SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005
& ANSI/NCSL Z540-1-1994 & ANSI/NCSL Z540.3

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CALIBRATION

Valid To: July 31, 2018 Certificate Number: 2353.01

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

I. Chemical

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
pH – Measuring Equipment[3]	(4, 7, 10) pH	0.016 pH	Buffer solutions
Electrolytic Conductivity – Measuring Equipment[3]	≈10 µS/cm ≈100 µS/cm ≈1000 µS/cm ≈10 000 µS/cm	0.53 µS/cm 2.4 µS/cm 23 µS/cm 0.23 mS/cm	Conductivity solutions

II. Dimensional

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
Flatness[3]	Up to 1 in	4.6 µin	Monochromatic light and optical flats

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
Hand Tools[3] Indicators Micrometers Depth Gages Height Gages Calipers	Up to 1 in	25 µin /in + 0.8 µin	Gage blocks
Pin and Plug Gages	(0.01 to 1) in	120 µin/in	Gage blocks and micrometer
Protractors and Tilt Sensors	Up to 60º	5.8”	Gage blocks & sine bar

III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2, 4, 5, 6] (±)	Comments
DC Voltage – Generate	Up 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	7.1 µV/V + 0.40 µV 3.7 µV/V + 0.80 µV 4.9 µV/V + 3.0 µV 4.9 µV/V + 4.3 µV 3.7 µV/V + 48 µV 4.7 µV/V + 0.48 mV	Fluke 5720A
Fixed Value	10.0 V	3.4 µV/V	Fluke 732A
DC Voltage[3] – Measure	(0 to 0.1) V (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1100) V	9.5 µV/V + 0.37 µV 6.1 µV/V + 0.37 µV 5.8 µV/V + 0.60 µV 8.7 µV/V + 37 µV 8.7 µV/V + 0.12 mV	Agilent 3458A
DC High Voltage[3] – Generate & Measure	(1 to 45) kV (45 to 200) kV	0.11 % 2.4 %	VD45 Ross divider VMP200 Ross divider

Parameter/Equipment	Range	CMC[2, 4, 5, 6] (±)	Comments
DC Current[3] – Generate	Up to 220 µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 11) A (0 to 10.9999) A (11 to 20.5) A (20 to 150) A (150 to 1000) A	35 µA/A + 6.0 nA 31 µA/A + 7.0 nA 30 µA/A + 41 nA 41 µA/A + 0.71 µA 77 µA/A + 12 µA 0.034 % + 0.48 mA 0.057 % + 500 µA 0.11 % + 750 µA 0.28 % + 500 µA 0.57 % + 500 µA	Fluke 5720A Fluke 5520A Fluke 5500A Coil/5520A

Parameter/Equipment	Range	CMC[2, 4, 5, 6] (±)	Comments
DC Current[3] – Measure	(0 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	17 µA/A + 0.80 nA 17 µA/A + 5.0 nA 17 µA/A + 50 nA 31 µA/A + 0.50 µA 0.010 % + 10 µA	Agilent 3458A

Parameter/Equipment	Range	CMC[2, 4, 5, 6] (±)	Comments
Resistance[3] – Generate	Up to 10.9999 Ω	40 μΩ/Ω + 1.0 mΩ	Fluke 5520A, 4-wire
	(11 to 32.9999) Ω	30 μΩ/Ω + 2.0 mΩ	
	(33 to 109.9999) Ω	28 μΩ/Ω + 2.0 mΩ	
	(110 to 329.9999) Ω	28 μΩ/Ω + 4.0 mΩ	
	(0.33 to 1.099999) kΩ	28 μΩ/Ω + 13 mΩ	
	(1.1 to 3.299999) kΩ	28 μΩ/Ω + 13 mΩ	
	(3.3 to 10.99999) kΩ	28 μΩ/Ω + 30 mΩ	
	(11 to 32.99999) kΩ	28 μΩ/Ω + 0.30 Ω	
	(33 to 109.999) kΩ	28 μΩ/Ω + 0.30 Ω	
	(110 to 329.999) kΩ	32 μΩ/Ω + 2.0 Ω	
	(0.33 to 1.09999) MΩ	32 μΩ/Ω + 2.2 Ω	Fluke 5520A, 2-wire
	(1.1 to 3.29900) MΩ	60 μΩ/Ω + 39 Ω	
	(3.3 to 10.9999) MΩ	0.013 % + 63 Ω	
	(11 to 32.9999) MΩ	0.025 % + 2.5 kΩ	
	(33 to 109.9999) MΩ	0.050 % + 3.0 kΩ	
	(110 to 329.9999) MΩ	0.30 % + 0.10 MΩ	
	(330 to 1100) MΩ	1.5 % + 0.50 MΩ	
Fixed Points	0 Ω	41 μΩ	Fluke 5720A
	1 Ω	81 μΩ/Ω	
	1.9 Ω	82 μΩ/Ω	
	10, 19 Ω	23 μΩ/Ω	
	100, 190 Ω	9.5 μΩ/Ω	
	1, 1.9 kΩ	8.5 μΩ/Ω	
	10, 19 kΩ	8.5 μΩ/Ω	
	100, 190 kΩ	11 μΩ/Ω	
	1 MΩ	20 μΩ/Ω	
	1.9 MΩ	30 μΩ/Ω	
	10 MΩ	35 μΩ/Ω	
	19 MΩ	45 μΩ/Ω	
	100 MΩ	0.010 %	
	1 MΩ	0.11 % per decade	IET HRRS-B-3-1M
	10 MΩ	0.11 % per decade	
	100 MΩ	0.23 % per decade	

Parameter/Equipment	Range	CMC[2, 4, 5, 6] (±)	Comments
Resistance[3] – Measure	100 mΩ to 10 Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ	18 μΩ/Ω + 58 μΩ 12 μΩ/Ω + 0.58 mΩ 9.5 μΩ/Ω + 5.8 mΩ 9.5 μΩ/Ω + 58 mΩ 9.7 μΩ/Ω + 0.58 Ω 15 μΩ/Ω + 2.3 Ω 58 μΩ/Ω + 0.12 kΩ 0.058 % + 1.2 kΩ 0.59 % + 12 kΩ	Agilent 3458A
Shunt [3]– AC/DC, Fixed Point	500.78 μΩ	0.028 %	ITT HA0511 100A, 50 mV
Ground Bond Test[3] – AC/DC, Fixed Point	0.1 Ω	33 μΩ/Ω	Ground bond test resistor
Corona Simulation[3]	(1 to 1000) pC	4 %	Agilent 34401A w/ Andeen-Hagerling AH2550

Parameter/Range	Frequency	CMC[2, 4, 5, 6] (±)	Comments
AC Voltage[3] – Generate			
Up 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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.022 % + 4.0 μV 85 μV/V + 4.0 μV 75 μV/V + 4.0 μV 0.018 % + 4.0 μV 0.046 % + 5.0 μV 0.090 % + 10 μV 0.12 % + 20 μV 0.25 % + 20 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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.022 % + 4.0 μV 85 μV/V + 4.0 μV 75 μV/V + 4.0 μV 0.018 % + 4.0 μV 0.046 % + 5.0 μV 0.090 % + 10 μV 0.12 % + 20 μV 0.25 % + 20 μV	

Parameter/Range	Frequency	CMC[2, 4, 5, 6] (±)	Comments
AC Voltage[3] – Generate (cont)			
(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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.022 % + 12 µV 85 µV/V + 7.0 µV 75 µV/V + 7.0 µV 0.018 % + 7.0 µV 0.042 % + 17 µV 0.075 % + 20 µV 0.12 % + 25 µV 0.25 % + 45 µV	Fluke 5720A
220 mV 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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.022 % + 82 µV 85 µV/V + 82 µV 40 µV/V + 82 µV 70 µV/V + 82 µV 0.011 % + 82 µV 0.034 % + 82 µV 0.090 % + 0.20 mV 0.15 % + 0.32 mV	
(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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.022 % + 0.40 mV 80 µV/V + 0.15 mV 40 µV/V + 50 µV 70 µV/V + 0.10 mV 95 µV/V + 0.20 mV 0.026 % + 0.60 mV 0.090 % + 2.0 mV 0.13 % + 3.2 mV	
(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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.022 % + 4.0 mV 80 µV/V + 1.5 mV 47 µV/V + 0.61 mV 75 µV/V + 1.0 mV 0.013 % + 2.5 mV 0.080 % + 16 mV 0.42 % + 40 mV 0.70 % + 80 mV	* 220 V range subject to 2.2E7 V-Hz limitation
(220 to 1100) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	80 µV/V + 4.1 mV 0.013 % + 6.1 mV 0.036 % + 11 mV	
(220 to 750) V	(30 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (500 to 1000) KHz	0.036 % + 11 mV 0.080 % + 45 mV 0.13 % + 83 mV 0.42 % + 91 mV 0.70 % + 1.1 V	

Parameter/Range	Frequency	CMC[2, 4, 5, 6] (±)	Comments
AC Voltage[3] – Measure			
(0.1 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	0.030 % + 3.3 µV 0.020 % + 1.8 µV 0.030 % + 1.8 µV 0.10 % + 1.8 µV 0.50 % + 1.8 µV 4.0 % + 1.8 µV	Agilent 3458A
(10 to 100) 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 (0.3 to 1) MHz (1 to 2) MHz	0.007 % + 10 µV 0.007 % + 2 µV 0.014 % + 2 µV 0.030 % + 2 µV 0.080 % + 2 µV 0.30 % + 10 µV 1.0 % + 10 µV 1.5 % + 10 µV	
100 mV to 1V	(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	0.007 % + 40 µV 0.007 % + 20 µV 0.014 % + 20 µV 0.030 % + 20 µV 0.080 % + 20 µV 0.30 % + 100 µV 1.0 % + 100 µV 1.5 % + 100 µV	
(1 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 (0.3 to 1) MHz (1 to 2) MHz	0.007 % + 0.40 mV 0.007 % + 0.20 mV 0.014 % + 0.20 mV 0.030 % + 0.20 mV 0.080 % + 0.20 mV 0.30 % + 1.0 mV 1.0 % + 1.0 mV 1.5 % + 1.0 mV	
(10 to 100) 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	0.02 % + 4.0 mV 0.02 % + 2.0 mV 0.02 % + 2.0 mV 0.04 % + 2.0 mV 0.12 % + 2.0 mV 0.40 % + 10 mV 1.5 % + 10 mV	

Parameter/Range	Frequency	CMC[2, 4, 5, 6](±)	Comments
AC Voltage[3] – Measure (cont.)			
(100 to 707) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.04 % + 40 mV 0.04 % + 20 mV 0.06 % + 20 mV 0.12 % + 20 mV 0.30 % + 20 mV	Agilent 3458A
AC High Voltage[3] – Measure			
(1 to 30) kVrms	60 Hz	0.26 %	Ross VD45
(30 to 142) kVrms	60 Hz	4.4 %	Ross VMP200
AC Current[3] – Generate			
Up to 220 µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.023 % + 16 nA 0.014 % + 10 nA 0.011 % + 8.0 nA 0.025 % + 12 nA 0.090 % + 65 nA 1.6 % + 0.40 µA	Fluke 5720A w/ 5725A Fluke 5520A
(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 (10 to 30) kHz	0.023 % + 41 nA 0.014 % + 36 nA 0.011 % + 36 nA 0.025 % + 0.11 µA 0.090 % + 0.65 µA 1.0 % + 0.60 µA	Fluke 5720A w/ 5725A Fluke 5520A

Parameter/Range	Frequency	CMC[2, 4, 5, 6](±)	Comments
AC Current[3] – Generate (cont)			
(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 (10 to 30) kHz	0.023 % + 0.40 µA 0.014 % + 0.36 µA 0.011 % + 0.36 µA 0.025 % + 0.56 µA 0.090 % + 5.0 µA 0.40 % + 4.0 µA	Fluke 5720A w/ 5725A Fluke 5520A
(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 (10 to 30) kHz	0.023 % + 4.1 µA 0.014 % + 3.6 µA 0.011 % + 2.6 µA 0.018 % + 3.6 µA 0.090 % + 10 µA 0.40 % + 0.20 mA	Fluke 5720A w/ 5725A Fluke 5520A
Up to 220 µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.023 % + 16 nA 0.014 % + 10 nA 0.011 % + 8.0 nA 0.025 % + 12 nA 0.090 % + 65 nA 1.6 % + 0.40 µA	Fluke 5720A w/ 5725A Fluke 5520A
(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 (10 to 30) kHz	0.023 % + 41 nA 0.014 % + 36 nA 0.011 % + 36 nA 0.025 % + 0.11 µA 0.090 % + 0.65 µA 1.0 % + 0.60 µA	Fluke 5720A w/ 5725A Fluke 5520A
(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 (10 to 30) kHz	0.023 % + 0.40 µA 0.014 % + 0.36 µA 0.011 % + 0.36 µA 0.025 % + 0.56 µA 0.090 % + 5.0 µA 0.40 % + 4.0 µA	Fluke 5720A w/ 5725A Fluke 5520A
(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 (10 to 30) kHz	0.023 % + 4.1 µA 0.014 % + 3.6 µA 0.011 % + 2.6 µA 0.018 % + 3.6 µA 0.090 % + 10 µA 0.40 % + 0.20 mA	Fluke 5720A w/ 5725A Fluke 5520A

Parameter/Range	Frequency	CMC[2, 4, 5, 6] (±)	Comments
AC Current[3] – Generate (cont.)			
(0.22 to 2.2) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.024 % + 36 µA 0.039 % + 80 µA 0.60 % + 0.16 mA	Fluke 5720A w/ 5725A
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.040 % + 0.18 mA 0.085 % + 0.39 mA 0.33 % + 0.75 mA	Fluke 5720A w/ 5725A
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.12 % + 5.1 mA 0.15 % + 5.1 mA 3.0 % + 5.1 mA	Fluke 5520A
(16.5 to 150) A	(45 to 65) Hz (65 to 440) Hz	0.38 % + 0.029 A 1.0 % + 0.031 A	Fluke 5520A w/ coil
(150 to 1025) A	(45 to 65) Hz (65 to 440) Hz	1.0 % + 0.031 A 1.0 % + 0.12 A	
AC Current[3] – Measure			
(5 to 100) µA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz	0.46 % + 0.035 µA 0.18 % + 0.035 µA 0.07 % + 0.035 µA	Agilent 3458A
(0.1 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.46 % + 0.024 % 0.18 % + 0.024 % 0.07 % + 0.024 % 0.036 % + 0.024 %	
(0.1 to 1) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.46 % + 0.23 mA 0.19 % + 0.23 mA 0.093 % + 0.23 mA 0.12 % + 0.23 mA	
100 mA to 20 A	Up to 1 kHz (1 to 5) kHz	0.039 % + 0.032 %* *F* 0.041 % + 0.032 %**F*	w/ Fluke Y5020 shunt **F* is the applied frequency

Parameter/Range	Frequency	CMC[2, 4, 5, 6] (±)	Comments
Capacitance[3] – Generate			
(0.10 to 3.299) nF	10 Hz to 10 kHz	0.51 % + 12 pF	Fluke 5520A
(0.33 to 10.999) nF	(10 to 1000) Hz	0.26 % + 12 pF	
(11 to 109.999) nF	(10 to 1000) Hz	0.26 % + 0.12 nF	
(110 to 329.99) nF	(10 to 1000) Hz	0.26 % + 0.31 nF	
(0.33 to 1.0999) µF	(10 to 600) Hz	0.26 % + 1.2 nF	
(1.1 to 3.2999) µF	(10 to 300) Hz	0.26 % + 3.1 nF	
(3.3 to 10.999) µF	(10 to 150) Hz	0.26 % + 12 nF	
(11 to 32.999) µF	(10 to 120) Hz	0.42 % + 31 nF	
(33 to 109.99) µF	(10 to 80) Hz	0.46 % + 0.12 µF	
(110 to 329.99) µF	Up to 50 Hz	0.46 % + 0.31 µF	
(0.33 to 1.0999) mF	Up to 20 Hz	0.46 % + 1.2 µF	
(1.1 to 3.2999) mF	Up to 6 Hz	0.46 % + 3.1 µF	
(3.3 to 10.999) mF	Up to 2 Hz	0.46 % + 12 µF	
(11 to 32.999) mF	Up to 0.6 Hz	0.78 % + 31 µF	
(33 to 110) mF	Up to 0.2 Hz	1.2 % + 0.12 mF	
Fixed Points			
1 pF	1 kHz to 13 MHz	0.37 %	Agilent 16381A
10 pF	1 kHz to 13 MHz	0.040 %	Agilent 16382A
100 pF	1 kHz to 13 MHz	0.067 %	Agilent 16383A
1000 pF	1 kHz to 13 MHz	0.33 %	Agilent 16384A
(10, 100, 1000) nF	120 Hz to 100 kHz	0.010 %	Agilent 16380C

Parameter/Range	Frequency	CMC[2, 4, 5, 6] (±)	Comments
Capacitance[3] – Measure			
1 pF	500 Hz to 5 kHz (5 to 100) kHz	12 % 1.2 %	Fluke PM6304C
10 pF	(150 to 500) Hz 500 Hz to 5 kHz (5 to 20) kHz (20 to 100) kHz	12 % 1.2 % 0.12 % 0.46 %	
100 pF	(50 to 250) Hz 250 Hz to 1 kHz (1 to 20) kHz (20 to 100) kHz	12 % 1.2 % 0.12 % 0.46 %	
1 nF	(50 to 250) Hz 250 Hz to 20 kHz (20 to 100) kHz	1.2 % 0.12 % 0.46 %	
10 nF	(50 to 500) Hz 500 Hz to 2 kHz (2 to 20) kHz (20 to 100) kHz	0.12 % 0.06 % 0.12 % 0.46 %	
100 nF	(50 to 150) Hz 150 Hz to 2 kHz (2 to 20) kHz (20 to 100) kHz	0.12 % 0.06 % 0.12 % 0.46 %	
1 µF	50 Hz to 2 kHz (2 to 20) kHz (20 to 100) kHz	0.06 % 0.12 % 0.46 %	
10 µF	(50 to 1500) Hz (1.5 to 15) kHz (15 to 50) kHz (50 to 100) kHz	0.06 % 0.12 % 1.2 % 12 %	
100 µF	(50 to 1500) Hz (1.5 to 15) kHz (15 to 50) kHz	0.12 % 1.2 % 12 %	

Parameter/Range	Frequency	CMC[2, 4, 5, 6] (±)	Comments
Inductance[3] – Generate Fixed Points 100 µH 1 mH 10 mH 100 mH 1 H	 400 Hz & 1 kHz	 1.2 % 0.13 % 0.083 % 0.083 % 0.083 %	 GenRad 1482 series
Inductance[3] – Measure 1 µH 10 µH 100 µH 1 mH 10 mH 100 mH 1 H 	 500 Hz to 1 kHz (50 to 100) kHz (250 to 500) Hz 500 Hz to 20 kHz (20 to 100) kHz (75 to 250) Hz (250 to 1500) Hz (1.5 to 20) kHz (20 to 100) kHz (50 to 75) Hz (75 to 250) Hz 250 Hz to 20 kHz (20 to 100) kHz (50 to 75) Hz (75 to 250) Hz 250 Hz to 2 kHz (2 to 20) kHz (20 to 100) kHz (50 to 75) Hz 75 Hz to 2 kHz (2 to 20) kHz (20 to 100) kHz 50 Hz to 2 kHz (2 to 20) kHz (20 to 100) kHz	 12 % 1.2 % 12 % 1.2 % 0.46 % 12 % 1.2 % 0.12 % 0.46 % 12 % 1.2 % 0.12 % 0.46 % 1.2 % 0.12 % 0.06 % 0.12 % 0.46 % 0.12 % 0.06 % 0.12 % 0.46 % 0.06 % 0.12 % 0.46 %	 Fluke PM6304C
Capacitance Dissipation Factor[3]–	(0.2 to 5) %	0.25 %	Andeen-Hagerling AH2550

Parameter/Range	Frequency	CMC[2, 4, 5, 6] (±)	Comments
Inductance[3] – Measure (cont)			
10 H	(50 to 250) Hz 250 Hz to 20 kHz (20 to 100) kHz	0.06 % 0.12 % 1.2 %	Fluke PM6304C
100 H	(50 to 2500) Hz (2.5 to 15) kHz (15 to 75) kHz	0.12 % 1.2 % 12 %	
1000 H	(50 to 250) Hz 250 Hz to 2.5 kHz (2.5 to 15) kHz	0.12 % 1.2 % 13 %	
Thermocouple[3] – Indicating Systems & Measure			
Type B	(600 to 800) °C (800 to 1550) °C (1550 to 1820) °C	0.35 °C 0.28 °C 0.22 °C	Fluke 7526A
Type C	(0 to 1000) °C (1000 to 1800) °C (1800 to 2000) °C (2000 to 2316) °C	0.16 °C 0.23 °C 0.26 °C 0.35 °C	
Type E	(-250 to -200) °C (-200 to -100) °C (-100 to 0) °C (0 to 600) °C (600 to 1000) °C	0.25 °C 0.12 °C 0.09 °C 0.08 °C 0.1 °C	
Type J	(-210 to -100) °C (-100 to 800) °C (800 to 1200) °C	0.14 °C 0.09 °C 0.1 °C	
Type K	(-250 to -200) °C (-200 to -100) °C (-100 to 500) °C (500 to 800) °C (800 to 1372) °C	0.46 °C 0.16 °C 0.1 °C 0.1 °C 0.13 °C	

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
Thermocouple[3] – Indicating Systems & Measure			
Type L			
	(-200 to -100) °C	0.1 °C	Fluke 7526A
	(-100 to 900) °C	0.09 °C	
Type N			
	(-250 to -200) °C	0.73 °C	
	(-200 to -100) °C	0.23 °C	
	(-100 to 0) °C	0.12 °C	
	(0 to 100) °C	0.11 °C	
	(100 to 800) °C	0.1 °C	
	(800 to 1300) °C	0.12 °C	
Type R			
	(-50 to -25) °C	0.55 °C	
	(-25 to 0) °C	0.45 °C	
	(0 to 100) °C	0.39 °C	
	(100 to 400) °C	0.28 °C	
	(400 to 600) °C	0.22 °C	
	(600 to 1000) °C	0.21 °C	
	(1000 to 1600) °C	0.19 °C	
	(1600 to 1767) °C	0.23 °C	
Type S			
	(-50 to -25) °C	0.51 °C	
	(-25 to 0) °C	0.43 °C	
	(0 to 100) °C	0.38 °C	
	(100 to 400) °C	0.29 °C	
	(400 to 600) °C	0.23 °C	
	(600 to 1000) °C	0.22 °C	
	(1000 to 1600) °C	0.22 °C	
	(1600 to 1767) °C	0.26 °C	
Type T			
	(-250 to -200) °C	0.35 °C	
	(-200 to -100) °C	0.16 °C	
	(-100 to 0) °C	0.11 °C	
	(0 to 200) °C	0.09 °C	
	(200 to 400) °C	0.09 °C	
Type U			
	(-200 to 0) °C	0.16 °C	
	(0 to 200) °C	0.1 °C	
	(200 to 600) °C	0.1 °C	

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
Electrical Calibration of RTDs[3] – Generate			
Pt 385, 100 Ω	(-200 to -80) °C (-80 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 800) °C	0.013 °C 0.02 °C 0.024 °C 0.026 °C 0.033 °C 0.038 °C	Fluke 7526A
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	0.013 °C 0.015 °C 0.017 °C 0.022 °C 0.026 °C 0.032 °C	
Pt 3916, 100 Ω	(-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.01 °C 0.013 °C 0.015 °C 0.017 °C 0.022 °C 0.026 °C 0.031 °C 0.033 °C	
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 630) °C	0.053 °C 0.056 °C 0.06 °C 0.06 °C 0.069 °C 0.071 °C 0.088 °C	
Pt 385, 500 Ω	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.026 °C 0.028 °C 0.034 °C 0.038 °C 0.045 °C	
Pt 385, 1000 Ω	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.015 °C 0.018 °C 0.024 °C 0.026 °C 0.033 °C	

Parameter/Equipment	Range	CMC[2, 4, 5, 6] (±)	Comments
Electrical Calibration of RTDs[3] – Generate (cont)			
Ni 385, 120 Ω	(-80 to 260) °C	0.009 °C	Fluke 7526A
Cu 427, 10 Ω	(-100 to 260) °C	0.11 °C	
SPRT	(-200 to 660) °C	0.06 °C	
Power Measuring Equipment AC, DC Power[3] – Generate			
PF = 1:			
(33 to 329.99) mV	(3.3 to 8.999) mA	0.16 %	Fluke 5520A
(45 to 65) Hz	(9 to 32.999) mA	0.11 %	
	(33 to 89.999) mA	0.16 %	
	(90 to 329.99) mA	0.12 %	
	(0.33 to 0.8999) A	0.15 %	
	(0.9 to 2.1999) A	0.12 %	
	(2.2 to 4.4999) A	0.15 %	
	(4.5 to 20.5) A	0.13 %	
330 mV to 1020 V	(3.3 to 8.999) mA	0.14 %	
(45 to 65) Hz	(9 to 32.999) mA	0.09 %	
	(33 to 89.999) mA	0.14 %	
	(90 to 329.99) mA	0.09 %	
	(0.33 to 0.8999) A	0.13 %	
	(0.9 to 2.1999) A	0.1 %	
	(2.2 to 4.4999) A	0.14 %	
	(4.5 to 20.5) A	0.12 %	
Phase/Power Factor[3] –			
(10 to 65) Hz	0Φ / PF 1		Fluke 5520A
PF (0 to 1)	10Φ / PF 0.985	0.58 %	
	20Φ / PF 0.940	0.29 %	
	30Φ / PF 0.866	0.22 %	
	40Φ / PF 0.766	0.22 %	
	50Φ / PF 0.643	0.26 %	
	60Φ / PF 0.500	0.35 %	
	70Φ / PF 0.342	0.55 %	
	80Φ / PF 0.174	1.1 %	

Parameter/Equipment	Range	CMC[2, 4, 6] (±)	Comments
Phase Angle[3] – Measure (0 to 359.9)°	20 Hz to 10 kHz (10 to 40) kHz (40 to 100) kHz	0.081 º 0.29 º 0.98 º	Krohn-Hite 6500
Oscilloscopes [3] –			
Rise Time	Single Sided	< 300 ps ± 120 ps	Fluke 5520A-SC1100
Bandwidth	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (0.6 to 1.1) GHz	3.5 % + 300 µV 4 % + 300 µV 6 % + 300 µV 7 % + 300 µV	Agilent 8340A w/: 8482A, 11667A 8481A, 11667A 8485A, 11667B
	(1.1 to 4.2) GHz (4.2 to 18) GHz (18 to 26.5) GHz	0.31 dB 0.74 dB 0.84 dB	
Audio Distortion[3] (THD)	Up to 100 kHz	1.2 dB	Agilent 8903B

IV. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC[2, 5, 6] (±)	Comments
Power Meter – Power Reference, @ 1 mW	50 MHz	1.9 %	Agilent 432A w/ 478A
Relative Power (Tuned RF Level) – Measure			
100 kHz to 50 GHz	(0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB (-40 to -50) dB (-50 to -60) dB (-60 to -70) dB (-70 to -80) dB (-80 to -90) dB	0.018 dB 0.019 dB 0.019 dB 0.056 dB 0.056 dB 0.057 dB 0.057 dB 0.094 dB 0.094 dB	Agilent E4448A

Parameter/Range	Frequency	CMC[2, 5, 6] (±)	Comments
Relative Power (Tuned RF Level) – Measure (cont)			
100 kHz to 50 GHz	(-90 to -100) dB (-100 to -110) dB (-110 to -120) dB (-120 to -130) dB	0.094 dB 0.095 dB 0.096 dB 0.096 dB 0.097 dB	Agilent E4448A
Absolute Power – Measure			Agilent N5531S w/
(-30 to -50) dBm (-50 to -60) dBm (-60 to 68) dBm	10 MHz to 18 GHz	1.3 % 2.6 % 15 %	N-Type power sensor, w/ power meter
(-30 to +10) dBm	100 kHz to 4.2 GHz (4.2 to 18) GHz (18 to 26.5) GHz (26.5 to 50) GHz	3.3 % 3.5 % 4.2 % 5.0 %	 3.5 mm 2.4 mm
(+10 to +20) dBm	100 kHz to 4.2 GHz (4.2 to 18) GHz (18 to 26.5) GHz (26.5 to 50) GHz	5.9 % 6.0 % 6.5 % 7.0 %	 3.5 mm 2.4 mm
VSWR	5 MHz to 2 GHz (2 to 12.5) GHz (12.5 to 18) GHz	0.11 dB 0.53 dB 0.85 dB	E4448A opt 233 Measuring receiver w/ SWR bridges
Frequency Modulation – Measure			
Mod Rate: 20 Hz to 10 kHz Dev.: 200 Hz to 40 kHz (ß > 0.2)	250 kHz to 10 MHz	1.0 %	E4448A opt 233 ß is the ratio of the frequency deviation to the modulation rate
Mod Rate: 50 Hz to 200 kHz Dev.: 250 Hz to 400 kHz (ß > 0.2)	10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 31.15) GHz (31.15 to 50) GHz	1.0 % 1.0 % 1.0 % 1.0 %	

Parameter/Range	Frequency	CMC[2, 5, 6] (±)	Comments
Amplitude Modulation – Measure			
Depth:			
(5 to 99) %	100 kHz to 10 MHz	0.75 %	E4448A opt 233
(5 to 20) %	10 MHz to 3 GHz	2.5 %	
(20 to 99) %	10 MHz to 3 GHz	0.50 %	
(5 to 20) %	(3 to 26.5) GHz	4.5 %	
(20 to 99) %	(3 to 26.5) GHz	1.5 %	
(5 to 20) %	(26.5 to 31.15) GHz	6.8 %	
(20 to 99) %	(26.5 to 31.15) GHz	1.9 %	
(5 to 20) %	(31.15 to 50) GHz	2.6 %	
(20 to 99) %	(31.15 to 50) GHz	6.0 %	
Phase Modulation –			
Mod Rate: (0.2 to 20) kHz			
0.3 rad < Dev ≤ 0.7 rad	100 kHz to 6.6 GHz	3.0 %	E4448A opt 233
Dev > 0.7 rad		1.0 %	
0.6 rad < Dev ≤ 2.0 rad	(6.6 to 13.2) GHz	3.0 %	
Dev > 2.0 rad		1.0 %	
1.2 rad < Dev ≤ 4.0 rad	(13.2 to 26.5) GHz	3.0 %	
Dev > 4.0 rad		1.0 %	
1.3 rad < Dev ≤ 4.0 rad	(26.5 to 31.5) GHz	3.0 %	
Dev > 4.0 rad		1.0 %	
2.4 rad < Dev ≤ 8.0 rad	(31.5 to 50) GHz	3.0 %	
Dev > 8.0 rad		1.0 %	
Transmission (S_{12}/S_{21}) – Measure	Type-N Connectors		Agilent 8753D VNA w/ 85032B calibration kit
Linear Phase	30 kHz to 2 GHz	(± 0.76 to ± 39)°	
Linear Mag.		(± 0.11 to ± 8.2) dB	
Linear Phase	(2 to 6) GHz	(± 2.1 to ± 15)°	
Linear Mag.		(± 0.25 to ± 1.9) dB	

Parameter/Range	Frequency	CMC[2, 5, 6] (±)	Comments
Reflection (S_{11}/S_{22}) – Measure	Type-N Connectors		Agilent 8753D VNA w/ 85032B calibration kit
Linear Phase	30 kHz to 2 GHz	(± 2.4 to ± 13)°	
Linear Mag.		(± 0.33 to ± 0.36) dB	
Linear Phase	(2 to 6) GHz	(± 12 to ± 35)°	
Linear Mag.		(± 1.1 to ± 1.6) dB	
Single Side-Band Phase Noise – Measure	Carrier: 50 kHz to 26.5 GHz		
Noise Floor:	Offset Frequency:		Agilent E4448A
-110 dB	10 Hz	1.5 dB	
-110 dB	100 Hz	1.5 dB	
-130 dB	1 kHz	1.5 dB	
-140 dB	10 kHz	1.5 dB	
-150 dB	100 kHz	1.5 dB	
-155 dB	1 MHz	1.5 dB	
-155 dB	10 MHz	1.5 dB	
-155 dB	100 MHz	1.5 dB	
Relative Power – Measure			
(0 to -10) dB	10 MHz to 26.5 GHz	0.046 dB	Agilent 8902A
(-10 to -20) dB	10 MHz to 26.5 GHz	0.053 dB	
(-20 to -30) dB	10 MHz to 26.5 GHz	0.080 dB	
(-30 to -40) dB	10 MHz to 26.5 GHz	0.098 dB	
(-40 to -50) dB	10 MHz to 26.5 GHz	0.11 dB	
(-50 to -60) dB	10 MHz to 26.5 GHz	0.12 dB	
(-60 to -70) dB	10 MHz to 26.5 GHz	0.13 dB	
(-70 to -80) dB	10 MHz to 26.5 GHz	0.17 dB	
(-80 to -90) dB	10 MHz to 26.5 GHz	0.18 dB	
(-90 to -100) dB	10 MHz to 26.5 GHz	0.19 dB	
(-100 to -110) dB	10 MHz to 26.5 GHz	0.19 dB	
(-110 to -120) dB	10 MHz to 26.5 GHz	0.21 dB	

Parameter/Range	Frequency	CMC[2, 5, 6] (±)	Comments
Absolute Power – Measure			Agilent 437B / E4418B:
(-70 to -30) dBm	10 MHz to 18 GHz	2.7 %	8484A, N-type
(-30 to +10) dBm	100 kHz to 4.2 GHz (4.2 to 18) GHz (18 to 26.5) GHz	1.4 % 1.9 % 2.4 %	8482A, N-type 8481A, N-type 8485A, 3.5 mm
(+10 to +20) dBm	100 kHz to 4.2 GHz (4.2 to 18) GHz (18 to 26.5) GHz	3.3 % 3.5 % 3.8 %	8482A, N-type 8481A, N-type 8485A, 3.5 mm

IV. Mechanical

Parameter/Range	Frequency	CMC[2, 5, 6] (±)	Comments
Accelerometers[3] – Frequency Response	100 Hz (ref) 159 Hz (ref) (5 to 100) Hz 100 Hz to 1 kHz (1 to 10) kHz	1.5 % 1.7 % 2.9 % 2.0 % 2.5 %	Vibration transducer calibration system referenced @ 1 g
Scales & Balance[3]	Up to 200 g Up to 4.5 kg Up to 700 lb	0.0005 % 0.002 % 0.01 %	Class 1 weights Class 3 weights Class 6, F weights
Force Gages[3]	Up to 1000 lbf	0.025 %	Class 6 and F weights
Torque Tools[3]	32 in·ozf to 250 ft·lbf	0.65 %	Torque transducers

Parameter/Range	Frequency	CMC[2, 5, 6] (±)	Comments
Pressure Measuring Equipment[3]	(0 to 1000) psi (≥ 1000 to 10,000) psi	0.28 psi 0.28 %	Additel ADT672 Additel ADT672
	(0 to 1) psid (-15 to 30) psig (30 to 100) psig (100 to 500) psig (500 to1000) psig (1000 to 3000) psig (3000 to 10,000) psig	0.01 % + 0.0015 psid 0.01 % + 0.023 psig 0.01 % + 0.05 psig 0.01 % + 0.25 psig 0.01 % + 0.50 psig 0.035 % + 2.5 psig 0.035 % + 8.3 psig	Process calibrator w/ 700P22 700PD5 700P06 700P07 700P08 700P29 700P31

V. Thermodynamics

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Relative Humidity[3] – Measure	(10 to 90) % RH	1.1 % RH	Vaisala 141/HMP46
Temperature[3] – Measure	(-20 to 60) °C	0.23 °C	Vaisala 141/HMP46
	(-195 to -38) °C (-38 to 0) °C (0 to 200) °C (200 to 400) °C (400 to 433) °C	0.28 °C 0.13 °C 0.12 °C 0.34 °C 0.37 °C	Burns 12001 PRT w/ Fluke 2180A

VI. Time & Frequency

Parameter/Range	Frequency	CMC[2, 6] (±)	Comments
Frequency – Measuring Equipment	1 mHz to 50 GHz	2.5 parts in 10^{12} + 0.1 mHz	GPS receiver w/ generator
Frequency – Measure	0.001 Hz to 46 GHz	2.5 parts in 10^{12} + 0.1 mHz	Counter locked to 10 MHz reference

[1] This laboratory offers commercial calibration service and field 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. CMC's 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] The stated measured values are determined using the indicated instruments (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.

[5] CMC components that can be reasonably attributed to the Unit Under Test have not been utilized in the calculation of the CMC value of this measurement parameter.

[6] In the statement of CMC, percentages are to be read as percent of reading unless indicated otherwise.

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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 R205 – Specific Requirements: Calibration Laboratory Accreditation Program. 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*).

Presented this 3rd day of March 2016.

President and CEO
For the Accreditation Council
Certificate Number 2353.01
Valid to July 31, 2018
Revised July 16, 2018

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