The American Association for Laboratory Accreditation

World Class Accreditation

Accredited Laboratory

A2LA has accredited

A.H. ELECTRONIC TEST EQUIPMENT REPAIR CENTER, INC.

Islip, NY

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 8 January 2009*).

AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION CORPORATE SEAL 1978 DISTRICT OF COLUMBIA A2LA

Presented this 9th day of December 2009.

President & CEO
For the Accreditation Council
Certificate Number 2635.01
Valid to February 28, 2011

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

A.H. ELECTRONIC TEST EQUIPMENT REPAIR CENTER
374 Islip Ave, Suite 201
Islip, NY 11751
Audley Haynes Phone: 631 277 628

CALIBRATION

Valid To: February 28, 2011 Certificate Number: 2635.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations[1]:

I. Electrical – DC & Low Frequency

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
DC Voltage – Generate[3]	(0 to 0.2) V (0.2 to 2) V (2 to 20) V (20 to 200) V	0.12 % + 350 µV 0.12 % + 360 µV 0.15 % + 1.5 mV 0.15 % + 11 mV	Keithley 6430
	(0 to 329.9999) mV (0.33 to 3.299999) V (3.3 to 32.99999) V (33 to 329.9999) V (330 to 1020) V	0.0047 % + 2.45 µV 0.0039 % + 4.0 µV 0.0043 % + 39 µV 0.0043 % + 390 µV 0.0043 % + 1.2 mV	Fluke 5500A
	(0 to 220) mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	0.0007 % + 0.84 µV 0.0005 % + 0.97 µV 0.0003 % + 2.5 µV 0.0003 % + 4.0 µV 0.0005 % + 390 µV 0.0006 % + 390 µV	Fluke 5700A

5301 Buckeystown Pike, Suite 350 | Frederick, Maryland 21704-8373 | Phone: 301 644 3248 | Fax: 301 662 2974 | www.A2LA.org

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
DC Voltage – Measure[3]	(0 to 200) mV (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 1000) V	0.0005 % + 94 µV 0.0003 % + 0.70 µV 0.0003 % + 7.0 µV 0.0005 % + 70 µV 0.0005 % + 750 µV	Fluke 8508A
	(10 to 100) mV (0.1 to 1.0) V (1.0 to 10) V (10 to 100) V	5.6 µV/V + 1.1 µV 5.2 µV/V + 1.1 µV 4.7 µV/V + 2.4 µV 6.6 µV/V + 37 µV	Agilent 3458A/100PLC Option 002
	(100 to 1000) V	19 µV/V + 0.14 µV	Add 12(Vin/1000)^2 µV/V for Vin> 100 V
	(1 to 40) kV	1 % + 28 µV	Fluke 80K-40
	(0 to 100) kV	0.1 % + 28 µV	Spellman HVD-100-1
DC Current – Generate	(0 to 1) pA (1 to 10) pA (10 to 100) pA (0.1 to 1) nA (1 to 10) nA (10 to 100) nA (0.1 to 1) µA (1 to 10) µA (10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA	1.0 % + 10 fA 0.50 % + 30 fA 0.15 % + 41 fA 0.05 % + 0.20 pA 0.05 % + 2.1 pA 0.05 % + 0.02 nA 0.05 % + 0.30 nA 0.05 % + 2.1 nA 0.03 % + 21 nA 0.03 % + 0.20 µA 0.05 % + 2.1 µA 0.18 % + 21 µA	Keithley 6430
DC Current – Generate[3]	(0 to 3.29999) mA (3.3 to 32.9999) mA (33 to 329.999) mA (330 to 2.19999) A (2.2 to 11) A	0.0101 % + 0.04 µA 0.0078 % + 0.19 µA 0.0078 % + 2.6 µA 0.024 % + 35 µA 0.047 % + 260 µA	Fluke 5500A
Toroidal Clamps	(10 to 16.4999) A (16.5 to 149.999) A (150 to 1025) A	0.19 % + 1.6 mA 0.19 % + 12 mA 0.19 % + 39 mA	Fluke 5500A/Coil
Other Clamps	(10 to 16.4999) A (16.5 to 149.999) A (150 to 1025) A	0.39 % + 16 mA 0.39 % + 109 mA 0.39 % + 390 mA	

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
DC Current – Generate	(0 to 220) µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	0.0039 % + 6.0 nA 0.0031 % + 6.2 nA 0.0031 % + 39 nA 0.0039 % + 0.62 µA 0.0070 % + 1.2 µA	Fluke 5700A
DC Current – Measure[3]	(0 to 1) pA (1 to 10) pA (10 to 100) pA (0.1 to 1) nA (1 to 10) nA (10 to 100) nA (0.1 to 1) µA (1 to 10) µA (10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0 to 200) µA (0.2 to 2) mA (2 to 20) mA (20 to 200) mA (0.2 to 2) A (2 to 20) A (10 to 100) µA (0.1 to 1) mA (10 to 100) mA (0.1 to 1) A	1.00 % + 59 fA 0.50 % + 59 fA 0.15 % + 66 fA 0.05 % + 0.21 pA 0.05 % + 2.1 pA 0.05 % + 0.02 nA 0.05 % + 0.31 nA 0.05 % + 2.1 nA 0.03 % + 8.4 nA 0.03 % + 84 nA 0.04 % + 0.84 µA 0.06 % + 8.4 µA 0.0012 % + 0.31 µA 0.0012 % + 3.1 µA 0.0014 % + 0.07 µA 0.0047 % + 0.85 µA 0.018 % + 14 µA 0.039 % + 320 µA 20 µA/A + 0.83 nA 20 µA/A + 5.3 nA 35 µA/A + 0.53 nA 0.011% + 11 µA	Keithley 6430 Fluke 8508A Agilent 3458A/100 PLC Option 002
Resistance – Generate[3]	(0 to 10.99) Ω (11 to 32.999) Ω (33 to 109.999) Ω (110 to 329.999) Ω (330 to 1.0999) kΩ (1.1 to 3.29999) kΩ (3.3 to 10.9999) kΩ (11 to 32.9999) kΩ (33 to 109.999) kΩ (110 to 329.999) kΩ	0.0093 % + 4.7 mΩ 0.0093 % + 7.8 mΩ 0.0070 % + 7.8 mΩ 0.0070 % + 7.8 mΩ 0.0070 % + 47 mΩ 0.0070 % + 47 mΩ 0.0070 % + 47 mΩ 0.0070 % + 47 mΩ 0.0085 % + 4.7 Ω 0.0093 % + 4.7 Ω	Fluke 5500A

Parameter/Equipment	Range[4]	CMC[2, 5] (±)	Comments
Resistance– Generate[3] (cont.)	(330 to 1099.99) kΩ (1.1 to 3.29999) MΩ (3.3 to 10.999) MΩ (11 to 32.9999) MΩ (33 to 109.999) MΩ (110 to 330) MΩ	0.012 % + 43 Ω 0.012 % + 43 Ω 0.047 % + 430 Ω 0.078 % + 430 Ω 0.39 % + 4.3 kΩ 0.39 % + 13 kΩ	Fluke 5500A
	1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	0.0085 % 0.0085 % 0.0021 % 0.0021 % 0.0009 % 0.0009 % 0.0008 % 0.0008 % 0.0008 % 0.0008 % + 0.01 Ω 0.0010 % + 0.01 Ω 0.0010 % + 0.06 Ω 0.0018 % + 0.06 Ω 0.0019 % + 0.58 Ω 0.0036 % + 0.58 Ω 0.0043 % + 5.8 Ω 0.0093 % + 5.8 Ω	Fluke 5700A
Resistance – Measure[3]	(2 to 20) Ω (20 to 200) Ω (200 to 2000) Ω (2 to 20) kΩ (20 to 200) kΩ (0.2 to 2) MΩ (2 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ (2 to 20) GΩ (20 to 200) GΩ (0.2 to 2) TΩ (2 to 20) TΩ	0.07 % + 1.2 mΩ 0.05 % + 11 mΩ 0.04 % + 110 mΩ 0.04 % + 1.0 Ω 0.06 % + 11 Ω 0.06 % + 110 Ω 0.07 % + 510 Ω 0.07 % + 5.1 kΩ 0.07 % + 51 kΩ 0.07 % + 510 kΩ 0.19 % + 5.1 MΩ 0.62 % + 51 MΩ 1.6 % + 510 MΩ	Keithley 6430
	(0 to 10) Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1.0) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1.0) GΩ	18 μΩ/Ω + 73 μΩ 13 μΩ/Ω + 0.73 μΩ 11 μΩ/Ω + 0.73 μΩ 11 μΩ/Ω + 7.3 mΩ 11 μΩ/Ω + 73 mΩ 15 μΩ/Ω + 2.3 Ω 53 μΩ/Ω + 370 Ω 0.05 % + 3.7 kΩ 0.5 % + 280 kΩ	Agilent 3458A/PLC 100 Option 002

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
DC Power – Generate[3]			Fluke 5500A
(33 mV to 1020 V)	109 µW to 1 mW (1 to 11) mW (11 to 108) mW 108 mW to 11 W 11 W to 5 kW (5 to 12) kW	0.03 % 0.03 % 0.06 % 0.03 % 0.09 % 0.07 %	

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
Distortion – Measure	10 Hz to 200 kHz	3 %	HP 333A
	20 Hz to 20 kHz (20 to 100) kHz	1 dB 2 dB	HP 8903A
AC Voltage – Generate			
(0 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (10 to 300) kHz (30 to 500) kHz (0.5 to 1) MHz	0.024 % + 3.9 µV 0.0089 % + 3.9 µV 0.0078 % + 3.9 µV 0.020 % + 3.9 µV 0.047 % + 4.7 µV 0.11 % + 9.3 µV 0.14 % + 20 µV 0.27 % + 20 µV	Fluke 5700A
(2.2 to 22) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (10 to 300) kHz (30 to 500) kHz 500 kHz to 1MHz	0.0233 % + 3.9 µV 0.0089 % + 3.9 µV 0.0078 % + 3.9 µV 0.020 % + 3.9 µV 0.047 % + 4.7 µV 0.11 % + 9.3 µV 0.14 % + 20 µV 0.27 % + 20 µV	
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (10 to 300) kHz (30 to 500) kHz 500 kHz to 1MHz	0.024 % + 12 µV 0.0089 % + 6.2 µV 0.0078 % + 6.2 µV 0.020 % + 6.2 µV 0.047 % + 16 µV 0.11 % + 20 µV 0.14 % + 24 µV 0.26 % + 47 µV	

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Voltage – Generate (cont.)			
(0 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (10 to 300) kHz (30 to 500) kHz 500 kHz to 1MHz	0.024 % + 39 µV 0.0085 % + 16 µV 0.0040 % + 7.8 µV 0.0070 % + 9.4 µV 0.011 % + 32 µV 0.039 % + 78 µV 0.093 % + 200 µV 0.16 % + 320 µV	Fluke 5700A
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (10 to 300) kHz (30 to 500) kHz 500 kHz to 1MHz	0.023 % + 40 µV 0.0081 % + 17 µV 0.0039 % + 10 µV 0.0067 % + 11 µV 0.0098 % + 32 µV 0.034 % + 78 µV 0.090 % + 200 µV 0.15 % + 320 µV	
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (10 to 300) kHz (30 to 500) kHz 500 kHz to 1MHz	0.024 % + 4.0 mV 0.0085 % + 1.2 mV 0.0050 % + 550 mV 0.0078 % + 0.93 mV 0.014 % + 2.4 mV 0.086 % + 16 mV 0.42 % + 39 mV 0.78 % + 78 mV	
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.028 % + 16 mV 0.0066 % + 3.1 mV	
AC Voltage – Measure			
(0 to 200) mV	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.016 % + 13 µV 0.013 % + 4.0 µV 0.011 % + 4.0 µV 0.011 % + 2.0 µV 0.013 % + 2.0 µV 0.031 % + 7.8 µV 0.067 % + 19 µV	Fluke 8508A
(0.2 to 2) V	(1 to 10) Hz (1 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz	0.015 % + 110 µV 0.011 % + 20 µV 0.0085 % + 20 µV 0.0070 % + 20 µV	

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Voltage – Measure (cont.)			
(0.2 to 2) V	(2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1MHz	0.011 % + 20 µV 0.021 % + 40 µV 0.051 % + 190 µV 0.24 % + 6.1 µV 0.78 % + 20 µV	Fluke 8508A
(2 to 20) V	(1 to 10) Hz (1 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1MHz	0.015 % + 58 µV 0.011 % + 200 µV 0.0085 % + 200 µV 0.0070 % + 200 µV 0.011 % + 200 µV 0.021 % + 400 µV 0.051 % + 59 µV 0.24 % + 61 µV 0.78 % + 200 µV	
(20 to 200) V	(1 to 10) Hz (1 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1MHz	0.015 % + 580 µV 0.011 % + 580 µV 0.0085 % + 580 µV 0.0070 % + 580 µV 0.011 % + 580 µV 0.021 % + 580 µV 0.051 % + 580 µV 0.24 % + 610 µV 0.78 % + 580 µV	
(200 to 1000) V	(1 to 10) Hz (1 to 40) Hz (40 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.015 % + 5.8 mV 0.012 % + 5.8 mV 0.011 % + 5.8 mV 0.021 % + 5.8 mV 0.055 % + 5.8 mV	
AC Voltage – Measure[3]			
(2 to 12) 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	0.024 % + 0.28 µV 0.016 % + 1.1 µV 0.024 % + 1.8 µV 0.078 % + 2.6 µV 0.39 % + 3.3 µV 3.2 % + 1.9 µV	Agilent 3458A Option 002
(12 to 120) mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz	0.0054 % + 3.8 µV 0.0054 % + 1.9 µV 0.011 % + 1.9 µV	

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Voltage– Measure[3] (cont.)			
(12 to 120) mV	(20 to 50) kHz	0.024 % + 1.86 µV	Agilent 3458A Option 002
	(50 to 100) kHz	0.062 % + 1.86 µV	
	(100 to 300) kHz	0.24 % + 9.30 µV	
	(0.3 to 1) MHz	0.78 % + 9.30 µV	
	(1 to 2) MHz	1.2 % + 9.30 µV	
(0.12 to 1.2) V	(1 to 40) Hz	0.0054 % + 37.21 µV	
	(40 to 1k) Hz	0.0054 % + 18.60 µV	
	(1 to 20) kHz	0.011 % + 18.60 µV	
	(20 to 50) kHz	0.024 % + 18.60 µV	
	(50 to 100) kHz	0.062 % + 18.60 µV	
	(100 to 300) kHz	0.24 % + 93.02 µV	
	(0.3 to 1) MHz	0.78 % + 93.02 µV	
	(1 to 2) MHz	1.2 % + 93.02 µV	
(1.2 to 12) V	(1 to 40) Hz	0.0054 % + 372.09 µV	
	(40 to 1k) Hz	0.0054 % + 186.05 µV	
	(1 to 20) kHz	0.011 % + 186.05 µV	
	(20 to 50) kHz	0.024 % + 186.05 µV	
	(50 to 100) kHz	0.062 % + 186.05 µV	
	(100 to 300) kHz	0.24 % + 930.23 µV	
	(0.3 to 1) MHz	0.78 % + 930.23 µV	
	(1 to 2) MHz	1.2 % + 930.23 µV	
(12 to 120) V	(1 to 40) Hz	0.016 % + 3.72 mV	
	(40 to 1k) Hz	0.016 % + 1.86 mV	
	(1 to 20) kHz	0.016 % + 1.86 mV	
	(20 to 50) kHz	0.028 % + 1.86 mV	
	(50 to 100) kHz	0.093 % + 1.86 mV	
	(100 to 300) kHz	0.32 % + 9.30 mV	
	(0.3 to 1) MHz	1.2 % + 9.30 mV	
(120 to 700) V	(1 to 40) Hz	0.031 % + 21.71 mV	
	(40 to 1k) Hz	0.031 % + 10.85 mV	
	(1 to 20) kHz	0.047 % + 10.85 mV	
	(20 to 50) kHz	0.093 % + 10.85 mV	
	(50 to 100) kHz	0.24 % + 10.85 mV	
AC Current – Generate			
(0 to 220) µA	(10 to 20) Hz	0.0233 % + 15.63 nA	Fluke 5700A
	(20 to 40) Hz	0.0155 % + 9.51 nA	
	40 Hz to 1 kHz	0.0109 % + 8.00 nA	
	(1 to 5) kHz	0.0271 % + 11.79 nA	
	(5 to 10) kHz	0.1008 % + 62.05 nA	

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Current – Generate (cont.)			
(0.22 to 2.2) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.024 % + 39 nA 0.016 % + 32 nA 0.011 % + 32 nA 0.019 % + 0.10 nA 0.11 % + 0.62 nA	Fluke 5700A
(2.2 to 22) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.024 % + 0.39 nA 0.016 % + 0.31 nA 0.011 % + 0.31 nA 0.019 % + 0.54 nA 0.11 % + 4.7 nA	
AC Current – Generate[3]			
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.024 % + 4.0 µA 0.016 % + 3.2 µA 0.011 % + 2.4 µA 0.019 % + 3.2 µA 0.11 % + 94 µA	Fluke 5500A/coil
(0.22 to 2.2) A	(20 to 1k) Hz (1k to 5k) Hz 5 kHz to 10 kHz	0.025 % + 32 µA 0.039 % + 78 µA 0.63 % + 160 µA	
Toroidal Clamps (45 to 65) Hz	(10 to 16.4999) A (16.5 to 149.999) A (150 to 1025) A	0.22 % + 2.4 mA 0.22 % + 20 mA 0.22 % + 70 mA	
(65 to 440) Hz	(10 to 16.4999) A (16.5 to 149.999) A (150 to 1025) A	0.61 % + 2.4 mA 0.61 % + 21 mA 0.61 % + 78 mA	
Other Clamps (45 to 65) Hz	(10 to 16.4999) A (16.5 to 149.999) A (150 to 1025) A	0.43 % + 24 mA 0.43 % + 200 mA 0.43 % + 700 mA	
(65 to 440) Hz	(10 to 16.4999) A (16.5 to 149.999) A (150 to 1025) A	0.78 % + 24 mA 0.78 % + 200 mA 0.78 % + 700 mA	

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Current – Measure			
(0 to 200) µA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.031 % + 0.06 µA 0.029 % + 0.06 µA 0.062 % + 0.06 µA 0.31 % + 0.06 µA	Fluke 8508A
(0.2 to 2) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.031 % + 0.61 µA 0.029 % + 0.61 µA 0.062 % + 0.61 µA 0.32 % + 0.61 µA	
(2 to 20) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.031 % + 6.1 µA 0.029 % + 6.1 µA 0.062 % + 6.1 µA 0.32 % + 6.1 µA	
(20 to 200) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz	0.031 % + 661µA 0.028 % + 61 µA 0.058 % + 61 µA	
(0.2 to 2) A	10 Hz to 2kHz (2 to 10) kHz (10 to 30) kHz	0.057 % + 610 µA 0.067 % + 610 µA 0.24 % + 610 µA	
(2 to 20) A	10 Hz to 2kHz (2 to 10) kHz	0.072 % + 59 µA 0.20 % + 59 µA	
AC Current[3] – Measure			
(20 to 120) µA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz	0.32 % + 0.03 µA 0.12 % + 0.03 µA 0.047 % + 0.03 µA 0.039 % + 0.03 µA	Agilent 3458A Option 002
(0.12 to 1.2) mA	(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	0.32 % + 0.19 µA 0.12 % + 0.19 µA 0.047 % + 0.19 µA 0.024 % + 0.19 µA 0.047 % + 0.19 µA 0.32 % + 0.37 µA 0.43 % + 1.4 µA	
(1.2 to 12) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (100 to 5k) Hz	0.32 % + 1.9 µA 0.12 % + 1.9 µA 0.047 % + 1.9 µA 0.024 % + 1.9 µA	

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Current[3] – Measure (cont.)			
(1.2 to 12) mA	(5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.047 % + 1.9 µA 0.32 % + 3.8 µA 0.43 % + 14 µA	Agilent 3458A Option 002
	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.32 % + 19 µA 0.12 % + 47 µA 0.047 % + 38 µA 0.024 % + 28 µA	
(12 to 120) mA	(5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.047 % + 19 µA 0.32 % + 38 µA 0.43 % + 140 µA	
	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.32 % + 190 µA 0.12 % + 190 µA 0.047 % + 190 µA 0.024 % + 190 µA	
(0.12 to 1.2) A	(5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.047 % + 190 µA 0.32 % + 380 µA 0.43 % + 1.4 mA	

Parameter/Range	Range	CMC[2, 5] (±)	Comments
AC Power – Generate	(45 to 65) Hz PF=1		Fluke 5500A
33 mV to 1020 V	109 µW to 1 mW (1 to 4) mW (4 to 1) mW (11 to 40) mW (40 to 396) mW 396 mW to 11 W (11 to 264) W 264 W to 3 kW (3 to 11) kW	0.03 % 0.19 % 0.19 % + 0.06 nW 0.12 % + 0.06 nW 0.12 % + 0.58 nW 0.19 % + 5.76 nW 0.12 % 0.16 % 0.12 %	

Parameter/Range	Range[4]	CMC[2, 5] (±)	Comments
Capacitance – Generate[3]			
(50 to 1000) Hz	(0.33 to 0.49999) nF	0.39 % + 7.8 pF	Fluke 5500A
	(0.5 to 1.0999) nF	0.39 % % + 7.8 pF	
	(1.1 to 3.2999) nF	0.39 % + 7.8 pF	
	(3.3 to 10.999) nF	0.39 % + 7.8 pF	
	(11 to 32.999) nF	0.20 % + 0.08 nF	
	(33 to 109.99) nF	0.20 % + 0.08 nF	
	(110 to 329.99) nF	0.20 % + 0.23 nF	
	(0.33 to 1.0999) µF	0.20 % + 0.78 nF	
	(1.1 to 3.2999) µF	0.28 % + 2.4 nF	
(50 to 400) Hz	(3.3 to 10.999) µF	0.28 % + 7.8 nF	
	(11 to 32.999) µF	0.32 % + 0.02 µF	
(50 to 200) Hz	(33 to 109.99) µF	0.39 % + 0.08 µF	
(50 to 100) Hz	(110 to 329.99) µF	0.55 % + 0.23 µF	
	(330 to 1.1) mF	0.78 % + 0.23 µF	
Capacitance – Generate	1000 pF	0.035 %	General Radio 1409-F
	0.01 µF	0.035 %	1409-L
	0.1 µF	0.035 %	1409-T
	1.0 µF	0.035 %	1409-Y
	50 pF to 0.1 µF	0.05 % + 5 pF	1412-BC
Capacitance – Measure	0.1 to 10.00 pf	0.20 % + 0.012 pf	HP 4262A
	10 to 100.0 pf	0.20 % + 0.12 pf	
	100 to 1000 pf	0.20 % + 1.2 pf	
	1 to 10.00 nF	0.20 % + 0.012 nF	
	10 to 100.0 nF	0.20 % + 0.12 nF	
	100 to 1000 nF	0.20 % + 1.2 nF	
	1 to 10.00 µF	0.20 % + 0.012 µF	
	10 to 100.0 µF	0.30 % + 0.21 µF	
	100 to 1000 µF	0.50 % + 2.1 µF	
	1 to 10.00 mF	1.0 % + 0.021 mF	

Parameter/Range	Range[4]	CMC[2, 5] (±)	Comments
Inductance – Generate	100 µH 1 mH 10 mH 100 mH 1 H 10 H	0.3 % 0.15 % 0.15 % 0.15 % 0.15 % 0.15 %	General Radio 1482-B 1482-E 1482-H 1482-L 1482-P 1482-T
Inductance – Measure	(0.2 to 10.00) µH (10 to 100.0) µH (100 to 1000) µH (1 to 10.00) mH (10 to 100.0) mH (100 to 1000) mH (1 to 10.00) H (10 to 100.0) H (100 to 1000) H	0.30 % + 0.021 µH 0.20 % + 0.208 µH 0.20 % + 2.082 µH 0.20 % + 0.021 mH 0.20 % + 0.208 mH 0.20 % + 2.082 mH 0.20 % + 0.021 H 1.0 % + 0.208 H 1.0 % + 2.082 H	HP 4262A

II. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
RF Power – Measure			
(-30 to +10) dBm 50 Ohms	0.1 MHz (0.3 to 100) MHz (300 to 2500) MHz (3000 to 4200)MHz	1.4 % 1.2 % 1.2 % 1.3 %	Agilent E4418B, Agilent 8482A
(-30 to -10) dBm 50 Ohms	(5000 to 7000) MHz (8000 to 11000) MHz (12000 to 13000) MHz (14000 to 15000) MHz 16000 MHz 17000 MHz 18000 MHz	1.5 % 1.6 % 1.6 % 1.7 % 1.8 % 1.9 % 2.0 %	Agilent E4418B, Agilent E9300B
(-10 to +10) dBm 50 Ohms	(5000 to 8000) MHz (9000 to 11000) MHz (12000 to 14000) MHz (15000 to 16000) MHz 17000 MHz 18000 MHz	1.6 % 1.6 % 1.7 % 1.8 % 1.9 % 2.0 %	

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
RF Power –Measure (cont.)			
(-70 to + 20) dBm 50 Ohms	(19000 to 20000) MHz	2.8 %	Agilent E4418B, Agilent E4413A
	(21000 to 22000) MHz	3.5 %	
	(23000 to 25000) MHz	3.0 %	
	26000 MHz	3.1 %	
	26500 MHz	3.2 %	
(-30 to +10) dBm 50 Ohms	(27000 to 29000) MHz	2.9 %	Agilent E4418B, Agilent 8487A
	(30000 to 32000) MHz	3.0 %	
	(33000 to 38000) MHz	3.1 %	
	(39000 to 40000) MHz	3.2 %	
	41000 MHz	3.3 %	
	(42000 to 43000) MHz	3.5 %	
	44000 MHz	3.8 %	
	45000 MHz	3.9 %	
	46000 MHz	3.8 %	
	(47000 to 48000) MHz	3.9 %	
	49000 MHz	3.9 %	
	50000 MHz	4.1 %	
0 dBm 50 Ohms	50 MHz	0.35 %	Wandel & Goltermann EPM-1 with TK-100 test probe
(-30 to +10) dBm 50 Ohms	0.1 MHz	1.4 %	Agilent E4418B, Agilent 8482A
	(0.3 to 100) MHz	1.2 %	
	(300 to 2500) MHz	1.2 %	
	(3000 to 4200) MHz	1.3 %	
(-30 to -10) dBm 50 Ohms	(5000 to 7000) MHz	1.5 %	Agilent E4418B, Agilent E9300B
	(8000 to 11000) MHz	1.6 %	
	(12000 to 13000) MHz	1.6 %	
	(14000 to 15000) MHz	1.7 %	
	16000 MHz	1.8 %	
	17000 MHz	1.9 %	
	18000 MHz	2.0 %	
(-10 to +10) dBm 50 Ohms	(5000 to 8000) MHz	1.6 %	
	(9000 to 11000) MHz	1.6 %	
	(12000 to 14000) MHz	1.7 %	
	(15000 to 16000) MHz	1.8 %	
	17000 MHz	1.9 %	
	18000 MHz	2.0 %	

Parameter/Range	Frequency	CMC[2] (±)	Comments
RF Power – Generate			
Signal Generator			
(+13 to -56) dBm	1 Hz to 20 MHz	0.52 dB	HP 3325B
(–20 to –10) dBm	250 kHz to 2 GHz (> 2 to 20) GHz (>20 to 40) GHz	1.4 dBm 1.2 dBm 1.3 dBm	Agilent E8257D
(-10 to 0) dBm	250 kHz to 2 GHz (> 2 to 20) GHz (>20 to 50) GHz	0.6 dBm 0.8 dBm 0.9 dBm	
(0 to +10) dBm	250 kHz to 2 GHz (> 2 to 20) GHz (>20 to 40) GHz	0.6 dBm 0.8 dBm 0.9 dBm	
(0 to +10) dBm	(>40 to 50) GHz	1.3 dBm	
>+10 dBm	250 kHz to 40 GHz	0.6 dBm	
RF Attenuation – Generate			
(0 to 12) dB	DC to 1 kHz 1 kHz to 500 MHz 500 MHz to 1 GHz	0.1 dB 0.25 dB 0.35 dB	HP 335C, 1 dB Steps
(0 to 120) dB	DC to 1 kHz 1 kHz to 500 MHz	0.1 dB 0.25 dB	HP 335D, 10 dB Steps
(0 to 120) dB	500 MHz to 1 GHz	0.35 dB	HP 335D, 10 dB Steps
(0 to 2) dB (3 to 6) dB (7 to 10) dB 11 dB	DC to 4 GHz DC to 4 GHz DC to 4 GHz DC to 4 GHz	0.2 dB 0.3 dB 0.4 dB 0.5 dB	HP 8494A, 1 dB Steps
10 dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB	DC to 4 GHz DC to 4 GHz DC to 4 GHz DC to 4 GHz DC to 4 GHz DC to 4 GHz DC to 4 GHz	0.2 dB 0.4 dB 0.5 dB 0.7 dB 0.8 dB 1.0 dB 1.2 dB	HP 8496A, 10 dB Steps

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
RF Attenuation – Generate (cont.)			
80 dB	DC to 4 GHz	1.3 dB	HP 8496A, 10 dB Steps
90 dB	DC to 4 GHz	1.5 dB	
100 dB	DC to 4 GHz	1.6 dB	
110 dB	DC to 4 GHz	1.8 dB	
Fixed Values			
DC to 18 GHz	1 dB	0.3 dB	Weinschel AS-18
	3 dB	0.3 dB	
	6 dB	0.3 dB	
	10 dB	0.5 dB	
	20 dB	0.5 dB	
	30 dB	1.0 dB	
Phase Modulation – Measure	3 Hz to 67 GHz	0.8 %	Agilent PSA E4448A
Amplitude Modulation – Measure	3 Hz to 67 GHz	0.8 %	Agilent PSA E4448A
Frequency Modulation – Measure	3 Hz to 67 GHz	0.8 %	Agilent PSA E4448A
Pulse Modulation – Measure	DC to 20 GHz	10 ps + 0.1 %	HP 54120T, HP 54120A, HP 54121A
Noise Source – Generate & Measure			
12 dB to 17 dB Excess Noise Ratio (ENR)	10.00 MHz	0.052 dB	Agilent N4002A noise source with N8975A noise figure meter
	100.00 MHz	0.13 dB	
	1000.00 MHz	0.12 dB	
	2000.00 MHz	0.13 dB	
	3000.00 MHz	0.14 dB	
	4000.00 MHz	0.20 dB	
	5000.00 MHz	0.21 dB	
	6000.00 MHz	0.20 dB	
	7000.00 MHz	0.20 dB	
	8000.00 MHz	0.20 dB	
	9000.00 MHz	0.19 dB	

Parameter/Range	Frequency	CMC[2] (±)	Comments
Noise Source – Generate & Measure (cont.)			
12 dB to 17 dB Excess Noise Ratio (ENR)	10 000.00 MHz 11 000.00 MHz 12 000.00 MHz 13 000.00 MHz 14 000.00 MHz 15 000.00 MHz 16 000.00 MHz 17 000.00 MHz 18 000.00 MHz 19 000.00 MHz 20 000.00 MHz 21 000.00 MHz 22 000.00 MHz 23 000.00 MHz 24 000.00 MHz 25 000.00 MHz 26 000.00 MHz 26 500.00 MHz	0.20 dB 0.20 dB 0.21 dB 0.20 dB 0.22 dB 0.20 dB 0.21 dB 0.20 dB 0.23 dB 0.25 dB 0.24 dB 0.26 dB 0.27 dB 0.28 dB 0.30 dB 0.29 dB 0.31 dB 0.35 dB	Agilent N4002A noise source with N8975A noise figure meter

III. Thermodynamics

Parameter/Equipment	Range[4]	CMC[2] (±)	Comments
Relative Humidity –			
Saturated Salt Solutions			Intrinsic standards
Magnesium Chloride @ 25°C	32.78 % RH	0.16 % RH	
Sodium Chloride @ 25°C	75.29 % RH	0.12 % RH	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Thermocouple – Measuring Equipment and Measure[3] (cont.)			
Type B	(600 to 800) °C (800 to 1000) °C (100 to 1550) °C (1550 to 1820) °C	0.44 °C 0.34 °C 0.30 °C 0.33 °C	Fluke 5500A/525A
Type C	(0 to 150) °C (150 to 650) °C (650 to 1000) °C (1000 to 1800) °C (1800 to 2316) °C	0.3 °C 0.26 °C 0.31 °C 0.50 °C 0.84 °C	
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.50 °C 0.16 °C 0.14 °C 0.16 °C 0.21 °C	
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.27 °C 0.16 °C 0.14 °C 0.17 °C 0.23 °C	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (100 to 1372) °C	0.33 °C 0.18 °C 0.16 °C 0.26 °C 0.40 °C	
Type L	(-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.37 °C 0.26 °C 0.17 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.40 °C 0.22 °C 0.19 °C 0.18 °C 0.27 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.57 °C 0.35 °C 0.33 °C 0.40 °C	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Thermocouple – Measuring Equipment and Measure[3] (cont.)			
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.47 °C 0.36 °C 0.37 °C 0.46 °C	Fluke 5500A/525A
Type T	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.63 °C 0.24 °C 0.16 °C 0.14 °C	
Type U	(0 to 600) °C	0.27 °C	
RTD – Measuring Equipment & Measure[3]			
Pt 395, 100	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.05 °C 0.05 °C 0.07 °C 0.09 °C 0.10 °C 0.12 °C 0.23 °C	Fluke 5500A/525A
Pt 3926, 100	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.05 °C 0.05 °C 0.07 °C 0.09 °C 0.10 °C 0.12 °C	
Pt 3916, 100	(-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.25 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.09 °C 0.10 °C 0.23 °C	

Parameter/Equipment	Range	CMC[2] (±)	Comments
RTD– Measuring Equipment & Measure[3] (cont.)			
Pt 385, 200	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.04 °C 0.04 °C 0.04 °C 0.05 °C 0.12 °C 0.13 °C 0.14 °C 0.16 °C	Fluke 5500A/525A
Pt 385, 500	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.04 °C 0.05 °C 0.05 °C 0.06 °C 0.08 °C 0.08 °C 0.09 °C 0.11 °C	
Pt 385, 1000	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.03 °C 0.03 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.07 °C 0.23 °C	
PtNi 385, 120	(-80 to 0) °C (0 to 100) °C (100 to 260) °C	0.08 °C 0.08 °C 0.14 °C	
Cu 427, 10	(-100 to 26) °C	0.30 °C	

IV. Time & Frequency

Parameter/Equipment	Range	CMC[2] (±)	Comments
Time Interval	1 s to 24 h	0.5s	HP 5345A

Parameter/Equipment	Range	CMC[2] (±)	Comments
Frequency – Measuring Equipment	5.0 MHz 10 MHz	2×10^{-13} 2×10^{-13}	Fluke 910R/ NIST 76100S frequency measurement analysis system
	DC to 500 MHz	5 ps	HP 3325B
	(0.5 to 50) GHz	5 ps	HP 83650B
Frequency – Measure	5.0 MHz 10 MHz	0.2 pHz/Hz 0.2 pHz/Hz	Fluke 910R/ NIST 76100S frequency measurement analysis system
	DC to 40 GHz	5 ps	HP 5345A

[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] Field calibration service is available for this calibration and this laboratory meets A2LA *R104 – General Requirements: Accreditation of Field Testing and Field Calibration Laboratories* for these calibrations. Please note the actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the CMC found 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 actual uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC.

[4] Where ranges are not specified, the CMC stated is for the cardinal points only.

[5] All percentages are percent of reading unless otherwise indicated.