



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005  
& ANSI/NCSL Z540.3-2006

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CALIBRATION

Valid to: August 31, 2018

Certificate Number: 2462.01

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

I. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC <sup>2,5,6</sup> (±)	Comments
DC Voltage – Generate	(0.001 to 0.004) V	23 µV/V	Fluke 5720A into Keithley 262 divider
	(0.004 to 0.01) V	14 µV/V	
	Up to 0.22 V	6.0 µV/V + 0.6 µV	Fluke 5720A (based on 90 day specs)
	(0.22 to 2.2) V	3.5 µV/V + 0.7 µV	
	(2.2 to 11) V	2.5 µV/V + 2.5 µV	
	(11 to 22) V	2.5 µV/V + 4 µV	
(22 to 220) V	3.5 µV/V + 40 µV		
(220 to 1100) V	4.5 µV/V + 0.4 mV		
Fixed Points	(300 to 3000) V	59 µV/V + 30 mV	Characterized Keithley 2657A, Keithley 2002
	0 V	50 nV	Copper short
	10 V	0.34 µV/V	Fluke 732B
	100 mV	1.3 µV/V	Characterized Fluke 5720A/Fluke 752A
	1 V	0.46 µV/V	
	100 V	0.45 µV/V	
1000 V	0.7 µV/V		
DC Voltage – Generate <sup>3</sup>	Up to 0.2 V	26 µV/V + 5.1 µV	Voltage source, Keithley 2002
(0.2 to 2) V	15 µV/V + 7.9 µV		
(2 to 20) V	17 µV/V + 79 µV		
(20 to 200) V	29 µV/V + 1 mV		
(200 to 500) V	34 µV/V + 0.92 mV		
(500 to 1000) V	49 µV/V + 15 mV		

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
DC Voltage – Measure <sup>4,5</sup>	(0 to 0.01) V	47 µV/V + 63 nV	Keithley 2182A (based on 90 day specs)
	(0.01 to 0.1) V (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 500) V (500 to 1000) V	3.4 µV/V + 0.42 µV 2.2 µV/V + 0.42 µV 1.1 µV/V + 1 µV 3.3 µV/V + 42 µV 6.8 µV/V + 0.16 mV 17 µV/V + 0.33 mV	Agilent 3458A (based on 24 hr specs)
Fixed Points	(300 to 3000) V	59 µV/V + 25 mV	Voltage divider and Keithley 2002
	10 V 1.018 V 1 V	0.34 µV/V 0.68 µV/V 0.64 µV/V	Fluke 734A 734A/3458A
DC Voltage – Measure <sup>3,4,5</sup>	100 mV 1 V 100 V 1000 V	1.3 µV/V 0.46 µV/V 0.45 µV/V 0.7 µV/V	Keithley 2182A nullmeter and Fluke 752A
	Up to 0.2 V (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 500) V (500 to 1000) V	26 µV/V + 5.1 µV 15 µV/V + 7.9 µV 17 µV/V + 79 µV 29 µV/V + 1 mV 34 µV/V + 0.92 mV 49 µV/V + 15 mV	Keithley 2002
DC Current – Generate <sup>5,6</sup>	Up to 100 nA 100 nA to 1 µA (1 to 10) µA (10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1.05) A (1 to 10) A	36 µA/A + 59 pA 19 µA/A + 74 pA 19 µA/A + 0.15 nA 19 µA/A + 1.3 nA 12 µA/A + 4 nA 13 µA/A + 40 nA 36 µA/A + 0.94 µA 0.012 % + 17 µA 0.038 % + 0.41 mA	Current source characterized with Agilent 3458A or Fluke 8508A
	Up to 100 nA 100 nA to 1 µA (1 to 10) µA	29 µA/A + 17 pA 28 µA/A + 0.12 nA 28 µA/A + 1.2 nA	Current source characterized with Agilent 3458A/shunts
Pulsed (1 ms Max)	(1 to 10) A (10 to 20) A (20 to 50) A	76 µA/A + 0.29 mA 76 µA/A + 0.93 mA 95 µA/A + 3.2 mA	Plus 0.1 Ω shunt

Parameter/Equipment	Range	CMC <sup>2, 5, 6</sup> (±)	Comments
DC Current –Generate (cont)	(0.2 to 2) pA (2 to 20) pA (20 to 200) pA (0.2 to 2) nA (2 to 20) nA (20 to 200) nA  (10 to 220) µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA (0.22 to 1) A (1 to 2.2) A (2.2 to 11) A  (0 to 100) nA (0.1 to 1) µA (1 to 10) µA (10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1.05) A	0.085 % + 4.1 fA 0.085 % + 4.1 fA 0.021 % + 41 fA 0.021 % + 41 fA 0.019 % + 0.41 pA 0.018 % + 4.1 pA  35 µA/A + 6 nA 30 µA/A + 7 nA 30 µA/A + 40 nA 40 µA/A + 0.7 µA 60 µA/A + 12 µA 0.011 % + 12 µA 0.034 % + 0.48 mA  6.7 µA/A + 1.7 pA 6.7 µA/A + 12 pA 6.8 µA/A + 18 pA 6.8 µA/A + 0.13 nA 5.9 µA/A + 0.76 nA 10 µA/A + 6.9 nA 17 µA/A + 0.13 µA 42 µA/A + 1.3 µA	Fluke 5720A KI 5156 applied to virtual ground current meters  Fluke 5720A (based on 90 day specs)  With Fluke 5725A  Keithley 263, Fluke 5450A, Fluke 8508A
DC Current – Generate <sup>3</sup>	Up to 1 pA (1 to 10) pA (10 to 100) pA (0.1 to 1) nA (1 to 10) nA (10 to 100) nA (0.1 to 1) µA (1 to 10) µA (10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	0.049 % + 2 fA 0.049 % + 5.9 fA 0.012 % + 16 fA 0.010 % + 82 fA 75 µA/A + 0.73 pA 65 µA/A + 2.6 pA 50 µA/A + 21 pA 45 µA/A + 0.14 nA 30 µA/A + 1.1 nA 28 µA/A + 12 nA 63 µA/A + 0.12 µA 97 µA/A + 1.4 µA 0.046 % + 19 µA	Keithley 2002, Keithley 7177, current source



Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments	
DC Current – Measure <sup>4</sup>	(0.2 to 2) pA	0.076 % + 0.71 fA	Keithley high resistance transfer system plus Keithley 5155 resistors	
	(2 to 20) pA	0.018 % + 0.77 fA		
	(20 to 200) pA	0.014 % + 3.3 fA		
	(0.2 to 2) nA	0.011 % + 32 fA		
	(2 to 20) nA	79 µA/A + 0.32 pA		
	(20 to 200) nA	52 µA/A + 3.2 pA		
	(0.2 to 2) µA	19 µA/A + 32 pA		
	Up to 100 nA	36 µA/A + 59 pA		Agilent 3458A (based on 90 day specs)
	100 nA to 1 µA	19 µA/A + 59 pA		
	(1 to 10) µA	19 µA/A + 0.13 nA		
(10 to 100) µA	19 µA/A + 1.1 nA			
100 µA to 1 mA	19 µA/A + 7 nA			
(1 to 10) mA	19 µA/A + 70 nA			
(10 to 100) mA	36 µA/A + 0.7 µA			
100 mA to 1.1 A	0.012 % + 13 µA	Fluke Y5020, Agilent 3458		
(0 to 11) A	67 µA/A + 48 µA			
Continuous	(0.1 to 1) pA	0.085 % + 4.1 fA	Keithley 5156 and Agilent 3458A	
	(1 to 10) pA	0.085 % + 4.1 fA		
	(10 to 100) pA	0.021 % + 41 fA		
	(0.1 to 1) nA	0.021 % + 41 fA		
	(1 to 10) nA	0.019 % + 0.41 pA		
	(10 to 100) nA	0.018 % + 4.1 pA		
	Up to 100 nA	29 µA/A + 17 pA		Various resistors and Agilent 3458A
	(0.1 to 1) µA	28 µA/A + 0.12 nA		
	(1 to 10) µA	28 µA/A + 1.2 nA		
	(10 to 220) µA	3.9 µA/A + 0.15 nA		
(0.22 to 2.2) mA	3.9 µA/A + 1.5 nA			
(2.2 to 22) mA	5.4 µA/A + 52 nA			
(22 to 220) mA	4.4 µA/A + 0.53 µA			
(0.22 to 2.2) A	27 µA/A + 4.3 µA			
Pulsed (1 ms Max)	(1 to 10) A	76 µA/A + 0.38 mA	Plus 0.1 Ω shunt	
	(10 to 20) A	76 µA/A + 0.72 mA		
	(20 to 50) A	95 µA/A + 6.4 mA		

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
DC Current – Measure <sup>3, 4, 5</sup>	Up to 1 pA (1 to 10) pA (10 to 100) pA (0.1 to 1) nA (1 to 10) nA (10 to 100) nA (0.1 to 1) μA (1 to 10) μA (10 to 100) μA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	0.049 % + 2 fA 0.049 % + 5.9 fA 0.012 % + 16 fA 0.010 % + 82 fA 75 μA/A + 0.73 pA 65 μA/A + 2.6 pA 50 μA/A + 21 pA 45 μA/A + 0.14 nA 30 μA/A + 1.1 nA 28 μA/A + 12 nA 63 μA/A + 0.12 μA 97 μA/A + 1.4 μA 0.046 % + 19 μA	Keithley 2002, Keithley 7177
DC Resistance – Generate <sup>5, 6</sup>	(0 to 1000) Ω	16 μΩ/Ω + 45 mΩ	Resistors characterized with Agilent 3458A
Fixed Points	0.1 Ω 1 Ω 1.9 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ  19 kΩ 100 kΩ 1 MΩ 10 MΩ 19 MΩ 100 MΩ  100 MΩ 900 MΩ 1 GΩ 10 GΩ 100 GΩ 1 TΩ 10 TΩ  0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ	0.78 μΩ/Ω 0.28 μΩ/Ω 0.37 μΩ/Ω 0.56 μΩ/Ω 0.85 μΩ/Ω 0.30 μΩ/Ω 0.18 μΩ/Ω  0.40 μΩ/Ω 0.95 μΩ/Ω 1.2 μΩ/Ω 3.1 μΩ/Ω 6.5 μΩ/Ω 36 μΩ/Ω  74 μΩ/Ω 0.014 % 97 μΩ/Ω 0.013 % 0.018 % 0.07 % 0.57 %  40 μΩ 80 μΩ/Ω 80 μΩ/Ω 21 μΩ/Ω 21 μΩ/Ω 9 μΩ/Ω 9 μΩ/Ω 7.5 μΩ/Ω 7.5 μΩ/Ω 7.5 μΩ/Ω 7.5 μΩ/Ω 9 μΩ/Ω	MI 6010B system with standard resistors  MI 6000B system with standard resistors  Keithley high resistance transfer system  Fluke 5720A (based on 90 day specs)



Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
DC Resistance – Generate, Fixed Points <sup>6</sup>	190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	9 μΩ/Ω 15 μΩ/Ω 16 μΩ/Ω 31 μΩ/Ω 39 μΩ/Ω 95 μΩ/Ω	Fluke 5720A (based on 90 day specs)
	1 Ω 10 Ω	20 μΩ/Ω 11 μΩ/Ω	R-source characterized with Fluke 8508A
DC Resistance – Generate, Fixed Points <sup>3,6</sup>	10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ 1 GΩ 10 GΩ 100 GΩ	96 μΩ/Ω 61 μΩ/Ω 24 μΩ/Ω 27 μΩ/Ω 42 μΩ/Ω 48 μΩ/Ω 63 μΩ/Ω 74 μΩ/Ω 0.01 % 0.012 % 0.049 %	Keithley 7177
DC Resistance – Measure <sup>4</sup>	0.01 Ω	31 μΩ/Ω	Standard shunt, current transfer
	(0.1 to 10) Ω	0.3 μΩ/Ω	MI 6010B and standard resistors
	(>10 to 100) Ω	0.72 μΩ/Ω	
	(>100 to <1000) Ω	0.72 μΩ/Ω	
	1 kΩ	0.22 μΩ/Ω	MI 6010B and standard resistors
	(>1 to 10) kΩ	0.32 μΩ/Ω	
	(>10 to 100) kΩ	0.2 μΩ/Ω	MI 6000B system with standard resistors
>100 kΩ to 1 MΩ	0.9 μΩ/Ω		
(>1 to 10) MΩ	3.1 μΩ/Ω		
(>10 to 100) MΩ	5 μΩ/Ω	Keithley high resistance transfer system	
>100 MΩ to 1 GΩ	40 μΩ/Ω		
(85 to 115) MΩ	64 μΩ/Ω		
(0.85 to 1.15) GΩ	87 μΩ/Ω		
(8.5 to 11.5) GΩ	0.012 %		
(85 to 115) GΩ	0.015 %		
(0.85 to 1.15) TΩ	0.052 %		
(8.5 to 11.5) TΩ	0.27 %		

Parameter/Equipment	Range	CMC <sup>2,6</sup> (±)	Comments
Thermocouple Simulation – Generate <sup>7</sup>  Thermocouple Type: K	(-25 to 150) °C	0.5 °C	Ectron 1120, TC simulator

Parameter/Range	Frequency	CMC <sup>2,6</sup> (±)	Comments
AC Current – Generate <sup>5</sup>  (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	0.023 % + 16 nA 0.014 % + 10 nA 0.011 % + 8 nA 0.025 % + 12 nA 0.09 % + 65 nA	Fluke 5720A (based on 90 day specs)
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	0.023 % + 40 nA 0.014 % + 35 nA 0.011 % + 35 nA 0.018 % + 0.11 µA 0.09 % + 0.65 µA	
(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	0.023 % + 0.4 µA 0.014 % + 0.35 µA 0.011 % + 0.35 µA 0.018 % + 0.55 µA 0.090 % + 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	0.023 % + 4 µA 0.014 % + 3.6 µA 0.011 % + 2.5 µA 0.018 % + 3.5 µA 0.09 % + 10 µA	
220 mA to 2.2 A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.024 % + 35 µA 0.039 % + 80 µA 0.6 % + 0.16 mA	
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.04 % + 0.17 mA 0.085 % + 0.38 mA 0.33 % + 0.75 mA	



Parameter/Range	Frequency	CMC <sup>2,5</sup> (±)	Comments
AC Current – Measure <sup>4</sup>			
(5 to 100) µA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.47 % + 35 nA 0.18 % + 35 nA 0.069 % + 35 nA 0.069 % + 35 nA	Agilent 3458A
Fixed Points			
190 µA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz	64 µA/A 45 µA/A 37 µA/A 37 µA/A 42 µA/A 78 µA/A 85 µA/A	Fluke 792A (Fluke 5790A with higher uncertainties) used with external current shunts
1.9 mA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz	47 µA/A 42 µA/A 31 µA/A 26 µA/A 40 µA/A 52 µA/A 38 µA/A	
19 mA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz	53 µA/A 44 µA/A 31 µA/A 31 µA/A 31 µA/A 31 µA/A 31 µA/A	
190 mA	10 Hz 20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz	56 µA/A 48 µA/A 32 µA/A 32 µA/A 32 µA/A 32 µA/A 33 µA/A	
1.9 A	20 Hz 40 Hz 400 Hz 1 kHz 5 kHz 10 kHz	69 µA/A 58 µA/A 55 µA/A 56 µA/A 61 µA/A 0.016 %	
10 A	40 Hz 400 Hz 1 kHz 5 kHz 10 kHz	0.011 % 0.011 % 0.011 % 0.011 % 0.014 %	Fluke 792A with external current shunts



Parameter/Range	Frequency	CMC <sup>2,5</sup> (±)	Comments
AC Current – Measure <sup>4</sup> (cont)			
(0.1 to 1) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.47 % + 0.23 µA 0.18 % + 0.23 µA 0.069 % + 0.23 µA 0.035 % + 0.23 µA	Agilent 3458A
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.47 % + 2.3 µA 0.19 % + 2.3 µA 0.069 % + 2.3 µA 0.035 % + 2.3 µA	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.47 % + 23 µA 0.18 % + 23 µA 0.069 % + 23 µA 0.035 % + 23 µA	
(0.1 to 1) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.47 % + 0.23 mA 0.19 % + 0.23 mA 0.092 % + 0.23 mA 0.12 % + 0.23 mA	
AC Voltage – Generate <sup>6</sup>			
(0 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	0.022 % + 4 µV 85 µV/V + 4 µV 75 µV/V + 4 µV 0.018 % + 4 µV 0.046 % + 5 µV 0.09 % + 10 µV 0.12 % + 20 µV 0.25 % + 20 µV	Fluke 5720A (based on 90 day specs)
(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	0.022 % + 12 µV 85 µV/V + 7.2 µV 75 µV/V + 7 µV 0.018 % + 7 µV 0.042 % + 17 µV 0.075 % + 20 µV 0.12 % + 25 µV 0.25 % + 45 µV	
220 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 500 kHz to 1 MHz	0.022 % + 40 µV 80 µV/V + 17 µV 40 µV/V + 8.0 µV 70 µV/V + 10 µV 0.011 % + 30 µV 0.034 % + 80 µV 0.09 % + 0.2 mV 0.15 % + 0.3 mV	



Parameter/Range	Frequency	CMC <sup>2, 5, 6</sup> (±)	Comments
AC Voltage – Generate			
(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	0.022 % + 0.4 mV 80 µV/V + 0.16 mV 40 µV/V + 50 µV 70 µV/V + 0.1 mV 95 µV/V + 0.2 mV 0.026 % + 0.6 mV 0.09 % + 2 mV 0.13 % + 3.2 mV	Fluke 5720A
(22 to 220) V (Limited to 2.2 x 10 <sup>7</sup> V·Hz)	(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	0.022 % + 4 mV 80 µV/V + 1.7 mV 47 µV/V + 0.6 mV 75 µV/V + 1 mV 0.013 % + 2.5 mV 0.08 % + 16 mV 0.42 % + 40 mV 0.7 % + 80 mV	
For the 1100 V Range:			
(220 to 250) V	(15 to 40) Hz	0.026 % + 16 mV	Plus Fluke 5725A
(220 to 1100) V	(40 to 50) Hz 50 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	80 µV/V + 4 mV 60 µV/V + 3.5 mV 0.013 % + 6 mV 0.036 % + 11 mV	
(220 to 750) V	(30 to 50) kHz (50 to 100) kHz	0.036 % + 11 mV 0.13 % + 45 mV	
AC Voltage – Measure <sup>4</sup>			
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 500 kHz to 1 MHz	0.13 % + 1 µV 0.057 % + 1 µV 0.033 % + 1 µV 0.063 % + 1.6 µV 0.093 % + 1.9 µV 0.18 % + 3.1 µV 0.19 % + 6.2 µV 0.27 % + 6.3 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 500 kHz to 1 MHz	0.066 % + 1 µV 0.029 % + 1 µV 0.016 % + 1 µV 0.31 % + 1.6 µV 0.047 % + 1.9 µV 0.093 % + 3.1 µV 0.1 % + 6.2 µV 0.18 % + 6.2 µV	

Parameter/Range	Frequency	CMC <sup>2, 4, 5</sup> (±)	Comments
AC Voltage – Measure (cont)			
(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 500 kHz to 1 MHz	0.022 % + 1 µV 0.015 % + 1 µV 85 µV/V + 1 µV 0.016 % + 1.6 µV 0.024 % + 1.9 µV 0.063 % + 3.1 µV 0.069 % + 6.2 µV 0.13 % + 6.3 µV	Fluke 5790A
(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 500 kHz to 1 MHz	0.019 % + 1.2 µV 93 µV/V + 1.2 µV 50 µV/V + 1.2 µV 0.01 % + 1.6 µV 0.02 % + 1.9 µV 0.40 % + 3.1 µV 0.052 % + 6.2 µV 0.085 % + 6.2 µV	
(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 500 kHz to 1 MHz	0.016 % + 1.9 µV 66 µV/V + 1.3 µV 29 µV/V + 1.2 µV 53 µV/V + 1.6 µV 0.012 % + 2 µV 0.019 % + 3.7 µV 0.029 % + 6.2 µV 0.078 % + 6.8 µV	
(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 500 kHz to 1 MHz	0.016 % + 1.2 µV 59 µV/V + 1.2 µV 26 µV/V + 1.2 µV 40 µV/V + 1.6 µV 61 µV/V + 1.9 µV 0.014 % + 3.1 µV 0.023 % + 6.2 µV 0.074 % + 6.2 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 500 kHz to 1 MHz	0.016 % + 14 µV 51 µV/V + 4.4 µV 19 µV/V + 2.5 µV 36 µV/V + 1.6 µV 55 µV/V + 2.4 µV 0.012 % + 16 µV 0.02 % + 5.1 µV 0.07 % + 16 µV	

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
AC Voltage – Measure <sup>4,5</sup> (cont)			
(2.2 to 7) 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	0.016 % + 0.6 μV 52 μV/V + 0.6 μV 19 μV/V + 0.6 μV 37 μV/V + 0.6 μV 63 μV/V + 0.6 μV 0.015 % + 0.6 μV 0.031 % + 0.6 μV 0.093 % + 0.6 μV	Fluke 5790A
(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 500 kHz to 1 MHz	0.016 % + 0.16 mV 52 μV/V + 38 μV 21 μV/V + 19 μV 37 μV/V + 21 μV 63 μV/V + 27 μV 0.015 % + 0.24 mV 0.031 % + 0.17 mV 0.093 % + 0.5 mV	
(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	0.016 % + 1.4 mV 53 μV/V + 0.77 mV 24 μV/V + 0.49 mV 53 μV/V + 0.36 mV 76 μV/V + 0.38 mV 0.016 % + 0.38 mV	
(700 to 1000) V	40 Hz to 20 kHz (20 to 50) kHz	29 μV/V + 0.77 mV 0.01 % + 58 μV	
Capacitance – Generate <sup>6</sup>			
Up to 0.7 nF (1 to 10) nF (10 to 100) nF (0.1 to 1) μF	1 kHz	0.063 % + 0.16 pF 0.063 % + 1.5 pF 0.063 % + 7.2 pF 0.063 % + 72 pF	IET 1423-9801
(1 to 10) μF (10 to 100) μF		0.057 % + 0.74 nF 0.057 % + 7.2 nF	IET HACS-Z-A-3E-1 uF
Fixed Point 100 μF		0.082 %	

Parameter/Range	Frequency	CMC <sup>2,4,5</sup> (±)	Comments
AC Voltage Flatness – Measure			
1 mV	10 kHz	0.05 %	Fluke 5790
	121 kHz	0.14 %	
	500 kHz	0.14 %	
	2.1 MHz	0.22 %	
	5 MHz	0.22 %	
	10.1 MHz	0.32 %	
	20.1 MHz	0.71 %	
	30 MHz	0.71 %	
3 mV	10 kHz	0.044 %	
	121 kHz	0.081 %	
	500 kHz	0.081 %	
	2.1 MHz	0.11 %	
	5 MHz	0.11 %	
	10.1 MHz	0.16 %	
	20.1 MHz	0.34 %	
	30 MHz	0.34 %	
10 mV	10 kHz	0.041 %	
	121 kHz	0.055 %	
	500 kHz	0.055 %	
	2.1 MHz	0.079 %	
	5 MHz	0.079 %	
	10.1 MHz	0.14 %	
	20.1 MHz	0.29 %	
	30 MHz	0.29 %	
30 mV	10 kHz	0.042 %	
	121 kHz	0.042 %	
	500 kHz	0.042 %	
	2.1 MHz	0.08 %	
	5 MHz	0.08 %	
	10.1 MHz	0.12 %	
	20.1 MHz	0.28 %	
	30 MHz	0.28 %	
100 mV	10 kHz	0.031 %	
	121 kHz	0.031 %	
	500 kHz	0.04 %	
	2.1 MHz	0.079 %	
	5 MHz	0.079 %	
	10.1 MHz	0.12 %	
	20.1 MHz	0.28 %	
	30 MHz	0.28 %	

Parameter/Range	Frequency	CMC <sup>2,4,5</sup> (±)	Comments
AC Voltage Flatness – Measure (cont)			
300 mV	10 kHz 121 kHz 500 kHz 2.1 MHz 5 MHz 10.1 MHz 20.1 MHz 30 MHz	0.022 % 0.022 % 0.041 % 0.08 % 0.08 % 0.12 % 0.28 % 0.28 %	Fluke 5790
1 V	10 kHz 121 kHz 500 kHz 2.1 MHz 5 MHz 10.1 MHz 20.1 MHz 30 MHz	0.021 % 0.021 % 0.04 % 0.079 % 0.079 % 0.12 % 0.28 % 0.28 %	
3 V	10 Hz 31 Hz 10 kHz 121 kHz 500 kHz 2.1 MHz 5 MHz 10.1 MHz 20.1 MHz 30 MHz	0.082 % 0.022 % 0.022 % 0.022 % 0.041 % 0.08 % 0.08 % 0.12 % 0.28 % 0.28 %	

## II. Time & Frequency

Parameter/Equipment	Range	CMC <sup>2,5</sup> (±)	Comments
Frequency – Measuring Equipment <sup>6</sup>	(1 to 10) Hz 10 Hz to 1 kHz 1 kHz to 20 MHz	6.2 µHz/Hz 5.9 µHz/Hz 5.9 µHz/Hz	Agilent 33220A and Fluke 910R
Fixed Point	10 MHz	33 pHz/Hz	Fluke 910R
Frequency – Measure <sup>4</sup>	10 Hz to 30 MHz	0.02 µHz/Hz	Agilent 53131A and Fluke 910R

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

- <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 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> This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. CMC is expressed as either a specific value that covers the full range or as a combination of the fraction/percent of the reading/output plus a range specification.
- <sup>5</sup> CMC is [ $\mu$ X/X of Reading] + offset (where listed) for the ranges indicated in the Parameter/Equipment column of table, where "X" equals V,  $\Omega$ , A or Hz, percentages are percentages of reading, unless otherwise indicated
- <sup>6</sup> This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. CMC is 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>7</sup> Electrically simulated thermocouple temperature. CMC is expressed as a specific value relative to the indicated value.



## Accredited Laboratory

A2LA has accredited

# KEITHLEY PRIMARY STANDARDS LABORATORY

*Cleveland, 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/NCSLI Z540.3-2006 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 day 5<sup>th</sup> of August 2016.

A handwritten signature in blue ink, appearing to read "J. C. Bunt".

Senior Director of Quality and Communications  
For the Accreditation Council  
Certificate Number 2462.01  
Valid to August 31, 2018

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