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

A.H. ELECTRONIC TEST EQUIPMENT REPAIR CENTER
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CALIBRATION

Valid To: February 28, 2019 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, 4] (±)	Comments
DC Voltage – Generate	(0 to 0.2) V (0.2 to 2) V (2 to 20) V (20 to 200) V	0.12 % + 350 µV 0.12 % + 350.05 µV 0.15 % + 1.5 mV 0.15 % + 10.02 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 % + 2.44 µV 0.0039 % + 3.95 µV 0.0043 % + 38.77 µV 0.0043 % + 387.64 µV 0.0043 % + 1.16 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 % + 2.44 µV 0.0003 % + 3.99 µV 0.0005 % + 38.77 µV 0.0006 % + 387.64 µV	Fluke 5720A

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Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
DC Voltage – Measure	(0 to 200) mV (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 1000) V	0.0005 % + 93.02 µV 0.0003 % + 0.70 µV 0.0003 % + 6.96 µV 0.0005 % + 69.6 µV 0.0005 % + 741.95 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 %	Fluke 80K-40
	(1 to 100) kV	0.5 %	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 % + 40.11 fA 0.05 % + 0.20 pA 0.05 % + 2.02 pA 0.05 % + 0.02 nA 0.05 % + 0.30 nA 0.05 % + 2.02 nA 0.03 % + 20.21 nA 0.03 % + 0.20 µA 0.05 % + 2.02 µA 0.18 % + 20.21 µA	Keithley 6430
	(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	0.011 % + 0.04 µA 0.0078 % + 0.19 µA 0.0078 % + 2.56 µA 0.024 % + 34.11 µA 0.047 % + 255.81 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 % + 15.5 mA 0.39 % + 108.53 mA 0.39 % + 387.6 mA	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
DC Current – Generate (cont)	(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 % + 5.43 nA 0.0031 % + 6.2 nA 0.0031 % + 38.76 nA 0.0039 % + 0.62 µA 0.0070 % + 1.16 µA	Fluke 5720A
DC Current – Measure	(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 % + 58.23 fA 0.50 % + 58.23 fA 0.15 % + 65.13 fA 0.05 % + 0.21 pA 0.05 % + 2.08 pA 0.05 % + 0.02 nA 0.05 % + 0.31 nA 0.05 % + 2.08 nA 0.03 % + 8.35 nA 0.03 % + 83.51 nA 0.04 % + 0.84 µA 0.06 % + 8.35 µA	Keithley 6430
	(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	0.0012 % + 0.31 µA 0.0012 % + 3.1 µA 0.0014 % + 0.07 µA 0.0047 % + 0.85 µA 0.018 % + 13.68 µA 0.039 % + 315.42 µA	Fluke 8508A
	(10 to 100) µA (0.1 to 1) mA (10 to 100) mA (0.1 to 1) A	20 µA/A + 0.83 nA 20 µA/A + 5.3 nA 35 µA/A + 0.53 nA 0.011 % + 11 µA	Agilent 3458A/100 PLC, option 002
Resistance – Generate	(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 % + 4.65 mΩ 0.0093 % + 7.75 mΩ 0.0070 % + 7.75 mΩ 0.0070 % + 7.75 mΩ 0.0070 % + 46.51 mΩ 0.0070 % + 46.52 mΩ 0.0070 % + 466 mΩ 0.0070 % + 466 mΩ 0.0085 % + 4.65 Ω 0.0093 % + 4.65 Ω	Fluke 5500A

Parameter/Equipment	Range[3]	CMC[2, 4] (±)	Comments
Resistance – Generate (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 % + 42.64 Ω 0.012 % + 42.64 Ω 0.047 % + 426.36 Ω 0.078 % + 426.4 Ω 0.39 % + 4.26 kΩ 0.39 % + 12.79 kΩ	Fluke 5500A
Fixed Points	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 % + 5.77 Ω 0.0093 % + 5.77 Ω	Fluke 5720A
Resistance – Measure	(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 % + 1.16 mΩ 0.05 % + 10.03 mΩ 0.04 % + 100.33 mΩ 0.04 % + 1.0 Ω 0.06 % + 10.03 Ω 0.06 % + 100.33 Ω 0.07 % + 506.63 Ω 0.07 % + 5.07 kΩ 0.07 % + 50.33 kΩ 0.07 % + 503.32 kΩ 0.19 % + 5.03 MΩ 0.62 % + 50.33 MΩ 1.6 % + 503.32 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, 4] (±)	Comments
DC Power – Generate			
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 %	Fluke 5500A

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
Distortion – Measure	10 Hz to 200 kHz 20 Hz to 20 kHz (20 to 100) kHz	3 % 1 dB 2 dB	HP 333A HP 8903A
AC Voltage – Generate			
(0.22 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 % + 3.88 µV 0.0089 % + 3.88 µV 0.0078 % + 3.88 µV 0.020 % + 3.88 µV 0.047 % + 4.65 µV 0.11 % + 9.3 µV 0.14 % + 19.38 µV 0.27 % + 19.38 µV	Fluke 5720A
(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 % + 3.88 µV 0.0089 % + 3.88 µV 0.0078 % + 3.88 µV 0.020 % + 3.88 µV 0.047 % + 4.65 µV 0.11 % + 9.3 µV 0.14 % + 19.38 µV 0.27 % + 19.38 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 1 MHz	0.024 % + 11.63 µV 0.0089 % + 6.2 µV 0.0078 % + 6.2 µV 0.020 % + 6.2 µV 0.047 % + 15.5 µV 0.11 % + 19.38 µV 0.14 % + 23.26 µV 0.26 % + 46.51 µV	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Voltage – Generate (cont)			
(0.22 to 2.2) 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 1 MHz	0.024 % + 38.76 µV 0.0085 % + 15.51 µV 0.0040 % + 7.77 µV 0.0070 % + 9.32 µV 0.011 % + 31.01 µV 0.039 % + 77.52 µV 0.093 % + 193.8 µV 0.16 % + 310.08 µV	Fluke 5720A
(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 1 MHz	0.023 % + 39.19 µV 0.0081 % + 16.54 µV 0.0039 % + 9.67 µV 0.0067 % + 10.95 µV 0.0098 % + 31.54 µV 0.034 % + 77.73 µV 0.090 % + 193.88 µV 0.15 % + 310.13 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 1 MHz	0.024 % + 3.88 mV 0.0085 % + 1.55 mV 0.0050 % + 542.64 mV 0.0078 % + 0.93 mV 0.014 % + 2.33 mV 0.086 % + 15.50 mV 0.42 % + 38.76 mV 0.78 % + 77.52 mV	Subject to 2.2 x 10^7 V-Hz limitation
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.028 % + 15.5 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 % + 12.42 µV 0.013 % + 3.92 µV 0.011 % + 3.92 µV 0.011 % + 1.95 µV 0.013 % + 3.92 µV 0.031 % + 7.77 µV 0.067 % + 18.61 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 % + 108.68 µV 0.011 % + 19.49 µV 0.0085 % + 19.49 µV 0.0070 % + 19.49 µV	

Parameter/Range	Frequency	CMC[2, 4] (±)	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 1 MHz	0.011 % + 19.49 µV 0.021 % + 39.19 µV 0.051 % + 186.14 µV 0.24 % + 6.07 µV 0.78 % + 19.48 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 1 MHz	0.015 % + 57.81 µV 0.011 % + 194.9 µV 0.0085 % + 194.9 µV 0.0070 % + 194.9 µV 0.011 % + 194.9 µV 0.021 % + 391.93 µV 0.051 % + 57.83 µV 0.24 % + 60.72 µV 0.78 % + 194.82 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 1 MHz	0.015 % + 578.14 µV 0.011 % + 578.04 µV 0.0085 % + 578.04 µV 0.0070 % + 578.04 µV 0.011 % + 578.04 µV 0.021 % + 578.05 µV 0.051 % + 578.33 µV 0.24 % + 607.24 µV 0.78 % + 578.04 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 % + 5.78 mV 0.012 % + 5.78 mV 0.011 % + 5.78 mV 0.021 % + 5.78 mV 0.055 % + 5.78 mV	
AC Voltage – Measure			
(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 % + 1.02 µV 0.024 % + 1.77 µV 0.078 % + 2.51 µV 0.39 % + 3.26 µV 3.2 % + 1.86 µV	Agilent 3458A, option 002
(12 to 120) mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz	0.0054 % + 3.72 µV 0.0054 % + 1.86 µV 0.011 % + 1.86 µV	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Voltage – Measure (cont)			
(12 to 120) mV	(20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz (1 to 2) MHz	0.024 % + 1.86 µV 0.062 % + 1.86 µV 0.24 % + 9.3 µV 0.78 % + 9.3 µV 1.2 % + 9.3 µV	Agilent 3458A, option 002
(0.12 to 1.2) V	(1 to 40) Hz 40 Hzto 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz (1 to 2) MHz	0.0054 % + 37.21 µV 0.0054 % + 18.60 µV 0.011 % + 18.60 µV 0.024 % + 18.60 µV 0.062 % + 18.60 µV 0.24 % + 93.02 µV 0.78 % + 93.02 µV 1.2 % + 93.02 µV	
(1.2 to 12) 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 (0.3 to 1) MHz (1 to 2) MHz	0.0054 % + 372.09 µV 0.0054 % + 186.05 µV 0.011 % + 186.05 µV 0.024 % + 186.05 µV 0.062 % + 186.05V 0.24 % + 930.23 µV 0.78 % + 930.23 µV 1.2 % + 930.23 µV	
(12 to 120) 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 (0.3 to 1) MHz	0.016 % + 3.72 mV 0.016 % + 1.86 mV 0.016 % + 1.86 mV 0.028 % + 1.86 mV 0.093 % + 1.86 mV 0.32 % + 9.3 mV 1.2 % + 9.3 mV	
(120 to 700) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.031 % + 21.71 mV 0.031 % + 10.85 mV 0.047 % + 10.85 mV 0.093 % + 10.85 mV 0.24 % + 10.85 mV	
AC Current – Generate			
(9 to 220) µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.024 % + 15.63 nA 0.016 % + 9.51 nA 0.011 % + 8.0 nA 0.028 % + 11.79 nA 0.11 % + 62.05 nA	Fluke 5720A

Parameter/Range	Frequency	CMC[2, 4] (±)	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 % + 38.80 nA 0.016 % + 31.06 nA 0.011 % + 31.06 nA 0.019 % + 0.10 nA 0.11 % + 0.62 nA	Fluke 5720A
(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 % + 4.65 nA	
(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 % + 3.92 µA 0.016 % + 3.15 µA 0.011 % + 2.4 µA 0.019 % + 3.15 µA 0.11 % + 93.8 µA	
(0.22 to 2.2) A	(20 to 1000) Hz (1000 to 5000) Hz (5 to 10) kHz	0.025 % + 31.01 µA 0.039 % + 77.52 µA 0.63 % + 155.04 µA	
Toroidal Clamps:			
(45 to 65) Hz	(10 to 16.4999) A (16.5 to 149.999) A (150 to 1025) A	0.22 % + 2.33 mA 0.22 % + 19.38 mA 0.22 % + 69.77 mA	Fluke 5500A w/coil
(65 to 440) Hz	(10 to 16.4999) A (16.5 to 149.999) A (150 to 1025) A	0.61 % + 2.33 mA 0.61 % + 20.93 mA 0.61 % + 77.52 mA	
Other Clamps			
(45 to 65) Hz	(10 to 16.4999) A (16.5 to 149.999) A (150 to 1025) A	0.43 % + 23.26 mA 0.43 % + 193.80 mA 0.43 % + 697.67 mA	

Parameter/Range	Frequency	CMC[2, 4] (±)	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 % + 6.09 µA 0.029 % + 6.09 µA 0.062 % + 6.09 µA 0.32 % + 6.09 µA	
(20 to 200) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz	0.031 % + 60.66 µA 0.028 % + 60.66 µA 0.058 % + 60.66 µA	
(0.2 to 2) A	10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz	0.057 % + 606.61 µA 0.067 % + 606.61 µA 0.24 % + 606.61 µA	
(2 to 20) A	10 Hz to 2 kHz (2 to 10) kHz	0.072 % + 58.12 µA 0.20 % + 58.12 µA	
AC Current – 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 Hz to 5 kHz	0.32 % + 1.86 µA 0.12 % + 1.86 µA 0.047 % + 1.86 µA 0.024 % + 1.86 µA	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Current – Measure (cont)			
(1.2 to 12) mA	(5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.047 % + 1.86 µA 0.32 % + 3.72 µA 0.43 % + 13.95 µA	Agilent 3458A, option 002
(12 to 120) 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 % + 18.6 µA 0.12 % + 46.51 µA 0.047 % + 37.21 µA 0.024 % + 27.91 µA 0.047 % + 18.6 µA 0.32 % + 37.21 µA 0.43 % + 139.53 µA	
(0.12 to 1.2) A	(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 % + 186.05 µA 0.12 % + 186.05 µA 0.047 % + 186.05 µA 0.024 % + 186.05 µA 0.047 % + 186.05 µA 0.32 % + 372.09 µA 0.43 % + 1.4 mA	

Parameter/Equipment	Range	CMC[2, 4] (±)	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/Equipment	Range[3]	CMC[2, 4] (±)	Comments
Capacitance – Generate			
(50 to 1000) Hz	(0.33 to 0.49999) nF (0.5 to 1.0999) nF (1.1 to 3.2999) nF (3.3 to 10.999) nF (11 to 32.999) nF (33 to 109.99) nF (110 to 329.99) nF (0.33 to 1.0999) µF (1.1 to 3.2999) µF	0.39 % + 7.79 pF 0.39 % + 7.79 pF 0.39 % + 7.79 pF 0.39 % + 7.79 pF 0.20 % + 0.08 nF 0.20 % + 0.08 nF 0.20 % + 0.23 nF 0.20 % + 0.78 nF 0.28 % + 2.33 nF	Fluke 5500A
(50 to 400) Hz	(3.3 to 10.999) µF (11 to 32.999) µF	0.28 % + 7.75 nF 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 (330 to 1.1) mF	0.55 % + 0.23 µF 0.78 % + 0.23 µF	
Capacitance – Generate, Fixed Points	1000 pF 0.01 µF 0.1 µF 1.0 µF 50 pF to 0.1 µF	0.035 % 0.035 % 0.035 % 0.035 % 0.05 % + 5 pF	General Radio 1409-F 1409-L 1409-T 1409-Y 1412-BC
Capacitance – Measure[5]			
10 aF to 10 F	10 Hz to 2 MHz	0.05 % + 50 aF	QuadTech 7600+
Inductance – Generate, Fixed Points	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

Parameter/Equipment	Range[3]	CMC[2, 4] (±)	Comments
Inductance – Measure[5]			
1 pH to 100 H	10 Hz to 2 MHz	0.05 % + 0.5 pH	QuadTech 7600+
Oscilloscope –			
Amplitude DC			
50 Ω	(0 to 6.6) V	0.25 % + 40 µV	Fluke 5500A/SC600
1 MΩ	(0 to 130) V	0.05 % + 40 µV	
Amplitude Square Wave			
50 Ω	1 mV to 6.6 $V_{(p-p)}$	0.25 % + 40 µV	
1 MΩ	1 mV to 130 $V_{(p-p)}$	0.1 % + 40 µV	
Leveled Sine Wave			
Amplitude	50 kHz Reference	2 % + 300 µV	
(50 kHz Ref)	50 kHz to 100 MHz	3.5 % + 300 µV	
	(100 to 300) MHz	4 % + 300 µV	
	(300 to 600) MHz	6 % + 300 µV	
Flatness	50 kHz to 100 MHz	1.5 % + 100 µV	
(Ref to 50 kHz)	(100 to 300) MHz	2 % + 100 µV	
	(300 to 600) MHz	4 % + 100 µV	
Time Marker	5 s to 50 ms	25 µs/s + 15 mHz	
	20 s to 2 ns	2.5 µs/s	
Rise Time – Generate	195.7 ps	44.1 ps	
Rise Time – Generate	88.3 ps	14.9 ps	Agilent 81134A and Fluke 910R

II. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
RF Power – Measure			
(-10 to +20) dBm 50 Ω	0.1 MHz (0.3 to 0.5) MHz (1 to 3) MHz 5 MHz (10 to 30) MHz 50 MHz (100 to 1500) MHz (2000 to 3000) MHz 4000 MHz 4200 MHz	5.7 % 2.5 % 1.7 % 1.7 % 1.7 % 1.5 % 1.7 % 4.5 % 4.5 % 4.5 %	Agilent E4418B, Agilent 8482A
(-10 to +20) dBm 50 Ω	50 MHz 100 MHz (300 to 1000) MHz 1500 MHz 2000 MHz (3000 to 6000) MHz (7000 to 12 000) MHz 12 400 MHz (13 000 to 15 000) MHz (16 000 to 17 000) MHz 18 000 MHz 19 000 MHz 20 000 MHz (21 000 to 22 000) MHz (23 000 to 24 000) MHz (25 000 to 26 000) MHz 26 500 MHz	2.0 % 2.6 % 2.3 % 2.3 % 2.6 % 3.1 % 3.1 % 3.2 % 3.7 % 3.8 % 4.3 % 4.3 % 5.1 % 5.1 % 5.2 % 5.2 % 5.3 %	Agilent E4418B, Agilent 8485A
(-10 to +20) dBm 50 Ω	50 MHz 100 MHz (300 to 2000) MHz 3000 MHz (4000 to 7000) MHz (8000 to 12 000) MHz (13 000 to 18 000) MHz (19 000 to 20 000) MHz (21 000 to 26 000) MHz (27 000 to 29 000) MHz 30 000 MHz 31 000 MHz 32 000 MHz 33 000 MHz (34 000 to 34 500) MHz	2.0 % 2.6 % 2.3 % 3.0 % 3.1 % 3.2 % 3.8 % 4.6 % 5.3 % 6.0 % 5.7 % 5.6 % 5.5 % 5.5 % 5.5 %	Agilent E4418B, Agilent 8487A

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
RF Power –Measure (cont)			
(-10 to +20) dBm 50 Ω	(35 000 to 40 000) MHz (41 000 to 50 000) MHz	5.4 % 9.5 %	Agilent E4418B, Agilent 8482A
-60 dBm 50 Ω	50 MHz (100 to 2000) MHz (3000 to 500) MHz (1500 to 1000) MHz 2000 MHz (3000 to 7000) MHz (8000 to 14 000) MHz (15 000 to 17 000) MHz 18 000 MHz (19 000 to 20 000) MHz (21 000 to 22 000) MHz (23 000 to 24 000) MHz (25 000 to 26 000) MHz 26 500 MHz	10 % 11 % 11 % 11 % 11 % 11 % 11 % 11 % 12 % 12 % 12 % 12 % 12 % 12 %	Agilent E4418B, Agilent E4413A
-50 dBm 50 Ω	50 MHz (100 to 2000) MHz (3000 to 7000) MHz (8000 to 14 000) MHz (15 000 to 17 000) MHz (18 000 to 20 000) MHz (21 000 to 22 000) MHz (23 000 to 24 000) MHz (25 000 to 26 000) MHz 26 500 MHz	2.8 % 4.4 % 5.0 % 4.4 % 4.4 % 5.0 % 5.2 % 5.2 % 5.7 % 5.7 %	Agilent E4418B, Agilent E4413A
(-40 to +20) dBm 50 Ω	50 MHz (100 to 2000) MHz (3000 to 7000) MHz (8000 to 14 000) MHz (15 000 to 17 000) MHz 18 000 MHz (19 000 to 20 000) MHz (21 000 to 22 000) MHz 23 000 MHz (24 000 to 26 000) MHz 26 500 MHz	2.6 % 4.3 % 4.8 % 4.3 % 4.3 % 4.8 % 5.1 % 5.1 % 5.6 % 5.6 % 6.3 %	Agilent E4418B, Agilent E4413A

Parameter/Frequency	Range	CMC[2, 4] (±)	Comments
RF Power – Generate	Signal Generator		
1 Hz to 20 MHz	(+13 to -56) dBm	0.52 dB	HP 3325B
250 kHz to 2 GHz (> 2 to 20) GHz (>20 to 40) GHz	(-20 to -10) dBm	1.4 dBm 1.2 dBm 1.3 dBm	Agilent E8257D
250 kHz to 2 GHz (> 2 to 20) GHz (>20 to 50) GHz	(-10 to 0) dBm	0.6 dBm 0.8 dBm 0.9 dBm	
250 kHz to 2 GHz (> 2 to 20) GHz (>20 to 40) GHz	(0 to +10) dBm	0.6 dBm 0.8 dBm 0.9 dBm	
(>40 to 50) GHz	(0 to +10) dBm	1.3 dBm	
250 kHz to 40 GHz	> +10 dBm	0.6 dBm	

Parameter/Frequency	Range	CMC[2] (±)	Comments
RF Attenuation – Generate			
DC to 1 kHz 1 kHz to 500 MHz 500 MHz to 1 GHz	(0 to 12) dB	0.1 dB 0.25 dB 0.35 dB	HP 355C, 1 dB steps
DC to 1 kHz 1 kHz to 1 GHz 1 kHz to 1 GHz	(0 to 120) dB (0 to 90) dB (90 to 120) dB	0.3 dB 1.5 dB 3 dB	HP 355D, 10 dB steps
DC to 4 GHz DC to 4 GHz DC to 4 GHz DC to 4 GHz	(0 to 2) dB (>2 to 6) dB (>6 to 10) dB (>10 to 11) dB	0.2 dB 0.3 dB 0.4 dB 0.5 dB	HP 8494A, 1 dB steps
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 DC to 4 GHz DC to 4 GHz DC to 4 GHz DC to 4 GHz	10 dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB 80 dB 90 dB 100 dB 110 dB	0.2 dB 0.4 dB 0.5 dB 0.7 dB 0.8 dB 1.0 dB 1.2 dB 1.3 dB 1.5 dB 1.6 dB 1.8 dB	HP 8496A, 10 dB steps
Fixed Values			
DC to 18 GHz	1 dB 3 dB 6 dB 10 dB 20 dB 30 dB	0.3 dB 0.3 dB 0.3 dB 0.5 dB 0.5 dB 1.0 dB	Weinschel AS-18
Noise Source – Generate & Measure, Excess Noise Ratio (ENR)			
10.00 MHz 100.00 MHz 1000.00 MHz 2000.00 MHz	(12 to 17) dB	0.052 dB 0.13 dB 0.12 dB 0.13 dB	Agilent N4002A noise source, w/N8975A noise figure meter

Parameter/Frequency	Range	CMC[2] (±)	Comments
Noise Source – Generate & Measure (cont)			
3000.00 MHz	(12 to 17) dB Excess Noise Ratio (ENR)	0.14 dB	Agilent N4002A noise source, w/N8975A noise figure meter
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	
10 000.00 MHz	(12 to 17) dB Excess Noise Ratio (ENR)	0.20 dB	Agilent N4002A noise source, w/N8975A noise figure meter
11 000.00 MHz		0.20 dB	
12 000.00 MHz		0.21 dB	
13 000.00 MHz		0.20 dB	
14 000.00 MHz		0.22 dB	
15 000.00 MHz		0.20 dB	
16 000.00 MHz		0.21 dB	
17 000.00 MHz		0.20 dB	
18 000.00 MHz		0.23 dB	
19 000.00 MHz		0.25 dB	
20 000.00 MHz		0.24 dB	
21 000.00 MHz		0.26 dB	
22 000.00 MHz		0.27 dB	
23 000.00 MHz		0.28 dB	
24 000.00 MHz		0.30 dB	
25 000.00 MHz		0.29 dB	
26 000.00 MHz		0.31 dB	
26 500.00 MHz		0.35 dB	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
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

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
Pulse Modulation – Measure	DC to 20 GHz	10 ps + 0.1 %	HP 54120T, HP 54120A, HP 54121A

III. Thermodynamics

Parameter/Equipment	Range[3]	CMC[2] (±)	Comments
Thermocouple – Measuring Equipment and Measure			
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 (1000 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	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Thermocouple – Measuring Equipment and Measure (cont)			
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	Fluke 5500A/525A
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	
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	
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			
Pt 385, 100 Ω	(-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 Ω	(-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	

Parameter/Equipment	Range	CMC[2] (±)	Comments
RTD – Measuring Equipment & Measure			
Pt 3916, 100 Ω	(-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	Fluke 5500A/525A
Pt 385, 200 Ω	(-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	
Pt 385, 500 Ω	(-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 Ω	(-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	

Parameter/Equipment	Range	CMC[2] (±)	Comments
RTD– Measuring Equipment & Measure (cont)			
PtNi 385, 120 Ω	(-80 to 0) °C (0 to 100) °C (100 to 260) °C	0.08 °C 0.08 °C 0.14 °C	Fluke 5500A/525A
Cu 427, 10 Ω	(-100 to 26) °C	0.30 °C	

IV. Time & Frequency

Parameter/Equipment	Range	CMC[2] (±)	Comments
Time Interval	1 s to 24 h	0.5 s	HP 5345A
Frequency – Measuring Equipment	5.0 MHz 10 MHz	2×10^{-12} Hz 2×10^{-12} Hz	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 Uncertainty (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. CMCs 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] Where ranges are not specified, the CMC stated is for the cardinal points only.

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

[5] The CMC is stated for 1 kHz and may vary with voltage and frequency.

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Presented this 20th day of March 2017.

President and CEO
For the Accreditation Council
Certificate Number 2635.01
Valid to February 28, 2019

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