

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

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CALIBRATION

Valid To: November 30, 2010

Certificate Number: 1995.02

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 (±)	Comments
DC Voltage ³ – Generate	(0 to 330) mV 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V (330 to 1020) V	70 µV/V + 4 µV 60 µV/V + 6 µV 60 µV/V + 67 µV 65 µV/V + 0.59 mV 65 µV/V + 1.8 mV	Fluke 5500A
DC Voltage ⁴ – Measure	(0 to 120) mV (0.12 to 1.2) V (1.2 to 12) V (12 to 120) V (120 to 1050) V	15 µV/V + 2 µV 14 µV/V + 2 µV 14 µV/V + 10 µV 16 µV/V + 0.12 mV 18 µV/V + 0.7 mV	HP 3458A
DC Current ³ – Generate	(0 to 3.3) mA (3.3 to 33) mA (33 to 330) mA 330 mA to 2.1 A (2.1 to 11) A	0.017 % + 0.06 µA 0.014 % + 0.29 µA 0.016 % + 3.8 µA 0.04 % + 51 µA 0.08 % + 0.38 mV	Fluke 5500A

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
DC Current ⁴ – Measure	(0 to 120) nA (0.12 to 1.2) μA (1.2 to 12) μA (12 to 120) μA (0.12 to 1.2) mA (1.2 to 12) mA (12 to 120) mA (0.12 to 1.05) A	78 μA/A + 12 nA 73 μA/A + 12 nA 73 μA/A + 12 nA 73 μA/A + 12 nA 73 μA/A + 13 nA 73 μA/A + 0.13 μA 90 μA/A + 1.3 μA 0.017 % + 37 μA	HP 3458A
Resistance ³ – Generate	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 to 1.1) kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ (0.33 to 1.1) MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ	0.014 % + 9 mΩ 0.014 % + 17 mΩ 0.01 % + 17 mΩ 0.01 % + 17 mΩ 0.01 % + 70 mΩ 0.01 % + 70 mΩ 0.01 % + 0.7 Ω 0.01 % + 0.7 Ω 0.013 % + 7 Ω 0.014 % + 7 Ω 0.017 % + 64 Ω 0.018 % + 0.13 kΩ 0.07 % + 0.65 kΩ 0.13 % + 1.3 kΩ 0.6 % + 6.5 kΩ 0.8 % + 23 kΩ	Fluke 5500A
By Decades	(1 to 10) Ω (0.1 to 1) kΩ (1 to 10) kΩ (0.1 to 1) MΩ (10 to 100) MΩ	$3.9 \times 10^{-6} \mu\Omega/\Omega$ $0.95 \times 10^{-6} \mu\Omega/\Omega$ $0.7 \times 10^{-6} \mu\Omega/\Omega$ $1.1 \times 10^{-6} \mu\Omega/\Omega$ $8.2 \times 10^{-6} \mu\Omega/\Omega$	ESI SR1010 ESI SR104 ESI SR1050
Resistance ⁴ – Measure	(0 to 12) Ω (12 to 120) Ω (0.12 to 1.2) kΩ (1.2 to 12) kΩ (12 to 120) kΩ (0.12 to 1.2) MΩ (1.2 to 12) MΩ (12 to 120) MΩ	42 μΩ/Ω + 58 μΩ 27 μΩ/Ω + 0.58 mΩ 21 μΩ/Ω + 0.58 mΩ 20 μΩ/Ω + 5.8 mΩ 22 μΩ/Ω + 58 mΩ 31 μΩ/Ω + 2.3 Ω 79 μΩ/Ω + 120 Ω 0.06 % + 1.2 kΩ	HP 3458A

Parameter/Equipment	Range	Best Uncertainty ² (±)	Comments
Electrical Calibration of Thermocouple Indicators ³ – Generate & Measure			
Type E	-250 °C to -100 °C -100 °C to -25 °C -25 °C to 350 °C 350 °C to 650 °C 650 °C to 1000 °C	0.58 °C 0.19 °C 0.16 °C 0.18 °C 0.24 °C	Fluke 5500A
Type J	-210 °C to -100 °C -100 °C to -30 °C -30 °C to 150 °C 150 °C to 760 °C 760 °C to 1200 °C	0.31 °C 0.19 °C 0.16 °C 0.2 °C 0.27 °C	
Type K	-200 °C to -100 °C -100 °C to -25 °C -25 °C to 120 °C 120 °C to 1000 °C 1000 °C to 1372 °C	0.38 °C 0.21 °C 0.19 °C 0.3 °C 0.46 °C	
Type R	0 °C to 250 °C 250 °C to 400 °C 400 °C to 1000 °C 1000 °C to 1767 °C	0.66 °C 0.4 °C 0.38 °C 0.46 °C	
Type S	0 °C to 250 °C 250 °C to 1000 °C 1000 °C to 1400 °C 1400 °C to 1767 °C	0.54 °C 0.42 °C 0.43 °C 0.53 °C	
Type T	-250 °C to -150 °C -150 °C to 0 °C 0 °C to 120 °C 120 °C to 400 °C	0.73 °C 0.28 °C 0.19 °C 0.16 °C	

Parameter/Equipment	Range	Best Uncertainty ^{2,5} (±)	Comments
Electrical Calibration of RTD Indicators – Generate ³ Pt 385, 100 Ω	-200 °C to -80 °C -80 °C to 0 °C 0 °C to 100 °C 100 °C to 300 °C 300 °C to 400 °C 400 °C to 630 °C 630 °C to 800 °C	0.059 °C 0.059 °C 0.082 °C 0.11 °C 0.12 °C 0.14 °C 0.27 °C	Fluke 5500A
Capacitance ³ – Generate 2 V @ 1 kHz 1 V @ 1 kHz 1 V @ 100 Hz Fixed Values (By Steps)	(0.33 to 0.5) nF (0.5 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (0.33 to 1.1) μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (0.0001 to 0.5) μF	58 μF/F + 12 pF 58 μF/F + 12 pF 58 μF/F + 12 pF 58 μF/F + 12 pF 29 μF/F + 120 pF 29 μF/F + 120 pF 29 μF/F + 350 pF 29 μF/F + 1.2 nF 40 μF/F + 3.5 nF 40 μF/F + 12 nF 46 μF/F + 35 nF 58 μF/F + 120 nF 0.1 %	Fluke 5500A Arco SS-32 standard capacitors
Capacitance – Measure	10 pF 100 pF 1.5 nF 6.4 nF 10 nF 25 nF 100 nF (200 to 1000) nF (10 to 100) μF	5.9 % 0.64 % 0.099 % 0.071 % 0.068 % 0.065 % 0.063 % 0.06 % 0.09 %	GenRad 1689M RLC Digibridge
Inductance – Generate, Fixed Values	100 mH	0.1 %	GenRad 1482-L

Parameter/Equipment	Range	Best Uncertainty ^{2,5} (±)	Comments
Inductance – Measure	1 mH to 10 H	0.12 %	GenRad 1689M

Parameter/Range	Frequency	Best Uncertainty ² (±)	Comments
AC Voltage ³ – Generate			
(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	0.41 % + 30 µV 0.17 % + 26 µV 0.23 % + 26 µV 0.29 % + 26 µV 0.42 % + 52 µV 1.2 % + 83 µV	Fluke 5500A
(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	0.3 % + 0.13 mV 0.06 % + 25 µV 0.12 % + 25 µV 0.19 % + 52 µV 0.28 % + 0.22 mV 0.82 % + 0.6 mV	
(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	0.19 % + 0.45 mV 0.04 % + 0.11 mV 0.09 % + 0.11 mV 0.16 % + 0.42 mV 0.28 % + 2.1 mV 0.6 % + 6.9 mV	
(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	0.19 % + 4.5 mV 0.05 % + 1.4 mV 0.09 % + 3.2 mV 0.22 % + 7.4 mV 0.29 % + 23 mV	
(33 to 330) V	45 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz	0.06 % + 8.9 mV 0.09 % + 1.2 mV 0.1 % + 1.2 mV	
(330 to 1020) V	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.06 % + 92 mV 0.23 % + 1.2 mV 0.23 % + 1.3 mV	

Parameter/Range	Frequency	Best Uncertainty ² (±)	Comments
AC Voltage ⁴ – Measure			
(0.6 to 12) mV	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz (0.1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 250) kHz	0.47 % + 38 μV 0.18 % + 30 μV 0.07 % + 30 μV 0.03 % + 30 μV 0.18 % + 30 μV 0.82 % + 41 μV 4.7 % + 83 μV	HP 3458A
(6 to 120) mV	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz (0.1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 250) kHz (250 to 500) kHz (0.5 to 1) MHz (1 to 2) MHz	0.47 % + 30 μV 0.18 % + 26 μV 0.07 % + 16 μV 0.03 % + 16 μV 0.18 % + 48 μV 0.69 % + 99 μV 2.3 % + 0.58 mV 3.5 % + 0.7 mV 5.8 % + 2.3 mV 12 % + 5.8 mV	
(0.06 to 1.2) V	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz (0.1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 250) kHz (250 to 500) kHz (0.5 to 1) MHz (1 to 2) MHz	0.47 % + 0.26 mV 0.17 % + 0.24 mV 0.07 % + 0.12 mV 0.025 % + 0.12 mV 0.17 % + 0.47 mV 0.69 % + 0.93 mV 2.3 % + 5.8 mV 3.5 % + 6.9 mV 5.8 % + 23 mV 12 % + 58 mV	
(0.6 to 12) V	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz (0.1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 250) kHz (250 to 500) kHz (0.5 to 1) MHz (1 to 2) MHz	0.47 % + 2.6 mV 0.17 % + 2.3 mV 0.07 % + 1.2 mV 0.025 % + 1.2 mV 0.17 % + 4.6 mV 0.69 % + 9.2 mV 2.3 % + 58 mV 3.5 % + 70 mV 5.8 % + 0.23 V 12 % + 0.58 V	

Parameter/Range	Frequency	Best Uncertainty ² (±)	Comments
AC Voltage ⁴ – Measure (cont.)			
(6 to 120) V	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz (0.1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 250) kHz (250 to 500) kHz (0.5 to 1) MHz	0.47 % + 23 mV 0.17 % + 23 mV 0.07 % + 12 mV 0.036 % + 12 mV 0.18 % + 46 mV 0.58 % + 92 mV 2.4 % + 0.58 V 3.6 % + 0.7 V 6 % + 2.3 V	HP 3458A
(53 to 1050) V	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz (0.1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.49 % + 0.35 V 0.2 % + 0.35 V 0.09 % + 0.23 V 0.07 % + 0.23 V 0.17 % + 0.47 V 0.69 % + 2.3 V	
AC Current ³ – Generate			
(0.03 to 0.33) mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.3 % + 0.2 µA 0.15 % + 0.2 µA 0.15 % + 0.3 µA 0.47 % + 0.6 µA 1.5 % + 1.2 µA	Fluke 5500A
(0.33 to 3.3) mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.25 % + 0.7 µA 0.13 % + 0.6 µA 0.12 % + 0.6 µA 0.24 % + 5.8 µA 0.72 % + 12 µA	
(3.3 to 33) mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.25 % + 6.7 µA 0.13 % + 5.8 µA 0.11 % + 5.8 µA 0.24 % + 58 µA 0.72 % + 0.12 mA	

Parameter/Range	Frequency	Best Uncertainty ² (±)	Comments
AC Current ³ – Generate (cont.)			
(33 to 330) mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.25 % + 35 µA 0.14 % + 35 µA 0.14 % + 58 µA 0.25 % + 0.12 mA 1.4 % + 0.24 mA	Fluke 5500A
(0.33 to 2.2) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz	0.25 % + 0.35 mA 0.14 % + 0.35 mA 0.87 % + 0.37 mA	
(2.2 to 11) A	(45 to 65) Hz (65 to 500) Hz (0.5 to 1) kHz	0.08 % + 2.3 mA 0.12 % + 2.3 mA 0.38 % + 2.3 mA	
AC Current ⁴ – Measure			
(6 to 120) µA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.47 % + 0.04 µA 0.18 % + 0.04 µA 0.072 % + 0.03 µA 0.11 % + 0.06 µA	HP 3458A
(0.06 to 1.2) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz (5 to 10) kHz	0.47 % + 0.24 µA 0.18 % + 0.24 µA 0.072 % + 0.24 µA 0.088 % + 0.62 µA 0.22 % + 1.2 µA	
(0.6 to 12) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz (5 to 10) kHz	0.47 % + 2.4 µA 0.18 % + 2.4 µA 0.072 % + 2.4 µA 0.088 % + 6.2 µA 0.22 % + 12 µA	
(6 to 120) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz (5 to 10) kHz	0.47 % + 24 µA 0.18 % + 24 µA 0.072 % + 23 µA 0.088 % + 62 µA 0.22 % + 0.12 mA	

Parameter/Range	Frequency	Best Uncertainty ² (±)	Comments
AC Current ⁴ – Measure (cont.) (0.053 to 1.05) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz (5 to 10) kHz	0.47 % + 24 μA 0.18 % + 24 μA 0.072 % + 23 μA 0.088 % + 62 μA 0.088 % + 62 μA	HP 3458A

II. Mechanical

Parameter/Equipment	Range	Best Uncertainty ^{2,5} (±)	Comments
Torque Wrenches and Testers	(2.5 to 750) in-lb (12.5 to 2000) ft-lb	0.6 % 0.6 %	CDI 2000 torque calibrator
Force Gauges	(5 to 62) lbf (62 to 2000) lbf (1 to 500) lbf	0.24 % 0.23 % 0.29 %	CDI 2000 torque/force calibrator Class “T” weights
Mass	(40 to 50) lb (30 to 40) lb (10 to 30) lb (1 to 10) lb	0.00026 lb (120 mg) 0.00028 lb (127 mg) 0.00027 lb (123 mg) 0.00016 lb (74 mg)	Analytical balances by the single substitution method.

III. Time & Frequency

Parameter/Equipment	Range	Best Uncertainty ^{2,5} (±)	Comments
Frequency Measuring Equipment – Fixed Value	10 MHz	1.1×10^{-9} Hz/Hz	Efratom MRT-H rubidium standard
Frequency – Measure	(1 to 40) Hz 40 Hz to 10 MHz	0.059 % 0.016 %	HP 5335A

¹ This laboratory offers commercial 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 and to influences from the circumstances of the specific calibration.

³ Fluke 5500A best uncertainties are based upon the temperature the standard was calibrated ($t_{cal} \pm 5 \text{ }^\circ\text{C}$) and assuming the instrument is zeroed at least every seven days or when the ambient temperature changes more than $5 \text{ }^\circ\text{C}$. For Resistance, a zero calibration is performed at least every 12 hours within $\pm 1 \text{ }^\circ\text{C}$ of use. For AC Current, best uncertainties are determined with the LCOMP off. Best uncertainties are also based upon 1-year floor specifications. 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.

⁴ HP 3458A best uncertainties are based upon the temperature the standard was calibrated ($t_{cal} \pm 5 \text{ }^\circ\text{C}$) and an auto calibration (ACAL) was performed within the previous 24 hours ($\pm 1 \text{ }^\circ\text{C}$ of ambient temperature). For AC voltage, best uncertainties are determined for the Analog Mode of measurement. Best uncertainties are also based upon 1-year floor specifications. 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.

⁵ In the statement of best uncertainty, uncertainties are percent of reading, unless otherwise indicated