



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017,
ANSI/NCSL Z540-1-1994 & ANSI/NCSL Z540-3-2006

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CALIBRATION

Valid To: March 31, 2020

Certificate Number: 1797.01

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

I. Device Specific Parameters

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
Coupling / Decoupling Networks ³ –			IEC 61000-4-6 using HP 8753D VNA
Insertion Loss	150 kHz to 230 MHz	0.30 dB	
Impedance	150 kHz to 230 MHz	3.7 %	
LISN ³ –			CISPR 16-1-2 using HP 8753D VNA
Insertion Loss	10 kHz to 1 GHz	0.30 dB	
Impedance	10 kHz to 100 MHz	3.4 %	
ESD Simulators ³ –			IEC 61000-4-2, ISO 10605 w/ Singer ESV
Air Discharge Voltage (positive and negative) (10, 20, 30) kV	(2 to 30) kV	1.3 %	
Peak Current (2 to 16) kV	(2 to 30) kV	2.9 %	Agilent 6 GHz Scope (2-ch mode)
Rise Time (10 to 90 %, 1 ns pulse)	(2 to 30) kV	78 ps	
Fall Time (30 to 800) ns	(2 to 30) kV	82 ps	Schaffner MD103

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
EMI Receivers ³ Sine Wave Output for CISPR Checks (@ 60 dB/μV) Errors for CISPR (Bands A, B, C and D) Impulse Spectral Amplitude	Bands A, B, C, D Band A (10 to 150) kHz Band B (0.15 to 30) MHz Band C and D (30 to 1000) MHz	0.33 dB 0.42 dB 0.56 dB 0.60 dB	CISPR 16-1-1 w/ IGUU 2916
EFT/Burst Generators ³ – Peak Voltage (±) Rise Time (±) Impulse Duration (±) Burst Duration (±) Burst Period (±) Repetition Rate (±)	10 V to 7 kV (± 10 %) (3.5 to 7) ns (30 to 150) ns (0.75, 15, 30) ms (± 20 %) 300 ms (± 20 %) (2.5, 5, 100) kHz (± 20 %)	1.9 % 1.0 % 1.0 % 1.0 % 1.0 % 1.0 %	IEC 61000-4-4 w/ Tek TDS7104 and Haefely PAT 50/1000
Surge Generators ³ – Front Time (±) Rise Time (±) Duration (±) Peak Voltage (±) Peak Current (±) AC Mains Sync	(0.5 to 13) μs (0.5 to 13) μs (5 to 1500) μs 10 V to 6 kV (± 10 %) 5 A to 3 kA (± 10 %) (Up to 360) ^o (± 10 ^o)	1.0 % 1.0 % 1.0 % 1.9 % 1.9 % 1.0 %	IEC 61000-4-5 w/ GR 1089 CORE TIA-968-B Tektronix TDS7104, Schaffner MD-200A high voltage probe, Pearson 110 current coil

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
AC Mains Dip/Surge/Interrupt Generators ³ –			IEC 61000-4-11 w/ Tektronix TDS7104, Schaffner MD-200A high voltage probe, Pearson 110 current coil
Line Voltage	(150 to 325) V _{pk} (± 5 %)	1.9 %	
AC Mains Sync	(Up to 360)° (± 10°)	1.0 %	
Peak Inrush Current	(Up to 500) A	1.9 %	
Dips / Overshoot	(Up to 325) V (± 5 %)	1.9 %	
Rise Time	(1 to 5) μs	1.0 %	
Damped Oscillatory Wave Generators / Ring Wave Generators ³ –			IEC 61000-4-12, IEC 61000-4-18 w/ Tektronix TDS7104, Schaffner MD-200A high voltage probe, Pearson 110 current coil
Peak Voltage (±)	250 V to 6 kV (± 10 %)	1.9 %	
Peak Current (±)	(1.25 to 500) A (± 10 %)	1.9 %	
Rise Time (±)	60 ns to 1 μs	1.0 %	
Oscillation Freq. (±)	(0.1, 1) MHz (± 10 %)	1.0 %	
Repetition Rate (±)	40/s for 100 kHz (± 10 %) 400/s for 1 MHz (± 10 %)	1.0 %	
Wave Decay	Up to 110 %	1.9 %	
Harmonic & Flicker Measure ³ –			IEC 61000-3-2, IEC 61000-3-3 w/
Voltage Current	(100 to 280) V (0.1 to 2) A (3 to 16) A	0.13 V 0.026 A 0.067 A	Agilent 3458A, Agilent 53132A, Agilent 34330A shunt
Perceptibility (Short-Term)	≥ 0.4 P _{st}	0.0042 P _{st}	

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
Oscilloscopes ³ –			
Bandwidth (Flatness)	0.1 Hz to 300 MHz (300 MHz to 550) MHz 550 MHz to 1.1 GHz (1.1 GHz to 3.2) GHz	2.5% 3.0 % 4.1 % 4.7 %	Fluke 9500B
Rise Time	150 ps to 100 ms	18 ps	

II. Dimensional

Parameter/Equipment	Range	CMC ² (±)	Comments
Gage Blocks	Up to 1 in (1 to 3) in (3 to 4) in	0.87 μin/in + 2.8 μin 0.87 μin/in + 3.6 μin 0.87 μin/in + 8.3 μin	Direct comparison using gage blocks
Hand Tools ^{3, 8} –			Gage blocks
Calipers	Up to 72 in	2.2 μin/in + 15 μin	
Micrometers	Up to 48 in	2.2 μin/in + 13 μin	
Height Gages	Up to 48 in	2.2 μin/in + 9.0 μin	
Drop Indicators	Up to 2 in	2.2 μin/in + 42 μin	
Depth Micrometers	Up to 12 in	2.2 μin/in + 4.8 μin	
End Standards ³	Up to 12 in	2.2 μin/in + 10 μin	Supermic w/ gage blocks
Diameter, External ⁸ – Cylindrical Plug Gages, Thread Wires	(0.011 to 0.60) in (0.00005 to 12) in	2.2 μin/in + 21 μin 2.2 μin/in + 8 μin	Laser micrometer Supermic w/ gage blocks

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Diameter, Internal ⁸ – Plain Ring Gages	Up to 4.0 in	1.6 μin/in + 4.2 μin	Trimos THV
Inside Micrometers, Intramik, Bore Gages, I.D. Comparators ³	(0.081 to 6.0) in	2.2 μin/in + 10 μin	Gage blocks w/ ring gages
Thickness Gages (Feeler Type) ³	(0.0005 to 0.0500) in	45 μin	Supermic w/ gage blocks
Precision Levels	Up to 1000"	0.50"	Surface plate, gage blocks
Protractors ³	(0 to 360)°	0.01°	Angle blocks, master granite square
Line Scales, Rulers, Tape Measures ³	Up to 6 ft (6 to 60) ft	(280 + 5L) μin (600 + 9L) μin	Renishaw laser measuring system

III. Dimensional Testing/Calibration

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
1D Length ⁷ (Accessibility Probes)	Up to 3 in	(61 + 3.7L) μin	Micrometer
	Up to 8 in	(1200 + 3.7L) μin	Caliper
	Up to 8 in	(25 + 3.7L) μin	Supermic
	Up to 18 in	(87 + 3.5L) μin	Renishaw laser measuring system
Diameter ⁷	Up to 3 in	(61 + 3.7L) μin	Micrometer

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
Radius ⁷	Up to 1 in	(620 + 3.5L) μin	Optical comparator
Angle ⁷	Up to 360 °	0.06 ° 0.05 °	Optical comparator digital protractor

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2,5,6} (±)	Comments
DC Voltage – Generate ³	(0 to 220) mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	9.2 μV/V + 0.40 μV 5.0 μV/V + 0.70 μV 3.5 μV/V + 2.5 μV 3.5 μV/V + 4.0 μV 5.0 μV/V + 40 μV 6.5 μV/V + 0.4 mV	Fluke 5720A
Fixed Values	1 V 10 V	1.1 part in 10 ⁶ 1.1 part in 10 ⁶	Fluke 732B
DC Voltage – Measure, Fixed Values	0.1 V 1 V 10 V 100 V 1000 V	1.3 μV/V 1.3 μV/V 1.3 μV/V 1.6 μV/V 1.6 μV/V	Fluke 732B, 752B, Agilent 34420A
DC Voltage – Measure ³	(0 to 1) mV (1 to 10) mV (10 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1050) V	1.3 μV/V + 3 nV 1.4 μV/V + 40 nV 3.4 μV/V + 0.4 μV 4.7 μV + 2.3 μV/V 4.7 μV + 2.3 μV/V 43 μV + 3.5 μV/V 0.57 mV + 10 μV/V	Keysight 34420A Fluke 3458A opt 002

Parameter/Equipment	Range	CMC ^{2,5,6} (±)	Comments
DC High Voltage ³ – Generate Measure	(0 to 10) kV	0.012 %	Fluke 410B monitored with Fluke 80E10 & Agilent 34401A
	(1 to 10) kV	0.01 %	Fluke 80E10 & Agilent 34401A
	(10 to 100) kV	0.70 %	Fluke 410B monitored with Spellman HVD-100-1 & Agilent 3458A
DC Current – Generate ³	(0 to 220) µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	42 µA/A + 6.0 nA 37 µA/A + 7.0 nA 36 µA/A + 40 nA 55 µA/A + 0.70 µA 0.013 % + 12 µA	Fluke 5720A
	(2.2 to 11) A (11 to 20.5) A	0.060 % + 0.33 mA 0.1 % + 58 µA	Fluke 5500A Fluke 5520A
	(10 to 300) A (300 to 550) A	0.3 % + 0.002A 0.34 % + 0.05A	w/ 50 turn coil
DC Current – Measure ³	(0 to 100) nA 100 nA to 1 µA (1 to 10) µA (10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	30 µA/A + 8.0 nA 15 µA/A + 1 nA 15 µA/A + 0.16 nA 15 µA/A + 0.83 nA 15 µA/A + 9.2 nA 15 µA/A + 90 nA 30 µA/A + 0.92 µA 100 µA/A + 13 µA	Agilent 3458A
	(1 to 10) A (10 to 120) A (120 to 500) A	0.030 % ppm 0.051 % ppm 0.011 % ppm	Keysight 34420A w/ Otto Wolf shunt L&N Shunt L&N Shunt

Parameter/Equipment	Range	CMC ^{2, 5, 6} (±)	Comments
DC Resistance – Generate, Fixed Points ³	(1, 1.9) Ω	96 μΩ/Ω	Fluke 5720A
	10 Ω	26 μΩ/Ω	
	19 Ω	26 μΩ/Ω	
	100 Ω	16 μΩ/Ω	
	190 Ω	11 μΩ/Ω	
	1 kΩ	9.0 μΩ/Ω	
	(1.9, 10) kΩ	9.0 μΩ/Ω	
	19 kΩ	9.0 μΩ/Ω	
	100 kΩ	12 μΩ/Ω	
	190 kΩ	12 μΩ/Ω	
	1 MΩ	21 μΩ/Ω	
	1.9 MΩ	22 μΩ/Ω	
	10 MΩ	41 μΩ/Ω	
	19 MΩ	48 μΩ/Ω	
	100 MΩ	0.011 %	
	1 GΩ	(0.5 % + 1 x 10 ⁻⁶ V) Ω	IET VRS-100-9-1K- BP-10KV
	10 GΩ	(0.51 % + 2 x 10 ⁻⁶ V) Ω	
100 GΩ	(1.1 % + 5 x 10 ⁻⁶ V) Ω		
DC Resistance – Generate ³	(0 to 10.9999) Ω	40 μΩ/Ω + 1.0 mΩ	Fluke 5520A, 4-wire
	(11 to 32.9999) Ω	30 μΩ /Ω + 1.5 mΩ	
	(33 to 109.9999) Ω	28 μΩ /Ω + 1.4 mΩ	
	(110 to 329.9999) Ω	28 μΩ /Ω + 2.0 mΩ	
	330 Ω to 1.09999 kΩ	28 μΩ /Ω + 6.8 mΩ	
	(1.1 to 3.299 999) kΩ	28 μΩ /Ω + 21 mΩ	
	(3.3 to 10.99 999) kΩ	28 μΩ /Ω + 25 mΩ	
	(11 to 32.99 999) kΩ	28 μΩ /Ω + 0.2 Ω	
	(33 to 109.9999) kΩ	28 μΩ /Ω + 0.22 Ω	
	(110 to 329.9999) kΩ	32 μΩ /Ω + 2.0 Ω	Fluke 5520A, 2-wire
	330 kΩ to 1.099 999 MΩ	32 μΩ /Ω + 2.6 Ω	
	(1.1 to 3.299 999) MΩ	60 μΩ /Ω + 42 Ω	
	(3.3 to 10.99 999) MΩ	0.013 % + 61 Ω	
	(11 to 32.99 999) MΩ	0.025 % + 2.7 kΩ	
	(33 to 109.9999) MΩ	0.05 % + 5.4 kΩ	
(110 to 329.9999) MΩ	0.3 % + 0.12 MΩ		
(330 to 1100) MΩ	1.5 % + 0.56 MΩ		

Parameter/Equipment	Range	CMC ^{2,5,6} (±)	Comments
DC Resistance – Measure ³	(0.9 to 100) mΩ	0.013 %	Fluke 5720A, Agilent 3458A and shunts: Fluke 742A-1k Fluke 742A-10k ESI SR-1010 L&N 4210-1 Fluke 742A-10M
	(0.1 to 1) Ω	4.7 μΩ/Ω	
	(1 to 10) Ω	6.6 μΩ/Ω	
	(10 to 100) Ω	7.9 μΩ/Ω	
	(0.1 to 1) kΩ	5.1 μΩ/Ω	
	(1 to 10) kΩ	8.6 μΩ/Ω	
	(10 to 100) kΩ	8.6 μΩ/Ω	
	(0.1 to 1) MΩ	8.6 μΩ/Ω	
	(1 to 10) MΩ	15 μΩ/Ω	
	(10 to 100) MΩ	17 μΩ/Ω	

Parameter/Range	Frequency	CMC ^{2,5,6} (±)	Comments	
AC Voltage – Generate ³	(0 to 2.2) mV	(10 to 20) Hz	0.024 % + 4.0 μV	Fluke 5720A
		(20 to 40) Hz	90 μV/V + 4.0 μV	
		40 Hz to 20 kHz	80 μV/V + 4.0 μV	
		(20 to 50) kHz	0.020 % + 4.0 μV	
		(50 to 100) kHz	0.050 % + 5.0 μV	
		(100 to 300) kHz	0.11 % + 10 μV	
		(300 to 500) kHz	0.14 % + 20 μV	
		(0.5 to 1) MHz	0.27 % + 20 μV	
	(2.2 to 22) mV	(10 to 20) Hz	0.024 % + 4.0 μV	
		(20 to 40) Hz	90 μV/V + 4.0 μV	
		40 Hz to 20 kHz	80 μV/V + 4.0 μV	
		(20 to 50) kHz	0.020 % + 4.0 μV	
		(50 to 100) kHz	0.050 % + 5.0 μV	
		(100 to 300) kHz	0.11 % + 10 μV	
		(300 to 500) kHz	0.14 % + 20 μV	
		(0.5 to 1) MHz	0.27 % + 20 μV	
	(22 to 220) mV	(10 to 20) Hz	0.024 % + 12 μV	
		(20 to 40) Hz	90 μV/V + 7.0 μV	
		40 Hz to 20 kHz	80 μV/V + 7.0 μV	
		(20 to 50) kHz	0.020 % + 7.0 μV	
		(50 to 100) kHz	0.046 % + 17 μV	
		(100 to 300) kHz	0.090 % + 20 μV	
		(300 to 500) kHz	0.14 % + 25 μV	
		(0.5 to 1) MHz	0.27 % + 45 μV	

Parameter/Range	Frequency	CMC ^{2,5,6} (±)	Comments
AC Voltage – Generate ³ (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 (0.5 to 1) MHz	0.024 % + 40 µV 90 µV/V + 15 µV 50 µV/V + 8.0 µV 80 µV/V + 10 µV 0.011 % + 30 µV 0.042 % + 80 µV 0.10 % + 0.20 mV 0.17 % + 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 (0.5 to 1) MHz	0.024 % + 400 µV 90 µV/V + 150 µV 50 µV/V + 51 µV 80 µV/V + 0.10 mV 0.010 % + 0.20 mV 0.028 % + 0.60 mV 0.1 % + 2.0 mV 0.15 % + 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* (0.5 to 1) MHz*	0.024 % + 4.0 µV 90 µV/V + 2.0 µV 50 µV/V + 1.0 µV 80 µV/V + 1.0 µV 0.015 % + 3.0 µV 0.090 % + 16 µV 0.44 % + 40 µV 0.80 % + 80 µV	*Limited to 2.2 × 10 ⁷ V- Hz
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz	0.030 % + 16 µV 0.0070 % + 4.0 µV	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
AC Voltage – Measure ³			
(0 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 % + 1.6 μV 0.074 % + 1.6 μV 0.042 % + 1.6 μV 0.081 % + 2.3 μV 0.12 % + 2.8 μV 0.23 % + 4.3 μV 0.24 % + 8.3 μV 0.35 % + 8.3 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 (0.5 to 1) MHz	0.085 % + 1.6 μV 0.037 % + 1.6 μV 0.021 % + 1.6 μV 0.040 % + 2.3 μV 0.060 % + 2.8 μV 0.12 % + 4.3 μV 0.13 % + 8.3 μV 0.23 % + 8.3 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 % + 1.6 μV 0.019 % + 1.6 μV 0.011 % + 1.6 μV 0.021 % + 2.3 μV 0.031 % + 2.8 μV 0.081 % + 4.3 μV 0.089 % + 8.3 μV 0.17 % + 8.3 μV	
(22 to 70) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.024 % + 1.8 μV 0.012 % + 1.8 μV 65 μV/V + 1.8 μV 0.013 % + 2.3 μV 0.026 % + 2.8 μV 0.051 % + 4.3 μV 0.067 % + 8.3 μV 0.11 % + 8.3 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 (0.5 to 1) MHz	0.021 % + 1.8 μV 85 μV/V + 1.8 μV 38 μV/V + 1.8 μV 69 μV/V + 2.3 μV 0.016 % + 2.8 μV 0.025 % + 4.3 μV 0.038 % + 8.3 μV 0.10 % + 8.3 μV	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
AC Voltage – Measure ³ (cont)			
(220 to 700) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.021 % + 1.8 μV 76 μV/V + 1.8 μV 33 μV/V + 1.8 μV 51 μV/V + 2.3 μV 79 μV/V + 2.8 μV 0.018 % + 4.3 μV 0.030 % + 8.3 μV 0.096 % + 8.3 μV	Fluke 5790A
700 mV to 2.2 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.020 % 66 μV/V 24 μV/V 46 μV/V 71 μV/V 0.016 % 0.026 % 0.090 %	
(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 (0.5 to 1) MHz	0.020 % 67 μV/V 24 μV/V 48 μV/V 81 μV/V 0.019 % 0.040 % 0.12 %	
(7 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.020 % 67 μV/V 27 μV/V 48 μV/V 81 μV/V 0.019 % 0.040 % 0.12 %	
(22 to 70) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.020 % 68 μV/V 32 μV/V 57 μV/V 94 μV/V 0.020 % 0.041 % 0.12 %	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
AC Voltage – Measure ³ (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 Voltage – Wide Band Input ³			
(0 to 2.2) mV	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.070 % + 1.3 μV 0.17 % + 1.3 μV 0.30 % + 1.3 μV 0.70 % + 2.3 μV	Fluke 5790A
(2.2 to 7) mV	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.070 % + 1.3 μV 0.10 % + 1.3 μV 0.17 % + 1.3 μV 0.37 % + 1.3 μV	
(7 to 22) mV	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.070 % + 0.30 μV 0.10 % + 0.30 μV 0.17 % + 0.30 μV 0.37 % + 0.30 μV	
22 mV to 7 V	(1 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.05 % + 2.1 μV 0.10 % + 2.1 μV 0.15 % + 2.1 μV 0.35 % + 2.1 μV	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
AC High Voltage – Measure ³ (1 to 7.5) kV	50 to 60 Hz	0.079 %	Fluke 80E10, Fluke 5720A
AC Current – Generate ³ (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	0.025 % + 16 nA 0.016 % + 10 nA 0.012 % + 8.0 nA 0.028 % + 12 nA 0.11 % + 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	0.025 % + 41 nA 0.016 % + 36 nA 0.012 % + 36 nA 0.02 % + 0.11 µA 0.11 % + 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	0.025 % + 0.41 µA 0.016 % + 0.36 µA 0.012 % + 0.36 µA 0.02 % + 0.56 µA 0.11 % + 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	0.025 % + 4.0 µA 0.016 % + 4.0 µA 0.012 % + 3.0 µA 0.02 % + 4.0 µA 0.11 % + 10 µA	
220 mA to 2.2 A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.026 % + 35 µA 0.045 % + 80 µA 0.70 % + 0.16 mA	
(1.1 to 2.99999) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.18 % + 0.10 mA 0.06 % + 0.10 mA 0.60 % + 1.0 mA 2.5 % + 5.0 mA	Fluke 5520A
(3 to 10.9999) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (45 to 100) Hz	0.06 % + 2.0 mA 0.10 % + 2.0 mA 3.0 % + 2.0 mA 0.12 % + 5.0 mA	
(11 to 20.5) A	100 Hz to 1 kHz 1 Hz to 5 kHz	0.15 % + 5.0 mA 3.0 % + 0.31 mA	
(10 to 550) A	(50 to 440) Hz	0.42 % + 0.5 A	w/ 50-turn coil

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
AC Current – Measure ³			
200 µA to 2 mA	(10 to 20) Hz 20 Hz to 1 kHz (1 to 10) kHz	0.021 % 0.010 % 54 µA/A	Fluke A40B, Fluke 5790A
(2 to 20) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 10 kHz	0.021 % 93 µA/A 54 µA/A	
(20 to 200) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 10 kHz	0.020 % 74 µA/A 39 µA/A	
200 mA to 2.2 A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	41 µA/A 74 µA/A 0.018 %	
(2.2 to 20) A	(45 to 100) Hz 100 to 1) kHz (1 to 5) kHz	62 µA/A 68 µA/A 0.018 %	
(10 to 120) A	(50 to 400) Hz	0.15%	L&N Shunt, Fluke 5790A
AC Ratio – Generate ³ 350 V max	0.35 · F (Hz)/V Up to 1 kHz	5 parts in 10 ⁶	ESI DT72A
Capacitance – Generate ³			
(0.19 to 0.3999) nF	10 Hz to 10 kHz	0.40 % + 0.013 nF	Fluke 5520A
(0.4 to 1.0999) nF	10 Hz to 10 kHz	0.42 % + 0.014 nF	
(1.1 to 3.2999) nF	10 Hz to 3 kHz	0.44 % + 0.017 nF	
(3.3 to 10.9999) nF	10 Hz to 1 kHz	0.21 % + 0.021 nF	
(11 to 32.9999) nF	10 Hz to 1 kHz	0.22 % + 0.14 nF	
(33 to 109.999) nF	10 Hz to 1 kHz	0.21 % + 0.21 nF	
(110 to 329.999) nF	10 Hz to 1 kHz	0.22 % + 0.62 nF	
(0.33 to 1.09999) µF	(10 to 600) Hz	0.22 % + 0.002 µF	
(1.1 to 3.29999) µF	(10 to 300) Hz	0.22 % + 0.01 µF	
(3.3 to 10.9999) µF	(10 to 150) Hz	0.23 % + 0.02 µF	
(11 to 32.9999) µF	(10 to 120) Hz	0.35 % + 0.08 µF	
(33 to 109.999) µF	(10 to 80) Hz	0.40 % + 0.26 µF	
(110 to 329.999) µF	(0 to 50) Hz	0.40 % + 0.83 µF	
(0.33 to 1.09999) mF	(0 to 20) Hz	0.38 % + 0.0026 mF	
(1.1 to 3.29999) mF	(0 to 6) Hz	0.38 % + 0.01 mF	
(3.3 to 10.9999) mF	(0 to 2) Hz	0.39 % + 0.025 mF	
(11 to 32.9999) mF	(0 to 0.6) Hz	0.77 % + 0.14 mF	
(33 to 110) mF	(0 to 0.2) Hz	0.9 % + 0.76 mF	

Parameter/Range	Frequency	CMC ^{2, 5, 6} (±)	Comments
Capacitance – Generate ³ (cont)			
Fixed Values			
1 pF	1 kHz	0.019 %	HP 16380 series
	1 MHz	0.021 %	
	2 MHz	0.030 %	
	3 MHz	0.046 %	
	4 MHz	0.067 %	
	5 MHz	0.092 %	
	10 MHz	0.26 %	
	13 MHz	0.38 %	
10 pF	1 kHz	0.012 %	
	1 MHz	0.012 %	
	2 MHz	0.012 %	
	3 MHz	0.013 %	
	4 MHz	0.012 %	
	5 MHz	0.011 %	
	10 MHz	0.018 %	
	13 MHz	0.042 %	
100 pF	1 kHz	0.0085 %	
	1 MHz	0.0086 %	
	2 MHz	0.009 %	
	3 MHz	0.011 %	
	4 MHz	0.012 %	
	5 MHz	0.016 %	
	10 MHz	0.034 %	
	13 MHz	0.050 %	
1 nF	1 kHz	0.010 %	
	1 MHz	0.011 %	
	2 MHz	0.018 %	
	3 MHz	0.030 %	
	4 MHz	0.046 %	
	5 MHz	0.067 %	
	10 MHz	0.19 %	
	13 MHz	0.29 %	
10 nF	120 Hz	0.0081 %	
	1 kHz	0.0081 %	
	10 kHz	0.0083 %	
	100 kHz	0.0088 %	

Parameter/Range	Frequency	CMC ^{2,5,6} (±)	Comments
Capacitance – Generate ³ (cont) Fixed Values 100 nF 1 μF	120 Hz 1 kHz 10 kHz 100 kHz 120 Hz 1 kHz 10 kHz 100 kHz	0.0066 % 0.0070 % 0.0069 % 0.012 % 0.011 % 0.012 % 0.011 % 0.014 %	HP 16380 series
Inductance – Generate ³ Fixed Points 20 μH 50 μH 10 mH 50 mH 500 mH 5 H	(0.1 to 10) kHz (0.1 to 1) kHz	0.10 % 0.086 % 0.025 % 0.031 % 0.028 % 0.045 %	QuadTech 1482
Distortion – Measure ³ (0 to -80) dB (0 to -65) dB	20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.3 dB	HP 8903B
AC Resistance – Generate ³ 0.1 Ω 1 Ω 10 Ω (0.1, 1, 10, 100) kΩ	DC to 13 MHz	1.2 % + 0.6R 0.12 % + 0.6R 0.11 % + 0.6R 0.032 % + 0.6R	Agilent 16074A AC

Parameter/Equipment	Range	CMC ² (±)	Comments
Thermocouple Simulation ³ –			
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.58 °C 0.19 °C 0.16 °C 0.19 °C 0.24 °C	Fluke 5500A
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.31 °C 0.19 °C 0.16 °C 0.20 °C 0.27 °C	
Type K	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.38 °C 0.21 °C 0.19 °C 0.30 °C 0.46 °C	
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.73 °C 0.28 °C 0.19 °C 0.16 °C	

V. Electrical – RF/Microwave

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
RF Microwave – Power ³			
Power Reference at 1 mW	50 MHz	0.36 %	HP 432A w/ 478-H55
Calibration Factor	0.1 MHz 0.3 MHz to 4 GHz (4 to 18) GHz (18 to 40) GHz (40 to 50) GHz	0.82 % 1.0 % 1.3 % 1.9 % 2.7 %	E4419B with 8481A, 8482A, 8487A, 11722A, 11792A

Parameter/Range	Frequency	CMC ^{2,6} (±)	Comments
RF Microwave – Absolute Power – Measure ³			Power meter w/:
(-60 to -30) dBm	9 kHz to 18 GHz	2.0 %	E9304A, N-type
(-30 to 10) dBm	100 kHz to 4.2 GHz	1.4 %	8482A, N-type
	(4.2 to 18) GHz	1.9 %	8481A, N-type
	(18 to 30) GHz	2.7 %	8487A, N-type
	(30 to 40) GHz	3.5 %	
	(40 to 50) GHz	5.3 %	
(10 to 20) dBm	100 kHz to 4.2 GHz	3.3 %	8482A, N-type
	(4.2 to 18) GHz	3.5 %	8481A, N-type
	(18 to 30) GHz	3.9 %	8487A, N-type
	(30 to 40) GHz	4.1 %	
	(40 to 50) GHz	5.0 %	
Harmonic Measurements ³			
3 Hz to 50 GHz	(-10 to -20) dBm ≤ -20 dBm	0.083 dB 0.15 dB	HP E4448A HP33120A
20 Hz to 40 MHz	(0 to -50) dBc (0 to -60) dBc (0 to -70) dBc	1.1 dB 1.5 dB 1.9 dB	HP 3585A
Single Sideband Phase Noise (SSB) – Measure ³			
CW Frequency: 10 MHz to 50 GHz	Markers: 100 Hz to 1 MHz	0.5 dB	HP E4448A

Parameter/Equipment	Range	CMC ^{2, 6} (±)	Comments
Tuned RF Power Relative – Measure ³			
10 MHz 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 -95) dB (-95 to -100) dB (-100 to -110) dB (-110 to -120) dB (-120 to -127) dB	0.022 dB 0.022 dB 0.032 dB 0.064 dB 0.044 dB 0.053 dB 0.069 dB 0.15 dB 0.14 dB 0.13 dB 0.14 dB 0.18 dB 0.18 dB 0.19 dB	HP E4448A
Amplitude Modulation – Measure ³			
5 % to 99 % Depth, 50 Hz to 100 kHz	100 kHz to 10 MHz	0.87 %	HP E4448A
20 % to 99 % Depth, 50 Hz to 100 kHz	10 MHz to 3 GHz	0.58 %	
5 % to 20 % Depth, 50 Hz to 100 kHz	10 MHz to 3 GHz	2.9 %	
20 % to 99 % Depth, 50 Hz to 100 kHz	(3 to 26.5) GHz	1.7 %	
5 % to 20 % Depth, 50 Hz to 100 kHz	(3 to 26.5) GHz	5.2 %	
20 % to 99 % Depth, 50 Hz to 100 kHz	(26.5 to 31.15) GHz	2.2 %	
5 % to 20 % Depth, 50 Hz to 100 kHz	(26.5 to 31.15) GHz	7.9 %	
20 % to 99 % Depth, 50 Hz to 100 kHz	(31.15 to 50) GHz	6.9 %	
5 % to 20 % Depth, 50 Hz to 100 kHz	(31.15 to 50) GHz	30 %	

Parameter/Equipment	Range	CMC ^{2, 6} (\pm)	Comments
Frequency Modulation – Measure ³			
Rate: 20 Hz to 10 kHz Peak Dev \leq 40 kHz, $\beta > 0.2$	250 kHz to 10 MHz	1.7 %	HP E4448A
Rate: 20 Hz to 10 kHz Peak Dev \leq 40 kHz, $\beta > 1.2$	250 kHz to 10 MHz	1.2 %	
Rate: 50 Hz to 200 kHz Peak Dev \leq 400 kHz, $\beta > 0.2$	10 MHz to 6.6 GHz	1.7 %	
Rate: 50 Hz to 200 kHz Peak Dev \leq 400 kHz, $\beta > 0.45$	10 MHz to 6.6 GHz	1.2 %	
Rate: 50 Hz to 200 kHz Peak Dev \leq 400 kHz, $\beta > 0.2$	(6.6 to 13.2) GHz	2.9 %	
Rate: 50 Hz to 200 kHz Peak Dev \leq 400 kHz, $\beta > 8$	(6.6 to 13.2) GHz	1.2 %	
Rate: 50 Hz to 200 kHz Peak Dev \leq 400 kHz, $\beta > 0.2$	(13.2 to 31.15) GHz	4.4 %	
Rate: 50 Hz to 200 kHz Peak Dev \leq 400 kHz, $\beta > 16$	(13.2 to 31.15) GHz	1.2 %	
Rate: 50 Hz to 200 kHz Peak Dev \leq 400 kHz, $\beta > 0.2$	(31.15 to 50) GHz	9.8 %	
Rate: 50 Hz to 200 kHz Peak Dev \leq 400 kHz, $\beta > 32$	(31.15 to 50) GHz	1.2 %	

Parameter/Equipment	Range	CMC ^{2, 6} (\pm)	Comments
Phase Modulation ³ – Rate: 200 Hz to 20 kHz	100 kHz to 6.6 GHz >0.7 rad >0.3 rad (6.6 to 13.2) GHz >2.0 rad >0.6 rad (13.2 to 26.5) GHz >4.0 rad >1.2 rad (26.5 to 31.5) GHz >4.0 rad >1.3 rad (31.5 to 50) GHz >4.0 rad >2.4 rad	1.2 % 3.5 % 1.2 % 3.5 % 1.2 % 3.5 % 1.2 % 3.5 %	HP E4448A
RF Microwave ³ – Parameters S ₁₁ and S ₁₂ Type N Connectors Reflection Coefficient ρ S ₁₁ : (0 to 1) Phase: Arg (S ₁₁) 0 < S ₁₁ < 1 -180° to + 180° Attenuation: S ₁₂ : (0 to 60) dB	10 kHz to 2 GHz (2 to 8) GHz (8 to 18) GHz 10 kHz to 45 MHz (45 to 2000) MHz (2 to 8) GHz (8 to 18) GHz 10 kHz to 45 MHz (45 to 2000) MHz (2 to 8) GHz (8 to 18) GHz	(0.0070 to 0.017) ρ (0.013 to 0.028) ρ (0.017 to 0.033) ρ (13 to 180)° (30 to 180)° (30 to 180)° (14 to 180)° (0.056 to 0.23) dB (0.057 to 0.25) dB (0.07 to 0.26) dB (0.12 to 0.43) dB	Vector Network analyzer w/ calibration kit ρ is the reflection coefficient

Parameter/Equipment	Range	CMC ² (±)	Comments
RF Microwave ³ – Parameters S ₁₁ and S ₁₂ (cont)			
7 mm Connectors			
Reflection Coefficient ρ S ₁₁ : (0 to 1)	10 kHz to 45 MHz (45 to 2000) MHz (2 to 8) GHz (8 to 18) GHz	(0.0040 to 0.011) ρ (0.0040 to 0.017) ρ (0.0060 to 0.028) ρ (0.0080 to 0.031) ρ	Vector Network analyzer w/calibration kit ρ is the reflection coefficient
Phase: Arg (S ₁₁) 0 < S ₁₁ < 1 -180° to + 180°	10 kHz to 45 MHz (45 to 2000) MHz (2 to 8) GHz (8 to 18) GHz	(3.8 to 180)° (20 to 180)° (6.3 to 180)° (6.6 to 180)°	
Attenuation: S ₁₂ : (0 to 60) dB	10 kHz to 45 MHz (45 to 2000) MHz (2 to 8) GHz (8 to 18) GHz	(0.035 to 0.21) dB (0.035 to 0.23) dB (0.048 to 0.23) dB (0.047 to 0.41) dB	
3.5 mm Connectors			
Reflection Coefficient ρ S ₁₁ : (0 to 1)	10 kHz to 45 MHz (45 to 2000) MHz (2 to 8) GHz (8 to 20) GHz (20 to 26.5) GHz	(0.010 to 0.018) ρ (0.007 to 0.023) ρ (0.007 to 0.013) ρ (0.010 to 0.016) ρ (0.013 to 0.019) ρ	Agilent VNA/PNA w/ 85057B
Phase: Arg (S ₁₁) 0 < S ₁₁ < 1 -180° to + 180°	10 kHz to 45 MHz (45 to 2000) MHz (2 to 8) GHz (8 to 20) GHz (20 to 26.5) GHz	(3.6 to 180)° (2.2 to 180)° (22 to 180)° (16 to 180)° (20 to 180)°	
Attenuation: S ₁₂ : (0 to 60) dB	10 kHz to 45 MHz (45 to 2000) MHz (2 to 8) GHz (8 to 20) GHz (20 to 26.5) GHz	(0.041 to 0.31) dB (0.035 to 0.17) dB (0.060 to 0.22) dB (0.075 to 0.51) dB (0.10 to 2.0) dB	

Parameter/Equipment	Range	CMC ² (±)	Comments
RF Microwave ³ – Parameters S11 and S12 (cont)			Agilent VNA/PNA w/ 85057B
2.4 mm connectors			
Reflection Coefficient ρ $ S_{11} $: (0 to 1)	45 MHz to 2.0 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	(0.028 to 0.032) ρ (0.030 to 0.036) ρ (0.047 to 0.053) ρ (0.057 to 0.070) ρ	ρ is the reflection coefficient
Attenuation: $ S_{12} $: (0 to 60) dB	45 MHz to 2.0 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	(0.07 to 0.22) dB (0.12 to 0.32) dB (0.25 to 0.54) dB (0.33 to 0.69) dB	
Phase: Arg (S11) $0 < S_{11} < 1$ -180° to +180°	45 MHz to 2.0 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	(0.92 to 1.6)° (4.1 to 5.0)° (8.0 to 9.6)° (10.1 to 12.4)°	

VI. Mechanical

Parameter/Equipment	Range	CMC ^{2,4,6} (±)	Comments
Mass	(10 to 100) mg 100 mg to 1 g (1 to 20) g (20 to 200) g 200 g to 2 kg (2 to 5) kg (5 to 23) kg	0.0078 mg 0.016 mg 0.028 mg 0.16 mg 1.5 mg 6.2 mg 58 mg	NIST SOP 4 w/ class 1 weights
Torque Analyzers	2 in·ozf to 10 in·lbf 10 in·lbf to 1000 ft·lbf	0.12 % 0.19 %	Calibrated weights and moment arms
Torque Tools ³	2 ozf·in to 250 lbf·ft (250 to 1000) lbf·ft	1.3 % 1.2 %	Torque tester w/ transducers

Parameter/Equipment	Range	CMC ^{2,4,6} (\pm)	Comments
Pressure – Measuring Equipment			
Hydraulic	(0 to 10 000) psig	3.2 psig	Additel ADT672-02-GP10K-PSI-N
Pneumatic ³	Ambient Barometric	0.13 mbar	CPC 6000
	(0 to 22.5) psia	0.0024 psia	
	(22.5 to 45) psia	0.0011 psia + 0.01%	
	(45 to 80) psia	0.0062 psia	
	(80 to 115) psia	0.0029 psia + 0.01%	
	(115 to 315) psia	0.027 psia	
	(315 to 515) psia	0.011 psia + 0.01 %	
	(515 to 765) psia	0.054 psia	
	(765 to 1015) psia	0.022 psia + 0.01 %	
	(0 to 22.5) psig	0.0037 psig	w/ barometer
	(22.5 to 45) psig	0.0051 psig + 0.01 %	
	(45 to 80) psig	0.011 psig	
	(80 to 115) psig	0.012 psig + 0.01 %	
	(115 to 315) psig	0.042 psig	
	(315 to 515) psig	0.053 psig + 0.01 %	
	(515 to 765) psig	0.095 psig	
	(765 to 1015) psig	0.1 psig + 0.01 %	
Force Gages – Tension & Compression ³	(1 to 16) ozf (1.0 to 100) lbf	0.023 % + 0.6R 0.012 % + 0.6R	Class F weights
Force – Measure, Tension & Compression	(10 to 1000) lbf (1000 to 50 000) lbf	0.044 % + 0.2 lbf 0.072 % + 2.2 lbf	Load cells
Acceleration –			
Sensitivity (mV/g, pC/g)	100 Hz	0.83 %	National Instruments USB-4431 System
Frequency Response	10 Hz to 10 kHz	1.5 %	
Optical Tachometers	(5 to 500 000) rpm	0.0021 rpm + 0.6R	Stroboscope and frequency counter phase locked to GPS receiver

Parameter/Equipment	Range	CMC ^{2,4,6} (±)	Comments
Scales and Balances ^{3,8}	(20 to 500) mg 500 mg to 10 g (10 to 100) g 100 g to 10 kg	0.023 mg 0.005 % 0.00058 % 0.00029 %	Class 1 weights
	(5 to 1000) lb	0.012 %	Class F weights

VII. Optical Quantities

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
Fiber Optic Power – Relative Measuring Equipment ³	(-50 to -40) dB (-40 to -30) dB (-30 to -20) dB (-20 to -10) dB (-10 to 0) dB (0 to 10) dB	0.026 dB 0.021 dB 0.024 dB 0.022 dB 0.02 dB 0.02 dB	Agilent 81623B
Fiber Optic Power – Measuring ³ (1000 to 1650) nm	(-50 to +10) dBm	0.095 dB	Agilent 81623B
Fiber Optic Wavelength – Measuring Equipment ³	(1510 to 1540) nm	0.7 pm	NIST SRM 2517A

VIII. Thermodynamics

Parameter/Equipment	Range	CMC ² (±)	Comments
Temperature – Measure ³	(-200 to 420) °C	0.074 °C	PRT and meter
Temperature – Measuring Equipment ³	(-55 to 420) °C	0.14 °C	Hart dry cells with PRT and meter
Relative Humidity – Measure ³	10 % RH 11.3 % RH 33.1 % RH 75.5 % RH 80 % RH 97.6 % RH	0.6 % RH 0.9 % RH 0.9 % RH 0.9 % RH 0.7 % RH 1.2 % RH	ASTM E104 w/ salts, PRT and meter
Relative Humidity – Measuring Equipment ³ Humidity (+15 to +25) °C (+15 to +25) °C (-20 to +40) °C (-40 to +180) °C Temperature (0 to 40) °C (-40 to 100) °C (-70 to 140) °C (140 to 180) °C	 (0 to 90) %RH (90 to 100) %RH (0 to 100) %RH (0 to 100) %RH (0 to 40) °C (-40 to 100) °C (-70 to 140) °C (140 to 180) °C	 1.2 % RH 2.0 % RH 1.2 % RH + 0.0092 % 1.8 % RH + 0.017 % 0.71 °C 0.79 °C 0.87 °C 0.95 °C	 Vaisala Humidity Meter/Probe

IX. Time and Frequency

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Frequency – Measuring Equipment ³	1 Hz to 10 MHz 10 MHz to 50 GHz	0.11 nHz/Hz 10 pHz/Hz	GPS receiver, Signal Generators
Frequency – Measure ^{3,8}	1 Hz to 10 MHz 10 MHz to 50 GHz	0.11 nHz/Hz 10 pHz/Hz	GPS receiver, Frequency Counters
Timers, Stopwatch ³	60 s to 24 hrs	0.9 s	Totalize method with counter phase locked to GPS receiver

-
- ¹ This laboratory offers commercial and field calibration services.
- ² 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.
- 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 and R is the numerical value of the resolution of the device.
- ⁵ The measurands stated are generated with the Fluke 5500A, 5520A, 5700A, 5720A or 5790A series of instruments. 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 of the reading plus a fixed floor specification.
- ⁶ Unless indicated otherwise, all CMCs stated in % are meant to be % of reading.
- ⁷ This laboratory meets R205 – Specific Requirements: Calibration Laboratory Accreditation Program for the types of dimensional tests listed above and is considered equivalent to that of a calibration.
- ⁸ Uncertainty components that can be reasonably attributed to the Unit Under Test have not been utilized in the calculation of the CMC value for this measurement parameter.



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This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets the requirements of ANSI/NCSLI Z540-1-1994 and the requirements of ANSI/NCSLI Z540.3-2006 and R205 – Specific Requirements: Calibration Laboratory Accreditation Program. 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 April 2017*).



Presented this 2nd day of August 2018.

A blue ink signature of the Vice President of Accreditation Services.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 1797.01
Valid to March 31, 2020
Revised May 8, 2019

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