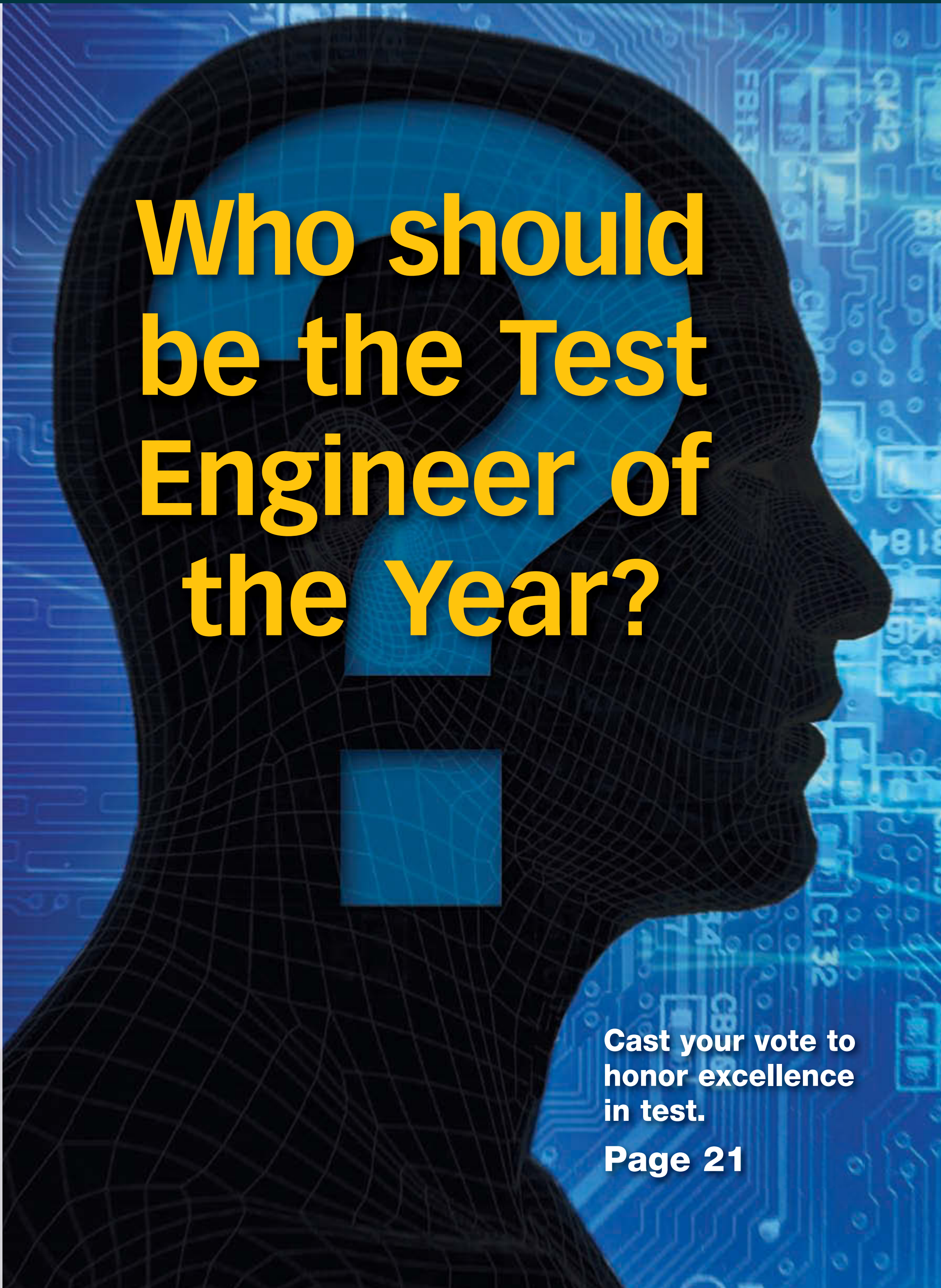
UBM Electronics

November 2011
www.tmworld.com

Test & Measurement World

THE MAGAZINE FOR QUALITY IN ELECTRONICS



Who should be the Test Engineer of the Year?

Cast your vote to honor excellence in test.

Page 21

NOVEMBER 2011
VOL. 31 NO. 10

Test & MEASUREMENT WORLD

COVER: COMPOSITE BY HECTOR TORRES, IMAGE BY ISTOCKPHOTO/DEM10

CONTENTS

FEATURES

News / Page 10

DEPARTMENTS

TECH TRENDS

TEST DIGEST

TEST REPORT SUPPLEMENT

Online now at TMWorld.com

Check out these exclusive features on the *Test & Measurement World* Website:

Vote for the Best in Test

Help us honor excellence and innovation in test, measurement, and inspection technologies. Visit our Website to read about the finalists for the 2012 Best in Test and Test of Time awards and then cast your votes for your favorites. The Best in Test awards recognize excellence and innovation in products and services introduced during the past year. The Test of Time award recognizes an innovative product that continues to provide state-of-the-art performance more than five years after its introduction. **The voting deadline is December 16;** winners will be announced on January 31 during DesignCon. (Plus, be sure to vote for the 2012 Test Engineer of the Year; see pp. 21–23).

www.tmworld.com/2012_awards

Vintage controller runs environmental tests

Steve Lindberg, an engineer at Tektronix, spends much of his off-work hours in his personal lab, which has about 350 test instruments. He explains that when building a home lab, you should look for instruments that have proved to be reliable over the long term—he has oscilloscopes, function generators, counters, and other instruments that are just as useful today as when they were built 20 or 30 years ago. One of his prized instruments is an HP 9000 series controller that he used to automate an environmental test.

www.tmworld.com/vintageHP9000

Blog commentaries and links

Rowe's and Columns

Martin Rowe, Senior Technical Editor

- Are engineers early adopters?
- Multimeter traces home wiring

Testing the Limits

UNH-IOL Staff

- Issues when using FR4 as PCB material
- PCIe: The next storage interface?
- The future of PONs

www.tmworld.com/blogs

Data acquisition just got a lot easier.

▶▶ Fast Forward with more ways to control and connect remotely.

The Agilent 34972A Data Acquisition Switch Unit takes our best-selling Agilent 34970A to the next level with breakthrough connectivity. For starters, you get convenient built-in LAN and USB connectivity. Plus, you can control your data acquisition remotely via Web interface. And transfer logged data to your PC with a simple flash drive. No more expensive adapters and connectors. That's easy. That's Agilent.

34972A	34970A
▶▶ USB and LAN	GPIB and RS232
Graphical web interface Benchlink data logger software SCPI programming	Benchlink data logger software SCPI programming
3-slot LXI unit with built-in 6 ½ digit DMM	
$1,845*	$1,597*

Scan the QR code or visit http://goo.gl/IsbZf to see 34972A promotion details

*Prices are in USD and are subject to change.
**Terms and conditions apply

Agilent and our Distributor Network
Right Instrument.
Right Expertise.
Delivered Right Now.

Newark element14™

800-463-9275
www.newark.com/agilent

▶▶ FREE 300 Mbps travel router and mobile app**
www.newark.com/Agilent_DAQ

Agilent Technologies

Test & MEASUREMENT WORLD

EDITORIAL STAFF

Director of Content: Patrick Mannion
patrick.mannion@ubm.com

Managing Editor: Deborah M. Sargent
deborah.sargent@ubm.com

Senior Technical Editor: Martin Rowe
martin.rowe@ubm.com

Contributing Technical Editors:
Bradley J. Thompson, brad@tmworld.com
Richard A. Quinnell, richquinnell@att.net
Ann R. Thryft, athryft@earthlink.net
Lawrence D. Maloney, larrymaloney@verizon.net

Art Director: Hector Torres

Illustrator: Dan Guidera

UNITED BUSINESS MEDIA EXECUTIVE OFFICERS

Chief Executive Officer, UBM Electronics & UBM Canon (Publishing Division): Paul Miller

Chief Information Officer: Brent Pearson

Senior Vice President: David Blaza

Senior Vice President of Content: Karen Field

Vice President of Finance: Jean-Marie Enjuto

Vice President of Partner Services & Operations: Barbara Couchois

Vice President of Marketing: Felicia Hamerman

Vice President of Sales: James Corcoran

Brand Director: Jim Dempsey

Director of Audience Engagement and Analytics: Amandeep Sandhu

HOW TO CONTACT T&MW

EDITORIAL:
33 Hayden Ave.
Lexington, MA 02421
Fax: 781-862-4853
E-mail: tmw@ubm.com
Web: www.tmworld.com

SUBSCRIPTIONS:
For address changes, cancellations, or questions about your subscription, please contact:

Customer Service
Test & Measurement World
P.O. Box 3609
Northbrook, IL 60065-3257
Phone: 847-559-7597
Fax: 847-564-9453
E-mail: tmw@omeda.com
Web: www.tmworld.com/subscribe

CIRCULATION:
Amandeep Sandhu
415-947-6301
amandeep.sandhu@ubm.com

LIST RENTAL:
Statlistics
203-778-8700

REPRINTS:
Wrights Media
877-652-5295
bkolb@wrightsmedia.com

Subscribe to T&MW online:
www.tmworld.com/subscribe

UBM Electronics — A UBM Electronics Publication

PATRICK MANNION
DIRECTOR OF CONTENT

Testing times bring opportunities

I had the good fortune of being able to drop by and visit with Tektronix at the recent Embedded Systems Conference in Boston. There, I was struck by how Mike Juliana's analysis of Tek's mid-summer acquisition of Veridae fit so well with the needs of today's test-and-measurement engineers, and how that mapped to openings we have here at *Test & Measurement World*.

As Juliana put it, and he's been with Tek for 20 years so he should know, logic analyzers are no longer sufficient to meet the system visibility needs of today's designs. Starting with highly integrated ICs with increasing functionality, right through to inter-IC, DDR3/4 memory and high-speed serial and parallel buses, and board and software high-speed interactions, designers are struggling to perform full-system embedded test in a reasonably timely fashion. Of course, that in itself isn't new.

If you like test and measurement and would enjoy helping engineers get their jobs done quickly, drop me a line.

What's new is the insight Veridae brings. Started in 2009, the company saw the burgeoning need for on-chip analysis with more complex SOC designs and developed a solution that allows design teams to see what's inside their ASICs and FPGAs. What the company developed comprises Certus, for debugging multi-FPGA prototyping of ASIC designs with I/O running at speed; Corus, for complex FPGA system validation and debug, delivering synchronized, time-correlated views with the FPGA and across software and external I/O domains; and Clarus, which serves post-validation of ASIC designs and delivers a systematic "design for validation" approach to semiconductor companies.

Armed with this new suite of tools in its arsenal, Tektronix is a big step closer to connecting the full IC-to-software embedded-system-analysis tool suite dots to give the ultimate in test-and-measurement visibility. And that's where the industry must go. Point solutions are good for specialized situations, but along with full hardware/software system co-design must come full hardware/software test and validation. Admittedly, Tektronix has a ways to go on the software end, and for now, it asks us to stay tuned.

In the meantime, yours truly is looking to provide you, the reader, with the full suite of information you need to get your job done. How you get and digest that information and interact with the test-and-measurement community has also undergone rapid change, and we're changing accordingly.

To that end, we are actively looking to you, the test, measurement, and evaluation engineering community, to join us in meeting those needs. Yes, you heard me, we have opportunities here—from regular, paid columns on such topics as The Art of Test, to full-time editorial positions across our online and print properties. The goal is to connect those who know with those who want to know. And only you, the readers, fully understand the nuances of this ever-changing industry.

So, if you like test and measurement, enjoy writing, like to travel, are actively engaged in social media and other means of connecting with your peers, and think you'd enjoy helping fellow engineers get their jobs done as quickly and efficiently as possible, drop me a line at patrick.mannion@ubm.com, or call me directly at 631-543-0445. T&MW

Enthusiasts puts vintage test equipment on show

In September, a museum dedicated to vintage Tektronix test equipment and memorabilia opened to the public in Portland, OR. The museum, VintageTek, was founded in 2009 by former Tektronix field engineers Stan Griffiths and Ed Sinclair. Volunteers—including former Tek employees as well as aficionados of vintage Tek equipment—have been working since 2010 to repair and refurbish instruments for display.

The exhibition is based on more than 1500 instruments donated by Griffiths, approximately 375 instruments donated by other former Tek employees, and a large supply of parts, accessories, and manuals. The museum also has plans to sell vintage equipment (including equipment from other manufacturers) that has been donated but is not needed for the display.

Admission to the museum is free. www.vintagetek.org.

IEEE gives go-ahead to P802.3bj

The IEEE reports that it has approved work on IEEE P802.3bj, an amendment to the 802.3 Ethernet standard that should enhance the 100-Gbps Ethernet physical layer capabilities defined in 802.3ba-2010. IEEE P802.3bj will specify 100-Gbps operation over backplanes and short-reach copper-cable assemblies.

"By expanding on the solid foundational standards work already completed, IEEE P802.3bj will provide better options for system designers to minimize or eliminate the bandwidth bottlenecks facing end users," said John D'Ambrosia, chair of the P802.3bj Task Force and chief Ethernet evangelist, CTO Office, at Dell.

The task force plans to define four-lane, 25-Gbps electrical signaling architectures that will support 100-Gbps Ethernet operation across backplanes up to 1 m in length and across copper-cable operations up to at least 5 m in length. www.ieee802.org/3/100GCU.

AIA begins work on USB3 Vision camera interface

The AIA (Automated Imaging Association) has begun developing USB3 Vision, a camera-interface standard based on USB 3.0 (SuperSpeed USB). USB3 Vision will offer a bandwidth of 3.2 Gbps with both power and data transmitted over a single 5-m passive cable or a single 10-m active cable.

Eric Gross of National Instruments, who is chairing the USB3 Vision committee, said that work on the specification is well underway with plans for a mid-2012 release date. "The architecture of the standard is based on existing consumer hardware and draws from widely adopted vision standards, such as GenICam," he said. "We expect this combination to reduce the time to market for a multitude of USB3 Vision components. This building-block approach simplifies the standard, as it will not be concerned with the camera functionality, but instead just four basic operations: device discovery, device control, event handling, and streaming data." www.machinevisiononline.org.

Editors' CHOICE

Single box tests embedded systems

Embedded-systems testing usually requires a logic analyzer or an oscilloscope, but with the MicroBench MB-500, you won't need either of those instruments. The MB-500, controlled by a PC's USB port, combines logic-analyzer, voltmeter, pattern-generator, arbitrary-waveform-generator, and protocol-analyzer functions in a single instrument that can simultaneously generate and capture digital signals.

You can use the nine-channel logic analyzer to trigger on a specific pattern, which can be up to three levels deep. Two additional input channels, which have a sample rate of 500 Msamples/s, connect to the MB-500 using standard oscilloscope probes. These logic channels, called "LiveLogic," perform continuous acquisition, which lets you see any transition with 2-ns resolution. (The instrument can store up to 2 ksamples in memory.) For pattern generation, the MB-500 has a programmable, nine-channel, 125-Msamples/s pattern generator; alternatively, the instrument can import CSV data and export files to generate digital patterns. When capturing SPI or I2C signals, the MB-500 can decode bits to produce the data they represent.

The instrument generates analog signals at levels from 0 V to 5 V. With a 250-ksamples/s sampling rate and an ability to source up to 100 mA into 50 Ω, the MB-500 can simulate battery-discharge curves or audio signals with 10-bit resolution.

Prices: $1325 to $2525. *Anewin, www.anewin.com.*

CALENDAR

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

IPC APEX, February 28–March 1, San Diego. *IPC, www.ipcapex-expo.org.*

Measurement Science Conference, March 19–23, Anaheim. *Measurement Science Conference, www.msc-conf.com.*

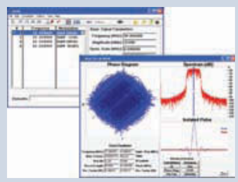
International Microwave Symposium, June 17–22, Montreal. *IEEE, www.ims2012.mtt.org.*

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

Editors' CHOICE

Create complex modulation with AWGs

AWGs (arbitrary waveform generators) let you create just about any waveform for testing, and the ArbIQ software lets you use any AWG to create wireless signals using many complex-modulation formats. You can create signals using the software or imported data files. Supported modulation schemes include OOK, BPSK, QPSK, Offset-QPSK, DQPSK, π/4-DQPSK, 8PSK, and O-8PSK (EDGE); QAM16/32/64/128/256/512/1024; 8/16VSB and DVB-C for digital video; 2/4/8/16/32FSK; and bandwidth-limited Gaussian noise with crest-factor control. With ArbIQ, you can create symbol-synchronous clock signals and sinusoidal analog AM, PM, and FM, as well as CDMA signals and UMTS/3GPP downlink signals.



ArbIQ includes signal-analysis tools that provide insight into the modulation signals. These tools provide you with information on signals before you apply them to an AWG. They include spectral plots, constellation diagrams, phase diagrams, eye diagrams, and histograms.

The ArbIQ software supports AWGs from Active Technologies, Agilent Technologies, B+K Precision, LeCroy, Rigol Technologies Tabor Instruments, Tektronix, and TTi.

Arbitrary Resources, www.arbitraryresources.com.

RON WILSON
CONTRIBUTING TECHNICAL EDITOR
tmworld@ubm.com

IC tools show integration progress

Presentations at the 2011 International Test Conference (September 18–23, Anaheim, CA) illustrated the growing level of integration within the respective product lines of Mentor Graphics and Synopsys. This evolution is partly a result of continuing integration of acquired companies (LogicVision by Mentor; Virage Logic by Synopsys) and partly a result of initiatives within the two EDA (electronic design automation) firms to build bridges between design intent, physical analysis, test generation, and yield management.

Connections between design and test are increasing. Mentor director of marketing Greg Aldrich said customers are already seeing positive results from, for example, increased use of timing-aware ATPG (automatic test-pattern generation) that focuses its search for delay faults on the nets with the least timing slack. He said some customers are also beginning to use Mentor's Calibre EDA tool to identify design-for-manufacturing hot spots in conjunction with LEF-DEF (library-exchange format/design-exchange format) layout data and silicon test results to zero in on yield issues early in the manufacturing cycle. Freescale Semiconductor, Aldrich said, has been able to extract significant data from as little as a few hundred dice in this way.

But Aldrich admitted that for many design teams, these are still leading-edge capabilities. Some of the biggest gains in SOC (system-on-chip) test productivity today, he said, are still coming from test compression, which has reached compression ratios of over 100.

In the near future, Aldrich projected, we will see on-chip test-compression logic merge with the logic for built-in self-test, increasing compression ratios further and improving coverage. And he suggested that test-pattern generation would become more closely associated with individual IP blocks rather than be seen as a full-chip task. This would allow test engineers to reuse patterns from previous instances of the IP, and to construct hierarchical test schemes to deal with very large SOCs.

Synopsys, meanwhile, continues to leverage its dominance in synthesis to strengthen its test offerings, gathering synthesis, scan insertion, timing closure, and ATPG into a single process. Synopsys marketing manager Chris Allsup said that integration of Virage's STAR (self-test-and-repair) Memory technology into the flow now allows the company to generate a single controller for STAR, logic test, and boundary scan. In addition, Synopsys described automatically reusing shift registers for scan and using the scan chains within STAR Memory instances in the testing of surrounding logic.

Synopsys also emphasized the value of providing timing-slack data to the ATPG tool to improve detection of delay faults. This becomes particularly important, Allsup suggested, when synthesis optimizations aggressively manipulate the logic design in order to close timing.

Both companies also discussed the importance of preserving designers' power intent while creating scan chains and patterns. Insertion and ATPG tools must be aware of power-domain crossings, especially in SOCs with dynamic voltage control. The fact that timing slacks may change in different power modes adds another dimension to the problem. And of course, the tools must explicitly test level shifters, power gates, and power controllers.

Altogether, both companies described an increasing flow of increasingly complex data between design tools, insertion tools, and ATPG tools on the front end. For the back end, both emphasized the growing convergence of design-analysis data and diagnostic-test data to identify yield issues. T&MW

ASSET puts board tester in your FPGA

With increasing integration and frequencies, test points are disappearing from many boards. ASSET InterTech has responded with ScanWorks FCT, a toolkit that will turn an FPGA that's already in your board design into an embedded board tester. ScanWorks FCT lets you select embedded instruments—such as a bit-error-rate tester or a memory tester—from an IP library, program them into your FPGA, and direct them to test your board, all through a drag-n-drop interface. www.asset-intertech.com.

Cascade unveils new probe

The InfinityQuad probe from Cascade Microtech ensures reliable measurements up to 110 GHz on DC, logic, RF, and millimeter-wave RFIC devices. The multicontact quadrant probe uses a fabricated coupon tip technology and is fully configurable with up to 25 contacts defined as either DC, logic, ground, RF, or millimeter-wave with an array of pitches. www.cmicro.com.

NI revises VeriStand

National Instruments has released VeriStand 2011, the latest version of its configuration-based software environment for creating real-time test and simulation applications, including HIL (hardware-in-the-loop) simulators and test cells. The updated software has been enhanced with a stimulus profile editor and a test-cell add-on. It also provides expanded native support for 14 modeling environments. www.ni.com.

MORE PERFORMANCE
MORE VALUE

New Products from the Leader in Low-Cost DAQ

16-BIT HIGH-SPEED MULTIFUNCTION DEVICES

NEW **USB-1608G Series**

- Up to 500 kS/s, 16-bit
- 16 analog inputs
- 8 digital I/O
- Up to 2 analog outputs

From Only **$399**

24-BIT TEMPERATURE AND VOLTAGE DEVICES

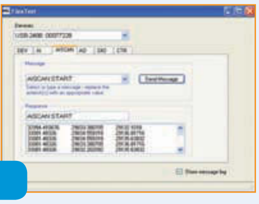
NEW **USB-2408 Series**

- 1 kS/s, 24-bit
- 8 thermocouple or 16 voltage inputs
- 8 digital I/O
- Up to 2 analog outputs

From Only **$599**

TracerDAQ

for Windows®, is included with most MCC hardware and features a strip-chart recorder, oscilloscope, function generator, and rate generator.



DAQFlex

is an open-source software framework that offers high performance in almost any OS. Drivers for Linux®, Mac®, and Windows® are available for download.

SOFTWARE ENGINEERED TO MEET YOUR NEEDS

Linux®, Mac®, Windows®

MULTI-PLATFORM SUPPORT with DAQFlex

Free Technical Support • Unmatched Warranties

mccdaq.com/NewProducts

MEASUREMENT COMPUTING™

Contact us

(800) 234-4232

[MACHINE VISION]

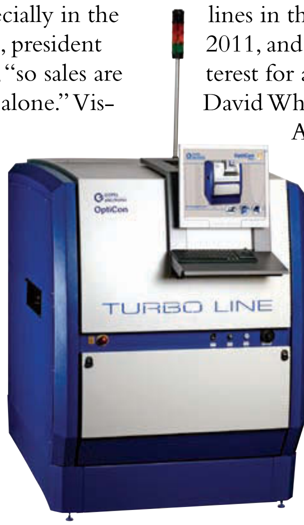
ANN R. THRYFT
CONTRIBUTING TECHNICAL EDITOR
athryft@earthlink.net

European AOI/AXI vision sales in US rise

Some European AOI (automated optical inspection) and AXI (automated x-ray inspection) manufacturers are experiencing increased sales in North America. "There's a recovery going on everywhere, especially in the US," said Carsten Salewski, president and CEO of Viscom USA, "so sales are picking up for that reason alone." Viscom experienced a steep rise in revenue growth this year from strong demand for AOI and AXI equipment, he said. "During the downturn, we continued to develop new products, [including] products that better fit the US and Asian markets' requirements. These S3088 series systems have better price/performance ratios, and their ease of use is also improved."

Most European AOI companies, especially German ones, have increased their sales in high-end electronics inspection, but North America has different requirements, Salewski explained. "For example, in Europe, we [have] customers with an engineering-driven, data-driven approach to test and inspection who want to find every defect," he said. "But in the US, especially in smaller and mid-size companies with fewer engineering resources, there's less capacity for complex programming. So, ease of programming is becoming more important than finding 100% of defects."

In the US, Viscom benefited from Agilent Technologies' exit from the AXI market in 2009, and has continued to develop its own AXI product line, said Salewski. The company has received many orders for replacement in-line AOI and AXI tools. AOI machines, for example, must be replaced every eight to 10 years. Some of those original suppliers no longer exist, increasing sales for companies doing business now.



European companies selling high-speed AOI equipment such as the OptiCon TurboLine have experienced a rise in sales in North America.
Courtesy of Goepel Electronics.

Goepel Electronics began marketing its AOI and AXI OptiCon product lines in the US at the beginning of 2011, and so far has seen strong interest for all of these products, said David Whetstone, director of North American sales and business development. The company established itself in North America over the last decade with its boundary-scan products and an office in Austin, TX, staffed with a direct sales and applications engineering team. "Goepel has been a prominent player in Europe for both product lines since the early 1990s," he said. "The company chose to initially test the US market with its boundary-scan products because management felt that, at the time, these had the best chance of a productive reception. AOI was not as widely used in electronics then as it is now, and AXI didn't really exist yet."

Over the last three years, Vi Technology Americas increased sales and applications staff to support double-digit growth in AOI sales, said Jean-Marc Peallat, president and CEO. "AOI is our core business and has driven a substantial part of our growth in the Americas [during] the past three years, along with new products like the 2K platform and new features such as Selective 3D AOI," he said. "Adding 3-D SPI [solder-paste inspection] in 2008 to our product portfolio created a real pull from our customers." The double-digit growth has occurred all over the Americas during the past two years. T&MW

29-Mpixel camera captures detail fast

Available with either Camera Link base or GigE outputs, The B6620 camera from Imperx has a 29-Mpixel resolution at 2.4 fps. It captures images at light levels as low as 1 lux and can output image data in 8-, 10-, 12-, or 14-bit formats. Up to eight separate areas of interest can be programmed via an RS-232 interface. www.imperx.com.

3-D vision software adds multicore support

Version 9.0 of Tordival's Scorpion software adds multicore support via manual thread management. In addition, new Scorpion Vision Apps simplify the integration of machine-vision into manufacturing. The software offers an improved MonoPose3D feature for locating objects in 3-D with one camera, an improved Locate3D feature for locating objects in 3-D with up to four cameras, and enhanced support for 2-D, 3-D, linescan, and smart cameras. www.scorpionvision.com.

System identifies 10-nm defects

KLA-Tencor's eDR-7000 electron-beam wafer-defect-review system locates, images, and identifies defects as small as 10 nm at device nodes of 20 nm and below. Features include a field-tested e-beam immersion column for higher resolution and topographic imaging, an advanced stage and vibration-isolation system for faster defect review, a reticle defect-review mode, and online defect classification. www.kla-tencor.com.

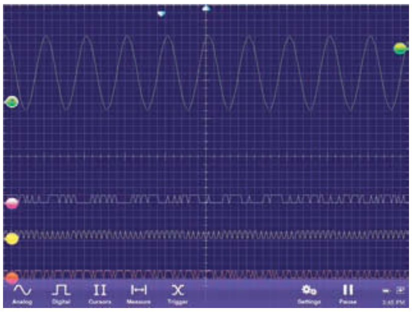

WaveRunner HRO 6 Zi
High Resolution Oscilloscope
Holy 12 bit!
LeCroy
Beyond the Limits

INSTRUMENTATION

Mobile apps show promise as engineering tools

On September 27, during the Embedded Systems Conference Boston 2011, I gave a demonstration of three mobile apps for the iPad as part of the "Mobile Apps for Geeks" session. The first was an iMSO-104 mixed-signal oscilloscope for the iPad and iPhone from Oscium (Ref. 1). Then, I played my song "The Measurement Blues" on a Play:3 wireless music system by Sonos. Using a wireless router, I used the iPad to control a laptop PC, which sent the song from its hard drive to the Play:3. An Ethernet cable connected the Play:3 to the wireless router. The Sonos system can also employ a wireless connection, but that requires a Sonos bridge that I didn't use. Finally, I used a free app called Sound Level, which displayed a plot of the music on the iPad through its built-in microphone.

These three apps show that the iPad, the iPhone, and the Android tablets and phones can be used as engineering tools, as each can serve as an interface to instrumentation or can be a system controller. The iPad could do more if it had a USB port that would let you connect instruments or USB flash drives. An SD card slot would also add removable memory and thus add value.



An iPad oscilloscope from Oscium captures signals on one analog and up to four digital channels.

Engineering apps now appear in the Apple App Store. For example, Xilinx recently announced an app that you can use to calculate the power consumption of its FPGAs on your iPhone (Ref. 2), and the company said that an Android version of the app is also underway. Sonos already has an Android app as well as PC and Mac software for controlling its home music systems.

Martin Rowe
Senior Technical Editor

REFERENCES

1. Dipert, Brian, "Oscium's iMSO-104: An Apple iOS-Based Oscilloscope With Features Galore, But Whose Price Tag May Leave You Yearning For More," *EDN*, April 27, 2011. www.edn.com/blog/Brian_s_Brain/index.php.

2. "Xilinx Releases Pocket Power Estimator App for the iPhone," September 27, 2011. press.xilinx.com/phoenix.zhtml?c=212763&p=irol-newsArticle&ID=1610514.

EMC

Design series covers electromagnetic compatibility

EMC (electromagnetic compatibility) problems—radiated emissions and immunity, conducted emissions and immunity, and electrostatic discharge immunity—can delay product releases and cause compliance problems if not identified early. Consultant Daryl Gerke has written a series of articles for planetanalog.com (part of the *EE Times* Website) that provides an introduction to EMC, describes sources of unwanted emissions, and explains how to minimize interference (Ref. 1).

The series discusses how critical circuit components such as clocks and voltage regulators can degrade EMC performance. Because clocks are oscillators, they emit signals, and you must use proper grounding and shielding to minimize any unwanted emissions (part 1 of the series covers oscillators; part 11 covers shielding).

In part 8, which discusses ways to troubleshoot EMI (electromagnetic interference), Gerke explains that clocks and other digital signal sources are hidden transmitters: "Highly repetitive signals such as clocks and clock-like signals (busses, repetitive control lines, etc.) generate strong harmonics. But even switching power electronics (power supplies and motor drives) can get into the act. As a helpful hint, we usually assume the first twenty harmonics of any repetitive signal are potential transmitters."

A spectrum analyzer can reveal the frequencies of offending emissions. Courtesy of Rhode & Schwarz.

Analog circuits can also cause emissions, because components such as voltage regulators and op amps may unintentionally oscillate. When that happens, you must either reduce the oscillation amplitude at the source or shield it from interfering with other nearby components, subsystems, or systems. Gerke recommends that you use a "sniffer" probe and a spectrum analyzer to find the source of emissions.

Martin Rowe
Senior Technical Editor

REFERENCE

1. You can link to the articles in the series by reading the editor's note at the beginning of part 11. www.eetimes.com/design/analog-design/4229258/EMC-Basics--11--An-introduction-to-EMC-shielding.

Test ideas

Measurement tips from readers

Logic probe uses two comparators

You can build a logic probe with voltage thresholds that vary with a circuit's power-supply voltage.

By Vladimir Rentyuk, Zaporozhye, Ukraine

Measurement instruments must not affect the circuits they're measuring. A logic probe, for example, must correctly detect logic levels, and it must place no undue loads on the test circuit. The logic probe must set thresholds on automatically checking logic levels, depending on the supply voltages of the ICs it is checking. It should also not cause the checking circuit to function incorrectly.

CMOS ICs such as NXP Semiconductors' HCMOS 74HC/HCT/HCU (Ref. 1) and Signetics' LOCMOS HE4000 families have input current as low as ±1 μA. The HE4000 family of logic ICs has input currents of ±0.1 to ±0.3 μA. The circuit in the **figure** is a logic probe for ICs in the HCMOS 74HCxx family. The logic probe comprises comparators IC_{1A} and IC_{1B}. Not every comparator will work properly in this circuit. The comparator must, for example, operate with minimal supply voltages, and it must have low input leakage current. The Analog Devices AD823AR or an equivalent comparator is a good choice.

Comparators IC_{1A} and IC_{1B} check logic-high and logic-low levels, respectively. The resistor-divider network comprising the 1%-tolerant, surface-mount, size-0805 R_4, R_5, and R_6 resistors sets the voltage levels, which vary in relation to the power-supply voltage. Connect the probe circuit to the same power supply that you use to power the circuit under test, allowing the comparator voltages to track the circuit's power supply.

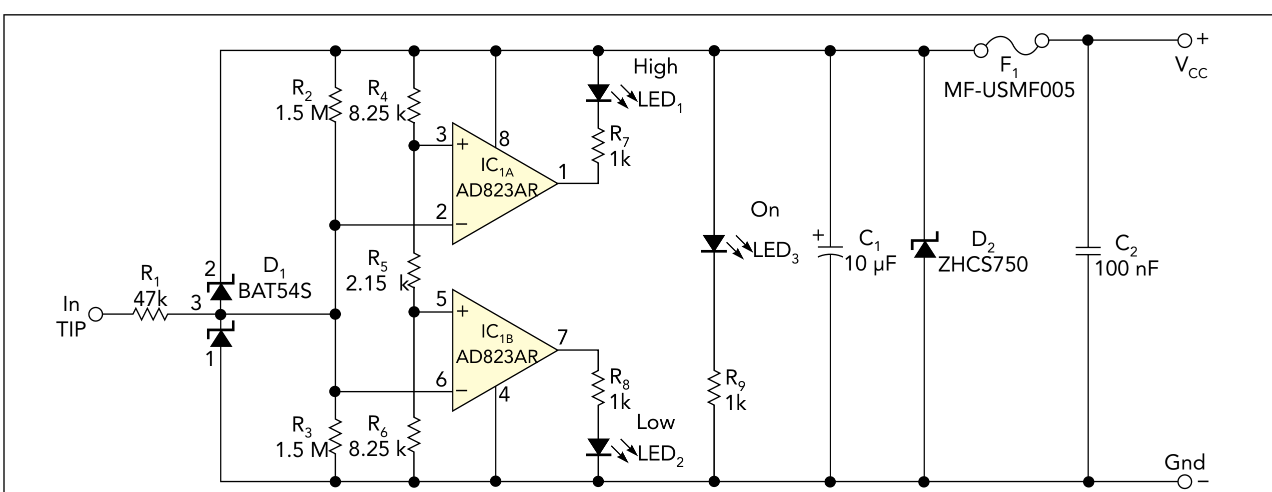
Green LED_1 and red LED_2 indicate logic-high and logic-low levels, respectively. If the input voltage is between those levels, neither LED will illuminate. **Table 1** highlights the logic-level voltages for the 74HCxx family of ICs, and **Table 2** shows the voltage levels for the 4000 series ICs.

The input current of the AD823AR is less than ±3 μA at a drain-to-drain voltage of 5 V, ±6 μA at a drain-to-drain voltage of 10 V, and ±9 μA at a drain-to-drain voltage of 15 V. You can reduce this current by increasing the value of resistors R_2 and R_3, which are 1.5 MΩ in the figure.

The network comprising R_1 and D_1, two BAT54S Schottky diodes, protects the logic-probe circuit from overvoltage at its input, from ESD (electrostatic discharge), and from signals of negative polarity. Yellow LED_3 indicates when the logic-probe circuit and the circuit under test start up. The yellow LED is useful if you connect the probe to the circuit under test with crocodile clips. This approach ensures that both the probe and the test circuit are always on.

D_2 and resettable fuse F_1, an MF-USMF005, which has a hold current of 0.05 A and which comes in a surface-mount package, protect the probe circuit from improperly powering up. Tantalum capacitor C_1, in size A or B, and ceramic capacitor C_2, in size 0805, prevent the test circuit from influencing power for the logic probe. R_1 minimizes the influence of input capacitance on this logic probe.

The logic-level thresholds automatically depend on the supply voltages (Tables 1 and 2). You can use this logic probe with other ICs, such as the 74HCU, the 74HCT, or the 4000 series. You can freely select the value of R_6. You can also calculate the value of R_5 and R_4 using $R_5 = V_H/(V_L/R_6) - R_6$ and $R_4 = V_{DD}/(V_L/R_6) - R_6 - R_5$, where V_{DD} is the supply voltage of



Two comparators and a resistor network track power-supply voltages and set logic-voltage levels.

Table 1. Logic-level voltages for 74HCxx family

Parameter	Symbol	Value (V)	Threshold (V)	Value (V)	Threshold (V)
DC-supply voltage	V_{CC}	4.5		6	
Low-level input voltage	V_{IL}	2.1	1.99	2.8	2.65
High-level input voltage	V_{IH}	2.4	2.51	3.2	3.35

Note: Thresholds were chosen on the basis of typical logical levels for ICs in the 74HCxx family.

Table 2. Logic-level voltages for 4000 family

Parameter	Symbol	Value (V)	Threshold (V)	Value (V)	Threshold (V)	Value (V)	Threshold (V)
DC-supply voltage	V_{CC}	5		10		15	
Low-level input voltage	V_{ILMAX}	1	0.93	2	1.86	2.5	2.51
High-level input voltage	V_{IHMIN}	4	4.3	8	8.61	12.5 8.25	11.62

Note: R_4, R_5, and R_6 are 6.2, 30, and 8.25 kΩ, respectively.

the device, V_H is the threshold for checking the high logic level for the chosen supply voltage, and V_L is the threshold for checking the low logic level for the chosen supply voltage. T&MW

REFERENCE

1. "HCMOS family characteristics," NXP Semiconductors, March 1988. bit.ly/npckkN.

A version of this article originally appeared in the August 25, 2011, edition of *EDN*.

Want to read other Test Ideas?

Check out our "Test Ideas" archive on the *Test & Measurement World* Website:

www.tmworld.com/testideas

Plus, you can access the archive of *EDN*'s "Design Ideas" at:

www.edn.com/designideas

Who should be the 2012 Test Engineer of the Year?

Help choose the winner for this prestigious award by voting online for one of the six finalists. Voting deadline is December 16.

Name almost any manufactured product with a long track record of success, and you'll find one essential ingredient: a reputation for quality and reliability. In issue after issue, this magazine describes the latest methods for achieving product quality as practiced by the people most responsible for it—test engineers. Their work touches products at every stage: research, design, compliance, manufacturing, and field service.

Test & Measurement World's annual Test Engineer of the Year award, now in its ninth year, honors the vital contributions that test engineers make to the quality of electronic components and systems. We will present the 2012 Test Engineer of the Year award at the "Best in Test" event on January 31 during DesignCon 2012 in Santa Clara, CA. Our March 2012 issue will also profile the award recipient, who will designate an engineering school to receive a $10,000 grant, courtesy of National Instruments.

This year, we received nominations of leading test engineers from a broad range of industries, and our editors have chosen six finalists for the award. The finalists' work demonstrates the far-reaching nature of test and measurement, from business machines and security systems to compact medical devices and instruments that monitor manufacturing processes.

Help choose the 2012 Test Engineer of the Year. On the following pages, you can read about the finalists, taking note of their on-the-job skills and overall contributions to their fields. Then, cast your vote for your favorite by visiting www.tmworld.com/2012_teoty, where you will find additional links to information about the candidates and their companies. T&MW

Who should be the 2012

SECURITY SYSTEM TEST

Bohdan Atamanchuk

Smiths Detection

In a year that marked the 10th anniversary of the September 11th tragedy, the importance of developing technologies for thwarting terrorists has once again been in the spotlight. As senior electrical designer in the Toronto, ON, division of Smiths Detection, Bohdan Atamanchuk plays a key role in ensuring the reliability of several systems, including handheld and desktop units that detect chemical and radiation threats.

Atamanchuk designs digital circuitry for the instruments and plans and implements test strategies. Among his most valuable tools: simulation software, environmental chambers, data-acquisition devices, and digital oscilloscopes with accessories for measuring current and high voltages. He also brings to his work a background in temperature measurement and control, based on his PhD work in nondestructive testing of sensors.

The sheer complexity of the company's products poses a constant challenge, noted Atamanchuk, since the systems rely on multiple disciplines: electrical engineering, chemistry, physics, and math. Instruments typically combine extreme electronics sensitivity, high switching voltages, and high temperatures, plus pumps, motors, valves, and heaters. Atamanchuk has to contend with all this, plus tough requirements for chemical cleanliness and overall robustness in harsh environments.

As part of his duties, Atamanchuk consults with manufacturing engineers and works closely with the sustaining engineering department. Currently, he is working on several projects aimed at improving the long-term performance of security devices while keeping costs low.

TEST SYSTEM INTEGRATOR

Tim Carroll

Optimation Technology

Engineers who work at Optimation Technology, a company that provides design, fabrication, and test systems for a wide range of industries, need a broad knowledge of new technologies and a deep understanding of a customer's application. Tim Carroll, senior systems integrator, fits that description to a T. In more than 200 projects since joining the company—about 75% of them involving test and measurement—Carroll has demonstrated proficiency in hardware integration as well as in a litany of programming languages, including C/C++, Visual Basic, ActiveX, Eclipse, Qt, LabView, and LabWindows/CVI. He also serves as a certified professional instructor for National Instruments.

At Optimation, Carroll has developed several medical neurostimulator test systems. His work has included design characterization, device and software verification testing, and compliance and product acceptance testing. One manufacturing test platform, which tests multiple products in parallel, achieved a 400% throughput increase over the previous design. This year, Carroll also led the engineering team's successful efforts to gain ISO 13485 certification, the quality standard for the medical device industry.

Carroll stresses the importance of developing test tools that can serve both design verification and manufacturing test. And while he has developed test systems for many industries, from aerospace to oil field exploration, he gets the most satisfaction from medical projects, "where I can contribute to products that save lives or improve the quality of life."

SEMICONDUCTOR TEST

Brad Davis

Broadcom

When Broadcom announced its BCM4330 wireless combo chip, some analysts commented on its complexity. On a single silicon die, the chip combines multiple cutting-edge wireless systems: 802.11n WiFi, Bluetooth 4.0, and FM radio. Such design complexity, while offering cost, size, and performance advantages for mobile devices, also comes with monumental test challenges, and that responsibility lands squarely in the lap of RF wireless engineering manager Brad Davis.

As leader of the WLAN hardware team, Davis manages and characterizes the RF performance of Broadcom's WLAN mobility chips, modules, and drivers throughout their life cycles. With their expertise in RF hardware design and test automation, Davis and his team have pioneered techniques that have increased test coverage many times over and have improved test speeds by a factor of three over prior methods.

"With product life cycles getting shorter, the test group doesn't want to be the hold-up," said Davis, who holds an MSEE degree. "That means days, not weeks, in getting drivers and boards tested and in the customer's hands." Davis takes pride in leading development of new test methodologies, such as extensive use of "one-box" testers to perform transmit-and-receive testing much faster than conventional bench equipment. He also has led efforts to implement multisite device testing and to automate measurement of low-current consumption, a vital issue in wireless combo chips.

VOTING DEADLINE: December 16, 2011
www.tmworld.com/2012_teoty

Test Engineer of the Year?

MANUFACTURING PROCESS MEASUREMENT

Scott Heinbuch

Brooks Automation

An amazing array of products rely on a manufacturing process that occurs under vacuum, including semiconductors, LEDs, solar panels, disk drives, and glass coatings. But how do you ensure that vacuum processes are free from leaks, contamination, and other problems?

The Granville-Phillips unit of Brooks Automation offers a compelling answer in its new VQM (Vacuum Quality Monitor). As the first commercial implementation of ART-MS (auto-resonant-trap mass spectrometer) technology, the system produces mass spectra more than 20 times faster, requires 80% less power, and calibrates much quicker than traditional gas analyzers.

At every stage of the VQM's development, product engineer Scott Heinbuch, a PhD electrical engineer, served as the prime test resource. Before the first version of control software was running, Heinbuch had developed an application to capture, display, and manipulate data coming from the ART-MS gauge. That software enabled hardware and firmware teams to test and debug early design concepts, slashing development time.

Later, Heinbuch implemented long-term reliability testing for electronics modules; conducted highly accelerated life tests and stress-screening tests as well as product-safety reviews; and performed pretesting for electromagnetic compatibility. He also proposed the data and reporting structure that organized test results for the team on a shared server. Finally, to prepare for pilot manufacturing, Heinbuch developed a bed-of-nails platform for electronics testing that also serves in volume manufacturing test.

COMPUTATIONAL MICROSCOPY

Aydogan Ozcan

UCLA Samueli School of Engineering

In a world where 5 billion people use cellphones—75% of them in developing countries—Associate Professor Aydogan Ozcan and his UCLA research team are clearly onto something: developing compact test devices that attach to mobile phones. The latest example is a flow cytometer, weighing just one-half ounce, that can examine cells, bacteria, and microscopic particles. The optofluidic device, integrating imaging cytometry and florescent microscopy, is based on a technology that Ozcan calls "lens-free computational microscopy."

"What we've done is design a purely digital, lens-free imaging platform," said Ozcan, a PhD electrical engineer. Behind that innovation: the use of computer algorithms to mimic the traditional function of a lens as an analog computer. In this approach, Ozcan's devices, which include several types of microscopes, detect shadows of specimens rather than their actual images.

The technology yields inexpensive devices with minimal hardware. For example, the flow cytometer could find wide application in the developing world to monitor patients with HIV, tuberculosis, or malaria. Ozcan also sees great potential for combining his computational tools with physical electronics to develop new kinds of portable sensors for environmental monitoring.

With several patents issued or pending, Ozcan has founded a start-up company to license the technology for commercial products. "As an engineer, I'll get the most satisfaction in seeing our platform used in real-world applications, such as improving health care in resource-poor countries."

COMPUTER DEVICE TEST

Pramada Singireddy

Dell

As Dell expands from being a PC kingpin into the world of computer networking and data storage, being able to deliver reliability along with competitive prices has become a chief concern for the company. That's why engineers like Pramada Singireddy are so important.

A test senior engineer in the Enterprise Product Group, Singireddy has led validation testing of servers, software, and storage hardware, which must be successfully integrated to satisfy wide-ranging customer applications. The work involves Dell's server-management product portfolio, including PowerEdge servers such as the R810.

As this portfolio of hardware and software increases, the test matrix for validation has grown exponentially. To address that concern, Singireddy embarked on an aggressive plan to develop and deploy test automation for expanding test coverage, improving product quality, and reducing program risk. This effort included extensive use of such tools as LoadRunner software to simulate system performance and the Python programming language for automating test scripts.

In addition, Singireddy tapped Dell's vast repository of customer data to analyze customer usage activities, as well as to extract product quality metrics. Armed with that information, she molded validation strategies, including life-cycle simulation of enterprise solutions. Recently, Singireddy was tapped for an exciting new project: serving as lead test engineer over 20 global teams that are developing highly complex software for the next generation of PowerEdge servers.

Vote for the Best in Test

We will announce the finalists for the 2012 Best in Test and Test of Time product awards on November 1 on www.tmworld.com. The annual Best in Test awards recognize excellence and innovation in products and services introduced during the past year. The annual Test of Time award recognizes an innovative product that continues to provide state-of-the-art performance more than five years after its introduction. Cast your vote today. Voting deadline is December 16, 2011. www.tmworld.com/2012_awards

REDUCE THE COST OF OPTICAL TRANSCEIVER TESTING

You can save money by shortening the time for extinction-ratio and eye-mask tests.

BY GREG LeCHEMINANT, AGILENT TECHNOLOGIES

Optical transceivers require measurements and tuning for optimal output power. Courtesy of Finisar.

Optical transceivers are essential components in mobile-phone base stations, short-link data centers, campus networks, and long-haul telecommunications networks. Transceiver manufacturers produce millions of these components every month, and a competitive marketplace forces vendors to keep their prices low. This price pressure compels manufacturers to find ways to drive down production costs—including the cost of test.

Improving test processes can reduce overall production costs. A single test system for transceivers can cost more than $100,000, and a typical manufacturing site will likely have many test systems. Given the small profit margins of optical transceivers, it may be surprising to find that the contribution of test instrumentation to overall costs may be quite small compared to the manufacturing cost for millions of transceivers. Test time, however, is a significant factor in overall manufacturing expenses, and reducing test time offers the greatest opportunity to cut costs.

Beyond electrical tests

From an electrical perspective, the laser in an optical transceiver operates as a diode, but the test process required for transceivers deviates significantly from the process used for purely electrical components. For example, the laser semiconductor chip must be mated with lens structures so its output efficiently couples into a fiber-optic cable.

Even if you have a mature product with a stable manufacturing process, you must individually tune each laser for correct biasing to achieve proper output power and waveform properties. The laser in the transceiver's transmitter produces an output-power-versus-input-current transfer function that's somewhat similar to the current-versus-voltage curve of a common diode. At lower current levels, a laser diode emits very little light power. The plot in **Figure 1** shows that at some point, the emitted light power increases rapidly with current. Thus, you must bias the laser so it emits very little light when it receives an electrical input of logic 0 and has a high light power at logic 1. The best way to perform the biasing is to use a resistor network optimized for the specific laser.

To gauge if a laser is correctly biased, you need to measure its light power at logic 0 and logic 1. You can use a wide-bandwidth oscilloscope with an integrated optical front end to make the measurement. These types of oscilloscopes, which Agilent Technologies calls DCAs (digital communications analyzers), display eye diagrams of many bits overlaid on each other. The eye diagram lets you see the laser's extinction ratio, which is the mean value of the logic-1 level of the eye divided by the mean value of the logic-0 level. Extinction ratio is a useful parameter that indicates how efficiently a laser diode converts electrical inputs to modulated light. You can use a histogram to analyze signal levels, which are usually based in the central 20% of the eye (**Figure 2**).

Extinction-ratio measurements let you set both the AC and DC laser-bias conditions. Laser biasing also influences the shape of the output waveform, which an eye diagram will show. You can monitor the eye diagram while tuning the laser, and you can use an eye mask to quantify the shape of the eye.

An eye mask consists of polygons placed above, within, and below the eye, which define regions where the eye diagram may not exist, essentially defining the minimum allowed opening of the eye. For the typical eye-mask test, the outliers of the eye-diagram sample population cause mask violations. It's common practice to proportionally expand the magnitude of the mask polygons to determine not just whether a transceiver passes the mask test, but also to determine a margin of compliance. Mask margin is the largest percentage expansion of the mask dimensions that an optical transmitter's signal can reach without violating the mask limits.

The laser-tuning process can represent significant cost to a transceiver manufacturer. Tuning takes time and will limit a manufacturing system's capacity, influencing the number of test stands and manufacturing floor space required to meet production demands. Although usually highly automated, the tuning process typically requires a technician or an engineer to install the transceiver in a test fixture and make the necessary fiber connections. The test equipment required to perform the eye diagram test can represent a significant capital outlay. Any efforts that improve test efficiency are likely to reduce the cost of testing a transceiver.

Checking test efficiency

To evaluate the efficiency of your test, begin by examining how you acquire and measure an eye diagram. To create the eye diagram, send an electrical data signal to the transmitter and capture the optical data signal with a DCA-type oscilloscope. The data pattern should represent the data that the transmitter will send when in actual use; engineers commonly use a PRBS (pseudorandom binary sequence) for this test because it represents a wide range of data patterns. The DCA will construct and display the transmitter signal's eye diagram by acquiring data samples from throughout the transmitted data pattern. You should set the DCA to run in infinite-persistence mode. Data samples will remain on the display indefinitely. The eye diagram will continue to build as the DCA collects more data samples.

Industry standards such as IEEE 802.3ae and 802.3ba and ITU G.957 and G.691 (Refs. 1–4) specify measurements and the test equipment you need to make those measurements, but they don't specify how much data you should collect. You might think that the more data you collect, the more likely it is that the eye-diagram will show the true performance of the transmitter. Acquiring more data takes more time, however, and it effectively increases the cost of test by reducing a test system's overall throughput. You could use a faster test system, but a better option is to develop a test method that provides valid results with only small amounts of data.

You can derive both the extinction-ratio and eye-mask results from the eye diagram, but the amount of data required for accurate results is very different for these two tests. Recall that the extinction-ratio results are obtained from the mean values of eye-diagram histograms; the eye-mask results depend on the statistical extremes of the eye-diagram data.

Finding the ideal biasing conditions is generally an iterative process. You need to set the bias, measure the eye, and adjust the bias levels until you get the greatest

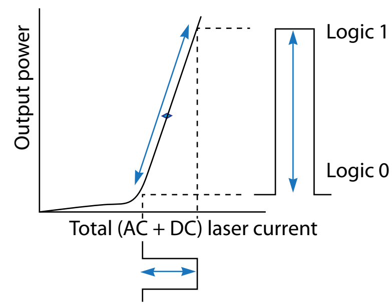


FIGURE 1. Adjusting the current bias in a laser diode can ensure the diode achieves the correct output waveform performance as long as the modulation keeps the diode in its linear region.

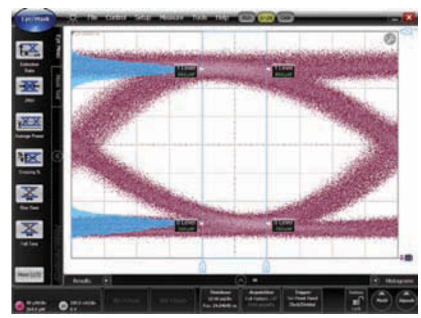


FIGURE 2. Use the center 20% of an eye diagram to find a laser's extinction ratio.

a) b)

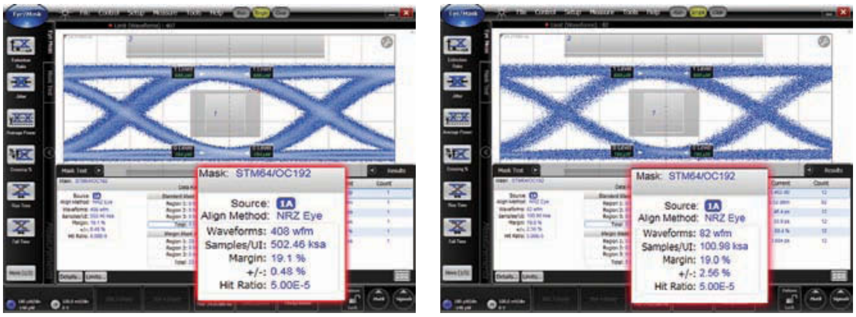


FIGURE 3. a) The eye-mask margin for a high-confidence factor requires 408 waveforms, yet the results are similar to those of b) a mask margin that collects only 82 waveforms in less than 3 s of test time.

extinction ratio. You must repeat the process until the optical transmitter achieves the required waveform performance.

Collecting a large sample size for each bias setting with the DCA-type oscilloscope in infinite-persistence mode could be extremely time consuming, and you can dramatically improve efficiency if you run the DCA in finite-persistence mode. The DCA will report the extinction-ratio results almost instantaneously because a small data set is sufficient to provide an accurate result. Thus, a test system can continuously tune a laser's bias while monitoring the extinction ratio. You can then achieve ideal bias in just a few seconds compared to the tens of seconds required using infinite persistence.

Eye-mask verification offers savings opportunities

Once you find the optimum laser bias, you can verify the eye-mask performance. The need to observe the statistical extremes of the waveform shape, however, requires that you operate the DCA in infinite-persistence mode so every waveform sample remains on the instrument display. Given that the waveform will contain random signal components such as noise and jitter, there's no guarantee that any practical sample population will include the extremes of the waveform. As the oscilloscope captures more samples, the likelihood increases that the transmitter will violate the eye mask. Thus, results can only get worse as the data set grows, which will lead to a smaller mask margin. Furthermore this testing is prone to inconsistency. For a given number of waveform samples, the mask margin will likely fluctuate from test to test because one collection of samples might have an extreme outlier, but another set of samples might not.

The IEEE and ITU communications standards resolve this measurement problem by allowing a small percentage of waveform samples to violate the mask. Typically, the standards allow one sample in every 20,000 to intersect the eye mask. With this approach, once the sample population is significantly above 20,000, results are very consistent regardless of the number of samples. This leads to an important question: How little data can you collect while providing a high level of confidence that the mask margin is accurately known? If you can obtain accurate results with less data, you can reduce test time and production costs.

You can trade off three different factors when setting up the mask test: the size of the sample population, the margin of the eye mask, and the measurement uncertainty of the reported eye-mask margin. For example, you can configure an eye-mask test so that the oscilloscope acquires data until the mask-margin expansion percentage is known to within ±1%. In another approach, you can find the largest mask-margin percentage with at most a ±2% error for a small sample size.

These two approaches may seem similar, but the former provides a method to efficiently find the true eye-mask margin, while the latter forces a smaller sample size (thus cutting test time) at the expense of how precisely you know the true mask margin. If you know a transceiver inherently has good mask margins, then you can reduce sample sizes to very small values. Assuming similar test-equipment costs, you must recognize that the most cost-effective test system isn't the one that collects data the fastest, but rather the one that provides accurate and usable results in the shortest time.

Figures 3a and **3b** highlight the tradeoff in eye-mask uncertainty and samples. In Figure 3a, the uncertainty of the eye-mask margin is ±0.48%. In Figure 3b, it is ±2.56%. The lower uncertainty in Figure 3a, however, comes at the expense of more samples, 502.46 ksamples versus 100.98 ksamples in Figure 3b. Remember that more samples take more time to acquire.

You can also drive down test costs by testing devices in parallel. Some DCA-type sampling oscilloscopes can simultaneously acquire data from several channels without degrading the system throughput. A test operator can thus connect four transceivers to the test system and automatically tune all four devices and obtain eye-diagram results.

The time needed to attach a transceiver to the test equipment becomes the limiting factor to continued cost reduction. Historically, the setup time was considered negligible. This may no longer be true. Handling and setup could become the next areas of the test process that offer opportunities for improvement.

Someday, optical transceiver tests may become as streamlined and efficient as those for purely electrical components. As long as lasers require tuning, waveform analysis using a high-speed sampling oscilloscope will be required. Ongoing steady improvements in test algorithms and processes have dramatically reduced the effective cost of test, which lets transceiver manufacturers meet rising production demands while simultaneously improving the cost of test. T&MW

REFERENCES

1. IEEE 802.3ae-2002, "IEEE Standard for Information Technology—Telecommunications and Information Exchange Between Systems—Local and Metropolitan Area Networks—Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Amendment: Media Access Control (MAC) Parameters, Physical Layers, and Management Parameters for 10 Gb/s Operation." ieeexplore.ieee.org.

2. IEEE 802.3ba-2010, "IEEE Standard for Information Technology—Telecommunications and Information Exchange Between Systems—Local and Metropolitan Area Networks—Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Amendment 4: Media Access Control Parameters, Physical Layers and Management Parameters for 40 Gb/s and 100 Gb/s Operation." ieeexplore.ieee.org.

3. ITU-T G.957, "Optical interfaces for equipments and systems relating to the synchronous digital hierarchy," International Telecommunication Union. www.itu.int.

4. ITU-T G.691, "Optical interfaces for single channel STM-64 and other SDH systems with optical amplifiers," International Telecommunication Union. www.itu.int.

Greg LeCheminant *is a measurement applications specialist for digital signal-analysis products in the Digital Test Division of Agilent Technologies, and he represents the company on several standards committees. LeCheminant is a contributing author to four textbooks on high-speed digital communications and has written numerous technical articles on test-related topics. He holds two patents and holds BSEET and MSEE degrees from Brigham Young University.*

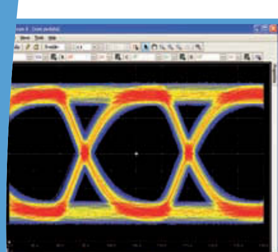
PICOSCOPE 6000 SERIES

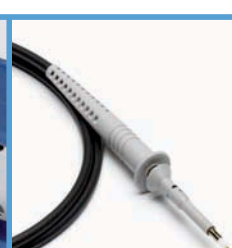
THE HIGHEST PERFORMANCE PC OSCILLOSCOPE

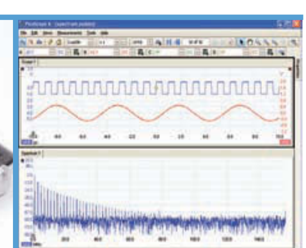
5 YEAR WARRANTY

500 MHz BANDWIDTH
5 GS/s SAMPLING
1 GS MEMORY

4 Channel oscilloscope with spectrum analyzer
Built-in arbitrary waveform generator
UART, SPI, I²C and CAN bus decoding
Advanced triggering
Mask limit testing
Full math and measurement functions
High Speed USB connection
Easy-to-use software
SDK for major third party applications
Segmented memory
Digital Triggers
Five Year Warranty







Contact us at 1-800-591-2796 or visit us at www.picotech.com/pco463

pico® Technology

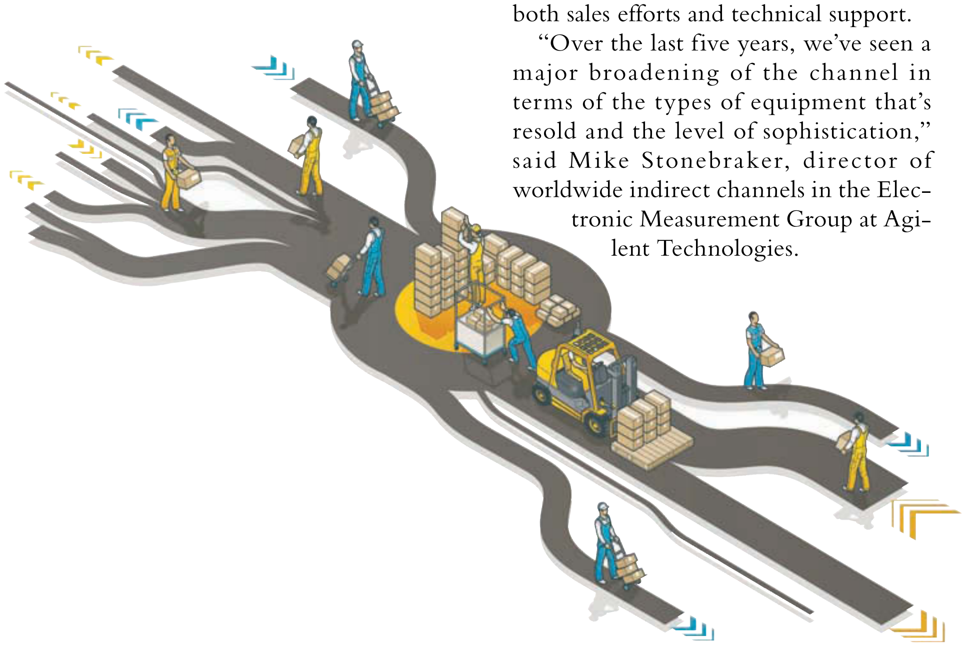
Manufacturers test new distribution channels

Third-party distributors now handle more than just low-end test instruments.

BY TAM HARBERT, CONTRIBUTING EDITOR

Prominent manufacturers of test equipment, who have historically sold directly to their customers, have begun exploring new sales channels and are now offering a wider variety of products through distributors, franchisees, and online stores. And what may be even more surprising is that their use of these new channels is not limited to low-end instruments. In fact, manufacturers are working more closely than ever with distributors to coordinate both sales efforts and technical support.

"Over the last five years, we've seen a major broadening of the channel in terms of the types of equipment that's resold and the level of sophistication," said Mike Stonebraker, director of worldwide indirect channels in the Electronic Measurement Group at Agilent Technologies.



Several factors are driving manufacturers to expand their sales channels. First, the rocky economy has them looking for more-efficient ways of reaching more markets. Test-equipment vendors were hit hard by the economic downturn—revenues shrank by more than 20% from 2008 to 2009 (**Figure 1**). Even though the market has resumed growth, it has not yet recovered to 2008 levels.

"That was the second downturn in 10 years," noted Jessy F. Cavazos, industry director of test and measurement at Frost & Sullivan. As a result, organizations are becoming more conservative and are trying to adjust sales strategies to enable them to ride out such swings.

Broadline distributor Allied Electronics has been approached by several test-and-measurement equipment manufacturers with formal programs to increase their sales through distribution, said Scott McLendon, VP of product management at the company. "[Vendors] have found that it's not very profitable for them to support the multitudes of smaller customers on a direct basis, given all the service-level implications, their return on working capital, and credit risks."

Second, as electronics has pervaded all sorts of consumer goods, the customer base for test-and-measurement equipment has grown beyond the traditional electronics test engineer. "You can hardly buy a fan anymore that doesn't have a microprocessor," quipped Stonebraker. At the same time, Moore's Law has enabled more sophisticated technology to go into smaller-sized instruments at lower price points.

And third, although the market has slowed in the US and other developed nations, vendors see potential double-digit growth in emerging markets, said Cavazos. She also noted that previously, vendors have sold equipment directly to multinationals that had R&D or production facilities in low-cost, developing regions, but today they see additional opportunities to sell to expanding indigenous companies as well.

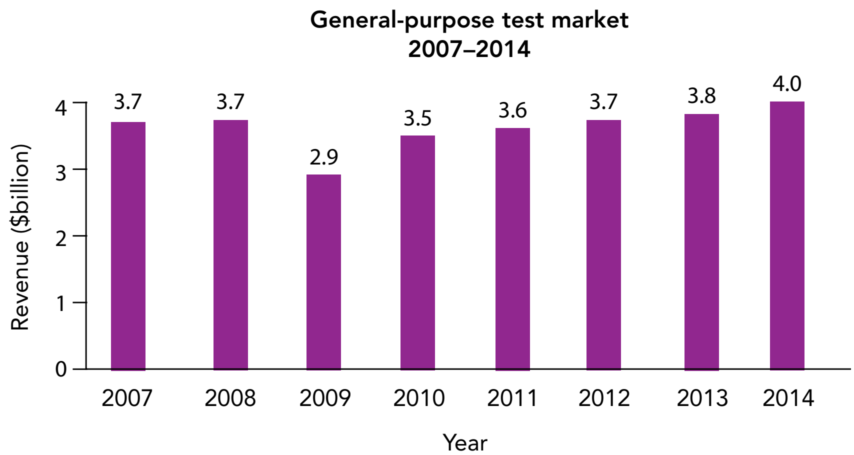


FIGURE 1. Manufacturers of general-purpose test equipment (which includes oscilloscopes, signal generators, arbitrary waveform generators, spectrum analyzers, network analyzers, power meters, electronic counters, logic analyzers, and digital multimeters) were hit hard by the economic downturn. Revenue should return to pre-2009 levels by 2012. Source: Frost & Sullivan.

Moving more product through the channel

Two of the most dominant test-and-measurement companies, Agilent and Tektronix, have both increased sales through distribution. Agilent has honed its distribution strategy over the last two years, a move that appears to be working out well for the company. "It's been a major trend in our business and a strong contributor to growth as well," said Stonebraker. Indeed, 25% of the company's orders come from indirect channels today, compared to only 8% two years ago, according to a company spokesperson.

Stonebraker gave credit to Tektronix and Fluke for pioneering the use of distribution for low-end equipment years ago. Agilent took note of their success, he said, realizing that its customers also likely wanted a more-efficient purchasing process. "Engineers don't necessarily need to see another engineer to make a decision on what piece of test equipment to buy," Stonebraker explained. "When a customer wants to buy their 10th scope and it's exactly like the previous nine, all they want is the quickest and simplest way."

Tektronix also has expanded its use of indirect channels. The company has used distributors for more than 20 years, but lately has started selling higher-end equipment through the channel. Late last year, Tektronix announced new distribution agreements with Allied Electronics, Entest, Newark, and TestEquity, authorizing those firms to carry higher-performance oscilloscopes, signal generators, spectrum analyzers, logic analyzers, and bit-error-rate testers. And this year, Tektronix, which is a subsidiary of Danaher, inked similar agreements with several European distributors.

Vendors are using specific channels to meet particular needs. Some high-end products are still only available directly from the manufacturer, such as the Tektronix DSA8200 digital sampling oscilloscope, which requires custom configuration, said Gina Bonini, technical marketing manager at Tektronix. On the other hand, some of the company's distributor partners are beefing up their technical chops and building their own applications teams, she added.

Tektronix direct and indirect sales people frequently work together on sales opportunities, said Faride Akretch, also a technical marketing manager. "We don't see it as either [a direct sale or an indirect sale]. We see it as a combination of the two."

A sampling of options

For manufacturers who choose to employ third-party distribution channels, several options are available:

- **Broadline distribution:** The core business of broadline distributors is wide

R&S marches to a different beat

While most instrument vendors are expanding their indirect sales, Rohde & Schwarz is moving in the opposite direction. Over the last 18 months, Rohde & Schwarz has cut its number of distributors from about 10 to five, said Daniel H. Henmi, the company's North American channel sales and marketing manager.

"Our strategy is to go direct for most products, and then have distributors to go after incremental opportunities that we can't touch with our direct sales force," he said. "We are cutting back on the distributors that aren't finding us incremental business, that don't have outside salespeople out there finding new business."

Another reason for the change is that many R&S products are difficult for distributors to stock. For example, the popular FSH series of handheld spectrum analyzers comes in about 14 different models, all of which must be customized at the factory, according to David Rountree, president of Entest, one of the five remaining Rohde & Schwarz distributors (Continental Resources, TestEquity, MetricTest, and Test-Mart are the others). With 14 different variations, "you can't stock very good inventory on these things," he said.—*Tam Harbert*

Tight budgets boost rental market

In these tough economic times, more and more companies are holding the line on capital expenditures for high-end test equipment. That's given a boost to companies that deal in rental equipment.

While ElectroRent serves as an Agilent Authorized Technology Partner for equipment sales, the lion's share of its business comes from the other part of its operations: rentals. That's where the company earns about 75 to 80% of its total revenue, said Tanya Jamison, ElectroRent's worldwide director of marketing. The company maintains a huge inventory of equipment, much of it newly purchased from the major test-and-measurement vendors. Customers can rent the equipment for the long term or month to month. At the end of the term, the equipment goes back into the rental pool or is sold as used.

The rental business is riding a more general trend of corporations shifting expenses from the capital budget to operating expenses. "Companies are realizing that the cost of buying the equipment is only a small percentage of the ownership costs," said Jamison. "They also have to maintain it, calibrate it, and store it." That's been good for ElectroRent's bottom line. Rental and lease revenues grew more than 25% over the last year, according to the firm's 2011 annual report.

Allied Electronics has seen evidence of this reining in of the capital budgets, said Scott McLendon, VP of product management. While the distributor's overall sales grew 30% last year, test and measurement grew less than 10%. "If it's only a 'nice to have,' they are not buying it today," he said. "It's got to be a 'have to have.'"

Rental and used equipment is projected to maintain healthy growth, said Jessy F. Cavazos, industry director of test and measurement at Frost & Sullivan. The research firm projects a compound annual growth rate of 4.5% from 2009, when revenue was $605 million, through 2015, when it is predicted to be $787 million.

Tam Harbert

selection, deep inventory, and fast shipping. If an engineer needs an instrument quickly, a broadline distributor is often the best bet. Broadline distributors can also be a convenient one-stop shop. By definition, these distributors carry a broad selection of both test products and other electronics equipment, so an engineer ordering for a project will likely be able to buy all he or she needs in one order.

• **Online sales:** Both manufacturers and distributors see more and more online ordering. McLendon said more than 40% of Allied Electronics' orders come through its Website. That compares to only 10% just three to four years ago. "The test-and-measurement vendors have been quite amazed at how much of their product we sell online," he said. "They were under the impression that [no one would] buy a $10,000 oscilloscope online. But it happens every day."

Some manufacturers are recognizing the potential of this channel and are moving to take more advantage of it. For example, in the fall of 2010, Tektronix launched its own online store for US customers

• **Specialty distributors:** For medium to high-end products that require a higher level of technical competency and more personal attention, manufacturers often work with distributors that specialize in test and measurement. Entest, for example, carries Tektronix oscilloscopes with sampling rates of up to 3.5 GHz and price tags of more than $30,000, according to David Rountree, Entest's president. The distributor has its own staff of account managers and reps who have deep technical knowledge, and the company maintains an inventory of high-end demo equipment. In addition to technical sales presentations and demos, Entest provides post-sales technical support and user training.

Some manufacturers are also using particular distributors to reach particular vertical markets. Agilent uses TESSCO, for example, which focuses exclusively on the installation and maintenance of cellular base stations.

• **Franchised technology partners:** At least one vendor is forging a new type of indirect channel. In 2009, Agilent franchised 10 ATPs (Authorized Technology Partners) to sell medium to high-end products in the $25,000 to $100,000 price range, said Stonebraker. The move is a way to offer special attention to particular customers who are important but not easily served by direct salespeople. That includes key strategic customers. For example, "a particular account may not generate a tremendous amount of revenue but they are extremely influential in what happens down the supply chain," he explained. "Maybe they are deciding on what the specs will be for the next generation of wireless services."

ElectroRent, one of Agilent's largest ATPs, has the franchise covering the US and Canada. It's a hybrid model that combines "the best of both worlds," with some features of direct sales and some aspects of distribution, said Tanya Jamison, ElectroRent's worldwide director of marketing. The franchisee can provide a technically specialized, personal sales force for customers, devoting the extra attention required to forge key relationships and grow incremental sales for the vendor.

The new model has "created a lot of buzz in the market," said Jamison. "We've had a lot of interest from other manufacturers" interested in doing something similar.

Watch this channel

Despite all the recent experimentation in test-and-measurement sales channels, there may be even more changes ahead. Manufacturers and distributors are still in the early stages of figuring out what combinations work best, said Stonebraker. "This is only the third inning or so in the development of the test-and-measurement channel," he noted. "There will continue to be innovation, expansion, and in the long term, some consolidation" as the industry figures out the most-effective ways to grow sales and serve an expanding customer base. T&MW

Evaluating inertial measurement units

Some simple equations can help you evaluate the effects an IMU's error specifications will have on position, velocity, and attitude.

BY RAYMOND CHOW, EPSON ELECTRONICS AMERICA

IMUs (inertial measurement units) have expanded from their traditional military usage and are now finding wider application in industrial segments. With their more compact form factors, lower power requirements, higher stability, and better accuracy, today's IMUs give designers flexibility when they are creating inertial sensing and control applications. When you are selecting IMUs, it's important to understand how their specifications (and error sources) can affect positioning, velocity, and orientation.

Although the definition of an IMU differs slightly among vendors, for this article, I am defining an IMU as consisting of a triad angular rate sensor (gyroscope) and a triad linear acceleration sensor (accelerometer). The IMU provides three-dimensional sensor data to an external system to describe the IMU body's spatial behavior and motion without an external reference. I am also assuming the IMU contains additional intelligence and integrated electronics to provide calibration, compensation, and digital processing; this is in contrast to an ISA (inertial sensor assembly), which consists only of a cluster of sensors with a fixed orientation relative to each other.

An IMU is a critical component of advanced inertial sensing subsystems such as AHRSs (attitude heading and reference systems) and INSs (inertial navigation systems), where the IMU sensor data is processed to obtain position, velocity, and attitude. **Figure 1** shows a high-level block diagram of a typical IMU. The key components and functional blocks include:

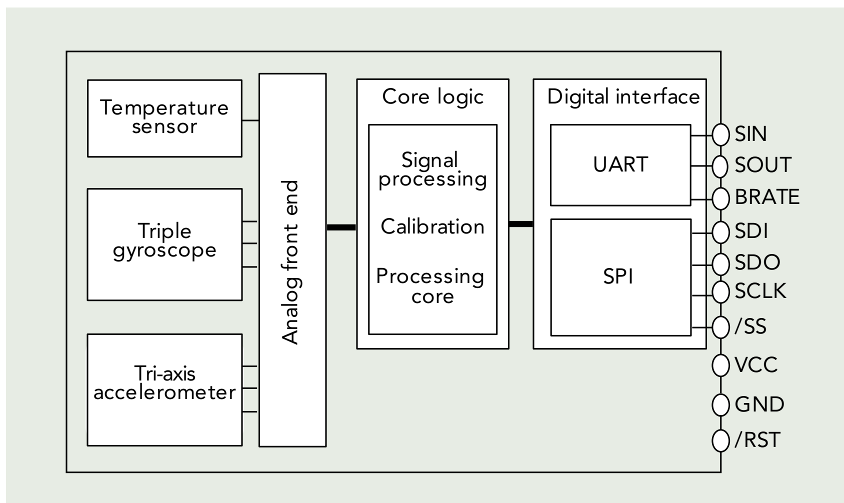


FIGURE 1. A typical inertial measurement unit includes an accelerometer, a gyroscope, and a temperature sensor, along with interfaces that connect the unit to various host systems.

- a three-axis orthogonal gyroscope and accelerometer to sense the angular velocity and linear specific force for six degrees of freedom;
- a precision temperature sensor used by the internal temperature compensation logic;
- an analog front end that filters and digitizes the sensor signal output for processing by the core logic;
- core logic, which includes digital signal filtering and sensor data enhancement through calibration, thermal compensation, and data formatting (unit conversion); and
- SPI or UART interface circuitry for open connectivity to a variety of host platforms.

Determining inertial sensor performance and calibration targets for a specific industrial application is a complex task. System-level performance may not co-relate easily to individual specification parameters, but comparing IMU specifications using unaided static error analysis to determine performance metrics is a good starting point. This selection process can help you determine if a calibrated solution is necessary, and it can also help you determine the level of quality of the IMU's calibration IP.

You must analyze a few key IMU specifications when designing with discrete inertial sensors. When using fully calibrated IMUs, you must evaluate the effect they will have on system-level position, velocity, and attitude errors. This will help you determine an IMU's cost/performance tradeoff and find an IMU that matches the system-level design goals.

Bias error, scale-factor error, noise, and bias stability—specifications that are commonly found in IMU data sheets—can have an impact when an IMU is operated in free-running inertial or orientation mode. Typically, you can compensate for these errors in an INS by using data from systems such as magnetometers, wheel encoders, other sensors, or a GNSS (global navigation satellite system). There may be times, however, when auxiliary sensor observations will be intermittent or unreliable.

To simplify my explanation of how these errors affect an IMU's operation, I will ignore the effects of temperature variation and will assume that all errors occur at a nominal temperature (25°C). Keep in mind, though, that temperature can have an adverse effect on errors from scale factor and bias. If the product will be used in wide environmental conditions, you must select an IMU with high-quality temperature compensation to help minimize thermal problems.

Bias error

Gyroscopes and accelerometers inside an IMU all exhibit some finite measured output, even under the absence of rotation or acceleration. This is called bias error, and it consists of two parts: short-term deterministic offset and long-term random drift. Here, I will focus on the short-term bias offset (for long-term bias error, see "Bias instability," below).

• **Accelerometer bias error.** Uncorrected accelerometer bias is a significant contributor to position and velocity error in navigation systems and to pitch-or-roll angle error in attitude and orientation systems. Accelerometer bias offset is measured in milli-g's (where g typically equals 9.80665 m/s^2, although it varies slightly with location).

Short-term bias-offset error shifts the acceleration vector from its true direction. This shift not only affects linear acceleration, but also, and more importantly, causes an error when the accelerometer is used to track the gravity vector. Nor-

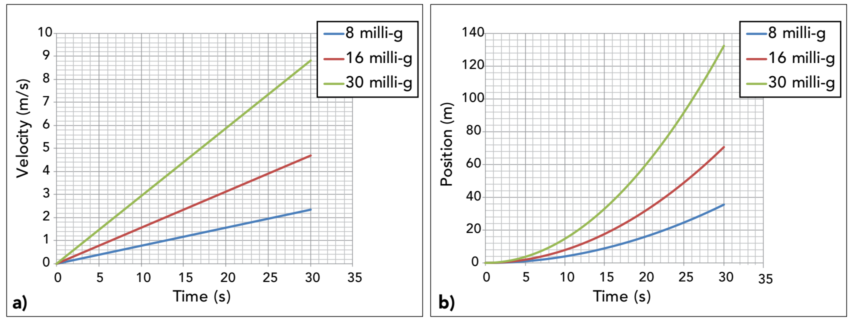


FIGURE 2. The estimated a) velocity and b) position error from gravity misalignment caused by accelerometer bias errors of 8, 16, and 30 milli-g.

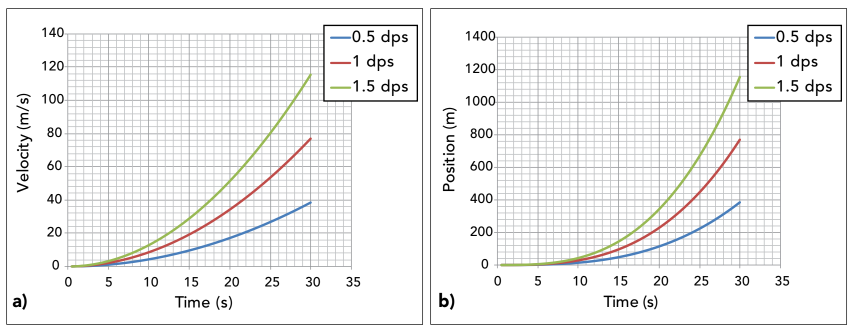


FIGURE 3. The estimated growth of a) velocity and b) position error from gravity misalignment caused by gyro bias errors of 0.5, 1, and 1.5 dps.

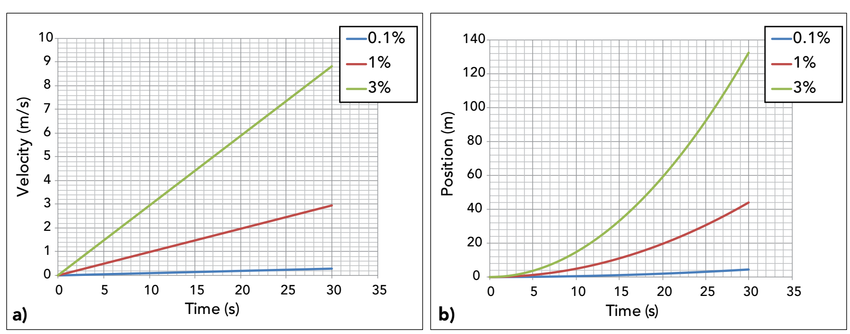


FIGURE 4. The estimated growth of a) velocity and b) position error from gravity misalignment caused by accelerometer scale-factor errors of 0.1%, 1%, and 3%.

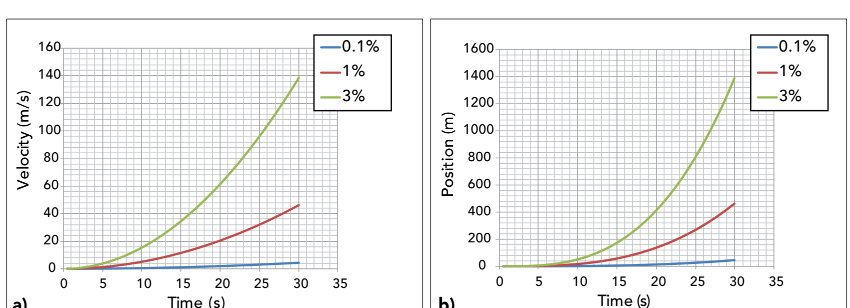


FIGURE 5. The estimated growth of a) velocity and b) position error at a 60°/s turn rate for gyro scale-factor errors of 0.1%, 1%, and 3%.

mally, the gravity vector is subtracted from the overall accelerometer output to determine the true linear acceleration of the IMU. But the residual error term from gravity detection will be integrated once producing velocity error (which increases proportionally with time), and twice producing position error (which increases proportionally with time^2).

You can estimate system-level velocity and position errors from accelerometer bias with this formula (**Figure 2**):

velocity error = (accelerator bias offset in g's) × (gravity in m/s^2) × (time in s)

position error = 1/2 × (accelerator bias offset in g's) × (gravity in m/s^2) × (time in s)^2

The accelerometer is commonly used for measuring static orientation in the horizontal plane; accelerometer bias error causes inaccuracies in measuring these pitch-or-roll angles, as you can calculate with this equation (**Table 1**):

pitch-or-roll error angle = asin(accelerator bias offset in g's)

- **Gyro bias error.** Any gyro bias offset present on the IMU output will be seen as angle error by the INS or AHRS. The angle error will increase proportionally with time when the gyro's output is mathematically integrated to produce an angle. Gyro bias offset is measured in dps (degrees per second).

The resulting angle error introduces misalignment of the IMU orientation, affecting the projection of the gravity vector and linear acceleration. This introduces velocity errors that increase proportionally with time^2, and introduces a position error that increases proportionally with time^3.

To estimate system-level velocity and position errors from gyro bias, you can use this formula (**Figure 3**):

velocity error = 1/2 × (gyro bias in dps) × π/180 × (gravity in m/s^2) × (time in s)^2

position error = 1/6 × (gyro bias in dps) × π/180 × (gravity in m/s^2) × (time in s)^3

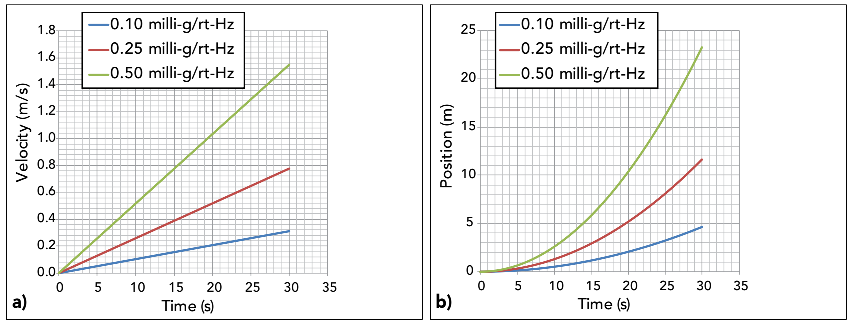


FIGURE 6. The estimated growth of a) velocity and b) position error at a 100-Hz accelerometer bandwidth for a rate-nose density of 0.10, 0.25, and 0.50 milli-g/rt-Hz.

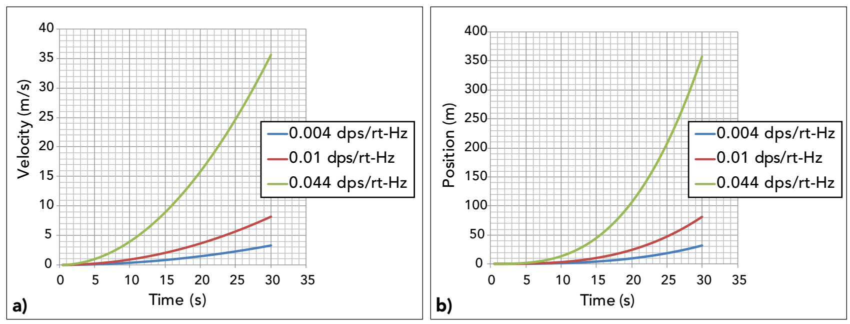


FIGURE 7. The estimated growth of a) velocity and b) position error at a 100-Hz sensor bandwidth for a rate-noise density of 0.004, 0.01, and 0.044 dps/rt-Hz.

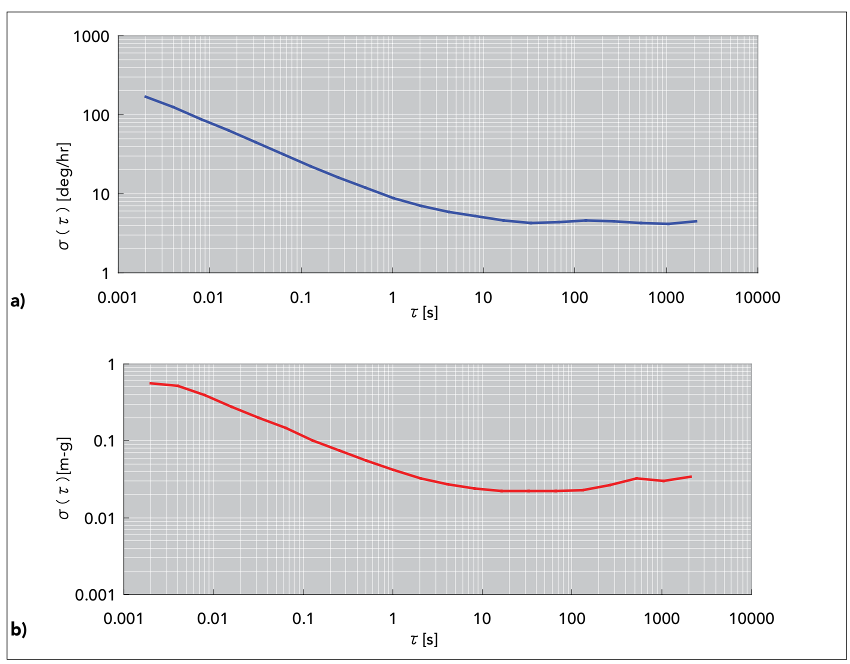


FIGURE 8. The Allan variance for a) a gyro and b) an accelerometer.

Scale-factor error

Scale factor or sensitivity is the ratio between the measured output and the change in sense input. In general, scale factor is the slope of a straight line fitted by a least-squares method on a plot of the sensor output over the full input range. Scale-factor error is the ratio of the output error (deviation from the fitted straight line slope) over the input and is typically expressed as a percentage or ppm (parts per million). In both accelerometer and gyro, the scale-factor error will usually not be as large a contributor to total error as bias error is, but you may still need to correct it.

- **Accelerometer scale-factor error.** The effect of accelerometer scale-factor error is similar to that of bias error, except that the error term increases as the input acceleration increases. Therefore, the scale-factor error effect is worse in conditions where the acceleration range is wide.

To estimate system-level velocity and position errors from accelerometer scale-factor error, use this formula (**Figure 4**):

velocity error = (accelerator scale-factor error) × (gravity in m/s^2) × (time in s)

position error = 1/2 × (accelerator scale-factor error) × (gravity in m/s^2) × (time in s)^2

Accelerometer scale-factor error will also cause inaccuracies in calculating pitch-or-roll angles; you can calculate the error (**Table 2**) with this formula:

pitch-or-roll error angle = asin(accelerator scale-factor error)

• **Gyro scale-factor error.** Gyro scale-factor error contributes significant errors to the angle tracking of the IMU during dynamic motion. The scale-factor error term is worse under large angular velocities; for example, a 0.1% scale-factor error on a 90°/s angular velocity can cause a 0.09°/s error. The effects of the resulting scale-factor error term can be treated similar to gyro bias error.

In this analysis of gyro scale-factor error, I arbitrarily assumed an angular rate of 60°/s. Then, I estimated system-level velocity and position errors from gyro bias using this formula (**Figure 5**):

velocity error = 1/2 × (gyro scale-factor error in dps) × π/180 × (gravity in m/s^2) × (time in s)^2

position error = 1/6 × (gyro scale-factor error in dps) × π/180 × (gravity in m/s^2) × (time in s)^3

Noise

Noise is the unwanted signal generated from internal electronics that interferes with measurement of the desired signal. The noise level will determine the minimum sensor output that is distinguishable from the background noise of the sensor or noise floor. Rate-noise density is specified in rms milli-g/rt-Hz (accelerometer) and rms dps/rt-Hz (gyro) and is a common spec used to quantify sensor white noise output for a given sensor bandwidth.

To estimate sensor rms noise level, determine the desired sensor bandwidth using this formula:

Table 1. Accelerator bias offset.

Accelerator bias offset (milli-g)	Pitch-or-roll error (degrees)
8	0.46
16	0.92
30	1.72

Table 2. Accelerator scale-factor error.

Accelerator scale-factor error (%)	Pitch-or-roll error (degrees)
0.1	0.06
1	0.57
3	1.72

Noise rms = noise density × √Bandwidth

where:

Bandwidth = frequency - 3 db × K_{FILTER} and K_{FILTER} = 1.57 (1st order), 1.11 (2nd order), and 1. 05 (3rd order).

In general, velocity, position, or pitch-or-roll error from the accelerometer or gyro white noise will be smaller than the other described noise sources (such as bias or scale-factor error).

• **Accelerometer noise.** The accelerometer noise will negatively affect the minimum pitch-or-roll angle resolvable and introduce velocity and position error caused by misalignment of the gravity vector.

To estimate system-level velocity and position errors from accelerometer noise, first calculate the accelerometer noise from the rate-noise density and bandwidth, and then use this formula (**Figure 6**):

velocity error = ($noise_{RMS}$ in g's) × (gravity in m/s^2) × (time in s)

position error = 1/2 × ($noise_{RMS}$ in g's) × (gravity in m/s^2) × (time in s)^2

To calculate the pitch-or-roll angle error from accelerometer noise (**Table 3**), use the following formula:

pitch-or-roll error angle = asin($noise_{RMS}$ in g's)

Table 3. Accelerator noise density.

Accelerator noise density (milli-g/rt-Hz)	Noise at 100 Hz, 2nd order (milli-g rms)	Pitch-or-roll error (degrees)
0.10	1.05	0.06
0.25	2.63	0.15
0.50	5.27	0.30

• **Gyro noise.** Gyro noise creates orientation angle errors for an INS or AHRS, which again negatively affect the projection of the gravity vector and results in velocity and position error.

To estimate system-level velocity and position errors from gyro noise, first calculate the gyro noise from the rate-noise density and bandwidth, and then use this formula (**Figure 7**):

velocity error = 1/2 × ($noise_{RMS}$ in dps) × π/180 × (gravity in m/s^2) × (time in s)^2

position error = 1/6 × ($noise_{RMS}$ in dps) × π/180 × (gravity in m/s^2) × (time in s)^3

Bias instability

Bias instability of the gyro or accelerometer is the random variation in the bias (due to 1/f noise) computed over a specified sample time and averaging time interval. The bias instability is expressed in degrees per hour for the gyro, and m/s^2 or milli-g for the accelerometer.

This parameter provides the benchmark of the best that is achievable for a selected gyro or accelerometer in terms of bias variation for a fully modeled sensor without "aiding" from other sources. Lower bias instability will lead to lower orientation, position, and velocity errors from the IMU. Bias instability is obtained by plotting an Allan-variance chart for a stationary gyro or accelerometer. As the averaging time increases, the noise output decreases and slopes downward until it reaches a minimum point and begins to increase again and slope upward. The minimum point on the graph is the bias instability.

Figure 8 shows the root Allan-variance graph for the gyro and accelerometer. To determine the bias instability, find the lowest point on the graph, and read the corresponding value on the vertical axis. The value returned is ~4.5°/hr and 25 micro-g. The bias instability will vary slightly from sample to sample and typically is stated for one standard deviation. T&MW

Raymond Chow *is an applications engineer for Epson Research and Development, Vancouver Design Center, providing technical support for Epson Electronics America and its line of IC sensing devices and sensing systems. Chow has experience in systems integration and circuit design of sensor, display, and imaging subsystems.*

PXI aids green revolution

By Richard A. Quinnell, Contributing Technical Editor

National Instruments has initiated a program to support developers who are trying to make the world a little greener. The company's Green Engineering Grant Program is open to developers of alternative-energy, energy-saving, and smart-grid energy-management systems. I spoke with Brian MacCleery, principal product manager for Clean Energy Technology at NI, to learn how the program gives a boost to developers.

Q: What does this grant program do?
A: The goal of the NI Green Engineering initiatives is to make heroes out of people doing important things to help the environment and create jobs by advancing clean-energy and energy-efficiency technologies. The grant program helps small companies get their green initiatives off the ground by awarding up to $25,000 in NI software and training.

Q: What prompted NI to create this program?
A: NI has been involved in green energy for a long time. Over the years, green energy has become one of the fastest-growing areas in the energy industry. What we have seen, though, is the importance of getting a prototype up and running quickly so the start-up company can move to the next stage of funding and commercialization.

Q: What role does the program play in helping green-engineering start-ups?
A: If you can't measure something, it's really hard to fix it, so engineers who have access to state-of-the-art instrumentation and embedded-system design tools are in a better position to succeed. Getting access to these tools may not be in the budget, though, when a development project is just starting out. The grant program was developed to help take down that barrier.

Q: How is the program progressing?
A: We started the program in 2010 and have awarded more than 40 grants since that time, a commitment of more than $900,000 in software and training by NI.

Q: How are recipients selected?
A: The details of how we evaluate applicants are confidential, but some of the big questions are "Will the grant play a significant role in getting the project moving?" and "Is NI technology a good fit for their needs?"

Q: Can you give examples of grant winners?
A: The Italian company KITEnergy is working on a technology called airborne wind turbines. These are a new type of wind turbine that uses tethered airfoils cabled to the ground rather than spinning blades to generate power. A kite or aircraft-like wing pulls out a cable that turns the electricity generator. The company is using PXI in the control system that steers the kite to maximize energy production.

Another interesting winner is Xtreme Power, which is developing a grid-level energy-storage system called Dynamic Power Resource. The system stores megawatts of energy that it can return to the grid almost instantaneously to level out the fluctuations in power output for wind- or solar-power systems. The company uses PXI in the monitoring and control systems to regulate the direction and amount of power flow from the storage system.

Q: What is the program's future?
A: The 2011 program ends in early November. A 2012 program has not yet been announced, but based on the success of the grant award companies, there is a strong case for continuing it. It has been a "win-win" for the grant winners, clean-tech jobs, and the environment. And when one of these start-ups breaks away to become a billion-dollar green-engineering company, NI technologies will already be baked into their designs. □

Brian MacCleery
Principal Product Manager for Clean Energy Technology
National Instruments

INSIDE THIS REPORT

EDITOR'S NOTE

Surprising synchronicity

By Richard Quinnell
Contributing Technical Editor

It is fascinating to watch how technologies advance, particularly how developments in one area end up being the key to advancements in another. USB is one example (see my September column). An interface created to reduce the confusion of cables at the back of a PC is fostering a new generation of modular test equipment.

The use of PXI for RF test (p. 42) represents not quite as large a jump, but it still shows how surprising the links between technologies can be. When I started covering PXI, it was assumed that the digital noise of a bus-based test system would make high-precision RF measurement impractical. Also, the space and power limits in PXI seemed likely to prevent the development of any significant RF functionality. There was no real motivation in the test industry to miniaturize RF components.

There *was* such motivation in the cellular telephony industry, however. To get from the boxy phones we once used to the shirt-pocket devices of today required a lot of effort and funding fueled by consumer demand. Test R&D is hard pressed to find the level of sponsorship that consumer devices generate.

But test R&D can be a beneficiary, and has been. Cellular component technologies have been key to bringing high-performance RF to PXI. Such unplanned spin-outs seem to occur frequently in technology, leaving us all wondering what other surprises await. □

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

HIGHLIGHTS

PXI 3000 series gains RF digitizer

Aeroflex has expanded its PXI 3000 series of RF modular instruments with the introduction of the 3036 RF digitizer. The three-slot module, which has a frequency range extending to 13 GHz, can be used in vector signal analysis of complex RF signals. Aeroflex says the 3036 provides wide instantaneous bandwidth, fast frequency switching, high linearity, and low noise.

The RF digitizer operates over 250 kHz to 13 GHz, with up to 90-MHz-wide digitized –1-dB bandwidth and 13-bit ADC resolution. It supports high-speed frequency switching in less than 325 µs. The 3036 can be used with a single-slot Aeroflex 3010 synthesizer module to provide precision conversion of RF signals into digital IF or I and Q sample data. Aeroflex's PXI Studio software comes standard with the 3036. www.aeroflex.com.

Agilent adds entry-level PXI DMM

Joining Agilent Technologies' family of PXI-based DMMs is the M9181A, a $995 module that measures parameters such as DC voltage, DC current, AC voltage, AC current, and two-wire and four-wire resistance. It offers basic one-year measurement accuracies of 90 ppm for DC voltage and 800 ppm for AC voltage.

Each PXI DMM ships with a suite of software designed to ease system integration. The DMMs also include IVI-COM, IVI-C, and LabView drivers that are compatible with C++, Visual Basic, LabView, and other PC software environments. www.agilent.com.

SPDT switch available on USB stick

Telemakus has release the USB-controlled TES7000-50 SPDT switch. The 1-oz, thumb-sized switch, which operates from 100 MHz to 7 GHz with <3 dB of insertion loss and 50 dB of isolation at 4 GHz, handles up to 24-dBm CW input power (29-dBm pulsed). A built-in pulse function allows users to select the pulse width and period from 250 ns to 8 s.

SMA connectors on the device enable users to cascade multiple accessories into customized configurations. The unit's flash memory contains the installation files for Windows XP or Vista. www.rfmw.com.

VXI-to-PCIe interface moves 40 Mbytes/s

With the ProDAQ 3026 interface module from Bustec, you can make a direct connection from a PC to a VXIbus mainframe. The single-slot, C-size VXI slot-0-to-PCI Express module can be used to replace legacy VXI interfaces, providing low latency and a throughput of up to 40 Mbytes/s.

The controller supports PCI Express hot-plug operation, which allows you to power up a host PC simultaneously or independently from any VXI chassis. Unlike interfaces that require you to power down a host PC before turning off a VXI chassis, the ProDAQ 3026 lets you power off any VXI chassis to interchange instruments without having to first shut down the PC.

Up to two ProDAQ 3026 units can be connected directly to the ProDAQ 3261 PCI Express host interface card, which fits into a standard PCI Express X4 slot in a desktop or server computer. For computers that have only PCI bus slots, the ProDAQ 3262 provides a PCI-to-PCI Express bridge that fits into a standard PCI slot and also allows up to two ProDAQ 3026 units to be connected. www.bustec.com.

With more flexibility and better performance, you're ready for the future.

The future of modular test is faster and more flexible. PXI Gen 2 lets you download entire waveforms in a quarter of the previous time and handle the most data-intensive streaming applications.

The all hybrid slots give you the flexibility to mix new or existing modules in a variety of PXI and PCI formats. Now you're ready for the future.

That's thinking ahead. That's Agilent.

Feature	Agilent M9018A	National Instruments PXI-1075
Hybrid slots	16	8
Throughput to system slot	8 GB/s	4 GB/s
Power	859 W	791 W
Price* (with cabled I/O to computer)	$9,585	$8,098
Price* (with above plus trade-in)	$7,485	N/A

National Instruments: PXIe-1075 User Manual, July 2008, 372437A-01 and 2008-9905-501-101-D Data Sheet

Discover the Alternatives...
...Agilent **Modular** Products

PXI

Compare and Trade In.
www.agilent.com/find/flexiblePXI

*Agilent prices are USD and subject to change.

u.s. 1-800-829-4444 canada 1-877-894-4414

Agilent Technologies

PXI answers the call for communications test

By Richard A. Quinnell, Contributing Technical Editor

When PXI first appeared in the late 1990s, few believed that it would ever be useful in RF test. Now, PXI modules are offering RF performance comparable to many box instruments. This performance coupled with PXI's flexibility and modularity is turning PXI into a preferred solution for communications test.

Improvements in PXI's RF performance have been surprisingly rapid, especially in the last few years. "In 2009, PXI was at the midrange of available RF instruments," said David Hall, product manager for RF and wireless at National Instruments. "PXI is now at the top end and can do almost everything that a traditional rack-and-stack instrument can." NI's recent release of the PXIe-5665 RF vector signal analyzer, with an input frequency range up to 14 GHz, is an example. The company asserts that the module has industry-leading dynamic range and phase-noise specifications that show PXI can hold its own among RF test instrumentation, regardless of form factor. "This puts a resounding nail in the coffin of old beliefs about PXI and RF," said Hall.

PXI's rise in RF capability has been due in part to the advances in component miniaturization coming out of the communications industry, which have made it easier to fit RF circuitry into PXI's small form factor. It seems only fair, then, that PXI is now returning the favor and addressing the needs of communications test. Increases in modulation complexity, the rise of multichannel signaling, and the dynamic nature of communications standards are all complicating the development of dedicated-box test instruments. They are also playing right into PXI's strengths: modularity and flexibility.

Consider the example of multichannel signaling. Cellular communication standards such as LTE and wireless networking standards such as IEEE 802.11n and 802.11ac use MIMO (multiple input, multiple output) techniques to increase link capacity. Transmitters and receivers must handle from two to as many as eight independent antennas, sometimes operating at independent frequencies.

Simulating and analyzing multichannel operation is a complex task. "MIMO test is not as simple as putting multiple instruments together," said Jim Litz, product manager for Agilent Technologies' N7109A multichannel signal-analysis system. "You need phase and time-domain synchronization among the test channels."

NI's Hall agreed, noting "Traditional signal generators and analyzers are designed to be stand-alone instruments and don't readily share timing and synchronization. It's difficult, though possible, to sync, say, four generators, but it's virtually impossible to sync four analyzers."

Hall pointed out that PXI, however, is designed to allow the sharing of sync signals, timing, local oscillators, triggers, and the like. Further, the modularity of PXI allows the test system to handle the multiple variations of MIMO technology in use today, such as 2x2, 2x4, 4x4, and 8x8. Modularity will also simplify test system expansion to accommodate technologies such as 16x16 MIMO as they become available.

Software provides flexibility

Because of its software-defined functionality, PXI is especially useful in handling rapidly evolving communications standards and the fast-paced communications market. "Software products such as Agilent's SystemVue for PXI are important for helping keep pace with changing standards," said Jung-ik Suh, Agilent's wireless marketing program manager. "LTE is now deployed at Release 9, and Release 10 (LTE-Advanced) deployment is coming. Meanwhile, the standards committee is working on Release 11."

Instruments such as this 14-GHz vector signal analyzer have proven the viability of PXI for high-end RF communications test applications.

Courtesy of National Instruments.

Even well-established communications standards continue to evolve. NI's Hall pointed to the advent of carrier aggregation (using two channels in parallel) in second-generation cellular systems as an example.

The software foundations of PXI-based test are also helpful when standards are not yet finalized. "Sometimes a developer, such as a chipset vendor, cannot wait for a specification to be set before getting started. Software allows them to start testing even before specs are fixed," said Jung-ik.

PXI's software-based functionality is also ideal for testing increasingly complex communications devices. Tim Carey, PXI product manager at Aeroflex, said, "We are seeing higher levels of integration in handsets and even single silicon, with designs combining wireless LAN, Bluetooth, GPS, FM, and a range of cellular standards in different frequency bands. Rather than use different instruments or re-tune one instrument to each of these standards, PXI allows testing all of them with a single instrument." Aeroflex's PXI Studio application software, for instance, works with all Aeroflex 3000-series PXI modules to handle GSM, CDMA, LTE, WLAN, and Bluetooth wireless test, and the company has recently added FM and ZigBee to the mix.

PXI's modularity simplifies the testing of MIMO communications by supporting synchronized operation of analyzers, as in the N7109A multichannel signal-analysis system.

Courtesy of Agilent Technologies.

Streaming aids data capture

With the advent of PXIe (PXI Express) came another valuable attribute for communications test: the ability to capture data for long periods of time. "Long measurement times are the holy grail of test," said Jean Dassonville, Agilent's digital wireless program manager. "For transient and one-time events, you have to make your measurement at the right time, but you don't know when that is."

PXIe, which supports the high-speed streaming of data to storage, has made it easier for engineers to capture data at the right time. Agilent, for instance, recently introduced streaming capability for its M9392A PXI vector signal analyzer and M9202A digitizer, which allows continuous capture of 100-MHz bandwidth data at frequencies up to 26.5 GHz. RAID arrays allow storage of up to 13 hr of data. Such capabilities allow communications test engineers to continually monitor devices under test and ensure they capture the time period when a fault occurs, even if the error does not become immediately evident.

PXI speeds manufacturing test

PXI is meeting many development-test needs in communications, but where it really shines is in manufacturing test. "PXI has automation and control as its focus," said Carey of Aeroflex, "and its modularity allows it to scale and adapt, making it an ideal solution for addressing current and next-generation production test in communications."

Modularity also addresses the need for speed in manufacturing test. "Test time is acutely important at component-level test," Carey added. "Ideally, you want to be able to test within the pick-and-place time of handlers—a few hundred milliseconds."

But as NI's Hall pointed out, in communications, test times are getting longer as each new technology uses increasingly complex modulation types. "With GSM, we could make all our tests in under 5 ms," said Hall. "With WCDMA, it became more like 25 ms, and with LTE, nearly 100."

"Speed of measurement involves several factors," said Agilent's Dassonville, "including hardware architecture and processing time. PXIe provides a big highway for data transfer from hardware to controller, and PXI allows a choice of high-performance controllers for the processing. Some measurement can also be accelerated using special FPGA modules for DSP."

Hall added, "With PXI, you can continue to upgrade your test equipment as CPUs evolve. Every two to three years, you can cut measurement times in half due to CPU evolution. That's traditionally not true in a dedicated box."

Many challenges still remain for PXI in communications test, however. "Frequency ranges for emerging standards are starting to push the envelope for PXI," said Carey. "Some go as high as 60 GHz. Communications bandwidth is another factor. With 3G cellular, you have a 10-MHz channel bandwidth, but new standards are starting to push up to 2 GHz. This is making wideband phase noise important, and providing both bandwidth and phase-noise performance is a challenge."

Customers demand applications

In addition to the challenges they face in developing hardware, PXI equipment vendors also face an increasingly difficult challenge in developing software applications for their customers. "Tools such as LabView let users do a lot with their PXI equipment," said Agilent's Litz, "but what they want are complete application packages."

"It's necessary for us to keep up to speed with the standards," added NI's Hall, "and it's a substantial R&D investment to develop applications test software in house. Software development ends up being a handshake between standards bodies, lead customers, and us."

The software environment is also become more complex. Carey explained that "PXI modules started out under Windows, but the market is not all about Windows anymore. Also, processors have moved to 64-bit operation. So, now our software needs to be compatible with a variety of operating systems. PXI is intertwined with

Software such as PXI Studio allows engineers to use a single test setup to perform tests for multiple communications standards. Courtesy of Aeroflex

the system controller, and its software needs to be native to the operating system the controller is running."

Software challenges may also be chipping away at the open architecture benefits of PXI. "It's one thing to pick modules out of a catalog and wrap software around it," said Agilent's Litz. "It's another thing altogether to have that work as a fully integrated system. You can spec a single module, but how do you spec the combination?" For this reason, Litz added, equipment vendors like Agilent are trying to offer entire packages for communications test.

But these challenges are not slowing PXI's movement into communications test. If anything, PXI vendors are expanding their RF capabilities. NI, for instance, this year acquired both AWR (an RF EDA tool vendor) and Phase Matrix (a developer of RF equipment) to help extend its product offerings into higher frequencies.

And PXI's scalability and adaptability, with the lowered costs they bring, will ensure a bright future for PXI in communications manufacturing test. "There are billions of dollars in single-box capital equipment out there that will not go forward to handle next-generation communications," said Aeroflex's Carey. PXI stands ready to answer the call for equipment that can evolve with the need. □

FOR MORE INFORMATION

Quinnell, Richard A., "User-configurable FPGA modules boost PXI system versatility, " *PXI Test Report, Test & Measurement World*, May 2010. www.tmworld.com/2010_05.

Statement of Ownership, Management, and Circulation for Test & Measurement World, November 2011 (required by 39 USC 3685)

1. Publication Title: Test and Measurement World. 2. Publication Number: USPS 660-730. 3. Filing Date: September 20, 2011. 4. Issue Frequency: Monthly except January. 5. No. of Issues Published Annually: 11. 6. Annual Subscription Price: $150. 7. Complete Mailing Address of Known Office of Publication: UBM LLC, 600 Community Drive, Manhasset, Nassau County, NY 11030-3875. 8. Complete Mailing Address of Headquarters or General Business Office of Publisher: UBM LLC, 600 Community Drive, Manhasset, NY 11030-3875. 9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor: Publisher: Bob Dumas, UBM LLC, 600 Community Drive, Manhasset, NY 11030-3875; Editor: None; Managing Editor: Deborah M. Sargent, UBM LLC, 33 Hayden Ave, Lexington, MA 02421. 10. Owner: UBM LLC, 600 Community Drive, Manhasset, NY 11030-3875; UBM PLC, Ludgate House, 245 Blackfriars Road, London SE1 9UY, UK. 11. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities: None. 12. (Must be completed if the publication title shown in item 1 is a publication published and owned by a nonprofit organization). The purpose, function and nonprofit status of this organization and the exempt status for federal income tax purposes: Has Not Changed During Preceding 12 Months. 13. Publication Title: Test and Measurement World. 14. Issue Date for Circulation Data: October 2011.

	Average No. of Copies Each Issue During Preceding 12 Months	Actual No. of Copies of Single Issue Published Nearest to Filing Date
Total number of copies (net press run)	40,833	39,153
Paid and/or requested distribution:		
Outside County paid/requested mail subscriptions stated on PS Form 3541	38,058	36,332
In-County paid/requested mail subscriptions stated on PS Form 3541	0	0
Sales through dealers, carriers, street vendors, counter sales, and other paid or requested distribution outside USPS	1759	1716
Requested copied distributed by other mail classes through the USPS	0	0
Total paid and/or requested circulation	39,817	38,048
Nonrequested distribution		
Outside County nonrequested copies stated on PS Form 3541	439	417
In-County nonrequested copies stated on PS Form 3541	0	0
Nonrequested copies distributed through the USPS by other classes of mail	0	0
Nonrequested copies distributed outside the mail	127	400
Total nonrequested distribution	566	817
Total distribution	40,383	38,865
Copies not distributed	450	288
Total distributed and not distributed	40,833	39,153
Percent paid and/or requested circulation	98.60%	97.90%

I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).

(Signed) Ken Bundy, Controller

Agilent introduces 67-GHz nonlinear VNA

Agilent Technologies has expanded the bandwidth of its PNA-X NVNA (nonlinear vector network analyzer) to 67 GHz and has also introduced a 67-GHz phase-reference calibration standard. With the Advanced Design System software option, the NVNA measures what Agilent calls X-parameters—a category of nonlinear network parameters for deterministic, high-frequency design that you can use to characterize a component's linear and nonlinear behavior.

The instrument's phase reference generates a comb of frequencies from 10 MHz to 67 GHz with a known cross-frequency phase relationship traceable to the National Institute of Standards and Technology. This relationship calibrates the NVNA to measure spectra to 67 GHz with a predictable cross-frequency phase.

With this capability, you can characterize X-parameters of active components like transmit and receive modules when you need to measure and predict harmonic content and distortion to 67 GHz. Characterizing a module's nonlinear behavior requires measurement up to the third harmonic (60 GHz), with a converter downconverting a 65-GHz signal to an intermediate frequency of 500 MHz.

Prices: NVNA and phase-reference calibration standard—$37,512. *Agilent Technologies, www.agilent.com.*

AutoBuzz simplifies boundary-scan test

JTAG Technologies has added the AutoBuzz tool to its line of boundary-scan test and debug products. Unlike products that require a netlist, AutoBuzz uses a "seek and discover" feature to scan a compliant design and perform comparative boundary-scan tests.

With boundary-scan-chain information and the BSDL models of boundary-scan (IEEE 1149.1) compliant parts, users of AutoBuzz will be able to connect to their designs via a number of interface options. AutoBuzz can then gather a complete "connectivity map" of any board's boundary-scan-to-boundary-scan pin connections.

In its Learn mode, AutoBuzz samples a known-good printed-circuit board to establish a reference connectivity map. In its Compare mode, AutoBuzz scans suspected faulty boards and compares their connectivity maps to that of the known-good board. Differences in the maps are highlighted to indicate possible faults.

JTAG Technologies expects the tool to be useful in repair and service centers as well as other debug facilities. AutoBuzz currently supports several interfaces: Altera's USB Blaster, Xilinx's parallel III/IV and USB interfaces, and JTAG Technologies' JT 3705/USB controller and JTAGLive dedicated USB controller.

JTAG Technologies, www.jtaglive.com.

FSW analyzer shows multiple measurements in single window

The new R&S FSW signal and spectrum analyzer from Rohde & Schwarz is available in three models that cover frequency ranges from 2 Hz to 8 GHz, 13 GHz, or 26.5 GHz. It comes in 80- and 160-MHz bandwidth versions and is designed to meet the requirements of development laboratories in the aerospace, defense, and communications industries.

A MultiView function enables the 12.1-in. touchscreen to display the results of different applications at the same time, so users can keep track of even the most complex signal analyses and find errors. At 10-kHz carrier offset, the R&S FSW achieves a phase noise specification of less than –137 dBc (1 Hz).

When equipped with the R&S FSW-K6 option, the R&S FSW can analyze pulsed signals for applications such as radar. Its analysis bandwidth of up to 160 MHz allows the instrument to measure wideband, hopping, and chirp signals, making it useful for wireless standards such as IEEE 802.11ac.

Rohde & Schwarz, www.rohde-schwarz.com.

AT4 system enables LTE design verification

The T4010 DV from AT4 wireless is an LTE RF test system for design verification that allows users to create or customize dedicated RF parametric test cases based on configurable test methods. It also furnishes a set of test cases following the 3GPP 36.521-1 test specifications to perform preconformance testing of LTE UE designs.

Used early in development, the T4010 DV lets you verify the RF characteristics of a design and avoid costly redesigns and modifications at later stages. It supports both FDD and TDD, providing test coverage for all existing 3GPP bands up to 3 GHz without hardware upgrades. In addition, AT4 claims that the system's L1 logging capabilities enable straightforward debugging of implementation issues.

AT4 Wireless, www.at4wireless.com.

Analyzer tackles DDR3 memory integration

LeCroy has upgraded the software for its Kibra 380 standalone DDR3 protocol analyzer to improve the system's ability to resolve memory-integration problems. In addition to providing DDR3 bus and JEDEC timing analysis, the Kibra 380 now supports LRDIMM testing. The new software provides enhancements designed to accelerate navigation, timing measurements, and waveform analysis. An overlay mode allows all signal lines to be floated for easy visual comparison. With LRDIMM support, the Kibra 380 system can be used to test higher-density memory systems. And a new CrossSync framework allows LeCroy's other analyzer platforms to be synchronized to provide a time-aligned display of protocol traffic across different buses.

The portable Kibra 380 can be controlled through a Windows-based PC, and it includes interposer probes that can monitor two slots of quad-rank DDR3 DIMMs operating at data rates of up to 1600 MT/s. The instrument uses dedicated triggering logic to identify over 65 unique JEDEC command and timing violations in real time.

LeCroy, www.lecroy.com.

Online calibration-management system gets a facelift

Version 5.1.5 of Calweb, the Tektronix online calibration-management system, adds a graphical dashboard for easier asset management. With Calweb, users can manage their instrument inventory, monitor the progress of each service event performed by Tektronix, maintain an online history of calibrations and repairs, and review future calibration requirements.

The new dashboard provides graphic indicators, lists, and charts. A drill-down capability lets users move seamlessly from analysis at the enterprise level down to individual pieces of equipment.

Engineers can use Calweb to learn whether the calibration of an individual asset is up to date, past due, or in compliance with corporate policies. The dashboard offers a live stream of service-event updates, and the information can be downloaded to an Excel spreadsheet for presentation and reporting.

Tektronix, service-solutions.tektronix.com.

Linescan cameras operate to 65°C

Teledyne Dalsa has increased the operating temperature of its Spyder3 Camera Link and GigE Vision-compliant dual-line-scan cameras from 50°C to 65°C. The cameras also feature an improved graphical user interface, simplifying the setup of exposure times, trigger modes, and gain setting.

Spyder3 cameras are available in monochrome and color versions with resolutions of 1k, 2k, and 4k pixels, as

well as line rates to 68 kHz. Other features include programmable gain and offset, selectable high and low sensitivity modes, and flat-field correction.

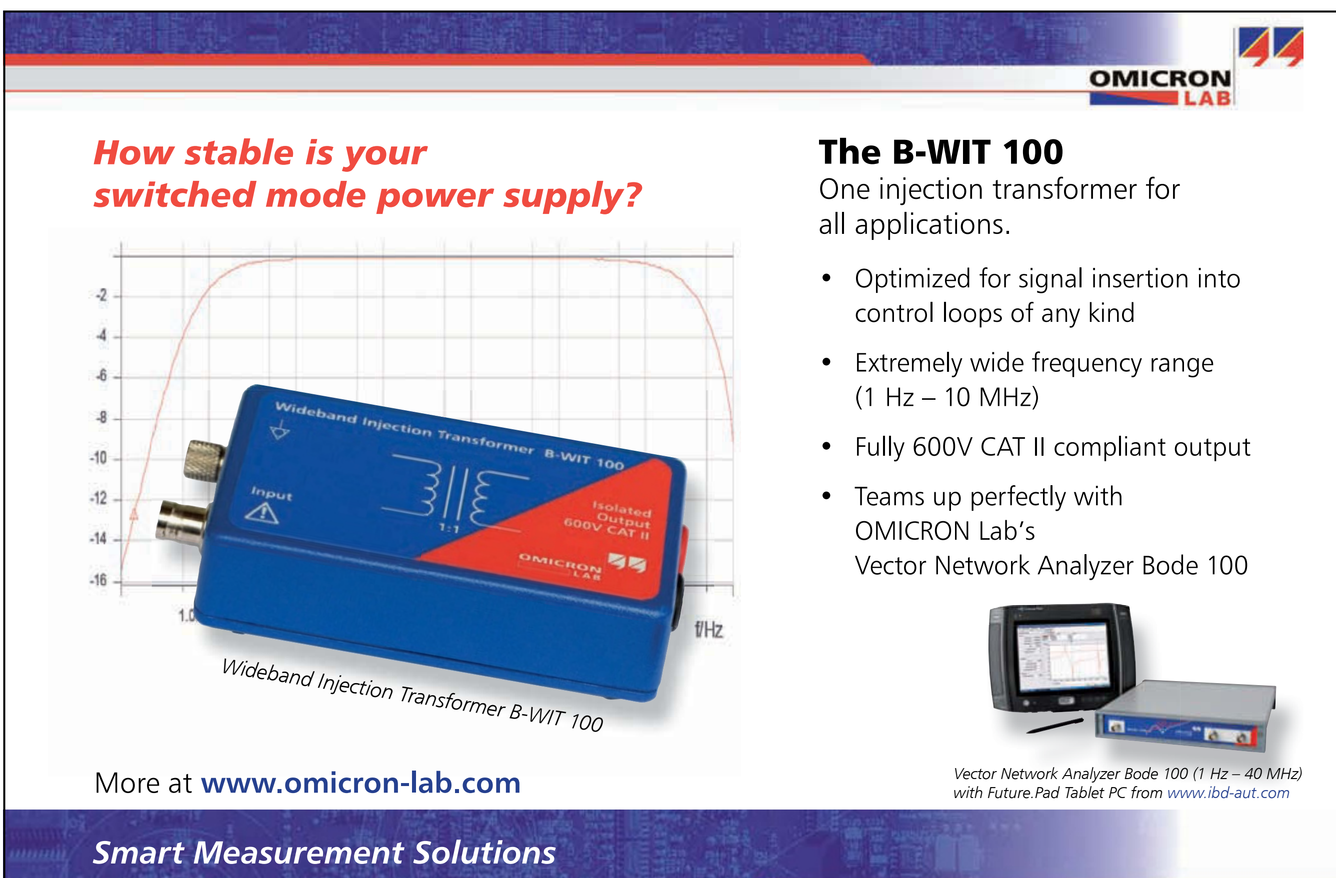
Teledyne Dalsa, www.teledynedalsa.com.

Corelis customizes JTAG hardware for Teradyne ICTs

Corelis has created a JTAG hardware platform that integrates boundary-scan test patterns into Teradyne ICTs (in-circuit testers). The USB-1149.1/CFM (custom functional module), which is designed for use with the Teradyne TestStation and GR228X series testers, is a single-slot board that installs directly into a Teradyne CFB (custom functional board).

By employing the USB-1149.1/CFM with the Corelis ScanExpress family of JTAG software, users of the Teradyne systems gain boundary-scan test support at a clock rate of 100 MHz; JTAG test-vector reusability across multiple manufacturing test stations; the ability to test IEEE 1149.6 AC-coupled digital networks; the ability to perform in-system programming of CPLD and flash devices, including direct SPI and I2C support; automated boundary-scan test-vector generation and execution; and a script engine to customize boundary-scan tests.

Corelis, www.corelis.com.



Test & Measurement World

BUSINESS STAFF

Senior Vice President, UBM Electronics:
David Blaza, david.blaza@ubm.com

Vice President of Sales:
James Corcoran, james.corcoran@ubm.com

Brand Director:
Jim Dempsey, jim.dempsey@ubm.com

Vice President of Partner Services & Operations:
Barbara Couchois, barbara.couchois@ubm.com

Senior Director, Interactive Media:
Laura Lang-Dacus, laura.lang@ubm.com

Interactive Media Manager:
Stephaney McGinnis, stephaney.mcginnis@ubm.com

Vice President of Marketing:
Felicia Hamerman, felicia.hamerman@ubm.com

Marketing Manager, Brands & Programs:
Melanie Perreault, melanie.perreault@ubm.com

Marketing Project Manager:
Esther Aronov, esther.aronov@ubm.com

ADVERTISING SALES

Eastern and Central US; Canada:
James Leahey, 262-656-1064; james.leahey@ubm.com

CA, CO, TX, and Northwest US:
Donna Marlett, 310-445-4213; donna.marlett@ubm.com

Germany, Austria, Switzerland:
Adela Ploner, Schondorf am Ammersee, Germany.
+49-8192-933-78-22; adela@ploner.de

PRODUCTION STAFF

Senior Vice President, Strategic Development and Business Administration: Pat Nohilly

Senior Vice President of Manufacturing:
Marie Myers, marie.myers@ubm.com

Senior Distribution Director:
James Pizzo, james.pizzo@ubm.com

Production Director:
Donna Ambrosino, donna.ambrosino@ubm.com

Production Manager:
Robert Steigleider, robert.steigleider@ubm.com

VOL. 31, NO. 10

Subscription Policy: Test & Measurement World® (ISSN 0744-1657) is published monthly except January by UBM Electronics, 600 Community Dr., Manhasset, NY 11030-3825. Periodicals postage paid at Manhasset, NY, and additional mailing offices. SUBSCRIPTIONS: Free to qualified subscribers as defined on the subscription card. Rates for nonqualified subscriptions, including all issues: 1 yr. $150, 2 yrs. $250, 3 yrs. $300. Except for special issues where price changes are indicated, single copies are available for $10 (US orders) and $15 (foreign orders). Buyer's Guide issue is available for $35 (US orders) and $40 (foreign orders). For telephone inquiries regarding subscriptions, call 847-559-7597. E-mail: tmw@omeda.com. CHANGE OF ADDRESS: Notices should be sent promptly to P.O. Box 47461, Plymouth, MN 55447. Please provide old mailing labels as well as new address. Allow two months for change. NOTICE: Every precaution is taken to ensure accuracy of content; however, the publishers cannot accept responsibility for the correctness of the information supplied or advertised or for any opinion expressed herein. **POSTMASTER: Send address changes to Test & Measurement World, P.O. Box 47461, Plymouth, MN 55447. Canada Post: Publications Mail Agreement 40612608. Return undeliverable Canadian addresses to: BleuChip International, P.O. Box 25542, London, ON N6C 6B2.** Printed in U.S.A.

ADVERTISER INDEX

DAVID HEARD
President
Communications Test & Measurement
JDS Uniphase
Milpitas, CA

David Heard was named president of JDSU's Communications Test & Measurement business segment in 2010. His 20-year career in the communications field includes 10 years with AT&T/Lucent, where he managed development of 3G wireless solutions. As president of the Tekelek/Santera Systems switching division, Heard established the company as a VoIP gateway supplier. Among other positions, he was COO of BigBand Networks, director of Somera Communications, and co-founder of Zyvex Performance Materials. Heard holds an MS in management from Stanford University, an MBA from the University of Dayton, and a BS in production and operations management from The Ohio State University.

Contributing editor Larry Maloney conducted an e-mail interview with David Heard on trends in communications test.

Demand heats up for communications test

Q: Could a "double-dip" recession dampen growth in communications test?

A: We believe that fundamental end-market drivers for our products remain strong for the long term, though we are not immune to current economic conditions in the US, Europe, and other global markets. While economic markets may slow, consumer demand for broadband services is rising rapidly with the proliferation of smartphones and tablets.

Q: What have been the chief growth drivers for JDSU's communications test business?

A: Since 80% of our business directly supports the rising demand for bandwidth globally, our growth is linked to enabling mobile broadband and helping providers ensure a quality experience for the end user. Our customers rely on JDSU solutions to quickly and reliably deploy new services and network technologies, while reducing costs with remote test solutions. Innovative test products have also been a key growth driver. Network solutions introduced in the last two years comprised 52% of our business unit's revenue in the fourth quarter of fiscal 2011.

Q: What progress are telecom companies making in implementing 4G/LTE networks?

A: In the US, Verizon, AT&T, and Sprint are spending billions of dollars to build their 4G/LTE networks and offer consumers these high-speed services. While deployments vary by carrier, it is expected that 81 LTE networks will be in commercial service by the end of 2012.

Q: Can you briefly describe some key test products that JDSU offers to network operators as they deploy next-generation networks?

A: Our products enable service providers to test their LTE networks during all stages of deployment—from network trials to deployment to service assurance. For example, JDSU's Signaling Analyzer Real Time LTE test solution provides fast, accurate, and reliable performance monitoring. In addition, our accessLTE service-assurance solution supports mobile service quality. Similarly, JDSU provides Ethernet service operators with testing solutions that monitor their entire network. For example, SAMComplete (Service Activation Methodology) enhances our comprehensive suite of automated field-test solutions for Ethernet network service activation. SAMComplete gives industry a bundled test solution, from basic link and customer services verification to troubleshooting in the field.

Q: What are the chief challenges in preserving service quality as network providers move to faster, higher-bandwidth networks?

A: With these new networks, service providers must ensure quality and consistent performance in the face of unpredictable data traffic and increasing stress on the network backbone. Providers deploying 100G Ethernet networks also face challenges resulting from data distribution over multiple channels. JDSU continues to enhance its suite of 100G testers for component developers, network equipment companies, and service providers. For instance, our Multi-Port test module for the ONT-600 supports development of next-generation optical network elements that deliver carrier Ethernet, optical transport networks, and 100G services. The ONT-600 platform maximizes scalability and flexibility through the support of 1G to 100G technologies in all stages of the product-development cycle, including research and design, system-verification testing, and network-element production testing. T&MW

David Heard discusses tests for cloud computing and other new technologies in the online version of this interview: www.tmworld.com/2011_11.

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