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

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CALIBRATION

Valid To: March 31, 2017 Certificate Number: 1277.01

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

I. Acoustical Quantities

Parameter/Range	Frequency	CMC[2] (±)	Comments
Microphone Acoustic Level –			
Sensitivity:			
¼ in	114 dB @ 250 Hz	0.16 dB	2900 B Larson Davis sound level calibration system (comparison method)
½ in	114 dB @ 250 Hz	0.2 dB	
1 in	114 dB @ 250 Hz	0.19 dB	
Frequency Response:			
¼ in			
½ in	(20 to 126) kHz	0.49 dB	
1 in	(50 to 126) kHz	0.63 dB	
	(20 to 126) kHz	0.2 dB	
Sound Level Calibrators –			
(94 to 114) dB	(0.25 to 1) kHz	0.18 dB	2900 B Larson Davis sound level calibration system (comparison method)

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Parameter/Range	Frequency	CMC[2] (±)	Comments
Sound Level Meters – (94 to 114) dB	(0.125 to 2) kHz (0.02 to 20) kHz	0.58 dB 0.12 dB	Acoustic method Electrical method

II. Chemical

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
pH	4.01 pH unit 7.01 pH unit 10.01 pH unit	0.013 pH unit + 0.6*R* 0.017 pH unit + 0.6*R* 0.016 pH unit + 0.6*R*	Accredited solutions
Conductance – Measuring Equipment	0.148 mS/cm 1.015 mS/cm 1.408 mS/cm 12.85 mS/cm 111.3 mS/cm	0.0029 mS/cm 0.0071 mS/cm 0.0094 mS/cm 0.059 mS/cm 0.75 mS/cm	Conductance solutions

III. Dimensional

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Micrometers[3]	(0 to 36) in	(4.6 + 5.0*L*) µin + 0.6*R*	Gage blocks/optical flat
Calipers[3]	(0 to 36) in	(2.9 + 11*L*) µin + 0.6*R*	Gage blocks
Angle	Up to ± 90°	3.7′	Optical protractor
Optical Comparators[3]	10× to 100× (0.001 to 6) in (30/60/90/120/150)°	440 µin 130 µin + 0.6*R* 0.0074° + 0.6*R*	Magnification scale Glass scale

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Pin & Plug Gages	(0.003 to 1.0) in	(31 + 4.6*L*) µin	Laser micrometer
Height Gages[3]	Up to 48 in	(2.4 + 12*L*) µin + 0.6*R*	Gage blocks
Indicators[3] – Dial & Digital	Up to 4 in Up to 100 mm	(1.4 + 4.5*L*) µin + 0.6*R* (54 + 7.6*L*) nm + 0.6*R*	Gage blocks
Gage Blocks	(0.5 to 1) in (>1.0 to 4) in (0.5 to 100) mm	4.1 µin (1.6 + 3.7*L*) µin (170 + 3.4*L*) nm	Twin head comparison

IV. Electrical – DC/Low Frequency

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Current[3] – Generate			
(29 to 330) µA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.25 % + 0.10 µA 0.18 % + 0.10 µA 0.15 % + 0.10 µA 0.37 % + 0.15 µA 0.94 % + 0.20 µA 1.9 % + 0.40 µA	Fluke 5520A
(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 (10 to 30) kHz	0.26 % + 0.15 µA 0.15 % + 0.15 µA 0.12 % + 0.15 µA 0.24 % + 0.30 µA 0.58 % + 0.30 µA 1.3 % + 0.60 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 (10 to 30) kHz	0.23 % + 2.0 µA 0.11 % + 2.0 µA 0.05 % + 2.0 µA 0.10 % + 2.0 µA 0.27 % + 3.0 µA 0.52 % + 4.0 µA	

Parameter/Range	Frequency	CMC[2, 4] (±)	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 (10 to 30) kHz	0.21 % + 20 µA 0.11 % + 20 µA 0.049 % + 20 µA 0.12 % + 50 µA 0.24 % + 0.10 mA 0.49 % + 0.20 mA	Fluke 5520A
(0.33 to 1) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.19 % + 0.1 mA 0.062 % + 0.10 mA 0.62 % + 1.0 mA 2.6 % + 5.0 mA	
(1.1 to 3) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.19 % + 0.10 mA 0.062 % + 0.10 mA 0.62 % + 1.0 mA 2.6 % + 5.0 mA	
(3 to 11) A	(45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.062 % + 2.0 mA 0.10 % + 2.0 mA 2.6 % + 2.0 mA	
(11 to 20.5) A	(45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.12 % + 5.0 mA 0.15 % + 5.0 mA 3.1 % + 5.0 mA	
AC Current[3] – Measure			
Up to 100 µA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz	0.51 % + 30 nA 0.21 % + 30 nA 0.13 % + 30 nA 0.13 % + 30 nA	HP 3458A, option II
(0.1 to 1) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz	0.49 % + 0.20 µA 0.21 % + 0.20 µA 0.10 % + 0.20 µA 0.061 % + 0.20 µA 0.085 % + 0.20 µA	
(1 to 10) mA	(10 to 20) Hz	0.49 % + 2.0 µA	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Current[3] – Measure (cont)			
(1 to 10) mA	(20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz	0.17 % + 2.0 µA 0.085 % + 2.0 µA 0.061 % + 2.0 µA 0.069 % + 2.0 µA	HP 3458A, option II
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz	0.49 % + 20 µA 0.18 % + 20 µA 0.078 % + 20 µA 0.061 % + 20 µA 0.085 % + 20 µA	
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.5 % + 0.2 mA 0.24 % + 0.2 mA 0.15 % + 0.2 mA 0.18 % + 0.2 mA	
(1 to 10) A	(45 to 1000) Hz (1 to 5) kHz	0.03 % 0.08 %	HP 3458A w/ Fluke Y5020A current shunt
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	0.085 % + 6.0 µV 0.017 % + 6.0 µV 0.021 % + 6.0 µV 0.11 % + 6.0 µV 0.39 % + 12 µV 1.0 % + 50 µV	Fluke 5520A
(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	0.031 % + 8.0 µV 0.016 % + 8.0 µV 0.018 % + 8.0 µV 0.042 % + 8.0 µV 0.084 % + 32 µV 0.24 % + 70 µV	
(0.3 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	0.033 % + 50 µV 0.016 % + 25 µV 0.020 % + 50 µV 0.036 % + 50 µV 0.076 % + 0.13 mV 0.25 % + 0.60 mV	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Voltage[3] – Generate (cont)			
(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	0.033 % + 0.65 mV 0.016 % + 0.20 mV 0.026 % + 0.60 mV 0.036 % + 0.60 mV 0.10 % + 1.6 mV	Fluke 5520A
(33 to 330) V	45 Hz to 1.0 kHz (1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.024 % + 2.0 mV 0.024 % + 6.0 mV 0.030 % + 6.0 mV 0.036 % + 6.0 mV 0.24 % + 50 mV	
(330 to 1020) V	(0.45 to 1) kHz (1 to 5) kHz (5 to 10) kHz	0.034 % + 10 mV 0.032 % + 10 mV 0.040 % + 10 mV	
AC Voltage[3] – Measure			
(0 to 10) mV	(1 to 40) Hz (40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.035 % + 3.0 µV 0.023 % + 1.1 µV 0.035 % + 1.1 µV 0.12 % + 1.1 µV 0.58 % + 1.1 µV 4.6 % + 2.0 µV	HP 3458A, option II
(10 to 100) mV	(1 to 40) Hz (40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 1000) kHz (1 to 2) MHz	0.0087 % + 4.0 µV 0.0087 % + 2.0 µV 0.017 % + 2.0 µV 0.035 % + 2.0 µV 0.093 % + 2.0 µV 0.35 % + 10 µV 1.2 % + 10 µV 1.7 % + 10 µV	
100 mV to 1 V	(1 to 40) Hz (40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 1000) kHz (1 to 2) MHz	0.0081 % + 40 µV 0.0081 % + 20 µV 0.016 % + 20 µV 0.035 % + 20 µV 0.092 % + 20 µV 0.35 % + 0.10 mV 1.2 % + 0.10 mV 1.7 % + 0.10 mV	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
AC Voltage[3] – Measure (cont)			
(1 to 10) V	(1 to 40) Hz (40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 1000) kHz (1 to 2) MHz	81 µV/V + 0.40 mV 81 µV/V + 0.20 mV 0.016 % + 0.20 mV 0.035 % + 0.20 mV 0.92 % + 0.20 mV 0.35 % + 1.0 mV 1.2 % + 1.0 mV 1.7 % + 1.0 mV	HP 458A, option II
(10 to 100) V	(1 to 40) Hz (40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 1000) kHz	0.023 % + 4.0 mV 0.023 % + 2.0 mV 0.023 % + 6.0 mV 0.040 % + 2.0 mV 0.14 % + 2.0 mV 0.46 % + 10 mV 1.7 % + 10 mV	
(100 to 1000) V	(1 to 40) Hz (40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.51 % + 40 mV 0.51 % + 20 mV 0.074 % + 20 mV 0.14 % + 20 mV 0.36 % + 20 mV	
Capacitance[3] – Generate			
(0.19 to 0.4) nF (0.4 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 (110 to 330) µF (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz (10 to 50) Hz (0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz	0.58 % + 0.010 nF 0.52 % + 0.010 nF 0.52 % + 0.010 nF 0.28 % + 0.010 nF 0.26 % + 0.10 nF 0.26 % + 0.10 nF 0.26 % + 0.30 nF 0.26 % + 1.0 nF 0.26 % + 3.0 nF 0.26 % + 10 nF 0.41 % + 30 nF 0.46 % + 0.10 µF 0.47 % + 0.30 µF 0.46 % + 1.0 µF 0.47 % + 3.0 µF 0.47 % + 10 µF 0.76 % + 30 µF 1.1 % + 0.10 mF	Fluke 5520A

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Oscilloscopes –			Fluke 5520A/SC600
Amplitude, DC Signal			
50 Ω Load	(-6.6 to 6.6) V	0.29 % IV + 40 µV	
1 MΩ Load	(-130 to 130) V	0.058 % IV + 40 µV	
Amplitude, Square Wave			
50 Ω Load	±1 mV to ±6.6 Vp-p 10 Hz to 10 kHz	0.29 % IV + 40 µV	
1 MΩ Load	±1 mV to ±130 Vp-p 10 Hz to 1 kHz	0.12 % IV + 40 µV	
Rise Time	<300 ps +0 ps/-100 ps	120 ps	
Time Marker into 50 Ω Load-Source	5 s to 50 ms 20 ms to 2 ns	29 ppm + 1000 ppm/s 2.9 ppm	
Leveled Sine Wave Relative to 50 kHz [5 mV to 5.5 V]p-p	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	2.0 % 2.5 % 4.7 %	
Capacitance – Fixed Points	100 pF to 1 µF 1 kHz	0.12 %	Standard capacitors
Capacitance – Measure	10 pF to 1.1 µF	0.011 %	Gen Rad 1615A capacitance bridge
DC Current[3] – Generate	Up to 330 µA 330 µA to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 1A (1.1 to 3) A (3 to 11) A (11 to 20) A	0.017 % + 0.02 µA 0.011 % + 0.034 µA 0.011 % + 0.20 µA 0.011 % + 2.4 µA 0.028 % + 40 µA 0.039 % + 40 µA 0.052 % + 0.33 mA 0.10 % + 0.75 mA	Fluke 5520A

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
DC Current[3] – Measure	(0 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 (0.1 to 1) A (1 to 10) A (10 to 20) A	0.052 % + 0.040 nA 42 µA/A + 0.04 nA 23 µA/A + 0.10 nA 22 µA/A + 0.80 nA 21 µA/A + 5.0 nA 21 µA/A + 50 nA 35 µA/A + 0.50 µA 0.011 % + 10 µA 0.032 % + 0.61 mA 0.027 % + 3.3 mA	HP 3458A, option II HP 3458A w/ Fluke Y5020 shunt
DC Voltage[3] – Measure	(0 to 100) mV (0.1 to 1) V (1.0 to 10) V (10 to 100) V (100 to 1000) V	5.2 µV/V + 0.30 µV 4.1 µV/V + 0.30 µV 4.0 µV/V + 0.50 µV 6.2 µV/V + 30 µV 63 µV/V + 0.1 mV*	HP 3458A, option II *Add 12 mV/V·$(V_{in}/1000)^2$ for input >100 V
DC Voltage[3] – Generate	(0 to 329.9999) mV (0 to 3.299999) V (0 to 32.99999) V (30 to 329.9999) V (100 to 1000) V	21 µV/V + 1.0 µV 12 µV/V + 2.0 µV 14 µV/V + 15 µV 19 µV/V + 0.15 mV 19 µV/V + 1.5 mV	Fluke 5520A
Inductance – Measure @ 100 Hz Fixed Values	100 µH to 5.0 H	0.30 %	General Radio 1632A bridge w/ standard inductor set
Inductance – Generate	100 µH to 5.0 H	0.33 %	Gen Rad 1482 standard inductors
Resistance[3] – Measure	(0 to 10) Ω (10 to100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	15 µΩ/Ω + 0.05 mΩ 13 µΩ/Ω + 0.50 mΩ 10 µΩ/Ω + 5.0 mΩ 10 µΩ/Ω + 50 mΩ 10 µΩ/Ω + 50 mΩ 16 µΩ/Ω + 2.0 Ω 52 µΩ/Ω + 100 Ω 0.051 % + 1.0 kΩ 0.5 % + 10 kΩ	HP 3458A, option II

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
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 (0.50 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ (330 to 1100) MΩ	46 μΩ/Ω + 0.0010 Ω 32 μΩ/Ω + 0.0015 Ω 30 μΩ/Ω + 0.0015 Ω 29 μΩ/Ω + 0.0020 Ω 29 μΩ/Ω + 0.0020 Ω 29 μΩ/Ω + 0.020 Ω 29 μΩ/Ω + 0.020 Ω 29 μΩ/Ω + 0.2 Ω 29 μΩ/Ω + 0.20 Ω 36 μΩ/Ω + 2.0 Ω 39 μΩ/Ω + 2.0 Ω 77 μΩ/Ω + 30 Ω 0.016 % + 50 Ω 0.031 % + 2.5 kΩ 0.084 % + 3.0 kΩ 0.33 % + 0.10 MΩ 1.8 % + 0.50 MΩ	Fluke 5520A
Resistance – Fixed Values	1 mΩ 10 mΩ 100 mΩ 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ	4.7 μΩ/Ω	L&N reference resistors ESI SR1010 reference resistors
Electrical Thermocouple[3] – Generate and Measure			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.22 °C 0.39 °C 0.35 °C 0.38 °C	Fluke 5520A
Type C	(0 to 150) °C (150 to 650) °C (650 to 1000) °C (1000 to 1800) °C (1800 to 2316) °C	0.35 °C 0.3 °C 0.36 °C 0.58 °C 0.97 °C	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Thermocouple[3] – Generate and Measure (cont)			
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.76 °C 0.32 °C 0.25 °C 0.26 °C 0.31 °C	Fluke 5520A
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.31 °C 0.19 °C 0.16 °C 0.2 °C 0.27 °C	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.38 °C 0.21 °C 0.19 °C 0.3 °C 0.46 °C	
Type L	(-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.43 °C 0.3 °C 0.2 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.46 °C 0.25 °C 0.22 °C 0.21 °C 0.31 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.75 °C 0.48 °C 0.38 °C 0.47 °C	
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.54 °C 0.42 °C 0.4 °C 0.53 °C	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Thermocouple[3] – Generate and Measure			
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.73 °C 0.28 °C 0.19 °C 0.16 °C	Fluke 5520A
Type U	(-200 to 0) °C (0 to 600) °C	0.65 °C 0.31 °C	
Electrical RTD Simulation[3] –			
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	0.058 °C 0.058 °C 0.085 °C 0.1 °C 0.12 °C 0.12 °C 0.27 °C	Fluke 5520A
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	0.058 °C 0.058 °C 0.081 °C 0.1 °C 0.12 °C 0.14 °C	
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	0.29 °C 0.046 °C 0.058 °C 0.069 °C 0.081 °C 0.092 °C 0.1 °C 0.12 °C 0.27 °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 600) °C (600 to 630) °C	0.046 °C 0.046 °C 0.046 °C 0.058 °C 0.14 °C 0.15 °C 0.16 °C 0.18 °C	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical RTD Simulation[3] – (cont)			
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	0.047 °C 0.058 °C 0.058 °C 0.069 °C 0.093 °C 0.093 °C 0.1 °C 0.13 °C	Fluke 5520A
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	0.035 °C 0.035 °C 0.046 °C 0.058 °C 0.069 °C 0.081 °C 0.081 °C 0.27 °C	
PtNi 385, 120 Ω	(-80 to 0) °C (0 to 100) °C (100 to 260) °C	0.092 °C 0.092 °C 0.16 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.35 °C	

V. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
RF Absolute Power[3, 5] – Measure			
1 mW Reference	50 MHz	0.38 %	HP 8478B sensor w/ HP 432A power meter and Type N connector
(-20 to +10) dBm	(0.01 to 0.05) GHz (0.05 to 1) GHz (1 to 3) GHz (3 to 7) GHz (7 to 12.4) GHz (12.4 to 15) GHz (15 to 16) GHz (16 to 18) GHz	2.2 % + 0.6 µW 1.4 % + 0.6 µW 1.5 % + 0.6 µW 1.8 % + 0.6 µW 2.4 % + 0.6 µW 2.6 % + 0.6 µW 2.3 % + 0.6 µW 4.2 % + 0.6 µW	

Parameter/Range	Frequency	CMC[2] (±)	Comments
RF Absolute Power[3, 5] – Measure (cont)			
(-20 to +30) dBm	100 kHz to 2.6 GHz	0.13 dB	HP 11722A sensor w/ HP 8902A, HP 11793A and Type N connector
(-50 to 0) dBm	50 MHz to 18 GHz	0.13 dB	HP 11792A sensor w/ HP 8902A, HP 11793A and APC 3.5 mm connector
	0.2 MHz to 4 GHz (4 to 8.2) GHz (8.2 to 12.4) GHz	0.38 dB 0.46 dB 0.57 dB	
(0 to +10) dBm	0.2 MHz to 4 GHz (4 to 8.2) GHz (8.2 to 12.4) GHz	0.38 dB 0.47 dB 0.58 dB	Boonton 42BD w/ 41- 4B power sensor and Type N connector
RF Absolute Power[3, 5] – Generate			
Sine Wave into 50 Ω			
(10 to 3) V_{p-p}	(0.001 to 100) kHz 100 kHz to 20 MHz	0.12 dB 0.32 dB	HP 3325 synthesized function generator w/ BNC connector
2.99 V_{p-p} to 1 mV_{p-p}	0.001 Hz to 100 kHz 100 kHz to 10 MHz	0.21 dB 0.53 dB	
2.99 V_{p-p} to 100 mV_{p-p}	(10 to 20) MHz	0.53 dB	
(99.9 to 1) mV_{p-p}	(10 to 20) MHz	0.53 dB	
(13.01 to -4.99) dBm	200 Hz to 80 MHz	0.17 dB	HP3335A synthesized level generator in 2 dBm steps, w/ BNC connector
(-6.99 to -44.99) dBm	200 Hz to 80 MHz	0.19 dB	
(-46.99 to -84.99) dBm	200 Hz to 80 MHz	0.26 dB	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
RF Tuned Power – Measure			
	Reference		
0 dB	(2.5 to 1300) MHz	0.073 dB + 0.001 dB/dB	HP 11722A/11792A sensors w/ HP 8902A, 11793A Converter and type N or type APC 3.5 mm connectors
(0 to -127) dB	2.5 MHz to 18 GHz	0.11 dB + 0.004 dB/dB	
Amplitude Modulation – Generate			
AM Flatness Carrier Frequency	Rate Frequency:		HP 11715A AM/FM test source
(11 to 13.5) MHz Depth: (0 to 99) %	50 Hz to 50 kHz 20 Hz to 100 kHz	0.12 % 0.31 %	
Amplitude Modulation – Measure			
Carrier Frequency	Rate Frequency:		HP 8902A w/ HP 11722A and 11792A sensors and HP 11793A converter
(0.15 to 10) MHz Depth: (5 to 99) % (0 to 99) %	50 Hz to 10 kHz 20 Hz to 10 kHz	3.5 % + 1 digit 4.1 % + 1 digit	
(10 to 1300) MHz Depth: (5 to 99) %	50 Hz to 50 kHz	1.6 % + 1 digit	
(1.3 to 18) GHz Depth: (5 to 99) %	50 Hz to 50 kHz	3.2 % + 1 digit	
10 MHz to 18 GHz Depth: (0 to 99) %	20 Hz to 100 kHz	4.2 % + 1 digit	

Parameter/Range	Frequency	CMC[2, 4] (±)	Comments
Frequency Modulation – Measure			
Carrier Frequency	Rate Frequency:		
(0.25 to 10) MHz ≤ 40 kHz Peak Deviation	20 Hz to 10 kHz	2.5 % + 1 digit	HP 8902A w/ HP 11722A and 11792A sensors and 11793A converter
10 MHz to 18 GHz ≤ 400 kHz Peak Deviation	50 Hz to 100 kHz 20 Hz to 200 kHz	3 % + 1 digit 6 % + 1 digit	
Frequency Modulation – Generate			
FM Flatness Carrier Frequency	Rate Frequency:		
(11 to 13.5) MHz	DC to 100 kHz (100 to 200) kHz	0.13 % 0.31 %	HP 11715A AM/FM test source
(88 to 108) MHz	DC to 100 kHz (100 to 200) kHz	0.11 % 0.30 %	
(352 to 432) MHz	DC to 100 kHz (100 to 200) kHz	0.11 % 0.30 %	
Phase Modulation – Measure			
Carrier Frequency	Rate Frequency:		
(0.15 to 10) MHz	200 Hz to 10 kHz	4.4 % + 1 digit	HP 8902A w/ HP 11792A & 11722A sensors
10 MHz to 18 GHz	200 Hz to 20 kHz	4.2 % + 1 digit	
RF Volts – Measure, Fixed Points			
3 V	(1 to 10) MHz (10 to 30) MHz (30 to 50) MHz (50 to 70) MHz (70 to 80) MHz (80 to 100) MHz	0.13 % 0.26 % 0.63 % 0.95 % 1.0 % 1.3 %	HP 11049A thermal voltage converter

VI. Mechanical

Parameter/Equipment	Range	CMC[2, 4, 6] (±)	Comments
Torque Wrench	(10 to 3120) in·lbf	1 % of IV from (10 to 100) % FS	Larson STWCS
	(0 to 1000) in·ozf	0.49 % of IV (10 to 100) % of range	Futek torque system
	(0 to 600) ft·lbf	1.8 ft·lbf (10 to 100) % of range	
Torque – Measuring Equipment			
Transducers	(0.6 to 42) ft·lbf (1.7 to 600) ft·lbf	0.032 % IV 0.019 % IV	Torque arm/dead weight
Acceleration/ Vibration	(5 to 2000) Hz (2 to 10) kHz	2.7 % IV 3.2 % IV	Back to back comparison method
Pressure Gages – Measuring Equipment			
Pneumatic	(-5 to 5) psig	0.0065 % IV + 0.0005 psig	Pace 6000
	(-15 to 50) psig	0.0055 % IV + 0.0033 psig	
	(-14.5 to 1000) psig	0.041 %	Deadweight tester
Hydraulic	(1000 to 10 000) psig (0 to 10) inH_2O	0.005 in·H_2O	Meriam manometer
Absolute Pressure – Measuring Equipment & Measure	(9 to 20) psia (0.5 to 80) psia (0.5 to 1030) psia	0.0058 % IV 0.0058 % IV 0.0064 % IV	Pace 6000

Parameter/Equipment	Range	CMC[2, 4, 6] (±)	Comments
Scales and Balances[3] –	(0.5 to 629) lb	0.01 % + 0.6*R*	ASTM Class 6 weights
Analytical Balances[3]	(5 to 100) mg	0.028 mg + 0.23 mg/g	ASTM Class 3 weights
	(100 to 500) mg	0.043 mg + 0.076 mg/g	
	(1 to 10) g	0.033 mg + 0.002 mg/g	ASTM Class 1 weights
	(10 to 100) g	0.03 mg + 0.0023 mg/g	
	(0.1 to 3) kg	0.0034 % + 0.6*R*	ASTM Class 2 weights
Force[3, 7]	(0.5 to 500) lbf	0.01 % IV + 0.6*R*	ASTM Class 6 weights
	(100 to 1000) lbf (200 to 2000) lbf (500 to 5000) lbf (1000 to 10 000) lbf	0.031 % FS 0.014 % FS 0.031 % FS 0.041 % FS	ASTM E74: tension and compression
	(2500 to 25 000) lbf (5000 to 50 000) lbf (10 000 to 100 000) lbf	0.078 % FS 0.051 % FS 0.051 % FS	ASTM E74: tension and compression
	(50 000 to 500 000) lbf	0.051 % FS	Compression only
Rockwell Hardness[3] – Indirect Verification of Superficial Hardness Testers	HRA: (< 70) HRA (≥ 70 and < 80) HRA (≥ 80) HRA	 0.54 HRA 0.43 HRA 0.32 HRA	ASTM E18
	HRBW: (< 60) HRBW (≥ 70 and < 80) HRBW (≥ 80) HRBW	 0.83 HRBW 1.0 HRBW 0.79 HRBW	
	HRC: (< 35) HRC (≥ 35 and < 60) HRC (≥ 60) HRC	 0.63 HRC 0.81 HRC 0.43 HRC	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Rockwell Hardness[3] – Indirect Verification of Superficial Hardness Testers (cont)	HRRW: (105 to 114) HREW (115 to 123) HREW HR15N: (< 78) HR15N (≥ 78 and < 90) HR15N (≥ 90) HR15N HR30N: (< 55) HR30N (≥ 55 and < 77) HR30N (≥ 77) HR30N HR15TW: (< 81) HRTW (≥ 81 and < 87) HRTW (≥ 87) HRTW HR30TW: (< 57) HRTW (≥ 57 and < 70) HRTW (≥ 70) HRTW	 1.6 HREW 1.6 HREW 0.99 HR15N 0.80 HR15N 0.97 HR15N 0.49 HR30N 0.78 HR30N 0.38 HR30N 0.52 HR15TW 0.59 HR15TW 0.48 HR15TW 0.97 HR30TW 0.77 HR30TW 0.57 HR30TW	ASTM E18
Brinell Hardness – Indirect Verification HBW 10/3000/15	(95 to 600) HBW	4.5 HBW	ASTM E10
Microindentation – Micro Vickers Macro Vickers Knoop	 (240 to 900) HV (100 to 600) HV (250 to 900) HK	 23 HV 8.3 HV 18 HK	 ASTM E384
Universal Testing Machine, Compression Testing Machines, Tension Testing Machines[3]	(0.5 to 500) lbf (100 to 1000) lbf (200 to 2000) lbf (500 to 5000) lbf (1000 to 10 000) lbf (2500 to 25 000) lbf (5000 to 50 000) lbf (10 000 to 100 000) lbf (50 000 to 500 000) lbf	0.011 % IV 0.032 % FS 0.015 % FS 0.033 % FS 0.042 % FS 0.082 % FS 0.056 % FS 0.056 % FS 0.056 % FS	ASTM E4, load cells and dead weights Tension & Compression Compression only

VII. Thermodynamics

Parameter/Equipment	Range	CMC[2] (±)	Comments
Temperature[3] – Measuring Equipment	(-25 to 400) °C	0.026 °C	Hart 1502 w/ PRT
Infrared Temperature	(25 to 400) °C	0.49 °C	Black Body
Temperature[3] – Measure	(-196 to 420) °C (200 to 1000) °F	0.025 °C 4.2 °F + 3.2 m°F/°F	Hart 1502 w/ PRT Fluke 5520A w/ Type N thermocouple
Thermocouple – Measure Types B, C, E, J, K N, R, S, T, U	(-20 to 420) °C (200 to 1000) °F	0.28 + 0.14 m°C/°C 4.2 °F + 3.2 m°F/°F	Fluke 5520A/ Hart 1502A/5614 Fluke 5520A, Type N thermocouple

Parameter/Equipment	Range	CMC[2] (±)	Comments
RTD – Measure	(-20 to 400) °C	0.027 °C	HP3458A/Hart 1502A/ 5614
Relative Humidity[3] – Measuring Equipment	11.3 % RH 33 % RH 75.5 % RH 97.7 % RH	1.5 % RH 1.3 % RH 1.6 % RH 2.5 % RH	Vaisala HMK15
Relative Humidity[3] – Measure	(10 to 90) % RH (90 to 99) % RH	2.2 % RH 3.1 % RH	Vaisala MI70/HMP77B

VIII. Time & Frequency

Parameter/Equipment	Range	CMC[2] (±)	Comments
Frequency – Measuring Equipment	10 MHz	5.7×10^{-12} Hz	NOVAS WR 2410 GPS receiver

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[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. 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] 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] In the statement of CMC, the value is defined as the percentage of reading unless otherwise indicated; IV represents *Indicated Value* and FS represents *Full Scale*.

[5] The CMCs do not include mismatch.

[6] In the statement of CMC, *L* represents the length of the unit under test in inches or millimeters, where appropriate; *R* represents the resolution of the unit under test.

[7] Greater than 25 000 lbf, field service available only.

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for technical competence in the field of

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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 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*).

Presented this 20th day of April 2015.

President & CEO
For the Accreditation Council
Certificate Number 1277.01
Valid to March 31, 2017

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