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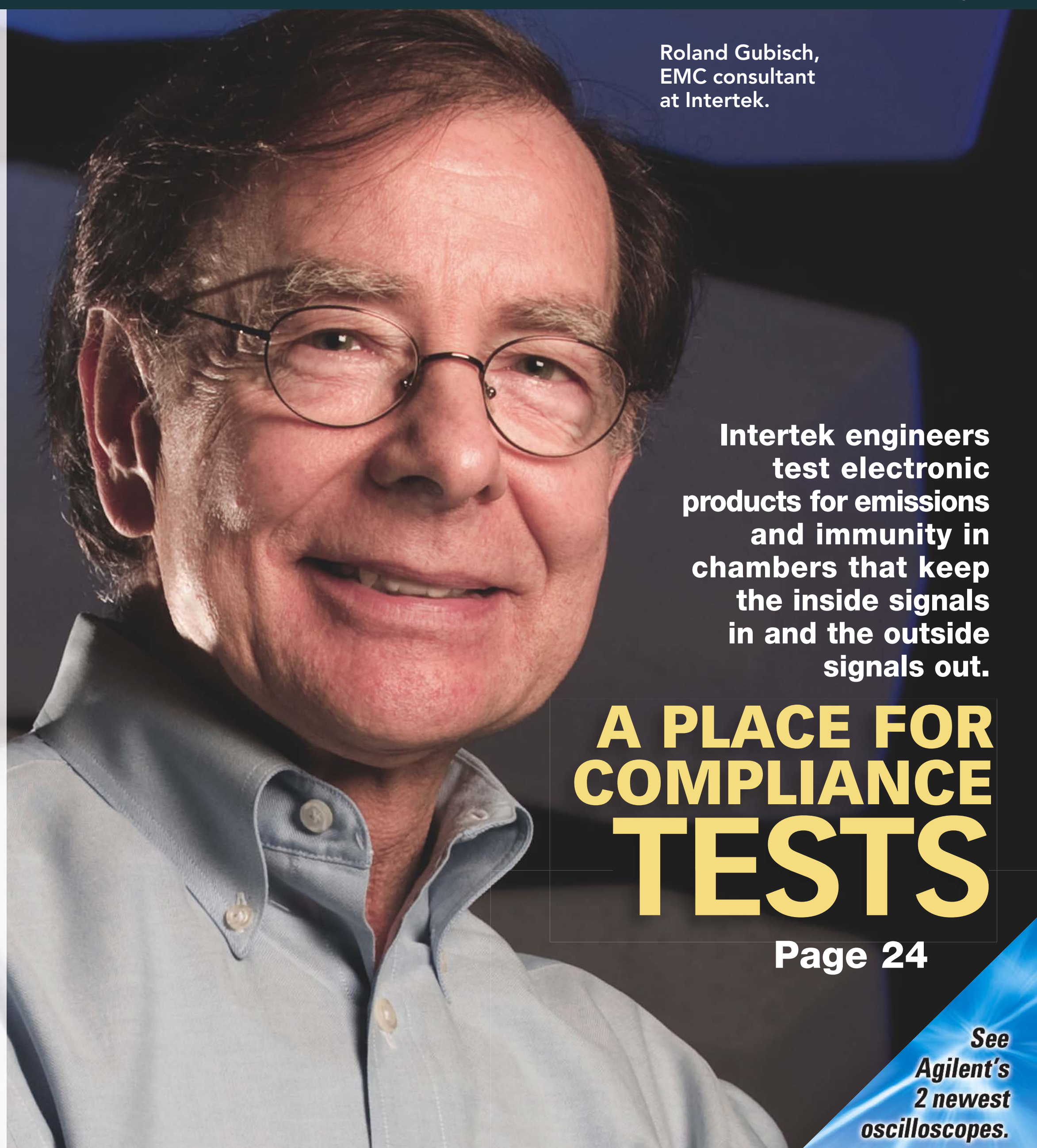

Roland Gubisch, EMC consultant at Intertek.

Intertek engineers test electronic products for emissions and immunity in chambers that keep the inside signals in and the outside signals out.

A PLACE FOR COMPLIANCE TESTS

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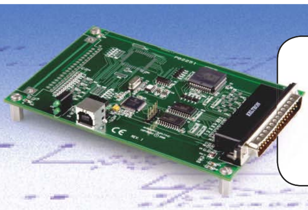

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RICK NELSON
EDITOR IN CHIEF

GM's meaningless 230-mpg spec for Volt

General Motors seems intent to focus on marketing hocus-pocus rather than trying to build and sell better cars. The latest is the outlandish claim that the Chevy Volt will get 230 mpg. According to the *New York Times* (Ref. 1), "The rating number, based on methodology drafted by the Environmental Protection Agency, is somewhat abstract…" in which "abstract," I assume, is equivalent to "meaningless." I think the proper phrase would be "…based on a *mythology* drafted by the EPA…." And not to be outdone, Nissan is claiming its Leaf will get 367 mpg using GM's formula.

According to the *Wall Street Journal* (Ref. 2), GM said the Volt will require 25 kW-hr per every 100 miles driven. Let's do the math: You can get about 39 kW-hr from a gallon of gas, but the efficiency of the internal combustion engine can't be more than about 30%, and then you'll lose a few percent in the electric generator. Let's be generous and say you might get about 15 kW-hr/gallon into the battery, which would only get you about 60 miles. Even if you consider as "free" the 40 miles you can drive the Volt on an overnight charge, you'll still be out a gallon of gas after 100 miles.

The GM/EPA mythology is based on expectations of how customers will drive the Volt.

The GM/EPA mythology is based on expectations of how customers will drive the Volt. Eight of 10, GM suggests, will not drive more than 40 miles per day and therefore, I take it, will get infinite gas mileage. It seems to be the other two of 10 that degrade the rating down to 230 mpg.

Now, I think it's going to be pretty much impossible to get the current generations of customers to start thinking in terms of kilowatt-hours per mile or petroleum equivalency figures. And I have commented (Ref. 3) that it would be desirable, but highly unlikely, to get them to think not in terms of miles per gallon but rather in terms of gallons per mile—a switch that would make it easier to see that an improvement from 14 to 24 mpg saves considerably more fuel than an improvement from 24 to 46 mpg. Nevertheless, some form of mpg equivalent for all-electric and hybrid vehicles is probably necessary.

And to be fair, the EPA says it hasn't tested the Volt and can't vouch for GM's claim. But when the EPA does come up with a formula and conducts the test, it should produce a much more realistic figure than the one GM is touting for the Volt. Fantastic claims of vehicle mileage will only discourage customers from choosing vehicles that offer significant, but not astronomical, energy-consumption-per-mile performance. T&MW

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2. Terlep, Sharon, "GM Hopes Volt Juices Its Future," *Wall Street Journal*, August 12, 2009. online.wsj.com/article/SB124998537270122333.html.

3. Nelson, Rick, "Taking the measure of gas mileage," *Test & Measurement World*, June 2, 2009. www.tmworld.com/blog/640000064/post/230045223.html.

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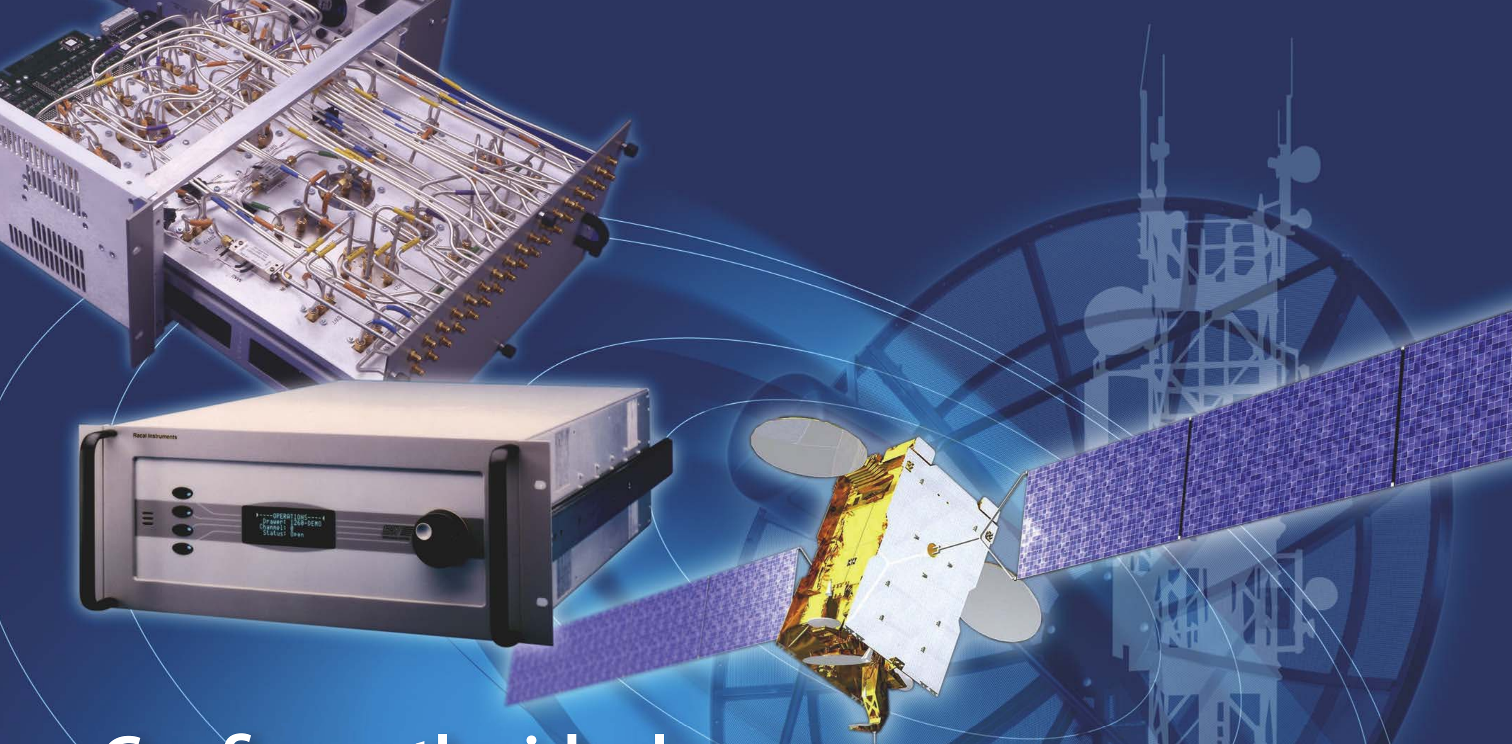

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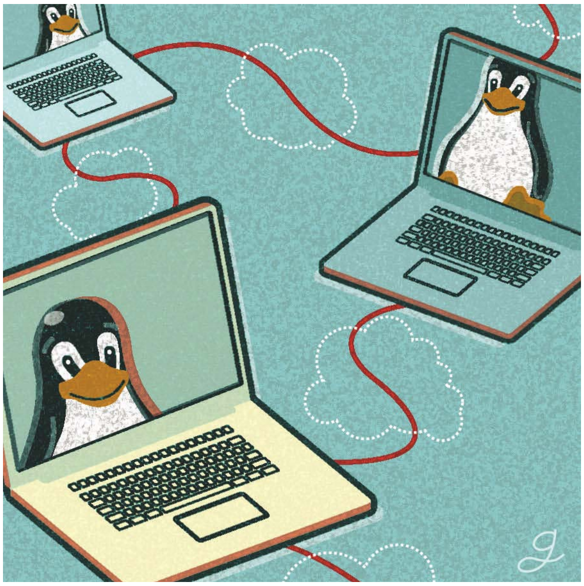
[An exclusive interview with a test engineer]

Linux works for test

Anshul Jain is assistant manager of test engineering at Tejas Networks. Based in Bangalore, India, Tejas Networks develops and manufactures optical networking switches. Jain is responsible for all test-engineering development, quality-assurance testing, and final deployment of Linux-based test systems for manufacturing. Martin Rowe conducted an e-mail interview with Jain about his work in Bangalore.


DANIEL GUIDERA

Q: What kinds of tests do your systems perform?
A: We have three test platforms. A parametric and data-path testing station is primarily a functional test platform that performs traffic testing at various SDH/SONET bit rates. We test with Gigabit Ethernet traffic and measure parameters such as frame sizes, frame rates, frame errors, and frame counts. Parametric testing includes line-card parameters such as output jitter, jitter tolerance, pulse mask, eye pattern and extinction ratios, optical spectral analysis, and return loss.

Our engineers use a power-supply test platform on the bench to test AC and DC power supplies that go into our systems. Tests include power-related measurement parameters such as load testing at various voltages. We also test for voltage-cutoff points—the lowest voltage that will keep our systems running.

Q: Why did you choose to use Linux as your operating system?
A: We chose Linux as the test platform because of hardware costs, software costs, and support. We minimize hardware costs because Linux runs on systems with minimal resources. With Linux, we can run PCs that are three or four years old. Windows requires more resources to run our test systems, requiring more powerful PCs. Because Linux is free, we don't need to purchase an operating-system license for every PC.

Q: What kind of support do you get for a free operating system?
A: We found that we can get good product support for Linux-based software. For example, LabView for Linux includes installers for GPIB and VISA protocols. These installers are very stable, which we need for extended manufacturing cycles. In addition, we successfully leverage the vast amount of knowledge available on open-source forums and communities.

We also run our software development, diagnostics, and FPGA design on Linux-based computers. As a side benefit, engineers were able to show management that Linux is a viable option for desktop users.

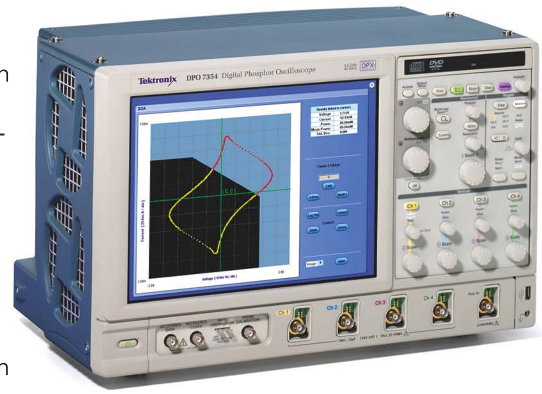
Q: What Linux tools do you use in addition to LabView?
A: We have standardized our test-deployment platforms on the Mandriva 2008 Spring and openSUSE 11.0 Linux distributions. Both are free and readily downloadable. Other than LabView, we use several open-source products for test development. The Linux-based tools include Subversion for source-code control. It integrates seamlessly with LabView and lets us perform distributed code development across several platforms.

We employ Linux shell programming scripts. Several of the scripts let contract manufacturers interface their inventory tracking databases to our LabView application. We've also created some report-generation programs based on OpenOffice for our test reports.

Because Linux is a very flexible operating system, we can use utilities such as mklivecd/draklive by Mandriva and Kiwi by openSUSE to build customized images that include VISA and GPIB instrument drivers. We can then load the images into our test stations for installing new systems and upgrades. 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. To read past "Test Voices" columns, go to www.tmworld.com/testvoices.

Tektronix offers options for 10GBase-T compliance tests



With the release of its XGbT test-automation software and test fixtures, Tektronix has introduced what it calls a "one-button solution" for performing 10GBase-T measurements. The options, when added to the company's DPO7000 series and DPO/DSA70000 series real-time oscilloscopes, allow customers to perform the necessary tests with a single instrument.

Compared to other test methods, which require an oscilloscope, a vector network analyzer, and a spectrum analyzer, Tektronix says that its oscilloscope and software option provides easier test setup and more repeatable results. This is especially important, according to the company, in distributed engineering environments where repeatable test methods are required across different groups using different test equipment. Tektronix says its solution conforms to 10GBase-T PHY electrical-testing specifications.

"The need for an improved 10GBase-T solution spans chip makers, product developers, and manufacturers around the world," said Brian Reich, VP, performance oscilloscopes, at Tektronix. "With our XGbT software and fixtures, we are delivering an affordable one-button solution that can perform repeatable conformance and validation tests at the press of a button, making it ideal for both design and manufacturing applications."

Jon Beckwith, R&D engineer at the University of New Hampshire InterOperability Laboratory, commented, "We are closely working with Tektronix to validate the one-button approach. Joint testing performed on a customer device shows that this method of testing correlates extremely well with the expected results." www.tektronix.com.

Editors' CHOICE

Curtiss-Wright Controls debuts FPGA-based frame grabber

Curtiss-Wright Controls Embedded Computing has introduced the XMC-270 rugged, high-resolution frame grabber and video-capture XMC card, which the company reports is suitable for use in aerospace and defense applications. The XMC-270 delivers analog and digital video-capture functionality as well as serial connectivity through a built-in PCI Express core. A Xilinx Virtex-5 FPGA enhances the card's functionality and permits it to be customized.

Available in both air- and conduction-cooled versions, the XMC-270 supports high-resolution digital and analog video formats, including legacy interlaced analog video. The card can transfer raw video data in a variety of color depths, including 8-bit YCbCr as well as 32- and 16-bit RGB formats and 8-bit mono (green only) format. It provides a range of video-capture features, including full frame rate, reduced frame rate (user programmable), and snapshot. The XMC-270 supports a range of video-capture inputs. Software support for the XMC-270 includes a capture driver, which enables a system designer to control the card's hardware capabilities. This software can be used either in standalone mode or can be integrated with other Curtiss-Wright Controls' graphics software.

Base price: $5683. *Curtiss-Wright Controls Embedded Computing, www.cwcembedded.com.*

Mentor Graphics acquires LogicVision

Mentor Graphics and LogicVision report that LogicVision stockholders have voted to approve, and the parties have closed, the merger agreement they announced in May. Former LogicVision stockholders will receive 0.2006 share of Mentor Graphics common stock in exchange for each share of LogicVision common stock.

LogicVision is a provider of BIST (built-in self-test) technologies for testing SOC (system-on-chip) designs. By combining Mentor's ATPG (automated test-pattern generation) and embedded test-pattern compression technology with LogicVision's BIST products, Mentor will be able to help customers address the test challenges of the digital logic and memory portions of their silicon designs as well as high-speed Serdes analog and DDR-based interfaces. LogicVision's test bring-up and silicon characterization tools—combined with Mentor's failure-diagnosis capabilities—will also help customers accelerate yield ramps, reducing time-to-volume.

Editors' CHOICE

LabView takes on software development

In the latest version of LabView, LabView 2009, National Instruments has added toolkits that focus on software design and validation and has also given users more control over multiple processor cores. Other new features focus on wireless signal testing.

The Unit Test Framework Toolkit automates and documents test-code validation by letting you enter known-good and known-bad values into a VI (virtual instrument), so you can see how your code performs with both in-spec and out-of-spec values. The Desktop Execution Trace Toolkit lets you trace the execution of a LabView application running on Windows. It detects and locates problems in your code that could affect performance or cause unexpected behavior.

The VI Analyzer Toolkit lets you configure more than 60 tests for automated code review and static code analysis of all VIs in an application. The tests look for proper documentation and code references that open but don't close. The Requirements Gateway helps you manage software requirements by comparing requirements stored in multiple different formats to how you implement them in LabView code.

LabView 2009 also gives you additional power over multicore processors. For example, the parallel for-loop functions let you run for-next loops on different processor cores. Thus, you can make sequential processes run in parallel. Other toolkits for LabView 2009 let you test wireless devices such as GPS, WiMAX, and WiFi for standards' compliance.

Base price: $1249. *National Instruments, www.ni.com/labview.*

"Our customers are facing significant new test challenges as they move to each new technology node," said Walden C. Rhines, chairman and CEO of Mentor Graphics. He continued, "Combining our industry-leading ATPG and embedded compression with the LogicVision memory and logic BIST technologies enables our customers to maintain high product quality and test standards, while reducing manufacturing costs and improving profitability."

LogicVision resources will be integrated into the Silicon Test Solutions group within the Mentor Design-to-Silicon division led by VP and GM Joseph Sawicki. The division also includes the Olympus-SOC and Calibre product groups. www.mentor.com.

CALENDAR

International Test Conference, November 1–6, Austin, TX. *IEEE, www.itctestweek.org.*

Vision 2009, November 3–5, Stuttgart, Germany. *Messe Stuttgart, www.messe-stuttgart.de/vision.*

Productronica, November 10–13, Munich, Germany. *Messe München, productronica.com.*

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

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CAST supports cooperation among ATE firms

Despite economic pressure, semiconductor test firms remain committed to R&D, according to comments at the Semicon West Executive Test Summit (July 14, San Francisco, CA). Keith Barnes, chairman, CEO, and president of Verigy, summed up the mood, saying, "…our R&D budget is under some pressure, but we're still committed to innovation." R. Keith Lee, president and CEO of Advantest America, said the company has significant cash reserves that let it maintain a strong R&D effort. Mark Jagiela, president of the Semiconductor Test Division of Teradyne, is looking to address time-to-market and yield improvement, while Dave Tacelli, CEO and president of LTX-Credence, is focused on innovation that keeps down the cost of test.

The T5385 offers 768-DUT parallel test capacity and the ability to deliver 533-Mbps performance. Courtesy of Advantest

The companies didn't make major product introductions during Semicon West, but Verigy shortly before the show introduced the V101 zero-footprint, 100-MHz system for wafer sort and final test as well as its Yield Learning Solution software, which, when used with the V93000, integrates on-tester, real-time capture and analysis of electrical failures on SOCs. And shortly after the show, Advantest debuted its T5385 system for DRAM wafer test.

Whether each ATE (automated test equipment) company can continue to afford sufficient R&D to meet customer demand is an open question. One goal of the now-defunct STC (Semiconductor Test Consortium) was to foster precompetitive cooperation on R&D initiatives. Efforts to get ATE suppliers—and their customers—to cooperate is now continuing with CAST (Collaborative Alliance for Semiconductor Test), which got its start at a private meeting at Semicon West 2008. CAST went public at the 2008 International Test Conference and subsequently organized as a special interest group within SEMI, Semicon West's organizer.

In an interview at this year's Semicon West, Mark Roos, CEO of Roos Instruments, commented on the end of the STC and the beginning of CAST. Intel and Advantest were instrumental in the formation of STC, and Roos said that heritage caused the organization to be closely identified with microprocessors and the Advantest-based OpenStar ATE mainframe architecture. Consequently, said Roos, whose firm was a member of STC and is a member of CAST, STC failed to gain the participation of the other big-iron ATE companies—except for some limited individuals' participation in tester-interface standardization efforts.

CAST, said Roos, now has full participation from all the major test companies. To signal its full separation from STC, Roos said, CAST founders decided the group should be aligned with an independent organization such as IEEE, GSA (Global Semiconductor Alliance), or SEMI. GSA and SEMI seemed most promising, Roos said, because CAST founding companies tend to be members of these organizations, while the IEEE membership consists of individuals. Ultimately, the founders settled on SEMI, in the expectation that the ATE companies, who tend to be members and supporters of SEMI, would be doing the bulk of the work, under consultation with their semiconductor-manufacturing customers, who tend to be GSA members. T&MW

Fulitech joins Goepel partner program

Goepel Electronic has announced the incorporation of Fulitech, based in Shenzhen, China, into Goepel's GATE (Goepel Associated Technical Experts) global-alliance program. The focus of the program is the development and practical implementation of new products and modules based on boundary-scan instrumentation as well as enhancements in the integration of boundary-scan products into existing test systems. www.fulitech.com.cn; www.goepel.com.

BGA socket offers low loss

Ironwood Electronics has introduced a BGA socket for 1.0-mm pitch BGAs. The SG-BGA-8019 socket is designed for a 35-mm package size and operates to 10 GHz with less than 1 dB of insertion loss. The socket is designed to dissipate 16 W with its swivel heat-sink lid. Contact resistance is typically 20 mΩ per pin. The temperature range is –40°C to +100°C, pin inductance is 0.15 nH., capacitance to ground is 0.10 pF, and current capacity is 2 A per pin. www.ironwoodelectronics.com.

Compal selects Teradyne TestStation LH

Teradyne has announced that Compal Electronics has ordered multiple Teradyne TestStation LH in-circuit test systems to test its latest generation of high-volume notebook and netbook products. Compal will make use of TestStation's Framescan vectorless test technologies and its SafeTest protection technologies for low-voltage components. www.compal.com; www.teradyne.com.

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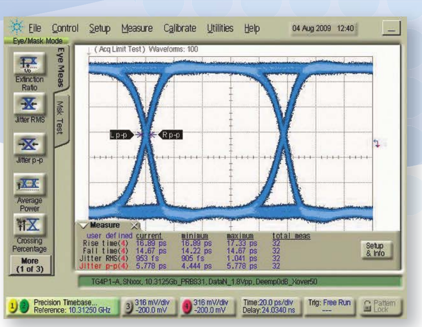

TG4P1-A output at end of a 3' cable: 10.3125Gb/s PRBS31 pattern, 1.8Vpp output, 50% crossover, 0VDC offset, 0dB de-emphasis.

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LARRY MALONEY
CONTRIBUTING TECHNICAL EDITOR
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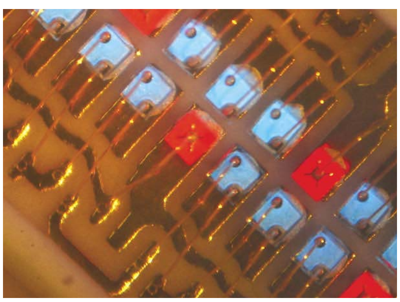
New building blocks for LED lighting

Smaller IC packages, ball-grid arrays, and a variety of solder pastes are prompting electronics engineers to look for better, more dependable lighting solutions for machine vision.

"The quality-control requirements in electronics for catching every single defect are very high," said Brian Merz, sales engineering manager for StockerYale, which manufactures fluorescent, laser, and LED illumination sources. "In that industry, a lot of very smart engineers are working on inspection systems, and they put every possible solution through its paces."



With COB packaging, LED chips can be placed on circuit boards in high-density arrays, creating illuminators that are compact, uniform, and extremely bright.

Merz, whose machine-vision experience also includes applications engineering work with lighting manufacturer CCS America and automation systems integrator Axis New England, sees an increasing interest in LED lighting for electronics applications. Not only do LED illuminators offer reliable and controllable illumination, but their designs can also be customized to fit the application.

Yet, because of their larger size and integrated optics, conventional surface-mount and through-hole LED illuminators sometimes fall short in tough electronics inspection applications, particularly when high intensity is required. To address that issue, more lighting companies now offer COB (chip-on-board) LED products. In these designs, LED chips are attached directly to the conductive tracks of the PCB (printed-circuit board).

In StockerYale's patented COBRA (chip-on-board reflective-array) design, the LED semiconductor dies almost touch one another, providing a very high level of intensity—up to 1 million lux—in a very compact footprint. The efficiency of this line-scan illuminator is further enhanced by placing a miniature reflector around each LED, which focuses more of the light forward where it is needed.

"Customers in the electronics and flat-panel industries tell us that we make the brightest LED lights they've ever seen," said Merz. "COB also offers great advantages in customization because you start with the most basic LED building blocks."

Merz pointed out that new COB designs also enhance LED longevity, which is already a prime reason why engineers switch to LEDs from other lighting options. For example, halogen bulbs typically last less than 3000 hr. In contrast, tests that StockerYale has conducted on its COBRA product have shown less than a 5% change in light output over 10,000 hr of service for the standard 630-nm model. Each individual COBRA Slim 100-mm substrate, containing well above 100 LEDs, also has its own temperature-monitoring system. If the unit overheats, then it automatically shuts down and an alarm signals a fault condition. Among other advantages, a simple 0–5-V control lets users adjust the brightness of all COBRA LEDs simultaneously.

As for costs, these COB-based LED lights occupy the middle ground between less-expensive fluorescent and halogen illuminators and costlier laser-based lighting. Yet, Merz predicts steady growth of COB LEDs, even in high-end electronics inspection. Said Merz: "IC and PCB inspection are definitely in our sweet spot, as are solar wafers and flat-panel displays." T&MW

Read past Tech Trends columns at www.tmworld.com/techtrends.

Software models vision options

Before investing in hardware, engineers can now simulate machine-vision applications with Vision System Designer software. The new tool from SensorDesk lets you model your design by combining various lenses, cameras, and light sources in a virtual 3-D environment. You can view simulated images of inspected objects as seen by the sensor and calculate performance characteristics like resolution, motion blur, and perspective distortion. www.sensordesk.com.

High-speed camera targets PCBs

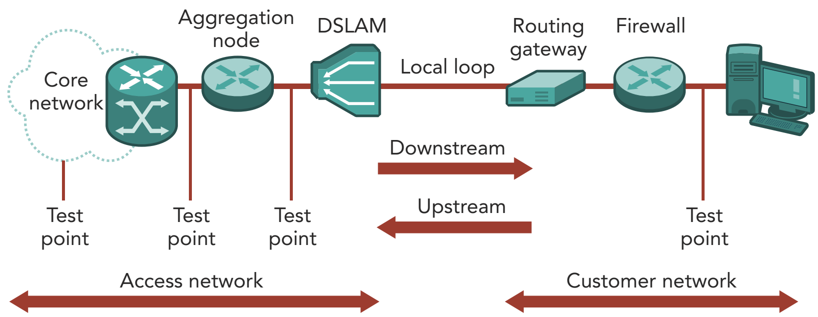
Dalsa has cited inspection of circuit boards, solar cells, and flat-panel displays as prime applications for its new Piranha HS 110-kHz camera. The new, high-speed Camera Link model features a 4k resolution, a 14x14-µm pixel size, and throughput of up to 640 Mpixels/s. It also offers Dalsa's TDI (time delay integration) technology, which reduces operating costs and allows for low-light imaging. www.dalsa.com.

Large-format lenses work with megapixel sensors

Navitar says that its new 50-mm large-format machine-vision lens is ideal for use with full-frame 11- and 16-Mpixel sensors. The Raptar lens has a focusing range of 0.5 m to infinity, a manual iris and focus control, an aperture range of f/2.0 to f/22.0, and an angular field that is 46.0° diagonal and 37.0° horizontal. www.navitar.com.

COMMUNICATIONS TEST

Verify Ethernet networks



Test points for DSL access range from the customer's network to the carrier's core network.

Ethernet is everywhere, from home networks to carrier networks. Service providers need to test Ethernet links between their carrier networks and access networks such as DSL. Testing Ethernet-based networks for QoS (quality of service) involves making packet jitter, throughput, latency, and frame-loss measurements.

All of these measurements can indicate delivery problems, particularly when a network carries voice or video. For example, too much packet jitter—the difference in delays between packets in a stream—can result in dropped packets, which can produce gaps in audio reception or blocks in video.

Ethernet testing is based on RFC 2544, which defines a set of test methodologies that carriers use to test Ethernet networks (Ref. 1). The **figure** shows several test points in the carrier's access network and at a customer's network.

Tests involve measuring parameters such as latency and throughput at any two points. Depending on the customer (business or residential), an Ethernet packet header may contain QoS bits that define the level of service that the carrier must provide. Three bits, called PCP (priority code point), indicate a frame's priority. Packets carrying video, for example, will likely get a higher priority than packets carrying data because of video's susceptibility to lost packets or excessive packet jitter.

To learn more about Ethernet testing, read "Basic connectivity testing and service verification," by Andy Hight, product manager at Sunrise Telecom; the paper is available from the online version of this article at www.tmworld.com/2009_09.

Martin Rowe, Senior Technical Editor

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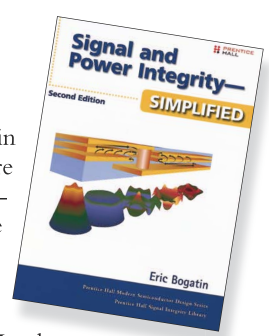
BOOK REVIEW

It's the interconnects that count

Signal and Power Integrity—Simplified, 2nd ed., by Eric Bogatin. Prentice Hall Pearson Higher Education (www.informit.com/ph), 2009. 757 pages. $99 hardcover, $75 download.



Signal and Power Integrity—Simplified is one of the better technical books I've ever read. I rank it right alongside Doug Smith's *High Frequency Measurements and Noise in Electronic Circuits* and Bonnie Baker's *A Baker's Dozen: Real Analog Solutions for Digital Designers.* Bogatin really does simplify complex concepts, and you'll walk away from this book feeling that you understand how interconnects (connectors, cables, wire bonds, PCB traces, etc.) affect signal integrity at high frequencies. He spends a chapter each on the four important concepts—resistance, capacitance, inductance (self and mutual), and transmission lines—and how they distort signals.

Bogatin, a signal-integrity engineering consultant, doesn't let you get lost in the math behind these concepts, yet he provides enough to clarify his points. After explaining the basic concepts, Bogatin applies them as he discusses more complex concepts such as attenuation, crosstalk, and differential pairs. The second edition adds chapters on S-parameters and power-distribution networks. Bogatin added this information because digital designers can no longer think in the time domain and they must consider how a product's power distribution can cause signal degradation.

Signal and Power Integrity—Simplified has more of a flow to it than most technical books. Much in the way lessons are presented in engineering school, the book builds on concepts from the early chapters and applies them later. In chapter 12, "S-Parameters for Signal Integrity Applications," Bogatin shows how you can apply S-parameters to transmissions lines, which he discussed in chapter 7. Because of the book's continuity, you can actually read it from beginning to end and build your knowledge along the way

Martin Rowe, Senior Technical Editor

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Pulse generator aids IC testing

You can build a circuit that generates up to three pulses for programming an IC's pin.

By Kevin Frick, Maxim Integrated Products, Sunnyvale, CA

As ICs increase in complexity and decrease in size, their pin counts drop or, at best, remain constant. The result: a need for pin-saving measures like serial programming. In the past, multiple pins might have been available for programming an IC's current or voltage limit, but today's ICs often encode that limit as a set number of pulses on a serial line.

You can generate pulses that program an IC's pin, but you usually need a microcontroller or arbitrary waveform generator. The circuit in **Figure 1** can help when you don't have either one. Consisting of a quad op amp, a logic gate, a pushbutton switch, a debounce circuit, and a D flip-flop, the circuit generates 500-Hz bursts of one, two, or three pulses.

In the oscillator section, the integrator (U1A) produces a triangle wave at its output (Ref. 1). That, in turn, enables U1B to produce an output square wave with a 50% duty cycle.

In the switch-debounce and timing-latch section, pushbutton switch S1 connects to a switch debouncer (U2), which provides a noise-free output signal for driving the D flip-flop. The D-input logic level passes to the Q output only on the rising edge of the CLK signal. The one-shot section is also timed with the rising edge of the CLK signal. The one shot forces the output pulses from U4, whether single or multiple, to have the same width.

In the one-shot section, a third op amp from U1 sets the number of pulses that the circuit will generate. The flip-flop output pulls the C4 voltage high, driving the positive input of U1D high. The U1D output then goes high, and sets the voltage on its positive input via the R8/R9 divider. Current through the R10-R13 network and C5 then produces an increasing voltage across C5 as it charges. When the voltage at U1D's negative input exceeds that of its positive input, the U1D output goes low.

The output signals from U1B and U1D connect to an AND gate, whose

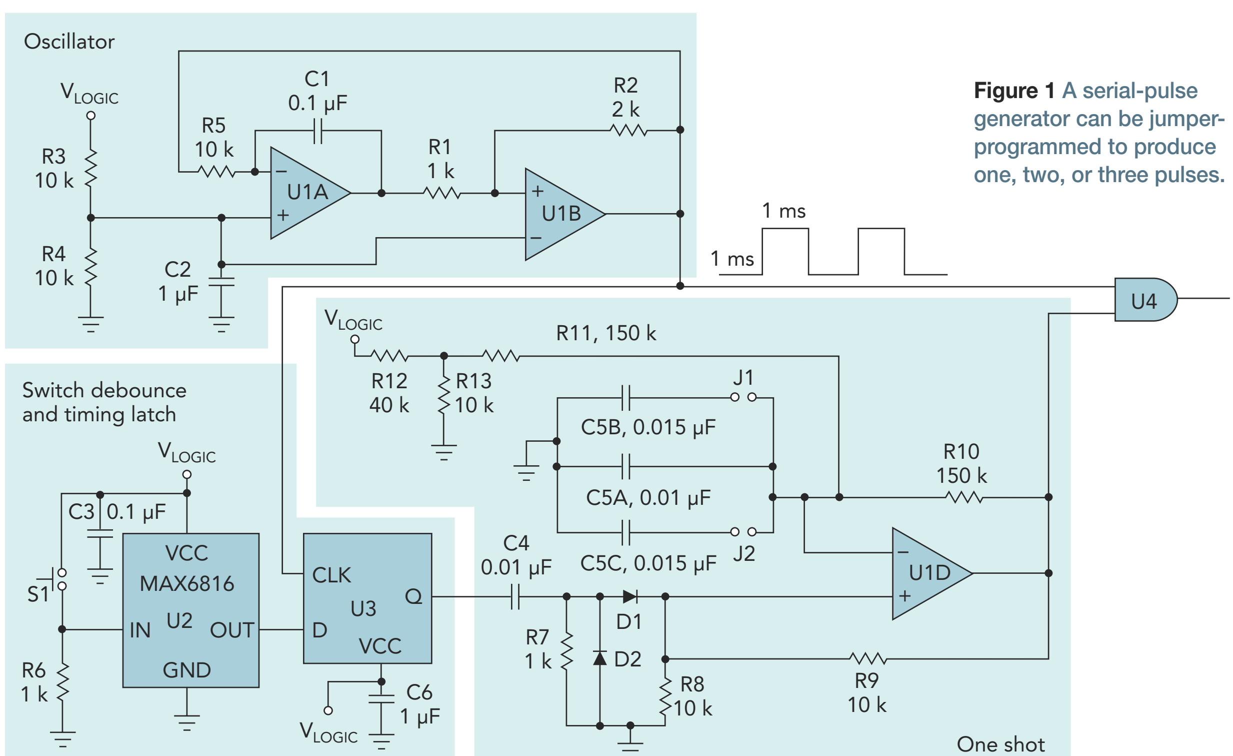

Figure 1 A serial-pulse generator can be jumper-programmed to produce one, two, or three pulses.

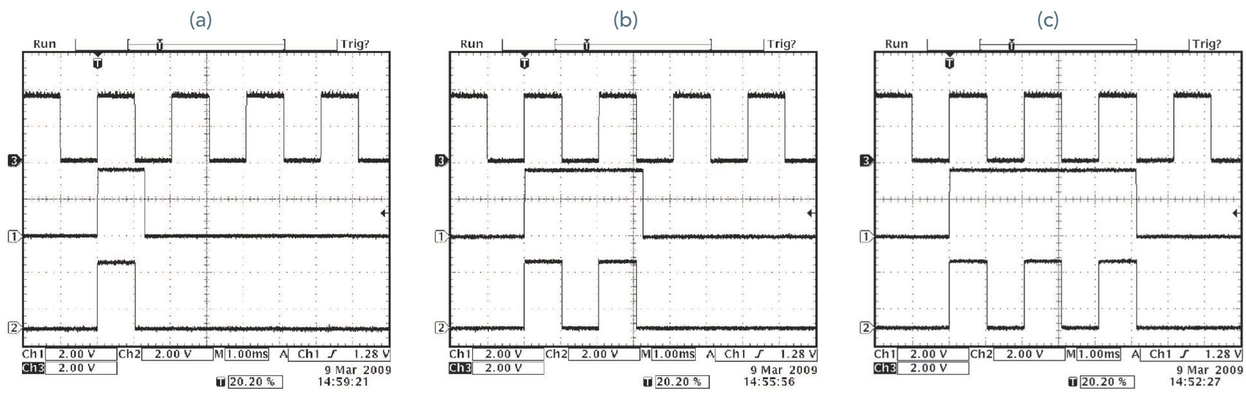

Figure 2 The Figure 1 circuit operates with (a) single pulses, (b) double pulses, or (c) triple pulses. The waveforms are the U1B output (top), U1D output (middle), and U4 output (bottom).

500-Hz output persists for an interval that allows just the number of pulses required. **Figure 2** shows the waveforms associated with one-, two-, and three-pulse outputs. Two jumpers (J1 and J2) set the number of pulses by altering the value of C5. Leaving both J1 and J2 open allows one pulse at the AND-gate output, closing (shunting) J1 only allows two pulses, and shunting both jumpers allows three pulses. T&MW

REFERENCE

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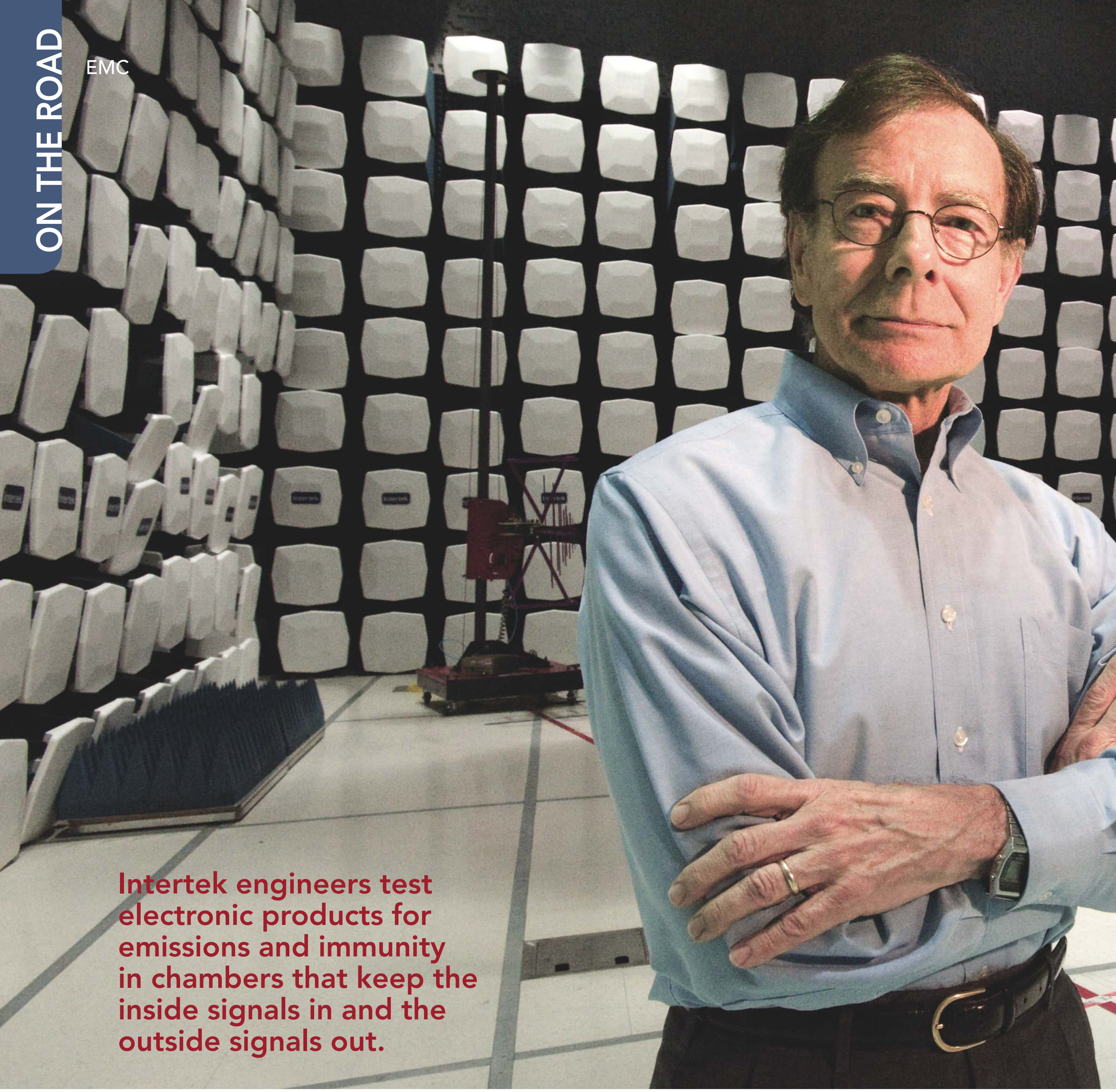
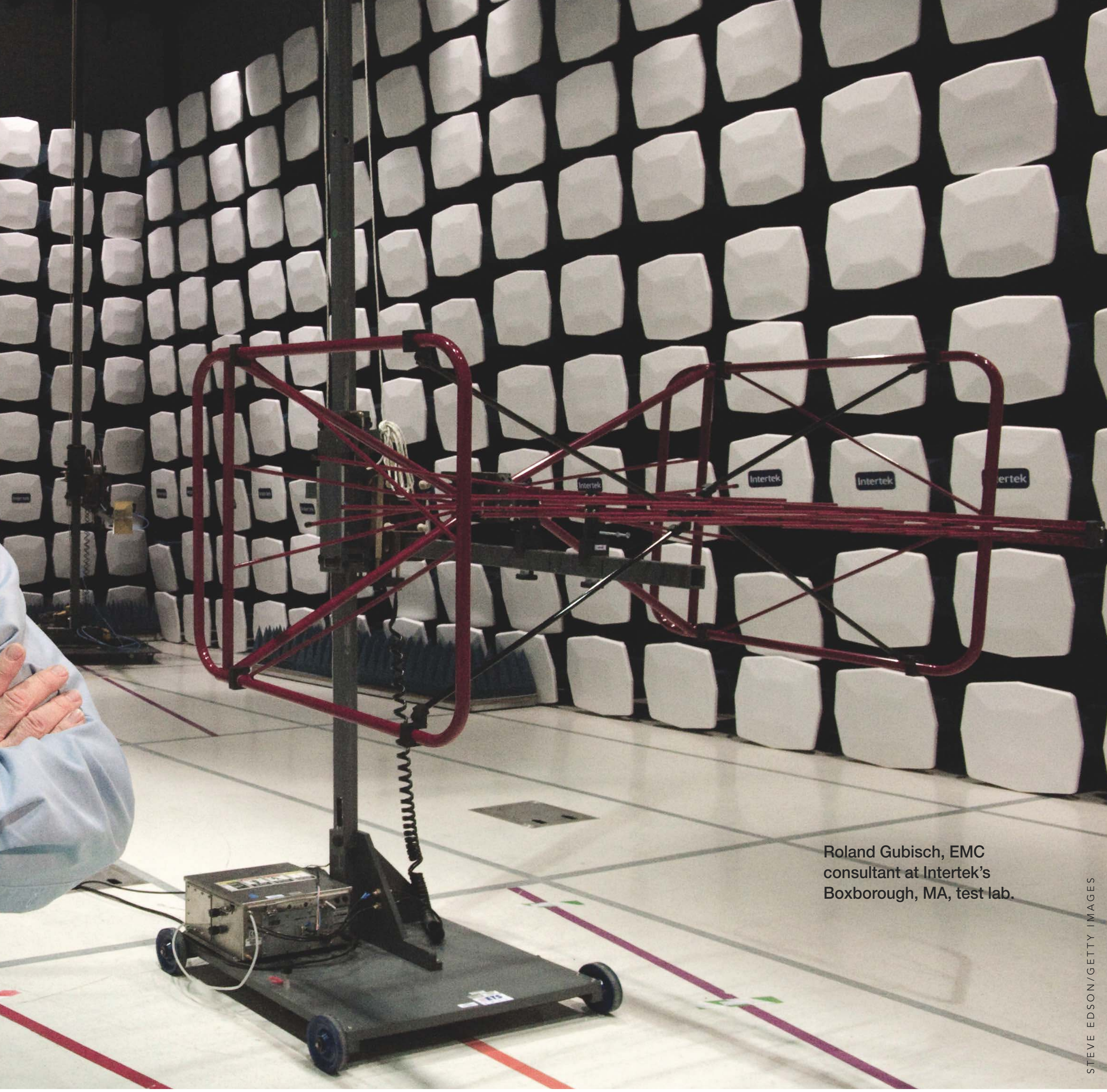


Intertek engineers test electronic products for emissions and immunity in chambers that keep the inside signals in and the outside signals out.

A place for COMPLIA

BOXBOROUGH, MA—On September weekends, people flock to this town and those around it to pick apples and other types of fruit. During the week, engineers from numerous manufacturers come here to test the fruits of their labor at any of several labs, including one run by Intertek.

At the Boxborough facility, which is one of many Intertek labs worldwide, engineers perform compliance and precompliance tests for EMC (electromagnetic compatibility) and safety as well as numerous other types of tests, including radio tests, environmental tests, telecom compliance tests, and laser-performance tests. Products that come through the lab include automotive components, military components and systems, home appliances, industrial products, consumer electronics, aerospace subsystems, telecom and wireless products, and medical equipment.



Roland Gubisch, EMC consultant at Intertek's Boxborough, MA, test lab.

STEVE EDSON/GETTY IMAGES

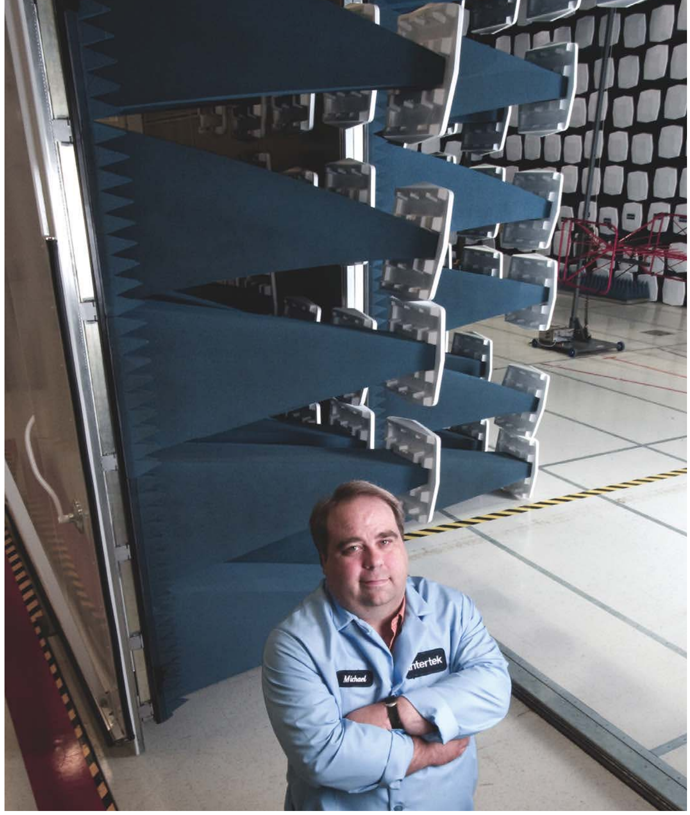
ANCE TESTS

BY MARTIN ROWE
SENIOR TECHNICAL EDITOR

My visit to the lab focused on the company's EMC and radio RF performance testing. Compliance tests that Intertek performs include those for FCC, UL, CSA, CENELEC, ANSI, military, and automotive standards. The Boxborough facility is also a Telecom Certification Body for the US and Canada, and a Notified Body for European EMC and radio testing.

The facility includes a lab that contains screen rooms, shielded rooms, a GTEM (gigahertz transverse electromagnetic mode) cell, and custom test setups for EMC and RF testing. A new building houses what Intertek says is the only independent 10-m anechoic chamber in New England. It also houses a recently constructed 5-m anechoic chamber.

Engineers use the screen rooms for conducted emissions and immunity testing. They perform BCI (bulk-current injection) tests on cables using current clamps and coupling-decoupling networks. "Using decoupling networks lets the injected noise



Mike Koffink supervised several engineers during the design, construction, and test of a 10-m anechoic chamber.

current flow into wires in one direction only, but current clamps let the injected current flow in both directions," said EMC staff engineer Bob Mitchell. "Different industries use particular methods for injecting noise into the cables."

A custom cable tester in the lab lets engineers inject noise into a cable's individual wires. **Figure 1** shows how engineers can place an excitation wire over the wires, which lets the engineers test for shielding effectiveness.

The engineers can connect each wire to a connection box, which provides access to a Tektronix oscilloscope for measuring induced current in the wires. The box also connects the wires under test to a signal source such as a function generator.

The engineers sometimes substitute an Agilent Technologies or Wavetek arbitrary waveform generator for the function generator when they need to create custom waveforms and triggers. The waveforms simulate the interference that can result during vehicle start-up, mostly produced by alternators and starters. Engineers may also use noise generators from NoiseKen to inject interference into automotive cables for Japanese automakers.

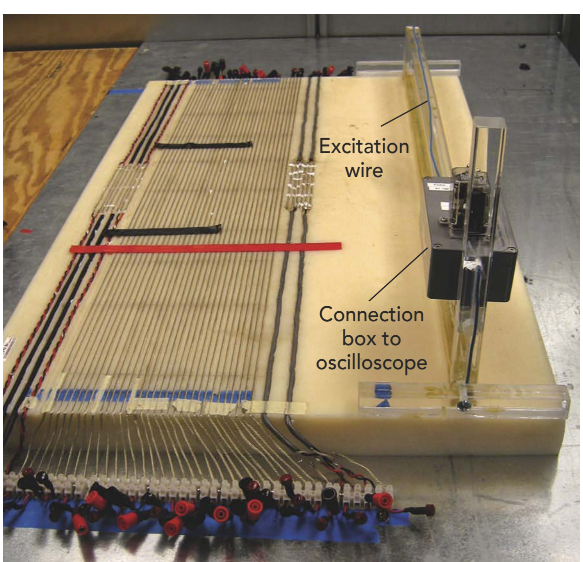


FIGURE 1. A custom-built conducted-immunity tester holds cable wires in place during a test.

Intertek's engineers conduct ESD (electrostatic discharge) tests in a shielded room from ETS-Lindgren. **Figure 2** shows a test setup that uses a stripline test fixture. Using a NoiseKen ESD simulator, the engineers inject ESD into the fixture's isolation pads. Current from the discharge travels through the cables to the EUT (equipment under test), where engineers check for ESD immunity.

Another shielded room lets engineers test the shielding effectiveness of materials such as composites and gaskets that are designed to reduce RF emissions from gaps between product enclosure doors, walls, and other openings. Roland Gubisch, former chief EMC engineer at Intertek and now an onsite consultant, pointed out that the materials are not always effective. "We once had a client who wanted us to test the shielding effectiveness of clothing material that its maker claimed would protect people from RF energy," said Gubisch. "Its shielding effectiveness was, unfortunately, nonexistent."

Figure 3 illustrates a chamber with a removable plate. A gasket (not shown) around the shielding material under test holds it in place against the plate. A transmitting antenna is just inside the chamber, connected to an HP (now Agilent) or Rohde & Schwarz signal generator. A Kalmus (now AR) RF amplifier boosts the signal to levels from 20 W to 1000 W, per MIL-DTL-83528 (Ref. 1). A receiving antenna just outside the chamber connects to an Agilent or Rohde & Schwarz spectrum analyzer to measure the exiting signal strength.

Mike Koffink, EMC operations manager, explained how engineers run the test: "We start with the plate removed and measure the power of the transmitted signal over the frequencies of interest. That gives us a baseline measurement. Then, we tighten the gasket around the plate with the shielding material in place. We then run an identical scan and measure how much the material attenuates the transmitted signal."

Koffink noted that the frequency range can be anywhere from 10 kHz to 18 GHz, depending on the customer requirements. The difference in decibels between the baseline signal and the attenuated signal is the material's shielding effectiveness.

The lab also has an ETS-Lindgren GTEM cell, because some standards require EMI (electromagnetic interference) measurements to be made in such a structure. A GTEM cell is a small anechoic chamber where the outer skin is the transmitting or receiving antenna. GTEM cells are often used for radiated emissions and immunity testing of small or board-level products.

Not all EMC testing is about high-frequency signals. Engineers use a tabletop stripline tester to perform radiated immunity testing on audio and video products (**Figure 4**). The tester generates fields at frequencies from a few kilohertz to a few megahertz by stimulating an active plate mounted between two grounded plates. "The field stays well contained," said Koffink. "We check it with isotropic probes."

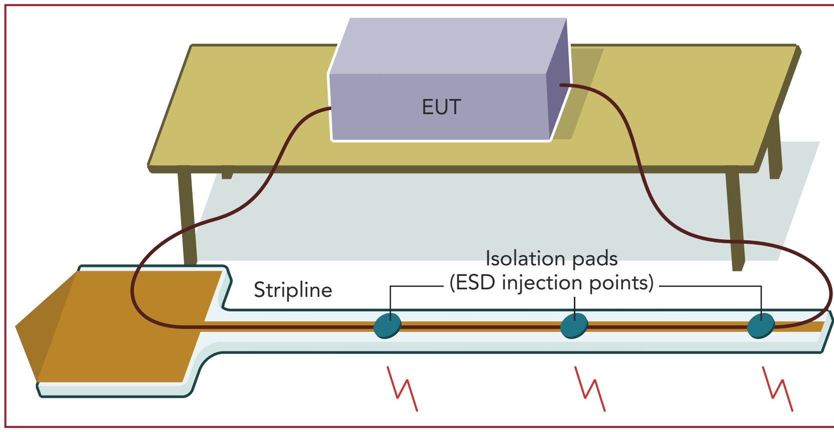


FIGURE 2. Intertek's engineers use a stripline test fixture for ISO 10605 automotive ESD tests.

Keep the outside noise out

In an ideal world, engineers perform radiated emissions testing in an environment with no ambient signals present. Intertek's Boxborough facility has two open area test sites that at one time had ambient signal levels low enough to permit the testing of many products. The low ambient signals were the reason that several companies built EMC labs around the apple orchards. Today, cellphones, cell towers, and other intentional radiators have arrived in the area, making the test sites less usable; in fact, one cell tower is in clear view of the Intertek sites. Digital TV, which has a wider bandwidth than analog TV, has also increased ambient emissions.

To create the necessary low-noise environment, Intertek has turned to using anechoic chambers, which shield most of the ambient signals from an EUT. In May 2009, the company completed work on an ETS-Lindgren 10-m anechoic chamber. During my visit in late June, a 5-m chamber was under construction, having been moved from a facility in nearby Littleton, MA, that Intertek owns as a result of its acquisition of Entela in 2004 (Ref. 2).

Both Koffink and Mitchell were Entela employees who stayed on after the acquisition. Koffink was responsible for the construction and certification of the building that houses the 10-m chamber. Mitchell spent the better part of a year working with suppliers and contractors on the design and construction of the chamber. His job was to produce the chamber to meet the requirements of 56 standards for EMI emissions and immunity as well as transmitter performance standards. Thus, Mitchell had to specify the chamber's design and materials.

For starters, the chamber's door had to be large enough to let vehicles in, and the flush-mounted turntable had to support 10,000 lbs. The motorized main door opens by backing out from the chamber wall and sliding away. Intertek chose the motorized design because the door is too large for one person to open, and a swinging door would be impractical because of the limited space outside the chamber.

Like most anechoic chambers, Intertek's chamber consists of two linings—ferrite tiles and absorbing cones—inside the shielded room. "Ferrite tiles and cones minimize reflections inside the chamber," said Mitchell. "The tiles absorb signals from 30 MHz to 1 GHz, and the cones absorb signals above 1 GHz."

The chamber is certified for emissions and immunity tests up to 40 GHz. To achieve that, Mitchell and others spent two weeks checking every seam and screw hole in the chamber. Every seam and hole needed shielding material such as copper or bronze foil to make openings electrically disappear. Mitchell worked with engineers from ETS-Lindgren to generate fields inside the chamber and check for leaks. "The chamber has about 50,000 screws," he said. "We checked them all."

The result: no ambient signals inside the chamber. At 40 GHz, the chamber attenuates outside signals by about 100 dB.

Gubisch explained why even small screw holes and gaps let signals penetrate a shielded chamber. "At 40 GHz, the signal wavelength is about 7.5 mm," he said. "Holes of 4 mm to 2 mm are enough to let half and quarter wavelengths pass through. You have to keep openings to less than 2 mm."

The 10-m chamber has Kalmus (now AR) amplifiers in an adja-

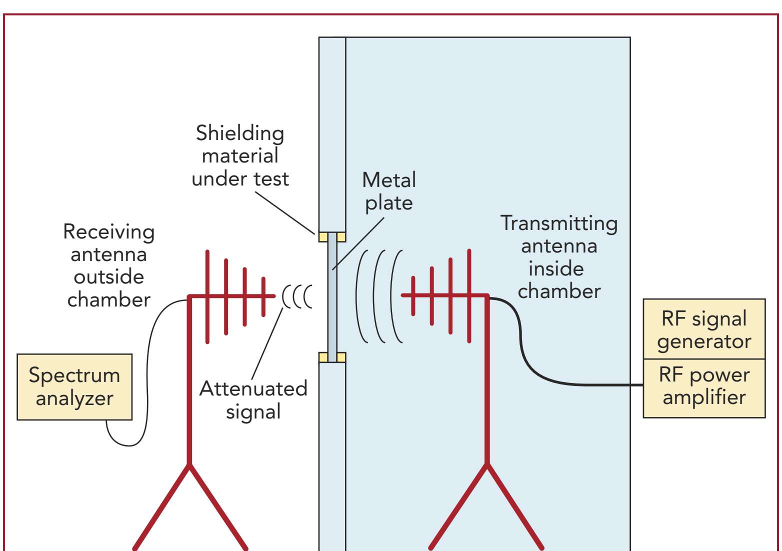


FIGURE 3. Antennas inside and outside a shielded room let engineers measure the shielding effectiveness of materials.

cent shielded room. These amplifiers produce 500-W signals, so they generate considerable heat. Rather than exhaust that heat to the outside, the chamber's ventilation system circulates it back into the building, which reduces heating costs.

EMI chambers need test equipment such as signal generators, amplifiers, oscilloscopes, spectrum analyzers, antennas, and antenna masts for engineers to run tests. The equipment requires automation to minimize test time and maximize measurement repeatability.

Intertek engineers prefer to automate test equipment with commercially available EMI automation software from Tektronix and Rohde & Schwarz. "We work with equipment manufacturers to get the software we want," said Scott Lambert, operations manager for product safety. "Writing and maintaining your own automation software is difficult." In particular, Lambert cited a need for software that could automate a test site that has multiple antennas.

Lambert also needs custom reports in graphical and tabular format. A radiated immunity test can have hundreds of scans because of different frequencies, turntable positions, and antenna positions. For customers who want raw data, the software can move data directly into Microsoft Word.

Hidden industry

The Intertek test labs handle a wide variety of equipment, but engineers in Boxborough do a surprising amount of automotive testing for a lab so far from Detroit. "Automotive products are a kind of hidden industry in New England," noted Albert Noyes, commercial and industrial department manager. "We test audio products, position sensors, heat sensors, and collision-avoidance systems." Audio systems include those from a major local manufacturer.

As the auto industry looks into alternative power sources, Intertek engineers find themselves testing battery packs for electric vehicles. Noyes described a test

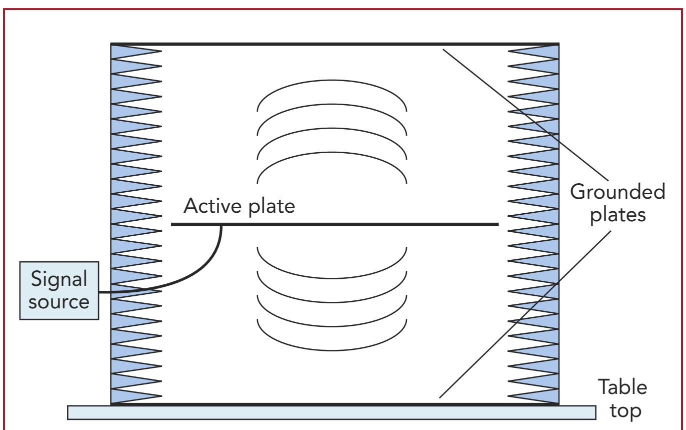


FIGURE 4. The combination of an active plate, grounded plates, and absorbing cones produce a uniform field for low-frequency immunity testing.

he performed on a battery system that measured 4 ft wide by 9 ft long by 1 ft thick. The battery is used to power buses in several major cities. Intertek engineers tested the battery's control electronics for emissions and immunity.

Automotive EMC testing differs from EMC testing for most other products because the automotive products are vehicle components rather than complete systems. Automotive EMC standards apply to entire vehicles rather than components. Thus, it's the system-level tests that count. Suppliers of automotive components go to test labs to verify that their product won't cause vehicle emissions or immunity tests to fail. But they can afford to sell products that might have emissions that are 1 dB or 2 dB above design specifications without needing to lower emissions.

"US automakers won't accept test results for validation programs from EMC labs they haven't certified," said Koffink. "Although we work with suppliers to the Big Three automakers, we need their certification before the suppliers accept our tests." Koffink noted that the lab has certification from Ford and General Motors. The automotive expertise came to Intertek through the Entela acquisition.

Automotive products designed for passenger vehicles must pass more stringent tests than products for emergency (police and fire) vehicles. Besides performing EMC tests, Intertek engineers also test transmitters used in emergency vehicles. They measure output power

STEVE EDSON/GETTY IMAGES

Nick Abbondante tests RF transmitters for output power, spectral density, and other characteristics.

and frequency. "Police and fire vehicles can have 20-W transmitters," said senior project engineer Nick Abbondante. "That much power can heat human tissue, but radio operators are trained to minimize transmission time. You can't do that with consumer transmitters, so they must have lower power."

Abbondante tests transmitters for Bluetooth, WiFi, and cellular use. He looks at in-band output power, adjacent-channel power, power spectral density, frequency stability, and harmonic emissions. "A 2.4-GHz signal has harmonics at 4.8 GHz and 7.2 GHz. Those frequencies are used by licensed services," he said. "Unlicensed 2.4-GHz devices can interfere with those services."

Keeping up

Intertek engineers must keep up-to-date on the wide array of standards in use today. EMC alone has dozens. Add safety and military standards for automotive products, IT/telecom products, medical products, and more, and you could have a full-time job just keeping up with the latest developments. To help the company anticipate changes and prepare for them, Intertek has industry and technology experts that serve on numerous standards committees. *(continued)*

Even though engineers in Boxborough regularly converse with Intertek's committee representatives, they must keep abreast of standards development and adoption on a daily basis. The International Electrotechnical Commission, for example, publishes newsletters that inform engineers when a new standard is published (Ref. 3).

"Just because a standard is published," added Gubisch, "doesn't mean anyone has adopted it as a legal requirement. I have to check the EU [European Union] Website every day to see if a standard has been adopted in Europe." He also checks the FCC, ANSI, and Food and Drug Administration Websites for recognitions of standards. In the US, problems arise because the FCC may not adopt a new version of a standard such as ANSI C63.4 (Ref. 4).

Even when a standard is adopted, it may have a transition period, particularly in the EU. A transition period covers a date of publication, a date of implementation, and a date of withdrawal (if a standard supersedes a previous one).

Gubisch also checks the content of a standard, because it could call for new test methods or combine test methods from other standards. When he finds the technical details of a standard to be unclear, he may contact an Intertek representative to a standards development organization to find out the organization's intent. He cited an example of CISPR 22, a standard containing telecom port emissions limits. "You couldn't perform the test as described. When labs tried to perform the tests, we found differences from 20 dB to 30 dB."

EMC and product safety testing, while not as transient as other engineering disciplines, do continue to evolve. Test labs such as Intertek must adapt to a myriad of changes in regulatory standards. That requires adding equipment (including chambers), monitoring standards bodies, and training its staff in new requirements. T&MW

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2. In 1999, Michigan-based Entela acquired Integrity Design and Test of Littleton, MA. Intertek subsequently acquired Entela in 2004 and is now merging the Littleton operations into its Boxborough facility. *Test & Measurement World* profiled Integrity Design and Test in "A Day in the Life of an EMC Lab" in our June 1996 issue. www.tmworld.com/contents/pdf/TMW96_06F1EMC.pdf.

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SELECTION GUIDE

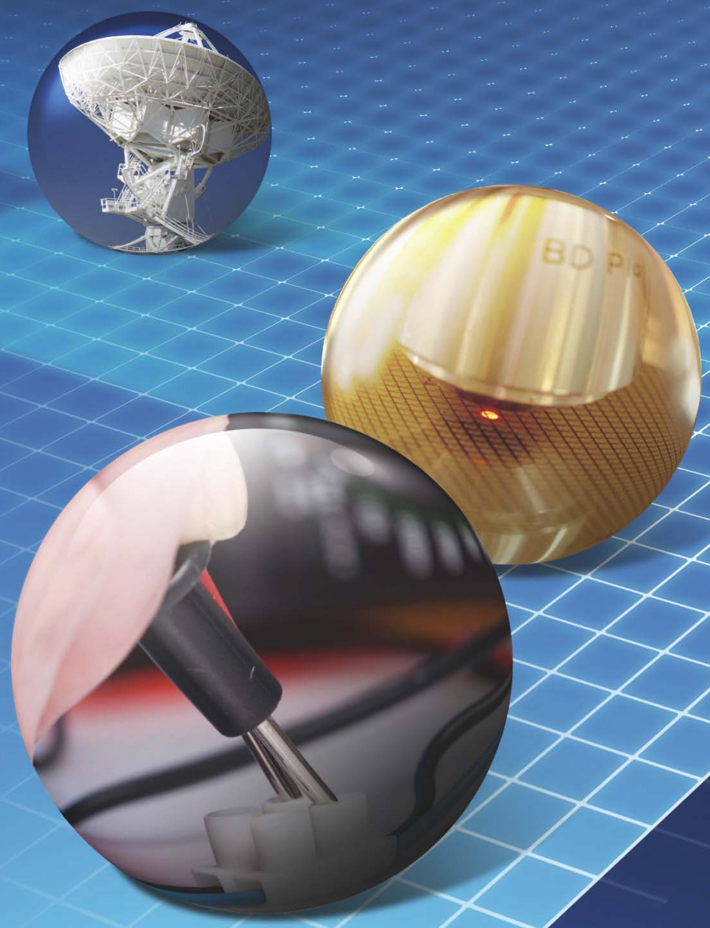
Selecting a Suitable Grabber for Imaging Systems

Application Story:

High-Speed Digitizer for Distributed Temperature Sensing

New Options on an Old Technology:

USB/GPIB Interface



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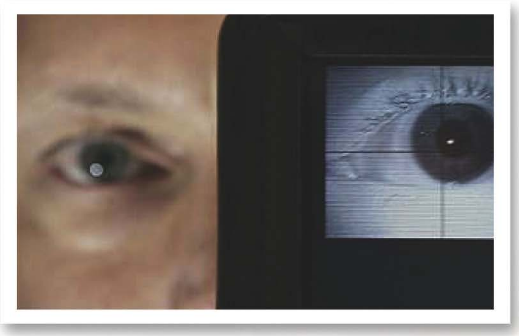
Selecting a Suitable Frame Grabber for Imaging Systems

Imaging systems are now widely used for diversified purposes. For example, in a hospital, imaging systems are essential to doctors for syndrome diagnosis, such as, MRI, computer tomography, examination and surgery devices in ophthalmology. These imaging systems use different "light" sources, in accordance with the tissues that doctors want to observe.

Imaging system designers also need one suitable interface card for the corresponding light source. Standard cameras may be adopted if visible light can obtain suitable images. For such cases, system designers can choose standard frame grabbers to interface with the cameras, such as frame grabbers with the FireWire, GigE Vision, or CameraLink interfaces.

When different light sources are selected for ultrasound, for example, PCI Express digitizers can convert raw analog signals into digital form to stream the imaging data back to the system for post processing. Sometimes X-ray sensors may incorporate digitizing functions and provide one high-speed digital interface for signal output. Imaging system designers can choose PCI or PCI Express® high speed digital I/O boards to accommodate the timing of the digital interface.

In addition to serving medical applications, these imaging systems can also be widely used in industrial, military, and research applications. Machine vision is well-known for production equipment. Millimeter wave monitoring systems and iris recognition systems are now emerging in military applications. For research purposes, engineers can choose data acquisition cards and digitizers based on signal characteristics, such as input range, bandwidth, and triggering modes, etc.



Talking to an expert can save you a lot of time in selecting the right interface for your imaging system design.

Don't hesitate to contact ADLINK's imaging expert, Jim Blasius, for more information.

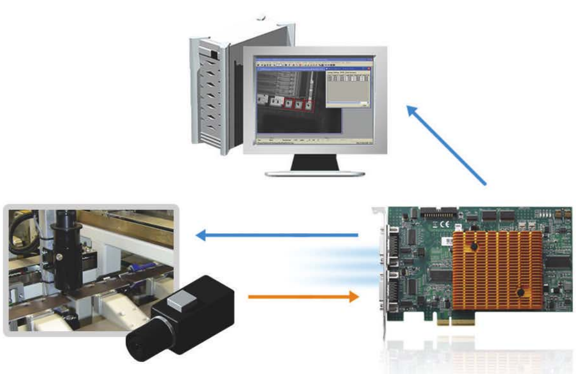
Jim Blasius

Jim Blasius
Director of Sales – Americas
Ampro ADLINK Technology, Inc.
Toll Free: +1-800-966-5200
jim.blasius@adlinktech.com

Increasing Image Acquisition Rates for Bandwidth-Hungry Applications

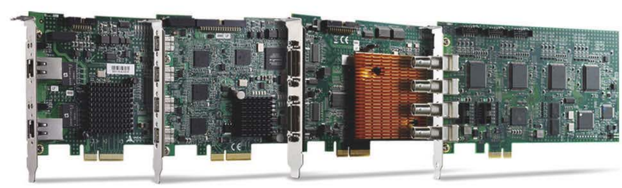
"Bandwidth-hungry" vision applications run into a bottleneck transferring image data. But now, PCI Express, Camera Link and FPGA technologies have been implemented to increase image acquisition and processing rates.

Electronic component manufacturers must continually improve productivity and quality to remain competitive. Motion control and machine vision play an important role in this effort by providing automated inspection capabilities that are more reliable and scalable than legacy methods. As manufacturers require increased image throughput and more sophisticated image processing, transferring the data from the camera to the PC, or bandwidth, often becomes a limiting factor that must be addressed. Standard VGA resolutions and 30 frame/second capture rates were sufficient for most production lines in the past. However, industry requirements are now demanding an increase in the dimensions scanned, e.g. line scan, 3D inspection, OCR, barcode and 3D barcode. In addition, there is a push for an increase in the production line conveyer speed, and more complex image processing. Meanwhile, bandwidth has remained the main bottleneck for PC-based machine vision systems.



ADLINK provides a series of PCI Express® (PCIe) products for industrial machine vision applications. The PCIe bus provides high-bandwidth and robust point-to-point interconnects, and complete software compatibility with the existing base of operating systems, PCI drivers, and software. The PCIe bus also provides a dedicated link for image data transmission.

A typical computer-based machine vision system includes a camera (or multiple cameras), a frame grabber card, and the computer system. The camera interface is the transmission protocol between the camera and computer system.
ADLINK provides several types of frame grabber cards, including:



PCI EXPRESS®

PoCL (Power over Camera Link®)

PCIe-CPL64

The PoCL standard allows the camera link cable to supply power to the camera through the Camera Link connector without losing backward compatibility with the previous Camera Link standard, This solution is particularly suitable for a small camera.

IEEE 1394.b

PCIe-FIW64/PCIe-FIW62

- Plug-and-play operation and easy maintenance
- Power over cable for reduced wiring

Gigabit Ethernet for Vision

PCIe-GIE62

- Long cable length: Gigabit Ethernet cables up to 100 m
- Low cabling cost: RJ-45 Cat-5e cables provide a competitive price for vision applications

Analog

PCIe-RTV24/PCI-RTV24/PCI-MPG24

Real-time signals: No network latency or protocol overhead.

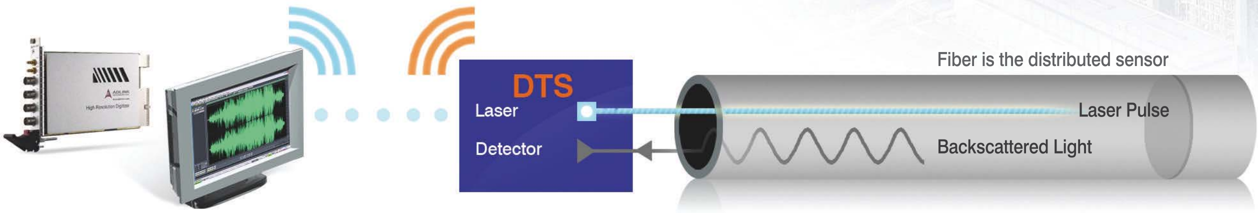
‹ ADVERTISEMENT ›

ADLINK Test & Measurement

Application Story

High-Speed Digitizer for Distributed Temperature Sensing

Temperature detection is vital for its added security value in applications such as subway/metro tunnels, mining, warehouse, and oil & gas facilities. The traditional method of measure temperature is to deploy measurement devices at specific locations. This is not practical when the area to measure spans several miles. Distributed temperature sensing (DTS) is a technology based on optical time domain reflectometer (OTDR) technologies. DTS systems can measure temperature profiles along optical fibers with lengths of up to 37 miles and obtain thousands of accurate temperature measurements.

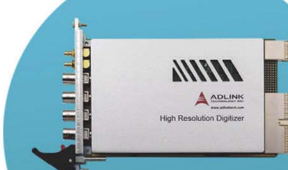


Within a DTS system, a laser pulse is coupled to an optical fiber. Light is backscattered as the pulse propagates through the fiber. The wavelengths of the light are affected by temperature changes at certain positions. By measuring the difference in the signal intensity of the backscattered light with high precision, an accurate temperature measurement can be made. When dealing with such high speed signals, a high-speed and high-resolution digitizer plays an important role in this application. The sampling rate of the digitizer determines the spatial resolution and its dynamic performance determines the temperature resolution.

New Product Showcase

PXI Digitizers Support up to 512 MB of On-board Memory

Enabling accurate monitoring of high-speed transient signals, the PXI-98X6 series is comprised of PXI-9816, PXI-9826, and PXI-9846 models that offer sampling rates of 10, 20, and 40 MS/sec, respectively. These digitizers utilize PXI trigger bus to synchronize multiple modules without external routing or cabling. The PXI-98X6 offers signal-to-noise ratio of up to 80.19 dB and 12.96 effective number of bits with 1 MHz sine wave input signal at -1 dBFS amplitude.



PXI digitizers supporting up to 512 MB of on-board memory.

PXI Solutions

We've Got You Covered

PXI Testing

We've Got You Covered

A PXI Chassis

Beyond Your Expectations

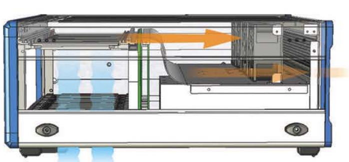
The PXIS-2558T is ADLINK's new-generation PXI chassis equipped with advanced features and functionalities. It's world's first bench-top PXI chassis that includes a 8.4" LCD touch panel. The PXIS-2558T also boasts of wider operating temperature range, lower operating noise, and robust system build. The 8.4" LCD touch panel, which support 800x600 resolution, is the distinguishing feature of PXIS-2558T. Combined with its 14.1 lbs light-weight construction, the PXIS-2558T delivers great portability for your PXI-based applications.

Smart | Quiet | Reliable

New Product Showcase

PXI Chassis Features Remote Status Monitoring

Suited for bench-top and rack-mount test and measurement applications, the 19-slot 3U Model PXIS-2719 features one system controller slot, 18 peripheral card slots, and smart chassis management. For uniform air flow, fans pull cool air in from bottom of chassis, though the PXI modules, and exhaust out rear. Fan speed is controlled manually or automatically based on the internal temperature. Chassis temperature, fan speed, and system voltages are continually self-monitored to ensure system stability.



Innovative Cooling Mechanism

A Sampling of ADLINK's PXI/CompactPCI Offering

GPIB Switches Vision Bus Expansion DAQ

ADLINK TECHNOLOGY INC.

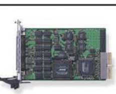
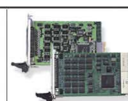
ADLINK Test & Measurement

DIO Selection Guide

Digital I/O Modules

									
Model Name	**PCI-7250/ PCI-7251**	**LPCI/ LPCIe-7250**	**cPCI-7252**	**PCI-7260/ PCI-7256**	**PCI-7258**	**PCI/ cPCI-8554**	**PCI-7442/ 7443/ 7444**	**PCI/cPCI-7432/ 7433/ 7434**	**cPCI-7452**
Form Factor	PCI	Low-Profile PCI/ Low-Profile PCI Express®	CompactPCI®	PCI	PCI	PCI/ CompactPCI®	PCI	PCI/ CompactPCI®	CompactPCI®
Isolation	√	√	√	√	√	-	√	√	√
Dedicated Inputs									
No. of Channels	8	8	16	8/16 + COS(1)	2	8	64 + COS(1)/ 128 + COS(1)/ -	32 / 64 / -	128+COS(1)
Logic Standard	V_{IH}=5-24 V V_{IL}=0-1.5 V	V_{IH}=5-24 V V_{IL}=0-1.5 V	V_{IH} = 3-24 V V_{IL} = 0-1 V	V_{IH}=10-24 V V_{IL}=0-2 V	V_{IH}=5-24 V V_{IL}=0-1.5 V	5 V/TTL	V_{IH}=5-28 V; V_{IL}=0-1.5 V/ V_{IH}=5-28 V; V_{IL}=0-1.5 V/ -	V_{IH}=5-24 V; V_{IL}=0-1.5 V/ V_{IH}=5-24 V; V_{IL}=0-1.5 V/ -	V_{IH}=5-28 V V_{IL}=0-1.5 V
Dedicated Outputs									
No. of Channels	8	8	8	8/16	32	8	64/ - /128	32 / - / 64	128
Output Type	Relay	Relay	Relay	Relay	PhotoMos Relay	5 V/TTL	Power MOSFET / - / Power MOSFET	Darlington / - / Darlington	Darlington
Timer/Counter									
Timer/Counter	-	-	-	-	-	10, 16-bit	- / - / -	-	-

Digital I/O Modules

									
Model Name	**PCIe-7350**	**PCI-7300A PCIe-7300A cPCI-7300**	**PCI-7200 cPCI-7200**	**PCI-7230/ cPCI-7230**	**LPCI-7230 LPCIe-7230**	**PCI-7233 PCI-7234P PCI-7234**	**PCI/PCIe-7296 PCI/PCIe-7248 PCI/PCIe-7224**	**PCI-7396 PCI-7348**	**cPCI-7248/ 7249R**
Form Factor	PCI Express®	PCI/ PCI Express®/ CompactPCI	PCI/ CompactPCI®	PCI/ CompactPCI®	Low-Profile PCI/ Low-Profile PCI Express®	PCI	PCI/ PCI Express®	PCI	CompactPCI®
Bus-mastering DMA	√	√	√	-	-	-	-	-	-
Isolation	-	-	-	√	√	√	-	-	-
High-Speed Digital I/O									
No. of Channels	32-bit DIO	2 x 16-bit DIO	32 DI, 32 DO	-	-	-	4/2/1 x 24-bit 8255 PIO	96/48 DIO + COS(1)	2 x 24-bit / 8255 PIO
Transfer Rate (Byte/s)	200 M	80 M	12 M	-	-	-	-	-	-
Logic Standard	1.8/2.5/3.3	5 V/TTL	5 V/TTL	-	-	-	5 V/TTL	5 V/TTL	5 V/TTL
Handshaking Transfer	√	√	√	-	-	-	-	-	-
Dedicated Inputs									
No. of Channels	8	4	-	16	16	32 + COS(1)/-	-	-	-
Logic Standard	1.8/2.5/3.3	5 V/TTL	-	V_{IH}=5-24 V V_{IL}=0-1.5 V	V_{IH}=5-24 V V_{IL}=0-1.5 V	V_{IH}=5-24 V/- V_{IL}=0-1.5 V/-	-	-	-
Dedicated Outputs									
No. of Channels	-	4	-	16	16	-/32	-	-	-
Output Type	-	5 V/TTL	-	Darlington	Darlington	-/Darlington(2)	-	-	-
Timer/Counter									
Timer/Counter	-	-	-	-	-	-	-	-	1-CH 16-bit counter ; 1-CH 32-bit timer

Legend: √ Supported - Not available
Notes: (1) Change-of-State detection (2) The PCI-7234P's outputs provide Darlington source drivers

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Find the Right Product
AIO Selector
Click on www.adlinktech.com/DAQ

DAQ Selection Guide

Simultaneous Sampling DAQ Cards / Analog Output Cards

						
Model Name	PXI/DAQ/DAQe-2010	PXI/DAQ/DAQe-2016	PXI/DAQ/DAQe-2005	PXI/DAQ/DAQe-2006	PXI/DAQ/DAQe-2501	PXI/DAQ/DAQe-2502
Form Factor	PXI/PCI[1]/ PCI Express®	PXI/PCI[1]/ PCI Express®	PXI/PCI[1]/ PCI Express®	PXI/PCI[1]/ PCI Express®	PXI/PCI[1]/ PCI Express®	PXI/PCI[1]/ PCI Express®
Bus-mastering DMA	Scatter-gather	Scatter-gather	Scatter-gather	Scatter-gather	Scatter-gather	Scatter-gather
Auto Calibration	√	√	√	√	√	√
Analog Input						
Analog Inputs	4 DI	4 DI	4 DI	4 DI	8 DI	4 DI
Max. Sampling Rates (S/s)	2 M	800 k	500 k	250 k	400 k	400 k
Simultaneous Sampling	√	√	√	√	√	√
AD Resolution (bits)	14	16	16	16	14	14
Bipolar Input Ranges (V)	±10 V to ±1.25 V	±10 V to ±1.25 V	±10 V to ±1.25 V	±10 V to ±1.25 V	±10 V	±10 V
Unipolar Input Ranges (V)	0-10 V to 0-1.25 V	0-10 V to 0-1.25 V	0-10 V to 0-1.25 V	0-10 V to 0-1.25 V	0-10 V	0-10 V
Analog Out						
Voltage Outputs	2 + AWG[2]	2 + AWG[2]	2 + AWG[2]	2 + AWG[2]	4 + AWG[2]	8 + AWG[2]
Update Rate (S/s)	1 M	1 M	1 M	1 M	1 M	1 M
Simultaneous Update	√	√	√	√	√	√
DA Resolution (bits)	12	12	12	12	12	12
Analog Output Ranges	±10 V, ±EXTREF, 0-10 V, 0-EXTREF	±10 V, ±EXTREF, 0-10 V, 0-EXTREF	±10 V, ±EXTREF, 0-10 V, 0-EXTREF	±10 V, ±EXTREF, 0-10 V, 0-EXTREF	±10 V, ±EXTREF, 0-10 V, 0-EXTREF	±10 V, ±EXTREF, 0-10 V, 0-EXTREF
Digital I/O and Timer/ Counter						
Digital I/O	24-bit 8255 PIO	24-bit 8255 PIO	24-bit 8255 PIO	24-bit 8255 PIO	24-bit 8255 PIO	24-bit 8255 PIO
Timer/ Counter	16-bit x 2	16-bit x 2	16-bit x 2	16-bit x 2	16-bit x 2	16-bit x 2

Multi-Function DAQ Cards

						
Model Name	PXI/DAQ/DAQe-2204	PXI/DAQ/DAQe-2205	PXI/DAQ/DAQe-2206	DAQ/DAQe-2213	DAQ/DAQe-2214	PXI/DAQ/DAQe-2208
Form Factor	PXI/PCI[1]/ PCI Express®	PXI/PCI[1]/ PCI Express®	PXI/PCI[1]/ PCI Express®	PXI/PCI[1]/ PCI Express®	PXI/PCI[1]/ PCI Express®	PXI/PCI[1]/ PCI Express®
Bus-mastering DMA	Scatter-gather	Scatter-gather	Scatter-gather	Scatter-gather	Scatter-gather	Scatter-gather
Auto Calibration	√	√	√	√	√	√
Analog Input						
Analog Inputs	64 SE/32 DI	64 SE/32 DI	64 SE/32 DI	16 SE/8 DI	16 SE/8 DI	96 SE/48 DI
Max. Sampling Rates (S/s)	3 M	500 k	250 k	250 k	250 k	3 M
Simultaneous Sampling	-	-	-	-	-	-
AD Resolution (bits)	12	16	16	16	16	12
Bipolar Input Ranges (V)	±10 V to ±0.05 V	±10 V to ±1.25 V	±10 V to ±1.25 V	±10 V to ±1.25 V	±10 V to ±1.25 V	±10 V to ±0.05 V
Unipolar Input Ranges (V)	0-10 V to 0-0.1 V	0-10 V to 0-1.25 V	0-10 V to 0-1.25 V	0-10 V to 0-1.25 V	0-10 V to 0-1.25 V	0-10 V to 0-0.1 V
Analog Output						
Voltage Outputs	2 + AWG[2]	2 + AWG[2]	2 + AWG[2]	-	2 + AWG[2]	-
Update Rate (S/s)	1 M	1 M	1 M	-	1 M	-
Simultaneous Update	√	√	√	-	√	-
DA Resolution (bits)	12	12	12	-	12	-
Analog Output Ranges	±10 V, ±EXTREF, 0-10 V, 0-EXTREF	±10 V, ±EXTREF, 0-10 V, 0-EXTREF	±10 V, ±EXTREF, 0-10 V, 0-EXTREF	-	±10 V, ±EXTREF, 0-10 V, 0-EXTREF	-
Digital I/O and Timer/ Counter						
Digital I/O	24-bit 8255 PIO	24-bit 8255 PIO	24-bit 8255 PIO	24-bit 8255 PIO	24-bit 8255 PIO	24-bit 8255 PIO
Timer/ Counter	16-bit x 2	16-bit x 2	16-bit x 2	16-bit x 2	16-bit x 2	-

Legend: √ Supported - Not available

Notes: (1) Supports 3.3 V/5 V PCI (2) Analog outputs with hardware-based arbitrary waveform generation

Multi-Function DAQ Cards

							
Model Name	**PCI-9222/9223**	**PCI-9221**	**PCI-9524**	**PCI-9114(A)-DG/-HG**	**PCI/LPCI/cPCI-9112**	**PCI-9111DG/HR**	**cPCI-9116**
Form Factor	PCI[3]	PCI[3]	PCI[3]	PCI[4]	PCI[3] /CompactPCI®	PCI [4]	CompactPCI®
Bus-mastering DMA	√	√	√	-	√	-	v
Auto Calibration	√	√	√	-	-	-	-
Analog Input							
Analog Inputs	32 SE/16 DI (PCI-9223) 16 SE/8 DI (PCI-9222)	16 SE/8 DI	4 + 4 (4-ch load cell inputs & 4-ch general purpose AD)	32 SE/16 DI	16 SE/8 DI	16 SE	64 SE/ 32 DI
Max. Smapling Rates (S/s)	500 k (PCI-9223) 250 k (PCI-9222	250 k	up to 30 k	250 k (PCI-9114A-DG/-HG)/ 100 k (PCI-9114DG/HG)	110 k	100 k	250 k
AD Resolution (bits)	16	16	24	16	12	12 (PCI-9111DG) 16 (PCI-9111HR)	12
Bipolar Input Ranges (V)	±10 V to ±0.25 V	±5 V to ±0.2 V	(5)	±10 V to ±1.25 V (PCI-9114(A)-DG)/ ±10 V to±0.1 V (PCI-9114(A)-HG)	±10 V to ±0.625 V	±10 V to ±0.625 V	±5 V, ±2.5 V, ±1.25 V, ±0.625 V
Unipolar Input Ranges (V)	-	-	-	-	0-10 V to 0-1.25 V	–	0-10 V, 0-5 V, 0-2.5 V, 0-1.25 V
Analog Output							
Voltage Outputs	2	2	2	-	2	1	-
Update Rate (S/s)	1 M	Static	5 k	-	33 k[1]	33 k[1]	-
DA Resolution (bits)	16	16	16	-	12	12	-
Analog Output Ranges	±10 V	±5 V	±10 V	-	0-5 V, 0-10 V, 0-EXTREF	±10 V, 0-10 V	-
Digital I/O and Timer/ Counter							
Digital I/O	16 DI, 16 DO[2]	8 DI, 4 DO[2]	8 DI, 8 DO (Isolated)	16 DI, 16 DO (Isolated)	16 DI, 16 DO	16 DI, 16 DO	8 DI, 8 DO
Timer/ Counter	32-bit x 4	32-bit x 2	-	16-bit	16-bit	-	1-CH 16-bit

Legend: √ Supported – Not available

Notes: (1) Actual maximum update rate is dependent on system performance (2) Programmable Function I/O (3) 3.3 V or 5 V universal PCI bus
(4) 5 V PCI bus (5) Load cell: Sensitivity - 1.0 mV/V to 4.0 mV/V, General-purpose AI: ±1.25 V to ±10 V

PCI AI Cards

		
Model Name	**PCI-9118 DG/L** **PCI-9118 HG/L**	**PCI-9113A**
Form Factor	PCI[3]	PCI[3]
Bus-mastering DMA	√	-
Analog Input		
Analog Inputs	16 SE/8 DI	32 SE/ 16 DI
Max. Sampling Rate (S/s)	333 k	100 k (Isolated)
AD Resolution (bits)	12 k	12 k
Channel gain Queue	256	-
Bipolar Input Ranges	±5 V to ±0.05 V	±10 V to ±0.05 V
Unipolar Input Ranges	0-10 V to 0-0.1 V	0-10 V to 0-0.1 V
Digital I/O and Timer/ Counter		
Digital I/O	4 DI, 4 DO	-
Timer/ Counter	-	-

Legend: √ Supported – Not available

Notes: (1) Actual maximum update rate is dependent on system performance
(2) 3.3 V or 5 V universal PCI bus
(3) 5 V PCI bus

PCI AO Cards

					
Model Name	**PCI-6202**	**cPCI/PCI/PCIe-6216V-GL** **cPCI/PCI/PCIe-6208V-GL**	**cPCI/PCI-6208A**	**PCI-6308V**	**PCI-6308A**
Form Factor	PCI[2]	PCI[2]/ CompactPCI® PCI Express®	PCI[3] / CompactPCI®	PCI[2]	PCI[2]
Bus-mastering DMA	-	-	-	-	
Analog Output					
Voltage Outputs	4	16 (cPCI/PCI-6216) 8 (cPCI/PCI-6208)	8	8	8
Current Outputs	-	-	8	-	8
Update Rate (S/s)	1 M	454 k[1]	454 k[1]	250 k[1] (Isolated)	250 k[1] (Isolated)
Simultaneous Update		-	-		
DA Resolution (bits)	16	16	16	12	12
Voltage Output Ranges	±10 V	±10 V	±10 V	±10 V, 0-10 V, 0-EXTREF	±10 V, 0-10 V, 0-EXTREF
Current Output Ranges	-	-	0-20 mA, 4-20 mA 5-25 mA	-	0-20 mA, 4-20 mA, 5-25 mA
Digital I/O and Timer/ Counter					
Digital I/O	16 DI, 16 DO (Isolated)	4 DI, 4 DO	4 DI, 4 DO	4 DI, 4 DO (Isolated)	4 DI, 4 DO (Isolated)
Timer/ Counter	32-bit x 4	-	-	-	-

ADLINK Corporate Overview

ADLINK Technology provides a wide range of embedded computing products and services to the test & measurement, automation & process control, gaming, communications, medical, network security, and transportation industries. ADLINK products include PCI Express®-based data acquisition and I/O; vision and motion control; and AdvancedTCA, CompactPCI, and Computer-on-Modules (COMs) for industrial computing. ADLINK's acquisition of Ampro Computers, Inc. in 2008 further added Ampro's expertise in rugged and industrial products for defense, aerospace, and transportation markets to ADLINK's diversified product offering.

ADLINK strives to minimize the total cost of ownership (TCO) of its customers by providing customization and system integration services, maintaining low manufacturing costs, and extending the lifecycle of its products.ADLINK is a global company with headquarters and manufacturing in Taiwan; R&D and integration in Taiwan, China, and the US; and an extensive network of worldwide sales and support offices.

ADLINK is ISO-9001, ISO-14001, and TL9000 certified, is an Associate Member of the Intel® Embedded and Communications Alliance, an Executive Member of PICMG, and a Sponsor Member of the PXI Systems Alliance.

Measurement & Automation

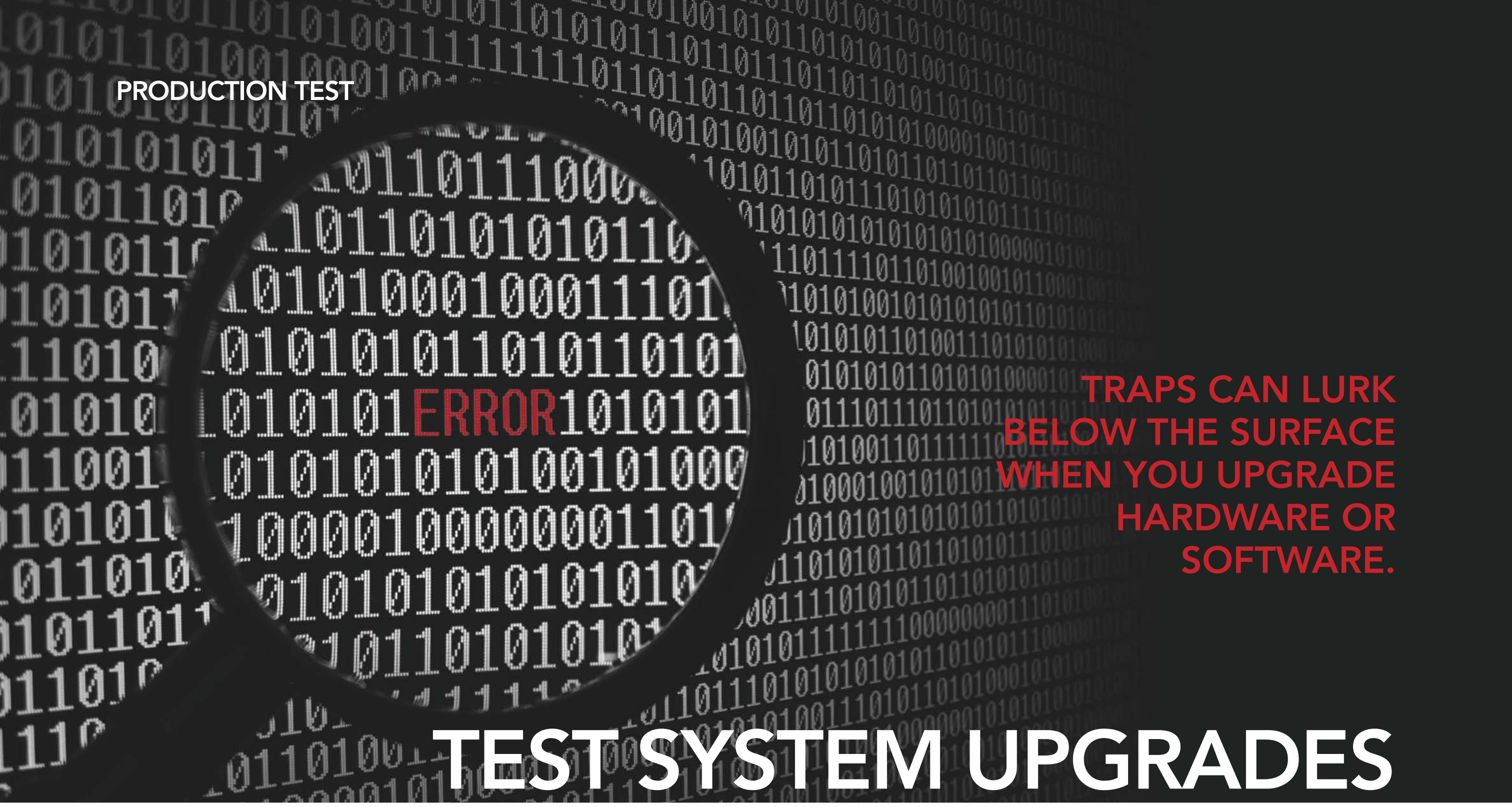
The mission of ADLINK's measurement and automation product segment (MAPS) is to provide the best performance-cost ratio and highest quality products for industrial I/O control, motion control, digital imaging, data acquisition, and modular instrument applications.

With our customers' requirements in mind, ADLINK continues to develop new PCI Express® cards for high bandwidth applications, PXI controllers with latest CPUs and chipsets, higher speed DIO cards and greater resolution digitizers, and the most advanced motion controllers. Our products support multiple operating systems and include comprehensive and easy-to-use software packages and services.

ADLINK's MAPS is committed to be your reliable partner by providing complete customer solutions for machine automation systems, machine vision systems, automated testing equipment, and measurement equipment.

- PXI & Modular Instruments
- GPIB and Bus Expansion
- DAQ (Data Acquisitions) Cards
- DAQ Software and Utilities
- Motion Control Cards

- Distributed I/O Modules
- Programmable Automation Controllers
- Communication Cards
- Digital Frame Grabbers
- Compact Vision Platforms



TRAPS CAN LURK BELOW THE SURFACE WHEN YOU UPGRADE HARDWARE OR SOFTWARE.

TEST SYSTEM UPGRADES CAN EXPOSE PROBLEMS

BY MIKE RUTLEDGE, EADS NORTH AMERICA TEST AND SERVICES

In industries such as the defense industry, test systems can remain in service for 20 years or more. The engineers who maintain such systems keep them going by repairing and replacing instruments and components that malfunction or fail. In the past, these engineers could count on identical replacements being available for many years, but now manufacturers frequently redesign or update their products in response to market pressures. The result has been a decline in the life span of each of the key components in test systems.

For instance, CPU life spans are now measured in months, rather than years. Associated operating systems likewise have much shorter life spans. Instrument manufacturers who once operated under a 10- to 15-year product life cycle are now in the 3- to 5-year mode. Thus, the issue of upgrading and managing test assets is becoming an ongoing concern, as opposed to a one-time activity during system development.

Just because parts of your test system need an overhaul does not mean that you can—or should—develop an entirely new system. You may merely need to upgrade some of the instruments or the software. Because upgrading a test system is a business decision, you must determine what upgrades are essential to your business needs and whether the expected improvements justify the investment in new equipment and new programming. And when undertaking an upgrade, be prepared to uncover new problems or to revisit problems for which you found a workaround in the past.

Preserving legacy elements

A test system relies on its application programs, typically in the form of TPS (Test Program Sets), to carry the workload of the platform. A typical TPS development process is shown in the **figure** (p. 44). The terminology in the figure reflects US Air Force jargon, so the term ITA (interface test adapter) is used for fixturing, as opposed to ID (interface device) or TUA (test unit adapter). (See the online version of this article at www.tmworld.com/2009_09 for a list of acronyms.) Fixturing, here, consists of the interconnectivity between the test resource and the UUT (unit under test).

The TPS development process is the legacy of the test system that you must either preserve or move to a new test asset. To the extent that you can move each box in the figure without change, you preserve investments, reduce cost, and mitigate risk for the upgraded platform. For each box that you must rework, the opposite is true: Past investment becomes sunk cost, expenditure increases, and risks are ex-

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posed. Thus, if you move to a totally new platform with completely new software, you are, in essence, performing a new development and not a migration.

The first task in any test system upgrade is to make sure you fully understand and define the problem you need to solve, such as replacing obsolete instruments or parts, expanding capability, improving poor performance, or adapting the system for a new purpose. Once you establish these parameters, you have a strategic direction on which to base decisions.

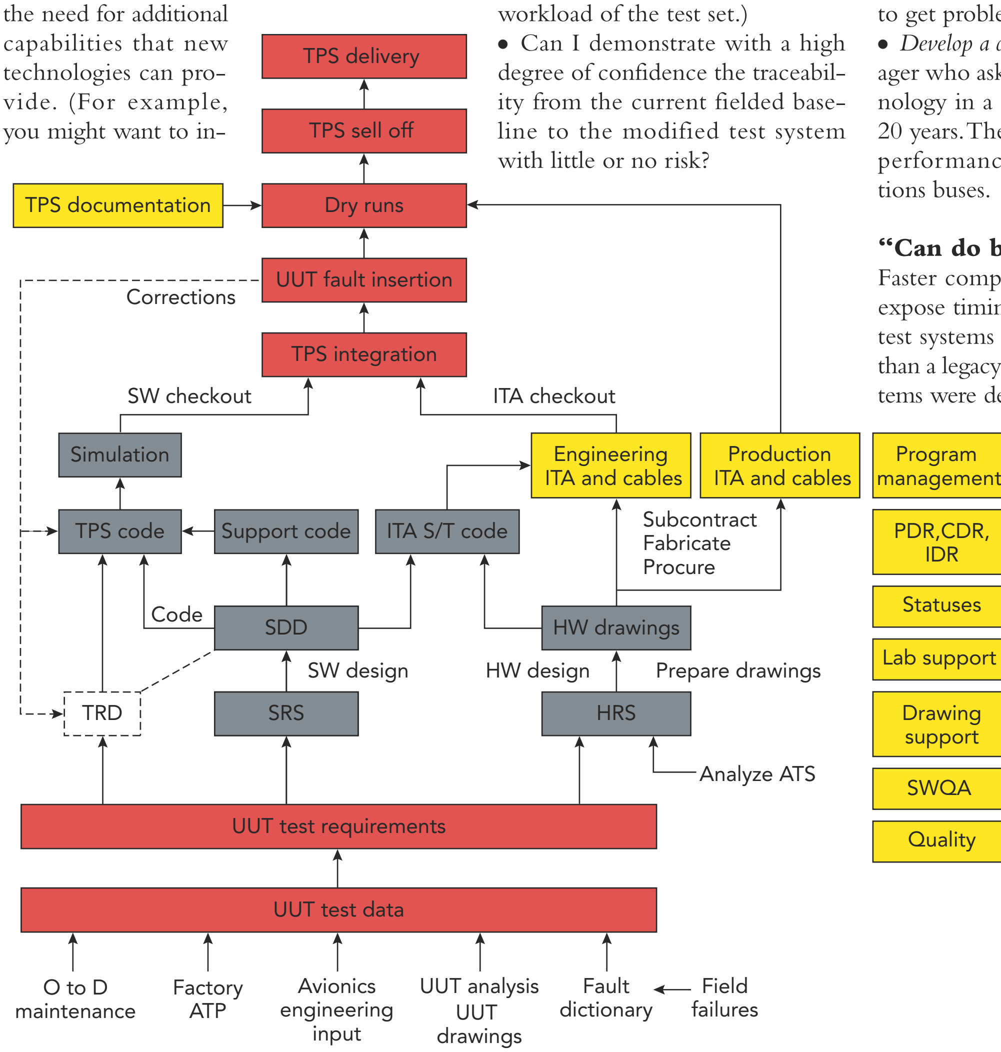
To define the problem, a systems approach is often useful. The primary issues might be component obsolescence; withered test assets, computer resources, and peripherals; high operational costs; and the need for additional capabilities that new technologies can provide. (For example, you might want to insert new technology to improve information management.) The interfaces to the fixture might be showing signs of wear and tear after years of use, or the UUT itself might have been upgraded with capabilities that are difficult or cost prohibitive to test with the existing test system.

Questions you need to consider include:

- What is the process of validating the resultant new test-system product or products?
- Will I need to complete a comprehensive regression test and fully qualify the new test-system product or products? (Regression testing and qualification can easily cost more than the test assets being replaced, depending on the workload of the test set.)
- Can I demonstrate with a high degree of confidence the traceability from the current fielded baseline to the modified test system with little or no risk?

Once you have defined the problem, you have several possible courses of action:

- *Modify the system while keeping the identical capabilities to the current system.* A product or item manager might say, "I want what I have, no more, no less. I'm modifying the system only because test equipment is no longer available that's a direct replacement." Such managers probably are not "test guys." They want capabilities at the lowest cost.
- *Develop a system with a few enhancements, such as better speed or accuracy.* Managers who request this option generally have some test savvy, know that bugs exist, or perhaps sense that certain aspects of their product are not perfect. This type of position uses obsolescence as a reason to get problems fixed.
- *Develop a completely new system.* A manager who asks for this wants today's technology in a system that will last another 20 years. The UUT will limit test system performance because of communications buses.



A test system relies on its application programs, typically in the form of a TPS, to carry the workload of the platform. The terminology shown here reflects US Air Force jargon, so the term ITA (interface test adapter) is used to refer to fixturing. Fixturing, here, consists of the interconnectivity between the test resource and the UUT. See the online version of this article at www.tmworld.com/2009_09 for a list of acronyms.

"Can do better" is a trap

Faster computers or test equipment can expose timing latencies that make newer test systems less compatible with UUTs than a legacy system. Many legacy test systems were designed specifically to test the asset; they did not result from efforts to adapt general-purpose COTS (commercial-off-the-shelf) products to a specific need. These legacy systems were usually highly optimized for that one application, and improving the efficiency of the test system without modifying the design of the UUT can create timing conflicts.

During an upgrade, you will often find timing problems that were masked by the architecture of the legacy system. As processing power removes latency from the system, some settling-time issues with respect to stability or power might emerge. Potential problems

might appear in something as simple as a step attenuator in the output of an RF signal, or they might appear in a current-sensing function monitoring a power supply's initial surge during power up. To ease these types of issues, you must fully understand the problem and apply systemic solutions, or the TPS will once again become attached to the particular test set.

Other timing problems may occur when better processors communicate with instrument buses at faster rates than the legacy processor could support. If the test executive does not provide hooks to manage this type of problem, you may need to modify the system drivers so they can support older products. The PAWS Run Time System development software, for example, provides for multiple ways to communicate with instruments and allows bus definitions to account for slow assets.

You might think that because the new test system offers 20, 40, 60, or more times the power of the legacy system, that the throughput should increase significantly. This expectation ignores the fact that the UUT is not 20, 40, 60, or more times more powerful, but remains as it ever was. Thus, while it is not unusual for newer systems to improve throughput, do not expect significant improvement to be the norm without a thorough analysis and quantification of exactly where these improvements will occur.

Hardware issues

The selection of a hardware architecture is one of the first decisions you will make. The increasing power and speed of a variety of buses and controllers provide a multitude of options. There are instrument interfaces based on Ethernet, VXI, PCI, USB, and GPIB, to name only the common ones. Each of these interfaces has advantages and disadvantages (number of vendors, degree of openness, conformance to open specifications, speed, durability, environmental considerations, and so on). Each of these will drive approaches to modularity, sparing and logistics, and maintenance. As you investigate these factors, you will need to address the following issues:

- *Old system functionality.* Did the designer of the legacy system use instruments in ways that were unorthodox (for example, using a digital multimeter's four-wire resistance-measurement feature as a current source in a way that is undocumented)? Can you duplicate that with new equipment? How?
- *Performance envelope.* Does the existing system operate at the corners of the test equipment? Can you characterize the entire performance envelope? Can you duplicate the performance envelope with automated software to minimize regression testing?
- *System asset improvements.* Will the new hardware with better specifications uncover problems masked by the legacy equipment? For example, an improved noise floor might uncover spurs that were not seen before, or the new hardware could present timing issues related to high-speed communication devices, raising bus conflicts and bus-settling issues.
- *Interfacing and fixturing.* Can you use legacy fixtures, or will you need new fixtures? If you need new fixturing, how can you characterize the performance of the device? Will new instruments detect crosstalk and noise that the older system ignored? Can you develop a standard system interface (ARINC 408 or CTI IEEE 1505) and adapt legacy ITAs to this with an adapter-adapter?
- *Grounding, cooling, and mechanical issues.* How was grounding implemented in the legacy system? Were floating grounds available to enable the use of the UUT ground as the reference? Can the new instruments provide a floating ground or are they tied to system ground?
- *Fundamental clock stability and noise.* If you need to phase-lock to a clock signal, can you? Can you use the UUT as a reference for phase measurements?

Software issues

The software architecture issues can be even more critical than the hardware architectural issues, because most commercial software vendors provide support for the current versions and perhaps one to two previous versions of their products.

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Therefore, for a 15- to 20-year life cycle, the software must either migrate with the technology continuously or be archived and supported with a specialized team at relatively high expense. In any event, you need to develop a strategy for migrating the software technology, or else you need to establish a baseline and hold it.

Software architectures today typically have some layer of abstraction above the primary instrument interface (vendor driver) to aid in the management of obsolescence and limit the dependence of the TPS to the particular instrument. This "middleware" layer can be used for system functions such as calibration factors, cross-instrument communication, and resource management to enable a programmer to adapt COTS resources to particular requirements. Unfortunately, this layer of abstraction does not engender enthusiasm from vendors, because it enables the integrator to treat instruments as commodities. The test industry has attempted to establish layers of abstraction in initiatives including VISA, VXIplug&play, IVI, and synthetic instruments, and it will continue to work on implementing these concepts.

To the degree that the software layers are "open" and not vendor-dependent, the system will be more supportable and susceptible to technology insertion and migration. For example, an IEEE language (such as ATLAS) is not subject to a particular business cycle and will likely provide a longer life than the current fad—although the current fad can often become a standard (see the history of the C language). The tradeoff is usually expediency (graphical or cool languages) versus supportability.

In either event, team discipline and communication is critical. As with hardware, there are issues to consider:

- *Rewrite.* Should you rewrite test code into a more modern language or try to use existing code? Can you convert existing code?
- *Programming assumptions.* What programming assumptions were made in the old software code?
- *Business or environment assumptions.* Elements of legacy code were probably based upon common understandings of software developers at the time they created the legacy code. These assumptions may not be documented, and they may not be obvious today.
- *Data.* Supporting data and documentation may be tied to the legacy code explicitly, and changing the code can result in significant costs to update and manage the associated data.
- *Instrument interchangeability.* The ability to interchange instruments combines hardware and software issues.

Role of virtual instrumentation

Virtual, or synthetic, instrumentation has been the topic of much discussion in the test industry. When deciding to replace a test instrument with virtual instrumentation, you need to evaluate how the legacy software took advantage of the characteristics of the legacy instruments, either knowingly or unknowingly. The specifications of the legacy system and its components may not describe the full envelope of performance that was assumed by the legacy applications, and this will create an unforeseen hurdle for migration.

Programmable, modular instruments, like the Talon Instruments T964 digital test resource module from EADS, provide the integrator with flexibility to respond to unforeseen issues as they emerge. The integrator can program such modules to fit into an existing test system rather than having to reprogram the entire system to accept a new instrument; this reduces the risk and cost associated with inserting new equipment and maintaining a legacy system. The T964 has the ability to mimic leakage current, for example, as a way to minimize any changes to the existing legacy TPS base.

As the current inventory of legacy test systems continues to age, more and more equipment will need to be migrated, either to a new platform or to a new computer. A systematic approach should help to identify risk areas. Minimizing the elements of the legacy system that are changing will reduce the cost and risk of replicating the existing performance. Modern tools and virtual-instrument assets are a means to help reach the end of a more supportable and sustainable test capability that preserves past investment to the maximum extent. T&MW

Mike Rutledge *is director, advanced programs, at EADS North America Test and Services.*

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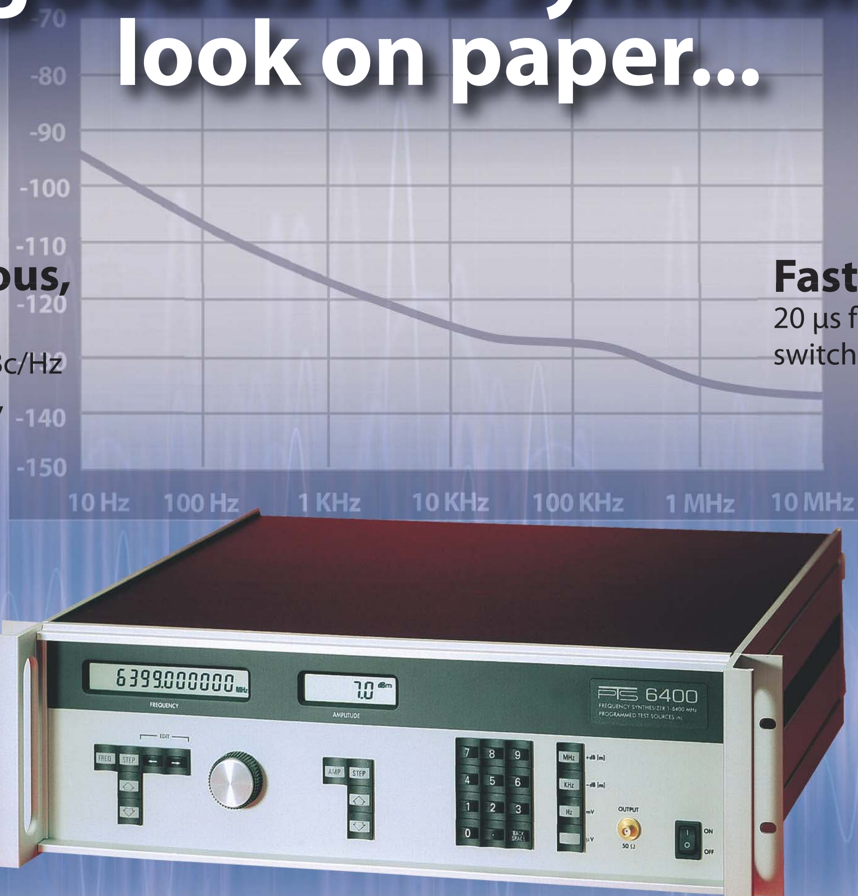

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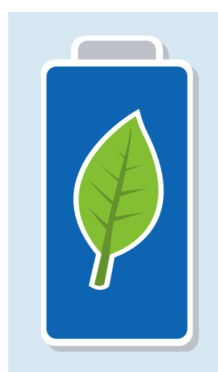
Light sensors PACK IN GREENER FEATURES

AMBIENT-LIGHT SENSORS HELP SMARTPHONES CONSERVE DISPLAY POWER AND IMPROVE BATTERY RUN TIME.

BY MARGERY CONNER, TECHNICAL EDITOR, *EDN*

ALSs (ambient-light sensors) have been around for years, but they are now seeing increased use due to the success of smartphones, such as Apple's iPhone. The iPhone uses an ALS to reduce power demands and eke out battery life by adjusting the display lighting for ambient-light conditions. The iPhone also uses a proximity detector, a close cousin of the ALS, to reconfigure itself in response to user actions (**Figure 1**).



Today, smartphones, with their trademark large LCDs, are the main users of ALSs, but future applications can realize energy savings and increased ease of use. For example, a large-screen LCD TV must adjust its LED backlighting to the ambient light. Similarly, a room with SSL (solid-state-lighting) illumination can change its lighting based on natural lighting or to suit its occupant's mood. Automobile lighting can accommodate day or night driving or reflect the brightness of streetlights, saving power and providing a better user experience.

At its most basic, an ALS consists of a photodiode or a phototransistor. A simple light-sensitive semiconductor is insufficient, however, because the ALS must be "photopic," meaning sensitive to the same frequency spectrum as the human eye (**Figure 2**). Incandescent and HID (high-intensity-discharge) lights emit 50 to 60% of their radiation in the nonvisible IR (infrared) range as heat. According to Oleg Steciw, product-marketing manager for ALS products at Intersil, you should use the HID with the best spectral response you can find. Otherwise, he said, "You'll be in a room, and, suddenly, the backlight will go haywire because there's some external light source that you can't even see, wreaking havoc."

Werner Mashig, application engineer on Arrow Electronics' lighting team, explained, "[Some] manufacturers put IR-filter [compounds] into the epoxy to fil-

FIGURE 1. Light and proximity sensors are often located next to a handheld device's speaker because both the sensors and the speaker require access to the outside world. The proximity sensor in a 3G iPhone is within the red circle, and the ambient-light sensor is the green part to its left. The iPhone's speaker is the gray, mesh-colored oblong. (See "iPhone puts proximity detection in your face," p. 52.) Courtesy of iFixit.

ter out the IR light so that the sensor will respond like the human eye."

Another approach is to use multiple photodiodes in the ALS. "One photodiode is a broadband one that sees everything from 300 to 1100 nm," said Carlo Strippoli, VP of marketing and sales for TAOS (Texas Advanced Optoelectronic Solutions). "The second diode is a dedicated IR photodiode and serves to monitor the IR reaching the sensor and then subtracting it from the light received at the broadband photodiode."

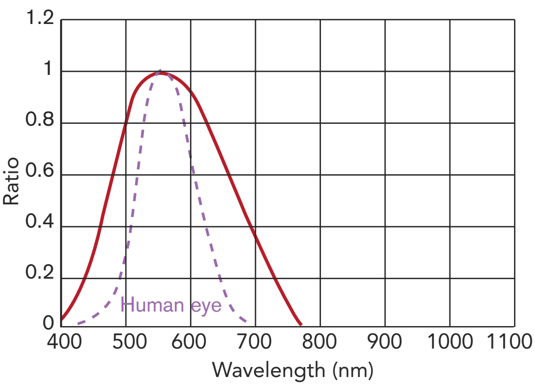


FIGURE 2. The human eye is sensitive to wavelengths of approximately 380 to 780 nm, peaking at approximately 555 nm. The wider red curve shows the sensitivity of a representative ambient-light sensor.

Fluorescent-light sources, which are more efficient than incandescent or HID lights, emit almost none of their radiation in the IR range, but they may exhibit a 60-Hz flicker that can cause an ALS to trigger when it's not supposed to. The newer digital ALSs integrate ADCs that convert the photocurrent to a digital signal to interface to a digital-communication bus. The ADC can serve double duty by filtering out optical noise, such as 60-Hz flicker, through high-resolution sampling.

Rohm's BH17xx series integrates a 16-bit ADC that produces 1-lux resolution over a range of 0 to 65,000 lux. Two measurement-resolution levels allow selection between sampling time and performance. In the high-resolution sampling mode, the ADC filters out optical noise. The lower-resolution mode with its shorter sampling time suits applications such as GPSs (global-positioning systems), in which the light-level changes are dynamic: A GPS system will probably operate in an automobile's interior or in natural light. The ideal ALS exhibits uniform light sensitivity regardless of the light source.

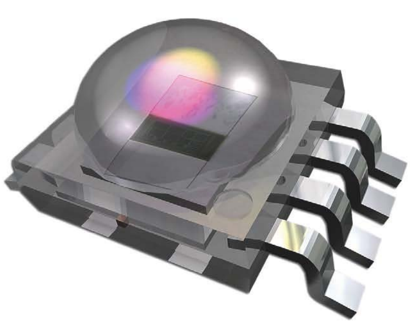


FIGURE 3. Although digital ALSs are now available, analog sensors are still popular for many applications. Microsemi's Best Eye processing provides a nearly perfect photopic light-wavelength-response curve. The sensor output feeds into a wide dynamic-range compression amplifier that provides accurate resolution over five decades of ambient light. Courtesy of Microsemi.

"Digital is the direction ambient-light sensing is going," said TAOS' Strippoli. "It allows you to put multiple sensors on a single two-wire bus," such as the I^2C. This feature is especially important for flip phones. A digital bus minimizes the number of wires at the hinged interface where the cellphone flips up.

An analog interface requires at least two wires for every sensor. Analog ALSs are still good fits for some designs, such as those in which the voltage or current output of the ALS directly drives the lighting subsystem, those lacking a microcontroller or an available ADC input, and those low-end designs in which price is the dominating feature (**Figure 3**).

In the past, ALSs could vary from part to part in the amount of current a given amount of light produces. Such variability makes it difficult to design for a tight sensitivity range. "The manufacturers are [now] doing a great job of binning the components to give more consistency across the design so there's not as much variation of the photocurrent," said Arrow's Mashig. He suggests looking at the specification for photocurrent versus brightness to check the tightness of manufacturers' binning.

A low-power lighting system is especially important for battery-powered devices, and this requirement includes the ALS itself. In general, both analog and digital versions of ALSs have a shutdown or sleep mode, during which the sensor operates at approximately 1 µA. Because of the relative simplicity of analog ALSs, they require less power than their digital counterparts.

For example, a representative digital ALS draws 190 µA in active mode and 1 µA in power-down mode due to the integration of the ADC; an analog equivalent of the part draws 97 µA and 0.4 µA, respectively. The total power consumption, however, is comparable to or a little less than that of an analog ALS with a separate ADC.

Integrating proximity detectors

In addition to an ALS, smartphones often use proximity detectors. Apple's integration of a proximity detector in the iPhone prompted a move toward making handheld consumer devices more intelligent when interacting with their users (see "iPhone puts proximity detection in your face," below). Because of the close links in both technology and usage between ALSs and proximity detectors, ALS vendors are starting to add proximity detection to the list of integrated features in ALSs. "The ISL29011 drives an

iPhone puts proximity detection in your face

The Apple iPhone packs several sensors into its slim profile: an ALS, an accelerometer, and a proximity sensor. In addition, the display itself is a giant touch sensor, and that fact could pose a problem when the phone is in use next to a user's face. Apple solved the problem of inadvertent activation of the screen by including a proximity sensor that detects proximity and turns off the touch screen when the phone is 3 to 5 cm from a user's face (see "iPhone 3G Teardown," www.ifixit.com/teardown/iphone-3g-s/817/1).

Margery Conner

external IR LED so that it synchronizes the transmittivity of the LED and then captures the reflection off the object in front of it," said Intersil's Steciw. "You want the sensing range to be within about 3 to 5 cm."

The placement of the IR LED outside the sensor package gives designers more flexibility in where they place the device or what they'll place it behind, said TAOS' Strippoli. "The iPhone puts [the proximity detector] behind a glass that blocks about 95% of visible light," he added. "So if you use a device that gives you just a [fixed] single output, you get a very low signal."

For discrete proximity sensors, it's still common to keep the IR-radiating LED inside the sensor package. Avago recently introduced the APDS-9120 proximity sensor, which combines a built-in signal-conditioning IC, an emitter, and a detector into a package that offers both analog- and digital-output options. Like Steciw, Strippoli views the power-saving requirements of portable devices driving the trend in packaging proximity detectors along with the ALS but sees it as part of the move toward greener products. He believes that Asian countries in particular are likely to mandate the ability to tell when a viewer is using a large screen or monitor by monitoring proximity.

ALSs in smartphones detect light intensity but provide no information about the color spectrum. A recent development in ALSs is the ability to perform RGB sensing, a necessary feature for large-screen LCDs. For the best viewing experience, these displays must match their backlighting to the color temperature of the ambient lighting (Ref. 1).

The LCD controller uses the RGB ALS output to tune the RGB HB (high-brightness) LEDs to match the ambient lighting: Backlighting for a fluorescent-lit room has a different color temperature from that of a natural- or incandescent-lit room. In addition, as RGB LEDs age, their color changes slightly, calling for an additional RGB ALS in the backlight itself to sense and give feedback to drive the compensation for the LEDs' color change. Intersil, TAOS, and Rohm all offer RGB sensors.

SSL is an emerging application for RGB ALSs. In this application, color sensors provide feedback to a room's lighting-control system to adjust the light intensity, color, and color-temperature output of the HB LED-based luminaires. Lighting-control information is more complex than the simple on/off-light-switch information that room lighting currently uses, and lighting designers must be familiar with communication protocols. The DALI (digital-addressable-lighting-interface) protocol, which theatrical lighting has used for years, is one possible approach (see "Taking advantage of light sensors with microcontrollers running DALI," above).

Automotive lighting also needs ALSs. Night-driving applications have for years used simple photosensors to turn lights on and off, but more complex ALSs optimize cabin lighting for safe driving and for aesthetics, such as colored lighting and light-intensity variation. Like most other automotive components, ALS specifications must include operation over the wider temperature and vibration range. T&MW

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Conner, Margery, "The direction of light: Electronic and thermal improvements bring advances to lighting technologies," *EDN*, February 5, 2009. p. 26.

A version of this article appeared in the August 6, 2009, edition of EDN.

Taking advantage of light sensors with microcontrollers running DALI

By Bobby Wong, Technical-Marketing Engineer, NEC Electronics America

In our energy-conscious world, one simple way to reduce energy consumption is by adjusting office lights to take advantage of the available natural light. Light sensors can operate in multiple locations to detect the amount of naturally occurring ambient light. With the appropriate lighting system, users could accordingly adjust office lights to produce the desired amount of total lighting necessary for each area. Sensors have proved that they can dramatically enhance lighting systems—from improving energy efficiency by sensing ambient light to improving color by detecting light output. Although sensors provide the data, the lighting system still needs an intelligent microcontroller to receive and process the data and adjust the lights accordingly.

Of course, saving energy should not reduce productivity. A smart microcontroller-based lighting system would allow users to override the automatic light-level sensors when necessary and "remember" programmed user settings to enhance the users' experience.

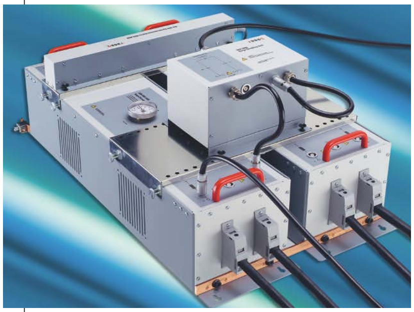
Although multiarea lighting control, sensor input/processing, and scene setting may sound complicated, the DALI protocol for white-light control in offices and factories already implements many of these features. Companies space these sensors and lights throughout their facilities, and the devices therefore require a network. The DALI network can control as many as 64 lights with 64 generic controls, such as slider dimmers and sensors. Each area light can store as many as 16 scenes, and each scene stores a digital-dimming level of 0 to 255. When a sensor provides ambient-light input to the microcontroller, the microcontroller can send a DALI command through the network to any of the 64 lights and control them to dim to a specific scene setting. The DALI protocol is also extensible, allowing a supplier to include vendor-specific features for added value. Some microcontrollers have specialized hardware for driving lights from fluorescent tubes to LEDs, and they simplify the support for a DALI network. Unlike discrete light drivers, these microcontrollers can process sensor inputs and intelligently control lights in a wide area using the DALI protocol to produce the optimized amount of light and save energy along the way (Ref. A).

REFERENCE

A. "Lighting-control solutions," NEC Electronics America. www.am.necel.com/applications/lighting.

Decoupling network meets IEC and ANSI specs

The CDN 3083-S100M portable coupling/decoupling network from Teseq lets you test power supplies, power cells, and power converters of up to 620 VAC to IEC EN 61000-4-5 and ANSI C62.45 specifications. It injects 1.2-µs and 50-µs combination wave surges at up to 8 kV (open-circuit). It also provides up to 4 kA, 8-µs and 20-µs surges (short circuit) into the main power supply of equipment under test. The network meets all IEC filter-inductance classes (up to 20 A; 20 A to 60 A; and 60 A to 100 A). It provides overload capacity on each 100-A phase during short periods, which lets it handle frequent inrushes of current.



Coupling modes on the network include surge differential, lines to ground, and common to ground with an ANSI coupling set. Decoupling conditions are per IEC 61000-4-5 and ANSI C62.45.

The CDN 3083-S100M includes rugged connectors and a solid ground line to ensure proper connection, which complies with IEC 61010 personal safety requirements. You can place the CDN 3083-S100M on the floor, on a table, or on a wall. It can also be wheel mounted, and the wheels include a brake, which lets you operate the unit on ramps and uneven surfaces.

Base price: $20,800. *Teseq, www.teseq.com.*

NI VeriStand 2009 serves test and simulation applications

National Instruments at NIWeek 2009 (August 4–6, Austin, TX) announced NI VeriStand 2009, an open, configuration-based software environment for creating real-time testing applications such as hardware-in-the-loop and controlled environmental tests. VeriStand implements the common functionalities of a real-time test system in a ready-to-use format, enabling developers to complete their test-application development efficiently. NI VeriStand helps developers configure a multicore-ready, real-time engine capable of supporting third-party I/O interfaces including a variety of data-acquisition and FPGA-based I/O interfaces as well as triggerable datalogging and stimulus-generation tasks.

Customers' control algorithms and simulation models often required by real-time testing applications also can be imported into NI VeriStand from NI LabView software and many third-party modeling environments, including The MathWorks' Simulink and ITI SimulationX. In addition, NI VeriStand provides a configurable run-time interface that includes a variety of tools to interact with real-time testing applications. The user interface is a run-time-editable workspace, so engineers can create and modify their user interfaces without interrupting real-time test-system execution.

NI VeriStand helps developers quickly capture the essential hardware I/O, simulation model, and other real-time task settings using an interactive system explorer window. These settings are saved in a system definition that is deployed to a real-time execution target such as a PXI system. Engineers then can add user-interface controls and indicators and map them to the system-definition resources to interact with their test systems. They also can use stimulus profile editors to create stimulus and logging configurations that are deployed to the execution target for deterministic execution.

While no programming knowledge is required to use NI VeriStand, the software is designed to be customized and extended using the LabView, LabView FPGA Module, NI TestStand, Microsoft Visual Studio .NET, and Python environments.

Base price: $1499. *National Instruments, www.ni.com.*

Analyze multiple optical networks

Anritsu's MP1590B Network Performance Tester, combined with the MU150110A Multirate Unit, can measure performance of optical networks such as SONET/SDH, OTN, Ethernet, and Ethernet over SONET at rates of up to 10 Gbps. The Multirate Unit eliminates the need for separate network interfaces for different data rates.

Measurements include jitter, BER, load tests, traffic measurements, and packet analysis. For traffic measurements, the instrument performs delay-time measurements, and it performs automatic protection switch tests, which check equipment switching time with 0.1-ms resolution. For optical transport networks, the MP1590B performs FEC tests by injecting Poisson-distributed random errors. It can perform these tests on 5376 channels simultaneously. For 10 GigE networks, the MP1590B provides PCS and link-fault signaling measurements.

Prices: MP1590B—$14,474; MU150110A—$37,791. *Anritsu, www.us.anritsu.com.*

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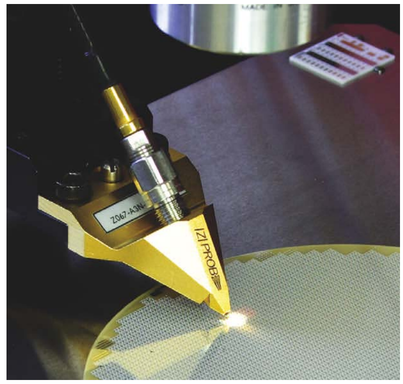
Suss adds 1MX technology to |Z| Probe line

Suss MicroTec has announced its new 1MX probe technology for the company's |Z| Probe product line. The 1MX technology retains the |Z| Probe product line's contact quality while providing a higher bandwidth, lower insertion loss, and higher isolation. Insertion loss, for example, is less than 0.8 dB at 67 GHz, and contact isolation is better than 40 dB.

The probes are optimized for 50- to 250-µm pitch. They come with a smaller contact footprint than standard |Z| Probe types to enable fine-pitch testing with less overtravel while maintaining a life span of 1 million touchdowns. The 1MX |Z| Probes are available in frequency ranges including 20, 40, 50, and 67 GHz and in GSG (ground-signal-ground), GS, SG, SGS, GSSG, and GSGSG footprint configurations. They are available in cryo (down to 10 K) and high-temperature (up to 300°C) versions.



Suss MicroTec Test Systems, www.suss.com.

Goepel supports double-sided in-line THT inspection

Goepel Electronic's OptiCon TurboLine system now supports efficient automated optical inspection for in-line THT (through-hole-technology) PCB manufacturing. The system allows the inspection of the component side of a board with a component-placement height of up to 85 mm, while a new integrated inspection module permits the simultaneous inspection of solder joints on the bottom side of the board. Thus, top- and bottom-side inspection can be executed in one operation. The OptiCon TurboLine can be applied before and after the soldering process and is suitable in particular for the inspection of power assemblies—checking, for instance, the polarity of electrolytic capacitors.

The OptiCon TurboLine provides a conveyor with an accumulator roller as well as a low-floor return conveyor for empty carriers to support the production of large PCBs. OptiCon Pilot software enables fast test-program generation and permits efficient use of the AOI system for THT manufacturing in very small batch or even one-off projects.

Goepel Electronic, www.goepel.com.

CATALOGS & PRODUCTS

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

Handheld spectrum analyzers

The lightweight R&S FSH4 and R&S FSH8 spectrum analyzers cover a frequency range from 9 kHz to 3.6 GHz or 8 GHz. Equipped with a battery pack, they support almost all RF measurement tasks in service, installation, and maintenance applications. *Rohde & Schwarz, www.rohde-schwarz.com.*

PXI downconverter modules

Phase Matrix's family of PXI downconverter modules for RF/microwave signal analysis are programmable and configurable to operate over a range between 100 kHz and 26.5 GHz. *Phase Matrix, www.phasematrix.com.*

Electronic load applications

Discover how to characterize a wide range of DC power sources, such as DC power supplies, batteries, fuel cells, and solar cells, by downloading "DC Electronic Load Applications and Examples." *B&K Precision, www.bkprecision.com.*

PXI automated test systems

The PXI-based GBATS (Geotest Basic Automated Test System) series includes standard configurations for mixed-signal test, digital test, boundary scan, and commercial/military avionics applications. The ATEasy software option offers an integrated test executive and development environment. *Geotest–Marvin Test Systems, www.geotestinc.com.*

Asset-management software

SMART/ENCATS 3.7 gives you complete reports on your lab, test, IT, and manufacturing assets (including performance characteristics), in well-organized, standardized formats. The software helps you standardize equipment records, modernize your asset-redeployment process, and maximize cost savings. *AssetSmart, www.assetsmart.com.*

Optical tester

JDSU's T-BERD 6000 is a highly integrated optical tester providing field-service technicians with more than 40 different application modules including LAN/FTTx/access networks, metro/core networks, ultra long-haul networks, and 10G/40G fiber characterization. *Advanced Test Equipment Rentals, www.atecorp.com.*

Open-air testing

The EMCC Dr. Rašek open-area test site in Unterleinleiter, Germany, provides ideal environmental conditions and infrastructure for EMC and RF investigations. The company says its underground laboratory offers a fully anechoic area with better quality than absorber halls. *EMCC, www.emcc.de.*

CATALOGS & PRODUCTS

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Solid-state amplifiers

AR RF/Microwave Instrumentation's new "S" solid-state amplifiers are more compact, more efficient, and more powerful than previous models. The "S" series covers a 0.8-to-4.2-GHz frequency range, available in 15-, 30-, 60-, and 120-W models. *AR RF/Microwave Instrumentation, www.ar-worldwide.com.*

Instrument-class accuracy

The USB-2416 series features 32 single-ended/16 differential analog inputs with full 24-bit resolution, configurable for either voltage or thermocouples. Products feature eight digital I/O lines, two 32-bit counters, and four optional analog outputs. *Measurement Computing, www.mccdaq.com.*

Handheld manometer

The HHP350 series of handheld digital manometers can display 11 different pressure scales as well as one user-defined scale. Standard features include min/max capture, display damping, backlit display, display hold, and leak-test functions. *Omega Engineering, www.omega.com.*

13.5-Gbps pattern generator

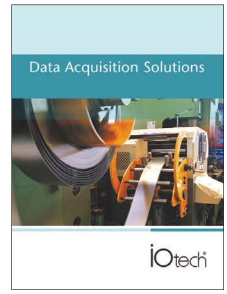
The Centellax TG4P1-A is a fully adjustable 0.6-to-13.5-Gbps programmable pattern generator. It offers single-tap de-emphasis, a precision clock phase adjuster, a 32-Mbit pattern memory, trigger and clock outputs, and a sinusoidal interference capability. *Centellax, www.centellax.com.*

Connector innovation continues

VPC's newest connector, i1, offers a range of hybrid connection options. Its half-turn quick-cam engagement,

removable backshell, and rugged durability make it an ideal solution for low I/O applications. *Virginia Panel, www.vpc.com.*

Free DAQ catalog

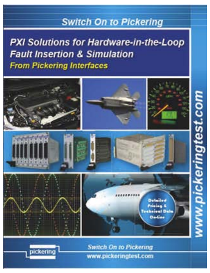


IOtech's free 2009 *Data Acquisition Solutions* catalog features Out-of-the-Box solutions to measure strain, temperature, voltage, vibration, pressure, and more. You can download the catalog from the company's Website. *IOtech, www.iotech.com.*

3.3-GHz and 8.5-GHz spectrum analyzers

B&K Precision's 2650A series spectrum analyzers can handle applications ranging from the installation of wireless communication systems to electric field-strength measurements. With their compact size, 4-lb weight, and 4 hr of battery life, they are ideal for field use. *B&K Precision, www.bkprecision.com.*

Fault-insertion switching



Pickering has a large selection of fault-insertion switching modules for hardware-in-the-loop simulation testing. A new catalog from the company highlights applications and the available choices. *Pickering Interfaces, www.pickeringtest.com.*

Automated switching systems

Cytec claims it can build systems for any type of signal you need to switch, so you can eliminate the tedium of constantly hooking up cables by hand. Visit the company's Website for a free product catalog. *Cytec, www.cytec-ate.com.*

Temperature and voltage measurement

Data Translation's MEASURpoint is designed for measuring any combination of RTD, thermocouple, and voltage ranges from 300 μV to 400 V. For harsh industrial environments, MEASURpoint is available in rugged NEMA enclosures. USB and Ethernet versions are available. *Data Translation, www.datatranslation.com.*

Tweezer-style multimeter

The Digital Multimeter Smart Tweezers automatically select measurement type and range with an accuracy of 1% to 3% for LCR and AC/DC voltage measurements. Used in diode/open-circuit/continuity tests, the meter measures capacitances as small as 1 pF. *Siborg Systems, www.siborg.com.*

Switch, measure, simplicity

VTI claims its scalable EX1200 series is the highest density switch/measure and control subsystem available. Modular and flexible, the EX1200 features LXI Class A technology and can measure up to 576 channels in a 1U format. *VTI Instruments, www.vtiinstruments.com/ad/ex1200/TMW.*

Compact signal generator

Despite its small size, the R&S SMC100A from Rohde & Schwarz generates signals of high spectral purity. The instrument integrates AM/FM/φM and pulse modulation, and its frequency range is 9 kHz to 1.1 GHz or 3.2 GHz. *Rohde & Schwarz, www.rohde-schwarz.com.*

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Production test evolves with PXI

By Richard A. Quinnell, Contributing Editor

Through a recent collaboration, Geotest–Marvin Test Systems and JTAG Technologies integrated one of JTAG's boundary-scan controllers into Geotest's preconfigured PXI test system for the production floor. This suggests that PXI may be moving into new realms in manufacturing test. I spoke with Mike Dewey, Geotest's senior product marketing manager, to learn more about how this application area is evolving.

Q: What prompted the collaboration?

A: We have been seeing more interest in using boundary scan for production testing as well as for programming of flash memory, CPLDs, and the like on the production floor. JTAG Technologies had PXI boundary-scan products and extensive support software, which made it easy for the companies to integrate their technologies into a preconfigured system.

Q: But hasn't boundary scan been available on PXI for a long time?

A: Yes, boundary-scan controllers have been available almost from PXI's inception [in 1997]. But the technology has been mostly used as an adjunct to in-circuit structural testing or as a separate test methodology and not part of a functional-test methodology that PXI systems typically provide. For whatever reasons, combining the two test techniques hasn't caught on, particularly in the North American marketplace, until now.

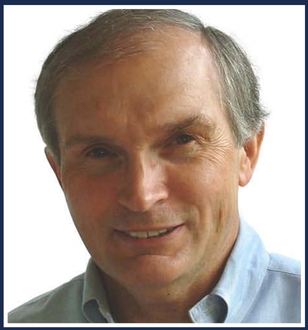
Q: Why is combined test catching on now?

A: What has happened is a loss of access to signals on boards and modules due to shrinking feature sizes, buried vias, and the like. This has made bed-of-nails probing or in-circuit testing more difficult, so the industry has been moving away from using in-circuit test systems and begun using x-ray and optical inspection as well as other forms of noncontact testing.

The industry has also been leaning more heavily on boundary scan. But if you're going to eliminate the stand-alone structural tester, where do you locate the boundary-scan controller? You still need it for some types of structural test as well as for flash and CPLD programming. So, why not add it to the functional tester? The idea has always been there, but now the implementation is moving forward.

Q: What other shifts in manufacturing test using PXI do you see?

A: One surprising area is that PXI is starting to move down from system- and module-level production test into component testing. Component-level test using PXI has been held back by a belief that dedicated ATE systems are needed for speed. But there has been increasing pressure to reduce test cost, and companies are looking for alternatives. This is opening the opportunity for PXI. You may need to give up some speed, but the test system will be significantly lower in capital cost, which could be a compelling tradeoff.



Mike Dewey
Senior Product Marketing Manager
Geotest–Marvin Test Systems

Q: What does PXI need to do to further open up this application area?

A: A lot of what is needed is already happening. PXI Express has become available for moving around the large test vectors that component test requires. The availability of high-performance FPGAs and the lowering cost of memory are also helping, resulting in more cost-effective instrumentation. PXI has been missing some things, such as the pin electronics, but this is also changing.

Q: Any other opportunities for PXI?

A: Portable test using compact, ruggedized platforms is on the rise. Such systems are valuable to flight lines, repair depots, motor pools, and other field environments. There are so many functions available in PXI today that it can be a compelling alternative to stand-alone instruments if the PXI system is hardy enough. □

INSIDE THIS REPORT

GUEST COMMENTARY

Customizing PXI test systems with FPGAs

By Sebastien Maury, Sundance Multiprocessor Technology

For the past decade, PXI-based systems have been successfully deployed for embedded signal-processing applications in data acquisition, industrial control, avionics, automated vision, medical instrumentation, and automated test. The high performance, modularity, and scalability of the PXI architecture have made it a compelling option for designers who require a rugged industrial form factor and real-time capabilities.

Today, designers and system engineers are increasingly deploying FPGA-based architectures to help deliver systems that are flexible and reconfigurable, support parallel processing, and offer a high data bandwidth. The integration of FPGAs into embedded signal-processing applications offers many benefits and advantages, but managing the diversity of I/O signals associated with FPGAs can make it difficult to interface devices to the external world.

Whether the I/O interfaces are digital, analog, single-ended, or differential, the preferred engineering solution is to allow designers to customize their FPGA-based hardware with the required I/O interfaces. Doing this while minimizing cost and customization is key.

New-generation FPGA products offer "plug-in" I/O hardware modules that are flexible enough to offer a wide range of interchangeable I/O functionality. These modules can directly interface to an FPGA, or other device, with reconfigurable I/O capability. They are configurable using programmable logic. Using FPGA mezzanine I/O modules can simplify system design, engineering time, and integration effort. Additionally, these modules can streamline the maintenance of the end product and increase the reusability of the main embedded signal-processing hardware units.

By combining FPGA cards and FPGA mezzanine I/O modules, users can design and deploy custom instrumentation. And with multichannel ADCs/DACs, RF front-ends, LVDS, LVTTL, Gigabit Ethernet, and serial interfaces, it is possible for test engineers to architect application-specific high-speed digital oscilloscopes, analyzers, arbitrary waveform generators, RF instrumentation, and vision systems. The combination of PXI and FPGA technology offers test engineers new options for building a modular, scalable system that meets their specific test needs. □

Sebastien Maury *is the Americas regional director at Sundance Multiprocessor Technology. sebastien.m@sundance.com.*

HIGHLIGHTS

Chroma unveils pin-electronics module

The 36010 pin-electronics module from Chroma ATE is a 100-MHz programmable module designed for characterizing and testing digital and mixed-signal ICs and electronics. The 36010 also supports scan pattern functions for scan test. Each module consists of a sequence pattern generator and a logic pin-electronics card with eight channels.

The sequence pattern generator, which provides more than 17 sequence commands to control the flow of pattern execution, is equipped with a 32-Mbyte sequence command memory. Each sequence pattern generator can support up to eight logic pin-electronics cards, allowing it to support up to 64 I/O channels and perform testing on eight devices simultaneously.

The per-pin timing generator in each logic pin-electronics card provides 32 sets of clock containing six programmable edges. In the analog function, the logic pin-electronics card has a tri-level driver and comparator with a 610-μV programmable resolution. It also offers active-load and high-voltage driver functions. www.chromaus.com.

NI debuts controllers and a chassis

During NIWeek 2009 (August 4–6, Austin, TX), National Instruments introduced low-cost PXI Express chassis and controller options for automated test-and-measurement applications. Included in the new offerings are the $1499 NI PXIe-1073 chassis and the NI PXIe-8102/01 embedded controllers, which start at $2999 each.

The NI PXIe-1073 chassis, which features an integrated remote controller, features five PXI Express hybrid slots that accept both PXI and PXI Express modules and an integrated MXI Express controller with a PCI Express host controller card and cable. Built-in timing and synchronization connections are integrated into the backplane of the chassis.

The NI PXIe-8102/01 embedded controllers can address the needs of test engineers who require a PXI Express system that couples the PC and chassis in a self-contained system. The NI PXIe-8102 features a dual-core 1.9-GHz Intel Celeron T3100 processor, and the NI PXIe-8101 includes a single-core 2.0-GHz Intel Celeron 575 processor. www.ni.com.

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Using a real-time OS with PXI

By Richard A. Quinnell, Contributing Technical Editor

Given PXI's roots in the PC field, it is no wonder that Windows is the dominant operating system for PXI system software. For some applications, however, Windows is not a good match to system requirements, and developers must employ another OS. Development teams seeking to move beyond Windows face challenges both in software availability and system programming, but new developments may offer a way past such problems. In fact, an evolving virtualization technology may permit a single test system to run more than one OS.

The drawbacks of Windows

One of the strengths of PXI is that the architecture is able to fully leverage technology advances coming from the fast-moving PC field. New processors, advanced interfaces, and development tools that arise in support of PCs can quickly be incorporated into PXI modules and systems. The same is true of advances in system software such as Windows.

But Windows is a double-edged sword when it comes to system control. It enjoys wide support in terms of tools, applications, and developer expertise, but it also has key drawbacks. Two of the most critical for equipment developers are reliability and determinism.

Windows can have unpredictable timing and sometimes will crash for no readily apparent reason, a failing that is not tolerable in critical applications. "There is nothing mission critical about most manufacturing test systems," said Wyatt Meek, director of business development at VI Engineering, "so they can run Windows, and if it crashes, they can simply reboot. But where operation is mission critical or there is critical control timing, you'll want something else."

As an example, Meek pointed to the JRETS (Jet and Rocket Engine Test System) that VI Engineering developed for Wyle Laboratories using multiple PXI systems to handle data acquisition and control. The system was designed to facilitate hot-fire testing of engines with as much as 50,000 lb of thrust, making consistent operation and well-controlled timing essential.

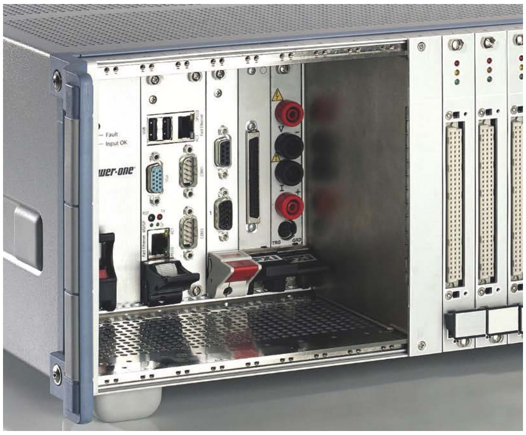
VI Engineering used the Phar Lap ETS RTOS (real-time operating system) instead of Windows, and used National Instruments' LabView with the LabView Real-Time module as the programming environment. Reliability was a key reason for this choice.

"You won't have a system crash with an RTOS if you implement it correctly," said Meek. "The fear with Windows is getting the 'blue screen of death' in the middle of a test." Meek also pointed to the maturity of LabView Real-Time, now at version 7, as a factor ensuring stable system operation.

In addition to reliability, the JRETS needed deterministic timing in its control paths. The variation in timing, or OS jitter, that Windows exhibits is typically 500 ms, and even when Windows is optimized for timing, the jitter can be more than 10 ms, according to Meek. An RTOS achieves jitter in the 1-to-10-ms range, making the system quicker to respond to errors, resulting in increased safety.

Developers want reliability

Even for systems that do not have such mission-critical requirements, however, some developers are looking for an alternative to Windows, according to Matthew Friedman, senior PXI platform manager at National Instruments. "A lot of users simply want more confidence in the reliability of their systems," said Friedman. "They may also be looking for a higher degree of synchronization between the controls driving the test and the measurement." Other reasons for choosing an alternative OS include vendor independence, version stability, and freedom from licensing fees.



For some developers of PXI systems, the reliability and functional stability of operating systems such as Linux offer an appealing alternative to Windows. Courtesy of Sekas.

If a PXI test system uses an external computer as the system controller, that computer can be running Windows, MacOS, Linux, or nearly any other OS that can send the appropriate commands. If the controller is embedded, however, off-the-shelf alternatives narrow.

Only a handful of manufacturers of PXI controllers support alternatives to Windows. Keithley Instruments, for instance, offers Linux for its controllers. NI has controllers with an embedded RTOS. MEN Mikro Electronik supports Linux, QNX, or VxWorks, depending on the controller model. Adlink has a Linux API (application programming interface) and driver library for its controllers and data-acquisition cards, and Team Solutions offers Linux drivers for the GPIB and PXI trigger functions built into its modular-CPU controller. Because the controller utilizes industry-standard plug-in CPU modules, however, OS support must come from the CPU module vendor.

If the controller is running an alternative OS, other system modules will require drivers appropriate to that OS. This can present developers with a challenge. "Not a lot of vendors have nonWindows drivers," said Meek, "so there is a smaller range of resources available for developers." Even when drivers are available, Meek noted, they may not support some of the module functions that the Windows drivers do.

Embracing a Windows alternative can also limit your options for application software. "Developers should look at which programs support their OS," said Meek, and he explained that if the test-control software does not run under the desired RTOS, developers will need to create their own test-sequencing engines.

There has been some industry activity to fill the gaps, at least for specific system configurations. LabView Real-Time, for instance, supports VISA (virtual instrumentation software architecture) drivers. So, if a module's driver is VISA-compliant, it will work under LabView Real-Time.

The German company Sekas is offering software that makes the Rohde & Schwarz CompactTSVP (test system versatile platform), which is used in automotive and telecommunications test, compatible with Linux. The Sekas software—TSVP-LXLib—replicates the software infrastructure that IVI (Interchangeable Virtual Instrument) drivers need, making it easier for developers to port the drivers to Linux.

Evaluate system needs

For the most part, however, PXI developers seeking an alternative to Windows must evaluate their choice carefully. "Survey your current needs to ensure that you have support for the new OS," said Gerardo Garcia, group manager for real-time software at NI. "Also, check to see if you are using OS-specific features such as ActiveX, which is only available under Windows. You need to make a full audit of what you are actually doing in your system."

Developers who are seeking to use an RTOS should also think twice about simply making the change on their own. "Bringing up a controller board under a new OS can be painful," said Garcia. "So, having out-of-the-box support for an RTOS from the board vendor is important."

VI Engineering's Meek also pointed out that moving a traditional PXI test application to a real-time system may require a learning curve. "You can't just take normal LabView code and have it work in real-time," said Meek. "You need to architect your program to allow independent threads, set priorities, and the like. This might not be difficult for a specific test, but it gets tricky if you are trying to design a generic system with looping and such. This adds cost and complexity to the development effort. You have to ask if the advantages of an RTOS are worth it."

Virtualization is on the horizon

Developers may not be facing an "either…or" OS choice in PXI system design for long, however. NI's Friedman said the industry is on the verge of supporting the best of both worlds by embracing technology from the IT field.

"Virtualization is an abstraction of hardware resources that allows multiple operating systems to run concurrently on a processor," said Friedman. "It employs a hypervisor software layer underneath the OSes that keeps them separate."

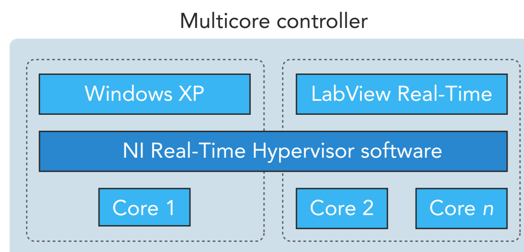
Virtualization technology takes advantage of the fact that all digital computing engines (processors) are Turing machines, which means that any processor can be programmed to mimic the behavior of any another processor regardless of structural and machine code differences. In virtualization, the hypervisor, also called the virtual machine monitor, runs at the processor's foundation level to mimic multiple copies of system resources to higher-level software, creating VMs (virtual machines) that can each execute an OS and application code.

A hypervisor can provide a high degree of separation between VMs. An OS on one VM can crash, for instance, without affecting the operation of the others. The hypervisor can also coordinate access to system hardware resources such as memory and I/O so that each VM can function as though it has dedicated resources even if the resources are actually shared. Hypervisors can thus "split" a single processor into several functionally independent ones.

Many of the latest generation of Intel and AMD processors now have hardware features that help them efficiently run such hypervisors, and more such features are added with each generation, according to Friedman. Multicore processors, which are becoming the standard approach for attaining the highest CPU performance, are also good candidates for virtualization techniques. Thus, the technology is on the edge of being available for PXI.

The advantage of using virtualization in a PXI system is that it gives developers the ability to segment a controller's functionality into multiple, independent parts. "You can keep the connectivity of Windows with one VM and use an RTOS for determinism in another VM," said Friedman. "This allows you to keep what you have under one OS but add more [functions] under another. It will allow for very innovative test system design."

At the very least, virtualization can help developers seeking to adopt Windows alternatives. By keeping only the most critical functions under RTOS control and the rest under Windows, developers reduce their need for alternative drivers and other support. Such an arrangement also restricts the need for new software development for the real-time portions of the system. Developers thus may not need to move entirely beyond Windows to achieve their goals. They may simply be able to stretch their system's reach a little. □



Virtualization may soon offer PXI developers a way of obtaining RTOS determinism for their systems without giving up the rich support of Windows. Courtesy of National Instruments.

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VIEWPOINT

[An exclusive interview with a technical leader]

WILLIAM BURROWS
Business Development Manager
Aeroflex
Plainview, NY

Bill Burrows began his test career 35 years ago as an RF engineer with Marconi Instruments in Britain and held technical, program, and market-management roles with that firm until its acquisition by IFR in 1998. He then spent eight years in the US in marketing and product management with a focus on public safety and land mobile products. IFR became part of Aeroflex in 2002, and in 2007 Burrows moved to the Stevenage, UK, operation of Aeroflex, where he is responsible for PXI, digital radio test, and general-purpose instruments.

Contributing editor Larry Maloney interviewed Burrows by phone on the test challenges presented by wireless, broadband, and military applications.

Test's essential ingredient: flexibility

Q: What's behind the increasing popularity of PXI-based instruments?

A: The growth in the PXI platform is a result of the openness of the standard and the flexibility that it offers. The ability to build complex configured test solutions that are optimized for high throughput has spurred a lot of interest, particularly in manufacturing test. With PXI, you can largely define the functionality of the test system by software. That gives you a very flexible platform for the diverse technologies in the wireless and broadband areas where multiple technologies are needed to test just a single device. Among the important PXI products we've brought to market recently are the 3021C and 3026C RF signal generators, which provide high output—+17 dBm—for frequencies up to 3 GHz and 6 GHz, respectively. These products are particularly effective for RFIC applications, where the DUT (device under test) is often embedded deeply in the system.

Q: Which of your target markets are poised for the greatest growth as the economy recovers?

A: Without a doubt, the cellular and wireless industry will remain our key growth area. The need for mobile broadband data services, such as those provided by LTE and WiMAX, will continue to increase. Our established TM500 Test Mobile and the new 7100 LTE Digital Radio Test Set are exciting products for future growth. This market is still very much in the R&D phase, so we've seen healthy levels of investment from global communications customers despite the downturn.

Q: With so many test companies targeting wireless, how does Aeroflex distinguish its solutions for that market?

A: Aeroflex looks for opportunities to develop test solutions that provide very good value for money spent. A good example is our new lower-cost 3250 series of spectrum analyzers, which offer many ease-of-use features, such as exceptional connectivity, while providing RF frequency ranges from 1 kHz to 26.6 GHz. Aeroflex has also been very successful in the PMR/LMR (private mobile radio/land mobile radio) market with solutions that address the needs of network support engineers.

Q: What special test challenges arise from multimedia broadband devices?

A: We are now in an era where "multifunction" is not an added bonus but a requirement. Designers and manufacturers can squeeze many different features into smaller packages, and complexities arise as we try to determine how to test all these features as accurately and quickly as possible. What we are seeing now is development of new automated test equipment for such devices. A good example is the MMTS (Multimedia Test System), developed by VI Technology, now an Aeroflex subsidiary. MMTS combines a number of test technologies, including solutions for digital audio and video, into one package.

Q: How do synthetic instruments fit into the Aeroflex product line?

A: In synthetic instruments, functionality is determined largely by the software and firmware applied to the device, which essentially consists of a signal source and measuring receiver. Our SMART^E line of synthetic instruments works especially well in high-performance, production, and complex test scenarios, such as military ATE. Earlier this year, for example, the company introduced a new synthetic solution for satellite payload test. Aeroflex is working on several products that use the synthetic concept, including our new 7100 LTE test set. T&MW

Bill Burrows addresses more questions on test solutions for broadband, avionics, and digital mobile radio in the online version of this interview: www.tmworld.com/2009_09.

To read past Viewpoint columns, go to www.tmworld.com/viewpoint.