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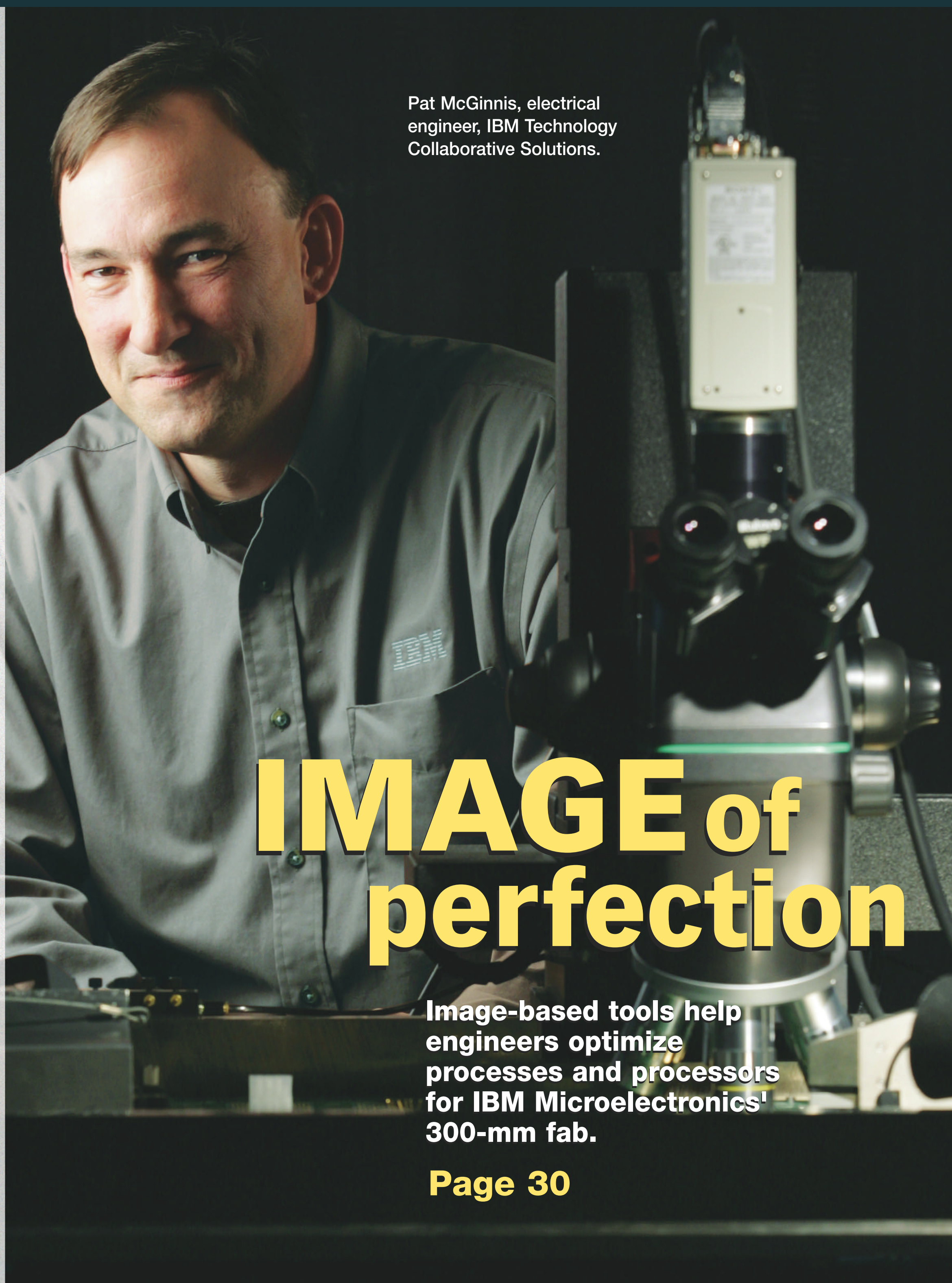
Test & Measurement World

25 Years of Quality

THE MAGAZINE FOR QUALITY IN ELECTRONICS



Pat McGinnis, electrical engineer, IBM Technology Collaborative Solutions.

IMAGE of perfection

Image-based tools help engineers optimize processes and processors for IBM Microelectronics' 300-mm fab.

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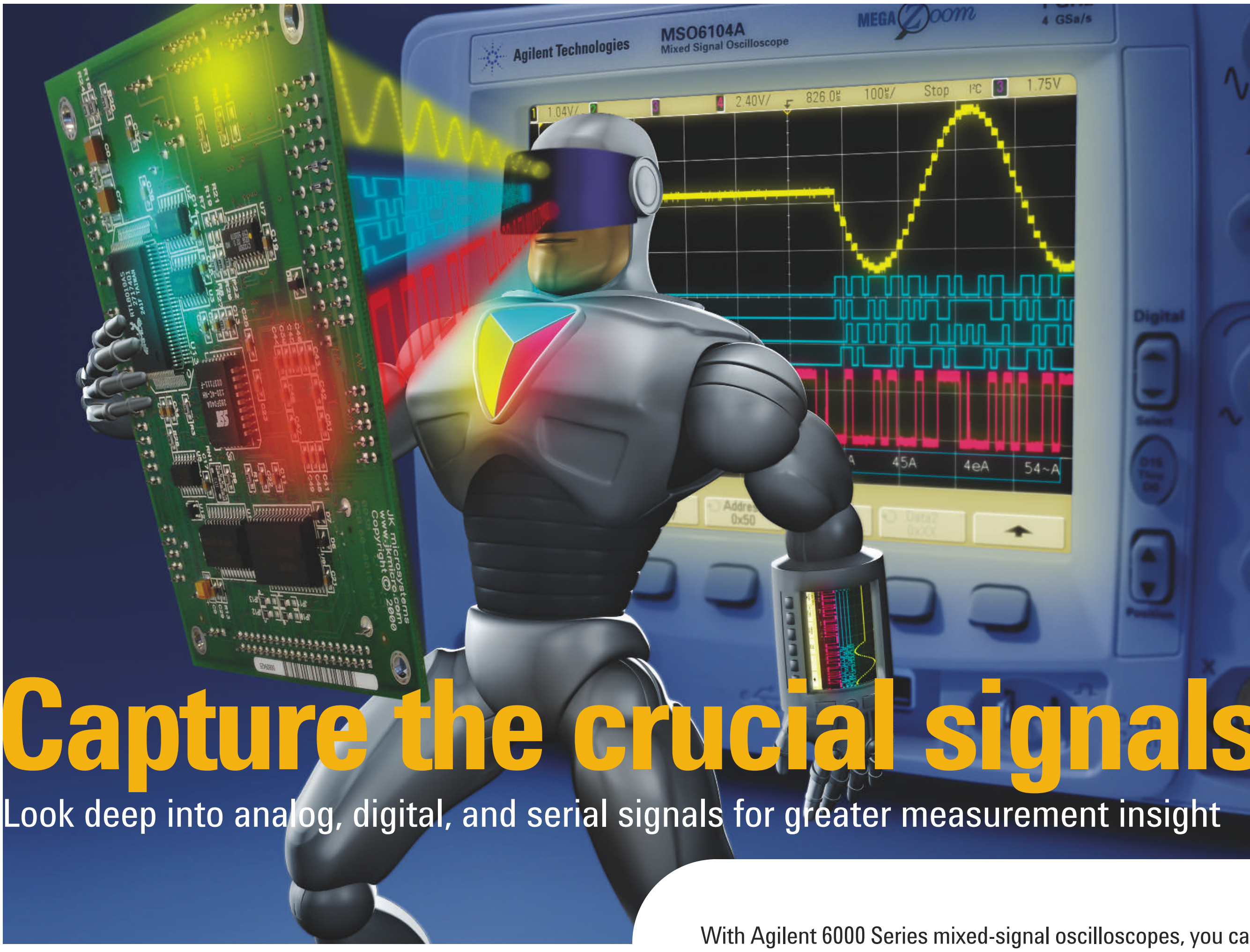

Capture the crucial signals

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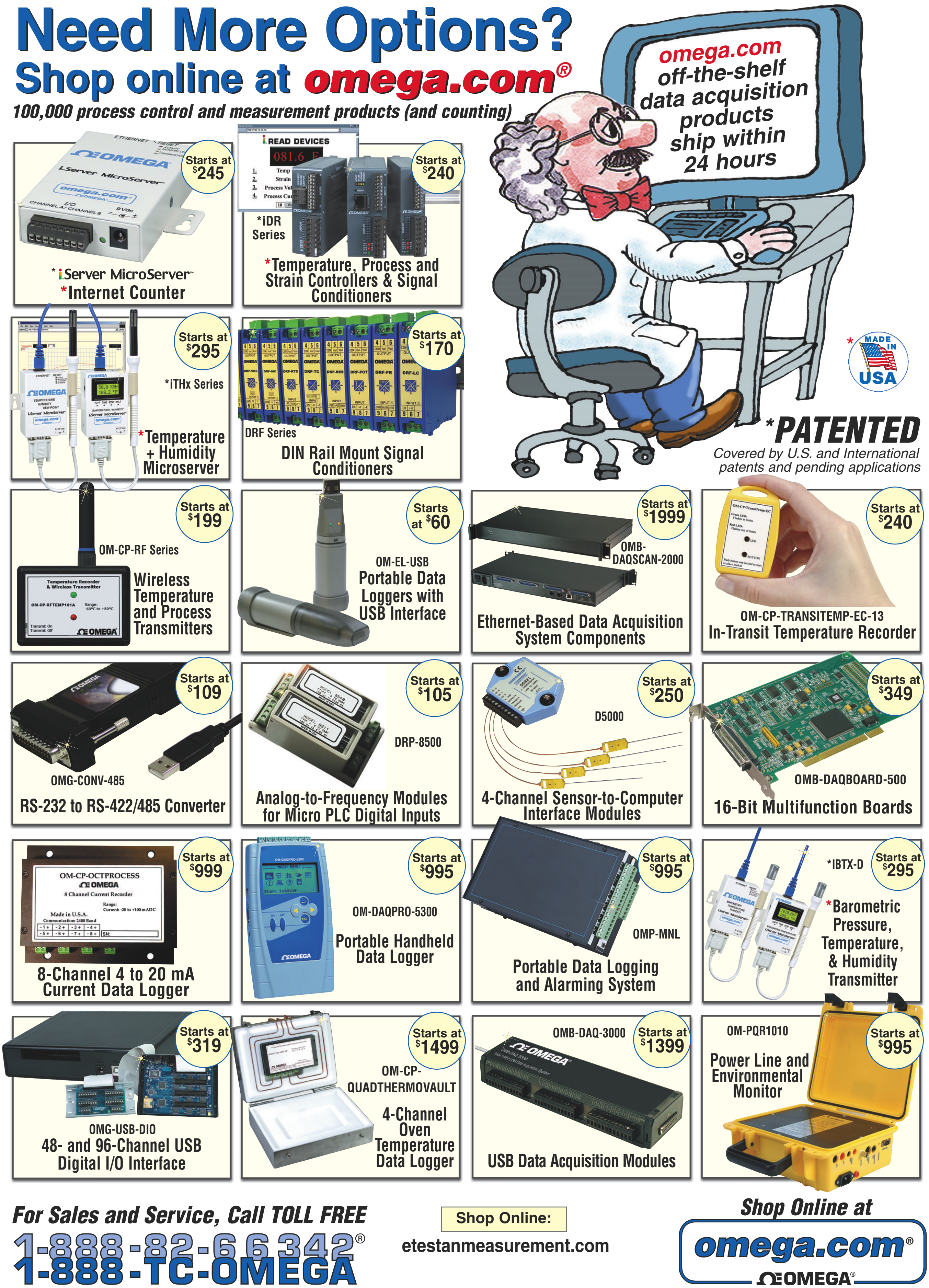
Agilent Technologies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COVER BY: NAJLAH FEANNY

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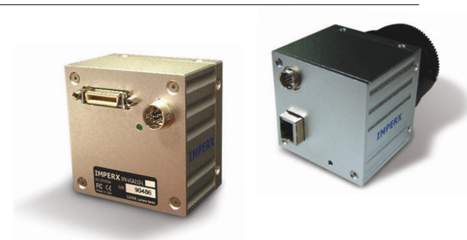

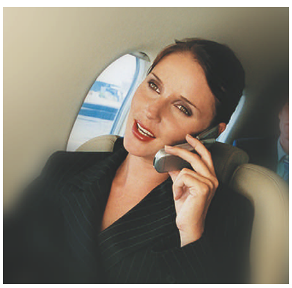

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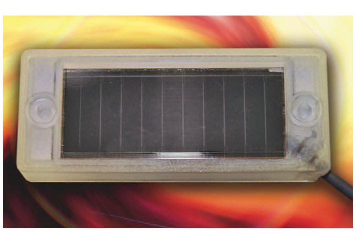

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TECH TRENDS

TEST DIGEST

TEST REPORT SUPPLEMENT

ONLINE

www.tmworld.com

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

Barnes comments on role at Verigy

Slated to become CEO of Agilent Technologies' semiconductor test subsidiary, Verigy, on May 1, Keith Barnes' first challenge will be to guide the subsidiary as Agilent completes the Verigy spin-off. Chief Editor Rick Nelson spoke with Barnes about the semiconductor-test industry in general and his new role in particular. www.tmworld.com/0506_barnes

Which test companies have the highest revenues?

Test & Measurement World has updated its compilation of the top 10 test and measurement companies by revenue based on reported figures for 2005. Find out how the rankings have changed.
www.tmworld.com/tops

Talus targets RTL to tape-out

Magma Design Automation is targeting the rapid design of ICs fabricated in 65-nm and smaller process geometries with its Talus RTL-to-tape-out EDA toolset. Now in beta release, Talus addresses timing, area, power, signal integrity, DFT, and manufacturability.
www.tmworld.com/0506_talus

LXI development continues

LAN eXtensions for Instrumentation (LXI) is an Ethernet-based standard for instrument communication and control. Its proponents claim that it lets Ethernet replace IEEE 488 as the first choice for instrument communications. To learn more about the progress of LXI, senior technical editor Martin Rowe spoke with Bob Rennard, program manager at Agilent Technologies and president of the LXI Consortium.
www.tmworld.com/0506_lxi

"Taking the Measure" (blog commentary and links)

- Prior art for wireless e-mail
- Processor cores vs. interconnects
- Acquisitions threaten Chinese innovation
- Hynix invests in China
- RoHS is here to stay
- Winners of Innovation Awards
- Readers comment on the switch to DTV
- China: World's factory floor, or design powerhouse?
- Myhrvold defends patent trolls

www.tmworld.com/blog

From the Archives

- What are S-parameters, anyway?
Scattering parameters offer an alternative to impedance parameters for characterizing high-frequency devices. Read the tutorial from our February 2001 issue.

www.tmworld.com/archives

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Time for D-Link to own up

Need to know the time? Please don't ask Poul-Henning Kamp. His experience attempting to operate a Danish timeserver *pro bono* reinforces the adage that no good deed goes unpunished. Nevertheless, it makes for a fascinating detective story, provides a valuable tutorial about network timeservers, and might serve as a cautionary tale about the perils of engineering ineptness.

Kamp's time server is hosted on DIX, the Danish Internet eXchange, which waives thousands of dollars in connection fees for Kamp because Kamp's server operates as a public service. His server is designed to accommodate roughly 2000 legitimate Danish users, but he began receiving up to 3.2 million illegitimate requests per day, a level of traffic DIX couldn't accommodate for free.

RICK NELSON, CHIEF EDITOR

Kamp enlisted the aid of Richard Clayton of the Security Group at the University of Cambridge Computer Laboratory, who ruled out a deliberate, denial-of-service attack. The culprits, he determined, were potentially millions of consumer network products from D-Link, which include firmware commanding them to repeatedly query stratum 1 timeservers such as Kamp's in violation of posted access policies. Kamp's, for example, reads "open access to servers, please, no client use." Others that seem to be affected offer less polite warnings: "prior permission required." The appropriate approach, Kamp and Clayton both report, is for client boxes such as D-Link's to query stratum 3 servers hosted by local ISPs or by D-Link itself.

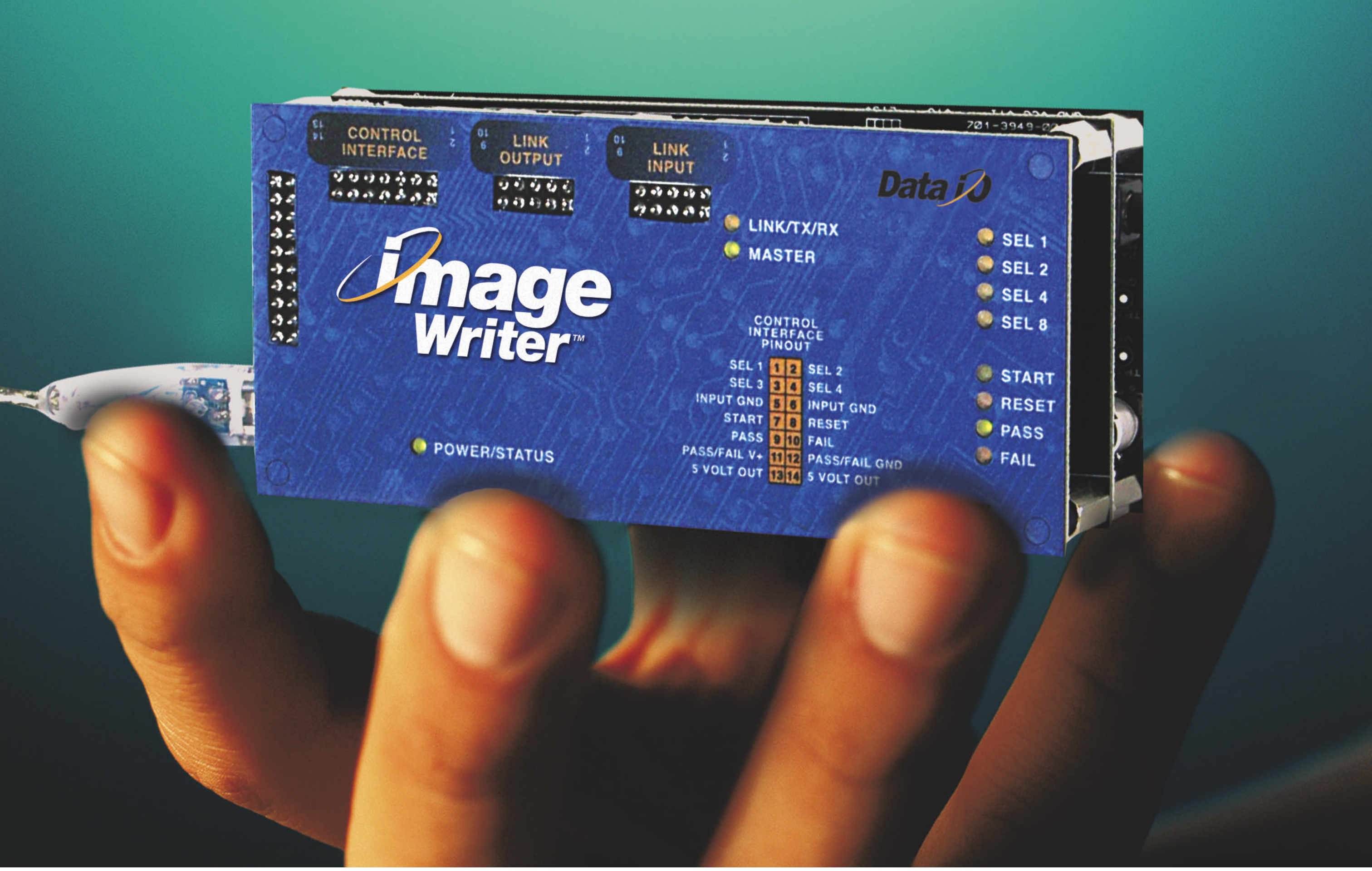
A Danish timeserver began receiving 3.2 million illegitimate requests per day.

Kamp has looked to D-Link for resolution, for restitution for costs he has incurred, and for compensation for his own time. Unable to obtain satisfaction, he has posted an open letter to D-Link outlining his travails. Subsequently, Clayton posted a description of his detective work. Both make for interesting, informative reading. (See the online version of this article for links.)

I asked D-Link for comment and received only this response: "D-Link is continuing to investigate the merits of Mr. Poul-Henning Kamp's claims in an attempt to achieve the full resolution of any issues. It is D-Link's long-standing policy not to comment further until an investigation is complete."

I suspect D-Link may be more concerned about investigating its legal liability with respect to other servers it may be abusing than about investigating the technical merits of Kamp's claim. In either event, there's already been plenty of time to investigate (Kamp says he first contacted D-Link in November 2005). It's time for D-Link to own up for its engineers' blunder, compensate Kamp for his trouble, and make some effort to convince millions of consumers to re-flash their D-Link boxes' firmware. T&MW

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



New! Powerful In-System Programming in a Compact Package

Are you challenged by a need for production ISP programming? Tested by device serialization? Pressured for greater speed and throughput? Relax. Now there's ImageWriter.

ImageWriter is a fast, compact, in-system programmer robust enough for fast paced manufacturing lines. It mounts neatly into any test fixture, ready to execute programming on command from the tester, LabVIEW™ or other process control application.

ImageWriter provides high-speed programming of flash microcontrollers and serially programmable memory devices. Compatible with ICT, MDA, and functional test systems from major manufacturers such as Agilent, Teradyne, or any test rack or fixture in your line. Flexible enough to handle single boards or panels, boosting your productivity.

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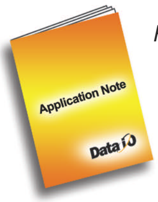

Read our application note on "Tips for In-System Programming." You'll find it at ***www.dataio.com/isp***

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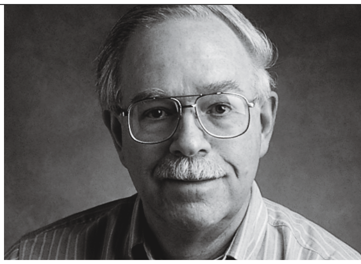
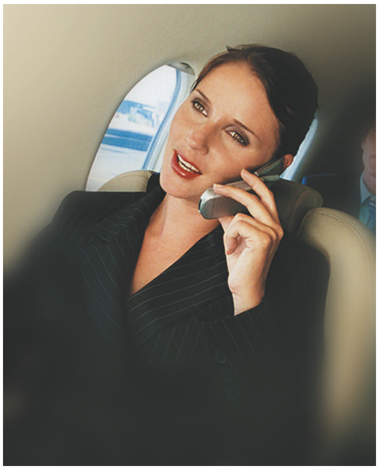


Up in the air over cell-phone EMI

And you thought that when you boarded an airliner, hijackers, bad food, surly passengers, and airborne hazards were all you had to worry about. How about electromagnetic interference (EMI) from cell phones? According to a program segment featured on National Public Radio's "Living on Earth," the Federal Communications Commission may change its rules and allow you to use your cell phone in flight.

Current FCC regulations prohibit the use of cell phones in flight because a phone moving at 500 mph doesn't remain in range of any ground site for more than a minute or two, but rules and regulations don't stop anyone with an exaggerated sense of self-importance from dialing up anyway.



And given our seemingly insatiable demands for entertainment and for squeezing the last drops of efficiency out of the workday, DVD players, handheld games, personal computers, and iPod-like gizmos have become standard wearing apparel for air travelers. All of these devices emit EMI in varying amounts, and their use is currently prohibited during takeoff and landing (but not in flight).

A few years ago, a group of researchers from Carnegie Mellon University assembled a test system consisting of a laptop computer, a wideband antenna, and a portable spectrum analyzer and flew the package on 37 commercial flights. According to the recently published research report, analysis of the RF environment on board showed that among other parts of the EM spectrum, transmissions from cell phones and other portable electronic devices (PEDs) produced interference in frequency ranges used by the Global Positioning System and aeronautical radio.

Are amusement and incessant communication worth the risk? As CMU's researchers point out, the FCC and FAA could better coordinate their EMI research and threat-assessment efforts. In addition, manufacturers could equip commercial aircraft with broadband RF analyzers that could sample EMI in the passenger cabin and, upon finding inappropriate levels, light a sign to warn passengers to turn off portable electronic equipment or risk getting fined. The analyzer could also log interference incidents in the aircraft's flight data recorder, just in case passenger-induced EMI contributed to an accident.

In the meantime, shut up, switch off, and enjoy your flight. T&MW

ARRIVALS AND DEPARTURES:

To review a transcript or download an MP3 or RealPlayer audio version, go to Living on Earth's Web site and scroll down to "Flight of Technology": www.loe.org/shows/shows.htm?programID=06-P13-00010#feature4

A Carnegie Mellon University press release describes the research: www.cmu.edu/PR/releases06/060228_cellphone.html

For more background on EMI from PEDs, read "Congress Reviews EMI Threat of PED Use on Aircraft": www.ce-mag.com/archive/2000/sepoct/newsline.html

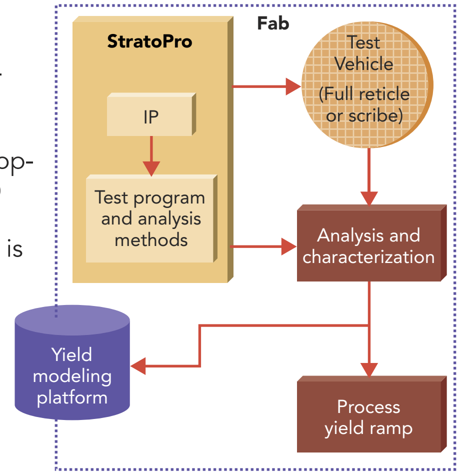
Entitled "Unsafe at any Airspeed?" an article published in *IEEE Spectrum* magazine for March 2006, describes CMU's investigation in detail and includes extensive references: www.spectrum.ieee.org/mar06/3069

A report entitled, "Determination of Receiver Susceptibility to Radio Frequency Interference from Portable Electronic Devices" and written by Truong X. Nguyen and Jay J. Ely of NASA's Langley Research Center, Hampton, VA, offers an extensive description of EMI susceptibility prediction and measurement in an avionics environment: library-dspace.larc.nasa.gov/dspace/jsp/handle/2002/11744

At least one instrument exists to test GPS receivers' susceptibility to jamming: www.reed-electronics.com/tmworld/article/CA323617

Unfortunately, predicting frequencies and amplitudes emitted inside an aircraft by gizmo-toting passengers is difficult at best, and especially so when intentional and unintentional nonlinear devices act as mixers or intermodulation-product generators. For a primer on intermodulation diagnosis and elimination, go to: www.softwright.com/faq/support/intermod_finding_solving.html

Stratosphere Solutions takes flight



Stratosphere Solutions, an industry newcomer, has begun shipping yield-improvement products that address the yield-ramp challenges faced by manufacturers and designers at sub-100-nanometer processes. Its first product is the StratoPro platform, a combination of silicon intellectual property (IP) and applications that enables design for manufacturability (DFM) and design for yield (DFY) through characterization of process variability.

Stratosphere Solutions was founded in 2004 by Dr. Jim Bordelon, who is CTO, and Prashant Maniar, chief strategy officer. Robert (Bob) Smith is chairman and CEO. Rounding out the executive team is Dr. Amitava Majumdar, director of engineering and architect. "Our motivation in starting Stratosphere Solutions was to build differentiated technology that meets a focused market demand, versus technology in search of a market," said Maniar.

Previously, Dr. Bordelon served as managing director of Testchip division of HPL Technologies, and Maniar served as director of marketing at HPL Technologies. An experienced executive within the EDA industry, Smith was most recently president and CEO of InTime Software and previously VP of marketing and business development at Magma Design Automation. Dr. Majumdar joined Stratosphere Solutions from Sun Microsystems, where he was senior staff engineer and architect. www.stratosol.com.

IBM chooses Denali to develop toolkits

Denali Software is working with IBM to create an arsenal of verification and compliance software for developers of Power Architecture-based designs that use the IBM CoreConnect on-chip bus technology. The toolkits will be distributed as part of Denali's PureSpec verification intellectual property (IP) and PureSuite compliance products, which are compatible with major design and verification tool platforms and can be implemented in any chip development flow.

Denali and IBM will collaborate on the development of verification IP, testbenches, and compliance suites for the PLB-4 (Processor Local Bus) specification, which is the current version of IBM's CoreConnect. Denali Software is a member of Power.org, a community of companies engaged in promoting Power Architecture technology as an open standard. www.denali.com.

Test & Measurement World China debuts

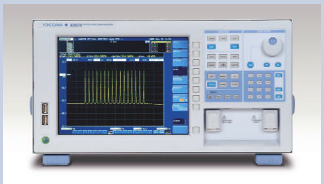
A new test-industry publication, *Test & Measurement World China*, made its debut during Nepcon China (April 4–7, Shanghai). *T&MW* publisher Russ Pratt and chief editor Rick Nelson joined Kevin Kang to introduce *Test & Measurement World China* to the show attendees. Kang is operations manager of the RBI/IDG joint venture that publishes *Test & Measurement World China* and other magazines targeting an Asian audience.

Under the direction of Beijing-based technical editor Tracy Tang, *Test & Mea-*

Editors' CHOICE

OSA cranks up the speed

Yokogawa's AQ6370 optical spectrum analyzer triples throughput over previous models. A measurement on the AQ6370 takes 1 s, which is significant in production of optical transceivers, amplifiers, and passive components. A dual-window display lets you zoom in on a frequency range while an inset lets you see the entire spectrum. The instrument covers wavelengths from 600 nm to 1700 nm, a span that includes the visible range. Power measurements range from +20 dBm to –90 dBm.



The AQ6370 contains 13 analysis functions including optical signal-to-noise, spectral width, polarization-mode dispersion analysis, and filter peak/bottom analysis. You can also perform pass-fail tests using templates that you can create and store in the instrument.

As a production tool, the AQ6370 can connect to a PC through IEEE 488, Ethernet, or RS-232. It is also code compatible with the company's AQ6317. You can create automated test procedures by recording front-panel operations and storing them in the instrument's 128 Mbytes of memory, which can also store waveform traces and analysis results. With its two IEEE 488 ports, the instrument can become an IEEE 488 bus controller.

Price: $30,000. *Yokogawa, www.us.yokogawa.com.*

Why USB for Data Acquisition?

Imagine adding data acquisition capabilities to a PC as easily as plugging in a mouse or a keyboard. Just connect a USB data acquisition module to the computer, install the supplied software, and connect the sensor directly to the module. In minutes, and with state-of-the-art accuracy, data is being captured: temperature, pressure, sound level, whatever. This is done without programming, without opening up the PC, without even thinking of board configuration, power requirements, or connection schemes. This convenience and power are available today. Our USB modules are easy to install and completely portable - even the most sophisticated data acquisition applications come out of the factory or lab and into the field.

High Performance: Isolated

Our high performance series of USB data acquisition modules offer:

- Up to 12 simultaneous analog inputs with sampling rates from 225kHz up to 2.0MHz per channel
- 16-bit resolution on up to 32 channels at 500kHz
- 2 counter/timers and 3 quadrature decoders for measuring position and detecting rotational speed
- 16-bit deglitched DACs for pure signal generation

All the individual subsystems on these boards can be run simultaneously and synchronously.

General Purpose: Isolated

Our general purpose line of USB data acquisition boards offer:

- a full range of multifunction modules
- 16 analog input channels at sampling rates up to 100kHz
- 12, 16, or 24-bit resolution
- 2 analog outputs, 16 digital I/O lines, and 2 counter/timers
- 96 digital I/O

Low Cost

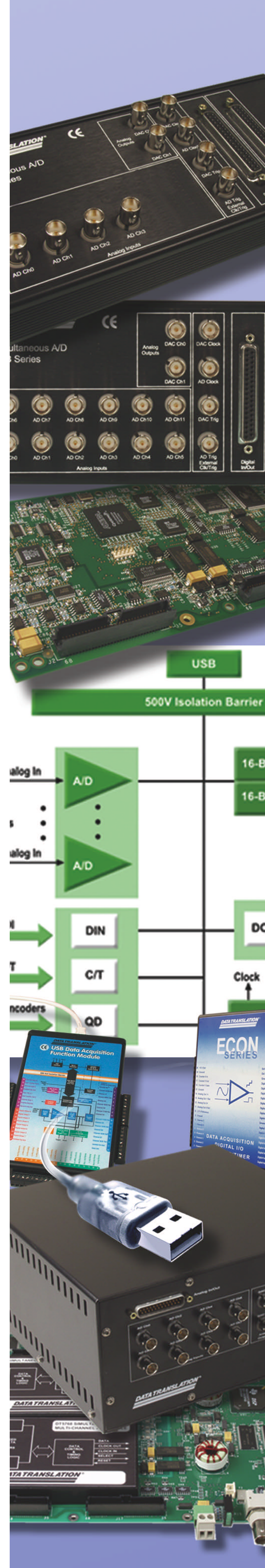
The ECONseries are economical mini-instruments for the USB bus that offer:

- a range of analog input channels (6, 8, 16, or 24)
- simultaneous sampling rates up to 150kHz
- 2 analog outputs
- 16 digital I/O lines with 1 counter/timer
- Packaged with the GO! application for oscilloscope, chart recorder, voltmeter, file viewer, analog output, digital I/O, and counter/timer functions

DSP: Isolated

The DT9840 Fulcrum II Series provides a complete USB data acquisition solution for real-time signal capture and processing. These modules offer:

- 8, 24-bit Delta-Sigma or 8, 16-bit SAR A/D converters
- 8, 24-bit Delta-Sigma or 2/8, 16-bit SAR D/A converters
- 24 Digital I/O, 3 counter/timers
- Uses the 300 MHz Texas Instruments TMS320C6713 DSP chip



Product Selection Charts

High Performance - Isolated

Simultaneous Series	Summary Description	Throughput per Channel	Analog In, Analog Out	DIO, C/T, Quad Decoder
DT9832A	High Throughput Simultaneous DAQ with 2 channels at 2.0MHz, 16-bit resolution	2.0MHz	2 SAI, 0/2 SAO	32 DIO, 2 C/T, 3 QD
DT9832	High Throughput Simultaneous DAQ with 4 channels at 1.25MHz, 16-bit resolution	1.25MHz	4 SAI, 0/2 SAO	32 DIO, 2 C/T, 3 QD
DT9836	High Throughput Simultaneous DAQ with up to 12 channels at 225kHz, 16-bit resolution	225kHz	6/12 SAI, 0/2 SAO	32 DIO, 2 C/T, 3 QD
Multichannel, High-Speed	**Summary Description**	**Throughput**	**Analog In, Analog Out**	**DIO, C/T**
DT9834	Multi-channel, multi-function DAQ with up to 32 channels @ 500kHz, 16-bit resolution	500kHz	8/16/32 AI, 0/4 SAO	32 DIO, 5 C/T

General Purpose - Isolated

	Summary Description	Throughput	Analog In, Analog Out	DIO, C/T
DT9801, DT9802, DT9803, DT9804	DAQ Multifunction Analog I/O, 12 or 16-bit resolution	100kHz	8/16 ch AI, 0/2 ch AO	16 DIO, 2 C/T
DT9805, DT9806	Thermocouple measurement, auto-ranging, CJC, temperature application, 16-bit resolution	50kHz	8/16 ch AI, 0/2 ch AO	16 DIO, 2 C/T
DT9821, DT9822	Highest Accuracy DAQ, 24-bit resolution	1kHz	4 ch SAI, 0/2 ch AO	16 DIO Only
DT9835	96-channel Digital I/O	—	—	96 DIO Only

Low-Cost

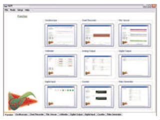
	Summary Description	Throughput	Analog In, Analog Out	DIO, C/T
DT9810	Lowest cost DAQ 10-bit resolution	25kHz	8 ch AI	20 DIO, 1 C/T
DT9812-10V, DT9813-10V, DT9814-10V	Low cost DAQ, up to 24 input channels, 12-bit resolution	50kHz	8/16/24 ch AI, 2 ch AO	Up to 16 DIO, 1 C/T
DT9816, DT9816-A	Simultaneous DAQ, 6 inputs @ 150kHz, 16-bit resolution	Up to 150kHz per channel	6 ch SAI	16 DIO, 1 C/T
DT9817, DT9817-H	Low Cost Digital I/O, 28 channels, drive solid state relays	—	—	28 DIO, 1 C/T
Low-Cost Isolated				
DT9817-R	Isolated, Low Cost Digital I/O, 16 channels, drive electro-mechanical relays/motors	—	—	16 DIO, 1 C/T

DSP - Isolated

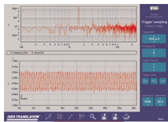
	Summary Description	Throughput per Channel	Analog In, Analog Out	DIO, C/T
DT9841	Simultaneous 8 input channel sigma-delta, 24-bit resolution, DSP	100kHz	8 ch SAI, 2 ch SAO	24 DIO, 3 C/T
DT9842	Simultaneous 8 input channel SAR, 16-bit resolution, DSP	100kHz	8 ch SAI, 2/8 ch SAO	24 DIO, 3 C/T
DT9841E	Low cost, 2 input channel, 24-bit resolution, DSP	100kHz	2 ch SAI, 2 ch SAO	24 DIO, 3 C/T

DAQ = Data Acquisition Module, AI = Analog Input, AO = Analog Output, DIO = Digital Input/Output, C/T = Counter/Timer, QD = Quadrature Decoder, SAI = Simultaneous Analog Input, SAO = Simultaneous Analog Output.

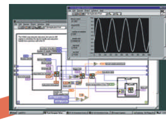
Software Choices



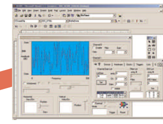
GO!
Eight mini-instruments, no programming



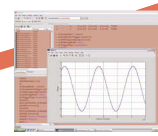
Quick DataAcq/ Scope
Ready-to-measure, applications, source code included



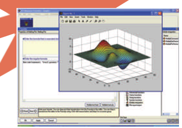
DT-LV Link
Access the power of our boards through LabVIEW



DTx-EZ
Visual Studio Development Tools, DT-Open Layers SDK



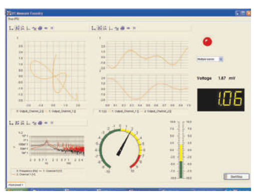
DAQ Adapter for MATLAB®
Access the visualization and analysis capabilities of MATLAB with our hardware



DT Measure Foundry
Graphical programming, drag & drop, no code, no wires

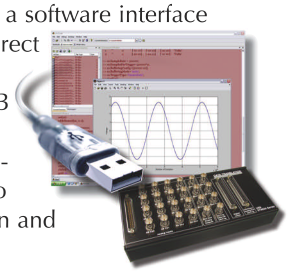
There are many software choices available for application development. Each option offers development capabilities at different levels — from ready-to-measure applications to full graphical programming with DT Measure Foundry.

DT Measure Foundry



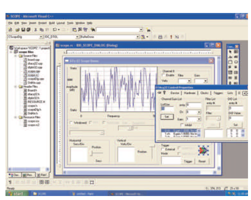
DT Measure Foundry is a powerful visual software environment for creating test and measurement, control, and analysis applications. By dragging and dropping instrument-like components and configuring their property pages, you can develop powerful applications quickly. No programming or wiring is required!

DAQ Adapter for MATLAB



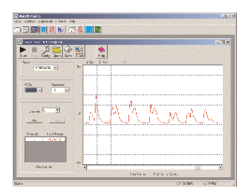
The DAQ Adapter for MATLAB is a software interface tool that allows MATLAB users direct access to analog and digital I/O data. Used together with MATLAB from the Mathworks and its Data Acquisition Toolbox, a single integrated environment is provided to support the entire data acquisition and analysis process.

DTx-EZ



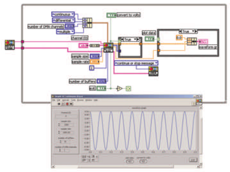
DTx-EZ™ provides visual programming tools for Microsoft® Visual Basic, Visual C++, Visual Basic.NET, Visual C++.NET, and Visual C#.NET that enable quick and easy development of test and measurement applications for DT-Open Layers-compliant USB and PCI boards.

Quick Data Acquisition



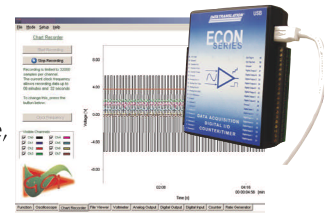
Quick DataAcq is a menu-driven, ready-to-run application that lets you verify the operation of your Data Translation board, collect A/D data, display data to the screen, and save data to disk. The source code is included. Modify the included Visual Basic source code using Visual Basic and DTx-EZ to fit your custom application.

DT-LV Link



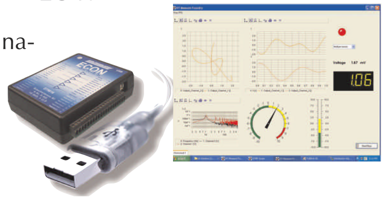
DT-LV Link provides a collection of Virtual Instruments (VIs) that give programmers the ability to access the power of Data Translation's USB and PCI data acquisition boards through LabVIEW. Three-levels of VIs allow full access to the analog I/O, digital I/O, and counter/timer signals on any DT-Open Layers-compliant board.

GO!



The GO! application was designed to work with the ECONseries of mini-instruments. This easy-to-use software offers oscilloscope, chart recorder, voltmeter, file viewer, analog output, digital I/O, and counter/timer functions.

Hardware/Software Bundles - Save 25%



Get all the performance you need for your application using measurement combinations that work. Our USB data acquisition bundles combine test and measurement hardware and software that were designed to work together. Plus, you can save 25%.

surement World China includes Chinese translations of material adapted from *T&MW*'s English edition as well as original Chinese-language material developed by Tang and her colleagues. *Test & Measurement World China* will be published six times per year. www.tmworld.com.cn.

Barnes to lead Verigy

Agilent Technologies has named Keith Barnes as president and CEO of its semiconductor test subsidiary, Verigy, effective May 1. Agilent plans to complete the spin-off of Verigy by October 31, the end of its fiscal year.

Barnes had been serving as the chairman and CEO of Electroglas, a manufacturer of integrated circuit (IC) probers. Prior to joining Electroglas, he was chairman and CEO of Integrated Measurement Systems (IMS) before it was acquired by Credence Systems in 2001. Barnes also served as a division president at Cadence Design Systems for the Prototype Verification Division and at Valid Logic Systems prior to its acquisition by Cadence. www.agilent.com.

CALENDAR

International Microwave Symposium, June 11–16, San Francisco, CA. Sponsored by IEEE Microwave Theory and Techniques Society (MTT-S). *www.ims2006.org.*

Semicon West, July 10–14, San Francisco, CA. Sponsored by SEMI. *www.semi.org.*

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

Editors' CHOICE

150-mm measurement platform

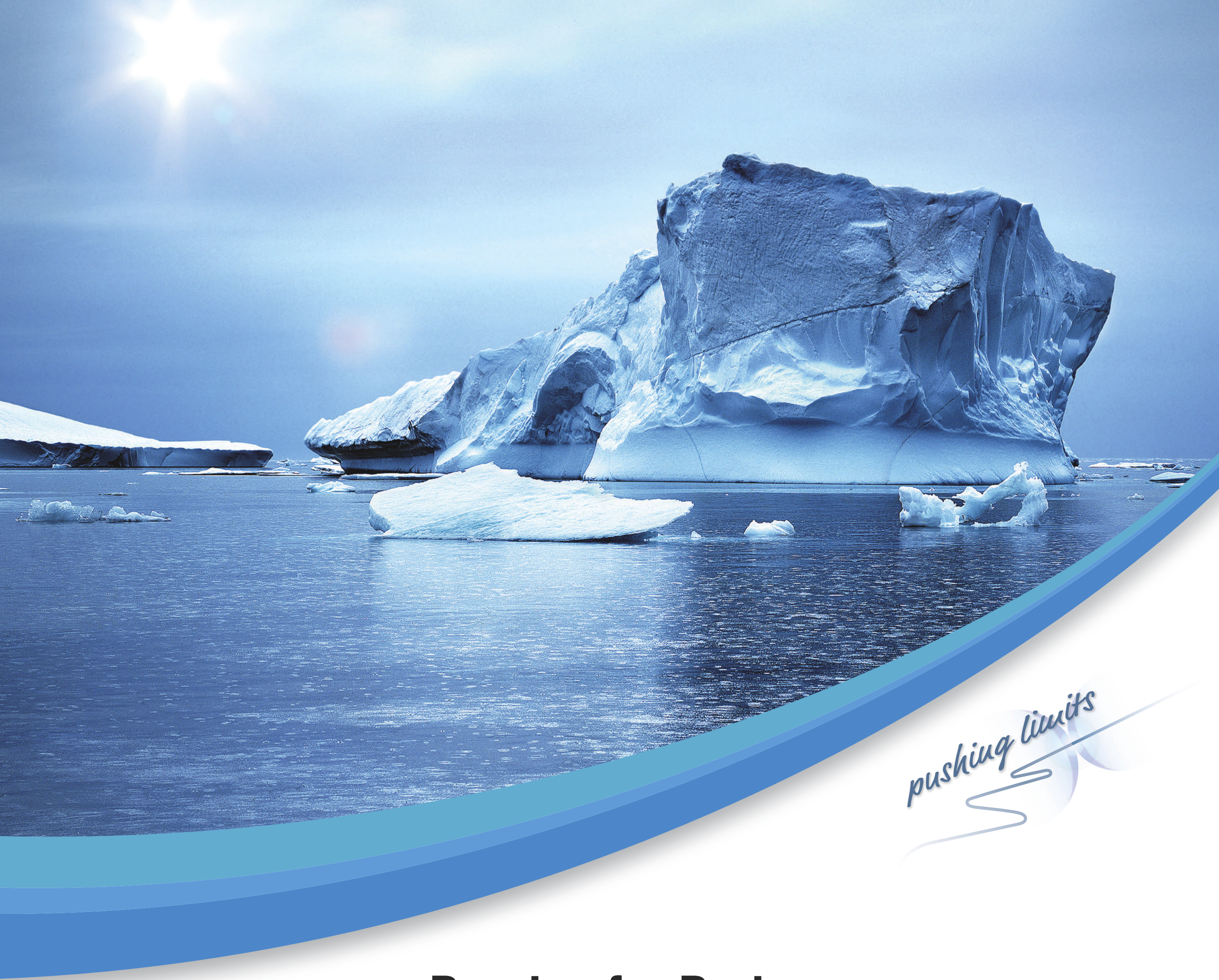
Targeting semiconductor wafers, ICs, printed-circuit boards, MEMS, and bioscience devices, the M150 brings Cascade Microtech's DC-to-220-GHz measurement capability to a low-cost, flexible, 150-mm device measurement platform that allows customers to switch between applications within minutes.

The M150 is customer-configurable with interchangeable standard parts and accessories optimized for specific measurement needs. The M150 helps customers solve device problems such as those related to power consumption, operating frequency, signal isolation, signal integrity, and channel bandwidth.

The M150, the vendor reports, is designed for customers who work in semiconductor fabs, yield departments, and failure-analysis labs; who are working on process characterization of III-V compound semiconductors such as gallium arsenide, silicon germanium, and indium phosphide for RF, microwave, and millimeter wave applications; who are investigating signal-integrity issues on PCBs and high-speed interconnects; and who are working with emerging technologies to accurately position, navigate, and view their analysis for applications such as lab-on-a-chip, microfluidics, organic transistors, polytec neurons, MEMS devices, and other biostructures.

The M150 is available in application-specific preconfigured packages for DC, RF, failure-analysis, PCB-test, or millimeter-wave applications. In addition, customers can build their own systems optimized to their applications.

Base prices: from $5000 for a basic DC measurement system to $45,000 for a millimeter-wave system. *Cascade Microtech, www.cascademicrotech.com.*


pushing limits

Show highlights China's production prowess

> > > Nepcon China, April 4–7, Shanghai, Reed Exhibitions, www.nepconchina.com.

Nepcon China helped reinforce China's reputation as the world's factory floor, at least with respect to printed-circuit boards and subassemblies. Only one exhibit fully addressed design: **Asset InterTech** (www.asset-intertech.com) was on hand to emphasize the importance of boundary-scan design-for-test tools. Emphasizing China's role in manufacturing, Aeroflex and Anritsu, known in North America for their communications test products, were demonstrating manufacturing tools: **Aeroflex** (www.aeroflex.com) highlighted its 4250 manufacturing test system, while **Anritsu** (www.anritsu.com) demonstrated its MK5400 solder-paste inspection system.

Many vendors enlisted the aid of complementary organizations to present their message to a Chinese audience. **BP Microsystems** (www.bpmico.com) highlighted its ISP-PRO device-programming socket module in conjunction with **Wong's Kong King International Holdings** (www.wkkintl.com). Also under the WKK banner, **Phoenix|x-ray** (www.phoenix-xray.com) presented its Microme|x submicron high-resolution semiautomatic x-ray system for the inspection of solder joints and electronic devices. **VJ Electronix** (www.vjelectronix.com) presented a paper on addressing rework challenges in lead-free processes and, in the WKK booth, displayed its Summit 1800 rework system.

ViTechnology (www.vitechnology.com), which was hosted by **American Tec** (www.autroncorp.com/co.html), presented its Vi-5000 Series AOI machines. In addition, **SZ Testsysteme** (a division of Credence Systems, www.credence.com), **Aehr Test Systems** (www.aehr.com), and **Scorpion Technologies** (www.scorpion-tech.com) all exhibited under the **Jointech Trade & Development Co.** (www.jointech.com.cn) banner.

Agilent Technologies (www.agilent.com) demonstrated versions of its Medalist in-circuit test systems and Medalist 5DX automated x-ray inspection systems. **Viscom** (www.viscom.de) demonstrated products including its X8011 in-line-capable x-ray inspection system. **Machine Vision Products** (www.visionpro.com) demonstrated its GEM inspection system. **X-Tek Systems** (www.xtekxray.com) highlighted its Linx compact x-ray system for BGA, flip-chip, PCB layer alignment, and general surface-mount inspection.

Teradyne (www.teradyne.com) displayed its XStation 3-D x-ray imaging system. **Elektrobit** (www.elektrobit.com) featured its Tiny Test Handler, which includes a two-level conveyor that accommodates compact layouts for functional test, boundary-scan test, and software-download applications. **TRI** (www.tri.com.tw) displayed its TR7006L 3-D solder-paste system and TR7500DT desktop AOI system. **Hamamatsu** (www.hamamatsu.com) highlighted its microfocus x-ray sources and camera units.

CyberOptics (www.cyberoptics.com) presented products such as its Flex AOI system. **Omron** (www.omron.com) displayed AOI systems for PCB inspection applications. **Seica** (www.seica.com) highlighted its flying-probe and other PCB test systems. **Digitaltest** (www.digitaltest.net) showcased its MTS180 board-test system. And **YESTech** (www.yestechinc.com) highlighted its line-up of AOI and AXI systems. T&MW

The Tiny Test Handler includes a two-level conveyor that accommodates compact layouts for various applications.

Courtesy of Elektrobit.

SAE Congress kicks off second century

> > > SAE 2006, April 3–7, Detroit, MI, Society of Automotive Engineers, www.sae.org.

SAE 2006 marked the Society of Automotive Engineers' 101st annual gathering. The SAE estimated that 35,000 visitors representing more than 45 countries converged on Detroit's Cobo Arena during the event.

The 2006 technical program offered 1500 papers, including about 400 test-related papers on topics including vehicle reliability, noise and vibration, vehicle aerodynamics, automotive lighting, occupant restraints, six sigma, brake technology test, and innovations in passive safety. Six new test seminars for SAE 2006 focused on tires and wheels, accident reconstruction methods, kinematics in rollovers, and powertrain and propulsion testing.

Products on display included a digital sensing data-acquisition system for vehicle and engine noise measurement from the **Larson Davis** (www.larsondavis.com) division of **PCB Piezotronics**, the PCI-6230 from **National Instruments** (www.ni.com) for isolated data acquisition with industrial sensors, the Laser Tracker X for measuring large parts and assemblies from **FARO Technologies** (www.faro.com), **Boxboro Systems**' (www.boxborosystems.com) and **Robert A. Denton, Inc.**'s (www.radenton.com) joint release of the RibEye deflection measurement system for monitoring crash-test dummies, and the TSD-100 two-zone thermal shock chamber from **Espec** (www.espec.co.jp). T&MW

[BENCH-LEVEL TEST]

MARTIN ROWE
SENIOR TECHNICAL EDITOR
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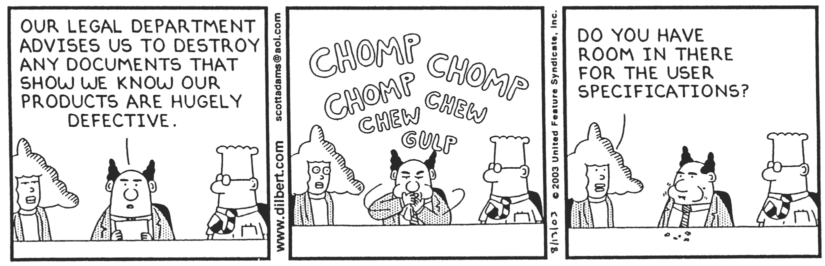
Here come the lawyers

If the lawyers have their way, you won't keep your measurement and calibration data as long as you would prefer. This was one of the points brought up at this year's Measurement Science Conference (February 27–March 3, Anaheim, CA) during a discussion about a new version of NCSLI Recommended Practice 1 (Ref.1). The next version of the document will include a discussion about data retention. Why? Because some lawyers may force the destruction of calibration data that proves product quality in an attempt to dismiss any chance of liability, said Don Wyatt, of Diversified Data Systems, and Charles Motzko, a test consultant.

"Historical data quantifies the acceptable limits of risk that a product will incorrectly pass a test," said Motzko. By advising clients to discard test and calibration data, the lawyers try to eliminate evidence of a "false accept" if the measurement equipment used to produce a product was out of tolerance. They want to eliminate evidence of possible defects.



DILBERT: © Scott Adams/Dist. by United Feature Syndicate, Inc.

"I've seen cases where an attorney enters a calibration lab and tells engineers that they must discard data after seven, five, or even three years," added Wyatt. "Lawyers don't understand calibration nor do they understand which data is important to keep, so they advise clients to discard all data as soon as legally possible."

Unfortunately, calibration data is the only means by which you can prove that your company's measurements are traceable to a national standards lab such as NIST. If you discard calibration and traceability data, the measurements used to design and manufacture a product become meaningless.

The problem is even more disheartening because some corporate calibration standards have data histories reaching back 40 or 50 years. Because historical data can prove that a calibration standard is stable over long periods, the standard may have five-year calibration cycles. Government guidelines often specify data-retention periods ranging from three to seven years, which may be short of even one calibration cycle (Ref. 2).

Another issue is measurement uncertainty. Every measurement is an estimate of an actual value, with an associated uncertainty and a probability that the actual value is within the uncertainty limits. Although small, a probability always exists that a measurement falls outside acceptable limits.

Lawyers, though, may not think in terms of uncertainty and probabilities, and they use that small probability that a measurement was out of tolerance to cast doubt. So, if no measurement records exist, prosecutors can't prove that a company manufactured a defective product. But neither can they prove that your product was built correctly or your engineering data is accurate. T&MW

REFERENCES

1. Rowe, Martin, "MSC panels discuss critical calibration standards," *Test & Measurement World*, "Test Industry News," March 7, 2006. www.tmworld.com.

2. Norenberg, Mark A., "Guidelines On Data Retention And Access," University of Pittsburgh, Pittsburgh, PA, 1997. www.pitt.edu/~provost/retention.html.

Agilent opens network-analyzer forum

Agilent Technologies has opened a discussion forum for engineers who use network analyzers. On the forum, you'll find discussions among engineers and comments from Agilent. You can browse discussions without registering, but you must register to post a message. www.agilent.com/find/agilent_naforum.

Advantech opens online tech support

Advantech's Industrial Automation Group had opened an online connection for technical support. Registered users can use the site to send a priority message to Advantech's technical support group. www.eautomationpro/us.

Solar panel extends sensor battery life

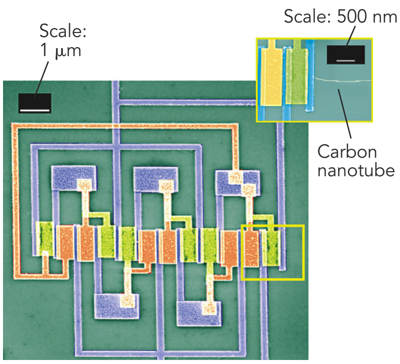
A solar panel for the P-44 Thru-beam photoelectric sensor/transmitter from EMX Industries extends battery life from 150 days to 2 years. The SP44 solar panel connects to the sensor through a 20-ft cable so you can supplement power to the P-44. Price: $43. www.emxinc.com.

STEVE SCHEIBER
CONTRIBUTING TECHNICAL EDITOR
sscheiber@aol.com

Electrons get faster

FEATURE SIZE. Circuit speed and complexity. Throughput. The game hasn't changed. Electronics designers' constant efforts to pack more performance into every device, board, and system enormously complicates the process of developing and executing an effective test strategy.

And researchers at IBM are making sure we don't become complacent. At the Thomas J. Watson Research Center (Yorktown Heights, NY), company researchers have used existing manufacturing techniques to create the first logic circuit made from a single molecule.



This close-up view shows IBM's five-stage CMOS ring oscillator. The inset shows the 2-nm-diameter nanotube itself. Courtesy of IBM.

Semiconductor makers have long looked for new materials to replace silicon, which is rapidly reaching its practical performance limits. Alternatives such as GaAs show promise but have limitations of their own. Instead, the IBM team constructed field-effect transistors along a carbon nanotube deposited on a silicon substrate. The resulting ring oscillator—a circuit commonly used for such early stages of development—showed almost no resistance to electron flow.

Such resistance is primarily caused by *plasmonic resonance,* which hinders an electron's path when it becomes coupled with vibrations that occur in the lattice structure. The electrons traveling along the nanotube do not experience such resonance, suggesting that circuits built this way could prove much faster than anything available today, approaching terahertz speeds, according to the researchers. A single-molecule circuit will also likely eliminate the problem of crosstalk caused by electrons jumping from one pathway to another—a problem that increasingly plagues ever-smaller silicon designs.

Don't expect to see molecular circuitry in routine production any time soon. It represents a significant breakthrough, but it is only a "proof of concept" that does not yet run even as fast as today's silicon-based versions. But the path is clear and the end result all but inevitable.

The news comes as another reminder that test technologies always remain at least one step behind the products they are testing. Both designers and manufacturers must become more creative when building test and inspection strategies. They can no longer expect strategies of the past to have any relevance to newer developments.

Nevertheless, some test-equipment companies expect to take these new challenges in stride. Alan Wadsworth, marketing and communications manager of the Hachioji Semiconductor Test Division of Agilent Technologies, noted, "Since carbon nanotube FETs appear to conduct current via ballistic transport, circuits constructed from them will likely produce much higher current densities than we see in conventional MOSFET devices. From a parametric test perspective, this might require new reliability test routines and, potentially, hardware with increased current-sourcing capacity. However, I feel that the ability to test such devices is well within our current knowledge and equipment capabilities." T&MW

AOI system

Leveraging YESTech's machine-vision software, the M1 Series automated PCB inspection system lets operators create a complete inspection program typically in less than 30 min, the vendor reports. The M1 Series uses a standard package library to simplify training and ensure program portability across manufacturing lines. With 3-Mpixel resolution and telecentric optics, the M1 Series adapts to pre- or post-reflow inspection. Base price: $82,500. www.yestechinc.com.

PXI Express boundary scan

Goepel electronic is developing a series of boundary-scan controllers with PXI Express interfaces as part of its ScanFlex boundary-scan hardware platform. A prototype, dubbed SFX/PXIe1149-(x), includes three models offering maximum TCK frequencies of 20, 50, and 80 MHz. The new family's x1 configuration achieves transfer rates up to 264 Mbytes/s in zero-wait-state burst mode. www.goepel.com.

Manual and automated x-ray systems

Macrotron Scientific Engineering has introduced the MSX line of x-ray inspection systems. New systems include the MSX 80 and MSX 90 machines for manual inspection of PCBs and components; the MSX 2000 series fully automated inspection systems with automated test-program generation and optional automated load and unload capability; and the MSX 3000 series, which provides 2-D transmission and 2-D off-axis modes while also allowing 3-D inspection. www.m-se.com.

EMI STANDARD

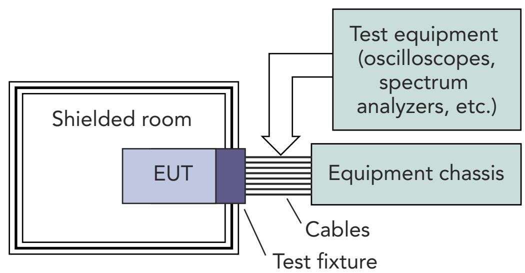
EMI standard planned for replaceable modules

EMI standards such as MIL-STD-461, CISPR 22 address stand-alone electronic products such as computers. Unfortunately, they don't address EMI limits or testing for systems that use replaceable electronic modules (REMs).

To remedy this, the IEEE-SA Standards Board has approved Project 1688, Standard for Module Electromagnetic Interference (EMI) Testing. Led by Fred Heather, electromagnetic environmental effects lead for the Joint Strike Fighter Program (www.jsf.mil), the group plans to draft a standard for performing susceptibility and emissions tests for radiated and conducted EMI on REMs.

The need for EMI test standards for REMs arose because engineers want to replace modules in a backplane without performing a complete EMI equipment level test. In complex systems, the cost and schedule impacts of prequalification testing because of one REM change can be more significant than the change itself. The new standard will allow qualification of the REM without further system-level EMI testing.

The group plans to produce a draft standard in time for the IEEE EMC Symposium (August 14-18, Portland, OR). The final standard should provide a test method for evaluating a card's or module's conducted and radiated EMI characteristics. While not intended as a compliance standard, the proposed 1688 standard should bring the risk that a card or module will interfere with system operation to an acceptable level.



A test fixture provides an interface between the equipment under test inside a shielded room and an outside chassis and test equipment.

The group is looking at cards and modules, not backplanes or motherboards. To thoroughly test a card, you need it to operate in its chassis connector, but the group wants to test the EMI characteristics of cards or modules only, separate from the chassis.

Group members want to keep the card or module under test inside a shielded room while keeping the interface and chassis backplane outside, so they are developing fixtures (**figure**) that mount in the walls of a shielded room, on an EMI bench, or in a TEM cell. Shielded cables connect the REM fixture to other interfaces. The interface equipment will reside outside the room and will include the test equipment used to test the REM in the factory. "We plan to use the standard EMI test equipment to measure emissions and to inject interference signals into interface lines," said Heather. Grounding, bonding, and heat sinking of the text fixture is important because you can't compromise signal integrity or thermal characteristics of a chassis.

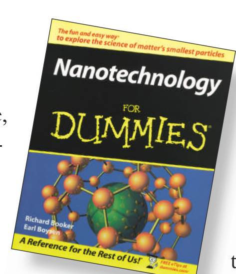
The P-1688 group is open to new participants. For more information, send an e-mail to heatherf@ieee.org.

Martin Rowe, Senior Technical Editor

BOOK REVIEW

Getting the dope on nanotechnology

Nanotechnology for Dummies, Richard Booker and Earl Boysen, Wiley (www.wiley.com), 2005. 361 pages. $16.



You don't have to be a dummy to find *Nanotechnology for Dummies* useful. As with other *Dummies* offerings, this book offers an easy-to-take introduction to its topic, but it goes into sufficient depth that you'll undoubtedly learn something new even if you've investigated the topic before.

The book covers applications ranging from medicine to nanotech-based composites, including carbon buckyballs and nanotubes. There's also a chapter on investment opportunities. Yet, there's plenty directly applicable to EEs. The introductory portion touches on spectroscopy as well as atomic-force, scanning-electron, transmission-electron, scanning-tunneling, and magnetic-resonance-force microscopy—techniques you've probably encountered in a failure-analysis lab. The descriptions of these techniques, though brief, are clear and interesting.

The most applicable part for EEs might be the 100-plus pages on computation and energy. Once you skim past the definitions of megabits and gigabytes, you'll come to a compelling description of the migration from field-effect transistors to single-electron transistors, and an actual dummy who picks up this book is likely to become lost in the section that describes Coulomb blockades and single-electron tunneling. It's not surprising that this section is quite detailed, as coauthor Booker is described as a veteran engineer in the semiconductor industry.

Throughout the computation section, you'll learn about competing chip-

Getting the dope on nanotechnology *(continued)*

fabrication techniques such as nano-imprint technology and the use of atomic-force microscopes to "write" nanotech structures onto chip substrates. You'll also learn about magnetic RAM (which needn't be clocked the way DRAM must be) and IBM's magnetic-tunnel-junction approach to MRAM compared with Naval Research Laboratory's vertical magnetoresistive RAM technique. The computation section also covers the manipulation of light using nano-designed crystals, the emergence of nano-optics for telecommunications applications, and the use of photoelectrochemical cells to produce hydrogen.

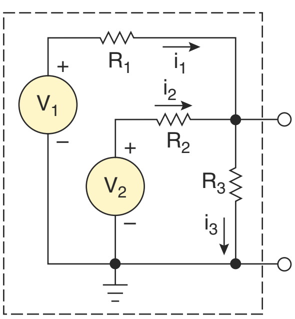
The book concludes with a compendium of organizations involved in nanotechnology research.

Rick Nelson, Chief Editor

CIRCUIT ANALYSIS

Deriving Thevenin equivalents

A book review in *Test & Measurement World*'s March issue (Ref. 1) takes an author to task for, in a chapter covering Thevenin's theorem (Ref. 2), failing to provide the Thevenin equivalent of a sample circuit he presents. The circuit appears in the **figure**.



To illustrate the power of Thevenin's theorem, this circuit can be analyzed in terms of voltage dividers and superposition, as outlined here. The Thevenin equivalent resistance is simply R_1 in parallel with R_2 in parallel with R_3:

$$R_T = \frac{[R_1R_2/(R_1+R_2)]R_3}{[R_1R_2/(R_1+R_2)]+R_3}$$

$$R_T = \frac{R_1R_2R_3}{R_1R_2+R_2R_3+R_1R_3}$$

With V_2 shorted:

$$V_{T1} = \frac{V_1(R_2||R_3)}{R_1+(R_2||R_3)}$$

$$V_{T1} = \frac{V_1R_2R_3}{R_1R_2+R_2R_3+R_1R_3}$$

With V_1 shorted:

$$V_{T2} = \frac{V_2(R_1||R_3)}{R_2+(R_1||R_3)}$$

$$V_{T2} = \frac{V_2R_1R_3}{R_1R_2+R_2R_3+R_1R_3}$$

By superposition:

$$V_T = V_{T1}+V_{T2}$$

$$V_T = \frac{V_1R_2R_3+V_2R_1R_3}{R_1R_2+R_2R_3+R_1R_3}$$

The Thevenin equivalent resistance is R_1 in parallel with R_2 in parallel with R_3:

$$R_T = \frac{[R_1R_2/(R_1+R_2)]R_3}{[R_1R_2/(R_1+R_2)]+R_3}$$

$$R_T = \frac{R_1R_2R_3}{R_1R_2+R_2R_3+R_1R_3}$$

This result can be verified by solving the node equation $i_1+i_2= i_3$ where:

$$i_1 = (V_1 - V_T)/R_1$$
$$i_2 = (V_2 - V_T)/R_2$$
$$i_3 = V_T/R_3$$

$$(V_1 - V_T)/R_1 + (V_2 - V_T)/R_2 = V_T/R_3$$

$$R_2R_3V_1 - R_2R_3V_T + R_1R_3V_2 - R_1R_3V_T = R_1R_2V_T$$

Solving for V_T yields:

$$V_T = \frac{V_1R_2R_3+V_2R_1R_3}{R_1R_2+R_2R_3+R_1R_3}$$

The online version of this article provides links to further information and discussion, www.tmworld.com/2006_05.

Rick Nelson, Chief Editor

REFERENCES

1. Nelson, Rick, "An EE course without the all-nighters," *Test & Measurement World*, March 2006. p. 17. www.tmworld.com/2006_03.

2. Ashby, Darren, *Electrical Engineering 101*, Newnes, 2006. pp. 33–38.

PROJECTPROFILE

INSTRUMENTS

Roll a million miles

DEVICE UNDER TEST
Cam follower rollers used in diesel and gasoline engines. The rollers are used as part of the engine's fuel-delivery system.

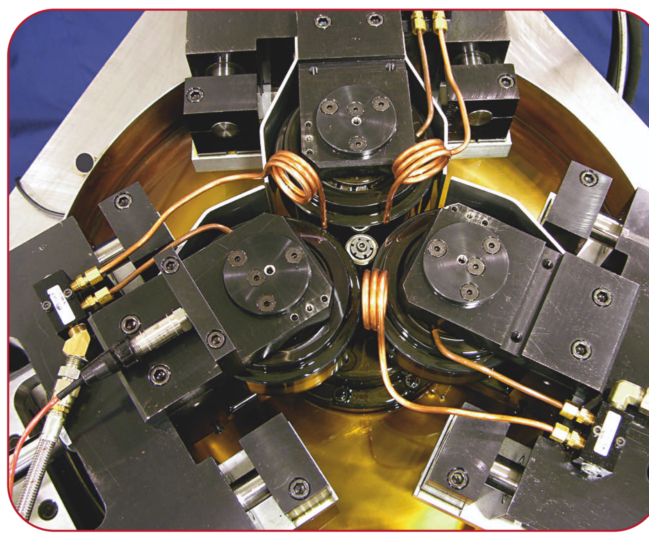
THE CHALLENGE
Reduce time to simulate 1 million miles of testing. Vary fatigue life by applying pressure from 500 lbs to 5000 lbs and oil ranging in temperature from 70°F to 280°F while spinning the roller at speeds from 500 rpm to 5000 rpm. Count roller revolutions and monitor vibration, looking for signs of failure.

THE TOOLS
- Bosch Rexroth: servo motor and variable-frequency servo drive. www.boschrexroth.com.
- National Instruments: 24-input, 24-output isolated PCI digital I/O card; 24-bit PCI analog-input card; multifunction PCI data-acquisition card; graphical programming language. www.ni.com.
- Omega Engineering: proportional-integral-derivative (PID) controller for oil temperature control. www.omega.com.
- PCB Piezoelectronics: accelerometer. www.pcb.com.

PROJECT DESCRIPTION

Engineers at GT Technologies (Westland, MI, www.gttechnologies.com) needed to perform life tests on cam follower rollers. Because these rollers go into truck diesel engines, they need to last 1 million miles or more. But a million-mile test could take as long as two years to complete. To cut test time, Erik Maassen, manager of testing, turned to VI Engineering (www.viengineering.com) to design and build a roller fatigue tester.

A test fixture (**photo**) holds the roller under test in its center. A motor mounted under the fixture and controlled by a PC through a servo drive spins the roller. Three hydraulically controlled idler rollers apply varying loads to the roller. A digital I/O card actuates the idler rollers to vary the load. Oil ranging in temperature from 70°F to 280°F is sprayed on the roller; the sprayer is controlled by a PC through a digital I/O card. A chamber around the roller contains the oil spray. PID controllers that control oil temperature get their settings from the PC through a serial port.



A roller under test spins in the center of this fixture while three rollers apply a load. A PC controls speed and load while monitoring roller performance. Courtesy of VI Engineering.

During a test, an accelerometer connected to the 24-bit analog-input card monitors the spinning roller. The PC performs a fast Fourier transform (FFT) of the accelerometer signal to produce a frequency plot, and a data-acquisition card uses signals from the motor controller to count revolutions.

The tester software operates in manual and automatic modes. In manual mode, a technician spends 10 to 15 min adjusting the roller speed and load. Using the results of the FFT and the geometry of the rollers, the technician selects five frequency bands from within a 100-Hz-to-10-kHz frequency range for the system to monitor during the automated test (a frequency band might be 100 Hz to 120 Hz). The technician sets amplitude limits for each frequency band before starting the automated test. "When the amplitude of a frequency band exceeds a limit," said Maassen, "it indicates failure, usually caused by cracks or material loss. At that point, the system aborts the test."

LESSONS LEARNED

VI Engineering designed the system with a pneumatic oil pump as opposed to an electric pump to spray oil on the roller. The pneumatic oil pump was less expensive, but it needed a pressure gauge with a regulator to sense if the air pressure was too high. It was also louder than the electric pump. "The electric pump would have been better based on total cost and performance," said systems engineer Raj Balsamy.

Initially, when the system sprayed oil on a roller spinning above 4000 rpm, the oil splashed outside the test fixture because of open spaces in the cover. Engineers added guards to keep the oil in place, but it took many tries to find the best solution.

Balsamy also found that even with shielded cables, noise can interfere with wanted signals. He noticed that a 0–5V signal indicating number of revolutions from the motor picked up noise from a nearby AC power cord. The solution: Use twisted-pair shielded cable, not just shielded cable.

Martin Rowe, Senior Technical Editor

Pat McGinnis poses with a Suss Microtec NC-1 noncontact probe system. McGinnis and his team collaborate with Suss engineers to develop sample-preparation techniques that provide noncontact probe access through SOI substrates.

EAST FISHKILL, NY. Manufacturing high-performance microprocessors in deep-submicron technologies on 300-mm wafers requires the utmost in process optimization and design-rule formulation and adherence. To ensure their company's products measure up to expectations, engineers at the diagnostic lab of IBM's Micro Test and Development (MTD) organization employ a host of imaging tools that can peer inside semiconductor wafers or packaged parts. Pat McGinnis, electrical engineer at IBM Technology Collaborative Solutions, works with six colleagues in the diagnostics lab here to employ ATE systems to exercise devices under test and to devise the fixtures necessary to interface to the DUTs within the various image systems they employ.

"Our organization's primary responsibility is power-on and test bring-up for IBM processors for the IBM Systems & Technology Group," explained McGinnis. "The mission of our lab—the image-diagnostics lab—is to support not only the power-on

A line-up of probe systems, emission microscopes, and other image-based tools helps engineers optimize processes and processors for IBM Microelectronics' 300-mm fab.

IMAGE *of* PERFECTION

RICK NELSON, CHIEF EDITOR

NAJLAH FEANNY

of all internal [IBM] 300-mm products, but also all 300-mm process development and external customer diagnostics. To that end, we have performed full SOC test and image-based diagnostics on the latest dual-core IBM POWER6 processor, on the STI [Sony, Toshiba, IBM] Cell processor, on the XBOX 360 game chip, and on the Nintendo PowerPC game processors."

An IBM-developed processors' first step within the MTD organization is through the primary MTD test lab, headed by Franco Motika. There, ATE systems including Advantest 6671/6672/6682 platforms and Teradyne Ultra Flexes put new products through their paces, looking for product and process problems through a range of structural and functional tests. If electrical tests suggest that a closer look is warranted, the DUTs could head across the hallway to the domain of McGinnis and the image-based diagnostics team.

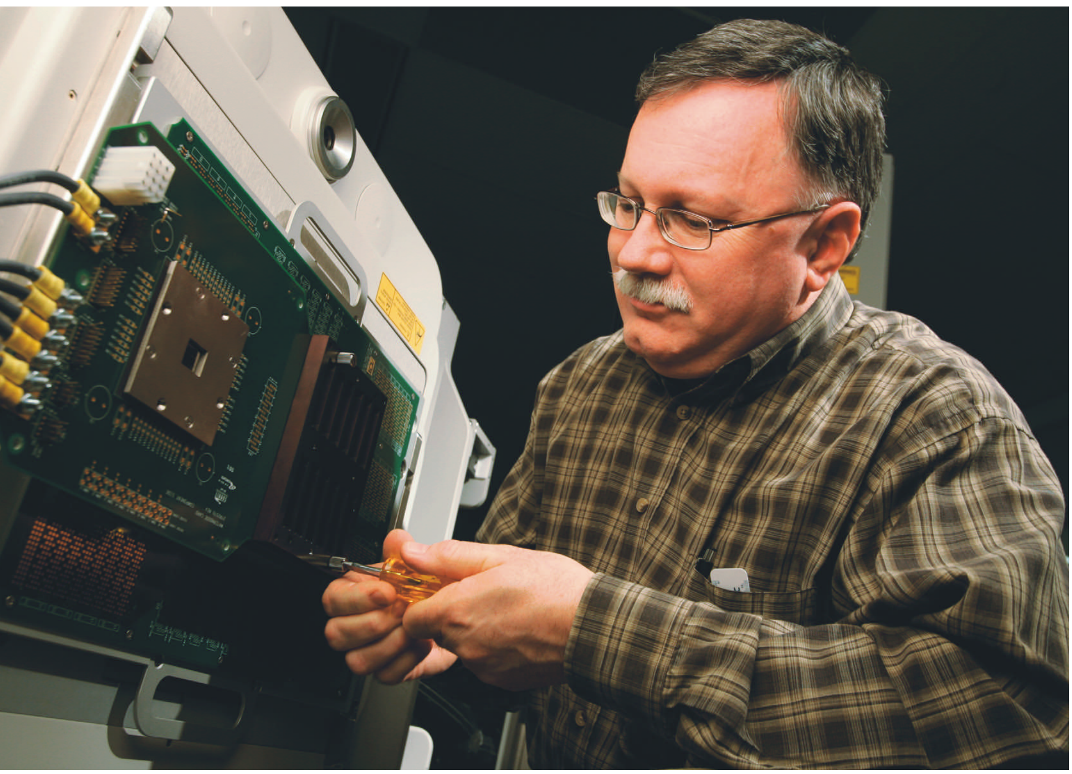
The lab, McGinnis said, was originally dedicated to isolating process-development failures. But with the advent of 300-mm technology, separate process and product diagnostic efforts became counterproductive. Combining the two simplifies technology transfer, he explained, and is increasingly important as process development and product design occur in parallel. McGinnis said the lab is capable of performing a range of tests, from inline tests of the kerf macros located between dies on a wafer to complete functional tests of a final semiconductor design.

McGinnis himself is in his tenth year at IBM. "I actually started in Boca Raton, FL, with a group called SEDAB, an acronym that stood for 'special equipment design and build,' where we were working with hard-disk-drive, microelectronics, and other IBM manufacturing organizations. On my last project there, I was in charge of building atomic force microscopes. That's where I cut my teeth in the microelectronics world, and that paved the way for me to come here six years ago."

Is it considered a mark of failure to have a product or process that ends up in McGinnis's lab? "Absolutely not," he emphasized. "Process development and product designs are moving in parallel with one another. You can't say problems are the fault of the integrators who are developing the process or the designers using them, because both groups are learning to use these new processes and new designs at the same time. Usually, when you run into a brick wall—when there's a major problem—it's because of something that was completely unknown to everybody. The trick is you have to have these groups working together. That's the only way you are going to resolve these problems—it might take a process change, or it might take a design change. One group not knowing what the other group is doing is not going to work."

Because of the range of technologies that his lab addresses, McGinnis said, "The demands on the engineers in this lab are pretty high, because you have to know what everybody else is doing. I always like to think that we know a little bit of everything but are masters of none, so we rely heavily on our counterparts to help us create test programs and understand the fab process. I deal with every community that's imaginable within IBM—the front-end-of-the-line integrators, the back-end-of-the-line process-development engineers, the designers, the test guys, you name it."

He also deals with IBM's customers: "IBM always takes care of its customers. If one of our partners is having problems isolating fails based on our process, even though it's been transferred to the partner's fab, we will still look at the partner's hardware with our custom toolset."



NAJLAH FEANNY

FIGURE 1. **Rich Oldrey displays an Agilent 93000 load board, which interfaces 93000 pin electronics with daughter-card modules or probe rings that hold and provide electrical connections to devices under test within imaging tools.**

A unique niche

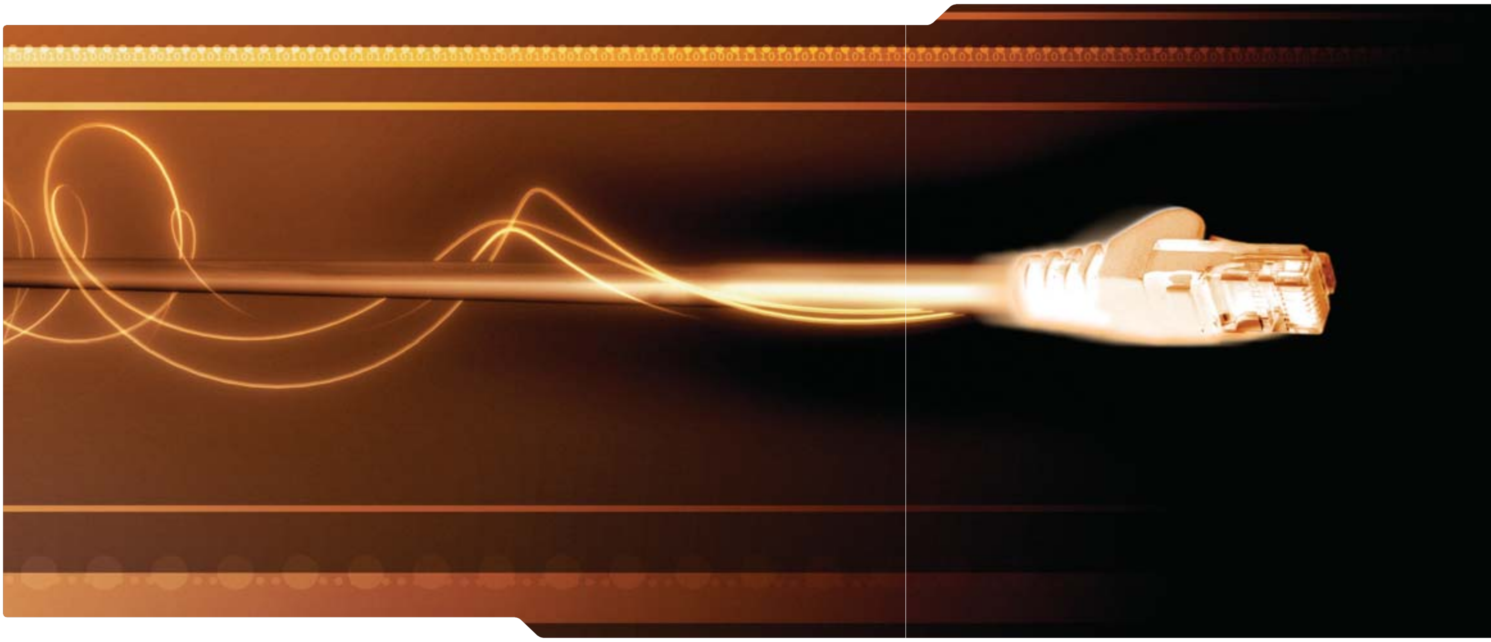
In addition to addressing both process and product diagnostics, McGinnis's lab occupies a unique niche between the electrical-test and physical-failure-analysis functions. "Electrical test—whether it's inline test, final wafer test, or final module test—can tell you a lot." As a result of problems detected though electrical test, he said, IBM's Fishkill-based physical failure analysis (PFA) lab will ultimately use tools such as scanning electron microscopes to identify actual physical defects. "But with devices getting smaller and smaller, it's important to be able to point the PFA team to a pretty tight area" where defects might appear.

Further, McGinnis pointed out, hard defects no longer predominate. He cited the increasing frequency of condition-sensitive failures that are difficult to detect with traditional approaches. "That's where we come in. We combine traditional PFA tools such as emission microscopes with the ability to exercise devices using an ATE system. We actively exercise parts, be they wafers or modules, and we develop the fixtures that let us observe the parts using our imaging tools as they are exercised. We custom design all of our fixturing to fit into these various image-based tools that we use.

"My lab has an array of image-based tools with a custom-designed fixture set that allows for full tester control of a device while image-based analysis is conducted. Our image-based tools include a Credence Emiscope III PICA [picosecond imaging circuit analysis] tool, a Hamamatsu Phemos 1000 emission microscope, and various semi-auto probe systems that can accommodate various probing hardware sets, including a Suss NC-1 noncontact prober."

As for the ATE systems used to exercise the parts being evaluated, the main system is an Agilent Technologies 93000. The company originally used an air-cooled HP 82000 ATE test system that was adapted for image diagnostics by John Sylvestri, who's responsible for engineering development, test, and image-based screening. McGinnis considers the 82000 to be "the predecessor of every SOC test system that's out there today. That system is 20 years old, and the fact is that HP-slash-Agilent doesn't support it anymore, but John has been running it for 15 years. It works great, lasts a long time."

McGinnis noted that the 82000 lacks the speed of newer testers, but he doesn't



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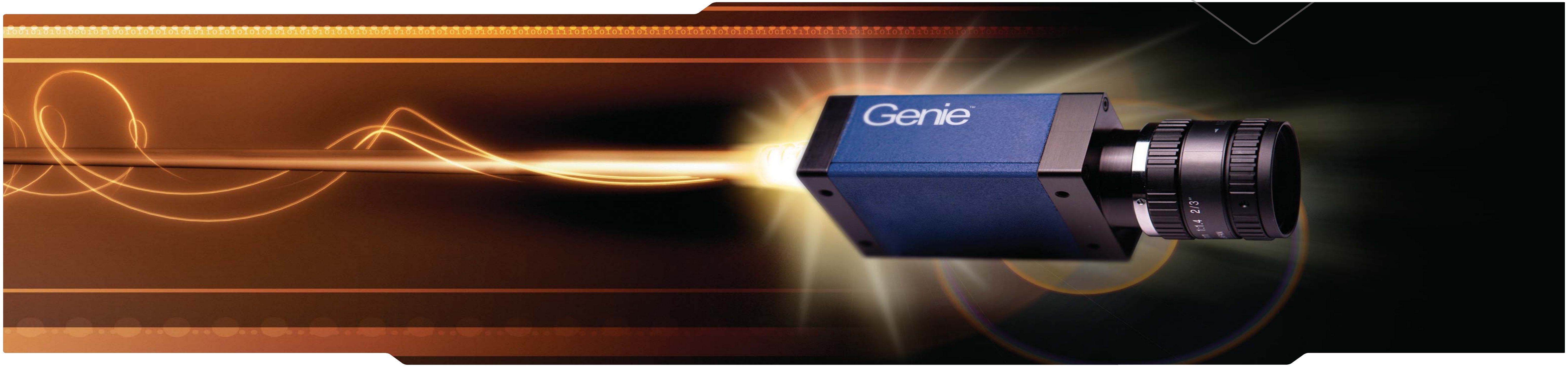

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consider that a major drawback for the diagnostics work the lab does. "In a diagnostics mode, everything can pretty much be run at a lower speed, and you get the same behavior at the low speeds as at the high speeds. And within the last five years, everything that runs at high speeds has gone to some type of onboard clock, so line loss or the round-trip delay through any of your test interfaces isn't an issue. All you need to do is be able to synchronize your tester to your device."

He did note, however, that the 82000 lacks the vector memory necessary to handle test data for some modern ASICs and microprocessors. That's one of the reasons his lab acquired an Agilent 93000, which now serves as "the main tester platform utilized in conjunction with the image-based tools."

Load boards and fixtures

McGinnis explained that a key advantage of the 93000 was that when his lab acquired the system, it was one of the few SOC testers, if not the only one, that integrated the pin electronics into the test head, making it easy to wheel the necessary test resources to the appropriate imaging tool. A key feature was a sufficiently long tether that can carry power and cooling water to the test head as the engineers maneuver it throughout the lab.

Many labs "take the approach of marrying a test system directly with a single tool—a probe station, emission microscope, or waveform tool like PICA," said Rich Oldrey, whose duties include engineering hardware design and build, test, and image-based screening. "We didn't go down that path. We chose to set a whole bunch of tools up and put a tester on wheels."

Said McGinnis, "That approach is much more cost effective. One load board fits right on to the tester. The footprint of all the I/O pins is pretty much set by the designer of the test head. We have a custom-designed cable interface that basically pulls all the I/Os from the test head to a daughter card or some other fixture, which is basically all we need to redesign on a per-part or per-module basis. Then, jumpers on the card or fixture allow us to configure the power supplies in any way we want; we can sense voltage droop remotely or locally—at the test head or at the probe rings, for instance. I think we were fortunate in that we got this pretty close to right the first time. It's proven to be a very versatile interface; it can handle very low voltage levels as well as power levels in excess of 1000 W."

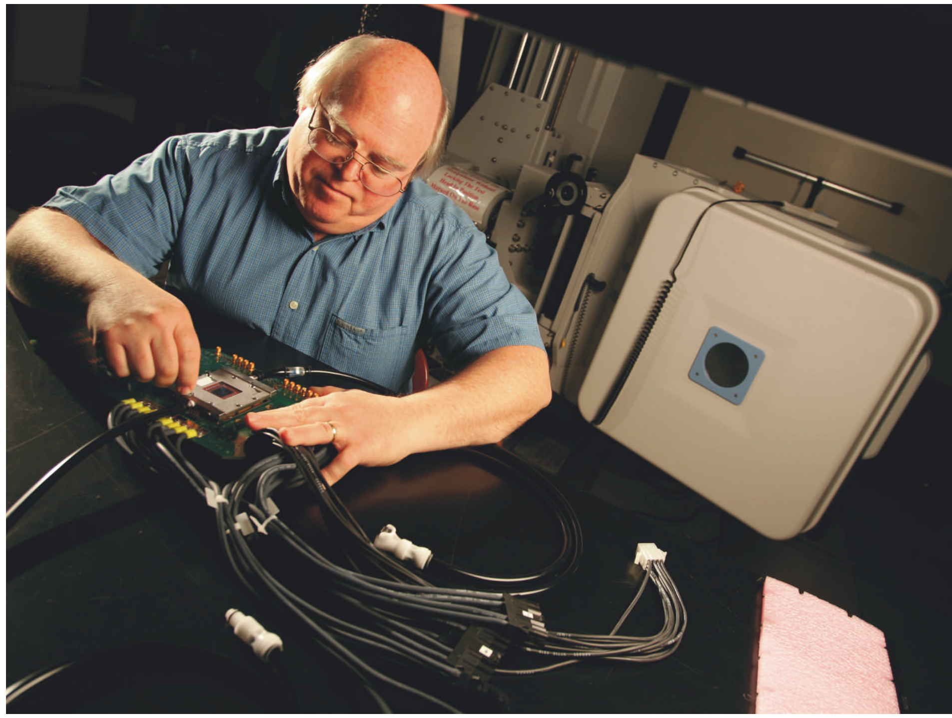
McGinnis attributed the success of the fixture scheme (**Figure 1**) to Oldrey and Darrell Miles, who is responsible for equipment maintenance, DUT hardware design and build, and image-based diagnostics support in the lab. Oldrey for his part attributed the success to the 25 years of experience he and John Sylvestri have in identifying the problems and pitfalls that can plague fixture-design efforts.

For a part that dissipates a lot of power, Miles came up with a design that involves forming a seal between a steel plate and the ceramic substrate of a DUT. He explained that the plate serves two purposes: It holds the part in a socket to form electrical connections, and it forms a cavity through which water from a chiller can be pumped, thereby forming a water heat sink that can dissipate 200 W/cm^2 while maintaining a sufficiently low z height to enable it to fit within the imaging tools (**Figure 2**).

Emissions and LSMs

With fixturing in place, the next step is to run the DUTs through the tester interface and perform image-based analysis. "Our workhorse in this lab for image-based analysis is the Hamamatsu Phemos 1000 emissions microscope, which also has an integrated laser scanning microscope," said McGinnis. "Emissions has become a very practical way of easily and quickly finding different types of fails. Of course, it is obviously very hard to look through up to 15 levels of metal, but with our fixturing, we can make contact through a cantilever assembly for full tester control, and then we can flip the whole assembly upside down so we can look at the part working through the backside silicon."

The approach requires a confocal microscope with sufficiently sensitive detectors as well as the appropriate fixturing. Typical emission microscopes, McGinnis said, have CCD detectors, but for the Phemos 1000, he specified an MCT (mercury cadmium telluride) detector, which lacks the resolution of a CCD but provides an order of magnitude improvement in quantum efficiency, not to mention broader spectral bandwidth. Over-

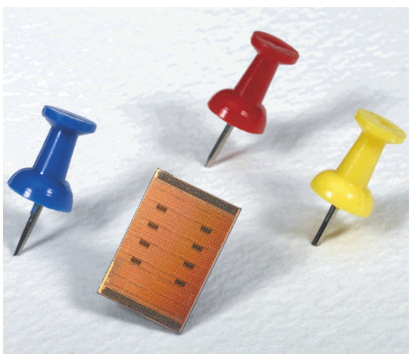


NAJLAH FEANNY

FIGURE 2. Darrell Miles developed a water-cooled lid assembly that forms a seal between a steel plate and the ceramic substrate of a device under test. The low z height of the assembly enables it to easily fit within various imaging systems.

laying the resultant emissions and laser scanning microscope (LSM) images, he explained, enables the isolation of various types of failures, or at least can rule out potential product or process problems.

Other tools in the diagnostics lab include an Emiscope III from Credence Systems, which builds on the PICA technology invented by IBM. Emiscope adds the ability to acquire timing information from the same devices that have provided emissions data. McGinnis says that the Emiscope can acquire a waveform in a matter of minutes, whereas five years ago, a PICA system would require hours to acquire the waveform. He cited as a unique feature of the Emiscope a water-cooling-spray assembly, developed by Credence, that keeps parts under test cool despite the loss of built-in heat-sinking that occurs when backside silicon is thinned to 150 to 200 nm to permit photon acquisition.



The IBM/Sony/Toshiba jointly developed Cell microprocessor is one device that has made the trip through IBM's image-based diagnostics lab. Essentially a supercomputer on a chip, the Cell features a multi-core design with high-speed communications capabilities that can deliver 10 times the performance of chips used in personal computers.

Courtesy of International Business Machines Corporation. Unauthorized use not permitted.

Probing systems

A tool like the Emiscope can show where edges are occurring, but it can't discern voltage levels. For that, McGinnis's team makes use of probing systems. McGinnis's atomic force microscopy experience led him to implement atomic force probing in the lab. In one approach, he enclosed a Cascade probing station within an acoustically isolated chamber. That approach, he said, enables him to make resistive contact with 100-nm targets without having to worry about acoustic noise in the lab.

Of course, resistive probing imposes loading on the circuit under test, and to get around that shortcoming, McGinnis has worked extensively with noncontact probing systems. He elaborated, "There are very small distinct electrical forces operating in the attractive van der Waals force range, and if you take advantage of maintaining device functionality through a synchronized tester interface, you can measure the dampening effects caused by these forces as they interact with your probe tip. You have to fly above the sur-

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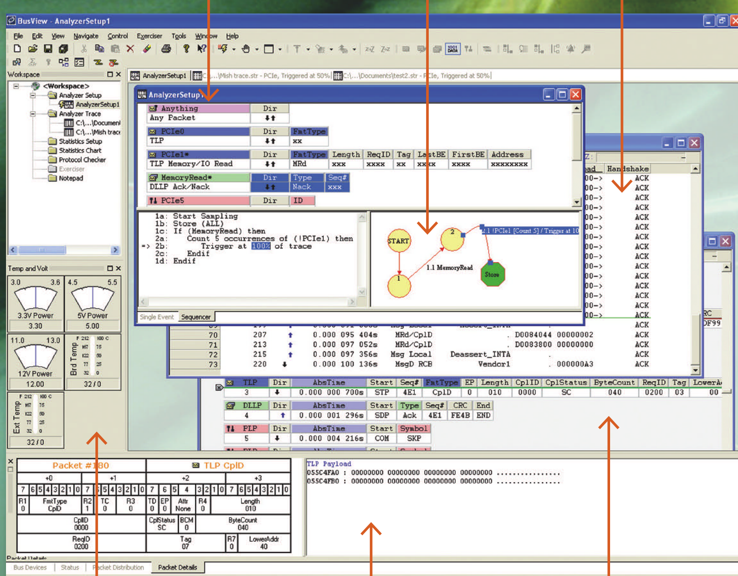

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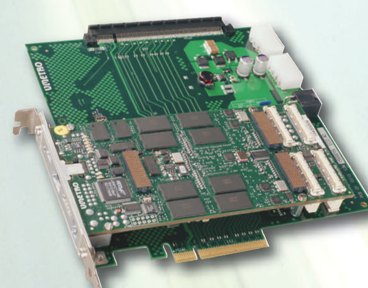

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face at a very stable height, and you have to be able to calibrate the mechanical dampening of the tip in order to detect the induced vibrations that are there. Then, the idea is that you digitize the signal and rely on synchronization and post processing so that what you end up with is a signal that not only gives you pretty good resolution for timing information but also a nonvolatile measurement of the peak-to-peak voltage, which is something that a light-based or an emission-based system can't do."

Initial efforts at noncontact probing yielded a system that could be made to work, he said, "but you practically needed four PhDs to run the thing. It wasn't a repeatable product. One of the big problems was synchronization through the tester interface."

That led to a collaboration between McGinnis and a team at Suss Microtec, lead by Dan Ouellette, noncontact probing manager at Suss. IBM provided test-device samples, and the Suss team provided the engineering to develop the NC-1, which Suss introduced as a commercially available tool last year (Refs. 1 and 2). Said McGinnis, "Dan and his cohorts have put a lot of time and effort into the system to make it repeatable and easy to use." The teams continue to collaborate on issues such as sample-preparation techniques that provide noncontact probe access through silicon-on-insulator (SOI) substrates.

Of course, the newest tools aren't always the best. In addition to the venerable HP 82000, McGinnis pointed out that the lab also has an old Zeiss LSM. "I call it the Bentley of the LSMs. It's old, it's ugly, but the darn thing works just as good as any of the other LSMs that are out there." And Miles, he said, has continued to enhance the tool over the last five years.

The continual enhancement of older tools helps the lab control costs. Said McGinnis, "You just can't keep throwing millions of dollars for another piece of equipment." Enhancement of older tools is part of that scheme; another is encouraging vendors to provide multiple functions within one piece of equipment. "Hamamatsu in particular has been a really good vendor for us to work with," given its willingness to integrate an emissions scope and LSM into one piece of equipment.

With the tools they have available, how does McGinnis's team know where to start? "Actually, in most instances, inline test data or wafer final test data gives us a good idea, because we know our own processes. We don't always get it right, but for the most part, I'd say 70% of the time, if I know I have gate leakage and I know I don't have a shorting mechanism, I just take the part over to the emissions microscope, and that will show me the devices that are leaking. If I know from a parametric sweep that I have a dead short, I can expect that OBIRCH [optical beam induced resistance change] is the best way to go. Tools like the noncontact probe system are used most often for design marginalities. The initial data tells us pretty much what tool to use."

Moving ahead

Looking to the future of imaging diagnostics, McGinnis noted that spectrometry shows promise for SOI technology. Many researchers, he said, find they can quantify emissions wavelengths, and they can learn a lot about what's happening at the device level—for example, whether a transistor is saturated or near breakdown. "Unfortunately," he added, "I think microelectronics in general is just moving faster than the development of the detectors, so it's a constant game of catch-up." By the time such an imaging tool is perfected, he said, "It's probably going to be applicable to 90-nm technology after we've reached 45."

Nevertheless, McGinnis remains prepared to adapt. "One thing I've learned in my career and that I try to share with some of the newer guys is that you can't rest on your laurels. In this industry, what you did five years ago isn't applicable to what you are doing today. You have to reteach yourself, you have to retrain yourself constantly. And quite honestly, this is the greatest environment in the world to learn new technology. Our scientists at the Watson Research Lab, and here in Fishkill, and in Poughkeepsie, Burlington, Austin, and Rochester, MN, are always coming up with new ideas, and we are always coming up with new solutions to test what they are coming up with. So it's always interesting, and there's always something new." T&MW

REFERENCES

1. "Noncontact Probe System Targets 65-nm Technology," Test Industry News, *Test & Measurement World*, July 18, 2005. www.tmworld.com.

2. Nelson, Rick, "Failure analysis gains electrical, microscopy tools," *Test & Measurement World*, September 2005. www.tmworld.com/archives.

FOR FURTHER READING

"The Cell project at IBM Research," www.research.ibm.com/cell/.

Johnson, Robert, "SEMs probe beneath the surface," *Test & Measurement World,* July 2001. p. 50. www.tmworld.com/archives.

Titus, Jon, "AFMs pinpoint surface defects," *Test & Measurement World,* March 2004. www.tmworld.com/archives.

ETHERNET VS. CAMERA LINK

Two high-speed buses make it easier for test engineers to interface a digital camera to a host computer.

JOHN EGRI, IMPERX

Over the past decade, test engineers' perceptions of video as a component in a variety of automated testing applications has gone from "Why would I need it?" to "Gotta have it." Test engineers have found that the visual information acquired from high-performance digital cameras can be useful in many test-related situations, from assembly-robot guidance and verification to flexure measurement of consumer-electronic subassemblies during vibration testing.

While specialized industrial digital cameras can acquire the image data, they still have to pipe them to a host computer where the image data can be integrated with measurements obtained through more traditional data-acquisition means. There are numerous ways to connect cameras and computers, but currently only two video-acquisition standards are fast enough and have a large enough industrial installed base to qualify as top contenders: Camera Link and Gigabit Ethernet (**Figure 1**).

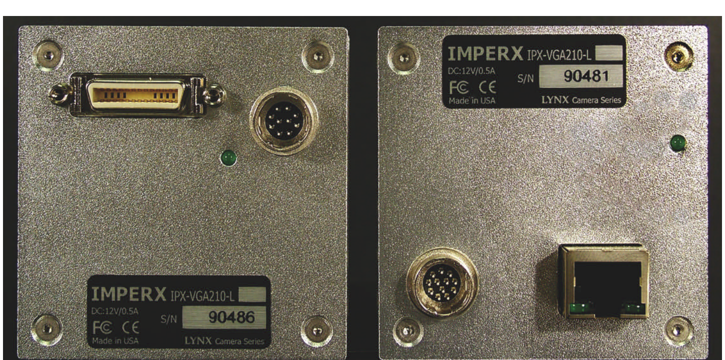

FIGURE 1. Camera Link cameras (left) use one or two D-shell connectors to transmit digital video information, while Gigabit Ethernet cameras (right) use a standard Gigabit Ethernet connector.

Camera Link

The Automated Imaging Association (AIA), a consortium of more than 200 camera and frame-grabber vendors, developed Camera Link to provide a standard interconnection between digital cameras and frame grabbers. Prior to Camera Link's introduction in 2000, a number of non-standard parallel interfaces employed either low-voltage digital signaling (LVDS) or RS-422 signaling. Different connectors and pin-outs made cable production difficult and confusing, and no standard communications method for configuring cameras existed.

Figure 2 shows the hardware structure behind "base" mode Camera Link, which is based on the earlier Channel Link interface. Channel Link consists of a set of driver/receiver pairs, each sending an LVDS signal directly over a pair of conductors. Each driver accepts 28-bit single-ended data, plus a clock. The 28-bit data includes 24 bits of video data (organized as three 8-bit ports) and four strobes—FVAL (frame valid), LVAL (line valid), DVAL (data valid), and a spare—multiplexed 7:1 and serialized. The resulting four data streams plus clock transfer over five LVDS pairs. The clock rate runs from 20 to 85 MHz, to yield up to 2.04 Gbps over a 10-m (maximum) cable.

Camera Link uses Channel Link for video data, strobes, and clock. It then adds an additional LVDS receiver and driver to provide a bidirectional asynchronous communications channel; the serial line to the frame grabber is called SerTFG, while the serial line to the camera is called SerTC. Camera Link also adds four more LVDS pairs for discrete general-purpose camera-control signals. These signals are often used for external triggering or dynamic exposure control.

The standard provides three signaling modes with progressively greater bandwidth: base, medium and full (**Table 1**). Base mode provides four video data lines, as shown in Figure 2. Medium mode adds a second Channel Link to double the number of digital data bits to 48, giving a bandwidth of 4.08 Gbps. Full mode adds a third Channel Link, upping the number of data bits to 64 and the bandwidth to 5.44 Gbps. Base mode uses a single 26-pin D-shell connector. The medium and full modes require two connectors to provide the additional conductor paths.

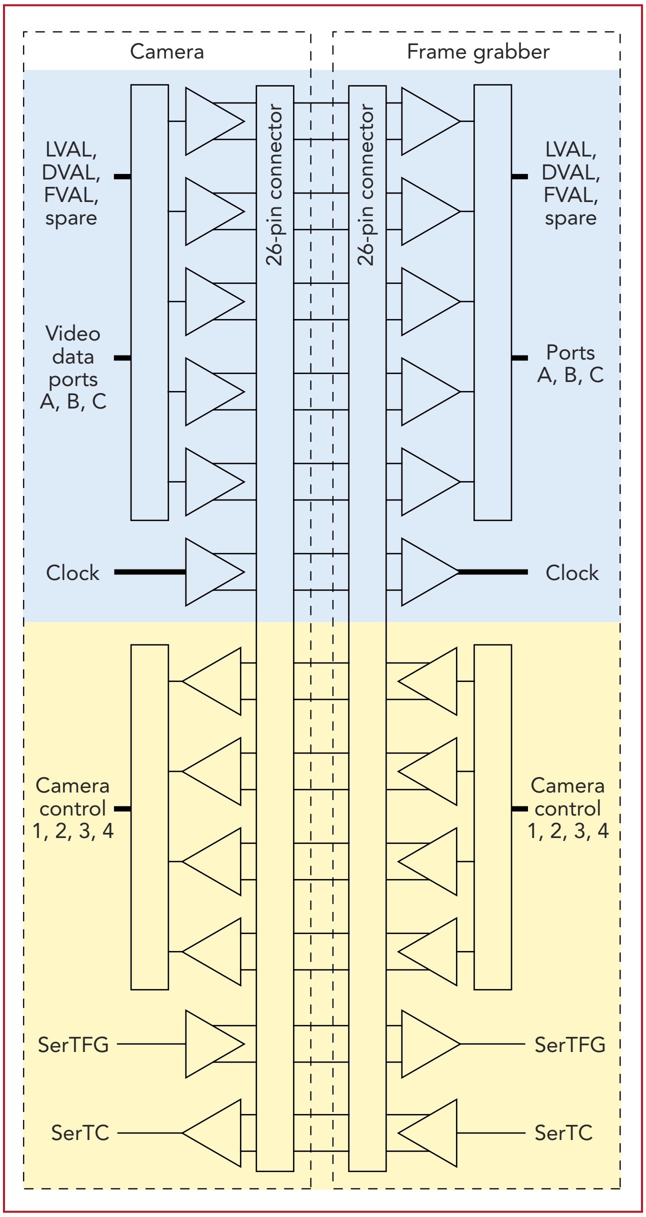

FIGURE 2. The Camera Link architecture is based on Channel Link (top, highlighted in blue), which consists of a set of driver/receiver pairs, each sending an LVDS signal directly over a pair of conductors. Camera Link (yellow) includes an additional LVDS receiver and driver, and it also adds four more LVDS pairs for discrete general-purpose camera control signals.

Gigabit Ethernet

Gigabit Ethernet is a generic name for an Ethernet system capable of transporting digital signals in full-duplex mode at 1 Gbps over a maximum cable length of 100 m. Various flavors of Gigabit Ethernet carry signals over various types of links, such as copper, fiber optics, and microwave. **Figure 3** shows the most common, 1000Base-T (Ref. 1), which uses five-level (quinary) pulse amplitude modulation (PAM5) to transmit full-duplex 1-Gbps signals over a category 5 cable containing four shielded twisted pairs of conductors (Ref. 2).

In Gigabit Ethernet, the sending computer breaks its information into discrete packets, which it sends individually over the link. Each packet includes headers and footers carrying protocol information, such as sending and receiving IP addresses. This leads to an encapsulation penalty.

How large the encapsulation penalty becomes in a video-transmission application depends on the camera setup, over which the user has some control. The tradeoff is that smaller packets lead to less latency but larger encapsulation penalties (and therefore less efficient use of the bandwidth), while larger packets result in a lower encapsulation penalty but contribute to greater transmission latency. Latency is an integral issue with all Ethernet schemes. Whether this interferes with conducting the test depends on the test's goals and how the test program is set up.

Because Ethernet is a computer-to-computer communication standard, it requires "intelligent" devices capable of protocol processing. The appearance of so-called "smart cameras" that feature built-in microprocessors, and their ready acceptance as the favored choice for incorporating video into test applications, has made Gigabit Ethernet a viable choice.

Choosing your poison

Both Gigabit Ethernet and Camera Link are capable of carrying digital video signals from high-performance industrial cameras to data-acquisition host computers. Which will do the better job in a given situation depends on the application's characteristics.

Gigabit Ethernet has shown itself to be a stellar performer in applications requiring long link lengths and simple cabling schemes and where triggered timing and latency are not an issue. For example, this standard is the overwhelming favorite for video surveillance applications.

Gigabit Ethernet is ideal for many applications in which a cable length of

10 m is simply inadequate, such as in control systems for large commercial aircraft, radar systems, or high-energy physics experiments. These physically spread-out applications can benefit from the use of video to verify whether, for example, an aircraft control surface has moved the correct amount.

Table 1. Comparison of Camera Link mode specifications

MODE	8-BIT PORTS	VIDEO DATA BITS	CONNECTORS	BANDWIDTH (Gbps)
Base	A, B, C	24	1	2.04
Medium	A, B, C, D, E, F	48	2	4.08
Full	A, B, C, D, E, F, G, H	64	2	5.44

Additionally, Ethernet's easy cabling solution might be an advantage to engineers setting up a production facility with multiple pick-and-place robots or several bare-board and solder-inspection stations. All that is needed to hook up a Gigabit Ethernet link is to plug in the ends of a standard cable of the right length. Keep in mind, though, that most computer Ethernet ports are not Gigabit Ethernet ports (see "When does Ethernet mean 'Gigabit Ethernet'?").

The fact that Gigabit Ethernet is used in a wide range of applications, reaching far beyond just those requiring the sharing of video signals, offers its own advantages: reduced cost and increased availability of technical assistance. Wider acceptance leads to larger manufacturing volumes, greater economies of production scale, and reduced costs for components such as cables and connectors. Wider acceptance also leads to larger user communities and greater availability of experts in the set up and use of the systems.

Despite its short cable length, Camera Link does offer advantages of its own. For example, Camera Link includes separate out-of-band signaling pathways for camera-control signals, making it possible to

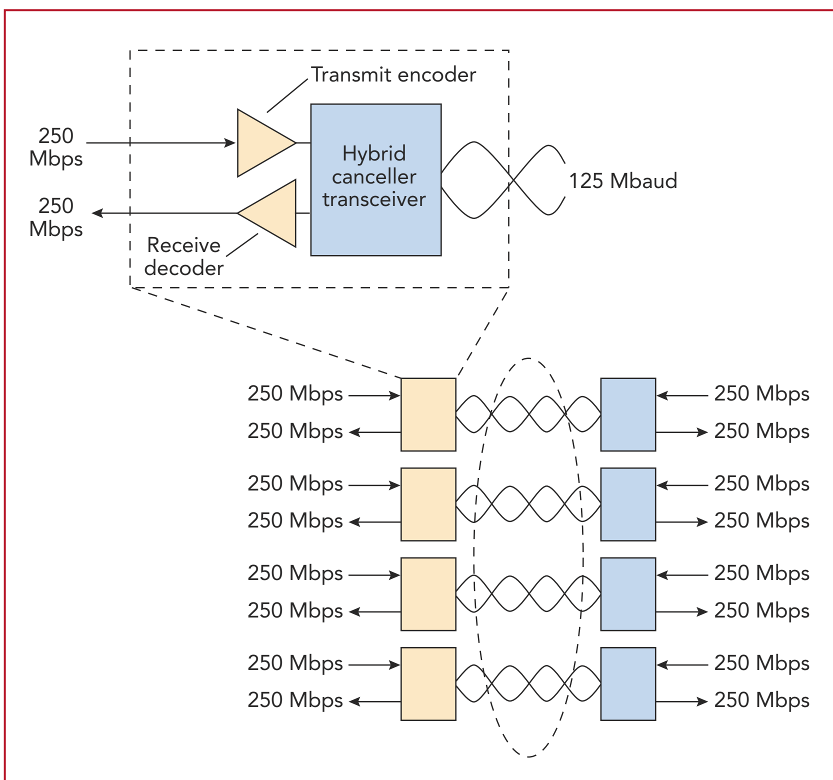

Figure 3. Gigabit Ethernet employs PAM5 encoding to provide 1-Gbps full-duplex transmission over a four-twisted-pair category 5 cable. Adapted from Ref. 1.

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modify camera settings on the fly without interfering with video transmission. Camera Link also provides separate paths for control signals, such as triggers, which are critically important for many data-acquisition and test applications. Camera Link also avoids latency by separating control and video signal paths, providing the full bandwidth to the video payload without any protocol overhead or encapsulation penalty.

Being specifically a video-transport standard, Camera Link provides all of the protocols needed to move a signal from the image sensor to the computer memory. Ethernet, being a general data-communications standard, does not have a formal description of how to format video signals. While such a video standard (called GigE Vision) is in committee, it has not yet been completed or ratified. In the meantime, it is up to the equipment manufacturer to specify video data formatting. Since Camera Link already has such a description, you can be confident that every Camera Link camera will work with every Camera Link frame grabber.

While requiring the use of a frame grabber increases installation complexity and expense, the Camera Link frame grabber provides resources that can help reduce the host computer's processor workload. Frame grabbers generally have an onboard buffering capability to ease computer-bus traffic congestion. High-end frame grabbers also can apply some simple hardware-based image-processing

When does Ethernet mean "Gigabit Ethernet"?

Gigabit Ethernet builds on top of the Ethernet protocol, but it increases speed tenfold over Fast Ethernet to 1000 Mbps, or 1 Gbps. This protocol, which was standardized in June 1998, promises to be a dominant player in high-speed local-area network backbones and server connectivity. Since Gigabit Ethernet significantly leverages on Ethernet, customers will be able to leverage their existing knowledge base to manage and maintain gigabit networks.

Until Gigabit Ethernet achieves dominance, however, users will have to pay close attention to the capabilities of the equipment they use. If you are using Ethernet to carry video signals across an existing network, you need to verify that every component in the path is ready and able to carry the faster signals. Most existing Ethernet equipment only conforms to the 100-Mbps version. Only installations made since 1998 and specifically intended to carry gigabit-rate signals will perform adequately.

John Egri

algorithms, such as thresholding and filtering, to further reduce the load on the host computer.

With its full-mode bandwidth of 5.44 Gbps, Camera Link provides up to a factor of 5 greater bandwidth than the 1-Gbps speed of Gigabit Ethernet. So, for high-speed, high-resolution applications, Camera Link is generally the better choice.

Most inspection and test applications are much smaller than commercial aircraft and thus do not require the long cable lengths that are available with Gigabit Ethernet. For example, a wave-solder inspection system is easily served by Camera Link's 10-m cables. In fact, the network latency of Ethernet could be a critical problem for an inspection system checking for defects on bare boards moving down a high-speed conveyor. A trigger signal delayed by Ethernet latency would make reliable inspection impossible. While installing separate trigger lines to coordinate video acquisition with data acquisition may be a viable solution, it often defeats the whole point of using a networking standard.

Frame-grabber suppliers have been manufacturing LVDS frame grabbers, which evolved into Camera Link frame grabbers, for more than 20 years. These companies produce market-tested software development kits (SDKs) and imaging libraries that provide image-analysis algorithms used in many machine-vision and inspection applications. Gigabit Ethernet, being a new technology, lacks these extensive imaging libraries. Gigabit Ethernet camera vendors are currently developing these software tools and soon many of the Camera Link frame-grabber vendors will also be offering imaging SDKs based on Gigabit Ethernet platforms.

The choice of whether to use Gigabit Ethernet or Camera Link in a particular test application is up to the system integrator. In most cases, one or more application characteristics will mandate one or the other standard. In other applications, there will be no clear winner—either will do a good job. At that point, it's a matter of personal preference. T&MW

REFERENCES

1. *Internetworking Technologies Handbook*, 4th edition, Cisco Systems, 2004. www.ciscopress.com.

2. Schroeder, George, "What PAM5 means to you," *Test & Measurement World*, April 2003, www.tmworld.com/archives.

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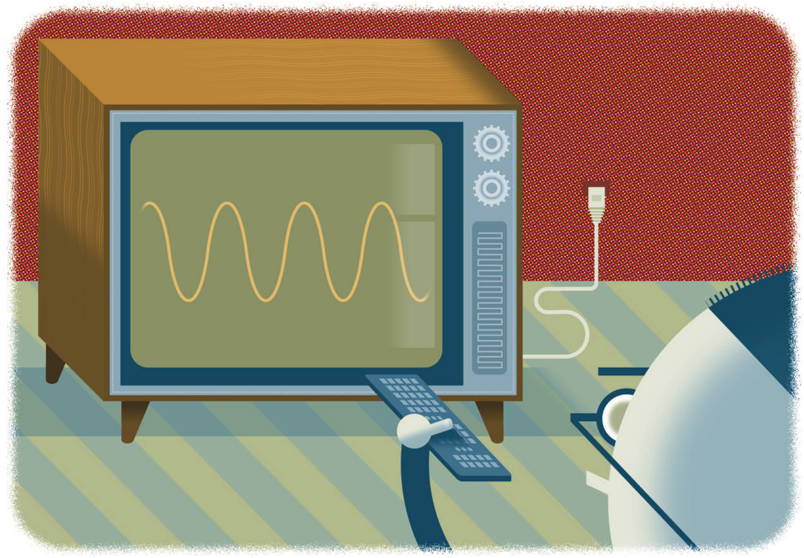

IPTV: VIDEO'S LATEST TEST FRONTIER

MARTIN ROWE, SENIOR TECHNICAL EDITOR

Ensuring a satisfying TV experience for consumers requires thorough testing of both the Ethernet network and the video transport streams.

Not long ago, Ethernet networks and Internet Protocol (IP) needed to deliver only packets of data that contained computer files or Web pages from a server to a client. Today, IP is delivering telephone service to millions of homes, and deployment of Internet Protocol TV (IPTV) has begun. Case in point: On March 7, 2006, the City of Anaheim became the first city in California to grant AT&T permission to install an IPTV network (Ref. 1).

Just because IPTV will be available in Anaheim and other cities doesn't mean it will succeed. Delivering quality TV over IP networks is far more difficult than delivering data or even voice. And as the Multimedia Research Group points out, people who spend thousands of dollars on high-definition home-theater systems will not tolerate poor video quality. Consumers will replace their cable and satellite systems only if they believe that IPTV can provide as good or better quality, and they will switch back if IPTV fails to live up to expectations (Ref. 2).

Testing both the IP networks and the MPEG video transport streams of IPTV is crucial to delivering the quality images that consumers demand. Unfortunately, the industry has yet to standardize on a measurement methodology for video transmissions.

What's the problem?

While IP packets can carry MPEG packets over a network, there is no guarantee that the packets will arrive at their destination in a steady stream. When transferring data, IP networks send data in packets, and the network has the luxury of resending a lost packet. As long as all packets arrive intact, the receiving computer can reassemble the original file—the user never knows that a packet was resent. Transmissions get slightly muddier with voice because packets must arrive in the proper order, but users can still tolerate some lost packets. "You can have a 20-ms gap in audio without much noticeable loss," said Kaynam Hedayet, CTO of Brix Networks

The human eye, however, is more sensitive to gaps than the ear, and lost video packets have a greater impact on picture quality and viewer enjoyment. In IPTV, IP packets encapsulate segments of MPEG-encoded video frames. MPEG streams contain three types of frames: I-frames, P-frames, and B-frames. "A Guide to MPEG Fundamentals and Protocol Analysis (including DVB and ATSC)" explains the frames in detail (Ref. 3). For a quick overview, see "MPEG Background," (Ref. 4)

An I-frame, or intra-coded picture reference frame, sends information about every pixel in the frame. To reduce bandwidth, MPEG uses forward and reverse referencing to generate the forward-predicted P-frames and bidirectional-predicted B-frames from I-frames. That is, the P-frames and B-frames contain information about only those pixels that differ from previous or subsequent frames.

In TV scenes with a relatively static background, such as when two people are standing in a room and talking, the P-frames and B-frames change very little from one to the next. In a more dynamic scene, such as a horse race, nearly every pixel changes in every frame.

If a transmission lacked I-frames, it would quickly become garbled, because the MPEG decoder would never receive a reference frame to restore the picture. Likewise, if a viewer turned on a channel in mid-program, the lack of a complete reference frame would leave the picture undecipherable until one arrived from the service provider. That's where the I-frames are essential. An I-frame containing complete image information must be inserted every few frames (about two or three times per second) to serve as a reference for the P-frames and B-frames.

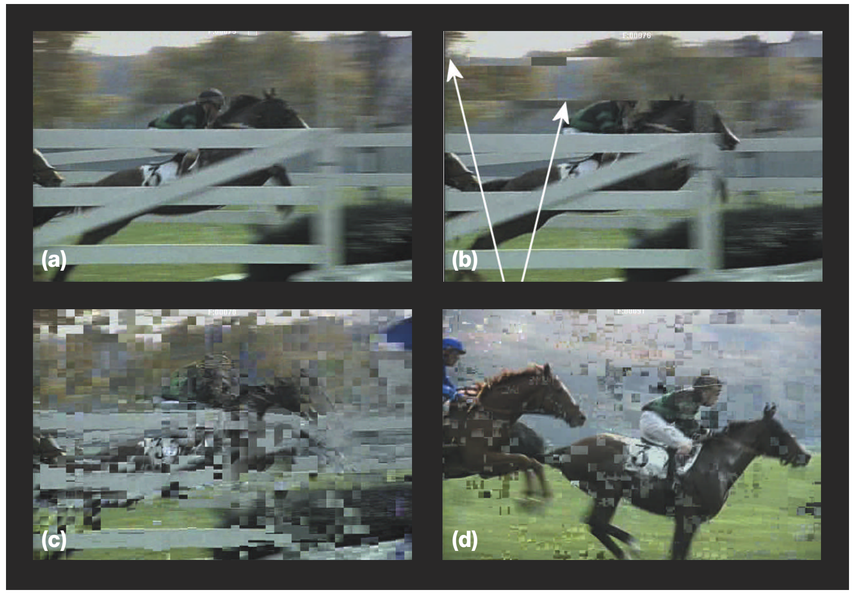

FIGURE 1. Lost video information from a bad I-frame produces poor quality video in three of the four frames. A bad I-frame can result from lost packets. (a) A good video frame without errors. (b) This figure has five bad MPEG slices that result from the B-frame forward-referencing a bad I-frame. (c) Here, forward-referencing a bad I-frame results in poor motion-vector placement. (d) This poor image results from reverse-referencing a bad I-frame. To view the entire video, see the online version of this article at www.tmworld.com/2006_05. Courtesy of Tektronix.

If an IP packet containing part of an I-frame is lost, the MPEG decoder in the receiver (TV set or set-top box) loses crucial information that affects preceding and following frames. "A set-top box may crash if it misses an I-frame" noted Paul Robinson, MPEG segment manager at Tektronix. So, a network must deliver nearly lossless IPTV streams. **Figure 1** shows the results of lost video information. (To see this scene in video format, you can download a video of these images from the online version of this article, www.tmworld.com/2006_05.)

Congestion often causes packet loss. Each IPTV program requires its own video stream. If two or more TVs or computers share an access network, such as a fiber passive optical network (PON), or an electrical access network, such as DSL,

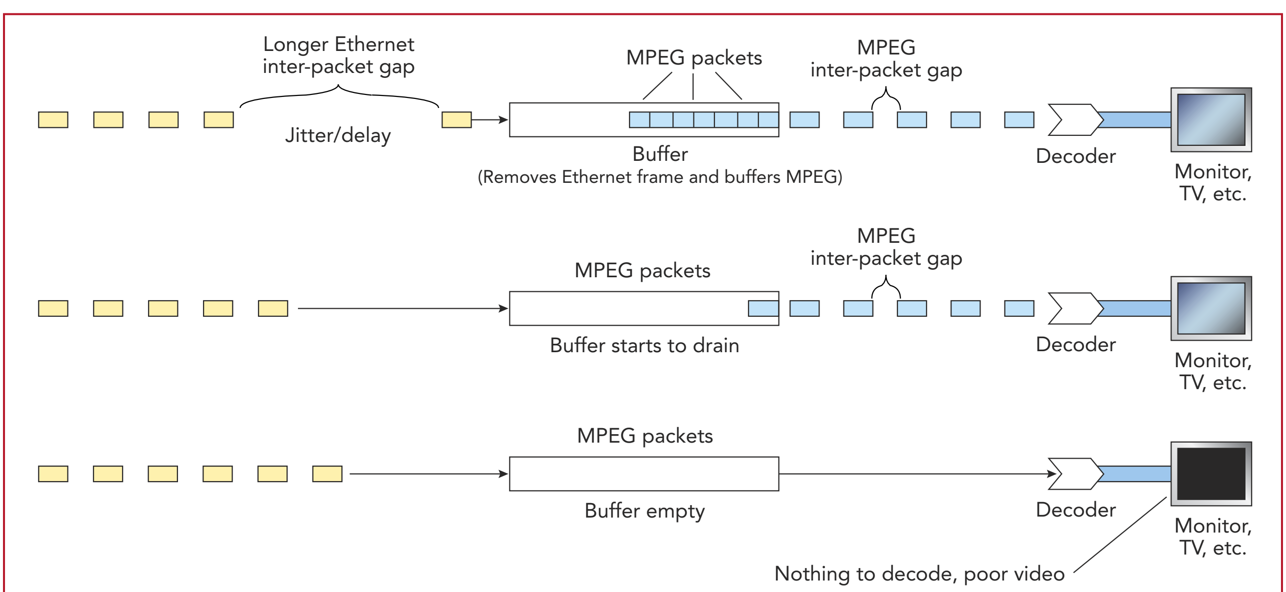

FIGURE 2. Jitter and long delays in delivery of Ethernet (IP) packets can cause an MPEG buffer to empty, resulting in picture loss. Courtesy of IneoQuest.

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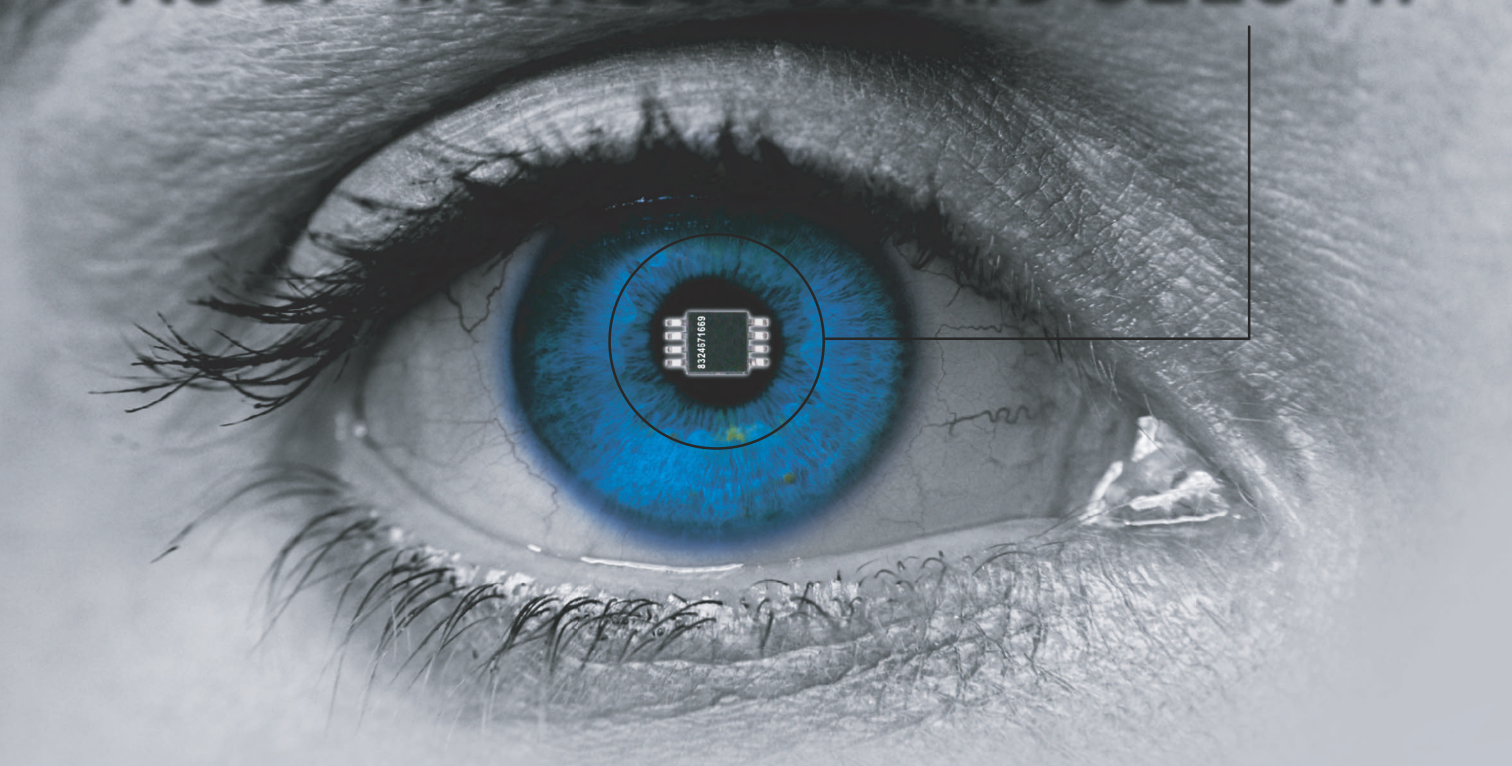

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1000 North Post Oak Road, Suite 225, Houston, Texas USA 77055 1.713.688.4600 www.bpmicro.com then multiple video streams could overload buffers in a network server or cause the access network to drop packets if the load exceeds the link's bandwidth. The problem worsens if that access network must also carry voice and data at the same time it carries video. In fact, data can cause more of a problem than voice, because voice uses a steady stream of bandwidth but data usually occurs in bursts.

Other network problems such as packet jitter and delay can reveal the health of a network. Packet jitter refers to difference in arrival times from one packet to another. "Jitter doesn't necessarily affect video quality," said Marc Todd, CEO of IneoQuest, "but jitter is a good indicator of potential packet loss." Buffers in network components, particularly in set-top boxes, store incoming packets and usually deliver them smoothly. Cumulative packet jitter across an IP network can result in packet loss if a buffer overfills. A gap in delivery that's too long can cause a buffer to empty, resulting in no program delivery. **Figure 2** shows the results of lost or delayed IP packets on an MPEG video stream.

The larger the buffer, the less likely it will overflow and cause packet loss, but there's a tradeoff. Each TV channel requires a unique MPEG stream. When you switch channels, your TV or set-top box must request the new channel from a server. If you have several TVs all on the same channel, they will share the same stream. But different channels require different streams, which taxes your access network.

Another problem occurs when you change channels. "When you switch channels, the decoder must clear the buffer," said Ofir Michael, director of product management for VoIP and IPTV at Radcom. "In addition, the server must check that the subscriber should get a requested channel." IP packets from the new channel must flow into the buffer and an MPEG decoder must wait for an I-frame from the new channel before it can strip the MPEG video stream from the IP packets and decode the MPEG stream.

Some members of the industry claim that the problem has been solved. "Channel change time isn't an issue," said Patrick Pfeffer, chief network architect at Detecon, during a press conference on the status of IPTV at this year's OFC/NFOEC conference in Anaheim. "Picture quality is better than analog."

Testing the network

Using most protocol analyzers, you can measure the packet jitter and loss in IP networks. The measurements will tell you if the IP network is healthy, but they provide no indication of the final product—video quality. To measure video quality, you need to test the MPEG transport stream as well. An MPEG protocol analyzer can provide a detailed look at a video stream's headers and payloads. "How do you test MPEG-2 transport streams?" describes how MPEG testers analyze the 188-byte packets that carry encoded video and audio (Ref. 5).

An audio/video server converts analog audio and video into an MPEG stream encapsulated into IP packets, ready for transport over Ethernet. Courtesy of Visionary Solutions.

The final leg in testing IPTV comes in testing the video quality. Some test companies offer video quality test equipment, but the industry has yet to settle on a standard measurement scale. Several makers of IPTV test equipment use a mean opinion score (MOS) algorithm to measure video quality. MOS is based on human perceptions of video quality, using a scale from 0 to 5. MOS is an subjective test based on people's opinions of video quality. ITU-T Recommendation P.800 defines the procedure for conducting MOS evaluations (Ref. 6). Some companies have developed their own algorithms to produce a consistent method of scoring perceived video quality. But ultimately, the consumer decides.

Brix networks, for example, uses the Brix Video Quality Index. The company's tester measures IP network parameters such as jitter and packet loss, but it also analyzes MPEG transport streams carried in IP packets. The Brix tester doesn't decode the MPEG streams of live video because of copyright issues, noted CTO Hedayet. It can, however, inject its own video streams into the network and compare decoded video against the original.

IneoQuest calls its measure Media Deliver Index (MDI). As the name implies, MDI looks at how well a network delivers MPEG video over an IP network. It measures delay factor and media loss rate. Delay factor is a computed arrival time of each packet. Media loss rate measures the difference between packets received and expected per second. IneoQuest also measures video-stream characteristics such as flow rate in megabits per second.

Video-quality measures attempt to eliminate human subjectivity and provide consistent test results. The industry will eventually need to standardize on one video-quality measure. Regardless of that measure, the success of IPTV depends on the viewing public's perception and its tolerance for errors and delays. T&MW

REFERENCES

1. Tully, Sarah, and Tamara Chuang, "Anaheim allows AT&T to install Internet TV," *Orange County Register*, March 8, 2006. p. 1. www.ocregister.com.

2. Larribeau, Bob, "IP TV Home Networking Strategies," Multimedia Research Group, Sunnyvale, CA, 2006. www.mrgco.com/TOC_IPTV_HN06.html.

3. "A Guide to MPEG Fundamentals and Protocol Analysis (including DVB and ATSC)," Tektronix, Beaverton, OR, 2002. www.tek.com/Measurement/applications/video/mpeg2.html.

4. "MPEG Background," Berkeley Multimedia Research Center, Berkeley, CA. bmrc.berkeley.edu/frame/research/mpeg/mpeg_overview.html

5. Rowe, Martin, "How do you test MPEG-2 transport streams?" *Test & Measurement World*, January 1997. p. 20. www.reed-electronics.com/tmworld/article/CA187542.html.

6. ITU-T P.800, *Methods for subjective determination of transmission quality*. International Telecommunications Union, Telecommunications Sector, Geneva, Switzerland. www.itu.int/ITU-T/.

ADDITIONAL IPTV RESOURCES

Application note: "Testing and Qualifying IPTV Networks for Streaming Media Applications," IneoQuest, Mansfield, MA, 2005. (Other papers also available.) www.ineoquest.com/page240.html.

Application Note: "Troubleshooting Both Network IP and MPEG for Video on Demand," Tektronix, Beaverton, OR, 2003. Links to this and other papers are at www.tek.com/Measurement/applications/video/mpeg2.html

White paper: "The Telco Triple-Play: Scoring a Successful Deployment with Comprehensive Lab Testing and Service Management." Spirent Communications, Calabasas, CA, May 2005. www.spirentcom.com/documents/3771.pdf.

White paper: "Video Quality Measurement Algorithms: Scaling IP Video Services for the Real World," Brix Networks, Chelmsford, MA, 2006. (Other papers also available.) www.brixnet.com/library/library_register.aspx.

PRODUCTUPDATE

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Mix and match modules in USB data-acquisition system

National Instruments' NI cDAQ-9172 lets you configure a USB data-acquisition system using up to eight signal-conditioning modules from its NI 9200 series. The modules cover a wide range of inputs such as voltage, thermocouple, and digital signals. Analog modules contain their own analog-to-digital converters, and the mainframe is small enough for bench or field measurements. The modules also work in NI's CompactRIO systems.

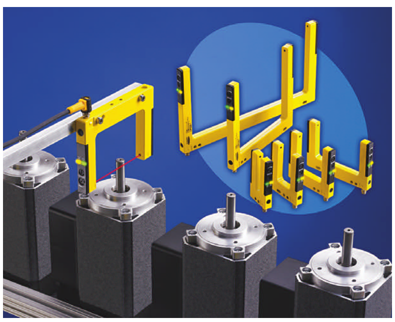
NI's C series modules let you build a custom system. They range from a $12, eight-channel DIO module to a $235, four-channel, 50-ksample/s digitizer for audio and vibration measurements. Modules are hot-swappable so you can reconfigure a system without powering down.

Software support includes NI-DAQmx, a driver that provides a datalogging application. Programming interfaces include LabView, Visual Studio .NET, and C/C++.

Price: mainframe—$999. *National Instruments, www.ni.com/compactdaq*.

Fixed-distance slot sensors available in six widths

The SLM series metal slot sensors sense objects that pass between their fixed-distance opposed-mode emitter and receiver. Available in six slot widths, all models have a rugged metal housing and a response time of 500 µs, making them suitable for high-speed counting, edge detecting, position verifying, and level-monitoring applications. The fixed slot width provides opposed-mode sensing of objects as small as 0.30 mm. Available models offer slot widths of 10, 30, 50, 80, 120, and 220 mm. Each model includes single-turn potentiometer sensitivity adjustment and generates a visible red beam; molded-in beam guides simplify beam placement.



Base price: $119 to $139. *Banner Engineering, www.bannerengineering.com*.

Service monitor features color display

Aeroflex has announced that it is advancing its portfolio of 2945 Series communications service monitors by introducing the 2944B analog radio test set. The successor to the 2944, the 2944B is an entry-level test set with added functionality and features that enhance its capability to carry out professional, cost-effective analog radio testing and maintenance.

The 2944B comes equipped with the tools and capabilities to perform installation, test, or fault diagnosis. Weighing in at 25 lbs, the 2944B incorporates a full-span spectrum analyzer and color transflective screen, making it viewable in sunlight. It also features a tracking generator with full offset tracking, supports all general AM/FM radio systems, and has a typical autotune speed of less than 3 s. A "live" look-and-listen capability and an internal battery are optional.

Base price: $12,995. options—$260 to $1500. *Aeroflex, www.aeroflex.com*.

ScanFlex available for in-circuit testers

SFX-TAP(x)/FXT transceivers, members of the vendor's ScanFlex boundary-scan platform, are designed to be integrated into in-circuit testers and optionally offer two, four, six, or eight parallel, independent TAPs. In contrast to previously available ScanFlex TAP transceivers, the new models' TAP interface cards (TIC) are differentially coupled over cables as long as 2 m and operate at frequencies to 80 MHz. Relays provide galvanic isolation from the UUT. Each TAP features programmable delay compensation combined with stepwise-programmable (250-Hz/1-MHz) TCK frequencies.

Resources such as 32 voltage-programmable dynamic I/O lines, two analog I/O channels, three digital I/O lines, and trigger lines come standard. The new transceivers communicate with ScanFlex controllers via PCI, PXI, USB, FireWire, or LAN. They work with the

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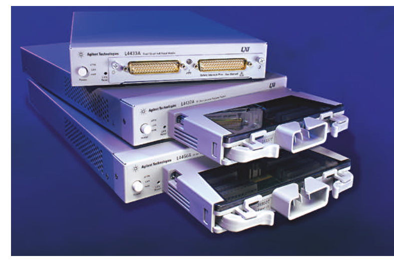
vendor's System Cascon software and are compliant with standards such as IEEE 1149.1, IEEE 1149.4, IEEE 1149.6, IEEE 1532, and JESD71. The software automatically recognizes the transceiver by an autodetect feature.

Base price: $1500. *Goepel electronic, www.goepel.com.*

A half rack of switch modules, please

Agilent Technologies has shrunk switching to a new level with the L4400 series of Class C LXI switch modules. The series consists of seven models that include switches, analog input and output, and relay drivers. These 1U high modules have a half-rack width.

Each module can operate independently through an Ethernet port or optional IEEE 488 port. You can use a module to add channels to a DMM or other instrument. The L4445A microwave switch/attenuator, combined with up to eight 34945EXT modules, lets you control a drawer of microwave switches. Under Ethernet control, the module



can stay close to your device under test. All modules are SCPI-code compatible with the Agilent 34980A switch/measure unit.

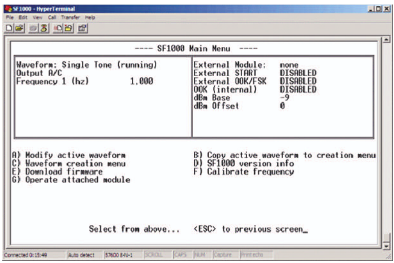
To connect your signals to the modules, you can design your own cables or use Agilent's 34952T connector module that mounts to the front of the L4400 series. You get terminal strips for easy connections.

Prices: $1400 to $3000. *Agilent Technologies, www.agilent.com/find/L4400.*

Portable signal generator offers multiple options

The Signal Forge 1000 offers a frequency range of 1 Hz to 1 GHz, multiple output types, and a variety of waveform modulation options that enable it to serve as a signal source, a function generator, and an arbitrary waveform generator. The 8.5x5.4x1.5-in., 1.75-lb instrument can fit in a briefcase, making it suitable for use with field engineers and service personnel. Setup and control is accomplished using the Wave Manager software installed onboard the SF1000. Standard serial communication software is used to access and display the Wave Manager on a PC.

Signal outputs include an AC-coupled output for RF and wireless device testing, a digital (TTL) output for testing clock-driven systems and ICs up to 110 MHz, and a differential output for testing communica-



tion equipment as well as differential clock-driven systems up to 1 GHz. The waveform-modulation functions range from square and sinusoidal functions to fully programmable frequency sweep control.

Price: $985. *Signal Forge, www.signalforge.com*.

Audio analyzer teams with programming applications

Users of National Instruments' LabView and TestStand software can leverage the measurement power of the dScope III audio analyzer from Prism Sound to develop applications that integrate audio test with other generic test equipment or data-acquisition systems. You can build sophisticated solutions for testing devices such as cell phones, CD/DVD/MP3 players, car radios, HDTV, and professional audio equipment.

All dScope III functions—including multitone testing—are available to LabView and TestStand through ActiveX controls. Visual Basic scripts can be created within the dScope software that perform a combination of audio test steps for use in LabView. These scripts can also be added as a single test step within TestStand through the use of the ActiveX adapter, which comes with the TestStand software package.

Prism Sound, www.prismsound.com.

Probe holder remains stable despite high or low temperatures

Micromanipulator offers its Model 79-8000-HCT-03 triaxial ceramic probe holder, which provides stable and uniform electrical contact over a long test time at high or low temperatures. Common semiconductor tests that use hot or cold temperatures include electromigration, metal stress, copper interconnect, oxide reliability/breakdown, hot carrier injection, mobile ion, negative bias temperature, and instability.

The ceramic probe holder is compatible with standard 7 series probe tips and is intended for use with Micromanipulator 4000, 8000, and 9000 series probe stations.

Micromanipulator, www.micromanipulator.com.

1-kVA power source works with electrical safety analyzers

A companion power source to the Omnia series of electrical safety compliance analyzers from Associated Research, the AC1000 is used in line leakage testing applications that require an isolation transformer that is adjustable to 110% of line voltages. It can also be used to simulate various utility power configurations for product application testing.

Omnia and the 1-kVA power source operate in master/slave con-

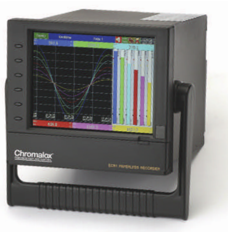
figuration by means of a PLC interface, which allows the Omnia to control various voltage and frequency setups stored in the AC1000's memory. The power source offers programmable software current limits to keep the output current from exceeding safe levels and a programmable over-current fold-back feature to maintain constant output current with a varying load.

Associated Research, www.asresearch.com.

Chart recorder monitors up to 18 process sensors

The Chromalox ECR1 electronic chart recorder allows precise trending and recording for any type of process. This paperless unit records and stores data from up to 18 process sensors, with multiple combinations of digital inputs and outputs for triggering events or alarms on the plant floor or in remote locations.

You can configure the ECR1 through a series of six slots in the rear of the recorder. Each slot accepts one card containing three sensor inputs, six digital inputs, or six digital outputs. With all six slots filled with sensor input cards, the ECR1 captures 18 process variables/s. Digital output cards contain six relays, each rated at 3 A.



The ECR1 records process-critical data on standard 16-Mbyte flash cards, while Ethernet network connectivity allows downloading data directly to a PC. Both portable benchtop and panel-mount configurations of the ECR1 are available.

Chromalox, www.chromalox.com.

Temperature loggers record data on eight channels

Operating without the need for a dedicated PC or laptop, the USB-5201 and USB-5203 eight-channel temperature loggers from Measurement Computing offer live temperature monitoring, as well as the ability to record data to removable CompactFlash cards.

The USB-5203 logs data from thermocouples, RTDs, thermistors, and semiconductor temperature sensors, while the USB-5201 logs data from thermocouples only. Both devices let you set temperature alarms for controlling eight digital output lines. The 64-Mbyte CompactFlash card that comes with each unit stores over 2 million time-stamped temperature values from a single channel. CompactFlash cards with up to 2 Gbytes of storage capacity are optional.

You can retrieve data from the USB-5201 and USB-5203 by connecting it to a computer using the supplied USB cable or by placing the removable flash card into any standard CompactFlash card reader.

Measurement Computing, www.measurementcomputing.com.

8-bit PCI digitizer acquires 250 Msamples/s

AlazarTech's ATS860 waveform digitizer uses a pair of 8-bit, 250-Msample/s ADCs to digitize input signals on two channels simultaneously. The board, which occupies a single half-length PCI slot, provides up to 256 Mbytes of acquisition memory. This onboard acquisition memory can optionally be converted to dual-port memory for applications in which acquisition cannot be stopped during data transfer to PC memory.

Price: $2995 with 256 Mbytes of memory; $645 for the dual-port memory upgrade. *AlazarTech, www.alazartech.com.*

AC/DC supplies permit plug-and-play customization

Producing output power ranging from 200 W to 1200 W in a 1U footprint, Power Sources' MultiStax family of AC/DC power supplies features a plug-and-play architecture that lets you configure a custom power solution in less than 5 min. Modules are available with single and dual adjustable outputs with fully floating voltages ranging from 1.5 VDC to 58 VDC. Current ratings are available up to 50 A, while a 5-VDC bias standby voltage is standard.

MultiStax output module specifications include line regulation to within ±0.1%, load and cross regulation to within ±0.2%, ripple and noise of 1% peak-to-peak, and transient response rated at 10% for load changes of 25% to 75%.

Base price: $281 for prototype quantities. *Power Sources Unlimited, www.psui.com.*

MACHINE VISION & INSPECTION

TEST REPORT

Agilent looks at inspection trends

Steve Scheiber, Contributing Technical Editor

In late 2005, Agilent Technologies moved its board test and parametric test organizations into its Electronic Measurement Group (EMG). I recently asked Kent Dinkel and Jeff Harrell, principals with the company's automated optical inspection (AOI) and automated x-ray inspection (AXI) products, to reflect on their place in the manufacturing process.

Q: How has inspection changed in the past few years?

Dinkel: One of the biggest changes is the growth of AOI and AXI on the same process line. In process placement, AOI is more versatile. You traditionally placed it after wave or reflow solder to look for the presence or absence of components, for the correct components and correct positioning, and at visible solder joints. But boards have become increasingly complex. Hidden joints, fine-pitch gull-wing heels, through-hole connectors, and RF shielding challenge this approach.

Harrell: You can also place AOI upstream. It can verify paste volume on boards before placing components, for example. A 2-D AOI system looks at the solder position on the pad and for deposit-area and bridging faults. Three-dimensional techniques permit more thoroughly assessing solder volume, which can determine good joint formation and, ultimately, board function.

After component placement and before wave or reflow, AOI looks again at component position, polarity, and identity. Some manufacturers perform AOI after placing only some components, examining the components as well as the solder paste on pads that will later be covered by BGAs. And many still perform post-reflow inspection. People want to take advantage of the machine's flexibility, buying only one AOI system for all process locations, if possible. We offer a "unified platform." You might use it with a 3-D analysis head at one point and an illumination-based head somewhere else.

Dinkel: AXI placement is more fixed—examining solder joints post-reflow or post-wave. It is also more expensive and slower, so you have to make sure it will justify its cost. X-ray offers 2-D or 3-D imaging and either automatic or semi-automatic operation. Automatic 2-D systems work best with less-complex single-sided boards. They lose effectiveness in double-sided applications. Three-dimensional systems can separate top and bottom side joints and can identify defects where 2-D systems are blind. Some manufacturers offer semi-automatic "2.5-D," combining 2-D inspection, oblique viewing, and software algorithms to make the analysis more 3-D-like. These solutions work well in off-line applications, such as failure analysis, but they are generally not fast or automatic enough for high-volume production.

Q: Where is the balance point between post-reflow AOI and AXI?

Harrell: You still see AOI more often in board manufacturing because of its throughput and cost advantages. As visual access to joints declines, we expect that situation to change. The balance also depends on board value and customer intention. Is the goal process analysis and defect prevention where you see pre- and post-reflow AOI more often or defect detection, which favors x-ray? How important are the cost of field failure and complete fault coverage—say an enterprise-level server or router vs. a cell phone? At the low end, most people emphasize AOI. As the board value and cost of escapes increases, AXI becomes more common. □

Kent Dinkel, imaging marketing manager

Jeff Harrell, AOI product manager

Photos courtesy of Agilent Technologies.

INSIDE THIS REPORT

EDITOR'S NOTE

A product for every taste

Steve Scheiber, Technical Editor

The electronics industry has forever changed Henry Ford's product concept of "any color as long as it's black" to a level of customization that not long ago would have seemed impossible. Today's PCs, entertainment systems, automobiles, and so on form but the scaffolding that provides a common structure for flexible electronic performance. By modifying or replacing ASICs, programmable devices, firmware, and software, it is possible to configure a system to address even the narrowest applications.

This paradigm shift pushes quality operations ever further into inspection as a technique of choice. In many cases, manufacturing volumes of identical products prove insufficient to amortize the cost of developing a comprehensive functional test. Inspection, on the other hand, examines only physical characteristics that remain relatively constant. By reading onboard codes, inspection can also ensure that installed programmable devices match the specified version more easily than a test can.

Still, even if inspection can cope with variation to cull bad products from good, you must still keep track of a product's different flavors to be sure you have made enough (and not too many) of each configuration and shipped them to the right locations. These "peripheral" activities often spell the difference between a successful operation and an unprofitable one. □

Contact Steve Scheiber at sscheiber@aol.com.

HIGHLIGHTS

Market study shows positive outlook

A new market study from the Automated Imaging Association (AIA) indicates that 2005 was a good year for the machine-vision and imaging industry and that continued growth is expected for 2006. The study, entitled *Machine Vision Markets—2005 Results and Forecasts to 2010*, reports that smart cameras saw the strongest growth in 2005, with a 19.1% increase in units and a 14.4% jump in revenue. Sales of application-specific machine-vision systems rose 13.6% in units and 6.4% in revenue.

"All indications point to continued growth in 2006, as companies continue to invest in technologies such as machine vision that can help them become stronger global competitors," said Paul Kellett, AIA's director of market analysis. The study costs $1395 ($995 for AIA members). www.machinevisiononline.org.

Agilent AOI system validates component placement

Agilent Technologies has announced it has successfully completed a study with Fuji Machine Manufacturing Co. to demonstrate the ability of Agilent's Medalist SJ50 automated optical inspection (AOI) system to validate the 01005 component-placement performance of Fuji pick-and-place equipment.

"Agilent is pleased to offer our leading-edge AOI solution to help Fuji verify its 01005 pick-and-place capability," said Kent Dinkel, AOI marketing manager at Agilent. "We will continue to introduce innovative imaging solutions to help our customers overcome new challenges brought on by ever-increasing needs for accuracy and repeatability as components become smaller and smaller," shrinking from 0402 down to 0201 and now 01005 chip sizes.

"In this collaborative study with Agilent to validate the placement performance of 01005 chip components, we were pleased that the Agilent Medalist SJ50 exceeded our measurement requirements in terms of accuracy and repeatability," said Sumio Kadomatsu, GM of the SMT Equipment Division at Fuji. www.agilent.com; www.fuji.co.jp.

CALENDAR

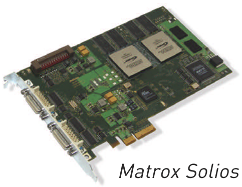
- **EMVA Business Conference**
  June 30–July 1
  Tampere, Finland
  European Machine Vision Association, www.emva.org
- **Vision 2006**
  November 7–9
  Stuttgart, Germany
  Messe Stuttgart, www.vision-messe.de

Basler launches camera lines

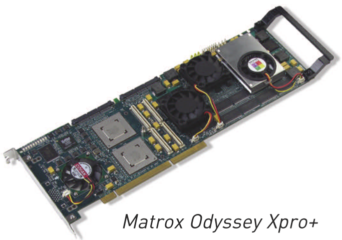
Basler Vision Components has announced two new camera families that it plans to exhibit at the Vision Show East (May 9–11, Boston, MA). The Basler Scout is based on Sony CCD sensors and is available in a variety of resolutions and speeds. The Scout also offers both Gigabit Ethernet (GigE) and FireWire-b interfaces.

The Basler Pioneer family employs a Kodak CCD sensor and provides a GigE interface. The Pioneer series also offers software features that can be integrated into the image-processing software on a remote computer.

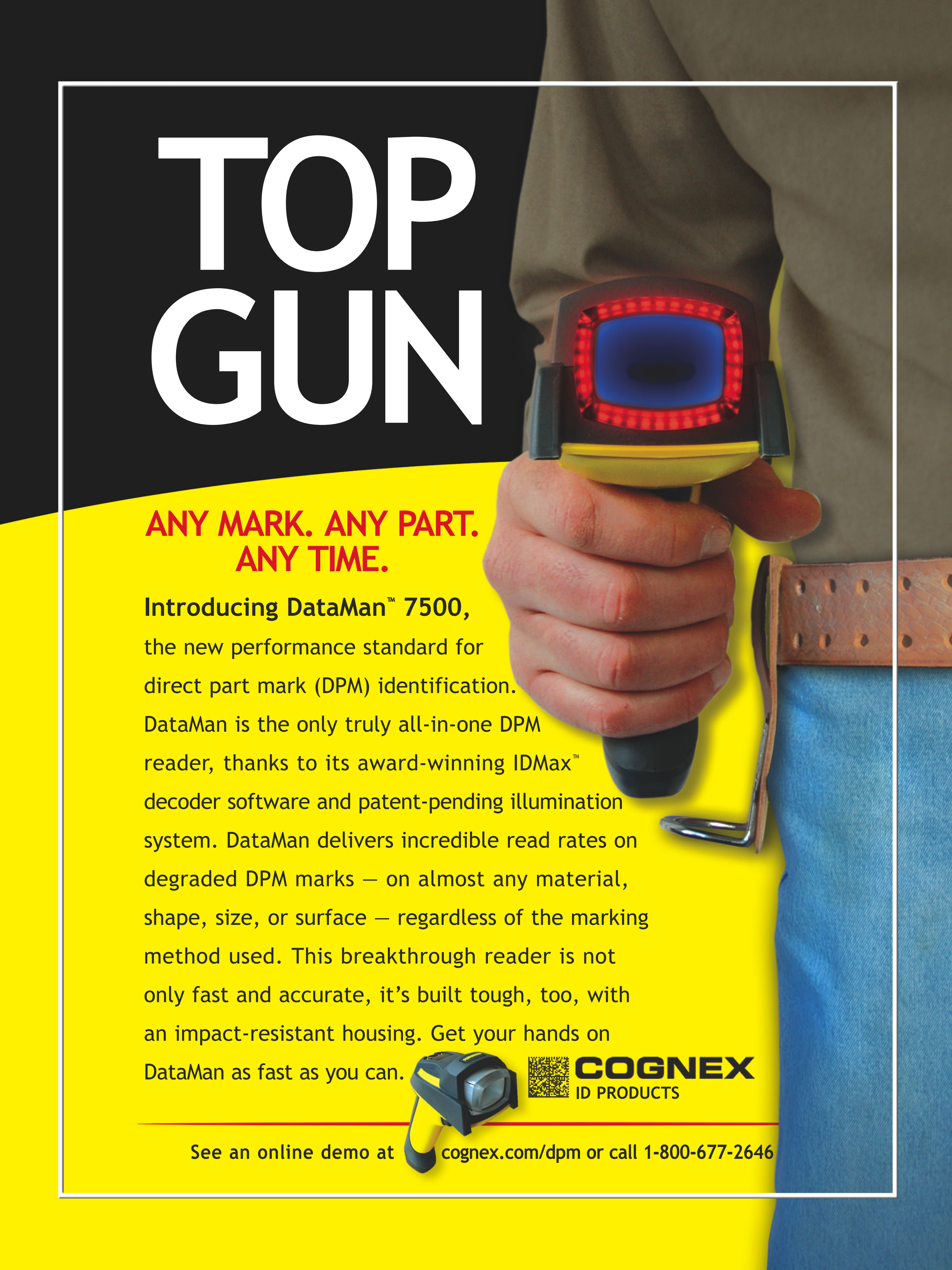
Basler says both the Scout and Pioneer families will feature a GenICam-compliant application programming interface (API) and will be compatible with all common software libraries. www.basler-vc.com.



Matrox Solios eCL



Matrox Odyssey Xpro+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Thermal imaging maps device heat dissipation

Steve Scheiber, Contributing Technical Editor

As the features in electronic devices get ever smaller, power consumption and heat generation become an increasing problem. An engineer with Dell Computer once explained to me why portable computers are now called "notebooks" rather than "laptops." "You can't put them on your lap anymore," she remarked. "They get too hot."

Semiconductor devices have undergone numerous design changes to reduce this effect. The development of dual-core microprocessors was partially driven by the need to increase the device's performance without overheating it.

At some point, it becomes necessary to assess the effect of generated heat on device quality. Merely measuring overall device temperature, however, is not enough. You have to map the heat distribution across the die surface to determine where the circuit is overheating, thereby permitting design or process modifications to minimize or eliminate the problem.

In fact, in a paper presented at the InfraMation 2005 conference, Volodymyr Malyutenko, from the Institute of Semiconductor Physics in Kiev, Ukraine, emphasized the necessity of creating such a high-resolution map of excess heat dissipation on a device's active area—which can be less than 0.1 mm^2 (Ref. 1). Malyutenko contends that the infrared cameras that manufacturers use to measure overheating of printed-circuit boards (PCBs) offer only a static low-resolution picture and cannot pinpoint physical (thermal) reasons why devices fail.

Malyutenko proposes a transition from a static map to one that shows micromapping parameters across the device's active area and changes over time. He and his colleagues developed a high-resolution multi-spectral IR (<1 μm, 3–5 μm, and 8–12 μm)

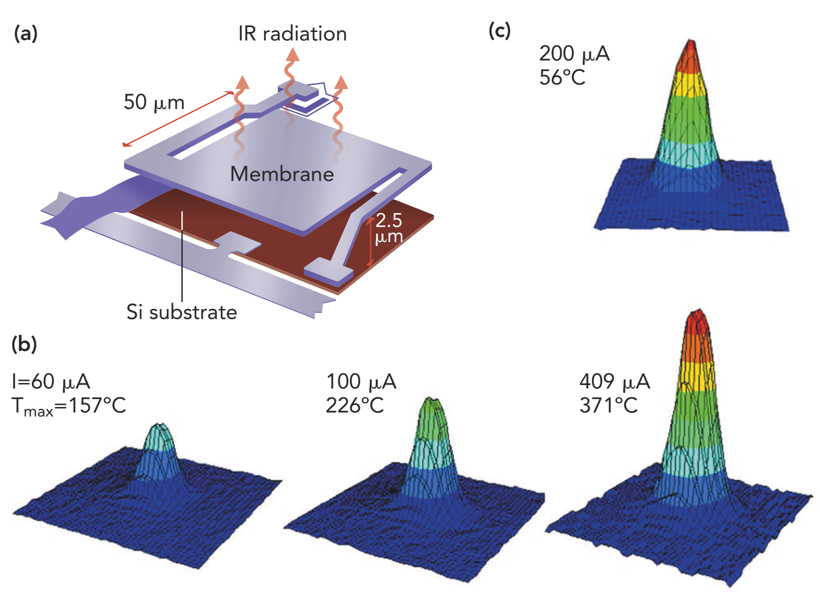

Fig. 1 **(a) This single micro-emitter produced the image in (b), captured with an 8–12-um camera at different bias currents. (c) This image depicts the profile for a device whose resonator cavity was deformed by Joule heating.**

Courtesy of Volodymyr Malyutenko, "What is Hot in IR Micro Vision," *Proceedings of InfraMation 2005.*

Thermal imaging • from page 65

"vision" facility, applying IR microscopy to IR thermal imaging. They used the apparatus to perform heat (T-approach), light (L-approach), and emissivity (ϵ-approach) tests on semiconductor devices. The researchers applied the technique to measure a variety of devices, contending that uneven light and heat distribution across the device active area are difficult to predict or avoid.

The T-approach

To create a thermal image of a semiconductor surface, you must measure the IR power (P) that the surface emits. This technique identifies hot regions on the device and graphs their patterns across the surface over time. The characteristics of these hot regions depends on thermal mass, thermal conductance, and the design of the heat sinks of the surrounding package. For example, the active-area temperature can significantly exceed the heat-sink temperature in places, which can cause lower-than-expected device efficiency as well as overheating at specific points on the device surface and can subsequently lead to device failure.

Malyutenko and his team found that for mapping the hot spots precisely and accurately, two-dimensional thermal resistor arrays on electrically heated pixels provide the most successful IR scene projectors in the 3–12-µm range. **Figure 1** shows these micro-membrane structures, which can measure object temperatures up to 500°C.

Unfortunately, the structures have many layers and tiny legs—used as a membrane's electrical contacts and mechanical supports—that present their own challenges. The sensing membrane sits 2.5 µm above the silicon surface whose temperature is being measured. The optical interference created by the resulting space permits the spectral emission band to be tuned. Thermal and mechanical stresses between layers dramatically reduce the IR power that the combination emits, making the IR "microscope" a much better tool than a conventional optical unit.

The researchers also measured thermal patterns on high-brightness LEDs. Such devices require 1-mm^2 dice and packages that can withstand high currents. LEDs that can provide 25 lumens of emitted light typically consume more than 1 W of power. Device efficiency generally remains below 50%, so more than half of that power shows up as heat that the de-

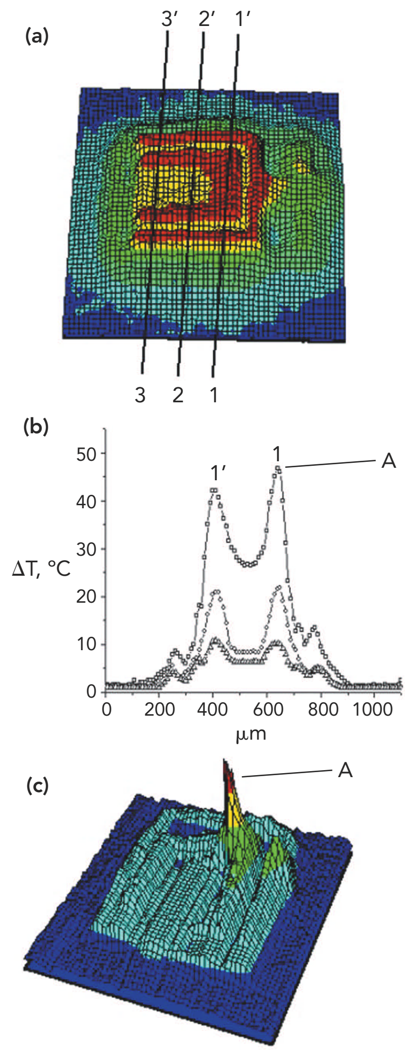

Fig. 2 **(a) This image depicts excess LED temperature captured through a sapphire substrate. (b) The profile shows two "hot spots" on the surface. (c) This image shows local overheating of a degraded device.**
Courtesy of Volodymyr Malyutenko, "What is Hot in IR Micro Vision," *Proceedings of InfraMation 2005.*

vice must dissipate somehow. Otherwise, the LED cannot live up to its reputation as a long-life alternative to other lighting elements. Again, thermal imaging provides direct and efficient depiction of heat patterns with a high degree of clarity.

Figure 2 depicts a typical heat pattern across an active device area. Figure 2a shows a pulse duration of 160 ms, a 25-Hz repetition rate, and a current of 200 mA. The temperature profile in Figure 2b—obtained by increasing the current to 800 mA and shortening pulse duration to 400 µs—clearly shows the two points of maximum temperature rise, corresponding to two symmetric "heat traps" near the crossbar of a contact fork. Although the local temperature spike at that point of more than 50°C appears reasonable, Malyutenko and his colleagues have estimated the maximum local heat density at a staggering 7000°C/cm!

Other techniques

In his paper, Malyutenko proposes two alternatives to the T-approach. The first technique involves interband luminescence (L), which appears in the fundamental absorption spectral band and expands over the 3–5-µm and the 8–12-µm spectral ranges, permitting monitoring by thermal-imaging cameras. The paper proposes a way to provoke luminescence from semiconductors through electroluminescence or photoluminescence.

A thermal-imaging camera interprets luminescence caused by excess free charge carriers (electrons) as a dynamic increase in temperature. Similarly, a charge-carrier deficiency ("holes") appears as a negative luminescence, which the camera sees as a temperature drop. The accuracy of this technique depends on keeping the actual surface temperature constant so that the charge-carrier status represents the only variable.

Another technique takes advantage of the device's emissivity (ϵ), which depends on the device's reflectivity and its transmissivity. In this case, the device emits IR power that depends on the spatial (charge-carrier diffusion length) and temporal (charge-carrier lifetime) evolution of the charge carriers. The researchers contend that this approach permits studying an electronic or optoelectronic device's properties as well as its performance.

When faced with the need to increase processing power while minimizing power consumption and heat dissipation, PCB manufacturers need a way to accurately measure the thermal properties of semiconductor devices both at localized points on the surface and as a function of time. Malyutenko and his colleagues have shown several approaches to this characterization that can predict device behavior and performance in the target products as well as indicate process changes that can minimize the thermal effects. □

Reference

1. Malyutenko, Volodymyr. "What is Hot in IR Micro Vision," *Proceedings of InfraMation 2005,* Flir Systems, www.inframation.org.

Data Matrix codes demand proper lighting

Steve Scheiber, Contributing Technical Editor

Since the government began requiring its suppliers to mark parts and assemblies with two-dimensional Data Matrix codes, the use of these codes has exploded even for products not destined for government applications. Data Matrix codes, which are imprinted on a part through direct-part marking (DPM), take up less real estate and can convey more information than conventional bar codes.

A Data Matrix code can contain a device's serial number, revision number, software version (in the case of programmable parts), lot number, production date, and even the production shift that produced the device. Incorporating such information directly into the code allows manufacturers to track parts into the field and to the end of their life cycles. Such precise traceability particularly benefits a manufacturer if a problem necessitates a product recall or upgrade.

The data collected from such parts tracing also provides feedback that can be used for process improvement. In addition, using DPM to imprint a Data Matrix code directly on a part or board surface offers distinct advantages over attaching a label that might curl, come off, or otherwise end up less than useful.

Jamie Pearce, DataMan product marketing manager at Cognex, explained that the recent dramatic growth in DPM identification results from significant advancements in the tools available to read the codes. Today's DPM readers combine high-speed processors, advanced software algorithms, and specialized lighting to permit the reading of codes on a wide range of surfaces.

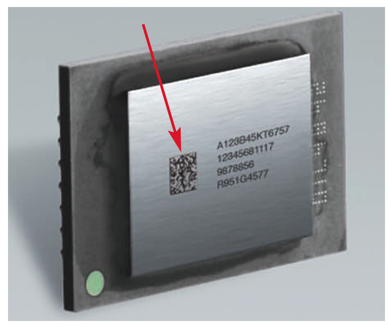

Fig. 1 **The correct light facilitates the accurate reading of Data Matrix marks (red arrow) despite poor contrast against the reflective surface.** Courtesy of Cognex.

Pearce said that some readers are versatile enough to offer all necessary illumination types and to automatically select the one that will produce the best results in a given situation. Such tools use pattern-matching software algorithms to successfully read printed bar codes and poorly marked DPM codes. Pearce said users of Data Matrix marking techniques need a DPM reader that offers:

- ruggedness to withstand the factory environment,
- high-yield reading to ensure accuracy under even adverse conditions,
- fast trigger-to-read response, allowing the reader to be as convenient to use as a bar-code reader,
- the ability to handle both easy and challenging applications, and
- a choice of form factors—corded and cordless, as well as handheld and stationary.

In adopting DPM identification for parts traceability, Pearce recommended that a manufacturer consider the amount of available real estate before deciding how much information to include in the Data Matrix code. Consider the surface that will contain the mark and the marking method. Laser techniques, for example, can offer a small mark if space is limited, but the marks may not survive on a high-wear surface. In that case, a dot-peen mark may be more appropriate.

Manufacturers also need to ensure that a code will be readable. Codes marked directly on part surfaces often exhibit much lower contrast than conventional black-on-white labels do. In addition, the characteristics of the part surface and the mark's location can greatly affect its readability. The manufacturing process itself can also degrade the mark's appearance.

Lighting choices

Achieving both reading speed and accuracy requires the right kind of lighting—not only adequate lighting, but diffused when necessary and at the best possible angle. For in-line automated production, both the light sources and inspection systems can be fixed. The light comes from the optimum angle to minimize shadows and maximize resolution in any specific situation, producing a high-quality image and a reliable pass/fail decision.

In low-volume situations however, such as low-volume manufacturing, prototyping, preproduction, and failure analysis, the "large-system stationary light source" and fixed-mount camera system model breaks down. Adapting the lighting technology used by machine-vision systems into handheld devices enables manufacturers to more easily meet that challenge. Traditionally, handheld DPM readers have suffered from limited lighting options, but newer ones, such as the DataMan ID readers from Cognex, include an integrated illumination system that offers a range of lighting choices.

Verifying DPM Data Matrix codes can require one of several lighting configurations (**Figure 2**):

- Bright-field illumination projects light directly at the mark surface. Although this configuration is often the simplest and least expensive option for a handheld reader, it does not always produce the best results. It works best for high-contrast labels and DPM on less reflective surfaces.
- Dark-field illumination projects light at the mark surface at a low angle. For marking methods such as dot peen, the low angle provides superior contrast. The light can reflect off the mark surface and back to the reader.
- Cloudy-day illumination creates a diffuse, even light across a mark surface that is especially beneficial for marks placed on curved parts or highly reflective materials.

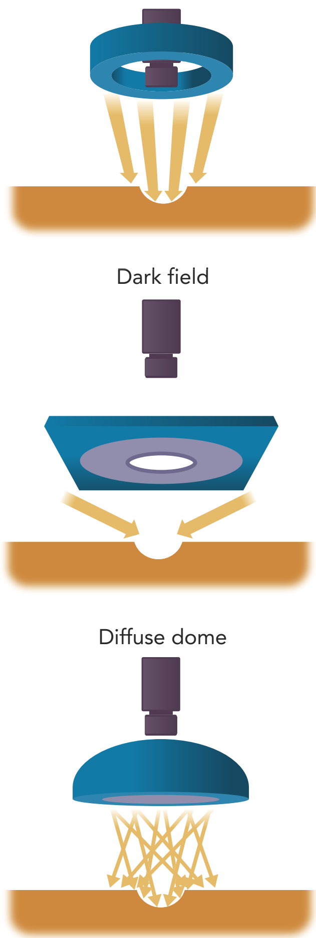

Fig. 2 The three types of illumination permit the reliable reading of marks even under difficult surface conditions.

The usefulness of Data Matrix codes depends on the ability to both apply them reliably to a product and read them accurately during test, inspection, and data analysis. Accomplishing those goals, in turn, requires a variety of lighting and reader-configuration alternatives. □


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PRODUCTS

Three-chip camera eases system integration

Contained in a miniature 44x44x78-mm package that weighs 5.47 oz, Toshiba's IK-TF2 industrial video camera easily integrates with high-speed machine-vision systems for applications requiring high definition and color resolution. The camera's three-CCD RGB Micro Prism system employs 1/3-in., 410,000-pixel sensors to capture computer-ready color images. The IK-TF2 provides an RS-232 serial interface, a 2:1 interlaced scanning system, on-screen menu programming, one-pulse or two-pulse random trigger, and C-mount lens flange. Specifications include a sensitivity of 10 lux minimum and a signal-to-noise ratio of 64 dB. *Toshiba Imaging Systems Division, www.cameras.toshiba.com.*

IR camera has broad spectral response

Based on a TE-cooled mercury-cadmium-telluride (MCT) detector array, Cedip Infrared Systems' Jade short-wave infrared (SWIR) camera provides spectral response ranging from 0.8 micron to 2.5 microns. This increased spectral response is beneficial for applications requiring high sensitivity

Products • from page 71

at IR wavelengths of up to 2500 nm, such as the water absorption band at 1.95 microns. The Jade camera operates at up to 200 frames/s at full-image size (320×256 pixels), with output digitized over a 14-bit dynamic range to clarify even the smallest area of defect or non-uniformity. Applications for the Jade SWIR camera include online thermal analysis, process control, IR radiometry, and IR signature analysis. *Cedip Infrared Systems, www.cedip-infrared.com.*

Library works with machine-vision software

New to Version 7.1 of MVTec's Halcon machine-vision software and HDevelop integrated development environment is the HDevelop Engine. HDevEngine is a library that works like an interpreter, allowing you to directly load and execute HDevelop programs and procedures from within a C++ application without having to run through a linking and compiling process. Halcon provides a library of more than 1150 operators for blob analysis, morphology, pattern matching, metrology, 3-D calibration, and binocular stereo vision. The software works with Windows, Linux, and Solaris and provides interfaces to more than 50 frame grabbers and hundreds of industrial cameras (analog, USB 2.0, IEEE 1394, and Gigabit Ethernet). *MVTec Software, www.mvtec.com.*

Software hones x-ray image inspection

A Windows XP-based x-ray image processor, VIPx from FocalSpot, offers an extended feature set of SMT/BGA inspection capabilities and image-enhancement tools for upgrading almost any PC-based x-ray inspection system (manual or semi-automated). VIPx makes use of algorithm-based inspection modules that automatically find solder connections and perform measurement and defect detection by operator-defined pass/fail analysis criteria. VIPx assists the operator by automatically finding failures at the solder joint level or selected regions of interest (voids, opens, shorts, ball size, ball shape, etc.) by color-coded indicators. In addition, the program's data-collection and measurement-reporting functions document faults for corrective action. *FocalSpot, www.focalspot.com.*

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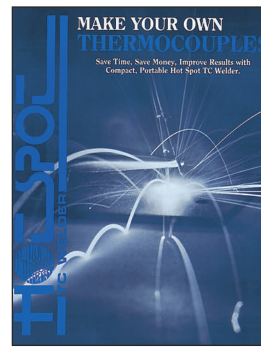

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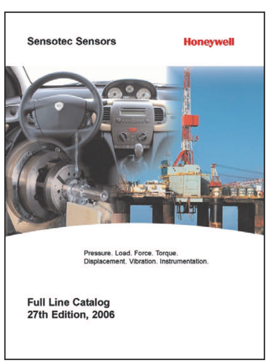

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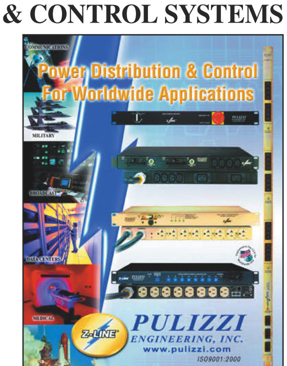

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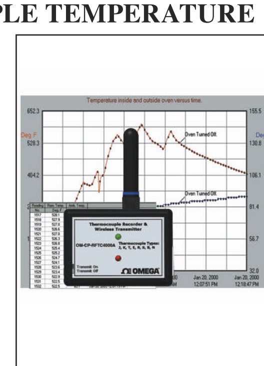

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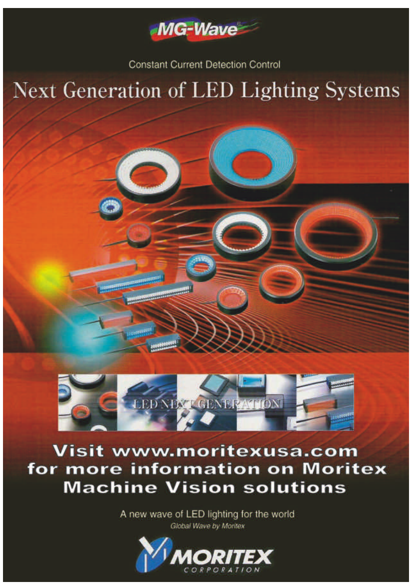
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JIM GIBSON
President & CEO
Landrex Technologies
Santa Clara, CA

Jim Gibson joined Landrex in 2001 to expand the company's global reach to the US. In 2004, he became president and COO of Landrex's AOI business unit. Before joining Landrex, he was president of the US subsidiary of Pematech Rohwedder, and he previously held a variety of executive management positions with Micro Component Technology (MCT), where he led an MCT team in the acquisition of an equipment-manufacturing business from National Semiconductor in Penang, Malaysia, and in the building of a factory there to produce MCT products. Gibson earned his bachelor's degree in business at the University of Southern California.

Rick Nelson spoke with Jim Gibson during the 2006 APEX show and followed up with an e-mail interview.

A global reach for AOI technology

Q: What is the history of Landrex?

A: Landrex was started in 1989 in Taiwan by three friends—Steve Hsu, Michael Lai, and Paul Hsu—to provide custom test fixtures for in-circuit-test (ICT), manufacturing-defects analysis (MDA), functional, and combinational testers. It was their vision to create not only a test-fixture company but one that could provide comprehensive PCB test solutions across all stages of manufacturing. To that end, Landrex joined forces with Teradyne in 2002 to distribute and support Teradyne's Optima AOI systems in Taiwan and China. Feeling bullish about the Optima products and the AOI industry, Landrex acquired this business from Teradyne in 2004 and began to design, manufacture, and sell the equipment under its own name all over the world.

Q: Isn't it unusual for an Asian firm to take ownership and control of the engineering, design, manufacturing, and sales from a US-based company?

A: Yes, this is quite unusual, but there are good reasons why our approach makes sense. In 2001, we saw a dramatic shift in PCB manufacturing away from the US and Europe to Asia, primarily Taiwan and China, and also a dramatic drop in the average selling prices (ASPs) of AOI systems due to the introduction of inferior but low-cost machines from Asian companies. Landrex knew that the Optima AOI machines were the best available, but Landrex and Teradyne believed Landrex was in a better position to serve customers in Asia and to reduce the manufacturing and product overhead to compete more aggressively with low-priced competitors.

Landrex retained the US-based engineering talent to make sure the "brain trust" behind the products stayed intact. As a result, Landrex can offer low-cost, high-quality AOI products while keeping a direct line open with customers to drive further product innovation. This is a new hybrid business model that should serve both countries—Taiwan and the US—very well, and I am excited to be a part of it.

Q: What has Landrex done since taking over the Teradyne AOI business?

A: The first thing we did was a large-scale "voice of the customer" investigation to understand the need for optical inspection systems in Asia and around the world. The feedback was that customers loved the quality of our systems but wanted them to be cheaper and faster. Using the combination of superior engineering talent in the US and low-cost, high-quality manufacturing in Taiwan, we launched two new products at APEX to enhance our flagship Optima 7300 post-reflow family and to respond to our customers' requests. The ASPs for both machines start at under $100,000. However, we didn't focus just on the scanning speed or prices of these machines; we also focused on the value for our customers, which is how these machines actually help increase yields. Another initiative we took was to compile a study of how our customers use the Optima 7210 pre-flow machine to increase their yields. As you know, we presented this data in a recent article in *Test & Measurement World* ("Process control keeps faults in check," Dec. 2005/Jan. 2006).

Q: How do customers view the value of AOI?

A: With device pitches getting smaller, boards getting denser and more complex, and materials changing from lead to lead-free, a strategy of relying solely on human inspection, ICT, and functional test will result in lower yields. Additionally, the margins most companies get per board are decreasing. As a result, most companies see a compelling reason to do 100% optical inspection to increase yields, decrease manufacturing cost, increase quality, and in the long run, grow market share. T&MW

Jim Gibson comments on how customers can differentiate among competing AOI technologies and on the potential hidden personnel costs of AOI in the online continuation of this interview: www.tmworld.com/2006_05.

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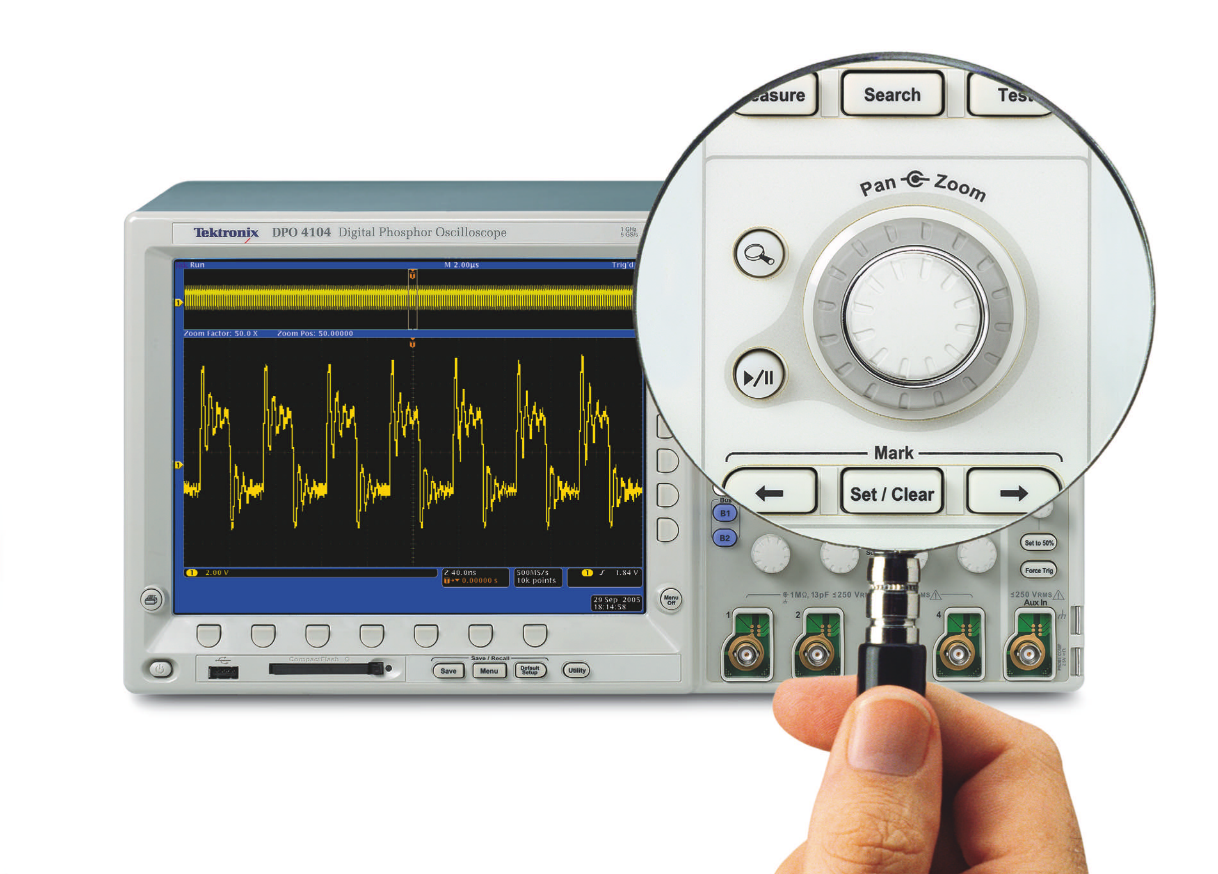

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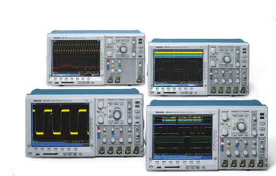

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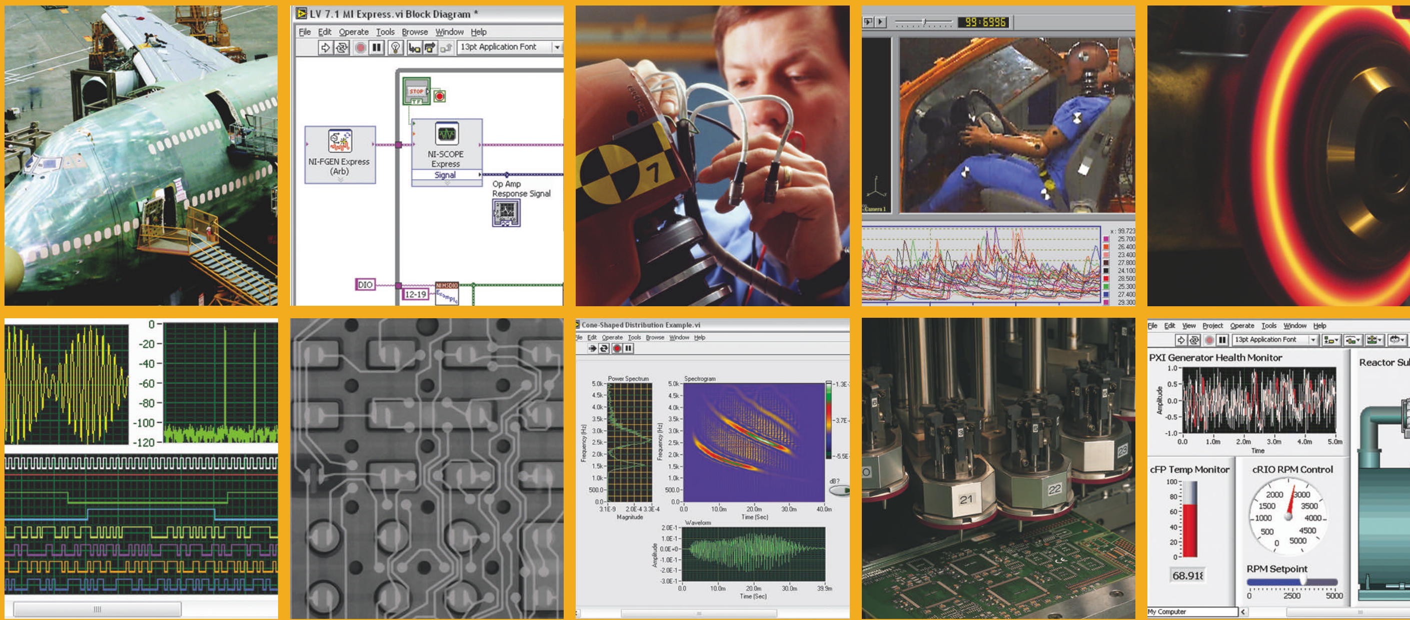

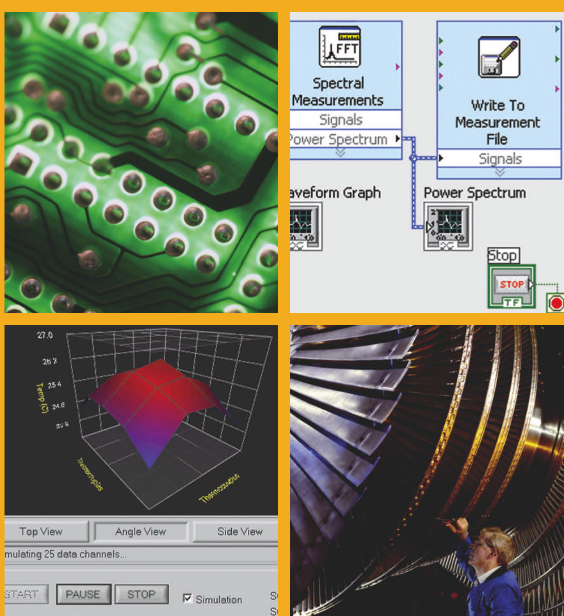

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