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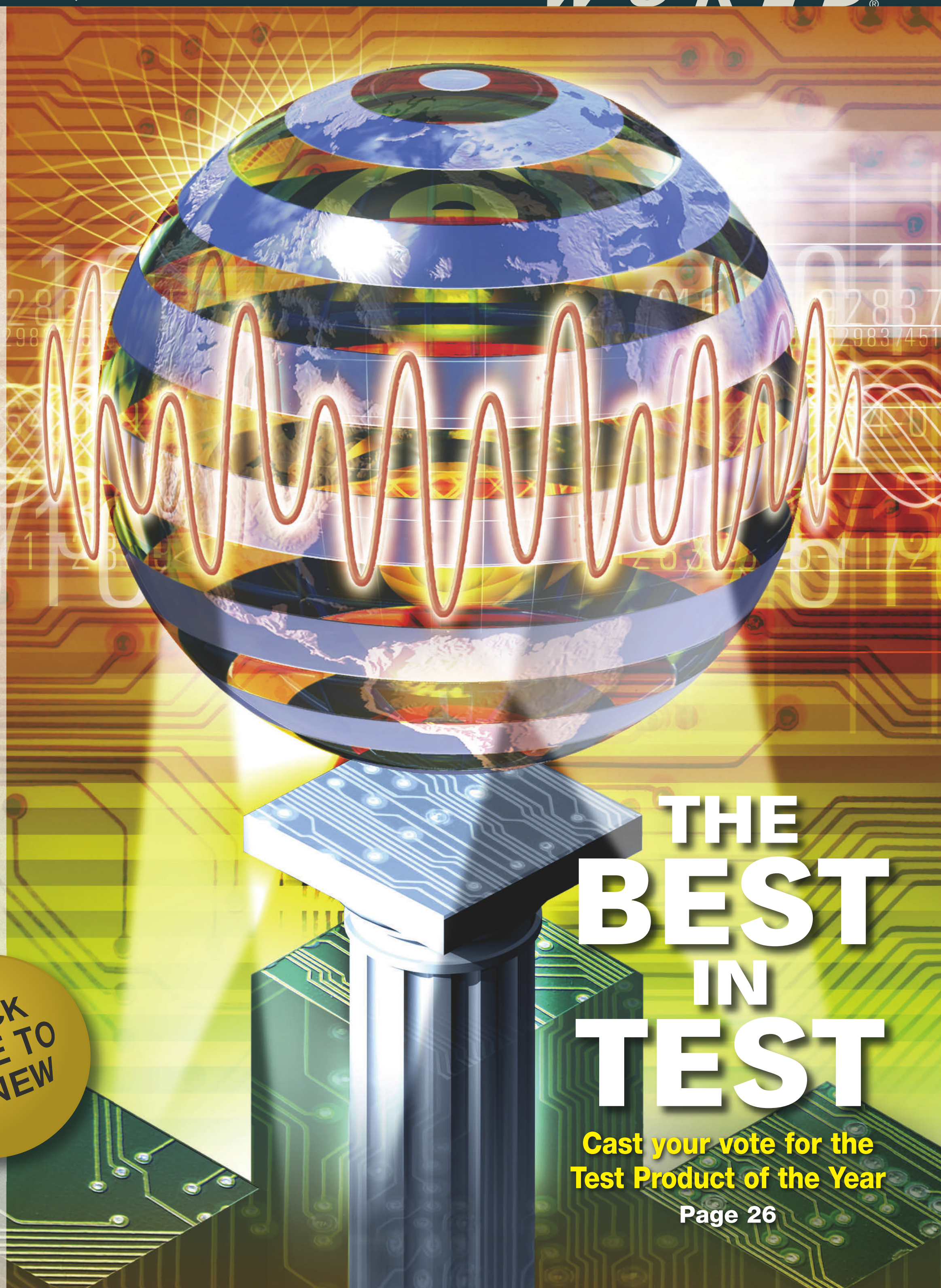

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COVER BY: ROY WIEMANN

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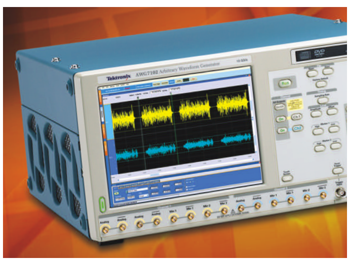

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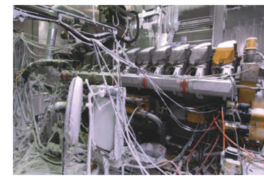
Automotive & Aerospace Test Report

- **Finding faults in circuit card assemblies**
  Testing circuit card assemblies (CCAs) requires balancing the need for thorough fault detection with the need to rein in total costs. Bill Curry, president of Huntron, discussed the testing of CCAs in this exclusive interview.



- **Tests simulate harsh environments**
  During a recent visit to Caterpillar's Engine Systems Technologies and Solutions laboratory, contributing technical editor Greg Reed learned how CAT engineers perform harsh-environment testing.
- **Model-based design aids test and verification**
  With model-based design, engineers use software simulations instead of prototypes to test and verify their designs. Companies such as The MathWorks produce software that help engineers implement the technique by aiding in design, simulation, and test.

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Take a Test & Measurement Challenge

Respondents who answer one of our Test & Measurement Challenge questions correctly are entered into a drawing for a prize, courtesy of the contest sponsor. Our current challenges cover Oscilloscopes and Data Acquisition. Submit your answer today!

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Blog commentaries and links

Taking the Measure

Rick Nelson, Chief Editor

- Interested in creativity?
- The right to bear cell phones

Rowe's and Columns

Martin Rowe, Senior Technical Editor

- Help a fellow engineer with a USB problem
- SCPI skips on

www.tmworld.com/blogs

Webcast: Finding and Troubleshooting Intermittent Signal Faults

Test & Measurement World and The *EDN* Network in partnership with LeCroy have produced a free Webcast covering the best practices for using digital oscilloscopes to identify and troubleshoot intermittent signal failures. The Webcast also explains how you can identify the source of intermittent failures when performing eye-pattern testing or jitter measurements.

www.tmworld.com/webcast

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[EDITOR'S NOTE]

Modest proposal for iPods

In an interview on National Public Radio in December, a *Wired* product editor commented that some tech products seem built to last only until the manufacturer is ready to sell you a new one. Planned obsolescence, of course, is neither a new concept nor a new consumer complaint. But as a complaint, it is undoubtedly exacerbated by the short lifetimes (and warranties) of expensive, though compact and fragile, consumer-electronic products, coupled with manufacturers' unwillingness or inability to repair them.

I have a modest proposal to address consumer concerns and manufacturers' marketing needs. Manufacturers should offer electronic products that come with a firmware-embedded self-destruct mechanism. Manufacturers should, of course, proudly announce this feature on product labels—for example: Congratulations on your purchase of a product that will cease operating in 12 months!

RICK NELSON, CHIEF EDITOR

This proposal clearly meets vendors' needs for predictable markets for replacement products. But what's in it for consumers? In the first place, many believe vendors have already adopted my proposal. A recent *Wall Street Journal* article quotes Matthew Bremner, a founder of iRepair.ca, a company that repairs iPods: "Some people swear there's a self-destruct mechanism" in each iPod, which activates as soon as the warranty is up.

Congratulations! You have purchased a product that will cease operating in 12 months!

If vendors formally adopt the policy that consumers believe is already in place, consumers will gain three benefits: extended warranty protection (with accompanying peace of mind), more innovation, and lower costs. Vendors should fully warrant their products until the self-destruct date. Consumers will know when to upgrade, and they won't have to worry about trusting their data to a three-year-old laptop (whose extended warranty expired a year ago). Meanwhile, vendors will have to become ever more innovative to beat their competitors in the replacement-product market.

As for price: Some hidebound companies will fail to adopt my proposal. The farsighted ones that do may need to cut prices, but they'll recoup the revenue shortfalls on volume. As you conclude your holiday shopping, which would you rather buy: a $200 MP3 player with an 18-month expiration date, or a $250 model with a six-month warranty and an undefined lifetime? I'll take the $50 now, thanks.

So come on, vendors. Don't just throw together a bunch of marginal components in the hope that a critical one will fail shortly after (but not just before) the warranty expires. Put some teeth in planned obsolescence. T&MW

See the online version of this article at www.tmworld.com/2006_12 for links to the NPR interview and the* Wall Street Journal *article. Post your comments at www.tmworld.com/blog.

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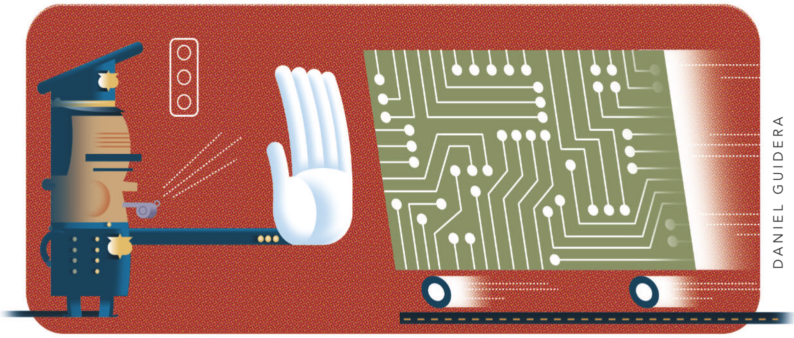
[An exclusive interview with a test engineer]

Vehicle electronics can't roll past him



Don Mersino is a test engineer for Magna Electronics (Holly, MI), a maker of automotive-control systems that include mirror electronics that provide outside air temperature, compass direction, and auto dimming features; control modules for power-lift gates, deployable running boards, and variable blower controllers; and automotive camera systems. Mersino recently discussed his work with senior technical editor Martin Rowe.

Q: What is your role in test?
A: I'm responsible for complete functional testing of production products. I develop PC-based testers that verify operation of automotive controls. I handle testing from the time we quote on new business through training production technicians.

Q: How do you get the specifications on I/O signals for each product?
A: Our hardware and software engineers work with customers to get details on a product's input and output signals. I receive signal specifications from the designers and develop an automated test system.

Q: What do you use to generate input signals for a controller, and what do you use to check a controller's outputs?
A: We use PCI multifunction I/O cards. The cards connect to an interface board that contains relays to simulate discrete inputs. We often need to add more digital I/O lines than a multifunction card can provide. We usually add another multifunction card, but I've been experimenting with a USB digital I/O module. Counter/timers simulate pulse-width modulated and Hall-effect signals.

I also develop machine-vision systems to verify LEDs and displays. Finally, I use frame grabbers to focus and test the camera products.

Q: How does the tester connect to the UUT?
A: A ribbon cable from a multifunction card connects to a custom interface board that breaks the connections out to screw-terminal connectors. Wires from the screw-terminal connectors attach to any necessary loads and to quick-disconnect connectors as part of a wire harness. The wire harness connects to another set of quick-disconnect connectors on a test fixture. Pogo pins on pneumatic cylinders connect test signals and loads to the UUT.

Q: What's the process for developing a tester?
A: After I have an understanding of the I/O signals, I assemble the I/O cards and interface boards. About 85% of the work involves software. I look for a tester with software that most closely matches my needs for a new system, then I modify the code and user interface, which is written in Visual Basic 6. For the most part, I can copy the data-handling routines from one system to another.

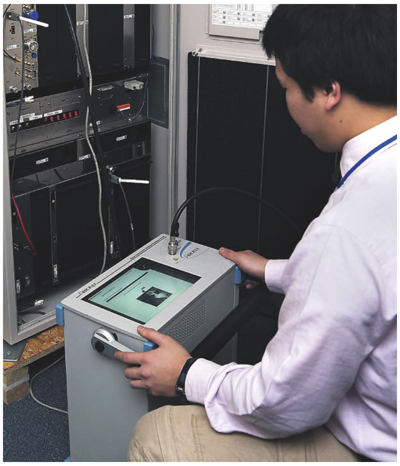
Q: What do your data-handling routines do?
A: The data-handling routines store measurements in a database on the PC, and we upload data to the network. Data is available through a Web server. We use the data to track production yields and throughput. The data also helps us with field returns. For example, if a product fails in a way that a production tester should have caught, then the customer usually wants to talk to me or another test engineer to learn how we tested the product.

Q: How do you introduce a tester to production?
A: I work with the manufacturing engineers to secure a place for the tester on the production floor. I then show the tester and UUT schematics to technicians and operators. I explain how the product works and what the tester does. I also show test operators how to load the UUT onto the tester and how to label a product after its test.

Q: Do you use the testers for production only or do you also use them for design verification?
A: Mostly, we use the testers for production. Once in a while, a design engineer will use a system to check a modified product. T&MW

Every other month, we will publish an interview with an electronics engineer who has test, measurement, or inspection responsibilities. If you'd like to participate in a future column, contact Martin Rowe at mrowe@tmworld.com.

Base-station tester now supports live receiver and transmitter tests



Aeroflex has added the ability to undertake live receiver and transmitter testing, including HSDPA testing, to its 6413A UMTS base-station test system. The capability will enable providers to perform ongoing maintenance of UMTS base stations without taking the systems out of service, meaning there will be no disruption to live traffic.

A single-box solution, the 6413A can take complete control of a base station via the Iub interface and perform transmitter, receiver, and functional tests without external control equipment or the need for detailed knowledge of the base station's operation and control. The addition of live receiver and transmitter testing capabilities to the tester complements its existing test mode, which facilitates repeatable test scenarios in controlled environments based on the methods defined in the ETSI standard 3GPP TS25.141.

With the instrument's touch-screen controls, users can initiate all functions from the front panel. Measurement results can be viewed while tests are running or stored for later analysis. Tests can be run manually or automatically using preprogrammed test sequences. www.aeroflex.com

Azimuth announces funding, CEO transition

Azimuth Systems, a provider of WiFi engineering test equipment, has announced that it has received $7.5 million in new venture capital funding from its current investors and that Jim Iuliano will join the company as CEO. The company said the new funding and management change will prepare it for expansion into the WiMax and cellular markets.

Founding CEO Ray Cronin commented, "Jim Iuliano's successful experience scaling systems businesses will enable Azimuth to accelerate its growth. We worked hard to find the right person to take us to the next level, and I look forward to working closely with Jim over the coming months to transition leadership of Azimuth during our significant growth phase."

Iuliano has been CEO for both public and private technology companies for more than a decade. Previously, he was CEO of E Ink, where he took the company from start-up into commercialization, built a global presence, and secured strategic alliances with Sony, Philips Electronics, and Lucent, among others.

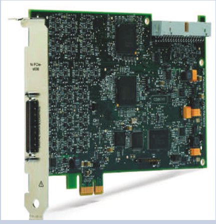
Prior to E Ink, Iuliano was president and CEO of Molecular Devices, and he led the company through 20 consecutive quarters of record revenues and profitability and was instrumental in orchestrating the measurement system company's IPO. Most recently, Iuliano was an entrepreneur in residence at North Bridge Venture Partners.

"Azimuth is extremely well positioned in the WiFi industry and for expansion into the WiMax and cellular markets," said Iuliano. "Ray has done a great job leading the company from concept to market leader, and I'm excited to build upon the many successes the team has achieved." www.azimuthsystems.com.

Editors' CHOICE

Digital I/O instruments meet PCI Express

The NI PCIe-6536 25-MHz and NI PCIe-6537 50-MHz digital I/O boards build on the throughput of the PCI Express interface to acquire and generate large digital patterns to meet applications including interfacing to memory devices, emulating communications protocols, and testing image sensors and display panels. The digital boards feature maximum clock rates of 25 MHz and 50 MHz across 32 channels for a maximum sustainable throughput of 100 Mbyte/s and 200 Mbyte/s, respectively.



Engineers can set the direction of each channel for acquisition or generation and can choose from 2.5-, 3.3-, or 5.0-V TTL-compliant logic levels per direction. The boards are capable of both synchronous and asynchronous timing modes. Engineers also can synchronize the new PCI Express digital boards with other PCI Express data-acquisition boards to create mixed-signal test systems. Customers can reuse existing digital applications written with the NI-DAQmx API for the NI 6533 and NI 6534 digital devices with the new PCI Express instruments.

Base price: $1799. *National Instruments, www.ni.com.*

Rapport adopts LogicVision BIST

LogicVision has announced that Rapport, which specializes in low-cost, dynamically configurable, massively parallel chips for compute-intensive applications at low power, has adopted LogicVision's memory BIST for next-generation Kilocore Architecture-based products.

The Rapport Kilocore devices combine hundreds or thousands of parallel processing elements in small, low-power chips that can be dynamically reconfigured in real time for consumer-electronics, mobile-gaming, homeland-security, server, image-processing, and suitcase-supercomputing applications. LogicVision's Embedded Memory Test provides built-in memory test for this type of device.

"LogicVision's Memory BIST solution gives us the flexibility we need to effectively and efficiently test the different embedded memories in next-generation Rapport Kilocore Architecture devices," said Dr. Benjamin Levine, director of chip development at Rapport. "LogicVision offers a solution that allows us to hierarchically group and test different types and sizes of memories and allows us to select the best options for testing each one. LogicVision also provides us with the tools to easily integrate their BIST solutions into our design flow with a minimum of effort." www.logicvision.com.

CALENDAR

Measurement Science Conference, January 22–26, Long Beach, CA. Sponsored by The Measurement Science Conference. www.msc-conf.com.

APEX/IPC Printed Circuits Expo, February 20–27, Los Angeles, CA. Sponsored by IPC. www.goapex.org.

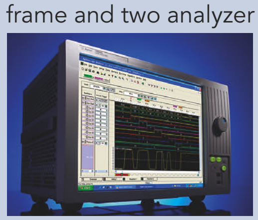
OFC/NFOEC, March 25–29, Los Angeles, CA. Sponsored by Optical Society of America, IEEE, and Telcordia. www.ofcnfoec.org.

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

Editors' CHOICE

Modular logic analyzer deepens memory

Engineers looking to debug digital systems need to isolate the causes of problems. The more samples of digital signals and bus transactions you can see, the more likely you are to find the source of the problem. To aid you in this task, Agilent Technologies has released the 16900 two-slot modular logic analyzer mainframe and two analyzer modules. The 16901A mainframe features a 15-in. color touch-screen display so you can get a clear view of bus signals. And it measures just 14.2-in. deep, which saves bench space.



Both of the logic analyzer modules provide 68 channels at a 1066-Mbps data rate, 4-GHz high-speed timing, and 1200-MHz conventional timing. The difference between them resides in their amount of memory. The 16950B has memory options of 1 Msample, 4 Msamples, 16 Msamples, 32 Msamples, and 64 Msamples. The 16951B provides 256 Msamples of memory. Applications include defense, wireless communications, wireline communications, and consumer electronics. Designers of PCI Express systems can use the FSI-60112 probe, which lets the instrument capture serial data on X1, X2, and X4 lane widths.

Prices: 16900 mainframe—$14,000; 16950A logic analyzer—$23,500; 16951B logic analyzer—$65,000; FSI-60112 probe—$19,500; B4645A—$3,000. *Agilent Technologies, www.agilent.com.*

JTAG, EDA, and ATE products take center stage

> > > International Test Conference, October 23–27, Santa Clara, CA. IEEE. www.itctestweek.org.

Synopsys (www.synopsys.com) announced links between its TetraMAX ATPG tool and Odyssey yield-management system. It also announced a collaborative effort with **Virage Logic** (www.viragelogic.com) on a test-reference design flow for testing and repairing embedded memories for SOC designs.

The **Semiconductor Test Consortium** (www.semitest.org) reported that it has created the Docking and Interface Working Group (DIWG) to develop ATE peripheral interface standards. **Corelis** (www.corelis.com) demonstrated its ScanExpress boundary-scan test and programming system.

Mentor Graphics (www.mentor.com) announced the release of TestKompress 2007, which offers improvements in ATPG productivity. Mentor also announced that its YieldAssist tool now supports an automated, server-based use model for high-volume diagnosis of wafer test failures. **LogicVision** (www.logicvision.com) unveiled its ScanBurst tool and announced that it has partnered with Mentor to deliver at-speed test for high-speed nanometer designs.

Electroglas (www.electroglas.com) reported that **King Yuan Electronics** (www.kyec.com) has qualified the Electroglas EG6000 for production probing of 300-mm wafers. **OptimalTest** (www.optimaltest.com) unveiled its Test Management Solutions (TMS) software for managing the entire IC testing process.

JTAG Technologies (www.jtag.com) announced that its ProVision software now supports tests based on the IEEE 1149.6 standard for digital networks. **Goepel electronic** (www.goepel.com) introduced a new GUI for its System Cascon boundary-scan software; the GUI features a "Multi-Phase-Inspector" that supports product life-cycle functions.

Nextest Systems (www.nextest.com) announced its Magnum iCP for high-volume test of CMOS image-sensor (CIS) devices. The tester integrates logic test with image-capture and image-analysis hardware. A light source and a wafer prober enable users to probe up to forty 256-Mpixel CIS devices in parallel. **Test Systems Strategies Inc.** (www.tessi.com) highlighted a partnership with **Toshiba Microelectronics** (www.toshiba.co.jp/tosmec) and **ATE Service** (www.ate.co.jp).

Asset InterTech (www.asset-intertech.com) debuted a controller card that handles JTAG and functional test chores. It also announced ScanWorks enhancements. **Cadence Design Systems** (www.cadence.com) demonstrated the new Logic Design Team Solution suite. **ARM** (www.arm.com) highlighted its emBISTRx embedded-memory test and repair system.

Intellitech (www.intellitech.com) announced support for Xilinx Virtex 4 RocketIO and for Asset Intertech ScanWorks, and it debuted a thumb-sized SystemBIST demo board. **Verigy** (www.verigy.com) and **Test Insight** (www.testinsight.com) announced the Verigy STIL Reader/Writer for creating and debugging test programs used with Verigy's V93000 SOC tester. T&MW

Nextest demonstrated the Magnum iCP integrated with an Aitos ATS1240 illuminator and a Semics Opus II wafer-probing system.

Courtesy of Nextest.

Test and inspection highlighted at European show

> > > Electronica, November 14–17, Munich, Germany. Messe München. www.electronica.de.

Aeroflex (www.aeroflex.com) announced the addition of a boundary-scan capability and a PXI software wrapper tool to its 5800 Series ATE system. The company has also added WiMax OFDMA, 1xEvDO, and HSUPA test capabilities to its PXI 3000 Series platform. **Digitaltest** (www.digitaltest.net) demonstrated new features for its Condor, MTS300 Sigma, and MTS 180 systems. **Teradyne** (www.teradyne.com) demonstrated the new UltraPin II 121 and 121a pin boards for the TestStation ICT platform and also highlighted its Debug Pro software for the platform.

Seica (www.seica.com) demonstrated functional, in-circuit, and flying-probe testers. **Viscom** (www.viscom.de) highlighted its S3016 PCB inspection system, its XT9000-P panoramic x-ray tube, and its new XMC software package. **Goepel electronic** (www.goepel.com) announced that it has added IEEE 1149.6 support to its System Cascon software.

XJTAG (www.xjtag.com) unveiled its XJTAG Professional development system. **Asset InterTech** (www.asset-intertech.com) and **JTAG Technologies** (www.jtag.com) presented to the European market products they debuted at ITC (above).

(continued)

> SEE OUR COMPLETE COVERAGE OF THE INTERNATIONAL TEST CONFERENCE, ELECTRONICA, AND VISION 2006 AT WWW.TMWORLD.COM/SHOWS.

Test and inspection highlighted at European show *(continued)*

Rohde & Schwarz (www.rohde-schwarz.com) debuted the FMU36 spectrum and vector-signal analyzer, its NRP-Z81 broadband power sensor, and its R6240A DC voltage and current source/monitor. **National Instruments** (www.ni.com) demonstrated new high-speed digital I/O instruments for PCI Express and announced pioneer programs for two devices based on the NI LabView FPGA module.

Pendulum Instruments (www.pendulum-instruments.com) demonstrated the CNT-90XL microwave frequency counter/analyzers that operate to 60 GHz. **Pickering Interfaces** (www.pickeringtest.com) highlighted its LXI microwave matrix products. T&MW

Vision software and hardware debut

> > > Vision 2006, November 7–9, Stuttgart, Germany. Messe Stuttgart. www.messe-stuttgart.de/vision.

Seldes (www.seldes.com) debuted the Chameleon-Link II and Chameleon-Link E frame grabbers, launched its Cougar embedded acquisition systems, and highlighted a partnership with **The MathWorks** (www.mathworks.com) for building FPGA-based image-processing applications. **Dalsa** (www.dalsa.com) announced the X64 Xcelera line of PCI Express frame grabbers and demonstrated its Piranha Color line-scan model for PCB inspection. Dalsa's ipd group (www.goipd.com) demonstrated the VA15 vision appliance for single-camera applications.

Sony Europe's Image Sensing Division (www.sonybiz.net/vision) launched the monochrome XCI-V3. **National Instruments** (www.ni.com) demonstrated new PCI Express frame grabbers. **Pleora Technologies** (www.pleora.com) highlighted a version of its iPORT software that provides a migration path to GigE Vision compliance. **Point Grey Research** (www.ptgrey.com) announced the opening of a Munich sales office.

Matrix Vision (www.matrix-vision.de) highlighted its mvDelta PCI Express frame grabber, its mvBlueCougar Gigabit Ethernet cameras, its mvHyperion-CLe PCI Express Camera Link frame grabber and its mvSigma-SQe four-channel frame grabber. **Kappa opto-electronics** (www.kappa.de) highlighted its PS series of low-noise cameras. **MVTec** (www.mvtec.com) demonstrated a six-axis industrial robot equipped with two cameras.

VCubed (www.smartledlighting.com) introduced its "Smart Design Concept," which integrates thermal management, LED failure detection, current control, and strobe control in LED illumination systems. **e2v technologies** (www.e2vtechnologies.com) announced that it has won a flight-phase contract to supply the European Space Agency with CCD image sensors for an instrument on the Gaia satellite.

Vision 2006 convened in Messe Stuttgart's Killesberg Park facility (pictured). Vision 2007 will take place at new fairgrounds near the Stuttgart airport.

Silicon Software (www.silicon-software.de) demonstrated its VisualApplets programming tools. **Matrox Imaging** (www.matrox.com) launched Solios GigE—the company's first interface card for the GigE Vision standard. Thirty new GigE Vision- and GenICam-compliant cameras highlighted **Basler Vision Technologies**' (www.basler-vc.com) exhibit. **Vision Components** (www.vision-components.com) and **SAC** (www.sac-vision.net) announced their cooperation on the development of the EyeSpector 1.4 (www.eyespector.com) machine-vision system. T&MW

RICK NELSON
CHIEF EDITOR
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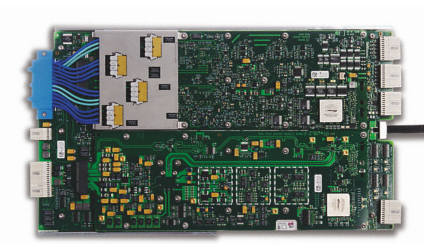
ATE adapts to meet SOC test needs

Has your company bought its last big-ticket ATE system for system-on-chip (SOC) devices? Probably not. Despite innovative design-for-test (DFT) products from EDA companies, SOC devices will continue to sport high-speed serial, RF, video, and other functions that aren't readily testable using DFT techniques. Nevertheless, you are likely to find that you can meet future test needs economically with a new system that's not drastically different from one you already have.



The Pin Scale HX high-speed extension card for the 93000 SOC tester supports characterization for devices and interfaces with data rates up to 12.8 Gbps.
Courtesy of Verigy.

Test innovations appearing in 2006 suggest that ATE makers are not intent on developing radically new technologies, as various flavors of systems such as the Advantest T2000, Credence Sapphire, LTX Fusion, and Verigy 93000 have adapted to provide the cost and performance levels you need for emerging deep-submicron designs. Illustrating the attractiveness of stable, standard platforms, Teradyne in October announced the shipment of its 1000th Flex system—to Texas Instruments, which received the first Flex system in 2002.

Illustrating ATE vendors' efforts to tailor systems to your needs, Credence Systems this year expanded its Sapphire test family with the addition of the Sapphire D-40, a tester that combines analog, digital, mixed-signal, and RF test instrumentation and leverages technologies first introduced in the Sapphire D-10 in 2005. The new system accommodates the company's Modulated Vector Network Analysis (MVNA) RF-measurement option, which adds wireless test capabilities for mobile phone, WLAN, WiMax, and Zigbee devices.

Similarly, LTX expanded its Fusion line with the Fusion LX, a zero-footprint ATE system based on an air-cooled infrastructure that can be configured with up to 20 slots that accommodate the company's X Series DSP, DC, and power instruments. It's available in production and engineering configurations.

Other firms have developed new instruments for their existing platforms. Advantest, for example, introduced the BBWGD (Base Band Waveform Generator Digitizer) module for its T2000 test system. The BBWGD accommodates DC, audio, and video as well as baseband signals to address the increasing number of mixed-signal I/O channels appearing on SOC devices.

In addition, Verigy introduced its Pin Scale HX high-speed extension card for the 93000, which supports characterization for devices and interfaces with data rates up to 12.8 Gbps. The Pin Scale HX is designed to provide the signal integrity required for at-speed design characterization and production test of Serdes device interfaces such as PCI Express and HyperTransport.

The most unusual SOC tester debut this year was Advantest Technology Solutions' Certimax event-based test system. In its initial configuration, the 80-lb system employs PXI cards to provide 128-pin, 125-MHz test capability. Certimax targets semiconductor design verification, however, leaving production-test chores to systems like Advantest's T2000. T&MW

Failure-analysis system debuts

Credence Systems has introduced the Meridian Electrical Failure Analysis Platform, which employs an emission microscope and a laser-scanning microscope to accelerate the debug process. Credence says failure-analysis engineers can use the system to move rapidly from fault detection to problem resolution on devices down to the 32-nm node. With both "top-down" and "inverted" configurations, the Meridian platform features a modular design that will enable customers to expand its capabilities. www.credence.com.

Spectrum and vector-signal analyzer

The Rohde & Schwarz FMU36 targets chipset development for mobile phones and base stations. The instrument features a frequency range to 36 MHz to measure baseband I/Q signals, and it includes two analog inputs that can be operated either in balanced or unbalanced modes. It provides the necessary sensitivity to make low-frequency measurements on RFID devices or ADSL modems. The analyzer runs without an external PC. For use in systems, it can be remote-controlled via GPIB or LAN. www.rohde-schwarz.com.

Magma buys Knights Technology

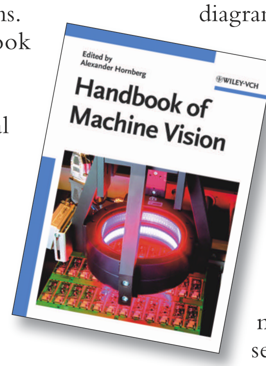
Magma Design Automation announced it has acquired Knights Technology, a provider of yield-management and failure-analysis software, from FEI. Knights Technology products and employees will be part of Magma's Fab Analysis Business Unit. Magma said it expects the acquisition to enable a tighter integration between Magma's design software and semiconductor manufacturing. www.magma-da.com.

JON TITUS
CONTRIBUTING TECHNICAL EDITOR
jontitus@comcast.net

Handbook shines light on vision

If you design or specify machine-vision systems, you'll like *Handbook of Machine Vision,* a book edited by Alexander Hornberg, a professor of physics and photonics at the University of Applied Sciences in Esslingen, Germany. In this 798-page volume (Ref. 1), Hornberg has compiled a wealth of information that addresses topics at both practical and theoretical levels. The book covers areas such as general system-design principles, lighting, optics, camera systems, computer interfaces, and algorithms.

I recommend you first read section nine, "Machine Vision in Manufacturing," because it provides a solid introduction to what vision systems can do and the problems they can solve. Then, jump to the front of the book. Although I found the first chapter on human vision and visual perception interesting, I read through it quickly so I could move to chapters that address real vision systems.



Flip through the book quickly and you will see many equations. The section on optical systems, for example, includes math-laden discussions of Gaussian optics, the wave nature of light, and image transfer and storage. But you need not master these topics to learn non-math lessons. The last few pages of this section, for example, hit the mark with useful information about image quality.

You'll also find a bit of math in the 180-page chapter on algorithms, but unless you plan to write algorithms, you can jump to the explanations and diagrams. Often, software vendors describe algorithms as though everyone understands what they do. In this chapter, readers will learn about many image-processing techniques that manipulate images so they yield more useful information. (The book does not provide algorithm code.)

Designers will also find much useful information in the section "Lighting in Machine Vision." This chapter provides just the type of explanations and illustrations that help engineers properly plan and assemble light sources for an application. If you still perceive lighting techniques to be black magic, turn to this chapter for advice. I cannot think of another source that offers as much practical information about lighting.

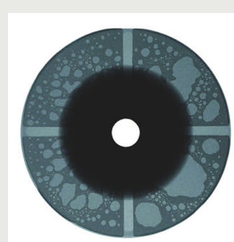
This reference book provides many helpful diagrams and photographs that illustrate how algorithms work, the results of lighting components in various ways, and how camera systems operate. Unfortunately, only some of the some illustrations include color; its wider use would enhance the book's value.

Readers will find a few gaps in the handbook's coverage of vision systems. The editor has not included information about color machine vision or about the practical aspects of lens selection. More information about communicating with industrial networks and control systems would help, too, but one book can contain only so much. T&MW

REFERENCE

1. *Handbook of Machine Vision,* edited by Alexander Hornberg, Wiley-VCH, Weinheim, Germany, 2006. ISBN: 978-3-527-40584-8. 798 pages. $190. (Available from John Wiley & Sons, www.wiley.com.)

Software supports live image



Viscom's new XMC software for its manual and semi-automatic x-ray systems supports real-time image processing to provide a live-image mode with no time delay. XMC is integrated into the Viscom Vision Pilot (VVP) unified operating interface for all Viscom systems. The software permits an operator to examine PCB defects such as voids in a solder joint. XMC optionally supports generation, display, and analysis of 3-D volumetric models using computed tomography. www.viscom.de.

StockerYale acquires Photonic Products

StockerYale has announced that it has acquired privately held Photonic Products, a UK-based provider of laser-diode modules and laser diodes, for $9.4 million in cash, stock, and bonds. StockerYale said the acquisition will broaden its portfolio of laser modules and increase its 2006 pro forma revenues by approximately 50%. www.stockeryale.com.

Automated nanoscale optical profiler

Hyphenated Systems has announced the release of its HS200A NanoScale optical profiler. The HS200A adds automation capability to Hyphenated Systems' HS200OP to provide repeatable nondestructive inspection, failure-analysis, and quality-control applications involving MEMS and other semiconductor devices. The system incorporates Hyphenated Systems' patented Advanced Confocal Microscopy (ACM) technology, which acquires and displays high-resolution (less than 50-nm) 3-D images in seconds. www.hyphenated-systems.com.

TEMPERATURE MEASUREMENT

Notes provide thermocouple basics

Thermocouples are the most popular temperature sensors in use today. They are used in applications ranging from bench measurements with a digital multimeter (DMM) to industrial measurement and control applications with dataloggers and temperature controllers. Two application notes from Dataforth help you understand how thermocouples work, and they provide tips on how to reduce measurement errors.

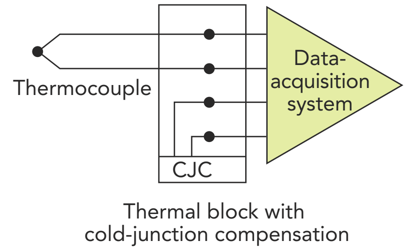
Application note 106, "Introduction to Thermocouples" (www.dataforth.com/catalog/pdf/an106.pdf), explains the physics behind thermocouples. It also accurately explains how thermocouples use the Seebeck Effect—where a voltage develops across the ends of a wire when the ends are at different temperatures—a concept that's often misrepresented in technical literature.

Application note 107, "Practical Thermocouple Temperature Measurements" (www.dataforth.com/catalog/pdf/an107.pdf), explains the different types of thermocouples, their temperature ranges, linearization, and measurement equipment. Graphs show you how thermocouple voltages are nonlinear with respect to temperature.

Note 107 also covers why instruments need cold-junction compensation and how they apply it. You'll get tips on how to use thermocouples and minimize measurement errors, such as those caused by ground loops. Finally, the note provides links to several sources for further reading.

Both application notes mention Dataforth products, but only as examples of technical concepts.

Martin Rowe, Senior Technical Editor



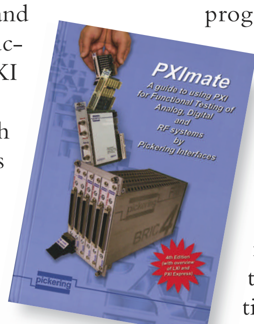
Thermocouples connect to data-acquisition systems through a thermal block that includes cold-junction compensation.

BOOK REVIEW

PXI book introduces LXI concepts

PXImate, 4th ed., Pickering Interfaces (www.pickeringtest.com/pximate), 2005. 172 pages. Free.

PXImate purports to be "a guide for using PXI for functional testing of analog, digital, and RF systems," and it readily lives up to that claim. The book, created by the staff of Pickering In- terfaces with input from Acqiris and Virginia Panel, also introduces concepts related to PXI Express and LXI.



The book kicks off with a chapter on PXI basics that's applicable for novice PXI users. It discusses 32- and 64-bit backplanes, their attendant bandwidths, and bridging considerations related to triggering. It also introduces PXI Express and comments on the use of hybrid PXI slots.

A chapter on software for PXI implementations comments on the use of Agilent Vee and NI LabView graphical programming for PXI applications, and it moves beyond the Windows environment to discuss the use of Unix, Linux, Solaris, and Macintosh operating systems. It notes that register-level programming can be used if available device drivers that support non-Windows environments can't be found, but it warns that such programming can become quite complex for all but the simplest instrument systems.

Chapter 3 provides a detailed introduction to LXI, comparing and contrasting it with PXI and succinctly describing the three LXI instrument classes. It also introduces the LXI physical configuration, reset mechanisms, LAN- and Web-based instrument communication, LXI triggering, and LXI programming.

The remainder of the book—chapters 4 through 10—focuses on implementation details. Chapter 4 defines basic switch configurations, ranging from SPST (single pole, single throw) through cascade and tree configurations and on to cross-point matrices. It describes the basic switch technologies (electromechanical, reed, mercury-wetted, edge-line, PIN-diode, FET, MEMS, and optical) and the modules in which they can be configured.

Subsequent chapters cover how to use switching systems for routing stimulus and response signals for digital circuits; how to select power supplies and simulate loads; how to integrate digital multimeters (DMMs), synthesizers, oscilloscopes, and digitizers into a PXI system; and how to select cables and connectors. A section on RF measurements provides information that's useful whether or not you are using a PXI platform; it defines and shows how to measure such specifications as 1-dB compression point and third-order intercept.

One thing the book doesn't do is expand on its PXI Express and LXI introductory material to go into detail on the nuances that those platforms might impose. We'll have to wait for the 5th edition for that.

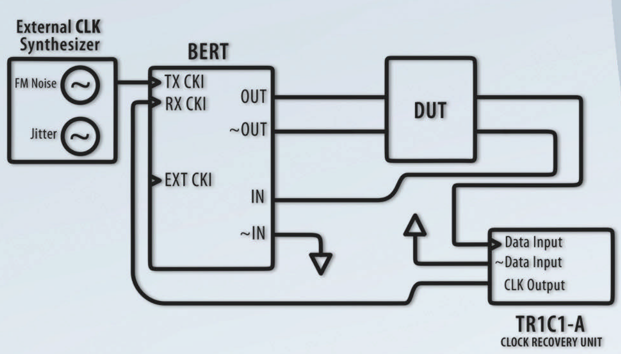
Rick Nelson, Chief Editor

Stand-Alone, AnyRate, Un-Banded

CLOCK RECOVERY UNIT

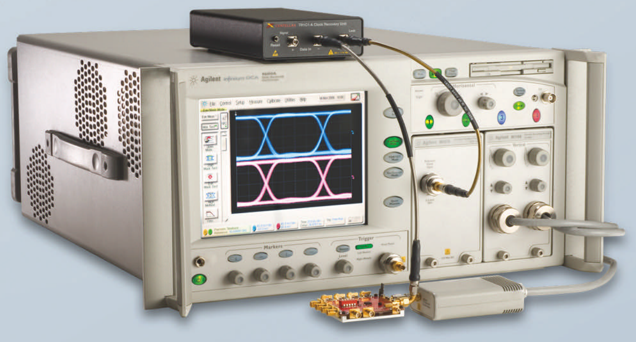
CLOCK EXTRACTION FOR BERT SYNCHRONIZATION

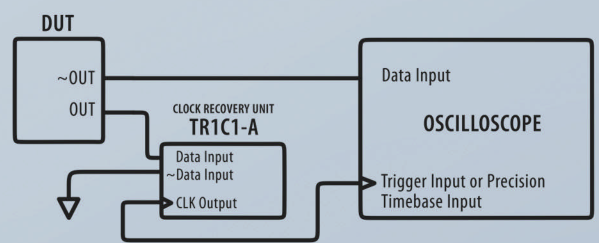
When a direct clock signal isn't available for your BERT error detector, the Centellax CRU extracts a clock signal from your data stream.



POWERFUL SCOPE TRIGGER

For sampling scope applications, the Centellax CRU recovers a clock signal from your degraded data stream.





Model No. TR1C1-A

7G / 13.5G CRU

622MHz to 13.5GHz

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ph +1.707.568.5900 | fax +1.707.568.7647 | sales@centellax.com
toll free +1.866.522.6888 | www.centellax.com

For additional details, application notes, and assembly diagrams, please visit:
www.centellax.com/?TR1C1-A
Secure online ordering available.

PROJECTPROFILE

COMMUNICATIONS TEST

Framed and moving

DEVICE UNDER TEST
2.5-Gbps multiservice framer ICs. The ICs combine Ethernet and PDH frames into synchronous optical network/synchronous digital hierarchy (SONET/SDH) frames for transport. The device can accept two Gigabit Ethernet streams, 28 DS1/E1 lines, three DS3/E3 lines, 24 SPI-3 channels, and four 622-Mbps SONET lanes. The devices also decode incoming frames from the SONET lanes into their respective tributaries.

THE CHALLENGE
Test each device for functional parameters such as framing, mapping, bit-error rate, jitter, and virtual concatenation of SONET/SDH containers into higher bit-rate streams for transport in 2.5-Gbps SONET/SDH signals. Measure current consumption and clock jitter.

THE TOOLS
- Agilent Technologies: digital data test sets, SONET/SDH testers, logic analyzer. www.agilent.com.
- Anue Systems: network emulator. www.anuesystems.com.
- Fluke: digital multimeter. www.fluke.com.
- Ixia: Ethernet tester. www.ixiacom.com.
- Spirent Communications: Ethernet tester. www.spirentcom.com.
- Tektronix: oscilloscope. www.tektronix.com.

PROJECT DESCRIPTION
Galazar Networks (Ottawa, ON, www.galazar.com) produces multiservice framer ICs for the telecom industry. Prior to releasing a product to production, Galazar engineers test devices for functional parameters such as throughput, bit-error rate, mapping, and framing. They also test devices for power consumption, clock jitter, setup and hold, and other parameters.

To verify that a device meets specifications, the engineers use a reference design board that provides support circuitry and a processor running the VxWorks operating system. The processor runs software that performs real-time functions such as performance monitoring and interrupt handling. The board also lets an external PC control the device under test's (DUT's) ports and configuration. Finally, it provides shunt resistors for measuring current consumption.

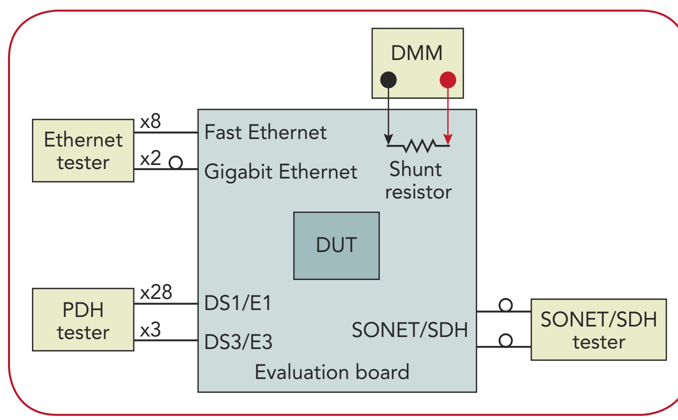
The framer must aggregate both plesiochronous digital hierarchy (PDH) frames from the digital data test sets and asynchronous Ethernet frames from the Ethernet testers into synchronous SONET frames. Engineers measure setup and hold (S&H) of the SONET data signals with an oscilloscope. They perform the test by looping the SONET lines back to the DUT. They measure S&H on a tributary DS1 or DS3 line, send the frames through the DUT, and measure the decoded stream's S&H.

Ethernet physical-layer hardware (PHY) extracts the clock from incoming streams so that engineers can measure the S&H time. The DUT must extract an embedded clock and make it available for jitter measurements with an oscilloscope. The engineers use the PDH testers to measure bit jitter on signals decoded from SONET frames and sent over the DS1/DS3 lines.

The Galazar engineers also must test for the device's latency in processing Ethernet frames. They generate time-stamped frames with the Ethernet tester and measure the time between when a frame is sent and when it is returned to the tester. A test also includes measuring lost Ethernet packets, which the engineers perform by breaking the SONET stream.

Engineer David Kirk and others also break the SONET loop so they can emulate an entire network with a network emulator. They can add impairments such as differential delay and bit errors.

Kirk explained that the engineers must automate the measurements by writing scripts for each tester and for the reference board. "When testing a new generation of parts," said Kirk, "we can spend four to six months because we have to write a new set of scripts. We must find and fix bugs in the scripts, the DUT, and sometimes the tester."



Ethernet and PDH testers generate bit frames that the service framer under test must aggregate into SONET/SDH frames.

LESSONS LEARNED
"Scripts are invaluable when we verify new products," said Kirk. "They let us set up and tear down configurations thousands of times. We can run a test in 24 hours that would take weeks if we operated test equipment manually."

Kirk also pointed out that it's important to work with test-equipment makers as they develop new products. Because Galazar engineers worked with Agilent Technologies during the development of enhancements to the SONET/SDH testers, they were able to influence the feature set in the Agilent tester.

Martin Rowe, Senior Technical Editor

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WWW. TMWORLD.COM/AWARDS

PROBING SYSTEMS

M150 Measurement Platform

CASCADE MICROTECH, www.cascademicrotech.com

The M150 Measurement Platform provides high-performance and precision electrical-measurement capabilities for any type of 150-mm device on a single platform. This platform has a configurable design that can make DC to 220-GHz measurements for the research and development of wafers, packages, boards, MEMS, and biological materials. Users can buy either a preconfigured application-specific system or configure their own system online.

With base prices that range from $7000 to $19,000, the platforms are affordable while offering users sufficient flexibility to switch between applications within minutes by adding accessory kits that cost from $5000 to $35,000. The M150 is compatible with the company's L-Series Microfluidics Metrology Systems.

AUDIO TEST

APx585 audio tester

AUDIO PRECISION, www.ap.com

The APx585 redefines ease of use for testing devices such as cell phones and MP3 players. It has eight analog audio inputs and eight analog outputs, and it supports eight channels of digitized audio. The APx585 performs up to 14 measurements in 10 s. Measurements include frequency response, total harmonic distortion plus noise, crosstalk, signal-to-noise ratio, and interchannel phase.

Windows software lets you develop custom test sequences in which you select any or all measurements. You can set limits for any measurement and see results in real time. Test results include a time or frequency plot and a bar graph that shows test results for each channel. A PC screen can also show the list of measurements and settings for the current measurement.


ROY WIEMANN

Each year, *Test & Measurement World*'s editors present the Best in Test awards to products we think are particularly innovative or useful. Here, we present the 2007 Best in Test winners as well as 24 products worthy of honorable mention (p. 30).

T&MW's editors narrowed this year's field from scores of deserving products, nominated by vendors, that were introduced between November 1, 2005, and October 31, 2006.

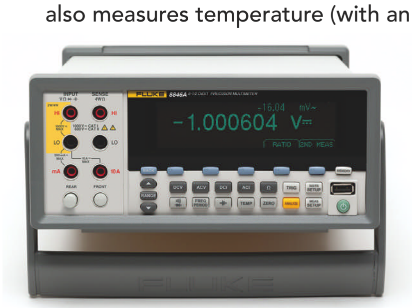
You can help determine which of the 12 Best in Test products will become the Test Product of the Year. Simply visit www.tmworld.com/awards and cast your vote by January 26, 2007. We will announce the winning product in February and will publish a story about it in our March 2007 issue.

DIGITAL MULTIMETERS

8846A digital multimeter

FLUKE, www.fluke.com

The 8846A puts Fluke into the 6.5-digit DMM market. It measures AC and DC voltage and current, two-wire and four-wire resistance, frequency, and period. The 8846A also measures temperature (with an RTD) and capacitance. Basic DC accuracy is 0.024%. A front-panel USB port lets you store data on a flash-memory device.



The DMM comes with special probes that let you make four-wire resistance measurements with two leads. Each probe lead contains a second, embedded wire and jacks that connect both wires in the lead to the meter. Soft keys let you invoke measurement functions such as statistics, histograms, and trend plots.

BOARD TEST

TapCommunicator boundary-scan interface

JTAG TECHNOLOGIES, www.jtag.com

JTAG TapCommunicator (TapComm) is an intelligent channel for communicating boundary-scan test vectors and device-programming data over unlimited distances to a target system. The product consists of Uplink and Downlink modules, both of which are compatible with IEEE 802.3z Gigabit Ethernet and IEEE 1149.1.

The Uplink and Downlink modules code and decode boundary-scan application data. The result is a communications system that provides a high-speed link of unlimited range between the tester and target with no signal degradation. TapComm supports up to four boundary-scan TAPs. Since it operates on the standard IEEE 1149.1 protocols and state machine, TapComm is vendor-independent and can be used with any compliant tester, emulator, or programmer.

> > >

MEMS TEST

InFlip MEMS strip-test module

MULTITEST, www.multitest.com

A member of Multitest's InMEMS product line, the InFlip MEMS strip-test module for three-axis low-g accelerometers incorporates a modular architecture designed to replace expensive custom-designed machinery. Convertible to support various MEMS applications and packages, the module can operate in a stand-alone mode in an engineering bench setup, or it can be configured with a Multitest InStrip platform for full automation.

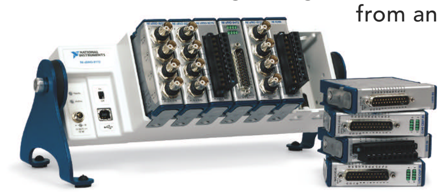
The InFlip module can handle panels and lead frames ranging from 20x150 mm to 65x225 mm. It supports tests over the –40°C to +150°C temperature range. Access rotation velocity is approximately 180° per second. Index time is 0.5 s; strip exchange time is 9 s.

DATA ACQUISITION

CompactDaq USB-based data-acquisition system

NATIONAL INSTRUMENTS, www.ni.com

You can use the CompactDaq mainframe to configure a USB data-acquisition system for the lab, the production floor, or the field. The mainframe accepts up to eight signal-conditioning modules for voltage, thermocouple, and digital signals. Analog modules contain their own analog-to-digital converters. Modules range from an eight-channel digital I/O module to a four-channel, 50-ksamples/s digitizer for audio and vibration measurements.



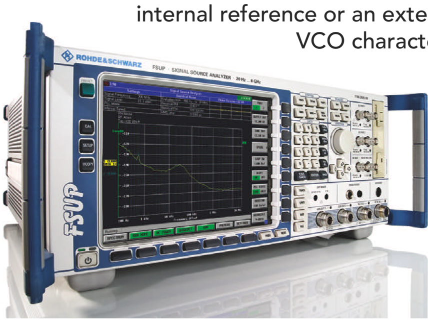
Modules are hot-swappable, so you can reconfigure a system without powering down. The mainframe increases throughput for large data transfers though direct memory access (DMA) transfer between the data-acquisition and USB sections. Software support includes a datalogging application and programming interfaces for LabView, Visual Studio .NET, and C/C++.

RF/MICROWAVE TEST

FSUP signal source analyzer

ROHDE & SCHWARZ, www.rohde-schwarz.com

The R&S FSUP combines a phase-noise test set with a high-performance spectrum analyzer (R&S FSU) in one box that can operate up to 50 GHz. When measuring phase noise, the instrument compares a signal from a device under test with a reference signal source using its internal reference or an external reference. For VCO characterization, the instrument measures VCO tuning characteristics and includes several low-noise DC sources to supply and control the device under test (DUT). A time-domain function measures settling times.



The FSU spectrum analyzer integrated in the instrument allows users to perform measurements on parameters such as adjacent channel power. The FSUP can also measure noise figure with the aid of a noise source and the optional R&S FS K30 noise-measurement software.

AUTOMATED OPTICAL INSPECTION

OptiCon BasicLine 1M/4M AOI system

GOEPEL ELECTRONIC, www.goepel.com

The OptiCon BasicLine 1M/4M is a stand-alone automated optical inspection (AOI) system for manual loading of components, PCBs, and assemblies. The centerpiece of the family is an extendable camera design, which allows alternative selection of a 1- and a 4-Mpixel camera module. Additional camera options support through-hole-technology (THT) component inspection, color inspection, and 3-D measurement. The system also offers an angled-view capability for the inspection of the pins of plastic-leaded chip-carrier (PLCC) and small-outline J-lead (SOJ) components.

The new OptiCon BasicLine 1M/4M platform is designed to offer short debug times, minimal false call rates, and high fault coverage. It also employs a linear drive system that results in an up to 50% higher test speed, compared with earlier generations.

VOTE ONLINE FOR THE TEST PRODUCT OF THE YEAR

WAVEFORM GENERATORS

AWG7000 series arbitrary waveform generators

TEKTRONIX, www.tektronix.com

The AWG7000 series consists of four models, with the top model capable of producing waveforms at 20 Gsamples/s with a 5.8-GHz bandwidth. That's high enough to simulate wireless signals and many serial data streams. All models in the series feature a 10.4-in. display, so you can see a detailed representation of the analog output signal. You also can capture signals from a Tektronix oscilloscope and replay them.

All models come with 64 Mbytes of waveform memory, but you can use loops and branches to produce longer waveforms. An external trigger lets you start a waveform, and a conditional trigger lets the instrument jump to a particular signal pattern stored in memory. Each AWG7000 generator includes a removable hard drive and USB ports for secure data storage.

WIRELINE COMMUNICATIONS

Spirent Protocol Tester

SPIRENT COMMUNICATIONS, www.spirentcom.com

Designed for protocol testing of convergence networks and network elements, the Spirent Protocol Tester can test any major VoIP protocol, and it can test the emerging integrated IP Multimedia Subsystem (IMS) protocols. The tester is available as a software-developer version for a PC or installed in either the Spirent Abacus call generator or a Protocol Tester chassis. The developer version lets you generate up to 50 calls, the Abacus version makes 400 calls, and the Protocol Tester chassis makes 10,000 calls.

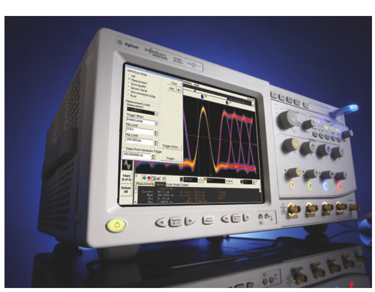
All versions support VoIP protocols such as SIP, RTP, H.323, and H.248. The tester also supports IMS Call Session Control Function and push-to-talk.

OSCILLOSCOPES

Infiniium 80000B series oscilloscopes

AGILENT TECHNOLOGIES, www.agilent.com

The improved noise floor in the Infiniium 80000B series of four-channel, 2-GHz to 13-GHz oscilloscopes lets you use a higher-bandwidth scope than you could with previous models. With the higher bandwidth, you can capture high-frequency harmonics and get a more accurate picture of a waveform. Because you can also upgrade an instrument's bandwidth without returning it to the factory, you can buy just enough bandwidth for your current application and then upgrade as your signals gain speed.



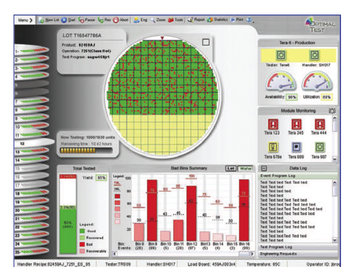
The Infiniiscan option lets you post-process signals and set triggers based on waveform parameters such as rise time, pulse width, frequency, jitter, or a combination of voltage and time characteristics. A menu lets you select from several categories of triggers.

SEMICONDUCTOR TEST

Test Management Solutions software

OPTIMALTEST, www.optimaltest.com

OptimalTest Test Management Solutions (OT-TMS) is a comprehensive, scalable, and universal software tool for the management of the IC testing process, from preproduction to post-production. OT-TMS delivers improvements in return on investment for installed test assets within an integrated device manufacturer (IDM), foundry, fabless company, or assembly/test house.



OT-TMS delivers seamless connectivity among its five modules: OT-Mgr, which provides integrated and coherent management of the multidisciplinary facets of test operations; OT-Sim, which enables the simulation of testing rules on actual test results; OT-Box, a real-time, universal station controller for testers, probers, handlers, and test programs; OT-Post, which reevaluates test results to control the quality and health of all facets of testing operations; and OT-Ops, which supports the need for productive test management while pinpointing inefficiencies to enable prompt responses.

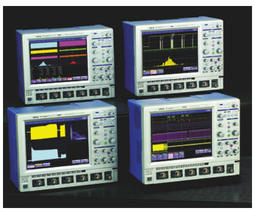
WWW.TMWORLD.COM/AWARDS • DEADLINE: JANUARY 26, 2007

Honorable Mentions

WaveRunner 204Xi oscilloscope

LECROY, www.lecroy.com

The WaveRunner Xi series with its 6-in. depth and 10.4-in. touch-screen display brings the form factor of LeCroy's WaveSurfer family to the company's midrange line of scopes. The 600-MHz, four-channel scope offers fast viewing with color-gradient displays. It operates at up to 10 Gsamples/s and updates the screen 8000 times/s. Options include a 32-channel logic probe, CAN bus triggering and decoding, power measurements, jitter measurements, digital filtering, EMI measurements, and up to 24 Msamples of waveform memory.



SystemBIST FPGA configuration device

INTELLITECH, www.intellitech.com

SystemBIST is a plug-and-play IC for flexible FPGA configuration and embedded PCB self-test. It loads designs into RAM-based FPGAs upon power-up, eliminating the need for serial configuration PROMs. SystemBIST can configure any IEEE 1532 or IEEE 1149.1 compliant FPGA. The IC stores IEEE 1149.1-based test patterns and scripts compressed in flash memory, enabling PCBs to be tested anywhere that they can be powered. This second-generation device also offers fail-safe FPGA updates in the field.

Vanguard Express AMC protocol & link analyzer

VMETRO, www.vmetro.com

The Vanguard Express AMC is a protocol and link analyzer for debugging, testing, and validating PCI Express in the AdvancedMC (AMC) form factor and, when used with an adapter, other form factors as well. The analyzer installs between the device under test and the host system and is controlled through a USB or Ethernet interface. Users decode the PCI Express protocol with the BusView 5 software. Trace data can be arranged in chronological order or grouped as link or split transactions.

BBWGD 16-channel mixed-signal module for SoC test

ADVANTEST, www.advantest.com

Advantest's Base Band Waveform Generator Digitizer (BBWGD) is a 16-channel mixed-signal module that lets you test multisite, multichannel system-on-chip devices used in mobile phones, set-top boxes, DVD players, and WLAN baseband equipment. The high channel density and mixed-signal capability of the board satisfies diverse test needs while delivering accuracy and flexibility. The BBWGD module further extends the capabilities of the T2000 SOC test platform, which is based on the OpenStar open architecture specifications.

AV6010 IC package & memory card inspection system

SOLVISION, www.solvision.net

In addition to inspecting conventional IC packages, the AV6010 performs package defect inspection and precise 2-D/3-D measurements on all types of memory cards, including MMCPlus, MMCMobile, MMCmicro, SD, miniSD, and microSD form factors. The AV6010 offers dual-sided in-tray inspection and advanced defect-detection capabilities, such as true 3-D measurement and warpage detection. It even detects label peeling and bubbles, which can affect memory card compatibility.

SigmaSure RMA Insight Web-based software

SIGMAQUEST, www.sigmaquest.com

The SigmaSure RMA Insight software enables OEMs to gain detailed knowledge of products returned by users. The Web-based software aggregates data from various sources, including return material authorization (RMA) databases, so OEMs can quickly learn the causes of product defects and gain statistical knowledge about product performance trends. With RMA Insight, you can drill down to get a single view of what, when, where, and how failures occur. In addition, OEMs can expedite product upgrades and recalls.

Optixia XM IP test system

IXIA, www.ixiacom.com

The Optixia XM is a single-chassis IP test platform that emulates voice, video, and data to the scale of a service provider. With the IxLoad and IxNetwork software, engineers can emulate IPTV and triple-play subscribers and test complex network topologies consisting of thousands of devices. The Optixia XM allows engineers to direct both real-world application and conventional packet-based network traffic over Internet-scaled, emulated IP/MPLS network topologies to determine subscribers' quality of experience.

UEILogger datalogger

UNITED ELECTRONIC INDUSTRIES, www.ueidaq.com

Offering more than 20 I/O boards, including serial and CAN bus inputs, the UEILogger gives you the flexibility to match datalogger I/O to a variety of applications. A six-slot version of the rugged datalogger/recorder accommodates up to 150 analog or 288 digital I/O channels and provides sampling rates of up to 100 samples/s on each channel or port; the unit logs data onto a 2-Gbyte SD memory card, which stores more than 500 million 16-bit analog-to-digital readings. The UEILogger operates from –45°C to +85°C and withstands 50-g shock and 5-g vibration.

N9020A MXA signal analyzer

AGILENT TECHNOLOGIES, www.agilent.com

Delivering the measurement speed of a high-end signal analyzer, the N9020A MXA mid-range analyzer (base price: $25,900) produces a W-CDMA ACLR fast-mode measurement speed of <14 ms, marker peak search at <5 ms, and RF center frequency tune and transfer over GPIB at <51 ms. Measurement-mode switching speeds are typically <75 ms. The MXA platform supports multiple frequency ranges up to 26.5 GHz, internal preamplifiers up to 26.5 GHz, and analysis bandwidths of 10 MHz or 25 MHz.

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Signature MS2781B signal analyzer

ANRITSU, www.us.anritsu.com

The Signature MS2781B provides spectrum analysis and integrated vector signal analysis over a frequency range of 100 Hz to 8 GHz with bandwidths to 50 MHz. The instrument offers a seamless interface to Matlab for extended analysis and visualization. Built-in one-touch "smart" measurements and optional personalities for phase noise, WiMax, WCDMA/HSDPA, and QAM/PSK modulation analysis ease measurements on complex signals.

DPO4000 oscilloscopes with Wave Inspector

TEKTRONIX, www.tektronix.com

Covering a range of 350 MHz to 1 GHz, the DPO4000 series of oscilloscopes is the first from Tektronix to offer the Wave Inspector tools for efficient viewing, navigation, and analysis of waveform data in a matter of seconds. The DPO4000 provides a standard record length of 10 million points, and Wave Inspector provides front-panel controls for zooming, panning, playing and pausing, setting and clearing user marks, navigating between marks, and searching for user-defined events throughout the 10-million-point record.

DT9837 USB sound and vibration acquisition module

DATA TRANSLATION, www.datatranslation.com

Powered through a USB connection to a laptop computer, the DT9837 accepts four simultaneous 24-bit IEPE sensor inputs that are synchronized with a tachometer input. You can use the DT9837 for performing portable sound and vibration measurements in applications such as automotive test, acoustics, and sonar. The module delivers a sampling rate of over 52 kHz per input channel and provides an analog input range of ±10 V with software-selectable gains of 1 and 10.

ZT4610 oscilloscopes

ZTEC INSTRUMENTS, www.ztecinstruments.com

The ZT4610 family brings benchtop oscilloscope capabilities to the VXI, PCI, and CompactPCI/PXI platforms. Each 8-bit model delivers a 4-Gsamples/s sampling rate with 800-MHz analog bandwidth. With record length options of 16- through 128-Msamples, the ZT4610 provides the deep memory required for acquiring complex signals. An analysis library includes typical oscilloscope vertical, horizontal, and frequency measurements. The PCI and PXI models offer two channels; the VXI model is available in both two- and four-channel versions.

Medalist iVTEP vectorless test software

AGILENT TECHNOLOGIES, www.agilent.com

Medalist iVTEP (Intelligent Vectorless Test Extended Performance) software addresses the challenges in PCB testing brought on by ultra-small device packages with minimal or no lead frames. The new iVTEP builds on vectorless test capabilities of the company's earlier VTEP and TestJet technologies, enabling more accurate measurements to be made on ICs. Medalist iVTEP is a software upgrade that works with any Medalist i5000 or 3070 in-circuit test system equipped with a VTEP-compatible fixture.

V93000 HSM high-speed DRAM tester

VERIGY, www.verigy.com

Intended for the final testing of high-speed memories, the V93000 HSM Series DRAM tester boasts 3.6-Gbps at-speed I/O and 3.6-Gbps at-speed memory core test functions. Besides providing fast data rates, the V93000 HSM Series leverages a scalable per-pin timing architecture that makes it adaptable for emerging DRAM technologies. It features fast yield learning, 16X site parallelism in a single test, and source synchronous and parallel eye-finding functions to support new I/O concepts for GDDR and XDR technologies.

CNT-90XL microwave counter/analyzer

PENDULUM INSTRUMENTS, www.pendulum-instruments.com

The CNT-90XL is a combined frequency counter and power meter for continuous wave and burst signals that delivers a measurement speed of up to 250,000 frequency samples/s. It displays frequency changes over time for analysis

2 GHz Clock Generator

CG635...$2490 *(U.S. list)*

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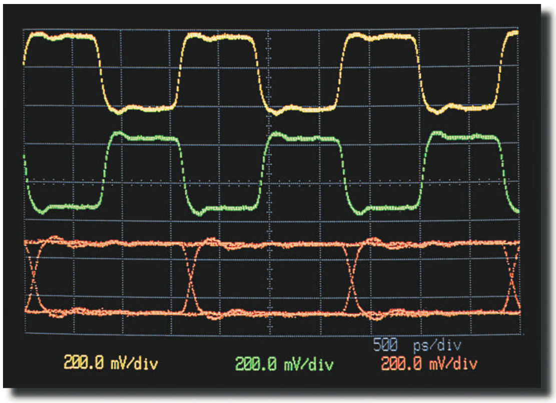
- ***Phase adjustment & time modulation***



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

The CG635 generates clock signals—flawlessly. The clock signals are fast, clean and accurate, and can be set to standard logic levels.

How fast? Frequency to 2.05 GHz with rise and fall times as short as 80 ps.

How clean? Jitter is less than 1 ps and phase noise is better than –90 dBc/Hz (100 Hz offset) at 622.08 MHz.

How accurate? Using the optional rubidium timebase, aging is better than 0.0005 ppm/year, and temperature stability is better than 0.0001 ppm.

You would expect an instrument this good to be expensive, but it isn't. You no longer have to buy an rf synthesizer to generate clock signals. The CG635 does the job better—at a fraction of the cost.

Stanford Research Systems

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of fast FM/AM, frequency/power settling and drift, and frequency/power drop out. Built-in statistical processing presents numerical stability data as well as frequency/power distribution histograms. Versions of the CNT-90XL cover frequencies up to 27 GHz, 40 GHz, 46 GHz, and 60 GHz.

Siloti SilVE visibility enhancement tool

NOVAS SOFTWARE, www.novas.com

Siloti SilVE visibility enhancement software helps engineers investigate complex IC and system-on-chip behavior for verification and system validation applications incorporating design-for-debug (DFD) methodologies. It compiles the HDL design and performs an analysis to identify essential signals in order to minimize the set of signals probed during silicon prototype. Siloti SilVE also correlates silicon data to the RTL source code and waveform views to aid in debugging. Users can optimize signal visibility using DFD logic while minimizing the impact on chip resources.

Optical backscatter reflectometer

LUNA TECHNOLOGIES, www.lunatechnologies.com

Luna's Optical Backscatter Reflectometer (OBR) with distributed sensing transforms telecom-grade fiber into a high-spatial-resolution strain and temperature sensor. The OBR uses swept wavelength interferometry to measure the Rayleigh backscatter as a function of length; it measures shifts in the backscatter pattern and scales them to give a distributed strain or temperature measurement with resolution as fine as 1 µstrain or 0.1°C. The OBR measures reflections with 125-dB sensitivity, 60-dB dynamic range, and 40-µm spatial resolution for up to 500 m of optical length.

Eclipse MA100 inverted metallographic microscope

NIKON INSTRUMENTS, www.nikonusa.com

The Eclipse MA100 inverted microscope is designed for reflected-illumination brightfield and simple polarizing observation and analysis of prepped materials and metallurgical samples, and its stable three-plate structure stage enables it to handle heavy samples. The MA100 is equipped with Nikon CFI-60 optics, which provides high numerical apertures and long working distances. To simplify polarization illumination, the polarizer and analyzer are linked so they are easily engaged from a single-action lever.

Wonder Wave 2074 waveform/function generator

TABOR ELECTRONICS, www.taborelec.com

The Wonder Wave 2074 four-channel arbitrary waveform/function generator operates at 200 Msamples/s with 16-bit vertical resolution. It outputs waveforms over a range of 100 µHz to 80 MHz, and all four output channels are synchronized to the same reference clock. The internal frequency reference has 1-ppm accuracy and stability over a period of one year. An external frequency reference is provided for applications requiring greater accuracy. The 2074 comes with Ethernet, USB 2.0, and GPIB control interfaces, as well as ArbConnection software.

E2960B Series protocol analyzer/exerciser for PCIe2

AGILENT TECHNOLOGIES, www.agilent.com

The E2960B integrates a complete x1 through x16 protocol analyzer, Link Training and Status State Machine (LTSSM) exerciser, midbus probes for nonintrusive measurements, and a gateway to logic analysis for PCI Express 2.0. Since the E2960B is based on the company's N2X platform, upgrading to PCIe2 allows reuse of chassis and probing solutions for PCIe1 applications and the use of backward-compatible API and scripts. The P2L protocol-to-logic gateway links the protocol analyzer to a logic analyzer to permit cross triggering and marker correlation.

DSG9000 HD radio test signal generator

NOISECOM, www.noisecom.com

The DSG9000 signal generator transmits vector signals via cables or audio antennas into an HD-type radio, allowing engineers to test both the analog and the digital circuitry. The DSG9000-02 contains a full suite of test vectors and can be used to analyze noise, distortion, and multipath errors on new designs. The DSG9000-01 is designed for production testing and includes one vector for AM and a second vector for FM. The intuitive interface helps broadcast engineers who are not familiar with test and measurement operations.

R&S ESU EMI test receivers

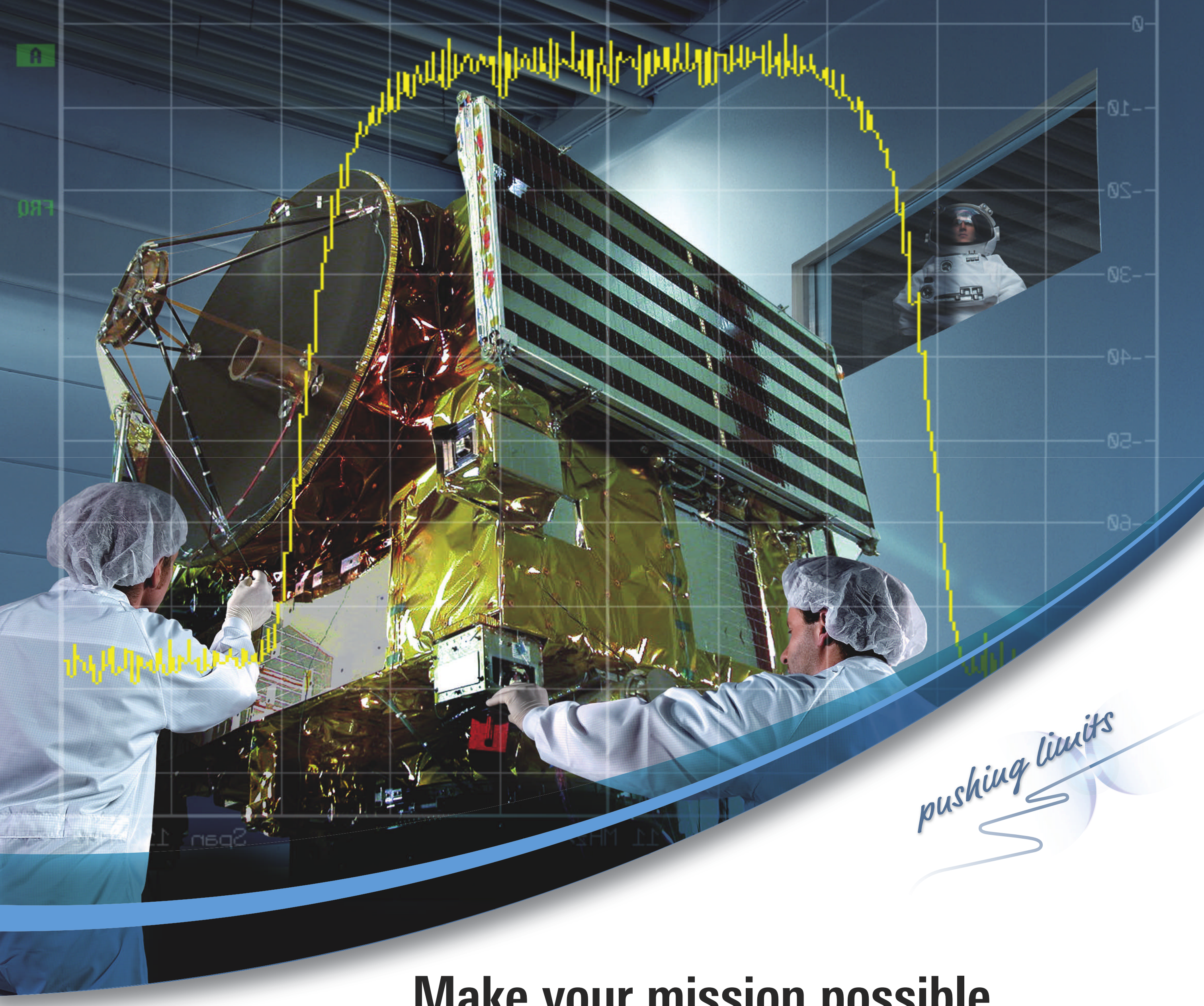
ROHDE & SCHWARZ, www.rohde-schwarz.com

The R&S ESU family of CISPR-1-1-compliant EMI test receivers meets civil and military standards for electromagnetic interference measurements. With the FFT-based time-domain scan, you can perform overview measurements more than 100 times faster than on previous test receivers. The instruments provide a complete set of parallel detectors (including the new CISPR-RMS detector), RF scan, IF analysis, and numerous report functions. Three models are available covering frequency ranges from 20 Hz up to 8 GHz, 26.5 GHz, or 40 GHz.

Model 2910/2810 vector signal generator/analyzer

KEITHLEY INSTRUMENTS, www.keithley.com

Useful for automated wireless device testing, the combination of the Model 2910 vector signal generator and the Model 2810 vector signal analyzer employs a digital software-defined radio architecture and DSP/FPGA design to achieve high speed, ease of use, and low cost (base price: $15,000 each). Both instruments have a digital up/downconverter synthesizer that can tune in less than 3 ms. The Model 2810 executes a 200-MHz bandwidth sweep with 100-Hz resolution in less than 15 s. Each unit runs under Windows CE.


pushing limits

Applying the right signal-calculation algorithms and techniques can compensate for AWG wraparound artifacts and can also save memory.

UNWRAPPING wireless signals

JOAN MERCADÉ,
ARBITRARY RESOURCES

State-of-the-art arbitrary waveform generators can directly generate multi-carrier digitally modulated signals. Courtesy of Tektronix.

Arbitrary waveform generators (AWGs) have become the standard signal sources for baseband and IF signals in wireless test applications. The increasing sampling speed, bandwidth, and linearity of available instruments are opening the door to direct RF generation. Although the instruments can generate high-quality signals, wraparound artifacts can ruin the final results. By using the right signal-calculation algorithms and techniques, you can eliminate wraparound problems while saving precious generation memory.

AWGs can create virtually any modulation scheme, including multicarrier, dissimilar signals with linear and nonlinear impairments. Some use firmware or external software to calculate the required samples according to user requests. The calculation software, unlike a real transmitter, need not calculate samples in real time, as samples are stored in the generation memory and played back at the required sampling speed during generation.

Current AWGs provide enough signal quality and sampling speed to generate highly accurate signals capable of testing the most demanding wireless devices. Although current implementations provide flexible signal generation, including long record lengths and intelligent segment sequencing, the only way to create arbitrarily long signals, including continuous generation, is by repeating or sequencing finite-duration waveforms. This is a classic AWG limitation that results in an unwanted side effect on the signal: the so-called "wraparound artifact."

Wraparound causes and effects

Wraparound artifacts (**Figure 1**) are caused by the discontinuity between both ends of a given waveform being repeated in a loop or, in a more general case, between the end and the beginning of two consecutive waveforms in a sequence. It is important to understand that AWGs can link signal segments without any gap or glitch related to the sampling period as samples are converted seamlessly regardless of their location.

The effect of wraparound artifacts may be negligible in many time-domain tests as users can restrict their measurements made on the device under test (DUT) to areas away from the transition between signal segments. The usage of synchronization signals provided by the generators makes this approach easy to implement in most test cases.

Even if the measurements are performed at the right moments in time, however, the intersegment transients can affect the behavior of the DUT. For example, in a serial-data transmission test, the clock-recovery circuits in a DUT can lose their lock if a transient results in truncated symbols or illegal line coding. Depending on the length of the data and the time taken by the DUT to lock the clock again, test results will not be valid as they will not reflect steady-state behavior.

Wireless test can be even more demanding. Wireless tests occur in many domains consecutively or simultaneously: time, frequency, modulation, channel-coding, and protocol. In many wireless-test situations, measurements cannot be easily restricted to signal areas away from the wraparound transients. (See "Impairment effects in various domains," p. 42, for an explanation of how wraparound artifacts can hinder wireless measurements.)

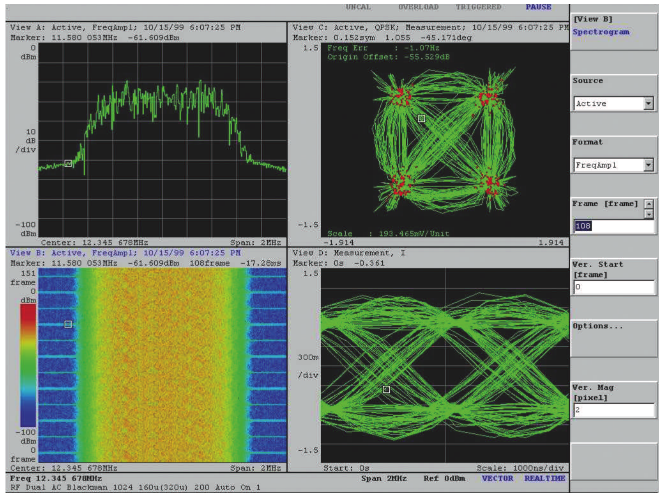


FIGURE 1. (Top left) This VSA display shows the effects of the wraparound artifacts on the signal. (Lower left) The spectrogram displays regular spectral-growth episodes, right at the connection between waveform segments. The constellation display (top right) and the eye diagram (bottom right) show how wraparound affects all the aspects of a digitally modulated signal.

Solving the problem

There are two basic ways to handle the wraparound problem: hide the symptoms or eliminate the causes.

For some wireless signals, just hiding the side effects of wraparound may be sufficient. The prime method for doing this is transient editing.

The idea is quite simple. Because discontinuity between the end and the beginning of consecutive signal segments is the main cause of impairments, editing the transition area so that both ends match as perfectly as possible could help solve the problem. This can be accomplished by manual editing or in a semi-automatic way through filtering or smoothing. Filtering is applied to the border sections of the waveforms to bring about a smooth transition (**Figure 2**). This methodology can attenuate, or even eliminate, the spectral-growth impairment to the level required by adjacent channel power ratio (ACPR) measurements.

Unfortunately, transient editing does not solve any of the other impairments, and in most cases the overall situation worsens. Any measurement of modulation quality must be performed away from the wraparound transient, which requires you to use time-gated measurements. Furthermore, DUTs must have enough time to settle between these transients. Time-gated measurements also require the use of measurement-synchronization signals to mark the distortion-free areas of the signal. Some AWGs offer such signals in the form of trigger or user-editable marker outputs.

When time-gated measurements are impossible or undesirable and the available generation time window at the target AWG is not enough to generate the required signal in a single pass, the only practical solution is to eliminate the wraparound problem. As the basic reason for wraparound is the repetition or the sequencing of inconsistent signals, an obvious solution would be to use a real-time generation architecture. After all, real-world transmitters, in which the carrier is modulated by nonrepetitive data and in which baseband filtering is performed in real time, do not show this problem.

But real-time generators also have limitations. In addition to being costly,

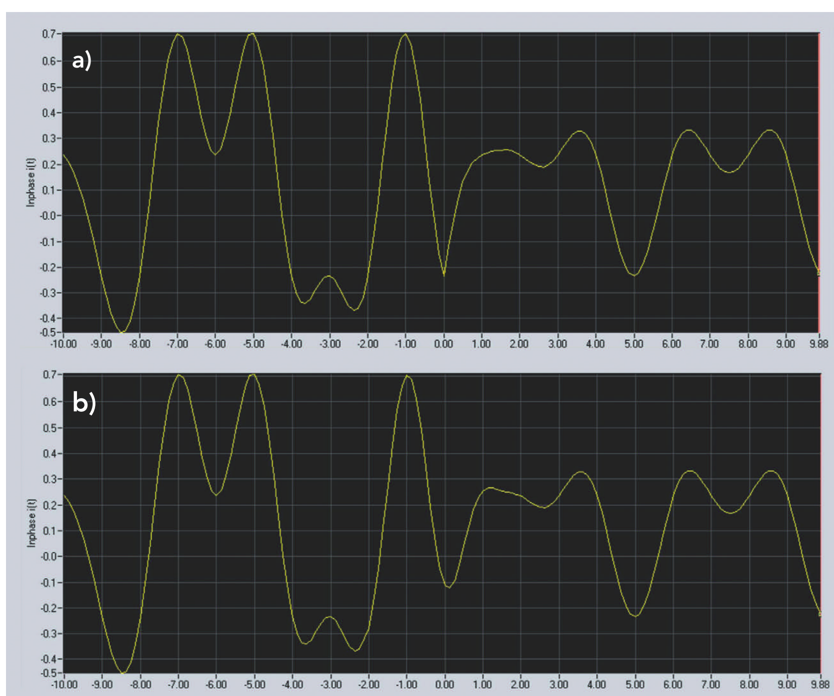


FIGURE 2. Transient smoothing can help reduce some of the side effects of wraparound, especially spectral growth. a) This display shows the result of looping a waveform with a discontinuity in its derivative at time 0. b) This display shows the same signal after transient smoothing, with no apparent discontinuities.

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they have a complex architecture that differs completely from the standard, scenario-based, AWG architecture. Also, real-time generators use DSPs to calculate the I and Q baseband samples in real time, so processing power is an issue. And all the calculations are performed by a program run by the DSP, so any modulation scheme must be supported by the instrument.

Sampling speed and signal quality are influenced by the processing power as they limit the oversampling capacity and the maximum symbol rate supported by the instrument. The quality of the signal may also be affected by the impulse response truncation required by implementation of the baseband digital filter. In addition, users are restricted to using the built-in signal standards and impairments instead of being able to create their own signals, as they can with conventional AWGs.

An alternative approach to using a real-time generator is to design the AWG's signals in such a way that the wraparound artifacts are completely eliminated. In such an environment, signals can be repeated or sequenced without any glitch during the waveform-to-waveform transitions just as in real transmitters when transmitting live traffic. Designing signals that meet these requirements is not as difficult as it may seem, at least at the basic layers of the protocol stack, but the signals do need to meet some requirements:

- The number of symbols in the signal must be an integer. Some modulation schemes may have additional requirements. The $\pi/4$ differential quadrature phase-shift keyed (DQPSK) scheme, as an example, requires the number of symbols to be an even number.
- For IF/RF signals, the number of carrier cycles must be an integer as well.
- For multicarrier signals, all the components must meet the two above conditions.

These conditions seem to impose restrictions to the values for carrier frequency and symbol rates, but if you carefully select the number of symbols, record length, and sampling speed, you can minimize frequency errors, especially when long record lengths are involved. In addition, in order to have glitch-free signals, you must perform baseband filtering seamlessly between the symbols at the end of the current waveform and at the beginning of the next.

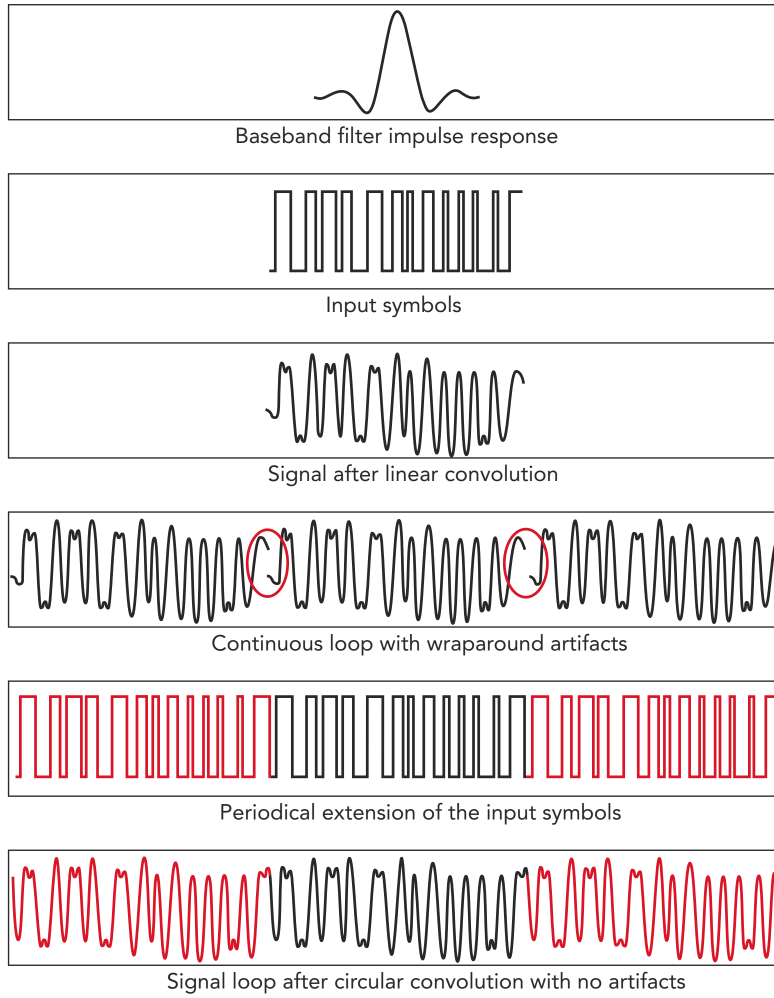

FIGURE 3. Circular convolution is the key to obtaining self-consistent signals that can be looped seamlessly.

For continuous repetition of any waveform, you must use the end symbols and the ones at the beginning in the convolution process with the baseband filter just as if they were part of the same sequence. You can accomplish this by applying an operation called circular convolution (**Figure 3**).

A similar approach, although more complex, can be applied to dissimilar waveforms in a sequence. The final result will be a waveform or set of waveforms that can be sequenced seamlessly without any wraparound impairments in the time, frequency, or modulation domains.

Although this methodology gives a general solution for baseband signals and for quadrature modulated IF/RF carriers, it is not enough to guarantee good results with frequency-shift keying (FSK) modulated carriers. FSK, including Gaussian minimum-shift keying (GMSK), will need an extra step to obtain a glitch-free signal, because even if all the previous conditions are met and circular convolution is applied to the modulating signal, the initial and final phase will differ.

Fortunately, there is a solution to this issue: adding a linear twist to the phase of the carrier. This "phase twisting" process is equivalent to modifying the carrier frequency. As the range for the phase difference is $\pm\pi$, a simple calculation

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Agilent Technologies

gives a maximum frequency error of $\pm 1/(2T_W)$, where T_W is the duration of the waveform segment. For a 100-Msamples/s, 10-Msample waveform, the worst-case error will be 5 Hz.

Going up in the protocol stack

In some cases, random data may be adequate, as it is the best payload for general-purpose time, frequency, and modulation domain testing. In other situations, though, a signal must convey framing, synchronization, or protocol information. So, even if the signal meets the basic wraparound, artifact-free conditions, you may need to take additional steps in order to avoid glitches at the required levels of channel coding or at the protocol layer.

A good example may be CATV DVB-C digital signals. To test the error level with a standard analysis tool, you must use a test signal with all the required channel coding, because errors are typically measured by using the error protection information carried by signal channel coding. This includes framing, block-error-correction (Reed-Solomon code) insertion, data interleaving, scrambling, and differential coding.

Fortunately, at this testing level, the contents of the payload are irrelevant. The minimum self-consistent data chunk for that kind of signal is 1632 (204x8) bytes long and includes eight complete error-protected packets along with the required synchronization and scrambling. The minimum symbol sequence that can accommodate a consistent data sequence depends, though, on the modulation scheme.

For QAM16 (4 bits/symbol), QAM64 (6 bits/symbol), and QAM256 (8 bits/

Impairment effects in various domains

Impairments in the frequency domain are disturbing because they influence not only the signal being generated but also the signals located in different channels, especially the adjacent ones. Any discontinuity between the beginning and the end of a signal will cause a frequency-domain impairment known as spectral growth.

The level of the impairment will depend basically on the size of the "discontinuity"—or any sudden difference between the signal and all its derivatives between the end of one waveform and the beginning of the next. The effects of the impairment will typically show up in a spectrum analyzer as "skirts" or "shoulders" close to the expected spectrum of the signal. The shape and location of these unwanted components can be easily confused with the effects of nonlinear component behavior, such as transmitter power-amplifier clipping, and can ruin any adjacent channel power ratio (ACPR) or spectral-mask compliance test made by regular swept-spectrum analyzers, no matter the performance of the generator, the analyzer, and the device under test.

The effect of wraparound at the modulation level is subtler but just as catastrophic. Any receiver (including vector spectrum analyzers) must process the received information to recover the transmitted message. Processing includes operations such as carrier and symbol clock recovery, I and Q component demodulation, and symbol estimation. Wraparound discontinuities affect all these operations. Carrier phase discontinuity will result in a transient hit for the carrier-recovery block that will affect the subsequent signal-processing blocks, as it influences the capability of the system to properly align the I and Q components of the message.

In a similar way, any symbol truncation will affect the clock recoverer and, as a consequence, the recovered data. Finally, a noncontinuous baseband filtering will show up as a higher error level when the matched filter at the receiver is applied to the signal, resulting, again, in a higher than expected bit-error level. If the receiver is a modulation or vector spectrum analyzer, its capability to measure the modulation quality properly is devastated by any combination of these effects resulting in higher than expected error vector magnitude (EVM) levels, corrupted constellation and eye diagrams, and data errors.

Channel coding is also affected by wraparound. To understand its effects, consider these examples. $\pi/4$ DQPSK signals are, in fact, quadrature-phase-shift-keying (QPSK)-modulated signals with an additional constellation rotation of $\pi/4$ from one symbol to the next. The resulting constellation diagram consists of eight equally spaced symbols located in a circle. Transitions are only legal between symbols located in different QPSK constellations, unlike 8-PSK modulated signals, where any transitions are legal. If the waveform segment stored in the AWG generation memory contains an odd number of symbols, the concatenation of the segment will result in an illegal transition between symbols located in the same QPSK subconstellation, confusing any receiver or measuring instrument trying to handle such a signal.

Another more elaborate example may be differentially modulated QAM signals. In such modulation schemes, the two most significant bits (MSBs) control the next quadrant of the symbol relative to the current one instead of the absolute. This enables you to obtain rotationally invariant modulation schemes so the receiver does not need to know the absolute phase for the I and Q axes as the information sent remains invariant no matter which phase reference is selected at the receiver. Signals properly coded may result in an illegal transition when the last and initial modulation states and the two initial MSBs result in a nonconsistent symbol location. Even if nothing is noticed at any other level, the decoded bits will show an error due to the wraparound effect on the consistency of the signal.

Generally speaking, the higher in the protocol stack the signal resides, the longer the necessary record length to implement it in a meaningful way, and the more difficult it is to avoid wraparound related impairments.—*Joan Mercadé*

symbol), the data sequence can be accommodated in an integer number of symbols. For QAM32 (5 bits/symbol) and QAM128 (7 bits/symbol), there is no way a single sequence can be accommodated in an integer number of symbols. If the sequence is truncated, it will lose its proper channel coding, and it will be meaningless for any receiver or analysis instrument. In other words, there will be a wraparound artifact at the channel-coding layer.

The solution is to require that the symbol length be a multiple of 5x1632 bytes or 7x1632 bytes for QAM32 or QAM128, respectively. But meeting this condition does not come without a cost: The sequence will need five or seven times more generation memory, which eventually may overflow the available size at the target instrument. Is that enough? The answer, unfortunately, is no. Differential modulation adds a new source of signal inconsistency.

In differentially modulated QAM signals, the two most-significant bits (MSBs) of the symbols control the relative phase jump from the previous quadrant. The remaining bits are mapped using Grey coding to the symbol location in the current quadrant so a rotationally invariant modulation is obtained.

The problem is that the last modulation state in the current waveform and the initial modulation state in the beginning of the next one may be inconsistent, even if the rest of the information is properly coded and filtered. As a result, the bit sequence will be improperly decoded, and the signal will be meaningless again.

There are several solutions for this problem. The most obvious one is to carefully select the data to ensure consistency at this level. Although this solution works, it does impose limitations on the acceptable data, and this may be inconvenient in some situations.

Another solution may be to repeat the same data sequence four times (in some cases, two repetitions may be enough). It is easy to find out that this will always create a consistent sequence no matter what data was used in the original sequence. Again, this solution comes at the expense of an increase in the record-length requirements for the AWG.

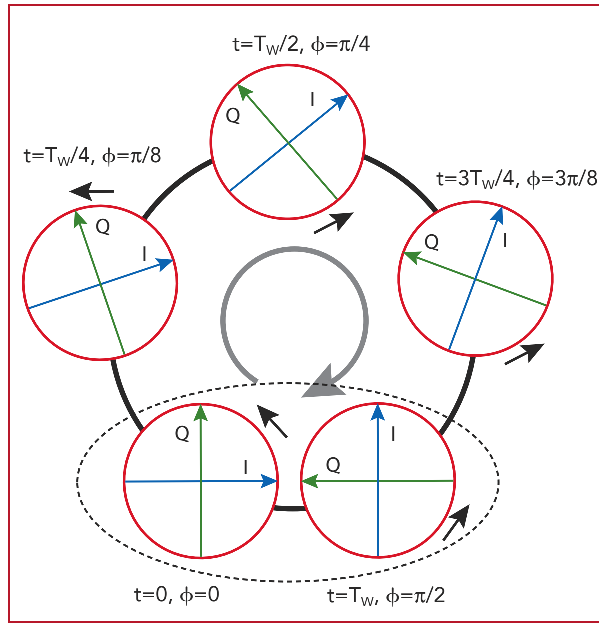

FIGURE 4. Phase twisting may be used to solve some specific wraparound problems related to signal consistency at the channel coding or protocol levels while saving precious waveform memory. T_W equals the time window.

Phase twister

If the previous solution does not work because there is not enough generation memory available, then there is another solution: twisting the phase (**Figure 4**). This solution is very similar to the FSK modulation where some linear phase shift must be added to every sample to compensate for the phase difference between the end and the beginning of the waveform.

For differentially modulated signals, the phase difference between the required phase at the beginning of the next waveform to play back and its actual value can be any multiple of $\pi/2$. If the signal phase is rotated in the same direction and magnitude as the error during the complete record, the result will be a wraparound-artifact-free signal without any glitch at the differential modulation level.

For baseband signals, the I and Q components at the output of a two-channel AWG will no longer be the original I and Q components but their projections on these axes with the added rotation. As in FSK-modulated signals, this is equivalent to slightly increasing or decreasing (depending on the rotation direction) the carrier frequency.

But things become strange: Circular convolution stops working and discontinuities will show up. For example, if the difference of phase to compensate is $\pi/2$, the I component will rotate 90° counterclockwise, and at the end of the record it will be, in fact, aligned with the Q component at the beginning. Similarly, the Q component at the end will be facing the –I component at the beginning.

The solution consists in simply applying the same calculation method, but in this example, the I component of the end symbols will be convolved along with the Q component of the initial symbols, and the Q component of the end symbols will be convolved along with the inverted I component of the initial symbols. Circular convolution takes the shape of a helix instead. This approach may be used in some other situations, such as accommodating an odd number of symbols in a $\pi/4$ DQPSK modulated signal. T&MW

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LAB AUTOMATION: SOME BUY, SOME BUILD

The buy versus develop decision depends in part on an organization's width and depth and whether it's commercial or military.

MARTIN ROWE, SENIOR TECHNICAL EDITOR

Most calibration labs use computers to fully or partially automate instrument calibrations. Some organizations use off-the-shelf automation software and prewritten procedures, while others develop their own software from the ground up. Two vastly different organizations—semiconductor maker Analog Devices and the US Air Force—took automation paths that are as different as their sizes and their missions.

To find out why these organizations chose the paths they did, I interviewed members of their engineering staffs. I met with Tony Giannasca, metrology manager at Analog Devices, at his Wilmington, MA, lab. I also spoke by telephone with Marc Monnin, automation programmer for the Air Force's Metrology and Calibration (AFMETCAL) program in Heath, OH.

Off the shelf

Analog Devices maintains its central calibration lab in Wilmington, where Giannasca and three technicians calibrate some 6000 instruments per year. The lab consists of four stations covering DC/low frequency, RF, oscilloscopes, and accelerometers. **Figure 1** shows the lab's RF calibration station.

In the early 1990s, Giannasca needed to improve lab throughput. He and his technicians knew how to calibrate instruments but not how to write software. So, he chose an off-the-shelf calibration software package that would minimize their having to learn programming.

"The technicians took to automation right away," said Giannasca. "They saw it as a way to grow with their jobs." Because all of the stations are automated, technicians are free to tackle other jobs, such as instrument repair, while running a calibration.

Because of the automation, technicians in the Wilmington facility can distribute automated calibration procedures to the company's labs in North Carolina, California, Ireland, and the Philippines. Engineers at the company's design centers

DANIEL GUIDERA

worldwide send their instruments to Wilmington for calibration.

For the company's production facility in the Philippines, the Wilmington technicians built a calibration rack that calibrates DMMs and signal generators used in production. Prior to having the rack, engineers in the Philippines would send equipment to Wilmington for calibra-

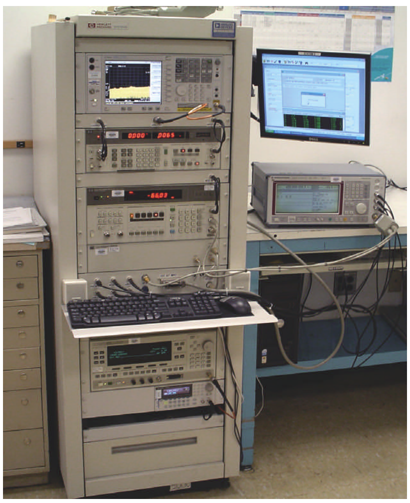


FIGURE 1. A calibration station at Analog Devices calibrates RF instruments under software control. Courtesy of Analog Devices.

tion. After receiving the rack, they continued to send oscilloscopes and spectrum analyzers to a local third-party lab.

"After six to nine months," said Giannasca, "we started receiving equipment from the Philippines that had been going to the third-party lab." Because of automation, the Wilmington lab could calibrate equipment at a lower price and with a faster turnaround than the third-party facility.

Future plans for the technicians in Wilmington include building a calibration rack for a company facility in San Jose, CA, to calibrate DMMs, function generators, electronic loads, power supplies, and oscilloscopes. Periodically, a technician from Wilmington will spend a week in San Jose, performing about 150 calibrations with the same automated procedures used in Wilmington.

Home-grown architecture

Although Analog Devices is a relatively large company, the number of calibrations needed to support engineering and manufacturing pales in comparison to the number needed by the US Air Force. The Air Force has some 77 calibration labs at bases around the world that must calibrate more than 900,000 instruments with more than 90,000 part numbers. The software used by the Air Force, and how it is developed, reflects the differences between a commercial organization performing calibrations on a few thousand pieces of equipment and a large organization that must calibrate more than 100 times as many instruments.

Over the last several years, engineers at the AFMETCAL program have developed a software architecture to automate calibrations. Software engineer Marc Monnin was one of several automation programmers who developed code for the NextGen Calibration Automation System (Ref. 1).

Because of the project's large scale, Air Force engineers wanted a flexible software architecture that would outlive any PC technology or operating system. "Typically," said Monnin, "automation software would work until a PC, operating system, or instrument changed."

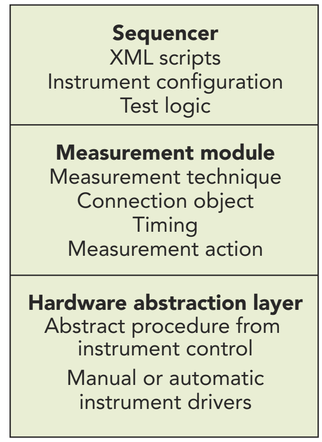


FIGURE 2. The US Air Force NextGen automation consists of three independent software layers.

To provide cross-platform compatibility, Air Force engineers developed a three-tier software architecture that consists of a sequencer, measurement modules, and a hardware-abstraction layer (**Figure 2**). Each layer is independent of the others. They communicate through an application-programming interface.

The sequencer is essentially a test executive. It reads information on the type of instrument to calibrate (DMM, oscilloscope, etc.), the test parameters, and the test limits from an instrument-specific XML file. The XML file also contains the test logic.

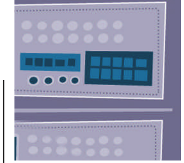
A separate measurement module contains the details about how the system must perform the calibration, including the measurement methodology and the steps that must be performed. Because some instruments can be calibrated in more than one way, the measurement module can handle more than one procedure.

Below the measurement module resides the hardware abstraction layer. This

Volts/Div	Offset (V)	Applied VDC	Upper limit (VDC)	Lower limit (VDC)	Result (VDC)
0.002	–0.4000	0.4000	0.405320	0.394680	

```
<Row>
        <TI_VoltDiv>0.002</TI_VoltDiv>
        <TI_OffsetVoltage>–0.4000</TI_OffsetVoltage>
        <CalibratorAppliedVoltage>0.4000</CalibratorAppliedVoltage>
        <UL>0.405320</UL>
        <LL>0.394680</LL>
        <Result />
        <Pass />
</Row>
```

FIGURE 3. A software tool creates XML scripts from entries in a table.



layer knows which instruments are under calibration and which instruments provide the calibration signal sources and measurements. It also contains hooks to instrument drivers.

Three groups of engineers

The development of a calibration procedure at AFMETCAL involves three groups of people: calibration engineers, software engineers, and technical order writers. Calibration engineers understand the metrology involved in a calibration. They provide input to the technical order writers, who write detailed procedures for performing a calibration. The calibration engineers then review each calibration procedure (called a technical order), looking at it from a metrology perspective. Finally, software engineers write the actual programming code.

Technical order writers need to know the specifications for each instrument setting. (To the Air Force, a calibration involves checking an instrument to verify that it's within the manufacturer's specifications. It doesn't involve adjustments to bring an in-tolerance piece of equipment closer to its nominal operation.) To streamline the writer's job, software developers created a tool that generates the XML code used in the sequencer. A technical-order writer enters test data into a table, and the tool produces the XML script (**Figure 3**).

Managing the automation of so many instruments requires a central database. From the data, the engineers and technicians at Air Force calibration labs can find which XML script to use for calibrating a given instrument. When the AFMETCAL program developers issue a new XML script, measurement module, or hardware-abstraction layer, engineers and technicians around the world simply replace the previous version of that module only. Monnin is now confident that the AFMETCAL program has a software architecture that will outlive computers, operating systems, and even instruments. T&MW

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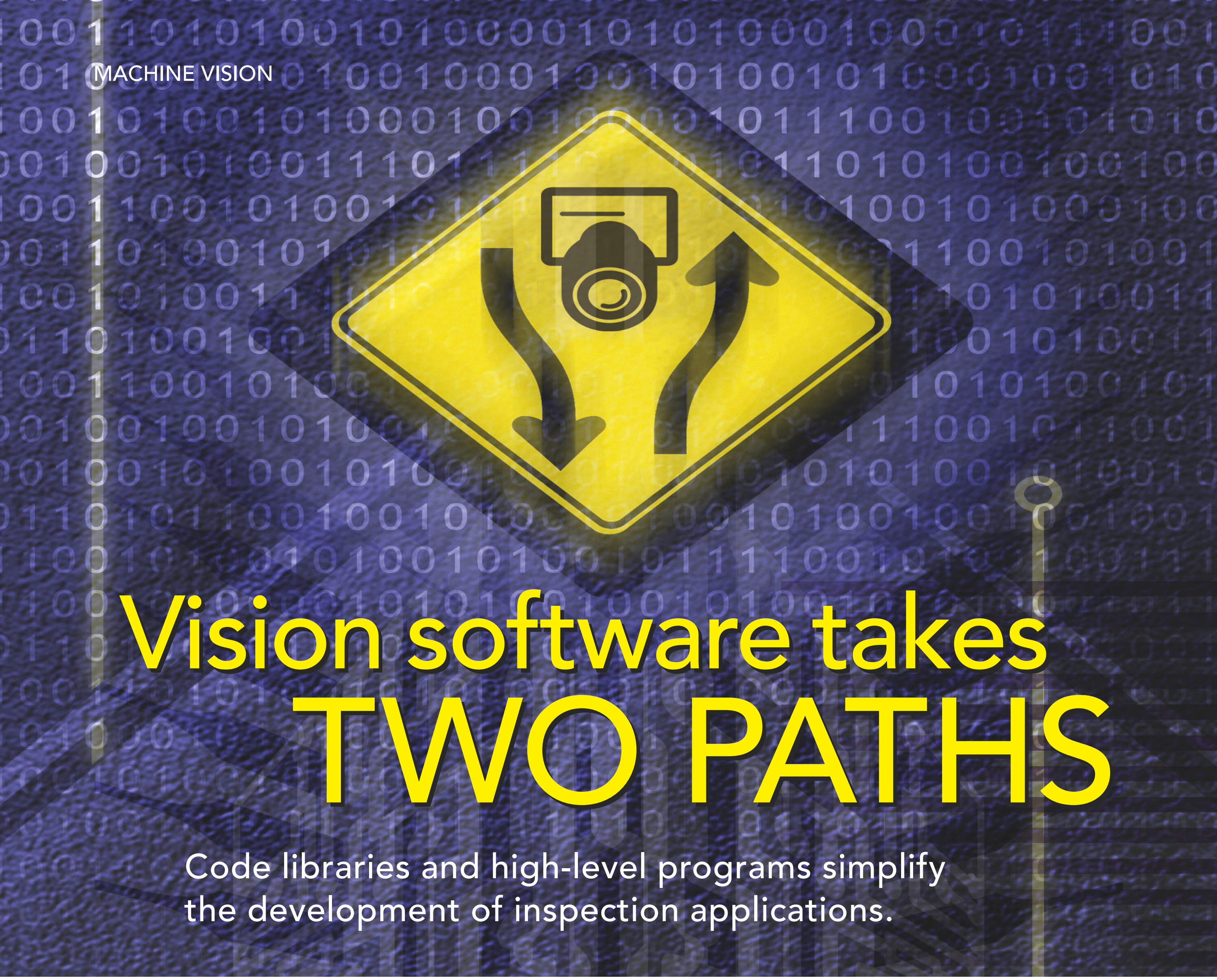


Vision software takes TWO PATHS

Code libraries and high-level programs simplify the development of inspection applications.

JON TITUS, CONTRIBUTING TECHNICAL EDITOR

Cameras, lights, and computers may be the mainstays of machine-vision systems, but it's the software that does the work. As a result, software development plays a key role in the creation of vision or inspection systems. Most engineers tackle the development of vision software in one of two ways.

The two approaches differ only in how far engineers remove themselves from software details and how much control over the software they want. In both cases, engineers rely on vendors to provide algorithms that match patterns, find edges, measure image features, and perform other key functions.

In the first approach, an engineer works with high-level programs that provide a graphical user interface (GUI) for connecting equipment-control and image-processing icons to create a sequence of inspection steps. Software vendors refer to programs that offer this feature as point-and-click, drag-and-drop, or configuration-based tools. These tools appeal to engineers who must quickly prototype a system to test its feasibility or who must solve basic inspection tasks that don't stray far from common requirements. Engineers who create one-off inspection systems often use this approach, too, because it takes little effort to create, maintain, and update an application.

In the second approach, an engineer buys or licenses libraries of image-acquisition and image-processing tools to integrate with code that he or she has written in C, C++, Visual Basic, or another language. This approach makes sense for engineers who plan to build many inspection stations and who must minimize costs. Some engineers use libraries when they need only a few functions, when they must optimize an application, or when they require advanced capabilities in their code.

To provide an overview of the state of vision software for both types of users, I talked with people at five vendors about their products. The descriptions below highlight new or improved capabilities and important features.

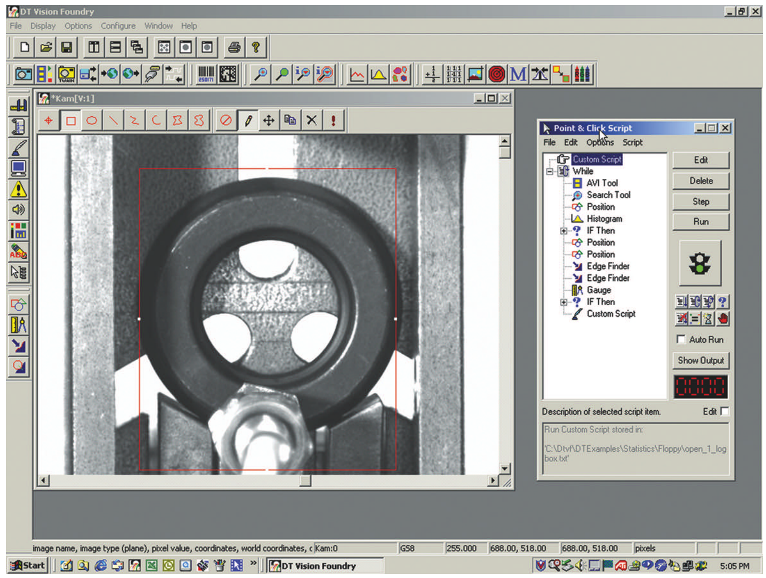


FIGURE 1. The main display for Vision Foundry shows a sample image, icons that represent operations and vision tools, and a point-and-click script window. The script controls let users step through and edit the script. Courtesy of Data Translation.

Connect the dots

The Vision Foundry from Data Translation comes in three sections: a GUI that contains drag-and-drop scripting tools, an application program interface (API) that gives engineers direct access to the software for all the Vision Foundry tools, and an expandable "container" that lets programmers create their own tools.

The GUI lets users link tools to create a sequential script of vision tasks. A simple script could acquire an image, look for "blobs," count the blobs, and make a decision based on the number of blobs present or based on other blob characteristics. In the vision industry, where blobs are simply objects in an image, a blob might represent an IC, a socket, a connector, or some other component. Thorsten Beierle, technical support and applications manager at Data Translation, said that within the Vision Foundry package, the blob tool gets the most use, either for using its results directly or as a basis for other tools.

Users can also "train" the pattern-matching tool in Vision Foundry to recognize a specific shape. The package will then search a gray-scale image for geometric features and determine when a region of interest within the image contains that shape. The tool determines and reports the shape's position and its scope—a measure of how well the shape matches a corresponding "golden image" template.

If an application requires more capabilities than a GUI-based script can provide, the system developer can access the same Vision Foundry tools through an API. As a result, when the developer writes code in Visual Basic or C++, he or she knows the underlying algorithms will work exactly as they did in the GUI script. Programmers also can use ActiveX controls that send and receive variables and images.

Routines created with Data Translation's Measure Foundry software, which controls data-acquisition and I/O boards, link easily with Vision Foundry scripts. Thus, you can easily include electrical measurements and the control of electrical devices within a machine-vision application. If you need to control a robot, for example, you can create your own tool and icon. Then, you can use the tool within Vision Foundry or use it in a C++ or Visual Basic program.

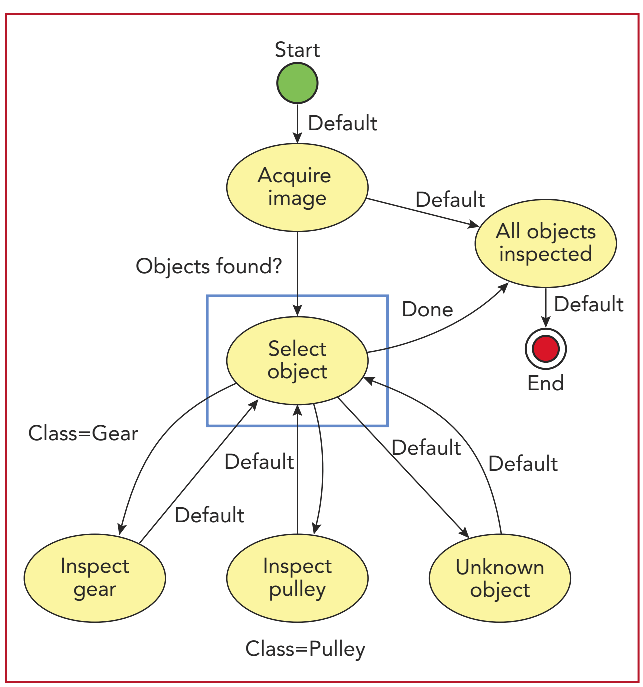


FIGURE 2. This state-machine diagram from Vision Builder AI 3.0 shows how a state machine uses six states to simultaneously inspect pulleys and gears. Courtesy of National Instruments.

Make a conditional change

Typically, applications based on drag-and-drop vision software execute a "loop" of sequential steps that runs indefinitely. To improve the versatility of this type of software, release 3.0 of Vision Builder for Automated Inspection from National Instruments allows for conditional branching. So, the result of one operation can determine which operation comes next. In effect, vision software appears to operate as a state machine.

"State machines describe applications as a series of discrete steps that move engineers away from implementation details," said Kyle Voosen, vision product manager at National Instruments. "A state machine only advances to the next state when it detects a specific condition."

Although the state-machine approach adds some complexity to code development, it comes nowhere near

the complexity involved with programming vision applications in programming languages such as Visual Basic or C/C++. By casting a vision application in terms of a state machine, users can add conditional loops and branches common to a language such as C or Basic. But because a single state can include many unconditional steps, even a complex task may need only a few states.

Vision Builder AI 3.0 continues to let engineers use the sequential nonbranching operations offered in earlier versions of the program. The new software doesn't force engineers to use the state-machine capabilities—it simply treats an application without conditional branching as a single-state state machine. And code developed with earlier versions of Vision Builder will continue to run under version 3.0, as will all National Instruments hardware.

Engineers also can benefit from the run-time versions of the Vision Builder software. They no longer must buy a complete software package for each vision system. Instead, they can develop software on one computer and deploy it on others that have an associated run-time license.

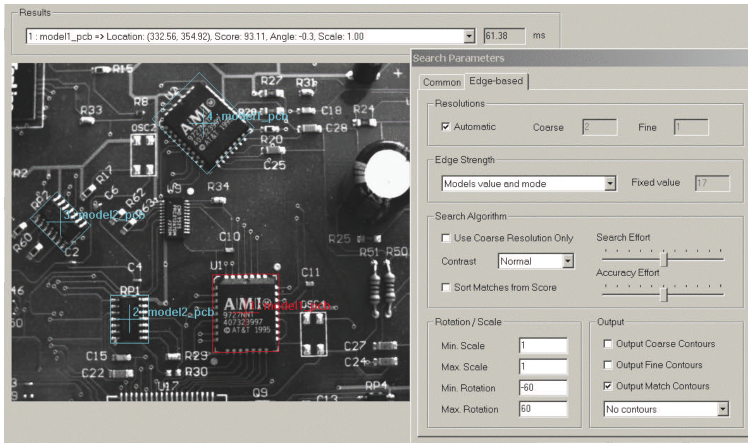


FIGURE 3. Edge-based search parameters set within the Sapera Essential tools let programmers "tune" the underlying algorithm for rotation, scale, and other factors. Courtesy of Dalsa.

Go to the library

When engineers need a special image-processing capability, or when they want to optimize operations, they must turn to libraries of functions that operate with languages such as C/C++, Visual Basic, and others. Dalsa bases the image-acquisition and image-processing code in its Sapera Essential package on a proprietary technique called Trigger-to-Image reliability. The technique provides a framework that guarantees the unambiguous identification of images from the moment a system captures them until the vision software makes a decision based on image information.

"The Sapera Essential 'infrastructure' that identifies, tracks, and reports results for each image processed frees users to refine and enhance their core algorithms," explained Inder Kohli, product

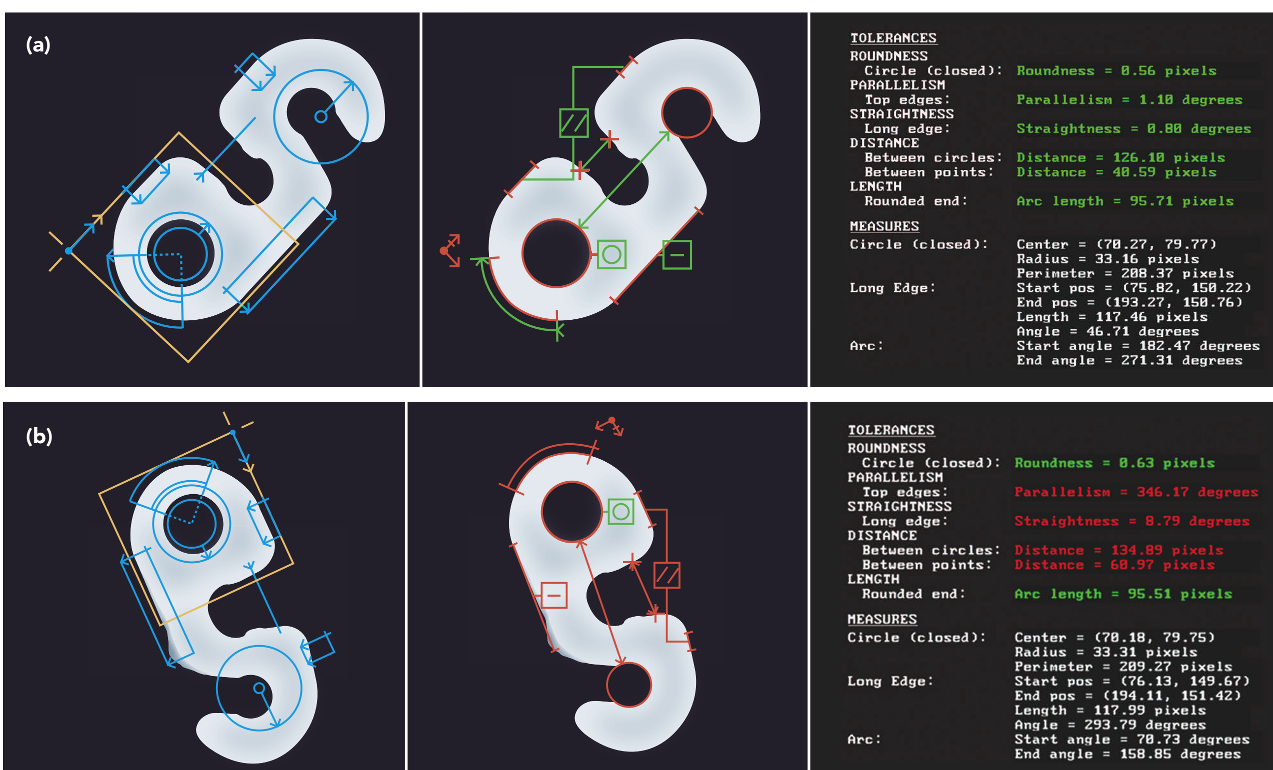


FIGURE 4. These two images show the areas used to measure characteristics of plastic hooks. a) A good hook passes inspection, while b) a defective hook fails, based on criteria set in software based on the Matrox Imaging Library. Courtesy of Matrox Imaging.

manager at Dalsa. "In addition, performance-analysis and prototyping tools let users identify and remedy potential performance bottlenecks."

To increase the value of the Sapera Essential libraries, Dalsa now provides access to all the image-processing primitives, or fundamental routines. These primitives cover basic morphology, segmentation, and similar operations. Modules build upon primitives and perform higher-level tasks. A simple edge-based search module, for example, can realign an image with a golden template. Rather than licensing an expensive and sophisticated suite of geometric pattern-matching algorithms that does more than you need, you can use small modules that better fit the tasks at hand.

Sapera Essential lets users choose the modules they want to license, and the majority of the modules cost nothing extra. Some modules, such as those for blob analysis and searching, require payment of run-time fees.

Soon Dalsa will offer a prototyping tool for Sapera Essential so engineers can quickly "connect" and evaluate image-capture and image-processing functions. The tool provides algorithms, modules, and other functions that let engineers try "proof-of-concept" code, but it will not create a complete application.

Quantify image measurements

Version 8.0 of the Matrox Imaging Library (MIL) from Matrox Imaging offers engineers an expanding set of tools they can use from within C/C++ programs. Active MIL, a subset of the more expansive MIL package, provides ActiveX controls. Recently, Matrox introduced a metrology module as part of Processing Pack 3, the latest update for the MIL package. The metrology module lets engineers measure characteristics of image features such as arcs, circles, line segments, and points. Because users can calibrate measurements, the module will convert image dimensions to real-world measurements and coordinate systems.

Pierantonio Boriero, product line manager at Matrox, stressed that rather than relying on low-level libraries of code from a microprocessor manufacturer such as Intel, Matrox programmers optimize the MIL code from the ground up. "Our people can optimize high-level algorithms in ways Intel doesn't address. We go through MIL's code line by line, and we also write code for Streaming SIMD Extensions 2 [SSE2] operations specific to several Intel and AMD processors." Those operations handle multiple data streams and vectors, which makes them particularly applicable to image-processing tasks.

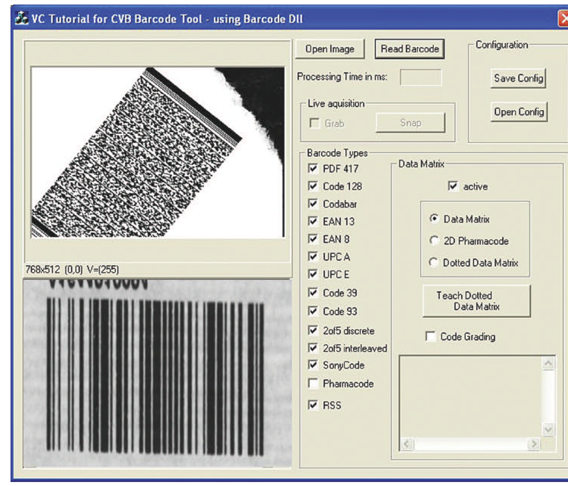


FIGURE 5. A tutorial for Common Vision Blox lets engineers try algorithms, in this case to determine their suitability for reading bar codes. Users can check off the types of codes they want to read during a test.

Courtesy of Image Labs International.

Boriero also noted many engineers forget the importance of image displays in vision systems. The MIL package includes functions that display images across multiple monitors, produce nontearing displays, and create nondestructive overlays. Boriero said that the optimized display functions don't take CPU horsepower away from image-processing tasks.

Buy the tools you need

Although Stemmer Imaging (Puchheim, Germany) has offered its comprehensive Common Vision Blox software for several years, the company now places many image-capture, blob-analysis, edge-detection, correlation-search, and filtering tools in its basic Foundation Package. This package also includes threshold operations, color-space conversions, overlay generators, and calibration tools.

As engineers need additional tools, perhaps for bar-code reading and character recognition, they buy or license them a la carte from Stemmer. "You add only the tools you need," said Brian Smithgall, president of Image Labs International, the US distributor of Stemmer software. "A free demo CD-ROM includes all the software tools, so engineers can try tools before they buy them," said Smithgall. "Some people will need only a few tools rather than the full Foundation Package."

Although engineers can use tools in the Foundation Package with C/C++, the tools also work with Microsoft's Visual C++, C#, and Visual Basic .NET. And the software also will work with older versions of Visual Basic, Borland's Delphi, and LabView. A "matrix" of sample code lets engineers choose examples that show how the tools work with a wide range of programming languages and image-acquisition hardware in many types of applications.

When it comes time to verify that a machine-vision setup works properly, engineers can "shoot" test images with a digital camera and use the Foundation Package's emulator to process the test images. The software "sees" the images as if they have come from a live camera. If system requirements change, engineers can always run through the images again to ensure their revised code executes properly and does not adversely affect other portions of their application. T&MW

FOR MORE INFORMATION

Dalsa, www.imaging.com. (Registration required to access data sheet.)

Data Translation, www.datx.com/products_software/prod_DTVF.htm.

Matrox Imaging, www.matrox.com/imaging/products/mil.

National Instruments, www.ni.com/vision/vbai.htm.

Image Labs International (Stemmer Imaging), www.imagelabs.com/cvb.


Your Search Is Over!

EXTRACTING VALUE *from outsourcing*

IDMs can make use of semiconductor electronics manufacturers to implement asset-light test strategies, but they must ensure their strategies represent a "win-win" for their SEM and ATE partners.

MARC A. MANGRUM
FREESCALE SEMICONDUCTOR

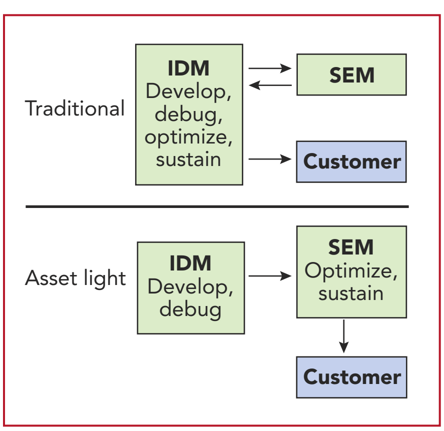


FIGURE 1. **In the traditional IDM/SEM test support model, the IDM retains test engineering responsibilities. The asset-light model shifts responsibilities to the SEM.**

The business focus for integrated device manufacturers (IDMs) in the commodity semiconductor market has shifted from a philosophy of "doing it all" to a philosophy in which management carefully selects activities that add value. Test, assembly, and, to some extent, wafer fabrication represent capital cost centers that do not necessarily add value. IDMs have therefore begun using "asset-light" test strategies that let them outsource manufacturing and test tasks to semiconductor electronics manufacturers (SEMs). Outsourcing can be effective as long as IDMs apply best-practice approaches to asset-light strategies and to the problem of competition and benchmarking.

Even when outsourcing production tasks, IDMs want to use their internal resources to add value by reducing product-development cycle time and by developing more cost-effective and competitive products. To do that, they need to partner with the appropriate SEMs and ATE vendors to develop cost-effective packaging and test solutions. For an outsourcing strategy to succeed, these partnerships must be "win-win." They need to account for the market behavior as well as the needs of the SEMs and the ATE providers.

When choosing an asset-light strategy, IDMs need to remember that "asset-light" differs from "capital avoidance." In the asset-light model, IDMs maintain some manufacturing equipment to support advanced development and strategic accounts and to monitor SEM pricing. They then work with their SEM partners to develop standards for wafer fabrication, packaging, and test of new products in the SEM factories. With this strategy, IDMs encourage SEMs to make capital-equipment purchases based on a solid business plan that acknowledges the SEMs' profitability requirements.

Capital avoidance, on the other hand, is not really a strategy; it is merely an attempt by IDMs to avoid purchasing any manufacturing equipment at all. The IDM requires SEMs to purchase and maintain equipment independent of a business plan, forecast, or partnership. This approach tends to result in higher prices and less flexibility to respond to fluctuating markets.

IDMs also must realize that competition and benchmarking are crucial to the success of an asset-light strategy. If an IDM focuses only on price while ignoring strategic considerations such as packaging roadmaps and ATE platform alliances, the IDM is in danger of paying more than is necessary. Developing and maintaining multiple suppliers and constantly benchmarking the SEM service market for both technology and pricing can help avoid this pitfall.

More than low price

For IDMs, finding value within the SEM market involves more than negotiating the lowest price. SEM services have diversified in type and have increased in quality. SEMs now offer true turnkey services, taking a customer's design from wafer fabrication and sort through to assembly and final test, including selecting the tester platform and developing the test program.

These services are not limited to the production of digital devices—they are becoming pervasive for analog and system-on-chip (SOC) devices as well. Yet, some IDMs might be unwilling to take full advantage of these services if they consider test development to be competitive intellectual property—especially with analog, RF, and SOC devices.

In these cases, IDMs can still take advantage of the productivity, yield-enhancement, and other engineering activities that SEMs provide. An IDM may outsource product development totally to SEM partners when limited intellectual property is involved to reduce time-to-market and to leverage the legacy product learning cycles that occurred within the SEMs. Because SEMs deal with multiple IDMs and fabless companies, their ability to leverage product-development cycles from multiple sources becomes a new source of value for IDMs.

IDMs must choose production-test platforms for the SEM market carefully, because SEMs will hold them responsible for underutilized equipment. The IDM should try to choose a test platform that is part of a SEM's installed base or its future tester roadmap. Because SEMs build their test-cost models around capital depreciation and utilization, the IDM can reduce costs by choosing a scalable platform that can serve for a long period of time (ideally, five to 10 years) and that is selected with a SEM's installed base and other customers' requirements in mind.

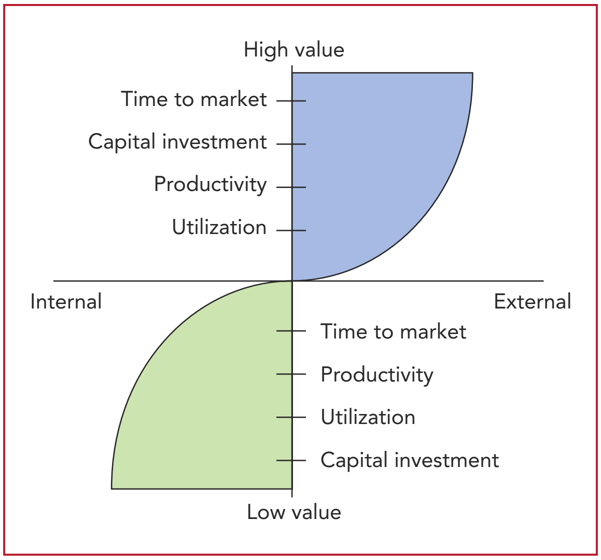


FIGURE 2. In this value curve, notice that IDMs and SEMs agree on the value of time to market, but IDMs are more concerned with the capital cost of the ATE while SEMs are more concerned with the utilization of a chosen asset.

In addition, to achieve the lowest possible test cost, the IDM must develop a strategy of platform indifference. By supporting test on multiple ATE platforms, an IDM enables its SEM partners to improve the utilization of their test systems and reduce capital expenses. IDMs need to become comfortable with the fact that SEMs will want to port mature products and test programs from one ATE platform to another.

Don't subsidize competitors

The traditional IDM/SEM test support model (**Figure 1**) follows a capital-avoidance strategy and exhibits these characteristics:

- The IDM maintains all test engineering resources.
- The IDM develops the test program while developing and debugging the silicon.
- The IDM optimizes the test program (to provide test-time reduction).
- The IDM provides all updates and supports all sustaining activities, including yield enhancements, program modifications driven by customer feedback, and modifications driven by test-platform changes to hardware or software.

In this model, the IDM performs all the engineering activities and provides the SEM with a billing mechanism. This model does not address time to market or use the SEM's full potential. Because SEMs do business with multiple customers—some of whom take advantage of the entire value a SEM offers—this flow could be considered a "competitor subsidy" model.

The resources and capital expense required to support a SEM's true value proposition are in fixed costs, which are applied against all of its service charges. This makes it extremely important for an IDM to use as many of these services as possible, to maximize the value of the SEM partnership.

In the less-traditional asset-light model, the IDM relies more on the expertise of the SEMs and ATE vendors. The IDM must extract value from the elements that a SEM has to offer. If not, the IDM could pay twice—once to own and maintain its own large internal manufacturing resources and once more for the resources it uses within the SEM. An asset-light strategy could work like this:

- To protect intellectual property, the IDM may continue to develop and debug the initial release of the test program.
- Once the program has been qualified, it can be released to the SEM.
- The SEM optimizes the program.
- The SEM monitors program performance, makes yield-enhancement recommendations, and provides approved modifications.
- The SEM provides sustaining engineering work that could include approved customer-driven program changes, productivity improvements such

as multisite development, and product-derivative test-program development.

- The SEM drop-ships fully tested devices to the IDM's end customer.

The curve in **Figure 2** provides another perspective on the IDM vs. SEM value proposition. The more an IDM tries to internalize, the less value it adds. In this curve, the elements are listed in the order of priority as viewed by each entity. Both agree that the highest value is time to market, but that the element's strategic importance differs. IDMs are more concerned with the pure capital cost of the ATE equipment, while SEMs are more concerned with the utilization of the chosen asset because of the difference between their respective single-customer (internal) or multi-customer (external) business models and markets.

SEMs tend to evaluate utilization and cost down to the channel-board level of any given ATE asset. Overly configured ATE platforms (supersets) may provide some flexibility, but if the instrument resources used to provide that flexibility do not support a SEM's cost model, the IDM can expect to pay a premium when other devices not requiring those resources are tested on it.

Choosing a test platform

Equipment longevity is a sensitive issue for both the IDM and the SEM. Product life cycles tend to be short, and the integration of more and more functions onto a single chip often require the migration to a new test system every few years. In this case, neither the IDM nor the SEM can extract full value from an ATE capital investment. Therefore, platform selection and subsequent alignments must go beyond the functional capability of the ATE platform and should consider the following:

- program portability,
- platform scalability,
- software and tools,
- multisite efficiency,
- instrumentation and configuration roadmaps,
- market inputs, and
- cost of hardware.

If an IDM specifies a particular ATE platform without permitting mature products to be ported to another platform, the IDM may end up with a noncompetitive test solution and a non-cost-effective SEM strategy. The IDM can expect to pay a higher test cost as well as be held responsible for any unused capacity of the equipment it specified. Some platform-specific requirements may be unavoidable, but in high-volume commodity electronic markets, the IDM should work with the SEM to take advantage of any installed systems.

The two most important elements that can improve test costs are utilization and purchasing power. These will drive both the capital cost of the equipment itself and the charge out to a SEM's customers. Volume purchases combined with higher utilization achieved by actual loadings and machine performance improve the return on investment. In turn, these benefits become the drivers for reducing the price of test that SEMs offer their customers.

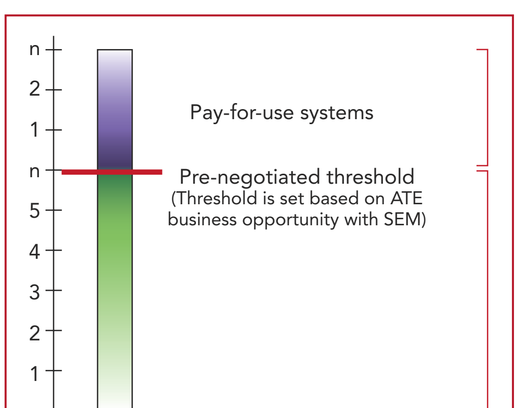
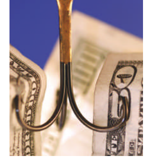


FIGURE 3. The IDM and SEM can negotiate a baseline test cost threshold based on business opportunities that the SEM can expect for an ATE system. The alternative is a pay-per-use model.

Competition is also important for extracting value. Maintaining multiple ATE platforms is a healthy practice and serves as a "checks and balances" function for a SEM's customers. A true multi-platform model produces competitive benchmarks that cannot be ignored by either the SEM quoting prices for test services or the ATE vendors competing to provide the platforms. Competition serves as a catalyst to drive continuous improvements to development tools, software and hardware, platform performance, productivity, capability, and price.



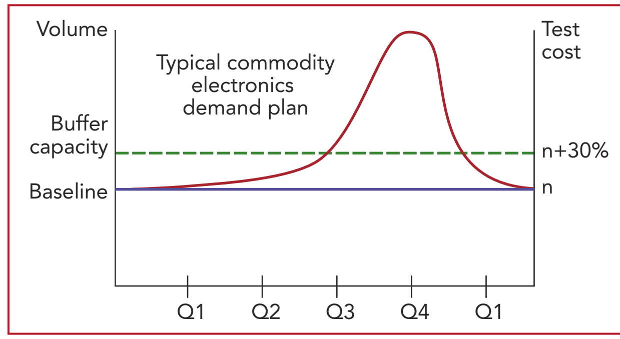


FIGURE 4. The red curve represents production volume fluctuations throughout a product's life cycle that can be addressed by establishing a buffer capacity above a baseline production capacity.

Development of base loading plans

A baseline plan for loading (**Figure 3**) requires close coordination among the SEM, IDM, and ATE manufacturers. It involves some risk management for all parties. In practice, an IDM agrees to forecast a "constant" run rate against an annual forecast provided by its customers.

The SEM then agrees to manufacture products at that capacity independent of actual demand. The inventory might build up at times, but never to a level that is not ultimately consumed by either normal demand fluctuation or by forecasted demand. When either an unforecasted upside occurs or a late-year forecasted ramp occurs, the SEM can manage the capacity ramp with the built-up inventory. This plan also minimizes the chance that the SEM will be cycled to zero loadings, which would impact pricing.

One way to manage the unforecasted upsides is to create short-term "flex capacity." The SEM agrees to pay the ATE vendor a monthly fee and pays for test time at a negotiated rate when products are actually tested. The SEM customers—the IDMs—agree to pay a fee slightly higher than the base test cost in order to secure the uncommitted "flex" capacity they require to support their business product ramp cycles as depicted in the **Figure 4** graph.

Because the success of outsourcing strategies depends on effective, well-managed partnerships between the IDM, the SEM, and ATE vendors, the ATE vendors must do their part as well. They need to adopt aggressive and flexible sales practices to support these models and drive the capital cost of their solutions to be in line with the markets they serve.

By fostering competition and multiplatform capability, IDMs can effectively drive the results they require. When IDMs enable SEMs and ATE vendors to provide and maintain test programs, the shared benefits can include higher utilization of total test assets, overall lower test cost, and more effective and efficient management of test capacity. T&MW

Marc Mangrum *is Freescale's advanced packaging technologies manager and has been with the company for the last 27 years. He has 18 years of product and test engineering experience in wireless and portable electronics, the last nine of which have been spent developing packaging and test strategies for the wireless baseband and applications processor products of Freescale's Wireless Mobile Systems Group, Austin, TX.*

For more product information, visit the *T&MW* Web site: www.tmworld.com/webproducts

Boundary-scan development system

The XJTAG Professional development system combines its vendor's hardware and software tools to support board developers' efforts to get their circuits up and running in hours, as opposed to days or weeks. Components of the system include the XJAnalyser graphical analysis and debugging tool, the XJEase C-like test description language for non-JTAG devices, the XJRunner run-only version of XJEase, the XJLink USB 2.0 hardware module, the XJDemo demonstration board, and the new XJIO board, which verifies unit-under-test signals through external connections.

Algorithm improvements in the software used in the development system enable it to exercise 5000 nets in less than a second. The system not only identifies faults but also accurately reports their locations.

XJTAG has enhanced the XJEase tool by adding language features to make the test-script writing process more intuitive. In addition, XJEase test code is separated from configuration files, so engineers can more easily make wholesale changes to test routines.

XJTAG has also added a COM interface to allow XJTAG Professional to integrate with test programs such as LabView and Visual Basic. Other new features include enhancements to XJAnalyser (to speed up debugging) and a new XJDemo board (which shows how, using XJEase, engineers can test the analog elements of their circuits).

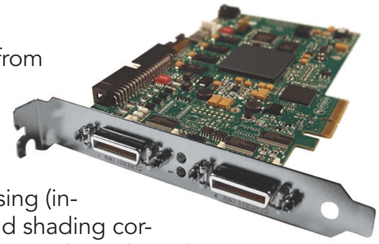
Price: from €5075 to €14,355 (approximately $6740 to $18,882). *XJTAG, www.xjtag.com.*

Frame grabbers ride PCI Express

Dalsa's X64 Xcelera line of scalable frame grabbers for the PCI Express bus currently support Camera Link cameras, and the company reports that future versions will support multiple input progressive-scan analog and parallel low-voltage differential signaling (LVDS) digital cameras.

The initial Xcelera models include the X64 Xcelera-CL PX4 Dual and the X64 Xcelera-CL PX4 Full versions. Both half-length x4 PCI Express boards support 85-MHz operation and are compatible with 64-bit versions of Windows XP Professional.

The Dual version complies with Dalsa's Trigger-to-Image Reliability (T2IR) framework to enhance acquisition control throughout the image-capture sequence, and it can acquire images from one Medium Camera Link camera or simultaneously from two Base cameras. The Dual version also performs FPGA-based processing (including Bayer decoding and shading correction for each input) and provides onboard optically isolated quadrature-shaft-encoder input.



The Full version can acquire images from one Base, Medium, or Full Camera Link camera. It can acquire images at rates to 1 Gbyte/s and transfer them to host memory at the same rate. The Full version of the frame grabber also supports an extended feature set for non-Camera Link configurations.

Base price: $1000. *Dalsa, www.dalsa.com.*

Analyzers add CW source

By adding a CW signal source and detector to its Site Master S810D and S820D cable and antenna analyzers, Anritsu has brought two-port measurement capabilities to handheld instruments. The new option lets you measure cable loss at frequencies from 2 MHz to 10.5 GHz with the Model S810D and from 2 MHz to 20 GHz with the S820D. To use the feature, you simply connect the source and detector to opposite ends of the cable under test.

The Site Master analyzers can make cable-loss measurements of up to 30 dB, more than enough to measure the typical 15-dB to 20-dB loss in some radar cables. The analyzers also measure VSWR, return loss, and cable loss and perform distance-to-fault (DTF) analysis using frequency domain reflectometry.

Base prices: S810D—$12,950; S820D—$19,950. *Anritsu, www.us.anritsu.com.*

SystemBIST evaluation module

Intellitech's SystemBIST evaluation thumb module contains Intellitech's SystemBIST FPGA configuration device. The module enables engineers to see how SystemBIST can be used as an FPGA programming device for single and multi-PCB systems.

SystemBIST enables multiple-design, multiple-FPGA configurations and can be used as a substitute for multiple-platform flash or PROMs for configuration of a single design. While lowering the FPGA configuration cost, SystemBIST adds the ability to update CPLDs when needed and execute boundary-scan tests at PCB

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power up, without a personal computer or ATE. The device does not require any JTAG software to execute or to integrate with the system mission mode software.

The thumb module contains a 512-Mbit Spansion flash device, pass and fail LED indicators, a 40-MHz oscillator, and a JTAG interface. Software enables users to create configuration and test scenarios and generate reports that indicate the amount of flash memory needed for a design. The SystemBIST IC measures 13x13 mm, and the PCB measures 4.8x3 cm.

Price: $295, including cables, schematics, and software. *Intellitech, www.intellitech.com.*

Aeroflex enters US ATE market

Aeroflex has introduced its 5800 series of configurable ATE systems into the US. Launched in Europe in 2005, the 5800 series provides board and system functional tests of avionics, automotive, military, and medical products. Available in bench, floor-standing, or rack-mount configurations, the system consists of a 21-slot PXI backplane that communicates to a PC through an MXI-4 link. The ATE systems are available with most Virginia Panel interfaces for connecting test instruments to your UUT.

The testers include IEEE-488, RS-232, and USB ports for use with external instruments. System software lets you develop your own test sequences or use test software developed with LabView, TestStand, or any .NET-compatible language. You can also use a DLL wrapper for instruments that lack an ActiveX driver. The tool lets you import and combine C-language headers and DLLs into callable instrument drivers.

Base price: $42,000. *Aeroflex, www.aeroflex.com.*

NI introduces low-cost 6.5-digit DMM card

National Instruments has added a 6.5-digit digital multimeter (DMM) card to complement its 7.5-digit model. The PCI-4065 and PCIe-4065 plug into PCI bus or PCI Express bus slots, respectively. Both DMMs measure DC or AC voltage and current, two-wire and four-wire resistance, and diodes. Both have 300-V isolation and ±950 μV accuracy (1-year calibration). Top measurement speed is 3000 readings/s.

Software support includes NI's LabView, LabWindows/CVI, and Measurement Studio, plus Visual Basic and Visual C++. The cards' software also includes NI-DMM drivers for Windows 2000/XP, a soft-front panel, and a LabView VI.

Base price: $1299. *National Instruments, www.ni.com.*

CATALOGS & PRODUCTS

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

Clock recovery unit

The Centellax AnyRate Electrical CRU is a stand-alone unbanded clock recovery solution. It offers a 622-GHz to 7-GHz operating range, with a wide bandwidth option up to 13.5 GHz. The small, low-cost CRU offers good input sensitivity (75 mVpp) and low residual jitter (300 fs). *Centellax, www.centellax.com.*

750-W to 3.3-kW programmable power

The Genesys family provides flexible, reliable power in test and measurement systems. The units offer three power levels (750 W, 1.5 kW, and 3.3 kW), output voltages of 7.5 V to 600 V, and current to 400 A, plus they provide high power density and low ripple. Active PFC inputs and a RS-232/485 port are standard. *Lambda Americas, www.lambda-hp.com.*

Infrared thermometers

Showcasing Omega's laser-circle sighting technology, the OSXL650 infrared thermometers perform non-contact temperature measurements over an operating range of –32 °C to 538°C (–25 °F to 1000°F). The thermometers also feature max/min/avg/diff, an electronic trigger lock, emissivity that is adjustable from 0.1 to 1.0, and 10-point data storage. Base price: $75. *Omega Engineering, www.omega.com.*

Mass interconnect products

The *Mass InterConnect Solutions Product Catalog* from VPC will simplify how you build a mass interconnection system. Exploded views for each product family are designed to help identify the components necessary to complete a setup. Also provided are product drawings and specifications plus tech tips and cross references. *Virginia Panel Corp., www.vpc.com.*

Test and burn-in socket

Aries Electronics now offers a new CSP test socket for devices from 28 mm^2 to 40 mm^2. The new socket is ideal for manual testing of devices with pitches down to 0.40 mm, such as CSP, MicroBGA, DSP, LGA, SRAM, DRAM, and Flash devices. *Aries Electronics, www.arieselec.com.*

2007 product catalog

Keithley Instruments' 2007 product catalog describes the company's state-of-the-art products and includes tips on how to choose the most effective solution for an application, increase productivity, lower your cost of testing, and avoid common measurement errors. *Keithley Instruments, www.keithley.com/at/410.*

Industrial PC

The UNO-1019 is a RSCI-grade DIN-rail PC featuring Windows CE 4.2 embedded OS, two Ethernet ports, four serial ports, four digital I/O ports, and one CF expansion slot for data buffering and storage. The UNO-1019 is suitable for converting communication protocols, I/O control, and data storage. *Advantech, eAutomation Group, www.eautomationpro.com/us.*

Probe and test lead catalog

Probe Master's catalog features 500-MHz oscilloscope probes, differential probes, and a full line of test and measurement accessories. Other products offered by the company include DMM test leads, BNC cables, probe test clips, adapters, and SMD probes and grippers. *Probe Master, www.probemaster.com.*

Modular DC power supply

The XMP from Xantrex is a 2600-W, multiple-output, programmable DC power system. The XMP 2600 can be customized by selecting up to eight of 22 different power modules, ranging from 160 W to 2.4 kW each. The power supply is designed for high-level test and OEM applications. *Xantrex Technology, www.xantrex.com.*

Microwave/RF assemblies configurator

The Gore Microwave/RF Assembly Builder, an online interactive configurator, provides simple step-by-step instructions for designing Gore microwave/RF assemblies. The configurator simplifies the assembly design process, enabling the user to build assemblies, view technical data, view a product data sheet for every assembly, and submit an RFQ electronically. *W.L. Gore & Associates, www.gore.com/rfcablebuilder.*

Imaging-optics catalog

Navitar, a leader in imaging-optics technology, has released its new 100-page, full-color product catalog. Featuring photos, drawings, and technical specifications, the catalog includes Navitar's complete product line of optical solutions for machine vision, automation, assembly, imaging, measuring, inspection, and the biomedical sciences. *Navitar, www.machinevision.navitar.com/catalogrequest/tm.*

PXI series supports WiMAX

Aeroflex has added new wireless test capabilities to aid the rapid production testing of popular consumer mobile devices. Within a single software-definable PXI modular platform, the Aeroflex PXI 3000 Series now adds support for WiMax OFDMA, *The following write-ups were supplied by advertisers in this issue.*

1xEVDO, and HSUPA. Aeroflex modular RF test systems allow testing of cellular, WLAN, and WiMax all in one product. *Aeroflex, www.aeroflex.com.*

3U PXI RF power analyzer

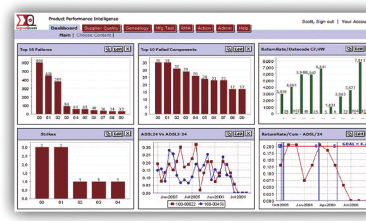
The GX2002 3U PXI RF analyzer performs CW and pulse-power measurements, frequency measurements, and pulse-repetition period measurements on RF signals from 100 MHz to 3 GHz. The module includes a full-featured user interface and drivers for ATEasy and other software development environments. *Geotest—Marvin Test Systems, www.geotestinc.com.*

6-GHz programmable attenuation

JFW has announced its latest advancement in programmable attenuation. The 50PA-266 integrated attenuator assembly operates from 2 to 6 GHz and includes three attenuation paths, with 63 dB of range in 1-dB steps. An Ethernet interface and SMA connectors are standard. Other configurations and connector types are also available. *JFW Industries, www.jfwindustries.com.*

Product-performance intelligence solution

Ensuring the quality of a product requires a solution that can acquire and deliver accurate, timely data from



suppliers, factories, and test systems. SigmaQuest provides an on-demand suite of solutions that help companies build better products using business intelligence techniques for product design, manufacturing, supplier quality, repair, and returns. *SigmaQuest, www.sigmaquest.com.*

DC to 40-GHz automated switch

The G2R40 switch module from Universal Switching can automatically switch broadband signals from DC to 40 GHz. Designed to plug into their popular Series G2 products, the module can be configured from a single 1x6 section to a full seven sections of 1x6. The unit is hot-swappable and has K-type connectors for high performance. *Universal Switching, www.uswi.com.*

Catalog features red hot mechanics

Edmund Optics' 2007 optics and optical components catalog contains more than 8000 products, more than 1000 of which are new. The catalog features EO's line of Tech Spec Mechanics providing superior quality mechanics at the right price. Also included are Tech

Spec Harsh Environment Optics and new LED-based illumination delivery systems. *Edmund Optics, www.edmundoptics.com.*

Desktop ATE

Qmax's V200 desktop ATE offers features typically found in high-end ATE. The tester performs in-circuit functional test for component-level/cluster tests; card-edge functional tests of digital, analog, and mixed-signal PCBs with guided-probe backtracking; and boundary-scan tests for high-density PCBs with PQFP, BGA, and other high-density chips. *Qmax Test Equipments, www.qmaxtest.com.*

Physical layer switch

The Media Cross Connect (MCC) product line from MRV is a modular, digital, patch panel that allows users to program a connection from any port to any other port. The MCC is a "must have" in every test lab and is a critical component in achieving test automation. *MRV Communications, www.mrv.com.*

Fast USB oscilloscope

The 250-MHz PicoScope 5204 PC oscilloscope from Pico Technology features a 128-Msample memory depth and a 1-Gsample/s real-time sampling rate. The PS5204 is complemented by an array of high-end functions including advanced triggering, a built-in 250-MHz spectrum analyzer, and a 12-bit, 125-Msamples/s arbitrary waveform generator. *Pico Technology, www.picotech.com/pco375.*

High-performance audio analyzers

Since 1984, AP has been a leader in audio test and measurement. The 2700 Series audio analyzer offers high performance, low distortion, and great flexibility. The new multichannel APx585 is fast and intuitive, capable of taking 14 measurements across eight channels in 14 s with one click. *Audio Precision, www.ap.com.*

Frame grabbers deliver flexibility

Dalsa's new X64 Xcelera frame grabber series leverage PCI Express to bring traditional image-acquisition and processing technology to new levels of performance and flexibility. The Xcelera Series are built on a unified and scalable platform, support Camera Link, and deliver 1 Gbyte/s over multiple-lane PCI Express implementations with room to grow. *Dalsa, www.dalsa.com.*

Low-profile rotary stages

Aerotech's ABRS series direct-drive, rotary, air-bearing stages provide superior angular positioning, velocity stability, and error-motion performance in a low-profile package. The ABRS is designed to meet the exacting requirements of wafer inspection, high-precision metrology, x-ray diffraction systems, optical inspection and fabrication, and MEMS/nanotechnology device fabrication. *Aerotech, www.aerotech.com.*

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VIEWPOINT

[An exclusive interview with a technical leader]

LOOFIE GUTTERMAN
President
Geotest—Marvin Test Systems
Irvine, CA

Co-founder of Geotest—Marvin Test Systems, Loofie Gutterman has more than 20 years of experience in the test and measurement industry. During his tenure with the company, he has served as VP of systems engineering, COO, and now president. His experience in the development of commercial and military test instruments, as well as turnkey solutions, paved the way for Geotest's growth in the PC- and PXI-based product markets. Prior to joining Geotest, Gutterman held several positions with test-systems manufacturer RSi, including program manager, COO, and technical director. He currently serves as the president of the PXI Systems Alliance.

Contributing editor Larry Maloney recently interviewed Gutterman by phone on developments in PXI and other test-industry trends.

Behind the boom in PXI

Q: To what extent is PXI replacing VXI in test applications?

A: At this year's Autotestcon, it was very impressive to see the wide extent to which PXI is being used, from manufacturing settings to rugged field applications. PXI's progress in replacing VXI is well ahead of the schedule that the PXI Alliance set for itself five years ago, and this growth includes many applications in military/aerospace, which was once pretty much owned by VXI.

Q: What's behind this rapid growth?

A: A lot of military test programs are coming up for technical refresh or are moving to next-generation designs, and PXI is now the clear choice for a number of reasons. PXI offers a much more compact footprint, versus the multi-bay designs that you often find in old VXI-based systems. So, you get more functionality in a much smaller package. You also pay about half as much for the test system without sacrificing performance.

Q: But what concerns do engineers have about PXI equipment?

A: Interoperability comes up a lot, and that's a key goal of the PXI Alliance. When a customer buys a mix of PXI products from different vendors, we want to make sure that the system functions properly. At Autotestcon, we did a demo of a plug-and-play RF test system that featured our new RF signal analyzer and our ATEasy software, used with an Aeroflex synthesizer and signal generator. The design also integrated one of our RF switching cards and a PXI programmable power supply. It was a complete, compact RF solution in a single chassis, and we put it together in just a few hours. This really appeals to customers—getting all the functionality they need in one chassis.

Q: What is the growth potential for PXI Express?

A: It makes sense for applications that require mass data transfer. The emergence of PXI Express will open up new opportunities for us in these high-bandwidth applications. One customer is talking about a data-acquisition system requiring a continuous transfer rate of hundreds of megabytes per second. Two years ago, using PXI only, we couldn't provide a solution. Now, with the addition of PXI Express, we can. In such cases, we see engineers using hybrid PXI-PXI Express systems. Companies will offer test chassis with, say, a dozen PXI cards and one or two PXI Express cards. For example, our high-speed, deep-memory digital cards can be ported over to PXI Express for faster load and unload times.

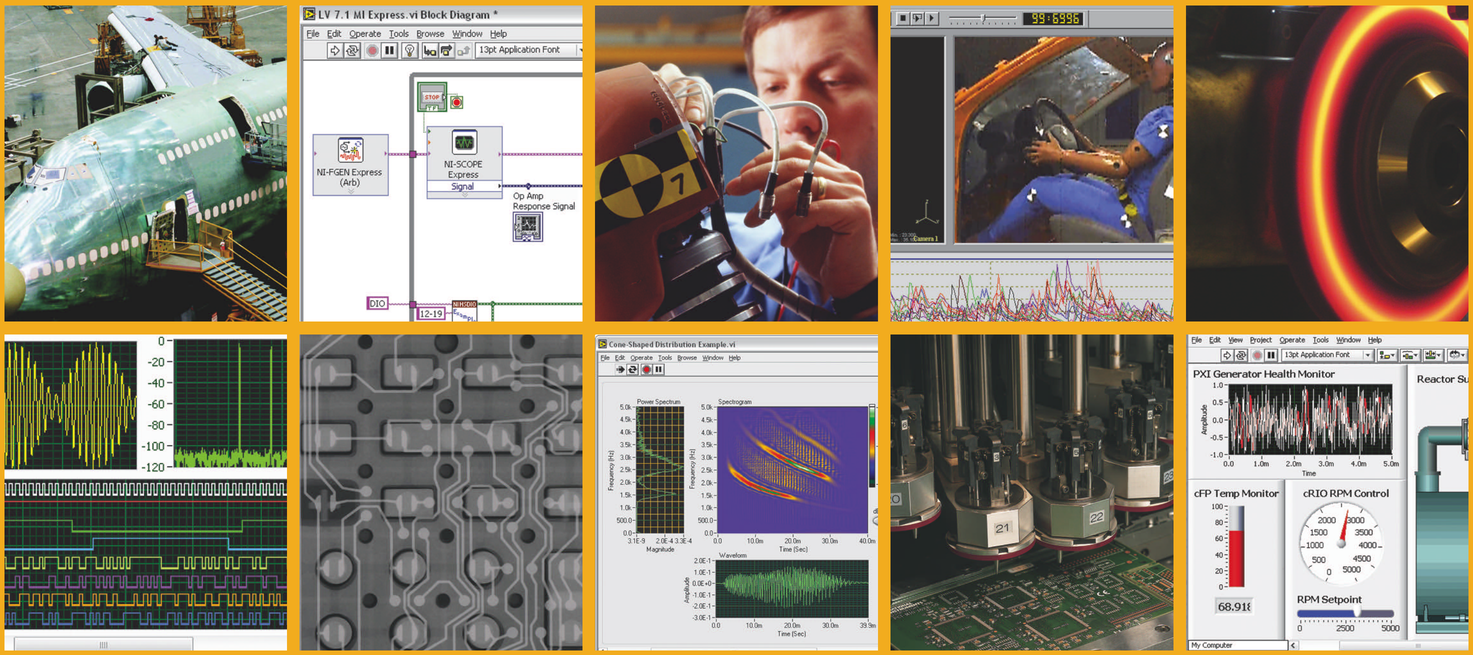
Q: Where does LXI fit into the test environment?

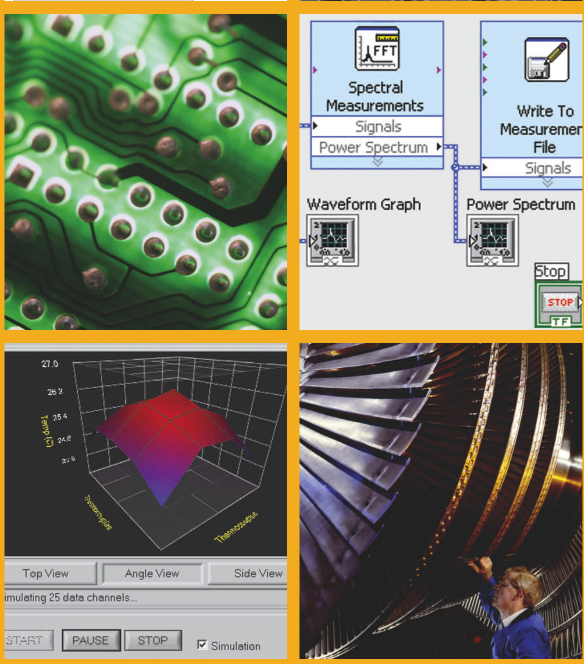
A: This Ethernet-based standard is a cost-effective successor to GPIB. We think it's a great solution, and we joined the LXI Consortium in 2006. You'll see more PXI–LXI hybrid systems. The big hang-up is getting enough LXI products out there. For example, many DMMs and signal analyzers still don't have the LXI interface.

Q: What are the most promising future markets for your company?

A: Military/aerospace, especially avionics test, is strong now, and will continue to do very well. Other attractive markets include medical, such as systems to test boards for pacemakers, and communications, especially testers for RF devices and wireless LAN. There's also a huge opportunity in semiconductor test, such as working with engineers who need to functionally test FPGAs. Overall, the market for PXI instruments is growing at a 25% annual rate, and demand for complete PXI systems is increasing even faster. Geotest is active in both areas. T&MW

Loofie Gutterman comments on new PXI products, turnkey systems, networked test, and other topics in the online version of this interview: www.tmworld.com/2006_12.





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