

*The IEEE Instrumentation & Measurement Magazine*  
*June 2017 Issue*

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*I&M for Farmers all over the World*

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*Editorial*

**I&M for Farmers**

Wendy Van Moer

My great grandfather was a farmer. He owned a horse, a carriage and a piece of land. By working very hard seven days a week and twenty-four hours a day, he made sure that there was food on the table for his family every day. This is only a century away, and since then a lot has changed.

Nowadays, farmers are more and more engineers. They use modern instrumentation and perform accurate measurements every day. These efforts improve the yield and its quality to be able to feed 7.4 billion mouths.

In this issue of our *Magazine*, you can find the latest technologic developments in the field of farming. Keep in mind that without continuous research in this field of science, the world would be very hungry.

Our guest editor for this issue is Dr. Samir Trabelsi. Dr. Trabelsi is a Research Electronics Engineer and Lead Scientist of the Dielectrics Group, Quality and Safety Assessment Research Unit (USDA ARS). He also holds an adjunct Associate Research Scientist position with the Department of Biological and Agricultural Engineering at the University of Georgia. His research involves the development of methods and sensors or rapid and nondestructive determination of bulk density and moisture content in granular and particulate materials, measurement, and modeling of dielectric properties of water containing materials at RF and microwave frequencies.

It was a great pleasure and honor to work with him on this issue, and I would like to take the opportunity to thank him for his dedication and valuable time.

Groetjes,

Wendy

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## *Guest Editorial*

### **New Technologies in Agriculture**

Samir Trabelsi

By 2050, the world population is projected to increase by 35% to approximately 9.7 billion, and crop production needs to double to feed that population according to a United Nations report. Historically, to meet such challenges, the solution has been to clear more land and grow more crops, which increases the constraints on available resources and negatively impacts our fragile planet. This solution may not be sustainable, given the fact that our planet is facing changes in climate patterns with destructive weather and prolonged periods of drought. Therefore, alternative solutions must be found to balance food security, world stability, and sustainability for future generations.

The most obvious solutions to having sufficient food consist of reducing food material losses, eliminating waste, and changing our diet, especially in rich and developing countries. In fact, every year, roughly one third of the food produced is lost or wasted, and obesity among children and adults is on the rise. However, these solutions require behavioral changes and sustained educational campaigns to improve understanding of the long-term implications of not addressing these issues.

On another level, the food challenge can be addressed by developing new plant varieties and new animal breeds, new farming strategies, better management of natural resources, and smart farming systems. Today, there are many available technologies that can be integrated within the food production systems to improve yields and quality and minimize food losses. There is no doubt that tools such as artificial intelligence, robots, machine vision, drones, and all kinds of

sensors will revolutionize farming the same way mechanization did in the past century. The question is how fast these tools will be adopted by farmers, processors, and regulators. It is not always the cost that is the barrier but rather a business mentality that is comfortable with the status quo.

I remember how reluctant the staff was at a peanut buying station in southwest Georgia (USA) when we presented to them for the first time our microwave moisture meter for in-shell peanuts. The meter provided instantaneously the peanut pod and kernel moisture contents, without having to shell the peanuts, from measurement of the dielectric properties at a single microwave frequency. We had to demonstrate the microwave moisture meter at several peanut farmers' shows and provide free testing at different buying stations before farmers and processors admitted, "This is the most valuable innovation in the peanut grading process we have seen in the last fifty years."

Today, excitement about this technology led the peanut inspectors to look into the idea of overhauling the entire peanut grading process and take advantage of modern technologies. This technology, along with other technologies for real-time sensing of moisture content and other physical properties of interest, will contribute in significantly reducing losses because of spoilage and poor post-harvest practices. In many ways, sensors implemented on combine harvesters, irrigation systems, in storage facilities, and other systems will provide growers with valuable information for sound decision making to optimize land and resource usage. This, in turn, will render agriculture more sustainable and much better positioned to feed the planet's population without harming the environment.

In this issue a sampler is presented of technologies with concrete potential to address the challenges facing agriculture and food needs for a growing global population. These technologies will reshape the agri-business landscape and allow all players in this field to achieve their goals in terms of both quantity and quality while preserving the well being of our planet. Take for example the use of drones for high throughput phenotyping as presented in the paper by Aaron Patrick and his colleagues. Use of such technology, combined with multispectral imaging, allowed them to collect important data on 20 genotypes of peanuts to distinguish those

resistant to tomato spot wilt disease from those susceptible to it. This will have significant impact in terms of production and quality. Other agricultural applications of drone-based technology are expected in a wide range of issues, including soil and root structure characteristics, yield monitoring, fertilizer usage, and resource management. Early detection technology can be instrumental in limiting waste because of spoilage. In their article, Speir and Haidekker use computed tomography (CT) for early detection of bacterial and fungal infections in onions. Ultimately, the CT scanners will be used in onion packing houses for automated quality assessment. This will enhance the onion quality and avoid considerable produce losses. Similarly, three-dimensional imaging with conventional 24 GHz Frequency-Modulated Continuous Wave (FMCW) radar was applied for detecting and remotely estimating the intra-parcel quantity of grapes as explained in the paper by Dominique Henry and co-authors. Further refinement of this technology will lead to its use for other crops and will certainly play an important role in precision agriculture.

In terms of quality control and management strategies, sensors play a major role because they provide growers and processors with real-time information for sound decision making. Moisture content is the single most critical parameter for optimizing harvest conditions and safe storage for many agricultural and food commodities. It is also important for fair pricing, and hence it has direct impact on revenue. Three of the papers presented in this issue deal with methods and sensors for routine nondestructive and instantaneous measurement of moisture content. In their paper, Cataldo *et al.* showcase the use of Time Domain Reflectometry (TDR) for moisture content determination. Similarly, Singh and Fielke use multiple humidity and temperature sensors to monitor moisture content in grain storage. Finally, in the paper by Shrestha and his colleagues, artificial neural networks were used for moisture determination independent of bulk density in herbaceous biomass from measurement of dielectric properties at microwave frequencies.

All of these technologies have the advantage of being versatile and flexible, and therefore they can be applied to a wide spectrum of agricultural needs and bring about a balance between increasing agriculture output and preserving the planet ecosystems.

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## *Article Summaries*

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### *High Throughput Phenotyping of Tomato Spot Wilt Disease in Peanuts Using Unmanned Aerial Systems and Multispectral Imaging*

(Summary)

Aaron Patrick, Sara Pelham, Albert Culbreath, C. Corely Holbrook, Ignácio José de Godoy, and Changying Li

The amount of visible and near infrared light reflected by plants varies depending on their health. In this study, multispectral images were acquired by a quadcopter for high throughput phenotyping of tomato spot wilt disease resistance among twenty genotypes of peanuts. The plants were visually assessed to acquire ground truth ratings of disease incidence. Multispectral images were processed into several vegetation indices. Ultimately, the best vegetation indices and pixel distribution feature for disease detection were determined and correlated with manual ratings and yield. The relative resistance of each genotype was then compared. Image-based disease ratings effectively ranked genotype resistance as early as 93 days from seeding.

*This summary includes text from the introduction of the article.*

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### *Onion Postharvest Quality Assessment with X-Ray Computed Tomography – A Pilot Study*

(Summary)

Richard A. Speir and Mark A. Haidekker

Onions are susceptible to bacterial and fungal infections, most critically during the short harvest period from April to May. To allow for a year-round supply, onions are stored in controlled atmosphere facilities. Infected onions, even if no decay or damage is visible, put the entire harvest in the storage facility at risk. Early detection of bacterial and fungal infections is therefore highly desirable. In this pilot study, the authors used a low-cost, custom-built x-ray

computed tomography (CT) scanner to obtain cross-sectional images of yellow sweet Granex onions (*Allium cepa*) that were inoculated with pathogens. CT images were analyzed for features that could potentially be used to detect signs of pathogen-related decay in the early stages of infection. The long-term vision is to use CT scanners in an onion packinghouse to perform automated postharvest quality assessment.

*This summary includes text from the introduction of the article.*

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## ***Remote Estimation of Intra-Parcel Grape Quantity from Three-Dimensional Imagery Technique Using Ground-Based Microwave FMCW Radar***

(Summary)

Dominique Henry, Hervé Aubert, Thierry Véronèse, and Éric Serrano

For better benefits and yields, a good estimation of the quantity of grapes in a vineyard is necessary. In this paper, a three-dimensional (3D) imagery technique using conventional 24 GHz frequency-modulated continuous-wave (FMCW) radar is applied for detecting and remotely estimating the intra-parcel quantity of grapes. The microwave sensing is performed from the radar beam scanning of a vineyard, and an estimator is defined to derive the quantity of grapes in grapevines from the radar echoes distribution in the interrogated 3D scene. An algorithm based on contour detection is applied to the 3D radar image and a new parameter, called the *spread factor*, is defined for classifying the echo levels of grapes. The quantity of grapes is finally deduced from an appropriate estimator. This remote sensing approach brings a new and flexible solution for precision viticulture by estimating the grape quantity even for grapes hidden by leaves.

*This summary includes text from the introduction of the article.*

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## ***TDR Application for Moisture Content Estimation in Agri-Food Materials***

(Summary)

Andrea Cataldo, Egidio De Benedetto, Christof Huebner, and Dennis Trebbels

Cereals and legumes are invaluable resources, as they represent the raw materials of many foods and beverages. Cereals are also largely used as livestock feeds, thus indirectly influencing the quality of dairy products and meat. Because of their key role in human nutrition and well-being, the safety and quality of these agri-food materials are extremely important topics in food science. In this regard, moisture content is one of the ultimate factors influencing the quality, safety and price of the final food product; hence, it is crucial to monitor water content of materials in the food production line. Starting from these considerations, this paper describes the use of time domain reflectometry (TDR) for both in-line and off-line moisture content sensing of agri-food materials. In particular, after a brief description of the basic principles of TDR, two representative application cases for moisture content measurements of agri-food materials are reported and commented on.

*This summary includes text from introduction of the article.*

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## *Recent Developments in Stored Grain Sensors, Monitoring and Management Technology*

(Summary)

Chandra B. Singh and John M. Fielke

Up to one third of the total annual global production of grain (cereals, oil seeds, and pulses) is lost primarily due to poor post-harvest management. Lack of control over grain moisture content, temperature and insect infestations are the three most significant factors causing this loss. Recent technological advancements in grain storage condition monitoring and control are now helping to safely store grain for periods of several years with minimal quality loss. Grain moisture content and temperature are controlled by installing multiple temperature and humidity sensors in the grain that are used to automate drying and aeration fans. Storage headspace condition monitoring and exhaust fan operation are used to avoid condensation forming in the storage facility. CO<sub>2</sub> and insect trap monitoring are used to detect growth in insect numbers and indicate if a control treatment is needed. Fumigant concentration monitoring is used to ensure a lethal dose of insecticide or controlled atmosphere is applied for the required time to the grain. Only with this suite of sensors and controls can large volumes of grain be monitored and controlled to provide

economic safe storage of bulk grain and thus provide an increase in the amount of grain available for consumption.

*This summary includes text from introduction of the article.*

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## *Microwave Permittivity-Assisted Artificial Neural Networks for Determining Moisture Content of Chopped Alfalfa Forage*

(Summary)

Bijay L. Shrestha, Hugh C. Wood, Lope Tabil, Oon-Doo Baik, and Shahab Sokhansanj

Moisture content of a commercially important forage biomass such as alfalfa (*Medicago sativa*), is essential at various stages of production including harvesting, baling, storing, pelleting, and cubing. In this study, the dielectric constants and the dielectric loss factors of chopped alfalfa were measured with an open ended coaxial probe with 20 inputs for artificial neural networks. A three-layer neural network with 20 inputs, five hidden nodes, and one output for moisture content was built on an error back-propagation algorithm with momentum and adaptive learning techniques to predict the moisture content of alfalfa. The prediction of moisture content of alfalfa independent of bulk density in 12 seconds exhibited the potential of this technique in measuring the moisture content of alfalfa and other medicinal and cash crops in batch and in production moisture measurements.

*This summary includes text from introduction of the article.*

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## *Blood Oxygenation Measurement by Smartphone*

(Summary)

Domenico Luca Carnì, Domenico Grimaldi, Alfonso Nastro,  
Vitaliano Spagnuolo, and Francesco Lamonaca

An important evaluation index is arterial blood oxygenation (SO<sub>2</sub>%), defined as the percentage ratio of the concentration of oxygen-saturated hemoglobin to the total amount of hemoglobin.

Normal values of blood oxygenation are in the range 95-100%. The blood oxygenation values are usually obtained by gas chromatography or use of a pulse oximeter. Both of these techniques have negative characteristics for the patient. This paper presents a comparative analysis of a proposed smartphone application for home use and self-monitoring as a valid alternative to the pulse oximeter and gas chromatograph and provides an emphasis on the accuracy of the experimental results.

*This summary includes text from introduction of the article.*

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## *Columns*

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### *Basic Metrology*

(Summary)

#### **How to Measure a Lobster or Size an Egg**

*Richard Davis*

There are measurements in daily life where only certain points along a continuum need to be precisely known. Purchasing the least-expansive postage stamp for a letter has been a traditional example. In France (where I live), I can save a little money if I can be sure that my letter weighs less than 20 g. The post office does not care to know how much under 20 g. This type of less-than/greater-than measurement also turns out to be important when catching lobsters or selling hen eggs.

*This summary was written by the author.*

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### *Future Trends in I&M*

(Summary)

#### **Synchronized Measurement Technology: A Blessing for Power Systems**

*Markos Asprou*

The advent of phasor measurement units (PMU) has brought a new era in the field of power system monitoring and has defined the future trend of applications that the power-system control center will accommodate. Measuring features such as the fast reporting rate (50-100

measurements/s), synchronization of measurements through GPS signals, measurements of frequency and frequency rate of change, and the provision of phase measurements (instead of only magnitude measurements) were enough to set the synchronized measurement technology (SMT) and consequently the PMU as the key enablers for the *real-time monitoring* of power systems. In this column, the author discusses how he “strongly believes that SMT is a blessing for power systems. It expands the capabilities and the flexibility of the power system operators to react promptly in emergency situations, and it increases the reliability and security of the power systems. These are very important characteristics for such a critical infrastructure as the electricity network. In the future, power systems are expected to experience unprecedented changes in structure and operation, and I believe that SMT will be a part of those important changes.”

*This summary includes text from the article and first person text from its conclusion.*

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## *Departments*

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## *New Products*

Robert Goldberg

Please send all “New Products” information to:

Robert M. Goldberg

1360 Clifton Ave.

PMB 336

Clifton, NJ 07012 USA

E-mail: [r.goldberg@ieee.org](mailto:r.goldberg@ieee.org)

### **High-Power Programmable AC and DC Cabinet Test Systems**

Pacific Power Source has announced a complete range of high-power AFX Series integrated cabinet test systems. The systems consist of two or more integrated AFX ac and dc capable programmable power sources in a parallel configuration for power levels of 18 kVA and higher. All of the sources are completely prewired for ac input and AC/DC output and ready to use out of the crate. AFX power sources use a proprietary, all-digital, power conversion technology delivering much higher power density than previously available, allowing a 45 kVA system to fit in a 33-inch bench height cabinet, for example.

All AFX cabinet systems feature active power corrected ac input with a wide input voltage range that allows them to be deployed anywhere in the world. Voltage, waveform, current, power, phase and frequency are programmable with 99 non-volatile setups that can be stored for quick recall as part of a test protocol to reduce remote control overhead.

Other features and capabilities include a 15 Hz to 1200 Hz frequency range, single 300 VRMS constant power mode voltage range, programmable RMS or dc and peak current limit functions, and included PPSC Studio Windows control software. All of this capability is easily controlled by the user through an intuitive front panel with a large, full-color, LCD display. For ATE applications, the AFX series offers a LAN interface with LXI compliance and IVI instrument drivers.

Cabinet systems from 18 kVA to 45 kVA are packaged in a small, 33 in tall, 19 in cabinet with casters for easy mobility. Systems above 45 kVA are provided in a 56 in tall cabinet. Also available in kit form without a cabinet, these AFX systems can be integrated into a new or existing ATE system as needed.

For more information on the new AFX Series, visit the Pacific Power Source website at [www.pacificpower.com](http://www.pacificpower.com).

### **6 GHz Lab Oscilloscope for Multi-Domain Applications**

Rohde & Schwarz has added a new 6 GHz model to its R&S RTO2000 Oscilloscope series, opening up measurements on fast communications interfaces and IoT applications. The characteristics of the compact R&S RTO2000 lab oscilloscopes make them suitable for demanding measurement tasks such as power integrity measurements.

The new R&S RTO2000 model with 6 GHz bandwidth allows developers to test the radio interfaces of 802.11ac WLAN components for IoT modules in the 5 GHz band as well as fast communications interfaces such as USB 3.1 Gen 1 with data rates of 5 Gbit/s. With its multi-domain functionality, only a single compact instrument is needed to analyze power supplies,

processors and sensors with up to 6 GHz bandwidth. Synchronized time, frequency, protocol and logic analyses results allow users to debug at the system level.

Up to 16-bit vertical resolution in high definition mode enables developers to detect even the smallest of signal details. R&S claims the RTO2000 is the only oscilloscope to offer one million waveforms per second, allowing fast identification of even the most sporadic signal faults. The integrated spectrum analysis and spectrogram display make it possible to observe the signal path in the frequency domain as well as over time.

The zone trigger for the time and frequency domain supports developers in their day-to-day tasks. This unique function lets them isolate events graphically in the time and frequency domain, for example, to separate read and write messages from memory interfaces. The R&S RTO2000 offers a 2 Gsample memory, so users can analyze even long pulse and protocol sequences. They can also use the history function to retrieve previously acquired waveforms. The high-resolution, 12.1 in touchscreen and the color-coded controls make the R&S RTO2000 especially intuitive to use. The app cockpit provides direct access to all available applications, such as trigger and decoding functions, conformance and signal integrity tests, I/Q analysis and even customer-specific development tools.

For more information about Rohde & Schwarz oscilloscopes, visit [www.rohde-schwarz.com/ad/press/rto2000](http://www.rohde-schwarz.com/ad/press/rto2000).

### **High-Density 2 Amp PXI Multiplexers**

Pickering Interfaces expands their range of High-Density 2 Amp PXI Multiplexers with this new range of High-Density 2 Amp PXI Multiplexers (40-614 family). They are available in 20 different configurations and are designed for signal routing in Automatic Test Equipment (ATE) and data acquisition systems. The range uses high-quality electromechanical signal relays, allowing each channel to switch current up to 2 Amps and voltage up to 200 VDC/140 VAC.

These PXI Multiplexers may be operated as conventional multiplexers with break-before-make action when a new channel is selected. In addition, multiple channels may be simultaneously selected on the 2, 4, 8, 16 and 32-pole versions. Large multiplexers may be constructed by daisy-chaining the common signals from multiple PXI modules.

The product range is also supported by several Pickering software and hardware tools; eBIRST Switching System Test Tools - these tools provide a quick and simple way of finding relay failures within the modules; and Switch Path Manager, for simplified signal routing through complex switching systems.

Additional information is supplied on their website at [www.pickeringtest.com](http://www.pickeringtest.com).

### **New Software for PicoScope Oscilloscopes**

Pico Technology has added CAN FD decoding to its PicoScope 6 software. This software, available free of charge for all PicoScope oscilloscopes, delivers advanced features such as serial decoding, channel math, mask limit testing and spectrum analysis, while maintaining a clear, uncluttered display with easy-to-use controls.

Serial decoding is an essential component of the PicoScope software and allows you to see the decoded data on the same timebase as the analog waveforms. Bit fields within frames are color-coded for easier identification, with errors highlighted in red. Click on a decoded frame, and PicoScope instantly highlights the same data in a table below the waveform. You can search and sort the decoded data, export it in text format, and display optional measurements such as peak voltage, packet duration and start and stop times.

PicoScope 6 runs on Windows PC, making it easy to share waveforms – just email a “.psdata” file or a screen shot. You can also export waveform data in a range of binary and text formats.

PicoScope 6.12.7 is available for download now, free of charge, from [picotech.com](http://picotech.com). It runs on Windows 7, 8 and 10, 32-bit or 64-bit, and is compatible with all PicoScope oscilloscopes.

More information on Pico Technology can be found at: [www.picotech.com](http://www.picotech.com).

### **New PXIe Test Instruments**

Astronics Test Systems has introduced two new test instruments. The new PXIe-1802 Arbitrary Waveform Generator and the new PXIe-1803 Digitizer deliver advanced test capabilities and measurement accuracy in a compact, robust PXI form factor for aerospace, defense, communications, and other high-reliability applications.

The PXIe-1802 Arbitrary Waveform Generator (AWG) offers both speed and performance for output frequencies of up to 125 MHz. With built-in waveforms, high signal quality, high density and modularity and a host of other convenient features, this AWG delivers dual 14/16-bit waveform generator channels, bandwidths of 90-140 MHz, synchronization, and 250  $\mu$ V measurement accuracy.

The PXIe-1803 is a 130/180 MS/s dual-channel digitizer providing industry-leading speed and performance for input frequencies up to 175 MHz. With notable signal integrity, high density, and modularity, this new digitizer provides a dual-channel 14/16-bit digitizer configurable as separate or fully synchronized channels. Other features include waveform bandwidths of 65-175 MHz (typical), 64 Megabytes of waveform memory per channel, and relative accuracy of up to 0.006%.

For more information, visit [www.astronics.com](http://www.astronics.com).

### **Thermographically-Calibrated Thermal Camera**

Sierra-Olympic Technologies infrared (IR) and thermal imaging components, cameras, and systems solutions for innovative imaging applications, introduces the affordable Viento-GT, an easy-to-use, thermographically-calibrated thermal camera. Available in two form factors, enclosed or split board, the feature-rich thermal imager is available with either 320 x 240 or 640 x 480 pixel resolution. The Viento-GT is a highly reliable, high resolution and low-cost thermal imager that can deliver thermographically-calibrated digital data for every pixel. The

camera is easy to power and control via a single Ethernet cable using the Gig-E Vision® and Power over Ethernet (PoE) standards.

Applications include temperature measurement, aka thermography, real-time process monitoring, non-destructive testing (NDT), hot-spot detection, bio and medical imaging, industrial inspection, quality control and assurance. With proprietary image contrast enhancement (ICE) and a wide array of lens options, the compact, low-power Viento-GT is suitable for thermal monitoring applications where affordability and high performance are key considerations. The Viento-GT thermal camera comes with a 1-year warranty.

For more information and to learn about easy export camera models, please visit <http://www.sierraolympic.com/products/lwir-optics/viento-thermal/>.

### **New CW UV Laser at 266 nm**

TOPTICA launches their first member of the new TopWave ultraviolet CW laser series that aims at industrial applications. The “TopWave 266” provides 150 mW CW output power at a wavelength of 266 nm and < 1 MHz linewidth. It stands out with excellent power stability, ultra-low noise operation and a premium beam quality.

The TopWave laser series incorporates successful building blocks from TOPTICA’s scientific tunable UV lasers (e.g., the SUV cavity design) and takes the performance of these lasers to a plug-and-play level. The entire UV beam path is enclosed in an especially sealed compartment. In combination with a fully automated shifter of the SHG crystal this enables a typical lifetime > 10,000 hours, which is key for the use in any industrial application.

Due to its reliability and industrial endurance behavior, the TopWave is a notable addition to the CW DUV laser market. Future power upgrades and additional TopWave models with other UV wavelengths will be released in the near future. The TopWave product line is well suited for applications like semiconductor inspection, optical lithography, Laser mastering and Raman spectroscopy.

Find more information at [www.toptica.com](http://www.toptica.com).

### **Laser Scanning Technology for Portable Coordinate Measurement Arm**

Hexagon Manufacturing Intelligence has announced that its new laser scanning technology is available for the portable ROMER Absolute Arm with Integrated Scanner (SI) series. The innovative RS4 scanner offers completely new optics and electronics, delivering a major performance leap with a scan rate nearly 60 percent faster than the previous model. The fully integrated scanner is optimized for measuring objects with challenging surfaces such as carbon fiber or machined steel. The complete scanning system delivers accuracy that is fully verifiable and traceable, ensuring complete confidence in the exactness of measurement results. The ROMER Absolute Arm SI with the RS4 scanner is suited for point-cloud inspection, product benchmarking, reverse engineering, rapid prototyping, virtual assembly and CNC milling. The solution provides tactile and non-contact dimensional measurements for applications in aerospace, automotive, power generation, medical, heavy equipment, defense, consumer products, and more.

The new RS4 scanner introduces an ultra-wide laser line nearly double the width of its predecessor, which translates to larger surface coverage and faster data collection. With a higher point resolution, ROMER users can obtain greater point cloud detail in significantly less time during a scanning session. The newly designed profile of the RS4 also allows users to scan more deeply into difficult-to-reach cavities than ever before, with no reduction in accuracy performance. Users of the portable measuring arm can switch seamlessly between tactile probe measurements and laser scanning to acquire 3D point data from a wide variety of surface types. As with every ROMER Absolute Arm model, scanner warm-up and time-consuming calibrations are not required, dramatically reducing set-up time. Hexagon Manufacturing Intelligence is the only metrology OEM in the marketplace that certifies volumetric performance of its arm/scanner combination.

The new laser scanner is available as a retro-fit product for existing ROMER Absolute Arm SI owners looking to upgrade their scanning performance. For more information, visit [www.HexagonMI.com](http://www.HexagonMI.com).

### **Mini Linear Positioning Stage**

The L-402 compact linear stage is the newest addition to the suite of motion control solutions available from PI (Physik Instrumente). This affordable miniature linear positioner is suited for micromanipulation, test systems, and opto-mechanical alignment automation applications.

With a travel range of 0.5 in (13 mm) and velocity to 0.2 in/second (5 mm/sec), the L-402 delivers high accuracy and smooth motion for loads up to 11lb with minimum incremental motion and repeatability down to 0.5 microns. The closed-loop version provides encoder resolution of 0.12 microns. Long service life and excellent guiding accuracy with minimum backlash are guaranteed by creep-free crossed roller bearings. The clever stage design allows for XY and XYZ stack configurations without the need for adapter plates.

The stage comes with the choice of two direct-drive motors, a dc servo motor with closed-loop encoder and 2-phase stepper motor. Other encoder options for OEMs are also available.

Noncontact, optical limit switches and reference point switches with direction sensing in the middle of the travel range simplify use in automation tasks.

Find more information at [www.pi-sa.us/products/Compact\\_Positioning\\_Stages/index.php#L402](http://www.pi-sa.us/products/Compact_Positioning_Stages/index.php#L402).

### **Boundary Scan Products**

A large number of today's electronic designs feature JTAG/boundary-scan components that provide valuable test resources during hardware debug, manufacturing test and even depot repair. JTAG Maps is a simple extension to the Altium Designer tool suite that allows the user/engineer to thoroughly assess the capabilities of the JTAG/boundary-scan resources on their design - before committing to layout.

Until now engineers could often spend hours highlighting the boundary-scan nets of a design manually to assess the fault coverage that boundary-scan testing could bring a specific design.

Today the free JTAG Maps for Altium, application extension, does all this and more, freeing up valuable time and allowing a more thorough design-for-test and speeding time to market.

Boundary-scan device models (BSDLs) are pivotal to any JTAG/boundary-scan process as they indicate precisely which pins can be controlled or observed by JTAG/boundary-scan. However, BSDL models are not always available in a timely manner. To overcome this potential problem, JTAG Maps for Altium includes an 'assume scan covered' feature enabling a view of potential boundary-scan coverage without a specific BSDL. This feature can also be used to indicate fault coverage to a connector (set to assume scan covered) or to highlight the differences in fault coverage between two equivalent parts, one with and one without built-in JTAG/boundary-scan.

JTAG Maps for Altium will automatically detect the scan chain path (or paths) with no limits to the number of paths (aka TAPs) in the design. The nets associated with the TAPs will be highlighted separately from the 'testable' nets using different colors.

While most users will want to simply use the quick coverage report that JTAG Maps for Altium can provide, it is still possible to import a more accurate picture. After exporting a JTAG ProVision project, the data can be sent to your local JTAG Technologies office, Approved Application Provider, or approved JTAG representative for further analysis. A simple message file containing full fault-coverage information can then be read back into JTAG Maps for display/highlighting.

For more information, please visit [www.jtag.com](http://www.jtag.com).

### **Unprecedented Infrared Emissivity for Blackbodies and Cold Shields**

Santa Barbara Infrared, Inc. announces a new ultra-black surface coating technology that improves infrared emissivity in the midwave-infrared (MWIR) and longwave-infrared (LWIR) spectral wavelengths. The unprecedented effective emissivity utilizes the Vantablack® S-VIS coating from Surrey NanoSystems (United Kingdom) for blackbody calibration sources and cold shields. In the MWIR (from 3 to 5 microns), emissivity is greater than 99.8 percent ( $\pm 0.1$  percent); in the LWIR (from 8 to 12 microns), it is greater than 99.5 percent ( $\pm 0.15$  percent).

SBIR now offers the Vantablack coating for terrestrial blackbody applications worldwide under an exclusive licensing agreement with Surrey NanoSystems.

Vantablack is the world's blackest surface coating material for the ultraviolet (UV) to far-infrared (FIR) spectrum. It employs an innovative nanomaterial structure that absorbs virtually all incident light. Developed for space-borne imaging applications, it offers exceptional IR absorption and excellent thermal, mechanical and environmental stability, making it ideal for the most demanding applications. The new material has already achieved space heritage with its recent deployment on an Earth-observation satellite.

The previously-unachievable emissivity levels on a flat-plate blackbody source provide improved radiometric accuracy for the calibration of IR cameras. Additionally, stray light reduction in baffles for cold-shield designs and IR radiation applications will also benefit from this novel technology.

For a close-up view of a Vantablack coating, go to: [www.youtube.com/watch?v=PGjJLl2JYpE](http://www.youtube.com/watch?v=PGjJLl2JYpE). For more information about Santa Barbara Infrared's blackening coating technology for blackbodies and cold shields, please visit: [www.sbir.com](http://www.sbir.com).

### **Monitor System Voltages**

The Texas Instrument TPS3890 is a precision voltage supervisor with low-quiescent current that monitors system voltages as low as 1.15 V, asserting an open-drain RESET signal when the SENSE voltage drops below a preset threshold or when the manual reset (MR) pin drops to a logic low. The RESET output remains low for the user-adjustable delay time after the SENSE voltage and manual reset (MR) return above the respective thresholds. The TPS3890 family uses a precision reference to achieve 1% threshold accuracy. The reset delay time can be user-adjusted between 40  $\mu$ s and 30 s by connecting the CT pin to an external capacitor. The TPS3890 has a very low quiescent current of 2.1  $\mu$ A and is available in a small 1.5-mm  $\times$  1.5-mm package, making the device well-suited for battery-powered and space-constrained applications. The device is fully specified over a temperature range of  $-40$   $^{\circ}$ C to  $+125$   $^{\circ}$ C (TJ).

Find more information at [www.ti.com/product/TPS3890/datasheet](http://www.ti.com/product/TPS3890/datasheet).

### **Square Body Gas Discharge Tubes Protect Against Overvoltage Transients**

Littelfuse, Inc. introduces the smallest (5.0×5.0×4.2 mm) squared Gas Discharge Tube (GDT) with a 5 kA surge capability and a  $\leq 0.7$  pF off-state capacitance value available in the market today. The SH Series GDT is designed to provide high levels of protection against fast-rising transients caused by lightning disturbances. Its low off-state capacitance is compatible with high bandwidth applications and this capacitance loading value does not vary if the signal voltage across the GDT changes. It was specifically designed for protection of electrical, multimedia, and communication equipment against overvoltage transients.

SH Series Gas Discharge Tubes offer these key benefits:

- High surge withstand capability in a miniature package makes them ideal for high surge, high density layout applications such as radio base station power and cable modems.
- Low off-state capacitance ( $\leq 0.7$  pF) minimizes insertion loss. Also, this value does not vary as the signal voltage varies, so it does not demodulate the signal of interest. These features make it compatible with high speed, wide bandwidth applications such as G.fast, xDSL equipment, and cable modems.
- The square body and terminals of the SH Series make the pick and place process simpler during automated PCB manufacturing, compared to cylindrical body GDTs.

For more information, please visit [www.Littelfuse.com](http://www.Littelfuse.com).