

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

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*Big Data in Instrumentation and Measurement*

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*Editorial*

**Big Data in I&M**

Who could have imagined in the year 1950, when the first mainframes were introduced and data was stored on paper cards, that now we would each have our own personal computer with several gigabytes of memory storage?

Every day people are using inexpensive devices like cameras, smartphones, and Wi-Fi-controllable devices which generate huge amounts of data. This data is stored and then analyzed later on. Think about the enormous amount of pictures that we all have on our smartphones... Which ones are useful and shall we keep?

In fact, we are facing the exact same kind of problems with our measurement devices... Today, the volume of captured data from measurement devices is so huge that we face issues that make its handling and processing a new challenge. Which data is correct, useful and shall we analyze?

The amount is that big that one computer is no longer able to process this data, and more and more, we are introducing 'parallel computing' running on several servers and personal computers. Data enough to spend an issue on this important topic...

Our Guest Editor for this issue of *I&M Magazine* is Professor Dario Petri. He is the Head of the Department of Information Engineering and Computer Science at the University of Trento, Italy and an expert in signal processing and analysis. It was a great pleasure and honor to work with him, and I would like to take the opportunity to thank him for his dedication and valuable time.

Enjoy this *Big* issue!

Groetjes,

Wendy

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## *Guest Editorial*

### **Big Data in Instrumentation and Measurement**

Dario Petri

The recent rapid growth of information-gathering technologies—from health tracking sensors to smartphones and satellites—produce massive amounts of data from the real world. Similarly, a huge amount of data is steadily collected from the cyber world as a result of internet technologies. In such a context, the “Big Data” phenomenon is expected to have a dramatic impact on society. Indeed, evidence resulting from Big Data is going to support decisions that have the potential to solve big societal problems, boost billion dollar businesses or simply make our everyday lives easier. However, ensuring and understanding the quality of data is crucial to achieve these goals. On one hand, metrology—a science of information quality—is at the very heart of data science. On the other hand, data science could open a new era for measurement science.

This special issue of *Instrumentation and Measurement Magazine* is focused on the relevance of the metrology culture and expertise for a data scientist. The paper “The Metrological Culture in the Context of Big Data: Managing Data-Driven Decision Confidence,” co-authored by Luca Mari and myself, deals with the need for a sound knowledge of measurement fundamentals to manage the risk of wrong decisions. In particular, a model that synthesizes the structure of data-driven decision processes is proposed. It facilitates both the identification of uncertainty sources and the assessment of their impact on decision confidence.

The paper “The Metrologist's Place is by the Machines!” by Jean-Michel Pou illustrates how the massive changes in business organizations driven by data, information and communication technologies is redefining the role of industrial metrologists. Indeed they not only have to

provide conformity to the requirements of existing regulations and traceability to national measurement standards, but they also have to ensure quality of data so that company decisions can be effectively supported by real-world information.

The essential role of data quality for business organizations is also emphasized in the paper “Big Data at Work: A Practitioner's Point of View” by Francesco Mari and Paolo Masini. In this paper, after explaining the main concepts related to Big Data, the authors highlight some major issues that must be addressed to transform data into sustainable business results. They discuss that the “data deluge” makes the metrological culture even more socially important than in the past, since it is crucial to enable the extraction of actionable and valuable knowledge from data.

When dealing with Big Data, we cannot miss considering possible legal issues. The paper “Big Data or Big (Privacy) Problem?” by Veronica Scotti covers the most important and currently critical legal implications concerning data, those of privacy. The author advises that the incorrect use of uncertain data and the lack of data validation may expose significant legal consequences. Hence, caution is always mandatory when dealing with Big Data.

I hope that the content of this special issue can catch the interest of magazine readers, especially those involved in the challenging, exciting and promising world of Big Data.

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## *Article Summaries*

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### *The Metrological Culture in the Context of Big Data: Managing Data-Driven Decision Confidence*

(Summary)

Luca Mari and Dario Petri

A main driver of the Big Data phenomenon is the importance attributed to information in supporting Decision Making, both when data is interpreted and processed by *a priori* interpretive models (weak-Data-driven decision making- D3M) or when “data speaks by itself,” since blind analysis methods are used (strong-Data-driven decision making- D3M). In particular, the latter

situation is expected to enable new strategies of making effective decisions in the empirical world, even though the lack of predefined interpretive models of the phenomenon at stake may strongly increase the risk of wrong decisions. This paper aimed at showing that a sound knowledge of measurement fundamentals can be helpful in managing such a risk, since it makes people aware about possible uncertainty sources and their effect on the confidence of the conclusions they draw. Specifically, a simplified model that synthesizes the structure of a D3M process has been proposed by identifying three main process stages: information generation, information processing, and decision making. Applying approaches used in the context of metrology, the main contributions that may affect the confidence of the final decision have been identified and highlighted in a D3M model.

*This text is from conclusion of the article.*

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## *The Metrologist's Place is by the Machines!*

(Summary)

Jean-Michel Pou

Industry 4.0, smart objects, new versions of ISO 9001 and 17025 standards, and so on... massive changes are taking place in companies that, as a result, are learning to be increasingly agile and responsive. It is time for metrology to remodel itself to keep pace. Smart Metrology needs to go beyond the role of ensuring conformity to regulatory standards and traceability to national measurement standards to gain the approval of auditors and focus its energy upon the true essential consideration: *the quality of the measurements made within a company!* Big Data is taking hold in companies that are conscious of the new possibilities (storage and analysis of massive data sets), but as a matter of fact, analysis can only give conclusive results if the data are reliable. New data are being produced every day, and the sooner metrologists grab their true place, 'out in the field,' the sooner they will be ready to assume a useful role in Big Data.

*This text is from the introduction and conclusion of the article.*

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## *Big-Data at Work: The Practitioners' Point of View*

(Summary)

Francesco Mari and Paolo Masini

Significant investments have been made in Big Data, and “many organizations are now looking at how to transform them into a source of sustainable value.” In this paper, the authors highlight some of the relevant issues, “looking at the intersection between Big Data and the IoT: how to organize the data for effective consumption, how to deal with questionable and uncertain data quality, and how to extract actionable and valuable knowledge from the data. Big Data creates new perspectives on the quantity vs. quality issue, but it is surely not a magic wand that improves data quality thanks to their quantity. Rather, the “data deluge” makes a basic metrological culture even more socially important for an appropriate understanding on the criteria of reliability of data in decision making.”

*This text is from the conclusion of the article.*

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## ***Big Data or Big (Privacy) Problem?***

(Summary)

Veronica Scotti

Big data offer a big opportunity of growth for probably all human activities, since they make available important data collected in distant places (both in space and time) virtually to everybody who has access to the internet. On the other hand, big data may also present problems that, if not properly addressed, may yield legal consequences to those who have been implied in data collection, validation, publication and utilization. This paper covered the most important and, up to now, the most widely considered consequence: privacy. It has also warned that the lack of validation of the posted data and their incautious use may expose liable subjects to legal consequences. To make things even more complex, it has also shown that the potentially liable subjects have not yet been fully identified. Therefore, caution is mandatory when dealing with big data!

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***How Synchronization Evolved from Analog to Digital in the TLC World***

(Summary)

Franco Baroncini and Simona Salicone

This paper has briefly described how telecommunications (TLC) has changed in the last decades, passing from the analog to the digital era, from the Frequency Domain to the Time Domain. The history of Plesiochronous Digital Hierarchy (PDH) is introduced, and how it is now almost completely substituted by the Synchronous Digital Hierarchy (SDH). “It is the authors' opinion that synchronization is one of the most challenging areas of interest of today and the coming years.”

*This summary includes text from the article.*

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### *Implementation of an 8-bit ADC Using Successive Subtraction Technique*

(Summary)

Sayantana Sinha

In this article, an 8-bit ADC circuit is proposed, using op amps in successive subtraction method. This circuit does not require any clock signal, internal DAC or decoder, etc. because it performs the conversion process completely in the analog domain. Applying a supply voltage of  $\pm 6$  V, it consumes 242 mW power and the settling time is measured as 156  $\mu$ s. The algorithm of this proposed ADC is somewhat similar to that of the successive approximation register (SAR) type ADC, although the circuitry is quite different and of asynchronous type like flash ADC. Because this ADC requires only  $(2n - 1)$  op amps, it is less expensive than a flash ADC but this comes at the expense of the speed of conversion.

*This text is from the introduction of the article.*

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### *Bandwidth-Efficient Synchronization for Fiber Optic Transmission: System Performance Measurements*

(Summary)

Oluyemi Omomukuyo, Octavia A. Dobre, Ramachandran Venkatesan,  
and Telex M. N. Ngatched

By any measure, the various services and applications which are crucial to today's society rely on fast, efficient, and reliable information exchange. Nowadays, most of this information traffic is carried over long distances by optical fiber, which has intrinsic advantages such as wide transmission bandwidth and low attenuation. However, continuing traffic growth has imposed many challenges, especially for equipment manufacturers who have to develop optical transmission solutions to handle the demand for higher data rates without incurring increased capital and operational costs. A feasible approach to overcoming these challenges is to scale the channel capacity by employing orthogonal frequency division multiplexing (OFDM) super-channels. In this article, the authors provide a brief overview of optical transmission systems and some of their performance specifications. They then present a simple, robust, and bandwidth-efficient OFDM synchronization method and carry out measurements to validate the presented synchronization method with the aid of an experimental setup.

*This text is from introduction of the article.*

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## *Photonics Enhanced Sensors for Food Monitoring: Part 3*

(Summary)

Wendy Meulebroeck, Hugo Thienpont, and Heidi Ottevaere

Food quality and food safety are gaining more and more importance in recent decades. In particular, applications have included domains such as the identification of foreign bodies in solid food streams, the quality screening of vegetables and fruits, the recognition of food products inducing a health risk and the monitoring of the quality and authentication of liquids. In the first part of this three-part series, the authors we described the theoretical aspects of the various physical phenomena that can occur during food screening, together with their related measurement set-ups, data-processing steps and the concerned sensing platforms. Part 2 covered the main application domains of foreign body identification. This final paper discusses seven concrete case studies that demonstrate the usefulness of optical screening methods to perform the quality screening of solid food products and the quality monitoring and authentication of liquids.

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*Columns*

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## *Future Trends in I&M*

(Summary)

### **Future Trends in Security for Instrumentation and Measurement**

Irina Florea

The main goal of this article is to understand that the biggest challenge of the present might be developing a solution that would allow secure instrumentation and making secure measurements for the future. By creating and developing security protocols, one can focus more on what is important, like understanding values being measured, rather than how to protect information after an “attack” has taken place. Learning from past experiences is definitely the most important lesson to ensure a secure future. If a few years ago uncertainty was the main issue that preoccupied the instrumentation industry, nowadays we come across a bigger challenge and that is how to prevent your measured data from getting into the wrong hands!

*This summary includes text from the column.*

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## *Basic Metrology*

(Summary)

### **The Story of Invar**

Richard Davis

Material properties are affected by temperature. This can be a major obstacle when, for instance, measuring precise lengths with a metal ruler. If the ruler was calibrated by one laboratory at a reference temperature—say 15 °C—but then used at a different temperature in another laboratory, then the calibration certificate might include the value of the ruler’s coefficient of thermal expansion, so that a correction could be made for the thermal expansion between the lower and higher temperatures. But what if the second “laboratory” was not a laboratory at all? What if it was an open field and the length to be measured was a 10 km geodesic baseline needed for surveying? This was a serious problem from the late 19th century to the late 20th century.

## *Society News*

The Administrative Committee (AdCom) of the IEEE Instrumentation and Measurement Society (IMS) met in May, 2017 immediately after the I<sup>2</sup>MTC, to advance our mission to:

- Provide the most *comprehensive* and *high-quality* services to our members and related professionals
- Serve as the professional *incubator* for the *growth* of all (particularly younger) members
- Be in the *forefront* of future I&M fundamental, technological, and application advances, and
- Provide education in the field of instrumentation and measurement.

Each of the AdCom committees conducted a meeting, and the full AdCom reviewed each committee's recommendations and decided on actions for the future. The following reports are organized by committee.

### **Membership Development Committee - Sergio Rapuano**

We experienced excellent growth in the past few years in both the number of new chapters formed and participation in our annual Chapter Chair Summit at I<sup>2</sup>MTC. The consistent attendance at the Summit has led to stronger and more engaged chapters. A report from this year's successful Chapter Chair Summit will be published in the December *I&M Magazine*. In particular, we are experiencing a significant growth in the Student Branch Chapters from Region 10.

A new Africa initiative was implemented in collaboration with the Finance Committee that aims to improve services to our members from that continent and form new chapters there.

The Chapter Development Program is now fully operational, and because of the number of funding requests received, the AdCom allocated additional funds to this program.

The Chapter Outreach Program is now nurturing five new chapters that were formed between 2014 and 2016. This program helps new chapters get started by designating a mentor for the chapter who attends a kick-off meeting, stays in regular contact with the Chapter Chair, and may periodically visit the chapter.

Several parallel events were organized during I<sup>2</sup>MTC 2017 for our affinity groups. These included a Women in Engineering panel, a Young Professional panel and meet-up event, and a Graduate Student meeting, all of which were well attended.

### **Publications Committee - Zheng Liu**

In 2017, the Publication Committee members have continued to work with the EICs to provide high-quality publications that serve our members and the wider I&M community. Together with the Society Management Committee, the Publications Committee successfully finished the IEEE five-year Publication Review as well as provided input for the publication section of the five-year Society Review. The *Transactions*' website implemented the Open Researcher and Contributor ID (ORCID) as part of the paper submission process in compliance with IEEE's policy. The advertising revenue of the *I&M Magazine* has increased 9.5% from the previous year. According to the recently released Journal Citation Report, the *Transactions on Instrumentation and Measurement* is ranked in Quarter 1 (Q1) of the Instruments & Instrumentation (I&I) category, and it is the only journal in Q1 of both the I&I and the Essential Science Indicators (ESI). The *Transactions*' Impact Factor has increased from 1.808 to 2.456, and the Impact Factor of the *I&M Magazine* has increased from 0.759 to 1.438. The committee will further enhance the connection with the society members through the IMS's publications in the coming year.

### **Conferences Committee - Chi Hung Hwang**

We wish to thank Sergio Rapuano and Ruqiang Yan for organizing the Chapter Chair Summit and the Technical Committee Chair meeting during I<sup>2</sup>MTC 2017. These were two great opportunities to meet with those who serve as either Chapter Chairs or Technical Committee Chairs and share with them the Conference Sponsorship Policies and the Society Conferences Management Guidelines. The Conferences Management Guidelines provide details about the

procedures for requesting a conference sponsorship from the IMS. These Guidelines include best practices for developing an organizing committee and managing a conference, and they help ensure that each conference is of the highest possible quality. In addition, the meetings included information on how the Conferences Committee serves our IMS members. We also were pleased to learn that chapters and TCs are initiating new technical events that cross several technical areas of interest and disciplines.

The Conferences Committee also made changes to the scope, plans and metrics for its portion of the Society Strategic Plan. In alignment with the core values of the IMS, the Conferences Committee will be taking a more proactive approach as part of its plans. It will work closely with the Technical and Standards Activities Committee and the Education Committee to identify emerging topics in instrumentation and measurement and to sponsor new events on these topics. The committee also agreed to invite all authors of *TIM*-published papers during 2017 to present their work at I<sup>2</sup>MTC 2018 as part of a pilot project. If the pilot project is successful, it will be implemented as part of future IMS conferences. In addition, the steering committee of SAS has proposed an SAS Handbook, which has been approved. This handbook will serve as an example for other IMS conferences to use and implement as part of the future management for their conferences. The handbook provides best practices learned from previous SAS offerings and will serve as guidelines for future events. The Conferences Committee members are continuing to work together to improve the quality of each of our conferences. Please feel free to contact any members of the Conferences Committee to share your ideas.

### **I<sup>2</sup>MTC Board of Directors - Reza Zoughi**

The IEEE International Instrumentation and Measurement Technology Conference (I<sup>2</sup>MTC) Board of Directors met at the conclusion of the I<sup>2</sup>MTC 2017 to receive updates from organizers of future conferences, as well as to select the venue for the 2020 conference. Updates were received by the general or general co-chairs of I<sup>2</sup>MTC 2017 (Turin, Italy), 2018 (Houston, TX, USA) and 2019 (Auckland, New Zealand). I<sup>2</sup>MTC 2017 in Turin was considered quite successful despite the short preparation time associated with this meeting. Organization of I<sup>2</sup>MTC 2018 is on track. This will mark the first time since 2013 that this conference will be held in the USA. Several new initiatives are being considered for implementation at this conference to

enhance the value and quality of the meeting and to provide an expanded experience for the attendees (visit the conference website at <http://imtc.ieee-ims.org/>). The organization of I<sup>2</sup>MTC 2019 is also on track. The organizing committee is expeditiously conducting all of the necessary tasks to ensure another successful conference in Region 10. After a successful bidding process for I<sup>2</sup>MTC 2020, and down-selection of potential sites to Washington, DC, USA, and Dubrovnik, Croatia, Dubrovnik was selected by the Board. As we look ahead towards these future meetings, we encourage our IMS members to consider attending these I<sup>2</sup>MTC meetings and suggest their colleagues (particularly those who would be new to I<sup>2</sup>MTC) attend as well.

### **Education Committee - Salvatore Baglio**

The Education Committee modified its mission to broaden the targets for educational services. The new mission begins with the following: “Provide the most *comprehensive* and *high-quality educational* services to the society, to IEEE and IMS members and to related professionals.”

The current goals and activities were divided into several categories: initiatives that are stable and simply need to be continued, those that have been started and need to be stabilized, and those that need to be started. The “need to be continued” category includes the successful Distinguished Lecturers program, the Tutorials program and the Education awards (Graduate Fellowship and Faculty Course Development Awards).

The Video Tutorials program is off to a great start but needs to be stabilized to assure it continues to provide value on new topics. At I<sup>2</sup>MTC2017 in Turin, we recorded five new tutorials that will be posted soon on both the IEEE TV and the IMS website. New opportunities to record tutorials will be provided at the IMS major conferences. Likewise, the “Meet the Instrumentation and Measurement Society” One-Day Workshops have had a strong beginning with events in Mexico and Taiwan, but new locations and corporate partnerships need to be established to assure these workshops reach new audiences. Stabilization will involve rigorous use of established metrics to evaluate the impact of each program on our members.

In the “need to be started” category, the Education Committee is working with the IEEE Sensors Council to organize two sessions of a student Sensors and Measurement System design contest that will encourage work in our fields of expertise. Students will be provided with a

development-board kit and challenged to create a unique application that will be judged at one of two conferences. Awards will be provided to the winners of the contest at each conference.

Please check the Education section of the IMS website for details.

The Education Committee will continue to review all its initiatives based on quantitative metrics.

### **Technical and Standards Activities Committee (TSAC) - Ruqiang Yan**

The Technical Committee (TC) Chairs meeting was held at I<sup>2</sup>MTC 2017, with eight TC Chairs in attendance. There was a discussion regarding how TCs can work together with the Conference Committee to promote various conferences. Fostering links with industry also was discussed. The TSAC actively encouraged TCs to propose special sessions for I<sup>2</sup>MTC 2017, and three special sessions were accepted. To recognize the contributions to the IMS from the TCs, IEEE certificates were sent out electronically to each of the TC members. We were especially pleased to recognize TC-39 as the recipient of the first Outstanding TC Award. Six TCs have active Project Authorization Requests (PARs), which are the means by which standards projects are started within the IEEE-SA. PARs define the scope, purpose, and contact points for the new project.

The TSAC continuously monitors TC activity, and currently there are 19 active TCs within the society. A new TC-42 Photonic Technology in Instrumentation and Measurement was approved upon submission of the proper documentation per our guidelines. This new TC provided a detailed plan on its future activities. Plans include advertising TC activities to all IMS members in the *I&M Magazine* and newsletter. A Standards webpage attached to the IMS webpage and a specific set of instructions will be developed to assist TCs who wish to start a conference. The IMS has an active and productive family of TCs!

### **Finance - Dario Petri**

The IMS mission is to promote the advancement of science, technology and applications in the I&M and related fields. This mission is implemented through a diverse set of technical activities performed by the volunteer members and “business” activities such as organizing meetings and

conferences, publishing periodicals, developing technical standards, and providing membership and educational support services.

The Finance Committee's mission is to provide the IMS's Administrative Committee (AdCom) with fiscally sound annual budgets to enable it to make effective decisions and optimize the quantity and quality of products and services provided to the members and the broader instrumentation-and-measurement community. Many of the IMS's activities are not revenue-producing, and thus must be subsidized by the revenue generated by publication subscriptions, conference fees, and membership dues.

In 2017, the total IMS revenue is expected to be approximately \$2.1M, with a year-ending balance close to zero, thus achieving the desired balance between revenue and expenses expected by a non-profit organization like the IMS. IMS publication income and expenses are expected to be approximately \$760K and \$620K, respectively. Income from membership fees is approximately \$90K. Conferences and workshops income and expenses are approximately \$1.06M and \$620K, respectively. The IEEE infrastructure dues are close to \$300K. AdCom expenses for volunteer support and investments in memberships, awards, chapter support, educational activities, and technical activities are approximately \$410K. The current reserves that insure the IMS against budget loss are close to \$2M.

### **Society Management Committee - Max Cortner**

The Society Management Committee is charged with coordinating all operational matters within the AdCom. One of those important tasks is reviewing and updating our governing documents. A number of changes to the Constitution and Bylaws were presented and voted on by the AdCom so that the quorum, election and officer-replacement sections were aligned with IEEE guidelines. The AdCom also voted to approve co-sponsorship of the *IEEE Journal on Miniaturization for Air & Space Systems* (J-MASS) once it receives final approval by IEEE TAB. In view of one of the recommendations from the IEEE Five-Year Publications Review to develop a publicity campaign for our publications, a motion was approved at the Spring AdCom meeting to allocate 50%-rule funds for this purpose. If the previous year's net operating balance is positive, 50% of that positive balance is made available in the next year to be spent on

additional activities not already included in the budget. Thus, this additional funding amount is called the 50%-rule funds. Since in 2016 we did have a positive balance, 50%-rule funds were available to support this additional activity.

In view of the lengthy travel required of AdCom members for some meetings, a motion was passed to allow those on flights of 8 hours or more to be reimbursed for “economy comfort,” “economy plus” or “premier seating” fees, which provide seats with extra legroom. This does not change the policy for business class or first-class seating, which requires special approval per IEEE rules.

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## *Departments*

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## *New Products*

Robert Goldberg

Please send all “New Products” information to:

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### **Portable Oscilloscope Supports Automotive Test**

Rohde & Schwarz has enhanced its R&S Scope Rider, adding triggering and decoding software for the CAN flexible data rate (CAN-FD) and single edge nibble transmission (SENT) bus systems. According to R&S, it is currently the only portable oscilloscope capable of analyzing CAN, LIN, CAN-FD and SENT bus signals, making it useful for troubleshooting automotive and other applications.

The portable R&S Scope Rider is versatile. It offers the functionality of eight T&M instruments—including protocol, logic and spectrum analyzers and a data logger for long-term monitoring—in a compact, robust design. This functionality makes the R&S Scope Rider useful for signal

integrity measurements on serial buses, for example. The fully isolated oscilloscope permits quick and easy differential measurements without the expensive extra equipment typically needed for serial protocols in automotive applications. This is significantly less expensive than a test setup with a lab oscilloscope and differential probes.

R&S claims the Scope Rider is the only portable oscilloscope on the market with protocol analysis functionality for SENT, a serial point-to-point protocol defined specifically for sensor communications in the automotive segment. The new R&S RTH-K10 SENT triggering and decoding software option offers extensive triggering options for acquiring specific events, data and error states from the fast and slow SENT protocol channels. It also supports the short and enhanced message format and the various available CRC check methods.

With the new R&S RTH-K9 CAN-FD triggering and decoding option based on the R&S RTH-K3 CAN triggering and decoding option, the user can also analyze CAN-FD signals. At transmission rates of up to 15 Mbit/s, the CAN-FD serial bus is significantly faster than the standard CAN (up to 1 Mbit/s) and is gaining in importance.

The digital triggering and decoding unit operates at a sampling rate of 1.25 Gsample/s, irrespective of the analog or digital channel sampling rates used for signal acquisition. This makes it possible to easily decode serial protocols even when very slow time domain signals are displayed at the same time.

The R&S Scope Rider comes as a two- or four-channel instrument for bandwidths up to 500 MHz.

For more information, visit [www.rohde-schwarz.com/ad/press/scoperider](http://www.rohde-schwarz.com/ad/press/scoperider).

**5G Test Solution Ensures Accurate 5G Planning Models**

Keysight Technologies, Inc. has announced a solution for measuring, analyzing and visualizing the coverage generated by 5G base stations. Keysight's Nemo Outdoor, combined with FieldFox handheld RF and microwave analyzers, enables mobile operators and network vendors to measure 5G radio propagation and coverage. The solution uses the Nemo Outdoor analytics tools to provide capabilities for visualizing and post-processing data, enabling network equipment manufacturers and mobile operators to evaluate and verify 5G base station propagation models for indicating 5G cellular coverage levels.

Mobile operators require extensive measurements and research to gather information about cellular mm-wave propagation in different radio environments—indoor and in the field. Real-world 5G measurements allow operators to supplement and verify initial radio network plans and models.

Keysight's 5G RF measurement solution provides a complete measurement system for millimeter wave propagation, including the necessary software and hardware to collect, post-process, analyze and visualize the data—generating statistical information that can easily be shared throughout the organization.

#### Highlights:

- Combines Keysight's Nemo Outdoor with FieldFox to enable field testing of 5G radio coverage to support early radio network planning
- Measures 5G base stations signal power levels
- Keysight's Nemo Outdoor field test solution measures radio interface parameters in wireless networks
- Keysight's FieldFox handheld RF and microwave analyzer has a range from 4 to 50 GHz

Additional information about Keysight's 5G base station coverage solution is available at <http://www.keysight.com/find/nemooutdoor>. A YouTube video of the Nemo 5G measurement solution is available at [www.youtube.com/watch?v=ZDbW6VPoOyI](http://www.youtube.com/watch?v=ZDbW6VPoOyI).

## **Vector Network Analyzer**

Pico Technology has applied its expertise in compact USB instrumentation, combined with its experience with high-performance sampling oscilloscopes and time domain reflectometry, to develop a high-quality, low-cost vector network analyzer.

If you work with high-speed data, communications or computing, you often need to characterize high-frequency interfaces, devices, multi-path interconnect and antennas. Today's engineers and systems integrators do not have time to become microwave specialists. They need a straightforward, accurate, fast, portable and low-cost measurement instrument, and ideally one that can support developing applications such as 5G, IoT, radar, and tissue and materials imaging.

The PicoVNA 106 is an all-new, UK-designed, USB-controlled, professional and laboratory-grade 300 kHz to 6 GHz vector network analyzer providing portability and affordability. Despite its small size and low cost, the instrument boasts a full-function, minimal-error, 'Quad RX' four-receiver architecture. This supports both 8 and 12-term calibration without the uncorrectable switching errors, delays and unreliability of traditional three-receiver designs.

The PicoVNA 106 has a dynamic range of up to 118 dB at 10 Hz and only 0.005 dB RMS trace noise at its maximum bandwidth of 140 kHz. It can gather all four S-parameters at just 190 microseconds per frequency point; in other words, a 500 point 2-port S2P Touchstone file, compatible with test, math, view and EDA simulation tools, in less than a tenth of a second. This performance compares with other full-function vector network analyzers at more than four times the cost.

The PicoVNA 106's small size, weight and cost along with high performance suit it to field service, installation test, embedded and training applications. Its remote automation interface suits it to test automation.

The PicoVNA 106 is supplied with Microsoft Windows software to support a full range of plot formats for scalar and vector view of dual or single-port parameters. These can be saved or exported in various graphic and tabular formats including Touchstone.

Unwanted measurement contributions from feed lines, probes or test jigs can be eliminated using manual or automatic reference plane offset, including fully independent offset for each S-parameter, when required. Alternatively, independent networks can be embedded or de-embedded at each port from a Touchstone representation of each, measured or synthesized. Unusually for any vector network analyzer, embedding or de-embedding is interpolated when measurement and network datasets do not share the same frequency points.

For more information, visit [www.picotech.com/vector-network-analyzer/picovna-106/picovna-series?hp1](http://www.picotech.com/vector-network-analyzer/picovna-106/picovna-series?hp1).

### **Low Noise, Low Drift, Low Power 3-Axis Accelerometer with Digital Output**

The ADXL355 is part of Analog Devices new family of low noise density, low 0 g offset drift, low power, 3-axis MEMS accelerometers with selectable measurement ranges. The ADXL355 supports the  $\pm 2.048$  g,  $\pm 4.096$  g, and  $\pm 8.192$  g ranges, and offers low noise, offset drift over temperature, and long-term stability, enabling precision applications with minimal calibration and with very low power consumption.

The ADXL355 and ADXL354 perform high resolution vibration measurement with very low noise and can be used in the early detection of structural defects via wireless sensor networks. The low power consumption of the new ADXL354 and ADXL355 accelerometers lengthens battery life and allows extended product usage by reducing the time between battery changes. The tilt stability of ADXL354 and ADXL355 accelerometers delivers excellent repeatability over temperature and time, which is ideal for orientation and navigation systems in unmanned aerial vehicles using Inertial Measurement Units (IMUs) and inclinometers.

The ADXL354 and ADXL355 accelerometers offer guaranteed temperature stability with null offset coefficients of 0.15 mg/C (max). The stability minimizes resource and expense associated with calibration and testing effort, helping to achieve higher throughput for device OEMs. In addition, the hermetic package helps ensure that the end product conforms to its repeatability and stability specifications long after they leave the factory.

With output of  $\pm 2$  g to  $\pm 8$  g full scale range (FSR), selectable digital filtering from 1 Hz to 1 kHz, and low noise density of  $25 \mu/\sqrt{\text{Hz}}$  at less than 200  $\mu\text{A}$  current consumption, the ADXL355 MEMS accelerometer offers performance level comparable to much more expensive devices but with less power consumption and cost.

Applications Include:

- Inertial measurement units (IMUs)/altitude and heading reference systems (AHRS)
- Platform stabilization systems
- Structural health monitoring
- Seismic imaging
- Tilt sensing
- Robotics
- Condition monitoring

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

### **Millimeter-Wave 5G Test System**

AceAxis has announced the launch of a millimeter-wave test system, initially targeted at 28 GHz, for characterizing the RF performance of prototype high-frequency components and systems for 5G.

Building upon their expertise in the design and supply of remote radio units (RRU) for 4G mobile networks, the Millimeter-Wave 5G Test System significantly extends the capability of the existing AceAxis 4G modular test system. The new modules offer a compact, flexible

solution for the emulation and aggregation of very wideband 5G radio channels at millimeter-wave frequencies. The modular design means that it is fully configurable to meet current and future standards and frequency bands.

The compact, rack-based Millimeter-Wave 5G Test System consists of five individual 1U modules and is expandable to scale for additional capacity and frequency bands. The units supplied as standard include: two AceAxis Ultra-400+ radio modules; a +10 dBm 400 MHz – 6 GHz wideband output module; a 2 x 8:1 combiner module; and a 28 GHz Millimetric Converter Module with an output bandwidth of over 1 GHz. The wide bandwidths of both the radio modules and the millimetric converter mean that up to eight 100 MHz carriers can readily be aggregated into a single 800 MHz carrier.

For more information, please visit [www.aceaxis.co.uk](http://www.aceaxis.co.uk).

### **New Functions for Vector Network Analyzer**

With the release of the new Bode Analyzer Suite V 3.00, all users of the Vector Network Analyzer, Bode 100, gain access to several new functions and features. The new software extends the upper measurement frequency of Bode 100, enabling a measurement range from 1 Hz to 50 MHz. Furthermore, a total of seven new impedance measurement modes are now offered, covering impedance measurements from Milli-Ohms to Mega-Ohms. This enables the user to perform impedance measurements of passive components as well as measuring the input and output impedance of active circuits such as power supplies.

Pre-defined measurement modes allow first-time users easy and quick access to various types of Gain/Phase, Vector Network Analysis and Impedance measurement modes. An all-new memory handling allows it to copy live measurements into memory traces with one mouse click. Quickly accessible math functions allow it to create new measurement traces by combining live measurements with earlier recorded memory traces.

The Bode Analyzer Suite V 3.00 update is offered to all users of Bode 100 at no cost. It can be downloaded free of charge from [www.omicron-lab.com/downloads](http://www.omicron-lab.com/downloads).

Find more information at [www.omicron-lab.com](http://www.omicron-lab.com).

### **Multi-Channel Arbitrary Waveform Generator (AWG)**

Advanced electronic systems are increasingly turning to parallel design architecture to increase their overall performance in applications such as MIMO, radar, quantum computing and multi-lane serial bus testing. To develop these systems, and those with similar multi-receiver/emitter or multi-sensor technology, it is helpful to have the ability to generate multiple synchronized waveforms. Fast Arbitrary Waveform Generators (AWGs) have become the instruments of choice as they allow easy and flexible signal generation. However, most high-performance AWGs only provide a limited channel count (1 to 4), which can make creating larger test systems quite expensive. In addition, these AWGs face serious problems when systems are scaled up for higher channel count applications as they typically present numerous synchronization issues. Spectrum's DN6.66xx series of AWGs overcomes these challenges by offering up to 24 fully synchronized channels. The series allows engineers to select from an extensive range of products that are cost effective and specifically designed for multi-channel, signal generation applications.

The DN6.66xx series adds eight new instruments to the company's generatorNETBOX line of AWGs. LXI compliant, they are easily integrated into any test system by a simple Ethernet connection to a PC or local area network (LAN). Using state-of-the-art 16 bit digital to analog technology (DAC), the AWGs offer from 6 to 24 fully synchronous channels, output rates up to 1.25 GS/s, analog bandwidth as high as 400 MHz, large on-board memories (up to 1 GSample per channel) and generous output voltage ranges of up to  $\pm 5$  V into high impedance and up to  $\pm 2.5$  V into 50  $\Omega$ .

Time skew between the channels is minimized, with the maximum skew between all channels being less than 130 picoseconds.

For applications where a generatorNETBOX needs to operate remotely, Spectrum offers an embedded server option, DN6.xxx-Emb. This option combines a powerful CPU, a freely accessible SSD, more memory and a remote software development access method. The embedded server option creates an open platform where users can run their own software while, at the time, still being connected via LAN for remote access.

For more information, visit [www.spectrum-instrumentation.com](http://www.spectrum-instrumentation.com).

### **Wideband Amplifier Covers 10 kHz - 1000 MHz Frequency Range**

AR RF Microwave Instrumentation has introduced a new family of RF solid state Class A power amplifiers that cover such a wide bandwidth that the applications are almost limitless. Each of the "U" Universal Series instruments will instantaneously cover 10 kHz to 1000 MHz with a single band amplifier, making these ideal for EMC testing, laboratory testing, antenna and component testing, watt meter calibration, medical/physics research, and more. Custom versions are also available, so there is no limit to where these versatile amplifiers can be put to work.

The initial models include the 1U1000, 2.5U1000, 10U1000, and 25U1000 which provide a minimum of 1, 2.5, 10 and 25 watts of RF power when driven by a sweep generator.

In addition to spanning the widest frequency range of any amplifier with comparable power, these innovative amplifiers are small and moderately priced, yet deliver high performance, durability and longevity.

Find more information at [www.arworld.us/](http://www.arworld.us/).

### **Coordinate Measuring Machine Platform**

Hexagon Manufacturing Intelligence has announced its GLOBAL S Coordinate Measuring Machine (CMM) platform. The Global S measuring solution is the initial offering in Hexagon's

Enhanced Productivity Series (EPS), featuring smart technologies such as user experience (UX) enhancements, measurement software and advanced “green” options. The EPS platform is designed specifically to simplify the creation, execution and analysis of measurement routines. The Global S CMM solution is a complete package utilized from start to finish in a Quality program, from the engineer creating the measurement routine to the operator executing the inspection program to the manager analyzing the data and improving processes in the production workflow. The Global S CMM impacts dimensional inspection operations with higher productivity in demand by industries such as automotive, aerospace, general mechanics and precision mechanics.

The Global S platform utilizes PC-DMIS CMM software for the collection, evaluation, management and presentation of manufacturing data. Leveraging software advancements, common tasks such as the selection of probe tips and importing files are now 3 to 8 times faster than existing solutions. Improvements such as feature sensor mapping allow the user to associate sensors to features more rapidly when importing inspection plans.

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

### **PXIe Digital Input/Output Modules**

With the introduction of the EMX-75XX Series of PXI Express (PXIe) Digital Input/Output Modules, AMETEK VTI Instruments continues to expand its Core ATE™ offering with a focus on performance and flexibility. The EMX-7510 is a high-performance I/O module with eight ports of 8 bits (64 channels) each. Plus, each 8-bit port may be configured as an input or output under program control. The ability to sink up to 300 mA, using built-in clamping diodes, makes this module ideal for driving and sensing external devices such as relays, extending both functionality and flexibility.

The EMX-7510, EMX-7511, EMX-7512, EMX-7513, EMX-7514, and EMX-7515 include variations that offer 1000 V signal isolation as well as fixed input/output modules for dedicated applications.

Top features include:

- Static digital input/output
- 64 channels total (8 ports of 8 bits each), bidirectional
- High current (300 mA) on each channel
- Voltage inputs and outputs from 2 V to 60 V on each channel
- Embedded soft front panel interface
- Common IVI software drivers available
- Multiple digital logic levels: LV TTL, TTL
- Optical isolation at 1000 V

Learn more about how the EMX-75XX Series can easily integrate with the rest of any ATE system by visiting: [marketing.vtiinstruments.com/e/12672/2017-05-11/3yzsfl/679518097](http://marketing.vtiinstruments.com/e/12672/2017-05-11/3yzsfl/679518097).

### **Miniature 700W Servo Motor Drive with Integrated Motion Controller**

Granite Devices Inc. has released a new industrial servo motor drive contributing high degree of time and cost saving features to the machine automation market. A “swiss knife of motion control,” IONI starts a new era of servo drives by bringing snap-on installation, built-in SIL2 safety functions and unforeseen compactness in 700 W class in just a 70 x 37 x 7 mm form factor.

IONI implements industry standard, torque, velocity and position controls for ac, brushless dc, brushed dc, linear servo motors and stepping motors between 2 W and 700 W power. An improved high dynamic range torque control allows it to seamlessly connect a record breaking range of motor variants to a single drive type.

The real beauty of IONI is the ability to perform multi-axis synchronous motion control out of non-realtime host, such as Windows PC with USB or Ethernet connection.

IONICUBE and IONICUBE 1X motherboards are offered alongside with IONI drives for customers to build 1-4 axis solutions or larger motion control systems by chaining the motherboards.

Further information, specifications and distributors may be found at: [www.granitedevices.com](http://www.granitedevices.com).

### **Boundary-Scan Test Compatible with MAC Panel**

JTAG Technologies has announced the release of a new JTAG/boundary-scan test hardware interface product compatible with the MAC Panel mass interconnect system. The JT 2147/eDAK is a multi-function signal conditioning module that allows 'ideal world' connections from JTAG Technologies PXI and PXIe DataBlasters to the MAC panel 'Scout' connection system.

Based on the popular QuadPod™ architecture from JTAG Technologies, the JT 2147/eDAK is an enhancement of JTAG's current DAK interface and has been specifically designed for robust high-integrity ATE systems. In using the JT 2147/eDAK, test system builders will greatly simplify their wiring task and, at the same time, retain the excellent signal integrity assured by the QuadPod's active interface.

In addition to four independent JTAG Test Access Ports (TAPs), the JT2147/eDAK features 64 digital I/O scan channels plus 16 'static' DIOs. Each TAP can be programmed to operate through a range of voltage levels, and two can also operate as other test and programming interfaces such as BDM or SWD.

eDAK adapters utilize standard MAC Panel series connector modules, providing a wide variety of contact types. The connection between the PXI instrument and receiver module is accomplished using either a passive printed circuit board, active signal condition module (as with the JT 2147/eDAK) or flex circuit, with each providing optimum connectivity performance while reducing wiring cost.

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