

The IEEE Instrumentation & Measurement Magazine
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Measurement Technologies from Past to Present

From the Editor's Bench

Shlomo Engelberg

Keeping in Touch

Some time ago my older daughter turned twelve, and my wife and I threw a large party to celebrate her coming of age. Then we came to New York to visit my parents and my extended family. Because my parents were not able to come to the celebration that my wife and I held, they decided to throw a party as well, and they invited friends and family who could not make it to the first party.

Initially, my wife and I looked forward to this second party with some trepidation. All of the work that goes into a successful party was still fresh in our minds. Although the second party was less work for us – my parents took care of much of the organizing and my sister and brother-in-law did lots of the work – it still required considerable effort. In addition, neither my wife nor I is at our best when we have to meet many people over a very short period.

As the party was going on, however, I realized again how important events that bring people together are. We saw family members who we would not otherwise have seen, and we renewed friendships that might otherwise have withered. I enjoyed seeing everyone who came; my only regret was that I did not have long enough to spend with each and every friend and family member. I was very happy that we had the party and saw how important it was.

The magazine is, in some ways, one of the society's ongoing "parties." Through its meetings and conferences, through the magazine and the transactions, the society enables us to keep in touch with one another. We get to see what people are up to and where the world of instrumentation and measurement is heading.

In this issue of the magazine, we have two articles written by some of the folks who participated in the Future of Instrumentation International Workshop held at Oak Ridge National Laboratory from November 8–10, 2010 (and we will have more articles in future issues of the magazine). The articles will help all of us to get a feel for where our field is heading, and I am grateful to the authors for the time and effort they put into writing up the ideas they discussed at the workshop.

As always, we have a variety of tutorials, articles, and columns that will help keep us informed about what is happening in the world of instrumentation and measurement. My thanks to all of our authors; the time and effort they invest to provide us with interesting and informative articles is greatly appreciated.

If you have recently done something that is of interest to the rest of the instrumentation and measurement family, consider writing an article for the magazine to keep us informed about your progress. I will be happy to receive your submission. (You may email me atshlomoe@jct.ac.il.)

Enjoy the issue!

Shlomo

President's Perspectives

Kim Fowler

Two Good Years

My tenure as President of the I&M Society is finished. It's been two good years with you and I have enjoyed it. While my presidency has ended, I'll continue as the Junior Past President and then later as the Senior Past President; this makes me available to help the AdCom in succeeding years to navigate uncharted waters - just as Steve Dyer and Alessandro Ferrero did before me.

For the past two years, the AdCom and I have struggled with how to be relevant and useful to you. That struggle will continue into the future. As the governing body of the I&M Society, the AdCom exists to serve you, the members. When we actually do serve you, we have fulfilled our mandate.

The AdCom cannot operate in a vacuum. We have our preconceptions of what the society needs, but we really need to know what your desires are, too. Your input is extremely important to us and we do consider it carefully. That said, here are some issues that I expect us to actively address in the future:

- The need to continue to fight the perception that measurement and instrumentation is “old science.”
- Members will want to see more tangible benefits from joining and remaining in the society. Examples include tested and certified design references, great tutorials, books, networking events, and social media connections.
- The need for virtual conferences – to aid those who cannot travel and for rapid review of topics of concern.
- Demand for webinars and discussion forums.
- Convening panels of experts to answer questions and provide advice.

As I close, I have several rounds of “Thank you!” First, thank you, the readers and members of the I&M Society for making this society what it is today and what it will become. Next, thank you to my colleagues on the Ad- Com for working diligently to serve the society. Finally, but not least, I thank Cam and Reta, the support staff for the Transactions; June, Kristy, and Gary, the support staff for the Instrumentation and Measurement Magazine; and Judy Scharmann, the society's Executive Assistant. Job well done!

We would love to hear from you. What would make the society more useful to you? Weigh in at our website forum at <http://www.ieee-ims.org/main/index.php> and click on the “Membership” tab and find the discussion forum.

Kim

Electronic Component Obsolescence

(Summary)

Christina D. Ward and Carl W. Sohns

With an increasing share of electronics being developed for a rapidly evolving consumer industry, components are being replaced by new designs in five years or less. This should be a major concern for instrumentation designers as they develop new products and support existing ones. This article describes the lifecycle of electronics and the need for proactively determining the total cost of a “last-time buy”, researching and buying an alternative replacement part, and redesigning a subsection or a complete product.

This summary includes text from the article.

Ultra Secure High Reliability Wireless Radiation Monitoring System

(Summary)

Joseph V. Cordaro, Davis Shull, Mark Farrar, and George Reeves

Researchers at the Department of Energy’s Savannah River National Laboratory (SRNL) have developed a prototype wireless radiation air monitoring system that addresses many of the concerns with wireless links and allows quick deployment in radiation and contamination areas. The strength of the combination of radiation sensing and wireless technologies in this system is the key to deployment in radiation areas. The main components are an electrometer, an ion chamber, a pre-amplifier, and an ultra secure communication system. Each aspect of the monitoring system is explained in this paper.

This summary includes text from the article.

WirelessHART Field Devices

(Summary)

Ivan Muller, Joao Cesar Netto, and Carlos Eduardo Pereira

In this paper, the *Wireless Highway Addressable Remote Transducer (WirelessHART, WH) Protocol* which has evolved from the HART Protocol is presented. It is one of the most prominent industrial wireless mesh network communications protocols for process automation applications. The authors describe how the protocol copes with RF link difficulties. A case study of the network behavior is given using a previously developed industrial field device with commercial tools and analysis software developed by the authors for use in industry to obtain network data.

Systematic Design of a Cross-Polarized Dermoscope for Visual Inspection and Digital Imaging

(Summary)

Hening Wang, Xin Xu, Xiaoqin Li, Peng Xi, and Qiushi Ren

In this paper, the authors describe the cross-polarization dermoscope, an instrument that can be used to obtain dermal images from the deep layers of the skin. The authors used cross-polarization principles to eliminate the use of an oil medium for superficial reflection cancellation. The system illumination and imaging performance was evaluated using optical simulation and the design was optimized, thereby revealing structures in deeper skin layers, such as pigmentation and capillary blood vessels.

This summary includes text from the article.

Practical Issues for Installing Instrumentation Outdoors, Part 1: Tutorial 36

(Summary)

Kim Fowler and Michael F. Gard

The external environment is hostile! This tutorial is the first article in a two-part series on the challenges of installing instrumentation in the wild. In this issue, the authors introduce problems with physical extremes and attacks by insects, animals, and human beings. In the next issue, solutions and case studies will be presented.

This summary includes text from the article.

Columns

Instrumentation Notes

An Energy-Saving Algorithm For Electromagnetic Flow Measurement in Open Channels

(Summary)

Andrzej Michalski and Jacek Jakubowski

Unlike flow in closed pipes, flow in open channels is often accompanied by changes in the filling, vegetation in natural conduits, and the varying direction of the moving water. All of these variables often make the use of standard approaches based on turbines, weirs, flumes and even ultrasonic methods impractical. An alternative solution to measure the flow is offered by electromagnetic flowmeters which have no moving parts, and there is no need for the typical

periodic maintenance. This column describes how to optimize the measurement algorithm. The authors explain the necessary quantitative power that the flowmeter coil has to receive to be able to realize a given measurement uncertainty with respect to analog and digital processing of the flow signals.

This summary includes text from the article.

Recalibration

The Evolution of Time Measurement, Part 3: Atomic Clocks

(Summary)

Michael Lombardi

The societal impact of atomic clocks has been immense. Many technologies that we take for granted rely on atomic clock accuracy, including mobile phones, Global Positioning System (GPS) satellite receivers, and the electric power grid. This makes it easy to forget that the first reliable atomic clocks appeared less than an average lifetime ago. This article is Part 3 of this series and looks at the origin of atomic clocks and some fundamental concepts. In the next installment, the author will move on to explore more recent advances in atomic timekeeping.

This summary includes text from the article.

History of Physical Standards

How Long Is It, Really?

(Summary)

James F. Schooley, Sr.

In this historical survey, the author discusses the development of measurement units related to length over time, the ensuing international deliberations to create a standard unit, and the related uncertainty involved. He reviews how the National Bureau of Standards' William F. Meggers began to accumulate prodigious amounts of spectroscopic data after being hired in 1914. Over a period of some thirty years, Meggers and his colleagues collected a great volume of data based on the wavelength of an atomic transition, made rapid progress in the analysis of the atomic states involved in the spectra, and in turn, led to a better understanding of the optimal criteria for a length standard.

This summary includes text from the article.

Departments

New Products

Robert Goldberg

Modular Power System Family Adds Application-Specific Modules for Battery Test, Mobile Device Manufacturing

Agilent Technologies Inc. announces the addition of two new application-specific modules to the N6700 Modular Power System (MPS) family: the N6783A-MFG mobile communications DC power module and the N6783A-BAT battery charge/discharge module.

The N6783A-MFG module offers sourcing and measurement capabilities specifically designed to meet the challenges of battery-powered (mobile) device manufacturing. The N6783A-BAT module offers basic two-quadrant operation for charging and discharging batteries as necessary for the design of a mobile device.

The Agilent N6783A-MFG module offers advanced features specifically for testing mobile devices in manufacturing. Its excellent voltage transient response ensures that a stable output voltage is maintained at the device under test during load transients.

The N6783A-BAT module is a basic two-quadrant DC module designed to enable mobile device designers to validate the battery to be used in the product being designed. During the research and development of a mobile device, the designer must properly validate the battery that will be used in the final design, especially if the battery will be permanently installed.

The N6783A-BAT's two-quadrant operation allows it to act as a power supply to charge the battery or as an electronic load to discharge the battery. Its built-in digitizing measurement system allows accurate measurements over the short and long term.

The N6783A-BAT can also be used to condition batteries for test in mobile devices by charging or discharging the battery to a specific level to see how the device performs under specific conditions. This allows R&D engineers to understand real-world operation of their designs during different levels of charge. The N6783A-BAT can be used for battery charge/discharge only.

The new N6783A-MFG and N6783A-BAT are a part of the N6700 modular power system family, which consists of the N6700 low-profile mainframes for automated test environments and the N6705 DC power analyzer mainframe for R&D.

More information about the Agilent N6783A-MFG can be found at www.agilent.com/find/n6783a-mfg.

For information about the Agilent N6783A-BAT, go to www.agilent.com/find/n6783a-bat.

Miniature, General Purpose, Piezoelectric Accelerometer

Meggitt Sensing Systems has announced the global market introduction of the Endevco® model 2250A, an extremely small, adhesive mounted ISOTRON® piezoelectric accelerometer with integral electronics, designed to support high-reliability vibration measurements of mini-structures and smaller objects within aerospace, automotive, electronic product and product life cycle testing (HALT/HASS/ESS) applications.

Offered with a sensitivity of 10 mV/g, the Endevco model 2250A features high resonance frequency and wide bandwidth, with a lightweight (0.4 gm) design that effectively eliminates mass loading effects. The accelerometer incorporates Meggitt's own Piezite® type P-8 crystal element operating in annular shear mode, which exhibits excellent output sensitivity stability over time. The accelerometer also incorporates an internal hybrid signal conditioner within a two-wire system which transmits its low-impedance voltage output through the same cable that supplies the constant current power. Signal ground is isolated from the mounting surface by a ceramic mounting base.

A field-replaceable miniature coaxial cable is supplied with the 2250A-10 as well as a special tool to ensure proper removal of the accelerometer (model 31275) from its adhesive mounting surface.

Recommended optional accessories for the Endevco model 2250A, sold separately, include: the model 133 three-channel piezoelectric signal conditioner; the model 4416B low-noise, compact signal conditioner; the model 2775B PE, Isotron and RCC signal conditioner; or the Oasis 2000 (4990A-X with cards 428 and/or 433) computer controlled system.

For more information, visit www.meggittsensingsystems.com.

3-Channel Current Data Logger

The new PicoLog CM3 USB/Ethernet Current Data Logger is a compact, easy-to-use instrument for measuring the power consumption of buildings and machinery. With three channels, it can monitor current in single-phase and 3-phase AC installations.

Applications include monitoring three-phase motors and generators and balancing phases in multiphase supplies. The logger is supplied complete with three AC current clamps and a data acquisition software package.

The PicoLog CM3's measuring range is 0 to 200 A, with an accuracy of $\pm 1\%$ and less than 10 mA of noise. Conversion resolution is 24 bits. The current clamps comply with IEC1010-1 (1995), with EN61010-1 (2001) at Cat. II 600 V, and with Cat. III 300 V.

The Current Data Logger is supplied with the PicoLog data logging software, which runs on any PC with Windows XP or later. PicoLog can collect data from up to 20 PicoLog CM3s at programmable intervals from 720 milliseconds per channel up to minutes, hours or even days. It displays readings in a monitor window with optional limit alarms, alongside optional live graph and table views of the same data.

Readings may be exported in a standard text format compatible with other spreadsheet and analysis programs. A software development kit that contains Windows DLLs, drivers and example code is also included. The development kit allows you to integrate the device into your own software.

More information on Pico Technology can be found at www.picotech.com.

Portable Multi-Channel Data Acquisition System

A new lightweight and compact portable data acquisition system has been introduced by Astro-Med, Inc. Designated the Dash® MX, the full-featured high speed multi-channel system is designed and engineered for capturing high frequency data and transient signals as well as long term trending.

The standard Dash MX records up to 8 channels of isolated voltage inputs to an internal 320 GB hard drive at sample rates of up to 200 kHz per channel. High frequency data captures can be saved directly to the hard drive for review and post-analysis. It also includes support for IRIG time codes A, B & E.

Equipped with a 12 in (30.5 cm) color display for intuitive touch-screen control as well as real-time data viewing and analysis, the graphical user interface of the Dash MX is optimized for ease of use. Simple menus permit the user to set most parameters using one touch buttons and checkbox controls. The system is built into a compact 13.25 in L x 12 in W x 5.3 in H (33.7 cm x 30.5 cm x 13.5 cm), lightweight, 20 lbs (9 kg) including input modules, rugged case for field or lab use.

Operating on 100 to 264 V ac, the Dash MX includes an internal rechargeable battery for power backup and up to 30 minutes of operation. The Dash MX comes equipped with isolated single-ended inputs that accept up to 250 VRMS. The Dash MX-H version is equipped with high voltage modules that can measure up to 1000 VRMS. Other signal input modules include thermocouple, bridge, piezoelectric and universal.

The versatile digital signal processing of the Dash MX provides a wide variety of capabilities, including low-pass, high-pass, band-pass and band-stop filtering. Derived channels (calculated channels based on user defined equations), variable sample rate during capture, and up to four sample rates per capture are some of the new, innovative capabilities of the Dash MX.

Designed for applications ranging from process trending to transient capture to remote troubleshooting, the Dash MX is portable and rugged for use in any environment.

For more information, please visit www.astro-med.com/.

50 GHz/67 GHz Switching Solutions for RF and Microwave ATE

Giga-tronics Incorporated announces the introduction of new 50 and 67 GHz switching solutions. This expands the capability of the Series 8000 and 8800 families from Gigatronics ASCOR. Offering a frequency range, up to 67 GHz enables inclusion of switching in Automated Test Equipment (ATE) for a number of aerospace and defense applications, including test of inter- satellite and point-to-point communication systems. In addition, 67 GHz covers the frequency band intended for the wireless transmission of multimedia data (wireless HDMI).

Building on 30 years of experience and partnerships with leading relay manufacturers, Giga-tronics ASCOR selects the relays that offer the best performance for the application, including high isolation, low insertion loss and high reliability. Typical specifications for the 67 GHz relays include:

Frequency	DC- 3 GHz	3- 12.4 GHz	12.4- 18 GHz	18- 26.5 GHz	26.5- 50 GHz	50- 67 GHz
Insertion Loss (dB)	0.4 max	0.5 max	0.7 max	0.8 max	1.0 max	1.1 max
VSWR (X:1)	1.15 max	1.25 max	1.3 max	1.7 max	1.9 max	1.9 max
Isolation (dB)	96 min	85 min	80 min	70 min	70 min	70 min

Repeatability: 0.08 dB, Life: 5 M cycles, RF Power Handling: 1 W average.

The Giga-tronics ASCOR Series 8000 and 8800 are available in a wide variety of configurations from a collection of individual relays, multiplexers, matrices or combinations thereof. For 50/67 GHz switching solutions configurations are comprised of SPDT, terminated SPDT, transfer, four- and five-port relays.

The Giga-tronics ASCOR 50/67 GHz switching solutions can be controlled over IEEE-488 (GPIB) or LAN using simple SCPI commands. Optional front panel LEDs provide test engineers instant status of all relay contacts to monitor system operation.

Find more information at www.gigatronics.com.

Precision Micro-Machined Silicon Transducers and Transmitters

Omega's new PXM409 Series precision metric calibrated micromachined silicon transducers and transmitters have an exceptionally high industrial grade accuracy of 0.08% and are supplied with a 5-point NIST traceable calibration.

The PXM409 has a broad compensated temperature range and excellent thermal compensation which makes this welded stainless steel constructed product ideal for scientific or industrial applications requiring a rugged, high accuracy transducer with very low thermal drift. This CE-compliant series is available in metric ranges of gauge, compound gauge, absolute, vacuum and barometric pressure.

The units have a standard G ¼ metric fitting and are available with cable, DIN connector, or 4-pin M12 electrical terminations. The PXM409 is ideal for calibration labs, engine test stands and industrial applications of pressure measurement and control that require a high degree of precision.

The complete spec sheet may be viewed at <http://www.omega.com/Pressure/pdf/PXM409.pdf>. Visit www.omega.com for more information.

Thermoelectric Cooler Provides Peltier Cooling for Electronic Enclosures

Pentair Technical Products announces the McLean Thermoelectric Cooler for cooling electronic components in small indoor or outdoor electronic enclosures. Operating on Peltier effect technology, McLean Thermoelectric Coolers deliver 60, 100 or 200 W of cooling for applications including telecommunications, battery cabinets, industrial enclosures, security systems and more. The compact coolers feature no refrigerant, compressors or filters, providing an ideal solution for demanding or low-maintenance environments. The 24 V dc and 48 V dc coolers are CE- and UL-recognized and are available in 13 versatile models.

The McLean Thermoelectric Cooler minimizes downtime and component loss by removing heat around critical components within an enclosure. The compact coolers can be mounted vertically or horizontally, and multiple units may be used on an enclosure to increase the cooling capacity. The thermoelectric coolers only have fans with moving parts, requiring minimal maintenance, and they do not require replenishment of fluids— as do refrigerant-based coolers. A filterless design further reduces maintenance intervals.

Features of the Thermoelectric Cooler that make it particularly effective and easy to use include:

- Operates on the Peltier effect for efficient cooling from 60 to 200 W,
- Includes 13 standard models with and without sheet metal shroud,
- Provides dc-powered operation with 24-V and 48-V models to suit varying application needs,
- Prewired with simple terminal block for easy wiring connection,
- Meets tough industrial and outdoor requirements,
- CE and UL recognized; UL Type 3R/Type 4,
- Features a filterless design to reduce maintenance requirements, and
- Includes no refrigerant or compressors, reducing the risk of leaks or added maintenance.

Pentair Technical Products offers Thermal Management Sizing and Selection Software to help customers select the right thermal management products for their application.

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

ESD Protection in the Ultra-Small 0201 Form Factor

Littelfuse, Inc., announces the addition of the SP1006 Series to its expanding TVS Diode Arrays (SPATM Family) of ESD and surge protection devices. The SP1006 Series TVS Diode Array is offered in the 0201 form factor (μ DFN-2) and provides ESD protection for electronic devices where board space is at a premium. The SP1006 Series is particularly suitable for miniature portable electronics applications.

The new SP1006 series is RoHS compliant and complies with the following standards: ESD, IEC61000-4-2, ± 30 kV (contact), ± 30 kV (air) EFT, IEC61000-4-5, 40 A (5/50 ns) Lightning, IEC61000-4-5, 5 A (8/20 μ s).

Along with superior ESD protection (± 30 kV, contact) and surge capability (5 A, 8/20 μ s), the SP1006 TVS diode array offers minimal capacitive loading with best-in-class clamping performance due to its low dynamic resistance of only 0.9 Ω . In addition, the extremely low leakage of <0.5 μ A (MAX) at 5 V is designed to maximize circuit reliability and minimize battery drain in portable devices.

For more information, please visit the Littelfuse web site at www.littelfuse.com.

Higher-Precision, Low Profile, Rotary Table

PI (Physik Instrumente) introduces a higher resolution, low profile rotary table driven by piezo motors which enable the very low profile of only 14 mm. The new model is equipped with a high accuracy, direct measuring encoder and provides eight times the position resolution of the existing version.

The M-660 rotary table can accelerate to velocities of 720 degrees/s, and its directly coupled precision optical encoder resolves positions down to 4 μrad (0.00023°) providing phase lag-free, backlash-free feedback to the servo controller. Its self-clamping ceramic drive provides very high stability with no energy consumption at rest and no heat generation.

Applications include semiconductor/test equipment, metrology and optical instrumentation.
Features & Advantages:

- Very low profile for easy integration: only 14 mm,
- Backlash-free direct drive and direct metrology optical encoder,
- 4 μrad resolution (0.00023°),
- Max. velocity 720 $^\circ/\text{s}$, unlimited travel range,
- Self-locking ceramic direct drive: energy saving & high position stability, and
- The PIIine[®] motor principle is non-magnetic and vacuum-compatible.

Mass and inertia were reduced significantly compared to conventional rotation stages, due to the lightweight direct-drive ceramic motor operating without gears or magnets. The net result is very fast start/ stop behavior and precise bidirectional speed and position control which is critical for high speed motion contouring.

These features make the M-660 outperform the stability, acceleration and settling speed of traditional servo motor direct drives and gear-driven mechanisms.

A special motion controller for piezo motors is available to take full advantage of the specific motion characteristics of ultrasonic ceramic motors. USB interfacing and a solid software and driver package (Lab View, MATLAB, etc.) for seamless integration are included.

Find datasheets and more information on the M-660 rotary table at <http://www.physikinstrumente.com/en/news/fullnews.php?newsid=175> or visit www.pi-usa.us for general information.

Solid State RF Switching in a PXI Platform

Pickering introduces the 40-880 Series Solid State RF Switching Platform. There is a demand for high pole count multiplexers in PXI based test systems where the test system will test multiple devices in sequence with minimal operator handling. The ability to move 10, 20 or more signals simultaneously from one device to another improves the efficiency of a test system.

Pickering Interfaces regularly releases a steady flow of new products in both the LXI and the PXI platforms. All Pickering Interfaces LXI products are now fully LXI compliant to the latest 1.4 specification. The new 40-880 Series Solid State RF Switching module features:

- Wide frequency range: 10 MHz to 6 GHz,
- High performance solid state switch,
- Dual, quad, hex and octal versions,
- Automatic termination of unused ports,
- High isolation,
- SMA coaxial connectors,
- VISA, IVI and kernel drivers supplied for Windows 2000/XP/Vista, and
- Supported in PXI or LXI chassis.

Find more information at www.pickeringtest.com.

Visual Alarm Device Tester

Product Technology Partners, Ltd., announces that its new VADER system for testing visual alarm devices has been approved for testing to EN 54-23:2010 standard.

This new standard applies to flashing beacons and strobes used in fire alarm systems, and proven compliance will be an essential step in the certification process for these devices.

Developed jointly with LPCB (Loss Prevention Certification Board) at BRE Global, the new automated system provides the first UKAS accredited certification service and is now available for commercial sale.

The VADER system is a novel design which allows high speed automated testing of devices during development as well as high accuracy measurement for reliable compliance testing. It can be used to measure a wide range of beacons from low-power LED ceiling units to high intensity Xenon strobes.

For more information, please contact Rachel Wood at PTP,sales@ptpart.co.uk.

Wheel Vector Sensing System for Simultaneous, Five-Axis Wheel Position and Orientation Measurements

Kistler has announced the North American launch of the Corrsys- Datron RV-4 wheel vector sensing system. It is designed to offer simultaneous measurements of all vehicle wheel displacements and directional coordinates in five axes for complete wheel movement evaluation capabilities within numerous vehicle dynamics testing applications.

The robust design of the RV-4 incorporates use of five high-precision absolute positioning transducers that measure wheel deflection, camber, and x-, y- and z-movements (spring travel) within a vehicle coordinate system.

The system is expressly designed for the incorporation of additional sensors and transducers and offers direct compatibility with Kistler wheel pulse encoders, slip angle sensors, wheel force transducers, dynamic camber systems and laser ride height sensors (sold separately). The sensor portion of the RV-4 system, which operates on the test car exterior, is IP67 rated for allweather testing, with high resistance to splash water, engine oil and anti-freeze. The system operates from standard 10-28 V dc vehicle power and offers easy and quick mounting capabilities.

Users can also monitor all wheel movements, allowing for real-time weight shift assessments and wheel travel investigations while braking or accelerating.

For additional details, drawings and specifications, visit www.kistler.com.

Digital High Speed Cameras

Vision Research unveils two additions to the company's Phantom® v-Series line of digital high-speed cameras with the introduction of the Phantom v1210 and v1610. These top-of-their-class cameras are the world's fastest 1 megapixel digital high-speed cameras. They feature high definition and widescreen 1280 x 800 CMOS sensors. Vision Research claims that the Phantom v1610 is 60 percent faster than any other camera on the market, with the ability to acquire more than 16,000 frames-per-second (fps) at full resolution and up to 1,000,000 fps at reduced resolution.

Both cameras are based on Vision Research proprietary sensors that not only offer high speeds but larger 28-micron pixels that allow for superior sensitivity when shooting in low light, which is often a problem with high-speed imaging.

The v-Series additions make image capture at more than 12,000 fps (12 Gigapixels/second) in full resolution possible when utilizing the v1210 and more than 16,000 fps (16 Gigapixels/second) when the v1610 is called into action. If higher speeds are needed, reduced resolution images are available at up to 650,000 fps or up to 1,000,000 fps when the FAST option is used.

Both cameras come standard with Vision Research's CineMag interface, allowing a user to save a high-speed shot from camera memory to non-volatile storage in a matter of seconds. For more information, please visit www.visionresearch.com.