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Engineers at GE Measurement & Control Solutions produce flow meters and moisture analyzers that give the right results.

Page 22

Dan Donaghey, design-verification and test engineer at GE Measurement & Control Solutions.

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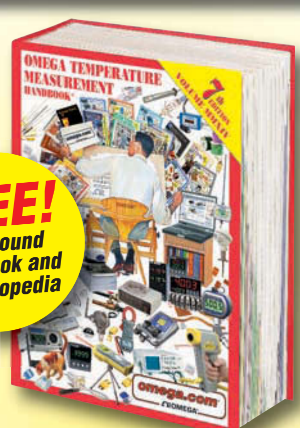

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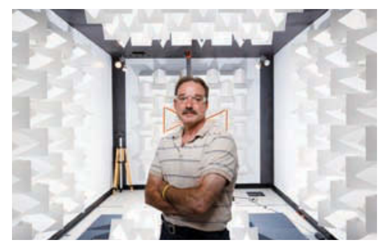
CONTENTS

Test voices / Page 11

DEPARTMENTS

FEATURES



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Call for nominations: *T&MW*'s annual awards

The editors of *Test & Measurement World* are now accepting nominations for the 2012 Best in Test and Test of Time awards, which recognize excellence and innovation in products and services used in electronics test, measurement, and inspection. The Best in Test awards honor new products introduced over the past year, while the Test of Time award honors a product introduced at least five years ago that continues to provide state-of-the-art service.

The nomination deadline is September 30, 2011. We will announce the finalists on our Website on November 1 and in our November issue, and we'll ask readers to vote for their favorites. The winners will be announced on January 31 during a ceremony at DesignCon 2012 in Santa Clara, CA.

www.tmworld.com/awards

Blog commentaries and links

Taking the Measure

Rick Nelson, Editor in Chief

- ESC Boston offers test track
- NI responds to Agilent's comments on VSA comparison
- Agilent responds to NI VSA comparison
- On the road to self-driving cars

Rowe's and Columns

Martin Rowe, Senior Technical Editor

- Strike up the EMC band again
- 40-Gbps optical agreement announced

Testing the Limits

UNH-IOL Staff

- Test modes: Pattern generators
- Test modes: Pattern checkers and error counters
- Test modes: Why do we care?

www.tmworld.com/blogs

RICK NELSON
EDITORIAL DIRECTOR

Meeting the grand challenges

The National Academy of Engineering's 14 grand engineering challenges received well-deserved attention last month when National Instruments relied on the list of challenges as a rough outline for demonstrations during its NIWeek event, August 2–4 in Austin, TX.

The challenges are as follows: Make solar energy economical, provide energy from fusion, develop carbon-sequestration methods, manage the nitrogen cycle, provide access to clean water, restore and improve urban infrastructure, advance health informatics, engineer better medicines, reverse-engineer the brain, prevent nuclear terror, secure cyberspace, enhance virtual reality, advance personalized learning, and engineer better tools of scientific discovery.

Gretlein urged the attendees at NIWeek to "look for something better."

Shelley Gretlein, NI's director of core platforms (software), told attendees at a Wednesday, August 3, keynote session, "You need tools that scale with your application as you address 14 grand engineering challenges." She quoted Ray Bradbury: "Predicting the future is much too easy…more of the same." She urged attendees to avoid "more of the same" and to "look for something better."

Gretlein then introduced several demonstrations that indeed point to something better. Some directly addressed the 14 challenges. Stefano Concezzi, director of physics at the University of Parma, and Michael Cerna, senior software engineer for NI's LabView scientific computing group, described the application of real-time math to the development of a practical fusion energy reactor. Addressing urban infrastructure, Jeremiah Fasl of the UT civil engineering department described his use of a wireless sensor network platform installed on a fracture-critical bridge in Austin. Vin Ratford of Xilinx discussed engineering the tools of scientific discovery, describing high-performance image-processing applications based on the Xilinx Zynq platform. And in a Tuesday presentation, Bill Kramer, R&D manager at the National Renewable Energy Lab, described the challenges of prototyping power inverters that could serve in solar and other renewable energy technologies.

Other presentations indirectly related to the challenges, dealing, for example, with the acquisition of information that might go into a health-care informatics system or optimizing the grid over which fusion- or solar-generated electricity might travel. In Wednesday presentations, for instance, Dr. Changho Chong of Santec described the world's smallest OCT (optical coherence tomography) noninvasive imaging system for medical and other applications. Jaswinder Singh of NexGEN Consultancy described efforts in Rajasthan, India, to renovate the electrical grid. And speaking on Tuesday, Michelle Tinsley, GM of the embedded computing division of Intel, predicted that by 2015 there will be 15 billion connected devices—and many will be connected embedded devices. It's not hard to imagine those devices serving in applications ranging from providing clean water to enhancing personalized learning.

Gretlein concluded the Wednesday session by telling her audience, "Of all the grand challenges, we are committed to do our part and equip you with the tools you need to create and deploy applications of the future. I am relying on you to solve the remaining engineering grand challenges we will face in the next quarter century." T&MW

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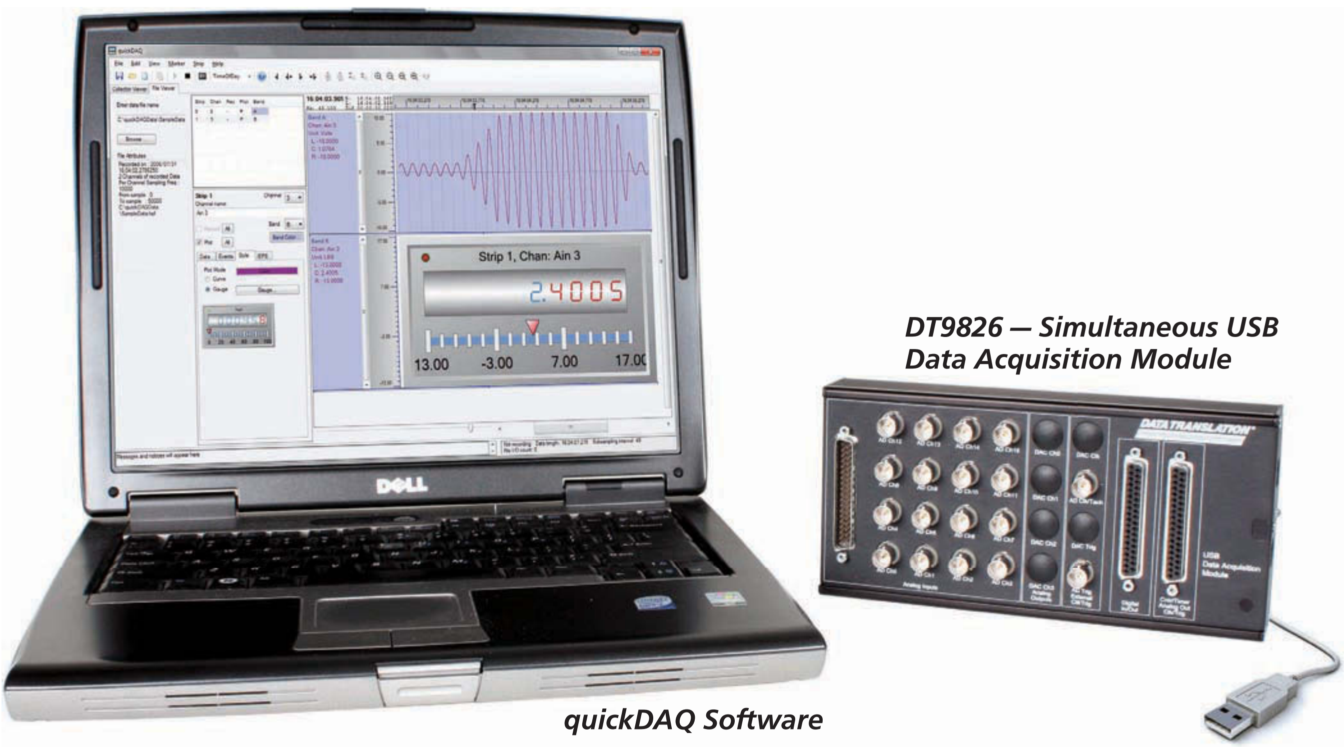

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[An exclusive interview with a test engineer]

Automation keeps RFICs in spec

Andy Street is a test and product engineer with NXP Semiconductors, a maker of RF amplifiers, mixers, upconverters, downconverters, and other components. Street works with design engineers and production engineers to characterize the company's RFICs and to ensure that the company's industrial test facilities are ready on time. Senior technical editor Martin Rowe met with Street at the NXP RF small-signal design center in Billerica, MA.

DANIEL GUIDERA

Q: What are your product engineer roles and test engineer roles?

A: Each design center has engineers who are responsible for product evaluation and production test. We see a product through from design to production. As a product engineer, I work with designers to develop tests for evaluating RF components. That involves making sure that designers design test features into our ICs. For example, analog test buses provide multiplexed access to a device's nodes that aren't available to the user. We also have power detectors in devices that monitor RF signals.

I then develop tests for measuring parameters such as frequency response, S-parameters, third-order intercepts, 1-dB compression points, and noise figure. As a test engineer, I develop test plans based on large-scale ATE (automated test equipment) systems located in Asia, where we do final assembly and test. The wafer fab is located in the Netherlands.

Q: What sort of testing do you perform at the design center?

A: I use test equipment such as VNAs (vector network analyzers) to characterize components under software control. VNAs can measure S-parameters, gain compression, and intermodulation distortion. I also have test benches that use signal generators and spectrum analyzers. We also use power supplies and digital multimeters to provide the necessary bias voltage or current to the device under test, or we may use source-monitor units. The test stations also use temperature control systems that let us rapidly characterize a device over a wide range of hot and cold temperatures.

I also write the code for the test stations. The test-station software consists of a test executive and code to control the instruments. A test-plan file defines the stimulus and measurement conditions, while other files hold the test-parameter definitions and their limits. We use another set of configuration files to manage a test station's hardware configuration, bias states, and digital states. Test systems also store test results, and engineers analyze them with statistical analysis software. Typically, we need about five files to configure and run a test, but this open, flexible approach allows us to test a wide variety of devices.

Q: How do you use the data-analysis software?

A: A device characterization requires many measurements. For example, a mixer may have as many as 10,000 measurements that cover the required temperature and voltage ranges. Data-analysis tools let us plot test results such as frequency response. The tools let us "slice" into the data.

For example, suppose we have a plot of gain versus frequency for an amplifier taken over several power-supply voltages and temperatures. We can focus on a few key frequencies and find the amplifier's gain versus voltage or temperature roll-off at a given frequency. The tools also help us understand part-to-part variations and correlate these variations back to fundamental wafer parameters.

Q: How many parts do you use in an evaluation?

A: It varies. For proof-of-concept builds, maybe five or 10 parts. If we're trying to understand a component's behavior, we might test from 30 to 50 parts. T&MW

Every other month, we interview an electronics engineer who has test, measurement, or inspection responsibilities. To participate in a future column, contact Martin Rowe at martin.rowe@ubm.com. To read past Test Voices columns, go to www.tmworld.com/testvoices.

NI debuts 14-GHz VSA plus DAQ and I/O products

At NIWeek (August 2–4, Austin, TX), National Instruments complemented the release of LabView 2011 (p. 38) with a new 14-GHz VSA (vector signal analyzer) as well as new data-acquisition and reconfigurable I/O products.

The company expanded the RF capabilities of its PXI line-up with the 14-GHz version (pictured) of its NI PXIe-5665 RF VSA. The VSA offers peer-to-peer data streaming for signal processing and a flexible MIMO (multiple input, multiple output) architecture for phase-coherent measurements. Speaking at an NIWeek keynote session, Sylvain Bertrand, RF broadband validation manager at ST-Ericsson, said the new NI PXIe-5665 VSA gives ST-Ericsson's characterization labs the performance and accuracy he needs for 3GPP RF IC design validation. "At the bottom line, the VSA reduces our system cost while increasing flexibility and decreasing physical bulk compared to our previous box solutions," he said. The base price for the new PXIe-5665 RF VSA is $49,999.

In addition, National Instruments announced the new NI cDAQ-9191, cDAQ-9181, and cDAQ-9171 one-slot chassis, which support all NI C Series modules for the NI CompactDAQ platform and can be used in conjunction with the existing four- and eight-slot chassis. NI also announced an expansion to its RIO (reconfigurable I/O) platform with the addition of multicore NI CompactRIO systems and small NI Single-Board RIO devices. The new NI cRIO-908x systems feature an Intel Core i7 dual-core processor, Xilinx Spartan-6 FPGAs, and a Windows Embedded Standard 7 OS configuration option. www.ni.com

Manufacturers announce 40-Gbps MSA

Five manufacturers recently announced an MSA (multisource agreement) for 40-Gbps pluggable transceiver modules. The new MSA covers TOSA (transmitter optical subassembly) and ROSA (receiver optical subassembly) modules.

The MSA specifies simple electrical interfaces and a low-profile and compact fit for pluggable modules. It defines the laser transmitter devices and the PIN-TIA (PIN photodiode-transimpedance amplifier) receiver devices that comply with 40-Gbps interface standards.

The five companies—Mitsubishi Electric, OKI Semiconductor, Opnext, Renesas Electronics, and Sumitomo Electric—also plan to specify the common mechanical dimensions, footprint, pin functions, and performance of the optical transmitter and receiver devices. The group expects to release its specifications within the next year.

An MSA committee spokesperson said that the agreement will lead to pluggable modules that will "provide advanced 40-Gbps serial solutions to high-capacity network and storage systems."

Editors' CHOICE

Geotest debuts semiconductor tester

Geotest has announced the TS-900, a new PXI-based test system for component, SOC, and SIP test applications. Offering up to 512 100-MHz channels with per-pin PMUs (parametric measurement units) and an integrated receiver interface, the modular TS-900 includes a set of hardware and software capabilities for digital and mixed-signal test applications. The custom-designed test interface supports the use of PCB DUT (device under test) boards for interfacing to the device under test. In addition, the receiver interface's pin blocks are field-configurable, allowing users to upgrade the receiver when they modify or upgrade the system for new applications. The system supports 64 to 512 dynamic digital channels as well as a range of analog, power-supply, and RF resources.

The basic TS-900 test system includes 64 100-MHz digital I/O channels, 64 static digital I/O channels, a programmable power supply, a system self-test feature, and a fixture. The software supplied with the TS-900 includes Geotest's DIOEasy, for digital waveform editing and display, and ATEasy, which provides an integrated and complete test executive and test-development environment, allowing users to quickly develop and easily maintain test applications. In addition, software tools are available for converting digital vectors from ASCII, WGL, or STIL formats. The TS-900 is available in both benchtop and cart configurations.

Base price: less than $75,000. *Geotest, www.geotestinc.com.*

CALENDAR

Automotive Testing Expo North America, October 25–27, Novi, MI. *UKIP Media & Events, www.testing-expo.com/usa.*

Vision 2011, November 8–10, Stuttgart, Germany. *Messe Stuttgart, www.messe-stuttgart.de.*

Productronica, November 15–18, Munich, Germany. *Messe München, www.productronica.com.*

DesignCon 2012, January 30–February 2, Santa Clara, CA. *UBM Electronics, www.designcon.techinsightsevents.com.*

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

Editors' CHOICE

PCIe board handles digital I/O

Computer-based test and automation systems often must sense digital signals and control motors and actuators. To that end, the DIO-16-LPCIe PCIe (PCI Express) I/O board from Sealevel Systems adds eight optically isolated digital inputs (3 V to 30 V) and eight reed-relay outputs.

You can use the inputs to detect digital signals from sensors such as proximity sensors. The reed-relay outputs can switch up to 500 mA, enough to drive small motors or other electromechanical devices such as solenoids. Contact voltage is 60 V, maximum. The digital inputs can sink up to 20 mA, and they provide 300-VAC isolation. The board's I/O connector also provides +5-V and +12-V power and three ground pins for when you need to supply voltage at a sensor.

The DIO-16-LPCIe is a low-profile board, which lets it fit into small PC cases. It uses one PCIe lane and thus is compatible with any PCIe expansion slot. Sealevel Systems' SealO software contains drivers for Windows operating systems from Windows 98 through Windows 7.

Price $289. *Sealevel Systems, www.sealevel.com.*

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RICK NELSON
EDITORIAL DIRECTOR
richard.nelson@ubm.com

Software key to effective use of ATE hardware

Semicon West was the venue for major ATE (automated test equipment) news, with Advantest touting its acquisition of Verigy. While Advantest and Verigy executives presented a united front at a July 12 press conference, Advantest and Verigy engineers proceeded on divergent paths as they debuted new modules for their T2000 and V93000 platforms. Not to be outdone by its newly constituted competitor, Teradyne announced new modules for its UltraFLEX platform.

James T. Healy, GM of Sony LSI Design, adopted a nautical theme to classify ATE players when he addressed the co-located ATE Vision 2020 workshop on July 14. He said the industry is populated by small Nemos (alluding to the boy clownfish protagonist of the 2003 *Finding Nemo* film) that come and go with the tide and are often eaten by the behemoth Bemos (who can become sick on their diet of Nemos). The third category, he said, are the Remos, who renovate repossessed or fully depreciated testers to test today's devices.

Yet another class of ATE provider, represented at Semicon West by Aeroflex, Geotest, and National Instruments, offers low-cost PXI-based systems (with Aeroflex adding AXIe as well). Following Healy's nomenclature, I'll call these companies Memos—multifaceted vendors adding IC test to their menu of applications served. Far from looking to become food for the Bemos, they are looking to eat some of the Bemos' lunch.

The AX-Series system for characterization and production testing of consumer RF and mixed-signal semiconductors employs PXI along with AXIe technology.
Courtesy of Aeroflex.

So from a hardware standpoint, customers can choose from a range of options. Unfortunately, hardware is only part of the problem, as presenters at the ATE Vision 2020 workshop made clear. Chris Lemoine of LTX-Credence said his customers invest millions of dollars in ATE software, and they want to protect that investment as hardware changes. Pete Hodakievic of AMD noted that great software can hide poor hardware, but great hardware can be 100% handicapped by poor software.

ATE vendors are addressing the software issue. For example, Peter Huber of Teradyne described his work on UTSL (Universal Test Specification Language), which imposes a slight test-time penalty but drastically speeds test-program development for automotive-device test.

ATE customers are mounting their own efforts. Radford Nguyen of AMD described his company's Unified Platform Architecture—a software framework for rapid test-program development for any available ATE platform.

Software firms are contributing as well. Geir Eide of Mentor Graphics teamed up with Markus Seuring of Verigy to describe an ATE-to-EDA connection through STDF V4-2007 that enables fast and robust scan-fail data collection. And Dan Glotter of OptimalTest, departing from Healy's nautical metaphors, said OptimalTest has paved the semiconductor information superhighway across the supply chain to support real-time data collection, secure data transfer, and data analysis.

Hodakievic concluded by noting that millennial engineers want to focus their creative energies on solving problems, not building toolkits. To that end, he said to general agreement, test engineers need an ATE app store. T&MW

IDM chooses Multitest DuraKelvin

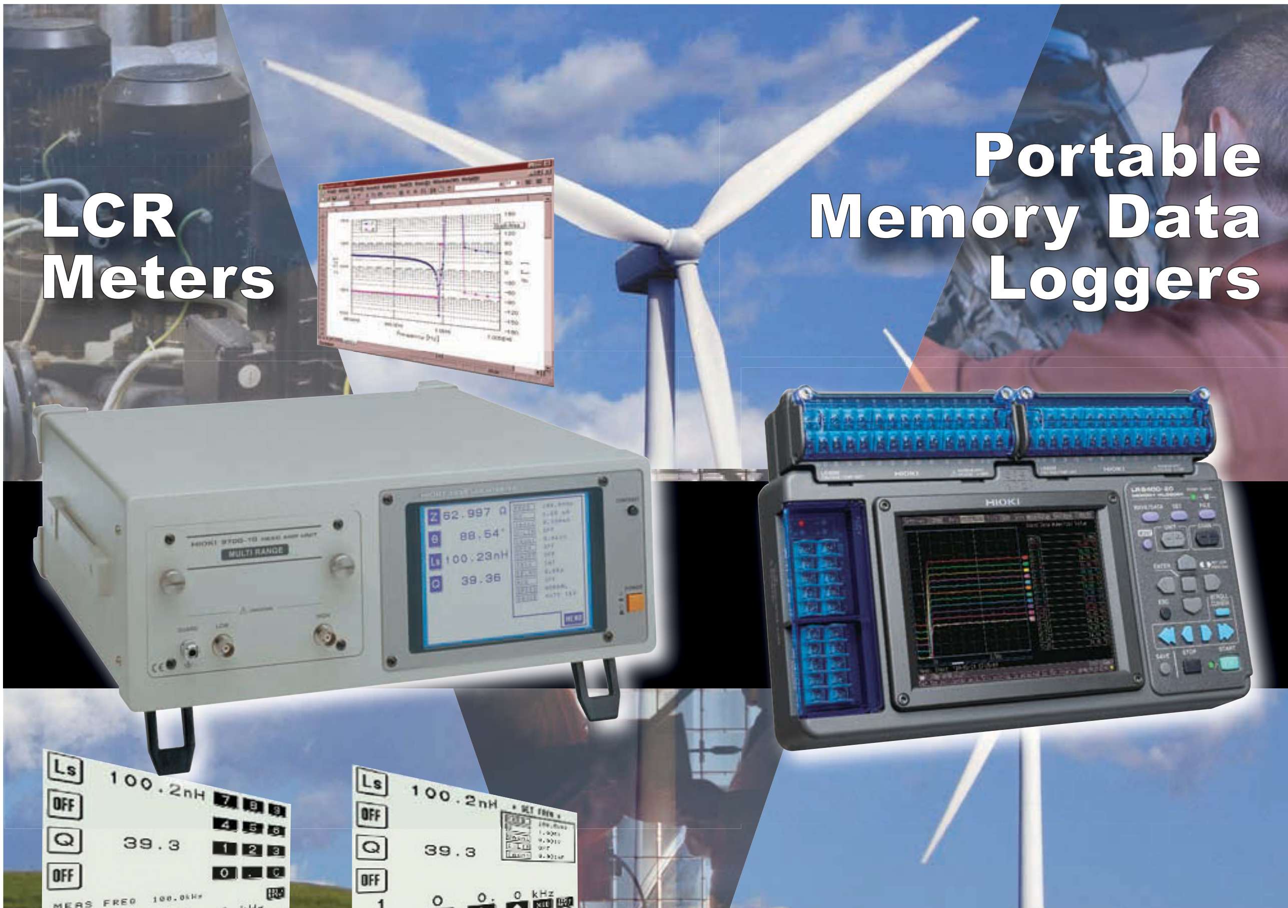
Multitest said that an IDM chose its DuraKelvin contactors for use in production test. The IDM reported that DuraKelvin achieved a life span of more than 4 million insertions—more than four times the set target. First-pass yield went from 95 to 98.5%, and the DuraKelvin only required cleaning after 100 hr, reducing test-cell downtime by 90% compared with the IDM's original configuration. www.multitest.com.

ChipVORX IP supports fast flash programming

Goepel Electronic has developed a ChipVORX model library series for accelerated in-system programming of FPGA flash devices. Developed in cooperation with Testonica, the ChipVORX models are structured modularly as intelligent IP and are available for all Altera and Xilinx FPGA families. www.goepel.com; www.testonica.com.

Wineman and Tecnalia debut Dynacar

Wineman Technology and Tecnalia Research have introduced Dynacar, a real-time vehicle model simulator for developing and testing passenger and light commercial vehicles. Dynacar—a plug-in for Wineman's Inertia test-automation software and National Instruments' VeriStand test-and-simulation software—provides a test platform that engineers can use from early vehicle design through hardware-in-the-loop and dynamometer testing. www.tecnalia.com/en; www.winemantech.com.



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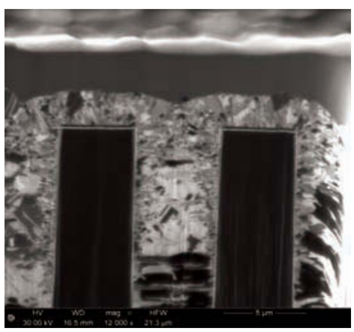
Plasma FIB speeds failure analysis

Conducting site-specific, cross-sectional failure analysis and fault isolation on complex, highly integrated packaged chips using FIB (focused ion beam) technology is no easy task. Analyzing 3-D IC packages and MEMS (microelectromechanical systems) with existing FIB techniques often requires several hours, instead of the minutes that would be required to make these techniques feasible in high-volume manufacturing environments. Consequently, to date this FIB analysis has been limited to relatively small numbers of samples, which has restricted the amount of development and failure-analysis feedback that can be done with these techniques.

In failure analysis, FIB systems remove material, add material, and form high-resolution images, all with the same beam. FIBs based on a Ga LMIS (gallium liquid metal ion source) have worked well in electronics applications for localized, site-specific sectioning and TEM (transmission electron microscope) sample preparation, said Richard Young, FEI's FIB technologist. "But in newer, highly integrated 3-D packaging applications, failure-analysis engineers are struggling with much larger volumes of material and larger sections that are hundreds of microns across," he said. "This can take hours of milling time with FIB systems based on a gallium liquid metal ion source. In particular, the development of TSVs [through-silicon vias] is being hindered by the metrology time required."

A new FIB source technology, ICP (inductively coupled plasma) using a xenon ion beam, can remove material up to 20 times faster than other FIB technologies, said Young. "ICP technology extends the maximum beam current to more than 1 microamp, compared to only a few tens of nanoamps for gallium liquid metal ion, thus removing material faster. At the same time, it can provide the lower beam currents needed for high-milling precision in final cuts and high-resolution, sub-30-nm cross-section imaging. It can cross-section features in a wide range of diameters, from 50 to 1000 microns."



This image shows a zoomed close-up of a feature in a TSV that has been located, cross-sectioned, and imaged by the Vion PFIB system.

Courtesy of FEI.

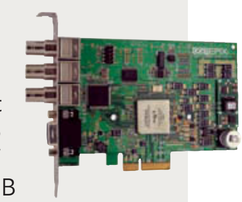
This combination of high-speed milling and deposition with precise control and high-quality imaging, realized in FEI's Vion PFIB (plasma FIB) system, makes the technology appropriate for several tasks. These include defect analysis of 3-D chips and MEMS devices; failure analysis of bumps, wire bonds, TSVs, and stacked die; and site-specific material removal to enable failure analysis and fault isolation on buried die. It's also possible to introduce different gases so the Vion PFIB can selectively etch certain materials or deposit patterned conductors and insulators. ICP has been used previously for TSV deposition and etching systems, but using it as an ion-beam source in a FIB system is new, said Young.

Not only are the volumes of material to be milled larger, but packaging and failure-analysis engineers are also dealing with new materials, smaller features, and thinner, more fragile samples, said Peter Carleson, FEI's product marketing manager. "The faster feedback provided by FEI's Vion PFIB system helps keep the high-volume development and failure analysis of TSVs, MEMS, and 3-D packages on track," he said. T&MW

Wafer-inspection system uses DUV

KLA-Tencor's latest generation of Surfscan wafer-defect and surface-quality inspection systems for substrate manufacturing and IC process monitoring, the SP3, is designed for extension to the next wafer size of 450 mm and to device nodes of 28 nm and below. The SP3 incorporates DUV (deep-ultraviolet) illumination, providing dramatic advances in sensitivity and throughput over its UV illumination predecessor. www.kla-tencor.com.

Frame grabber captures 30 bits/pixel



The PIXCI A310 from Epix uses a PCI Express x4 slot for capturing up to 30 bits per pixel of high-resolution RGB video. It acquires images from monochrome or RGB cameras with RS-170, CCIR, RS-343, VGA, SVGA, XGA, WXGA, SXGA, SXGA+, WXGA, WSGA+, and UXGA formats. The card's 64-bit memory addressing allows it to capture image sequences directly to PC memory. www.epixinc.com.

Metrology system examines 3-D ICs

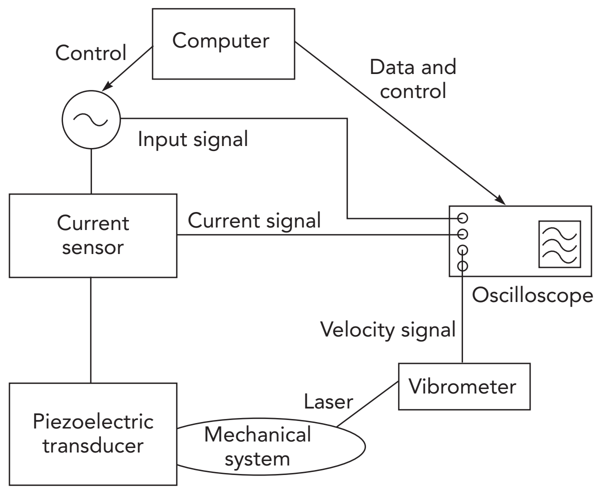
The 3DIR (three-dimensional infrared) metrology and defect-review system uses confocal IR laser-scanning microscopy to monitor post-bond parameters of 3-D stacked ICs, measuring alignment points at selected die, storing images, and summarizing results. Correlating overlay-alignment-offset data to electrical yield provides an early indication of bonded wafer yield. www.olympus-ita.com.

INSTRUMENTS

Control test instruments with Python

Many engineers write code to automate instruments and collect data. While you can use commercially available programming languages, you can also use open-source software tools to write your automation code.

Sinay Goldberg, an engineer in Ra'anna, Israel, needed to measure the frequency response of a mechanical system. Using an oscilloscope, a function generator, a current sensor, a piezoelectric transducer, and a laser vibrometer, Goldberg designed a measurement system that generates a stimulus signal and captures the mechanical system's response signals (see figure). He controls the oscilloscope and function generator through a USB port and with software written in Python (www.python.org). A pyvisa application provides a link to the instruments through a common programming interface (sourceforge.net/projects/pyvisa).



An input signal excites a transducer to cause vibration in a mechanical system, which the oscilloscope measures.

The function generator excites the mechanical system using a swept-frequency sine wave. When the mechanical system vibrates, the vibrometer converts mechanical motion into an electrical signal that the oscilloscope captures. After transferring the data to a PC, Goldberg's Python application software converts the signals to the frequency domain for analysis.

You can read about the application in more detail and obtain the Python source code from the online version of this article (www.tmworld.com/2011_09).

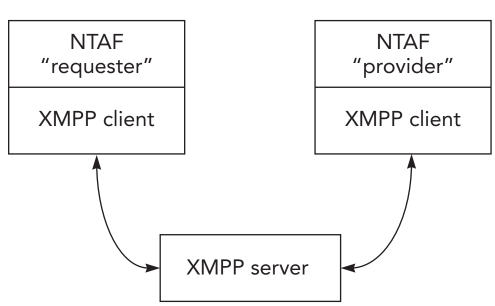
Martin Rowe
Senior Technical Editor

WEBCAST

Automating network test

On June 22, 2011, the NTAF (Network Test Automation Forum) presented a Webcast to provide an overview of its specifications for automation and interoperability in network testing (Ref. 1). Bruno Giguere from EXFO, Kenneth Green from Ixia, and Todd Law from Spirent Communications made presentations, and I served as moderator.

EXFO's Giguere opened by recounting the history of NTAF, and he explained the need for a unified software standard for automating network test. "Today's test solutions are often vendor specific and there are no standards for interoperability," he said. Giguere demonstrated what can happen when you try to integrate a test system using equipment from multiple suppliers: "You end up entangled in different programming commands that lead to interoperability problems." NTAF brings test-equipment makers, network-equipment makers, and service providers together under a single specification for automating network tests.



NTAF "requesters" and "providers" of network resources communicate through an XMPP server.

Next, Ixia's Green delved into the details, explaining that the NTAF software standard is based on XMPP (Extensible Messaging and Presence Protocol), a protocol developed for instant messaging. XMPP lets automation tools—computers or servers running automation software—communicate with test equipment and network equipment across LANs and WANs.

"It [XMPP] can easily traverse the security gateways present in today's test environments," Green said. An NTAF server controls NTAF-compliant equipment on the network under test. The server is essentially a standard XMPP server configured with an NTAF registry that lets NTAF-aware tools identify NTAF-capable equipment and

Automating network test *(continued)*

establish communications between the tools and the equipment using standard XMPP message-passing technology.

The NTAF specification consists of two parts. TS-001 covers registry, discovery, and activation of NTAF-compliant equipment. TS-002 contains the syntax and content that describes the capabilities and actions of test equipment or network elements that an automation toll can invoke.

"It's basically an XML schema," said Green. Using standard XMPP services, a network resource (tester or network element) can publish itself on the network and make its information available to test-automation tools on the network.

Green then covered NTAF proxies, a part of TS-001 that describes the capabilities of a tester or a network element to the automation tools on the network. Proxies also manage network resources. A network tester, for example, has many resources, but you may not want all of them running at once. An NTAF automation tool can launch a tester application through a proxy. When the test finishes, the automation tool can release those resources for later use.

TS-002 describes NTAF harnesses, which define the actions that a tool can perform, the action's parameters, and the parameters of the associated responses (a tool can make these capabilities public on the network, either directly or through a proxy). Parameters can be simple values but may also include tables, structured data, or XML data. The NTAF specification also defines a mechanism for initiating file transfers between NTAF entities; the mechanism provides an efficient exchange of complex setup data or bulk test results.

Law from Spirent Communications described an example of how equipment and tools can register themselves on an NTAF network. Automation tools can identify NTAF-enabled devices on the network and communicate with them. Law described how resources can turn on or off as needed based on capabilities and testing needs. Network equipment and automation tools can serve as a requester or provider, depending on the services an automated test needs (**figure**). The NTAF XMPP server and the automation tools that run on it act as an arbiter between network elements and test equipment.

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REFERENCE

1. "Introducing the next generation of test automation & interoperability - the NTAF Specification." June 22, 2011. bit.ly/lE0rlK.

Measure resistance and temperature with a sound card

Measure resistance and use free software to convert to temperature.

Zoltan Gingl and Peter Kocsis, University of Szeged, Szeged, Hungary

Unless you add a measurement instrument to your computer, you have only the sound card as an analog I/O port. You can use the sound card to digitize AC analog voltages but only within a limited range. You can, however, add some signal processing and measure a wider variety of signals, even those that produce DC or low-frequency outputs. For example, you can directly connect a thermistor to make a sound-card thermometer to monitor or record the temperature on PCBs (printed-circuit boards), circuits, heat sinks, and more.

Thermistors are popular temperature sensors because they allow easy detection of changes in resistance. Once you measure a thermistor's resistance, you can apply the following equation to find the temperature:

$$T = \frac{1}{\frac{1}{T_O} + \frac{1}{\beta}\ln\left(\frac{R_T}{R_O}\right)}$$

where R_T is the thermistor resistance and T_O is the temperature in Kelvins at which the thermistor's resistance is R_O. You can find the value of β in a thermistor's data sheet.

Figure 1 shows the easiest way to interface a thermistor to a sound card. The microphone input has an internal bias resistor, R, with a typical value of 2 to 5 kΩ. A DC bias voltage drives this resistor. The bias resistor connects the thermistor between the line or the headphone output and the microphone input, which forms a voltage divider with the internal bias resistor. Those components are all the circuit needs. Note that some microphone inputs may have different internal connections, so check yours before use.

You also need a sinusoidal signal because the sound card's inputs are AC-coupled. The sound card's audio output can produce an AC voltage at the microphone input, whose amplitude is proportional to $R/(R+R_T)$. You can do a simple calibration to find the output signal's amplitude and the value of R by replacing R_T with known values, such as 0 and 10 kΩ.

A sound card's measurement accuracy is worse than what you could achieve using a commercial data-acquisition card, but this ratiometric arrangement and calibration keep errors to approximately 1% for resistor values of 1 to 100 kΩ. Even without temperature calibration, you should get temperature errors of 1 to 2 K with a 10-kΩ thermistor at room temperature. Accuracy degrades to 3 to 5 K over the thermistor's operating temperature.

You can download simple, free, and open-source software in Java that you can use as a simple ohmmeter, thermometer, or chart recorder under Windows or Linux. You can download a Java executable or the Java source code (Ref. 1).

You should consider adding protection to the sound card's audio I/O ports by inserting series resistors. Typically, a few kilohms is all the circuit needs. You can also use an inexpensive USB sound card to spare and protect your PC sound card's inputs.

You can add second and third thermistors by adding an external resistor divider (**Figure 2**). This lets you use both audio channels and a third thermistor at the microphone input. In addition to using thermistors, you can use the sound card with other resistive sensors, such as photoresistors or potentiometric displacement sensors. You can even connect capacitive sensors if you add some more components and signal processing (Ref. 2). T&MW

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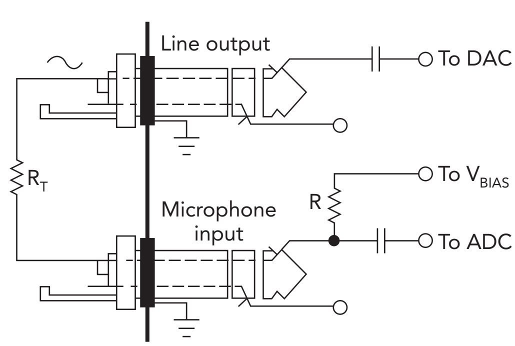

Figure 1 The internal microphone bias resistor and the externally connected thermistor form a voltage divider.

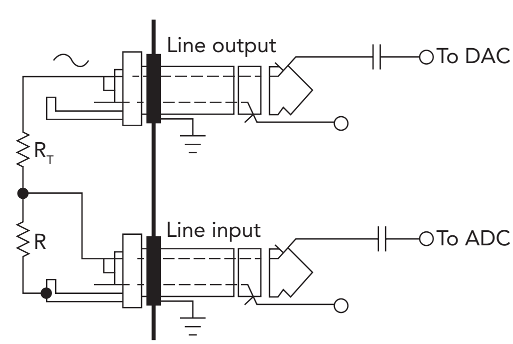

Figure 2 You can add second and third thermistors to your system by adding an external resistor divider.

Keeping the measurements flowing

Engineers at GE Measurement & Control Solutions produce flow meters and moisture analyzers that give the right results.

BY MARTIN ROWE, SENIOR TECHNICAL EDITOR

BILLERICA, MA—When you buy gasoline for your car or fuel oil or natural gas for your home, you expect an accurate measurement of the quantity you buy. The companies that supply those products to your local gas station, oil-delivery company, or gas company also expect accurate and reliable measurements when they make purchases from their suppliers.

For all these transactions, the engineers at GE Measurement & Control Solutions design and test meters that measure flow rate and calculate purchase quantities. In addition, the engineers also design and test moisture analyzers that ensure that natural gas contains only trace amounts of water.

The engineers start at the board level where they test circuits and software, then move on to test sensors and mechanical parts, and then test the entire system with tests that resemble actual customer use in oil and gas fields. Along the way, they make EMC (electromagnetic compliance) and environmental tests to ensure the products comply with regulations.

Measuring more than liquid

When GE engineers talk about a flow meter, they are referring to the entire device that is inserted into a pipeline—electronics, sensors, pipes, and other parts. In addition to sensing flow and water, flow meters and moisture analyzers measure the temperature and pressure inside a pipeline and use those measurements to calculate flow rates and moisture levels.

Flow meters and moisture analyzers contain several inputs and outputs. Flow meters, for example, may produce pulse trains in which the pulse frequency represents flow rate. They may also produce 4–20-mA analog outputs that represent flow or another value such as temperature. Flow meters and moisture analyzers also have one or more communications buses such as RS-232/422/485, Modbus, Fieldbus, and HART bus. The instruments use these buses for receiving commands and for transferring data to a host computer.

Engineering tests start on the bench with simulations, after which design engineers build and evaluate digital control circuits, signal-conditioning circuits for the sensors, and analog and digital output circuits. The GE engineers typically build several complete prototype units, on which they perform accuracy tests, functional tests, EMC tests, and environmental tests. Finally, the production department will use actual production processes to build a larger quantity of units for a pilot evaluation. Engineers then repeat all the tests on these units, which represent the final design. If everything passes, full production begins.

The test plans start as soon as design engineers begin designing electronics, sensors, and mechanical parts. Michael Gambuzza, the lead electrical engineer for the moisture and gas group, designs and tests the analog and digital circuits that go into a meter's controls. While Gambuzza is designing electronics, other engineers are developing test schedules, readying the EMC lab, and preparing for environmental tests and flow-rate tests.

Although Gambuzza spends much of his time designing circuits, he also tests them in complete systems. For example, after he designed the electronics for GE's Aurora series moisture analyzers, Gambuzza ran tests in the optical lab. Why an optical lab? Because the Aurora moisture analyzers use the Beer-Lambert Law of Absorption. They measure reflected light and, through digital-signal processing, calculate the moisture content in natural gas as it travels through a pipeline. (The Aurora moisture analyzer can measure moisture as low as 5 ppm.) Analog circuits, under microprocessor control, drive a laser diode over a swept-frequency spectrum (**Figure 1**).

"We generate a drive signal to a laser diode to sweep its input current," said Gambuzza. "That sweeps the tunable diode laser through a spectrum of wavelengths. At a particular wavelength, you get the most light absorption because of the presence of water." The more moisture in a gas line, the more light

Design-verification and test engineer Dan Donaghey works with design engineers to develop test plans for new products.

JASON GROW

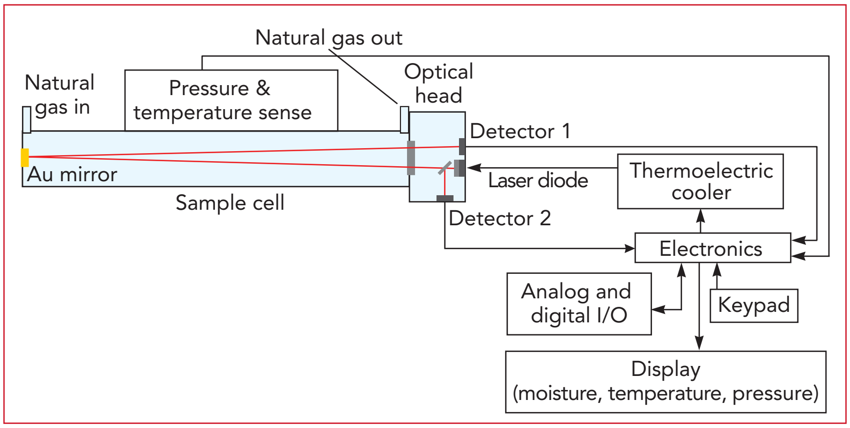

FIGURE 1. A moisture analyzer detects moisture in a gas by measuring the amount of light that reflects from a mirror. Courtesy of GE Measurement & Control Solutions.

it absorbs, so less light bounces off a gold mirror.

Gambuzza and Dan Donaghey, a design-verification and test engineer at GE, demonstrated a moisture analyzer test-and-calibration system in the optical lab (**Figure 2**). Gambuzza often uses this system to run functional tests and accuracy tests on new or modified circuits. The test-and-calibration system uses a moisture generator and a chilled-mirror moisture hygrometer as a reference measuring instrument and also to measure the dewpoint. Because laser-diode current and moisture content are known quantities, Gambuzza can test an analyzer for functionality and measurement accuracy. The system also measures temperature and pressure inside the flow line, because those conditions greatly influence other measurements.

The system uses a series of valves driven by a National Instruments PXI chassis under LabView control. The calibration process begins with a calibration at known moisture concentrations in nitrogen or methane. The system starts calibrating at the lowest moisture levels and then increases the levels. (Adding moisture takes less time than removing moisture.)

As the system increases the moisture levels and measures the results from the moisture analyzer under test, a host computer collects the measurements and calculates the differences between the meter's measurements and those from the reference chilled-mirror hygrometer. The software uses those differences to calculate offsets based on temperature and pressure. Then, it builds a curve-fit equation that it applies to the analyzer under test to linearize its measurements. Calibrating the moisture analyzer's accuracy at several moisture levels takes several hours, so the calibrations run overnight, and the engineers are able to run accuracy tests on the moisture analyzer the next morning.

Planning a gamut of tests

While Gambuzza is designing circuits and running initial bench tests, Donaghey plans tests from engineering evaluations through to production. Starting with engineering design specifications, Donaghey develops a spreadsheet that lists the tests a product will need to undergo prior to production. These tests include functional tests, accuracy tests, user-interface tests, EMC tests, and environmental tests. He also develops a bug-tracking database where engineers can record problems that must be resolved.

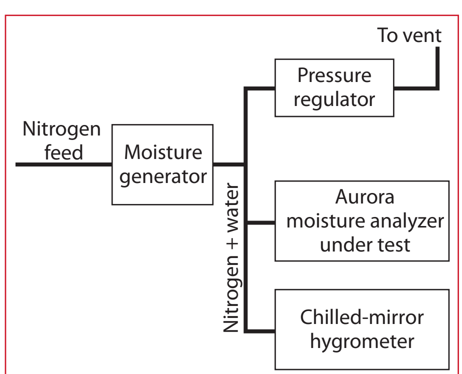

FIGURE 2. A moisture-analyzer test-and-calibration system compares the measurements from the analyzer under test to those from a chilled mirror hygrometer.
Courtesy of GE Measurement & Control Solutions.

Donaghey spends much of his time on user-interface testing for each new product and software revision. GE's products have a series of menus that let users configure them. Some flow meters must operate behind glass enclosures, which requires operators to use a wand with a magnetic tip to operate the meter. As part of a user-interface test, Donaghey verifies that an LED flashes to indicate the active meter control. He also goes beyond requirements by testing a product by operating the meter without referring to user documentation. "I often don't read manuals after buying a new consumer product," he explained, "so I assume that users of our products won't read the manuals, either."

Donaghey starts user-interface testing by creating a software menu map for checking menus and functions. He has automated some menu testing by using a meter's communications interface to a computer. Test software can record his steps and recreate them. He must, though, manually test a flow meter when the test requires use of the magnetic wand.

In addition to listing the required tests for a product, Donaghey develops a test plan that specifies which tests a new product will need. After an engineering and marketing review, he writes test cases where he specifies the equipment, procedures, and reference documents that the tests will need. Accuracy tests, such as the one he and Gambuzza demonstrated, are among those that Donaghey develops.

Guaranteeing compliance

GE engineers don't wait for a completed product to begin testing it. Even before GE engineers have a product's firmware, they'll send it to EMC engineer Charlie Martin, who readies the EMC lab and decides which national and international standards will apply to a product. Martin runs EMC compliance tests on meters and analyzers for conducted emissions, conducted immunity, and ESD immunity. He also runs precompliance radiated emissions tests, using an outside lab for compliance tests. His test chamber limits tests to a distance of 3 m, but some standards call for tests in a 10-m chamber. *(continued)*


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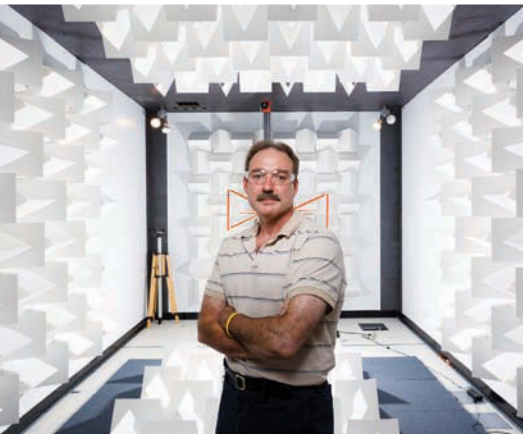
"I test entire systems," said Martin. "Sometimes, engineers send products before they're functional, just to run initial tests." Those initial tests help design engineers verify that their protection circuits will properly protect sensitive components from power-line surges, bursts, and voltage dips and from ESD (electrostatic discharge). These tests let designers uncover weaknesses in the design and determine whether they have used protection circuits with the proper ratings or if PCB (printed-circuit board) traces need rerouting. If problems occur, Martin can consult with design engineers on ways to improve a system's EMC performance.



EMC engineer Charlie Martin runs compliance and precompliance tests in GE's EMC lab.

The lab consists of a 3-m Panashield chamber and several test benches. The chamber, which Martin uses for compliance radiated-immunity and precompliance radiated-emissions tests, consists of an antenna from Schaffner-Chase (now Teseq) and a mast and turntable from Sunol Sciences. He uses a Hewlett-Packard (now Agilent Technologies) EMI (electromagnetic interference) receiver for emissions measurements, a Kalmus (now AR) amplifier, and an IFR (now Aeroflex) signal generator for immunity tests. An Agilent AC power source lets Martin add disturbances to power lines for immunity testing. The lab also contains several test benches for conducted, power-line, and ESD immunity tests. Martin built the benches in different sizes to accommodate an array of product sizes. He can join the benches together when a product is too large for one bench. Each bench has a ground plane that adjusts in size when Martin combines benches.

Martin also designed and constructed many parts of the EMC lab. For example, he specified the test equipment and the 3-m chamber. From his experience, Martin has learned to plan for technological advancements, such as increased operating frequencies, when designing an EMC test facility. When he designed the 3-m chamber, he installed ferrite tiles on the walls that could absorb energy and minimize reflections at frequencies up to 1 GHz. When standards called for measurements up to 3 GHz, Martin had to install additional Panashield absorbing material.

When he designed the lab, Martin had to contend with interference from a nearby cell tower, so he added more grounding than an EMC lab usually needs. In fact, the chamber's ground connections go directly to its own ground rods at a point just outside the chamber. There's only one ground point for the chamber and its associated test equipment, which eliminates the possibility of ground loops that can degrade measurement performance.

All of the products tested in the EMC lab run from 230-V/50-Hz power. To generate that power, the lab has a motor-generator that can produce up to 24 A. The test equipment, though, runs from 110-V, 60-Hz AC mains. Isolation transformers isolate the power for the equipment from the power for the building. Line filters are used on both the 230-V and 110-V outlets at each test station to minimize power-line noise.

Testing at the extremes

Not only must GE's flow meters and moisture analyzers comply with worldwide standards, they must also withstand the frigid cold of the Arctic and the blazing heat of the desert. To ensure that GE products work under those conditions, environmental test engineer Dave Gifford tests them at extreme temperatures, and he also runs HALT/HASS (highly accelerated life tests/highly accelerated stress screening) tests, because the meters must withstand shipping to oil and gas fields. And they must withstand water as well.

Gifford tests meters at temperatures that may exceed operating specs. Gambuzza may specify a temperature range of –20°C to 60°C, but Gifford often tests over a wider range, which gives him confidence that the product will operate as intended. Temperature tests typically run for 7 days (168 hr), during which time Gifford will ramp the temperature between the extremes of the range. In a temperature-storage test, Gifford leaves the units in a temperature chamber, unpowered, for six days. He also runs humidity test that range from 20% to 90%.

Flow meters vary in size depending on the size of the user's pipeline, which can reach a diameter of 24 in. Because of that size, Gifford can't put some complete flow meters in his environmental chambers. He has to test the components separately.

GE's environmental lab also has a water tank where Gifford submerges flow meters so he can test for water tightness. He places the meters in a tank to a depth of

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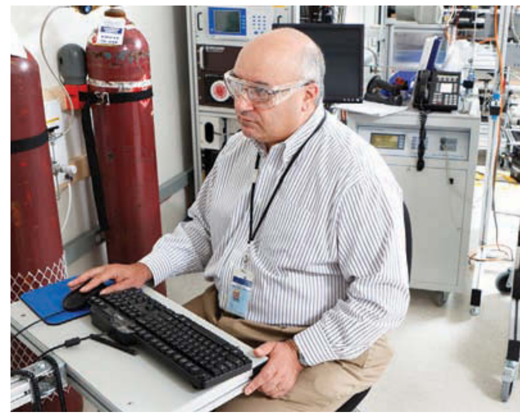


Lead electrical engineer Michael Gambuzza designs analog and digital circuits that control flow meters and moisture analyzers.

1 m. He also tests GE's products for water leaks under a known pressure. To do that, Gifford built his own test apparatus.

"You have to get creative with testing, and you may need homemade test equipment," he explained. He added plumbing to a tank that connects to a submersible pump. Water from that tank comes out of a fire hose at 65 gal/min. Gifford then hoses down a meter on all sides and looks for leaks to ensure compliance with NEMA standards. Some tests require a special nozzle manufactured by ED&D, because it produces water flow at a known pressure. Gifford uses a GE flow meter to measure the flow rate through the nozzle.

Environmental test engineer Dave Gifford performs high and low temperature tests and accelerated life tests.

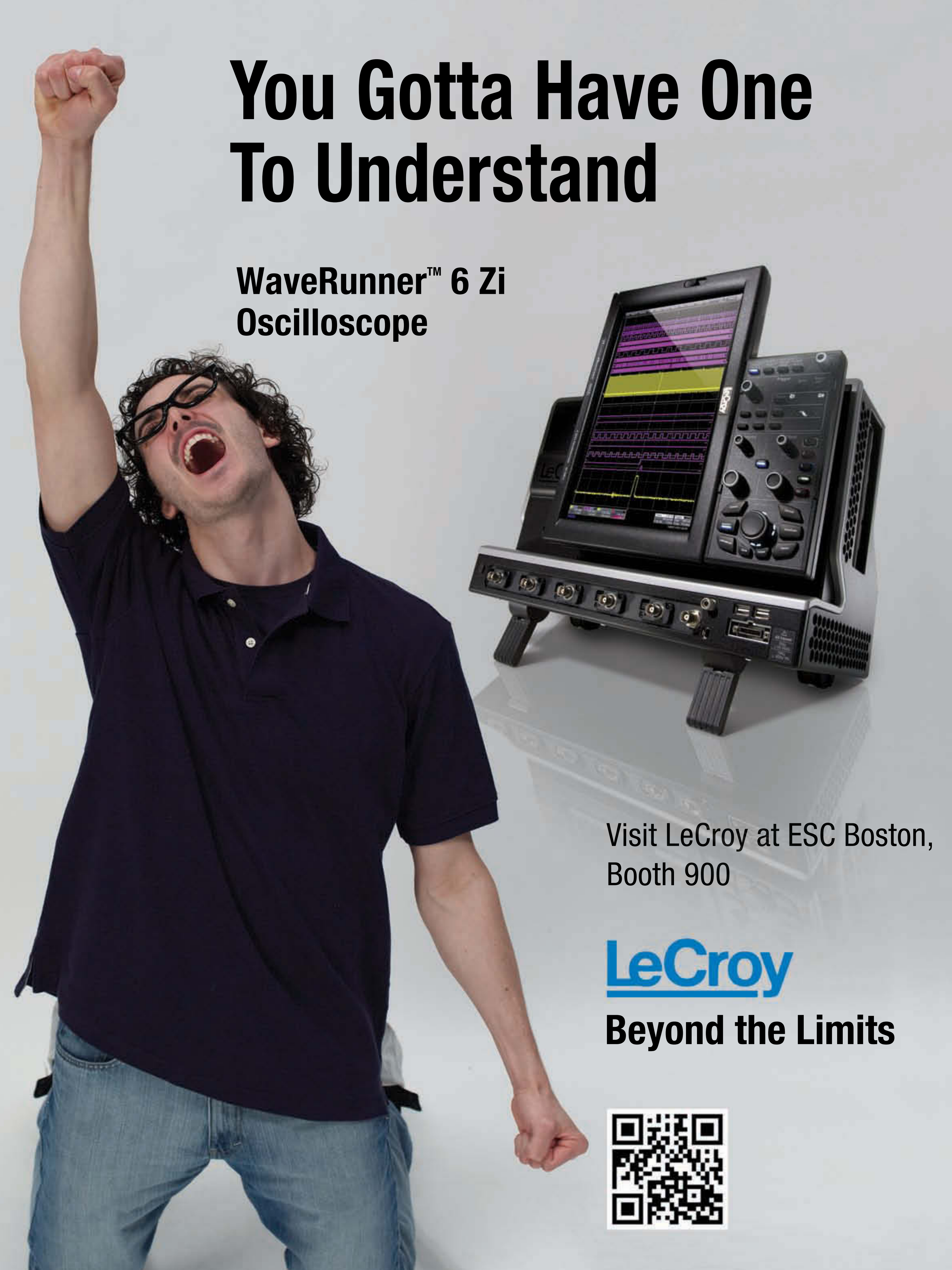
JASON GROW

Gifford also tests a flow meter's transducers. To do that, he needs to know how much water a transducer measures in a given amount of time, from which he can calculate the flow rate. For this test, Gifford uses a GE handheld flow meter to measure water that flows into a tank. When the tank has the desired amount of water, a gate opens to let the water flow out. Because Gifford knows how much water was in the tank, he can measure the time required for the tank to empty and thus determine the flow rate. He can check the accuracy of the flow meter in question.

Entire flow meters also require accuracy testing. Senior engineer Nick Mollo runs those tests in the water lab, which has pipelines with up to 4-in. diameters. Larger flow meters go to an outside lab for accuracy testing.

In the water lab, Mollo records flow measurements as well as the temperature and pressure conditions that affect them. "We have two measurement methods," he explained. "In the gravametric method, we use a tank that we fill for a known period of time and measure the weight of the water. From that measurement, we know how much water flowed into the tank, from which we can calculate the average flow rate." The other method uses a calibrated inline magnetic flow meter as a reference standard. The gravametric method is more accurate, but it can test only until the tank empties, which is about 20 s. Mollo uses the flow-meter method when he needs to run test for longer periods.

GE engineers understand the needs for accurate measurements in commerce. The world's energy suppliers depend on GE engineers to develop and produce equipment that keeps the energy flowing at known quantities. T&MW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To Understand
WaveRunner™ 6 Zi
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Charge-pumping measurements

A system that incorporates a pulse generator and a sensitive DC ammeter can reveal information about the quality of semiconductor devices.

BY MARY ANNE TUPTA, KEITHLEY INSTRUMENTS

Charge pumping is a well-known technique for characterizing the semiconductor-dielectric interface of MOS structures. Labs can obtain invaluable information about the quality and degradation of a device from I_{CP} (charge-pumping-current) measurements, including information about the interface-trap density and the mean-capture cross section. To make I_{CP} measurements, you must pulse a gate voltage and measure a DC substrate current simultaneously, so you need a test system that incorporates both a pulse generator and a sensitive DC ammeter.

Figure 1 shows a charge-pumping measurement circuit. Essentially, the gate of a MOSFET connects to a pulse generator, which repeatedly switches the transistor from accumulation to inversion. While the gate is pulsed, a recombination process of majority and minority carriers occurs on the rising and falling edges of the pulses, causing a current to flow in the opposite direction of the normal drain-to-source current. You can measure this induced current, the I_{CP}, by connecting a sensitive ammeter to the substrate, or bulk terminal, of the MOSFET.

Although several charge-pumping methods have been developed, the basic technique involves measuring the substrate current while applying voltage pulses of fixed amplitude, rise time, and frequency to the transistor gate. The source and drain are either tied to ground or slightly reverse-biased. In the two most commonly used methods, the measurement equipment must apply the voltage pulse either with a fixed amplitude while sweeping the base voltage or with a fixed base voltage while sweeping the voltage amplitude of the pulse.

In the first method, the fixed-amplitude/voltage-base-sweep method, the amplitude and period (width) of the pulse are kept constant while the base voltage is swept from inversion to accumulation. **Figure 2** illustrates both this output waveform and the resulting curve of the I_{CP} as a function of the base voltage. From this data, you can use the following equation to calculate the interface-trap-charge density:

$$N_{IT} = I_{CP}/(qfA)$$

where:
N_{IT} = interface-trap-charge density in cm^{-2},
I_{CP} = charge-pumping current in A,
f = test frequency in Hz,
q = electron charge (1.6022×10^{-19} C), and
A = channel area in cm^2.

(continued)

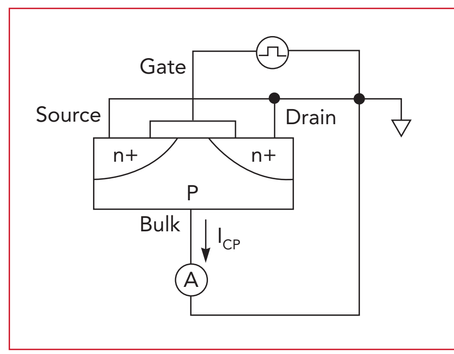

FIGURE 1. This basic charge-pumping measurement circuit incorporates a pulse generator and ammeter connected to a MOSFET under test.

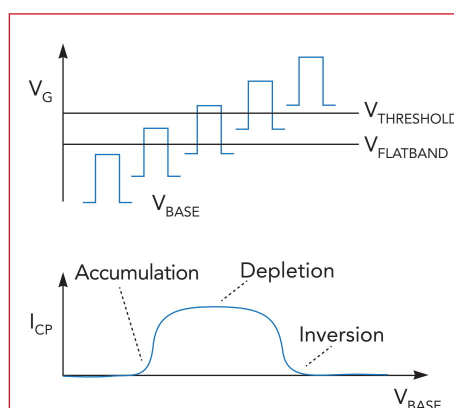

FIGURE 2. The pulse waveform for a fixed-amplitude/voltage-base sweep (top) results in the corresponding charge-pumping current curve (bottom).

The following equation enables the extraction of the interface-trap density as a function of band bending:

$$D_{IT} = I_{CP}/(qfA\Delta E)$$

where
D_{IT} = interface-trap-charge density in $cm^{-2}eV^{-1}$, and
ΔE = the difference between the inversion Fermi level and the accumulation Fermi level (Ref. 1).

In the second common technique, the fixed-base/variable-amplitude-sweep method, the base voltage is kept constant in accumulation, and the variable voltage amplitude is pulsed into inversion. As the voltage amplitude (V_{AMP}) of the pulses increases, I_{CP} saturates and stays saturated (**Figure 3**).

In addition to these two methods, engineers may also employ other charge-pumping techniques. For example, they can use different voltage waveform shapes, vary the rise and fall times, or measure the charge-pumping current as a function of frequency.

Hardware configuration

The equipment used to make charge-pumping measurements has traditionally included a pulse generator and a DC ammeter capable of measuring current in the picoamp range. **Figure 4** illustrates a more modern configuration that employs a semiconductor parameter analyzer with an integrated pulse generator and two SMUs (source-measure units), one of which is equipped with a preamplifier for measuring ultra-low currents.

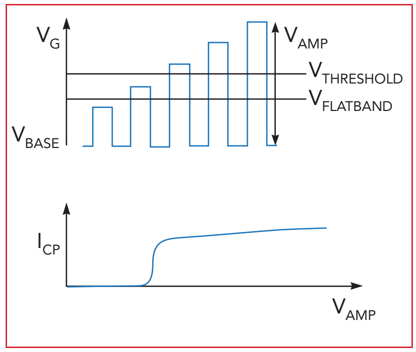

FIGURE 3. The pulse waveform for a fixed-base/variable-amplitude sweep (top) results in the corresponding charge-pumping current curve (bottom).

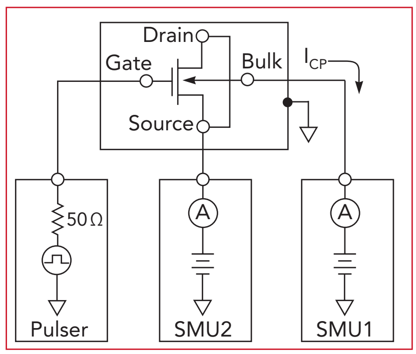

FIGURE 4. In this configuration for charge-pumping current measurements, a pulser applies pulses to the gate of a transistor under test. The SMU2 voltage source supplies a reverse bias to the source and drain (which alternatively can be tied to common), while SMU1, which includes a preamplifier, measures I_{CP}.

The pulser connects to the gate of the MOSFET in order to apply pulses of sufficient amplitude to drive the device between inversion and accumulation. Depending on the charge-pumping method used, the pulser allows users to sweep the pulse amplitude, sweep the base voltage, adjust the rise and fall times, and vary the test frequency. The test frequency is usually in the kilohertz to megahertz range.

As shown in Figure 4, SMU1 connects to the bulk terminal and measures the resulting substrate current. Given that I_{CP} is often in the nanoamp or picoamp range, an SMU equipped with a preamp is typically required to achieve the necessary sensitivity.

The source and drain terminals of the MOSFET are tied together and connected to the second SMU (SMU2), which applies a slight reverse bias (V_R). If V_R = 0, then the source and drain terminals can be connected to the ground unit rather than to SMU2.

To prevent oscillations and minimize noise, it is important to connect the LO (common) terminals of all the SMUs and the pulser as close as possible to the DUT (device under test). To minimize noise caused by electrostatic interference in low-current measurements,

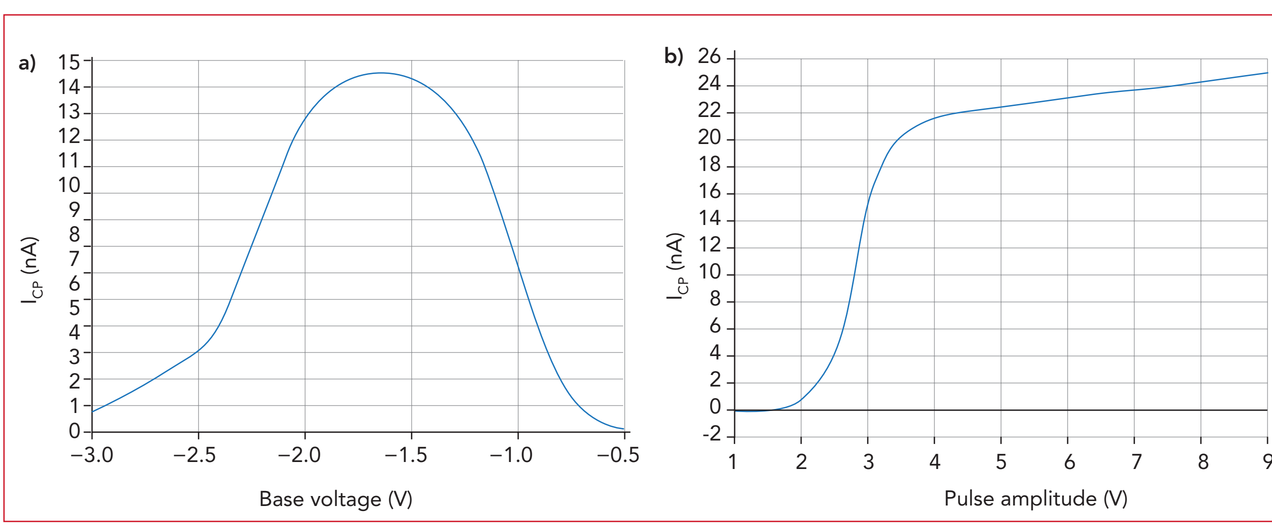

FIGURE 5. These curves show the results of measuring charge-pumping current as a function of the base voltage (a) or as a function of pulse amplitude (b).

engineers must shield the DUT by placing it in a metal enclosure with the shield connected to the LO terminal of the SMU.

Charge-pumping-test variations

You can add software libraries to the setup shown in Figure 4 to automate both the fixed-amplitude/voltage-base-sweep and the fixed-base/variable-amplitude-sweep charge-pumping tests (Ref. 2). You can also use this setup to perform several variations on those basic methods; in all of the methods, except where modifications are noted, the source and drain terminals are tied to ground:

- In the base-sweep technique, the tester sweeps the base voltage of the waveform while keeping the amplitude of the pulse constant (Figure 2). It graphs I_{CP} as a function of the base voltage (**Figure 5a**). A modification to this technique adds a second SMU to apply a DC voltage bias to the source and drain terminals.
- In the amplitude-sweep technique, the tester sweeps the amplitude of the pulse while keeping the base voltage constant (Figure 3). It graphs I_{CP} as a function of the pulse-amplitude voltage (**Figure 5b**). As with the base-sweep technique, you can modify this technique by adding a second SMU to apply a DC voltage bias to the source and drain terminals.
- In the rise-time linear-sweep technique, the tester performs a linear sweep of the rising transition time of the pulse, and it graphs I_{CP} as a function of the rise time.
- In the fall-time linear-sweep technique, the tester performs a linear sweep of the falling transition time of the pulse and graphs I_{CP} as a function of the fall time.
- In the frequency linear-sweep technique, the tester holds the amplitude, offset voltage, and rise and fall times constant and measures I_{CP} as a function of a linear sweep of the test frequency. In the frequency log-sweep variation, the tester graphs I_{CP} as a function of a log sweep of the test frequency. T&MW

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Speeding SOC test

Protocol-aware ATE hardware boosts the efficiency of parallel-site and concurrent tests for SIP, SOC, and MCM designs.

BY TIM LYONS, TERADYNE

Integrated semiconductor products often include building blocks from a variety of sources that are implemented as an ASIC, as individual dies on a common substrate, or as stacked dies connected through vias. In all cases, individual blocks commonly have their own time base, communication bus, and perhaps even free-running clocks. For example, the processing unit of a netbook or tablet may have interfaces that let it communicate with external networks, high-definition televisions, and cellular networks as well as interfaces for internal PCI, memory, flash, and display buses.

Each of these interfaces has a different standardized timing and protocol, and testing each of them with a traditional tester can greatly slow down your throughput (**Figure 1**). A better option for production test of complex packages is to perform multisite parallel testing with an ATE (automated test equipment) system that includes a PA (protocol-aware) tester.

For test purposes, each separate block of a semiconductor requires a digital test instrument to align itself in frequency, phase, and data against the output timing of that block. Although the exact frequencies are known in the test environment, because they are mathematically derived from tester-sourced input clocks, the phase timing of output edges and the location of data words within the larger stream of bits are unknown. For traditional ATE architectures, the test programmer must implement a match loop using a common fail flag to search for the timing of the output edges and must implement a search for unique patterns buried in continuous data streams. The programmer also must manually compensate for round-trip delay, digital pipelines, analog latency, and asynchronous time bases. The **table** shows the typical logical programming flow for testing interactions among concurrent blocks in a device. The flow is repeated serially for each test site.

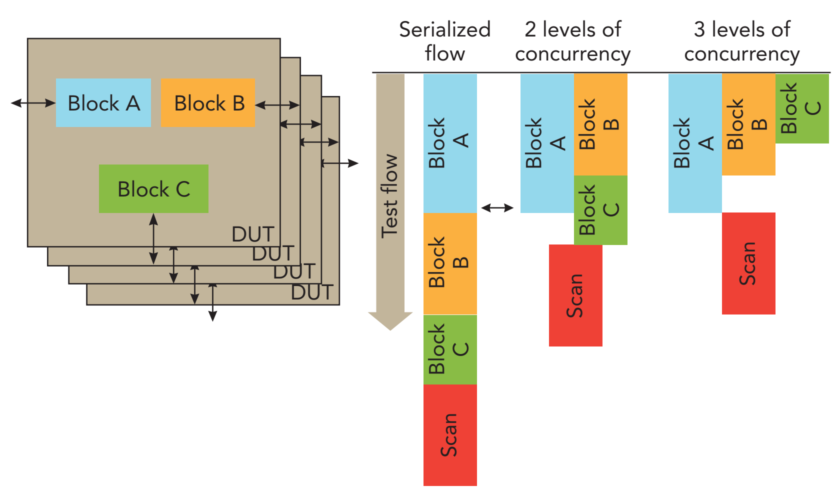


FIGURE 1. **Complex devices implemented with concurrent blocks present test-management and programming challenges for both concurrent test and parallel-site test.**

Verifying functional performance

The complexity of programming and test-instrumentation management can make it difficult for engineers to verify a device's functional performance and the interactions among its separate blocks. A traditional tester typically has one or two fail flags that must be shared among blocks and must be reset by the test controller between each timing search. The resulting measured and corrected timing for a block will need to be reprogrammed with a slow asynchronous test controller broadcasting new timing to all of the affected instruments. The programming process is handed off for the next block and repeated serially.

Parallel-site testing further complicates the testing of asynchronous blocks. After a single site is programmed correctly, the process is handed off and repeated for other parallel test sites and repeated again for every timing, level, and temperature parameter. The problem rapidly becomes a daunting programming challenge that complicates code maintainability and leads to inefficient testing. For example, every 1% of serialized overhead in single-site test will translate into an 8% reduction of parallel efficiency for octal-site testing, assuming all else is 100% parallel efficient. Clearly, improvements in efficiency have real benefits in reducing test costs and improving capital equipment usage.

You can resolve these test challenges by using an ATE system that includes hardware-based PA test. A PA tester can stimulate the device under test, measure and interpret the device response, and then re-stimulate the device with new data based on the timing and message content of the device response, all without the need for a programmer to write code. The PA tester can form the stimulus and response in compliance with standard protocols that define variability in bit patterns, data frequency, error encoding, latency of response, and code scrambling.

A USB 3.0 example

For example, a USB 3.0 interface may be one of many bus interfaces incorporated in a larger integrated device. For tests performed with a traditional tester architecture, a programmer must derive the correct packetized data from the USB 3.0 standard, perform 8b/10b encoding on the data, and program the tester to stimulate the interface at a nominal 5 Gbps and be compliant to the wake-up sequence.

After a varying time allowed by the standard, the device provides a response to the wake-up sequence at a nominal data rate, which may be slightly offset or slightly modulated with spread-spectrum clocking. The programmer must implement a match loop to derive the phase and frequency of the output bits, reprogram the digital-receiver timing, and then implement a second match loop to detect the packet boundaries. There may be a need for a third match loop to locate the actual packet data.

After all these interactions, if the wake-up sequence is just part of the larger wake-up of the whole device, the programmer must perform match loops to wake up the other buses on the device. Then, the process must be repeated for the next parallel site. Due to the limits of traditional testers, each step uses one of only a few fail flags and relies on a central test controller to reprogram timing.

To improve this process, Teradyne has developed a PA engine that provides a new programming interface (**Figure 2**) for its UltraFLEX tester. Local to the digital pin electronics, the hardware-based PA engine can stimulate and respond to the DUT (device under test) in compliance

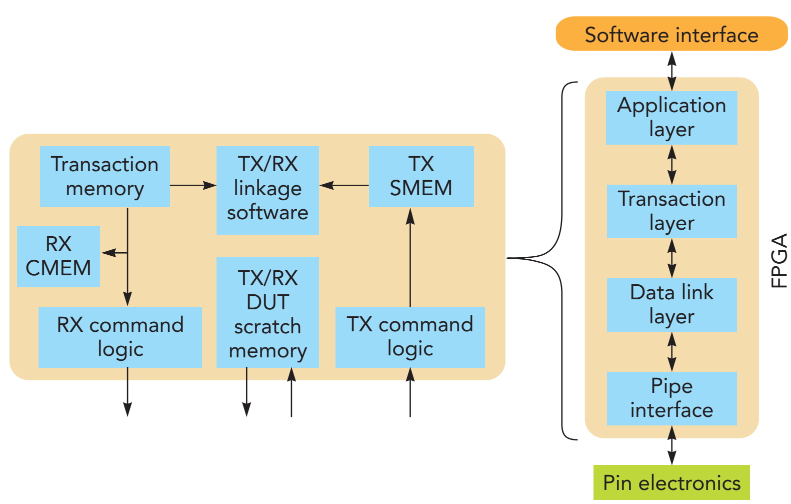


FIGURE 2. The UltraSerial10G protocol-aware test instrument for Teradyne's UltraFLEX platform includes parallel independently programmable protocol engines with local intelligence for measuring device response and providing test stimulus. The instrument includes logic and memory blocks, including RX CMEM (receive capture memory) and TX SMEM (transmit source memory).

Table. Logical programming flow in traditional ATE architectures

Start test:
Power and provide input clock to block A
Power and provide input clock to block B
Power and provide input clock to block C

Block A:
Ignore blocks B and C
Program nominal output timing for block A
Assign shared time measurement to block A pins
Enter search loop to detect block A output timing
Reprogram block A output timing

Block B:
Ignore blocks A and C
Program nominal output timing for block B
Assign shared time measurement to block B pins
Enter search loop to detect block B output timing
Reprogram block B output timing

(Repeat for all logic blocks)
Functionally stimulate all blocks
Functionally test all blocks' outputs

with the selected protocol. For the USB 3.0 example, the local engine initiates the wake-up sequence and expects a compliant response. It can locally decode and encode packets and data, and it can control timing in compliance with the standard. Only for the highest data rates will the local decoding not keep up with received packets and require non-real-time processing. The protocol engine detects DUT timing and measures the timing values. If the values are not in compliance with the standard, the tester reports the result to the test controller, and the DUT is failed or retested.

The test programmer can focus on understanding the data and messaging and is relieved of the burden of force-fitting an inherently statically predicted digital system to the variable timing and encoding of a semiconductor device's complex protocol. The complex series of steps described in the table could be replaced by a simple series of calls already verified to be compliant with the relevant standard, such as:

"dataOut = pcie(write, Addr, <array>)"

Although conceived as an efficient method for rapidly developing tests for standard interfaces, the addition of a hardware-based PA tester enables an ATE system to rapidly detect an output clock, align itself to the clock's phase, and correctly detect and decode data words within the related interface bus. This functionality also has the potential to greatly improve throughput.

For example, a complex test program can have well over 100 pattern starts. If each pattern start requires a phase alignment against the DUT output data, there will be 100 match loops per interface that may need to be serialized per interface. Each match loop needs to be followed with a timing reprogram for the digital instrument connected to the interface.

For a traditional tester, each timing reprogram and fail flag reset may consume 5 ms of tester time. It's not unusual to spend 500 ms of total time that then serializes across multiple parallel test sites. A built-in PA tester can achieve much faster round-trip performance. The 5-ms match-loop and reprogram time can be reduced to as little as 100 ns, and the programming code will be easier to maintain.

In fact, a PA test architecture can provide independent hardware PA engines to every eight digital pins, providing true parallel-test capability across the entire DUT for all test sites. The negative impact on parallel test efficiency caused by match loops vanishes.

A full PA hardware architecture not only speeds test development and improves programming code maintainability, it also has the unexpected side benefit of providing improved test capability for parallel and concurrent test, as it distributes parallel control and response across the digital instruments. As a final bonus, PA directly addresses the thorniest of parallel test-programming challenges. T&MW

Tim Lyons *is an applications engineer in the Semiconductor Test Division of Teradyne in North Reading, MA, with 24 years of experience. He is focused on SerDes, jitter, and high-frequency analog test solutions. Lyons has an MSEE degree concentrating in digital-signal processing from Tufts University.*

LabView 2011 goes for productivity

With the release of LabView 2011, National Instruments has focused on productivity, adding functions that make the programming environment easier to use. For example, LabView 2011 adds engineering libraries that include user-interface components, trigonometry VIs (virtual instruments), linear algebra VIs, error-calculation VIs, and scaling VIs. The new "silver palette" lets you use updated user-interface objects, which produce more modern-looking control panels.

LabView 2011 improves code-writing productivity by automating tasks with advanced application features. The application-builder API (application-programming interface) feature helps you create executable files, and the asynchronous VI palette lets you take better advantage of multithreading: You can create VIs that run independently and you can also create asynchronous processes that run in separate threads. The processes have the ability to pass data among the themselves.

You can use LabView 2011 with code written in other languages, so you can reuse legacy or optimized code. With support for Microsoft .NET CLR 4.0, LabView 2011 lets you write code in the latest version of .NET and integrate that code into your LabView application.

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

OTA test enclosure handles MIMO devices

The octoBox OTA (over-the-air) test station enables OTA testing of conventional and MIMO wireless devices in a customizable, refrigerator-sized anechoic enclosure. It is applicable to the design, test, and verification of multi-radio devices, such as smartphones and USB dongles.

The dual-chamber RF enclosure houses isolated and controlled OTA test setups for production, quality assurance, and R&D test. The self-contained test station incorporates test instrumentation, test antennas, and an easily accessible chamber for the DUT (device under test).

To achieve repeatable OTA test results, octoBox can be customized to ensure far-field coupling between the DUT antennas and the test antennas, as well as to ensure uniform antenna fields between the DUT antennas and the test antennas with no nearby nulls that can cause sharp amplitude gradients in the field. A single octoBox allows the simultaneous parallel testing of eight or more fully assembled smartphones through their antennas.

octoBox provides isolation up to 6 GHz. All power and data lines entering the box employ feed-through filters. Signal reflections from the metal walls of the octoBox are absorbed by specialized absorptive foam.

octoScope, www.octoscope.com.

VXI 4.0 adds power and bandwidth

By Richard A. Quinnell, Contributing Technical Editor

It has been more than a year since Revision 4.0 of the VXI specification was finalized in May 2010. To learn what impact VXI 4.0 will have on the test industry, I spoke with Tom Sarfi, the VXIbus Consortium president.

Q: What prompted VXI Rev. 4.0?
A: More and more applications require test instruments that can supply more power and increased data throughput, particularly in the high-speed digital and data-acquisition domains. While the VXIbus has been an excellent platform for high-performance applications, there were certain limitations in the specification that presented challenges for instrumentation suppliers. The VXI Consortium saw an opportunity to leverage the specification's ties to the VMEbus and adopted a few of the enhancements that have occurred on that platform over the years. The result was additional power and bandwidth capacity in the VXIbus core infrastructure to better satisfy the emerging application requirements.

Q: What bandwidth improvements has the Rev. 4.0 spec brought to VXI?
A: We addressed bus bandwidth in two ways. One was to adopt the 2eSST [dual-edge source-synchronous] protocol to achieve rates to 320 Mbytes/s on the backplane. We also added a VITA 41 VXS [VMEbus switched-serial] bus connector to support PCI Express implementations. The backplane offers switched routing for up to 12 modules with links supporting 2 Gbytes/s in each direction and an aggregate bandwidth up to 8 Gbytes/s to and from the host.

INSIDE THIS REPORT

Q: What about the power issue?
A: Using the VME-64 five-row connector allowed VXI Rev. 4.0 to provide more power lines to each module, supporting up to 418 W per slot. In addition, we added 3.3 V to the traditional rail power options.

Q: How does Rev. 4.0 fit in with earlier VXI equipment?
A: One of the objectives was to ensure backward compatibility with legacy products. The 4.0 backplane was designed to accept 3.0 and earlier cards.

Q: What application areas will benefit from Rev. 4.0?
A: In the high-speed digital domain, Rev. 4.0 will be useful as the increase in power will allow for increased voltage levels and higher slew rates than what is commonly available on the market. Data-acquisition applications such as vibration and acoustic analysis and digital-bus emulation will all benefit from the ability of Rev. 4.0 to support more channels and higher data-throughput rates to disk. In some applications, like signal switching, the previous specifications were sufficient, and end users can continue to use those cards alongside Rev. 4.0 modules.

Tom Sarfi
President
VXIbus Consortium

Q: What kind of Rev. 4.0 equipment has become available?
A: One of the first devices out was a slot 0 card using the 2eSST protocol and offering a PCI Express link to a host controller. Cards like this are important in VXI because the flexibility in remotely interfacing to a VXIbus mainframe is a valuable and unique ability of VXI. High-speed digital-bus emulation modules have also been introduced, as well as high-speed data-acquisition cards. Also, a lot of vendors are keeping up with operating system changes by introducing drivers that support 64-bit OSes such as Windows 7.

Q: What's next for VXI that Rev. 4.0 enables?
A: We can expect to see carrier cards that can adapt other modular card types to VXI. For instance, VME modules and XMC mezzanines that provide digital-signal processing and high-performance CPUs can be adapted to work in a VXIbus environment, and simple carriers will allow VXI 4.0 to support PXI and PXI Express modules with no software changes needed. Access to all this capability will make VXIbus one of the most versatile modular instrument platforms available for years to come. □

EDITOR'S NOTE

Vindication at last

By Richard A. Quinnell
Contributing Technical Editor

Back in the mid-'90s I was a technical editor with *EDN,* working on a "hands-on" project using the newly released Universal Serial Bus. This was revision 1.1, the first to begin entering the market. It was so new I had to get beta software from Microsoft in order to access the bus on the new computer I was using.

My goal was to evaluate the USB as a data-acquisition channel for test-and-measurement purposes. The plug-and-play connectivity and host-power attributes of USB convinced me that there was tremendous potential for using the bus to implement highly portable instruments. I wanted to see how well it actually worked in practice.

Well, it didn't go smoothly. What I finally wrote about the bus in October 1996 was entitled, "USB: a neat package with a few loose ends." There were some problems with that first release.

From what I discovered researching the feature article in this Test Report, however, it seems that those early problems have long since been overcome (p. 44). USB is now well-established as a viable means for turning a PC into a test instrument.

A co-worker at the time thought that USB would only be good for keyboards, mice, and printers, and that FireWire was the way to go for high-speed external connections.

I got to be proven right. He, on the other hand, got promoted. Which is better, I wonder? □

Contact Richard A. Quinnell at richquinnell@att.net.

HIGHLIGHTS

High-res PCIe digitizers offer 16-bit resolution

The Oscar CompuScope digitizers from Gage Applied Technologies offer two or four digitizing channels with 12, 14, or 16 bits of vertical resolution and sampling rates of 100 Msamples/s per channel. The Oscar digitizers come with 1 Gsample or more of dual-port memory and support data streaming, which allows waveform data to be transferred directly to PC RAM.

The boards operate in a full-length eight-lane (x8) Gen2 PCI Express slot and provide a maximum theoretical throughput of 4 Gbytes/s. In operation, though, bus latencies and handshaking protocols limit the maximum sustained throughput to about 3 Gbytes/s.

The dual-port memory architecture allows the memory to be simultaneously written to and read from. Data can be streamed to a high-speed hard-drive array with no programming. You can also incorporate the data-streaming functionality into a C application program to analyze, display, or transfer the data stream during acquisition as required. Drivers for Windows 7, Vista, XP, and 2000 are supplied with each board, as is a Lite Edition of GageScope PC oscilloscope software. www.gage-applied.com.

PXI modules simulate fault conditions

Pickering Interfaces has introduced the 40-197 and 40-198 fault-insertion PXI modules that can be used within an automatic test system to simulate common fault conditions, such as an open, a short to ground, or a short to other connections in a device under test.

The 40-197 provides up to 35 fault-insertion channels that can be connected to any of four fault-bus connections, each having two different conditions. Each channel can switch up to 220 VDC at 60 W.

The 40-198 furnishes up to 20 fault-insertion channels that can be connected to one of two fault-insertion buses, each of which has three optional fault definitions. Each channel can hot-switch up to 110 VDC at 150 W. www.pickeringtest.com.

USB digitizer handles 5 Gsamples/s

The PicoScope 6407 USB digitizer from Pico Technology provides high-speed data capture for almost any application. With four 1-GHz, 50-Ω analog inputs and a 5-Gsamples/s real-time sampling rate, the instrument can handle a wide variety of signals, such as high-speed serial data signals; waveforms for automated test rigs, prototype circuits, and high-frequency printed-circuit boards; and radio, laser, and radar IF signals.

A 1-Gsample memory buffer allows the 6407 to capture very long data records, while the USB streaming mode allows for continuous capture of unlimited amounts of data at up to 13 Msamples/s. In addition, the 6407 includes a built-in function generator and arbitrary waveform generator, plus an external trigger input.

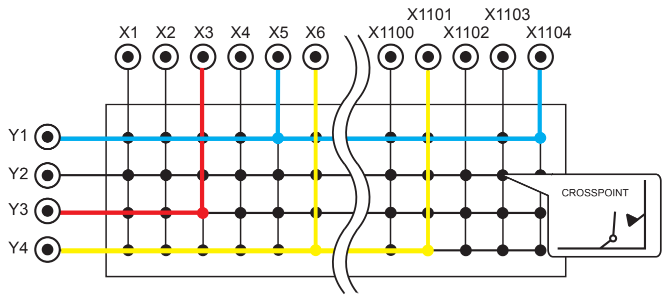
The PicoScope 6407 connects to any computer with a USB 2.0 port running under Windows XP, Vista, or 7. PicoScope software, supplied with the digitizer, provides all the functions of an oscilloscope and spectrum analyzer, as well as advanced features, such as automatic measurements with statistics, color persistence, mask-limit testing, advanced triggering and serial decoding. www.picotech.com.

PXI Matrix Switching

High Performance Scalable Matrix Solutions

BRIC™

Over 8 years experience and 100's of proven applications	✓
Highest Quality Reed Relays with *SoftCenter™ Technology for maximum reliability	✓
Support for all major programming environments: all Windows versions, **LabView, SwitchExecutive	✓
Fault Insertion & ARINC 608A variants	✓
Highest PXI Switch density with up to 4416 crosspoints per module	✓



*SoftCenter is trademark of Pickering Electronics

**LabVIEW and SwitchExecutive are registered trademarks of National Instruments

Parameter	Pickering PXI BRIC	PXI Alternative
Integrated Analog Bus	Yes, Single or Dual Bus	Yes, Single Bus only
PXI Slots Occupied	2, 4, 8 Slots	4 Slot only
Choice of Relay Type to match your application	Yes, Reed Relay, Armature or Solid State. 1 or 2 Pole.	1 Pole Reed Relay only
Choice of Current Ratings	0.5A, 1A, 2A or 10A	0.25A or 1A only
Relay Self Test?	BIRST with milliOhm resolution and programmable resistance threshold	Pass/Fail
LXI Chassis Version	Yes	No, PXI only
Analog Bus Width	4, 8, 16, 32 pole	4, 8 pole
Warranty	2 Year	1 Year
Number of matrix module configurations	500+	< 20

Go to **www.pickeringtest.com/BRICadvantage/** and see all the choices available that can help make your next test system more flexible.

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Detailed Pricing & Technical Data On-Line

USB test instruments provide portable modularity

By Richard A. Quinnell, Contributing Technical Editor

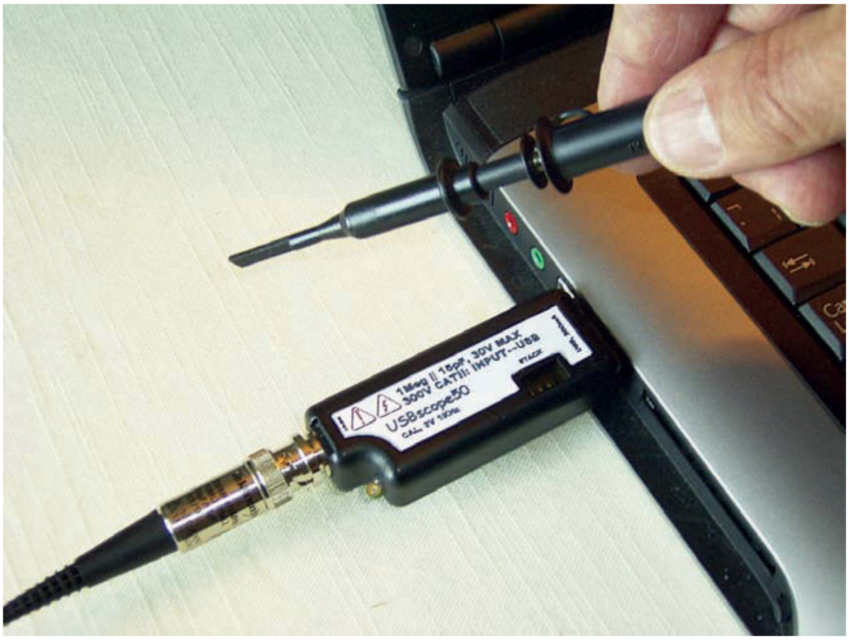

Fig. 1 **USB instruments can pack considerable test capability into a tiny package, such as this 50-Msamples/s shirt-pocket digital storage oscilloscope.**
Courtesy of Elan Digital Systems.

The USB (Universal Serial Bus) provides PC connectivity with many desirable attributes, so it is no surprise that test instruments have arisen that use the USB to link to a host computer. What may be surprising, however, is the range of functions and performance levels available from USB test instruments. Data-acquisition, signal-generation, measurement, and RF instruments are all available with USB connectivity, and engineers can mix-and-match multiple instruments to form a complete test platform.

True to their "universal" name, USB ports have become pervasive, available on virtually every personal and industrial computer in production. Even production-test systems based on the personal computer architecture offer USB ports. And for good reason. A USB 2.0 port (the most commonly available) provides hot-swappable plug-and-play connectivity, transfers data at rates up to 480 Mbps (faster than 100-Mbps Ethernet), offers host power to attached devices, and has the ability to connect 128 unique endpoints to the host through a single port. The new USB 3.0 specification boosts data rates nearly tenfold.

To leverage the availability and simplicity of USB, a number of companies have created test instruments that link through USB to a host PC for processing, control, and display. The most common of these instruments are DSOs (digital storage oscilloscopes) and function generators, many from small companies that specialize in these portable instruments. The Australian company Esis and the UK-based Elan Digital Systems, for instance, both offer the USBscope50—a PC plug-in not much larger than a flash drive that accepts standard BNC probes (**Figure 1**). The instrument has a 75-MHz input bandwidth and can capture 8-bit samples at a rate of 50 Msamples/s in single-shot capture. For repetitive signals, the instrument provides capture timing equivalent to 1 Gsample/s.

The two companies also offer a 12.5-MHz DDS function generator with 0.2-Hz resolution and ±10-V output, a 100-MHz clock and pulse generator, and a 50-MHz frequency/period counter, all in the same form factor. The modules are stackable to form a suite of interrelated instruments, using an adapter that permits four modules to share the same USB port. Thus, you can provide a test stimulus, measure output frequency, and examine two waveform channels using an ordinary laptop and a collection of modules that could fit into a shirt pocket.

China's Novatek offers a series of larger and higher-performance dual-channel DSOs with analog bandwidths ranging up to 200 MHz. The devices also double as spectrum analyzers by using FFT (fast-Fourier transform) software on the host PC. The company also offers a DDS (direct-digital synthesis) arbitrary waveform generator for frequencies up to 5 MHz with 0.1-Hz resolution that also serves as a frequency counter with an input range to 2.7 GHz. Novatek's dual-direction GPIB module allows the USB port to control up to 14 instruments with data transfer rates above 1 Mbyte/s.

Link Instruments in the US offers a dual-channel DSO with 100-MHz analog bandwidth and sample rates to 500 Msamples/s in single-shot mode. The company also offers mixed-signal oscilloscopes that incorporate signal generators with the DSO. The MSO-19, for instance, is a combination DSO, pattern generator, logic analyzer, and time-domain reflectometer, with all functions operating at 200 Msamples/s.

USB handles RF/microwave test

While these DSOs and related instruments are the most commonly available, there are other types of USB-based test equipment to be found. Both Telemakus and LadyBug Technologies, for instance, offer instruments addressing RF and microwave test needs. Telemakus has RMS (root-mean-square) detectors, vector modulators, signal generators, attenuators, and switches that serve a variety of RF and microwave frequencies ranging from the L-band to the X-band. LadyBug Technologies offers sensors for continuous-wave, peak, profile, and average power measurements covering the 10-MHz to 26.5-GHz frequency range (**Figure 2**).

The USB test-instrument market is not limited to specialty companies, either. Both Agilent Technologies and National Instruments offer numerous

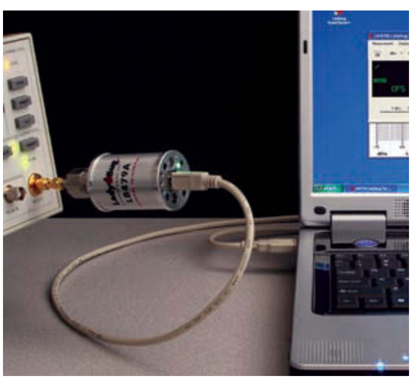

Fig. 2 In addition to DSOs and data-acquisition units, USB instrumentation provides RF and microwave test capabilities such as power meters and synthesized sources.
Courtesy of LadyBug Technologies.

USB-based test instruments. NI, for instance, has more than 50 different USB instrument modules, including 6.5-digit DMMs (digital multimeters), RF power meters, data-acquisition units, thermocouple signal conditioners, and DSOs. Agilent has many similar types of instruments along with unique functions such as a 4x8 two-wire switch matrix and source-measure units with four-quadrant operation.

The USB instruments from both companies can operate as stand-alone devices or can be plugged into a chassis that aggregates several instruments into a test-equipment platform. The chassis enables triggering and synchronization of module operation as well as aggregating the command and data transfer for multiple instruments onto a single USB port. Further, chassis mounting helps ruggedize the USB modules, providing added protection against field hazards. NI offers four- and eight-slot USB module enclosures and has recently introduced a one-slot CompactDAQ enclosure for USB, Ethernet, or wireless connectivity. Agilent has a chassis capable of handling six modules (**Figure 3**).

The use of a chassis to combine multiple USB modules into an integrated test platform can push the bus to its limits. While a USB port can supply power to the attached instrument, for instance, that power is limited to 500 mA at 5 V. As a result, chassis systems must use an external power "brick" rather than drawing from the host, and then supply power to the plug-in modules from this external source.

Handling USB bandwidth limits

Chassis operation also pushes against USB's bandwidth capacity. The bus's 480-Mbps bandwidth must be shared among all the channels that the instruments provide, reducing the data rate each can sustain. Aggravating the situation is the fact that USB was not designed for reliable high-speed transfers. The USB protocol provides four types of communications: control, interrupt, isochronous, and bulk. All communications are initiated by the host controller, which polls the endpoints of devices attached to the port to allocate bus capacity.

Of the four types, only control transfers (which are typically short messages carrying setup or status information) and interrupt transfers (which can carry a modest data payload) offer reliable data transmission with low, bounded latency. Isochronous transfers have the largest bandwidth potential and lowest latency, but have no resend mechanism. As a result, isochronous transfers can lose data with no recovery. Bulk transfers offer a reliable means of transferring large files, but they operate on a space-available basis and provide no guarantee of bandwidth or latency.

The vendors of USB test instruments address this bandwidth issue in different ways. Some instruments, such as RF power meters, don't have high data-transmission requirements and so work well within USB's bandwidth limits. DSOs typically capture a signal at a high speed and send it to the PC for display later, while function generators form their signals from pre-loaded patterns. Both uses can tolerate latency in the data transfers as long as the trigger or update rates are moderate.

In supporting its multi-instrument platform using USB, Agilent simply works within the limitations of standard PC host USB drivers. NI, on the other hand, provides a patented signal-streaming USB stack to replace the host drivers and help eliminate overhead in the protocol and boost achievable bandwidth. Both methods target applications that need single-point measurements rather than applications needing high levels of involvement from the user.

Similar limitations exist with GPIB instruments, though, according to Telemakus CEO Craig Walsh. He pointed out that users creating stimulus-and-response test setups using USB can be successful as long as they are aware of the delays inherent in USB data transfers. "The test programmer has to know what events must happen in the right order and to manage how Windows handles the traffic," said Walsh.

Fig. 3 USB instruments are available in a wide variety of functions, operating as individual units or by plugging into a chassis to form a complete test platform. Courtesy of Agilent Technologies.

Compelling advantages for key applications

If the application can tolerate the limitations, though, USB instruments can provide a compelling alternative to their larger competitors. The USB devices are easy to setup and use, are highly portable, and can be extremely low cost. An eight-channel, 12-bit USB data-acquisition module from NI costs less than $170, and a 200-Msamples/s DSO from Link Instruments sells for less than $800. As Walsh pointed out, this places many USB instruments within the spending-authorization limits of many engineers, allowing them to acquire a "personal" suite of test instruments that they can use at their convenience rather than having "to wait for access to that $200K tester." He added, "USB instruments can give people a lot of freedom to do testing that they might not otherwise have in their work situation."

Other instrument vendors agree that price is a major benefit of USB devices. "USB instruments are the best value for the money in applications that can work within their specifications," said Edwin Hoh, market segment manager for Agilent's USB instrument product line. "USB reaches out to certain customers perfectly by being cost-effective and compact." □

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VIEWPOINT

[An exclusive interview with a technical leader]

LAVAL TREMBLAY
VP of Engineering
Matrox Imaging
Dorval, QC, Canada

Laval Tremblay received his electrical engineering degree from Montreal's École Polytechnique in 1980 and joined Matrox Imaging in 1983 after working at Mitel Semiconductor and Northern Telecom. By 1986, Tremblay had been promoted to project leader, working on the company's first PC-based image-processor add-on hardware. By the time he was named director of engineering in 1994, Tremblay had already begun to set Matrox on a course to redefine industry standards in image processing. He was named VP of engineering in 2004.

Contributing editor Larry Maloney conducted an e-mail interview with Laval Tremblay on trends in machine-vision applications.

Machine-vision industry bounces back

Q: Has the machine-vision industry recovered from the global recession?

A: The industry has recovered exceptionally well as a result of the manufacturing sector leading the overall recovery. Major players in the industry—including Matrox Imaging—are experiencing record sales. Manufacturers, especially those in the electronics and semiconductor sectors, better managed their inventories, having learned from the dot-com bubble. This discipline has resulted in an upsurge in demand for machine-vision components. Moreover, although the latest recession severely affected all economic activity, it had a greater negative impact on the financial, real-estate, and construction sectors. The question to ask, though, is how long can this strong resurgence be sustained?

Q: Which industries are leading the way in adopting inspection solutions based on machine vision?

A: Industries like semiconductors, electronics, and flat-panel displays continue to be big consumers of machine-vision inspection technology. Industries that are tightly regulated and those that need to mitigate potential liability—like food and beverage and pharmaceuticals—are also increasingly using vision. Plus, we're seeing a rebound in automotive demand with the growth in electronics content for battery management, start/stop systems, onboard infotainment, and communications. LED lighting and new power-train investments, which promote smarter use of our scarce energy resources, are also creating new demand for machine vision in the automotive sector.

Q: What are some typical applications for the Matrox Supersight system?

A: The Matrox Supersight computing platform is designed for high-throughput and computationally demanding vision applications, such as semiconductor wafer and mask inspection and flat-panel-display inspection. Among its key features is a unique PCIe Gen 2 switched-fabric backplane that removes I/O bottlenecks between installed devices. Supersight is also well-suited to medical imaging, where applications demand high data and data/task-level parallelism and employ multiple CPU cores or GPU accelerator boards, or a mix of both of these processing technologies.

Q: Can you briefly sort out the landscape of vision interface standards?

A: For moderate-bandwidth applications, GigE Vision has become the preferred choice over IEEE 1394 and USB because of cabling advantages. GigE provides enough bandwidth for all but the highest-speed cameras, and cables can be as long as 100 m. Camera Link is holding its own for more exacting applications because of the better determinism, despite the fact that it requires specialized computer-interface hardware.

For high bandwidth, Camera Link is still king, although it is losing some of its dominance. This situation has prompted the creation of the CoaXPress and Camera Link HS standards, which offer greater bandwidth over longer distances. Initially, we see CoaXPress as being complementary to Camera Link, but we do see it eroding the Camera Link market as time goes on. CoaXPress offers several advantages, such as the ability to transfer higher data rates over longer distances with simplified cabling.

Q: How have smart cameras changed the machine-vision field?

A: It is not the camera hardware that is changing machine vision, but rather the software environment that is associated with the camera. Customers have certain expectations, such as quick-and-easy application development, which includes algorithms, the human-machine interface, and connections to other equipment. Software plays a major role in meeting those needs. T&MW

Laval Tremblay discusses smart cameras and other machine-vision technologies in the online version of this interview: www.tmworld.com/2011_09.

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

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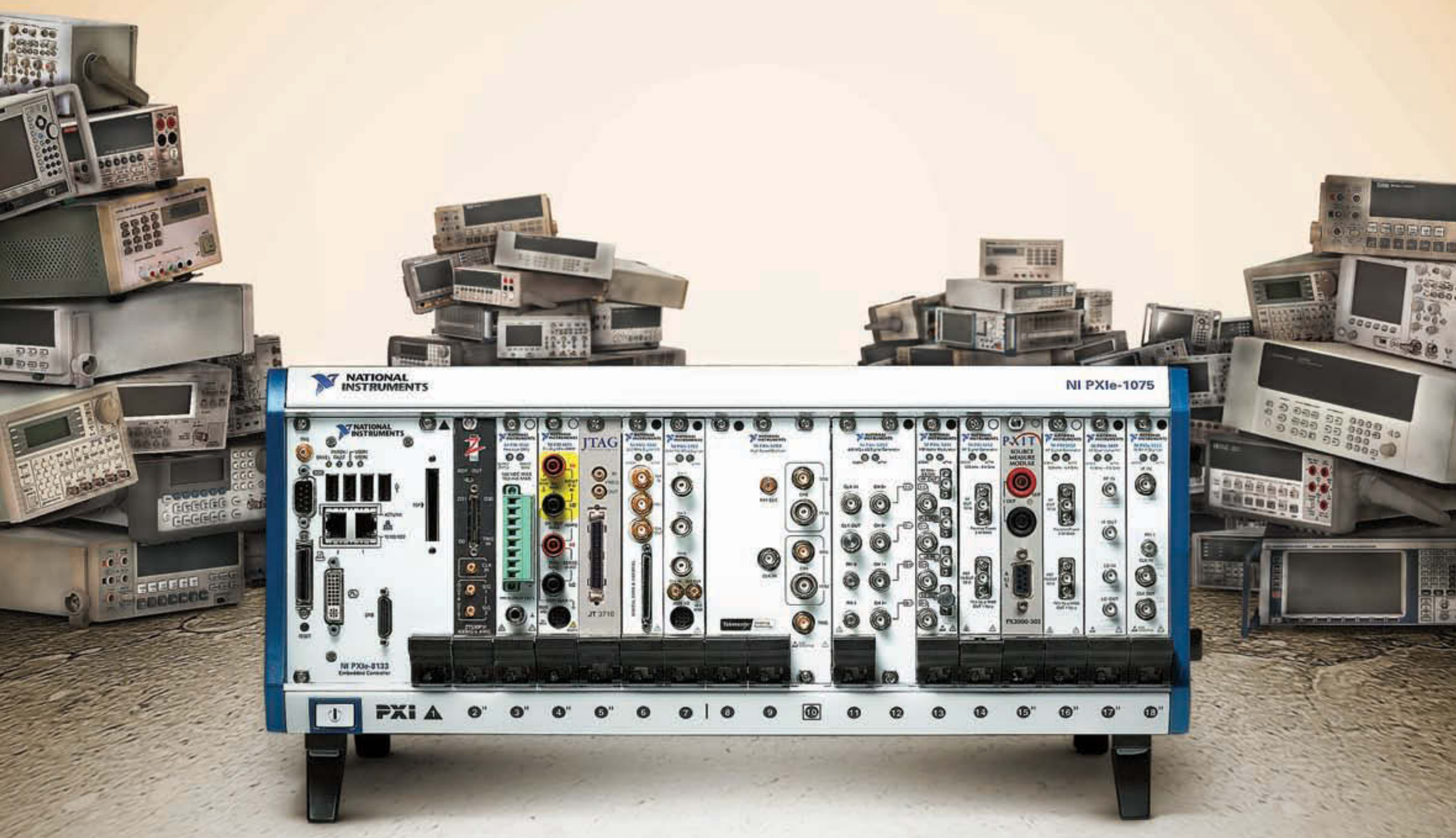

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