



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

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CALIBRATION

Valid To: November 30, 2022

Certificate Number: 2450.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations<sup>1, 6</sup>:

I. Electrical – DC / Low Frequency

Parameter/Equipment	Range	CMC <sup>2,4,5</sup> (±)	Comments
DC Voltage <sup>3</sup> – Generate	(0 to 330) mV	16 µV/V + 1.6 µV	Fluke 5520A
	330 mV to 3.3 V	8.5 µV/V + 9.6 µV	
	(3.3 to 33) V	9.3 µV/V + 180 µV	
	(33 to 330) V	14 µV/V + 1 mV	
	(330 to 1000) V	14 µV/V + 3.4 mV	
	Fluke 5700A	(0 to 220) mV	8.0 µV/V + 0.68 µV
		220 mV to 2.2 V	7.0 µV/V + 1.4 µV
		(2.2 to 11) V	7.0 µV/V + 6.5 µV
		(11 to 22) V	7.0 µV/V + 12 µV
		(22 to 220) V	8.0 µV/V + 140 µV
	Pintek HVC-801	(220 to 1100) V	9.0 µV/V + 1.5 mV
		(> 1 to 10) kV	0.58 % + 25 V
(10 to 20) kV		0.58 % + 26 V	
(20 to 30) kV		0.58 % + 27 V	
	(30 to 40) kV	0.58 % + 30 V	
DC Voltage <sup>3</sup> – Measure	(0 to 100) mV	11 µV /V + 1.0 µV	Agilent 3458A
	(0 to 1) V	10 µV/V + 1.0 µV	
	(0 to 10) V	10 µV/V + 2.1 µV	
	(0 to 100) V	12 µV/V + 34 µV	
	(0 to 1000) V	24 µV/V + 0.13 mV	

Parameter/Equipment	Range	CMC <sup>2, 4, 5</sup> (±)	Comments
DC Voltage <sup>3</sup> – Measure (cont)	100 V to 15 kV	3.9 %	Tektronix P6015A with 1 MΩ impedance oscilloscope
	(0.5 to 6) kV	0.035 % + 0.58 V	Vitrek 4700
	(> 6 to 10) kV	0.035 % + 5.8 V	
	(> 10 to 40) kV (40 to 70) kV (70 to 100) kV	0.058 % + 5.8 V 0.058 % + 58 V 0.058 % + 0.12 kV	Vitrek 4700 + Vitrek HVL-100 probe
DC Current <sup>3</sup> – Generate	(0 to 330) μA	120 μA/A + 16 nA	Fluke 5520A
	330 μA to 3.3 mA	78 μA/A + 52 nA	
	(3.3 to 33) mA	78 μA/A + 0.37 μA	
	(33 to 330) mA	78 μA/A + 7.0 μA	
	330 mA to 1.1 A	0.016 % + 52 μA	
	(1.1 to 3) A	0.029 % + 0.19 mA	Fluke 5520A + Fluke 5500A/COIL
	(3 to 11) A	0.039 % + 0.74 mA	
	(11 to 20.5) A	0.078 % + 2.4 mA	
	(> 20 to 50) A	0.19 % + 0.20 A	
	(50 to 100) A	0.20 % + 0.40 A	APM SPS40VDC1000W
(100 to 500) A	0.20 % + 1.0 A		
(500 to 1000) A	0.21 % + 1.8 A		
(>20 to 120) A	0.01 % + 0.13 A		
(0 to 220) μA	50 μA/A + 10 nA	Fluke 5700A	
220 μA to 2.2 mA	50 μA/A + 22 nA		
(2.2 to 22) mA	50 μA/A + 0.25 μA		
(22 to 220) mA	60 μA/A + 1.8 μA		
220 mA to 2.2 A	80 μA/A + 59 μA		
DC Current <sup>3</sup> – Measure	(0 to 100) μA	25 μA/A + 2.1 nA	Agilent 3458A
	100 μA to 1 mA	25 μA/A + 17 nA	
	(1 to 10) mA	25 μA/A + 0.17 μA	
	(10 to 100) mA	40 μA/A + 2.4 μA	
	100 mA to 1 A	120 μA/A + 50 μA	
	(1 to 3) A	0.016 % + 4.4 mA	Fluke 8846A
	(3 to 10) A	0.039 % + 4.4 mA	
(10 to 20) A	0.21 % + 9.7 mA	Agilent 3458A & 50 A/50 mV current shunt	

Parameter/Equipment	Range	CMC <sup>2, 4, 5</sup> (±)	Comments
Resistance <sup>3</sup> – Measure (2-wire and 4-wire)	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	18 μΩ/Ω + 0.11 mΩ 15 μΩ/Ω + 1.0 mΩ 13 μΩ/Ω + 7.5 mΩ 13 μΩ/Ω + 75 mΩ 13 μΩ/Ω + 0.75 Ω 18 μΩ/Ω + 8.3 Ω 53 μΩ/Ω + 0.20 kΩ 0.050 % + 0.24 kΩ 0.50 % + 0.24 MΩ	Agilent 3458A
Resistance <sup>3</sup> – Generate	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ 330 kΩ to 1.1 MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ 330 MΩ to 1.1 GΩ	31 μΩ/Ω + 0.79 mΩ 23 μΩ/Ω + 1.2 mΩ 22 μΩ/Ω + 1.5 mΩ 22 μΩ/Ω + 0.024 Ω 22 μΩ/Ω + 0.0059 Ω 22 μΩ/Ω + 0.030 Ω 22 μΩ/Ω + 0.083 Ω 22 μΩ/Ω + 0.30 Ω 22 μΩ/Ω + 0.90 Ω 25 μΩ/Ω + 2.7 Ω 25 μΩ/Ω + 8.4 Ω 47 μΩ/Ω + 48 Ω 0.010 % + 200 Ω 0.019 % + 2.7 kΩ 0.039 % + 9.4 kΩ 0.23 % + 110 kΩ 1.2 % + 1.3 MΩ	Fluke 5520A

Parameter/Equipment	Range	CMC <sup>2, 4, 5</sup> (±)	Comments
Resistance – Generate, (2-wire and 4-wire) Fixed Points	0 Ω	56 μΩ	Fluke 5700A
	1 Ω	120 μΩ	
	1.9 Ω	220 μΩ	
	10 Ω	370 μΩ	
	19 Ω	720 μΩ	
	100 Ω	2.0 mΩ	
	190 Ω	3.0 mΩ	
	1 kΩ	16 mΩ	
	1.9 kΩ	32 mΩ	
	10 kΩ	120 mΩ	
	19 kΩ	290 mΩ	
	100 kΩ	1.7 Ω	
	190 kΩ	2.7 Ω	
	1 MΩ	25 Ω	
	1.9 MΩ	51 Ω	
	10 MΩ	490 Ω	
	19 MΩ	1.7 kΩ	
	100 MΩ	16 kΩ	
	0.001 Ω	0.15 μΩ	KAENAHO B CCCP fixed value resistor
	0.01 Ω	0.94 μΩ	
	0.1 Ω	16 μΩ	
	1 Ω	0.16 mΩ	
	10 Ω	0.73 mΩ	
	100 Ω	14 mΩ	
	1 kΩ	87 mΩ	
	10 kΩ	1.0 Ω	
	100 kΩ	23 Ω	

Parameter/Range	Frequency	CMC <sup>2, 4, 5</sup> (±)	Comments
AC Voltage <sup>3</sup> – Generate			
(1 to 33) mV	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.062 % + 5.0 μV 0.012 % + 5.0 μV 0.016 % + 5.6 μV 0.078 % + 7.7 μV 0.27 % + 12 μV 0.62 % + 45 μV	Fluke 5520A
(33 to 330) mV	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.023 % + 25 μV 0.011 % + 11 μV 0.012 % + 11 μV 0.027 % + 33 μV 0.062 % + 35 μV 0.16 % + 93 μV	
330 mV to 3.3 V	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz	0.023 % + 150 μV 0.012 % + 100 μV 0.015 % + 100 μV 0.023 % + 120 μV 0.054 % + 220 μV 0.19 % + 1.0 mV	
(3.3 to 33) V	(10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.023 % + 3.4 mV 0.012 % + 1.0 mV 0.019 % + 1.1 mV 0.027 % + 1.5 mV 0.070 % + 2.6 mV	
(33 to 330) V	45 Hz to 1 kHz (1 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.015 % + 12 mV 0.016 % + 13 mV 0.019 % + 14 mV 0.023 % + 31 mV 0.16 % + 49 mV	
(330 to 1020) V	45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.023 % + 54 mV 0.019 % + 32 mV 0.023 % + 35 mV	
(1 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 500 kHz 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 % + 7.0 μV 0.11 % + 13 μV 0.17 % + 25 μV 0.34 % + 25 μV	

Parameter/Range	Frequency	CMC <sup>2, 4, 5</sup> (±)	Comments
AC Voltage <sup>3</sup> – 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 500 kHz to 1 MHz	0.055 % + 5.1 μV 0.021 % + 5.2 μV 0.011 % + 4.2 μV 0.037 % + 5.1 μV 0.085 % + 7.0 μV 0.11 % + 12 μV 0.17 % + 25 μV 0.34 % + 25 μV	Fluke 5520A
(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 500 kHz to 1 MHz	0.055 % + 13 μV 0.021 % + 8.0 μV 0.011 % + 8.0 μV 0.037 % + 8.0 μV 0.085 % + 25 μV 0.11 % + 25 μV 0.17 % + 35 μV 0.34 % + 80 μV	
(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 500 kHz to 1 MHz	0.050 % + 130 μV 0.016 % + 55 μV 0.0080 % + 41 μV 0.012 % + 83 μV 0.025 % + 140 μV 0.043 % + 280 μV 0.11 % + 530 μV 0.22 % + 1.6 mV	
(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 500 kHz to 1 MHz	0.050 % + 1.3 mV 0.016 % + 560 μV 0.008 % + 440 μV 0.012 % + 860 μV 0.025 % + 1.3 mV 0.050 % + 3.3 mV 0.13 % + 7.5 mV 0.27 % + 20 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	0.050 % + 13 mV 0.016 % + 5.8 mV 0.0080 % + 5.1 mV 0.022 % + 12 mV 0.050 % + 17 mV	
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.040 % + 95 mV 0.0080 % + 94 mV	

Parameter/Range	Frequency	CMC <sup>2, 4, 5</sup> (±)	Comments
AC Voltage <sup>3</sup> – Measure			
(1 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 300 kHz to 1 MHz	0.30 μV/V + 4.1 μV 0.20 μV/V + 3.0 μV 0.30 μV/V + 3.1 μV 1.0 μV/V + 3.1 μV 5.0 μV/V + 9.1 μV 40 μV/V + 66 μV 40 μV/V + 66 μV	Agilent 3458A
(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 300 kHz to 1 MHz (1 to 2) MHz (2 to 4) MHz (4 to 6) MHz (6 to 8) MHz (8 to 10) MHz	72 nV/V + 7.0 μV 72 nV/V + 6.1 μV 0.14 μV/V + 8.1 μV 0.30 μV/V + 8.1 μV 0.80 μV/V + 37 μV 3.0 μV/V + 70 μV 10 μV/V + 70 μV 15 μV/V + 91 μV 40 μV/V + 0.72 mV 40 μV/V + 0.77 mV 40 μV/V + 0.77 mV 0.015 % + 2.3 mV	
100 mV to 1V	(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 300 kHz to 1 MHz (1 to 2) MHz (2 to 4) MHz (4 to 6) MHz (6 to 8) MHz (8 to 10) MHz	72 nV/V + 64 μV 72 nV/V + 54 μV 0.014 % + 72 μV 0.030 % + 0.13 mV 0.080 % + 0.21 mV 0.30 % + 0.61 mV 1.0 % + 1.7 mV 1.5 % + 1.8 mV 4.0 % + 7.2 mV 4.0 % + 7.7 mV 4.0 % + 7.7 mV 15 % + 25 mV	
(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 300 kHz to 1 MHz	72 μV/V + 0.71 mV 72 μV/V + 0.54 mV 0.014 % + 0.71 mV 0.030 % + 1.3 mV 0.080 % + 1.6 mV 0.30 % + 5.2 mV 1.0 % + 16 mV	

Parameter/Range	Frequency	CMC <sup>2, 4, 5</sup> (±)	Comments
AC Voltage <sup>3</sup> – Measure			
(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 300 kHz to 1 MHz	0.020 % + 9.3 mV 0.020 % + 8.6 mV 0.020 % + 12 mV 0.035 % + 14 mV 0.12 % + 34 mV 0.40 % + 35 mV 1.5 % + 35 mV	Agilent 3458A
(100 to 700) V	(1 to 50) Hz 50 Hz to 1 kHz (1 to 10) kHz	0.040 % + 87 mV 0.040 % + 80 mV 0.060 % + 80 mV	
100 V to 15 kV	60 Hz	3.9 %	Tektronix P6015A with 1MΩ impedance oscilloscope
(0.5 to 5) kV (> 5 to 10) kV	60 Hz	0.14 % + 0.60 V 0.14 % + 29 V	Vitretek 4700
(> 10 to 20) kV (20 to 50) kV (50 to 70) kV	60 Hz	0.14 % + 29 V 0.14 % + 58 V 0.14 % + 0.12 kV	Vitretek 4700 + Vitretek HVL-100 Probe
100 V to 1 kV	400 Hz	0.46 % + 0.13 V	Vitretek 4700



Parameter/Range	Frequency	CMC <sup>2, 4, 5</sup> (±)	Comments
AC Current <sup>3</sup> – Generate			
(29 to 330) μA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.16 % + 0.11 μA 0.12 % + 0.10 μA 0.097 % + 0.11 μA 0.23 % + 0.16 μA 0.62 % + 0.22 μA 1.2 % + 0.41 μA	Fluke 5520A
(0.33 to 3.3) mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.16 % + 0.49 μA 0.097 % + 0.42 μA 0.078 % + 0.41 μA 0.16 % + 0.51 μA 0.39 % + 0.93 μA 0.78 % + 2.8 μA	
(3.3 to 33) mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.14 % + 4.5 μA 0.070 % + 4.3 μA 0.031 % + 4.1 μA 0.062 % + 5.0 μA 0.16 % + 9.0 μA 0.31 % + 21 μA	
(0 to 220) μA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.070 % + 28 nA 0.035 % + 24 nA 0.014 % + 21 nA 0.060 % + 42 nA 0.16 % + 82 nA	Fluke 5700A
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	0.070 % + 140 nA 0.035 % + 170 nA 0.014 % + 140 nA 0.060 % + 420 nA 0.16 % + 810 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	0.070 % + 1.5 μA 0.035 % + 1.4 μA 0.014 % + 1.4 μA 0.060 % + 4.3 μA 0.16 % + 8.1 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	0.070 % + 1.4 μA 0.035 % + 1.4 μA 0.014 % + 1.4 μA 0.060 % + 42 μA 0.16 % + 81 μA	

Parameter/Range	Frequency	CMC <sup>2, 4, 5</sup> (±)	Comments
AC Current <sup>3</sup> – Generate (cont)			
220 mA to 2.2 A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.065 % + 140 µA 0.075 % + 160 µA 0.85 % + 210 µA	Fluke 5700A
(33 to 330) mA	(10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.14 % + 47 µA 0.070 % + 45 µA 0.031 % + 42 µA 0.078 % + 62 µA 0.16 % + 120 µA 0.31 % + 310 µA	Fluke 5520A
(0.33 to 1.1) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.14 % + 0.14 mA 0.039 % + 0.13 mA 0.47 % + 0.80 mA 2.0 % + 3.9 mA	
(1.1 to 3) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.14 % + 1.1 mA 0.046 % + 1.0 mA 0.47 % + 1.5 mA 2.0 % + 4.4 mA	
(3 to 11) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.047 % + 3.1 mA 0.078 % + 3.1 mA 0.23 % + 4.0 mA	
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.093 % + 6.3 mA 0.12 % + 6.1 mA 0.23 % + 7.5 mA	
(> 20 to 50) A	(50 to 100) Hz (100 to 400) Hz	0.23 % + 0.12 A 0.62 % + 0.12 A	Fluke 5520A + Fluke 5500A/Coil
(50 to 100) A	(50 to 100) Hz (100 to 400) Hz	0.23 % + 0.21 A 0.62 % + 0.21 A	
(100 to 500) A	(50 to 100) Hz (100 to 400) Hz	0.23 % + 1.1 A 0.62 % + 1.1 A	
(500 to 1000) A	(50 to 100) Hz (100 to 400) Hz	0.24 % + 2.1 A 0.63 % + 1.9 A	

Parameter/Range	Frequency	CMC <sup>2, 4, 5</sup> (±)	Comments
AC Current <sup>3</sup> – Measure			
(10 to 100) μA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 10) kHz	0.40 % + 44 nA 0.15 % + 44 nA 0.061 % + 44 nA 0.061 % + 44 nA 0.061 % + 44 nA	Agilent 3458A
100 μA to 1 mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 10) kHz	0.40 % + 0.23 μA 0.15 % + 0.23 μA 0.061 % + 0.23 μA 0.031 % + 0.23 μA 0.061 % + 0.23 μA	
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 10) kHz	0.40 % + 2.8 μA 0.15 % + 2.8 μA 0.061 % + 2.8 μA 0.031 % + 2.8 μA 0.061 % + 2.8 μA	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 10) kHz	0.40 % + 28 μA 0.15 % + 28 μA 0.061 % + 28 μA 0.031 % + 28 μA 0.061 % + 28 μA	
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 10) kHz	0.40 % + 0.29 mA 0.18% + 0.29 mA 0.081 % + 0.29 mA 0.11 % + 0.29 mA 0.31 % + 0.29 mA	
(1 to 3) A	10 Hz to 1 kHz (1 to 5) kHz	0.14 % + 3.8 mA 2.3 % + 4.5 mA	Fluke 8846A
(3 to 10) A	10 Hz to 1 kHz (1 to 5) kHz	0.14 % + 9.4 mA 2.3 % + 9.7 mA	
(10 to 20) A	10 Hz to 400 Hz 400 Hz to 1 kHz	0.23 % + 18 mA 0.23 % + 38 mA	Agilent 3458A & 50A/50mV current shunt

Parameter/Range	Frequency	CMC <sup>2, 4, 5</sup> (±)	Comments
Capacitance <sup>3</sup> – Generate			
(0.19 to 0.4) nF	10 Hz to 10 kHz	0.39 % + 0.0079 nF	Fluke 5520A
(0.4 to 1.1) nF	10 Hz to 10 kHz	0.39 % + 0.0080 nF	
(1.1 to 3.3) nF	10 Hz to 3 kHz	0.39 % + 0.0085 nF	
(3.3 to 11) nF	10 Hz to 1 kHz	0.19 % + 0.012 nF	
(11 to 33) nF	10 Hz to 1 kHz	0.19 % + 0.080 nF	
(33 to 110) nF	10 Hz to 1 kHz	0.19 % + 0.10 nF	
(110 to 330) nF	10 Hz to 1 kHz	0.19 % + 0.32 nF	
(0.33 to 1.1) μF	(10 to 600) Hz	0.19 % + 1.1 nF	
(1.1 to 3.3) μF	(10 to 300) Hz	0.19 % + 3.0 nF	
(3.3 to 11) μF	(10 to 150) Hz	0.19 % + 12 nF	
(11 to 33) μF	(10 to 120) Hz	0.31 % + 23 nF	
(33 to 110) μF	(10 to 80) Hz	0.35 % + 150 nF	
(110 to 330) μF	Up to 50 Hz	0.35 % + 420 nF	
(0.33 to 1.1) mF	Up to 20 Hz	0.35 % + 1.1 μF	
(1.1 to 3.3) mF	Up to 6 Hz	0.35 % + 2.5 μF	
(3.3 to 11) mF	Up to 2 Hz	0.35 % + 9.5 μF	
(11 to 33) mF	Up to 0.6 Hz	0.58 % + 25 μF	
(33 to 110) mF	Up to 0.2 Hz	0.85 % + 81 μF	

Parameter/Equipment	Range	CMC <sup>2, 5</sup> (±)	Comments
Electrical Simulation of Thermocouple Indicating Systems <sup>3</sup> –			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.34 °C 0.27 °C 0.24 °C 0.26 °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	0.23 °C 0.20 °C 0.24 °C 0.39 °C 0.65 °C	
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.39 °C 0.13 °C 0.11 °C 0.14 °C 0.17 °C	
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.21 °C 0.13 °C 0.11 °C 0.13 °C 0.18 °C	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.26 °C 0.14 °C 0.13 °C 0.20 °C 0.31 °C	
Type L	(-200 to -100) °C (-100 to -800) °C (-800 to 900) °C	0.29 °C 0.20 °C 0.14 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.31 °C 0.17 °C 0.15 °C 0.14 °C 0.21 °C	
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	

Parameter/Equipment	Range	CMC <sup>2, 5</sup> (±)	Comments
Electrical Simulation of Thermocouple Indicating Systems <sup>3</sup> – (cont)			
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.36 °C 0.28 °C 0.29 °C 0.36 °C	Fluke 5520A
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	0.43 °C 0.21 °C	
Electrical Simulation of RTD Indicators and Indicating Systems <sup>3</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	0.040 °C 0.040 °C 0.050 °C 0.070 °C 0.080 °C 0.090 °C 0.18 °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	0.040 °C 0.040 °C 0.060 °C 0.070 °C 0.080 °C 0.090 °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	0.19 °C 0.030 °C 0.040 °C 0.050 °C 0.050 °C 0.060 °C 0.070 °C 0.080 °C 0.18 °C	

Parameter/Equipment	Range	CMC <sup>2, 5</sup> (±)	Comments
Electrical Simulation of RTD Indicators and Indicating Systems <sup>3</sup> (cont)–			
Pt 385, 200 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	0.030 °C 0.030 °C 0.030 °C 0.040 °C 0.090 °C 0.10 °C 0.11 °C 0.12 °C	Fluke 5520A
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	0.030 °C 0.040 °C 0.040 °C 0.050 °C 0.060 °C 0.060 °C 0.070 °C 0.090 °C	
Pt 385, 1000 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	0.020 °C 0.020 °C 0.030 °C 0.040 °C 0.050 °C 0.050 °C 0.050 °C 0.18 °C	
PtNi 385, 120 Ω	(-80 to 0) °C (0 to 100) °C (100 to 260) °C	0.060 °C 0.060 °C 0.11 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.23 °C	

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
<p>Oscilloscope<sup>3</sup> –</p> <p>Square Wave Amplitude: 50 Ω Load 1 MΩ Load</p> <p>DC Signal Output: 50 Ω Load 1 MΩ Load</p> <p>Leveled Sine Wave Amplitude: 5 mV<sub>p-p</sub> to 5.5 V<sub>p-p</sub></p> <p>5 mV<sub>p-p</sub> to 3.5 V<sub>p-p</sub></p> <p>Flatness: Relative to 50 kHz 5 mV<sub>p-p</sub> to 5.5 V<sub>p-p</sub></p> <p>Time Marker: 50 Ω Load</p> <p>Edge-Rise Time</p>	<p>V<sub>p-p</sub> 1 mV to 6.6 V V<sub>p-p</sub> 1 mV to 130 V ≤ 1 kHz &gt; 1 kHz</p> <p>V<sub>dc</sub> (0 to 6.6) V V<sub>dc</sub> (0 to 130) V</p> <p>50 kHz reference 50 KHz to 100 MHz (100 to 300) MHz</p> <p>(300 to 600) MHz (600 to 1100) MHz</p> <p>50 kHz reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz</p> <p>5 s to 50 ms (20 to 1.0) ms (50 to 20) ns 10 ns (5 to 1) ns</p> <p>1 kHz to 10 MHz</p>	<p>0.19 % of output + 39 μV 0.08 % of output + 39 μV 0.08 % of output + 39 μV</p> <p>0.19 % of output + 5.9 μV 0.040 % of output + 8.0 μV</p> <p>1.6 % of output + 250 μV 2.8 % of output + 400 μV 3.1 % of output + 660 μV</p> <p>4.7 % of output + 660 μV 5.5 % of output + 250 μV</p> <p>1.5 % of output + 240 μV 2.0 % of output + 240 μV 4.0 % of output + 240 μV 5.0 % of output + 240 μV</p> <p>8.1 μs/s 8.1 μs/s 8.1 μs/s 5.8 μs/s 5.8 μs/s</p> <p>≤ 300 ps</p>	<p>Fluke 5520A with SC-1100 option</p>
<p>DC Power<sup>3</sup> –</p> <p>33 mV to 1020 V</p>	<p>330 μA to 330 mA &gt; 330 mA to 3 A (&gt; 3 to 20) A</p>	<p>0.018 % 0.041 % 0.078 %</p>	<p>Fluke 5520A</p>





Parameter/Range	Frequency	CMC <sup>2, 4</sup> (±)	Comments
AC Power <sup>3</sup> – (cont)			
(> 3 to 9) mA	(5 to 10) kHz	0.18 %	Fluke 5520A
(> 9 to 33) mA		0.16 %	
(> 33 to 90) mA		0.18 %	
(> 90 to 330) mA		0.16 %	
> 330 mA to 0.9 A		2.0 %	
(> 0.9 to 2.2) A		2.2 %	

## II. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
RF Absolute Power – Measure			
(20 to 44) dBm	10 MHz to 4 GHz	0.73 dB	30 dB attenuator with HP8482B
(-30 to 20) dBm	0.1 MHz to 4 GHz	0.16 dB	HP437B+HP 8482A
(-20 to -70) dBm	10 MHz to 8 GHz	0.11 dB	HP437B+HP8481D
	(> 8 to 10) GHz	0.13 dB	HP437B+HP8481D
	(> 10 to 14) GHz	0.14 dB	HP437B+HP8481D
	(> 14 to 18) GHz	0.16 dB	HP437B+HP8481D
(10 to -10) dBm	10 MHz to 8 GHz	0.13 dB	HP437B+HP8481A
	(> 8 to 10) GHz	0.17 dB	HP437B+HP8481A
	(> 10 to 14) GHz	0.17 dB	HP437B+HP8481A
	(> 14 to 18) GHz	0.21 dB	HP437B+HP8481A

### III. Mechanical

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Pressure <sup>3</sup> – Generate and Measure	Pneumatic		
	(-14 to 0) PSI	0.025 % + 0.73 PSI	Druck DPI610
	(0 to 300) PSI	0.025 % + 0.73 PSI	
	Hydraulic	(0 to 2000) PSI	0.02 % + 0.34 PSI
(>2000 to 10 000) PSI		0.1 % + 0.69 PSI	

### IV. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Frequency and Period – Measuring Equipment	10 MHz	0.035 mHz	Brandywine Communication GPS time/frequency system
	(0.01 to 119.99) Hz	3.0 pHz/Hz + 5.8 mHz	Fluke 5520A
	(120.0 to 1199.9) Hz	3.0 pHz/Hz + 58 mHz	(w/10 MHz GPS external clock)
	(1.200 to 11.999) kHz	3.0 pHz/Hz + 0.58 Hz	
	(12.00 to 119.99) kHz	3.0 pHz/Hz + 5.8 Hz	
	(120.0 to 1199.9) kHz	3.0 pHz/Hz + 58 Hz	
	(1.200 to 2.000) MHz	3.0 pHz/Hz + 0.58 kHz	
	(0.05 to 100) MHz	3.0 pHz/Hz + 5.8 kHz	
	(100 to 300) MHz	3.0 pHz/Hz + 5.8 kHz	
	(300 to 600) MHz	3.0 pHz/Hz + 5.8 kHz	
(600 to 1100) MHz	3.0 pHz/Hz + 58 kHz		

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

<sup>2</sup> Calibration and Measurement Capability Uncertainty (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. CMCs 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. 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> Unless otherwise noted, in the statement of CMC, percent refers to percent of reading.
- <sup>5</sup> The measurands stated are generated using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure the measurand in the ranges indicated. CMC are expressed as either a specific value that covers the full range or as a fraction/percent of the reading plus a fixed floor specification.
- <sup>6</sup> This scope meets A2LA's *P112 Flexible Scope Policy*.