



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

TEKTRONIX SERVICE SOLUTIONS
 8020 Southpark Circle, Suite 300
 Littleton, CO 80120
 Andrew Beckerdite Phone: 303 798 2243

CALIBRATION

Valid To: June 30, 2013

Certificate Number: 1623.10

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations and dimensional inspections¹:

I. Dimensional

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
Angle	0° to 90°	0.42 arc sec	10-inch sine bar with gage blocks, granite square
Calipers ³	Up to 32 in	(700 + 1.6L) μin	Grade 1 gage blocks
Indicators ³	Up to 6 in	(77 + 1.6L) μin	Grade 1 gage blocks
Micrometers, Depth and Height Gages ³	Up to 32 in	(77 + 1.6L) μin	Grade 1 gage blocks
Plain Plugs and Pins	Up to 10 in	(42 + 1.6L) μin	P&W supermic with grade 1 gage blocks
Rulers ³	Up to 32 in	0.009 in	CMM or gage blocks

Parameter/Equipment	Range	CMC ^{2, 6, 8} (±)	Comments
Surface Plate Flatness ³	Up to 48 in × 96 in Up to < 500 μin > 500 μin	7.8 μin 0.63 %	Federal electronic level system
Threaded Plugs – Outside Diameter (4 to 96) TPI	(0 to 10) in	(42 + 1.6L) μin	P&W supermic with grade 1 gage blocks

II. Dimensional Testing/Calibration

Parameter/Equipment	Range	CMC ² (±)	Comments
Height ⁹	Up to 28 in	0.00047 in	CMM
Length ⁹	Up to 40 in	0.00042 in	CMM
Width ⁹	Up to 28 in	0.00042 in	CMM

III. Electrical – DC & Low Frequency

Parameter/Range	Frequency	CMC ^{2, 8} (±)	Comments
AC Current – Generate ^{3, 4} (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	0.07 % + 25 nA 0.035 % + 20 nA 0.014 % + 16 nA 0.06 % + 40 nA 0.16 % + 80 nA	Fluke 5700A
(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	0.07 % + 40 nA 0.035 % + 35 nA 0.014 % + 35 nA 0.06 % + 400 nA 0.16 % + 800 nA	

Parameter/Range	Frequency	CMC ^{2, 4, 5, 8} (±)	Comments
AC Current – Generate (cont) ³			
(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	0.025 % + 0.4 µA 0.016 % + 0.35 µA 0.012 % + 0.35 µA 0.02 % + 0.6 µA 0.11 % + 5 µA	Fluke 5700A
(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	0.025 % + 4 µA 0.016 % + 3.5 µA 0.012 % + 2.5 µA 0.02 % + 3.5 µA 0.11 % + 10 µA	
(0.22 to 2.2) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.026 % + 35 µV 0.045 % + 80 µV 0.7 % + 160 µV	
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.046 % + 170 µV 0.095 % + 380 µV 0.36 % + 750 µV	
(11 to 20.5) A	(10 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.15 % + 5 mA 0.18 % + 5 mA 3.5 % + 5 mA	Fluke 5520A
Clamp-On Only			
(0 to 110) A	(65 to 440) Hz	0.32 % + 0.5A	Fluke 5500A with coil
(0 to 550) A	(45 to 65) Hz	0.38 % + 0.5A	
AC Current – Measure ³			
(10 to 100) µA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 1) kHz	0.46 % + 0.03 µA 0.17 % + 0.03 µA 0.07 % + 0.03 µA 0.07 % + 0.03 µA	HP 3458A
(0.1 to 1) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.5 % + 0.2 µA 0.17 % + 0.2 µA 0.07 % + 0.2 µA 0.04 % + 0.2 µA	

Parameter/Range	Frequency	CMC ^{2,5,8} (±)	Comments
AC Current – Measure (cont) ³			
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.46 % + 2 μA 0.17 % + 2 μA 0.07 % + 2 μA 0.04 % + 2 μA	HP 3458A
(10 to 100) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.46 % + 20 μA 0.17 % + 20 μA 0.07 % + 20 μA 0.04 % + 20 μA	
(0.1 to 1) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.46 % + 200 μA 0.18 % + 200 μA 0.09 % + 200 μA 0.12 % + 200 μA	
AC Resistance – Generate ³			
Fixed Points			
10 Ω	DC to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.13 % 0.14 % 0.17 % 0.19 % 0.26 % 0.66 % 1 %	HP 42030A resistance set
100 Ω	DC to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.13 % 0.14 % 0.17 % 0.14 % 0.17 % 0.34 % 0.46 %	
1 kΩ	DC to 3 MHz (3 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.08 % 0.11 % 0.28 % 0.41 %	
(10, 100) kΩ	DC to 1 MHz	0.088 %	

Parameter/Range	Frequency	CMC ^{2,4,8} (±)	Comments
AC Resistance – Measure ³ 1 Ω to 1 MΩ	12 Hz to 100 kHz	0.025 %	Quad Tech 1689M
AC Voltage – Generate ³ (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 (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.055 % + 4.5 μV 0.021 % + 4.5 μV 0.011 % + 4.5 μV 0.037 % + 4.5 μV 0.085 % + 7 μV 0.11 % + 13 μV 0.17 % + 25 μV 0.34 % + 25 μV	Fluke 5700A
(2.2 to 22) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.055 % + 5 μV 0.021 % + 5 μV 0.011 % + 5 μV 0.037 % + 5 μV 0.085 % + 7 μV 0.11 % + 12 μV 0.17 % + 25 μV 0.34 % + 25 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 (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.055 % + 13 μV 0.021 % + 8 μV 0.011 % + 8 μV 0.032 % + 8 μV 0.085 % + 25 μV 0.11 % + 25 μV 0.17 % + 35 μV 0.34 % + 80 μV	

Parameter/Range	Frequency	CMC ^{2,4,8} (±)	Comments
AC Voltage Generate ³ (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 (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.05 % + 80 µV 0.016 % + 25 µV 75 µV/V + 6 µV 0.012 % + 16 µV 0.025 % + 70 µV 0.043 % + 130 µV 0.11 % + 350 µV 0.22 % + 850 µV	Fluke 5700A
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.05 % + 0.8 mV 0.016 % + 0.25 mV 75 µV/V + 0.06 mV 0.012 % + 0.16 mV 0.025 % + 0.35 mV 0.05 % + 1.5 mV 0.13 % + 4.3 mV 0.27 % + 8.5 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 (0.5 to 1) MHz	0.05 % + 8 mV 0.016 % + 2.5 mV 80 µV/V + 0.8 mV 0.022 % + 3.5 mV 0.05 % + 8 mV 0.15 % + 90 mV 0.47 % + 90 mV 1.2 % + 190 mV	
(220 to 750) V	30 Hz to 50 kHz (50 to 100) kHz	0.06 % + 11 mV 0.23 % + 45 mV	
(220 to 1100) V	(15 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.04 % + 16 mV 90 µV/V + 4 mV 0.017 % + 6 mV 0.06 % + 11 mV	

Parameter/Range	Frequency	CMC ^{2, 5, 8} (±)	Comments	
AC Voltage – Measure ³				
3 μV 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	0.03 % + 2 μV 0.02 % + 2 μV 0.03 % + 2 μV 0.12 % + 2 μV 0.58 % + 2 μV 4.6 % + 2 μV	HP 3458A, synchronous sub-sampled mode	
(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	80 μV/V + 4 μV 90 μV/V + 2 μV 0.02 % + 2 μV 0.03 % + 2 μV 0.09 % + 2 μV 0.35 % + 10 μV 1.2 % + 10 μV 1.7 % + 10 μV		
(0.1 to 1) 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	80 μV/V + 40 μV 90 μV/V + 20 μV 0.02 % + 20 μV 0.03 % + 20 μV 0.09 % + 20 μV 0.35 % + 100 μV 1.2 % + 100 μV 1.7 % + 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	88 μV/V + 0.4 mV 88 μV/V + 0.2 mV 0.02 % + 0.2 mV 0.03 % + 0.2 mV 0.09 % + 0.2 mV 0.35 % + 1 mV 1.2 % + 1 mV 1.7 % + 1 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 mV 0.02 % + 2 mV 0.02 % + 2 mV 0.04 % + 2 mV 0.14 % + 2 mV 0.46 % + 10 mV 1.7 % + 10 mV		
(100 to 700) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.05 % + 40 mV 0.05 % + 20 mV 0.07 % + 20 mV 0.14 % + 20 mV 0.35 % + 20 mV		
(0.7 to 30) kV	60 Hz	0.58 %		Ross VD60 with 34401A

Parameter/Range	Frequency	CMC ^{2, 4, 5, 7, 8} (±)	Comments
Bandwidth ³	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz	2.2 % 2.7 % 4.8 % 5.9 %	Fluke 5520A/SC1.1
Capacitance – Measure ³ 0.1 pF to 1 mF	12 Hz to 100 kHz	0.02 %	GenRad 1689M
Capacitance – Generate ³ Fixed Values 1 pF 10 pF 100 pF 1000 pF	100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz 100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz 100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz 100 Hz to 1 kHz 1 kHz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz	0.062 % 0.072 % 0.083 % 0.099 % 0.16 % 0.22 % 0.68 % 1 % 0.062 % 0.066 % 0.075 % 0.076 % 0.083 % 0.095 % 0.15 % 0.18 % 0.073 % 0.066 % 0.075 % 0.076 % 0.083 % 0.095 % 0.15 % 0.18 % 0.062 % 0.072 % 0.083 % 0.099 % 0.13 % 0.16 % 0.35 % 0.48 %	HP 1638XX standard capacitor

Parameter/Range	Frequency	CMC ^{2,4,7,8} (±)	Comments
Capacitance – Generate (cont) ³			
(0.19 to 1.09) nF	10 Hz to 10 kHz	0.54 % + 0.01 nF	Fluke 5520A
(1.1 to 3.29) nF	10 Hz to 3 kHz	0.54 % + 0.01 nF	
(3.3 to 10.9) nF	10 Hz to 1 kHz	0.32 % + 0.01 nF	
(11 to 109.9) nF	10 Hz to 1 kHz	0.27 % + 0.1 nF	
(110 to 329.9) nF	10 Hz to 1 kHz	0.27 % + 0.3 nF	
(0.33 to 1.09) μF	(10 to 600) Hz	0.27 % + 1 nF	
(1.1 to 3.29) μF	(10 to 300) Hz	0.27 % + 3 nF	
(3.29 to 10.9) μF	(10 to 150) Hz	0.29 % + 10 nF	
(11 to 32.9) μF	(10 to 120) Hz	0.46 % + 30 nF	
(33 to 109.9) μF	(10 to 80) Hz	0.51 % + 100 nF	
(110 to 329.9) μF	(10 to 50) Hz	0.54 % + 300 nF	
(0.33 to 1.09) mF	(10 to 20) Hz	0.62 % + 1000 nF	

Parameter/Equipment	Range	CMC ^{2,4,5,8} (±)	Comments
DC Current – Generate ³	0.1 nA 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	50 μA/A + 8 nA 50 μA/A + 8 nA 50 μA/A + 80 nA 60 μA/A + 0.8 μA 80 μA/A + 25 μA 0.036 % + 480 μA	Fluke 5700A with 5725A
	(11 to 100) A	0.03 %	Power supply with L&N 4361 shunt
Clamp-On Only	(0 to 550) A	0.3 % + 0.5 A	Fluke 5520A with 5500A coil
DC Current – Measure ³	100 pA to 100 μA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	24 μA/A + 0.8 nA 24 μA/A + 5 nA 24 μA/A + 50 nA 41 μA/A + 0.5 μA 0.013 % + 10 μA	HP 3458A
	(1 to 100) A	0.03 %	L & N shunt

Parameter/Equipment	Range	CMC ^{2, 4, 5, 8} (\pm)	Comments
DC Resistance – Measure ³	(0.1 to 10) Ω (10 to 100) Ω (0.1 to 1) k Ω (1 to 10) k Ω (10 to 100) k Ω (0.1 to 1) M Ω (1 to 10) M Ω (10 to 100) M Ω (0.1 to 1) G Ω	19 $\mu\Omega/\Omega$ + 0.05 m Ω 15 $\mu\Omega/\Omega$ + 0.5 m Ω 13 $\mu\Omega/\Omega$ + 0.5 m Ω 12 $\mu\Omega/\Omega$ + 5 m Ω 13 $\mu\Omega/\Omega$ + 0.05 Ω 24 $\mu\Omega/\Omega$ + 2 Ω 65 $\mu\Omega/\Omega$ + 100 Ω 0.058 % + 1 k Ω 0.58 % + 10 k Ω	HP 3458A
DC Resistance – Generate ³	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (0.11 to 1.1) k Ω (1.1 to 11) k Ω (11 to 110) k Ω (0.11 to 1.1) M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω (330 to 1100) M Ω	40 $\mu\Omega/\Omega$ + 1 m Ω 30 $\mu\Omega/\Omega$ + 1.5 m Ω 28 $\mu\Omega/\Omega$ + 1.4 m Ω 28 $\mu\Omega/\Omega$ + 2 m Ω 28 $\mu\Omega/\Omega$ + 20 m Ω 28 $\mu\Omega/\Omega$ + 200 m Ω 32 $\mu\Omega/\Omega$ + 2 Ω 60 $\mu\Omega/\Omega$ + 30 Ω 0.015 % + 50 Ω 0.025 % + 2.5 k Ω 0.05 % + 3 k Ω 0.3 % + 0.1 M Ω 1.5 % + 0.5 M Ω	Fluke 5520A
Fixed Points	0.01 Ω 0.1 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	0.043 % 0.043 % 95 parts in 10 ⁶ 95 parts in 10 ⁶ 28 parts in 10 ⁶ 27 parts in 10 ⁶ 17 parts in 10 ⁶ 17 parts in 10 ⁶ 13 parts in 10 ⁶ 13 parts in 10 ⁶ 12 parts in 10 ⁶ 12 parts in 10 ⁶ 14 parts in 10 ⁶ 14 parts in 10 ⁶ 20 parts in 10 ⁶ 21 parts in 10 ⁶ 40 parts in 10 ⁶ 47 parts in 10 ⁶ 0.011 %	L & N 4361 Honeywell 1163 Fluke 5700A

Parameter/Equipment	Range	CMC ^{2,4,5,8} (±)	Comments
DC Voltage – Measure ³	(0 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1100) V (1 to 60) kV	6.2 μV/V + 3 μV/V 5.2 μV/V + 0.3 μV/V 5.2 μV/V + 0.05 μV/V 7.3 μV/V + 0.3 μV/V 7.3 μV/V + 0.1 μV/V 0.12 %	HP 3458A opt 002 VD60 Ross divider with HP 34401A
DC Voltage – Generate ³	(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	8.1 μV/V + 0.6 μV 7.1 μV/V + 1 μV 7.1 μV/V + 3.5 μV 7.1 μV/V + 6.5 μV 8.1 μV/V + 80 μV 9.1 μV/V + 500 μV	Fluke 5700A
Distortion ³ – Measure Fundamental Frequency			
20 Hz to 20 kHz	(0 to 99.9) dB 50 Hz to 500 kHz	1.2 dB	HP 8903B
(20 to 100) kHz	(0 to 99.9) dB 50 Hz to 500 kHz	2.3 dB	
Electrical Calibration of Thermocouple Indicators ³ –			
Type B	600 °C to 800 °C 800 °C to 1000 °C 1000 °C to 1550 °C 1550 °C to 1820 °C	0.5 °C 0.4 °C 0.36 °C 0.39 °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	0.36 °C 0.32 °C 0.37 °C 0.56 °C 0.9 °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	0.56 °C 0.22 °C 0.2 °C 0.22 °C 0.27 °C	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Electrical Calibration of Thermocouple Indicators ³ (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	0.33 °C 0.22 °C 0.2 °C 0.23 °C 0.29 °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	0.39 °C 0.24 °C 0.22 °C 0.32 °C 0.46 °C	
Type L	-200 °C to -100 °C -100 °C to 800 °C 800 °C to 900 °C	0.43 °C 0.32 °C 0.23 °C	
Type N	-200 °C to -100 °C -100 °C to -25 °C -25 °C to 120 °C 120 °C to 410 °C 410 °C to 1300 °C	0.46 °C 0.28 °C 0.25 °C 0.24 °C 0.33 °C	
Type R	0 °C to 250 °C 250 °C to 400 °C 400 °C to 1000 °C 1000 °C to 1767 °C	0.63 °C 0.41 °C 0.39 °C 0.46 °C	
Type S	0 °C to 250 °C 250 °C to 1000 °C 1000 °C to 1400 °C 1400 °C to 1767 °C	0.53 °C 0.42 °C 0.43 °C 0.52 °C	
Type T	-250 °C to -150 °C -150 °C to 0 °C 0 °C to 120 °C 120 °C to 400 °C	0.69 °C 0.3 °C 0.22 °C 0.2 °C	
Type U	-200 °C to 0 °C 0 °C to 600 °C	0.62 °C 0.33 °C	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Electrical Calibration of RTDs ³ –			
Pt 385, 100 Ω	-200 °C to -80 °C -80 °C to 0 °C 0 °C to 100 °C 100 °C to 300 °C 300 °C to 400 °C 400 °C to 630 °C 630 °C to 800 °C	0.06 °C 0.06 °C 0.08 °C 0.1 °C 0.11 °C 0.13 °C 0.24 °C	Fluke 5520A
Pt 3926, 100 Ω	-200 °C to -80 °C -80 °C to 0 °C 0 °C to 100 °C 100 °C to 300 °C 300 °C to 400 °C 400 °C to 630 °C	0.06 °C 0.06 °C 0.08 °C 0.1 °C 0.11 °C 0.13 °C	
Pt 3916, 100 Ω	-200 °C to -190 °C -190 °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	0.26 °C 0.05 °C 0.06 °C 0.07 °C 0.07 °C 0.09 °C 0.1 °C 0.11 °C 0.24 °C	
Pt 385, 200 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 0.05 °C 0.06 °C 0.13 °C 0.14 °C 0.15 °C 0.17 °C	
Pt 385, 500 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 0.06 °C 0.06 °C 0.07 °C 0.09 °C 0.09 °C 0.1 °C 0.12 °C	

Parameter/Range	Frequency	CMC ^{2, 4, 8} (±)	Comments
Electrical Calibration of RTDs 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	0.04 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.08 °C 0.24 °C	Fluke 5520A
PtNi 385, 120 Ω	-80 °C to 0 °C 0 °C to 100 °C 100 °C to 260 °C	0.09 °C 0.09 °C 0.15 °C	
Cu 427, 10 Ω	-100 °C to 260 °C	0.31 °C	
Inductance – Generate ³ (1, 10, 100) mH (1, 5) H	(0.1 to 1) kHz	0.03 % 0.06 %	GenRad 1482X
Inductance – Measure ³ 100 μH to 10 H	12 Hz to 100 kHz	0.025 %	GenRad 1689M
Phase Noise – Measure ³ Carrier Frequency: 5 MHz to 1.3 GHz	Carrier Freq. Offset: ≤1 Hz @ ≤-54 dBc ≤ 10 Hz @ ≤ -84 dBc ≤ 100Hz @ ≤ -104 dBc ≤ 1kHz @ ≤ -121 dBc ≤ 3kHz @ ≤ -121 dBc ≤ 5kHz @ ≤ -129 dBc ≤ 10kHz @ ≤ -145 dBc ≤ 100kHz @ ≤ -157 dBc	2.4 dBc Phase Noise	HP 11848A with HP 3561A

Parameter/Range	Frequency	CMC ^{2, 8} (±)	Comments
Rise Time – Measure ³ , Fixed Point	7 ps	7 ps + 3.5 %	CSA803 with SD32

IV. Electrical – RF & Microwave

Parameter/Range	Frequency	CMC ^{2, 8} (±)	Comments
Amplitude Modulation– Generate ³			
Rate: 50 Hz to 100 kHz Depths: 5 % to 95 %	10 kHz to 13.5 MHz	0.12 %	HP 11715A
Rate: 1 kHz Depths: 30 %	10 MHz to 26.5 GHz	5.8 %	HP 8340B
Rate: DC to 10 kHz Depths: 0 % to 90 %	10 MHz to 26.5 GHz	5.8 % + 0.2 dB	
Amplitude Modulation – Measure ³			
Rate: 50 Hz to 10 kHz Depths: 5 % to 99 %	150 kHz to 10 MHz	2 % + 1 digit	HP 8902A
Rate: 20 Hz to 10 kHz Depths: to 99 %	150 kHz to 10 MHz	3 % + 1 digit	
Rate: 50 Hz to 50 kHz Depths: 5 % to 99 %	10 MHz to 1.3 GHz	1 % + 1 digit	
Rate: 20 Hz to 100 kHz Depths: to 99 %	10 MHz to 1.3 GHz	3 % + 1 digit	
Rate: 20 Hz to 100 kHz Depths: 5 % to 99 %	(1.3 to 26.5) GHz	1.5 % + 1 digit	with 11793A
Rate: 20 Hz to 100 kHz Depths: to 99 %	(1.3 to 26.5) GHz	3 % + 1 digit	

Parameter/Range	Frequency	CMC ^{2, 7, 8} (±)	Comments
Frequency Modulation – Generate ³ Rate: 20 Hz to 100 kHz Dev.: ≤ 12.5 kHz peak Rate: 20 Hz to 100 kHz Dev.: ≤ 100 kHz peak Rate: 20 Hz to 100 kHz Dev.: ≤ 400 kHz peak Rate: 50 kHz to 10 MHz Dev.: ≤ 10 MHz	11 MHz to 13.5 MHz 88 MHz to 108 MHz 352 MHz to 432 MHz 10 kHz to 26.5 GHz	0.1 % 0.1 % 0.1 % 10 %	HP 11715A HP 8340B
Frequency Modulation – Measure ³ Rate: 20 Hz to 10 kHz Dev.: ≤ 40 kHz peak Rate: 50 Hz to 100 kHz Dev.: ≤ 400 kHz peak Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak Rate: 50 Hz to 100 kHz Dev.: ≤ 400 kHz peak Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	250 kHz to 10 MHz 10 MHz to 1.3 GHz 10 MHz to 1.3 GHz (1.3 to 26.5) GHz (1.3 to 26.5) GHz	2 % + 1 digit 1 % + 1 digit 5 % + 1 digit 1 % + 1 digit 5 % + 1 digit	HP 8902A with 11793A
RF Attenuation Tuned RF Power – Measure ³ (-0.0 to -1) dB (-1 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 (-90 to -100) dB (-100 to -110) dB (-110 to -120) dB	100 kHz to 26.5 GHz	0.008 dB 0.023 dB 0.052 dB 0.073 dB 0.11 dB 0.13 dB 0.15 dB 0.19 dB 0.22 dB 0.24 dB 0.26 dB 0.31 dB 0.37 dB	HP 8902A HP 11722A HP 11792A HP 11793A

Parameter/Range	Frequency	CMC ^{2,8} (±)	Comments
RF Power – Generate ³ (+23.98 to -56.02) dBm (+13 to -127) dBm	0.01 Hz to 20 MHz 20 MHz to 26.5 GHz	0.5 dB 0.7 dB	HP 3325A HP 8340B
RF Power – Measure ³ (+30 to -20) dBm (-20 to -70) dBm	100 kHz to 26.5 GHz 50 MHz to 26.5 GHz	2.9 % 2.9 %	HP 8902A with 11722A and 11792A HP 436A with 8485D
Power Sensor Gold Calibration – Calibration Factor 8481D / 8484A (-70 to -20) dBm	10 MHz 30 MHz 50 MHz 100 MHz 300 MHz 500 MHz 1 GHz 1.5, 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz 7 GHz 8 GHz 9 GHz 10 GHz 11 GHz 12 GHz 12.4 GHz 13 GHz 14 GHz 15 GHz 16 GHz 17 GHz 18 GHz	2.0 % 1.6 % 1.5 % 1.4 % 1.5 % 1.4 % 1.5 % 1.4 % 1.4 % 1.4 % 1.4 % 1.4 % 1.4 % 1.4 % 1.5 % 1.4 % 1.4 % 1.4 % 1.4 % 1.5 % 1.5 % 1.5 % 1.5 % 1.6 % 1.7 %	HP gold sensor 8481D with 436A

Parameter/Range	Frequency	CMC ^{2, 8} (±)	Comments
Phase Modulation – Measure ³			
Rate: 200 Hz to 10 kHz	150 kHz to 10 MHz	4 % + 1 digit	HP 8902A
Rate: 200 Hz to 20 kHz	10 MHz to 1.3 GHz	3 % + 1 digit	
Rate: 200 Hz to 20 kHz	(1.3 to 26.5) GHz	3 % + 1 digit	with 11793A

V. Fluid

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
Gas Flow	(10 to 30 000) sccm	0.34 %	DHI molbox flow system

VI. Mechanical

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
Force – Compression ³			
Measure	(1 to 10) klb _f	0.06 %	Omega LCCB-500
Measuring Equipment	(5 to 650) lbf	0.06 %	Omega LC101-10k
Force – Tension ³			
Measure	(5 to 500) lbf	0.06 %	Omega LCCB-500
Measuring Equipment	(5 to 650) lbf	0.06 %	Omega LC101-10k
Pressure ³	(5 to 10 000) psig	0.12 %	Ametek DWT

Parameter/Equipment	Range	CMC ^{2,8} (±)	Comments
Scales & Balances ³	(1 to 5) mg (5 to 10) mg (10 to 30) mg (30 to 200) mg (200 to 500) mg (0.5 to 1) g (1 to 10) g (10 to 50) g (50 to 100) g (100 to 200) g	0.037 mg 0.052 mg 0.057 mg 0.11 mg 0.18 mg 0.25 mg 0.34 mg 0.64 mg 1.1 mg 2.1 mg	Class S1 weights
	(0.25 to 0.5) lb (0.5 to 10) lb (10 to 25) lb (25 to 50) lb (50 to 100) lb (100 to 500) lb (500 to 650) lb	100 µlb 0.001 lb 0.004 lb 0.006 lb 0.014 lb 0.052 lb 0.11 lb	Class F weights
Torque Transducers ³	(600 to 1000) ft·lb	0.12 %	40-inch torque arm with class F weights
	(250 to 600) ft·lb	0.12 %	12-inch torque arm with class F weights
	50 in·lb to 250 ft·lb	0.12 %	10-inch torque arm with class F weights
Torque Wrenches ³	5 in·lb to 650 ft·lb	0.32 %	CDI 950 with TTPM-41 and 650 ft·lb transducer

VII. Thermodynamics

Parameter/Equipment	Range	CMC ^{2,8} (±)	Comments
Relative Humidity ³ – Measuring Equipment	(10 to 95) % RH	0.54 %	Thunder Scientific 2500

Parameter/Equipment	Range	CMC ^{2,8} (±)	Comments
Relative Humidity – Measure ³	(10 to 90) % RH	2 %	Vaisala HMI-41 RH meter with HMP 46 Probe
Temperature – Measure ³	-200 °C to 400 °C	0.03 % + 0.05 °C	Hart 5615-9 with ISO/CAL 9000

VIII. Time & Frequency

Parameter/Equipment	Range	CMC ² (±)	Comments
Frequency – Measuring Equipment ³	10 MHz	6 part in 10 ¹¹	Symmetricom ET 6000-RV
	DC to 20 MHz	6 part in 10 ¹¹	HP 3325A
	20 MHz to 26.5 GHz	6 part in 10 ¹¹	HP 8340B
Frequency – Measure, Fixed Points ³	DC to 26.5 GHz		Symmetricom ET 6000-RV
	1 s	6 part in 10 ¹¹	HP 5343A
	10 s	6 part in 10 ¹¹	
	100 s	6 part in 10 ¹¹	
24 hr	6 part in 10 ¹¹		
Time Interval ³	1 s to 3 hr	0.52 s	HP53132A

¹ This laboratory offers commercial dimensional testing/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. 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 measurands stated are generated with the Fluke 5000 series instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. CMC is read as output plus one-year floor specifications where defined and are based on using the standard at the temperature the instrument was calibrated ($t_{cal} \pm 5\text{ }^{\circ}\text{C}$) and assuming the instrument is zeroed at least every seven (7) days or when the ambient temperature changes more than $5\text{ }^{\circ}\text{C}$. For resistance a zero calibration is performed at least every 12 hours within $\pm 1\text{ }^{\circ}\text{C}$ of use.
- ⁵ The measurands stated are measured with the HP 3458A, 8903B, 42030A, 1638XX, and 331A. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. CMC is based upon one-year floor specifications and is read as output plus range and is based on using the HP 3458A at the temperature it was calibrated $\pm 5\text{ }^{\circ}\text{C}$ and an auto-calibration (ACAL) was performed within the previous 24 hours ($\pm 1\text{ }^{\circ}\text{C}$ of ambient temperature).
- ⁶ In the statement of CMC, L is the numerical value of the nominal length of the device measured in inches.
- ⁷ The deviation is the lesser of either $\leq 10\text{ MHz}$ or ($n \times$ modulation rate) where $n = 1, 2, 3$ or 4 depending upon the frequency multiplier.
- ⁸ Percents not identified in the CMC statement are % of reading.
- ⁹ This laboratory meets R205 – *Specific Requirements: Calibration Laboratory Accreditation Program* for the types of dimensional tests listed above and is considered equivalent to that of a calibration.



World Class Accreditation

The American Association for Laboratory Accreditation

Accredited Laboratory

A2LA has accredited

TEKTRONIX SERVICE SOLUTIONS

Littleton, CO

for technical competence in the field of

Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 *General Requirements for the Competence of Testing and Calibration Laboratories*. This laboratory also meets the requirements of ANSI/NCSL Z540-1-1994 and any additional program requirements in the field of calibration. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009*).

Presented this 17th day of August 2011.



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

President & CEO
For the Accreditation Council
Certificate Number 1623.10
Valid to June 30, 2013

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