



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

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CALIBRATION

Valid To: March 31, 2013

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 calibrations¹:

I. Acoustical Quantities

Parameter/Range	Frequency	CMC ² (±)	Comments
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	0.16 dB	
1 in	114 dB @ 250 Hz	0.17 dB	
Frequency Response			
¼ in	20 Hz to 50 kHz (50 to 126) kHz	0.2 dB 0.63 dB	
½ in	20 Hz to 50 kHz (50to 126) kHz	0.2 dB 0.63 dB	
1 in	20 Hz to 50 kHz (50 to 126) kHz	0.2 dB 0.63 dB	
Capacitance	< 100 pF	0.3 pF	

II. Chemical

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
pH	4.01 pH unit 7.01 pH unit 10.01 pH unit	0.012 pH unit + 0.6R 0.015 pH unit + 0.6R 0.028 pH unit + 0.6R	Accredited solutions; R is the resolution of the unit under test in pH
Conductance – Measuring Equipment	1.015 mS/cm 1.408 mS/cm 12.85 mS/cm 111.3 mS/cm	0.0066 mS/cm 0.0089 mS/cm 0.055 mS/cm 0.71 mS/cm	Conductance solutions

III. Dimensional

Parameter/Equipment	Range	CMC ^{2, 4, 6} (±)	Comments
Micrometers ³	(0 to 36) in	(4.6 + 5.0L) μin + 0.6R	Gage blocks/optical flat
Calipers ³	(0 to 36) in	(2.9 + 11L) μin + 0.6R	Gage blocks
Coordinate Measuring Machines (CMM) –			ASME B89.4.1, section 5.4 using laser w/ environmental compensation
Linear Displacement	(0 to 120) in	(25 + 1.6L) μin	w/ ball bar
Volumetric Performance	300 mm 600 mm	2.3 μm 4.0 μm	
Squareness	300 mm 600 mm	2.3 μm 4.0 μm	
Machine Repeatability	1 in	51 μin	and 5.3.3 w/ sphere
Linear Velocity ³	± 14 in/s	0.067 %	Laser
Angle	± 90°	1.0 %	Optical protractor

Parameter/Equipment	Range	CMC ^{2,6} (\pm)	Comments
Optical Comparators ³	10 \times to 100 \times (0.001 to 6) in (30/60/90/120/150) $^\circ$	440 μ in + 0.6R 130 μ in + 0.6R 0.0074 $^\circ$ + 0.6R	Magnification scale Glass scale
Pin & Plug Gages	(0.003 to 1.0) in	(31 + 4.6L) μ in	Laser micrometer
Height Gages ³	(0 to 48) in	(2.4 + 12L) μ in + 0.6R	Gage blocks
Indicators ³ – Dial & Digital	(0 to 4) in (0 to 100) mm	(1.4 + 4.5L) μ in + 0.6R (54 + 7.6L) nm + 0.6R	Gage blocks
Gage Blocks	(0.5 to 1) in (0.01 to 4) in (0.5 to 100) mm	4.1 μ in (1.6 + 3.7L) μ in (74 + 3.4L) nm	Twin head comparison

IV. Electrical – DC/Low Frequency

Parameter/Range	Frequency	CMC ^{2,4} (\pm)	Comments
AC Current ³ – Generate (29 to 330) μ A	(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 % + 0.1 μ A 0.18 % + 0.1 μ A 0.15 % + 0.1 μ A 0.37 % + 0.15 μ A 0.94 % + 0.2 μ A 1.9 % + 0.4 μ A	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 μ A 0.15 % + 0.15 μ A 0.12 % + 0.15 μ A 0.24 % + 0.2 μ A 0.6 % + 0.3 μ A 1.3 % + 0.6 μ A	
(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 μ A 0.11 % + 2 μ A 0.05 % + 2 μ A 0.10 % + 2 μ A 0.27 % + 3 μ A 0.52 % + 4 μ A	

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 % + 0.1 mA 0.49 % + 0.2 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 % + 0.1 mA 0.62 % + 1 mA 2.6 % + 5 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 % + 0.1 mA 0.062 % + 0.1 mA 0.62 % + 1 mA 2.6 % + 5 mA	
(3 to 11) A	(45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.062 % + 2 mA 0.10 % + 2 mA 2.6 % + 2 mA	
(11 to 20.5) A	(45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.12 % + 5 mA 0.15 % + 5 mA 3.1 % + 5 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 % + 0.14 µA 0.21 % + 0.14 µA 0.13 % + 0.14 µA 0.13 % + 0.15 µA	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 % + 0.15 µA 0.21 % + 0.15 µA 0.1 % + 0.15 µA 0.061 % + 0.3 µA 0.085 % + 0.6 µA	
(1 to 10) mA	(10 to 20) Hz	0.49 % + 2 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 % + 4 µA 0.085 % + 2 µA 0.061 % + 3 µA 0.069 % + 4 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 % + 50 µA 0.085 % + 200 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 % + 0.1 mA 0.24 % + 0.1 mA 0.15 % + 0.1 mA 0.18 % + 0.2 mA	
(1 to 10) A	(45 to 1000) Hz (1 to 5) kHz	0.03 % 0.08 %	HP 3458A with 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 µV 0.017 % + 6 µV 0.021 % + 6 µV 0.11 % + 6 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 µV 0.016 % + 8 µV 0.018 % + 8 µV 0.042 % + 8 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 % + 60 µV 0.020 % + 60 µV 0.036 % + 50 µV 0.076 % + 0.13 mV 0.25 % + 0.6 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 % + 0.2 mV 0.026 % + 0.6 mV 0.036 % + 0.6 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 mV 0.024 % + 6 mV 0.03 % + 6 mV 0.036 % + 6 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 % + 10mV 0.040 % + 10 mV	
AC Voltage ³ – Measure			
(0 to 10) mV	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz 100 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 250) kHz	0.46 % + 0.6 μV 0.18 % + 0.6 μV 0.08 % + 0.6 μV 0.048 % + 0.6 μV 0.18 % + 0.6 μV 0.96 % + 1.2 μV 6.1 % + 5 μV	HP3458A, option II
(10 to 100) mV	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz 100 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 250) kHz (250 to 500) kHz	0.46 % + 8 μV 0.17 % + 8 μV 0.07 % + 8 μV 0.029 % + 8 μV 0.17 % + 70 μV 0.7 % + 70 μV 2.3 % + 70 μV 3.5 % + 70 μV	
100 mV to 1 V	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz 100 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 250) kHz (250 to 500) kHz	0.46 % + 50 μV 0.17 % + 50 μV 0.071 % + 25 μV 0.029 % + 50 μV 0.18 % + 25 μV 0.7 % + 25 μV 2.9 % + 0.006 mV 3.6 % + 0.006 mV	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage ³ – Measure (cont)			
(1 to 10) V	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz 100 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.46 % + 0.0065 mV 0.18 % + 0.006 mV 0.071 % + 0.002 mV 0.029 % + 0.006 mV 0.18 % + 1.6 mV 0.7 % + 1.6 mV	HP3458A, option II
(10 to 100) V	(40 to 100) Hz 100 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.095 % + 2 mV 0.073 % + 6 mV 0.18 % + 50 mV 0.7 % + 50 mV	
(100 to 1000) V	(40 to 100) Hz	0.073 % + 20 mV	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Capacitance ³ – Generate			
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	(0.19 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	0.59 % + 0.01 nF 0.53 % + 0.01 nF 0.53 % + 0.01 nF 0.28 % + 0.01 nF 0.26 % + 0.1 nF 0.27 % + 0.1 nF 0.26 % + 0.3 nF 0.26 % + 1 nF 0.27 % + 3 nF 0.27 % + 10 nF 0.42 % + 30 nF 0.47 % + 0.1 µF 0.47 % + 0.3 µF 0.46 % + 1 µF 0.47 % + 3 µF 0.47 % + 10 µF 0.75 % + 30 µF 1.1 % + 0.1 mF	Fluke 5520A
Capacitance – Measure	10 pF to 1.1 µF	0.011 %	Gen Rad 1615A capacitance bridge

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
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 0.012 % + 0.03 µA 0.012 % + 0.20 µA 0.012 % + 2.0 µA 0.028 % + 40 µA 0.039 % + 40 µA 0.052 % + 30 µA 0.1 % + 0.75 mA	Fluke 5520A
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 100) A	0.052 % + 0.04 nA 0.0042 % + 0.04 nA 0.0022 % + 0.1 nA 0.0021 % + 0.8 nA 0.0021 % + 5 nA 0.0021 % + 50 nA 0.0035 % + 0.5 µA 0.011 % + 10 µA 0.028 % + 0.61 mA 0.030 % + 3.3 mA	HP 3458A, option II HP 3458A w/ L&N 4363 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	0.00052 % + 0.3 µV 0.00041 % + 0.3 µV 0.0004 % + 0.5 µV 0.00062 % + 30 µV 0.0063 % + 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	0.0021 % + 1 µV 0.0012 % + 2 µV 0.0014 % + 15 µV 0.0019 % + 0.15 mV 0.0019 % + 1.5 mV	Fluke 5520A
Inductance – Measure @ 100 Hz Fixed Values	0.1 nH to 0.1 µH 0.1 µH to 5.0 H	1 % 0.3 %	General Radio 1632A bridge with standard inductor set
Inductance – Generate	100 µH to 5 H	0.32 %	Gen Rad 1482 standard inductors

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	0.0046 % + 0.001 Ω 0.0032 % + 0.0015 Ω 0.003 % + 0.0015 Ω 0.0029 % + 0.002 Ω 0.0029 % + 0.002 Ω 0.0029 % + 0.02 Ω 0.0029 % + 0.02 Ω 0.0029 % + 0.2 Ω 0.0029 % + 0.2 Ω 0.0036 % + 2 Ω 0.0039 % + 2 Ω 0.0077 % + 30 Ω 0.016 % + 50 Ω 0.031 % + 2.5 kΩ 0.084 % + 3 kΩ 0.33 % + 0.1 MΩ 1.8 % + 0.5 MΩ	Fluke5520A
Resistance ³ – Measure	(0 to 10) Ω (10 to 100) 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	0.0015 % + 0.5 mΩ 0.0013 % + 0.5 mΩ 0.001 % + 5 mΩ 0.001 % + 50 mΩ 0.001 % + 0.5 Ω 0.0016 % + 2 Ω 0.0052 % + 100 Ω 0.051 % + 1 kΩ 0.5 % + 10 kΩ	HP 3458A, option II
Electrical Thermocouple ³ – Generate and Measure			
Type B	600 °C to 800 °C 800 °C to 1000 °C 1000 °C to 1550 °C 1550 °C to 1820 °C	0.46 °C 0.36 °C 0.32 °C 0.35 °C	Fluke 5520A
Type C	0 °C to 150 °C 150 °C to 650 °C 650 °C to 1000 °C 1000 °C to 1800 °C 1800 °C to 2316 °C	0.32 °C 0.28 °C 0.33 °C 0.52 °C 0.86 °C	
Type E	-250 °C to -100 °C -100 °C to -25 °C -25 °C to 350 °C 350 °C to 650 °C 650 °C to 1000 °C	0.52 °C 0.18 °C 0.16 °C 0.18 °C 0.23 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Thermocouple ³ – Generate and Measure (cont)			
Type J	-210 °C to -100 °C -100 °C to -30 °C -30 °C to 150 °C 150 °C to 760 °C 760 °C to 1200 °C	0.29 °C 0.18 °C 0.16 °C 0.19 °C 0.25 °C	Fluke 5520A
Type K	-200 °C to -100 °C -100 °C to -25 °C -25 °C to 120 °C 120 °C to 1000 °C 1000 °C to 1372 °C	0.35 °C 0.20 °C 0.18 °C 0.28 °C 0.42 °C	
Type L	-200 °C to -100 °C -100 °C to 800 °C 800 °C to 900 °C	0.39 °C 0.28 °C 0.19 °C	
Type N	-250 °C to -100 °C -100 °C to -25 °C -25 °C to 120 °C 120 °C to 410 °C 410 °C to 1300 °C	0.42 °C 0.24 °C 0.21 °C 0.20 °C 0.29 °C	
Type R	0 °C to 250 °C 250 °C to 400 °C 400 °C to 1000 °C 1000 °C to 1767 °C	0.59 °C 0.37 °C 0.35 °C 0.42 °C	
Type S	0 °C to 250 °C 250 °C to 1000 °C 1000 °C to 1400 °C 1400 °C to 1767 °C	0.49 °C 0.38 °C 0.39 °C 0.48 °C	
Type T	-250 °C to -150 °C -150 °C to 0 °C 0 °C to 120 °C 120 °C to 400 °C	0.65 °C 0.22 °C 0.18 °C 0.16 °C	
Type U	-200 °C to 0 °C 0 °C to 600 °C	0.58 °C 0.29 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical RTD Simulation ³ –			
Pt 385, 100 Ω	-200 °C to -80 °C	0.07 °C	Fluke 5520A
	-80 °C to 0 °C	0.07 °C	
	0 °C to 100 °C	0.09 °C	
	100 °C to 300 °C	0.11 °C	
	300 °C to 400 °C	0.12 °C	
	400 °C to 630 °C	0.14 °C	
	630 °C to 800 °C	0.25 °C	
Pt 3926, 100 Ω	-200 °C to -80 °C	0.07 °C	
	-80 °C to 0 °C	0.07 °C	
	0 °C to 100 °C	0.09 °C	
	100 °C to 300 °C	0.11 °C	
	300 °C to 400 °C	0.12 °C	
	400 °C to 630 °C	0.14 °C	
Pt 3916, 100 Ω	-200 °C to -190 °C	0.27 °C	
	-190 °C to -80 °C	0.06 °C	
	-80 °C to 0 °C	0.07 °C	
	0 °C to 100 °C	0.08 °C	
	100 °C to 260 °C	0.09 °C	
	260 °C to 300 °C	0.10 °C	
	300 °C to 400 °C	0.11 °C	
	400 °C to 600 °C	0.12 °C	
600 °C to 630 °C	0.25 °C		
Pt 385, 200 Ω	-200 °C to -80 °C	0.06 °C	
	-80 °C to 0 °C	0.06 °C	
	0 °C to 100 °C	0.06 °C	
	100 °C to 260 °C	0.07 °C	
	260 °C to 300 °C	0.14 °C	
	300 °C to 400 °C	0.15 °C	
	400 °C to 600 °C	0.16 °C	
600 °C to 630 °C	0.18 °C		
Pt 385, 500 Ω	-200 °C to -80 °C	0.06 °C	
	-80 °C to 0 °C	0.07 °C	
	0 °C to 100 °C	0.07 °C	
	100 °C to 260 °C	0.08 °C	
	260 °C to 300 °C	0.10 °C	
	300 °C to 400 °C	0.10 °C	
	400 °C to 600 °C	0.11 °C	
600 °C to 630 °C	0.13 °C		

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical RTD Simulation ³ – (cont)			
Pt 385, 1000 Ω	-200 °C to -80 °C -80 °C to 0 °C 0 °C to 100 °C 100 °C to 260 °C 260 °C to 300 °C 300 °C to 400 °C 400 °C to 600 °C 600 °C to 630 °C	0.05 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.09 °C 0.09 °C 0.25 °C	Fluke 5520A
PtNi 385, 120 Ω	-80 °C to 0 °C 0 °C to 100 °C 100 °C to 260 °C	0.10 °C 0.10 °C 0.16 °C	
Cu 427, 10 Ω	-100 °C to 260 °C	0.32 °C	

V. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
RF Absolute Power ⁵ – Measure			
1 mW Reference	50 MHz	0.38 %	HP 8478B sensor with 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	2.1 % + 0.6 μW 1.3 % + 0.6 μW 1.4 % + 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	
(-20 to +30) dBm	100 kHz to 2.6 GHz	0.13 dB	HP 11722A sensor with HP 8902A, HP 11793A and Type N connector
	50 MHz to 18 GHz	0.13 dB	HP 11792A sensor with HP 8902A, HP 11793A and APC 3.5 mm connector

Parameter/Range	Frequency	CMC ² (±)	Comments
RF Absolute Power ⁵ – Measure (cont)			
(-60 to -50) dBm	0.2 MHz to 4 GHz (4 to 8.2) GHz (8.2 to 12.4) GHz	0.34 dB 0.65 dB 0.77 dB	Boonton 42BD with 41- 4B power sensor and Type N connector
(-50 to 0) dBm	0.2 MHz to 4 GHz (4 to 8.2) GHz (8.2 to 12.4) GHz	0.29 dB 0.41 dB 0.53 dB	
(0 to +10) dBm	0.2 MHz to 4 GHz (4 to 8.2) GHz (8.2 to 12.4) GHz	0.29 dB 0.41 dB 0.53 dB	
RF Absolute Power ⁵ – Measuring Equipment			
Sine Wave into 50 W			
(10 to 3) Vp-p	(0.001 to 100) kHz 100 kHz to 20 MHz	0.11 dB 0.32 dB	HP 3325 synthesized function generator with BNC connector
2.99 Vp-p to 1 mVp-p	0.001 Hz to 100 kHz 100 kHz to 10 MHz	0.21 dB 0.53 dB	
2.99 Vp-p to 100 mVp-p	(10 to 20) MHz	0.53 dB	
(99.9 to 1) mVp-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, with 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	
RF Tuned Power – Measure			
0 dB	Reference		
(0 to -127) dB	(2.5 to 1300) MHz 2.5 MHz to 18 GHz	(0.042 to 0.002) dB (0.045 to 0.004) dB	HP 11722A sensor with HP 8902A, 11793A and type N or type APC 3.5 mm connector

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Amplitude Modulation – Measuring Equipment AM Flatness Carrier Frequency (11 to 13.5) MHz Depth 0 % to 99 %	Rate Frequency 50 Hz to 50 kHz 20 Hz to 100 kHz	0.11 % 0.28 %	HP 11715A AM/FM test source
Amplitude Modulation – Measure Carrier Frequency (0.15 to 10) MHz Depth 5 % to 99 % 0 % to 99 % (10 to 1300) MHz Depth 5 % to 99 % (1.3 to 18) GHz Depth 5 % to 99 % 10 MHz to 18 GHz Depth 0 % to 99 %	Rate Frequency 50 Hz to 10 kHz 20 Hz to 10 kHz 50 Hz to 50 kHz 50 Hz to 50 kHz 20 Hz to 100 kHz	3.5 % + 1 digit 4.1 % + 1 digit 1.6 % + 1 digit 3.2 % + 1 digit 4.2 % + 1 digit	HP 8902A with HP 11722A & 11792A sensors & HP 11793A converter
Frequency Modulation – Measure Carrier Frequency (0.25 to 10) MHz ≤ 40 kHz Peak Deviation 10 MHz to 18 GHz ≤ 400 kHz Peak Deviation	Rate Frequency 20 Hz to 10 kHz 50 Hz to 100 kHz 20 Hz to 200 kHz	2.5 % + 1 digit 3 % + 1 digit 6 % + 1 digit	HP 8902A with HP 11722A & 11792A sensors and 11793A converter

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Frequency Modulation – Measuring Equipment			
FM Flatness Carrier Frequency	Rate Frequency		HP 11715A AM/FM test source
(11 to 13.5) MHz	DC to 100 kHz (100 to 200) kHz	0.13 % 0.28 %	
(88 to 108) MHz	DC to 100 kHz (100 to 200) kHz	0.11 % 0.26 %	
(352 to 432) MHz	DC to 100 kHz (100 to 200) kHz	0.11 % 0.26 %	
Phase Modulation – Measure			
Carrier Frequency	Rate Frequency		HP 8902A with HP 11792A & 11722A sensors
(0.15 to 10) MHz	200 Hz to 10 kHz	4.3 % + 1 digit	
10 MHz to 18 GHz	200 Hz to 20 kHz	4.2 % + 1 digit	
RF Volts – Measure, Fixes 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	0.095 % 0.18 % 0.43 % 0.65 % 0.65 % 0.88 %	HP 11049A thermal voltage converter

VI. Mechanical

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Torque Wrench	(10 to 3120) in·lb	1 % of rdg from (10 to 100) % FS	Larson STWCS

Parameter/Equipment	Range	CMC ^{2, 4, 6} (±)	Comments
Torque – Measuring Equipment Transducers	(0.6 to 42) ft·lb (1.7 to 600) ft·lb	0.032 % of rdg 0.019 % of rdg	Torque arm/dead weight
Acceleration/ Vibration	(5 to 2000) Hz (2 to 10) kHz	1.8 % of rdg 3 % of rdg	Back to back comparison method
Pressure Gages – Measuring Equipment Pneumatic Hydraulic	(1 to 200) psig (200 to 300) psig (300 to 600) psig (600 to 1000) psig (1000 to 10 000) psig (0 to 10) in·H ₂ O	0.016 % of rdg 0.016 % of FS 0.016 % of FS 0.016 % of FS 0.041 % of rdg 0.005 in·H ₂ O	Deadweight tester / pressure calibrator Incline manometer
Absolute Pressure – Measuring Equipment & Measure	(0 to 30) psia (30 to 60) psia (60 to 100) psia (100 to 300) psia (300 to 600) psia (600 to 1000) psia	0.016 % of FS 0.016 % of FS 0.016 % of FS 0.016 % of FS 0.016 % of FS 0.016 % of FS	Deadweight tester / pressure calibrator
Scales and Balances ³ Analytical Balances ³	(0.5 to 629) lb (5 to 100) mg (100 to 500) mg (1 to 10) g (10 to 100) g (0.1 to 3) kg	0.01 % of rdg + 0.6R 0.028 mg + 0.00023 mg/g 0.043 mg + 0.000076 mg/g 0.033 mg + 0.002 mg/g 0.03 mg + 0.0023 mg/g 15 mg + 0.6R	ASTM Class 6 weights ASTM Class 3 weights ASTM Class 1 weights ASTM Class 2 weights
Force ^{3, 7}	(0.5 to 500) lbf (100 to 1000) lbf (200 to 2000) lbf (1000 to 10 000) lbf	0.01 % + 0.6R 0.031 % 0.014 % FS 0.041 %	ASTM Class 6 weights ASTM E74: tension & compression

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Force ^{3,7} (cont)	(2500 to 25 000) lbf (5000 to 50 000) lbf (10 000 to 100 000) lbf (50 000 to 500 000) lbf	0.078 % FS 0.051 % 0.051 % 0.051 %	ASTM E74: tension & compression Compression only
Rockwell Hardness ³ – Indirect Verification of Superficial Hardness Testers	HRA Low Medium High HRBW Low Medium High HRC Low Medium High HRR Low Medium High HR15N Low Medium High HR30N Low Medium High HR15T Low Medium High HR30T Low Medium High	0.34 HRA 0.43 HRA 0.32 HRA 0.48 HRBW 0.48 HRBW 0.34 HRBW 0.39 HRC 0.40 HRC 0.40 HRC 1.6 HRR 1.6 HRR 1.6 HRR 1.1 HR15N 0.8 HR15N 0.97 HR15N 0.49 HR30N 0.78 HR30N 0.38 HR30N 0.52 HR15T 0.59 HR15T 0.48 HR15T 0.97 HR30T 0.7 HR30T 0.57 HR30T	ASTM E18

Parameter/Equipment	Range	CMC ² (±)	Comments
Brinell Hardness – Indirect Verification	(95 to 600) HBW	0.043 mm	ASTM E10
Microindentation – Micro Vickers	(240 to 900) HV	0.69 μm	ASTM E384
Macro Vickers	(100 to 600) HV	3.1 μm	
Knoop	(250 to 900) HK	3.3 μm	

VII. Thermodynamics

Parameter/Equipment	Range	CMC ² (±)	Comments
Temperature ³ – Measuring Equipment	(-25 to 400) °C	0.024 °C + 29 μ°C/°C	Hart 1502 w/ PRT
Temperature ³ – Measure	(-200 to 420) °C (-20 to 1000) °C	0.025 °C + 0.003 % rdg 2.4 °C + 5.1 m°C/°C	PRT Type K thermocouple
Thermocouple – Measure Types B, C, E, J, K N, R, S, T, U	(-20 to 1000) °C	0.28 + 1.4 x 10 ⁻⁴ °C/°C	Fluke 5520A/ Hart 1502A/5614
RTD – Measure	(-20 to 400) °C	0.026 °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 HMK 15

Parameter/Equipment	Range	CMC ² (±)	Comments
Relative Humidity ³ – Measure	(10 to 90) % RH (90 to 99) % RH	2.8 % RH 3.9 % RH	Vaisala HMP231

VIII. Time & Frequency

Parameter/Equipment	Range	CMC ² (±)	Comments
Frequency – Measuring Equipment	10 MHz	7.9 nHz/Hz	Spectracom 8161 WWB receiver

¹ This laboratory offers commercial calibration service and field 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 In the statement of CMC, the value is defined as the percentage of reading unless otherwise indicated.

⁵ CMCs does not include mismatch.

⁶ L is the length of the unit under test in inches or millimeters, where appropriate. R is the resolution of the unit under test in inches or millimeters, where appropriate.

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



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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 31st day of March 2011.



A handwritten signature in black ink, appearing to read "Peter Meyer".

President & CEO
For the Accreditation Council
Certificate Number 1277.01
Valid to March 31, 2013

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