



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

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CALIBRATION

Valid To: April 30, 2015

Certificate Number: 3410.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations¹:

I. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments	
DC Voltage – Generate	(0 to 220) mV	7.2 $\mu\text{V/V} + 0.5 \mu\text{V}$	Fluke 5720A	
	220 mV to 2.2 V	4.7 $\mu\text{V/V} + 1 \mu\text{V}$		
	(2.2 to 11) V	3.2 $\mu\text{V/V} + 3 \mu\text{V}$		
	(11 to 22) V	3.1 $\mu\text{V/V} + 5.5 \mu\text{V}$		
	(22 to 220) V	4.8 $\mu\text{V/V} + 50 \mu\text{V}$		
	(220 to 1100) V	11 $\mu\text{V/V} + 420 \mu\text{V}$		
	(1 to 2) kV	0.12 %	Vitrek 4600with SRS PS350 high voltage supply and or equivalent	
	(2 to 20) kV	0.28 %		
	(20 to 120) kV	1.2 %		
DC Voltage – Measure	(0 to 100) mV	6 $\mu\text{V/V} + 0.38 \mu\text{V}$	Agilent 3458A	
	(0.1 to 1) V	4.8 $\mu\text{V/V} + 0.38 \mu\text{V}$		
	(1 to 10) V	4.7 $\mu\text{V/V} + 0.61 \mu\text{V}$		
	(10 to 100) V	7.1 $\mu\text{V/V} + 60 \mu\text{V}$		
	(100 to 1000) V	12 $\mu\text{V/V} + 0.13 \text{ mV}$		
	(0 to 2) kV	0.12 %		
	(2 to 20) kV	0.28 %	Vitrek VM4600	
	(20 to 64) kV	0.16 %	VMP200-3.8-J-U-ALFA-CK Probe/Voltmeter	
		(64 to 85) kV		0.12 %
		(85 to 100) kV		0.15 %
		(100 to 140) kV		0.12 %

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
DC Current – Generate	(1 to 220) μ A 220 μ A to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	41 μ A/A + 5.4 nA 33 μ A/A + 6.2 nA 34 μ A/A + 40 nA 43 μ A/A + 0.7 μ A 83 μ A/A + 12 μ A	Fluke 5720
	(1.1 to 2.99999) A (3 to 10.9999) A (11 to 20.5) A	0.031 % + 31 μ A 0.04 % + 390 μ A 0.083 % + 580 μ A	Fluke 5520A
DC Current – Measure	Up to 100 nA 100 nA to 1 μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	39 μ A/A + 46 pA 25 μ A/A + 46 pA 25 μ A/A + 120 pA 23 μ A/A + 930 pA 23 μ A/A + 6.2 nA 23 μ A/A + 58 nA 41 μ A/A + 1.3 μ A 0.015 % + 17 μ A	Agilent 3458A
	(1.1 to 3) A (3 to 11) A (11 to 20) A	0.04 % 0.04 % 0.04 %	Fluke Y5020 with Agilent 3458A
	(20 to 200) A	0.25 %	L&N 4363 with Agilent 3458A
DC Power – Generate	(0.3 to 330) W (0.33 to 6.6) kW (6.6 to 20) kW	0.06 % 0.09 % 0.13 %	Fluke 5520A
DC Resistance – Generate	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.11 to 1.1) k Ω (1.3 to 3.3) k Ω (3.3 to 11) k Ω (11 to 33) k Ω (33 to 110) k Ω (110 to 330) k Ω (0.33 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 330) M Ω (330 to 1100) M Ω	0.026 % + 0.6 m Ω 0.015 % + 0.9 m Ω 77 $\mu\Omega/\Omega$ + 0.8 m Ω 65 $\mu\Omega/\Omega$ + 1.2 m Ω 78 $\mu\Omega/\Omega$ + 1.2 m Ω 21 $\mu\Omega/\Omega$ + 12 m Ω 37 $\mu\Omega/\Omega$ + 12 m Ω 73 $\mu\Omega/\Omega$ + 120 m Ω 55 $\mu\Omega/\Omega$ + 120 m Ω 71 $\mu\Omega/\Omega$ + 1.2 Ω 55 $\mu\Omega/\Omega$ + 1.2 Ω 0.013 % + 18 Ω 0.025 % + 30 Ω 0.061 % + 1.5 k Ω 0.6 % + 6 k Ω 3.1 % + 310 k Ω	Fluke 5520A

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
DC Resistance – Generate	Up to 11 Ω	0.026 % + 0.6 mΩ	Fluke 5520A
	(11 to 33) Ω	0.015 % + 0.9 mΩ	
	(33 to 110) Ω	77 μΩ/Ω + 0.8 mΩ	
	(110 to 330) Ω	65 μΩ/Ω + 1.2 mΩ	
	(0.11 to 1.1) kΩ	78 μΩ/Ω + 1.2 mΩ	
	(1.3 to 3.3) kΩ	21 μΩ/Ω + 12 mΩ	
	(3.3 to 11) kΩ	37 μΩ/Ω + 12 mΩ	
	(11 to 33) kΩ	73 μΩ/Ω + 120 mΩ	
	(33 to 110) kΩ	55 μΩ/Ω + 120 mΩ	
	(110 to 330) kΩ	71 μΩ/Ω + 1.2 Ω	
	(0.33 to 1.1) MΩ	55 μΩ/Ω + 1.2 Ω	
	(1.1 to 3.3) MΩ	0.013 % + 18 Ω	
	(3.3 to 11) MΩ	0.025 % + 30 Ω	
	(11 to 33) MΩ	0.061 % + 1.5 kΩ	
	(33 to 330) MΩ	0.6 % + 6 kΩ	
	(330 to 1100) MΩ	3.1 % + 310 kΩ	
	Fixed Points	1 Ω	
1.9 Ω		91 μΩ/Ω	
10 Ω		33 μΩ/Ω	
19 Ω		28 μΩ/Ω	
100 Ω		11 μΩ/Ω	
190 Ω		9.9 μΩ/Ω	
1 kΩ		8.2 μΩ/Ω	
1.9 kΩ		8.2 μΩ/Ω	
10 kΩ		8.3 μΩ/Ω	
19 kΩ		8.1 μΩ/Ω	
100 kΩ		11 μΩ/Ω	
190 kΩ		12 μΩ/Ω	
1 MΩ		20 μΩ/Ω	
1.9 MΩ		25 μΩ/Ω	
10 MΩ		40 μΩ/Ω	
19 MΩ		55 μΩ/Ω	
100 MΩ		95 μΩ/Ω	
1 mΩ		0.47 %	L&N 4363
10 mΩ		0.48 %	L&N 4361
100 mΩ		0.1 %	L&N 4360
1 Ω	0.09 %	L&N 4210	
10 kΩ	6.1 μΩ/Ω	ESI SR104	

Parameter/Equipment	Range	CMC ^{2, 4} (±)	Comments
DC Resistance – Generate(cont)			
Decade Resistance Generate	10 MΩ 20 MΩ 30 MΩ 40 MΩ 50 MΩ 60 MΩ 70 MΩ 80 MΩ 90 MΩ 100 MΩ 110 MΩ	70 μΩ/Ω 75 μΩ/Ω 75 μΩ/Ω 75 μΩ/Ω 75 μΩ/Ω 77 Ω/Ω 82 μΩ/Ω 76 μΩ/Ω 77 μΩ/Ω 76 μΩ/Ω 76 μΩ/Ω	ESI SR1050-10/3458
Fixed Resistor	1.0 GΩ (250 V) (250 V) (750 V) (1 kV)	0.0024 % 0.0024 % 0.0092 % 1.3 %	Ohm-Labs 109
	10 GΩ (250 V) (500 V) (1 kV)	0.11 % 0.005 % 0.012 %	Ohm-Labs 110
	100 GΩ (250 V) (500 V) (1 kV) (5 kV)	0.18 % 0.21 % 0.16 % 3.6 %	Ohm-Labs 111
	1 TΩ (100 V) (200 V) (1 kV) (5 kV)	2.6 % 2.5 % 2.7 % 2.2 %	Ohm-Labs 112
DC Resistance – Measure	(0 to 1) Ω (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	41 μΩ/Ω + 3.7 μΩ 18 μΩ/Ω + 37 μΩ 14 μΩ/Ω + 140 μΩ 12 μΩ/Ω + 830 μΩ 12 μΩ/Ω + 8.1 mΩ 12 μΩ/Ω + 81 mΩ 20 μΩ/Ω + 1.9 Ω 0.014 % + 81 Ω 0.061 % + 1.9 kΩ 0.58 % + 168 kΩ	Agilent 3458A

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – Generate			
(0 to 2.2) mV	(40 to 100) Hz (100 to 500) Hz 500 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.08 % + 3.9 μV 0.08 % + 3.9 μV 0.08 % + 3.9 μV 0.14 % + 3.9 μV 0.19 % + 4.7 μV 0.71 % + 9.3 μV 0.67 % + 20 μV 0.27 % + 20 μV	Fluke 5720
(2.2 to 22) mV	(40 to 100) Hz (100 to 500) Hz 500 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.01 % + 3.9 μV 0.01 % + 3.9 μV 0.01 % + 3.9 μV 0.03 % + 3.9 μV 0.06 % + 4.7 μV 0.12 % + 9.3 μV 0.24 % + 20 μV 0.28 % + 20 μV	
(22 to 220) mV	(40 to 100) Hz (100 to 500) Hz 500 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.009 % + 6.2 μV 0.009 % + 6.2 μV 0.008 % + 6.3 μV 0.021 % + 6.6 μV 0.049 % + 17 μV 0.089 % + 21 μV 0.14 % + 26 μV 0.27 % + 52 μV	
220 mV to 2.2 V	(40 to 100) Hz (100 to 500) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.075 % + 7.8 μV 0.075 % + 7.9 μV 0.005 % + 7.8 μV 0.008 % + 9.6 μV 0.011 % + 32 μV 0.044 % + 80 μV 0.098 % + 200 μV 0.16 % + 330 μV	
(2.2 to 22) V	(40 to 100) Hz (100 to 500) Hz 500 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1MHz	0.01 % + 56 μV 0.01 % + 56 μV 0.01 % + 56 μV 0.01 % + 96 μV 0.01 % + 200 μV 0.03 % + 650 μV 0.1 % + 2 mV 0.15 % + 3.2 mV	
(22 to 220) V	(40 to 100) Hz (100 to 500) Hz 500 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.01 % + 0.55 mV 0.01 % + 0.55 mV 0.01 % + 0.55 mV 0.02 % + 1.5 mV 0.02 % + 2.4 mV	
(220 to 1100) V	(50 to 500) Hz 500 Hz to 1 kHz	0.01 % + 3.1 mV 0.01 % + 0.9 mV	

Parameter/Range	Frequency	CMC ^{2, 4} (±)	Comments
AC Voltage – Measure			
(0 to 10) mV	(1 to 100) Hz 100 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	0.04 % + 5.3 μV 0.06 % + 5.3 μV 0.05 % + 5.3 μV 0.05 % + 5.5 μV 0.41 % + 8.4 μV 5.3 % + 15 μV 1.6 % + 15 μV	Agilent 3458A synchronous sub-sampled mode
(10 to 100) mV	(1 to 100) Hz 100 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	0.01 % + 5.9 μV 1.2 % + 5.9 μV 0.02 % + 5.9 μV 0.02 % + 6.1 μV 0.98 % + 8.4 μV 0.42 % + 15 μV 1.4 % + 30 μV 1.9 % + 30 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	0.03 % + 93 μV 0.03 % + 29 μV 0.03 % + 7 μV 0.05 % + 19 μV 0.11 % + 81 μV 0.45 % + 150 μV 1.3 % + 410 μV 1.7 % + 990 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	0.04 % + 930 μV 0.04 % + 71 μV 0.05 % + 71 μV 0.06 % + 190 μV 0.11 % + 410 μV 0.41 % + 1.7 mV 1.2 % + 5 mV 1.5 % + 10 mV	
(10 to 100) V	(1 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.04 % + 9.3 mV 0.04 % + 4.2 mV 0.05 % + 9.3 mV 0.15 % + 110 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	0.06 % + 19 mV 0.06 % + 19 mV 0.07 % + 4.2 mV 0.14 % + 4.2 mV 0.32 % + 4.2 mV	VMP200-3.8-J-U-ALFA-CK probe/voltmeter
(0.7 to 2) kV (2 to 20) kV (20 to 85) kV	60 Hz 60 Hz 60 Hz	0.42 % 0.41 % 1.2 %	ROSS VMP 200

Parameter/Range	Frequency	CMC ^{2, 4} (±)	Comments
AC Current – Generate			
(0 to 220) µA	(40 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.01 % + 7.8 nA 0.01 % + 7.8 nA 0.03 % + 12 nA 0.12 % + 130 nA	Fluke 5720A
(0.22 to 2.2) mA	(40 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.01 % + 32 nA 0.01 % + 32 nA 0.02 % + 160 nA 0.11 % + 780 nA	
(2.2 to 22) mA	(40 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.01 % + 310 nA 0.01 % + 310 nA 0.02 % + 720 nA 0.11 % + 4.8 µA	
(22 to 220) mA	(40 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.01 % + 2.3 µA 0.01 % + 2.3 µA 0.02 % + 3.9 µA 0.11 % + 11 µA	
(0.22 to 2.2) A	(40 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.03 % + 32 µA 0.03 % + 32 µA 0.04 % + 78 µA 0.64 % + 160 µA	
(1.1 to 2.99999) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.14 % + 78 µA 0.05 % + 78 µA 0.48 % + 780 µA 2.1 % + 3.9 mA	Fluke 5520A
(3 to 10.9999) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.06 % + 1.6 mA 0.09 % + 1.6 mA 2.2 % + 1.6 mA	
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.12 % + 3.9 mA 0.15 % + 3.9 mA 2.5 % + 3.9 mA	
Clamp-On Only			
(16.5 to 149.99) A	(45 to 440) Hz	0.76 %	Fluke 5520A with 5500 coil
(150 to 1025) A	(45 to 440) Hz	0.61 %	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments	
AC Current – Measure				
(5 to 100) µA	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.07 % + 36 nA 0.07 % + 24 nA 0.07 % + 58 nA	Agilent 3458A	
(0.1 to 1) mA	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.11 % + 58 nA 0.09 % + 46 nA 0.09 % + 590 nA 0.11 % + 1.3 µA		
(1 to 10) mA	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10)kHz	0.07 % + 0.6 µA 0.02 % + 0.5 µA 0.04 % + 5.8 µA 0.07 % + 12 µA		
(10 to 100) mA	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.07 % + 6.3 µA 0.04 % + 6.3µA 0.04 % + 58 µA 0.07 % + 120 µA		
(0.1 to 1) A	(45 to 100) Hz 100 Hz to 5 kHz	0.1 % + 52 µA 0.12 % + 120 µA		
(0 to 10) A	(50 to 100) Hz 100 Hz to 1 kHz 1 kHz to 5 kHz	0.1 % 0.67 % 0.53 %		Fluke Y5020 with Agilent 3458A
(10 to 20) A	(50 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.16 % 0.16 % 0.16 %		
AC Power – Generation				
(0.01 to 0.1) W (0.1 to 36) W (0.89 to 3) kW (3 to 20) kW	(45 to 65) Hz, PF = 1	0.04 % 0.06 % 0.06 % 0.12 %	Fluke 5520A	
Capacitance– Generate				
Up to 220 pF (220 to 390) pF (0.390 to 0.6) nF (0.6 to 1.0) nF (1.0 to 3.0) nF (3.0 to 3.3) nF (3.3 to 30) nF (30 to 300) nF (300 to 330) nF (0.3 to 1.2) µF (1.2 to 3.3) µF (3.3 to 10.9) µF	1 kHz 1 kHz 1 kHz 1 kHz 1 kHz 1 kHz 1 kHz 1 kHz 100 Hz 100 Hz 100 Hz 100 Hz	3.7 % + 10 pF 2.1 % + 10 pF 1.6 % + 10 pF 1.3 % + 10 pF 1.3 % + 10 pF 1.2 % + 10 pF 0.23 % + 100 pF 0.23 % + 300 pF 0.23 % + 1 nF 0.55 % + 3 nF 0.38 % + 10 nF 1.8 % + 10 nF	Fluke 5520A	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Oscilloscope –			
Level Sine Wave – Amplitude Characteristics 50 kHz	5 mV 10 mV 20 mV 50 mV 100 mV 200 mV 0.5 V 1 V 2V 5V	1.9 + 240 μV 2 % + 240 μV 1.9 % + 240 μV 1.9 % + 240 μV 2.1 % + 240 μV 2 % + 240 μV 2 % + 240 μV 2 % + 240 μV 2 % + 240 μV 2 % + 240 μV	Fluke 5820A
Leveled Sine Flatness Test (50 kHz)			
5.5 V	1 MHz 10 MHz 50 MHz 100 MHz 200 MHz 300 MHz 400 MHz 500 MHz 600 MHz	3.2 % + 240 μV 3.3 % + 240 μV 3.4 % + 240 μV 3.9 % + 240 μV 4 % + 240 μV 4.3 % + 240 μV 5.5 % + 240 μV 5.5 % + 240 μV 5.6 % + 240 μV	
3.4 V	1 MHz 10 MHz 50 MHz 100 MHz 200 MHz 300 MHz 400 MHz 500 MHz 600 MHz	3.2 % + 240 μV 3.2 % + 240 μV 3.4 % + 240 μV 3.8 % + 240 μV 3.9 % + 240 μV 4.2 % + 240 μV 5.5 % + 240 μV 5.4 % + 240 μV 5.6 % + 240 μV	
1.3 V	1 MHz 10 MHz 50 MHz 100 MHz 200 MHz 300 MHz 400 MHz 500 MHz 600 MHz	3.4 % + 240 μV 3.2 % + 240 μV 3.4 % + 240 μV 3.8 % + 240 μV 3.9 % + 240 μV 4.2 % + 240 μV 5.8 % + 240 μV 5.7 % + 240 μV 5.5 % + 240 μV	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Oscilloscopes (cont) – Leveled Sine Flatness Test (50 kHz)			
1.2 V	1 MHz	3.4 % + 240 μV	Fluke 5820A
	10 MHz	3.2 % + 240 μV	
	50 MHz	3.4 % + 240 μV	
	100 MHz	3.8 % + 240 μV	
	200 MHz	3.9 % + 240 μV	
	300 MHz	4.2 % + 240 μV	
	400 MHz	5.5 % + 240 μV	
	500 MHz	5.4 % + 240 μV	
	600 MHz	5.7 % + 240 μV	
400 mV	1 MHz	3.1 % + 240 μV	Fluke 5820A
	10 MHz	3.2 % + 240 μV	
	50 MHz	3.4 % + 240 μV	
	100 MHz	3.8 % + 240 μV	
	200 MHz	3.9 % + 240 μV	
	300 MHz	4.2 % + 240 μV	
	400 MHz	5.8 % + 240 μV	
	500 MHz	6.0 % + 240 μV	
	600 MHz	5.7 % + 240 μV	
100 mV	1 MHz	3.2 % + 240 μV	Fluke 5820A
	10 MHz	3.2 % + 240 μV	
	50 MHz	3.3 % + 240 μV	
	100 MHz	3.5 % + 240 μV	
	200 MHz	3.9 % + 240 μV	
	300 MHz	4.2 % + 240 μV	
	400 MHz	5.8 % + 240 μV	
	500 MHz	5.8 % + 240 μV	
	600 MHz	5.5 % + 240 μV	
10 mV	1 MHz	3.2 % + 240 μV	Fluke 5820A
	10 MHz	2.9 % + 240 μV	
	50 MHz	3.3 % + 240 μV	
	100 MHz	3.8 % + 240 μV	
	200 MHz	3.8 % + 240 μV	
	300 MHz	4.2 % + 240 μV	
	400 MHz	5.5 % + 240 μV	
	500 MHz	5.5 % + 240 μV	
	600 MHz	5.6 % + 240 μV	

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Oscilloscope (cont) – Amplitude/Vertical Gain Characteristics- Volt Function			
Square @ 1kHz (1 MΩ)	1.8 mV _{pk-pk} 12 mV _{pk-pk} 22 mV _{pk-pk} 56 mV _{pk-pk} 90 mV _{pk-pk} 155 mV _{pk-pk} 220 mV _{pk-pk} 560 mV _{pk-pk} 0.9 V _{pk-pk} 3.75 V _{pk-pk} 6.6 V _{pk-pk} 30.8 V _{pk-pk} 55 V _{pk-pk}	1.3 % + 32 μV 1.6 % + 32 μV 0.08 % + 32 μV 0.08 % + 32 μV 0.08 % + 32 μV 0.09 % + 32 μV 0.09 % + 32 μV 0.08 % + 32 μV 0.1 % + 32 μV 0.09 % + 32 μV 0.1 % + 32 μV 0.08 % + 32 μV 0.08 % + 32 μV	Fluke 5820A
Square @ 1kHz (50 Ω)	1.8 mV _{pk-pk} 6.4 mV _{pk-pk} 10.9 mV _{pk-pk} 28 mV _{pk-pk} 44.9 mV _{pk-pk} 78 mV _{pk-pk} 110 mV _{pk-pk} 280 mV _{pk-pk} 0.45 V _{pk-pk} 0.78 V _{pk-pk} 1.1 V _{pk-pk} 2.5 V _{pk-pk}	1.5 % + 32 μV 0.65 % + 32 μV 0.79 % + 32 μV 0.23 % + 32 μV 0.22 % + 32 μV 0.72 % + 32 μV 0.44 % + 32 μV 0.43 % + 32 μV 0.39 % + 32 μV 0.38 % + 32 μV 0.52 % + 32 μV 0.48 % + 32 μV	
Leveled Sine Frequency Source	50 kHz 500 kHz 5 MHz 50 MHz 500 MHz	13 μHz/Hz 2.9 μHz/Hz 2.4 μHz/Hz 2.3 μHz/Hz 2 μHz/Hz	
Time Marker	2.0 ns 5.0 ns 10.0 ns 20.0 ns 50.0 ns 100.0 ns 10.0 ms 20.0 ms 50.0 ms 100 ms 2 s 5 s	2.3 ms/s 1.6 ms/s 0.9 ms/s 0.6 ms/s 0.6 ms/s 68 ms/s 0.2 ms/s 3.5 ms/s 58 ms/s 0.2 ms/s 1.7 ms/s 4 ms/s	
Rise Time: 4mV to 2.5V (p-p) 1 kHz to 10 MHz	≤ 300 ps	250 ps	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Thermocouple Indicators –			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.31 °C 0.29 °C 0.26 °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	0.26 °C 0.2 °C 0.27 °C 0.41 °C 0.66 °C	
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.4 °C 0.17 °C 0.17 °C 0.18 °C 0.21 °C	
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.24 °C 0.16 °C 0.56 °C 0.17 °C 0.21 °C	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.28 °C 0.18 °C 0.21 °C 0.23 °C 0.33 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.33 °C 0.3 °C 0.2 °C 0.19 °C 0.25 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.39 °C 0.26 °C 0.24 °C 0.29 °C	
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.38 °C 0.22 °C 0.25 °C 0.29 °C	
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.5 °C 0.22 °C 0.16 °C 0.17 °C	
Type U	(-200 to 0) °C (0 to 600) °C	0.45 °C 0.25 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of RTDs –			
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	0.07 °C 0.07 °C 0.08 °C 0.09 °C 0.09 °C 0.11 °C 0.19 °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 0.07 °C 0.09 °C 0.09 °C 0.11 °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	0.04 °C 0.04 °C 0.04 °C 0.05 °C 0.06 °C 0.06 °C 0.06 °C 0.07 °C 0.11 °C	
Pt 385, 500 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.03 °C 0.03 °C 0.04 °C 0.06 °C 0.06 °C 0.06 °C 0.07 °C 0.09 °C	
Pt 385, 1 kΩ	(-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	0.02 °C 0.02 °C 0.04 °C 0.06 °C 0.06 °C 0.06 °C 0.06 °C 0.18 °C	
Ni 120, 120 Ω	(-80 to 0) °C (0 to 100) °C (100 to 260) °C	0.08 °C 0.05 °C 0.04 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.09 °C	

II. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2,3} (±)	Comments
RF Power – Measure			
Power Reference 1 mW, Type-N(f) 50 Ω	50 MHz	0.33 %	Agilent 432A with 478A-H75
(-30 to +20) dBm ³	50 MHz to 1 GHz (1 to 2) GHz (2 to 4) GHz (4 to 6) GHz (6 to 8) GHz	4.5 % + <i>M</i> 4.5 % + <i>M</i> 4.6 % + <i>M</i> 4.6 % + <i>M</i> 4.6 % + <i>M</i>	Agilent 8487A with E4419A
(-30 to +20) dBm ³	(8 to 10) GHz (10 to 12) GHz (12 to 14) GHz (14 to 16) GHz (16 to 18) GHz (18 to 22) GHz (22 to 26.5) GHz (26.5 to 28) GHz (28 to 30) GHz (30 to 33) GHz (33 to 34.5) GHz (34.5 to 37) GHz (37 to 40) GHz (40 to 42) GHz (42 to 44) GHz (44 to 46) GHz (46 to 48) GHz (48 to 50) GHz 50 GHz	4.6 % + <i>M</i> 4.6 % + <i>M</i> 4.6 % + <i>M</i> 4.6 % + <i>M</i> 4.6 % + <i>M</i> 4.6 % + <i>M</i> 4.7 % + <i>M</i> 4.8 % + <i>M</i> 4.9 % + <i>M</i> 4.8 % + <i>M</i> 4.9 % + <i>M</i> 5.1 % + <i>M</i> 5.6 % + <i>M</i> 5.3 % + <i>M</i> 5.8 % + <i>M</i> 5.2 % + <i>M</i> 5.5 % + <i>M</i> 5.7 % + <i>M</i> 6.5 % + <i>M</i>	
(-20 to +30) dBm ³	100 kHz to 1.3 GHz (50 to 1300) MHz (1.3 to 18) GHz (18 to 26.5) GHz	0.15 dB 0.18 dB 0.2 dB 0.22 dB	Agilent 8902A with 11722A Agilent 8902A with 11792A and 11793A

Parameter/Frequency	Range	CMC ² (±)	Comments
Amplitude Modulation – Measure			
(0.15 to 10) MHz	Rate: 50 Hz to 10 kHz, 5 % to 99 %	2.4 % + 2.8 digit	Agilent 8902A
(0.15 to 10) MHz	20 Hz to 10 kHz, To 99 %	1.3 % + 2.8 digit	
(10 to 1300) MHz	50 Hz to 50 kHz, 5 % to 99 %	3.5 % + 2.8 digit	
(10 to 1300) MHz	20 Hz to 100 kHz, To 99 %	3.5 % + 2.8 digit	
Frequency Modulation – Measure			
(0.25 to 10) MHz	Rate: 20 Hz to 10 kHz ≤ 40 kHz peak	0.91 kHz + 2 digit	Agilent 8902A
(10 to 1300) MHz	Rate: 50 Hz to 10 kHz ≤ 40 kHz peak	0.4 kHz + 2 digit	
(10 to 1300) MHz	Rate: 20 Hz to 200 kHz ≤ 400 kHz peak	0.4 kHz + 2 digit	
(0.01 to 26.5) GHz	Rate: 50 Hz to 10 kHz, ≤ 40 kHz peak	0.32 kHz + 2 digit	
(0.01 to 26.5) GHz	Rate: 20 Hz to 200 kHz, ≤ 400 kHz peak	0.33 kHz + 2 digit	
Phase Modulation – Measure			
Rate: 250 rad	150 kHz to 10 MHz 10 MHz to 1.3 GHz (0.01 to 26.5) GHz	4.6 % + 2 digit 3.5 % + 2 digit 3.5 % + 2 digit	Agilent 8902A

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
ESD Simulators –			
Contact Voltage	200 V to 30 kV	3.8 %	Calibration method based on IEC/EN 61000-4-2, IEC 801-2 Brandenburg 149-03 Attenuator Tek TDS7404 with Schaffner MD103 Target
Rise Time	(0.7 to 1) ns	3.6 %	
Peak Current	(7.5 to 112.5) A	5 %	
30 ns Current	(4 to 60) A	4.4 %	
60 ns Current	(2 to 30) A	3.9 %	
RC Time Constant	600 ns ± 130 ns 300 ns ± 60 ns	3.5 % 3.5 %	
EFT/Burst Generators –			
Voltage	20 V to 8 kV 1000:1 divider 2000:1 divider	3.6 % 3.1 %	IEC/EN 61000-4-4, ANSI/IEEE C37.90, ISO 7637-2 Tektronix TDS5104 with Schaffner CAS-3025 attenuator set
Rise Time	5 ns	5.5 %	
Fall Time	5 ns	2.7 %	
Pulse Width	(35 to 200) ns	3.3 %	
Burst Duration	(0.5 to 20) ms	3 %	
Burst Period	(100 to 300) ms	1.1 %	
Repetition Rate	1 kHz to 1 MHz	1 %	
Transient Generators –			
Front/Rise Time – Open Circuit Short Circuit	1 µs to 10 ms (1 to 100) µs	7.7 % 3.9 %	IEC/EN 61000-4-5, IEC 61000-4-9, IEC 61000-4-10, IEC 61000-4-12, ANSI C37.90, ANSI C62.41, ISO 7637-2
Fall time Open Circuit Short Circuit	1 µs to 10 ms (1 to 100) ms	4.5 % 3.9 %	
Pulse Width– Open Circuit	1 µs to 1000 ms	2.1 %	
			Tektronix TDS5104 with Sapphire SI-

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Transient Generators –			
Pulse Width Short Circuit	1µs to 1 ms	1.1 %	9010A and Pearson 110
Open Circuit Voltage	10 V to 20 kV	3.7 %	
Short Circuit Current	1 A to 4 kA	1.2 %	
Repetition Rate	(0.1 to 100) s	1.6 %	
Ring/Oscillatory Wave – Rise Time	75 ns (0.5 to 1.5) µs	4.4 %	
Fall Time	75 ns (0.5 to 1.5) µs	4.5 %	
Frequency	5 kHz to 1 MHz	2.4 %	
Current	1 A to 4 kA	1.6 %	
PQT – Voltage Dips and Interruptions –			
Output Voltage	Up to 260 V AC or DC	2.1 %	IEC/EN 61000-4-11
Phase Angle	(0 to 359) °	2.3 %	Tektronix TDS5104
Pulse Rise/Fall Time	(1 to 5) ns	1.5 %	
RF Bulk Injection Probe –			
Insertion Loss	10 Hz to 3 GHz	1.4 %	Agilent E5061B
Horn Antenna –	10 kHz to 10 MHz (10 to 100) MHz (0.1 to 1) GHz (1 to 10) GHz (10 to 20) GHz	3.7 % 3.6 % 4.6 % 6.6 % 8.4 %	R & S ESU 40/Agilent E7405/GTEM5407/SES571
E-Probe	10 kHz to 10 MHz (10 to 100) MHz (1.1 to 1) GHz (2 to 10) GHz (10 to 20) GHz	3.7 % 3.6 % 4.6 % 6.6 % 8.4 %	R & S ESU 40/Agilent E7405/GTEM5407/SES571

III. Time & Frequency

Parameter/Equipment	Range	CMC ² (±)	Comments
Frequency – Measuring Equipment			
Fixed Point	10 Hz	0.41 nHz/Hz	Spectracom GPS-89 receiver
	Up to to 1kHz	3.3 mHz/Hz	Agilent 33250A referenced to GPS receiver
	1 kHz to 100 kHz	2.5 mHz/Hz	
	100 kHz to 1 MHz	11 nHz/Hz	
	(1 to 80) MHz	7.1 nHz/Hz	
	50 MHz to 40 GHz	11 nHz/Hz	Anritsu 68369B referenced to GPS receiver
Frequency– Measure	10 µHz to 1kHz	2.1 mHz/Hz	Agilent 53132A referenced to GPS receiver
	1 kHz to 1MHz	14 nHz/Hz	
	(1 to 80) MHz	10 nHz/Hz	
	50 MHz to 40 GHz	11 nHz/Hz	Agilent 5352A referenced to GPS receiver

IV. Thermodynamics

Parameter/Equipment	Range	CMC ² (±)	Comments
Temperature – Measure	(-180 to 240) °C	0.20 °C	Guildline 9540
Temperature – Measuring Equipment	-38 °C	0.03 °C	Triple point of Mercury
	0 °C	0.18 °C	Ice bath
	(30 to 150) °C	0.03 °C	Furnace with Guildline 9540
	(150 to 240) °C	0.18 °C	
Relative Humidity – Measuring Equipment			
Fixed Points	11 % RH	2.7 % RH	Vaisala HMK-15 – new salts are yet to be purchased.
	44 % RH	3.9 % RH	
	75 % RH	3 % RH	LiCL Solution Interpolation and Inter-comparison using Fluke 1621-3 K ₂ SO ₄ solution

¹ This laboratory offers commercial 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 M is the Mismatch error. Uncertainty does not include mismatch error due to connections of the device to other devices in actual use. Mismatch uncertainties, due to the reflection coefficient of the device to be calibrated, are to be included in the overall measurement uncertainty. The approach of determining expanded uncertainties at approximately the 95% level of confidence, (using a coverage factor of $k = 2$) is to be applied for this calculation as well.

⁴ In the statement of CMC, percentages are percentage of reading, unless otherwise indicated.



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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/NCSLI 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 15th day of July 2013.



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

President & CEO
For the Accreditation Council
Certificate Number 3410.01
Valid to April 30, 2015

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