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Test & Measurement World

THE MAGAZINE FOR QUALITY IN ELECTRONICS

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An RFIC for the WORLD

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Mark D'Amato, systems engineer at BitWave Semiconductor.

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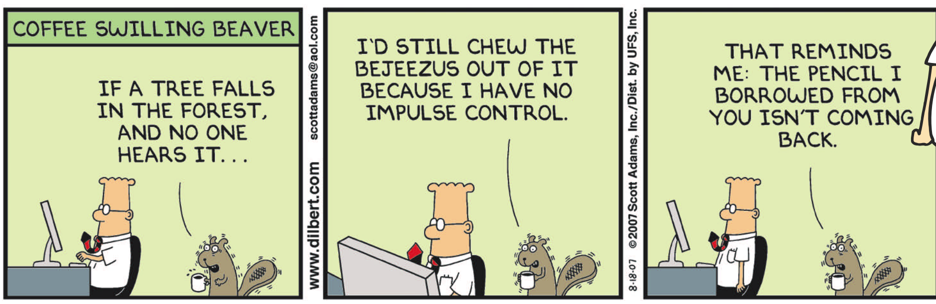

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Test & MEASUREMENT WORLD®

COVER BY: MARK WILSON

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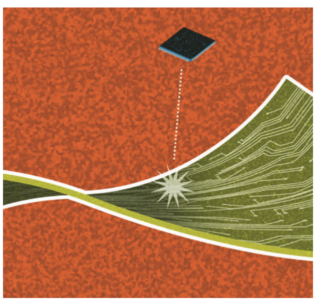

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RICK NELSON
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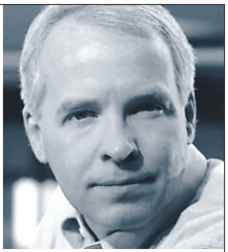

It's the message, not the medium

The US presidential campaign has brought to the forefront the question of whether a national leader should be computer-literate. The leading candidates offer a stark contrast, with the technologically savvy Barack Obama vying with the self-described technological Neanderthal John McCain.

All else being equal (which, of course, it isn't), the nod would seem to go to the more computer-literate candidate. But the *Wall Street Journal* columnist Lee Gomes (Ref. 1) questions whether some jobs might be "…too important for the office holder to be spending the day deleting spam or closing pop-up windows…."

And familiarity and involvement with technology can be a downright drawback. Al Gore in the 2000 election, for example, was ridiculed after the false accusation that he had claimed to have invented the Internet.

"It's immaterial whether the next president can blog, post videos, or send e-mail."

Of course, a successful candidate can't be too unfamiliar with technology. President George H.W. Bush had already received his own round of ridicule during his 1992 re-election bid when he expressed amazement at a supermarket checkout scanner.

So some middle-of-the-road approach might be best. Gomes recommends that the next president spend 20 minutes a day at a computer, reading a favorite blog, visiting YouTube, or playing Spider Solitaire, if for no other reason than as "a good way to keep up with the common folk."

That sounds arbitrary to me. I think it's immaterial whether the next president can blog, post videos, or send e-mail. Should any of those become necessary, an assistant can contend with spam, pop-ups, and the vagaries of the operating system.

When it comes to tech savvy, I want a president who has succinctly and correctly answered the 14 questions posed by Science Debate 2008 (Ref. 2). Here are some excerpts:

- What policies will you support to ensure that America remains the world leader in innovation?
- What policies would you support to meet demand for energy while ensuring an economically and environmentally sustainable future?
- What role do you think the federal government should play in preparing K–12 students for the science and technology driven 21st century?
- What is your view of how science and technology can best be used to ensure national security?
- The study of earth from space can yield important information about climate change…. How would you prioritize space in your administration?
- Is it acceptable for elected officials to hold back or alter scientific reports if they conflict with their own views, and how will you balance scientific information with politics and personal beliefs in your decision making?
- What priority would you give to investment in basic research in upcoming budgets?

As far as I'm concerned, the candidates can post their answers on the Web or carve them in stone tablets. It's the content—not the medium—that counts. T&MW

REFERENCES

1. Gomes, Lee, "Note to Next President: Avoid Computers," *Wall Street Journal*, July 30, 2008, p. B6.

2. "Innovation 2008: 14 questions the candidates for President should answer about science and America's future," Science Debate 2008, www.sciencedebate2008.com/www/index.php?=id=35.

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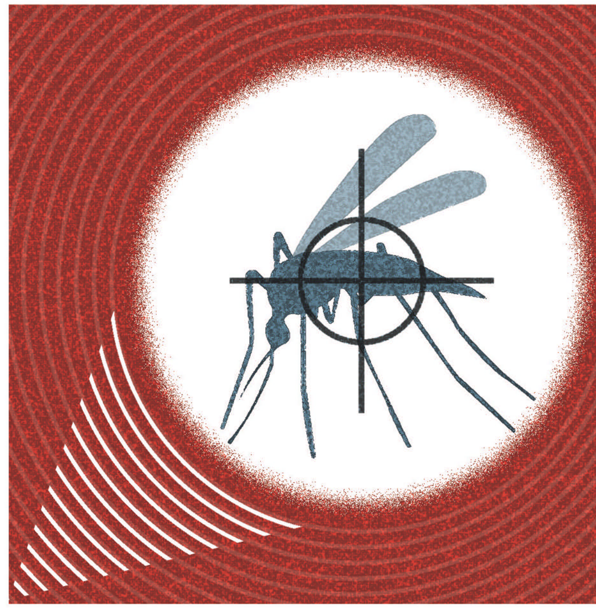

DANIEL GUIDERA

Abel Raynus is an electrical engineer at Armatron International's Flowtron Outdoor Products Division. Once known as Automatic Radio, a manufacturer of car radios, Armatron International now manufactures lawn and garden products through its Flowtron division. Raynus designed the electronics and the testers used in production of the company's electronically controlled mosquito-control products. Senior technical editor Martin Rowe met with Raynus at his office in Malden, MA.

Q: What kind of electronics are in a mosquito killer?
A: The mosquito killer uses a microcontroller to control an exothermic reaction that produces carbon dioxide from propane gas. The microcontroller controls a heater and it also handles the user interface, which contains buttons for setting the amount of time that the mosquito killer is on. LEDs tell the user when the product is on and working.

Q: How does the microcontroller control the exothermic reaction?
A: When you first start the mosquito killer, the heating element is cold. The controller turns on the heater while monitoring the internal temperature. As temperature rises, the propane gas produces CO_2, which simulates human breathing that attracts mosquitoes. As internal temperature rises, the microcontroller adjusts the gas flow, which controls temperature.

Q: How does the unit monitor temperature?
A: Thermocouples in the unit measure internal temperature, and thermistors monitor outside temperature. A photocell senses light that the microcontroller uses to turn the unit off during daylight hours. The microcontroller has built-in analog-to-digital converters that measure the temperature and light levels.

Q: How do you program the microcontroller?
A: I program in assembly language. It's much more efficient than writing code in C. By writing the code in assembly language, I was able to fit the control algorithm into 4 kbytes of program memory.

Q: What kind of tester did you design?
A: I designed a test fixture to verify that the controller boards function properly. The fixture contains spring-contact pins that connect to a microcontroller-based board in the tester. The tester's board measures voltages on the board under test. A go/no-go LED tells the operator if the board under test has passed all tests. If it hasn't, then other LEDs indicate which tests failed. From those LEDs, we get enough information to troubleshoot and repair the board.

Q: What tools do you use for design and test of new microcontroller boards?
A: I have all the usual tools such as oscilloscopes, signal generators, and multimeters. I also use electronic-circuit-design and printed-circuit-board layout software.

Q: Do you have to justify the purchase of electronic parts and tools?
A: Not if they are required in the development of new designs that have been approved and authorized by management. T&MW

Every other month, we will publish an interview with an electronics engineer who has test, measurement, or inspection responsibilities. If you'd like to participate in a future column, contact Martin Rowe at mrowe@tmworld.com.

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Agilent Technologies

College teams begin green-vehicle competition

NATICK, MA—Teams of students representing 17 North American universities converged at the MathWorks August 13 for a week of training that kicks off a three-year competition to improve vehicle efficiency and reduce emissions. The competition—called EcoCAR: The NeXt Challenge—builds on the Department of Energy's 20-year history of sponsoring advanced vehicle technology competitions, according to Connie Bezanson, lead engineer, program planning, at the DOE.

Paul Smith, director of North American consulting services at the MathWorks, said that during year 1, students will focus on model-based mechanical and electrical design of powertrain components and controllers, using tools such as his firm's Matlab and SimuLink as well as tools from other competition sponsors, including dSpace and National Instruments. In years 2 and 3, each team will integrate its design into a General Motors-provided Saturn Vue. The entire competition, said Cindy Svestka, executive technical assistant for powertrain/vehicle integration at GM, mimics GM's own global vehicle-development process.

The program offers many benefits. Smith said that students tend to stress software in ways that industrial users don't, providing valuable feedback. Bezanson said that engineers at Argonne National Laboratory, which manages the competition for the DOE, can learn from students as the students exercise the lab's Powertrain Systems Analysis Toolkit (PSAT) software. But Svestka said that from GM's perspective, the ultimate goal is to instill in the next generation of engineers knowledge of advanced vehicle technologies that employees in GM's core businesses might lack. "We have a great hybrid team," she said, "but it will need twice the number of people within the next 10 years." www.ecocarchallenge.org.

Accellera updates Verilog-AMS standard

Accellera, an organization that develops electronic design automation (EDA) standards, reports that its board of directors and technical committee members have approved Verilog-AMS 2.3, a new version of the Verilog-analog mixed-signal (AMS) standard covering design and simulation. Verilog-AMS 2.3 unifies the Verilog-AMS 2.2 specification with the IEEE 1364-2005 standard that defines the Verilog hardware-description language.

According to Accellera, Verilog-AMS 2.3 will enable users to develop tightly integrated Verilog-AMS modules and allow EDA software tool developers to implement EDA tools without ambiguities in the interpretation of the language. Verilog-AMS 2.3 also introduces new analog and mixed-signal features that support improved top-down AMS design and verification methodologies. These include enhancements to table_model, support for multiple analog blocks, and resolution of language conflicts with the SystemVerilog standard (IEEE P1800), such as changing the digital domain name to 'ddiscrete' from 'logic' (because 'logic' is a keyword in SystemVerilog), and making the use of array literals consistent. www.accellera.org.

Asset's ScanWorks supports Avago ASICs

Asset InterTech has announced that it has reached an agreement under which ScanWorks, the company's platform for

Editors' CHOICE

Network analyzers get boost to 20 GHz

Agilent Technologies has added a 20-GHz option to its 8.5-GHz E5071C ENA network analyzers and has introduced a new E5092A configurable multiport test set. The ENA series offers a range of capabilities, from basic S-parameter measurements to advanced multiport and balanced measurements.

The new 20-GHz option supports measurement of the third harmonics of passive components in WLAN, WiMAX, UWB, 4G-cellular, or any technology that uses a carrier frequency up to 6 GHz. The option also supports both two-port and four-port configurations and is available as an upgrade to existing equipment.

The E5092A configurable multiport test set, which replaces the E5091A test set, works with ENA series network analyzers to provide up to 22-port measurements (or up to 10-port full-crossbar measurements). The E5092A can be used with the Measurement Wizard Assistant software to simplify complex system setups and increase measurement productivity.

Base prices: two-port, 300-kHz to 20-GHz option—$56,485; four-port, 300-kHz to 20-GHz option—$66,755; configurable multiport test set—$33,583. *Agilent Technologies, www.agilent.com.*

open embedded instrumentation tools, will support Avago Technologies' embedded-instrumentation technology for selected ASICs that target high-performance server applications.

Initially, ScanWorks will support Avago ASICs featuring SerDes cores that are compatible with Intel's QuickPath Interconnect (QPI) and interconnect built-in self-test (IBIST) technologies. ScanWorks automates the analysis of data generated by the IBIST function, providing access to IBIST data from a QPI SerDes-equipped Avago ASIC and to IBIST data from an Intel chipset.

ScanWorks support for Avago ASICs that feature Intel QPI SerDes will be available as an add-on module to ScanWorks during Q4 of 2008 at a price of $8250. www.asset-intertech.com; www.avagotech.com

CALENDAR

International Test Conference, October 26–31, Santa Clara, CA. Sponsored by the IEEE. www.itctestweek.org.

Vision 2008, November 4–6, Stuttgart, Germany. Produced by Messe Stuttgart. www.messe-stuttgart.de.

Electronica, November 11–14, Munich, Germany. Produced by Messe München. www.electronica.de.

To learn about other conferences, courses, and calls for papers, visit www.tmworld.com/events.

Seica and Corelis form partnership

Seica and Corelis have announced the formation of a partnership to deliver and support integrated systems based on flying probers from Seica and boundary-scan products from Corelis. The partnership's initial offering is Seica Pilot with integrated Corelis ScanExpress software. The integrated system has been deployed at a major defense electronics manufacturer, the companies report. www.seica.com; www.corelis.com.

Editors' CHOICE

LabView adds wireless, enhances multicore and FPGA features

With the introduction of version 8.6, LabView now lets you make remote measurements using a WiFi connection to data-acquisition devices. In addition, you can connect to wireless devices through Bluetooth, GPRS, and GSM. Version 8.6 also enables you to download drivers for numerous proprietary wireless sensor networks. Using the LabView Wireless Toolkit, you can test wireless devices that use any of these technologies.

A new feature lets you bring in simulations of mechanical devices, then collect data on a real device and integrate the data into the model. You can see how a model reacts in response to design changes.

Version 8.6 also extends the software beyond its traditional test-and-measurement base. You can use new development and integration features to add functions to a field-programmable gate array (FPGA) without writing FPGA code. Predefined functions include fast Fourier transforms. You also get more than 1200 data-analysis functions optimized for multicore processors.

LabView 8.6 lets you convert applications into Web services that run on desktop or real-time processors that run HTML, Java, or Flash. Users can gain access to your applications through any Web-enabled device, including smart phones, PDAs, and PCs.

Base price: $1199. *National Instruments, www.ni.com.*

Instruments complement sockets, systems, and software

> > > Semicon West, San Francisco, CA, July 15–17, SEMI. www.semiconwest.org.

Offerings at Semicon West included test sockets, RF and digital instruments, compact test systems, complete test cells, and software focused on yield management, failure analysis, characterization, and design for manufacture.

Aries Electronics updated its line-up of test and burn-in sockets, debuting a 6.5-mm center-probe test socket, CSP/BGA sockets with pitches down to 0.3 mm, and a CSP/MicroBGA socket that accommodates devices up to 6 mm^2.

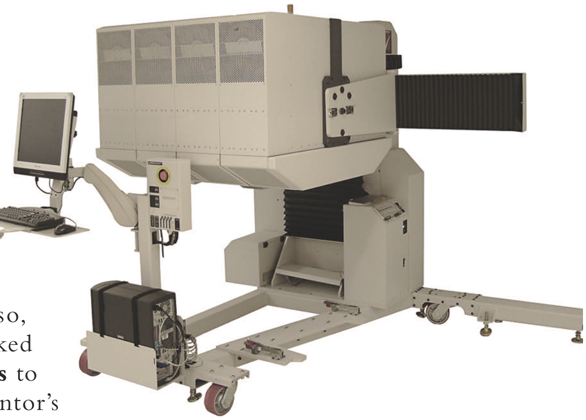
Teradyne highlighted five products it has introduced during 2008, including the UltraWave 12G 12-GHz RF instrument, the 800-Mbps UltraPin800 128-digital-pin instrument, the small-footprint 12-slot UltraFLEX-HD test system, the D750Ex LCD driver test system, and the Magnum II system—from the company's recently acquired Nextest business unit—for flash and embedded-memory test.

Keithley Instruments introduced Keithley Test Environment Interactive (KTEI) V7.1 software for the company's Model 4200-SCS semiconductor characterization system. The upgrade broadens the capabilities of the Model 4200-CVU (capacitance-voltage unit), offering software support for characterizing higher-power semiconductor devices at up to 200 VDC (or 400-V differential) and up to 300 mA. The company also announced an expansion of its Series 3700 system switch/multimeter and plug-in card family (see p. 55).

National Instruments invited **Credence Systems** to its booth to demonstrate the use of modular instruments in semiconductor test applications. The companies demonstrated a Credence ASL 100 system that integrates an NI PCI-5122 high-speed digitizer to acquire audio and video signals. The digitizer plugs into the ASL's PCI backplane; an external ASL-generated clock signal provides synchronization.

Advantest emphasized RF test, highlighting its 12-GHz quad-core monolithic RF module integrated into a T2000 LS mainframe; a M4841 handler and multisite load board completed the company's full RF test-cell approach. In addition, via a remote connection to its facility in Gunma, Japan, the company demonstrated quad-site test of a WiMAX device.

Magma Design Automation offered enhancements to its Knights Camelot CAD navigation system, including an option enabling failure-analysis engineers to perform design-rule checking in a fab. Also, Magma said it has worked with **Mentor Graphics** to link Camelot with Mentor's YieldAssist test-failure-diagnostic engine. In addition, Magma said that **Zyvex** will include Camelot as an option on its nProber nanoprobing system. Magma also announced it has added new bitmap defect-analysis capability to its Knights YieldManager software, and it announced new versions of Knights LogicMap and IntensityMap.



The Magnum II provides a 400-MHz clock and supports up to an 800-Mbps data rate in what its vendor calls a SuperMux mode. Its algorithmic pattern generator supports the test of terabyte-scale memories.
Courtesy of Teradyne.

Verigy engineers were on hand to describe the company's Inovys Silicon Debug technology (based on technology obtained with the acquisition of Inovys) to address the need for more efficient debug to accelerate time to volume production of new system-on-chip (SOC) devices. Verigy's new approach combines Inovys Fault-Insyte software with the Verigy V93000 SOC test system.

Synopsys highlighted its manufacturing products, describing a yield-management-activity matrix with predictive, corrective, and diagnostic functions spanning design, manufacture, and test.

Inspection products were also on display. For example, **Viscom** exhibited its MX100IR desktop automatic wafer-inspection system. **Surface Imaging Systems** introduced its NanoStation 300, which augments atomic force microscopy with optical inspection. **KLA-Tencor,** at the co-located InterSolar North America show, highlighted its surface-metrology capabilities applicable to solar-power applications. The *Machine-Vision & Inspection Test Report* in our October issue will highlight additional inspection products from Semicon West. T&MW

RICK NELSON
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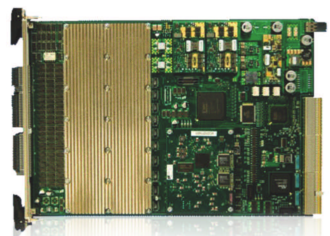
Diamond advances amid merger process

Credence and LTX executives remain mum on long-term plans to rationalize product lines in light of the two firms' plan to merge, but on the Credence side, development continues apace on instrumentation for the Diamond platform. The latest entry is the 72-channel HDVI (high-density voltage/current) instrument, which is targeted at reducing the cost of test by enabling large numbers of sites to be tested in parallel.

In a phone interview with Arun Kancharla, product marketing manager at Credence, and Thomas Vana, marketing director for the Diamond platform, Kancharla said that the new instrument—and in fact the entire Diamond platform—targets high-volume consumer-electronics devices such as microcontrollers, programmable logic devices (PLDs), FPGAs, gate arrays, DSPs, and embedded controllers used in audio, video, wireless-cellular, digital-camera, baseband, and power-management applications. That's in keeping with a Credence focus on low-cost test for small- to moderate-scale chips that was described by Lavi Lev, Credence's president and CEO, in January.



The 72-channel HDVI instrument targets high-volume consumer-electronics devices such as microcontrollers, PLDs, FPGAs, gate arrays, DSPs, and embedded controllers.
Courtesy of Credence Systems.

One might infer a bright future for the Diamond platform despite the inability of Credence and LTX to state a long-term product rationalization plan at this point in the merger process. Vana said the Diamond has "stickiness"—as 250 of the platforms are installed worldwide; double-digit growth in device volumes suggest additional opportunities for Diamond adoption. Vana added that customers deploy the low-cost systems to keep test costs down so they can remain profitable as average selling prices of consumer chips fall. With Diamonds having a base price of $60,000, Vana said, customers can deploy them in their labs for code development as well as on the factory floor.

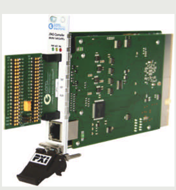
Vana said a customer can unpack a Diamond, plug it in, and be up and running in 10 minutes. Kancharla added that the new HDVI increases the flexibility of already-deployed Diamonds—replacing four 16-channel instruments with a 72-channel HDVI frees up three slots for other instruments. In total, the HDVI permits up to 432 V/I channels on the Diamond 10 and up to 1728 V/I channels on the Diamond 40—at a price, Vana said, of as low as $1500 per channel. As to how many V/I channels a customer might actually need, Vana said that one customer was evaluating a 1200-channel system for massively parallel test at wafer probe. Kancharla commented that another customer deployed a high-channel-count Diamond to implement a 100-site strip test, reducing test costs by 40%.

In addition, he said, a customer reduced capital costs by 30% by deploying the Diamond platform in an eight-site production test program for large GPS baseband processors; another cut capital costs by 40% in a 16-site Bluetooth device test program.

As for the future of expensive big-iron ATE, Vana said he has seen a customer bring up chips on a high-end tester but transfer the test job to Diamond platforms. As for the future of the LTX and Credence platforms, Vana would only say that while the merger goes forward, customers still need to reduce their cost of test. T&MW

Goepel debuts PXI boundary-scan controllers

Goepel electronic has introduced a series of PXI-based controllers for its ScanFlex boundary-scan hardware platform. The new SFX/PXI1149/C4-FXT controllers incorporate the normally external ScanFlex TAP transceivers into the single-slot, 3U-high unit. The transceivers link to external TAP interface cards (TIC), which can be located within a test fixture or environmental test chamber. The new controllers each offer four parallel TAPs and are available in three performance classes offering TCK frequencies of 20, 50, and 80 MHz. www.goepel.com.



Hana Micron buys Verigy Port Scale RF

Verigy has announced that Hana Micron, a Korea-based company specializing in the assembly and test of semiconductor packages and modules, has selected the Verigy Port Scale RF instrument for testing its IDM and fabless customers' consumer wireless devices. The Port Scale RF will complement the MB AV8 multiband audio-video cards in Verigy small-test-head systems to test devices targeting applications such as UWB, WiMAX, and mobile TV. www.hanamicron.co.kr; www.verigy.com.

Hynix chooses Teradyne for image-sensor test

Teradyne has announced the introduction of its IP750Ex, an extension of the company's J750 platform designed specifically to test image sensors featuring up to 32M pixels. Teradyne also announced that Hynix Semiconductor has chosen the new IP750Ex for the production test of its first CMOS image sensor. www.hynix.com; www.teradyne.com.

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USB-1604HS	Four 16-bit, 1.33 MS/s single-ended analog inputs	$1999
USB-1604HS-2AO	Four 16-bit, 1.33 MS/s single-ended analog inputs; two 16-bit, 1 MS/s analog outputs	$2199

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USB-1616HS-4	16 single-ended or 8 differential analog inputs; four 16-bit, 1 MS/s analog outputs; 24 digital I/O	**$1599**
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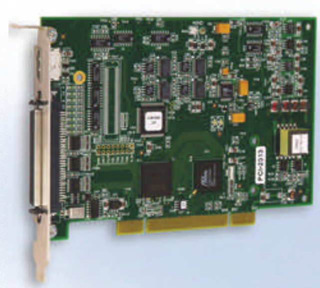

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PCI-2513	16 single-ended or 8 differential analog inputs	**$749**
PCI-2515	16 single-ended or 8 differential analog inputs; two 16-bit, 1 MS/s analog outputs	**$849**
PCI-2517	16 single-ended or 8 differential analog inputs; four 16-bit, 1 MS/s analog outputs	**$949**

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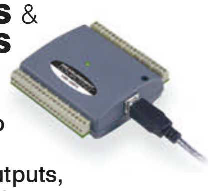

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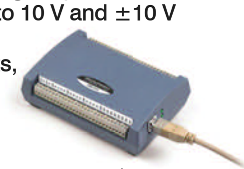

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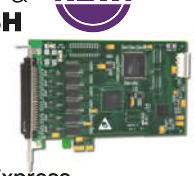

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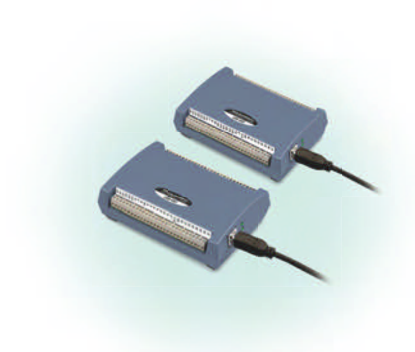

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USB-502	Temperature/ humidity	Intervals: 10 sec–12 hrs.	-35 to +80 °C (-31 to +176 °F)	16K	$82
USB-503	Voltage	Intervals: 10 sec–12 hrs.	0 to 30 VDC	32K	$72
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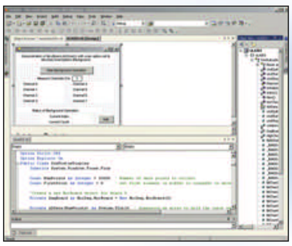

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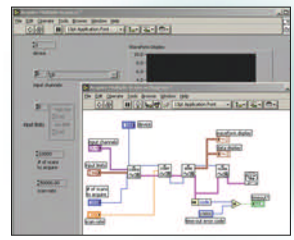

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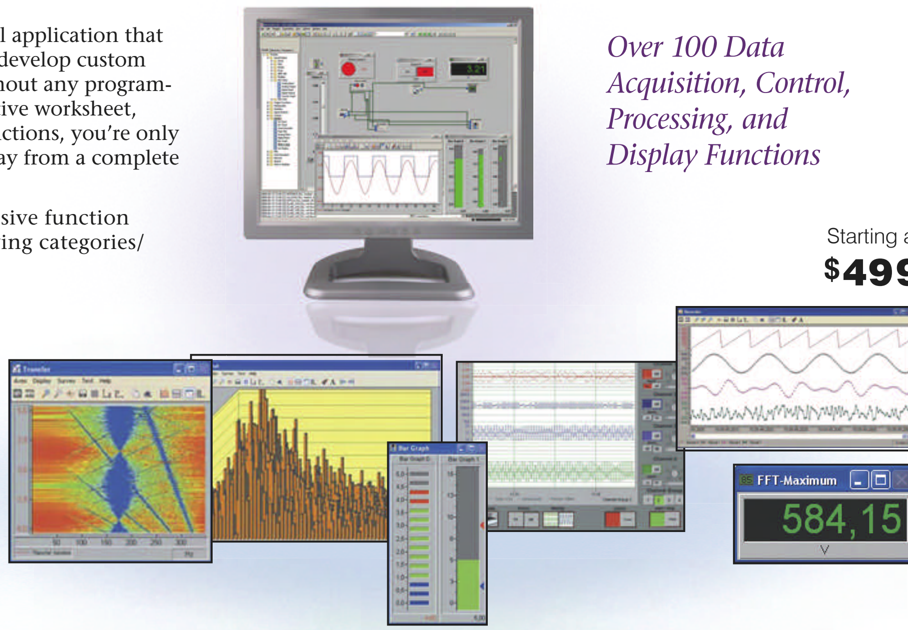

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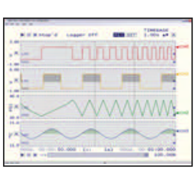

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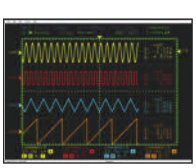

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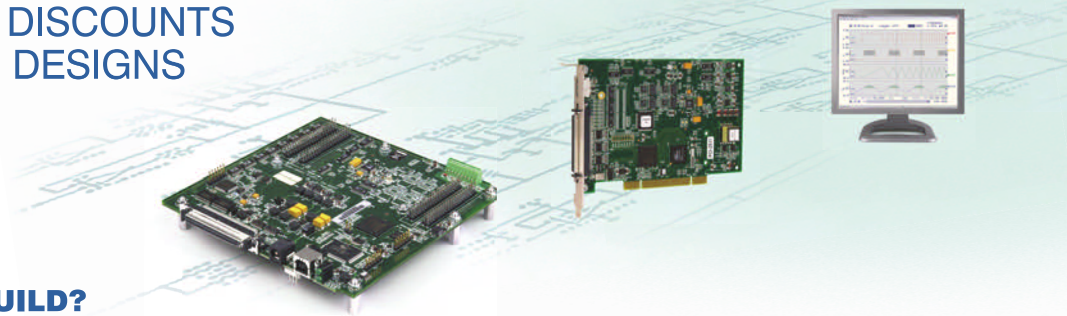

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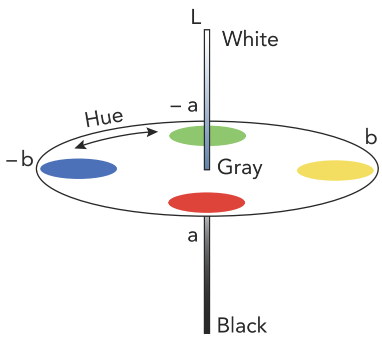
Making the right color match

Most machine-vision installations rely on black-and-white images, but increasingly color is becoming a necessity. One color application that is gaining ground is "color matching," according to Glenn Archer of EPIC Vision Solutions, a St. Louis integrator that designs machine-vision systems for blue-chip customers like Boeing, 3M, and Procter & Gamble.



Many industries use the CIELab color model to evaluate exact specifications for paint and dyes on manufactured products. The "L" axis represents how dark or light an image is. On the horizontal axes, "a" is green at one extreme and red at the other, while the "b" axis has blue at one end and yellow at the other.

"A good example of color matching," explained Archer, "is building components. Your vision systems help ensure that the color of a new replacement part will match the color in an assembly produced earlier."

What's involved in color matching? Archer, an electrical engineer and director of business development, described a system that EPIC designed to inspect 5-ft-long extruded plastic building components on the production line. The setup required lighting techniques that would allow highly consistent and repeatable color detection. Furthermore, the system had to deliver the required accuracy in an environment where temperatures can reach more than 100°F.

To meet these challenges, EPIC built a 3-ft-long enclosed inspection station designed to block out ambient light. Openings just 4-in. high on two sides of the ventilated station permit entry and exit of components as they move along the conveyor. Lighting inside the enclosure consists of two, 18-in.-long white LED strips placed on either side of the part at 45° angles for optimum imaging.

"We initially selected fluorescent light strips but found that we could not achieve the uniform intensity we wanted," explained Archer.

To capture the images, the engineers chose a 2-Mpixel color PixeLINK camera that connects via FireWire to an adjacent PC for image processing. The camera includes built-in temperature compensation, a key feature since small changes in ambient temperature can adversely affect image consistency. A software utility from the camera manufacturer called "flat field correction" also contributes to uniform lighting intensity by eliminating hot spots.

The software used to program the application, LabView, allowed for a large region of interest (ROI) to be directly converted from the camera's RGB values to CIELab values, which was the color space that the customer chose for evaluating images (see **figure**).

System software combines the 15 individual images needed to represent a complete part into a unified average for comparison to a reference color. It also lets operators match a part's color to that of a part produced previously. With the strategically chosen ROI size, operators can also set pass/fail criteria for each image, based on such anomalies as stains, spots, and streaks.

How much does a color-match vision system cost versus a black-and-white solution? Ballpark estimate: about 20% more, according to Archer. The added expense lies not so much in the hardware but in the extra engineering required to solve tougher application challenges. T&MW

Vision lights up the solar industry

A new white paper from Adept Technology discusses productivity gains from combining robotics and machine vision in solar-wafer inspection. For such applications, Adept typically uses its new four-axis Quattro, which can pick parts from conveyor belts at the rate of up to 180 per minute. The company's vision library can be embedded in Adept's SmartController CX, in a PC platform, or in smart cameras. www.adept.com.

Software tool targets high performance

Allied Vision Technologies has introduced a software development kit for 64-bit image applications, such as video-compression and technical calculations in object recognition or edge detection. The AVT FirePackage64 includes a 64-bit driver for AVT FireWire cameras and a C-program interface. It also allows faster data transfers on FireWire—up to 800 Mbps—and eases the migration of 32-bit applications to 64-bit. www.alliedvisiontec.com.

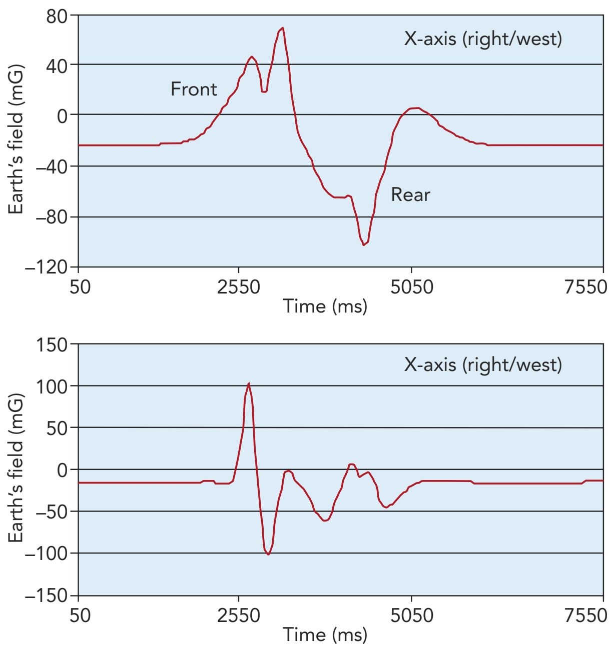
GigE camera touts speed

Prosilica, which was recently acquired by Allied Vision Technologies, has introduced the GE1050, a compact CCD camera with a Gigabit Ethernet interface capable of running at 60 fps at 1000x1000 resolution. Available in color and monochrome versions, the camera incorporates Kodak's new KAI-01050 megapixel, half-inch optical format. www.prosilica.com.

INSTRUMENTATION

Magnetic measurement tools attract attention

In one of the earliest magnetic measurements, primitive mariners used lodestones—magnetized pieces of magnetite—to determine the earth's magnetic field. Today, thousands of applications require the measurement of magnetic fields. For example, sensors in automobiles use the earth's magnetic field to help with navigation, and roadway sensors examine the magnetic signature of vehicles going by to determine the type of vehicle and its direction (**figure**). In another application, geologists and earth-science researchers can detect iron ore and other mineral anomalies by precisely mapping magnetic fields.



A magnetic sensor in the road can determine vehicle direction and type, distinguishing, for example, (top) a Silhouette van from (bottom) a Saturn sedan.
Courtesy of Honeywell.

One of the primary military applications for magnetic-field measurement is the detection of submarines. For example, the submarine-hunting Orion P3C military aircraft has a long tail boom to house the magnetometer far away from the engines and other sources of interference. Other military uses for magnetic measurements include instrumentation of small-caliber shells in the development of ranging fuzes.

Countless other applications exist in the industrial, scientific, and medical fields. Industrial customers may simply need to verify the north and south poles on magnets used in motors. Paul Elliot, owner of Magnetic Sciences, a vendor of magnetic-field sensors, reports that installers of oil pipelines need to measure the pipes to ensure that no latent magnetism resides in the steel. Many industrial users must measure the field of a magnet to ensure that it has not lost its strength. Another industrial use is to verify whether shipping containers are emitting a magnetic field that is greater than the legal limit.

Scientific uses of magnetic measurements include disk-drive-read-head research. The behavior of material in intense magnetic fields is an area of active study, and it is often necessary to measure the intense field that resistive, room-temperature, and superconducting magnets produce during research.

Whatever your application, you'll find that measuring magnetic fields requires specialized sensors and a knowledge of physics and electronics. You can use a variety of instruments, including gaussmeters, teslameters, fluxmeters, and magnetometers, to measure magnetism, and prices for these units range from pennies to hundreds of thousands of dollars. You can learn which sensor fits your application by reading the online version of this article in sibling publication *EDN* at www.edn.com/article/CA6578134.html.

Paul Rako, Technical Editor, EDN

BOOK REVIEW

Thermography and the detectors that make it work

The Ultimate Infrared Handbook for R&D Professionals,
FLIR Systems, www.flir.com. 40 pages. $29.95.

"Ultimate" is a risky tag to assign to one's literary efforts, and an infrared (IR) expert might not think a 40-page book could warrant that tag. But for those of us with a passing familiarity with IR technology, or for beginners just getting involved in IR inspection applications, this short book provides a wealth of valuable introductory information as well as specific information you can apply on the job.

Chapter 1 begins by defining the IR range (900–14,000 nm) and relates an IR camera's operation to that of a digital video camera, with a focal-plane array implemented in thermal (microbolometer) or quantum detector technology. It proceeds with a background on blackbody radiation, Planck's law, and Wien's displacement law, leading to a description of how to derive

Thermography and the detectors that make it work *(continued)*

temperature when given factors such as an object's emissivity, atmospheric attenuation, and ambient temperature.

Subsequent chapters cover topics such as filters, detector types, high-speed thermography, and how to make the most of your IR camera. Chapter 2, for example, provides details on quantum detectors, which respond to IR inputs by elevating electrons in the detector material to higher energy states. Of these types, the book notes, InSb and quantum well infrared photon (QWIP) types offer high sensitivity, detector uniformity, and relatively low cost.

Chapter 3 provides information on spot and area temperature measurements, emissivity correction, and camera specs. Filters, chapter 4 notes, can be useful for materials that are transparent or opaque to IR wavelengths. Chapter 5 describes high-speed applications, such as temperature measurement of a 0.30-caliber bullet in flight.

The book includes a table of FLIR products as well as about five pages of advertisements, including one from this magazine and a competitor.

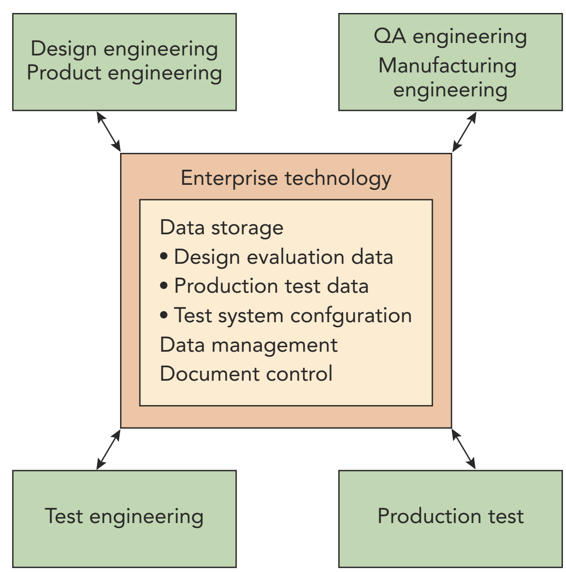
Rick Nelson, Editor in Chief

TEST DATA MANAGEMENT

Share data across departments

No engineer works alone. You're part of a group, and members of a group work together to develop new products and characterize designs.

And groups don't work in isolation, either—each group works with other groups across an organization. Test engineering must work with design engineering, production test, quality assurance, and other departments. Thus, people and departments need to share data.



Enterprise technology helps engineers in all departments share data.

"Enterprise software improves test-engineering collaboration," a paper written by Gricha Raether of VI Technology, explains how you can use enterprise technology to share data among the departments in your organization. Raether explains that sharing data involves more than simply saving test results in an Excel sheet. Often, you must make data available in a database so others can query the data depending on their needs. Companies often store data in an industry-standard format, but they may use industry-specific software to query the data and produce reports.

Of course, you'll need to share more than just the results of your tests. Raether's paper also discusses how you can use enterprise software and LANs to create test plans and then make the plans available to people in design, test, and production.

To learn more about enterprise software, download the complete paper from the online version of this article, www.tmworld.com/2008_09.

Martin Rowe, Senior Technical Editor

Here's The Idea Behind Our Subampability™ Concepts!

Subampability™: (sub-amp-ability). noun: The ability to use an amplifier individually, or as a building block, upon which power can be added incrementally.

Grow as you go. One small step at a time. Building on what's already there.

AR has applied this age-old idea to amplifiers used for EMC testing. When you need a more powerful amplifier, now you can add the power, instead of tossing out the old amp and starting all over again.

Add Power To Existing Amps.

With test specs constantly changing, it's an idea whose time has come. Many amplifiers within our "S" and "W" Series are designed so that the power can be expanded with a relatively simple upgrade. Of course, the amplifiers can still be used individually when needed.

The latest examples are Models 10S4G11A (10 watts, 4-10.6 GHz) and 15S4G8A (15 watts, 4-8 GHz). A fairly simple upgrade performed by AR expands the 10S4G11A to a 20S4G11A (20 watts, 4-10.6 GHz) … and the 15S4G8A to a 35S4G8A (35 watts, 4-8 GHz).

Once this initial upgrade is performed, the sky's the limit. The 20S4G11A and the 35S4G8A are like building blocks that can easily be expanded by adding sub amps and controller/combiner units.

At AR, we're always thinking ahead. And we know you are, too. That's why you'll appreciate our Subampability concept … and the fact that all AR products are backed by the strongest, most comprehensive warranty in the industry, and a global support system that's second to none.

To learn more, visit www.ar-worldwide.com or call us at 215-723-8181.

See Application Note #40 Expandable Power for further details.

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DPGA conditions signals with negative time constant

With two op amps and three analog switches, you can build a programmable amplifier that conditions signals prior to digitizing.

By W. Stephen Woodward, Consultant, Chapel Hill, NC

Digitally programmable gain amplifiers (DPGAs) amplify or attenuate analog signals, which maximizes an analog-to-digital converter's (ADC's) dynamic range. Most monolithic DPGAs such as the Maxim LTC6910 and the National Semiconductor LPM8100 use a multiplying digital-to-analog converter (DAC) in an op amp's feedback loop so that the DAC's input code sets the amplifier's closed-loop gain. Instead of using a monolithic DPGA, you can use two op amps and three analog switches to build a DPGA that is based on negative time constants.

You're no doubt familiar with the $e^{-t/RC}$ convergent exponential in which a capacitor in an RC circuit asymptotically

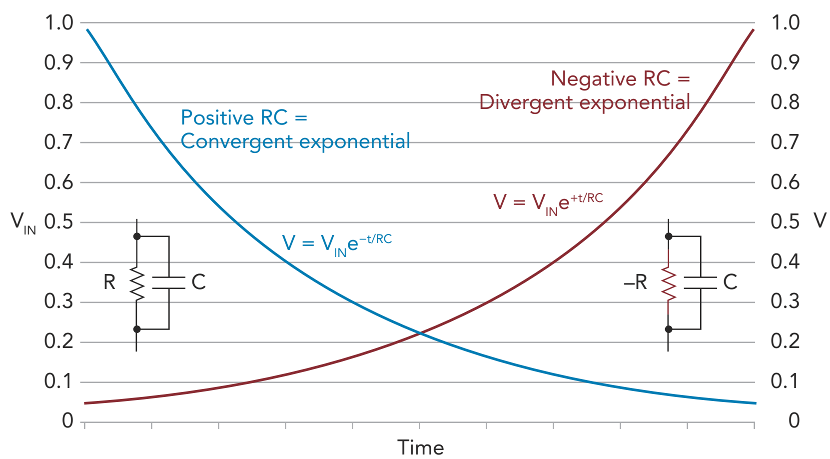

Figure 1 A negative time constant causes V to increase exponentially over time.

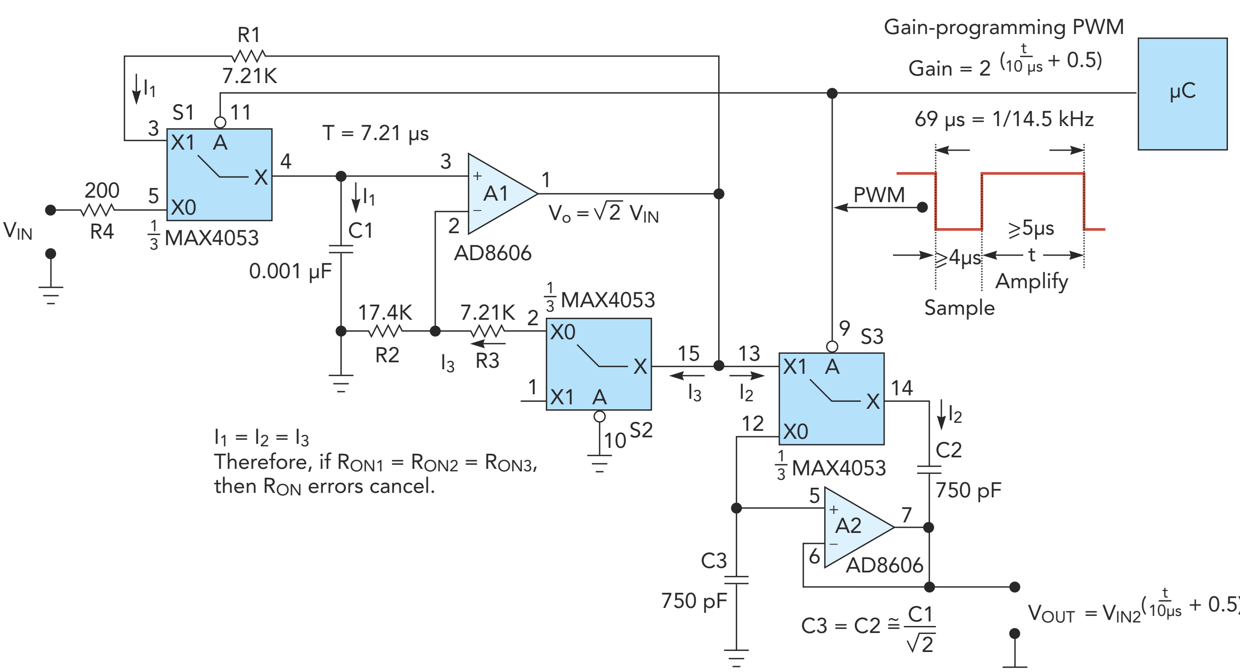

Figure 2 Positive feedback from amplifier A1 causes C1 to increase in voltage, which amplifies V_{IN} exponentially.

discharges to zero. For input V_{IN}, $V = V_{IN}/2$ at $t = T = \log_e(2)RC$, $V = V_{IN}/4$ at $t = 2T$, $V = V_{IN}/8$ at $t = 3T$, and so forth.

Less familiar, but just as simple, is the behavior of the same RC topology when R is replaced with an active circuit that synthesizes a negative resistance (**Figure 1**). If you replace resistor R with –R, you create a positive RC time constant. Thus, you create a *divergent* exponential, $V_{IN}e^{+t/RC}$.

Instead of converging to zero, the waveform theoretically diverges to infinity, and $V = 2V_{IN}$ when $t = T$, $V = 4V_{IN}$ at $t = 2T$, $V = 8V_{IN}$ at $t = 3T$, etc. Therefore, you can amplify V_{IN} by simply waiting the right amount of time ($t = \log_2(V/V_{IN})T$) after starting the "negative discharge." The divergent exponential and the negative time constant are the core concepts of the circuit in **Figure 2**.

You can program the amplifier's gain with a pulse-width modulation (PWM) signal produced from a microcontroller or other circuit. When the PWM signal goes to logic 0, sample-and-hold capacitor C1 charges to V_{IN}. When the PWM signal cycles to logic 1, op amp A1 drives the R1C1 positive-feedback loop, creating a negative time constant.

The resulting divergent exponential rise of C1's charge continues as long as the PWM signal remains at logic 1. That creates a net voltage gain of $V_{OUT}(t) = V_{IN}2^{(t/10\mu s\ +\ .5)}$. Thus, gain $= 2^{(t/10\mu s\ +\ .5)}$, and log(gain) = 3 + 0.6 dB/µs. At the end of the amplification cycle, when PWM returns to logic 0, amplifier A2 captures and holds the amplified V_{IN}.

The logarithmic relationship between gain and timing provides excellent gain resolution even when a PWM signal has just 8 bits of resolution and its programmable gain has a wide range—better than 0.2 dB/LSB_step. (The online version of this article includes log and linear plots of gain versus time using the amplify phase, www.tmworld.com/2008_09.)

The accuracy and repeatability of the timing of the exponential signal, the ADC sampling, the jitter, and the RC time constant stability all limit the amplifier's gain-programming accuracy. In Figure 2, 1 ns of timing error or jitter produces 0.007% of gain-programming error. Fortunately, the near ubiquity of programmable timer/counter hardware in microcontrollers and data-acquisition systems usually makes it easy to digitally generate a repeatable PWM control signal. T&MW

Do you have a test or design idea you'd like to share?

Publish it here, and receive $150.

Send your ideas to:
tmwtestideas@reedbusiness.com.

BitWave Semiconductor has developed a software-defined radio IC that supports multiple RF wireless standards and requires test methods that are as flexible as the device itself.

An RFIC for the WORLD

BY MARTIN ROWE, SENIOR TECHNICAL EDITOR

LOWELL, MA—When you use your cellphone indoors, do you lose the signal? When you need to travel overseas, do you need another phone because yours isn't compatible with the network? Have you had to replace your phone because your carrier upgraded to a new network? If you answered "yes" to any of these questions, then you will appreciate the work being done at BitWave Semiconductor.

Engineers at this fabless semiconductor company have developed a software-defined radio (SDR) IC that can morph itself to work with at least 16 wireless network interfaces, including GSM, WCDMA, WiFi, WiMAX, and UMTS long term evolution (LTE). Because BitWave's IC is so flexible, the engineers must verify that it will work on any network anywhere in the world.

The first prototypes of the device, called the "Softransceiver RFIC," were available in early 2007, and the IC is now nearing commercial release, with engineers testing and characterizing the devices in production volumes. "Inside the Softransceiver," p. 39, explains how the device works at frequencies from 700 MHz to 3.8 GHz.

System engineer Mark D'Amato evaluates preproduction devices in simulated networks. System engineer Rick Quintal characterizes the ICs for physical-layer compliance. And test engineer Sreekar Javvadi pulls the testing together by automating tests that would otherwise take years to perform.

Quintal, Javvadi, and D'Amato work in a lab equipped with several benches that contain identical equipment: spectrum analyzers, logic ana-

Systems engineer Mark D'Amato evaluates preproduction RFICs in simulated networks, often redefining the functions of a device.

lyzers, vector signal generators, and digital serial interface modules (DSIMs) from Agilent Technologies. The engineers also use vector signal analyzer software and Baseband Studio baseband capture and playback software from Agilent and an in-house test tool called the "Softuner." All benches are automated with LabView from National Instruments. **Figure 1** shows how the equipment and software connect. Because all test benches contain the same equipment, engineers can run any test on any bench.

"We needed our test stands to be as programmable as our devices, to cover all frequencies and protocols" said D'Amato. "We couldn't build dedicated test benches for each wireless technology or we'd have dozens of them."

Before D'Amato can test a Softransceiver, Quintal must characterize the device's programmable radio components, which include RF amplifiers, voltage-controlled oscillators (VCOs), mixers, filters, local oscillators (LOs), baseband amplifiers, and analog-to-digital converters (ADCs). He tests these components for parameters such as bandwidth, carrier suppression, sideband suppression, noise, and signal-to-noise ratio (SNR).

First silicon

When Quintal gets the first parts from the foundry, he may perform some tests manually using the Softuner. He uses an evaluation board (**Figure 2**) that provides him with access to RF and digital signals and to the device's programming registers. The board lets him configure the device's registers from a PC through a USB port. An interface IC on the board converts the USB signals to Serial Peripheral Interface (SPI) format for communication with the Softransceiver RFIC.

The Softuner provides Quintal with many pages that he uses to configure the RFIC's programmable components. He also configures the RFIC using an application programming interface (API) when he needs to write directly to the device's registers. Baseband Studio lets Quintal create and capture signals such as digital I/Q modulation signals and send them to the device in digital format through the DSIM.

Beginning with a receiver test, Quintal configures the RFIC for the most demanding channel bandwidths and frequencies. The goal: Determine the performance envelope of the device

MARK WILSON

and compare it to the requirements for all wireless standards.

"You have to know that the chip works before you can characterize it," said Quintal. He will spend up to two months characterizing initial parts before they're ready for automated tests. He starts by configuring the RFIC's receiver to get basic measurements.

Using a vector signal generator, Quintal injects a modulated carrier into the Softransceiver's RF input, keeping the device's internal amplifier gains low. "We start with a sine/cosine I/Q signal and look for carrier suppression, sideband suppression, and output power," he said. He also sweeps the intermediate frequency (IF) carrier of the device from DC to 40 MHz to check how the baseband section responds, and he sweeps the RF input from 700 MHz to 5 GHz while looking at the receiver's response to find the optimal frequency. To perform these tests, Quintal connects the device's 12-bit digital I/Q output to a logic analyzer.

The device's transmitter section has an LO and a mixer. To test the transmitter, Quintal enters digital data from the DSIM and measures the gain and bandwidth from the transmitter's analog output with a spectrum analyzer. He modulates the carrier with a sine-cosine tone from DC to 40 MHz and measures the baseband section's response.

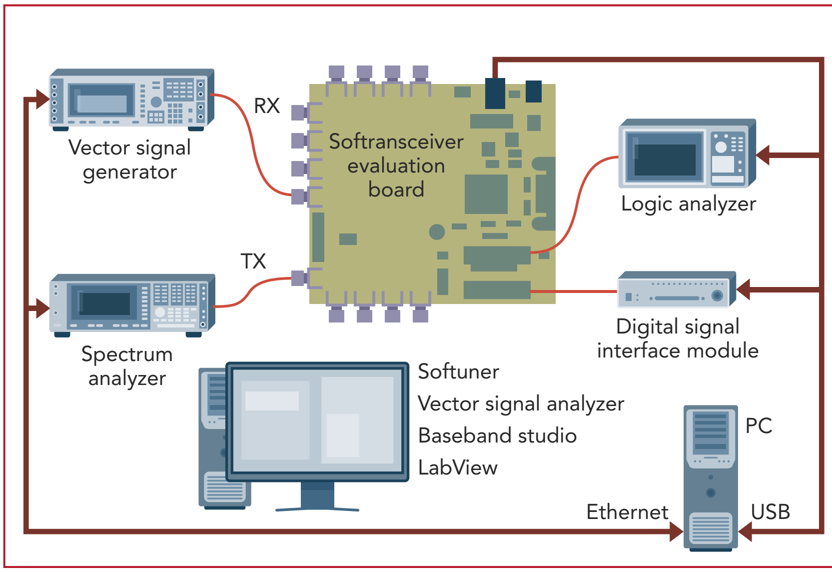

FIGURE 1. RF and digital test equipment populate several test benches in BitWave's engineering lab.

Once Quintal finds the frequency with the best response, he may need to tune the device based on customer requirements. For example, if the customer will use the RFIC for 2.1-GHz WCDMA, then Quintal will use the Softuner to optimize the device for that frequency. Using the Softuner's tuning page, Quintal adjusts parameters such as filter bandwidth, which must change depending on the device's configuration. The tuning page contains a virtual "knob" for bandwidth. Turning that knob actually causes the software to write to four or five registers that configure the device's internal filters.

To characterize the receiver, Quintal must measure conversion gain, frequency response, and SNR. He injects a two-tone signal into the receiver from which he calculates third-order intercept, gain, and linearity. He will also use the vector signal analyzer software to measure S-parameters in order to characterize the device in the frequency domain.

Quintal also looks at VCO bias current, which can range from a few microamps to 20 mA. He then optimizes the device for minimum bias current. He also looks at performance versus power consumption.

Because the Softransceiver contains programmable function blocks, Quintal can change the device's architecture, including the internal ADC. There isn't one ADC architecture that works best for all wireless technologies. For example, the Softransceiver will configure itself for a 4-bit delta-sigma ADC when it needs to operate as a WCDMA interface, but it might use a 10-bit pipeline con-

MARK WILSON

Systems engineer Rick Quintal evaluates components such as RF amplifiers, mixers, and oscillators for compliance with physical-layer standards.

verter for other standards. Both architectures are already designed into the silicon and can be configured from the same shared building blocks; the Softransceiver configures whichever converter is better for a given application.

In addition to performing tests that verify the basic functionality of the IC, Quintal also needs to test it under a range of conditions. For example, he must test the device over a standard industrial temperature range (–30°C to 85°C), with several power-supply voltage, and in the presence of radiated interference.

The device uses four DC voltages (1.2 V, 1.5 V, 1.8 V, and 3.3 V) that the evaluation board regulates down from 5 V. Quintal tests the device by changing each voltage by ±10% from nominal.

Quintal looks at how electromagnetic interference (EMI) and noise affect the VCO's phase noise. An increase in phase noise will decrease the eye opening of a received data stream, making it harder for the receiver to accurately detect bits. Quintal noted that an open board is just about the worst test condition possible with regard to EMI. Using a shield, Quintal gets a baseline phase-noise measurement. Then, he adds noise to a transmitter's analog input, looking for phase-noise changes from the VCO output. He also tests the RFIC with noisy DC power, looking for phase-noise differences.

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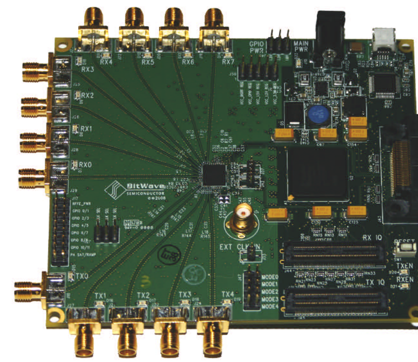


FIGURE 2. An evaluation board provides access to the RF and digital sections of the BitWave RFIC. It also supplies power and control signals that configure the device. Courtesy of BitWave Semiconductor.

Inside the Softransceiver

RFICs used in today's cellphones are designed for a specific cellular protocol. That limits a phone's usefulness. "Cellphone users want their phone to work everywhere," noted BitWave cofounder and chief marketing officer Russell Cyr. In order to operate in multiple networks, a phone needs additional RFICs, which adds to the phone's bill of materials. It also means that only one RFIC is in use at any time.

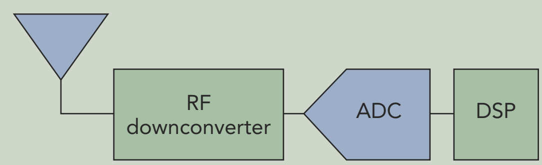


FIGURE A. A traditional SDR moves the ADC as close to the antenna as possible.

With the Softransceiver RFIC, the engineers at BitWave have designed a device that can adapt itself to whichever wireless technology it encounters, including GSM, EDGE, WCDMA, HSDPA, EVDO, and LTE. To provide seamless coverage between standards such as GSM and WCDMA, the Softransceiver must perform a compressed mode handoff in 125 µs. Additionally, the Softransceiver must be able to switch modes fast enough that end users don't perceive a delay.

The Softransceiver will typically switch frequencies and protocols in about 250 µs, but the time depends primarily upon the synthesizer settling time. In addition to changing wireless protocols, the Softransceiver must also work at frequencies from 700 MHz to 3.8 GHz. To make the transformation, the Softransceiver contains programmable RF function blocks such as RF amplifiers, VCOs, mixers, filters, LOs, baseband amplifiers, and ADCs.

The BitWave device isn't a typical SDR. Most SDRs use a high-speed ADC to digitize the incoming signal as close to the antenna as possible. Depending on the carrier frequency, an ADC may be able to digitize an RF signal or it may digitize a signal mixed down to an IF. Then, a DSP demodulates the digitized signal (**Figure A**).

BitWave takes a different approach. The company's RFIC replaces a traditional transceiver and includes all the RF blocks from a low-noise amplifier to a digital I/Q interface and includes blocks such as mixers and filters. These subsystems produce a digital I/Q signal that is passed to a baseband modem and demodulated. The baseband modem can then use the information to connect with speakers, microphones, and keyboards (**Figure B**). The device also connects to an RF front end that contains filters and amplifiers.

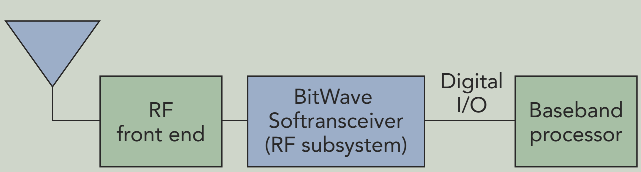
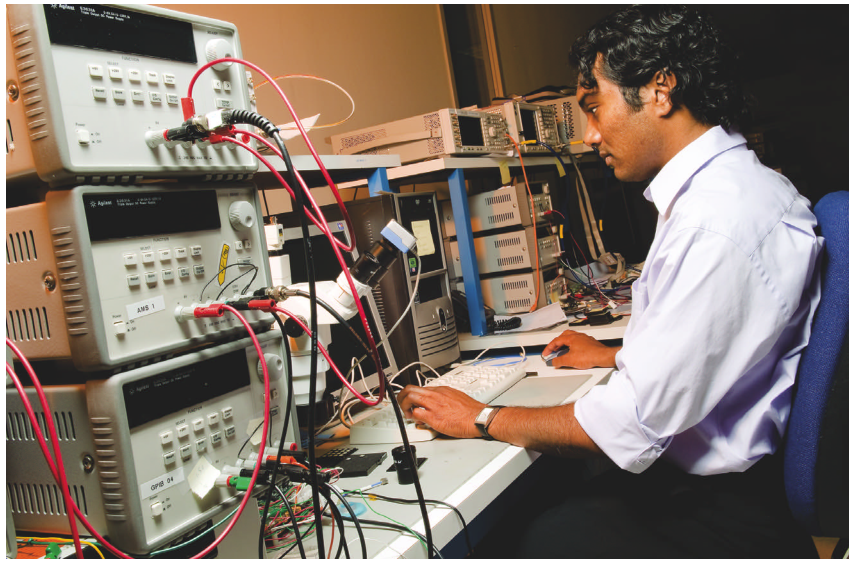


FIGURE B. The Softransceiver consists of a programmable RF transceiver that includes functional blocks from the front end through a digital I/Q interface to the baseband processor.

To reconfigure itself, the BitWave device contains a database of configuration data. An 8051 microcontroller core, embedded in the chip, manages the device's configuration and calibration whenever the phone changes wireless interfaces. Built on a 130-µm CMOS process, the BitWave device takes up no more space, nor does it use any more power, than a dedicated RFIC.—*Martin Rowe*



MARK WILSON

Test engineer Sreekar Javvadi automates tests based on test parameters stored in spreadsheets.

Automation saves time

Quintal currently performs many tests manually using the Softuner tool but his colleague Sreekar Javvadi is working to automate the tests. Using LabView, Javvadi is developing a long list of tests that will automate Quintal's work, reducing test time and providing more repeatable measurements.

BitWave hired test-services company Anagon to develop the overall architecture for automated testing. Javvadi supplements the architecture by developing and running specific tests.

Taking data from Quintal's tests, Javvadi has developed Excel spreadsheets of test parameters that include the data needed for standards-compliance tests. To configure the device, the LabView code reads configuration data from an Excel sheet for a wireless standard such as GSM or WCDMA.

Each compliance test uses a set of LabView virtual instruments (VIs) that make API calls to the RFIC that configures its internal function blocks. The VI then makes API calls directly to the device's registers. For example, an API call to the device will configure its RF section, such as an LO or a filter. **Table 1** provides examples of file names used for some transmitter and clock tests. **Figure 3** shows an example of LabView code used for measuring the transfer function of an RF filter used on the RFIC's receiver block.

"At this stage, we pass real data to the device, modulated on an RF signal," said Javvadi. "The modulation schemes depend on the compliance standard."

Javvadi doesn't just develop automation software, he runs tests, too. He'll run automated tests to verify that his code is properly written by comparing his results to those measured by Quintal. Once satisfied with the software quality, Javvadi will test as many as 200 devices from which he can develop enough statistics to conclude that the design will pass compliance tests.

Because a test involves thousands of measurements on at least 16 wireless standards, an evaluation can generate more data than Excel can hold. To process the data, Javvadi will import the test results into Matlab for analysis. "We can call Matlab from LabView and analyze data on the fly," he said.

Into the system

While characterization and compliance tests are crucial, testing isn't complete until systems engineer Mark D'Amato runs system-level tests. D'Amato combines the data from Quintal's characterization tests and Javvadi's test automation into tests that determine how well the Softransceiver will respond when integrated into a cellphone. Instead of treating the device's receiver and transmitter separately, D'Amato treats the entire RFIC as if it were a "black box," and he studies how it interacts with surrounding circuits.

As part of a system test, D'Amato often has to define a new function block depending on the system surrounding the IC. "I need to verify that the receiver/transmitter pair passes certain linearity tests. I apply what Rick and Sreekar have learned about a device. We have many adjustments to make in the device because it must interoperate with over 16 different wireless standards."

D'Amato's job is to fine-tune the RFIC until it works. He looks at its performance data and then investigates how to tune the RFIC's functional blocks such as VCOs, filters, and mixers. The device has five RF stages and each needs tuning. By programming the device's registers, D'Amato can adjust component values that change the device's characteristics. He looks at the device amplifiers to determine their gain, bandwidth, and other parameters before reprogramming the device.

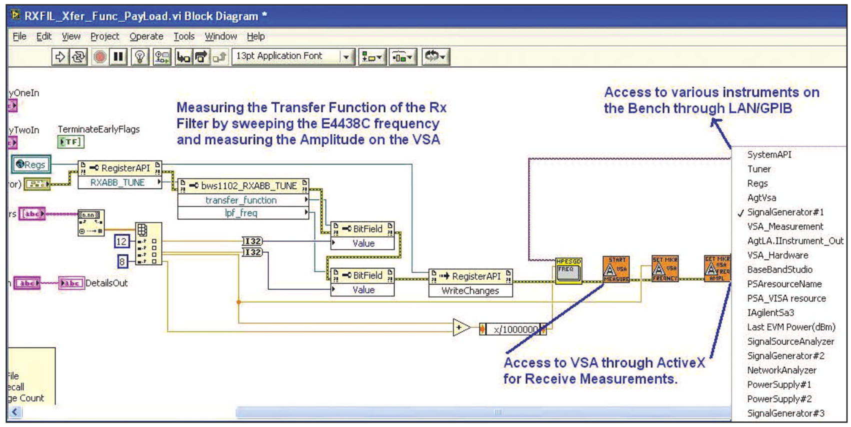


FIGURE 3. LabView code writes data to the DUT's registers to measure a filter's transfer function. Courtesy of BitWave Semiconductor.

D'Amato uses the Softuner's tuning pages to make adjustments. The tool provides access to the components that make up programmable amplifiers where D'Amato adjusts gain and frequency response. "When you change a setting on the tuning page," said D'Amato, "it pushes that change down to the appropriate register. When you make a change to a register through an API call using LabView, the change pushes back up to the tuning tool."

(continued)

Table 1. Function calls and the tests they perform.

Test #	File name	Block	Test	Type	Measure port
1	TXLO_OPEN_LOOP	TXVCO	Band select and KVCO	AUTO	RF VGA
2	TXLO_OPEN_LOOP	TXVCO	Phase noise	AUTO	RF VGA
3	TXLO_OPEN_LOOP	TXVCO	VCO pushing	AUTO	RF VGA
4	BBCLK_PHASE_NOISE	BBCLK	Frequency stability	AUTO	SYSCLK
5	TXSYNTH_CLOSED_ LOOP	TX SYNTH	Lock test and phase noise	AUTO	RF VGA

To perform the tests, D'Amato uses the vector signal generator to generate the cellular-modulation signals. Because the RFIC can also reconfigure itself to connect to WiFi networks to keep calls intact, D'Amato tests the devices using cells from RadioFrame Networks.

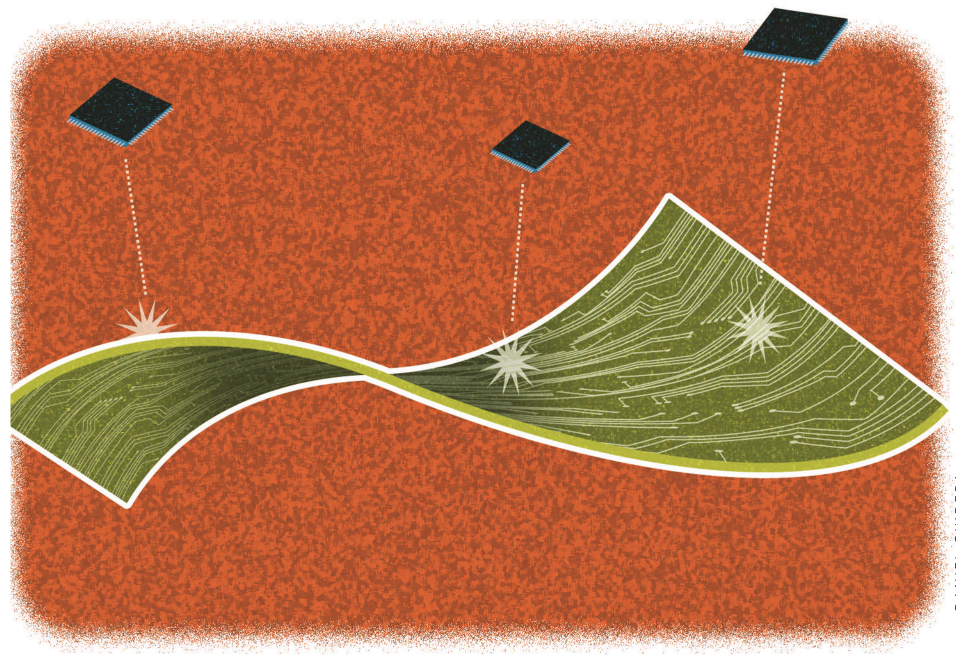
"We send jamming signals to the device to verify how well it works in the presence of interference. We must maintain communications in the presence of noise. Thus, we measure signal-to-noise ratio on receivers to see how much noise they can tolerate and still receive properly." SNR is just one of many tests required by wireless standards. The data for these tests resides in the spreadsheets that Quintal generates.

Given that the BitWave Softransceiver RFIC is the first reconfigurable SDR, D'Amato has run into limitations on the test equipment he uses. "Our I/Q modulation signal is digital as where most other RFICs use analog signals," he said. D'Amato uses the DSIM to generate the 16-bit digital I/Q modulation signal. From that signal, the device's embedded digital signal processor (DSP) generates a 12-bit I/Q signal that becomes the output of the RFIC's receiver port. Using a logic analyzer, he captures the resulting 12-bit I/Q signal at 15.6 Msamples/s.

The logic analyzer lets D'Amato analyze the digital modulation for signal integrity with a vector signal analyzer. Looking at the RFIC from a system level, he uses the data to make adjustments to the device's internal blocks and thus he can verify that the RFIC will work under all of the wireless standards it supports.

Because the Softransceiver supports so many wireless standards, BitWave engineers have perhaps the most expensive RF test equipment available. That's because the company had to purchase a personality profile for each standard. Most RFICs support just one standard and thus need just one profile. T&MW

The consortium has initiated projects for assessing functional test and board flexure and for encouraging the use of boundary scan.



DANIEL GUIDERA

iNEMI addresses BOARD QUALITY

BY STEVE SCHEIBER, CONTRIBUTING TECHNICAL EDITOR

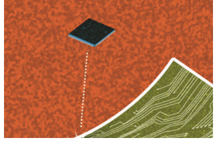
The International Electronics Manufacturing Initiative (iNEMI) consortium of companies has initiated three projects intended to help manufacturers improve the quality of printed-circuit boards (PCBs). One project aims to establish a standard methodology for assessing functional-test fault coverage, the second will encourage wider adoption of boundary scan by components manufacturers, and the third aims to establish a method for testing the mechanical performance of printed-circuit assemblies.

iNEMI's stated mission is to identify and close technology gaps by encouraging the accelerated deployment of new technology, the development of industry infrastructure, the dissemination of efficient business practices, and the stimulation of standards. The consortium executes projects through Technology Integration Groups (TIGs) organized around specific areas identified in an iNEMI roadmap that assesses the industry's most critical needs. **Figure 1** presents the roadmap's basic project model. Board-level projects are being pursued through the Board and Systems Manufacturing Test TIG chaired by Rosa Reinosa from Hewlett-Packard and J.J. Grealish of Intel.

Assessing functional-test fault coverage

The first project begun under iNEMI's board-test TIG seeks to create a quantitative model to estimate and predict functional-test fault coverage. Tony Taylor, test-development engineer at Intel, originally proposed the idea to a forum of board manufacturers and equipment suppliers in Taiwan in 2006. Forum participants wanted feedback from the wider industry in order to establish consistent guidelines, and they suggested that Taylor work with iNEMI. Chaired by Taylor, the project involves a number of otherwise highly competitive companies that have maintained an atmosphere of cooperation, recognizing that the result of their work will benefit everyone.

"We understood from the beginning that functional test was fundamentally different from structural techniques like in-circuit test [ICT] and auto-



mated-optical inspection [AOI]," commented Taylor. "Those approaches permit a fairly consistent fault-coverage methodology because they rely on relatively predictable criteria and utilize vendor-supplied equipment."

He added, "Functional test has to run at speed and in the product's native environment. Monitoring a board's performance using conventional rack-and-stack instruments or cards with different features from different vendors inevitably produces a wide variety of results. Also, in a functional test you can narrow a problem down to the circuit elements that perform a particular function, but not necessarily to the condition or behavior of a single component. There is no way to fully automate fault-coverage analysis."

The group realized early on that although the various board-test techniques overlap to some extent, functional test can provide information about circuit performance that structural test cannot. The goal was to reinterpret functional tests in terms of their structural equivalents where possible, add functional-test's unique coverage capabilities, and create a framework that companies throughout the industry could use as a reference. iNEMI would then release the results.

"We wanted to involve companies representing all perspectives in board test," Taylor continued. "Participants brought with them unique points of view and a vast array of experience. The project will begin by laying the methodological groundwork. Then, the companies will implement the approach and provide feedback on its validity."

One concern in creating a methodology is determining the assessment criteria. An initial paper analysis—in which engineers analyze board schematics and test code—will provide a first-pass specification on how to determine whether a test program covers a board's critical features. The paper analysis alone will generally suffice for inexpensive or low-margin boards featuring primarily stable technology. Observing the test by hooking a board up to actual instruments can increase confidence in the paper analysis, but it adds to the cost and time required. Test budgets may not permit these extra steps on inexpensive boards, boards with high component counts (which dramatically increase assessment time), and high-complexity circuits that can render fault-coverage determination both time-consuming and ambiguous.

If the product warrants a high-confidence fault-coverage assessment, an additional step will inject faults to determine whether running the test on a board with a known defect will identify the defect. The paper analysis might predict that a test will cover certain faults, but observation may show that the predicted coverage is not valid when the test actually runs.

Consider AC-coupled differential pairs using coupling capacitors. In some circuits, removing a coupling capacitor will not cause the test to fail. The differential line with an open can capacitively couple across other traces or connector/component pins and still arrive at the differential receiver, albeit with marginal signal integrity. The paper analysis predicted a failure, but the actual test passes in spite of the fault. In actual use, such a board may exhibit intermittent failures.

In another case, tracing through a section of test code might indicate a certain level of coverage, but because of a coding

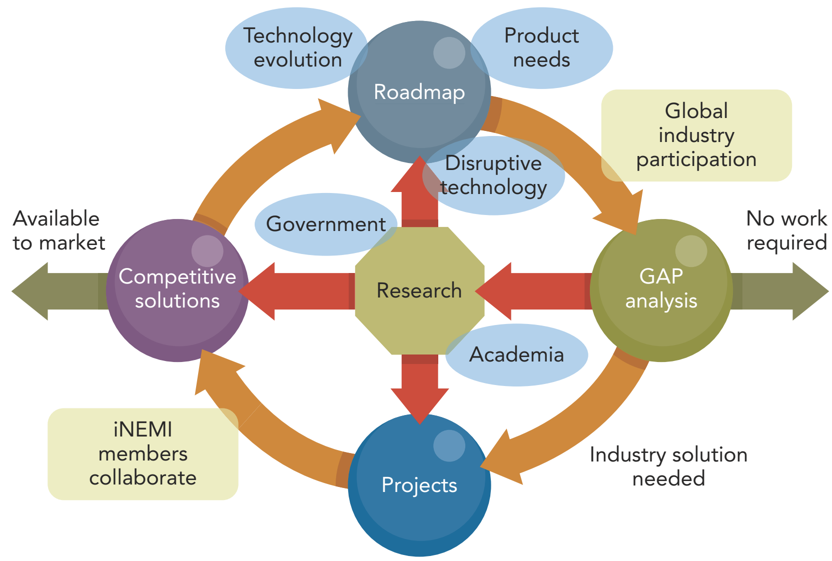


FIGURE 1. The basic flow chart for projects initiated through iNEMI TIGs shows that the organization consults with manufacturers as well as with academics and government bodies. Source: iNEMI 2007 Test, Inspection, and Measurement Roadmap. Courtesy of iNEMI.

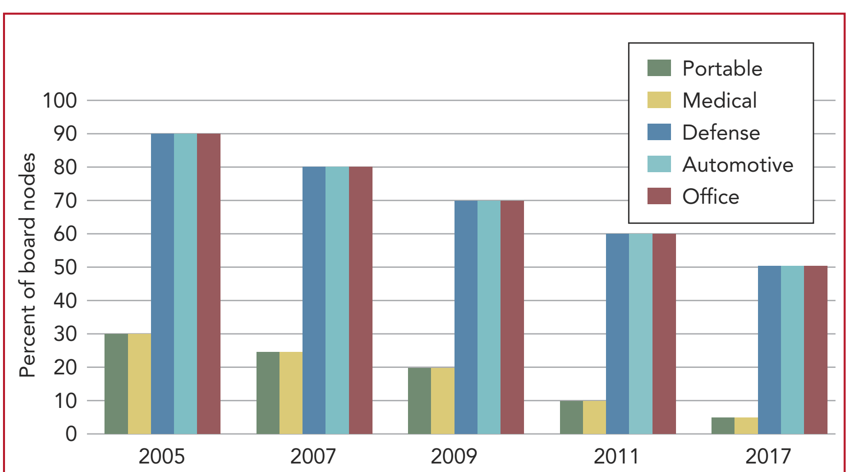


FIGURE 2. The erosion of electrical access to board nodes for testing is making it more urgent for manufacturers to adopt boundary scan.
Source: iNEMI 2007 Test, Inspection, and Measurement Roadmap. Courtesy of iNEMI.

error, that section of the code never actually executes. Again, the paper analysis predicted coverage that did not exist.

The TIG is proposing a methodology that consists of

- reinterpreting functional test in existing structural-coverage terms,
- introducing new coverage elements unique to functional test, and
- reporting functional test coverage in a meaningful and reproducible manner.

The group will apply the methodology to three disparate products—an implantable medical product, an optical networking board, and a PC server board—that offer a range of technologies, complexities, and consequences of failure.

"We'll exercise our initial methodology on the products," continued Taylor, "then apply what we learn to fine-tune it, iterating to a usable framework. We will release enough information about our proposed solution and sample results to allow nonparticipating companies to take advantage of our efforts without revealing any proprietary information."

He cautioned, "Our intention is not to simplify the process, but to create consistency in the industry. Initially, we'll run statistical reports to establish a baseline. That information will allow us to evaluate the advantages and disadvantages and what the numbers really mean."

If all goes according to plan, the group's conclusions should be available by the end of the year.

Spreading the gospel of boundary scan

Boundary scan evolved almost two decades ago to cope with ever-declining access to logic nodes on crowded and complex PCBs (**Figure 2**). Designers have resisted using the technique because of its design-time overhead and consumption of precious real estate, along with a perception that adopting boundary scan would have a deleterious (if intangible) effect on board "performance."

Evolving board technology has increased the pressure from test engineers to include boundary scan in board designs. So, the board-test TIG launched a project to determine the level of acceptance among component manufacturers and to develop strategies to improve that acceptance and encourage the standardization of component-level implementation. Steve Butkovich of Cisco was chosen to head the project because the nature of Cisco's products and processes long ago elevated boundary scan to a top priority issue at the company. Other participants include representatives from a variety of companies, including OEMs and contract manufacturers.

"When asked why they haven't embraced the technique more enthusiastically," Butkovich commented, "component vendors contended that there is no market—not enough demand from individual customers. One purpose of our project is to bring the request to vendors in an industry forum instead of just from a few individual companies. That way we give it more weight."

Advances in device technology have dramatically reduced the validity of the designers' early arguments, according to Butkovich. "To start with, some of the component vendors who implemented boundary scan didn't do it very well," he said. "The extra circuitry might add 4000 or 5000 gates to a device, but as gates have shrunk, the amount of real estate it [boundary scan] consumes has become insignificant. Automated tools have reduced designers' time to at most a couple of days. The cost premium, once 15%, has fallen to the point where adding boundary scan shouldn't increase device costs at all."

Butkovich contends that presenting the need for boundary scan to vendors in an industry forum brings it in at a high level, emphasizing that the capability is essential to test a lot of products. Vendors shouldn't consider the inclusion of boundary-scan components as a competitive advantage, but rather as a baseline requirement that all product manufacturers should embrace.

"We all see that traditional ICT methods have become ever more difficult and impractical to get adequate test coverage," he continued. "Because of the types of products we make [**Figure 3**], many of our boards include little or no conventional access. Inspection hasn't provided an effective solution. We need a valid electrical test."

The project's initial effort will survey 12 to 15 companies, analyzing the information received to fine-tune a wider survey of as many as 100 companies. The scope of the survey will help let board and system manufacturers know that they aren't alone—that the need for this capability in the devices they buy is not unique to a single company or a small subset of companies, but is in fact an industry-wide issue.

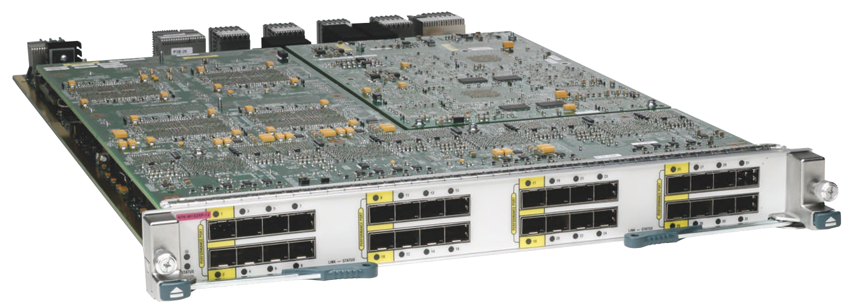
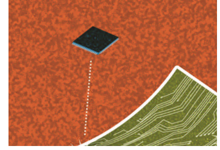


FIGURE 3. Complex boards like this one with little or no conventional access to logic nodes demand boundary scan to permit a comprehensive test. Courtesy of Cisco.

"This is everyone's business," Butkovich insisted. "We want the project to encourage vendors to get proper tools in place to make the transition to routinely producing boundary-scan devices as easy as possible by pinging the device designers themselves. We know what the designers did two years ago by looking at products already on the market. The survey will tell us what is currently in the pipeline."

The first surveys have already been sent out. Butkovich expects the data-gathering phase to be complete by late September. After that comes the task of publishing the data and disseminating it to the industry at large. He noted that published results will include only trends and statistics, not individual comments, protecting the anonymity of the participants.

Like Taylor, Butkovich found that working with these otherwise highly competitive companies fostered high levels of cooperation and mutual sup-



port. "The companies may compete with each other," he remarked, "but test engineers don't generally perceive themselves that way. The project isn't about proprietary information, but addresses methods that everyone can use to raise the quality bar for everybody. By involving iNEMI, we have created a kind of demilitarized zone for moving the industry forward as a whole. It's one of the reasons companies join iNEMI."

That's the way the board bends

The move to lead-free solder, combined with the circuit densities and component types found on today's PCBs, has aggravated the potential consequences of board deformation that occurs during manufacturing, handling, and normal use. The standards established to measure board susceptibility to flexure damage—IPC/JEDEC 9702 and 9704—need updating to reflect these technology changes. In addition, inconsistencies in the ways that manufacturers apply existing strain-test

One goal was to incorporate the spherical-bend test into a standard for verifying mechanical performance.

methods create confusion in assessing damage risks. These concerns spawned the Board Flexure Standardization Project, chaired by Reinosa of HP and co-chaired by Alan McAllister of Intel.

Reinosa explained that one of the first goals of the project was to incorporate the spherical-bend test method (**Figure 4**) into a standard to verify a board's mechanical performance. "The current IPC/JEDEC 9702 standard outlines the four-point bend technique," she commented, "but it doesn't include the spherical-bend test method. Intel developed the approach to look more precisely at worst-case bend-test conditions, and HP and other companies have adopted it. Spherical bend will help component manufacturers to more accurately determine the strain limits for particular packages. The IPC may use our results to modify the existing standard, or they may decide to introduce it as a separate one."

The board-flexure project also plans to address the way that manufacturers present strain specifications. Reinosa put it this way, "There are two ways to express maximum strain—principal strain and diagonal strain. Customers may not understand the distinction. Manufacturers and vendors must express and use strain limits consistently."

Part of introducing a new strain-measurement standard or modifying an existing one is understanding the factors that affect board strain. Some of the participating companies have already begun this part of the investigation. "We are looking at the effects of various materials and board features, such as board laminates, BGA [ball-grid array] package sizes, and sizes and types of solder pads," Reinosa remarked. "The results depend on the type of solder, for example. Lead-free solders are stiffer than the leaded variety. When a board deforms, more of the load transfers to the board laminate and the pad interfaces than with tin-lead solder, so manufacturers need to reduce the maximum permissible strain to ensure board quality.

"Whatever recommendations we make to the standards organizations will *not* define actual strain limits for particular boards, components, or technologies," Reinosa emphasized. "Every company has to decide the maximum risk level that each board or product can tolerate. Component manufacturers may quote a different strain limit for each BGA they make, so a board's limit depends on the design, materials, and BGA mix on that board. Even within a company, the limits may depend on each product's use. Laptops and cellphones, for example, experience much more cyclic strain than would the motherboard in a desktop PC."

The project's participants will also likely agree to disagree over failure criteria. Deciding what test results justify failing a board will depend on the characteristics of each product, product line, and specific company guidelines. "For one product, a company may consider any damage as a failure," Reinosa observed. "Another product or another company might have a different failure criterion."

To succeed in moving standards forward, the project has to generate, analyze,

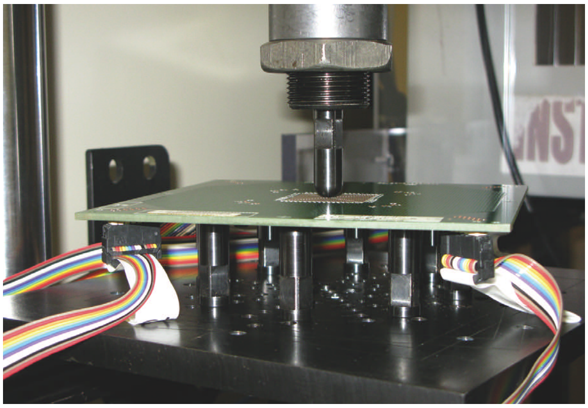


FIGURE 4. The spherical-bend test provides an accurate picture of how the device will respond to board stress.
Courtesy of Hewlett-Packard.

and present a lot of data. "IPC and JEDEC won't change their standards unless they can match the proposed changes against real manufacturer experience. The companies involved will have to share their experimental data. The information provided to the public may be more general, but without the specific data, the committees will not take the needed actions."

Like the other board-level projects, the flexure project runs on a relatively tight schedule. The group plans to present its findings to IPC and JEDEC by the end of 2008. Reinosa expects a decision from those bodies much more quickly than often occurs in standards debates.

"By working through iNEMI," she said, "by the time we make our proposal, we will have already consolidated numerous contrasting opinions. This type of project also brings together companies with experience in different aspects of the problem under discussion. One company may know more about laminates, another about package sizes, still another may be an expert in solder-joint characteristics. They each will present their findings, and our standards proposal will present a consensus as much as possible."

Reinosa continued, "We are not looking to mandate or even recommend maximum strain-level standards for board thicknesses, materials, or any other particulars in the manufacturing process itself. Our goal is only to provide a proven methodology for determining strain limits. Currently, OEMs may specify different acceptance criteria to the same contract manufacturers. By offering a new set of standards that reflect the evolution in board technology and methodologies that has occurred since the previous standards were adopted, we hope to help manufacturers provide consistent, predictable performance and reliability of the boards when they reach customers." T&MW

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Using a function generator and an oscilloscope, you can measure gain and phase shift versus frequency in a power supply's control loop.

Measure power-supply LOOP TRANSFER

BY FREDERIK DOSTAL, NATIONAL SEMICONDUCTOR

Power supplies use control-loop circuits to produce constant voltage or current. The transfer function—gain and phase as a function of frequency—provides valuable information about a control loop's speed and stability. Knowing a control loop's transfer function, as well as the poles and zeros of the transfer circuit, can help you select the right compensation and power-stage components.

You can measure gain and phase shifts and plot them with a network analyzer that sweeps the frequency of an injected signal and automatically computes the control loop's phase difference and the gain. Such an instrument is nice to have and very convenient—but is also expensive. If you don't have one available, you can make the measurements with an oscilloscope, a signal generator, and a standard transformer.

To perform the measurements, you inject a small AC signal into the power supply's control-loop circuit and measure the loop's gain and phase shift. By measuring the gain and phase, you can plot them with a Bode plot. The gain and phase differences between the injected signal and the control loop's output is the transfer function.

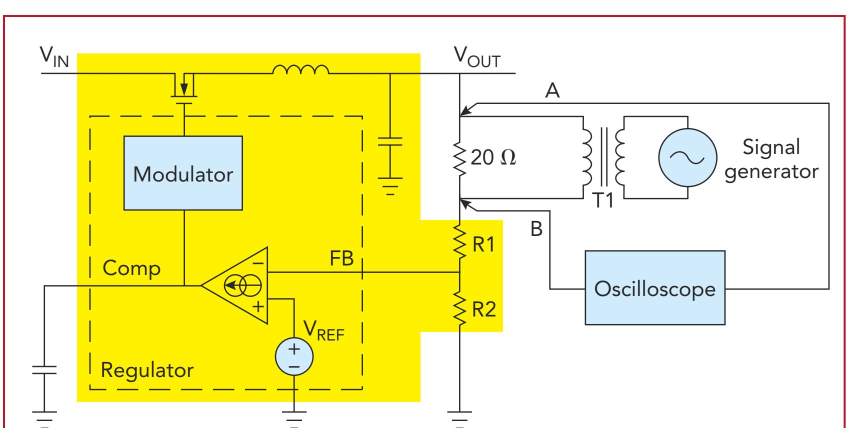

FIGURE 1. This measurement setup lets you compare an injected sine wave to the signal as it rides on a power supply's output (V_{OUT}).

Prepare the circuit

Figure 1 shows a typical step-down switch-mode regulator with the required measurement setup. Start by breaking the loop of the power supply's regulator circuit (highlighted area in Figure 1) so you'll have a point at which to inject the small signal and measure the loop's response. You can break the loop at the low-impedance output node above the high side feedback resistor (R1) in the feedback path.

You must electrically isolate the measurement points, A and B, by placing a small resistance, such as 20 Ω, in the control loop's feedback path. A 20-Ω resistor in the control loop will have a negligible effect on the power supply's output voltage (V_{OUT}).

To inject the signal into the control loop and make the measurements, you need a sound measurement structure. The online version of this article contains a sidebar, "Good connections," that explains how to modify a regulator IC evaluation board for these measurements (www.tmworld.com/2008_09).

The injected signal must be small in relation to the output voltage so it won't change the way the power supply handles large signals. Yet, the injected signal must be large enough that you can recognize it in the control loop. The injected signal must not trigger a voltage protection threshold at a regulator IC's feedback pin (FB in Figure 1).

You should inject a sine wave with an amplitude between 30 mV and 100 mV across the 20-Ω resistor in Figure 1. The exact signal amplitude you need may change depending on the control loop's gain, and the amplitude will vary with frequency. Start by injecting a small signal and then increase its amplitude as needed until you can see it on an oscilloscope screen. This will ensure that the signal is still small relative to the loop's DC output.

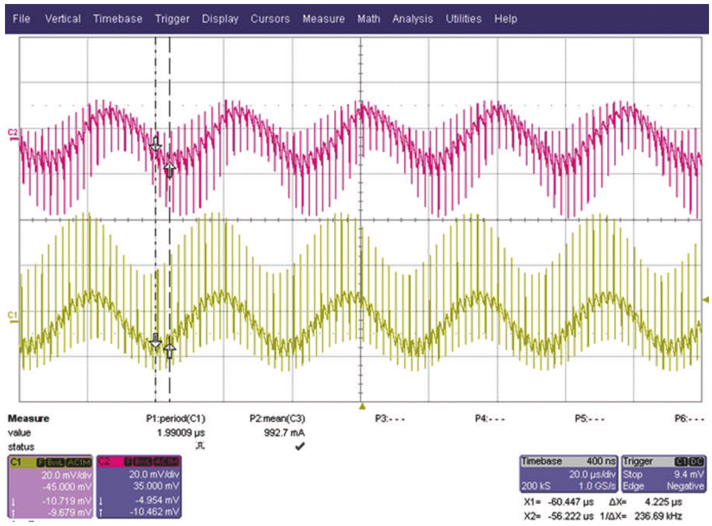

FIGURE 2. When control loop gain = 1 (0 dB), the amplitude of the injected signal (upper trace) will equal the amplitude of the output signal (lower trace).

The injection transformer, T1 in Figure 1, prevents DC from entering the control loop. Look for a transformer that offers a flat voltage transmission over a wide frequency band. If you don't have such a transformer, you can compensate for frequency variations in your transformer's flatness by adjusting the signal generator's output amplitude.

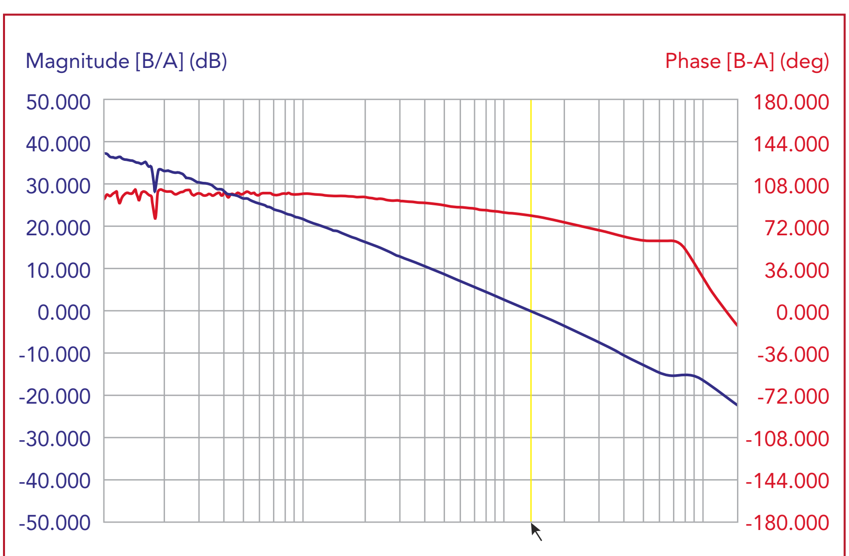

FIGURE 3. A Bode plot shows the point where gain (blue trace) is 0 dB and also shows the corresponding phase offset (yellow vertical line indicated by the arrow).

Connect the signal generator to the transformer's primary side, then turn on the generator. Measure the injected signal across the 20-Ω resistor using two calibrated oscilloscope probes. (Attach the ground leads of both probes to a common ground point on the power supply under test.) To make the measurement, you'll need to view the difference between the signals on channel A and channel B.

Adjust the signal generator's amplitude so the transformer's output voltage won't drive the control-loop circuit into nonlinear operation. Set the DC offset of the signal generator's output to 0 V so you don't introduce DC into the measurement circuit.

To prevent switching noise from filling the oscilloscope's screen and covering the waveform of interest, set the oscilloscope for bandwidth limiting. You can ensure a well-triggered waveform by connecting a third oscilloscope channel to the signal generator's output and triggering on the output signal.

Set up the power supply

Next, you should power up the control-loop circuit, attach a load, and make a stability measurement by looking for oscillations in V_{OUT}. Repeat this measurement under different load and line conditions. At low output loads, most power supplies will go into discontinuous current-conduction mode, which will change the control loop's characteristics. In voltage mode, a power supply's loop characteristics will change with input voltage.

After setting up the equipment and powering the control loop, you should see a line on the channel connected to V_{OUT} (probe A in Figure 1) and a noisy sine wave on the other channel. If you don't see a sine wave, then set the oscilloscope to the highest amplitude resolution (typically 20 mV/div) or increase the amplitude of the signal generator's output.

Once you see a sine wave, change its frequency by adjusting the signal generator. You will see a change in amplitude on channel A. Look for a frequency where the sine waves of channel A and channel B have equal amplitude—this is the point where the gain of the control loop is 1 (0 dB). This frequency is the loop's 0-dB crossover frequency (**Figure 2**).

Typically, the two sine waves will be phase shifted relative to each other. The amount of phase difference at the 0-dB crossover frequency is the phase margin of the control loop. Besides measuring the injected and output sine waves at the 0-dB crossover point, you should also measure the sine wave riding on V_{OUT} at lower frequencies. The amplitude difference between channel A and channel B gives the gain at a given frequency. **Table 1** lists the voltage ratio between the injected sine wave and the sine wave riding on V_{OUT} and the corresponding values in decibels.

You can successfully make these loop measurements on a control loop that doesn't oscillate or is in some sort of hysteretic overvoltage protection mode. If the error amplifier is a transconductance amplifier, you can achieve a stable loop design by placing a capacitor from the regulator IC's compensation pin to ground. If the error amplifier is a standard voltage-to-voltage error amplifier, then place a capacitor from the compensation pin to the FB pin. A 1-μF capacitor will typically work well. It will set a pole at very low frequencies and force the gain to drop quickly so that the 0-dB crossover is at a very low frequency. In current-mode control designs, the phase margin at very low frequencies is usually enough to yield a stable circuit.

Table 1. Commonly used decibel values for voltage ratios.

Voltage ratio (A/B)	Decibel level (20 * log[A/B])
0.03162	–30 dB
0.1	–20 dB
0.3162	–10 dB
0.7071	–3 dB
1	0 dB
1.414	3 dB
3.162	10 dB
10	20 dB
31.62	30 dB

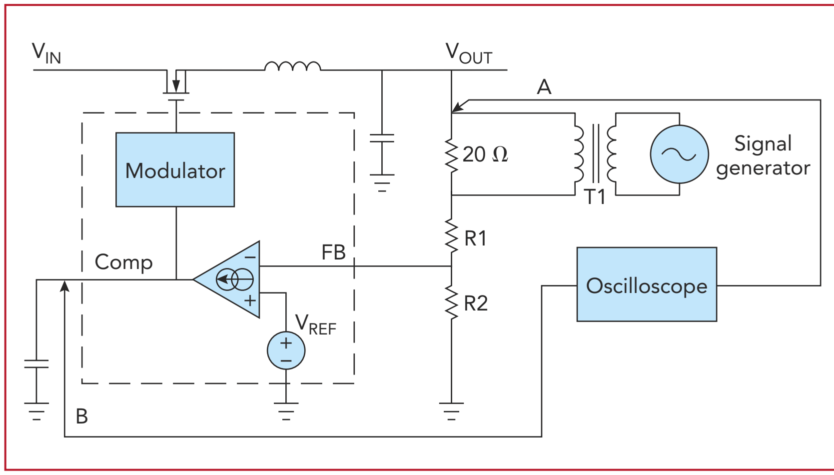

FIGURE 4. This measurement setup lets you measure the compensation signal of the voltage regulator IC (probe B).

The Bode plot

To generate a Bode plot, you must sweep the signal generator's frequency across the frequency range of interest and measure the gain and the phase shift between the input signal (probe B in Figure 1) and the output signal (probe A). For very large and very small gains, you might have a difficult time seeing results on the oscilloscope screen. At 30-dB gain, for example, it's difficult to see a voltage relationship between channel A and channel B.

For typical designs, you can easily and accurately measure the most important points of a Bode plot such as the 0-dB crossover point. At high gain frequencies, you might have a difficult time viewing the exact decibel value, but you can make a quantitative observation such as "the gain is very high and probably above 30 dB." **Figure 3** shows the control loop's 0-dB gain crossover frequency, where the blue trace crosses 0 dB.

You can consider loop bandwidth as a combination of the level of DC gain and the frequency of the 0-dB crossover. This measurement—the control loop's phase margin—can indicate the control loop's stability margin. Depending on the design, you need a minimum phase margin of 45° to 50°. More is better.

Besides using the measurement setup in Figure 1, you can connect the oscilloscope channel that was measuring injected signal (probe B) to the compensation pin of a power-supply regulator IC (**Figure 4**). In this setup, you can measure the transfer function of the control loop without the influence of the compensation network (the capacitor connected to the regulator's compensation pin). With the information you obtain about the power stage with this measurement, you can easily select optimized compensation components for a desired control-loop bandwidth and phase margin. T&MW

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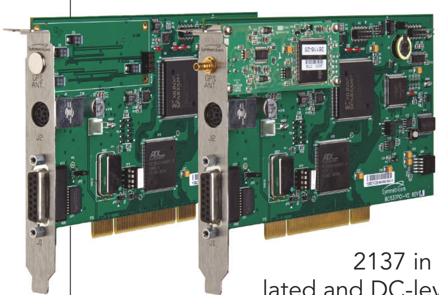
ON THE WEB

The online version of this article contains a link to a 7-min video that describes the test procedure. It also contains a sidebar, "Good connections," that describes how to modify a regulator IC evaluation board. **www.tmworld.com/2008_09.**

Boards keep time to within 50 ns

When you need precise timing in a PC-based data-acquisition system, you can add either the bc635PCI-V2 or the GPS-referenced bc637PCI-V2 time and frequency processor board to any PCI slot. The cards provide timing that is accurate to within 50 ns of coordinated universal time (UTC), and they also provide extensive time-code generation and translation based on IRIG A, B, G, E; IEEE 1344; NASA 36; XR3; or 2137 in both amplitude-modulated and DC-level-shift formats.

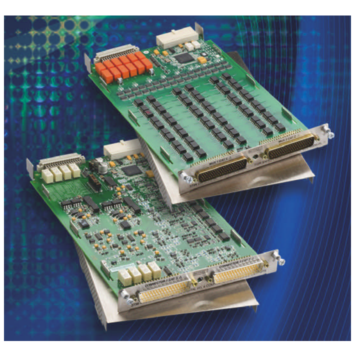


The boards support more than 30 input and output time-code variations with the ability to process them in parallel. They also provide a periodic pulse-rate generator based on direct digital synthesis that is capable of 0.0000001 pulses per second (pps) to 100 Mpps. The boards also include a battery-backed real-time clock. Software support includes Windows, Solaris, and Linux.

Price range: $1295–$3095. *Symmetricom, www.symmetricom.com.*

Keithley expands switch/multimeter line

Keithley Instruments has announced an expansion of its Series 3700 system switch/multimeter and plug-in card family with the addition of two new plug-in cards, the Model 3724 dual 1X30 solid-state FET relay multiplexer card and the Model 3750 multifunction I/O card.



The Model 3724 multiplexer card features scanning speeds of greater than 1000 channels/s, including measurement, and switch-only scan rates of greater than 1200 channels/s. The card also offers 200-V, 0.1-A switch/carry capacity with offset current of less than 10 nA. The solid-state relays can be automatically configured into either a dual 1x30 or a 1x60 multiplexer. The card also features temperature-measurement capability with automatic CJC sensors when used with the optional screw terminal accessory.

The Model 3750 multifunction I/O card features 40 digital I/O channels with high-current driver outputs that can sink up to 300 mA, allowing them to drive relays directly without any interface circuitry. It also features two programmable analog outputs offering both voltage- and current-programmable isolated analog outputs including 0 to 20 mA, 4 to 20 mA, or ±12 VDC. It also comes with four totalizers/counters with 32-bit resolution and is gated with a 1-MHz input rate.

Prices: Model 3724—$1595; Model 3750—$1250. *Keithley Instruments, www.keithley.com.*

NI debuts WiFi DAQ systems

To complement the new wireless data-acquisition control capabilities of LabView 8.6 (see p. 14), National Instruments has debuted 10 WiFi and Ethernet data-acquisition devices. The new devices include built-in signal conditioning and direct sensor connectivity for electrical, physical, mechanical, and acoustic signals. They can stream 24-bit-wide data on each of four channels at rates from 14 samples/s for a thermocouple application to more than 50 ksamples/s for integrated electronics piezoelectric (IEPE) accelerometer and microphone applications.

The WiFi and Ethernet devices are shipped with NI-DAQmx driver software and NI LabView SignalExpress LE, an interactive datalogging software tool for acquiring, analyzing, and presenting data without any programming. The NI-DAQmx driver delivers features such as the configuration-based NI DAQ Assistant with code generation for both LabView and text-based languages, it offers more than 3000 measurement examples and supports device simulation, and it is compatible with LabView, ANSI C/C++, C#, Visual Basic .NET, and Visual Basic 6.0.

Base prices: WiFi devices—$699; wired Ethernet devices—$599. *National Instruments, www.ni.com.*

System tests automotive emissions

The AES 5500 EMC transient emissions test system from Teseq lets you test automotive systems for conducted electrical transients. Designed for tests compliant with ISO 7637-2, the system consists of a mechanical switch, a line-stabilization network, an electronic switch, and a controller. To perform a test, you connect a power

> > > > > > >

source such as a battery to the mechanical switch.

When you apply power to the equipment under test (EUT), the system lets you capture EUT disturbances. The EUT connects to the electronic switch; when the electronic switch closes, the disturbance passes through to the EUT, and you

can capture the EUT's response with an oscilloscope. The system can handle battery current up to 100 A with a 1000-A inrush current for 10 ms or with a 300-A inrush current for 1 s. You can also connect multiple mechanical switches and close them simultaneously.

Teseq, www.teseq.com.

Protocol analyzer tests USB 3.0

LeCroy has unveiled the Voyager verification system, a protocol analyzer exerciser system for testing USB 3.0 devices, systems, and software. The company says that this sixth-generation verification platform will help developers bring USB

3.0 products to market faster, while ensuring compatibility with USB 2.0 products.

The Voyager protocol analyzer provides simultaneous protocol capture of both USB 2.0 and USB 3.0 signaling. It uses the CATC Trace protocol-analysis software display to illustrate the USB 3.0 protocol, and it offers advanced triggering and hardware filtering to help developers quickly understand and verify early USB 3.0 protocol behavior.

LeCroy, www.lecroy.com.

Field tool tests carrier Ethernet networks

The battery-powered, handheld Unipro GbE from Trend Communications is intended for the roll-out of metropolitan, access, and carrier Ethernet networks. The instrument lets you test and verify any Ethernet service from the physical layer to the IP layer, and it incorporates traffic generation, filtering and analysis, IP ping, and trace route.

The Trend Unipro GbE executes RFC 2544 tests and verifies connectivity, frame transportability, and throughput. Advanced tests include verification of auto-negotiation when connecting nodes, VLAN configuration and routing, admission

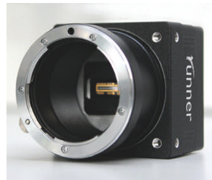
control and congestion avoidance mechanisms, quality of service provided by the network, and service-level agreements.

The tester has two electrical RJ-45 ports and two optical SFP GBICs, which simplify bidirectional traffic monitoring. When the Unipro GbE is used in through mode, it simultaneously works with two transmitters and two receivers, enabling intrusive monitoring. This mode is also useful for general monitoring when no splitter is available.

Trend Communications, www.trendcomms.com.

Line-scan cameras excel at low-speed tasks

The runner series of line-scan cameras from Basler is designed to perform especially well in applications with minimum line rates of 1 Hz up to 100 Hz. The company claims that a built-in sensor-clearing function improves the CCD sensor's



readout at low speeds and that noise and artifacts are limited, resulting in better images and better image-processing results.

All seven models in the runner series are equipped with GigE Vision interfaces. Monochrome cameras are available with a single-line 1024-pixel or 2048-pixel sensor and line rates of up to 56.1 kHz. A tri-linear color unit delivers three 2098-pixel lines and a line rate of up to 9.2 kHz. A combination of inputs and outputs can be used to implement real-time triggers, adjust lighting, and transfer the trigger signal to another camera running in parallel. The runner cameras also offer three integration modes, as well as adjustable gain and offset. They can be triggered via an external sync signal or operated in an internally controlled free-run mode.

Basler, www.baslerweb.com.

Handheld BER testers handle 50 bps to 50 Mbps

The LinkTest bit-error-rate (BER) testers from GL Communications can be used to test a variety of communications facilities and equipment. The handheld testers cover data rates ranging from 50 bps to 50 Mbps and include a built-in speaker for monitoring DS0s or time slots. They also display G.821 performance measurements and operate from AC or battery power.

The LinkTest Single unit tests asynchronous, synchronous, T1, Fractional T1, E1, Fractional E1 modems, multiplexers, CSU/DSUs, T1 ESF CSUs, DUs, NTUs, and TIUs. The unit is supplied with V.35, RS-232, RS-422/RS-530, X.21, DS1 (T1, 1.544-Mbps), and G.703 (E1, 2.048-Mbps) interfaces, as well as a wall-mounted AC transformer.

The LinkTest Single+ adds T3 and E3 testing capability, while the LinkTest Dual provides dual-interface test-

ing. The LinkTest Dual also has a LAN interface for TELNET and TFTP. All three models can be controlled from the front panel or through a command line interface, with options for control from a VT100 console, Windows GUI, or local/remote terminal.

GL Communications, www.gl.com.

Low-cost DC supplies are feature-rich

A low-cost expansion of the Agilent E3600 series, the U8000 series of single-output, nonprogrammable DC power supplies offers power ranging from 90 W to 150 W. The U8000 provides integrated overvoltage and overcurrent protection to prevent damage to devices under test. During test setup, you can save and recall up to three memory states to help minimize manual errors. Agilent claims the series offers excellent load and line regulation, fast transient response, and low output noise.

Base price: $295. *Agilent Technologies, www.agilent.com.*

SEM minimizes beam charge

JEOL USA's JSM-7600F thermal field-emission-gun scanning-electron microscope (SEM) integrates a semi-in-lens objective lens with an in-lens thermal electron gun to provide sharp imaging of nonconductive samples that charge, such as photomasks and ceramics. The JSM-7600F minimizes beam charge on heat-sensitive samples, like low-K dielectrics, and offers improved stability for unattended data acquisition in metrology, particle analysis, defect review, and x-ray mapping applications.

The in-lens thermal electron gun, combined with an aperture angle optimizing lens, achieves a probe current of 200 nA or higher at an accelerating voltage of 15 kV. The JSM-7600F has a guaranteed resolution of 1.0 nm at a high accelerating voltage of 30 kV and a working distance 4.5 mm; a guaranteed resolution of 1.5 nm at a low accelerating voltage of 1 kV and a working distance of 1.5 mm; and a guaranteed resolution of 3.0 nm at a high probe current of 5 nA, an accelerating voltage of 15 kV, and a working distance of 8 mm.

JEOL USA, www.jeolusa.com.

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CATALOGS & PRODUCTS

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Intelligent power solutions

MRV Communications says that its Out-of-Band Network reduces costs and improves service levels by providing a solution for sophisticated remote power control and environmental automation for devices in an organization's networks and infrastructures. *MRV Communications, www.mrv.com/oobn.*

Versatile bench multimeters

The 8845A/8846A 6.5-digit meters are ideal for R&D or automated test systems. The 8808A 5.5-digit meter is designed for manufacturing, development, and service. *Fluke, www.fluke.com.*

Frequency synthesizer sources

A catalog from Programmed Test Sources describes the PTS line of frequency synthesizers that produce fast-switching, low-phase-noise precision frequencies ranging from 0.1 to 6400 MHz. Options and accessories are available to create a product that matches your specifications. *Programmed Test Sources, www.programmedtest.com.*

Complete test system

CheckSum's Analyst systems deliver a complete test solution: in-circuit test, TestJet technology, boundary-scan, and in-system programming (ISP) capability in a compact, rugged package supported by CheckSum's exclusive turnkey services. *CheckSum, www.checksum.com.*

High-performance digital I/O

Featuring high-voltage pin electronics with all features programmable on a per-channel basis, the 50-MHz GX5055 PXI I/O card represents a new level of performance and capabilities for PXI-based digital instrumentation. *Geotest—Marvin Test Systems, www.geotestinc.com.*

Conducted immunity generators

AR offers three self-contained systems that simplify RF conducted immunity testing. The Model CI00250 (75 W, 10 kHz–250 MHz) meets IEC specifications. The Models CI00400 and CI00401 (100 W, 10 kHz–400 MHz) meet MIL-STD/DO-160 and automotive standards, respectively. *AR RF/Microwave Instrumentation, www.ar-worldwide.com.*

Small temperature datalogger

The OM-MicroLite is Omega's new pocket-sized portable temperature datalogger with a USB interface for fast-track communication. High in accuracy, the datalogger can be used globally because of its CE mark and standard 3-V lithium battery. *Omega Engineering, www.omega.com.*

New, powerful PXI

The first PXI controller designed with a Mobile Intel GME965 chipset, the PXI-3950 combines the Intel Core2 Duo 2.2-GHz T7500 processor and 4 Gbytes of memory, making it ideal for high-end test and measurement. *Adlink Technology, www.adlinktech.com.*

Optics source book

Edmund Optics' 400+-page *Master Source Book* features more than 2275 optics and photonics products. The catalog provides product listings, pricing, technical articles, and application guides, making it an ideal resource and buyer's guide for researchers, designers, and OEM users. *Edmund Optics, www.edmundoptics.com/CatalogRequest.*

Measurement systems

Data Translation's free product catalog offers an overview of the company's USB data-acquisition, temperature-measurement, sound-and-vibration, and test-and-measurement software products. Comprehensive charts help simplify your product selection. *Data Translation, www.datx.com/products/catalog/default.asp.*

Multifunction synchronous DAQ

Measurement Computing's USB-1602HS/1604HS multifunction data-acquisition modules feature two or four simultaneous-sampling 16-bit analog inputs at rates to 2 Msamples/s, with two 32-bit counters, 32 synchronous digital I/O lines, and optional analog outputs. *Measurement Computing, www.mccdaq.com.*

3-GHz spectrum analyzer

Instek's new GPS-830 3-GHz spectrum analyzer offers many features such as a low-noise floor, autoset, automatic measurements, a USB interface, and a brilliant TFT color display in one package at an affordable price. *Instek America, www.instekamerica.com.*

High-performance oscilloscopes

ZTEC Instruments provides high-performance PCI, PXI, VXI, and LXI oscilloscopes with sampling rates up to 4 Gsamples/s and bandwidths up to 1 GHz. *ZTEC Instruments, www.ztecinstruments.com.*

Learn what's hot!

FLIR's Infrared Training Center is the place to get high-quality interactive thermography training from what the company says are the most qualified international thermography instructors in the industry. You can sign up for training by calling 866-872-4647. *FLIR Systems, www.infraredtraining.com.*

RF configuration tools

Gore's interactive, online design guides provide step-by-step instructions for configuring RF/microwave assemblies, Gore High-Flex round or flat cables, Gore Trackless cables, and Gore UHD interconnects. *W.L. Gore & Associates, www.gore.com/designcenter.*

T&M solutions for aerospace

The latest brochure from Rohde & Schwarz (order number PD 5214.1420.62) lists test and measurement products specifically for aerospace and defense contractors to use in cutting-edge R&D, production, and operational-support programs. *Rohde & Schwarz, www.rohde-schwarz.com.*

Fast pulse test solutions

Avtech's Web Guide and Short Form Catalog 17S outlines the company's family of high-speed (40-ps to 100-ns rise time), high-current (0.1 to 500 A), and high-voltage (2 to 3000 V) pulse generators, drivers, and amplifiers for research and production-testing applications. *Avtech, www.avtechpulse.com/literature/cat17s.pdf.*

CATALOGS & PRODUCTS

The following write-ups were supplied by advertisers in this issue.

Be precise

A new short-form catalog from Huber+Suhner presents an extract of the company's wide range of components with high-performance and stable characteristics that suit the needs of test and measurement applications. *Huber+Suhner, www.hubersuhner.com.*

Modular connector system

The EasyMate connector system uses modular blocks matched to the unit under test. This results in simple test adapters perfect for departments looking to reduce interface inventories and costs. *DIT-MCO International, www.ditmco.com.*

PXI datacom multiplexer

Pickering Interfaces has launched its PXI 40-736 data-communications multiplexer module, designed to switch differential pairs. The module is configurable as 32 single to eight quad pairs, including 100BaseT/Gigabit Ethernet, POTS, USB, and AFDX. *Pickering Interfaces, www.pickeringtest.com.*

Center probe socket

A socket for devices up to 13 mm^2, available in versions with ratings of 1–3 GHz, 3–5 GHz, 5–9 GHz, and 10–18 GHz, offers minimal signal loss for higher bandwidth capability and uses solderless, pressure-mount, compression-spring probes. *Aries Electronics, www.arieselec.com.*

Switching system catalog

Cytec has released a 60-page catalog of its complete line of programmable switching systems for automated test, data acquisition, and communications. A price list is included. *Cytec, www.cytec-ate.com.*

DC power systems

AMREL develops custom-tailored DC power systems, available with high-power, current, and voltage eLoad and ePower ratings. AMREL's new fully integrated systems offer one-stop shopping for your testing needs. *AMREL/American Reliance, www.amrel.com.*

High-speed DAQ

The new Yokogawa SL1000 delivers independent, isolated channel hardware at 100-Msamples/channel rates, with no compromise in bit resolution, memory depth, or streaming performance. Extensive trigger, probe, accessory, and module libraries are available. *Yokogawa, www.yokogawa.com.*

18-GHz attenuators

JFW's low-cost 50HFP-XXX-10 attenuators offer high-powered performance from DC to 18 GHz, are rated at up to 10-W continuous power (500-W peak), and are available in values of 3, 6, 10, 20, and 30 dB. N and SMA versions are available. *JFW Industries, www.jfwindustries.com.*

FREE WEBCAST

TEST APPLICATIONS USING LXI INSTRUMENTS

SEPTEMBER 24TH 2008
2:00 PM ET/11:00 AM PT

MODERATED BY

Rick Nelson
Editor-in-Chief, TMW and EDN

Why use LXI Instruments to build test systems? How do you get started building a test system using LXI instruments? What are the network configurations and expected performance? What can I do with LXI that saves me money, time, and provides unique solutions?

This webcast will guide you through these topics and focus on two areas — replacing GPIB instruments with LXI Class C and advanced test system solutions using LXI Class B instruments. Solutions like Far-field Antenna measurements, power shutdown, and system characterization are made much easier with LXI Class B instruments.

This Webcast starts with a recording of the AUTOTESTCON 2008 panel session on this topic. After the recording, experts from several manufacturers of LXI instruments will be available to answer your questions live.

PANELISTS INCLUDE

- **Conrad Proft**
  Technology Product Planner/Applications Engineer, Agilent Technologies Inc.
- **Rob Purser**
  Senior Team Lead, connectivity products, The MathWorks
- **Brian Powell**
  Software Principal Architect in LabVIEW R&D, National Instruments
- **Tom Sarfi**
  Functional Test Business Unit Manager, VXI Technology

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TEST REPORT

Seminars highlight PXI interoperability

By Richard A. Quinnell, Contributing Technical Editor

A trio of companies—Geotest, KineticSystems, and Pickering Interfaces—have banded together to address what appears to be a common misperception about PXI by offering a series of educational seminars entitled the No Compromise Test Solutions Conference. I caught up with Loofie Gutterman, president of Geotest, to discuss the continuing need for education about PXI.

Q: What are the No Compromise seminars about?
A: The purpose of our seminars is to demonstrate to and convince customers that PXI products and software from multiple vendors will all work together. We have a half day of discussions and demonstrations, and afterward people can try some hands-on activity as well.

Q: PXI just celebrated its 10th anniversary. Isn't it well understood by now?
A: We did the "PXI 101" type of education years ago to tell folks why and how to use PXI, and everyone now understands that part of the story. But we realized as we talked with customers that many do not realize the degree of interoperability that PXI offers. Some people are still concerned about it all playing together if they were to buy boards from several vendors and software from yet another source.

Q: How did those concerns manifest themselves?
A: Customers were telling us that this or that product was close to what they wanted but not quite, and they wanted help making tradeoff decisions. We asked "Why not use this other board which is exactly what you need?" It turned out that they were making compromises so that they could buy everything from a single vendor to avoid any system-integration issues later.

Q: What is the source of those concerns?
A: We don't know all the reasons for this fear, but some may stem from old expectations based on other bus standards where mixing and matching didn't work. The VXIplug&play initiative, for instance, was known as "plug and pray" because of interoperability problems. Whatever the cause, we recognized that these concerns existed in the market and believe they are completely unjustified.

At Autotestcon 2007, for example, the PXI Systems Alliance (PXISA) had three demos using multiple vendors' products, and they were very successful. We based our No Compromise seminars along the same lines.

Loofie Gutterman
President
Geotest—Marvin Test Systems

Q: Isn't conducting seminars the kind of thing the PXISA should be doing instead of companies?
A: Other industry organizations have large marketing budgets, but the PXISA is operating on a modest budget and can't afford to do these seminars as they cost a lot of money. While this is not an official PXISA seminar, it is open to participation by other member companies. In fact, we initially invited four or five others to join in but ended up with three only because we wanted to get going quickly and these three were ready to commit the time and money.

Q: How long will these seminars be offered?
A: It depends on the feedback. We are planning on half a dozen to begin with, but they may continue if interest is high. When we started our PXI 101 seminars in 2001, we originally planned only three, and were so successful we ended up doing 80 more. □

For details on the seminars, including dates, locations, and registrations, click on the Workshops link at www.geotestinc.com.

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GUEST COMMENTARY

PXI gains momentum in mil/aero industry

By Mark Morris, ADLINK Technology America

When sitting down to write this column, I thought back to 1997 when I worked for National Instruments and sold my first PXI system to a group of early adopters at Los Alamos National Laboratory. Although these guys were truly "rocket scientists," I doubt even they could have foreseen the success that PXI would have. According to the PXI Systems Alliance, there are now more than 1150 PXI products on the market from upwards of 50 manufacturers. This success has accelerated the use of PXI in many areas, including both the commercial and military segments of the aerospace industry.

Because of PXI's flexibility, compact footprint, and high performance—as well as its commercial-off-the-shelf pricing—it is no surprise that the technology has become a viable choice for many mil/aero test programs. The synchronization features of PXI, such as triggering and clock sharing, are ideal for high-channel-count aerospace applications. Also, the star trigger line allows for less than 2 ns of propagation delay, and the dedicated 10-MHz system reference clock ensures device synchronization.

Existing mil/aero test platforms for USAF and NAVAIR avionics are transitioning to PXI, and many portable field and flight-line testers are now available in PXI as well. In the commercial segment, suppliers such as Teledyne Controls and Korry Electronics are using PXI systems to test products such as 787 flight-deck systems and Airbus advanced flight data-acquisition management systems.

The list of available PXI products continues to grow. Products include avionics bus interface cards, programmable power supplies, analog and digital I/O cards, arbitrary waveform generators, signal conditioners, switching cards, and chassis. Also popular are cards that link to other buses. In fact, many find it surprising that GPIB interface cards for PXI continue to be some of the most popular products sold by ADLINK.

Looking forward, PXI Express will provide the performance needed to meet the test requirements for software-defined radio, high-speed image acquisition, and high-channel-count data acquisition. In addition to significantly increased bandwidth, PXI Express provides users with software and hardware compatibility with the PXI modules deployed today, preserving the user's current investment. □

Mark Morris is the VP of sales and marketing for measurement and automation products at ADLINK Technology America. mark.morris.adlinktech@gmail.com.

HIGHLIGHTS

PXISA reaches out to China

By Richard Quinnell
Contributing Technical Editor

In May, the PXI Systems Alliance (PXISA) held its fifth technology conference in China to help foster the adoption of PXI in the growing industrial giant. New initiatives this year included an entire track on module creation and the first PXISA general meeting held in China.

"Next-generation test systems such as PXI are very popular in China," said PXISA marketing co-chair Matthew Friedman, "and the growth in China has been amazing." This year's conference achieved record attendance levels, with more than 550 engineers and vendors participating. Friedman explained that one of the most popular venues was the new technical track on module development. "It was standing room only for the entire track," he said.

The addition of the developer's track reflects growing interest within China to develop PXI modules both for internal use and for outside sales. "In past years, the event focused on the use of PXI," said Friedman, "but now people there are looking at development. They love the idea of creating their own modules to meet their unique test needs."

To ensure that development adheres to standards, the PXISA invited test equipment vendors to a general meeting, held concurrently with the conference. "A key reason the PXISA exists is to help maintain the spec and ensure interoperability," said Friedman, "so we have a focus on the Asian community to help keep them on spec."

The meeting was open to PXISA members, nonmembers, and the Chinese technical press. Committee chairs presented updates on technology development as well as on PXISA marketing efforts. "There are some companies developing modules that don't know much about the PXISA," said Friedman, "and we wanted them to learn about the benefits and technical help that membership makes available."

The outreach to China is already showing results. Both Jovian and the Automatic Test and Control Institute at the Harbin Institute of Technology have expressed interest in joining the PXISA.

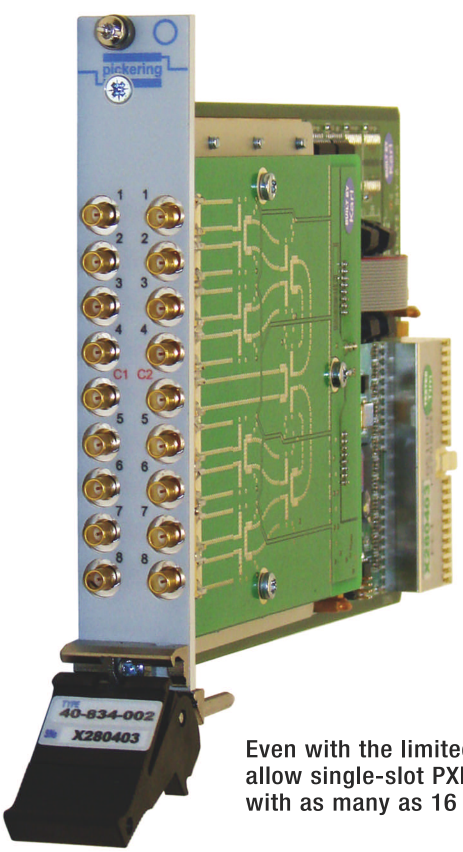
Technical chair Mark Wetzel noted, "I was impressed to see the tremendous interest in developing PXI modules and expect to see many new PXI products from Chinese companies in the near future." Friedman added that the activity in China underscores the fact that PXI is a global standard that is continuing to grow. □

RF switches for PXI begin proliferation

By Richard A. Quinnell, Contributing Technical Editor

Growing interest in PXI as an RF test platform has stimulated demand for high-density RF switching modules. The result has been a jump in the range of switch configurations available, with one drawback: The limitations of the PXI panel size can quickly force system developers into a tradeoff between performance and density.

Continual increases in the performance of signal-generator and data-acquisition modules, together with an expanded bus bandwidth, have brought RF testing well within the reach of PXI systems. In fact, manufacturers such as Aeroflex, Geotest, and National Instruments have developed a variety of PXI modules with RF test capabilities. To create a complete test system, however, developers need more than test modules. They need RF switches to help manage the test connections, and the higher the density, the better.



Even with the limited panel space, high-density connectors allow single-slot PXI modules to provide RF multiplexers with as many as 16 channels. Courtesy of Pickering Interfaces.

This need has prompted a dramatic increase in the number of offerings and range of configurations available for PXI RF switches. National Instruments, for example, nearly tripled its offerings during 2007. "We went from four switches to 15 last year," said NI's switches product manager Jaideep Jhangiani. "At 3 GHz, for instance, we started 2007 with only a 4x1 switch module. We have now added a dual 4x1, an 8x1, SPDT [single pole, double throw], and terminated dual-SPDT configurations."

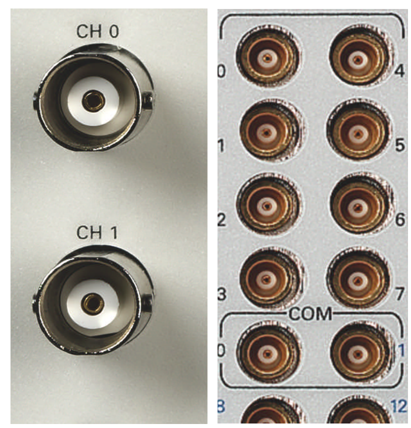
Pickering Instruments is offering an even more extensive range of products. "We have 30 to 40 products in a variety of configurations," said the company's marketing manager, Bob Stasonis, "and that's a big enabler for building RF test systems. A few years ago, we didn't have that capability." Other vendors of PXI RF switches include Aeroflex, Geotest, and Dow-Key Microwave.

Connectors force choices

Further growth in RF switching options faces a significant challenge, however, because of the space constraints on PXI cards. "PXI gives you a lot of functional density in a rack," said Mike Dewey, Geotest's senior product manager, "but it also has 0.8-in. spacing." This presents a particular problem for switching signals in the microwave end of the RF spectrum (typically considered to be frequencies above 5 GHz by switch vendors), where coaxial switches are the only option.

"You used to not be able to even fit a coaxial switch in a single-width PXI module," said Dewey, "but that is now changing. Vendors are downsizing their switch modules so you can fit a 1x2 in single width and a 1x4 in two slots."

The situation eases only slightly at frequencies in the 3-GHz range.



Moving from (left) a BNC connector to something like (right) an MCX connector offers greatly increased front-panel connector density although at the cost of performance and repeatability.

Courtesy of National Instruments.

Here, module vendors are able to use the smaller electromechanical relays in the signal path and are thus able to fit more switches onto a single-width module, but panel space still represents a significant limitation. This forces RF test engineers to choose between switching density and performance.

Two key performance metrics for RF switching are insertion loss through the circuit and return loss due to reflections at junctions within the switch. (Vendors remind developers to account for these losses throughout the entire circuit, not just in the switch module.) While careful layout and fabrication of the printed-circuit board within a switch module can help minimize these losses, the connectors themselves play a significant role.

The threaded SMA and the twist-lock BNC connectors provide better and more repeatable performance than the smaller, push-on SMB, SMX, and MCX connectors. The SMA and BNC connectors are also more familiar to most test engineers and so are easier to integrate into system cabling. The trouble is that they take up significantly more panel space for both the connector and finger access than the smaller alternatives; hence fewer ports will fit onto the PXI panel.

Vendors have responded to these limitations in different ways. Geotest, for instance, has chosen to concentrate on higher performance, and thus primarily uses BNC and SMA connectors. "We try to stay away from exotic mechanisms," said Dewey. "We may get lower density but also have a more robust connection."

Pickering Interfaces, on the other hand, has embraced the more compact SMX and SMB connectors. "We moved to higher-density connectors to lower the cost per channel," said Stasonis. "This now allows us to fit a 16-channel RF multiplexer onto a single 3U module."

The use of SMX and SMB connectors to achieve higher-density systems can present a challenge for test engineers who are unfamiliar with them, however. The engineers may need to create custom cabling or interface panels to match the switch module with the more traditional connectors on their other instruments, without having the experience or tools necessary for the task. Module vendors can help by providing support in designing or even fabricating the necessary interface panels and cables.

Regardless of the connector approach a vendor has taken, the expectation is that more RF switching options will be forthcoming as application needs grow. In addition to 50-Ω switches for traditional RF, vendors are increasing their 75-Ω offerings for high-frequency video and set-top box test. Pickering has recently introduced a balanced 100-Ω switch for Gigabit Ethernet, as well.

The bottom line for test engineers is to check with their vendors when developing a test system to learn whether any new switch options are forthcoming. "Talk with the vendors with the specs in hand," said Stasonis. "That way you can get the best of what is available." □

FOR MORE INFORMATION

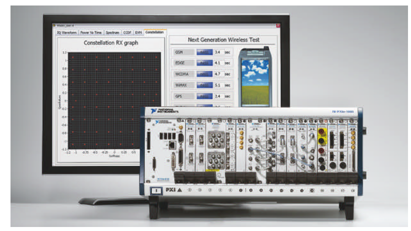
"PXI makes inroads into RF test," *PXI Test Report*, November 2007, p. 61. www.tmworld.com/2007_11.

PRODUCTS

NI extends PXI RF capabilities

National Instruments chose its NIWeek event in August to announce that it has extended the measurement range of its PXI RF instrument line-up beyond 6 GHz. The company debuted two instruments, the NI PXIe-5663 6.6-GHz RF vector signal analyzer and the NI PXIe-5673 6.6-GHz RF vector signal generator, as well as the NI PXIe-1075 18-slot high-bandwidth chassis.

Both PXI cards include 16-bit data converters, support OFDM and MIMO modulation schemes, and can test multiprotocol cellphones with radios meeting WiMAX, GPS, WCDMA, GSM,



EDGE, broadcast video, 802.11 WiFi, and Bluetooth standards. Because the cards are based on software-defined architectures, engineers can develop and test wireless protocols by simply reconfiguring the software by using LabView toolkits or writing their own modulation algorithms.

The NI PXIe-5663 RF vector signal analyzer handles signals from 10 MHz to 6.6 GHz with up to 50 MHz of instantaneous bandwidth. It also offers pass-band flatness and low phase noise for accurately measuring modulated signals

The NI PXIe-5673 vector signal generator delivers signal generation from 85 MHz to 6.6 GHz and uses direct RF upconversion to provide up to 100 MHz of RF bandwidth. An impairment mode enables engineers to use an onboard FPGA to manually adjust gain imbalance, I/Q offsets, and quadrature skew. With the card's baseband impairments optimized for a particular frequency, engineers can achieve better than −85 dBc of carrier and image suppression.

The NI PXIe-1075 chassis provides PCI Express lanes routed to every slot, providing up to 1 Gbyte/s per-slot bandwidth and up to 4 Gbyte/s total system bandwidth. It provides eight hybrid slots that can hold either PXI Express or PXI hybrid-slot-compatible modules. The chassis offers an operating temperature range of 0 to 50°C.

Base prices: PXIe-5663 vector signal analyzer—$22,999; PXIe-5673 vector signal generator—$23,999; PXIe-1075 chassis—$5999. *National Instruments, www.ni.com.*

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VIEWPOINT

[An exclusive interview with a technical leader]

ALAN HUMPHREY
President
Brüel & Kjaer North America
Norcross, GA

With more than 24 years of physical testing, simulation, and business management experience, Alan Humphrey joined Brüel & Kjaer in 2003 as president of the company's American operations. His career started in the automotive industry at Jaguar Cars, where he worked in R&D applications involving instrumentation, data acquisition, analysis, and simulation testing of components and full vehicles. In 1987, he moved to the US to work for MTS Systems, with management responsibilities focusing on the automotive, aerospace, and defense industries. Humphrey holds a BSc in mechanical engineering from the UK's University of Salford.

Contributing editor Larry Maloney conducted a phone interview with Alan Humphrey on the growing need for sound and vibration measurement in a wide range of applications.

Tools to tame noise and vibration

Q: What industries are driving the need for better control of sound and vibration?

A: There's quite a variety, including automotive, aerospace, defense, telecom, audio, office equipment, consumer goods, and heavy industry. Another growing area is "community comfort," which targets the control of environmental noise from many sources, such as airports, roads, rail yards, and construction sites.

Q: Are tougher government regulations also a factor?

A: Many of the product areas I've mentioned are heavily regulated by national and international standards and legislation, such as occupational safety, health regulations, and product noise-level requirements. It may come as a surprise that hearing loss from workplace noise is second only to the broad category of "disorders of the locomotor system" on the list of occupational diseases. As a result, many countries have implemented hearing conservation programs to assess and control noise problems. Companies that fall under these regulations must manage, retrieve, and report data on noise measurements, as in cases where worker claims are filed.

Q: How do your products help customers address these challenges?

A: A good example is our recently released LAN-XI data-acquisition hardware. You can deploy this equipment to make multichannel measurements using several large-rack systems, or you can make a simple two-channel measurement using a single module. Running on AC, DC, or Power over Ethernet (PoE), this modular hardware can operate as a stand-alone instrument or as part of a distributed setup, such as in an aircraft application.

Our Type 2270 handheld analyzer offers two-channel measurement capability, LAN and USB interfaces, a ruggedized design, and an integrated digital camera to document the measurement environment, such as a construction site or an automotive test lab. It serves many purposes, including sound-level metering, real-time frequency analysis, and sound and vibration recording.

Q: What is the purpose of your noise, vibration, and harshness (NVH) center in Canton, MI?

A: We set up this new facility with our partners, Material Sciences and Link Engineering, to support customers who must address noise and vibration issues in such industries as automotive, medical, and appliances. Staffed by experienced NVH engineers, the research center helps customers with applications and also trains them to do their own testing. State-of-the-art equipment includes a hemi-anechoic chamber equipped with a four-wheel-drive dynamometer to test light-duty trucks. A Sound Transmission Loss (STL) suite features a large hemi-anechoic chamber, as well as reverberant chambers for transmission loss testing of horizontal panels, such as floor and carpet systems, as well as vertical panels and firewalls.

Q: Do customers also use your equipment to design in sound characteristics that enhance the customer experience?

A: That's the part of our business we call "sound quality," and it is a growing segment. For example, we offer special modules and NVH simulators for the automotive industry to help engineers achieve sound characteristics that correlate to consumer perceptions of quality, such as the sound that a car door should make when it closes.

Many companies today want to differentiate themselves based on the acoustic characteristics of their products, whether it's a quiet dishwasher or the sound of a high-performance engine. T&MW

Alan Humphrey addresses more questions on sound and vibration applications, including environmental noise, in the online version of this interview: www.tmworld.com/2008_09.