Instrumentation Newsletter

The Worldwide Publication for Measurement and Automation | **Second Quarter 2011**

The New Era of Automated Test

page 3

Taking Measure of a New Era

At NIWeek 1997, I recall listening to Dr. Truchard and other NI employees discuss the idea of PXI. It occurred to them that the Eurocard standard of CompactPCI could be perfect for instrumentation if it only had a few enhancements. They thought that adding timing and triggering architecture to CompactPCI could produce an ideal platform for instrumentation and control. This conversation was the seed of innovation that led to the NI PXI platform.

Today, PXI is a leading industry standard for automated test. Over 60 companies deliver more than 1,500 PXI modules. PXI has transformed the way that engineers conduct automated test. Several device-under-test throughput rates have shown increases up to 20 times the rate of other systems. It is clear that PXI has emerged as the de facto platform for automated testing.

Beyond automated test, PXI is making significant strides in the control market. One of the most high-profile control applications using PXI is the beam collimation on the CERN Large Hadron Collider. Tuning the particle beam requires custom high-speed control made possible only by the characteristics of PXI.

Recent advancements in the evolution of PXI include PXI Express and field-programmable gate arrays (FPGAs). The PXI Express platform adds the latest high-speed bus technology, PCI Express, while maintaining backward compatibility with hybrid (PCI) slots. This is important because this speed transports measurements into microprocessor memory space where decisions are made, thus producing faster test and control responses. With the emergence of FPGAs, PXI and peer-to-peer streaming modules can transport measurement and control data between modules and then process the data with unprecedented speed and determinism.

With such an effect on measurements and control, the marketplace has clearly indicated its acceptance and demand for this platform. Vendors who were reluctant to join the movement are now fully endorsing the PXI platform (see page 3 in the article titled "The New Era of Automated Test"). As all of the players line up to support PXI, we will see movement away from traditional instrumentation for automated test and an outbreak of activities and innovation in this new era of modular, software-based instrumentation. As we look back, traditional rack-and-stack instrumentation has had a great run. Looking forward, we have entered a new era of measurement and automation where impressive performance and applications will rule the day.

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The New Era of Automated Test

For more than 30 years, the technology community has witnessed Moore's law in action.

The reality that transistor density doubles every 18 months has led to significant advances in the performance of electronic devices. This is evident not only in the latest Intel i7 processors but also in the shrinking of technology such as 64 GB solid-state drives (SSDs), which are now as small as a postage stamp. These technological advances translate into considerable cost reductions. For example, LCD video screens that previously cost hundreds of dollars are now available in low-cost greeting cards. With devices that are faster, smaller, and lower cost than ever, the industry has seen an explosion of new products that combine the functionality of gadgets like a GPS, digital camera, and phone into a single, integrated tool. Furthermore, these tools are software-defined, so users can download apps to customize each device to their exact needs.

With increased technological innovation comes the challenge of testing each new breakthrough. For example, adding wireless LAN capability to a next-generation product typically introduces 50 new tests that must be performed at the same time as previous-generation product tests. Fortunately, Moore's law is just as relevant for the next generation of test platforms and modular instrumentation. Coupled with a software-defined solution, these test systems are more than capable of keeping pace with the new developments in devices under test (DUTs).

From Rack and Stack to PXI

For decades, engineers have built automated test systems by taking the same traditional box instruments they use on the engineering bench and placing them in a rack, stacked one on top of the other. The rack is connected over an instrument control interface to a computer, where a software program automates the system. While these rack-and-stack systems are functional, they do not apply the instruments as they were intended to be used.

Traditional box instruments are designed for the bench, when an engineer or technician wants to manually test or troubleshoot a device. In a rack, the instruments' screens, knobs, and buttons can often become a waste of space and money. Furthermore, these instruments are not necessarily designed for the measurement speed or data throughput required in automated uses. On a design bench, 10 seconds for measurement is negligible, but it can mean hundreds of thousands of dollars lost when compounded over the testing of thousands of devices on a production line.

> *"With PXI, you can have a better solution that's smaller, more cost-effective, and better suited to your needs than traditional rack-and-stack instrumentation."*
>
> – Jessy Cavazos, Frost & Sullivan

Over the last few years, the industry reached a tipping point in automated test and is now making a large-scale switch to PXI. Optimized for automated test, PXI provides a solution that is faster, smaller, and more cost-effective than rack-and-stack options. For example, when Harris RF Communications, a provider of multiband tactical radios for military use, recently experienced a dramatic increase in demand for its

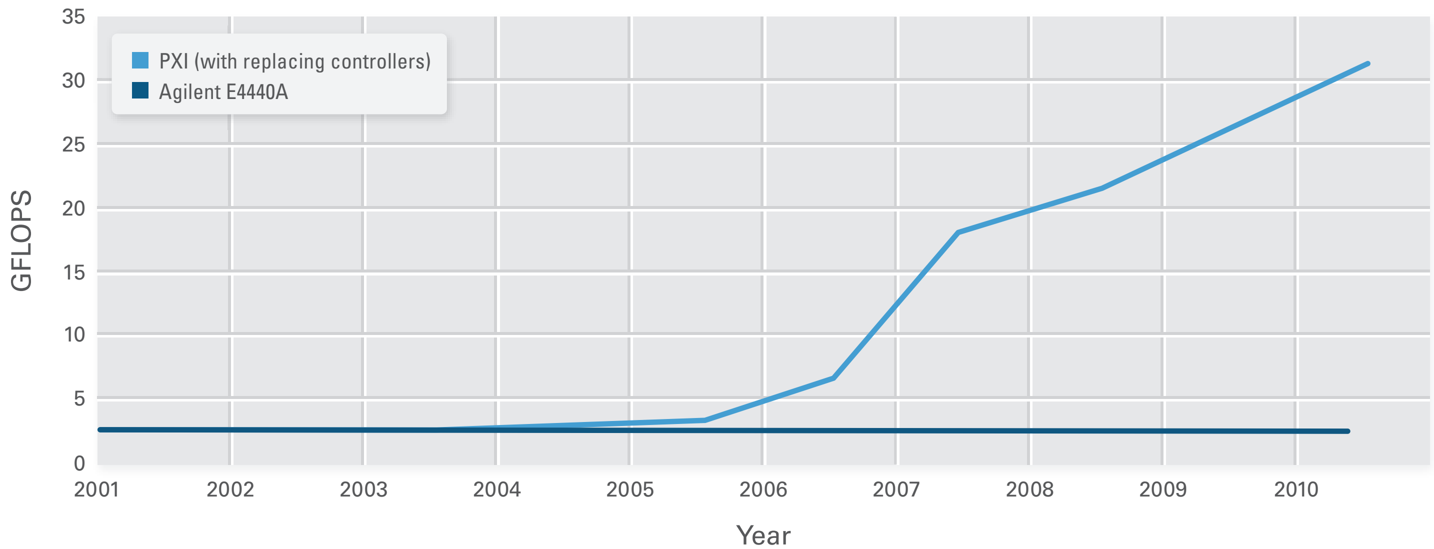

Figure 1. *Unlike traditional rack-and-stack instruments, engineers can increase PXI system performance throughout its lifetime by upgrading the controller to the latest processing capabilities.*

Falcon line of high-performance radios, the company required an updated testing methodology that would increase the number of radios being tested at a time. Harris selected NI TestStand software and PXI hardware as the basis for its next-generation test system. Using the NI platform, Harris was able to increase the number of radios tested and reduce the cost for testing each one by 74 percent.

> *"With our new platform based on NI PXI technologies, we've maintained both measurement and performance integrity while achieving three times cost reduction and 10 times improvement in semiconductor validation throughput."*
>
> – Ray Morgan, ON Semiconductor

A recent NI survey of test managers from around the world confirms the tipping point. In the survey, more than 70 percent of test managers indicated they will use PXI as the core of at least one of their next automated test systems. This is in contrast to only 30 percent of test managers who will continue to use rack-and-stack instrumentation in their automated test systems.

Figure 2. *The new NI PXIe-5665 provides industry-leading RF performance and is 40 percent less expensive and 1/10 the size of comparable rack-and-stack solutions.*

Traditional box instrument vendors are also making a large investment in PXI. For example, Agilent Technologies announced its commitment to the PXI platform in September 2010 while launching more than 40 PXI modules. Agilent joins more than 60 vendors in the PXI Systems Alliance, an industry consortium that promotes and maintains the PXI Standard, who are making investments in the open, multivendor standard.

Moore's Law Takes PXI Into the Future

Using commercial off-the-shelf technology, PXI benefits immensely from Moore's law. With transistors 2,000 times smaller than those created 20 years ago, NI provides high-performance RF instrumentation in a compact 3U package that is 10 times smaller than a comparable box instrument. This translates to less rack space as well as a reduction in weight and power usage. When Analog Devices switched from traditional automated test equipment (ATE) to PXI to test its MEMS microphones, the company reduced the weight of its test system by 66 times and power usage by 16 times. The shipping container for the previous ATE system alone cost as much as the entire new PXI test system.

The effect of Moore's law is also evident in the processing capability of PXI. With a modular controller architecture, engineers can add extra processing capabilities by simply swapping the controller while keeping the same chassis and instrumentation. To improve performance, they can easily switch a system built in 2001 operating at 2.5 GFLOPS with a controller running the latest Intel core i7 processor at over 35 GFLOPS. Advanced processing power is important in computationally intense applications like RF signal processing and analysis. For example, TriQuint Semiconductor saw a 6 to 14 times reduction in GSM, EDGE, and WCDMA test times during the characterization of its power amplifiers by switching to a PXI-based system from traditional bench instruments. Using NI PXI modular instruments, the company reduced characterization of new parts from two weeks to about a day.

Beyond providing a smaller and faster solution, PXI continues to push the boundaries of measurement performance in instruments of any platform. The new NI PXIe-5665 vector signal analyzer (VSA) delivers best-in-class RF performance including industry-leading phase noise, amplitude accuracy, and dynamic range. The VSA achieves optimum performance while being 40 percent less expensive and 1/10 the size of comparable box solutions. Another example of leading measurement technology is the new NI PXIe-5186 digitizer. Co-developed by National Instruments and Tektronix™, the world's leading oscilloscope manufacturer, the NI PXIe-5186 is the highest performing PXI digitizer on the market, with 5 GHz bandwidth and up to 12.5 GS/s sampling rate (see page 10 for more information).

The Evolution of Software

While PXI provides a faster, smaller, and more cost-effective option, its real power lies in offering a truly software-defined solution. Unlike traditional box instruments with fixed, vendor-defined functionality, PXI test systems are defined by the software that is written for them. Just like engineers can download apps to customize their smartphones, they can now customize test systems for their exact DUTs.

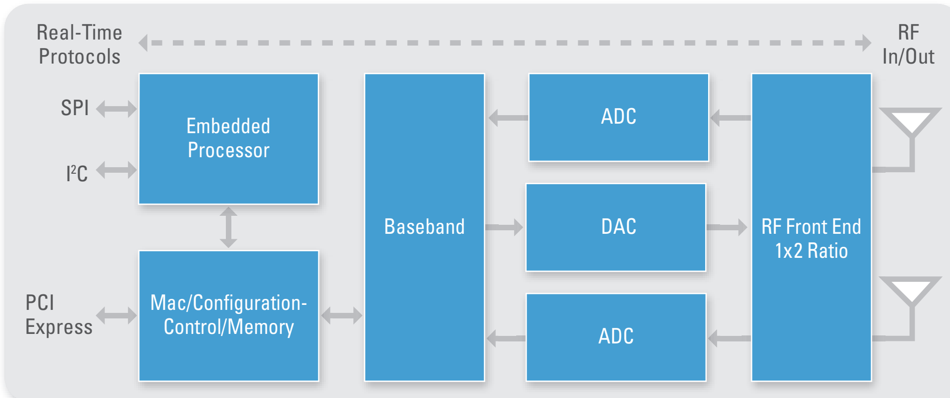

Figure 3. *Testing complex systems like WLAN on a chip requires new levels of test software abstraction and capabilities.*

PXI system software continues to evolve as DUT complexity increases. When engineers test a device like a WLAN system on a chip (SOC), they no longer perform simple stimulus and response tests to verify components. Instead, the test systems often need to communicate over real-time digital protocols such as I^2C, PCI Express, and SPI to exercise the device and synchronize the RF measurement on the back end. This level of complexity requires new levels of software abstraction to model, control, and test these systems.

> *"The NI PXI platform allowed us to significantly reduce our development time while maintaining great flexibility and real-time performance. Using LabVIEW allowed for the implementation of a real-time controller and FPGA modules in the same environment, helping us gain fast integration and obtain a stand-alone, reliable product."*
>
> – Miguel Núñez, Instituto de Astrofísica de Canarias (IAC)

Fortunately, tools such as NI LabVIEW graphical system design software make this possible. The same graphical programming environment used to control box instruments for 25 years provides test engineers the ability to model complex systems of stimuli and responses, including intricate timing and synchronization. Furthermore, engineers can download this same code directly to user-accessible FPGAs on PXI instrumentation for inline signal processing, custom protocol communication, and more.

As Moore's law dictates, newly developed devices are faster, smaller, and lower cost than ever before. To keep up with their DUTs, test engineers must switch to PXI-based test systems.

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Matthew Friedman is the senior product manager for the PXI platform at National Instruments and serves as a director and marketing co-chairman of the PXI Systems Alliance. Follow Matthew on Twitter from @PXI to get the latest updates about PXI.

To switch to PXI visit ni.com/automatedtest/softwaredefined.

Under the Hood of Smart Grid Control Systems: The IT Revolution Is Here

It is increasingly difficult to find aspects of our lives that technology has not transformed – from the phones in our hands to how we read books.

Whole industries are converting to the digital domain–the new world of information technology (IT) where software, networks, processors, and sensors fuse and exchange information.

What makes this shift so compelling that seemingly no business can resist? There are many reasons ranging from new features to faster delivery of goods and services to greater productivity. However, first and foremost, is performance over cost. Eventually, information technologies deliver faster rates of improvement because performance increases exponentially (in the numerator) while price decreases exponentially (in the denominator). Businesses that resist "digitization" are at risk of being rendered obsolete.

Look closely at the electrical grid. In contrast to many other industries, the way we generate, transmit, and distribute electrical power is still firmly rooted in "pre-IT" technologies. Despite its millions of miles of humming wires, thousands of power generators, and billions of interconnected devices, the grid still operates primarily under the control of antiquated technologies developed before the modern computer and Internet era. Nonetheless, under the hood of new grid-tied control systems, a digital revolution is under way. The revolution delivers higher performance, lower cost, and essential new features such as seamless integration of electric vehicles, grid-level energy storage, and distributed renewable energy generation. Although in its early stages, the smart grid revolution has begun and no energy business can afford to ignore it.

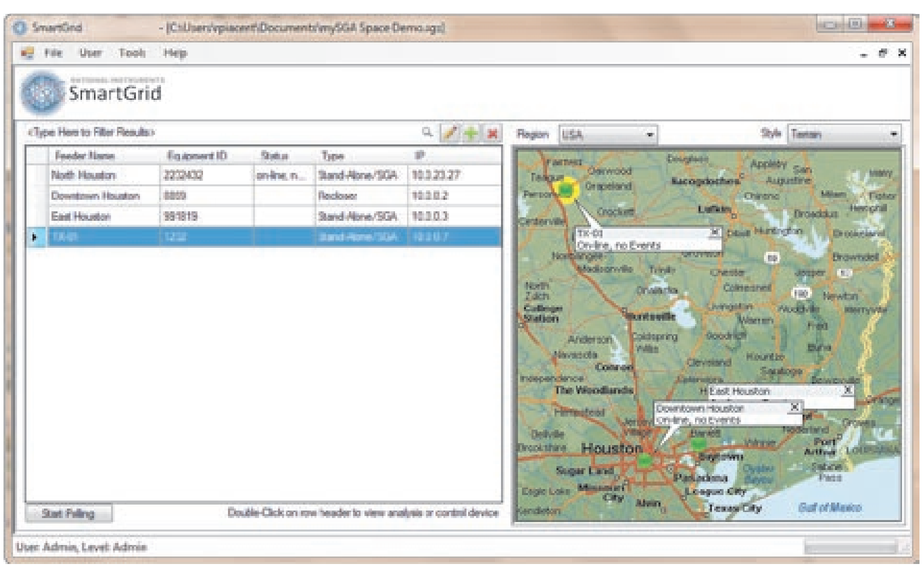


Figure 1. *PMUs based on NI CompactRIO provide field-reconfigurable embedded instrumentation – which can be updated remotely even after years of deployment on the grid.*

The Grid Awakens

The first step toward digitizing the grid is distributed sensing technology. Imagine embedded instrumentation systems distributed throughout the grid that acquire electric power signals from transmission lines, digitize them, and transmit them across the Internet. Phasor measurement units, or PMUs, measure the flow by comparing synchronized voltage and phase measurements from multiple points on the grid. The goal is to evaluate grid stability, detect problems before outages occur, and even "heal" the grid when faults happen. This requires real-time analytics to process high-speed data from the grid, feed it into computerized models, and turn it into meaningful results for control room operators. NI refers to this as "acquire, analyze, and present" on a worldwide scale.

Satisfying the technical requirements to make this a reality is no simple endeavor. PMUs require accurate measurements of high voltages and currents, precisely synchronized sampling, onboard signal processing, and sufficient communication bandwidth to reliably transmit packets. Driving all of these requirements is the analytics. Measurements stream in at 30 to 60 frames per second from the field. For the algorithms that inform grid operators to work, the data must be up to date and accurate. PMUs based on FPGA technology can help make this a reality by providing high-fidelity measurements and the ability to handle multiple tasks in parallel. Most important is field reconfigurability, which gives the system the capacity to rewire its internal circuitry and adapt to changing requirements. The ability to reconfigure the system down to the silicon gate array level, even after deployment to the field, is critical for the years ahead because the standards for PMUs and other smart grid devices are still evolving. For example, a new PMU standard for precision time synchronization, IEEE 1588 PC37.238, and an updated protocol for communication, IEC 61850-90-5, will not be released until later in 2011.

The Grid Responds

The second step toward digitizing the grid is control through intelligent distributed systems that can sense and take action to maintain peak performance. High-performance synchronized measurements, real-time

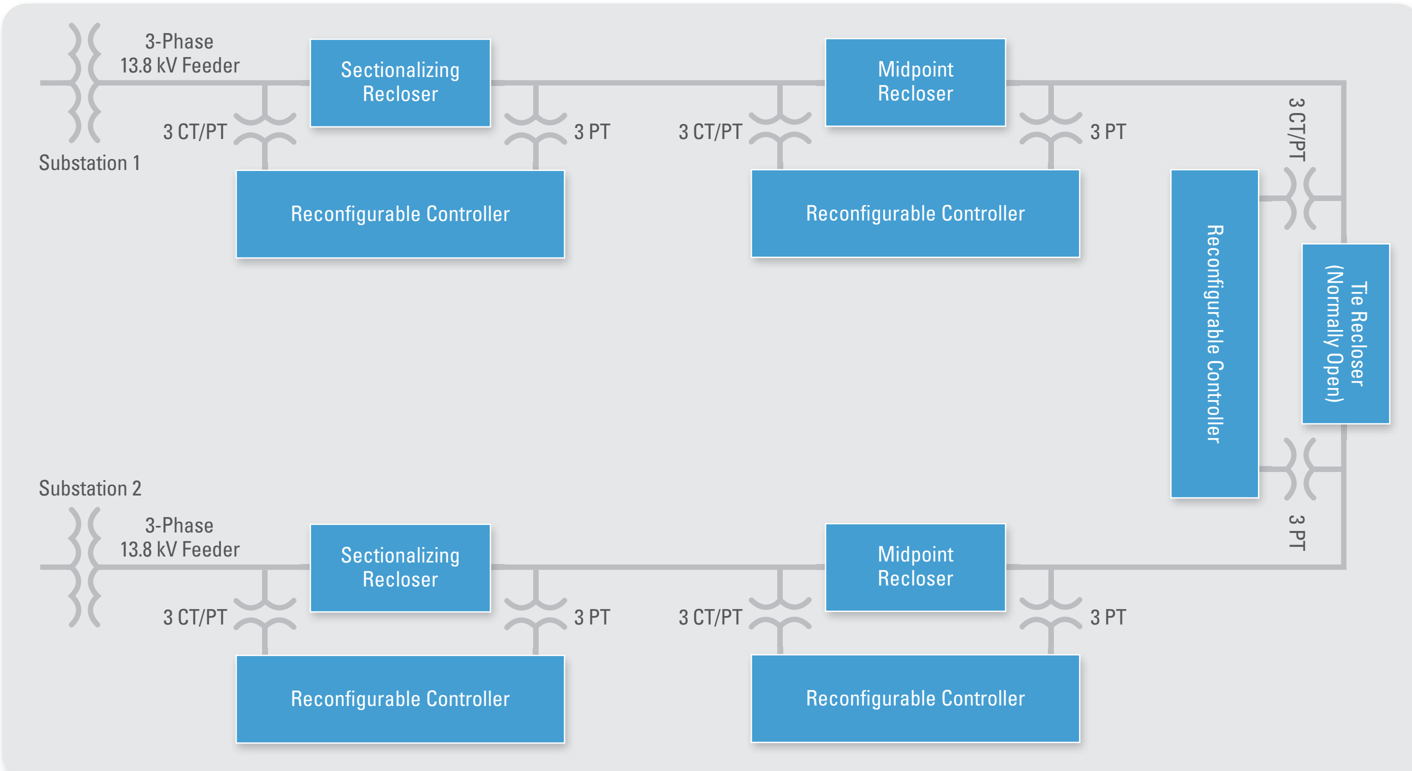


Figure 2. *A "self healing" power distribution system can automatically sense and adapt to achieve a higher level of reliability.*

communication, and embedded analytics drive these systems, which increase the reliability of power distribution, the final stage in electricity delivery.

Distribution systems include substations where high-voltage transmission signals are reduced to medium-voltage levels for power lines. Then electricity flows to pole-mounted transformers that provide low-voltage outputs for homes and businesses. The distribution network around the world is undergoing changes to incorporate digital control systems such as smart recloser protection devices.

If your lights have flickered during a thunderstorm, you may have seen a recloser in action. A smart recloser combines electrical switch gear to interrupt fault currents and real-time signal processing to monitor power signals and determine when to open the switch. The devices work like a smart circuit breaker because they protect the circuit in case of fault currents, but they also can "reclose" to restore service and prevent downtime.

The Grid Heals

Smart reclosers can increase awareness and reroute power when problems occur. This is known as "self healing." A loop consisting of two feeders tied together with smart devices achieves a higher level of reliability. Typically there is a sectionalizing recloser near the substation, a midpoint recloser along the power line, and a tie recloser that can optionally connect the two feeds. In the case of a fault, the smart reclosers can provide immediate protection while identifying the nature of the fault. Finally, the system automatically restores and reroutes power to heal itself by activating the appropriate reclosers, minimizing the outage.

Think of smart reclosers as the future Internet routers of the smart grid – automatically diagnosing and adapting to the flow of energy. Networked embedded systems that combine instrumentation, analytics, and control are transforming the grid to be more like the Internet – self-diagnosing, self-healing, and distributed rather than centralized. Like the Internet, the smart grid revolution is powered by engineers pioneering the technologies that are modernizing how electricity is produced, consumed, and distributed.

– Brian MacCleery brian.maccleery@ni.com

Brian MacCleery is the principal product manager for clean energy technology at NI. He was last featured in Instrumentation Newsletter *as the co-author of "Powering the Smart Grid" in the Q4 2010 issue.*

– Todd Walter todd.walter@ni.com

Todd Walter is a senior group manager for embedded system applications at National Instruments. He recently presented on smart grid control systems for the Smart Grid Webcast Series on ni.com.

To learn more about essential smart grid technologies, visit ni.com/power.

Avoiding Catastrophe From Unit Confusion

On September 23, 1999, the Mars Climate Orbiter disintegrated in the atmosphere of the planet and was never heard from again – a preventable disaster, given the right tools for the job.

After 10 long months of space travel, a team of exhausted NASA engineers and scientists eagerly awaited the opportunity to celebrate the successful insertion of the Mars Climate Orbiter spacecraft into Martian orbit. However, the mission soon became known as the mission that failed due to confusion between units of measurement and cost US taxpayers more than $125 million USD.

In a joint effort to better understand Mars, NASA and subcontractors designed the Orbiter program as one in a series of missions. The unmanned spacecraft was to collect data on the planet's climate and serve as a communication relay between mission control and future spacecraft in the program.

On its journey, the Orbiter approached the planet following a precisely calculated flight path. The spacecraft was to enter Martian orbit at a specific altitude that would prevent it from breaching the upper atmosphere and encountering catastrophic atmospheric stresses. As NASA engineers stood by, communication with the Orbiter was suddenly lost and never established again. The Orbiter never successfully transmitted data from the red planet, except for a single grainy picture of Mars taken at a distance of about 4.5 million km. The mission was a total failure.

A Completely Avoidable Root Cause

The intended trajectory of the spacecraft would have resulted in an orbiting altitude of 226 km above the surface of the planet, far above the dangerous conditions of Mars' upper atmosphere. However, a NASA investigation found that the actual Orbiter approach trajectory brought the spacecraft within 57 km of the planet's surface – even though the Orbiter was thought to be able to survive only at altitudes greater than 80 km. The extreme environmental conditions of Mars' upper atmosphere destroyed the spacecraft within seconds.

Further analysis concluded that human error caused the discrepancy in trajectories: the flight system software onboard the Orbiter was written to calculate thruster performance in metric Newtons (N), but mission control on Earth was inputting course corrections using the Imperial measure, pound-force (lbf).

"People sometimes make errors," said Dr. Edward Weiler, NASA associate administrator for space science. "The problem here was not the error, it was the failure of NASAs systems engineering, and the checks and balances in our processes to detect the error. That's why we lost the spacecraft."[1]

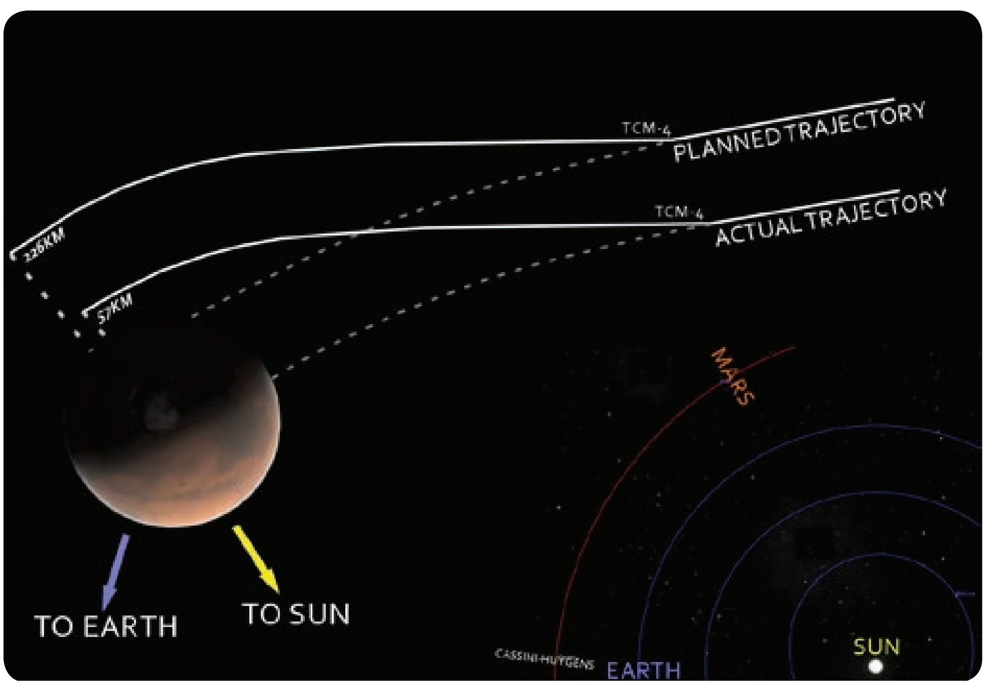


Figure 1. *Due to confusion between measurement units for a vital spacecraft operation, the actual trajectory taken was far closer to the planet than intended.*

Industry Trends Demand Smarter Tools

With the advances of communication technology in the last decade, global development teams can work together like never before. Multinational corporations often design products in one geographical location, send prototypes for validation testing to another location, and perform end-of-line tests at manufacturing sites located in completely different countries. Furthermore, today's complex designs often include components from globally diverse suppliers, and entire aspects of a project may be delegated to subcontractors.

For teams that collaborate across borders, the difference in measurement unit standards (International System of Units (SI) versus Imperial) is only part of the challenge. Given any quantity, there are multiple ways to represent the same measurement.

[1]"NASA's Metric Confusion Caused Mars Orbiter Loss," last modified September 30, 1999, http://articles.cnn.com/1999-09-30/tech/9909_30_mars.metric_1_mars-orbiter-climate-orbiter-spacecraft-team?_s=PM:TECH.

For example, miles per hour – a common representation of speed in the United States – can be represented as mph, mi/h, mi/hr, and more depending on personal preference.

These discrepancies with measurement units are ripe for human error. Engineers need smarter data-processing tools that account for units and help avoid catastrophe before the next instance of unit confusion leads to loss of life.

The Right Tool for the Job

Most data-processing software options, including spreadsheets designed for accountants' financial use, completely ignore measurement units. As the disaster surrounding the Mars Climate Orbiter showed, units can make all the difference. Data without context is nothing more than a series of numbers.

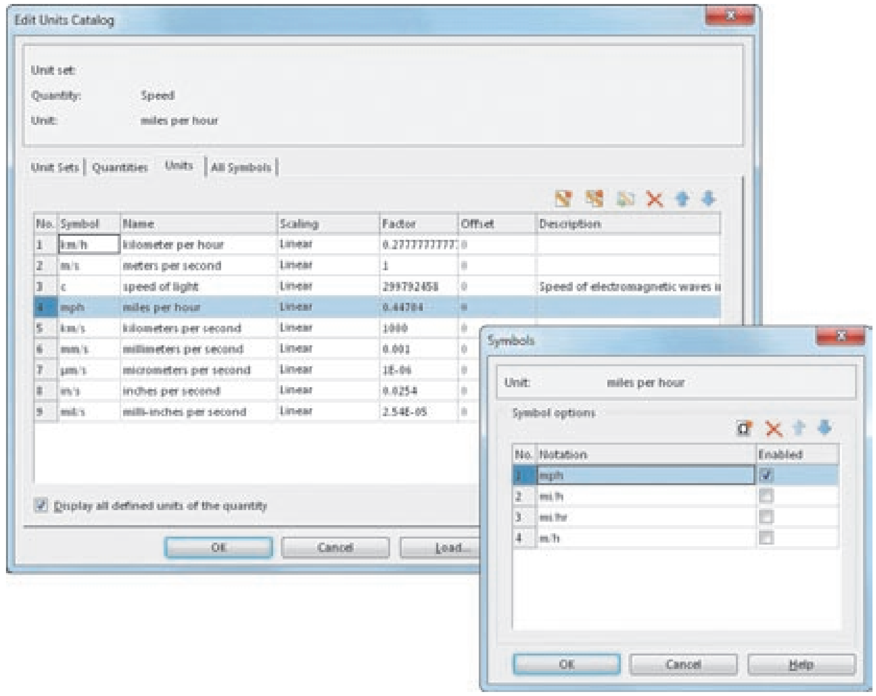


Figure 2. *DIAdem features a Units Catalog, complete with aliases, that directly integrates with various functionality in the environment.*

To overcome today's challenges and prevent mistakes caused by human error, NI DIAdem software adds context to data by associating descriptive property information with raw measurement data. The integrated Units Catalog in DIAdem provides five distinct benefits over alternative data analysis and reporting tools:

1. DIAdem sees all data as a measurement quantity, complete with units. Engineers can instantly convert measurement data between units with one mouse click.

2. The Units Catalog features unit aliases. Engineers can identify different symbolic representations that specify the same measurement unit.

3. All analysis calculations take units into account. If a calculation is performed using conflicting measurement units, DIAdem handles the internal conversion to maintain the integrity of the result.

4. All report graphs specify a measurement unit. If data with a differing unit is graphed, DIAdem handles the internal conversion necessary to maintain the unit quantity represented by the graph.

5. Engineers can process data using the units they prefer while ensuring conversion to an alternate established standard in the end.

DIAdem is a dedicated visualization, analysis, and reporting tool that is designed to process measurement data sets stored in any format. It includes many features, such as the Units Catalog, that help engineers gain efficiency and overcome today's data-processing challenges.

– Derrick Snyder derrick.snyder@ni.com

Derrick Snyder is a product manager for DIAdem and data management software at National Instruments. In his spare time, Derrick is a marathon runner and uses DIAdem to correlate and synchronize the playback of the GPS, elevation, and pace information to improve run times.

To learn more about how engineers worldwide use DIAdem to save time with data visualization, analysis, and reporting, visit ni.com/diadem.

Managing Measurement Units in DIAdem

Don't know what this thing is? Check out page 31 for instructions, and then watch this video to see how DIAdem can help you convert between or manage measurement units.

NI and Tektronix™ Introduce the Industry's Highest Performance Digitizers

If you attended NIWeek 2009, you got a sneak preview of one of the test and measurement industry's most significant prospects. It was on the keynote stage that National Instruments and Tektronix announced their collaboration to create the fastest modular 3U PXI digitizers ever produced.

In fields as diverse as physics/research, semiconductor, aerospace and defense, consumer electronics, and RF and wireless test, customers wanted to see NI and Tektronix push the limits of performance. For Tektronix, this meant exploring how to deliver its leading signal acquisition performance in a size more suitable for automated test and high-channel-count acquisition systems. For NI, it meant an addition to the company's traditional strategy of using commercial off-the-shelf A/D converter (ADC) technologies and taking its 10-year relationship with Tektronix to new levels. By capitalizing on their strengths – Tektronix in high-bandwidth analog design and NI in high data throughput and tight timing and synchronization – the companies delivered breakthrough technology that takes advantage of the size, modularity, and software integration benefits of the 3U PXI package pioneered by NI. The new 5 GHz bandwidth NI PXIe-5186 and 3 GHz bandwidth NI PXIe-5185 digitizers sample at 12.5 GS/s in single-channel mode and 6.25 GS/s when using both channels simultaneously.

National Instruments and Tektronix teamed up to create the fastest modular 3U PXI digitizers in the industry.

Combining Leading Technologies

The digitizers' analog front end and ADC application-specific integrated circuits (ASICs) are state-of-the-art silicon germanium (SiGe) parts designed by Tektronix and used across the full suite of Tektronix high-performance oscilloscopes. This technology is widely used to acquire and characterize high-speed pulses and to measure digital signal parameters such as rise time, jitter, and wideband RF signals.

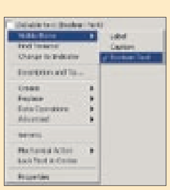
As an industry leader in automated test, NI contributed its expertise to the digital back-end design and software driver framework. Using NI technology, the PXI Express digitizers deliver high data throughput for faster test execution and precision multimodule timing and synchronization to build high-channel-count, integrated test systems. The digitizers can stream data at rates greater than 700 MB/s and can be synchronized to ±80 ps resolution.

Simplified Platform Integration

The digitizers use the NI-SCOPE driver, which is shared across the full suite of NI digitizers, ranging from high-speed devices featuring up to 12.5 GS/s sample rates to high-resolution devices featuring up to 24 bits of vertical resolution.

For more information and full product specifications, visit ni.com/info and enter nsi1202.

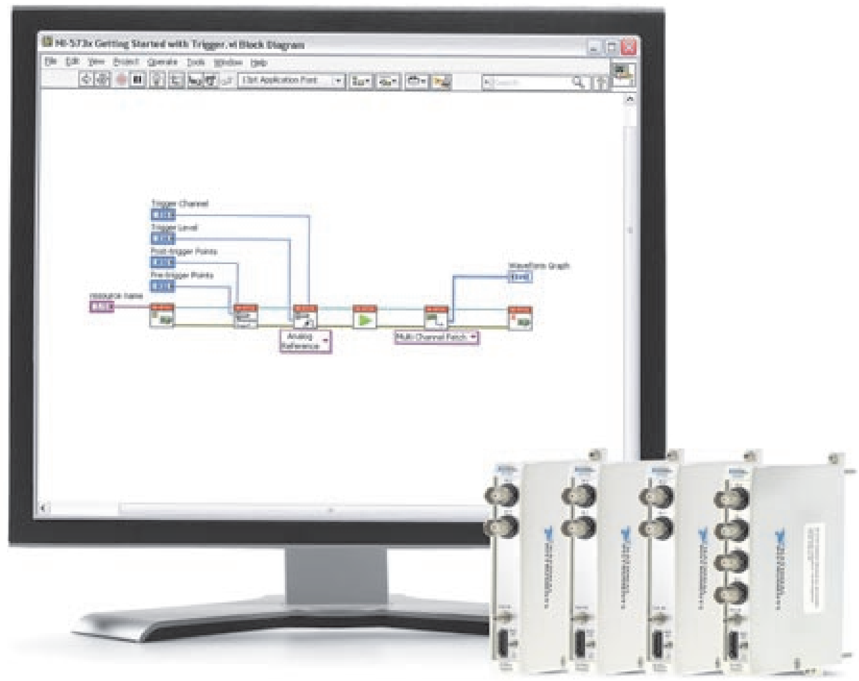
Darren's LabVIEW Nugget: Checkboxes and Boolean Text



If you want your checkbox controls to have clickable text, as in clicking the checkbox text will toggle the checkbox just like clicking the checkbox itself, you need to show the Boolean Text on the checkbox and hide the label. Clicking the label will not toggle a checkbox value at run time.

For more information on this nugget, visit ni.com/info and enter nsi1203.

Digitizer Adapter Modules for NI FlexRIO Offer Versatility and Quicker Measurements



An open default personality for the FPGA based on LabVIEW FPGA, along with the corresponding host API, reduces the time to your first measurement with NI FlexRIO technology.

The NI 573x digitizer adapter modules are the most recent addition to the NI FlexRIO product family from National Instruments. With selectable voltage ranges, AC and DC coupling, multiple input filters, and simplified connectivity, the modules deliver increased versatility to high-performance FPGA-based I/O. A default personality for the FPGA and host API can help you significantly reduce the time to your first measurement. Applications for the modules range from high-resolution pulse and time domain measurements to wide bandwidth, high dynamic range frequency domain acquisition.

Model	Sample Rate	Resolution	Channels
NI 5731	40 MS/s	12 bits	2
NI 5732	80 MS/s	14 bits	2
NI 5733	120 MS/s	16 bits	2
NI 5734	120 MS/s	16 bits	4

The NI 573x adapter modules offer a variety of sample rates, resolutions, and channel counts to meet your acquisition needs.

These four digitizer modules offer different feature sets ranging from 40 to 120 MS/s sample rates, 12- to 16-bit resolution, and two to four simultaneously sampled channels. All models have a 50 Ω input impedance with a 2 $V_{pk\text{-}pk}$ range, and 0, 6, and 12 dB of selectable analog gain. The modules include an elliptic filter for frequency domain acquisition, a Bessel filter for time domain measurements, and a bypass path for undersampling applications. Despite this increased versatility, the NI 573x modules do not compromise on performance. On the 16-bit, 120 MS/s NI 5733/34, typical signal-to-noise ratio is as high as 69.6 dB, total harmonic distortion is as low as -86 dBc, and spurious-free dynamic range is below -87 dBc. For this level of performance, you also get high channel density. The NI 5734 offers four channels in a single PXI slot. All of these features are available at a starting price of $799 USD, € 779, and ¥ 112,000 for the NI 5731 (FPGA module required.)

With the power of NI FlexRIO FPGA modules and LabVIEW FPGA Module software, you can implement a variety of algorithms including custom triggering, pulse counting and measuring, data reduction, filtering, and frequency domain transforms directly in the hardware. Before investing the time to develop these capabilities yourself, however, check out the NI-573xR Example Instrument Driver at **ni.com/labs** to download a default personality and host API for the NI 573x modules. You can use the personality to quickly make measurements on real-world signals for better algorithm design without the need to compile any FPGA code or develop a host application. The download provides LabVIEW FPGA code that uses the onboard DRAM of an NI FlexRIO FPGA module to implement a basic digitizer multirecord acquisition engine, precompiled bitfiles for each NI FlexRIO FPGA module with onboard DRAM, a host API that controls the FPGA similarly to NI-SCOPE, and example programs to perform basic acquisitions. All of this code is user accessible, so when you begin developing your own FPGA application, you can add your functionality into the existing signal flow, rather than starting from scratch.

To view specifications and pricing for the NI 573x modules, visit ni.com/flexrio.

Know the Weakest Link in Your RF Network Analysis

A chain is only as strong as its weakest link, and an RF measurement is only as reliable as the most uncertain component or practice.

Exceptional accuracy and flexibility have made the vector network analyzer (VNA) the instrument of choice for many RF measurements. To fully realize these benefits, you must understand the weaknesses of your measurement and correct for them where possible.

1 Correct for Systematic Errors

Understanding the error sources in any RF measurement setup is a prerequisite to making accurate measurements. Like all RF instruments, network analyzers require a certified calibration laboratory to perform a yearly factory calibration. However, the key to the exceptional measurement accuracy achieved by network analyzers is performing a user calibration more frequently. Figure 1 shows a simplified block diagram of the NI PXIe-5630 VNA and the sources of systematic error that can be corrected for during a properly performed user calibration.

- Transmission and reflection tracking – Frequency response errors, or transmitted and reflected signal loss, result across all frequencies and must be characterized and corrected.
- Source and load mismatch – Many RF systems have a characteristic impedance of 50 Ω. To properly measure the impedance of the device under test (DUT), any impedance errors in the system must be accounted for.
- Isolation – Errors can occur from crosstalk between various components in the test setup, VNA ports, and measurement reference planes.
- Coupler directivity – VNAs rely on directional couplers to separate the transmitted signals from the reflected signals. Ideally, a directional coupler measures the forward or reverse traveling signals and produces no output for signals traveling in the opposite direction. Because this is rare, the coupler leakage must be accounted for.

To correct for these systematic errors, you perform a user calibration and measure a set of known standards, compare the measured value to the value of the known standard to calculate the error for each data point, and finally apply the appropriate error correction for each frequency point in the measurement. Using broadband short, open, load, and through (SOLT) standards is a common, accurate calibration method for RF frequencies.

Many factors determine how often a user calibration is performed including the required measurement accuracy, environmental conditions, and the repeatability of the DUT connection. A fresh user calibration may be necessary hourly or weekly. You should use verification standards or the less stringent practice of measuring a "golden DUT" to determine how often to calibrate.

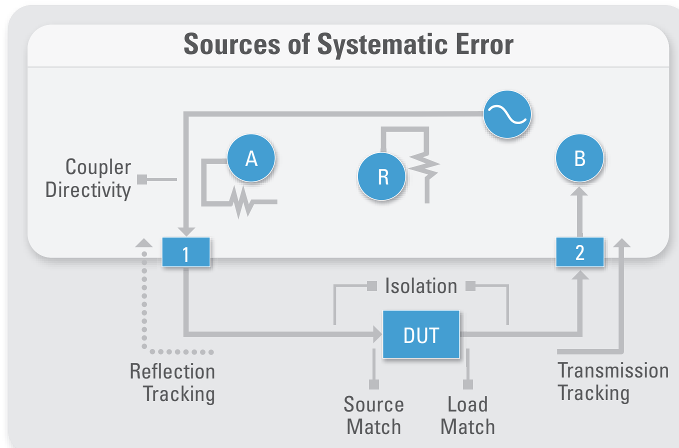


Figure 1. *During the user calibration of the NI PXIe-5630, you can correct for common sources of systematic error.*

2 Throw Out Bad Cables and Adapters

Quality RF cables and adaptors that are required to make highly accurate measurements carry expensive price tags that make them difficult to throw out. However, RF adapters and cables must be regarded as disposable. Designing and producing high-quality RF systems depends on the high measurement accuracy of the VNA; a weak or damaged cable or adapter compromises the result and should be discarded. This is simply a part of the expense of making highly accurate measurements.

In addition to meticulous connector care, automatic calibration kits can extend the life of your RF adapters and cables. All RF cables and adaptors are rated for a limited number of connections. With an automatic calibration module, you perform only one connection during calibration rather than the five connections required for a manual SOLT calibration.

3 Mind Your Reference Plane

In a VNA measurement, the reference plane is the location in the system where you performed the user calibration and therefore is the plane from which the measurement is being made. When calibrating a VNA using the SOLT method, for example, attaching the calibration standards to the ends of the cables connected to ports 1 and 2 establishes the end of those cables as your reference plane. Any adapters or test fixtures placed between those cables and your DUT are included as part of the measurement and can dramatically alter your results. Consider a 6 GHz signal. With a 5 cm wavelength, even a single millimeter difference in your actual and desired reference plane results in 7.2 degrees of phase error.

When it isn't feasible to create custom calibration standards matching the test setup, these two methods can extend the reference plane of your measurement without additional characterization:

- Automatic reference plane extensions – To move your reference plane after calibration, insert an open or short calibration standard at the location in the test setup where you'd like to relocate the reference plane. The VNA can then perform the calculations necessary to move the reference plane and adjust subsequent measurements to match your desired measurement setup.
- Time domain gating – A VNA makes measurements in the frequency domain and then performs an inverse fast Fourier transform (FFT) to display the response in the time domain. This opens up a wide range of applications including time domain gating. By observing the varying impedance values through an RF signal chain, you can identify (in time and distance) various components in the system. Figure 2 shows that by gating only the desired components in the time domain and converting the data back to the frequency domain, you are able to estimate the magnitude and phase response of only the DUT and not the fixture or any additional adapters.

4 Don't Be the Weakest Link

After taking time to ensure that the instrument and test setup are properly calibrated and understood, don't let poor measurement practices limit the accuracy and reliability of the results. The best network analyzer is quickly rendered ineffective, for example, if proper torque isn't used and the quality of the connection to the DUT is compromised.

Following a well-developed process, can ensure that you adhere to best practices and dramatically improve your results.

Prepare

1. Warm up the VNA and DUT
2. Inspect and properly gauge all connectors
3. Select which S-parameters to measure
4. Identify the desired reference plane
5. Connect cables and adapters to the VNA

Practice

1. Set the frequency, power, and IF bandwidth for the VNA
2. Connect the DUT and verify the setup
3. Extend the reference plane if necessary
4. Measure the desired S-parameters
5. Remove the DUT

Calibrate

1. Choose the proper calibration kit
2. Set IF bandwidth and averaging to minimize noise
3. Perform the calibration
4. Verify the calibration with a verification kit or a "golden DUT"
5. Save the calibration setup

Perform

1. Connect the DUT
2. Apply the calibration performed
3. Measure and save the S-parameter data

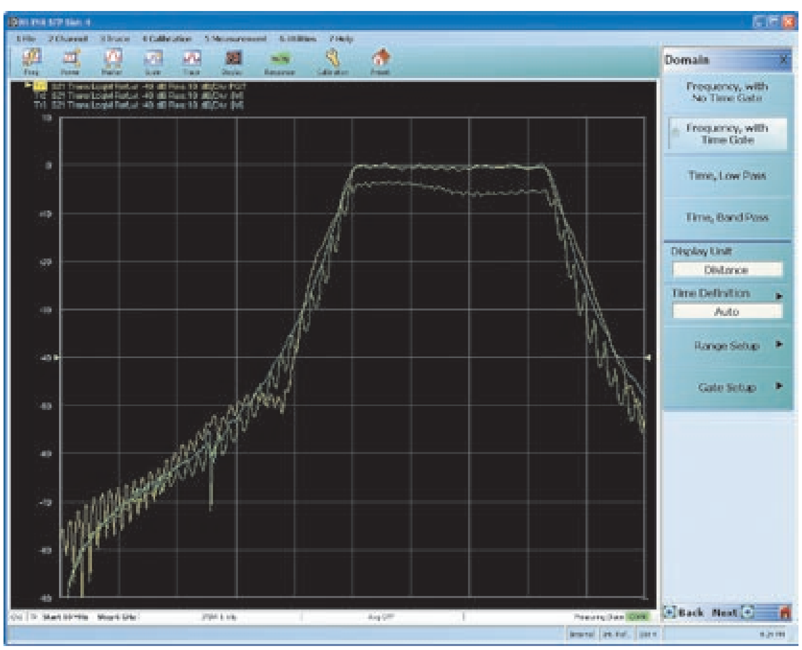


Figure 2. *The response of the DUT (shown in blue) is estimated (shown in yellow) by using time domain gating to remove the additional response of a test fixture (shown in green).*

VNAs are indispensible tools for accurately measuring the magnitude and phase response of complex RF networks. By understanding the weaknesses of your RF network analysis system, you can ensure that a weak link doesn't prevent you from achieving highly accurate and repeatable VNA measurements.

– David Broadbent david.broadbent@ni.com

David Broadbent is a product manager for RF and wireless test products at National Instruments. Before joining NI in 2007, David managed EverLight in Salt Lake City, a lighting business he started in college. David holds a bachelor's degree in physics.

To learn more about making accurate VNA measurements, visit ni.com/vna.

Get Real About Teaching Science and Engineering

National Instruments is helping students get more out of their science classes with the launch of K12Lab.com, a website designed to inspire and equip teachers to integrate real-world engineering projects using NI LabVIEW software into a wide range of science, technology, engineering, and math (STEM) curricula.

The site provides a place for teachers to browse and share lesson plans, find inspiration from people doing cool stuff with technology, and get the tools and support to help their students reach that *aha!* moment faster.

Get Lessons

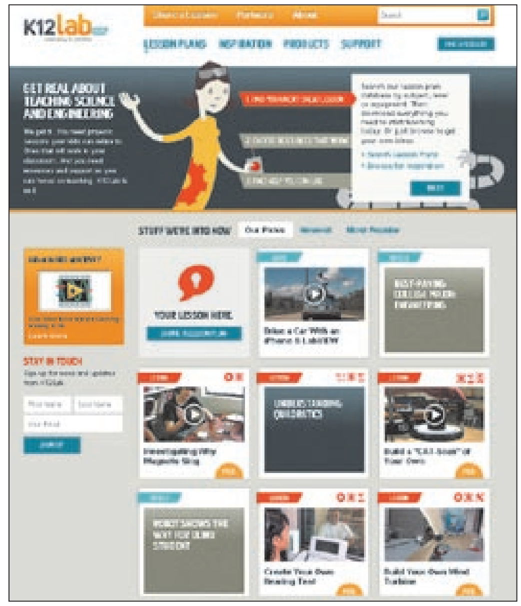
Teachers can access a library of lesson plans and lab activities based on LabVIEW, share their own lessons, or suggest a lab they would like to see developed in the future. The lessons cover subjects including engineering, physics, and robotics and are tagged by grade level, hardware, and teaching concepts, making it easy to quickly identify the different kinds of content.

Get Inspired

LabVIEW provides a canvas to connect data with ideas. K12Lab highlights videos and articles about how people are using LabVIEW to meet complex challenges in the real world. Teachers can be inspired by these new classroom projects and fresh ideas on how to bring theoretical math and science concepts to life.

Get Tools

K12Lab helps teachers discover an assortment of technology to build a great classroom. Teachers can tour LabVIEW, explore how the software integrates with Vernier sensors and the LEGO® Education robotics platform, and find out how to buy the right tools for their classrooms.



K12Lab is the place for teachers who want to find and share creative ways to engage students in science, technology, engineering, and math coursework.

Get Support

The site connects teachers with all the resources they need, all in one place. Teachers can access getting started tutorials, find information on training opportunities, and connect to a community of educators and product experts.

To help today's students get more out of their science classes, visit K12Lab.com.

Preparing Future Engineers With LabVIEW for LEGO® MINDSTORMS®

LabVIEW for LEGO MINDSTORMS, a new version of NI LabVIEW software you can use with the LEGO Education robotics platform, is a teaching tool that helps students program the LEGO MINDSTORMS NXT brick. The software turns any LEGO MINDSTORMS Education set into a full-featured science and engineering learning station. The platform also encourages experimentation, promotes creativity, and equips the engineers of tomorrow with valuable inquiry skills.

The software is optimized for classroom use through videos, tutorials, and teaching resources and is a programming language option for teams competing in the 2011 *FIRST* Tech Challenge robotics competition.

To purchase LabVIEW for LEGO MINDSTORMS, visit K12Lab.com.

Shipping LabVIEW Across the Country

Do you ever wonder how your packages are treated when you ship them using a major shipping company? *Popular Mechanics* magazine and National Instruments set out to answer this question. The team of editors and engineers devised a system to measure and characterize what a package experiences when it leaves your hands and travels to its destination.

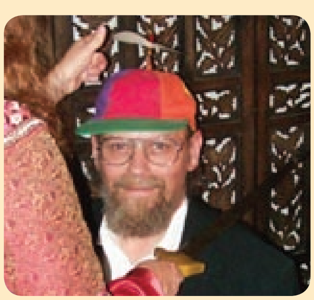
Using the NI LabVIEW Embedded Module for ARM Microcontrollers and a Texas Instruments ARM Cortex-M3 evaluation board, the team created a system to read an accelerometer within the package and log the data to an SD card. The LabVIEW application queried the accelerometer and received acceleration data in the x, y, and z axes; recognized the orientation of the device; and measured temperature from a thermocouple. One of the project challenges was the amount of battery life necessary for a cross-country flight, including time spent in sorting facilities along the route. To power the device for three days without an external power source, the team took advantage of the power saving options in the ARM architecture. By writing custom VIs to put the processor to sleep and selectively power off board-level I/O, the team far exceeded its initial power management goals and created a device that could constantly monitor package conditions during a three-day shipping period.

NI and *Popular Mechanics* shipped the device dozens of times over a 12-month period between New York, Los Angeles, and Austin using three major shipping companies: UPS, FedEx, and USPS. Although the results were not intended to be statistically significant, they do provide insight into the forces a package experiences such as the number of times a package is flipped during shipping and whether marking your package as "Fragile" really makes a difference. You can read the full results of the study in the December 2010 issue of *Popular Mechanics*.

A team of engineers from NI and editors from Popular Mechanics *magazine used LabVIEW to measure the acceleration, temperature, and orientation of a package shipped across the United States.*

To check out more cutting-edge applications created with LabVIEW, visit ni.com/sweetapps.

How LabVIEW Helped One Developer Choose a Career



Ben Rayner (DSAutomation.com) is a Certified LabVIEW Architect, a Knight of NI, and a person with dyslexia. After teaching himself to program in VAX-Macro and struggling to work in ANSI C, Ben found NI LabVIEW software and felt like a weight had lifted off his shoulders. "For the first time in my life, I could express my designs as images rather than as a series of alphanumerics," Ben says. "If it weren't for LabVIEW, I would not have pursued a career in software."

To read more stories about how LabVIEW helps engineers and scientists do their jobs, visit ni.com/info and enter nsi1204.

25 Years and 9,000 Drivers – Stronger Than Ever

Instrument drivers have been an integral part of test systems for more than 25 years. These software routines for controlling programmable instruments are critical components that save application development time, reduce system complexity, and ensure application longevity.

1986

NI releases LabVIEW 1.0 software, along with the first LabVIEW instrument driver.

1993

The VXIplug&play Systems Alliance forms to address issues with multivendor interoperability for test systems. VISA follows shortly after.

1995

NI creates the online Instrument Driver Network at ni.com/idnet, a year after launching ni.com.

"If the equipment manufacturer has a LabVIEW driver available, we'll always select that device over one that does not have a LabVIEW instrument driver."

Ernie Clifford, ***Hardware Test Engineer, International Game Technology***

“LabVIEW provides Tektronix customers with industry-leading instrument control capabilities, including the new, time-saving Instrument Driver Finder utility, which is built into LabVIEW and provides the shortest time to achieve automated measurements.”

*Martyn Etherington, **Vice President of Worldwide Marketing, Tektronix***

2003

The Instrument Driver Advisory Board forms to guide LabVIEW architectural standards. NI establishes Certified LabVIEW Plug and Play instrument drivers.

2011

NI announces over 9,000 drivers from 350 vendors in the Instrument Driver Network.

1998

LabVIEW 5.0 and NI LabWindows™/CVI 5.0 software introduces instrument driver wizards and the IVI Foundation forms.

2005

LabVIEW 8.0 introduces the Instrument Driver Finder, which detects, finds, and installs instrument drivers from within the software.

To leave a comment about how NI instrument drivers have helped you, visit ni.com/info and enter nsi1205.

Build Versus Buy: Which Is the Best Choice for Your Embedded Design?

When developing an embedded system, deciding which portion of the system to design and which to buy off the shelf can be daunting. You can design and build an entire solution to completely customize the end result and optimize costs, but any design specification changes or oversights can cause lengthy and expensive delays. Alternatively, an off-the-shelf platform increases the cost of goods sold and you may pay for features that are not necessary for your design. However, off-the-shelf systems typically provide a faster validation cycle and, therefore, shorter time to market.

The "Build" Approach: Custom Design

A custom embedded design includes many technologies:

- The processor for the primary system controller and any digital signal processing
- Bus interfaces for various components
- I/O circuitry for analog and digital signal acquisition, generation, and control
- A software architecture to support processor hardware, device driver development, driver APIs, and the actual application software

To make an educated build versus buy decision, you must accurately estimate the cost of building your own custom solution. If you simply add up the cost of the board components plus the hardware and software development time, you may significantly underestimate the total investment. The costs of manufacturing, maintaining inventory, and developing software for the OS, driver, and middleware are frequently underestimated. At the same time, engineers and management are often overly optimistic in their projected unit volumes, especially within the first two or three years.

The "Buy" Approach: Off-the-Shelf Embedded Systems

An alternative to custom design is using an off-the-shelf platform that provides an infrastructure to build around. Although you typically pay significantly more than the cost of the board components, you can expect to reach the market much faster because the vendor does a lot of the low-level design and implementation work for you. In addition, these systems have smoother expansion paths, so addressing the inevitable feature creep that occurs during concept and prototyping phases is far less painful.

When working with a new technology, getting a prototype up and running quickly is often imperative to determining whether the product has technical and business value. With newer products and technologies, it is difficult to determine with certainty the market demand and unit volumes the product will achieve. You can use off-the-shelf tools to quickly build prototypes and develop systems without having to invest too much capital up front.

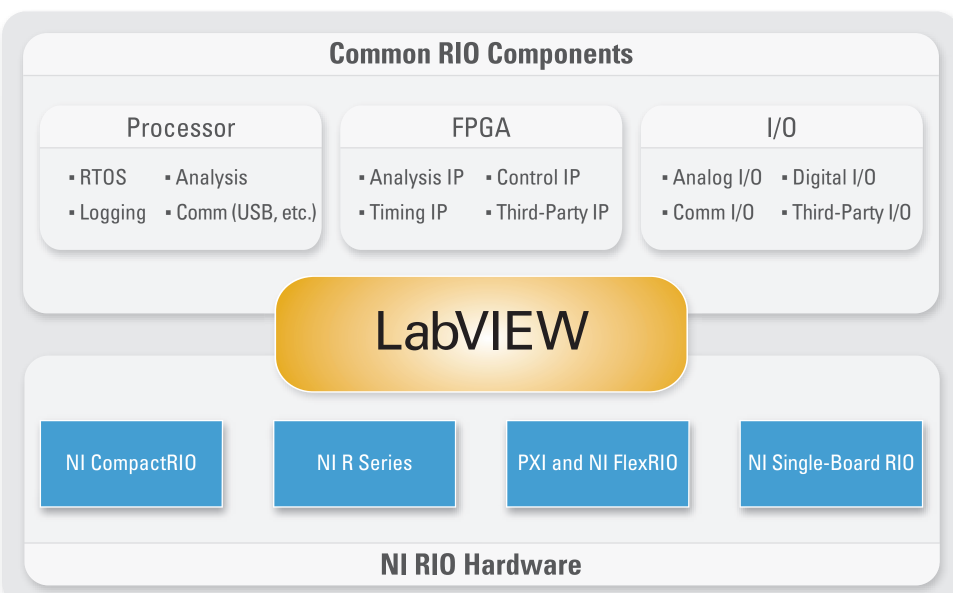


Figure 1. *NI graphical system design tools, including LabVIEW and RIO embedded hardware, combine the benefits of off-the-shelf tools with the performance of custom design.*

Off-the-Shelf Platforms From High Volume to High Performance

National Instruments makes tools that increase productivity and help companies and smaller engineering teams get their products to market faster. NI graphical system design tools, including NI LabVIEW software and reconfigurable embedded systems, combine the benefits of an off-the-shelf platform with the customization and flexibility of custom hardware. NI offers embedded solutions to meet both high-volume deployments and high-performance application needs. By using the online NI Graphical System Design Calculator, you can visualize the impact of choosing NI tools for your embedded solution in terms of total system cost and time to market.

High-Volume Embedded Applications

Off-the-shelf platforms are becoming cost-effective enough to be financially viable for high-volume embedded applications (unit volumes between 10s and 1,000s of deployments per year). The NI CompactRIO family of embedded platform components provides the performance and reliability required for industrial and embedded applications. In addition, it delivers an ideal platform for designing and prototyping measurement and control systems. Each CompactRIO system blends the functionality of an open embedded architecture and the reliability of a field-programmable gate array (FPGA) with rugged and hot-swappable industrial I/O modules.

For high-volume system deployments and OEM solutions, the new, value-oriented NI cRIO-9075 and cRIO-9076 integrated CompactRIO chassis present an appealing option with a small footprint, low cost, and flexible reconfigurable I/O (RIO) architecture. These systems feature integrated real-time controllers with 400 MHz processors, Xilinx Spartan-6 FPGAs, and four C Series I/O slots for modular, signal-conditioned I/O. With LabVIEW, you can rapidly develop flexible, modular measurement and control systems and realize significant time-to-market benefits.

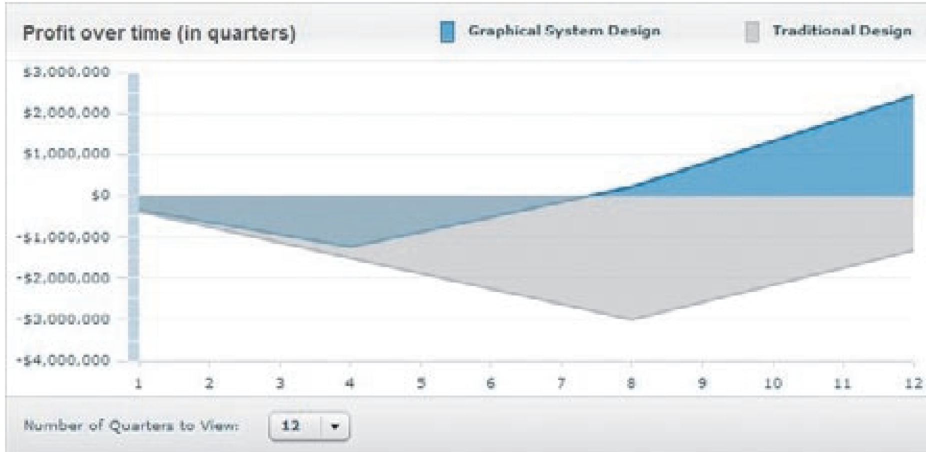


Figure 2. *With the online NI Graphical System Design Calculator, you can visualize the time, productivity, and cost benefits of using NI graphical system design tools.*

High-Performance Embedded Applications

Low-volume embedded applications that require extreme performance aren't as cost sensitive as high-volume applications, so off-the-shelf platforms with integrated FPGAs are ideal. In most cases, these applications see much more value in a flexible, high-performance off-the-shelf platform that can shorten the time between design iterations and time to market. For high-performance embedded applications, NI FlexRIO combines modular FPGA hardware, a Virtex-5 FPGA, and customizable I/O in a PXI form factor. The platform provides the following:

- Built-in infrastructure components including PCI Express bus interfacing at 800 MB/s
- DRAM communication
- Integration with Xilinx CORE Generator or other third-party IP
- Peer-to-peer streaming over DMA between two FPGA modules in the system

These components help a team quickly prototype a new design while focusing on the parts of the system where they add the most value. With PXI and NI FlexRIO, embedded designers are building highly flexible, scalable, and customizable systems for applications with high-performance signal processing requirements including medical imaging, RF processing, high-speed control, and custom protocol generation and acquisition.

Off-the-Shelf Tools Decrease Top Expenses and Shorten Time to Market

Customers using graphical system design have proven that they can use off-the-shelf tools to build custom embedded systems with much smaller teams. Using system-level software tools for programming hardware with built-in processors, FPGAs, and I/O, smaller teams can accomplish a task that traditionally required at least twice as many people. The result is a decrease in hardware and software development expenses that typically are the top expenses for an embedded design. An off-the-shelf platform helps you shorten your time to market and focus on differentiating technology to make your product better and get to profitability sooner.

– John Hottenroth john.hottenroth@ni.com
John Hottenroth is a market development manager for RIO hardware at NI. He helps customers shorten their development time on high-performance design projects and recently worked with a customer who created the world's first real-time 3D OCT medical imaging system with LabVIEW and NI FlexRIO.

– Nick Butler nick.butler@ni.com
Nick Butler is a product marketing manager at NI for the wireless sensor network platform. He recently delivered presentations at the WSN and Energy Harvesting Conference in Boston and Sensors Expo in Rosemont.

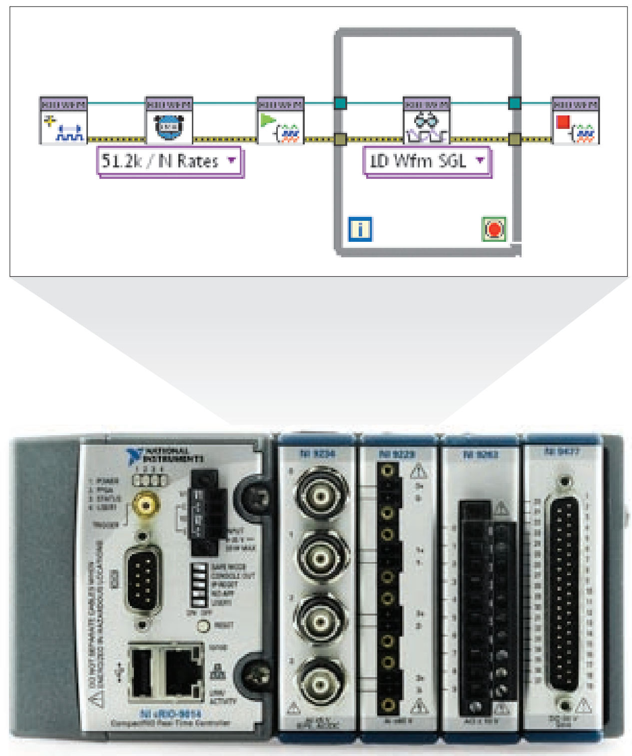
To visualize the impact of NI graphical system design tools on your embedded system using the online calculator, visit ni.com/buildvsbuy.

Acquiring High-Speed Waveforms With CompactRIO Just Got a Whole Lot Easier

National Instruments designed the NI CompactRIO Waveform Reference Library to save you time and improve system performance when developing high-speed waveform acquisition applications with the NI LabVIEW FPGA Module. Available for free download on the new LabVIEW Tools Network, the library offers a performance-optimized LabVIEW FPGA template as an easy starting point and a LabVIEW API experience for interacting with the FPGA template from the LabVIEW Real-Time Module.

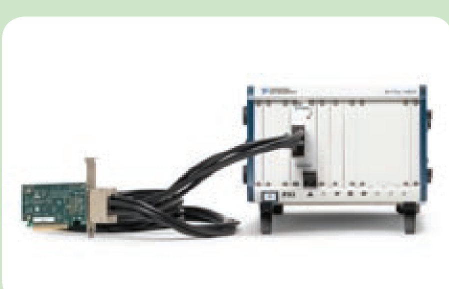
The CompactRIO Waveform Reference Library includes several optimizations that lead to faster calculations on more channels. The reference library uses a polling architecture to reduce the CPU load when reading from the DMA buffers. In addition, specific data type conversions and a suite of error checking maximize performance and free up resources on the real-time controller. With these implementations, you can run more advanced signal processing inline with the data collection. For example, the NI Sound and Vibration Measurement Suite takes advantage of these optimizations to implement optimized-for-embedded order analysis and envelope detection algorithms, nearly doubling the number of channels that you can analyze at one time.

To learn how you can save time developing your FPGA solution, visit ni.com/info and enter nsi1206.



The CompactRIO Waveform Reference Library offers an intuitive and performance-optimized LabVIEW API experience for the LabVIEW FPGA and LabVIEW Real-Time modules.

Introducing the Industry's Fastest PXI Express Remote Controller



The NI PXIe-PCIe8388 is the industry's fastest PXI Express remote controller that uses a x16 Gen 2 PCI Express link to control a PXI Express chassis. The new remote controller works with National Instruments rack-mount controllers and provides a fully software transparent link with a theoretical maximum throughput of 8 GB/s/direction. The NI PXIe-PCIe8388 is also available with an optional downstream port that connects to other PXI Express chassis to create high-performance, multichassis PXI systems.

To view product specifications and pricing, visit ni.com/info and enter nsi1207.

FBG Optical Sensors: Powerful Yet Simple

Figure 1. *A variety of FBG gages is available including the FBG strain gage by Micron Optics Inc.*

Fiber Bragg grating (FBG) optical sensors provide many benefits over conventional electrical sensors, making them well suited for applications that are otherwise very challenging or impossible. Because they are electrically passive, FBG sensors are ideal for use in explosive environments, near high voltages, or in high electromagnetic interference (EMI) environments. These benefits, coupled with an easy user experience that is similar to conventional electrical sensors, make FBG sensors a powerful technology that you can implement to tackle your most challenging requirements.

Powerful

FBG sensors use glass instead of copper and light rather than electricity, making them nonconductive, electrically passive, and immune to EMI. In addition, FBG technology provides the ability to daisy chain dozens of sensors along a single optical fiber over distances up to 10 km.

FBG strain sensors typically provide longer fatigue life and can measure higher absolute strain than resistive foil strain gages. Temperature FBG sensors, on the other hand, provide faster response times than thermocouples and resistence temperature detectors (RTDs) because they typically have a lower thermal mass.

Simple

As FBG packaging and mechanical design have improved, the method for installing and using FBG optical sensors is now very similar to the established methods used for electrical sensors. Because each FBG sensor operates within a unique wavelength range, FBG sensors connected along the same fiber must be chosen with nonoverlapping operating wavelength ranges. You can daisy chain these sensors (strain, temperature, and so on) in any order along a single optical fiber by using optical connectors or splicing bare fibers with a commercially available and relatively inexpensive fusion splicer. You can obtain sensors individually or in a preassembled array to meet your exact requirements.

Installing FBG optical sensors is equally simple and often even easier than traditional electrical sensors. You can glue, weld, and embed FBG sensors while having fewer cables to manage with zero noise, isolation, and/or shielding considerations to address. You can choose from a variety of optical cables, from simple low-cost cables to rugged deep sea cables, to meet your most extreme and rigid requirements.

The benefits of FBG optical sensors help solve many challenging sensing applications. Optical sensors are distinctively different from the traditional sensor archetype yet deliver a familiar ease of use. With the new NI PXIe-4844 optical sensor interrogator, you can automatically detect and interrogate your FBG sensors with just a few mouse clicks. In short, FBG optical sensors are powerful yet simple tools that any engineer or scientist can quickly adopt.

Figure 2. *Two types of connectors are typically found in FBG sensing systems: FC/APC and LC/APC.*

To learn more about FBG optical sensing technology, visit ni.com/opticalsensing.

Introducing 4-Slot NI CompactRIO Systems for High-Volume Deployments

With a small footprint, low cost, and flexible reconfigurable I/O (RIO) architecture, the NI cRIO-9075 and cRIO-9076 integrated CompactRIO chassis are an appealing option for high-volume deployments and OEM solutions. These systems feature integrated real-time controllers with 400 MHz processors, Xilinx Spartan-6 field-programmable gate arrays, and four C Series I/O slots for modular, signal-conditioned I/O.

To view product specifications, visit ni.com/info and enter nsi1208.

NI and SeaSolve Software Combine Forces on ZigBee Testing

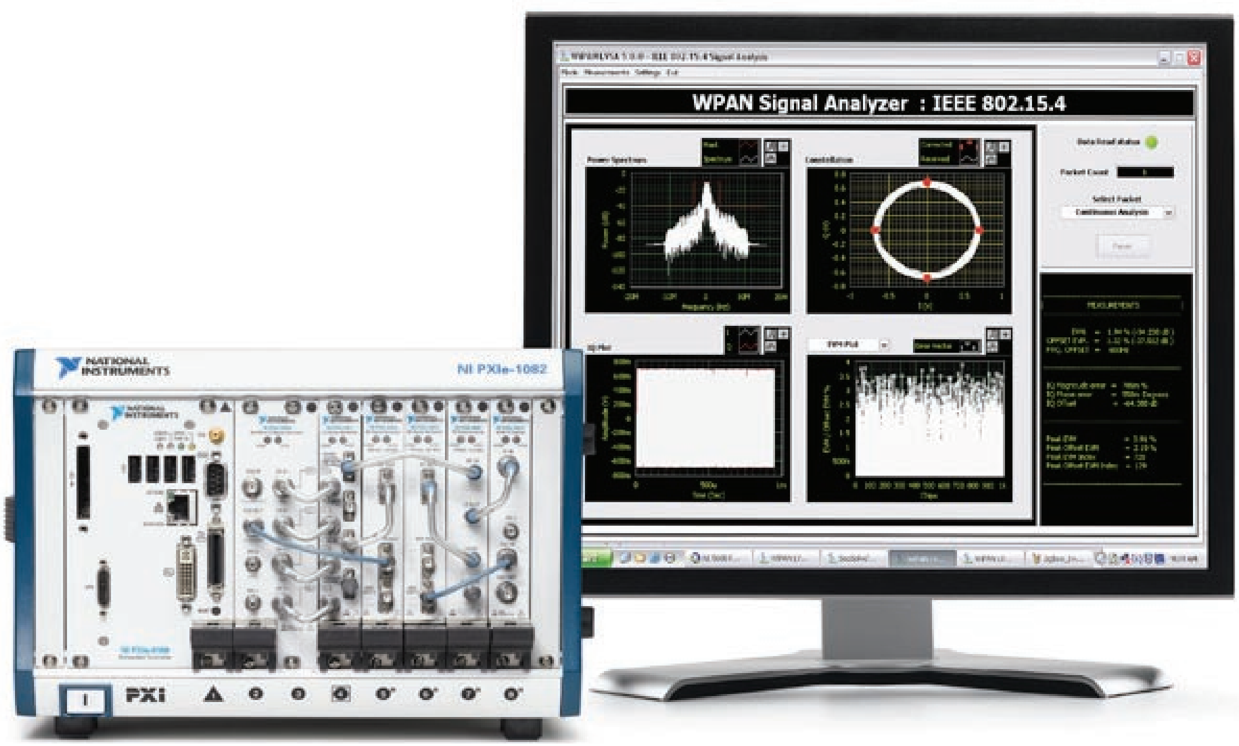
The new NI ZigBee Measurement Suite helps you test ZigBee and IEEE 802.15.4 devices using PXI RF vector signal generators and analyzers. The new measurement suite combines the NI ZigBee Generation Toolkit and the NI ZigBee Analysis Toolkit to offer support for both the 900 MHz and 2.4 GHz industrial, scientific, and medical (ISM) bands. NI LabVIEW software example code is included with the measurement suite to help you automate ZigBee testing, and use soft front panels for interactive measurements.

The ZigBee Generation Toolkit uses PXI RF vector signal generators to help you generate a wide range of highly customized IEEE 802.15.4 signals. The generation toolkit gives you the option to choose from various MAC layer settings, including a variety of custom frame types, various options for subframe commands, and even custom encryption for packet payload. In addition, you can generate ZigBee tests with custom signal impairments including quadrature impairments, additive white Gaussian noise, and memory-less nonlinearity. You can perform more thorough ZigBee receiver testing with a wide range of signal generator impairments and customization options.

For ZigBee transmitter testing with NI PXI vector signal analyzers, the ZigBee Analysis Toolkit provides tools for both MAC layer and physical layer testing. For MAC layer validation, the toolkit can decode ZigBee signal transmissions down to the bitstream – helping you verify payload and other MAC layer information. For physical layer measurements, the ZigBee Analysis Toolkit provides RF measurement capabilities, including measurements for power spectrum density, transmit power, error vector magnitude, and complementary cumulative distribution function. Using these tools for physical layer measurements, you can test and validate ZigBee transmitter performance either for R&D or manufacturing test.

SeaSolve Software is a National Instruments Alliance Partner with broad experience integrating the ZigBee Measurement Suite. The company's expertise in both validation and manufacturing test makes it possible for them to help numerous companies including Ember, Radio Pulse, and SemIndia. "Our partnership with SeaSolve to develop a manufacturing test solution for the testing of Ember's ZigBee chips enables our clients to start up manufacturing in a matter of days while achieving the lowest cost of test at the highest coverage," says John Loukota, director of hardware engineering at Ember.

To obtain more information about NI ZigBee measurement tools, visit ni.com/automatedtest/zigbee.



The NI ZigBee Measurement Suite helps you test ZigBee devices faster than before using PXI RF vector signal analyzers.

NI Digital Video Analyzer Now Includes HDMI 1.4 Protocol

Perform a complete functional test on HDMI-enabled devices, including HDMI protocol and real-time picture quality analysis, with the NI Digital Video Analyzer.

The NI Digital Video Analyzer makes it easy to test the latest HDMI 1.4 features such as 3D video, HDMI 1.4 protocol, and picture quality analysis. The analyzer uses configuration-based test steps to automate measurements on HDMI-enabled devices such as Blu-ray Disc players and set-top boxes. With hardware based on the PXI Express platform and software designed for multicore computing, it offers high-performance measurements in a fraction of the time of traditional test systems.

The NI analyzer combines with NI Picture Quality Analysis software to remove subjective operator inspection with fast and reliable measurements. You can choose from a variety of defect-specific measurements such as macroblocking, stuck frames, and audio drops, or apply higher performance measurements for total picture quality that apply pixel-to-pixel reference tests such as PSNR or structural similarity (SSIM).

The NI Digital Video Analyzer also supports HDMI protocol tests including InfoFrames, consumer electronics control messaging, extended display identification data emulation, and hot plug detect events. This extensive support means the analyzer can simulate any LCD or HDTV and better guarantee interoperability with other HDMI-enabled devices.

To view a demo and learn more about NI audio and video test solutions, visit ni.com/vms.

Leverage PXI Express Synchronization

Introducing PXI Express to the PXI platform did more than add the enhanced performance of the PCI Express interface it also added advanced timing and synchronization features. In addition to all standard PXI timing and synchronization features, PXI Express system backplanes have a 100 MHz reference clock and three sets of differential star trigger lines. This provides even tighter trigger distribution as well as the ability to share high-speed clock references over the star trigger lines.

The NI PXIe-6674T timing and synchronization module offers direct access to all PXI Express timing and synchronization features. The NI PXIe-6674T has an onboard high-stability 10 MHz oven-controlled oscillator that can override the 10 MHz backplane clock. The module also has a high-resolution direct digital synthesis clock generator capable of generating frequencies up to 1 GHz.

The NI PXIe-6674T can access PXIe-DStarA, B, and C trigger buses on the backplane. You can route triggers from these lines to the front panel of the module for use external to the system. The NI PXIe-6674T has a flexible architecture that is also useful for routing signals between other modules and importing/exporting these signals to the chassis.

The new NI PXIe-6674T timing module includes the advanced timing and synchronization features of PXI Express.

When coupled with the NI PXI-6682H, you can also discipline the 10 MHz clock to multiple time references including GPS, IEEE 1588, and IRIG-B.

To view specifications and pricing for the NI PXIe-6674T, visit ni.com/info and enter nsi1209.

Sell More With the LabVIEW Tools Network

The LabVIEW Tools Network is a new online marketplace for National Instruments and third-party LabVIEW add-ons and apps. As a product partner, you can post your product based on NI LabVIEW software to the LabVIEW Tools Network and access associated NI marketing resources. Using these free resources to supplement your marketing strategy can be effective in pushing your sales and market awareness to the next level. Engineers at ImagingLab, a winner of the 2010 LabVIEW Add-On of the Year Award, saw a performance increase with its Robotics Library for DENSO. Follow these four steps to see similar results with your add-on.

Figure 1. *Post your product based on LabVIEW to the LabVIEW Tools Network.*

1 Get Certified Through the 'Compatible With LabVIEW' Program

All third-party add-ons in the LabVIEW Tools Network meet specific guidelines to ensure that they properly integrate with LabVIEW. Each product meets certain criteria or is tested by NI and given a "Compatible with LabVIEW" certification level – Standard, Silver, or Gold. This helps customers be more confident in their purchases. The ImagingLab Robotics Library for DENSO received the Silver rating, which demonstrates that this add-on is a highly compatible, field-proven library with effective architectural design.

2 Work With the LabVIEW Partner Team to Use Marketing Resources on ni.com

When you take advantage of the LabVIEW partner team, you gain access to a wide variety of resources on ni.com. These resources include discussion forums, tutorials, and webcasts that educate LabVIEW users about specific products. ImagingLab now has its own section on the discussion forums to interact with customers for feedback and support. The model page also features links to a tutorial explaining the Robotics Library for DENSO and a webcast to get you started. These resources have increased the company's marketing collateral and exposure while providing a direct line to its customers.

3 Supplement Your Marketing, Don't Replace It

Working with NI to supplement its marketing strategy contributed to ImagingLab's success. Specifically, ImagingLab actively promoted its Robotics Library for DENSO through industry events, engaged in PR activities, and built strong relationships with leaders in the robotics industry in addition to working with the LabVIEW partner team. This combination of activities helped ImagingLab effectively reach its market.

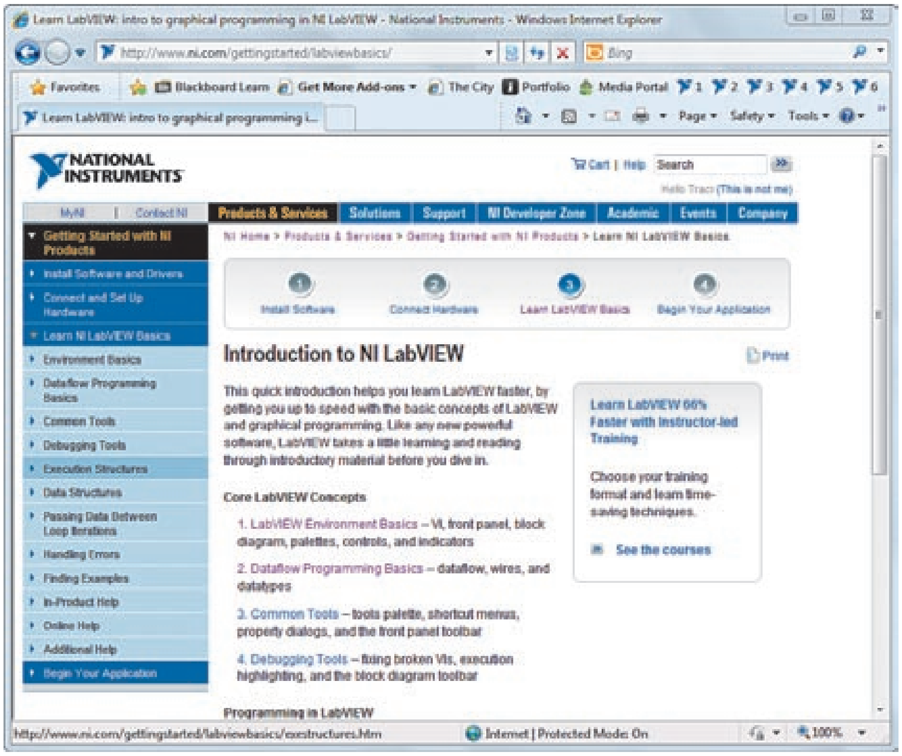
4 Get Paid

ImagingLab worked throughout 2010 to promote its Robotics Library for DENSO. The company posted an evaluation version to the LabVIEW Tools Network in November and saw more than 1,400 visits and 130 downloads from ni.com in the first six months, resulting in strong sales for ImagingLab. The company plans to continue developing robotics libraries and posting them to the LabVIEW Tools Network to expand on this success. They have recently added libraries for Mitsubishi and KUKA Robots.

Figure 2. *This DENSO robot is controlled with LabVIEW using the ImagingLab Robotics Library for DENSO.*

To learn how you can contribute your add-on or app to the LabVIEW Tools Network, visit ni.com/labviewtools.

Getting Started With LabVIEW



Take advantage of online LabVIEW tutorials to quickly learn the basics you need.

Learning a new programming environment can be daunting. You have NI LabVIEW software, which is a great first step. But you may be wondering, "Now what?"

National Instruments provides the resources you need to get started. The **ni.com/gettingstarted** website offers succinct but information-rich tutorials designed to help you succeed with your new NI software. Taking the time to learn the basics now can lead to increased productivity and efficiency later.

The tutorials at **ni.com/gettingstarted** cover common LabVIEW topics in three categories:

- Core LabVIEW concepts
- How to program in LabVIEW
- Finding examples and getting help

Both text and video clearly explain subjects from dataflow programming basics to using the LabVIEW Help feature. Become familiar with the core LabVIEW concepts to understand the environment and then proceed to information specific to your application with learning modules such as "Logging Data With a USB Data Acquisition Device" and "Building a Graphical User Interface (GUI) for Data Acquisition Applications." Think of these tutorials as a quick-start manual for basic proficiency over a wide variety of subjects. With a little training in LabVIEW, you're on your way to engineering a better world.

To explore the LabVIEW tutorials, visit ni.com/gettingstarted/labviewbasics.

Try Your Hand – Enter the Caption Contest

Congratulations to last quarter's winner, Andy Baxter, from Sumitomo Electronic Device Innovations, for submitting the following caption for the image of an NI employee's visit to the CERN Large Hadron Collider:

"Do you think I should tell them about the 'Clean Up Diagram' button?"

To submit your caption for this image of two engineers on top of a wind turbine, e-mail **newsletter@ni.com**. Please include your name, company name, and how long you have been a subscriber. After deliberating, we will print the entry deemed most worthy in the next issue of *Instrumentation Newsletter* and award the winner a surprise gift from the NI junk drawer. The deadline for submitting entries is June 30, 2011.

Building Advanced User Interfaces in LabVIEW

If you're still populating a default gray front panel with modern or classic controls and indicators, then you haven't even scratched the surface of building user interfaces (UIs).

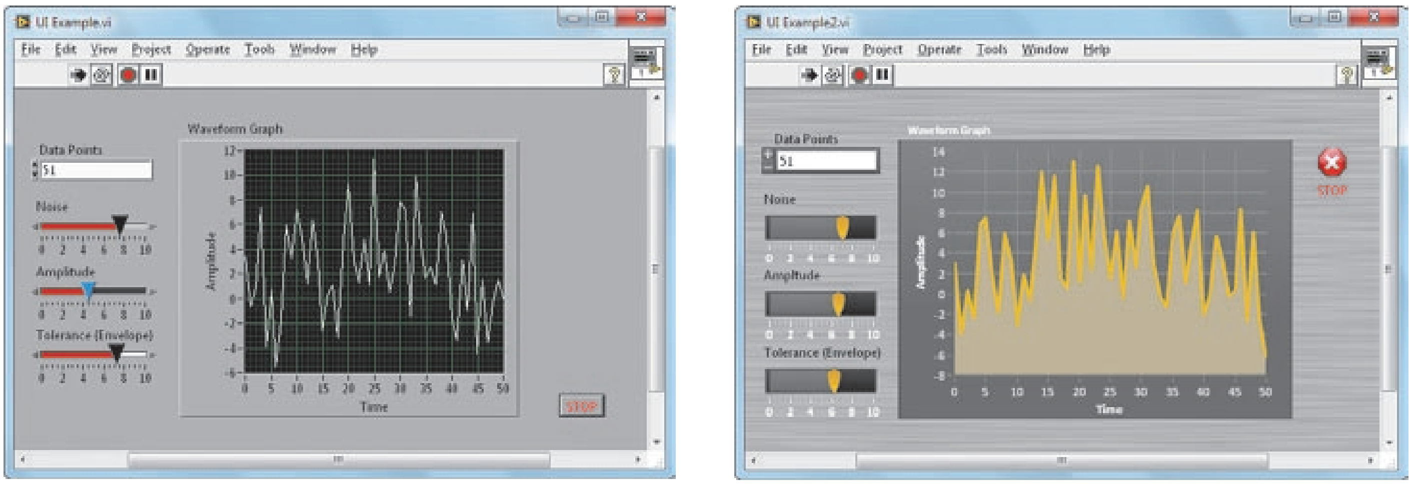


Figure 1. *A few small changes go a long way toward making your UIs nicer to look at and easier to use.*

If a well-architected and fully functional block diagram is the meat of the sandwich, then a stylish but practical UI is the bacon on top. Is it necessary? Arguably not, but it can make all the difference in the world.

UI Design: A Lost Art?

If you ask NI LabVIEW developers to name their favorite part about using LabVIEW software, most would give a wide variety of responses about the ease of interacting with real-world signals, the efficiency gained by using higher level tools, or the more natural programming paradigm of the graphical dataflow approach. Developers often overlook the advantages to the other "graphical" side of LabVIEW that makes up half of every VI created: the LabVIEW front panel.

Writing good code is an integral part of every application. After all, if a program doesn't execute well or at all, it's not as useful an investment. With the ever-extending reach of LabVIEW and its repeated adoption in increasingly complex applications, developers have to pay more attention to the aesthetic side of application development because a well-functioning application is also less useful if it's too confusing to use.

Create UIs that contribute to your application both cosmetically and functionally with the following three LabVIEW techniques.

1. Give Your UI a Custom Look

The simplest way to enhance the look of your UI is to use something other than the default gray LabVIEW front panel background and the modern controls palette. By merely changing the background color of the front panel, populating your UI with images from external sources, or even simply using the system controls palette, you can achieve a unique look without investing much time in customization. Plus, the system controls and indicators are typically more familiar to most users because they're designed to mimic OS style. This provides instant familiarity and therefore increased usability.

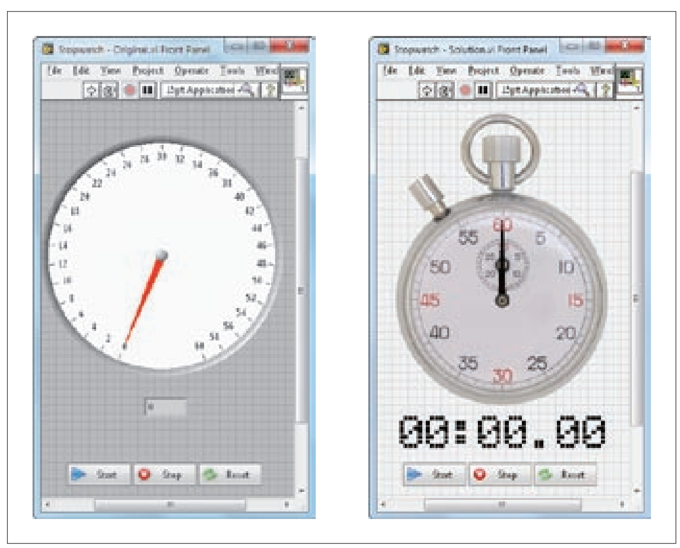


Figure 2. *Though both VIs are functionally equivalent, it is easier to recognize stopwatch functionality if the control actually looks like a stopwatch.*

Customizing controls adds a layer of complexity and flexibility. Using the LabVIEW control editor, you can dissect each control to isolate and modify the individual lower level graphic components that compose every control. This technique makes individual controls and indicators more stylish, recognizable, or representative of the real-world signals they portray. From adding decals to buttons to changing the image of a gauge background, control customization is one of the most popular ways to improve the cosmetic appeal of your LabVIEW UI.

2. Organize Your Complex UIs

Unfortunately, as you increase the scope of your application, you often have to increase the sheer amount of information displayed on your LabVIEW front panel. Luckily, there are two easy LabVIEW techniques for simplifying the busyness of complex UIs when not all controls and indicators need to be visible at the same time.

Tab controls are a commonly used UI component and an effective method of encapsulating UI functionality into distinct and differentiated sections. They are easy to use and more flexible than most developers realize. After adding a tab control to your front panel and populating tabs with additional controls and indicators, you can add or subtract tabs, make tabs transparent, rearrange the physical location of tabs to implement vertically tabbed functionality, and even add images to tabs.

However, what you gain in ease of use with the tab control, you sacrifice in scalability. Depending on the amount of space on your user's screen, there is a limit to the number of tabs you can gracefully add to a tab control. This is a good detail to consider before you begin development. Furthermore, a tab control loads all of its controls and indicators into memory at once, even if most of the content isn't on the foremost (visible) tab. This could affect the performance of your application.

A more scalable approach to UI organization is the LabVIEW subpanel. Using subpanels, you can create an unlimited number of subVIs and dynamically populate a subpanel control with specific subVI content when appropriate. With LabVIEW subpanels, you can decide when content is loaded into or released from memory, giving you more control over your application.

3. Inform the User During Slow Operations

There is nothing more frustrating than trying to use an application that appears to be frozen when it's merely trying to complete a time-intensive task. It is important to keep the user informed when beginning, ending, or progressing through a lengthy operation.

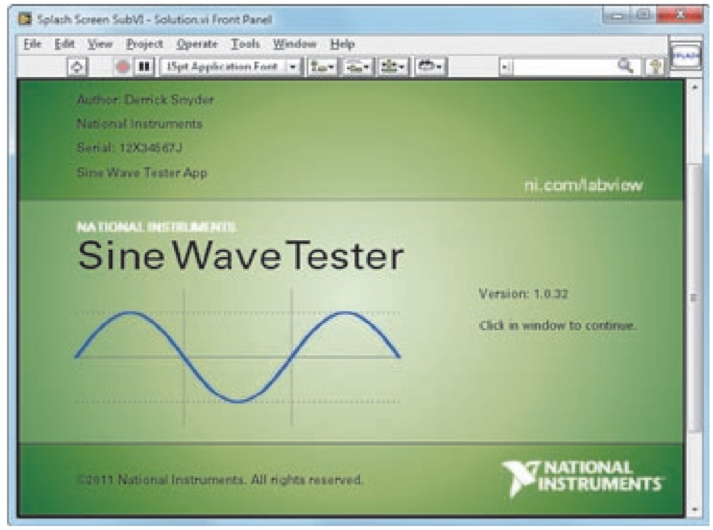


Figure 3. *You can easily create and use splash screens to inform your user during long load times.*

LabVIEW includes built-in busy cursors and progress bar controls that are an easy way to notify the user when the application is processing a task in the background. When you know the details of the progress of an operation – for example, many iterations of an intensive For Loop – the system horizontal progress bar is an effective control choice.

Your application may have a long load time when a user first launches it. You can implement a splash screen to let your user know that the application has successfully launched and simultaneously communicate load progress. By using front panel transparency and centering the splash screen, LabVIEW makes it easy to achieve a professional outcome with only a few quick property changes.

– Derrick Snyder derrick.snyder@ni.com

Derrick Snyder is a product manager for NI DIAdem and data management software at National Instruments. You can read more from Derrick in this issue in the article on page 8 titled, "Avoiding Catastrophe From Unit Confusion."

– Simon Hogg simon.hogg@ni.com

Simon Hogg is a LabVIEW product manager at National Instruments. He holds bachelor's degrees in electrical engineering and managerial studies from Rice University. Simon is responsible for dozens of customized UI example codes on the NI Community UI Interest Group.

To join an online community of LabVIEW developers who are passionate about UIs, visit ni.com/info and enter nsi1210.

Powering Remote Villages With Revolutionary Airborne Wind Technology

THE CHALLENGE

Providing portable renewable energy to remote villages and other areas that do not have access to the power grid.

THE SOLUTION

Using NI CompactRIO hardware and LabVIEW software to develop a portable 12 kW airborne wind energy system that uses a flexible airfoil to replace the blades and tower found on traditional wind turbines.

Windlift was founded in 2006 to develop portable airborne wind energy (AWE) technology for postconflict reconstruction, disaster relief, and third-world development. This technology has the potential to also benefit military operations by displacing diesel generators as the primary source of electricity for forward operating units.

AWE technology uses a flexible airfoil to capture power from the wind. The airfoil is tethered to a base station and the tethers are spooled onto a large drum. The system, which is mounted to a trailer, operates as a long-stroke reciprocating engine. During the generation phase of the cycle, the airfoil is actively flown in a cross-wind manner downwind of the base station, which maximizes the tension in the tethers. As the airfoil moves away from the ground station, the tethers unspool from the drum and drive it to turn a motor/generator. Electrical power from the generator is transmitted to a battery bank that is also mounted to the trailer. When the maximum tether length is reached, the airfoil is "depowered" and retracted. The net energy gain per cycle is the energy generated during the outgoing stroke minus the energy consumed during the retract stroke.

The seamless interface between CompactRIO and the LabVIEW development environment offers a turnkey hardware/software solution. Also, the power and flexibility of the combined field-programmable gate array (FPGA) and real-time processor architecture offer functionality that would not be possible with either component alone. Lastly, National Instruments illustrated a clear development pathway with CompactRIO from prototype to production using the same hardware and software.

We used an NI Green Engineering Grant award to acquire the software needed for development. One of the most useful tools for this project outside the LabVIEW development environment was NI DIAdem data analysis software. We used the shared variable engine feature of CompactRIO to port data over a TCP/IP connection to a remote laptop for data logging.

The portable 12 kW airborne wind energy system uses a flexible airfoil to capture power from wind.

We are currently in the final stages of testing the portable AWE system prototype. The CompactRIO embedded system has been a valuable asset during this development process and we anticipate that it will continue to be an integral part of the system.

– Matt Bennett, *Windlift*

Siemens Wind Power and the NI Graphical System Design Platform

Don't know what this thing is? Check out page 31 for instructions, and then watch this video to see how Siemens uses LabVIEW and user-defined hardware to develop state-of-the art wind turbines.

Building an Embedded Measurement System for Remote Wind Turbine Monitoring

THE CHALLENGE

Developing new remote wind turbine monitoring systems that are time synchronized for performing measurements at a higher sample rate and with higher accuracy.

THE SOLUTION

Developing a flexible NI LabVIEW software application based on the CompactRIO platform that can acquire measurements, filter signals, and transmit data.

ECN Wind Energy is the leading institute in the Netherlands for research on sustainable energy, energy conservation, and clean fossil fuel use. The company focuses on wind turbine optimization and offers measurements of wind turbine characteristics to wind turbine manufacturers and owners. The systems are used to conduct routine measurements and to support research studies.

To study wind turbine aerodynamics and designs, wind turbines are equipped with different sensors to measure the force and vibration applied to the blades, gears, and bearings as well as temperature, wind direction, and blade and shaft position. For correct analysis, all the signals need to be synchronized because the load measured on a blade in a vertical position is different than a blade in a horizontal position. Our current custom measurement system has limited capabilities and can only sample at a fixed rate of 128 Hz. For upcoming research projects, we needed faster sampling rates and higher accuracy.

The system architecture consists of measurement units and sensors inside the blade hub and the wind turbine gearbox. A local host computer acquires the measurement data and configures the measurements. At ECN headquarters, a remote host computer system collects the measurements and stores them in a central database. We chose NI hardware for our new measurement systems because CompactRIO provides one platform that can connect to multiple types of sensors including temperature, acceleration, strain, communication, and protocol. Also, it can be synchronized to a master clock device. Other benefits are that it is rugged, can perform high and low sample rates, and is a modular, off-the-shelf product, which makes future expansion or modifications possible.

National Instruments Alliance Partner T&M Solutions developed the software application using LabVIEW and the LabVIEW Real-Time and LabVIEW FPGA modules. The field-programmable gate array (FPGA) identifies the attached measurement modules. The software uses a set of precompiled bitfiles to support the different modules and locations. In addition, by preprocessing the data in the FPGA, we decrease the CPU usage for the real-time processor.

We tested the first measurement unit in a nearby wind turbine. The CompactRIO modules provided better measurement results compared to the existing system. For example, we can now acquire strain data at 24 bits and 6-wire measurements at a higher rate. After completing our final tests, we plan to roll out systems based on CompactRIO in new wind farms.

– F.A. Kaandorp, *ECN Wind Energy*
– Arnoud De Kuijper, *T&M Solutions*

NI Publishes 2010 Citizenship Report

National Instruments recently released its annual citizenship report, which details its 2010 citizenship performance and states its 2011 goals. The 2010 report outlines how the company maintains an innovative culture, provides tools that empower customers to improve the world, works to reduce its environmental footprint, and helps improve local communities.

To read the complete report, visit ni.com/citizenship.

NI Corporate Citizenship

Don't know what this thing is? Check out page 31 for instructions, and then watch this video to hear NI leaders talk about what makes NI a responsible corporate citizen.

NIWeek Early Bird Registration Ends May 31

National Instruments is hosting the industry's premier graphical system design event that attracts more than 3,000 engineers, educators, and scientists. NIWeek 2011, the 17th annual customer and technology conference, is August 2–4 in Austin, Texas.

The conference features more than 200 interactive sessions and five industry-targeted summits focusing on the latest advances in the energy, aerospace and defense, RF, robotics, and vision industries. NIWeek also features keynote presentations and demonstrations that highlight how engineers and scientists can use NI graphical system design to test, measure, and fix inefficient products and processes to improve everyday life.

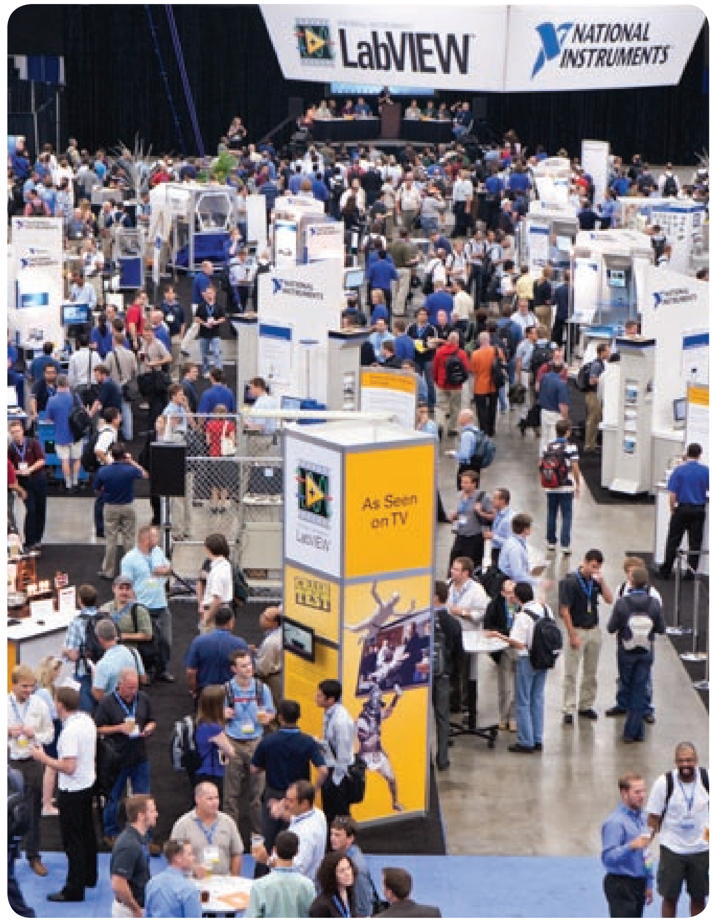
Read what one attendee said about last year's event:

> *"NIWeek was a fantastic experience and the exposure to the new technologies and best practices presented by so many professionals was an extraordinary opportunity."*
>
> – Dan Nightingale, Corning Incorporated

Register today to take advantage of special discounts:

- Early bird registration – register by May 31 for the best pricing option
- Volume discount – register four attendees for the price of three
- Academic discounts – for full-time faculty members or graduate students
- Discounted prices on training and certification exams

To register and learn more about NIWeek 2011, visit ni.com/niweek.



By the Numbers: NIWeek

200 interactive sessions
50 hands-on workshops
150 exhibitions on the latest technological advances
5 industry-targeted summits
3 keynote presentations

To browse the preliminary program and start planning your schedule, visit ni.com/niweek.

Top 5 ni.com Webcasts

1. NI Multisim Interactive Demonstration
2. Introduction to NI TestStand Test Management Software
3. Understand the Most Missed Concepts Within the Certified LabVIEW Associate Developer Exam
4. What's New in LabVIEW 2010
5. Introduction to LabVIEW FPGA

To watch these and other webcasts, visit ni.com/webcasts.

Affordable and Personalized On-Site Training

Hach Company manufactures and distributes analytical instruments and reagents used to test the quality of water and other aqueous solutions. At Hach, operations manager Leah Martinez recently identified some urgent training needs for her team of test engineers.

The Problem

"Most of the team had been using LabVIEW for some time, so most felt comfortable with the basics," Leah said. However, after the team accepted a large project, it became clear that there were knowledge gaps with NI LabVIEW software and varied understanding of test and measurement techniques. "LabVIEW is an easy language to pick up, but we discovered a couple of things we were doing that didn't scale well," she said.

The Solution

Working with her National Instruments account manager, Leah decided the best fit for her team's needs was on-site training classes in both LabVIEW and NI TestStand. On-site LabVIEW training was an excellent way for her to efficiently train multiple programmers at once and provide flexibility for each individual to address questions throughout the course that were specific to their use cases.

On-site training offered the following unique ways to tailor the course material to the company's needs:

- Discussions focused on each programmer's specific needs and skill level
- Example applications to work through from the company's own test systems

Most of the engineers had never used NI TestStand or any other type of sequencing software. For NI TestStand, Leah created a simulator to use and then met with the NI trainer to create a new lesson plan for the course. "This certainly could not have happened if we had done training off-site," Leah noted.

The Results

"There has been a step function improvement in my team's knowledge of LabVIEW and NI TestStand programming," Leah said. She has observed improvements within her team including the following:

- An increased willingness to use NI TestStand
- Team members who are more likely to seek help from their colleagues
- Greater efficiency with LabVIEW project management
- Team members who are more likely to take advantage of ni.com and other forums for help

Success

With on-site training, the team invested a limited budget, did not travel, and made the course material fit their specific needs. On-site courses deliver the classroom learning experience to a company's facilities, allowing their employees the unique opportunity to modify a course for the company's specific needs.

To learn more about on-site training from NI, request a consultation by calling (800) 531-5066.

Not Sure What These Boxes Are?

They're mobile bar codes or tags. Follow three easy steps to start using them.

1. **Download the app**
You can read mobile bar codes using a smartphone camera. Search "tag reader" or go to **http://gettag.mobi** to find a free app.

2. **Scan the code**
Open the app and hold your phone over one of the bar codes in *Instrumentation Newsletter*. The app uses your camera to read the code.

3. **See something new**
The bar code directs your phone to a video, photo, website, or other cool item we think you should see.

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Technology Outlook

NI Technology Partner Xilinx Announces ARM-Based Processing Platform

XILINX®

National Instruments has recently been a part of the definition and testing of a new Extensible Processing Platform (EPP) family from Xilinx Inc. On March 1, Xilinx unveiled its new Zynq-7000 EPP family, which boots at power-up and can run a variety of OSs independent of the programmable logic. Vendors have previously offered field-programmable gate arrays (FPGAs) with hard-wired and soft onboard processors, but the new Zynq-7000 EPP takes a unique approach in that the ARM processor system, rather than the programmable logic, runs the show.

The Zynq-7000 EPP devices tightly integrate a complete ARM® Cortex-A9 MPCore processor-based system with 28 nm, low-power programmable logic that is implemented in high-performance TSMC. The processing system then configures the programmable logic on an as needed basis. With this approach, the software programming model is exactly the same as standard, fully featured ARM processor-based systems on a chip (SOCs).

The other innovation that makes this new product unique is the tight integration of the processing system with the programmable logic, which has over 3,000 interconnections. This offers designers unprecedented throughput between the hardware and software domains at a low power level and cost, and allows them to build not only peripherals but also hardware accelerators to boost the overall performance of their systems.

Because of this, Zynq-7000 EPP devices are both powerful and intuitive, and they are designed for broad use by system architects, software developers, and hardware engineers. Product development teams will be extending, customizing, optimizing, and differentiating their products in a wide range of markets such as video surveillance, automotive driver assistance, factory automation, and many others.

Xilinx expects the first of these silicon devices to ship in the second half of 2011 with general engineering samples available in the first half of 2012.

To explore the Zynq-7000 family, visit xilinx.com/zynq.

Newsletter Information and Resources

- To view past issues of *Instrumentation Newsletter*, update your subscription preferences; or subscribe to the semimonthly NI e-mail newsletter, *NI News*, visit **ni.com/newsletter**.
- For inquiries, requests for permission, or changes of address, e-mail the managing editor at **newsletter@ni.com**.

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