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Test & MEASUREMENT WORLD®

THE MAGAZINE FOR QUALITY IN ELECTRONICS

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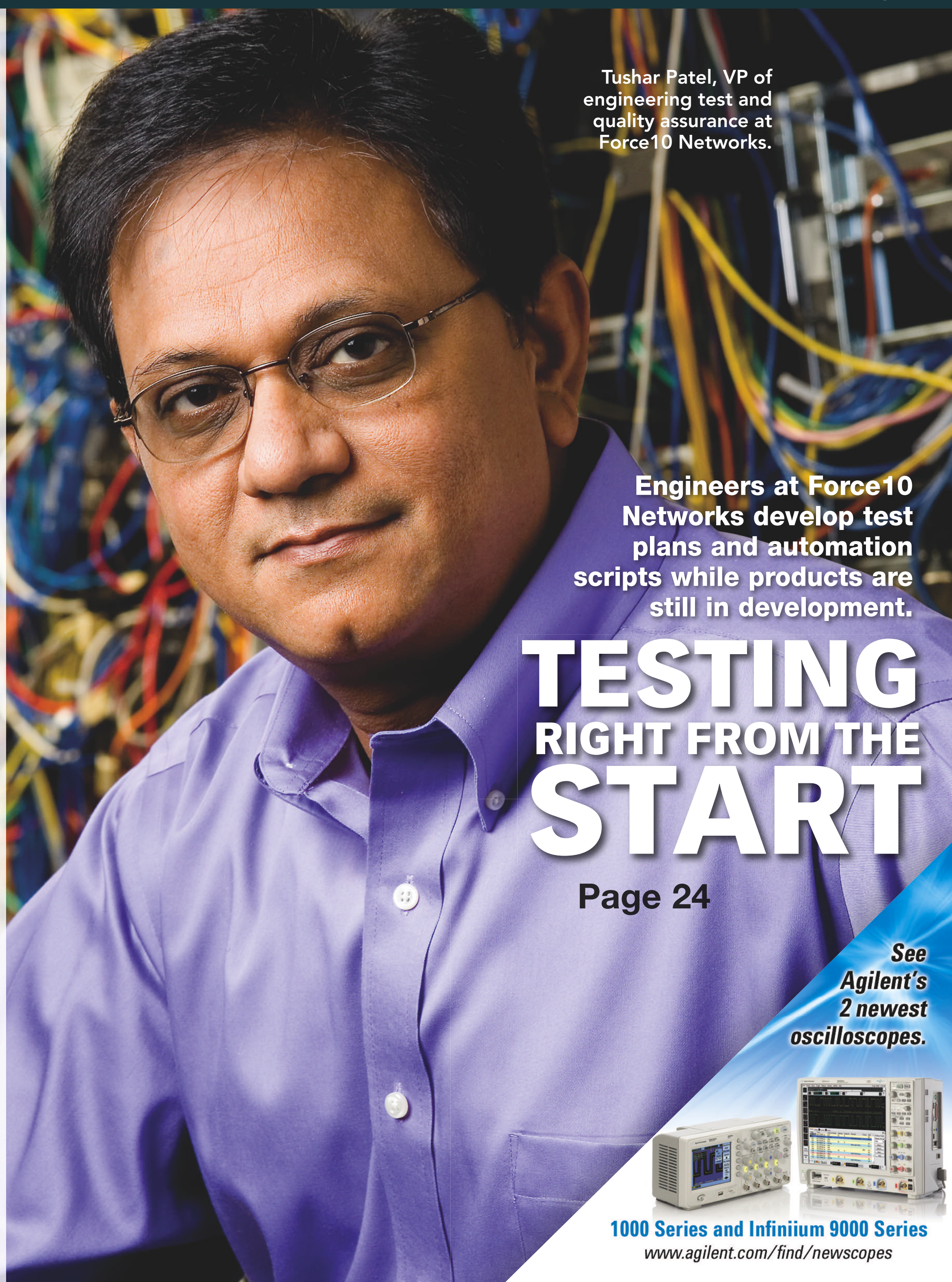

Tushar Patel, VP of engineering test and quality assurance at Force10 Networks.

Engineers at Force10 Networks develop test plans and automation scripts while products are still in development.

TESTING RIGHT FROM THE START

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USB Data Acquisition.

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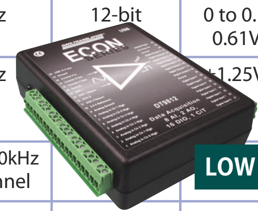
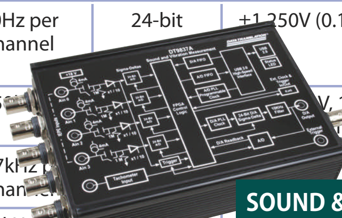
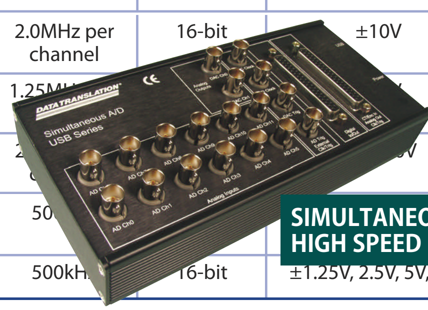
Product Selection Chart

			Analog Input Features				
	Model	**Summary**	**# of Channels**	**Throughput**	**Resolution**	**Input Range**	**A/D Ty**
Low Cost	DT9810	Lowest cost, 10-bit, non-isolated	8SE	25kHz	10-bit	0 to 2.44V	SAR
	DT9812-2.5V	Low cost, 8 analog inputs, 12-bit, 2.5V range, non-isolated	8SE	50kHz	12-bit	0 to 0.1525V, 0.305V, 0.61V, 1.22V, 2.44V	SAR
	DT9812-10V DT9813-10V DT9814-10V	Low cost, up to 24 analog inputs, 12-bit, 10V range, non-isolated	8/16/24SE	50kHz		±1.25V, 2.5V, 5V, 10V	SAR
	DT9816 DT9816-A	Low cost, simultaneous, 6 A/Ds @ up to 150kHz, 16-bit, non-isolated	6SE	50kHz/150kHz per channel			SAR
	DT9853 DT9854	Low cost, up to 8 analog outputs, 16-bit, 16 digital I/O, 1 C/T, 300V isolation	–	–	–	–	–
Temp.	TEMPpoint	Thermocouple, voltage, or RTD inputs, A/D and CJC per input, high accuracy	8-48	10Hz per channel	24-bit	±1.250V (0.15mV LSB)	Delta-Si
	DT9805 DT9806	7 thermocouples, 1 CJC, temperature applications, 500V isolation	8DI/16SE	5		V, 100mV, 0V	SAR
Sound & Vibration	DT9837 DT9837A	4 IEPE (ICP) sensor inputs, tachometer, simultaneous A/Ds	4 IEPE (SE) + 1 Tacho	52.7kHz chan		10V	Delta-Si
	DT9841-VIB	8 IEPE (ICP) sensor inputs, simultaneous A/Ds with DSP, 500V isolation	8 IEPE (SE)	100kHz per channel	bit		Delta-Si with D
Simultaneous High Speed	DT9832A	Simultaneous, 2 A/Ds @ 2.0MHz each, 500V isolation	2SE	2.0MHz per channel	16-bit	±10V	SAR
	DT9832	Simultaneous, 4 A/Ds @ 1.25MHz each, 500V isolation	4SE	1.25M		V	SAR
	DT9836	Simultaneous, up to 12 A/Ds @ 225kHz each, 500V isolation	6 or 12SE	2		0V	SAR
High Speed	DT9834	High-speed, up to 16 analog inputs, 500kHz, 16-bit, 500V isolation	16SE/8DI	50			SAR
	DT9834-32	High-speed, up to 32 analog inputs, 500kHz, 16-bit, 500V isolation	32SE/16DI	500kH	16-bit	±1.25V, 2.5V, 5V, 10V	SAR







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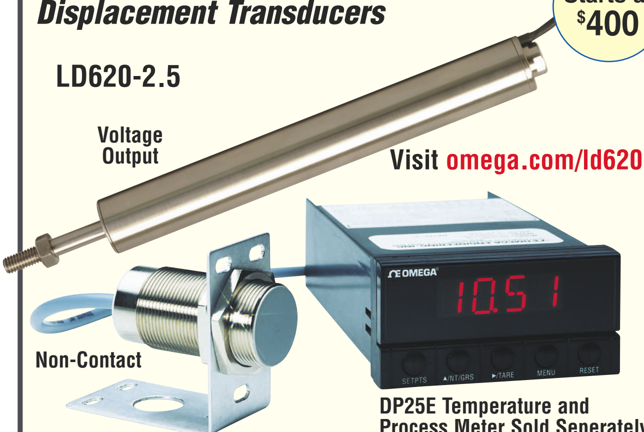

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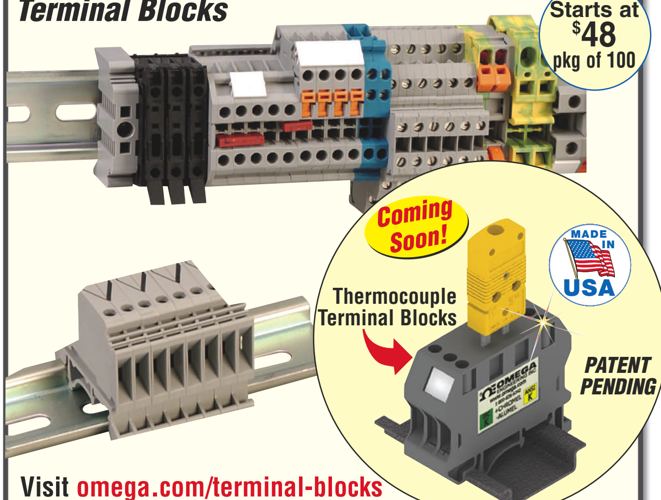

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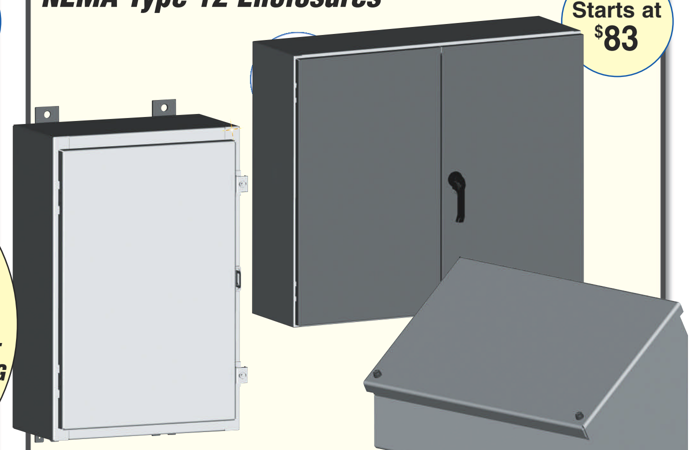

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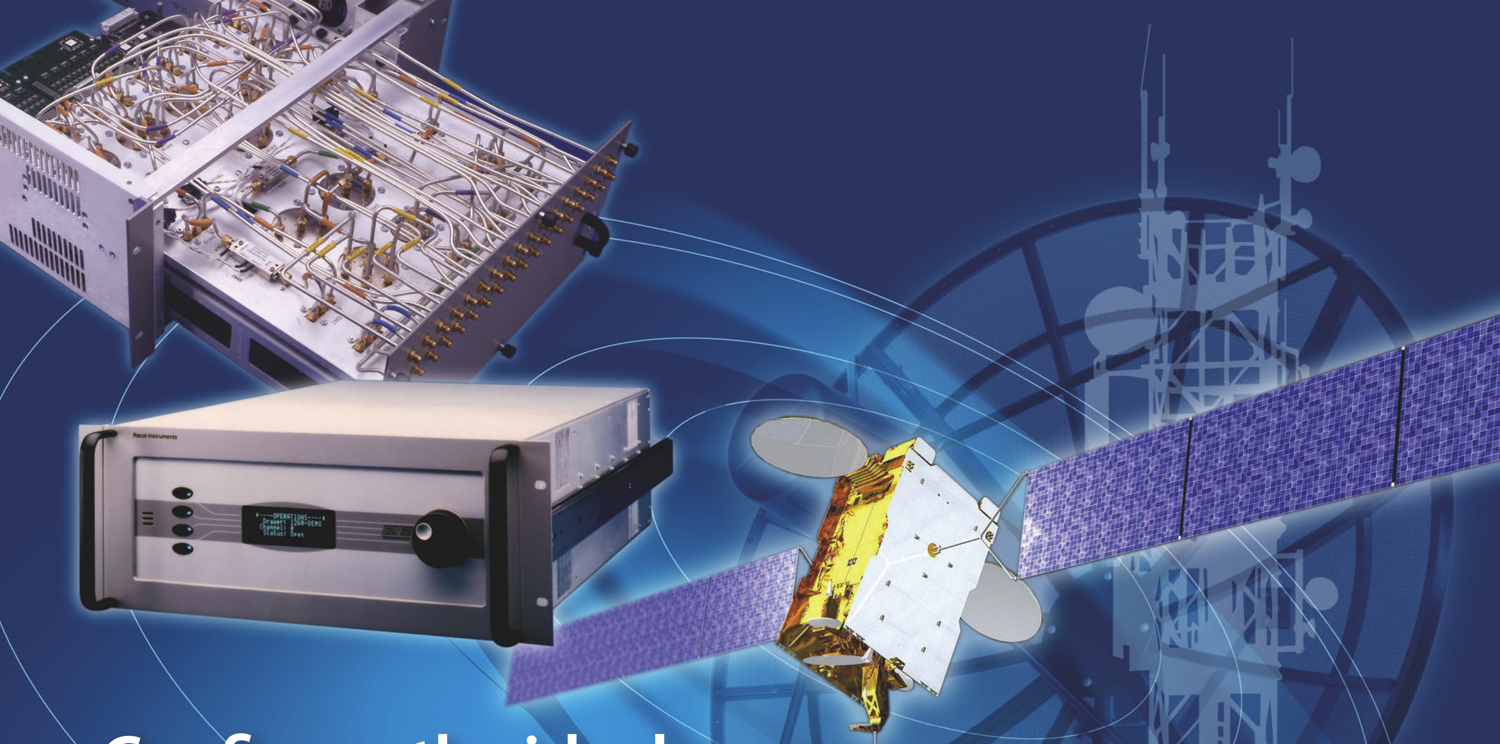

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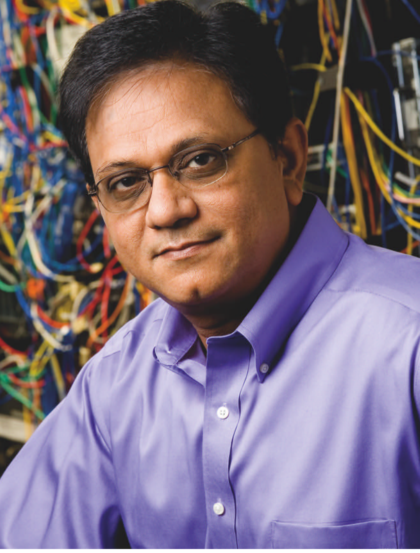

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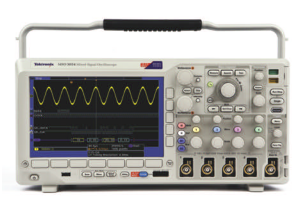

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Executives discuss challenges in semiconductor test industry

At a Test Summit held during Semicon West 2009, executives from Advantest America, LTX-Credence, Teradyne, and Verigy discussed the economic conditions that are challenging innovation in semiconductor test and commented on the state of technologies such as embedded, built-in, and system-level test.

www.tmworld.com/testsummit_2009

Former NI exec joins Asset

Tim Dehne, who in a 21-year career at National Instruments held positions such as VP of strategic marketing and VP of R&D, has joined the board of directors at Asset Intertech. In an exclusive interview, Dehne, along with Asset's CEO Glenn Woppman, explained that in addition to taking on the traditional board of directors' governance role, Dehne will also offer marketing and engineering advice in an effort to help Asset grow.

www.tmworld.com/asset_dehne

Blog commentaries and links

Taking the Measure

Rick Nelson, Editor in Chief

- Data suggests possible recovery despite glum Semicon West mood
- Bloodthirsty thrill in Google vs. Microsoft, a cheaper Kindle, and the automation paradox

Rowe's and Columns

Martin Rowe, Senior Technical Editor

- My piece of Apollo
- Engineering social networking
- Java as a test language?

Engineering Education and Careers

Jennifer Kempe, Contributing Editor

- White House honors upcoming researchers
- The bright side of recession
- College makes a comeback
- SCRATCHbot—the latest in whisker technology

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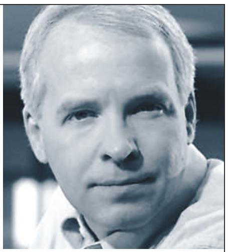

Behind-the-wheel multitasking

There are many ways of looking at the dangers of using mobile communications devices while driving. Back in 2002, I addressed the costs and (supposed) benefits of TWD, or talking while driving (Ref. 1). The "benefits," it was argued disingenuously at the time, stemmed from calculations based on the so-called VSL (value of a statistical life) spec, which then equaled $6.6 million. At the time, I suggested (also disingenuously) that technology would solve the problem it had created: "Aggressive TWDers are early adopters who will promptly outfit their cars with collision-avoidance radar, thereby limiting adjacent lane interference."

While evidence of the dangers of mobile communications may have been mostly anecdotal in 2002, the news has gotten worse over the past seven years, culminating in a September 2008 commuter train crash in Los Angeles that killed 25 people (Ref. 2). National Transportation Safety Board investigators said the operator had sent text messages shortly before the train ran a red light and hit a freight train.

It's appalling that the government would stifle research.

And just this spring, a Boston Green Line trolley operator was reportedly texting when he rear-ended another trolley (Ref. 3)—an accident that fortunately had no fatalities, although many were injured.

What's particularly disturbing is that researchers have known about the problem for quite some time and could have supplanted anecdotal evidence with the results of detailed research. Reports the *New York Times* (Ref. 4), "In 2003, researchers at a federal agency proposed a long-term study of 10,000 drivers to assess the safety risk posed by cellphone use behind the wheel....But such an ambitious study never happened." In fact, the *Times* says, researchers buried what results they did have—"that drivers using a hand-held device were at 1.3 times greater risk of a crash or near crash, and at three times the risk when dialing compared with other drivers"—"in part, officials say, because of concerns about angering Congress."

The *Times* quoted Clarence Ditlow, director of the Center for Auto Safety, as saying, "We're looking at a problem that could be as bad as drunk driving, and the government has covered it up."

Now, I don't know that legislation is an appropriate remedy to the problem. Laws are not particularly effective at preventing behavior that significant portions of the population don't believe is wrong. And in fact, what laws there are on the books are probably ineffective. They tend to permit hands-free cellphone use, which, researchers found, does not eliminate serious accident risk.

Education is the first step, and that requires that the educators have available the best information to address what the *Times* calls "a culture of behind-the-wheel multitasking." It's appalling that the government would stifle research and suppress what information it did have. T&MW

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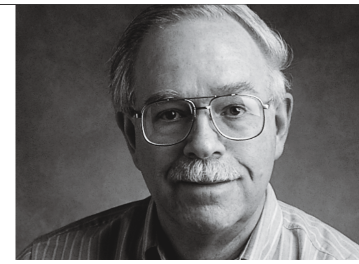


Oscilloscautopsy

Under normal circumstances, dismantling anything manufactured by Tektronix strikes me as akin to drowning kittens—horrific activities that I have sworn to never carry out. But for one specialized oscilloscope, a Tektronix RM 529 waveform monitor, the time had come.

Introduced in the early 1960s and dropped from Tektronix's catalog in 1975, the 529 and its RM (rack-mounted) variant could measure and display just about any part of an analog NTSC video signal. My RM 529 served in a television station's control room until the mid-1990s, when it was sold to a surplus store. I purchased it for $10 in 2002, but several intermittent problems and a collapsed horizontal-sweep trace kept it near the bottom of my repair and restoration list.

Rather than junk the intact RM 529, I autopsied it. I decided some components would go into the transplant bins, while aluminum panels and copper wire would get recycled. I began by salvaging control knobs and removing the front panel, pulling tubes and transistors from their sockets, and snipping wiring harnesses at strategic points.

Doing so uncovered a variety of interesting problems. A loose lug on the AC power on/off switch had overheated and oxidized the wire attached to the lug, embrittling the wire's insulation.

R474 (bottom image in **photo**), a 41.5 k ±1%, 8-W power resistor, had split open, revealing resistance wire wound on a mica card. Amazingly, the damaged resistor was still within tolerance, as was R564, also 41.5 k (top).

The cathode-ray tube's face showed phosphor burn-in marks. Plastics didn't fare well—the CRT socket's insulating cap crumbled at a touch, as did the plastic form of variable inductor L262. I spot-checked the values of a few carbon-composition resistors and electrolytic capacitors and found them to be within tolerances.

Over its service life, the RM 529 had undergone a few repairs. Two ECG-188 transistors had replaced a push-pull pair of original transistors, a task made easier by the use of sockets for all small-signal transistors. Incidentally, the sockets still provided considerable retention force that made transistor removal a challenge. All tubes except for two hard-wired 5642 subminiature high-voltage rectifiers had been replaced.

Could this RM 529 have been restored? Yes. Its designers and builders should be proud of their workmanship. T&MW

WHERE TO FIND MANUALS FOR OLDER INSTRUMENTS

Begin by visiting the manufacturers' Websites, but note that most don't provide service manuals for older instruments. The premier archive for these is the BAMA site and its Edebris mirror site:

bama.sbc.edu
bama.edebris.com/manuals

Incidentally, BAMA has nothing to do with Alabama or the Crimson Tide—it's an acronym for Boat Anchor Manual Archive. You can also purchase scanned copies of manuals from various vendors via the Internet, but be aware that some are copies of freely available manuals and may be of lower quality.

COMPONENTS TO SAVE FOR REUSE

If you maintain (as I do) a fleet of older test equipment, salvaged parts can help you save an obsolete instrument or build a specialized test fixture. Here's my salvage list:

High priority: knobs, dial scales, active devices (test before reuse), power transformers, potentiometers, panel meters, and specialized components (e.g., high-voltage capacitors, power resistors, and connectors for plug-ins).

Medium priority: device sockets, multideck rotary switches and associated components (with stubs of wiring still attached), ceramic terminal strips, specialized mechanical hardware (e.g., oscilloscope bezels and retaining nuts and standoff insulators), indicator lamps, inductors (fixed and variable), and silver-mica capacitors.

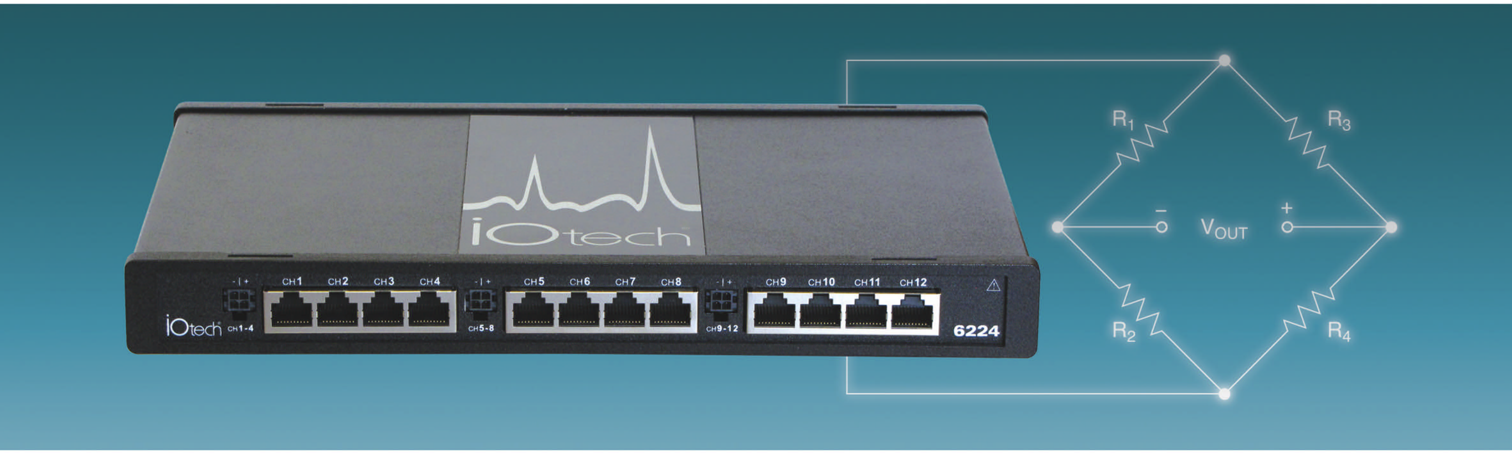
Low priority: discrete components (resistors and capacitors) and mechanical hardware (nuts and bolts).

Don't bother saving: electrolytic capacitors and "Black Beauty" and waxed-paper tubular capacitors.

Recycle: hookup wire and steel and aluminum panels and chassis.

24-Bit Strain MEASUREMENT

NEW!



New IOtech 6224 Strain-Gage Module

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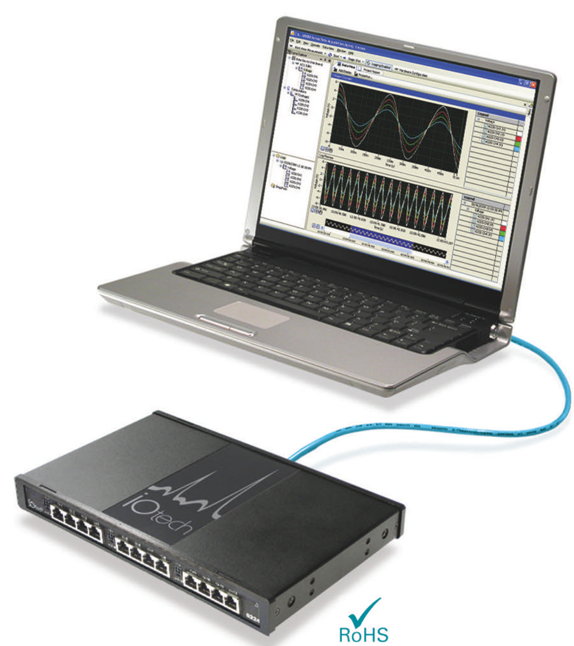

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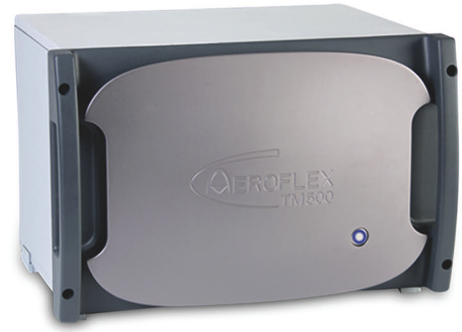


Aeroflex has announced the TM500 TD-LTE Multi-UE, which adds multiple-handset testing capabilities to its test equipment that supports TD-LTE infrastructure development. The TM500 TD-LTE Multi-UE enables TD-LTE infrastructure equipment vendors to test the performance of their TD-LTE base stations under loaded conditions.

The TM500 TD-LTE Multi-UE replicates multiple TD-LTE handsets in a single mobile test system, simplifying complex tasks such as functional network testing with multiple handsets and measuring the performance of resource-scheduling algorithms. The TM500 TD-LTE Multi-UE can repeatedly generate controlled test scenarios involving a user-defined number of handsets.

The TM500 TD-LTE Multi-UE enables manufacturers to measure the performance of loaded base stations before real handsets become available. The platform also makes it possible to run tests that require handset coordination and for which it is not practicable to use independent handsets. Such tests include contention between handsets attempting to access the network simultaneously and the ability to check a network's response if multiple handsets behave unexpectedly or abnormally together. The TM500 TD-LTE Multi-UE can also be used to measure, optimize, and demonstrate functionality such as the resource scheduler performance of a base station. The Multi-UE capability can co-exist on customers' existing TM500 LTE equipment. www.aeroflex.com.

IVI Foundation releases components for Vista

With its release of 64-bit IVI Shared Components and VISA Shared Components, the IVI (Interchangeable Virtual Instrument) Foundation is enabling vendors to provide 64-bit IVI and VISA (virtual instrumentation system architecture) drivers to test and measurement customers. The shared components provide common services to drivers and driver clients.

In addition to providing support for 64-bit Vista, the VISA Shared Components also include a VISA Router and a VISA Conflict Resolver, making it easier for users to create I/O systems with hardware and software from multiple vendors. Previously, the IVI Foundation says, users had to specify which VISA was primary and configure all the instrument communication to route through that VISA; in systems with hardware from multiple vendors, two

CALENDAR

Autotestcon, September 14–17, Anaheim, CA. *IEEE, www.autotestcon.com.*

International Test Conference, November 1–6, Austin, TX. *IEEE, www.itctestweek.org.*

Vision 2009, November 3–5, Stuttgart, Germany. *Messe Stuttgart, www.messe-stuttgart.de/vision.*

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

Editors' CHOICE

Verigy introduces zero-footprint tester

Verigy's V101 zero-footprint, 100-MHz system performs wafer sort and final test of cost-sensitive ICs, including MCUs (microcontroller units). A typical 512-I/O-channel configuration is available for less than $300,000.

Able to accommodate up to 1024 I/O channels, the V101 features what Verigy calls a Tester-on-Board architecture, which places the digital and DC resources directly on the tester board. This architecture supports multisite efficiency with high throughput and at lower test costs. The architecture also makes it easy to expand or reduce capacity as requirements change.

The V101 is designed to test 4-, 8- and 16-bit MCUs and other low-pin-count, low-end ICs. The digital instrument accommodates up to eight device power supplies, and it offers deep vector memory (60 M) and capture memory (8 M). Onboard multi-DC measurement units eliminate the need for separate analog cards, and they allow the testing of embedded ADCs.

The V101 is optimized for wafer sort with support for direct probing, so costly add-on interfaces are not needed for wafer-sort testing. The V101's design also results in greater signal fidelity and simplified production setup at wafer sort. It uses Verigy's Stylus operating system software, which features direct EDA links for shorter program development times.

Verigy, www.verigy.com.

different I/O devices could be assigned the same address, resulting in a conflict.

With the VISA Router, users no longer have to identify one VISA as primary but can use the VISA of choice. The Conflict Resolver will automatically notify the user of a conflict, allowing the user to correct the problem.

The release of the 64-bit IVI Shared Components includes a C API (application programming interface) for the IVIConfigServer. The IVI Foundation says that this allows customers who use IVI-C drivers to use native C interfaces instead of COM when using the Config Server. www.ivifoundation.org.

JDSU acquires part of Finisar

JDSU has agreed to acquire the Network Tools business of Finisar for approximately $40.6 million in cash. The Network Tools business provides SAN (storage area network) protocol test tools, software, and services; it had revenues of $44.2 million in its fiscal year 2009, which ended April 30.

The Network Tools products cover a range of protocols, including Fibre Channel, Gigabit Ethernet, 10GigE, iSCSI, SAS, and SATA. JDSU expects the combination of its own 40G/100G communications test expertise with the Network Tools' capabilities will lead to product innovations in emerging areas such as Fibre Channel over Ethernet. www.jdsu.com.

Editors' CHOICE

Analyze digital I/O signals

Electronic devices such as ADCs and DACs generate or produce digital signals. To generate or capture parallel digital data, you can use the NI PXIe-6544 or NI PXIe-6545 PXI Express cards. Both cards have 32 digital I/O channels and run on standard logic voltages. The NI PXIe-6544 supports clock signals to 100 MHz; the NI PXIe-6545 supports clock signals to 200 MHz.

Because the cards have a 32-bit digital I/O port, you can test two 16-bit parallel digital buses at once. You can also simulate bus signals on parallel backplanes or capture backplane signals for analysis.

The PXIe-6544 has 1 Mbit/channel ($5499) or 8 Mbits/channel ($7999). The PXIe-6545 has 8 Mbits/channel ($9499) or 64 Mbits/channel ($10,999). Both cards support Windows and real-time operating systems.

National Instruments has also released the NI PXIe-1082 eight-slot PXIe chassis ($2999), which has three PXIe slots and four hybrid PXI/PXIe slots. Software support includes Windows, Linux, Mac OS, and real-time operating systems.

National Instruments, www.ni.com/pxi.

Data suggests semiconductor recovery

> > > Semicon West, July 13–17, San Francisco, CA, SEMI, www.semi.org.

Semicon West 2009 wrapped up with mixed messages on the economic prospects for the semiconductor industry and semiconductor equipment market, including the market for test equipment. Exhibitors and visitors were cautious at best—with the notable exception of Walden C. Rhines, chairman and CEO of Mentor Graphics. In a July 15 keynote address (Ref. 1), Rhines said, "It's really hard to believe that in a recession like this one the semiconductor market can fare better than the overall economy," but he went on to describe why he believes the semiconductor market is indeed poised to fare better than other markets. He concluded by saying, "Unit growth and innovation will drive the 35% per year per transistor cost reduction needed to enable the next wave of applications."

In a July 14 press conference (Ref. 2), Stanley T. Myers, president and CEO of SEMI, said a few data points indicate positive momentum for the industry. Among those points is that the silicon-area shipment index (measured on a three-month moving average) is up 60% from the trough at the beginning of this year. In addition, he said, lead-frame unit shipments on a three-month moving average were up 20% from May compared with April (albeit 31% less than a year ago), and semiconductor unit shipments on a three-month moving average were up 8.9% in May over April (albeit 19% below a year ago).

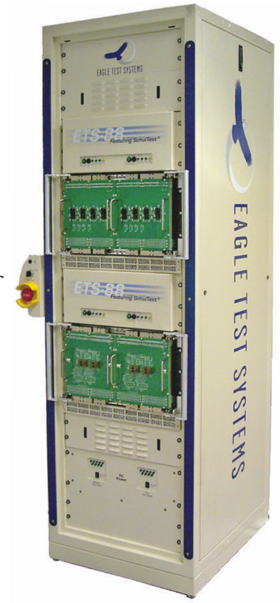
As for the semiconductor equipment outlook, Myers said SEMI's mid-year 2009 semiconductor consensus forecast estimates sales of $14.14 billion in 2009 and $20.74 billion in 2010, compared with actual sales of $42.77 billion in 2007 and $29.52 billion in 2008. The test-equipment portion of those totals is $5.05 billion in 2007 (actual), $3.45 billion in 2008 (actual), $1.78 billion in 2009 (forecast), and $2.54 billion in 2010 (forecast).

ON THE EXHIBIT FLOOR

On the show floor at Semicon West, **IMEC** (a Belgium-based research center covering nanoelectronics and nanotechnology) pointed the way toward future innovation, outlining technologies for scaling CMOS transistors and interconnects to 22 nm and below. Representatives of **Teradyne** were on hand to highlight the company's market position in the wireless test market, citing Gartner research showing that Teradyne enjoyed a 66.5% share of the worldwide ATE RF testing market for 2008. Teradyne also highlighted its Eagle Test line-up, including the new ETS-88 (**photo**). **Verigy** at its booth celebrated the 10th anniversary of the V93000, which debuted under the Hewlett-Packard banner at Semicon West 1999. The company reported that the first system, sold in 1999 to **STMicroelectronics** is still in use.

Roos Instruments exhibited its line-up of RF test systems. CEO Mark Roos was on hand to comment on CAST (Collaborative Alliance for Semiconductor Test), which, under the auspices of SEMI, facilitates precompetitive cooperation among test firms. Roos Instruments is a member, as are test firms Advantest, LTX-Credence, Teradyne, Yokogawa, and Verigy. Members in the semiconductor R&D, production, packaging, and test areas include Amkor, Intel, and STARC (Semiconductor Technology Academic Research Center). Mark Roos said that CAST supersedes the STC (Semiconductor Test Consortium), which, driven by Intel, originally was an attempt to open up an Advantest tester architecture for third-party development, so that suppliers like Roos could develop compatible instruments. He explained that the close identification with Advantest discouraged other major tester companies from participating in the STC, a problem overcome with the new CAST organization.

At the co-located **Intersolar North America**, **TÜV SÜD America** announced an agreement to cooperate on PV (photovoltaic) test and certification with the Renewable Energy Test Center, which is establishing PV test laboratories in Fremont, CA, and expects to become operational in 2010. Also at Intersolar, **Vela Solaris** announced an upgrade to its Polysun simulation software to include updated data from the Solar Rating and Certification Corporation for US solar-system components. T&MW



The ETS-88 supports multi-application operation and combines four independent mixed-signal testers in a box. Each mini tester can drive its own handler or prober.
Courtesy of Teradyne.

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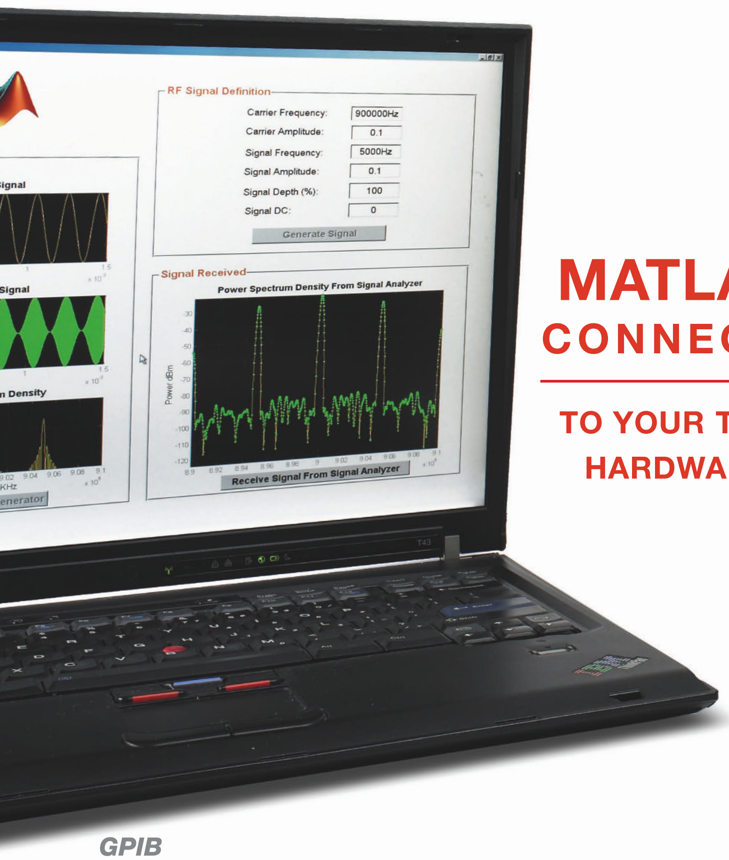

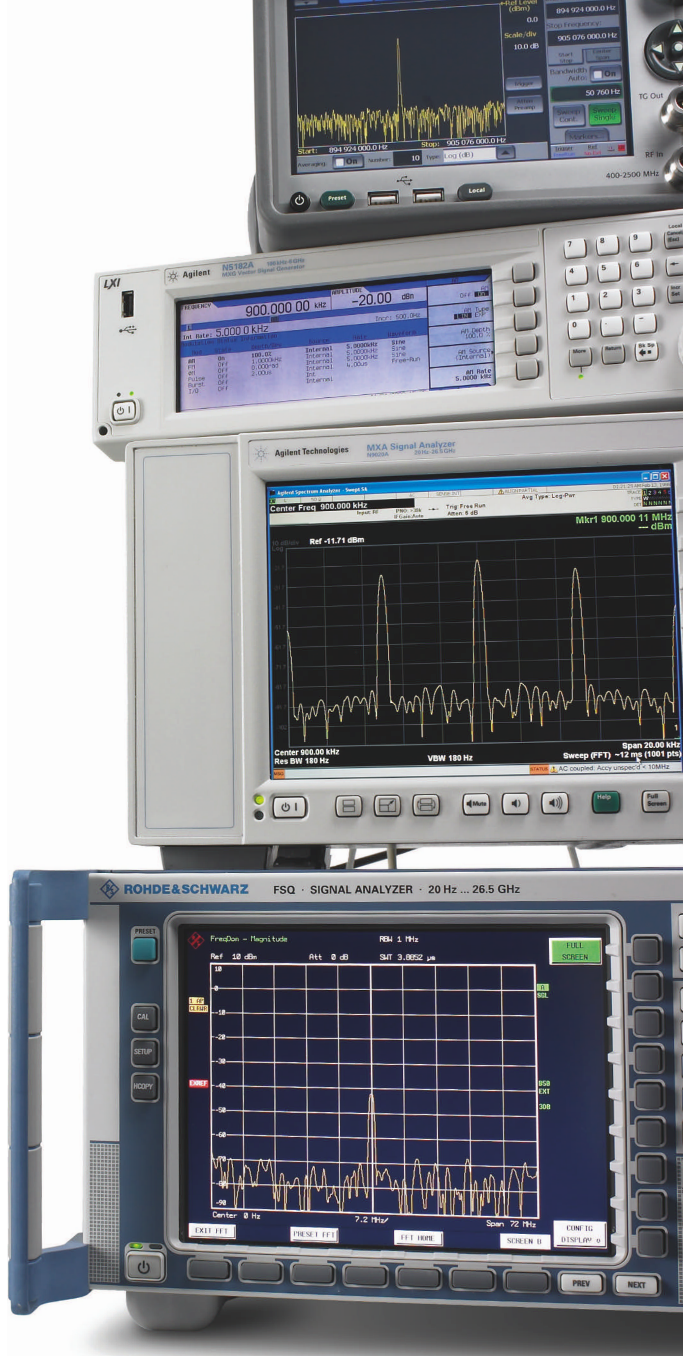

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Serial data streams pose EMI issues

Serial data streams of 10 Gbps are common today, and their clock frequencies and harmonics easily run into the microwave range. Testing these data streams for EMI (electromagnetic interference) emissions gets difficult because emitted signals become directional, test equipment noise floors rise, and measurement uncertainties increase compared to lower frequencies.

In a serial data stream, data is clocked on both rising and falling edges. Thus, the clock frequency is half the data rate. The 1000Base-LR Ethernet physical layer, for example, has a bit rate of 10.3125 Gbps with a clock speed of 5.15625 GHz (Ref. 1).

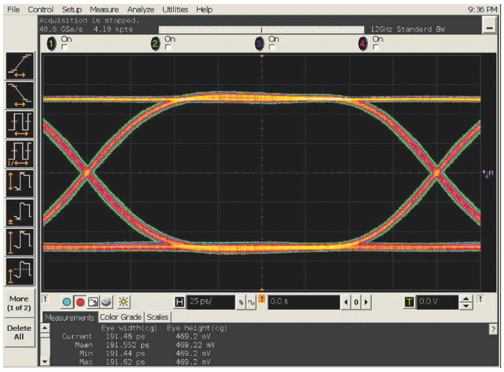
FCC Part 15 requires radiated emissions testing of unintentional radiators to the "fifth harmonic of the highest frequency or 40 GHz, whichever is lower" (Ref. 2). The fifth harmonic of 5.15625 GHz is 25.78115 GHz. Thus, a test lab needs a high-frequency EMI receiver or spectrum analyzer, special antennas, calibrated cables or waveguides, and low-noise pre-amps with enough capability. "Labs that perform military RF testing are used to making measurements up to 40 GHz," said Jim Press, EMC national director at National Technical Systems

At such high frequencies, signals become more directional than at lower frequencies. Antenna positioning becomes critical, and you will need to find the direction and position where your antenna will receive the highest emissions. This may entail not only raising and lowering the receive antenna, but also moving it horizontally across the face of the equipment under test.

Reflections can add to measurement uncertainty. Press noted that you can get reflections even in an anechoic chamber at high frequencies.

Scott Drysdale, EMC lab manager at Global Advantage International, commented, "For CISPR 22 testing, which would only require measurements up to 6 GHz, the calibration of the test chamber for above 1 GHz can take two or three days to qualify the chamber."

As with any radio measurement above 1 GHz, the higher the frequency, the greater the noise floor of your system. Noise at high frequencies means that you may have to place your EMI antenna at a closer distance to the equipment under test to reliably receive emissions. You then must extrapolate signal strength to 3 m for compliance tests. High-gain pre-amplifiers and premium-quality RF cables and connectors must also be used to ensure that the specified emissions limit is at least 6 dB above the noise floor.



High-speed serial data streams produce harmonics that challenge EMI measurements. Courtesy of Agilent Technologies.

"Test methods are among the largest sources of difficulty in measurement," said Bill Stumpf, site manager at D.L.S. Electronic Systems. "Published USA domestic and international procedures for testing above 1 GHz differ. For example, the FCC won't accept the CISPR method of planar antenna maximization." T&MW

REFERENCE

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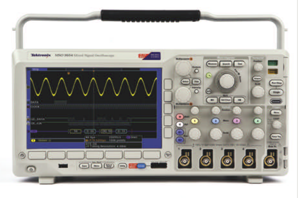
Meter captures electromagnetic events

The EM Eye Meter can detect ESD (electrostatic discharge) events, measure electromagnetic fields, or measure RF signal strength. You simply change sensor heads as needed. The meter provides on-screen and audio notification of ESD events and stores data on an SD memory card. www.3mstatic.com.

Mixed-signal oscilloscopes capture up to 2.5 Gsamples/s



The MSO 3000 series of mixed-signal oscilloscopes provides two or four analog and 16 digital channels. Bandwidths range from 100 MHz to 500 MHz with record lengths of up to 5 Msamples and a signal-capture rate of 2.5 Gsamples/s. www.tektronix.com.

Education kits cover engineering topics

Agilent Technologies has added three kits to its line of educational materials. The Analog Electronics Lab Station features semiconductor fundamentals, circuit analysis, and applications of diodes, transistors, and op amps. The Digital Signal Processing Lab targets digital system design, digital programming, and digital logic design. The Digital RF Communications Training Kit covers RF digital communication and wireless standards. www.agilent.com/find/edu.

[IMS TESTING]

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IP multimedia subsystems deployment continues to grow

Designed to fill the gap between traditional telecommunications technology and Internet technology, IMS (IP multimedia subsystem) technology allows service providers and network operators to offer innovative services to their customers. This technology has evolved over the last few years with a reasonably mature standard available currently. It is expected that in the future, the subsystems will likely be deployed in large numbers. Key market drivers for test and monitoring equipment for this technology include the growth of LTE (long term evolution) deployments and the scalability of IMS (see **chart**).

The capability of IMS to deliver faster transmission of voice and data, including standard calling features like caller ID, click-to-call, and messaging, as well as a whole gamut of enriching services like voice and video for TV-screen delivery, access to call history, and click-to-call from the IPTV remote, at much cheaper rates, will likely ensure more deployment of the technology in the future. IMS provides scalability, flexibility, and ease of use for service providers and network operators. IMS deployment has moved from projects that were mostly experimental and small scale to more realistic deployments that must ensure QoE (Quality of Experience) and QoS (Quality of Service) for consumers. The technology now focuses more on the access side of both wireline and wireless networks.

IMS offers a scalable architecture that enables the gradual build up of networks. Such scalability augurs well for the deployment of this service-enriching technology during the current economic situation. The deployment may face some resistance as service providers and network operators put a freeze on capital expenditure, but because they face the challenge of ensuring higher average revenues per user, it makes sense to gradually build a scalable and flexible setup that can ultimately yield a complete deployment of IMS. Moving from 2010 onward, when service providers feel that they are unable to manage their services with legacy networks, IMS deployment will likely grow.

Another important driver, the scheduled LTE deployment, will likely happen in 2010 with larger versions to follow a couple of years later. LTE's support for IP-based traffic with end-to-end QoS supports IMS well. From the network equipment manufacturer's viewpoint, IMS is considered a foundation for LTE deployment, and these manufacturers have supported the technology throughout its evolution. Alcatel-Lucent, Nokia Siemens, Verizon, and others are currently capable of offering infrastructure for IP converged applications and services on their wireless and landline broadband networks. LTE will remain one of the key wireless access networks linked to the IMS technology.

The overall picture in the IMS test and monitoring market, even under a strained economy, depends on the capabilities of the technology. The IMS test and monitoring market, though crowded, remains very competitive with a very high potential for growth. T&MW

Key drivers in the world market for IMS test and monitoring equipment.

- Maturity of standards
- New economic cycle
- Inability of legacy networks to adapt
- Capability to provide enriching services
- Growth in LTE deployments
- Scalability of IMS architecture

802.11n chips to surpass 802.11g versions

With growth rates over 100% in 2010, shipments of WiFi chipsets based on the draft 802.11n standard will surge ahead of those based on 802.11g, reports In-Stat. "802.11n chipset revenue will surpass that of 802.11g this year as a result of higher ASPs [average selling prices]," said Victoria Fodale, In-Stat analyst. "ASPs for draft n/802.11n chipsets are complex, as there are more options that can impact prices. These options include support for the 5-GHz spectrum and the number of data streams, which can range from one to four." Details can be found in the $3495 report, "Global Wi-Fi Chipset Forecast and Analysis: 2007-2013." www.in-stat.com.

PCB book-to-bill

Compared with the previous month, rigid PCB (printed-circuit board) shipments grew 3.6% in May 2009 and rigid bookings decreased 1.1%. The book-to-bill ratio for the North American rigid PCB industry in May continued to climb and reached 1.03. The North American flexible circuit book-to-bill ratio in May inched up to 0.96, and the combined (rigid and flex) industry book-to-bill ratio climbed to 1.02. www.ipc.org.

Semiconductor equipment book-to-bill

North American-based manufacturers of semiconductor equipment posted $288.5 million in orders in May 2009 (three-month-average basis) and a book-to-bill ratio of 0.74. The three-month average of worldwide bookings in May 2009 was $288.5 million. The bookings figure is about 16% greater than the final April 2009 level of $249 million, and about 72% less than the $1.03 billion in orders posted in May 2008. For more on the semiconductor industry, see p. 15. www.semi.org.

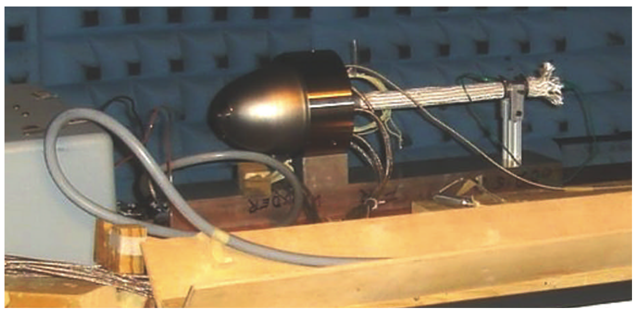
EMC

Military standard gets a revision

MIL-STD-461, "Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment," has long defined military EMC (electromagnetic compliance) tests. With version F, the standard incorporates numerous changes (both significant and minor) and reinstates an old test method. Released in December 2007, MIL-STD-461F is now being implemented on products and systems developed for Department of Defense applications.

The current version of the standard incorporates a dozen or so significant changes. Some of those changes are easy to understand, but others may lead to confusion. A paper by Steve Ferguson, VP of operations at Washington Laboratories, spells out these changes in detail. In his paper, Ferguson assumes that you're already familiar with previous versions of MIL-STD-461. You can download the paper, "MIL-STD-461 evolves to version F," from the online version of this article (www.tmworld.com/2009_08).

Ferguson points to a new frequency-scanning technique as a possible point of confusion. He notes that the standard lets you run faster scans, but that the faster scans don't mean you'll reduce testing time. You still must comply with a minimum measurement time defined in the standard, even though new equipment can scan faster than older equipment.



MIL-STD-461F defines military EMC test configurations and procedures. Courtesy of Washington Laboratories.

A requirement for power-line voltage testing, dropped from the standard with revision D in 1993, has been reinstated for some applications. MIL-STD-461F requires a single 400-V, 5-μs pulse calibrated with a noninductive 5-Ω resistor.

If you perform automated tests, then MIL-STD-461F requires that you verify operation of your software, whether you use commercial software or develop your own. You must describe the control and methodology of your software. If you write your own test procedure for use at a commercial EMC lab, you'll need detailed knowledge of how the software works.

Martin Rowe, Senior Technical Editor

DESIGN FOR TEST

RTL approach supports memory BIST and repair insertion

SOC (system-on-chip) designs often incorporate multiple instantiations of various types of memories, including single-port, double-port, and content-addressable memories of various sizes and cuts. In addition to the memory itself, a memory provider also supplies the IP (intellectual property) necessary to implement memory BIST (built-in self test) and—for redundant memory—repair.

Traditionally, you would implement MBIST (memory BIST) and repair functionality at the gate level. But now you can use an approach that inserts MBIST and repair at the RTL (register transfer level). The approach is independent of BIST IP technology and works with any supplier's qualified ASIC design kit and BIST libraries.

```
// BLOCK_Insertion file:

// Following are abstract models created during block level run
blockname IO_CTL_modified       replace_module IO_CTL
blockname BUS_ARB_modified      replace_module BUS_ARB
blockname TLB_PROC_modified     replace_module TLB_PROC

// Following are inserted at top level


blockname top_bist_manager   insertion_point  top_mbist_mgr
blockname BSR_top_inst       insertion_point  BSR_top_inst
blockname tmode_control_reg  insertion_point  tmode_control_reg
```

The SpyGlass-MBIST insertion tool supports a bottom-up flow where the memories in lower-level blocks are replaced with BIST-enabled memories.

The approach offers several benefits when compared with MBIST insertion at the gate level. For example, with gate-level insertion, functional verification will take longer, and any optimization you perform during synthesis and early floor planning will not optimize the MBIST logic you later insert at the gate level. In contrast, with MBIST inserted at the RTL, you can perform mission- and test-mode verification at the RTL, and you can minimize iterations between RTL and gate-level design.

In the white paper "A Register Transfer Level Approach to Memory Built-in Self Test and Repair Insertion," Dr. Aloke Das and Kiran Vittal of Atrenta describe the use of the company's SpyGlass-MBIST tool to insert "vendor independent" MBIST IP at the RTL in Verilog or VHDL. They note that the approach has been deployed at customer environments based on qualified libraries supplied by the ASIC vendors. The SpyGlass-MBIST insertion tool supports a bottom-up flow where the memories in lower-level blocks are replaced with BIST-enabled memories (**figure**).

You can find a link to the paper in the online version of this article at www.tmworld.com/2009_08.

Rick Nelson, Editor in Chief

OSCILLOSCOPES

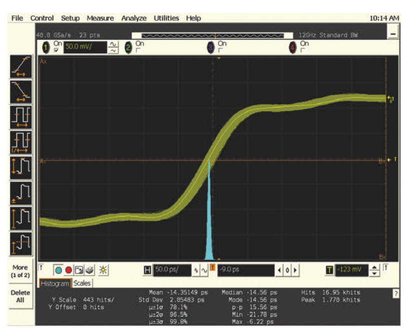
How to measure display jitter

All serial data streams and clocks have jitter (the difference between the arrival of an edge and the expected time of arrival). The jitter you see on an oscilloscope is a function of the signal's timing jitter and amplitude noise, plus the jitter and noise that the oscilloscope adds to the signal.

The jitter that an oscilloscope adds to the signal you see (call it display jitter) is a combination of the instrument's trigger noise and trigger jitter. Noise on an input signal produces a timing error in the displayed signal. If, at the start of a rising edge, noise has pulled a signal's amplitude low, the rising signal will cross a threshold point later than it would in a noise-free signal.

Trigger noise will also add jitter because it affects the point where an edge crosses the trigger level. The amount that trigger noise contributes to display jitter depends on the input signal's slew rate. The greater the slew rate (faster rise or fall time), the less display jitter you will see.

Oscilloscopes have traditionally measured display jitter (but called it trigger jitter) using a histogram (**figure**). But in some oscilloscopes, hardware has improved to where trigger noise dominates display jitter, making the trigger jitter component negligible. In addition, some oscilloscopes



A histogram shows the distribution of jitter in a rising edge. Courtesy of Agilent Technologies.

can mathematically remove most of the instrument's display jitter, producing a waveform that appears to have no noise or jitter at the trigger point.

Because of those factors, the traditional measurement won't work. You can, though, use a different technique to measure an oscilloscope's display jitter. It involves using a sine wave and employing frequency-domain techniques. To learn how the technique works and how to apply it, download the paper "The evolution of trigger jitter" by Steve Draving, hardware engineer at Agilent Technologies, from the online version of this article (www.tmworld.com/2009_08).

Martin Rowe, Senior Technical Editor

Dropout alarm frees engineers' time

Monitor a voltage and get an audible alarm when the voltage drops.

By John Lo Giudice, STMicroelectronics

When testing a power supply or running a thermal test on a component or system, you often need to monitor a voltage and take action should that voltage drop below a specified level. If all you have is a basic handheld DMM (digital multimeter) to measure the voltage and your meter doesn't have a digital output, you can build a circuit that monitors a test voltage and triggers an audible alarm if the voltage dips too low or shuts off. The circuit keeps the buzzer on until you reset the circuit with a pushbutton, even if the test voltage recovers.

The circuit in **Figure 1** uses an LM393 comparator with a 2.5-V programmable voltage reference (TL431) on the non-inverting input (pin 3). The LM393 compares a reference voltage (V_{REF}) to the output of a power supply divided through potentiometer R1 and resistor R5. R1 lets you adjust the voltage from the DUT (device under test). If the test voltage drops below the reference voltage, the comparator's output goes from low to high, which triggers the 2N5060 SCR (silicon-controlled rectifier). The SCR will then conduct, sounding the buzzer, and will keep the buzzer on until you press the momentary pushbutton switch. Resistor R6 is in parallel with the buzzer, which guarantees that the latching current through the SCR keeps the buzzer on even if the comparator's output resets and goes low. **Figure 2** shows the circuit's operation as a function of time.

You can operate the circuit from a 9-V battery or from an external power source. Once the DUT is running, use the DMM to measure the voltage across R5 until it reaches the desired level above V_{REF}. You can then connect the DMM in parallel with the test voltage to get a visual display. If the test voltage drops below the reference voltage, the alarm will sound. T&MW

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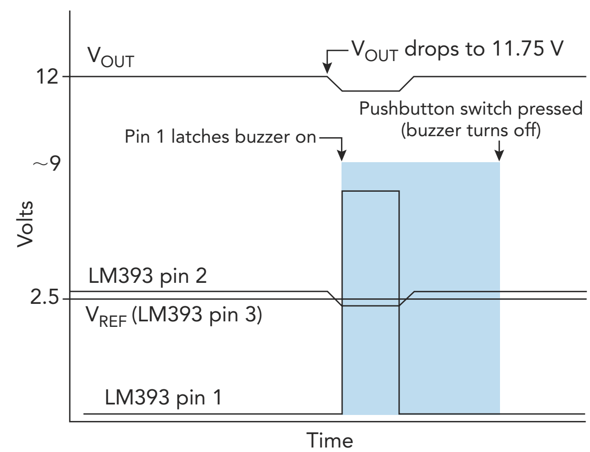


Figure 2 The SCR continues to conduct until the pushbutton switch is pressed, which turns the buzzer off.

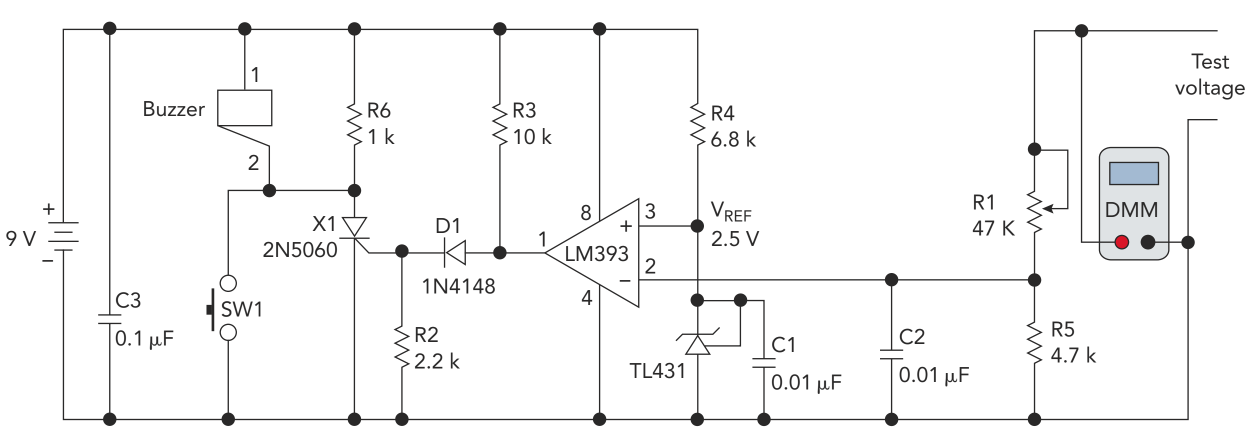
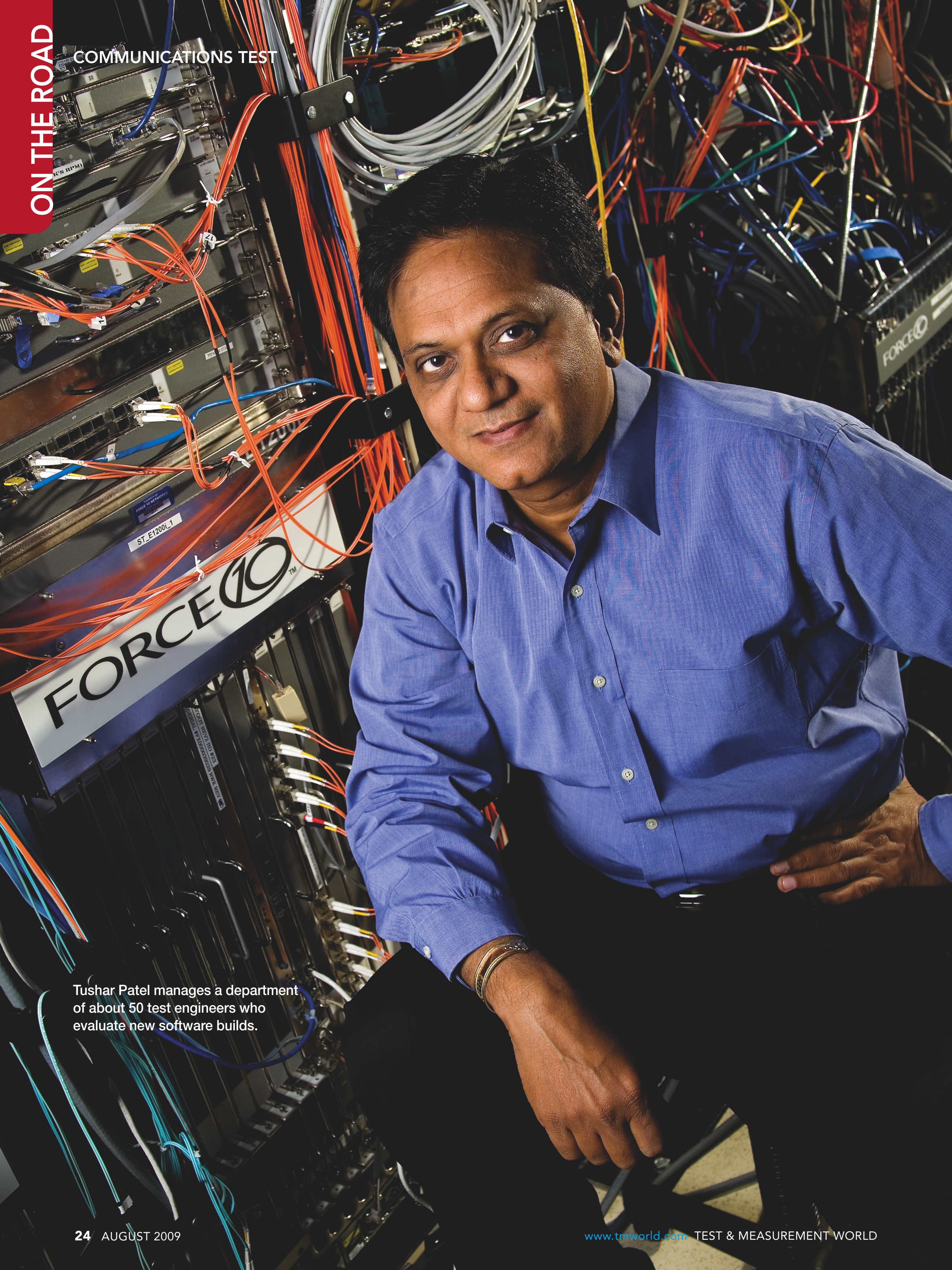


Figure 1 An LM393 comparator triggers the 2N5060 SCR, which turns on a buzzer when the test voltage drops too low.



Tushar Patel manages a department of about 50 test engineers who evaluate new software builds.

TESTING RIGHT FROM THE START

ENGINEERS AT FORCE10 NETWORKS DEVELOP TEST PLANS AND AUTOMATION SCRIPTS WHILE PRODUCTS ARE STILL IN DEVELOPMENT.

BY MARTIN ROWE, SENIOR TECHNICAL EDITOR

San Jose, CA—Internet service providers, enterprises, data centers, and research labs process billions of bits of data per second. To make sure all those bits, bytes, and packets reach their destinations, these organizations rely on combination Ethernet switches and backbone routers from Force10 Networks.

A high-end switch/router from Force10 can process more than 32 billion packets per second through 1-Gbit Ethernet and 10-Gbit Ethernet ports that connect thousands of network devices to network backbones. The company's product line consists of chassis with removable line cards as well as fixed, stackable units (**Figure 1**). A high-end line card can have up to 90 1-GigE ports that connect to servers, and a chassis can have up to 140 10-GigE ports for connecting to a network backbone. Each system has a processor board with three processors, and each line card has its own processor, all of which run FTOS (Force10 operating system). FTOS is based on the NetBSD open-source kernel.

Reliability is paramount in network equipment, which is why Force10's test engineers get involved early in a product's development—so early, in fact, that they write software product definitions, test plans, and automated test scripts. Tushar Patel, VP of engineering test and quality assurance, heads a team of engineers who perform software testing on processor cards, line cards, integrated systems, and complete networks. They validate both new-feature software releases and maintenance releases.

Network backgrounds

Testing at Force10 Networks differs from that at other network-equipment companies in that the test engineers have networking backgrounds, which enables them to get involved early in product definition and development. "Our test engineers not only know protocols, but they have done

FIGURE 1. All switches and routers from Force10 Networks, regardless of configuration, share a common code base.

GARY LAUFMAN / GETTY IMAGES

network design, installation, and operation," said Patel.

Patel joined Force10 soon after the company was formed in 1999, and all of the test managers who work for him have been with the company for eight or nine years. "I joined Force10 because the founders recognized early that testing is important," said Patel. "They didn't wait until they had a product to begin building a test organization. I was able to build a testing team earlier than I could at most companies. I think this helps us maintain higher-quality code as we add features and functionality to FTOS."

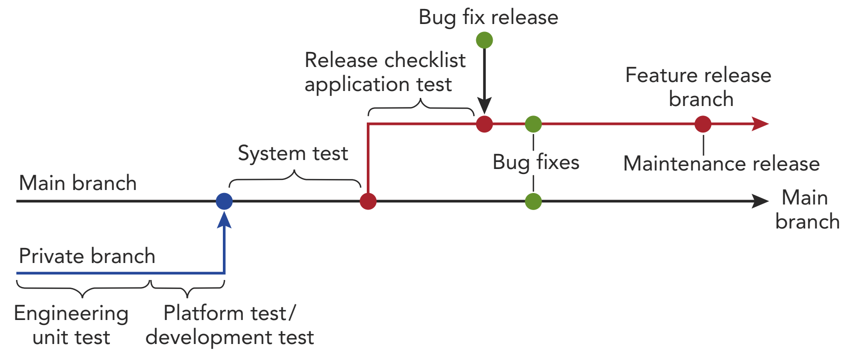


FIGURE 2. Test engineers evaluate new code in a private branch before merging it with existing code in the main branch and running system tests.

Force10 software engineers produce two major releases per year, with maintenance releases as needed. All of the company's switch/routers use the same software code base. That streamlines software development and ensures that a bug fix will cross product lines. Each system has a set of software drivers for communicating between FTOS and the hardware. The common code base results in greater stability, manageable code maintenance, and simpler product training.

Test engineers are responsible for evaluating new software features, and they perform regression testing to assure customers that new code won't adversely affect existing installations. **Table 1** highlights the test-engineering departments, their managers, and some of their functions.

Table 1. Force10 test departments and their functions.

Department	Manager	Functions (partial listing)
Unit test	Development group	Unit testing Software quality tool development Code review
Platform test	Subarrao Karavadi	Hardware bring up Diagnostic testing Environment testing Performance testing Redundancy and high-availability testing Interoperability Regression
Development test	Narmada Chenna	Integration and merge Routing and switching protocol functional test Stability test Interoperability Regression
System test	Balu Ramappa	Robustness Resiliency Interoperability Large-scale topologies
Application test	Hitha Shetty	Customer-specific application test Proof-of-concept test

Figure 2 shows the path of a software build through the test groups. The main branch represents the software code base that is used across all of the company's platforms. A private development branch refers to unverified code prior to its merging with the main code branch, whether the new code provides bug fixes or adds new features.

A private branch starts with software developers who perform unit test and work closely with the engineers who perform platform tests. Engineers in the platform-test group evaluate how new code interacts with hardware, often working on individual processor cards or line cards. They merge code into the existing main branch for system test and application test.

Engineers in the system-test group run the new code on an integrated switch/router after the private branch is merged with the main branch. If they approve the new code, it will remain part of the main branch for new products. "While system test and development test teams run through a release check list," said Patel, "the applications test group performs application testing."

Test engineers in all groups use test beds that consist of Force10 products, competitors' products, and network traffic generators from Ixia, Spirent Communications, and Agilent Technologies. They use proprietary software tools to write scripts without needing to know the scripting language's syntax. Through the scripts that the proprietary tools generate, engineers can control systems under test and the traffic generators because the scripting tool includes application programming interfaces to traffic generators. Scripts verify the data that passes through the test bed. Engineers use a command-line interface to run the scripts on a Linux- or Unix-based computer. Because test engineers use Force10's scripting tool to write high-level scripts, they can test an entire switch/router in a test bed with just a few commands.

Platform test

Software developers write code and perform initial functional tests. From there, the platform-test group, managed by Subarrao Karavadi, tests how new FTOS code handles protocols and how it controls hardware functions such as power and cooling. This group tests the software that controls cooling fans and how the hardware switches to backup power supplies if needed.

Platform-test engineers also test hot swapping of all field-replaceable units, including line cards, control modules, switch fabric modules, power supplies, and fan trays. "Hot-swap testing of these

components is very critical because customers must be able to add or replace them without affecting a switch's operation," said Karavadi. "FTOS needs to know when each component is installed or removed. Traffic should pass to a new line card whenever it's inserted." Platform-test engineers also test control modules to ensure that a backup control module takes over without any traffic loss should a primary control module fail.

While engineers in Karavadi's group don't test for initial board start-up, they do test to make sure that FTOS boots a board's processors. An FPGA (field-programmable gate array) can load the FTOS image from a network through FTP (file transfer protocol), a local Compact Flash card, or a USB "thumb" drive. His group also checks operation of hardware such as flash memory, optics, and processor chip sets but does not test for memory leaks or initial booting. Hardware engineers led by Jim Miller handle that. (See "Under the software," p. 31.)

Subarrao Karavadi's group of test engineers evaluate the interactions between new software and hardware.

GARY LAUFMAN / GETTY IMAGES

Engineers in the platform-test group also measure packet throughput, latency, and jitter. They use several network configurations such as full mesh, many to one, one to many, and many to many for these measurements. Such tests often require hundreds of traffic-generator ports, which can get expensive.

"We accomplish our tests by using relatively few traffic-generator ports in combination with a proprietary algorithm, "said Karavadi. "Engineers program hardware in 'snake' configurations where data from one port passes to an adjacent port in the line card." **Figure 3** shows a configuration for a 48-port line card. Engineers can expand the test to cover every port in a chassis.

Karavadi's group also performs basic layer 2 and layer 3 protocol testing. Once they're satisfied with how a new software build works with the hardware, they pass it on to the development-test engineers. Development-test engineers, managed by Narmada Chenna, run functional tests on new code features. They also run stability tests to ensure that the code won't get into undesired conditions. Interoperability tests let them check whether Force10's products will communicate to network equipment from other companies. Development-test engineers also run regression tests, which can uncover bugs when new features interact with existing code.

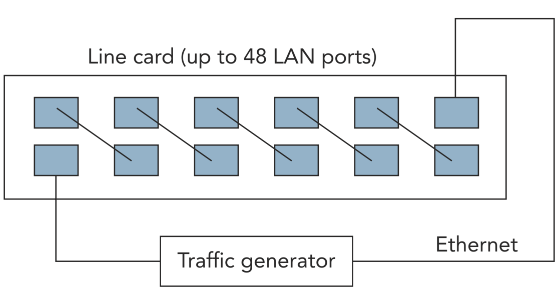


FIGURE 3. One traffic generator can test layer 2 switching on all 48 LAN ports.

System test

Software test manager Balu Ramappa leads the system-test group, whose engineers use the test beds to simulate complex networks found at Internet service providers and data centers. They perform a system test for about six weeks.

"Our test beds are a superset of customer network configurations," said Ramappa. "A typical data center has 20,000 servers that communicate with 200 routers. We can stress test our equipment by simulating 40,000 to 50,000 servers and 400 to 600 routers."

Force10's larger customers require that the company test software on test beds that emulate their networks. That job falls to Hitha Shetty, manager of customer applications and response. Shetty's group uses test beds to simulate network traffic. "We go through customer topologies, configurations, and issues," said Shetty. "We provide feedback to software developers and test engineers."

When customers have software problems that first-line product-support engineers can't recreate in the customer-support lab, Shetty's engineers try to replicate the problem in the customer-application lab. Once the problem is identified, fixed, and verified, engineers apply the fix to all the release branches. If a customer situation demands a new code revision, engineers will issue a spot-patch release.

The difficulty in replicating a condition and identifying a problem depends on the symptom. For example, if a feature doesn't work for a customer, engineers can usually isolate the problem and either recommend workarounds or request a code revision.

Other problems are more difficult to find. The most difficult involve networks where customers use equipment from two or more manufacturers. "We try to develop software with a focus on standards and interoperability" said Shetty. "But implementation differences exist

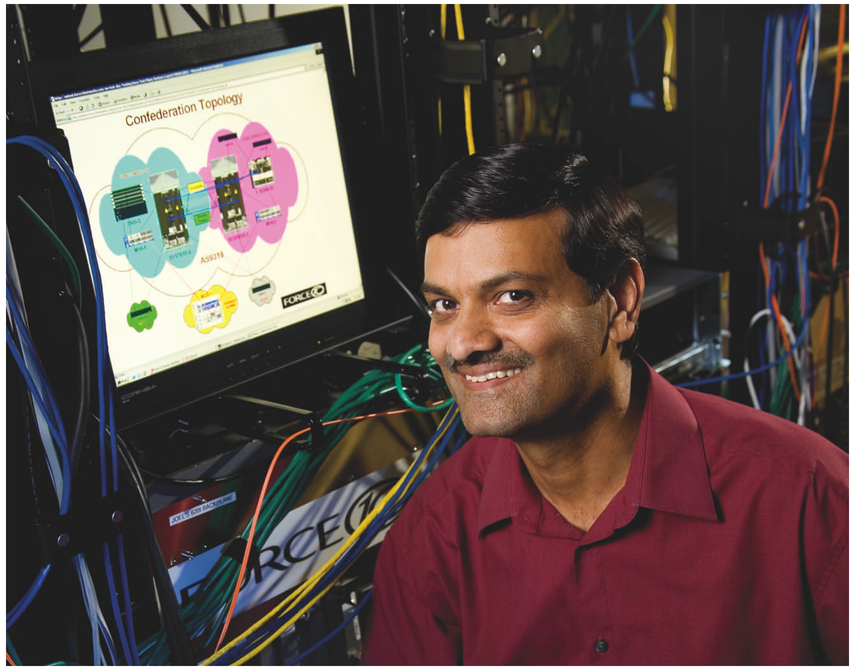
when equipment manufacturers interpret the standard differently or deliver two different versions of the same standard." When that happens, Force10 customers must contact both companies.

"An update to a communications standard can be a source of interoperability problems," noted Shetty. "Not every customer upgrades their equipment with every new software release."

Newer code may have a desired behavior change or bug fix, but customers, especially large customers, don't like frequent upgrades because each upgrade requires that they test it prior to deployment. "Customers want to use a software release for as long as two years," added Patel. "Small customers are more likely to upgrade than large customers."

When to release

Test engineers at Force10 have considerable influence over software definitions and releases. Patel and his managers make the final call on when to release. Instead



GARY LAUFMAN / GETTY IMAGES

Balu Ramappa manages the system-test group, which tests software in complete switch/router systems.

Under the software

Essential to all of Force10's software are hardware components such as microprocessors, memory modules, FPGAs, ASICs, communications ports, and circuit boards. Before software can run on a board, the hardware must work. The job of ensuring that it does falls to Jim Miller, who leads a group of four electrical engineers and three technicians. Miller's group is responsible for bringing a board to the point where the company's FTOS can load on it.

A microprocessor-based board needs diagnostic software just to get started. Engineers start with an ICE (in-circuit emulator) to get signals moving and make sure that the board is properly assembled and that its components have power.

Boot code from a flash-memory card gets a board to the point where it can get instructions through an RS-232 port to load FTOS. Engineers can then load drivers to control the board and run diagnostics. For example, they will run overnight memory tests to ensure a board has access to all memory. When testing line cards, engineers must test the I/O ports, which differ depending on the interface (copper or fiber). The engineers also check communications to a backplane, which has 3.125-Gbps data links.—*Martin Rowe*

of applying only a strict definition of severity to bugs that must be resolved before a release, they again use their networking backgrounds to make a more nuanced call on which bugs actually are likely to impact the customer.

Test engineers set bug priorities and can delay a release if they are not satisfied with new code. Once satisfied, the system-test group performs a 72-hr stress test in the lab before signing off on the code. This test raises confidence that the code will perform as expected in customer networks. "If we find any critical bug," said Ramappa, "we can return the code to the software developers. Once the bug is fixed and verified, this test starts again.

Test engineers at Force10 Networks manage software builds and releases, which gives them considerable control over the software quality. With their networking backgrounds, they bring a customer's perspective to test. The company's system of evaluating software has many processes, any of which can catch and report bugs before reaching customers' networks. T&MW

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A BA609 tilt-rotor aircraft undergoing flight testing flies in airplane mode over the Alps in northern Italy; the photograph was taken from an Italian Air Force cargo plane. Courtesy of Bell/Agusta Aerospace.

TEAMING UP on design and test

BY RICK NELSON, EDITOR IN CHIEF

Powerful high-level software tools give domain experts in such diverse fields as aerospace engineering and medical electronics increasing control over the design and verification of embedded systems. What's more, the tools themselves are adapting, with graphical design environments intended for test now aiding the design process, and design, modeling, and simulation tools enabling such techniques as HIL (hardware-in-the-loop) testing.

During a panel discussion at the Embedded Systems Conference 2008, the idea of domain experts supplanting electrical engineers gained some currency (Ref. 1). A look at the current state of affairs does suggest that domain experts and high-level systems architects—as opposed to coders and processor experts—have gained significant ability to participate throughout the embedded-system-design process. But the need for C coders and hardware engineers is not going away. What's occurring in most cases is that domain experts and EEs are collaborating to get increasingly complex products to market quickly.

Commenting on the 2008 panel discussion during a May 2009 interview, Jim Tung, a fellow at The MathWorks, said, "The premise was that people who have to implement an embedded system and the people who know what needs to be implemented never know how to talk to each other. Certainly the world has moved away from that starting point. What you certainly do see now is collaboration. The people who have the implementation skills needed to deliver a device with a certain power consumption and performance profile can work more effectively with the domain experts—the people who know what the functionality needs to be." High-level languages like The MathWorks' Matlab and Simulink, he said, are what enable that collaboration to take place.

Test software addresses design

Another firm that sees opportunities in working with domain experts is National Instruments. NI has been promoting its LabView graphical design software, which initially served test-and-measurement applications, as a tool for embedded-system design. An NI spokeswoman explained, "With the thousands of technical challenges the engineering community faces today within application spaces like medical, robotics, and green, we don't have enough embedded engineering experts to address all of these problems. Therefore, the masses of domain experts out there become a critical part of helping the engineering community out. We've seen numer-

No longer isolated disciplines, design and test work together, and test tools are taking on design tasks.

ous domain experts be very successful using our graphical system design tools to design embedded systems in the medical, robotics, and renewable energy industries, and we will continue creating new embedded hardware and software tools that allow any domain experts and scientists to innovate themselves and design embedded systems."

One NI customer that has successfully used NI tools in embedded-system design is Alliance Spacesystems, which makes mechatronics systems such as robots for NASA (Ref. 2). Shelley Gretlein, LabView real-time and embedded product marketing manager at NI, described the company's mechatronics group as a multidisciplinary team comprising aerospace, mechanical, electrical, and control engineers all cooperating on the same team. Said Gretlein, "You see much less pure EE or strong embedded experience. Much more, you see people coming from different backgrounds to build these systems."

The move to the embedded space has been an evolutionary one for NI, but that doesn't mean NI is moving away from test. Todd Dobberstein, product manager of industrial and embedded technologies for National Instruments, said, "Test is NI's bread and butter—we've been dealing with test and data acquisition since we started as a company." The company's test expertise, he said, complements the design capabilities inherent in LabView. In fact, said NI's Gretlein, the group she works with at Alliance Spacesystems began as a test customer and has increasingly adopted NI tools for design, leading to a unified tool chain.

PJ Tanzillo, biomedical segment lead and embedded software manager at NI, cited another customer who has successfully applied NI's tools in an embedded-system design project: Sanarus, which used the tools as it developed the Visica 2 cryoablation system for the treatment of tumors. Tanzillo described the systems engineer on the project, Jeff Stevens, not as a domain expert but as an EE by training whose expertise is at the systems-architecture level—rather than at the coding and hardware-optimization level. Such systems architects may be able to apply their talent across multiple disciplines, from robotics to medical electronics, but, said Tanzillo, they understand the underlying technology, albeit not necessarily down to the level of developing a driver for an ADC (analog-to-digital converter) or writing HDL (hardware description language) code for an FPGA (field-programmable gate array).

The Visica 2 cryoablation system for the treatment of tumors (left, courtesy of Sanarus) went from a requirements document to first revenue in 14 months, according to systems engineer Jeff Stevens. Stevens used LabView to develop code for the CompactRIO platform (right, courtesy of National Instruments) that served as the embedded engine in the Visica 2.

Designing the Visica 2

I spoke with Stevens to get his views on domain expertise and embedded-system design. He described himself as a systems engineer with degrees in EE who had never written any code that would see the light of day. That changed, he said, when he joined Sanarus in November 2005 as principal systems engineer and faced a four-month window to develop a fully functional prototype of the Visica 2. "As the system architect, I could see that we'd need a custom PCB [printed-circuit board] for the microprocessor and all the I/O, and we'd have to outsource all the firmware because nobody at Sanarus spoke software. That was the approach Sanarus had followed on its existing product, but that product was an order of magnitude simpler than Visica 2."

Further making the task challenging was the small team available to work on the project. The four-person team included a project manager, a mechanical engineer, and a "super-tech," who had a degree in psychology but was creative at prototyping and could solder circuit boards. All in all, said Stevens, "I was thinking eight months might be enough to accommodate board and code spins plus integration, but four months fell squarely in the 'no way' bucket."

At that point, he met with representatives from NI and investigated the company's CompactRIO platform as a hardware target for embedded code that could run software that he could develop on LabView—a tool he had heard of from the test operations of companies he had worked for but had never used. He presented his case to Sanarus management and got approval to adopt the NI approach. With the help of NI support personnel and a developer from Cal-Bay, who spent a week teaching him LabView best practices, he said, "I comfortably hit the working prototype in the four-months target." He added, "Visica 2 went from a requirements document to first revenue in 14 months, which is pretty good for an invasive medical device. The *Wall Street Journal* awarded Visica 2 the runner-up prize for medical devices in its 2008 Technology Innovation competition [Ref. 3]."

Higher levels of abstraction

The Visica 2 project was one that was completed without the intervention of traditional embedded-system designers. But that may be the exception that proves the rule. Tung at The MathWorks elaborated, "Think about the 'good old days'—if you wanted high-performance software running on your desktop, you had to write in assembler." Subsequently, he said, "optimizing compilers have reduced the need for people to work at that level, so they are able to work at a higher level of abstraction—let's say C code."

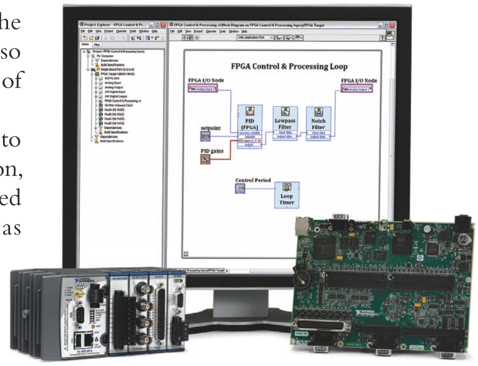
Domain experts, Tung said, will want to work at an even higher level of abstraction, with Simulink, for example, and he added that automatic code generation has reached the point where the resulting code is efficient enough in terms of memory and provides sufficient throughput to satisfy many applications. "However," he said, "there are still times when you need to really tune and optimize that implementation, so the need in an embedded system for somebody to write in C code hasn't gone away."

Tung added, "If I am gong to write something and really fine-tune it at the C code level, I only want to do that once. If I'm going to hand write something, then a high-level modeling language, like Simulink, should be able to encapsulate it and make it available to the system-level engineers so they can look at the design exploration tradeoffs and make a much more informed decision. And [the encapsulation] facilitates reuse."

Domain experts vs. systems architects

As did Tanzillo at NI, Tung distinguished between domain experts and systems engineers or architects. Although NI promotes LabView for both, Tung said that domain experts working at the algorithmic level would more often use Matlab, while of Simulink users, he said, "I think in an increasing number of cases they will be multidomain in their perspective."

Tung also noted that apart from performing system design, users of high-level tools can leverage them to perform verification. He explained, "Let's take a case in automotive suspension systems. You'll have the model of the suspension systems and the algorithms that will be describing the damping and other behaviors, but you will also have the portion of the models that will be describing road surfaces, vehicle dynamics, driver behavior, and all the other things important to understanding if the suspension will do what you want. One portion of the models that describes the suspension system can automatically generate the code that goes into the microcontroller, and it ships as part of the car. The other portion of



Traditionally having served test applications, the LabView graphical design environment is taking on design chores for embedded systems. Potential hardware targets include the modular CompactRIO and the Single-Board RIO.
Courtesy of National Instruments.

the models essentially becomes the basis for the test bed—you essentially generate code for that other portion of the models comprising the road surface, the vehicle dynamics, and the driver, and you run that in a real-time HIL system that essentially is the test bed."

Fly-by-wire at Bell Helicopter

I asked David King, principal engineer at Bell Helicopter, about trends with domain experts. He said, "Looking back 15 years when we did some of our legacy fly-by-wire development programs, we had a much larger proportion of specialists for low-level programming languages on our team. Now if we look at the proportion of the team, the majority of them are not well versed in the low-level languages, but they are more or less system-level engineers using the model-based design process." He said the shift seems to be gradual, and in good news for embedded-system designers, he added, "I don't see that we are dropping our number of specialists in the programming languages, but we are growing on the systems side, so the proportion is changing."

King is currently working on the Bell/Agusta Aerospace BA609 aircraft project, which he described as the world's first commercial, nine-passenger, tilt-rotor vehicle. The 609 program provides some perspective, he said: "We started with model-based design 11 years ago, in the summer of 1998. That was even before the term 'model-based design' was coined. What we did was put together a process using Matlab and Simulink to try to take out some of the manual steps in the process, such as hand coding from design data. And the one thing that's interesting is it's not just hand coding for the embedded source code, but it was the hand coding for all the analytical tools that are used to analyze the various aspects of the aircraft and system performance," including simulation, development of the test cases, and verification.

King said Bell still uses hand-coded embedded software in the flight-control computers on the aircraft but uses the autocoded models for all the analytical tools to perform simulation, structural analysis, stability analysis, and test-case generation, all of which, he said, represented "a big chunk of the workload."

King added, "I am really seeing the benefit of model-based design in that we can have one model of the aircraft and the flight-control system that is in a very usable format, and that model is used by various disciplines to do analysis. For example, we use it for simulation to analyze dynamic loads and to analyze handling qualities. We use it for real-time simulation with the pilot in the loop, and we also use it for non-real-time evaluation when we are checking stability and control characteristics."

King indicated he expects the trend toward an increasing emphasis on high-level tools to continue, noting, "If you look at the toolset and the maturity of the tools that The MathWorks produces and that the industry is using now, they've progressed quite a bit since we started [the 609] program 11 years ago. For our next programs, we are looking at additional automated steps, including [generating the] embedded software." T&MW

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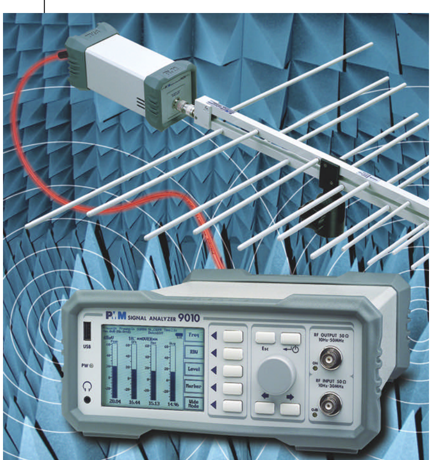
A version of this article appeared in the July 9 issue of EDN.

PRODUCTUPDATE

Digital EMI receiver enables CISPR 16 measurements

The PMM 9010 digital EMI receiver from Teseq lets you perform emissions testing from 30 MHz to 6 GHz. The receiver makes measurements in the time domain, digitizes them, and converts them to the frequency domain. You can use the PMM 9010 to make measurements that comply with CISPR 16-1-1, including the new RMS-AVG (root mean square-average) detector and APD (amplitude probability distribution) for testing above 1 GHz.

The PMM 9010 includes a fully compliant CISPR 14-1 click-meter option, which automatically evaluates the click rate and applies the use of exceptions when applicable. The instrument uses the upper-quartile method for making click measurements.



Because of its digital-signal processing, the PMM 9010 lets you swap out components such as the ADC and RF signal generator. You can replace system firmware to add measurement features such as detectors, resolution bandwidth filters, and other measurement methods as they become available.

Base price $17,500. *Teseq, www.teseq.com.*

Anritsu introduces 4G handheld base-station analyzer

Anritsu has introduced the BTS Master MT8221B, a handheld base-station analyzer that supports emerging 4G standards as well as installed 2G/3G networks. The MT8221B's platform provides a 20-MHz demodulation capability to measure technologies such as LTE and WiMAX, and it offers a 30-MHz zero-span IF output for external demodulation of virtually any other wideband signal. In addition, the company offers a vector-signal-generator option that can generate two modulated signals plus noise for receiver testing.

The instrument detects key performance indicators, such as dropped calls, call denial, or call-blocking rates caused by a malfunction at the cell site or by interference, and it can measure the RF quality and modulation quality of a wireless signal to verify the performance of virtually every subsystem in a base station's transmitter. Technicians and engineers can use the BTS Master MT8221B to conduct line sweeps, analyze components and antennas, troubleshoot down to a field-replaceable unit in a base station, verify the performance of a cell site's backhaul lines, and locate hard-to-find interference problems. Downlink OTA quality tests verify the performance of the downlink with the OTA scanners.

The BTS Master comes with the MST (Master Software Tools) package that allows data acquired by the analyzer to be easily transferred to a computer. MST saves time generating reports by using a trace-rename utility and a group-edit function. The MST Folder Spectrogram's 3-D view allows users to zoom into a week's worth of acquired data and provides independent three-axis rotation control. The software also provides a remote access tool for monitoring and controlling the BTS Master over the Internet.

Base price: $19,950. *Anritsu, www.us.anritsu.com.*

Cascade Microtech addresses power semiconductors and RFICs

Cascade Microtech is addressing the emerging energy-efficiency standards that are driving the need for accurate power-device characterization in automotive, mobile-device, transportation, and other applications. In addition, the company is targeting probing for millimeter-wave RFICs that will serve applications operating in the 60- to 80-GHz range.

To address power-characterization needs, the company has introduced a set of new probes and accessories for its Tesla on-wafer power-device characterization system, making Tesla fully compatible with the recently released Agilent Technologies' B1505A power-device analyzer. The combined system offers an extended triaxial mea-

surement range to accommodate low-noise probing of power devices up to 2000 V.

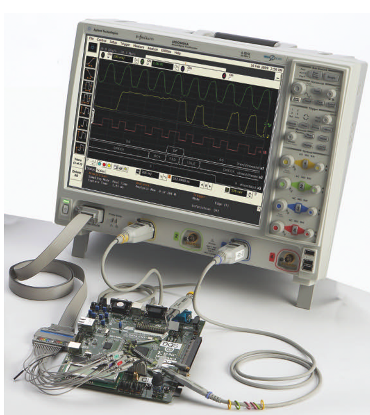
The Tesla system meets these demands for making measurements at increasing voltage and current levels when characterizing devices fabricated using new wide-band-gap materials such as SiC and GaN. Tesla offers what the company says is the industry's highest voltage and current range for on-wafer measurements: up to 2000 V triax or 3000 V coax, and up to 60 A pulsed or 20 A continuous.

Cascade has also released two products that streamline engineering and production testing of high-bandwidth, short-range RFIC devices for WirelessHD, automotive radar, and other 60-GHz wireless applications. Using a combination of Cascade Microtech's thin-film technology and coaxial probe technology from its Infinity Probe architecture, the 110-GHz Unity-MW millimeter-wave RFIC engineering probe (**pictured**) supports the precision characterization and testing of these multiple-port emerging technologies. Using the same membrane technology, the Pyramid-MW 81-GHz production probe card supports the at-speed test of known-good-die in high volumes.

Cascade Microtech, www.cascademicrotech.com.

Large-screen MSOs go to 4 GHz

Agilent Technologies' Infiniium 9000 series of mixed-signal oscilloscopes include six models, all with 15-in. (38.1-cm) displays. At just 9-in. (22.9-cm) deep, the instruments include four analog and 16 logic channels with bandwidths from 1 GHz to 4 GHz. Logic channels sample at up to 2 Gsamples/s. All models sample the analog channels at 10 Gsamples/s on all channels and 20 Gsamples/s when running two channels. Standard memory is 10 Msamples or 20 Msamples, respectively.



Applications for the 9000 series include USB 2.0 compliance tests, Ethernet eye masks, jitter analysis, and DDR memory compliance tests, and Matlab software is available as an option.

Base prices: $19,900 (DSO9104A) to $41,500 (MSO9404A). *Agilent Technologies, www.agilent.com/find/9000.*

MACHINE-VISION&INSPECTION

TEST REPORT

Machine-vision lighting improves

By Ann R. Thryft, Contributing Technical Editor

In many machine-vision applications, LEDs have begun to replace halogen bulbs as the lighting source in fiber-optic light guides. Carl VanDommelen, business manager for machine vision for Schott North America's Lighting and Imaging division, commented on the advantages of LEDs and how they produce brighter illumination while consuming less power.

Q: During what parts of the semiconductor and electronics inspection process is lighting needed?

A: Lighting is needed wherever machine vision is used, at any of several steps throughout the manufacturing process. I divide the use of machine vision, and therefore lighting, into two main categories: process control and inspection. In process control, machine vision provides positional and dimensional information to the manufacturing equipment. In inspection, the focus is on whether or not the product conforms to its design within manufacturer-specified tolerances. Is the product within specification? Does it have any visual defects that may indicate a functional problem?

Q: What types of lighting techniques are needed for electronics inspection?

A: Lighting techniques depend primarily on the features you are looking for and how you can best separate them from their backgrounds. For example, are you measuring something, trying to recognize a particular pattern, or looking for particular defects? Techniques include bright field, dark field, rear or back illumination, directional, and diffuse lighting. These may also require different light characteristics, including specific wavelengths, structured or coherent lighting, polarization, and strobing. Lighting vendors must thus have a large product portfolio that includes different light sources and configurations such as rings, light lines, spotlights, backlights, diffuse domes, and coaxial illuminators.

Q: What are some recent changes in lighting technology?

A: High-brightness LEDs are becoming readily available at intensities that let them directly replace more traditional light sources. Their main advantages are longer lifetime, low heat generation, and low power consumption. In addition, chip-on-board LEDs allow for very small and uniform LED configurations, such as a row. Unless diffused, however, even the smallest LED array can appear as an individual point source when illuminating a reflective part, such as a silicon wafer. By coupling an LED light source to a fiber-optic light guide, we can reduce or almost eliminate this effect entirely. The pairing of these two technologies will improve performance in machine-vision systems.

Carl VanDommelen
Business Manager for
Machine Vision
Lighting and Imaging Division
Schott North America

Q: Why use an LED-based fiber-optic light source?

A: Combining fiber-optic light guides with an LED light source is somewhat new in machine-vision lighting. Until recently, LED brightness has not been sufficient in arrays small enough for use with fiber light guides. For example, the latest generation of our LLS (LED Light Source) improves brightness by two to three times over the previous version, and it is actually brighter than some of our halogen light sources. The power consumption of our LLS is about $1/10$ to $1/8$ of a halogen bulb's, and lifetimes can be 20 times longer or more. In addition, it is easily serviced. This ultimately translates to lower costs of ownership and operation. □

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EDITOR'S NOTE

GigE connectivity expands

By Ann R. Thryft
Contributing Technical Editor

Connectivity themes are in the news. Smart cameras are not only getting smarter and easier to use, but also more connected. The gap has been closing between the interface choices available for smart cameras versus those available in PCs. Now, more smart cameras feature not only IEEE 1394 and Ethernet interfaces, but GigE Vision interfaces, too, which means that they no longer need a frame grabber.

The main reason for this expansion of connectivity is the fact that manufacturers of smart cameras are increasingly taking advantage of high-performance general-purpose processors and the much bigger array of ports accompanying them on the processor card. That's the same reason smart cameras are getting easier to use: Industry-standard development software and tools already available for those processors can now be aimed at developing machine-vision applications for smart cameras as well as for PC-based vision systems (p. 42).

Meanwhile, in other machine-vision connectivity news, the Automated Imaging Association has issued its first update to the GigE Vision spec since the standard was originally released (p. 45). Although Version 1.1 is a minor release, there are more changes coming: Versions 1.2 and 2.0 are not far off, and the 2.0 spec will incorporate support for 10 GigE. □

Contact Ann R. Thryft at ann@tmworld.com.

HIGHLIGHTS

Vision Engineering unveils video measuring microscope

The Falcon three-axis noncontact video measuring system from Vision Engineering employs high-resolution indexed zoom optics (up to 100X magnification) to provide enhanced component-edge definition. An indexed camera-iris control reduces depth of field, increasing accuracy and repeatability of z-axis results.

The Falcon system offers controllable-quadrant LED illumination, motorized z-axis control, and a touch-screen display, and its precision measuring stages provide a measurement area of up to 150x150x115 mm. www.visioneng.com.

USB camera employs 1.3-Mpixel sensor

Joining the Firefly MV line of FireWire and USB digital cameras, the FMVU-13S2C from Point Grey Research is based on a color version of Sony's IMX035 ⅓-in. CMOS image sensor. The FMVU-13S2C achieves rates of 23 fps at its full resolution of 1328x1048 pixels, 60 fps at 664x524 pixels, and 60 fps at 640x480 pixels. Its USB 2.0 digital interface allows users to plug the camera directly into a computer. The camera is equipped with a CS-mount lens holder, removable IR cut filter, and a seven-pin I/O connector that can be used to synchronize the camera to a device such as a trigger or light source. www.ptgrey.com.

Aviator cameras enter production

Basler Vision Technologies has begun production of its Aviator camera, which the company introduced last fall. Based on Kodak's KAI-1050 CCD sensor with a resolution of 1024x1024 pixels, the camera series operates at 120 fps. With its progressive-scan readout, global shutter technology, and Camera Link interface, the Aviator is suited for applications in semiconductor and electronics manufacturing, metrology, and medical imaging. www.baslerweb.com.

3M rolls out PoCL cables

3M Electronic Solutions Division now offers cabling for high-performance digital camera applications. The high-speed 0.8-mm cable assemblies are based on the PoCL (Power over Camera Link) base configuration for machine-vision applications. According to 3M, the cable assemblies offer high performance and reliability, even in tough industrial settings. www.3minterconnects.com.

MVTec enhances Halcon library

Release 9.0.1 of Halcon, MVTec's software library for machine vision, now provides a silent installer that makes it possible to install the Halcon run-time version under Windows without any user interaction. According to MVTec, the silent installer can automatically roll out Halcon-based application software on many computers and eases the remote maintenance of machines if the software must be updated. In addition, a new 3-D visualization mode in Halcon's HDevelop integrated development environment is especially suited for interactively inspecting distant images.

Halcon is platform-independent and compatible with Windows, Linux, and Solaris. It includes functions for blob analysis, morphology, pattern matching, measuring, 3-D object recognition, and binocular stereo vision. www.halcon.com.

Analyzing prober defects in-line

By Ann R. Thryft, Contributing Technical Editor

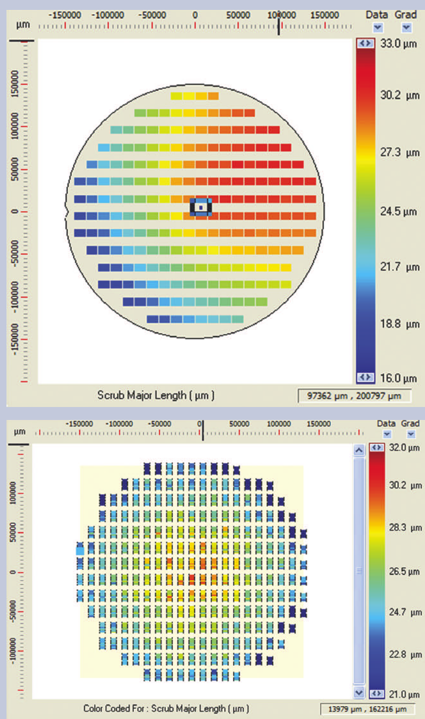
As shrinking die size has caused a reduction in the size of bond pads used as contacts during electrical testing, there is less room for error in the electrical probing process. This situation has prompted some semiconductor manufacturers to begin using probe-mark analysis, in addition to probe-mark inspection, to uncover the source of errors caused by their probing equipment.

"When you inspect a single probe mark, all you see is the resulting total error of the probing process," said Darren James, product manager, probe card test and analysis for Rudolph Technologies. "Being able to identify the origin of an error will help you improve that piece of the process." Three main types of equipment in the probing process can contribute to the total error: prober, probe card, and setup or interface.

"One of the best ways to take cost out of semiconductor manufacturing in the back end is to monitor and improve back-end processes to make sure you're not throwing away or retesting die because of prober or tester issues," said James. "Users of test and prober systems need a process that flags those issues in advance of failures."

Most manufacturers monitor their probing process only after failures have occurred, often by examining yield bins to determine lower yields in a particular prober card. These checks only indicate whether the wafer is good or bad, and do not measure the overall health of the process.

To automate and speed up the analysis of the probing process, Rudolph has integrated the WaferWoRx system it acquired from Applied Precision in 2007 with its NSX macro inspection tool. The combined system analyzes the probing process in-line, enabling manufacturers to detect defects created during manufacturing, probing, bumping, dicing, or handling. The NSX system uses optical microscopy to detect and record information about probe marks, such as their location and size, and the WaferWoRx system analyzes the data to identify the source of probe errors (prober, probe card, or setup).

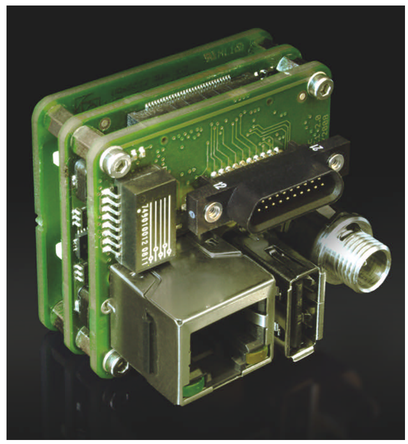


(Top) This wafer map from the NSX system with WaferWoRx shows the average probe mark length per die based on raw data. (Bottom) To evaluate the performance of the probe card, the software aggregates the raw data, removes errors caused by the prober and the setup, and normalizes the remaining probe marks. Courtesy of Rudolph Technologies.

Bringing control in-line saves time and increases precision, said James. "What was once an off-line sampling procedure that required extra time and equipment is now part of a high-throughput in-line system that can be used to identify the root cause of the failure and accelerate its resolution." □

Smart cameras get smarter, easier to use

By Ann R. Thryft, Contributing Technical Editor



Developers can transfer their own algorithms to Linux-based, open-source intelligent cameras such as this one from VRmagic. Courtesy of Stemmer Imaging and VRmagic.

Smart cameras are becoming smarter as the processors upon which their intelligence is based gain computing power and as more powerful sensors provide better image quality. Smart cameras are also becoming smaller, more integrated, and easier to use.

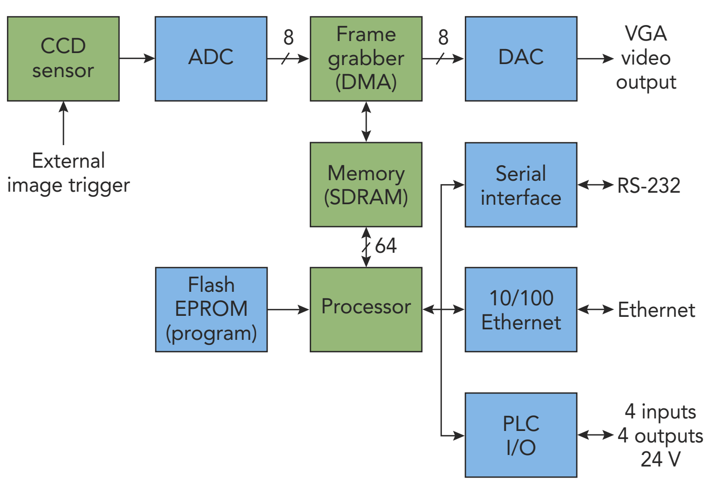
In contrast to standard machine-vision cameras, a smart camera includes some kind of computing module with local memory, a sensor, and often a frame grabber, as well as a communication module with interfaces such as Ethernet, digital I/O, and perhaps a serial port, said Matrox Imaging's Fabio Perelli, product manager for smart cameras. Although smart cameras often use FPGAs (field-programmable gate arrays) or DSPs (digital signal processors) for their intelligence, general-purpose processors such as the Intel Atom are becoming more common because they increase processing power and make cameras simpler to use.

As DSP chip performance has increased, image sensors have also improved. Many sensors can now run complex, performance-intensive algorithms that previously required a PC-based vision system, said Narayan Subramaniam, product manager for Cognex' vision systems business unit. For example, the company's pattern-recognition algorithm used to be available only on a PC, but now it's available on even entry-level smart cameras.

Aside from components, the other major difference between smart cameras and standard cameras is the fact that smart cameras require software, said Patrick Gailer, business development manager for Stemmer Imaging. "[Smart cameras] can range from one that is extremely easy to use, such as a low-end camera with point-and-click software, to a Linux-based, open-source, 'naked' smart camera that requires you to build your own software."

A smart camera's basic software is a shell or operating system, and most are sold with preloaded application software for system integrators or end users, said Endre Toth, business development manager for Vision Components. "Since we are mainly an OEM provider of board-level and packaged smart cameras, most of our smart cameras come only with basic software," he said. Customers can also use an optional, open-source machine-vision software package that runs on all of the company's cameras and is used in semiconductor and electronics inspection.

Although plain machine-vision cameras can also perform image processing, the processing is usually done with an FPGA, said Michael Schwaer, product manager at Basler Vision Technologies. Machine-vision cameras need a PC to evaluate the captured images, but a smart camera does not. Compared to PC-based systems, smart cameras are cheaper, easier to use, take up less space, and need less system integration. A PC-based vision system usually requires more effort from the system engineer, since it needs more complex wiring between its components. "A smart camera is easy to integrate because the PC is already inside," he said. "Only a digital I/O cable has to be installed; no further



A typical smart camera acquires, converts, and digitizes an image; places it into memory; processes the image and extracts information from it; and then outputs the result. Courtesy of Vision Components.

cable for monitor or keyboard is needed."

In contrast to smart cameras, PC-based vision systems involve a frame grabber and software running on a PC, said Subramaniam. They target very different types of applications. "For example, in solar-cell inspection, if all you want to do is detect edge cracks or perhaps discontinuities in the bus bars, you don't need very high resolutions, so a smart camera fits in well," he said. "The maximum resolution in our smart cameras is 1600x1200 pixels. However, if you are trying to detect pinholes or the grain pattern on a solar wafer, you need the higher resolution of a PC-based system."

Schwaer said that smart cameras are a good fit for applications that require only a moderate amount of CPU performance; examples include bar-code reading and number-plate detection, which use algorithms like edge detection or blob analysis merely to compute a result. In contrast, a PC-based system is a better fit for applications that need high resolution and high frame rates, such as web inspection.

With faster, low-power processors such as the Intel Atom, the types of applications engineers can address with smart cameras increases, said Stemmer's Gailer. "But whenever you need more processing power, you will fall back on the PC side," he said. "Both will coexist for a long time."

Basler's eXcite smart cameras, shown with a heat sink (left) and a contact plane (right), are equipped with 64-bit, 1-GHz MIPS processors.

Courtesy of Basler Vision Technologies.

Smart cameras such as Matrox Imaging's Iris GT are beginning to incorporate general-purpose processors like the Intel Atom that improve the cameras' ease of use.

Courtesy of Matrox Imaging.

Weighing costs

Entry-level systems based on smart cameras, not PCs, may be cheaper to purchase, but as the vision system's resolution and processing power increase, PC-based systems usually become less expensive. If a vision system needs several cameras, a PC is more cost effective because it can handle multiple cameras in a single system, said Perelli of Matrox Imaging. Implementing multiple smart cameras makes the cost go up faster, because each of them costs more than a traditional camera.

"Let's say you need to accommodate three different levels of inspection: an entry-level system with two cameras looking at a PCB [printed-circuit board], an intermediate solution that adds another camera for some additional inspection steps, and a deluxe level with many cameras," Perelli said. "If you have a PC-based solution, you need the largest, highest-performance PC to handle the deluxe level." But you will also use that same powerful PC on the simplest level, so as an entry-level solution, it would cost you more and have higher overhead than if you just used two smart cameras for your entry-level system. "With a system based on smart cameras, you only need to add one camera to increase your level of inspection, so your cost increment is more linear," explained Perelli.

Smart cameras have gotten easier to network, as many of them now feature Ethernet or IEEE 1394 interfaces. In addition, the proliferation of open standards has helped foster more acceptance of smart cameras on the factory floor, said Subramaniam of Cognex. "Most of our smart cameras can take advantage of common protocols such as DeviceNet, Profibus, OPC [OLE for Process Control], and ActiveX."

Linescan smart cameras, such as the In-Sight 5604 from Cognex, are still relatively new, and are especially useful in applications that call for lower resolutions. Courtesy of Cognex.

A recent trend is the development of open-source smart cameras, such as Supercomputing Systems' smart camera based on open-source hardware and software (Ref. 1). An open-source architecture gives users the flexibility to extend and modify the base behavior of the software package, said Subramaniam. "Open-source systems that leverage customization of the software package are usually most appropriate for applications where hundreds of systems can be programmed to do the same task, so the software development support and change management costs of customization can be amortized effectively. But for the general smart-camera marketplace, the open-source model is still a small niche."

Open-source smart cameras have definite uses, mainly for big OEMs building their own inspection systems that will be used many times for the same high-volume applications, said Gailer. Engineers do need to know how to program them. "But once you've done all that—the programming and all the development work—then you have a relatively inexpensive system," he said.

The smaller real estate of a smart camera is one benefit for system integrators, said Vision Components' Toth. Others include reduced cabling and the concomitant cost savings, less hardware complexity, less cooling, and only one unit to change during upgrading or troubleshooting. Smart cameras are definitely getting smaller and integrating more functions. "An even stronger trend is the same size camera containing even higher-resolution sensors, more memory, and increased computing power," he said.

Because of heat-dissipation issues, however, smaller cameras are not always desirable, said Gailer of Stemmer. In semiconductor inspection applications, many customers are still using old-fashioned analog cameras because they do the job and there's no need to change the technology. On the other hand, Gailer said, "Windows-based PC systems are becoming so small, such as the handheld ultra-mobile PCs, that you could connect a dumb camera to one of them with a cable, and you would have exactly the same solution as a smart camera: It would be the same size, it would cost less because of the high volumes, and the only additional cost would be the cable." □

REFERENCE

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GigE Vision update heralds more changes

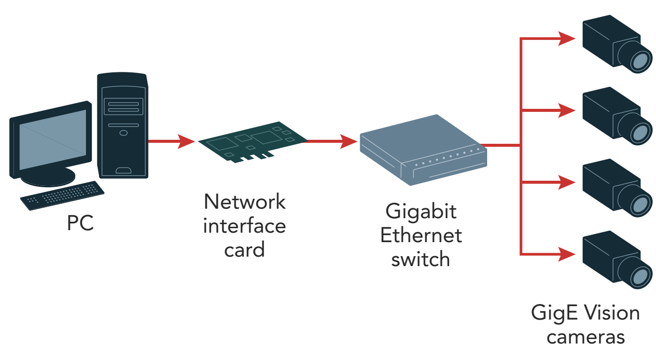
By Ann R. Thryft, Contributing Technical Editor

Changes are brewing in the GigE Vision camera interface standard. In April, the AIA (Automated Imaging Association) issued release version 1.1. Although a minor update, this is the first since the standard was introduced in 2006, and more changes are in the works. The GigE Vision standard committee plans to release another update, version 1.2, by the end of this year, said committee chair Eric Carey, who is also director of R&D for Dalsa, and he added that by the end of 2010, the committee expects to provide support for 10 GigE in version 2.0.

The GigE Vision standard defines an interface that can transfer data at rates of 1 Gbps over cables of up to 100 m in length. Version 1.1 introduces several changes, according to Carey. The standard now offers better support for syncing multiple cameras so they can simultaneously capture an image of the same object. New commands let a PC broadcast the action command to multiple devices on the network (see **figure**). "Since most systems use only one or two Ethernet switches, any network latencies will likely be minimal," he said.

New types of support for the European Machine Vision Association's GenICam schema and GenAPI programming interface have also been added. GigE Vision 1.0 included an XML file description based on GenICam 1.0. But several updates to GenICam introduced support for new data types into this XML file description, said Carey. "GigE Vision 1.1 allows the GigE camera to provide multiple XML files, each tagged to the corresponding GenICam version."

Version 1.1 also adds four other features, Carey said. The first provides a standardized way to identify the speed of the Ethernet link: A register reports whether link speed is 100 Mbps or 1 Gbps. Another feature helps applications open a UDP (User Datagram Protocol) port in order to get around PC firewalls so the camera can send images to the PC. New pixel formats include Bayer pixel formats and 14-bit monochrome, bringing the number of standardized pixel formats covered by version 1.1 to 52. "With support for all of these, the camera and the software can understand many specialized pixel formats, which is one of the requirements for improving interoperability," he said.



GigE Vision Version 1.1 lets the PC broadcast an action command to multiple network devices, enabling synchronized software triggers for simultaneous image capture. Courtesy of Dalsa.

Error-handling features added in version 1.1 include more descriptions and some new status and error codes, said Carey. One is a code that helps explain linescan camera operation to applications. In particular, when the belt carrying items to be photographed slows too much or stops, the camera's output stops. "This can make data acquisition proceed so slowly that you actually exceed the time-out needed to receive the packets, but you often don't know what the problem is," he said.

In addition to the cameras supported in GigE Vision 1.0 and 1.1, GigE Vision 1.2 will also support nonstreamable devices, such as strobe lights, said Carey. Devices that will not return images to the PC could be attached to the network using the same switch as the GigE Vision camera. "With the same API [application programming interface], control protocol, and GenICam XML file description, you can configure the registers of either the camera or the strobe light," he said. "Instead of integrating SDKs [software development kits] from different vendors, you can control all of your GigE Vision devices on the network and simplify your software."

The AIA's High-Speed Transmission subcommittee, which is investigating technologies with speeds faster than Camera Link, is studying how to provide support for the IEEE's 10 GigE standard. The subcommittee expects to get draft proposals in 2009 and review them in 2010, said Carey. "We may investigate integrating the IEEE spec's link-aggregation features into GigE Vision. Although 10 GigE's speed is about the same as Camera Link's, at around 650 Mbytes/s, aggregating 10 GigE links would give us a way to go far beyond that without waiting for the next Ethernet speed step, which is probably 100 GigE." Aside from increasing the raw speed of the link, the committee is also studying data-compression techniques. □

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VOL. 29, NO. 7

Subscription Policy

Test & Measurement World® (ISSN 0744-1657) (GST Reg.# 123397457) is published monthly except January by Reed Business Information, 8878 S. Barrons Blvd., Highlands Ranch, CO 80129-2345. Reed Business Information, a division of Reed Elsevier, is located at 360 Park Avenue, New York, NY 10010. Tad Smith, CEO. Periodicals postage paid at Littleton, CO 80126, and additional mailing offices. Circulation records are maintained at Reed Business Information, 8878 S. Barrons Blvd., Highlands Ranch, CO 80129-2345. Telephone: 800-446-6551. **POSTMASTER: Send address changes to** Test & Measurement World®, P.O. Box 7500, Highlands Ranch, CO 80163-7500. **For Canada:** Publications Mail Agreement No. 40685520. Return undeliverable Canadian addresses to: RCS International, Box 697 STN A, Windsor Ontario N9A 6N4. Email: Subsmail@ReedBusiness.com. *Test & Measurement World*® copyright 2009 by Reed Elsevier Inc. Rates for non-qualified one-year subscriptions, including all issues: US, $110.99; Canada, $159.99 (includes 7% GST, GST# 123397457); Mexico, $159.99; International (Priority), $219.99. Except for special issues where price changes are indicated, single copies are available for $10 (US orders) and $15 (foreign orders). Buyer's Guide Issue (July) is available for $35 (US orders) and $40 (foreign orders). **Please address all subscription mail to** *Test & Measurement World*®, 8878 S. Barrons Blvd., Highlands Ranch, CO 80129-2345. *Test & Measurement World*® is a registered trademark of Reed Properties Inc., used under license.
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VIEWPOINT

[An exclusive interview with a technical leader]

BRYAN SAYLER
Senior VP and
General Manager
ETS-Lindgren
Cedar Park, TX

Bryan Sayler is a senior VP and general manager at ETS-Lindgren with more than 20 years of experience developing RF test solutions for EMC (electromagnetic compatibility), microwave and wireless testing, EMF (electromagnetic field) measurement, RF personal safety monitoring, and control of acoustic environments. He is an active member of several industry organizations, including the WiMAX Forum and 3GPP for the development of standardized wireless performance measurements. Sayler received his BA degree from Southeastern University and his MBA from Baylor University.

Contributing editor Larry Maloney conducted a phone interview with Bryan Sayler on EMC and wireless testing.

Tools to cure your compliance headaches

Q: Have compliance challenges become tougher for electronics test engineers?

A: The overall compliance environment is getting more complicated as new standards are developed on top of old ones still in force. Design and test engineers often must balance the requirements of competing standards while also trying to improve the performance of ever-smaller devices. At the same time, these engineers must cope with the pressures of shorter development cycles.

Q: What applications are spawning the biggest compliance issues?

A: Because it spans so many market segments, wireless technology has created a lot of compliance concerns, even for companies that aren't in the wireless business. For example, the number of wireless applications in automotive has grown dramatically, and it's absolutely critical that these wireless devices don't interfere with vehicle performance and safety. The same is true of commercial aviation. In the handset market, today's smart phones are loaded down with more and more features, raising concerns about whether all these functions can work together properly.

Q: How does ETS-Lindgren help engineers cope with these challenges?

A: Our company is an expert in dealing with all sorts of radiated energy, including RF and acoustic. Our engineers actively participate in the industry associations that develop standards on radiated energy, both for compliance and performance, and we provide the products that enable customers to measure radiated energy in devices they're developing.

Q: What are some of your most significant new test-related products?

A: A good example is our new line of omnidirectional antennas for tests associated with the new CISPR 16 disturbance and immunity standards. These new EMC standards qualify chamber facilities for above 1-GHz testing.

In the wireless world, we also recently announced an integrated solution that lets device manufacturers test products for compliance with the CTIA's new requirements for OTA (over-the-air) performance testing of A-GPS-enabled mobile devices. Our solution expands our company's AMS-8000 series of antenna-measurement systems, which includes a fully anechoic RF test chamber equipped with DUT (device under test) positioning equipment, antennas, instrumentation, and test-automation software.

In addition, we've introduced some affordable precompliance solutions, such as our portable RF-shielded test cell, the Model 5247. You can move it easily between locations for making OTA performance measurements and production-line measurements.

Q: Are an increasing number of manufacturers outsourcing compliance testing?

A: Most of our manufacturing customers do their own compliance testing. But lately there's been a shift toward outsourcing more EMC and wireless testing to compliance labs. We attribute that trend largely to the pressures on companies to reduce capital spending during the recession. As business picks up, manufacturers typically invest in their own compliance testing facilities to improve time to market. Many smaller companies, of course, can't afford such equipment and therefore outsource this work to a lab. Other customers do their own internal R&D testing but don't maintain the necessary accreditation to do certification testing. For these companies, we offer more affordable precompliance solutions so that they can send products to independent labs for full compliance testing with a high degree of confidence. T&MW

Bryan Sayler addresses more questions on new hardware and software for compliance testing in the online version of this interview: www.tmworld.com/2009_08.