CAL LAB

THE INTERNATIONAL JOURNAL OF METROLOGY

2015
JANUARY
FEBRUARY
MARCH

Electric Current Measurement

DS Series Current Transducers

DANISENSE

±300A to ±8000A, high accuracy for Power Analyzers and improved performance for Power Amplifiers

- Very high absolute amplitude and phase accuracy from dc to over 1kHz
- Low signal output noise
- Low fluxgate switching noise on the pimary
- Enhanced electrostatic shielding to increase rejection of primary dV/dt coupling
- Increased operating temperature range
- Reduced mechanical dimensions
- Options: Voltage Output Signal; Calibration Winding
- Amplitude and Phase measurement to 300kHz included with each head

DS200

DS2000

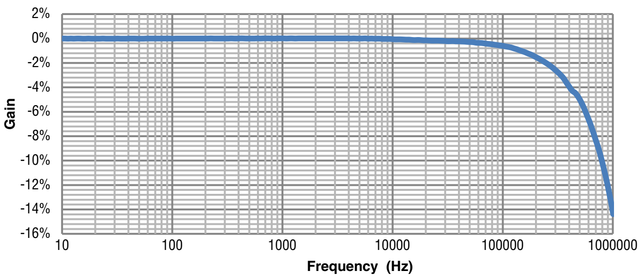
	DS200	DS600	DS2000	DS5000
Primary Current, rms	200A	600A	2000A	5000A
Primary Current, Peak	±300A	±900A	±3000A	±7000A
Turns Ratio	500:1	1500:1	1500:1	2500:1
Output Signal (rms/Peak)	0.4A/±0.6A†	0.4A/±0.6A†	1.33A/±2A†	2A/±3.2A†
Overall Accuracy	0.01%	0.01%	0.01%	
Offset	<20ppm	<10ppm	<10ppm	<5ppm
Linearity	<1ppm	<1ppm	<1ppm	<1ppm
Operating Temperature	-40 to 85˚C	-40 to 85˚C	-40 to 85˚C	0 to 55˚C
Aperature Diameter	27.6mm	27.6mm	68mm	150mm

Bandwidth Bands for Gain and Phase Error	DS200			DS600			DS2000			DS5000	
	<5kHz	<100kHz	<1MHz	<2kHz	<10kHz	<100kHz	<500Hz	<1kHz	<10kHz	<5kHz	<20kHz
Gain (sensitivity) Error	0.01%	0.5%	20%	0.01%	0.5%	3%	0.01%	0.05%	3%	0.01%	1%
Phase Error	0.2˚	4˚	30˚	0.1˚	0.5˚	3˚	0.01˚	0.1˚	1˚	0.01˚	1˚

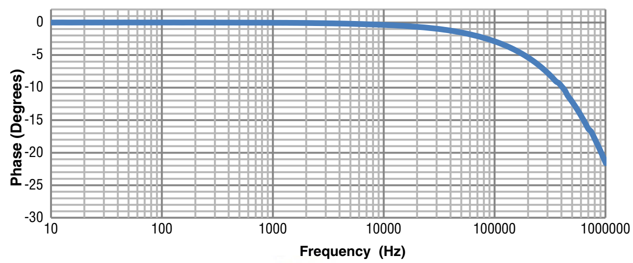
† Voltage Output options available in ±1V and ±10V

Gain / Phase

Gain (DS200, typical)



Phase (DS200, typical)



DSSIU-4 for Multi Channel Systems

4-channel Transducer Interface Unit and Power Supply improved performance for Power Amplifiers

- Power and Signal connections for up to four Current Transducer heads
- Heads may be mixed (e.g.: One DS2000 Head and three DS200 Heads)

DSSIU-4

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FEATURES

DEPARTMENTS

ON THE COVER: Network Analyzer Station in the RF Microwave Lab at the Air Force Primary Standards Laboratory in Heath, Ohio. Janna Hetrick, an Engineering Technician with the Bionetics Corp., performs a two-port calibration in preparation for making measurements.

CALENDAR

UPCOMING CONFERENCES & MEETINGS

Mar 2-5, 2015 - 15th International Conference on Metrology and Properties of Engineering Surfaces (MET & PROPS). Univ. of North Carolina at Charlotte. UNC-Charlotte is home to the Center for Precision Metrology, an interdisciplinary association of UNC Charlotte faculty and student researchers, allied with industrial partners in the research, development and integration of precision metrology as applied to manufacturing. http://aspe.net/metprops2015.html.

Mar 3-4, 2015 South East Asia Flow Measurement Conference. Kuala Lumpur, Malaysia. The 2015 South East Asia Flow Measurement Conference will continue to meet economic and environmental impacts of the oil and gas industry head on, by staying ahead of developments in technology, regulation and practice. http://www.tuvnel.com/.

Mar 17-18, 2015 METROMEET. Bilbao, Spain. The International Conference of Industrial Dimensional Metrology. During METROMEET we provide information about the latest technological progress made in the sector and we constitute a forum for debate on metrology and its development in a fast changing industry. http://metromeet.org.

Mar 17-19, 2015 European Flow Measurement Workshop. Noordwijk, Netherlands. Previously held in Portugal, this year's 3rd annual workshop will take place in the Grand Hotel Huis ter Duin in Noordwijk, Netherlands. With the change of venue we will be able to accommodate more sponsors and exhibitors. http://www.efmws.eu/.

Mar 18-20, 2015 Measurement Science Conference (MSC) & Training Symposium. Anaheim, CA. "Engaging Measurement Science to Inspire Organizational Excellence" for 45 years. http://msc-conf.com.

Mar 20-22, 2015 A2LA Technical Forum & Annual Meeting. Baltimore, MD. http://www.a2la.org/techforum.

Apr 14-17, 2015 International Symposium on Fluid Flow Measurement. Arlington, VA. http://www.isffm.org.

Apr 27-29, 2015 Council on Ionizing Radiation Measurements and Standards (CIRMS) Conference. Gaithersburg, MD. http://www.cirms.org/conferences.html.

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EDITOR'S DESK

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In Search of Culture & Better Measurements

I recently had the opportunity to take my first step outside my cultural comfort zone, into the wider world where footballs are round. I set foot on the continents of Europe, Asia, and the region of the Middle East. My mind was blown by the incredible growth, juxtaposed with old world decay, as well as the desperation of homeless refugees. My persona of judgment melted away and I no longer knew what to think. After all, there is nothing left to do but appreciate the luxury of being able to do as much as one can, in preparation for when days are better. While abroad, I also appreciated the fact that regular folks in the rest of the world know how to eat better than regular folks in the US.

This issue you hold in your hand is coincidentally heavy on the practice and procedures of measurement in the calibration lab, beginning with a "How To" on repeatability measurements, based on a series of blogs created by Mr. Richard Hogan.

Next, the National Institute of Metrology in Mexico, Centro Nacional de Metrología (CENAM) shared a paper with us, presented at last October's Simposio de Metrologia in the city of Santiago de Querétaro, Mexico. Their paper, "Treatment of Conditional Measurement Bias in Measuring Instruments,"demonstrates the significance of periodic revisions of a laboratory's quality system to include documented bias correction estimates.

And to round off this issue's accidental theme of good practices and procedures, A2LA's Pam Wright, contributed "A Practical Guide for Selecting, Purchasing, and Receiving Accredited Calibration Service."

Also included in this issue is an informative article by Mr. David Walker of Dryad Consultancy, providing insight on doing business with European Union funded NMIs.

Happy Measuring,

Sita P. Schwartz

CALENDAR

Apr 27-30, 2015 ESTECH. Danvers, MA. ESTECH 2015 is the 61st Annual Technical Meeting and Exposition of the Institute of Environmental Science & Technology (IEST). The conference offers a valuable experience to industry professionals in the fields of contamination control; design, test, and evaluation; product reliability; aerospace; and nanotechnology. http://www.iest.org.

Apr 28-30, 2015 – 4th African Forum of Metrology. Angers, France. The African Committee of Metrology (CAFMET) is organizing, with the help of the Agency for Standardization and Technology Transfer (ANTT), the Fourth African Forum of Metrology which will be a forum for industrialists and scientists to share information, ideas and experiences, during conferences, open discussions, training courses and exhibition booths. Be careful, all programs will be in French! http://www.ac-metrology.com.

May 11-14, 2015 IEEE International Instrumentation and Measurement Technology Conference (I2MTC). Pisa, Italy. http://imtc.ieee-ims.org.

May 19-21, 2015 FORUMESURE. Algiers, Algeria. Exhibition on Quality, Measurement, Accreditation and Instrumentation. FORUMESURE is an annual event, for companies and also institutions wishing to present their know-how, new products and services to hundreds of international visitors. This event is organized by The African Committee of Metrology (CAFMET) located in Angers. http://www.forumesure.com.

May 20-22, 2015 – 11th Moscow International Innovative Forum (MetrolExpo). Moscow, Russia. "Precision Measurements – the Basis of Quality and Safety." http://www.metrol.expoprom.ru.

May 22, 2015 – 85th ARFTG Microwave Measurement Symposium. Phoenix, AZ. http://www.arftg.org.

Jun 4-5, 2015 IEEE International Workshop on Metrology for Aerospace. Benevento, Italy. MetroAeroSpace aims to gather people who work in developing instrumentation and measurement methods for aerospace. http://www.metroaerospace.org.

Jul 8-10, 2015 – 5th ASPE Topical Meeting on Precision Interferometric Metrology. Golden, CO. http://aspe.net/technical-meetings/.

Jul 19-23, 2015 – 100th Annual Meeting of the National Conference on Weights and Measures (NCWM). Philadelphia, PA. http://www.ncwm.net.

Jul 20-24, 2015 – 31st Annual Coordinate Metrology Systems Conference (CMSC). Hollywood, FL. http://www.cmsc.org.

Aug 30-Sep 4, 2015 – XXI IMEKO World Congress. Prague, Czech Republic. http://www.imeko2015.org.

SEMINARS: Online & Independent Study

ASQ CCT (Certified Calibration Technician) Exam Preparation Program. Learning Measure. http://www.learningmeasure.com/.

AC-DC Metrology– Self-Paced Online Training. Fluke Training. http://us.flukecal.com/training/courses.

Basic Measurement Concepts Program. Learning Measure. http://www.learningmeasure.com/.

Basic Measuring Tools – Self Directed Learning. The QC Group, http://www.qcgroup.com/sdl/.

Basic RF and Microwave Program. Learning Measure. http://www.learningmeasure.com/.

Certified Calibration Technician – Self-study Course. J&G Technology. http://www.jg-technology.com/selfstudy.html.

Introduction to Measurement and Calibration – Online Training. The QC Group, http://www.qcgroup.com/online/.

Introduction to Measurement and Calibration – Self-Paced Online Classes. Fluke Calibration. http://www.flukecal.com/training.

Instrumentation for Test and Measurement – OnDemand Complete Internet Course. Technology Training, Inc. (TTI), http://pubs.ttiedu.com/?q=course_list.

ISO/IEC 17025 Accreditation Courses. WorkPlace Training, tel (612) 308-2202, info@wptraining.com, http://www.wptraining.com/.

Measurement Uncertainty – Self-Paced Online Training. Fluke Training. http://us.flukecal.com/training/courses.

Measurement Uncertainty Analysis – Online Training. The QC Group, http://www.qcgroup.com/online/.

Metrology for Cal Lab Personnel– Self-Paced Online Training. Fluke Training. http://us.flukecal.com/training/courses.

Metrology Concepts. QUAMETEC Institute of Measurement Technology. http://www.QIMTonline.com.

Metrology Concepts – OnDemand Complete Internet Course. Technology Training, Inc. (TTI), http://pubs.ttiedu.com/?q=course_list.

CALENDAR

Precision Measurement Series Level 1 & 2. WorkPlace Training, http://www.wptraining.com/.

Precision Electrical Measurement – Self-Paced Online Training. Fluke Training. http://us.flukecal.com/training/courses.

Vibration and Shock Testing. Equipment Reliability Institute, http://www.equipment-reliability.com/distance_learning.html.

The Uncertainty Analysis Program. Learning Measure. http://www.learningmeasure.com/.

Do you offer Online Learning you want us to know about?
Email office@callabmag.com.

SEMINARS: Analytical

Mar 18, 2015 Analytical Spectrophotometer Metrology Short Course. Anaheim, CA (Downtown Disneyland). Stranaska Analytical Metrology Education Program. Learn how to recognize the analytical science that underscores the scientific credibility and defensibility of spectrophotometer qualification approaches and reference material artifacts. http://stranaska.com/.

SEMINARS: Dimensional

Mar 5-6, 2015 Gage Calibration Systems and Methods. City of Industry, CA. Mitutoyo Institute of Metrology. http://www.mitutoyo.com/support/mitutoyo-institute-of-metrology/.

Mar 17-19, 2015 Hands-On Gage Calibration. Aurora, IL. Mitutoyo Institute of Metrology. http://www.mitutoyo.com/support/mitutoyo-institute-of-metrology/.

Mar 19-20, 2015 Hands-On Gage Calibration and Repair Workshop. Louisville, KY. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

Apr 7-8, 2015 Hands-On Gage Calibration and Repair Workshop. St. Louis, MO. http://www.iictenterprisesllc.com/.


The smart ones make it look easy.
Introducing a smarter way to increased productivity:
The DPI 620 Genii multifunction calibrator and communicator.
Do more with less with this multifunction powerhouse product. The Druck Genii from GE is the first device to offer state-of-the-art precision calibration, communication, data management and software integration together in one hand-held instrument that incorporates simple-to-use swipe screen technology. Experience higher levels of accuracy, more data integration, and ultra-fast performance with one of the most advanced multifunction calibrators and communicators in the field.
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E: gb.sensing.sales@ge.com
www.genii.dpi620.com

CALENDAR

Apr 9-10, 2015 Hands-On Gage Calibration and Repair Workshop. Peoria, IL. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

Apr 23-24, 2015 Hands-On Gage Calibration and Repair Workshop. Portland, OR. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

Apr 28-29, 2015 Hands-On Gage Calibration and Repair Workshop. Salt Lake City, UT. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

May 12-13, 2015 Hands-On Gage Calibration and Repair Workshop. Cleveland, OH. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

May 19-20, 2015 Hands-On Gage Calibration and Repair Workshop. Houston, TX. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

May 21-22, 2015 Hands-On Gage Calibration and Repair Workshop. Dallas, TX. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

Jun 4-5, 2015 Hands-On Gage Calibration and Repair Workshop. Hartford, CT. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

Jun 8-9, 2015 Hands-On Gage Calibration and Repair Workshop. Myrtle Beach, SC. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

Jun 11-12, 2015 Hands-On Gage Calibration and Repair Workshop. Virginia Beach, VA. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

Jun 25-26, 2015 Hands-On Gage Calibration and Repair Workshop. Bloomington, MN. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

Jul 7-8, 2015 Hands-On Gage Calibration and Repair Workshop. Schaumburg, IL. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

Jul 9-10, 2015 Hands-On Gage Calibration and Repair Workshop. Milwaukee, WI. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

Jul 23-24, 2015 Hands-On Gage Calibration and Repair Workshop. Pasadena/Arcadia, CA. IICT Enterprises LLC. http://

www.iictenterprisesllc.com/.

Jul 27-28, 2015 Hands-On Gage Calibration and Repair Workshop. Las Vegas, NV. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

Jul 30-31, 2015 Hands-On Gage Calibration and Repair Workshop. Denver, CO. IICT Enterprises LLC. http://www.iictenterprisesllc.com/.

SEMINARS: Electrical

Apr 20-23, 2015 MET-101 Basic Hands-on Metrology. Everett, WA. Fluke Calibration. http://us.flukecal.com/training/courses/MET-101.

May 18-21, 2015 MET-301 Advanced Hands-on Metrology. Everett, WA. Fluke Calibration. http://us.flukecal.com/training/courses/MET-301.

Jun 15-18 Applied Measurements/Instrumentation for Electrical Test & Measurement (Combined Courses 166/164). Las Vegas, NV. Technology Training, Inc. (TTi). http://www.ttiedu.com.

Aug 17-20, 2015 MET-101 Basic Hands-on Metrology. Everett, WA. Fluke Calibration. http://us.flukecal.com/training/courses/MET-101.

SEMINARS: Flow & Pressure

Feb 23-27, 2015 Principles of Pressure Calibration. Phoenix, AZ. Fluke Calibration. http://us.flukecal.com/Principles-of-Pressure.

Apr 20-24, 2015. Advanced Piston Gauge Metrology. Phoenix, AZ. Fluke Calibration. http://us.flukecal.com/training.

May 18-22, 2015 Principles of Pressure Calibration. Phoenix, AZ. Fluke Calibration. http://us.flukecal.com/Principles-of-Pressure.

Sep 23-25, 2015 TrigasFI Flow Seminar (English). Neufahrn, Germany. http://www.trigasfi.de/.

Sep 28-30, 2015 TrigasFI Flow Seminar (Deutscher Sprache). Neufahrn, Germany. http://www.trigasfi.de/.

SEMINARS: General & Management

Feb 9-13, 2015 Fundamentals of Metrology. Gaithersburg, MD. http://www.nist.gov/pml/wmd/labmetrology/training.cfm.

Mar 2-6, 2015 Fundamentals of Metrology. Gaithersburg, MD. http://www.nist.gov/pml/wmd/labmetrology/training.cfm.

Mar 30-31, 2015 Internal Auditing. Charleston, SC. A2LA. This 2-day training course practices the internationally-recognized approaches of ISO 19011:2011 to conducting effective internal audits. http://www.a2la.org/training/intaudit.cfm?private=no.

Apr 1, 2015 Root Cause Analysis and Corrective Action (RCA/CA). Frederick, MD. A2LA. Presentations, discussions and exercises that provide an in-depth understanding of how to analyze a system in order to identify the root causes of problems and to prevent them from recurring. http://www.a2la.org/training/rootcause.cfm?private=no.

Apr 7-8, 2015 Benchmark Challenge: Electrical, Temperature, Pressure. York, PA. WorkPlace Training. http://www.wptraining.com.

Apr 7-9, 2015 Instrumentation for Test and Measurements. Las Vegas, NV. Technology Training, Inc. (TTi). http://www.ttiedu.com.

Apr 15, 2015 Root Cause Analysis and Corrective Action (RCA/CA). Boulder, CO. A2LA. Presentations, discussions and exercises that provide an in-depth understanding of how to analyze a system in order to identify the root causes of problems and to prevent them from recurring. http://www.a2la.org/training/rootcause.cfm?private=no.

Apr 21-23, 2015 Cal Lab Manager Training; Beyond 17025 Training. Boca Raton, FL. WorkPlace Training. http://www.wptraining.com.

Apr 23-24, 2015 Internal Auditing. Frederick, MD. A2LA. This 2-day training course practices the internationally-recognized approaches of ISO 19011:2011 to conducting effective internal audits. http://www.a2la.org/training/intaudit.cfm?private=no.

May 8, 2015 Root Cause Analysis and Corrective Action (RCA/CA). Frederick, MD. A2LA. Presentations, discussions and exercises that provide an in-depth understanding of how to analyze a system in order to identify the root causes of problems and to prevent them from recurring. http://www.a2la.org/training/rootcause.cfm?private=no.

May 11-13, 2015 Cal Lab Manager Training; Beyond 17025 Training. Los Angeles (Fullerton), CA. WorkPlace Training. http://www.wptraining.com.

May 14-15, 2015 Internal Auditing. Minneapolis, MN. A2LA. This 2-day training course practices the internationally-recognized approaches of ISO 19011:2011 to conducting effective internal audits. http://www.a2la.org/training/intaudit.cfm?private=no.

Jun 25-26, 2015 Internal Auditing. Frederick, MD. A2LA. This 2-day training course practices the internationally-recognized approaches of ISO 19011:2011 to conducting effective internal audits. http://www.a2la.org/training/intaudit.cfm?private=no.

SEMINARS: Industry Standards

Mar 16-20, 2015 Assessment of Laboratory Competence. Baltimore, MD. A2LA. This course is a comprehensive look at the ISO/IEC 17025:2005 requirements and a detailed approach to the assessment of a laboratory's competence. http://www.a2la.org/training/aolc.cfm?private=no.

Mar 19, 2015 ISO/IEC 17025:2005 Advanced: Beyond the Basics. Baltimore, MD. A2LA. The course will provide a brief overview of the requirements of this laboratory standard, as well as provide an understanding of how to apply specific sections of the Standard in your laboratory. http://www.a2la.org/training/ISO17025forAccredCABs.cfm?private=no.

Mar 30-31, 2015 ISO/IEC 17025:2005 and Laboratory Accreditation. Frederick, MD. A2LA. This course is an introductory look at ISO/IEC 17025 and its requirements for demonstrating the technical competence of testing and calibration laboratories. http://www.a2la.org/training/iso17025.cfm?private=no.

Apr 13-14, 2015 ISO/IEC 17025:2005 and Laboratory Accreditation. Boulder, CO. A2LA. This course is an introductory look at ISO/IEC 17025 and its requirements for demonstrating the technical competence of testing and calibration laboratories. http://www.a2la.org/training/iso17025.cfm?private=no.

May 6-7, 2015 ISO/IEC 17025:2005 and Laboratory Accreditation. Frederick, MD. A2LA. This course is an introductory look at ISO/IEC 17025 and its requirements for demonstrating the technical competence of testing and calibration laboratories. http://www.a2la.org/training/iso17025.cfm?private=no.

Jun 1-5, 2015 Assessment of Laboratory Competence. Frederick, MD. A2LA. This course is a comprehensive look at the ISO/IEC 17025:2005 requirements and a detailed approach to the assessment of a laboratory's competence. http://www.a2la.org/training/aolc.cfm?private=no.

Jun 17-19, 2015 ISO/IEC 17025:2005 and Laboratory Accreditation. Detroit/Livonia, MI. A2LA. This course is an introductory look at ISO/IEC 17025 and its requirements for demonstrating the technical competence of testing and calibration laboratories. http://www.a2la.org/training/iso17025.cfm?private=no.

Sep 15-16, 2015 ISO/IEC 17025:2005 and Laboratory Accreditation. Frederick, MD. A2LA. This course is an introductory look at ISO/IEC 17025 and its requirements for demonstrating the technical competence of testing and calibration laboratories. http://www.a2la.org/training/iso17025.cfm?private=no.

SEMINARS: Mass

Mar 16-27, 2015 Mass Metrology Seminar. Gaithersburg, MD. NIST Office of Weights and Measures. http://www.nist.gov/pml/wmd/labmetrology/training.cfm.

Jun 1-11, 2015 Advanced Mass Seminar. Gaithersburg, MD. NIST Office of Weights and Measures. The 9 day, hands-on seminar focuses on the comprehension and application of the advanced mass procedures, the equations, and associated calculations. >> http://www.nist.gov/pml/wmd/5349.cfm.

SEMINARS: Measurement Uncertainty

Apr 9-10, 2015 Measurement Uncertainty (per ILAC P14 Guidelines). York, PA. WorkPlace Training. http://www.wptraining.com.

Apr 20-21, 2015 Measurement Uncertainty Advanced Topics. Frederick, MD. A2LA. The use of industry-proven tools covered in this workshop helps establish a laboratory's reputation in providing the correct solutions to its customers and maintaining its accreditation. http://www.a2la.org/training/muadvanced.cfm?private=no.

May 7-8, 2015 Measurement Uncertainty (per ILAC P14 Guidelines). Nashville, TN. WorkPlace Training. http://www.wptraining.com.

May 14-15, 2015 Measurement Performance Improvement Using Statistical Tools. Frederick, MD. A2LA. The use of industry-proven tools covered in this workshop helps establish a laboratory's reputation in providing the correct solutions to its customers and maintaining its accreditation. http://www.a2la.org/training/MeasPerfImp.cfm?private=no.

Jun 15-16, 2015 Introduction to Measurement Uncertainty. Detroit/Livonia, MI. American Association for Laboratory Accreditation, http://www.a2la.org/training/course_schedule.cfm.

Jun 18-19, 2015 Measurement Uncertainty (per ILAC P14 Guidelines). Seattle, WA. WorkPlace Training. http://www.wptraining.com.

SEMINARS: Temperature

Apr 14-16, 2015 Principles of Temperature Metrology. American Fork, UT. Fluke Calibration. http://us.flukecal.com/training/courses/Principles-Temperature-Metrology.

Jun 9-11, 2015 Principles of Temperature Metrology. American Fork, UT. Fluke Calibration. http://us.flukecal.com/training/courses/Principles-Temperature-Metrology.

SEMINARS: Vibration

April 6-8, 2015 Random Vibration and Shock Testing. Santa Clarita, CA. http://www.equipment-reliability.com.

SEMINARS: Volume

Aug 17-21, 2015 Volume Metrology. Gaithersburg, MD. NIST Office of Weights and Measures. The entire seminar incorporates statistical analysis, process measurement control methods, uncertainty analyses, traceability assessments, and generation of ISO/IEC 17025 compliant calibration certificates for all measurements made during the seminar and builds on the concepts covered in the Fundamentals of Metrology seminar. >> http://www.nist.gov/pml/wmd/5356.cfm.

Visit **www.callabmag.com** for upcoming and future events!

Detector Standard for Terahertz Radiation

The first capacity worldwide for the precise calibration of the power responsivity of detectors for terahertz (THz) radiation has been developed at PTB in the form of a novel detector standard. Its spectral responsivity was traced back to the International System of Units (SI) by means of visible laser light. This was achieved with a standard measurement uncertainty of less than 2 % for all emission lines of a molecular gas laser in the spectral range from 1 THz to 5 THz.

Terahertz radiation has wavelengths that are nearly 1000 times longer than those of visible light. The radiation's diffraction is stronger, so that it is more difficult to focus it compared to visible light. The aperture of a THz detector must therefore be large enough to detect all the radiation without losses due to diffraction. Also, the wavelength-dependent absorption of the detector absorber has to be taken into account.

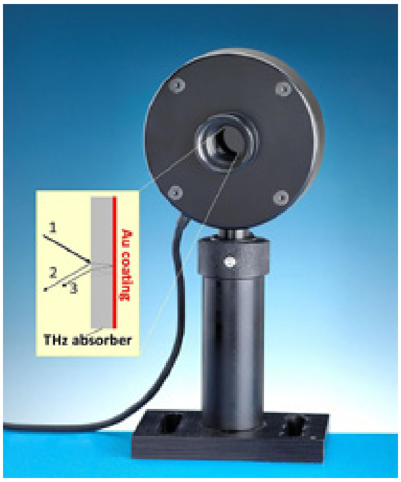
The absorber and detection medium for the new THz standard is a special neutral-density glass plate of optical quality. It is mounted into a conventional measuring instrument for laser radiant power. The optical losses could be determined accurately because, in addition, the rear side of the glass plates was coated with a thin layer of gold. The specular reflection of the front surface is thus the sole significant detection loss. This could be measured accurately – namely both in the THz and in the visible spectral ranges where the absorptivity of the neutral-density glass is similar. It was thus possible to trace back the spectral responsivity of the THz detector to the International System of Units (SI) at the wavelength of a red helium-neon laser with the lowest possible uncertainty and to extend this precision into the THz range. A consistent THz scale is essential for risk assessment in potential new applications of THz radiation, which is invisible and penetrates numerous substances. Examples are security applications, medical diagnostics and the non-destructive testing of materials.

PTB is the first metrology institute to be able to calibrate THz detectors. This service immediately sparked interest worldwide: the first calibration orders were placed by customers from Israel, the USA, France and Canada. Further customers in Japan, Russia and China were served with THz detectors developed in collaboration with a German manufacturer and calibrated by PTB.

Contact: Andreas Steiger, Department 7.3 Detector Radiometry and Radiation Thermometry , +49 (0)30 3481-7532, andreas.steiger@ptb.de.

Scientific publication: R. Müller, W. Bohmeyer, M. Kehrt, K. Lange, C. Monte, A. Steiger: Novel detectors for traceable THz power measurements. Journal of Infrared, Millimeter, and Terahertz Waves 35, 8, 659–670 (2014).

Source: PTB News 2/2014 (http://www.ptb.de/cms/en/publikationen/zeitschriften/ptb-news/ptb-news-2014-2/detector-standard-for-terahertz-radiation.html).



PTB's new THz detector standard. The cutaway view depicts a cross section of the THz absorber with gold coating (Au) on its rear side. The radiation loss due to specular reflection (2) of the incident (1) radiation has been precisely measured. If the absorption is strong enough in the absorber, the beam (3) is negligible.

Weighing Gas with Sound and Microwaves

Scientists at the National Institute of Standards and Technology (NIST) have developed a novel method to rapidly and accurately calibrate gas flow meters, such as those used to measure natural gas flowing in pipelines, by applying a fundamental physical principle: When a sound wave travels through a gas with regions at different temperatures, the sound wave's average speed is determined by the average temperature of the gas.

Accurate calibrations of gas flow meters issues are of urgent interest to meter manufacturers and calibration labs, and potentially impact all segments of the natural gas industry.

Conventional calibrations are typically conducted by flowing a gas stream through the meter being calibrated during a measured time interval. The quantity of gas that passes through the meter is determined by collecting the gas in a large tank of known volume and measuring its average temperature and pressure, which in turn, reveals the amount of gas.

However, collecting the gas in large tanks—NIST uses a 27 cubic-meter tank (a tank with 27,000 liters capacity)—generates different temperatures in different parts of the tank, which make the average temperature difficult to measure. Those gradients persist for hours or days. Thus, a fast reading is inherently inaccurate.

To get around that problem, current practice entails calibrating many small meters, one at a time, and then using them in parallel to calibrate a larger meter. This is done with a smaller collection tank where temperature differences are reduced to produce more accurate reading. However, the multiple calibrations are inherently time-consuming, and therefore, expensive.

NIST's innovation replaces the difficult problem of accurately measuring the average temperature of a large volume of gas with the easier problem of accurately measuring the average speed-of-sound in the gas.

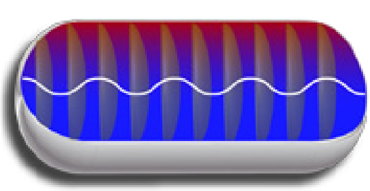
In one recent, proof-of-concept, paper,* NIST researchers deduced the internal shape, thermal expansion and volume of a 300 liter collection tank by measuring which microwave frequencies resonated (formed standing waves) within the evacuated tank.

In a second set of experiments, described in a forthcoming paper, they filled the tank with argon gas and measured the frequencies of the acoustic resonances. From the frequencies and the pressure, they deduced the mass of the argon in the tank.

Finally, they heated the top of the tank to establish a temperature difference across the gas of 4 percent of the average gas temperature. The temperature difference changed the acoustic resonance frequencies and the pressure; however, the mass of the argon, as deduced from the frequencies and the pressure, was unchanged within 0.01 percent.

This result implies that the acoustic resonance technique could be used to measure the collected gas, even in the presence of a temperature gradient such as those that occur in a much larger tanks located outside the well-controlled environment of a laboratory.

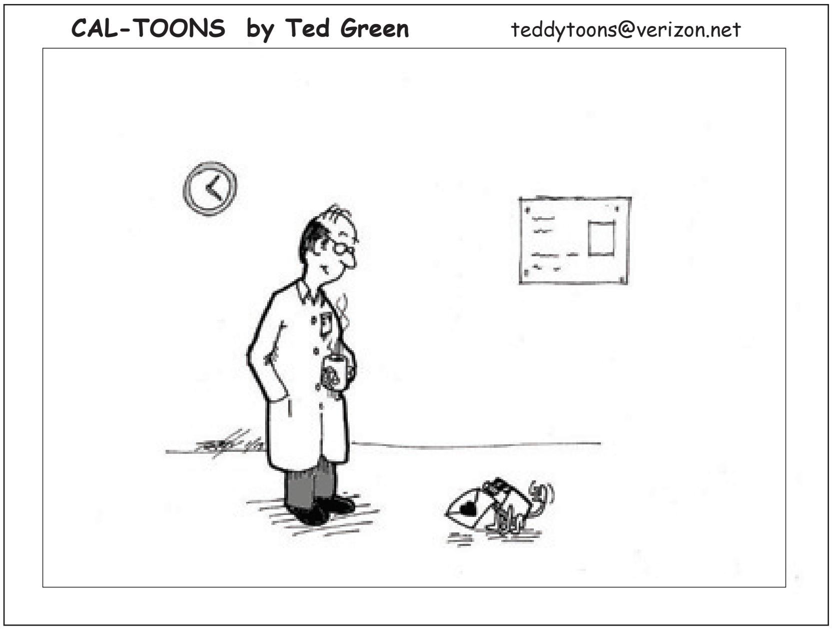
Technical Contact: Mike Moldover, 301-975-2459



Schematic diagram of a gas-filled pressure vessel. The red-to-blue shading represents the temperature gradient in the gas, with the higher (red) temperatures near the top. The ovals represent a standing sound wave; its frequency is mostly determined by the average temperature of the gas. The wavy line represents a resonant electromagnetic wave; its frequency is mostly determined by the length of the tank. Wavelengths are not to scale. Credit: NIST

* M.R Moldover, J.W. Schmidt, K.A. Gillis, J.B.Mehl and J.D.Wright. Microwave determination of the volume of a pressure vessel. Meas. Sci. Technol. 26 015304 (2015) doi:10.1088/0957-0233/26/1/015304.

Source: NIST Tech Beat for February 3, 2015 (http://www.nist.gov/public_affairs/tech-beat/tb20150203.cfm#flowmeter).

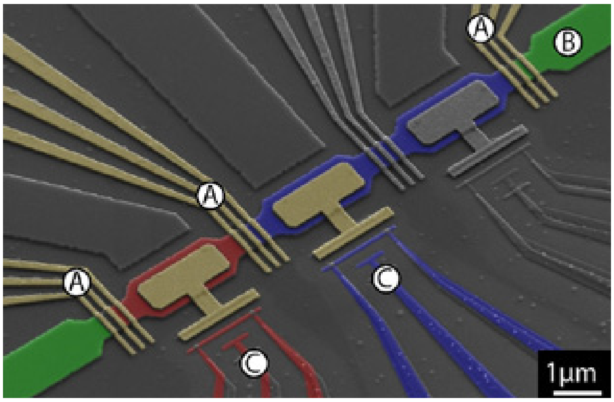


The Ampere – On Its Way To a New Definition

A new basis consisting of fundamental constants is to be provided to the International System of Units (SI). In this system, the electric units are represented by the base unit ampere. Contrary to the ohm and the volt, which are already traceable to fundamental constants, such a realization has, to date, not been achieved for the unit of current. PTB has now succeeded in developing a current standard which generates a current based on the clocked transfer of single electrons and simultaneously measures the precision of the generated current independently.

The ampere is a base unit in the International System of Units (SI), and yet, to realize it with metrological accuracy in practice, a detour via Ohm's law (i.e. via the electric units the volt and the ohm) is always necessary. Those two units can be accurately realized on the basis of fundamental constants – the Josephson constant (for the volt) and the von Klitzing constant (for the ohm). The corresponding fundamental constant for the ampere is the charge of a single electron.

It is, in principle, possible to realize the ampere in a new way, by temporally clocking the flow of single electrons by means of so-called "single-electron pumps". In the pumping mode, electrons coming from the current lead on the left are first trapped one by one and then released into the other current lead. If this procedure is repeated periodically, this generates a current which is determined only by the clock frequency, the number of electrons transferred per cycle and by the electric charge of the electron.



This semiconductor structure can measure single electrons and their respective charge. Three singleelectron pumps are operated on the chip; these are connected in series by a semiconductor wire (marked with A). The transferred electrons are detected by means of the two single-electron detectors (C). (Idle elements that do not influence the array are coloured in grey. B: Semiconductor channel)

The self-referenced quantum current source developed at PTB is based on such single-electron pumps: several such pumps are arranged consecutively in a semiconductor array and are connected via islands. Highly sensitive detectors are coupled to these islands to count the number of electrons present on the island. This has allowed a clocked current to be generated and checked in situ. Since the new pump only transports a few dozen electrons per second, it is slow enough to allow the corresponding precision measurements. Additionally, it allows validated small currents down to the attoampere range (10–18 ampere) to be generated with a clearly lower measurement uncertainty than would be achievable using conventional current measurement methods. Hence, it enables measuring instruments to be calibrated for small currents, as are used, for example, in radiation protection.

The scientists involved in the development of this current standard were awarded the Hermann von Helmholtz Prize in 2014.

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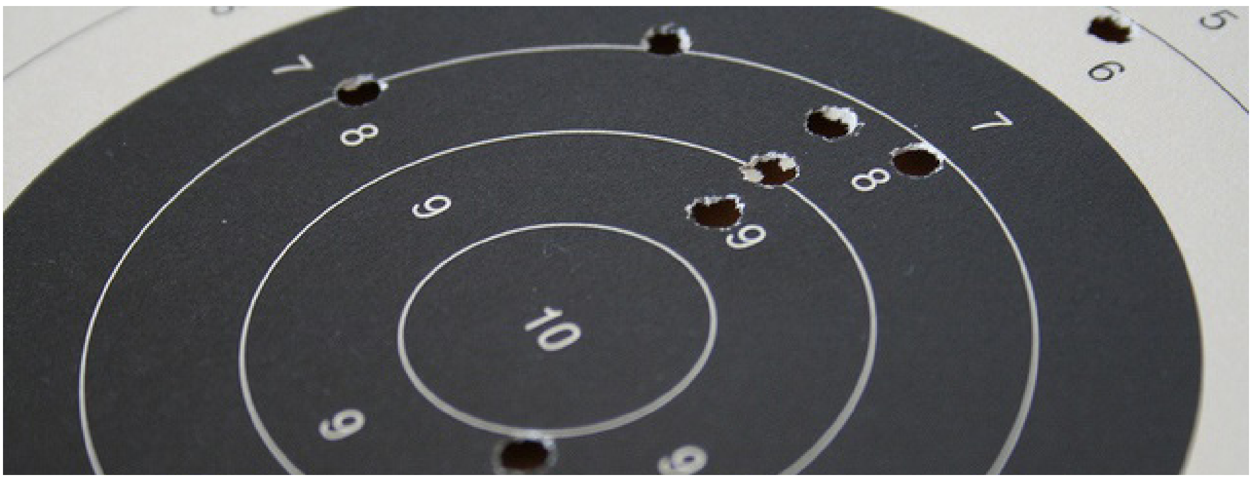
Scientific publication: L. Fricke, M.Wulf, B. Kästner, F. Hohls, P. Mirovsky, B. Mackrodt, R. Dolata, Th. Weimann, K. Pierz, U. Siegner, H. W. Schumacher: A self-referenced single-electron quantized-current source. Phys. Rev. Lett. 112, 226803 (2014).

Source: PTB News 2/2014 (http://www.ptb.de/cms/en/publikationen/zeitschriften/ptb-news/ptb-news-2014-2/the-ampere-on-its-way-to-a-new-definition.html).

How to Perform a Repeatability Test

Richard Hogan

The evaluation of uncertainty in measurement results is becoming an important requirement for laboratories seeking to attain or retain ISO/IEC 17025 accreditation. When assessors evaluate a laboratory's uncertainty budgets, they commonly look for the inclusion of type A, or actual test data. Type A data may include, but is not limited to, evaluations of repeatability, reproducibility, and stability testing. However, the most common expression of Type A data found in an uncertainty budget is the results of repeatability testing. Repeatability testing is the most common because it is usually quick and easy to complete, but it is not always performed correctly. In this article, I am going to show you how to perform repeatability experiments and evaluate the data.



I. An Overview of the Experiment Process

Create A Plan

When deciding to conduct repeatability experiments, it is important to have a plan. Planning allows you to design and develop your experiment to minimize the risk of mistakes and errors. By creating a plan, you will be able to increase the effectiveness and efficiency of your experimental efforts. There is nothing worse than expending time and effort to perform a task where the results are invalidated and the experiment must be repeated.

To develop a plan, you should first identify your goals; what do you expect to accomplish as a result of your experiment? Next, you should focus on the design of your experiment. To keep this process simple and effective, answer the questions: who, what, when, where, why, and how. Accomplish this task and you should have a pretty good idea of how to plan your experiment.

Select A Function or Parameter

After establishing your goals, now you need to identify what you are going to test. Using your laboratory's scope of accreditation, select a specific function or parameter of interest. Next, identify what range or ranges you prefer to evaluate. Although this task is simple, it will drastically narrow the breadth of your experiment. Therefore, it is important to target what you will be testing.

Select A Method

Now that you have chosen what you are going to test, let's determine how you are going to test it. Similar to any test or calibration that your laboratory performs, you will need to select a method. Choosing a method allows you to further narrow the scope of your experiment, control how the experiment will be conducted, and maintain consistency when you repeat these experiments in the future. Similar to having a plan, selecting a method or procedure is an intelligent idea.

Select The Equipment

Selecting equipment to perform an experiment is important to achieving your goals. Preferably, you should select the equipment that is listed in your scope of accreditation and ensure that the equipment that you have selected is identified in your test method. Furthermore, it is recommended to choose equipment that will best showcase your laboratory's measurement capability. Selecting the right equipment can have a significant impact of the results of your experiment. So, be sure to choose your equipment wisely.

Select The Personnel

Who you select to perform experiments is an important variable that can have a significant impact on the results of your experiment. You should only allow authorized personnel to perform experiments. Additionally, you should select personnel whose expertise is in the function or parameter you are planning to test. It is important that the personnel performing experiments should be aware of the importance of their task. By selecting the appropriate personnel, you should be able to increase confidence and reduce uncertainty in the measurement results.

Perform The Experiment

Now, that you have identified your goals and selected what you will test, how you will test it, and with whom, it is time to perform a repeatability experiment. However, before you begin, it is recommended that you identify how many samples will be collected (i.e., how many times the test will be repeated), how the samples will be recorded, and where will they be stored. Once this is accomplished, you should be ready to begin the experiment.

When conducting the experiment, it is important to monitor the environmental conditions. Similar to test and calibrations, I recommend that you monitor and record this information. After your experiment has been repeated over time, it will allow you evaluate how environmental conditions affect the test results. Furthermore, it will allow you to identify and invalidate test results prior to analysis and evaluation. Invalidated data can have a negative or false impact on your estimation of measurement uncertainty.

Perform The Analysis

After performing your experiment, it is time to analyze the results. Although there are many ways to quantitatively analyze data, I recommend that you focus on calculating the mean (i.e., average), standard deviation, and degrees of freedom from the collected data. The mean is a statistical average of your pool of collected data. Recording this information will help you with other experiments such as the evaluation of reproducibility and stability. The standard deviation is the average dispersion of data about the mean. It is the best predictor of the uncertainty in measurement results observed during experimentation under repeatable conditions. The degrees of freedom are the number of values which the result is free to vary. This is an important value to consider should you decide to perform uncertainty analysis using Bayesian Statistics.

Conduct An Evaluation

With the completion of quantitative analysis, you may wish to perform qualitative analysis and evaluate the results of your experiment. Comparing the expressed CMC, or Calibration Measurement Capability, published in your scope of accreditation, how did the results of your repeatability experiment compare? If the results are less than the CMC expressed in your scope, then your current CMC may be adequately represented. If the results are greater than the CMC expressed in your scope, then you may need to investigate why the results of your experiment do not conform. Regardless of the results, it is important to evaluate the outcome of your experiments and use what you have learned to improve your process.

Establish A Schedule

One test does not validate a postulate (i.e., hypothesis). It is important to repeat experiments and perform verification studies before validating your results. Scheduling future experiments will help you organize and control your experimentation process. No one likes to (and should not) cram hundreds of experiments right before an assessment. Instead, develop a schedule and allow yourself adequate time to properly evaluate results. It will reduce the occurrence of invalidated results and reduce the impact on your laboratory’s productivity.

Repeatability tests are an important factor when performing uncertainty analysis. Laboratories should consider incorporating these experiments into their quality processes so they become routine and not burdensome. Otherwise, an assessor may determine to report a laboratory as deficient and mark parameters on a laboratory’s scope as "TBD." Furthermore, you will not have any evidence to support your calculations of uncertainty in measurement results.

I will go more into depth about the steps described in this article. Additionally, I will demonstrate and explain how to collect, record, and analyze the data.

II. How Many Samples Should You Collect?

Collecting Data

The number of samples collected during experimentation has an effect on the analysis of results and the validity of the test data collected. Over the years, I have observed several conflicting accounts of how many samples one should collect during experimentation. According to many introductory statistics textbooks, the number of samples collected depends on the population. A small population is considered a collection of 30 samples or less, while a large population is considered a collection of more than 30 samples. However, more advanced subject areas of statistics will have multiple assertions in relation to the goals of analysis and the expected confidence in results. If you were to survey a group of professionals from different organizations and different industries, you would receive a collection of varied opinions. This is the result of differing world views; each person and organization is going to have different goals. Therefore, they will have a degree of varied opinions.

What To Do

In my professional opinion, the number of samples you collect should be in relation to your organization's goals and the level of confidence expected in the results. If your laboratory seeks to attain a 95.45% level of confidence (where k=2.00), I recommend that you collect 22 samples for each experiment. If your goal was to achieve a confidence level of 99%, I would recommend that you collect 100 samples. Why? The answer is outliers. You can validate your results with outliers. If you collect 22 samples and seek to achieve a 95.45% level of confidence, you will typically find one outlier in your pool of collected samples. This is how you can ensure that you are achieving the level of confidence that meets your goals. Furthermore, it allows you to control the effectiveness and efficiency of your data collection efforts. Why collect 100 samples if you only need 22; or, why collect 22 samples if you need 100? Only expend the resources that you need to achieve your goals. Otherwise, you are wasting your time and resources that could be used to perform other tasks. Using the following equation, you can determine the appropriate number of samples you wish to collect in order to achieve a specific level of confidence.

$$n = \frac{1}{1-p} = [1-p]^{-1} \qquad \text{or} \qquad n = \frac{1}{q} = q^{-1}$$

where
n = number of samples,
p = probability of success, and
q = probability of failure.

Let's Break It Down

Not sure if my theory is valid? Then, let me show you quantitative and qualitative results that support my opinion. Using a Monte Carlo simulation, I will generate a pool of random data that is supposed to conform to a specified level of confidence (i.e., 95.45%) exhibiting a Gaussian distribution. With this data, I will calculate the mean, standard deviation, and degrees of freedom and report the results for you to evaluate (see figure below). From here, you can formulate your own opinion and choose to agree or disagree with me.

<u>The Results</u>

- 95.46% of trials exhibited one outlier or less
- 68.18% of trials exhibited at least one outlier
- 4.54% of trials exhibited more than one outlier

<u>Notes</u>

1. The numbers in the left column represent the sample number for each trial, totaling 22.
2. The numbers in the top row represent the trial number, totaling 22.
3. The upper and lower limits were quantified by calculating the sum and the difference of the mean and twice the standard deviation (i.e., 2-sigma).
4. The values that do not conform, or outliers, are the cells not highlighted in green.

Now that I have provided you some information and methods that you can use to determine the most efficient number of samples to collect for your repeatability experiments, how many samples will you collect?

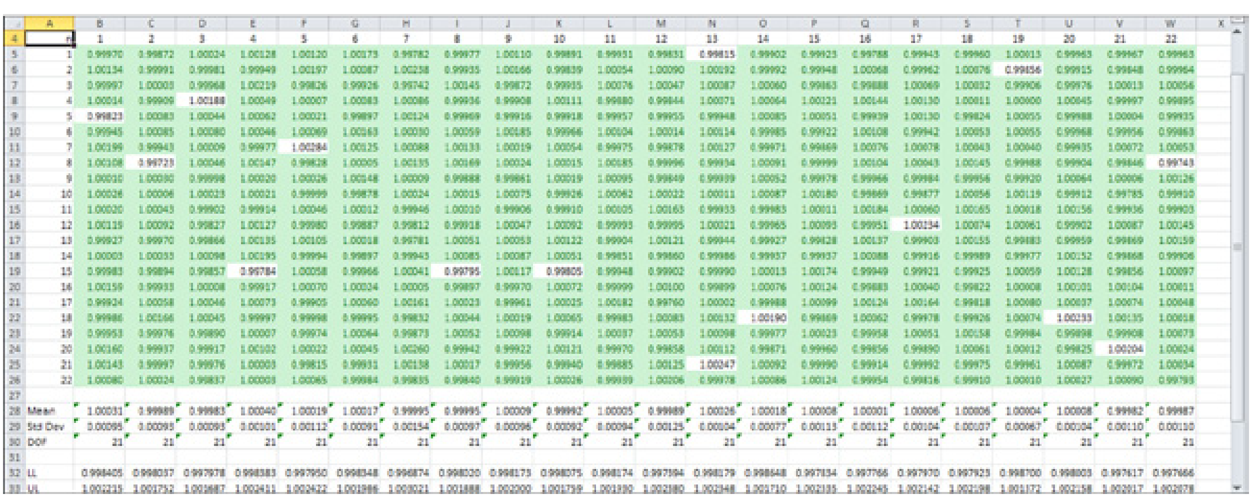
III. Collecting Data and Analyzing the Results

Collecting Data

Before you can analyze and evaluate the measurement system and process, you must collect some data. However, before diving in head first, there are some things that should be considered.

Review the Plan

First, review your plan. If you do not, you may find yourself repeating the experiment. It is more time efficient to do things right the first time. Identify what measurement functions, parameters, and ranges will be evaluated. Identify how you will perform the experiment by selecting your method. Finally, select the equipment you will need to perform the experiment.



Data Collection

Now that you have reviewed the plan, you need to determine what data you will collect and how you will collect it. This is important because good record-keeping practices will save you a lot of time later. Additionally, if you follow my advice, you will be able to perform further analysis, at a later time, to determine additional uncertainties that are influenced by the operator, the environment, and the passage of time.

The Checklist

I recommend developing a checklist for the data collection process. The checklist should identify the following information:

1. the parameter, function, and range(s) tested;
2. the equipment used and their associated identification numbers;
3. the date;
4. the operator;
5. the method;
6. the environmental conditions (e.g., temperature, humidity, etc.); and
7. the sample data collected.

Analyzing the Results

Now that you have collected your data, you will need to use descriptive statistics to analyze the results. By calculating the following parameters, you should be able to learn more about the behavior of your measuring systems, equipment, and processes. This will be beneficial when performing uncertainty analysis.

Mean

The first parameter that should be calculated is the mean. The mean is the calculated average or central value of your measurement results. The mean is calculated by finding the sum of all the measured values and dividing it by the total number of samples collected.

$$\bar{y} = \frac{\sum_{i=1}^{n} y_i}{n}$$

Excel function: =average(cell 1, cell 2,…,cell n)

Standard Deviation

The next parameter of interest is the standard deviation. The standard deviation is a measure of the variance or the dispersion of the set of data about the mean. A large standard deviation indicates that the data is broadly dispersed about the mean, and a small standard deviation infers that the data is narrowly clustered around the mean.

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (y_i - \bar{y})^2}{n}}$$

Excel function: =stdev(cell 1, cell 2,…,cell n)

Degrees of Freedom

After calculating the mean and standard deviation, you will want to know how many degrees of freedom are associated with your results. The degrees of freedom are the number of values of a statistical calculation which are free to vary. The greater the degrees of freedom, the more confident you should be about the final result.

$$v = n - 1$$

Excel function: =count(cell 1, cell 2,…,cell n)-1

Standard Deviation of the Mean

When evaluating the precision of the mean, it is common to calculate the standard deviation of the mean. This is accomplished by finding the quotient or the result of dividing the calculated standard deviation by the square root of the number of samples collected in a sample set. This is the uncertainty associated with the measurement results related to repeatability.

$$\sigma_{\bar{y}} = \frac{\sigma}{\sqrt{n}}$$

Excel function: =stdev(cell 1, cell 2,…,cell n)/ sqrt(count(cell 1, cell 2,…,cell n)-1)

Now that you have performed a repeatability experiment, you should feel more confident the next time you repeat it or experiment with another measurement discipline. By experimenting with your actual measurement processes you will begin to understand and predict how they will perform. Furthermore, you will be able to evaluate and improve your processes to reduce the uncertainty in measurement associated with the results.

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Made in America – European Origin?

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On an ongoing basis, the European Union (EU) is funding infrastructural development projects within the EU member states, pre-accession countries (i.e. countries likely to join the EU) and regions in Africa and Latin America where political and economical links are being forged. Improvements to quality infrastructure generally involve either the creation or augmentation of NMI capability. As is the case with all EU funded procurement, there is an overriding directive that Euro spending is for product (or services) sourced in the EU.

US manufactured metrology products may have final processes such as testing, calibration, verification and certification performed within the EU – where this is the case, the product could be considered to be of EU origin. This paper discusses some of the issues involved in establishing EU origin.

Introduction

The European Union ('EU') has an annual budget of around $160 billion. How this is collected and allocated is a subject well beyond the confines of this article, but it is certainly the case that as a source of aid and development finance, it is second to none on the planet!

At a micro level, the EU has funded $10s of millions, over the past decade, on the creation, or augmentation, of NMIs around the World. As readers will understand, the quest for economic cohesion and trading relationships must, inevitably, include the development of quality regimes and therefore, ultimately, the capabilities of NMIs and the metrological structures which they support.

This article discusses some of the issues for US manufacturers of metrology equipment when dealing with European Union funded programs. It is often the case that 'EU' funding is available only for products whose origin is deemed to be from one of the member states. The rules applying to origin and bidder status are strict but do accommodate the scenario of product produced over more than one country. Where a product's final, substantial, processing is performed within the EU, it could be certified to have origin in one of the member states. Equipment for an expanding, or new, National Measurement Institute (NMI) is inevitably both highly specialized and produced by a very small number of suppliers, therefore, tender authorities, specifiers and end users are concerned as to the legitimacy of origin declarations within EU regulations.

NMI projects have included Malta, Latvia, Lithuania, Macedonia, Serbia and Slovenia. Currently, there is funding for NMIs in Latin America and African states. It follows, therefore, that EU funding is not simply for the 27 member states but also for countries joining the union (pre-accession countries) and for areas where EU aid has been deemed appropriate.

EU procurement law runs to hundreds of thousands of words; this article is intended only to provide an insight into the issues that could be important to a US based supplier of metrological equipment.

Product Origin: A Summary of the Rules

The *The Practical Guide to Contract Procedures for EU External Actions* [1] is clear on the rules of origin. Tenders must adhere to the regulation that, in general, goods to be supplied originate in EU Member States and/or the regions covered and/or the rules governing a program under which a contract is being financed. For example, where the EU is providing funding in association with another organization, members thereof may be able to bid product produced in their countries. (Rarely the case, the criterion being the GDP of the recipient country.)

It is also the case that the contracting authority may derogate (i.e. exceptions to the general rules) certain products where it believes that there is only one source – this is most unusual.

In a tender response, a tenderer must provide a declaration to the effect that the goods comply with the applicable origin rules and the country of origin. A "Certificate of Origin" will normally be required with the shipment and, in most countries, this would be issued by the local Chamber of Commerce or by the manufacturer acting on their behalf. Generally, the customs authorities are the final arbiters of the transaction from the standpoint of origin. If the tenderer's declaration is in doubt, he may be required to provide evidence of origin prior to the acceptance stage.

It is the requirement that each item bid in a particular "lot" meets the criteria – not a percentage of the items or contract value. Any item in a lot failing to meet either the rules or specifications will render the entire lot non-compliant. The rules for establishment of origin will be covered in more detail in the next section.

How is Origin Established?

In order to establish origin, it is necessary to determine where production or some processing has occurred. Products cannot originate in a country where no processing has taken place, however, the country of origin might not be where only some stages of production have taken place or from where the goods are shipped. If only one country is involved in the entire production process, then origin is clear, however, where multiple countries are involved, the situation becomes more complex.

It is the understanding of the EU origin rules that this article will explore in more depth and discuss how they could apply to US metrology products.

The term *origin* is defined by EU legislation on rules of origin for customs purposes, EEC 2913/92, and the code's implementing provisions in EEC 2454/93.

Relevant here is EEC 2913/92 Article 24 which covers production over more than one country. It states:

> Goods whose production involved more than one country shall be deemed to originate in the country where they underwent their last, substantial, economically justified processing or working in an undertaking equipped for that purpose and resulting in the manufacture of a new product or representing an important stage of manufacture.[2]

In financial terms, the added value is generally considered to be 45% of the ex-works price.

How Might this Relate to US Metrological Products?

Clearly, product could be built and processed entirely within the EU, however, this may be impractical and/or uneconomic. Examples might be a Super Platinum Resistance Thermometer (SPRT), where the assembly process can only be achieved by a very small team, or a component conditioning process that would be impractical to duplicate and transport.

The process of applying for origin approval will be dealt with later in this article, however, the basis for the justification could be as follows.

- The product is physically assembled in the USA.
- Product destined for a new or developing NMI will have little value to the end user without the final stages of: Testing, Calibration, Verification, Certification, Finishing and Packaging.
- These processes could be deemed to be "economically justified" and certainly the "final" and "important stage of manufacture."
- If these operations take place within a UKAS environment (in the case of the UK), then the criteria for an "undertaking equipped for purpose" may be met.

The next section discusses how to seek agreement that the conditions of Article 24 have been met and the advantages of the appropriate certification.

The Binding Origin Information (BOI)

The terminology used in this article applies to the UK authorities however other EU countries have their equivalents. What is a BOI?

- A BOI is a written origin decision which is legally binding throughout the EU and remains valid for three years. No EU customs authority can challenge the BOI provided the product and the production regime submitted remain unchanged.
- The legal provisions relating to BOI are contained within EC 2913/92 (customs code) and 2454/93 (customs code implementation regulation).
- It is especially helpful where origin is difficult to determine as might be the case with product produced/processed over more than one country.

BOI: The Commercial Issues

There are three key advantages to having a BOI in place, they may be summarized as follows:

- A tenderer can respond to an invitation to tender with a clear statement as to the agreed origin.
- An EU country's certificate origin (BOI) will be accepted by the relevant chambers of commerce and customs authorities throughout the EU. A BOI correctly obtained, therefore, provides security to the supplier and tenderer that no EU regulation, in respect of origin, will be contravened.
- Specification writers can be informed prior to any procurement that product may be considered to be of EU origin – US product is often ignored as it assumed to be ineligible.

A BOI may only be applied for with specific export transactions envisaged. It is also the case that processing within the EU in order to circumvent the regulations is not permitted (EC2913/92, Article 25) [2]. A US company may be processing a "substantial transformation" to a product in the EU for various reasons (e.g. EU technical back up, local language support, training logistics, time zone issues, customer liason, line/environmental considerations or EU traceability). Given this, application for EU origin, for export requirements, may be entirely appropriate.

The Application Process

The details of the forms are beyond the scope of this article but it will be necessary to supply at least the following:

- Product description
- EU law considered applicable
- Previous BOIs (if applicable)
- Brochures, photos etc.
- Customs codes
- Materials used
- Ex –works price
- Details of the applicant
- Details of works performed within the EU

It is possible that presentations may be requested by customs authorities and/or other organizations from whom they may seek guidance.

If a BOI is awarded, it is contingent on the product and procedures remaining the same for the duration of the documentation. The customs authorities reserve the right to audit the claims made.

Persons Eligible

In general terms EU tenders are to open to "Natural" and "Legal" persons established in a member state—in essence, real people and legal entities. This is to prevent transactions with "mail box" companies regardless of origin issues.

False Declarations: The Penalties

The rules are clear and strict. Tenderers who are found to have made false declarations can be excluded from ALL EU procurements for up to five years after the infringement and possibly 10 years in the event of a second offence! There may also be financial penalties, depending on the seriousness of the fraud, ranging from 2% to 10% of the estimated value of the contract being awarded.

Summary

The author has experience of obtaining BOI certification for products assembled in the USA, but taken through calibration processes in UK accredited laboratories and tendered by EU legal entities. This article cannot, exhaustively, detail every aspect of relevant EU law or customs procedures. It is intended to provide an insight into the potential for supplying US assembled product into EU funded metrology projects and some of the considerations entailed.

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Treatment of Conditional Measurement Bias in Measuring Instruments

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Calibration information of experimental instruments often is used for correcting measurements. In this work we present examples of analysis of historic data from specific instruments. Significant evidence that current recommendations and practices suggesting the measurements correction may introduce bias not covered by the declared uncertainty is given. A general procedure to handle consistently this situation is outlined.

1. Introduction

In practice, all quality systems require, among other things, that every equipment and instrument involved in the measuring procedure of a laboratory must be calibrated periodically in order to ensure measurement traceability. It is also common to find calibration plans and logs within laboratories compliant with some quality system. Documented uncertainty and bias correction estimates are the core information in the related calibration certificates. Uncertainty estimation is widely and well documented [1], [2], however bias estimation and treatment is not; neither the bias correction nor the uncertainty attached to it [3].

Most of the calibration procedures provide the estimates conditioned at each point in time. The users of these certificates often limit themselves to this information. However, deeper understanding of the measuring process can be gained if data is analyzed over time.

Instead we propose modeling the behavior of the conditional bias as a random variable, using the time and level of the measurand as predictors of this model. This approach leads to unconditional estimators and general expressions can be obtained for distributional parameters.

The importance of this approach becomes evident when contrasting the current practices versus the availability of a framework to decide on optimizing the use of the calibration information.

2. Techniques and Models

Ideally, we consider a generic quantity to be measured μ, however, in practice we observe X with some measurement bias b and some measurement error ϵ attached to it. If we consider n replications, using the suffix $i = 1, \dots, n$, we get

$$X_i = \mu + b + \epsilon_i \tag{1}$$

where ϵ_i has mean zero and variance σ^2 at time t. In this sense we may use the typical notation for random variables

$$X_i \sim N(\mu + b, \sigma^2) \tag{2}$$

where $X \sim N(\mu, \sigma^2)$ reads as X is a random variable with normal distribution with expected value μ and variance σ^2.

We must emphasize that the bias b is attached to a measuring procedure. By definition, the bias is an unknown deterministic quantity and it equates to the difference of the unconditional expected value of the sample and the parameter it tries to estimate. If D is a statistic provided to estimate the true unknown parameter Δ, then

$$Bias[D] = E[D] - \Delta.$$

In order to gain deeper understanding on model (2) we must stress the notation. At each point in time t we observe some conditional bias to correct for and some conditional compound uncertainty, hence the three quantities are conditioned on time [5]. By definition

$$X_i \mid (M, T) = M + B \mid (M, T) + \epsilon_i \mid (M, T), \tag{3}$$

where the conditional bias $B|(M,T)$ and the conditional measurement error $\epsilon_i|(M,T)$ are random variables, both dependent of the random value M and the random time T. We assume independence of M and T.

Typically, the compound uncertainty includes uncertainty from several sources: repeatability, short period stability, instrumental drift, experimental room conditions, hysteresis, involved standards, and reference materials, among others.

If we consider these quantities changing over time, and assuming the conditioned bias and conditioned measurement errors are uncorrelated, then applying the law of conditional expectation and conditional variance

[5] we get

$$E\,[X_i \mid M\,] = M + E\,[B \mid M\,] + E\,[\epsilon_i \mid M\,] \qquad (4)$$

$$V\,[X_i \mid M\,] = V\,[B \mid M\,] + V\,[\epsilon_i \mid M\,], \qquad (5)$$

Where $E\ [B \mid M\ ]$ is the expected value of B while keeping the condition of M, and $V[B|M]$ is the variance of B while keeping the condition of M, in both cases an integration over time is done. That is the reason they become unconditional quantities on time.

$V[B|M]$ accounts for the variance component due to intermediate precision conditions of the measuring procedure and instrument stability. This variance component is hidden when conditioned on time, however, the associated deviation $B|M,\ T$ is often interpreted as a constant (unconditional) bias at each specific point in time and it is often reported and handled as a required adjustment.

This approach is applicable in general; however, the requirement on available historical data becomes an important practical constraint. For example, some metrology laboratories may not plan for their instruments calibration regularly or they depart from their calibration plans. As a result, considerable gaps may exist in their historic calibration logs.

By modeling the conditional measurement bias and the conditional measurement error, the treatment and results may depend on the specific form assumed for these conditional quantities: $B|(M,T)$ and $\epsilon_i|(M,T)$.

The model in equation 4 may be partially identifiable or identifiable. When estimating M and $T\ [B|M]$, both quantities may be cofounded; in such a case just the overall estimate of $M{+}E[B|M]$ can be obtained. Often, some independent estimate of M is available; in such a case the model becomes identifiable.

Data from multiple instruments is systematically analyzed over time and conclusions are drawn and documented. The type and number of instruments was limited mainly to those of the Chemical Division at CENAM and to specific examples from other Divisions. We used the R language [12] to perform the data analysis.

When several metrologists are involved in the calibration of any instrument, some caution must be exercised due to the learning curve of the novice personnel. Typically a first few calibrations of an instrument performed by an unfamiliar metrologist tend to be outliers [6], [7] and they are good candidates for exclusion from the data analysis. This is exercised in subsection 3.1.

The intermediate measurement precision estimation must include measurements over an extended period of time and may include other conditions involving changes [7], [8], [10]. Hence the suggested treatment of the conditional bias is a formal method to estimate components of uncertainty associated to the intermediate precision.

In general, the true population parameters are unknown. Instead, we replace the population parameters with sample estimates in equations (1)-(5), when required.

3. Results

Several types of instruments were analyzed. The results of this analysis were grouped by family of instruments.

Some other families of instrument (Thermometers, Hygrometers, Gas Divisors, and Density-meters) were analyzed, however the available data was not representative for drawing any specific conclusion. For example, some datasets were just 2 or 3 calibrations long, and even fitting a simple linear model is worthless.

3.1 Digital Balances

Figure 1 (left) shows the reported correction (=conditional negative bias) after excluding data from calibrations 2. Clearly the conditional bias is not constant; rather it likely behaves as a random variable, centered at zero and with increasing variance on the level of the measurand M.

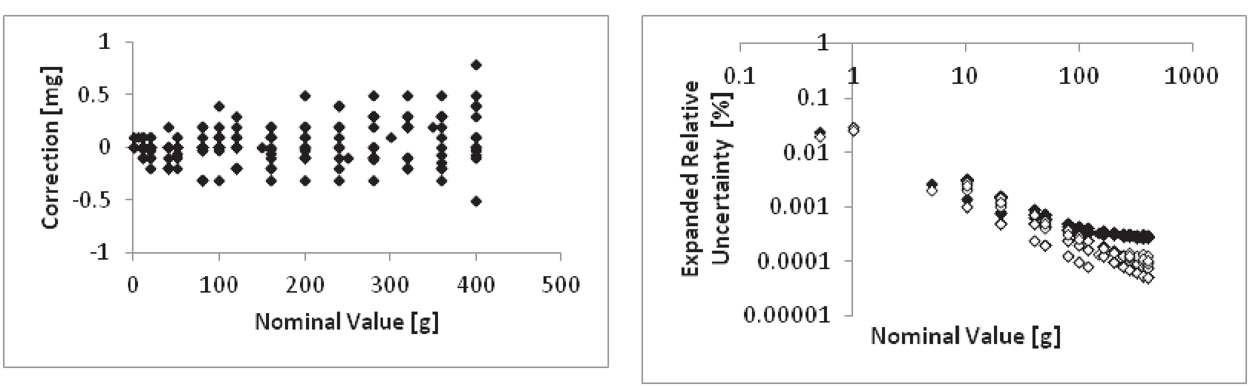


Figure 1. (left) correction as reported, (right) relative expanded uncertainty as reported (open symbols), including the estimated component of uncertainty due to the intermediate precision conditions (closed symbols).

In this case, the absolute correction can be regressed on the nominal value to estimate the linear regression parameters $(\beta_0, \beta_1, \sigma_\delta^2)$.

$$|\bar{X}_T - M| = \beta_0 + \beta_1 M + \delta_T, \qquad V[\delta_T] = \sigma_B^2 .$$

The estimated parameters are

$\hat{\beta}_0$ [g]	0.052(30)
$\hat{\beta}_1$	0.48(14) + 10^{-3}
$\hat{\sigma}_B$ [g]	0.123(13)

with 174 degrees of freedom.

The bias can be modeled unconditionally on time as

$$B|M \sim N(0, (\beta_0 + \beta_1 M)^2 + \sigma_B^2).$$

This may be interpreted as uncertainty increasing on the level of the measurand (nominal value) M and not as constant bias. This is evidence of heteroskedasticity. The reported uncertainty is itself increasing on the level of the measurand M. We can fit a second linear model for the standard uncertainty against the nominal value.

$$u_c = \gamma_0 + \gamma_1 M + \xi_T, \qquad V[\xi_T] = \sigma_U^2 .$$

where $u_c = U_c/2$ is the standard uncertainty, U_c is the reported conditional expanded uncertainty and we have assumed an expansion factor of 2. The estimated parameters are

$\hat{\gamma}_0$ [g]	0.112(5)
$\hat{\gamma}_1$	1.01(44) × 10^{-4}
$\hat{\sigma}_U$ [g]	0.0376(40)

with 174 degrees of freedom.

The observed response can be modeled unconditionally on time as

$$X_i|M \sim N(M, \sigma_c^2(M)),$$

Where $\sigma_c^2(M)$ is a function of the nominal value:

$$\sigma_c^2(M) = (\beta_0 + \beta_1 M)^2 + \sigma_B^2 + (\gamma_0 + \gamma_1 M)^2 + \sigma_U^2 .$$

Then we build a confidence band [11] for the expanded uncertainty accounting for intermediate precision conditions

$$k\sigma_c(M).$$

In doing so, we may use an expansion factor k considering a Student's T distribution with the estimated degrees of freedom.

The estimated variance component due to the conditioned bias is increasing on the nominal value and it is comparable to the conditional compound uncertainty.

Note that $\hat{\gamma}_0 > \hat{\beta}_0$, hence the uncertainty component due to the conditional uncertainty is dominant for the low region of the digital balance. On the other hand, $\hat{\gamma}_1 < \hat{\beta}_1$, hence the uncertainty component due to the conditional bias may become dominant for the high region of the instrument.

Figure 1 (right) shows the estimated conditional compound uncertainty of one instrument and the estimated unconditional compound uncertainty.

3.2 Mechanical Barometers

The conditional bias seems to be linear on time with some uncertainty attached to it of constant variance, as shown in Figure 2 (left). The conditional bias can model as

$$B|(M, T) \sim N(\beta_0 + \beta_1 T, \sigma_B^2).$$

This may be interpreted as additional uncertainty and if $\beta_1 \neq 0$, there is a constant drift due to degradation of the standard over time.

In this case, the correction can be regressed on time to estimate the linear regression parameters $(\beta_0, \beta_1, \sigma_B^2)$. The nominal value associated to these measurements remains virtually fixed. The estimated parameters are

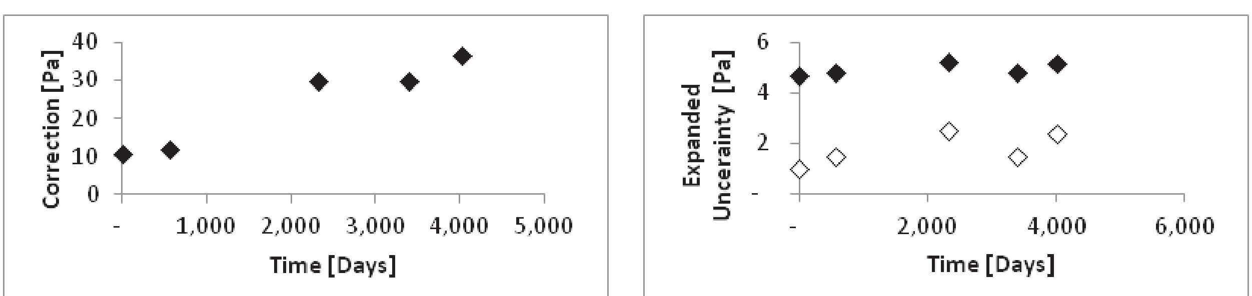


Figure 2. (left) correction as reported, (right) relative expanded uncertainty as reported (open symbols), including the estimated component of uncertainty due to the intermediate precision conditions (closed symbols).

$\hat{\beta}_0$ [Pa]	10.28(7.57)
$\hat{\beta}_1$ [Pa/day]	0.0066(29)
$\hat{\sigma}_B$ [Pa]	3.22(14)

with 3 degrees of freedom. We can conclude the slope is statistically different from zero; hence, there is evidence of a drift of the instrument over time. We proceed to assess if the reported conditional uncertainty varies linearly with time or if it remains constant.

$$u_c = \gamma_0 + \gamma_1 T + \xi_T, \qquad V[\xi_T] = \sigma_U^2$$

where $u_c = U_c/2$ is the standard uncertainty, U_c is the reported conditional expanded uncertainty and we have assumed an expansion factor of 2. The estimated parameters are

$\hat{\gamma}_0$ [Pa]	0.63(65)
$\hat{\gamma}_1$ [Pa/day]	$0.125(250) \times 10^{-4}$
$\hat{\sigma}_U$ [Pa]	0.225, $95\%CI = \{0.127, 0.839\}$

with 3 degrees of freedom. These estimates do not support the model of the conditional uncertainty as a linear function of time.

Note that the residual standard error $\hat{\sigma}_U$ has only 3 degrees of freedom and it likely follows an asymmetric distribution even assuming normality of the random errors. In this case it is preferable to express an asymmetric confidence interval instead of a symmetric expanded uncertainty of it, since we know it must be non-negative. We conclude the conditional uncertainty is best described as a constant $u_c = 0.89(29)$ [Pa].

Then we combine the conditional (reported) expanded uncertainty with the estimate from the linear regression $\sqrt{k^2\hat{\sigma}_B^2 + U_c^2} = 4.9$ [Pa]. In doing so, we may use an expansion factor k considering a Student's T distribution with the estimated degrees of freedom.

Figure 2 (right) shows the reported correction and conditional compound uncertainty of one instrument. The estimated uncertainty component due to the conditional bias appears to be constant and it is dominant (3.22 or approximately 93% of the variance) in comparison to the reported compound uncertainty (0.89 or approximately 7% of the variance). The bias model is valid if the historical conditions of its use remain in the future. For example, the rate of degradation may depend on how often it is used. If the barometer is used in the future half of the times in comparison with the frequency it was used in the past, then its degradation rate will likely be reduced to half the estimated rate.

3.3 Standard Weights and Sets of Weights

In the case of a set of weights, each standard must be analyzed individually. The conditional bias likely behaves as a random variable, centered at the true unconditional bias and with some additional uncertainty, as shown in Figure 3 (left). In some cases the conditional bias is a linear function of time: $B|(M,\ T) \sim N(\beta_0 + \beta_1 T,\ \sigma_B^2)$.

This may be interpreted as additional uncertainty and if $\beta_1 \neq 0$, there is a constant drift due to degradation of the standard over time. We proceed as in subsection 3.2.

The nominal value associated to these measurements remains fixed. The estimated parameters are

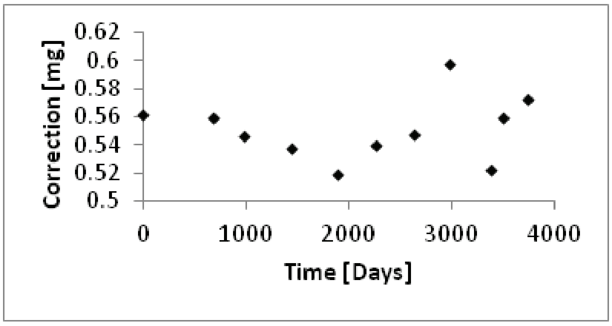
$\hat{\beta}_0$ [mg]	0.547(33)
$\hat{\beta}_1$ [mg/day]	$2(14) \times 10^{-6}$
$\hat{\sigma}_B$ [mg]	0.024(13)

with 9 degrees of freedom. In this case, β_1 is statistically zero.

By looking at the plotted data in Figure 3 (left) it may be worth to analyze a quadratic model on time

$$B|(M,\ T) \sim N(\beta_0 + \beta_1 T + \beta_2 T^2, \sigma_B^2).$$

This may be interpreted as additional uncertainty and if



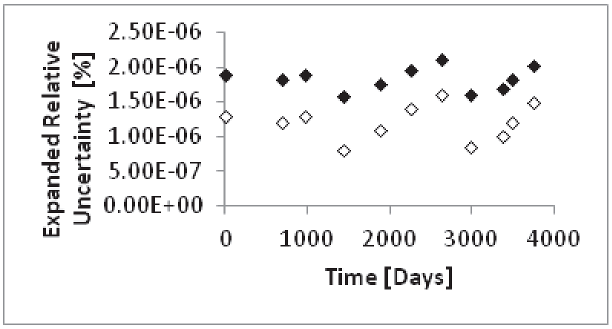


Figure 3. (top) correction as reported, (bottom) relative expanded uncertainty as reported (open symbols), including the estimated component of uncertainty due to the intermediate precision conditions (closed symbols).

$\beta_2 \neq 0$, there is a drift due to degradation of the standard over time and the drift is quadratic on time. The estimated parameters for this second model are

$\hat{\beta}_0$ [mg]	0.564(45)
$\hat{\beta}_1$ [mg/day]	$-26(52) \times 10^{-6}$
$\hat{\beta}_2$ [*mg/day*^{2}]	$7(13) \times 10^{-9}$
$\hat{\sigma}_B$ [mg]	0.023(14)

with 8 degrees of freedom. In this case, both β_1 and β_2 are statistically zero. Therefore, a constant model describes better this standard

$$B \mid (M, T) \sim N(\beta_0, \sigma_B^2).$$

The estimated parameter for a constant bias model is

$\hat{\beta}_0$ [mg]	0.551(15)

with 10 degrees of freedom. Figure 3 (right) shows the reported conditional compound uncertainty of one standard and the unconditional uncertainty including the uncertainty component due to intermediate precision conditions.

The estimated uncertainty due to the conditioned bias remains constant and it is similar (0.0068 mg or approximately 56% of the variance) to the reported compound uncertainty (0.0060 mg or approximately 44% of the variance).

The constant bias model is valid if the historical conditions of its use remain in the future. For example, the rate of degradation may depend on how often it is used. If the standard is used in the future twice the times in comparison with the frequency it was used in the past, then a degradation rate may become present.

4. Discussion

In all the analyzed cases, the uncertainty component due to the conditional bias was non-negligible in comparison to the conditional compound uncertainty (reported uncertainty).

Analyzing a whole family of instruments may provide additional information of the instrumental capabilities. The unconditional behavior naturally emerges and sometimes new understanding of the process is gained in ways that may not be evident from the conditional models.

Figure 4 shows a set of three analyzed digital balances allowing contrasting their performance. The one in the middle is repeated from the first example, plus two other instruments. All of them show a clear underestimated uncertainty, especially at the high end of their scale. The balance with the lowest scale appears clearly with a degraded response reaching about 1% of relative expanded uncertainty, giving evidence of the need of defining a minimum amount of the quantity to be measured.

Detailed data is available on request.

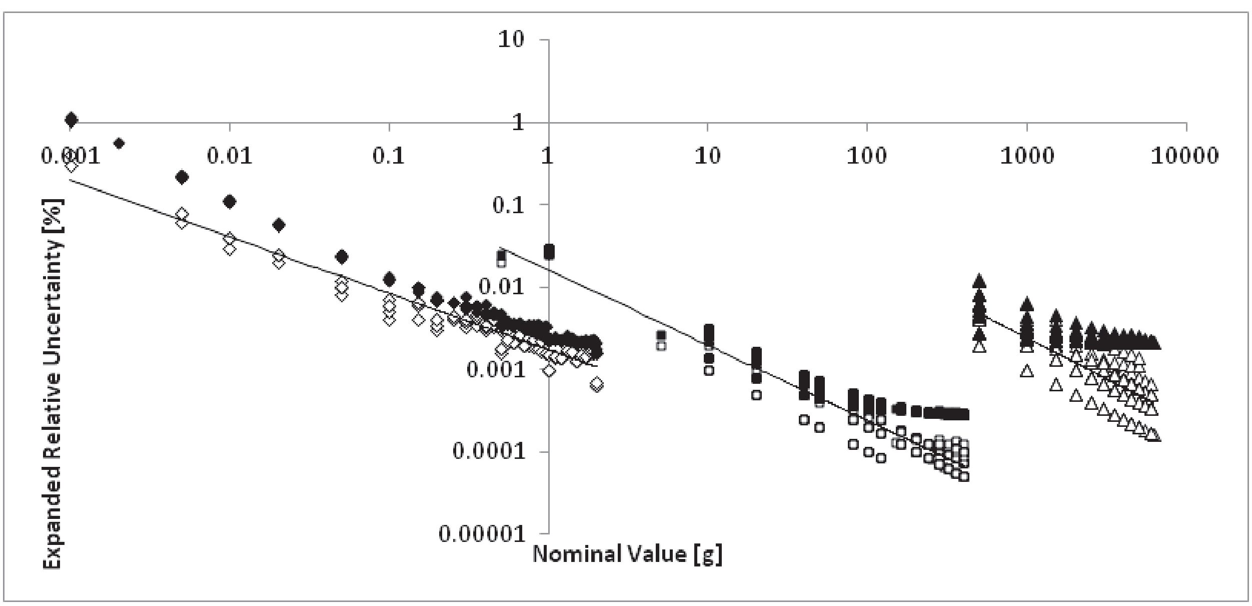


Figure 4. Relative expanded uncertainty as reported (open symbols) and estimated expanded uncertainty including the uncertainty component due to the intermediate precision conditions (closed symbols).

5. Conclusions

The widely installed practices seem to systematically underestimate the measurement uncertainty. We have shown evidence of up to fivefold uncertainty underestimation for the first two examples, about twofold underestimation for the third example and about tenfold underestimation for the fourth example. This is in accordance with results from other researchers [9], [2].

The common practice of correcting for conditional bias may introduce bias not covered by the estimated conditional uncertainty leading to biased results.

In all the cases, the evidence of underestimation is statistically significant and in some cases may not be negligible by its own or for its dissemination chain. This study suggests avoiding the common practice of adjusting for conditional bias when historic data is already available. Instead, we strongly suggest modeling the unconditional bias as a function of time and nominal value, then estimating a component of uncertainty due to the intermediate precision conditions accordingly.

In this order, two conditions can make difficult or impossible to conduct an analysis: when no historic data is available or historic data is too short (two or three points in time); and the second condition is when the quality of the data is questionable, leading to indefensible estimates at least for some instruments.

The use of systematic data analysis over historic data logs allows better characterizing the laboratory instruments for metrology purposes. Although this study was limited to instruments, it may be extended to evaluate the effectiveness of current training programs for improvement purposes by analyzing the information against the involved personnel over time instead of analyzing the information against time itself.

6. Acknowledgements

We want to thank to the groups of Organic Chemistry and Density and Mass Metrology at CENAM for providing some of the detailed data and allowing us to have access to their instruments historic calibration log for this study. We also want to acknowledge the referees for their comments.

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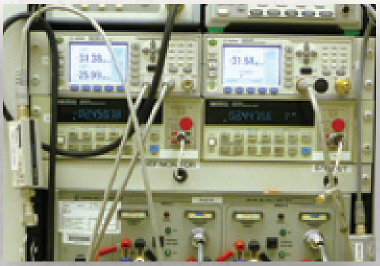
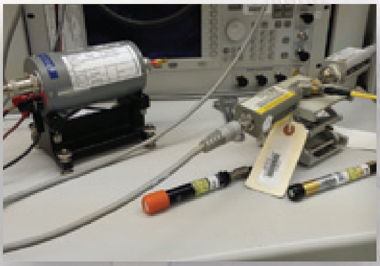




A Practical Guide for Selecting, Purchasing, and Receiving Accredited Calibration Service

Pam Wright
American Association for Laboratory Accreditation (A2LA)

Nearly everyone struggles with selecting, purchasing, and receiving accredited calibration services. This article is designed to provide practical guidance on ordering calibration service and what to do once the equipment is returned to the laboratory. This guidance is based on real-life situations that are often encountered by our accredited testing laboratories.

First, let me describe what happens when there is a lack of communication on and responsibility (by all parties) for the calibration service provided:

The testing laboratory ships an instrument to their calibration vendor with a purchase order that simply says *calibrate per ISO/IEC 17025*. "After all," says the testing quality manager, "the type of service provided is best left up to the calibration experts."

The calibration laboratory receives the order and contacts the testing laboratory to obtain specific information on the service needed. The shipping clerk at the testing laboratory, who is answering the phones because everyone else is in a meeting, cannot answer the questions and instructs the calibration provider to "just do what's best." The calibration provider, being in a hurry to complete the calibration because it is a rush order, defaults to their "standard" level of service.

The testing laboratory receives the calibrated instrument, performs a cursory check to ensure that the instrument turns on and that the paperwork was included in the box and places the instrument back into the laboratory for use.

Later, when a third-party assessor assesses the testing laboratory, they receive two deficiencies regarding traceability because only a limited calibration (where only a portion of the specification was evaluated) was done on the instrument and because the calibration certificate was not endorsed with the accrediting body's (AB's) symbol and the laboratory's accreditation certificate number. The quality manager for the testing laboratory, when filling out the "root cause" information in his corrective action form, writes "the calibration laboratory provided poor service."

What went wrong here?

To answer this question, let's talk about selection of calibration service.

Selecting

If we were to make a major purchase for our home, such as a refrigerator, most of us would begin with some research. Perhaps we would conduct an evaluation of all the possible manufacturers and models available and their specifications (size, temperature range, various features, price, etc.) to be sure that the one we choose will fit in the space available, that it provides the temperature needed and that it is priced reasonably. We might review a consumer's report on the top ten refrigerators, rating features, functions and specifications. Similarly, when the refrigerator requires service to replace water lines and filters, we might search the manufacturer's website for recommended service providers. We would then call the service providers and ask whether they use genuine manufacturer parts when performing the service, how many years they have been servicing our particular refrigerator model, etc. Once the service is conducted we would check to see that we received the agreed upon services.

The process for selecting calibration service is similar to the process for purchasing or servicing our refrigerator.

Section 4.6.1 of ISO/IEC 17025 requires laboratories to have "… a policy and procedure for the selection and purchasing of services … that affect the quality of the tests and/or calibrations." This includes the purchase of new equipment or the service of existing equipment. Be sure your policy/procedure requires a review of the calibration provider's Scope of Accreditation before you actually use them. This should be repeated with each new request for service, since calibration laboratories often add, remove, or change items on their Scope and you need to be sure that the service you want, in the range and/or with the measurement uncertainty you need, is still on their Scope. It is best not to assume that your vendors will automatically notify you of any updates or Scope changes. If you have not selected a calibration provider yet, check the websites of accrediting bodies (such as www.A2LA.org). This is similar to checking a consumer's report when shopping for refrigerators or looking at recommended refrigerator service providers on the manufacturer's website.

If you aren't sure whether the Scope from your calibration vendor meets your needs, call the calibration provider and ask specific questions about which parameters and which ranges on the Scope apply to your instrument. Do not hesitate to speak with the staff metrologist or technical manager rather than a sales representative or staff receptionist who may not be as knowledgeable in the technical aspects of the Scope of Accreditation as the calibration staff would be. A reputable calibration provider is willing to assist customers with their inquiries, so if your provider is not cooperative in answering basic questions about their Scope, you may want to consider another calibration provider.

Be careful when leaving the decision on the selection of a calibration provider to a purchasing agent or staff member that is not well-versed in the needs of the equipment or the requirements for traceability. Often times they will select a provider based simply on cost, not understanding that they may have selected a non-accredited service that is not deemed traceable or an accredited calibration that is limited in capability and, therefore, does not meet your needs. Selecting the least expensive service can very well haunt you later with regard to the data your test laboratory ultimately generates AND in the form of a deficiency for lack of traceability or lack of properly calibrated equipment.

Purchasing

Let's talks about ordering a calibration service:

Section 4.6.3 of ISO/IEC 17025 requires that your "purchasing documents for items affecting the quality of laboratory output shall contain data describing the services … ordered." The description may include type, class, grade, precise identification, specifications, drawings, inspection instructions, etc. This document is where you tell the calibration provider what you want. Being clear up front speeds up the calibration process since the provider does not have to stop and play "telephone tag" with you to obtain clear instructions on the calibration service desired.

If you do not know what you need then this would be an ideal time to find out. You could start by determining which specification the equipment must meet. Is it one from the manufacturer or does the test method include a specification? At the very least, be sure to request that your equipment be evaluated against the full specification in order to avoid receiving a partial or limited calibration. This is similar to servicing our refrigerator since, when placing the service order, we want to be as specific as possible to be sure the right parts for our make and model are installed.

Other areas you should consider, at a minimum, in describing the service ordered include:

- **The Accreditation Body's "Accredited" Symbol (including accreditation certificate number)**

Be aware that a calibration provider may offer various levels of service from non-accredited service, to accredited service with data and measurement uncertainty, to everything in-between. It is best not to assume that, because a laboratory is accredited, you will automatically receive accredited results. Some accredited calibration laboratories only provide accredited results, while others only provide them upon request. If you need accredited results, be sure to specifically ask that an accredited symbol with accreditation certificate number (and measurement uncertainty) be included on the final calibration certificate in order to ensure the traceability of the result. It is best not to rely solely on terms such as "accredited" or "ISO/IEC 17025" calibration in your purchasing document as these are not always interpreted in the same way by everyone.

- **Measurement Data**

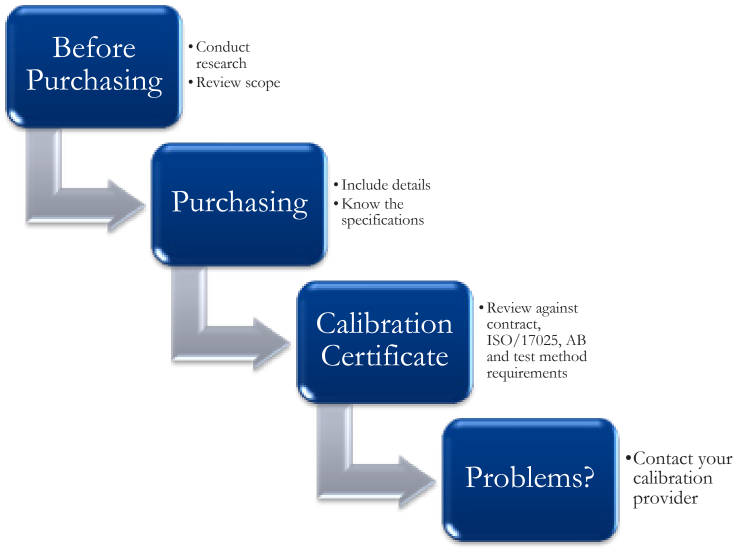
Be sure to specify that you want all measurement data included on the calibration certificate. Some calibration providers have a "no data" option for service. Also, where necessary, make sure all the needed data points are requested. If you are not sure which data points or how many of them are needed, you may want to consult the manufacturer's equipment manual and any applicable test methods. Compare them with the ranges over which the equipment is used to ensure they are covered. For example, if the acceptable laboratory environment range is 21 °C ± 2 °C then, for the calibration of your thermohygrometer, you should request at least two data points at 19 °C and 23 °C in order to ensure that the instrument can measure across the full range at which it is used.

- **Measurement Uncertainty**

While A2LA requires inclusion of the measurement uncertainty whenever the "A2LA Accredited" symbol is used on the calibration certificate, other accrediting bodies may not.

- **Calibration Interval**

If you have established a particular calibration interval, such as two years, be sure to include this in your request for service. Some calibration laboratories put a default "one year calibration interval unless specified otherwise by the customer" into their contracts, so be sure that your provider understands the interval desired for your instrument.



Receiving

Now that your properly calibrated equipment has been returned to you, let's talk about how to confirm that the results are in agreement with the service requested and purchased. This is analogous to our confirming that the water filters and lines in our newly serviced refrigerator were actually replaced with the correct parts.

Similar to our refrigerator scenario, where the replaced filter and water lines are confirmed through a physical inspection and review of the accompanying paperwork, the same type of check should to be done with equipment that is returned to the laboratory after calibration. Section 4.6.2 of ISO/IEC 17025 requires all laboratories "to ensure that purchased supplies … that affect the quality of tests and/or calibrations are not used until they have been inspected or otherwise verified as complying with standard specifications or requirements defined in the methods for the tests and/or calibrations concerned."

However, if you do not know the details of your equipment specifications or what the test method requires regarding the equipment, how will you be able to carry out this task? Take the time to understand your equipment. If possible, hire someone who understands the specifications that must be met for the equipment and/or the test methods for which the equipment is used, or obtain training for a staff member in this area. This will go a long way toward identifying problems with the equipment that could have occurred during shipping, as well as potential issues with the calibration certificate once the equipment is returned to the laboratory.

While calibration certificates issued to customers should be error free, occasional mistakes can and do occur. In addition, some items may be omitted from the certificate due to the details of the service contract. Be sure to review the calibration certificate carefully to ensure that it includes all the necessary elements outlined in ISO/IEC 17025, any specific accreditation body requirements, any applicable test method requirements and the requirements of your own contract for service. It is always better for you to find any errors or omissions and address them with your calibration provider internally rather than having an external auditor find them and then have to implement a time-consuming formal corrective action process.

The most common issues encountered with calibration certificates relate to:

- **Inclusion of the Accreditation Body's "Accredited" Symbol**

Make sure the accredited symbol and accreditation certificate number are included. Alternatively, a laboratory may use a statement such as: "The results are accredited to ISO/IEC 17025 through A2LA Certificate Number 0000.00." Without the symbol or this explicit statement, the results may not be deemed traceable. Do not accept a generic statement such as: "The laboratory is accredited to ISO/IEC 17025 by A2LA." This advertises the fact that the laboratory is accredited, but does not reference their exact A2LA certificate number for traceability to their Scope of Accreditation.

- **Inclusion of Measurement Data**

When you receive the calibration certificate, be sure that all of the data points requested in your purchasing document are included. If you requested information on functional checks, be sure that information was provided as well.

- **Inclusion of Measurement Uncertainty**

Make sure the measurement uncertainty is included. In order for the results to be traceable, the measurement uncertainty is normally required. In addition, be sure the measurement uncertainty is properly rounded to two significant figures and is rounded per the usual rules for rounding numbers in accordance with ILAC P14:01/2013.

- **Inclusion of a Coverage Factor and Confidence Interval**

Make sure an explanation of the meaning of the uncertainty statement is included. For example: "This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2."

- **Inclusion of a Traceability Statement**

Be sure your calibration certificate includes a traceability statement such as: "This calibration was conducted using standards traceable to the SI through NIST." Keep in mind that NIST test report numbers are used solely for administrative purposes by NIST and do not provide information on traceability.

- **Indication of the Method Used**

The calibration method used must be included on the calibration certificate. Sometimes the calibration provider will include the procedure instead. Be sure that at least one of these is included, particularly if you require evidence that a particular test method, such as ASTM or ASME, was used to perform the calibration.

- **Indication of the Reference Standards Used**

Make sure the necessary reference standards are included. If some of the reference standards are excluded from the calibration certificate it may be an indication that only a partial or limited calibration was provided. Take the time to understand your equipment and do not hesitate to seek information on which reference standards are needed to calibrate the ranges over which you use your instrument. The equipment manufacturer would be a good place to start your search. If you do not see all of the applicable reference standards on the certificate, question the provider as to how the ranges of your instrument were evaluated given the lack of notation of certain reference standards. Consider, for example, the calibration of an environmental chamber. If the calibration provider only lists an electrical reference standard on the calibration certificate, then you likely have received a partial or limited calibration where only the controller was checked.

- **Use of Asterisks**

Look for issues with any asterisks (or otherwise marked items). In many cases a calibration laboratory will report both accredited results (covered by the Scope of Accreditation) and non-accredited results that are not covered by the Scope. The non-accredited results are typically marked with an asterisk.

- **Recommendation of a Calibration Interval**

If a calibration interval is included on the certificate, be sure it is one that has been agreed upon between you and the calibration provider. If you did not agree to a calibration interval and the calibration laboratory included a recalibration due date, check your contract for any default language, such as, "unless otherwise noted by the customer the calibration interval will be set at one year."

- **Use of Statements of Compliance (in/out tolerance, in/out specification, pass/fail, etc.)**

In cases where a statement of compliance is reported without taking into account the measurement uncertainty, be sure to review the data; take into consideration the measurement uncertainty and then compare against the tolerance to determine acceptability. If you determine that a particular data point exceeds the tolerance when the uncertainty is considered, be sure to evaluate the risk associated with the out-of-tolerance condition (see section 5.9 of ISO/IEC 17025 for non-conforming work).

For example, if a data point is out of tolerance but is part of a range of the instrument that is not used during testing or calibration, you may decide that the risk to the measurements being taken is negligible and that the instrument is acceptable for use.

Additionally, make sure the correct specification or tolerance of the instrument (or the one agreed upon in the contract) is listed. Since many certificates are imported from a template, it is possible that the calibration provider selected an incorrect template when importing the results, thereby including the incorrect specification or tolerance. If you are not certain what the proper tolerance or specification is for your instrument, check the manufacturer's instrument manual or the test method involved.

Resolving Issues

Any time you notice a problem with your calibration certificate, do not hesitate to contact your calibration provider and, if necessary, request an amended certificate or even recalibration of your instrument. A reputable calibration provider will want to ensure that the correct calibration was provided and that the correct certificate was issued to its customers.

When both parties understand the requirements for purchasing and receiving calibration services, properly communicate their needs, and take more responsibility for the service provided, many of the misunderstandings that occur during this process can be avoided. It is our sincere hope that the information provided in this article helps you to improve upon the way in which you select and order calibration services and evaluate the services provided once the equipment has been returned to your laboratory.

For questions related to this article please contact the author Pam Wright, A2LA Accreditation Manager - Calibration, at pwright@A2LA.org.

NEW PRODUCTS AND SERVICES

Metrology.NET™ Software

Cal Lab Solutions, Inc., a metrology software and consulting company is releasing Metrology.NET™ to help customers integrate their different lab software and databases into a single solution. Metrology.NET™ is a new modular approach to metrology automation and data management. Designed to be a system of systems, Metrology.NET bridges the gap between the multiverses of software tools currently used in calibration labs by acting as a connector layer, allowing users to build and reconfigure "pieces parts" of different software applications into their total solution.

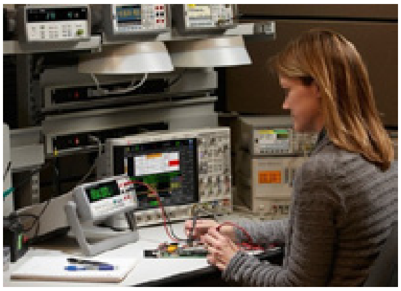
In a push to continue to support customers using Fluke's MET/CAL®, Edison's MUDCATS, Microsoft's .NET® and various other platforms, Cal Lab Solutions, Inc.'s goal was to get all of their IP, contained in their library of automated calibration procedures, into a single silo. Mike Schwartz, President and Automation Director of Cal Lab Solutions, Inc., explains, "We discovered as a company, we have been developing the same software, just in different formats. To get all of our software working together required one flexible system not tied to any one language or computing platform. So we designed Metrology.NET." In doing so, Cal Lab Solutions, Inc. completely retooled the automation process into smaller, modular pieces.

METROLOGY.NET

The advantages of modularization are many-fold:

- Ability to integrate Metrology.NET™ with different metrology software tools on the market (legacy, current and future applications).
- Integration in stages for minimal downtime.
- Adaptable to unknown standards, hardware and measurement techniques, because it is based on a set of known communication rules.
- Platform and language independence allows customers to use the best tool for the job, as well as leverage software and samples provided by the manufacturer.
- The scalable architecture allows it to run as a network distributed solution or on a single computer.

For more information on Metrology.NET™, visit http://metrology.net, call (303) 317-6670 MST, or email: sales@callabsolutions.com.



Keysight Technologies Launches Complimentary Seminar Tours

SANTA ROSA, Calif., Jan. 23, 2015 —Keysight Technologies, Inc. (NYSE: KEYS) today announced an all-new Insight Seminar Series to help engineers hone their test and measurement skills. The series includes two free seminars, one focused on advanced measurement theory and techniques, the other on core benchtop-instrument measurements. Both seminars will help engineers overcome current and emerging test challenges and gain practical insights into using the latest test and measurement instruments.

The Advanced Measurements Seminar tour begins Feb. 2 and the Core Bench Lab Seminar begins Feb. 24. The seminar tours will make more than 70 stops in cities across the United States and Canada.

The Advanced Measurements Seminar offers engineers with the opportunity to explore advanced measurement theory and techniques. Attendees will have the opportunity to use high-performance Keysight oscilloscopes, spectrum analyzers, signal generators and network analyzers to solve tough test challenges. Working side-by-side with Keysight engineers, attendees will gain a deeper understanding of theory, techniques, tools and best practices that will help them do their jobs better.

The Core Bench Lab Seminar offers a full day of hands-on labs and workshops featuring Keysight benchtop instruments. Seminar attendees will learn best practices and develop new skills that help them quickly overcome design and test challenges using Keysight instruments and BenchVue software. Engineers will be able to test-drive the latest Keysight electronic test and measurement tools, learn from Keysight engineers and get hands-on lab experience with:

- New InfiniiVision 3000T X-Series oscilloscopes
- Data acquisition units, digital multimeters and thermal imagers
- Precision benchtop instruments including the B2902A
- RF instruments including FieldFox handheld CAT/VNA/SA combination analyzers and USB power sensors
- BenchVue software for multi-instrument visibility and data capture

Seminar participants will receive a certificate of completion and have the opportunity to enter a drawing for a U1273A handheld multimeter and U1117A Bluetooth® adapter. Lunch will be provided.

Engineers can register for the Insight Seminar Series at www.keysight.com/find/insightseminars.

LadyBug RF Power Sensor

LadyBug Technologies, new LB5900 series of patented no-zero no-cal before use USB RF Power Sensors offers coverage from 9kHz to 40GHz. The product's broad frequency range combined with exceptional sensitivity make them ideal for satellite, radar, EMC testing along with defence applications and general testing.

The sensor line includes several calibration tables for use by calibration laboratories or other users wishing to install frequency offset correction for attenuators, cables or for other use. The tables are easily accessible using standard SCPI commands through the USBTMC or USB HID interfaces or by using the sensor's included software.

The product line offers excellent flatness and dynamic range. The sensor's offer advanced time-gated triggering, internal real time clock, large data storage and other new features such as unattended operation capability. The new product line includes six sensors designed cover a variety of customer applications.

LadyBug Technologies LLC, www.ladybug-tech.com, 707-546-105, sales@ladybug-tech.com.

NIST Portable Vacuum Standard

January 23, 2015—A novel Portable Vacuum Standard (PVS) has been added to the roster of the National Institute of Standards and Technology's (NIST) Standard Reference Instruments (SRI). It is now available for purchase as part of NIST's ongoing commitment to disseminate measurement standards and thereby reduce the need for the expensive and time-consuming process of transporting customer instruments to NIST for calibration.

The PVS is a compact, high-accuracy, low-pressure/vacuum laboratory standard that is calibrated directly against the primary standard at NIST. It enables high-precision calibrations, measurements, or inter-laboratory comparisons (ILC) at a customer's facility.

It can be used as a direct replacement for a commercial mercury manometer, while offering similar or better uncertainties and lower cost of ownership. The PVS package is also more rugged and does not contain mercury – a significant safety issue for the common high-accuracy manometers that it replaces.

Many customers do not have the technical expertise to build their own standards or only need a standard for a short period of time, such as during an ILC. For about $100,000 per unit (depending on specifications and configuration), the PVS can meet those needs. NIST will provide the relevant calibration reports and method for analyzing the measurements.

The latest version of the standard, which has been under development for more than a decade by scientists in NIST's Thermodynamic Metrology Group, enables pressure measurements from 1 Pa to 130,000 Pa. (Air pressure at sea level is about 101,325 Pa.) It is possible to extend the instrument's range to 370,000 Pa as needed.

The PVS combines two different kinds of low-pressure sensors enclosed in an insulated container the size of a suitcase that maintains a constant internal temperature to within 5 mK. The first is a resonance silicon gauge (RSG) that monitors two capacitance diaphragm gauges (CDGs). RSGs are microelectromechanical systems (MEMS) that measure the effect of pressure-induced strain on the resonant frequency of a silicon oscillator. CDGs measure pressure-induced changes in the position of an alloy diaphragm that serves as one plate of a capacitor, and are the workhorse sensors for most high-precision vacuum operations.

Combining the two, says project scientist Jay Hendricks, brings unique benefits: "CDGs have extremely fine resolution at low pressure. RSGs have outstanding long-term drift stability—in the range of 0.01%, which is a factor of 10 better than the CDGs. So to get the best of both, we use an RSG to calibrate the CDGs."

Contact: Jacob Ricker, (301) 975-4475.

Source URL: http://www.nist.gov/pml/div685/grp01/new-portable-vacuum-standard.cfm.

Crystal Engineering HPC40 Series Handheld Pressure Calibrator

SAN LUIS OBISPO, CA---The new HPC40 Series handheld pressure calibrator from Crystal Engineeing, a unit of AMETEK Test & Calibration Instruments, is engineered for "advanced simplicity," incorporating a number of useful features that greatly extend the range and functionality of the compact instrument.

The HPC40 Series offers deadweight tester accuracy along with a host of user friendly features that allow the handheld device to deliver laboratory accuracy to an on-site, field usable instrument. The versatle HPC40 Series is suitable for calibrating pressures ranging from vacuum to 15 000 psi with accuracy of 0.035% of reading for all ranges. It is ideal for process control applications, such as verification or calibration of pressure gauges, transducers, transmitters, pressure switches and safety valves.

The HPC40 Series also is the world's first mA loop calibrator that is fully temperature compensated from -20o to 50oC., enabling it to deliver the same accuracy whether measuring pressure, current, voltage or temperature.

A single HPC40 Series device can typically replace several gauges or calibrators. With the addition of a Crystal Engineering Advance Pressure Module, the calibrator can read up to three pressures using a single device and the differential pressure between any two. It is available in a single or dual sensor option and it also can be used along with a reference temperature detector as a high-accuracy thermometer.

The calibrator's large, full-color display combined with its new user interface makes the HPC40 Series the easiest-to-use pressure calibrator available. Its single layer user interface has no deep menu structure, allowing tasks to be performed quickly and intuitively. Its intelligent memory slots allow the HPC40 Series to store up to five screens (both upper and lower windows) simplifying recall of previous stored settings and user setups.

Another unique feature is its use of newly patented Crystal Pressure Fittings. These 316 stainless steel fittings are designed to operate at 10 000 psi / 700 bar and ensure leak-free connections without the use of tools. In addition, the fittings' self-ventilating weep holes alert users when disconnecting from a pressurized system.

The HPC40 Series can be used as an individual calibrator or combined with AMETEK pressure generating products into a a complete ready-to-use calibration system. These products include everything from small pneumatic hand pumps to precision, hydraulic pressure comparators able to generate up to 15 000 psi / 1000 bar.

Crystal Engineering produces highly accurate, field-grade testing and calibration equipment for measurement applications in oil and natural gas, power generation, waste water, water supply, manufacturing, aerospace, and aircraft maintenance. It is a unit of AMETEK Test & Calibration Instruments, a division of AMETEK, Inc., a leading global manufacturer of electronic instruments and electromechanical devices with annualized sales of US$4.2 billion.

For more information on the HPC 40 Series and Crystal Engineering's full line of calibration instruments, contact Crystal Engineering, 708 Fiero Lane, San Luis Obispo, CA 93401. Phone: 805-595-5477. Fax: 805-595-5466. Web site: www.crystalengineering.net.

R&S RTM Bench Oscilloscope

Rohde & Schwarz is expanding its R&S RTM bench oscilloscope family by adding a new model that is ideal for the education sector. The instrument features a 200 MHz bandwidth and an education mode that deactivates special measurement tools to help students quickly learn how to work with an oscilloscope. The new digital voltmeter and frequency counter option also supports users in development, manufacturing and service with fast, precise results.

Rohde & Schwarz designed the new 200 MHz models of the R&S RTM oscilloscope especially for universities and educational institutions. The education mode was developed for test and measurement practica and makes it possible to disable all analysis tools (e.g. Autoset and QuickMeas) and automatic measurements. This improves the learning effect as students and learners have to calculate measurement results on their own. The mode is password protected and available for the other bandwidth models of the R&S RTM family as well.

The R&S RTM is also ideal for general T&M applications in development, manufacturing and service. Using the R&S RTM B200, B201 and B202 bandwidth upgrade options, the 200 MHz models can grow with future requirements and be expanded to 500 MHz. The new R&S RTM-K32 digital voltmeter option enables the R&S RTM to measure various values such as AC, DC, peak and crest factor with three digit accuracy regardless of the oscilloscope's triggering. A seven digit frequency counter has also been integrated into the scope.

With a sampling rate of 5 Gsample/s and a memory depth of 20 Msample, the R&S RTM bench oscilloscope is the best in its class, and its functional range can be further expanded with additional options.
The new R&S RTM models with 200 MHz bandwidth and two or four channels as well as the optional R&S RTM-K32 digital voltmeter are available now. For more information, see: www.scope-of-the-art.com/ad/press/rtm.

Keithley Introduces Graphical Sampling Digital Multimeter

CLEVELAND, OH – Keithley Instruments, a world leader in advanced electrical test instruments and systems, announced today the introduction of the DMM7510 7½-Digit Graphical Sampling Multimeter, the first of a new class of digital multimeters. It integrates a high accuracy digital multimeter, a digitizer for waveform capture, and a capacitive touchscreen user interface. The DMM7510 is designed to give users confidence in the accuracy of their results, the ability to explore measurements further, and intuitive touchscreen operation. Its user interface continues the company's "Touch, Test, Invent®" design philosophy that lets users learn faster, work smarter and invent easier. More information is available at: www.keithley.com/dmm7510.

Jerry Janesch, a senior market development manager at Keithley, noted, "To get an in-depth understanding of their devices under test, engineers need to capture small signals at higher accuracy and faster speeds than traditional DMMs can provide. The DMM7510's intuitive operation and high speed digitizer allow it to address a wide range of test applications, including device characterization, debugging, and analysis; production test/ATE; and applications in research labs and universities."

The DMM7510 offers users a powerful combination of capabilities:

- Higher measurement accuracy, so they can be confident of the integrity of their results.
- High accuracy signal sampling with an 1MS/sec, 18-bit digitizer.
- Interactivity and waveform visualization via the five-inch capacitive touchscreen interface.

Connections and controls simplify configuring multi-instrument test solutions, including input connectors, remote control interfaces (GPIB, USB 2.0 and LXI/Ethernet), a D-sub 9-pin digital I/O port (for internal/external trigger signals and handler control), and TSP-Link® jacks for connecting to other Keithley instruments with an embedded Test Script Processor (TSP®).

Pricing and Availability
The US list price for the DMM7510 is $3,990, with immediate availability from Keithley sales partners.

For More Information
More information on the DMM7510 is available on Keithley's website at www.keithley.com/dmm7510.

New Hand-Held Pressure Calibrator From GE Druck

Groby, UK – GE Measurement & Control announced the new DPI 611 hand-held pressure calibrator from the GE Druck family of products. The DPI 611business builds on the legacy of the DPI 610, which has long been acknowledged as the industrial workhorse of pressure test and calibration. A robust and easy-to-use device, it is twice as efficient at generating pressure, half the size of its predecessor, and has twice the pressure accuracy and three times better electrical accuracy. The DPI 611 is the latest addition to GE's integrated calibration and communication solutions platform and are designed for use throughout the process, oil and gas, power generation and general engineering sectors.

The new instrument is the first dedicated pressure calibrator to feature swipe screen touch technology. Its intuitive screen interface displays a comprehensive application dashboard, and a task menu allows simple, three-touch set-up for any pressure test or calibration. A "Favourites" facility also enables quick access to frequently used tasks and custom

configurations, which are easily stored. Results are displayed on the large screen and can be documented in 8GB of user memory. The instrument can automate processes to significantly reduce calibration times by running pre-defined procedures, calculating errors and reporting PASS/FAIL errors. The DPI 611 integrates seamlessly with leading calibration and maintenance software, including 4Sight from GE, to help maintain compliance with industry standards and regulations and improve process and operational efficiency.

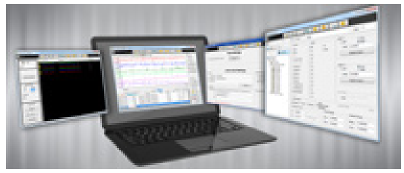
The DPI 611 retains the comprehensive electrical measurement and sourcing capabilities of the DPI 610 and includes a 10VDC regulated supply and 24V loop power but is three times more accurate. However, it is in pressure generation where it demonstrates truly significant improvements. Its mechanical pressure-generating system eliminates the pitfalls of electro-mechanical devices and has been totally redesigned to create 95 percent vacuum or generate maximum pressure of 20bar/300psi in just 30 seconds, while holding the instrument in one hand or on a table top.

"The DPI 611 will be the new workhorse of instrument calibration, a workhorse with thoroughbred features," said Mike Shelton, product manager at GE. "It is rugged and waterproof, light and compact and easy to use, offering reliable, fast and powerful performance in the most arduous of working conditions."

GE Measurement & Control is a leading innovator in advanced, sensor-based measurement; non-destructive testing and inspection; flow and process control; turbine, generator, and plant controls; and condition monitoring. Providing healthcare for our customers' most critical assets, we deliver accuracy, productivity and safety to a wide range of industries, including oil & gas, power generation, aerospace, metals and transportation. Headquartered in Boston, USA, Measurement & Control has more than 40 facilities in 25 countries and is part of GE Oil & Gas. For further information, visit www.ge-mcs.com.

GE Oil & Gas works on the things that matter in the oil and gas industry. In collaboration with our customers, we push the boundaries of technology to bring energy to the world. From extraction to transportation to end use, we address today's toughest challenges in order to fuel the future.

Follow GE Oil & Gas on Twitter @GE_OilandGas.



Release of Fluke DAQ 6.0

Everett, Wash., Jan. 19, 2015 – Fluke Corp. introduces Fluke® DAQ 6.0, the latest version of its popular data acquisition application software. The powerful and versatile application provides effortless configuration, data logging, and analysis for the 2640A and 2645A NetDAQ Networked Data Acquisition Unit and 2680 Series Data Acquisition Systems, plus adds support for Fluke 2638A Hydra Series III Data Acquisition System/Digital Multimeter and Fluke Calibration 1586A Super-DAQ Precision Temperature Scanner.

With DAQ 6.0, setting up an instrument is as easy as connecting it to the technician's computer — the current hardware configuration pre-populates the configuration set-up area, which can then be easily edited if necessary. The simple copy-and-paste feature makes quick work of setting up multiple channels with similar input. Version 6.0 features improved trending with up to 32 trends visible on one graph and the ability to save and load historical charts as well as add new chart formats. Data can be extracted from any portion of the historical chart data and saved to a .csv file format.

The new DAQ application adds a new Web interface and controls, which allow users to display trend charts and alarm screens in a Web browser to share with up to four remote users. Instrument scanning can be started and stopped remotely from the Web view screen in a browser using one of the four thin Web clients within Fluke DAQ. The new version also adds the capability to print trend charts and alarm status information from a local PC or the Fluke DAQ Web view, and supports multiple languages, including English, Spanish, Swedish, Russian, Korean, Japanese, Italian, German, French, and Chinese.

To learn more, visit www.flukecal.com/daq6.

For information on Fluke tools and applications, or to find the location of your nearest distributor, call (800) 44-FLUKE (800-443-5853), e-mail fluke-info@fluke.com or visit the Fluke Web site at http://www.fluke.com.

Transmille 4000 Series Advanced Multiproduct Calibrator

Signaling the latest addition to our range of calibrators, the 4000 Series Advanced Multiproduct calibrator adds advanced functionality through a new touch enabled interface. A large, high resolution 7" touchscreen enables direct access to key parameters, and an integrated procedure mode enables calibration of multimeters and other test equipment to be automated without requiring a computer.

New to the 4000 Series is an advanced oscilloscope option with variable level bandwidth output of up to 6 GHz, enabling calibration of high bandwidth oscilloscopes and spectrum analyzers.

The 4000 Series also include fully variable capacitance, increased resistance ranges and a unique self cal routine via external standards.

Features include:

- AC/DC Voltage to 1000V
- AC/DC Current to 30A Frequency (1500A with coil)
- Inductance
- TC & PRT Embedded Calibration System
- Integrated 7 Inch LCD Touchscreen
- High Bandwidth Scope Functions
- Variable and Passive Resistance
- Variable and Passive Capacitance
- Power Calibration
- Self-Calibrating against External Reference

For more information, visit: http://www.transmillecalibration.com/.

Intelligence at the End of the Wire

Michael Schwartz
Cal Lab Solutions, Inc.

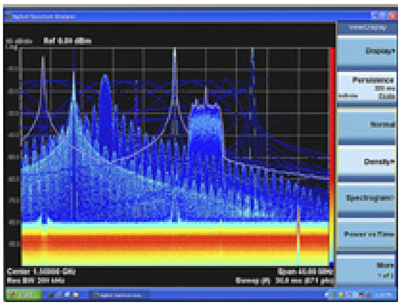
In today's world, computers are everywhere and in everything, as well as at the heart of our test equipment. If you would have told me 25 years ago that my oscilloscope would come with Windows® already installed, I would have called you crazy! But today it is hard to find that dividing line between test equipment and computer, especially in the high end instruments.

Now we all know that inside of every piece digital test equipment there is a small embedded microcontroller responsible for converting analog to digital and back again. These microprocessors have traditionally been inexpensive, lower end chips, solely dedicated to the tasks required by the hardware. But as the world of test equipment continues to merge with computers, these embedded micro-controllers are becoming more powerful. As their computing power increase so does our test equipments' ability to take on more complex measurements and tasks.

With the increase of computing power, test equipment becomes smarter—intelligent, if you will. And with intelligent test equipment at the end of the wire, we can now change how we think of measurements and instrumentation control.

No longer do we have to think of automation control in terms of sending low-level, bit wise configuration commands. We are now able to move into the next generation of automation control where our test equipment becomes part of a distributed computing system. Now our test equipment can be an intelligent team player in our local lab network all the way up to an enterprise-wide measurement system.

As we move into the next generations of automation control, the paradigm in how computers communicate with test equipment will change. More intelligent instruments, the ones with full blown operating systems like Windows®, will communicate and behave on the network more like a computing system than an instrument. Some of them already have HTTP web servers allowing users to interact with them using nothing more than a web browser. But this is just the start of computer to computer interaction with test equipment.



Screenshot of a Windows® embedded spectrum analyzer.

As we continue morph test equipment with computers, so too will we treat them as servers. Only instead or rendering up web pages, they will render our measurements. Many of them, I believe, will start to incorporate to Representational State Transfer (REST) calls as a standard means of communication.

For many of you, this may be the first time you have heard of REST communications. But it has been around for many years, and is at the heart of how servers on the internet communicate with each other. So it is inevitable that test equipment start to implement it in one form or another.

Like the evolution of HP-IB to GPIB to VISA to LXI, and all the other standards we have been through over the past 30 years, REST calls, as it relates to test equipment, will also evolve. But more system—like Metrology.NET™—will emerge, relying on REST communications as the back bone for their communications.

Its biggest advantage to REST is its scalability and flexibility. It allows engineers to design systems without relying on the specifics of the implementation. They don't care if a server is running Windows® or UNIX; only that it complies with the message format. For metrology, it will allow us to design measurement systems with multiple implementations not based on specific commands to the hardware. REST communications, with intelligent test equipment, will allow us to define our measurement requirements and pass them to the measurement hardware in the REST call. Then the measurement hardware will perform the task as defined in the REST call and return the results. This will all function regardless of the specific hardware or version used to make the measurement.

We must embrace the fact our test equipment and computer systems are now one in the same; change how we think about the equipment we are trying to control and realize there is now more intelligence at the end of the wire. In doing, so we can focus on automation designs from a measurement definition approach and leave the specific implementation to the smart measurement systems. ❧