of each module, so you can quickly connect and disconnect signals directly to the module.

Measure signals from ICP accelerometers, ICP microphones, LVDTs, RVDTs, and resolvers.

The SCXI-1540 linear variable differential transformer (LVDT) module is a new 8-channel input module for measuring position with AC LVDTs, rotational variable differential transformer (RVDT), and resolvers. Because this module is extremely versatile, you can programmatically change the input range, voltage excitation level, and voltage excitation frequencies on a per-channel basis. Therefore, you can customize the channel settings to match each of your position transducers. With its external synchronization capabilities, you can synchronize the phase of one or more of the AC excitation signals for your transducers. This prevents possible excitation signal coupling from affecting your position measurements. The SCXI-1530/1531 and SCXI-1540 include onboard calibration circuitry for self-calibration.

New SCXI Modules

Name	Description
SCXI-1530	4 Ch ICP Accelerometer Input Module
SCXI-1531	8 Ch ICP Accelerometer Input Module
SCXI-1540	8 Ch LVDT Input Module
SCXI-1104C	32 Ch 60 VDC,42VAC Analog Input Module

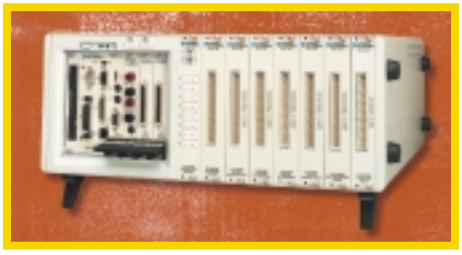
The SCXI-1104C high-voltage module is a 32-channel 42 VAC/60 VDC input module for dynamic signals. Each channel has its own instrumentation amplifier and 10 kHz filter; you can scan multiple channels at rates up to 333 kHz. This module provides a cost-effective solution for automotive, aerospace, or any other industry where common signal levels are between 10 to 42 VAC or 60 VDC.

For more information, visit ni.com/sigcon and click on the "what's new" page.

ni.com/sigcon

PXI-1011 Combination Chassis Offers Many Solutions

The new 12-slot PXI-1011 combination chassis is now available for integrating computer-based measurement and automation applications. The PXI-1011 combines the power of PXI/CompactPCI with the flexibility of SCXI signal conditioning into a single, rugged chassis. You get four PXI/CompactPCI slots for installing data acquisition devices, instruments, motion control, vision, and industrial communication devices. Use the eight SCXI slots for adding signal conditioning and switching modules to expand your channel count, add system protection, and programmatically control signal routing. Control your integrated system via an embedded controller or with a desktop computer via MXI™-3. Using this unique and



powerful architecture, you can build a variety of high-performance data acquisition, test, and industrial systems in a single, flexible chassis, such as:

- Data acquisition – combine PXI data acquisition devices with SCXI signal conditioning to measure temperature, pressure, strain, vibration, position, or flow. Compliment the system with digital I/O, analog output, counter/timer, and switching.
- Instrumentation/switch – combine PXI instruments with SCXI switching to create a single-unit automated test system.
- Industrial control – combine PXI technologies for industrial communication protocols, data acquisition, image acquisition, and motion control with SCXI isolated modules and switching to create an industrial monitoring and control system.

For more information, visit ni.com/sigcon and click on "what's new."

ni.com/sigcon

PCMCIA Devices Make High-Performance, Portable Data Acquisition Possible

Two new PCMCIA data acquisition devices from National Instruments deliver high speed input and output for your portable measurement needs. These high-performance, multifunction devices for PCMCIA contain first-in, first-out (FIFO) memory for both analog input and output. You can use them to create truly portable, flexible data acquisition (DAQ) systems using National Instruments measurement ready technologies.

The DAQCard™-6062E multifunction digitizer is a full-featured, high-performance E Series data acquisition device that delivers 500 kS/s scanning of 16 analog input channels and 12 bits of resolution. The 6062E also features two 12-bit analog output channels at 500 kS/s, eight digital I/O lines, and two 24-bit counter/timers.

The DAQCard-6715 high-speed waveform generator delivers 12-bit analog output and generates waveforms on eight

channels. It provides a single channel output speed of 1 MS/s, and also features eight digital I/O lines and two 24-bit counter/timers. These boards offer National Instruments measurement ready technologies that ensure reliable and highly accurate measurements.

Using miniaturized versions of the DAQ-STC™ and MITE™ ASICs that power the entire E Series lines, these new PCMCIA devices retain software compatibility with all other E Series devices from National Instruments. With this scalable technology, you can take advantage of a proven design while reusing your existing knowledge and application software. To fulfill your needs for portable data acquisition, you can now run your laptop with the same technology that powers your desktop PCI or PXI/CompactPCI DAQ devices.

For more information, check DAQCard-6062E and DAQCard-6715 data sheets on the reply card or download them at ni.com/info/news

ni.com/daq

Automate Measurements with Motion Using the MID-7604 Stepper Drive

National Instruments now offers a four-axis stepper motor drive built within a compact metal case, that is the size of a laptop computer. The CE-certified MID-7604 stepper drive simplifies motor setup and control with user-friendly features such as LED motor status display, front panel axis configuration, and easy-to-use motor and limit-switch connections. All motor commands, motion I/O, control, and feedback take place across a single, shielded cable that connects the MID-7604 stepper drive to a PC-based motion controller plug-in board.

The bipolar, chopper-type drive features a built-in power supply and configurable microstepping for smooth, low-speed operation and enhanced performance across the entire motion range. Engineers and scientists can configure the microstepping of the stepper drive and set current limits for each axis by accessing DIP switches in the front panel of the unit. The MID-7604 stepper drive provides between 0.2 and 1.4 A per axis. Motion I/O limit and home switch inputs incorporate input filtering for noise immunity.

Using the MID-7604

With the MID-7604 motion controller, users work more efficiently because they can quickly set up their motion applications. Users connect the PC, limits, motors, and encoders with little effort – checking the status of motor operation requires little more than a simple glance at the LED indicators of the unit.

The MID-7604 works with National Instruments FlexMotion™ and ValueMotion™ family of motion controllers as well as LabVIEW™ software, so that users can easily automate measurements using graphical programming tools. The National Instruments family of motion controllers,

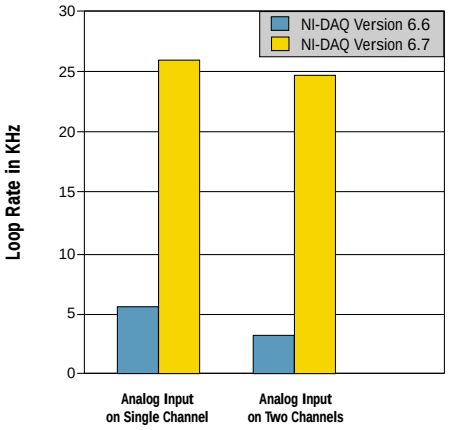
which are available in PCI, PXI/CompactPCI, and IEEE 1394 platforms, come with NI-Motion™, which includes driver software, sample code, setup and tuning utilities, and programming libraries for LabVIEW, C/C++, Visual Basic, and LabWindows/CVI.

For more information, visit ni.com/info/news to download the MID-7604 data sheet.

ni.com/motion

NI-DAQ Version 6.7 Data Acquisition Software Driver Boosts Single-Point Performance

The latest version of the National Instruments data acquisition (DAQ) software driver, NI-DAQ Version 6.7, boosts single-point performance, reduces DAQ virtual instruments (VIs) load-time, scales measurements faster and works with LabVIEW RT to drive PXI data acquisition modules in real time. Continuing the commitment to our international customers, NI-DAQ 6.7 components have been fully localized in French, German, and Japanese. NI-DAQ 6.7 increases the speed of single-point analog input and output operations up to 11 times for faster, more efficient control loop applications. It also decreases the load-time of DAQ VIs in LabVIEW by an average of 82 percent, making DAQ applications load faster. This new version of NI-DAQ also includes improved scaling algorithms in our easy-to-use configuration utility, Measurement & Automation Explorer (MAX). With the new scaling algorithms in MAX, users taking sensor measurements can convert voltage readings to physical values, such as temperature, up to 94 percent faster than before.



To create real-time DAQ or control applications, users run NI-DAQ 6.7 and LabVIEW RT on a PXI controller together with PXI DAQ devices in the same chassis. The application runs deterministically and reliably on the embedded PXI controller, while performing analog and digital I/O with National Instruments DAQ and signal conditioning modules plugged into the PXI system chassis.

Take advantage of the benefits of NI-DAQ 6.7 immediately! To upgrade, visit ni.com/nidaq

ni.com/nidaq

Monitor Motion Faster with New FireWire Motion Controller

With the National Instruments FW-7344 motion controller, users can now install multiaxis distributed motion controllers that use the high-speed IEEE 1394 (FireWire) network bus. This new communication technology provides faster data transfer rates than traditional buses.

The FW-7344 computer-based controller is the first multiaxis distributed controller to use FireWire as a communication bus. With FireWire, the host PC monitors motion at a much faster rate than other serial buses. The FireWire bus transfers data at 400 Mbs, which is markedly faster than traditional serial buses and the Universal Serial Bus (12 Mbs).

Once programmed, the FW-7344 controller monitors and controls motion independently from its host PC. Because the controller operates independently from the PC and communicates across the FireWire bus, the FW-7344 performs exceptionally well at high speeds.

Using the FW-7344

Users can quickly install the FW-7344 anywhere within 4.5 m of its host PC or another FW-7344 module. With FireWire, users can also connect as many as 32 FW-7344 controllers in a daisychain configuration. The self-contained units connect to each other and the PC with a FireWire port and cable. With the installation of FireWire conversion boards, which are sold separately, PCs are easily equipped to accept FireWire connections.

Motion controllers often operate in industrial environments, such as the production or manufacturing floor. At home in these harsh environments, as well as in the test laboratory, the FW-7344 is a sturdy, self-contained device.

LabVIEW users who expect easy programming can use LabVIEW to integrate motion control with their other data acquisition systems. Users can also program the FW-7344 distributed motion controller with C/C++, Visual Basic, LabVIEW, or LabWindows/CVI, a component of National Instruments Measurement Studio. Users simply download their software programs to the controller across the FireWire communication bus.

For more information, visit ni.com/info/news to download the FW-7344 data sheet.

ni.com/motion

Digital Camera Image Acquisition Gives You More

Digital and Analog Camera Comparison

Digital Cameras	Analog Cameras
Image transferred digitally to image acquisition board	Image transferred by analog video signal to image acquisition board
Digital data less susceptible to noise during transfer from camera	Analog signal susceptible to noise and interference
Typically have square pixels which makes dimensional measurements easier	Typically have rectangular pixels – vertical and horizontal pixel sizes often differ
Higher number of pixels and larger CCD sensors, resulting in greater gray scale and spatial resolution	CCD sensor usually standard sizes
Larger footprint	Smaller footprint
More expensive	Less expensive

For better resolution and faster acquisition rates, developers often use digital cameras rather than traditional analog cameras. National Instruments offers a wide range of image acquisition (IMAQ™) boards that use advanced digital camera features. With a digital camera IMAQ board, you can acquire images at thousands of frames/s with greater gray scale resolution and with more spatial resolution (up to 4,000 x 4,000 pixels).

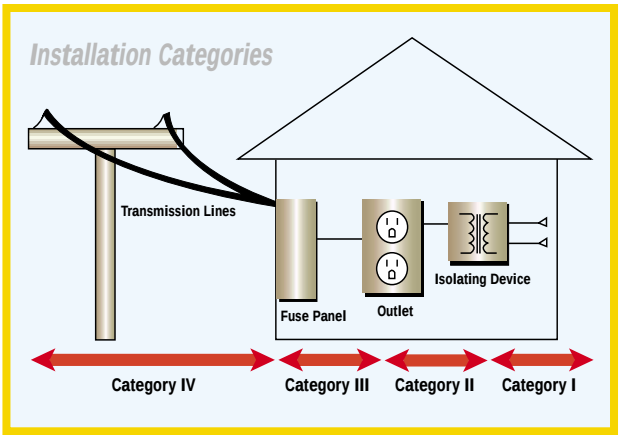
National Instruments 1424 Series boards for PCI and PXI/CompactPCI are some of the fastest digital image acquisition boards available with a 50 MHz pixel clock and 32-bit wide digital input (four 8-bit pixels). With 80 MB of onboard memory, the NI 1424 can acquire data at a top rate of 200 MB/s. The 1422 Series boards feature a 16-bit input and a 40 MHz pixel clock for lower cost digital image acquisition applications. National Instruments latest offering includes IMAQ hardware for the digital camera low-voltage differential signaling (LVDS) standard. LVDS is a device that extends the performance of the commonly used digital camera RS-422 differential data bus. RS-422 limits the frequency to the 20 MHz range. However, LVDS cameras can clock data out at 50 MHz using the IMAQ PCI-1424 LVDS board. Plus, you can use the LVDS of the IMAQ board to transmit data as far as 100 ft. LVDS also reduces noise significantly. Visit National Instruments Camera Advisor™ **ni.com/cameras** to select a camera that meets your application needs.

For more information, visit ni.com/cameras

ni.com/vision

The Shocking Truth About Isolation

When deciding on a measurement and automation system, always consider if your system needs isolation. Isolation breaks ground loops and eliminates the worries of signal referencing. The most common reason for using an isolated measurement system is to prevent voltage spikes, high common-mode signals, or improper signal connections from damaging your system or hurting the operator. If your system is measuring or exposed to signals above 50 V, we strongly recommend isolation.



Installation categories describe the possible transient signals you can expect for various signals.

How can you be sure your system really offers the isolation your application demands? The safest way is to look for an Underwriters Laboratory (UL) or International Electrotechnical Commission (IEC) isolation rating. In order for a product to meet UL or IEC isolation specifications, it has working safety voltage rating and a safety installation rating. Without these two pieces of information, your system may be susceptible to damage from transient voltage signals.

Working safety voltage ratings describe the largest voltage your system can accept without damage under normal working conditions. It is generally stated as a voltage value such as 300 Vrms. Working safety voltage ratings have a built-in safety factor to handle transient signals that may well exceed the working safety voltage value.

Safety installation ratings describe the largest transient signal your system can accept without causing your isolation to fail. They are described by category ratings, namely category I, II, III, or IV. Safety installation ratings are most commonly found in the power industry, describing where a piece of equipment could be used to measure power-line voltages and currents. For example, you can use a product rated for category II to measure the voltage signal out of a wall outlet. However, if you wanted to measure the voltage signal on transmission lines, your equipment must be rated for category IV because the transient signals on transmission lines are much larger than you would find at your wall outlet.

While you may not be measuring power signals from a wall outlet, your equipment may still require working safety voltage and installation

continued on page 21

Low Cost PXI Chassis Packs Performance into Small Places

With National Instruments new PXI-1002 chassis, you can package high-performance measurement and automation systems in a very compact space.

At half the size and less than half the cost of our standard PXI-1000B eight-slot chassis, the PXI-1002 four-slot chassis forms the basis for low-cost PXI/CompactPCI systems. The PXI-1002 chassis can hold up to three peripheral PXI/CompactPCI modules and an embedded controller. Alternatively, you can control it remotely from a PC with a National Instruments MXI™-3 interface in place of the embedded controller.

PXI-1002 provides you with a low-cost PXI/CompactPCI option.

Features of the PXI-1002 Chassis

The PXI-1002 chassis incorporates all features defined by the PXI and CompactPCI specifications, including a rugged, modular construction, integrated cooling, and a high-performance backplane. All PXI timing and triggering features are integrated in the backplane providing for tight synchronization of measurement and automation modules.

These features include a built-in 10 MHz reference clock, trigger bus, star trigger, and module-to-module local buses. An integrated fan with a removable filter provides dust-free cooling for modules in the chassis. The 170 W power supply has universal AC input for worldwide use. The PXI-1002 chassis is ideally suited for engineers, scientists, and systems integrators seeking a small, affordable, and powerful platform.

Installation and Mounting Options

The compact PXI-1002 chassis is available with options for a variety of different implementations in today's measurement and automation systems. Select the rack mount option for installation in 19 in. instrument cabinets or for wall mount configurations. You can install the rack mount kit on the front or rear of the chassis and recess the chassis in one inch increments, giving you complete mounting flexibility. Additionally, the chassis features numerous mounting points for applications that require an embedded installation. An optional handle and feet kit simplifies bench top and portable solutions.

Applications for the PXI-1002 Chassis

A wide range of measurement and automation systems can benefit from the small size and low cost of the PXI-1002 chassis. The following applications demonstrate how the PXI-1002 chassis offers a compelling system solution.

The PXI-1002 excels as a platform for applications in machinery automation where motion control and machine vision functions require tight coordination.

Combined Motion Control and Machine Vision System

The PXI-1002 excels as a platform for applications in machinery automation where motion control and machine vision functions require tight coordination. For the best image processing performance, slot one in this system can use a PXI-8170 embedded controller with a 700 MHz Pentium III processor using MMX technology. Slot two can harbor the PXI-1422, a digital image acquisition module – monochrome and color image acquisition modules are also available. Two PXI-7344 motion control modules can reside in slots three and four to control up to eight servo or stepper motors. You can program this complete system with LabVIEW to perform a wide variety of machine automation tasks.

Embedded Real-Time Control System

The small size of the PXI-1002 chassis is well suited to embedded applications where space is a constraint. When hard real-time control is a requirement, the PXI-1002 chassis housing a PXI-8156B embedded controller running LabVIEW RT provides an ideal solution. Choose from a broad selection of data acquisition (DAQ) modules for your I/O interface. For example:

- Slot 2 – PXI-6030E module with 16 channels of 16-bit analog input
- Slot 3 – PXI-6704 module with 16 current and 16 voltage outputs
- Slot 4 – PXI-6527 module with isolated digital I/O up to 28 VDC

Compact Multi-Instrument Test Platform

Using the PXI-1002, a MXI-3 interface to your PC, and instrument modules, you can build a very compact, low cost automatic test system. For example, many test applications require these basic components:

- Slot 2 – NI 5112 100 MHz 2-channel oscilloscope
- Slot 3 – NI 4060 5 ½ digit multimeter
- Slot 4 – NI 2503 24x1 multiplexing switch

You can take a closer look at all these systems and even purchase them online by going to the PXI Configurator™ at **ni.com/pxiconfig** and entering the following configuration IDs:

- Combined Motion Control and Machine Vision System, ID# 22897
- Embedded Real-Time Control System, ID# 22913
- Compact Multi-Instrument Test Platform, ID# 22905

For more information, please visit ni.com/pxiconfig or check PXI-1002 data sheet on the reply card.

Carsten Puls
Instrument Control/Systems Product Manager
carsten.puls@ni.com

ni.com/pxiconfig

Ethernet Device Server Simplifies Distributed Connectivity

The new ENET-232 and ENET-485 Ethernet device servers for RS-232 and RS-485/422 are self-contained box products that have a 100 or 10 baseT Ethernet input and either two or four ports of RS-232 or RS-485/422 outputs. Using the Ethernet-Serial device servers, users can control serial devices, such as instruments, scales, drives, or programmable logic controllers (PLCs), located in remote locations where Ethernet connections are available, making remote distributed connectivity easier.

Use Native Serial Ports

The ENET-232 and ENET-485 virtualize the serial ports as if they were native on the host computer. For example, if computer 1 is communicating with the ENET-232/485 port #1, then computer 2 can still communicate, for example, with port #2 of the same box. However, if computer 1 is already communicating with port #1, then no other application within computer 1 or any other computer can access that same serial port until the computer 1 application releases serial port #1.

Use Standard Windows API

We include the NI-Serial driver software for Windows NT with all Ethernet device servers. Users have the freedom to use any application software package that uses the standard Microsoft serial function calls. For example, the LabVIEW serial or VISA VIs can communicate with the ENET-232 and ENET-485 device server. Likewise, users can use standard serial calls from within standard applications such as Microsoft Excel, Visual Basic, or Visual C/C++.

The NI-Serial driver software handles the configuration of the Enet-Serial device server. Users can configure the IP address for the box either statically or automatically (DHEP) using a utility that ships with the driver. We designed the ENET-232 and ENET-485 device server to take advantage of standard Ethernet technology, which means users can use it with any TCP/IP-based network.

For more information, check the Serial data sheet on the reply card or download it at ni.com/info/news

ni.com/serial

SCXI-1190/1191 Offers High-Density Switching Up to 4 GHz

The new switch modules from National Instruments, SCXI-1190 and SCXI-1191, extend applications to new frequency levels. The modules are 50 Ω, quad 4x1 switches with 1.3 and 4 GHz bandwidth respectively, non-terminated.

RF Routing Capabilities

The SCXI-1190 is four times more dense than the NI 2590 for PXI, announced just last summer. This module is a quad 4x1 multiplexer and capable of routing high-frequency signals with minimal loss. SCXI-1191 has the same architecture with a bandwidth of 4 GHz. The modules have a lifecycle of five million switches in the nonload condition.

Application for Cellular Phone Testing

Both modules are ideal to route several high-frequency signals to a single channel of an oscilloscope card – such as the NI 5112 – or to route a signal from an arbitrary waveform generator such as the NI 5411 – to several testing points. Typical applications for these products range from testing base stations to wireless components, wireless accessories, satellite dishes, antennas, and cellular phones.

In addition, connectivity for the SCXI-1190 and SCXI-1191 is easy because we clearly placed all the SMB (SCXI-1190) and SMA (SCXI-1191) connectors in front of the modules. Moreover, because the modules are SCXI-based, you can build a completely integrated, hybrid system with signal conditioning and switching, all controlled by the same measurement device.

Use SCXI-1190 and SCXI-1191 for high-frequency applications.

Unsurpassed Functionality

The SCXI-1190 and SCXI-1191 further extend our SCXI switching offering in the high-frequency domain for new and exciting applications. The tight integration between PXI/CompactPCI and SCXI delivers to the user unsurpassed functionality for a very reasonable price.

For more information, check SCXI-1190/ SCXI-1191 data sheet on the reply card or visit ni.com/info/news

ni.com/sigcon

SCXI-1190/1191 High-Frequency Switching Modules

	Insertion Loss (dB)	VSWR	Isolation (dB)
SCXI-1190 (@ 1.3 GHz)	< 1.5	< 1.5	< -50
SCXI 1191 (@ 4 GHz)	< 0.9	< 1.5	< -55

The Intel AudioScope Measurement System

by Stuart Sherlock, Sr. Test Engineer, Intel Corp.

The Challenge: Developing a consistent resolution and tuning process to ensure audio clarity and overall quality of Intel Telephony products.

The Solution: Using National Instruments dynamic signal analyzer (DSA) boards to create a test process for audio performance designed to measure audio latency, data loss, volume, and frequency response.

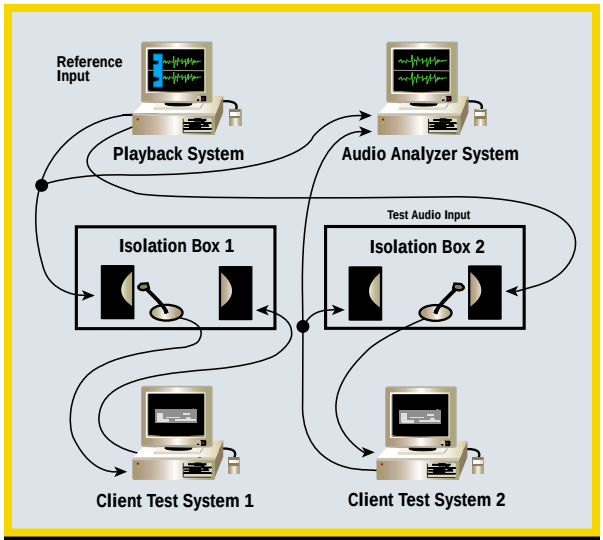
AudioScope, the measurement system developed by Intel engineers, monitors an input audio signal from a sending system and the received output audio signal from a receiving system. Audio performance encompasses latency and data loss due to transmission delays over Internet media or a Public Switch Telephone Network (PSTN) in media conferencing applications. To reproduce the audio inputs and to control the audio acquisition process, the system uses three standard types of wave files for repeatable reference sources; continuous, alternating, and Pink Noise.

National Instruments DSA board, NI 4551, is the core measurement device that helped us meet our audio testing demands.

System Configuration

Delivering unparalleled versatility and performance for audio measurements ranging from 20 Hz to 20 KHz, the acquisition system features a Pentium processor-based computer with National Instruments NI 4551 PCI DSA as the core measurement device. The NI 4551 onboard FFT signal processor delivers fast spectrum analysis and transient event analysis of real-time sampled time domain waveforms inputs. Additional features of the system include data logging, presets, and a strip recorder.

We developed an intuitive virtual panel that interfaces with the NI 4551 board with Visual Basic and National Instruments ComponentWorks™. The user interface provides the controls and visual indicators for the test software. Menu items provide access to most of the program controls and functionality. And with AudioScope options setting, the user can easily acquire other types of waveforms for real-time display and analysis such as volume verification, CODEC analysis, and jitter analysis.



Test Configuration and Layout of the Audio Measurement System

Measuring Audio Latency

Audio latency, the amount of audio transmission delay in a call between the sending system and the receiving system, is measured with the NI 4551 from the time audio enters the sending system microphone (or sound card microphone input) to the time audio is received at the receiving system speakers (or sound card speaker output). We modify the input reference signals to handle triggering on the AudioScope received input channel. Thus, the acquisition is a point-to-point black box timing measurement. The measurement process is independent of the media used to handle the audio call.

Measuring Data Loss

Data loss is perceived as a temporary loss of volume, usually associated with dropped audio packets. However, as network jitter increases, the audio playback buffer on the receiving system tends to under run. In actuality, there is no true data loss, just a change in the timing of the playback buffers. A plot of playback audio suffering from jitter looks very similar to one with data loss. However, there are distinct pieces of the waveform missing when compared with the original input signal. For test purposes, we can plot both conditions on the same graph to observe the results.

We designed and set AudioScope for the maximum displayed acquisition time base window of five seconds. However, analyzing the data loss acquired in this five-second window is difficult because the loss would occur randomly at any occurrence and duration. For this reason, AudioScope strip recording mode provides continuous acquisition over a user prescribed time, only limited by the size of the hard drive.

Calibration and Accuracy

To preserve the integrity of the acquired data, the system is calibrated by comparing signals with known latency values. We check calibration at several different latency intervals (100 ms, 200 ms, 400 ms and 800 ms) and correct for deviations.

Mobile Test System

We constructed a second system to meet the audio testing demands from other test and development groups within Intel. We organized this system to fit on a four-wheeled rack. The test systems are identical, with the exception of the sizes of the isolation boxes.

For more information, contact Stuart Sherlock, Sr. Test Engineer, Intel Corp., tel (503) 264-3089, e-mail stuart.sherlock@intel.com

ni.com/success

Get All Your Instrument Drivers Through IDNet

If you are building instrument control software solutions, National Instruments provides you with all of the tools necessary to make the task less difficult. Both our LabVIEW and Measurement Studio application development environments include native support for instrument communication through NI-488.2™ and NI-VISA™ device driver software. In addition, we have more than 1,200 instrument drivers available for FREE download through our Instrument Driver Network (IDNet) at **ni.com/idnet** Also part of the NI Developer Zone (see page 1), IDNet includes more than 200 contributed and beta instrument drivers available as-is.

Instrument drivers are a collection of high-level instrument control functions that mask the low-level communication details from the user. Instrument drivers can help speed up application development time considerably. There are several types of instrument drivers available from National Instruments:

- LabVIEW and LabWindows/CVI – a component of Measurement Studio – drivers provide basic functionality and full programmatic control of instruments
- VXI*plug&play* drivers for both LabVIEW and LabWindows/CVI follow a more consistent driver model and have a more defined feature set
- Interchangeable Virtual Instrument (IVI) drivers work with LabVIEW, LabWindows/CVI, and any environments that can call a dynamic link library (DLL). Based on specifications defined by the IVI Foundation, IVI drivers include additional features such as instrument interchangeability, state caching, and simulation

Regardless of your instrument communication needs, National Instruments provides the tools that you need to increase your development productivity and decrease your development cost.

IVI Foundation Update

The IVI Foundation, which is now 50 members strong, met in Austin, Texas in February and continued its work to define additional instrument class specifications and IVI architectural components. In addition, the Foundation membership decided to incorporate as a non-profit legal entity to protect shared intellectual property. Finally, the user members of the Foundation formed a working group to address user needs and streamline communication with the rest of the Foundation. For more information on the IVI Foundation, please visit **ivifoundation.org**

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

ni.com/ivi

New 13-Slot VXI Mainframe Ensures Maintainability

National Instruments introduces the VXI-1501, a high-performance, C-size, 13-slot VXI mainframe. The modular design ensures the highest level of maintainability, which results in a very low mean-time-to-repair (MTTR). This chassis fully complies with the latest VXIbus specification and is VXI*plug&play* compliant. The VXI-1501 mainframe provides easy airflow and power supply serviceability via the rear panel, and the backplane features solid-state, automatic, daisy-chain jumpering for VMEbus grant and interrupt acknowledge lines, eliminating the need for hand selection of switch settings.

The VXI-1501 is designed for easy maintenance and serviceability.

The VXI-1501 is designed for easy maintenance and serviceability. There is an air filter mounted on the rear panel that you can clean without tools. The cableless power supply interconnect to the backplane eliminates the risk of miswiring and enhances the safety of the chassis.

The autoranging power supply is capable of providing a maximum of 1,690 W with 120 to 240 VAC and more than 60 A at 5 V. It has built-in over-temperature, over-voltage, over-current, and short-to-ground protection for all outputs. A connector on the rear panel provides access to the power supply voltages so you can remotely monitor and operate the power supply.

A number of rack-mount options are available. The rack-mount kits give you various options to install chassis slides, cable trays, handles, flanges, and a combination of accessories you may require.

For more information, check VXI-1501 data sheet on the reply card or visit ni.com/info/news

ni.com/vxi

Using LabVIEW RT to Implement Complex Control Systems

by Martin Baird, TRW
Aeronautical Systems Group

The Challenge: Precisely implementing complex control algorithms specified in Matrixx format.

The Solution: Converting the control algorithms to LabVIEW and running them using LabVIEW RT.

Introduction

TRW Aeronautical Systems (formally Lucas Aerospace) is a leading international organization providing advanced technological systems, products, and services to the world's aerospace markets. In Birmingham, we are involved in the design and manufacture of engine control systems, in particular fuel systems, pumps, and linear actuators.

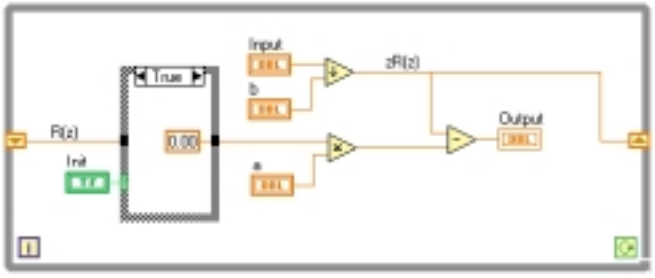
In the aircraft we control our hydromechanical systems by the engine Full Authority Digital Electronic Controller (FADEC). However, during the development and testing, a FADEC is often not available, so we have to specially design and build control systems for each system.

LabVIEW RT has provided us with a valuable tool to accurately implement control systems in a short time.

Hydromechanical systems are becoming more complicated, performance levels are increasing, and the designers now require us to provide control systems which precisely mimic the aircraft system so we can confirm system performance long before a FADEC is available. An analogue solution is no longer feasible.

We are building new test rigs using National Instruments data acquisition (DAQ) and control equipment running under LabVIEW. We also designed our new test units to run exclusively via a DAQ board and LabVIEW. We initially considered a LabVIEW solution to our control problem, however, at the time we rejected it because deterministic performance at very short cycle periods was not possible.

An alternative approach would have been to use Matrixx to generate object code to run on a separate DOS–based system. This method was ruled out because of high licensing costs, poor data storage, and display facilities.



LabVIEW Version of the z-Transform (z-a)/bz

National Instruments announced LabVIEW RT about the time that we were getting into some difficulty with a complex control system for the control of a multistage spool valve system. The idea of a dedicated processor to run our control system – programmed in LabVIEW – was precisely what we wanted, and just in time.

Control Algorithm

We were very familiar with LabVIEW because we have used it successfully for a number of projects. However, we designed our control systems using Matrixx. Control algorithms are described in a graphical manner rather similar to LabVIEW with functional blocks joined by data paths (wires). Each block is a function or a subroutine similar to a LabVIEW (VI) program.

To succeed, every Matrixx function and subroutine had to be exactly duplicated in LabVIEW. Most of the Matrixx functions have direct equivalents in LabVIEW. Less obvious solutions involved blocks described by Laplace transforms or worse still (for the writer) z transforms.

System Implementation

We used an RT Series DAQ board, the PCI-7030/6040E containing an AMD486DX5 processor. The complete control algorithm ran on the RT Series DAQ board in 330 µs per cycle. However, adding I/O increased cycle time over our 2 ms target. We set priority levels for all VIs to the subroutine level and ran the RT system top-level VI at time-critical priority cycle time to bring the loop back under 2 ms. We could set the scan rate accurately to 500 Hz using hardware timing.

Next we designed the host LabVIEW program to provide the interface to the RT system. Communication between the RT system and host system is via 1 kB of shared memory.

Using part of the shared memory as a circular buffer meant the RT Series DAQ board could read and write data on every one of its cycles (once every 2 ms) while the host system could read and write variable size batches of data whenever it was ready. Writing the batches of data to a chart provided an excellent real-time display which the user could stop and expand at any time to give detailed information on test performance.

Results

LabVIEW RT provides us with a valuable tool to accurately implement control systems in a short time. Users particularly appreciate the flexibility of LabVIEW. We can set up new tests in minutes and change control parameters with just a few key strokes.

We have further high-performance control systems to complete in the near future. Rather than spending hundreds of man-hours in designing and building special discrete control systems which would only give approximately correct control algorithms we will spend a day or two writing a new LabVIEW RT program in the certain knowledge that it will provide correct results.

For more information, contact
Martin Baird, TRW Aeronautical Systems Group, Shaftmoore Lane, Hall Green Birmingham, B28 8SW, England,
tel 0121-707-7111, fax 0121-706-9622,
e-mail martin.baird@lucasvarity.com

ni.com/success

Distributing Virtual Instruments over the Internet

Measurement and automation applications are no longer confined to a single computer – the acquisition, analysis, and presentation of the virtual instrument can now be seamlessly extended over a local network or the Internet to create a *distributed virtual instrument*. With distributed virtual instruments, you can take remote measurements, distribute a program's execution, or publish measurement data over the Internet. National Instruments hardware and software technologies provide you with the tools you need to easily build a powerful distributed system.

By publishing your measurement or automation application over the Internet, users on remote computers can view real-time data. With National Instruments application development environments – LabVIEW and Measurement Studio – Web servers are available so you can publish a user interface to the Internet. Without any additional programming, you can publish your front panel as a Web page so users across the Internet can view these panels running within any standard Web browser.

Increasingly, applications have one or more measurement nodes physically separated from the computer that is controlling them and collecting data. Remote measurement applications often require high speed streaming of data and several clients connected to a single measurement. For streaming measurement data across a network, DataSocket™ provides you with an easy-to-use interface. Using DataSocket within your LabVIEW or Measurement Studio program, you can easily stream any kind of measurement data across a local area network or the Internet to several client programs. Both Web servers and DataSocket provide a simple and convenient way to publish your measurement data.

NI provides the tools you need to build a powerful distributed system.

To see distributed systems or learn how we can help you build distributed virtual instruments, visit ni.com/dvi

ni.com/dvi

Connecting LabVIEW and Visual Basic

As you develop a measurement and automation system, you may be asked to integrate LabVIEW programs with other tools such as Microsoft Visual Basic. Fortunately, there are many ways to integrate LabVIEW and Visual Basic. Typically, you want either LabVIEW to execute code written in Visual Basic, or you want Visual Basic to execute VIs written in LabVIEW.

Integrate Visual Basic into LabVIEW

If the Visual Basic application has a user interface that you want to access from LabVIEW, develop your Visual Basic project as an ActiveX control. The ActiveX Container available on the LabVIEW front panel can contain any ActiveX control you can create in Visual Basic. After placing your Visual Basic ActiveX Control in the LabVIEW ActiveX Container, you can programmatically access the properties and methods of the control using the Property Node and Invoke Node on the LabVIEW diagram.

If your application does not need to display a user interface and needs to directly execute functions created in Visual Basic, you can use the same Invoke Node and Property Node to access properties and methods defined on an ActiveX EXE you create in Visual Basic. This provides the best method for calling functions written in Visual Basic.

Integrate LabVIEW into Visual Basic

Because LabVIEW is an ActiveX Automation server, you can control LabVIEW from other applications through the LabVIEW VI Server. From Visual Basic, you first create an object representing the LabVIEW execution environment and another representing the VI you want to run. By then calling well defined methods on the objects, you can run VIs and return the results to Visual Basic. Detailed information is available in the *LabVIEW 5.1 Online Reference*, Network and Interapplication Communication Topic. This example shows you how to call LabVIEW and retrieve the results into Visual Basic.

```
'Define variables
Dim LVApp As LabVIEW.Application
Dim VI As LabVIEW.VirtualInstrument
Dim paramNames(0), paramVals(0)

'Load LabVIEW
Set LVApp =
   CreateObject("LabVIEW.Application")
'Define LabVIEW VI to open
viPath = LVApp.ApplicationDirectory +
   "\examples\apps\freqresp.llb\
   Frequency Response.vi"
'Load the VI into memory
Set VI = LVApp.GetVIReference(viPath)
'Open front panel
VI.FPWinOpen = True
'Keep front panel at front
VI.FPWinIsFrontMost = True
'Invoke Run method with name of output
paramNames(0) = "Response Graph"

'Run the VI
Call VI.Call(paramNames, paramVals)
```

For more information on executing LabVIEW VIs from Visual Basic, download Application Note 142, The Versatility and Power of VI Server at ni.com/info/news

zone.ni.com

Measurement Studio™ – Measurement Tools for Programmers

Measurement Studio, National Instruments latest software package, continues the Measurement Revolution and addresses those who do not use graphical programming. With the rising use of popular programming languages in the measurement and automation market, Measurement Studio spans the gap in measurement functionality missing from these environments.

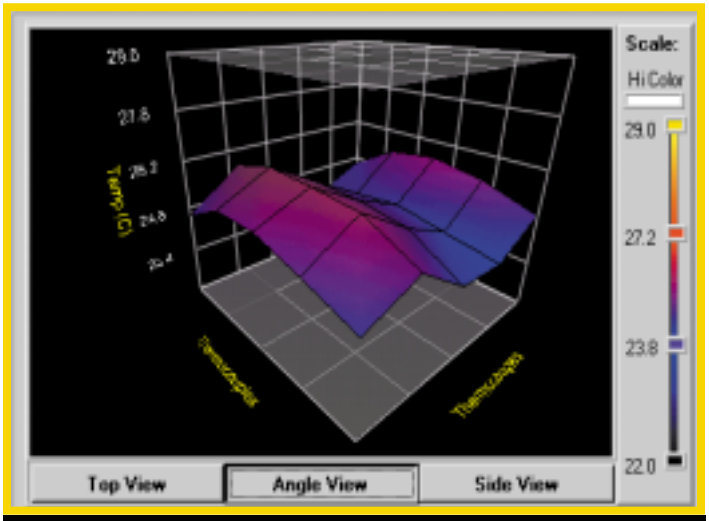
With integrated tools for Microsoft Visual Basic and Visual C++ and National Instruments LabWindows/CVI for C programming, National Instruments Measurement Studio gives you the flexibility to choose the tools that best suites the application you are programming in one complete solution.

Measurement Studio Measurement Functionality

Measurement Functions	Features
Acquisition	Instrument Control – GPIB, Serial, VXI, VISA, IVI Data Acquisition – analog I/O, digital I/O, counter/timer Computer-Based Instruments – scopes, arbs, switches, DMMs, and dynamic signal analyzers
Analysis	Vector matrix algebra, statistics, complex arithmetic, frequency domain analysis, time domain, windows, filters, signal generation, probability, and curve fitting
Presentation	Real time 2D and 3D graphs Knobs, switches, LEDs, gauges, and more Interactive Web pages

Tools for Visual Basic

By integrating the tools directly into the programming environment, you can quickly and easily build measurement and automation applications. The measurement tools for Visual Basic are ActiveX controls that integrate into any ActiveX control container. By combining intuitive interactive property pages to configure and control your application with a high-level measurement API for easier coding, you have the ability to quickly design and create a measurement application. The lower level code is still available for the power users who would like to have complete control over every aspect of their application.



Use 3D graphing to represent measurement data visually.

Tools for Visual C++

The measurement tools for Visual C++ integrate three basic components into Visual C++. The first of which is a measurement application wizard that builds on top of the MFC AppWizard and adds measurement specific functionality and tools to your application template, thus simplifying the creation of measurement applications. Next, it adds more than 100 measurement specific C++ classes for acquisition and analysis that can be accessed easily from within Visual C++. Last, it adds custom wrapped ActiveX controls to aid in the creation of the user interface of your application and easily pass data to and from the control using native C++ data types.

LabWindows/CVI

National Instruments LabWindows/CVI is the premier development environment for creating measurement and automation applications using the standard C programming language. LabWindows/CVI consists of a complete development environment with editor and debugger, and provides a user interface editor with automatic code creation. LabWindows/CVI function panels make writing C code easy as filling out a list of fields, and you can test it before adding the code to your application.

Measurement Studio spans the gap with measurement specific functionality absent from today's standard programming environments. By providing these tools, Measurement Studio gives you the power to program measurement applications with whatever your situation requires. For instance, you can integrate your manufacturing applications into your business process by using the built-in database and Web functionality inside Visual Basic and Visual C++. Or you can use LabWindows/CVI to easily create instrument drivers for custom instruments. With Measurement Studio, we give you the power to build applications with tools specific to your environment and your needs.

For more information, check Measurement Studio brochure on the reply card or visit ni.com/info/news

To request the Measurement Studio Evaluation CD, visit ni.com/mstudio

ni.com/mstudio

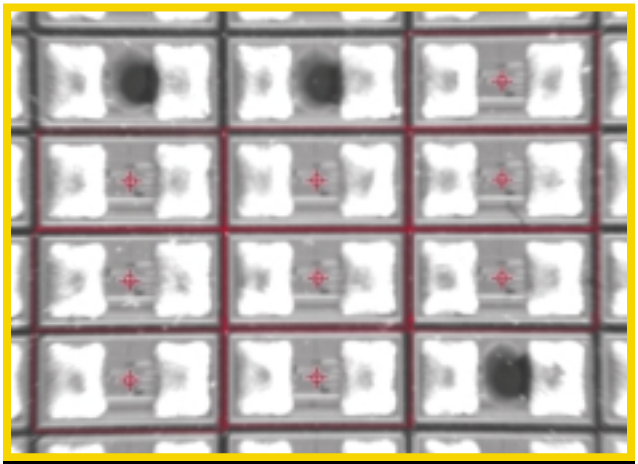
New Vision Software Focuses on Automated Test Applications

More and more automated test engineers are embracing machine vision as a key technology in automated test applications. IMAQ Vision Version 5.0 for LabWindows/CVI and C++ is replacing manual visual inspection because components, chips, and printed circuit board assemblies are significantly smaller than just a few years ago. In addition, today's PCs have the processing power to handle automated inspection, and vision software has become easier to use. Version 5.0 adds new high-speed pattern matching features for automotive, semiconductor, and electronics automated test applications. Use IMAQ Vision for detecting common manufacturing process faults, such as component placement and gross solder defects. The IMAQ Vision software can be used to identify:

- Missing or misplaced components
- Misaligned parts
- Loose or skewed parts
- Rotated and reversed parts
- Incorrect component size
- Excess solder and solder bridges
- Bent or lifted component leads
- Color discrepancy

National Instruments pattern matching software handles process variations that may change during the inspection task. The pattern matching software locates objects in the image if the object is illuminated poorly, rotated, blurred, or even partially hidden. IMAQ Vision 5.0 is being used in a wide range of applications from inspecting the liquid crystal displays of cell phones or printed circuit boards to semiconductor wafer inspection. Other new features include color compare and caliper functionality for dimensional measurements. Version 5.0 also includes a multithread-safe library for C++ developers.

Integrate your inspection solution easily with TestStand™ software and use IMAQ Vision 5.0 with National Instruments wide range of image acquisition hardware for monochrome, color, and digital cameras.



IMAQ Vision 5.0 adds new high-speed pattern matching features.

For more information, check Vision Product Guide on the reply card.

ni.com/imaq

LabVIEW 5.1 Wins *Evaluation Engineering* Award

LabVIEW 5.1 won top software honors in the 1999 Evaluation Engineering Readers' Choice Awards.

Evaluation Engineering announced its 7th Annual Readers' Choice Awards in its March 2000 issue. Other award categories include instrumentation, data acquisition, communications test, and environmental test. *Evaluation Engineering* readers selected their favorite products from those that were introduced last year by casting electronic ballots on the *Evaluation Engineering* Web site and by e-mail.

"We conducted the Readers' Choice Awards on our Web site for the first time and as a result, polled a good sample of the industry," said Paul Milo, Editor of *Evaluation Engineering*. "The readers chose LabVIEW as the best software of 1999 by a significant number of votes, which is a credit to the ease-of-use of LabVIEW and the popularity of graphical programming."

ni.com/labview

The Shocking Truth About Isolation

continued from page 13

ratings. For example, when you measure the signal from a thermocouple attached to the winding of a motor, your actual signal is only a couple of millivolts. However, this signal may have several hundred volts of common-mode voltage, thus requiring your equipment to have a high working safety voltage rating. In addition, a motor generates large transient signals. Therefore, without the proper isolation, your system could fail, causing damage or injury.

All National Instruments products with isolation have a working safety voltage and an installation rating. In addition, we test all of our isolated products to meet the UL and IEC safety requirements.

So, the next time you choose a measurement system that requires isolation, look for the complete isolation specification, a working safety voltage, and a safety installation rating, or proceed at your own risk.

For more information, visit ni.com/info/news to download the Understanding Isolation white paper.

ni.com/sigcon

Catalog Features Motion and Vision Systems Components

Data Science Automation (DSA), a Select Integrator, is now offering a 40-page catalog to simplify the selection and purchase of motion and vision components, complete systems, and integration services. With the *DSA Motion and Vision Systems and Components* catalog, you can quickly get complete system components that integrate well with National Instruments products.

The catalog describes all of the various motion and vision system components and identifies the numerous options for each.

In addition to component descriptions, the catalog includes sections on complete system design, software, and engineering services and training. DSA hosts and administers four National Instruments Certified Training Centers in various regions to complement technical consulting and integration services. Course offerings include user training in vision and motion tools and application development techniques.

Call DSA to learn more about their integration services, for a copy of the catalog, and for consultation on motion and vision projects.

For more information, contact Data Science Automation, 400 Southpointe Blvd., Canonsburg, PA 15317, tel (724) 745-8400, fax (724) 745-8461, e-mail dsa@DSAutomation.com, Web www.DSAutomation.com

DAQSIS Offer Cable Modem Test Solution

DAQTron introduces DAQSIS, the cable industry's most comprehensive, automated Standardized Cable Modem Performance Test instrument. The DAQSIS system uses National Instruments LabVIEW to create test scripts that run under the National Instruments TestStand™ test executive along with other manufacturer's hardware in a rugged, rack mount cabinet.

DAQSIS helps cable modem manufacturers perform tests required by CableLabs for certification under data over cable services interface specification (DOCSIS) 1.0. The test set creates the reports required for submission to CableLabs prior to the certification process.

DAQTron uses LabVIEW scripts inside TestStand to create a comprehensive set of tests found within CableLabs 1.0 acceptance test plan (ATP).

The DAQTron DAQSIS replaces previous time-consuming manual tasks with a single automated solution for faster development of reliable, high-speed modem products.

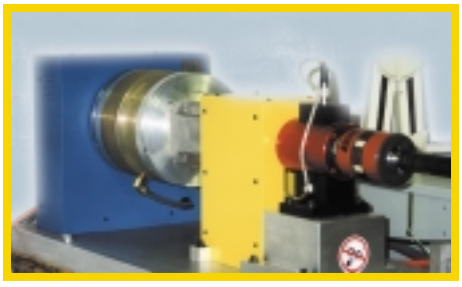
DAQSIS reduces the chance for operator error while providing consistent automated high-speed cable modem testing to the DOCSIS standards. The system can save countless resources in certification fees and product introduction delays.

For more information, contact DAQTron, Inc., 1007-B Mansell Road, Roswell, GA 30076, tel (770) 643-1878, fax (770) 645-6403, Web www.daqtron.com

SAKOR DynoLAB EM Tests Electric Motors and Devices

SAKOR Technologies Inc. provides a NI-based system for assessing the electrical and mechanical performance electric motors and motorized devices. Based on LabVIEW, the DynoLAB™ EM features an easy-to-use supervisor and incorporates a wide range of National Instruments hardware, including E Series, SCXI™, FieldPoint™, 5B, and others.

DynoLAB EM was recently incorporated into a dual-function test stand for a customer's magnetic drill product. The magnet tester portion includes a computer-controlled hydraulic unit capable of smoothly applying up to 3,000 pounds of force to the component under test. The motor test portion uses a high-torque, hysteresis brake dynamometer, precision gear box, and power switching



circuits capable of performing durability cycling, torque ramp testing, in-use load profile simulation, and thermal testing of drill motor/gear units.

With DynoLAB EM, test engineers quickly and easily perform a variety of procedures. The "smart instrument interface" of DynoLAB provides a convenient mechanism for engineers to incorporate specialized or proprietary instruments into test systems. They can also incorporate other LabVIEW and DynoLAB features, such as internal network compatibility and remote Internet access and diagnostics.

SAKOR uses the DynoLAB EM as the basis for building turnkey systems, which can integrate a variety of customized test equipment and unique customer requirements.

For more information, contact SAKOR Technologies, Inc., 2855 W Jolly Rd, Okemos, MI 48864, tel (517) 332-7256, fax (517) 332-7250, or e-mail rbeattie@sakor.com Readers can also access the company's Web site at sakor.com

Roush Industries Releases New Version of BrakeDAQ Software

In 1997, Roush Industries designed and developed BrakeDAQ, a NI-based system that automates the acquisition and analysis of brake noise events. By encapsulating both of these functions in a single test system, we reduced the post-processing time and assigned objective results to the brake noise testing community.

BrakeDAQ measures brake vibration at the wheel with high-temperatures accelerometers attached to each pad. A microphone inside the passenger compartment measures audible brake noise. These signals are routed through a SCXI-1141 for filtering. We attach thermocouples at the pad and conditioned them via the SCXI-1102. Front and rear brake pressure signals are sensed with independent pressure transducers and connected to a SCXI-1121 module. We can monitor brake pedal signal, manual triggers, and other voltages with a SCXI-1100. We developed custom SCXI modules to provide conditioning for vehicle speed and ICP Power. We sampled all aforementioned signals with E Series DAQ boards.

By porting the software to LabVIEW, we were able to add new features, including:

- Flexibility in channel setup
- Independent software application for post-processing
- Event-based data recording
- Improved file formats and structure

For more information contact Aaron Grzymkowski, Roush Industries, 11916 Market St., Livonia, MI 48150, tel (734) 779-7547, fax (734) 779-7996, Web www.roushind.com

Motor Test System from MicroCraft Improves Quality

Using National Instruments PXI/CompactPCI modular instrumentation hardware, MicroCraft Corporation, a Select Integrator, has developed the MTS-2000 Motor Test System to test AC and DC brushed motors. MicroCraft Corporation delivers the MTS-2000 ready to begin production testing. Designed to withstand the rigors of the factory floor, the system is housed in a 15"x 21.5"x 22" industrial enclosure and contains a National Instruments PXI industrial computer, a PXI-6025 E Series multifunction I/O card, and a PXI-6527 isolated digital I/O card.

Each MTS-2000 offers Current Signature Analysis, a revolutionary testing method that detects armature failures at run-time. Signature Analysis identifies brush misalignments, shorts, opens, nicked wires,

and out-of-balance armatures, which results in less rework and fewer field returns.

The standard MTS-2000 also performs three other tests. Start Current testing monitors the RMS current and rejects if the current exceeds the user-defined limit. The Running Current test measures the RMS current after the motor has run for a user-defined period of time and compares the measurement against specified limits. The Internal RPM test determines the shaft RPM of the motor by evaluating its current waveform.

The MTS-2000 offers an automation interface, which enables interconnection with a PLC or other digital interfaces. Because the system is based on PC technology, it handles a variety of add-ons including digital I/O, motion control, vision, sensor inputs, network connections, and custom fixturing.

For more information, contact MicroCraft Corporation, 3209-154 Gresham Lake Road, Raleigh, NC 27615, tel (919) 872-2272 ext 28, fax (919) 872-5822, e-mail stan.craft@microcraftcorp.com, Web www.microcraftcorp.com

First Online Quote Generator Available for Instrument Drivers

VI Technology Inc., a Select Integrator, introduces DriversDirect™, the first online tool to generate immediate quotes and take orders for custom-developed instrument drivers. Continuing with an emphasis on built-to-order instrumentation products, VI Technology is combining its nine years of expertise in driver development and its innovations in direct engineering solutions to deliver the industry's first Web-based built-to-order instrumentation software. Historically, the process of getting a quote for custom instrument driver development has been time consuming. DriversDirect simplifies this process by immediately delivering a quote from the Web at vi-tech.com/vidirect DriversDirect offers five possibilities for development:

- Basic – the lowest cost driver package typically for a company's internal use
- Full – cost effective driver suitable for distribution to customers
- Professional – high quality driver package suitable for distribution by instrument manufacturers
- Professional VXI*plug&play* and Professional IVI – both offer the highest quality driver suitable for distribution by instrument manufacturers

Typical prices for custom instrument driver development range from $5,000 to $25,000 depending on the complexity of the instrument.

For more information, contact VI Technology, 5114 Balcones Woods Dr, Ste 307, Austin, Texas 78759, tel (512) 327-3348, fax (512) 327-3341, e-mail driversdirect@vi-tech.com, Web www.vi-tech.com

In This Issue

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

EuroMesures – Paris, France	June 6-8	**SIMTOS 2000** – Seoul, Korea	June 14-19
Autec – Sinsheim, Germany	June 6-8	**ASEE** – St. Louis, MO USA	June 19-21
MT München – München, Germany	June 7-8	**Instrumentation** – Harrogate, UK	June 27-28
Asian Elenex 2000 – Hong Kong, China	June 13-16	**e-EXPO** – Nanjn, Jaingsu, China	June 28 - July 1
Nepcon East – Boston, MA USA	June 13-14	**Taipei International Automated Machinery and Tools** – Taipei, Taiwan	June 30 - July 3
IEEE MTT-S – Boston, MA USA	June 13-15	**SEMICon** – San Jose, CA USA	July 12-14
JEMIMA Measurement Plaza – Osaka, Japan	June 13-15	**Embedded Systems Expo Conference** – Tokyo, Japan	July 12-14
Exhibition on Sensing via Image Information – Tokyo, Japan	June 14-16	**Photonics** – Taipei, Taiwan	July 27-30

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