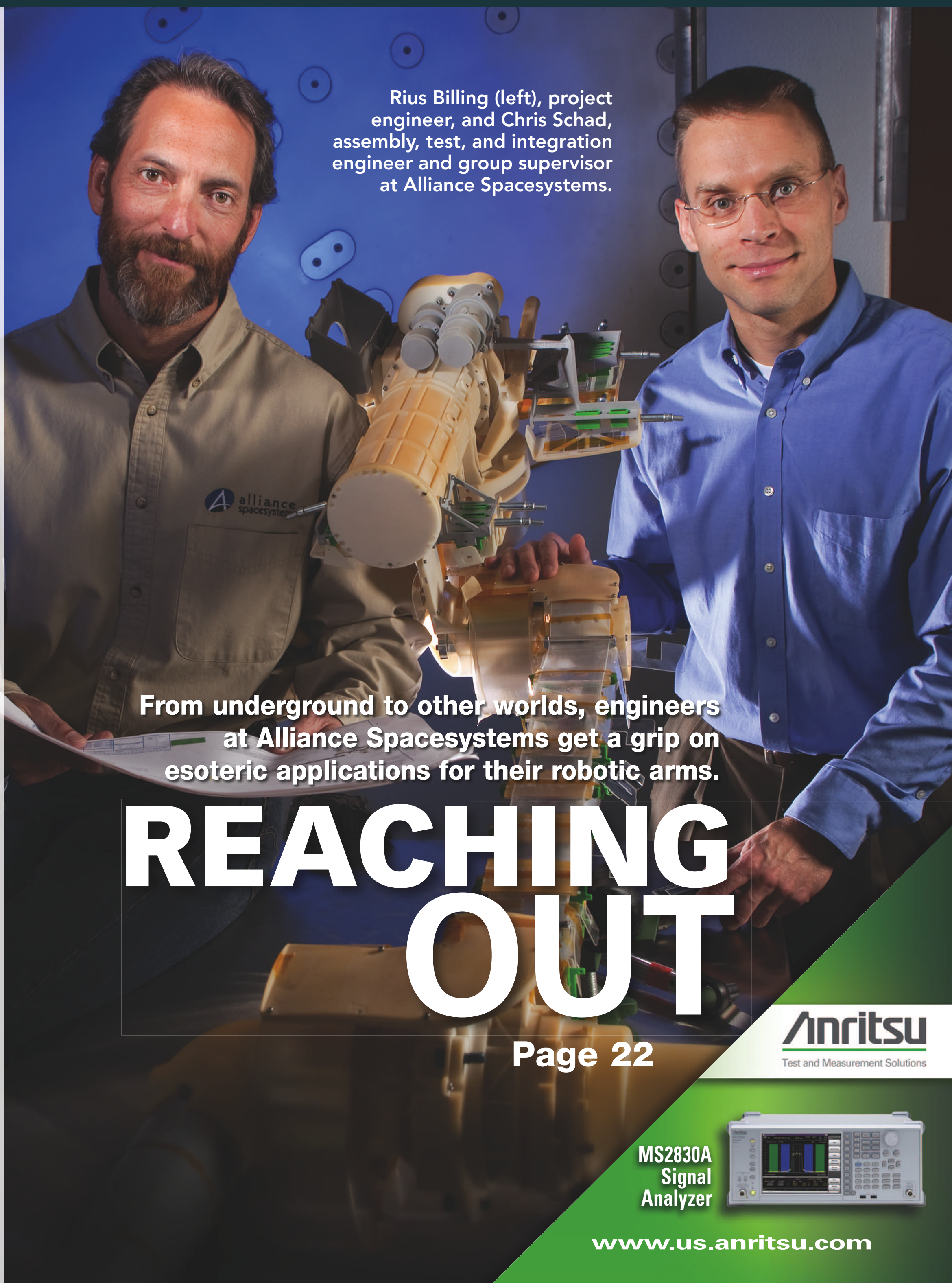
Reed Business Information. (RBI.)
March 2010
www.tmworld.com

Test & MEASUREMENT WORLD®

THE MAGAZINE FOR QUALITY IN ELECTRONICS



Rius Billing (left), project engineer, and Chris Schad, assembly, test, and integration engineer and group supervisor at Alliance Spacesystems.

From underground to other worlds, engineers at Alliance Spacesystems get a grip on esoteric applications for their robotic arms.

REACHING OUT

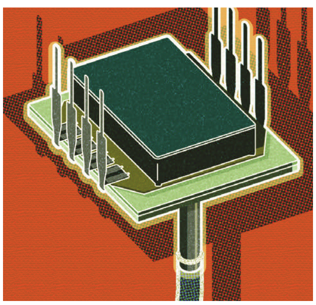
Page 22

COVER BY: STEVE LABADESSA

Test & MEASUREMENT WORLD®

MARCH 2010
VOL. 29 NO. 2

CONTENTS



DEPARTMENTS

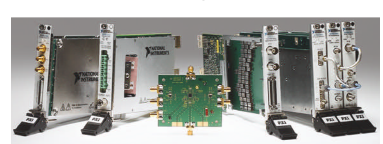
FEATURES

TECH TRENDS

MECHATRONICS IN DESIGN

TEST DIGEST

TEST REPORT SUPPLEMENT



RENEW YOUR T&MW SUBSCRIPTION ONLINE: WWW.GETFREEMAG.COM/TMW

HOW TO CONTACT T&MW

EDITORIAL:
225 Wyman St.
Waltham, MA 02451

Phone: 781-734-8423
Fax: 781-734-8070
E-mail: tmw@reedbusiness.com
Web: www.tmworld.com

SUBSCRIPTIONS:
For address changes, cancellations, or questions about your subscription, please contact:

Customer Service
Reed Business Information
8878 S. Barrons Blvd.
Highlands Ranch, CO 80129

Phone: 800-446-6551
Fax: 303-470-4280
E-mail: subsmail@reedbusiness.com
Web: www.getfreemag.com/tmw

CIRCULATION:
Jeff Rovner
303-265-6266
jrovner@reedbusiness.com

LIST RENTAL:
Hector Gonzalez
630-288-8368
hector.gonzalez@reedbusiness.com

GENERAL AD SALES AND MARKETING:
800-438-6597

REPRINTS:
The YGS Group
800-290-5460, Text. 149;
tandmw@theygsgroup.com

Subscribe to *T&MW* online:
www.getfreemag.com/tmw

Reed Business Information. (RBI)

ONLINE www.tmworld.com

Check out these exclusive features on the *Test & Measurement World* Web site:

Blog commentaries and links

Taking the Measure

Rick Nelson, Editor in Chief

- Volcker bemoans lack of interest in real engineering
- Cars are oh so scary
- Are EEs overconfident?

Rowe's and Columns

Martin Rowe, Senior Technical Editor

- A Carton of advice
- CISPR 16-1-1 Ed.3 published
- Handheld spectrum analyzer reviewed

Engineering Education and Careers

Matthew Yiu, Contributing Editor

- Step UP brings Science Across the City
- MIT encourages America's teens
- Training the computer to mimic human performance

www.tmworld.com/blogs

Take a T&M Challenge

Answer our latest challenge question, and you could win a prize courtesy of the challenge sponsor. Recent challenges have covered thermocouples, GPIB, Ethernet, and LXI. In March, the LTE Challenge, sponsored by Anritsu, will have an Amazon Kindle as a prize.

www.tmworld.com/challenge

Stay connected with *Test & Measurement World*

Become a member of the *Test & Measurement World* group on LinkedIn.com or find us on Facebook to join discussions on test, measurement, and inspection; receive updates on industry news; and network with your peers. In addition, you can also follow our editor in chief, Rick Nelson, on Twitter.

www.linkedin.com/e/gis/2196932

www.tmworld.com/Facebook

twitter.com/rick_editor

EDN Innovation finalists

EDN has announced the finalists for its 20th annual Innovation Awards. Cast your votes for the winner in 30 product categories, including oscilloscopes, RF/microwave test, and network test, and then vote for the Innovator of the Year. Voting deadline is March 19.

www.edn.com/innovation

USB Data Acquisition.

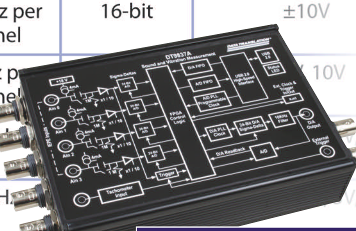
Every feature. Compare. Learn. Use.
Always, 5-Day Delivery.

Product Selection Chart

	Model	Summary	Analog Input Features			
			# of Channels	Throughput	Resolution	Input Range
High Res.	DT9824	**ISO-Channel™**, High Stability, High Accuracy, Fully Isolated USB Data Acquisition Module	4DI	4800Hz per channel	24-bit	±312.5mV, ±625m ±1.25V, ±10V (unipolar avail.)
Low Cost	DT9810	Lowest cost, 10-bit, non-isolated	8SE	25kH		
	DT9812-2.5V	Low cost, 8 analog inputs, 12-bit, 2.5V range, non-isolated	8SE	50kH		
	DT9812-10V DT9813-10V DT9814-10V	Low cost, up to 24 analog inputs, 12-bit, 10V range, non-isolated	8/16/24SE	50kHz	12-b	
	DT9816 DT9816-A	Low cost, simultaneous, 6 A/Ds @ up to 150kHz, 16-bit, non-isolated	6SE	50kHz/150kHz per channel	16-bit	±5V, 10V
	DT9853 DT9854	Low cost, up to 8 analog outputs, 16-bit, 16 digital I/O, 1 C/T, 300V isolation	–	–		–
Sound & Vibration	DT9837 DT9837A	4 IEPE (ICP) sensor inputs, tachometer, simultaneous A/Ds	4 IEPE (SE) + 1 Tacho	52.7kHz per channel		10V
	DT9841-VIB	8 IEPE (ICP) sensor inputs, simultaneous A/Ds with DSP, 500V isolation	8 IEPE (SE)	100kHz per channel	2	±10V
Simultaneous High Speed	DT9832A	Simultaneous, 2 A/Ds @ 2.0MHz each, 500V isolation	2SE	2.0MHz per channel	16-bit	±10V
	DT9832	Simultaneous, 4 A/Ds @ 1.25MHz each, 500V isolation	4SE	1.25MHz per channel	16-bit	±10V
	DT9836	Simultaneous, up to 12 A/Ds @ 225kHz each, 500V isolation	6 or 12SE	225kHz p channe		10V
High Speed	DT9834	High-speed, up to 16 analog inputs, 500kHz, 16-bit, 500V isolation	16SE/8DI	500k		
	DT9834-32	High-speed, up to 32 analog inputs, 500kHz, 16-bit, 500V isolation	32SE/16DI	500kH		V, 1
Temp.	TEMPpoint	**ISO-Channel™**, Thermocouple, voltage, or RTD inputs, A/D and CJC per input, high accuracy	8-48	10Hz per channel	24-b	

DT9824 – ISO-Channel™, High Resolution

DT9812 – Low Cost



DT9837A – Sound and Vibration

DT8837 – Sound and Vibration for Ethernet

800-525-8528
www.datatranslation.com

DATA TRANSLATION®

RICK NELSON
EDITOR IN CHIEF

Space flight: humans or robots?

The future of US manned space flight is in doubt, as the Obama administration has withdrawn support for NASA's Constellation program. To *Washington Post* columnist Charles Krauthammer, this is a bad idea. He writes (Ref. 1) that should Constellation be canceled, the US, for the first time since John Glenn flew in 1962, will have no way to get humans into space. As for administration proposals for private industry to take over launch responsibilities, Krauthammer calls that "nonsense"—saying that space flight is too expensive and experimental with unreachably high safety standards. He describes a vague commitment to put humans on Mars as a ruse, killing the doable (reaching the moon) "…in the name of some distant sophisticated alternative, which either never gets developed or is simply killed later in the name of yet another, even more sophisticated alternative of the further future."

"What 'trace on the national consciousness' would a repeat of the successes of Mercury, Gemini, and Apollo leave?"

James Bacchus, a former member of Congress whose Florida district included the Kennedy Space Center, is less pessimistic. He writes (Ref. 2), "Obama is looking to NASA itself to develop new heavy-lift rockets that would eventually carry new spacecraft beyond Earth orbit on new manned missions of space exploration." But he continues, "In the meantime, though, the President is looking not to NASA, but instead to a rapidly growing American commercial space industry…to develop much less expensive vehicles to resupply the space station." Without private industry efforts, he adds, NASA will have no backup. He writes, "At a time when American leadership in space technology is being increasingly challenged worldwide, we need to continue to help move our private sector forward."

It's interesting to see Krauthammer, a conservative, downplaying private industry capabilities while a former Democratic Congressman praises them. Be that as it may, I come down on the side of Bacchus and favor a more nuanced approach than a crash program to return to the moon.

Krauthammer writes, "Today the manned space program will die for want of $3 billion a year—1/300th of last year's stimulus package with its endless make-work projects that will leave not a trace on the national consciousness." But what "trace on the national consciousness" would a repeat of the successes of Mercury, Gemini, and Apollo leave? The manned space program of the '60s grew in an environment of military and ideological competitiveness that doesn't exist today, and there is little political will to expend vast sums of money on a repeat performance.

If, as Krauthammer says, human flight to Mars is out of reach for the foreseeable future, why not emphasize robotic exploration? The Mars Science Laboratory is one robotic exploration initiative, and this month's cover story looks at one company that is developing robotic arms for the mission. Expanded robotic exploration would seem a good alternative as human-space-flight technologies, capabilities, and goals evolve gradually in response to reasonably budgeted combinations of private and government initiatives. T&MW

REFERENCES

1. Krauthammer, Charles, "Closing the new frontier," *Washington Post*, February 12, 2010. www.washingtonpost.com.

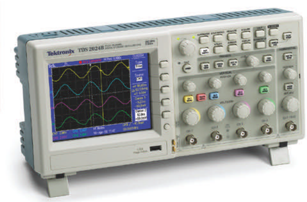
2. Bacchus, James, "Obama's Plan for NASA and Reaffirming Our Commitment to Space Exploration," *Huffington Post*, February 9, 2010. www.huffingtonpost.com.

> > > POST YOUR COMMENTS AT WWW.TMWORLD.COM/BLOG.

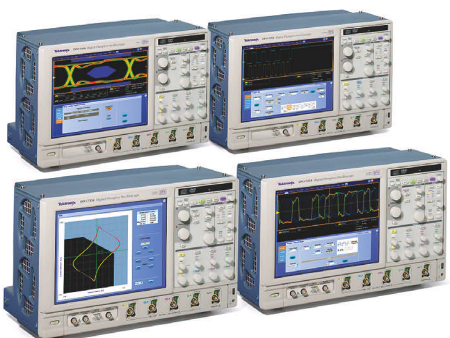
The world standard.

TDS3000C Series
100 to 500 MHz

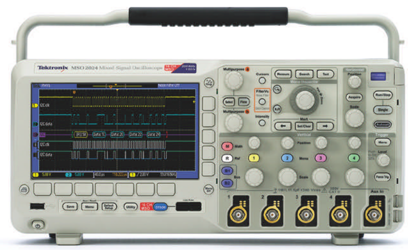
DPO70000B/DSA70000B Series
4 to 20 GHz



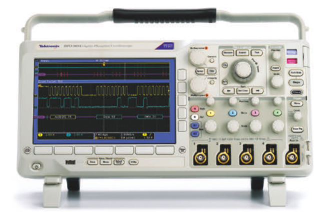
TDS1000B/TDS2000B Series
40 to 200 MHz



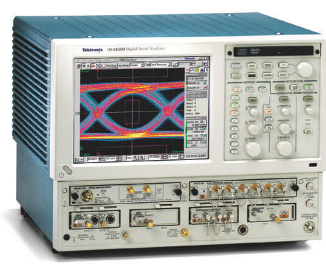
DPO7000 Series
500 MHz to 3.5 GHz



MSO2000/DPO2000 Series
100 to 200 MHz



DPO3000 Series
100 to 500 MHz

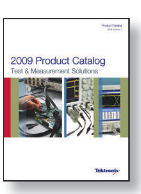


DSA8200 Series
DC to 70+ GHz

MSO4000/DPO4000 Series
350 MHz to 1 GHz

8 out of 10 engineers the world over rely on Tektronix oscilloscopes to help them meet their design goals. So can you.

The vast majority of engineers depend on the industry-leading performance, precision, flexibility, ease-of-use and reliability of Tektronix oscilloscopes, software applications and accessories. In short, they set the standard by which all others are judged. Our broad portfolio includes everything from complete debug and analysis to the most advanced acquisition engines, including the 20 GHz DPO72004B and DSA72004B, the world's fastest real-time scopes. In fact, Tektronix has remained an innovator in test and measurement for over 60 years. So rely on a Tektronix scope, and the experts standing behind it, to help you take on the world.



The best scopes on the planet.

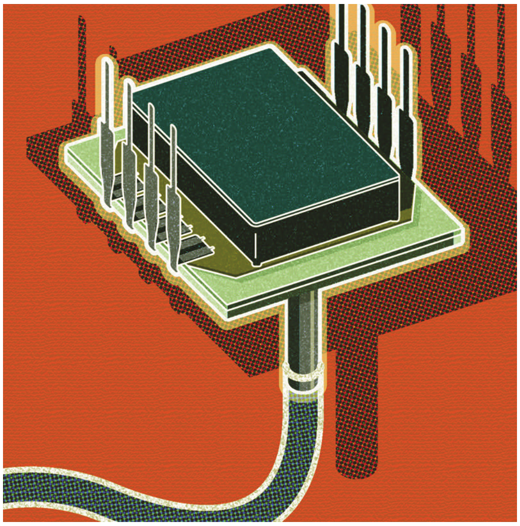
**Download the product catalog at:
www.tektronix.com/catalog**

Tektronix®

[An exclusive interview with a test engineer]

Keep the pressure on

Doug Kmiec is the director of test and package engineering at Silicon Microstructures, a manufacturer of MEMS pressure sensors. The sensors measure absolute, differential, and gauge pressure from 0.15 psi to 100 psi, producing analog and digital outputs that are proportional to pressure. Kmiec is currently developing automated test stations that will eliminate some manual test procedures, increase throughput, and provide easier upgrade paths than the current test stations. Senior technical editor Martin Rowe met with Kmiec at his office in Milpitas, CA.



DANIEL GUIDERA

Q: How do you test a pressure sensor?

A: A sensor's circuitry is essentially a piezo-resistor Wheatstone bridge built on a flexible membrane. We calibrate the devices by applying known pressures and temperatures to the part and trimming external resistors. Some of our parts use ASICs to get the desired output instead of trim resistors. We calibrate these parts to establish the sensor's coefficients. The ASIC stores and compensates the sensor's output.

Q: Do you test your parts outside published specifications to provide design margins?

A: We typically characterize parts to meet customer requirements, but we always look for ways to enhance production test. Our new test platform will let us test a device at pressures that exceed published specifications. We will test a 100-psi part at 225 psi to ensure the die and the package integrity.

Q: Why did you decide to develop a new test platform?

A: Cost, quality, and data reporting were the reasons. Stabilizing the pressure and temperature of the parts takes time. The new system will stabilize parts more quickly, and it will have shorter load and unload times. The new platform also will improve consistency of test data. It will consolidate and store data in a data warehouse. We will displace several hardware and software platforms giving Silicon Microstructures one system for hardware upgrades, maintenance, software language, and algorithms. We'll use the new system for production, R&D, engineering, and failure analysis. With a single test platform, performing tester measurement subsystem calibrations will require fewer spare subsystems when the subsystems go out for calibration validation.

Q: How will the new tester work?

A: The new tester tests up to 32 sensors at once. It has four VTI Instruments chassis, each containing a DMM (digital multimeter) that measures sensor output voltages. Multiplexers route the signals from the DUTs (devices under test) to the DMMs. Using multiplexers eases tester conversion. Power supplies excite the sensors with either constant voltage or constant current.

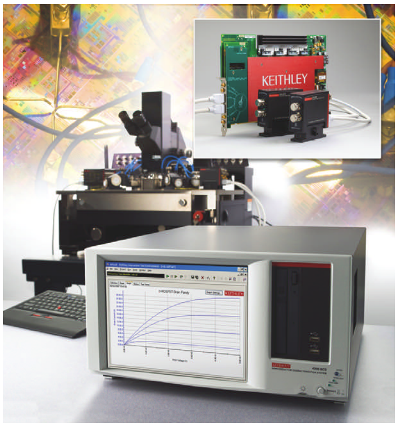
There are four gas flowmeters that measure gas flow during test. If flow is detected, it is due to an unseated or leaking part. Leaks cause a pressure gradient that diminishes the results of nearby parts. This flow measurement allows valves to be closed on bad sockets but continues the test on other parts. Ethernet provides communication to temperature, pressure, electronics, and transport equipment.

Q: Why did you choose Ethernet?

A: Ethernet is a standard that's available on all PCs. It's independent of vendor and hardware generation. Each PC has two Ethernet connections: one without a firewall for tester component communications and another with a firewall for external connections. With our short measurement time and long stabilization time, Ethernet overhead isn't an issue. Utilizing Ethernet may eliminate hardware dependences, latent software bugs, and obsolescence issues in the future. T&MW

Every other month, we publish an interview with an electronics engineer who has test, measurement, or inspection responsibilities. If you would like to participate in a future column, contact Martin Rowe at mrowe@tmworld.com. To read past "Test Voices" columns, go to www.tmworld.com/testvoices.

Keithley debuts ultra-fast current-voltage system



Keithley Instruments has introduced the Model 4225-PMU Ultra Fast I-V Module, an addition to its instrumentation options for the Model 4200-SCS semiconductor characterization system. The new module integrates ultra-fast voltage-waveform generation and current-and-voltage measurement capabilities into the Model 4200-SCS's test environment to deliver what Keithley says is the industry's broadest dynamic range of voltage, current, and rise, fall, and pulse times.

Lee Stauffer, marketing engineer at Keithley, said that to characterize and understand any device, material, or process fully, engineers need to make three types of measurements: precision DC I-V measurements (which Keithley's 4200-SMU accomplishes), AC impedance (which C-V instruments like the company's Model 4210-CVU can make), and ultra-fast I-V, or transient I-V, measurements. Stauffer said the Model 4225-PMU makes ultra-fast I-V sourcing and measurement as easy as making DC I-V measurements.

Keithley has also introduced the optional Model 4225-RPM remote amplifier/switch, which gives the 4225-PMU four additional low-current ranges, extending sensitivity down to tens of picoamps. The 4225-RPM can switch automatically among a 4225-PMU and C-V or DC source-measure instruments. Stauffer says the 4225-RPM can be located at Suss MicroTec and Cascade Microtech probers to make on-wafer measurements.

The Model 4225-PMU costs $19,000. A typical configuration of one Model 4225-PMU and two Model 4225-RPMs costs $25,000. The products will be available in May. www.keithley.com.

IEEE publishes 1149.7

In February, the IEEE published the IEEE 1149.7 test and debug standard, which complements the IEEE 1149.1 (JTAG) family of standards. Developed in an IEEE working group led by Texas Instruments, IEEE 1149.7 offers features and upgrades aimed at the test challenges posed by small consumer electronics. Such challenges include complex digital circuitry, multiple CPUs, and the size constraints imposed by small form factors. The six classes in the standard include IEEE 1149.1 extensions, ensuring compliance for chips with multiple TAPs.

According to the IEEE, the new and enhanced features include significantly decreased scan-chain lengths; well-defined power control functions, including four selectable power modes; support for two-pin operation, instruction, and custom pin usage; new test tools such as chip bypass and star topology testing; increased port efficiency; and background data transfers concurrent with advanced scan transactions.

"IEEE 1149.7 offers a flexible, dynamic solution for designers and engineers contending with shifting design paradigms without eroding the firm foundation established by earlier standards, such as IEEE 1149.1," said Stephen Lau, emulation technology product manager at Texas Instruments, in a prepared statement. "The combination of an extraordinary level of customizability with already-proven technologies maximizes IEEE 1149.7's effectiveness, ensuring its role as an essential, cost-effective test and debug tool." grouper.ieee.org/groups/1149/7.

Editors' CHOICE

Aeroflex debuts LTE simulator

To speed up real-world testing of mobile handsets for LTE networks ahead of network deployment later this year, Aeroflex has introduced a one-box test system, based on its 7100 Series radio test set, for cellphone signal-fading simulation. The company says its 7100 Series with a fading simulator software option provides fading simulation that meets or exceeds all 3GPP requirements and offers flexibility in the allocation cells and fading taps for LTE user equipment without the need for manual reconfiguration. The system's fully repeatable test scenarios include the emulation of dynamic environments and realistic and accurate testing of MIMO scenarios.

Targeting RF engineers, system integrators, and regression test engineers, the 7100 Series fading simulator supports all 3GPP fading profiles and also supports LTE bandwidths to 20 MHz with a frequency range up to 6 GHz.

Price: a typical system with two RF carriers and 2x2 MIMO—approximately $100,000; the fading simulator software option for units already in the field—$10,000. *Aeroflex, www.aeroflex.com.*

CALENDAR

IPC APEX, April 6–9, Las Vegas, NV. *IPC. www.goipcshows.org.*

SAE World Congress, April 13–15, Detroit, MI. *SAE International. www.sae.org.*

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

The Vision Show, May 25–27, Boston, MA. *Automated Imaging Association, www.machinevision-online.org.*

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

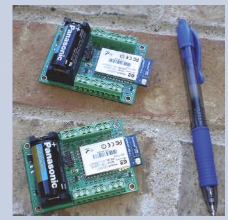
To learn about other conferences, courses, and calls for papers, visit www.tmworld.com/events.

Editors' CHOICE

Connect sensors to the Internet

The Tag4M "sensor tag" is an 802.11b/g device for connecting sensors to the Internet. The Tag4M lets you create a sensor network that you can control online through a WiFi interface, and it uses RFID to provide an IP address so you can collect data.

To control the Tag4M, you can write an application in LabView or C++ to send commands to collect data, or you can subscribe to a service such as pachube.com to store data. Each sensor tag's 802.11b/g interface has a range of 50 m indoors and 100 m outdoors through its ceramic antenna. The Tag4M consumes 4 µA in sleep mode, 50 mA when receiving commands, and 210 mA when transmitting data.



Powered by a 3-V battery or an external 3.3–V source, the sensor tag has a 14-bit ADC with five analog inputs and four programmable digital I/O lines. It also has an onboard thermistor for measuring temperature. The analog input range is 0–10 V on one channel with three channels having a range of 0–0.4 V. A fifth channel can measure 4–20 mA of current. The sensor has an onboard shunt resistor for current measurement. It scans the channels at 3.3 Hz, and it can store 10 ksamples of 14-bit data.

Price: $124. *Cores Electronic, www.tag4m.com.*

RICK NELSON
EDITOR IN CHIEF
rnelson@tmworld.com

HIL drives real-time test requirements

Design and test functions are inextricably linked in today's complex system-level electrical and mechanical designs, where simulations stand in for prototype hardware during many phases of the design process. Model-based design is an enabling technique for HIL (hardware-in-the-loop) testing, in which, for example, a physical ECU (electronic control unit) prototype interacts with a software simulation of the rest of the vehicle in which the ECU will ultimately be deployed. In a MotoTron ECU application (**figure**), National Instruments hardware and software products simulate and respond to sensor feedback and actuator commands to verify that the unit under test performs as it should in a closed-loop system. Model-based design and HIL testing have found success in medical-device, industrial-machine, power-generation, aerospace, and even white-goods applications as well as in automotive and other industries (Ref. 1).

NI VeriStand software combines with PXI hardware to support HIL simulations for a MotoTron electronic control unit application. Courtesy of National Instruments.

But as system designs involve increasing numbers of increasingly complex devices and subsystems, engineers can face challenges applying the HIL technique. Chris Washington, a senior product manager at NI, explained that new HIL interfacing is becoming difficult because, for example, units under test are increasingly incorporating the sensors that measure parameters—such as temperature, pressure, and acceleration—that a simulation would normally provide in the HIL process. Consequently, real temperatures, pressures, and accelerations must be provided—in real time—during the HIL process. Washington called the approach "real-time testing" and said it has been applied to wind-tunnel, environmental, and dynamometer testing applications.

Requirements for real-time test, Washington said, include configurable I/O, a run-time editable user interface, multichannel synchronization, and stimulus generation and datalogging capability. NI supports real-time test with its NI VeriStand software in conjunction with LabView and other software as well as PXI and other hardware. Multicore-ready VeriStand, introduced last August, implements the common functionalities of a real-time test system to help developers configure a real-time system. In addition to supporting NI hardware and software, VeriStand supports third-party data-acquisition and FPGA-based I/O interfaces and third-party modeling environments including The MathWorks' Simulink and ITI SimulationX.

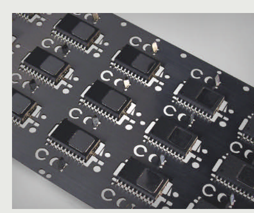
Washington said several customers have successfully applied the NI-based real-time test approach: Siemens, for example, applied it to HIL testing of wind-turbine control-system software, and MicroNova used it in the real-time thermodynamic simulation of combustion engines. T&MW

REFERENCE

1. Nelson, Rick, "Model-based design and early verification aid designers," *EDN*, December 15, 2009. p. 22. www.edn.com.

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

Multitest gets InCarrier order



Multitest reports it has received its first multisystem order for its InCarrier handler from a European IDM. The systems will be used for high-parallel test of small MEMS sensors. InCarrier combines the advantages of strip and standard handling processes, overcoming the constraints of the strip test with respect to singulation after test. InCarrier supports ASIC as well as MEMS test and also supports full device traceability. www.multitest.com.

LTX-Credence debuts VI instrument for ASL

LTX-Credence's new XVI multichannel VI instrument enhances multisite capability for the ASL1000 and ASL 3000 test systems, offering 14 channels per board. The XVI provides extended power ranges, enhanced source and measure accuracy, and per-pin digitizer capability. The company says these features will provide users with up to 40% faster test times compared with existing ASL VI instrumentation. www.ltxc.com.

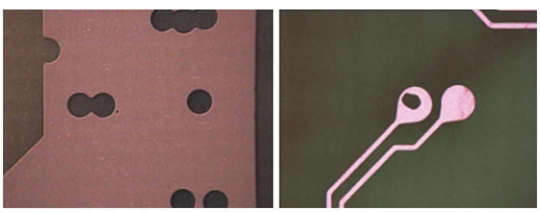
Global Unichip adds Verigy V101

Verigy has announced that GUC (Global Unichip) has chosen the Verigy V101 low-cost, zero-footprint, 100-MHz system for SOC device test. "As a leading design foundry, GUC designs complicated SOC devices with millions of gates and high-speed interfaces," said Jerry Tzou, GUC's VP of product operations. "We already use Verigy's V93000 platform for testing our customers' complex SOCs. As a long-standing Verigy customer, we are pleased to partner with the company to provide more value to our end customers with the V101." www.verigy.com.

ANN R. THRYFT
CONTRIBUTING TECHNICAL EDITOR
ann@tmworld.com

AOI business surviving during downturn

Last year's economic downturn had several effects on the makers of AOI (automated optical inspection) equipment. In February 2009, Agilent announced that it was leaving the AOI and AXI (automated x-ray inspection) markets. In its fourth quarter financial statement, Orbotech said it would sell its AOI business aimed at manufacturers of assembled PCBs (printed-circuit boards) in Europe and the Americas, while continuing to support and service its assembled PCB customers in Asia. Some AOI manufacturers speculated that such actions might herald a wave of industry contraction and consolidation (Ref. 1), although that has not occurred.



User-set parameters for detecting defects by size and location of nicks, protrusions, and pin holes are a critical feature in bare-board AOI machines such as TRI's TR9000. Pin-hole locations include the ground plane (left image) and pads (right image). Courtesy of TRI.

The downturn severely affected at least some sectors of machine vision, including AOI. But things are looking up again, said Jonathan Lin, VP of international business development for Taiwan-based TRI. "Our business was impacted during the first half of 2009," he said. "In the second half, we had a pickup in orders from customers in Asia, and business began expanding again overall in the third quarter, although on a very small scale." The AOI equipment industry lags a few months behind the semiconductor equipment industry, which began increasing capacity in September, he explained. In November, TRI saw significant AOI expenditures from the top five EMS (electronics manufacturing services) companies, and it expects the increase in orders to last into late March or early April of this year.

"We also refocused our strategy," said Lin. "Instead of going after global companies, we started pursuing small- and medium-sized customers, which are buying again, since they react much faster to changing conditions."

TRI also increased its R&D investment last year by about 20% over 2008, said Lin, and designs its systems, such as its latest bare-board AOI system, the TR9000, entirely in-house. One of the biggest demands the company encounters is for reduced cycle times. In particular, large laptop and cellphone OEM manufacturers in China are asking for reductions of 15 to 20%. Although a few high-end, top-tier OEM customers are requesting 3-D capability in AOI systems, there still isn't much demand from the majority. "We have 3-D technologies available and ready, but we're not launching any 3-D AOI systems this year," said Lin. "Only 10 to 15% of our AOI base wants 3-D, compared to a much larger percentage of SPI customers." One of the main reasons is the fact that a 3-D-equipped AOI system costs about three times that of a non-3-D AOI machine, he said.

During 2010, TRI expects manufacturers to start spending money again on AOI, but it probably won't be in huge quantities, said Lin. "People are now cautiously optimistic," he said, and he expects more EMS companies to use AOI in the next year or two, because "everyone is moving to more sophisticated inspection techniques to enhance image quality." T&MW

REFERENCE

1. Thryft, Ann R., "AOI and AXI business contracts, machines improve," *Machine-Vision & Inspection Test Report, Test & Measurement World,* June 2009. p. 50. www.tmworld.com/2009_06.

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

HD color camera boosts light sensitivity

Toshiba Teli America has launched the CSDS60CM3 high-definition color camera for industrial machine vision.

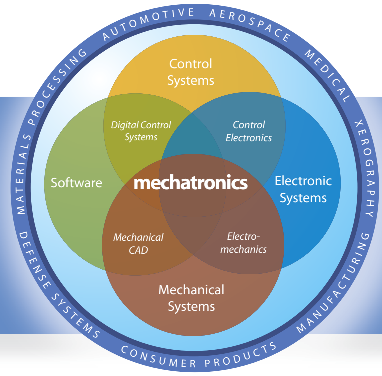
The one-piece camera incorporates a ⅓-in. CMOS progressive-scan color sensor with user-selectable resolutions of either 1280x1024 or 1280x720 at up to 60 fps. It employs backside illumination to increase light sensitivity and absorption. www.toshiba-teli.com.

Acoustic analysis detects more fake parts

Sonoscan's SonoLab division now uses 25 acoustically detectable features and characteristics to separate counterfeit from genuine plastic IC packages. As counterfeiters become better skilled, the use of more than a handful of analytical techniques increases confidence levels. In addition, acoustic techniques can detect features and material characteristics that are hard to imitate, the company claims. www.sonoscan.com.

Vision software simplifies programming

The Vision2009 integrated software suite from Vi Technology includes wizards that speed up programming and improve fine-tuning compared to Vision2008. The software, which runs on the company's AOI machines, includes Teach Assist for model creation, VisCAM for defining board layouts, Tune Assist for setting solder-joint parameters, and Library Live Update for updating libraries during production without affecting cycle time. www.vitechnology.com.



Looking beyond STEM

Engineers must lead in innovation, but STEM is only part of the solution.

Lately, I have seen more and more emphasis from K–12 educators and from private and public funding agencies on STEM (science, technology, engineering, and mathematics) activities. STEM initiatives seem to be the focal point now for addressing the innovation crisis in the US. While I agree this emphasis is essential, I believe the focus is too narrow and exclusionary.

We are in competition with the entire world, and the innovation crisis we find ourselves in has been fueled by a crisis in education, not only K–12 education, but university education as well. Most students focus on facts, tests, and grades, and they fail to understand concepts and processes. The inability of graduating students to integrate all they have learned in the solution of a real-world problem, at any level, is a failure. The main goal of education at all levels must be to create critical-thinking problem solvers and teach them that society's problems are complex and multidisciplinary.

Jon Jensen, associate dean at Marquette University and K–12 outreach director for the university, makes the point that we are a nation of assessors and somewhat obsessed with comparisons, particularly with other nations. Our youth seem to lag behind those in other countries, most notably in the STEM areas. He says we actually do better as a country than most think, and while we do have a great educational system, we still have a long way to go.

If I am a student with no interest or particular talent in the STEM area, I feel irrelevant to solving the innovation crisis. If I am a teacher in a non-STEM area, I also feel irrelevant. Students as early as the fourth grade are segregated into a college-bound STEM track and the "other" track, the irrelevant one. Parents feel frustrated that their children are not valued for their individual abilities and passions when they do not conform to the perceived valued path as indicated by the proliferation of STEM charter schools and programs.

The STEM disciplines will never solve the innovation crisis alone. As we engineers know, they are only a part of the solution. Innovation, the process of inventing something new, desirable, useful, and sustainable, happens at the intersection of technology (is it feasible?), business (is it viable and sustainable?), human factors (is it desirable?), and complexity (is it usable?). In addition, basic science, mathematics, and engineering skills have become commodities worldwide and are available elsewhere at a fraction of the cost here.

Yes, critical-thinking problem solvers from all disciplines working together are the key to innovation. Innovation is local—you don't import it and you don't export it. You create it. It is a culture. It is a way of thinking, communicating, and doing.

STEM students and teachers, together with students and teachers from the humanities, arts, social sciences, and business, must all realize they are equal partners in solving the innovation crisis. They each play a vital role and together must be able to identify the needs of people and society, critically think and solve problems, generate human-centered ideas and rapidly prototype concepts, integrate human values and business into concepts, manage complexity, work in multidisciplinary teams, and effectively communicate results.

The message to our students must be that they are each vital to solving the innovation crisis, and this message must be delivered early and often and in the context of real-world problems. They need to set high expectations for themselves, as we set high expectations for each of them. They need to discover their passion and their talents and take ownership for developing those talents, knowing that in doing so they will play a vital role in transforming the world we live in.

Engineers can make a vital contribution by setting a professional example and giving a real-world context to what young students study. Are you up to the challenge? We all know amazing things happen when together we attempt the seemingly impossible. T&MW

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.

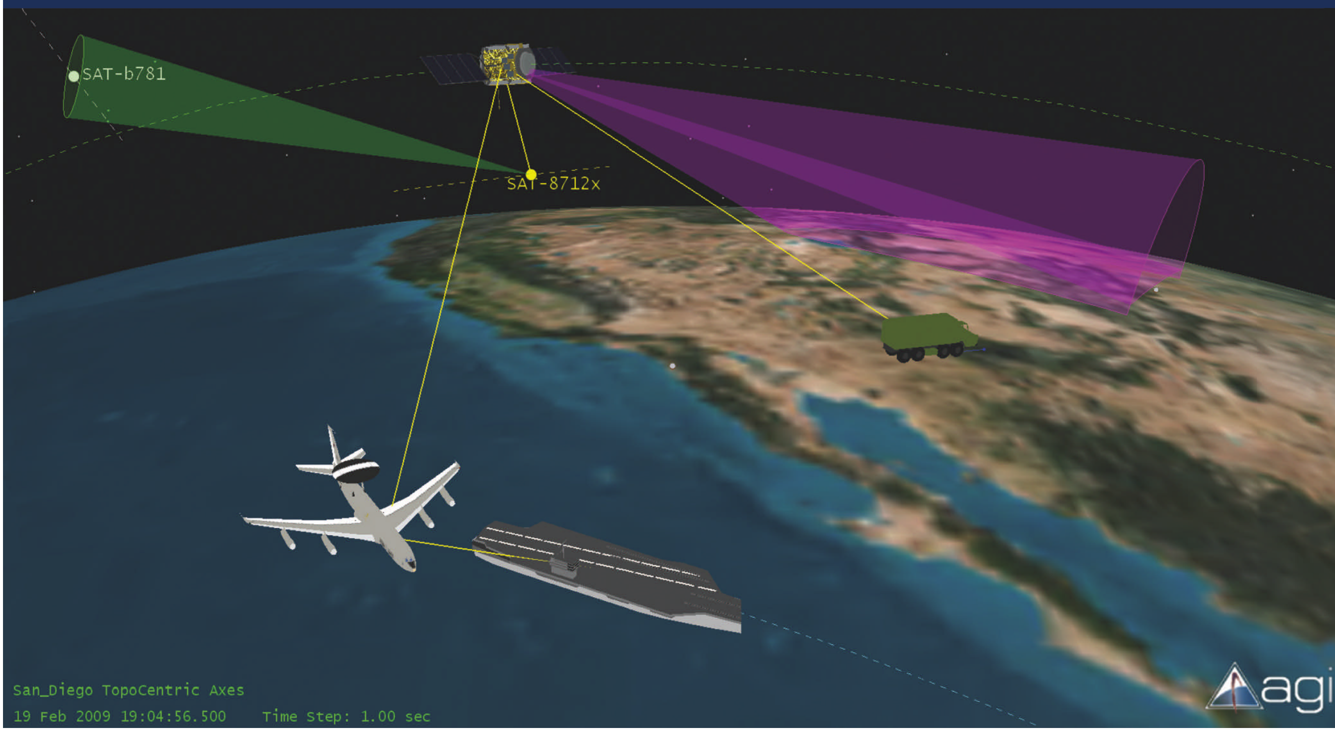
For more information about mechatronics issues, check out the Webcasts "Lessons Learned: The Power of Industry-University Collaboration" and "How Do You Design A Military Robot?" at The Mechatronics Zone. The Mechatronics Zone also includes the Mechatronics Blog, with recent postings entitled "Get A Red-Hot Thermoelectric Handbook" and "Smooth Your Entry into Motor Control." mechatronicszone.com.


Test & Measurement World
TMWorld.com
• Industry News
• Blogs
• Contests
• Video
• White Papers & Design Guides
• Webcasts
• e-Newsletters
Compelling, Current, Original Content.

RF Channel Simulation

When communications really count

DOPPLER • DELAY • PATH LOSS • NOISE • INTERFERENCE



The RT Logic T400CS Channel Simulator adds dynamic, phase-continuous, physics-compliant signal and carrier Doppler shift, delay, path loss, noise and interference to the signals you test with.

Develop and test realistically, thoroughly, quickly and easily, under the most punishing RF and complex motion conditions imaginable - *without ever leaving the lab*.

- Flight and ground system assurance
- Performance and functional verification
- Compliance and regression testing

Visit www.rtlogic.com/cs for demo movies, tech briefs and more.

The Integral Family of Solution Providers.

INTEGRAL SYSTEMS • RT LOGIC an Integral Systems Company • NEWPOINT TECHNOLOGIES, INC. • SAT CORPORATION An Integral Systems Company • LUMISTAR • INTEGRAL SYSTEMS EUROPE

The Integral Difference.

RT LOGIC
an Integral Systems Company

719-598-2801 • sales@rtlogic.com • www.rtlogic.com

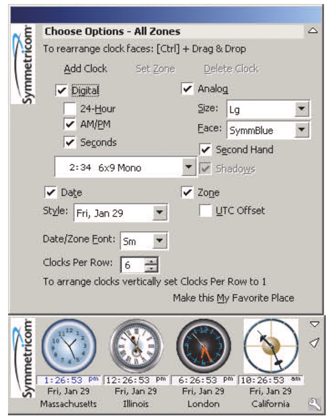
INSTRUMENTATION

Synchronize your PC's clock

PC clocks are notorious for not keeping good time. SymmTime, a free Windows application from Symmetricom, lets you synchronize your PC's clock to any of numerous time servers over the Internet. SymmTime 2010 (version 4.9) lets you display clocks from any time zone (or even make up your own).

When you open SymmTime, you see the clock display shown at the bottom of the figure. To get access to the control panel on the upper part of the screen, you must click on the "wrench" in the lower-right corner. The control panel lets you select the number of clocks to display, choose the design of the clock faces, and determine whether the clocks should be analog, digital, or both. But it does not give you a direct link to select a network time server or to synchronize. To do that, you must right click on the clock window, or you can right click or double click on the Symm-Time taskbar icon.

Once you open the sync menu, you can select a time server. The default server is located at Symmetricom's home in San Jose, CA, but I prefer to find the server that is located closest to me, because that should minimize Internet traffic delays. SymmTime also gives you access to a NIST time server. If you don't see your preferred server, you can easily find one through an Internet search.



SymmTime lets you synchronize your PC's internal clock to a time server over the Internet.

You can select when you want SymmTime to synchronize: at regular intervals, when you open SymmTime, or never. You can also synchronize manually.

You can download SymmTime at www.symmetricom.com/resources/downloads/symmtime. The program will install on your PC even if you don't have administrator privileges.

Martin Rowe, Senior Technical Editor

RF/WIRELESS TEST

Xilinx applies Agilent tools to LTE verification

Agilent Technologies has announced that Xilinx has employed Agilent EEsof SystemVue software plus Agilent test equipment, including the Agilent N5106A PXB baseband generator and channel emulator, to verify 3GPP LTE hardware blocks using precisely configured test vectors from a credible algorithmic reference.

Xilinx employed Agilent EEsof SystemVue software and the Agilent N5106A PXB baseband generator and channel emulator (pictured) to verify 3GPP LTE hardware blocks using precisely configured test vectors.

Courtesy of Agilent Technologies.

The Xilinx wireless engineering team needed to develop production-quality LTE uplink LogiCORE IP for Xilinx eNodeB customers. Xilinx had to verify all LTE algorithms and hardware IP cores against published standards, but the company's engineers found that existing test-vector creation methods either lacked the fine parameterization and flexibility needed to test individual LTE PHY algorithms and blocks, or they lagged behind updates to the standard.

Bill Wilkie, wireless and signal processing director (Europe) at Xilinx, commented on the solution: "We used Agilent's SystemVue LTE baseband verification library to validate Xilinx's LTE reference IP against the latest version of the LTE standard. When combined with Agilent's N5106A, SystemVue not only saved us weeks of validation time, but also it gave us confidence that our LTE Layer 1 reference design was 'production ready' for our customers. SystemVue clearly added value to our traditional Layer 1 design and verification process."

Xilinx used Agilent SystemVue and the W1910 LTE baseband verification library to create highly specific LTE test vectors, which were downloaded to the Agilent N5106A PXB baseband generator and channel emulator, which added fading and control to the real-time test environment. A hardware digital interface supported the Xilinx Virtex-6 FPGAs.

Key features of SystemVue that Xilinx employed in this project include direct links to the Agilent N5106A and 89601A vector signal analyzer software, the W1910 LTE PHY reference library that interoperates with the measurement equipment, and a simple polymorphic modeling interface.

Rick Nelson, Editor in Chief

FOR FURTHER READING

"LTE Layer 1 Verification using SystemVue," Agilent Technologies, 2010, cp.literature.agilent.com/litweb/pdf/5990-5314EN.pdf.

*A Marriage Made in Heaven**

We'll be glad to make you a proposal.

Provide your internal customers with standardized equipment nomenclature so they can better manage your organization's mission critical resources. Couple the power of **SMART|ENCATS'** structured catalog data with your equipment inventory data in your own Property Management, Equipment Management, Calibration Management or ERP system.

SMART|ENCATS™ breaches the information gap with a bonus of easy to search performance specifications tied to your equipment inventory–so that your engineers and equipment specialists can spend their time managing projects instead of ordering new equipment.

Let us help you make the perfect union today with our turnkey software and master catalog containing data on 300,000 test, instrument and IT equipment products. Transform your system into a true asset management system.

Call us at 1.800.755.3968. We'll help you plan a great honeymoon.

* If not in California

AssetSmart®
smart asset management software
by **PMSC**

2800 28th Street, Santa Monica, California 90405 USA 310.450.2566 **info@assetsmart.com** **www.assetsmart.com**

Test ideas

Measurement tips from readers

Linearize measurements from bridge circuits

Linearizing eases the conversion from temperature to voltage prior to digitizing.

By Camilo Quintáns-Graña and Jorge Marcos-Acevedo, University of Vigo, Spain

Bridge circuits have long been popular for conditioning signals from resistive sensors. These circuits are sensitive to small changes in resistance, and they provide a differential output from a single current or voltage source. But the sensors you connect to a passive bridge with one measuring branch don't produce linear outputs.

Temperature sensors such as RTDs produce small resistance changes as a function of temperature. You can linearize a bridge circuit's output by adding external linearizing circuits. But adding op amps to linearize the output means you'll need a bipolar power supply. The circuit in **Figure 1** represents an active bridge providing a linear voltage output using a unipolar power supply.

The circuit uses the popular Pt100 RTD, which has a resistance of 100 Ω at 0°C. Its temperature coefficient of 0.00385 Ω/Ω/°C produces a 38.5-Ω increase in resistance from 0°C to 100°C. Thus, the resistance is 138.5 Ω at 100°C.

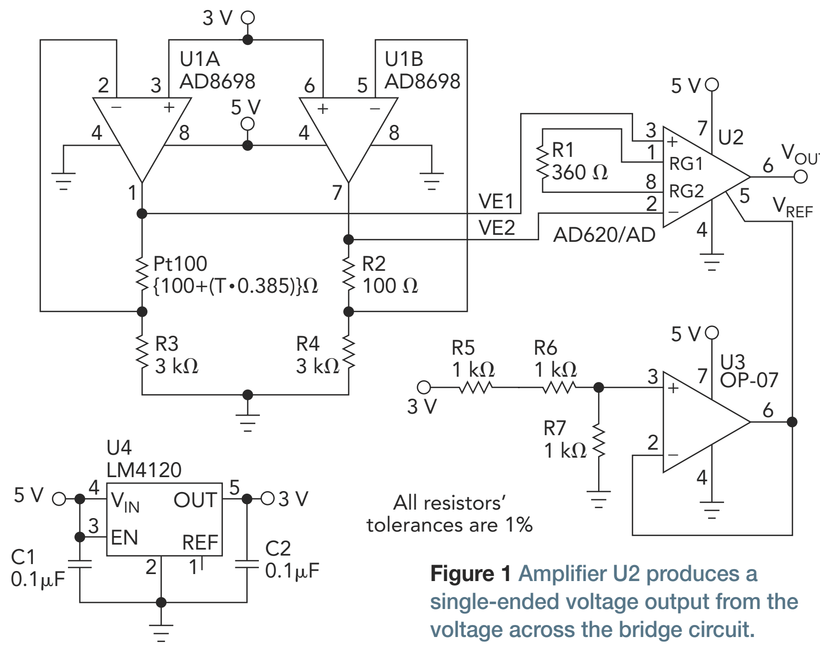


Figure 1 Amplifier U2 produces a single-ended voltage output from the voltage across the bridge circuit.

In Figure 1, resistors R3 and R4 convert the output from the 3-V power supply into two 1-mA constant currents, one in each branch of the bridge. At 0°C, the bridge is balanced and, thus, $V_1 - V_2 = 0$ V. The equation below describes the circuit's output:

$$V_{OUT} = 0.385 \cdot \left(1 + \frac{49400}{R1}\right) \cdot 10^{-3} \cdot T + V_{REF} = 0.053215 \cdot T + 1$$

Figure 2 shows a simulation of the circuit's output from 0°C to 50°C. If you use a passive bridge that produces a nonlinear resistance, then you still need linearizing circuits prior to digitizing the circuit's analog output or you need to linearize the output in software after digitizing.

Resistive sensors require excitation current, which this circuit provides. A Pt100 RTD requires 1 mA of excitation current to get its specified performance. As the bridge voltage is 3 V, you get 1 mA through the RTD, for which the circuit consumes 0.1 mW in the sensor. That low power dissipation minimizes self-heating, which can affect measurement accuracy. T&MW

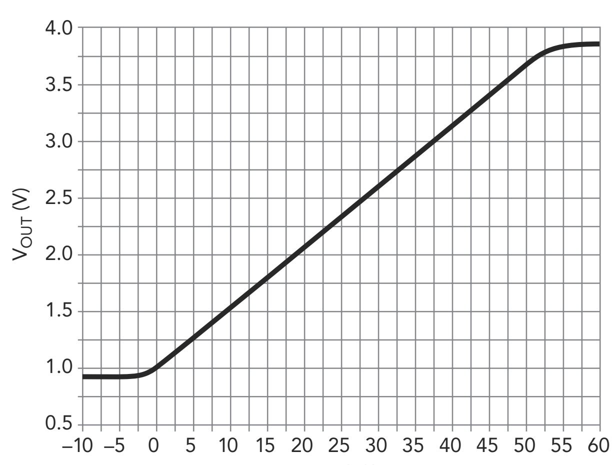
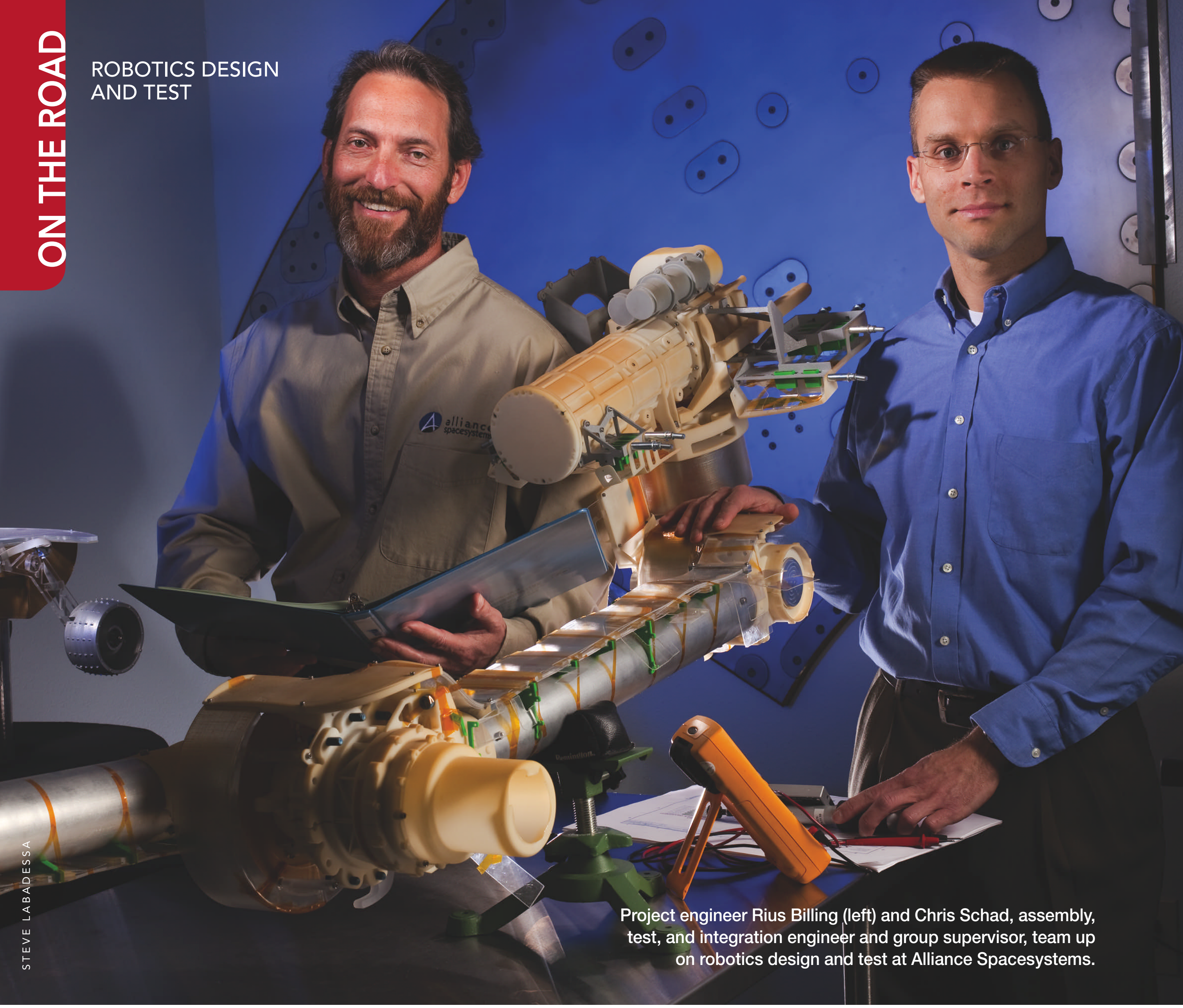


Figure 2 A simulation shows that the circuit provides a linear response for 0°C to 50°C.



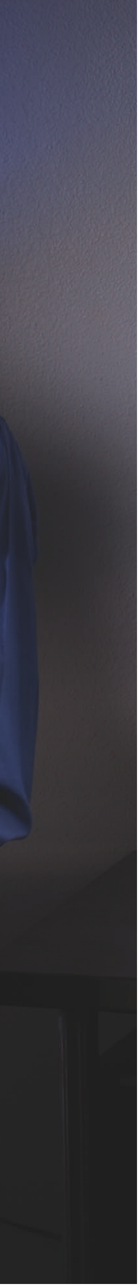
STEVE LABADESSA

Project engineer Rius Billing (left) and Chris Schad, assembly, test, and integration engineer and group supervisor, team up on robotics design and test at Alliance Spacesystems.

REACHING OUT

FROM UNDERGROUND TO OTHER WORLDS, ENGINEERS AT ALLIANCE SPACESYSTEMS GET A GRIP ON ESOTERIC APPLICATIONS FOR THEIR ROBOTIC ARMS.

BY RICK NELSON, EDITOR IN CHIEF



PASADENA, CA—Robotics applications at Alliance Spacesystems tie together mechanical and electrical engineering disciplines in ways that can create significant challenges for system design and test. The engineering team has met those challenges for applications including underground gas-pipe exploration and camera-boom mechanisms that mount on a car roof to facilitate the filming of Hollywood chase scenes. But as the company's name suggests, its primary focus is on aerospace applications, including robotic arms for Mars explorers.

"We're considered mostly an aerospace company, but I like the fact that we work with terrestrial robotics and other areas, too," said Sean Dougherty, mechatronics technical advisor at Alliance Spacesystems. "It's a neat mix. For aerospace, reliability is everything, and it's nice that we can apply that to the terrestrial world, too." Shorter-term terrestrial projects, he said, allow the team to remain productive and to hone their expertise during gaps in the longer-term aerospace projects.

Dougherty outlined some of the projects in which Alliance Spacesystems has been involved:

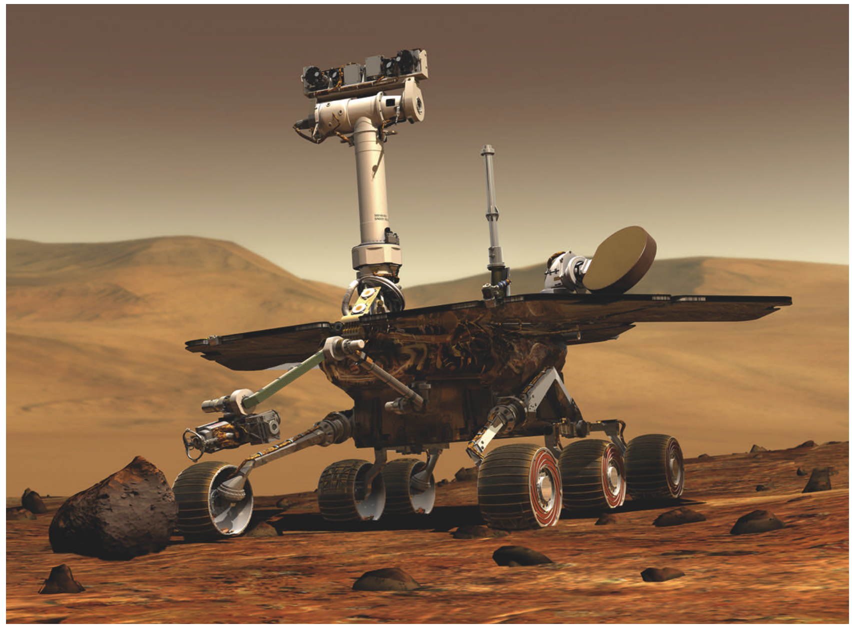
- End effectors—tools at the end of robotic appendages that perform specific tasks such as drilling, trenching, or grasping. Alliance's LSAS (Low-force Sample Acquisition System) can drill into rocks and frozen soils on Mars' surface using a percussive hammer action. LSAS has been successfully tested in a thermal-vacuum chamber that mimics Mars' pressure and temperatures, and in the Mars Yard at NASA's JPL (Jet Propulsion Laboratory) while mounted to the robotic arm of the Rocky 8 rover. In addition, the MIDAS (Mars Integrated Drilling And Sampling) System meets NASA's need for drilling, coring, and abrading tools using low-mass, mobile, robotic platforms.
- Gas-pipe explorers—a series of self-propelled prototype robots that inspect 4- and 6-in. underground gas pipes by moving inchworm-like through them. The first cylindrical model propelled itself using a lead screw and the sequential inflation and deflation of airbags that gripped the pipe wall. The latest design contains deployable wheels and can access pipelines via a hole as small as 1 in. in diameter.
- A robotic arm for the Mars Surveyor 2001 spacecraft. Under contract to JPL, Alliance Spacesystems modified the design of the robotic arm from the Mars Polar Lander to adapt it to the Surveyor spacecraft and its lander mission. Following redesign, Alliance Spacesystems fabricated, assembled, and tested the robotic arm prior to its on-time delivery to NASA.
- Robotic arms for Spirit and Opportunity, NASA's Mars exploration rovers. Called the Instrument Deployment Device, or IDD, each robotic arm brings a rover's scientific instruments into contact with Mars' rocks and soils. Each arm is equipped with numerous Alliance-developed mechanisms, including actuators that position scientific instruments, contact sensors that detect proximity to targets of interest, and an interconnect system that traverses the rotating joints to conduct power and signals to the electromechanical devices and instruments.
- A robotic arm for NASA's Phoenix Mars Lander, which landed on Mars on May 25, 2008, and operated successfully about two months longer than its planned three-month mission near the Martian north polar region. As this article goes to print, the NASA Mars Odyssey orbiter is listening for the Phoenix Mars Lander in the unlikely event that Phoenix survived Martian arctic winter conditions.
- A robotic prototype for the Hubble Space Telescope mission to repair the STIS (Space Telescope Imaging Spectrograph), an instrument on the Hubble that suffered electronic board failures. Never intended to be serviced in orbit, the STIS interior is accessible only after removing a cover attached by more than 100

Sean Dougherty employs National Instruments hardware and software when developing prototypes of robotic arms. Courtesy of National Instruments.

screws of three different head types, some of which are covered by a nameplate. Alliance developed a fully functional conceptual prototype in only three months to prove the feasibility of a robotically assisted repair.

- Robotics for DARPA's FREND (Front-end Robotics Enabling Near-term Demonstration) program (originally called Spacecraft for the Universal Modification of Orbits, or SUMO). The NRL (Naval Research Laboratory) contracted with Alliance Spacesystems to design and build the robotics that would allow a servicing spacecraft to dock with satellites not originally designed for servicing. The 2-m-long FREND arm offers the potential for spacecraft salvage, repair, rescue, repositioning, de-orbit and retirement, and debris removal.

In process now, said Dougherty, are robotic arms for the MSL (Mars Science Laboratory) rover, which must be able to lift almost 75 lb of instruments to reach out and test Martian rocks and soil. The arm also must provide support for a sampling drill, which must be held steady during operation. Engineers at Alliance Spacesystems working in conjunction with engineers at JPL are building two identical arms, one of



The Instrument Deployment Device, or IDD, is an Alliance Spacesystems robotic arm that brings the scientific instruments on NASA's Mars rovers into contact with rocks and soils on the planet. Courtesy of Alliance Spacesystems.

STEVE LABADESSA

Richard Fleischner, group supervisor for mechanical engineering at Alliance Spacesystems, said he focuses on the nuts and bolts of mechanisms and structures, adding, "When it comes to pumping electrons, that's where I stop."

which, already completed, will remain on Earth to help in planning mission requirements. The other will go to Mars on the rover.

Putting all these projects together requires a multidisciplinary approach. Referring to an article in *EDN* (Ref. 1), Dougherty said, "Your article described us as domain experts, and that's a good description. We do have some very detail-oriented mechanical designers and electrical designers, but for the most part, we try to focus on the end-to-end solution." To be able to focus on the end solution, he said, the engineers use high-level software and rapid prototyping hardware to quickly evaluate designs.

Dougherty himself has degrees in mechanical engineering and aerospace engineering. "As an undergrad, I wasn't very interested in electrical engineering," he said, "but when I went back to grad school at Stanford, I took a mechatronics class, and that piqued my interest. I was already interested in robotics, and the instructor was really good at explaining electronics and its role in controlling physical motion. I was in the aerospace department there, and aerospace engineering tends to be more of a system-engineering discipline, where you combine electrical and controls knowledge along with an understanding of structures and mechanisms." He said tools like LabView, which he first used in college for test and data-acquisition applications, enable him to handle electronics design tasks involving sensors, actuators, and motors without having to do detailed printed-circuit-board-level development work.

After getting his undergraduate degree, Dougherty worked at Johnson Space Center in Houston on the International Space Station program, training astronauts on robotics. After grad school, he came in contact with Alliance Spacesystems at a conference and joined the then-two-year-old company in 2000.

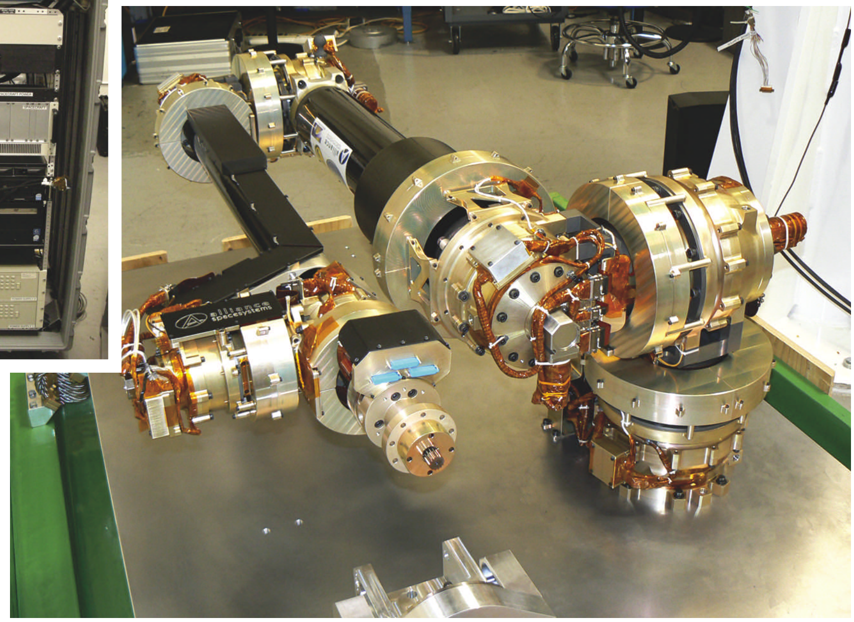
Four engineering groups

Alliance has four main engineering groups, explained Dougherty. The mechanical design group's members perform CAD (computer-aided design) but also do their own calculations and finite-element analysis. That group includes Richard Fleischner, group supervisor for mechanical engineering, who said he focuses on the nuts and bolts of mechanisms and structures, adding, "When it comes to pumping electrons, that's where I stop." Illustrating the multidisciplinary nature of the team, Rius Billing, project engineer for the MSL robotic arm, was educated in electrical engineering and worked as an electrical engineer at JPL, but now focuses on mechanical design at Alliance.

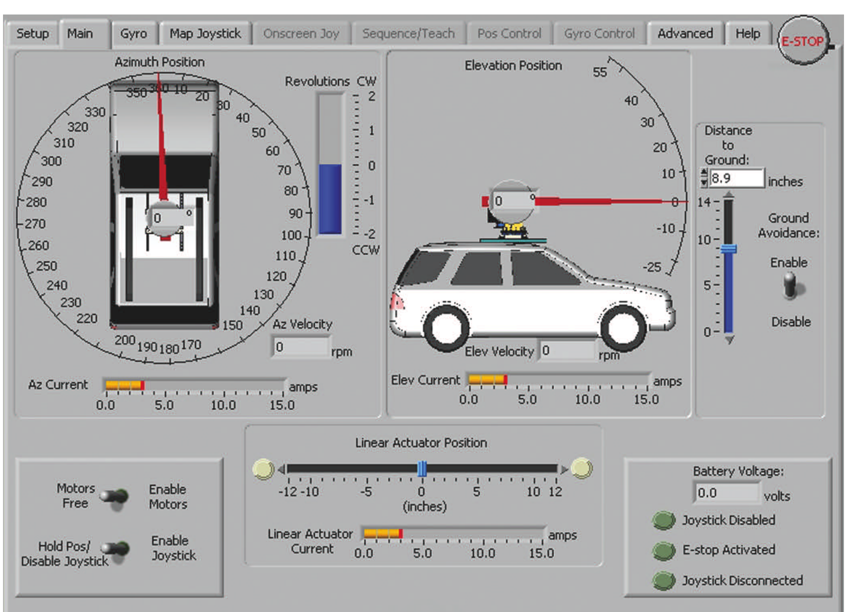
A second group, called the analysts, solves the most complex analysis problems, according to Dougherty. "Both groups are multidisciplinary in that they have to understand a lot of different software," he said. "Almost everyone at the company knows SolidWorks [CAD software], a lot know Nastran [finite element analysis software from NEi Software], and all have to understand motors and electronics."

His own group is the mechatronics group, which is probably the most multidisciplinary. "We have to know SolidWorks and do some mechanical design, but we focus mostly on how we control the mechanisms. We do software and controls work, and also need to understand stiffness and the torques and forces and dynamics."

The final group is the assembly, integration, and test group. Members of that group are also multidisciplinary, Dougherty said. "They have to understand how the whole project works and how it goes together. They also do a lot of LabView work, because a lot of our test equipment uses LabView to do data acquisition and to control various mechanisms used in the life testing. Our two groups intermingle, and often you can't really distinguish between the two. It just depends on the phase of the program." He added, "Because we are a small company, we encourage everyone to have skills in every area. Our work is just so diverse that you don't know exactly what you might be working on, so if you have multiple skills it really helps out the company, and it makes the job really interesting."



Alliance Spacesystems built a prototype robotic arm for the Naval Research Laboratory in support of DARPA's FREND (Front-end Robotics Enabling Near-term Demonstration) program. Alliance Spacesystems is providing the robotics and associated control electronics (inset) to enable FREND to autonomously grapple satellites, including those that are not outfitted with custom interfaces. Courtesy of Alliance Spacesystems.



Shown modeled in LabView, a joystick-controlled camera boom assists with filming car chases and other movie scenes. Courtesy of Alliance Spacesystems.

Chris Schad, assembly, test, and integration engineer and group supervisor, stressed that the multidisciplinary nature of the job extends beyond engineering disciplines. "There are days when I do my own shipping and receiving and act as my own purchasing agent and facilities manager," he said. The day we spoke, he said, was more rewarding. "This morning I worked a little bit of the MSL arm, handling some high-level wiring. Then, I got into some detail work on a precision hinge we are working on. We need to find a solenoid that will work in a thermal vac chamber, so later I'll be calling some solenoid vendors and doing some static analysis to figure out how much force and how much stroke I need."

Testing the MSL arm

Schad outlined some of the test challenges his group faces. "For the MSL flight arm," he said, "we have to plan thermal-vac testing as well as some pretty intensive vibe testing. The vibration testing will pose particular challenges, because of stringent requirements on contamination control and planetary protection" to avoid introducing Earthly microbes into the Martian environment. He explained, "We are going to shake [the robotic arm] in a bag, and we have to figure out how to do that. There is the potential that we are going to have to partially take the arm out of its launch locks to perform one of the vibration tests to simulate the rover traversing Mars. So, that's going to present some pretty significant challenges associated with keeping it clean, getting it out of its locks, and getting it back into the locks for the ride home."

But despite the testing challenges, Schad said, "The greatest challenge we face on an almost daily basis is balancing work. We have a couple of jobs right now, MSL being one, that are all going to hit at the same time. I really have to stay plugged in and do the best I can anticipating problems and delegating and fighting the fires as they come up." He added, "Because we are a small group, we have very much a matrix-management style. Now I'm working with some analysts doing structural proof testing. Normally, they wouldn't come in until the end of the project, but I've got them involved in preplanning and ordering nuts and bolts for the test." His goal, he said, "is to make sure that I've anticipated things far out enough so I can have the right people available for each program," managing technician loading and having sufficient engineers available for testing.

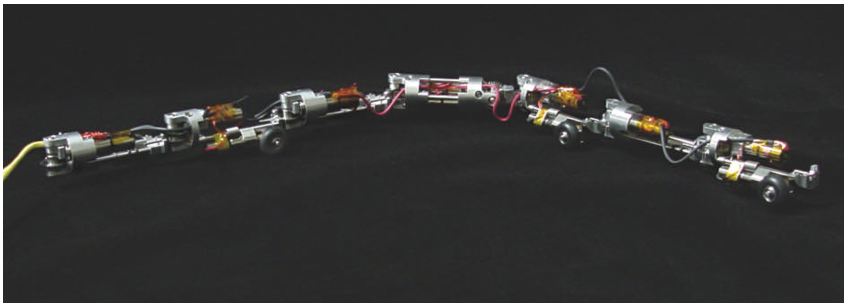
The Mars Science Laboratory flight arm will require thermal-vac testing as well as some pretty intensive vibe testing while meeting stringent requirements on contamination control and planetary protection.

Hardware and software for prototyping

Alliance Spacesystems has been working with National Instruments tools since the days of SCSI hardware and is now using NI PXI and USB data-acquisition tools, among others. Dougherty also cited NI CompactRIO, saying that platform was valuable in building a robotics test bed for Spirit and Opportunity. "Obviously, the arms on Mars don't use CompactRIO, but it is a great platform for building a customizable test bed" that let the team quickly evaluate and optimize control algorithms. What flies, he said, is specialized hardware with code written in C.

He said that as tools like LabView increasingly work with aerospace mainstays such as Wind River's VxWorks (Ref. 2), the high-level tools may be used more. He noted that reliable software is critical during test. "We don't want to damage the hardware. We don't have that many copies, and it's not like we can go buy one if we break it. For Mars, every two years you have a launch window, and if you miss it, you are waiting another two years. Damage could have a huge impact, but we have few concerns about interfacing our hardware with LabView."

Dougherty said rapid prototyping capability was particularly important in designing a camera boom for use in the movie industry. Unlike in the aerospace industry, movie makers don't tend to spend a lot of time developing detailed requirements documents. One group of filmmakers, for example, just knew they wanted a camera boom that could be mounted on the roof of a Porsche Cayenne SUV, for example, and that could be controlled by a camera operator inside the vehicle while the vehicle traveled at speeds up to 100 mph. Using LabView to complete several iterative designs of a camera crane, the Alliance Spacesystems team was able to determine that a velocity-con-



The GPEX gas-pipe explorers are a series of self-propelled prototype robots. Where the first GPEX model moved like an inchworm to inspect 4- and 6-in. underground natural gas pipes, the latest design contains deployable wheels and can access pipelines via a hole as small as 1 in. in diameter. Courtesy of Alliance Spacesystems.

trolled-joystick approach, rather than a position-controlled approach, provided optimum performance, and it enabled the team to smoothly implement range sensors and gyro control to avoid contact of the camera with the vehicle or ground even when the camera operator had an obstructed view. The gyro and sensors also kept the boom level when the vehicle climbed or descended a hill.

Dougherty said Alliance uses LabView mostly for test, but added that it's also involved in the design process—for projects like the camera boom as well as for aerospace projects. "With our prototype flight arm," he explained, "LabView allows us to rapidly try new things. One experiment we want to do is called compliance control, where we have a force-torque sensor on the end of the arm, and we try to minimize the forces imparted to a spacecraft. With such experiments, there are a lot of different approaches we want to try, and a lot of iterations. We use LabView because we can change the code really easily, and it has interfaces to all the drivers and hardware we use, so we don't have to worry too much about the low-level programming and can directly address the engineering problem right away."

Dougherty cited other tools Alliance engineers use, including Quanser software for controls work, noting that Quanser has LabView plug-ins, as do the MathWorks' Matlab and Simulink, other tools the Alliance engineers use. If there is one thing Dougherty would like to see vendors provide, it is an end-to-end solution that would support models from all the software the company uses. He noted that LabView will work with SolidWorks, for example, but the simulations don't run in real time. He added that Energid has really efficient solvers for robotics, but that there is still some interfacing work to do. What happens, he said, is that often the engineers will build one model in SolidWorks, then another in Nastran to do dynamics analysis, and then yet another in Simulink to do controls work. "Getting to where you can use the same model in all those different tools would be nice. It feels like we are close, but it's not seamless yet." T&MW

REFERENCES

1. Nelson, Rick, "High-level software for embedded-system design: doing your job?" *EDN,* July 9, 2009. p. 20. www.edn.com/article/CA6668610.html.

2. "NI LabView Real-Time teams with Wind River VxWorks RTOS," April 16, 2007, *Test & Measurement World,* www.tmworld.com/article/320431-NI_LabView_Real_Time_teams_with_Wind_River_VxWorks_RTOS.php.

FOR FURTHER READING

"NASA To Check For Unlikely Winter Survival Of Mars Lander," January 21, 2010. phoenix.lpl.arizona.edu/news.php.

"The Rover Gets Strong-Armed," Jet Propulsion Laboratory, June 12, 2009. marsprogram.jpl.nasa.gov/msl/news/whatsnew/index.cfm?FuseAction=ShowNews&NewsID=113.

COMPLEX *modulation comes to* OPTICAL FIBER

MARTIN ROWE, SENIOR TECHNICAL EDITOR

FIBER IS RUNNING OUT OF BANDWIDTH JUST AS DIAL-UP LINES DID YEARS AGO. COMPLEX MODULATION SOLVES THE PROBLEM, AGAIN.

The demand for greater data throughput seems endless, and it is accelerating faster than many people expected, creating bottlenecks in fiber-optics networks. Digital transmissions of 100 Gbps, which are just now being introduced, are expected to alleviate some of these bottlenecks.

A year ago, most of the work surrounding 100-Gbps links started with ten 10-Gbps lanes over short distances. Since then, the first long-haul 100-Gbps link using four 25-Gbps lanes has been deployed (Ref. 1). With it comes complex modulation never before used in optical communications.

The new modulation schemes are necessary to handle long-distance transmissions. Short-haul communications, the so-called "client side" (**Figure 1**) used within campuses and local metropolitan areas, don't need complex modulation because their distances are short enough to accommodate the higher speeds. On the client side (distances up to 40 km), 100-Gbps links may use four 25-Gbps lanes. (IEEE 802.3ba defines these data links; see Ref. 2.) Because short-haul 100-Gbps links will use four wavelengths on a single fiber or even ten 10-Gbps fibers over the shortest distances, more fiber may be needed to increase over the current 10-Gbps speed. Installing additional fiber over the short distances between buildings on a campus isn't very expensive.

Not so for long-haul transmissions—the "line side" of networks where service providers need transmissions of hundreds of kilometers. Adding fiber to compensate for additional lanes is just too expensive. "Carriers need to squeeze 100-Gbps throughput rates into their existing fiber plants, many of which were designed for 10 Gbps and some were designed for 2.5-Gbps fiber links," said Pavel Zivny, product engineer at Tektronix.

Simply squeezing a 100-Gbps NRZ stream into existing fiber is impractical. Existing DWDM (dense-wavelength division multiplexing) fibers use 50-GHz spacing between channels. While that channel spacing is sufficient for 10-Gbps data streams sent using NRZ modulation, it is too narrow for 100-Gbps NRZ streams. "You can't put 100-Gbps streams right on the carrier," said Mike Schnecker, business development manager at LeCroy. That's because for a 100-Gbps NRZ signal, each bit is just 10 ps wide.

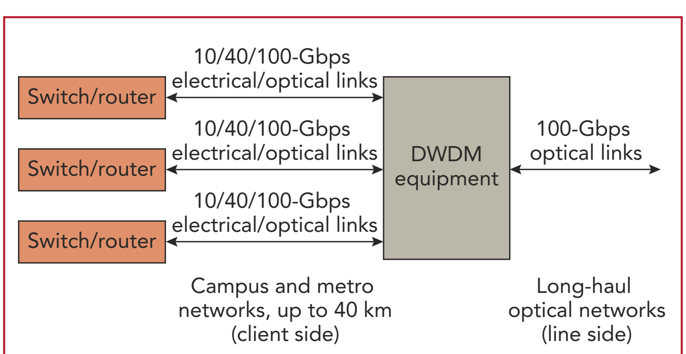


FIGURE 1. Carriers use the line side of a data link for long-haul transmissions between cities. Client-side transmissions link campuses and local metropolitan areas.

Hiroshi Goto, optical product specialist at Anritsu, explained the problem. "Because of crosstalk between adjacent channels, 100-Gbps data streams can't be used in DWDM systems. PMD [polarization-mode dispersion] and CD [chromatic dispersion] prevent that. There's too much distortion. The pulses distort and overlap."

To work around the problem, the OIF (Optical Internetworking Forum) has recommended using complex modulation to squeeze more bits/s/Hz from existing fiber. The OIF-proposed modulation uses QPSK (quadrature phase-shift keying) and two polarizations to achieve 100-Gbps throughput on a single wavelength. QPSK is common in digital RF communications, but it's new to fiber-optics communications.

A 100-Gbps link will consist of two 50-Gbps streams in two polarizations—TE (transverse electric) and TM (transverse magnetic)—that propagate in two orthogonal polarization planes. Each 50-Gbps stream will consist of 25 Gsymbols/s. QPSK modulation packs two bits into one symbol.

Because the QPSK signal travels in two polarizations, it is called either DP-QPSK (dual-polarization QPSK) or PM-QPSK (polarization-mode QPSK)—the terms are interchangeable and both are commonly used. In this article, I'll use DP-QPSK when referring to the two polarizations and QPSK when referring to one polarization.

Complex modulation

Figure 2 illustrates the modulation process. A single 100-Gbps bit stream splits into TE and TM polarizations. That produces two carriers at the same frequency. Each carrier is then I/Q modulated, resulting in two 25-Gsymbol streams. The total: 100 Gbps, but the actual data rate is somewhat higher (see "What's in a 'G'?" p. 30).

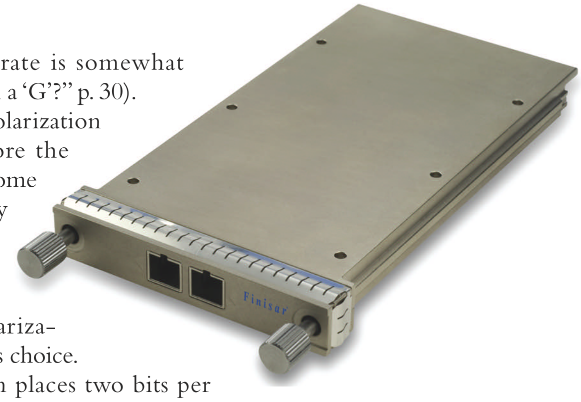


FIGURE 3. Optical transceivers for client-side transmission are based on the CFP Multi-Source Agreement for size and electrical connections to a line card (Ref. 4).
Courtesy of Finisar.

In Figure 2, the polarization splitter appears before the QPSK modulators. Some transceiver designs may place the I/Q modulators first, then split the modulated signals into two polarizations. It's the designer's choice.

QPSK modulation places two bits per symbol by phase-shifting a carrier of light in response to incoming bit pairs (00, 01, 10, 11). Each symbol represents two bits. A receiver will demodulate each symbol into its two bits and produce a 50-Gbps digital data stream. In addition, bits are precoded before modulation and decoded after modulation. (A technical note from Anritsu explains the coding details; see Ref. 3.) A receiver will then produce four 25-Gbps electrical signals after it demodulates and decodes the incoming DP-QPSK signal.

QPSK signals carry twice the number of bits per symbol that NRZ signals carry. Thus, the two modulations produce signals that degrade differently as they pass through fiber. Peter Andrekson, director of EXFO Sweden, explained that QPSK signals are more susceptible to noise and nonlinear phase distortion than NRZ signals. "Because of the higher noise susceptibility, QPSK-modulated signals will require higher power than NRZ signals."

QPSK signals have an important advantage over NRZ signals, though. They're less susceptible to bit errors from chromatic dispersion and group delay at the same bit rate. That's because one UI (unit inter-

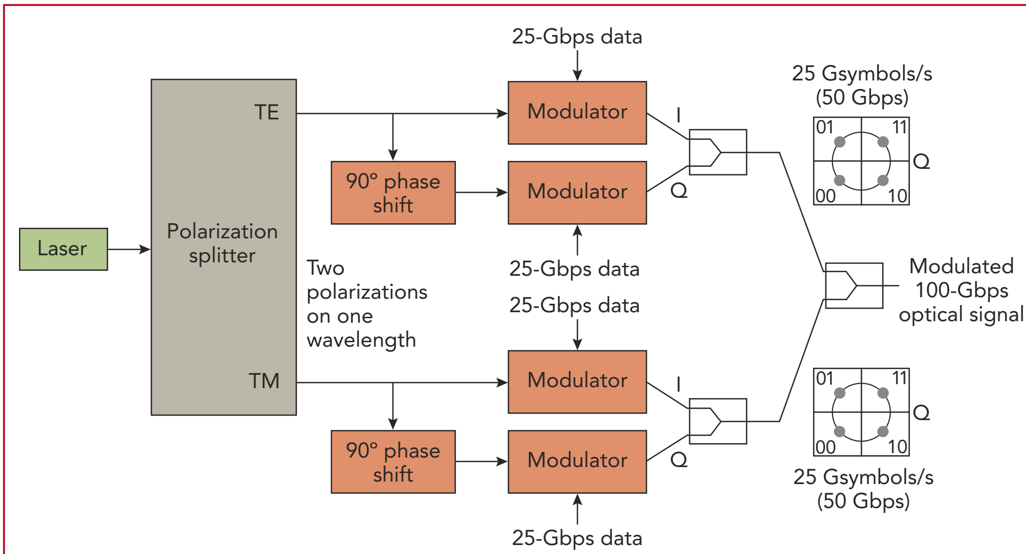


FIGURE 2. A 100-Gbps transmitter splits a laser into two polarizations and then modulates four 25-Gbps data streams onto a single fiber at a single wavelength.

val) of a 100-Gbps data stream is 10 ps wide. Because line-side transmissions use four 25-Gbps lanes, each symbol is 40 ps wide, which results in a lower bandwidth.

Compared to a 10-Gbps NRZ signal (100 ps wide), the 40-ps-wide symbol of a 25-Gsymbols/s stream is shorter and requires more bandwidth. Thus, the 25-Gsymbols/s signal is more susceptible to errors from dispersion than a 10-Gbps NRZ signal, but it's less susceptible to degradation than a 100-Gbps NRZ signal. Andrekson explained, "There is a tradeoff between complexity and SNR [signal-to-noise ratio] versus dispersion tolerance and hardware bandwidth at a given bit rate."

The DP-QPSK technology is so new that no transceiver modules exist for the line side. Chris Cole, senior member of the technical staff at Finisar, explained that line-side transceiver modules will be larger than client-side modules (**Figure 3**), which are currently defined in a multisource agreement (Ref. 4). Cole noted that line-side transceivers may even be implemented as line cards rather than as modules.

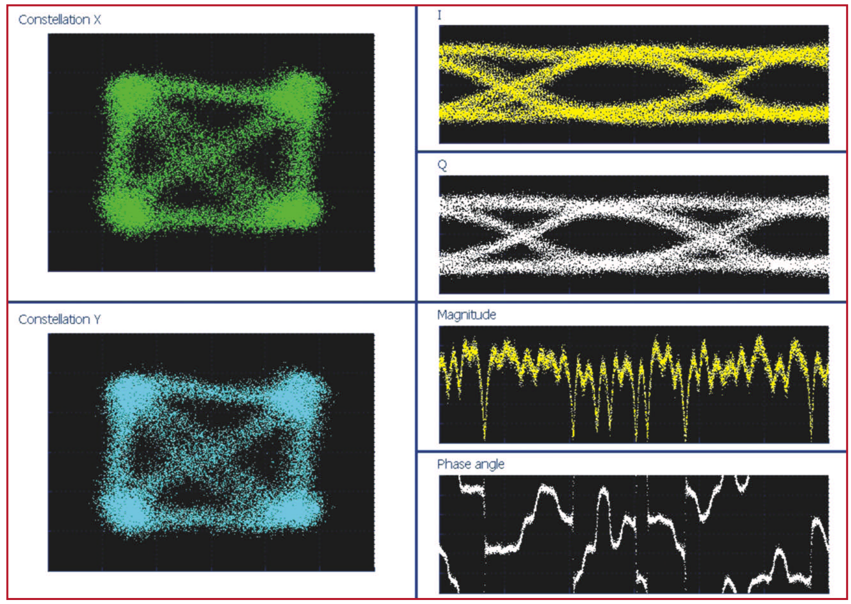


FIGURE 4. Constellation diagrams will become a mainstream tool for analyzing DP-QPSK modulated signals. Courtesy of EXFO.

Test will change, too

The shift from NRZ to DP-QPSK modulation brings the constellation diagram to the forefront of fiber-optics test. While constellation diagrams are common in RF wireless transmissions, they're new to optical communications. Constellation diagrams are the first measurement made on a QPSK transmission.

Constellation diagrams provide information about the transmitted signal's integrity. Signal degradation caused by dispersion and nonlinearities can result in signal distortion. The left side of **Figure 4** shows constellation diagrams for both polarizations in a DP-QPSK signal. The constellation's points are clearly visible in Figure 4, but they can become indistinguishable in the presence of too much distortion.

The two lower-right traces in Figure 4 show the QPSK-modulated signal's magnitude (upper trace) and phase (lower trace). Note the apparent discontinuities on the phase-angle diagram. They result from phase shifts caused by the encoding of bit pairs in the QPSK modulation.

For testing the optical DP-QPSK signal, you can use an optical modulation analyzer or optical signal analyzer. These instruments produce constellation diagrams and decode them into electrical data streams and display them as eye diagrams. Agilent Technologies, Anritsu, EXFO, and Optametra serve this market (the Optametra product is based on a Tektronix oscilloscope).

Finisar's Cole noted that "There's no test specification for the 100-Gbps long-haul optical waveform, so test-equipment makers must talk to the optical module makers to find out what they need to measure. Each company will have different needs." Cole also noted that test equipment will need to support 28-Gsymbols/s and 32-Gsymbols/s signals. "There are DP-QPSK test systems that run at 22 Gsymbols/s for 40-Gbps links, but new equipment will need to run at 28 Gsymbols/s and 32 Gsymbols/s to support 100-Gbps links."

What's in a "G"?

The terms "100G," "40G," and "25G" refer to the data throughput of an optical link. Because of formatting and FEC (forward-error correction), actual data rates are higher than the numbers indicate. For example, the data rate for a 100G (100 Gigabit Ethernet) transmission is actually 103.125 Gbps, but the data throughput is 25 Gbps. Thus, each 25-Gbps lane actually carries 25.78125 Gbps (26 Gbps) for the client side. So, if you see test equipment claiming 26-Gbps speed, it is designed to cover the 25.78125-Gbps data rate. A 27.739-Gbps (28 Gbps) data rate is also under consideration for Ethernet client-side networks.

For line-side, long-haul transmissions, links need additional FEC. The line rate for 100G links with 7% FEC is about 112 Gbps, which translates to about 28 Gbps on each lane. According to the OIF "100G Ultra Long Haul DWDM Framework Document," the exact rate isn't yet specified (see reference). A higher FEC overhead of 20% may also be used, which increases the bit rate to about 32 Gbps.—*Martin Rowe*

REFERENCE

"100G Ultra Long Haul DWDM Framework Document," Optical Internetworking Forum. www.oiforum.com/public/documents/OIF-FD-100G-DWDM-01.0.pdf.

Testing the receive side of optical transceivers is even more up in the air because there are no specifications for stressed-receiver testing. Cole said he needs test equipment that can generate DP-QPSK signals and that can introduce controlled impairments such as chromatic dispersion and polarization-mode dispersion. These impairments cause the TE and TM carriers to rotate as they pass through fiber. The impairments must produce stressed-eye patterns after demodulating and decoding so that engineers can measure the signals once they're in electrical form.

Figure 4 also shows the two eye diagrams (upper right). The eye diagrams represent two 25-Gbps lanes from one polarization. "You'll have to look at eye-mask margins, jitter, and extinction ratio; that's the same as for 10-Gbps links," said Cole.

Currently, engineers are using oscilloscopes and BER (bit-error rate) testers to analyze eye diagrams. Some engineers are using high-bandwidth oscilloscopes to capture DP-QPSK signals. "Because of the modulation, signals at the receiver look like noise," said LeCroy's Schnecker. "Signals are no longer repetitive and, thus, you need a real-time oscilloscope." Zivny of Tektronix has also worked with engineers using real-time oscilloscopes on DP-QPSK signals. A four-channel oscilloscope lets you see all four decoded, demodulated data streams with high time-base correlation.

Engineers developing DP-QPSK transceivers also use BER testers to produce the 25-Gbps data streams for each I and Q phase of a QPSK signal. They also use BER testers to measure BER on the demodulated, decoded signals. BER testers from Agilent Technologies and Synthesys Research can measure BER at data rates up to 28 Gbps.

Over the next few years, the industry will continue to develop 100-Gbps line-side transmissions. Test specifications will also emerge as optical module manufacturers work with test-equipment makers and standards bodies to identify test issues and to develop test procedures and equipment. T&MW

REFERENCES

1. "Verizon Deploys Commercial 100G Ultra-Long-Haul Optical System on Portion of Its Core European Network," Press Release, Verizon, December 14, 2009. newscenter.verizon.com/press-releases/verizon/2009/verizon-deploys-commercial.html.

2. Di Minico, Chris, "802.3ba Cu specifications," January 2008, IEEE. grouper.ieee.org/groups/802/3/ba/public/jan08/diminico_01_0108.pdf.

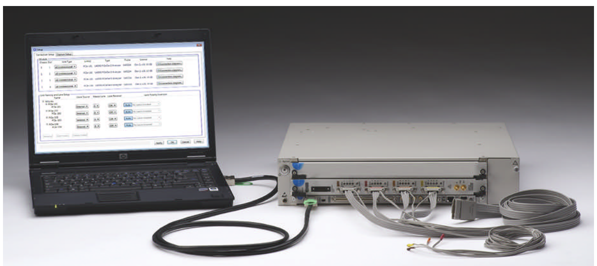
3. "Trends and Issues in Ultra-High Speed Transmission Technologies: For the implementation of 100 GbE/40 GbE and long haul transmission by optical modulation," Technical Note, Anritsu, 2009. www.eu.anritsu.com/files/MP1800A_40_100GbE_EE1200.pdf.

4. "CFP Multi-Source Agreement Draft 1.0," March 23, 2009. www.cfp-msa.org/Documents/CFP-MSA-DRAFT-rev-1-0.pdf.

Test PCIe 3.0 through the layers

PCI Express 3.0 doubles data throughput over PCIe 2.0 (8 Gbps compared to 4 Gbps) while maintaining compatibility back to PCIe 1.0. The U4301A PCIe 3.0 Digital Test Console from Agilent Technologies lets you test bus signals at the physical layer through the transaction layer on 1-, 2-, 4-, 8-, and 16-lane configurations.

The Test Console lets you measure jitter and analyze bus transactions. At the physical layer, it lets you



add impairments for receiver testing. At the data link and transaction protocol layers, the Test Console decodes the new encoding schemes that let the bus increase throughput. The U4301A also generates traffic, and it supports LTSSM (Link Training and Status State Machine) testing.

At such high data rates, probes can affect measurements, and the signal at a receiver can look like noise rather than a clean eye. To compensate for those problems, the Test Console uses its equalization snoop probe. The probe's tunable equalization can open the eye for the instrument to analyze the signals.

Base price: $75,000. *Agilent Technologies. www.agilent.com.*

Expand your oscilloscope's bandwidth

Gigamax Technologies, a new company formed by former Wavecrest employees, has introduced the Scopemax, a tool for capturing and analyzing serial data streams that are too fast for some oscilloscopes. The Scopemax is a front-end signal processor that has a 12.5-GHz bandwidth. It produces a lower-speed copy of a signal that you can then view on any real-time oscilloscope that can sample at 10 Gsamples/s or higher on three channels. In addition to making a copy of a signal, the Scopemax measures time based on a software reference clock or "golden" PLL. Thus, it measures the time between edges of a data stream.

You connect the outputs of the Scopemax to the probe inputs of your oscilloscope, which can use a USB connection to control the tool. The Scopemax includes software for Agilent Technologies, LeCroy, and Tektronix oscilloscopes that analyzes signals. You don't need additional software such as jitter-analysis packages, but you will need to add probes with enough bandwidth for your measurements. The Scopemax has a power connector for Agilent InfiniiMax probes.

Price: $29,900. *Gigamax Technologies, www.gigamaxtech.com.*

OTA emulator supports MIMO mobile terminals

EB Elektrobit has announced the EB Propsim F8 MIMO OTA emulator, which the company says is the industry's first commercially available MIMO OTA (over-the-air) emulator that supports the increased performance and data rates of MIMO mobile terminals. Janne Kolu, director of product management for wireless communications tools, said the company has delivered a custom implementation for LG Electronics and is now making a commercial version available for other mobile terminal vendors as well as to wireless operators.

With the emulator, EB's customers can benchmark the performance of mobile devices for quality of service, data throughput, latency, and spectrum availability to select the best devices needed to address the growing adoption of higher data-rate applications such as downloading graphics, playing games, and watching video.

Traditionally, OTA testing focused on single-input-single-output devices by only measuring power and antenna efficiency. With MIMO OTA testing, EB's customers can assess the true performance of a terminal as a whole. It allows them to evaluate different designs in a fully repeatable and realistic wireless network environment so they can test all critical parts of the mobile terminal design at once, including antennas, RF front end, and baseband processing—eliminating the need for cables and test connectors and leaving the mobile device intact, which provides more accurate results of how the device will perform in a real-world environment.

The EB Propsim F8 MIMO OTA emulator is designed to meet the conformance-testing requirements of WCDMA, HSPA, 3GPP LTE, WiMAX, and WLAN.

Elektrobit, www.elektrobit.com.

Agilent LTE applications target 4G system-level designers

Agilent Technologies has introduced a new line of system-level design and verification products for 3GPP LTE physical-layer design. In addition to its traditional test and measurement products, Agilent now provides predictive products and algorithmic references for the SystemVue platform that are consistent with the LTE v.8.9.0 (December 2009) standard.

The new SystemVue platform products include:

- W1715 MIMO Channel Builder, a simulation block set for LTE architecture and receiver designers, based on the WINNER and WINNER-II fading algorithms. By incorporating non-ideal MIMO antenna performance (for example, crosstalk and directionality), the W1715 enables 2-D far-field data to be imported from antenna measurements or 3-D electromagnetic simulations. Realistic antenna degradations allow accurate assessments of link-level LTE architectures and receiver algorithms to be made at an early stage, before prototypes have been committed for the mechanical, RF/antenna, or baseband/DSP designs. Previously, according to Agilent, interactions between these domains required a fully operational hardware radio and came later in the design process, possibly during drive test. The W1715 brings some of this drive-test realism into the algorithm phase of the design.
- W1716 Digital Pre-Distortion (DPD) software, which helps LTE system integrators, RF component designers, and baseband architects transition from 3G to 4G by creating baseband signal-processing networks that improve the range of analog power amplifiers and transceiver ICs, improve efficiency, and extend battery life. The W1716 also assesses the suitability of existing 3G designs for 4G applications.
- W1910/2 LTE Baseband Verification Library reference block set, which supports LTE v.8.9.0. This update to the company's W1910 verification library includes expanded PRACH and HARQ support. The HARQ simulation support uses a data-flow simulation mode that allows the symbol rate to change dynamically over the course of the simulation while retaining the timing and carrier information necessary for full RF effects, frequency-dependent phase noise, and channel fading.
- W1912 LTE Baseband Exploration Library, an updated C++ source-code version of the W1910. The W1912 allows deeper algorithmic insights, control, line-by-line software debugging, and precise test-vector generation from inside the algorithms of a working LTE v.8.9.0 physical layer.

Base price: approximately $17,000; a free 30-day evaluation is available. *Agilent Technologies, www.agilent.com.*

Dalsa adds color processing to vision camera

A color version of the BOA vision system is now available from Dalsa. You can use the BOA smart camera for a broad range of color-inspection applications, such as identification of parts or assembly features, sorting, counting, and verification of color hue. Its color tools can be combined with standard measurement or identification tools to perform complete inspection of parts and assemblies. The iNspect Express software interface allows you to quickly prototype and deploy applications, and it is available with a full-featured emulator for offline application development and debugging.

Combining all the elements of an industrial machine-vision system in a tiny camera-style package, the BOA's 44-mm cube form factor fits tight setups, while its IP67-rated housing means the camera can be deployed in harsh, wash-down environments. The BOA camera is outfitted with a ⅓-in. monochrome or color VGA (640x480-pixel) CCD sensor operating at up to 60 images/s.

Dalsa, www.dalsa.com.

Test & Measurement World

PXI

TEST REPORT

PXI speeds aircraft maintenance

By Richard A. Quinnell, Contributing Editor

As a safety feature in commercial aircraft, proximity sensors monitor the status of mechanical elements such as forward wing flaps, landing gear, and access doors. But when the sensors give false error readings, the need to find the problem can keep an aircraft grounded for hours, annoying travelers and cutting airline revenue.

Now, aviation consulting firm R.H. Caldwell & Associates uses a PXI-based aircraft sensor test system that speeds problem solving and supports preventative maintenance. I spoke with project consultant Roger Caldwell to learn more about the system.

Q: What does the test system do?

A: This system runs real-time tests on a variety of safety sensors in Boeing aircraft to determine if they are operating properly. Sensor issues have plagued airliners during the last seven or eight years, with erroneous messages indicating wing flaps and slat position, landing gear, and access doors and hatches being open, and the like. These false errors may account for over half of aircraft flight delays and are very expensive to diagnose and repair, notwithstanding the obvious passenger inconvenience. The standard method for testing, however, uses a manual LCR meter and simple breakout box that looks like something right out of the 1950s.

This new system automates the testing, provides a graphical indication of a failed sensor's location, and gathers data for long-term, fleet-wide performance analysis and predictive failure models. In essence, the entire aircraft is viewed as a flying circuit board, and multiple onboard electrical networks with passive and active components may be ATE test subjects.

Q: What made you choose PXI?

A: We fell into it by accident. When we first set out, we contacted Tektronix to see if there was anything suitable off-the-shelf. There wasn't, but Tektronix put us in touch with Geotest, which built us a system using its portable PXI box.

Our job was to define the aircraft interface, specify how the system would operate, and generate maintenance manuals with related aircraft technician training. Geotest configured the chassis and created the software, while the Seattle-based engineering firm Aero Northwest helped design and fabricate the aircraft interfaces.

Q: What do you think of PXI?

A: It has been great. It is so readily configurable that we can write a statement of work, and in a week Geotest will come back with an implementation plan. The software is also configurable, so we can tweak it ourselves as we gain field experience with the system.

Roger Caldwell
Project Consultant
R.H. Caldwell & Associates

PXI instrument cards offer capabilities that we want to tap in new applications. For instance, aircraft maintenance has a need for updated time-domain reflectometry testing to identify the location of failures in cabling without crawling all through the airframe. In fact, any maintenance procedure that has an electrical interface with the aircraft is a candidate for a PXI test system. The only real concern has been mechanical. The equipment operates in a heavy aircraft maintenance environment and must be mechanically secure and protected from the environment.

Q: Any recommendations for other system designers considering PXI?

A: Spend extra time ensuring the user interface is correct. Our users are not engineers looking at data; they are technicians and mechanics looking to resolve problems quickly. Engineers can analyze the data later, but the mechanics need something that simplifies the job at hand. So, making sure the system is easy to transport and attach and has informative display screens have been key elements in this system's success. □

INSIDE THIS REPORT

GUEST COMMENTARY

Why integrators choose PXI

By Jonathan Murray, Bloomy Controls

As a test engineer, where do you go when your manager asks you to develop a complex control system for manufacturing and testing ground-breaking medical devices? How about an automated solution for testing electric-vehicle battery-management systems? And of course it has to be completed in a short time frame and needs to be low cost.

Such a system is not trivial; it usually must be custom designed and requires the developer to have extensive knowledge of new technologies and the ability to integrate a diverse set of instrumentation including RF communications, source-measurement units, switch matrices, and FPGAs for onboard processing.

System integrators have experience working with the latest instrumentation and are equipped with the knowledge to take on the challenges of developing advanced systems for a wide range of industries including alternative energy, medical, and defense. As PXI modular instrumentation continues to expand and increase in performance, leading integrators have adopted the PXI platform, making it the preferred architecture for system development.

PXI has many advantages, such as system expandability, a small form factor, a wide range of instrumentation and vendors, integrated timing and synchronization, and mass data transfer. These key features contribute to the continuing success of the PXI platform and give integrators the tools needed to develop high-performance customized solutions that meet strict requirements.

There are many benefits to engaging an integrator familiar with PXI. Integrators who take advantage of PXI's inherent modularity and virtual instrumentation usually have a library of reusable software and hardware components that they can use to decrease overall development time. With their extensive knowledge of PXI, integrators can develop systems for use throughout the life cycle of a product, from R&D, to automated manufacturing facilities, to field applications. Leveraging the PXI platform's hardware flexibility and software-defined instrumentation allows integrators to deliver innovative, high-quality, and reliable systems in a shorter period of time and at lower costs. □

Jonathan Murray *is the business development manager at Bloomy Controls. jonathan.murray@bloomy.com.*

HIGHLIGHTS

NI expands RF offerings

National Instruments recently introduced two PXI modules for RF signal-conditioning applications and enhanced two PXI Express 6.6-GHz modules for wireless device test.

The first signal-conditioning module, the PXI-5695, is a 50-MHz-to-8-GHz, two-channel programmable RF attenuator. NI says engineers can integrate the PXI-5695 with the company's RF vector signal generators to control signal power with up to 60 dB of total attenuation and a typical voltage standing wave ratio of 1.3:1.

The second signal-conditioning module, the PXI-5691, is a 50-MHz-to-8-GHz, two-channel programmable RF amplifier that can function as a pre-amplifier and as a power amplifier. The amplifier offers 20 dBm of maximum output power, up to 60 dB of total gain, 0.5 dB of gain resolution, a +31-dBm third-order intercept point, and 5-dB noise figures; it can be integrated with NI's RF vector signal generators to increase maximum power and can be integrated with the company's vector signal analyzers to measure low-level signals.

On the PXI Express front, NI says its enhanced PXIe-5663E vector signal analyzer and PXIe-5673E vector signal generator improve automated test times for WLAN, WiMAX, and GSM/EDGE/WCDMA devices. A new RF list mode feature enables engineers to configure the modules to rapidly switch through a list of RF settings at deterministic timing intervals, and a new wide-loop bandwidth mode permits the instruments to achieve typical tuning times of 300 and 400 µs for frequencies between 800 and 1950 MHz. www.ni.com.

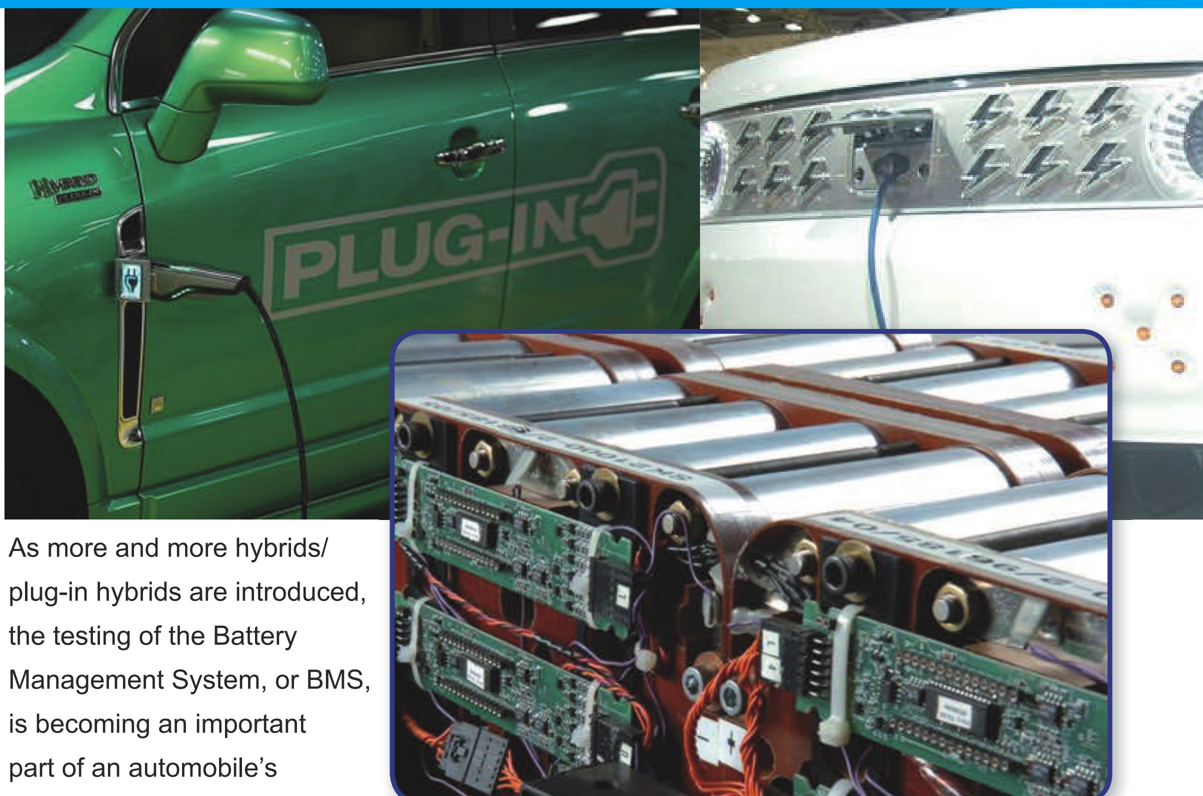
Agilent updates Acqiris software

Agilent Technologies has unveiled Acqiris Software Release 4.0 for its Acqiris digitizers, which are available in PCI, PXI, CompactPCI, and VME formats. The digitizers have acquisition rates ranging from 500 Msamples/s to 8 Gsamples/s with resolutions of 8, 10, or 12 bits.

In addition to supporting the 32-bit and 64-bit versions of Windows 7, Release 4.0 supports the XP64, Vista64, and Linux 64-bit operating systems. The software provides drivers for Windows, LabView RT, Linux, and VxWorks, and it includes application code examples for Matlab, C/C++, VisualBasic.NET, LabView, and LabWindows/CVI. Agilent says users can port code developed in 32-bit environments to the 64-bit operating systems. www.agilent.com.

Battery Management Systems Testing?

Look to Pickering Interfaces for answers



*Automotive photos courtesy of www.electriclithiumbattery.com

As more and more hybrids/ plug-in hybrids are introduced, the testing of the Battery Management System, or BMS, is becoming an important part of an automobile's manufacturing process.
The ability to simulate problems such as overcharged, shorted, or failing cells while testing the entire system response is crucial to validating a safe BMS. That is why Pickering has introduced the 41-752, the only multi-channel battery simulator in PXI. With six independent channels per module and high voltage isolation allowing multiple modules to be stacked to simulate a vehicle's battery system, the 41-752 should be an integral part of your BMS test strategy. Contact your local Pickering sales representative or go to pickeringtest.com and see how we can make your test process fast and efficient.

41-752
6 Channel Battery Simulator Module

PXI Chassis with sixteen 41-752s, simulating 96 cells of a Lithium Ion battery stack

Pickering Interfaces

Pickering Interfaces Inc., Grants Pass, OR. Tel: +1 541 471 0700
E-mail: ussales@pickeringtest.com
(East Coast Regional Office) Woburn, MA. Tel: +1 781 897 1710

Direct Sales Offices in USA, UK, Sweden, Germany, Czech Republic, France and China

pickering

Detailed Pricing & Technical Data On-Line

www.pickeringtest.com

PXI's Digital Solutions

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

The industry's highest performance and best value

- **Aerospace Test Applications**
  Performance leading digital test solutions with high voltage (-10V to +15V) and per-pin programmability

- **Semiconductor Test Applications**
  Digital test solutions with 100MHz+ data rates, 512 MB of memory, per-pin programmability, and real-time compare

- **Communication Test Applications**
  Industry-leading digital I/O for serial test applications supports data rates to 200MHz

- **State-of-the-Art Software Tools**
  Vector editors and converters for LASAR and WGL file formats

With specialized digital I/O test solutions for all markets, Geotest is the world leader in digital I/O test solutions and your source for your next test application.

The Marvin Group ◤ Geotest - Marvin Test Systems, Inc. ◤ Toll Free: 888.837.8297 ◤ Tel: 949.263.2222 ◤ www.geotestinc.com

PXI keeps pushing envelope

By Richard A. Quinnell, Contributing Editor

From its humble beginnings as a low-cost alternative to bench instrumentation, the PXI architecture has evolved to hold its own against high-end dedicated test systems. Now, advances in semiconductor integration and a weakened economy are helping PXI vendors to further push the envelope of what can be achieved with PXI. Modules for data acquisition, RF, switching, and data storage are among many that have continued improving, with vendors already planning for the next challenge.

A quick look at the PXI instrumentation released during the latter half of 2009 shows the levels to which PXI has risen. Adlink Technology, for instance, introduced its PCI-984x family of four-channel digitizers capable of sampling to 40 MHz at a resolution of 16-bits. ZTec Instruments released the ZT4440 series of digital sampling oscilloscopes capable of capturing 400 Msamples/s at 14-bit resolution. National Instruments created a suite of instrument modules that included the NI 4132 source-measurement unit, which offers sensitivity down to 10 pA. All compare favorably to available benchtop offerings. "Best-in-class instrumentation is now becoming available on PXI," said Matt Friedman, NI's senior product manager for the PXI platform.

The data-processing power available on PXI is even surpassing bench instrumentation in some areas. The advent of PXIe (PXI Express), for instance, virtually eliminated the backplane's data-bandwidth limitation. "In terms of data transfers, PXI is now orders of magnitude faster than rack-and-stack instruments, approaching gigabyte transfer speeds between instruments and the host or storage," said Friedman. To cite one example, Conduant recently released the PXIe-compatible NTX16 system that can handle 800-Mbytes/s reads and writes with a storage capacity to 32 Tbytes.

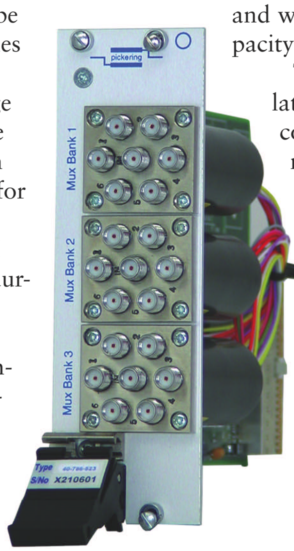


Fig. 1 PXI offerings now include high-performance RF modules, like this microwave switch from Pickering Interfaces, that were considered impossible only a few years ago.

Courtesy of Pickering Interfaces.

The ability to manipulate this information is coming in part from PXI modules that make use of FPGA technology, such as the NI FlexRIO series and the recently introduced GX3500 from Geotest—Marvin Test Systems. These modules, which use adapter cards for signal conditioning and preprocessing, allow test engineers to perform hardware-based manipulation of data that is beyond the capacity of system CPUs.

Software-based signal processing is not far behind, however. The PXISA (PXI Systems Alliance) recently released the PXImc hardware and software specifications that will enable developers to implement multicomputing structures in PXI that leverage PXIe. Modules should start becoming available in 2010 that will allow software processing to multiply its performance in a PXI system.

PXI's continual improvement appears even among humble yet critical signal-switching modules. "In today's world, all signals are demanding greater bandwidth," said Walt Strickler, VP of business development for switching solutions at Gigatronics. "As a result, there continue to be advances in the PXI platform. In the past, for instance, we would shoot for a 1-MHz bandwidth on a switching card, but today, 10 MHz is more typical, and we are seeing some at 100 MHz."

RF highlights PXI's expansion

This ability of the PXI community to keep pushing the envelope of possibilities is nowhere more evident than in RF test. "It was once viewed that you could not possibly put quality RF instrumentation on PXI," said Tim Carey, PXI product manager at Aeroflex. "Now, that view has been knocked over."

Recent PXI releases in the RF space tell the tale. Aeroflex's 3026C 6-GHz RF signal generator raised the bar on RF output power from its prior limit of 1 dBm to a robust 17 dBm. Phase Matrix released a family of RF downconverters capable of operating at frequencies to 26.5 GHz. RF switching has also taken PXI into frequency ranges unimaginable only a few years ago. The 40-78x PXI microwave switch family from Pickering Interfaces, for example, handles signals to 65 GHz (**Fig. 1**).

All this capability has arisen despite what critics point to as PXI's limitations on space and power. Not that these constraints aren't real. "It's a constant challenge," said Geotest's senior product marketing manager Mike Dewey. "We can put in the functionality but then bump against limits in power draw, heat dissipation, and the like." But the constraints are not as insurmountable as they might first appear. "You have to get more clever and use things such as enhanced cooling," explained Dewey.

The electrical noise inherent in a backplane-based architecture is another apparent limitation that good engineering is resolving. “We have to design for the noise, because we cannot control what connects to the backplane,” said Aeroflex’s Carey. “So, we need high levels of screening, and [we need to] put the RF on a separate module with its own bus. But rack-and-stack instruments face the same issues. The only difference is the proximity of the instruments.”

“The key to handling the noise in PXI is to use best practices in the design,” said Gigatronics’ Strickler. He added that designers must “separate chassis and control grounds from the signal ground, use multilayer boards, and treat signals as transmission lines, matching impedance and stub lengths.”

Fig. 2 The manufacturing test market is helping foster PXI innovation as it encourages companies to develop high-performance instrumentation. Shown here are modules from NI’s Semiconductor Suite. Courtesy of National Instruments.

Constraints foster innovation

Facing challenges such as noise and power restrictions may, in fact, be part of PXI’s secret for continued enhancement. “Having these constraints can lead to very elegant design,” said Aeroflex’s Carey. “People used to think that high-quality RF needed large, heavy, expensive systems, but a lot of the size and weight arose because the engineering was not constrained. To put things into PXI, someone had to be clever, so we have ended up with designs that are efficient, lean, and not power hogs. Now, it’s the capability of the transducer that is the hard limiter to what’s possible.”

The ever-shrinking dimensions of electronic systems that mobile devices exemplify is helping PXI developers overcome these restrictions, as well. “The global move toward miniaturization has been a boon for PXI, letting us pack in more capability,” said NI’s Friedman. “A PXI module is gigantic compared to an iPhone.”

Counter to intuition, the worldwide economic recession is also contributing to PXI’s expansion, as semiconductor and device manufacturing turns to PXI for production test solutions. “Manufacturers have had to take a hard look at capital costs,” said Geotest’s Dewey. “They used to be able to spend half a million dollars on a tester because of production volume. Now, they’re looking to reduce costs by orders of magnitude, and PXI’s technology has evolved to where it can handle the testing.”

Manufacturers are also looking at the flexibility that PXI’s modular architecture allows. “More and more, we’re seeing a ‘boutique’ view of how testing is done,” said Dewey. “Manufacturers are screening devices differently for various customers, so production test runs for a given configuration are lower in volume.” The ability of PXI systems to be rapidly customized and reconfigured supports this new test paradigm.

Production test pushing PXI

The rise of production test as a market for PXI has fostered a flurry of innovation as PXI vendors work to achieve the required performance levels. In fact, the industry has seen a rise in the number of PXI modules and systems specifically targeting manufacturing test. One recent example is NI’s Semiconductor Suite, which includes nine modules ranging from source-measurement units to vector signal analyzers.

This pushing against the performance envelope shows no signs of slowing, much less stopping. To address the needs of wireless LAN device testing, which requires 5.8-GHz signal switching, Gigatronics is exploring new options to replace board-mounted electromechanical switches, which only provide 3- to 4-GHz bandwidth. “We need higher performance switches in smaller packages,” said Strickler, “and [we] expect to have them in the next few years.”

Instrumentation is also increasing its bandwidth. NI and Tektronix recently announced a joint effort to develop a PXI digitizer module that can achieve sample rates beyond 10 Gsamples/s with a signal bandwidth in excess of 3 GHz. The companies expect to release the module during 2010.

This relentless push against the boundaries has paid off handsomely for PXI. As Gigatronics’ Strickler pointed out, “In a down economy, an organization like the PXISA would normally decline, but it is continuing to grow as the number of people doing products on PXI increases. This is a clear validation of PXI’s benefits.” In fact, the PXISA says that industry analyst Frost & Sullivan confirms the upward trend, predicting a compound annual growth rate of 17.6% through 2014 for PXI systems (Ref. 1).

The ability to maintain the push will ultimately determine how PXI fares against emerging modular instrumentation rivals such as LXI. While each technology has its advantages in specific applications, it is the continued improvement in performance that will determine PXI’s long-term fate. “PXI cannot survive being an also-ran in terms of performance,” said Aeroflex’s Carey. Given the history of innovation in its first decade, however, PXI has no worries there. □

REFERENCE

1. “New PXI MultiComputing Specification Enables Multi-Controller Systems with High Performance Communication,” PXISA, November 16, 2009. www.pxisa.org.

FOR FURTHER READING

Quinnell, Richard A., “PXI system tests MEMS products,” *PXI Test Report, Test & Measurement World,* November 2009. p. 45. www.tmworld.com/2009_11.

Test & Measurement World

225 Wyman St., Waltham, MA 02451
Phone: 781-734-8423 Fax: 781-734-8070
Sales e-mail: tmwsales@reedbusiness.com
Web: www.tmworld.com

BUSINESS STAFF

Publisher: Russell E. Pratt, rpratt@reedbusiness.com

Associate Publisher: Judy Hayes, judy.hayes@reedbusiness.com

Director, Custom Programs and Solutions: Karen Norris-Roberts, knorris@reedbusiness.com

Online Account and Marketing Manager: Melanie Turpin, melanie.turpin@reedbusiness.com

Assistant to the Publisher: Darlene Fisher

Online Client Services Manager: Jennifer Caruso

Market Research Director: Rhonda McGee

Group Production Director: Dorothy Buchholz

Production Manager: Joshua Levin-Epstein

Customer Contracts Coordinator: Maureen Lesko

ADVERTISING SALES

CT, NJ, New York City, Long Island: Mike Moore, Chatham, NJ. 973-701-9340 1.mikemoore@gmail.com

Midwest, Southeast, NY (except NYC & LI), PA, MD, DE, and Canada: James Leahey, Kenosha, WI. 262-656-1064 james.leahey@reedbusiness.com

CA, CO, TX, and Northwest: Mary Lu Buse, Calabassas, CA. 818-880-4024 marylu.buse@reedbusiness.com

New England, South Central; Classified, Test Marts, TestLits, and Account Development Nationwide: Kathy McNamara, Waltham, MA. 781-734-8421 kathy.mcnamara@reedbusiness.com

Internet Sales Director: Laura Lang-Dacus, 408-984-4871 laura.lang-dacus@reedbusiness.com

France, Spain, UK, Ireland, Benelux, Scandinavia: John Waddell, London, England. 44-20-8312-4696

Germany, Austria, Switzerland: Adela Ploner, Dachau, Germany. 49-8131-366992-0

Italy: Roberto Laureri, Milan, Italy. 39-02-236-2500

Israel: Asa Talbar, Tel Aviv, Israel. Fax: 972-3-562-9565

Japan: Shintaro Koyama, Tokyo, Japan. 81-3-3402-0028

Taiwan: Laura Chen, Taiwan, ROC. 886-2-2314-7206

Singapore, Malaysia, Hong Kong: Wai Chun Chen, Singapore. 65-6544-1151

VOL. 30, NO. 2

Subscription Policy

Test & Measurement World® (ISSN 0744-1657) (GST Reg.# 123397457) is published monthly except January by Reed Business Information, 8878 S. Barrons Blvd., Highlands Ranch, CO 80129-2345. Reed Business Information, a division of Reed Elsevier, is located at 360 Park Avenue, New York, NY 10010. Tad Smith, CEO. Periodicals postage paid at Littleton, CO 80126, and additional mailing offices. Circulation records are maintained at Reed Business Information, 8878 S. Barrons Blvd., Highlands Ranch, CO 80129-2345. Telephone: 800-446-6551. **POSTMASTER: Send address changes to** Test & Measurement World®, P.O. Box 7500, Highlands Ranch, CO 80163-7500. **For Canada:** Publications Mail Agreement No. 40685520. Return undeliverable Canadian addresses to: RCS International, Box 697 STN A, Windsor Ontario N9A 6N4. Email: Subsmail@ReedBusiness.com.

Rates for non-qualified one-year subscriptions, including all issues: US, $110.99; Canada, $159.99 (includes 7% GST, GST# 123397457); Mexico, $159.99; International (Priority), $219.99. Except for special issues where price changes are indicated, single copies are available for $10 (US orders) and $15 (foreign orders). Buyer's Guide Issue (July) is available for $35 (US orders) and $40 (foreign orders). **Please address all subscription mail to** *Test & Measurement World®*, 8878 S. Barrons Blvd., Highlands Ranch, CO 80129-2345. *Test & Measurement World®* is a registered trademark of Reed Properties Inc., used under license.
(Printed in U.S.A.)

BPA Worldwide   Reed Business Information (RBI)

BARBARA B. HULIT
President
Fluke
Everett, WA

On becoming president of Fluke in September 2005, Barbara Hulit assumed responsibility for the Fluke Industrial and Fluke Precision Measurement businesses. She came to Fluke from The Boston Consulting Group, where she was a VP and director with responsibility for the firm's packaged-goods sector. Her background also includes senior positions at Noxell, Frito-Lay, and Marketing Corporation of America. As Fluke president, Hulit has been instrumental in developing the company's new indoor-air-quality and thermography businesses. She holds an MBA from Northwestern University and a BA in marketing from the University of Texas.

Contributing editor Larry Maloney conducted an e-mail interview with Barbara Hulit on Fluke's expanding stable of test and measurement technologies.

Innovating through economic downturns

Q: What signs do you see of a pickup in demand for test equipment?
A: I'm not sure we have a better ability to call the market than do all the economists we read daily! That said, we have seen increases in run rates through the second half of 2009 and going into 2010. Our customers rely on us to introduce innovative products to better solve their needs. In the back half of 2009, we introduced several such products that have led our customers back into the market.

Q: How did the recession affect your product-development strategies?
A: We have a fundamental belief that great companies continue to invest in innovation even through downturns. This was our overriding philosophy in late 2008 and 2009. We tightened spending in noncritical areas so we could continue to make significant investments in R&D. For example, the Fluke 233 remote-display multimeter—the first wireless DMM (digital multimeter)—is a true breakthrough that makes an engineer's life easier by allowing him or her to be in two places at one time. Another DMM, the Fluke 28 II, is targeted for harsh environments, adding a new definition of ruggedness to the market. Among other introductions, the Fluke Ti32 thermal imager is the first 320x240-resolution imager for under $9000, and the Fluke 6105 electrical standard for the calibration of energy-metering devices is filling a need in that market.

Q: What segments of test are your prime targets?
A: Our founder, John Fluke, Sr., laid the groundwork for our low-voltage metrology measurement tools, and we have been introducing new technologies in rapid succession for 60-plus years. In that time, we have expanded the parameters beyond electrical to temperature, pressure, flow, and distance. The readers of *Test & Measurement World* look to Fluke for a variety of measurement needs, but are especially interested in sourcing DC and AC signals up to 6 GHz. They use many of our precision electronic instruments as systems references. Other applications range from stimulating and measuring strain gages to testing radar systems.

Q: How are Fluke's investments in thermal imaging panning out?
A: Thermal imaging is an increasingly important product line. We entered that market with a belief that we could make core infrared technology less expensive and easier to use through a more-intuitive user interface, combined with accuracy and reliability. Our brand awareness is growing, and we are having great success in extending our market reach.

The biggest driver for this business is what I call "best maintenance practice." It encompasses preventive maintenance, energy efficiency, and safety. A thermal imager is a single tool you can put in the hands of a knowledgeable maintenance professional to quickly scan systems and equipment from a safe distance to determine potential problems. The other big growth area is building diagnostics—scanning the envelope of a structure for air or water leaks. This is becoming increasingly important as the world seeks to become more energy efficient.

Q: Looking ahead, what new applications will Fluke be targeting?
A: The move into the vibration market is a focus for us, and we will continue to address new opportunities in energy and building diagnostics. This year, we'll also provide engineers with a more robust offering of technical information on our global Website. T&MW

Barbara Hulit answers more questions on changing demands for test products and about the smart grid in the online version of this interview: www.tmworld.com/2010_03.

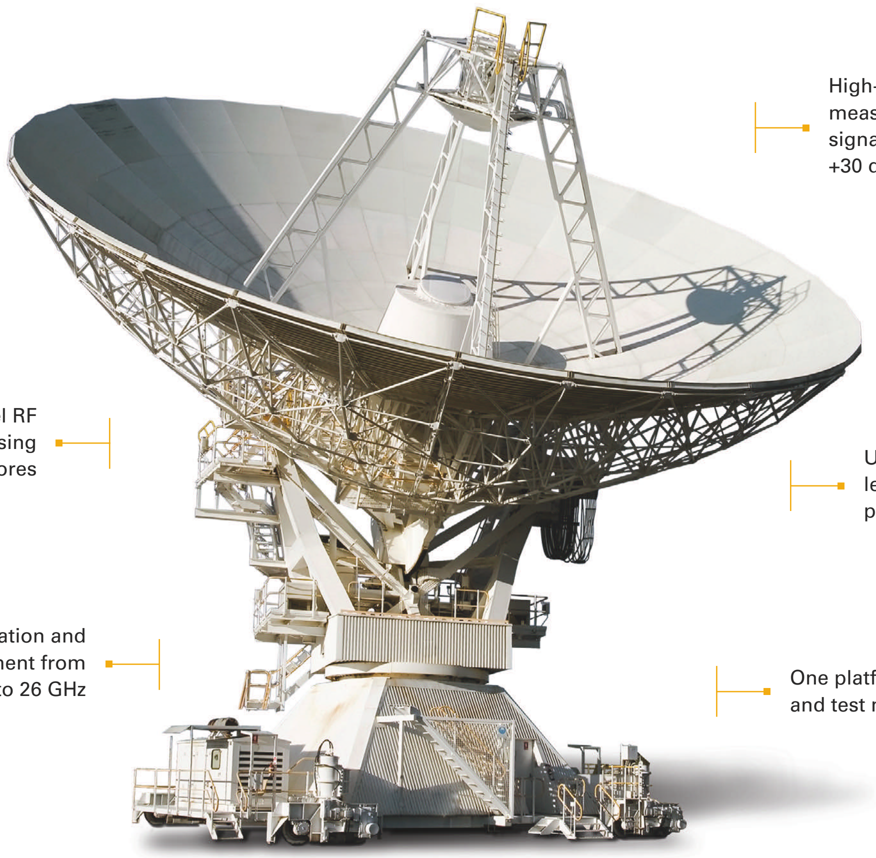
To read past Viewpoint columns, go to www.tmworld.com/viewpoint.

NI LabVIEW

Limited Only by Your Imagination

High-quality RF measurements on signals from -165 to +30 dBm

Parallel RF signal processing on multiple cores



Up to 8 by 8 MIMO with less than 0.5 degrees of phase error

Signal simulation and measurement from DC up to 26 GHz

One platform to prototype and test multiple protocols

RF

Medical

Robotics

Multicore

From satellite communications to cellular base stations, LabVIEW graphical programming and NI PXI hardware are helping engineers stay ahead of the changing wireless industry with a flexible, low-cost prototyping and testing platform.

PRODUCT PLATFORM

NI LabVIEW graphical and textual programming

NI LabVIEW Modulation Toolkit

NI Spectral Measurements Toolkit

NI PXI instrumentation platform

>> Find out what else LabVIEW can do at **ni.com/imagine/rf**

866 337 5041

NATIONAL INSTRUMENTS™