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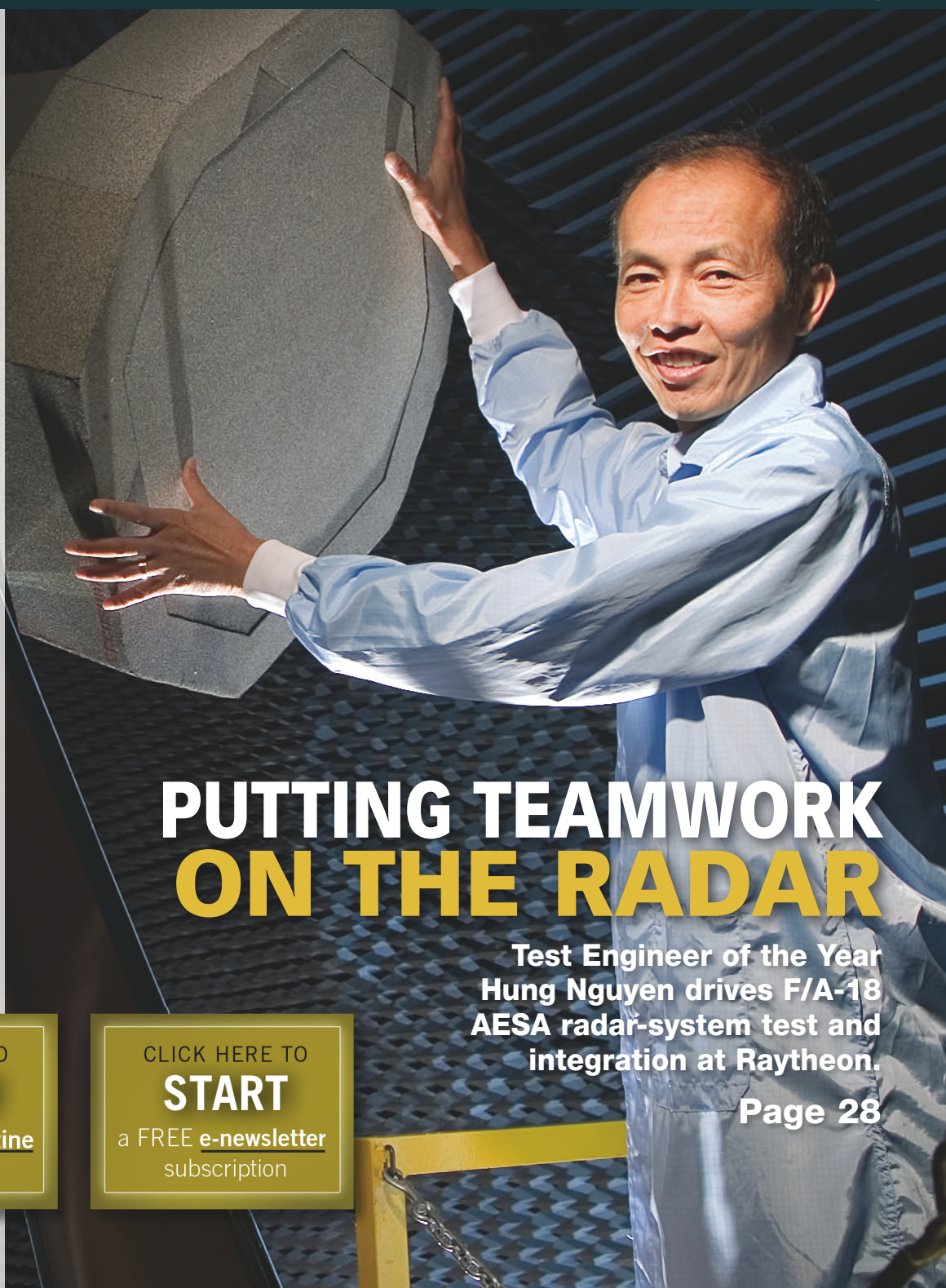

PUTTING TEAMWORK ON THE RADAR

Test Engineer of the Year Hung Nguyen drives F/A-18 AESA radar-system test and integration at Raytheon.

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2 GHz Clock Generator

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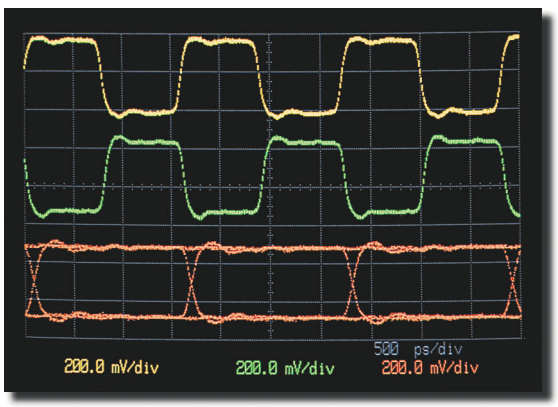

Plot shows complementary clocks and PRBS (opt. 01) outputs at 622.08 Mb/s with LVDS levels. Traces have transition times of 80 ps and jitter less than 1 ps (rms).

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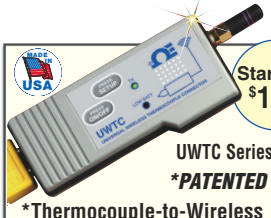

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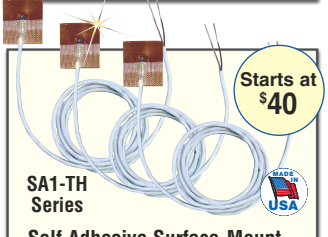

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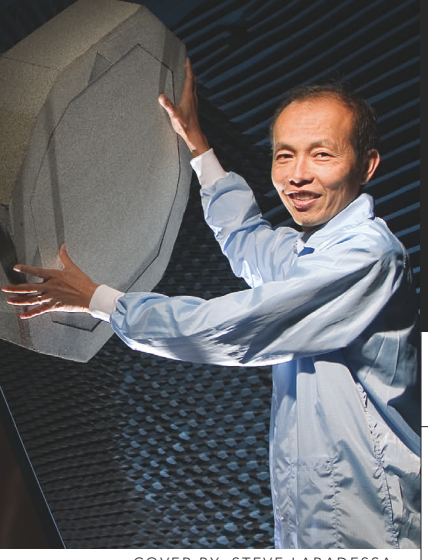

COVER BY: STEVE LABADESSA

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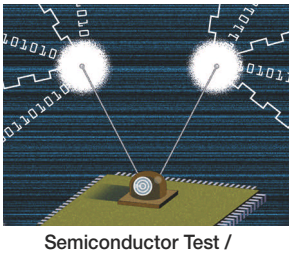

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New LXI products and capabilities unleash the power of Ethernet

Bob Rennard, president of the LXI Consortium, explains how the power of LXI becomes clear with Class B- and Class A-compliant devices that eliminate the PC bottleneck and are as easy to configure as a printer.

Metrology personnel shortage is real

Chris Grachanen, master engineer and operations manager for the Houston Metrology Group at Hewlett-Packard, explains how the National Conference of Standards Laboratories International (NCSLI) is taking steps to recruit and train the next generation of metrology engineers.

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- Hummer vs. hybrid
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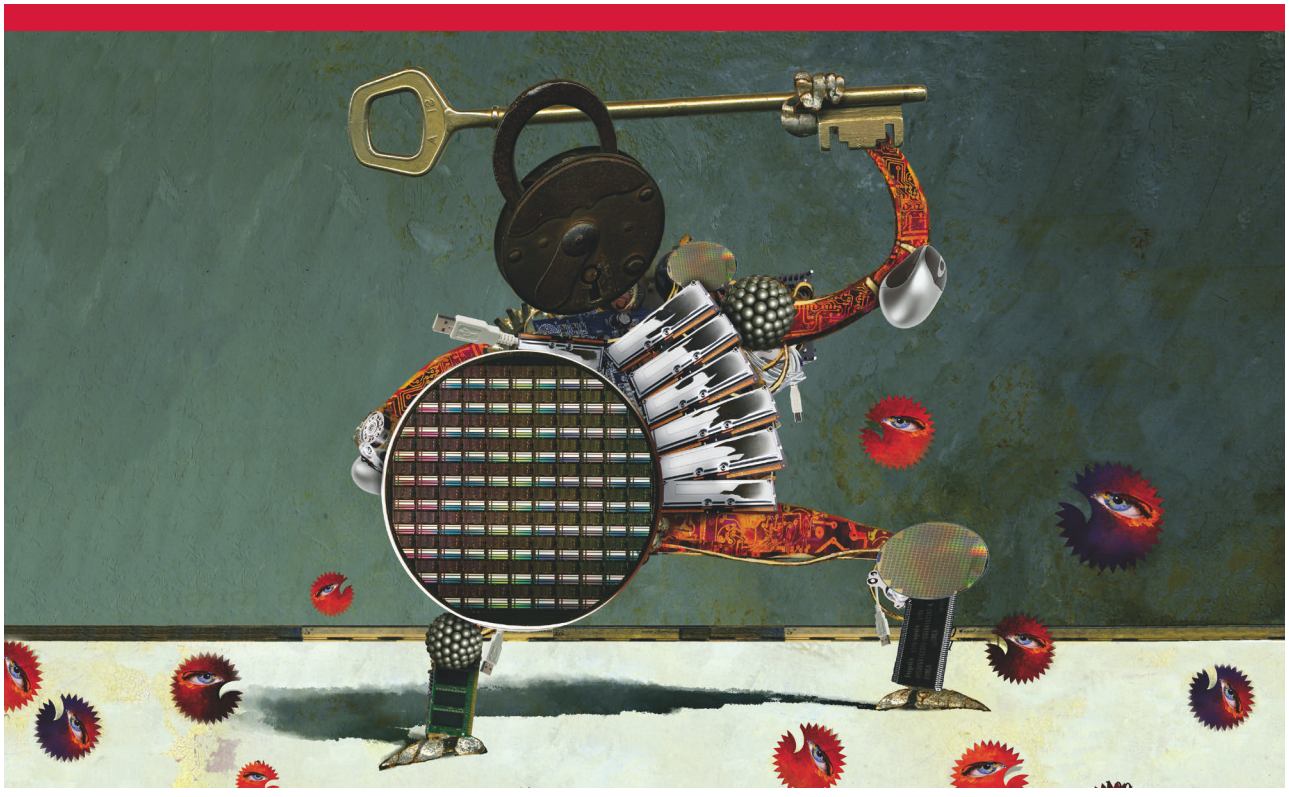

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RICK NELSON
EDITOR IN CHIEF

Talk, no action on education

Education is a bit like the weather—everybody talks about it, but nobody does anything about it. A recent bloviater on the subject is Microsoft chairman Bill Gates, who told members of Congress on March 12 that unless the US takes steps to reform immigration policies, education, and investment in scientific research, it will soon lose its competitive edge in technology.

To remedy what he called a dangerous shortfall of skilled scientists and engineers who can develop breakthrough technologies, Gates called for a serious commitment from and partnership between both the public and private sectors to strengthen America's educational opportunities, as reported in *Electronic News*.

"Chinese high-school students spend almost twice as much time on schoolwork as their American peers."

On the need for education reform, Gates called for full funding of the America COMPETES Act, which I wrote about in my September 2007 "Editor's Note." The act, Gates told Congress, would provide funding for about 1000 more science, technology, engineering, and math (STEM) graduate students than were funded in 2007, allowing the National Science Foundation to support more than 35,000 STEM graduate students during 2008 and approximately 41,000 during 2009.

Meanwhile, efforts at developing engineering talent are ad hoc. For example, in this issue's cover story (p. 28), I profile Hung Nguyen, chief scientist at Raytheon Space and Airborne Systems, who won this year's Test Engineer of the Year award in part because of his ability to mentor entry-level engineers, who are often more adept at playing video games than in working in a real-world laboratory.

The state of American education looks particularly dim when viewed in the light of education elsewhere. In her March 12 "Beautiful Country" column in the online *Wall Street Journal,* Li Yuan recounts the case of Jack Li, whose father, a Caterpillar employee in Beijing, was transferred to Peoria, IL. "Jack enrolled in high school as a ninth-grader," she writes, adding that his parents weren't worried about their son's academic prospects in a new school, because "They believed that China has better K–12 education than the US."

"Jack didn't disappoint them," Yuan continues, adding that three months into his new school, "he scored high enough on the SATs to put him in the top 3% in math and well above-average in writing and reading."

Yuan notes that "Chinese students like Jack are examples of why Microsoft's Bill Gates asked Congress today to spend more to improve American education in math and science." She cites the documentary "2 Million Minutes" (the four years of high school), which concludes that Chinese high-school students spend almost twice as much time on schoolwork as their American peers.

It's nice that parents from other countries can expect their children to excel in American schools. But there is a not-so-nice flip side to that. I serve as a tutor in English as a second language in a local adult literacy program, and I work with many Chinese families who are in the US for a few months or a few years. The parents' main concern? How far behind their children might find themselves on returning to school in China. T&MW

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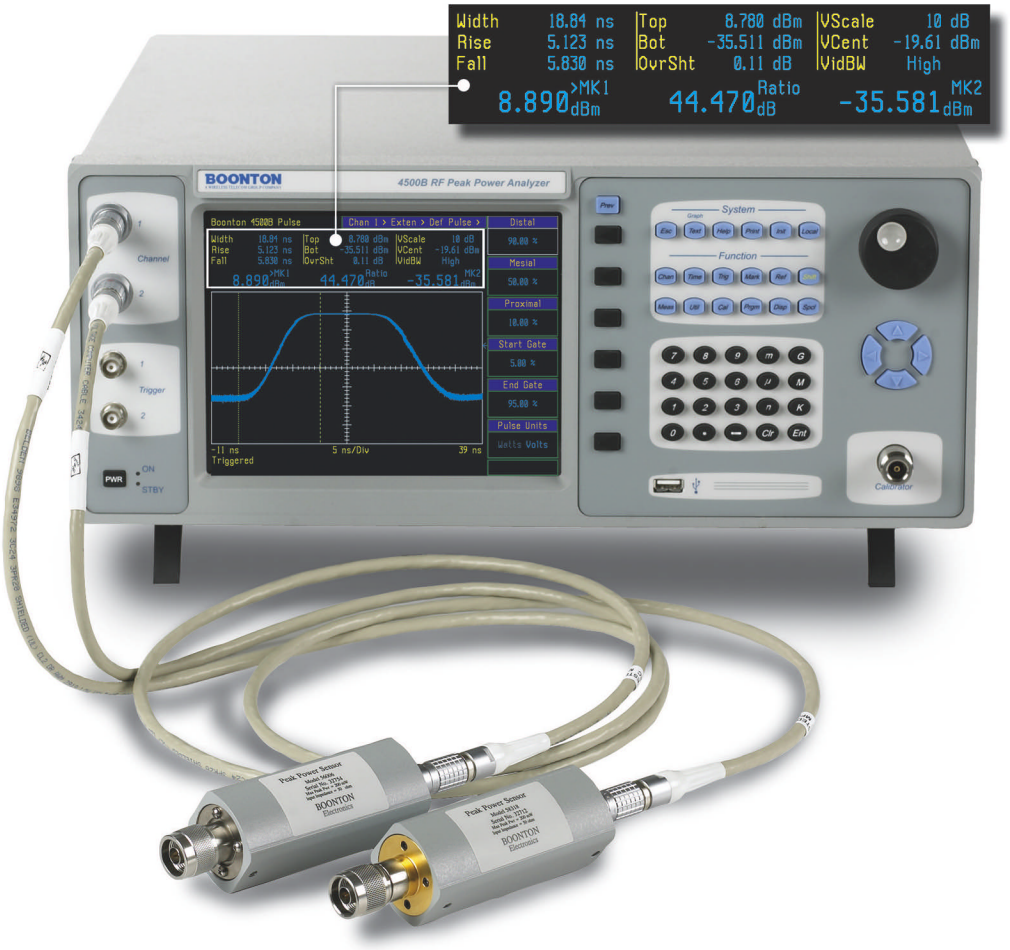

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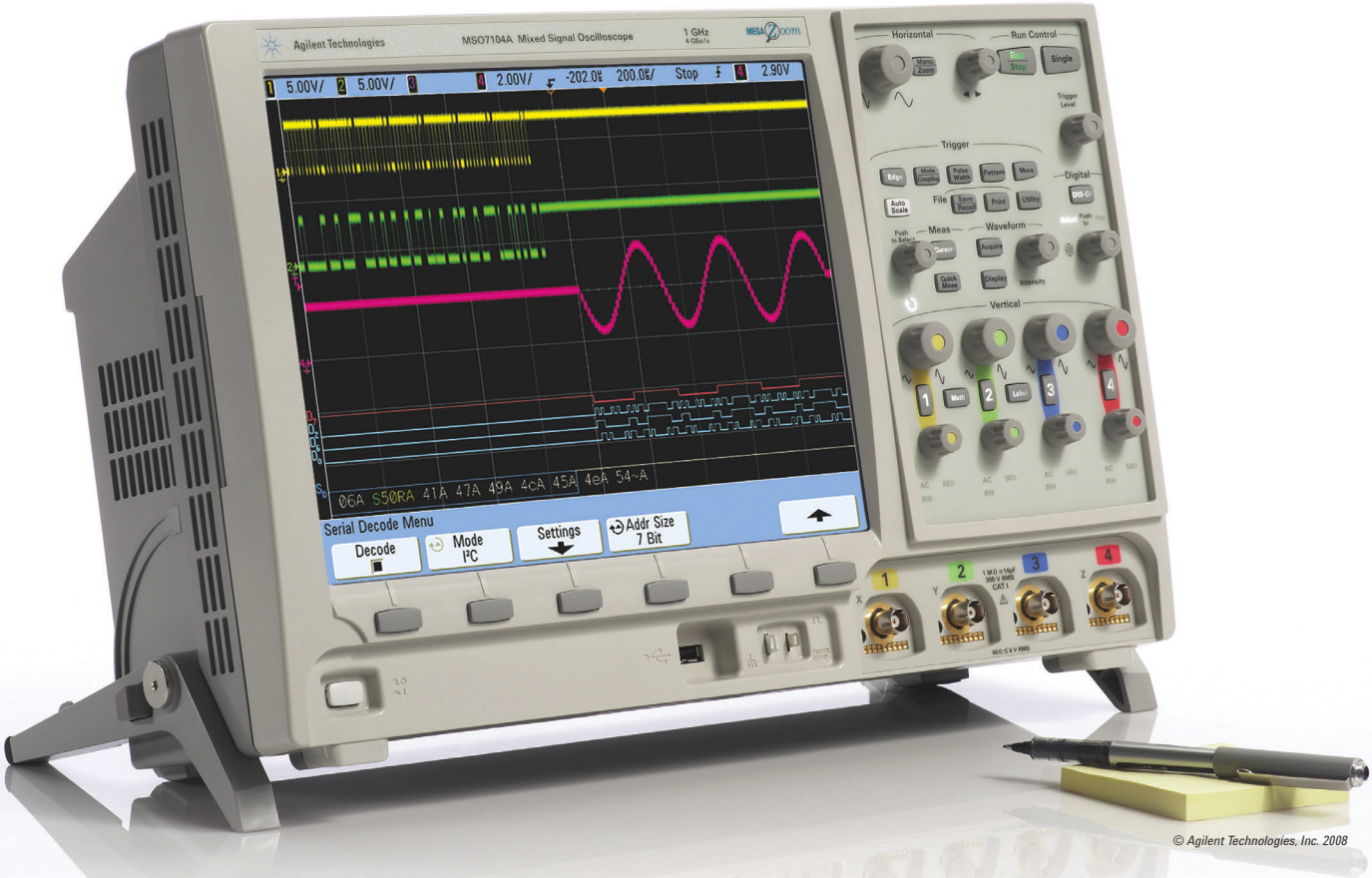

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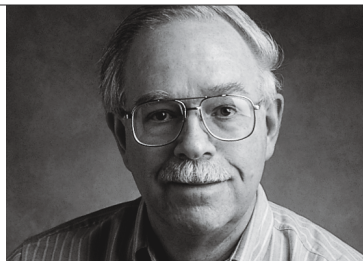
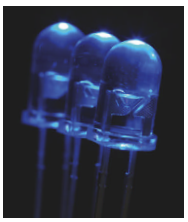


Odds and ends

From the Human Factors department: What's with the trend toward illuminating everything with blue LEDs? I recently purchased a Sears electrostatic air cleaner that



features function switches illuminated from the rear by blue LEDs. Under normal lighting conditions, the indicators' black-on-silver icons are perfectly readable. Unfortunately, the stylists selected blue point source LEDs for backlights, which render the icons almost unreadable under low-light conditions.

Good reasons exist for not using blue illumination, including the human eye's difficulty in focusing blue light. Aside from blue-lighted automobile gauges, I'm unaware of any professional-quality test instruments that use blue LEDs as illuminators or indicators. Let's hope that function continues to triumph over fashion, and that the human-factors engineers beat the blue daylights out of the stylists.

From the Better Health department: If you've ever bloodied your knuckles while bolting up a waveguide, chances are you'll cheer the arrival of a new technology that enables fabrication of waveguides and other structures on substrates. Developed in conjunction with researchers from the University of Colorado at Boulder, the PolyStrata process uses a polymer molding material deposited in a layer surrounding electroplated metallic structures. Repeated deposition of plating and molding materials produces 3-D structures filled with the polymer. Dissolving the polymer yields microminiature waveguides and air-dielectric transmission lines.

The technology appears well-suited to building systems on a substrate that incorporate everything up to and including an antenna array. From a test-engineering viewpoint, adding test connectors might prove challenging, and you'd do well to incorporate built-in test equipment (BITE) onto the substrate. But you'll never skin your knuckles again.

From the Low Budget department: If you're a student, an impoverished experimenter, or a test-instrument collector, you may have accumulated one or more instruments that include an IEEE 488 (GPIB) interface. While several manufacturers offer highly capable data-acquisition and control packages (e.g., National Instruments' LabView), the software alone may cost more than your entire instrument collection. As an alternative, you can download EZGPIB, a freeware GPIB, RS-232, and TCP/IP program that features a Pascal-like programming language.

Developed by Ulrich Bangert, holder of German amateur radio license DF6JB, EZGPIB runs on an IBM-compatible PC that's equipped with either of two GPIB interfaces (see "More odds and ends" at right) and uses Windows 2000 or a more recent Microsoft operating system. You'll need to become familiar with your instrument's GPIB programming commands, though. Give EZGPIB a try! T&MW

MORE ODDS AND ENDS

Aesthetics aside, some controversy exists regarding the possible health hazards presented by blue LEDs:
texyt.com/bright+blue+leds+annoyance+health+risks

If you use a popular search engine to look for "polystrata," you may encounter a batch of scholarly papers dealing with red algae, paleobiology, and paleoecology. Instead, use the search phrase "polystrata microwave" or read the following on the *Microwave Journal* site:

- To learn more about Rohm and Haas' PolyStrata technology, read *Microwave Journal* for February 2008, pp. 66–86.
www.mwjournal.com/Journal/article.asp?HH_ID=AR_5448

- To read an interview with David Sherer, Director of Research and Product Development at Rohm and Haas' Electronics Materials Division, go here:
www.mwjournal.com/News/article.asp?HH_ID=AR_5479

To download a free copy of Ulrich Bangert's EZGPIB software, go to:
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For information on Prologix' inexpensive ($149.95) GPIB-USB interface, go to:
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To learn more about the current version of NI's LabView software, go to:
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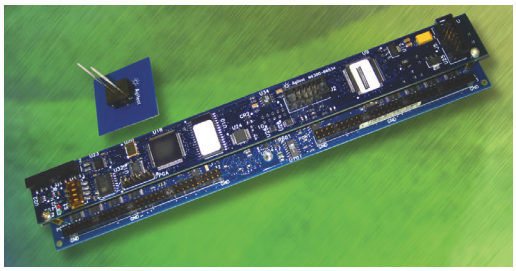
Agilent's Cover-Extend cuts test-point requirements



Agilent Technologies has unveiled a limited-access technology for in-circuit test (ICT) that eliminates the need for physical test points, offering benefits that Agilent's traditional VTEP technology cannot provide. Part of Agilent's VTEP v2.0 Powered test suite, the Cover-Extend technology is a hybrid of boundary scan and VTEP vectorless test. It leverages VTEP hardware, such as the VTEP probe and mux card (pictured).

Unlike VTEP test, which requires physical test points on the printed-circuit-board assembly (PCBA) for the injection of test stimulus signals, Cover-Extend relies on stimulus provided by boundary-scan cells, which do not require physical test points. The benefits include improved test coverage, which preserves users' investment in in-circuit testers. (Cover-Extend can recover up to 50% node access.) Other benefits include savings on fixturing, a continuous operating cost that can easily exceed the price of the ICT system itself over time. A typical factory using Cover-Extend on 30 lines can potentially save up to $500,000 per year, Agilent reports. In addition, the technology provides strain relief on solder joints, resulting from fewer test probes needed underneath high-density ICs (for instance, ball-grid arrays), greatly reducing potential solder-joint damage due to excessive strain. www.agilent.com.

Credence sells diagnostics business

Credence Systems, which is continuing its focus on automated test equipment (ATE) for the semiconductor industry, has announced the sale of its diagnostics and characterization business to DCG Systems, an independent company led by Dr. Israel Niv, the founder of Optonics and the GM of Credence's Diagnostics and Characterization Group from January 2003 to February 2005. Under the agreement, Credence will receive up to $10 million for the business.

Products covered in the transaction include the recently introduced Ruby laser voltage prober, the OptiFIB-IV focused ion-beam system, the Meridian-IV emission system, and the NEXS suite of EDA link software. In addition, DCG Systems will offer the EmiScope, TriVision, and P3X instruments. The newly formed DCG Systems will be headquartered in Fremont, CA. www.credence.com.

Lab gains extended accreditation

TÜV SÜD America reports that its Danvers, MA, facility has been granted a scope extension by the International Electrotechnical Commission of Electrical Engineers (IECEE), the worldwide system for conformity testing and certification of electrical equipment and components. With this extension, TÜV SÜD America, a testing and certification firm, is now accredited to test products to 25 IEC standards.

The CB scope extension gives TÜV SÜD America continued testing capabilities in the OFF (IT and office equipment) category and additional testing capabilities in the MEAS (mea-

Editors' CHOICE

Sockets to 18 GHz target devices up to 13 mm²

Aries Electronics' new high-frequency center-probe test sockets operate to 18 GHz and accommodate devices measuring up to 13 mm². Available in four versions with ratings of 1 to 3 GHz, 3 to 5 GHz, 5 to 9 GHz, and 10 to 18 GHz, the new sockets serve in high-speed testing of devices in packages including CSPs, µBGAs, and LGAs with pitches as low as 0.40 mm.

The sockets' solderless, pressure-mount, compression-spring probes allow for easy mounting to and removal from a test board. A four-point crown ensures adequate scrub on solder balls for reliable contact mating, and a raised tip probe ensures adequate scrub on pads. The new sockets provide minimal signal loss for higher bandwidth capability via a signal path measuring only 0.077 in. Overall socket size is 1.200x0.840x0.440 in. Pin inductance is 0.59 nH at 0.50-mm pitch; mutual capacitance is 0.12 pF, and contact resistance is less than 40 mΩ.

The compression-spring probes in the new RF sockets are constructed of durable heat-treated beryllium-copper alloy, plated with 0.75-µm gold over 0.75-µm nickel. All hardware is stainless steel. Contact forces range from 16 g to 25 g per contact, depending on pitch. Operating temperature is –55°C to 150°C, and estimated contact life is more than 500,000 cycles.

Base price: $330. *Aries Electronics, www.arieselec.com.*

suring instruments), MED (electrical equipment for medical use), HOUS (household and similar equipment), and TRON (electronics entertainment) categories. "I am very pleased that we can now offer a much broader scope of CB certificates," said Joe Janeliunas, senior compliance manager for TÜV SÜD America. "CB work is important for our customers because it allows them to market their product in most parts of the world." www.TUVamerica.com.

City-scale network test facility opens

IP performance test system provider Ixia has opened iSimCity, a proof-of-concept lab and executive briefing center in Santa Clara, CA. The company has also conducted a city-scale demonstration on ensuring quality-of-experience (QoE) in high-performance, converged multiplay networks.

With the ability to conduct city-scale testing with Ixia products at iSimCity, customers can access thousands of test ports and aggregate traffic in the range of 10 to 100 Gbps, emulate thousands of subscribers/users, and generate millions of routes with thousands of routing peers. They can also conduct system testing by emulating dozens of infrastructure servers, including load balancers, denial of service defenders, switches, routers, video servers, SIP proxies, and DNS and DHCP servers. www.ixiacom.com.

CALENDAR

Design Automation Conference (DAC), June 8–13, Anaheim, CA. Sponsored by IEEE, ACM, and EDA Consortium. www.dac.com.

The Vision Show, June 10–12, Boston, MA. Sponsored by the Automated Imaging Association, www.machinevisiononline.org.

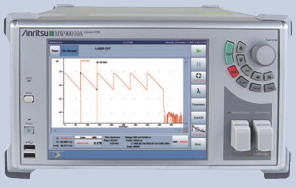
International Microwave Symposium, June 15–20, Atlanta, GA. Sponsored by IEEE Microwave Theory and Techniques Society (MTT-S), www.ims2008.org.

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

Find faults in long optical cables

Editors' CHOICE

Anritsu's MW90010A Coherent OTDR (C-OTDR) can detect faults in optical cables up to 12,000 km long, even with multiple repeaters in the cable. And because it collects 1.2 million data points, the MW90010A is able to detect faults with 10-m resolution at the 12,000-km length. A built-in tunable light source covers the 1535.03-nm to 1565.08-nm wavelength range with ±0.2% accuracy. The instrument pulses that light with widths of 3, 10, 30, 60, or 100 µs with adjustable output power from 0 dBm to +13 dBm. It has a dynamic range of >17 dB at cable distances of 1000 km.



Once it makes a measurement, the MW90010A displays a graph representing the cable showing where faults occur. It lets you store waveforms, and it displays up to eight waveforms at once, letting you compare current to previous measurements and monitor performance as a cable ages. It also features measurements such as splice loss and decibels/kilometer loss, and you can display distance in miles, feet, kilofeet, meters, or kilometers. You can store measurements in the instrument's 2.8-Gbyte internal memory, or you can transfer data to an external USB memory device. The instrument produces reports in pdf format that you can store and print.

Base price $400,000. *Anritsu, www.us.anritsu.com.*

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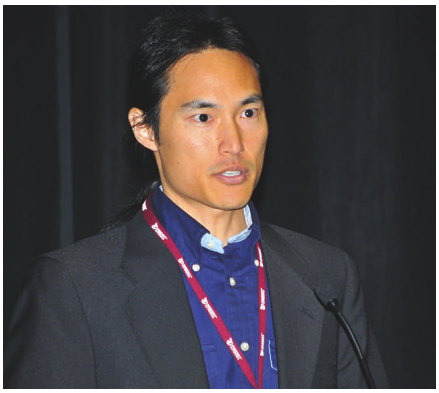
For more details on the Fluke family of bench DMMs go to **www.fluke.com**. Or contact your local Fluke representative.

OFCNFOEC: On to 100G

> > > OFCNFOEC 2008, February 24–28, San Diego, CA, www.ofcnfoec.org.

From listening to the talk at OFCNFOEC 2008, it's clear that the fiber pipelines, once partially dark, are now illuminated around the world. This year, there was no more talk about how fiber to the premises (FTTP) is going to save the industry. Emphasis has shifted to core networks to carry the increased network traffic. Today, people are looking toward the next big step in core-network technology: 100-Gbps Ethernet, known here as "100G." (100G, formally IEEE 802.3ba, was announced in December 2007.)

Ethernet co-inventor Bob Metcalfe envisions Terabit Ethernet networks in labs in 2015.



Network engineer Don Lee of Facebook needs Terabit Ethernet by 2011.

For the last several years, 40-Gbps fiber links were considered laboratory projects. Now, they've started to move into deployment, as evidenced by the fact that people have started talking about reducing the cost of 40-Gbps optical components.

At the plenary session, Pieter Poll, CTO at Qwest Communications, told the crowd that "IP traffic is increasing faster than Moore's Law" and that 100-Gbps networks will need more complex circuits than 10-Gbps and 40-Gbps links. He said he expects IEEE 802.3ba to be ratified in 2009, with components appearing on the market starting between 2010 and 2012. He also noted that today's 10-Gbps networks need to become more economical and more reliable. He sees 40 Gbps as an interim technology before service providers move to 100 Gbps.

Following Poll, Ethernet co-inventor Bob Metcalfe went a step further, predicting the advent of the Terabit Ethernet and speculating that the first terabit networks in labs will appear in 2015. "Applications will drive Terabit Ethernet," he said, "and television will top the list." In fact, you can already see it coming given the proliferation of IPTV and Web sites such as YouTube. "If we build Terabyte Ethernet, they will come," he said. But he warned that moving to terabit networks will require a new fiber infrastructure, claiming that the existing "plumbing" won't handle the speed.

Metcalfe also predicted that Ethernet will eventually kill SONET because Ethernet standards provide no design options, and thus improve on interoperability of networks. "People fail because they put too much emphasis on standards compliance and not enough emphasis on interoperability." He went on to say that "OC-768 will be the last SONET standard. "There will be no OC-3072." (SONET usually leaps in multiples of 4, thus 4x768, or 3072.)

OFCNFOEC featured a panel discussion with members of companies ranging from Facebook to component maker Avago Technologies to Reuters. Each panel member discussed how video-based applications such as Facebook and YouTube that stress core networks are fueling a demand for ever-more network bandwidth. Don Lee, network engineer at Facebook, told the audience that he needs 100-Gbps Ethernet right now and he'll need Terabit Ethernet by 2011. Lee cited Facebook's 66 million active users who load audio and video onto their pages, and he noted that Facebook adds 1 million new users each week.

Dave D'Andrea of Avago Technologies cited a problem with 10-Gbps optical transceivers: too many configurations. "Today's connectors and transceivers never achieved a low enough price," he said, which keeps costs too high for many data centers to move to 10-Gbps links. "Unlike Gigabit Ethernet and Fast Ethernet, connectors and transceivers for 10-Gbit Ethernet are not being made by the millions needed to get the economies of scale that push prices down." D'Andrea is pushing a new connector called SPF+ as the solution, even though the standard for the transceiver is not yet ratified. T&MW

See the online version of this article at www.tmworld.com/2008_04 for our full coverage of OFC-NFOEC, including coverage of the exhibit floor.

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MARTIN ROWE
SENIOR TECHNICAL EDITOR
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VXI keeps hanging around

In 2002 I wrote "Don't write off VXI," where I noted that VXI was still a viable bus (Ref. 1). Now over 20 years old, VXI remains entrenched in military and aerospace test applications. PXI, now more than 10 years old, has made inroads into commercial applications where VXI's higher cost can't go.

VXI remains strong in mil/aero testing because products in those industries have long life spans, with 15 to 20 years not unusual. Because VXI was the first industry standard for modular instruments, it was widely adopted, and with the cost of changing buses being so high, many companies are reluctant to swap their VXI systems for something newer. Although PXI (and PXI Express) and the more recent LXI buses use PC standard communications links, their software drivers differ from those used by VXI. Furthermore, VXI's large card size lets test engineers put more components—usually switches—in a slot than is possible in smaller PXI slots.

Development of VXI modules continues, although a new VXI product doesn't receive the fanfare that a PXI or LXI product receives. That's because VXI equipment makers know their customers well. "VXI is a stable marketplace," said Mike Granieri, VP of advanced programs at Phase Matrix. "It has pragmatic users for whom performance specifications matter greatly."

PC technology is coming to VXI, though. On March 4, National Instruments announced a cabled PCI Express link between a PC and a VXI slot-0 controller. (See "Cabled PCI Express link" in the box and see Ref. 2 for more on cabled PCI Express.)

Defense contractors are looking to complement VXI with other technologies. "At last year's Autotestcon, there was considerable excitement over using new technologies such as software-defined radio with VXI," said Richard McDonell, senior group manager for PXI and instrument control at National Instruments. "There's a huge VXI infrastructure in place that contractors want to keep using."

"Some VXI-based systems were deployed in the early 1990s, and they're still in use today," added Mark Morris, marketing manager at ZTEC Instruments. "They often need replacements for obsolete instruments." Because of that need, ZTEC, VXI Technology, and others have developed replacements for modules originally from Hewlett-Packard (Agilent Technologies) and Tektronix. "We're still seeing new test systems incorporating VXI," said Morris.

VXI remains entrenched in military and aerospace testing, although some competition comes from PXI and LXI. Courtesy of VXI Technology.

Tom Sarfi, president of the VXIbus Consortium, points to the DoD's Joint Strike Fighter program. "Design began in 2001 and the Lockheed Martin F-35 is yet to be deployed, but it uses VXI-based testers."

Not everyone, however, is so excited about VXI. "We haven't built a VXI-based system in several years," said Tim Brooks, business development manager at National Technical Systems (formerly BB Technologies). "We're steering our customers toward PXI. Some are replacing some rack-and-stack systems with PXI, jumping over VXI because of the cost."

Granieri counters that applications using VXI favor the measurement performance and larger card size of VXI over the bus speed of PXI or LXI. "We still sell microwave counters in GPIB," he said, "because some customers don't need the higher bus speeds of modular instruments." T&MW

Cabled PCI Express link

The VXI-8360T VXI-MXI-Express controller passes data at speeds up to 29 Mbytes/s between a PC and a VXI chassis. It brings an industry-standard bus to VXI through a smaller cable than the MXI-2 bus. The VXI-8360T includes a VXI slot-0 controller and a PCI Express adapter card for desktop or notebook PCs. www.ni.com/vxi.

Wireless Dilbert

Omega Engineering's wireless data-acquisition catalog features the company's wireless products and 60 Dilbert cartoons. To request a copy, go to www.omega.com/wireless.

RapidIO testing white paper

A white paper from the RapidIO Trade Association and Fabric Embedded Tools introduces RIOLAB, an independent test lab for RapidIO devices. The paper explains the ups and downs of relying on semiconductor manufacturers' interoperability test results. www.rapidio.org/education/interoperability.

REFERENCES

1. Rowe, Martin, "Don't write off VXI," *Test & Measurement World*, May 2002. www.tmworld.com/article/CA214119.html.

2. Rowe, Martin, "PCI Express goes cabled," *Test & Measurement World*, August 2007. www.tmworld.com/article/CA6463852.html.

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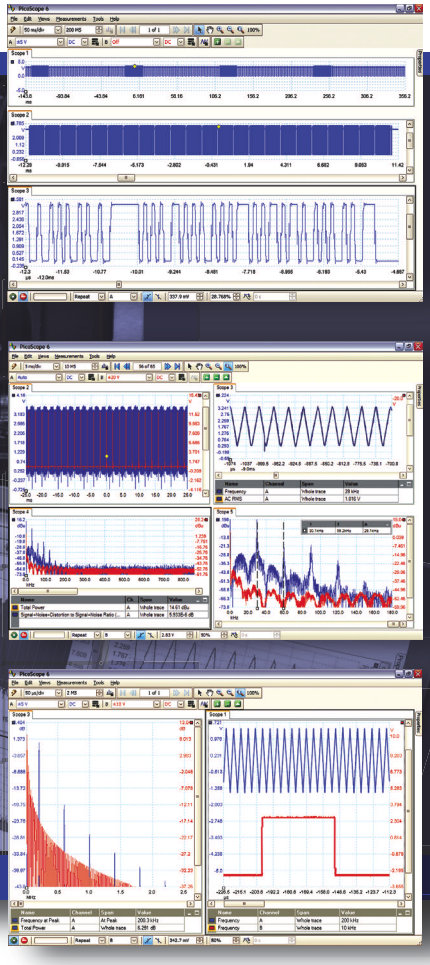

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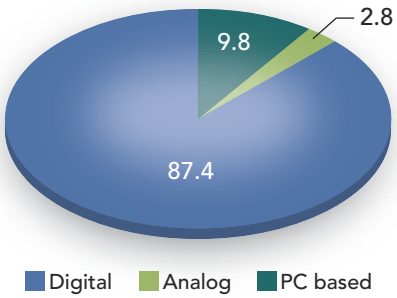
Iridescent future ahead for the oscilloscope market

Compared with other types of general-purpose test and measurement equipment, the oscilloscope market has witnessed the most technological innovations and changing market trends. The oscilloscope market exceeded $1.2 billion in 2007, driven primarily by constantly evolving technologies in the communications and computer industries.

A key driver in the oscilloscope market has been the increased adoption of high-speed serial data bus technologies such as PCI Express 2.0, Serial ATA III, and HDMI 1.3 in the computer and consumer electronics industries. Growing signal complexity and challenges associated with signal integrity and data acquisition have raised the bar in terms of performance requirements for digital oscilloscopes.

Another standard that is growing in prominence in the audio/video application space is DisplayPort, the high-speed serial interface standard developed by the Video Electronics Standards Association (VESA). DisplayPort, which aims at addressing the growing bandwidth needs of high-resolution audio and video applications, is expected to replace LVDS, DVI, and VGA, thereby providing significant growth opportunities for oscilloscope vendors.

The communications industry also provides significant growth potential for the oscilloscope market. The transition from analog to digital RF technology has generated the need for high-performance RF test tools and has fueled the demand for digital as well as PC-based oscilloscopes or digitizers. At the same time, demand for their analog counterparts continues to decline. Unable to keep pace with challenges associated with complex signal analysis, analog scopes have limited capabilities that are driving them toward extinction (**figure**).



Demand for analog oscilloscopes continues to decline as they become replaced by digital and PC-based versions.

There has been increasing demand among customers for the ability to tailor their test equipment for particular applications. Customers look for a software-based approach to instrumentation that allows them to customize their own solutions, and PC-based oscilloscopes are able to take advantage of the power and versatility of PCs. While the concept of a software-based approach to testing has been around for more than two decades, it has gained prominence over the past few years because of two key technological trends that have helped customers improve throughput while reducing the cost of test: the adoption of high-speed serial buses like PCI Express and the evolution of multicore processors.

With technology evolving at unprecedented rates in the communication and PC industries and as the use of high-speed serial interfaces continues to spread across various consumer market segments, the future of the oscilloscopes market has never held more promise. The performance competencies of these instruments will continue to improve to surpass the needs of its demanding and diverse customer base. T&MW

Converged devices don't compel users

Conventional wisdom within the portable device industry is that consumers have a preference for converged devices that combine the functionality of previously separate devices, reports In-Stat. But the idea that there will be wholesale adoption of a device that simply combines multiple devices is unrealistic, the market-research firm says. A recent In-Stat report, "Converged Devices: US Road Warriors Start Cord Cutting," notes that users tend to remain loyal to older technology, although 8% of businesspeople who travel frequently have given up a desk phone to rely solely on their mobile number. www.in-stat.com.

PCB book-to-bill

For rigid printed-circuit boards (PCBs) and flexible circuits combined, industry shipments in January 2008 increased 4.0% from January 2007, and orders booked increased 10.9% from January 2007. The combined (rigid and flex) industry book-to-bill ratio in January 2008 fell to 0.97, down from 1.01 in December 2007. www.ipc.org.

Semiconductor equipment book-to-bill

North American-based manufacturers of semiconductor equipment posted $1.12 billion in orders in January 2008 (three-month average basis) and a book-to-bill ratio of 0.89. "Orders remain below levels reported in early 2007 and are consistent with the reduction in capital spending announced by many device manufacturers," said Stanley T. Myers, president and CEO of SEMI. "While new capacity will be added this year, the industry appears cautious about new investments in the near term." www.semi.org.

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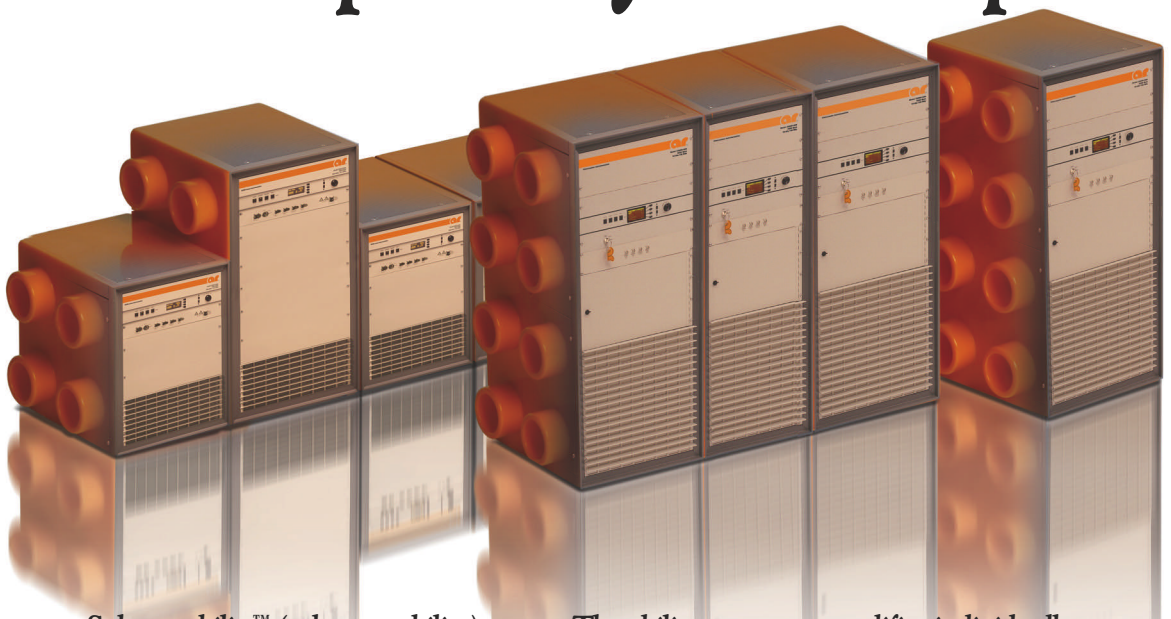

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Once this initial upgrade is performed, the sky's the limit. The 20S4G11A and the 35S4G8A are like building blocks that can easily be expanded by adding sub amps and controller/combiner units.

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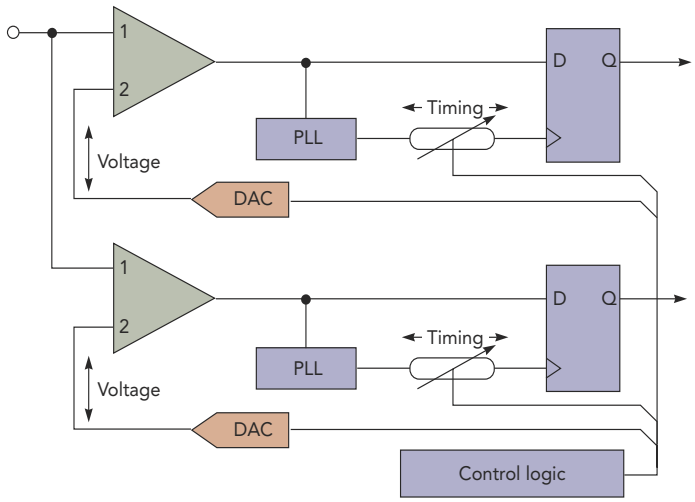
SEMICONDUCTOR TEST

As SOCs grow, instruments move on-chip

As system-level ICs grow larger and more complex, they become impossible to observe and stimulate. Internal nodes aren't accessible to bonding pads or even to probes. Signal voltages are small, noise thresholds are tiny, and drive strengths are negligible. As critical circuits reach gigahertz frequencies, it becomes physically impossible to get an accurate representation of signals off the die, even if you can probe the circuit.



Vitesse has devised a two-channel approach to implementing on-chip receiver instrumentation that supports the generation of an eye diagram or bathtub curve.

Yet, the need for capturing on-chip-signal information remains. Chip designers must be able to observe and stimulate individual blocks in a system-on-chip (SOC) to bring up the silicon. Manufacturing-test engineers must be able to create fast test programs on affordable test equipment. Increasingly, chip designers must also create autocalibration routines that can compensate critical circuits for process, voltage, temperature, impedance, and noise variations while the chip is in use. The only apparent option is to move test-and-measurement instruments—the racks of logic analyzers, bus analyzers, communications testers, and oscilloscopes that populate the bring-up lab—onto the chip itself.

And this option is now available. Beginning perhaps with debugging facilities built into CPU cores, extending through bus-diagnostic blocks and logic built-in self-test blocks, on-chip instrumentation is now extending into high-speed transceivers and RF circuits. In the future, you may see on-chip analog instrumentation for characterization and calibration routinely becoming part of analog design.

To learn how firms including Analog Devices, ARM, Dafca, Rambus, STMicroelectronics, and Vitesse are adding instruments to their devices, see the full-length version of this article, from sibling publication *EDN:* www.edn.com/article/CA6531583.html.

Ron Wilson, Executive Editor, EDN

BOOK REVIEW

Get the eye on communications test

Digital Communications Test and Measurement: High-Speed Physical Layer Characterization. Dennis Derickson and Marcus Müller, eds. Prentice Hall Semiconductor Design Series, Pearson Education (www.prenhallprofessional.com), 2007. 935 pages. $99.

If ever there was a book that covered all the aspects of physical-layer test and measurement, this is it. *Digital Communications Test and Measurement* is a compilation of chapters written by engineers at several leading companies and universities—some of whom have also written articles for *Test & Measurement World*.

The chapters in this book cover important topics such as jitter, eye diagrams, clock recovery, bit-error-rate (BER) testing, and stress testing for both electrical and optical communications links. Unfortunately, the editors push the importance of jitter (chapter 2) to the point where they cover the topic before covering the basics of communications systems in chapter 3; I think they should have reversed the order of these chapters.

Aside from that, this book just about covers it all. I found chapter 4, "Bit Error Ratio Testing," particularly useful. It provides just enough depth to cover the topic without delving into the underlying statistics.

Because each chapter is written by a different author, you'll get some redundancy—jitter and BER appear in several chapters. For example, in addition to the coverage of jitter in chapter 2, chapters 6 and 7 describe techniques for measuring jitter with real-time oscilloscopes and

Get the eye on communications test *(continued)*

sampling oscilloscopes. *Digital Communications Test and Measurement* isn't just about jitter and BER, though. It also covers the time domain and the frequency domain and provides information about time-domain reflectometry and S-parameters.

If you need in-depth knowledge about any of the topics in this book, you can find books dedicated to each. But if you need an introduction to the practical measurements you need to make, this book is for you.

Martin Rowe, Senior Technical Editor

COMMUNICATIONS TEST

Mobile voice quality poor in 39% of calls

Unsatisfactory voice quality caused more than 66,583,174 mobile subscribers to leave their service provider during 2007, ultimately costing the global mobile services industry approximately $23.6 billion, according to estimates in a September 2007 report from communications-equipment vendor Ditech Networks. A follow-up audit report released February 6 suggests the situation may be even worse, reported Ken Croley, Ditech's director of marketing. To develop that report, Ditech used its EXi technology to evaluate 630 million live mobile calls in 16 different networks across 12 countries; 39% of calls failed to meet a minimum quality standard set by the ITU.

"What our audit shows is that the cost of churn is probably higher than what we estimated back in September, because percentage of calls affected by ambient noise and echo is larger than what's been previously indicated in the industry," said Croley, adding that the audit focused on identifying problems—such as ambient noise and acoustic echo—that exist outside of a carrier's network.

Croley said the audit is unique in providing carriers with quantitative voice-quality data. "Carriers have lots of technology to measure what's going on inside their network," he said, "but until now there hasn't been a technology that will quantify voice quality outside the network. What carriers have not known about is what's going on with a live subscriber." EXi, he said, is a complement to the ITU's Perceptual Evaluation of Speech Quality (PESQ) algorithm, which, he added, does not work well for quality problems that occur outside a network.

See the online version of this article for links to Ditech Networks' reports and to a white paper on the limitations of PESQ: www.tmworld.com/2008_04.

Rick Nelson, Editor in Chief

Audit highlights

- In mature markets, 23% of all calls fall below the industry minimum quality standard.
- In rapid growth markets, 59% of all calls fall below the industry minimum quality standard.
- Ambient noise was rated "objectionable" on up to 50% of all calls in some regions.
- Acoustic echo was rated "objectionable" on up to 11% of all calls in some regions.
- Voice-level mismatch was rated "objectionable" on up to 28% of all calls in some regions.

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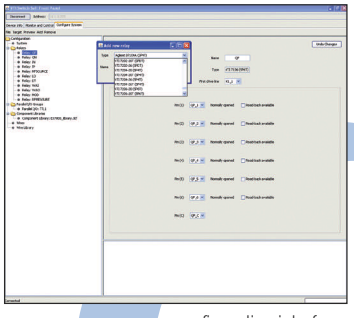
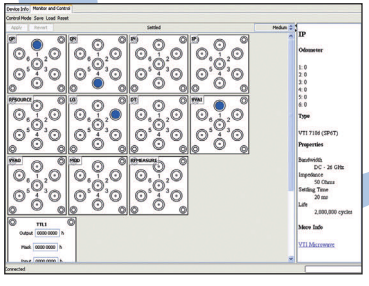


configuration interface



soft front panel interface

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Cellphones connect through Ethernet

DEVICE UNDER TEST

Base stations that let you use your cellphone indoors through a LAN. The base station connects to a DSL or cable modem and to a cellphone through GSM, digital communications system (DCS), or personal communications services (PCS) networks.

THE CHALLENGE

Measure and calibrate transmitter output power and receiver sensitivity. Test RF transmit and receive functions for power, frequency, spectrum, and bit-error rate (BER). Measure voltages and power consumption. Control electromechanical devices that automate the connecting of test cables.

THE TOOLS

- Agilent Technologies: rack-mount power supply, digital multimeter (DMM) with internal switching card. www.agilent.com.
- Amfax: PXI-based RF test system consisting of a chassis, controller, signal generator, and vector signal analyzer. www.amfax.co.uk.
- National Instruments: PXI data-acquisition card, PXI digital I/O card, PXI counter-timer card, PXI RS-232 interface card, PXI RS-485 interface card, graphical programming language. www.ni.com.

PROJECT DESCRIPTION

Cellphones may not work indoors because of weak signals. To help people who need to use their cellphones in home offices and in small businesses, RadioFrame Networks (Redmond, WA, www.radioframenetworks.com) developed base stations that let users connect to a cell network through a DSL or cable modem.

To test the RadioFrame base stations, test development manager Paul Knight needed a system to measure and calibrate the transmitters and receivers. He based his system on a commercially available RF test system and added components that let it perform a complete functional test. The system tests production base stations by making RF measurements, frequency measurements, and power measurements under digital control.

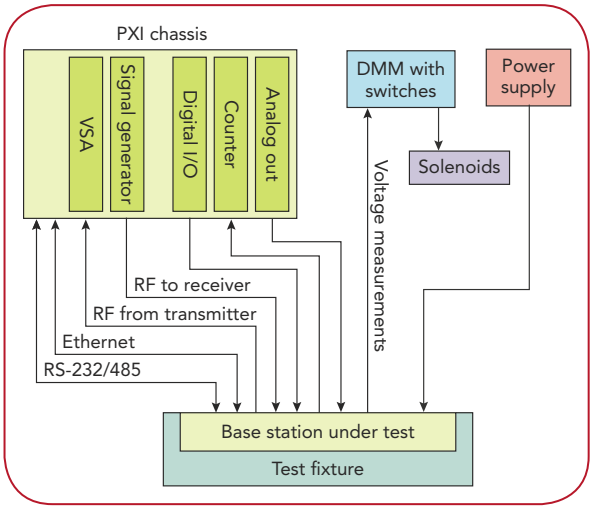
The basic RF test system consisted of an eight-slot PXI chassis, an embedded controller, a signal generator, a vector signal analyzer (VSA), and a software library of functional tests. RadioFrame engineers substituted an 18-slot PXI chassis for the eight-slot chassis, then added PXI modules, GPIB instruments, and the code needed to control them (**figure**).

After a test operator connects a unit under test (UUT) board to the test fixture, the system programs an address into the board through a serial port. Once programmed, the UUT can operate over Ethernet with a Telnet interface.

A test starts with basic functional measurements such as current consumption and oscillator frequency. The power supply measures current, and the counter/timer card measures oscillator frequencies on the board's processor clock, field-programmable gate array (FPGA) clock, and RF reference clock. The DMM measures all voltage levels on the board: 2.5 V, 3.0 V, 3.3 V, 3.6 V, and 5.0 V.

Calibration takes most of the 15-min test time. In a transmitter calibration, the system commands the UUT to produce a specified power (19 dBm, 42 dBm, or 67 dBm). The VSA measures RF power, and the system adjusts the power until it's within tolerance. It then repeats the measurements across four frequency bands. (The online version of this article contains a table of the frequency bands: www.tmworld.com/2008_04.) After measuring each power level, the system calculates correction factors and stores them in EEPROM.

With a transmitter calibrated, the VSA measures transmit power, frequency error, phase error, adjacent-channel power, and power-versus time (for a transmit burst).



A PXI-based system tests cellular-to-LAN base stations.

The system calibrates a UUT's receiver when the signal generator produces a modulated carrier of known frequency and power. The UUT contains diagnostics that report received power levels. Using those reports, the test system calculates correction factors. Following calibration, the system performs BER tests on the receiver.

In addition to making measurements, the test system automates parts of the test setup by moving Ethernet cables into place. "We broke off the clips on the Ethernet cables and use solenoids to connect them to the UUT," said Knight.

LESSONS LEARNED

"When we first began testing the boards, we had set the RF measurement limits too tight," said Knight. "We were failing good boards. Some tests limits were flexible, and we needed a statistically large sample of tests before we could properly set test limits."

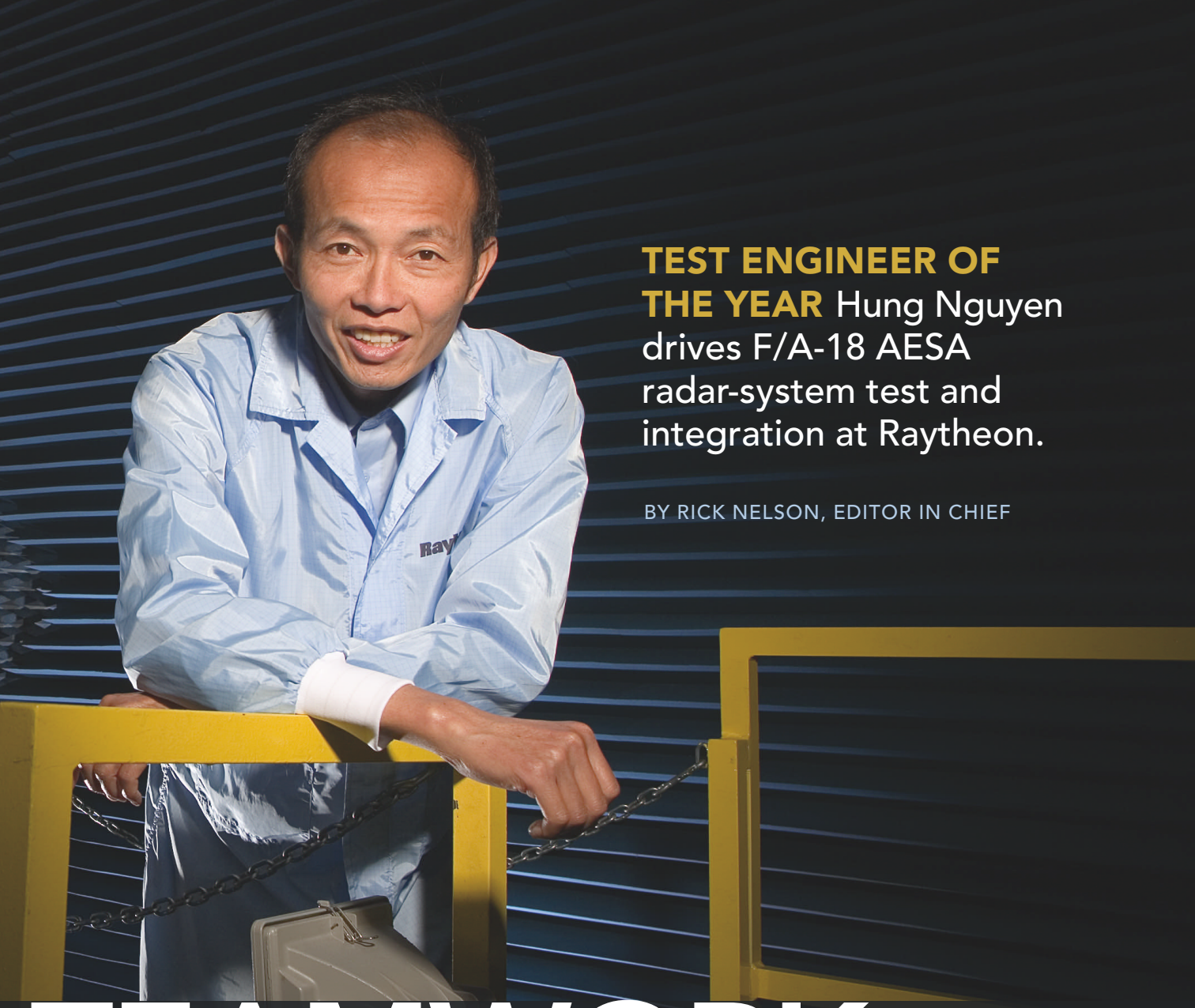
Martin Rowe, Senior Technical Editor

In our October 2007 issue, we profiled the accomplishments of six outstanding test engineers from various industries, and we asked our readers to vote for the Test Engineer of the Year. Your choice? Hung Nguyen of Raytheon.

As part of his award, Nguyen will designate an engineering or science program to receive a $20,000 grant, courtesy of award sponsors Keithley Instruments and National Instruments.

PUTTING ON

EL SEGUNDO, CA. Modern radar system design and test strategies have undergone a revolution that has drastically increased the importance of teamwork in pulling together the disparate components and subsystems that make up products such as Raytheon's APG-79 Active Electronically Scanned Array (AESA) radar for the US Navy's F/A-18 air-



TEST ENGINEER OF THE YEAR Hung Nguyen drives F/A-18 AESA radar-system test and integration at Raytheon.

BY RICK NELSON, EDITOR IN CHIEF

TEAMWORK THE RADAR

STEVE LABADESSA

craft. By the time Raytheon gained Navy approval for the APG-79 last summer, it had relied heavily on the efforts of Hung Nguyen, chief scientist at Raytheon Space and Airborne Systems, who possessed the leadership skills required to guide the project team and the broad system knowledge necessary to integrate the various AESA hardware and software components and to troubleshoot the complete radar system. Nguyen remains a key contributor to the program as Raytheon works to deliver 437 systems for the Navy in coming years. Because of his accomplishments, he was nominated for the annual Test Engineer of

the Year award and was voted as the winner by the readers of *Test & Measurement World*.

Thomas A. Kennedy, VP of tactical airborne systems for Raytheon's Space and Airborne Systems business, described the APG-79 as "beyond state-of-the-art"—incorporating as it does a solid-state actively scanned array that replaces the rotating antennas of traditional radar systems, supporting multi-target tracking by "an immense amount of software running on multiple processors." As for Nguyen's contribution, Kennedy said, "Hung has the unique skill set to make sure the RF portion is properly integrated with the digital portion," which performs operations ranging from the common fast Fourier transforms (FFTs) to the other specialized processing necessary to develop usable information from the RF signals.

STEVE LABADESSA

Bill Gardner, Raytheon's tactical airborne systems radar product line director (left), and Thomas A. Kennedy, VP of tactical airborne systems (right), study a simulation with Nguyen.

while providing instantaneous situational awareness to a fighter pilot whose life depends on its correct operation. Kennedy has an affinity for the AESA program. Before his promotion to VP in 2004, he was program manager for the Navy's early AESA radar-development program, taking it from development through test and transition to production.

In air-to-air engagements, the radar allows targets to be engaged at very long ranges and offers reduced air-crew workload via its resource manager. The system also offers high-resolution ground mapping at long standoff ranges for air-to-surface tracking, with an interleaved mode capability and at least a threefold to fivefold increase in system reliability. The system, Kennedy said, provides air-to-air and air-to-ground operation and is driven

The radar revolution

Bill Gardner, Raytheon's tactical airborne systems radar product line director, explained how radar design has evolved to place a greater emphasis on the teamwork that Nguyen facilitates: "Prior designs were based on highly specialized and unique systems architectures and components. Those radar systems/architectures were 'one of a kind,' designed specifically to provide extremely high performance in very stressing environments with minimal consideration for cost and schedule."

But that's no longer the case, he explained, adding, "Today's military defense-budget challenges and advances in the commercial sector have totally antiquated this design strategy and have revolutionized the way we design, fabricate, test, and integrate military radar products. Today's radars, for example, are based on commercial Fibre Channel architectures and standards, they utilize high-speed digital processors that are available commercially, and they integrate commercial design tools."

The revolution, he said, has not been without significant test and integration challenges, adding that "Hung led our industry through these challenges and achieved success with the integration and now production of the APG-79 AESA for the F/A-18E/F Super Hornet."

Gardner elaborated on the challenges involved in leveraging the benefits of advanced microwave and digital technologies in radar systems while achieving high levels of reliability and stability. Modern radar systems, he said, comprise several hundred thousand parts and millions of lines of software code, and they employ extremely complex high-data-rate-communication schemes that must provide for system-critical data transfer under severe timing constraints. "Hung and his team have developed and instituted rigorous test and integration processes, tools, and supporting test equipment to drive fundamental system reliability and stability to the levels required," he said.

Gardner further described the testability challenges: Historically, with one-of-a-kind custom radar systems, engineers could build in testability. But with commercial-off-the-shelf (COTS) components, "you've got what you've got, and you're highly dependent upon what testability is provided with the COTS components. Hung has the skills to take commercial systems with limited testability and adapt them into production-ready testable systems. He is able to adapt commercial products to unique military requirements." Gardner added that while Nguyen has been focused on the new APG-79, he works across all of Raytheon Space and Airborne Systems product lines, including the ASTOR (Airborne Stand-Off Radar) program for the UK Ministry of Defence. That advanced ground-surveillance sys-

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tem will be jointly operated by the Royal Air Force and the British Army.

Nguyen's background is in mathematics, and he has a PhD in the subject from the University of California at Berkeley. That background has positioned him well to have an understanding of all aspects of radar-system design. As Kennedy put it, "Hung works the whole chain—from RF down to DC. He understands all of the different disciplines involved."

The soft-spoken Nguyen may seem an unlikely candidate for gaining the cooperation of the many teams made up of the approximately 8000 employees at the Raytheon facility here. And he himself was unsure whether his career would blossom at Raytheon when in 1985 he joined the Hughes Aircraft division that ultimately, through acquisitions, became Raytheon Space and Airborne Systems.

STEVE LABADESSA

Bill Gardner:

"Hung has the skills to take commercial systems with limited testability and adapt them into production-ready testable systems."

"My background was in mathematics," he explained, "and I was very much interested in problem solving in theoretical mathematics. I didn't at the time have much interest in the applied world of industry. I was interested in understanding and solving problems in the quest for more knowledge."

He had reason to doubt the practicability of theoretical math when, on completing his bachelor's degree at Trinity Christian College, he went to Berkeley. "When I started at graduate school," he commented, "the department chairman in a welcoming speech said, 'If you're thinking about making a living from using mathematics, you should think twice.'"

But he was able to put his education to use as a programmer at what's now Raytheon. He found himself initially focused on the relatively narrow task of programming operator-selectable radar modes, while other teams focused on the development of antennas, transmitters, receivers, processors, and so forth. But what really piqued his interest was his first participation in the integration phase that brings the fruits of each individual team together. "It's a little bit of a marvel to see how your small piece, which you've been working on for two years, becomes part of the big picture."

After several months in the integration lab, Nguyen developed some grasp of a complete radar system. Then the lead integrator was reassigned, and Nguyen was able to fill his shoes. "That, for me, was the turning point," he said. "I got very busy with my work here, and for the last 20 years or so, I've stayed busy, doing the job of system integration and troubleshooting."

His hobby of gardening—from which he draws analogies to the test challenges he faces on the job—suggests a quiet patience. But another hobby—distance running, including marathons—suggests persistence as well as patience. Indeed, development programs director Kenneth Flack described him as "our ace in the hole—a logical and methodical pit bull who won't let go of a problem until it's solved."

Nguyen divides test into two categories. First is verification, in which a product passes a checklist of tests before being shipped to a customer. Second is troubleshooting, in which engineers try to figure out why a product exhibits an anomaly every so often.

"To find out what caused that anomaly, we first determine whether it's a phenomenon that can be duplicated reliably. We then try to narrow down the cause of that phenomenon to a particular piece of hardware or particular piece of software, so we devise tests to find out what the source of the problem is. We try to eliminate potential sources to eventually narrow down our search to the particular source that caused the problem.

"It's just like gardening," he continued. "I plant roses, and if my roses don't grow well, I need to determine whether the problem is the location or too much or too little fertilizer." In fact, he said, "Everyone does some sort of testing every day. We all—not just scientists and engineers—do it all the time."

Mentor and leader

Many of Nguyen's coworkers pointed out that he is not just a team worker but a strong team builder who nurtures

This photograph taken at Naval Air Station Oceana shows the APG-79 AESA radar installed in an F/A-18 Super Hornet. Inset: a Navy maintainer works with the radar. Courtesy of Boeing.

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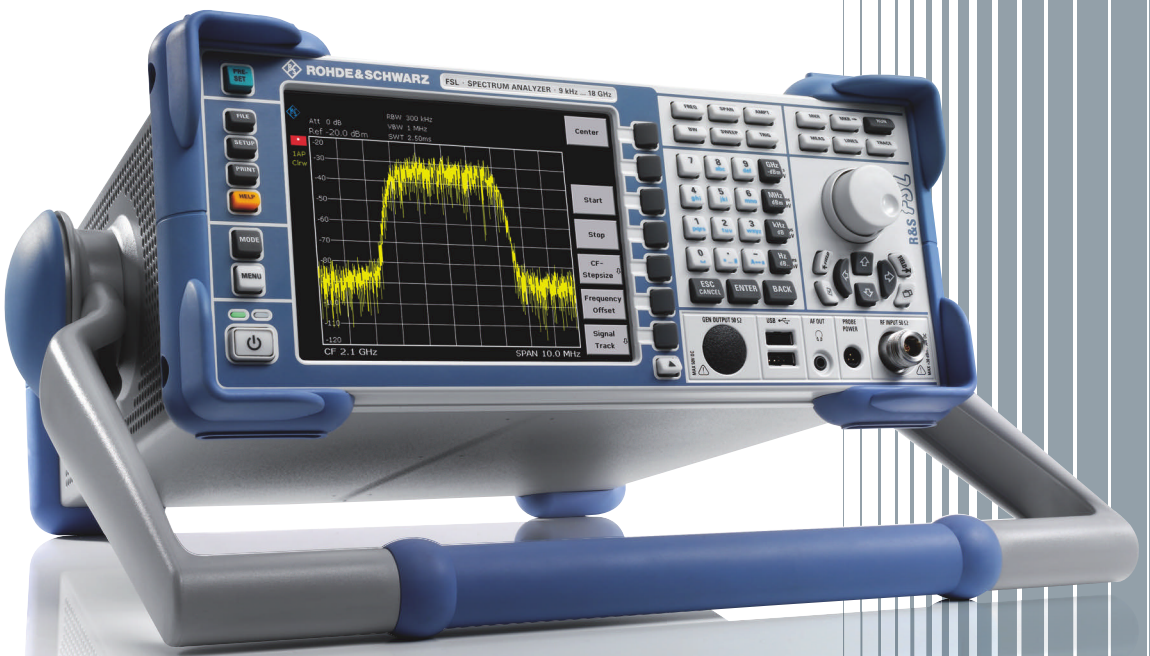

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young engineers. And that's critical, Flack said, because entry-level engineers may have more experience playing video games than in real-world laboratories. Today's young people want everything to operate by push-button, he said, adding, "Well, engineering is not push-button. It's not a game. You can't turn it off."

As Gardner put it, "The industry is in a transitional state. Military defense contractor consolidations that occurred in the past five to 10 years, along with the drain of engineering talent to the commercial sector and the rise in retirements of seasoned aerospace engineers, have opened the gap in highly trained and experienced test and integration engineers." Therefore, he said, the industry must face the challenges posed by the radar revolution with less-experienced personnel. "Hung," he said, "has taken on the role as a leader/mentor to several younger-generation engineers and is key to imparting his level of understanding, intuition, and rigor into the test and integration process. His leadership is critical to developing the next generation of test and integration engineers."

Thomas A. Kennedy:
"Hung works the whole chain—from RF down to DC. He understands all of the different disciplines involved."

STEVE LABADESSA

Ruby Torres, who as deputy director of the systems verification center is responsible for system integration, verification, and validation processes and for the development of test systems, described Nguyen as "a tried and true systems engineer with end-to-end capability and ownership," who works effectively with experienced engineers, entry-level engineers, and customers. "Hung is deeply involved developing our test strategies and in reconciling test requirements" as the disparate components, subsystems, and software that make up a radar system come together. She alluded to manager Ken Flack's comments about Nguyen's pit-bull tendencies: "He's our 'go-to' person. And if something doesn't work, he keeps trying until it does."

Does he have any shortcomings? "Hung is very humble and doesn't promote his accomplishments," she said. That's what prompted her to nominate him for the 2008 Test Engineer of the Year award. T&MW

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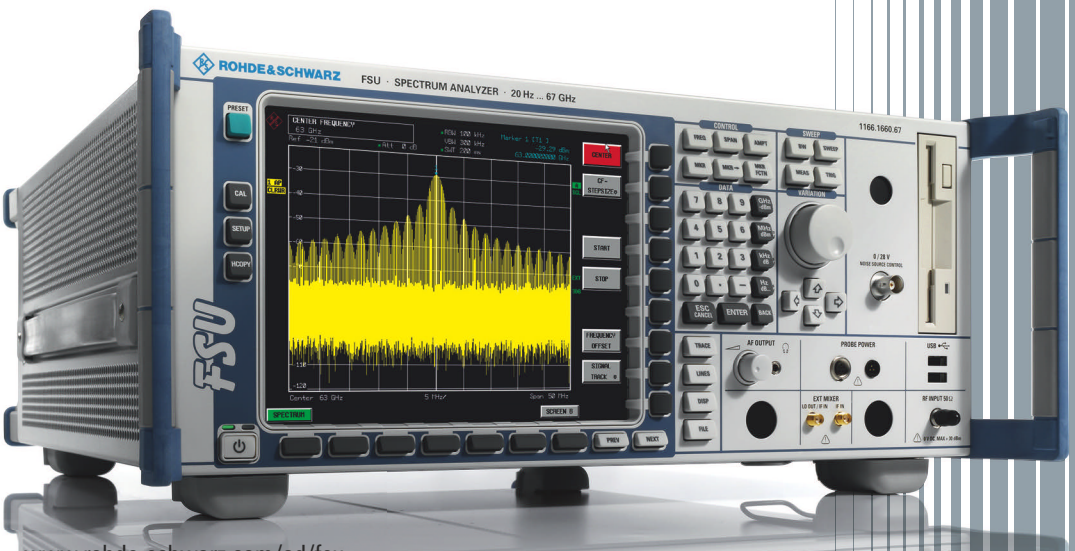

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DC POWER ANALYZER WINS 2008 HONORS

BY RICK NELSON, EDITOR IN CHIEF

Automatically sequencing power to a board or device under test often requires engineers to write code to control a programmable power supply and then write additional code to measure voltage and current. Not so with the N6705A DC power analyzer from Agilent Technologies. The instrument, one of 12 products chosen as 2008 Best in Test winners by the editors of *Test & Measurement World* and voted as the Test Product of the Year by our readers, combines in one mainframe up to four DC power-supply modules as well as digital multimeter (DMM), oscilloscope, arbitrary waveform generator, and datalogger functions. Users can program all of the functions from the instrument's front panel and save instrument sequences for future use.

Hardware and software engineers at Agilent's Bud Lake, NJ, facility contributed to the N6705A DC power analyzer's success. Courtesy of Agilent Technologies.

Kevin Cavell, product manager for the N6705A DC power analyzer, said the concept for the instrument grew out of work done several years ago in the development of low-profile mainframes for rack-mount applications. "They were designed specifically for ATE systems," he said, "and we got a lot of great feedback about them. Our ATE customers loved them, but as we sold more and more, we found they weren't only being sold into ATE systems—they were also being sold into R&D labs." That prompted additional feedback, he said, with customers asking, "Why don't you come out with a more bench-friendly mainframe?" Market research, he said, confirmed the need for such a product.

Cavell pointed out that to take advantage of the capabilities of power modules within the original low-profile mainframe, users would have to write some code. In contrast, he said, "The DC power analyzer was designed to not have to be programmed at all." Of course, users who do wish to program can do so in languages like Agilent Vee or Microsoft Visual Basic by way of the analyzer's USB, GPIB, and LAN (LXI class C) ports. But, Cavell emphasized, a key design goal was to ensure that any function a user might like to do—ranging from generating arbitrary waveforms with some power behind them to datalogging—could be done from the front panel.

To that end, he said, the Agilent team relied on usability experts to come up with the right front-panel design and menu system to make operation intuitive—to give the instrument the look and feel of an oscilloscope, for example, so anyone who knew how to use an oscilloscope could immediately begin making the types of measurements of which the analyzer is capable. That took a significant effort on the part of Agilent's firmware team, who augmented the original low-profile system's code to support the new instrument's front-panel, menu-driven user interface. "It took a little intuition and a lot of programming to put the functionality all together into one box," he said.

Initial reports, Cavell said, indicate that the Agilent hardware and software teams succeeded. Once customers grasp the concept of the product, he said, they realize how much time they can save by not having to put their own systems together and write their own code. He concluded, "They can do tasks in minutes that used to take hours or even days." T&MW

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MARTIN ROWE, SENIOR TECHNICAL EDITOR

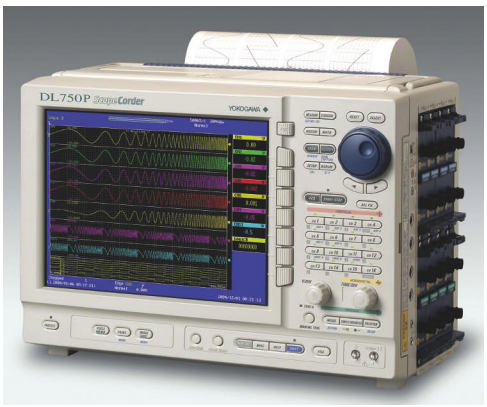
When I look at my digital camera, I'm amazed at how the mechanical engineers managed to fit a lens, motor, battery, memory card, flash, USB connector, circuit board, and controls into a package that easily fits in my hand. The DL750 ScopeCorder from Yokogawa represents an equally impressive packaging job in an instrument that is also a useful measurement tool. The ScopeCorder allows users to trigger and capture instantaneous electrical events or make prolonged trend measurements of physical sensors such as thermocouples or strain gages. It is popular with engineers who make automotive, aerospace, electrical power, and electromechanical measurements.

In recognition of the instrument's reliability and versatility, the editors of *Test & Measurement World* have named it the winner of the 2008 Test of Time award. The annual Test of Time award honors a product that continues to provide state-of-the art performance for at least five years after its introduction (www.tmworld.com/awards).

Yokogawa created the DL700 ScopeCorder in 1997 for electromechanical applications that couldn't be addressed with an oscilloscope or a data-acquisition recorder alone. In 2002, the company unveiled the DL750 model, which is billed as having triple the analog accuracy at half the physical size (355x250x180 mm) of its predecessor.

The DL750 packs a large display on the front, a hard drive inside, and a printer on top. Three USB ports, an Ethernet port, a SCSI port, a video port, a GPIB port, 16 digital inputs, and a ZIP drive, floppy drive, or PC Card drive populate the unit's left side panel, with space for the power plug. On the right side, the DL750 has room for 8 two-channel input modules. It even has a voice recorder for documentation.

In between the inputs and communications ports, the 22-lb DL750 has up to 1 Gsample of memory. You can allocate the memory to any channel or combination of channels.



The DL750 ScopeCorder from Yokogawa packs up to 16 analog inputs, 16 channels, and just about every I/O port imaginable into a portable, large-screen instrument. Courtesy of Yokogawa.

The instrument has all the input modules you'd expect—temperature, strain, acceleration, and voltage. It packs speeds of up to 10 Msamples/s with 12-bit resolution and 1 Msample/s at 16-bit resolution. Most modules provide 1000 V of signal isolation. How did Yokogawa engineers design the DL750? Product manager Joseph Ting explained.

"It is a tremendous challenge to fit our electrical technology, physical controls, I/O, and other hardware functions into the DL750 mechanical package. Although we used both computer and mechanical modeling for various aspects of the mechanical design, we ran into the computational limit of the PC mechanical simulator for thermal investigation. To verify the performance, we created transparent boards and mechanical models, then investigated the flow and speed of air with smoke, and we verified temperature distribution using internal heating elements. From this, we were able to optimize the position, size, and rotational speed of the blower."

Mechanical design challenges weren't the only problems that Yokogawa engineers had to solve. The DL750 had to acquire up to 1 Gsample of data running all 16 channels at 10 Msamples/s. To accomplish that, engineers designed their most complex ASIC up to that time. Ting explained that when designing the unit's GigaZoom engine, which lets you zoom in on any portion of the instrument's 1 Gsample of memory, engineers had to overcome timing problems and debug complex internal logical contradictions inside the circuit block.

Because of those efforts, the DL750 ScopeCorder can capture and analyze data in real time with functions usually reserved for digital oscilloscopes. Functions include channel math (such as sine, cosine, log, and integrals), digital filtering, spectral analysis, and go/no-go limit testing. With all of its capabilities, the DL750 ScopeCorder, according to Ting, is going to have a long life and has yet to reach its sales peak. T&MW

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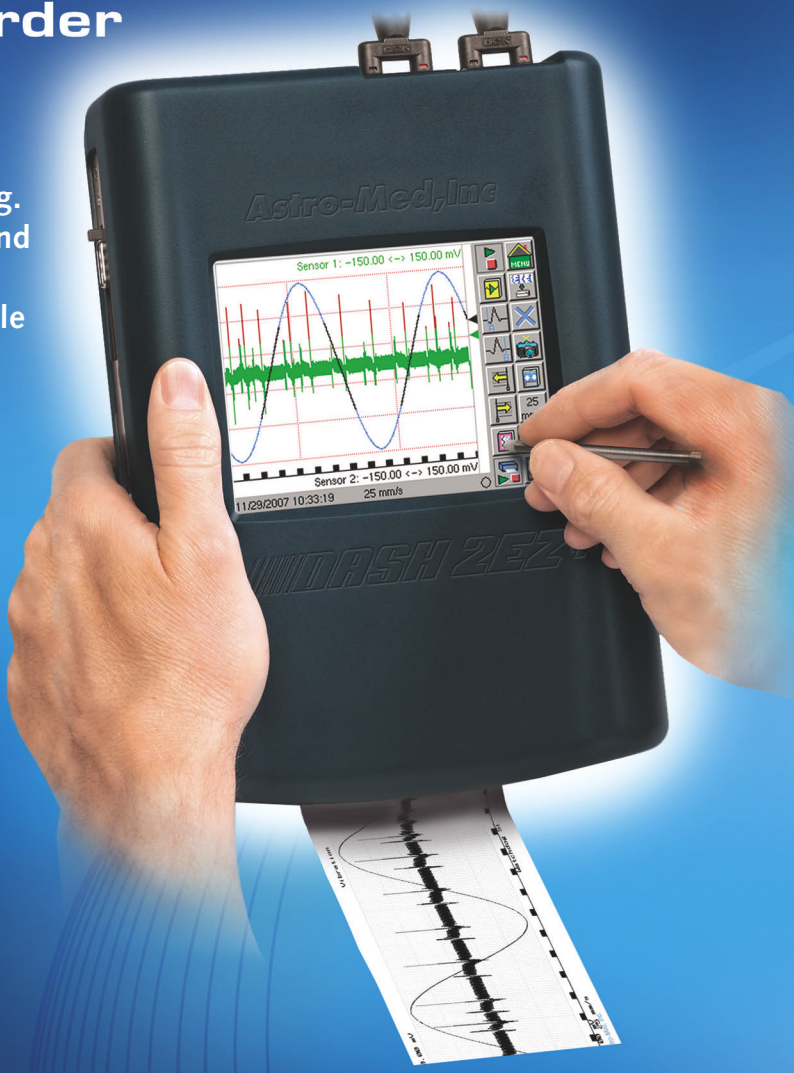

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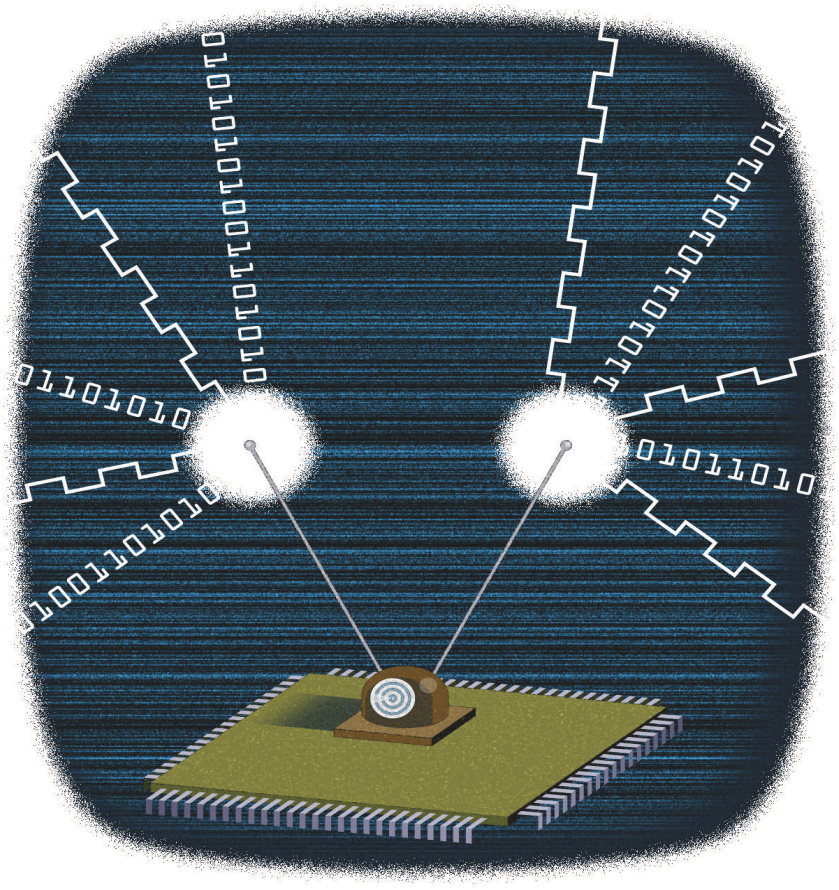

DAN GUIDERA

MIMO challenges existing ATE

BY KEITH SCHAUB, ADVANTEST AMERICA

2008 promises to be an exciting year for the wireless industry, in particular because many multiple-input multiple-output (MIMO) devices will ramp into high-volume production, enabling increases in data throughput and link range through higher spectral efficiency. In order for MIMO technology to become widely accepted by consumers, it will have to cost about the same as present-day wireless technology. This dictates that test-system manufacturers rein in test costs by developing automatic test equipment (ATE) that can handle MIMO devices during high-volume production.

Today, non-MIMO devices such as multibanded cellphones, with anywhere from two to 10 radios, already ship in volume on ATE. You might ask then, what's so different and challenging about MIMO, when the ATE industry has been testing multiple-radio systems successfully for several years? The answer lies in the fact that MIMO systems use the radios simultaneously to take advantage of the multipath effect, meaning at any given time they all are "on," either transmitting or receiving, whereas a multibanded phone has only one radio "on" at any given time. Therefore, to adequately test MIMO devices, ATE systems need an architecture similar to the MIMO systems themselves. Currently, the industry expects to see up to 4x4 MIMO, which will require the ATE to have four independent transmitters and four independent receivers.

This requirement, which will have both business and technical repercussions, is driven by the fact that several key interference signal measurements are performed on radios on ATE systems. Typically, a desired signal plus one or more interfering signals are simultaneously injected into the device under test (DUT) to determine the receiver's ability to detect the desired signal in the presence of interference, blockers, or jamming signals. This multi-DUT testing has traditionally been accom-

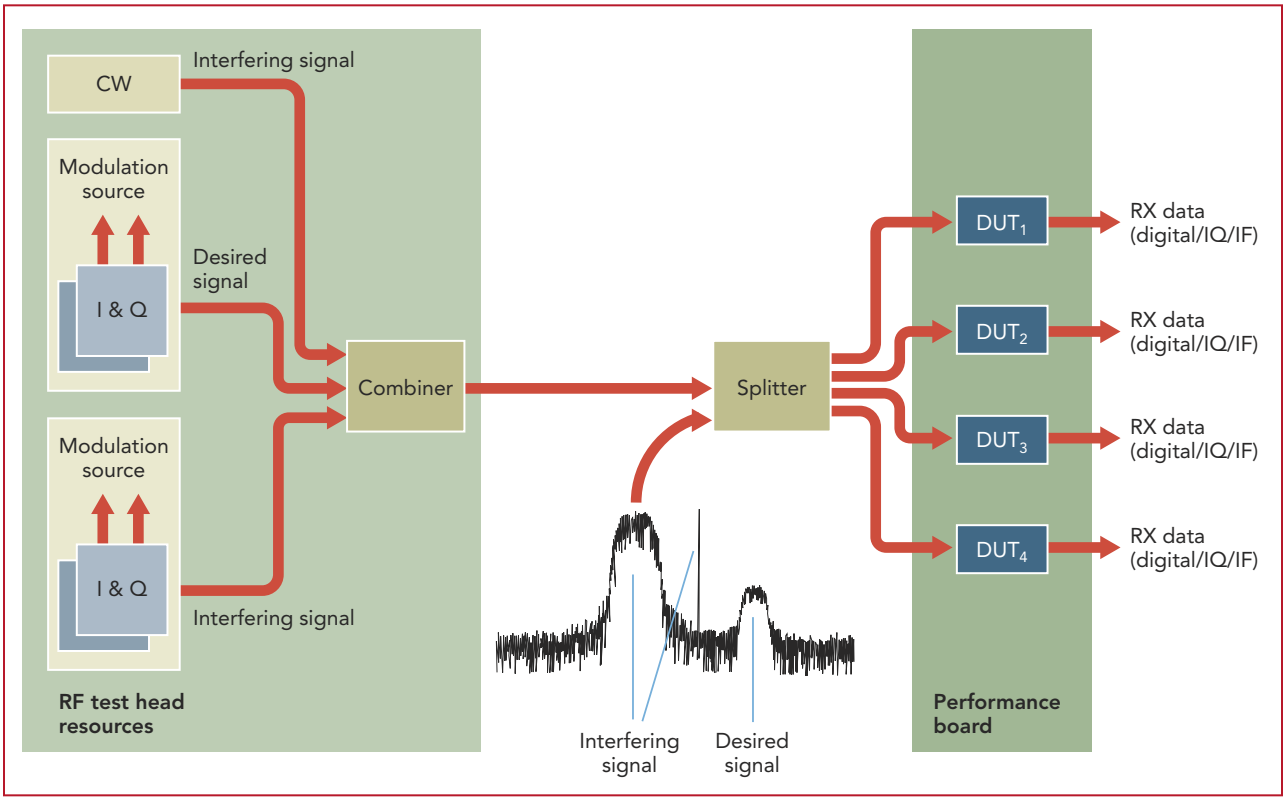

FIGURE 1. In traditional multisite testing, a splitter routes one input signal to several DUTs.

plished by the use of a splitter that routes the same input signal to several DUTs at once (**Figure 1**).

Because MIMO takes advantage of the multipath effect, however, this method is insufficient. To assess a DUT receiver's ability to perform as a MIMO system, the ATE will need to inject it with multiple independent signals with different noise, interfering, and channel characteristics. This means simply using a splitter is not enough.

Instead, manufacturers will need to use quad-site parallel testing for RF/wireless chipsets. ATE systems for MIMO devices will need independent vector signal generators (VSGs) and vector signal analyzers (VSAs) as well as multiple and independent digitizers and arbitrary waveform generators (AWGs), as illustrated in **Figure 2**.

Another challenge facing MIMO test is the amount of data that the test system must handle. MIMO by definition involves considerable digital signal processing. Combining the processing requirements with the need to test multiple MIMO chips in parallel (that is, quad-DUT 4x4 MIMO) leads to a dramatic increase in the amount of test data captured, transferred across the backplane/bus, and processed. Consequently, meeting the required cost of test (COT) targets can become very difficult.

Some vendors have tried to meet this challenge by providing local digital signal processors (DSPs) or field-programmable gate arrays (FPGAs) to reduce the amount of data transferring and reduce the load on the system computer. While this approach does help to reduce the load on the system backplane (bus) and the system controller, the system controller then becomes the master gatekeeper. As a result, the master controller, which still must make all of the decisions regarding all of the MIMO sites, ends up becoming the bottleneck. Not only does this negatively impact throughput, but site independence is lost.

Fortunately, ATE systems that employ multicore processors can now support independent site controllers; this allows each MIMO site to operate completely independently from the other sites. Effectively, the ATE system behaves as if it were four ATE systems in one, enabling device manufacturers to employ innovative testing strategies that drastically reduce the cost of test. Here are two examples:

- Independent programs can be loaded into each site's processor, opening up new characterization and production strategies.
- Handler and tester interfacing can be optimized for minimum test time and maximum throughput. Each site "decides" independently what, when, and how to log and bin its DUT.

With total independence architected into the ATE, new testing models can be created, which ultimately allow the target test costs to be realized for both characterization and production testing.

Load board real estate

There is still another major burden that parallel MIMO testing imposes on ATE, and that is real estate. Newer ATE systems offer smaller footprints that reduce the initial capital cost for device manufacturers. So, the real estate burden is exacerbated by the fact that not only has

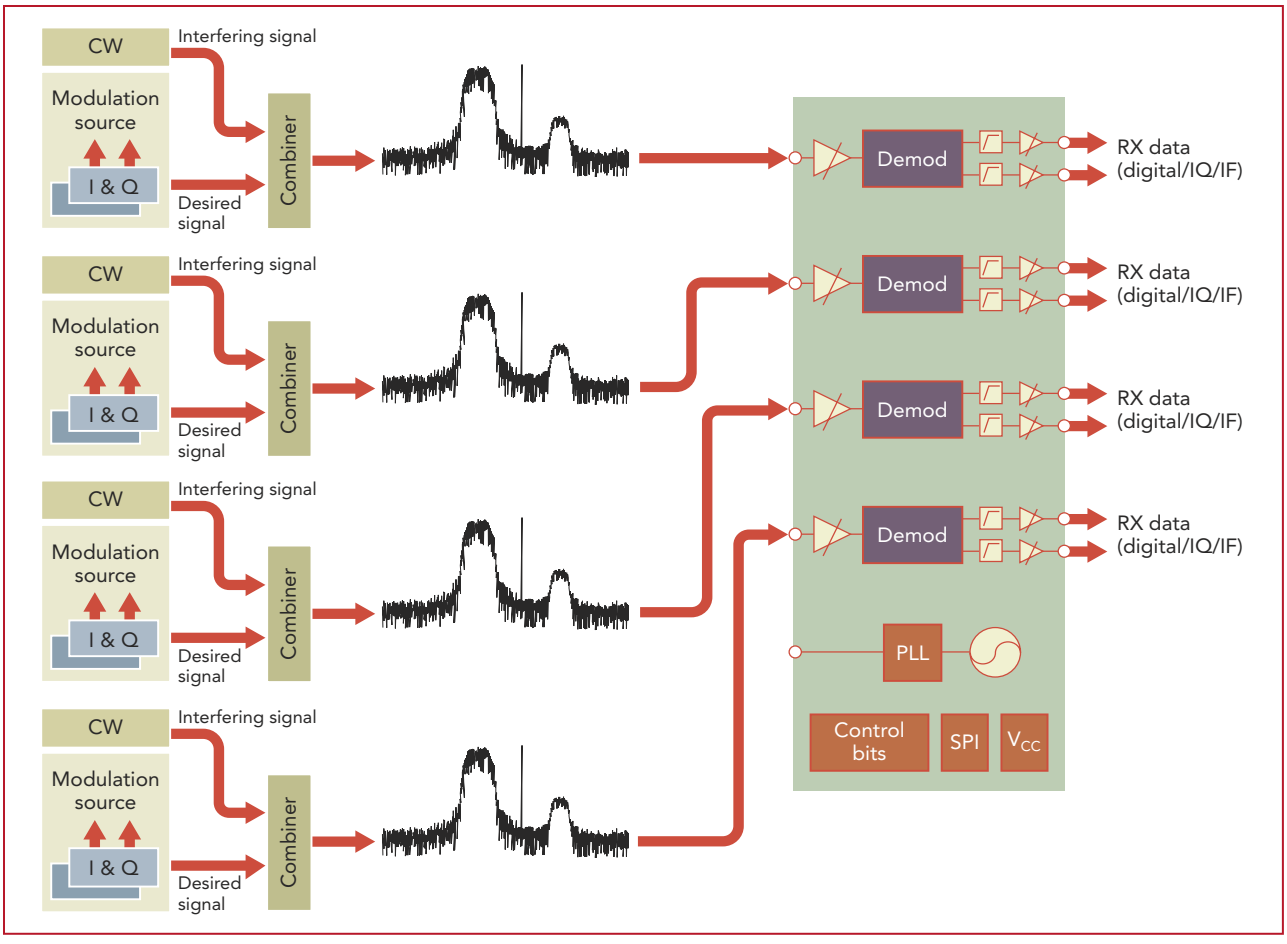

FIGURE 2. A 4x4 MIMO test system must deliver independent, controllable signals to each radio under test.

the RF pin density increased by a factor of 10, but the layout space on the load board has been reduced because of the smaller-footprint test heads.

A quad-site MIMO solution can potentially require up to 32 RF pins for transmit and receive. Even if the ATE system has enough pins, the traditional RF pins found on most ATE systems are SMA connectors, and SMA pins require too much real estate on the performance board.

To achieve quad-DUT and higher parallelism, the SMA pins will have to be replaced by smaller footprint pins like SMPs. Yet smaller pins will not solve the real estate problem by themselves. The RF signal routing to and from these pins and to and from the test head connectors becomes impractical without additional innovation, such as the use of vertical RF pins and the use of an intermediate layout layer architected into the ATE.

The use of vertical RF pins will eliminate the cutouts that are common

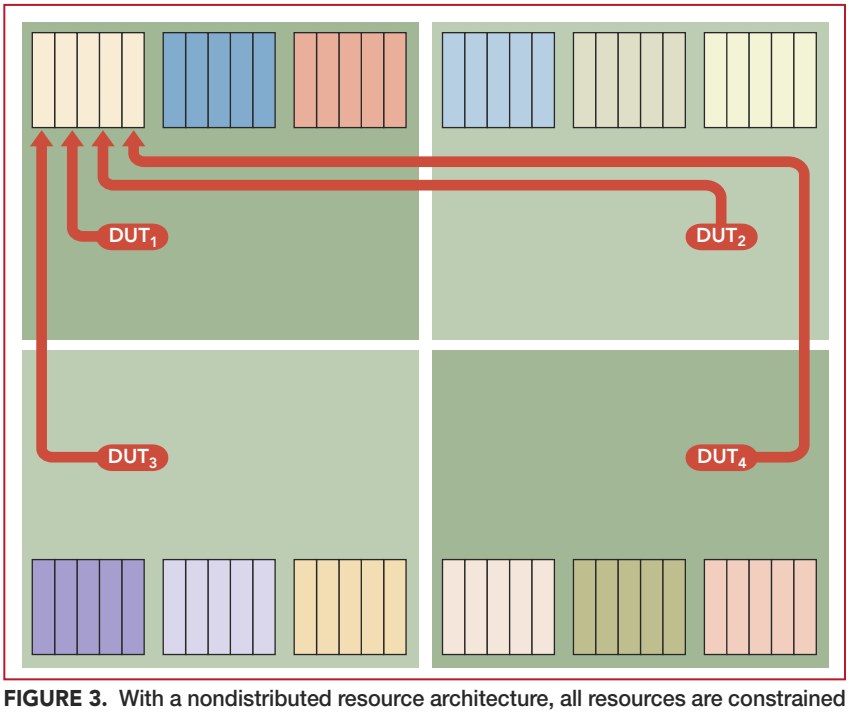

FIGURE 3. With a nondistributed resource architecture, all resources are constrained to a single Pogo block, resulting in nonsymmetrical multi-DUT layouts.

on today's RF boards. Each cutout is a hole that eliminates any possibility of routing signals through it. For a quad-DUT and higher board, the real estate is too valuable to discard, because it is needed for signal routing. The vertical RF pin can minimize or eliminate the cutouts.

reason alone, RF signal routing is always constrained to be on the top layer. Therefore, routing 32 RF pins on the top layer to a single block interface is not practical without an intermediate layout layer. The intermediate layer distributes resources symmetrically across the load board so designers are able to

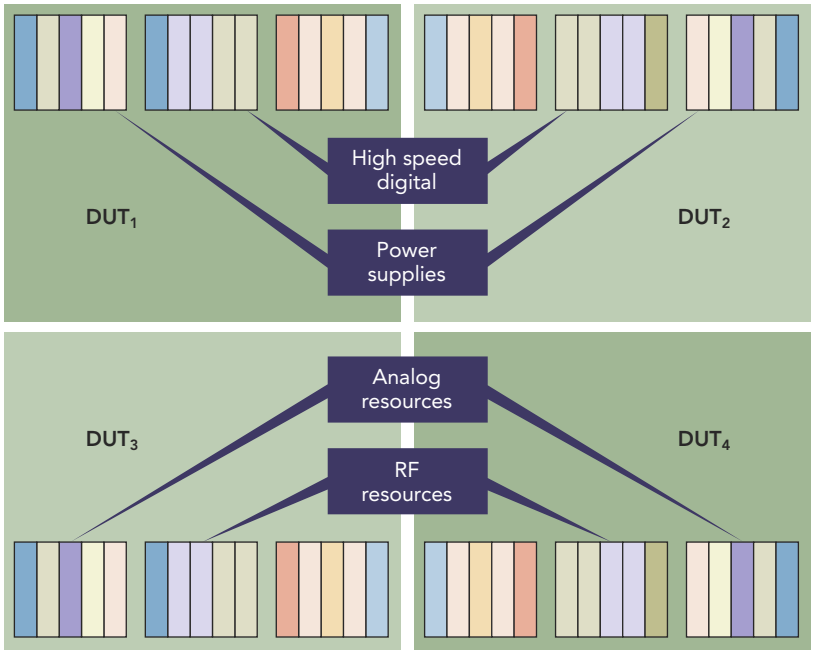

FIGURE 4. A symmetrical performance-board implementation distributes high-density resources in a way that enables designers to route signals uniformly.

Another issue facing system designers is the routing of the test pins. Testers used for system-on-chip (SOC) devices are card based, meaning the customer places the appropriate cards in the test head, and all of the pins for that card interface to a specific Pogo-block or sub-quadrant location (**Figure 3**). The board designer can now lay out the board, but all of the DUT pins specific to a particular module must be routed to the same Pogo-block location. For devices with only a few RF pins, this is a relatively minor issue.

But the single Pogo-block model quickly breaks down for devices with 32 or more RF pins. For most of the pins, including DC and low-speed digital and low-frequency analog pins, the designer can use the multiple layers of the load board. For RF and high-speed digital pins, however, the impedance is paramount and must remain uniformly at 50 Ω throughout the board. For that route the signals symmetrically and uniformly based upon the DUT pinout (**Figure 4**).

It's clear that MIMO devices present multiple challenges to the ATE environment. To meet these challenges, most leading ATE companies have either introduced or will soon introduce multiple receiver products. The true challenge now is to engineer a viable, cost-effective, production-worthy ATE solution that manages the multi-RF receiver resource routing issues, optimizes DUT-to-DUT correlation, and minimizes leakage and cross-coupling isolation in the load board. T&MW

Keith Schaub *is an RF product engineer with Advantest America and is the author of the book* Production Testing of RF and System-on-a-Chip Devices for Wireless Communications. *He has an MS in electrical engineering from the University of Texas, Dallas.*

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DUST AND WATER VAPOR on electronic components can pose risks to product users, so design your products to resist the shorts and shocks that can result from buildup.

DESIGN *for* DUST

BY DAVID LOHBECK, NATIONAL INSTRUMENTS

Just because you work in an air-conditioned office or a temperature-controlled lab and breathe filtered air doesn't mean your equipment won't suffer from indoor air pollution. Dust and moisture still accumulate on printed-circuit boards (PCBs) inside product enclosures, increasing the chance of an electrical breakdown (arc-over) between circuits. Electrical breakdown can put users at shock risk or can result in a product fire. To guard against the negative effects of airborne pollution, you must design products to meet insulation requirements.

Air is a mixture of nitrogen, oxygen, carbon dioxide, argon, and trace gases. When you add dust (particulate matter) and water (vapor), you get indoor air pollution. Studies from state and federal environmental agencies show that indoor pollution levels can sometimes range between two and five times higher than outdoor levels (Refs. 1, 2).

Most indoor dust pollution comes from building materials such as airborne fiberglass, partition fibers, and carpets as well as office machines, copiers, and smoke. The insides of computers in service for only a few months can often be coated with layers of dust, which can cause electrical shorts (**Figure 1**). Metallic dust particles present in industrial environments cause more trouble because they're more conductive than typical office dust. Conductive dust sources include motors, paper shredders, conveyors, and manufacturing and construction processes. Electronic equipment manufacturers often suggest cleaning internal PCBs and air filters in products to prevent dust buildup.

Water pollution also raises safety risks. Water vapor can come from many sources including cleaning products, air conditioners, water coolers, carpets, and fumes, and from the heating of food and beverages. Your breath contains hundreds of drops of water vapor, which you can see form when you breathe on a cold pair of eyeglasses. One person's breathing can produce ¼ cup of water per hour.

Condensation coats the surface of electrical circuitry and can saturate dust coatings. Moisture can

increase conductivity between electrical circuits, which can cause short circuits resulting in product damage, fire, or electrical shock (Ref. 3).

Safety standards address pollution

Although modern buildings use air-filtration systems, dust and water will still build up over time. Product safety standards take air pollution into account, and by designing your product to comply with these standards, you will minimize safety risks.

One thing you need to do is use the proper insulating materials and then provide sufficient distance between components and PCB traces. Electrical insulation, a dielectric, resists the flow of electric current. Dielectric strength is a measure of an insulating material's ability to withstand voltage stress without failure. The amount of insulation you need depends on the voltage and intended environment of your product.

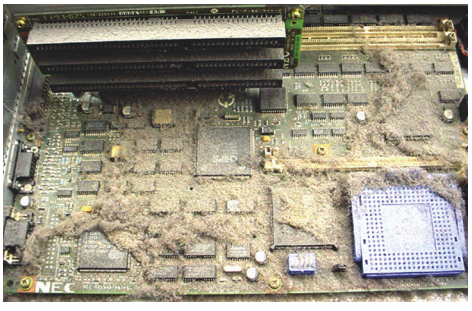

FIGURE 1. Dust can accumulate on PCBs, which can cause electrical failures and safety hazards.
Courtesy of www.computerservicesusa.com/dirty_computers.html.

Plastics and air are two common insulators used to separate circuits and prevent unsafe current flow. Using air as insulation raises concerns about environmental pollution. The addition of solids, liquids, or ionized gases and moisture can reduce dielectric strength. Product standards such as IEC 60947-1 classify environmental conditions according to the amount and frequency of occurrence of hygroscopic dust, ionized gas, and salt, with regard to relative humidity (Ref. 4).

Product standards also specify "pollution degrees" for various types of products. The pollution degree defines the level of dust and water pollution within a product's operating environment. Pollution degrees range from 1 to 4, with higher numbers indicating more dust and water in the environment. **Table 1** explains the four pollution degrees.

Table 1. Pollution degrees and their descriptions

Pollution degree level	Description
1	No pollution or only dry, nonconductive pollution, which has no influence on safety. You can achieve pollution degree 1 through encapsulation or the use of hermetically sealed components or through conformal coating of PCBs.
2	Nonconductive pollution where occasional temporary condensation can occur. This is the most common environment and generally is required for products used in homes, offices, and laboratories.
3	Conductive pollution or dry nonconductive pollution, which could become conductive due to expected condensation. This generally applies to industrial environments. You can use ingress protection (IP) enclosures to achieve pollution degree 3.
4	Pollution that generates persistent conductivity, such as by rain, snow, or conductive dust. This category applies to outdoor environments and is not applicable when the product standard specifies indoor use.

Pollution degree 2 generally applies to homes, offices, and laboratories (**Figure 2**). For example, pollution degree 2 is appropriate for information technology equipment (IEC 60950-1), test and measurement equipment (IEC 61010-1), household appliances (IEC 60335-1), audio-visual equipment (IEC 60065), electronic equipment (ECMA-287), and industrial control products (UL 508).

Insulation, creepage, and clearance

An environment's pollution degree, combined with electrical and environmental factors such as working voltage and overvoltage category, can affect a product's insulation. The working voltage is the highest AC RMS or DC voltage across the insulation that a product can withstand. The overvoltage category classifies the power source according to potential voltage transients (spikes) on the power line.

Overvoltage category II, for example, applies to 120/230 VAC mains outlet power. Home, office, laboratory, and manufacturing power typically fall into category II, which includes computers, measurement instruments, appliances, and televisions.

Inadequately insulated hazardous voltages can cause fires or shock. Hazardous voltages are those greater than 30 V_{RMS} and 42.4 V_{pk} or 60 VDC. Many products contain both hazardous and nonhazardous voltages.

User-touchable voltages must be nonhazardous; such voltages are also called safety extra-low voltage (SELV). SELV circuits often run at low power and logic levels, such as ±3.3 to ±24 VDC. Examples of user-touchable circuits are input/output connectors and cables used to attach peripheral devices such as printers, keyboards, monitors, and external drives.

You must insulate hazardous voltages from user-touchable circuits. There are several types of insulation:

- *Functional* insulation ensures correct product operation but does not provide safety protection.
- *Basic* insulation provides a single layer of insulation.
- *Supplementary* insulation is the addition of an independent layer of insulation to basic insulation. *(continued)*

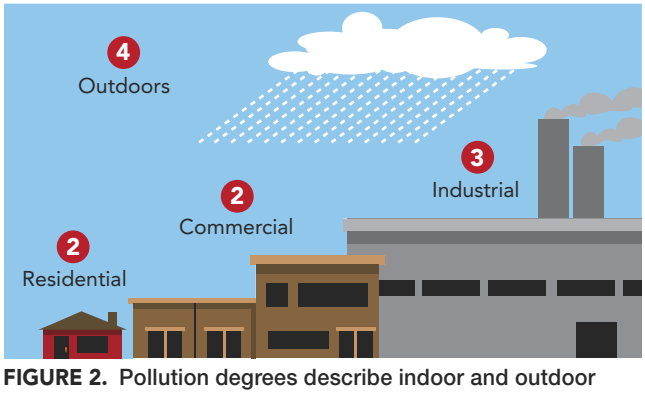

FIGURE 2. Pollution degrees describe indoor and outdoor environments. Artwork by Melinda Vaughan, National Instruments.

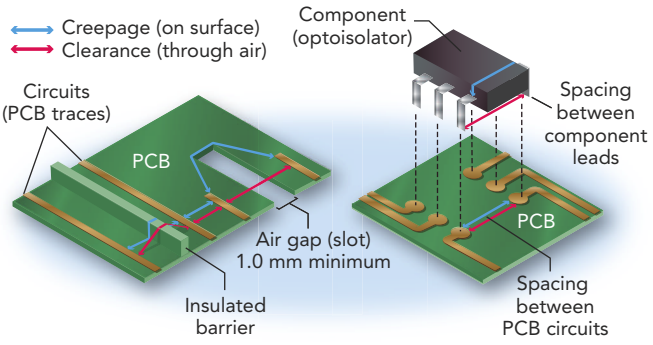

FIGURE 3. Safety standards specify creepage and clearance spacing. Artwork by Melinda Vaughan, National Instruments.

- *Double* insulation combines basic and supplementary insulation.
- *Reinforced* insulation is a single system that provides the same protection as double insulation.

Safety standards require that you protect users from hazards during the normal operation of a product and under an abnormal (single-fault) condition. Double or reinforced insulation provides this protection; in the event of a failure of the basic insulation, a second layer remains for protection.

Tables in the standards specify insulation spacing values between two circuits. To prevent electrical breakdown, you need to increase the spacing distance as the pollution degree increases (**Table 2**).

Two other factors to consider are creepage and clearance, which define circuit spacings measured from the closest two points across the insulation, such as between PCB traces or between the edges of PCB pads around soldered connections (**Figure 3**). *Creepage* is the shortest distance across a surface between conductive circuits. *Clearance* is the shortest path through air between the circuits. Insulating barriers or slots can influence design decisions about spacing between circuits. Pollution, relative humidity, and condensation can affect creepage distances. Clearance is most affected by air pressure and temperature.

Figure 4 illustrates a 300-V digital multimeter (DMM) designed for use in a pollution degree 2 environment. The DMM needs reinforced spacing of 3.0 mm minimum between the 300-V input and the 5-V communication ports. *(continued)*

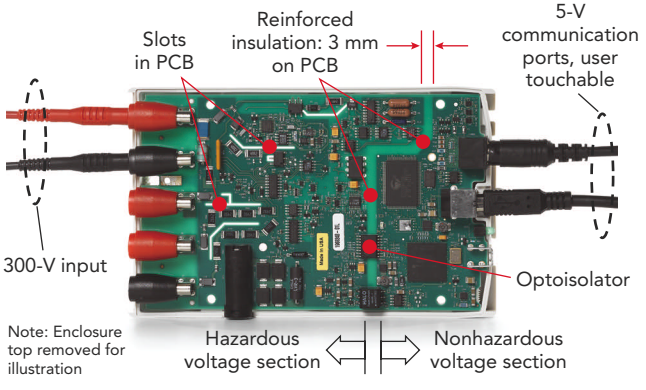

FIGURE 4. Insulation separates the hazardous voltages from nonhazardous voltages on a PCB.

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Testing for safety compliance

The IEC standards also specify an electric strength test that stresses the insulation beyond what it should encounter in normal operation. This test is called a dielectric-withstand or high-potential (hipot) test. Dielectric tests consist of measuring the leakage current through the product's insulation under a high voltage (overvoltage) for 1 min. Insulation failure occurs when an arc-over occurs, causing excessive current to flow.

The dielectric test voltage is based on the working voltage and the required insulation, such as 2500 V_{RMS} hipot from the input-to-communication connections in the DMM in Figure 4. To simulate water pollution on PCBs and components, you should perform dielectric tests after 48 hr of humidity preconditioning. Product designers should focus on insulation spacings first, because dielectric testing does not reduce or eliminate the required spacing distances. T&MW.

Table 2. Double or reinforced insulation for a 300-V product

	Pollution degree	
Spacing type	2 (typical products)	3 (industrial areas)
Clearance	3.0 mm	3.0 mm
Creepage on PCBs	3.0 mm	10.0 mm

REFERENCES

1. "Air Quality in Offices," Vermont Department of Health, healthvermont.gov/enviro/indoor_air/air_office.aspx.
2. "The Inside Story: A Guide to Indoor Air Quality" US Environmental Protection Agency. www.epa.gov/iaq/pubs/insidest.html.
3. "Humidity and the Indoor Environment," Minnesota Blue Flame Gas Association. www.blueflame.org/datasheets/humidity.html.
4. IEC 60947-1, Low-voltage switchgear and controlgear - Part 1: General rules, International Electrotechnical Commission, www.iec.ch.

FOR FURTHER READING

IEC 60664-1, Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests, International Electrotechnical Commission, www.iec.ch.

Lohbeck, David, "Safety isolation protects users and electronic instruments," *EDN*, September 30, 2004. p. 59. www.edn.com/article/CA454635.html.

Lohbeck, David, "Hazardous-voltage primer," *EDN*, May 11, 2006. p. 39. www.edn.com/article/CA6330100.html.

"Safety Articles and Videos," National Instruments Product Certification. zone.ni.com/devzone/cda/tut/p/id/5427.

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Optical power meters connect four channels at once

Manufacturers of fiber-optic components are always under pressure to slice test time. The N7744A (four-channel) and N7745A (eight-channel) optical multiport power meters can help by providing multiple measurements on one meter. These displayless meters feature a mechanical interface that lets you connect four inputs at a time through a connector that holds four optical fibers. (The N7745A has two four-port connectors.) The four-port connector (photo) can travel with four fibers through production, reducing connect time.

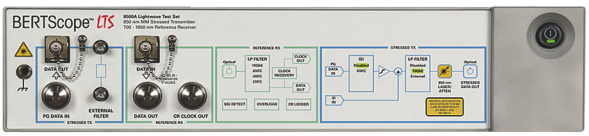
The power meters use InGaAs optical sensors and operate at 1250-nm to 1625-nm wavelengths. They cover a power range of –80 dBm to +10 dBm, and they can log 1 million measurements per port. Dynamic range covers 55 dB to 65 dB, depending on measurement averaging time, with better than 55-dB return loss. The meters connect to a host computer through USB and Ethernet ports.

Prices: N7744A—$9500; N7745A—$14,500. *Agilent Technologies, www.tm.agilent.com.*

Stress test optical receivers

Synthesys Research, makers of the BertScope, has added the first signal source to its product line. With the Lightwave Test Set (LTS) 8500A, you can test optical receivers for jitter tolerance. The 8500A is an 850-nm multimode optical transmitter that works in conjunction with the company's BertScope bit-error-rate (BER) tester/oscilloscope and the BertScope DCRj clock-recovery module. The 8500A lets you perform stressed-eye testing on optical receivers such as XPF and SPF+ types.

The LTS 8500A has an average optical output power that ranges between 0.6 mW and 1.1 mW. It tests receivers used for Fibre Channel (10x, 8x, 4x, 2x, and 1x speeds) as well as 10-Gbit Ethernet receivers. It includes a switchable risetime filter that lets you adjust the risetime of an optical signal. You can also connect an external filter. With the optional reference receiver, you can use the LTS 8500A to test transmitters as well. The receiver also lets you calibrate your stressed-eye signals when testing receivers.



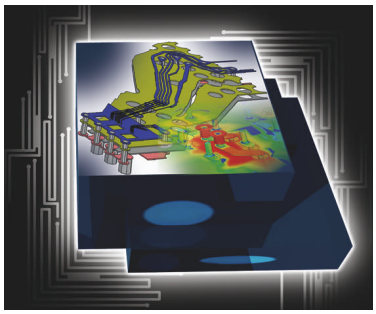
To operate the LTS 8500A, connect it to a PC through a USB port and run the user-interface software. With the software, you'll get plots of the receiver's performance.

Base price: $49,000. *Synthesys Research, www.bertscope.com.*

Ansoft updates 3-D parasitic extraction software

Version 8 of Q3D Extractor, Ansoft's 3-D parasitic extraction program, includes a new capacitance solver that extracts the capacitance and conductance of lossy dielectrics. The solver is optimized to exploit available computer memory and perform multiple frequency evaluations.

Used in the design of multilayer boards, complex IC packages, and on-chip passive components, Q3D Extractor performs the 3-D and 2-D electromagnetic-field simulation required for the extraction of RLCG parameters from an interconnect structure and automatically generates an equivalent SPICE subcircuit model. The model can then be used to perform signal-integrity analysis to study electromagnetic phenomena, such as crosstalk, ground bounce, interconnect delays, and ringing.



Version 8 of Q3D Extractor also adds infinite ground plane capability, multiprocessing and distributed analysis options, a frequency-dependent dielectric loss model (Djordjevic-Sarkar), GDSII export, and a revised user interface for the 2-D extractor that improves 2-D modeling and lets you perform discrete and interpolating frequency sweeps. Q3D Extractor is available for Windows, Linux, and Solaris.

Ansoft, www.ansoft.com.

B&K Precision touts multirange DC power supply

Differing from conventional power supplies with fixed outputs, B&K Precision's Model 9110 DC power supply automatically recalculates the voltage/current limits for each setting and provides 100 W of output power in any voltage/current combination within its rated limits of 60 V and 5 A. By expanding the number of maximum power volt/amp combinations, the Model 9110—a digitally controlled, mixed-mode linear/switching supply—enables you to reduce the number of individual power supplies needed for an application.

The Model 9110 provides 10-mV/1-mA resolution over its full range. The unit can store and recall 4x100 groups of preset volt/amp values, and it features overcurrent, overvoltage, and overtemperature protection.

By automatically recalculating voltage/current limits, the power supply forms a constant-power hyperbolic-shaped boundary. For example, when setting the voltage to the maximum of 60 V, the maximum current value is 100 W/60 V = 1.66 A. For a 20-V setting, the maximum current is 5 A. Full output power of 100 W is possible for all volt/amp combinations that lie on the hyperbolic curve.

Price: $275. *B&K Precision, www.bkprecision.com.*

PXI modules perform ARINC 608A switching

Expanding its line of products for the aerospace market, Pickering Interfaces has introduced two PXI switching modules that route signals in avionics test systems. The modules can be used in any 3U PXI chassis as well as in Pickering's LXI modular switching chassis.

The 40-569 module comes as a four-slot or eight-slot BRIC module that integrates a 16-wire analog backplane to accommodate resource distributor and bus matrix input daughtercards in accordance with Appendix D of the ARINC 608A specification. The scalable design permits the inclusion of up to two resource distributor subsystems and up to six bus matrix subsystems in an eight-slot BRIC module.

The 40-618 is a source switching module that implements the switching functions defined in Appendix D of the ARINC specification. It comprises 12 4:1 multiplexers and 44 SPST uncommitted relays in a single-slot PXI module.

All modules employ electromechanical relays with 2-A switch/carry current and 250-VAC/220-VDC voltage ratings. Both the 40-569 and 40-618 are implemented in a 3U PXI format that is compatible with the 60-100 LXI modular switching chassis, permitting the modules to be controlled through either a PCI- or an LXI-compliant interface. Pickering reports that it has worked with MAC Panel to ensure that a Scout mass interconnect system is available to simplify integration of the modules into aerospace test systems.

Pickering Interfaces, www.pickeringtest.com.

Omega launches wireless RS-232-to-USB transceiver

With Omega Engineering's Model WRS232-USB universal wireless RS-232-to-USB transceiver, you can make any RS-232 device wireless. Simply connect the wireless transmitter module to the device's RS-232 interface and the wireless receiver module to the USB port of a PC. The RS-232 device can now communicate as if it was directly connected to the PC.

A single wireless receiver module can operate with multiple wireless transmitter modules up to 120 m away on a clear line-of-sight. The WRS232-USB operates over the 2.4-GHz ISM band and can be used in both portable and fixed-mount industrial applications. A 9-VDC adapter for the wireless transmitter is optional.

Price: $159. *Omega Engineering, www.omega.com.*

FREE WEBCAST

BENEFITS OF REAL-TIME ANALYSIS TECHNIQUES AND MEASUREMENTS FOR RADIO COMMUNICATIONS

In the days of analog communications, everything was real-time. Broadcast communications and analog radios provided real-time sensory analysis on the quality of the signal being received. Real-time analysis has undergone rapid transformation in the advent of modern digital radio development. As the processing power of the computer world blends into the world of RF, the resulting Digital RF technologies require new real-time tools for development and analysis.

Whether analyzing the propagation of MIMO radio signals, amplifying the latest WiMax or LTE amplifiers, or debugging Software Defined Radios, real-time analysis techniques and measurements enable the rapid development of Radio Communications systems.

SPEAKER:
Marcus Dasilva
Manager of Strategy & Advanced Technology, Tektronix

Date: Tuesday, April 15, 2008 **Time:** 9:00 am PDT, Noon ET

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CATALOGS & PRODUCTS

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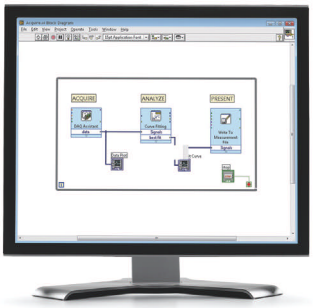


Test drive software online

National Instruments' LabView software offers powerful features for creating user-defined design, control, and test and measurement systems. You can view interactive demos and try LabView free online. *National Instruments, www.ni.com/labview/whatis/.*

High-speed camera

The Phantom V5.2 high-speed digital camera can capture up to 1000 pictures per second at a resolution of 1152x896. It is designed for capturing fast-moving events associated with R&D and manufacturing applications. *Vision Research, www.visionresearch.com/go/tmw.*

3.0-GHz spectrum analyzer

Instek's GSP-830 3.0 GHz spectrum analyzer offers features such as autoset, a USB interface, and a 6.4-in. TFT color display. The battery option, lightweight design, and low noise floor make the unit appropriate for the lab or the field. *Instek America, www.goodwill.com.tw.*

Accessories and instruments brochure

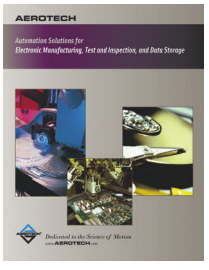
AR's *RF & Microwave Accessories & Instruments* brochure highlights signal generators, system controllers, directional couplers, EMC test software, test cells, and field-monitoring equipment. Photographs, descriptions, and specifications are included for each model. *AR RF/Microwave Instrumentation, www.ar-worldwide.com.*

Embedded vision system

The Matrox 4Sight X high-performance embedded system for image capture, processing, and display features Intel multicore CPU and GPU technology. A small footprint and rugged construction make it ideal for demanding industrial environments. *Matrox Imaging, www.matroximaging.com.*

Motion-control products

Automation Solutions for Electronic Manufacturing, Test and Inspection, and Data Storage presents motion-control products for electronic assembly, pick-and-place, PCB laser drilling and stencil cutting, wafer singulation, and automated optical inspection. *Aerotech, www.aerotech.com.*



Connector catalog

VPC has released a new catalog for its iCon rack-and-panel connector that contains 12 new modules and two new configurations. New features include a 75-Ω high-definition coaxial connector and PCB-mountable capabilities. *Virginia Panel Corp., www.vpc.com.*

Distribution amplifiers

SRS has introduced the FS730 series of distribution amplifiers for signal distribution of 10-MHz, 5-MHz, CMOS logic, broadband (50/75 V), and SDI video sources. The amplifiers are available in bench and rack-mount configurations. *Stanford Research Systems, www.thinkSRS.com.*

Adjustable-height cart

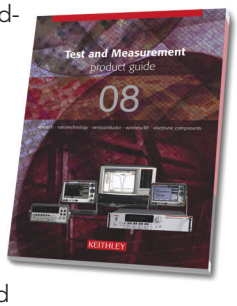
Anthro has introduced Zido, a compact cart with a small, sturdy frame and 4-in. casters. With various widths and heights, Zido provides flexibility in a cart for smaller spaces. *Anthro, www.anthro.com.*

32-channel acquisition

The Dash 32HF is engineered for capturing high-frequency data and transients. It records up to 32 channels to an internal hard drive at sample rates of up to 500 kHz. *Astro-Med, www.astro-med.com/tmindex.html.*

T&M product guide

Keithley's 2008 product guide includes useful tutorials and selector guides as well as information on the company's newest innovations in test and measurement. The guide covers instrumentation and software designed to handle challenging test and measurement applications. *Keithley Instruments, www.keithley.com.*



Four-camera frame grabber

The PIXCI SI4 frame grabber from EPIX can expose four Silicon Video cameras from one trigger or use four triggers for four cameras. Cameras may be identical or mixed. The board includes the company's XCAP-Lite imaging software. *EPIX, www.epixinc.com.*

In-line telecentric lenses

EO's series of in-line illumination telecentric lenses feature a compact size, a long working distance, and ⅔-in. maximum sensor format. These lenses correct perspective errors throughout the depth of field to avoid changes in magnification. *Edmund Optics, www.edmundoptics.com.*

CATALOGS & PRODUCTS

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

Fixed power supply

Amrel's military-grade MFP-1200 fixed power supply pushes the power envelope to enclose 1.2 kW in a 16x7.5x3.5-in. package. The MFP-1200 is certified to MIL-STD-810F/461E for resistance to rain, dust, humidity, shock, vibration, extreme temperatures, and electromagnetic emissions. *Amrel, www.amrel.com.*

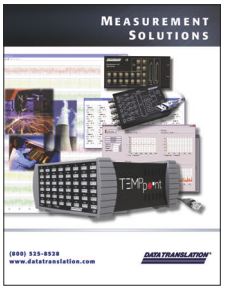
Dynamic signal analyzers

IOtech's 600e Series of Ethernet dynamic signal analyzers offers an economical solution for vibration monitoring, NVH measurements, and rotating machinery analysis. Four software packages are tailored to a particular type of vibration measurement and analysis application. *IOtech, www.iotech.com.*

RF test socket

A new socket for devices up to 13mm² is available in four versions with ratings of 1–3 GHz, 3–5 GHz, 5–9 GHz, and 10–18 GHz. The socket offers minimal signal loss for higher bandwidth capability and solderless, pressure-mount, compression-spring probes. *Aries Electronics, www.arieselec.com.*

Measurement solutions



Data Translation's product guide offers an overview of USB data-acquisition, temperature-measurement, sound and vibration, and test and measurement software products. Comprehensive charts simplify product selection. *Data Translation, www.datatranslation.com.*

Low-frequency VNA

The wide frequency range (1 Hz to 40 MHz) of the PC-controlled Bode 100 vector network analyzer is ideal for many RF and low-frequency applications such as control circuit analysis. *OMICRON Lab, www.omicron-lab.com.*

Temperature datalogger

The OM-CP-HiTemp-150FP is a small, rugged, reusable temperature datalogger designed for harsh environments. It comes standard with a

silicone rubber cable and a stainless-steel probe and body. *Omega Engineering, www.omega.com.*

Versatile bench multimeters

Fluke's 8845A/8846A 6.5-digit multimeters are ideal for R&D or automated test systems. In addition, the company's 8808A 5.5-digit meter is designed for manufacturing, development, and service. *Fluke, www.fluke.com.*

USB-based JTAG system

The NT3000 CPU Commander interfaces to the unit under test through an on-chip debug or JTAG port. The NT3000 is a high-performance JTAG and background-debug-mode diagnostic system designed for functional test and troubleshooting of microprocessor systems. *Navatek, www.navatek.com*

Electronic loads

The XBL Dynaload Series features 800-, 2000-, 4000-, and 6000-W models with a wide range of voltage inputs and computer programming via GPIB, Ethernet, or RS-232. All models include master-slave parallel capabilities. *TDI, www.tdipower.com.*

LXI RFIUs

The EX7000 family of modular microwave subsystems features an open-architecture Ethernet/LXI platform that cuts the development time and costs of building custom COTS-like RF interface units with its common hardware platform and communications interface. *VTI Microwave, www.vtimicrowave.com.*

Lab automation products

MRV's test-management and automation products are designed to increase the efficiency in the test lab environment, enabling more tests and results in less time with fewer resources. *MRV Communications, mrv.com/tap.*

High-performance BNC DAQ

Measurement Computing's USB-1616HS-BNC is a BNC connector multifunction, measurement and control device that features 16 single-ended and eight differential 16-bit analog inputs, multiple ranges, 24 digital I/O ports, four counter inputs, and two counter outputs. *Measurement Computing, www.mccdaq.com.*

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Small components challenge inspection throughput

By Steve Scheiber, Contributing Technical Editor

Any discussion of printed-circuit-board inspection must address the tradeoffs between methods and process points. Josh Petras, product manager for YESTech, explained how a combination of automated optical inspection (AOI) and x-ray inspection can address this perpetual dilemma.

Q: How do you maximize throughput with ever-smaller devices?
A: Consider a typical AOI sensor configuration consisting of a digital camera with constant resolution and a fixed-focus lens. The smallest detectable inspection feature depends on lens magnification. At some point, shrinking components and solder features will become too small to analyze accurately. Increasing magnification reduces the field of view, so the AOI system would have to acquire more images for the same area. Increasing the camera's resolution with a larger sensor but equivalent frame rate costs more and typically requires higher quality optics and more post-processing PC hardware.

INSIDE THIS REPORT

Q: And if you can't justify the expense?
A: In that case, you can outfit a single system with several cameras and lenses. This allows the AOI operator to select resolution on-the-fly in software. You might mount a 25-micron (pixel-size) camera/lens configuration for lower-resolution bar codes and to verify component placement and mount a 12.5-micron configuration to inspect 0201s and other fine-pitch devices, thereby providing the best balance of magnification and speed.

Q: How does x-ray fit into the picture?
A: Although there is some overlap, AOI gives a fast picture of component placement and other visible features, while x-ray provides the best inspection of solder joints, especially on ball-grid arrays, chip-scale devices, and other devices with hidden joints.

Maintaining two individual machines allows you to fine-tune each to balance detection and inspection speed. In addition, you can place the AOI system either directly in front of x-ray at post-reflow or at pre-reflow. Either way, results pass to the rework operator as a unified report.

Q: When would such a dual-system solution be most advantageous?
A: You would generally adopt it with high-reliability boards where throughput is important and where you can justify the cost of repair. Repairing high-reliability boards tends to be easier than repairing cellphones and similar products because they don't generally include as many small components.

Josh Petras
Product Manager
YESTech
Courtesy of YESTech.

Q: What happens when repair is difficult or not cost effective?
A: In those cases, we advocate you "inspect early and often." Process monitoring is more important because you will need to scrap most defective boards. The goal is to identify the defect trends and modify the process to prevent them.

Q: Should you inspect before or after reflow?
A: It depends. Suppose a component is slightly off-pad. The pre-reflow step identifies it as a failure, but the liquefaction of the solder during reflow causes it to correct itself. If you repair based only on pre-reflow results, some repairs may be unneeded. The beauty of the dual-system approach is it lets you keep x-ray at post-reflow but move AOI to where it will best address your production problems. □

EDITOR'S NOTE

An Internet show

Steve Scheiber, Technical Editor

Once upon a time, going to a trade show meant flying to a central location, taking up residence in a hotel or conference center, visiting manufacturers' booths, and listening to seminars and technical papers from a variety of points of view. But costs, security issues,

and other factors reduced companies' enthusiasm for such activities, and trade-show attendance fell off dramatically. Numerous shows simply died.

But what was the alternative? How could engineers and managers evaluate and compare the latest inspection system without spending the time traveling to all the vendor candidates and examining their offerings?

Enter the "teleshow." For two days in February, PCB inspection vendors like Agilent Technologies joined their colleagues from other parts of the manufacturing-and-test process to hold a trade show over the Internet (www.virtual-pcb.com). Users could sign in at any time and enjoy approximately the level of personal service that one would expect from the onsite version.

It's difficult to say whether this event signals a paradigm shift, but it's hard to deny its advantages. As price erosion continues to work at cross purposes to increasing product complexity, companies have to find shortcuts that reduce costs without compromising quality. Eliminating travel expenses and drastically reducing time away from the office boosts overall productivity. Everybody wins. You just can't "kick the tires." □

Contact Steve Scheiber at sscheiber@aol.com.

HIGHLIGHTS

Nikon, JEOL introduce bench SEM

Nikon Instruments and JEOL have collaborated on the NeoScope, a new bench scanning electron microscope (SEM) that the companies say fills the optical microscopist's need for advanced imaging capability that is affordable and easy to use. The companies expect the NeoScope will help accelerate research in several fields, including failure analysis of manufacturing materials.

The NeoScope SEM offers 10X to 20,000X magnification without the need for a lens change. Operation is simplified through auto-focus, auto-contrast, and auto-brightness controls. In addition, the instrument operates in both low- and high-vacuum modes and has three settings for accelerating voltage (15 kV, 10 kV, and 5 kV), all of which can be programmed in stored recipe files. The NeoScope can handle samples of up to 70 mm in diameter and up to 50 mm thick.

"We've found a natural platform where both companies meet," said Peter Genovese, JEOL USA VP and GM of sales in Peabody, MA. "Nikon and JEOL have products that complement one another in the laboratory and research environment. The science of electron microscopy is very closely related to optical microscopy, but the NeoScope SEM extends the depth of field and resolution far beyond the optical microscope." www.jeolusa.com; www.nikoninstruments.com.

Interface cards ease vision setup

The Concord family of interface cards from Matrox Imaging is prelicensed for use with the Matrox Imaging Library (MIL) and is designed to simplify the connection to GigE Vision or IEEE 1394 IIDC devices. The single-port Concord GigE interface card is configured to reduce GigE Vision protocol loading on the host through the default enabling of jumbo packets, and it provides optimum settings for the interrupt throttling rate and number of receiver buffers.

The Concord 1394 interface card features three IEEE-1394a/b adapter ports and a 1394a/b bilingual copper connection. The card also handles the S400 and S800 transfer rates of 1394a and 1394b.

Both versions support 64-bit conventional PCI and x1 PCI Express host interfaces. Software support is available for 32-bit Microsoft Windows XP. www.matrox.com/imaging.

Pleora honored for innovation

Consulting firm Frost & Sullivan recently honored Pleora Technologies with its 2007 North American Frost & Sullivan Award for Product Innovation. The award recognized the role Pleora played in bringing Gigabit Ethernet (GigE) products to the machine-vision market.

"Pleora's iPORT family of GigE connectivity products broke new technological ground," said Vishnu Sivadevan, a research analyst at Frost & Sullivan. "The company proved that machine-vision applications, where performance and reliability is paramount, can use the economical GigE platform to transport video and imaging data in real time between cameras and PCs, eliminating the need for more costly specialized equipment. This award is a validation of the technology risks Pleora took in carving out a place for GigE connectivity in high-performance vision applications."

The iPORT IP engines convert video and imaging data to IP packets for distribution over Ethernet networks. www.frost.com; www.pleora.com.

FREE WEBCAST

INJECT PULSES INTO CIRCUITS AND TEST for EMI IMMUNITY

SPEAKER:
Doug Smith
EMC Consultant

MODERATOR
Martin Rowe
Sr. Technical Editor, Test & Measurement World

Join editors of Test & Measurement World and EMC expert, Doug Smith, to learn and discuss how to troubleshoot for EMI immunity. Here is a brief overview of what this hour-long webcast will cover:

Pulses with amplitudes of dozens of volts can couple across cables, resulting in unwanted interference that can wreak havoc on electronic systems. EMC consultant Doug Smith will present a technique for inductively coupling pulses into circuits for troubleshooting designs. Using current probes, Smith will show how to use injected pulses to test circuits before committing them to production. Using Smith's technique, engineers can easily inject dozens of volts into cables. Engineers can use this technique to troubleshoot ESD problems as well.

FROM THIS WEBCAST, viewers will learn:

- The importance of testing for immunity to pulses on signal cables
- How pulses can disrupt the operation of electronic circuits
- How to inject test pulses and how to verify their amplitude and timing before subjecting them to your EUT
- What factors can influence the test and how to ensure that you're getting the right signal to the EUT.

Date: **Friday, April 18, 2008**
Time: **11:00 am PST, 2:00 pm EST**

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A maturing AOI industry moves forward

By Steve Scheiber, Contributing Technical Editor

Not many years ago, vendors of automated-optical-inspection (AOI) equipment expended much of their marketing effort convincing electronics manufacturers to adopt the technique as part of a comprehensive inspection-and-test strategy. Today, the benefits of AOI itself are rarely questioned, but some of the issues that customers have always faced remain: cost of ownership, whether to use 2-D or 3-D inspection, and how to store the captured image data.

The SJ50 AOI system can perform 2-D paste, pre-reflow, and post-reflow inspection.
Courtesy of Agilent Technologies.

Economic pressures challenge the manufacturers of AOI systems to improve the performance of their products and lower the all-important cost per use. One way they can do this is by building flexible systems that can be adapted to multiple projects. As a product matures, its process yield generally rises, so it needs less inspection to achieve the same level of quality. As a result, AOI equipment that was once fully utilized can have spare capacity to apply elsewhere, allowing the customer to allocate the cost of the system to several projects.

Jeff Bishop, product marketing engineer for Agilent Technologies, put it this way: "Return on investment has become more complicated. It has to include some more intangible considerations. For example, if I buy a machine for this particular product or process, can I easily transfer it somewhere else? A more flexible machine may prove less expensive even if the initial outlay appears higher."

Part of the flexibility issue lies with where to place AOI in the process. It can generate equally important data at various stages: immediately after deposition of solder paste, after component placement and before reflow, and after reflow. But buying equipment for each of those venues is obviously an expensive proposition. According to Bishop, "Generally speaking, companies perform paste inspection and then pre-reflow or paste inspection followed by post-reflow. Not many manufacturers inspect at all three stages. For one thing, managers are reluctant to authorize pre-reflow, objecting to a step that only verifies that the pick-and-place machine is out of whack. Adjust the machine and the extra step becomes unnecessary. In the final analysis, companies often decide where to perform AOI based on results from the x-ray inspection system downstream."

Systems offering higher throughput also significantly impact inspection cost. "Even if those systems are more expensive," said Bishop, "customers can easily accept a $10,000 or $15,000 price premium. Cellphones, automotive, and similar applications feature relatively small boards, say, 5x8. If inspection produces a cycle time of perhaps 15 seconds per board, the faster throughput and handling that cuts the effective time to 7 or 8 seconds represents a huge savings."

Ultimately, Bishop doesn't expect AOI to become much less expensive than it is today. "Prices have already declined enormously, from the neighborhood of $200,000 in 1999 to perhaps $70,000 to $100,000 today," he said. "There isn't really a lot of room to lower the price any further unless a steep drop in camera prices or other factors lower manufacturing costs. Vendors will pretty much stick to improving existing hardware designs and upgrading the software.

"I see a lot of companies abandoning this end of the business. Initially, starting an AOI company didn't require a lot of capital. Rather than try to make a splash in the overall market, a company merely had to identify a niche, corner it, and push outward from there. Price pressures and increased capability for the same price will likely drive some of the more marginal players away."

2-D vs. 3-D

Besides considering the cost of an AOI system, a customer also needs to determine whether 2-D or 3-D inspection works better for a given application. As with x-ray, opinions differ as to which option provides the optimum balance of throughput, cost, and fault resolution. If managers are considering 3-D at all, they may consider using the approach only during ramp-up to full production or while tuning the process to bring it under control, relying on 2-D for more routine situations.

Two-dimensional imaging tends to be faster and less expensive. It can measure the area of solder paste on the pads to determine fairly accurately whether the amount of solder is sufficient, and it can see bridges that would act as shorts on the finished board. On a loaded board, either before or after reflow, 2-D can determine if the components are positioned correctly.

In contrast, 3-D techniques such as triangulation or laser inspection can also determine the height of solder on the pad, offering a more accurate measure of solder volume. The jury is still out, however, on whether you should consider insufficient solder

volume a defect. Bishop explained, "The information to date is preliminary as to the correlation between AOI results and the defects detected at x-ray. Some companies have found that if solder falls below a certain percentage of nominal volume, the joint will show up later as a defect. But not everyone shares that experience.

"Solder-paste inspection has become much more common in the past few years," he continued. "As recently as the mid '90s, companies relied primarily on 2-D and volumetric sampling. Today's 3-D equipment is more effective, easier to program, and less expensive than it used to be, so it is becoming much more common.

"The ultimate driver is quality. At the demand of customers, manufacturers—especially contract manufacturers, but it holds across the board—have to ensure the quality of the products they deliver. This attitude is very common in the US and more recently in Western Europe. Automated techniques have caught on more slowly in Asia, where cost consciousness and the relatively lower cost of labor has skewed the economics a bit."

Dealing with data

As the capability of AOI systems has exploded, so has the amount of data that they produce, and storing and tracking the data have proven increasingly difficult. Consequently, data handling and dispersal become important considerations when selecting a system.

"Storing images and raw measurement data inherently takes up more space than storing a "mere" numerical representation. Bishop commented, "In the past, people kept many gigabytes of images, only a small portion of which were used to create the Pareto charts and other analytical tools. Expect to see inspection companies provide better statistical process control (SPC) and process-feedback software. Right now, people are trying to limit storage to only the relevant information about the product—pictures of components, pictures of boards, pictures of bar codes—primarily for liability purposes. For cellphones and other consumer goods, the storage period can be quite short. Medical, military, and other high-reliability products require keeping the data much longer. Still, there is no reason to store every data point for every system down the line. Decide what you need to store and conform to that limit."

Bishop explained that some companies distribute the data to make storage easier. "Companies have become smarter about storing data and have therefore reduced its volume," he said. "They have begun to divide the data rather than keeping everything at all locations to minimize the amount that has to be stored in any one place. Managers hold onto some of it, while some is retained by line workers. Some data is even given to customers, who then become responsible for it.

"If we are going to use the data to improve the process, we have to analyze it in a more timely manner. Empower operators to identify and predict problems in real time and generate reports automatically. Perhaps the source of the problem is not the process but bad components or bare boards. What kind of paste are you using? How fast are the boards going through the paste step? If you keep all the data, there is so much of it out there that analyzing it could take months. Considering the short life of a product generation these days, you may not even be making it anymore.

"It also helps if you use the data at all levels. That is, apply your analysis of the data generated at x-ray to improve AOI. Conversely, if x-ray inspection has missed something, can you find it at the earlier step?

"The point is to make the best use of all the tools at your disposal. X-ray and AOI provide complementary results. X-ray will remain a production tool because of the explosion of solder joints in recent years and the number of them hidden under BGAs and similar packages. On the other hand, x-ray can't read component labels or detect certain polarity defects. You will always need them in combination." □

Rudolph broadens wafer inspection

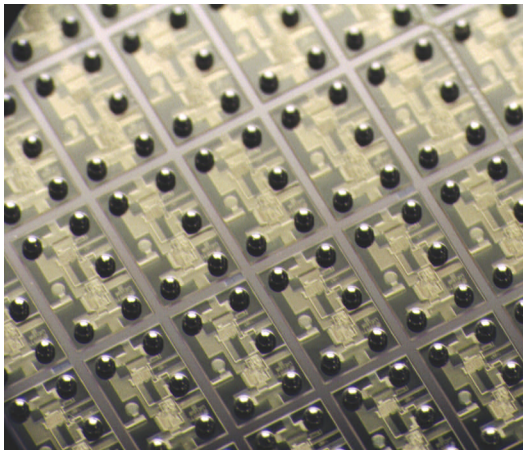
By Steve Scheiber, Contributing Technical Editor

On January 22, 2008, Rudolph Technologies, a maker of back-end wafer inspection and metrology equipment, acquired the intellectual property rights, along with selected assets, from the three-dimensional wafer-characterization product line of RVSI Inspection. This followed closely on the company's December 2007 acquisition of Applied Precision.

In the wake of these decisions, I asked Rajiv Roy, Rudolph's marketing manager for final manufacturing and test, to assess the hot issues in wafer inspection today and how the company's latest acquisition fits into that picture.

"We have always positioned ourselves as a process-oriented company," commented Roy. "We utilize what we call 'a camera with measurement,' generally looking for 'macro-defects'—defects of 1 micron or more in size, several orders of magnitude larger than the circuit's smallest features. In 2006, we merged with August Technologies, a maker of two-dimensional wafer-inspection equipment. The RVSI product line broadens our expertise in that area by giving us three-dimensional capability, an important enhancement with today's ever-smaller wafer features."

"People have always appreciated RVSI's technology but questioned their financial stability. For customers, our acquisition alleviates those reservations," he explained. "In addition, RVSI Inspection's 3-D capability addresses a very specific new and fast-growing requirement by the wafer-fabrication industry. For years, people have been striving to increase device circuit density by making features smaller. Today, we routinely see 90-nm geometries, soon to be 45 nm, then 32. At the same time, the cost of that shrinkage has skyrocketed."



Stacking chips in a single semiconductor package requires novel interconnect solutions, such as these solder bumps. Courtesy of Rudolph Technologies.

Roy continued: "A less-expensive alternative would stack chips vertically in a single package. Such an architecture, though, requires the use of bump-type interconnects and through-silicon vias, inherently three-dimensional features, on the wafer. Wire-bond interconnects can't meet the new devices' speed specifications. You have to verify bump integrity on each individual die before bonding them together to

Rajiv Roy
Marketing Manager
Rudolph Technologies

Courtesy of Rudolph Technologies.

ensure that the fabrication process leaves no contaminants. Contaminants can cause minor explosions or other reliability problems when heated, and if you do not detect a contaminant prior to the bonding step, it will never show up when you inspect the stacked die. We are concentrating our efforts in that area."

Inspecting probe cards

But applying inspection techniques to ensure wafer quality extends beyond the wafer-inspection step itself. As circuit logic has become increasingly complex and companies want to test more than one device at a time, the probe cards used in probe-based wafer tests have become much more expensive.

Rudolph also employs inspection methods to ensure integrity of those cards. Needles must conform to precise placement and height specifications and must make proper contact with wafer sites. To maintain test accuracy and reduce damage to wafer surfaces, cards must undergo comprehensive analysis throughout their useful lives. Rudolph is now able to verify this part of the process through its acquisition of Applied Precision, makers of equipment that subjects the probe cards to a verification that Roy refers to as "inspection with data."

"Because of the demand for high-temperature wafer testing," explained Roy, "the probe quality has to be tightly controlled. You need more tools. Applied gave us a couple of hundred such tools worldwide in one step."

He concluded, "By combining Rudolph's expertise with the parts of the total picture contributed by these other companies, we can now provide the full solution from one place. To serve the automobile industry, for example, where consumption of semiconductors has exploded in recent years and the companies exhibit a well-known zero tolerance for failures, adding RVSI's powerful three-dimensional wafer scanner enhances our ability to offer a comprehensive, cost-effective three-dimensional solution." □

PRODUCTS

Vision sensor line expands

Checker 232, the newest Checker vision sensor from Cognex, is designed to inspect small features over a wide area. It provides reliable inspection results on fast production lines, detecting and inspecting up to 1500 ppm.

Cognex says that Checker 232 is ideal for applications where small features are being inspected on large parts, such as the inspection of clips and springs on large automotive assemblies. Checker sensors use multi-image analysis to determine if a part is present without an external trigger, simplifying installation. This capability enables Checker to track parts in varying positions along the production line, overcoming imprecise part positioning and delivering consistent pass/fall results. *Cognex, www.cognex.com.*

Scout family grows

Basler has expanded its scout series of cameras with four new models based on Sony's ICX285 CCD sensor. These cameras feature a 30-fps image-capture rate and are aimed at applications such as semiconductor and electronics manufacturing.

The cameras feature either a Gigabit Ethernet interface

or a FireWire 1394b interface and are available in monochrome or color. Basler's pylon driver package supports both versions. With their GigE Vision-compliant interface, the cameras can perform 12-bit image-data transfer and color output at the full 30-fps speed, according to the company. *Basler Vision Technologies, www.baslerweb.com.*

Starrett offers large-capacity, multisensor vision system

The Galileo AV1824 CNC video-measuring system from Starrett provides zoom magnification of 12:1 with a programmable magnification range of 15X to 550X with auxiliary lenses. A dual-output LED illuminator, ring light, and coaxial illumination deliver optimum lighting. The system also includes dual flat-panel displays.

The AV1824 includes 3-D metrology software with video edge detection and full CNC control. The work envelope of the system offers a measurement volume of 24x18x6 in. Options include a Renishaw touch probe, a laser scanner, and a CNC rotary-positioning device. *L.S. Starrett, www.starrett.com.*

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VIEWPOINT

[An exclusive interview with a technical leader]

LINDA C. RAE
Executive VP and COO
Keithley Instruments
Cleveland, OH

Linda Rae joined Keithley Instruments in 1995 in product marketing and then served as head of the Component Test Group as well as the company's Optoelectronics Group. She was later promoted to senior VP and general manager. In 2005, she was named executive VP and COO. Rae earned a BSEE degree from the University of Florida. She also holds MBA and MSEE degrees from Case Western Reserve University. As part of Keithley work teams, Rae received two EDI (NorTech) awards and an internal Keithley QSII (Quality-Service-Innovation-Integrity) award for innovation.

Contributing editor Larry Maloney conducted a phone interview with Linda Rae on solutions that Keithley has developed to meet the test and measurement needs of emerging technologies.

Technologies that press the limits of test

Q: What emerging technologies present the biggest challenges to the test field?

A: Wireless is generating many new transmission and reception protocols, including the merging of voice and data so that we can perform more functions on our cellphones. At Keithley, we've been focusing particular attention on the multiple-input multiple-output (MIMO) radio architecture. Here, our challenge is to test multiple transmitters and receivers simultaneously, which adds complexity to the measurements that have to be made and to the data analysis that has to be done.

Among other emerging areas, we see new challenges from nanotechnology and from the shrinking geometries in semiconductors. In these applications, Keithley brings to bear one of its core competencies, very low current and voltage measurement. Our instruments also must address the thermal energy that devices are subject to during tests, so you see more use of pulse techniques to limit device self-heating.

Q: How is Keithley getting involved in development of nanotech innovations?

A: Most of our participation today is in the research area, where we have established partnerships with such centers as the NanoSystems Institute at UCLA and France's CEA Leti Lab. Here again, we are lending our skills in low-level measurement to researchers whose expertise is in designing and characterizing nanodevices.

Among the Keithley instruments used in this work are our Models 6220 and 6221 current sources, our high-accuracy electrometers and picoammeters, and our Model 4200-SCS Semiconductor Characterization System. Last year, we also introduced a new line of SourceMeter instruments with femtoamp resolution for making very high-speed I-V measurements.

Q: How about your involvement in alternative energy sources?

A: We've worked with fuel-cell manufacturers and researchers, as well as in the testing and characterization of photovoltaic cells for solar energy. Much of our work in fuel cells is still in research applications, since our instruments are more suited for testing lower-power fuel cells targeted for portable consumer electronics. Many of the same instruments mentioned earlier are being used in these applications.

Our SourceMeter instruments, for example, are very well-suited for solar-cell applications, where you are working with basic DC I-V curves. You can create multiple channels for testing solar-cell arrays by connecting the SourceMeter instruments with our new Series 3700 Switch System and Multimeter to achieve very high throughput and excellent measurement accuracy.

Q: What are some key innovations that you see in wireless technology?

A: There's a lot of exciting work being done in this field. I recently visited South Korea's Electronics and Telecommunications Research Institute (ETRI), where researchers are working on 8x8 MIMO and pushing communications capabilities in both mobility and bandwidth. Their goal is to design a wireless system that would allow you to drive your car at high speeds and still get 3 Gbps of data coming into your wireless device.

Q: How important is customer collaboration to product development?

A: Every time we have a new product concept, the first thing we do is conduct a lot of voice-of-the-customer work, including getting input from customer companies all around the world. We want to understand not just what customers want today but also a year or two from now when they are bringing new products to market. So, customer input is by far the dominating factor in our new product development. T&MW

Linda Rae discusses more Keithley products, as well as software advances, in the online version of this interview: www.tmworld.com/2008_04.

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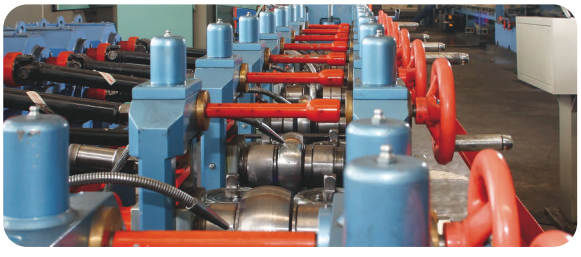

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