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THE MAGAZINE FOR QUALITY IN ELECTRONICS

Lisa Moder, Senior Test Engineer at EchoStar Technologies.

From SOFTWARE *to* RF

Test Engineer of the Year Lisa Moder ensures the quality of EchoStar's set-top boxes at manufacturing facilities around the world.

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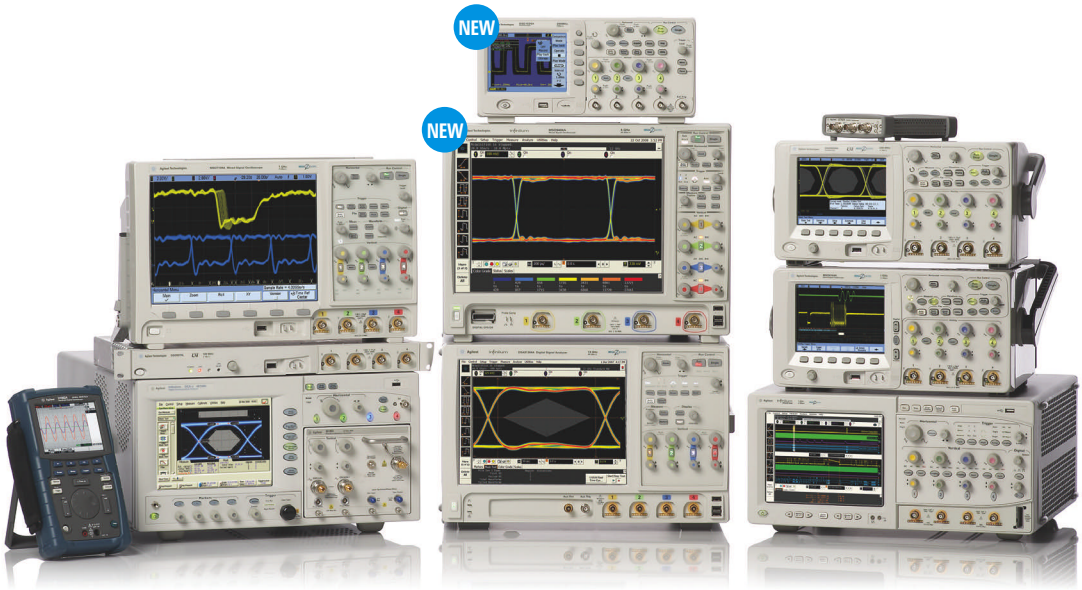
Why is Agilent the fastest growing oscilloscope manufacturer?



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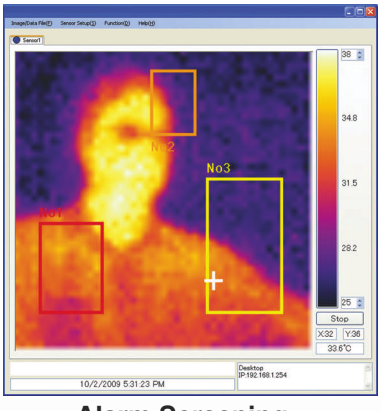

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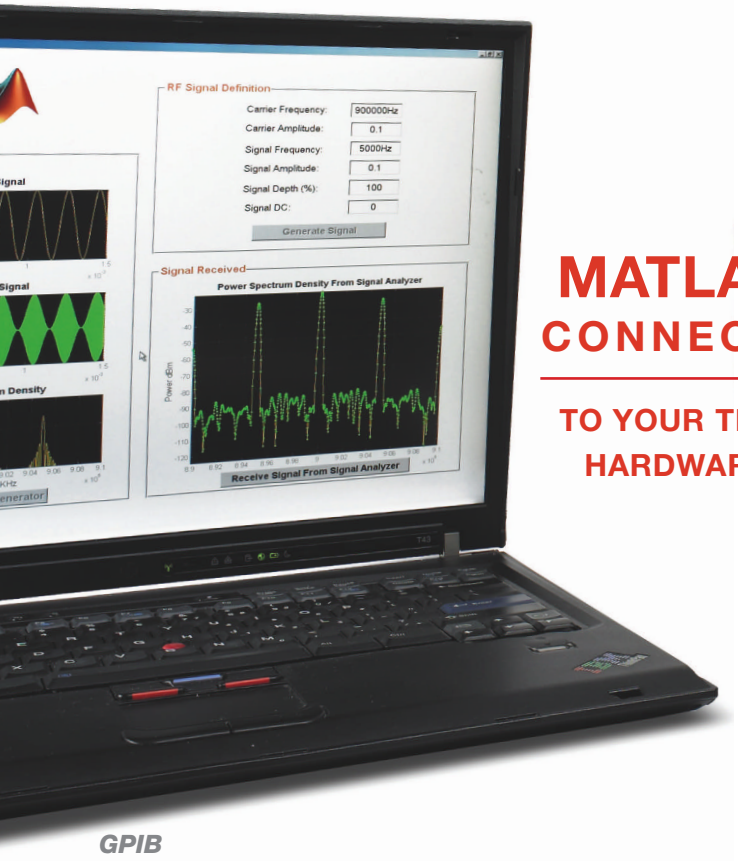

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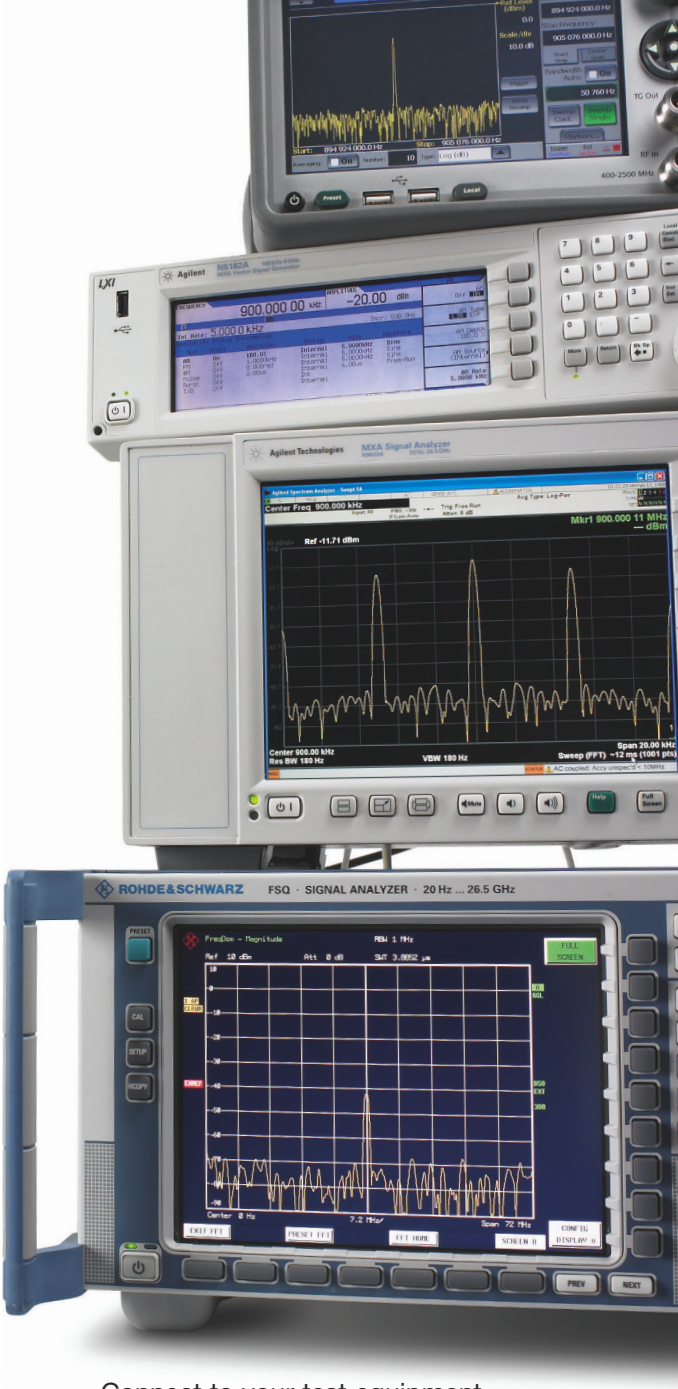

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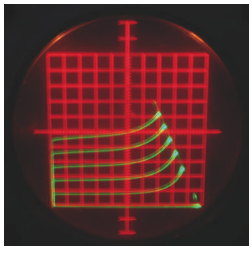

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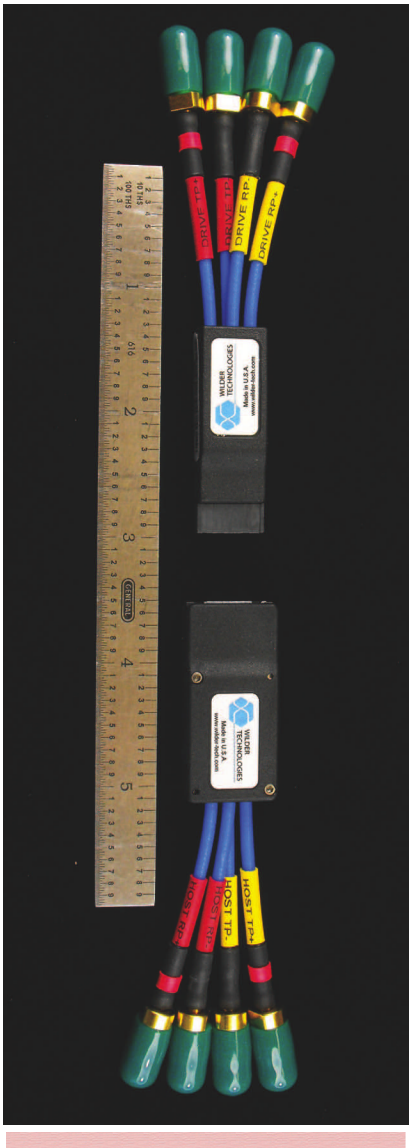

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RICK NELSON
EDITOR IN CHIEF

Car or driver?

Controversy continues to swirl around Toyota and its sudden acceleration problem. What's wrong? Is it the floor mats or a sticky pedal? What about drive-by-wire and related software? How about driver error? Does it even matter?

My colleague Ron Wilson addresses the problem in *EDN* (Ref. 1): "I see from the morning news that Toyota's adventure into the world of embedded software is going badly. The company's second attempt to find a quick fix for unintended acceleration in its conventionally powered vehicles is barely under way, and evidence is already emerging that the underlying problem is likely in the engine controller, not in the pedal's mechanical assembly." He goes on to recount Audi's similar problems decades ago.

The money spent investigating unintended acceleration could probably be better spent elsewhere.

Notes Wilson, "Now, after decades invested in metrics-driven verification, formal verification, and methodology management, designers find that their chips don't work as expected because the software is still being 'verified' by feeding it test cases until the schedule expires. Consumers find that their cars run into these problems for the same reason, and the press blames the problem on 'electronics.'"

It's unfortunate that consumers associate automotive electronics and mission-critical real-time software with the foibles of PC performance, but it's inevitable. It's particularly unfortunate because of emerging evidence that the culprit is often driver error.

One proposed solution involves smart pedals. But in the *New York Times* (Ref. 2), Richard A. Schmidt, a professor emeritus of psychology at the University of California, Los Angeles, comments, "…based on my experience in the 1980s helping investigate unintended acceleration in the Audi 5000, I suspect that smart pedals cannot solve the problem," because the problem is often caused by drivers who hit the gas when they intend to hit the brake.

So, car or driver? We're wasting time asking, reports one Toyota owner, Robert Wright (Ref. 3). Expressing sympathy for victims of accidents that may have been related to unattended acceleration, he nevertheless writes that driving one of these suspect Toyotas raises your chances of dying in a car crash over the next two years from 0.01907% to 0.01935%, and he says he can live with those odds. As he notes, the money spent addressing the problem could probably save more lives if spent elsewhere.

Wright comments that he could take the gas money he saves via potentially dangerous electronic throttle control and use it to save several lives in Africa. He acknowledges that he probably won't, but he suggests that any of us who pass up the chance to spend some money to save lives are no less culpable than Toyota was when it bargained with the government for approval of the cheap floor-mat fix without worrying too much about root causes of the problem. T&MW

REFERENCES

1. Wilson, Ron, "Toyota, drive by wire, and our failure to learn from experience," *EDN,* March 4, 2010. www.edn.com.

2. Schmidt, Richard A., "Braking bad," *New York Times,* March 10, 2010. www.nytimes.com.

3. Wright, Robert, "Toyotas Are Safe (Enough)," *New York Times,* March 9, 2010. www.nytimes.com.

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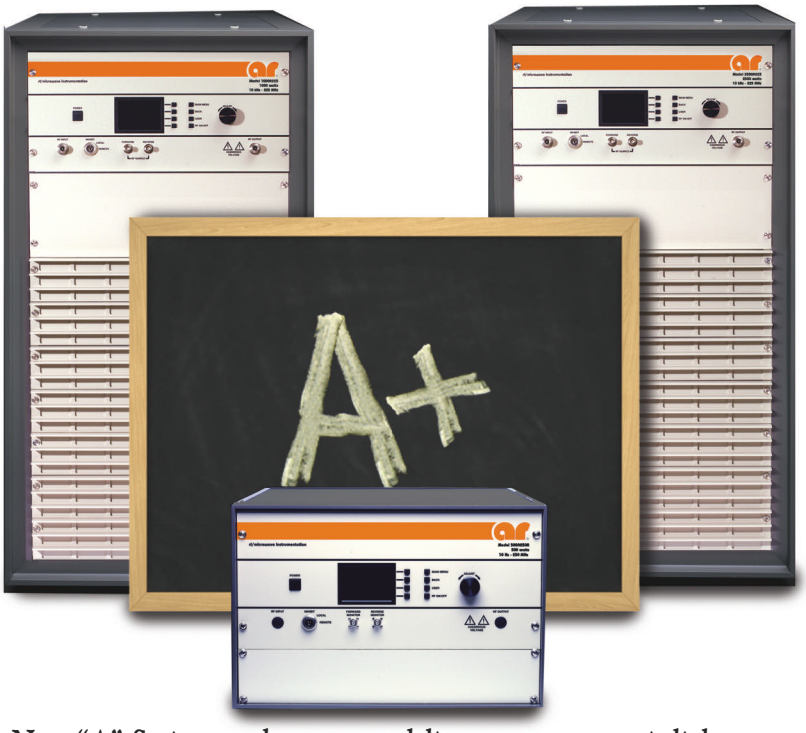
Maybe We Should Have Called It The A+ Series.



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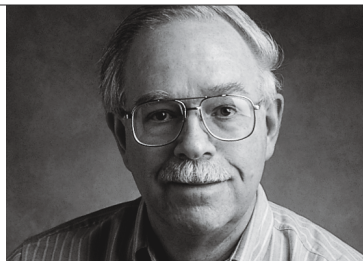
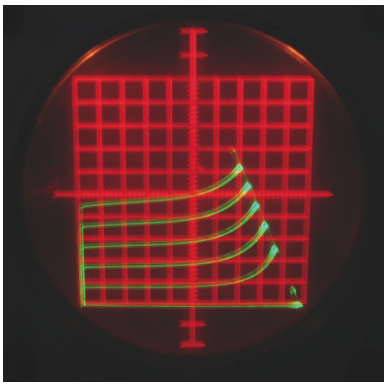


Throw it a curve (tracer)

Some instruments merely make measurements, while others offer insights. My top three candidates for the latter role are the oscilloscope, the spectrum analyzer, and the curve tracer. While measuring instruments deliver raw data, insight-producing instruments convey their users more directly to an "aha!" moment.

For example, measuring the DC voltage across a relay-driver transistor likely won't show a marginal collector-emitter voltage breakdown problem. An oscilloscope measurement reveals a suspicious "wiggle" in the collector turnoff voltage. Plugging the transistor into a curve tracer and cranking up its collector voltage confirms at a glance its premature breakdown.



Assembling a rudimentary curve tracer is trivially simple. You need an oscilloscope, an isolated AC variable-voltage source, and a few resistors. The AC source applies forward and reverse voltages to the semiconductor junction of a DUT (device under test), and a resistor samples the current flowing through the junction. The oscilloscope displays the junction's voltage-versus-current (V-I) characteristic. To record the display, you use a camera to photograph the CRT's screen.

The next level of complexity adds a voltage or current staircase-waveform source that's synchronized to the AC line. Applied to the DUT's control electrode, the staircase produces a family of V-I conduction curves. Commercially available curve tracers feature circuit refinements that include precision sources and multiple measurement modes.

As examples of stand-alone curve tracers, Tektronix's venerable Model 575 and its solid-state descendents (e.g., the Models 576 and 370) are perhaps most familiar to test engineers from college labs.

Currently, instrument manufacturers have discontinued traditional oscilloscope-based curve tracers in favor of more sophisticated (and expensive) computer-based source-measure units that ease data capture and analysis. Prospective users can still find used stand-alone curve tracers on auction and used-equipment Websites.

Time and again, curve tracing has proved itself to be an indispensable problem-solving tool. So, when you're pitching for the home team and a malfunctioning semiconductor steps up to the plate, throw it a curve (tracer). T&MW

To read past "Test Voices" columns, go to www.tmworld.com/testvoices.

HERE'S THE WINDUP

Wikipedia offers a brief introduction to curve tracers:
en.wikipedia.org/wiki/Semiconductor_curve_tracer

Build a basic semiconductor curve tracer from the designs described here (scroll down to "Quick and Dirty Curve Tracer" or the "Simple Curve Tracer" designs):
www.repairfaq.org/sam/semitest.htm

Use a PC's sound card, a test fixture, and software to assemble a calibrated curve tracer that uses your PC's display:
www.arrl.org/qst/2006/07/steber.pdf

Still using vacuum tubes? Introduced in the mid-1950s, Tektronix's Model 570 traced tubes' curves. Today, the Tek 570 is rare and expensive—and beloved by tube-audio fans. Here's a modern version:
www.instructables.com/id/Tube-Curve-Tracer

A Tektronix 575 curve tracer can display a tube's low-voltage characteristics. Connect the plate pin to the 575's collector terminal, the control grid to the base, and the cathode (or one side of the filament) to the emitter. Use an external voltage source to power the tube's filament or heater.

Do you mess with MESFETs? Molest mixers? Rassle with regulators? Use your curve tracer to check all three devices:
www.microwaves101.com/encyclopedia/curvetracer.cfm

SUGGESTED READING

Devised decades ago as an aid for aircraft pilots, the checklist imposed structure on complex procedures and helped prevent accidents. Dr. Atul Gawande says applying the checklist to medical processes can save lives. In our industry, could wider adoption of the checklist reduce in-process errors and improve yields?

The Checklist Manifesto: How to Get Things Right, by Atul Gawande. Metropolitan Books (us.macmillan.com/Metropolitan.aspx), 2009. 224 pages.

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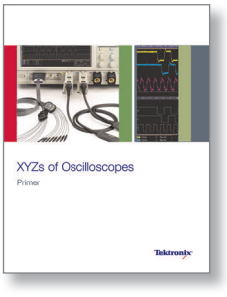

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Advantest introduces air-cooled mainframe for semiconductor tester

The new T2000 LSMF (Light Star Mainframe) from Advantest is an air-cooled test platform that offers cost-effective test of semiconductor devices. The T2000 LSMF supports modules developed for the existing T2000 mainframes while cutting investment costs 30%, according to Dave Armstrong, director of marketing and product engineering for Advantest America. By replacing conventional liquid-cooling technology with an air-cooled configuration, the T2000 LSMF eliminates the need for a separate cooling unit.

Armstrong said that although Advantest has previously offered air-cooled modules for its T2000 systems, the version introduced March 15 is the first that can operate with no liquid cooling whatsoever. He said the new LSMF represents a low-cost complement to Advantest's high-end and midrange mainframes, which require some level of liquid cooling.

The LSMF platform can test up to 64 devices in parallel and operates on single-line 200 VAC power. It is compatible with the following T2000 modules: the 250-Mbps digital module, the multi-purpose PMU32 (parametric measurement unit, 32-channel) module, the 16-channel AAWGD (audio waveform generator/digitizer) mixed-signal module, the 16-channel BBWGD (baseband waveform generator/digitizer) mixed-signal module, and the 12GWSGA (12-GHz wideband signal generator/analyzer) RF module.

The new T2000 LSMF platform targets analog, power-management, and RF ICs as well as ICs for PCs, netbooks, and other computing applications. www.advantest.com.

Geotest and Pickering announce PXI Website

To aid engineers designing PXI-based systems, Geotest-Marvin Test Systems, a producer of PXI test equipment, and Pickering Interfaces, a manufacturer of switching and conditioning systems, have jointly developed a Website that provides customers with access to information about PXI products and technologies. The site describes the types of products the companies make and links to descriptions of the products on each company's own Website. In addition, the new site includes links to other sources of information, such as industry associations, trade shows, and articles written by the companies. www.PXI4test.com.

G Systems delivers NASA Orion test stations

G Systems has delivered its first system for a new Orion crew-exploration-vehicle test station to NASA's Michoud Assembly Facility in New Orleans, LA. Lockheed Martin, the prime contractor for NASA's Orion, awarded three contracts valued at more than $1 million to G Systems to design and install an automated data-acquisition and analysis test station for Orion by June 2010. The test station will provide critical data to ensure structural endurance and spacecraft safety.

The first system, the DAS (Data Acquisition System), will collect and analyze data from more than 1400 analog data channels. The second, the DDS (Data Distribution System), will collect, distribute, and analyze audio, video, and parametric data collected by the DAS. The third system is a computerized pressure and vent system that integrates with the DAS for pressure testing the Orion's crew module. www.gsystems.com.

Editors' CHOICE

PCI bus gains boundary-scan controller

Goepel Electronic has augmented its ScanBooster line with the ScanBooster/PCI-DT boundary-scan controller. The new controller is compliant with the PCI bus specification and supports JTAG/boundary-scan tests, VarioTAP emulation tests, ISP (in-system programming) for PLDs and FPGAs, and ISP for flash serial EEPROM devices of moderate size.

ScanBooster/PCI-DT consists of a PCI plug-in card coupled with an external TAP (Test Access Port) transceiver unit, supporting distances to 4 m. It features two separate TAPs and supports a programmable TCK frequency to 16 MHz. Test bus parameters such as output and input voltage as well as output and input impedance can be programmed independently for both TAPs.

As additional resources, the controller provides 32 voltage-level-programmable, dynamic parallel I/O ports; two ADC/DAC channels; external trigger signals; and three static I/O lines. Programs developed for the controller are compatible with any controller from Goepel's ScanBooster series or the ScanFlex boundary-scan platform.

Base price: $2000. *Goepel Electronic, www.goepel.com.*

CALENDAR

International Microwave Symposium, May 23–28, Anaheim, CA. *IEEE, www.ims2010.org.*

The Vision Show, May 25–27, Boston, MA. *AIA, www.machinevisiononline.org.*

Sensors Expo, June 7–9, Rosemont, IL. *Questex Media Group, www.sensorsexpo.com.*

Design Automation Conference, June 13–18, Anaheim, CA. *ACM SIGDA, IEEE, and the EDA Consortium, www2.dac.com.*

Semicon West, July 13–15, San Francisco, CA. *SEMI, www.semiconwest.org.*

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

Four-port VNA operates at 67 GHz

Editors' CHOICE

The ZVA67, a 67-GHz vector network analyzer from Rohde & Schwarz, now has four ports, so you can use the instrument to evaluate multiport microwave components such as amplifiers, mixers, couplers, balanced components, and unbalanced components. The ZVA67 lets you make measurements such as S-parameters, intermodulation distortion, compression, noise figure, gain, phase, and group delay.

With the instrument's four signal sources and eight receivers, you can simultaneously apply test signals to devices under test while still having enough signal sources available to measure intermodulation distortion on amplifiers and conversion gain on mixers without the need for an external generator. The instrument also lets you simultaneously measure noise figure and S-parameters on amplifiers without modifying any connections.

The ZVA67 contains a built-in PC motherboard with Windows software for saving data and producing plots in many common formats. When you need to automate measurements, you can use a text-based driver file that lets you enter SCPI commands and then control the instrument through its GPIB, Ethernet, or USB interfaces.

Base price: $243,340. *Rohde & Schwarz, www.rohde-schwarz.com.*

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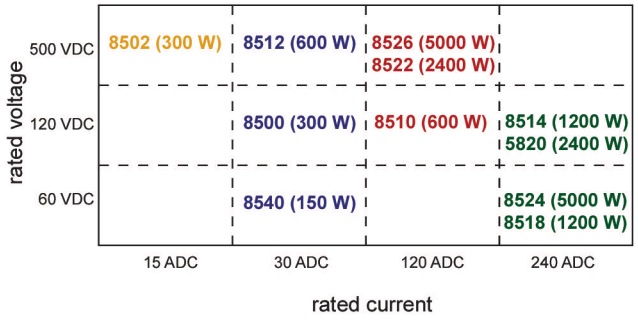

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Verifying "green" electronics

Measurements play a vital role in the push to reduce energy consumption. Often, the drive to produce products that use less electrical energy arises from economic considerations, yet lowering energy consumption also offers the added benefit of less pollution. Engineers need to measure energy use both at the component level, where designers are looking to cut power to save a few milliwatts, and at the system level, where the goal is to save kilowatts.

When testing components and boards, engineers often need to measure low levels of voltage, current, and power, comparing inputs to outputs to determine efficiency. In many cases, the reason for improving efficiency is simply to lengthen battery life.

Source-measure units let you excite a component with voltage or current and measure its response.
Courtesy of Keithley Instruments.

Components such as LEDs require low-level measurements such as forward and reverse voltage and forward current. Engineers often use SMUs (source-measure units) to characterize components such as LEDs and power semiconductors (see **figure** and the box below). SMUs provide excitation voltage or current, and they measure voltage and current in components.

Products that don't run on batteries still must make the most out of every milliwatt. Steve Connors, consulting design engineer at Data Translation, designs USB bus-powered instruments that can't draw more than 500 mA of current at 5 V. He uses switching power sources to get voltages as high as ±15 V for analog circuits to as low as +2.5 V for digital circuits. Connors noted that while these converters may have efficiency specs of 90% to 95% in the lab, measurements show that their efficiency drops to 80% to 85% in the field, because he must reduce their electromagnetic emissions.

Test-equipment designers have also found ways to recycle energy from tests that involve charging and discharging batteries. Rather than let the energy from discharging batteries under test go to waste, Chroma ATE recycles that power back into its systems' DC power grid. The company's testers also reduce energy use through DC-DC converters instead of power MOSFETS to drop 12 V down to 0 VDC to 4 VDC.

Components and boards come together to form systems that can consume considerable electrical energy. The information technology industry, which uses enormous amounts of electricity for switches, routers, and servers, employs AC power meters and analyzers in central offices and server farms. Yusuf Chitalwala, applications engineer at Yokogawa, noted that the computer industry has developed specifications through an industry organization for measuring power consumption (Ref. 1). Chitalwala explained that the specifications require measurements for different server activities.

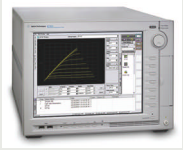
Manufacturers of PoE (Power over Ethernet) switches also look to reduce energy consumption. Microsemi, which manufactures PoE switches and detectors, has developed a Green Power over Ethernet Certification program that is mirrored on existing methodology to measure storage efficiency in networks. To do that, engineers measure the real AC power needed to deliver full PoE DC power loads, half loads, and no loads. T&MW

REFERENCE

1. Standard Performance Evaluation Corporation, www.spec.org.

To read past "Tech Trends" columns, go to www.tmworld.com/techtrends.

Characterize high-power devices with a curve tracer



The B1505A curve tracer from Agilent Technologies now lets you characterize high-power devices such as MOSFETs at up to 40 A current at 3000 V. The enhancement comes from an ability to use two source-measure units. www.agilent.com.

Audio analyzer software gets upgrade

NTi Audio has released a free upgrade for its XL2 audio analyzer software. New features in version 1.12 include live sound measurements and environmental noise monitoring. The software extends polarity measurements for subwoofers to below 100 Hz. www.nti-audio.com/XL2.

Measure loudspeakers on the production line

The SoundCheck ONE from Listen is designed for production line test of loudspeakers and microphones. The test system integrates software with a PC sound card and the AmpConnect microphone and test interface. Measurements include frequency response, sensitivity, and total harmonic distortion. www.listeninc.com.

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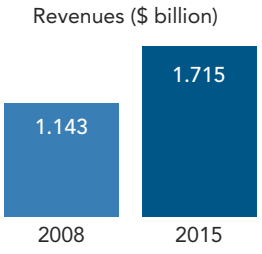
Board-test market on the path to recovery

Over the years, the world PCB (printed-circuit board) ATE (automated test equipment) market has moved from North America and Europe to Asia. This is a result of the increasing number of manufacturing facilities being set up in Asia, making it the world's manufacturing hub for PCBs. While China and India offer the most significant opportunities in the region for vendors of PCB ATE, Taiwan and Malaysia also offer good prospects. These countries and others, such as Thailand and Vietnam, are known as low-cost manufacturing sites for many PCB manufacturers from Japan, North America, and Europe.



Revenues for the PCB ATE market, which includes in-circuit ATE, functional ATE, boundary-scan testers, and manufacturing defect analyzers, are predicted to increase by 2015.

Even in Asia, though, the PCB market did not escape the global economic downturn, which had an adverse impact on related industries, including the ATE market. This was mainly due to a reduction in investment in manufacturing test, as the performance of leading vendors such as Agilent Technologies and Teradyne can attest. Agilent's semiconductor and board test group, for example, witnessed revenue declines of 63%, 59%, and 43% in the last three quarters of fiscal year 2009, respectively, in comparison to the same quarters of the previous year, according to the company's earnings calls. Again, this was during a global downturn, with all geographies off by 50%. While Teradyne has not disclosed revenue details about its PCB ATE business, the company indicated in its earnings calls that it received lower than normal orders for in-circuit board testers from contract manufacturers in Asia during the first quarter of 2009.

The market seems to have hit bottom, and going forward a turn of fortune is expected in the short term. While market conditions remain difficult, there are signs of recovery. Case in point: While Agilent's semiconductor board-test revenues have continued to decline in 2009 in comparison to 2008, the rate of decline has decelerated significantly over the past four quarters. Growth is in the cards for the PCB market, and this is expected to bode well for the PCB ATE market over the next five years. In addition to increased production, the increase in PCB design complexity augurs well for the PCB ATE market.

While manufacturers have seen stronger signs of market recovery in other segments of the test and measurement market, such as semiconductor testing, the PCB ATE market is also on the path to recovery, although not yet out of the woods. Improved economic conditions and other trends point to a brighter future for PCB ATE vendors. At the same time, vendors will have to overcome significant challenges including the lack of experts in end-user organizations, especially in Asia. T&MW

To read past "Market Trends" columns, go to www.tmworld.com/markettrends.

IC Insights ups worldwide IC market forecast to 27%

With the DRAM market expected to increase 74% this year, market researchers at IC Insights now predict that the worldwide IC market will jump 27% in 2010 to $253 billion—exceeding the previous high of $234 billion reached in 2007—and an additional 15% in 2011 to $290 billion. In making this forecast, IC Insights commented that even if the January DRAM market stayed flat for the next 11 months, the DRAM market would still register 61% growth for 2009 and 2010 combined. The firm added that strong DRAM conditions should help support the 100%+ capital spending increases now budgeted by many of the DRAM manufacturers this year.

This 27% forecast is an upgrade to IC Insights' earlier worldwide IC market forecast, which called for 15% growth this year, and is almost entirely due to a revision in the IC market change expected for Q4 2009 and Q1 2010, the company noted. While the company had expected a moderate seasonal decline in IC sales for Q4 2009 and Q1 2010 combined, its most recent prediction was for a 3% increase for that period.

Further, due to the depressed state of the Q1 2009 IC market, being the extreme bottom of the downturn in 2008 and 2009, the market increase from Q1 2009 to Q1 2010 is likely to be greater than 50%, but as the year progresses, IC Insights expects the quarterly year-over-year comparisons to fall back to more realistic levels, with the IC market for Q4 2010 forecast to be only 14% greater than that for Q4 2009.

IC Insights pointed out that forecasts for the Q2, Q3, and Q4 sequential quarterly IC market increases this year include a relatively flat Q2, a 9% increase in Q3, and a moderate 3% increase in Q4—remaining essentially unchanged from the company's previous expectations.

Ann Steffora Mutschler, Contributing Editor, EDN

From the market leaders in pc oscilloscopes...

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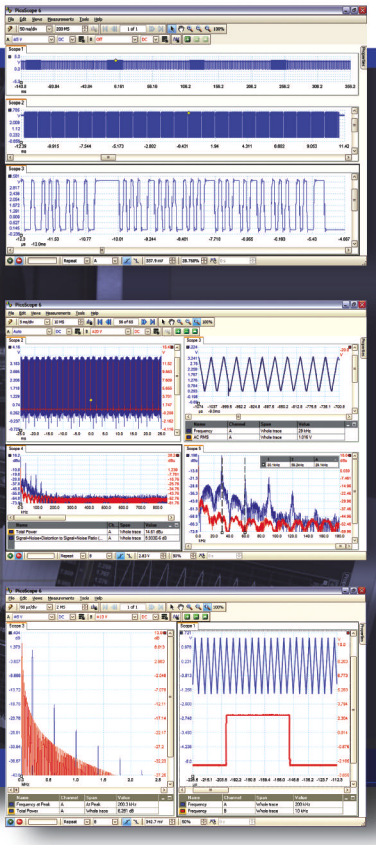

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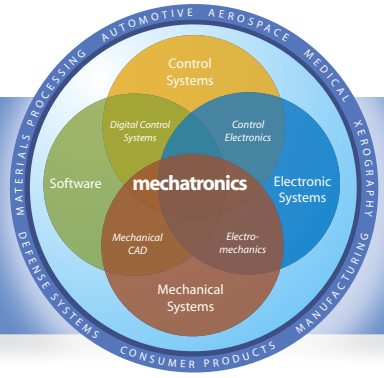
CONTROL ENGINEERING design news EDN Test & MEASUREMENT WORLD

MECHATRONICS IN DESIGN

FRESH IDEAS ON INTEGRATING MECHANICAL SYSTEMS, ELECTRONICS, CONTROL SYSTEMS, AND SOFTWARE IN DESIGN



Analogies give engineers insight

Insight based on fundamentals is the key to multidisciplinary problem solving.

Kevin C. Craig, PhD
Robert C. Greenheck Chair in Engineering Design & Professor of Mechanical Engineering, College of Engineering, Marquette University.

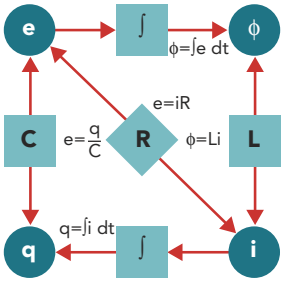
For more mechatronics news, visit: mechatronicszone.com.

A person trying to explain a difficult concept will often say "Well, the analogy is…." The use of analogies in everyday life aids in understanding and makes everyone better communicators. Mechatronic systems depend on the interactions among mechanical, electrical, magnetic, fluid, thermal, and chemical elements, and most likely combinations of these. They are truly multidisciplinary, and the designers of mechatronic systems are from diverse backgrounds. Knowledge of physical system analogies can give design teams a competitive advantage.

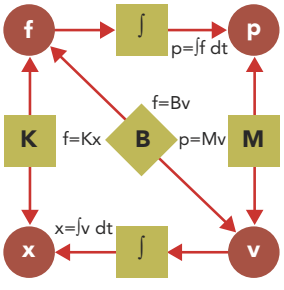
Consider the exhaust system of a motorcycle and its heat shield. Temperatures have to be controlled through design for performance but also to protect the rider. Being able to model this system as a network of thermal resistances and capacitances, just like an electrical circuit, is a powerful design tool. It allows the engineer to visualize the flow of heat and the storage of thermal energy, and also to specify key temperatures by selection of materials and geometries that vary the network thermal resistances (conduction, convection, and radiation) and capacitances. Improving performance happens with understanding—not by trial and error—and quickly.

To explore in some depth the nature of physical system analogies, consider the common electrical-mechanical analogy. Electrical and mechanical systems are modeled using combinations of elements that are pure (only have the characteristic for which they are named) and ideal (linear in behavior): resistor (R), capacitor (C), and inductor (L) for electrical systems, and damper (B), spring (K), and mass (M) for mechanical systems. The variables of interest are voltage (e) and current (i) for electrical systems and force (f) and velocity (v) for mechanical systems. The **top figure** at left shows the model structures for these systems. The analogy is obvious!

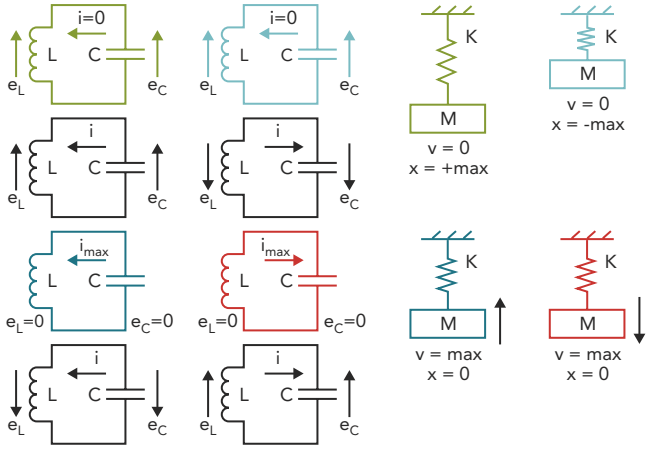
Model structure for electrical systems



Model structure for mechanical systems



This analogy can be used to explain the flow of current and the changes in voltages in an LC (inductor-capacitor) electrical circuit—difficult to envision for most mechanical engineers and even for some electrical engineers—by comparing it to a spring-mass mechanical system. The top figure shows this comparison. The **bottom figure** is color-coded: green, blue, and orange diagrams for each system correspond to each other. By comparing the motion of the mass—its changing potential energy corresponding to energy stored in the electric field of the capacitor and its changing kinetic energy corresponding to energy stored in the magnetic field of the inductor—one can better understand how electrical capacitors and inductors function.



For enhanced multidisciplinary engineering system design and better communication and insight among the design team members, the use of analogies is a powerful addition to an engineer's toolbox. T&MW

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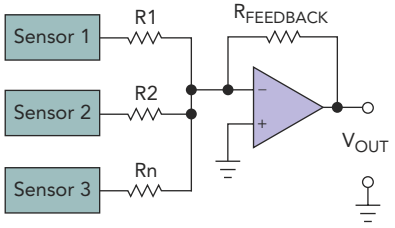
REINFORCED plastics

INSTRUMENTATION

Summing inverter aids sensor calibration

When you need to use multiple sensors with analog outputs in a measurement system, each sensor may respond differently to a known stimulus. As a result, you'll probably need to calibrate the system. You can do that by converting the sensors' individual voltage outputs to current and summing them.

The **figure** shows a simplified version of a summing amplifier circuit. Each sensor has a voltage output. Resistors R1, R2…Rn each consists of two resistors in series (shown as one in the figure). By adjusting one of the two resistors, you can adjust the current from each sensor. The voltage between the sensor outputs and a reference voltage (shown as ground in the figure), in combination with the resistors, sets the current. The feedback resistor $R_{FEEDBACK}$ sets the gain of the summing amplifier.



A summing amplifier produces a voltage output that is proportional to the sum of the sensor outputs, which allows for a system calibration.

The calibration procedure is described in detail in a paper by Hing Kai Chan and Sai Ho Chung, "A Low-Cost Voltage-to-Current Calibration Technique for Multiple-Sensor Systems," which you can download from the online version of this article (www.tmworld.com/2010_04). The paper describes the technique for calibrating a weighing system using piezoresistive sensors, but you can apply it to other measurement applications.

The calibration procedure starts with measurements on the sensor outputs under no load. Start with resistors R1, R2, etc. as single resistors, and measure each sensor's output voltage. You can then calculate the current in each leg of the amplifier. Then, apply a known load and measure each leg's current. From this measurement, you can calculate a correction factor and thus calculate the additional resistance you need to produce a calibrated system. The paper provides all the equations you need for the calculations.

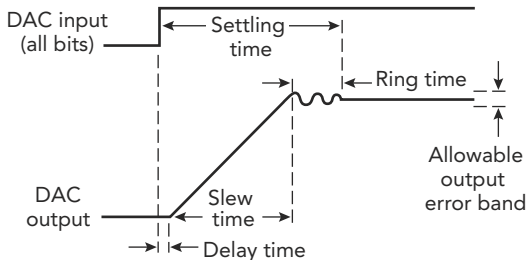
Martin Rowe, Senior Technical Editor

DATA ACQUISITION

Measure DAC settling time to 1 ppm

Instrumentation, inertial navigation systems, medical apparatus, and other precision applications now require 18-bit converters. Verifying that the DC specifications of a DAC meet the requirements is relatively easy, but verifying the AC specs demands a sophisticated approach. A DAC's settling time is the elapsed time from an input code application until the output remains within a specified error band around the final value. The settling time of a DAC and its output amplifier is difficult to determine at 18-bit, or 4-ppm, resolution. To measure an 18-bit DAC, you must use measurement techniques with 20-bit, or 1-ppm, resolution for settling times as short as 265 ns. Manufacturers usually specify a DAC's settling times for a full-scale 10-V transition.

DAC settling time has three distinct components: delay time, slew time, and ring time (**figure**). The delay time is small and is almost entirely due to propagation delay through the DAC and the output amplifier. During slew time, the output amplifier moves at its highest possible speed toward the final value. Ring time defines the region in which the amplifier recovers from slewing and ceases movement within some defined error band.



DAC settling time components include delay, slew, and ring time. Fast amplifiers reduce slew time, although a longer ring time usually results. Delay time is normally a small term.

Measuring anything at any speed to 20-bit, or 1-ppm, resolution is difficult. Making dynamic measurements to 20-bit resolution is particularly challenging. Making reliable 1-ppm DAC-settling-time measurements constitutes a difficult problem requiring exceptional care in approach and experimental technique. My article in sibling publication *EDN* shows how you can use an oscilloscope to accurately display DAC-settling-time information for a 10-V step with 1-ppm, or 10-µV, resolution within 265 ns (Ref. 1). The approach permits you to observe small amplitude information at the excursion limits of large waveforms without overdriving the oscilloscope.

Jim Williams, EDN *consulting editor and Linear Technology staff scientist*

REFERENCE

1. Williams, Jim, "Precisely measure settling time to 1 ppm," *EDN*, March 4, 2010. p. 20. www.edn.com/article/CA6720346.html.

Program the SPI bus with a DIO module

Function libraries, called at run time, let you change instruments without changing code.

By William Drago, L-3 Communications, Hauppauge, NY

At L-3 Communications, we use PLLs (phase-locked loops) in many of our products to generate precise, stable signals. To program these parts, we must load several control registers with digital words that correspond to the desired PLL output parameters. The PLLs, like many programmable devices, use the SPI (Serial Peripheral Interface) bus, which consists of four lines. Because we need only write data to the PLLs, we need just three lines for the SPI; a fourth line, which is not part of the SPI, ties to the PLL's lock detect output to indicate that the PLL is locked.

Figure 1 shows an SPI bus timing diagram. Data on the MOSI (master out, slave in) line is clocked into the PLL when the CS (chip select) line is enabled (low). By "bit-banging" the correct sequence on the clock and data lines, while enabling the appropriate CS line, you can emulate the SPI bus.

Just about any DIO (digital I/O) interface lets you emulate the SPI bus. You can generate the bus signals by writing to your PC's serial port or to a parallel port, if you have one. That may be acceptable for lab tests, but in production or in a busy lab environment, a dedicated DIO interface will be more reliable, more versatile, and ultimately, less expensive.

In our lab, we shuffle equipment around frequently enough to warrant the use of laptop computers over desktop machines. Because laptops have limited expansion capabilities, we rely on USB devices in place of traditional PCI interface cards. **Figure 2** shows the setup we use to program the PLLs using a USB DIO module. We use the Measurement Computing USB-1208 data-acquisition module, but most USB data-acquisition or DIO modules should let you program a device through their SPI bus interface. The USB-1208 provides 16 DIO channels and eight single-ended analog input channels (or four differential-input channels). The analog inputs come in handy when you need to measure analog signals. Nearly every test fixture we build has a USB data-acquisition or DIO module.

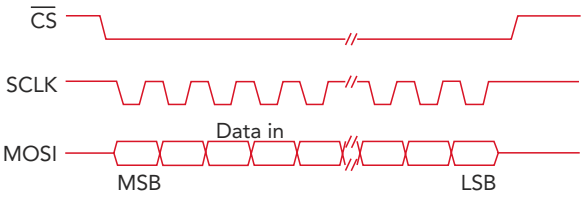


Figure 1 The SPI bus loads data on clock edges when the chip select line is active (low).

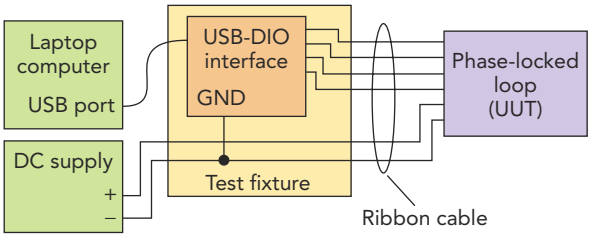


Figure 2 A USB digital I/O module emulates the SPI bus for the phase-locked loop under test.

Figure 3 shows the software architecture. Each path (A and B) contains the same functions but with different DIO function libraries. The online version of this article shows part of the code, written in Agilent Vee Pro (www.tmworld.com/2010_04).

At the time I wrote the software, we needed the ability to use DIO modules from either Measurement Computing or National Instruments without changing the code in my main pro-

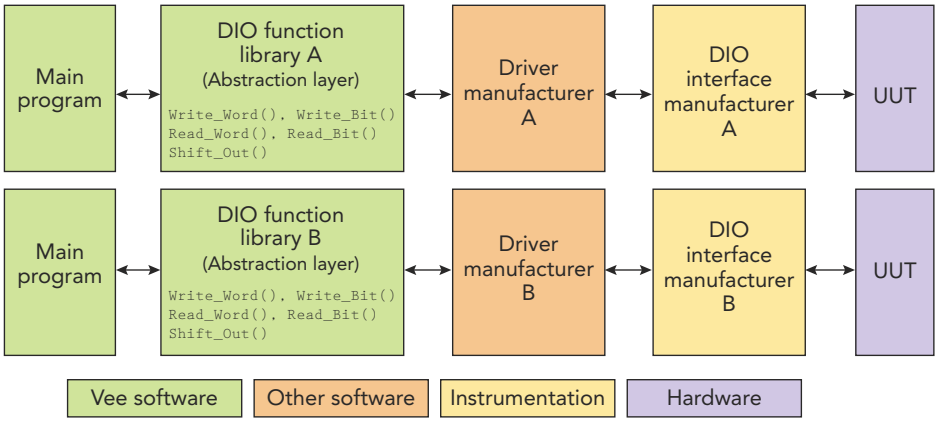


Figure 3 External function libraries let you change instrument hardware without recoding your main program.

gram. Manufacturers provide function libraries that provide an interface between the main program and their instruments. Unfortunately for us test engineers, manufacturer-supplied function libraries work for products from that manufacturer only.

Adding an abstraction layer between my main program and the manufacturer's function libraries eliminates changing the main program's code even when changing module manufacturers. This layer makes all DIO and data-acquisition modules look the same to the main program. By using the abstraction layer, I just needed to write a function library for each device and load the appropriate library at run time.

The libraries in Figure 3 have functions such as Write_Word(), Read_Word(), Write_Bit(), and Read_Bit() that correspond directly to the functions in the .NET library provided with the USB-1208. To build the serial data stream, I wrote the Shift_Out() function, which works by putting the Bit_Out() function in a loop to generate SPI bus clock and data signals. T&MW

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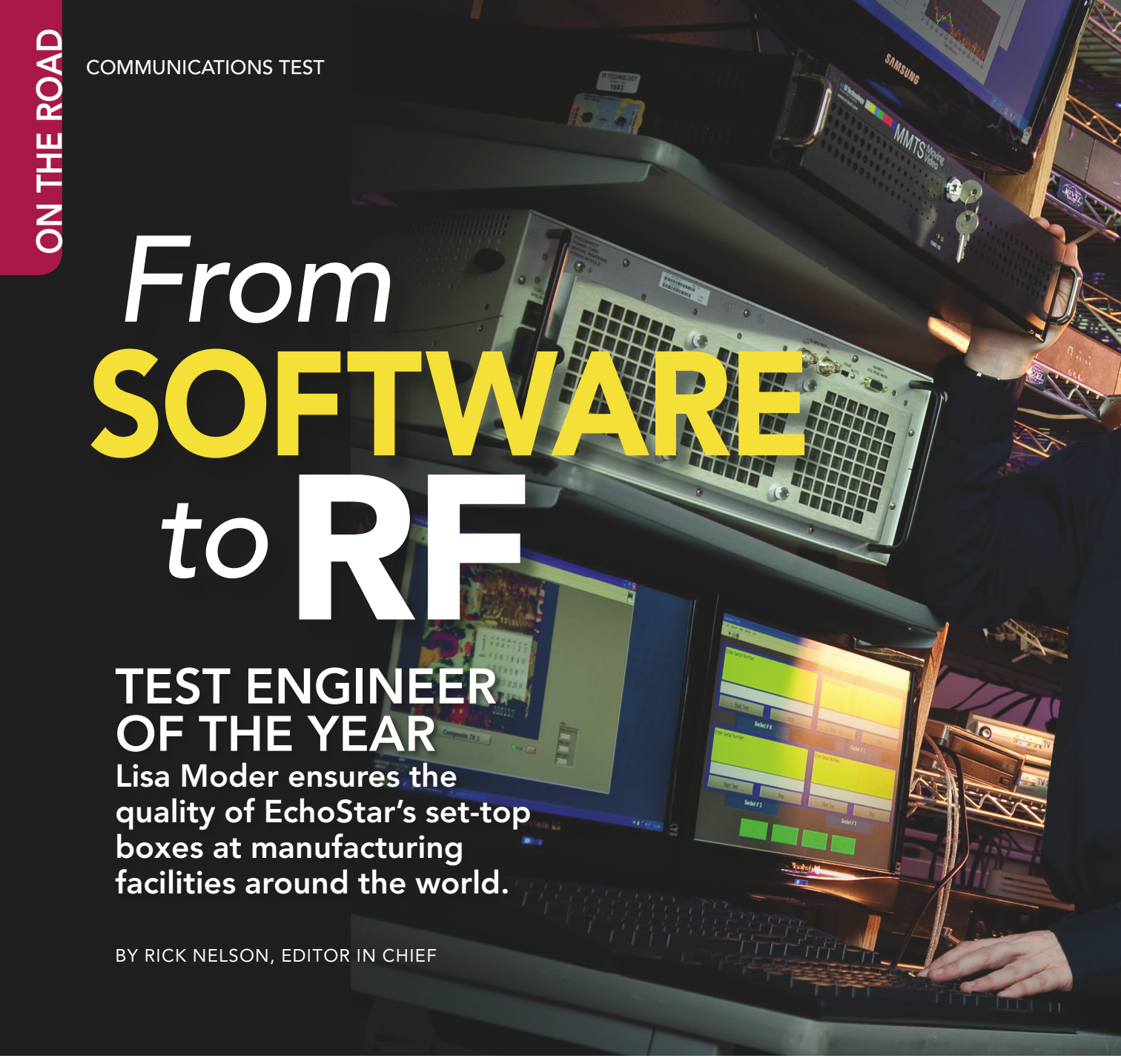


From SOFTWARE to RF

TEST ENGINEER OF THE YEAR

Lisa Moder ensures the quality of EchoStar's set-top boxes at manufacturing facilities around the world.

BY RICK NELSON, EDITOR IN CHIEF

ENGLEWOOD, CO—EchoStar Technologies employs nearly 2400 people worldwide to develop and market its line of set-top boxes, including ones that incorporate technology from Sling Media, which EchoStar purchased in 2007. With products like EchoStar's SlingLoaded set-top box, consumers can view their satellite, cable, or off-air programs from the comfort of their living rooms or from anywhere in the world where an Internet connection is available.

The benefits of Sling technology are not lost on senior test engineer Lisa Moder, who spends significant time on the road working with EchoStar's contract manufacturers around the world, ensuring that their test lines are up and running successfully. Speaking of her engineering team, she said, "Traveling around the way we do, we bring our own personal Slingboxes that we can tap into from anywhere in the world. It lets us bring a little bit of home with us. It's nice to be able to tap in and watch shows from home."

The results can be a little disconcerting for family members, though. Moder said, "When I'm 14 hours away and changing channels, the kids are home sitting in the living room and wondering what's going on with the TV." And they can voice their consternation via a pop-up message that appears on Moder's screen. Fortunately for her family, Moder's life on the road often involves 16-hour days working with contract manufacturers, which doesn't leave much time for channel surfing, and the kids can watch their movies uninterrupted.

When Moder is not on the road, she is involved in planning and implementing test strategies while dealing with a variety of

Test Engineer of the Year Lisa Moder is working to integrate the VI Technology MMTS Moving Video Test System into EchoStar's test stations for its set-top boxes. To make use of the MMTS, Moder implemented a frame-numbering scheme that allows frame-by-frame comparisons with a golden video.

In our November 2009 issue, we profiled the accomplishments of six outstanding test engineers from various industries, and we asked our readers to vote for the Test Engineer of the Year. Your choice? Lisa Moder of EchoStar Technologies.

As part of her award, Moder has designated the Metropolitan State College of Denver to receive a $10,000 grant, courtesy of National Instruments, the award sponsor.
www.tmworld.com/teoty

challenges unique to the set-top box industry. Although compact, EchoStar's set-top boxes incorporate a bewildering array of technologies, so Moder must be well-versed in electrical engineering disciplines as diverse as software, streaming video, and R.F. To deter pirates looking for free TV, the set-top boxes are designed to be hacker-proof, but security built into the boxes also limits visibility into them during the manufacturing test process, a challenge that Moder has to work around. In addition, she has to evaluate appropriate levels of automation, working to take human subjectivity out of production-line test while ensuring quality and maintaining throughput.

For successfully meeting these challenges and positioning her team for further accomplishments this year, Moder was nominated for the 2010 Test Engineer of the Year award and was voted as the winner by the readers of *Test & Measurement World*.

Company evolution

Moder said EchoStar was a considerably different company when she joined it in February 2002. "I was probably the fourth test engineer who was hired. We were doing basic single-tuner satellite set-top boxes that were standard-definition only." Engineering manager Alexander Matteo said that at that time, the company's set-top-box manufacturing was performed at a single facility in Huntsville, AL, with some circuit boards fabricated in Guadalajara, Mexico.

The company's technology and manufacturing capabilities evolved rapidly. Soon, Moder said, EchoStar was adding hard drives to its products, turning them into what were then called PVRs (personal video recorders) and are now called DVRs (digital video recorders). In addition, the set-top boxes soon included secondary tuners, high-definition

PAUL WEDLAKE

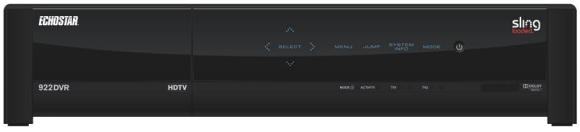
reception, and the ability to receive off-air broadcasts.

As the products evolved, so, too, did EchoStar's manufacturing approach and the responsibilities of Moder's group. Now, said Rojai Elsell, director of operations for global manufacturing, "Basically, all our manufacturing operations are subcontracted to large tier 1 contract manufacturers around the world."

Moder said that her group of engineers within the global manufacturing operation were initially responsible for ensuring that the test processes the CMs (contract manufacturers) developed yielded products that met EchoStar's design engineers' specs. Now, Elsell explained, the operations group takes a product from development into factory implementation, essentially providing project management all the way through to actual production as well as delivery. EchoStar's manufacturing operation, Elsell said, "stays in touch with a product through its entire manufacturing cycle, from inception to end of life."

EchoStar engineers still don't get involved in all of the details of fixture development and ICT (in-circuit-test) programming. That's left to the CMs, who work with the Gerber files that EchoStar engineers provide. One of Moder's goals is to ensure adequate test coverage. She said, "We make sure that the test coverage is there so [the CMs] could do ICT. We work with the layout group and the design engineering group to provide adequate test coverage and test points so that ICT can be performed in the factory environment, should we choose to go that route, and typically we do."

She elaborated, "We interface with the design teams on a daily basis—both the software and the hardware design teams. The hardware design engineers need our input so they know where to put test coverage, and they need to know about component placement. They also define the specifications, so we take their performance specs and produce a production spec that we hand off to the factory. We work with the design guys on what the specs need to be and what the board needs to look like, and we work with the factory on what the factory process needs to look like. And we work with the factories on fixturing. The factory engineers are ultimately the designers of the board-level fixturing, but we help them debug their designs."



The EchoStar Technologies' ViP 922 set-top box is one of many EchoStar products to which Test Engineer of the Year Lisa Moder has applied her talents. The 922 is the first high-definition DVR (digital video recorder) that incorporates Sling Media's Slingbox technology, which enables long-distance control and viewing via Internet connectivity. Courtesy of EchoStar Technologies.

Testing secure products

Although many companies rely on boundary scan to augment test coverage, that technique has not been viable for EchoStar. Said Moder, "Part of the problem we run into with boundary scan is that our chips are locked down. JTAG isn't generally available because of the security requirements imposed by the nature of the business we are in. Our products need to be secure. If the software we run on our set-top boxes were to be hacked, people would have free television, and if people have free television, we don't make any money."

She noted, however, that EchoStar is beginning to use some boundary-scan functions. She said, "The processor manufacturers have given us what we call limited boundary-scan capability. It's not full boundary scan and it doesn't provide potential hackers access through the JTAG port, but it does give us a little bit of access. We are working with our CMs to implement limited boundary scan to gain increased coverage."

Moder added, "There are software hackers everywhere. If they are allowed access into the box, they can change the software such that the satellite signal coming down is decrypted and they have free content." She explained that this is a problem faced by any company that delivers pay TV, including cable companies and satellite companies. "All the people in the industry are dealing with this piracy issue," she said, "and as a result, we all have to get smart about locking down our software. So, everything is encrypted today, which makes it difficult in a manufacturing environment. We cannot do full-on boundary scan for that reason. We are happy that we have limited boundary scan—that was a huge win for us."

Another approach Moder is working on is Bead Probe technology (Ref. 1), developed by Agilent Technologies. The Bead Probe technology places solder beads that can be contacted by a test probe directly onto PCB signal traces, making it possible to avoid the rerouting of signal paths to accommodate traditional test pads.

PAUL WEDLAKE

Lisa Moder developed a satellite simulator that generates streaming audio and video, RF-modulates it, and upconverts it. In addition, the simulator includes interference test sets to help determine how well a set-top box will perform in the presence of cloud cover, rain, snow, or other adverse conditions.

"The approach is particularly useful for providing test coverage on densely packed high-speed bus lines that we can't attach a test point to," said Matteo. "The market really likes smaller boxes, but these computers are so complex with so much functionality, and every time we add a test pad we take up physical real estate on the board. As Lisa leads us into using Bead Probe, we can get a lot more test coverage without increasing the size of the box."

Testing without a satellite

Since the primary purpose of a set-top box is to receive satellite, cable, or off-air signals, a suitable signal must be available for production test. In a manufacturing environment, though, obtaining a real-world satellite signal can be impossible, because EchoStar's set-top boxes are manufactured in worldwide factories that aren't within the footprint of an EchoStar satellite. And even if the factories were within range of an appropriate satellite, it wouldn't be possible to dial-up rain or other sources of potential signal interference to test the resiliency of the boxes.

PAUL WEDLAKE

Engineering manager Alexander Matteo: "Lisa is driving the team to automate stream analysis because we would like to take the human eyeball out of the equation."

Explained Moder, "One of my jobs is that I am responsible for signal distribution within the factory environment. I have to fool the set-top boxes into thinking they're connected to the satellite." To that end, she has developed satellite simulators—racks of equipment that generate streaming audio and video, RF-modulate it, and upconvert it. In addition, the simulators include interference test sets. "If you've got cloud cover or it's raining or it's snowing—that's going to cause a noise that occurs on the signal, and we need to know that our set-top box can handle a certain level of that," said Moder. Of course, it's sometimes helpful for engineers to make sure that the simulators deliver good representations of actual signals, and for that, she said, "I've got dishes on the roof."

Removing human subjectivity

The ultimate measure of the quality of a set-top box is the quality of the picture it delivers. That's now judged by a human operator, but the company is moving toward an automated evaluation system.

Said Matteo, "You have a human operator making an executive decision on the quality of your product," and that operator's judgment could be affected by fatigue or the pressure to meet quotas. Moder added, "In order for us to be able to evaluate video, we want to be able to take the subjectivity out of testing and have it automated to the point where you don't have an operator sitting there watching and listening to exactly the same stuff over and over. Because we are all human, we make mistakes. We miss things—we don't mean to, but that's what happens."

Matteo explained that "Lisa is driving the team to automate stream analysis because we would like to take the human eyeball out of the equation." Nevertheless, he said, there is some hesitancy to take humans out of the process because they represent a comfort zone. The team needs to be convinced, he said, "that a computer can detect shadows, jitter, macroblocking, ghosting, or other stream anomalies that would cause a user to say, 'No, that doesn't look right. I don't want this service anymore.'" Added Moder, "And we don't want that. We want you to like our service. We want you to like our products."

Moder's efforts to replace the human eyeball center on VI Technology's MMTS Moving Video Test System, the winner of *Test & Measurement World*'s Best in Test award in the "Audio/video and multimedia" category (p. 29). Said Moder, "The MMTS box is probably the best commercially available device for measuring motion video." To make use of the box, Moder implemented a frame-numbering scheme that allows frame-by-frame comparisons with a golden video. She said, "We are really excited about implementing this into our full-on automated test system from a unit-level test perspective."

Adding the MMTS won't completely remove the operator, however. "There are some things that do not lend themselves to automation because they are too costly," Moder explained. "Take button-pushing. Yes, you can automate that with pneumatics, but the way we have our rack set up, that's a very costly endeavor. And we've chosen not to go down that path just yet."

Diverse background

Moder brings a diverse background to her responsibilities at EchoStar. She studied computer science in college and then found herself at a small medical electronics company designing high-power RF amplifiers for magnetic resonance imaging machines. When she came to EchoStar in 2002, her first assignment was to develop the satellite simulator. Then, she said, "We had a whole bunch of set-top boxes that got released in a single year, and as a result we all jumped on board, and we learned what we needed to learn to implement these new technologies."

The ability to learn quickly should serve Moder and her team well as they bring new products online and pursue further automation and test throughput. One challenge was contending with one device whose test requires three 83-s reboots (to test power cycling, reset, and operating-system-upgrade functions). The implementation of automation and parallel test capabilities ensures that the operator keeps busy during the reboot cycles. Next up is full implementation of the MMTS on EchoStar's set-top-box line-up, which Moder hopes to extend to the Slingbox line as well.

Noted Matteo, commenting on Moder and her colleagues, "This is a very stable team, thankfully. We've seen a lot of new product introductions, and we can really beat up a design and make sure it's ready for mass production." Concluded Moder, "When you get an issue with a brand new technology, you won't know off the bat whether you have a hardware or software problem. But we can work with every facet of this company to get these issues resolved quickly." T&MW

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T&MW ANNOUNCES 2010 AWARD WINNERS

BY *TEST & MEASUREMENT WORLD* STAFF

The staff of *Test & Measurement World* is pleased to announce the winners of our annual Best in Test and Test of Time awards, which honor important and innovative products and services in the electronics test, measurement, and inspection industry.

In our December/January issue, we announced the finalists for the 2010 Best in Test and Test of Time awards and asked our readers to vote for their favorites. The 2010 Best in Test winner in each of the 17 product categories is listed at right. Of these, the overall top vote getter will be named the 2010 Test Product of the Year; the announcement will be made on www.tmworld.com on April 7.

For the annual Test of Time award, which honors a product that continues to provide state-of-the-art service five or more years after its introduction, we named seven finalists in our December/January issue. Our readers voted Agilent Technologies' 89600 Vector Signal Analysis Software as the recipient of the 2010 award.

For more information about the *Test & Measurement World* awards program and to read about all of the finalists and winners, see www.tmworld.com/awards. T&MW

2010
Best in Test
AWARD
WINNERS

2010
Test of Time
AWARD
WINNER

Audio/video and multimedia
MMTS Moving Video Test System
VI TECHNOLOGY

Bit-error-rate testers
J-BERT
AGILENT TECHNOLOGIES

Board and system test
URT 5.0 Universal Receiver Tester
AVERNA

Communications network test
T-BERD/MTS-4000 Multiple Services Test Platform
JDSU

Computer bus analyzers
PCIe Jammer Error-Injection Tool
AGILENT TECHNOLOGIES

Data acquisition
NI X Series Devices for PCI Express and PXI Express
NATIONAL INSTRUMENTS

DFT, boundary scan, and emulation
JULIET Desktop JTAG Tester
GOEPEL ELECTRONIC

EMC and safety test
NSG 3040 EMC Multifunction Generator
TESEQ

Fiber optics
N4391A Optical Modulation Analyzer
AGILENT TECHNOLOGIES

General-purpose instruments (non-oscilloscopes)
EX1200 Series Switch/Measure System
VTI INSTRUMENTS

Machine vision and inspection
BOA Vision System
DALSA

Oscilloscopes
MSO70000
TEKTRONIX

RF/microwave instruments (general purpose)
N9030A PXA Signal Analyzer
AGILENT TECHNOLOGIES

Semiconductor test
ETS-88 Multisite Test System
TERADYNE

Test components and subsystems
EX72SF Microwave Switching Subsystem
VTI INSTRUMENTS

Test-development and analysis software
Proligent Analytics
AVERNA

Wireless test (standard specific)
ACE MX MIMO Channel Emulator
AZIMUTH SYSTEMS

89600 Vector Signal Analysis Software
AGILENT TECHNOLOGIES

Agilent says that its 89600 VSA software plays a key role in the communications and wireless networking revolutions by providing analysis tools for the PHY layer that are crucial to the development of base stations, access points, and mobile units. Since its introduction in 2000, the software has had 29 updates, including support for cdma2000, W-CDMA, WiMAX, and LTE.

According to Agilent, the software is the first PC-based signal-analysis software, the first software to make measurements with more than one signal-analyzer platform, the first software to perform wideband vector signal analysis up to 36 MHz, and the first software to analyze over 70 signal formats. VSA analyzes signals acquired by signal, spectrum, and logic analyzers and oscilloscopes, and it can measure signals anywhere in the radio block diagram. The software analyzes narrowband AM as easily as ultrawideband multiband-OFDM and also analyzes modulated signals ranging from tens of megahertz to hundreds of terahertz.

TEST PRODUCT OF THE YEAR

Test Product of the Year to be announced on April 7

The Best in Test winner that received the most overall votes will be named the Test Product of the Year for 2010. We will announce the winner on www.tmworld.com on April 7. You can also read about the winning product in our May 2010 issue.

Test your TESTERS for R&R

PERIODIC CHECKS OF YOUR TESTER'S RELIABILITY AND REPEATABILITY MINIMIZE THE CHANCE OF FALSE TEST RESULTS.

BY MARTIN ROWE, SENIOR TECHNICAL EDITOR

Automated test systems need to operate within designed parameters so that they produce reliable and repeatable results. False failures mean good products don't ship, and false passes can result in field problems. To keep a test system operating properly, you need to know how well it worked when it was put into operation or last calibrated, and you need to monitor the station for deviations.

The methods for testing a tester can vary depending on the tester's use and specifications, but there are many common techniques. One involves the use of check standards, which could be components such as resistors, voltage sources, current sources, or frequency sources that may be built into a test system or attached when needed. You can also use known-good devices—often called "golden" devices—to verify a tester's integrity, or you may want to rely on instrument self-test and loopback tests at regular intervals to keep testers running properly

Set a baseline

Before putting a test system into service, you need to characterize it. Here's where a calibrated check standard or golden UUT (unit under test) can help. Such components let you establish a set of baseline measurements for each instrument and for the entire system. The best check standards are calibrated using methods traceable to NIST (National Institute of Standards and Technology) or another national lab. A golden UUT lets you check all of the connections in your system using the same cables, connectors, and fixtures that the system will use every day.

When you characterize a tester, always record and plot your results. You'll need them to compare against future measurements. Plots can reveal trends before the tester exceeds its

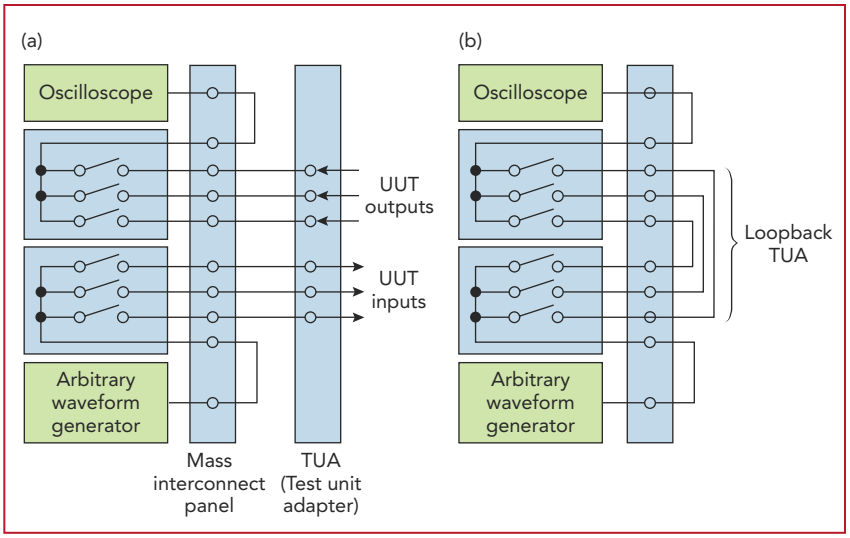

FIGURE 1. a) A TUA makes the instruments available to the DUT, while (b) a loopback TUA routes signals from the waveform generator to the oscilloscope for system test. Courtesy of Ideal Aerosmith.

limits. Over time, you'll make thousands of measurements that let you develop a performance history of R&R (reliability and repeatability).

Larry Raymond, president of Intrinsic Quality, a test-system developer, explained how to establish a baseline set of measurements for an in-circuit tester. "Use a reference board, or better yet, a set of boards with component values you trust," he said. Raymond recommends that you make enough measurements to establish a good statistical sample, typically hundreds to start. Then, you should plot a histogram so you can verify the tester's repeatability.

Raymond explained that sometimes one of his customers will provide just one board for verifying a tester. When that happens, he requires hundreds of measurements to prove that the tester is repeatable.

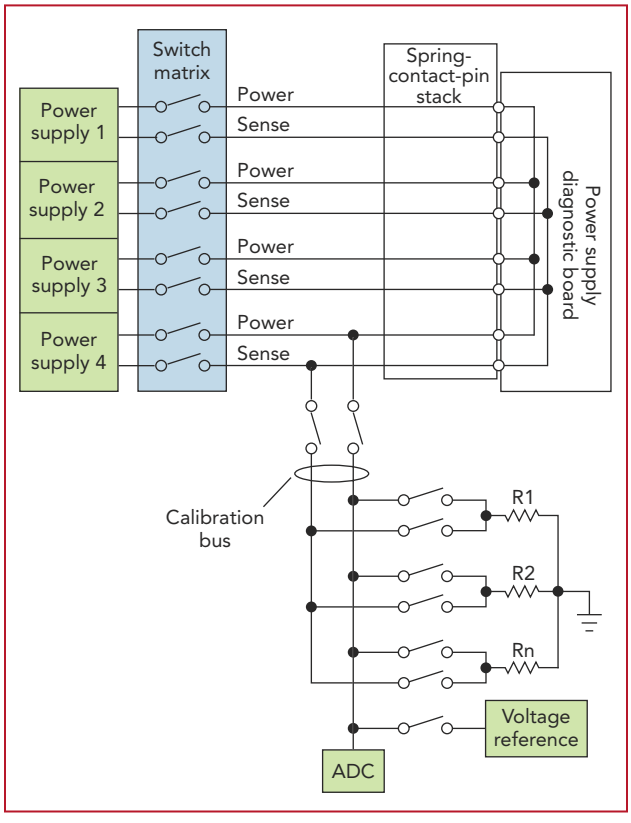

FIGURE 2. Switches connect a calibration bus to a test system's power supplies.

If possible, you should measure the components on several boards. That will give you a better statistical sample. It will also give you a clue as to how the components' values vary, which lets you establish the tester's R&R.

If you have more than one sample UUT, you should look for inconsistencies in measurements. For example, you may find that a large set of capacitance measurements range between 120 µF and 132 µF. In such a case, Raymond suggests that you set the tester's acceptable limits for the component limits to perhaps 110 µF and 140 µF. If measurements fall outside those limits, you should check the tester against a reference board. Center your test window around the mean of the distribution of the baseline measurements. If the tester is operating within specifications, you may need to change tester parameters such as test current to compensate for the errors.

Loopback tests

Letting the tester test itself is a common technique that many engineers use. Marius Gheorghe, engineering manager at test-system integrator Ideal Aerosmith, explained that the company often provides loopback TUAs (test unit adapters) that connect signal sources to measuring instruments. **Figure 1** diagrams a test system that uses a loopback TUA to connect its oscilloscope and arbitrary waveform generator.

Figure 1a shows the normal operation where the waveform generator's outputs and the oscilloscope's inputs come to a mass-termination panel. A TUA that attaches to the panel during normal operation routes signals to a DUT (device under test). Diagnostic software in the system controls both instruments and verifies that the waveform generator's signals are within limits.

Gheorghe suggests letting your loopback TUA make the connections between the signal sources and the measuring instruments and switching subsystems. "Don't route signals used for system self-test entirely through the system," he said. "Use an adapter. You'll get more flexibility."

Diagnostic panels such as the loopback TUA in Figure 1b may do more than just connect two instruments. They can hold test components such as resistors, voltage sources, current sources, or oscillators. They can also connect instruments to any test and calibration resources that may reside in the test system, such as DMMs (digital multimeters), oscilloscopes, and signal sources..

Test systems that consist mostly of card-based instruments may have just one stand-alone measuring instrument: an oscilloscope. Engineers often use the oscilloscope not only as part of the system, but also as a diagnostic tool. The oscilloscope can check signals as they pass through switches, cable, connectors, and mass-termination panels. *(continued)*

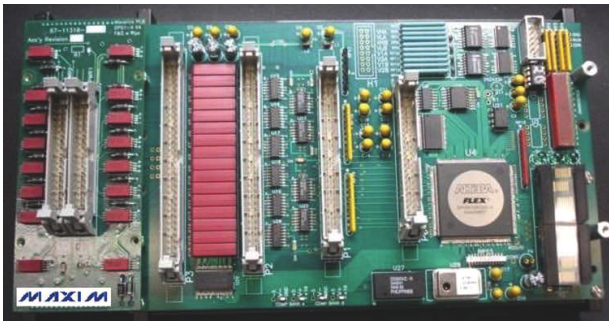

FIGURE 3. Load boards may contain connectors, relays, and electronics that engineers use to verify test-system integrity. Courtesy of Maxim Integrated Products.

Mark Carlson spent 30 years as a test engineer with Texas Instruments. During that time, he developed testers for the company's analog and digital ICs. In addition to using a loopback TUA, the testers he developed have a "calibration bus" that lets engineers check and calibrate power-supply outputs (**Figure 2**).

The calibration bus connects test equipment to resistors with 0.01% tolerance and to an ADC. The resistors provide a precision load for the power supplies, while the ADC measures power-supply voltages. Carlson explained that the ADC makes two voltage measurements on each power supply at the low and high ends of its range. A PC then calculates slope and offset (mX+b) to calibrate the power supply's output. The results go into a look-up table. Whenever the system needs an output voltage, it refers to the look-up table before sending a command to the power supply. The TUA also holds a NIST-traceable voltage reference for the ADC, making its measurements credible and verifiable.

Loopback tests and instrument calibration let you verify that a signal path is working properly, but what if the measurements seem wrong? You must troubleshoot the system. Here, reference devices can help you isolate errors.

For example, if your system has a DMM that measures power-supply voltage and the DMM has a self-test, then run the test. Try checking the meter with a known voltage that you've checked on another meter. Check the power supply's output. Is it what you expected? If it is, you likely have a problem with a cable, connector, or switch.

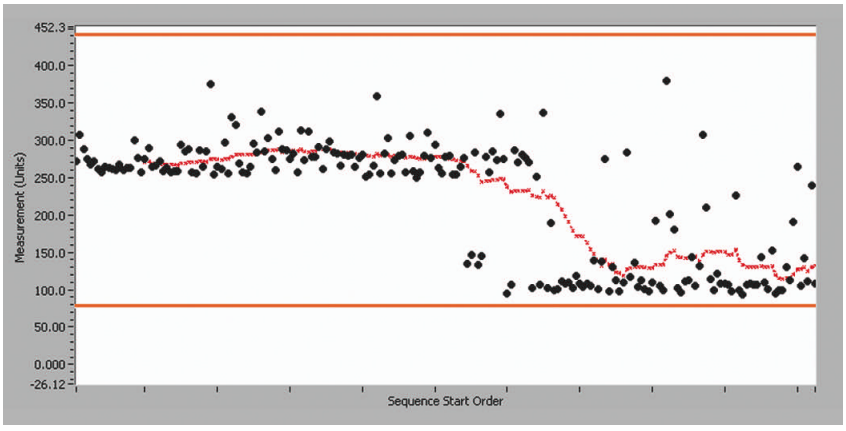

FIGURE 5. Test data shows a sudden measurement dropoff, but not from all measurements, which could indicate intermittent performance. Courtesy of Tektronix.

Test adapters that use golden UUTs may be far more complex than those that simply route signals between instruments. The board in **Figure 3** contains relays, an FPGA, and other devices that test engineer Todd Grey of Maxim Integrated Products uses to test digital ICs.

The FPGA works in combination with the relays under software control to connect a DUT to a power supply and to the appropriate pull-up components for the DUT's communications bus. The pull-ups can be either resistors or FETs, depending on pull-up requirements for the DUT.

How often to check?

Once you've established a baseline for a tester's performance, you should periodically check it. You can use a loopback setup, a reference component, or a golden UUT to conduct periodic checks. As a start, you can take advantage of self-test features built into your test equipment. You can run self-tests before every shift, every day, or every week, or you can run them at longer intervals, depending on how much you can trust the test equipment's stability.

Grey uses the test board in Figure 3 at least once a week. He performs his tests using the tester's built-in diagnostics, a set of golden devices, and load boards. He will run complete characterization tests on the golden devices and compare the results against previous results. These tests provide greater test coverage than production tests. He often uses a separate DMM and oscilloscope when checking the tester.

Checking your instruments frequently can help you catch errors caused by signal-path degradation or by an instrument drifting out of calibration, especially if you use that instrument to test an important product specification. David Buxton, senior test engineer at Tektronix, noted that "The last thing you want is to have a calibration lab report that one or more specifications, for an item of test equipment, was received out of tolerance. When that happens, an investigation should follow, which can lead to a recall notice for a free recalibration of the instrument."

Buxton noted that you can apply SPC (statistical process control) analysis to the test data to look for trends. If the reference component is built into the system, then you can program it to automatically run a check and log the results.

Checking production test data can provide clues about a tester's health. Look for trends in the measurements on produc-

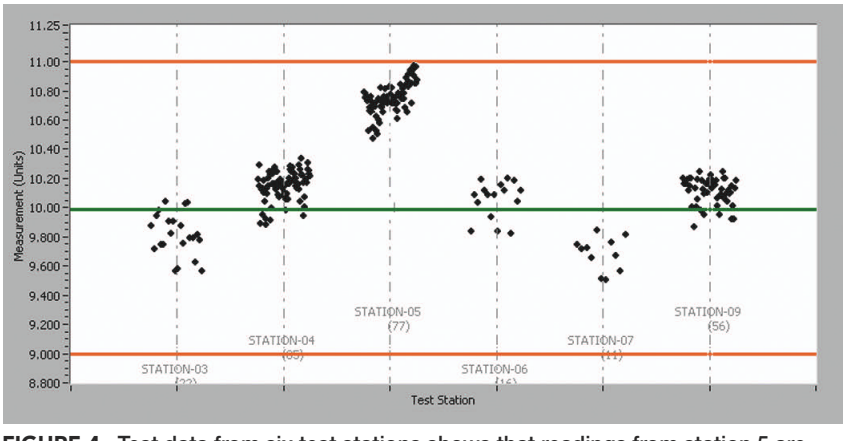

FIGURE 4. Test data from six test stations shows that readings from station 5 are near the high limit. Courtesy of Tektronix.

tion parts. A trend could indicate that an instrument is drifting out of its tolerance or that something else is wrong. **Figure 4** gives an example of measurements made on five test stations, while **Figure 5** shows data from a single tester.

In Figure 4, the data from station 5 indicates a measurement problem with the station. For example, if you notice that a power supply's voltage is dropping, it could indicate an increased resistance in a switch, connector, pin, or relay. Test pins get soft, and they may not make good contact over time. In addition, poor test-clamp alignment may also cause measurement errors.

Figure 5 illustrates a problem from a single test station. The plot highlights a drop in a measured value, and the measurements are erratic. This could indicate an intermittent instrument problem or a signal-channel problem that will require troubleshooting.

If you encounter situations like those depicted in Figures 4 and 5, you can start by checking the test equipment against a known reference. You can also run the same measurement on a different instrument or tester. If you see significant differences in a measurement from one tester to another, you know to suspect the tester.

You should try to minimize the number of obstacles in the suspected measurement path. Running a signal from a signal generator through an amplifier, an attenuator, and a test head to a spectrum analyzer means that any of them could cause a measurement error. You will likely have to check each component.

Signal paths that carry RF signals such as radar or serial data streams of 10-Gbps Ethernet have more possibilities for signal errors than low-frequency signals because of losses and reflections. Chris Scholz, field applications engineer at LeCroy, recommends that you use a TDR (time-domain reflectometer) to characterize signal paths and that you periodically rerun TDR measurements, looking for changes in results that could indicate a change in impedance.

TDRs are usually an option on high-bandwidth sampling oscilloscopes. Their wideband analog front ends let them measure reflections on repetitive pulses with rise time of tens of picoseconds (Ref. 1). You can use TDR measurements to calculate S-parameters that characterize a signal path in the frequency domain. You can also use a VNA (vector network analyzer) if you have one.

Knowing the characteristics of your signal path, you can "de-embed" or compensate for channel losses in your measurements. If you shut down your tester for maintenance say, every six months, then that's the time to run a TDR measurement. You need to make measurements with a TDR or VNA for every test fixture that carries high-frequency signals. T&MW

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WEBCAST ON TUESDAY 4/27 2 PM EST/11 AM PST

*FROM **TEST DATA** TO* business intelligence

How to quickly and effectively drill into your test data and obtain a complete 360-degree view of your manufacturing operations.

Identify the challenges of gathering, monitoring and understanding component and PCB supplier data, manufacturing test data, and CM process information. Understand the business impact associated with each of these challenges. Learn how you can address these challenges today, and change the way you manage the complete spectrum of your manufacturing business.

***Webcast** on Tuesday 4/27*
2 PM EST/11 AM PST
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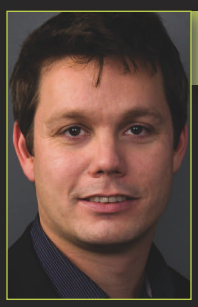

Jean-Lévy Beaudoin
Director, Business Development, Proligent

Jean-Lévy Beaudoin has accrued 10 years of experience in introducing new technology to communications and electronics OEMs. He has a technical and professional background in electrical engineering, semiconductors, and electronics testing, and has become a specialist in test solutions. He has held positions, for electronics OEMs such as Matrox, in software R&D, NPI management, product management, and business development, giving him well-rounded expertise in test engineering best practices. This experience and knowledge has enabled him to participate in international symposiums, where he has actively promoted advanced technologies such as Enterprise Test Software (ETS) as a critical component of accelerating time-to-market.

Test & MEASUREMENT WORLD

Averna

High-speed digitizer family expands with USB models

GaGe has added three USB models to its CompuScope line of high-speed digitizers. The model 121G11U is a one-channel, 12-bit digitizer that can sample at up to 1.1 Gsamples/s. The model 144002U has two 14-bit channels sampling at 400 Msamples/s per channel (each channel has a dedicated ADC). A single-channel 14-bit model, the 148001U, samples at up to 800 Msamples/s. All models include 128 Mbytes of waveform memory.

You can trigger an acquisition based on measured voltage levels or through an external trigger. You can then initiate measurements through an external clock input when you need to control speed and timing. All inputs use SMA connectors, and the signal integrity input voltage range is ±1.1 V.

All three models work with GaGe's CompuScope Lite software, which provides a user interface for controlling the instrument, viewing waveforms, and storing data. A full version of CompuScope that adds advanced triggering data analysis is also available. An optional software development kit lets you develop your own applications.

Prices: 144002U—$8390; 148001U—$10,595; 121G11U—$10,995. *GaGe, www.gage-applied.com.*

USB module has 24-bit inputs

Data Translation's DT9824 USB data-acquisition module has four 24-bit simultaneously sampled inputs. The unit features ±500-V galvanic isolation between the channels and between each input and the module's chassis. Sampling at up to 4800 samples/s, the DT9824 has input gains of 1, 8, 16, and 32, which correspond to input ranges of ±10 V, ±1.25 V, ±0.625 V, and ±0.3125 V. You can program a channel list for any gain on any channel.

You can set up the DT9824 USB to trigger a measurement based on software or on an external signal. With an external trigger, you can program the module to trigger on a rising or falling edge. You can set up the module to trigger a single acquisition or continuous acquisition.

The DT9824 also has eight digital inputs and eight digital outputs, all with 250-V isolation. Inputs can accept voltage levels from +3 V to +28 V DC. The eight latched digital outputs use solid-state relays that operate at ±30 V at currents up to 400 mA peak (AC or DC).

Software support includes Windows drivers, a calibration utility, and applications that let you test the module and perform basic operations. You also get several .NET example applications.

Price: $1695. *Data Translation, www.datatranslation.com.*

Software troubleshoots 10-GbE networks

Channel Stats software from Anritsu works with the company's CMA5000a multilayer network test platform to streamline the measurement of 10-GbE networks. When installed in the CMA5000a with the UTA (Universal Transport Analysis) module, the software displays statistical information on the various signals transmitted over 10-GbE networks, allowing service engineers to troubleshoot dropped network connections and slow speeds with a single instrument.

With the integrated hardware/software platform, you can detect the occupied bandwidth, errors, and throughput of 10-GbE transport signals. The software automatically sorts signals according to parameters, such as VLAN ID and TCP port numbers, and displays 35 types of statistical information to speed the troubleshooting of network faults. Plug-in measurement modules for the portable CMA5000a support SDH/SONET, OTN, and WDM, as well as 10 GbE. All measurements can be viewed on the 10.4-in. LCD touchscreen interface of the CMA5000a.

Anritsu, www.us.anritsu.com.

Sonoscan offers mil/aero inspection service for latent defects

Sonoscan has publicly announced SCE (Sonoscan Critical Evaluation), a confidential service for acoustically inspecting critical electronic components, such as hybrids, capacitors, and plastic-encapsulated microcircuits, used in military and aerospace systems. The service uses acoustic microimaging to nondestructively image hidden latent defects, including delaminations, cracks, and voids. The service helps customers locate, identify, and analyze internal anomalies that can cause

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electrical failures in service, like die attach voids in a hybrid device or singulation cracks in a capacitor.

SCE handles individual components, hybrid devices, and printed wiring boards. Typically, client engineers handle their own parts and load them into a laboratory C-SAM system in a secure room at the SonoLab in Elk Grove Village, IL. Acoustic imaging is supervised by Sonoscan specialists who will interpret images and also apply alternate imaging techniques to achieve the component reliability required by the client. Sonoscan will also design adapted fixtures to hold parts or modify programs to provide the optimum imaging of critical parts.

Sonoscan, www.sonoscan.com.

8-GHz socket suits DDR2/DDR3 memories

Designated the SG-BGA-6292, Ironwood Electronics' universal BGA socket for 0.8-mm pitch DDR2 and DDR3 memory packages accommodates IC size variations ranging from 7.5 mm to 15.5 mm. What's more, the socket operates at bandwidths of up to 8 GHz with less than 1-dB of insertion loss.

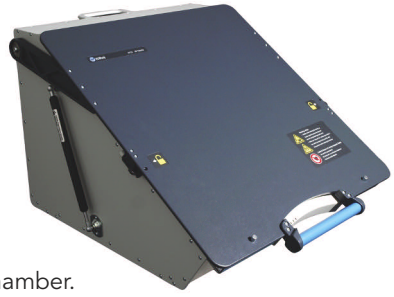
The sockets are manufactured with a replaceable IC guide for each package size and employ a quick-insertion method so that the IC and device guide can be changed quickly. Contact resistance is typically 20 mΩ per pin. The socket connects all pins with 8-GHz bandwidth on all connections. It is mounted on the target printed-circuit board without soldering and occupies a minimal footprint.

Constructed with a high-performance, low-inductance elastomer contactor, the SG-BGA-6292 operates over a temperature range of –35°C to +100°C. The pin self-inductance is 0.11 nH, while mutual inductance is 0.028 nH. Capacitance to ground is 0.028 pF. Current capacity is 2 A/pin.

Price: $360 for a single socket. *Ironwood Electronics, www.ironwoodelectronics.com.*

RF shield box accommodates bulky electronics

You can use Willtek Communications' 4933 RF Shield to perform radiation and quality measurements on large radio transceivers, notebook PCs, and other cumbersome electronic equipment. This large shield box offers a high degree of absorption with negligible reflections for repeatable test results, enabling users to perform measurements for an EMC prequalification test without having to rent a large anechoic shielded chamber.



The 4933 RF Shield employs a wide flip-up lid that opens at the push of a button for easy access to the enclosure. It also has a control panel and a zero-force latch with a solenoid lock. An external PC can be used to read the status and even release the lock remotely through a USB interface.

Willtek Communications, www.willtek.com.

JTAG adds simple continuity test to boundary-scan tool

An interim update of JTAG Technologies' ProVision boundary-scan development tool suite includes Buzz, a module that allows users to quickly check the continuity between two or more pins. First released in 2006, ProVision leverages a project-database structure, automatically analyzing the boundary-scan and nonboundary-scan elements of a design to create a full set of tests and in-system programming applications. With the Buzz module, you can easily check up to 10 pin-to-pin connections. Through the user interface, you can drag and drop pins into a continuity test panel and "buzz-out" a connection as you might do with a conventional digital multimeter.

In addition, a new Watch feature uses the JTAG SAMPLE instruction to asynchronously monitor the activity of a selected pin without disturbing the operation of the UUT.

Price: Service Pack One for CD release 15 (CD15-SP1) is available for downloading for licensed users with a current support contract. A free version is also available for those without a contract. *JTAG Technologies, www.jtag.com.*

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LED wafer inspectors gain sensitivity

By Ann R. Thryft, Contributing Technical Editor

Manufacturers of LEDs and MEMS (microelectromechanical systems) are always concerned about improving yield and quality, and they work to prevent dies with visible defects from entering the expensive packaging phase. That requires greater sensitivity to critical process defects, said Mike von den Hoff, director of marketing for KLA-Tencor's ICOS Wafer Inspection Division, who commented on techniques for improving both speed and sensitivity in wafer-inspection systems.

Q: What are the biggest inspection challenges for manufacturers of LEDs and MEMS?

A: Two problems need to be addressed in the LED space. In outgoing wafer-quality check, manufacturers must catch bad dies that pass probe test but still have defects that can cause reliability or performance problems. The dies need to be marked as bad so they don't get packaged or put on a die sort sheet. But it's also increasingly important to find defects inside the wafer fab before probe test. The process for MEMS, which represent a much smaller market, is totally different—bigger dies and very different devices and defects—but the overall issues are very similar.

Q: How can wafer-inspection speed be improved?

A: Increasing the tool speed requires improvement in the image sensor, the image-processing computers, the mechanical stage that's moving the wafer, and the illumination intensity. The speed of our ICOS WI-2250 is two to four times faster—depending on inspection-mode sensitivity and lighting—than the speed of the previous-generation WI-2200.

Q: What's involved in boosting inspection sensitivity?

A: Sensitivity is really about the signal-to-noise ratio, meaning finding the defects that matter rather than those that don't matter. We needed to reduce noise sources on the tool to improve overkill and underkill in post-die inspection.

Overkill is when you reject a die that's actually good. The economic impact is simple: You've thrown away a good die. In underkill, you don't find a bad die and it goes into packaging. Since the cost of a chip's packaging can be higher than the cost of its entire manufacturing process, your underkill costs could be even higher. Many of our customers are more concerned about underkill than overkill, because of cost reasons, but also to avoid possible returns from their customers.

Mike von den Hoff
Director of Marketing
ICOS Wafer Inspection Div.
KLA-Tencor

Q: What else has KLA-Tencor done to help address the challenges of LED manufacturing?

A: Once you find certain post-processing defects, you want to classify them so you can make better decisions for disposition of the dies and for yield improvements. In addition, accelerating root-cause analyses requires an improved correlation between front-end and back-end inspection steps. We've taken classification algorithms developed for previous KLA-Tencor systems that inspect higher-end semiconductors and integrated those into the WI-2250. These algorithms are very effective and have been proven in the industry for many years.

In solid-state lighting, as die sizes increase, defects will have a much bigger yield impact, and yield improvement will have a much higher priority. For example, at a typical LED wafer fab with 12,000 wafer starts a month, a 1% improvement is worth roughly $1 million in savings per month. □

INSIDE THIS REPORT

EDITOR'S NOTE

The flat machine-vision world

By Ann R. Thryft, Technical Editor

Although it may not be hot or crowded yet, the world of machine vision is definitely becoming flat—and global. This by itself isn't news, but a cooperative agreement among the top three vision standards organizations certainly is worthy of note (p. 45). Initiated by the Japan Industrial Imaging Association and embraced by the Automated Imaging Association and the European Machine Vision Association, the unprecedented agreement attempts to bring clarity to an industry that is becoming awash with competing standards for vision technologies while it grows more interconnected.

One standard that is getting an overhaul is Camera Link, the long-lived, parallel camera interface specification designed for high-speed image acquisition (p. 43). Some major changes will be needed to accommodate the demands of high-throughput machine-vision systems for even faster data acquisition, along with easier to use, lower-cost, off-the-shelf hardware. A roadmap for the result, Camera Link 2, may come as early as this spring.

Meanwhile, a recent study from ITM Marketing of AOI systems that inspect PCBs finds that 3-D capability is becoming more popular for use in demanding applications (see adjacent box). These include bump inspection and tacky flux application for stacked die, as well as inspection of area, height, and volume in very-fine-pitch solder-paste deposition. □

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

HIGHLIGHTS

Vision software uses statistical analysis

Unlike inspection technologies that use signal processing to detect surface defects during production, the VisionPro Surface software from Cognex monitors the appearance of a material and uses statistical analysis to identify potential defects on the material's surface. The software then classifies the defects into user-defined groups based on similarity in contrast, texture, or geometry. Hardware components such as cameras, lights, and cabling can be purchased separately from Cognex or third-party vendors. www.cognex.com.

SDK drives FireWire and GigE cameras

The AVT Universal Package SDK (software development kit) from Allied Vision Technologies supports both FireWire and GigE Vision interfaces. It also includes the company's UniAPI universal application programming interface, which was previously available only for FireWire cameras. The Universal Package, which is compatible with Windows 32-bit operating systems, is available for AVT camera users as a free download. www.alliedvisiontec.com.

Smart camera runs Windows XP Embedded

The Matrox Iris GT camera now includes the Windows XP Embedded operating system, enabling system integrators to develop applications using standard Windows development tools, such as Microsoft's Visual Studio, in conjunction with the Matrox Imaging Library. The Iris GT camera offers a choice of monochrome or color CCD sensor teamed with an Intel Atom embedded processor. Resolutions range from VGA to 2 Mpixels. www.matrox.com.

3-D increasing in AOI systems

According to a recent study from market research firm ITM Marketing, the primary end-user applications for AOI (automated optical inspection) systems worldwide are SPI (solder-paste inspection) and process optimization. The study, titled "Automated Optical Inspection (AOI) Benchmark Report," looks at trends in key market dynamics of AOI systems used for inspecting PCBs (printed-circuit boards) and for SPI applications, said Bob Klenke, the firm's managing director.

Klenke explained that although the AOI market is fragmented regarding specific imaging technologies, SPI and process optimization remain the two primary applications for AOI systems. "Some view SPI as a separate entity," he said, "but continuous monitoring and feedback of solder-paste deposition is considered the 'holy grail' of process refinement."

The study also showed an increase in the inclusion of emerging technologies in AOI systems, such as 3-D AOI and optical-measurement capabilities. Increasingly, users want 3-D for accurately measuring processes such as very fine-pitch solder-paste deposition.

Klenke noted that more companies are using smaller benchtop systems for offline inspection. Many of these are smaller companies that choose the benchtop systems to reduce capital costs. But companies that place larger AOI systems in-line can not only inspect products but also gain continuous feedback, which gives them an opportunity to refine their processes.—*Ann R. Thryft*

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Camera Link 2 is on the way

By Ann R. Thryft, Contributing Technical Editor

Over the last decade, the Camera Link parallel interface standard (Ref. 1) has served the needs of industrial machine vision for real-time, high-bandwidth, digital image acquisition. But today's high-end systems demand bandwidth greater than the standard's 6-Gbps maximum. Many machine-vision systems now employ line-scan cameras with 1k, 2k, or higher pixel lines and line rates above 100 kHz, more than double the speed that was common when the standard was being developed in the late 1990s. Meanwhile, fast CMOS image sensors are becoming available with machine-vision-friendly features.

"Camera Link needs a future for machine vision, and specifically for machine vision in industrial manufacturing," said Steve Kinney, chair of the AIA (Automated Imaging Association) Camera Link committee. "CMOS image sensors have been gaining features like global shutter and higher image quality that are required for industrial applications. They also provide higher speeds than comparable-resolution CCDs, but that means dealing with a much higher data rate, which is why we need Camera Link 2."

Builders of high-speed vision systems are also looking for a solution that's more convenient and easier to implement than the current Camera Link "full" interface, which requires two cables and is limited to 10 m. "Camera Link revolves around real-time, high-bandwidth image acquisition, so speeds in next-generation Camera Link 2 should be in the 20- to 40-Gbps range," Kinney said.

The Camera Link technical committee has examined Dalsa's HSLink proposal (Ref. 2), which will probably serve as a basis for Camera Link 2, said Kinney. "HSLink is thorough, well thought-out, and a good platform for development," he said. "If we do use it as a base proposal, we will make changes to it as determined by the technical committee's findings."

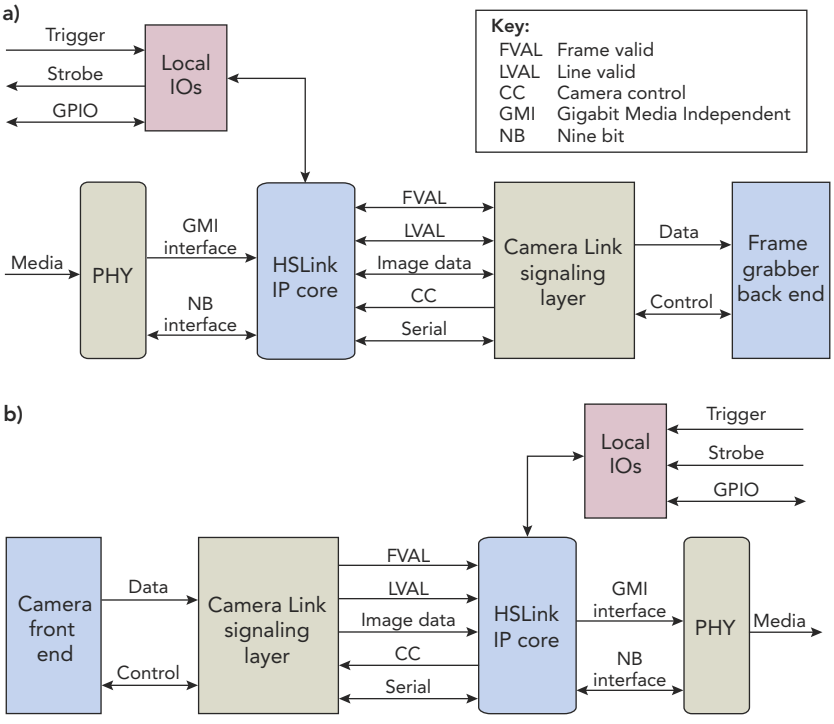


Fig. 1 These figures show a simplified version of the HSLink system architecture for a) a frame grabber and b) a camera. Courtesy of Dalsa.

Although the HSLink draft specification is not complete, it does have a structure, said Jeff Fryman, director of standards development for the AIA. "We may decide to make several changes, such as in cabling, or change some of the capabilities." The **figure** illustrates the concept behind the HSLink architecture for connecting a frame grabber and a camera.

The design of HSLink focuses on using some of Camera Link's key strengths, said Mark Butler, product manager for Dalsa. The protocol carries lower-jitter, real-time triggering signals; image data; and configuration data, and the specification is based on off-the-shelf components, each with a clearly defined, long-term roadmap for performance improvements. HSLink bandwidth is scalable from 2.4 Gbps using one lane to 48 Gbps using 20 lanes, in steps of 2.4 Gbps. Unused lanes can be turned off to save power.

To meet demands for low cost, ease of use, flexibility, and data reliability, the serial, packet-based protocol was designed from the system point of view, using a simple network topology that supports cameras, frame grabbers, and intermediate devices such as those that interface to GPIO. HSLink's main components are the physical-layer SerDes chip, cabling, and FPGAs. "All of these are widely available from multiple sources and are used in industries with volumes much larger than machine vision, in order to keep the costs low," said Butler.

HSLink also makes possible some new configurations. Because bandwidth is so high, some customers want to distribute the image from one camera to multiple frame grabbers for processing to help reduce system costs, while others want to connect multiple cameras, sometimes at different speeds, to one frame grabber. *(continued)*

Dalsa looked at several changes to improve on Camera Link, said Butler. "We wanted to guarantee data reliability with built-in error detection and notification," he said. "The hardware resend capability allows buffer sizes small enough to integrate the HSLink protocol into an FPGA to reduce part counts. We also wanted to reduce cable costs, and make the connector smaller."

Cables used with HSLink include coax cables at low bandwidths of one or two lanes, CX-4 cables at mid-bandwidths of three to seven lanes, and Infiniband cables for higher bandwidths. HSLink can also take advantage of low-cost, off-the-shelf, fiber-optic cabling at any bandwidth for long transmission distances. Nominal transmission distance is 15 m on CX-4, although Dalsa has achieved 20 m in its labs, and 80 m is theoretically possible on RG6 coaxial cable.

To ensure an expandable, long-lived interface, HSLink complies with GenICam, and there is also the potential for Power over HSLink to extend the Power over Camera Link interface, said Butler. GPIO is supported by a frame grabber and optionally by a camera. HSLink's low 3.2-ns jitter makes it viable for applications with linescan cameras faster than 300 kHz. If jitter becomes too large, the exposure time would vary enough to produce a line-by-line ripple in the image.

Working products based on the draft specification of HSLink—Dalsa's

JIIA hosting coax-based camera standard

Another standard that could soon play a role in machine-vision applications is CoaXPress, which is being hosted by the JIIA (Japan Industrial Imaging Association). The CoaXPress Consortium handed over ownership of the serial, high-speed, packet-based camera interface standard to the JIIA in December 2009 as the first step toward seeing it published as an international standard.

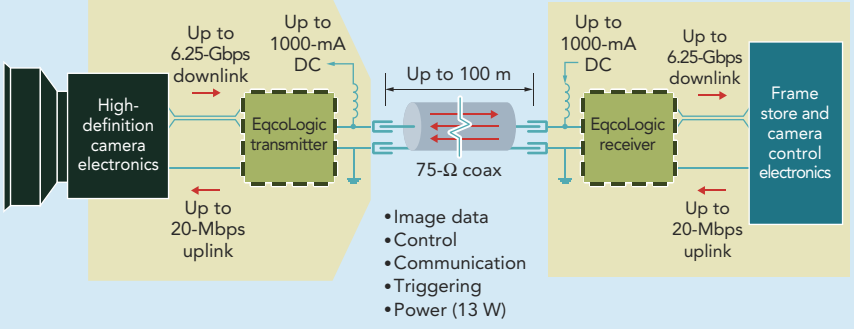
CoaXPress has a base speed of 3.125 Gbps for distances of up to 100 m, or a maximum sustained speed of 6.25 Gbps up to 40 m, said Jochem Herrmann, CTO of consortium member Adimec. Higher speeds are possible by using multiple cables in parallel, and the standard does not limit the number of cables that can be used.

Although CoaXPress currently depends on a single-source transceiver chipset from consortium member EqcoLogic, the standard will not specify that silicon, said Peter Helfet, EqcoLogic's CEO. "We've arranged an escrow agreement with JIIA for safe storage of our IP and all related information," he said. "We are also talking with other companies about second sourcing, and JIIA is supporting this effort."

A key feature of CoaXPress is the fact that it runs on coax cable at all speeds. "Coax is easy to use, low cost, and reliable," said Colin Pearce, CEO of consortium member Active Silicon. It is also available in many different varieties, partly driven by the extensive use of coax in industries such as broadcast, where the progression to HDTV has also resulted in a demand for high-quality coax. Given the huge legacy of coax cables installed in industrial applications, CoaXPress provides an easy and cost-effective upgrade path for the introduction of high-resolution digital cameras. "In fact, 60% of Japan's machine-vision industry still uses analog cameras and associated cabling," Pearce said. "This is one of the reasons JIIA was keen to host CoaXPress as a standard."

The draft standard was implemented in several products demonstrated by consortium members at Vision 2009 (November 3–5, Stuttgart, Germany), including cameras, frame grabbers, cable solutions, and CoaXPress-to-Camera Link converters, said Adimec's Herrmann. Production shipments are expected by the early second quarter this year.

Although the physical interface won't change, some firmware may change during the standardization process, and all draft standard products will be firmware-updatable. "We expect that the first version of the standard will be backward compatible with draft standard products," he said. "By the end of 2010, we hope to present the formal standard at either Vision 2010 in Stuttgart in November or at ITE [International Technical Exhibition on Image Technology and Equipment] in Yokohama in December." The consortium will provide JIIA with technical input during the standard-development process.—*Ann R. Thryft*



The CoaXPress standard allows a coax cable to operate bidirectionally, carrying image data and control signals including triggering and general-purpose I/O. Up to 13 W of power at 24 V is transmitted to the camera from the frame grabber.

Courtesy of CoaXPress Consortium.

Vision standards groups to cooperate

Last November at the Vision 2009 show in Stuttgart, the AIA (Automated Imaging Association), EMVA (European Machine Vision Association), and the JIIA (Japan Industrial Imaging Association) standards organizations signed an agreement to cooperatively develop and promote global machine-vision standards. In the future, when all three organizations agree on the need for a standard, one will develop the specification and all three will promote the result globally. Each association retains the right to develop standards on its own when there is no consensus on a global need.

The original initiative for the agreement came from JIIA in 2006, when its representatives talked to those from the AIA and EMVA about the necessity of a framework for global standardization, said JIIA chairman Shigeo Oka. As the variety of interfaces for cameras and frame grabbers have increased, and quite a few digital interfaces and high-resolution imaging cameras have emerged, the types of applications for machine vision are expanding. Developing standards independently for local markets could be uneconomical and confusing. "We are very confident that this global coordination will play a key role in accelerating the adoption of machine-vision standardization, and will help to maximize dissemination and applications of the standards," he said.

The agreement is about making machine vision easier to use, said Jeff Burnstein, AIA president. "If there are standardized ways of doing things in machine vision that make it cheaper, faster, better, and easier, then our job as a trade association is to help promote them," he said. It's taken about three years to finalize the agreement, since each association has its own procedures for developing standards and each operates in a different country, governed by different laws. "We needed to make sure that we're following open procedures that are transparent and that benefit the members of our associations and users in the industry," he said. "If we all endorse a standard, we all need to be aware of the way it's developed and satisfied with its outcome. Standards are complicated, but we're confident that working cooperatively across the globe will be good for the machine-vision industry."

The agreement starts a global discussion of standards that can avoid overlapping functions or duplication of tasks, as has sometimes happened in the past, said Cor Maas, VP of the EMVA. The EMVA has proposed a new standard for consideration within the agreement based on a technology Intel is developing called Light Peak. The 10-Gbps optical cable communications technology could become an alternative to USB 3.0 and Camera Link. "If Intel eventually puts it on motherboards, consumer adoption would drive prices down low enough to use this technology in machine vision," he said.

Some legacy standards of the individual associations may move into the context of the cooperative agreement, said Maas. Possible candidates include the EMVA's GenICam and 1288. Moving legacy standards into consideration by all three associations lets members of the other two organizations join those initiatives and work on their next steps, without needing to become members of the other associations. "It also ensures that these standards will be promoted by the three associations to the machine-vision industry in all geographical areas," he said.—*Ann R. Thryft*

Piranha HS 12k camera and the Xcelera-HS PX8 frame grabber—use CX-4 cable, said Butler. The Piranha HS 12k runs at over 90 kHz and requires five video lanes to operate at its full speed of 12 Gbps. "We wanted to make sure everything works at this speed first, because it's what our customers need to satisfy their line rate and resolution requirements," he said. "If we use Infiniband x12 cables, we can expand to 48 Gbps."

The path for approval

The AIA standard development process includes multiple steps to make sure the whole committee agrees with what's being developed, said Kinney. "We have a discussion with the full Camera Link coordinating committee, and then it goes to the technical committee for action," he said. "Then, it's a matter of how many companies are participating and how long it takes to work out all the details."

Fryman explained that the Camera Link technical committee, which is a subset of the larger coordinating committee, will approve and maintain the standard, develop and write support documentation, and establish technical certification and validation requirements. "The technical committee concept is new to Camera Link now that we're entering the full-blown development process in Camera Link 2, although we use it in GigE Vision," he said. "This is the first time we're taking a clean sheet and starting from scratch, albeit with guidance. Because of our development process, by the time we finalize a standard, all of the material that went into its making has been fully vetted and there are no surprises." The AIA hopes to have a Camera Link 2 roadmap in May, said Fryman.

"At this point, Camera Link is nearly 10 years old, and we want to make sure we develop Camera Link 2 so it lasts for the next 10 years," said Kinney. "That takes time, especially considering all the input that's required for a worldwide standard. Our goal is to finalize Camera Link 2 within the next year." □

REFERENCES

1. "Camera Link," Automated Imaging Association. www.machinevisiononline.org/vision-standards-details.cfm?type=6.

2. "HSLink Overview," Dalsa. www.dalsa.com/mv/knowledge/hslink.aspx.

CATALOGS & PRODUCTS

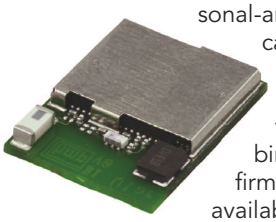
The following write-ups were supplied by advertisers in this issue.

USB DAQ module

Data Translation's DT9824 USB DAQ module allows users to simultaneously sample up to four fully isolated 24-bit inputs, ensuring signal measurement protection from environmental or system noise. The company says the high-stability design delivers better results than other systems. *Data Translation, www.datatranslation.com.*

RF modules

Panasonic Electronic Components provides flexible, cost-effective RF modules for a variety of wireless personal-area-network applications. Extended range products featuring small footprints combined with network firmware flexibility are available in 802.15.4, Bluetooth, ISM, and new RPA (relative position awareness) hardware technologies. *Panasonic, www.panasonic.com/indcomp/rf.*



Phase-coherent MIMO measurements

The software-defined NI PXIe-5663E 6.6-GHz RF vector signal analyzer and NI PXIe-5673E 6.6-GHz RF vector signal generator are designed for prototyping and testing multichannel MIMO wireless devices, such as those built for WiMAX, LTE, and 802.11n. *National Instruments, www.ni.com/automatedtest/mimo.*

Low I/O connector

VPC's i1 is ideal for small connector needs, offering up to 160 signal points in each unit and allowing for a variety of I/O options, including signal, power, and coax. *Virginia Panel Corp., www.vpc.com.*

Tiny smart camera

BOA is a highly integrated optical inspection tool for controlling quality and increasing productivity. It comprises all the elements of an industrial machine-vision system in a tiny smart camera. *Dalsa, www.dalsa.com/Home.aspx.*

Test-data management

Proligent integrates test-data management, process and quality control, reporting, and analysis in a closed-loop environment. OEMs can define, deploy, and control test execution locally and remotely, and management and quality executives can share and analyze results from multiple sites. *Averna, www.averna.com/proligent.*

Temperature measurement

Omega's *Temperature Measurement Handbook* offers detailed information and specs on more than 40,000 products for process measurement and control, including sanitary temperature sensors and devices, wireless connectors and instruments, profile temperature labels, thermal imagers, and infrared temperature products. *Omega Engineering, www.omega.com.*

VNA software

The new Bode Analyzer Suite V2.3 adds many functions to the Bode 100 vector network analyzer, including RLC sweeps, faster measurements, and extended trace functions. *OMICRON Lab, www.omicron-lab.com.*

DAQ switch unit

The 34972A data-acquisition switch unit from Agilent Technologies features built-in LAN and USB connectivity so you can control your data acquisition remotely via a Web interface and transfer logged data to a PC with a simple flash drive. *Agilent Technologies, www.agilent.com/find/Agilent34972A.*

PC-based oscilloscopes

Pico says its PicoScope 6000 Series instruments are the ultimate USB oscilloscopes. The PC-based test instruments offer four channels, a 350-MHz bandwidth, 5-Gsamples/s real-time sampling, and record lengths up to 1 Gsample. *Pico Technology, www.picotech.com/pco435.*

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VIEWPOINT

[An exclusive interview with a technical leader]

BRIAN DOODY
CEO
Dalsa
Waterloo, ON, Canada

Brian Doody joined Dalsa in 1985, taking on roles of progressively increasing responsibility. Prior to his appointment to CEO in September 2007, he had been COO since 2006 and, prior to that, president of Digital Imaging since 1999. Previously, he held posts as VP of operations and VP of manufacturing and engineering. Doody has participated in and managed both custom and standard product development projects and was directly involved in establishing many of Dalsa's production capabilities. A professional engineer, Doody has a BSEE from Queen's University and an MASc from the University of Waterloo.

Contributing editor Larry Maloney conducted a phone interview with Brian Doody on the business recovery in machine vision and the technologies that are leading the comeback.

Strategies for making vision affordable

Q: How did the recession change the machine-vision industry?
A: It certainly put a reset on growth in the business. The sense I get is that there will be more consolidation in the industry. Companies will also need to focus more on doing a few things really well, rather than trying to support a large breadth of products.

Q: What areas will grow fastest as machine vision rebounds?
A: For Dalsa, recovery in semiconductors will be very important, both because we supply capital equipment to that industry and because we are a semiconductor foundry ourselves. Fortunately, semiconductor markets have started to rebound, both for capital equipment for wafer and mask inspection as well as for inspection of flat-panel displays. A second area of growth is the smart-camera business. While companies are still cautious about large outlays for capital equipment, smaller-scale vision systems featuring smart cameras are much more affordable and will see solid growth as automation specialists seek efficiency improvements.

Q: How did Dalsa revamp its product development during the downswing?
A: We definitely had to make some choices. My goal was to have important new products available and ready to ship as we recovered from the slump. We focused especially on smart cameras, introducing the new BOA camera, a very powerful and self-contained solution for factory automation. We also introduced the Piranha HS 12K, the next generation of our high-sensitivity, high-speed digital cameras targeted primarily at the semiconductor and electronics inspection markets.

Q: What do you see as the prime obstacles to greater adoption of vision solutions?
A: In the short run, costs will continue to be the prime obstacle. Integration of machine vision with existing automation can also be an issue, particularly as companies move past early vision systems and adopt more advanced solutions. In such cases, companies can incur some pretty significant nonrecurring engineering costs. And certainly, ease of use is always a concern when new companies adopt machine vision.

Q: How is Dalsa addressing these obstacles?
A: A good example is the launch of our BOA smart-camera line. The camera offers complete plug-and-play capability with no CDs to load and has built-in multiple processors and control lines that can be connected to standard PLCs [programmable logic controllers] on the factory floor. When you combine all these elements, you get for a few thousand dollars a very compact machine-vision system that can be easily integrated into existing equipment. At the other end of the scale, for continued leadership in the semiconductor inspection and flat-panel display markets, we must have products that deliver speed and high performance. That's the focus of our Piranha HS camera line. Certainly, strong technical support is also very important, especially in emerging regions, such as China, where we're adding more customer support staff.

Q: As companies boost productivity with lean manufacturing, does the case for machine vision get stronger?
A: I think it does. Machine-vision applications are becoming more cost-effective, particularly with the availability of small-scale systems based on smart cameras. And that trend will give a boost to companies that are under pressure to get their manufacturing back on line while keeping costs in check. T&MW

Brian Doody answers more questions on new machine-vision technology, as well as interface standards, in the online version of this interview: www.tmworld.com/2010_04.

To read past Viewpoint columns, go to www.tmworld.com/viewpoint.

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