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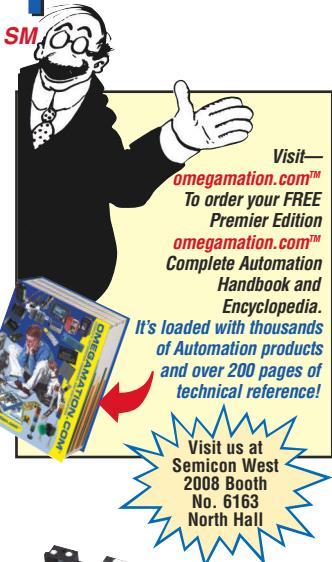
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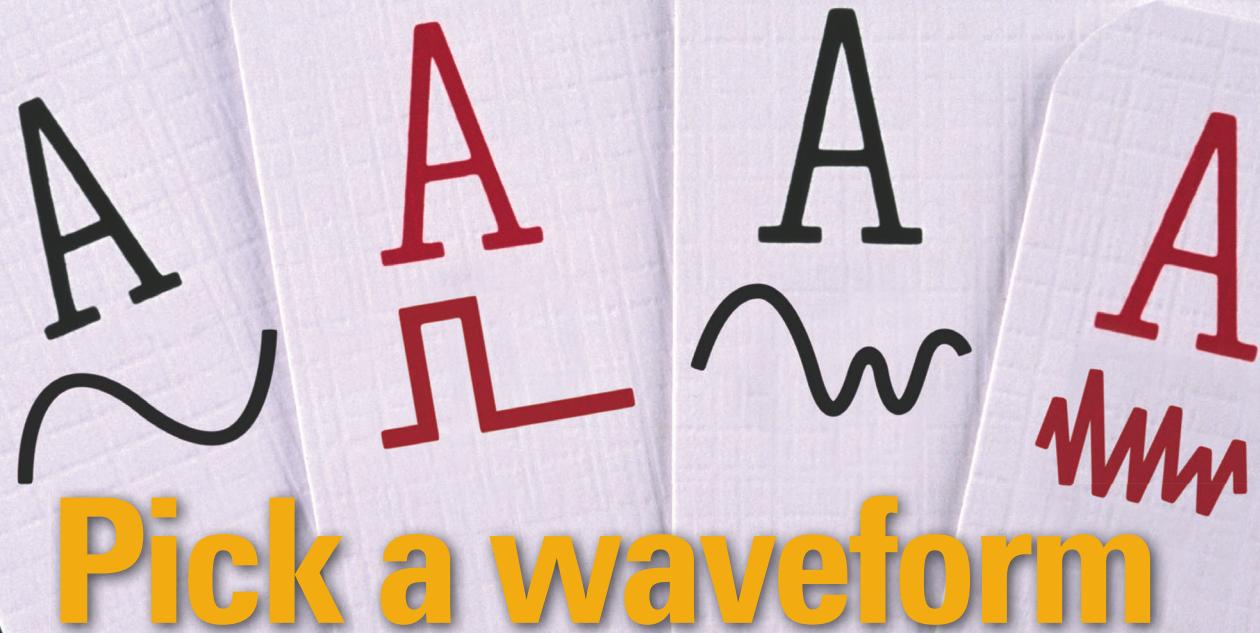
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JULY 2008
VOL. 28 NO. 6



COVER BY: GORDON STUDER

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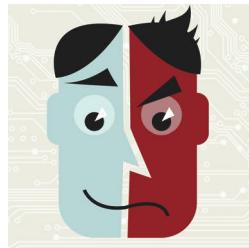
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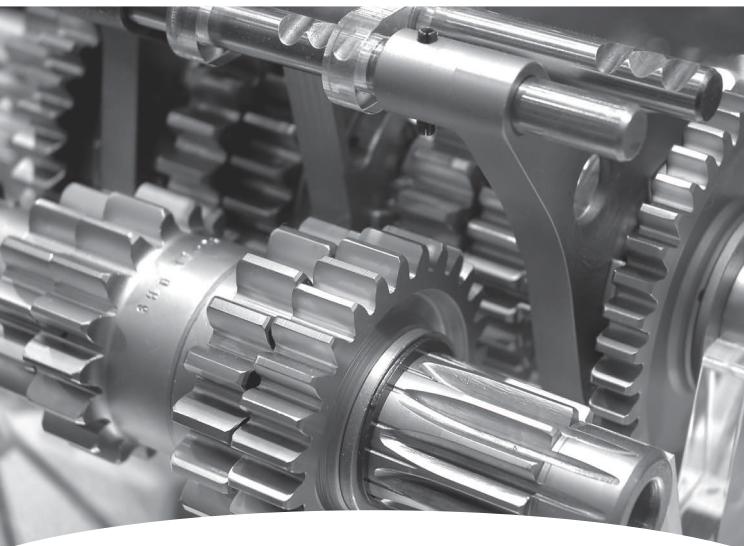
Test's split personality

For the leading companies that provide the instruments for electronics test, the past year produced sharply contrasting results.

By Lawrence D. Maloney, Contributing Editor

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RICK NELSON
EDITOR IN CHIEF



Science vs. technology

I had always wanted to study theoretical physics in college, but my parents thought that a more practical field, such as accounting, would provide a better return on their tuition investment. We compromised, and I studied electrical engineering.

Of course, there needn't be a sharp divide between pure science and applications-oriented engineering. The relationship between the two was addressed by Joseph H. Taylor, the 1993 Nobel Laureate in Physics, in a keynote speech at the IEEE MTT-S International Microwave Symposium on June 17 in Atlanta.

During his talk, titled "Symbiotic Relationships in Technology and Basic Science," Taylor invited the attendees to think about the relationship

Technologists need mathematical descriptions of nature's laws.

of nature's laws to form extrapolations to predict how materials will respond in real-world applications. "It's a two-way street," he said. "Science enables technology, and technology enables science to get done."

Taylor commented that it's only been for the last couple of hundred years, commencing with Michael Faraday's experiments and continuing with Joseph Henry's work on mutual- and self-inductance, that we've had any idea of the relationship of magnetism and electricity. He said that researchers like Faraday and Henry were not engineers, but rather scientists doing research just to acquire understanding.

Indicating the tension that can exist between scientists and engineers, Taylor said that Henry, the first head of the Smithsonian Institution, built

the first telegraph, but as a professor, he didn't get the credit—that went to Samuel F.B. Morse.

Taylor noted that James Clerk Maxwell put into a mathematical framework the experimental observations of others. Maxwell's equations, he said, predict a radiative form of electromagnetic energy, which Heinrich Rudolf Hertz was later able to generate and detect. It wasn't long, Taylor said, until practical radios came into use.

Taylor described his work with the large radio telescope at Arecibo, Puerto Rico, recounting the 1974 discovery of a binary pulsar and the observations on that pulsar that confirm Albert Einstein's prediction that objects accelerated in a strong gravitational field emit gravitational waves. The pulsar's relativistic velocities of one tenth the speed of light, Taylor said, afforded an opportunity to test predictions that the pulsar's orbit should shrink by 1 mm per orbit.

"It was the ultimate in scientific chutzpah," Taylor said, "to think that we could make that measurement from 25,000 light-years away." But he added that very-high-bandwidth, low-noise receiver front ends developed by engineers helped make the feat possible. Such discoveries, he concluded, would not have been possible without healthy and continual interaction between scientists and engineers.

I would agree with that. My only quibble might be in Taylor's drawing of such a sharp line between pure science and applied engineering. Samuel F.B. Morse was not an engineer; he was a painter who had a serendipitous encounter with the experimenter Charles Thomas Jackson that led to a practical telegraph. And Taylor did acknowledge that there is crossover in which scientists may turn to engineering, and vice versa. The important thing, he said, is to find a position for which you can't wait to get up in the morning and get to work. T&MW

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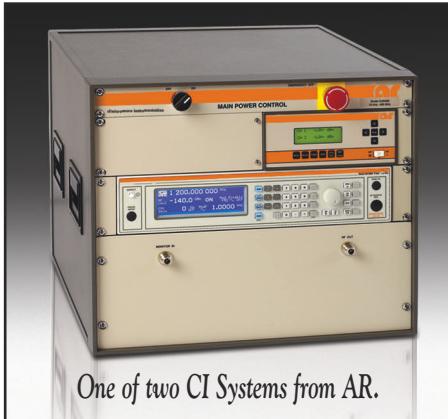
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T&M Milestones

Rohde & Schwarz: 75 Years of Driving Innovation

Higher, faster, more precise – the T&M industry is almost Olympic in nature, and not only since yesterday. Numerous new technologies and increasingly higher frequencies are challenging T&M. For 75 years now, Rohde & Schwarz has been in business and successfully combining seasoned know-how with strong innovation. And the company's T&M solutions for wireless communications, general electronics and microwave are often ahead of their time. A historical snapshot.

The present – 2008: Rohde & Schwarz is a leading global supplier of T&M equipment for wireless communications and electromagnetic compatibility (EMC). Every second mobile phone is produced or developed using T&M equipment from the Munich-based electronics group. Manufacturers of electronics around the world rely on high-quality products from the T&M expert – regardless whether in spectrum and network analysis, signal generation or power measurement. More than 70 subsidiaries and offices stand ready with direct customer care, and the company's great manufacturing depth translates into maximum quality and precision. But how did all of this start?

We glance back to the year 1932. Even before founding the company, Dr. Lothar Rohde and Dr. Hermann Schwarz developed their first T&M solution: a dissipation factor meter. Starting in autumn 1933, the company launched operations under the name „Physikalisch-Technisches Entwicklungs-

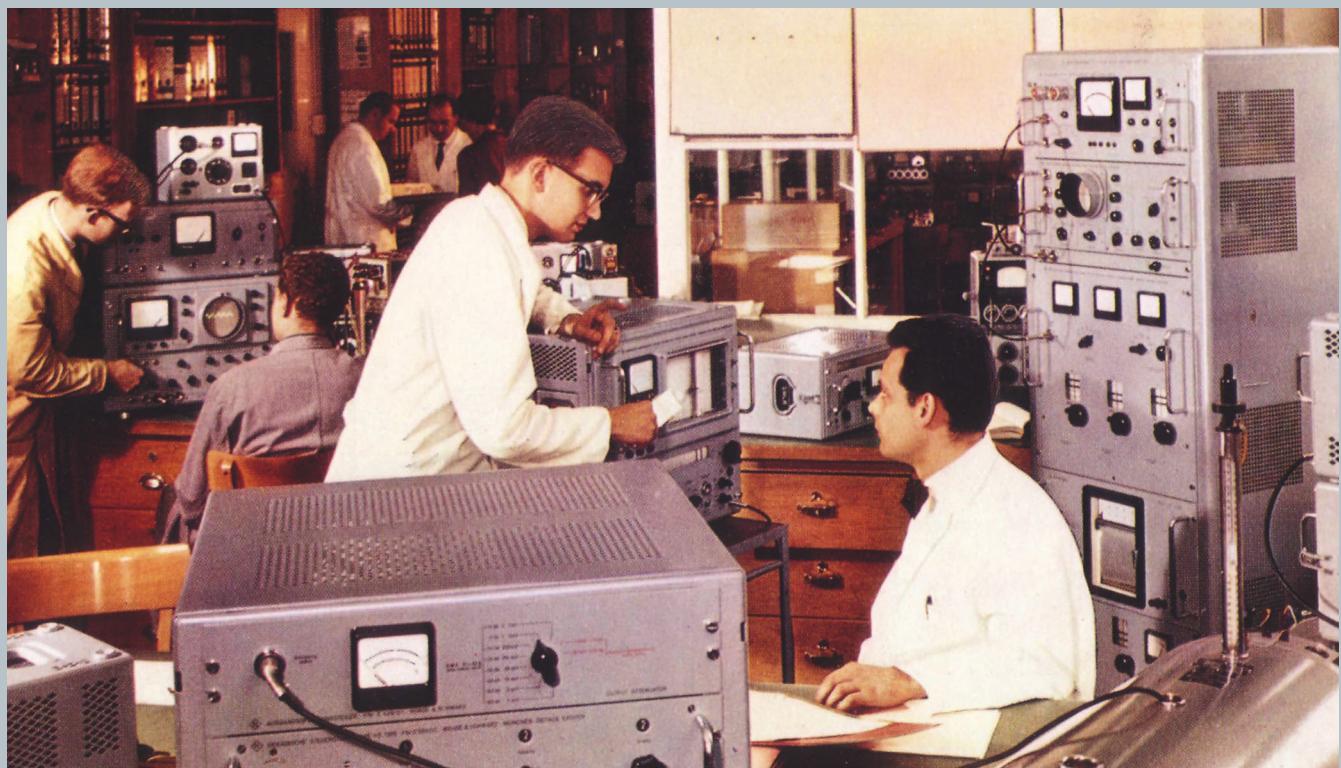
labor Dr. L. Rohde und Dr. H. Schwarz“ – now known as Rohde & Schwarz since the 1940s. The company's first best-seller was the WIP interference wavemeter from 1933, sold throughout the world for more than 20 years.

Since its early days, the company's objective has been to provide customers with cost-efficient solutions and to achieve high integration. To avoid the use of numerous separate test instruments, the company in 1952 developed the URL electronic multimeter – a small, ten kilogram tester. Likewise in the 1950s, the T&M expert became a pioneer in network analysis: The first vector network analyzer worldwide finally made it possible to measure the magnitude and phase of S-parameters and to display them in a Smith chart.

A further highlight from this era was the compact SWOB wideband sweep generator, whose successors were considered a standard in TV set alignment for years to come.

Germany's Wirtschaftswunder (economic miracle) and the continued general evolution of technology led to a strong increase in the number of electronic components and instruments over the following decades. EMC measurements gained in significance. Rohde & Schwarz responded logically by using its expertise in receiver development as a springboard to the field of EMC T&M. In 1987/88, for example, the company equipped Europe's most advanced and largest EMC anechoic chamber in Greding, Germany.

During this phase, Rohde & Schwarz step-by-step gained a solid foothold in further T&M fields. In 1985, the UPA audio



Rohde & Schwarz not only develops and sells T&M instruments – it also uses them in its own labs (picture from 1963).

analyzer rapidly became a standard in audio engineering. In 1982, the SWP became the first synthesized sweeper on the market. And the high-quality SMPC frequency synthesizer also won over customers worldwide with its low single sideband phase noise and high spurious suppression. The company's entry into spectrum analysis followed in 1986 – and, to the surprise of the competition, Rohde & Schwarz bounded into the major leagues in one leap with its FSA. Plus, the story of power and voltage measurement – one of the company's business fields since its founding – stands out owing to numerous innovations. In the mid-1980s, for example, a data memory for calibration data was directly integrated into a power sensor for the first time. In 2002, the world's first USB power sensors were brought to market.

Finally, Rohde & Schwarz has for decades been playing a major role in T&M equipment for the wireless market. By introducing the first GSM system simulator in 1991, the company helped GSM conquer the world. The system helped determine whether mobile phones performed to standard. Since then, test systems and testers from Munich have accompanied all major developments in the wireless industry.

This brief journey through seven and a half decades is now nearing an end. Manufacturers of electronics and wireless companies know Rohde & Schwarz as a supplier of customized solutions. The company's signal generators offer dual-path capability and generate spectrally ultra-pure signals. In network analysis, the product portfolio offers the

economy-priced R&S ZVL vector network analyzer as well as the high-end model up to 50 GHz with four-port architecture. The R&S ESIB and R&S ESU have become fixtures in EMC labs as reference standards for compliance measurements. Users can also find everything they need in spectrum analysis – from a handheld instrument for mobile use all the way up to a 67 GHz analyzer. And in the field of T&M equipment for the wireless sector, Rohde & Schwarz stands shoulder-to-shoulder with other pioneers in next-generation wireless, which is already taking shape with WiMAX and 3GPP LTE. In 2008, the company's sixth-generation wireless testers appeared on the market: The R&S CMW500 embodies decades of combined know-how.

A success story that is far from over.

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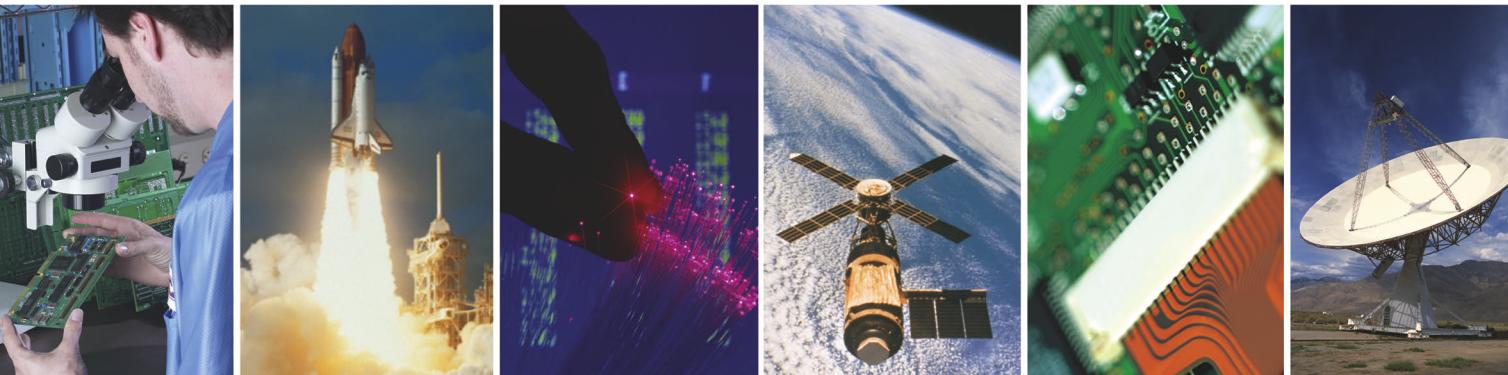
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From design to production

Stewart Wilde is a test-development engineer at International Rectifier. Working in the company's Durham, NC, design center, Wilde is responsible for test programming and design verification for packaged ICs used for power-monitoring and pulse-width-modulation (PWM) applications. Senior technical editor Martin Rowe spoke with Wilde by phone.

Q: When do you get involved in a new product design?

A: I start just after a part has a product objective data sheet, which is a list of specifications that a designer wants to achieve. I begin to formulate a test plan based on specifications for each IC pin. I also take part in design reviews, where I can suggest design-for-test improvements.

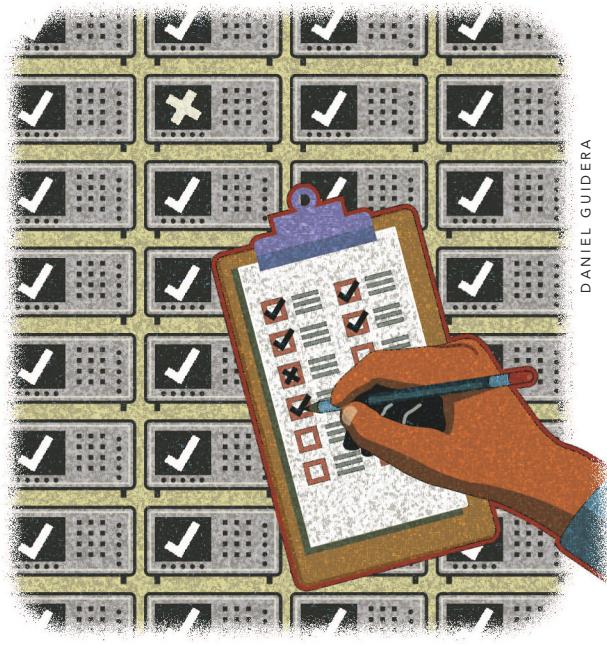
Q: What's involved in developing a test?

A: The test plan spreadsheet contains the parameters for each test. We develop tests for Credence ASL series ATE systems, using the Credence test executive to write test sequences that call out test code. The test code makes calls to test functions provided by the ATE manufacturer. They include force, measure, arm, and trigger.

Our code also maps these functions to the appropriate device pins. We use Microsoft Visual C++ to write the code needed to test each IC pin and debug on one of two ASL systems in the lab. A test plan and code takes several months to develop.

Q: What tests do you perform in design verification?

A: Tests include measuring current consumption, input bias current, reference voltages, and PWM duty cycle. We also measure $R_{DS(on)}$ for field-effect transistor (FET) devices. We measure these parameters over a specified temperature range, looking for unacceptable drift. To perform voltage and current measurements, we use the ATE system's voltage and current sources.



Test parameters range from 20 V at 30 mA to 100 V at 100 A.

The tests are designed to help us find inconsistencies that a design engineer can't predict during design simulation. Sometimes, we run tests that the designer didn't request but we know are necessary based on prior experience.

Q: How many devices do you test in a design validation?

A: We typically test three lots, each with at least 30 devices. The lots are produced at the same factory, but at different times. We look for variations that could be related to the manufacturing process. We also look for measurement variations from devices tested several times with the same test fixture. Then, we change the load board and analyze measurement variations because component tolerances and calibration between the test systems can affect measurements. If we find inconsistent test results, then we may have to write new code. We must make the test results repeatable in production. Furthermore, we've found timing variations between the ASL 1000 and ASL 3000 ATE systems, so we have to compensate for that.

Q: Do you reuse code written for design verification in production?

A: Yes, we reuse most of the test code for production because the production line uses the same ATE systems that we use in the design center. **T&MW**

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

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LeCroy has introduced a new line of WavePro general-purpose oscilloscopes, serial data analyzers, and disk-drive analyzers—the 700Zi series—that feature a 15.3-in. wide-screen display and give you the option of adding a second screen of the same size. In addition, the 700Zi instruments have a removable control panel so you can operate them without looking up from your circuit.

Available in bandwidths from 1.5 GHz to 6 GHz, the instruments provide up to 128 Msamples/channel of waveform memory on four channels and up to 256 Msamples/channel on two. All models contain both 50- Ω and 1-M Ω input capability.

Using LeCroy's X-Stream II technology and a quad-core processor, the WavePro 700Zi can process data at rates up to 750,000 measurements/s. The processor runs 64-bit Windows Vista and has 8 Gbytes of processor memory, large enough to handle real-time calculations on long data records. The 700Zi can run data-processing code written in Java, C, Matlab, or Visual Basic, and you can move data to a PC at 500 Mbytes/s through an optional Cabled PCI Express link.

A TriggerScan feature lets the 700Zi look at a repetitive waveform shape and decide which waveform to store. User-defined parameters set the criteria for data storage. You can then process the data using built-in math functions or with your own code. A mixed-signal option adds digital channels. Prices range from \$23,500 to \$59,490. www.lecroy.com.



Credence and LTX sign merger agreement

Credence Systems and LTX have announced that they have entered into an agreement to combine the two companies in a tax-free, all-stock “merger of equals.” Credence and LTX say the combined company will offer a complementary portfolio of technologies and the largest installed base in the Asia-Pacific region. The new company’s systems will address the test requirements of the wireless, computing, automotive, and entertainment markets.

Lavi Lev, president and CEO of Credence, will become executive chairman of the combined company for a transitional period. David Tacelli, CEO and president of LTX, will become CEO and president; and Mark Gallenberger, CFO and VP of LTX, will become CFO.

The merger is subject to approval by both companies’ stockholders. Under the terms of the agreement, Credence shareholders will own 50.02% of the outstanding shares of the combined company and LTX shareholders will own 49.98%. The boards of directors of both companies have unanimously approved the agreement and recommend their stock-

holders vote in favor of it. Pending regulatory approval, the companies expect the transaction to be completed by the end of September 2008. www.credence.com; www.ltx.com.

Cognex sues MVTEC

Cognex recently announced that it has filed a complaint against MVTEC Software GmbH of Germany as well as its US subsidiary, MVTEC LLC. The com-

Test converged networks

VeriWave has added hardware and software to its WaveTest wired and wireless network-test system. The new hardware—the WaveBlade Ethernet 1104—adds four Ethernet ports. Each port can generate or analyze traffic on 10/100/1000-Gbps Ethernet layer 2 through layer 7, and each port supports up to 500 clients. You can use the WaveBlade to connect the test system to wired Ethernet devices, and then use wireless-interface cards to connect the test system to IEEE 802.11a.b/g/n networks.

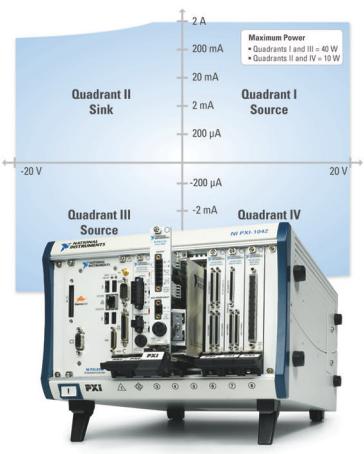
The new WaveQoE software lets the WaveTest system measure end-user Quality of Experience (QoE). You can use it to test wired and wireless edge-network elements such as routers, gateways, security-enabled switches, and network accelerators. The software enables you to create profiles and test conditions that generate mixtures of traffic that simulate actual network conditions. WaveQoE controls traffic-carrying applications such as HTTP, FTP, and TCP protocols for data; VoIP for voice; and MPEG-2 for video. The software also controls traffic flow rate, traffic direction, and traffic load.

Test reporting includes real-time and final results. You can export final results into comma-separated variable or HTML formats. WaveQoS can also generate reports in PDF format.

Prices: WaveBlade Ethernet 1104—\$24,000; WaveQoE—\$6000 per port that the software will control. VeriWave, www.veriwave.com.

Editors' CHOICE

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plaint was filed in the US District Court for the District of Massachusetts in Boston.

The complaint by Cognex alleges that MVTec's Halcon machine-vision software infringes the claims of at least seven Cognex patents. Cognex is asking the court to enjoin MVTec from making and selling the infringing software and is seeking unspecified damages in compensation for past infringement. Fuji America, a company selling semiconductor capital equipment that incorporates MVTec's Halcon software, was also named in the complaint.

Dr. Robert J. Shillman, chairman and CEO of Cognex, said, "Cognex has made a very significant investment in R&D over the years, and we have a responsibility to both our investors and to our customers who have paid for Cognex proprietary technology to protect that investment."

Dr. Olaf Munkelt, managing director of MVTec Software GmbH, issued this statement in response to the lawsuit: "MVTec is ready and committed to defend itself as well as its customers

CALENDAR

IEEE EMC Symposium, August 18–22, Detroit, MI. Sponsored by the EMC Society of the IEEE. www.emc2008.org.

Autotestcon, September 8–11, Salt Lake City, UT. Sponsored by the IEEE. www.autotestcon.com.

International Test Conference, October 26–31, Santa Clara, CA. Sponsored by the IEEE. www.itctestweek.org.

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

against these claims because we believe these claims to be unfounded. MVTec has spent a great amount of resources over the years to invent, develop, and to patent machine-vision technology." www.cognex.com; www.mvtc.com.

VNA analyzes active-device nonlinear behavior

Agilent Technologies has announced nonlinear vector network analyzer (NVNA) capability for its PNA-X microwave network analyzer, which operates from 10 MHz to 26.5 GHz. Requiring minimal external hardware, the Agilent NVNA software effectively converts a four-port PNA-X into a high-performance nonlinear analyzer. The new capability features nonlinear component characterization, nonlinear pulse envelope domain capabilities, and support for nonlinear scattering parameters that Agilent calls X-parameters; it targets engineers designing active RF components.

The instrument's new X-parameter support extends linear scattering parameters (S-parameters) into the nonlinear operating region and enables an accurate portrayal of both nonlinear device and cascaded nonlinear device behavior using measurement-based data. The NVNA can measure the calibrated amplitude and cross-frequency relative phase of measured spectra from 10 MHz to 26.5 GHz to help engineers better understand and control the nonlinear behavior of their DUTs. Data can be displayed in time, frequency, power, or user-defined custom domain. The NVNA also provides a nonlinear pulse-envelope domain measurement.

Base price: nonlinear support option—\$56,000. Agilent Technologies, www.agilent.com.

Editors' CHOICE



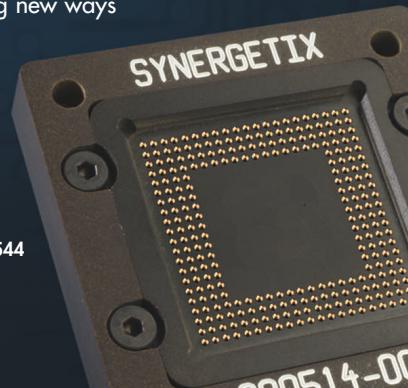
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Sensor networks large and small

>>> Sensors Expo and Conference, June 9–11, Rosemont, IL, www.sensorsexpo.com.

What was once a conference and show for sensor and data-acquisition equipment manufacturers has turned into an event that includes wireless sensors, data converters, microcontrollers, RF interface ICs, and wired interface ICs. The change came about because sensors are no longer used in just industrial monitoring and control systems, and they no longer need to be wired to vehicles or aircraft. Wireless sensor networks now monitor agricultural fields, oil wells, power plants, and many other facilities.

On a smaller scale, IC sensors mount on circuit boards and connect to microcontrollers with integrated analog-to-digital converters or to data converters and digital signal processors. These systems measure temperature, weight, strain, position, and other parameters in vehicles, machines, and other equipment.

“Sensors Expo is no longer just about sensor manufacturers improving on specifications,” said marketing consultant Roger Grace, who chaired an all-day session on MEMS sensors. “It’s much more applications focused now.”

ON THE EXHIBIT FLOOR

PCB Piezotronics announced several products, including the series 3991 and 3993 MEMS-based accelerometers that mount on printed-circuit boards. The company’s Model 410B01 force sensor signal-conditioning module, which works with strain sensors, mounts on rails and produces a 0 to 10-V output. PCB Piezotronics’ automotive division introduced a line of microphones designed for automotive testing that help engineers measure wind noise, road noise, brake squeal, and sound quality. The company also introduced an automotive accelerometer preamplifier for high-temperature areas such as power trains.

Analog Devices introduced a motion sensor with six degrees of freedom. The ADIS16365 module mounts on a PCB and contains three linear motion sensors and three rotational sensors. It includes digital signal processing and a digital output. **Texas Instruments** demonstrated several bus transceivers that run on 3.3 V. The company also demonstrated its CAN bus interface devices and low-power RF ICs for developing wireless sensor networks.

Millennial Net exhibited MeshScape, a wireless sensor protocol that creates a wireless mesh network that runs over a 2.4-GHz link.

Crossbow Technology also demonstrated a wireless mesh network protocol for its accelerometers and tilt sensors. While these two companies use proprietary protocols, **Solidica** uses IEEE 802.15.4 (ZigBee) low-speed wireless, and others use IEEE 802.11 wireless Ethernet.

“Wireless is just another instrumentation bus,” said **National Instruments**’ product manager Jared Aho. Because several technologies are used for wireless sensor networks, National Instruments has developed LabView drivers that let you use the programming language to collect data wirelessly. Support includes IEEE 802.11, IEEE 802.15.4, Bluetooth, and proprietary protocols. The company also demonstrated a module that lets you use its C series data-acquisition modules over wireless Ethernet.

Pico Technology exhibited its Model 5000 USB 1-GHz oscilloscope and the Model 9201, a 12-GHz USB sampling oscilloscope. **Yokogawa** displayed its new WT500 power analyzer, its SB5310 automotive serial-data-bus analyzer, a mixed-signal oscilloscope, the GS610 source-measure unit, and the DL750 ScopeCorder. **Lambda** exhibited its Genesys line of rack-mounted power supplies with GPIB and LXI interfaces. **OriginLab** demonstrated its Origin8 data-analysis and plotting software. **T&MW**



Microphones from PCB Piezotronics connect to a data-acquisition system to record noise in a vehicle door.

Courtesy of PCB Piezotronics.

From system-level design to hardware prototypes

>>> Design Automation Conference, June 8–13, Anaheim, CA, IEEE, EDA Consortium, and SIGDA, www.dac.com.

STMicroelectronics at the **Mentor Graphics** booth highlighted an electronic-system-level (ESL) reference design flow that is integrated with **Atrenta’s** SpyGlass for register-transfer-level (RTL) lint-checking and power-analysis tool as well as Mentor’s Catapult C synthesis tool and **Calypto Design Systems’** sequential logic equivalence checker (SLEC). Atrenta at its booth announced its 1Team-Genesis product, which spans design-specification capture through correct-by-construction chip assembly. ST representatives were on hand at the Atrenta booth to explain that 1Team-Genesis forms the basis of a collaborative effort in the area of power estimation and management.

(continued)

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SHOW HIGHLIGHTS

Design Automation Conference (continued)

Virage Logic demonstrated an open RTL-to-test-floor embedded-memory test-and-repair subsystem based on the company's Self-Test and Repair (STAR) memory system and yield accelerator. Virage also announced support for **TSMC's** Power Trim Service technology, which helps control leakage. **Apache Design Solutions** announced that TSMC's Reference Flow 9.0 accommodates Apache's technology for jitter, power, noise, and leakage analysis.

Berkeley Design Automation announced a co-simulation capability for its Analog FastSpice circuit simulator with third-party Verilog hardware-description-language (HDL) simulators. **Extreme DA** and **UMC** announced their collaboration on variation-aware

IC design flows for 65-nm and finer process technologies. The flows predict design performance and yield by analyzing timing behavior in the presence of process variations.

National Instruments was one of the few companies to have hardware on display to complement software offerings. NI highlighted an automated chip characterization and validation system based on LabView and PXI instruments. NI also demonstrated a prototype field-programmable-gate-array (FPGA)-based engine-control system put together by **Drivven. T&MW**

See the online version of this article at www.tmworld.com/2008_07 for our coverage of the DAC keynote address.

Vendors tout performance gains at vision show

>>> **The Vision Show, June 10–12, Boston, MA, Automated Imaging Association, www.machinevisiononline.org.**

While Corning automation expert Babak Raj described in his keynote speech a spectacular future for vision technology, including "imaging pills" for diagnosing disease, vendors on the show floor unveiled technology advances for the here and now.

Among a flurry of new camera designs, **FLIR Systems** debuted its A325, which it claims is the world's first plug-and-play infrared camera, compatible with both GigEVision and GenICam standards. Key application: process monitoring on production lines.

Dalsa added one color model (C1410) and one monochrome model (M1410) to its Genie line of area-scan cameras. Operating at 22 fps, the cameras feature a Sony CCD sensor. The company also showed a new Camera Link version of its Spyder 3 line of dual-scan cameras.

Aiming at customers needing high resolution at low cost, **CIS America**

showed color and monochrome versions (VCC-F60 and VCC-G60) of its 5-Mpixel, GigE camera. Specializing in FireWire-compatible cameras for economical machine vision, **Allied Vision Technologies** introduced its Stingray line, which features a heat-dissipating design, resolutions up to 2 Mpixels, and data transfer rates up to 84 fps.

Also offering cost-saving solutions, **EPIX** is offering its new PIXCI S14 system, which includes four "Silicon Video" cameras, cabling, and frame grabbers for \$5295. Finally, **PPT Vision** claimed its tiny A20

Impact camera, priced at \$2995 and including more than 100 programs, offers the power of a vision system in a sensor footprint. **T&MW**



Camera introductions dominated The Vision Show, including Dalsa's new Camera Link version of its Spyder 3 line of dual-scan cameras.

Courtesy of Dalsa.

See the online version of this article at www.tmworld.com/2008_07 for additional coverage of technology at The Vision Show.

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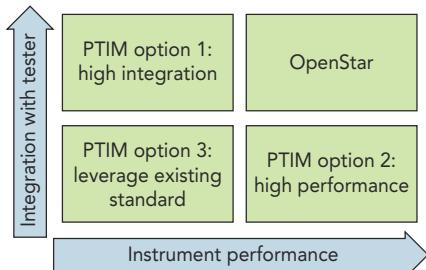


Agilent Technologies



STC to help test keep pace with design

Design productivity is outpacing test capabilities—that's one conclusion to be drawn from the global Semiconductor Test Consortium (STC) conference held June 4–6 in San Diego. That situation has implications for areas ranging from instrumentation to education, according to conference presenters.



Two PTIM options would offer either the integration or the performance levels of native semiconductor ATE instrumentation. A third option would leverage existing instrument platforms like PXI.

Don Edenfeld of Intel laid out the implications for instrumentation in his presentation as chair of the STC's as-yet unofficial Portable Test Instrument Module (PTIM) working group. To emphasize the need for a PTIM standard, Edenfeld cited a scenario in which last-minute design changes mandate test capabilities not available in existing native ATE system instruments—such as those complying with the STC's OpenStar standard. Development of a new ATE-class instrument that could provide the necessary capabilities might represent a \$2 million investment over 18 to 24 months, he said, making the time and cost prohibitive.

Edenfeld said that because of gaps in existing standard instrument platforms like PXI and GPIB, working group participants ruled them out, but based on a subsequent evaluation of the time and expense necessary to develop a new platform, existing platforms are back under consideration.

Luke Schreier of National Instruments made the case for PXI as the

basis for a PTIM standard. He presented a picture (**figure**) in which two PTIM options offer the system-integration capabilities or the performance of native-mode ATE instruments, but at high development costs and with long turnaround times. He proposed a third option that would complement the integration and performance of native ATE instruments while leveraging an existing instrument platform.

PXI would serve well as that platform, Schreier said, because of the breadth of instruments already available, including digital, RF, and precision DC instruments; arbitrary waveform generators; digitizers; and clock generators.

Edenfeld said a draft standard could be available in the third quarter with a final spec completed by year's end.

Paul Roddy of Advantest laid out the implications for education in a presentation titled "Aligning Academia with Leading Edge Semiconductor Test

Technology." Roddy, a co-chair of the STC University Working Group (UWG), said the group is working to align academic programs with industry needs, establish a global database for test research projects (to avoid duplication of effort), partner with other organizations to promote research, and set up a repository for test-engineering curricula.

Specific efforts of the UWG, Roddy said, include putting OpenStar testers in university labs and working with organizations such as Science-Engineering-Technology Congressional Visit Day (www.setcvd.org) and Alliance for Science & Technology Research in America (www.aboutastr.org). Such efforts, he said, can reduce the six to 18 months it now takes new engineering graduates to become fully integrated into industry test projects—with a concomitant reduction in the time senior engineers need to train them. **T&MW**

Handler technique passes customer test

Multitest has announced that its "voice coil" pick-and-place handler technology passed an evaluation at a German production site of an international integrated device manufacturer (IDM). The voice-coil principle—used to control the z-axis height while placing a device under test—increases overall test cell efficiency by speeding device handling, the company reports; Multitest also says that the technique is particularly suitable for applications with short test times and high parallelism. www.multitest.com.



UTAC Taiwan acquires V93000 HSM2200 systems

Verigy has announced that United Test and Assembly Center Taiwan (UTAC Taiwan), a semiconductor test and assembly service provider, has acquired multiple V93000 HSM2200 high-speed memory test systems for high-volume production of DDR3 devices. DDR3 features per-pin data rates of up to 1600 or 2133 Mbps, doubling the maximum data transfer rates of DDR2. www.utacgroup.com; www.verigy.com.

Teradyne's Nextest unit ships 2000th tester

Teradyne has announced the shipment of the 2000th test system from its Nextest business unit. "This significant milestone underscores the success of Magnum and its ability to provide customers with compelling test solutions from engineering through the critically important high-volume production process," said Tim Moriarty, GM of the Nextest business unit. www.teradyne.com.

Pump Up Image Processing Performance

Gone are the days of the single processor! Today's PCs offer more processing power than ever before. Multi-core CPUs and Graphics Processing Units (GPUs) are readily available to boost image processing performance.

But did you know?

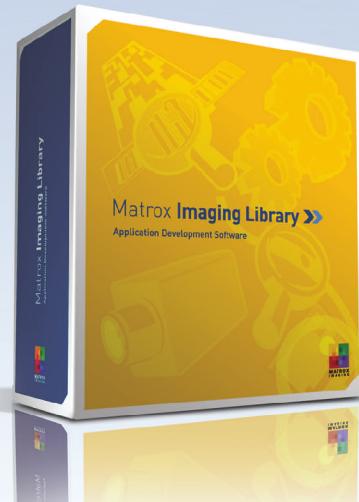
- All imaging operations won't run eight times faster on a eight-core machine.
- GPUs offer tremendous computing power for image processing applications.
- The Matrox Imaging Library (MIL) 9.0 is optimized for maximum performance on multi-core systems and GPUs.

What else should I know?

The truth is, software tools provided by the silicon manufacturers are not specifically designed for image processing. The Matrox Imaging Library (MIL) is a field-proven toolkit containing hundreds of image processing operations for imaging and machine vision applications, as well as functions for video capture and display.

Not all functions are created equal

Not all operations benefit equally from multiple-cores as shown in the graph. Matrox Imaging has analyzed the functions in MIL and determined which respond best under multi-core processing conditions: arithmetic, filtering, LUT mapping, morphological and geometric transformation operations. MIL 9.0 automatically and intelligently dispatches an application to the appropriate number of cores for maximum performance. Programmers can also tune the application's usage of host resources by controlling the maximum number of cores used by a thread that is executing MIL operations.



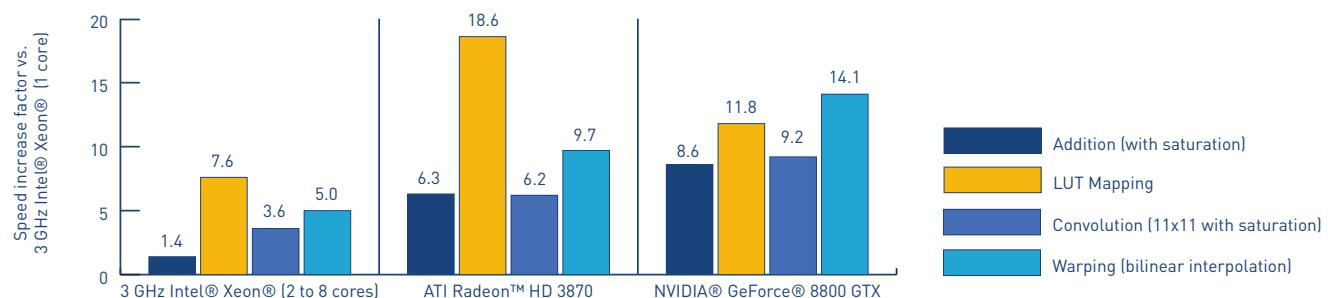
The graph also shows that GPUs can greatly accelerate image processing functions. Knowing that image data needs to be transferred to and sometimes back from the GPU, a GPU is best used for performing long sequences of operations in order to minimize the transfers between the system and local GPU memory.

Do things the optimized way

The "do it yourself" approach is always an option: take a chance with a low-level tool from a silicon vendor. But it's easier, faster, and more cost-effective to use an image processing library like MIL 9.0. We've already done the work for you!

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Do you want data or results?

In the fall of 2000, vision and camera experts established the Camera Link standard to address the needs of high-speed digital cameras. This standard defines low-voltage differential signaling (LVDS) communications that transmit serial pixel data from a camera to a computer. Recent changes to the Camera Link spec include a method that lets manufacturers provide power to a camera through a Camera Link cable. Sprucing up the Cam-

This development kit from Avnet includes a camera module, an Analog Devices' Blackfin digital signal processing (DSP) board, and software tools. Designers use this type of kit to develop and test smart-camera algorithms. Courtesy of Avnet.

era Link spec may seem like a good idea, but the vision industry should also concentrate on developing a new approach to camera-to-PC communications.

Designers can now use high-bandwidth Gigabit Ethernet (GigE) connections when they must place a high-speed or high-resolution camera beyond the 10-m limit inherent to Camera Link cables. But as image-sensor resolutions increase and as inspection equipment must operate at higher frame rates, the demand for more bandwidth will run up against GigE's limits.

I see several paths that designers of cameras and vision equipment can consider.

First, look to a new serial-data standard. One possibility is USB 3.0, which Intel demonstrated about nine months ago. Reports say that Intel demonstrated USB 3.0 with a fiber-optic connection operating at 5 Gbps, but Intel has released no hard information about the final physical interface. Could USB 3.0 use a regular USB connector and an electrical bus? Who knows? At this

point, implementation of USB 3.0 in vision equipment seems far off.

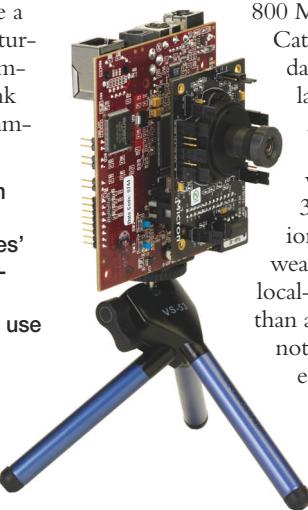
Second, consider whether recent changes to FireWire make the bus appropriate for your application. The IEEE 1394c-2006 standard, which codifies the FireWire S800T link, should

lead to equipment that operates at 800 Mbps over inexpensive Cat-5e cable and uses standard RJ45 connectors. In late 2007, the 1394 Trade Association announced FireWire S3200, which will increase data rates to 3.2 Gbps. But in my opinion, FireWire comes on as a weak contender. It uses a local-access protocol rather than a network protocol, so it's not great for networked cameras. And who knows when S3200-based hardware will arrive?

Third, build smarter cameras. This approach puts vision-processing and vision-analysis tasks where they belong—close to the sensor. Why stream masses of raw data through a bottleneck, er interface, only to process it in a PC and discard most of the collected pixels? Texas Instrument's Open Multimedia Application Platform (OMAP) ICs and the Blackfin signal-processing devices from Analog Devices, for example, will help developers quickly extract useful information from raw image data. Low-power field-programmable gate arrays (FPGAs) also let engineers put custom image-analysis algorithms within a camera. These types of proven chips and associated design tools already exist. Take advantage of them. **T&MW**

SIGNING OFF

I tend to have careers that last nine or 10 years, so after writing about inspection and machine vision for over a dozen years, I decided it's time to have someone else write this column. But no retirement for me. You'll continue to see my byline in electronics publications and on related Web sites.—**Jon Titus**



Toshiba announces 12-Mpixel camera

Toshiba Teli America has introduced a CMOS-based machine-vision camera with a 12-Mpixel, 1.9-in. CMOS monochrome progressive-scan sensor. The CleverDragon CSC12M25BMP19 offers 4096x3072 resolution along with a 25-fps full-frame speed. A Camera Link interface is standard. www.toshiba-teli.com.



AXI system offers 2-D and 3-D capabilities

The X-Series automated x-ray inspection (AXI) system from YESTech rapidly gathers multiple oblique images of a sample to construct a 3-D rendering used for identifying solder and component-related defects on both single- and double-sided printed-circuit boards. The X3 can selectively use 2-D or 3-D technology to inspect specific regions of interest, and it separates the top and bottom images of double-sided boards for automated inspection of solder joints. www.yestechinc.com.

Dalsa extends software capability

Dalsa has released a color version of the iNspect software for its Vision Appliance line of embedded machine-vision products. The iNspect Color software segments images by color so technicians can apply standard measurement tools for verification, sorting, and inspection of parts and assemblies. In addition, the software offers on-the-fly image rotation and multi-camera tiling. www.dalsa.com.



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Test's **SPLIT** PERSONALITY

BY LAWRENCE D. MALONEY, CONTRIBUTING EDITOR

Upbeat and downcast. The mood of the test field's giant companies swung both ways in the turbulent year of 2007.

Companies selling general-purpose test equipment notched respectable sales, and those with test platforms that target fast-growing communications applications like WiMAX reported banner years.

But for companies producing big-ticket automated test equipment (ATE) systems for semiconductor test, it was surely a year to forget. Many saw their sales dive sharply compared to their 2006 figures, as manufacturers found themselves with excess capacity in a slumping global economy.

"Semiconductor test is once again in one of its down cycles," said S. Vidyasankar, a senior research analyst for Frost & Sullivan. "And that has put downward pressure on ATE equipment prices, which hurts profitability."

Meanwhile, the ranks of the test industry's Top 10 publicly held companies were rocked by two major acquisitions. Danaher, a diversified industrial powerhouse, brought Tektronix under its corporate umbrella last October. And last July, Aeroflex, the ninth largest publicly held test company in 2006, was acquired by private equity funds managed by Veritas Capital, Golden Gate Private Equity, and Goldman Sachs.



Communications sets the pace

One thing was clear in analyzing company results for 2007: Companies heavily focused on equipment aimed at communications test led the pack in terms of percentage growth. For example, JDSU saw sales of its communications test and measurement products jump by 25% in fiscal 2007. Among its hot products: the T-BERD 8000 field instrument for high-speed fiber networks.

"The test solutions we offer for the installation and maintenance of IP-based triple-play services, such as IPTV and VoIP, and for the deployment of FTTx networks have been very well received by customers and contributed significantly to our growth," noted JDSU senior VP Dave Holly.

Japan's Anritsu views communications test as a prime opportunity. President Hiromichi Toda pointed to growing opportunities for test devices resulting from deployment of 3G and 3.5G throughout the world, as well as from next-generation networks and the popularity of WiMAX and wireless LAN. Said Toda: "With the spread of the Internet and the increase in transmission capacity, the transmission speed of the backbone is becoming faster, from 2.5 Gbps to 10 Gbps. We even saw a 40-Gbps system commercialized recently." As for Anritsu products aimed at such applications, Toda cited a new signal quality analyzer for testing optical transceivers and modules up to 12.5 Gbps, and the com-

pany's spectrum analyzers and master base-station analyzers for deploying and maintaining mobile WiMAX networks.

Industry kingpin Agilent Technologies, by far the industry leader with sales of \$3.4 billion in 2007, has been shifting more of its resources into test products for wireless and aerospace and defense applications. Ron Nersesian, GM of the company's Wireless Business Unit, said Agilent's new E6620 wireless test set for



Dave Holly says that test products for triple-play services have contributed significantly to JDSU's growth.

to focus company test technologies on such aerospace applications as electronic warfare, networked communications systems, military ATE, portable test, and data converters.

Even so, the sheer breadth of Agilent's product line makes it difficult for the firm to sharply increase year-to-year sales. In 2007, for example, Agilent's revenues in electronic measurement, viewed by analysts as a mature market, grew by just 3.4%. Compare that to a whopping 24% jump in sales for Agilent's bio-analytical measurement business, a market where Agilent has a less dominant market share.

"Agilent is really two companies," said John Harman, an analyst with Needham & Company. "Last year was a tough one for its electronic test business, but its chemical analysis business was hitting on all cylinders, and that's where the company is putting a lot of its investment."

Of course, Agilent doesn't lack competitors seeking to grab market share. Harman singles out National Instruments as a firm that year after year has posted double-digit growth, outperforming most companies in electronics test. In 2007, revenues grew by 12% to

LTE designers is a good example of a hot-selling communications product. Another is the firm's E6651A platform for WiMAX applications, including base-station emulation and protocol performance test. Agilent also has launched a new organization, called the Signal Networking Division,

Top 10 test-and-measurement companies in 2007 revenue (publicly traded companies)

COMPANY	2007 RANK	2006 RANK	2007 REVENUES (MILLIONS US\$)	2006 REVENUES (MILLIONS US\$)	PERCENT CHANGE
Agilent Technologies	1	1	3,415.0 ¹	3,302.0	3.4
Advantest	2	2	1,824.0 ²	1,999.0	-8.8
Tektronix	3	4	1,105.0 ³	1,039.9	3.0
Teradyne	4	3	1,102.2	1,356.2	-18.7
Fluke	5	5	1,091.8 ⁴	1,011.0	8.0
Anritsu	6	6	1,005.0 ²	842.0	19.3
Verigy	7	7	761.0	778.0	-2.2
National Instruments	8	8	740.3	660.4	12.0
JDSU	9	10	619.2	494.5	25.2
Credence	10	—	461.1	493.4	-6.5

¹Agilent revenues include only electronic measurement operations. Instrumentation for bio-analytical measurement totaled \$2.005 billion in 2007.

²Revenues shown for 2007 for Japanese companies Advantest and Anritsu reflect the sharp rise in the value of the yen versus the dollar over the past year.

³Tektronix became part of Danaher in October 2007. Figures are for the fiscal year ending May 2007, prior to the acquisition.

⁴Danaher does not report separate sales figures on its Fluke/Fluke Networks units. The figures in this table are an estimate, based on the reported business increase in 2007 for the company's electronic test businesses.

Notes:

Rohde & Schwarz, a privately held company, reported annual sales of 1.4 billion euros in the fiscal year ending June 2007, a 7.6% increase over the previous year.

Aeroflex (last year's number 9 company) became privately held in July 2007 and thus was not eligible for inclusion in this chart. Its latest report as a public company (nine months ending March 2007) showed sales of \$432 million and projected sales of \$162 million for the final quarter.

more than \$740 million. "NI's product pipeline is full in such areas as general-purpose and communication test, and it has leveraged LabView into other applications like industrial control, embedded systems, and mechatronics," said Harman.



Advantest America's R. Keith Lee: Customers want to expand parallel test capacity.

NI CEO James Truchard sees attractive opportunities in such areas as multicore- and emulation-based test systems. The firm will also continue to invest heavily in LabView FPGA technology. "It's been

amazing to see what users have been able to do with this technology—from implementing complex custom protocols to test missile systems to creating a software-defined radio," said Truchard. Among other prime areas for new product investment: PXI and PXI Express.

Preparing for the upturn

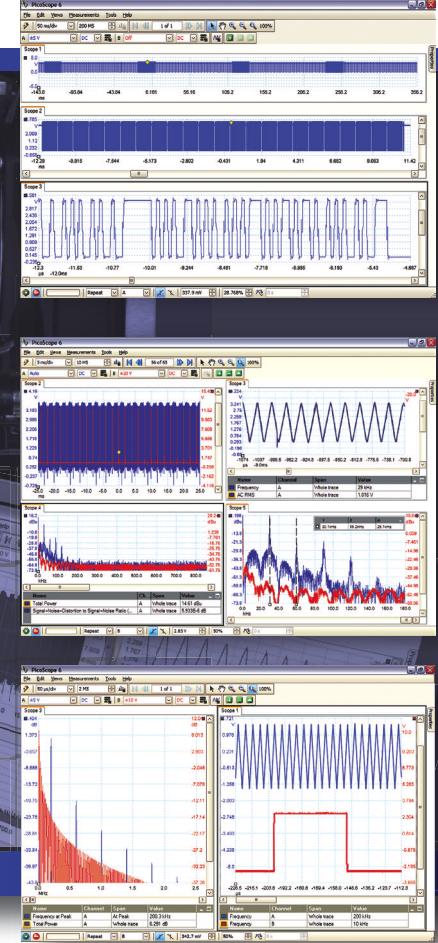
The mood is far more subdued in semiconductor test. Advantest, the world's leading equipment supplier in that segment, saw sales decline by 8.8%, much of it as a result of industry overcapacity in system-on-chip (SOC) testers and the stagnation of semiconductor prices. In recent years, Advantest has been expanding beyond commoditized memory ATE and into logic test, especially SOC test.

In the face of such market pressures, the company is developing lower-cost solutions for SOC test, such as its new T2000 GS compact test system. R. Keith Lee, CEO of Advantest America, speculates that more companies will be seeking to increase their parallel test capacity, and that could fuel sales for the company's high-volume SOC test cell, the T2000 LS mainframe, integrated with the company's M4841 dynamic handler. "Our SOC test innovations all are aimed at weathering the cycles of supply and demand and the resultant pressures on average selling prices," said Lee.

Teradyne, another major player in the SOC test market, also endured a tough

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TOPS IN TEST

2007, with sales off 18.7% from the previous year. Frost & Sullivan analyst Vidyasankar, however, views the late 2007 acquisition of Nextest Systems as a positive development for Teradyne, since it strengthens the company's capability in flash memory test, a sector that rides the booming interest in consumer electronics. Of Nextest's \$95.8 million in revenue in 2006, sales of flash memory testers accounted for \$80 million.

Verigy, the company that emerged from Agilent's 2006 spinoff of its ATE business, fared better than most firms in the ATE sector in 2007, with only a slight decline in sales. And its first quarter 2008 revenues were up 21% over the same period in 2007. Early this year, the company also completed the acquisition of Inovys, which provides products for design debug, failure analysis, and yield acceleration. Commented CEO Keith Barnes: "This acquisition allows us to further differentiate Verigy from other automated test equipment suppliers by offering a completely integrated solution, which leverages our proven SOC

and memory test platforms with a best-in-class, time-to-yield solution for semiconductor manufacturing."

For Credence, on the bottom rung of the Top 10 list, revenues were down 6.5% in 2007, but CEO Lavi Lev this year is stressing a strategy of focusing

R&D on test platforms, such as the Diamond, that are used particularly in Asia-driven consumer semiconductor markets.

The changing landscape

Two other leading companies, Tektronix and Aeroflex, began 2008 under new corporate umbrellas. Following its best performance in six years as an independent company, with sales of more than \$1.1 billion in fiscal 2007, Tektronix was acquired by Danaher last October. While some observers wondered whether the instrument maker would lose some of its high-tech focus as part of industrial giant

Danaher, analyst Vijay Mathew of Frost & Sullivan predicted the change will be beneficial for the Tektronix brand, just as it was for Fluke—another perennial member of the top 10 list—when it was acquired by Danaher a decade ago. A key reason: Danaher's operating efficiencies

could free up more development funds for further expansion of the Tektronix product line, which recently added new entries in signal sources, mixed-signal oscilloscopes, and real-time spectrum analyzers.

Rick Wills, who continues to head Tektronix operations, also sees synergies with Danaher's other major electronic test unit, Fluke. "While the Tektronix and Fluke brands will remain separate operating entities, our customers will see benefits from focused R&D that drives continuous innovation."

Aeroflex, which has been focusing increasingly on equipment for wireless test, also made its corporate switch on a high note. Prior to being purchased by the private equity firms last summer (which made it ineligible for this year's top 10 list), the company reported a sales increase of just under 8% for the nine-month period ending March 2007 versus the prior year. It also had order backlogs totaling \$253 million. Like the situation for Tektronix, Aeroflex could also gain from the change. "It's going to allow Aeroflex to increase its R&D investment," predicted Vidyasankar of Frost, "and they got a very good offer from Veritas."

Such acquisitions, some would say, have whittled down the big players in test's public arena. Yet, there are always up-and-coming firms that are looking for a niche to exploit. Perhaps the best example, argues Harman of Needham & Company, is EXFO. Targeting test opportunities in telecom, the Canadian company increased its sales in 2007 by nearly 20% to \$152.9 million and is laying the groundwork for even more growth with key acquisitions in 2008. **T&M**

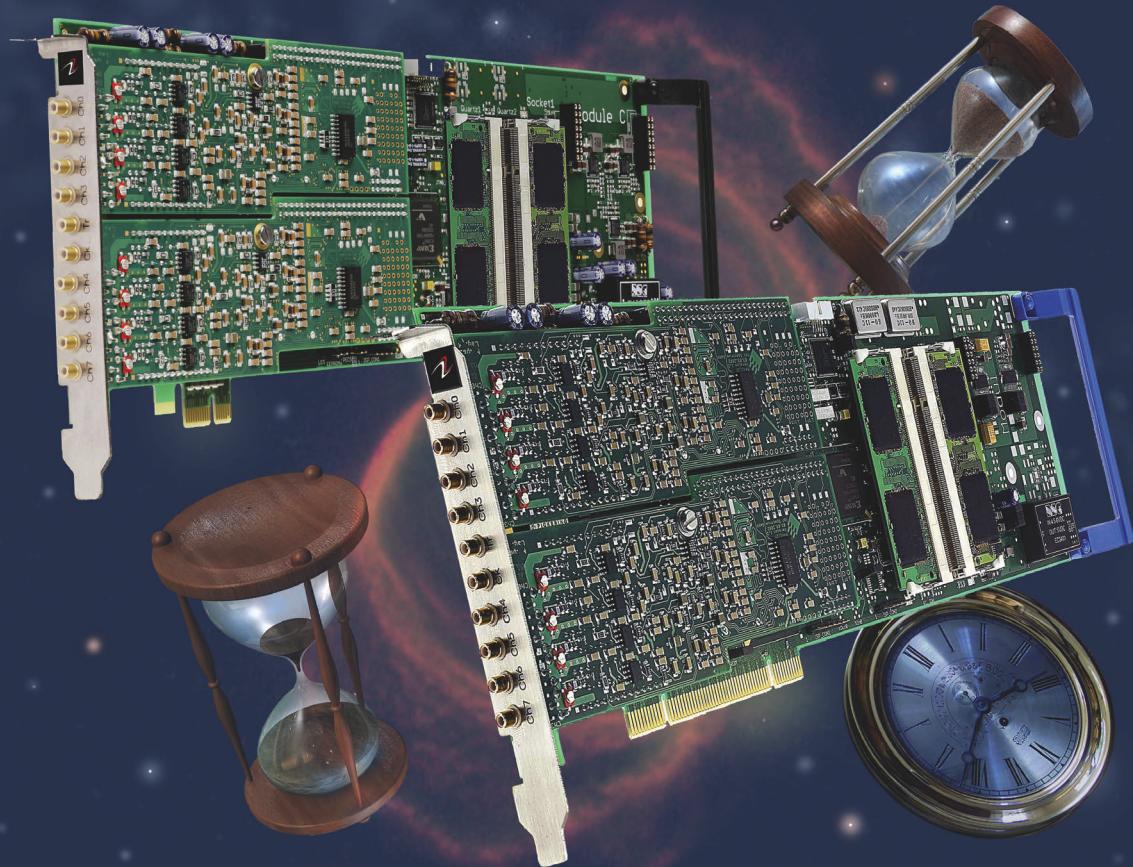


Agilent Technologies' global sales pacesetters, says
VP Ron Nersesian, include new test sets for wireless
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Hiromichi Toda of
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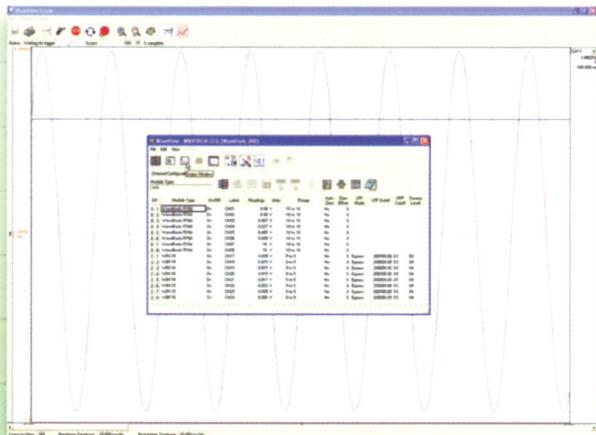
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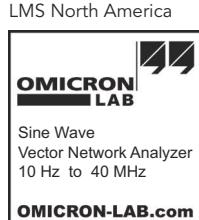
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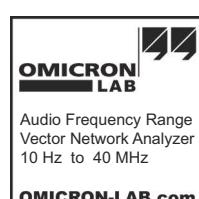
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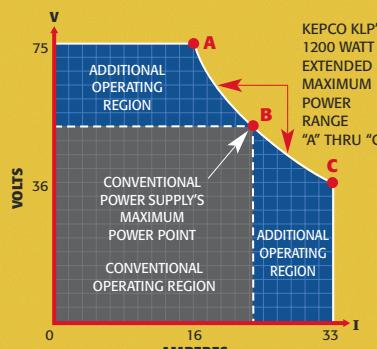
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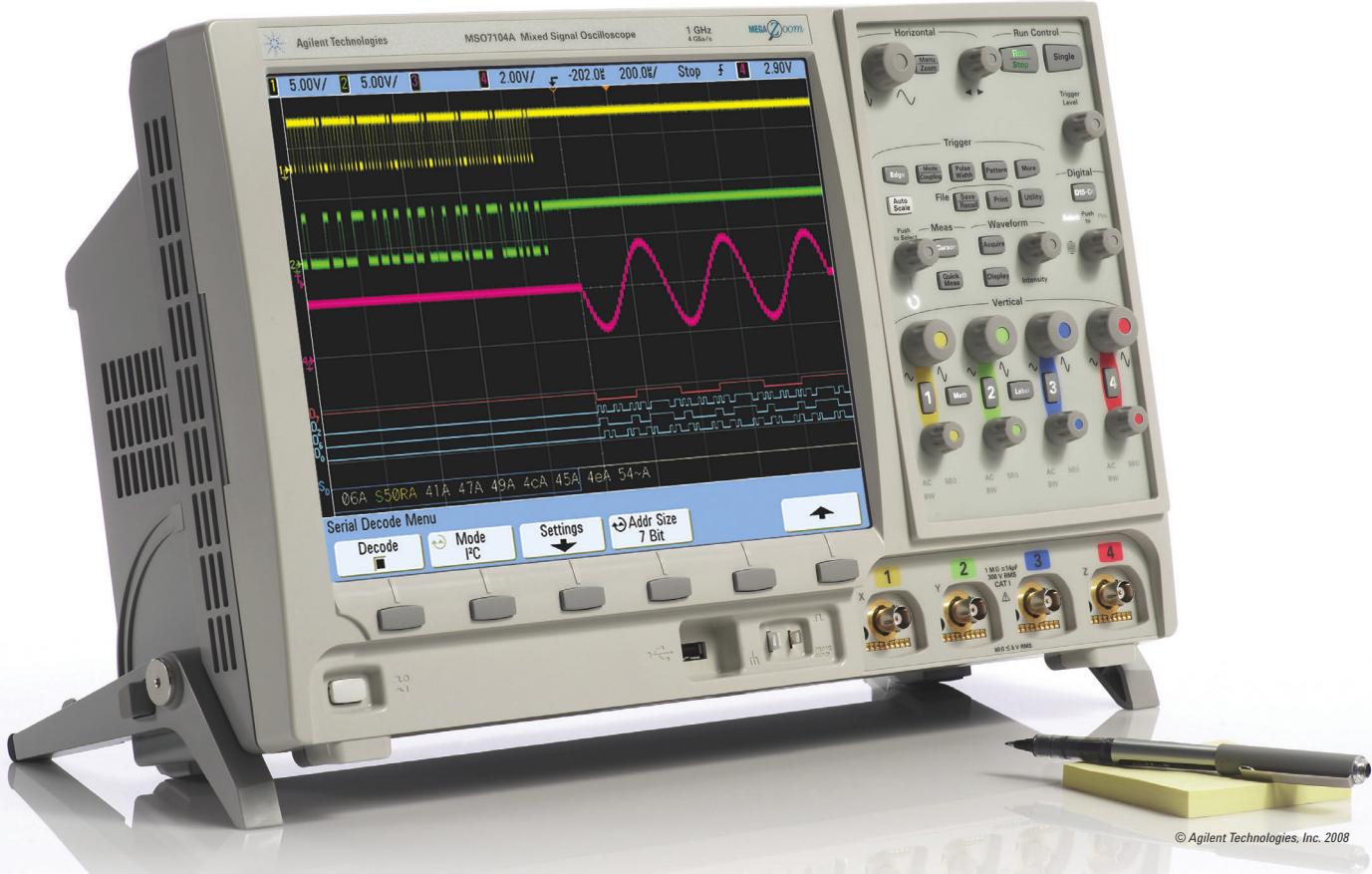
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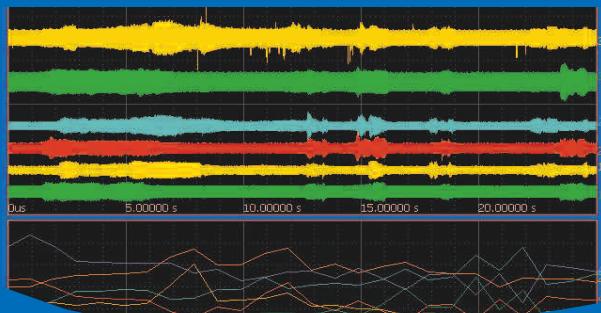
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50us	-1.550mV	1.250mV	-1.250mV	1.563mV	-3.5844mV	3.0844mV
100us	-1.700mV	1.250mV	-1.625mV	1.375mV	-3.3375mV	3.3125mV
150us	-1.850mV	1.150mV	-1.563mV	1.563mV	-3.3188mV	3.0969mV
200us	-1.900mV	1.350mV	-1.500mV	1.500mV	-2.9656mV	2.5063mV
250us	-1.850mV	0.900mV	-1.625mV	1.500mV	-1.0188mV	1.6719mV
300us	-1.800mV	1.050mV	-1.812mV	1.375mV	1.8594mV	-0.9875mV
350us	-2.100mV	1.100mV	-1.563mV	1.500mV	3.5719mV	-2.6156mV
400us	-2.000mV	1.150mV	-1.625mV	1.438mV	4.0094mV	-2.3031mV
450us	-2.100mV	1.250mV	-1.063mV	1.125mV	3.8906mV	-2.5719mV
500us	0.150mV	0.450mV	0.875mV	-0.125mV	3.6912mV	-2.8719mV
550us	2.000mV	-1.000mV	1.750mV	-0.875mV	4.1938mV	-2.3938mV
600us	2.000mV	-1.400mV	1.688mV	-0.937mV	3.8438mV	-2.7281mV
650us	1.900mV	1.050mV	1.688mV	-0.937mV	3.4375mV	-2.8687mV
700us	1.950mV	1.250mV	1.812mV	-0.937mV	3.0563mV	-2.2563mV
750us	1.900mV	1.150mV	1.750mV	-0.937mV	1.4344mV	-0.8281mV
800us	2.400mV	1.150mV	1.750mV	-0.937mV	-1.9437mV	1.2094mV
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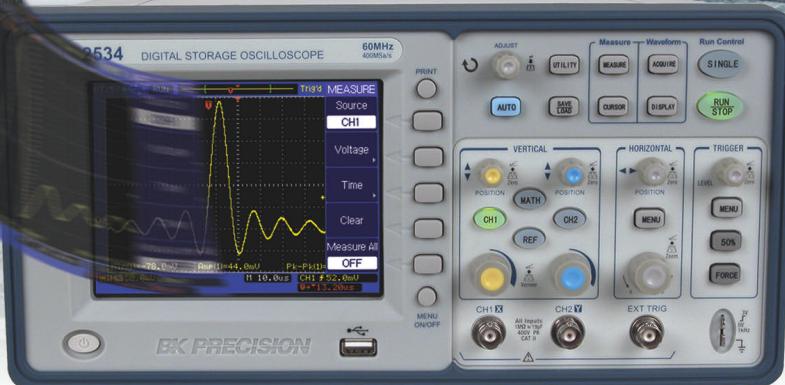
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RS-232C Timer



TOS5051A

TOS5000A SERIES

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- Digital timer
- Window comparator type employed for PASS/FAIL judgement.
- Equipped with remote control function
- Various signal outputs
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- Provided with zero turn-on switch
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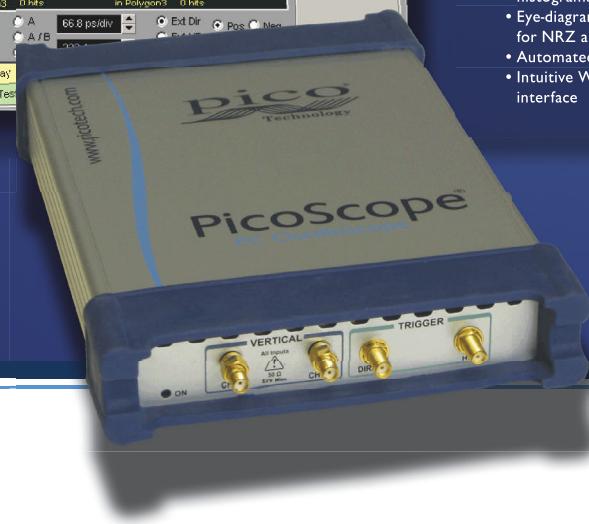
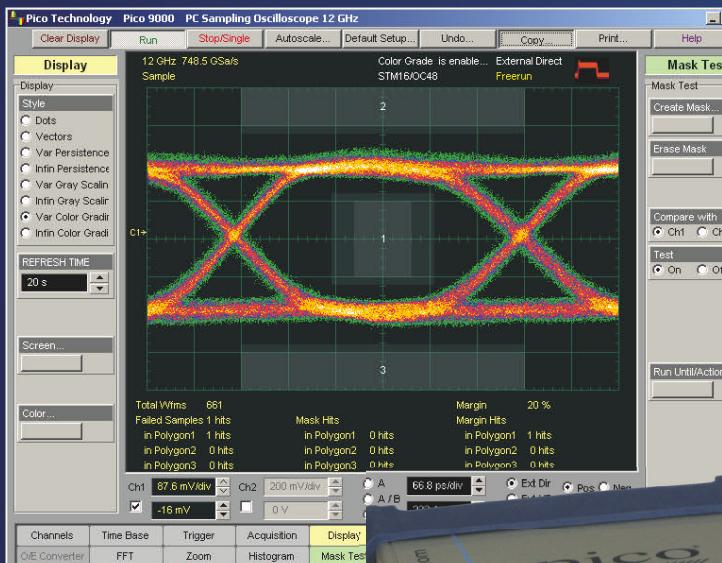
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Withstanding voltage tester supporting standard tests

Model TOS8030

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Compact model supporting the simplified test





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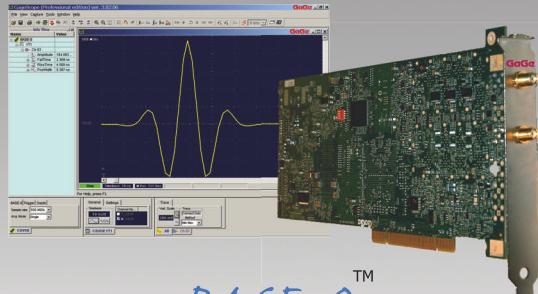
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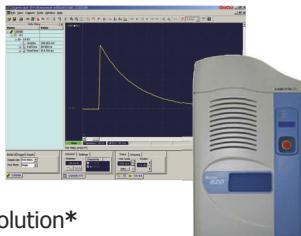
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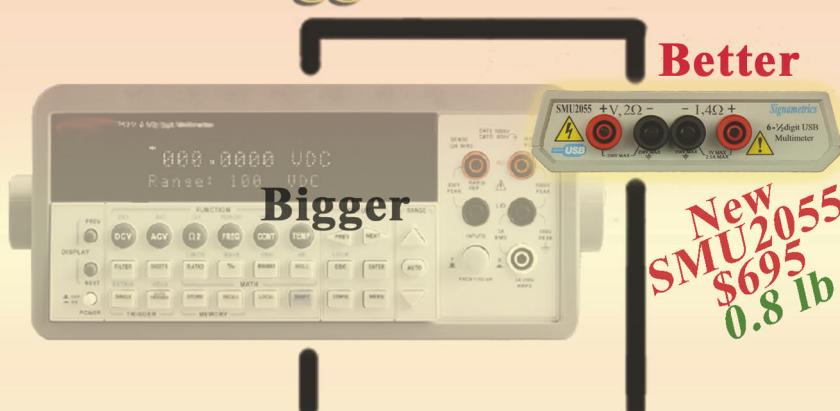
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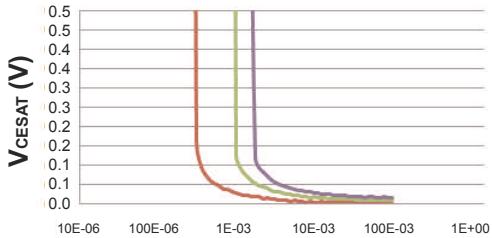
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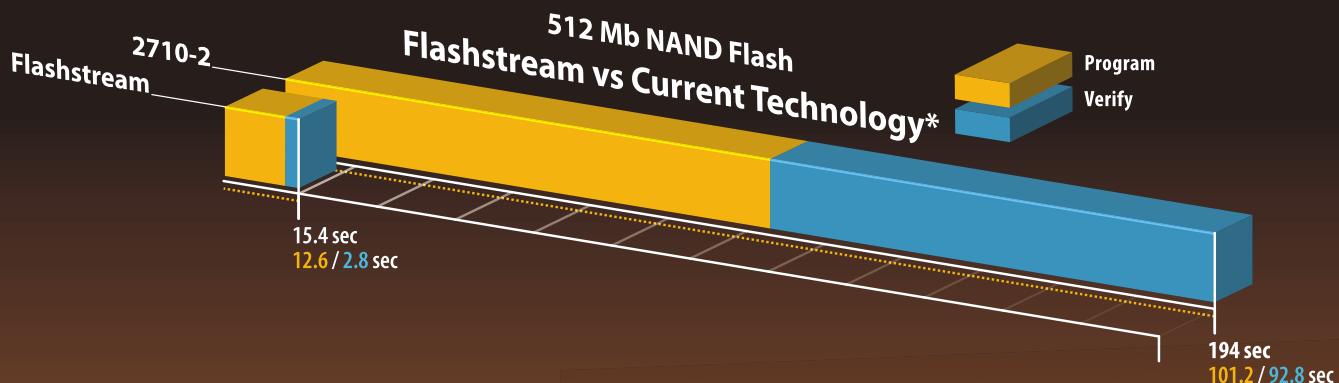
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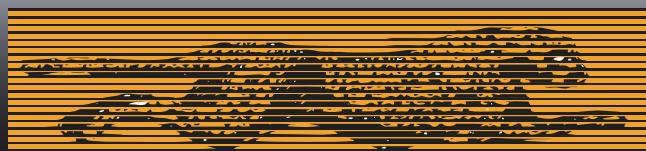
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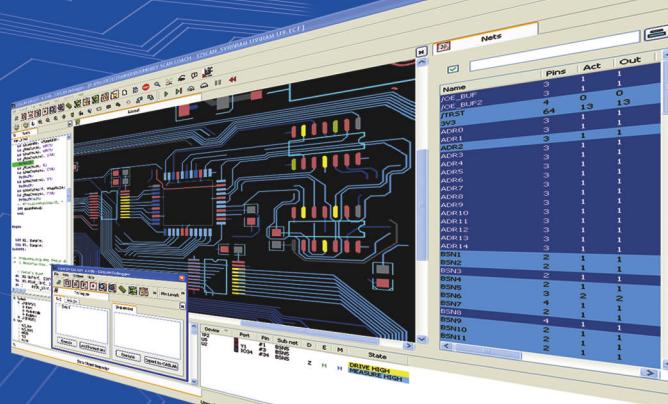
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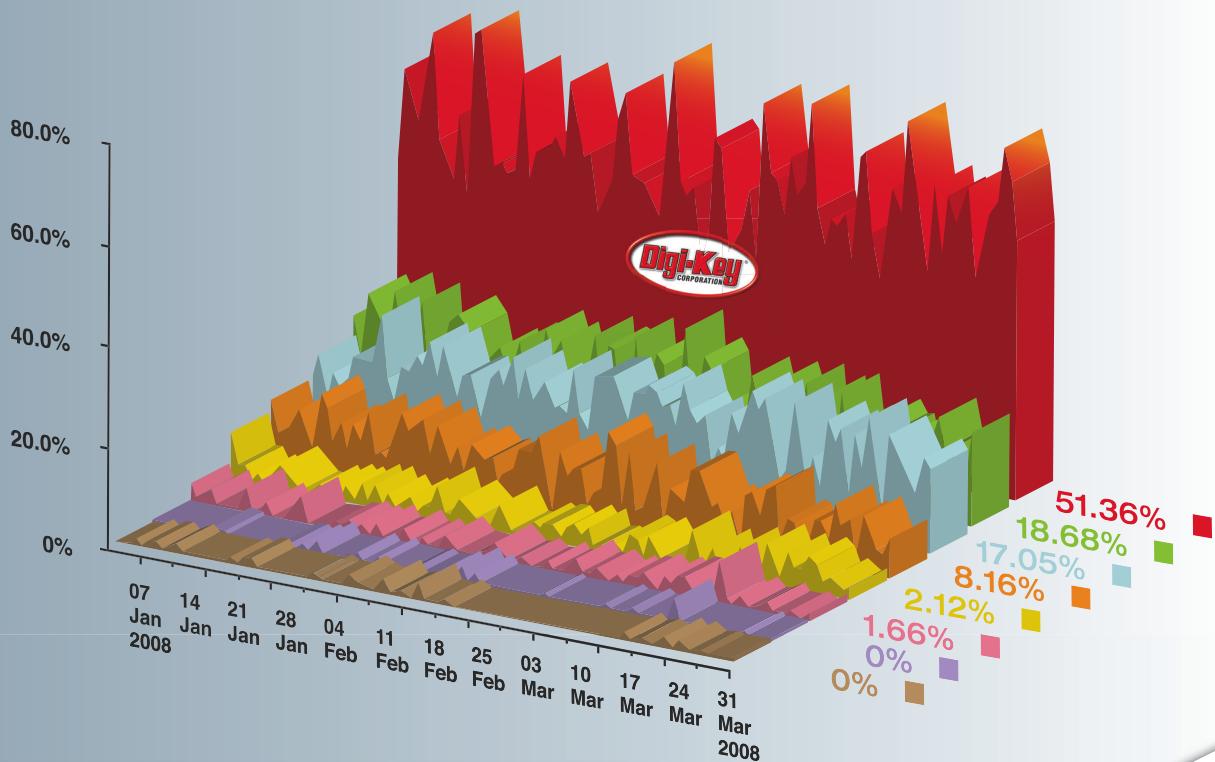
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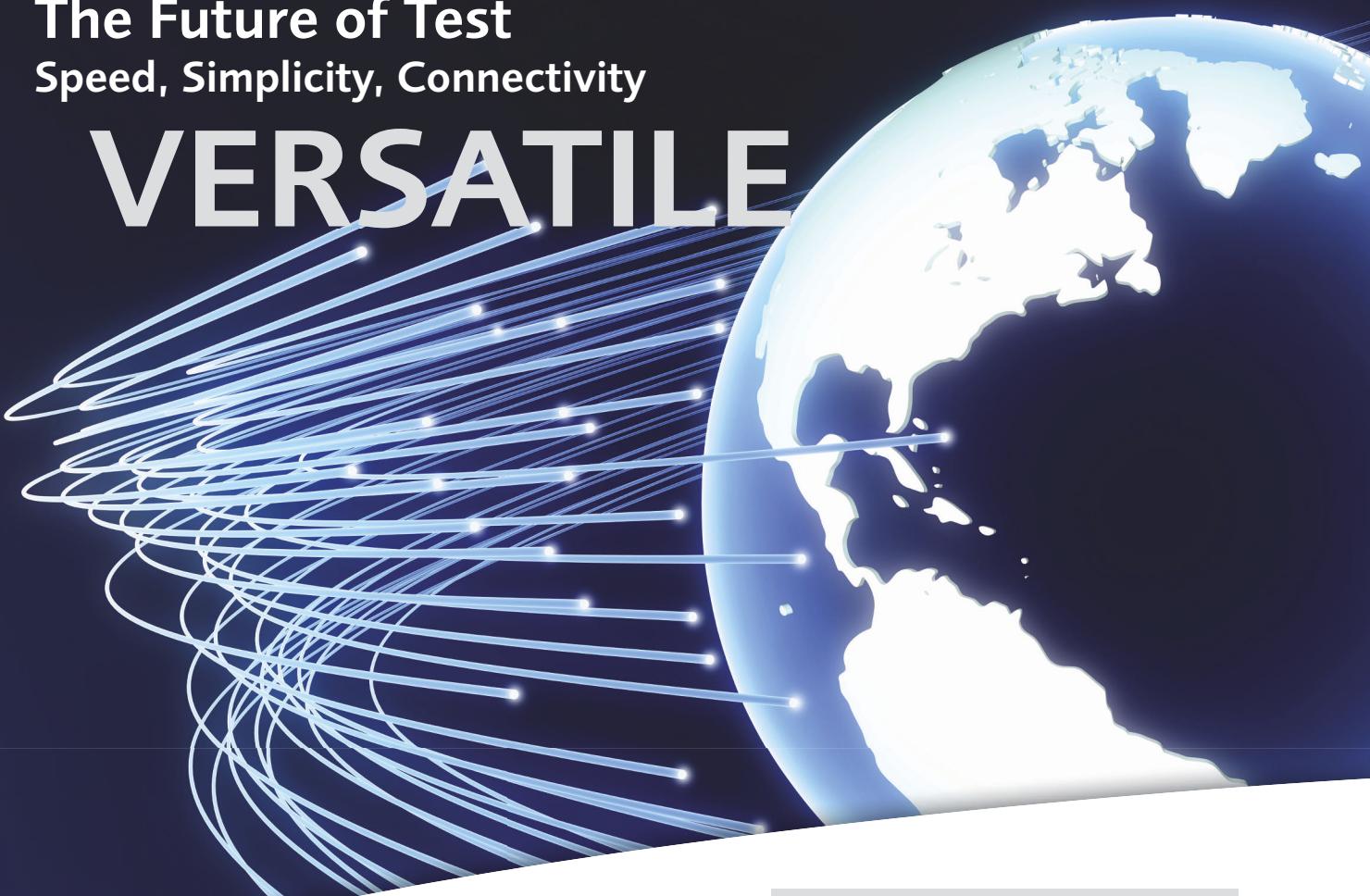
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> MACHINE-VISION & INSPECTION EQUIPMENT Continued

Tamar Technology
Ultrafast Sensors
View Engineering
Vision Engineering
WESCO

Focused Ion Beam Systems
Credence Systems
FEI Co.
JEOL USA

Frame Grabbers

Active Silicon
Adlink Technology
Alacron
BitFlow
Cognex
Dalsa
Data Translation
EPIX
Euresys
Fast-Vision
Foresight Imaging
The Imaging Source
Imperx
KAPPA opto-electronics
Leutron Vision
Matrox Imaging
National Instruments
PerkinElmer Optoelectronics
Pleora Technologies
SVS-Vistek

Inspection Systems for Packaged Devices

AccuSentry
CheckSum
Dage Precision Industries
Dalsa
DiagnoSYS Systems
Edmund Optics
MatriX Technologies
Micromanipulator
Micro-Vu
OptoMetrix
phoenix x-ray Systems + Services
View Engineering
WESCO
Wintriss Engineering
X-TEK Group
YesTech
YXLON International
Zygo

Inspection Systems for PCBs/Hybrids

AccuSentry
Aerotech
Agilent Technologies
Chroma Systems Solutions
DiagnoSYS Systems
Edmund Optics
EPIX
GOEPEL Electronics
Landrex Technologies
Machine Vision Products
MatriX Technologies
Metron Optics
Micromanipulator
Micro-Vu
Optical Gaging Products
Panasonic Factory Solutions Company of America
phoenix x-ray Systems + Services
ScanCAD International
Tamar Technology
View Engineering
Viscom
Vision Engineering
Vistec Semiconductor Systems
WESCO
YXLON International
Zmation
Zygo

Panasonic Factory Solutions Company of America
phoenix x-ray Systems + Services
Rudolph Technologies

ScanCAD International
Tamar Technology
View Engineering
Viscom
Vision Engineering
Vistec Semiconductor Systems
WESCO
YXLON International
Zmation
Zygo

Inspection Systems, Thermal/Infrared

Compix

compix
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SDK for custom applications
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FLIR Systems

Hamamatsu
Ircan

Inspection Systems, Video

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Agilent Technologies
Dalsa

Edmund Optics
EPIX
Huntron

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Integrated Design Tools

KAPPA opto-electronics
Keyence
Landrex Technologies
Matrox Imaging

Meiji Techno America
MicrolImage Video Systems
Micro-Vu
MTI Instruments
Nikon Instruments
Olympus, Industrial Micro-Imaging
OptoMetrix

Panasonic Vision Systems
Photron
RAM Optical Instrumentation
Rudolph Technologies
Silicon Imaging
Tamar Technology
Unitron
View Engineering
Vision Engineering
Volpi USA
WESCO
Wintriss Engineering
Zmation

Inspection Systems, X-Ray

Aerotech
Agilent Technologies

Dage Precision Industries
Faxitron X-Ray

Glenbrook Technologies
GOEPEL Electronics
Hamamatsu
MatriX Technologies
phoenix x-ray Systems + Services

Rad-Icon Imaging
Sens-Tech
Teradyne
Viscom
VJ Electronix
X-TEK Group
YesTech
YXLON International

Inspection Targets/Grids

AccuSentry
Geller Microanalytical Lab
Integrated Design Tools
MicrolImage Video Systems

Lenses, Camera

Cognex
CVI Melles Griot
The Imaging Source
LINOS Photonics
Moritex USA
Navitar
NET USA
PCO
QIOPTIQ Imaging Solutions
Rolyn Optics
Sentech America

Think ~~outside~~ **inside** the box.

StingRay Optics
Tamron USA
Volpi USA
WESCO

Lenses, Microscope

Anchor Optics
CVI Melles Griot
The Imaging Source
Infinity Photo-Optical
Meiji Techno America
Navitar
Nikon Instruments
QIOPTIQ Imaging Solutions
Rolyn Optics
StingRay Optics
Unitron
WESCO

Lighting, Machine-Vision

AccuSentry
Advanced Illumination
Cognex
Fiberoptic Systems
The Imaging Source
Moritex USA
NET USA
PerkinElmer
Optoelectronics
Phlox
QIOPTIQ Imaging Solutions
Schott North America
StockerYale
Sunnex
Tamar Technology
Volpi USA
WESCO
Wintress Engineering

Lighting, Microscopy

The Imaging Source
Meiji Techno America
QIOPTIQ Imaging Solutions
Schott North America
StockerYale
Sunnex
Tamar Technology
Volpi USA
WESCO

Magnifiers

GEI International
QIOPTIQ Imaging Solutions

Sunnex
Vision Engineering

Microscopes, Accessories

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Microlimaging
Creative Devices
Geller Microanalytical Lab
Infinity Photo-Optical
Meiji Techno America
Micromanipulator
Prior Scientific
QIOPTIQ Imaging Solutions
Rolyn Optics
Tamar Technology
Unitron
Vision Engineering
WESCO
Zygo

Microscopes, Electron

FEI Co.
JEOL USA

Microscopes, Emission

Hamamatsu
Micromanipulator

Microscopes, Optical

AFL
Telecommunications
Anchor Optics
Carl Zeiss
Microlimaging
Chroma Systems Solutions
Credence Systems
Edmund Optics
GEI International
Infinity Photo-Optical
Klein Instruments
Meiji Techno America
Metron Optics
Nikon Instruments
Olympus, Industrial Micro-Imaging
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RAM Optical
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Continued >

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> MACHINE-VISION & INSPECTION EQUIPMENT *Continued*

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Unitron
Vision Engineering
WESCO
WITec Instruments
Zygo

Microscopes, Scanning Probe
Ambios Technology
JEOL USA
Multiprobe
OptoMetrix
Ultrafast Sensors
WITec Instruments

Optical Comparators
GEI International
Metron Optics
Micro-Vu
Nikon Instruments
Optical Gaging Products

QIOPTIQ Imaging Solutions
Rudolph Technologies
Sencore
Vision Engineering

Positioning Stages and Tables

Aerotech
CGI
CIMTEK
Dynamic Solutions
Micromanipulator
Piezosystem Jena
Prior Scientific
Suss MicroTec
Tamar Technology
TDK RF Solutions
Zmation

Mitutoyo America
MTI Instruments
Olympus, Industrial Micro-Imaging
Optical Gaging Products
Solaris Development
Tamar Technology
Ultrafast Sensors
Wintress Engineering
Zygo

Vision Sensors

Cognex
Dalsa
Integral Vision
LMI Technologies
Omron Electronics
PPT VISION
QIOPTIQ Imaging Solutions
Sentech America
Teledyne Scientific & Imaging
Vision Components
Wintress Engineering
Zmation

Sample Preparation Equipment

JEOL USA

Surface-Analysis/Profiling Equipment

Ambios Technology
Carl Zeiss
MicrolImaging
Geller Microanalytical Lab
JEOL USA

MACHINE-VISION SOFTWARE

Image-Analysis Software

BitFlow
CIMTEK
Alacron
BitFlow
Cognex
Dalsa
Data Translation
Dalsa
Data Translation
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Euresys
Golden Software
KAPPA opto-electronics
Landrex Technologies
The MathWorks
MatriX Technologies
Matrox Imaging
Micromanipulator
MVTec Software
National Instruments
NorPix
Pixelink
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Agilent Technologies
Industrial Resources
Microlease
TRS-RenTelco

Training: Inspection

A.T.E. Solutions
Matrox Imaging
phoenix x-ray Systems + Services
Sypnis Test & Measurement

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Creative Devices
FLIR Systems
Industrial Resources
K & Us Equipment
NEA
phoenix x-ray Systems + Services
Teradyne
TRS-RenTelco
YXLON International

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Amkor Technology
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Geller Microanalytical Lab
Glenbrook Technologies
GOEPEL Electronics
Integra Technologies
Nevada Automotive Test Center
Oneida Research Services
phoenix x-ray Systems + Services
Pikes Peak Test Labs
Premier Semiconductor Services
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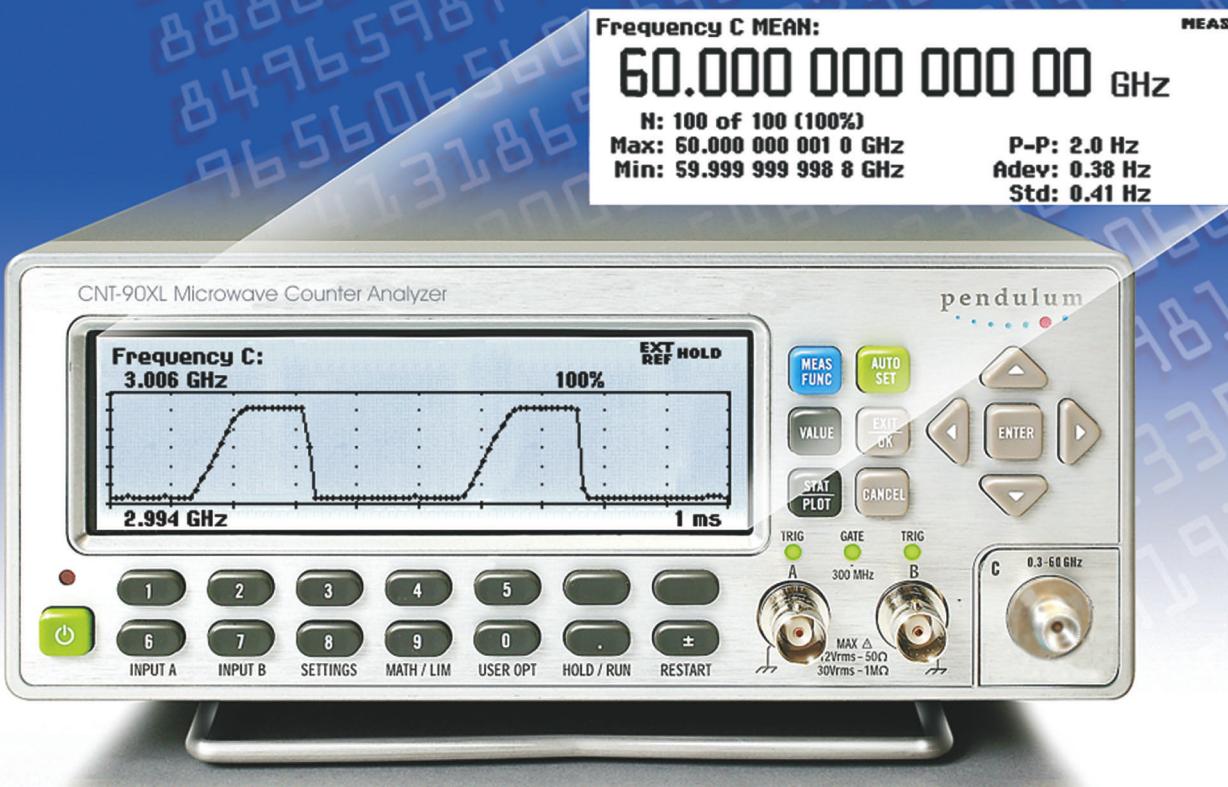
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COMMUNICATIONS TEST

In this section

- RF/Microwave and Wireless Communications Test Equipment, see below
- Telecom/Datacom Test Equipment, p. 82
- Fiber-Optic/Electro-Optic Test Equipment, p. 99
- Third-Party Suppliers, p. 100
- Services/Labs/Test Houses, p. 101

Vendor contact information begins on p. 106.

RF/MICROWAVE AND WIRELESS COMMUNICATIONS TEST EQUIPMENT

Calibration Sets, Microwave

Boonton Electronics
Cascade Microtech
Colby Instruments
Pendulum Instruments
Rohde & Schwarz

Calibrators, Antenna

A.H. Systems
Colby Instruments
Schomandl

Channel Simulators

Anite Group
Azimuth Systems
Leader Instruments

Frequency Counters, RF/Microwave

Advantest America
Aeroflex
Agilent Technologies
Anritsu

B&K Precision

EADS North America Test & Services

Fluke

Instek America
National Instruments

Pendulum Instruments

Phase Matrix

Precision Test Systems

Protek Test and Measurement

Tabor Electronics

Keithley Instruments

National Instruments

Pendulum Instruments

Phase Matrix

Praxsym

Precision Test Systems

Ramsey Electronics

Rohde & Schwarz

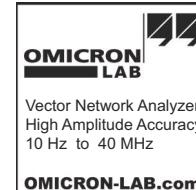
Schomandl

Tegam

Tektronix

Network Analyzers, RF/Microwave

Advantest America
Agilent Technologies
Anritsu
Cascade Microtech
Giga-tronics
JDSU
National Instruments
OMICRON Electronics



Power Meters, RF/Microwave

Aeroflex
Agilent Technologies
Anritsu
AR, RF/Microwave Instrumentation

Berkeley Varitronics Systems

Bird Electronic
Boonton Electronics
EADS North America Test & Services

ETS-Lindgren

Focus Microwaves
Giga-tronics

Keithley Instruments

National Instruments

Pendulum Instruments

Phase Matrix

Praxsym

Precision Test Systems

Ramsey Electronics

Rohde & Schwarz

Schomandl

Tegam

Tektronix

Lake Shore Cryotronics
Leader Instruments
Pendulum Instruments
Precision Test Systems
Schomandl
Sencore
Tektronix

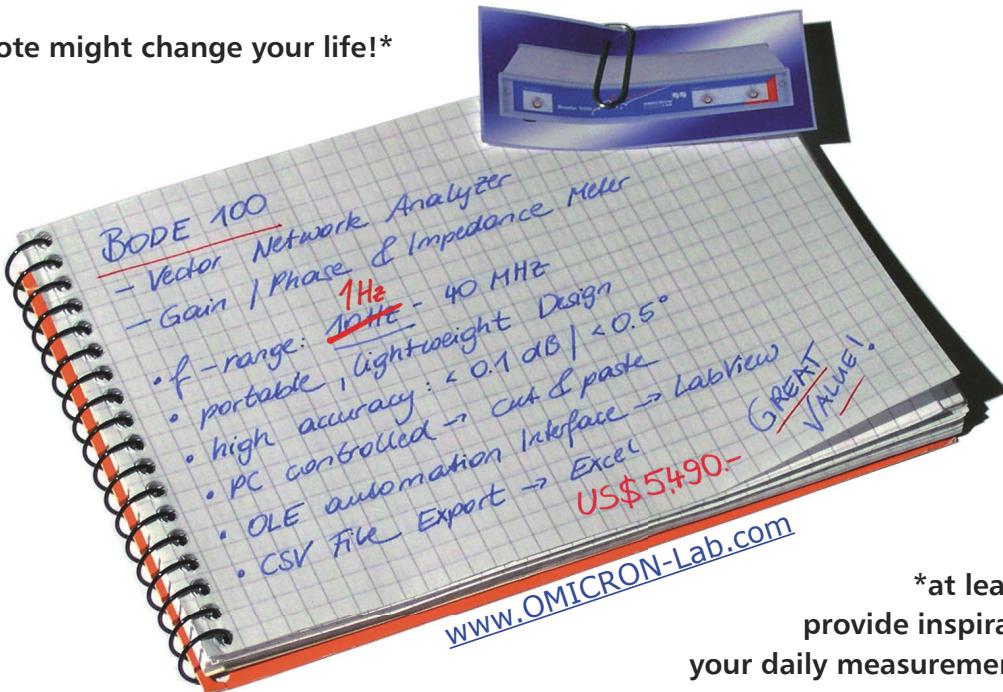
Signal Analyzers, RF

Advantest America
Aeroflex
Agilent Technologies
Anritsu
Bird Electronic
Boonton Electronics
Keithley Instruments
MI Technologies
National Instruments
Opticom
Pendulum Instruments
Precision Test Systems
Rohde & Schwarz
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Tektronix

Continued >



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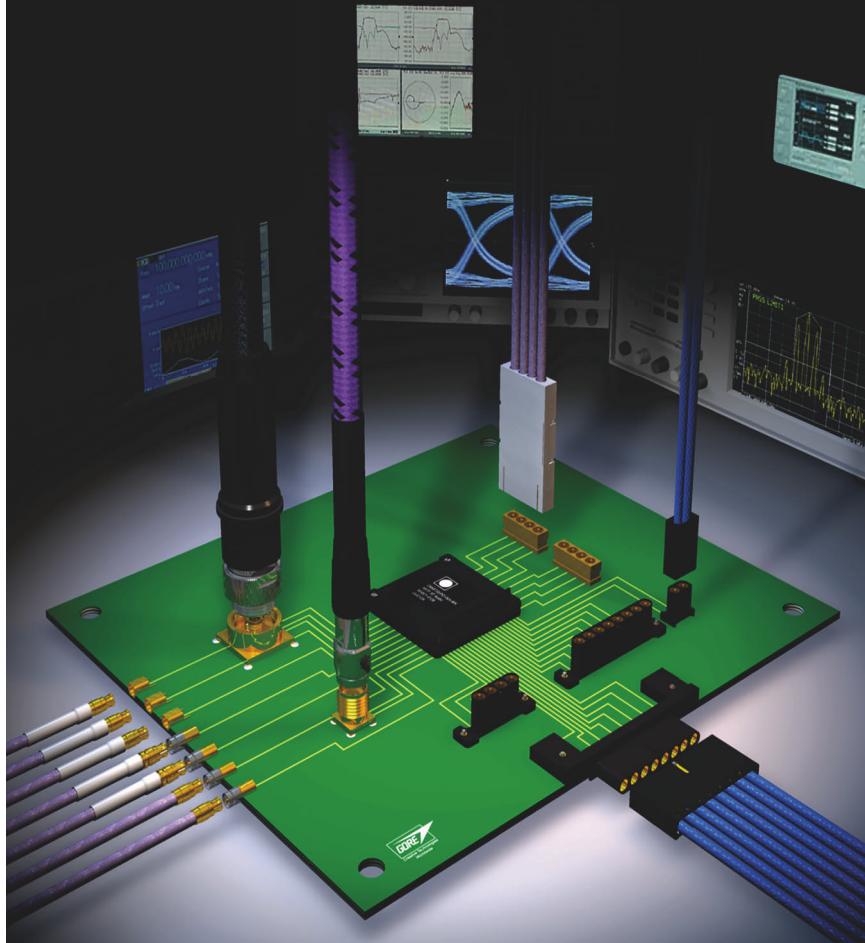
*at least it will
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COMMUNICATIONS TEST

> RF/MICROWAVE AND WIRELESS TEST *Continued*

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Agilent Technologies

Anritsu

Chase Scientific

EADS North America
Test & Services

Fluke

Giga-tronics

Instek America

Keithley Instruments

L-3 Communications

Nova Engineering

Leader Instruments

MI Technologies

Micro Lambda

Wireless

National Instruments

Noise Com

Novatech Instruments

Pendulum Instruments

Pentek

Phase Matrix

Picosecond Pulse
Labs

Praxsym

Precision Test Systems

Protek Test and
Measurement

Rohde & Schwarz

Schomandl

Tabor Electronics

Tektronix

> RF/MICROWAVE AND WIRELESS TEST *Continued*

Switching Matrices, RF/Microwave

AR, RF/Microwave
Instrumentation

Colby Instruments

Cytec

Dow-Key Microwave

EADS North America
Test & Services

Fluke

Giga-tronics

JDSU

JFW Industries

Keithley Instruments

National Instruments

Pickering Interfaces

Rohde & Schwarz

Teledyne Relays

Universal Switching

VXI Technology

Wireless Communications Testers

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Aeroflex

Agilent Technologies

Anite Group

Anritsu

Azimuth Systems

Berkeley Vartronics
Systems

Catapult
Communications

CIMTEK

Colby Instruments

Comarco Wireless
Test Solutions

EADS North America
Test & Services

Ixia

Keithley Instruments

MI Technologies

Noise Com

Pendulum Instruments

Praxsym

Precision Test Systems

RADCOM

Rohde & Schwarz

Schomandl

SeaSolve Software

Spectracom

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Tektronix

Willtek

Communications

ZTEC Instruments

Spectrum Analyzers, RF/Microwave

Advantest America

Aeroflex

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Agilent Technologies				DiagnoSYS Systems	
Anritsu	AEMC Instruments			EXFO	
Centellax	Anritsu			GL Communications	
Connecticut Technology Products	EXFO			JDSU	
EXFO	JDSU			Microtronix Systems	
Finisar	Leader Instruments			Spirent Communications	
GL Communications	Sunrise Telecom			Sunrise Telecom	
Ixia				Terahertz Technologies	
JDSU					
Megatel-CTC Group USA	Agilent Technologies				
Noise Com	EXFO				
Spirent Communications	Hermon Labs				
Sunrise Telecom	Ixia				
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Microtronix Systems
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Prism Sound
QualityLogic
Quantum Data
RADCOM
Rohde & Schwarz
Sencore
Spirent Communications
Sunrise Telecom
Tektronix

Telephone & DSL Line Simulators

Advent Instruments
Catapult Communications
DiagnoSYS Systems
GL Communications
Gordon Kapes
Micro Seven
Microtronix Systems

Continued >



COMMUNICATIONS TEST

FIBER-OPTIC/ELECTRO-OPTIC TEST EQUIPMENT

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Instrument Systems
Integral Vision
Keithley Instruments
Klein Instruments
Microvision
National Instruments
Optomistic Products
Radiant Imaging
Sencore
Test Coach
Vektrex Electronic Systems

Electro-Optics Testers

CIMTEK
EADS North America Test & Services
Gigahertz-Optik
JDSU
Keithley Instruments
National Instruments
Newport
Terahertz Technologies
Vektrex Electronic Systems

Fault Locators

AEMC Instruments
AFL
Telecommunications
Anritsu
EXFO
JDSU
OZ Optics
Sunrise Telecom
Terahertz Technologies

Fiber-Optic Attenuators

AFL
Telecommunications
EXFO
JDSU
OZ Optics

Fiber-Optic Laser Sources

AFL
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Agilent Technologies
Anritsu
Berkeley Nucleonics
Calmar Optcom
dBm Optics
EXFO
ILX Lightwave
JDSU

Luna Technologies
MTI Instruments
Newport
OptoTest
OZ Optics
Princetel
StockerYale
Terahertz Technologies

EXFO
Moritex USA
MTI Instruments
OptoTest
OZ Optics
PerkinElmer
Optoelectronics

Princetel
QIOPTIQ Imaging Solutions
StockerYale
Terahertz Technologies
Vektrex Electronic Systems

Loss Test Sets
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Telecommunications
Anritsu
EXFO
JDSU
OptoTest

OZ Optics
Sunrise Telecom
Terahertz Technologies

Continued >

Fiber-Optic Power Meters

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Telecommunications
Anritsu
EXFO
Gigahertz-Optik
JDSU
Megatel-CTC Group USA
Newport
OptoTest
OZ Optics
Sunrise Telecom
Terahertz Technologies

Fiber-Optics Testers

AFL
Telecommunications
Agilent Technologies
Anritsu
CableTest Systems
dBm Optics
DIT-MCO International
EXFO
Ixia
JDSU
Luna Technologies
National Instruments
Newport
OptoTest
Photon
Sunrise Telecom
Terahertz Technologies

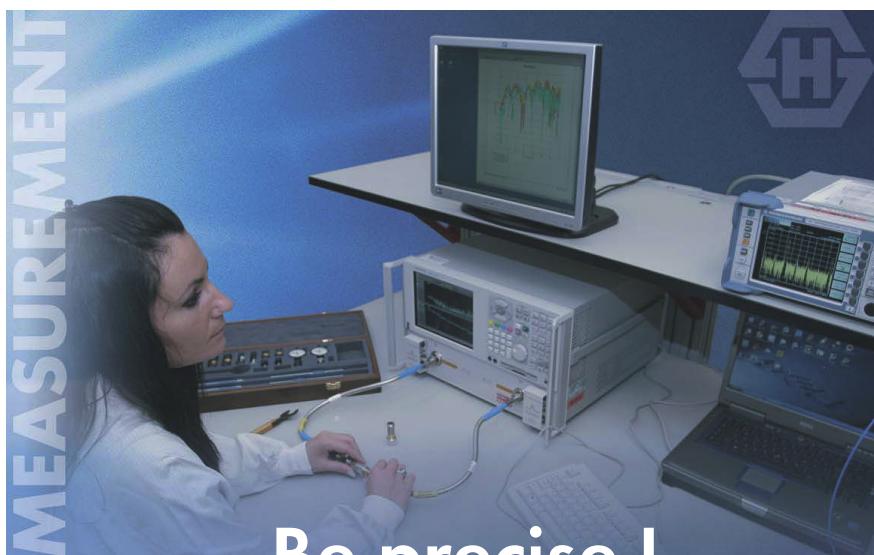
Light and Illumination Meters

Gigahertz-Optik
Klein Instruments
Newport
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Light/Laser Sources

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COMMUNICATIONS TEST

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dBm Optics
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Test & Services
EXFO
JDSU
Megatel-CTC Group
USA
Newport
OZ Optics
Photon
VXI Technology

Optical Detectors

dBm Optics
Edmund Optics
EXFO
Gigahertz-Optik
International Light
JDSU
Keithley Instruments
Newport
PerkinElmer
Optoelectronics
Photon

Optical Dispersion Testers

Agilent Technologies
Anritsu
dBm Optics
EXFO
JDSU
Luna Technologies
Sunrise Telecom

Optical Power Meters

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Telecommunications
Agilent Technologies
Anritsu
dBm Optics
Edmund Optics
EXFO
Gigahertz-Optik
ILX Lightwave
JDSU
Megatel-CTC Group
USA
Newport
OptoTest
OZ Optics
Sunrise Telecom
Terahertz Technologies

Optical Spectrum Analyzers

Agilent Technologies
Anritsu
dBm Optics
EXFO
JDSU
Newport

Optical Switches

Cytec
dBm Optics
EADS North America
Test & Services
EXFO
ILX Lightwave
Ixia
JDSU
Keithley Instruments
Luna Technologies
MRV Communications
Newport
Pickering Interfaces
Piezosystem Jena
Universal Switching
VXI Technology

Optical Time Domain Reflectometers

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Telecommunications
Agilent Technologies
Anritsu
EXFO
JDSU
Luna Technologies
OZ Optics
Sunrise Telecom

Photometers & Radiometers

Agilent Technologies
Gigahertz-Optik
Instrument Systems
International Light
Klein Instruments
Newport
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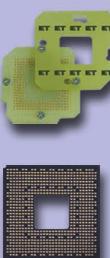
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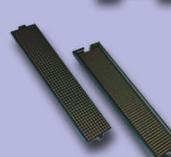
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ELECTRICAL & PHYSICAL ENVIRONMENTAL TEST

In this section

- Environmental Test Equipment, below
- ESD Control/Protection, below
- EMC Test Equipment, below
- Services/Labs/Test Houses, p. 104
- Third-Party Suppliers, p. 104

Vendor contact information begins on p. 106.

ENVIRONMENTAL TEST EQUIPMENT

Burn-In Trays/ Sockets

Antares Advanced Test Technologies
Aries Electronics
Armel Electronics
Cascade Microtech
Emulation Technology
Ironwood Electronics
Micro Control
3M Electronics
Plastronics
Robson Technologies
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Test Tooling Solutions Group
Yamaichi Electronics

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C&H Technologies
Chart Industries
CIMTEK
Cincinnati Sub-Zero
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Integrated Technology Corp.
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Micro Control
Sharetree

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Thermonics
Thermotron Industries
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Trio-Tech International
Vektrex Electronic Systems
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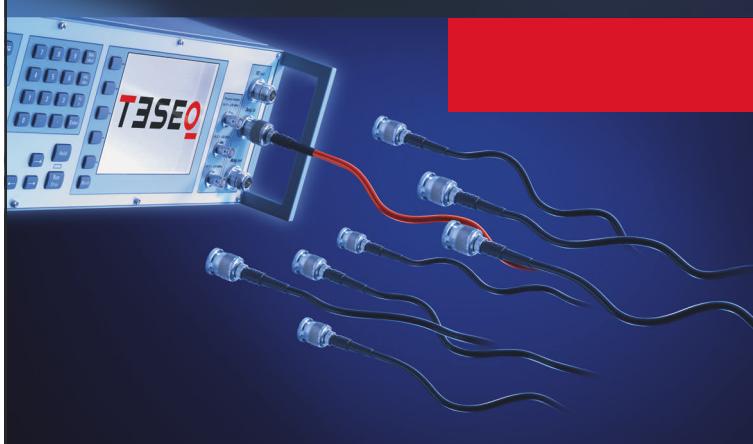
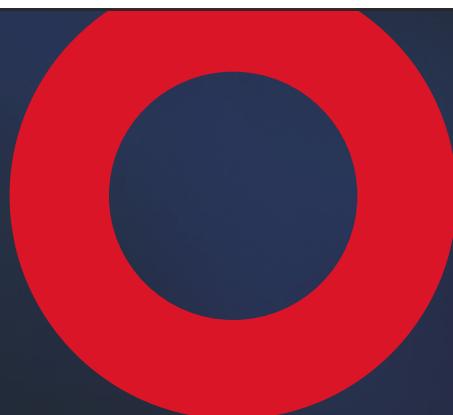
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Autotest Co., San Antonio, TX. 210-661-8661. www.autotest.com.

Avalon Equipment, Vista, CA. 760-536-0191. www.avalontest.com.

Averna, Montreal, QC, Canada. 514-842-7577. www.averna.com.

Avtech Electrosystems, Ogdensburg, NY. 888-670-8729. www.avtechpulse.com.

Azimuth Systems, Acton, MA. 978-263-6610. www.azimuthsystems.com.

B

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BioFit Engineered Products, Waterville, OH. 800-597-0246. www.biofit.com.

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Burnsco Technologies, Kanata, ON, Canada. 613-591-0247. www.burnsco.ca.

Bustec, Yucaipa, CA. 909-797-0484. www.bustec.com.

C

C&H Technologies, Round Rock, TX. 512-733-2621. www.chtech.com.

Cables on Demand, An Amphenol Co., Endicott, NY. 866-223-2860. www.cablesondemand.com.

Cablescan, Ontario, CA. 909-483-2436. www.cablescan.com.

CableTest Systems, Markham, ON, Canada. 905-475-2607. www.CableTest.com.

Cadence, San Jose, CA. 408-943-1234. www.cadence.com.

Cal Test Electronics, Yorba Linda, CA. 714-221-9330. www.caltestelectronics.com.

California Instruments, San Diego, CA. 858-677-9040. www.california-instruments.com.

Calmar Optcom, Sunnyvale, CA. 408-733-7800. www.calmaropt.com.

CAMI Research, Acton, MA. 800-776-0414. www.camiresearch.com.

Campbell Scientific, Logan, UT. 435-753-2342. www.campbellsci.com.

Camtek USA, Santa Clara, CA. 800-986-6540. www.camtekusa.com.

Caris Network Solutions, Phoenix, NY. 315-695-3222. www.carisnet.com.

Carl Zeiss MicroImaging, Thornwood, NY. 800-233-2343. www.zeiss.com/micro.

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Test Site Services, Milford, MA. 508-634-3444. www.testsiteservices.com.
Test Tooling Solutions Group, Singapore. +65-677-96866. www.tts-grp.com.
TestEdge, San Diego, CA. 858-451-1012. www.testedgeinc.com.
TestEquity, Thousand Oaks, CA. 800-950-3457. www.testequity.com.
TestForce, St. Laurent, QC, Canada. 514-856-0970. www.testforce.com.
TestMart, San Bruno, CA. 650-624-0525. www.testmart.com.
Texas Instruments, Dallas, TX. 800-336-5236. www.ti.com.
ThermaCal, Solon, OH. 440-498-1005. www.thermacal.com.
Thermo Electric, Saddle Brook, NJ. 201-843-5800. www.thermo-electric-direct.com.
Thermo Fisher Scientific, Liverpool, NY. 315-451-9410. www.thermo.com/cidtec.
Thermo Scientific, Lowell, MA. 978-275-0800. www.thermo.com/esd.
Thermonics, Sunnyvale, CA. 408-542-5900. www.thermonics.com.
Thermotron Industries, Holland, MI. 616-393-4580. www.thermotron.com.
Thunder Scientific, Albuquerque, NM. 505-265-8701. www.ThunderScientific.com.
Thurby-Thandar Instruments (TTI), Huntingdon, Cambs, UK. +44-148-041-2451. www.tti-test.com.
TPS, Thermal Product Solutions, Williamsport, PA. 570-326-1770. www.thermalproductsolutions.com.
Tracespan Communications, Ann Arbor, MI. 734-846-0549. www.tracespan.com.
Tracewell Systems, Westerville, OH. 800-848-4524. www.tracewellsystems.com.
Transcat, Rochester, NY. 800-828-1470. www.transcat.com.
TREK, Medina, NY. 585-798-3140. www.trekinc.com.
Trek Equipment, Sausalito, CA. 415-332-1555. www.trekequip.com.
Trio-Tech International, Van Nuys, CA. 818-787-7000. www.triotech.com.
TRS-RenTelco, DFW Airport, TX. 800-874-7123. wwwTRS-rentelco.com.
Tucker Electronics, Garland, TX. 800-527-4642. www.tucker.com.
TUV Rheinland of North America, Newtown, CT. 888-975-3943. www.tuv.com.
TUV SUD America, Peabody, MA. 800-888-0123. www.tuvamerica.com.
TYX, Reston, VA. 703-264-1080. www.tyx.com.

U

Ultrafast Sensors, Thousand Oaks, CA. 866-205-0592. www.ultrafastsensors.com.
UltraTest International, San Jose, CA. 408-433-2244. www.ultratest.com.
Underwriters Laboratories, Northbrook, IL. 847-272-8800. www.ul.com.
Unholtz-Dickie, Wallingford, CT. 203-265-3929. www.udco.com.
Unisoft, Milford, CT. 888-486-4246. www.unisoft-cim.com.
United Electronic Industries, Canton, MA. 781-821-2890. www.ueidaq.com.
Unitron, Bohemia, NY. 631-589-6666. www.unitronusa.com.
Universal Switching, Burbank, CA. 818-381-5111. www.uswi.com.

V

Valutronics, Elgin, IL. 800-552-8258. www.valutronics.com.
Vektrex Electronic Systems, San Diego, CA. 858-558-8282. www.vekrex.com.
Verigy, Cupertino, CA. 408-864-2900. www.verigy.com.
VI Technology, Austin, TX. 512-327-3348. www.vi-tech.com.
Vibration Research, Jenison, MI. 616-669-3028. www.vibrationresearch.com.
Vicor, Andover, MA. 978-470-2900. www.vicorpowers.com.
Videology Imaging Solutions, Greenville, RI. 401-949-5332. www.videologyinc.com.
View Engineering, Simi Valley, CA. 805-578-5000. www.viewengineering.com.
Viewpoint Data Management, Rochester, NY. 585-475-9555. www.myaperio.com.
Viewpoint Systems, Rochester, NY. 585-475-9555. www.viewpointusa.com.
Virginia Panel, Waynesboro, VA. 540-932-3300. www.vpc.com.
Viscom, Duluth, GA. 678-966-9835. www.viscom.com.
Vision Components, Hudson, NH. 603-598-2588. www.vision-components.com.
Vision Engineering, New Milford, CT. 860-355-3776. www.visioneng.com.
Vision Research, Wayne, NJ. 866-450-7426. www.visionresearch.com.
Vision Systems International, Yardley, PA. 215-736-0994. www.vision1.com/vsi.
Vistec Semiconductor Systems, Fremont, CA. 510-623-3000. www.vistec-semi.com.
VJ Electronix, Littleton, MA. 978-486-4777. www.vjelectronix.com.
VLSI Standards, San Jose, CA. 408-428-1800. www.vlsistandards.com.
VMETRO, Houston, TX. 281-584-0728. www.vmetro.com.
Volpi USA, Auburn, NY. 315-255-1737. www.volpiusa.com.
VXI Technology, Irvine, CA. 949-955-1894. www.vxitech.com.

W

W.L. Gore & Associates, Elkton, MD. 800-311-3060. www.gore.com.
W.M. Hague, Pepperell, MA. 978-433-3777. www.WMHague.com.
Wavecrest, Eden Prairie, MN. 952-831-0030. www.wavecrest.com.
Wentworth Laboratories, Brookfield, CT. 203-775-0449. www.wentworthlabs.com.
WESCO, Western Scientific, San Francisco, CA. 415-826-5732. www.wescomicroscopes.com.
Willtek Communications, Parsippany, NJ. 973-386-9696. www.willtek.com.
Winchester Electronics, Wallingford, CT. 203-741-5400. www.winchesterelectronics.com.
Wintriss Engineering, San Diego, CA. 800-550-7300. www.weco.com.
WITec Instruments, Savoy, IL. 217-351-9705. www.witec-instruments.com.
World Cal, Elk Horn, IA. 712-764-2197. www.world-cal.com.

X

Xantrex Technology, San Diego, CA. 858-458-0223. www.programmablepower.com.
Xilinx, San Jose, CA. 408-559-7778. www.xilinx.com.
Xitron Technologies, San Diego, CA. 858-530-8099. www.xitrontech.com.
X-TEK Group, Tyngsboro, MA. 978-649-6333. www.xtekxray.com.

Y

Y.P. Unitesters, Yucaipa, CA. 909-797-0484. www.ypu.co.il.
Yamaichi Electronics USA, San Jose, CA. 408-715-9100. www.yeu.com.
YesTech, San Clemente, CA. 949-361-2714. www.yestechinc.com.
Yokogawa Corp. of America, Newnan, GA. 770-254-0400. www.yokogawa.com/us.
YXLON International, Akron, OH. 330-798-4800. www.yxlon.com.

Z

Zmation, Portland, OR. 503-253-8871. www.znation.com.
ZTEC Instruments, Albuquerque, NM. 866-ZTEC-NOW. www.ztecinstruments.com.
Zygo, Middlefield, CT. 860-347-8506. www.zygo.com.

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Red indicates an advertiser in this issue (See Advertiser Index)

PROFESSIONAL SOCIETIES & TRADE ASSOCIATIONS

3rd Generation Partnership Project (3GPP), www.3gpp.org. The 3GPP brings together a number of telecommunications standards bodies.

Accellera, www.accellera.org. Accellera's mission is to drive development of standards that enhance a language-based design automation process.

AeA, www.aeanet.org. Formerly the American Electronics Association, AeA is a trade association representing all segments of the technology industry.

Alliance for Telecommunications Industry Solutions (ATIS), wwwatis.org. ATIS is a US-based body that is committed to developing technical and operations standards for the communications and information technologies industry worldwide.

American Association for Laboratory Accreditation (A2LA), www.a2la.org. The A2LA is dedicated to accreditation of competent testing and calibration laboratories, proficiency testing providers, and reference materials producers.

American Council of Independent Laboratories (ACIL), www.acil.org. ACIL is a trade association representing independent, commercial scientific, and engineering firms.

American National Standards Institute (ANSI), www.ansi.org. ANSI is a private, nonprofit administrator and coordinator of the US voluntary standardization system.

American Society for Nondestructive Testing (ASNT), www.asnt.org. ASNT promotes nondestructive testing (NDT) as a profession and facilitates NDT research.

American Society for Quality (ASQ), www.asq.org. The ASQ advances learning, quality improvement, and knowledge exchange to improve business results.

American Society of Test Engineers (ASTE), www.astest.org. The ASTE, a nonprofit corporation, is dedicated to promoting test engineering as a profession.

ASTM International, www.astm.org. ASTM develops and distributes voluntary technical standards for materials, products, systems, and services.

Audio Engineering Society (AES), www.aes.org. The AES is a professional society devoted exclusively to audio technology.

Automated Imaging Association (AIA), www.machinevisiononline.org. The AIA is a trade association for machine-vision imaging suppliers and users. AIA also maintains the Camera Link and GigE Vision standards.

British Standards Institution (BSI), www.bsi-global.com. BSI is the National Standards Body of the UK, responsible for publishing and marketing British Standards.

Canadian Standards Association (CSA), www.csa.ca. CSA works in Canada and around the world to develop standards that enhance public safety and facilitate trade.

DSL Forum, www.dslforum.org. DSL Forum is a consortium of telecom, equipment, networking, and service-provider companies that promotes the use of DSL technology.

Electronic Industries Alliance (EIA), www.eia.org. EIA represents companies involved in the manufacture of electronic components, parts, systems, and equipment.

ESD Association, www.esda.org. The ESD Association is dedicated to advancing the theory and practice of electrostatic discharge avoidance.

European Committee for Electrotechnical Standardization (CENELEC), www.cenelec.org. CENELEC creates electrotechnical standards, many of them following the mandates of the European Commission.

European Committee for Standardization (CEN), www.cen.eu. CEN works to implement voluntary technical harmonization in Europe.

European Machine Vision Association (EMVA), www.emva.org. The EMVA works to strengthen the position of its members in worldwide markets, and it hosts the GenICam standard group.

European Telecommunications Standards Institute (ETSI), www.etsi.org. ETSI's mission is to produce the telecom standards that will be used throughout Europe.

Federal Communications Commission (FCC), www.fcc.gov. The FCC is charged with regulating interstate and international communications by radio, television, wire, satellite, and cable.

Fibre Channel Industry Association (FCIA), www.fibrechannel.org. The FCIA aims to develop the market for fibre channel products.

IEEE, www.ieee.org. The IEEE is a professional society that advances the theory and practice of electrical, electronics, computer engineering, and computer science.

Institute of Environmental Sciences and Technology (IEST), www.iest.org. The IEST is concerned with the effects that natural, indoor, and extreme environments have on equipment and machinery.

Institute for National Measurement Standards (INMS), inms-iemn.nrc-cnrc.gc.ca. The INMS (Canada's national metrology institute) carries out a range of research and service activities.

Institution of Engineering and Technology (IET), www.theiet.org. The IET, a UK-based professional organization, aims to lead in the advancement of engineering and technology by facilitating the exchange of knowledge and ideas.

International National Committee for Information Technology Standards, www.incits.org. The INCITS works to produce voluntary consensus standards for storage media, databases, programming languages, multimedia, and communication among computing devices and information systems.

International Electrotechnical Commission (IEC), www.iec.ch. The IEC creates international consensus standards and conformity assessment schemes in the fields of electricity, electronics, and associated technologies.

International Microelectronics and Packaging Society (IMAPS), www.imaps.org. IMAPS is a professional society dedicated to educating engineers in all phases of electronics packaging.

International Organization for Standardization (ISO), www.iso.org. The ISO promotes the development of international standards.

International Telecommunication Union (ITU), www.itu.int. Through the ITU, governments and industries establish and coordinate policies, standards, regulations, and treaties covering global telecommunication networks.

IP/MPLS Forum (formerly MFA Forum), www.ipmplsforum.org. The IP/MPLS Forum's mission is to drive the success of IP/MPLS-based technology, networks, and services while focusing on application and deployment solutions.

IPC-Association Connecting Electronics Industries, www.ipc.org. IPC is a global trade association that represents all facets of the electronic interconnection industry, including design, printed wiring board manufacturing, and electronics assembly.

ISA, The Instrumentation, Systems, and Automation Society, www.isa.org. ISA is a society of professionals involved in instrumentation, measurement, and control.

Japan Electric Measuring Instruments Manufacturer's Association (JEMIMA), www.jemima.or.jp/english. JEMIMA promotes research and standards to help develop Japan's electric measuring instrument industry.

LXI Consortium, www.lxistandard.org. The LXI Consortium is working to develop the LAN eXtensions for Instrumentation (LXI) standard.

Microelectronics Packaging and Test Engineering Council (MEPTEC), www.meptec.org. MEPTEC is a trade association committed to enhancing the competitiveness of the back-end portion (assembly and testing) of the semiconductor business.

National Cooperation for Laboratory Accreditation (NACLA), www.nacla.net. NACLA's primary mission is to evaluate US laboratory accreditation bodies (ABs).

National Institute of Standards and Technology (NIST), www.nist.gov. NIST promotes US economic growth by working with industry to develop and apply technology, measurements, and standards.

National Society of Professional Engineers (NSPE), www.nspe.org. The NSPE is an interdisciplinary professional engineering society.

National Voluntary Laboratory Accreditation Program (NVLAP), www.nist.gov/nvlap. Administered by NIST, NVLAP provides third-party laboratory accreditation services.

NCSL International, www.ncsl.org. The National Conference of Standards Laboratories, NCSL International, is an association of metrology organizations with a focus on education.

Optical Society of America (OSA), www.osa.org. The OSA is a nonprofit professional society of engineers and scientists in the optics and photonics community.

PC/104 Embedded Consortium, www.pc104.org. The PC/104 Embedded Consortium disseminates information about PC/104 and serves a liaison function between PC/104 and standards organizations.

PCI Special Interest Group (PCI-SIG), www.pcisig.com. The PCI SIG is committed to the development and enhancement of the PCI standard.

PCMCIA, www.pcmcia.org. PCMCIA is an international standards body and trade association that promotes the interoperability of PC Cards in a variety of products.

PXI Systems Alliance, www.pxisa.org. The PXI Systems Alliance maintains the PXI specification, promotes PXI technology, and ensures multivendor interoperability.

SAE International, www.sae.org. SAE International works to advance the engineering of mobility systems, whether for use on land or sea or in air or space.

Semiconductor Equipment and Materials International (SEMI), www.semi.org. SEMI is an international trade association for equipment and materials suppliers to the semiconductor, MEMS, and flat-panel display industries.

Semiconductor Industry Association (SIA), www.sia-online.org. The SIA is a trade organization that represents US-based semiconductor manufacturers.

Semiconductor Test Consortium (STC), www.semitest.org. The STC oversees the Openstar (Open Semiconductor Test Architecture) platform.

Society for Information Display (SID), www.sid.org. The SID is devoted to the advancement of electronic display technology, manufacturing, and applications.

Society of Flight Test Engineers (SFTE), www.sfte.org. The SFTE is a fraternity of engineers whose principal professional interest is the flight testing of aircraft and missiles.

SPIE (formerly International Society for Optical Engineering), www.spie.org. The SPIE is a technical society dedicated to advancing engineering and commercial applications of optical, photonic, imaging, electronic, and optoelectronic technologies.

Standards Council of Canada, www.scc.ca. The Standards Council of Canada, charged with promoting efficient and effective standardization, oversees Canada's National Standards System.

Surface Mount Technology Association (SMTA), www.smta.org. The SMTA seeks to advance the industry through education, training, and networking in regards to electronics assembly technologies and related business operations.

Telecommunications Industry Association (TIA), www.tiaonline.org. The TIA is a trade association serving the communications and information technology industries.

Test and Diagnostics Consortium (TDC), www.test-diagnostics.org. The TDC brings together users and suppliers from industries such as medical, automotive, satellite, railroad, trucking, and defense to optimize the test and diagnostic environment.

Underwriters Laboratories (UL), www.ul.com. The UL is an independent, nonprofit certification organization that evaluates products in the interest of public safety.

VMEbus International Trade Association (VITA), www.vita.com. VITA is a nonprofit trade association that promotes the use of open system architectures.

VXIbus Consortium, www.vxibus.org. The VXIbus Consortium develops and promotes the VXIbus instrumentation standard.

WiMAX Forum, www.wimaxforum.org. The WiMAX Forum certifies and promotes the compatibility and interoperability of broadband wireless products based upon the harmonized IEEE 802.16/ETSI HiperMAN standard.

ZigBee Alliance, www.zigbee.org. The ZigBee Alliance works to enable low-power, wirelessly networked, monitoring and control products based on a global standard.

T&MW

CATALOGS & PRODUCTS

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

RF test socket

The Multitest Econ is a new-generation plunge-to-board socket for RF and high-current applications for QFN, QFP, and SO packages with a lead pitch down to 0.3 mm. *Multitest Electronic Systems*, www.multitest.com/sockets.

JTAG products and support

Goepel electronics is a leading vendor of innovative JTAG and boundary-scan solutions, offering mature software tools in an integrated development environment, high-performance boundary-scan controllers and accessories, as well as comprehensive product support and value-added services. *Goepel electronics*, www.goepelusa.com.

5-Mpixel cameras

The Basler pilot models are all equipped with highly sensitive Kodak and Sony CCD sensors from VGA to 5 Mpixels. With its extremely slim design and a footprint of 29x44 mm, the Basler pilot is the smallest camera in its class, according to the company. *Basler Vision Technologies*, www.baslerweb.com.

Firsthand technical knowledge



Rohde & Schwarz is now offering its own selection of books written by in-house experts who are able to bring you the latest in theory and practice. *Rohde & Schwarz*, www.books.rohde-schwarz.com.

Ethernet analyzer

GL's T3/E3 T1/E1 Ethernet analyzer is a compact, portable, and powerful unit that complies with USB 2.0, provides recording and playback of entire T3/E3 streams, and performs protocol testing. It supports channelized (M13, E12, G.747) as well as unchannelized T3/E3 modes. *GL Communications*, www.gl.com/laptpt3e3.html.

Pad and leaded contactors

Johnstech's ROL Technology contactors are now available for both Pad and Leaded packages. The ROL Technology provides excellent electrical and mechanical reliability on all types of RoHS-compliant devices. *Johnstech International*, www.johnstech.com.

AC power sources

The Associated Power Technologies 5000 Series is an entry-level line of AC power sources that provide simple and cost-effective control of voltage and frequency. Models up to 4 kVA are available. *Associated Power Technologies*, www.aspowertechnologies.com.

Extensive sensor selection

The 2008 T&M sensor catalog is now available from Honeywell. Accuracy, repeatability, and durability are built into all of the company's load cells, torque transducers, digital gages, accelerometers, pressure sensors, force sensors, and instrumentation. *Honeywell Sensing and Control*, www.honeywell.com/sensing.

Free "virtual chapters"

Free access to "virtual chapters" from Keithley's popular line of six informative handbooks is available on the company's Website. To obtain a free copy of each handbook by mail, simply submit your request online. *Keithley Instruments*, www.keithley.com/at/551.

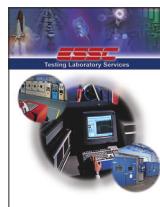
Environmental products handbook

The 8th edition *Flow, Level and Environmental Handbook and Encyclopedia* contains 1400 pages of information on flow, level, and environmental products. This free handbook has a technical reference section, unit conversion tables, and a glossary. *Omega Engineering*, www.omegacom.

ATE test tooling

Test Tooling Solutions Group specializes in providing integrated and turn-key solutions for burn-in boards and load boards. The company focuses on lowering the total cost of final test for customers. *Test Tooling Solutions Group*, www.tts-grp.com.

Test laboratory



ESSC Test Laboratories provides climatic testing services including temperature cycling, humidity, vibration, shock, thermal shock, altitude, salt spray, and cycling corrosion. Both laboratories in Ohio and Michigan are accredited by the A2LA. *ESSC Test Laboratories*, www.esscinc.com.

Multifunction synchronous DAQ

Measurement Computing's USB-1600HS Series multifunction data-acquisition modules feature two, four, or eight simultaneous 16-bit analog inputs at rates to 2 Msamples/s, with 32 synchronous digital I/O lines, two 32-bit counters, and optional analog outputs. *Measurement Computing*, www.mccdaq.com.

LXI information

Pickering Interfaces has published the second edition of *LXImate*, a 130-page book that provides an overview of the LXI standard, discovering devices, and operation via a LAN/Web interface, as well as descriptions of LAN, IEEE 1588, and wired triggers. *Pickering Interfaces*, www.pickeringtest.com.

Be precise

The Huber+Suhner Test & Measurement components catalog offers a comprehensive range of RF products meeting the specific requirements of special applications encountered in test and measurement laboratories. *Huber+Suhner*, www.hubersuhner.com.

PRODUCT FOCUS

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

Data-acquisition catalog



lets you acquire, save, analyze, and view data within minutes. *IOtech*, www.iotech.com.

Programmable power

The Programmable RKW Series of single-output DC power supplies is available in 300-, 600-, and 1500-W sizes. The instruments offer outputs of 0–3.3 to 0–48 VDC and operate from 85 to 265 VAC with active power factor correction (PFC). *Kepco*, www.kepcopower.com/rkwp.htm.

3.0-GHz spectrum analyzer

Insteek's GSP-830 3.0-GHz spectrum analyzer offers autoset, a USB interface, and a brilliant TFT color display in one package at an affordable price. The battery-pack option and low noise floor make this unit ideal for the lab or the field. *Insteek America*, www.goodwill.com.tw.

Express instruments

During the last 12 months, Strategic Test has released more than 80 new PCI Express instrument cards. These include digitizers/oscilloscopes, arbitrary waveform generators, high-speed digital I/O, and pattern generators. *Strategic Test*, www.strategic-test.com.

Complimentary white papers

TÜV SÜD America offers complimentary white papers written by industry professionals who are experts in their fields. The company's white papers offer clarification and insight on a variety of topics. *TÜV SÜD America*, www.tuvamerica.com/tuvnews/whitepapers.cfm.

Benchmark for pick-and-place test

The MT2168 pick-and-place handler optimizes test cell efficiency. Its speed and high parallelism permit shorter test times and multi-site testing. The MT2168 is scalable for different test situations from engineering to high-volume production, it can be converted for various package styles, and it offers a flexible contact site, which is adaptable to all existing load boards.

Multitest Electronic Systems, www.multitest.com/MT2168.

WiMAX tester simplifies setup

Rohde & Schwarz says that the measurement speed of its new R&S CMW270 WiMAX tester is up to 10 times higher than that of



other test options. This ensures maximum throughput in the production of WiMAX chipsets and mobile stations. In addition, the R&S CMW270 offers the capability to emulate a base station (signaling mode).

Rohde & Schwarz, www.rohde-schwarz.com.

Vector-network analyzer

The Bode 100 combines a PC-controlled vector-network analyzer, a gain/phase meter, an impedance meter, and a sine-wave generator in a compact and lightweight



design. The wide frequency range of 10 Hz to 40 MHz is ideal for many RF and low-frequency applications, such as control circuit analysis.

Omicron Lab, www.omicron-lab.com.

JTAG emulation tool

The VarioTAP tool from Goepel electronics is based on a flexibly configurable streaming technology of the TAP signals based on re-



spective microprocessor model libraries (VarioTAP Models). Thus, VarioTAP enables a complete fusion of JTAG emulation and boundary-scan test for real interlaced test operations and multivalent flash in-system programming.

Goepel electronics, www.goepelusa.com.

PRODUCT FOCUS

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

Mobile benches and carts

Anthro, a leader in lab furniture since 1984, provides mobile benches and equipment carts that can be configured specifically for your application. Options include monitor arms, storage bins, additional shelves

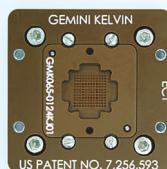
(holding up to 500 lbs), and height-adjustable workstations so everyone can work in comfort. A lifetime warranty is included.

Anthro,
www.anthro.com/labs.



Kelvin probes for BGA

ECT has enhanced its popular Gemini Kelvin series to include contactors for BGA devices.



Entire arrays down to 0.65-mm pitch can now make true Kelvin connections, as can partial arrays at 0.5 mm and 0.4 mm. All designs include a floating alignment plate for ideal alignment and probe protection.

Everett Charles Technologies, www.ectinfo.com.

Module simplifies maintenance

Featuring NIST-traceable voltage, frequency, and resistance standards, the GX1034 is a 3U, PXI module that can be incorporated

into a PXI system to support an in-system accuracy verification

strategy for recertifying a system's source and measurement instrumentation. Such integration results in simplified support and maintenance logistics and improved system availability.

Geotest – Marvin Test Systems, www.geotestinc.com.



Antenna kits

A.H. Systems offers nine models of portable antenna kits from 2 GHz to 40 GHz. Each kit provides all the antennas, current probes, and accessories needed to satisfy a wide array of customer requirements. Additional pre-amplifiers and cables can be added. The company offers what you need for compliance testing with next-day delivery.

A.H. Systems,
www.ahsystems.com.



Cameras offer 140-kHz line rates

The sprint series cameras from Basler offer line rates up to 140 kHz at 2k or 4k resolution and 70 kHz at 8k resolution. With outstanding sensitivity and a high signal-to-noise ratio in low-light conditions, these cameras can increase the efficiency of imaging applications.

All resolutions will be available in mono versions and in color versions that use a Bayer pattern concept.

Basler Vision Technologies, www.baslerweb.com.



SPDT terminated switch

Dow-Key has introduced a new line of SPDT terminated switches: the 521U series. The 521U series is a break-before-make SPDT switch noted for its 5-million actuation life cycle



and for its various RF configuration options—an unterminated 2/3 (DP3T) switch, 2-W or 5-W internal terminations, and 2-W or 5-W external terminations.

Dow-Key Microwave,
www.dowkey.com.

Advanced AC power source

The Associated Power Technologies Model 6010 is a full-featured 1-kVA AC power source. The 6010 offers advanced features including a standard RS-232 interface with GPIB op-

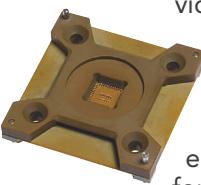


tional. This programmable AC power source is well-suited for a variety of test and measurement, avionics, manufacturing, and military applications.

Associated Power Technologies, www.aspowertechnologies.com.

Pad and leaded test contactors

Johnstech's patented ROL Technology is now available for both pad and leaded devices. ROL



Technology provides excellent electrical performance and proven mechanical reliability on both matte-tin and nickel-palladium-gold devices. Two contact configurations, Eco-1 and Gold-Plated, allow for testing on a wide array of RoHS-compliant packages.

Johnstech International, www.johnstech.com.

Microwave spectrum analyzer

Featuring a frequency range of 9 kHz to 18 GHz, the R&S FSL18 can perform mea-



surements on microwave systems, including tests on radar and microwave link systems as well as production tests on microwave components such as mixers and amplifiers. The company says it is the only instrument in its class to support the WLAN, WiMAX, and WCDMA standards.

Rohde & Schwarz, www.rohde-schwarz.com.

Sourcing and measurement resource guide

Keithley's newest CD guide contains more than a dozen application notes on topics such as measurements for BTI characterization, increasing production throughput of multipin devices, and making precision measurements. The CD also includes white papers on test-sequencing instruments and introducing pulsing into reliability tests for CMOS technologies.

Keithley Instruments, www.keithley.com/at/553.



Surface probe calibrator

The CL1600 surface probe calibrator is designed to calibrate and verify surface probe readings from 25°C to 450°C (77°F to 842°F). This rugged, compact bench



device provides a large 120-mm (4.75-in.) diameter, high-grade aluminum surface. The calibrator is RoHS-compliant.

Omega Engineering, www.omega.com.

Zoom lens

With a 4:1 zoom ratio, the VZM 100i maintains 1:1 maximum magnification at an extra long constant working distance of 175 mm. The



VZM 100i also has an adjustable locking iris to compensate for changing lighting conditions or to increase the depth of field during high-magnification inspection.

Edmund Optics, www.edmundoptics.com/US.

PRODUCT FOCUS

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

Scalable, flexible data-acquisition

IOtech's DaqBook/2000 Series Ethernet-based, 16-bit, 200-kHz analog-to-digital data-acquisition systems



are supported by a variety of datalogging

and analysis software. More than 40 expansion options are available for customizing a system for a particular application. With the included Out-of-the-Box software, you can begin acquiring data within minutes.

IOtech,
www.iotech.com.

Compact thermal-shock chamber

CSZ has introduced a new vertical thermal-shock chamber with a small footprint. The chamber offers 1 ft³ of interior workspace volume and

incorporates many standard features, including CSZ's EZT-560i touch-screen controller. The product-transfer mechanism provides smooth transfer and requires only 208-V power to operate, so no special utilities such as air are required.

*Cincinnati Sub-Zero,
www.cszindustrial.com.*



ATE test and tooling

Test Tooling Solutions Group specializes in providing integrated and turnkey solution for burn-in boards and load boards.

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Test Tooling Solutions Group, www.tts-grp.com.



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The SucoTest 18 ruggedized, 18-GHz test cables can withstand bending and torsion while providing excellent



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Huber+Suhner,
www.hubersuhner.com.

InfiniiVision 7000 now available

MetricTest has introduced the Agilent InfiniiVision 7000 series oscilloscopes to its



product offerings. The company says the InfiniiVision 7000 includes advanced technology that will allow you to see more subtle signal detail and more infrequent events than any other scope.

*MetricTest,
www.metrictest.com.*

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play in one package at an affordable price. The battery-pack option and low noise floor make this unit ideal for the lab or the field.

*Insteek America,
www.goodwill.com.tw.*

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full 24-bit resolution, configurable for either voltage or thermocouples. They also offer eight high-speed digital I/O lines, two 32-bit counters, and a 200-samples/s aggregate throughput.

*Measurement Computing,
www.mccdaq.com.*

Four-port network analyzer

Rohde & Schwarz is expanding its network-analyzer portfolio to higher frequencies. With two integrated



sources, the new R&S ZVA50 makes it possible to perform measurements on multiport and balanced components in the 50-GHz frequency range using a single instrument.

*Rohde & Schwarz,
www.rohde-schwarz.com.*

High-density LXI switching

Pickering Interfaces has announced two additions to its growing family of 1U LXI switching systems: The 60-



550/552 electromagnetic relay matrices feature 2-A switching and up to 4096 cross points. The 60-600 high-current matrix features 10-A switching and up to 256 cross points in the same 1U rack space.

*Pickering Interfaces,
www.pickeringtest.com.*

PCI digitizers get bigger memory

Strategic Test now equips all of its digitizer, arbitrary waveform generator, and high-speed digital I/O PCI and PCI Express cards with 256 Mbytes of onboard memory. This allows longer



recording and generation times and delivers

greater value for the money. Data sheets and prices are available on the company's Website.

*Strategic Test,
www.strategic-test.com.*

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The company's NRTL information bank—NRTL Spotlight—provides information on OSHA, NRTLs, and standards. NRTL Spotlight also includes FAQs and lets you pose questions to experts, download white papers, and play trivia games.

*TÜV SÜD America,
www.tuvamerica.com/nrtl.*



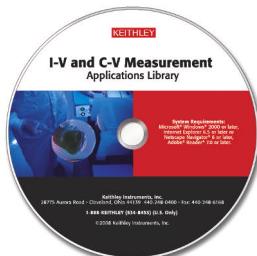
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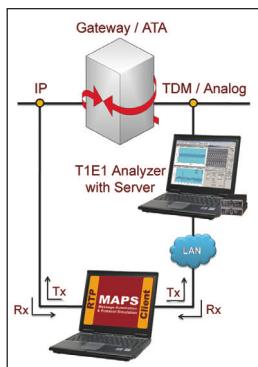


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Omega Engineering, Inc.

203-359-1660, <http://www.omega.com/pptst/DR900.html>



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Test & MEASUREMENT WORLD

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VOL. 28, NO. 6

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: Submail@ReedBusiness.com. Test & Measurement World® copyright 2008 by Reed Elsevier Inc. Rates for non-qualified one-year subscriptions, including all issues: US, \$103; Canada, \$152 (includes 7% GST, GST# 123397457); Mexico, \$150; International (Priority), \$215. 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. (Printed in U.S.A.)



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DR. JAMES TRUCHARD

President and CEO
National Instruments
Austin, TX

Dr. James Truchard co-founded National Instruments in 1976 while working for the Applied Research Laboratories at the University of Texas. In 1986, together with Jeff Kodosky, he invented LabView, the graphical development software that is the cornerstone of the company's virtual instrumentation technology. NI has since grown into a global organization with more than 4000 employees. Among his extensive career honors, Truchard was elected to membership in the National Academy of Engineering in 2007. He holds a doctorate in electrical engineering, as well as an MS and a BS in physics, all from The University of Texas at Austin.

Contributing editor Larry Maloney conducted an e-mail interview with Dr. Truchard on important trends in the test field.

Harnessing the power of multicore

Q: NI has been focusing increasingly on multicore technology. What are the potential productivity gains from multicore in test?

A: Multicore chips hold great promise for test because they can handle the concurrency requirements of most I/O-based systems. The real challenge is software. Up until now, traditional programming languages have provided performance increases with each new processor generation. With multicore architectures, however, traditional programming languages won't continue to provide automatic performance benefits. As Herb Sutter of Microsoft has said, "The free lunch is over."

Graphical languages, such as NI LabView, can represent the concurrency of a multicore system naturally. Two parallel loops can literally be drawn in parallel and will execute on separate cores. LabView automatically executes the program on the cores available to it and scales to execute on as many cores as are present in the system.

Q: Do you see continued interest in PXI-based testing?

A: PXI is growing rapidly and expanding into new applications. In 2007, PXI vendors shipped over 15,000 systems, and the market overall is growing at over 25% annually. With continued miniaturization of semiconductor technology, vendors can fit more and more performance into PXI modules. Modules are available for high-performance RF, optical measurement, high-speed digitizers, precision digital multimeters (DMMs), and many other instruments. With the introduction of PXI Express products, which increases the backplane performance by 45X, we see growth of PXI in new applications that can benefit from very high data throughput.

Q: What is driving the growing popularity of field-programmable-gate-array-enabled instruments?

A: FPGAs are powerful because they are inherently parallel, deterministic, and reliable. They also can be defined in software.

With software-reconfigurable FPGAs on modular instruments, test engineers can embed a custom algorithm into the device to perform in-line processing or emulate part of the system that requires real-time response.

Most test engineers lack the expertise to program FPGAs with traditional hardware description languages like Verilog or VHDL. LabView can target onboard FPGAs and synthesize the necessary hardware directly from a LabView program. This dramatically reduces the complexity of code development.

Q: What new automated test equipment (ATE) approaches are needed for complex semiconductors?

A: As semiconductors get more complex, testing each part completely with a traditional vector-based test methodology is increasingly difficult and expensive. Complex systems-on-a-chip (SOCs) and systems-in-a-package (SIPs) require testing at the functional level. A higher-level test methodology is called for to both reduce tester complexity and provide a tighter link back to system-level design tools.

The idea is to create a test system that can perform functional testing of a device by emulating the device in its intended surroundings. This requires the capability to model other components of the system and to interact with the device in real time.

This emulation-based ATE, also termed "Protocol-Aware ATE" during last year's International Test Conference, combines FPGA-based hardware to emulate the rest of the system in real time with the pin electronics found in traditional ATE. This both lowers the total cost of test and improves the user's ability to debug failures. **T&MW**



Dr. Truchard gives more insights on changing needs in the test field and the role of virtual instruments in the online version of this interview: www.tmworld.com/2008_07.

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