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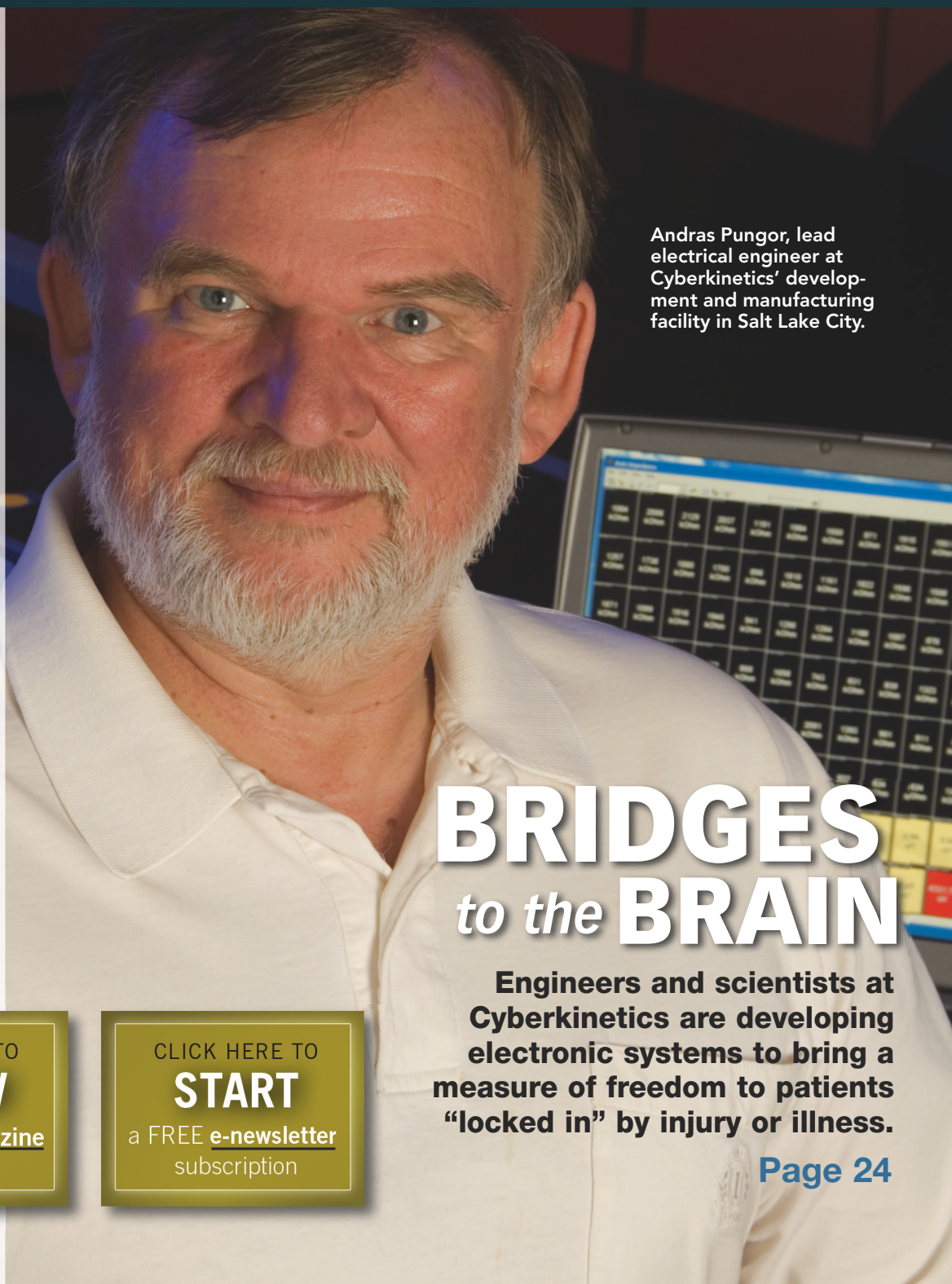

Andras Pungor, lead electrical engineer at Cyberkinetics' development and manufacturing facility in Salt Lake City.

BRIDGES *to the* BRAIN

Engineers and scientists at Cyberkinetics are developing electronic systems to bring a measure of freedom to patients "locked in" by injury or illness.

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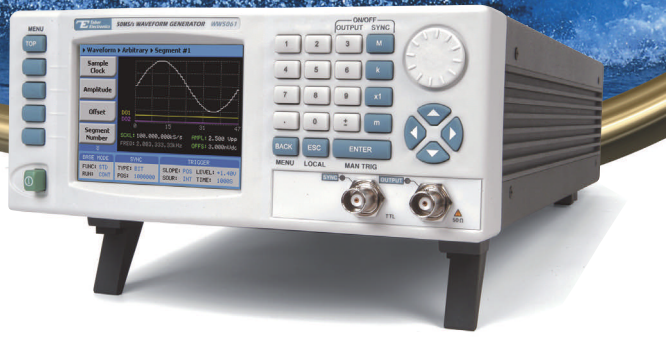

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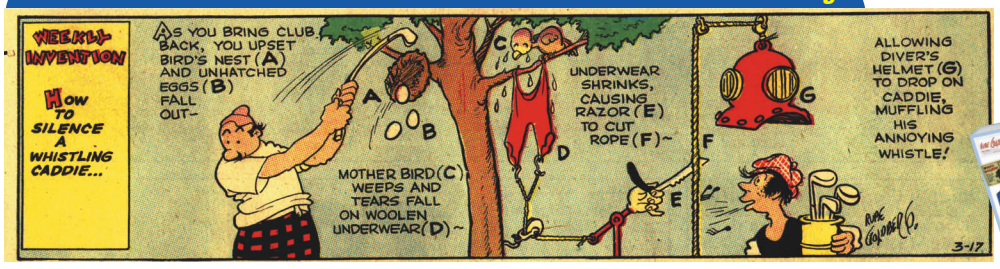

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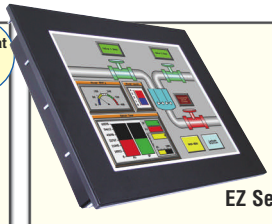

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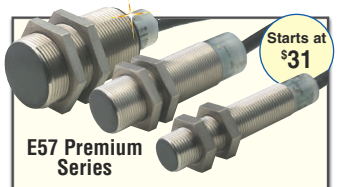

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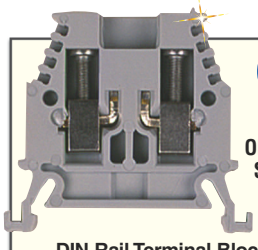

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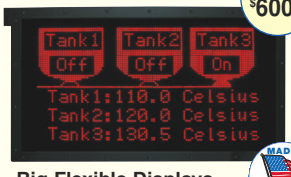

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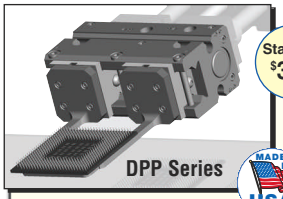

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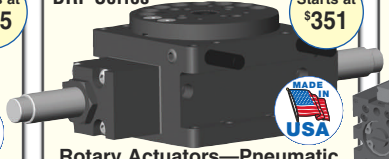

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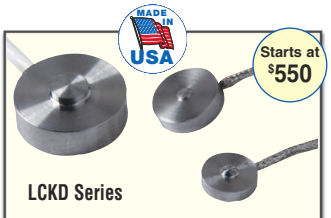

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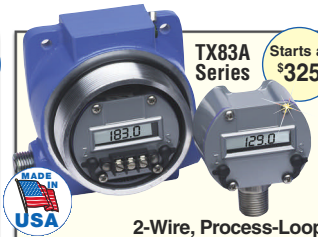

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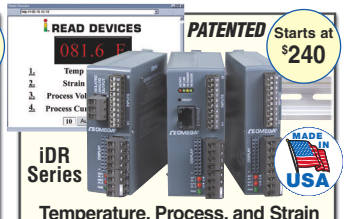

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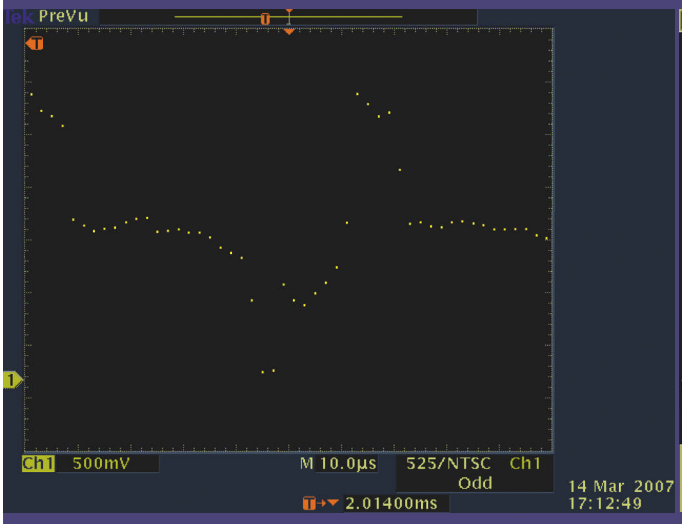
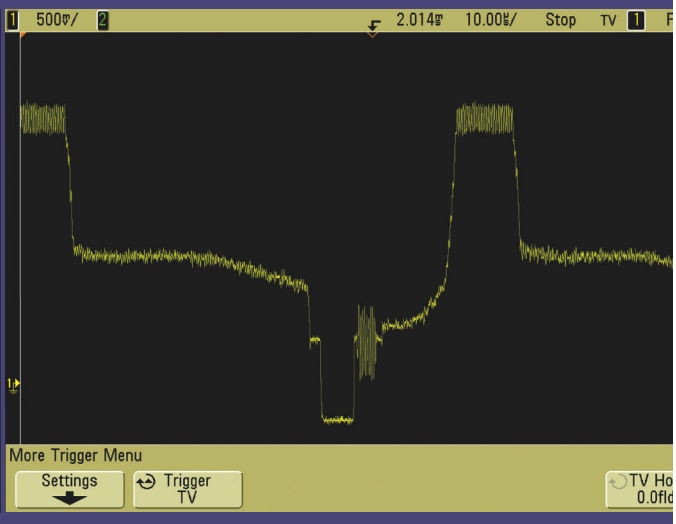


Tektronix TDS3054B display



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Memory Depth	10 kpts, max	**1 Mpts, max**
Channels	2, 4	**2, 4**
Waveform Update Rate	3,600 wfms/s, max	**100,000 wfms/s, max**
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**Tektronix TDS3000B Series User Manual 071-0957-04, October 4, 2004.*
***Agilent 5000 Series Oscilloscope data sheet, Pub No 5989-6385EN, April 18, 2007.*
Agilent and Tektronix oscilloscope acquisitions taken at identical settings: horizontal timebase = 2ms/div, vertical volts/div = 500 mV/div, connect the dots = on. 10:1 passive probes used for both measurements. Final screen images show both acquisitions zoomed in to 10 µs/div.

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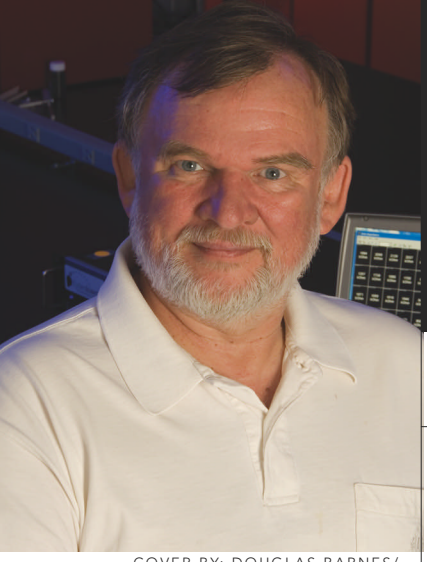

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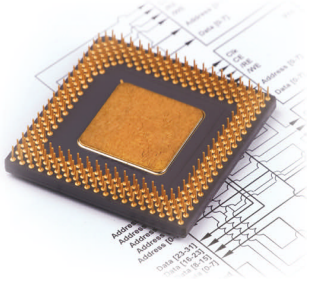

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Check out these exclusive features on the *Test & Measurement World* Web site:

Guest commentary

FPGAs serve next-generation test systems

In part 3 of a series on Instrumentation 2.0, Rick Kuhlman, the National Instruments product marketing engineer responsible for the company's LabView FPGA business, describes how FPGA hardware and high-level FPGA design tools can help test engineers efficiently employ FPGA technology in their next-generation test systems.

www.tmworld.com/guests

How does your salary compare?

SALARY SURVEY 2007

Check out the results of our 2007 Salary Survey to find out whether your salary and benefits are competitive with the rest of the test-engineering industry. Plus, in "Testing in a frantic environment," contributing editor Lawrence D. Maloney notes that the concerns of engineers have shifted from worrying about job security to finding enough time to deal with an often overloaded plate of projects.

www.tmworld.com/salary2007

Blog commentaries and links

Taking the Measure

Rick Nelson, Chief Editor

- Wallowing in an analog backwater
- Jet-fuel-powered iPods

Education and Careers

Amy Laskowski, Contributing Editor

- Competition encourages students to save the environment with technology
- Studying for the SATs at the beach

Engineering Students at Work

Jessica MacNeil, Contributing Editor

- Gaining valuable experience
- Engineering solutions: home and abroad

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Take a T&M Challenge

Respondents who answer our Oscilloscope Challenge question correctly will be entered into a drawing for an Apple iPod, courtesy of Yokogawa. New challenge questions every month!

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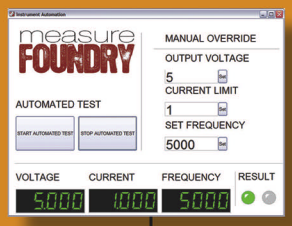

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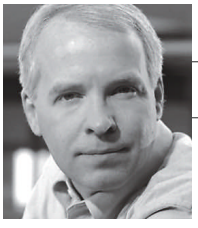
Industry can help solar power

Solar power is capturing the public's imagination. As a *San Francisco Chronicle* article ("Power burst," July 18) puts it, "Spreading one rooftop at a time, solar panels in California are finally generating serious power." Solar's popularity is further attested to by a poll conducted for the trade association for the nuclear power industry, which asked Americans what energy source they thought would be used most for generating electricity in 15 years. The winner was the sun, picked by 27% of respondents, as reported in the *New York Times*.



RICK NELSON, CHIEF EDITOR

But the *Times'* article ("Solar Power Wins Enthusiasts but Not Money," July 16) adds that solar's popularity has not been sufficient to spur on adequate investment in solar power. The article notes that solar energy last year provided less than 0.01% of this country's electricity supply and may account for only 2% or 3% of the grid electricity in the US a quarter century from now, in part because government-funded research on solar power receives less funding than "energy options with more political support."

Semi industry can compensate for insufficient government investment.

But if government funding is lacking, perhaps the private sector can help. In fact, Rhone Resch, president of the Solar Energy Industries Association, urged attendees at Semicon West to get involved in the solar business. In a keynote address July 18, he said the present low percentage of power that solar methods produce should make solar an attractive growth opportunity for the semiconductor industry. He said the market has, since 2000, experienced a worldwide compound annual growth rate (CAGR) of 46%. Going forward, he said, he expects the US solar industry to post an 80% CAGR through 2010, vs. a 36.5% rate worldwide.

Evidence of industry support is emerging. Applied Materials, for example, has invested in the solar sector and has won contracts for solar-cell production equipment. As Resch told Aaron Hand, executive editor at *Semiconductor International*, "I think when Applied Materials makes a jump into a new industry, it shows that it's a real industry…and that it's safe for others to jump in."

Indeed, spurred on by Resch's keynote, solar was a hot topic on the Semicon West exhibit floor. For example, Ross Overstreet, scientific segment engineer at FLIR, at his booth described to me a technique that can help evaluate solar-panel quality. When solar panels are reverse-powered, he explained, they emit infrared radiation, which enables his firm's IR cameras to detect defects.

Concerted efforts on fronts ranging from production to quality control can help drive solar's penetration into consumer markets, where by 2015, Resch predicted, solar will become cheaper than traditional electricity sources. T&MW

Post your comments at www.tmworld.com/blog.

HIGH-SPEED TEST

(Loop)back to the future

New test methods tackle ≥6.4Gbps data rates

Rudy Garcia, Member of Technical Staff
Credence Systems Corporation
rudy_garcia@credence.com

*Manufacturers of microprocessors and high-end graphics chipsets are now employing high-speed serial buses like PCI Express and HyperTransport to deliver data and I/O rates up to 6.4Gbps. By 2010, 10Gbps and above may be the norm.**

Test, as always, will play a critical role in delivering these exponentially higher speeds at not-much-higher cost. However, faster serial buses introduce tough challenges, where traditional functional test and simple design-for-test (DFT) methodologies fall short. Older "functional" test flows on high-end ATE platforms offer the most thorough fault coverage, but these time-tested methods prove increasingly prohibitive in terms of cost, complexity and cycle times. Moreover, cost per pin rises with bus speed in high-speed data applications, making functional testing even less viable.

Manufacturers have thus turned to loopback techniques (i.e., using the device to source the test data and receive it back into the device for recognition) that enable cost optimized testing of today's high-speed buses. Loopback testing can be very effective, but the manner in which it is implemented is especially critical, considering the typical loss budget for high-speed signals. This loss budget, which determines the magnitude of acceptable signal degradation, typically has three components—contributed by the transmitter, receiver, and interconnect—all of which could degrade the signal "eye" over the loopback path and thus impact coverage.

To date, alternative DFT techniques like "near-end loopback" have already introduced cost efficiencies (via ease of programming and reduced capital investment in ATE) in testing devices for high-end consumer and computing applications. Near-end loopback techniques can be self-contained within the DUT with pathways created between the I/O pins. However, the inherent cost savings and simplicity carry stiff tradeoffs in terms of coverage. There are no parametric measurements, a lack of signal control, and lower likelihood of catching faults related to signal integrity or bit errors. For example, a simple internal, or load board loopback, would allow a marginal receiver to "hide" in the shadow of a robust transmitter and pass the loopback test screen. While these uncertainties can be worked around at lower speeds, compromising coverage at ≥6.4Gbps is way too risky.

Far-end Loopback: Less Jittery, Lower Cost

Between the two extremes, innovative techniques such as far-end loopback combine the flexibility of DFT with the more in-depth diagnostics of functional testing. Lengthening the feedback path by placing the DUT in communication with an intelligent but still cost-effective tester makes production-level testing of high-speed buses viable for the first time. Even more compelling, far end loopback with programmable signal degradation can be employed to cut costs and speed time-to-market while introducing unprecedented coverage.

This type of loopback offers significant advantages:

- Provides signal control to stress the eye
- Increased coverage in detecting sensitivity to signal integrity issues and bit errors
- Addition of circuitry enabling jitter to be injected and measured
- Covers all three parts of the loss budget
- R_X and T_X channels can be used to deliver test vectors to the core logic and protocol stack
- Access to device pins for full DC parametric testing

Clearly, exponentially faster bus speeds are driving fundamental shifts across the board, from design through production. Test companies can play an important leadership role in this fast-paced environment, by delivering innovative products and solutions that enable customers to optimize and accelerate their latest test methodologies at lower cost, while minimizing risk.

To see how our latest products and innovative test techniques can solve your high speed challenges, visit www.credence.com/loopback

*ITRS 2005 Roadmap

BRAD THOMPSON
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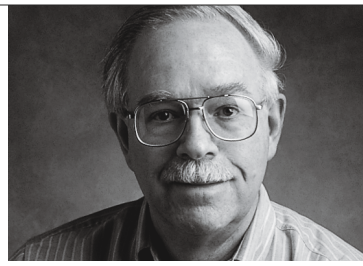
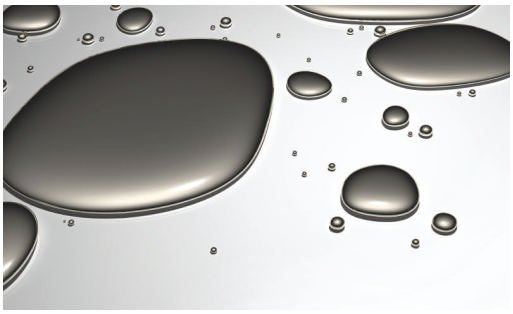


So, where's the mercury?

I subscribe to TechRepublic, a useful online source of timely information about all aspects of computing. One entry on the site features several "Creative uses for dead computers."

Among the subtopics, a photo essay describing Hewlett-Packard's corporate computer-recycling facilities attracted my attention.

You can no doubt understand my curiosity when I read the following caption that accompanied a photo of a corrugated-board Gaylord bin containing several cathode-ray tubes (CRTs): "Items collected by HP, like these cathode-ray tubes from monitors, are sent directly to a smelter because they contain mercury bulbs, which are considered hazardous to the environment."



After spending over a half century of my life messing around with electronics as an amateur and as a professional, I believe that I have acquired a general understanding of most aspects of the technology. And as a volunteer at an electronics-recycling facility, I take interest in the components we encounter both as a source of reusable materials and as hazards to my fellow recyclers.

So, where's the mercury? Trust me…in my career, I've deliberately and inadvertently busted quite a few CRTs, and I can assure you that every one of them contained an electron gun assembly, an accelerator anode, a phosphor-coated screen, and a few other doodads, but no bulbs—mercury, tulip, or otherwise. Most of the funnel-shaped glass envelopes in CRTs contain lead, barium, strontium, and other metals that suppress soft x-rays generated during normal operation. But there's no mercury.

So, where *is* the mercury? Fluorescent lamps used for backlighting liquid-crystal displays contain traces of mercury. Chances are the writer of the caption erroneously assumed that all computer displays feature identical internal construction. Thanks—or no thanks—to the Internet, a factual error like this can propagate quickly and reappear in dozens of places. Websites that encourage recycling may soon sport references to CRTs with "mercury bulbs."

We live in an increasingly complicated world that is heavily affected by the benefits and hazards of technology. As electronic-test professionals, we're in an ideal position to know what's hazardous in the products we review, and it is up to us to blow the whistle on egregious errors of fact or interpretation of the technologies we know best. T&MW

THE MERCURY HUNT

Odds are, traces of mercury reside in your freshwater fish dinner—and possibly in you. Most of *T&MW*'s older readers have probably directly contacted metallic mercury while "silvering" a coin or conducting science experiments. Residents of the northeast get the dubious benefits of indirectly absorbing mercuric emissions from Midwestern coal-fired power plants and incinerated waste containing thermostats, thermometers, and childrens' light-up sneakers.

Mercury also serves as a component of dental amalgam and as a preservative (thimerosal) in certain medicines. Considerable controversy exists about the benefits and hazards of these applications, which are best discussed with qualified medical and dental practitioners and not with electronic-test editors.

Here is a limited collection of sources that will help you in your own quest for more information about mercury.

To learn more about TechRepublic, go to: techrepublic.com.com.

For a photo tour of Hewlett-Packard's recycling facilities, go to: content.techrepublic.com.com/2346-10877_11-88409.html?tag=nl.e099.dl062007.

Here's more information on x-rays and other radiation produced by CRTs: www.xbitlabs.com/articles/other/display/lcd-guide_17.html.

To read about the CRT-glass recycling market, go to: findarticles.com/p/articles/mi_m0KWH/is_12_41/ai_111896642/pg_1.

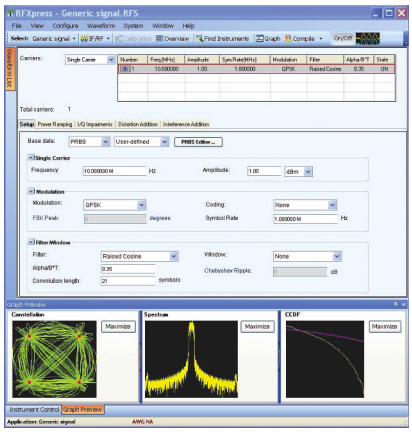
How did mercury switches find their way into children's footwear? sneakers.pair.com/lightup.htm.

The US Environmental Protection Agency (EPA) offers the following information on mercury in humans and in the environment: www.epa.gov/mercury/index.htm.

AWGs gain software plug-in for RF/IF/IQ waveforms

Tektronix has released a software package for its AWG5000 and AWG7000 families of arbitrary waveform generators (AWGs) that helps users create and edit digital RF/IF/IQ waveforms. The RFXpress software also provides UWB-WiMedia plug-ins and a library of waveforms for testing new designs.

RFXpress supports modulation schemes such as QPSK, QAM, and GMSK as well as custom-built modulation schemes, and it allows users to add impairments, interference, and distortions to signals captured on a spectrum analyzer or oscilloscope before replaying them on an AWG5000 or AWG7000. The WiMedia custom mode plug-in enables engineers to configure every part of the WiMedia frame/packet for characterization, limit, and stress test of the receiver's PHY layer. With RFXpress and the AWG7000, customers can generate bandhopping signals for UWB-WiMedia Bandgroups 1 and 2 without the need for multiple instruments.



"RFXpress is ideal for design and test engineers who need to perform validation and characterization of prototype digital RF wireless communication designs," said Mike Higashi, VP of the company's signal source product line. "Instead of needing to create mathematical formulas, the intuitive UI provided by the general-purpose RFXpress application enables efficient use by providing predefined, fill-in-the-blank templates for frequencies, modulation schemes, etc." Prices: RFXpress—$5000; UWB WiMedia compliance plug-in—$2200; UWB WiMedia custom plug-in (including compliance plug-in)—$7200. www.tektronix.com.

New NIST office focuses on innovation

Kicking off the second phase of an effort to ensure that the US measurement infrastructure can sustain US innovation, the National Institute of Standards and Technology (NIST) recently created the US Measurement System (USMS) Office.

The first phase of the USMS effort culminated in February with the publication of a report about the state of the nation's measurement system and its impact on innovation. To produce the report (available on the NIST Web site), NIST surveyed measurement needs across 11 industrial sectors and technology areas and identified more than 700 measurement-related barriers to innovation.

During the second phase, being led by the new USMS Office, NIST will continually collect information about the measurement needs of US industry, government, and the scientific community and will periodically assess the health of the US Measurement System. If there are areas that need improvement, the USMS Office will alert measurement providers as a way to facilitate the necessary changes.

NIST director William Jeffrey has named Clare Allocca as the chief of the USMS Office. Prior to this appointment, Allocca served as scientific advisor to the director of NIST's Materials Science and Engineering Laboratory and also held several other positions at the agency. Before joining NIST, she was a senior materials engineer for Pratt & Whitney. www.nist.gov/usms.

Startup releases wireless IC test probe

During Semicon West 2007 (July 16-20, San Francisco, CA), startup firm Scanimetrics launched its first product for the semiconductor test market: a wireless noncontact "virtual probe." The Wi-TAP (Wireless Test Access Port) technology helps manufacturers of system-in-package (SIP) chips identify defective devices before they are assembled into multichip packages.

To use the Wi-TAP technology, manufacturers must add special antenna and RF transceiver circuits to their chips, but Scanimetrics claims that these have no impact on performance or real estate. The Wi-TAP probe consists of a CMOS device with its own micro antennas and RF transceiver circuits; the probe interfaces to standard automated test equipment (ATE).

Wi-TAP relies on short-range, nearfield communications to transfer data at gigabit-per-second rates between the probe card and the device under test (DUT) on a wafer. Each antenna and transceiver circuit is capable of probing one I/O site on the DUT.

Chip makers can perform testing at the beginning of SIP assembly and again after the addition of each new chip. If Wi-TAP uncovers a bad die or an assembly defect, the package can be reworked before assembly is completed, saving the manufacturer money in both chip costs and manufacturing time. www.scanimetrics.com.

Corrections

Our June 2007 article on spectrum analyzers incorrectly reported the capture bandwidth of the Tektronix RTSA on p. 48. The correct figure is 110 MHz.

JDSU, which acquired Acterna in 2005, reported test-and-measurement revenues of $494.5 million for 2006. The company should have been included in 10th place in the "Tops in Test" article in our July 2007 issue (p. 22).

Editors' CHOICE

A scope with a host of measurements

LeCroy's WaveExpert 100H four-channel sampling oscilloscope may offer a 100-GHz bandwidth, but it's the measurement functions on this instrument that stand out. With the 100H, you can characterize transmission channels and even simulate signal integrity in impossible-to-reach places.

The instrument includes a time-domain reflectometer (TDR) that lets you measure two-port differential S-parameters (up to 20 GHz) on a channel. You can use those parameters in conjunction with oscilloscope measurements to predict the characteristics of a waveform in places such as inside an IC.

The Eye Doctor software feature acts as a virtual probe that simulates a signal wherever you need it. You can use it to simulate the effects of cables, backplanes, and fixtures. Eye Doctor uses graphical connections to steer measurements to S-parameters, process them, and produce simulated waveforms. Eye Doctor also simulates the effects that equalization can have on digital signals.

The WaveExpert 100H also has all the measurement capabilities you'd expect in a high-end oscilloscope, including jitter analysis, rise time, and fall time.

Prices: mainframe with S-parameter software—$22,150; options—$7000 to $52,500. *LeCroy, www.lecroy.com.*

USB sensors measure power to 24 GHz

The Agilent Technologies U2000 Series of USB 2.0-based power sensors can be used with a variety of the company's signal sources, spectrum analyzers, and network analyzers, extending each instrument's capabilities for performing average-power measurements. Because the sensors are USB powered and provide built-in triggering, they don't require external power adapters and triggering modules for synchronization with external instruments or events.

The U2000 Series currently includes four models that deliver up to 250 readings/s. They operate over the 9-kHz to 24-GHz frequency range and the –60-dBm to +20-dBm power range.The sensors offer an internal zeroing capability, which means calibration can be performed without disconnecting a sensor from the DUT.

The sensor displays power-measurement results on a PC or an Agilent instrument running the company's N1918A Power Analysis Manager software. On top of the normal waveform-monitoring option, the software also eases monitoring and troubleshooting with functions such as limit and alert settings, record and playback, multiple-list view, overlay, and channel mathematics.

Base price: $2300. *Agilent Technologies, www.agilent.com.*

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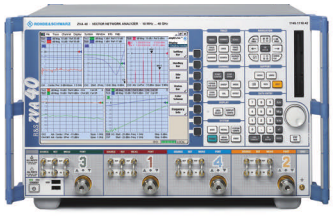

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Telecom industry gathers in Chicago

> > > NXTcomm, McCormick Place, Chicago, IL, June 18–21, 2007, www.nxtcommshow.com.

Several test-equipment manufacturers were on hand at the inaugural NXTcomm show (formerly GlobalComm, formerly SuperComm). **AgilentTechnologies** introduced the N5575A/N5576A enhancement to its N2X multiservice test platform. The new option emulates transmission control protocol (TCP) in hardware, which increases the speed at which it can generate and analyze TCP traffic. The N2X, which consists of a chassis and line cards, implements its TCP protocol stack using FPGA rather than software and can test protocol layers 2 through 7. Agilent also introduced the N4192A network tester for testing networks at layers 4 through 7. The tester supports more than 21 protocols including IPv6. It generates and analyzes voice, video, and data traffic and also simulates network attacks.

Symmetricom announced the Q-400 monitoring probe that provides end-to-end network performance monitoring. It provides quality of service (QoS) and quality of experience (QoE) measurements using the company's V-Factor scale. The Q-400 can monitor up to 400 standard-definition (SD) or high-definition (HD) IPTV streams that use H.264 protocols and up to 10,000 VoIP streams. It uses the mean opinion score (MOS) for VoIP.

Polatis introduced its wavelength selective switch (WSS), an ultra low-loss switching technology for DWDM networks. The WSS can attenuate or block any wavelength, and it can pass or drop any wavelength with 3 dB of optical insertion loss. You can configure the WSS for 1x9, 1x4, and 1x20 fiber drops. **Ixia** added Provider Backbone Bridging and Provider Backbone Transport support to its IxNetwork test software, which runs on the company's Aptixia network testers. Release 5.30 also adds Ethernet operations and maintenance (OAM) and configuration fault management (CFM), which comply with IEEE 802.1a/g.

JDSU demonstrated the 2.5/2.7G jitter/wander module for its T-Berd/MTS-8000 mainframe. This module performs jitter measurements in the field on SONET/SDH networks. The company also announced ADSL2+, VDSL, and IPTV enhancements to its HST-3000 handheld DSL tester.

Pixelmetrix exhibited an enhanced version of the DVStation-IP video-monitoring system. DVStation-IP³ can monitor and evaluate video quality in cable, satellite, and terrestrial video streams. **Tektronix** announced the Unified Assurance for Converged Networks (UACN), which provides service-level diagnostics on all user sessions across multiple access and core networks. The UACN currently focuses on voice service-level monitoring and diagnostics.

The Q-400 monitoring probe provides QoS and QoE network measurements.
Courtesy of Symmetricom.

Spirent Communications demonstrated its Spirent TestCenter 2.0 for testing voice, data, and video networks. The system consists of a chassis with network-interface cards that generate and analyze traffic access networks, core networks, switches, routers, and DSLAMs at protocol layers 2 through 7. TestCenter 2.0's software includes a tool that lets you set up tests with a GUI and convert them to Tcl scripts. TestCenter 2.0 also includes prewritten test scripts for protocols such as Ethernet, Internet Protocol (IP), and Multiprotocol Label Switching (MPLS). The company also announced a 10GBase-T interface for TestCenter, making the tester compliant with IEEE 802.3a/n. T&MW

Exhibitors highlight sensors and controllers

> > > Sensors Expo, June 8–11, 2007, Rosemont, IL, www.sensorsexpo.com.

Sypris Test & Measurement highlighted its 4100 Series Hall-effect gauss/tesla meters. **Endevco** touted its Model 87 low-noise compact seismic accelerometer. **PCB Piezotronics** highlighted pressure and strain sensors, a calibration system, a shaker kit, and a torque transducer.

Microchip Technology announced the 40-MIPS dsPIC33FJ12GP family of digital signal controllers for smart-sensor applications. **Analog Devices** extended its iSensor intelligent sensor product family with a motion sensor that allows industrial designers to equip their products with full-range, multi-axis inertial sensing.

Bennington Microtechnology Center representatives announced MEMS-related alliances with Metrikos and Apogee Technology. And **Kistler** highlighted its PiezoSmart automatic sensor identification scheme, based on the IEEE 1451.4 (TEDS) standard. T&MW

See the online version of this article (www.tmworld.com/2007_08) for links to vendors and to our complete coverage of NXTcomm and Sensors Expo.

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PCI Express goes cabled

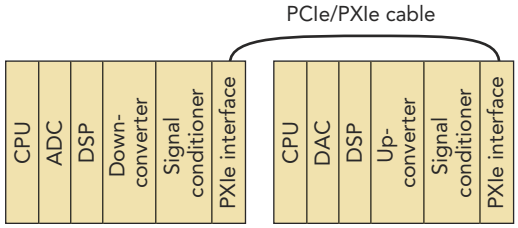
JUST WHEN YOU THOUGHT you've seen enough computer buses, along comes cabled PCI Express (PCIe) and its companion, cabled PXI Express (PXIe). Engineers developing synthetic-instrument-based test systems for military applications have shown interest in cabled PCIe because it has enough bandwidth for applications where digital signal processing (DSP) takes place in a separate box from measurement or stimulus systems.

"Cabled PCI Express is still a few years away from making it into everyday PCs," said Richard McDonell, PXI and instrument control product group manager at National Instruments. "It requires less processing than parallel PCI, uses a thin cable, and can transfer about 250 Mbytes/s per lane. A four-lane PCIe system can transfer 1 Gbyte/s, although effective throughput is about 800 Mbytes/s."

Today, you can get that speed between a PC and a PXI chassis, but some applications demand more speed. Wade Lowdermilk, engineering fellow at BAE Systems in San Diego, found that neither USB nor Ethernet had the high bandwidth and low latency he needed to move data from a digitizer to a processor. His system consists of two 2-channel PCI digitizers (14 bit, 100 Msamples/s, and 8 bit, 1 Gsample/s) mounted in a VXI system through adapter cards.

The VXI bus doesn't have the bandwidth to move data from the digitizers to processor cards quickly enough. Lowdermilk tried PCI-to-USB and PCI-to-Ethernet interface cards to circumvent the VXI bus, but found that neither had the bandwidth he needs. "The link was not real time," he lamented. His only option is cabled PCIe. "I like cabled PCI Express because it supports multiple platforms," he said. "I can use it to transfer data to an outside processor or FPGA at speeds that let me view processed data in real time."

Currently, the best cabled PCIe interface from National Instruments can handle four lanes, each at 2.5 Gbps per lane, or about 800-Mbytes/s data throughput. Lowdermilk needs eight lanes, but he is able to use a four-lane, PCIe generation 2 link, which runs at 5 Gbps per lane.

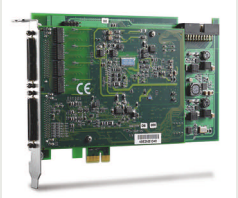


A PXIe based synthetic-instrument system needs the high bandwidth that only cabled PCIe/PXIe can deliver.

Lowdermilk had another application that requires cabled PCIe with higher speeds than currently available. He's working with National Instruments and Phase Matrix on a PXIe-based synthetic-instrument system that uses two 18-slot PXIe chassis, one for measurement and the other for stimulus (see **figure**). His application requires two 8-bit digitizer channels that run at 2 Gsamples/s. To process and view the signals in real time, Lowdermilk needs a 16-lane PXIe link or an 8-lane PXIe generation 2 link. He currently has preproduction PXIe interface cards that he's evaluating for his system. He'll either build his own interface cards or work with National Instruments to develop the cards

Cabled PCIe shows promise for applications that process data separately from digitizers. Should it become available in standard PCs, cabled PCIe could find use in video systems. It has already attracted the interest of test engineers. T&MW

PCIe data-acquisition card has 12-bit resolution



Adlink's DAQe-2200 series of 64-channel simultaneous-sampling data-acquisition cards use one PCIe lane. The DAQe-2204 has 12-bit resolution and samples at 3 Msamples/s. The DAQe-2205 is a 16-bit digitizer card with a 500-ksamples/s sampling rate, and the 16-bit DAQe-2206 simultaneously samples at 250 ksamples/s. Base price: $895. www.adlinktech.com/TM.

2-Gsamples/s PCI digitizer features 15-W power dissipation

The DP1400 two-channel, 8-bit, PCI digitizer card from the Acqiris division of Agilent features 15-W power dissipation and, with the simultaneous acquisition and readout (SAR) option, can continuously stream data to disk or to a PC screen. The DP1400 can segment its onboard memory into three parts, which lets it buffer captured samples for display while it stores later samples. Price: $9490; SAR option—$1000. www.acqiris.com.

Video tester supports HDMI 1.3

Quantum Data's 882EA generates and analyzes 36-bit deep color video and includes an HDMI 1.3 video interface. It emulates both source and sink devices so that manufacturers of displays, set-top boxes, disc players, and repeaters can verify compliance and interoperability of HDMI video ports. Price: $14,745. www.quantumdata.com.

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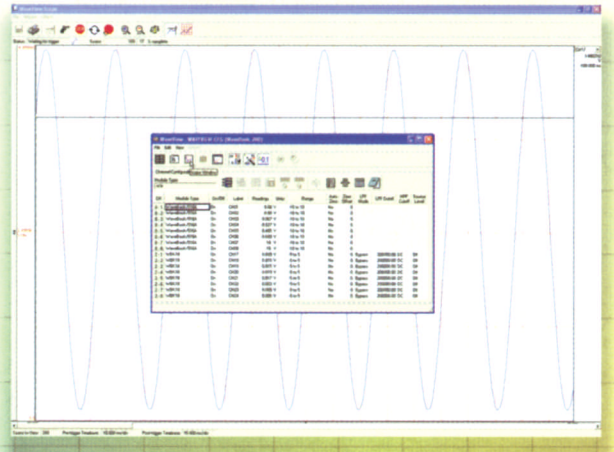

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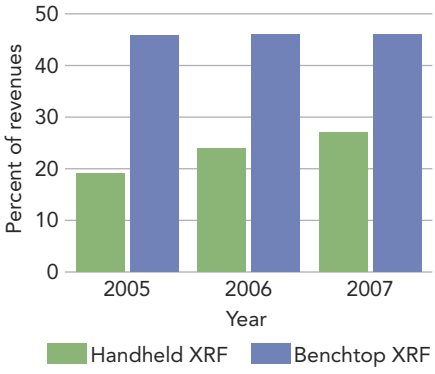
Keep them handy—the rise of handheld XRF instruments

ONE OF THE MOST significant trends in the x-ray instrumentation market has been the emergence of handheld x-ray fluorescence (XRF) analyzers. Although bench systems have been more popular in the past for elemental analysis, there has been an exceptional rise in the demand for handheld XRF systems in the past year. In fact, the market exceeded the $100 million mark in 2006 and is expected to continue to grow in the future.

How is this possible considering that until even recently end users have had many apprehensions about using handheld systems? The key here has been the development of low-power x-ray tubes that do not rely on radioactive materials.

The growth of the handheld instruments market is mainly attributed to the European Union's (EU's) Regulation of Hazardous Substances (RoHS) directive and the Waste Electrical and Electronic Equipment (WEEE) directive. These directives restrict metals such as Pb, Hg, Cd, Cr, and Br in products, thereby providing significant growth opportunities for handheld XRF system vendors.

XRF has emerged as the main technology used to screen products for regulatory compliance. Moreover, the scarcity of many metals in developing economies such as China, Russia, and India has led to handheld XRF instruments playing a major role in the mining industries. The boom in manufacturing activity, especially in the metals industry, has further driven the demand for XRF instruments.



Worldwide handheld XRF revenues will grow as a percentage of the total XRF market, driven in part by the new RoHS and WEEE directives. Source: Frost & Sullivan.

With the advancement in technology, handheld XRF systems have evolved into systems that offer greater detection capabilities while also meeting the demands of the RoHS and WEEE directives. Furthermore, handheld instruments are less expensive than bench equipment, and their ability to analyze small parts made of various materials has been instrumental in generating demand for them.

Although bench instruments provide much more conclusive results for compliance, handheld XRF analyzers are becoming increasingly preferred as screening tools by a wide range of end user industries such as energy and power, aerospace, metallurgy, and geology. The popularity of handheld instruments is driven by their portability and their ability to rapidly analyze, identify, and characterize a wide range of elements, along with the fact that little technical expertise is needed to operate them. Thermo Fisher Scientific, Bruker Biosciences, Innov-X Systems, Spectro, and Oxford Instruments are some of the leading participants in this market. They are competing to develop handheld instruments with performance levels approaching bench equipment but at a lower price. T&MW

PCB book to bill

The book-to-bill ratio for the North American rigid PCB industry in May 2007 dipped slightly below parity—its April level—to 0.98. The North American flexible circuit book-to-bill ratio continued its climb, from 1.28 in April to 1.32 in May, indicating probable sales growth in the near term. The combined (rigid and flex) industry book-to-bill ratio in May remained just above parity at 1.01. www.ipc.org.

IEEE 1394 interface headed for decline

IEEE 1394, also called FireWire or i.Link, faces major challenges, and its market share is stagnating, reports In-Stat. The peak year for 1394 devices is expected to be 2008, and a slow decline will set in beginning in 2009, the market research firm says. "1394 suffers from being the second-choice technology in many product segments," said Brian O'Rourke, In-Stat analyst. "For example, 1394's historic one-third penetration of the PC market is now dwarfed by high-speed USB's 100% penetration. This has helped high-speed USB become the interface of choice for PC peripherals." More information is available in the $3495 report, "1394 2007: A Niche Interface." www.in-stat.com.

Semiconductor equipment book to bill

North American-based manufacturers of semiconductor equipment posted $1.67 billion in orders in May 2007 (three-month average basis) and a book-to-bill ratio of 1.00. The ratio stood at 0.98 in April. The bookings figure is about 6% greater than the final April 2007 level of $1.57 billion and about 3% greater than the $1.62 billion in orders posted in May 2006. www.semi.org.

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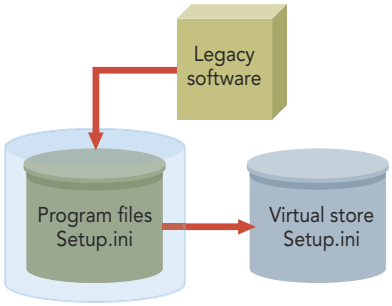
PC-BASED INSTRUMENTS

Windows Vista: migrate or not?

In January, Microsoft released Windows Vista, its latest operating system. Today, you'd have a hard time finding a new PC with Windows XP, although some are available. Should you migrate to Vista?

In general, the answer is "no," according to Mike Neal, LabView product manager at National Instruments. Vista's security enhancements make installing software more difficult than ever by limiting access, even to administrators. Furthermore, Vista uses a process called "virtualization" (see **figure**) to maintain compatibility with older Windows versions while isolating those programs from parts of the operating system.

In his article, "Should you migrate test applications to Windows Vista?" Neal warns that "Although most legacy applications created for previous versions of Windows will run because of virtualization, it is not an ideal solution and only intended to serve as a short-term workaround. Because virtualization isolates files in per-user locations, it can lead to undesirable and seemingly bizarre behavior, especially on computers shared by multiple users."



Virtualization helps protect various parts of the file system and registry while maintaining compatibility with legacy software.

Neal also says that you don't need the 64-bit version of Vista because the performance boost is minimal and it might require you to recompile your applications and drivers. Applications that require more than 4 Gbytes of memory, such as large computational programs or large databases, will benefit from 64 bits, but others won't.

You can read Neal's article at www.tmworld.com/vista_ni. You can also read an interview with Neal about Vista from *Design News* at www.designnews.com/article/CA6409236.html

Martin Rowe, Senior Technical Editor

WEBCAST

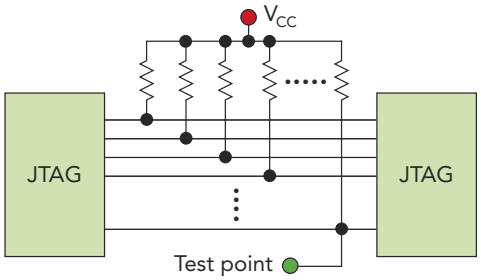
Optimizing printed-circuit-board test coverage

Test engineers struggle to find the optimum balance between printed-circuit-board (PCB) cost and test coverage. Low coverage leads to excessive field returns, warranty replacements, and even lawsuits. Attempts to provide too much coverage lead to reduced profits, canceled projects, and even bankruptcy.

That's the message Arden Bjerkeli, director of support, training, and services at Asset InterTech, delivers in the Webcast "Test Coverage Decisions for the Printed Circuit Assembly Factory." Bjerkeli notes that several techniques are available to help diagnose and repair defects, prevent test escapes, and improve processes while minimizing costs:

- process monitoring and structural test, which use automated optical inspection (AOI), automated x-ray inspection (AXI), and manual visual inspection;
- electrical structural testing, including in-circuit test (ICT), flying probe test, and IEEE 1149.x JTAG; and
- functional board test, which can employ a system mock-up, self-diagnostics, simulation, emulation, or external instrumentation under control of a test executive.

Bjerkeli notes that these techniques can be combined, citing as an example a board having 128 pull-up resistors of the same value (**figure**). If all the resistors will be placed from the same reel, you can use ICT to check the value of only one and assume that the value of the other 127 is the same. Then, you can use AOI or AXI to verify that each resistor is present and aligned properly and that it exhibits high-quality solder joints. Finally, JTAG technology can ensure that each resistor is neither shorted nor open.



You can combine ICT, inspection, and JTAG techniques to achieve a high level of coverage on 128 devices with only one test point on a signal net.

He covers proposed standards for defining the structural PCB defect universe, including Agilent Technologies' PCOLA/SOQ (for Presence, Correct, Orientation, Live, Alignment, Short, Open, Quality), ASTER Ingenierie's PPVS (Presence, Polarity, Value, Solder), and Philips Research's MPS (Material, Placement, Solder). He also covers iNEMI's FAIM (Feature, At-speed, In-Parallel, Measurement) extension to PCOLA/SOQ as well as Philips Research's DMPSF (Design, Material, Placement, Solder, Function).

For more details, view the archived Webcast, sponsored by Asset InterTech and *Test & Measurement World*, at www.tmworld.com/webcasts.

Rick Nelson, Chief Editor

BOOK REVIEW

Get the basics of data acquisition

Understanding New Developments in Data Acquisition, Measurement, and Control, Keithley Instruments, Cleveland, OH, 2007. www.keithley.com/wb/201. Cost: free.

The phrase "New Developments" in the title of this handbook from Keithley Instruments refers to computer networking—a topic you need to understand now that so many instruments have LAN ports. The rest of the information in this book, while hardly new, is still relevant and useful.

This handbook will help new engineers, technicians, students, and hobbyists understand the basics behind PC-based instrumentation. Besides explaining how to configure instruments for use over LANs, the book provides a solid background on analog measurements. It covers simple signal conditioning, starting with components and moving up to functional circuits. It also covers filters, data conversion, bridge circuits, logic circuits, and most importantly, ground loops.

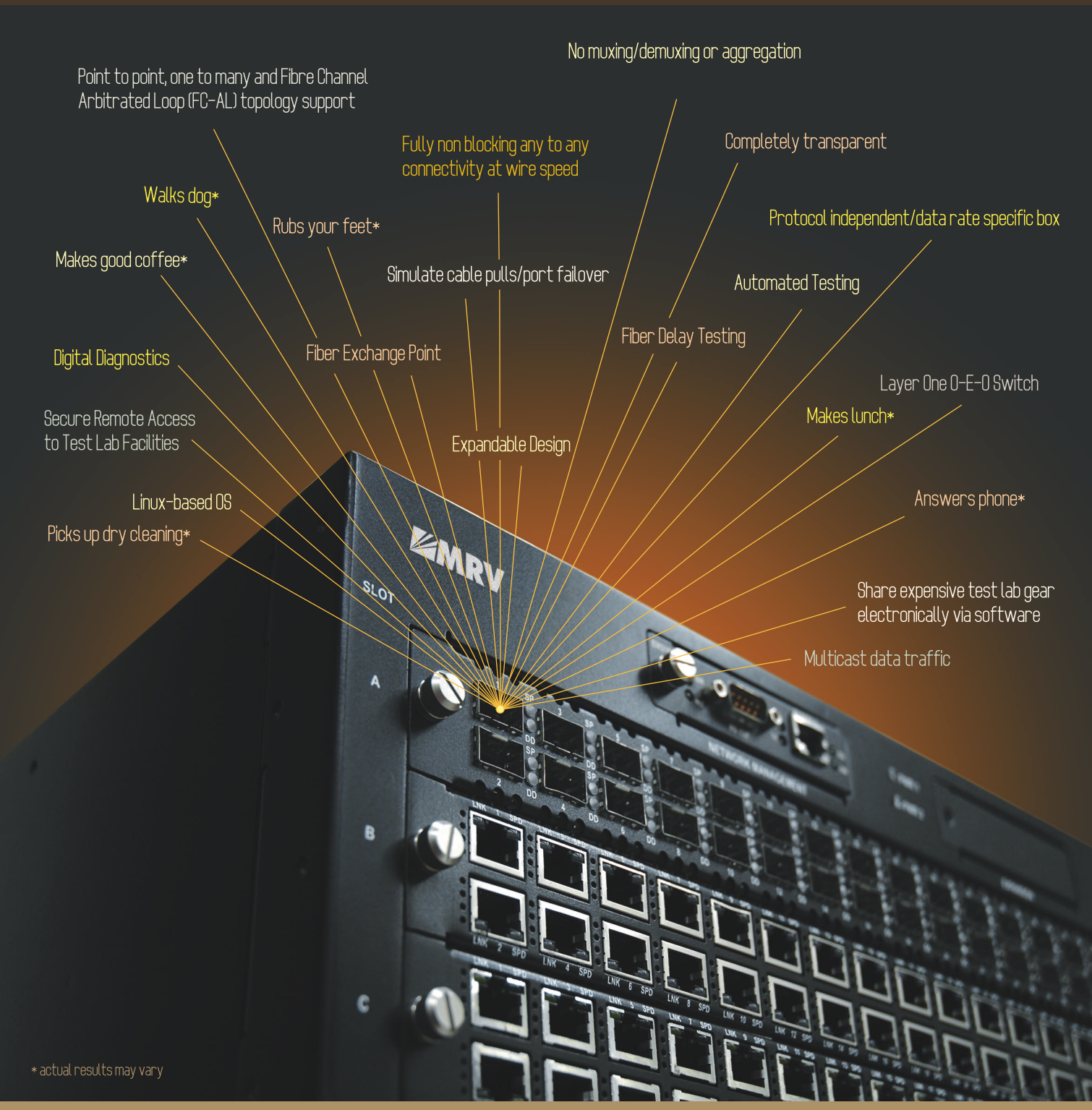
An entire section of the book covers temperature measurements, a topic that is always important because temperature is by far the most common physical measurement. The book, however, inaccurately describes the Seebeck Effect by stating, "In the early 1800's, Thomas Seebeck discovered that the junction between two wires generates a voltage that is a function of temperature." This is a common misstatement. Seebeck discovered that a wire whose ends are at different temperatures will develop a voltage across those ends. This error doesn't detract from the book's practical information on using thermocouples, however, because the book uses several diagrams to accurately describe how thermocouples work.

If you've designed PC-based data-acquisition systems for years, you won't gain much from this book. If you're new to the task, though, then you stand to learn from it. Given that Keithley offers the book for no charge, you can't go wrong.

Martin Rowe, Senior Technical Editor

At times, nothing could be better than a free port

(Especially when that port can do so much)



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DEVICE UNDER TEST

Physical-layer interface (PHY) ICs embedded into network-interface cards (NICs), Ethernet switches, and test equipment. The PHY devices provide a 10GBase-T (10-Gbps) interface from the equipment to Ethernet networks.

THE CHALLENGE

Test for physical-layer interoperability between equipment. Construct a pair of test networks, one each for equipment connected with each PHY IC. Test for interoperability among equipment on each network and then connect the two networks and perform interoperability testing between the two PHY ICs.

THE TOOLS

- Agilent Technologies: Ethernet cable tester. www.tm.agilent.com.
- Fluke Networks: Ethernet cable tester. www.flukenetworks.com.
- Fulcrum Microsystems: Ethernet switch. www.fulcrummicro.com.
- Ixia: data generator. www.ixiacom.com.
- LeCroy: digital oscilloscope. www.lecroy.com.
- The Mathworks: technical computing software. www.mathworks.com.
- SMC Networks: Ethernet switch. www.smc.com.
- Spirent Communications: data generator. www.spirentcom.com.

PROJECT DESCRIPTION

The University of New Hampshire Interoperability Lab (UNH-IOL, www.iol.unh.edu) participated in a May 2007 demonstration with the Ethernet Alliance (www.ethernetalliance.org) of physical-layer interoperability. In preparation for the demo, staff engineers and students led by UNH-IOL 10 Gigabit Ethernet Consortium manager Jeff Lapak tested two 10GBase-T PHY ICs for interoperability.

The test bed consisted of two independent networks that were later connected. Each network used servers containing NICs, an Ethernet switch, and a data generator, all of which contained a 10GBase-T PHY from the same source (PHY-A and PHY-B in the **figure**).

Engineers started by connecting two servers with the same PHY over a 5-ft, Cat-6A cable to verify that the identical PHYs would communicate. This test consisted of each server sending a "ping" signal to the other.

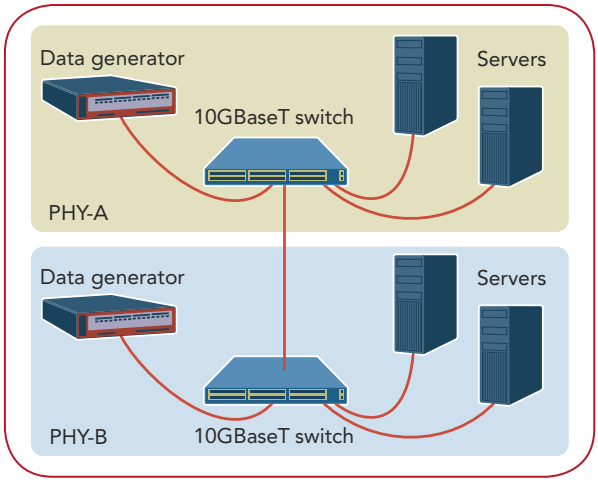
With communication established, the engineers connected the servers and a data generator to an Ethernet switch, with all equipment in each network using the same PHY. This configuration used 100-ft Cat-6A cables. Engineers used cable testers to measure insertion loss, return loss, and crosstalk of the cables.

The engineers set the data generator to loopback mode, so it received its own transmissions through the switch. The servers then sent 100-Gbps data streams to each other through the switch.

Because the PHYs in each network were early revisions, engineers from each PHY manufacturer were on hand to make firmware changes following a test. "This process takes about two days," noted Lapak.

With interoperability established, UNH-IOL engineers tested the cables for interference. While the servers loaded the network, the data generator sent traffic to itself though the switch and counted packet errors. "We consider the test a success if the data generator counts less than one error per hour," said Lapak. The engineers repeated the interference tests with cables from three manufacturers (Panduit, Siemon, and Systimax).

In the final test, engineers connected the two networks so they could demonstrate whether PHY-A and PHY-B equipment could communicate. Communication initially failed, so the engineers used an oscilloscope to verify that each PHY complied with 10GBase-T Ethernet standards. They measured jitter, power, rise time, and clock frequency.



Two networks, each with equipment containing PHY-A or PHY-B ICs, let engineers perform interoperability tests.

A UNH-IOL-developed Ethernet autonegotiation test tool monitored the negotiation process, looking for violations from the standards. Once engineers from Solarflare and Teranetics modified their respective firmware, UNH-IOL engineers turn to the PHYs' built-in diagnostics to complete the test.

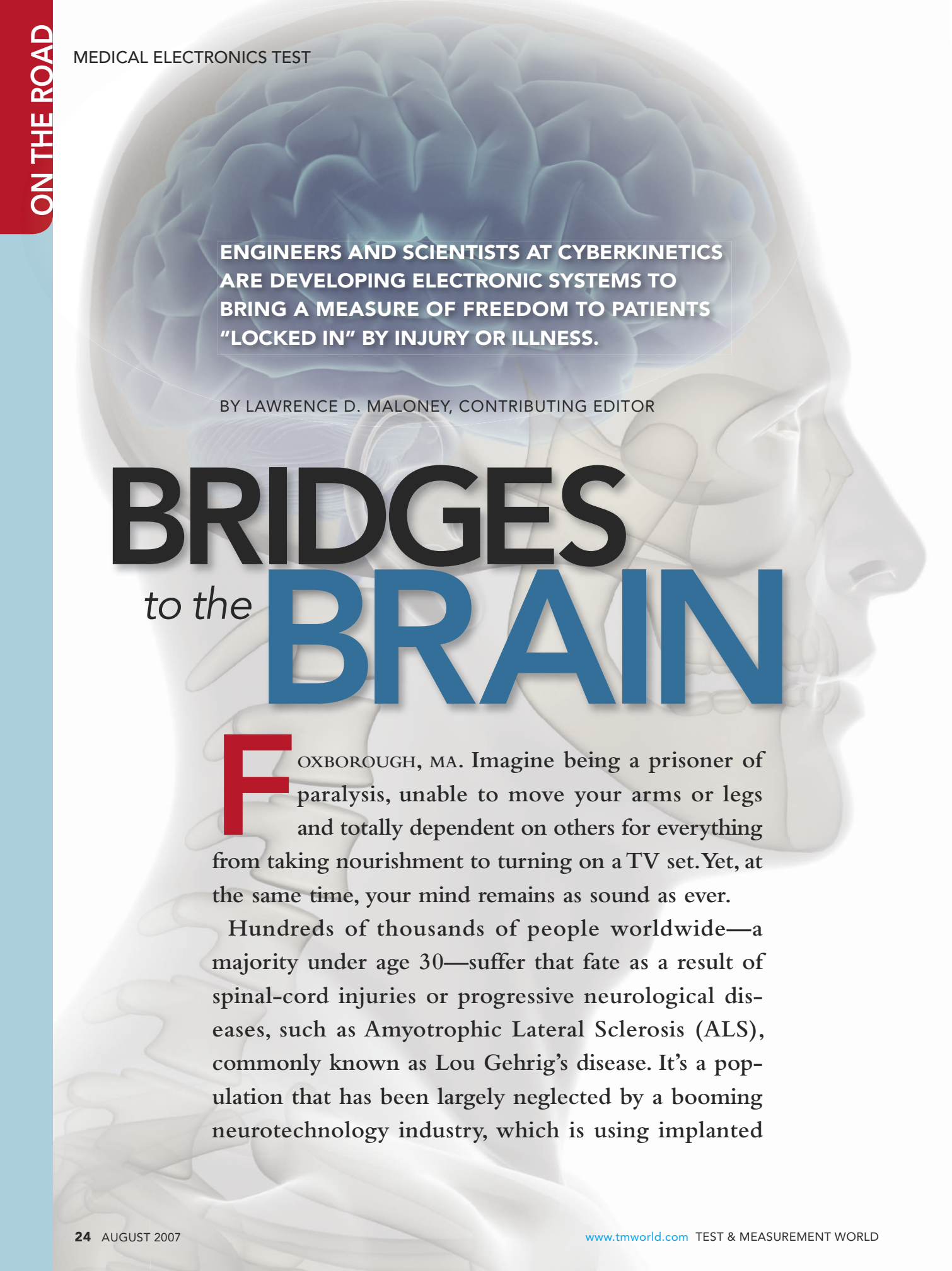
LESSONS LEARNED

Just because communications devices meet industry standards doesn't guarantee they will work with compliant devices from other sources. Interoperability tests let engineers verify that devices will behave as expected.

Martin Rowe, Senior Technical Editor

FOR MORE INFORMATION

Rowe, Martin, "Today's testing, tomorrow's engineers" (a story about the UNH-IOL), *Test & Measurement World*, April 2006. www.tmworld.com/2006_04.



ENGINEERS AND SCIENTISTS AT CYBERKINETICS ARE DEVELOPING ELECTRONIC SYSTEMS TO BRING A MEASURE OF FREEDOM TO PATIENTS "LOCKED IN" BY INJURY OR ILLNESS.

BY LAWRENCE D. MALONEY, CONTRIBUTING EDITOR

BRIDGES *to the* BRAIN

FOXBOROUGH, MA. Imagine being a prisoner of paralysis, unable to move your arms or legs and totally dependent on others for everything from taking nourishment to turning on a TV set. Yet, at the same time, your mind remains as sound as ever.

Hundreds of thousands of people worldwide—a majority under age 30—suffer that fate as a result of spinal-cord injuries or progressive neurological diseases, such as Amyotrophic Lateral Sclerosis (ALS), commonly known as Lou Gehrig's disease. It's a population that has been largely neglected by a booming neurotechnology industry, which is using implanted

MATTHEW MCKEE

Field clinical engineer Abe Caplan conducts a session with an ALS patient, who uses his thoughts to control a cursor on a computer monitor.

electronic stimulators to address conditions ranging from chronic back pain to deafness to Parkinson's disease.

Now, however, Cyberkinetics Neurotechnology Systems, a Massachusetts startup, has earmarked those with severe paralysis as its target population for electronic devices designed to accomplish what some might say is impossible. Its implanted Andara Oscillating Field Stimulator (OFS) System promotes tissue growth in the vicinity of a spinal injury, thereby restoring some sensation and movement (see "The quest for regeneration" in the online version of this article at www.tmworld.com/2007_08).

Perhaps even more incredible, the company's BrainGate Neural Interface System harnesses signals from the brain to allow severely motor-impaired patients to control a computer, appliances, or a prosthetic arm.

"Cyberkinetics is doing great things and deserves a lot of credit for focusing on a market that other companies have bypassed as being too small," noted James Cavuoto, a biomedical engineer who publishes *Neurotech Reports*, an industry newsletter. "This company has looked at a segment of the disabilities community that is most in need and is making significant progress."

DOUGLAS BARNES/NPN WORLDWIDE

Lead electrical engineer Andras Pungor designed an automated impedance tester that played a key role in speeding development of the BrainGate system. Within seconds, the tester can identify leaks, shorts, or connection problems in the 96-channel electrode array.

Those gains, however, have come only after millions of dollars in investment and years of research for the publicly held firm, including a long litany of development tests, many of them homegrown, to validate the systems.

From thoughts to control

Experts both within and outside Cyberkinetics see the BrainGate system as by far the company's most challenging from a design and test standpoint. It begins with the design and test of a reliable three-dimensional electrode array, implanted in the region of the cortex associated with motor control function.

The original electrode design dates back to the early 1990s, when University of Utah biomedical professor Richard Normann obtained a patent for an array originally targeted for restoring rudimentary vision to the blind. The company he founded, Bionic Technologies, continued to improve on electrode designs until it was acquired by Cyberkinetics, founded in 2001 by Brown University neuroscientist John Donoghue. For more than a decade prior to starting the company, Donoghue had conducted animal research to build computer interfaces for processing brain signals.

The current array, now being implanted in patients in clinical trials, consists of 100 platinum-tipped silicon electrodes, insulated with Parylene C. Individual electrodes, 96 of which are available for recording neuronal activity, are 1 mm long and spaced just 400 µm apart. A tiny wire bundle from the electrodes connects through the skin to a titanium pedestal anchored to the exterior of the skull.

The pedestal, which contains amplifier and signal-conditioning hardware, connects to a cable that carries the amplified neural signals to computers resting on a cart near the patient. Future designs, now under development, will feature infrared wireless technology linked to a more compact computer, mounted on the patient's wheelchair.

The challenge in all this is twofold. First, the engineers must obtain good quality signals from the electrode array. And second, they need to devise computer algorithms or "filters" to decode the neural spiking from the electrodes,

which appear as waveforms on the technician's computer screen. The goal is to screen out noise and convert those brain signals in real time into control signals that will allow a patient to move a computer cursor, click on an icon that will turn on an appliance, or even maneuver a robotic arm.

Patients have demonstrated all these functions in clinical trials.

"We are asking the system to deliver 30 kHz of signal for 96 channels, so there is a lot of processing," noted Donoghue, the company's chief scientific officer and director of the Brain Science Program at Brown University. "One of our biggest challenges is decoding the signals to convert them from a stream of impulses into a command signal. We have to process 96 channels of data, signal condition it, discriminate the signals, and then interpret the impulse—all in less than 150 ms."

DOUGLAS BARNES/NPN WORLDWIDE

Before Almut Branner and her colleagues developed an automatic spike sorter, it could take up to an hour for engineers to classify the neural "spikes" or action potential waveforms from brain activity picked up by the BrainGate electrode array.

Do we have a signal?

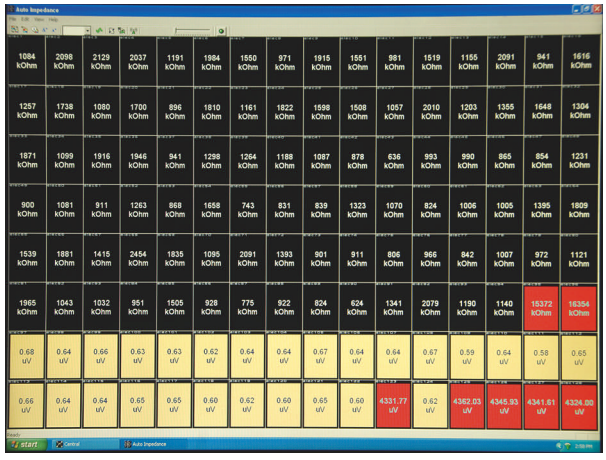
Critical to this operation is knowing how each of the electrodes is functioning. To address that need, Andras Pungor, the lead electrical engineer at Cyberkinetics' development and manufacturing facility in Salt Lake City, designed what Donoghue describes as a "very elegant" automatic impedance tester.

Early in the system's design, Pungor had designed his own bench-level impedance tester, but the shortcomings were soon apparent. "It took 20 to 30 min to measure each electrode in a 96-channel system," recalled Pungor. "And even good bench-level impedance testers could only measure low currents down to 1 nA at an average of 100 mV."

By contrast, his new patented automatic impedance tester can measure current in the range of 10 pA and voltages as low as 5 mV. Moreover, results of this impedance test of all 96 channels are graphically displayed on a monitor in just 10 s.

Hardware consists of a 1x1-in. circuit board embedded in the cable that connects to the pedestal mounted on the patient's skull. To take a measurement, a technician simply flips a switch on the cable, sending a 1-kHz signal at 5 mV. In contrast to using a passive impedance tester, operators do not have to disconnect the patient from BrainGate to do the test.

During the test, the graphic display shows a map of the array system, with each channel appearing as a block with impedance values. "It is a snapshot, and you can set up desired parameters," explained Pungor. "For example, you can ask the system which electrodes are within specific ranges, such as between 200 and 400 kΩ. The channels within that range will show up as black, those above the range in red, and those below the range in yellow. When you are looking at 96 channels at the same time, it is much easier with this color-code system."



With the automated impedance tester, operators can quickly identify which electrodes are operating within specific ranges, such as between 200 and 400 kΩ. The channels within that range will show up as black, those above the range in red, and those below the range in yellow.

For human clinical use, the acceptable operating range for electrodes is between 100 and 800 kΩ, added Pungor.

Members of the Cyberkinetics team agree that the impedance tester has been a vital tool both in developing the system and in facilitating sessions with patients using the system in clinical trials. For example, the tester can quickly identify problems such as leaks, shorts, or poor connections in the array.

"The quality of the circuit may change because of all sorts of factors, including tissue response and material changes in the device itself," noted Donoghue. "This impedance tester is an extremely sensitive and extraordinarily valuable tool to insure that the circuit is intact and performing as it should."

Necessity breeds invention

The impedance tester is just one example of many "homegrown" test and measurement devices and methods created by the Cyberkinetics staff. Pungor recalled that early in the development of the electrode array, there were no off-the-shelf

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Agilent Technologies

high-power amplifiers for 100 channels. "You had racks of amplifiers, and there were a lot of ground problems and noise problems. So we said, 'Why don't we build an artificial electronic neuron source to simulate every channel?'"

What the engineers came up with was a signal generator with 128 channels and capable of putting out neural type signals in the range of 120 to 150 μV at a 200 kΩ impedance. Each channel in turn could generate four different kinds of signals each second.

"This was a very valuable tool in troubleshooting as we developed the array," said Pungor, "versus having to do testing in living animals."

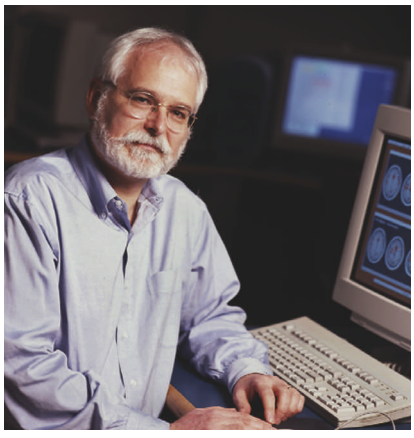
As the technology evolved, the engineering team developed a PC-based system, called the motor cortex simulator, featuring 100 channels of firing neurons and a touch screen that let researchers alter the modulation of the neurons. One PC was used as a function generator, simulating the firing of the neurons, and two others served as signal processors.

"This tool allowed us to validate all parts of the system, both hardware and software," explained Donoghue. "It evaluated both the throughput speed and the accuracy of capturing the analog waveforms and processing them into a digital pulse."

Sorting the data

On the software side, Cyberkinetics has relied heavily on tools such as The MathWorks' Matlab to address many technical issues, and the team created diagnostic software that detects crosstalk between electrode channels. Even more significant, the engineers used software to devise a time-saving measurement tool for sorting the vast amount of neural data pouring into the system from the 96 channels.

Manual methods for detecting and classifying these neural "spikes" or action-potential waveforms had become too time consuming. Using software analysis of waveform shape and amplitude, researchers have to set up different classification rules for each of five waveforms coming from each channel. Classifying these waveforms is an essential preliminary step for devising the software-based rules that enable patients to perform control functions during their sessions with researchers and technicians.



BrainGate could establish a new line of communications for severely paralyzed individuals who have been cut off from the world, said John Donoghue, the Brown University neuroscientist who founded Cyberkinetics. Courtesy of Cyberkinetics.

Yet this "spike sorting" was taking an hour or more in setup time.

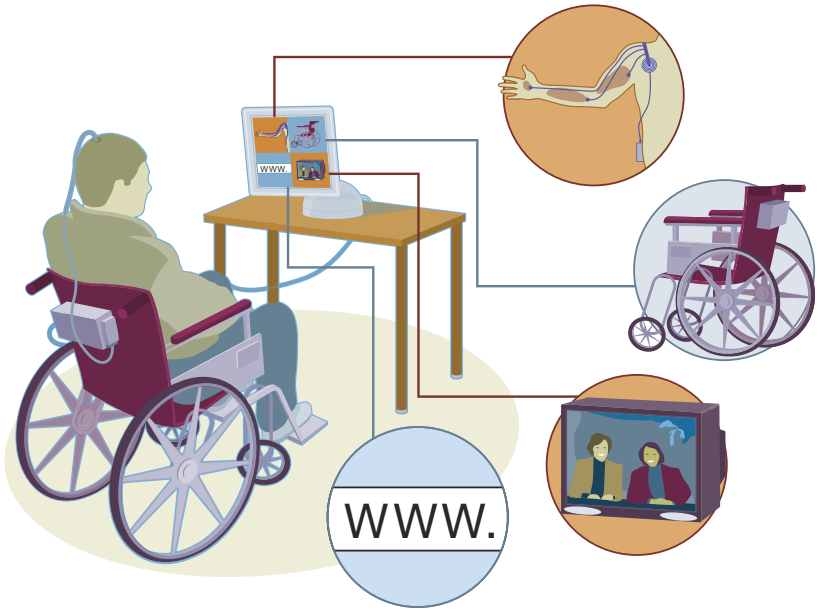
"We needed to automate this process by coming up with an algorithm to create these rules," explained Almut Branner, a Cyberkinetics biomedical engineer who headed the team that developed what is called "the automated spike sorter." The new system, devised with the help of Matlab and its signal-processing toolbox, now takes the continuous signal that comes in from the patient and makes decisions about whether the signal is noise or one of the action-potential waveforms. The process now takes just a few minutes.

The automated spike sorter, added Branner, is also an essential step toward the goal of a future BrainGate system that could be operated by patients without the assistance of technicians. "Eventually, the algorithm could perhaps be implemented on a DSP chip that is implanted in the body," she said. "This would greatly reduce the bandwidth of the signal that we now send out of the body. We collect 30,000 data points per second on every channel, and right now it is almost impossible to do this wirelessly."

Years of development

The BrainGate system follows nearly two decades of research, both in New England where Donoghue and his team did 10 years of animal studies in his Brown University lab, as well as in Utah, dating back to Richard Normann's first electrode designs.

"We did a lot of histology tests in monkeys, looking at the tissue reaction to the implanted array," recalled Donoghue. "Early on, just getting the data was a major measurement accomplishment. You need to place the electrodes very close to any neurons to pick up the sig-



In clinical trials, patients with the BrainGate implant have performed a number of functions, such as moving a computer cursor, clicking on an icon to activate appliances, and maneuvering a robotic arm.

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nal—within 150 microns. If the electrode were to move, or if you had scarring around the tip of the electrode, you could lose the signal."

At the Salt Lake City development and manufacturing facility, senior biomedical engineer Rick Van Wagenen cited a whole litany of essential tests that were instrumental both in developing the initial electrode array, as well as other components of neural interface systems that the company sells to researchers around the world. These products range from cables, connectors, and customized electrode arrays to amplifiers and neural signal processors. Among the tests and procedures that Van Wagenen said have been essential to the team's research and development work on BrainGate:

- scanning electron microscopy for such tasks as studying the morphology of the platinum metal that is sputter-deposited on the electrode tips;
- impedance tests, using such tools as the homegrown automatic impedance tester, as well as electrochemical impedance spectroscopy with gamma ray instruments; such tests help determine a profile of the impedance performance as a function of frequency, a key step in making an electrical model of the neural interface;
- profilometry for measuring the surface roughness and other parameters of metal elements of the implanted array, and ellipsometry for measuring thickness of coatings and films used in the implanted assembly;
- accelerated life tests, ranging from several months to years, of operational arrays in a saline bath at temperatures in the range of 58°C to 68°C; a multichannel signal generator provides the pulsing energy to the electrodes; and
- electromagnetic interference (EMI), radio-frequency interference (RFI), electrostatic discharge (ESD), and other susceptibility tests on prototypes, typically performed by outside labs, such as Curtis Straus, in accordance with ISO 60601 standards for implantable electronic devices.

Manufacturing of the company's neural interface components takes place in an FDA-registered clean-room environment, monitored regularly for humidity, temperature, and bacteria counts. Technicians routinely employ optical microscopes to inspect electrode tips, and a stereomicroscope with photographic attachment is used to take a picture of every electrode array for record keeping.

Packages of array components for implants are sent to an outside vendor for sterilization and are returned with test data certifying the effectiveness of the process. The company even validates its packaging methods for array assemblies by sending samples to vendors, such as UPS Professional Service, for vibration, compression, and drop tests.

DOUGLAS BARNES/NPN WORLDWIDE

Engineer Rick Van Wagenen does a microscopic inspection of BrainGate's electrode leads, one of a long litany of procedures performed on the system.

The long path to market

With so much effort involved in this ground-breaking neural interface work, the logical question is how long before the company sees a commercial payoff from its showcase system, BrainGate?

"We are perhaps four or five years away from an FDA premarketing agreement, and we may need to invest 30 to 40 million more," noted Cyberkinetics president and CEO Timothy Surgenor.

Even so, the R&D work is already paying off, not just in sales of research products, but in medical devices that are offshoots of BrainGate. For example, the company has received FDA clearance for its NeuroPort Neural Monitoring System, which uses the BrainGate array to help physicians analyze abnormal brain activity in patients, such as seizures suffered by patients with epilepsy.

"BrainGate is really the basic platform for a whole range of applications, because it is, in effect, a test and measurement device for the brain," said Donoghue. In epilepsy patients, for example, Donoghue envisions future applications in which the array would first detect the onset of seizures and then activate an electronic stimulus to restore normal brain activity or, alternatively, an implanted microfluidic pump that would inject preventive medication.

Researchers outside the company also are working with Cyberkinetics to link BrainGate with other implanted devices, such as stimulators that enable paralyzed individuals to move their arms and hands. In addition, Cyberkinetics is already designing compact versions of the system that would use infrared technology to transmit the brain signals.

Behind all this effort is the desire to make a difference in the lives of severely paralyzed individuals who are cut off from the world. "This technology promises to give them an output to perform the functions that most of us take for granted," said Donoghue. "It may ultimately allow them to communicate and connect, which could have a huge impact on people who have gotten a really raw deal from life." T&MW

ON TMWorld.com

To learn more about the Andara Oscillating Field Stimulator (OFS) System, which promotes tissue growth in the vicinity of a spinal injury, read "The quest for regeneration" in the online version of this article. Also in the online article, "A pairing of technologies" explains how one research team is combining BrainGate with an implanted functional electrical stimulator (FES) to activate muscles in the hand and arm.

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Our hands-on evaluation of four models shows a wide array of performance, features, and price.

Fluke's 199C ScopeMeter has the largest screen of the four oscilloscopes.

Handheld OSCILLOSCOPES offer varied features

BY MARTIN ROWE, SENIOR TECHNICAL EDITOR

Agilent's U1604A provides both a wheel and buttons for setting the instrument.

Handheld oscilloscopes, once thought of as baby cousins to bench models, now offer performance levels that rival those of their larger cousins while adding battery-powered operation and a portability not available in the bench instruments. To find out how this class of instruments—which cover a wide price range—stack up, I evaluated four models:

- AEMC OX 7104-C (100 MHz, four channels, $5995),
- Fluke 199C (200 MHz, two channels, $2999),
- Agilent Technologies U1604A (40 MHz, two channels, $1651), and
- Protek 860F (60 MHz, two channels, $1686).

Tektronix also offers a handheld oscilloscope, the THS730, but the company chose not to participate in the evaluation. For a signal source, I used an Agilent 33220A, a 20-MHz function generator.

All four oscilloscope models include a built-in digital multimeter (DMM) and all come with oscilloscope and DMM probes. All except the Fluke instrument include communications cables and software as standard features. They all provide measurements such as RMS voltage, peak-to-peak voltage, and frequency. All include some form of spectral analysis, and all except the Protek model include a data recorder.

The Agilent and Protek models are not only comparable in price, but their firmware and software

The AEMC OX 7104-C features a touch screen at 12-bit resolution.

led me to believe that they come from the same source. Thus, I'll cover them together, pointing out similarities and differences.

With handheld oscilloscopes, the intangibles can matter more than they do for bench instruments. For example, battery life, the ability to change batteries in the field, and screen readability in daylight are factors irrelevant to bench oscilloscopes. The online version of this article contains a link to a table that compares features, price, and my likes and dislikes. It also contains a link to my blog, were you can read detailed evaluations of the instruments (www.tmworld.com/2007_08).

AEMC OX 7104-C

AEMC's Model OX 7104-C is the only four-channel handheld oscilloscope on the market. Its 12-bit resolution, 100-MHz bandwidth, and touch-screen display put it high on the performance list. To justify its $5995 price, you'd better need the portability (AEMC offers a two-channel version for $3995). If not, you can find plenty of bench oscilloscopes with comparable performance and price, but most have 8-bit resolution as opposed to AEMC's 12-bit resolution.

The OX 7104-C's most striking physical features are its touch screen and probes. The probes connect to the top of the scope through adapters permanently attached to the probe cables. The instrument knows whenever you connect a probe, and it detects the probe's attenuation level. The probes come with a handy light that you control with a button on the probe handle.

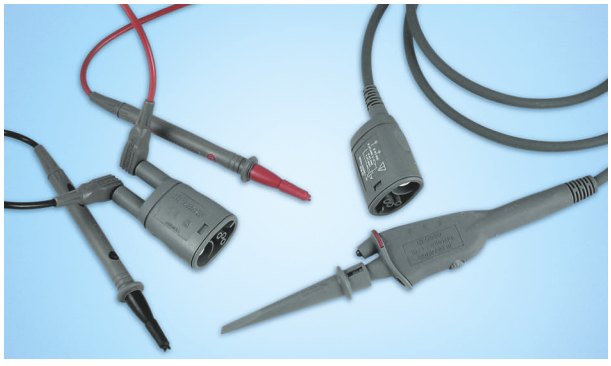
AEMC's AC mains adapter is large, but the power supply is inline. Thus, its standard AC plug covers only one space on a power strip. The oscilloscope end of the power cord has a four-prong plug that looks as though it plugs in more than one way. Fortunately, it doesn't.

You can also use separate adapters that provide BNC jacks for connecting cables. I used one to connect a function generator to the oscilloscope. Another adapter provides banana jacks for DMM probes. That's handy, because it lets you mix and match channels and thus connect oscilloscope probes, DMM leads, or accessories such as current probes to any channel. All other oscilloscopes in this evaluation have two oscilloscope channels and one DMM channel.

The touch screen lets you operate the instrument without using the buttons, although the buttons are neatly organized. If you use the stylus, you get more than one way to activate a feature. For example, you can change a channel's configuration by tapping on that channel's colored box on the screen or by using menus. The stylus attaches to the back of the case when not in use.

Protek's 860F would benefit from buttons for vertical and horizontal settings.

AEMC's handheld oscilloscope includes a harmonic analyzer that is designed for power-quality analysis and covers 40 Hz to 450 Hz. At low voltage levels, I was able to get reliable results to 5 kHz. I tested the analyzer with a sine wave and a square wave, seeing only the fundamental of a sine wave and only odd harmonics of the square wave as I expected.



Adapters for the AEMC oscilloscope let you mix and match scope and DMM channels.

The harmonic analyzer display shows a signal's spectrum harmonics to the 30th harmonic with a check box under each one. Tapping the check box lets you display amplitude and phase information for that harmonic. The screen also displays RMS amplitude and total-harmonic distortion on the signal.

AEMC's SX-Metro software lets you import data from the OX 7104-C into a PC and operate the oscilloscope (in scope mode) remotely. I used the RS-232 connection first, and the PC quickly recognized the oscilloscope. Not so with the optional Ethernet link. I had to go into the Options menu in the SX-Metro software to change the IP address to match that of the scope. I kept getting a communication error on my PC, so I returned to RS-232 to evaluate the software.

To send a screen image to the PC, you must use the oscilloscope's file manager. I found that confusing to use and needed several tries to understand its operation. I also found the communication cable connectors difficult to insert. You must press the connector's release button to insert it into the socket and even then, you must jiggle the connector to make a secure connection. You could break the clips if you push too hard. In addition, the molded cover designed for the communications and power connectors kept popping off, but the cover is attached to the unit, so you can't lose it.

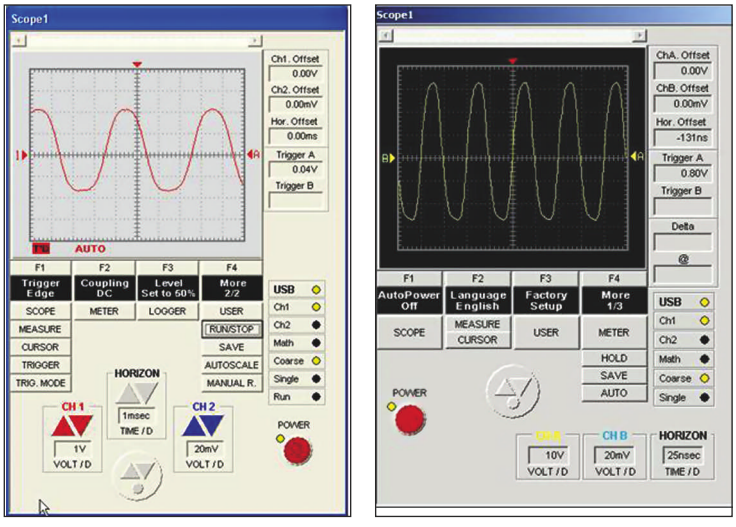
The AEMC OX 7104-C is a powerful instrument. Its bandwidth and resolution make it a viable alternative to some bench scopes, and its ability to mix and match oscilloscope and DMM inputs with its four channels is unique. The instrument has a few quirks, though, particularly when saving files for PC downloading, and its price is difficult to justify.

Fluke 199C ScopeMeter

At half the price of the AEMC and nearly twice the price of the Agilent and Protek models, the Fluke 199C ScopeMeter boasts the highest bandwidth of the lot (200 MHz) and the highest sampling rate (2.5 Gsamples/s). Fluke pio-

neered the handheld oscilloscope market, and the 199C has come a long way from the original ScopeMeter. The 199C is far easier to use than its ancestors. The buttons are neatly organized—though slightly too close together—and the four soft keys are easy to understand.

The screen is the largest of the four models I evaluated. It looks bright and clear when used indoors, but the plastic cover is so shiny that you can't see the traces outdoors because of reflections. The oscilloscope has a hand strap on its left side, but the strap can be moved to the right side, making this the only one of the four instruments that addresses the needs of lefties. Moving the strap, however, will cover the optical communications port. The Fluke oscilloscope also has the most rugged stand of the group, and it is the only one with a strap that lets you hang the instrument while in use.



Agilent's PC software (left) and Protek's PC software bear striking similarities, as do their firmware.

The ScopeMeter has two dedicated buttons marked "Zoom" and "Replay." The zoom button cuts the time/div in half, which gives you a quick 2X zoom of the waveform. The replay button gives you a link to the past, letting you view the last 100 screens in reverse chronological order. When you exit the replay feature, you lose the data, because the scope starts recording another 100 screens.

The Fluke recorder feature stands out. It has three modes, of which two are for the oscilloscope, not just for the DMM. The scope trend plot lets you record scope measurements such as Vpk-pk, VAC, rise time, and frequency. I used it to record Vpk-pk and frequency because they're easy to change in the function generator. The Scope Record option lets you store a long string of scope acquisitions into the unit's deep memory. The DMM recorder lets you plot a selected DMM measurement. I chose V_{RMS} and produced a trend plot.

Trend plots let you look at long-term changes in a signal. The 199C will record data until its memory fills, then it compresses the data to free half the memory and thus double the unit's capacity. Record size is 27,000 points per input. You can set the instrument to stop recording when the memory is full, and you can use the time/div button to increase or decrease the time/recorder screen.

The FlukeView software lets you take a snapshot of the instrument's screen, but it doesn't provide oscilloscope updates in real time. It also provides limited online control of the instrument—once you find that feature in the program's Instrument menu. You can change mode (scope, meter, logger), and you can recall setups. You can operate the recorder to capture DMM measurements in real time as well as save setups, print, and log data to the PC. You can also get a spectrum display of an input signal after first downloading a waveform display.

The Fluke 199C is a powerful handheld oscilloscope. If you're left-handed, it's the one for you. Its hanging strap makes the instrument useful for electrical applications where you often need both hands free. The software is good for downloading data for offline storage and analysis. Perhaps the only drawback is the highly reflective screen cover.

Agilent Technologies U1604A Protek 860F

Because of the striking similarities between these two instruments, you can't talk about one without talking about the other. So, I'll first discuss their similarities and then point out their differences.

The user interface on both instruments uses four soft keys and a wheel. (I found Protek's wheel easy to spin, but Agilent's was difficult, often requiring two hands.) The soft keys let you set parameters such as oscilloscope vertical and horizontal scales, triggers, measurement functions, math, and utilities. One utility lets you enable or disable the instrument's mini-USB connectivity port and the standard USB port for use with flash memory. You must navigate the utility menu to find the setting to enable the USB ports. With USB off, you'll get no communications or flash-memory access.

Measurement functions include peak-to-peak, RMS, frequency, rise time, and fall time. You make a measurement by pressing the corresponding soft key and using the wheel to scroll through the choices. The math menu also lets you select FFT and a filtering window (Hamming, Hanning, Blackman, or rectangular), and you can get spectral plots in real time on the screen.

Pressing the Meter button brings up a blank screen with three soft-key options: Volt Meter, Ohm Meter, and Aux Meter. Pressing the aux meter (F3) key brings up choices for temperature, current, humidity, and pressure. For the voltmeter, you can choose from AC/DC, min/max, and relative measurements. To return to other meter functions, you must press the meter button, which brings you to the top of the meter menu; there's no "back" button. Pressing the ohmmeter button gives you resistance, diode, continuity, and capacitance measurements. (I wouldn't have expected to find capacitance buried under ohms, though.) You make your selection by repeatedly pressing the F1 key.

The only significant difference between the Agilent and Protek user interfaces occurs on the screen when you enter DMM mode. The Agilent screen

describes the meter functions, while the Protek screen is blank until soft-key functions appear.

Both instruments let you save screens and waveform data to a USB flash drive. You can save screens in graphical formats for importing into reports, and you can save data in text format for importing into Excel or other software. You can also save screens in a proprietary format that you can open with the PC software.

The PC software on the two instruments is also strikingly similar, right down to the word "Horizon" over the horizontal scale (time/div) indicator. The software lets you take complete control of the instrument and get screen updates in real time. It also lets you view measurement parameters, save waveforms in digital form, and capture screens. Once you install the software and turn on each instrument's USB function, you establish communications by clicking on the virtual power button.

There are, however, hardware, firmware, and PC software differences worth noting. Agilent provides buttons for vertical and horizontal screen settings. Protek makes you change all settings through menus. Agilent uses a color screen whereas Protek's screen is monochrome, and the monochrome screen is easier to see in daylight than the color screens from Agilent, AEMC, and Fluke. Protek gives you 20 MHz more bandwidth than Agilent. Both companies offer 20-MHz and 40-MHz models, with Protek also offering a 60-MHz model. Agilent includes a logger function for recording DMM measurements. Protek doesn't.

Other physical differences include a strap on the Agilent unit only. Both instruments have a holster, but Protek's was rather loose fitting. Protek is the only oscilloscope of the four that lets you install any AA-size batteries, which means you can buy extra batteries anywhere. The others force you to buy a custom battery pack. Protek's stand design requires you to push and pull on it to lock it into place. I nearly broke the stand the first time I attempted to close it.

Although the oscilloscope BNC connectors are mounted on top of both instruments, Agilent's case causes the connectors to be recessed. That makes it difficult to connect and lock the probes unless you have especially small fingers.

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Product reviews:

OSCILLOSCOPES

To read more of Martin Rowe's observations about these oscilloscopes, to view a table that compares instrument features and prices, and to see photos of some of the features described here, check out the online version of this article. The article also links to Rowe's evaluation of the Agilent 33220A waveform generator.

www.tmworld.com/2007_08

Protek's power button gave me problems. It was somewhat sticky. I had to pull it out with my fingernails each time I turned the unit on or off. The first time I attempted to shut down the unit, the button stuck in the on position overnight and drained the battery.

Although the PC software (Agilent PC Link and Protek WaveLink) is nearly the same, the install procedures differ. With Protek, you simply run the setup routine. The drivers and oscilloscope application will easily install. Communication to the instrument was easy once I enabled the USB port.

Agilent requires you to install the drivers separately. I was at first unable to get the Agilent U1604A to communicate with the PC. I believe the cause was the Protek driver, which uses the same files as Agilent. Several phone calls and e-mails to Agilent technical support failed. The solution: Reformat the PC's hard drive to eliminate all Protek drivers. Even then, the Agilent installation was awkward. It's easy to make a mistake and have the PC fail to communicate with the oscilloscope.

Given that the operations and prices of the Agilent U1604A and Protek 860F are strikingly similar, the choice comes down to the small differences. If you need PC connectivity, go with the Protek instrument until Agilent updates its software-installation procedure. You should also select Protek if you need to replace batteries in the field or if you need the additional 20-MHz bandwidth. If you insist on buttons for basic oscilloscope settings, a recorder function, a color display, or a handle, then choose the Agilent model. T&MW

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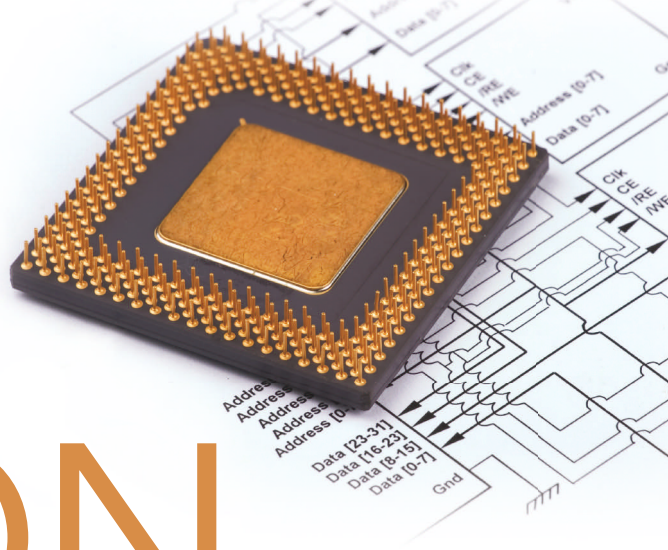


VALIDATING SILICON in embedded designs

Chip vendors and their customers can employ simulation models to ensure designs meet or exceed performance objectives

BY BRIAN DAVIS, PLX TECHNOLOGY

Many semiconductor manufactures are providing board and system designers with a new generation of simulation models—either Verilog or VHDL—of their devices. Simulating designs with these models provides those designers with the ability to

- debug and validate system functionality,
- measure system performance, and
- identify and work around errors that the semiconductor vendor may not be aware of.

Typically, these simulation models are compiled from the register transfer logic (RTL) Verilog or VHDL code and are cycle-based—that is, they behave just like RTL and do not contain timing delays. Models created properly are exact representations of the silicon device.

Not all chip vendors provide simulation models of their chips, and those who do may not have models for all of their chips. Additionally, some chip vendors may have a model of a particular chip but are willing to provide it only to their key customers.

Even when a Verilog or VHDL simulation model is available, you may have difficulty obtaining it. Searching a silicon vendor's Web site may not turn up any reference to a model, much less information about ordering one. Diligence can pay off, though; respected vendors will generally provide the needed simulation model when asked.

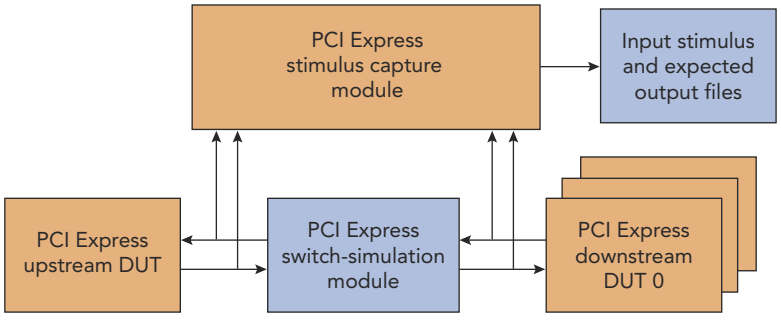
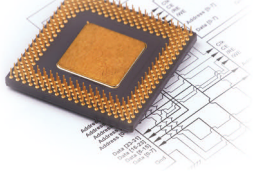


FIGURE 1. Engineers at PLX created a Verilog stimulus-capture module that can be installed in a Verilog simulation test environment.



RTLs and operating systems

EDA vendors such as Cadence, Mentor Graphics, and Synopsys provide software tools that compile a device's RTL into an encrypted Verilog or VHDL simulation module. By encrypting the RTL code, the ASIC vendor can protect its intellectual property and still provide a way for system designers to simulate a design. When these "black box" encrypted modules (simulation models) are used with a compatible simulator, they behave exactly like the RTL.

Depending upon the tool used to compile the RTL, the model may or may not be platform-operating-system-specific (for example, Linux, Windows NT, or Solaris). In addition, the model may or may not be simulator-specific (for example, VSIM, VCS, or Verilog-XL).

For example, the model compilation tool we use at PLX Technology for our PCI switches and bridges compiles the RTL into an operating system (OS) executable file with an industry-standard SWIFT interface to achieve simulator independence. An installation program is provided with the files to install the model on the designer's particular OS platform.

Due to the wide variety of simulators, OS C-shell configurations, and models used by designers, interoperability issues can occur. Models compiled with older versions of Linux, for example, may be incompatible with newer commercial versions of the OS. These issues can be overcome by working with the EDA and chip vendors' technical support groups.

Once a Verilog or VHDL simulation test environment is functioning, you can measure the system's performance and adjust it if necessary. Besides ensuring that the system performs as required, you may uncover "show stopper" errors and find ways to work around them.

Many ASIC chips have errors—such as not passing a PCI-SIG compliance test—that may impact a system. By obtaining the ASIC vendor's most recent errata sheet, system designers can work around these problems. Simulations may also reveal some undocumented, yet critical, problems. Undocumented problems are rare when you work with a respected chip vendor, but if you do uncover some and find a way to work around them, you will give your product a competitive advantage.

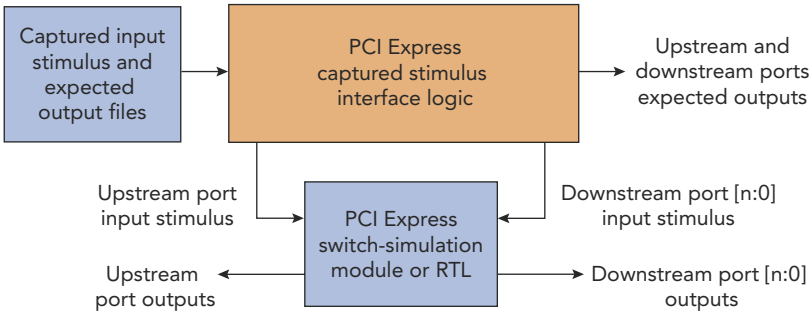


FIGURE 2. A captured-stimulus simulation-test environment contains a single instance of the switch device under test (DUT) and Verilog code to call and run the captured stimulus.

PCI Express raises the bar

When you view a PCI bus simulation, it is relatively easy to interpret the activity and discern what's occurring on the bus. The same cannot be said for a PCI Express link, which is serialized, supports lane polarity inversion and lane reversal, and may be composed of a variable amount of serial lanes (x1, x2, x4, x8, x12, x16, x24, or x32). PCI Express bytes are 10-bit-encoded, may be scrambled, and are byte-striped across the available lanes. Additionally, PCI Express transfers use encoded packets.

Because of these factors, waveforms cannot be depended on to communicate the chip's state when an issue occurs over a PCI Express link. Even with simulation monitors and bus tracking code that logs the link activity, recreating a designer's model simulation problem becomes an extremely difficult proposition.

The idea of capturing a stimulus at the pin level by monitoring the signals or pins and writing a file on a signal change is anything but new. The level of complexity of creating such a file increases significantly if a pin or bus is bidirectional; that is, the bus can be driven by more than one device or can go to a high-impedance state. Fortunately, from the point of view of writing code to create a PCI Express switch simulation capture module, a PCI Express link pin is always either an input or an output.

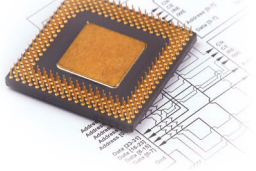
At PLX, we created a Verilog stimulus-capture module that can be installed in a Verilog simulation test environment (**Figure 1**). Since the capture module has the identical signaling I/O as the chip-simulation model, a designer can just copy, paste, and change the model instance name (for example, change pex8532 to pex8532_cap) inside the simulation-test environment. After adding the capture module file name (pex8532_cap.v) to the RTL run list, the designer is ready to capture the PCI Express switch simulation in the form of a stimulus file.

A captured-stimulus-simulation-test environment contains a single instance of the switch device under test (DUT) and the Verilog code to call and run the captured stimulus (**Figure 2**). Once the designer has verified the captured-stimulus simulation, he or she provides the simulation-stimulus file to the chip vendor for analysis. The vendor then runs the simulation stimulus using the RTL instead of the model so that the internal logic nodes can be observed and the simulation can be analyzed.

In one case, a manufacturer implemented the capture module and was able to provide the captured stimulus—all in the time it took to run the simulation and transfer the files electronically. The stimulus files were then run with the RTL and the simulation was analyzed. As it turned out, an error was found and fixed in a subsequent revision of the chip.

Capture module and stimulus file

The key to the capture module and the stimulus it generates is the simulation time scale. If a time scale of 1 ps/ps is used in a simulation, then a #1 in Verilog code is 1 ps, a #1000 is 1 ns, and so on. For a time scale of 1 ps/ps, an internal clock (CAP_CLK) can be generated to run with a period of 2 ps. The capture module logic uses the fact that simulators evaluate and update signals based on the



same time scale. A portion of the capture module logic uses the CAP_CLK to keep track of the time delay between the detection of signal changes. When a signal change does occur, it is detected on the rising edge of CAP_CLK. This signal change event triggers the capture module logic to write the stimulus file.

The stimulus file that the capture module writes contains an elementary sequence of Verilog signal force statements preceded with #DELAY statements. By using both clock edges of the CAP_CLK, the capture module logic is able to adjust the running time count delay between signal changes to match the actual time the signal changes before writing the #DELAY statement.

Initially, the capture module logic writes the stimulus file with a set of force statements for every input signal. After this initial phase, it will append additional #DELAY and force statements to the stimulus file in response to a signal change. Below is a snapshot of the Verilog code the capture module writes to the stimulus file after the initialization phase:

```
#    5000
force PEX_REFCLKp = 1'b0;
force PEX_REFCLKn = 1'b1;
#    5000
force PEX_REFCLKp = 1'b1;
force PEX_REFCLKn = 1'b0;
```

In addition to capturing the input stimulus, the capture module also writes a file that tracks the outputs. Although not critical to recreating the designer's problem, the captured-output file can be joined with the captured input stimulus. Then, by tracing the captured outputs alongside the outputs generated when the captured input stimulus is run with the RTL or the model, the designer and chip vendor can ensure the captured stimulus does indeed re-create the issue in question.

Simulator limitations and stimulus file sizes

Because the stimulus file size increases the longer the simulation is run, it is possible for the simulation to create a stimulus file that is too large for the simulator's memory. The size of the stimulus file that the simulator can run depends on how much RTL is compiled with the stimulus, the number of signal transactions in the stimulus file, the simulator version and configuration, and the OS on which the simulator is running. If the size of the stimulus file reaches the memory limit, you will need to simplify or shorten the simulation.

Chip vendors and designers alike have benefited from using the types of simulation models I have described. They've used the models to debug and validate system functionality and ensure designs meet or exceed performance objectives. T&MW

Brian Davis *is senior applications engineer at PLX Technology in Sunnyvale, CA, where he is responsible for providing and supporting simulation models. Davis holds a BSEE from San Diego State University.*

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Fault coverage vs. throughput in x-ray inspection

By Steve Scheiber, Contributing Technical Editor

Should x-ray inspection aim for fault comprehensiveness or should it concentrate on providing high-volume throughput? I broached the subject with Peter Edelstein, automated x-ray inspection (AXI) product manager for Teradyne.

Q: Where should x-ray inspection systems concentrate their efforts?

A: There is no simple answer to that question. X-ray inspection can identify solder-joint defects that no other test method (such as automated optical inspection or in-circuit test) can find. But you have to trade off fault coverage, false-call rates, and throughput. Some x-ray approaches are time-consuming, lending themselves primarily to high-value situations with low volumes or to product sampling for process modifications. We also contend that some methods are mechanically complex enough to make setup and adjustment more difficult, which reduces their ability to handle high-mix situations. Image resolution and analysis techniques determine what a particular method can find and the likelihood of false failures.

Q: Are you talking only about automated systems?

A: Not necessarily. Manual x-ray systems can provide very high-quality images, allowing close examination of a board's solder joints and therefore its faults. Such systems are generally less expensive than the automated variety, but they are also much slower. They usually use 2-D transmission technology, and they can experience false failure rates as high as 10,000 false failures per million solder joints. They work most effectively during product development or for product sampling or very low-volume production.

Q: What factors determine which is the best solution?

A: The answer depends on who the customer is and what kinds of products the customer produces. In both automotive and medical applications, for example, customers suffer catastrophic consequences in the event of system failure. Medical devices are generally high-value products that can absorb additional costs to insure against faults. Car makers run at high volume on relatively thin margins and will not tolerate any added costs. They can't afford faulty products to escape, but for them, false failures are of particular concern. Cell-phone manufacturers also run at high volumes and low margins, but failures are more annoying than dangerous.

Peter Edelstein
AXI Product Manager
Teradyne
Courtesy of Teradyne.

Q: Is 3-D imaging necessary?

A: We believe it is, although perhaps not at every location on every board. There are several ways to achieve it.

Laminography techniques produce "slices" of the board at different depths. They require a moving image train, which makes the systems mechanically more complicated.

Our alternative—off-center tomosynthesis—gathers image information using a static image train and then applies software algorithms to digitally construct a 3-D representation of the object under inspection. Using this approach, we can provide 2-D and 3-D information from the same data.

We have obtained excellent fault-coverage results and significantly reduced false-failure rates with this approach. Laminography is still common, but we expect the popularity of tomosynthesis to grow rapidly as new machines adopt the technique. □

INSIDE THIS REPORT

EDITOR'S NOTE

Inspection in a changing landscape

By Steve Scheiber, Technical Editor

Like all "test" techniques, inspection has become part of the production mainstream. Nevertheless, the logistics of the overall quality strategy have evolved.

Electronics manufacturing companies generally no longer dictate

a single process from a central hub. They often allow individual operations to make many process decisions, so equipment and vendor choices lack consistency. Avoiding incompatibilities calls for a two-pronged approach.

First, a company's upper management should retain some control over decisions made by their counterparts in the field. When one facility uses post-paste inspection while others do not, for example, it becomes difficult to track quality and failure data. Setting guidelines for local managers' decisions will minimize this type of confusion. At the same time, production managers "in the trenches" must voice their concerns when the guidelines do not meet their needs.

Second, quality data must be collected in a common format, regardless of the process that generates it. Environments like Microsoft Excel and National Instruments' LabView can address a wide variety of situations.

Like the technology, the manufacturing process forever remains a moving target. Fighting that inevitability is a useless exercise. It makes more sense to find creative ways to embrace the changes to improve overall process and product performance. □

Contact Steve Scheiber at sscheiber@aol.com.

HIGHLIGHTS

Carl Zeiss SMT ships helium-ion microscope to NIST

Carl Zeiss SMT, a provider of electron- and ion-beam imaging and analysis equipment for nanotechnology applications, reports that it has shipped its first Orion helium ion microscope to the National Institute of Standards and Technology (NIST) in Gaithersburg, MD. The microscope, which has already achieved site acceptance, uses proprietary new technology developed by ALIS, a Peabody, MA, startup company acquired by Carl Zeiss SMT in 2006.

The Orion microscope is being delivered to the Precision Engineering Division of the NIST Manufacturing Engineering Laboratory and will be installed in the Advanced Measurement Laboratory (AML). The AML features stringent environmental controls to allow researchers to conduct exacting measurements and develop standards for a wide range of fields, such as nanotechnology, nanomanufacturing, semiconductor electronics, and biotechnology.

The Orion scanning ion microscope uses a beam of helium ions, rather than the electrons typically used in scanning electron microscopes (SEM), to generate the signals to be measured and imaged. Since helium ions can be focused into a substantially smaller probe size and reveal a much stronger sample interaction compared to electrons, the Orion system can generate higher resolution images with improved material contrast.

Dirk Stenkamp, member of the Carl Zeiss SMT executive board, said, "The fact that this instrument has been shipped to a selected customer before its official market introduction later this year clearly reveals the demand for this breakthrough technology. We are especially pleased that the first Orion microscope is destined for the NIST laboratories where research at the limits of physics is carried out on a daily basis." www.smt.zeiss.com.

Lloyd Doyle reports AOT installation

Lloyd Doyle, a supplier of automatic optical test (AOT) and inspection systems for bare printed-circuit boards, has announced the installation of its latest generation bare-board PCB automatic optical test system at Hausermann in Gars am Kamp, Austria. The company reports that Hausermann has taken delivery of a high-resolution LD6000 7.5-µm redline system to address production volume increases. www.lloyd-doyle.com.

Phenom bridges gap between optical and scanning electron microscopy

FEI has released its Phenom microscope, which the company says bridges the price and performance gap between optical and scanning electron microscope (SEM) technologies. Capable of yielding magnification up to 20,000X, the Phenom addresses a variety of industrial and academic applications, including quality assurance, product development, research, and teaching.

"The Phenom represents a technology jump similar to that of moving from CDs to MP3s," said Dr. Steven Berger, VP of the Phenom development group for FEI. "This is FEI's iPod—it's beautiful to look at and has a simple, intuitive interface. Its ease of use makes it extremely inviting, even to those who have never before operated a microscope." www.fei.com/phenom.

Lights, cameras, optics

International Robots & Vision Show, June 12–14, 2007, Rosemont, IL, www.robots-vision-show.info.

At this year's International Robots & Vision Show, **Toshiba Teli America** launched its CSB1000, offering uncompressed frame rates of 443 fps at 1280x1024-pixel resolution for high-speed, smear-free image capture. **Edmund Optics** highlighted two new fast, fixed-focal-length lenses that offer object-space resolution better than two line-pairs per millimeter and are available in focal lengths such as 8.5 and 12 mm.

Point Grey Research announced the introduction of its Grasshopper line of IEEE-1394b (FireWire) cameras. **Lumenera** announced the release of the Lw570 and Lw575 series of color USB 2.0 cameras, designed for use in a variety of industrial and scientific applications demanding high resolution and low-light performance. **Schott** formally introduced to the North American market new products in its fiber-optic and LED portfolio. **Basler** was on hand to highlight its scout and pioneer cameras; after the show, the company introduced new driver software for them.

The TM-2030 Gigabit Ethernet cameras feature a 16x9 aspect ratio and HDTV resolution of 1920x1088 pixels. Courtesy of JAI.

Allied displayed the new Guppy F-146 1.4-Mpixel color and black-and-white cameras. **Imperx** highlighted its TEC family of cameras, which are optimized for low-thermal-noise performance. **Cognex** displayed its next-generation Checker 200 inspection sensors. **Vision Components** demonstrated its EyeSpector 1.4 for industrial image processing; its VisiCube compact smart vision sensor; its VC eXcite single-board cameras; its VC4472, VC4458, and VC4058 smart cameras; and its VC4002 intelligent line-scan camera.

Sony demonstrated its XCI-V3 smart cameras. **JAI** highlighted its new TM-2030 Series, which includes GigE Vision and Camera Link cameras featuring a 16x9 aspect ratio and full HDTV resolution of 1920x1088 pixels. **Active Silicon** highlighted its Power over Camera Link (PoCL) Phoenix digital frame grabbers. **Epix** touted its PIXCI EC1 notebook Camera Link frame grabber and its Silicon Video 5C10 inspection station. **PixeLink** showed its USB 2.0 and FireWire cameras and software. **Innovative Optics & Illumination** highlighted its topSpot line of LED illuminators. □

Inspection moves into the mainstream

By Steve Scheiber, Contributing Technical Editor

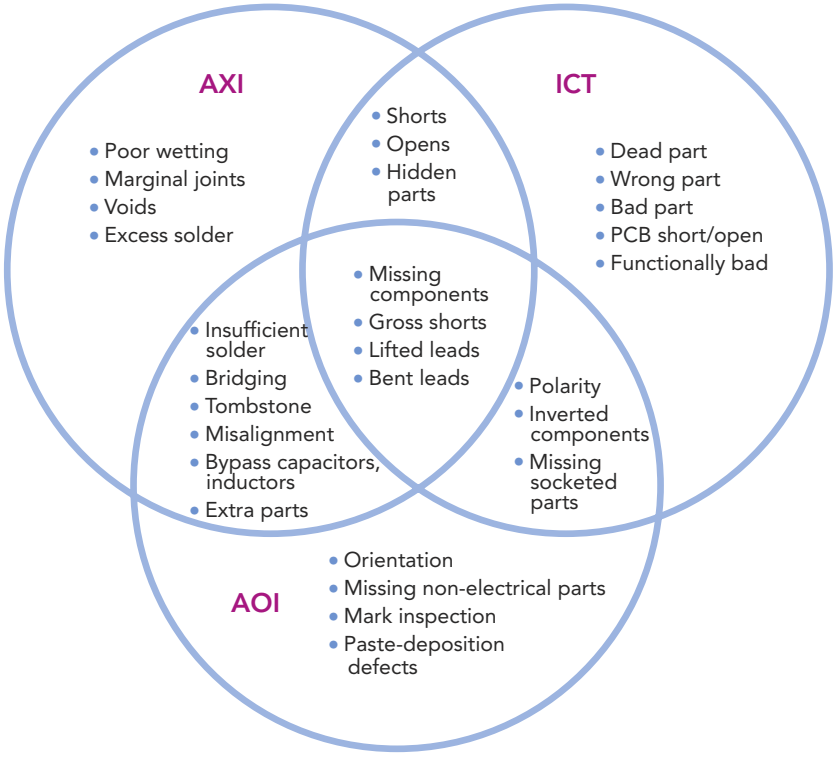
As inspection has evolved from an end-of-line procedure into an integral part of many production lines, inspection technology itself has also evolved. Stacy Kalisz Johnson, market development manager at Agilent Technologies in Phoenix, AZ, suggests that the logistics of electronics manufacturing have moved the goalposts, so to speak, as users demand more from the companies supplying their equipment.

Johnson said that the most obvious evolutionary issues relate to equipment cost. "A few years ago, the post-reflow niche for AOI [automated optical inspection] required moderate system reliability and fault coverage, with price less of a factor. Some systems sold for $250,000 or more. Using AOI systems for solder-paste and pre-reflow inspection was confined primarily to telecom, military, and automotive industries.

"Today, competition both among equipment vendors and among the manufacturers themselves have pushed prices down. Most significant are assembly's continued migration into such cost-conscious locations as Asia and Eastern Europe and the need to sell companies' products in those areas."

Johnson explained that electronics manufacturers have increasingly accepted inspection as a standard part of the process, so equipment suppliers expend much less time and effort "justifying" the approach. "There is much less need to convince customers of the advantages of 3-D solder-paste inspection, for example," she said. "They already appreciate the benefits of 3-D imaging to their products' long-term reliability."

Johnson continued, "There has also been a major effort in the past couple of years to concentrate on defect prevention instead of merely detection, pushing more inspection up the line, which explains the increasing popularity of using AOI for solder-paste inspection."



This classic Venn diagram shows the types of faults expected at each assembly step. Courtesy of Agilent Technologies.

The logistics of selecting process equipment and distributing it to far-flung manufacturing facilities has changed as well. Companies once made all test strategy and other equipment-purchase decisions centrally and then imposed those decisions on the individual factories.

In today's more globalized structure, factory managers often make the decisions for themselves, based on their own requirements. Whichever process they use, they expect inspection-system suppliers to keep their offerings flexible enough and configurable enough to accommodate them.

"Today, we have to coordinate all parts of the sales and support process, maintaining communication across the regions," said Johnson. "I not only know who the salespeople are in Asia, I talk to them almost every day. We travel to Asia to visit manufacturers there because that is where the action is. There is no way to 'un-globalize' the electronics industry. We travel around to assess our customers' needs."

Where in the process manufacturers put their inspection equipment also depends heavily on circumstances. X-ray systems, once primarily relegated to product sampling or other forms of very targeted inspection, have become much more common in the mainstream manufacturing process, and they can now examine many more types of solder joints.

The decision about whether to use AOI after paste, before reflow, after reflow, or in some combination also depends on the type of product and on such issues as the consequences of failure. Even contract manufacturers, who often have inspection equipment available at every stage of the assembly process, may allocate their resources based on an economic cost-benefit analysis for each of their customers and for each particular project.

"In high-reliability cases, companies may perform AOI at all three process locations," commented Johnson, "although makers of low- or medium-complexity products may not use them all on every production run.

"Instead, solder-paste inspection may be used only during ramp-up to full production. Pre-reflow could supply information for defect prevention. Once the process achieves stability, a manufacturer may reserve even post-reflow inspection for production samples only, to reduce costs and maximize throughput."

Fault types haven't changed

Despite the industry's evolution, some aspects of the inspection task remain constant. Fault types, for example, have remained relatively constant since surface-mount components largely replaced through-hole and since reflow solder supplanted the old wave technique. Company strategies still detect certain fault types with corresponding classes of equipment. Only the proportions of those fault types at the board level have changed.

Johnson contributed the familiar Venn diagram in the **figure,** explaining, "The fundamental relationship still applies. AXI [automated x-ray inspection] can still provide the greatest test coverage overall, but the most economical balance includes the perfect combination of AOI, AXI, and in-circuit test [ICT].

"Such a mixed approach avoids committing solder-printing faults and component-placement issues to reflow, saving rework costs. Using inspection and in-circuit test to find the remaining faults after the reflow step prevents faulty boards from getting out the door to customers.

"Data collection and process-control tools that tie all of the pieces together are far more comprehensive than they were several years ago. They help to improve the overall process, producing fewer defects.

"They also permit analyzing the process to show how to take advantage of inspection's capabilities most efficiently and cost effectively. In fact, the application of data analysis often provides the differentiator when an OEM selects a contract manufacturer."

Inspection, once an isolated part of the manufacturing process, is now integrated with test and process control techniques to provide the best product results. The interlinking and overlapping will continue until the line between inspection and other process steps fades into insignificance. □

Software improves vision hardware

By Steve Scheiber, Contributing Technical Editor

To achieve the best possible image quality on machine-vision systems used for robotic assembly and inspection, you need software that can improve on the hardware-generated results. Every lens produces spherical distortion that increases toward the image extremities, making points appear closer to the center of the field of view than they are. The wider the field of view, the more severe the distortion.

Vision-system software must compensate for this discrepancy to permit accurate measurements and to ensure that an inspection system correctly identifies good and bad parts. The software also ensures that a robot relying on the image will know where to reach for components or other objects.

Calibrating a vision system

Bryan Boatner, product manager for Cognex, explained, "An important function of good vision software is to perform a nonlinear calibration that compensates for the spherical distortion. A common calibration technique involves a grid of very precisely etched dots or drilled holes on a glass or ceramic substrate. When you insert the grid into a vision system's field of view, the dotted lines appear curved [**Figure 1**].

"Calibration software calculates the degree of distortion at each location in the field of view and the necessary adjustment that would be required to eliminate it [**Figure 2**]. With that information, the software can modify pixel locations for any image acquired by the system, permitting precise measurements and other analysis." The missing dots along the axes in the figures allow the software to unambiguously identify which is the x- and which is the y-axis.

Boatner continued, "Another issue is how the system identifies components in the field of view. The sim-

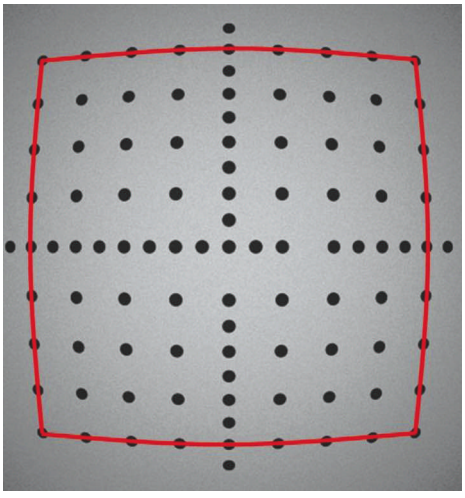


Fig. 1 A precise orthogonal dot grid may appear curved because of spherical distortion from any lens. Courtesy of Cognex.

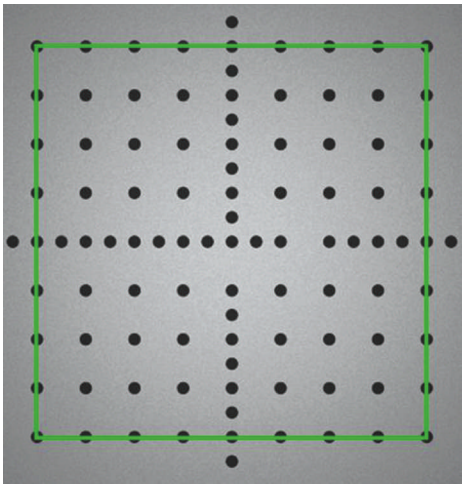


Fig. 2 A software algorithm calculates compensating displacements to generate an accurate image. Courtesy of Cognex.

plest method is called 'blob analysis,' which looks explicitly for the object itself. Accuracy is at most 1 pixel, and unless the object is oriented in the correct direction, identification may be difficult.

"Also, many inspection stages are not evenly lit, a situation that can interfere with the image analysis, and there are many cases where two allegedly identical parts will not reflect the light in exactly the same way. To reduce the variation, you may have to buy additional lighting equipment or enclose the inspection stage in some kind of shroud. Components from two vendors may not be quite the same shape and can be a totally different color.

"Using a geometric pattern-matching algorithm that detects component edges is much more accurate. You look only for the transition between the board surface and the component surface. The technique is much less affected by uneven lighting and other irregularities in the 'appearance' of the inspection stage in the field of view."

Preventing false failures

One of the chief criticisms of automated inspection is the preponderance of false failures. You want your pass/fail criteria to be flexible but sufficiently limited to avoid escapes. If your standards are too narrow, good parts will fail. Where do you draw the line?

"Typically, the pattern-finding tool determines an overall score for the object," said Boatner. "If there is anything unwanted in the image, that too gets a score. You decide how closely you want the part under inspection to match the learned or programmed part. We typically analyze a large selection of good parts and bad parts, performing an analysis that will establish statistical boundaries around 'good' and 'bad' to reduce the number of false calls."

Some hardware manufacturers develop their own vision software, while others partner with an independent software supplier. Developing hardware and software within the same company means that you have complete control over the integration process. The same engineers who build the robot itself design its native "language."

But a robot company's expertise is robots. Those engineers may not take advantage of the software's full potential or produce the most capable or accurate result. Boatner concluded, "Working with a partner means that each engineering group addresses the issues that it knows best." □

PRODUCTS

GigE Vision camera

The GE4900 camera from Prosilica captures 3 fps at a 4872x3248-pixel resolution over a GigE Vision interface. The 16-Mpixel digital CCD camera has an electronic global shutter suitable for capturing high-speed events, and exposure times are programmable from 1/100,000 s to 60 s. The GE4900 offers asynchronous external trigger and sync, automatic exposure and white-balance, region of interest read-out, and binning modes to 8x8. Applications include LCD panel inspection and 3-D measurement. The camera is available in monochrome and color models. *Prosilica, www.prosilica.com.*

Camera Link frame grabber

Euresys recently introduced the Grablink Express—a Camera Link frame grabber in the PCI Express form factor. Compliant with Camera Link 1.2's base configuration, the Grablink Express board acquires 24-bit images at 85 MHz. It supports line-scan and area-scan cameras and is equipped with nine I/O lines, including TTL, LVDS, and opto-isolated lines. *Euresys, www.euresys.com.*

Color sensors

Pepperl+Fuchs has introduced the Dura-Vue DF12 color sensor that can be taught to recognize three independent colors. The company says that programming is easy via a potentiometer setting at the sensor or by a remote teach signal from a PLC. Each of the three channels can be taught to detect minute color variations with varying degrees of tolerance. *Pepperl+Fuchs, www.am.pepperl-fuchs.com.*

Telecentric lens

The SOD-10X, a new telecentric micromachine lens from Moritex, delivers up to 20X magnification without affecting resolution or numerical aperture. The Super Optical Device has 1.5-mm spatial resolution, which Moritex claims is 5X the resolution of other micromachine lenses. With its high numerical aperture (0.23) and long working distance, the SOD-10X C-mount lens can serve in machine-vision applications for semiconductor or LCD alignment and inspection. *Moritex, www.moritex.com.*

Mini Camera Link cameras

JAI has released four progressive-scan CCD cameras that are digital Mini Camera Link (MCL) versions of the company's analog CV-A1 and CV-A2 cameras. The new cameras are available in monochrome (CM) and Bayer mosaic color (CB) versions. The CM-140 MCL and CB-140 MCL offer a 1.45-Mpixel resolution (½-in. SXGA) and operate at a maximum 31 fps, while the CM-200 MCL and CB-200 MCL have a 2-Mpixel resolution (1/1.8-in. UXGA) and operate at a maximum 25 fps. *JAI, www.jai.com.*

Area-scan camera

The Falcon 4M60 area-scan camera from Dalsa includes features that make it appropriate for electronics inspection, machine vision, and imaging. The Falcon 4M60 has a Camera Link interface, offers 4-Mpixel resolution at 60 fps, and has a nonrolling shutter for capturing images of moving objects. The camera is also compatible with the company's Xcelera-CL PX4 PCI Express frame grabbers. *Dalsa, www.dalsa.com.*

Driver package

Basler has released version 1.0 of its pylon driver package, which integrates a GigE Vision and an IEEE 1394 interface. The package supports all models of Basler's scout and pioneer cameras as well as older cameras, such as the A100, A300, and A600. All cameras can be controlled with a single set of commands via pylon's unified C++ camera API. The pylon package offers a DMA function, a Microsoft DirectX interface, and a list of sample programs. *Basler, www.basler-vc.com.*

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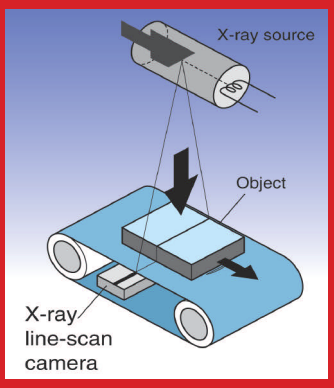

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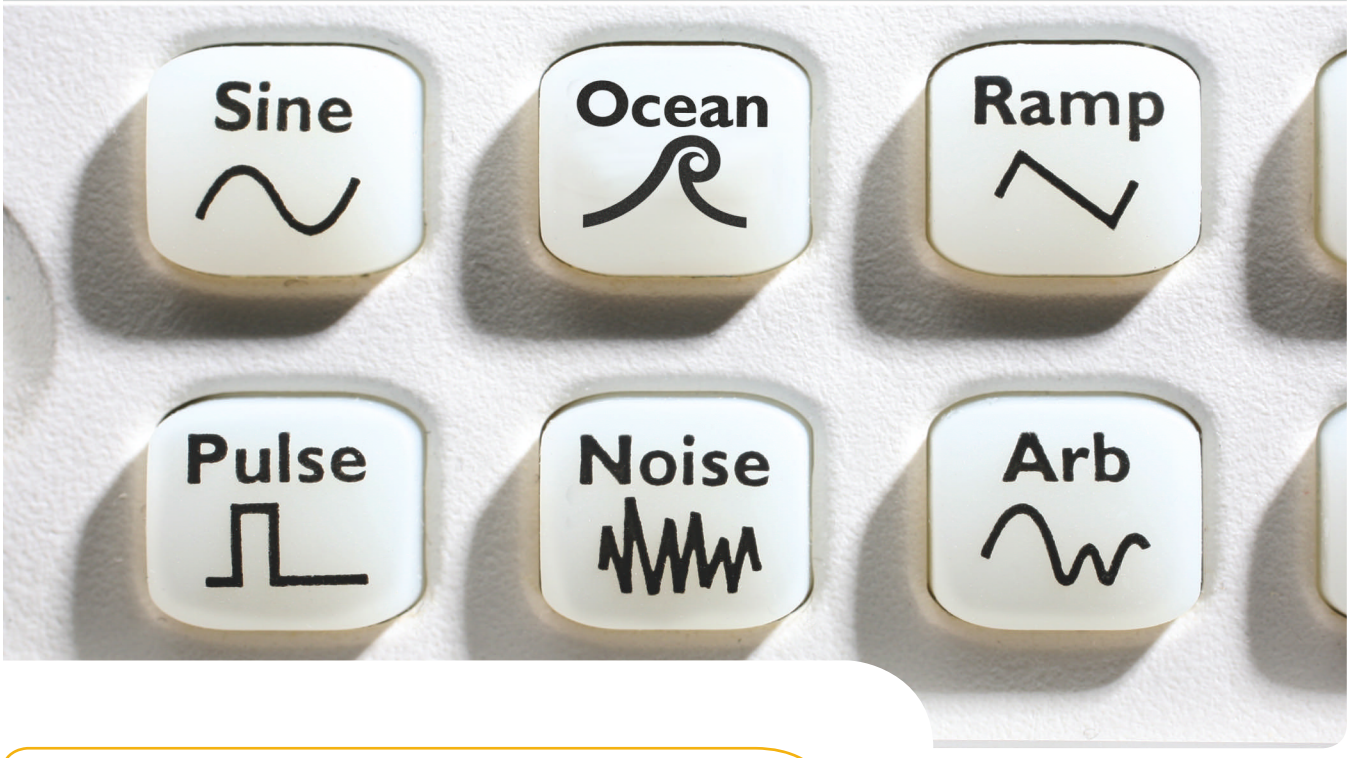

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Agilent Technologies

DMM covers all the bases

Keithley's Model 2100 digital multimeter (DMM) family gives you 6½-digit resolution and includes many popular measurement features, while boasting a 10-VDC accuracy of 38 ppm. At 6½ digits, the 2120 takes 50 readings/s over the USB bus. At 4½ digits, speed increases to 2000 readings/s. The 2120 can store up to 2000 readings.

Measurement functions include AC and DC voltage (0.1-V to 1000-V DC scales with AC to 750 V) and current (10-mA to 3-A ranges), two-wire and four-wire resistance, frequency (3 Hz to 300 KHz), and RTD temperature. The instrument performs calculations such as mX+b, dB, dBm, min/max, and ratio.

The Model 2100 has selectable front and rear inputs, and you can make two-wire and four-wire resistance

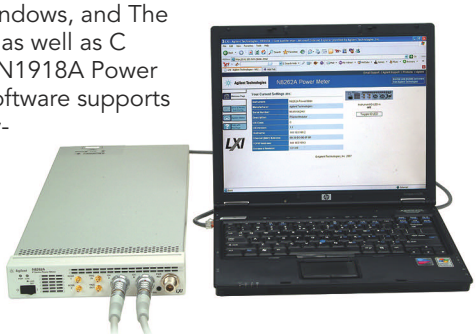
measurements from either the front or rear panel. The rear-panel connections are useful for rack-mounted applications. The rear panel also provides a USB port. You can write your own applications using SCPI commands, or you can use included software to log data to Excel or Word.

Price: $845 ($795 until September 30, 2007). *Keithley Instruments, www.keithley.com.*

Agilent debuts LXI-compliant power meter

Agilent Technologies has introduced what it calls the world's first LXI-compliant power meter. The N8262A P-Series instrument is 1U high and supports LAN-based automated measurements of peak power, average power, and peak-to-average ratio. The company reports that the meter's small size and its ability to operate without shared power supplies, card cages, or system controllers enables a lower startup cost for an automated test system. Compliant with IVI drivers, the meter is designed for seamless operation with existing test assets.

The N8262A modular power meter is LXI Class C compliant and has a sampling rate of 100 Msamples/s. Besides power measurements, the N8262A also performs time and CCDF statistical measurements. Users can program the meter with various programming languages, including Agilent Vee, National Instruments LabView and LabWindows, and The MathWorks Matlab, as well as C and C++. Optional N1918A Power Analysis Manager software supports more complex analysis and adds advanced troubleshooting functions.



The Agilent N8262A is code-compatible with the Agilent P-Series power meters and is backward compatible with the P-Series, E-Series (except E9320), and 8480 Series power sensors. When used with the P-Series wideband power sensors, the N8262A offers a 30-MHz video bandwidth, up to 40-GHz frequency coverage, a dynamic range of –35 dBm to +20 dBm, and internal zeroing capability.

Base price: $11,474. *Agilent Technologies, www.agilent.com.*

Add jitter to serial streams

With high-speed serial buses showing up everywhere and data rates constantly on the rise, jitter becomes ever more of a problem. Receivers of serial bit streams such as PCI Express Gen I & II, Serial ATA, and Fibre Channel need testing for their immunity to jitter. The J7000A series of noise sources from NoiseCom lets you add random jitter to serial data streams so you can test for jitter tolerance, clock recovery, and bit-error rate (BER).

With a controlled noise source, you can vary the amplitude of the random jitter over a range of 127 dB in

1-dB increments. An option lets you adjust jitter amplitude from 0 dB to 63 dB in 0.1-dB increments for noise bandwidth less than 2 GHz.

The series consists of six models based on bandwidth. They range from 1 MHz to 10 MHz (Model

> > > > > > > >

J7105A) up to 10 MHz to 5 GHz (Model J7115A). The instruments include Ethernet communications with IEEE 488 optional.

Prices: $18,000 to $23,000.
NoiseCom, www.noisecom.com.

Test software gains boundary-scan scripting

The ScanExpressTPG and ScanExpress Runner tools from Corelis now support integrated boundary-scan scripting capabilities, a feature that allows users to create customized testing sessions. ScanExpressTPG incorporates a Script Debugger GUI for creating and editing scripted test steps for use in ScanExpress Runner. The C-like script syntax is consistent with the format of other Corelis products that support scripting.

The built-in Script Debugger assists in script generation by providing syntax highlighting and syntax checking. Boundary-scan-specific functions allow users to group pins, as well as read and set pin values. Script command files can contain one or more functions. Users can also create subroutines and call them from the main function, thus reducing the need for repetition of commonly used tasks.

Corelis, www.corelis.com.

Hardware-in-the-loop added to fault-simulation modules

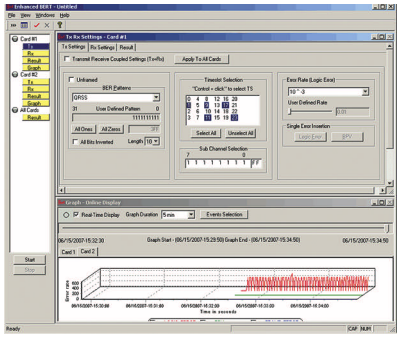
Pickering Interfaces has expanded its range of PXI switching products designed for hardware-in-the-loop fault-simulation applications with the introduction of three new fault-simulation modules, the 40-190, 40-195 and 40-196. The 40-190 is primarily designed for automotive applications where the response of safety-critical controllers under fault conditions must be tested. It permits 64 controller connections and supports up to eight fault conditions, and it has a hot or cold switching current rating of 2 A. The 40-195, which supports up to 1-A hot or cold switching, supports 22 channels of two-wire connections and permits the channels to be opened, shorted together, or connected to a user-supplied fault. The 40-196 is 10-bank design that supports 5-A hot

or cold switching. The new models include VISA drivers and are configured in single-slot 3U PXI modules.

Pickering Interfaces, www.pickeringtest.com.

GL releases enhanced BERT application

GL Communications' enhanced bit-error-rate tester (BERT) measures the correctness of data received on T1/E1 lines according to a repetitive fixed or pseudorandom pattern for a given transmission. The application



generates and detects framed, unframed, fractional, and subchannel bit-error rate (BER) patterns with a variety of static and pseudorandom data patterns. You can perform BERT testing simultaneously in real time or in off-line mode on multiple cards. Transmit and receive settings can be independently controlled or set as coupled.

The enhanced BERT supports user-defined patterns consisting of up to 32 bits and provides improved error-insertion capability using predefined error-insertion rates (from 10^{-9} to 10^{-2}) or user-defined error rates.

GL Communications, www.gl.com.

Datalogger captures up to 200 channels

Weighing just over 2 lbs, the GL800 portable datalogger from Graphtec America is intended for relatively slow datalogging of up to 200 photoMOS relay isolated input channels. The GL800 accommodates voltage, current, thermocouple, RTD, and humidity inputs with a maximum sampling rate of 10 samples/s. A built-in TFT color LCD makes it easy to review and analyze data, while navigation keys simplify configuration and operation.

The GL800 comes with 12 Mbytes of onboard nonvolatile memory that retains data even after the unit is turned off. You can also record directly to USB memory sticks with a capacity of up to 1 Gbyte. An optional battery pack provides up to 9 hrs of continuous recording and serves as a UPS in the event of a power failure.

Graphtec America, www.graphtecinstruments.com.

Handheld instrument identifies optical fiber faults

Tyco Electronics has introduced the handheld Visual Fault Locator (VFL), which can identify breaks and bending in optical fibers and cabling. The instrument's red 650-nm laser, which causes the VFL cable jacket to glow red at the location of a fault, helps users locate damaged, broken, or tightly bent fibers that cause undesirable attenuation in systems.

The flash button allows the user to toggle between continuous or pulsed mode. A single AA battery is sufficient for more than 30 hrs of continuous use, according to the manufacturer. A soft-side protective case with belt loop makes it easy to transport the instrument.

Tyco Electronics, www.tycoelectronics.com.

Yield-enhancement tool protects IP

SecureXY, a yield-enhancement tool from Teseda, enables the sharing and analysis of failure information in the physical domain without compromising intellectual property (IP). SecureXY works in conjunction with ScanXY, the first tool in the company's Diagnostic Manager Suite. ScanXY takes scan failure information and design information and presents failure data in a physical die view showing failing scan cells, failing scan chains, and x-y location data.

SecureXY is able to take the ScanXY data and present it as an x-y view while protecting sensitive design IP information. The design IP is protected at varying levels that can be selected by the design creators.

Base price: Diagnostic Manager tools—$20,000. *Teseda, www.teseda.com.*

ADVERTISER INDEX

FREE WEBCAST

DESIGNING GOOD SWITCHING MODULES FOR ATE SYSTEMS

SWITCHING MODULES ARE PROBABLY THE MOST overlooked and misunderstood piece of hardware in an ATE system. This tutorial will provide attendees with an understanding of switching systems and the elements in them. It will also describe the discontinuities associated with putting switches in a signal-transmission path. In addition, the Webcast will discuss the techniques used in designing good switching systems and will outline the value of a good driver design that lowers the overall integration cost.

Topics include

- Typical problems in current ATE designs,
- The most overlooked part of an ATE system--the switching,
- The Achilles heel in a switch system design,
- Problems associated with various types of relays used to make a switch system,
- Grounding, and
- Different design approaches and their impact on the cost.

August 15, 2007 12 p.m. ET, 9 a.m. PT

SPEAKER:
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Chief Technical Officer/
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VIEWPOINT

[An exclusive interview with a technical leader]

MONTY JOHNSON
CEO and Vice Chairman
Wireless Telecom Group
Parsippany, NJ

Monty Johnson joined Wireless Telecom Group in January 2006 as CEO and Vice Chairman. With more than 25 years in the telecommunications industry, he has extensive experience in delivering network services to the world's largest wireless and wireline carriers. Prior to joining Wireless Telecom Group, Johnson served as president and GM of Tekelec's Network Signaling Group. His career also includes management positions at Motorola and dynamicsoft, a communications software company acquired by Cisco Systems in 2004. Johnson received a BSEE from The Citadel and an MSEE from the Georgia Institute of Technology.

Contributing editor Larry Maloney spoke with Monty Johnson about testing for wireless applications in a recent telephone interview.

Targeting the RF market

Q: What test businesses fall under the Wireless Telecom Group?
A: Willtek, our largest unit, focuses on mobile-handset testing, both in manufacturing and in after-sale service and repair. Another division, Boonton, is a world leader in peak power analyzers. NoiseCom, the company's first business, is a global pacesetter in noise generators, used extensively to test how high-performance communications systems perform in the presence of signal impairments. Beyond test, we have a fourth business, Microlab, which provides very-high-performance passive components to carry and distribute multiband RF signals.

Q: So, the heart of your company is expertise in RF technology?
A: Yes. Within that core expertise, we provide general-purpose test and measurement equipment, such as our 4500B peak-power meter and our 9100 family of handheld spectrum analyzers. We also apply that expertise to special-purpose equipment like our 4400 mobile-handset tester. An example in the special-purpose arena is the use of our random-noise-generation instrument for jitter testing in high-speed serial communications lines, such as PCI Express.

Q: Which of your test applications is growing the fastest?
A: Our fastest area of growth has been supporting the expansion of mobile communications, including all the commercial 2G and 3G wireless standards. This includes not just mobile handsets, but also support of base-station deployments and wireless deployments within buildings. Those in-building wireless deployments include commercial wireless standards, as well as WiFi, RFMD, and, increasingly, WiMAX.

Q: How much of your 38.7% net sales increase in 2006 was due to your Willtek acquisition?
A: The revenues of Germany-based Willtek before the 2005 merger were roughly similar to the combined revenues of our existing units, so clearly most of the revenue growth in 2006 revenues can be traced to the acquisition. Even so, we saw close to double-digit growth across our other businesses as well.

Q: How does the Willtek acquisition complement your overall product line?
A: Willtek's core technology is wireless RF, just like our other businesses. Our growing expertise in RF has allowed us to move into such applications as a new analyzer for the TETRA (Trans European Trunk Radio) air interface. We also announced on June 12 a new TETRA handset tester, the Willtek 2303 Stabilock TETRA. It is the first TETRA mobile-station tester tailor-made for the professional mobile-radio-handset service environment.

Q: What emerging technologies and standards offer the most growth potential for your company?
A: We are prepared for the future in that we are fully anticipating new standards, such as 802.11n for wireless LAN. In many cases, we have designed for those standards within our current products. For instance, our Willtek 4400 communications tester has as its core signaling engine an extremely flexible and programmable multi-core DSP from PicoChip. That company's family of chips is now being used as the programmable engine for many emerging applications, including both 2G and 3G femtocells and WiMAX base stations. Our relationship with PicoChip also enables us to quickly service new 4G-like applications.

Overall, we believe the continued evolution and growth in the mobile-communications markets create more and more demand for our products. T&MW

Monty Johnson provides more specifics on his company's products and test applications, as well as on fast-growing global markets, in the online version of this interview: www.tmworld.com/2007_08.

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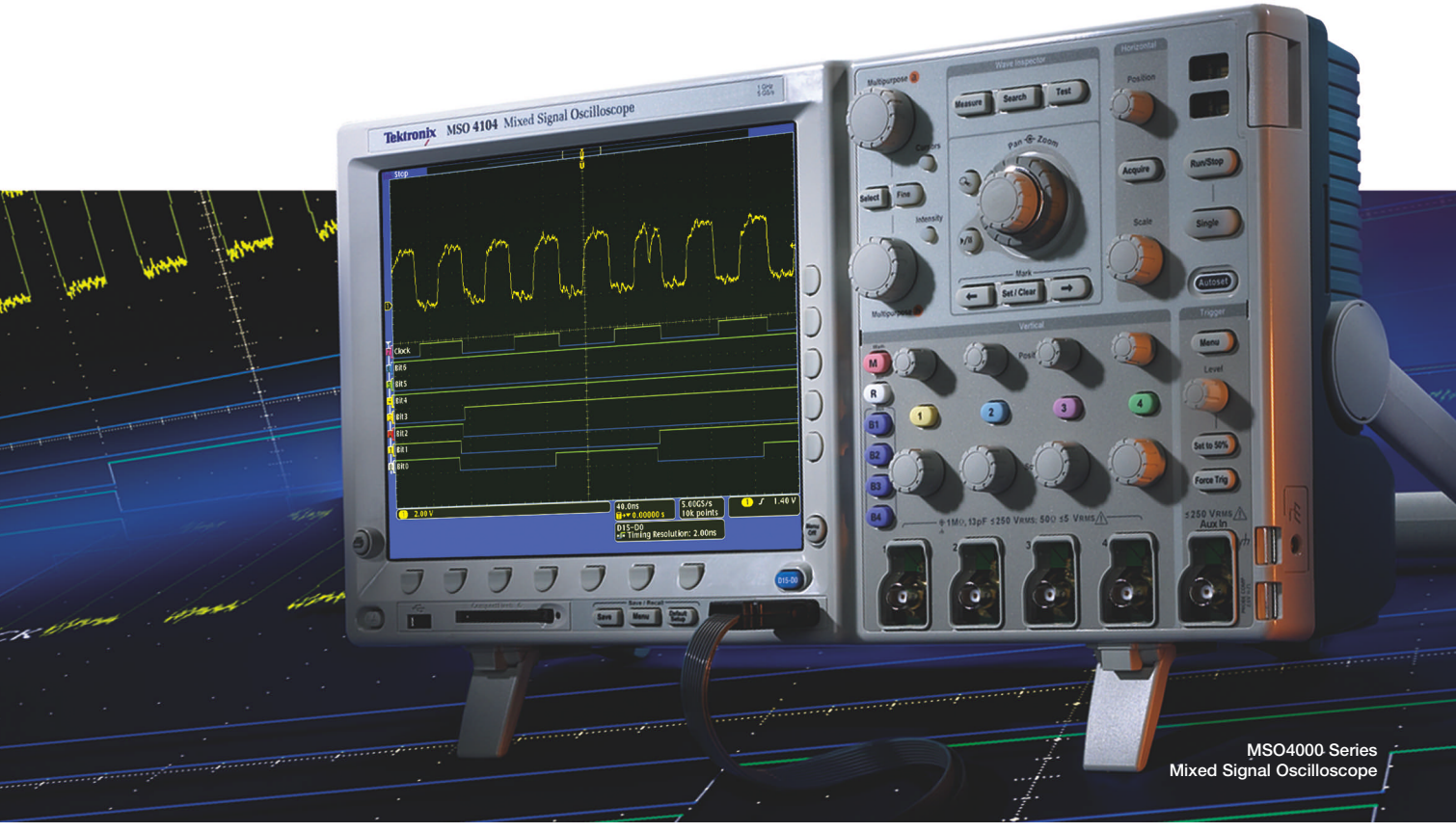

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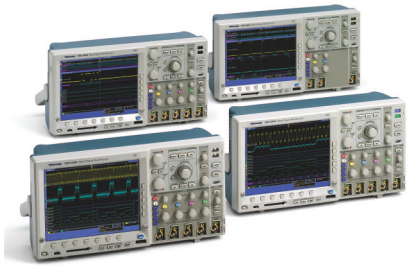

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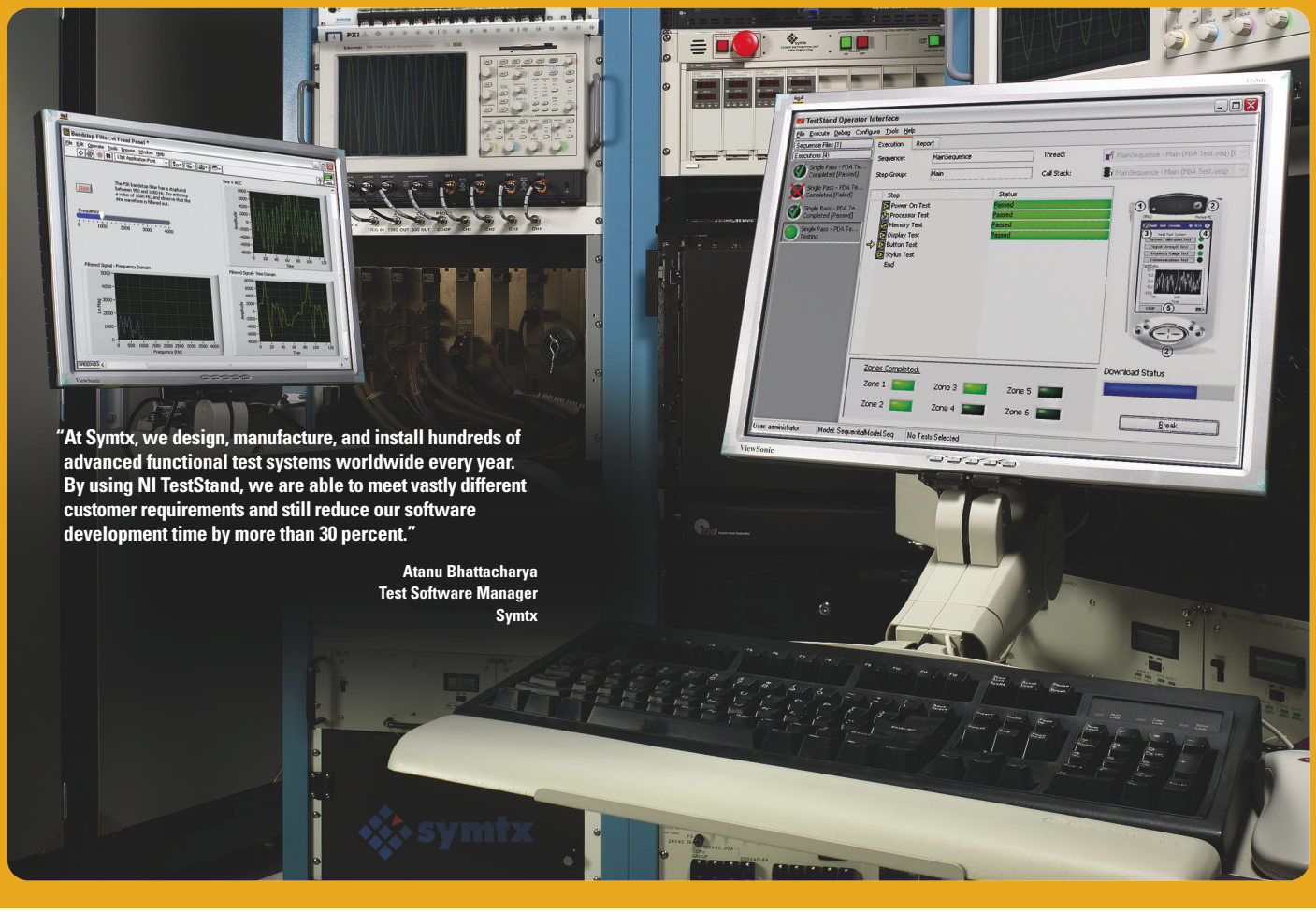

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