

The IEEE Instrumentation & Measurement Magazine
October 2016 Issue

*Is There a Doctor in the House? A Special Issue on Medical
Measurements and Applications*

Guest Editorial

Special Issue on Medical Measurements

Sabrina Grassini and Sergio Rapuano

This special issue of the *IEEE I&M Magazine* contains a concise but significant selection of contributions to the research in measurement for medicine, as provided by researchers from universities and industry, who are interested in developing novel solutions to the instrumentation and measurement (I&M) problems that are encountered in modern health care. The papers are mainly extended versions of contributions presented at the annual IEEE International Symposium on Medical Measurements and Applications (MeMeA), sponsored by the IEEE Instrumentation and Measurement Society.

MeMeA is an annual conference devoted to all aspects of interaction between measurement and medical fields with the aim of highlighting how measurements represent a real challenge for collecting correct and trustworthy data for patient healthcare. MeMeA is a place where measurement specialists, electronic and bioelectronics equipment designers and users of measurement methods and instrumentation can share their points of view, experiences, results and form new joint multidisciplinary and international research groups. MeMeA contributions include sensor design and calibration, instrument and virtual instrument design and calibration, measurement methods, analysis of measurement results, measurement image and signal processing for medicine.

Details and exciting perspectives of a hybridization among I&M, bioengineering, and the medical research fields have been reviewed and presented in the paper that introduces this

special issue: “Instrumentation and Measurement in Medical, Biomedical, and Healthcare Systems,” by Shervin Shirmohammadi *et al.*

The remaining part of this issue is devoted to some of the results of such hybridization. In particular, the presented research fields are related to measurement quality and sensor design and calibration. All of these research fields have a clear intersection with the medicine and biology fields and demonstrate the need for a deep interaction between measurement researchers who provide design and methodology contributions and medicine and biology researchers who provide specifications, requests, new findings and, above all, effective usage of the measurement results. All of these fields are traditionally taught in measurement courses at universities, and all present aspects of great interest from the measurement research community.

Five contributions have been selected from MeMeA 2014 and 2015 as examples that show the characteristic marks of the research in measurement for medicine and instrumentation and encourage people who feel to be able to say something in this field to join the MeMeA community. In this view, researchers dealing with sensors and instruments, studying reliability, traceability and uncertainty, have been invited to present and discuss the state of the art in a specific field, significant experimental investigations, or novel proposals in the selected list of papers that you will find in this issue.

Concerning the importance of the quality of the measurements and the methods adopted to ensure a given quality of the measurements, the paper “Ultrasound Physiotherapy Devices: How to Measure Them” by Giovanni Durando and Claudio Guglielmone focuses on that topic. The quality of measurements ensures safe and effective treatments. They highlight and describe how the use of uncalibrated electronic medical systems could produce treatments that are inefficient or even harmful to patients. The authors devoted their research to evaluate the performance of ultrasound devices that are used commonly in physical therapy departments, describing calibration methods, instruments and results.

On the same topic, the paper “Investigation of Thermal Effect by Focused Ultrasound in Cancer Treatment,” by Baki Karaböce shows how a high measurement accuracy can positively influence

the capability of cancer treatments, like High Intensity Focused Ultrasound (HIFU), providing an effective thermal ablation of the malignant mass while limiting the side effects on the nearby healthy tissues.

The paper “Dynamic Threshold Algorithm to Evaluate Trustworthiness of the Estimated Blood Pressure in Oscillometry” by Iraj Koohi *et al.* deals with repeatability of blood pressure measurements obtained by means of oscillometric automatic measurement equipment. The sensitivity of those systems to measuring conditions, like the posture of the body, the arm, and the body movements during the measurement procedure, is a well-known issue that affects the trustworthiness of the results. With the aim of having results that can be effectively used the authors describe a novel method, proposed by them, that evaluates trustworthiness of the measurements immediately after the blood pressure is estimated.

Within the very wide field of sensor design and calibration, one of the most interesting research sectors is focused on non-invasive sensors for health monitoring. The paper “Architecture of Smart Clothing for Standardized Wearable Sensor Systems” by Krišjanis Nesenbergs presents a review of different design and material solutions available to set-up wearable sensor systems embedded in clothes that could be useful in different fields, such as early disease detection, treatment and rehabilitation, care of elder people, and sports. The challenges in the fields of hardware, software, architecture, and manufacturing are also discussed in the paper.

In the paper “Measuring Inside Your Mouth! Measurement Approaches, Design Considerations, and One Example for Tongue Pressure Monitoring,” the authors Michela Borghetti and Mauro Serpelloni deal with a typical topic of measurement research in medicine: non-invasive sensors for health assessment. In their paper, the authors describe different approaches and design considerations for non-invasive sensors and present a new implantable intraoral device that they developed to measure tongue pressure, which would be beneficial to practitioners studying behaviors such as chewing, swallowing and speech production.

Two additional articles in this special issue present biomedical research that has been broadened for the I&M community. The paper “No-Contact Oxygen Saturation Measuring Technology for

Skin Tissue and its Application” by Hsin-Yi Tsai *et al.* presents a non-contact oxygen saturation system based on image processing to allow for a continuous, non-invasive saturation monitoring. The determination of oxygen saturation (SpO₂) in the human body in a short time is crucial for clinical diagnosis and treatment.

The paper “Commercial Tactile Sensors for Hand Exoskeletons: Practical Considerations for Ultra-Low Cost and Very-Low Complexity Read-Out” by Alessia Damilano *et al.* discusses the advantages of wearable robots as human-oriented devices to complement, substitute or enhance human capabilities and, more specifically, empower or replace a human limb. In particular, the authors focus on wearable and rehabilitative exoskeletons and present their latest findings about the development of tactile sensors for hand-based remote control of actuators. A large part of the paper is devoted to the presentation and discussion of the calibration phase necessary to characterize any sensor.

Teaching the subjects treated in these papers is not a trivial task, due to the experimental nature of the measurement science and the critical effects of the decisions of the method or equipment designer on the quality of the measurement results. To help faculty members to work on this subject, the IEEE I&M Society activated a specific award, called the Faculty Course Development Award, to support the realization of university courses in the measurement field. Please consider applying to receive this award and designing new courses in the medical measurement field to increase both interest and participation of new young students and researchers.

The last paper “Advanced Sensors and Instrumentation: A Project Based Paper with Emphasis on Remote Environmental Parameters Measurement” by Subhas Mukhopadhyay, describes the development of a paper in Advanced Sensors and Instrumentation at the Massey University in New Zealand.

We hope you will enjoy reading this special issue.

Instrumentation and Measurement in Medical, Biomedical, and Healthcare Systems

(Summary)

Shervin Shirmohammadi, Kurt Barbé, Domenico Grimaldi,
Sergio Rapuano, and Sabrina Grassini

Proper measurement is crucial in the medical, biomedical, and healthcare fields because it forms the basis of medical diagnosis, prognosis, and evaluation. In this article, the authors look at the latest biomedical topics from the perspective of instrumentation and measurement and summarize the latest medical I&M topics published in *IEEE Transactions on Instrumentation and Measurement* (TIM), to familiarize medical practitioners and researchers in how to achieve a proper medical I&M paper. The authors briefly introduce the IEEE Instrumentation and Measurement Society's main medical conference, the IEEE International Symposium on Medical Measurements and Applications, which promotes the I&M aspects of the medical field in general and present guidelines on the I&M aspects that are useful for authors with primarily biomedical backgrounds who would like to publish in IEEE TIM.

This summary includes text from introduction of the article.

Ultrasound Physiotherapeutic Devices: How to Measure Them

(Summary)

Giovanni Durando and Claudio Guglielmo

Physiotherapists frequently use ultrasound machines for the treatment of chronic inflammation, degenerative rheumatic disorders, ankle distortions, and post-traumatic diseases, such as lateral epicondylitis and acute soft tissue injuries. At a low power of less than three-watts, ultrasound effects could produce stable cavitation in biological issues, which in turn could affect the permeability of cell membranes. At high power settings up to twelve-watts, the absorption of ultrasound energy by tissues causes a temperature increase, which causes an increase in the blood flow. To ensure safe and effective treatments, it is important that the adopted ultrasound

therapy devices are accurate. In general, the use of uncalibrated systems could produce treatments that are inefficient or even harmful to patients. In this article, the authors evaluate the performance of ultrasound devices that are commonly used in physical therapy departments.

This summary includes text from the introduction of the article.

Investigation of Thermal Effect by Focused Ultrasound In Cancer Treatment

(Summary)

Baki Karaböce

High intensity *focused* ultrasound (HIFU) is a very attractive and new technique that is used in cancer treatment, physiotherapy, and other similar treatments. An HIFU transducer coupled to an electronic supply system generates high frequency sound waves and delivers a strong beam to a specific part of cancer tissue. To ensure safe and efficient treatment, the temperature and ultrasound field distribution should ideally be measured with sufficiently high accuracy, to warrant a safe medical application. Mapping temperature distribution in tissue when ultrasound is applied will ensure it is used safely and effectively.

This summary includes text from the article.

Dynamic Threshold Algorithm to Evaluate Trustworthiness of the Estimated Blood Pressure in Oscillometry

(Summary)

Iraj Koohi, Saif Ahmad, Izmail Batkin, Voicu Groza,
Shervin Shirmohammadi, and Hilmi R. Dajani

Blood pressure (BP) readings in oscillometry are very sensitive to the posture of the body, arm, and body movements during the measurements, so measuring conditions are the first important factors for trusted BP readings. Next is the BP estimation algorithm, which is responsible to convert the cuff deflation curve pressure signal to accurate BP readings. With proper measuring conditions and an accurate BP estimation algorithm one can expect trusted BP readings. To this

end, we have proposed a novel method called a Dynamic Threshold Algorithm (DTA) that evaluates trustworthiness of the BP readings immediately after the BP is estimated, such that the patient can decide whether to repeat the measurement or not. DTA employs the heart rate of the subject and determines a specific threshold and maximum and minimum limits for trustable pressures. In this research, DTA is applied on three different data- sets of healthy and sick subjects.

This summary includes text from introduction of the article.

Architecture of Smart Clothing for Standardized Wearable Sensor Systems

(Summary)

Krišjanis Nesenbergs

The field of wearable computing has great implications in the measurement of the human body and its surrounding environment, with potentially high impact in medical applications such as early detection, treatment, compliance monitoring, care for the frail and elderly, telemedicine, physical therapy, etc.. Unfortunately, the field of wearable computing is still held back by the lack of a standardized framework and development process, forcing developers into custom and time intensive solutions. In this paper, the current progress of development of a universal smart textile system is discussed which would solve this problem and accelerate the field of smart wearable electronics, providing a universal platform for attaching several hundreds of sensors to clothing in convenient, unobtrusive and energy efficient ways. The main problems and potential solutions discussed in this article include power and data transfer wire topology, allowing the textile to be arbitrarily cut and sewn into smart clothing, data transmission architecture, providing high bandwidth and low energy data transfer, and support for miniaturization and elasticity, making the potential end product as unobtrusive as possible.

This summary includes text from introduction of the article.

Measuring Inside Your Mouth! Measurement Approaches, Design Considerations, and One Example for Tongue Pressure Monitoring

(Summary)

Michela Borghetti and Mauro Serpelloni

The tongue is an important muscular organ, and its interaction with the hard palate is fundamental during speech and deglutition (the act or process of swallowing). First submitted to the IEEE International Symposium on Medical Measurements and Applications 2014, this paper describes different approaches, design considerations, and one example: a new implantable intraoral device that we developed to measure tongue pressure. This new device measures tongue pressure on the hard palate directly inside the oral cavity and transmits the data via a wireless link. The authors describe a typical experimental setup to study the mechanical behavior of these devices in the laboratory and specific test protocols.

This summary includes text from introduction of the article.

*Commercial Tactile Sensors for Hand Exoskeletons:
Practical Considerations for Ultra-Low Cost and
Very-Low Complexity Read-Out*

(Summary)

Alessia Damilano, Andrea Lince, Silvia Appendino, Hafiz Muhammad Afzal Hayat,
Paolo Ariano, Danilo Demarchi, and Marco Crepaldi

In the last two decades, wearable robots have emerged as human-oriented devices to complement, substitute or enhance human capabilities and, more specifically, empower or replace a human limb. The development of wearable and rehabilitative exoskeletons is increasingly attracting attention to help finger movements in free motion and assist the user with grasping. This paper shows that a simple underpowered digital oscillator electronic interface takes advantage of the capacitive variations in commercial piezoresistive transducers to sense applied pressure. Furthermore, thanks to the analysis of the static performance, practical

considerations are drawn about the use of commercial sensors and a read out circuit to be exploited in a control system for hand exoskeletons.

This summary includes text from introduction of the article.

No-Contact Oxygen Saturation Measuring Technology for Skin Tissue and its Application

(Summary)

Hsin-Yi Tsai, Kuo-Cheng Huang, and J. Andrew Yeh

Low oxygen supply can damage the human tissues and cause hypoxia and loss of consciousness. Moreover, oxygen deficiency in the brain can directly damage the nervous system, resulting in memory loss and unconsciousness if the deficiency persists. Therefore, the determination of oxygen saturation (SpO₂) in the human body in a short time is crucial for clinical diagnosis and treatment. In response to this need, the authors developed a *no-contact skin oxygen-saturation imaging* (SOSI) system to determine SpO₂ in the human body. The measuring method uses the reflected image of shallow tissue skin to create a SpO₂ distribution map of the entire measuring region, which then can be used to evaluate heart rate and blood flow velocity that determine the status of patients' cardiovascular systems.

This summary includes text from introduction of the article.

Advanced Sensors and Instrumentation: A Project Based Paper with Emphasis on Remote Environmental Parameters Measurement

(Summary)

Subhas Mukhopadhyay

Sensors and instrumentation play an important role to improve the lifestyle of people and their surroundings. The IEEE IMS Faculty Course Development Award supports and encourages faculty members to develop a new course or significantly revise existing accredited engineering/physics/science curricula with specific focus on instrumentation and/or

measurement. The Faculty Course Development Award 2013 provided funding that helped to develop this paper named “Advanced Sensors and Instrumentation” with a special emphasis on measurement of remote environmental parameters at Massey University, New Zealand. Engineering students will gain knowledge to take up the challenges to design, fabricate and implement sensing systems and necessary instrumentation circuits for monitoring the environment. The content of the paper has been presented at other universities, and the materials are available for any faculty to use in their own teaching.

This summary includes text from introduction of the article.

Columns

Future Trends in I&M

(Summary)

Among the Challenges and Future Trends in I&M

Melanie Po-Leen Ooi

The guest author for the column on Future Trends in Instrumentation and Measurement, dedicated to young and brilliant engineers, is Melanie Po-Leen Ooi. The author introduces the column, stating “by its very nature, instrumentation and measurement is an enabling technology that supports progress and development in a great multitude of areas in science, engineering and beyond. Measurement is used to help make rational decisions, inference or planning. When used incorrectly, it can lead to wrong conclusions, bad choices, poor designs, etc., ultimately leading to dire consequences.” She gives valuable insight from her experience as an engineer in a large semiconductor manufacturing company.

Society News

Max Cortner

Spring 2016 IMS Administrative Committee Meeting

The Instrumentation and Measurement Society (IMS) Administrative Committee (AdCom) was honored to have Division II Director Hirofumi Akagi join us for our meetings. Professor Akagi

described the organization of the IEEE and reviewed the six societies that make up Division II. He encouraged cooperation among the six societies of Division II as well as involvement in the Technical Activities.

Ruth Dyer, our IMS President, addressed the body and welcomed our new AdCom members: Octavia Dobre, Christophe Dubois, Chi Hung Hwang, Katelyn Brinker, and Erik Timpson. She then described the large number of IEEE and IMS initiatives underway in the coming year. Ruth also pointed out the 2017 Society Review and the Publications Review, both of which will require extra preparation efforts during 2016. The entire AdCom will take part in providing the IEEE review committee with a comprehensive document about the activities and accomplishments of the IMS over the past five years.

As an IEEE Society, we are also challenged to improve our interactions with councils we currently support: Biometrics, Nanotechnology, Sensors, Superconductivity, Systems, and RFID. We must continue our drive to improve interactions with Technical and Standards Activities Committees to support and draw strength from their membership in our conference, publication, and membership development activities.

Ruth summarized the IEEE Initiatives and our response so far: Brain Initiative, Collabratec Community, Internet of Things Community, Environmental Engineering, and the Africa Initiative. We are responding as efficiently and effectively as possible by identifying existing volunteers who can provide expertise for the particular initiatives. For example, Sergio Rapuano, our Chapter Chair Liaison, will organize the IMS effort to establish more chapters in Africa, and Zheng Liu, our Vice President for Publications, has agreed to be our representative to the Internet of Things Community.

Mark Yeary, VP of Conferences, presented a report of results and plans. He shared a list of the five IMS sponsored or co-sponsored conferences successfully held already in 2016. The geographic span of these conferences and the ten more planned in 2016 demonstrate our commitment to keeping IMS a global society. IMS sponsored or co-sponsored conferences in

2016 are in India, Canada, Italy, Hungary, Sweden, Germany, Greece, Brazil, Spain, China, and the U.S.

Mark continues to expand our cooperation with other societies and IEEE units. He signed a Memoranda of Understanding for technical co-sponsorships of the International Forum on Smart Grids for Smart Cities and the 2016 International Symposium on Flexible Automation.

The Conference Committee continues to improve the Conference Management Guidelines to provide conference teams with clear techniques to ensure that our sponsored and cosponsored conferences are successful and compliant with IEEE expectations.

I2MTC Board Chair Reza Zoughi reported on the meeting of the I2MTC Board of Directors. It is the role of the Board to assure that each I2MTC is successful, and recent world news about the Zika virus in South America had raised concerns about attendance at the 2017 I2MTC, which is slated for Natal, Brazil. Yuri Catunda (Chair of I2MTC 2017 Natal) gave an excellent presentation on the risks and perceived risks to attendees.

The Board heard from its members and the officers of the AdCom before making the difficult decision to change the location for 2017 I2MTC. Board Chair Reza Zoughi thanked Yuri and his team for their service and complimented them on the amount of work already done. A process was put in place to select an alternative location for 2017 I2MTC within a few weeks. That location has now been identified as Torino, Italy.

Salvatore Baglio, VP of Education, presented a proposal to identify “Hot Topics” on which the Education Committee might focus some of its activities. He also introduced initiatives from the committee, including the addition of an Honorary Distinguished Lecturer from industry. The education committee also proposes to organize a series of one-day “Meet the Instrumentation and Measurement Society” seminars held at local universities with cooperation from industry and local chapters.

Salvatore announced that the Video Tutorials team had successfully completed the recording of the first IMS Video Tutorials. Recording stages will be set up at major conferences in the future to allow addition of pertinent tutorial topics to the catalog. All Video Tutorials will be available through the IMS website. Finally, the Education Committee is revising its award guidelines to ensure our educational award and grant committees have clear instructions for avoiding conflicts of interest.

Shervin Shirmohammadi reported on the activity of the Membership Development Committee. The first motion was a simplification in the metrics collected to measure the progress and effectiveness of the various programs of this committee. To revitalize the industry liaison idea, the committee worked with local organizers to introduce an Industry Session at the 2016 I2MTC. There were fifteen accepted papers from industry. The session boosted local attendance, as ten of the papers were from Taiwan.

The Chapter Chair Summit program provides an opportunity for Chapter Chairs from across the world to gather, share information with another, and learn about new programs that both IMS and IEEE have to offer them. This Summit has continued to experience increased attendance, which is a sign of success for this annual meeting. Additionally, the Chapter Support Program has successfully expanded to help more chapters form and succeed. We had a record 13 new IMS chapters formed in 2015. These and other recently formed chapters were provided with organizational help and access to program content such as Distinguished Lecturers. Recent successes include the following:

- South China University of Technology I&M Student Branch Chapter
- Lebanon Section Robotics and Automation, I&M, and Control Systems Joint Societies Chapter
- Xian Jiaotong University I&M Student Branch Chapter
- Colombia Section I&M Society Chapter
- Tokyo Section I&M Chapter
- France Section Chapter

The Membership Committee includes special liaisons who focus their efforts on programs for specific populations within our Society, such as Women in Instrumentation and Measurement (WIM), young professionals, graduate students, and undergraduate students. There were special sessions at the 2016 I2MTC for all of these groups, and the June 2016 issue of the *Instrumentation & Measurement Magazine* highlights the achievements of women in our society.

Future initiatives include leveraging social media to reach collegiate members and to encourage Young Professionals to become members. A Best Student Chapter award is also being developed to encourage students to participate in the IMS.

Overall, the Membership Committee continues to deliver well directed programs to increase membership and add chapters to our society. IEEE societies membership is shrinking at an average rate of 3.3% while IMS membership declined by only 1.8%. By focusing on growth, the Membership Development Committee is changing the outcome! Because Region 10 (R10) membership in the IMS lags in proportion to R10 membership in IEEE overall, we have appointed an R10 Liaison and are actively forming chapters in R10. Worldwide, 20 new IMS Chapters have been formed in the past three years.

Zheng Liu, VP for Publications, gave a comprehensive report on all of the Society's publications and highlighted recent initiatives, including online submission of magazine articles directly to Allentrack and the implementation of ORCID by IEEE. The goal of ORCID is to provide a digital identifier for each author, so that it is easy to clearly distinguish authors who may have the same or very similar names.

In an attempt to reduce the number of out-of-scope and immediately rejected papers submitted to our publications, the Publications Committee invited Professor Reza Zoughi to create a detailed tutorial on preparation of papers acceptable for our publications. This special session at the 2016 I2MTC was well attended and very interactive.

Zheng reviewed a new National Science Foundation policy, which may preempt Open Access in the United States. Papers funded by NSF must be made publicly available through an NSF site within 12 months of submission.

Wendy Van Moer, Editor-in-Chief (EIC) of the *Instrumentation & Measurement Magazine*, reviewed an exciting lineup of magazine issues that focus on medicine, criminal investigation, farming, and global instrumentation. She reported on recent cost-saving measures that will allow the magazine to continue its excellent offerings and begin a digital publishing initiative.

Alessandro Ferrero, EIC of the *IEEE Transactions on Instrumentation and Measurement* (TIM), reported on the excellent and improving record of TIM. There were 385 papers published in 2015. While maintaining the highest quality, Alessandro and his team have improved the response time to electronic publication from 59 days in 2008 to 27 days this year.

Publication quality is measured by multiple numbers compiled by Thomson Reuters and others. Through the diligent effort of our editorial staff, scores such as our Impact Factor have risen steadily over the past five years, and TIM is now ranked first or second among Instrumentation and Measurement Journals.

Ruqiang Yan, VP of Technical and Standards Activities Committee (TSAC), reported that the Technical Committee (TC) Chairs Summit initiated at 2016 I2MTC was a success, with eight TC Chairs attending the first meeting. Ruqiang also reported that the committee's efforts to encourage TC involvement resulted in four proposed special sessions for 2016 I2MTC. Five of the TCs have standards under development.

The TSAC continuously monitors TC activity and considers whether any TCs should be closed, based on whether they are not meeting the criteria for an active TC. Two new TCs were approved upon submission of the proper documentation per our guidelines. The new TCs are TC-40 Secure and Dependable Measurement and TC-41 Traffic Enforcement Technologies.

Dario Petri, VP of Finance, and Juan Manuel Ramirez-Cortes, Treasurer, provided a thorough review of society finances. In 2015, for the sixth year in a row, we have successfully managed the budget to achieve a positive operating net balance.

Dario and Juan Manuel reviewed the status of the 2016 budget and the expenditure proposals from the various IMS committees for the 2017 budget. The IMS AdCom is committed to continuing its fiscally responsible approach to leverage revenue generated from our conference and publications to provide benefits to our members.

Max Cortner, Executive VP, reported for the Society Management Committee. He demonstrated a survey response search tool recently provided by IEEE which allows us to mine the data from the recent IEEE member survey and gather information about what our IMS members value and expect. The main focus of the Society Management Committee this year will be the preparation for the Publications Review and the Society Review, for which reports are due in 2017. Max will work with each EIC and VP to gather content and prepare answers to the review committee questionnaires. The Publications Review will occur in February of 2017, and the Society Review will be conducted in June 2017.

Departments

New Products

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Compact 9-Axis Motion Sensor

Bosch Sensortec is launching the BMX160, a compact 9-axis motion sensor that is ideally suited for a wide range of mobile or wearable devices as well as Augmented/Virtual Reality devices.

Compared to smartphones, wearables face much harsher space and power constraints. It is precisely this environment where a tiny power-efficient 9-axis sensor like the BMX160 offers an ideal solution. This new sensor is housed in a compact 2.5 x 3.0 x 0.95 mm package.

By combining Bosch Sensortec's advanced accelerometer, gyroscope and geomagnetic sensor technologies, the BMX160 is able to meet the increasingly more stringent low-power requirements demanded by wearable devices. Bosch's low-power sensor technology makes this a standout 9-axis inertial sensor, reducing power consumption below 1.5 mA. This sensor is ideally suited for applications that face extreme form factor restraints, e.g., in smart glasses.

The BMX160 sensor enables Android wearable applications relying on sensor data such as device orientation, magnetic heading or the gravity vector. Moreover, the sensor supports applications such as 3D indoor mapping and smartphone optimized virtual reality applications – e.g., cardboard Virtual Reality (VR). The sensor can be used in conjunction with the Bosch Sensortec BSX sensor data fusion software library to further optimize performance.

The single-package BMX160 effectively replaces the present mainstream two-component workaround solution, i.e., combination of a 6-axis IMU with a 3-axis geomagnetic sensor. This innovative 9-axis motion sensor provides the placement flexibility necessary for overcoming current limitations on positioning of the magnetic sensor.

The accelerometer, gyroscope and magnetic technology in the BMX160 have been optimized for low offset, low noise and best temperature stability. Bosch Sensortec gyroscope technology offers an extremely low drift, which is a key requirement for an accurate real-time user experience, especially in augmented and virtual reality applications.

Samples are available for development partners. For more information, please visit www.bosch-sensortec.com.

Midrange Signal and Spectrum Analyzer

Rohde & Schwarz introduces the R&S FSVA, an enhanced midrange signal and spectrum analyzer for signal analysis and demodulation up to millimeter wave frequencies. Users benefit from the features of this instrument in all measurements up to 40 GHz where low phase noise, high sensitivity and wide analysis bandwidth are required.

The new R&S FSVA offers a 160 MHz analysis bandwidth over its entire frequency range. R&S claims that it is the only analyzer in its class to do so at frequencies between 26.5 and 40 GHz. With its enhanced phase noise performance, the instrument offers users very high accuracy in spectral measurements on narrowband modulated signals and in phase noise measurements.

The advanced features of the R&S FSVA include more than the improved phase noise of typically -117 dBc at 1 GHz with 10 kHz offset. Rohde & Schwarz also has improved the third order intercept (TOI) for frequencies lower than 7 GHz, for a higher dynamic range. As a result, the R&S FSVA offers enhanced spectrum measurements compared with the current R&S FSV family, e.g., spectrum emission mask and ACLR under higher power conditions. The sensitivity of the preamplifier of typically -166 dBm for frequencies lower than 7 GHz has also been improved.

Like the R&S FSV, the R&S FSVA is available in five models, covering frequency ranges from 10 Hz to 4 GHz, 7 GHz, 13.6 GHz, 30 GHz and 40 GHz. The R&S FSVA supports all R&S FSV hardware functions and firmware options. Plus, the R&S FSV and the R&S FSVA are fully remote control compatible for use in complex test setups.

Find more information at www.rohde-schwarz.com/.

Expanded GENASYS Platform Capabilities for Functional Test

Marvin Test Solutions (MTS), Inc. announces two new products for the GENASYS functional test platform. Building on the performance architecture of the GENASYS switching subsystem, MTS has added the GX7017 Integrated GENASYS Chassis to the GENASYS product line,

providing digital, analog and high performance switching capability within a single, compact, 6U PXI chassis footprint.

The GX7017 is a 20-slot 6U PXI chassis with an integrated MAC Panel SCOUT mass interconnect receiver that can accommodate up to 9 GENASYS switching modules, 8 high-performance digital instruments, and additional PXI instrument modules providing the flexibility to address a wide range of analog / digital ATE applications.

Featuring high density signal switching for board and system level functional test with an “any-resource to any-pin” architecture, the GX7017 can accommodate any of the GENASYS switch modules, providing up to 2304 multiplexed, hybrid I/O pins without cabled connections via a MAC Panel 6U SCOUT receiver. In addition, the GX7017 can support up to 256 performance digital test channels for mixed-signal test applications.

The GX7017 chassis is available as a subsystem or as part of the TS-321, Marvin Test Solutions’ single-bay GENASYS functional test platform.

To further extend the switching capabilities of the GENASYS platform, Marvin Test Solutions has also introduced the GX6864, a 500 MHz, 75 Ohm RF multiplexer switch module for high I/O count, video switching / test applications.

For further information about the expanded GENASYS product line, please visit www.marvintest.com/ or send email to sales@marvintest.com.

Easier Test of DIMM Sockets with Universal JTAG Hardware

JTAG Technologies announces a new family of hardware adapters specifically designed for testing of a variety of DIMM & SODIMM sockets (sizes and styles), using a JTAG/boundary-scan controller and supporting software.

The problem of testing DIMM memory sockets has always been troublesome for test and production engineers using JTAG/boundary-scan systems. Even when it is possible to create

memory writes and reads from the boundary-scan compliant access device on the UUT (Unit Under Test), the initialization process may fail, leaving clients with little diagnostics information. What's more, clients will still be uncertain whether fault lays with the DIMM module itself or the socket. Using the new JT 2127-Flex system from JTAG Technologies, clients get pin-point diagnostics from a known-good test interface so they can be certain if the socket is soldered correctly (or not).

The JT 2127-Flex system comprises two basic elements:

- a high-speed multi-channel IO module – JT 2127/DMU, and
- a personality adapter for the chosen DIMM type – JT 2127-Flex xxx.

The combination of the DMU and Flex adapter allows test signals to be sent to and from the boundary-scan source device on the UUT, performing a thorough check for open pins and short circuits. In addition, the voltages on the power pins of the DIMM socket are also measured. Currently supported DIMM types are xxx = 204-3, 244-mi3, 260-4 and 288-4. Due to the modularity of this test system, other DIMM formats can be supported quickly upon request.

Software support for test development is provided through JTAG Technologies ProVision developer tool-suite, which is shipped with a full set of support files for the new system.

For more information, please visit www.jtag.com.

New High-Density 2 Amp PXI Relay Module

Pickering Interfaces announces the launch of a new High-Density 2 Amp PXI Relay Module (model 40-100). Configured with 83 SPDT relays, this Relay Module was originally designed for applications in Aerospace and Defense requiring a higher density 2 Amp alternative to Pickering's current 52 SPDT Module (model 40-139). This new Relay Module is suitable for applications requiring medium power switching with very high density. It features a 2 Amp current capacity and voltages to 200 VDC/140 VAC.

Connections for the 40-100 high-density Relay Module are made via a front panel mounted 500-pin SEARAY high-density connector. Pickering also offers standard cabling solutions, converting from this high-density connector to more standard interfaces such as D connectors, IDC connectors as well as an unterminated option for ease of use.

For more information on signal switching and conditioning products or sales contacts, please visit www.pickeringtest.com.

Wide Dynamic Range Shortwave IR Camera Systems

Sierra-Olympic Technologies now offers New Imaging Technologies' (NIT) wide-dynamic-range (WDR), indium gallium arsenide (InGaAs) shortwave infrared (SWIR) sensors and camera systems. The new SWIR imaging product family delivers a dynamic range greater than 140 dB in a single snapshot, without any processing or tone mapping. The NIT WDR sensors' internal Fixed Pattern Noise correction offers high uniformity images under all lighting conditions.

The new InGaAs photodiode array features a patented readout integrated circuit (ROIC). Available in 640 x 512 (with 15-micron pitch) or 320 x 256 (with 25-micron pitch) pixel resolution, both operate in the SWIR spectrum from 900 nm up to 1700 nm with high quantum efficiency. Power consumption is less than 1.5 W. By design, the proprietary NIT ROIC has proven to be highly functional for fast, triggered imaging applications such as range-gated imaging and synchronous illuminated imaging.

NIT's SWIR 640 and 320 camera modules offer digital video outputs in USB2.0 or Camera Link® formats. The SWIR family of cameras with wide dynamic range is delivered calibrated, with software and cables in shock-proof cases.

To learn more about Sierra-Olympic Technologies' wide array of advanced infrared imaging systems and solutions, please visit www.sierraolympic.com.

High Speed PXI Express Digitizer Family

Spectrum GmbH has released its first high-speed digitizer product line based on the PXIe (PCI Express) modular instrumentation standard. The M4x.44xx series consists of six new products, each packaged in a dual-width 3U module and incorporating a four lane PCI Express Generation 2 interface. The high-performance interface allows data transfer speeds in excess of 1.7 GB/s, making the cards ideal for use in today's fastest PXIe mainframe systems.

The new digitizers include versions with two and four fully synchronous channels, and they come with resolutions of either 14 bits, for sampling at rates up to 500 MS/s, or 16 bits, for sampling at rates up to 130 or 250 MS/s. With analog bandwidth up to 250 MHz, the digitizers are suited to use in ATE systems where electronic signals in the 1 to 200 MHz range need to be acquired and measured with the best possible speed and precision.

Designed so that they can be used with the widest range of signals, the M4x.44xx series cards feature an oscilloscope style front-end. Each channel has its own separate monolithic ADC and low noise signal conditioning circuitry. Fully programmable, the cards provide six gain input ranges (± 200 mV up to ± 10 V), selectable input impedance of 50 Ohms or 1 Megohm and AC or DC coupling. Furthermore, an internal bandwidth filter can be activated in situations where high frequency noise, that may mask signals, needs to be suppressed.

All of the digitizers come with a standard 4 GByte (2 Giga-Samples) of on-board acquisition memory. The large memory makes it easy to acquire long and complex signals.

To control and operate the digitizers, Spectrum provides its SBench 6 program. SBench 6 supports all of the key functions of the digitizer as well as providing data display, storage, analysis and documentation. The program offers both oscilloscope and transient recording modes, including data streaming.

More information about Spectrum can be found at www.spectrum-instrumentation.com.

Mobile Laser Power Meter with Silicon Sensor

Gentec EO announces the PRONTO-Si mobile laser power meter. The device has a robust, easy-to-handle housing, and the operation via self-explanatory symbols on an illuminated, touch-sensitive color display is intuitive. When this compact device is folded up, both the sensor and the color touchscreen display are optimally protected. In the area of the silicon sensor, this device is just 6 mm thick and allows for power measurement even in very tight spaces.

Thanks to the highly-sensitive silicon sensor with an effective aperture of 10 mm x 10 mm, it is possible to quickly and precisely measure power levels significantly less than 1 nW. In addition, without the need for extra space, the range of measurement can be expanded into the three-digit mW range due to an integrated, "upstream" OD1 attenuator. Low laser power in the wavelength range from 320 nm to 1,100 nm can be measured "in a blink."

The charging of integrated Li-ion batteries (for a runtime of up to 17 hours), the readout of internal measurement data memory (for 50,000 measurements), and future software updates can be carried out via the existing mini USB connection.

More information is available at www.lasercomponents.com/.

High-Performance Impedance Analyzer & LCR Meter for Mid-Frequency Testing

Zurich Instruments has announced the launch of its new Mid-Frequency Impedance Analyzer and Precision LCR (MFIA) Meter. The MFIA measures in the frequency range from DC to 5 MHz. It is based on the Zurich Instruments' Mid-Frequency (MF) platform. The MFIA offers 0.05% basic accuracy and a measurement range spanning 1 mΩ to 10 GΩ. The instrument has high measurement repeatability with a low temperature drift. It is quick, too. Accurate measurements can be made within 25 seconds of powering on the instrument.

Three instrument control innovations are utilized to support impedance analysis. They are the Compensation Advisor, Parametric Sweeper and MFIA Lock-in Amplifier.

The LabOne Compensation Advisor guides users step-by-step. Each compensation step is validated and feedback is provided to the user before the data is taken to correct measurement errors.

Each data point for shielding, gain error, compensation error, overflow and underflow is validated by the LabOne Confidence Indicator. If accuracy is compromised, suggestions are made on how to improve the result.

With the Parametric Sweeper, users are free to scan any instrument parameter (e.g., frequency, bias voltage, test amplitude); ranges are freely adjustable with an unlimited number of step points. The Sweeper supports linear scans and logarithmic scans. A number of optimized application modes are pre-programmed to assist the user to achieve the most accurate results in a minimum amount of time without tedious manual adjustments.

The MFIA is integrated with the MFLI lock-in amplifier so that measurements can be easily synchronized with external sources. It displays individual voltage and current measurements at high-bandwidths. Support for DC measurements is included, as is the ability to record I-V curves.

Every instrument comes with an impedance test fixture, which is optimized for minimal parasitics and adds less than 10 fF capacity. A set of 12 sample carriers is also included, containing a short, an open and precision 1 k Ω load to accommodate a variety of compensation schemes.

For more information, please visit www.zhinst.com/products/mfia.

Digitizer Combines High Performance in a Very Small Form Factor

Keysight Technologies, Inc. has announced the U5310A 10-bit PCIe® high-speed digitizer running at 10 GS/s. With its very-high dynamic range and 10-bit resolution across a wide 2.5 GHz bandwidth, the high-speed digitizer allows the capture of fast transients with high fidelity.

This unique ADC card is designed for embedded OEM applications, such as medical research, analytical time-of-flight (MS-TOF), environmental monitoring (LiDAR), ultrasonic non-destructive testing (NDT), semiconductor testing and distributed strain temperature sensor (DSTS).

The new U5310A high-speed digitizer features two channels with 10-bit resolution, simultaneous sampling at up to 5 GS/s, and an unrivaled 10 GS/s in interleaved mode. With a DC up to 2.5 GHz bandwidth, this digitizer provides on-board real-time averaging at full sampling rate and large 4 GB memory.

Keysight developed new proprietary ICs for the U5310A. In particular, the low distortion and low noise LDNA front-end amplifier IC drives the ADC. This key component provides single ended to differential outputs with a distortion from 10 to 15 dB lower than the distortion of the ADC—therefore overall performance is not impacted.

Keysight also designed a low noise dedicated QMCK clock IC with very low 25 fs jitter. This specific IC drives the two ADCs, minimizing jitter. Moreover, the TRAC trigger IC provides time precision of 15 ps RMS.

The averager (-AVG) firmware ensures accumulation of a large number of triggers for synchronous real-time sampling at 5 GS/s on two channels and 10 GS/s when interleaved.

This new PCIe high-speed digitizer focuses on interoperability, reusability and upgradability with other U53xxA digitizers. The U5310A's software driver provides support for multiple programmable interfaces, ensuring easy integration of the ADC card into existing environments.

Additional information about product configuration and pricing is available at www.keysight.com/find/U5310A.

Precise Compact Linear Positioner

PI's new N-565 compact, nanometer-precision linear stages are designed for high-end applications in bio-nanotechnology, fiber-optics, microscopy, semiconductor testing, and metrology and scientific research in beamlines and laser labs.

Due to the fully integrated linear piezo motor, the low-profile stages have a very small footprint with a width of only 65mm and length from 80mm. Travel ranges 1/2", 1" and 2" are offered in 13, 26 or 52 mm.

An integrated interferometric linear encoder developed by PI can resolve to 20 pm and allows incremental motion below one nanometer. Due to the short signal period of 0.5 μm , the linearity error of PIONe encoders is less than 1%.

The PiezoWalk® technology combines the technological advantages of piezo class resolution with long travel ranges: they offer sub nanometer resolution, high forces, and high stiffness. In contrast to conventional long-travel piezo-motor principles, PiezoWalk® stepping drives are not subject to sliding friction effects, and virtually wear free motion is achieved because the "legs" lift off for each step. Preloading the actuators against the runner ensures a self-clamping force even when powered down, and the piezo stepping drive holds a position mechanically stable without servo jitter and energy consumption. PiezoWalk® motors were developed for the semiconductor industry over a decade ago and provide extreme reliability.

Features & Advantages:

- Ultra-High Precision Design: 0.5nm Encoder Resolution
- Patented PiezoWalk® technology combines piezo-class resolution with long travel and extreme reliability
- Self-Locking at power off. No drift, no heat generation at position hold
- 3 Travel Ranges: 1/2", 1" and 2"
- Compact Design: 65mm Width, 20mm Height

Find more information at www.pi-usa.us/products/precision_positioning_pi-micos/Linear_Precision_Positioning_Stages_Mc.php#N565.

Customizable Smart Graphics Displays

The OMEGA® OM-SGD Series of panel meters with bright color TFT smart graphics displays are available in 3 screen sizes. They offer a wide operating power supply voltage range of 4 to 30 Vdc and two alarm outputs. Waterproof NEMA 6 (IP67) versions are also available. Using the provided Simple Wizard based configuration software, select from over 40 standard display configurations to program in seconds to your exact requirements. Customize colors, text labels, input scaling and units before uploading the selected display configuration to the meter via USB interface to the PC. The OM-SGD is ideal for process monitoring in a wide range of industrial or laboratory applications in a large number of industries.

For complete specifications of the Smart Graphics Display, please visit www.omega.com/pptst/OM-SGD-SERIES.html.