

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 recommended for TTI's [Instrumentation Test Specialist Diploma Program](#) and is designed to provide a 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 measurement uncertainty.

The course then covers calibration equipment and techniques in detail, starting with a discussion of electrical instrument calibration with precision instruments such as VOM devices, oscillators, counters, function generators, power supplies, RF power instrumentation, temperature simulation and measuring equipment, and fiber optic instruments.

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 than on 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.

DIPLOMA PROGRAMS This course is recommended for TTI's <http://pubs.ttiedu.com/ITS>. It may be used as an optional course for any other [TTi diploma 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 student will receive access to the on-line electronic course workbook, including most of the slides used in the course presentation. An initial subscription is included in the price of the course and renewals are available for an additional fee. The appendix includes metrology reference information.

COURSE HOURS, CERTIFICATE AND CEUs 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.

Course Outline

Introduction and Focus • Metrology Terminology

Scope of Metrology • Measurement Processes • Units
Measurement error • Classification of Error • Error vs. Accuracy

Measurement Standards and Traceability

Measurement Standards • Traceability • Definition of the Second Coordinated Universal Time (UTC) • Definition of the Ampere Voltage Reference • Josephson Junction • Standard Resistor

Technical Requirements in Calibration Standards

US Government Agencies • Calibration Program—Operations
Historical requirements: MIL-STD 45662A • ANSI Z540-1-1994
Compliance Documents • NIST • Calibration Procedure Template
Handling, Records, Certificates & Reports • Accreditation
Technical and Calibration requirements in ISO 9000

Types of Standards: Oscilloscope Calibrators

Multifunction Calibrators • Distortion Analyzers • Counters
LF Spectrum Analyzers & FFTs • RCL Devices

Measurement Uncertainty

Purpose of a Measurement • Accuracy Concept
Error types: Random, Instrumentation, Environmental and Observational • Reduction of Observer Bias (exercise)
Estimating Measurement Uncertainty of a Calibration Process

Example: Estimating Electrical Uncertainty

Calibration of a Hand-Held Digital Multi-meter at 100 V dc
Resolution • Uncertainty Budget • Expanded Uncertainty

Electrical Calibration

VOM Devices: Digital Multi-Meters • DMM Data Sheet • Tolerances
Terminology • Two Wire and Four Wire Ohms • Processes

Synthesizers/Sweepers: Dbm and Dbu Power

Synthesized Sweep Oscillator Specifications • Level Specs
Output Level Flatness • Frequency Specifications • Harmonics
Phase Noise Display • Modulation • Measuring Power
Mismatch Calculation and Conversions • Frequency Meter
Harmonic Test with Spectrum Analyzer • Phase Noise Test

Counters, Function & Pulse Generators, Power Supplies

Counters • Frequency Standards • Counters—Functions

Function and Pulse Generators • Pulse Characteristics

Power Supplies • Grounding of Power Supply

Temperature/ Humidity Simulation & Measurement

Thermocouple • SPRT • RTD • Data Logging Types

Humidity Calibration • Chilled Mirror Concept

Spectrum and Network Analyzers: The Frequency Domain
Calibration and Validation Kits

Impedance Bridges • Amplifiers • Logic Analyzers

Angle Position Indicators

RF Power Measurement: RF Power Meter Use

RF Power Meter and Sensor Calibration

Fiber Optic Calibration: Overview • Optical Specifications

Optical Devices: Power Meter, Sources, Spectrum Analyzers

Wave Meters • OTDR and Back Reflection • Optical Attenuator

Calibration of Vibration Measuring Instruments: Transducers

Strain Gages • Accelerometers • Comparison Method

Oscilloscopes: Analog • Digital • High Bandwidth • Specifications

Calibration Procedures

Overview of ISO 17025

Material Review Boards • Corrective Action • Preventive Action

Class Project • Summary, Final Review

Award of certificates for successful completion



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