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Test & Measurement World

THE MAGAZINE FOR QUALITY IN ELECTRONICS

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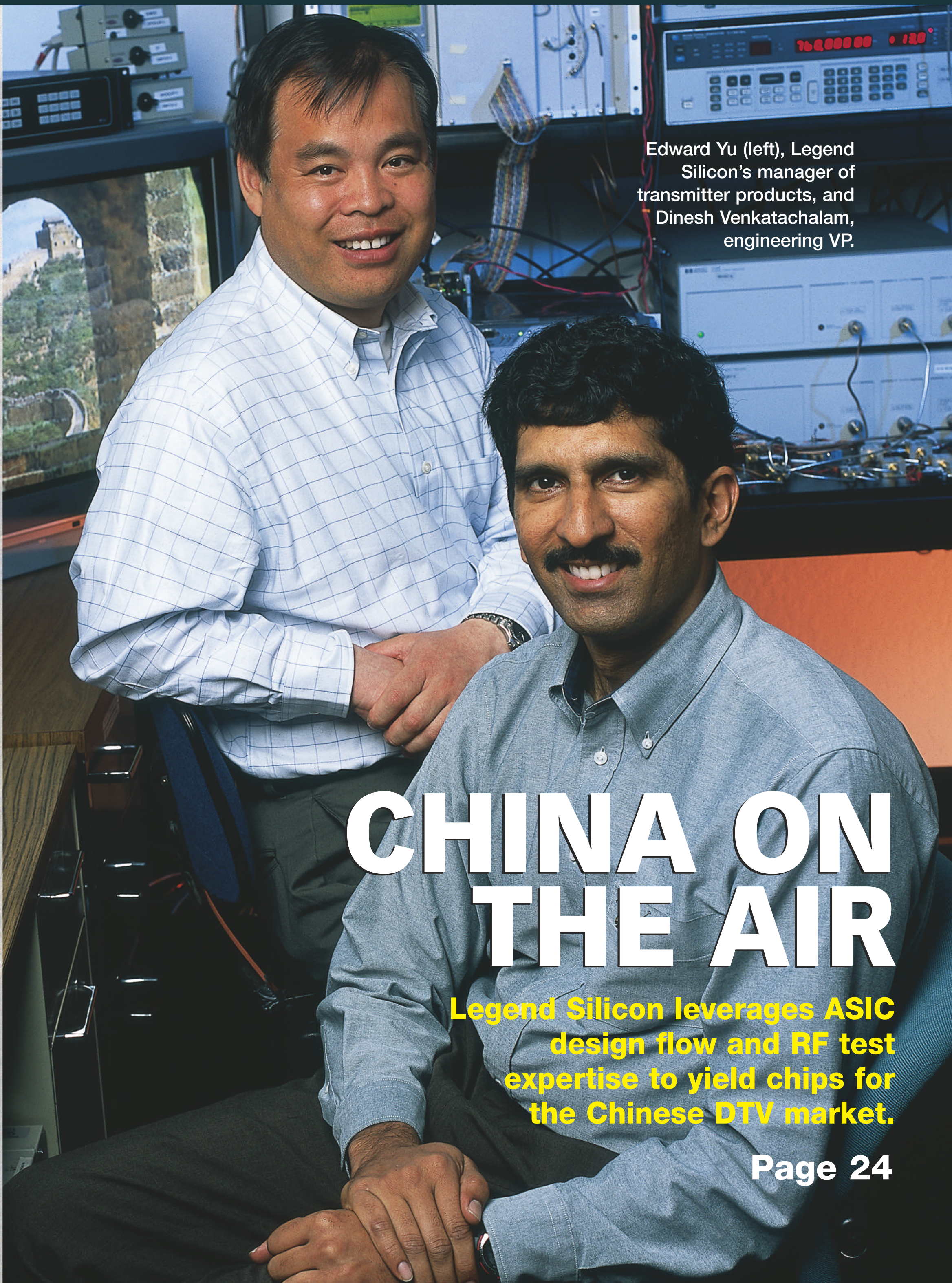

Edward Yu (left), Legend Silicon's manager of transmitter products, and Dinesh Venkatachalam, engineering VP.

CHINA ON THE AIR

Legend Silicon leverages ASIC design flow and RF test expertise to yield chips for the Chinese DTV market.

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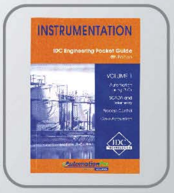

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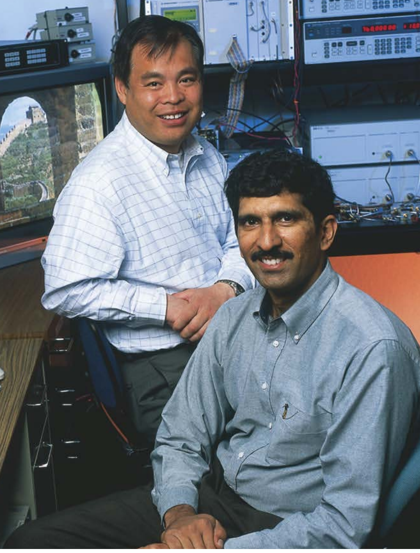

COVER BY: GARY LAUFMAN

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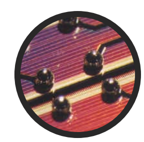

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▶ **Who is the World's Smartest Test Engineer?**
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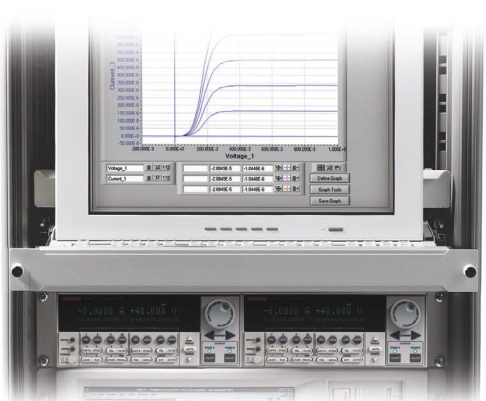

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Reed Electronics Group

Recognizing engineers

Last month, I commented that it's increasingly difficult to attract youngsters to engineering professions, citing possible causes ranging from the difficulty of the subject matter to concern about employment prospects. Several readers proposed another possibility: a lack of recognition. Les Howell at Teradyne writes, "A songwriter or a producer is better known than the guys who produced TCP/IP."

My colleague John Dodge, editor in chief at sister publication *EDN*, advances a similar point. In a recent column (www.edn.com/article/CA526328), he quotes Geoffrey Orsak, dean of the School of Engineering at Southern Methodist University: "We have to celebrate our people. As long as we continue to view engineering as about widgets and not about people, we will have a perception problem."

RICK NELSON, CHIEF EDITOR

To alleviate the perception problem, SMU and other universities along with Texas Instruments, National Instruments, and Tyco Electronics are supporting the Infinity Project, which, notes Orsak on the Infinity Project Web site (www.infinity-project.org), is designed to "fuel a love for engineering and technology" among high-school students and "to show students how they can use what they've studied to build better, brighter futures."

It's your turn to promote the profession by nominating a "Test Engineer of the Year."

At *Test & Measurement World*, we've been addressing the recognition issue by encouraging our readers to nominate and vote for a "Test Engineer of the Year," who is the focus of a cover-story profile and who may designate a $20,000 educational grant to an engineering school, courtesy of sponsor National Instruments. In 2004, we honored Chris Grachanen, a metrologist who not only works diligently for his employer Hewlett-Packard but who has worked tirelessly for the metrology profession as a whole by developing metrology training programs. This year, we honored Anthony Levandowski, a recent UC-Berkeley engineering graduate who's racing against the clock to ready his autonomous motorcycle for the October 8 DARPA Grand Challenge.

Now, we're beginning the process of choosing our 2006 Test Engineer of the Year, and it's your turn to promote the profession by nominating a candidate. Just send me an e-mail giving some details on the individual's major professional contributions. Also include the phone number and e-mail address for the engineer, as well as for the PR manager at his or her facility (if you know it). Please send your nomination by June 24. Based on your recommendations, we will select six finalists and publish profiles about them in our September issue. From among those six, we will ask readers to vote on their choice for the Test Engineer of the Year. T&MW

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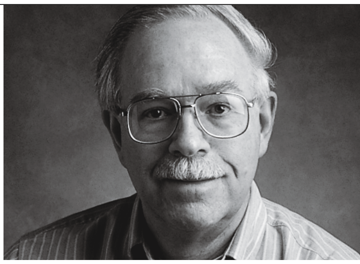


PC-based test anniversaries

Anniversaries and waveform glitches share attributes of sneaking past when you don't pay attention, only becoming evident when you try to figure out what happened.

For example, 2004 marked the 30th anniversary of "Build the Mark-8 . . . Your Personal Minicomputer." Written by Jon Titus, former editor of and current contributor to *Test & Measurement World* and in my opinion one of microcomputing's too-often overlooked pioneers, the article appeared in *Radio-Electronics* magazine's July 1974 issue and described what's arguably the first expandable microcomputer.

Popular Electronics magazine for December 1975 featured a cover story written by Ed Roberts, founder of Micro Instrumentation and Telemetry Systems (MITS). Roberts' company, a struggling model-rocket accessory manufacturer, offered the Altair 8800 microcomputer as a kit. A casual observer would immediately note its similarities to a minicomputer—front-panel data-entry switches, lots of status indicator lights, and an internal expansion bus enabling custom configurations.

The Altair's S-100 bus offered a cheap alternative to minicomputers and an open architecture that encouraged design of specialty boards aimed at data-acquisition and test markets. Although primitive by today's standards, S-100 boards found their way into everything from experimental agricultural-machine controls to automated cash dispensers, and inspired today's PC-based test, measurement, and control industry.

Using surface-mount components, you could shrink the functions contained on a 5.27-by-10-in. S-100 board—or an entire S-100 system—to fit onto a business card.

Nowadays, S-100 systems are history and PCs rule the market. Shrinkage continues, and truly tiny PCs are becoming available. For years to come, existing investments in support software and low-cost hardware will keep PCs in test applications.

Beyond that, I envision ad hoc test systems assembled from domino-sized wireless data-acquisition "points," all chirping away like crickets in a woodpile and relaying data to each other and a central host and datalogging system.

And over coffee, an engineer will say, "Hey, think what we could do if we put a bunch of these little guys on a 5-by-10-in. circuit board. . . ." T&MW

WHAT'S AN S-100 BUS?

Put simply, an S-100 bus is a printed-circuit parallel-trace backplane populated with 100-pin edge connectors selected from a surplus catalog. In the mid-1970s, expensive switched-mode power supplies drove designers to use massive iron-core transformers and unregulated power supplies. Distributing filtered DC allowed point-of-use regulation on individual S-100 boards and helped distribute the thermal load.

Bus signals included address and data lines, a clock, and assorted interface and control signals derived from the processor's I/O pins. The bus suffered from timing incompatibilities that often made system integration more a matter of luck than design. Manufacturers wrangled over standardization, but eventual agreement earned the bus designation as IEEE 696.

An S-100 system typically consisted of a CPU board sporting either an Intel 8080 or Zilog Z-80 microprocessor, one or more static memory boards, and one or more I/O boards. Mass storage began with perforated paper tapes and progressed to audio frequency-shift keyed (AFSK) cassette tapes and 5.25- or 8-in. floppy disks, and eventually, 5- and 10-Mbyte (megabyte!) hard-disk drives. User I/O consisted of a Teletype machine, a monochrome video board, or a serial-interface CRT data terminal.

As with hardware, S-100 system software followed a "let a hundred flowers bloom" philosophy, and even Microsoft's landmark CP/M operating system suffered from incompatibilities. High-performance control applications relied heavily on assembly-language routines.

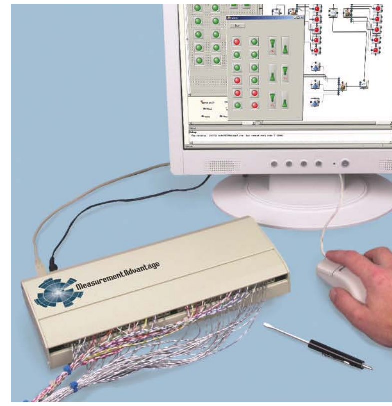
For a history of the Mark-8 and Jon Titus' narrative of its origin:
www.his.com/%7ejlewczyk/mark8.html

For more S-100/IEEE696 bus history:
www.hartetechnologies.com/manuals/

A PC on a chip? Not quite, but close:
www.zfmicro.com/zfx86.html

This PC fits onto a pancake:
www.viamainboards.com/product/epia_mini_itx_spec.jsp?motherboardId=21

National Instruments acquires Measurement Computing



In late April, National Instruments announced that it had acquired the operating assets of Measurement Computing Corp. Founded in 1989, Measurement Computing manufactures data-acquisition products for ISA, PCI, and USB (pictured) interfaces. Terms of the acquisition were not disclosed.

"The acquisition of Measurement Computing is another step in NI's long history of providing very high value-added alternatives to traditional instrumentation," said Dr. James Truchard, National Instruments CEO and co-founder. He added, "This acquisition will strengthen both our hardware and software positions and further our goal of bringing our virtual instrumentation vision to millions of engineering applications worldwide."

The Measurement Computing business, as a wholly owned NI subsidiary, is expected to continue to run its operation as is out of Middleboro, MA. Measurement Computing will sell and support its products through its existing channels. www.ni.com.

NIST plans measurement roadmap

Through an initiative called "Roadmapping America's Measurement Needs for a Strong Innovation Infrastructure," the National Institute of Standards and Technology (NIST) plans to identify priority measurement infrastructure needs across industry and the economy and recommend steps to address them. A final report is expected to be published in early 2007.

NIST is launching the effort because it sees measurement capabilities as necessary for innovation and US industrial competitiveness. During testimony before the House Subcommittee on Environment, Technology, and Standards, NIST Acting Director Hratch Semerjian said, "The goal of this very important initiative, which will be undertaken in close cooperation with the private sector and other agencies, is to ensure that the nation's highest-priority measurement needs are identified and met. We need to be certain that the US measurement system is robust so that it can sustain America's economy and citizens at world-class levels in the 21st century."

NIST is planning several workshops at which representatives of industry, government, and academia will document measurement needs. Possible topics include manufacturing and reliability of nanotechnology systems, measurements for broadband communications, and data-storage technologies. NIST is inviting businesses, trade associations, professional groups, and other organizations to describe pressing measurement infrastructure needs and gaps in their particular areas.

In early 2006, the organization will convene a US Measurement Summit that will provide a venue for key customers and stakeholders to discuss priority measurement system needs and ways for addressing them. usms.nist.gov

EDITORS' CHOICE

IC reliability tester targets 65 nm

Keithley Instruments has announced the S510, a high-channel-count, turnkey semiconductor reliability test system for use in lifetime modeling of advanced ULSI CMOS processes at the 65-nm node. With its high-throughput rate, the system reduces the time required to assess wafer reliability and perform lifetime modeling.

A fully automated, multichannel parallel reliability tester, the S510 system features scalable channel counts from 20 to 72 channels, an independent stress/measure channel for each structure, and simultaneous measurement across all channels. It can test multiple devices simultaneously on a wafer in conjunction with a semi-automatic or fully automatic probe station.

The capabilities of the S510, which employs a source-measure-unit (SMU) per-device architecture, are built on Keithley's KTE automation test executive software. The interactive component, KTEI, supports real-time graphing, interactive test modules, and lab-grade automation for use with analytical probers or semiautomatic probers. The S510 system software includes a parallel test module that performs tests for negative bias temperature instability (NBTI), time-dependent dielectric breakdown (TDDB), and channel-hot-carrier (CHC), and it is optimized to address the challenges of controlling up to 72 pins in parallel.

Base price: $240,000. *Keithley Instruments,* WWW.KEITHLEY.COM.

Cognex acquires DVT

Vision-system-manufacturer Cognex recently announced that it has acquired privately held DVT. Under the terms of the acquisition, Cognex purchased all of the outstanding shares of DVT for approximately $115 million. The acquisition was completed on May 9.

Cognex plans to maintain operations at DVT's facility in Duluth, GA, and to continue selling and supporting DVT vision products through DVT's third-party distribution channel.

"This is the largest acquisition that Cognex has ever completed . . .in terms of price, in terms of revenue, and most importantly, in terms of the positive impact that it will likely have on our company," said Dr. Robert J. Shillman, Cognex chairman and CEO.

Dr. Shillman added, "During 2004, Cognex started to build a third-party distribution channel, and prior to this acquisition we had signed over 40 distributors, mostly in North America. With the acquisition of DVT, Cognex immediately gains a worldwide network of more than 150 additional industrial distributors, all fully trained in selling and supporting machine-vision products."

As a result of the acquisition, Cognex expects an increase in its revenue of approximately $15 to $20 million during fiscal year 2005, but the acquisition is expected to be neutral to earnings in 2005. www.cognex.com.

CALENDAR

Semicon West, July 11–15, San Francisco, CA. Sponsored by SEMI. *www.semicon.org.*

EMC Symposium, August 8–12, Chicago, IL. Sponsored by IEEE, EMC Society. *www.emc2005.org.*

EOS/ESD Symposium, September 8–16, Anaheim, CA. Sponsored by ESD Association. *www.esda.org.*

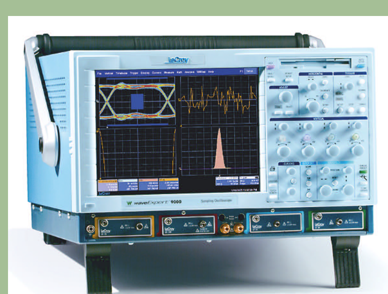
Autotestcon, September 26–29, Orlando, FL. Sponsored by IEEE. *www.autotestcon.com.*

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

EDITORS' CHOICE

Analyze serial data to 11 GHz

Serial data streams continue to increase in speed, and measurements have to stay one step ahead of them. LeCroy's SDA 11000 claims an 11-GHz bandwidth on two channels, wide enough to measure 5-Gbps PCI Express, 6-Gbps Serial ATA III, and 4.25-Gbps Fibre Channel signals. When running on four channels, the instrument's bandwidth is 6 GHz.



When running on one or two channels, the SDA 11000 samples at 40 Gsamples/s with 16 Msamples of memory. It runs at 20 Gsamples/s (8 Msamples of memory) on three or four channels. The company also offers options for 32/16 Msamples and 100/50 Msamples of memory. Two front-panel USB ports lets you download data into a flash drive for security.

Like its predecessors, the SDA 11000 comes with a suite of measurement and analysis tools for jitter and eye diagrams. It measures eye patterns based on a stream of 12 million consecutive unit intervals. It shows mask violations and extrapolates a jitter-bathtub curve based on time-interval analysis. It also measures edge-to-edge jitter and extracts total jitter based on histogram measurements. Base price: $105,000. *LeCroy,* WWW.LECROY.COM.

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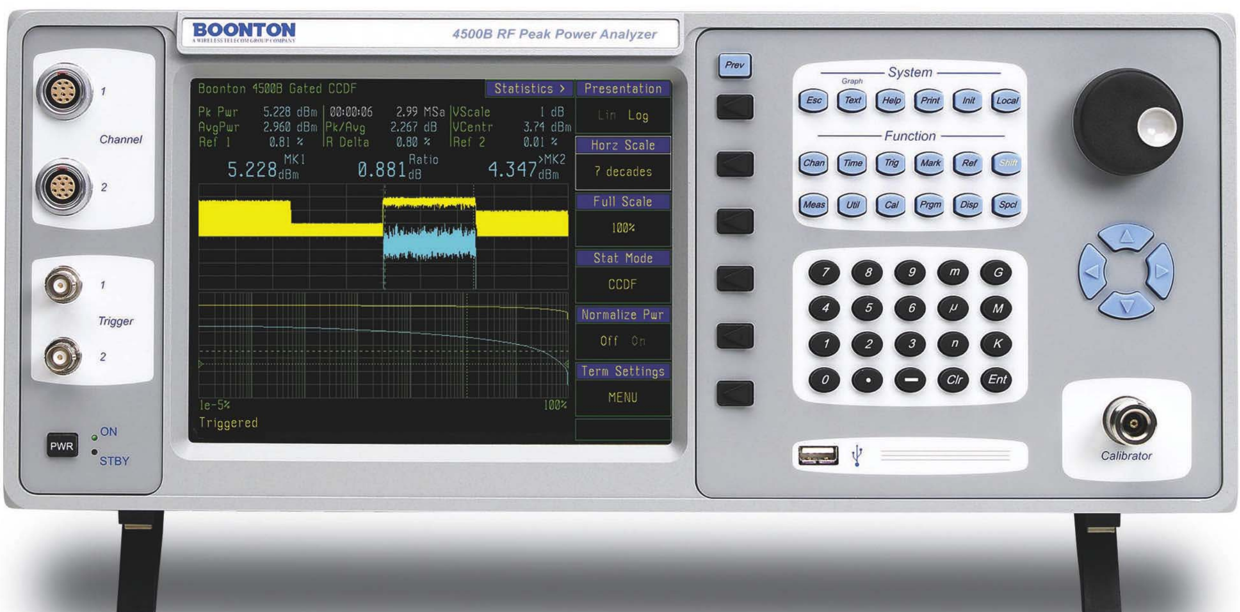

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A sampler of test products and techniques

> > > Wescon D2M, April 12–14, Santa Clara, CA, www.wescon.com.

Exhibits and presentations at Wescon D2M (Design to Manufacture) touched on the gamut of test issues, ranging from semiconductor design for test and design for manufacture to benchtop instruments for PCB development and test. David Ambercrombie, DFM project manager at **Mentor Graphics** (www.mentor.com), presented information on how to use semiconductor production-test data to help implement effective DFM strategies, increasing defect coverage and yields while lowering costs.

Representatives of two digital oscilloscope manufacturers described factors to consider when employing the instruments for serial data-bus analysis. In a session introduced by *T&MW* chief editor Rick Nelson, Michael Lauterbach, director of product management at **LeCroy** (www.lecroy.com), addressed PCI Express-class buses operating at multi-gigabit-per-second rates. He presented general rules of thumb—for instance, that a scope's bandwidth should be 1.8 times the maximum data rate of interest. But he warned that users should consider a scope's "goodness of bandwidth," or flatness, as well as a single value.

In a separate session, Boyd Shaw, product manager for **Yokogawa**'s (www.yokogawa.com) digital oscilloscopes, described techniques for using a general-purpose digital scope to troubleshoot buses such as the CAN bus, the I2C bus, and the SPI bus. Employing such buses, he said, saves development time and PCB space. He added that some digital scopes can measure serial data signal integrity and help isolate problems.

BEYOND OSCILLOSCOPES

But instruments other than oscilloscopes were also on the docket. In another bench-level instrument presentation, Quentin Thomas, a training manager at **Tektronix** (www.tektronix.com), described the application of logic analyzers to the debug of high-speed digital systems—a step that can help shorten a design schedule.

On the exhibit floor, **Aries Electronics** (www.arieselec.com) exhibited its line of test and burn-in sockets, including one socket designed to accommodate device packages ranging from 41 to 55 mm^2 at frequencies to 1 GHz. Another of the company's RF sockets is designed for use with Delta handlers. In addition, **Tidal Engineering** (www.tidaleng.com) described its line of temperature/humidity controllers for environmental-test applications. **VI Technology** (www.vi-tech.com) highlighted its Arendar test-data-management software. And **SyntheSys Research** (www.bertscope.com) displayed its BERTScope instruments, which combine sampling-oscilloscope capabilities with bit-error-rate analysis. T&MW

This center-probe RF test socket was designed specifically for use with Delta handlers; it incorporates built-in replaceable aligning features to accommodate the handlers.

Courtesy of Aries Electronics.

Panelists discuss where to build

> > > NEPCON East/Assembly East, May 3–5, Boston, MA, www.nepconeast.com.

On Wednesday, May 4, the American Society of Test Engineers (www.astetest.org) sponsored a panel discussion entitled, "What Should You Build? What Should You Outsource?" during NEPCON East. The panel consisted of Bob Stasonis, sales and marketing manager for **Pickering Interfaces** (www.pickeringinterfaces.com); Fred Molinari, president of **Data Translation** (www.datatranslation.com); Ray Boissoneau, president of **Electropac** (www.electropac.com), a manufacturer of printed-circuit boards; and *Test & Measurement World* senior technical editor Martin Rowe.

Each panelist gave a two-minute introduction, followed by questions from the audience. During the introductions, the panelists noted that outsourcing is nothing new to New England. It started when textile manufacturing moved south and then offshore. Many other products once manufactured here are now manufactured in China or Mexico.

When asked if their companies manufacture in China, both Boissoneau and Molinari said that they keep manufacturing close to home because doing so gives them greater control over the process. "We build about 20,000 boards a year at our Marlboro, MA, facility," noted Molinari. Boissoneau added, "We're one of the few companies still making all of our printed-circuit boards in North America"

The panelists noted that as manufacturing has moved into China, other countries have lost manufacturing jobs, too. When manufacturing moved to Japan, Singapore, and Taiwan, it raised the standard of living in those countries. Now, those countries have lost some manufacturing to mainland China. The same increase in the standard of living will happen in China, and manufacturers will look elsewhere for lower labor costs. Countries with stable governments will be the first to benefit. T&MW

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Is FTTP a home run?

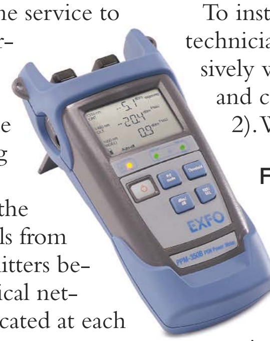
Ever since the telecom crash, the fiber-optics industry has yearned for a new technology to pull it out of the doldrums. At this year's Optical Fiber Communications Conference (OFC; March 7-9, Anaheim, CA), the industry seemed ready to embrace fiber-to-the-premises (FTTP) as the technology that will return it to happier times. Numerous companies have developed optical components that carry signals from a central office (CO) to homes and small businesses. Transmitters, receivers, attenuators, and splitters that go into passive optical networks (PONs) were everywhere. Test equipment for FTTP has also appeared.

Verizon Communications has spearheaded the FTTP push by deploying fiber to many homes and businesses. Because FTTP eliminates as much as three miles of twisted-pair wires, it has the potential to deliver voice, video, and data at rates that may reach 2.5 Gbps. Verizon has taken the lead in deploying PONs to combat cable operators who are adding phone service to their existing hybrid fiber-coax (HFC) networks.

An FTTP network consists of one optical line terminal (OLT)—residing on a CO—that connects numerous subscribers to the provider's network. Signals from the OLT pass through splitters before they arrive at an optical network terminal (ONT) located at each subscriber's premises.

"An ONT converts light to electrical signals," said Benoit Masson, senor product manager at EXFO, "It provides RJ-11 connections for phones, RJ-45 connections for data, and coax for video." Voice and data travel upstream using a 1310-nm link at speeds from 155 Mbps to 622 Mbps and downstream on 1490 nm at 622 Mbps. Analog and digital video consumes the remaining bandwidth on a 1550-nm link (Ref. 1).

To install PONs, Verizon now trains technicians who have worked exclusively with copper on how to install and connect fiber to ONTs (Ref. 2). With fiber installations, technicians need to use optical time-domain reflectometers (ODTRs) instead of electrical TDRs to characterize their installations. As a result, companies such as Acterna, Agilent Technologies, Anritsu, and EXFO have introduced OTDRs and other equipment for FTTP deployment. "Technicians need to measure optical power loss across an entire network," said Peter Schwieger, optical network test manager at Agilent, "That includes making measurements through numerous optical splitters."



Fiber-to-the-premises technology has spawned portable test equipment such as this passive-optical network power meter. Courtesy of EXFO.

If individuals and businesses subscribe to FTTP in droves, it may bring better times to the telecom-equipment business along with more demand for test equipment. If cable wins, there will be little demand for new products because HFC networks are already in place. T&MW

REFERENCES

1. O'Byrne, Vincent, "FTTP (Fiber-to-the-Premises), Next Generation Broadband Access Network." New England Fiberoptic Council, Chestnut Hill, MA, July 2004. www.nefc.com/2004_Downloads/FTTP_NEFC_2004.zip.

2. Howe, Peter J., "Verizon retraining workers to help usher in the future," *Boston Globe*, March 26, 2005. p. E1. www.bostonglobe.com.

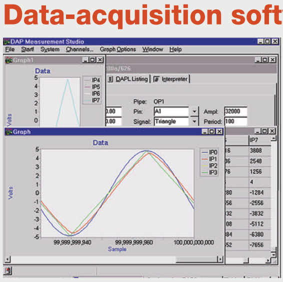
NPL offers practical EMC guides

The UK's National Physical Laboratory offers numerous EMC guides at no charge. Recent guides include "Calibration and use of antennas, focusing on EMC applications," "Good Practice Guide to Phase Noise Measurement," and "The Use of GTEM Cells for EMC Measurements." The complete list also covers guides on topics other than EMC, such as electrical and physical measurements. www.npl.co.uk/electromagnetic/publications.

Eye-diagram wall poster

Synthesis Research has produced a free wall poster entitled "The Anatomy of an Eye Diagram," which covers eye diagrams for transmitter measurements, channel measurements, and receiver stressed-eye measurements. www.synthesysresearch.com.

Data-acquisition software



Microstar Labs has released version 1.5 of DAPstudio software that can be used with the company's data-acquisition boards to acquire and analyze data. DAPstudio lets you develop custom applications and user interfaces without programming. When an application runs, it sends commands to a card's onboard processor. Price: $199. www.mstarlabs.com.

Test & Measurement World

PXI TEST REPORT

INSTRUMENTATION

PXI DMMs gain a digit

Richard A. Quinnell, Contributing Technical Editor

Compared with instruments such as oscilloscopes and vector analyzers, the digital multimeter (DMM) may not seem very exciting. For versatility, however, the DMM is unmatched among bench tools.

The recent introductions of DMM PXI cards by National Instruments and Signametrics have extended that versatility even further. The new instruments offer a full 7.5-digit resolution along with features that extend their range of function.

"By increasing precision and resolution to 7.5 digits, we have opened up new applications," said Zwie Amitai, Signametrics' director of operations. "These include IC pin leakage measurements, and cable manufacturing, which uses both high-ohm and low-ohm resistance measurements in production." Kevin Bisking, DMM product marketing manger for National Instruments, agreed, noting "These instruments offer picoamp and nanovolt sensitivity, now allowing them to measure parameters such as transistor current-voltage transfer characteristics."

Achieving this level of precision was a challenge, especially in light of the backplane noise in PXI systems. According to Amitai, some of the techniques that Signametrics used included extensive isolation. The design incorporates an isolated power supply and optical isolation for its measurement circuitry to keep the PXI bus noise at bay. In addition, the unit's internal layout included extra spacing to separate the sensitive analog circuitry from the digital section.

Bisking said a key element in the NI design is a high-precision thermally stabilized voltage reference that allows the instrument to perform self-calibration to correct for time and temperature-related drift. In addition, he noted, the small form factor of the PXI board helps keep traces short to reduce noise pickup.

Both companies point out that the versatility of a DMM is a particular advantage in the PXI format. For example, the triggering capabilities of PXI can combine with the DMM's sampling ability to measure parameters at specific events in an oscilloscope-like function. This ability can also extend to perform rough digital oscilloscope functions at modest sample rates.

The NI PXI 4071 Flex, for example, can sample as fast as 1.8 Msamples/s with 3-digit accuracy and 5 ksamples/s with 5.5 digits. The Signametrics SMX2064 offers selectable measurement time aperture to permit a balance between measurement speed and noise and a top sampling rate of 20 ksamples/s. This sample rate/accuracy tradeoff is particularly important in manufacturing applications where measurement times are critical.

While these sample rates represent only modest performance for an oscilloscope, they are enough for many applications. The DMMs also offer a more extended measurement range and higher isolation than a traditional oscilloscope. According to Bisking, the NI design achieves an internal common mode voltage rating of 500 V—a wide enough range, for instance, to test a 400-V fuel cell stack as an entire unit as well as each individual 1-V cell with the same instrument.

The ability to replace multiple instruments is one of the most valuable aspects of the PXI-based DMMs. The Signametrics device offers full LCR measurements, current and voltage sourcing for circuit simulation, and support for thermocouples for temperature measurements. NI has incorporated its DMM as part of its virtual instrument program, which allows users to configure a variety of instruments that have functions in common from units that contain those functions. In either case, the range and versatility of the PXI DMM has grown significantly with these latest releases. □

A PXI DMM provides extended utility as well as high accuracy. Courtesy of National Instruments.

For more on how manufacturers calculate the number of digits in a PXI DMM, see "DMM digits depend on performance," on p. 19 of this month's issue of *Test & Measurement World*, available online at www.tmworld.com/archives.

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EDITOR'S NOTE

Take PXI to the next level

Richard A. Quinnell, Technical Editor

Engineers are great problem solvers, and because of that, we love to see clever solutions. We especially delight in solutions that combine things in a novel way. A case in point is the article in this issue on a product that merges PXI and boundary scan (p. P5). It combines the test ability of boundary scan with the triggering ability of PXI to extend the capabilities of both.

To achieve those kinds of solutions, however, takes a special talent—the ability to "think outside of the box." There is a wonderful puzzle that demonstrates this ability. You are given a candle, a string, and a box of thumbtacks and told to mount the candle on the wall as a lantern.

The trick to this one is to realize that you have something more there than candle, string, and tacks. The additional item is disguised by conventional thinking so you don't realize that you have it. It is the box the thumbtacks are in. With it, you can use the thumbtack to mount the box to the wall as a platform for the candle, perhaps using the string to hold up the end of the cantilevered box.

Try exercising your ability to think outside of the box as you take PXI systems to the next level. Look at all of the resources you have by listing the components of each and seeing if one can be used in a different way. You may find the hidden box, and you will come up with a clever solution that can delight those who see it. □

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

NEWS

Picolight chooses PXIT products

PICOLIGHT, A DESIGNER and manufacturer of high-speed optoelectronic components and fiber-optic transceivers, has chosen to incorporate test instrumentation from PXIT in its multi-gigabit transceiver production. The transceivers will be used in enterprise, storage, access, and metropolitan fiber systems. The PXIT digital communications analyzers and bit-error-rate testers will help Picolight optimize its transceiver manufacturing. www.pxit.com. □

Collaboration produces PXI real-time simulation

APPLIED DYNAMICS International (ADI) and National Instruments have collaborated to produce a high-performance PXI-based real-time simulation system. The rtX aims at the development and test of real-time embedded systems in aerospace, defense, and automotive applications. It uses ADI's Advantage real-time simulation framework, NI's LabView graphical development tools, and NI hardware to produce a computing system that can model engine, powertrain, and chassis systems in either open-loop testing or closed-loop simulation. www.adi.com. □

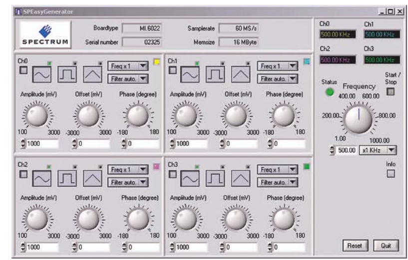
Calendar

NIWeek
August 16–18
Austin, TX
Sponsored by National Instruments
www.ni.com/niweek

Autotestcon
September 26–29
Orlando, FL
Sponsored by IEEE
www.autotestcon.com

DAC boards get software upgrade

SPECTRUM IS NOW including software with its MI, MX, and MC series of digital-to-analog converter (DAC) boards. The SPEasyGenerator allows a first test of the delivered board and offers an easy-to-use function generator program.



The function generator permits users to produce a variety of waveform shapes (sine, rectangle, sawtooth) and change the frequency, phase, output amplitude, offset, and filter with a few mouse clicks. The software, which is available as a free download from the company's Web site, is based on LabWindows and runs under all current Windows versions. www.spectrum-gmbh.com. □

Pickering Interfaces adds Mexican distributor

IN MAY, Pickering Interfaces announced that it has appointed LogicBus to distribute its PXI products to the Mexican market. LogicBus, based in Guadalajara, will provide sales and service for Pickering's complete product line.

"Many of our global customers now require support on their doorsteps," said Keith Moore of Pickering Interfaces. "Pickering Interfaces' new partnership with LogicBus is a significant step towards providing true support on a worldwide basis. LogicBus is a well-respected company who is ideally placed to maximize the benefits our customers can gain from using Pickering Interfaces' products." www.pickeringtest.com. □

DESIGN FOR TEST

PXI extends reach of boundary scan

Mario Berger, Göpel electronic

Boundary-scan technology arose to simplify the testing of connections on fine-pitch printed-circuit boards. Now, as test-equipment manufacturers combine the features of PXI-based instruments with boundary scan, faster testing and new test options are becoming available.

Boundary scan was developed in the late 1980s by the Joint Test Action Group (JTAG) and was approved as IEEE 1149.1 in 1990. The basic principle (**Figure 1**) is that boundary-scan-compliant devices incorporate a scan register at each digital I/O pin, connected together in a chain. Each register provides an input cell that can measure the signal present on the pin, an output cell that can send a signal to the pin, and storage cells that connect to form a shift register. Connecting boundary-scan devices together extends the shift register, creating a single chain that allows access to every digital I/O pin on a circuit board.

In normal operation, signals moving on and off the chip pass through the boundary-scan cells. When in test mode, however, the registers can impose a signal on an output pin or capture a signal from an input pin—core logic and pins are basically disconnected. To load the register (boundary-scan cells), the user shifts a test vector through the scan chain with the proper logic values for the input, output, and control cells.

Triggering the test mode causes the output cells to replace a device's normal output signals at its I/O pins, and then captures the data present at the input cells. To read the results, the user shifts the vector out of the chain. The technology thus provides embedded test access to all of a circuit board's nodes that contain boundary-scan cells, reducing or eliminating the need for mechanical access through probes.

Teamwork

Combining PXI with boundary scan can provide a variety of useful test options to design and test engineers. Simply running a boundary-scan test pattern under PXI system control is nothing new, though. The key to expanding the limits of plain boundary scan lies in incorporating PXI's trigger features, which allow the rest of the PXI resources to become synchronized with the boundary-scan test activity.

One example is to use the PXI and boundary-scan combination to monitor the power supply of a unit under test (UUT). When a power supply does not work properly, diagnosing its faults can often require lengthy debug sessions. With a combined PXI and boundary-scan test setup, how-

continued on page P6

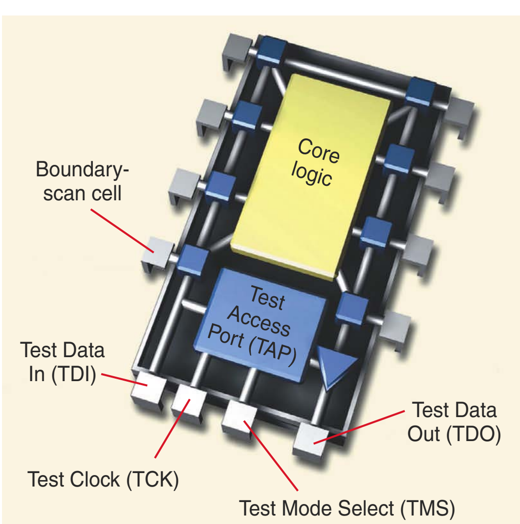


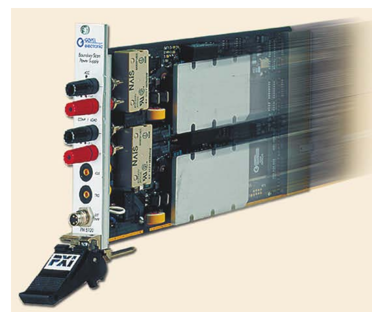
Fig. 1 JTAG boundary-scan outfits each pin of a digital device with test registers that can stimulate or record I/O data.

PXI and boundary scan • from page P5

ever, a PXI card can record the supply voltage and the current values during boundary-scan test execution. Correlating these recorded values to specific boundary-scan vectors can help you diagnose events such as ground bounce and logic-induced shorts to power-supply rails on the UUT.

The combination can also extend boundary-scan test to a board's analog section. PXI modules provide the tools for the stimulation and measurement, synchronized to the boundary-scan test stimulus and response patterns. This allows verification of functional blocks such as digital-to-analog converters and analog-to-digital converters, limit comparators, and a host of other mixed-signal operations.

The combination can also enhance the performance of boundary scan in manufacturing testing. Using the parallel PXI bus to control digital I/O modules allows parallel stimulation of a UUT's peripheral connectors in sync with the boundary-scan test pattern. This permits the test software to treat UUT and I/O modules as independent units. It also bypasses the need to shift



Using trigger signals to synchronize analog sensor operation with a boundary-scan clock allows PXI modules such as this power supply to extend scan test to encompass analog functions.

test vectors—or reduces the number of vectors—into the boundary-scan chain, resulting in faster test execution. Similarly, time-intensive boundary-scan applications such as in-system configuration of Flash devices execute much faster in this configuration.

These few examples suggest the enormous potential that lies in the combination of PXI and boundary scan. The open, modular architecture of PXI, combined with its trigger and local bus features, provides an ideal high-performance platform for enhancing the capabilities of boundary scan. With sophisticated implementations and automated software support, PXI-based boundary-scan I/O modules pave the road for new test capabilities. □

Mario Berger is application engineer–boundary scan at Göpel electronic in Jena, Germany. m.berger@goepel.com.

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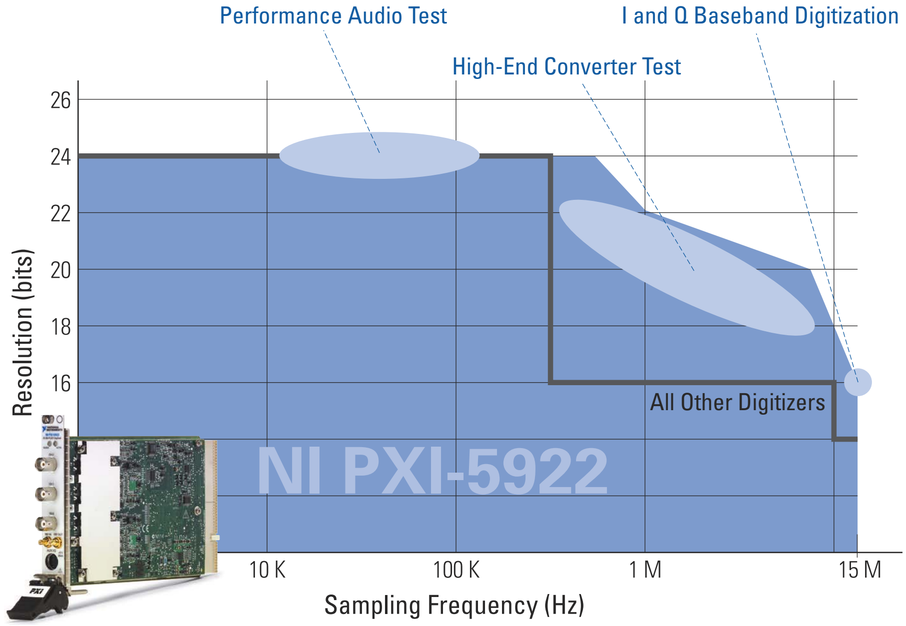

To view a seven-minute online demo of the **NI PXI-5922**, go to **ni.com/modularinstruments**.

(800) 449 6347 or **ni.com**

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The new National Instruments PXI-5922 flexible-resolution digitizer uses patented techniques to deliver the highest resolution and highest dynamic range of any digitizer today up to 15 MS/s. The dual-channel digitizer features:

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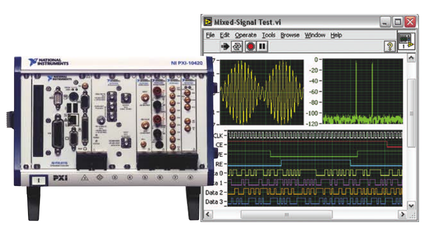
With innovative hardware capabilities and more than 400 measurement and analysis functions, the NI PXI-5922 revolutionizes dynamic measurements for user-defined applications. From DC to RF, NI modular instruments power measurements from prototype to production.



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Switching	Multiplexers, matrices, RF switches, relays
Multifunction I/O	Analog input and output, digital I/O, counters

2005-5073-101-D

NATIONAL INSTRUMENTS™

COMMUNICATIONS TEST

PXI in optical test

Richard A. Quinnell, Contributing Technical Editor

Optical communications testing deals with exceptionally wide bandwidth signals at very high data rates and low signal levels. Instrumentation for this market must thus offer the highest performance possible. Tackling this demanding field with PXI-based instrumentation presents significant challenges. *Test & Measurement World* asked Fadi Daou, president and CTO of optical test instrument maker PXIT, about the use of PXI instrumentation in optical test.

Q: A quick search of the Internet did not reveal many companies involved in PXI-based optical test. Is this a small market, or is there some other reason why there appears to be limited activity?

A: This is a very small market just now, although there is a much larger untapped market out there. The real challenge facing us by using the PXI platform is the need to change people's mindsets. Convincing customers to use PC-based test instruments as opposed to large mainframes with knobs and dials on them is harder than you would think. It is mostly about breaking down the mental barriers. R&D customers still prefer the knobs, although manufacturing customers now prefer the PC control-card instruments

Q: What are the needs of optical testing that PXI is addressing?

A: PXI is addressing the needs of manufacturing test for components in the optical communications industry. PXIT, in particular, is meeting DC test needs of the optical component market with our current source, power meters, and spectrometer and LIV (light current versus voltage) testing for LEDs and VCSELs (vertical cavity surface emitting lasers). Our transmission test products include data-generation capability, bit-error-rate testing, and eye-diagram tests.

Bit-error-rate testing is one of the many functions for optical communications test available on the PXI platform. Courtesy of PXIT.

Q: What kinds of test setups do the PXI instruments replace?

A: For the present range of transmission test instruments, companies were previously using rack-and-stack instruments from manufacturers such as Agilent, Tektronix, and Anritsu.

Q: Why choose PXI as the basis for your optical test products, as opposed to VME or other frameworks?

A: PXIT already had a range of products in the PXI form factor, such as optical and electrical switches, current sources, and power meters, so it was the natural step to use the PXI platform for our optical test product range.

Q: What, if any, characteristics of PXI make it particularly useful in optical test?

A: Two of PXI's extremely useful attributes are its form factor and its scalability. The issue of size speaks for itself. The scalability of PXI opens the possibility for customers to scale their production and test capacity without significantly increasing costs or space demands. An additional benefit of PXI is that it uses PC-based technology. This makes it extremely user friendly in ATE environments. You do not need fully qualified engineers to man test stations in order to control the testing and interpret the results. Using PC technology allows less-skilled (and less-expensive) personnel to perform the task.

Q: What limitations exist in using PXI as the basis for optical test?

A: We have not been limited at all by using PXI. The size of the board does introduce some design challenges, however.

Q: What else do you see as the challenges that the PXI architecture must face in the future?

A: PXI could use more standardization. We develop high-end products with stringent performance requirements that typically compete with high-end benchtop instruments selling above $50k. In order to ensure the required performance of our instruments in the field, we must test them with a wide sample of chassis and power supplies from various PXI vendors.

Accommodating the variations among suppliers imposed additional constraints on the design of our instruments. In other words, there is wide performance variation among supplies and chassis offered from different vendors. What would help is some standardization, such as two levels of performance specifications like commercial and industrial or low-cost and high-performance grade to meet the requirements of various applications. □

PRODUCTS

Modular DSO family

ZTEC has announced the ZT450 family of modular digital storage oscilloscopes (DSOs) for PCI, CompactPCI, and PXI systems. The PXI version offers two channels, each of which can run at 1 Gsample/s. Interleaved sampling allows one channel to attain 2 Gsamples/s and repetitive-time sampling achieves 50 Gsamples/s. The 8-bit DSO has a 500-MHz bandwidth with as much as 32 Mbytes of sample memory per channel. A 1-GHz analog bandwidth option is available.

In addition to making voltage, frequency, and time measurements, the instrument can provide measurement statistics, limit, and mask testing. Adding, subtracting, and windowing acquired waveforms is possible along with FFT functions. In dual-channel mode, cross-channel measurements such as phase and delay are also possible. *ZTEC, www.ztec-inc.com.*

PCI controllers

Two new PCI controllers from National Instruments are based on the Pentium M 760 processor and the Mobile Intel 915GM Express chipset. The PXI-8195 and PXI-8196 use 2-GHz processors and offer performances that NI says beat Pentium 4-based controllers by more than 50%.

Both controllers feature dual-channel DDR2 memory with 2-Gbyte capacity as well as full-rate Gigabit Ethernet. The two controllers work with the entire suite of NI LabView development tools and with environments such as Visual Basic and C++. The controllers ship with Microsoft Windows XP Professional pre-installed. *National Instruments, www.ni.com.*

Portable chassis

Elma Electronic has announced a packaging chassis for portable PXI instrumentation systems. The eight-slot Type 32 PXI chassis is 17x10.5 in. and includes dual 5.25-in. disk drives with a 350-W plug-in power supply and fan. The supply offers an option for dual redundancy.

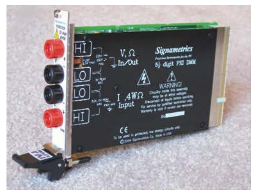
The chassis features vinyl-clad aluminum covers to resist scratches, rubber-soled feet to prevent it from damaging desktops, and a handle for easy portability. It includes an option to include EMI spoons for EMC compliance. Various backplane options are available. *Elma Electronic, www.elma.com.*

Aeroflex offers new catalog

Aeroflex has produced a new short-form catalog and CD for its test products. The company manufactures products for communications test, cellular parametric test, and protocol and conformance test. Products include RF signal generators; PXI modules for RF test; microwave, spectrum, and signal analyzers; synthetic test systems; and phase-noise test systems. The CD includes interactive links that provide access to all product data sheets. *Aeroflex, www.aeroflex.com/catalog.*

5.5-digit DMM

Capturing more than 100 readings/s, the SMX2055 5.5-digit PXI/cPCI digital multimeter features two- and four-wire resistance measurements with six ranges from 240 Ω to 24 MΩ; true RMS AC voltage and current measurements; and diode V/I characterization. The instrument is capable of performing auto-range, relative, min/max, dB, and percent-deviation measurements with the same look and feel of bench instruments.



The board includes front-panel software, DLLs for Windows, and LabView and Linux drivers. Price: less than $800. *Signametrics, www.signametrics.com.*

Optical data digitizers

New dual- and single-channel 6U CompactPCI streamer analyzers with optical data link (ODL) interfaces can handle data streaming to 25 Gbps. The SC210 and SC240 are designed for use with mass storage devices or subsequent post-processing engines in applications such as synthetic aperture radar (SAR) and radio astronomy. With an onboard FPGA for data processing, the analyzers can execute 18x18-bit multiplications in 5 ns and handle data sampling as fast as 1 Gsample/s/channel. *Acqiris, www.acqiris.com.*

Data-acquisition tool for Linux

Exacq Technologies has released version 1.06 of its data-acquisition tools for the Linux operating system. The release includes drivers, applications, and programming tools needed to use the company's data-acquisition boards.

The tool requires an Intel Linux distribution based on a v2.4.x kernel with module and proc file system support, but any v2.4.x distribution should be compatible. The tool release is provided at no extra charge as part of every data-acquisition board. Existing users

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can download the tool from the company's download page. In addition to the Linux tools, Exacq has released version 1.8 of its software development kit. *Exacq Technologies, www.exacq.com.*

CPU board with FPGA

The F11 single-board computer based on the Pentium III Celeron processor is designed for low-voltage and harsh environment applications. The board includes an Altera Cyclone FPGA, allowing developers to customize the board's I/O structure.

Available cores include CAN, digital I/O, and touch control. In addition, the board offers two Ethernet and two RS-232 interfaces for front- or rear-panel connection. Dual USB, graphics, keyboard, and mouse ports are available from the front, and IDE, COM, PS/2, and PXI triggers are available from the rear. The system also includes 512 Mbytes of SO-DIMM, SRAM, and a CompactFlash hard disk. *MEN Mikro Elektronik, www.menmicro.com.*

Toolset for IEEE 1641

Racal Instruments has released its newWave software toolset in support of the IEEE 1641 Signal Definition Standard. The standard allows test developers to define signals in a nonprocedural manner so the signals can be reused in a multitude of test environments and test situations. The newWave toolset enables the export of signal definitions into ATML, C++, and a variety of other test-programming environments. It also provides a visual development environment for defining signals based on the standard. Using the toolset, engineers can create real-time signals using DirectX streaming. *Racal Instruments, www.racalinst.com.*

Portable test system

A rugged portable test system from Advint Advanced Integration is designed for factory or field support. The Puma platform provides an open-architecture platform based on PXI for functional testing of digital, analog, and RF electronics. It employs a single-frame 19-in. rack-mount system with 3U PXI and SCXI chassis and uses LabWindows and LabView for test program installation.

Comprehensive self-test and field-calibration capabilities are available with the addition of an interface test adapter. The Puma unit also has a Windows-based GUI that allows an operator to control the unit's power supply assemblies, its PXI instruments, and the system under test. *Advint Advanced, www.advint.com.*

Universal time interval counters

The GC22x0 series of 3U PCI universal time-interval counters use onboard microprocessors with embedded firmware to create 14 predefined measurement functions for frequency, period, pulse width, time interval, and more. Each unit has an internal clock source and supports external reference sources as well. The GC2210 measures frequencies from DC to 225 MHz with 1-ns resolution. The GC2220 goes to 1.3 GHz with 100-ps resolution. The GC2230 covers frequencies up to 2 GHz and can determine frequency to 0.1 ppm in just 1 ms with a time resolution to 100 ps. *Geotest-Marvin Test Systems, www.geotestinc.com.*

Switching matrix test tool

Pickering Interfaces has introduced the PI-MXT90-100, a test tool that identifies faulty relays on the company's PXI switching matrices. The diagnostic tool uses a test adapter and a DMM, which operate under automatic software control to perform tests with a minimum of operator intervention. Having located a faulty relay, the modules enable you to install replacements without the need for specialized tools. The diagnostic tool aims to let you support any Pickering Interfaces' switching product in the field. *Pickering Interfaces, www.pickeringtest.com.*

STEVE SCHEIBER
CONTRIBUTING TECHNICAL EDITOR
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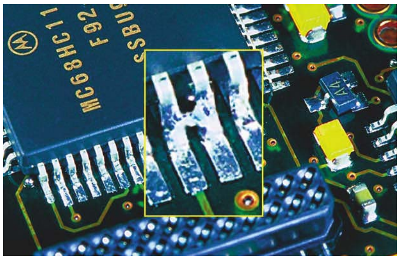
Putting the pigeons in the right holes

Historically, in performing economic analysis of board-test strategies—either for strategy decision-making or capital-equipment justification—the biggest hurdle lay in the fact that many companies did not adequately account for scrap. Standard practice often classified scrapped boards as "inventory." The practice began years ago when companies could reasonably expect to go back to the "bonepile," repair the boards, and use them in subsequent production.

Considering the speed with which technology changes today, boards that don't get repaired during initial manufacturing will be obsolete and useless by the time you get back to them. Unfortunately, reclassifying inventoried boards as scrap reduces the value of inventory assets, directly reducing the company's bottom line. No one seems willing to accept that responsibility. The situation is even more severe in Europe, where strict rules on recovery and recycling of scrapped materials represent an addition financial burden.



An inadequate test strategy may scrap even a board with a simple short that it cannot find. Courtesy of Teradyne.

In the wake of the Enron disintegration and the passage of the Sarbanes-Oxley Act governing financial disclosures, however, the atmosphere has changed. Categorizing "scrap" as "inventory" has been designated one area of inaccurate accounting that must be corrected. This paradigm shift has significant implications for engineers looking to "sell" test-strategy ideas to upper management.

In nearly two decades of performing economic analyses of manufacturing and test operations, I have discovered one undeniable constant: If a process creates more than a tiny percentage of scrap, the value of that scrap rapidly swamps all other costs for test-and-repair operations. A few years ago, I created what I thought was a reasonably realistic repair vs. scrap example. When I ran the numbers, I discovered that repairing 90% of bad boards instead of scrapping them saved my mythical company more than $7 billion. Although that example was hypothetical, the point it made was very real.

Correctly taking scrap into account enormously increases the payback of a successful test strategy. It permits justifying a more comprehensive strategy even lacking a non-monetary consequence of shipping defective products (as with medical equipment). The additional ammunition may even permit you to justify amplifying an existing strategy—by calculating the cost of a new strategy against the "do nothing" alternative. In addition, acquiring even the most elaborate data-gathering and materials-tracking tools becomes more cost-effective, because those tools minimize the necessity to count inventory directly.

For years, engineers have tried to change management's perception that testing has no value. Perhaps the current environment will help us to do exactly that. T&MW

Power and flexibility

Boasting new software and a tester-per-pin architecture, Agilent's i5000 in-circuit test system offers a 1:1 ratio of hybrid channel-to-node and tester-per-pin, allowing developers to assign test resources during program generation regardless of their location, so fixtures can be built in parallel. Agilent claims that the i5000's tests are transportable and repeatable, permitting migration from tester to tester, line to line, and site to site with minimal impact on the results. www.agilent.com.

Another toolbox for quality engineers

Completely updating its best-selling title, the American Society for Quality has published the second edition of *The Quality Toolbox*. The new edition includes 34 additional tools and 18 variations, including proven methods for analyzing processes, determining root causes for failures, and handling complex data. A chapter on quality improvement stories includes case studies from Malcolm Baldrige Award winners. www.asq.org.

Cirrus Logic sells in-house test operations

Premier Semiconductor Services has acquired the in-house semiconductor test operation of Cirrus Logic (Austin, TX). Included in the transfer will be equipment such as testers, handlers, and probers. In addition, the employees in Cirrus Logic's test operation will become Premier employees. From its new site, Premier will provide test services to Cirrus Logic and will also provide test, test-engineering development, wafer probe/sort, and burn-in services to other customers. www.premierS2.com.


SNAP CONNECTORS
H+S MMPX 65 GHz

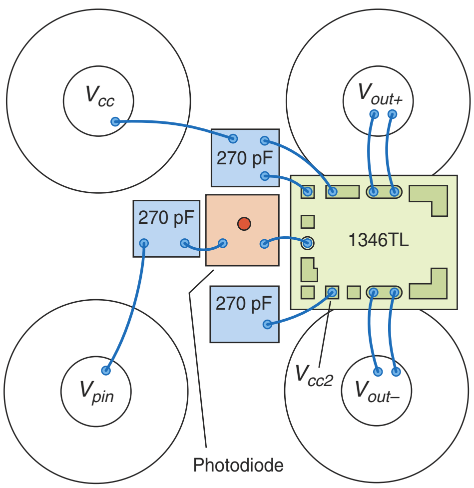
ELECTROMAGNETIC COMPLIANCE

Vias reduce EMI in photonics ICs

Inphi manufactures transimpedance amplifier ICs that its customers package with photodiodes into cases that they then install in optical transceivers. The photodiode converts light into current, which the amplifier converts into voltage. Because of price pressures, Inphi's customers want to package the chips into common component cases such as TO-46.

When Inphi began producing 10-Gbps devices, the company's engineers found that the electrical signals between the photodiode and the amplifier interfered with signals on the amplifier die. Thus, they needed a way to reduce emissions.

A TO-46 case provides just four connections to the outside world (see **figure**). When assembled with a photodiode and a 1346TL transimpedance amplifier, the case needs one pin to power the photodiode (*Vpin*), one to power the amplifier (*Vcc*), and two for the amplifier's differential output (*Vout+* and *Vout–*).



Vias in the 1346TL transimpedance amplifier (large die) connect the underside of the device to a TO-46 case, thus making several connections to ground. Courtesy of Inphi.

To ground the ICs, Inphi's engineers built vias into the amplifier's die that make ground connections possible from the underside of the die to the case. The 10 to 12 vias are placed where they separate connections between critical circuits on the amplifier die. EMI emitted from the bond wires that connect the photodiode to the amplifier get routed to ground through the vias and away from critical circuits. Thus, the vias make it possible to use a TO-46 case by providing numerous ground connections that shield critical circuits from EMI. Two or three bypass capacitors isolate the devices from noise on the power lines.

Martin Rowe, Senior Technical Editor

INSTRUMENTS

DMM digits depend on performance

Makers of handheld digital multimeters (DMMs) specify a meter's resolution based on its display. A 3.5-digit meter, for example, produces counts from 0000 to ±1999. It has three full digits (0–9) and a half digit (0–1). A 3.75-digit DMM counts from 0000 to ±3999, where the three-quarter digit counts from 0 to 3.

Card-based DMMs, such as the 6.5-digit and 7.5-digit PXI and PCI models from National Instruments and Signametrics, don't base their digits on display counts because they lack displays. Instead, they base their digits on the DMM's performance range and noise. To calculate the number of digits, the companies use an equation similar to the following:

$$Digits = \log_{10}(ADC\ counts)$$

The **table** shows the relationship among analog-to-digital converter (ADC) bits, ADC counts, and DMM digits (rounded to two decimal places). If a DMM had a noiseless, perfectly linear, 1-million count ADC, it would have exactly 6 digits of resolution. ADCs, however, have counts based on powers of two. Thus, a 7.5-digit DMM needs 25 *effective* bits.

Unfortunately, all measurement systems suffer from noise and nonlinearities, which reduces their effective number of bits (ENOB) and thus their effective number of digits (ENOD). Ken Reindel, director of measurement technology at National Instruments, uses this equation to characterize his company's card-based DMMs:

$$ENOD = \frac{total\ measurement\ span}{\sqrt{12} * rms\ noise}$$

Zwie Amitai, director of operations at Signametrics, points out that the actual bits of a DMM's ADC must be greater than shown in the table to compensate for noise and nonlinearities. "Our SM2064 PXI DMM has 24,000,000 effective counts (up and down), which corresponds to $\log_{10}$(24,000,000), or 7.38 digits." To get the 24 million effective counts, the DMM needs an ADC with better than 25 bits.

Relationship of bits to counts and digits.

ADC BITS	ADC COUNTS	DIGITS
18	262,144	5.42
19	524,288	5.72
20	1,048,576	6.02
21	2,097,152	6.32
22	4,194,304	6.62
23	8,388,608	6.92
24	16,777,216	7.22
25	33,554,432	7.53
26	67,108,864	7.83

Martin Rowe, Senior Technical Editor

BASIC MEASUREMENTS

Reduce noise in low-current measurements

Noise can cause errors when you make low-current measurements, especially at levels under 1 nA. Here are a few likely causes of noise in such measurements along with suggestions for ways to avoid them:

• **Electrostatic coupling.** Coupling occurs when an electrically charged object is brought near an uncharged object.

Remedies: Be sure to shield the device or circuit. High-impedance materials don't let the charge decay quickly. Shielding the device or circuit under test greatly reduces the electrostatic interference. Connect the shield to circuit low.

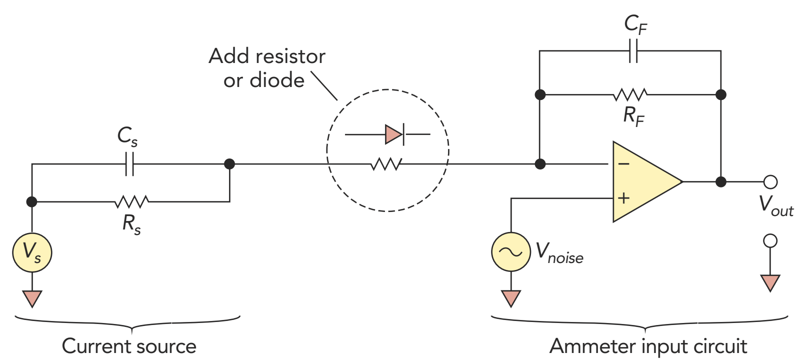
Also, avoid movement and vibration near the test area. Keep all charged objects (including people) and conductors away from sensitive areas of the test circuit.

• **Low source impedance.** When the impedance of a current source (Z_S) is low relative to an ammeter's input impedance (Z_F), noise will cause measurement errors.

Remedies: Try adding some series resistance when measuring current from a capacitive source to reduce noise (see **figure**). Alternatively, you can add a forward-biased diode in series with the ammeter's input. The diode acts like a variable resistance—low when the charging current is high and then increasing in value as the current decreases with time. For nanoamp measurements, the combined source impedance and added resistor or diode should be at least 1 MΩ.

• **Vibration.** Vibration produces a triboelectric effect that can cause noise currents to flow.

Remedies: You can use low-noise cables, which have graphite lubrication on the shield braid, to reduce the friction between insulators in the cable to reduce this effect. You should also secure the cables to avoid any unnecessary vibration.



Adding a resistor or diode to a current source increases its impedance and reduces noise.

• **Offset current drift.** Offset currents can drift over a period of time, usually because of temperature changes in the device and the meter.

Remedy: Stabilize the temperature of the meter, the device, and the general environment of the measurement.

Dale Cigoy, Applications Engineer
Keithley Instruments, Cleveland, OH

FOR MORE INFORMATION

To learn additional basic measurement techniques, see Dale Cigoy's article "When high-resistance measurements are too low," *Test & Measurement World*, April 2005. www.tmworld.com/archives.

No Batteries, No Limits

Freedom to Test as Long as You Want

Opportunity Gain

Have you ever delayed a test because the batteries in your probe weren't fully charged? Did you ever want to run an overnight test, but didn't do it because batteries wouldn't last that long? Or maybe you hesitated putting your probe in an ideal, but difficult to reach place, because recovering it for a recharge was too much of a hassle?

Laser Power

Now you never have to wait for batteries to recharge, limit how long you can test, or compromise on the best place to locate your probe. The secret is the laser power source we developed for our new HI-6105 E-field probe. It's only slightly larger than an iPod ™, runs cool, and uses power from the USB port of a PC.

A USB port supplies power for the laser.

More Flexibility

With laser power, you can perform tests and make measurements that would have been impossible before. For example, long-term measurements in remote or hazardous locations are no longer out of the question. And the minimal power requirements create new possibilities. Just plug our probe into a laptop and suddenly you have a portable test station.

More to Come

Our laser powered probe is just one of a large family of probes we offer that cover a broad spectrum of frequencies and applications. In addition to probes, we offer system solutions for EMC, microwave, wireless, and acoustic testing. Stay in touch and visit our website for information, news and upcoming product announcements.

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DATA ACQUISITION

Distributed data

DEVICE UNDER TEST

Aircraft gas turbine engines and generators, which require testing under conditions that simulate the pressures and temperatures found in flight.

THE CHALLENGE

Develop a data-acquisition system that records temperature, pressure, and flow from more than 2000 channels. The system must control test parameters as well as distribute data to a control room and store every data point.

THE TOOLS

- Exact Flow: flow meters and flow computers. www.exactflow.com.
- National Instruments: two PXI chassis; multifunction data-acquisition cards; digital I/O cards; and a signal-conditioning chassis with current and voltage signal conditioners, thermocouple signal conditioners, isolated analog-input modules, isolated frequency-input modules, and relay modules. www.ni.com.
- Scanivalve: Ethernet-based pressure and temperature data-acquisition systems. www.scanivalve.com.
- Sorensen: power supplies. www.elgar.com/products/sorensen.
- VMIC (now GE Fanuc): reflective-memory cards. www.geindustrial.com/cwc/gefanuc.

PROJECT DESCRIPTION

Honeywell Engines, Systems & Services (Torrance, CA) manufactures aircraft components such as gas turbine engines and auxiliary power units. Because these components need dedicated test facilities, the company built a test bed that simulates the pressure and temperature conditions that an engine encounters in flight. But the company needed help developing a measurement system for the test bed. System integrator Cal-Bay Systems (Irvine, CA; www.calbay.com) filled the void by delivering a system that samples more than 2000 data channels at rates from 1 sample/s to 100 samples/s.

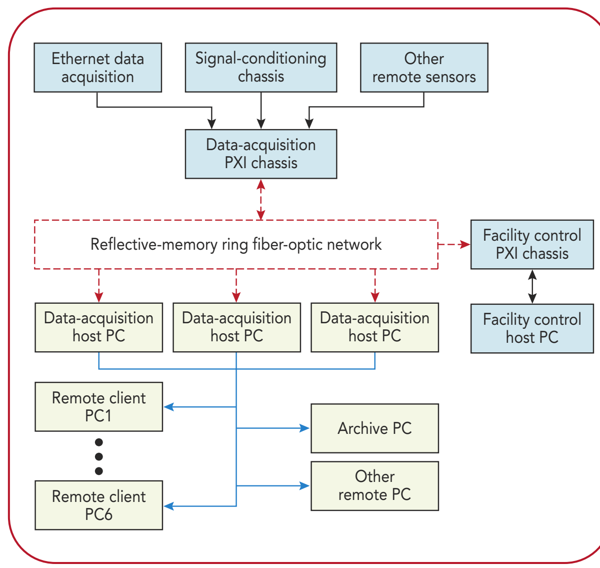
Honeywell specified that the system use distributed architecture to perform real-time control of the test parameters for the unit under test. And the system had to let engineers, analysts, and technicians monitor the tests from six locations.

The distributed system consists of five computers, two of which are embedded PXI controllers. One handles the data acquisition of temperature, flow, and pressure; the other, called the facility-control computer, performs real-time control of the test bed.

To keep the data flowing, all five computers use a reflective memory architecture that updates all computers' memory over a fiber-optic ring network. As the data-acquisition chassis collects data, the data is instantly copied into the memory of the other four computers on the ring. The three host computers make data available to six display clients, a data-archive computer, and another remote computer. All data from the host computers travels over a Gigabit Ethernet network. Test engineers, analysts, and technicians look at the data during and after a test to see how different flight parameters affect the component under test.

The data-acquisition PXI chassis collects temperature, pressure, and flow data from sensors connected to a local signal-conditioning chassis. A frequency-input module collects data from flow meters, while pressure sensors send 0-V to 10-V and 4-mA to 20-mA signals to other signal-conditioning cards. Thermocouples connect to thermocouple-input modules that boost the signals and send them to the data-acquisition card in the PXI chassis. The facility-control PXI chassis uses PXI cards with 0-V to 10-V analog outputs and 24-V digital outputs to control valves, pumps, and heaters.

Multiple remote data-acquisition modules collect additional absolute and relative pressure, temperature, and flow data. Both units connect to the data-acquisition chassis through an Ethernet port. Honeywell chose these systems to reduce the amount of wiring in the system and to distribute the acquisition channels around the test facility.

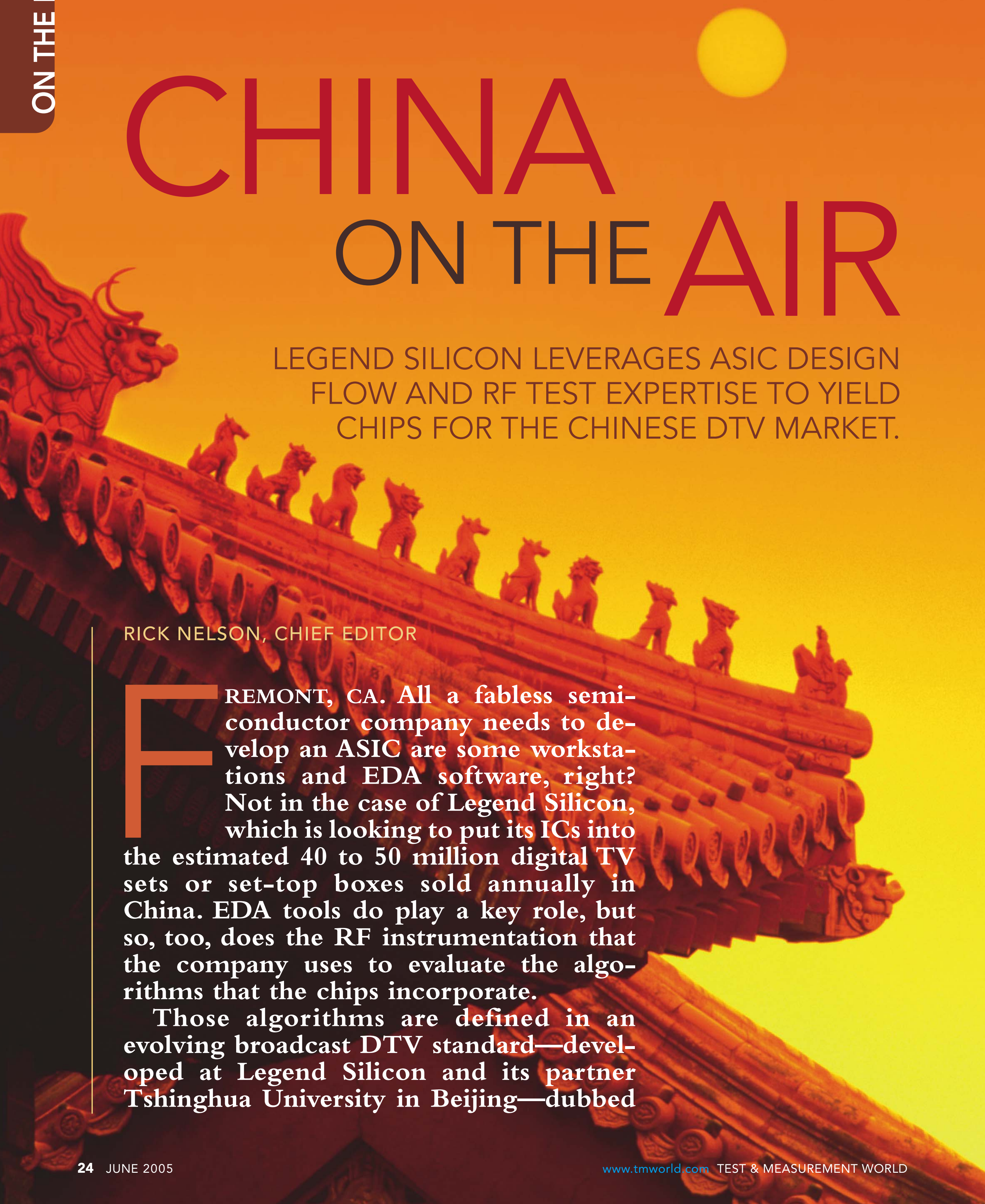


A distributed data-acquisition system measures parameters from an aircraft engine component and distributes more than 2000 channels of data to remote computers.

RESULTS

Prior to using this system, engineers used various data-acquisition systems, all of which incorporated numerous PC platforms. All of these systems could acquire and display a limited number of parameters. The new system has the capability of collecting and storing many more parameters and provides additional features, such as multiple viewing stations and simultaneous real-time and historical data analysis.

Martin Rowe, Senior Technical Editor



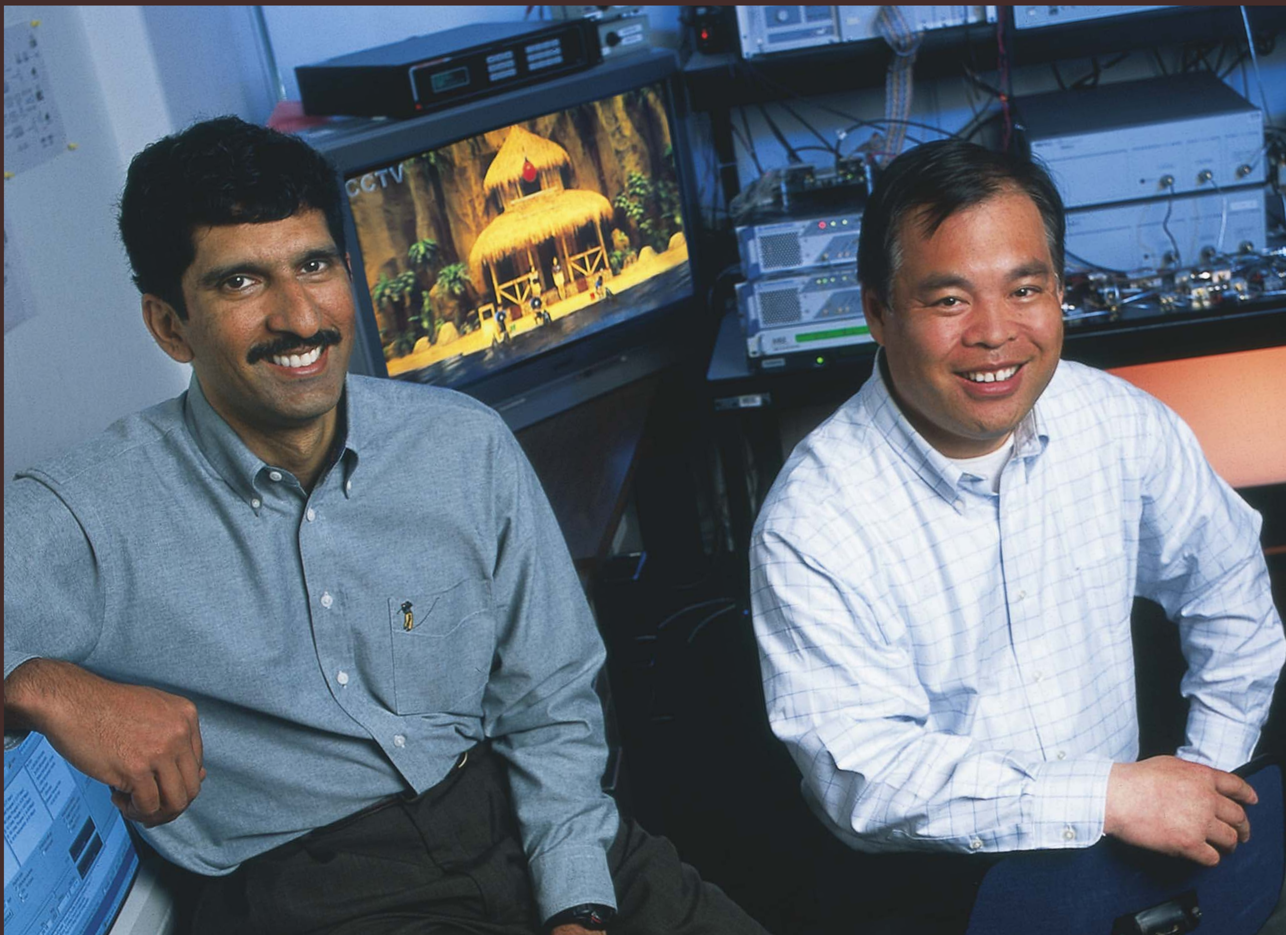
CHINA ON THE AIR

LEGEND SILICON LEVERAGES ASIC DESIGN FLOW AND RF TEST EXPERTISE TO YIELD CHIPS FOR THE CHINESE DTV MARKET.

RICK NELSON, CHIEF EDITOR

FREMONT, CA. All a fabless semiconductor company needs to develop an ASIC are some workstations and EDA software, right? Not in the case of Legend Silicon, which is looking to put its ICs into the estimated 40 to 50 million digital TV sets or set-top boxes sold annually in China. EDA tools do play a key role, but so, too, does the RF instrumentation that the company uses to evaluate the algorithms that the chips incorporate.

Those algorithms are defined in an evolving broadcast DTV standard—developed at Legend Silicon and its partner Tshinghua University in Beijing—dubbed



GARY LAUFMAN

Dinesh Venkatachalam, Legend Silicon's engineering VP, and Edward Yu, manager of transmitter products, evaluate DMB-T performance in Legend Silicon's RF laboratory.

DMB-T, for Digital Multimedia Broadcast Technology. The goals for Chinese DTV are similar to those for ATSC in North America; DVB-T in Western Europe, Singapore, and Australia (see p. 51); and ISDB-T in Japan: for consumers, clear audio and sharp video free of ghosts and snow, and for broadcasters, more programming capacity in the bandwidth once occupied by a single analog channel.

According to Dinesh Venkatachalam, Legend Silicon's engineering VP, the Chinese government is promulgating its own DTV standard for both business and technological reasons. On the business side, the adoption of a homegrown standard will provide a competitive boost for Chinese manufacturers, as it will help them avoid the disadvantages they faced when the country adopted the GSM cell-phone standard. Dinesh said that China still imports 80% of the GSM handsets sold there, and the government doesn't want to adopt a DTV standard that gives foreign manufacturers the head start enjoyed by foreign GSM suppliers.

The technological advantages of DMB-T include its ability to work indoors and outdoors for fixed and mobile receivers as well as its support for data broadcasting, instant messaging, and Internet access. "In a nutshell," said Dinesh, "we have taken the best of ISDB-T and DVB-T and expanded on them."

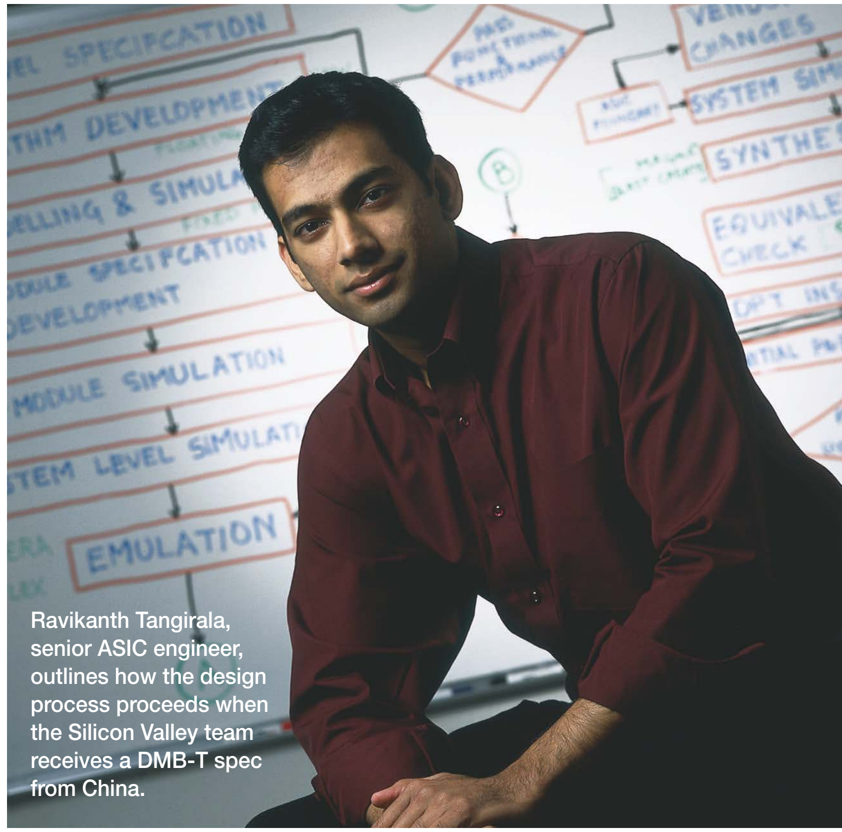
DMB-T details

DMB-T employs time-domain-synchronized multiple orthogonal-frequency-division-multiplexing (TS-OFDM) carriers to provide resistance to multipath distortion in high-reflection environments. OFDM techniques provide robust reception of control signals, and concatenated forward error correction (FEC) boosts performance, Dinesh explained, adding, "we do pay a little bit in terms of chip area, but it's worth it to get the much better performance that the concatenated FEC provides." Byte interleaving and time interleaving provide resilience to impulse and burst noise.

Legend Silicon's role in DMB-T, said Dinesh, is to employ the company's knowledge of the standard to "provide end-to-end solutions for the DTV broadcast market. We provide solutions based on FPGAs for the exciters that generate RF broadcast signals, and we develop ASICs for digital receivers and set-top boxes. We also provide ASIC and FPGA-based test solutions to measure parameters such as MER [modulation error ratio] and BER in DTV head-end installations."

He added, "Our FPGA system solutions are market enablers." The primary FPGA customers, he said, are exciter makers in China, Japan, and Europe, adding that the volumes, and profits, will come from the demodulator ASICs that will populate receivers and set-top boxes purchased by Chinese consumers. "We sell our FPGAs to broadcast equipment makers like Rohde & Schwarz, because the more boxes they sell, the more set-top boxes our customers will sell."

The function of Legend Silicon's ASICs, which in the current generation are fabricated in 180-nm CMOS, is to take an IF input from a tuner and generate an MPEG-2 transport stream (**Figure 1**). An I²C bus provides for demodulator control, usually by a CPU within the MPEG decoder.



Ravikanth Tangirala, senior ASIC engineer, outlines how the design process proceeds when the Silicon Valley team receives a DMB-T spec from China.

GARY LAUFMAN

Design process

Legend Silicon, which employs engineers in Fremont and Beijing, does much of its design and test work here in Silicon Valley, developing systems, FPGAs, and ASICs and evaluating the RF and functional performance of the equipment that incorporates them. The RF tests employ real-world RF data recorded in the field by the company's Beijing-based applications engineers and university partner.

The starting point for Legend Silicon's design effort is a specification provided by the company's Chinese university partner, working closely with Dr. Lin Yang, the company's co-founder, chairman, and CTO. Ravikanth Tangirala, senior ASIC engineer, described how the design process proceeds when the team receives the spec from China (**Figure 2**).

First, Tangirala said, the engineers perform floating-point algorithm exploration using CoWare's SPW tool. SPW, he said, lets the team simulate its design's operation in the presence of real-world data loaded into the simulator to make quick decisions about architectural tradeoffs.

Though floating-point solutions are convenient for exploring various architec-

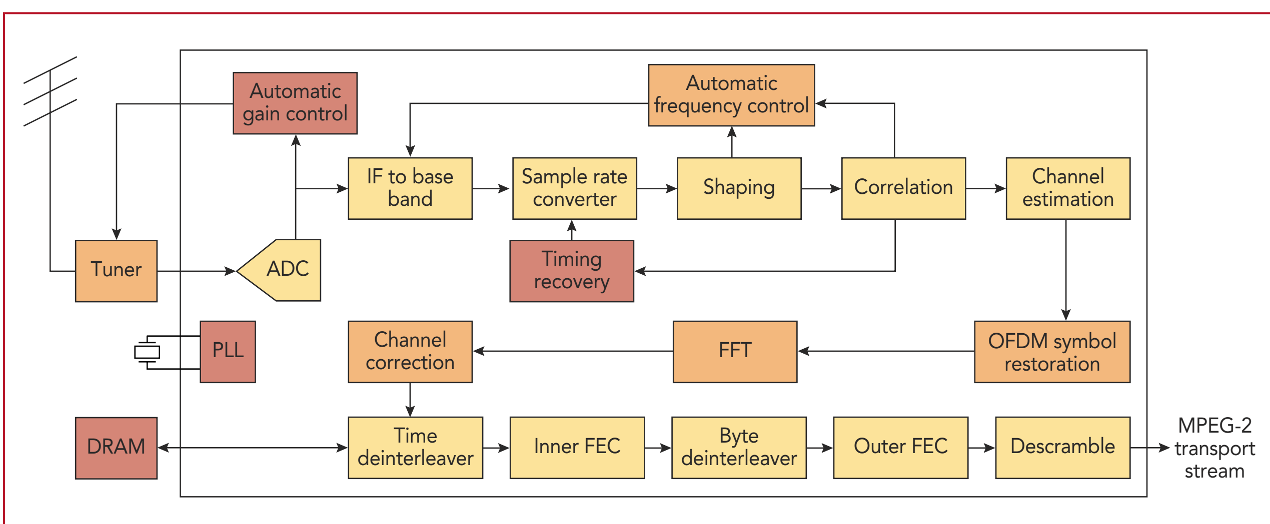
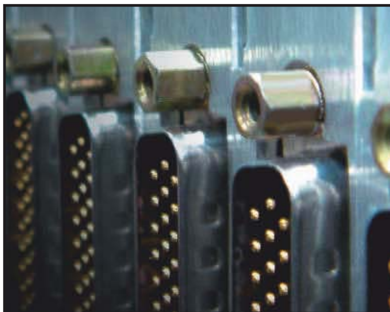
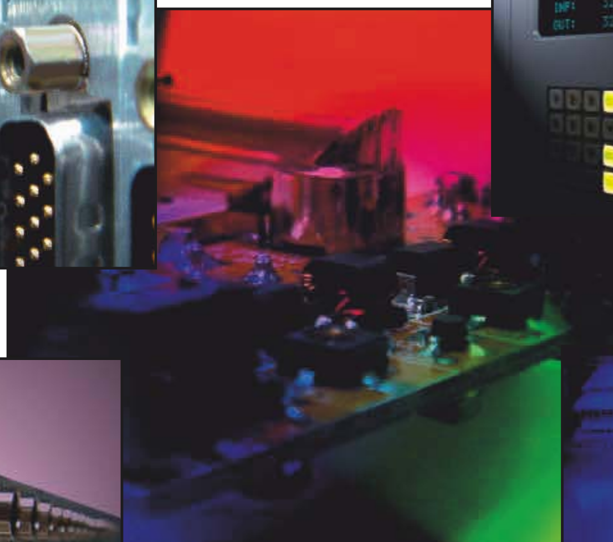


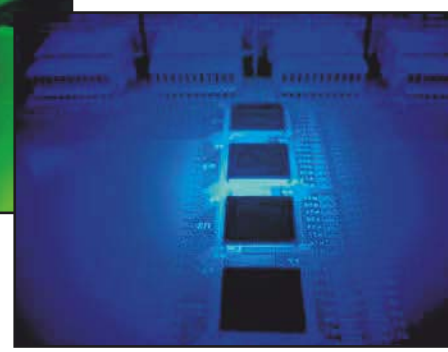
FIGURE 1. Legend Silicon's ASIC, designated the LGS-8222-A1 in the current generation, takes a tuner input and generates an MPEG-2 transport stream. It requires only an external DRAM and crystal. An I²C bus (not shown) provides for communication with an MPEG decoder.

Switching?





Includes control via
TCP/IP

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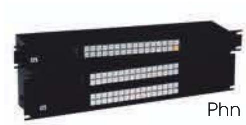

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tures, Tangirala explained, they would be impractical in a low-cost IC destined for high-volume consumer applications. When floating-point simulations in the presence of real-world data appear to be performing well, the engineers convert their floating-point code into a fixed-point C-language representation.

"There are some tools showing up now that do these conversions, but we have found the automated ones are not as good. The manual approach is much more time-consuming, but you get a better result," Tangirala said.

Using fixed-point C simulations, the engineers can determine the effects of bit truncation and other fixed-point restrictions as they work to achieve sufficient performance. The fixed-point C is then thoroughly tested to make sure it meets performance criteria and is translated into fixed-point RTL code. To demonstrate the functionality of their fixed-point RTL design, the engineers employ a Verilog-based simulator.

Were Legend Silicon implementing a well-defined, mature standard, the completion of a fixed-point RTL design could represent the point at which ASIC design begins in earnest. But because the engineers are implementing a new, evolving standard, they want to evaluate their design in real-world situations before committing to an ASIC. Consequently, they implement their design in an Altera StratixII FPGA or an IPFLEX DAPDNA-2 reconfigurable processor and exercise it thoroughly in their Silicon Valley RF lab and in real-world RF environments in live broadcast field trials in China.

"When we do the emulation, we keep in mind that our ultimate target is an ASIC. So we try to partition our emulation system to mimic our ASIC's partitioning in order to minimize the changes needed for the FPGA-to-ASIC transition," said Tangirala. "That's important, because for the ASIC, the only sources of verification are our simulations and formal equivalence checks; we can't do an actual performance evaluation until ASIC samples come back from the foundry. But if we keep the emulation and ASIC code very close, we can have a high confidence level that our ASIC will work. And we use a top-down flow to simplify the synthesis process. Since we have started using the Magma flow, it's gotten much easier. The interface is much cleaner now."

"In the past," Tangirala said, "the emulation flow was completely different from the ASIC flow, and we had to deal with issues involving, for example, differences in how to implement state machines. Now, all the vendor tools can handle the same kind of code, so the code we use for our FPGAs can go right to the Magma tools we use for ASIC synthesis. This ability to use the same code increases our level of confidence in the project."

Dinesh added, "We are also coming up to speed on emulation based on the IPFLEX DAPDNA-2. This is a dynamically reconfigurable processor capable of mapping from fixed-point C code directly to a hardware emulation platform, eliminating the transition from fixed-point C code to RTL and then to gates. This new class of devices eliminates the performance barrier we experience with FPGAs."

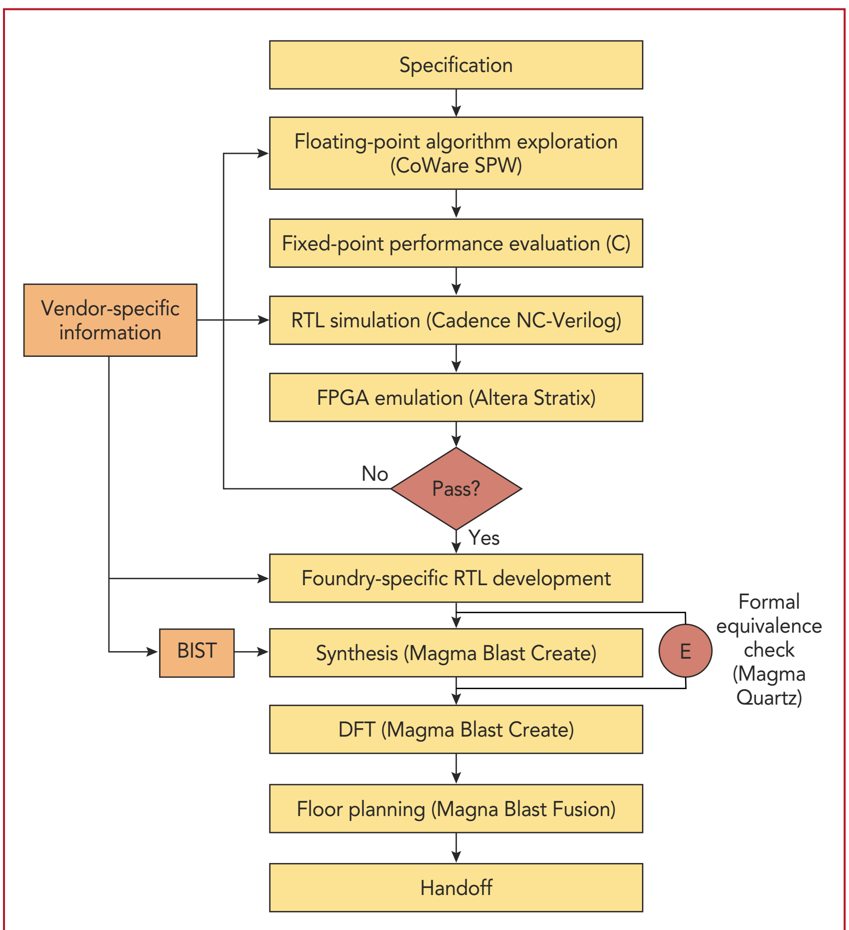
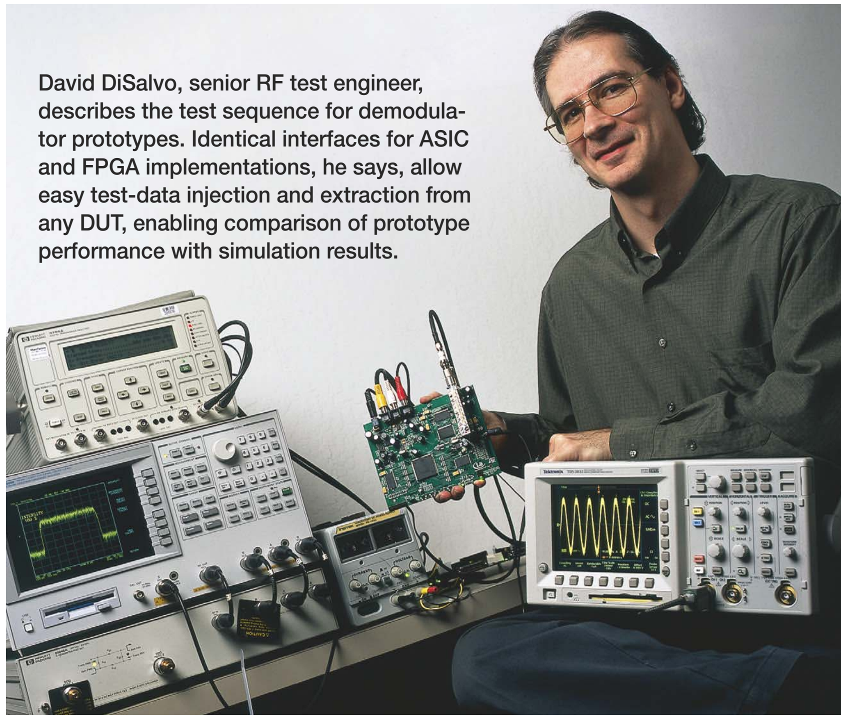


FIGURE 2. Engineers at Legend Silicon take a design from high-level specification through some floor planning before handing it off to a silicon foundry. Although not shown in this diagram, simulations or other checks at each stage provide feedback to improve the design.

RF tests

Exhaustive test of the FPGA implementation must precede the FPGA-to-ASIC transition. Edward Yu, manager of transmitter products, described a typical test setup (**Figure 3**). A transmitter generates a signal based on PN23, PN15, and PN9 pseudorandom bit sequences in a test mode. An Agilent Technologies BERT analyzes the pseudorandom sequences at the output. A channel model represents real-world interference, using a ghost generator that simulates reflections off buildings or vehicles.

"On the receiver side," Yu said, "we have an RF input into a tuner, an analog-to-digital converter, which may or may



David DiSalvo, senior RF test engineer, describes the test sequence for demodulator prototypes. Identical interfaces for ASIC and FPGA implementations, he says, allow easy test-data injection and extraction from any DUT, enabling comparison of prototype performance with simulation results.

GARY LAUFMAN

not be included in our chip, and then the demodulator, which in normal operation drives an MPEG decoder, and which during test drives a bit-error-rate tester so we can do end-to-end testing. That allows us to examine performance bit-by-bit and plot error rate vs. signal-to-noise ratio." In addition to performing end-to-end tests, he said, the engineers "can inject signals and make measurements at multiple points along the signal path."

"The ultimate question we want to answer," said Dinesh, "is how well we can recover data from a real-world environment full of reflections and noise. That's the measure of our chips' performance. And all of our testing helps us achieve optimum tradeoff between data rate and error correction."

When lab results are satisfactory, Dinesh said, "an FPGA-based receiver system goes into the field. It gets driven around, in a special van with datalogging capabilities, through cities and along highways—every possible situation to make sure the thing works. We investigate all kinds of effects, including weather impact as well as reflections from cars, buses, and planes flying overhead. In addition, we evaluate Doppler effects, which require more stringent tests than were employed 10 years ago for systems like ATSC in the US. In mobile systems, the environment is changing millisecond by millisecond, and we have to employ stratagems in our product to take that into account. We have demonstrated operation to 150 kilometers per hour, with the goal of providing over-the-air standard-definition TV reception in buses and on 420-kilometer-per-hour high-speed trains."

The extensive testing results in lots of data the engineers have to analyze. "We record any place where a problem occurs and see if it's a real problem that we need to solve. Often, it's not—the truck may have driven too far from the transmitter, for example, and we have to ensure the coverage exceeds the theoretical coverage area that would be used in deployment.

"We've done a lot of work correlating our lab noise generators with real-world data acquired over the last four years to ensure that our laboratory setup represents the worst-case scenario. We are not licensed to broadcast over the air in the US, but here in the lab we can duplicate any worst-case real-world scenarios—Doppler effects and reflections—to represent worst-case field-testing. We then take our systems back to the field to make sure that, yes, we have simulated the worst-case situations in our lab."

That's not to say that meeting the letter of the specification pleases everyone: "Somebody always wants to keep extending the reach of a transmitter without putting in additional stations, and eventually someone will want to put high-definition TV on a high-speed

Data models and language transcendence

Legend Silicon's development projects require the efforts of geographically dispersed groups of engineers, and coordination among those groups "can be a little painful," said engineering VP Dinesh Venkatachalam, with language barriers presenting problems.

"I'd be on the phone with a design house based in Taiwan or China and have to put someone on hold while I went to find a person who spoke Mandarin" he said, adding that Magma's design flow with its unified data-model approach has helped alleviate the language-barrier problem: "I can send other teams data in a single format they can understand and say, 'Here is all the information you need from me; now you can go do your job, and you don't need to ask me any questions.' I want to throw it over the wall and have it never come back again."

I asked Yatin Trivedi, director of product marketing at Magma Design Automation, whether the need to transcend language barriers had been an impetus for developing Magma's design-flow architecture. Trivedi said that it had not: The Magma architecture's evolution toward a unified data model stemmed from efforts to improve the predictability of the results of the implement-analyze iteration stages that occur throughout a design project. Legend Silicon, he said, serendipitously discovered the language-barrier transcendence "as an early adopter of Magma's RTL-to-GDS II flow who deployed it between US and offshore design environments." Trivedi added that other customers have since begun "deploying flows similar to Legend's and have been able to reap the by-product benefits of improved communication with non-native speakers," be they Chinese, Indian, Armenian, or Russian.—*Rick Nelson*

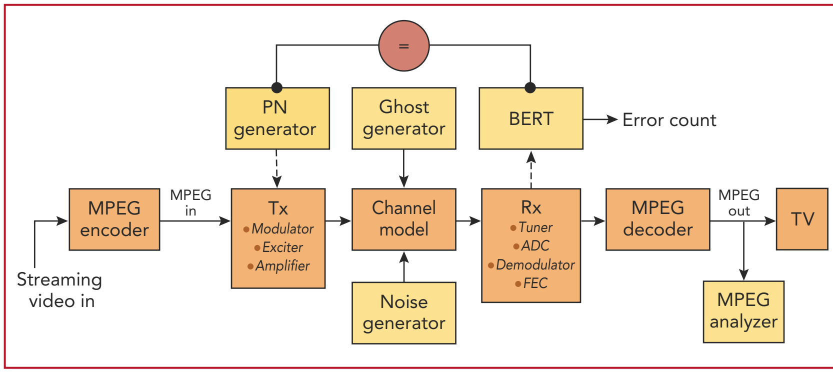


FIGURE 3. Using real-world RF signals recorded in China, Legend Silicon engineers evaluate the performance of their ASIC (whose functions are highlighted here) in their Silicon Valley RF lab.

train. Those are situations that future generations of the algorithms can address."

Of course, some problems do require fixes. "We generally go back to our fixed-point simulations. If there's a bug in our design, we'll fix it and generate the new FPGA code that can be downloaded in China, where we take our test receiver to the spot where we had problems to prove that our fix works."

ASIC flow

With FPGA tests complete, ASIC design begins in earnest. Although some vendor-specific functions common to the FPGA and ASIC are taken into account in the Verilog RTL simulation, the designers inject additional vendor-specific details such as I/O cells, analog IP cores, scan cells, and scan paths plus foundry-specific BIST-enabled RAM blocks.

"Now our flow uses Magma software from RTL to netlist," said Tangirala. Although not shown in the Figure 2 flow chart, the team does extensive simulations at each stage of the development process. For example, he said, "We'll run an ASIC simulation once we insert vendor-specific RAM blocks, and we will do another after DFT scan insertion to make sure all the scan chains work. We also use Magma Quartz to do RTL-to-gate formal verification, and we do lots of gate-level simulations to make sure the synthesized logic does what the RTL is asking it to do. We'll simulate the first gate-level netlist the synthesizer generates without timing information and then again with full timing information."

FOR MORE INFORMATION
* On design for test, visit WWW.TMWORLD.COM/DFT

Some companies will skip the intermediate simulations, said Dinesh, settling for RTL and gate-level simulations with full timing (which can have much longer run times than simulations without timing), but he explained that "if something breaks in between" those two stages "it can take a long time to find the problem."

Particularly valuable, Dinesh and Tangirala agreed, is the ability to do some floor planning. Traditionally, said Dinesh, "We'd throw our design over the wall, and the foundry would come back and tell us, 'OK, here is your die size.'" His response to that, he said, feigning incredulity, was often, "What are you talking about?" Now, added Tangirala, "We can use Magma Blast Create and Blast Fusion to place macro blocks, and we can define the data paths efficiently because we know where the data is coming from and going to. An overnight simulation lets us know whether the die size we have chosen will work, and that's very important to us because every millimeter or even half millimeter increase in size represents a substantially higher cost."

When asked about using an integrated flow like Magma's vs. point tools for functions like scan insertion, Dinesh said, "Point tools give better performance in certain cases, but just going in and out of the [point-tool and synthesis-flow vendor] databases, you tend to make a lot more mistakes. If you want to squeeze out the most compact set of test vectors or if you feel your fault coverage has to be 99.9 percent, then run a point

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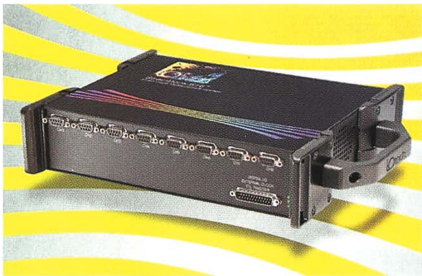

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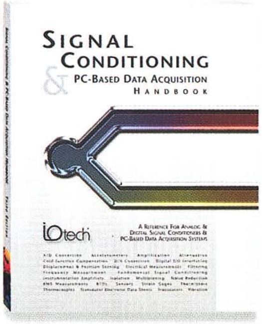

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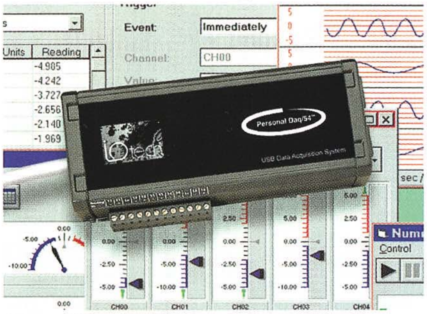

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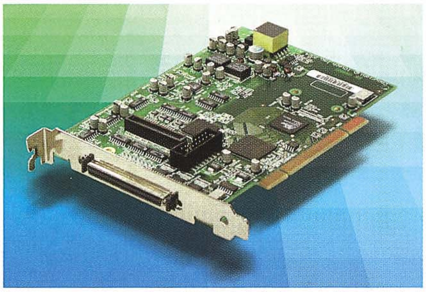

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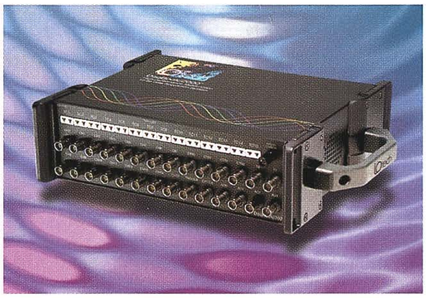

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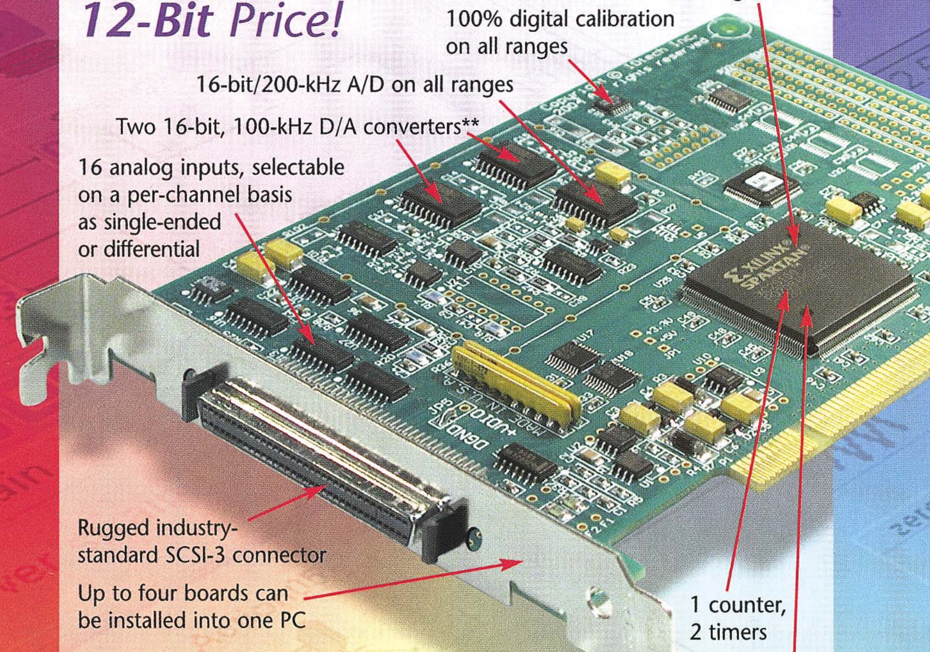

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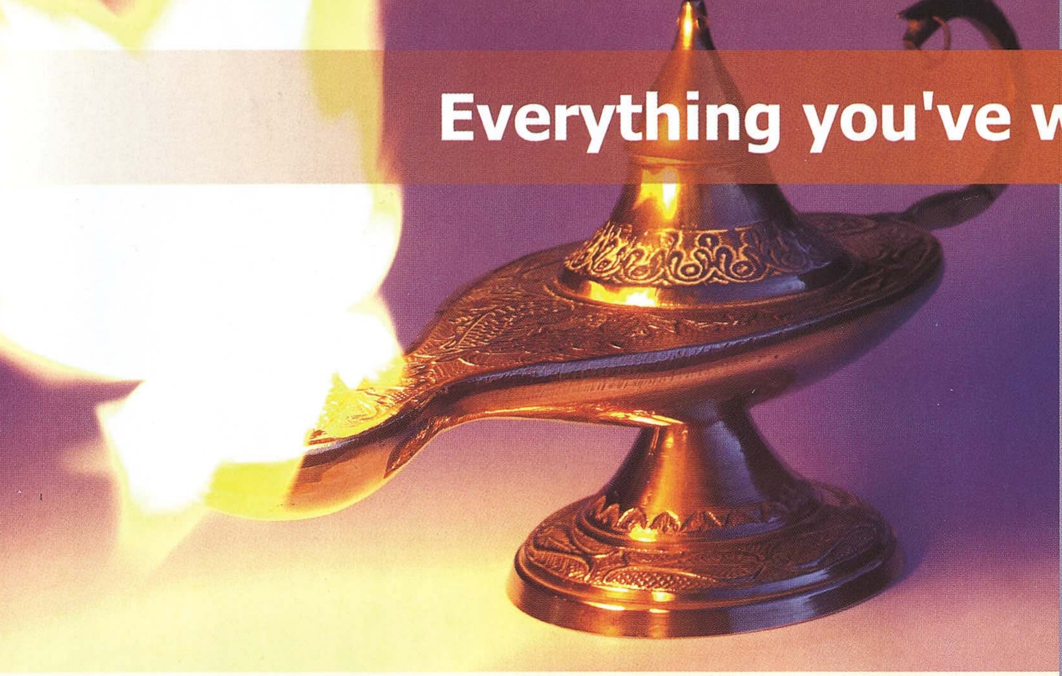

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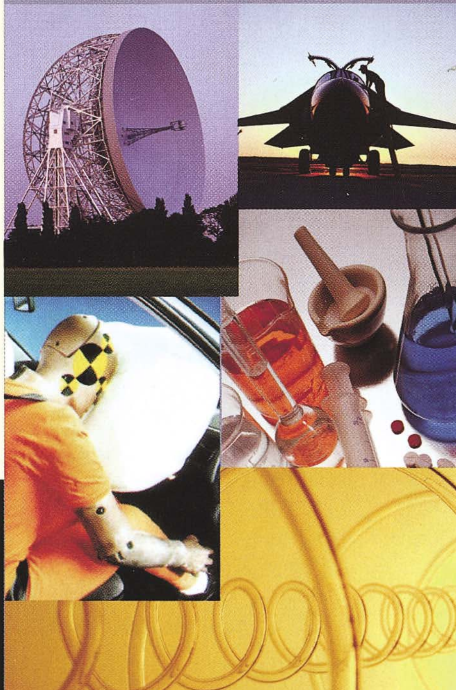

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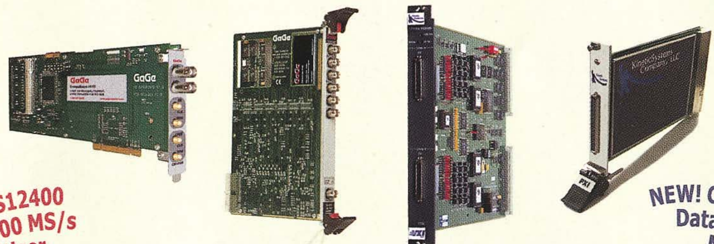

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tool, but if 98 percent is good enough, then it's better to go with the more integrated flow because of the mistakes you can avoid and the time you can save. One reason we went with Magma was to eliminate the many scripts that we had to write to convert between different vendors' formats. A simple typo could cost you a month. We wanted the same database throughout the whole flow to avoid mistakes like that."

With simulations and all functional and timing checks complete, the team sends its design, along with test vectors, to a foundry, which returns sample ASICs. At that point, explained David DiSalvo, senior RF test engineer, "we put it in a socketed test board we've developed, power it up, and run some simple tests, looking for opens and shorts. Current levels can tell us if there is a serious problem or not. If everything looks good, we run a BIST check over the I^2C interface."

He said the company doesn't build in an IEEE 1149.1 interface, which represents too much overhead for a low-cost consumer chip, but the chip does include a NAND-tree structure, which he runs tests on as a "quick and dirty way" to make sure all the device pins make contact with the board. The team also does some subjective thermal tests, he said, heating up and cooling down the chip to look for anomalies. "Thermal performance is guaranteed by the factory, but we want to make sure nothing unusual is going on."

With preliminary tests complete, said DiSalvo, "we take the board and run RF tests to make sure the ASIC's performance is better than the FPGA's, which we would expect because clock jitter should be much less on the ASIC." At that point, the foundry will have completed its back-end test strategy, he said, and the parts should be ready for production.

Next generation

Even as one ASIC generation gets to market, the team is working on another, and in fact, each ASIC design takes into account the needs of the next-generation development effort. Said Haiyun Yang, Legend Silicon ASIC architect, "We design the chip so we can switch out various functions." For example, he said, discussions are taking place in China regarding the FEC algorithm. To evaluate a potential upgrade, he said, "We can switch out our ASIC FEC implementation and replace it with a new one implemented in an FPGA."

The next generation will embody new FEC capabilities, and it will be fabricated in a submicron process. "We don't need to push the technology to get gigahertz speeds," said Dinesh, "and so far, 180 nanometers has been the sweet spot as far as price goes. But that's changing, and the new ones will be 130 or 90 nanometers. Our basic next-generation goals are better performance and lower costs." T&MW

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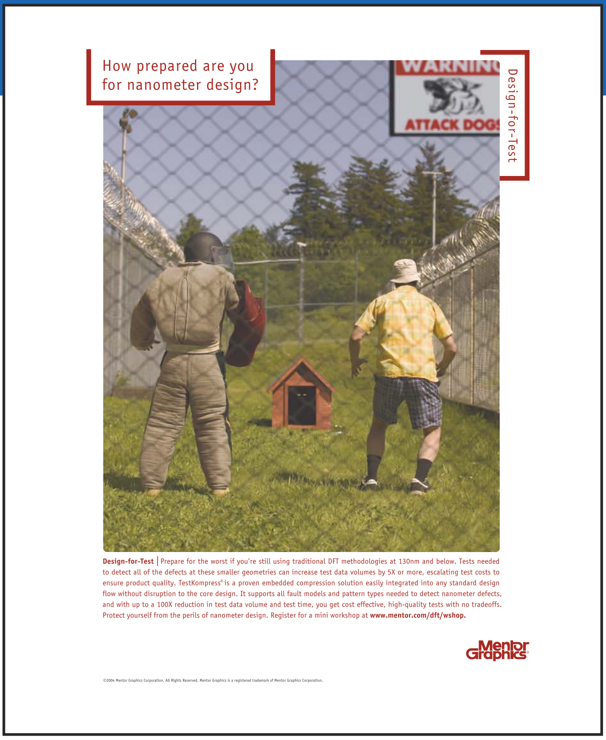

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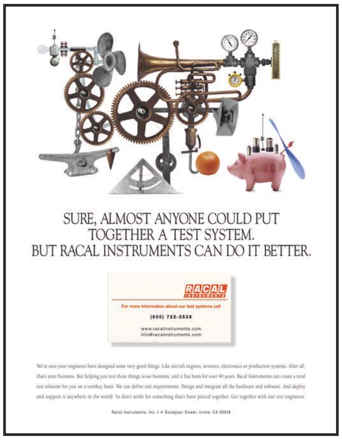

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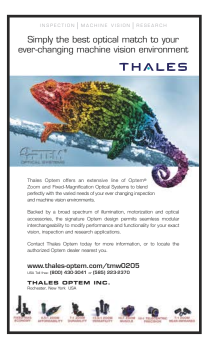

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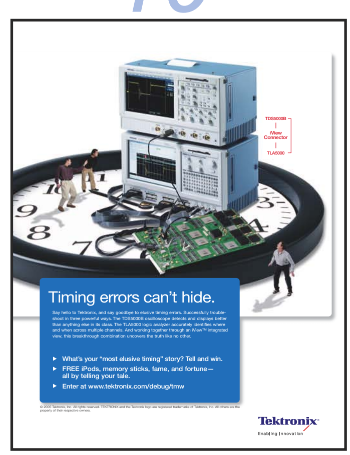

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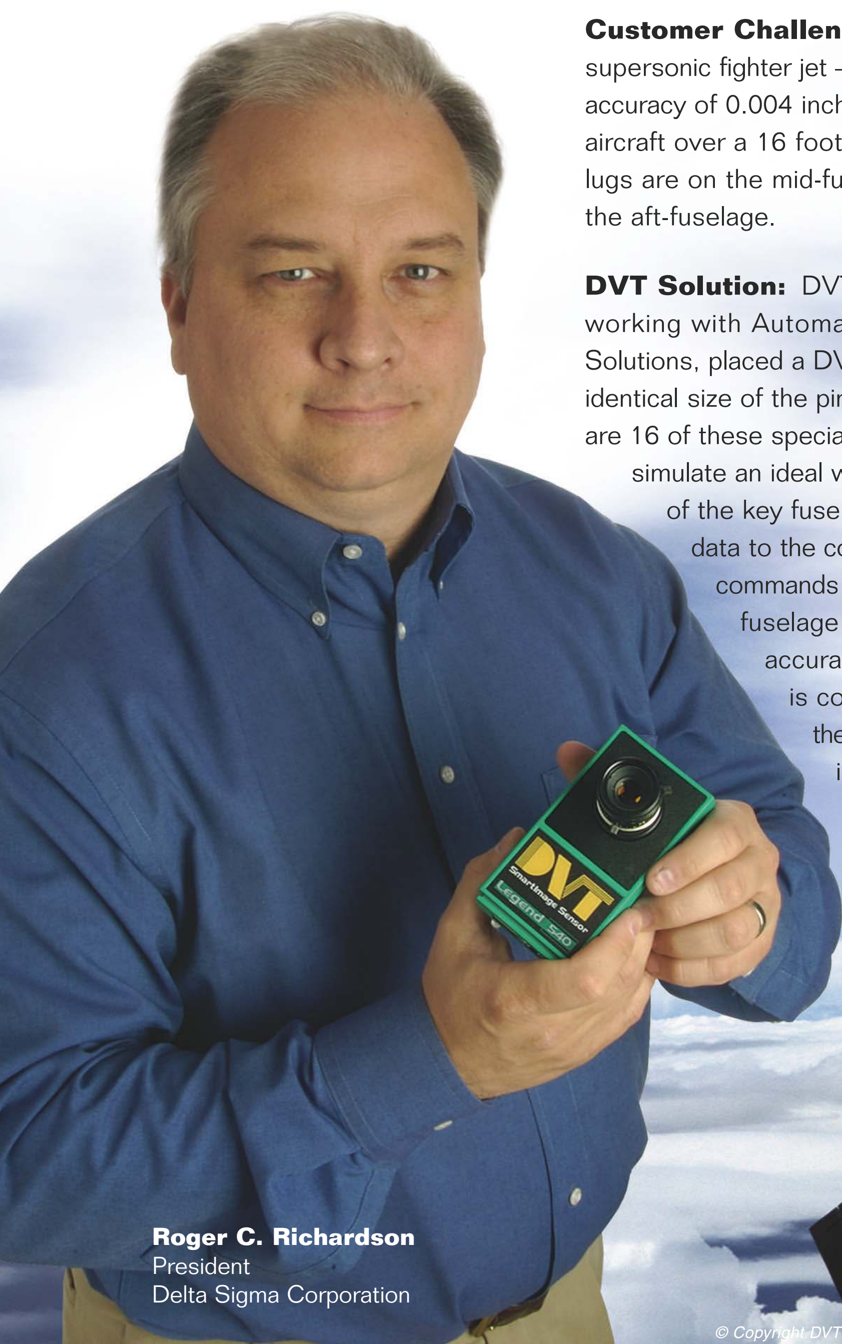

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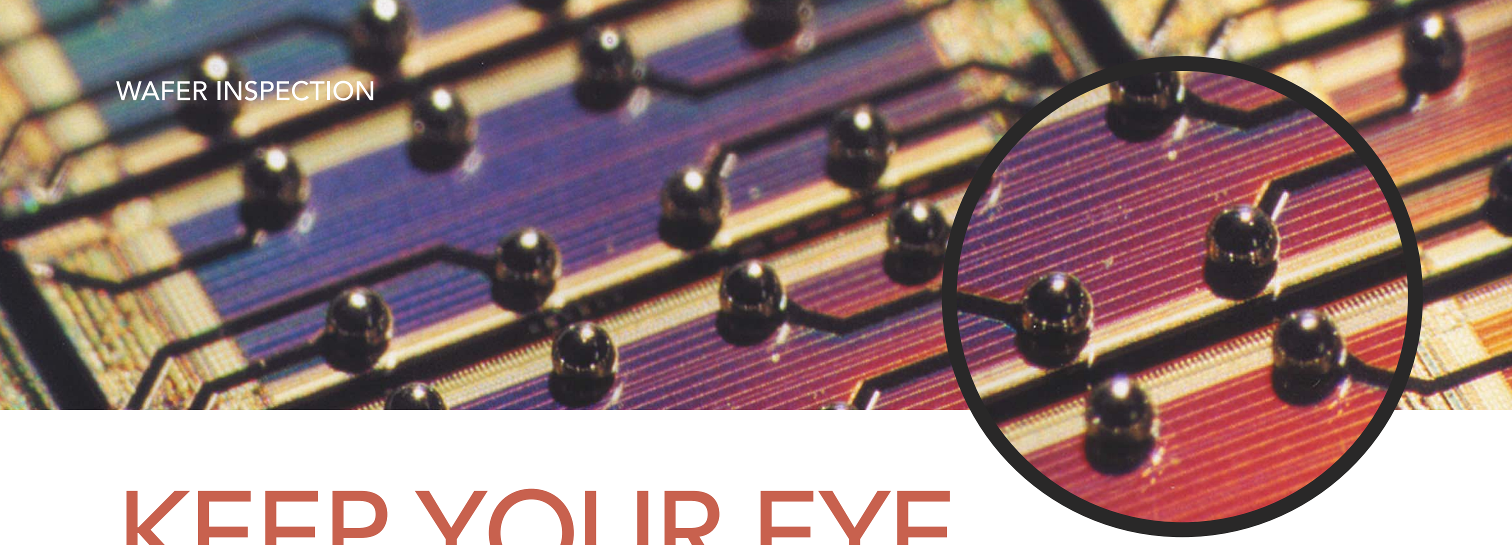


KEEP YOUR EYE *on the* METAL BUMPS

JON TITUS, CONTRIBUTING TECHNICAL EDITOR

Inspection technologies ensure the quality of wafers bound for flip-chip packages.

Bumped wafers, and thus bumped chips, facilitate flip-chip mounting techniques. By eliminating the need for leaded packages, metal bumps reduce costs and enhance reliability. The capability to use metal as direct contacts on a chip also lets designers place I/O connections across the chip's surface, not just along its edges. In addition, the direct placement of contact points on a wafer can reduce processing and rework costs.

Getting the bumps—usually solder or gold—onto wafers (**Figure 1**) introduces challenges that include inspecting the bumps to ensure they meet design criteria. (See, "How wafers get their bumps," p. 40.) At present, three inspection technologies predominate—laser scanning and image analysis, conformal microscopy, and Moiré interferometry. Understanding their characteristics and the requirements for inspecting bumped wafers will help you decide which techniques suit your present and future needs.

Laser and camera scans twice

A combination of inspection technologies lets systems from RVSI Inspection (**Figure 2**) examine bumps two ways. The first technology uses a laser-triangulation system; the second employs a line-scan camera that acquires images of a wafer's surface.

"Our equipment makes two passes, one with the laser and one with the camera," said Reza Asgari, the director of marketing for wafer-inspection products at RVSI Inspection. The laser system employs a triangulation technique that obtains bump height and measures bump coplanarity.

A second scan with the camera obtains quantitative information about bump diameter and location. That scan also picks up defects such as missing bumps, misshaped bumps, mouse bites, nodules, and bump bridging. Because image analysis can cover any area on a wafer—not just bumps—the system also can look for other problems, such as etch residue, foreign materials, and holes in the passivation layer.

"Typically, we examine solder bumps with a diameter of 100-microns, placed 100 to 200 microns on centers," said John Schaefer, RVSI Inspection's engineering manager for wafer-inspection products. "In general, users operate

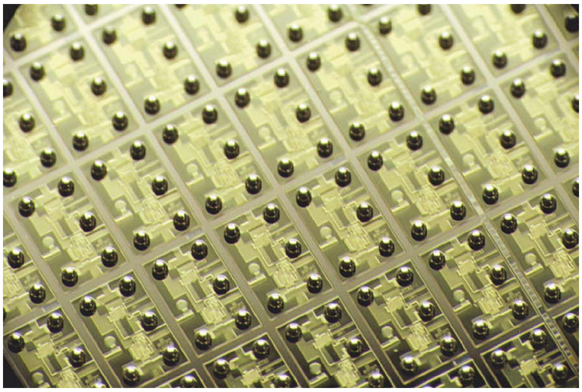


FIGURE 1. A field of solder bumps on a wafer shows their relative position and size. In this case, wide spaces separate the bumps. Courtesy of August Technology.

Top Image: Courtesy of August Technology.

within a ±10% tolerance, so for a 100-micron-diameter bump, they can accept bumps within a ±10-micron tolerance." For the inspection system itself, users want accuracy five- to tenfold better than the tolerance, which translates to ±1–2 µm. In the case of gold bumps, which can range in height from 16–20 µm, users require a machine accuracy of ±0.2–0.5 µm.

"Even though more users require 100% inspection of a wafer, they don't always inspect the height of every bump," explained Asgari. "They may scan a small sample of bumps with the laser to obtain height data and then scan the entire wafer with the camera to look for defects."

"Triangulation with a laser looks easy on paper," said Asgari, "but the system must work with a variety of surfaces, from highly reflective lead-based solder to duller lead-free solder. The hardware and the software take that sort of variation into account and continue to produce accurate information."

The system's line-scan camera relies on a time-delay integration (TDI) image sensor that transfers pixel data from one row of detectors to the next in synchronization with the wafer's motion. In this way, the sensor integrates a line scan, which increases scan rates and reduces the amount of light needed to illuminate the wafer. Like any camera, a line-scan camera produces small distortions, but algorithms can quickly correct them. An area-scan sensor, on the other hand, introduces distortions in two dimensions, which take image-analysis programs longer to compensate for.

FIGURE 2. **The WS-3000 system inspects 200- and 300-mm wafers. This unit combines 3-D laser technology with a 2-D high-resolution camera to provide quantitative and qualitative inspection information.** Courtesy of RVSI Inspection.

Microscope maps bump feature

Several years ago, August Technology adopted confocal microscopy as its main inspection technology. "We call it the rapid confocal sensor (RCS) technology,"

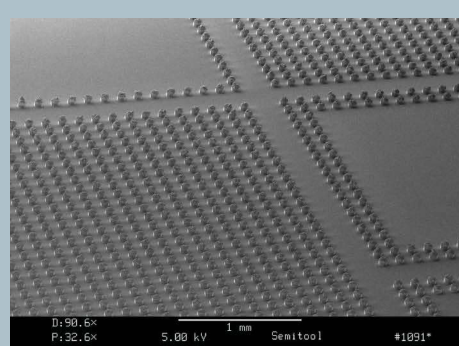
How the wafers get their bumps

Manufacturers use several techniques to place metal—usually solder or gold—bumps on wafers. Although equipment can deposit individual solder balls, most manufacturers rely on either printing or electroplating.

Printing solder paste—a mixture of solder and flux—on a wafer occurs much like deposition of solder paste on bare PCBs. A machine aligns a stencil with small openings and a wafer. A squeegee then presses the paste into the openings to leave small quantities on the wafer. Heating the wafer melts (or reflows) the solder, and surface tension forms the molten solder into balls.

Electroplating provides another means to put solder on wafers. Dan Schmauch, business-development manager for advanced packaging at Semitool, explained the process in general steps. The bumping facility deposits two or more layers of metal, called under-bump metallization (UBM), over an entire wafer. The metal contacts the exposed pads and covers the wafer's passivation layer. Next, equipment deposits a layer of photoresist that gets exposed and developed to open vias at the pad locations. Then, the wafers move to aqueous baths in which electrochemical plating deposits thicker UBM "studs" and lead-tin or lead-free solder in the photoresist vias.

After deposition of sufficient solder, the wafer goes through steps that remove the resist as well as the metal deposited over the passivation material. The solder now appears on the wafer as small pillars, or mesas (**figure**). A reflow step forms the solder into balls.



Solder bumps plated on a 300-mm wafer look like small mesas in neat rows. Reflowing will form the solder into balls. Courtesy of Semitool.

Not everyone uses solder, though. Manufacturers of displays and display controllers, for example, often like gold bumps because their smaller dimensions suit high-density connections. Gold efficiently carries high currents and conducts heat away from components.

Dan Evans, senior scientist at Palomar Technologies, explained a proprietary technique—PlanarBump—his company developed to form gold balls. "We attach a gold wire to a chip's bonding pad and break off the wire in a unique way to create a flat-top ball bump." Most gold-ball bumps in the industry look like Hershey's Kisses and typically require a secondary coining process that flattens the shape to make the bump tops coplanar.

Palomar's technique forms gold bumps with a flat top and low height profile. "Other companies might produce a 40-micron-high bump, but we can make bumps from 12 to 20 microns high without the need to 'coin' the gold," said Evans. (Coining involves pressing a metal die onto the gold to form it into a regular shape.)

"When you require fewer than 140k bumps per wafer," explained Evans, "gold-ball bumping is less expensive than gold-bump plating, which requires extra wafer-processing steps. A typical wafer we see requires 50k to 60k bumps."—*Jon Titus*

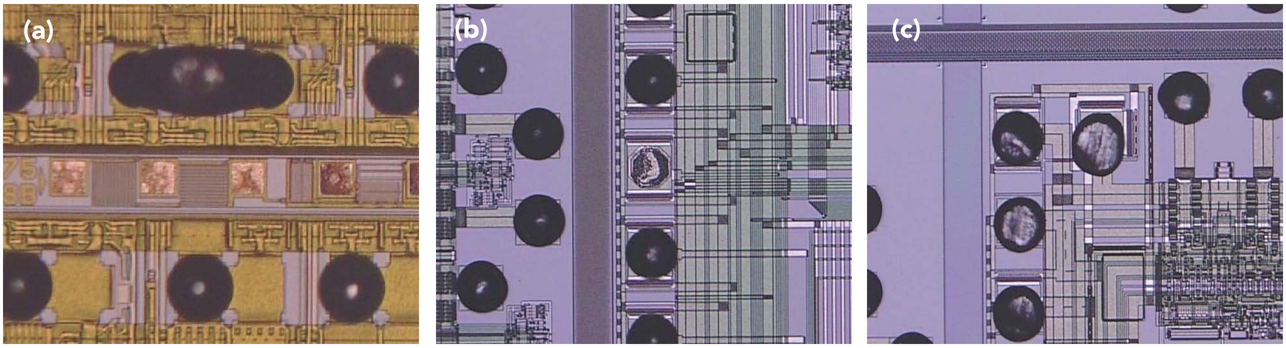


FIGURE 3. A rapid confocal scanning (RCS) system produces images such as these that show (a) a bump bridge, (b) a missing bump, and (c) sheared-off solder bumps. Courtesy of August Technology.

noted Rajiv Roy, the company's marketing manager. "Our equipment inspects standard 100-micron and 150-micron type bumps, and it also inspects bumps less than 50 microns high."

As part of an in-house study, one RCS user inspects bump heights about 10 times smaller than the dimensions noted above. "That system isn't part of the production process yet," said Roy, "but the customer plans to deploy it."

Confocal microscopy employs a point light source, usually a laser diode, and a detector that measures only a pinpoint of light. The resulting image lets the inspection system obtain depth information from features in an image. In simple terms, the system adjusts the microscope's height and focuses the image to produce a height measurement for a bump under the microscope. During an inspection pass across a wafer, for example, a confocal microscope maps x-, y-, and z-axis coordinates across each bump. The microscope also provides images of the wafer (**Figure 3**).

The RCS equipment also performs bump morphology, or bump-top mapping. Bumps require a surface roughness within a specific range to ensure good adhesion to another conductor. A smooth bump won't adhere to its surface, and an overly rough bump won't offer enough surface contacts for a solid bond. "Users can measure the surface roughness and also look for nodules or craters, both of which affect contact," Roy explained.

Traditionally, when engineers discuss bump inspection, they imply the need to inspect wafers after bump formation and prior to shipment. "Some customers now inspect wafers during bump processing," said Roy. "Prior to applying under-bump metallization (UBM) layers, they inspect wafers to check for any corrosion that would adversely affect metal bonding. After they apply the UBM layers, they inspect again to check the metal surface for defects." (The UBM layers provide a metal base to which the solder will adhere.)

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On inspection, visit WWW.TMWORLD.COM/INS

During solder-electroplate steps, for example, process engineers can monitor wafers to ensure vias have filled with solder. If a wafer needs more solder, it can go back into a plating bath. If a wafer has too much solder, the process engineers can remove the excess. "By inspecting at several steps, you gain the opportunity to rework valuable wafers," explained Roy.

Throughput of wafers matters, too, and the goal for 2-D and 3-D bump inspection ranges from 10 to 20 wafers/hr for 200- and 300-mm wafers. "Users don't want equipment to spend more than three or four minutes inspecting a wafer," noted John Pak, product manager at August Technology.

Although the change to lead-free solder or gold bumps may affect some inspection technologies, because of surface-reflectance and bump-size differences, Pak emphasized August hasn't experienced any problems as customers change materials.

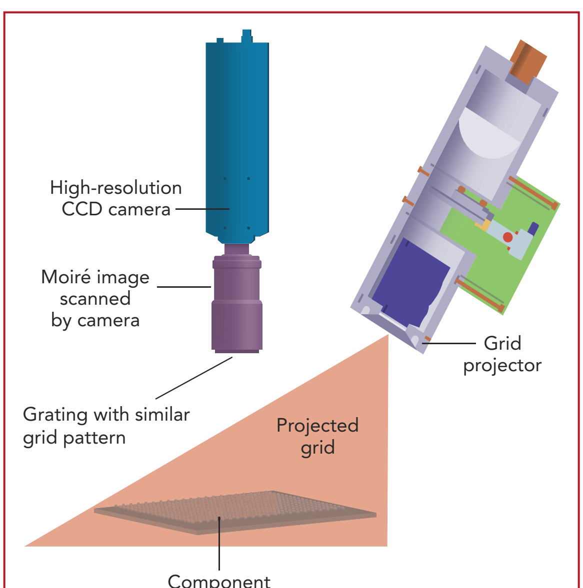

FIGURE 4. Measuring slight changes in the Moiré image produced by passing a reflected grid pattern through a similar pattern provides geometric information about metal bumps on a wafer.

"Often, people have two inspection needs," said Michael Clay, product and applications engineering manager at Solvision. "They want to know about the quality of the bumps, and they want to look for non-bump defects that affect wafer yield." In some cases, they may need two inspection systems—one for bumps and one for wafer defects. Clay noted, "Some companies can perform both inspections in one system, but they need a different sensor for each type of inspection, and an additional pass across the wafer will decrease throughput."

Users also face challenges as bumps get smaller. "Engineers design IC packages that require 50–90-micron bump diameters, and they put the bumps closer

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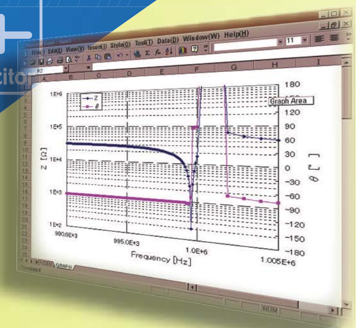

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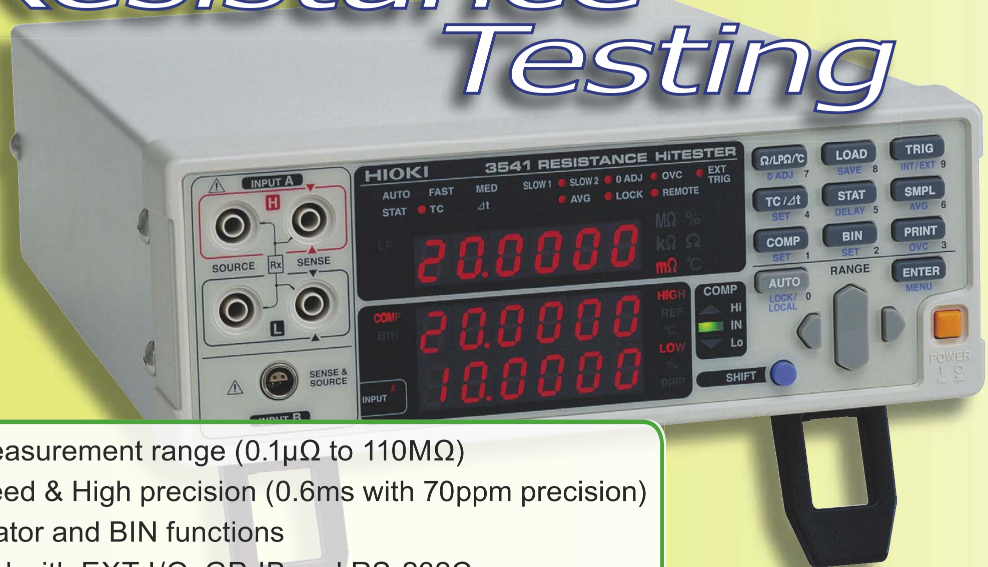

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together," said Clay. "We see side-to-side spacing down to about 50 microns." The same sorts of dimension reductions take place for gold bumps. Today, 15–17-µm-tall gold bumps are typical, although Clay reported some manufacturers plan to deploy products with 5-µm-tall gold bumps. Gold-bump spacing may range from 7–10 µm from side to side. Clay added, "At those dimensions, some inspection technologies reach their limit. So, equipment will find it difficult to differentiate bumps from the other 'features' on a wafer's surface."

Moiré patterns ease area analysis

Solvision employs a patented technique that the company calls fast Moiré interferometry (FMI), which combines principles of Moiré interferometry and phase shifting (**Figure 4**). The FMI technique can detect bump heights with a resolution of 100 nm.

In a typical Moiré interferometry system, a projector shines a pattern of lines or a grid on the wafer surface (**Figure 5**). The reflected pattern or grid passes through a grating that has a similar pattern of lines or a grid on it. Passing one pattern through another creates the Moiré pattern that the camera observes and passes to a computer. Mathematical analysis of the Moiré image yields dimensional information.

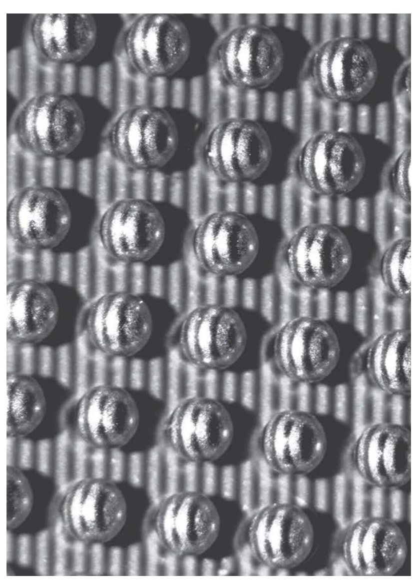


FIGURE 5. A projected grid moves slightly to scan solder bumps on a wafer. In the FMI instrument, only the projected grid moves. The camera and wafer remain stationary. Courtesy of Solvision.

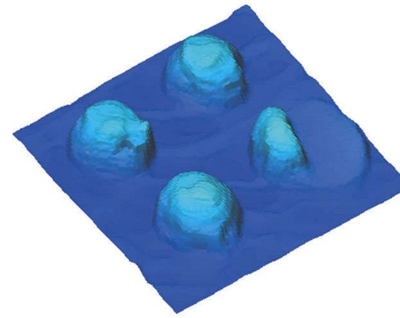
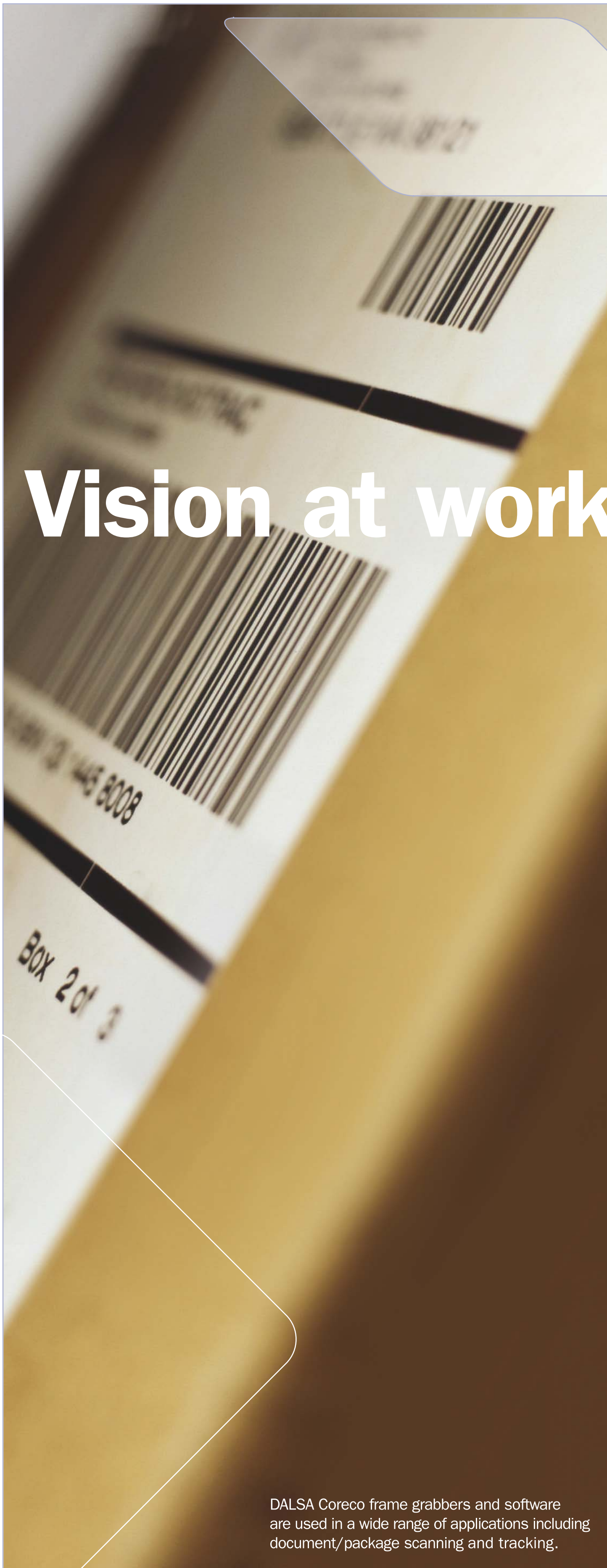


FIGURE 6. A false-color 3-D plot, obtained from interferometry data, shows four solder bumps. The one on the right is defective. Courtesy of Solvision.

Solvision combines Moiré interferometry with phase shifting to produce a system that simultaneously inspects solder bumps, wafer defects, and the wafer's surface. The FMI technique measures light-intensity changes as the system moves the light pattern in small increments across the surface of a wafer. "Unlike other inspection equipment, an FMI system doesn't move from bump to bump to take measurements," stressed Clay. "Instead, it measures all of the bumps in the field of view. Thus, the FMI technique makes it easy to increase the field of view so a system can inspect more bumps or features at one time."

Mathematical algorithms process the Moiré image data and yield a plot of the wafer's topography (**Figure 6**). The equipment's 2-D data provides information about cracks, proper fiducial alignment, the presence or absence of bumps and leads, and so on. Because the 3-D topographic information includes a height value for each pixel, algorithms can calculate solder volumes for electroplated solder and screen-printed solder prior to reflow.

August's Roy noted a growing interest in placing post-passivation layers (PPLs) on top of wafers. Designers use these layers to hold resistors, capacitors, inductors, and other components formed using large-geometry processes with feature sizes that range from 2–10 µm. Moving components to PPLs improves device performance, but the process adds from four to 20 layers. Engineers need inspection systems that will examine the PPLs and ensure they're ready to accept solder bumps. "When people buy an inspection system, they must ensure it will adapt to new technologies," said Roy. T&MW



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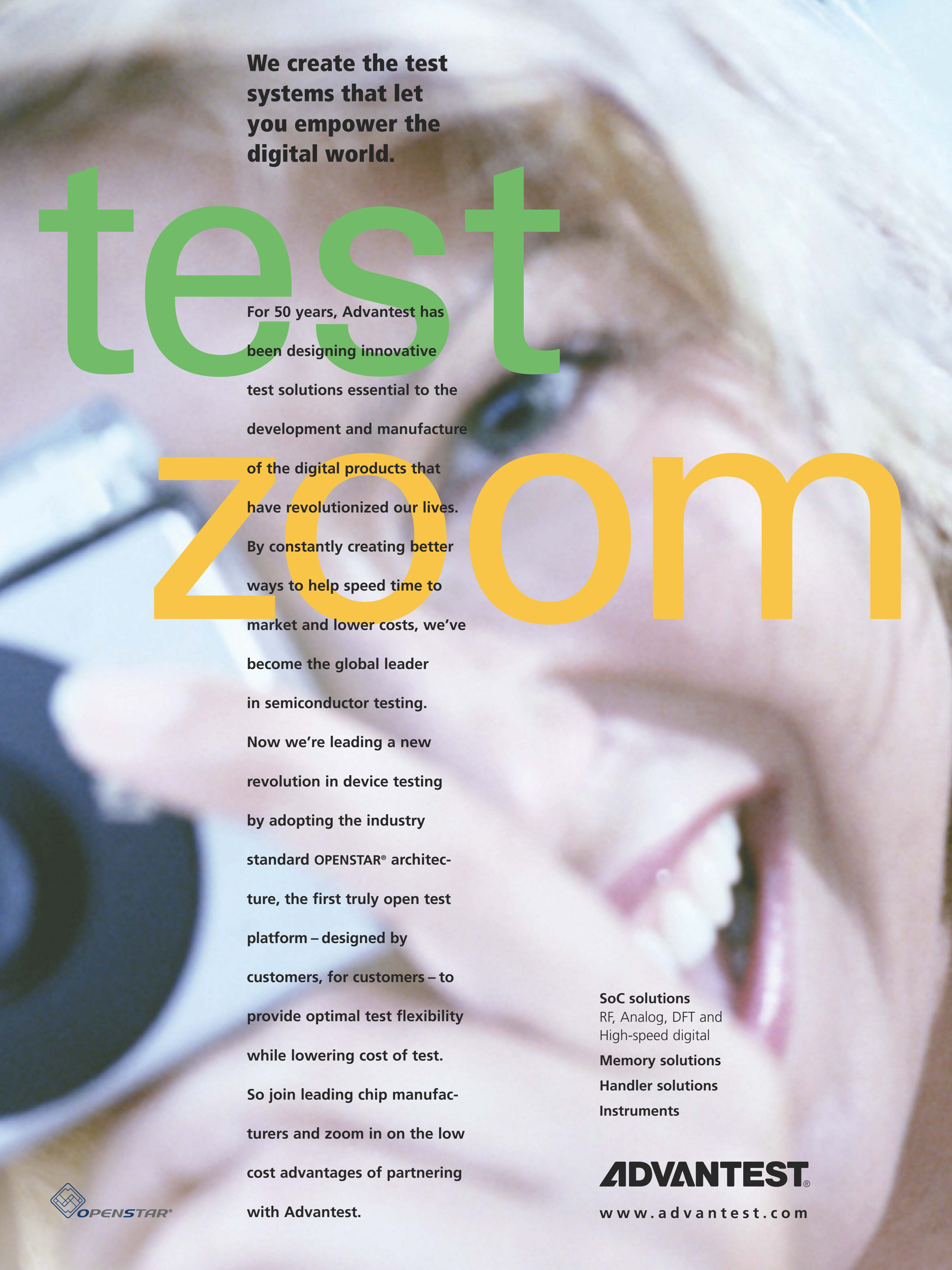
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USB REACHES MAINSTREAM STATUS

MARTIN ROWE, SENIOR TECHNICAL EDITOR

Given the popularity of USB as a peripheral bus on today's PCs, instrument makers have recently produced a flurry of data-acquisition products in the USB form factor. Today, you can get USB data-acquisition modules that range in price from $50 to $2495. Sample rates now reach 500 ksamples/s, and thanks to USB 2.0, the bus doesn't limit throughput to slower sample rates as it once did. Even handheld DMMs have switched to USB because the PC's RS-232 port is vanishing (**Figure 1**).

IOtech's PersonalDaq (**Figure 2**) and National Instruments' DAQPad pioneered USB data-acquisition in 1998; both were slow-speed, high-resolution instruments. Data Translation was the first to offer acquisition rates comparable to plug-in cards (100 ksamples/s) when it introduced the DT9801 in 1999.

Software and hardware

When those first USB instruments appeared, Windows support for USB was still in flux. With Windows 98 Second Edition, Microsoft stabilized USB support, although not until Windows 2000 did USB take off. Today, many USB data-acquisition products require Windows 2000 or Windows XP. (See the online version of this article at www.tmworld.com/archives for a table that lists a variety of models and their specifications.)

Early USB instruments connected to PCs over the 12-Mbps USB 1.1, which limited throughput to 100 ksamples/s with 16-bit resolution. With USB 2.0 running at "high speed" (480 Mbps), data-acquisition modules such as the DT 9834 from Data Translation and the KUSB-3116 from Keithley Instruments now provide throughput as high as 500 ksamples/s with 16-bit resolution on eight channels while controlling analog and digital outputs.

Because USB offers plug-and-play capabilities, it is well-suited for quick measurement applications. It also removes sensitive analog circuits from the electrically noisy PC. USB instruments can easily move from one PC to another—as long as you install the drivers in

Numerous choices and price ranges, combined with a plug-and-play capability, make USB products a viable alternative to PCI cards.

FIGURE 1. Fluke's Model 189 DMM now connects to PCs though their USB ports. Courtesy of Fluke.

every lab PC and you don't lose the driver CD. Indeed, the academic, engineering, and scientific communities have embraced USB. "Instructors like the ability to take quick measurements," said Craig Anderson, product marketing engineer for data-acquisition software at National Instruments. "With USB, students don't need to become prolific with PC-based instruments. They can focus on collecting and analyzing data for their projects."

The automotive industry has also embraced USB. Douglas Gerard, director of software R&D at Roehrig Engineering, specifies a USB data-acquisition module from Measurement Computing for each shock-absorber dynamometer and suspension-spring rater that his company makes. Prior to using USB-based data acquisition, Gerard used a PC plug-in card and ran an unwieldy cable from a desktop PC to the dynamometer's analog signals. With USB, he eliminated the bulky cabling and put the digitizing electronics inside the dynamometer. All he needs to interrogate and control the dynamometer is a notebook PC and the company's software.

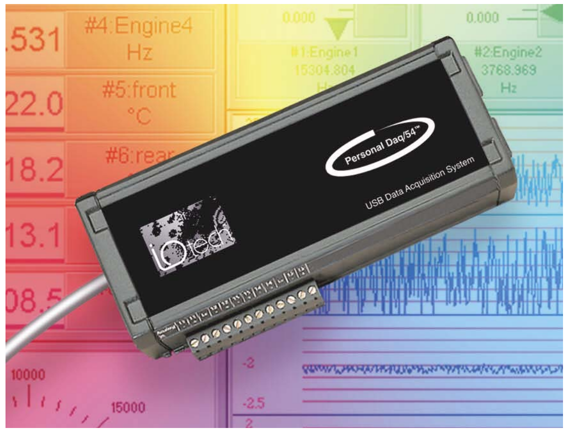


FIGURE 2. IOtech's PersonalDaq/54 is a descendant of the PersonalDaq/56, one of the first USB data-acquisition modules. Courtesy of IOtech.

Not everyone wants to write custom application software, though. To aid users who want to collect data without programming, manufacturers of USB data-acquisition modules provide datalogging software for collecting and storing data. IOtech adds offline data-analysis and plotting software. As a general rule, the more you pay, the more you get for stand-alone software, although Dataq Instruments supplies a flexible datalogging program even with its $50 module.

Over the last year, Data Translation, Measurement Computing, and National Instruments have introduced USB data-acquisition modules priced just under $150. To get a feel for how these units work and what you get, I tried each of them. "What do you get for $150?" below explains my impressions of the modules and their software. (I chose not to evaluate the Dataq $50 instrument in order to keep the playing field level; thus, I limited my evaluations to the three $150 models.)

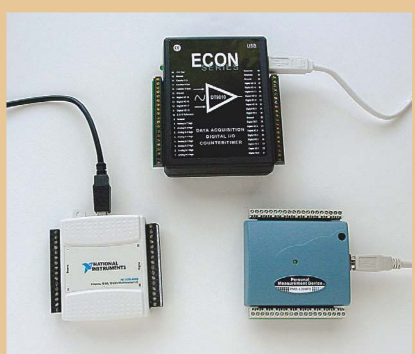
Some companies provide application-development packages with their USB modules. Data Translation, for example, supplies a fully functional version of DT Measure Foundry that runs for 14 days. In that time, you can develop run-time-

What do you get for $150?

When I noticed three USB data-acquisition modules available for just under $150, I decided to give them a try. If you're looking to make quick measurements, the software that accompanies these modules may prove inadequate.

I tried the DT-9810 from Data Translation ($149), the PMD-1208FS from Measurement Computing ($149), and the USB-6008 from National Instruments ($145). All units come with datalogging software that lets you view stored data, but only Data Translation gives you control of the modules' digital I/O port. (*Editor's note: On April 29, National Instruments announced that it has purchased Measurement Computing.*)

Data Translation also provides an oscilloscope display and a software digital voltmeter (DVM). Of the three companies, only Data Translation provides the most important tool—a screwdriver. But the DT-9810's input voltage range is just 2.4 V, so you have to provide your own signal conditioning for higher voltages or move up to a $249 model. For programming support, you get the company's DT Open Layers API for Windows, LabView VIs, and a 14-day evaluation copy of DT Measure Foundry.



You can get USB data-acquisition modules from National Instruments, Data Translation, and Measurement Computing for just under $150.

With its PMD-1208FS, Measurement Computing provides TracerDAQ, a datalogging package that lets you view data and store it in Excel or in delimited-text format. TracerDAQ also features a scope display, but it limits the module's sample rate to 1 sample/s, although the module can sample at 50 ksamples/s. TracerDaq provides no access to the PMD-1208FS's digital I/O port. The company also supplies InstaCal, which lets you calibrate the module against its internal voltage source.

National Instruments provides a datalogging application as part of its DAQ-mx Base driver that is packaged with the USB-6008. The datalogger will let you operate the module at full speed (48 ksamples/s), but it doesn't let you control the module's digital I/O port. The software lets you save data to disk in Excel format, but it saves every time you operate the module. The software should let you disable the recording feature until you're ready to collect data.—*Martin Rowe*

only applications that don't expire. Measurement Computing supplies a fully functional, free copy of SoftWire, an application-development program for Visual Studio .NET.

Not for everyone

USB isn't the perfect I/O bus for all applications, though. Some engineers question its usefulness in production environments, and with good reason. The USB cable's connectors can easily come out. In addition, the USB cables themselves lack the robustness of IEEE 488 cables, and they lack the length of Ethernet cables—because of signal reflections, the USB specification limits cable length to 5 m (Ref. 1).

The bits that travel along USB cables can move at "full speed" (12 Mbps) on USB 1.1-compliant modules and computers or at "high speed" (480 Mbps), provided that the host PC, the instrument, and all hubs in between comply with the USB 2.0 specification. But be aware of products that claim to be "USB 2.0 compatible." Such products may communicate with a USB 2.0-compliant port, but at full speed, not high speed. For example, National Instruments' Anderson said that at present, all of his company's USB data-acquisition products run at USB full speed but are compatible with USB 2.0-compliant ports. Check an instrument's data sheet if to see if will run at high speed.

Although USB moves the analog circuits away from the PC and closer to the measurement source, you can still get into trouble if you don't properly connect your signals. Interference caused by ground loops can produce measurement errors. If you use a USB instrument with a laptop PC running on battery power, you won't introduce a ground loop though the computer. If you use a PC connected to AC mains power, however, you can introduce ground loops through the power cord. "Isolate or denigrate" highlights how ground loops can cause errors and how USB instruments isolate measurement signals from PC grounds (Ref. 2). Keithley Instruments has also published a paper on making measurements with USB data-acquisition instruments (Ref. 3).

The 5 V of power that a USB cable supplies to a peripheral device may not provide enough power for the devices that a data-acquisition module controls. For example, multifunction data-acquisition modules provide digital I/O lines, and digital I/O modules provide as many as 96 I/O lines.

Because of the limited power of the USB, you may not be able to use digital outputs to source current. Or, the current you get may not be sufficient for your application. The best way to get adequate current is to use the digital outputs to sink current supplied by an external supply. Check the specification for a module's digital outputs to see what you need to drive your circuits.

With USB product offerings now wide enough to cover many applications, the bus is ready to take its place among the major choices of instrument buses. All that remains is to see how USB instruments from different manufacturers work together in automated test systems. T&MW

FOR MORE INFORMATION

* On instrument interfaces, visit WWW.TMWORLD.COM/BUS

USB data-acquisition products

To see the specs of a sampling of USB data-acquisition products from the following companies, see the online version of this article at www.tmworld.com/archives.

- Data Translation
- Dataq Instruments
- Fluke
- IOtech
- Keithley Instruments
- LabJack
- Measurement Computing
- Omega Engineering
- National Instruments

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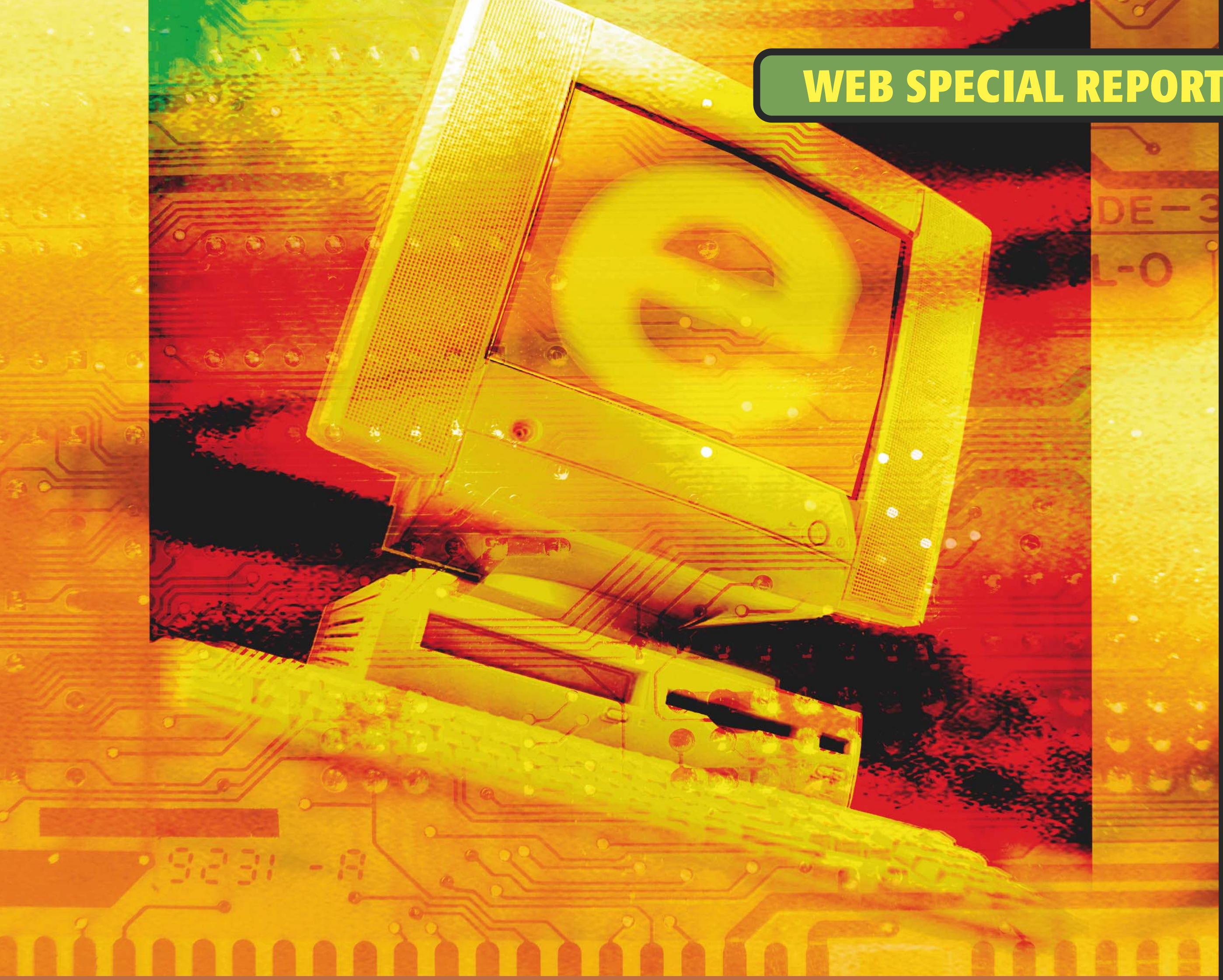
WEB SPECIAL REPORT



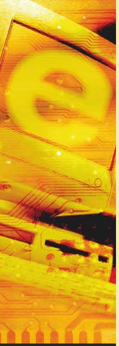
A NEW *TEST & MEASUREMENT WORLD* READER SURVEY SHOWS HOW THE INTERNET CONTINUES TO TRANSFORM THE WORK LIVES OF ENGINEERS

ENGINEERING'S INDISPENSABLE TOOL

LAWRENCE D. MALONEY
Contributing Editor

Take away a test instrument or favorite software program, and you can bet most engineers will find a way to work around it. But don't even think about depriving them of their Web access.

Results of the latest *T&MW* "Internet Usage Study," along with interviews with engineers and industry experts, reveal that the test community is becoming ever more reliant on the Web to solve job-related challenges. > > > > > >



Whether they're tapping into search engines and vendor sites or participating in chat groups and online seminars, engineers increasingly view the Web as their number-one source of technical data, especially when it comes to meeting an immediate information need.

"For me, the Web has gone from being a curiosity in 1992 to where I use it every hour of every working day," said Robert Santini, director of instrumentation for Purdue University's chemistry department.

Fast access anytime

Another engineering veteran, Kevin Parmenter of Fairchild Semiconductor, adds that engineers not only depend on the Web's easy access to information, 24/7, but that they also expect the Web to deliver continued improvements in speed and performance. Indeed, the *T&MW* usage survey shows that the Web's ability to slash the time it takes to search for information is its biggest benefit for respondents.

The average test engineer consults Web resources 8 hrs a week for business purposes, according to the study, compared with just 5 hrs a week for leisure purposes. What's more, those work activities often spill over to the home computer as well. "I'm doing eight to 10 hours of work per week on research for work at home," noted Mike Hartge, a reliability engineer for Tyco's Harman Electronic Div. in Mansfield, OH. "This includes preparing for test setups, which I can do at a more leisurely pace at home."

Most respondents (86%) rely on the Web for such work-related research, the survey shows, making it the second biggest reason for accessing the Internet on the job, following the need to visit vendor Web sites for service or support (90% of respondents). Among other top Web uses: e-mail (86%), downloading software (73%), evaluating products (71%), and accessing the corporate Intranet (52%). Engineers tend to rely on the Web most in the planning phase of new projects, when they are gathering ideas, investigating test tools, and establishing specifications.

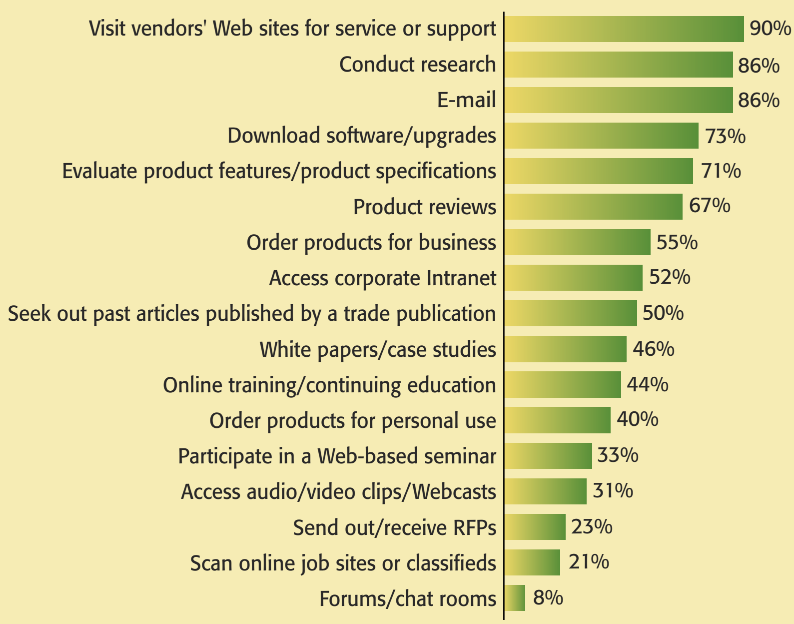
Engineers also are finding more ways to integrate the Web into the test process itself. Purdue researchers, for example, depend on wireless networks to access test data on environmental conditions in Alaska's North Slope. "I can get on my laptop and not only watch the data stream but also adjust the instruments through a built-in scope card," explained Santini, the instrumentation director.

Purdue, through a National Science Foundation grant program, harnesses the Web to enable outside researchers to set up and control experiments in its chemistry lab. Santini explained, "Not everyone can afford to buy his own $120,000 infrared spectrometer, but this program gives researchers remote access to such equipment."

Frank Chambers, an independent engineering consultant in Maine, also points to the Web's role in answering the needs of technical professionals in remote areas. "I couldn't live without it," said the fiber-optics expert and former R&D manager for Eaton Corp. Among his most useful Web

How engineers use the Internet on the job

% of respondents



Source for all charts: 2005 Internet Study, *Test & Measurement World*/Reed Research Group chores: downloading software upgrades from such companies as MathWorks, Microchip, and Photon Engineering.

From search engines to Webcasts

Asked about the search engine they rely on most, Google ranked first (85%) in the *T&MW* reader survey—and it was the first word out of the mouth of every engineer interviewed for this report when asked about most useful search engines. Trailing well behind: Yahoo, MSN, Dogpile, and AltaVista. Test industry kingpins, such as Agilent, Tektronix, and National Instruments, also scored high among frequently visited Web sites in the survey, as did the Web sites of major broad-based electronics distributors like Digi-Key, Newark, and Allied.

How do leading vendors lure Web visitors?

Among our respondents' favorite resources for job-related tasks are the Web sites of four familiar companies: Agilent Technologies, Digi-Key, National Instruments, and Tektronix. We spoke with the Internet specialists at these firms to learn how they keep their Web sites fresh.

To read about their recent endeavors—including online shopping and support services, tailored content, and helpful search engines—see the online version of this article at **www.tmworld.com/archives.**

"If I were on a desert island and could access only two Web sites for work, they would be Google and Digi-Key," observed Parmenter.

Nearly half of the survey respondents begin their technical research by accessing a search engine first; about 30% go directly to a manufacturer's Web site. Nearly 15% start their Web research by first going to the Web site of a technical magazine. Among the magazine Web sites visited most: *Test & Measurement World* (29%), *EDN* (23%), and *EE Times* (19%).

The *T&MW* research finds that a large percentage of respondents (66%) are buying work-related instruments, components, and software via the Web—typically after comparing prices online. Median online purchases for work totaled just over $6,200 in the last 12 months, according to the survey. "If I want to buy a Fluke DMM, I could get on the phone and go back and forth with a salesperson," noted Parmenter, "but it is so much easier to type in 'lowest price for a Fluke DMM' on

Gurus chart Web's future

Barely a dozen years old, the Internet has triggered enormous social changes that will only intensify in the years ahead. That's the conclusion of a recent "Future of the Internet" survey of Web experts conducted by the Washington-based Pew Foundation and North Carolina's Elon University (the survey is accessible at www.pewinternet.org).

Asked to forecast the next decade of Internet development, nearly 1300 respondents—most of them Web insiders—painted this picture:

- 66% predict at least one devastating attack on network information infrastructure or the nation's power grid.
- 59% see increased government and business surveillance.
- 57% forecast more virtual classes in formal education.
- 56% agree that the boundaries between work and leisure will blur, with the spread of telecommuting.
- 54% look for a new age of creativity in which people use the Internet to collaborate with others.

Which institutions will be transformed most by the Web? The Internet experts singled out the news and publishing industries, where what one called new "digital media titans" will form connections across media, entertainment, advertising, and commerce. The same respondent noted: "Well-branded innovators like Google and Starbucks have a chance to build all-new distribution models tied to ad revenue and retail sales."

Elon's Anderson: Conflicting attitudes

Other comments came from respondents representing entities ranging from AOL, IBM, Intel, and Microsoft to Harvard, Yale, and the US Census Bureau. A sampling of those views:

- "Health care is approximately 10 years behind other endeavors in being transformed, and will experience its boom in the next 10 years.
- "Digitization and the Internet make for a potent brew. . . .TiVo kills the commercial television format. Napster, Kazaa, and iPod kill the 'album' format."
- "Hyperlinks subvert hierarchy. The Net will wear away institutions that have forgotten how to sound human and how to engage in conversation."
- "The next decade should see the development of a more thoughtful Internet. We've had the blood rush to the head, we've had the hangover from that blood rush. This next decade is the rethink."

One of the study's directors, Elon Communications Professor Janna Quitney Anderson, told *T&MW* that the survey revealed many conflicting attitudes about the Web, such as an endorsement of the Internet's openness mixed with fears of security breaches. "Overall, people have embraced the Web and would be lost without it," she said, "but at the same time it is exhausting them, because they are now reachable 24 hours a day."

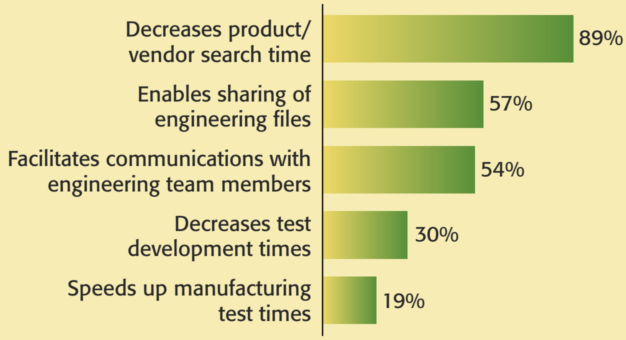
Lawrence D. Maloney

Google and follow the links."

Chambers, the Maine fiber-optics test expert, did Web shopping for the components needed to build a high-performance PC. He figures he saved about 30% and got exactly what he wanted. Others trust the Web to help them decide on big-ticket purchases as well. For instance, Mike Donegan, owner of Digital Services, an engineering consulting company in Ottawa, relied on Web research to purchase a $70,000 FLIR Systems infrared camera. Canadian custom duties discourage him from actually making purchases online, unless the vendor is shipping from a distribution point in Canada.

Chief benefits of the Web for enineering work

% of respondents



Research from the Forrester Group shows that business-to-business online purchases far eclipses the amount of online buying in the consumer realm, despite the popularity of operations such as Amazon.com, which sold 2.8 million books online in a single day last Christmas season. Forrester analyst Andrew Bartels projects that B2B e-commerce in the US will grow from $1.5 trillion in 2004 to about $2 trillion in 2007. He notes a direct relationship between the size of a company and the amount of e-commerce. For instance, he estimates that 60% of companies with annual sales of $1 billion or more have set up online transaction capabilities.

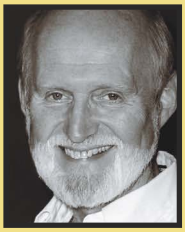
This growth in e-commerce continues, despite concerns about online security fanned by recent instances of hacker intrusions into the online databases of such companies as LexisNexis, ChoicePoint, and Bank of America. "I am no more concerned about online purchases than I am about using my credit card in a restaurant," com-

Too much of a good thing?

While engineers praise the Web for its many benefits, many complain about the struggle to escape its clutches. Some psychologists and social scientists believe that an increasing percentage of us are spending too much time on the Web—and getting stressed out because of it.

Connecticut psychologist Dave Greenfield, for example, has conducted studies indicating that more than 5% of Web users may be addicted to it. His Web site even includes a self-appraisal test to assess whether you're becoming a Web junkie (www.psychhealth-net.com/test_internetaddict.htm).

Anthropologist Douglas Raybeck of New York's Hamilton College also wonders whether human beings are really equipped to process the flood of information coming at them every day via cell phones, PDAs, laptops, and desktops—not to mention radio, TV, newspapers, and magazines. In an interview with *Test & Measurement World*, Professor Raybeck shared his concerns about several effects of Web use:



Anthropologist Raybeck: Productivity race.

- **Addiction to surfing**. "There can be an actual pattern of addiction. Some people are simply information seekers; some visit chat rooms for a social fix. And others, no surprise, are into pornography."
- **Snowballing effect.** "You start using the Web for a specific purpose—say to acquire information and contact colleagues. But things can become sticky. The Web can pull you in, a little bit like a pitcher plant, and it can be hell to climb back out."
- **Productivity race.** "Personally, I'm maybe 35% more productive than I was 20 years ago because of the Web, but so are all my colleagues. That means I have to be more productive just to stay even, to read what they've written, to evaluate their research and experiments. So, the pace keeps stepping up."
- **Testing the breaking point**. "At the psychological level, heavy Web users may experience increased irritability—barking at their families. Socially, it's gone too far if you are estranged from people, spending too much time boxed in front of a computer. Human beings are a social species who spent 3 million years running around in groups of 30 people. To now find those relationships being supplanted by electronic media is not all that satisfying."

Raybeck sees no letup in the Web invasion, with instances of burnout becoming more commonplace. "The electronic demands that beset us are going to increase," he said. "We are asking people to do more in the same amount of time, while having less face-to-face contact with the people who matter."

Lawrence D. Maloney

mented R. Vijayakumar, VP of technology for Air Techniques International, which makes test equipment for high-efficiency filters.

Besides e-commerce, Vijayakumar taps the Web to receive about 20 electronic newsletters, which he finds helpful in keeping up with both technical and marketing trends in the test field. He's got plenty of company. The *T&MW* survey found that 38% of respondents rate e-mail newsletters as "extremely useful" or "very useful" in their work, while 54% found them to be "somewhat useful."

About half of survey respondents say they attend online Webcasts and trade shows. Michael Bowman, a test engineer with Mid-South Electronics in Alabama, is moving from a Windows to a Linux-based operating system for some of the functional tests he does on the boards that his company builds. A Linux Webcast eased that transition.

Fairchild's Parmenter is also a Webcast fan. "They can be a wonderful training vehicle," he said, citing the online seminars on semiconductors and test topics found on TechOnLine.

While agreeing on the educational potential of online seminars, Vijayakumar observed that Webcasts often fall short when it comes to the quality of presentations. "Many have not moved beyond the look of flip charts and overheads," he complained.

Even so, test companies that were founded on an educational model, such as California-based A.T.E. (Advanced Test Engineering) Solutions, are conducting more of their classes online in real time. "Online students can ask questions as we go along," noted Louis Ungar, president of the company, "and others can chime in with a 'me too' on those questions. This tells us when we've got a point that needs more explaining."

Ungar added that, because test engineers always seem to be responding to some crisis, they are more likely to register for an online event versus making a travel commitment to a training site. "With online learning, there's less of a hassle if you have to cancel at the last minute."

Travel concerns also have hurt many trade shows and fostered an increase in virtual trade shows and search engines like Direct Industry (www.directindustry.com), which describes itself as a "virtual industrial exhibition." Parmenter noted that many managers are reluctant to pay for engineers' travel to trade shows when they can get the same product information over the Web.

A note of caution

With such an explosion of Web content, some observers wonder whether engineers, like those in other professions, have become too dependent on the Web. "I have an incredible collection of data sheets on my computer," said Maine engineering consultant Chambers, "and it can be like finding a needle in a haystack."

To cope with the data deluge, more engineers say they are trying new types of search engines, such as Copernic Desktop Search (www.copernic.com), to help them manage and search all the files that pile up on their own PC.

Others worry about reliability issues. "The chief downside of the Web is when the system crashes," said Hartge of Tyco/Hartman. "We've become so dependent on it, and we need to develop backup strategies."

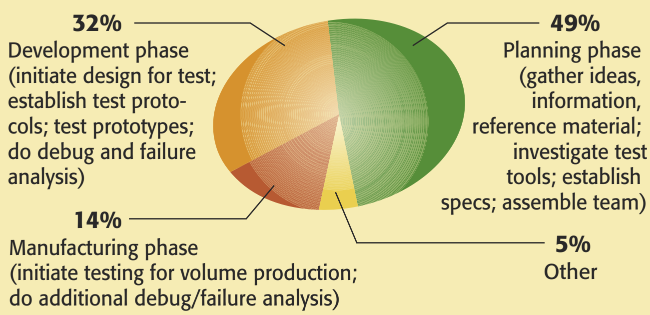
Although 56% of respondents to the *T&MW* survey report that the Web has become their prime source of information, 93% indicate that they continue to find it necessary to read technical publications, especially for new product information, problem-solving ideas, and tutorials on testing.

"I still value the technical magazines immensely," noted Vijayakumar. "The Web does not give you all the nuances of the technology that you find in the magazines. It's more like fast food." And while most engineers praise e-mail for fostering collaboration, Vijayakumar worries that there is now less personal contact among engineers, "so you lose the benefits of crossing swords face to face with your peers."

More engineers report that they have switched from print magazines to the new digital versions of such publications as *T&MW, EDN,* and *Design News.* Chief reasons: The digital option eliminates storage problems of

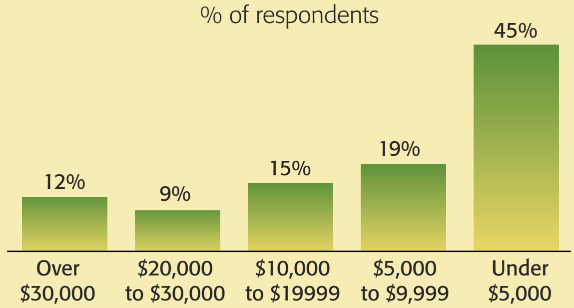
Product life-cycle stage when Web is used most

% of respondents



Value of job-related online purchases (2004)

% of respondents



older issues, while providing instant Web links to companies featured in stories and advertising.

What the future holds

Looking ahead, engineers and media experts envision an even greater reliance on Web-delivered information.

Like other fields, engineering is spawning an expanding network of Web logs or "blogs"—regularly updated Web sites maintained by self-styled gurus or experts from companies or organizations. Richard House, president of VI Technology (Austin, TX), a company that sells test-management software, points to a raft of blogs that his engineers consult on a regular basis (see "One company's Web favorites," below).

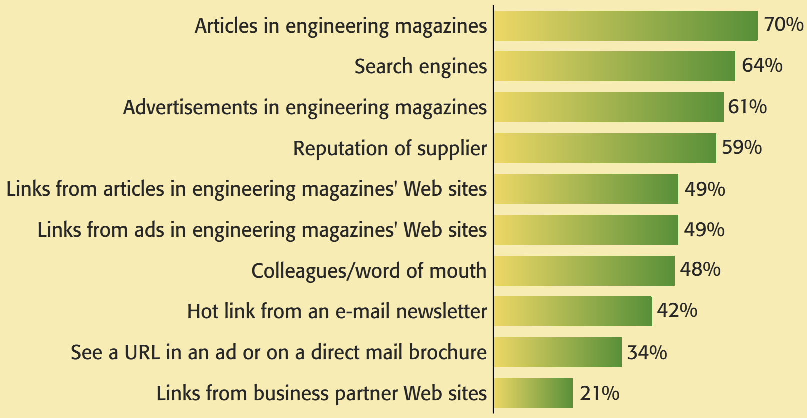
House also predicts an increase in test instruments with built-in Web capabilities. For example, National Instruments' FieldPoint I/O product features an embedded Web server with a LabView remote-panel user interface. Similarly, engineers can use any standard Web browser to set up and remotely operate Agilent's 34980A multifunction switch/measurement unit.

Other industry experts see a growth in Web services in which software companies deliver their products on a downloadable "pay-for-use" basis rather than selling customers periodic new releases. Salesforce.com has successfully employed this model in software that salespeople use to manage customer relations.

Ungar of A.T.E. Solutions predicts that more Web services from companies or independent engineers will spring up in niche areas, such as telecommunications test and EMC/EMI. He said, "In fast-moving fields, or those where government regulations are always changing, test engineers need the Web to tap the knowledge of experts who can give them answers, not just sell them a product." T&MW

Key drivers to supplier Web sites

% of respondents



One company's Web favorites

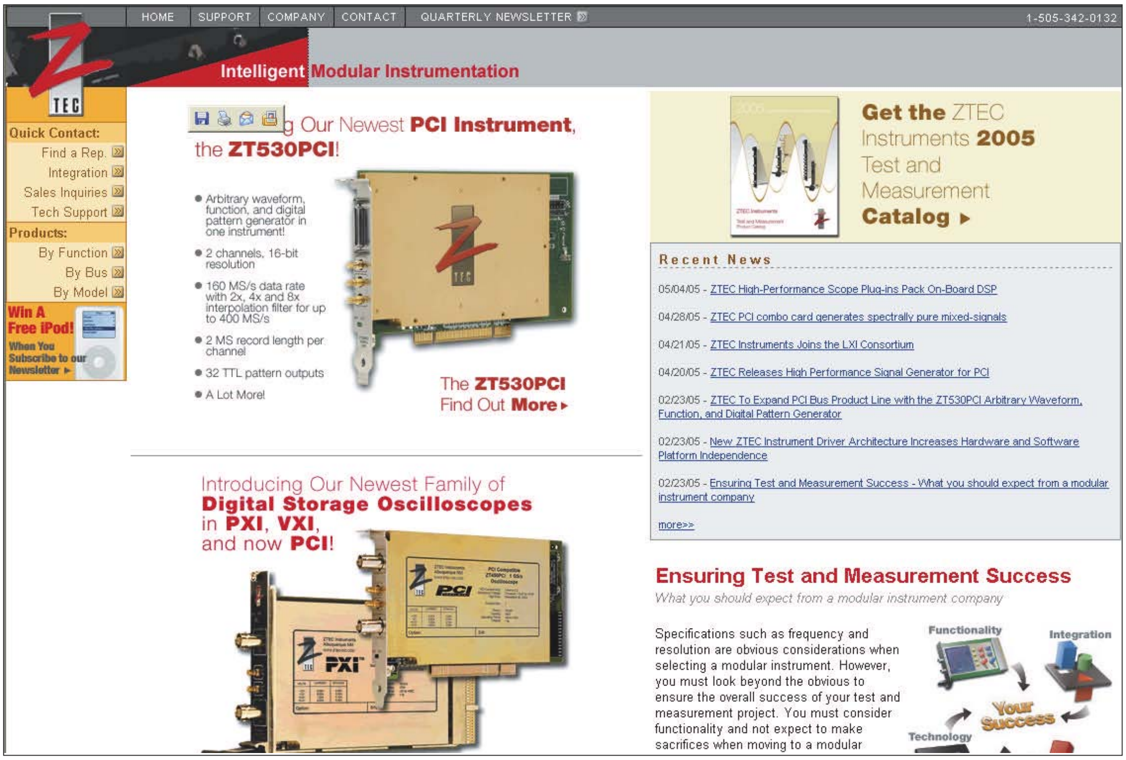
Like engineers everywhere, technical staffers at Texas-based VI Technology are assembling an ever-expanding litany of Web resources vital to their work. As consultants and developers of Arendar test-management software, the VI engineers know the benefits of Web-based tools for sharing test data and finding fast solutions to technical problems.

Recently, VI president Richard House asked his staff to name some Web sites, chat groups, and blogs that they turn to again and again. Among their favorites:

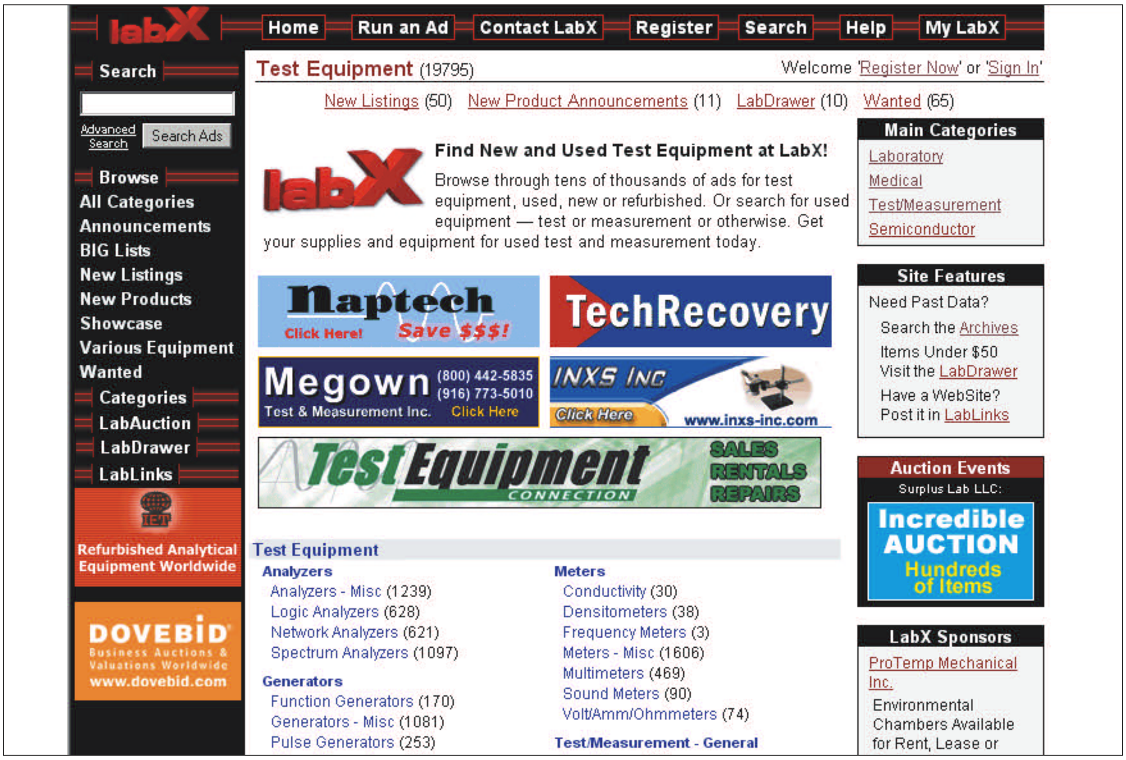
- Resources for Open Source code and applications. (sourceforge.net)
- Microsoft .Net Framework community. Blogs and resources on .Net topics. (gotdotnet.com)
- Java, .Net, C++, Web development, and database articles, code, and discussion forums. (www.devx.com)
- C++, C#, and .Net articles, code, and discussion forums. (www.codeproject.com)
- Helpful resource for developers using Microsoft technologies. (msdn.microsoft.com)
- Web logs on ASP.NET development. (Weblogs.asp.net)

Web sites solve many daily challenges for VI engineers Marcela Maldonado and Aaron Gelfand.

- Six sigma, SPC, quality tools. (www.isisigma.com)
- Online Analytical Processing information. (www.mosha.com/msolap)
- Discussion forum for the use of LabView. (www.info-labview.org)
- Blog and discussion forum for LabView developers. (lavausergroup.org)
- LabView Open Source community. (www.openG.org).



ZTEC Instruments, Inc.: www.ztec-inc.com



LabX: www.labx.com • http://test.labx.com

DVB-H test techniques promise to bring reliable TV reception to handheld devices.

VIDEO GOES MOBILE

SIMONE GERSTL, ROHDE & SCHWARZ

Mobile phone industry and broadcasting network operators are more and more willing to offer multimedia streaming video content for mobile receivers including notebooks, cell phones, and PDAs. DVB-H technology stands ready to transmit television signals to handheld devices, overcoming the limitations that hinder the use of DVB-T in a mobile environment. Furthermore, test techniques are evolving that will ensure reliable integrated circuits, terminals, and networks for DVB-H applications.

DVB-H (see "Digital video terminology," p. 56) is ideal for mobile television transmission, as it meets the two main challenges that occur in mobile television:

- First, DVB-H ensures stable reception even in difficult environments by incorporating additional error correction called MPE-FEC, which is not available in DVB-T. MPE-FEC operates at the Internet Protocol level to allow secure reception even if many packets are lost.
- Second, to extend a mobile receiver's battery life, DVB-H cuts power consumption by as much as 90% compared to DVB-T; to do that, it employs time-slicing technology that transmits data in bursts instead of continuously, allowing the receiver to switch off between those bursts.

Another enhancement to the DVB-T standard is the 4k modulation mode in DVB-H (**Figure 1**). This com-

DANIEL GUIDERA

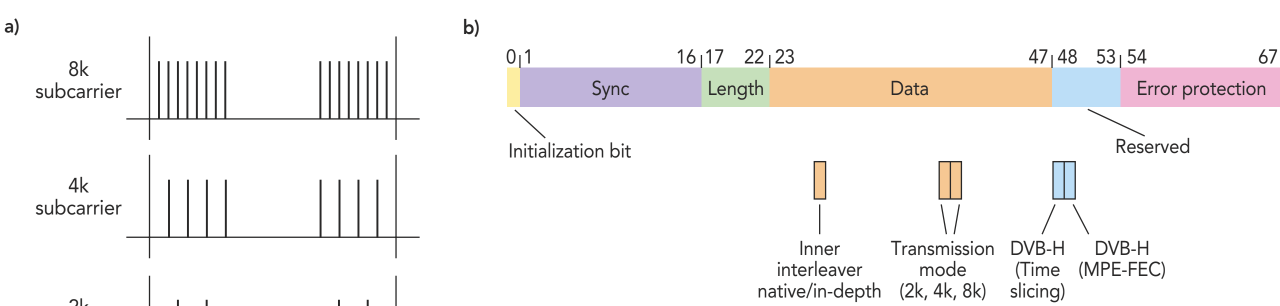


FIGURE 1. a) A 4k modulation scheme represents a compromise between 2k and 8k versions. b) TPS signaling indicates DVB-H-specific features.

promise between 8k (which allows big single frequency networks [SFNs] but only at limited speed) and 2k (which allows very high speed but only on small SFNs), ensures stable mobile reception at high speed. (In this context, the "size" of an SFN refers to the maximum distance between two transmitters within the SFN.) Transmission parameter signaling (TPS) bits indicate to the receiver whether DVB-H-specific features are used and, if so, which ones.

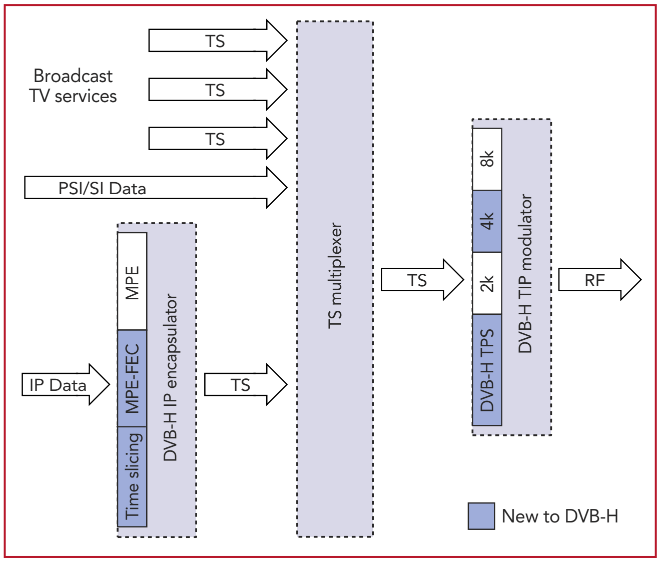


FIGURE 2. A playout center incorporating a multiplexer can combine DVB-H and DVB-T services.

DVB-H network setup

As DVB-H is based on DVB-T, the network setups are similar. A playout center (**Figure 2**) consists of a multiplexer that has MPEG-2 transport streams (TS) as inputs. A new feature in DVB-H is that at least one TS comes from a DVB-H IP encapsulator, such as the R&S DIP010, which encapsulates incoming IP data in order to pack it in a transport stream.

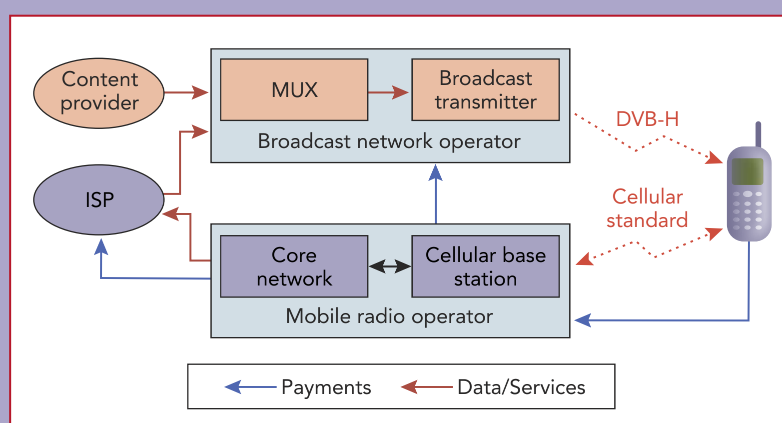
The output TS of the multiplexer feeds the DVB-H-compatible modulator/transmitter, such as those in the R&S 7000 series, capable of supporting the 4k modulation mode and the DVB-H-specific TPS-bits. Because this technical setup is similar to that of DVB-T, broadcasters can combine DVB-T and DVB-H services within a network sharing one multiplexer. This makes it possible to offer DVB-H services using an existing network, thus lowering the cost for the operator and reducing the risk of investing in DVB-H technology. Especially for the trial networks, this is an advantage for network operators, who can

DVB-H business models

While the technological aspects of DVB-H are pretty clear, there is still a question mark regarding DVB-H business models and the DVB-H players. At this moment, it's not clear who those players will be; well-known players from the cellular world and players from the TV broadcasting world are possible participants.

Both the telecommunication and the broadcasting industry can make use of their core competences:

- The cellular world is characterized by one-to-one transmission and mobile interaction, and the cellular operator knows exactly who the customer is and can transmit personalized content and handle billing.
- The broadcasting world is characterized by scheduled delivery of content to an unknown number of viewers, which is very cost-efficient if there are a lot of viewers.



Mobile-video business models will likely consist of teams of content providers, ISPs, and network and mobile-radio operators.

Several operators have announced they will operate trial DVB-H networks in the near future. The idea behind those trials is to gather information about the end-user acceptance as well as to test technical performance.

In one trial that is underway, leading Finnish broadcast, content, and mobile communications companies have signed an agreement to start pilot testing a commercial broadcast service to mobile devices. The participating groups are TeliaSonera and Radiolinja, which provide end users with access to TV services; MTV, Nelonen, and YLE, which provide content; Digita, the Finnish broadcasting network operator that takes care of the network operation; and Nokia, which supplies the mobile terminals.

The network is up and running using R&S TV transmitters in the Helsinki area, and the participants plan to recruit roughly 500 end users this year. This commercial pilot already indicates what future cooperation between telecommunications and media industry could look like. Some other DVB-H trials are planned for the next months, including ones by Deutsche Telekom in Berlin, Germany, and NTL in Oxford, UK.—*Simone Gerstl*

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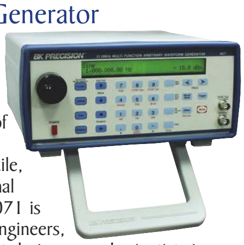

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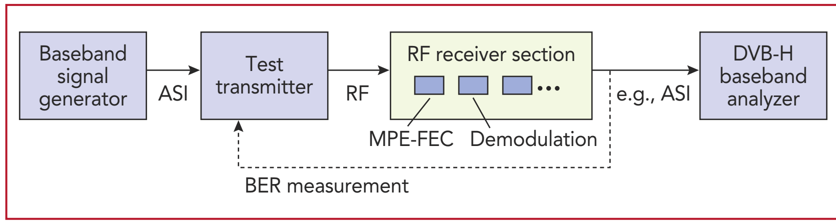


FIGURE 3. A setup for testing DVB-H-compatible chips can test multiple functions within a DUT, including MPE-FEC and demodulation stages.

use existing equipment instead of procuring new systems.

As new technologies evolve, the main demands for test and measurement equipment can be found within the R&D process. In the case of DVB-H, there are mainly two R&D applications: R&D for DVB-H chips and R&D for DVB-H-compatible mobiles.

DVB-H testing

In a setup for testing a DVB-H compatible RF chip within an R&D lab (**Figure 3**), a signal source provides a baseband signal (DVB-H stream) that feeds a test transmitter. From there, the RF signal goes into the device under test (DUT). The output signal of the DUT goes to a baseband DVB-H analyzer.

For testing the different functional groups within an RF receiver chip, the incoming signal can be varied. In principle, it is possible to test all the functionalities of a chip by changing the respective parameters in the input signal. At the signal-generation stage, for example, the MPE-FEC can be switched on and off in order to test the performance of a chip's MPE-FEC section. The test transmitter can change the

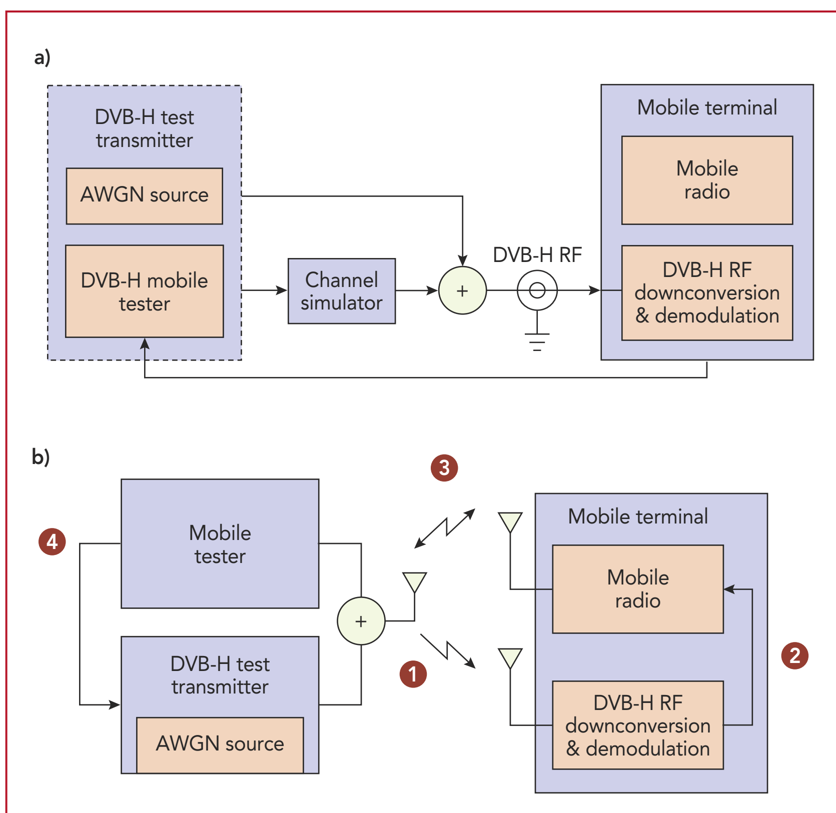


FIGURE 4. a) To test a mobile terminal, you use a DVB-H test transmitter to establish a transmission and add calibrated Gaussian noise to simulate real-life situations. b) Closed-loop testing evaluates the reverse link.

transmission mode (2k, 4k, 8k) or make variations in the parameters (for example, modulation level), insert transmission noise, and simulate moving receivers by introducing fading. Thus, the receiver performance can be easily checked by means of a BER (bit-error-rate) measurement.

For testing the performance of a mobile terminal, you establish a real transmission by using a DVB-H test transmitter. To simulate real-life situations (**Figure 4a**), you add calibrated Gaussian noise to an ideal signal from the test transmitter and apply the combined signal to the receiver section of the mobile terminal under test. BER tests will show how well the receiver can handle those noisy situations.

You must use channel simulation to test how the unit behaves when it is on the move.

For a mobile terminal, you must use channel simulation, or fading simulation, to test how the unit behaves when it is on the move. Fading reflects the fact that transmitted signals reach a moving receiver over different signal paths. The receiver must cope with the fact that these paths have different levels and phases and also different delays. The test transmitter also performs the fading.

After checking the DVB-H implementation in the mobile terminal, you can use a closed-loop test to evaluate the reverse channel (**Figure 4b**). Combining a DVB-H test transmitter with a radio communication tester provides for the necessary transmission simulations. The circled numbers in Figure 4b show the sequential steps:

1. A DVB-H tester generates packets over the air.
2. A DVB-H mobile terminal's RF downconversion and demodulation function demodulates the test signal and issues demodulated packets to the terminal's mobile radio stage.
3. The radio transports packets over-the-air on the reverse link.
4. A mobile tester examines the loop-back packets and calculates packet error rate.

The DVB-H section of the mobile phone receives DVB-H signals from the

Digital video terminology

ABBREVIATION	TERM	DESCRIPTION
ASI	Asynchronous serial interface	A method for transferring digital TV data as a single-program TS.
DVB-H	Digital Video Broadcasting —Handhelds	
DVB-T	Digital Video Broadcasting —Terrestrial	
FEC	Forward-error correction	Algorithm to correct transmission errors on the receiving end.
IP	Internet Protocol	Specification of packet format and address scheme.
MPE	Multi protocol encapsulation	Methods to encode IP datagram stream onto TS.
MPE-FEC	Multi protocol encapsulation forward-error correction	
PSI/SI	Program specific information	Data required by the receiver to de-multiplex and decode the various programs in the TS (e.g., NIT, INT).
SFN	Single frequency network	
TPS	Transmission parameter signaling	Signaling of parameters related to the transmission scheme (e.g., to channel, coding, and modulation).
TS	Transport stream	

test transmitter. An application running in the mobile phone initializes the wireless return path, over which it will transmit, for example, a summary of the data it has received via the DVB-H channel. A mobile radio tester receives and analyzes these signals. Communication with the DVB-H test transmitter closes the loop and allows the calculation of a closed-loop packet error rate. Inserting Gaussian noise into the DVB-H signal thus allows the test system to determine receiver limitations.

Network operator considerations

When running a DVB-H network (both pilot networks and real operational networks), an operator must be able to analyze the transmitted signal. For this purpose, you can use a test receiver to demodulate the DVB-H signal. The output baseband signal can then feed an MPEG-2 analyzer, which can carry out tasks such as analyzing the content and structure of the services and performing timing and data-rate measurements. In addition, an MPEG-2 analyzer can export the IP content of a DVB-H stream to an arbitrary IP address. An application for this is to play out the content in the service with an MPEG player or H.264 player.

One open question about DVB-H is exactly who the network operators will be, with business issues now surpassing technological ones as potential impediments (see "DVB-H business models," p. 52). Trials that are underway or are imminent will address the business questions, with effective solutions emerging to match the technological ones. T&MW

FOR MORE INFORMATION

* On communications, visit WWW.TMWORLD.COM/COMM

Simone Gerstl, *Dipl. Wirtsch.-Ing., is a product manager for terrestrial transmitter systems at Rohde & Schwarz in Munich, Germany*

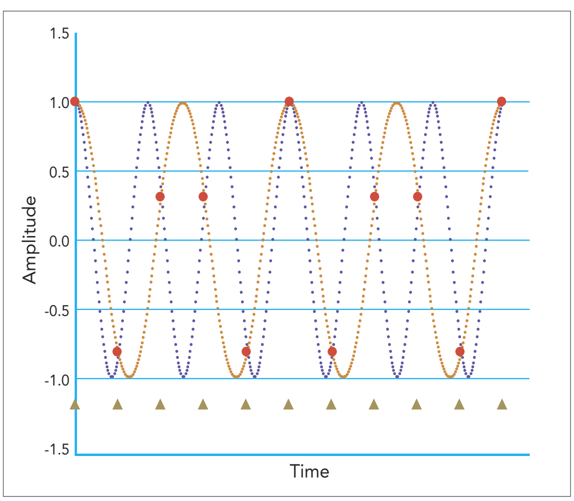
THE DATA DETECTIVE

Signals Assume an Alias

After you sample a continuous waveform, you end up with discrete-time values rather than the original signal. The very act of sampling can cause problems when it comes time to analyze the data. You can solve those problems or take advantage of them.

Most engineers understand the principle behind the Nyquist frequency, which states; for a sampling frequency of F, you can accurately measure frequency components below F/2, the Nyquist frequency. Some people forget the highest-frequency component isn't always the signal they want to measure. Energy may exist in their signal above the sampling system's Nyquist frequency. As a result, they often find unexpected signals—sometimes noise—in their frequency-domain analysis results.

These unwanted, or aliased, signals occur when engineers under-sample a signal. The 11 data points shown in the plot below could have come from either sine wave, or from an infinite number of other sine waves. So, what do those 11 points represent? If they come from an under-sampled signal, you cannot tell.



Signal-analysis math, such as an FFT, moves, or aliases, energy at frequencies above the Nyquist frequency into lower-frequency bins. If a data-acquisition system operates at 6 ksamples/sec and acquires data from a 7-kHz signal, the FFT results will show energy at 1 kHz. Thus, the 7-kHz signal has assumed an alias of 1 kHz. As such, you cannot examine the FFT results and differentiate energy of a 1-kHz signal from that aliased down to 1 kHz from the 7-kHz signal.

Engineers can eliminate or greatly reduce aliasing effects by placing an anti-alias filter, usually a low-pass filter, between their signal source and their data-acquisition system. The filter must remove frequencies from the unknown signal starting at the Nyquist frequency, or half the sampling frequency. Also, the filter's response must correspond to the characteristics of the sampling system. Thus, if the system's analog-to-digital converter (ADC) has a full-scale range of 80 dB (1 part in 10,000), the anti-alias filter must attenuate out-of-band frequencies to 80 dB below the converter's full-scale value.

Aliasing does have its benefits, though. Deliberately sampling a signal at less than the Nyquist rate moves a signal to a lower frequency as noted above. Thus, if you sample a 40-MHz sine wave at 50 Msamples/sec, the energy determined by an FFT will appear at 50 Msamples/sec-40 MHz, or at 10 MHz. Because you know the signal has assumed an alias, you can reverse the relationship to determine the signal's frequency.

The Signal's Alias

Beth has received a 70-MHz signal source that produces a pure sine wave without any spurs and with very low noise. She decides to digitize the output signal and run it through an FFT routine to check the source's frequency and signal level. Although she has several digitizers handy, none operates at 140 Msamples/sec.

Can you help Beth understand undersampling and aliasing so she can determine which digitizer—if any—to employ?

http://rbi.ims.ca/4392-510.

Harry Nyquist, a researcher with Bell Telephone Laboratories, actually said the sampling rate must occur at more than double a signal's bandwidth, not more than double a signal's highest frequency component. So, digitizing a signal that contains frequencies between 30 MHz and 35 MHz, for example, only requires a sample rate of >10 Msamples/sec, or greater than twice the 5-MHz bandwidth. You commonly find band-limited signals like this in ultrasonic testers, Doppler radars and communications systems.

When you are deliberately under-sampling a signal, first you must use a bandpass filter to remove signals outside the frequency band of interest. Second, the ADC must have an analog bandwidth greater than the bandwidth of the signal you want to acquire.

For Further Reading

Lyons, Richard G., "Understanding Digital Signal Processing," 2nd ed., Prentice-Hall, Upper Saddle River, NJ. 2004.

Go to http://rbi.ims.ca/4392-510 to solve the challenge!

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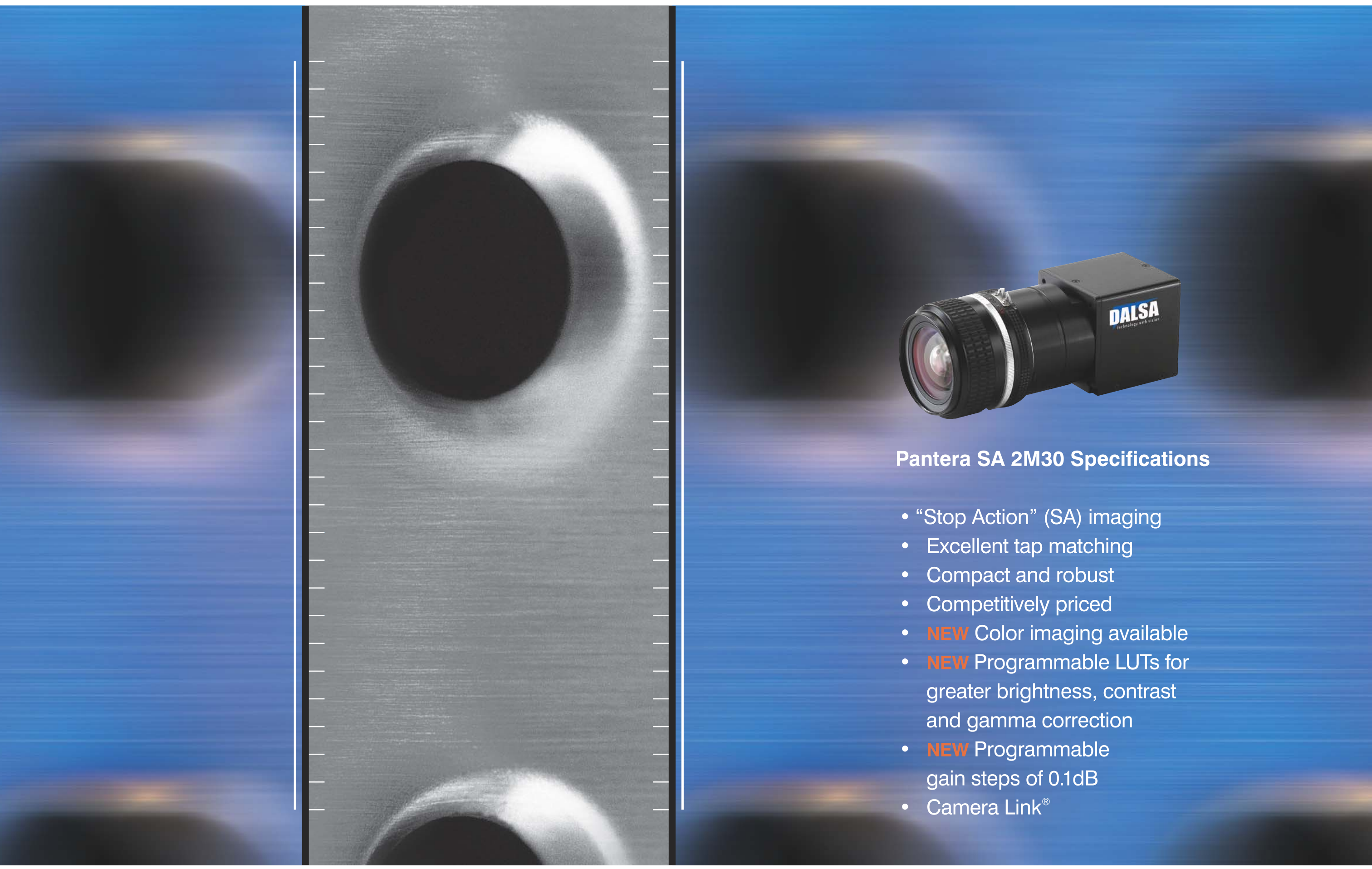

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STANDARDS

Consortium promotes control applications

Greg Reed, Contributing Technical Editor

With the goal of developing an advanced communication system for automotive applications, several firms have joined forces to form the FlexRay Consortium. Members include BMW, DaimlerChrysler, Motorola, and Philips. Another member is TTTech Computertechnik, a Vienna-based supplier of time-triggered systems.

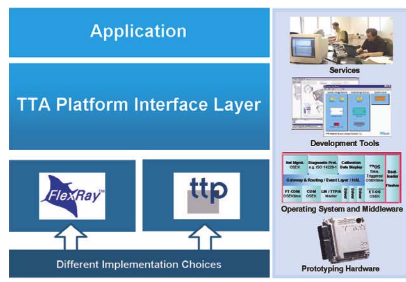
Dr. Markus Plankensteiner, marketing director at TTTech Computertechnik, serves as a development member within the FlexRay Consortium. I recently asked him about the consortium and about his company's involvement with it.

Q: What is the FlexRay Consortium?
A: An alliance of automotive, semiconductor, and electronic systems manufacturers. These companies are working to develop a deterministic and fault-tolerant bus system with high data rates for advanced automotive control applications. The consortium was formed to drive the adoption of the FlexRay communication system as the de facto standard for high-speed communication networks for automotive applications.

The consortium intends to create an industry standard for serial communication systems to efficiently support the control of communication between electromechanical nodes in automotive applications. The adoption of FlexRay will simplify the manufacture, design, and testing of vehicles and enable the development of advanced electronic systems that will become an integral part of next-generation vehicles.

Q: Explain TTAutomotive's role within FlexRay.
A: TTAutomotive [a TTTech Computertechnik subsidiary] will provide development tools, middleware, and prototyping hardware as well as services and engineering support for customer projects in the automotive industry. The company's mission is to advance the implementation of time-triggered technology in the automotive industry.

Q: Which systems are primary candidates for time-triggered technology?
A: Time-triggered architecture (TTA) is an appropriate solution for fault-tolerant and hard real-time distributed systems. In the automotive industry, this encompasses most advanced distributed driving and vehicle control functions, such as steering or braking by wire, and stability and chassis control algorithms that combine current stability functions such as ABS and ESP. Systems in the aerospace industry that apply time-triggered technology include engine control, fly-by-wire, and cabin pressure control. Time-triggered protocols (TTPs) can transmit 10 or even 20 times more application data than a single CAN link or a comparable aerospace ARINC 429 network.



Time-triggered architecture interfaces speed the transmission of test data for automotive and aerospace applications. Courtesy of TTAutomotive.

Q: What are the primary challenges to implementation?
A: Aerospace engineers typically are familiar with the concept of safety by redundancy and with time-triggered scheduled communication systems. Challenges include restricting the function design to periodic activities and the mapping of event-based functions to periodic functions.

Another challenge is the redesigning of soft-real-time functions as hard-real-time functions in order to map them to hard-real-time time-triggered networks. Also, the use of asynchronous or nonperiodic interrupt service functions for application processing has to be reduced or eliminated. The problem of managing the higher complexity and computation effort that comes with the higher data throughput without losing comprehensibility of software is met by already available standardized software layers. □

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EDITOR'S NOTE

SAE collaborates

Greg Reed, Technical Editor

The Society of Automotive Engineers met for its 100th World Congress in April at Detroit's Cobo Center with 35,000 attendees joining the celebration. Emphasizing the international competition among automakers, exhibitors represented 37 countries, while conference sessions included presentations by authors from all global automaking regions.

Collaboration—in the form of alliances, partnerships, and trading partners—emerged as a dominant theme. Booth visits and individual meetings confirmed several collaborative test efforts underway by numerous automotive suppliers. One common refrain confirming collaborative test and integration efforts was, "aerospace safety at automotive cost." This declaration was heard from both commercial and military suppliers of test equipment. Moreover, technical paper presentations on test and measurement systems consistently reflected industry, academia, and government collaboration.

Among test technology providers, collaboration to integrate platforms, data-acquisition tools, diagnostics equipment, hardware, and software appears to transcend traditional proprietary mindsets since the emerging alliances offer compelling competitive advantages.

Creating a competitive edge, eliminating waste, and reducing customer lead times have long driven manufacturing and test operations. With such intense international competition inside the automotive industry, perhaps collaboration among competitors has become a survival necessity? □

Contact Greg Reed at editor@aatr.net.

NEWS

USAF selects Tek as scope supplier

TEKTRONIX HAS BEEN awarded a contract to supply the US Air Force with digital oscilloscopes. Issued by Warner Robins Air Logistics Center (WR-ALC), the contract covers three of the company's digital phosphor oscilloscopes: the two-channel, 300-MHz Model TDS3032B; the four-channel, 500-MHz Model TDS5054B; and the four-channel, 1-GHz Model TDS5104B. The instruments will be used in the installation and maintenance of electronic equipment and systems ranging from low-end radio systems to sophisticated radar and electronic warfare systems. www.tektronix.com

Simulation prepares race car for Le Mans

USING THE PAM-CRASH simulation software from ESI Group, Courage Compétition reports that it was able to test the crashworthiness of the composite nose of its new C60 race car, which the company expects to enter in the next running of the 24 Hours of Le Mans race (June 18–19). The analysis of the composite material used in the C60's nose has unusual requirements, because unlike metallic materials that deform under impact, this material explodes in multiple tiny pieces. PAM-CRASH helped Courage comply with stringent frontal crash test regulations. Simulation results were reportedly within 3% of the actual physical test results.

Yves Courage, founder of the company, explained that to simulate the composite, ESI Group had to develop a new material model, which required its engineers to write and validate new algorithms. www.esi-group.com. □

Tutorial covers noise and vibration control

A WHITE PAPER from E-A-R Specialty Composites describes how passive acoustical systems can be used to improve automotive designs. The free eight-page paper, "The Four-Fold Method of Noise and Vibration Control," describes tools used for noise and vibration control: damping, isolation, absorption, and barrier materials.

George Gabuzda, senior director of E-A-R Specialty Composites, commented, "Whether automotive engineers are attempting to retrofit noise and vibration controls into existing products, or considering new product designs, it pays to have a better handle on basic principles that affect choices of materials for noise or vibration controls." www.earsc.com/pdfs/engineering/4foldWP.pdf.

Calendar

AIAA Guidance Navigation and Control Conference
August 15–18
San Francisco, CA
www.aiaa.org

Military and Aerospace Applications of Programmable Devices and Technologies
September 7–9
Washington, DC
klabs.org/mapld05/index.htm

SAE AeroTech Congress & Exhibition
October 3–6
Dallas/Ft. Worth Airport, TX
www.sae.org/events/atc

Aerospace Testing Expo 2005—North America
November 8–10
Long Beach, CA
www.aerospacetesting-expo.com/northamerica

Guide lists CANopen products

CAN IN AUTOMATION (CiA) has released the 2005 edition of its CANopen Product Guide, which includes 295 CANopen-specific entries, an increase of 67 entries over the 2004 edition. Devices are listed by type and application as well as by their conformance to the CiA device and application profiles. www.can-cia.org/products/pg2005. □

SAE revises crash-test standard for electric vehicles

THE FUEL CELL Standards Committee of the SAE has revised the "Recommended Practice for Electric and Hybrid Electric Vehicle Battery Systems Crash Integrity Testing." Applicable to all electric vehicle and hybrid electric vehicle battery designs, including those described in SAE J1797, this document defines test methods and performance criteria for evaluating battery system spillage, battery retention, and electrical system isolation during specified crash tests. www.sae.org. □

JDS Uniphase consolidates operations

IN A STRATEGY TO reduce costs, JDS Uniphase plans to restructure its manufacturing operations. The company will transfer manufacturing facilities from Ewing and Mountain Lakes, NJ, to Fabrinet, one of its manufacturing partners; the transfer should be complete by the end of June. In addition, by the end of the year, the company expects to phase out some of the products produced at its Santa Rosa, CA, plant, including high-volume consumer light engines and coated micro display windows. The changes will lead to the elimination of about 850 jobs. www.jds-uniphase.com. □

SAE 2005 WORLD CONGRESS

100 years of automotive engineering

Greg Reed, Contributing Technical Editor

The Society of Automotive Engineers staged a centennial celebration event during SAE 2005 (April 10–14, Detroit, MI). Besides a busy exhibition floor with more than 35,000 attendees rubbing shoulders, SAE 2005 offered an extensive technical program showcasing advanced automotive technology and engineering techniques plus business sessions featuring top executives.

In addition to the full slate of traditional technical presentation sessions, technical information was also provided via Webcasts for those unable to travel to Detroit. At the AVL Technology Theater, 10 panel sessions and nine keynote addresses were broadcast by Internet to registered online attendees.

The opening keynote address, "Driving Performance in a Global Auto Industry," was delivered by James E. Queen, VP of global engineering for General Motors and the general chairman of the SAE World Congress. Following-day keynotes covered electrical innovation with model-based development (William Mattingly of DaimlerChrysler), research through collaboration (Burkhard Goschel of GMW Group), and the future of powertrain technology (Michiyoshi Hagino of Honda Motors).

Of special interest to the test engineering community was a three-day series entitled "The Next Generation of Automotive Safety Systems." Featured speakers represented Robert Bosch, Delphi, General Motors, DaimlerChrysler, Infineon, Toyota, BMW Group, DENSO, and Honda Motors, among others. Technical paper topics included accelerated life testing, lean manufacturing and test principles, next-generation test automation, the integration of test platforms, and portable measurement systems.

An emerging technologies section offered alternatives to a gas-guzzling world, with exhibits and technical sessions highlighting hydrogen fuel cells, hybrids, diesel, and modified gasoline products.

Military ground vehicles were displayed by armed forces personnel at the Tank Automotive Research, Development and Engineering Center (TARDEC) on the exposition floor. Military track technical sessions centered on mobility, survivability, intelligent systems, industry's role for technology transfer to military applications, and future challenges. □

News announcements from SAE

MBtech Group supplies testing to Chrysler Group

Mercedes-Benz Technology (MBtech Group) has agreed to provide simulation, modeling, and testing services to Chrysler Group. With extensive automotive simulation and modeling experience, MBtech will implement hardware-in-the-loop (HIL) for Chrysler. Activities will include multisite support for HIL labs, creation of models to support future software and hardware features, development of test strategies for automated testing, and consultation on development of next-generation HIL testing systems. www.mbtech-group.com.

German test center gets 17-kW fiber laser

IPG Laser claims to have installed the world's first 17-kW fiber laser at the new Test Center for Aluminum Alloy Welding (Centr-Al) at BIAS in Bremen, Germany. The test center will use the YLR-17000 fiber laser for deep penetration and high-speed welding of different materials for aircraft, aerospace, automotive, transportation, and shipbuilding applications. www.ipgphotonics.com.

Intertek plans Shanghai automotive test lab

Intertek ETL Entela has unveiled plans for a new automotive component and systems test lab in Shanghai. Located in the Pudong region of Shanghai, the 40,000-ft^2 facility will provide a range of automotive performance tests for electronics, audio, and interior components. Test will include vibration (sine, random, shock), thermal aging (walk-in chambers, drive-in chambers), thermal cycling, programmable chamber exposures, temperature, humidity, and BSR (buzz, squeak, rattle). In the future, Intertek hopes to add EMC testing and multi-axis vibration/accelerated stress testing. www.entela.com.

I/O boards emulate analog sensors

Applied Dynamics International released the PCI-RTA line of I/O boards for real-time sensor emulation, development testing, and acceptance testing of electronic control modules (ECMs). Used with the company's rtX real-time simulation computer, the boards emulate analog output devices such as strain-gauge sensors, high-voltage ratiometric devices, thermistor sensors, low-voltage analog sensors such as oxygen sensors, and very-low-voltage sensors such as thermocouples. www.adi.com.

AUTOMATION

Used robots perform auto and aero tasks

Greg Reed, Contributing Technical Editor

Contrary to what you may see in blockbuster movies, robots are not going to take over the world. But they are performing more tasks and becoming more prevalent in many industries.

I recently spoke with Peter Struwing about the use of robots—including secondhand robots—in automotive and aerospace applications. An industrial technologist and robotics pioneer, Struwing has experience in automation design, installation, and maintenance. As co-founder of Robotic Production Machinery in Ontario, Struwing was responsible for engineering and installing robot assembly teams at the Ford, GM, and Chrysler plants in Canada. His expertise encompasses many makes of robots—from ABB to Motoman—but he specializes in the installation and debugging of FANUC automation systems.

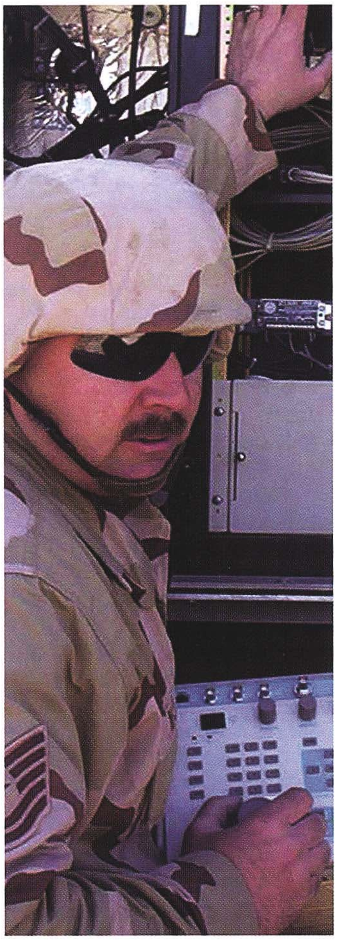

Peter Struwing

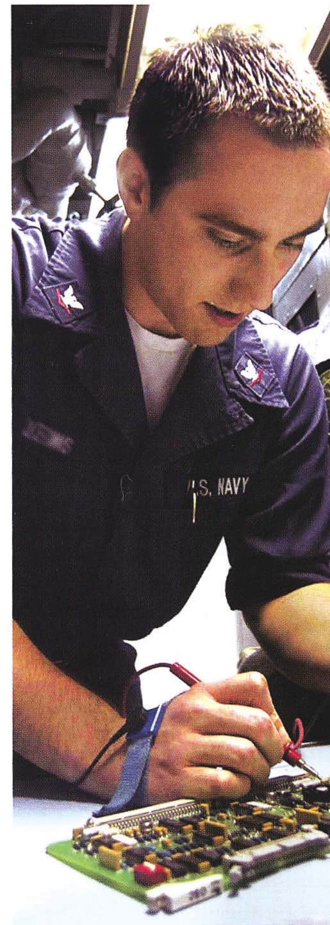
Q: What activities do robots perform during automotive and aerospace manufacturing?

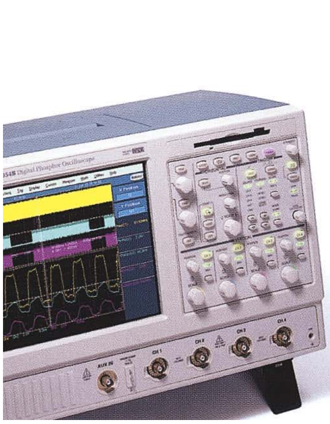
A: There are many processes that are similar in automotive and aerospace. The use of robots for tasks such as welding, material handling, deburring, and paint and coating applications is quite common. Robots are now performing functions that were deemed impossible a few years ago, thanks to continuous advancements in the components that make up a robotic system, including the mechanical unit itself, motion-control application-specific software, and the tooling that actually does the work.

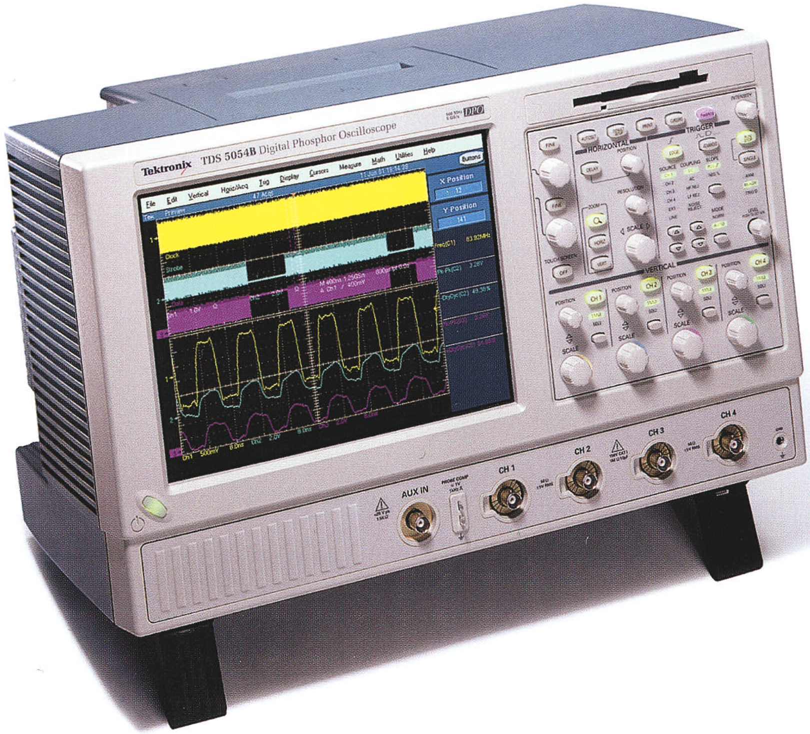
Q: Why employ "used" robots? Aren't new robots more advanced?

A: Yes, new models are more advanced with greater capabilities, but not every manufacturer can afford to purchase a new robot, and









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TDS5034B	350MHz	5GSa/s	4	8Mb
TDS5052B	500MHz	5GSa/s	2	4Mb
TDS5054B	500MHz	5GSa/s	4	4Mb
TDS5104B	1GHz	5GSa/s	4	2Mb

*Record length can be doubled with option 3M.

Logic Analyzers

Model	Channels	Max. time	Max. state	Depth
TLA5201	34	2GHz	235MHz	512kb
TLA5202	68	2GHz	235MHz	512kb
TLA5203	102	2GHz	235MHz	512kb
TLA5204	136	2GHz	235MHz	512kb

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NAVSUP Naval Supply Systems Command Naval Inventory Control Point not all applications require the advanced functions that come with a new robot. The lower price of a used robot can make the cost justification easier. Used robots are another variable in the equation to justify a project. If you are using your computer for word-processing and e-mail functions, then you do not need the "latest and greatest" processor, but if you are doing lots of CAD or graphics, then you do need the "latest and greatest."

Q: Are there suppliers that specialize in robotics for automotive and aerospace applications?

A: Yes, there are several OEM suppliers and there are many integrators that can service even the most rare and demanding application. Robots are very flexible and over the years have become easy to program and operate in a safe environment.

Q: What are the significant limitations of robotics in automotive or aerospace manufacturing?

A: The limitations are few, as there is such a variety of robots in size and payload rating that the limitations today are external to the robot, as in the tooling design and parts delivery. The robots of today maintain their repeatability even after many hours of use.

Q: Do you have advice for engineers seeking to purchase used robots?

A: Define where you are starting at (part size, production rate, space availability) and where you need to go to meet your project objectives. Ask your supplier as many questions as possible about your application to be sure you are getting the correct robot for the job. Is the supplier experienced enough to understand your process now and down the road? Let the suppliers—and integrators—bring their experience to your project.

Q: Any final comments?

A: Industrial robots are user friendly, and you can find one at a price that fits most budgets. But be cautious about buying a robot with no after-support, such as from an auction, as you may not be getting an operational unit.

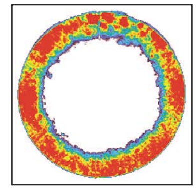
Getting such a robot to run could cost more than buying one from a reseller who offers a warranty. Installing a first robot brings up many questions, so work with a qualified integrator who understands your process and who is qualified to install the robot safely. □

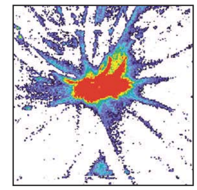
You can reach Peter Struwing at strandgaard@cogeco.ca

PRODUCTS

Pressure-sensing film

Tactile pressure sensor film (TPSF) from Sensor Products can help engineers map pressure distribution and magnitude between any two surfaces. For example, TPSF can be used in engine gaskets to evaluate adequate torque and consistency of junctions in head, valve cover, oil pan, and intake/exhaust manifold gaskets and o-rings. In brakes and clutches, the film can be used to verify consistent compressive force across brake shoe or clutch surfaces (top photo). It can also be used to determine the location and force of impact during airbag deployment (bottom photo).





Available in seven pressure ranges measuring 2 to 43,200 psi, TPSF comes in a clear mylar sheet. When placed between contacting surfaces, the film permanently changes color in correlation to the amount of pressure applied; pressure magnitude can be determined by comparing color variations to a color-correlation chart. *Sensor Products, www.sensorprod.com.*

Automotive test kit

The Fluke 88V Automotive Test Combo Kit comes with a digital multimeter designed specifically for automotive applications, along with a variety of accessories. Complete with a built-in thermometer, the 88V meter is rated for use in high-energy environments such as the electrical systems found in hybrid vehicles. *Fluke, www.fluke.com.*

Dynamometer tables

Eight corrosion-resistant tables designed for Magtrol's hysteresis/engine (HD/ED) and eddy-current/powder-brake dynamometers can be customized for most test applications. Options include 19-in. rack mounts for controllers, power analyzers, and other electronics. *Magtrol, www.magtrol.com.*

High-energy impact tester

The Dynatup 8100 tests the strength of steel and cast-iron components for use in automotive and aerospace applications. The test platform provides a determination of fracture loads, velocities, and energies; it delivers impact energies up to 27,800 J and impact velocities of up to 22 ft/s. *Instron, www.instron.com.*

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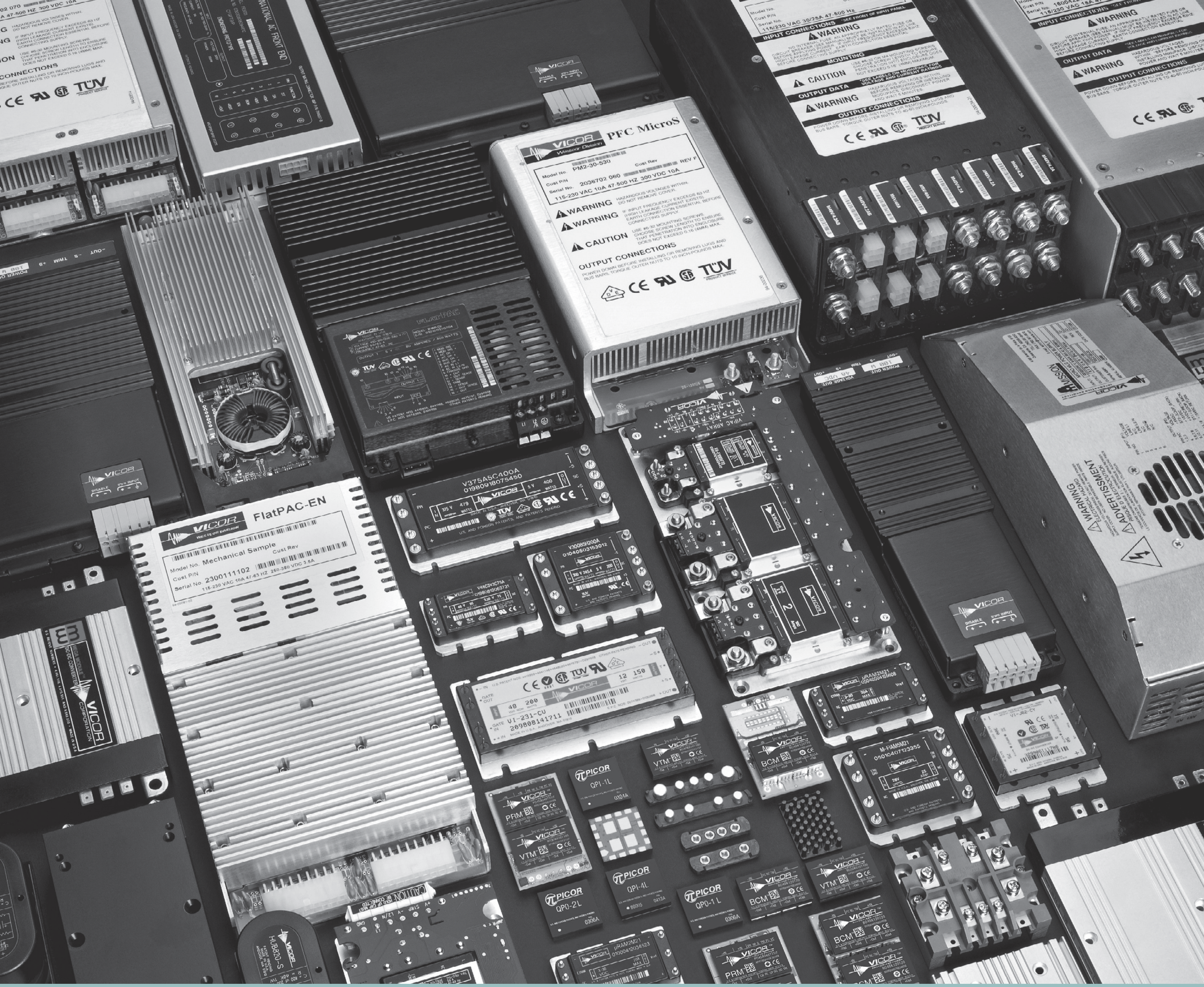
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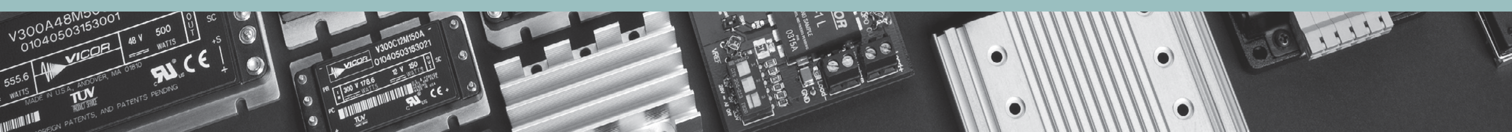

For more product information, visit the *T&MW* Web site: www.tmworld.com/webproducts

Agilent Vee makes ties to NI

With version 7.5, Agilent Vee adds access to numerous PC functions. Most notably, it now works with National Instruments' NI-DAQ drivers to identify NI cards. This feature lets you incorporate NI card-based instruments (PCI, PXI, and SCXI) into automated test systems that use IEEE 488, LAN, or USB-based instruments.

Vee 7.5 also adds an Excel menu that lets you write Excel functions into your Vee applications. For example, you can save data in Excel and you can add charts and graphs into spreadsheets through your Vee programs. You also get access to Microsoft .NET functions so you can create folders, copy files, or send e-mail. Another new feature includes more sample programs for commonly used instruments such as DMMs and scopes. The examples can run as stand-alone Vee programs or you can incorporate them into larger applications.

Price: $1495; upgrade from Vee 7.0—$495; upgrade from Vee 6.0—$997. *Agilent Technologies, www.agilent.com/find/vee.*

On-wafer probing for semiconductor R&D

Cascade Microtech developed its PureLine technology to provide measurement capability for 200-mm and 300-mm on-wafer probing systems aimed at R&D applications. PureLine systems are designed to accommodate operating voltages that will fall from 0.9 V to 0.7 V by 2010, leaving less head room to tolerate spurious signals. They can accommodate lower applied stress voltages in time-dependent dielectric-breakdown (TDDB) measurements and smaller voltage steps for generating IV curves.

In addition to TDDB, PureLine systems support MOS DC characterization (which requires accurate threshold voltage measurements), 1/f flicker-noise test (which requires low background radiated noise and which is important for communications devices), and MOS CV capacitance measurements (at low AC stimulus levels). They employ patented technology to provide high immunity from conducted, radiated, and internal noise

Base price: $75,000 for a manual system configured with typical options. *Cascade Microtech, www.cascademicrotech.com.*

DMM with software

Fluke has combined its top-of-the-line digital multimeter (DMM) with accessories and software to form a complete kit for making power-line measurements. The heart of the kit is Fluke's Model 189, a 40,000-count datalogging DMM. Fluke then adds four clamp adapters for measuring AC and DC current and voltage. The kit also includes an additional battery pack that attaches to the back of the meter and lets you power the meter with C-cell instead of AA-cell batteries. The larger batteries increase usable time from 72 hrs to more than 400 hrs.

The kit also includes an optically isolated data cable that connects the meter to a USB port. FlukeView software lets you download data from the meter, plot the data, and store it.

The Model 189 has 0.025% DC accuracy. In addition to measuring voltage and current, the meter measures frequency and temperature. A thermocouple included in the kit connects to the meter's voltage inputs.

Price $499. *Fluke, www.fluke.com.*

Low-noise 16-bit ADC

Targeting test and measurement equipment as well as military and aerospace communication systems, Analog Devices now offers two versions of the AD9446, a 16-bit ADC that keeps aperture jitter down to just 60 fs.The AD9446-100 delivers 100-Msample/s data rates while offering high 80-dBfs signal-to-noise ratio (SNR) and 90-dBc spurious-free dynamic range (SFDR). An 80-Msample/s version, the AD9446-80, achieves 85-dBc SFDR and 82-dBfs SNR.

In addition, the AD9446 features a typical 16-bit differential nonlinearity (DNL) of ±0.5 LSB and a typical 16-bit integral nonlinearity (INL) of ±3 LSB. The

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AD9446 is part of a family of high-speed ADCs that includes the recently introduced 14-bit, 80-Msample/s AD9444 and the 14-bit, 125-Msample/s AD9445. As with the AD9444 and the AD9445, the new AD9446 features parallel low-voltage differential signaling (LVDS) outputs, including an output clock, which simplifies the interface to digital-processing components and reduces the potential for digital noise coupling back into the ADC core. The device is available in a Pb-free, 100-lead surface-mount plastic package (100-lead TQFP/EP).

Base prices (in 1000-unit quantities): AD9446-80—$72.25; AD9446-100—$79.90. Delivery: samples now; production quantities in September. *Analog Devices*, www.analog.com/AD9446.

NAND-based flash ISP support

JTAG Technologies has added in-system programming (ISP) capabilities for NAND-based flash memories to its boundary-scan products. NAND memory ISP comes as part of the Block-based Flash Media (BFM) option for JTAG's standard FDS software, which runs on the company's hardware operating as a stand-alone boundary-scan station or integrated within an in-circuit tester, a flying-probe tester, or a functional test system. The option supports major NAND flash types without the need for hardware adapters. The option also supports standard bad-block management schemes.

Base price: free with FDS software. *JTAG Technologies*, www.jtag.com.

2-Mpixel CCD vision system

The CV-2600 high-speed machine-vision system from Keyence features a 2-Mpixel CCD (1620x1220 pixels) in a compact camera housing. The camera sensitivity is adjustable in 81 increments. A flexible camera cable that can withstand over 1 million bend cycles is available for robotic applications.

The CV-2600 features a variety of inspection capabilities, including area, pattern-search, multiple-search, edge-angle, edge-width, number-of-edges, stain, blob, intensity, trend-edge-position, and trend-edge-width functions. On-screen programming menus guide users through simple setup procedures.

Newly developed ASIC technology enables high-speed, real-time rotational searches with a minimum speed of 61 ms. The high-speed CCD combined with a LVDS transfer method operates 2.5 times faster than conventional models, says the company.

The CV-2600 will average multiple images to yield stable, reliable data. Using a combination of subpixel processing and digitized image data, the CV-2600 achieves high accuracy and repeatability down to ±0.05 pixels. Subpixel processing allows the display resolution to be reduced to one thousandth of a pixel. *Keyence*, www.keyence.com.

Semiconductor device analyzer

Agilent Technologies' Model B1500A, a Windows-based, expandable parametric-characterization analyzer for semiconductors, integrates CV and IV measurements into a single instrument that can handle 65-nm lithographies and beyond. The modular instrument has a 10-slot configuration and supports Agilent's new EasyExpert software, providing a "top down" approach to device characterization.

The EasyExpert software supplies a library of device application tests that the user selects based on the type of measurement required. After the user makes a few simple selections, such as identifying the technology by classification and selecting the appropriate device type, the software selects the appropriate settings, makes the measurements, analyzes the data, and displays it graphically.

Because this single instrument handles both IV and CV measurements, engineers need not switch between incompatible connectors, which can be difficult and trouble-prone, especially when using positioners on wafer probers. The B1500A's 10-slot configuration supports high-resolution, medium power, and high-power source-measurement units.

A multi-frequency capacitance measurement unit is also available, and a 4.2-A ground unit is included with the B1500A mainframe. An atto-sense and switch unit (ASU) is also available to provide measurement resolution at 100 aA and 500 nV.

Base price: $45,000. Availability: August 2005. *Agilent Technologies*, www.agilent.com.

Memory tester debuts

The Model T5372 offers test speeds to 143 MHz (286 MHz in DDR mode)—double those of its predecessor, the T5371—enabling it to support increasingly high-speed devices. Its optional failure-analysis functions include Fail Bit Compress Engine (which accelerates the transmission of failure data) and Address Fail Memory (which allows dual-mode operation of partitioned failure memory).

Able to test up to 128 devices in parallel, the T5372 is available with one or two test stations, each of which features a maximum of 32 DC units and 128 programmable power sources. The T5372 also retains compatibility with the T5371 and can therefore be used with existing customer assets, including test programs and probe cards, enabling a seamless upgrade.

Advantest, www.advantest.com.

VXI Slot 0 controller

Contained on a single-width C-size module, the V153 VXIbus Slot 0 controller leverages a Pentium 4 embedded processor with 1.7-GHz and 2.2-GHz clocking options. Two on-board Ethernet controllers accommodate 10BaseT, 100BaseTX, and 1000BaseT interfaces. The V153 also sports up to 1 Gbyte of bootable flash memory through a secondary IDE port, up to 1 Gbyte of PC1600 DDR SDRAM, a front-panel USB 2.0 port, and a PMC expansion site. Compatibility with the VXIplug&play Virtual Instruments Systems Architecture (VISA) standard I/O control library allows the module to be controlled via several interfaces with the same I/O function calls. *KineticSystems, www.kscorp.com.*

Digital I/O modules

Joining Sealevel Systems' Seal/O family of modular I/O products are the Seal/O-462 and Seal/O-463, both of which offer 96 channels of TTL-level digital I/O. The two devices address their 96 channels of I/O as 12 8-bit ports, each programmable as input or output. The Seal/O-462 uses dual DB-78 female connectors, while the Seal/O-463 uses four internal 50-pin headers that connect to relay racks via standard ribbon cables. You can order either unit with an Ethernet (Modbus/TCP), RS-485 (Modbus/RTU), USB, or RS-232 host control interface. Base price: $239. *Sealevel Systems, www.sealevel.com.*

USB-to-GPIB controller

This compact controller transforms any computer with a USB port into a full-function, plug-and-play IEEE 488.2 controller for up to 14 programmable GPIB instruments. The USB 2.0-compliant GPIB-USB-HS transfers data at rates of up to 1.8 Mbytes/s using the standard IEEE 488 handshake and 7.2 Mbytes/s using the high-speed IEEE 488 handshake (HS488). The controller comes with NI-488.2 and NI-VISA driver software for Windows 2000/XP and works with LabView, LabWindows/CVI (ANSI C), and Measurement Studio for Visual Studio (Visual Basic/C/ C++). Base price: $495. *National Instruments, www.ni.com.*

Serial-to-Ethernet adapter

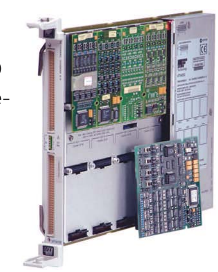
With AR Worldwide's Model IA232ET Ethernet adapter, any of the company's products equipped with an RS-232 interface can be remotely monitored, managed, and controlled over both 10BaseT and

100BaseTX networks, eliminating limited distance point-to-point connections. The adapter uses a method called serial tunneling to encapsulate serial data into packets and transport it over IP-based Ethernet networks. *AR Worldwide RF/Microwave Instrumentation*, www.ar-worldwide.com.

DSP data-acquisition board

Outfitted with a USB 2.0 interface for communicating with a host PC, the DT9841 two-channel DSP data-acquisition board samples at rates of up to 100 kHz/channel. In addition to two 24-bit analog input channels and two 24-bit analog output channels, the DT9841E offers three 32-bit counter/timers and 24 digital I/O lines. Its onboard TMS320C6713 300-MHz DSP performs real-time signal processing, while 500 V of galvanic isolation maximizes signal integrity. You can use the company's DT Measure Foundry/RT Streaming visual software environment for creating test and measurement, control, and analysis applications. Price: $1495. *Data Translation*, www.datatranslation.com.

Signal-conditioning module



Mounted on one of VXI Technology's motherboards, the VT1521 signal-conditioning module provides four channels of programmable bridge excitation with voltage values of 1 V, 2 V, 5 V, and 10 V. It also supplies wideband buffered outputs compatible with the VT1413C, VT1415A, and VT1419A series of scanning A/D converters. Independent fourth-order low-pass Butterworth filters with cutoff frequencies ranging from 100 Hz to 10 kHz protect against signal aliasing and reduce measurement noise. The VT1521 accommodates both 120-Ω and 350-Ω quarter-bridge completion resistors. *VXI Technology*, www.vxitech.com.

FIR filter option

Implemented in an onboard FPGA, a finite impulse response (FIR) filter option for Gage 14-bit digitizers lets you filter digitized data in real time using complex, customizable filtering parameters. The FPGA image allows processing by an FIR filter with up to 20 taps. Filtering is done in real time during the transfer of data over the PCI bus to a PC and does not reduce the repetitive signal capture rate of the digitizer. *Gage Applied Technologies*, www.gage-applied.com.

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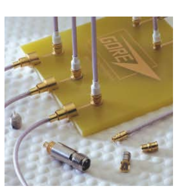

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HIROMICHI TODA
President
Anritsu
Kanagawa, Japan

Hiromichi Toda joined Anritsu in 1971, after graduating from the Waseda University Department of Science and Engineering. He has held engineering and general business management positions in the Kanagawa, Japan, headquarters and at the US subsidiary, based in Morgan Hill, CA. He was appointed senior VP and GM of Anritsu's measurement business group in June 2004 and became executive deputy president in April 2005. He formally assumes the role of president at this month's shareholder meeting. Chief editor Rick Nelson caught up with Toda and Mark Evans, executive VP and the new GM of Anritsu's measurement business, at Anritsu's Morgan Hill facility.

▶ Toda and Evans elaborate on evolving markets, modular instruments, and competitiveness. Read more in the online version of this article:

www.tmworld.com/archives

Opportunities in RF/network convergence

About two-thirds of Anritsu's 3600 employees worldwide focus on communications test. President Hiromichi Toda sees network and wireless technologies converging, and he is positioning measurement divisions in Japan, the US, and the UK to take full advantage.

T&MW: Where are the best opportunities for communications test equipment now, in landline or wireless communications?
Toda: In the landline or fiber-optics area, core network capacity is sufficient for several more years, although there are opportunities in the "last mile." But the main opportunities are in the 3G and 3.5G wireless business. That said, wireless and wired technologies are converging through IP [Internet Protocol], and it's becoming more difficult to separate them. Within Anritsu, a division in Japan that has developed SONET test solutions is now working on solutions for mobile base stations. We expect our test-business opportunities for the wired or network side will increase with expansion of wireless data communications.

T&MW: Is each division responsible for a particular technology?
Toda: Most instruments for mobile products have been developed in Japan, and most protocol test software products, in the UK, although some base-station and microwave test equipment has been developed here in Morgan Hill. Historically, there has been a technology difference in each division's development efforts, but with the convergence that I just mentioned, we have a lot of divisions that interact with the same customers in the same markets.

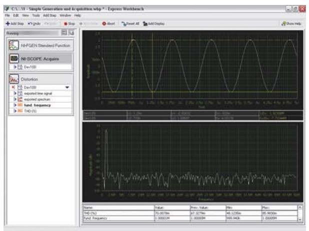
T&MW: What are the prospects for 4G wireless technology?
Toda: NTT DoCoMo in Japan, with whom we work closely, has experimental 4G systems, whose goal is to exceed 100-Mbps speeds. Such high-speed mobile systems require complicated technologies, and current experimental systems are too big to be practical. It will take time for 4G products to be ready for commercial use—2010 or so. But some combinations of current 3G or 3.5G with new advanced wireless broadband-access technologies could become practical sooner—especially in the US.

T&MW: What types of RF test instruments do you offer?
Toda: Our general-purpose instruments are addressing measurement requirements through 4G. For 3G and 3.5G, we are supplying standard-specific test instruments—supporting HSDPA [High Speed Downlink Packet Access], for example. We just announced a signaling tester for HSDPA that we have been supplying to some advanced customers for more than one year.

T&MW: Geographically, what markets are particularly important for you? Is the US decreasing in importance?
Toda: Especially for manufacturing, China and all of Southeast Asia represent growing markets. But of course for R&D and cutting-edge test capability, the US remains important. Even for test equipment destined for Asia, the purchasing decision is often made in the US. Also, SOC test is increasingly important for us as SOCs acquire more RF functions, and many of the key chipset manufacturers are US-based.

T&MW: In April, Anritsu appointed an American as general manager for the test-and-measurement business.
Toda: Yes. We are a Japanese company, but we nominated Mr. Mark Evans as GM of our test-and-measurement operation, which is a very important position because test and measurement represents two-thirds of our business. Appointing an American to this position is an epoch-making move that indicates how important global markets are for us. T&MW

NI LabVIEW – From Interactive Measurements to Graphical System Design



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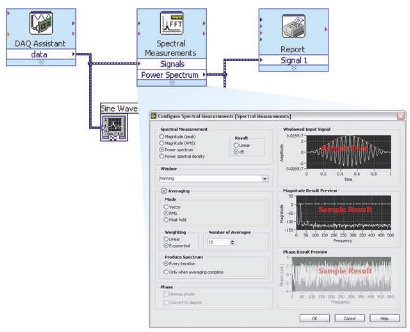

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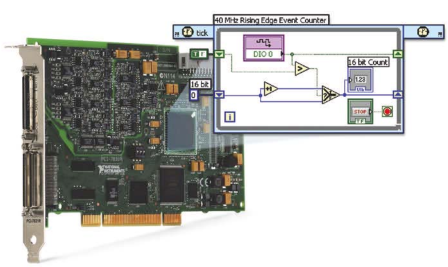

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