



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005
ANSI/NCSL Z540-1-1994 & ANSI/NCSL Z540.3-2006

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CALIBRATION

Valid To: March 31, 2013

Certificate Number: 2516.02

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

I. Chemical

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
pH Measuring Equipment ³	(4, 7, 10) units	0.012 units	Buffer solutions
Electrolytic Conductivity Measuring Equipment ³	≈10 μS/cm ≈100 μS/cm ≈1000 μS/cm ≈10 000 μS/cm	0.49 μS/cm 2.4 μS/cm 23 μS/cm 0.23 mS/cm	Conductivity solutions

II. Dimensional

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Micrometers ³	Up to 40 in	14 μin/in + 0.6R	Gage blocks
Indicators ³	Up to 6 in	14 μin/in + 0.6R	Gage blocks
Calipers	Up to 24 in	14 μin/in + 0.6R	Gage blocks

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Height Gages ³	Up to 24 in	14 μin/in + 0.6R	Gage blocks
Depth Gages ³	Up to 24 in	14 μin/in + 0.6R	Gage blocks
Bore Gages, Bore Micrometers & Holtests ³	(0.075 to 6) in	19 μin/in + 0.6R	Gage blocks
Steel Tapes ³	Up to 30 ft	0.05 in	Master tapes
Steel Rules	Up to 24 in	0.05 in	Master tape
Optical Comparators ³ – Linear Travel Magnification	Up to 30 in 10x to 100x	0.13 min 0.12 % of reading	Glass scales and balls
Surface Plates ³	Up to (72 x 144) in	1.4·D μin	Laser D = length of the diagonal in inches
Coordinate Measuring Machines ³ – Repeatability Linear Accuracy Squareness Volumetric Performance	Sphere Up to 24 in Up to 24 in 600 mm	23 μin 71 μin + 1.4 μin/in 31 μin 0.14 min	ASME B89.4.10360.2-2008 Sphere Step gage Ball bar Ball bar

III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
DC Voltage ³ – Generate	Up to 220 mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	7.1 μV/V + 0.40 μV 3.7 μV/V + 0.80 μV 4.9 μV/V + 3.0 μV 4.9 μV/V + 4.3 μV 3.7 μV/V + 48 μV 4.7 μV/V + 0.48 mV	Fluke 5720A
DC Voltage – Measure	Up to 100 mV to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V	9.5 μV/V + 0.37 μV 6.1 μV/V + 0.37 μV 5.8 μV/V + 0.60 μV 8.7 μV/V + 37 μV 8.7 μV/V + 0.12 mV*	Agilent 3458A w. opt 2 *Add 12 μV/V · (V _{in} /1000) ² for inputs > 100 V
DC Voltage ³ – Generate, Fixed Points	1 V 10 V	1.4 μV/V 0.43 μV/V	Fluke 732B, HP 3458A opt 002
DC High Voltage ³ – Measure	(1 to 40) kV	1.1 %	Fluke 80K series probe & 87-III meter
DC Current ³ – Generate	Up to 200 pA (0.2 to 200) nA Up to 220 μA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 11) A (11 to 20.5) A (20.5 to 150) A (150 to 1000) A	1.9 % + 13 fA 0.35 % + 13 fA 35 μA/A + 6.0 nA 31 μA/A + 7.0 nA 30 μA/A + 41 nA 41 μA/A + 0.71 μA 77 μA/A + 12 μA 0.034 % + 0.48 mA 0.10 % + 0.91 A 0.58 % + 0.16 A 0.60 % + 0.58 A	Keithley 617 electrometer & voltage source Fluke 5720A Fluke 5520A Fluke 5520A w/ 50 turn coil

Parameter/Equipment	Range	CMC ^{2, 5, 7} (\pm)	Comments
DC Current ³ – Measure	Up to 200 pA (0.2 to 200) nA	1.9 % +13 fA 0.35 % +13 fA	Keithley 617
	Up to 100 μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	17 μ A/A + 0.80 nA 17 μ A/A + 5.0 nA 17 μ A/A + 50 nA 31 μ A/A + 0.50 μ A 0.010 % + 10 μ A	Agilent 3458A, opt 2
Resistance ³ – Generate	Up to 10.9999 Ω (11 to 32.9999) Ω (33 to 109.9999) Ω (110 to 329.9999) Ω (0.33 to 1.099999) k Ω (1.1 to 3.299999) k Ω (3.3 to 10.99999) k Ω (11 to 32.99999) k Ω (33 to 109.999) k Ω (110 to 329.999) k Ω	40 $\mu\Omega/\Omega$ + 1.0 m Ω 28 $\mu\Omega/\Omega$ + 2.0 m Ω 28 $\mu\Omega/\Omega$ + 2.0 Ω 28 $\mu\Omega/\Omega$ + 4.0 m Ω 28 $\mu\Omega/\Omega$ + 13 m Ω 28 $\mu\Omega/\Omega$ + 13 m Ω 28 $\mu\Omega/\Omega$ + 30 m Ω 28 $\mu\Omega/\Omega$ + 0.30 Ω 28 $\mu\Omega/\Omega$ + 0.30 Ω 32 $\mu\Omega/\Omega$ + 2.0 Ω	Fluke 5520A, 4-wire
	(0.33 to 1.09999) M Ω (1.1 to 3.29900) M Ω (3.3 to 10.9999) M Ω (11 to 32.9999) M Ω (33 to 109.9999) M Ω (110 to 329.9999) M Ω (330 to 1100) M Ω	32 $\mu\Omega/\Omega$ + 2.2 Ω 60 $\mu\Omega/\Omega$ + 39 Ω 0.013 % + 63 Ω 0.025 % + 2.5 k Ω 0.050 % + 3.0 k Ω 0.30 % + 0.10 M Ω 1.5 % + 0.50 M Ω	Fluke 5520A, 2-wire
Fixed Points	0 Ω 1 Ω 1.9 Ω 10, 19 Ω 100, 190 Ω 1, 1.9 k Ω 10, 19 k Ω	41 $\mu\Omega$ 81 $\mu\Omega/\Omega$ 82 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$	Fluke 5720A

Parameter/Equipment	Range	CMC ^{2, 5, 6, 7} (±)	Comments
Resistance ³ – Generate, Fixed Points (cont)	100, 190 kΩ	11 μΩ/Ω	Fluke 5720A Shunt Shunt Standard resistors
	1 MΩ	20 μΩ/Ω	
	1.9 MΩ	30 μΩ/Ω	
	10 MΩ	35 μΩ/Ω	
	19 MΩ	45 μΩ/Ω	
	100 MΩ	0.010 %	
	0.05 mΩ	0.30 %	
	0.1 mΩ	0.29 %	
	1 mΩ	90 μΩ/Ω	
	10 mΩ	94 μΩ/Ω	
	100 mΩ	85 μΩ/Ω	
	1.0	2.5 μΩ/Ω	
	(1.9, 10, 100) Ω	2.3 μΩ/Ω	
	1 kΩ	3.2 μΩ/Ω	
	10 kΩ	2.4 μΩ/Ω	
	19 kΩ	5.0 μΩ/Ω	
	100 kΩ	5.6 μΩ/Ω	
	1 MΩ	11 μΩ/Ω	
	10 MΩ	31 μΩ/Ω	
	19 MΩ	41 μΩ/Ω	
Resistance ³ – Measure	Up to 10 Ω	18 μΩ/Ω + 58 μΩ	Agilent 3458A w/ opt 002 Current source: Fluke 5720A calibrator DMM: Agilent 3458A
	(10 to 100) Ω	12 μΩ/Ω + 0.58 mΩ	
	(100 to 1000) Ω	9.5 μΩ/Ω + 5.8 mΩ	
	(1 to 10) kΩ	9.5 μΩ/Ω + 58 mΩ	
	(10 to 100) kΩ	9.7 μΩ/Ω + 0.58 Ω	
	(100 to 1000) kΩ	15 μΩ/Ω + 2.3 Ω	
	(1 to 10) MΩ	58 μΩ/Ω + 0.12 kΩ	
	(10 to 100) MΩ	0.058 % + 1.2 kΩ	
	(0.1 to 1) GΩ	0.59 % + 12 kΩ	
	(0.1 to 1) Ω	61 μΩ/Ω	
	(1 to 1.9) Ω	17 μΩ/Ω	
	(1.9 to 10) Ω	13 μΩ/Ω	
	(10 to 100) Ω	14 μΩ/Ω	
	(0.1 to 1) kΩ	14 μΩ/Ω	
	(1 to 10) kΩ	4.9 μΩ/Ω	
	(10 to 19) kΩ	4.9 μΩ/Ω	
	(19 to 100) kΩ	4.9 μΩ/Ω	
	(0.1 to 1) MΩ	7.5 μΩ/Ω	
	(1 to 10) MΩ	10 μΩ/Ω	
	(10 to 19) MΩ	13 μΩ/Ω	
(19 to 100) MΩ	22 μΩ/Ω		

Parameter/Equipment	Range	CMC ^{2, 4, 5, 7} (±)	Comments
Capacitance ³ – Measure, (0.1, 0.12, 1 and 10) kHz	Up to 10 pF 100 pF 1000 pF 10 nF 100 nF 1000 nF 10 µF 100 µF 1000 µF	0.16 % 0.24 % 0.15 % 0.14 % 0.14 % 0.13 % 0.21 % 0.21 % 0.21 %	GenRad 1689 M RLC Digibridge
Capacitance ³ – Generate			Fluke 5520A
10 Hz to 10 kHz	(0.19 to 1.0999) nF	0.51 % + 12 pF	
10 Hz to 3 kHz	(1.1 to 3.299) nF	0.51 % + 12 pF	
(10 to 1000) Hz	(0.33 to 10.999) nF	0.26 % + 12 pF	
(10 to 1000) Hz	(11 to 109.999) nF	0.26 % + 0.12 nF	
(10 to 1000) Hz	(110 to 329.99) nF	0.26 % + 0.31 nF	
(10 to 600) Hz	(0.33 to 1.0999) µF	0.26 % + 1.2 nF	
(10 to 300) Hz	(1.1 to 3.2999) µF	0.26 % + 3.1 nF	
(10 to 150) Hz	(3.3 to 10.999) µF	0.26 % + 12 nF	
(10 to 120) Hz	(11 to 32.999) µF	0.42 % + 31 nF	
(10 to 80) Hz	(33 to 109.99) µF	0.46 % + 0.12 µF	
To 50 Hz	(110 to 329.99) µF	0.46 % + 0.31 µF	
To 20 Hz	(0.33 to 1.0999) mF	0.46 % + 1.2 µF	
To 6 Hz	(1.1 to 3.2999) mF	0.46 % + 3.1 µF	
To 2 Hz	(3.3 to 10.999) mF	0.46 % + 12 µF	
To 0.6 Hz	(11 to 32.999) mF	0.78 % + 31 µF	
To 0.2 Hz	(33 to 110) mF	1.2 % + 0.12 mF	
Fixed Points			
1 kHz to 13 MHz	1 pF	0.37 % + 0.6R	Agilent 16381A standard air capacitor
1 kHz to 13 MHz	10 pF	0.040 % + 0.6R	Agilent 16382A
1 kHz to 13 MHz	100 pF	0.067 % + 0.6R	Agilent 16383A
1 kHz to 13 MHz	1000 pF	0.33 % + 0.6R	Agilent 16384A
120 Hz to 100 kHz	(10, 100, 1000) nF	0.010 % + 0.6R	Agilent 16380C series air capacitors

Parameter/Equipment	Range	CMC ^{2, 4, 5, 7} (±)	Comments
Inductance ³ – Generate, @ 1 kHz	1 mH to 1 H	0.13 % + 0.6R	GenRad 1490A standard inductors
Fixed Points 400 Hz & 1 kHz	100 μH 1 mH 10 mH 100 mH 1 H	1.2 % + 0.6R 0.13 % + 0.6R 0.083 % + 0.6R 0.083 % + 0.6R 0.083 % + 0.6R	General Radio 1482 series
Inductance – Measure, @ 1 kHz	1 μH to 100 H	0.13 %	GenRad 1689 M RLC Digibridge
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 500 kHz to 1 MHz	0.022 % + 4.0 μV 85 μV/V + 4.0 μV 75 μV/V + 4.0 μV 0.018 % + 4.0 μV 0.046 % + 5.0 μV 0.090 % + 10 μV 0.12 % + 20 μV 0.25 % + 20 μV	Fluke 5720A
(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	0.022 % + 4.0 μV 85 μV/V + 4.0 μV 75 μV/V + 4.0 μV 0.018 % + 4.0 μV 0.046 % + 5.0 μV 0.090 % + 10 μV 0.12 % + 20 μV 0.25 % + 20 μV	
(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 + 7.0 μV 75 μV/V + 7.0 μV 0.018 % + 7.0 μV 0.042 % + 17 μV 0.075 % + 20 μV 0.12 % + 25 μV 0.25 % + 45 μV	

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage ³ – Generate (cont)			
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 85 μV/V + 15 μV 40 μV/V + 8.0 μV 70 μV/V + 10 μV 0.011 % + 30 μV 0.034 % + 80 μV 0.090 % + 0.20 mV 0.15 % + 0.30 mV	Fluke 5720A
(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 % + 0.40 mV 80 μV/V + 0.15 mV 40 μV/V + 50 μV 70 μV/V + 0.10 mV 95 μV/V + 0.20 mV 0.026 % + 0.60 mV 0.090 % + 2.0 mV 0.13 % + 3.2 mV	
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.022 % + 4.0 mV 80 μV/V + 1.5 mV 47 μV/V + 0.60 mV 75 μV/V + 1.0 mV 0.013 % + 2.5 mV 0.080 % + 16 mV 0.42 % + 40 mV 0.70 % + 80 mV	
(220 to 250) V	(15 to 50) Hz 50 Hz to 1 kHz	0.035% + 30 mV 90 μV/V + 6 mV	
(220 to 1100) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	80 μV/V + 4.0 mV 0.013 % + 6.0 mV 0.036 % + 11 mV	w/ 5725A amplifier
(220 to 750) V	(30 to 50) kHz (50 to 100) kHz	0.036 % + 11 mV 0.13 % + 45 mV	

Parameter/Range	Frequency	CMC ^{2, 6, 7} (±)	Comments
AC Voltage – Measure			
(0.7 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.17 % + 1.3 µV 0.074 % + 1.3 µV 0.042 % + 1.3 µV 0.081 % + 2.0 µV 0.12 % + 2.5 µV 0.23 % + 4.0 µV 0.24 % + 8.0 µV 0.35 % + 8.0 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) MHz	0.085 % + 1.3 µV 0.037 % + 1.3 µV 0.021 % + 1.3 µV 0.040 % + 2.0 µV 0.060 % + 2.5 µV 0.12 % + 4.0 µV 0.13 % + 8.0 µV 0.23 % + 8.0 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) MHz	0.029 % + 1.3 µV 0.019 % + 1.3 µV 0.011 % + 1.3 µV 0.021 % + 2.0 µV 0.031 % + 2.5 µV 0.081 % + 4.0 µV 0.089 % + 8.0 µV 0.17 % + 8.0 µV	
(22 to 70) mV	(9.5 to 10)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 (0.5 to 1) MHz	0.10 % + 1.8 µV 0.024 % + 1.6 µV 0.012 % + 1.6 µV 65 µV/V + 1.8 µV 0.013 % + 2.0 µV 0.026 % + 2.5 µV 0.051 % + 4.0 µV 0.067 % + 8.0 µV 0.11 % + 8.0 µV	
(70 to 220) mV	(9.5 to 10)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 (0.5 to 1) MHz	0.11 % + 2.5 µV 0.021 % + 2.5 µV 85 µV/V + 1.8 µV 38 µV/V + 1.8 µV 69 µV/V + 2.3 µV 0.016 % + 2.7 µV 0.025 % + 4.1 µV 0.038 % + 8.2 µV 0.10 % + 8.9 µV	

Parameter/Range	Frequency	CMC ^{2,5,6} (\pm)	Comments
AC Voltage – Measure (cont)			
(220 to 700) mV	(9.5 to 10)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 (0.5 to 1) MHz	0.10 % + 3.3 μ V 0.021 % + 3.4 μ V 76 μ V/V + 3.4 μ V 33 μ V/V + 3.4 μ V 51 μ V/V + 3.6 μ V 79 μ V/V + 3.9 μ V 0.018 % + 6.4 μ V 0.030 % + 9.4 μ V 0.096 % + 11 μ V	Fluke 5790A
700 mV to 2.2 V	(9.5 to 10)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 (0.5 to 1) MHz	0.10 % 0.020 % 66 μ V/V 24 μ V/V 46 μ V/V 71 μ V/V 0.016 % 0.026 % 0.090 %	
(2.2 to 7) V	(9.5 to 10)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 (0.5 to 1) MHz	0.10 % 0.020 % 67 μ V/V 24 μ V/V 48 μ V/V 81 μ V/V 0.019 % 0.040 % 0.12 %	
(7 to 22) V	(9.5 to 10)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 (0.5 to 1) MHz	0.10 % 0.020 % 67 μ V/V 27 μ V/V 48 μ V/V 81 μ V/V 0.019 % 0.040 % 0.12 %	
(22 to 70) V	(9.5 to 10)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 (0.5 to 1) MHz	0.10 % 0.020 % 68 μ V/V 32 μ V/V 57 μ V/V 94 μ V/V 0.020 % 0.041 % 0.12 %	

Parameter/Range	Frequency	CMC ^{2, 6, 7} (±)	Comments
AC Voltage ³ – Measure (cont)			
(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 % 68 µV/V 31 µV/V 69 µV/V 98 µV/V 0.021 % 0.050 %	Fluke 5790A
(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 % 99 µV/V 41 µV/V 0.013 % 0.050 %	
(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 % 99 µV/V 38 µV/V 0.013 % 0.050 %	
AC Flatness –			
Up to 2.2 mV	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.10 % + 82 nV 0.050 % + 82 nV 0.050 % + 82 nV 0.050 % + 82 nV 0.070 % + 1.0 µV 0.070 % + 1.0 µV 0.070 % + 1.0 µV 0.17 % + 1.0 µV 0.30 % + 1.0 µV 0.70 % + 2.0 µV	Fluke 5790A
(2.2 to 7) mV	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.10 % + 82 nV 0.050 % + 82 nV 0.050 % + 82 nV 0.050 % + 82 nV 0.070 % + 1.0 µV 0.070 % + 1.0 µV 0.070 % + 1.0 µV 1.0 % + 1.0 µV 0.17 % + 1.0 µV 0.37 % + 1.0 µV	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
AC Flatness – (cont)			
(7 to 22) mV	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.10 % + 82 nV 0.050 % + 82 nV 0.050 % + 82 nV 0.050 % + 82 nV 0.00 % + 82 nV 0.070 % + 82 nV 0.070 % + 82 nV 0.10 % + 82 nV 0.17 % + 82 nV 0.37 % + 82 nV	Fluke 5790A
(22 to 70) mV	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.10 % + 0.82 μV 0.050 % + 0.82 μV 0.050 % + 0.82 μV 0.050 % + 0.82 μV 0.050 % + 0.82 μV 0.050 % + 0.82 μV 0.050 % + 0.82 μV 0.10 % + 0.82 μV 0.15 % + 0.82 μV 0.35 % + 0.82 μV	
(70 to 220) mV	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.10 % + 0.82 μV 0.040 % + 0.82 μV 0.040 % + 0.82 μV 0.040 % + 0.82 μV 0.040 % + 0.82 μV 0.050 % + 0.82 μV 0.050 % + 0.82 μV 0.10 % + 0.82 μV 0.15 % + 0.82 μV 0.35 % + 0.82 μV	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
AC Flatness – (cont)			
(220 to 700) mV	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.10 % + 8.2 μV 0.050 % + 8.2 μV 0.050 % + 8.2 μV 0.050 % + 8.2 μV 0.050 % + 8.2 μV 0.050 % + 8.2 μV 0.050 % + 8.2 μV 0.10 % + 8.2 μV 0.15 % + 8.2 μV 0.35 % + 8.2 μV	Fluke 5790A
700 mV to 2.2 V	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.10 % + 8.2 μV 0.030 % + 8.2 μV 0.030 % + 8.2 μV 0.030 % + 8.2 μV 0.030 % + 8.2 μV 0.050 % + 8.2 μV 0.050 % + 8.2 μV 0.10 % + 8.2 μV 0.15 % + 8.2 μV 0.35 % + 8.2 μV	
(2.2 to 7) V	(10 to 30) Hz (30 to 120) Hz (0.12 to 1.2) kHz (1.2 to 120) kHz (120 to 500) kHz (0.5 to 1.2) MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.10 % + 82 μV 0.030 % + 82 μV 0.030 % + 82 μV 0.030 % + 82 μV 0.030 % + 82 μV 0.050 % + 82 μV 0.050 % + 82 μV 0.10 % + 82 μV 0.15 % + 82 μV 0.35 % + 82 μV	
AC High Voltage ³ – Measure			
(1 to 4.2) kV	60 Hz (0 to 500) Hz (500 to 1000) Hz	1.7 % 3.1 % 3.7 %	Fluke 80K series probe & Fluke 87-III meter
(4.2 to 28) kV	60 Hz	5.9 %	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
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	0.023 % + 16 nA 0.014 % + 10 nA 0.011 % + 8.0 nA 0.025 % + 12 nA 0.090 % + 65 nA	Fluke 5720A
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 0.033 % + 35 nA 0.013 % + 35 nA 0.051 % + 0.11 µA 0.15 % + 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 % + 0.40 µA 0.033 % + 0.35 µA 0.013 % + 0.35 µA 0.051 % + 0.55 µA 0.15 % + 5.0 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 % + 4.0 µA 0.033 % + 3.5 µA 0.013 % + 2.5 µA 0.018 % + 3.5 µA 0.15 % + 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 % + 88 µA 0.60 % + 0.16 mA	
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.040 % + 0.17 mA 0.085 % + 0.38 mA 0.33 % + 0.75 mA	
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.12 % + 5.1 mA 0.15 % + 5.1 mA 3.0 % + 5.1 mA	Fluke 5520A
(20.5 to 150) A (150 to 1025) A	45 to 65 Hz 45 to 65 Hz	0.38 % + 0.029 A 1.0 % + 0.031 A	Fluke 5520A w. 50-turn Coil
(20.5 to 150) A (150 to 1025) A	65 to 440 Hz 65 to 440 Hz	1.0 % + 0.031 A 1.0 % + 0.12 A	

Parameter/Range	Frequency	CMC ^{2, 4, 6, 7} (\pm)	Comments
AC Current ³ – Measure			
10 μ A to 20A	10 Hz to 10 kHz	0.015 %	5790A w/A40s
(5 to 100) μ A	(10 to 20) Hz (20 to 45) Hz 45 Hz to 5 kHz	0.46 % + 35 nA 0.15 % + 35 nA 0.060 % + 35 nA	Agilent 3458A opt 002
(0.1 to 1) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.40 % + 0.20 μ A 0.15 % + 0.20 μ A 0.06 % + 0.20 μ A 0.030 % + 0.20 μ A 0.60 % + 0.20 μ A 0.40 % + 0.40 μ A 0.55 % + 1.5 μ A	
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.40 % + 2.0 μ A 0.16 % + 2.0 μ A 0.060 % + 2.0 μ A 0.030 % + 2.0 μ A 0.060 % + 2.0 μ A 0.40 % + 4.0 μ A 0.55 % + 15 μ A	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.40 % + 20 μ A 0.16 % + 20 μ A 0.060 % + 20 μ A 0.030 % + 20 μ A 0.060 % + 20 μ A 0.40 % + 40 μ A 0.55 % + 0.15 mA	
(0.1 to 1) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	0.40 % + 0.20 mA 0.16 % + 0.20 mA 0.080 % + 0.20 mA 0.16 % + 0.20 mA 0.30 % + 0.20 mA 1.0 % + 0.40 mA	
AC Resistance ³ – Generate			
0.1 Ω 1 Ω 10 Ω (0.1, 1) k Ω 10 k Ω , 100 k Ω	DC to 13 MHz DC to 13 MHz DC to 13 MHz DC to 13 MHz DC to 1 MHz	1.2 % + 0.6R 0.12 % + 0.6R 0.11 % + 0.6R 0.032 % + 0.6R 0.032 % + 0.6R	Agilent 16074A AC resistance standards

Parameter/Range	Frequency	CMC ^{2, 4, 6, 7} (\pm)	Comments
Oscilloscopes ³ –			
Risetime – Generate	>70 ps	16 ps	Fluke 9500A
Risetime – Measure	>7 ps	4.3 ps	Tektronix 80E01
Bandwidth (Flatness)	50 kHz to 300 MHz (300 to 550) MHz (0.55 to 1.1) GHz (0.11 to 3.2) GHz (3.2 to 6.0) GHz	3.4 % 5.5 % 4.4 % 5.3 % 5.6 %	Fluke 9500A
	100 kHz to 4.2 GHz (4.2 to 18) GHz (18 to 26.5) GHz (26.5 to 50) GHz	0.24 dB 0.24 dB 0.30 dB 0.62 dB	Signal generator w/ power sensor
Phase Angle ³ – Generate (0.0 to 360)°	(1 to 1000) Hz (1.01 to 6.25) kHz (6.26 to 50) kHz (50.01 to 100) kHz	6.2 m° 12 m° 29 m° 58 m°	Clarke-Hess 5500 Phase Standard m° = millidegrees
Phase Angle ³ - Measure	20 Hz to 10 kHz (10 to 40) kHz (40 to 100) kHz	81 m° 0.29 ° 0.98 °	Krohn-Hite 6500 Phasemeter
Audio Distortion (THD) ³	(0.02 to 20) kHz (20 to 100) kHz	1.0 dB 2.0 dB	Agilent 8903 audio analyzer
Thermocouple ³ – Indicating Systems, Generate & Measure	E, J, K, T, N,U R, S, B, C	37 μ C/°C + 0.045 °C 37 μ C/°C + 0.087 °C	Agilent 3458A w/ DCV source
Electrical Calibration of RTDs – Generate & Measure	(-200 to 850) °C	0.13 °C + 0.6R	Agilent 3458A DMM

IV. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2,4,7} (±)	Comments
Power Meter ³ – Power Reference, @ 1 mW	50 MHz	1.9 %	Agilent 432A power meter w/ 478A thermistor sensor
Relative Power ³ – Measure 100 kHz to 50 GHz	(0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB (-40 to -50) dB (-50 to -60) dB (-60 to -70) dB (-70 to -80) dB (-80 to -90) dB (-90 to -100) dB (-100 to -110) dB (-110 to -120) dB (-120 to -130) dB	0.018 dB 0.019 dB 0.019 dB 0.056 dB 0.056 dB 0.057 dB 0.057 dB 0.094 dB 0.094 dB 0.095 dB 0.096 dB 0.096 dB 0.097 dB	Agilent N5531S measuring receiver system
RF Absolute Power ³ – Measure (-30 to -50) dBm (-50 to -60) dBm (-60 to -70) dBm (-30 to +10) dBm (+10 to +20) dBm	10 MHz to 18 GHz 100 kHz to 4.2 GHz (4.2 to 18) GHz (18 to 26.5) GHz (26.5 to 50) GHz 100 kHz to 4.2 GHz (4.2 to 18) GHz (18 to 26.5) GHz (26.5 to 50) GHz	1.3 % 2.6 % 15 % 5.9 % 6.0 % 6.5 % 7.0 % 3.3 % 3.5 % 4.2 % 5.0 %	Power sensor, N Type w/ power meter 3.5 mm 2.4 mm 3.5 mm 2.4 mm
VSWR ³	5 MHz to 2 GHz (2 to 12.5) GHz (12.5 to 18) GHz	0.11 dB 0.53 dB 0.85 dB	Measuring receiver w/ Wiltron SWR bridges

Parameter/Range	Frequency	CMC ^{2,4,7} (±)	Comments
Frequency Modulation ³ – Measure Mod Rate: 20 Hz to 10 kHz Dev.: 200 Hz to 40 kHz ($\beta > 0.2$) Mod Rate: 50 Hz to 200 kHz Dev.: 250 Hz to 400 kHz ($\beta > 0.2$)	250 kHz to 10 MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 31.15) GHz (31.15 to 50) GHz	1.0 % 1.0 % 1.0 % 1.0 % 1.0 %	Agilent N5531S measuring receiver system β is the ratio of the frequency deviation to the modulation rate
Amplitude Modulation ³ – Measure 100 kHz to 10 MHz 10 MHz to 3 GHz 10 MHz to 3 GHz (3 to 26.5) GHz (3 to 26.5) GHz (26.5 to 31.15) GHz (26.5 to 31.15) GHz (31.15 to 50) GHz (31.15 to 50) GHz	Depth: (5 to 99) % (5 to 20) % (20 to 99) % (5 to 20) % (20 to 99) % (5 to 20) % (20 to 99) % (5 to 20) % (20 to 99) %	0.75 % 2.5 % 0.50 % 4.5 % 1.5 % 6.8 % 1.9 % 2.6 % 6.0 %	Agilent N5531S measuring receiver system

Parameter/Range	Frequency	CMC ^{2, 4, 7} (±)	Comments
Phase Modulation ³ – Mod Rate: (0.2 to 20) kHz 0.3 rad < Dev ≤ 0.7 rad Dev > 0.7 rad 0.6 rad < Dev ≤ 2.0 rad Dev > 2.0 rad 1.2 rad < Dev ≤ 4.0 rad Dev > 4.0 rad 1.3 rad < Dev ≤ 4.0 rad Dev > 4.0 rad 2.4 rad < Dev ≤ 8.0 rad Dev > 8.0 rad	100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz (26.5 to 31.5) GHz (31.5 to 50) GHz	3.0 % 1.0 % 3.0 % 1.0 % 3.0 % 1.0 % 3.0 % 1.0 % 3.0 % 1.0 %	Agilent N5531S measuring receiver system

V. Mechanical

Parameter/Equipment	Range	CMC ^{2, 4, 7} (±)	Comments
Balances ³	(1 to 10) mg (10 to 100) mg (0.1 to) 1 g (1 to 10) g (10 to 3200) g (3.2 to 22) kg (22 to 55) kg	0.045 % + 0.6R 0.089 % + 0.6R 0.020 % + 0.6R 0.00040 % + 0.6R 0.00028 % + 0.6R 0.00020 % + 0.6R 0.0050 % + 0.6R	Class 1 weights Class 3 weights
Scales ³	Up to 1000 lb (>1000 to 4800) lb	0.023 % 0.10 %	Handbook 44 w/ Class F weights
Force Gauges	Up to 1000 lbf	0.020 % + 0.6R	Deadweights

Parameter/Range	Frequency	CMC ^{2,4,7} (\pm)	Comments
Torque Tools ³	(0.5 to 215) in·ozf 5 in·lbs to 200 ft·lbs (200 to 1000) ft·lbs	0.51 % 0.30 % + 0.6R 0.24 % + 0.6R	Torque watch calibrator Torque tester
Pressure ³	(0.5 to 23) psia (23 to 1015) psia (1000 to 3000) psig (3000 to 6000) psig (6000 to 10000) psig (10000 to 30000) psig	0.011 % + 0.00030 psi 0.010 % + 0.6R 0.62 psi 1.3 psi 2.1 psi 25 psi	Pressure calibration system Pressure calibrator High pressure calibrator
Durometer Calibration ³ – Spring Force	Types: A and D	0.60 pts	Shore durocalibrator w/ calibrated weights
Indirect Verification of Brinell Hardness Testers at Test Conditions ³ – 10/3000/15	Repeatability: \leq 263 HBW > 263 to 591 HBW Error: \leq 263 HBW > 263 to 591 HBW	0.028d 0.011d 1.0 % 1.2 %	ASTM E10-07a with hardness test blocks and Brinell scope d is the mean of the n diameters in millimeters Uncertainty is stated as a percentage of the standardized test block hardness value

Parameter/Equipment	Range	CMC ^{2,4,7} (±)	Comments
Indirect Verification of Rockwell Hardness Testers ³	HRBW: Low Mid High HRC: Low Mid High HREW: Low High HR30N: Low Mid High HR30TW: Low High	0.050 HRBW 0.030 HRBW 0.10 HRBW 0.43 HRC 0.54 HRC 0.53 HRC 0.20 HREW 0.20 HREW 0.20 HR30N 0.50 HR30N 0.30 HR30N 1.2 HR30TW 0.20 HR30TW	ASTM E18-08 using traceable blocks through NIST

VI. Thermodynamics

Parameter/Equipment	Range	CMC ^{2,4,7} (±)	Comments
Temperature Measuring Equipment ³	(-25 to 600) °C	0.0038 % + 0.068 °C	Hart Scientific 9105 & 9123 baths
Temperature ³ – Measure	(-197 to 425) °C	0.0038 % + 0.068 °C	Hart Scientific 5627 PRT & 1522 indicator
Infrared Thermometers ³	(50, 100, 150) °C	1.2 °C + 0.6R	Hart 9135 black body
Relative Humidity ³ – Measure	(10 to 90) % RH	2.5 % RH	Veriteq 5000A-RH/T data logger

VII. Time & Frequency

Parameter/Equipment	Frequency	CMC ^{2,4} (±)	Comments
Frequency Measuring Equipment ³	1 mHz to 50 GHz	2.5 parts in 10 ¹² +0.6R	GPS receiver w/ generator
Frequency - Measure ³	0.001 Hz to 50 GHz	2.5 parts in 10 ¹² + 0.6R	Counter locked to 10 MHz reference

¹ This laboratory offers commercial calibration service and field calibration service. This accreditation covers calibrations performed at the main laboratory listed as well as the satellite locations listed on page 1 of this scope of accreditation.

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; R is the value of the resolution of the device under test; D is the length of the diagonal in inches; M is the source of mismatch uncertainty

⁵ The measurands stated are generated with the Fluke 5700A or 5520A series of instruments. This capability is suitable for the calibration of the devices intended to measure the stated measurand in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.

⁶ The measurands stated are measured with the Agilent 3458A. This capability is suitable for the calibration of the devices intended to generate the measurand in the ranges indicated. CMCs are expressed as either a specific value that covers the full range or as a combination of the fraction of the reading/output plus a range specification.

⁷ In the statement of CMC, percentages are percentage of reading, unless otherwise indicated.