



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

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CALIBRATION

Valid To: December 31, 2011

Certificate Number: 1623.09

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations and dimensional testing<sup>1</sup>:

I. Dimensional

Parameter/Equipment	Range	CMC <sup>2,6</sup> (±)	Comments
Micrometers & Height Gages <sup>3</sup>	(0 to 48) in	(65 + 1.6L) μin	Grade 2 gage blocks
Depth Gages	(0 to 48) in	(65 + 1.6L) μin	Grade 2 gage blocks
Calipers <sup>3</sup>	(0 to 48) in	(620 + 1.6L) μin	Grade 2 gage blocks
Indicators <sup>3</sup>	(0 to 2) in	(65 + 1.6L) μin	Grade 2 gage blocks
Pins <sup>3</sup>	(0 to 2) in	140 μin	Laser mic, master pins
Radius Gages	Up to 3 in	420 μin	Optical comparator
Optical Comparators <sup>3</sup> – Length (X, Y direction)	Up to 10 in	0.0003 in	Acu-Rite mag checker
Magnification (×10, ×20, ×31.25 and ×50)	Up to 10 in	0.0006 in	Scale

Parameter/Equipment	Range	CMC <sup>2,6</sup> (±)	Comments
Surface Plate Flatness <sup>3</sup>	Up to 96 in × 48 in	84 μin	Rahn 36-inch planekator  Note: Uncertainty to be no less than the acceptable closure error for the procedure.

## II. Dimensional Testing

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Length	Up to 6 in Up to 1 in Up to 2 in	300 μin 140 μin 0.0019 in	Optical comparator Digital micrometer Digital calipers

## III. Electrical – DC & Low Frequency

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
DC Voltage – Generate <sup>3,4</sup>	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	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
DC Current – Generate <sup>3,4</sup>	Up 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 + 80 nA 60 μA/A + 0.8 μA 80 μA/A + 25 μA 0.036 % + 480 μA	Fluke 5700A/5725A
Clamp-On Only	(11 to 22) A (22 to 100) A  (0 to 550) A (550 to 1000) A	0.04 % + 6 mA 0.04 % + 30 mA  0.3 % + 0.5 A 0.33 % + 0.5 A	Valhalla 2555A  Fluke 5520A with coil
DC Power – Generate <sup>3,4</sup>	(0.01 to 330) W (0.33 to 11) kW (11 to 20.5) kW	0.2 % 0.21 % 0.23 %	Fluke 5520A

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
DC Resistance – Generate <sup>3,4</sup>	(0 to 11) Ω	40 μΩ/Ω + 1 mΩ	Fluke 5520A
	(11 to 33) Ω	30 μΩ/Ω + 1.5 mΩ	
(33 to 110) Ω	28 μΩ/Ω + 1.4 mΩ		
(0.11 to 1.1) kΩ	28 μΩ/Ω + 2 mΩ		
(1.1 to 11) kΩ	28 μΩ/Ω + 20 mΩ		
(11 to 110) kΩ	28 μΩ/Ω + 0.2 Ω		
(0.11 to 1.1) MΩ	32 μΩ/Ω + 2 Ω		
(1.1 to 3.3) MΩ	60 μΩ/Ω + 30 Ω		
(3.3 to 11) MΩ	0.015 % + 50 Ω		
(11 to 33) MΩ	0.025 % + 2.5 kΩ		
(33 to 110) MΩ	0.05 % + 3 kΩ		
(110 to 330) MΩ	0.3 % + 100 kΩ		
(330 to 1100) MΩ	1.5 % + 500 kΩ		
Fixed Points	0.100 Ω	0.013 % of reading	Guildline 9211A
	0.01 Ω	0.013 % of reading	
0.001 Ω	0.064 % of reading		
0.000333 Ω	0.13 % of reading		
	1 Ω	95 μΩ/Ω	Fluke 5700A
	1.9 Ω	95 μΩ/Ω	
	10 Ω	28 μΩ/Ω	
	19 Ω	27 μΩ/Ω	
	100 Ω	17 μΩ/Ω	
	190 Ω	17 μΩ/Ω	
	1 kΩ	13 μΩ/Ω	
	1.9 kΩ	13 μΩ/Ω	
	10 kΩ	12 μΩ/Ω	
	19 kΩ	12 μΩ/Ω	
	100 kΩ	14 μΩ/Ω	
	190 kΩ	14 μΩ/Ω	
	1 MΩ	20 μΩ/Ω	
	1.9 MΩ	21 μΩ/Ω	
	10 MΩ	40 μΩ/Ω	
	19 MΩ	47 μΩ/Ω	
100 MΩ	0.011 % of reading		
DC Voltage <sup>3,5</sup> – Measure	Up to 100 mV	6.2 μV/V + 0.3 μV	HP 3458A, Opt. 002
	(0.1 to 1) V	5.2 μV/V + 0.3 μV	
(1 to 10) V	5.2 μV/V + 0.5 μV		
(10 to 100) V	7.3 μV/V + 30 μV		
(100 to 1000) V	7.3 μV/V + 100 μV		
	(1.1 to 120) kV	1.5 mV/V	w/ Ross 120 kV divider

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
DC Current – Measure <sup>3,5</sup>	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 10) A (10 to 100) A (100 to 300) A	0.013 % of reading 0.064 % of reading 0.13 % of reading	w/ Guildline 9211A
DC Resistance – Measure <sup>3,5</sup>	(0.1 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 1.2) GΩ	18 μΩ/Ω + 50 μΩ 14 μΩ/Ω + 0.5 mΩ 12 μΩ/Ω + 0.5 mΩ 12 μΩ/Ω + 5 mΩ 12 μΩ/Ω + 50 mΩ 18 μΩ/Ω + 2 Ω 58 μΩ/Ω + 100 Ω 0.058 % + 1 kΩ 0.58 % + 10 kΩ	HP 3458A

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
AC Voltage – Generate <sup>3,4</sup>  (0.2 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 with 5725A
	(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	

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
AC Voltage – Generate <sup>3,4</sup> (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 (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	Fluke 5700A with 5725A
(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	
(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 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	
(220 to 750) V	30 Hz to 50 kHz (50 to 100) kHz	0.06 % + 11 mV 0.23 % + 45 mV	

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
AC Current – Generate <sup>3,4</sup>			
(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	
(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	0.07 % + 0.4 µA 0.035 % + 0.35 µA 0.014 % + 0.35 µA 0.06 % + 4 µA 0.16 % + 8 µA	
(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	0.07 % + 4 µA 0.035 % + 3.5 µA 0.014 % + 3.5 µA 0.06 % + 40 µA 0.16 % + 80 µA	
(0.22 to 2.2) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.065 % + 35 µA 0.075 % + 80 µA 0.85 % + 160 µA	
(2.2 to 11) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.046 % + 170 µA 0.095 % + 380 µA 0.36 % + 750 µA	
(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
(20 to 100) A	(10 to 100) Hz (100 to 400) Hz (0.4 to 1) kHz	0.18 % of output + 0.15 A 0.24 % of output + 0.2 A 0.34 % of output + 0.3 A	Fluke 5700A w/ Valhalla 2555
Clamp-On Only			
(0 to 550) A (0 to 110) A	(45 to 65) Hz (65 to 440) Hz	0.38 % + 0.5 A 0.32 % + 0.5 A	Fluke 5500A with coil

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
AC Power – Generate <sup>3,4</sup>  (0.01 to 0.1) W (0.1 to 890) W (0.89 to 3) kW (3 to 11) kW (11 to 20.5) kW	(45 to 65) Hz; PF = 1	0.23 % of reading 0.14 % of reading 0.13 % of reading 0.15 % of reading 0.13 % of reading	Fluke 5520A
AC Resistance – Generate <sup>3</sup>  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	0.068 % of reading 0.086 % of reading 0.092 % of reading 0.11 % of reading 0.13 % of reading 0.42 % of reading 0.62 % of reading	HP 42030 resistor 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	0.068 % of reading 0.081 % of reading 0.086 % of reading 0.091 % of reading 0.097 % of reading 0.24 % of reading 0.33 % of reading	
1 kΩ	DC to 100 kHz (0.1 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	0.068 % of reading 0.076 % of reading 0.076 % of reading 0.076 % of reading 0.086 % of reading 0.097 % of reading 0.24 % of reading 0.33 % of reading	
10 kΩ	DC to 100 kHz (0.1 to 1) MHz	0.064 % of reading 0.076 % of reading	
100 kΩ	DC to 100 kHz (0.1 to 1 MHz)	0.065 % of reading 0.066 % of reading	

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
AC Voltage – Measure <sup>3,5</sup>			
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	0.07 % + 3 μV 0.04 % + 1.1 μV 0.05 % + 1.1 μV 0.13 % + 1.1 μV 0.59 % + 1.1 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	130 μV/V + 4 μV 110 μV/V + 2 μV 0.02 % + 2 μV 0.04 % + 2 μV 0.09 % + 2 μV 0.36 % + 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	130 μV/V + 40 μV 110 μV/V + 20 μV 0.02 % + 20 μV 0.04 % + 20 μV 0.09 % + 20 μV 0.36 % + 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	80 μV/V + 0.4 mV 80 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 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	0.03 % + 4 mV 0.03 % + 2 mV 0.04 % + 2 mV 0.14 % + 2 mV 0.47 % + 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 84) kV	60 Hz	0.58 %	Ross VD120-16.5Y with Fluke 8060

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
AC Current – Measure <sup>3,5</sup>			
(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	
(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	
(10 to 100) mA	(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	
(1 to 10) A	(10 Hz to 10) kHz	0.25 %	w/ 80J10 SHUNT
Capacitance – Generate <sup>3</sup>			
Fixed Points			
1 pF	(0.1 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 %	HP 1638XX capacitance set

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
Capacitance – Generate <sup>3</sup> (cont.)			
Fixed Points			HP 1638XX capacitance set
10 pF	(0.1 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 % 0.066 % 0.075 % 0.076 % 0.083 % 0.095 % 0.15 % 0.18 %	
100 pF	(0.1 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	0.073 % 0.066 % 0.075 % 0.076 % 0.083 % 0.095 % 0.15 % 0.18 %	
1000 pF	(0.1 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 % 0.13 % 0.16 % 0.35 % 0.48 %	
(10 and 100) nF	(100 to 120) Hz (0.12 to 1) kHz (1 to 10) kHz (10 to 100) kHz	0.063 % 0.062 % 0.064 % 0.071 %	
1 μF	(100 to 120) Hz (0.12 to 1) kHz (1 to 10) kHz (10 to 100) kHz	0.067 % 0.062 % 0.067 % 0.091 %	
0.001 μF	1 kHz	0.02 %	GenRad 1409F
0.01 μF	1 kHz	0.02 %	GenRad 1409L

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
Capacitance – Generate <sup>3</sup> (cont.)  Fixed Points  0.1 μF  1.0 μF	   1 kHz  1 kHz	   0.02 % of reading  0.02 % of reading	   GenRad 1409T  GenRad 1409Y
Inductance – Generate <sup>3</sup>  1 mH 100 mH	 100 Hz & 1 kHz	 0.03 % of reading 0.03 % of reading	 GenRad 1482 Series
AC Level Flatness <sup>3</sup> –  0.5 VRMS, 1 VRMS 3 VRMS	10 Hz 100 Hz 10 kHz 30 kHz 100 kHz 300 kHz 1 MHz 3 MHz 8 MHz 10 MHz 20 MHz 30 MHz 50 MHz 70 MHz 80 MHz 100 MHz	0.017 % of reading 0.009 % of reading 0.009 % of reading 0.009 % of reading 0.010 % of reading 0.012 % of reading 0.012 % of reading 0.087 % of reading 0.087 % of reading 0.087 % of reading 0.17 % of reading 0.17 % of reading 0.46 % of reading 0.65 % of reading 0.87 % of reading 1.1 % of reading	   Thermal converters
Phase – Generate <sup>3,4</sup>  0° to 180°	(10 to 65) Hz (65 to 500) Hz (0.5 to 1) kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.14° 0.28° 0.52° 3° 5.4° 10°	      Fluke 5520A

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Rise Time – Generate <sup>3</sup>	350 ps	3.5 %	Fluke 5520A with SC1100
Band Width <sup>3,4</sup>	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1050) MHz	2.1 % 2.6 % 4.6 % 5.9 %	Fluke 5520A with SC1100
Electrical Calibration of Thermocouple Indicators <sup>3,4</sup> –			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.5 °C 0.4 °C 0.36 °C 0.39 °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	0.36 °C 0.32 °C 0.37 °C 0.56 °C 0.9 °C	
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.56 °C 0.22 °C 0.2 °C 0.22 °C 0.27 °C	
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.33 °C 0.22 °C 0.2 °C 0.23 °C 0.29 °C	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.39 °C 0.24 °C 0.22 °C 0.32 °C 0.46 °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 0.28 °C 0.25 °C 0.24 °C 0.33 °C	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Electrical Calibration of Thermocouple Indicators <sup>3,4</sup> – (cont.)			
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.63 °C 0.41 °C 0.39 °C 0.46 °C	Fluke 5520A
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.53 °C 0.42 °C 0.43 °C 0.52 °C	
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.69 °C 0.3 °C 0.22 °C 0.2 °C	
Type U	(-200 to 0) °C (0 to 600) °C	0.62 °C 0.33 °C	
Electrical Calibration of RTDs <sup>3,4</sup> –			
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	0.06 °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 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 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 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	0.26 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.09 °C 0.1 °C 0.11 °C 0.24 °C	

Parameter/Equipment	Range	CMC2 ( $\pm$ )	Comments
Electrical Calibration of RTDs <sup>3,4</sup> – (cont.)			
Pt 385, 200 $\Omega$	(-200 to 100) $^{\circ}\text{C}$ (100 to 260) $^{\circ}\text{C}$ (260 to 300) $^{\circ}\text{C}$ (300 to 400) $^{\circ}\text{C}$ (400 to 600) $^{\circ}\text{C}$ (600 to 630) $^{\circ}\text{C}$	0.05 $^{\circ}\text{C}$ 0.06 $^{\circ}\text{C}$ 0.13 $^{\circ}\text{C}$ 0.14 $^{\circ}\text{C}$ 0.15 $^{\circ}\text{C}$ 0.17 $^{\circ}\text{C}$	Fluke 5520A
Pt 385, 500 $\Omega$	(-200 to -80) $^{\circ}\text{C}$ (-80 to 100) $^{\circ}\text{C}$ (100 to 260) $^{\circ}\text{C}$ (260 to 400) $^{\circ}\text{C}$ (400 to 600) $^{\circ}\text{C}$ (600 to 630) $^{\circ}\text{C}$	0.05 $^{\circ}\text{C}$ 0.06 $^{\circ}\text{C}$ 0.07 $^{\circ}\text{C}$ 0.09 $^{\circ}\text{C}$ 0.1 $^{\circ}\text{C}$ 0.12 $^{\circ}\text{C}$	
Pt 385, 1000 $\Omega$	(-200 to 0) $^{\circ}\text{C}$ (0 to 100) $^{\circ}\text{C}$ (100 to 260) $^{\circ}\text{C}$ (260 to 300) $^{\circ}\text{C}$ (300 to 600) $^{\circ}\text{C}$ (600 to 630) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$ 0.05 $^{\circ}\text{C}$ 0.06 $^{\circ}\text{C}$ 0.07 $^{\circ}\text{C}$ 0.08 $^{\circ}\text{C}$ 0.24 $^{\circ}\text{C}$	
PtNi 385, 120 $\Omega$	(-80 to 100) $^{\circ}\text{C}$ (100 to 260) $^{\circ}\text{C}$	0.09 $^{\circ}\text{C}$ 0.15 $^{\circ}\text{C}$	
Cu 427, 10 $\Omega$	(-100 to 260) $^{\circ}\text{C}$	0.31 $^{\circ}\text{C}$	

VI. Electrical – RF & Microwave

Parameter/Range	Frequency	CMC <sup>2</sup> ( $\pm$ )	Comments
RF Attenuation – Tuned RF Power Measure <sup>3</sup>			
(0.0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB (-40 to -50) dB (-50 to -60) dB	100 kHz to 18 GHz	0.03 dB 0.06 dB 0.08 dB 0.11 dB 0.14 dB 0.16 dB	HP 8902A HP 11722A HP 11792A HP 11793A

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
RF Attenuation – Tuned RF Power Measure <sup>3</sup> (cont.)  (-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 18 GHz	0.20 dB 0.22 dB 0.24 dB 0.26 dB 0.32 dB 0.37 dB	HP 8902A HP 11722A HP 11792A HP 11793A
RF Attenuation – Generate <sup>3</sup>  (0 to 81) dB in 1 dB steps, Decade Attenuators	DC to 18 GHz	0.34 dB	HP 8494B and 8495B
RF Power – Generate <sup>3</sup>  (+13 to -127) dB	1 Hz to 20 MHz  20 MHz to 18 GHz	0.52 dB  3.1 % of reading	HP 3325B  HP 8340B with 8902A and 11792A
RF Power – Measure <sup>3</sup>  (+3 to -20) dBm  (-70 to -20) dBm	100 kHz to 18 GHz  (0.05 to 18) GHz	2.9 % of reading  2.9 % of reading	HP 8902A with 11722A and 11793A  HP 437B with 8484A
Distortion – Measure <sup>3</sup>  50 Hz to 500 kHz (0 to 99.9) dB	20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.3 dB	HP 8903B
Phase Modulation – Measure <sup>3</sup>  Rate: 200 Hz to 10 kHz  Rate: 200 Hz to 20 kHz	150 kHz to 10 MHz  10 MHz to 1.3 GHz (1.3 to 18) GHz	5 % reading + 1 digit  4 % reading + 1 digit 5 % reading + 1 digit	HP 8902A  with 11793A

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
Amplitude Modulation – Measuring Equipment <sup>3</sup>			
Rate: 50 Hz to 100 kHz Depths: 5 % to 95 %	10 kHz to 13.5 MHz	0.1 % of reading	11715A
Rate: 50 Hz to 100 kHz Depths: 95 % to 99 %	10 kHz to 13.5 MHz	0.2 % of reading	
Amplitude Modulation – Measure <sup>3</sup>			
Rate: 50 Hz to 10 kHz Depths: 5 % to 99 %	150 kHz to 10 MHz	2.3 % of rdg + 1 digit	HP 8902A
Rate: 20 Hz to 10 kHz Depths: to 99 %	150 kHz to 10 MHz	3.5 % of rdg + 1 digit	
Rate: 50 Hz to 50 kHz Depths: 5 % to 99 %	10 MHz to 1.3 GHz	1.2 % of rdg + 1 digit	
Rate: 20 Hz to 100 kHz Depths: to 99 %	10 MHz to 1.3 GHz	3.5 % of rdg + 1 digit	
Rate: 20 Hz to 100 kHz Depths: 5 % to 99 %	(1.3 to 18) GHz	1.8 % of rdg + 1 digit	with 11793A
Rate: 20 Hz to 100 kHz Depths: to 99 %	(1.3 to 18) GHz	3 % of rdg + 1 digit	
Frequency Modulation – Generate <sup>3</sup>			
Rate: 20 Hz to 200 kHz Dev.: ≤400 kHz peak	10 kHz to 432 MHz	0.12 % of reading	11715A

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
Frequency Modulation – Measure <sup>3</sup>			
Rate: 20 Hz to 10 kHz Dev.: ≤ 40 kHz peak	250 kHz to 10 MHz	2.3 % of rdg + 1 digit	HP 8902A with 11722A
Rate: 50 Hz to 100 kHz Dev.: ≤ 400 kHz peak	10 MHz to 1.3 GHz	1.2 % of rdg + 1 digit	
Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	10 MHz to 1.3 GHz	5.8 % of rdg + 1 digit	
Rate: 50 Hz to 100 kHz Dev.: ≤ 400 kHz peak	(1.3 to 18) GHz	1.2 % of rdg + 1 digit	
Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	(1.3 to 18) GHz	5.8 % of rdg + 1 digit	

#### V. Fluid Quantities

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Viscosity – Measuring Equipment	(4920, 12320, 58880) cSt	1.2 % of reading	Standard solutions
Conductivity – Measuring Equipment	(1.015, 12.85, 111.3) mS	1.2 % of reading	Standard solutions
pH – Measuring Equipment	(4.005, 7.000, 10.012) pH units	0.02 pH units	Standard solutions

VI. Mechanical

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Scales & Balances <sup>3</sup>	1 to 50 g 50 to 300 g 0.3 to 1 kg 1 to 2 kg  2 to 5 lb 5 to 10 lb 10 to 30 lb 25 to 50 lb 50 to 100 lb 100 to 500 lbs 500 to 1000 lbs	0.64 mg 3.1 mg 10 mg 30 mg  0.0010 lbs 0.0012 lbs 0.004 lbs 0.006 lbs 0.014 lbs 0.02 lbs 0.10 lbs	Class S1 weights  Class F weights
Force <sup>3</sup>	Up to 20 000 lbf	0.56 % of range	Omega load cells LCCA-500, LCCA-10K and LCCA-20K
Torque – Measure <sup>3</sup>	(20 to 200) in·oz (5 to 50) in·lb (50 to 200) in·lb (250 to 1000) in·lb (25 to 250) ft·lb	0.32 % of range 0.32 % of range 0.32 % of range 0.32 % of range 0.32 % of range	CDI 950 with TTPM-41 and 2001-OTTP
Torque Transducers & Calibrators <sup>3</sup>	40 in·oz to 55 in·lb 20 in·lb to 300 ft·lb	0.12 % of reading 0.12 % of reading	Class F weights with: 5-in wheel 10-in butterfly
Vacuum Gauges & Transducers <sup>3</sup>	(0.5 to -14.7) psig	0.012 % of range	Mensor 2500
Pressure	0-17 psia 0-100 inH <sub>2</sub> O  Up to 100 psig  (100 to 10 000) psig	0.002 psia 0.012 inH <sub>2</sub> O  0.07 psig  0.12 % of reading	Mensor 2500  Druck DPI 601 Ametek T-100

VII. Thermodynamics

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Temperature – Measuring Equipment <sup>3</sup>	-25 °C to 650 °C	0.1 °C	Hart 9103 with 9141
Temperature – Measure <sup>3</sup>	-130 °C to 650 °C	0.07 °C	Hart 5626 PRT with 1502
Infrared Temperature – Measuring Equipment <sup>3</sup>	50 °C to 100 °C 100 °C to 500 °C	0.88 °C 1.2 °C	Hart 9132 IR calibrator
Relative Humidity – Measuring Equipment <sup>3</sup>	5 % to 90 %	1.5 % of reading	General Eastern chamber with Vaisala HMI-41/HMP-46

VIII. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Time Interval <sup>3</sup>	1 s to 24 hr	0.5 s	HP 5334A
Frequency – Measuring Equipment	10 MHz	1 part in 10 <sup>11</sup>	Datum GPS receiver
	DC to 20 MHz	1 part in 10 <sup>11</sup>	HP 3325A
	20 MHz to 18 GHz	1 part in 10 <sup>11</sup>	HP 8340B
Frequency <sup>3</sup> – Measure	DC to 18 GHz	6 parts in 10 <sup>11</sup>	HP 5342A

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<sup>1</sup> This laboratory offers commercial calibration service and field calibration service.

<sup>2</sup> 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.

<sup>3</sup> 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.

<sup>4</sup> The measurands stated are generated with the Fluke 5500A and the Valhalla 2555A. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a combination of the percent or portion of the reading plus a fixed floor specification. Where "ppm" appears in the CMC, it is equivalent to that part in one million.

<sup>5</sup> The measurands stated are measured with the HP 3458A. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a combination of the percent or portion of the reading/output plus a range specification. Where "ppm" appears in the CMC, it is equivalent to that part in one million.

<sup>6</sup> In the statement of CMC,  $L$  is the numerical value of the nominal length of the device measured in inches.



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### 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 7<sup>th</sup> day of October 2009.



  
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Peter Meyer

President & CEO  
For the Accreditation Council  
Certificate Number 1623.09  
Valid to December 31, 2011  
Revised November 30, 2011

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