# Instrumentation

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Newsletter™





# Increase Measurement Accuracy by 10 Times with Signal Conditioning

With the speed and accuracy of modern data acquisition boards, it is easy to overlook the need for signal conditioning. While plug-in DAQ boards specifically and accurately measure voltage signals, voltage is only one of many I/O types required by modern measurement and automation applications. Many current DAQ systems must also measure physical, chemical, or mechanical phenomena with sensors. While several of these sensors, such as RTDs and strain gauges, need signal conditioning to return a measurement, they all require conditioning to return accurate measurements.


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# Innovating on LabVIEW for FPGA

After a significant development investment, we are excited to share the latest breakthrough innovation from LabVIEW, now running on FPGA chip technology. Announced at NIWeek this past August, it was the culmination of a long-held vision for LabVIEW designing instrumentation hardware directly. With LabVIEW FPGA technology, the logic of your LabVIEW block diagram translates to the circuitry of the hardware itself, bringing the concept of virtual instrumentation to a new level.

However, while this is a tremendous innovation, it is only one of many more to come from LabVIEW. From the very beginning, the vision for LabVIEW was about creating a tool for engineers and scientists that is as productive for measurement and automation as the spreadsheet is for financial applications. As engineers and scientists continue to solve new problems with new technology, we can meet that productivity vision only by constantly raising the bar on LabVIEW. To deliver this vision continuously through the years, we considered how we could make possible both incremental improvements and breakthrough innovations in LabVIEW. Therefore, in designing LabVIEW, we invented an environment based on not just tools, but a new fully realized graphical language. With a unified architecture that provides intuitive dataflow productivity melded into the graphical programming language itself, LabVIEW has the solid architectural foundation that can scale to meet your current and future needs.

The first breakthrough innovation was LabVIEW 1.0 running on a Macintosh desktop, the only commercially available technology at the time that provided the user interface needed for LabVIEW. With the evolution of computing technologies, such as Windows operating systems and the Web, the core foundation of LabVIEW graphical programming took advantage of each technology for measurement and automation development. As the idea of virtual instrumentation took shape and grew with LabVIEW, it became the de facto standard for PC-based measurement and automation development.

Then in 1999, we introduced LabVIEW Real-Time, another breakthrough innovation. With LabVIEW Real-Time, you apply the concepts of virtual instrumentation and the same productivity of LabVIEW to real-time and embedded systems development. Though LabVIEW now enabled users to develop an entirely new set of applications with very different requirements, the LabVIEW graphical language and tools were flexible enough to scale to this new area without changing the core fundamentals of the development paradigm. Now in 2002 with LabVIEW FPGA, NI once again scales to leverage commercial technology to bring LabVIEW productivity to a new domain of embedded development for you.

***Now in 2002 with LabVIEW FPGA, NI once again scales to leverage commercial technology to bring LabVIEW productivity to a new domain of embedded development for you.***

In August, we provided several LabVIEW FPGA Pioneer Systems to a set of leading LabVIEW users who needed the tight timing and synchronization for measurement and control applications that LabVIEW FPGA can deliver. As we work in close collaboration with these lead users, we drive the product to better solve the broad base of applications you can build with the LabVIEW FPGA technology. These lead users, just like many others of you in the LabVIEW community, are the ones who push the envelope on the concept of virtual instrumentation. On behalf of all of us here at NI, thank you for taking us to places we have never dreamed of, and helping us design the next breakthrough innovations for LabVIEW. ■

**John Graff, VP Marketing**
**E-Mail john.graff@ni.com**

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# Australian Military Reduces Test Costs Using LabVIEW

Since 2000, the Royal Australian Air Force, Army, and Navy have used National Instruments LabVIEW software and PXI hardware to help determine procedures for landing the military's fleet of 40 Black Hawk helicopters on the decks of troop transport ships. The NI-based system has saved the military time and as much as 66 percent on test equipment costs, and based on this recent success, the Australian military plans to expand the use of NI LabVIEW and PXI on additional types of helicopters.

The NI-based system, known as the Airborne Data Acquisition and Recording System (ADARS), has identified safe landing procedures for its Black Hawk helicopters by acquiring and analyzing vital information such as rotor speed, air speed, aircraft position, and engine torque as pilots land in various weather and sea conditions.

Photo: Defence – Australia

*In the ADARS application, PXI and LabVIEW acquire, analyze, and present data by pulling information from Black Hawk navigation and avionics systems. The ADARS also acquires video from the Black Hawk cockpit.*

During test landings onboard amphibious troop transport ships, LabVIEW provides a single, tightly integrated software development environment for both acquiring data and performing complex inline mathematical analysis. Specifically, LabVIEW performs some heavy number crunching, applying third-order calibration polynomials to each of ADARS 40 analog inputs and to the calculations of derived parameters by mathematically combining the inputs using control margin algorithms.

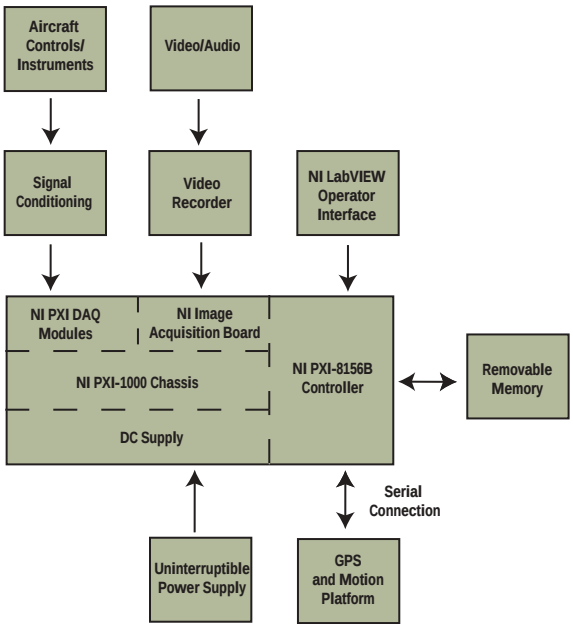
LabVIEW also logs the results so that military officials can use the data to determine the proper landing techniques that all Black Hawk helicopter pilots should follow. The test program has been so successful, the military plans to build additional ADARS to determine landing procedures for its fleet of Sea King and Sea Hawk helicopters.

Using standard computer-based technologies from NI, instead of expensive proprietary test components, the Australian military not only significantly reduced test equipment costs but also reduced application development time from months to weeks.

Also, because the LabVIEW-based system uses a modular PXI architecture, Australian military officials can quickly reconfigure the test system simply by plugging in different PXI measurement modules. For example, the military did not originally intend to acquire live video from the cockpit; however, they easily added that capability by installing an NI image acquisition board in the PXI chassis and programming it using the same familiar LabVIEW development environment that controls the acquisition of other measurements.

Because the PXI system is both compact and durable, the ADARS resides onboard the helicopters during test landings. It pulls data from the helicopter using an NI PXI-1000 eight-slot chassis and an NI PXI-8156B embedded controller. Installed in the chassis are an NI PXI-6071E multifunction data acquisition board, an NI PXI-6533 high-speed digital I/O module, and an NI PXI-6602 counter/timer. All totaled, the system acquires 40 digital and 40 analog signals from the helicopter's navigation system and a variety of strain gauges and linear position transducers. An NI IMAQ image board also acquires images of the cockpit and pilot from up to four CCD cameras while a GPS and inertial motion unit track aircraft motion and position. These external instruments send data to the ADARS via a serial connection to the PXI controller. ■

*To learn more about LabVIEW analysis capabilities, visit ni.com/info and enter* nsi3102.




*Data acquired, analyzed, and displayed by ADARS system helps the Australian military establish flight procedures for several combinations of weather, sea, and aircraft conditions.*

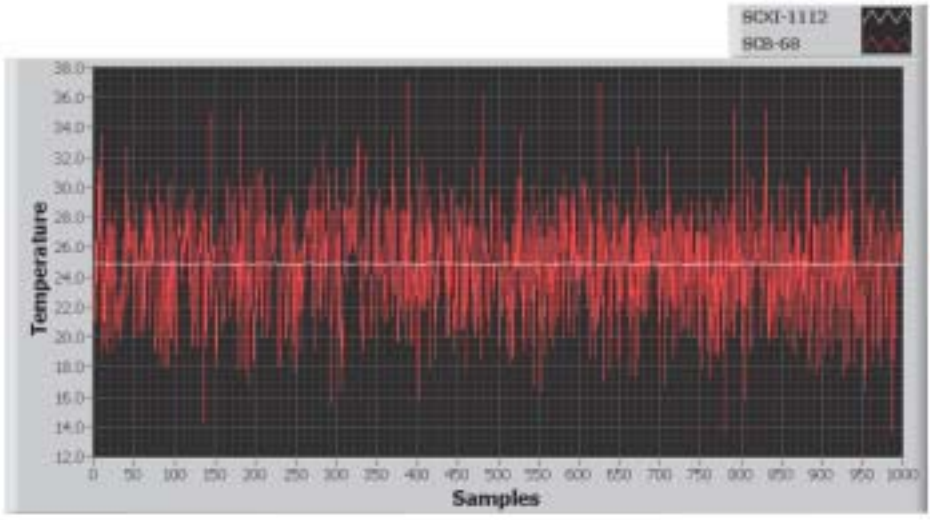
ni.com/success

# Increase Measurement Accuracy with Signal Conditioning

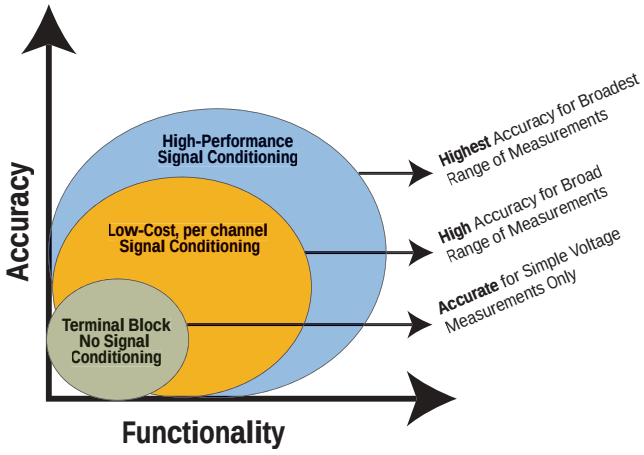
continued from page 1

To illustrate the necessity of signal conditioning, consider a thermocouple. To accurately measure thermocouple signals, you must provide amplification, filtering, and cold-junction compensation. The small magnitude of these signals demands amplification that you must apply as close to the thermocouple as possible to increase your signal-to-noise ratio (SNR). While this amplification helps reduce the effect of noise on your signal, you must also provide filtering to eliminate environmental noise from power lines and other electric devices. Cold-junction compensation also is necessary to offset temperature differences between the measurement junction of the thermocouple and its junction with the data acquisition device. As a result, providing this signal conditioning dramatically improves accuracy. The graph to the right displays a thermocouple measurement taken at 25 °C using a National Instruments thermocouple signal conditioning module and an SCB-68, which is a screw terminal connector block with a temperature sensor for cold-junction compensation. The SCXI-1112 module achieves an accuracy of ± 0.3 °C, compared to ± 5.0 °C accuracy with the screw terminal connector block. Thus, the SCXI-1112 signal conditioning module provides a thermocouple measurement 10 times more accurate than the terminal block due to pre-amplification, low-pass filtering, and a more accurate temperature sensor.

As you can see, signal conditioning is a fundamental part of any DAQ system.




*Accuracy comparison: The NI SCXI-1112 signal conditioning module delivered ± 0.3 °C accuracy compared to ± 5.0 °C with the SCB-68 terminal block using a calibrated input.*




*Overview of Sensor Measurement Accuracy and Functionality for Signal Conditioning Hardware and Standard Terminal Blocks*

NI offers a breadth of signal conditioning options. In particular, SCXI provides a high-performance signal conditioning hardware designed for high-channel-count applications requiring both high-speed and rugged packaging. For applications requiring more portability and lower channel count, the SCC hardware offers modular, flexible signal conditioning on a per channel basis. National Instruments FieldPoint distributed I/O systems integrate both signal conditioning and a digitizer in a rugged, distributed form factor ideal for monitoring and control applications. It is important to consider which features are important for your particular application. Most engineers and scientists demand hardware that meets their current needs and offers the flexibility to meet future needs. There are many parameters to consider, ranging from accuracy to expandability to packaging.

## Five Considerations When Selecting Signal Conditioning

### 1. Breadth of Signal Types

Selecting signal conditioning hardware that supports a large breadth of signal types is critical to protecting your DAQ system investment. In addition, the ability to incorporate all of these measurements into a single DAQ system can dramatically reduce your development time so you can focus on implementing your tests rather than learning how to configure your hardware. To illustrate, consider an application where you must validate the design of an automobile engine. To accurately characterize the engine, you must measure a variety of signal types, including temperature, vibration, frequency (RPM), and torque – each with unique conditioning requirements. Traditionally, you needed individual, stand-alone instruments or a custom DAQ device for each type of measurement, requiring you to configure multiple devices. With modern, high-performance signal conditioning hardware, such as SCXI and SCC, you can easily incorporate measurements into a single, rugged chassis and configure them from a single software interface such as NI-DAQ. This reduces the development time and cost of your current application, while protecting your DAQ system investment and providing the flexibility to address future applications.

### 2. Connectivity

With the diverse range of sensor connectors available, it is critical that your signal conditioning hardware not only offers a variety of connectivity options, but more importantly, the specific options you need. Whether you use a strain gauge with a

D-Sub connector or an accelerometer with a BNC interface, your signal conditioning platform should simplify your system setup by enabling you to easily connect to all of your sensors. Some signal conditioning hardware, such as SCC, offers direct connectivity options on a per channel basis, so you can match each channel to the required connector. Using the system's sensor-specific connectors, you can easily remove and replace individual sensors while your DAQ system is running – making it easier to troubleshoot and minimizing system downtime.

### 3. Expandability

As your application evolves and the measurement requirements change, it is essential to have a DAQ system that provides the flexibility to expand and change with your application. Expanding your DAQ system should not require a complete overhaul of your signal conditioning platform. With modular signal conditioning hardware, such as SCXI, SCC, and FieldPoint, you can very quickly increase the number and variety of signals in your system by simply plugging in another module. This protects your DAQ system investment, so you can expand your channel count in a matter of minutes, dramatically reducing the time it takes to get your modified system up and running. This flexibility reduces the total cost of ownership for your overall DAQ system.

### 4. Form Factor

The size and environmental constraints of your application most often dictate the form factor of your signal conditioning hardware. Because space is at a premium on most laboratory and test floors, you should choose a DAQ system that packs more channels into less space. Signal conditioning with high-channel density, such as SCXI, minimizes the space requirements of your DAQ system while reducing its cost per channel. In portable applications, your signal conditioning hardware must be compact and lightweight, while offering a high level of performance and functionality. For example, SCC signal conditioning provides low-profile carriers that quickly connect to a DAQ device and easily fit under a laptop. This offers flexible signal connectivity options on a per channel basis and provides high-quality measurements. Alternatively, applications running in harsh, industrial environments require signal conditioning with rugged mechanical packaging, such as FieldPoint or SCXI. To operate effectively in such extreme environments, hardware such as FieldPoint and SCXI can endure a wide operating temperature range (-40 °C to 70 °C for FieldPoint) in addition to severe shock and vibration.

| | High-Performance Signal Conditioning | Affordable, Per Channel Signal Conditioning | Distributable DAQ with Integrated Signal Conditioning |
|---|---|---|---|
| | SCXI | SCC | FieldPoint |
| Supported Signal Types | ● | ◑ | ◑ |
| Connectivity | ◑ | ● | ◑ |
| **Performance** | | | |
| Acquisition Speed | ● | ● | ◑ |
| System Accuracy | ● | ◑ | ◑ |
| **Capacity** | | | |
| Expandability | ● | ○ | ● |
| Channel Density | ● | ○ | ◑ |
| **Form Factor** | | | |
| Portability | ◑ | ● | ◑ |
| Rugged/Industrial | ● | ○ | ● |
| Distributable | ○ | ○ | ● |
| For more info. | *ni.com/sigcon* | *ni.com/sigcon* | *ni.com/fieldpoint* |

○ Good ◑ Better ● Best

*Signal Conditioning Hardware Selection Guide*

### 5. Integration

To realize the full productivity potential and value of your DAQ system, all of its components must integrate seamlessly. Specifically, your signal conditioning hardware must incorporate mixed signal types into a single system while providing quick and easy connection to your DAQ device. With this capability, you can dramatically reduce your setup time. Furthermore, by selecting signal conditioning hardware that tightly integrates with your DAQ device, you can easily increase the speed and resolution of your entire DAQ system as your application requirements evolve by simply upgrading the DAQ device. Thus, tightly integrated signal conditioning hardware can reduce both current and future system development costs.

While hardware integration is critical, you cannot fully take advantage of it without easy-to-use software tools that maximize your productivity. In particular, driver software should provide a single interface, such as the Measurement & Automation Explorer in NI-DAQ, for configuring and testing your entire DAQ system while integrating with your application development environment (ADE). NI-DAQ driver software integrates with LabVIEW, so you can easily configure and test your sensor measurements and quickly incorporate them into your DAQ system application. When you consider that application development is a major portion of a DAQ total system cost, tight integration between your driver software and ADE is even more essential.

Overall, signal conditioning defines measurement capabilities and is a critical component of any complete DAQ system. Furthermore, you need signal conditioning for accurate sensor measurements.

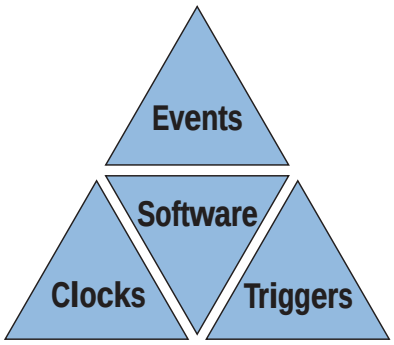
National Instruments offers a range of signal conditioning hardware capable of interfacing virtually any signal or sensor to your DAQ system. Please refer to the selection guide above to find the right signal conditioning hardware for your application. ■

**Ryan Wynn,**
**DAQ Systems Product Manager**
**E-Mail ryan.wynn@ni.com**

*To read a white paper to find out if your DAQ system is measurement ready, visit ni.com/info and enter* nsi3101.

***ni.com/daq***

# Improve Your Systems with Timing and Synchronization




*The Building Blocks of Timing and Synchronization*

Timing and synchronization play an essential part in every measurement and automation system. With modular instrumentation systems in particular, precise timing and synchronization is a key technology you can use to create user-defined systems that deliver superior performance with diverse functionality. Thus, modular software and hardware systems can take advantage of integrated timing tools and technologies.

Understanding how to use timing and synchronization helps you take more accurate measurements in less time. These technologies can be used to create flexible measurement and automation systems to solve applications that previously required expensive proprietary solutions or simply remained unsolved.

This article first defines the building blocks of timing and synchronization and then discusses applications that can benefit from these technologies and concepts.

## Building Blocks of Timing and Synchronization

There are four key building blocks of timing and synchronization: timing control software, triggers, events, and clocks.

Timing control software includes the infrastructure software for routing and controlling the system's hardware timing signals, and the programming interface and configuration tools you use to interact with these capabilities. Software is essential to any timing and synchronization system because it sets up and controls the entire system. Without good software tools for timing and synchronization, well-integrated systems can be difficult, if not impossible, to create.

Triggers act as signals used to initiate or stop a task, such as an acquisition. You can receive triggers from the system under test or control, or from other modules within the test system itself. For example, you can set up a digitizer to start an acquisition when it receives a digital trigger that comes from another module or the device under test (UUT).

Events indicate a change in state or the completion of a task. An arbitrary waveform generator, for example, can use a digital signal, or a marker, as an event to indicate it has finished a section of a waveform. Or, a switch can use a scanner advance signal as an event to indicate to a digital multimeter (DMM) that its relays have closed and settled.

Clocks act as periodic signals used to synchronize an acquisition or generate an aligned set of signals, and crystal oscillators typically generate clocks. Multiple modules use a reference clock to synchronize their own onboard oscillators to a shared time base. The accuracy of a systems clock is a major factor in the accuracy with which it takes measurements.

## The Benefits of Modular Systems

Traditionally, test and automation systems came with fixed, vendor-defined functionality. The boxes that encapsulate this functionality include dedicated hardware and fixed-functionality software. Increasingly, systems built using flexible software and hardware blocks that fit together to create a customized system with the exact functionality needed for a particular application replace this "one-size-fits-all" approach. This gives users highly flexible, inexpensive, and scalable systems to meet future needs.

Traditional vendor-defined instruments have synchronization within the box, but do not integrate well with other components of a system. Consequently, creating systems with tight synchronization using traditional instruments is often cumbersome, and sometimes impossible. Modular instrumentation, however, is inherently designed to provide precise timing and synchronization as a system-wide resource. Because the concept of modular instrumentation is that you build complete systems by combining measurement and control modules, system-level synchronization is an inherent requirement.

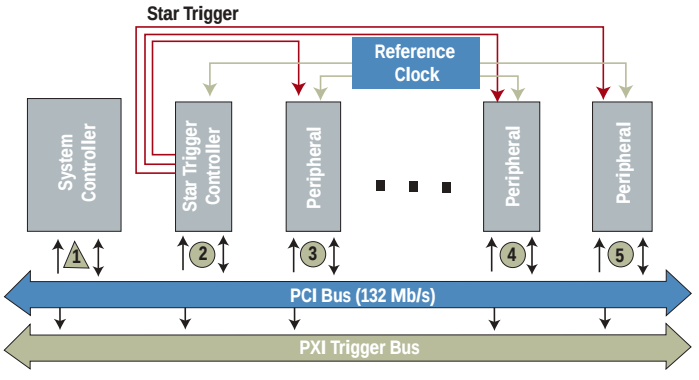
## PXI – Designed for Timing and Synchronization

PXI is an industry standard for multivendor measurement and control systems. PXI is a modular system that combines the commercial PCI bus with a full set of features for integrated timing and synchronization. Because timing and synchronization act as part of the PXI architecture, all PXI modules have a standard set of triggers and event signals, along with a reference clock, shared for creating tightly synchronized systems. A schematic diagram below shows a PXI system with the timing features highlighted.

The system reference clock is a 10 MHz clock source provided to all slots in a PXI chassis. Modules use this clock as a reference frequency source to synchronize onboard oscillators. Multiple modules can then simultaneously input or output clocked data at high frequencies.

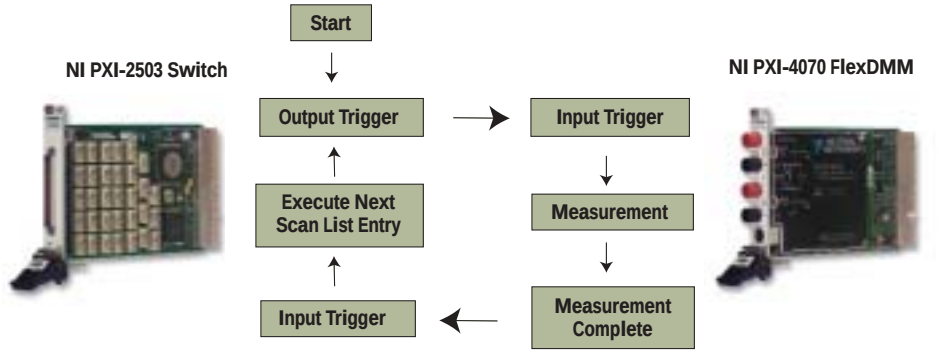
The PXI trigger acts as a set of eight bussed trigger lines for any module to send or receive triggers and events to and from other modules in the system.

The PXI star trigger is a dedicated trigger line going from Slot 2 to all other slots in the system with matched trace lengths. This enables a star trigger controller device to deliver a trigger signal to multiple modules in the system, with less than 1 ns skew.




*PXI provides an integrated trigger bus and reference clock for accurate syncronization.*

You can also use Slot 2 in a PXI system to override the built-in 10 MHz reference clock with a more stable oscillator. For example, the NI PXI-6608 counter/timer has a highly stable oven-controlled crystal oscillator (OCXO) that can generate a 10 MHz clock with stability of 75 ppb. All modules in the chassis that use the reference clock immediately become more accurate by using the time base in the Slot 2 PXI chassis.




*A modular NI DMM and switch can use handshaking to increase throughput.*

## Increase Measurement Accuracy

In automated measurement and automation systems, the timing relationship between the point at which you apply a stimulus and the point at which you take measurements can significantly impact the result. When measuring steady-state signals, for example, you typically apply a stimulus to the system being measured and then wait for the signal to settle before taking a measurement. If the measurement is made too soon or too late, your results can be inaccurate. Using a trigger or event ensures you take the measurement after the system settles.

In machine monitoring applications, you use accelerometers to measure vibration data on multiple axes of a machine. The system analyzes the vibration levels to determine if parts of the machine such as the rotor and bearings wear out. The phase relationship between accelerometer measurements is crucial. A phase delay between channels of just one degree can cause a significant error in the interpretation of the result. To take accurate measurements, the NI PXI-4472 dynamic signal acquisition board uses the PXI star trigger to synchronize boards using a sample clock. With this level of synchronization, a PXI system can achieve accuracy within .1 degree of phase mismatch on a 1 kHz acquisition.

## Increase Throughput

In many automated test applications, increasing test throughput is a primary goal. On the manufacturing floor, a few seconds saved in a test increases equipment utilization and can often save millions of dollars. Many test programs use software delays to wait on signals to settle from the UUT or the measurement equipment. These delays often represent a significant portion of the overall test time. Using hardware triggers and events, instead of software delays, enables a system to take steady-state measurements in the shortest possible time, to optimize your test system's throughput. For example, you can configure a modular DMM and switch to "handshake" on a set of measurements using hardware triggers. When the switch settles, it sends a scanner advance trigger signal to the DMM, which then takes a measurement and sends a "voltmeter complete" trigger signal to the switch to connect the next path. Hardware handshaking truly optimizes a DMM switch system and can lead to throughput increases of 10 times or more.

***On the manufacturing floor, a few seconds saved in a test increases equipment utilization and can often save millions of dollars.***

## Solve New Applications

Vendor-defined systems, by their very definition, solve a common set of requirements among a defined set of users. However, many applications fall outside this standard set of features. These applications either have a unique set of requirements for a particular measurement, or they require integration between functionality.

Precision alignment applications, for example, require tight synchronization within a vision component to visually check an alignment, and a motion component to move the object into position. In fiber optic applications, you can add data acquisition to measure the magnitude of the optical signal passing through the two pieces of fiber being aligned. These systems require very tight integration of timing signals to achieve the precision required. Further, a well-synchronized system can deliver an order of magnitude decrease in the alignment time.

In machine monitoring, integrated timing synchronization enables modular systems that measure correlated vibration, position, electrical power, and other qualities to assess a machine's health. The precision of the timing relationship of these measurements is extremely important, as small variations in channel-to-channel phase skew can completely change the interpretation of a measurement.

Timing and synchronization is an essential consideration in all measurement and control systems. Unlike systems built using traditional instruments, modular instrument systems provide key timing and synchronization functionality, to increase throughput and measurement accuracy. PXI, in particular, enables you to use integrated timing and synchronization to save time and money, and to solve new applications in creative, new ways. ■

**Eric Starkloff,**
**PXI and Modular Instruments**
**Marketing Manager**
**E-Mail eric.starkloff@ni.com**

*To learn more about specific techniques in timing and synchronization, visit ni.com/info and enter* nsi3103.

***ni.com/pxi***

# New, Low-Priced, 16-bit DAQ Devices for LabVIEW

The NI PCI-6013 and NI PCI-6014 family of basic multifunction data acquisition (DAQ) devices provides inexpensive, entry-level functionality for new virtual instrument developers and OEM (original equipment manufacturer) developers who need minimal features and accurate measurements. This family of basic multifunction DAQ devices offers a new level of value not only because of its low price, but also because it interfaces with the NI LabVIEW graphical development environment and Measurement Studio through the familiar NI-DAQ driver software. The easy-to-use programming interface, along with thousands of existing example programs for NI multifunction DAQ boards, reduces the amount of configuration and programming time invested in building applications.

Engineers and scientists now can choose from three NI multifunction DAQ product families based on accuracy, signal conditioning options, and timing and synchronization capabilities. Knowing which features come with each product family is only a start to choosing the right device. Selecting the right DAQ product also requires an understanding of which features and specifications are useful or critical in your application.

| 16-bit Absolute Accuracy at Full Scale (±1mV) | | | | | |
|---|---|---|---|---|---|
| | | Low-Cost E Series | E Series | | |
| Range | NI PCI 6013, 6014 | NI 6034E, 6036E | NI 6052E | NI 6030E | Best 12-bit |
| ± 10 | 8.984 | 8.553 | 4.747 | 1.147 | 14.369 |
| ± 5 | 2.003 | 1.787 | 0.876 | 2.077 | 5.139 |
| ± 0.5 | 0.471 | 0.448 | 0.243 | 0.215 | .735 |
| ± 0.05 | 0.069 | 0.066 | 0.035 | N/A | 0.91 |
| | | | | More Ranges Available | |

Assumes 100 averaged samples, dithering for 12-bit, ±1 °C of an internal calibration temperature, and ± 10 °C of an external calibration temperature.
("Best 12-bit" refers to the NI 607xE product family)

*16-bit Multifunction DAQ Comparison Chart*

| Quantization Error, including noise (mV) | | | | | |
|---|---|---|---|---|---|
| | NEW Basic | Low-Cost E Series | E Series | | |
| Range | NI 6013, 6014 | NI 6034E, 6036E | NI 6052E | NI 6030E | Best 12-bit |
| ± 10 | 0.082 | 0.077 | 0.087 | 0.054 | 0.846 |
| ± 5 | 0.041 | 0.039 | 0.043 | 0.028 | 0.423 |
| ± 0.5 | 0.005 | 0.005 | 0.005 | 0.003 | 0.042 |
| ± 0.05 | 0.003 | 0.003 | 0.002 | N/A | 0.007 |
| | | | | More Ranges Available | |

*16-bit Multifunction DAQ Quantization Error Chart, Including Noise*

## E Series, S Series, and Basic Multifunction DAQ Accuracy

Contrary to popular belief, measurement accuracy is not defined by bits of resolution. Although all of the NI multifunction DAQ product families have either 12-bit or 16-bit devices, the overall accuracy of devices with the same resolution varies from one product family to the next. You cannot gauge the accuracy of any type of measurement product simply by knowing the bits of resolution of the product. With inadequate board design, some 16-bit data acquisition devices could actually have less accuracy than their 12-bit counterparts. Fortunately, National Instruments provides a simple table of specifications that describe the worst-case theoretical voltage error for the full functionality E Series, the high-performance S Series, and the new basic multifunction DAQ boards. With this table, you can easily translate the voltage into the units or measurements for your application. This absolute accuracy table is listed in *The Measurement and Automation Catalog* in print, and online at ***ni.com/daq*** The first table above summarizes the worst-case theoretical error from a few 16-bit products for the E Series and the new basic multifunction DAQ products.

***With inadequate board design, some 16-bit boards could actually have less accuracy than their 12-bit counterparts.***

Rather than evaluating the total amount of signal error from the actual signal value, other applications might simply require a measure of the magnitude of change in a signal. The noise plus quantization error specification determines the amount of change in a signal that a data acquisition board can detect.

The second table above is a comparison of some 16-bit products and their quantization error, including noise.

The third table, on page 9, compares analog input feature differences that are important to consider when selecting the right DAQ product family. Notice that the new NI PCI-6013 and 6014 are similar to the low-cost E Series family, but lack SCXI signal conditioning support, an onboard temperature sensor, and an external metal shield. SCXI signal conditioning expands the number of analog input channels for a DAQ device and provides isolation, filtering, amplification, and connectivity for a variety of signals and sensors. The onboard temperature sensor on E Series and S Series devices is important for calibration purposes, and to use the NI absolute accuracy tables, you must know the operating temperature of your board. Without the onboard temperature sensor, basic multifunction DAQ devices require an external temperature sensor for more thorough calibration procedures.

## Comparing Timing and Synchronization

These new basic DAQ devices have the same custom timing and triggering ASIC included on the full functionality E Series and the high-performance S Series multifunction DAQ products. This ASIC, also called the DAQ-STC, controls the onboard timing signals for the analog input, analog output, and counter/timer I/O operations. Part of the DAQ-STC is a software-controlled set of switches for sharing timing signals between boards for analog input, analog output, and counter/timer operations. All four DAQ product families, except the new basic multifunction DAQ devices, also have a board-to-board synchronization bus called the RTSI bus. Using this bus, you can expand synchronized operations for multiple DAQ

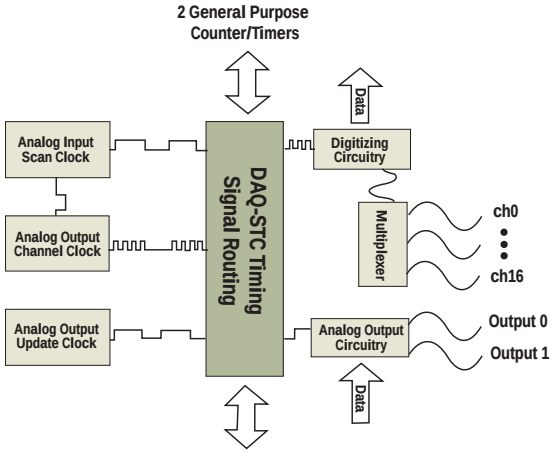
devices or a DAQ device with NI motion devices, NI vision devices, and NI modular instrumentation. The figure at right shows how some of the major onboard timing signals pass through the DAQ-STC circuitry for synchronization of different operations.

The high-performance S Series products differ slightly because they have a dedicated analog-to-digital converter per channel. Therefore, S Series devices sample all channels simultaneously. Using the channel clock and the multiplexer on the E Series and basic multifunction DAQ device products, you can quickly switch a single A/D converter through the active analog input channels.

Controlling timing and synchronization from NI LabVIEW is easy because the configuration functions for analog input and analog output have a parameter for routing timing signals. Also, there is a dedicated subroutine, or subVI, in LabVIEW for selecting timing signals for each operation called Route Signal.vi. For instance, you can connect the analog input start signal to the analog output trigger signal for stimulus/response measurements.

## Transferring Data to and from the PC

One important difference in DAQ products to consider when building an application is the transfer rates of data between the PC memory and the DAQ device. The basic multifunction DAQ and low-cost E Series devices have one direct memory access (DMA) channel that you can use for analog input, output, or counter/timer operations. For simultaneous onboard operations, the system automatically assigns interrupt requests (IRQs) to secondary operations. The DMA channel can transfer data much faster than any of the sampling rates of the DAQ products, and IRQs can only transfer data at about 1 kS/s and depend heavily on computer performance. The E Series and S Series products, on the other hand, have three DMA channels to avoid buffer overflow errors for systems requiring multiple high-speed operations. For instance, capturing and generating a sine wave simultaneously would require at least two DMA channels.




*Timing and Synchronization Diagram, Including Key Timing Signals*

## Complete Technical Support

These new basic multifunction data acquisition devices come with several resources to reduce costs:

- Thousands of online example programs for LabVIEW and Measurement Studio for Visual Studio at ***zone.ni.com***
- Compatibility between E Series example programs and the new NI PCI-6013 and NI PCI-6014
- A repository of KnowledgeBase entries for fast answers to technical questions at ***ni.com/support***
- Technical phone and email support from trained engineers at ***ni.com/ask***

Additionally, you have access to a customer discussion forum where you can post a question for the rest of the community and generally receive an answer within 72 hours. For more sophisticated applications, you can take advantage of the National Instruments Alliance Program – a group of more than 600 third-party integrators with a history of quality application design and expertise with NI products. To find out more about the NI Alliance program, visit ***ni.com/alliance*** ■

**Jace Curtis,**
**DAQ Product Manager**
**E-Mail jace.curtis@ni.com**

| | NEW Basic NI PCI 6013/6014 | Low-Cost E Series | E Series | S Series |
|---|---|---|---|---|
| Max Sampling Rate (kS/sec) | 200 | 200 | 100 to 1,250 | 800 to 10,000 |
| Number of Single-Ended Channels per Module | 16 | 16 | 16 to 64 | 2 to 4 |
| External Shield (16-bit Only) | – | ✓ | ✓ | – |
| Number of Ranges | 4 | 4 | 14-15 | 8 |
| Polarity | bipolar | bipolar | unipolar, bipolar | bipolar |
| On-board Anti-alias Filters | – | – | – | ✓ |
| Dedicated A/D Converters per Channel | – | – | – | ✓ |
| SCXI Signal Conditioning Compatibility | – | ✓ | ✓ | – |
| SCC Signal Conditioning Compatibility | ✓ | ✓ | ✓ | – |
| Automatic On-Board Calibration | ✓ | ✓ | ✓ | ✓ |
| On-Board Calibration at all Ranges | – | – | – | ✓ |
| NIST Traceable Calibration Certificate | ✓ | ✓ | ✓ | ✓ |
| On-Board Temperature Sensor | – | ✓ | ✓ | ✓ |

*Multifunction DAQ Analog Input Comparison Table*

*To read an interactive white paper that provides an in-depth look at data acquisition software and hardware design, visit ni.com/info and enter* nsi3104.

*To see LabVIEW data acquisition example programs for multiple applications, visit ni.com/info and enter* nsi3105.

***ni.com/daq***

# NI Introduces Development Tools for Smart Sensors

Setup time, data entry errors, and general confusion surrounding the configuration of traditional sensors have served as long-standing frustrations for test engineers. In response to this, National Instruments announces the TEDS library for LabVIEW and the NI Plug & Play Sensors Development Kit, two new development tools you can use to quickly and easily configure sensors into computer-based data acquisition systems.

The IEEE P1451.4 standard creates plug and play capability for analog sensors – leading to automated sensor configuration for computer-based measurement and automation systems. As part of IEEE 1451.4, plug and play sensors use a standard format for Transducer Electronic Data Sheets (TEDS) to communicate the necessary scaling information within a measurement test system, such as range, sensitivity, and other parameters. With plug and play sensors, you achieve faster system setup, improved diagnostics, and sensor data management, including automated use of sensor-specific calibration data, which delivers greater accuracy for your measurement.


*With the TEDS library for LabVIEW 6.1, you can incorporate TEDS into your LabVIEW application.*

A smart TEDS sensor, as defined by IEEE P1451.4, includes a simple memory chip attached to the sensor and uses a mixed-mode interface that accommodates both an analog signal for measurement signal and a serial digital channel for accessing the digital TEDS information.

## Developing Measurement Test Systems

The TEDS library for LabVIEW and NI Plug & Play Sensor Development Kit assist LabVIEW and NI-DAQ customers developing measurement test systems. The TEDS library for LabVIEW provides a library of VIs available for download on ni.com that implements the basic TEDS reading and writing functions to the sensors and LabVIEW application software.

The LabVIEW Plug & Play Sensor Development Kit is a complete data acquisition system for evaluating, using, and developing technology based on the IEEE P1451.4 specification. Intended for sensor manufacturers, developers, and systems integrators, the development kit includes everything you need to interface, read, and manage TEDS data. The kit even includes information on how to create and reprogram a smart TEDS sensor.

National Instruments also plans to introduce Virtual TEDS to bring you the benefits of the IEEE P1451.4 standard to the installed user base of legacy sensor products. National Instruments is collaborating with leading sensor vendors to create Virtual TEDS and a Plug & Play Sensor Advisor, to provide more and better-integrated sensor product information for your measurement and automation system.

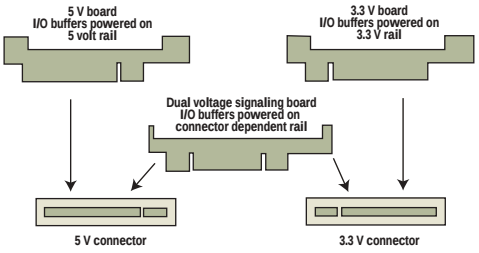
Using the TEDS library for LabVIEW and the NI Plug & Play Sensors Development Kit, you can incorporate IEEE P1451.4 smart TEDS analog sensors into your computer-based data acquisition system. ■

*For more information on plug and play sensors, visit ni.com/info and enter* nsi3106.

**ni.com/sensors**

# NI PCI Boards Offer Universal PCI Compliance

To ensure that you can use NI hardware regardless of the age of your PC or type of PCI interface slot, NI recently began upgrading our PCI plug-in boards to include universal connectors for use in any PCI slot. NI currently offers universal PCI boards for our GPIB interface boards, E Series multifunction and digital and timing I/O data acquisition boards, motion control and image acquisition boards, and modular instrumentation devices.




*Measurement Studio components extend Visual Studio for faster development of integrated measurement applications.*

## Less Heat, Lower Power Consumption

Since 1992, personal computers have come equipped with PCI expansion slots, which originally were designed to work with 5 V electrical signaling. However, recent updates to the PCI specifications define a 3.3 V signaling alternative, which offers several advantages, including less heat dissipation, lower power consumption, and lower-cost system components. Today, personal computers come equipped with only 3.3 V PCI slots. The 5 V and 3.3 V signaling alternatives are physically differentiated by "keys" in their connectors. Vendors deliver hardware keyed either for compatibility with the 3.3 V or 5 V slots or a universal key for use in both.

## Compatibility with Any Computer Equipment

From the migration from ISA to PCI through the new PCI expansion slots, you can be confident that NI hardware works with any computer equipment, regardless of its age. Combining measurement hardware with high-quality driver software, such as NI-488.2 and NI-DAQ, helps you avoid hardware changes, as drivers abstract away and handle the low-level bus communication details. ■

**ni.com/gpib**

# Autoscheduling Optimizes Instrument Utilization

Improving your instrument utilization rates plays a key role in increasing your test throughput and reducing your total cost to test. A new NI technology called autoscheduling optimizes instrument use rates with state-of-the-art parallel testing features in TestStand 2.0. Parallel testing typically yields a 30 to 50 percent increase in instrument utilization rates and test throughput when compared to traditional test systems. Autoscheduling enhances these rates even further to return an additional 10 to 15 percent in addition to the efficiency achieved through parallel testing.

## Typical Flow of a Parallel Test System

The parallel testing chart below illustrates the typical order and flow of a parallel test system running tests on four separate UUTs. To further illustrate the advantages of autoscheduling, we created a typical automated test system using NI TestStand and NI LabVIEW applications, and PXI instrumentation including two sources, a digital multimeter, digitizer, multiplexer, and high-density switch.

| Parallel Testing | | | | | | | |
|---|---|---|---|---|---|---|---|
| UUT 1 | Test 1 | Test 2 | Test 3 | | | | |
| UUT 2 | | Test 1 | Test 2 | Test 3 | | | |
| UUT 3 | | | Test 1 | Test 2 | Test 3 | | |
| UUT 4 | | | | Test 1 | Test 2 | Test 3 | |

*Execution Order Using Traditional Parallel Testing*

Using this typical test configuration, autoscheduling improves the instrument utilization and test throughput by eliminating a major portion of the idle time at the beginning of test executions, as shown in the autoschedule parallel testing chart above. You can implement this using autoscheduling step types for TestStand that contain algorithms that skip tests that are waiting to acquire resources and return to them later once the resources become available.

| Autoschedule Parallel Testing | | | | | | | |
|---|---|---|---|---|---|---|---|
| UUT 1 | Test 1 | Test 2 | Test 3 | | | | |
| UUT 2 | Test 2 | Test 3 | | Test 1 | | | |
| UUT 3 | Test 3 | | Test 1 | Test 2 | | | |
| UUT 4 | | Test 1 | Test 2 | Test 3 | | | |

*Parallel testing execution using autoscheduling eliminates idle time.*

| | Execution Time | DMM Utilization Rate | Digitizer Utilization Rate |
|---|---|---|---|
| Sequential Testing | 43 s | 53% | 44% |
| Parallel Testing | 29 s | 78% | 65% |
| Autoscheduling | 25 s | 92% | 76% |

*Autoscheduling increases DMM and digitizer use rates by nearly 40 percent, and increases throughput by nearly 50 percent.*

## Increased Throughput and Use Rates

Results shown in the conversion chart above further highlight the optimization in instrument use and throughput. In the typical automated test application created for this test, autoscheduling increased the DMM and digitizer utilization rates by nearly 40 percent, and increased the throughput by nearly 50 percent, compared to traditional sequential testing. ■

*To download the ready-to-use autoscheduling step types, and a complete description of techniques and key points to consider, visit ni.com/info and enter* nsi3107.

**ni.com/teststand**

# New Measurement Driver Software Provides Flexibility

The new NI Measurement Hardware Driver Development Kit (DDK) delivers development tools and a register-level programming interface for NI measurement hardware under practically any operating system (OS) not already supported by NI-DAQ for Windows.

The Measurement Hardware DDK exposes the full register map of each board and provides examples for completing common measurement and control functions.

## Customizable Bus Interface Component

E Series multifunction, analog output, digital I/O, and counter/timer I/O work with the DDK. You can customize the bus interface component for any OS by changing three function calls.

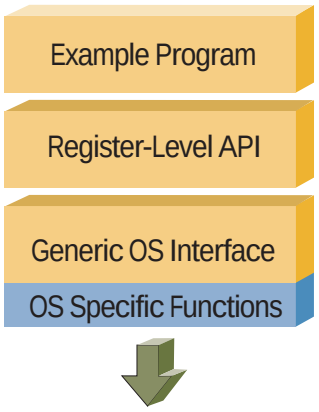
Currently implemented operating systems include:

- Linux
- Pocket PC/Windows CE
- Mac OS X
- QNX
- LabVIEW Real-Time
- Windows 2000/NT/XP/Me/9x

## Developing OEM-Type Systems

NI designed the Measurement Hardware DDK to assist the experienced register-level programmer in developing Original Equipment Manufacturer-type (OEM) systems. When creating such higher volume systems, you can afford to amortize the time and expense of register-level programming across many systems. ■

*To download example code, visit ni.com/info and enter* nsi3108.




*The NI Measurement Hardware Driver Development Kit provides a bus interface, register-level API, and example programs for your DAQ device.*

**ni.com/daq**

# NI Provides Flexible Tools for 42-Volt Automotive Test

In the past few years, automobile manufacturers have increased the electronic content within vehicles, ranging from navigation systems to full entertainment systems. Additionally, many automotive regulatory pressures require reduced emissions and improved fuel economy. These automotive trends require large amounts of power, such as "idle stop," in which an engine shuts down completely when it would traditionally idle. Increased electronic content and features necessary for reduced emissions require more power than current 14 V systems can provide. To address the need for additional power, the automotive industry has now agreed upon 42 V as the next electrical system standard. NI offers data acquisition and signal conditioning products to meet this automotive industry trend.

| Product | Platform/bus | Resolution | Scan Rate | Input Range |
|---|---|---|---|---|
| NI SCXI-1125 | SCXI* | 12 or 16-bit | 333 kS/s | ±300 V |
| NI SCXI-1104 | SCXI | 12 or 16-bit | 333 kS/s | ±60 V |
| NI PXI-4070 | PXI | 6 1/2 digit | 5 kS/s | ±300 V |
| NI FP AI-102 | FieldPoint | 12-bit | 360 S/s | ±120 V |
| NI-6115 | PCI, PXI | 12-bit | 10 MS/s | ±42 V |

* Requires the SCXI-1313 Terminal Block

*NI Data Acquisition Products for 42 V Tests*

## Virtual Instrumentation Eases Redesign and Test

The new 42 V electrical system standard means many components and in-vehicle systems require redesign and testing. For instance, the vendors of batteries, power semiconductors, ECUs, and other power electronic devices must re-engineer many of the 14 V tests that have not changed in the last 50 years. To facilitate this re-engineering, engineers and scientists today can use computer-based measurement and automation, or virtual instrumentation.

## Development and Design Validation Speed

Many National Instruments data acquisition hardware platforms, such as compact distributed FieldPoint and modular, rugged PXI, significantly speed up development and design validation of 42 V electronic components when combined with NI measurement and control software, such as LabVIEW. NI offers several data acquisition products to meet the common requirements for 42 V tests, such as ± 60 V signal ranges and 142 V protection. Additionally, many of the analysis functions necessary for testing 42 V systems, such as transient analysis and power measurements, are native analysis functions in LabVIEW. Look to NI for the technology to test all of your automotive designs, including your 42 V innovations. ■

*To download your FREE 42 V transient detector and get detailed product information for 42 V tests, visit ni.com/info and enter* nsi3109.

**ni.com/automotive**

# Low-Cost, High-Performance Data Acquisition for Laptops

Engineers and scientists can now benefit from high-performance, portable 16-bit data acquisition (DAQ) at a lower price than ever before with the NI DAQCard-6036E. The speed of the new DAQ device surpasses all other NI 16-bit products in PCMCIA format. Clocking in at rates of up to 200 kS/s, this new device offers speed increases of up to 10 times that of comparable products. Additionally, it provides 16 single-ended or eight differential analog input channels, two 16-bit analog outputs, two 24-bit counter/timers, and eight digital I/O lines.


*The new DAQCard-603E delivers the fastest 16-bit measurements for PCMCIA.*

## Accurate, Reliable Measurements

National Instruments E Series data acquisition DAQ devices deliver accurate, reliable measurements through a number of features, including temperature drift protection circuitry, self-calibration to a highly stable onboard voltage source, resolution improvement technologies, and the NI-PGIA measurement amplifier. You can further ensure the accuracy of your measurements and connect to more types of signals by using signal conditioning, such as the SCC platform, to form a complete, portable data acquisition system.

The DAQCard-6036E comes with NI-DAQ driver software, which makes configuration and programming identical to that of any other NI plug-in DAQ device. In addition, the new device is compatible with NI LabVIEW applications developed for other E Series boards.

## Meeting Space and Portability Requirements

The DAQCard-6036E low-cost, 16-bit device works ideally in applications that require portability or have space constraints, such as field service and research, in-vehicle testing, portable data logging, or general laboratory instrumentation. ■

*To download a white paper about the benefits of measurement ready DAQ, visit ni.com/info and enter* nsi3110.

*To download the data sheet for the NI DAQCard-6036E and other portable DAQ and SCC products from NI, visit ni.com/info and enter* nsi3111.

**ni.com/daq**

# NI Offers More Than 24,000 FREE Source Code Examples

Enhance your application development with the NI Development Library, consisting of more than 2,400 National Instruments LabVIEW, LabWindows/CVI, and Microsoft Visual Basic, and Visual C++ source code examples written by NI development and application engineers, systems integrators, and customers. The FREE measurement examples cover basic functional examples, such as analog and digital I/O, counter/timer operations, and signal processing and analysis. Plus, you can search for applications ranging from temperature and strain, to sound and vibration, to machine vision and motion control. With the increasing number of NI virtual instrumentation developers, the NI Development Library offers a growing number of measurement software examples.

## Save Hours in Development Time

Overall, you can save hours of development time when you find an example that closely matches your application. For example, you can find a reference design and third-party sensor and hardware recommendations that help you finish your development quickly. You can easily modify and customize the example programs to fit your application.

If you are new to virtual instrumentation, an example program can help you learn the programming language and give you the insight to improve the performance of your application.

## Search Tips for Online Examples

- Search general or application-specific terms; broader terms return more results, but more exact terms may return an example that specifically fits your application
- Include your programming language, such as LabVIEW
- Do not forget to look at documentation, code readability, and level of support as other criteria for keeping or discarding an example
- Broaden your search terms if none of the original results fit


*The NI Development Library provides thousands of FREE source code examples.*

- If you have trouble finding a particular application, visit ***ni.com/ask*** for additional help ■

*To find the right FREE online example program to benefit your application from more than 2,400 NI examples, visit ni.com/info and enter* nsi3112.

***ni.com/devzone***

# Using NI LabVIEW for Large Project Development

If you do not focus on good application design, you sacrifice performance. Additionally, you should learn about ways to manage the development and maintenance of more robust and advanced applications to maximize productivity. In this article, we examine how LabVIEW successfully addresses the primary concerns facing developers – code maintainability and application performance.

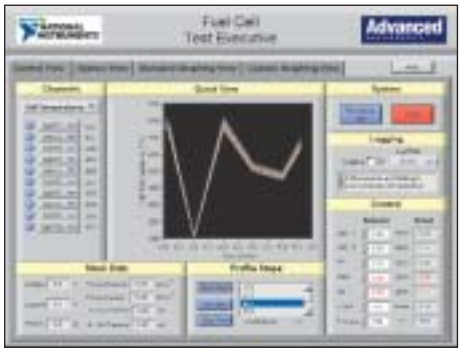
## Building Maintainable Code

Regardless of your development environment, well-designed code is always easier to maintain because it is more organized. Learning good software design techniques seems difficult, especially without a software engineering background. However, there are several tools you can use to make this easier in LabVIEW. The LabVIEW Development Guidelines manual, which ships with LabVIEW and is available for download on ***ni.com***, helps you learn good software design practices. You also can find several tutorials on ***ni.com*** about application design patterns and object-oriented design tools. By applying these design practices, you can better organize your applications for greater efficiency, quicker development, and easier maintenance. For example, by applying the strategies discussed in the LabVIEW Application Design Patterns presentation, your applications become much more modular, taking less time to modify, and giving you better performance.

## Increasing Application Performance

As your applications grow in size, you look for ways to optimize performance. LabVIEW consistently delivers excellent performance for both small and large applications. By designing your applications using strong code development techniques, you can further enhance your application performance. To help you do this, LabVIEW contains VI Metrics tools for analyzing applications to pinpoint areas in code that require a lot of processing time or memory. You can find several tutorials on ***ni.com*** for improving performance in your applications.

LabVIEW provides an environment that easily scales with your applications and provides many tools for increasing your application's performance and ease of maintenance. ■




*This example fuel cell testing application presents a professional user interface, increasing its usability. Its modular design reduces maintanance and modification time.*

*For more information on using LabVIEW software for large application development, and to find the resources mentioned in this article, visit ni.com/info and enter* nsi3113.

***ni.com/labview***

# Drive Down Design Time with NI LabVIEW Measurements

Through a new initiative to integrate with the most popular design tools, LabVIEW graphical development environment now contributes more to reducing design cycle times for engineers, making it easier to support designs throughout validation and production. This results in faster time-to-market, higher quality designs, and reduced cost to test. By using LabVIEW as a single measurement platform from design to production, companies can ultimately achieve better productivity throughout the design flow.

## Measurements throughout the Design Flow

In today's competitive business climate, design engineers have less time than ever to go through the design flow. In addition, the designer needs to create more complex products than ever. Designing and producing a product involves a variety of tasks from modeling and simulation, to verification and validation, to final manufacturing. Engineers need measurements and tests to verify the function of their designs. LabVIEW and virtual instrumentation make measurements a powerful tool that increases design productivity. Virtual instrumentation, heavily leveraging industry-standard computing technology, complements today's computer-aided design tools. With virtual instrumentation, real-world measurements can easily add value throughout the design flow, encouraging designers to test early and often. More design iterations up front using real-world data help you detect design flaws earlier in the process, reducing the risk of test systems debugging products on the factory floor.

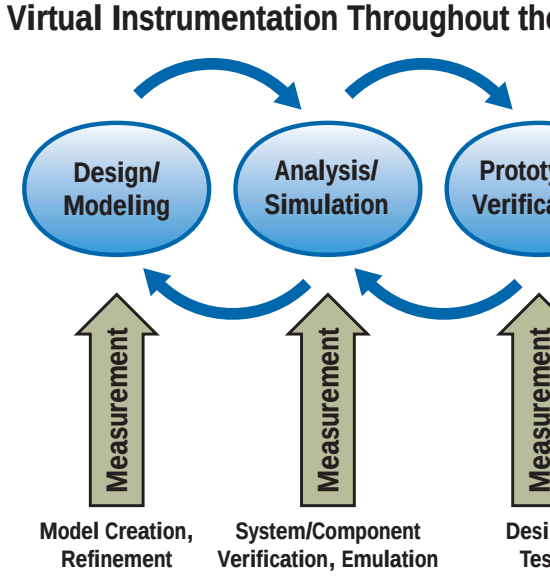
Design flows vary greatly across applications, industries, and disciplines. The measurement needs not only vary from one application to the next, but also depend on where the engineer is in the design flow. In the earliest phase of design, real-world measurements on existing components are essential to ensure that simulated design models form an accurate foundation for the design simulation. When checking initial prototypes, the engineer needs easy, interactive access to a variety of measurements that support benchtop evaluation of the basic performance of the prototype compared to expected performance. During validation, engineers need flexible measurement tools to repeatedly run profiles of tests to explore design characteristics. In production, automated testing must deliver fast results, with a focus on reducing test time to minimize costs and maximize throughput.

Despite these varying requirements, LabVIEW, integrated with a wide range of measurement and control I/O, is a single measurement platform that delivers value at every stage for acquiring, analyzing, and presenting data. It provides value by adapting to the needs of the engineer at each stage for greater flexibility, performance, or reliability. While LabVIEW is widely used for measurements in validation and production, many design engineers do not yet see an advantage in using software to take measurements as opposed to simply using benchtop instruments. However, integrating LabVIEW with popular design tools gives the designer ready access to measurements in a way not easily achieved using traditional instrumentation. This integration helps the design engineer iterate their designs faster and easier using accurate and complete real-world data to compare to their designs.

***From simulation to model design, analysis, and verification, LabVIEW makes it much easier for the design engineer to make measurements during the design process.***

## NI LabVIEW Integration with Design Software

LabVIEW software now makes it easier for design engineers to analyze and compare real-world data with design models. By comparing data with the expected results from the design, the design engineer can adjust design parameters to acheive the desired real-world behavior they need. From the selected design software environment, engineers can call LabVIEW measurement libraries to pull the real-world data from the measurements easily into the design software. These libraries are custom designed for software packages such as Wolfram Research Mathematica modeling software and Ansoft Serenade Designer RF circuit simulation software. Engineers also can rapidly develop an easy-to-use diagnostic interface in NI LabVIEW, then call VIs that integrate models from software such as The MathWorks MATLAB, MathSoft Mathcad, Electronic Workbench Multisim, and Electronic Workbench circuit simulation software. For example, you may design an electronic filter in a circuit design software package, then open a LabVIEW VI that imports the filter data from the software dynamically and plots it against acquired data from a prototype. Using LabVIEW, it is easy to continuously monitor the real-world measurements as you adjust your prototype to make them more consistent. Or, you may want to adjust your algorithm or model in the design software against a real-world system to match the two as closely as possible. Making this comparison and subsequent adjustments in the iteration

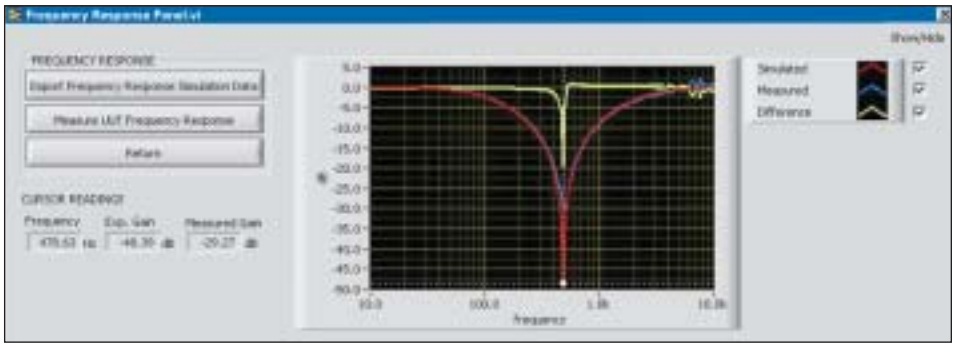



*Measurements in the Design Flow*

process creates easier results in faster design iterations earlier in the design process.

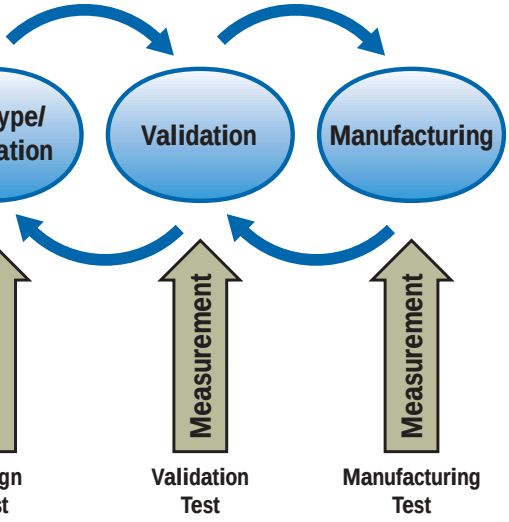
## DSP and Hardware-in-the-Loop Testing Using NI LabVIEW

In addition to verification of models, engineers can easily test the designs themselves using LabVIEW. For example, engineers often run simulation models of engines or other automotive parts on LabVIEW Real-Time systems to act as the I/O for testing electronic



*Frequency Response Comparing Real-World to Model Data*

## e Design and Manufacturing Process




control units, otherwise known as hardware-in-the-loop testing. LabVIEW Real-Time can easily integrate a wide variety of hardware including analog and digital signals, counters, image acquisition and motion control devices, CAN and serial buses, RS-232, and third-party hardware such as MIL 1553 bus cards. Its I/O integration added to ease-of-use and real-time performance makes LabVIEW Real-Time an ideal platform for prototyping and testing a variety of real-time measurement and control systems.

In particular, testing Texas Instruments DSP designs have now become easier with the integration of LabVIEW and the TI Code Composer Studio DSP development environment. The joint initiative by National Instruments and Texas Instruments to make it easier to develop and test DSP-based designs includes a set of VIs to automate the Texas Instruments Code Composer Studio environment and to communicate test data directly to and from the memory on the DSP chip. Using these tools, a DSP design engineer can create a complete virtual testing environment for his DSP-based device. LabVIEW can read and write data internal to the DSP, while also generating real-world stimuli and taking real-world measurements. LabVIEW applications can thus correlate different operating parameters of the DSP algorithms with the actual effect seen on the real-world inputs and outputs to the DSP.

Finally, design engineers using the latest Tektronix high-performance oscilloscopes as their measurement system also can take advantage of LabVIEW. A LabVIEW analysis, visualization, and report generation application now runs on the Windows desktop of the Tektronix open Windows oscilloscopes. Using the application, you can select different analysis functions such as spectrum analysis and tone detection, to perform in real-time as the data scope acquires the data. In addition, you can publish reports on the data in HTML or other formats directly from the application. A fully functional NI LabVIEW evaluation version installed on the oscilloscopes provides many example programs written specifically for that family of scopes. The oscilloscope families that ship with this software include the Tektronix 5000, 6000, 7000, and 8000 series instruments. You also can download the software FREE on ***ni.com*** to use with any existing Tektronix open Windows oscilloscopes.

By making the measurements and testing easier for the design engineer, LabVIEW eases the transition and support of a design through the validation and production phases further down the flow. From simulation to model design, analysis, and verification, LabVIEW makes it much easier for engineers to make measurements during the design process. With LabVIEW, companies now have a reusable industry-standard measurement software platform from design to validation to production, which provides value at every phase of the design flow. ■

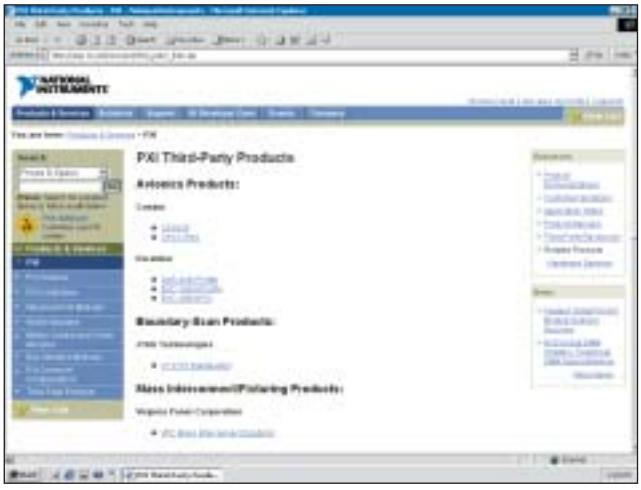
*To download LabVIEW examples that can integrate with your design software, visit ni.com/info and enter* nsi3114.

**ni.com/labview**

# Access Hundreds of Third-Party PXI Products Online

PXI represents the fastest growing open multivendor measurement platform, with more than 700 PXI products available today.

Because of the growing demand for PXI systems, NI introduces a new area of *ni.com* – the PXI Third Party Products Web page, which lists some of the most commonly used PXI products. The page includes detailed information about PXI products, ranging from boundary scan controllers, avionics bus interfaces, optical switching modules, and power supplies. For each product listed, you can find information on features, a detailed data sheet, and a link to the manufacturer's Web site.




*With the PXI Third-Party Products page, you can quickly find commonly used modules from the more than 700 PXI products available.*

## New PXI Products for Aerospace

The aerospace industry has quickly adopted designing applications in PXI for new requirements and for mid-life upgrades of existing systems because of its high performance, small size, and diversity of functionality. Using PXI-based systems, the aerospace industry is implementing a wide range of applications, including avionics testers, actuator testers, engine testers, and structural tests of satellites.

Some key third-party products for aerospace applications include:

### Condor

- CEI-620 (amp.ni.com/niwc/pxi/100.jsp): ARINC 429 and ARINC 717 high-performance interfaces
- CPCI-1553 (amp.ni.com/niwc/pxi/101.jsp): MIL-STD-1553 multifunction interfaces

### Excalibur

- DAS-429cPCI/Mx (amp.ni.com/niwc/pxi/107.jsp): ARINC 429 interfaces
- EXC-1553cPCI/Px (amp.ni.com/niwc/pxi/108.jsp): MIL-STD-1553 multifunction interfaces
- EXC-4000cPCI (amp.ni.com/niwc/pxi/109.jsp): Carrier card that supports ARINC 429, 525, MIL-STD-1553, RS 232/422/485 and ARINC-708

### North Atlantic Industries

- cPCI-75DS1: Digital-to-Synchro/Resolver module
- cPCI-75D1: LVDT Measurement module
- cPCI75SD1: Synchro/Resolver-to-Digital module
- cPCI-75DL1: LVDT/RVDT programmable output module

*To see how NI customers use PXI products for their aerospace applications, visit ni.com/info and enter* nsi3115.

Other PXI industry resources include:

***PXI Technology Review***
**pxionline.com**
This magazine and its Web site provide the latest news and trends of PXI suppliers, products, and solutions. The Web page for this publication contains links for both a PXI buyer's guide as well as a searchable product directory.

**PCI Industrial Computers Manufacturers Group**
**picmg.com**
This site lists more than 600 companies that maintain the CompactPCI specification. The site contains a searchable CompactPCI product listing for both CompactPCI and PXI products.

**PXI Systems Alliance**
**pxisa.org**
This consortium of more than 50 companies maintains the PXI specification. The organization's Web site lists PXI vendors and their products, along with a product catalog, which you can request online.

***Evaluation Engineering***
**evaluationengineering.com**
The PXI/VXI Buyers' Guide on this site includes an extensive listing of the companies that offer PXI and VXI products and services.

***VXIbus & PXI Newsletter***
**www.vxinl.com**
This newsletter publishes a catalog of all PXI products, which you can request online. ■

*To access the PXI Third-Party Products Web page, visit ni.com/info and enter* nsi3116.

*ni.com/pxi*

# New PXI Baseband Digitizer Delivers 14 Bits at 64 MS/s

The new NI PXI-5621 high-performance, baseband digitizer is a flexible, software-based modular instrument that works well with a wide variety of applications, ranging from communications, surveillance, and spectral analysis, to video and imaging acquisition. The new baseband digitizer offers 14-bit resolution, 64 MB of onboard memory, and a variable sampling rate of up to 64 MS/s. With 71 dB of spurious free dynamic range, the new digitizer helps you accurately measure small amplitude signals in the presence of larger signals, while offering low distortion.

*The Spectral Measurements Toolset included with the NI PXI-5621 provides the flexibility to create cusomized measurements.*

## Measurement Software

The baseband digitizer provides measurement flexibility by supporting a diverse set of measurements in your software. The NI-SCOPE instrument driver implements more than 50 built-in measurement functions so you can develop powerful measurement solutions in minimal time. The baseband digitizer also includes the NI LabVIEW Spectral Measurements Toolset that provides a set of measurement building blocks for frequency domain and power measurements, including zoom FFT processing, power spectral density, power in band, adjacent channel power, and occupied bandwidth.

## Digital Downconversion

To further increase your performance, the new baseband digitizer uses an onboard digital downconverter chip (DDC) to deliver spectral measurements at rates up to five times faster than traditional methods on frequency spans of 1.25 MHz or less. Using the included Spectral Measurements Toolset, DDC programming remains transparent and automatically enabled when you select a frequency span of 1.25 MHz or less.

*For detailed information on the NI PXI-5621 baseband digitizer, visit ni.com/info and enter* nsi3117.

**ni.com/pxi**

# Use LabVIEW to Timestamp Digital State Changes

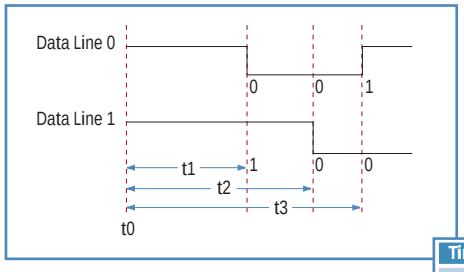
The time between digital state changes is critical for any system that acts under digital control. To monitor digital lines for state changes, you can use LabVIEW and the Digital Time Interval Analyzer Start-Up Kit. This LabVIEW example program monitors digital devices, such as relays and solenoids, and logs the times of the digital state changes to disk. Because the system logs the relative times of state changes, rather than continuously polling, it decreases the load on the computer bus, frees CPU time, and minimizes the space required for log file storage. The system combines the power of LabVIEW with digital I/O and counter/timer devices to simplify configuration and lower cost. You can customize the LabVIEW application to monitor more digital lines, add analysis functionality, or connect to other I/O devices.

The figure below shows an example timing diagram for lines that you want to timestamp. You may need to monitor the output from a digital device, such as a printer head, or you may need to know when a valve opens or closes. Given a set of digital values and the corresponding timestamp information, you can postprocess the data in LabVIEW to obtain frequency data or other timing information for individual lines.

The software and hardware for the Digital Time Interval Analyzer Start-Up Kit give you the flexibility to configure your system to meet your specific I/O count and desired analysis. The LabVIEW example provides high-performance operation and maintains flexibility for modification. The example also monitors 32 digital lines, and you can modify it to monitor hundreds of input lines. The system consists of three software components:

- Digital Time Interval example application program
- LabVIEW 6*i* or higher
- NI-DAQ driver 6.9 or higher (included with LabVIEW)

The Digital Time Interval Analyzer Start-Up Kit works with the NI 6533, a 32-bit digital pattern I/O and handshaking device, and an NI 660x 32-bit counter/timer device. The NI 6533 digital device captures the line state changes, and the NI 660x counter/timer timestamps those changes. The two devices share timing and synchronization signals over the RTSI or PXI Trigger Bus, and both are available for PXI/CompactPCI and PCI.




*The LabVIEW example program monitors digital devices, such as relays and solenoids, and logs the times of the digital state changes to disk.*

| Time of Change | Line States After Change |
|---|---|
| t1 | 10 |
| t2 | 00 |
| t3 | 01 |

*To download FREE code for this LabVIEW application, visit ni.com/info and enter* nsi3118.

**ni.com/labview**

# NI Optimizes Productivity of Tektronix Oscilloscopes

National Instruments and Tektronix are working together to maximize design engineer productivity by delivering customized NI LabVIEW software pre-installed on Tektronix open Windows oscilloscopes for custom analysis and report generation. You also can download this software FREE at ***ni.com/tek*** for use on your existing Tektronix open Window oscilloscope.

## Expand Oscilloscope Functionality with LabVIEW

The NI LabVIEW Add-On for Tektronix Open Windows Oscilloscopes software ships pre-installed on the Tektronix TDS5000, TDS6604, TDS/CSA7000, and TDS/CSA8000 series open Windows oscilloscopes and runs natively on these oscilloscopes as well as on any PC connected to them via GPIB or Ethernet. The add-on software package includes a fully functional evaluation version of NI LabVIEW along with demos, examples, and a custom VI palette so LabVIEW novices and experts alike can quickly get up and running.

The LabVIEW Scope Analysis Demo, a stand-alone application included in the LabVIEW add-on software, features quick acquisition, analysis, and presentation of waveform data. With the application, you can perform interactive signal processing and analyze live or file-based signals from your oscilloscope. The NI LabVIEW add-on software also contains a set of documented example VIs with source code that you can use as teaching tools or starting points in building custom LabVIEW applications for Tektronix open Windows oscilloscopes. The examples range from single-shot waveform acquisitions to continuous acquisition of waveforms with tone detection analysis. The software comes with a convenient and interactive interface that presents a categorized list of the examples.

The add-on software also features scope-specific VIs that simplify waveform transfer between custom LabVIEW VIs and Tektronix open Windows oscilloscopes. The TDS5000, TDS6604, TDS/CSA7000, and TDS/CSA8000 series oscilloscopes each have a palette containing five VIs. NI built these high-level VIs on top of the Tektronix instrument driver for each scope to deliver high-level, common scope functions such as "initialize" and "get waveform."

## Customize Analysis for Your Oscilloscope

You can try out additional analysis and other functions to customize your application to fit your scope data with the evaluation version of LabVIEW. You then can use this fully-functional version of LabVIEW to efficiently automate your measurements by combining the advanced analysis and automation capabilities of LabVIEW with the high-precision measurements of Tektronix open Windows oscilloscopes. You can use the evaluation version for 30 days after the first launch and then easily remove it to install the full version without losing any of the Tektronix add-on software.

*The seamless integration between NI LabVIEW and Tektronix open Windows oscilloscopes maximize productivity for design engineers.*

LabVIEW provides powerful integrated functions and add-on tools for measurement, analysis, and signal processing that expand the precision measurement capabilities of open Windows oscilloscopes, including:

- Waveform Analysis – AC and DC estimate, amplitude and frequency estimate, amplitude and phase spectrum, auto/cross power spectrum, harmonic analyzer, impulse response, limit-mask testing, network functions, phase transition, power and frequency estimate, scaled time domain window, spectrum unit conversion, and transfer function
- Signal Processing – Convolution, cross power, fast Hilbert transform, fast Hartley transform, integral x(t), inverse real and complex FFT, inverse FHT, power spectrum, pulse parameters, real and complex FFT, threshold peak detector, and unwrap phase
- Filters – Bessel filter, Butterworth filter, Chebyshev filter, elliptic filter, Equi-Ripple filter, FIR filter, IIR cascade filter, IIR filter with I.C., IIR filter, inverse Chebyshev, and median filter
- Windowing – Blackman window, Blackman-Harris window, cosine tapered window, exact Blackman window, exponential window, flat top window, force window, general cosine window, Hamming window, Hanning window, Kaiser-Bessel window, and triangle window

In addition to the advanced analysis capabilities, NI LabVIEW extends your presentation and connectivity options with open Windows oscilloscopes. You can easily create customized user interfaces to quickly display acquired and analyzed signals on the same screen. With LabVIEW, you can publish your data to a variety of sources including HTML reports, Microsoft Office applications, spreadsheets, databases, and ASCII files. You also can quickly control and monitor your VIs remotely from anywhere in the world using a Web browser through the remote-panel features in LabVIEW 6.1. ■

*To download or request a FREE copy of the LabVIEW Add-On Software for Tektronix open Windows oscilloscopes, visit ni.com/info and enter* nsi3119.

***ni.com/tek***

# Automate Agilent Gas Chromatographs with NI LabVIEW

The NI Instrument Driver Network (*ni.com/idnet*), your central resource for downloading, developing, and submitting instrument drivers, now features NI LabVIEW connectivity to Agilent gas chromatographs using an industry-standard, OPC-based instrument driver. The network features example VIs to jump-start your application development in LabVIEW and a direct link to purchase the software from Agilent. This software further expands the diverse offerings of LabVIEW drivers through the Instrument Driver Network and other vendors.

## Automate Your Application

Agilent Technologies Life Science and Chemical Analysis group recently released a new OPC instrument driver, OPC Communications for Cerity NDS for Chemical QA/QC, that makes it possible to use the NI LabVIEW Datalogging and Supervisory Control Module to communicate with and acquire data from Agilent gas chromatographs. With this driver software, you can quickly integrate Agilent Cerity Chemical software into LabVIEW to control your gas chromatographs for natural gas, petroleum refining, and petrochemical or chemical QA/QC analyses that integrate with larger systems to solve applications including data logging, analysis, reporting, and supervisory control.

The OPC software works with the following Agilent gas chromatographs:

- M200 Micro GC
- 3000 Micro GC
- 5890 Series II GC
- 6890 GC
- M400 Micro GC
- 4890D GC
- 6850 GC
- 35900E A/D

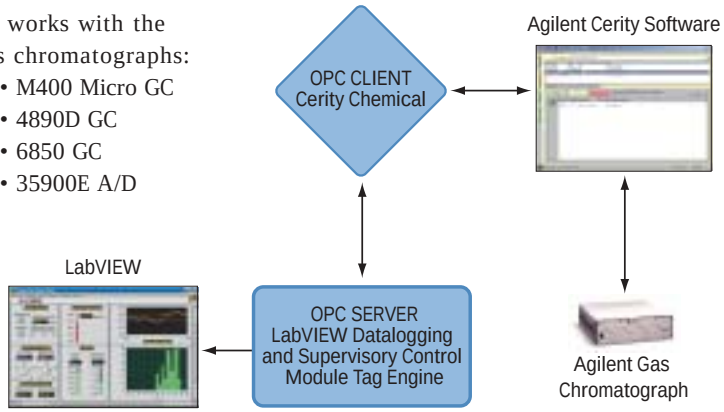
## Instantly Acquire Data

The OPC Communications for Cerity NDS for Chemical QA/QC software publishes results from Agilent Cerity Chemical software to the LabVIEW Datalogging and Supervisory Control Module through OPC.

With the Cerity Chemical software environment, you can configure up to 32 gas chromatographs and control up to eight gas chromatographs at maximum data acquisition rates. You specify your various samples and methods in the Cerity Chemical software, and the OPC software automatically publishes the results from each test. With the LabVIEW Datalogging and Supervisory Control Module, you can automate this process by automatically launching the Cerity Chemical software and instantly acquiring data through OPC.

With the LabVIEW module, you can easily acquire results, configuration settings, timestamps, calibration information, and other data from your Agilent gas chromatograph. With the Agilent OPC software, you can select the data to publish to NI LabVIEW. ■

*To download a FREE white paper and application examples for using NI LabVIEW with Agilent gas chromatographs, visit ni.com/info and enter* nsi3120.




*You now can use NI LabVIEW to communicate with and acquire data from Agilent gas chromatographs.*

## Instrument Driver Network: Spotlight on DMM

The NI Instrument Driver Network (*ni.com/idnet*) contains more than 1,600 instrument drivers from more than 150 instrument vendors, NI Alliance Program members, and other developers for use with NI LabVIEW and LabWindows/CVI development environments and Measurement Studio add-ons for Microsoft Visual Studio.

Listed below is a sampling of DMM instrument drivers available in the instrument driver network:

**Advantest** – R6552
**Agilent/Hewlett-Packard** – 34401A, 3456A, 3457A, 3458A, 3478A, E1326A, E1410A, E1411A, E1412A
**Black Star** – 4503
**Datron** – 1061A, 1071A
**Datron Wavetek** – 1362, 1362, 1362S
**Fluke** – 45, 8502A, 8505A, 8506A, 8520A, 8840A, 8842A
**Fluke/Philips** – PM 2525, PM 2534, PM 2535
**Iwatsu** – VOAC 7510, VOAC 7512, VOAC 7513
**Keithley** – 192, 195A, 196, 197A, 2000, 2002
**LEM Instruments** – MP11, MP12, MP13, MP14
**Prema** – 4000, 5000, 5001, 5017, 6000, 6001, 6031
**Siemens** – B3220
**Solartron** – 7061A, 7061A, 7081, 7150, 7151
**Tektronix** – DM 5010, DM 5110, TX1, TX3, VX4234, VX4234, VX4236, VX4236
**Wavetek** – 1362S
**Yokogawa** – 7552, 7555

*ni.com/idnet*

# Learn, Share, and Collaborate at *LabVIEW Zone*

Engineers and scientists have built applications using LabVIEW for more than 16 years. What began as some early pioneers creating single applications has become a large and growing LabVIEW community that creates diverse applications, actively shares code, and uses various tools to collaborate with each other. The LabVIEW community and its shared resources have become a valuable aspect driving the LabVIEW revolution. The more we work together as a community, the better LabVIEW developers we become and the stronger the community as a whole becomes – driving the future of measurement and automation.

To facilitate this communication and to continue to grow the community, NI introduces *LabVIEW Zone*. This forum delivers collaborative tools to share ideas and code, network with one another, and improve LabVIEW skills. For *LabVIEW Zone* to be a success, the LabVIEW community must work together to turn the collection of technologies into a true community that positively impacts LabVIEW developers worldwide.

Browse through the following sections of *LabVIEW Zone*:

### Discussion Forum

Interact with other wireworkers in the community. Share application information and network with thousands of other LabVIEW developers around the world.

### Code Sharing

Find that piece of LabVIEW code you are searching for, or post your latest marvels so others can learn.


LabVIEW Zone, *at* ***ni.com/labviewzone****, is your source for all things LabVIEW.*

### User Groups

Find a user group or seminars in your area, start your own local group, or share presentations.

### Articles

Dive into LabVIEW development by reading the latest *Insights* article and learn to incorporate application design patterns into your projects. View an online LabVIEW R&D presentation covering the intricacies of LabVIEW development. Or if you are more interested in reading about the future of LabVIEW directly from LabVIEW inventor Jeff Kodosky, check out his quarterly article, *The VIEW*.

### Games and More

Compare your skills with the skills of other LabVIEW developers with the monthly coding challenge. Or check out the talent from LabVIEW developers who have created games, poems, and even songs about LabVIEW.

Whether you are new to LabVIEW or a savvy wireworker, *LabVIEW Zone* has opportunities for you to learn, interact with other LabVIEW enthusiasts, show off your talents, and help further the LabVIEW Revolution. Join us the next time you visit ***ni.com*** by going to ***ni.com/labviewzone*** ■

## Current Featured Items on LabVIEW Zone

***The VIEW*** • Jeff Kodosky, the inventor of LabVIEW, answers the question, "Is LabVIEW a programming language?"

**This Month's Featured Discussion Topic** Is messaging a critical aspect of your LabVIEW applications?

**Special Live Web Presentation** • Inside LabVIEW – Events Structure, presented by LabVIEW R&D.

*Take a look at these featured items at* ***ni.com/labviewzone***

## Ask Dr. VI

*Are globals good or bad and how often should I use them?*

When someone categorically states that globals are bad, they are, of course, oversimplifying the explanation. Similarly, the statement that globals are great fails to tell the whole story.

The two common problems that globals cause in an application are race conditions and performance issues. These problems are easy to diagnose and relatively easy to fix if you understand the circumstances where the problems occur.

*To see the entire answer, visit* ***ni.com/labviewzone***

In *LabVIEW Zone*, certified NI LabVIEW engineers answer some of the most commonly asked questions about LabVIEW. E-mail your questions to Dr. VI today.

***ni.com/labviewzone***

# Flextronics Uses NI Tools for Cell Phone LCD Inspection

by Bryan Moore, Senior Software Test Engineer, Flextronics

**The Challenge:**
**Performing efficient and cost-effective LCD inspection tasks on cellular phones with high-density displays.**

**The Solution:**
**Developing a system for display inspection using NI LabVIEW, NI-IMAQ vision software, and the NI-1424 digital image acquisition board with a dual-head digital camera setup.**

At Flextronics, we were looking for a machine vision solution to inspect the display panels on cell phones. Our project required that we inspect two screens – one on the front displaying numbers or address books and a smaller screen on the back displaying the caller identification number. We also had to inspect the displays covered with protective tape. We had two goals – one, we needed to find an inspection solution, and two, we wanted to become self-reliant with machine vision for future projects. We looked at a handful of vendors for help. Most offered complete turnkey solutions, though inspection with the protective tape was still a challenge. These companies could come into our plant and implement the complete solution for us.

*Flextronics inspects two displays simultaneously using NI software and hardware tools and Duncan Technology Cameras.*

Turnkey solutions were an expensive option, and they failed to meet one of our key criteria – that we become self-reliant with vision. If our testing needs were to change or expand, we would have to contact the consultants to scale the system to our new needs.

## Using Off-the-Shelf Tools to Customize the System

National Instruments offered us the guidance to learn how to incorporate vision into our test programs. Because we were already strong LabVIEW users, we easily programmed the NI vision tools to accomplish the needs of our current display inspection project for cell phones while developing the skills needed for the projects. ■

*To read the full-length customer solution, visit ni.com and enter* nsi3121.

**ni.com/success**

# Lucent Cuts Process Test Time in Half Using NI TestStand

by Richard E. Mattila, Test Technology Engineer, Lucent Technologies

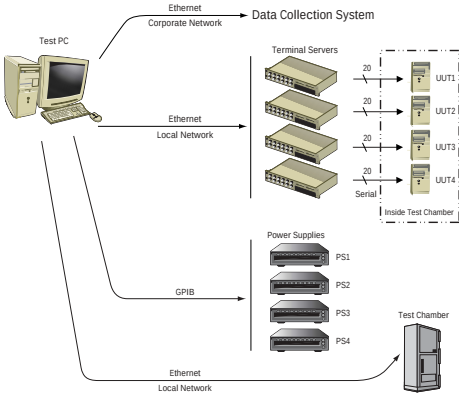
**The Challenge:** **Developing a common operator interface capable of simultaneously testing a wide variety of Lucent Technology Core and Edge Multiservice WAN Switch products.**

**The Solution:** **Customizing the LabVIEW example operator interface supplied by TestStand 2.0 and using the LabVIEW Internet Toolkit for data collection to simplify implementation of the first highly accelerated stress screening (HASS) test solution.**

## Meeting Demands of Current and Future Test Development Efforts

The Test Automation Group, a division of the Supply Chain Networks Test Engineering department, develops and deploys test solutions used by international contract manufacturers to build Lucent Technologies Core and Edge Multiservice WAN Switch products, such as the CBX 500 (R) Multiservice WAN Switch. We can use HASS to test virtually any communications or PC-based product. NI TestStand and LabVIEW help us meet the demands of current and future test development efforts while substantially reducing test execution time. TestStand 2.0 provides a test management environment, where we execute the TestStand sequences from the operator interface and get data collection results. We modified the TestStand off-the-shelf LabVIEW example operator interface VI to fit our needs and reduce development time. TestStand also fulfilled additional requirements, such as flow control (preconditions, pretest, post-test, and looping), and user-management login, providing different program features to operators and administrators.

The ability to simultaneously test multiple board types is critical to ensuring we maximize system throughput. ■




*Lucent Automated HASS Test System*

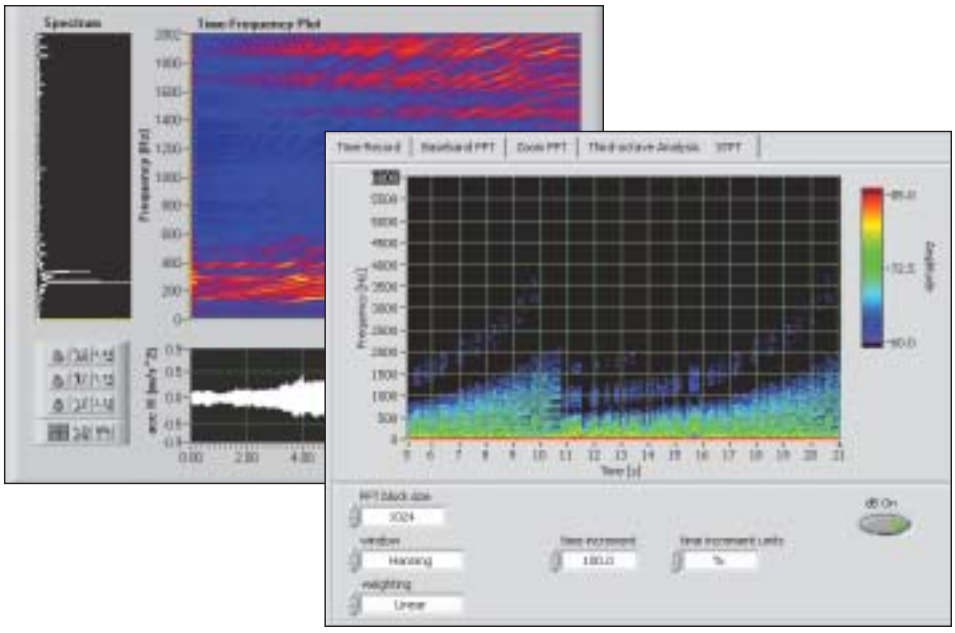
*To read the full-length customer solution, visit ni.com and enter* nsi3122.

**ni.com/success**

# Perform Spectrum Analysis with the Proper FFT Tools

The FFT is the basis for computer-based spectrum analysis, which relies on the representation of a signal in the frequency domain and is one of the most commonly used methods to analyze signals and waveforms. The FFT works on the principle that you can express any waveform as a sum of sinusoids. However, it makes one important assumption – that the waveform is periodic.

The result of an FFT is typically an array of real and imaginary numbers, which you can convert into magnitude and phase information about each of the sinusoidal waveforms that make up the signal. If the phase information is unnecessary, you can typically use the FFT-based power spectrum. There are many frequency analysis tools based on the FFT or that attempt to provide similar results. The specific use of the FFT depends on the characteristics of the signal of interest and desired results.



*FFT Array of Numbers Converted into Magnitude and Phase Information about Each Sinusoidal Wave Form*

## Zoom FFT

Zoom FFT analysis is simply an efficient computation of a subset of the FFT. You use this kind of tool when you need to analyze a specific frequency band of 10 to 11 kHz. Rather than computing the FFT for the entire frequency range, you only perform computations on a subset of frequencies. Thus, you can save a significant amount of processing power and time using this method.

There are many ways to implement the zoom FFT. The techniques NI LabVIEW Sound and Vibration Toolset software use come from the use of a digital filter-based method and a partial Fourier transform. After modulation by the center frequency, the digital filter-based method applies a bandpass filter, eliminating frequency elements outside your range of interest. Once completed, you perform down sampling to reduce the number of data samples. Finally, you compute the regular FFT of the reduced data set. This method is suitable for inline processing.

Applications of the zoom FFT include ultrasonic blood flow analysis, RF communications, mechanical stress analysis, Doppler radar, side-band analysis, and modulation analysis.

## Joint Time-Frequency Analysis

The frequency content of most signals encountered in everyday life changes over time. These are commonly known as transient signals. Because the basis functions used in classical Fourier analysis do not associate with any particular time instant, the resulting measurements, Fourier transforms, do not explicitly reflect the signal time-varying nature. One way to overcome the deficiencies of the regular Fourier transform is to compare the signal with elementary functions that simultaneously localize in time and frequency domains. Joint time-frequency analysis (JTFA) provides this capability. Typical applications where JTFA is the best tool include frequency-domain display of audio signals, time-varying linear, and nonlinear filtering.

The most common method the domain of JTFA uses is known as the short-time Fourier transform (STFT). This method involves taking sliding snapshots of your waveform, and then performing an FFT on that subset. By performing this action multiple times, you obtain a sliding window, which emphasizes "local" frequency properties.

## Super Resolution Spectral Analysis

Super resolution spectral analysis (SRSA) does not incorporate the FFT, but rather is a model-based alternative to the FFT for spectral analysis that you can use to estimate frequency information despite a limited number of sample points. With these tools, you also can estimate phase, amplitude, and damping factor of the sinusoidal components of a signal. One disadvantage is that it requires prior knowledge of the input signal. In other words, the tools of the SRSA component require an estimate of the number of sinusoidal components in your input signal. Another weakness of this method is that it is more computationally intensive than an FFT – therefore, it is suitable for smaller datasets of fewer than 100 points. Typical applications for the SRSA include biomedical research, economics, geophysics, noise, vibration, and speech analysis. ■

*NI LabVIEW contains all these and other powerful measurement analysis capabilities. To learn more about LabVIEW-based analysis, visit ni.com and enter* nsi3123.

**ni.com/analysis**

# Quickly Select NI Products with 12 Online Advisors

Easily configure your system using the respective product advisors at ni.com/advisor Our recent additions include switch and motion control product line advisors.

## NI Switch Advisor

Identifying a large matrix switching application can be daunting and time consuming. One of your first tasks is to determine the appropriate software and hardware for your application. The NI Switch Advisor simplifies this task by recommending the optimal hardware for your application based on your input. The Switch Advisor prompts you with questions, such as matrix, multiplexer configuration, and application requirements, including switch topology, number of connections, and signal characteristics. You also can choose to add NI PXI or SCXI chassis and components to your hardware configuration. Throughout the decision-making process, you can access more information about the available software and hardware.

## NI Motion Advisors

To make designing motion systems easier, NI now offers the NI Motion Controllers and Drive Advisor. This is a special Internet-based application designed to help you choose the right components for your motion control system. Use the NI Motion Advisor to input information about the motors, stages, or actuators. Based on your input, the advisor recommends which NI motion controllers, cables, and drives you can use.

If you need information on stages, use the Stage Advisor, which also is available at ni.com/advisor This advisor provides a searchable database of more than 140 NI-certified, compatible stages. After determining the correct stage for your application using the Stage Advisor, you can then switch to the NI Motion Controllers and Drive Advisor and use the information about the stage and the application you plan to create to determine the correct NI products to finish your application.

With the addition of these advisors, NI now offers a total of 12 product advisors with information about more than 900 NI products. NI also features third-party advisors, where you can search to find the NI products that work with third-party products. Also included is the specifications search from our content partner, Globalspec.com, with which you can select from 800 suppliers to build a complete solution.

*Visit ni.com/advisor today to start building your application.*

## NI Online Tutorials

ni.com is your resource to learn about technical concepts related to your measurement and automation applications. You can learn about NI products and technologies with NI online tutorials and Web events without leaving your desk. The self-paced tutorials cover a wide range of technical subjects and are available 24 hours a day at ni.com/tutorials

Our most popular tutorial covers the fundamentals of FFTs. Not only does this 25-minute tutorial define basic frequency measurements and how they are derived, but also discusses challenging topics, such as windowing and frequency resolution. Unlike application notes or white papers, online tutorials use multimedia to teach concepts. Also, think carefully before answering the quiz questions to verify your understanding. Few people answer all the questions right.

Check out our latest tutorial on using Microsoft Visual Basic to perform data acquisition. With this tutorial, you can learn to create a simple application, which captures a waveform, displays it in a graph, performs multiple types of analysis, and displays the result on the Web.

***NI now offers a total of 12 product advisors with information about more than 900 NI products.***

If you are interested in using NI LabVIEW on the Web, take advantage of the Distance Learning with Remote Laboratories tutorial. This tutorial explains how you can use LabVIEW to set up a remote experiment. Because the online tutorial teaches you how to use LabVIEW on the Web, you can try our online experiment, which controls a system in Austin, Texas.

If you prefer to learn through seminars, but cannot find time to leave the office, attend an online Web event. Enroll in one of many upcoming Web events at ni.com/webevents. Here you can learn about many topics, including the new NI 6½-digit FlexDMM.

Online tutorials are the latest way that NI brings you helpful measurement and automation information to ensure success with your applications. NI is developing new tutorials so more information is available to you though this convenient Web site. ■

*Visit ni.com/tutorials to learn more about this great source for helpful information, and to submit questions to gain insight from NI industry experts.*


*Take advantage of NI product advisors, offering information about more than 900 NI products.*

ni.com

# NI Introduces LabVIEW Certification and Real-Time Course

Use National Instruments Certification Program to validate your expertise with NI products and technologies. Through our Certification Program, you gain recognition from employers, clients, and peers in the measurement and automation industry. Enjoy the satisfaction of this distinguished accomplishment and establish your knowledge in industrial automation, measurement, and control applications.

Engineers can earn NI certification for an edge over competitors and demonstrate knowledge of measurement and automation capabilities. Managers can qualify job applicants and potential consultants, and verify employee progress through training programs.

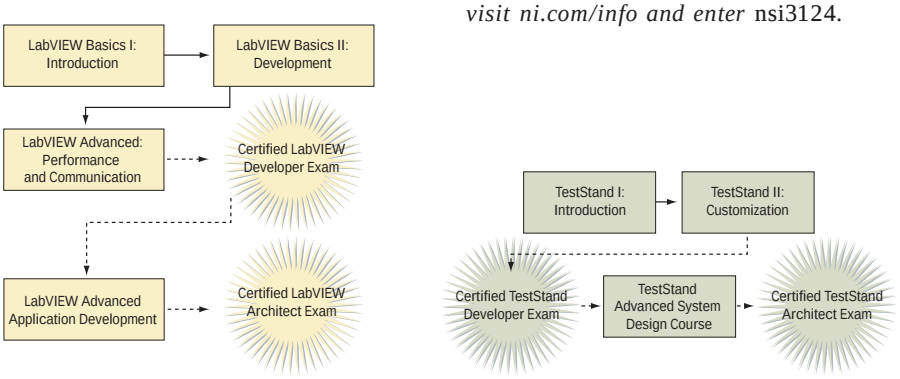
Currently, Select Integrator employees from companies such as Bloomy Controls, Data Science Automation, VI Engineering, and VI Technology, hold NI certification in NI LabVIEW and TestStand. Many engineers and scientists from these and other companies have attended advanced training courses leading to certification.

NI adds the LabVIEW Architect certification to current certifications including:

- LabVIEW Developer
- TestStand Developer
- TestStand Architect

## Certified LabVIEW Architect

The Certified LabVIEW Architect certification expands on the Certified LabVIEW Developer certification to verify mastery of LabVIEW. A Certified LabVIEW Architect has mastered not only the technical aspects of LabVIEW, but also the ability to lead complex projects from conception to completion.




*Certification Program Tracks*

High-level design, code review, and source code control are expectations of this credential. Upon completion of the Certified LabVIEW Architect certification program, you also have knowledge of advanced programming techniques, such as reuse libraries, plug-in architectures, and object-oriented coding styles.

## Taking the Exams

Although it is not a requirement to attend training courses prior to exams, certification applicants may find prepatory courses helpful. NI offers program tracks for LabVIEW and TestStand certifications. Please note that exams are practical in nature, and the best preparation combines course attendance and experience. NI currently offers all certification exams in English and administers them through branch offices throughout the United States and in 35 countries. ■

*For information on certification, requirements and conditions, exam applications, and tasks and objectives, visit ni.com/info and enter* nsi3124.

## NI Offers New LabVIEW Real-Time Course Using FieldPoint

National Instruments introduces "LabVIEW Real-Time Systems Using FieldPoint," a new hands-on course that teaches you how to develop and deploy real-time applications for distributed measurement and control. The three-day course uses LabVIEW Real-Time, PID Control Toolset, and a National Instruments FP-20xx real-time controller. The course benefits:

- New LabVIEW Real-Time and FieldPoint distributed I/O users
- Technical managers evaluating products for real-time applications
- Engineers and scientists developing real-time distributed measurement and control applications

After taking this course, you grasp the concepts of real time and determinism, LabVIEW embedded control, data logging, and real-time network communication. Further, you learn how to install, configure, and communicate with FieldPoint real-time hardware, and understand LabVIEW Real-Time considerations such as memory usage, shared resources, multithreading, and priorities.

NI offers this course in more than 100 training centers worldwide, or we can conduct training onsite at your facility, reducing employee travel time and expenses. ■

*To enroll or access a detailed course outline, please visit ni.com/info and enter* nsi3125.

*ni.com/services*

# Proligent Data Management System Optimizes Production

Averna Technologies introduces Proligent, a factory and laboratory technical information management system that uses NI TestStand to integrate sequence execution with a sophisticated product and process management system.

This technical information management system uses an extensive suite of data analysis and reporting tools that help you define and track manufacturing processes for your entire product line. With these tools, you can monitor and optimize your processes with timely, detailed information about your shop floor performance.

With Proligent, you can manage your production logistics, including inventory allocation and the calibration records of test instruments. Combined with its instrument command definition module, this system can create an abstraction layer between the test cases and instruments for interchangeability that does not require testing code modifications.

This system has a user-friendly interface that provides product specifications and test limits to NI TestStand at run-time. All results generated from this sequence execution are automatically stored in the Proligent database for future tracking and analysis.


*The Proligent system seamlessly integrates with your IT infrastructure.*

The Proligent system comes with a set of test applications that span a wide range of generic testing needs and includes an API with which you can integrate custom or legacy test applications. You also can easily integrate manual and/or automated procedures in the same consistent test environment. ■

*For more information about Proligent, visit ni.com/info and enter* nsi3126.

**ni.com/alliance**

# PXI System Configures Transmission Test Applications

*NI PXI and SCXI hardware make it possible to combine multiple signals into one test system.*

ES-International, an NI Alliance Program member in Belgium, announces the Real Time Acquisition System (RTAS), a real-time data acquisition system based on NI LabVIEW Real-Time and PXI.

Test engineers at ZF Getriebe in Belgium use RTAS to configure transmission and engine test cells for the continuous variable transmissions in new generation cars. You also can use RTAS to test vehicle road performance. With dynamic and quick set up features, you can define cyclic or noncyclic test runs for speed, load, environmental conditions, road maps, and cycle parameters. RTAS enables you to quickly change the test setup for each test using a monitoring PC that connects to RTAS via Ethernet. Together with real-time viewing possibilities and synoptics, you can use this system for a wide range of automotive testing needs.

With RTAS, you can quickly set up a data acquisition system with easy-to-use wizards and tables. This system also works as a high-speed data logger and controls analog and digital outputs according to free configurable input conditions, such as alarms, test profiles, and triggers.

Because RTAS is based on a real-time controller, the synchronization between inputs and outputs are possible in short and stable cycle times with fast reaction on dynamic triggers. This system is easy to configure for real-time control applications and can work with CAN and Profibus interfaces, SCXI signal conditioning modules, various types of sensors, and a variety of PXI acquisition boards. ■

*For more information about RTAS, visit ni.com/info and enter* nsi3127.

**ni.com/alliance**

# Biometric Toolkits Create Applications for LabVIEW

JYE Studio introduces two authentication toolkits that use biometrics to create personal authentication applications in NI LabVIEW – the BiometricsVIEW facial recognition toolkit and the BiometricsVIEW fingerprint recognition toolkit. With these toolkits, you can capture and analyze a face or a fingerprint from an image and translate the image into a template for inter-template identity comparison.

The BiometricsVIEW recognition toolkits are considerably more accurate than existing methods, such as passwords or personal identification numbers. Now, with these toolkits, you can directly link between a biometric signal and an individual, preventing an unauthorized user from interrupting your authentication.

You can use the BiometricsVIEW face recognition toolkit to locate the head, face, and eyes in an image or you can locate several faces within one image. With the BiometricsVIEW fingerprint recognition toolkit, you can locate and classify minutiae points and determine the position and angle of the core in a fingerprint image. ■


*Use BiometricsVIEW toolkits for personal authentication applications.*

*For more information about BiometricsVIEW toolkits, visit ni.com/info and enter* nsi3128.

**ni.com/alliance**

# Test Multiple Products With One Thermotron Test System

*With the Functional and Parametric Test System, you can develop tests in the design stage and then duplicate these tests during production.*

Thermotron Industries introduces the Functional and Parametric Test System, a product test solution that combines commercial off-the-shelf instruments, popular software tools, and Thermotron-tested system designs. With this test system, you can meet the cycle rates and monitoring requirements for applications in a variety of industries, including automotive, telecommunications, and defense electronics.

The Functional and Parametric Test System enables you to test multiple product types with one system. With this system, you can adapt the base design to a variety of product testing requirements. This standardizes the base configuration, which reduces your costs and minimizes training. The system also includes a PXI-based hardware platform and an open architecture for future upgrades and expansion.

The Functional and Parametric Test system has both manual and automatic modes of operation. With the manual mode, you can interactively configure or run a test. This reduces your costs by giving you the benefits of a troubleshooting and software verification tool. The automatic mode uses NI TestStand to create predefined tests, making this a valuable tool for end-of-line testing. You also can reduce your test setup by applying information from the manual mode to the automatic mode. ■

*For more information about the Thermotron Functional and Parametric Test System, visit ni.com/info and enter* nsi3129.

**ni.com/alliance**

# Upcoming NI Events Around the World

## On the Road Again

As the new year ramps up, so does the National Instruments tradeshow schedule. Do not miss your chance to learn about the latest technologies and advancements in virtual instrumentation from NI.

**2003 Spring Highlights:**
**SAE 2003 • March 3 - 6**
**Detroit, MI**
Stop by our booth to learn more about the latest advancements in the automotive test platform (ATP). The ATP, based on NI LabVIEW and PXI, helps you develop complete, customizable automotive measurement and automation solutions.

**National Manufacturing Week • March 3 - 6**
**Chicago, IL**
Let NI show you how to meet manufacturing challenges with integrated software and hardware platforms.

**APEX • March 31 - April 2**
**Anaheim, CA**
Stop by our booth to learn how virtual instrumentation can reduce your test time by 90 percent.

*For a complete list of trade shows, visit ni.com/info and enter* nsi3130.

| Spring 2003 Trade Shows | | |
|---|---|---|
| Date | Show | City |
| January 22 - 24 | Electrotest | Tokyo, Japan |
| January 28 - 30 | Photonics West | San Jose, CA |
| February 18 - 21 | ExpoComm | Mexico City, Mexico |
| February 19 - 21 | MD&M West | Anaheim, CA |
| March 4 - 7 | PA 2003 | Lillestrøm, Norway |
| March 9 - 14 | PittCon | Orlando, FL |
| March 11 - 13 | Måling & Kvalitet | Odense, Denmark |
| March 12 - 13 | High Tech | Toronto, Canada |
| March 25 - 27 | OFC | Atlanta, GA |
| March 25 - 27 | Elkom 2003 | Helsinki, Finland |
| March 25 - 27 | Expo Manufactura | Monterrey, Mexico |

## NIDays 2002-2003 – Spring Events

This spring, come see the future of measurement and automation at NIDays, National Instruments annual series of virtual instrumentation conferences reaching 35 countries and 60 cities across the globe. More than 8,000 engineers and scientists attended the conferences last year, exchanged ideas on innovative approaches to technical challenges, and studied future technology trends in virtual instrumentation.

*For more information and a complete list of all locations, visit ni.com/info and enter* nsi3131.

## Attend Live Events via the Web

Join us for live, interactive Web events featuring a variety of topics, including application solutions, hot technology topics, and more. Recent topics include "Optimize Test System Throughput with the NI PXI-4070 6½-Digit FlexDMM" and "Acquire, Analyze, and Present Your Data with NI LabVIEW."

*To view topics and an archive of past events, and to register online, visit ni.com/info and enter* nsi3132.

## Upcoming Seminars in Your Area

Technical seminars help you stay ahead of the latest technologies and trends in measurement and automation. National Instruments regularly holds seminars around the world to show you how to get the most out of your test, measurement, and control applications. Look for this new featured seminar in your area.

**Computer-Based Measurement and Automation**
This three-hour presentation covers how current PC technologies combined with powerful, modular software and hardware tools yield shorter development times and lower overall system costs for your measurement and automation application.

With this seminar, you:
- Discover how virtual instrumentation transforms test, measurement, and automation applications into tightly integrated, high-performance measurement and automation systems
- Learn how measurement and automation gives engineers and scientists the freedom to create a new level of powerful, customized measurement systems ■

*Register online for upcoming live, interactive Web events, for information on application solutions, hot technology topics, and more.*

*To view and register for upcoming seminars in your area, visit ni.com/info and enter* nsi3133.

## NIWeek Call for Papers

National Instruments invites you to submit a paper to the NIWeek 2003 Best Applications of Measurement and Automation Paper Contest and receive a discount on the cost of your NIWeek conference pass.

*Visit ni.com/info and enter* nsi3134 *for more information and to download the 2003 Paper Contest Author Packet.*

## NIWeek Call for Presentations

National Instruments is seeking conference presenters for NIWeek 2003. As an NIWeek presenter, you receive many benefits, including a discount on the cost of your NIWeek conference pass and industry recognition and exposure.

*To submit a proposal or to view more information, visit ni.com/info and enter* nsi3135.

***ni.com/events***

# Record-Breaking Success at NIWeek 2002

NIWeek 2002, the worldwide conference on virtual instrumentation, welcomed nearly 1,500 engineers, scientists, Alliance Program members, press, and educators to Austin, Texas, to experience National Instruments latest technologies and powerful new products. This year's conference offered 140 presentations and hands-on sessions to an audience representing 16 different industries and 55 countries. NIWeek also included presentations from industry experts who provided fresh perspectives on NI products and virtual instrumentation.

As always, we announced and demonstrated exciting new products during NIWeek 2002 including the NI PXI-4070 6½-Digit FlexDMM, NI PXI-5660 RF signal analyzer, and NI DIAdem 8.1. NI President and CEO, Dr. James Truchard, launched NIWeek 2002 on Wednesday, August 14, 2002, with a keynote highlighting new products and technologies that fulfill the company's vision of virtual instrumentation. NI Vice President of Engineering, Tim Dehne, followed with new product demonstrations, and a team of student engineers from Virginia Tech presented an innovative remote LabVIEW Real-Time application. On Thursday, NI Vice President of Product Strategy, Ray Almgren, along with NI Business and Technology Fellows, Mike Santori and Jeff Kodosky, discussed the history of LabVIEW and its emerging role in the design process. On the last day, NI welcomed guest keynote speaker Dr. Michael Hawley of MIT, whose thought-provoking lecture on the digital divide between industrial countries and the developing world was the perfect end to the week.

Do not miss the opportunity to attend NIWeek 2003 when National Instruments presents an innovative conference, exciting exhibitions and festivities, and the latest technologies driving the future of virtual instrumentation. ■


*Attendees visit the Virtual Instrumentation exhibit at NIWeek 2002.*

*To register for NIWeek 2003, visit ni.com/info and enter* nsi3136.

**ni.com/niweek**

## More Information and Resources

- For a complete listing of recent newsletter issues in PDF form, other resources, and new product information, visit ni.com/info and enter newsletter
- To view our current training schedule, visit ni.com/info and enter nsiedu
- To subscribe to our FREE monthly customized e-mail newsletters, *NI News* or *eSupport News*, visit ni.com/info and enter nsinews
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