



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

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CALIBRATION

Valid To: November 30, 2012

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	CMC 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	CMC 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	CMC 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	CMC ^{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	CMC ^{2,5} (±)	Comments
Inductance – Measure	1 mH to 10 H	0.12 %	GenRad 1689M

Parameter/Range	Frequency	CMC 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	CMC 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	CMC 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	CMC 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	CMC 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	CMC ^{2,5} (±)	Comments
Torque Testers	0 to 2000 ft-lb	0.17 %	Torque arms and weights
Torque Wrenches	(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

III. Time & Frequency

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Frequency Measuring Equipment – Fixed Value	10 MHz	1.1 parts in 10 ⁹	End Run Technology GPS, 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 Calibration and Measurement Capability (CMC) 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 or nearly ideal measuring equipment. Calibration and Measurement Capabilities represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of $k = 2$. The actual measurement uncertainty of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer's device and to influences from the circumstances of the specific calibration.

³ Fluke 5500A CMCs 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, CMCs are determined with the LCOMP off. CMCs are also based upon 1-year floor specifications. CMCs 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 CMCs 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, CMCs are determined for the Analog Mode of measurement. CMCs are also based upon 1-year floor specifications. CMCs 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 CMC, uncertainties are percent of reading, unless otherwise indicated