

Electrical Instrumentation Calibration Procedures

Course No. 136

FOR WHOM INTENDED This course is intended for personnel involved in metrology, instrumentation and various testing activities. It is an elective for TTI's [Metrology Specialist Certificate Program](#) and is designed to provide basic understanding of the methodology of calibration of electrical measuring and test equipment.

BRIEF COURSE DESCRIPTION The course commences with a brief review of some basic terminology, systems of units, measurement standards, traceability and types of error. The course then covers calibration standards and documents affecting the calibration of electrical items.

A brief review is made of statistical analysis and uncertainty analysis, distributions and explanation of common definitions and notations used. Technical requirements in calibration procedures are covered, with content requirements.

The course then covers calibration equipment and techniques in detail, starting with a discussion of electrical instrument calibration with precision instruments such as analog and digital voltmeters, oscilloscopes, oscillators, counters, function generators, power supplies, RF Power Instrumentation, temperature simulation and measuring equipment, and other related devices.

Electrical working standards are discussed, such as meter calibrators, oscilloscope calibrators, multi-function calibrators, distortion analyzers, counters, LF Spectrum Analyzers, RCL Meters and substitution boxes, and more.

Attention will focus more on generic processes and theory of individual measurements versus how to calibrate a specific instrument. We will explore the background and theory of precision measurements in voltage, current, resistance, capacitance, inductance, frequency, and LF/RF power. Further discussion of measurement and theory in noise, total harmonic distortion, phase angle, modulation, and rise time will be pursued in detail.

The instructor presents the course aided by overhead Power Point slides. Students are expected to participate in classroom discussion and exercises.

CERTIFICATE PROGRAMS This course is required for TTI's [Instrumentation Test Specialist Certificate Program](#). A recommended elective for the [Metrology Specialist Certificate](#), it may be an elective for any other [TTI certificate program](#).

PREREQUISITES There are no definite prerequisites, but TTI's courses [Electronics for Non-Electronic Engineers](#), [Metrology Concepts](#) and [Instrumentation for Electrical Test and Measurement](#) would be helpful.

Supervisors are invited to telephone or e-mail TTI on prospective attendees' backgrounds and needs.

TEXT Each participant will receive a [course workbook](#), which contains most of the PowerPoint slides used during the presentation. The appendix includes metrology reference information.

COURSE HOURS, CERTIFICATE AND CEUs Open courses meet seven hours per day. Upcoming presentation dates can be found on our current [open course schedule](#). Class hours/days for on-site courses can vary from 14–35 hours over 2–5 days as requested by our clients. Upon successful course completion, each participant receives a certificate of completion and one Continuing Education Unit (CEU) for every ten class hours.

For [schedules](#), [general information](#) and a [registration form](#), see TTI's web site.

Course Outline

Introduction and Focus • Metrology Terminology:

Scope of Metrology • Measurement Processes
Definitions of Measurement — Calibration • VIM • Glossaries
International System of Units ("SI")
Base units • Derived units • Customary units in US
Measurement Standards • Traceability • Measurement error

Technical Requirements in Calibration Standards

Management vs. technical requirements
Technical requirements: MIL-STD 45662A • ANSI Z540-1-1994
Calibration requirements in ISO 9000 series quality documents
Technical Requirements in ISO Guide 25 & Standard 17025
Applicable Quality Standards
Types of Standards: Meter Calibrators • Oscilloscope Calibrators
Multifunction Calibrators • Distortion Analyzers • Counters
LF Spectrum Analyzers & FFTs • RCL Devices
Ancillary Equipment

Review of Statistical Analysis and Uncertainty

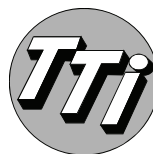
Uncertainty Components • Statistics of Measurement:
Experimental Standard Deviations • Efficiency of Arithmetic Mean • Cumulative Distribution and Probability Density Functions • Confidence Levels
Purpose of a Measurement • Decision Risks • Class Exercise:
Estimating Measurement Uncertainty of a Calibration Process
Technical Requirements in Calibration Procedures
Procedure content requirements

Electrical Calibration

VOM Devices:
Voltmeters • Ammeters • Ohmmeters • Multi-Meters
Oscilloscopes: Analog • Digital • High Bandwidth
Synthesizers/Sweepers: Distortion • Review of logarithmic scales
Attenuation • Flatness • Modulation: AM, FM, PM, Pulse
Counters: Frequency Offset versus Drift • Period • Phase
Totalize • Ratio
Function Generators & Pulse Generators
Square Wave Characteristics • Pulse Parameters
Triangular and Ramp Linearity • Arbitrary Wave Generation
Power Supplies: Line Regulation • Load Regulation
Noise & Ripple • Other Parameters
Temperature/ Humidity Simulation & Measure:
Thermocouple • RTD • SPRT • Data Logging Types
Chart Recorders • Humidity Generation
Spectrum and Network Analyzers: The Frequency Domain
Center Frequency and Span Tests • Flatness Tests
Bandwidth, Selectivity, and IM Tests • Tracking Generators
Calibration and Validation Kits
Impedance Bridges • Amplifiers • Logic Analyzers
Angle Position Indicators
RF Power Measurement: Diode and Thermistor Sensors
Power Meters • Uncertainty Factors
Vibration Equipment: Accelerometers
Vibration Monitors and Controllers
Class Suggested Devices/Concerns

Overview of ISO 17025

Material Review Boards • Corrective Action • Preventive Action
Class Project • Summary, Final exam
Award of certificates for successful completion



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