

The IEEE Instrumentation & Measurement Magazine
December 2013 Issue

Energy: Instrumentation and Measurement for Petroleum Drilling

From the Editor's Bench

Mike Gard

**December 2013: Instrumentation and Measurement for
Petroleum Drilling**

This issue of the *IEEE I&M Magazine* is a direct result of tutorials given during the International Instrumentation and Measurement Technology Conference (I2MTC) 2012 held in Graz, Austria. One of the tutorial tracks consisted of presentations by the Drilling Systems Automation Technical Section (DSATS) of the Society of Petroleum Engineers (SPE), referred to as SPE-DSATS. It was evident to SPE-DSATS presenters and IEEE participants alike that successful petroleum drilling automation will be heavily dependent on downhole and borehole measurements made by rugged instrumentation packages. Both groups also recognized the IEEE Instrumentation and Measurement Society (IMS) consists of exactly those I&M specialists capable of advancing the state-of-the-art in areas of research and development related to drilling needs. The suggestion that our respective organizations (SPE-DSATS and IEEE-IMS) should cooperate at an organizational level was a very natural outgrowth of these complementary needs and interests, and agreement was enthusiastic. This special issue is the first step of the cooperative effort initially discussed in May 2012.

The I&M Magazine's Editor-in-Chief takes a particular delight in this issue because he grew up in the Kansas oilpatch and worked eight years as an R&D engineer for the AMOCO Production Company's Tulsa, Oklahoma Research Center and the ARCO Oil and Gas Company's Plano, Texas Research Center – both long ago swallowed up by corporate mergers. The problems being addressed in the petroleum industry are demanding by any standard, involving extremes of temperature and pressure, hostile environments, severe operating constraints, and requirements for accuracy and reliability that can be intimidating.

The search for oil is supported by good science and exceptional signal processing and computing capabilities. Seismic exploration remains the primary search tool although supplemented by other techniques when possible. Oilfield geologists and geophysicists, in their efforts to model complex earth structures from seismic data sets, pioneered many of the data processing applications now routinely used in medicine, physics, and similar endeavors. At some point, however, when the science and data processing is done and the geologists and geophysicists have scoured their last shot record for clues, signs, omens, and portents, there is only one way to know if there really is oil down there – you prepare to spend millions of dollars and call the drillers.

Drilling has many features in common with the military. The work takes place around the globe, in all climates, and in all conditions. It is logistically complex and physically demanding. The work is difficult, and the rig floor is a dangerous work environment. There are occasions, although rare, when things start to go wrong and correct decisions must be made in a very brief period of time, often with incomplete information. It is no place for the timid. It is small wonder that drillers are working hard to improve their measurements and automate their processes – health and safety are on the line, along with millions of dollars and serious environmental concerns.

There is a two-fold purpose to this issue. The first purpose is to introduce drilling to the I&M community, who generally have had little opportunity to learn about the petroleum industry and drilling processes. You will be fascinated to learn of a business where drillpipe is routinely measured in kilometers and a 4 km hole in solid rock is often considered too shallow to be interesting. The second purpose is to share certain recent advancements from the I&M community and industrial R&D operations with the drillers. This issue seeks to satisfy both purposes. It is necessarily brief, but it will give readers a better insight into one of the most fascinating and technically challenging industrial operations in existence.

The articles in this issue are generally concerned with land drilling. A superb illustration of a land drilling rig is on page 6 of this issue. Although only a few of the structures are named, it was necessary to make the illustration readable. Offshore rigs, those used when drilling in deep water, are exceptionally complex and may possibly be addressed in a later issue. These articles are also the first in what is planned to be a continuing series of articles by SPE-DSATS authors, with the objective of helping SPE and IEEE help each other in the search for excellent technology to meet extraordinarily demanding requirements. We requested the SPE-DSATS authors to give IMS readers an indication of technology developments needed to do their

work, and you will find their responses in the articles in this issue and in an excellent introductory article by SPE-DSATS author Fred Florence in the October 2013 issue of the *I&M Magazine*.

As always, we appreciate and encourage reader feedback. Exciting articles and tutorials are in preparation, some in direct response to reader comments. The February 2014 issue will feature articles by a number of authors at CERN, who will share information about some of the remarkable technologies developed to support the hunt for the Higgs boson. The April 2014 issue will have papers dealing with instrumentation and measurement applications in alternative energy research. *I&M Magazine* encourages manuscripts from industrial authors.

Instrumentation and measurement activity accompanies almost any serious effort in applied science and engineering, so we welcome submissions from authors working in almost any measurement field. The *I&M Magazine* staff sincerely hopes you enjoy this issue. Please let us know what you think of it.

More later,
Mike

Please contact Mike at IandMMagazineEIC@ieee.org. His bio is available at <http://www.ieee-ms.org>.

Feature Articles

Oil and Gas Drilling Processes and Instrumentation Open to New Technology

Fred Florence

Editor's note: The oil and gas industry is heavily dependent on instrumentation and measurement technology. This article explores the relationship between the petroleum industry and the I&M technology that supports it. It specifically identifies technology needed by, but not yet available to, the industry. Research groups are invited to consider how their efforts might be applied to the industry's exciting and remarkably demanding measurement problems.

Drilling Trajectory Optimization

John Macpherson

Editor's note: This is an excellent introduction to contemporary drilling technology. A well is not just a hole in the ground; putting the hole where you want it is no small matter.

Acoustic Telemetry for Oilfield Operations

Don Kyle, Michael Fripp, and Kevin Fink

Editor's note: The continuing need for a reliable data path up to 10 km long with reasonable data rate is a critical issue for any number of petroleum industry applications. This article gives a brief introduction to well completions; casing and tubing use in finished wells; and considerations affecting a commercial system addressing the data rate problem in a finished well. The Measure-While-Drilling application necessarily has a toolstring in the hole, which greatly complicates the already complex task of data communications.

Rotary In-Drilling Alignment using an Autonomous MEMS-Based Inertial Measurement Unit for Measurement-While-Drilling Processes

(Summary)

Zhenhua Wang, Michael Poscente, Dobromir Filip, Marian Dimanchev,
and Martin P. Mintchev

Editor's note: The severe conditions of the drilling environment greatly limit technical options available to the equipment designer. Some desirable options cannot be used simply because they are too large for the restricted diameters available in drilling tools. Drilling would greatly benefit from inertial navigation solutions, but suitable conventional components cannot be used because of their physical size. This article describes work directed to the provision of improved navigation solutions for MWD applications.

Spectrum Analyzers Today and Tomorrow: Part 2 Towards filterbanks-enabled real-time spectrum analysis

(Summary)

Adnan Al Adnani, Jonathan Duplicy and Lieven Philips

This is Part 2 of the two-part article on spectrum analyzer technology and the future capabilities enabled by introducing filterbanks. A filterbank (FB) based real-time spectrum analyzer (RTSA) is proposed here to mitigate the limitations of classical overlapped windowed fast Fourier transform (FFT), i.e., amplitude and frequency gaps, while maintaining optimum bandwidth and throughput performance. The FB's structure is a generalization of the classical overlapped windowed-FFT, and therefore maintaining backward compatibility, and provides superior time-frequency performance.

This summary includes text from the article.

Time Interleaved Analog to Digital Converters: Tutorial 44 (Summary)

Charna Parkey and Wasfy Mikhael

The purpose of this tutorial is to introduce the general readership to the benefits, problems, and implementations of Time Interleaved Analog to Digital Converters (TIADCs). An ideal TIADC increases the overall sample rate by M times while preserving the performance, characteristics of a single ADC, where M is the number of converters interleaved. In practice, periodic time varying mismatches are introduced through channel differences that increase the static, linear and nonlinear errors and distortion. In addition to the errors introduced strictly due to interleaving the sub-ADCs, the analog front end, including the sample and hold(s) that may be required to support the sampling operation, add additional nonlinear errors.

This summary includes text from the article.

In Memoriam

Milton G. Slade
(1927 – 2013)

It is with much sadness that we share with you the passing of Milton G. Slade on July 16, 2013. In these pages, we briefly describe Milt's many professional contributions to the IEEE Instrumentation and Measurement Society and compile remembrances from his family and a few of his colleagues. As we all know so well, it is the interactions with our family members, friends and colleagues that truly provide the richness and breadth of a life "well-lived." Milton was

loved deeply by his wife, four daughters, and four grandchildren and is remembered fondly by many friends and colleagues, both in the U.S. and throughout the world. For those of you who knew him, this tribute will undoubtedly rekindle your own memories and interactions with Milt, and for those who did not have the fortune to know him personally, we hope these brief stories will give you a glimpse into his character and love for life.

—Ruth Dyer

Professional Contributions to the I&M Society

Milton was a devoted and valued member of the I&M Society. His contributions were many and included service as Vice President (1992-93) and President (1994-95) of the Society, fifteen years as a member of the Technical Committee on Automated Instrumentation, ten years on the AUTOTESTCON Board of Directors, member and Chairman of the IMTC Board of Directors, member of the Editorial Board of the I&M Magazine, Editor-in-Chief of the I&M Transactions (1999-2006), and Editor of the I&M Newsletter.

Milton was a 1948 graduate of MIT where he earned a BS in Electrical Engineering. He retired from GTE Government Systems after fifteen years of program management where he was responsible for automatic test programs, group support equipment, and a military telephone message switch. Earlier in his career, he was active in the development of automatic support equipment at Sanders Associates and systems engineering and management of communications, radar systems, and automatic test equipment at RCA. He conducted research in guided missile telemetry at the MIT Research Laboratory of Electronics and flight planning and analysis of variable incidence hydrofoil control systems at the MIT Flight Control Laboratory.

Milt was a Life Fellow and a recipient of the IEEE AUTOTESTCON Frank McGinnis Professional Achievement Award. In 2007, he was the recipient of the I&M Society Career Excellence Award which is granted to recognize a lifetime career of meritorious achievement and outstanding technical contribution by an individual in the field of instrumentation and measurement. The citation for Milt's Career Excellence Award was, "For a lifelong career in automated test and measurement and over fifteen years of volunteer service to the Instrumentation and Measurement Society."

Family Remembrances

Dad was always doing projects, and we can only imagine that it must've started early in his life. He grew up in Dartmouth, Massachusetts with his parents and two sisters who were considerably

older. Reading and having a knack for remembering directions at a very young age, he graduated at the top of a small high school class and went on to be a fish (or beaver) in the bigger pond of MIT. He commuted to Cambridge, living with his sister and her husband in Malden. Mom was working as a secretary at MIT, and she and Dad met and were active in Monitor Youth Forum, a social group of area Christian Scientists. Dad and Mom were married in 1951 and lived with Mom's parents in Melrose for a year because of a delay in the completion of their house that was being built in Concord.

Dad and several others at MIT had responded to a notice they had seen posted about a development of homes designed by architects Rupert Maclaurin and Carl Koch to be set in a wooded area of Concord near the Sudbury River. The area came to be called Conantum. The homes were contemporary and simple in design and were meant to be affordable with minimal disturbance to the land. This is what has come to be known as part of the mid-century modern design that was also taking hold in other pockets outside of Boston. Although there were problems and delays with the project, Dad and Mom were able to move into their house in 1952 with one floor complete.

From the beginning, Dad was intrigued with how things were done and he learned by doing. Initially, he landscaped around the house, completed the second floor, and got a garage built with a terrace on top. After the family grew to four daughters by 1962, he designed an addition to the house to include an entry hall and living room, with input and approval from a Conantum neighbor and renowned architect Jean-Paul Carlhian. That living room was host to many happy family holidays and eventually contained a grand piano, which welcomed daughters and neighbor children for piano lessons and displayed artwork by talented neighbor artists. He tackled an outdoor shed and finished the basement and did the wiring and plumbing himself. When the electrical box was inspected, Dad was complimented on his neat work.

As a member of the Christian Science church in Concord, he was involved in many capacities, from Treasurer, to Usher to Sunday School teacher. His biggest contribution was in helping with upkeep. When a new sound system was needed, when someone needed to be available as a contact for the furnace maintenance, when fires needed to be built in the fireplace before church services, when a railing was needed for the front entrances, or property cleanup was needed, Dad was involved.

Around 1970, he bought land on Long Lake in Maine to have a summer house that was a reasonable driving distance from Concord and one where we could swim. As he didn't like to throw things away, he was always happy to prove that he'd been justified in saving something that ended up being used. Church chairs and furniture from the Concord house went to Maine as well as former kitchen cabinets. At least one appliance went up in the station wagon in the winter and was delivered to the front door by toboggan because the driveway wasn't plowed. Dad had the frame of the house put up in 1972 and over the years he did the entire inside, himself, including carpentry, plumbing and electrical work. He used a green bathroom sink no one else wanted and made his own clever light fixtures. The dining room table was made from a solid core door with false organ pipes for legs, removed and saved when the Concord church renovated its organ. He was always moving rocks, and he built impressive stone walls in front of the house, outlining garden and driveway, along the edge of the shore and under the dock. The house, first built on support posts that proved not quite sufficient, needed a foundation. He borrowed a friend's cement mixer, intending to make the footings and have someone come in to pour the foundation. But, he just kept going, much to the disappointment of his teenage daughters since work often started at 7:00 AM. By the time he'd completed the foundation, he'd worn a hole in the mixer!

Dad was affectionately named Sid by one of his daughters when she was ten, and the name remained, even being used by some friends and relatives. He was known to wear shorts so often that the neighbors could tell that it was really cold if Sid was outside working and he was wearing pants! He was also at home in the kitchen, usually preparing the meat portion of the meal. His stuffing for the turkey was different every year and he would often make interesting casseroles (or glop, as the family called it) with whatever was in the refrigerator. He was famous for his carrot cake and fruitcake which became expected with great anticipation at work holiday parties. He had a vegetable garden on common land in the Conantum neighborhood and knew the names of many plants, bushes and trees. He seemed happiest working outside in the yard and always enjoyed showing his daughters, or later one of his four grandchildren, the toad under the rock or the lady slipper and trillium in the woods. Dad and Mom were proud owners of their house for sixty years and were ready but sad to leave it in the summer of 2012. Both Concord and the lake in Maine were wonderful places to grow up, and all four of us are extremely grateful for the life that Dad and Mom built and provided for us.

—Debbie Slade Pierce

One of my earliest experiences with Milt and his wife Jean was when my husband and I attended the 1994 IMTC in Hamamatsu, Japan. This was the very first time that IMTC was held outside of North America, and there was some concern as to whether the attendance would be negatively impacted by holding the conference in Asia. It turned out to be the largest attendance IMTC had ever had, and as President of the IMS at that time, Milt did a wonderful job of welcoming the participants and presiding at the opening and closing events. His gentle, caring nature and his ever-present smile made everyone feel welcome and included. Since 1994, we have held half of the IMTCs in either Europe or Asia and expanded our international presence. Twenty years later in 2014, IMTC will be held in South America for the first time, and I know that Milt will be smiling down with approval upon us as we gather there next year.

Several of Milt's IMS colleagues have provided brief perspectives on their interactions and experiences with Milt as part of the roles within the IMS, as well as the impact he had on their lives. Their remembrances will give you at least a small glimpse into the character of Milt Slade and the contributions he made in so many ways.

—Ruth Dyer

IMS Vice President for Finance

I can't remember exactly when I first met Milton, probably because I can't think of the IMS without him. It was probably in the late 1980s or early 90s at one of the IMTCs I started to attend on a regular basis. In the late 90s, when I started to be more involved with the IMS as the General Chair of IMTC 1999, the first IMTC to be held in Italy, he was the chair of the IMTC Board of Directors. I learned a lot from him and the way he chaired the Board, smoothing every potential conflict with his gentle smile. He was a true mentor to me and the new generation of people who volunteered their time to the IMS, and I was really proud when he nominated me as his successor as the Board Chair.

The few times we were in disagreement, I had to admit that he was right. He had a true gift in recognizing the value of people. Only once I was just a bit perplexed on his evaluation, and of course, he was right and I was wrong. And every time we met, he reminded me of this. But he did this with his usual smile and with such a cheerful glance, that I could do nothing else than smile back at him and say, "I know you were right Milt! Luckily, you didn't listen to me!" I suspect that part of the fun was to force me to admit that I was wrong... and I know for sure that this was also his caring way to remind me to always look to the very heart of a matter.

Now that you're not with us any longer, I realize how much I learned from you, and how much I'll miss you Milt. Rest in peace. I'm sure that you're looking down at us with your smile... I can feel it.

— Alessandro Ferrero
Editor-in-Chief
Transactions on Instrumentation & Measurement

I met Milton in the late 1990s and started working more closely with him during his tenure as the Editor-in-Chief (EIC) of the I&M Transactions, TIM, serving as one of his associate editors. My interactions with Milton began to increase in 2003 when I managed the publication of (then) the IMTC special issue as its guest editor and later as I joined the I&M Society AdCom. When Milton decided to step down from the position of EIC, he nominated me to the AdCom to take over this position and the associated immense responsibilities that he had fulfilled for many years. I was incredibly honored by the confidence and support he showed in me. I worked very closely with Milton in 2006 when I was the associate EIC and was learning my way around issues related to the Transactions. Subsequently, I would personally visit with Milton at least a couple of times a year during the AdCom meetings. Milton was a true gentleman and was patient, caring, thoughtful, respectful of others, fair and objective. I always remember him with his warm and friendly smile every time we visited. I would call him from time to time to update him on the affairs of the Transactions, and he would always be supportive of the changes we were implementing at the time. Milton's long tenure in the I&M Society was a great experiential resource for me as I was increasingly becoming involved in the Society. He always gave me his honest advice and candid opinion. I would always look forward to personally visiting with him and experiencing his warm, inviting, caring and fatherly demeanor. I learned a lot from Milton, not just on matters related to the Society, but as a person. Even though we did not communicate on a regular basis in the past couple of years, I still sorely miss him. Rest in peace my friend, you were a great friend and a wonderful colleague.

— Reza Zoughi
Executive Vice President, I&M Society

I had the opportunity to work with Milton during the time he was Editor-in-Chief of the Transactions between 1999 and 2006. Milton was a wonderful person to work for and an excellent Editor. He was always very patient with my questions, and I really appreciated this. He was a very organized person, and I learned so much from him.

It was a real pleasure during the years to visit with Milton and his wife Jean at the IMTC conferences and other meetings that we attended together. They have both made so many contributions to the Society, and we thank them. I always looked forward to the conferences because of the chance to visit with them.

Milton was also an excellent storyteller. I especially enjoyed his stories about the major hurricanes that made their way up the East coast to his part of Massachusetts. From his stories, it was easy to picture Milton as a young boy on his way home from grade school with a friend and almost being blown out into the middle of the street because of the winds from the hurricane. I was sad when I heard that Milton had passed away. I will miss Milton and will always remember him.

— Cam Ingelin
Editorial Assistant, TIM

When I first began working with the I&M Society in January of 2007, I had the pleasure of meeting so many wonderful people in this “family” that we call the AdCom. Milton Slade was one of those people. I saw right away that the I&M AdCom was a special group of people. At that time, Milton was not an elected member of the AdCom but was on a “special assignment” to the AdCom. What did this mean? It meant that the leadership of the AdCom knew a good thing when they saw it! When Milton’s official elected terms were over, they kept him on to serve in an “advisory” role. Milton’s wisdom was vast, not only his knowledge of history but also his vision for the society. He stayed on this special assignment in 2008 and 2009.

I also had the pleasure to work with Milton as he served on the AUTOTESTCON Board of Directors from 2008-2010, a board which I supported. I truly loved seeing him and Jean at the AUTOTESTCON and for many reasons: he and Jean were always smiling, he had such a dedication to this conference, he was always ready to lend a hand, he served impeccably on the board, in a quiet yet confident manner, and last but not least, he always gave me the bottle of wine left in his room!

I was so thrilled when Milton was chosen to receive the Career Excellence Award in 2007. It was such an honor for him to receive this award in Warsaw. Watching Milton receive this award, well, that’s when I truly understood the significance of the Career Excellence Award.

I have many fond memories of Milton, and one stands out above all others. The AdCom was in Stresa, Italy for their fall meeting in 2007. The AdCom dinner was held on Isola dei Pescatori in the middle of Lake Maggiore. We took a boat to the island. We had wonderful food and wine, and we all were entertaining each other with songs and stories. Milton shared an old fraternity song from his college days, and it was priceless! He stood up and sang with such pride! Below is a picture from that night back in 2007. It was truly a magical night. This is how I will remember Milton: a man of history and vision, a man of extreme kindness and humility, and a man that could stand up and belt out a song when among friends. Milton, you will be missed.

— Judy Scharmann
Director of Client Services
Conference Catalysts, LLC

This column includes photographs of Milton Slade and the Fall 2007 I&M Society Administrative Committee dinner in Stresa, Italy.

Departments

New Products

Robert Goldberg

Digital Radio Test Set

Aeroflex Incorporated introduces the new 3920B Digital Radio Test Set for Analog AM and FM, Digital P25, P25 Phase II, DMR, NXDN™, TETRA, TEDS and other technologies. The 3920B features a new low phase noise RF signal generator in addition to the already advanced functionality available on the Aeroflex 3900 Series Radio Test Sets. The 3920B is the direct replacement for all versions of the Aeroflex 3900 Series, including the 3901, the 3902, and the 3920.

The 3920B features a new low phase noise RF signal generator providing enhanced spectral purity with SSB phase noise specified at -110 dBc/Hz at 10 kHz offset. This level of performance is achieved at an offset from the carrier that is significantly less than the industry standard for this type of specification, which is typically 20 kHz. The ability of the 3920B to achieve such low phase noise specifications close to the carrier makes the 3920B an ideal test solution for today's digital narrowband or analog receiver testing where narrowband phase noise is critical.

The 3920B includes all of the features and function of the 3920. This includes Aeroflex's expanding library of Auto-Test II capabilities for automated test and alignment of a wide range of mission critical radios. The 3920B provides Auto- Test II capabilities for Motorola APX, Motorola XTS and XTL Series as well as Harris, EF Johnson, Relm/BK and Kenwood radios, with support for additional radios coming in the near future.

For more information, contact your local Aeroflex sales office by calling Aeroflex Sales at +1(800) 835-2352 or send an email to info-test@aeroflex.com.

Triaxial, Variable Capacitance Accelerometer for High Accuracy in Low Frequency Measurements

Meggitt Sensing Systems has launched the Endevco model 7298 triaxial, variable capacitance accelerometer designed for highly accurate measurement of low-frequency events. Typical applications require measurement of whole-body motion in three mutually orthogonal directions immediately following a shock or in the presence of severe vibrational inputs.

With its exceptional bandwidth, precision accuracy and high shock survivability, the Endevco model 7298 is ideal for use in aircraft flight and flutter testing, automotive rough road body motion studies, suspension system tests, railroad testing and train tilt control, centrifugal force, launch loading and acceleration, and short-term navigation.

Available in six models, ranging from 2 to 100 g, the Endevco model 7298 incorporates a patented sensing element with gas damping and internal over-range stops, which enable the transducer to withstand high shock and acceleration loads. It also features a stainless steel, hermetically sealed package utilizing an integral water-resistant connector that, when combined with the optional model 3907 cable assembly, allows for extended outdoor exposure.

With a low profile of 14.2 mm high and light weight of 22 g, the impact of the Endevco model 7298 on the mass of the test object is minimal. It has a very broad standard excitation input range covering 6 to 45 Vdc, operates across the full military temperature range of -55 to +125 °C with integral digital temperature compensation, and is easy to install with simple two-screw mounting. In addition, it offers +0.5% FSO typical non-linearity and hysteresis for most ranges and +1% FSO maximum for both thermal sensitivity shift and thermal zero shift, enabling it to provide the highest level of total accuracy available.

For more information on the Endevco product line, visit www.endevco.com. For full details on all Meggitt Sensing Systems products, visit www.meggittsensing.com.

Crash Test Accelerometers for High-G Impact Events

PCB Automotive Sensors, a division of PCB Piezotronics, Inc., introduces a new series of DC MEMS shock accelerometers for automotive crash testing and similar applications. Available in damped and undamped versions, the PCB Series 3641 and 3651 are designed for applications that require small mass and a broad frequency response, such as crash testing, drop testing and sled testing. Both sensors offer a 2000 G full-scale measurement range with mechanical overload limit stops and a frequency range of 0 to 5000 Hz. In addition, these models meet SAE J211 and SAE J2570 specifications.

PCB Series 3641 and 3651 are designed with standard low transverse sensitivity and standard low zero G offset. PCB does not charge extra for standard lower transverse sensitivity and zero G offset temperature shift. The Series 3641 and 3651 achieve true dc response for measuring long duration shock. For this reason, they are preferred for applications in which integration from acceleration to velocity to displacement may be performed.

For more information, please visit www.pcb.com/Auto.

High Shock Tolerant Angular Rate Sensor

Diversified Technical Systems, Inc. (DTS) introduces the ARS PRO series of high performance angular rate sensor for dynamic testing applications. The ARS PRO is a silicon-based microelectromechanical-system, MEMS, that uses a resonating gyro to discern angular rates by measuring deflections in the sensing element that occur when rotational forces are applied. Key advantages include dc response, low power requirements, compact form factor and high shock tolerance.

All models are linear over the rated range and comply with SAE and ISO recommended practices for frequency response in all applications. DTS offers full-scale ranges from ± 300 to ± 50000 °/s and bandwidths up to 2000 Hz, fully supporting CFC 180, 600 and 1000 testing requirements. DTS also offers the ARS HG with an impressive 10,000 G shock rating, the highest in the industry, and features reinforced mounting points designed to withstand high energy test environments including blast and missile. All models are packaged in compact rugged enclosures and weigh only 2.5 g. Other features include high output voltage and shunt check capability. DTS ARS mounting blocks offer an easy triax solution. Blocks also include mounting points for three accelerometers to create a six degree of freedom package.

For more information and detailed specifications on the ARS PRO, visit www.dtsweb.com.

2-Port RS-422/485 Serial Interface for PCI Express

Sealevel Systems announces the 7204e, a new PCI Express serial interface adapter that provides two serial ports individually configurable for RS-422 or RS-485 communications. For error-free operation in high-speed serial applications, the board's high-performance 16C950 UART includes 128-byte FIFOs,

eight times larger than those found on standard 16550 UARTs. Additionally, the 16C950 UART supports 9-bit framing and is fully software compatible with legacy UART applications. The 7204e is ideal for a variety of applications including process control and test and measurement.

Product features include:

- Two serial ports configurable for RS-422 or RS-485,
- Oscillator and clock prescaler support wide range of baud rates,
- Supports 9-bit protocol framing and data rates to 921.6 kb/s,
- Automatic RS-485 transmitter enable/disable via hardware,
- Fully compliant with all PCI Express X1 slots, and
- It is supported in Windows and Linux operating systems.

The 7204e's 14.7456 MHz oscillator and the UART's flexible clock prescaler support the widest range of standard and non-standard baud rates. With this advanced architecture, each serial port is capable of data rates to 921.6 kb/s. In RS-485 mode, the transmitter is automatically enabled in hardware, eliminating the need for application software control. This allows the 7204e to be used with standard serial applications while removing the risk of bus contention and data corruption.

All Sealevel PCI Express serial adapters include SeaCOM software for Windows and Linux operating systems. As an added value, customers also receive WinSSD, a full-featured application for testing and diagnostics including Bit Error Rate Testing (BERT) throughput monitoring, loopback tests, and test pattern message transmissions.

For more information, visit www.sealevel.com.

Low-Noise MEMS Accelerometer

Silicon Designs, Inc. announces the global market introduction of its model 1521 surface mount accelerometer series. The distinguishing feature of this series is its extremely durable design which incorporates Silicon Designs' own proprietary MEMS chip development and fabrication. This provides an *industry best in class* MEMS variable capacitance accelerometer with up to 2,000 h of measurement stability, in temperatures as high as +175 °C, with 6,000 G shock survivability and zero signal degradation.

Expressly designed as a high-performance, pin-compatible drop-in replacement for the company's model 1210 and 1221 series, the new Silicon Designs model 1521 series features nonferrous construction and a highly durable nitrogen-damped MEMS sensing element, housed within a miniature hermetically sealed gold ceramic 20-pin LCC or JLCC package. All Silicon Designs accelerometers feature a custom

integrated circuit with onboard sensing amplifier and differential output stage, with a 0.5 to 4.5 V single-ended or ± 4 V differential output, proportional to the amount of measured acceleration.

Series units can respond to either dc or ac acceleration. Each accelerometer is fully calibrated and traceable. The model 1521 series is available in standard measuring ranges from ± 2 g to ± 200 g with nominal frequency response, either from 0 to 400 Hz (± 2 g) or 0 to 3000 Hz (± 200 g). The Silicon Designs' model 1521 series is also insensitive to temperature changes and gradients, with signal output unaffected by electromagnetic interference and requiring no warm-up period. The ± 2 g version of this series is further offered with very low noise floor, in direct support of seismic and other low-frequency vibration measurements. With its high end performance characteristics, the Silicon Designs' model 1521 series offers improved long-term measurement stability and repeatability, making it ideal for extended-use shock and vibration measurement applications, particularly within harsh environments.

For more information about the model 1521 series, please visit www.silicondesigns.com.

High-Speed EMI Test Receiver for Standard-Compliant EMC Testing Up To 26.5 GHz

The new R&S ESR26 EMI test receiver from Rohde & Schwarz covers the frequency range from 10 Hz to 26.5 GHz. The instrument performs conducted or radiated certification measurements in line with commercial standards such as EN, CISPR and FCC as well as military standards. The North American FCC standard and the CISPR standard both specify EMI measurements up to 18 GHz.

Thanks to its broadband architecture, the R&S ESR26 performs standard-compliant disturbance measurements up to 6000 times faster than other testers. EMI measurements that took hours in the past can now be completed in just seconds, saving users valuable time on the way to obtaining desired results. In addition, the instrument offers comprehensive diagnostic tools to support design engineers. The persistence mode allows users to clearly differentiate between pulse and continuous disturbances. It displays the probability of amplitudes occurring at specific frequencies using different colors, making it possible to detect disturbances that are hidden by broadband signals. The frequency mask trigger responds to specific events within a disturbance spectrum. If the mask is violated, a trigger is activated. The measurement is then stopped, and the user can analyze the disturbance and its effect.

Users can verify existing results by means of the conventional stepped frequency scan of the R&S ESR26. Plus, the instrument is a full-featured spectrum analyzer and provides tried and tested analysis tools such as IF analysis and time domain display. Besides the test receiver's compact, robust design and its low weight, a number of options make the R&S ESR26 ideal for field use. These include a dc power supply with rechargeable battery pack, a solid state drive (SSD), and an optional ruggedized housing.

The R&S ESR26 not only features outstanding functionality, it also provides ease of operation and a clearly structured touchscreen. Complex measurements and automated test sequences are easy to configure. The R&S EMC32 software can be used to remotely control the R&S ESR26 and integrate it into complex EMC test systems for automated measurement sequences.

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

Free Web-Based Seminar Shares the Secrets of How to Choose and Use a Source Measure Unit Instrument

Keithley Instruments, Inc. is offering a free, web-based seminar titled “What is a Source Measure Unit (SMU) Instrument and Which One is Right for Your Application.” This event, which is available for on-demand viewing, offers useful insights into making accurate electrical measurements with SMUs, including the basics of how SMU instruments work, key features, capabilities to consider in selecting one, and an actual performance comparison of different SMU instruments in *real-world* applications. “What is a Source Measure Unit (SMU) Instrument and Which One is Right for Your Application” is recommended for those with a need to measure current vs. voltage (I/V) and engineers, researchers, educators, and students who need to characterize and test semiconductor-based devices, components, materials, and technologies in particular.

Participants will learn how to use a SMU instrument to:

- Deliver more complete characterization of devices or materials,
- Boost test system productivity, and
- Increase overall test system performance.

To register for on-demand viewing of this webinar, please visit <http://www.keithley.com/ws/1395>.

Z-Axis Positioner / Optical Axis Nanopositioning System

PI (Physik Instrumente) claims their high precision positioning system of microscope objectives along the optical axis has just made a giant leap forward. While piezo actuation has always been the undisputed choice in optical positioning when dynamics and accuracy matter most, some applications could have benefitted from more travel range. A new design principle developed by PI now extends the positioning range to 2 mm while maintaining very short settling times on Optical Axis Piezo Z-Positioner on the order of 20 ms.

Optical metrology, super-resolution microscopy and other techniques require the nanometer and sub-nanometer level resolution and millisecond response provided by piezo nanopositioning devices. Until now, travel ranges of a few hundred microns were available, enough for most microscopy applications. PI’s new drive principle is based on a coordinated motion of multiple piezo elements overcomes these

limitations. Deep penetration microscopy methods, such as two-photon microscopy, benefit from the new piezo positioning device.

For a datasheet on the optics positioner please visit: http://www.pi-usa.us/products/Microscopy_Imaging/Precision_Microscope_Stage.php?onl_prw#PIF.

Temperature/Process Meters

Omega's new user-friendly iSeries is a simple to configure meter with alarms that features universal inputs, high accuracy, two relay alarm outputs, totally programmable color displays, built-in excitation, AC or DC powered units, front removable plug connectors, and programmable digital filter. The Dpi-AL series offers unparalleled flexibility in process measurement and alarm applications. This product can be used to monitor the temperature of a clean room, and with the programmable alarm setpoints, the meter can provide a visual display color change and alarm relay outputs if an alarm condition exists.

For a complete spec sheet, visit <http://www.omega.com/pptst/DPI-AL.html>.

Encapsulated LED Area Work Lights

Banner Engineering announces its WLA Series Encapsulated Area Lights. Designed for use in industrial environments, these powerful, solid-state LED lights are completely encapsulated in optically clear polyurethane, enhancing their chemical compatibility and increasing their resistance to shock and vibrations. The Encapsulated WLA light is a rugged, high intensity light ideal for machine lighting, visual inspection stations and general industrial area lighting. The sealed light is available in four sizes and has a sleek polycarbonate housing and slim profile.

Featuring a maintenance-free design, the energy-efficient Banner WLA Encapsulated Area lights are designed to withstand high-pressure, high-temperature washdown applications and are rated to IP69K. Easy installation options include quick disconnect or cable versions, a versatile angle bracket, and a convenient magnetic mount solution.

For more information on Banner's WLA Series encapsulated work lights, visit <http://bannerengineering.com>.

White Body LED Protectors Enhance Overall Light Engine Efficiency

Littelfuse, Inc. has introduced an addition to the company's PLED Open LED protection devices line. The PLEDxSW Series LED Protector, unlike earlier PLED devices from Littelfuse that had black molded bodies, is molded from a white material which makes it less noticeable in LED fixtures, particularly for indoor applications. It also reflects more light to improve overall light engine efficiency.

This device provides an electronic shunt path when an LED in an LED string fails as an open circuit. PLED devices are connected in parallel with each LED in a series string. If one LED fails as an open circuit, the PLED connected to it turns on and carries the current that would have gone through the failed LED. This keeps the rest of the string operating, so only a single LED goes dark rather than the whole string. PLEDxSW Series LED Protectors are compatible with 1-, 2-, and 3-watt LEDs. Their low-profile, small-footprint package dissipates heat efficiently, so they are ideal for use in dense board applications.

In contrast with earlier open LED protection solutions such as silicon controlled rectifiers (SCRs) and Zener diodes, they offer higher reliability and lower maintenance requirements. For example, SCRs are usually large and require additional components like resistors to set the trigger or turn-on voltage, and their trigger voltage will vary widely over temperature. Zener diodes create additional power dissipation once the LEDs they are protecting fail to open. They are also not rated for large dc currents which can shorten life or lead to catastrophic failure.

Additional information is available on the PLEDxSW Series product page at <http://www.littelfuse.com/products/led-protectors/led-protector/pledsw.aspx>.

Dual Output Boost Regulator Uses Only 150 nA

Touchstone Semiconductor has announced the TS3310 dual output boost regulator. The TS3310 consumes only 150 nA of supply current. Boost regulators are traditionally the highest current consumer in a system during sleep modes. The TS3310 removes this major constraint in power budgeting and enables years of battery life from a tiny battery cell. The TS3310 has an always-on output and an instant-on output. The always-on output is ideal for powering a microcontroller, enabling long battery life by minimizing battery drain during sleep mode. The instant-on output is ideal for powering a short-burst load, such as a Zigbee or Bluetooth radio.

The TS3310 operates from supply voltages as low as 0.9 V up to 3.6 V and can deliver at least 50 mA of continuous output current. The TS3310 is ideally suited to be powered from a wide variety of power sources including tiny button cells, single or multiple-cell alkaline cells or single Li-chemistry batteries. The boost regulator's output voltage range can be user-set from 1.8 V to 5 V to power a wide range of microcontrollers, low-power analog circuits and radio burst loads simultaneously. The TS3310 can also charge up a buffer capacitor to provide large burst currents to high power radios or other peripherals, even from tiny coin cell batteries.

The TS3310 also addresses the problem of leaky peripherals. The instant-on output features a load switch that allows users to “pull the plug” on a peripheral that draws unwanted current when it should be off. For example, a radio peripheral that draws 10 μ A in the “off” mode still consumes more than 10 times the current drawn by a sleeping microcontroller. Users can turn off the load switch to eliminate the battery

drain. The TS3310 has a fail-safe battery protection feature. If the battery voltage drops because of cold temperatures or at the end of life, the battery's internal impedance goes up. An undervoltage lockout then scheme "pauses" the switching activity, so the battery cannot get dragged down below 900 mV.

For more information on Touchstone's TS3310 or to download a data sheet, visit <http://touchstonesemi.com/products/TS3310>.