

# CALLAB

THE INTERNATIONAL JOURNAL OF METROLOGY



**Automating Calibration with Lab VIEW:  
A Practical Guide for Calibration  
Laboratories – 2nd Continuum**

2025  
JULY  
AUGUST  
SEPTEMBER

**Metrology and Meteorology: Measuring Hurricanes**

**Calibration Supplier Complaint – An Accreditation  
Case Study**

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**ON THE COVER:** Charles Ellis and Richard Brynteson of The National Association for Proficiency Testing (NAPT) and Jake Biancur of Additel in the Exhibitor Hall at the annual MSC Training Symposium this past May in Anaheim, California. Next year, MSC Training Symposium will be February 2-5 in Garden Grove, California. Visit [msc-conf.com](http://msc-conf.com) for more information.

# CALENDAR

## UPCOMING CONFERENCES & MEETINGS

The following event dates are subject to change. Visit the event URL provided for the latest information.

**Sep 21-26, 2025 European Microwave Week.** Utrecht, Netherlands. EuMW 2025 comprises three co-located conferences: The European Microwave Conference (EuMC), The European Microwave Integrated Circuits Conference (EuMIC), and The European Radar Conference (EuRAD). <https://www.eumweek.com/>

**Sep 22-24, 2025. TC23 8th IMEKOFOODS Conference.** Ljubljana, SLOVENIA. The theme for this event is "Food Safety and Metrology for a Sustainable Future." The 8th IMEKOFOODS Conference aims to bring together leading scientists working in food-related fields, such as authenticity, traceability, nutrition, food safety, quality, and risk assessment, where metrology plays a crucial role. <https://conferences.imeko.org/event/12/>

**Oct 7-8, 2025 Metrologietagen.** Böblingen, Germany. For the fifth time, the metrology network comes together for knowledge exchange and special insights into the practice

of calibration. <https://metrologietage.com/>

**Oct 7-9, 2025 MATHMET.** Gothenburg, Sweden. Mathmet 2025 is an event of the European Metrology Network (EMN) for Mathematics and Statistics to promote new analytical and computational approaches in measurement science. <https://www.ri.se/en/news/calendar/mathmet-2025-conference>

**Oct 8-10, 2025 IEEE MetroSea.** Genoa, Italy. IEEE International Workshop on Metrology for the Sea (MetroSea) will be broad in scope covering all areas concerning research in measurements and instrumentation field. <https://metrosea.org/>

**Oct 20-24, 2025 IMEKO TC12 XVth Symposium on Temperature and Thermal Measurements in Industry and Science and VIIth International Symposium on Humidity and Moisture.** Reims, France. TC12 TEMPMEKO –

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## Model 1220

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Note: The specifications listed, and the information provided are subject to change without notice.



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**No Paywall**

BIPM recently announced that *Metrologia* will transition to an open access publishing model. We reprinted the announcement in this issue and there is a source URL provided to the BIPM website. While we support a publisher's right to make payroll and keep the lights on, we have kept the print edition of Cal Lab Magazine freely available to US readers—**compliments of our advertisers**—for over 30 years!

We do this out of a sense of obligation to a community that prides itself for the work it does, knowing how much of what they do is foundational to a safer today and tomorrow. It is also a community that has provided for us resources and partnerships throughout our careers, for which we are grateful.

For this issue, we have a second installment on "Automating Calibration with LabVIEW," this time with a focus on Design Patterns. Ajay Vignesh Manonmani Velumani, a Certified LabVIEW Architect, has more installments in the works for us, so stay tuned!

An Adjunct Faculty Instructor at Monroe County Community College, Mike Taylor, sent us a student paper to include in this issue. We used to reprint measurement science papers presented by high school students at the annual Measurement Science Conference. Papers are less of a requirement at conferences than in the past, so I was pleased when Mike shared some of his student papers with us!

Chris Grachanen sent us a case study that everyone who works in a cal lab should read, whether your lab is accredited or not. In "Calibration Supplier Complaint – An Accreditation Case Study," the author narrates from the perspective of a SME, highlights challenges when going through the process of making a formal complaint, and reinforces the need for labs to maintain communication and ultimate responsibility for any discrepancies when outsourcing services.

Finally, we have another vintage meter article from Dan Wiswell. In a previous issue, Dan wrote (and shared some great photos) of vintage GE models, "meatballs," produced in Schenectady, New York. This time, we get to learn about a very industrious man named George Westinghouse and some instruments that came out of the era of AC vs. DC.

I hope you enjoy reading this issue!

Happy Measuring,

Sita Schwartz  
 Editor



# CALENDAR

ISHM 2025 is one of the most important international scientific events held every three years under the auspices of TC12 IMEKO and CIPM Consultative Committee for Thermometry Working Group Humidity. <https://tempmeko-ishm2025.com/>

**Oct 28-30, 2025 IEEE MetroAgriFor.** Bologna, Italy. The International Workshop on Metrology for Agriculture and Forestry is an active and stimulating forum where academics, researchers and industry experts in the field of measurement and data processing techniques for Agriculture, Forestry and Food can meet and share new advances and research results. <https://www.metroagrifor.org/>

**Jan 18-21, 2026 106th ARFTG Microwave Measurement Symposium.** Hollywood, CA. "Microwave Measurements for Communication and Sensing Technologies" is co-located with Radio & Wireless Week (RWW-2026). <https://arftg.org/106-conference/>

**Feb 2-6, 2026 MSC Training Symposium.** Garden Grove, CA. Come join us for 100+ hours of classroom training and networking for metrology professionals and newcomers alike. <https://msc-conf.com/>

## SEMINARS & WEBINARS: Dimensional

**Sep 17-18, 2025 Hands-On Precision Gage Calibration and Repair Training.** Omaha, NE. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. <https://calibrationtraining.com/>

**Sep 17-18, 2025 EDU-113 Dimensional Gage Calibration.** Aurora, IL. Mitutoyo America's Gage Calibration course is a unique, active, educational experience designed specifically for those who plan and perform calibrations of dimensional measuring tools, gages, and instruments. This course is a condensed version of Seminar #114 (3-day version) focusing on small, hand-held gages. <https://www.mitutoyo.com/training-education/>

**Sep 29-30, 2025 Virtual Hands-On Precision Gage Calibration and Repair Training.** IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. <https://calibrationtraining.com/>

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# CALENDAR

**Sep 29-30, 2025 Dimensional Measurement Tools Basics Class.** Mason, OH. QC Training. This program provides a fundamental and practical review of Basic Dimensional Measurement Tools and Methods, including variable gages such as steel rules, depth and dial gages, micrometers, and calipers. In addition, attribute gages such as plug, ring and screw thread gages are covered. <https://qctraininginc.com/courses/>

**Oct 9, 2025 EDU-V111 Introduction to Dimensional Gage Calibration (1/2 day, Virtual).** Mitutoyo America's Gage Calibration courses are unique, active, educational experience designed specifically for those who plan and perform calibrations of dimensional measuring tools, gages, and instruments. This course is taught in the Mitutoyo Institute of Metrology's Training Lab in Aurora, IL and broadcast live in a virtual session. <https://www.mitutoyo.com/training-education/>

**Oct 9-10, 2025 Hands-On Precision Gage Calibration and Repair Training.** Bloomington, MN. IICT Enterprises. Enhance your career knowledge in Metrology with

this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. <https://calibrationtraining.com/>

**Oct 23-24, 2025 Virtual Hands-On Precision Gage Calibration and Repair Training.** IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. <https://calibrationtraining.com/>

**Nov 10, 2025 EDU-101 Introduction to Dimensional Metrology Hand Tools (Fundamental Tools).** Aurora, IL. Mitutoyo. EDU-101 is a one-day class for entry-level team members who need to learn the fundamentals of the steel rule, caliper, micrometer, pin gage, and gage block. <https://www.mitutoyo.com/training-education/>

**Nov 11-12, 2025 EDU-113 Dimensional Gage Calibration.** Aurora, IL. Mitutoyo America's Gage Calibration course is a unique, active, educational experience designed specifically for those who plan and perform calibrations of dimensional



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# CALENDAR

measuring tools, gages, and instruments. <https://www.mitutoyo.com/training-education/>

**Nov 13-14, 2025 Hands-On Precision Gage Calibration and Repair Training.** Bloomington, MN. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. <https://calibrationtraining.com/>

**Nov 13-14, 2025 EDU-302 Small Tool Repair Course.** Aurora, IL. Mitutoyo America is offering a two-day small tool gage maintenance and repair training. Hosted at the Mitutoyo America Headquarters in Aurora, Illinois, the course will be taught by Mitutoyo's very own repair specialists. <https://www.mitutoyo.com/training-education/>

**Nov 20-21, 2025 Virtual Hands-On Precision Gage Calibration and Repair Training.** IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. <https://calibrationtraining.com/>

**Dec 11-12, 2025 Hands-On Precision Gage Calibration and Repair Training.** Bloomington, MN. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. <https://calibrationtraining.com/>

**Dec 16-18, 2025 Dimensional Gage Calibration and Repair.** Aurora, IL. Mitutoyo. Mitutoyo America's Gage Calibration course is a unique, active, educational experience designed specifically for those who plan and perform calibrations of dimensional measuring tools, gages, and instruments. <https://www.mitutoyo.com/training-education/>

**Dec 18-19, 2025 Virtual Hands-On Precision Gage Calibration and Repair Training.** IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. <https://calibrationtraining.com/>

## SEMINARS & WEBINARS: Electrical

**Sep 29-Oct 2, 2025 MET-301 Advanced Hands-On Metrology.** Everett, WA. Fluke Calibration. This course introduces the student to advanced measurement concepts and math used in standards laboratories. <https://www.fluke.com/>

**Nov 3-6, 2025 MET-101 Basic Hands-On Metrology.** Everett, WA. Fluke Calibration. This Metrology 101 basic metrology training course introduces the student to basic measurement concepts, basic electronics related to measurement instruments and math used in calibration. <https://www.fluke.com/>

## SEMINARS & WEBINARS: Flow

**Sep 23-26, 2025 Gas Flow Calibration Using molbloc/molbox.** Phoenix, AZ. Fluke Calibration. This is a four day training course in the operation and maintenance of a Fluke Calibration molbloc/molbox system. <https://www.fluke.com>

**Nov 26-27, 2025 Calibration of Liquid Hydrocarbon Flow Meters.** Londonderry, NSW. Australian NMI. This two-day course provides training on the calibration of liquid-hydrocarbon LPG and petroleum flow meters. It is aimed at manufacturers, technicians and laboratory managers involved in the calibration and use of flowmeters. <https://shop.measurement.gov.au/collections/physical-metrology-training>

## SEMINARS & WEBINARS: General

**Oct 20-22, 2025 C-101 Calibration.** Memphis, TN. TriNova Technical Education. This instructor led calibration course is delivered by our experienced technical education specialists who deliver a high-quality course covering calibration fundamentals, detailed documentation procedures, temperature, and pressure basics, and basics of DP flow calibration. In-depth demonstrations and hands-on exercises will follow each lecture. <https://trinova.arlo.co/w/>

**Dec 3, 2025 Calibration and Measurement Fundamentals.** Online. Australian NMI. This course covers general metrological terms, definitions and explains practical concept applications involved in calibration and measurements. The course is recommended for technical officers and laboratory technicians working in all industry sectors who are involved in making measurements and calibration process. <https://shop.measurement.gov.au/collections/physical-metrology-training>

**Dec 8-10, 2025 C-101 Calibration.** Clifton Park, NY. TriNova Technical Education. This instructor led calibration course is delivered by our experienced technical education specialists who deliver a high-quality course covering calibration fundamentals, detailed documentation procedures, temperature, and pressure basics, and basics of DP flow calibration. In-depth demonstrations and hands-on exercises will follow each lecture. <https://trinova.arlo.co/w/>

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# CALENDAR

**Jan 26-30, 2026 Fundamentals of Metrology.** Gaithersburg, MD. NIST. This 5-day seminar is an intensive course that introduces participants to the concepts of measurement systems, units, good laboratory practices, data integrity, measurement uncertainty, measurement assurance, traceability, basic statistics and how they fit into a laboratory Quality Management System. <https://www.nist.gov/pml/owm/owm-training-and-events>

**Apr 6-10, 2026 Fundamentals of Metrology.** Gaithersburg, MD. NIST. The 5-day Fundamentals of Metrology seminar is an intensive course that introduces participants to the concepts of measurement systems, units, good laboratory practices, data integrity, measurement uncertainty, measurement assurance, traceability, basic statistics and how they fit into a laboratory Quality Management System. <https://www.nist.gov/pml/owm/owm-training-and-events>

## SEMINARS & WEBINARS: Industry Standards

**Sep 16-17, 2025 Auditing Your Laboratory to ISO/IEC 17025:2017.** Virtual. A2LA WorkPlace Training. This

ISO/IEC 17025 auditor training course will introduce participants to ISO/IEC 19011, the guideline for auditing management systems as applied to ISO/IEC 17025:2017. <https://a2lawpt.org/>

**Sep 16-17, 2025 ISO/IEC 17043:2023 and Statistical Analysis for Proficiency Testing.** Virtual. A2LA WorkPlace Training. This course provides the participant with a comprehensive look at Proficiency Testing (PT), including the design and operation of PT schemes, statistical methods, reporting, and interpretation. <https://a2lawpt.org/>

**Oct 7-8, 2025 Understanding ISO/IEC 17025 for Testing and Calibration Labs.** Online Training for the Americas. IAS. This 2-day Training Course examines structural components of the standard. Quality system and technical requirements are grouped in a manner that makes them clear and understandable. <https://www.iasonline.org/training/ias-training-schedule/>

**Oct 20-23, 2025 Auditing Your Laboratory to ISO/IEC**

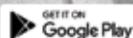
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# CALENDAR

**17025:2017.** Virtual. A2LA WorkPlace Training. This ISO/IEC 17025 auditor training course will introduce participants to ISO/IEC 19011, the guideline for auditing management systems as applied to ISO/IEC 17025:2017. <https://a2lawpt.org/courses/training/auditing-your-laboratory-to-iso-iec-170252017/>

**Oct 20-23, 2025 Understanding ISO/IEC 17025:2017 for Testing & Calibration Labs.** Virtual Class by A2LA WorkPlace Training. This course is a comprehensive review of the philosophies and requirements of ISO/IEC 17025:2017. <https://a2lawpt.org/courses/training/understanding-iso-iec-170252017-for-testing-calibration-labs/>

**Nov 10-11, 2025 Understanding ISO/IEC 17025:2017 for Testing & Calibration Labs.** Livonia, MI. A2LA WorkPlace Training. This course is a comprehensive review of the philosophies and requirements of ISO/IEC 17025:2017. <https://a2lawpt.org/courses/training/understanding-iso-iec-170252017-for-testing-calibration-labs/>

**Nov 12-13, 2025 Auditing Your Laboratory to ISO/IEC 17025:2017.** Livonia, MI. A2LA WorkPlace Training. This ISO/IEC 17025 auditor training course will introduce participants to ISO/IEC 19011, the guideline for auditing management systems as applied to ISO/IEC 17025:2017. <https://a2lawpt.org/courses/training/auditing-your-laboratory-to-iso-iec-170252017/>

**Nov 17-20, 2025 Understanding ISO/IEC 17025:2017 for Testing & Calibration Labs.** Virtual Class by A2LA WorkPlace Training. This course is a comprehensive review of the philosophies and requirements of ISO/IEC 17025:2017. <https://a2lawpt.org/courses/training/understanding-iso-iec-170252017-for-testing-calibration-labs/>

**Dec 8-11, 2025 Auditing Your Laboratory to ISO/IEC 17025:2017.** Virtual. A2LA WorkPlace Training. This ISO/IEC 17025 auditor training course will introduce participants to ISO/IEC 19011, the guideline for auditing management systems as applied to ISO/IEC 17025:2017. <https://a2lawpt.org/>

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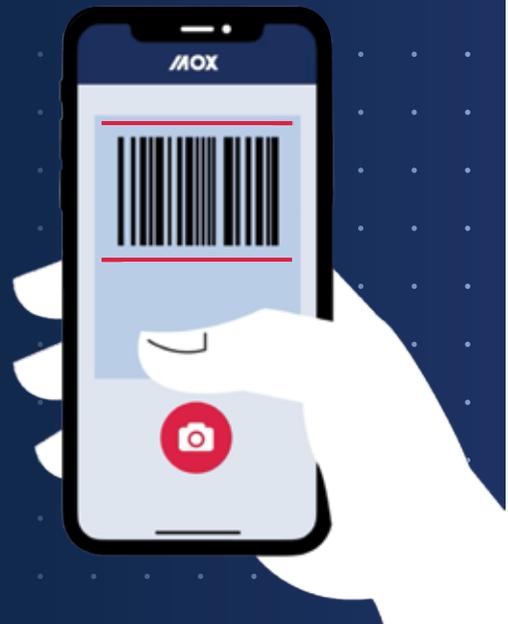
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[www.moxpage.com/mox2go/](http://www.moxpage.com/mox2go/)



# CALENDAR

## SEMINARS & WEBINARS: Lab Management

**Oct 20-21, 2025 Laboratory Manager – How to run an effective lab.** Daniel Island, SC. IndySoft. This two-day professional workshop is for Calibration, Testing, Maintenance, and Analytical Lab Managers, Supervisors, and Quality Assurance Representatives who would like an intensive short course on how to maximize your lab's efficiency and profitability while most effectively leading your most valuable resource - your employees. <https://www.workshop.indysoft.com/>

## SEMINARS & WEBINARS: Mass

**Oct 6-10, 2025 Mass Metrology Course for High Accuracy: OIML class F to E.** Pretoria, South Africa. NMISA. The course provides fundamentals of mass measurements, looking at what affects reliability and accuracy of mass measurements, and how to ensure traceability in weighing. It also covers the evaluation of different weighing techniques used to calibrate mass pieces, the requirements for and calibration of weighing instruments and how to evaluate measurement uncertainty in weighing. <https://www.nmisa.org/applied-metrology/Pages/Metrology-Training-Centre.aspx>

**Oct 27-Nov 7, 2025 Mass Metrology Seminar.** Gaithersburg, MD. NIST. The Mass Metrology Seminar is a two-week, "hands-on" seminar. It incorporates approximately 30 percent lectures and 70 percent demonstrations and laboratory work in which the trainee performs measurements by applying procedures and equations discussed in the classroom. <https://www.nist.gov/pml/owm/owm-training-and-events>

## SEMINARS & WEBINARS: Measurement Uncertainty

**Oct 6-9, 2025 Applied Measurement Uncertainty for Testing Laboratories.** Virtual Class. A2LA. During this workshop, the participant will be introduced to several tools and techniques that can be applied in the testing laboratory environment to efficiently and effectively create measurement uncertainty budgets that comply with ISO/IEC 17025 requirements. <https://a2lawpt.org/courses/training/applied-measurement-uncertainty-for-testing-laboratories/>

**Oct 21-22, 2025 Uncertainty of Measurement for Labs.** Online training for the Americas. IAS. The training includes case studies and discussions, with application of statistical components in practical examples that are frequently encountered by testing laboratories. <https://www.iasonline.org/training/uncertainty-of-measurement/>

**Nov 10, 2025 Introduction to Measurement Uncertainty.** Livonia, MI. A2LA. This course is a suitable introduction for both calibration and testing laboratory participants, focusing on the mathematics, basic statistics, key concepts, and approaches of the measurement uncertainty evaluation process. <https://a2lawpt.org/courses/training/introduction-to-measurement-uncertainty/>

**Nov 11-12, 2025 Applied Measurement Uncertainty for Testing Laboratories.** Livonia, MI. A2LA. During this workshop, the participant will be introduced to several tools and techniques that can be applied in the testing laboratory environment to efficiently and effectively create measurement uncertainty budgets that comply with ISO/IEC 17025 requirements. <https://a2lawpt.org/courses/training/applied-measurement-uncertainty-for-testing-laboratories/>

**Nov 17-18, 2025 Uncertainty of Measurement for Labs.** Online training for the Middle East and South Asia. IAS. The training includes case studies and discussions, with application of statistical components in practical examples that are frequently encountered by testing laboratories. <https://www.iasonline.org/training/uncertainty-of-measurement/>

## SEMINARS & WEBINARS: Pressure

**Oct 20-24, 2025 Advanced Piston Gauge Metrology.** Phoenix, AZ. Fluke Calibration. Focus is on the theory, use and calibration of piston gauges and dead weight testers. <https://www.fluke.com>

**Nov 10-14, 2025 TWB 1061 Principles of Pressure Calibration Web-Based Training (Online).** Fluke Calibration. This is a short form of the regular five-day in-person Principles of Pressure Calibration class. <https://www.fluke.com>

## SEMINARS & WEBINARS: Software

**Oct 6-10, 2025 MC-207 Advanced MET/CAL® Procedure Writing.** Everett, WA. Fluke Calibration. This course covers advanced topics and requires an existing knowledge of MET/CAL® calibration software. Students are strongly encouraged to first attend the MC-206 course, followed by 6 months of procedure editing/development experience prior to enrolling in MC-207. <https://www.fluke.com>

**Oct 14, 2025 DCC Workshop for Calibration Labs. Online.** NPL is hosting an online workshop for calibration laboratories on Digital Calibration Certificates (DCCs). The main objective of this workshop is to introduce DCCs and help calibration laboratories begin to understand

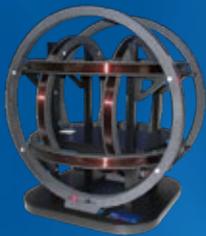
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# CALENDAR

some of the benefits and challenges that come with DCC implementation. <https://www.npl.co.uk/events/online-workshop-for-calibration-labs-digital-calibration-certificates>

**Oct 20-24, 2025 MC-205 MET/TEAM® Asset Management.** Everett, WA. Fluke Calibration. This five-day course presents a comprehensive overview of how to use MET/TEAM® Test Equipment and Asset Management Software in an Internet browser to develop your asset management system. <https://www.fluke.com>

**Oct 27-31, 2025 TWB 1031 MET/CAL® Procedure Development Web-Based.** Online. Fluke Calibration. Learn to create procedures with the latest version of MET/CAL, without leaving your office. <https://www.fluke.com>

**Nov 4-7, 2025 VNA Tools Training Course & VNA Expert Day.** Wabern, Switzerland. METAS. VNA Tools is a free software developed by METAS for measurements with the Vector Network Analyzer (VNA). The software facilitates the tasks of evaluating measurement uncertainty in

compliance with the ISO-GUM and justifying metrological traceability. The software is available for download at [www.metas.ch/vnatools](http://www.metas.ch/vnatools). The three day course provides a practical and hands-on lesson with this superior and versatile software. Day 4: State of the art primary S-parameter traceability and how VNA Tools can support. <https://www.metas.ch>

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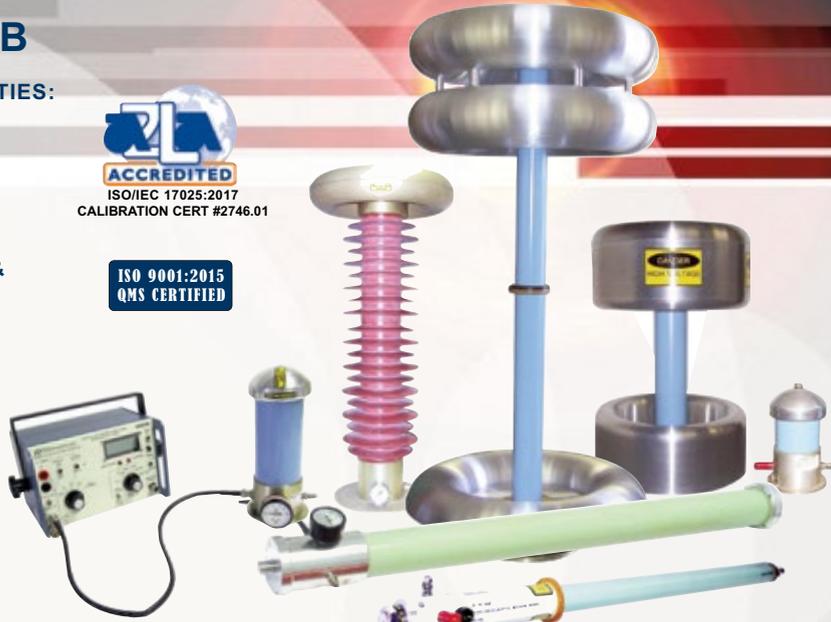
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# CALENDAR

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**Nov 20-21, 2025 Humidity Measurement and Calibration.** Teddington, UK. NPL. This two-day course features classroom learning together with a tour of the NPL Humidity laboratory and laboratory-based sessions. Refine your knowledge of humidity measurement and calibration with the UK's leading metrology experts. <https://www.npl.co.uk/events/humidity-measurement-calibration>

## SEMINARS & WEBINARS: Weight

**Nov 4-7, 2024 5853 Balance and Scale Calibration and Uncertainties.** NIST. Gaithersburg, MD. This 4-day seminar will cover the calibration and use of analytical weighing instruments (balances and laboratory/bench-top scales), including sources of weighing errors in analytical environments, methodologies for quantifying the errors, and computation of balance calibration uncertainty and global (user) uncertainty. <https://www.nist.gov/pml/owm/training>

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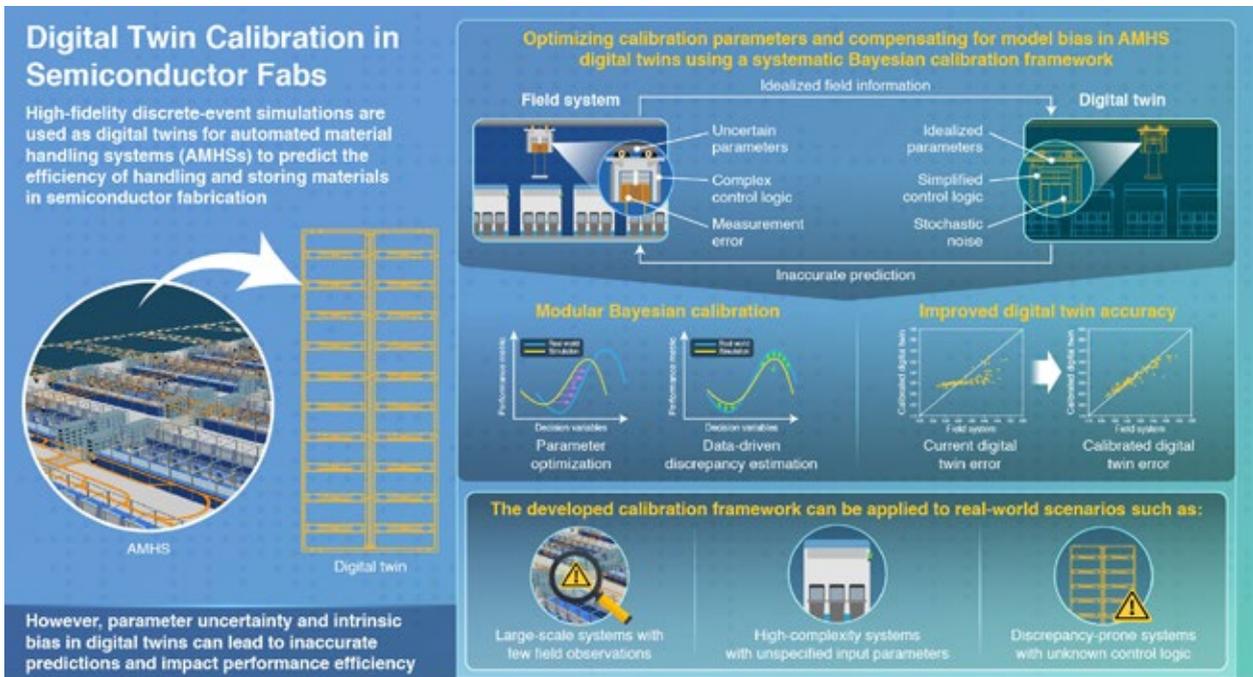
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Lab website:  
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ORCID ID:  
0000-0001-7917-6776



PUSAN NATIONAL UNIVERSITY

## Pusan National University Researchers Reveal New Calibration Framework for Digital Twins

*A new Bayesian calibration framework enhances prediction accuracy for digital twins in semiconductor material handling systems*

BUSAN, South Korea, July 22, 2025 /PRNewswire/ -- To handle growing complexity in semiconductor and display manufacturing, industries use automated material handling systems (AMHSs). Digital twins offer better visibility and control, but mismatches with real-world conditions can impact production and cause delays.

Digital twins of AMHSs face two major issues: parameter uncertainty and discrepancy. Parameter uncertainty arises from real-world parameters that are difficult to measure precisely but are essential for accurate modeling. While discrepancy originates from the difference in operational logic between the real-world system and the digital twin. Over time, these issues reduce prediction accuracy. Yet, most calibration methods focus only on parameter uncertainty and require extensive field data, often neglecting discrepancy.

To address this gap, a research team led by Professor Soondo Hong of the Department of Industrial Engineering at Pusan National University, South Korea, developed a new Bayesian calibration framework. “Our

framework enables us to simultaneously optimize calibration parameters and compensate for discrepancy,” explains Prof. Hong. “It is designed to scale across large smart factory environments, delivering reliable calibration performance with significantly less field data than conventional methods.” Their study was made available online on May 8, 2025, and published in Volume 80 of the *Journal of Manufacturing Systems* on June 1, 2025.<sup>1</sup>

The researchers applied modular Bayesian calibration for various operating scenarios. This approach can estimate uncertain parameters and account for discrepancies using sparse real-world data. It combines field observations and prior knowledge with digital twin simulations through probabilistic models—specifically Gaussian processes—to produce a posterior distribution of calibrated outcomes. They evaluated three models:

1. A field-only surrogate that predicts real-world behavior directly from observed data;
2. A baseline digital twin model using only calibrated parameters; and
3. A calibrated twin model accounting for both parameter uncertainty and discrepancy.

<sup>1</sup> Title of original paper: A digital twin calibration for an automated material handling system in a semiconductor fab. Journal: *Journal of Manufacturing Systems* DOI: 10.1016/j.jmsy.2025.04.015

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The calibrated digital twin model significantly outperformed the field-only surrogate and showed measurable improvements in prediction accuracy over the baseline digital model. “Our approach enables effective calibration even with scant real-world observations, while also accounting for inherent model discrepancy,” notes Prof. Hong. “Importantly, it offers a practical and reusable calibration procedure validated through empirical experiments, and can be customized for each facility’s characteristics.”

The developed framework is a practical and reusable solution to accurately calibrate and optimize digital twins, otherwise hindered by scale, discrepancy, complexity, or the need for flexibility across industries. It accurately predicted field system responses for large-scale systems with limited observations and enabled rapid calibration of future production schedules in real-world systems. The calibration system is also suited for discrepancy-prone digital models that behave differently than their real-world counterparts due to simplified logic or code. High-complexity production and material handling environments—where manual optimization is challenging—can also benefit from this calibration framework. It enables the development of sustainable, reusable digital twin frameworks that are transferable across different industries. The framework is currently being applied and scaled at Samsung Display, where the researchers are collaborating with operations teams to adapt the system to real-world complexities.

This novel framework has the potential to transform the applicability and effectivity of AMHSs. Looking ahead, Prof. Hong concludes: “Our research offers a pathway toward self-adaptive digital twins, and in the future, has strong potential to become a core enabler of smart manufacturing.”

## IOP Publishing and BIPM Transition *Metrologia* to Fully Open Access

July 31, 2025 – The Bureau International des Poids et Mesures (BIPM) and IOP Publishing (IOPP) will convert *Metrologia*, the leading international journal in pure and applied metrology, to a fully open access (OA) publishing model.

The move reflects the growing global demand for open science and underscores both BIPM’s and IOPP’s commitment to making universal access to research a reality. It also aligns with funder mandates that require publicly funded research to be published in OA journals.

From 1 January 2026, all articles published in *Metrologia* will be freely accessible to readers worldwide, removing barriers to knowledge and significantly enhancing the visibility and impact of the journal’s content.

IOPP, which has co-published *Metrologia* with the BIPM since 2003, has successfully supported similar transitions to fully OA for the American Astronomical Society, the International Atomic Energy Agency, and the Japan Society of Applied Physics.

“Open access is a natural evolution for *Metrologia*, ensuring that the journal continues to serve the global metrology community while supporting the principles of transparency, accessibility, and equity in science,” says Dr Martin Milton, Director of the BIPM.

“We’re proud to support BIPM in making *Metrologia* more accessible to researchers and readers around the world. This transition reflects our shared commitment to open science and to supporting our publishing partners through sustainable and inclusive open access models,” adds Violeta Ribarska, Head of Partner Publishing and Engagement at IOP Publishing.

To support the transition, any articles submitted after 18 August 2025 will be processed as open access submissions. *Metrologia* will be included in IOPP’s transformative agreements, allowing authors affiliated with participating institutions to publish OA without incurring direct costs.

For more information visit: <https://iopscience.iop.org/journal/0026-1394>

### About IOP Publishing

IOP Publishing is a society-owned scientific publisher, delivering impact, recognition and value to the scientific community. Its purpose is to expand the world of physics, offering a portfolio of journals, ebooks, conference proceedings and science news resources globally. IOPP is a member of Purpose-Led Publishing, a coalition of society publishers who pledge to put purpose above profit.

As a wholly owned subsidiary of the Institute of Physics, a not-for-profit society, IOP Publishing supports the Institute’s work to inspire people to develop their knowledge, understanding and enjoyment of physics. Visit [iopublishing.org](http://iopublishing.org) to learn more.

### About the BIPM

The Bureau International des Poids et Mesures (BIPM) is the international organization through which Member States work together on matters related to metrology. The signing of the Metre Convention in 1875 created the BIPM and for the first time formalized international cooperation in metrology.

As the home of the International System of Units (SI) and the international reference time scale (UTC), the BIPM promotes and advances the global comparability and traceability of measurements for scientific discovery and innovation, industrial manufacturing and international trade, improving quality of life and sustaining the global environment. Visit [www.bipm.org](http://www.bipm.org) to learn more.

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## All In One: NIST Develops Single Device to Realize Electrical Standards

*Prototype instrument may enable industry and the military to calibrate electrical equipment to international standards in their own laboratories.*

August 12, 2025 NIST Updates – Researchers at the National Institute of Standards and Technology (NIST) have developed one of the first all-in-one instruments for realizing the most up-to-date standards for voltage, resistance, and current. The prototype instrument—a sort of Swiss Army knife for electrical standards—could pave the way for a compact tool that would save both time and money by enabling engineers in their own laboratories to directly calibrate electrical equipment to international standards.

Currently, engineers must periodically ship devices that act as calibration standards to NIST or other calibration labs to ensure the measuring instruments are directly tied to international standards. The new instrument would eliminate the need to ship such devices.

In accordance with the International System of Units (SI), the standards are based on the fundamental constants of nature and are critical for applications ranging from the proper operation of electrical power grids to advanced military equipment.

Since 1990, the ohm (the SI unit of resistance) has been based on the quantum Hall effect (QHE), in which the resistance of certain atomically-thin sheets of material takes on discrete (quantized) values, dictated by the fundamental constants of nature. To create the quantized values of

resistance, the sheets must be cooled to 4 degrees above absolute zero (4 Kelvin or -269 Celsius) and subject to a high magnetic field oriented perpendicular to the flow of current in the material.

For years, NIST metrologists have sought to realize the quantum electrical standards for current, voltage, and resistance in a single instrument, an endeavor that would greatly simplify the dissemination of these standards to industry, government, and academia. That’s been a challenge because the large magnetic field required for the QHE resistance standard – six to nine times greater than the field used in a typical medical MRI machine – would cause superconducting devices employed for the voltage standard to fail. As a result, researchers have had to use separate cryostats – or even separate laboratories – to measure voltage, current, and resistance.

In 2013, however, scientists discovered a new type of quantized resistance, the quantum anomalous Hall effect (QAHE), which is also based on the fundamental constants. Like the QHE, the QAHE occurs in atom-thin sheets of material, but the sheets must be cooled to even lower temperatures, about one-hundredth of a degree above absolute zero (0.01 K). Significantly, the QAHE is induced with a magnetic field only one-fifth to one-fortieth of that required for the QHE. Moreover, the field is only required to magnetize the sample; it can then be switched off.

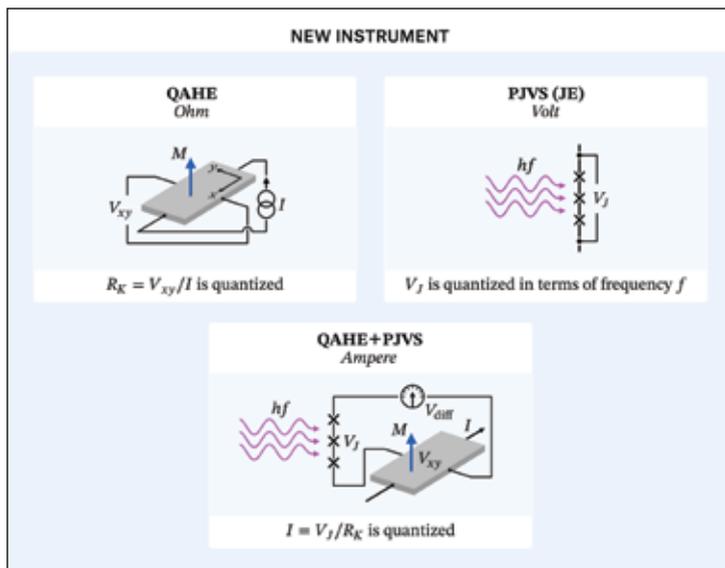
With a magnetic field no longer needed, the researchers were able to insert the quantum device that generates precision voltages into the same cryostat that houses the QAHE resistance standard.

The precision voltage standard, known as a programmable Josephson voltage standard, consists of an integrated circuit chip containing pairs of miniature superconductors separated by a thin metal barrier (known as a Josephson junction). Inside these junctions, electrons pair up and may tunnel back and forth across the barrier. When a microwave signal is applied, the tunneling produces a highly accurate voltage that depends only on the signal’s frequency and the fundamental constants.

To house these instruments, the researchers built a cryostat that occupies a floor space of about 4 square meters, comparable to those commonly used in quantum computing laboratories.

“This early prototype is proof that practical integration is feasible,” said NIST researcher Jason Underwood.

While the achievement is an important milestone in quantum standards development, widespread distribution of the prototype is still years away. That’s mainly because most materials now known to exhibit QAHE only do so at extremely low temperatures, requiring a massive



A new instrument developed at NIST realizes the most up-to-date standards for voltage, resistance, and current in a single cryostat. Credit: S. Kelley/NIST

## INDUSTRY AND RESEARCH NEWS

refrigeration system. Scientists, including those at NIST, are searching for materials that reliably show the QAHE at higher temperatures. Such materials would allow the electrical standards to be realized in a more portable cryostat that would be easier for industrial laboratories to use.

“As the performance of QAHE materials advances, we can shrink the size of the cryostat substantially, especially if we can achieve a robust QAHE at temperatures above 0.1 Kelvin (a tenth of a degree above absolute zero),” added Underwood. “The cryogenic hardware at those higher temperatures is far more compact and transportable. Like NIST’s standard reference instruments, a future unified instrument could fit inside of a standard 19” equipment rack, calibrating multiple SI units in a space that currently offers just one.”

The relative accuracy of the new instrument for voltage, resistance, and current is several parts in a million, comparable to the best calibration and measurement capabilities of national metrology institutes across the globe. But researchers say a less expensive version of the instrument with lower accuracy would also suffice for creating the necessary electrical standards.

“While we always seek to reduce our uncertainties, a deployable calibration instrument doesn’t necessarily have to achieve uncertainties as small as national metrology institute standards,” Underwood said. “The uncertainties just have to be low enough to meet the customer’s calibration goals.”

NIST researchers developed the new instrument in collaboration with scientists from Stanford University; the University of Maryland, College Park; and the University of California, Los Angeles (UCLA). The scientists described their study online in *Nature Electronics* on Aug. 12.

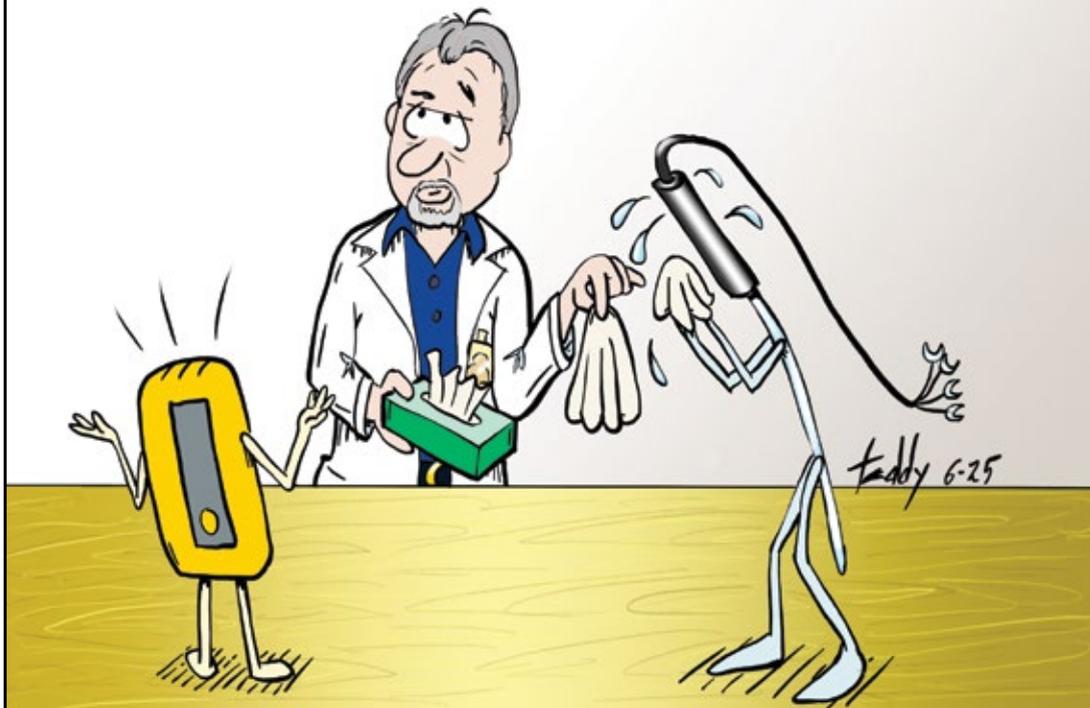
Paper: Rodenbach, L.K., Underwood, J.M., Tran, N.T.M., Panna, A. R., Andersen, M.P., Barcikowski, Z.S., Payagala, S.U., Zhang, P., Tai, L., Wang, K.L., Elmquist, R.E., Jarrett, D.G., Newell, D.B., Rigosi, A.F., and Goldhaber-Gordon, D. A unified realization of electrical quantities from the quantum International System of Units. *Nature Electronics*, 2025, posted online Aug. 12, 2025. DOI: <https://dx.doi.org/10.1038/s41928-025-01421-2>

Source: <https://www.nist.gov/news-events/news/2025/08/all-one-nist-develops-single-device-realize-electrical-standards>

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# Automating Calibration with LabVIEW: A Practical Guide for Calibration Laboratories - 2nd Continuum

AjayVignesh Manonmani Velumani, CLA  
Makkal Limited, Ireland

Hello again, fellow metrologists and calibration enthusiasts! I'm thrilled to continue our journey into the world of automated calibration with LabVIEW. In our previous article, "Automating Calibration with LabVIEW: A Practical Guide," we explored how LabVIEW empowers calibration laboratories to enhance efficiency, reduce human error, and streamline their verification processes. We even walked through the exciting five-step process of building a simple calibration verifier tool. Remember how we designed the user interface, implemented the block diagram logic, and even touched upon data logging and generating reports? It was a fantastic first step towards digital transformation in the lab!

Now, building on that foundation, we're ready to dive a bit deeper. This article will explore some core programming principles that truly transform those initial, enthusiastic scripts into robust, scalable, and maintainable calibration tools. We'll be focusing on powerful LabVIEW design patterns: state machines, event-driven programming, and the producer/

consumer architecture. These patterns are like secret ingredients that streamline automation workflows while ensuring your applications are responsive and reliable. By the end of this article, you'll have a solid understanding of how to structure your LabVIEW code for industrial-grade calibration systems—it's going to be a game-changer!

## LabVIEW Basics: Loops and Case Structures

Before we leap into the exciting world of state machines, let's have a quick recap of two foundational LabVIEW elements that make it all possible: loops and case structures. They're truly the bread and butter of LabVIEW programming!

### 1. While Loops

Imagine you have a task that needs to be repeated over and over again until a specific condition is met, like continuously monitoring an instrument or

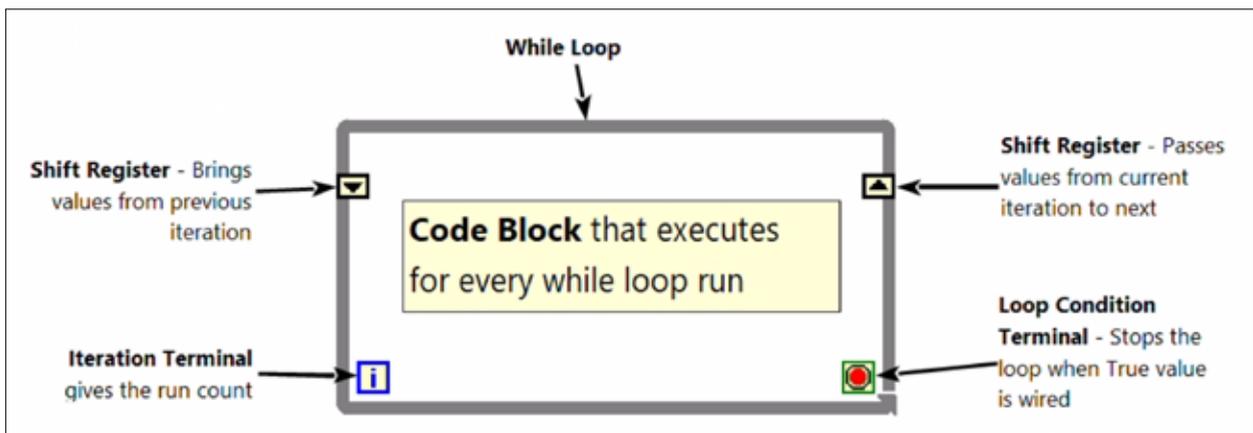


Figure 1. While Loop with Iteration Terminal, Loop Condition Terminal and Shift Registers.

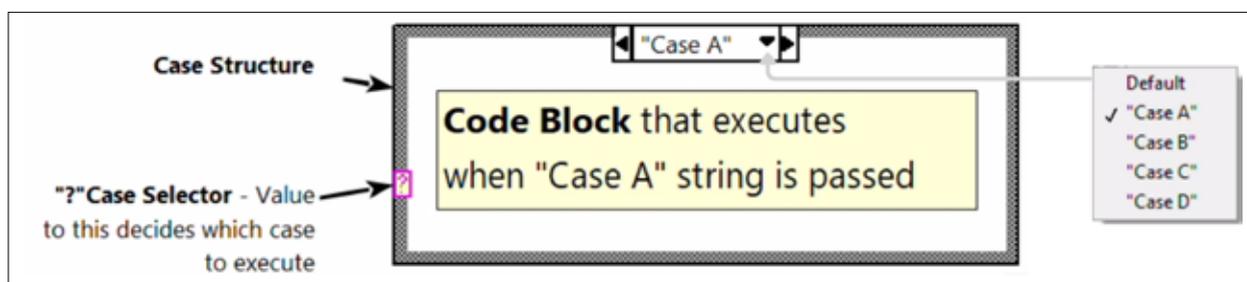


Figure 2. Case Structure showing Case A, “?” case Selector and list of cases. Various states are shown on the right.

patiently waiting for a user’s input. That’s precisely what a While Loop (Fig. 1) does! It executes code blocks repeatedly until a stop condition is met. A really neat feature of While Loops in LabVIEW is their shift registers. These handy little features allow you to pass data from the end of one loop run to the beginning of the next loop run, making it super easy to maintain continuity in your processes.

## 2. Case Structures

Now, what if you have different actions you want your program to take based on a specific input or condition? Think about initializing instruments in one scenario, or perhaps taking a measurement in another. This is where a Case Structure (Fig. 2) shines! It selectively executes subdiagrams (which we call “cases”) based on an input value. Each case represents a distinct action, allowing your program to make decisions and perform the right task (code) at the right time.

## 1. State Machine: The Backbone of Calibration Logic

Alright, let’s talk about the state machine—it’s a truly elegant programming architecture that’s perfect for calibration applications! Imagine your program always being in one specific “state” at any given moment, like “initializing” or “taking a measurement.” A state machine allows your program to transition gracefully between these states based on various conditions or user input. In LabVIEW, we typically implement a state machine by combining a While Loop with a Case Structure inside, where each case wonderfully represents a distinct state.

### LabVIEW State Machine

In LabVIEW, you form a State Machine by combining loops and case structures. Placing a case structure inside a while loop creates a basic state machine framework. The loop continually iterates,

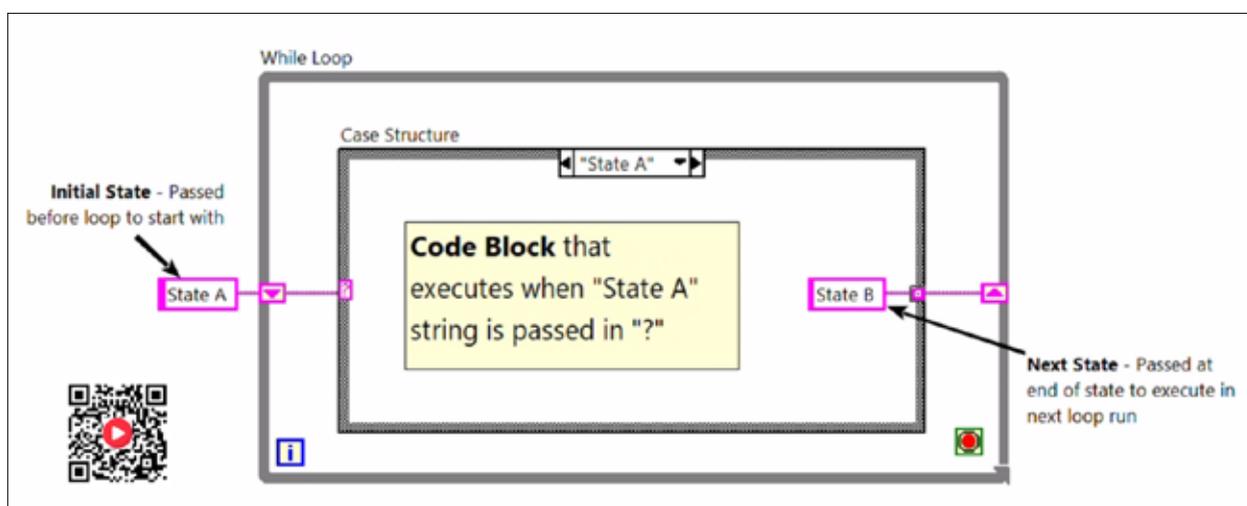


Figure 3. Simple state machine with while loop and case structure showing State A executed at beginning and passed State B for next loop run.



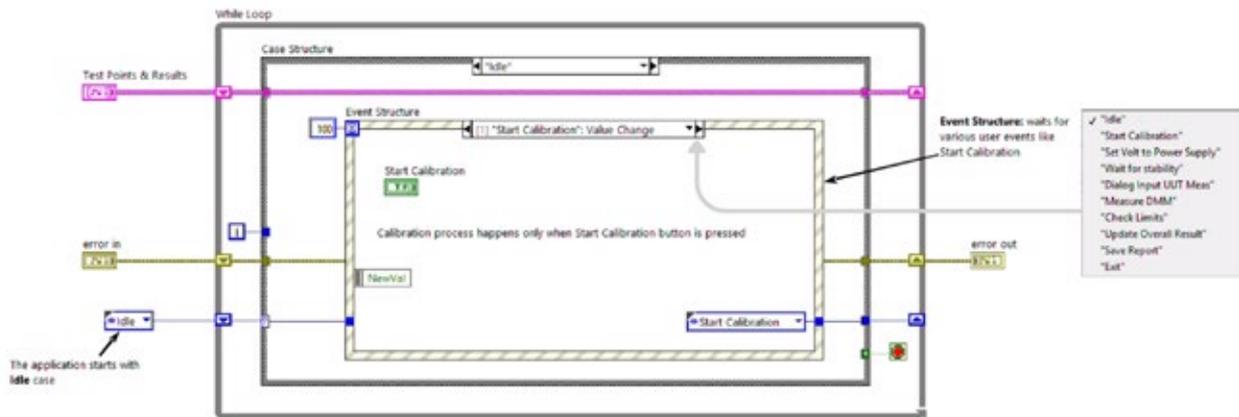


Figure 5. Event structure inside case structure can wait for events like Start Calibration. Usually such event structures are placed inside the “Idle” state in the case structure.

## 2. Event-Driven State Machine: Enhancing Responsiveness

While a basic state machine is fantastic for linear workflows, real-world calibration tools often need to be more interactive. Imagine needing to pause a measurement, stop a test prematurely, or even start a new sequence with a button click. This is precisely where **event-driven programming** truly shines! A state machine becomes even more powerful and user-friendly when combined with event-driven programming. Here, user actions (like pressing a button) or system events trigger state transitions, making your application feel incredibly responsive and lively.

### LabVIEW Event Structure

In LabVIEW, you can use the **Event Structure** (Fig. 5) to listen for user actions (like those satisfying button clicks!) or even system events (such as a timeout). It’s like your program has ears, waiting for something exciting to happen!

To gracefully integrate Events into a State Machine:

- Add an **Event Structure** inside your While Loop. This structure is designed to pause execution until a user interacts with the front panel or a specified timeout occurs.
- Events like a “Start” button click would trigger a smooth transition to our measurement states, while a “Stop” button would safely and responsibly shut down all our calibration processes.

### Event-Driven Programming for Calibration

In LabVIEW, embedding an Event Structure within your state machine’s idle or wait state is a truly elegant solution. This clever setup allows your application to:

- Respond immediately and enthusiastically to user actions (like starting, stopping, or pausing a process).
- Gracefully handle resource cleanup (such as politely closing instrument connections) when the user decides to press that stop button.
- Even automatically restart the calibration sequence after completion, without any manual intervention from you!

### How to Implement:

- **Event Structure:** This is our diligent listener, waiting for user events (like those satisfying button clicks!).
- **Timeout Case:** This case thoughtfully executes the current state when no user event occurs within a specified time. It’s a nice way to keep things moving even when there’s no immediate interaction.
- **State Transitions:** These are elegantly triggered by either user events or our internal program logic. It’s how we move smoothly from one task to the next.

This approach ensures a clean, wonderfully responsive user interface and robust resource management—both absolutely essential for building executable applications that users can safely interrupt and control with ease.

## 3. Producer/Consumer State Machine: Enhancing Responsiveness

Now, sometimes, even with event-driven programming, you might find your program becomes a little sluggish or unresponsive, especially when it's busy executing a particularly demanding state. This is where the **producer/consumer pattern** comes to the rescue! This brilliant design separates the event structure (our "event producer") from the state machine (our "event consumer"), allowing these tasks to run in parallel loops. How do they talk to each other, you ask? Through wonderful little "queues" that facilitate seamless communication between them!

### Producer/Consumer in Calibration Automation

Let's break down how this powerful pattern works in calibration automation:

- **Producer Loop:** This loop is like a diligent observer, constantly capturing events (for example, those satisfying user clicks on the front panel).
- **Consumer Loop:** This loop is the workhorse, gracefully handling the states and performing the heavy lifting (like checking limits, updating results, and communicating with instruments).

Queue: This is the magical conduit that efficiently transfers data and instructions from the producer

loop to the consumer loop.

This architecture ensures that your user interface remains beautifully responsive, even when your program is engaged in lengthy calibration procedures or intensive data processing tasks. It's all about keeping things smooth and snappy!

In our next article, we'll dive even deeper into the fascinating world of queues and explore how this producer/consumer pattern comes to life with the industry-wide popular DQMH (Delacor Queued Message Handler) architecture. Get ready for more LabVIEW wizardry!

These advanced programming concepts enable the creation of calibration certificates that offer "efficient handling" compared to traditional paper certificates. While we're excited about the future of Digital Calibration Certificates (DCCs) and how calibration laboratories are increasingly transitioning to digital processes, these capabilities already provide:

- Seamless integration with digital quality systems, making your life so much easier.
- Enhanced traceability through machine-readable formats, which is a dream for auditing!
- Reduced administrative burden through automated reporting—less paperwork, more science!
- Future-proofing as industry standards gracefully evolve toward digital documentation.

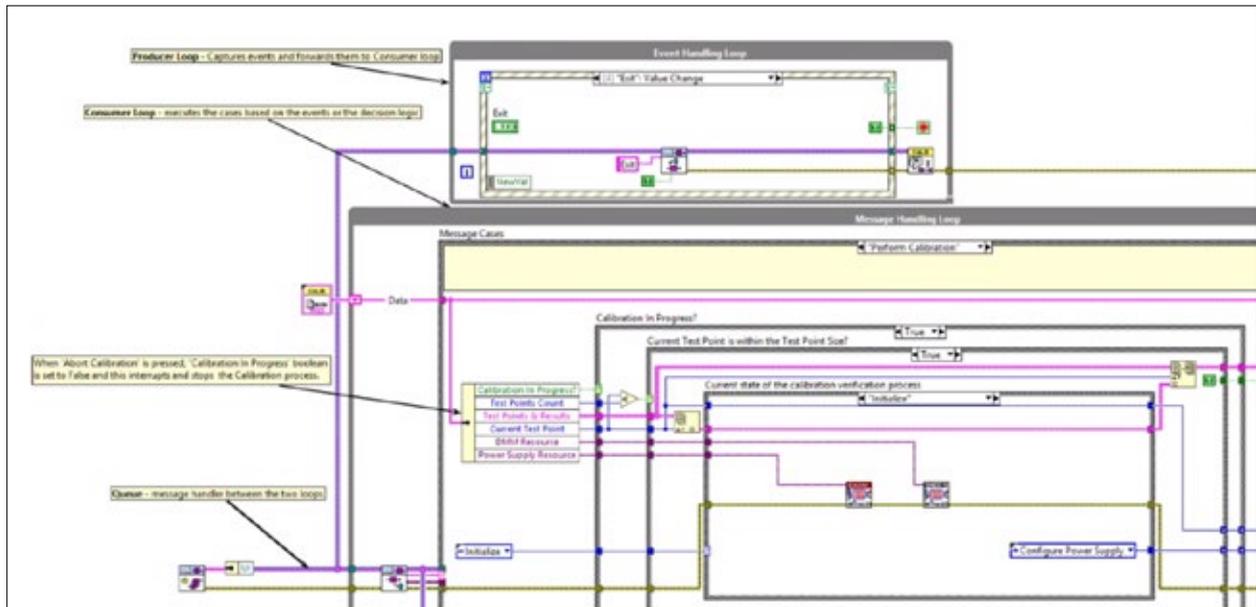


Figure 6. Producer Consumer loop architecture with event structure as producer that can continue capturing events while event consumer loop continues its operations.

## Summary

So there you have it! By embracing these powerful LabVIEW design patterns—state machines, event-driven programming, and producer/consumer architectures—you can build calibration verifier tools that offer truly significant benefits for your calibration laboratories. These tools will be:

- **Structured:** Making them easy to read, modify, and scale as your needs grow.
- **Responsive:** Beautifully handling user interactions smoothly and efficiently.
- **Efficient:** Executing tasks in parallel without ever blocking that lovely user interface.

By automating your verification processes with these sophisticated techniques, you can achieve greater accuracy, consistency, and efficiency, all while gracefully transitioning toward the exciting future of digital documentation through Digital Calibration Certificates (DCCs).

In our very next article, we'll introduce the

incredible DQMH framework, a fantastic tool that formalizes these patterns into reusable modules, perfect for building enterprise-grade calibration systems. Stay tuned for more insights into making your calibration lab a powerhouse of efficiency and accuracy!

## About the Author

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# Metrology and Meteorology: Measuring Hurricanes

Jeffrey R. Carlson, A.T.  
Metrology and Quality Program Student,  
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Imagine a homeowner, waiting for the hurricane to come, fixated on news reports advising evacuation, yet the evacuation zones are constantly changing due to the storm's path shifting. Gas stations are out of fuel, roadways are bottle-necked, a decision must be made. Grabbing necessities, jumping in the car and scrambling to get out of the path. The next report indicates the path has changed, do not evacuate, then the storm shifts, there's no time, sheltering in place is the only option. Preventing loss of life is why our methods of accuracy in measurement and prevention must evolve along with the hurricanes.

Tracking hurricane winds and speed has been beneficial, but hurricane measuring systems must be improved. The Saffir-Simpson scale, one of the most common measurements used, needs to be improved; its inaccuracies have been proven. The destruction of a hurricane was significantly greater than the model indicated, and preventable loss of life took place.

Measuring hurricanes, before, during and after, and understanding how metrology partners with meteorology is more important than ever. "In May, the National Oceanic and Atmospheric Administration predicted 2024 would bring 'above-normal' hurricane activity, with 17 to 25 named storms, eight to 13 hurricanes and four to seven major hurricanes of Category 3 strength and above. It was the highest number of storms forecast in NOAA's history. (Bubnash, 2024)" With more extreme weather comes more loss of life, property and infrastructure.

Metrology is used in every phase of a hurricane's life cycle. Beginning with predicting the season, to the right conditions for a tropical storm to form, then onto predicting the path and the evolution to a hurricane. This includes measuring wind speed, when it will make landfall and at what strength, to assessing the damage after the event. More sophisticated methods of extreme weather measurement are evolving every

day, but metrologists must remain vigilant and continue this essential work.

The Saffir-Simpson Hurricane Wind Scale is an assigned hurricane category rating of 1 - 5 based solely on wind speed. This measurement was introduced in 1971 by Hurbert Saffir and Robert Simpson and began wide-spread use in 1973. To obtain the wind speed the National Hurricane Center measures winds 10 meters above ground level, averaged over one minute. Methods of obtaining these measurements vary based on where the storm is located. Storms that are forming over the ocean are typically measured using satellites allowing a fairly accurate measurement of speed and pressure.

As the storm continues toward landfall, more exacting measurements are obtained by hurricane hunters, special airplanes that drop sensors called Dropsondes; these devices measure the winds and transmit the data as they drop into the ocean. These planes also use a measurement instrument called Stepped Frequency Microwave Radiometers which measure surface winds by looking for radiation on the ocean's surface.

As the storm approaches land, the next type of measurement used is Ground-Based Nexrad Doppler Radar which provides comprehensive images and views of the storm's full wind field (NOAA NHC, 2012). At present, the Saffir-Simpson Hurricane Wind Scale is considered a "poor measurement of the destructive potential of the storm. (Misra, DiNapli, & Powell, 2013)" Sandy in 2012, while relatively weak on the Saffir-Simpson Scale caused considerable damage and mortality (Misra, DiNapli, & Powell, 2013). With hurricanes becoming stronger and more frequent metrologist and meteorologists are considering if an additional category 6 should be added to the scale.

Internet of Things (IoT) sensors are devices used to assist in analyzing and measuring the brunt

of the storm at ground level. These devices are placed on surfaces and measure the impact of the storm at ground level by measuring wind and rain (SafetyCulture, 2024).

Integrated Kinetic Energy (IKE) is a cadent or algorithm used to calculate the square of the winds surrounding the eye of the storm. It is a useful tool to determine and measure the destructive potential of the hurricane and it is a more comprehensive measurement than intensity alone. Improvements need to be made to measure more information and for a longer duration.

Track Integrated Kinetic Energy (TIKE) is a method that combines other verified obtained measurements such as wind field, intensity and the lifespan of the storm. This method is also used to aid in the measurement of potential destruction and informs evacuation and security measures (Misra, DiNapli, & Powell, 2013).

The greatest threat to life during and after a hurricane is the storm surge, or the atypical rise in sea level above the ground during and after a storm. Globally, more than 250 million people in coastal areas live under the threat of storm surge (McMichael, Dasgupta, Ayeb-Karlsson, & Kelman, 2020). Because storm surge represents such an important measurement for hurricanes, there are a number of ways it is predicted before, during and after a hurricane, but improvements are needed.

Tide Stations measure the difference in water level in coastal areas. They are the basis used for the prediction for storm surge estimates. Incoming and outgoing tides are published and predictable, and because of this storm surge is easily measured by subtracting what level the water should have been without the presence of a hurricane from the measured water level that occurred. However, they are not infallible, "We cannot predict the effect that wind, rain, freshwater runoff, and other short-term meteorological events will have on the tides (NOAA Tides & Currents, 2024)." Also used are pressure transducers, sensors which are placed at the expected areas of high surge as predicted by tide stations and other measures. The transducers record the degree, intensity and timing of storm surge and are placed where they will be submerged and accurately measure the water height. High water marks (HWMs) are simply lines on trees and structures which show the maximum rise of water for a flood. Surveyors find

HWMs after a storm to aid in the analysis after the hurricane (Weather.gov, 2012).

After the hurricane many more measurements take place in the form of assessing damage. Obviously the most important measurement after a hurricane is the mortality or loss of life. Even though local, state and federal government agencies take a number of measures to ensure people are informed of the potential threats and they are told to evacuate to safe shelters it's not absolute, as hurricanes are not 100% predictable. Hurricane Helene caused over 230 deaths across several states, and this number continues to rise as relief efforts continue. In October, 2024 hurricane Milton killed at least 32 in Florida. Two weeks before Milton, hurricane Helene had killed over 230. Many criticize the government for their response system, or lack of (Melissa Chan, Solis, Strickler, & Thompson, 2024).

Another measurement taken post-hurricane is damage to infrastructure, transport infrastructure includes bridges, roads and other transportation venues. This damage can have a long-lasting impact and can isolate people who live on islands and depend on roads and bridges. Utilities such as electrical power, gas, and water damage have a huge impact on potential loss of life. Automated damage assessment is used to measure impact of the storm on utilities, it is a cumulation of measurements uploaded to a central site where it is processed and a plan to restore is created.

Property damage is the most difficult component to measure, and it can take the longest as it is dependent on gathering information from many different sources and is typically an estimate. Even though structures are now built to withstand hurricane force winds significant damage occurs. The total approximate cost of damages from weather and climate disasters from 1980 to present (February 2025) is \$2.915 trillion dollars (NOAA Office for Coastal Management, 2025).

These instruments, devices and methods represent only a fraction of measurements taken before, during and after the life cycle of a hurricane yet they create a fair representation of the important role metrology plays in meteorology and demonstrate how it can aid in reducing loss of life during a catastrophic storm. The need to continually evaluate, improve and advance measurements for severe weather must be a priority as extreme weather continues to evolve and become even deadlier.

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## About the Author

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# Calibration Supplier Complaint – An Accreditation Case Study

Christopher L. Grachanen



The following is a case study involving an accredited calibration supplier, hereby referred to as the cal lab, an accreditation testing facility hereby referred to as the test lab, an accreditation provider (AP) that accredits both the cal lab and the test lab and a Metrology subject matter expert (SME). It is sufficed to say all parties are seasoned players within their respected fields and possess the necessary resources to adequately perform their respected tasks. The following case study will chronologically relate events surrounding a complaint made to the AP by the SME regarding calibration services provided by the cal lab for the test lab. All events related are documented by electronic correspondences i.e. e-mails and attachments. The following case study is narrated from the perspective of the SME and strives to enlighten readers as to some of the challenges one may encounter when lodging a complaint against an accredited calibration supplier as well as underscoring the worn-out adage “let the buyer beware.”

## Discovery

Our case study begins with the SME requesting copies of calibration certificates from a newly acquired company in order to evaluate future calibration support requirements. Upon examining the certificates, the SME discovered multiple deficiencies/discrepancies. As the examined certificates were only summary in

nature and were non-accredited calibrations, there was little recourse for the SME to do but to communicate his findings to the newly acquired company personnel and offer technical assistance. However, during the course of examining the certificates the SME became aware that the issuer of the certifications (the cal lab) was the same calibration supplier used by an internal testing group (the test lab). The SME knew the test lab requires accredited calibrations in order to comply with accreditation testing requirements. Based on this insight the SME requested copies of some of the test lab’s test equipment accredited calibration certificates to see if they also had problems. The SME was disheartened to discover the following upon examining the calibration certificates:

- Several calibration parameters verified were not listed in the cal lab’s Scope of Accreditation.
- Some of the listed calibration equipment possessed neither functionality or capability to perform OEM recommended calibrations.
- Some of the calibration equipment used to perform OEM recommended calibrations were not listed.
- Multiple OEM recommended calibration parameters were not verified.
- Some calibration procedure sources were not uniquely identified i.e. general references to manufacturer specifications.

## Initial Responses

It must be noted that the examined calibration certificates were for calibrations performed on-site at the test lab facility. The aforementioned deficiencies/discrepancies were shared with test lab personnel and a conference call scheduled with cal lab management personnel. Note: The cal lab's AP procedure for resolving customer complaints recommends starting a dialog directly with the calibration supplier as a first step. Prior to the conference call, the aforementioned deficiencies/discrepancies were compiled and shared with cal lab management personnel. The following are some of their responses:

1. *Our calibrations and quotation for this service include test and measurement of key functions only. Calibrating to full functionality as specified in the service manual, would require pickup and delivery and a sizeable increase in cost for this service. Technicians are limited to key measurement standards and equipment, when calibrating from a moving cart.*

**Note:** This was the response given why some OEM recommended calibration parameters were not performed. It must be noted that calibration certificates did not specify "limited calibrations" despite calibration sources cited on the certificates as manufacturer's manual.

2. *This particular test is presently not being performed, citing customer agreement.*

**Note:** This was the response given why a critical calibration parameter was not tested. It must be noted that cal lab management could not produce documented evidence of any customer agreements directing cal lab personnel to deviate from OEM recommended calibrations (agreements claimed to be verbal in nature between test lab personnel and cal lab technicians).

3. *This calibration is performed by test lab personnel along with test lab equipment, including a cal lab precision multimeter which shall be listed in future calibration reports or as directed by local test lab facility personnel. The cal lab stands as a calibration witness only.*

**Note:** this was the response given why some calibration equipment used in performing

calibrations was not listed in the accredited calibration certificates. It must be noted that the terms; calibration witness, witness calibration are not defined in ISO/IEC Guide 99, International Vocabulary of Metrology – Basic and General Concepts and Associated Terms, commonly referred to as the VIM. It also must be noted that test lab personnel, test lab equipment and the terms; calibration witness, witness calibration, are not annotated on the examined calibration certificates.

4. *In reference to the cal lab's Scope of Accreditation support, listed disciplines as required have been included in the cal lab's latest Scope of Accreditation Draft. Audit results are in the process of being evaluated by the cal lab's Quality department along with the cal lab's AP. Results shall be made available upon the AP's response.*

**Note:** This was the response given for tested calibration parameters that were not listed in the cal lab's Scope of Accreditation enforced at the time the calibrations were performed.

## The Ensuing Discussion

The conference call was attended by cal lab management, the SME and the SME's manager. To ensure topics and responses discussed in the conference call were not misconstrued, a correspondence was sent to cal lab management in order to solicit concurrence. The following are the cal lab's quality manager responses for the topics discussed:

**Preamble:** Regarding recommended test equipment (or its equivalent) used for performing OEMs calibrations that does not appear on calibration certificates (for both accredited and non-accredited calibrations) as well as determining which individual OEM calibration tests to perform or not perform is because:

**Statement:** Test lab personnel direct cal lab technicians as to what test equipment is to be used in a calibration, what test equipment is to be included on a calibration certificate as well as which calibration tests to perform and which to omit.

**Response:** This holds true at the test lab facility for the referenced (discussed) calibrations

**Statement:** Cal lab personnel assume test lab

personnel to be technically competent to make these Metrology directives for each piece of customer test equipment calibrated and that these directives are verbal in nature and not specified in the customer's purchase order.

**Response:** Correct

**Statement:** Cal lab personnel assume that by the test lab personnel accepting a calibration certificate, that they (test lab personnel) are in agreement with its content and any omissions.

**Response:** Correct

**Preamble:** Regarding accredited calibrations that list test equipment in the calibration certificate possessing neither the functionality nor capability to have made the recorded calibration data:

**Statement:** Cal lab personnel employ test lab test equipment and test lab personnel in a quasi-subcontracting arrangement to perform these types of calibrations and that only cal lab equipment used in the calibration is listed on the calibration certificate.

**Response:** Correct

**Statement:** For these types of calibrations, the Cal lab is only a 'calibration witness' and that issued calibration certificates should be understood in this context.

**Response:** Correct

**Statement:** The cal lab assumes that test lab personnel are competent to perform these quasi-subcontracting activities and that test lab test equipment used in these activities meet requirements for each applicable calibration test they are used in.

**Response:** Correct

**Preamble:** Regarding accredited calibrations performed which include measurement functions not contained within cal lab's Scope of Accreditation in force at the time of the calibrations is because:

**Statement:** The cal lab acknowledges that some calibrations were performed with some measurement functions (calibration parameters) not listed in their Scope of Accreditation in force at the time of calibration.

**Response:** This is true only after review and acceptance of respective calibration certificates by test lab personnel

**Statement:** The cal lab submitted a draft Scope of Accreditation to their AP which includes the aforementioned measurement functions (calibration

parameters) necessary to perform applicable accredited calibrations. The cal lab is awaiting audit results and AP response regarding their submitted Scope of Accreditation draft.

**Response:** Correct

The above state of affairs would require several additional pages to adequately articulate departure from industry accepted metrological practices, so for brevity's sake, it is suffice to say they represent unique practices which should have been written into the test lab's calibration purchase agreement to ensure mutual understanding and acceptance. It must be noted that cal lab personnel assumptions made about test lab personnel metrological expertise, as well as validity of carrying out verbal directives based on these assumptions, were intentionally not challenged in order to avoid a classical "he said, she said" scenario.

## A Scheduled Meeting

It was soon after the above responses were received that cal lab management requested a meeting at the SME's facility. This meeting was attended by the cal lab's manager, the cal lab's quality engineer, the SME, the SME's manager, a regulatory test engineer and the test lab's director. During the meeting topics and questions previously responded to were discussed in length which resulted in the following key action item: The SME will file a complaint with the cal lab's AP regarding accreditation violations as discussed in the face-to-face meeting.

As timing would have it, the SME was schedule to attend a conference where the cal lab's AP would be represented. At the conference the SME formally filed a customer complaint against the cal lab with the AP's calibration accreditation manager. The SME provided the calibration accreditation manager with hardcopies of electronic correspondences and other supporting documentation substantiating the complaint. The SME also informed the calibration accreditation manager that the AP was also the AP for the test lab and that AP auditors did not catch the aforementioned deficiencies/discrepancies when they reviewed the test lab's accredited calibration certificates (Note: APs normally have separate programs for accreditation of calibration laboratories and testing laboratories).

## On-Site Assessment & Resulting Correspondence

Four months after the SME filed the formal customer complaint, an on-site assessment of the cal lab was performed. Despite the protests of the SME, the on-site assessment was scheduled during a time when many calibration practitioners take vacation and that the on-site assessor would be the same assessor that had previously audited the cal lab for accreditation renewal. It is interesting to note that during these four months the AP took no action to suspend any portion of the cal lab's accreditation despite possessing documented evidence (accredited calibration certificates) of the cal lab performing accredited calibrations outside their scope of accreditation (this scenario is listed as one of the main reasons to suspend a laboratory's accreditation as per the AP's policy).

One month later, the SME received correspondence relating the results of the on-site assessment of the cal lab facility (five months had elapsed since initiating the customer complaint). The following are excerpts from that correspondence:

*Although data for the calibrations in question have been reported on calibration certificates endorsed with the "AP Accredited" symbol, they were not calibrations that are contained on the current Scope of Accreditation for this laboratory. The ramifications of this are two-fold:*

*Since the calibrations in question are not listed on the laboratory's current AP's Scope of Accreditation, we were not in a position to evaluate and cite deficiencies against the specific records associated with the specific instances that you brought to our attention. Those particular calibrations done at that time are considered non-accredited...*

*The fact that the AP Accredited symbol was used to endorse the results of non-accredited calibrations is misleading and counter to AP policy...*

*The outcome of this on-site assessment has been shared with our President/CEO and Vice President/COO. The decision was made that the outcome did not warrant immediate suspension of the laboratory.*

The SME protested the AP's decision to essentially negate all the aforementioned deficiencies/discrepancies evident in "out of Scope of Accreditation calibrations" despite them bearing the AP's accreditation logo. The following are excerpts from the correspondence the SME received

after protesting to the AP (section underlined was underlined in the correspondence):

*The assessment of the cal lab did not reveal any technical issues with the calibrations that are accredited and within our control that would warrant immediate suspension. However, we do see a systematic, a corporate wide problem with the way in which the cal lab separates its accredited and non accredited work in relation to the use of our AP symbol. This is a serious problem for us and cal lab clients, greatly confuses the marketplace, and undermines the AP's credibility. The cal lab must provide a complete corrective action with root cause analysis within 30 days... This includes correcting any erroneous certificates that went out to their clients...*

*In order to improve the rigor of review of calibration certificates issued by AP accredited labs, AP is now requiring our assessors to spend more time reviewing the calibration certificates for technical content and use of the symbol for future assessments...*

*We will also make every effort to move more quickly with assessment visits that result from a complaint that we receive, even if it means we cannot send an assessor from the last assessment the lab in question had.*

As evident from the above correspondence, apparently all past accreditation infractions perpetrated by the cal lab will be rectified by calibration certificate reissuance and modifications /additions to cal lab procedures and that other deficiencies/discrepancies duly noted in 'out of Scope of Accreditation calibrations' will not be specifically addressed.

The SME had two "takeaways" from this accreditation compliant episode:

1. When purchasing calibration services, purchase agreements should contain verbiage which specifically details expectations in order to avoid unforeseen problems and help ensure the quality and content of the services paid for
2. Reconfirmation of the SME's belief that accreditation programs are only as good as their swift and strict enforcement of violation penalties.

## Epilogue

The topic of calibration purchase order content is commendably addressed in an on-line article from Agilent's Metrology Forum entitled, "Defining Your

Calibration Requirements.”<sup>1</sup> The article’s author(s) constructed a calibration purchase order statement that avoids many expectation pitfalls associated with procuring calibration services. This statement is as follows:

*Calibration shall be undertaken against full manufacturers’ specifications. Where equipment is found to be out of specification, full performance test results, in the as-received condition, must be obtained before any adjustment or repair action is taken. On completion of the calibration work a certificate of calibration is required, signed by your authorized representative, containing a statement confirming that the calibration can be demonstrated to be traceable to National or International standards and stating the item’s full compliance with its performance specifications. Full performance test results,*

*taking the form of measured values, are to be supplied. Any omissions from the full calibration are to be notified to us and shall be agreed in writing before a certificate, clearly annotated “Limited Calibration” is issued. A declaration of measurement uncertainty values shall be included with all test results.*

Readers are encouraged to read the aforementioned article to have a better understanding of this statement.

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Assessor

1 <http://metrologyforum.tm.agilent.com/cal-reqts.shtml>



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# That Wild, Wild, Westinghouse

Dan Wiswell

Amblyonix Industrial Instrument Company

When considering this article, I thought I'd give you all a short summer read and present a few instruments that I don't focus on very much. Thinking back on subjects I've previously written about, I figured that it was time to look at the Westinghouse meters in my collection as I've already shown meters and instruments made by one of that company's competitors, Thomas Edison and the General Electric Company. Now that I have, I've found that it is difficult to focus on Westinghouse history very much because George Westinghouse was a very busy guy. It would be easy to go off on many tangents when writing about this man as he had his hand in so many ventures starting from a very early age. As an overview, George Westinghouse was granted his first patent when he was nineteen years old. During his life he held more than three hundred and fifty patents and founded over sixty companies. By 1900 more than fifty thousand employees were on his various payrolls. He had his hand in so many ventures that they seem

to have no boundaries. He was involved in a dizzying array of industries that include not just electrical construction, transmission, and distribution, but also transportation, communications, entertainment, broadcast news, nuclear power, aerospace, consumer products--it's hard to know where to stop.

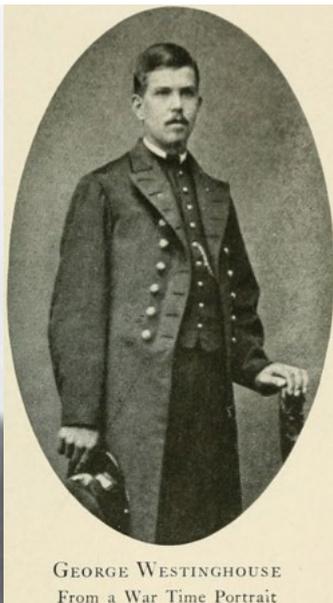
George Westinghouse was born in 1846 in Central Bridge, New York. He was named after his father, George Sr., and as a boy he worked in his father's Westinghouse Company where they manufactured farm automation equipment among other things.

At the age of fourteen he attempted to join a local regiment to fight in the Civil War but was stopped by his father. At seventeen his parents relented, and he joined the 12th regiment of the New York National Guard after which he transferred to the 16th regiment of the New York Cavalry.

He was honorably discharged in November of 1863 and almost immediately joined the Union Navy. After the war he returned home and honed his engineering

skills in his father's machine shop. This seems to be the point at which this young man's career went into high gear. By the end of the 1860's he had already patented several devices related to steam engines and railroad braking and switching equipment, and in 1869 he founded the Westinghouse Air Brake Company (WABCO). He was twenty-three years old.

During the 1870s he employed thousands of workers at WABCO. His engineering staff improved his brake and switching systems, which transformed railroad safety in an era when thousands of rail workers were killed or maimed each year. In 1881 George Westinghouse founded the Union Switch and Signal Company. This company's products are still being used in modern rail systems. Many of these devices have passed



Picture 1 (left). Portrait of George Westinghouse, 1884. Picture 2 (right). Portrait of George Westinghouse, 1864, at age 17 years. Credit: Wikipedia

## IN DAYS OF OLD

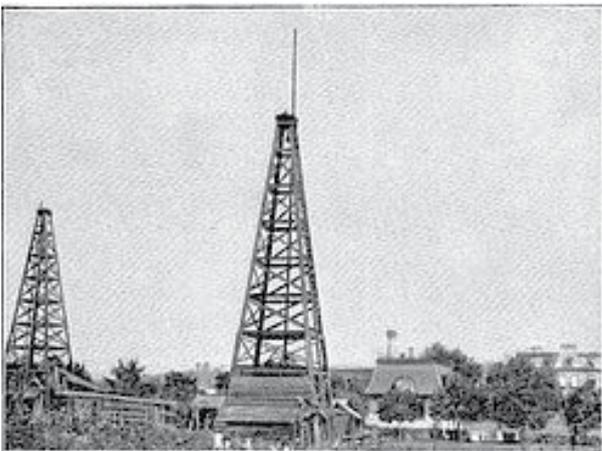


Picture 3. First Westinghouse Air Brake Factory in Pittsburgh.  
Credit: Wikipedia

through my own laboratories when they required repair or calibration.

In the late 1870s natural gas exploration began in Pennsylvania and George Westinghouse immediately saw the commercial potential of this natural resource. He began drilling for natural gas on his estate in Pittsburgh, and by 1886 his Philadelphia Company owned nearly sixty wells and approximately one hundred and fifty miles of distribution pipelines in the metropolitan Pittsburgh area.

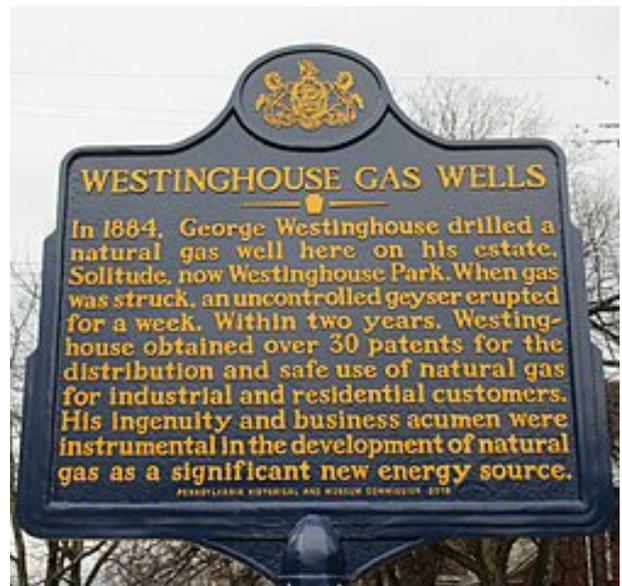
By the following year his company was supplying natural gas to over twelve thousand homes and nearly six hundred industrial customers throughout Pennsylvania. Not satisfied with exploiting natural gas, by the early 1880s he began directing his energies toward the newly established field of electrical power. He began competing with Thomas Edison in 1884 and created his own distributed direct-current-based system with the help of physicist William Stanley Jr.



Picture 4 (above). Westinghouse Gas Derrick No. 1.  
Picture 5 (right). Westinghouse Gas Wells Sign.  
Credit: Wikipedia

In the fall of 1885, Mr. Stanley began construction on a prototype electrical distribution system based on transformers and alternating current. The system was powered by a Westinghouse steam engine and a Siemens 500 VAC electrical generator. Located in the western Massachusetts town of Great Barrington, it was originally designed to electrically illuminate approximately two dozen businesses along the town's main street. It distributed power by stringing cables from tree to tree and used Stanley's transformers to transmit and then step the voltage down from the 500-volt primary output of the generator to the 100 volts at which the incandescent light bulbs operated, at minimal loss. The system is now recognized as the world's first transformer and AC powered electrical-distribution system. It became the prototype for future AC power systems that Westinghouse began installing around the United States beginning the following year in 1886. Many dozens of these systems were created in the next few years.

This timeline is important to consider for several reasons. In 1886, The Boston Edison Company was originally incorporated as the Edison Electric Illuminating Company of Boston. Back then Edison Electric Companies were only supplying direct current to their customers. Westinghouse and Edison would not have mixed very well if they happened to show up at the same party, as Edison didn't particularly care for competition of any kind. The rift between these gentlemen escalated as events moved forward. In the beginning, when transmission



## IN DAYS OF OLD



Picture 6. Front panel from a dry-cell battery charger, made in 1898.

and distribution of electric power was all done on a local level, the pros and cons of each approach could easily be debated. However, as electrical power systems grew to encompass larger geographic areas, the advantages of AC power transmission became obvious. In 1892, it was J.P. Morgan that forced Edison's hand by demanding that Edison's General Electric Company switch over to AC power. Next, as one of the company's primary shareholders he forced Edison out of his own company. As you may imagine, quite a bit of bad blood and strategic maneuvering ensued, the likes of which are beyond the scope of this article—all of which can easily be found in many sources both in print and online. Which (finally)

brings us around to my original intent of showing some electrical instruments.

Many years ago, I was sifting through a pile of scrapped electrical equipment and happened upon a discarded front panel from an old dry-cell battery charger. Most of the components mounted on the chassis were missing, but it still had a working panel meter. That meter became one of the first instruments to make its way into my collection. It was made in 1898 and is depicted to the left (Picture 6).

I guess I thought it would make a good paperweight, as it only measures about two and a half inches square. I never imagined that I would be writing about it someday. Most of the other Westinghouse pieces in my collection are switchboard panel meters. This probably makes sense as these meters are mostly taken from old electrical service panels from Westinghouse switch gear. My collection from this brand name would probably outweigh everything else I've got if I had focused on glass-jar-style watt hour meters, much to the relief of my wife. We'd probably be passing salt and pepper shakers around them at the dinner table. A few examples of these meters are depicted in the next few pictures below. These meters were used to monitor AC current, power factor, and frequency.

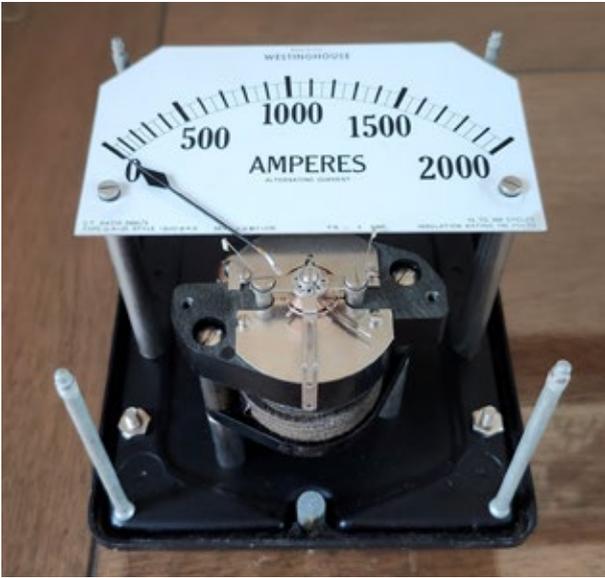
These meters were designed with AC iron-vane meter movements. Iron-vane meter movements were most often designed with five-amp field coils, which is why most current transformers have N:5 ratios. This type of movement can be seen in detail in Picture 10.

One of the Westinghouse panel meters that I salvaged came from a meter calibrator made by the Automatic Electric Company, a large manufacturer of telephones and telephone switching equipment.

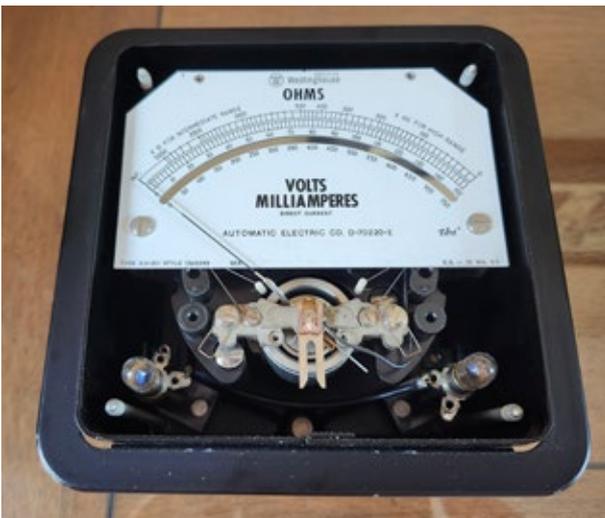


Pictures 7, 8, 9. Westinghouse switchboard panel meters used to monitor AC current, power factor, and frequency.

## IN DAYS OF OLD



Picture 10. An example of an AC iron-vane meter movement designed with five-amp field coils.



Picture 11. An example of a panel meter with the front plate removed to show a DC, taut-band style (TBS) meter movement.

Although it looks like the other panel meters in this series, the picture detail shows that instead of an AC iron-vane meter movement, it has a DC, taut-band style meter movement (Picture 11). This is signified by the letters TBS on the meter scale which stands for "taut-band suspension."

I'll close by showing an absolutely beautiful piece of test equipment. It is the only Westinghouse test instrument I've got. I found it tucked away in one of

the drawers of a work bench from one of my mentors who passed away many years ago.

Pete Peterson, this one's for you. Thank you for starting me on this path. I've carried your love of metrology forward as best as I've been able. My life has been enriched many times by the lessons I've learned from you.



Picture 12.

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## Keysight Introduces Two Frequency Extenders and Calibration Kit to Extend Broadband Vector Network Analyzer up to 250 GHz

*New VNA accessories accelerate design and validation of 1.6/3.2 Tb/s components and next-generation semiconductors*

SANTA ROSA, Calif., SEPTEMBER 9, 2025 — Keysight Technologies, Inc. (NYSE: KEYS) introduces two new millimeter-wave frequency extender modules, the NA5305A Frequency Extender up to 170 GHz and NA5307A Frequency Extender up to 250 GHz, and the 85065A Precision Calibration Kit 0.5 mm. When used with Keysight's PNA/PNA-X Vector Network Analyzers (VNA) and the N5292A Test Set Controller, the new accessories enable engineers to achieve fully calibrated single-sweep broadband S-parameter measurements from 100kHz (or 10 MHz) to 170/250 GHz. Existing customers using the 110 GHz /120 GHz VNA can easily upgrade their configuration, providing added value to their original investment.

The 85065A Precision Calibration Kit 0.5 mm enables precise measurements up to 250 GHz when used with the broadband VNA solution. The broadband VNA accessories simplify test setups and allow engineers to characterize various sub-THz on-wafer or packaged components such as optical RF drivers, TIAs, PCBs, cables, packages, and passive devices. The new accessories help engineers characterize these components and reduce lengthy design and verification cycles.

As AI pushes the limits of data communications with 1.6 Tb/s and 3.2 Tb/s networks and wireless research continues in sub-THz frequencies, test and measurement solutions must evolve to keep pace. Engineers developing next-generation semiconductors and high-speed interconnects, millimeter-wave and sub-THz wireless devices, and advanced semiconductors require instruments that deliver accurate broadband VNA measurements at ever-higher frequencies to validate designs and correlate simulations with real-world performance.

**Among the benefits of the new broadband VNA accessories:**

- Achieve the system dynamic range of 105 dB at 170 GHz to accommodate various measurements, lossy passive component test, high rejection filters, and active devices test under various power levels.
- Provide differential measurement capability to help engineers validate differential active devices and the signal integrity of high-speed interconnects.
- Enable greater insight into the characteristics of active components like amplifiers with the maximum output power of 0 dBm at 170 GHz and – 5 dBm at 220 GHz.

Measuring sub-THz signals in on-wafer and packaged components demands specialized probes, adapters, and test cables that complement Keysight's new frequency extenders

and calibration kit to form a comprehensive test setup.

To deliver complete measurement capabilities, Keysight has collaborated with top-tier industry solution partners; FormFactor Inc. and MPI Corp. have engineered advanced single-ended and differential RF probes. In addition, Spinner GmbH, a leading supplier of coaxial adapters, has developed ruggedized 0.5- to 0.8-mm coaxial adapters that support frequencies up to 167 GHz, along with 0.5-mm PC board-mount connectors. Junkosha Inc. has introduced high-performance 0.5-mm test cables.

**Jens Klattenhoff, SVP and General Manager Systems Business Unit, FormFactor Inc. said:** "We are proud to partner with Keysight to extend Infinity Probe Technology, WinCal, and MicroChamber® Technology and deliver a fully integrated on-wafer coaxial solution up to 250 GHz. Our new InfinityXF™ 250 GHz probe series, featuring advanced thin-film contact technology, empowers engineers to achieve fast, precise, and repeatable measurements from DC to sub-THz frequencies, driving significant time savings and simplified setup for accurate data across a wide range of next-generation semiconductor device RF applications."

**Dr. Stojan Kanev, General Manager, Advanced Semiconductor Test Division, MPI Corporation said:** "This latest collaboration with Keysight marks a significant step forward, delivering a fully integrated 250 GHz solution that combines Keysight's high-performance PNA-X platform with our advanced TITAN™ probe technology. Together with Keysight's broadband extenders, this solution enables rapid deployment, seamless reconfiguration, and robust protection of sensitive system components, ensuring engineers achieve peak performance while safeguarding their investment."

**Joe Rickert, Vice President and General Manager, Keysight High-Frequency Measurements Center of Excellence said:** "With the introduction of our 170 and 250 GHz broadband VNA extenders, we are delivering the performance engineers need to validate next-generation semiconductors and high-speed network components. By combining industry-leading dynamic range and output power with a complete 0.5 mm coaxial ecosystem, we enable a simplified, high-confidence path for their high-frequency measurements."

### About Keysight Technologies

At Keysight (NYSE: KEYS), we inspire and empower innovators to bring world-changing technologies to life. As an S&P 500 company, we're delivering market-leading design, emulation, and test solutions to help engineers develop and deploy faster, with less risk, throughout the entire product life cycle. We're a global innovation partner enabling customers in communications, industrial automation, aerospace and defense, automotive, semiconductor, and general electronics markets to accelerate innovation to connect and secure the world. Learn more at Keysight Newsroom (<https://www.keysight.com/go/news>) and [www.keysight.com](http://www.keysight.com).

# NEW PRODUCTS AND SERVICES

## Fluke Expands Calibration Portfolio with New Solutions to Enhance Efficiency and Precision

*New calibrator and Null Meter option lowers costs, expands device workloads, and improves automation, addressing the modern workload of calibration professionals*

EVERETT, Wash., August 28, 2025 – Fluke Corporation announced a new addition to its 55XX multi-product calibrator series with the Fluke 5530A Basic Multi-Product Calibrator. Designed for calibration and metrology technicians, the 5530A targets industrial calibration workloads at a more affordable price point. In addition, a new Null Meter option was added to the Fluke 8588A-series Reference Multimeter for metrologists and calibration technicians in laboratory environments, creating a new generation of digital null meter capability that will obsolete analog null detectors.

“These new solutions reflect our deep collaboration with calibration professionals,” said Ben Ewoldt, Product Manager Fluke Calibration. “By listening closely to our customers, we developed the 5530A calibrator and enhanced Null Meter capabilities to deliver the precision, flexibility, and automation they need – at a better cost and with greater efficiency.”

The new 5530A Basic Multi-Product Calibrator is designed to be a workhorse for industrial organizations. The 5530A enables calibration technicians to keep their factories running and their equipment calibrated at a lower cost. Key features of the system include calibration support for 4.5-digit multimeters and as well as compatibility with the Fluke Calibration 52120A Transconductance Amplifier for expanded workloads. The 5530A also addresses power workloads with dual output for ACV and DCV.

Fluke also announced new firmware updates across its Fluke 55XX series that allow organizations to expand and automate their calibration workloads. The 55XX series of multiproduct calibrators, 5560A, 5550A, and 5540A, are receiving a new firmware update, allowing technicians and metrologists to execute calibrations with more automation.

The firmware update supports for higher amps on clamp meters for expanded workloads. Users can:

- Drive efficiency, save time in set up, and enhance the overall user experience with full control of up to three 52120A Transconductance Amplifiers via rear panel connectors.
- Understand exactly which coil is producing which amount of effective source current with Fluke Coil support through the graphical user interface (GUI).
- Take out the guesswork out of doing calculations by using the GUI to display how specifications are derived.

The new Null Meter option is now available for the 8588A Reference Multimeter. This option allows users to automate and complete null detection faster and more accurately with extremely low noise. New functionality includes:

- Aligning and balancing divider networks: Before use in high precision calibrations with 0.2ppm-0.5ppm accuracy.
- Digital-forward design: The null meter has an intuitive user interface to collect measurements that can be automated as needed.
- Less noise: Internal 5 Hz LP filter is now enabled when using this option, significantly reducing measurement noise to levels comparable to or better than traditional analog null detectors.
- Reduced current bias (typically less than 5pA, specified to less than 20pA).

To learn more about Fluke’s solutions for electrical calibration please visit <https://www.fluke.com/en-us/products/calibration-tools/electrical-calibration>.

### About Fluke

Founded in 1948, Fluke Corporation (<https://www.fluke.com/>) is the world leader in compact, professional electronic test tools and software for measuring and condition monitoring. Fluke customers are technicians, engineers, electricians, maintenance managers, and metrologists who install, troubleshoot, and maintain industrial, electrical, and electronic equipment and calibration processes.

*FLUKE is a registered trademark of Fluke Corporation. For more information, visit the Fluke website.*



# AI Needs Well-Formatted Data

Michael L. Schwartz

Cal Lab Solutions, Inc.

A couple of months ago, I presented at NCSLI on AI (Artificial Intelligence) and why AI doesn't work so well in metrology. At the heart of the problem is the mess of unstructured data.

Large Language Models (LLMs) operate by predicting the most probable next word in a sequence. Trained on massive datasets of text, they learn complex linguistic patterns to generate coherent and contextually relevant responses. When given a prompt, an LLM does not understand it in a human sense; instead, it statistically determines which words should follow based on its training. This "next-word prediction" mechanism, while simple in concept, enables LLMs to perform sophisticated tasks like writing essays and answering questions.

However, this text-based architecture makes LLMs fundamentally ill-suited for calculations, often required for analyzing scientific data. Lacking an inherent understanding of mathematical principles, they don't perform arithmetic like a calculator. Instead, an LLM guesses an answer by recalling how similar calculations appeared in its training data. This probabilistic approach makes them prone to errors and "hallucinating" numerically unsound results, as their strength lies in linguistic fluency, not the deterministic accuracy required for computation.

Writing automated calibration procedures is 80% about getting the test points, test limits, and all the unit-under-test's settings correct.

Looking up and calculating the test points from the equipment specification is NOT something LLMs are trained to do, and can lead to severe hallucinations. It is like having an untrained calibration technician just guessing what the test limits should be.

Manufacturers present specifications in columns, a format intuitive for human readers. However, Large Language Models (LLMs) process information sequentially, reading from left to right. This fundamental mismatch causes LLMs to struggle with associating vertically aligned values, labels, and units. This creates a significant bottleneck, leading to errors in automated data extraction and analysis.

What everybody writing automation for calibration wants an AI to do, is write the automated calibration procedure. So I thought I would give it a try with my AI server running Ollama.

After uploading the HP 34401A's calibration procedure and the specifications for the Fluke 5730A, along with the Fluke MET/CAL® help files, I asked several LLMs to write a MET/CAL procedure to calibrate the 34401A with the 5730A.

Based on my previous experience with AI, I didn't expect a successful outcome. I also didn't expect such a resounding failure. Though I was aware of the structural issues with the specification formatting in the manuals, I didn't realize the potential for errors was multi-layered.

Not only are the specifications

in a column format, those columns have different specifications based on different time periods. The 34401A has 24 hour ( $23\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ ), 90 Day ( $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ ), and 1 Year ( $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ ) specifications with an additional confusing column for Temperature Coefficient / $^{\circ}\text{C}$  ( $0\text{ }^{\circ}\text{C} - 18\text{ }^{\circ}\text{C}$ ) & ( $28\text{ }^{\circ}\text{C} - 55\text{ }^{\circ}\text{C}$ ).

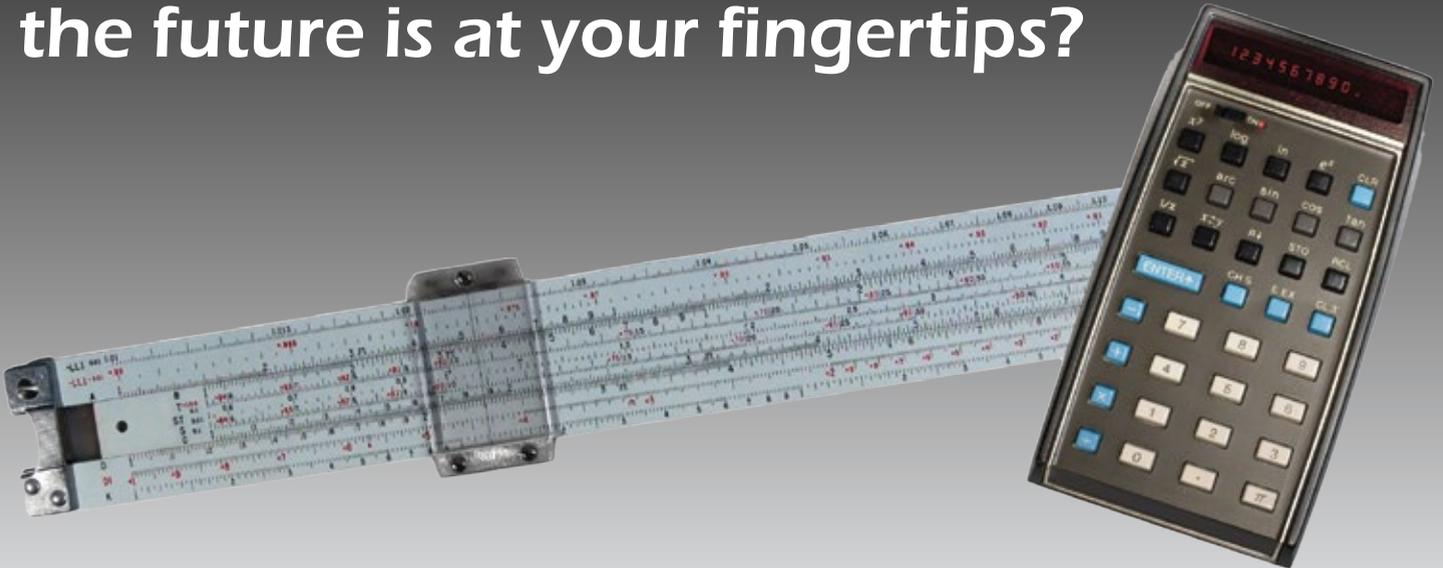
In my initial prompt, I didn't add a specification interval or temperature, but don't worry, updating the AI prompt didn't help!

Then I opened up the Fluke 5730A specifications and found even more potential confusion for an LLM. The intervals are similar, with the 5730A adding a 180 Day set of specifications, but the problems start with confidence. The 5730A has specifications for two different confidence levels, 99% and 95%. Even if I put the confidence level in the prompt, the 34401A documents didn't include confidence.

Temperature can also lead to confusion because the 5730A specs are written as "Absolute /  $\pm 5\text{ }^{\circ}\text{C}$  from calibration temperature" with an additional temperature spec of "Relative  $\pm 1\text{ }^{\circ}\text{C}$ " for 24 Hour and 90 Day specs. If the AI was to write this procedure meeting 100% of the quality and uncertainty calculations, it would have to know the calibration temperature of the 5730A when it was calibrated, something I didn't add to the prompt.

I know this is a long way of saying "We need well-formatted data in metrology to enable AI to generate reliable results!"

# Why struggle with the past when the future is at your fingertips?



## DISRUPTIVE INNOVATION

The **1972 introduction of the HP-35 scientific calculator** by Hewlett-Packard was a **classic example of disruptive innovation** that also triggered a **paradigm shift** in engineering and scientific calculations. The HP-35 effectively rendered the **slide rule**, the dominant tool for engineers and scientists for decades, **obsolete almost overnight**.

Similarly, **Metrology.NET** is positioned to revolutionize the calibration industry by replacing outdated legacy software with a modern, integrated, and automated solution.

Aspect	Slide Rule (Legacy Software)	HP-35 Calculator (Metrology.NET)
<b>Ease of Use</b>	Complex, requires expertise and training	Simple, intuitive, minimal learning curve
<b>Speed &amp; Efficiency</b>	Slow, manual calculations	Fast, automated processing
<b>Accuracy</b>	Prone to human error	Highly precise with minimal error
<b>Portability/Scalability</b>	Bulky, single-user	Compact, multi-user, and scalable
<b>Technological Advancement</b>	Mechanical, limited in functions	Digital, continuously evolving
<b>Market Disruption</b>	Decades of dominance ended overnight	Established software is now outdated
<b>Cost &amp; ROI</b>	Initially cheaper, but labor-intensive	Higher upfront, but massive long-term savings

# Additel 992 / 993 / 997 Handheld Pressure Pumps



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Capability*



*Adjustable Reference  
Connection*



*Up To 10,000 PSI  
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