



World Class Accreditation

The American Association for Laboratory Accreditation

Accredited Laboratory

A2LA has accredited

BROADVIEW INSTRUMENTATION SERVICES, INC.

Valley View, OH

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 29th day of March 2011.





President & CEO

For the Accreditation Council
Certificate Number 2046.01
Valid to March 31, 2013

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



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

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CALIBRATION

Valid To: March 31, 2013

Certificate Number: 2046.01

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/Equipment	Range	CMC ² (±)	Comments
Sound Pressure Level ³	94 dB 114 dB	0.35 dB 0.58 dB	Sound level calibrator

II. Chemical Quantities

Parameter/Equipment	Range	CMC ^{2, 4, 5} (±)	Comments
pH ³ – Measuring Equipment	(4.01, 7.00, 10.0) pH	0.012 + 0.6R pH units	Standard solutions
	(0 to 14) pH	0.012 + 0.6R pH units	Fluke 5520A
Conductivity ³ – Fixed Points	84 µS 447 µS 15 mS 80 mS	6.0 % + 0.6R µS 1.5 % + 0.6R µS 1.0 % + 0.6R mS 1.0 % + 0.6R mS	Standard solutions

III. Dimensional

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Micrometers and Calipers ³	(0 to 0.109) in (0.1 to 0.499) in (0.5 to 0.999) in (1 to 1.999) in (2 to 2.999) in (3 to 24) in	29 µin 29 µin 30 µin 30 µin 31 µin 33 µin	Gage blocks (Grade 1)
Gage Blocks	(0 to 13) in	(3.6 + 2.5L) µin	P&W Labmaster
Height Gages ³	(0 to 0.109) in (0.1 to 0.499) in (0.5 to 0.999) in (1 to 1.999) in (2 to 2.999) in (3 to 24) in	29 µin 29 µin 30 µin 30 µin 31 µin 33 µin	Gage blocks (Grade 1)
Profilometers ³ – Fixed Points	16 µin 34.4 µin 119.3 µin	3.8 µin 3.1 µin 3.3 µin	Taylor Hobson surface Standard blocks

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
DC Voltage ³ – Generate	(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	9.6 µV/V + 0.4 µV 6.2 µV/V + 0.7 µV 5.2 µV/V + 2.5 µV 5.2 µV/V + 4 µV 7.3 µV/V + 40 µV 8.3 µV/V + 400 µV	Fluke 5720A
Fixed Points (In Steps)	(1000 to 10 000) V (10 000 to 40 000) V 100 mV 1 V 10 V 100 V 1000 V	0.011 % 580 V 1.9 µV/V 1.9 µV/V 1.8 µV/V 1.9 µV/V 1.9 µV/V	HV Supply Ratio metric techniques
DC Voltage ³ – Measure	(0 to 200) mV 200 mV to 2 V (2 to 20) V (20 to 200) V (200 to 1000) V (1 to 10) kV (10 to 100) kV	6 µV/V + 0.11 µV 3.3 µV/V + 0.41 µV 3.7 µV/V + 4.1 µV 5.1 µV/V + 410 µV 5.0 µV/V + 510 µV 0.012 % 0.58 %	Fluke 8508A Voltage divider and precision DMM

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
DC Current ³ – Measure	(0 to 200) µA 200 µA to 2.0 mA (2.0 to 20) mA (2 to 200) mA (200 to 2000) mA (2 to 20) A	13 µA/A + 400 pA 14 µA/A + 4 nA 14 µA/A + 40 nA 40 µA/A + 800 nA 180 µA/A + 16 µA 390 µA/A + 400 µA	Fluke 8508A
	(20 to 100) A (100 to 1000) A (1000 to 3000) A	0.046 % 0.30 % 0.29 %	Various current shunts
DC Current ³ – Generate	10 fA to 1 pA (1 to 10) pA (10 to 100) pA 100 pA to 1 nA (1 to 10) nA (10 to 100) nA 100 nA to 110 µA (110 to 220) µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A	2.9 % 1.8 % 1.7 % 1.7 % 1.7 % 1.7 % 0.31 % 44 µA/A + 6 nA 40 µA/A + 7 nA 41 µA/A + 40 nA 58 µA/A + 0.7 µA 155 µA/A + 12 µA 480 µA/A + 480 µA	Pico ampere source Fluke 5720A Fluke 5725A amplifier
	(1 to 100) A (100 to 590) A	0.046 % 0.30 %	Valhalla various shunts

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage ³ – Generate Up to 2.2 mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	330 µV/V + 4 µV 120 µV/V + 4 µV 96 µV/V + 4 µV 0.020 % + 4 µV 0.058 % + 5 µV 0.12 % + 10 µV 0.16 % + 20 µV 0.31 % + 20 µV	Fluke 5720A

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage ³ – Generate (cont)			
(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 1.0) MHz	310 μV/V + 4 μV 170 μV/V % + 4 μV 170 μV/V % + 4 μV 250 μV/V + 4 μV 680 μV/V + 5 μV 0.13 % + 10 μV 0.18 % + 20 μV 0.31 % + 20 μV	Fluke 5720A
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	0.025 % + 12 μV 100 μV/V + 7 μV 90 μV/V + 7 μV 0.023 % + 7 μV 0.049 % + 17 μV 0.10 % + 20 μV 0.15 % + 25 μV 0.27 % + 45 μV	
220 mV to 2.2 V	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	0.049 % + 40 μV 0.011 % + 15 μV 53 μV/V + 8 μV 0.012 % + 10 μV 0.016 % + 30 μV 0.050 % + 80 μV 0.14 % + 200 μV 0.20 % + 300 μV	
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	0.029 % + 400 μV 0.011 % + 150 μV 60 μV/V + 50 μV 100 μV/V + 100 μV 0.013 % + 200 μV 0.035 % + 600 μV 0.12 % + 2 mV 0.18 % + 3.2 mV	
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	0.033 % + 4 mV 0.012 % + 1.5 mV 65 μV/V + 600 μV 0.011 % + 1 mV 0.018 % + 2.5 mV 0.09 % + 16 mV 0.44 % + 40 mV 0.8 % + 80 mV	Subject to 2.2 E ⁷ V-Hz limitation
(220 to 1100) V	(15 to 50) Hz (0.05 to 1.0) kHz	0.035 % + 16 mV 85 μV/V + 3.5 mV	

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
AC Voltage ³ – Generate (cont)			
1100 V	40 Hz to 1.0 kHz (1 to 20) kHz (20 to 30) kHz	75 µV/V + 4 mV 0.013 % + 6 mV 0.047 % + 11 mV	5725A amplifier
750V	(30 to 50) kHz (50 to 100) kHz	0.05 % + 11 mV 0.18 % + 45 mV	5725A amplifier
(1 to 5) kV	60 Hz	0.5 % + 5 V	Fluke 5320A high voltage load adaptor
AC Voltage ³ – Measure			
Up to 2.2 mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	0.17 % + 1.3 µV 760 µV/V + 1.3 µV 0.044 % + 1.3 µV 0.083 % + 2 µV 0.12 % + 2.5 µV 0.23 % + 4 µV 0.25 % + 8 µV 0.36 % + 8 µV	Fluke 5790A
(2.2 to 7) 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 1.0) MHz	0.087 % + 1.3 µV 0.038 % + 1.3 µV 0.022 % + 1.3 µV 0.041 % + 2 µV 0.061 % + 2.5 µV 0.12 % + 4 µV 0.13 % + 8 µV 0.20 % + 8 µV	
(7 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 1.0) MHz	0.030 % + 1.3 µV 0.018 % + 1.3 µV 0.011 % + 1.3 µV 0.021 % + 2 µV 0.032 % + 2.5 µV 0.083 % + 4 µV 0.088 % + 8 µV 0.14 % + 8 µV	
(22 to 70) 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 1.0) MHz	0.025 % + 1.5 µV 0.012 % + 1.5 µV 70 µV/V + 1.5 µV 0.013 % + 2 µV 0.027 % + 2.5 µV 0.052 % + 4 µV 0.068 % + 8 µV 0.11 % + 8 µV	

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
AC Voltage ³ – Measure (cont)			
(70 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 1.0) MHz	0.021 % + 1.5 μV 90 μV/V + 1.5 μV 40 μV/V + 1.5 μV 70 μV/V + 2 μV 0.016 % + 2.5 μV 0.026 % + 4 μV 0.039 % + 8 μV 0.1 % + 8 μV	Fluke 5790A
(220 to 700) 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 1.0) MHz	0.021 % + 1.5 μV 80 μV/V + 1.5 μV 30 μV/V + 1.5 μV 50 μV/V + 2 μV 80 μV/V + 2.5 μV 0.018 % + 4 μV 0.031 % + 8 μV 0.1 % + 8 μV	
700 mV to 2.2 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	0.020 % 70 μV/V 20 μV/V 50 μV/V 70 μV/V 0.016 % 0.027 % 0.1 %	
(2.2 to 7.0) 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 1.0) MHz	0.020 % 70 μV/V 30 μV/V 50 μV/V 80 μV/V 0.019 % 0.041 % 0.12 %	
(7 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 1.0) MHz	0.020 % 70 μV/V 30 μV/V 50 μV/V 80 μV/V 0.019 % 0.041 % 0.12 %	

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage ³ – Measure (cont)			
(22 to 70) 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 1.0) MHz	0.020 % 70 µV/V 30 µV/V 60 µV/V 0.010 % 0.021 % 0.042 % 0.12 %	Fluke 5790A
(70 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	0.020 % 70 µV/V 30 µV/V 70 µV/V 100 µV/V 0.021 % 0.051 %	
(220 to 700) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.020 % 100 µV/V 40 µV/V 0.013 % 0.051 %	
(700 to 1000) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.020 % 100 µV/V 40 µV/V 0.013 % 0.051 %	
(1 to 10) kV (10 to 40) kV	(50 to 60) Hz (50 to 60) Hz	0.5 % + 5 V 0.5 % + 10 V	Fluke 5320A high voltage load adaptor
(40 to 100) kV	(50 to 60) Hz	1.2 kV	AC voltage standard with voltage divider and precision DMM
AC Current ³ – Generate			
Up to 220 µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.024 % + 16 nA 0.017 % + 10 nA 0.014 % + 8 nA 0.027 % + 12 nA 0.10 % + 65 nA	Fluke 5720A

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Current ³ – Generate (cont)			
220 µA 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	0.036 % + 40 nA 0.021 % + 35 nA 0.015 % + 35 nA 0.024 % + 110 nA 0.13 % + 650 nA	Fluke 5720A
(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	0.036 % + 400 nA 0.019 % + 350 nA 0.015 % + 350 nA 0.024 % + 550 nA 0.13 % + 5 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	0.026 % + 4 µA 0.017 % + 3.5 µA 0.013 % + 2.5 µA 0.021 % + 3.5 µA 0.11 % + 10 µA	
220 mA to 2.2 A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.032 % + 35 µA 0.056 % + 80 µA 0.81 % + 160 µA	Fluke 5720A with 5725 amplifier
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.061 % + 170 µA 0.10 % + 380 µA 0.37 % + 750 µA	
(11 to 20.5) A	45 Hz to 100 Hz (0.1 to 1) kHz (1 to 5) kHz	0.13 % + 5 mA 0.16 % + 5 mA 3.0 % + 5 mA	Fluke 5520A
(20.5 to 550) A	(45 to 440) Hz	0.36 %	Fluke 5520a Coil
(550 to 3000) A	(45 to 120) Hz	0.29 %	Valhalla

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
AC Current ³ – Measure			
Up to 200 µA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.030 % + 20 nA 0.030 % + 20 nA 0.068 % + 20 nA 0.40 % + 20 nA	Fluke 8508A
200 µA to 2 mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.029 % + 200 nA 0.028 % + 200 nA 0.065 % + 200 nA 0.41 % + 200 nA	
(2 to 20) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.029 % + 2 µA 0.029 % + 2 µA 0.066 % + 2 µA 0.41 % + 2 µA	
(20 to 200) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz	0.029 % + 20 µA 0.025 % + 20 µA 0.060 % + 20 µA	
200 mA to 2 A	10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz	0.060 % + 200 µA 0.070 % + 200 µA 0.30 % + 200 µA	
(2 to 20) A (20 to 100) A	10 Hz to 2 kHz (2 to 10) kHz	0.09 % + 2 mA 0.25 % + 2 mA	Various current shunts
(100 to 1200) A (1000 to 1200) A (1200 to 3000) A	(0 to 100) Hz	0.12 % + 300 mA 0.23 % + 400 mA 0.35 % + 600 mA	

Parameter/Equipment	Range	CMC ^{2, 4, 5} (±)	Comments
Resistance ³ – Generate & Measuring Equipment	0.001 Ω 0.01 Ω 0.1 Ω 1.0 Ω 10 kΩ	0.046 % 0.046 % 0.046 % 8.8 µΩ/Ω + R 4 µΩ/Ω + R	Short current shunt Fluke 742A-1 Fluke 742A-10k
	(0 to 1) Ω (1 to 1.9) Ω (1.9 to 10) Ω (10 to 19) Ω (19 to 100) Ω	98 µΩ/Ω + 40 µΩ 98 µΩ/Ω + 40 µΩ 26 µΩ/Ω + 40 µΩ 26 µΩ/Ω + 40 µΩ 14 µΩ/Ω + 40 µΩ	Fluke 5720A

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments		
Resistance ³ – Generate & Measuring Equipment (cont)	(100 to 190) Ω	14 μΩ/Ω + 40 μΩ	Fluke 5720A		
	(190 to 1000) Ω	13 μΩ/Ω			
	(1 to 1.9) kΩ	12 μΩ/Ω			
	(1.9 to 10) kΩ	13 μΩ/Ω			
	(10 to 19) kΩ	12 μΩ/Ω			
	(19 to 100) kΩ	15 μΩ/Ω			
	(100 to 190) kΩ	15 μΩ/Ω			
	(190 to 1000) kΩ	24 μΩ/Ω			
	(1 to 1.9) MΩ	24 μΩ/Ω			
	(1.9 to 10) MΩ	49 μΩ/Ω			
	(10 to 19) MΩ	53 μΩ/Ω			
	(19 to 100) MΩ	160 μΩ/Ω			
	Fixed Points	(1.00 to 1000) MΩ		0.24 %	Biddle 72-6346-1
		(1 000 to 10 000) MΩ		0.70 %	
(10 to 100) GΩ		1.5 %			
10 MΩ		0.14 %	Keithley 5155-7		
100 MΩ		0.14 %	Keithley 5155-8		
1 GΩ		0.14 %	Keithley 5155-9		
10 GΩ		0.14 %	Keithley 5155-10		
Resistance ³ – Measure	100 GΩ	0.16 %	Keithley 5155-11		
	1 TΩ	0.14 %	Keithley 5155-12		
	(0 to 0.25) Ω	12 μΩ/Ω	Hart Scientific 1590		
	(0.25 to 4.0) Ω	47 μΩ/Ω			
	(2.5 to 40) Ω	24 μΩ/Ω			
	(0 to 25) Ω	180 μΩ/Ω			
	(25 to 400) Ω	7 μΩ/Ω			
	(400 to 1000) Ω	12 μΩ/Ω			
	(1 to 25) kΩ	30 mΩ/Ω			
	(25 to 40) kΩ	12 μΩ/Ω			
	(40 to 100) kΩ	35 μΩ/Ω			
	(100 to 500) kΩ	140 μΩ/Ω			
	(0 to 2) Ω	19 μΩ/Ω + 4 μΩ		Fluke 8508A	
	(2 to 20) Ω	10 μΩ/Ω + 14 μΩ			
(20 to 200) Ω	8 μΩ/Ω + 50 μΩ				
(200 to 2000) Ω	8 μΩ/Ω + 500 μΩ				

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Resistance ³ – Measure (cont)	(2 to 20) kΩ (20 to 200) kΩ (0.2 to 2) MΩ (2 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ	8 μΩ/Ω + 5 mΩ 8 μΩ/Ω + 50 mΩ 10 μΩ/Ω + 1 Ω 20 μΩ/Ω + 100 Ω 60 μΩ/Ω + 10 kΩ 0.053 % + 100 kΩ	Fluke 8508A
	(2 to 100) GΩ (100 to 1000) GΩ	0.52 % 0.54 %	Quadtech 1865
Harmonic Distortion Measurement	(20 Hz to 20 kHz) 2 nd Harmonic 3 rd Harmonic 4 th Harmonic 5 th Harmonic 6 th Harmonic	2.0 dB 2.0 dB 2.0 dB 2.0 dB 2.0 dB	Keithley
Capacitance ³ – Generate, Fixed Points	1000 pF @ 1KHz 100 pF @ 1 KHz	14 μF/F 16 μF/F	Genrad 1404-A Genrad 1404-B

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
DC Power ³ – Measuring Equipment 33 mV to 1020 V	(0.33 to 330) mA (0.33 to 3) A (3 to 20.5) A	0.018 % 0.017 % 0.054 %	Fluke 5520A
Capacitance ³ – Generate, Fixed Points 1 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	44 μF/F 90 μF/F 0.023 % 0.041 % 0.063 % 0.088 % 0.25% 0.37 %	HP 1638XX standard capacitor

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
Capacitance ³ – Generate, Fixed Points (cont)			
10 pF	100 Hz to 1kHz 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	39 μF/F 39 μF/F 40 μF/F 43 μF/F 47 μF/F 54 μF/F 0.012 % 0.016%	HP 1638XX standard capacitor
100 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	38 μF/F 40 μF/F 48 μF/F 66 μF/F 91 μF/F 0.013 % 0.033 % 0.049 %	
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	41 μF/F 64 μF/F 0.015 % 0.028 % 0.044 % 0.062 % 0.19 % 0.28 %	
0.001 μF 0.01 μF 0.1 μF 1.0 μF 0.02 μF 0.005 μF 0.05 μF	20 Hz to 1 khz 20 Hz to 1 kHz 20 Hz to 1 kHz 20 Hz to 1 kHz 20 Hz to 1 kHz 20 Hz to 1 kHz 20 Hz to 1 kHz	0.6 pF 6 pF 60 pF 0.6 nF 12 pF 5.8 pF 29 pf	GR, 1409 series
(0.19 to 0.3999) nF (0.4 to 1.0999) nF (1.1 to 3.29) nF (3.3 to 10.9) nF (11 to 32.9999) nF (33 to 109.9) nF (110 to 329.999) nF	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	0.51 % + 0.01 nF 0.51 % + 0.01 nF 0.51 % + 0.01 nF 0.27 % + 0.01 nF 0.27 % + 0.1 nF 0.27 % + 0.1 nF 0.27 % + 0.3 nF	Fluke 5520A

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
Capacitance ³ – Generate, Fixed Points (cont)			
(0.33 to 1.09) μF	(10 to 600) Hz	0.27 % + 1 nF	Fluke 5520A
(1.1 to 3.29999) μF	(10 to 300) Hz	0.27 % + 3 nF	
(3.3 to 10.9999) μF	(10 to 150) Hz	0.27 % + 10 nF	
(11 to 32.9999) μF	(10 to 120) Hz	0.41 % + 30 nF	
(33 to 109.999) μF	(10 to 80) Hz	0.46 % + 100 nF	
(110 to 329.999) μF	(10 to 50) Hz	0.46 % + 300 nF	
(0.3 to 1.09999) mF	(10 to 20) Hz	0.46 % + 1 pF	
(1.1 to 3.2999) mF	(0 to 6) Hz	0.46 % + 3 pF	
(3.3 to 10.9999) mF	(0 to 2) Hz	0.46 % + 10 pF	
(11 to 32.9999) mF	(0 to 0.6) Hz	0.76 % + 30 pF	
(33 to 110) mF	(0 to 0.2) Hz	1.1 % + 100 pF	
Capacitance ³ – Measure, Fixed Points			
1 pF	(0.1 to 1.0) kHz (1 to 10) kHz	12 % 1.2 %	Agilent 4980
10 pF	(20 to 1000) Hz (1 to 10) kHz (10 to 100) kHz (0.1 to 2) MHz	12 % 1.2 % 0.12 % 0.35 %	
100 pF	(20 to 100) Hz (0.1 to 1.0) kHz 1.0 kHz to 2 MHz	12 % 1.2 % 0.12 %	
1 nF	(20 to 100) Hz 100 Hz to 1.0 MHz (1 to 2) MHz	1.2 % 0.12 % 0.35 %	
10 nF	(20 to 100) Hz 100 Hz to 100 kHz 100 kHz to 2 MHz	0.35 % 0.12 % 0.35 %	
100 nF	20 Hz to 10 kHz 10 kHz to 2 MHz	0.12 % 0.35 %	
1.0 μF	20 Hz to 10 kHz 10 kHz to 2 MHz	0.12 % 0.35 %	
10.0 μF	(20 to 1000) Hz (1 to 100) kHz (0.1 to 2) MHz	0.12 % 0.35 % 1.2 %	

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
Capacitance ³ – Measure, Fixed Points (cont)			
100.0 µF	100 Hz to 10 kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 2) MHz	0.35 % 1.2 % 6.9 % 12 %	Agilent 4980
1.0 mF	(20 to 1000) Hz (1 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz	0.35 % 1.2 % 6.9 % 12 %	
10 mF	(20 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz	0.81 % 1.2 % 9.2 % 12 %	
100 mF	(20 to 100) Hz 100 Hz to 10 kHz	5.8 %	
1.0 nF to 10 µF	20 Hz to 2 kHz	0.03 %	
Inductance ³ – Measure			
100 µHz	50 Hz to 500 Hz	0.05 %	ESI video bridge
1 mHz	500 Hz to 10 kHz	0.05 %	
10 mHz	50 Hz to 10 kHz	0.05 %	
1 Hz	50 Hz to 10 kHz	0.05 %	
1 µHz	(0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 2) MHz	12 % 1.2 % 0.35 % 0.12 % 0.35 %	Agilent 4980
10 µHz	(20 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 2) MHz	12 % 1.2 % 0.35 % 0.12 % 0.12 % 0.35 %	
100 µHz	(20 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 2) MHz	1.2 % 0.35 % 0.12 % 0.12 % 0.12 % 0.12 %	

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
Inductance ³ – Measure (cont)			
1 mH	(20 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 2) MHz	0.35 % 0.12 % 0.12 % 0.12 % 0.12 % 0.35 %	Agilent 4980
10 mH	(20 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 2) MHz	0.35 % 0.12 % 0.12 % 0.12 % 0.12 % 0.35 %	
100 mH	(20 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 2) MHz	0.35 % 0.12 % 0.12 % 0.12 % 0.35 % 0.35 %	
1 H	(20 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 2) MHz	0.12 % 0.12 % 0.12 % 0.12 % 1.2 % 12 %	
10 H	(20 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz (0.1 to 1) MHz (1 to 2) MHz	0.12 % 0.12 % 0.12 % 0.35 % 0.35 % 12 %	
100 H	(20 to 100) Hz (0.1 to 1) kHz (1 to 10) kHz (10 to 100) kHz (0.1 to 2) MHz	0.12 % 0.35 % 0.35 % 1.2 % 12 %	
Inductance ³ – Generate @ 1000 Hz Generate Equipment, Fixed Points	100 µH to 1.111 H (100 µH Steps) 200 µH 500 µH 1 mH 5 mH 10 mH 50 mH 500 mH 2 H	2.3 % 0.13 %	

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
ESD Simulator – Measure			
Contact Discharge (Positive and Negative)	(2 to 6) kV 30 kV	1.2 % 1.2 %	Fluke 80K-6, Agilent 34401A EN 61000-4-2
Rise Time	1.0 ns	52 ps	Tektronix TDS 684B, CTC-3 IES target
30 nS Current	(2.8 to 20.8) A	2.1 %	IEC 61000-4-5
60 nS Current	(1.4 to 10.4) A	2.1 %	IEC 61000-4-5
Oscilloscopes ³ –			
Voltage (50 ohm _{pk-pk})	(1 to 556) mV 556 mV to 5.56 V	0.12 % + 10 μV 1.2 % + 10 μV	Fluke 9500B
Sweep Time	9 ns to 55 s	0.29 fs	
Rise time	150 ps to 100 ms	21 ps	
Bandwidth	0.1 Hz to 3.2 GHz	6 % flatness	
Phase Angle ³ – Generate			
0° to 360°	(10 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.1° of reading 0.25° of reading 0.5° of reading 2.5° of reading 5° of reading 10° of reading	Fluke 5520A
AC Power ³ – Measuring Equipment			
(33 to 330) mV Power Factor = 1	(3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (330 to 900) mA 900 mA to 2.2 A (2.2 to 4.5) A (4.5 to 20.5) A	0.14 % 0.1 % 0.14 % 0.1 % 0.13 % 0.11 % 0.13 % 0.11 %	Fluke 5520A frequency (45 to 65) Hz
330 mV to 1020 V Power Factor = 1	(3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (330 to 900) mA 900 mA to 2.2 A (2.2 to 4.5) A (4.5 to 20.5) A	0.12 % 0.08 % 0.12 % 0.08 % 0.11 % 0.09 % 0.12 % 0.1 %	

V. Electrical – Microwave/RF

Parameter/Range	Frequency	CMC ^{2, 4, 5} (±)	Comments
Attenuation ³ – Measure (0 to 100) dB	100 kHz to 18 GHz	0.17 dB	HP 8902A, HP 11793A, and HP 11722A
RF Power ³ – Measure (-120 to 30) dBm	100 kHz to 26 GHz	0.17 dB	HP 8902A
RF Power – 1 mW	(0.01 to 10) MHz (0.01 to 10) GHz (10 to 18) GHz	0.95 % 1.3 % 1.4 %	Tegam F1130A Tegam F1130A Tegam F1130A
LISN Insertion Loss ³ – Measure (0 to -50) dBm (-50 to -80) dBm (-80 to -120) dBm	(0.1 to 1.3) GHz	0.17 db + M	HP 8902A
Surge Generator ³ – Front Time (±) Rise Time Open Circuit (±) Short Circuit (±) Time to Half-Value (±) Open Circuit Voltage (±) Short Circuit Current (±) Ring Wave Voltage Ring Wave Rise Time Ring Wave Frequency	(1.2 to 50) µs (1.2 to 50) µs (20 to 700) µs 10 V to 12 kV (0.125 to 3) kA 1 kV ± 10 % 1.5 µs ± 0.5 µs 5 kHz ± 1 kHz	0.74 ns 1.2 ns 0.74 ns 2.3 % 2.8 % 2.8 % 0.74 ns 22 Hz (freq) 2.8 % (volt)	EN61000-4-5; IEC61000-4-8; IEC61000-4-9; IEC61000-4-10; IEC61000-4-11; IEC6100-4-12; UL 864; UL 1449; ISO 763702; ISO 17069 ITU Rec K.17, K.20, ITU Rec K.21; SBC-TP-76200; GR1089CORE Tektronix TDS 684B; ANSI 62.41, 1991

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
EFT/Burst Generator ³ –			
Voltage (±)	10 V to 6 kV	2.3 %	EN 6200-4-4; IEC 61000-4-6; GR 1089 CORE Tektronix TDS 3052
Rise Time	5 ns ± 30 %	0.8 ns	
Impulse Duration	50 ns ± 30 %	0.74 ns	
Burst Duration	15 ms ± 20 %	0.74 ns	
Burst Period	300 ms ± 20 %	0.74 ns	
Repetition Rate			
0.125 kV	5 kHz ± 20 %	23 Hz (freq)	
0.25 kV	5 kHz ± 20 %	2.8 % (volt)	
0.25 kV	5 kHz ± 20 %		
1.0 kV	5 kHz ± 20 %		
2.0 kV	2.5 kHz ± 20 %		

VI. Fluid

Parameter/Equipment	Range	CMC ² (±)	Comments
Volume – Pipettes	(100 to 5000) µL	0.0071 µL	Gravimetric calibration using Sartorius balance and ANSI/ASTM E617 class 1 weights

VII. Fluid Quantities

Parameter/Equipment	Range	CMC ^{2,4,5} (±)	Comments
Mass Flow	(5 to 50) SCCM (100 to 1000) SCCM (1 to 10) SLPM (3 to 30) SLPM (30 to 300) SLPM (120 to 1200) SLPM (400 to 4000) SLPM	0.42 % + 0.6R 0.43 % + 0.6R 0.44 % + 0.6R 0.43 % + 0.6R 0.42 % + 0.6R 0.42 % + 0.6R 0.43 % + 0.6R	DHI molbox

Parameter/Equipment	Range	CMC ^{2, 4, 5} (±)	Comments
RPM ³ – Generate			
Optical	(1 to 100 000) rpm	0.18 rpm + 0.6R	Frequency counter/ motor
Contact	(1 to 3000) rpm	0.26 rpm + 0.6R	
Air Speed – Measuring Equipment	(30 to 9000) fpm	3 %	Wind tunnel and Omega differential pressure sensor, model WT4401S
Acceleration ³ – Measure New System	1 g peak	0.88 %	Accelerometer
Force – Measure Tension & Compression	(0 to 2500) lbf (2500 to 25 000) lbf	0.32 lbf 3.1 lbf	Morehouse tension and compression
	(25 000 to 60 000) lbf	690 lbf	Tinius Olsen Super-L w/computer display
“Direct Verification” of Durometers ³ –			ASTM D2240 using:
Spring Force	A, B, O, D, C, DO scales	0.5 points	Durocalibrator

IX. Optical Radiation

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Photometric – Measure ³	(1 to 10 000) fc	5.2 %	Radiometer

X. Thermodynamic

Parameter/Equipment	Range	CMC ² (±)	Comments
Temperature – Measuring Equipment, Fixed Points	(0.01 °C)	0.0021 °C	Triple point water cell
	(29.7646 °C)	0.0047 °C	Melting point of Gallium cell
	(231.928 °C)	0.0024 °C	Freeze point of Tin cell
Electrical Calibration of Thermocouples ³ – Generate and Measure			
Type B	(600 to 800) °C	0.34 °C	Fluke 5520A
	(800 to 1000) °C	0.26 °C	
	(1000 to 1550) °C	0.23 °C	
	(1550 to 1820) °C	0.26 °C	
Type C	(0 to 150) °C	0.23 °C	
	(150 to 650) °C	0.2 °C	
	(650 to 1000) °C	0.24 °C	
	(1000 to 1800) °C	0.39 °C	
	(1800 to 2316) °C	0.65 °C	
Type E	(-100 to -25) °C	0.13 °C	
	(-25 to 350) °C	0.11 °C	
	(350 to 650) °C	0.13 °C	
	(650 to 1000) °C	0.17 °C	
Type J	(-250 to -100) °C	0.21 °C	
	(-100 to -30) °C	0.13 °C	
	(-30 to 150) °C	0.11 °C	
	(150 to 760) °C	0.13 °C	
	(760 to 1200) °C	0.18 °C	
Type K	(-200 to -100) °C	0.26 °C	
	(-100 to -25) °C	0.14 °C	
	(-25 to 120) °C	0.13 °C	
	(120 to 1000) °C	0.2 °C	
	(1000 to 1372) °C	0.31 °C	
Type L	(-200 to -100) °C	0.26 °C	
	(-100 to 800) °C	0.2 °C	
	(800 to 900) °C	0.14 °C	
Type N	(-200 to -100) °C	0.31 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 120) °C	0.15 °C	
	(120 to 410) °C	0.14 °C	
	(410 to 1300) °C	0.21 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouples ³ – Generate and Measure (cont)			
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.44 °C 0.27 °C 0.26 °C 0.31 °C	Fluke 5520A
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.37 °C 0.28 °C 0.29 °C 0.36 °C	
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.49 °C 0.19 °C 0.13 °C 0.11 °C	
Type U	(-200 to 0) °C (0 to 600) °C	0.44 °C 0.21 °C	
Electrical Calibration of RTDs ³ – Measure and Generate			
RTD Type Pt 385, 100Ω	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.039 °C 0.019 °C 0.07 °C 0.078 °C 0.093 °C 0.18 °C	Fluke 5520A – 4 wire compensation
RTD Type Pt 3926, 100Ω	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.039 °C 0.054 °C 0.07 °C 0.078 °C 0.093 °C	
RTD Type Pt 3916, 100Ω	(-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	0.2 °C 0.031 °C 0.038 °C 0.047 °C 0.055 °C 0.062 °C 0.07 °C 0.078 °C 0.18 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of RTDs ³ – Measure and Generate (cont)			
RTD Type Pt 385, 200Ω	(-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	0.031 °C 0.031 °C 0.031 °C 0.039 °C 0.093 °C 0.1 °C 0.11 °C 0.13 °C	Fluke 5520A – 4 wire compensation
RTD Type Pt 385, 500Ω	(-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	0.031 °C 0.039 °C 0.039 °C 0.047 °C 0.062 °C 0.062 °C 0.07 °C 0.085 °C	
RTD Type Pt 385, 1000Ω	(-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	0.024 °C 0.024 °C 0.031 °C 0.039 °C 0.047 °C 0.055 °C 0.055 °C 0.18 °C	
RTD Type PtNi, 120Ω (Ni120)	(-80 to 0) °C (0 to 100) °C (100 to 260) °C	0.062 °C 0.062 °C 0.11 °C	
RTD Type Cu 427, 10Ω	(-100 to 260) °C	0.24 °C	
Infrared Thermometers –	(-15 to 120) °C (120 to 500) °C	0.73 °C 2.0 °C	Black body
Hart Furnace	(500 to 1200) °C	0.71 °C	Target with SPRT

Parameter/Equipment	Range	CMC ^{2,4,5} (±)	Comments
Temperature ³ – Measure	(-80 to 0) °C	0.015 °C	Hart Scientific 7381 with 1590 Super thermometer and Hart Scientific 5626 PRT
	(-10 to 500) °C	0.04 °C	Isotech Medusa/Iso-cal
	(30 to 550) °C	0.05 °C	Hart 6331 oil bath
	(150 to 1200) °C	0.71 °C	Hart 9150 furnace
Humidity ³ – Measuring Equipment	(10 to 95) % RH	0.58 % + 0.6R	Thunder Scientific 2500
	(0 to 90) % RH	1.3 % RH	Vaisala HumiCap (on-site only) X = reading
	(90 to 100) % RH	2 % RH	
	(-40 to 180) °C	(1 + 0.015X) % RH	
Dew Point ³	(-20 to 60) °C	0.14 °C	Thunder Scientific 1200

XI. Time and Frequency

Parameter/Equipment	Range	CMC ² (±)	Comments
Frequency ³ – Measure	0.001 Hz to 2.7 GHz (2 to 20) GHz	6 parts in 10 ⁹ 8 parts in 10 ⁹ + 1 Hz	Wavetek 901R HP 5350B

¹ This laboratory offers commercial calibration service and field calibration service, where noted.

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; L is the numerical value of the nominal length of the device measured in inches; D is the numerical value of the nominal diameter of the device measured in inches; R is the numerical value of the resolution of the device in its respective units; M is the mismatch error; P is the pressure in psia.

⁵ In the statement of CMC, percentages are read as percent of reading/output, unless otherwise noted.