



THE AMERICAN ASSOCIATION FOR
LABORATORY ACCREDITATION

ACCREDITED LABORATORY

A2LA has accredited

TECHNICAL MAINTENANCE INCORPORATED **Madison, AL**

for technical competence in the field of

Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This laboratory also meets the requirements of ANSI/NCSL Z540-1-1994 and any additional program requirements in the field of calibration. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 18 June 2005*).

Presented this 2nd day of May 2008.

A handwritten signature in cursive script, reading "Peter Abney", positioned above a horizontal line.

President
For the Accreditation Council
Certificate Number 1378.03
Valid to March 31, 2010



For the calibrations to which this accreditation applies, please refer to the laboratory's Calibration Scope of Accreditation.

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005
& ANSI/NCSL Z540-1-1994

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CALIBRATION

Valid To: March 31, 2010

Certificate Number: 1378.03

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations¹:

I. Electrical – DC & Low Frequency

Parameter/Equipment	Range	Best Uncertainty ^{2, 3, 5, 6, 7} (±)	Comments
DC Voltage – Generate	Up to 330 mV 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V (330 to 1000) V	21 µV/V + 1 µV 12 µV/V + 2 µV 13 µV/V + 20 µV 19 µV/V + 150 µV 19 µV/V + 1.5 mV	Fluke 5520A
DC Voltage – Measure	Up to 100 mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1000) V	11 µV/V + 0.3 µV 10 µV/V + 0.3 µV 10 µV/V + 0.5 µV 12 µV/V + 30 µV 12 µV/V + 100 µV + 12 (V _{IN} /1000) ² µV/V	HP 3458A
DC Current – Generate	Up to 330 µA 330 µA to 3.3 mA 3.3 mA to 330 mA 33 mA to 330 mA 330 mA to 1.1 A (1.1 to 3.0) A (3.0 to 11) A (11 to 20.5) A	160 µA/A + 0.02 µA 110 µA/A + 0.03 µA 110 µA/A + 0.2 µA 110 µA/A + 2.5 µA 210 µA/A + 40 µA 390 µA/A + 40 µA 510 µA/A + 500 µA 0.11 % + 750 µA	Fluke 5520A

Parameter/Equipment	Range	Best Uncertainty ^{2, 3,5,6,7} (±)	Comments
DC Current – Measure	Up to 100 µA 100 µA to 10 mA (10 to 100) mA 100 mA to 1 A	22 µA/A + 0.8 nA 22 µA/A + 0.05 µA 37 µA/A + 0.5 µA 0.012 % + 10 µA	HP 3458A
AC Voltage – Generate			Fluke 5520A
(1 to 33) mV	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.09 % + 6 µV 0.03 % + 6 µV 0.03 % + 6 µV 0.1 % + 6 µV 0.36 % + 12 µV 0.8 % + 50 µV	
(33 to 330) mV	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.04 % + 8 µV 0.03 % + 8 µV 0.03 % + 8 µV 0.05 % + 8 µV 0.09 % + 32 µV 0.21 % + 70 µV	
(0.33 to 3.3) V	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.04 % + 50 µV 0.03 % + 25 µV 0.03 % + 50 µV 0.04 % + 50 µV 0.09 % + 130 µV 0.25 % + 600 µV	
(3.3 to 33) V	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.03 % + 650 µV 0.02 % + 200 µV 0.03 % + 600 µV 0.04 % + 600 µV 0.09 % + 1600 µV	

Parameter/Equipment	Range	Best Uncertainty ^{2,3,5,6,7} (±)	Comments
AC Voltage – Generate (cont)			
(33 to 330) V	45 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.02 % + 2 mV 0.02 % + 6 mV 0.03 % + 6 mV 0.03 % + 6 mV 0.20 % + 50 mV	Fluke 5520A
(330 to 1020) V	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.03 % +10 mV 0.03 % +10 mV 0.03 % +10 mV	
AC Voltage – Measure			
Up to 10 mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.04 % reading + 0.03 % range 0.03 % reading + 0.011 % range 0.04 % reading + 0.011 % range 0.1 % reading + 0.011 % range 0.5 % reading + 0.011 % range 4 % reading + 0.02 % range	HP 3458A
10 mV to 10 V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	0.02 % reading + 0.004 % range 0.02 % reading + 0.002 % range 0.026 % reading + 0.002 % range 0.04 % reading + 0.002 % range 0.09 % reading + 0.002 % range 0.31 % reading + 0.01 % range 1 % reading + 0.01 % range 1.5 % reading + 0.01 % range	
(10 to 100) V	(1 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.04 % reading + 0.002 % range 0.03 % reading + 0.002 % range 0.05 % reading + 0.002 % range 0.13 % reading + 0.002 % range 0.4 % reading + 0.01 % range 1.5 % reading + 0.01 % range	
(100 to 1000) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.05 % reading + 0.004 % range 0.05 % reading + 0.002 % range 0.07 % reading + 0.002 % range 0.13 % reading + 0.002 % range 0.3 % reading + 0.002 % range	

Parameter/Range	Frequency	Best Uncertainty ^{2,3,5,6,7} (±)	Comments
AC Current – Generate ³ (29 to 330) µA 330 µA to 3.3 mA (3.3 to 33) mA (33 mA to 330) mA 330 mA to 1.1 A (1.1 to 3) A (3 to 11) A (11 to 20.5) A	45 Hz to 1 kHz	0.14 % + 0.1 µA 0.11 % + 0.15 µA 0.05 % + 2 µA 0.05 % + 20 µA 0.07 % + 100 µA 0.08 % + 1 mA 0.12 % + 2 mA 0.16 % + 5 mA	Fluke 5520A

Parameter/Equipment	Range	Best Uncertainty ^{2,3,5} (±)	Comments
AC Current – Measure Up to 100 µA 100 µA to 100 mA 100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	0.41 % + 0.03 pA 0.16 % + 0.03 pA 0.07 % + 0.03 pA 0.41 % + 20 µA 0.16 % + 20 µA 0.07 % + 20 µA 0.04 % + 20 µA 0.07 % + 20 µA 0.41 % + 40 µA 0.56 % + 150 µA 0.41 % + 0.2 mA 0.17 % + 0.2 mA 0.09 % + 0.2 mA 0.11 % + 0.2 mA 0.31 % + 0.2 mA 1 % + 0.4 mA	HP 3458A

Parameter/Equipment	Range	Best Uncertainty ^{2, 3,5,6,7} (\pm)	Comments	
Resistance – Generate	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 k Ω (1.1 to 3.3) k Ω (3.3 to 11) k Ω (11 to 33) k Ω (33 to 110) k Ω (110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω 330 M Ω to 1.1 G Ω	42 $\mu\Omega/\Omega$ + 0.01 Ω 43 $\mu\Omega/\Omega$ + 0.015 Ω 31 $\mu\Omega/\Omega$ + 0.015 Ω 32 $\mu\Omega/\Omega$ + 0.02 Ω 30 $\mu\Omega/\Omega$ + 0.02 Ω 31 $\mu\Omega/\Omega$ + 0.2 Ω 31 $\mu\Omega/\Omega$ + 0.02 Ω 31 $\mu\Omega/\Omega$ + 1 Ω 30 $\mu\Omega/\Omega$ + 1 Ω 35 $\mu\Omega/\Omega$ + 10 Ω 34 $\mu\Omega/\Omega$ + 10 Ω 61 $\mu\Omega/\Omega$ + 150 Ω 0.013 % + 250 Ω 0.025 % + 2500 Ω 0.05 % + 3000 Ω 0.3 % + 100 k Ω 1.5 % + 500 k Ω	Fluke 5520A	
Resistance – Measure	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 k Ω 1 k Ω to 10 k Ω 10 k Ω to 100 k Ω 100 k Ω to 1 M Ω 1 M Ω to 10M Ω 10 M Ω to 100 M Ω 100 M Ω to 1 G Ω	20 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 18 $\mu\Omega/\Omega$ + 0.5 m Ω 15 $\mu\Omega/\Omega$ + 0.5 m Ω 13 Ω/Ω + 5 m Ω 16 $\mu\Omega/\Omega$ + 5 m Ω 19 $\mu\Omega/\Omega$ + 2 Ω 51 $\mu\Omega/\Omega$ + 100 Ω 0.05 % + 1 k Ω 0.6 % + 10 k Ω	HP 3458A	
Capacitance – Generate	(0.19 to 0.1099) nF (1.1 to 3.2999) nF (3.3 to 329.999) nF (0.33 to 1.09999) μ F (1.1 to 3.29999) μ F (3.3 to 10.9999) μ F (11 to 32.999) μ F (33 to 109.999) μ F (110 to 329.999) μ F (0.33 to 1.09999) mF (1.1 to 3.2999) mF (3.3 to 10.9999) mF (11 to 32.9999) mF (3.3 to 110) mF	10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz (0 to 50) Hz (0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz	1.2 % + 0.01 nF 1.2 % + 0.01 nF 0.37 % + 0.3 nF 0.39 % + 3 nF 0.39 % + 3 nF 0.4 % + 10 nF 0.59 % + 30 nF 0.57 % + 100 nF 0.57 % + 300 nF 0.57 % + 1 μ F 0.6 % + 3 μ F 0.59 % + 10 μ F 0.6 % + 30 μ F 1.3 % + 100 μ F	Fluke 5520A

Parameter/Equipment	Range	Best Uncertainty ^{2,3,4,5,6,7} (\pm)	Comments
Power Meters	3 μ W to 100 mW	0.06 % of reading (rdg)	HP 11683A
Oscilloscopes – Amplitude – Square Wave (peak to peak) 50 Ω 1 M Ω Rise Time Flatness (50 kHz reference) 5 mV to 5.5 V Time Marker	 1 mV to 6.6 V 1 mV to 130 V <300 ps 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz 1 ns to 20 ms 50 ms to 5 s	 0.5 % + 40 μ V 0.3 % + 40 μ V (+13 ps / -101 ps) 1.5 % + 100 μ V 2 % + 100 μ V 4 % + 100 μ V 5 % + 100 μ V 3 parts in 10 ⁶ (26 + 1000t) parts in 10 ⁶	Fluke 5520A/SC1100

Parameter/Equipment	Range	Best Uncertainty ^{2,3,5,6} (\pm)	Comments
Electrical Calibration of Thermocouple Indicating Devices – Type J Type K Type T	 -210 °C to 1200 °C -200 °C to 1372 °C -250 °C to 400 °C	 0.28 °C 0.41 °C 0.49 °C	Fluke 5520A

II. Electrical – RF/Microwave

Parameter/Range	Frequency	Best Uncertainty ^{2,3} (±)	Comments
RF Attenuation – (0 to -10) dB	(10 to 1300) MHz (1.3 to 26.5) GHz	0.026 dB 0.028 dB	HP 8902A w/ HP 11722A, HP 11792A
(-11 to -20) dB	(10 to 1300) MHz (1.3 to 26.5) GHz	0.033 dB 0.035 dB	
(-21 to -30) dB	(10 to 1300) MHz (1.3 to 26.5) GHz	0.048 dB 0.049 dB	
(-31 to -40) dB	(10 to 1300) MHz (1.3 to 26.5) GHz	0.048 dB 0.049 dB	
(-41 to -50) dB	(10 to 1300) MHz (1.3 to 26.5) GHz	0.05 dB 0.06 dB	
(-51 to -60) dB	(10 to 1300) MHz (1.3 to 26.5) GHz	0.06 dB 0.07 dB	
(-61 to -70) dB	(10 to 1300) MHz (1.3 to 26.5) GHz	0.08 dB 0.09 dB	
(-71 to -80) dB	(10 to 1300) MHz (1.3 to 26.5) GHz	0.09 dB 0.10 dB	
(-81 to -90) dB	(10 to 1300) MHz (1.3 to 26.5) GHz	0.09 dB 0.25 dB	
(-91 to -100) dB	(10 to 1300) MHz (1.3 to 26.5) GHz	0.10 dB 0.36 dB	
(-101 to -110) dB	(10 to 1300) MHz	0.12 dB	
(-111 to -120) dB	(10 to 1300) MHz	0.24 dB	

Parameter/Range	Frequency	Best Uncertainty ^{2,3} (\pm)	Comments
Amplitude Modulation – 5 % to 99 %	150 kHz to 10 MHz (10 to 1300) MHz (1.3 to 26.5) GHz	2.1 % of rdg + 1 digit 1.2 % of rdg + 1 digit 1.7 % of rdg + 1 digit	HP 8902A
Frequency Modulation – (\leq 400 kHz)	250 kHz to 10 MHz 10 MHz to 26.5 GHz	2.1 % of rdg + 1 digit 1.3 % of rdg + 1 digit	HP 8902A
Phase Modulation – 200 Hz to 10 kHz	150 kHz to 10 MHz 10 MHz 26.5 GHz	4.5 % of rdg + 1 digit 3.9 % of rdg + 1 digit	HP 8902A
RF Power – (0 to 30) dBm	100 kHz to 2.6 GHz (0.1 to 26.5) GHz	2.0 % of rdg 3.5 % of rdg	HP 8902A w/ 11722A HP 8902A w/ 11792A

II. Mechanical

Parameter/Equipment	Range	Best Uncertainty ^{2,3,4} (\pm)	Comments
Scales and Balances	10 g to 500 lb	0.01% of rdg + 0.6R	Class F weights
Pressure	(5 to 10 000) psi	0.1 % of rdg	Ametek R-100
Torque – Measure	5 in·lb to 1000 ft·lb	0.8 % of rdg	CDI torque system
Torque Analyzers	Up to 1000 ft·lb	0.09 % of rdg	Weights and Arm
Force – (Tension and Compression)	10 mgf to 540 lbf	0.1 % of rdg	Class F weights

IV. Dimensional

Parameter/Equipment	Range	Best Uncertainty ^{2,3,4} (±)	Comments
Micrometers	Up to 46 in	(11 + 12L) μin	Gage blocks (Grade 2)
Calipers	Up to 46 in	(34 + 10L) μin	Gage blocks (Grade 2)
Rulers	Up to 46 in	0.009 in	Gage blocks (Grade 2)
Surface Plates – Flatness	Up to 6 ft × 6 ft	94 μin 74 μin	Rhan planeakator Repeat-o-Meter
Optical Comparators – Linearity	Up to 20 in (20 to 40) in	540 μin 760 μin	Precision balls, Starret Webber 81, SI Industries glass scales
Magnification	10x to 100x	700 μin	
Pin Gages	Up to 1 in	50 μin	Micrometer, Class ZZ
Dial Indicators	Up to 12 in	(120 + 3.7L) μin	Gage blocks (Grade 2)

V. Time and Frequency

Parameter/Range	Frequency	Best Uncertainty ^{2,3} (±)	Comments
Frequency – Measure	10 MHz	5 parts in 10 ¹⁰	Loran C
	10 Hz to 500 MHz	3 parts in 10 ⁹	HP 5345A
	500 MHz to 26.5 GHz	5 parts in 10 ⁹	HP 5343A

VI. Thermodynamics

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Relative Humidity	11 % RH 33 % RH 75 % RH	1.0 % of rdg RH 1.0 % of rdg RH 1.0 % of rdg RH	Vaisala LiCl Salt Vaisala MgCl Salt Vaisala NaCl Salt

¹ This laboratory offers commercial calibration service and on-site calibration service.

² “Best Uncertainty” is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards of nearly ideal measuring equipment. Best uncertainties represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of $k = 2$. The best uncertainty of a specific calibration performed by the laboratory may be greater than the best uncertainty due to the behavior of the customer’s device, to the environment (if the calibration is performed in the field) and to influences from the circumstances of the specific calibration.

³ The uncertainties achievable on a customer's site can normally be expected to be larger than the Best Measurement Capabilities (BMC) that the accredited laboratory has been assigned as Best Uncertainty on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the calibration uncertainty being larger than the BMC.

⁴ In the statement of best uncertainty, L is the numerical value of the nominal length of the device measured in inches; R is the numerical value for the resolution of the weight; and, t is the numerical value of the nominal time in seconds.

⁵ Uncertainties on electrical parameters listed in percentages are a percent of reading unless otherwise indicated.

⁶ The measurands stated are generated with the Fluke 5500 series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. Best measurement uncertainties are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.

⁷ The measurands stated are measured with the HP 3458A. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. Best measurement uncertainties are expressed as either a specific value that covers the full range or as a combination of the fraction of the reading/output plus a range specification.