



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

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CALIBRATION

Valid To: September 30, 2019

Certificate Number: 2560.01

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

I. Dimensional

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Gage Blocks	(0.05 to 4) in (>4 to 12) in	(5.2 + 3.5L) μin (4.0 + 5.4L) μin	P&W Labmaster™, gage blocks
Micrometers ³ – Head, Inside, Outside, Depth	Up to 20 in	69 μin	Gage blocks
Calipers ³ – Dial, Vernier, & Digital	Up to 48 in	330 μin	Gage blocks
Indicators ³ – Dial & Digital	0 to 1 in 0 to 6 in	13 μin + 0.6R 33 μin + 0.6R	P&W Labmaster™, gage blocks
Height Gages ³ – Dial, Vernier, & Digital	Up to 24 in	480 μin	Gage blocks, surface plates
Thread Plug Gages – English & Metric, 60° Pitch Diameter			
Major Diameter	(0.06 to 4) in	(40 + 5.0L) μin	P&W Labmaster™, gage blocks, thread wires
Pitch Diameter	(8 to 80) TPI	130 μin	

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Cylindrical Plug Gages & Thread Wires	Up to 7 in	(40 + 5.0L) μin	P&W Labmaster™, gage blocks
Ring Gages	(0.04 to 10) in	(40 + 3.7L) μin	P&W Labmaster™, gage blocks, master ring gages
Surface Plates ³ – Flatness Only	(15 to 192) in diagonal	3.0 μin/in	Talyvel 6 electronic level system

II. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 4, 7} (±)	Comments
DC Voltage ³ – Generate	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1000) V	9.9 μV/V + 0.40 μV 5.8 μV/V + 0.70 μV 4.0 μV/V + 2.5 μV 4.0 μV/V + 4.0 μV 5.8 μV/V + 40 μV 7.5 μV/V + 0.40 mV	Fluke 5720A
DC Voltage ³ – Measure	(0 to 100) mV (100 to 200) mV 200 mV to 1 V (1 to 2) V (2 to 10) V (10 to 20) V (20 to 200) V (200 to 1000) V (0 to 10) kV (0 to 100) kV	26 μV/V + 0.30 μV 6.9 μV/V + 0.10 μV 9.9 μV/V + 0.30 μV 3.5 μV/V + 0.40 μV 9.6 μV/V + 0.50 μV 3.5 μV/V + 4.00 μV 5.2 μV/V + 40 μV 5.2 μV/V + 0.05 mV 0.04 % + 30 mV 0.07 % + 0.30 V	HP 3458A Fluke 8508A HP 3458A Fluke 8508A HP 3458A Fluke 8508A Vitrek 4700

Parameter/Equipment	Range	CMC ^{2, 4, 7} (\pm)	Comments
DC Current ³ – Generate	(0 to 220) μ A 220 μ A to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11.0) A (11 to 20) A	46 μ A/A + 6.0 nA 40 μ A/A + 7.0 nA 40 μ A/A + 40 nA 63 μ A/A + 0.70 μ A 150 μ A/A + 12 μ A 420 μ A/A + 0.48 mA 0.12 % + 0.75 mA*	Fluke 5720A Fluke 5720A & 5725A Fluke 5520A-SC1100 *floor after 30 s
DC Current ³ – Measure	(0 to 0.1) μ A (0.1 to 1) μ A (1 to 10) μ A (10 to 200) μ A (0.2 to 2) mA (10 to 20) mA (20 to 200) mA 200 mA to 1 A (1 to 2) A (2 to 20) A	0.15 % + 40 pA 91 μ A/A + 40 pA 55 μ A/A + 0.10 nA 18 μ A/A + 0.40 nA 14 μ A/A + 4.0 nA 15 μ A/A + 40 nA 42 μ A/A + 0.80 μ A 180 μ A/A + 10 μ A 200 μ A/A + 16 μ A 440 μ A/A + 0.4 mA	HP 3458A Fluke 8508A HP 3458A Fluke 8508A
Resistance ³ – Generate Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	59 $\mu\Omega$ 110 $\mu\Omega$ 210 $\mu\Omega$ 270 $\mu\Omega$ 510 $\mu\Omega$ 1.2 m Ω 2.2 m Ω 9.8 m Ω 19 m Ω 98 m Ω 190 m Ω 1.3 Ω 2.4 Ω 23 Ω 46 Ω 460 Ω 1.0 k Ω 12 k Ω	Fluke 5720A

Parameter/Equipment	Range	CMC ^{2, 4, 7} (±)	Comments
Resistance ³ – Measure	(0 to 2) Ω (2 to 20) Ω (20 to 200) Ω 200 Ω to 2 kΩ (2 to 20) kΩ (20 to 200) kΩ 200 kΩ to 2 MΩ (2 to 20) MΩ (20 to 200) MΩ 200 MΩ to 2 GΩ (2 to 20) GΩ	18 μΩ/Ω + 4 μΩ 11 μΩ/Ω + 14 μΩ 9.9 μΩ/Ω + 50 μΩ 9.9 μΩ/Ω + 0.5 mΩ 9.9 μΩ/Ω + 5 mΩ 9.9 μΩ/Ω + 50 mΩ 11 μΩ/Ω + 1 Ω 18 μΩ/Ω + 10 Ω 69 μΩ/Ω + 1 kΩ 170 μΩ/Ω + 100 kΩ 610 μΩ/Ω + 10 MΩ	Fluke 8508A
	0.0 to 0.01 Ω	250 μΩ/Ω + 0.06 μΩ	Fluke 5720, Fluke 8508A

Parameter/Range	Frequency	CMC ^{2, 4, 7} (±)	Comments
Capacitance ³ – Generate			
(0.19 to 0.3999) nF	10 Hz to 10 kHz	0.85 % + 0.010 nF	Fluke 5520A-SC1100
(0.4000 to 1.0999) nF	10 Hz to 10 kHz	0.62 % + 0.010 nF	
(1.1000 to 3.2999) nF	10 Hz to 3 kHz	0.59 % + 0.010 nF	
(3.3000 to 10.9999) nF	10 Hz to 1 kHz	0.30 % + 0.010 nF	
(11.0000 to 109.999) nF	10 Hz to 1 kHz	0.30 % + 0.10 nF	
(110.000 to 329.999) nF	10 Hz to 1 kHz	0.30 % + 0.30 nF	
(0.33000 to 1.09999) μF	(10 to 600) Hz	0.29 % + 1.0 nF	
(1.10000 to 3.29999) μF	(10 to 300) Hz	0.30 % + 3.0 nF	
(3.3000 to 10.9999) μF	(10 to 150) Hz	0.30 % + 10 nF	
(11.0000 to 32.9999) μF	(10 to 120) Hz	0.47 % + 30 nF	
(33.000 to 109.999) μF	(10 to 80) Hz	0.53 % + 0.10 μF	
(110.000 to 329.999) μF	(0 to 50) Hz	0.53 % + 0.30 μF	
(0.33000 to 1.09999) mF	(0 to 20) Hz	0.53 % + 1.0 μF	
(1.10000 to 3.29999) mF	(0 to 6) Hz	0.52 % + 3.0 μF	
(3.3000 to 10.9999) mF	(0 to 2) Hz	0.52 % + 10 μF	
(11.0000 to 32.9999) mF	(0 to 0.6) Hz	0.87 % + 30 μF	
(33.00 to 110.00) mF	(0 to 0.2) Hz	1.3 % + 0.10 mF	



Parameter/Equipment	Range	CMC ^{2, 4, 7} (±)	Comments
Capacitance ³ – Generate (cont) Fixed Points @ 1kHz	1 pF 10 pF 100 pF 1000 pF 10 nF 100 nF 1 μF	350 μF/F 350 μF/F 350 μF/F 350 μF/F 73 μF/F 73 μF/F 73 μF/F	Fluke 5520A-SC1100
Capacitance – Measure @1 kHz	(0 to 10) pF (10 to 100) pF (100 to 400) pF (400 to 1600) pF (1600 to 6400) pF 6400 pF to 25 nF (25 to 100) nF (100 to 400) nF (400 to 1600) nF 1600 nF to 6 μF (6 to 25) μF (25 to 100) μF (100 to 1000) μF	0.48 % 0.06 % 0.03 % 0.03 % 0.03 % 0.03 % 0.03 % 0.03 % 0.03 % 0.03 % 0.03 % 0.06 % 0.48 %	GenRad 1689-9700
Inductance – Measure	100 μH to 10 H	0.15 %	GenRad 1689-9700
Oscilloscopes ³ – Amplitude DC Signal 50 Ω Load 1 MΩ Load Leveled Sine Flatness 50 kHz Reference Time Marker 50 Ω Load Rise Time	(0 to ± 6.6) V (0 to ± 130) V 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1100) MHz 1 ns to 20 ms 50 ms to 5 s ≤ 2 MHz > 2 MHz	0.28 % + 40 μV 0.057 % + 40 μV 1.9 % + 0.10 mV 2.4 % + 0.10 mV 4.6 % + 0.10 mV 5.7 % + 0.10 mV 2.8 μs/s (29 + 1000t) μs/s 300 ps 350 ps	Fluke 5520-SC1100 <i>t</i> = time interval (s)



Parameter/Equipment	Range	CMC ^{2,7} (±)	Comments
Electrical Simulation of Thermocouple ³ – Generate			
Type E	(-250 to -100) °C (-100 to -25.0) °C (-25.0 to 350) °C (350 to 650) °C (650 to 1000) °C	0.60 °C 0.19 °C 0.60 °C 0.19 °C 0.25 °C	Fluke 5520-SC1100
Type J	(-210 to -100) °C (-100 to -30.0) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.32 °C 0.19 °C 0.30 °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	0.39 °C 0.21 °C 0.27 °C 0.31 °C 0.48 °C	
Type T	(-250 to -150) °C (-150 to 0.0) °C (0.0 to 120) °C (120 to 400) °C	0.75 °C 0.29 °C 0.27 °C 0.17 °C	

Parameter/Range	Frequency	CMC ^{2,4,7} (±)	Comments
AC Voltage ³ – Generate			
(0 to 2.2) mV	(10 to 20) Hz 20 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	280 μV/V + 4.0 μV 100 μV/V + 4.0 μV 240 μV/V + 4.0 μV 580 μV/V + 5.0 μV 0.16 % + 20 μV 0.31 % + 20 μV	Fluke 5720A
(2.2 to 22) mV	(10 to 20) Hz 20 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	280 μV/V + 4.0 μV 100 μV/V + 4.0 μV 240 μV/V + 4.0 μV 580 μV/V + 5.0 μV 0.16 % + 20 μV 0.31 % + 20 μV	



Parameter/Range	Frequency	CMC ^{2, 4, 7} (±)	Comments
AC Voltage ³ – Generate (cont)			
(22 to 220) mV	(10 to 20) Hz 20 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	280 μV/V + 12 μV 100 μV/V + 7.0 μV 240 μV/V + 7.0 μV 530 μV/V + 17 μV 0.16 % + 25 μV 0.31 % + 45 μV	Fluke 5720A
220 mV to 2.2 V	(10 to 20) Hz 20 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	280 μV/V + 40 μV 100 μV/V + 15 μV 110 μV/V + 10 μV 140 μV/V + 30 μV 0.12 % + 0.20 mV 0.20 % + 0.30 mV	
(2.2 to 22) V	(10 to 20) Hz 20 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz 500 kHz to 1 MHz	280 μV/V + 0.40 mV 100 μV/V + 0.15 mV 110 μV/V + 0.10 mV 130 μV/V + 0.20 mV 0.12 % + 2.0 mV 0.17 % + 3.2 mV	
(22 to 220) V	(10 to 20) Hz 20 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	280 μV/V + 4.0 mV 100 μV/V + 1.5 mV 110 μV/V + 1 mV 180 μV/V + 2.5 mV	
(220 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz (30 to 50) kHz (50 to 100) kHz	350 μV/V + 16 mV 81 μV/V + 3.5 mV 200 μV/V + 6.0 mV 700 μV/V + 11 mV 700 μV/V + 11 mV 0.27 % + 45 mV	plus Fluke 5725A



Parameter/Range	Frequency	CMC ^{2, 4, 7} (±)	Comments
AC Voltage ³ – Measure			
(0 to 10) mV	(10 to 20) Hz (20 to 40) Hz (40 to 100) Hz 100 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.48 % + 3.0 μV 0.18 % + 3.0 μV 0.08 % + 1.1 μV 0.043 % + 1.1 μV 0.18 % + 1.1 μV 0.84 % + 1.1 μV 4.8 % + 2.0 μV	HP 3458A, option II
(10 to 100) mV	(100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (1 to 2) MHz	2.4 % + 10 μV 3.6 % + 10 μV 6.0 % + 10 μV 12 % + 10 μV	
(10 to 200) mV	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	180 μV/V + 14 μV 150 μV/V + 4 μV 130 μV/V + 4 μV 120 μV/V + 2 μV 120 μV/V + 4 μV 350 μV/V + 8 μV 810 μV/V + 20 μV	Fluke 8508A
100 mV to 1 V	(1 to 2) MHz	12 % + 0.10 mV	HP 3458A, option II
100 mV to 2 V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	160 μV/V + 120 μV 120 μV/V + 20 μV 98 μV/V + 20 μV 75 μV/V + 20 μV 98 μV/V + 20 μV 240 μV/V + 40 μV 580 μV/V + 200 μV 0.35 % + 2 mV 1.2 % + 20 mV	Fluke 8508A
(1 to 10) V	(1 to 2) MHz	12 % + 1.0 mV	HP 3458A, option II
(2 to 20) V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	160 μV/V + 1.2 mV 120 μV/V + 0.20 mV 98 μV/V + 0.20 mV 75 μV/V + 0.20 mV 98 μV/V + 0.20 mV 240 μV/V + 0.40 mV 580 μV/V + 2.0 mV 0.35 % + 20 mV 1.2 % + 0.20 V	Fluke 8508A

Parameter/Range	Frequency	CMC ^{2, 4, 7} (±)	Comments
AC Voltage ³ – Measure (cont)			
(20 to 200) V	(1 to 10) Hz (10 to 40) Hz (40 to 100) Hz 100 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	160 μV/V + 12 mV 120 μV/V + 2.0 mV 98 μV/V + 2.0 mV 75 μV/V + 2.0 mV 98 μV/V + 2.0 mV 240 μV/V + 4.0 mV 580 μV/V + 20 mV 0.35 % + 200 mV 1.2 % + 2.0 V	Fluke 8508A
(200 to 1000) V	(1 to 10) Hz (10 to 40) Hz 40 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	160 μV/V + 70 mV 130 μV/V + 20 mV 110 μV/V + 20 mV 240 μV/V + 40 mV 590 μV/V + 0.20 V	
(0 to 7) kV (0 to 70) kV	(50 to 60) Hz (50 to 60) Hz	0.15 % + 0.10 V 0.13 % + 0.60 V	Vitretek 4700/HVL-100



Parameter/Range	Frequency	CMC ^{2, 4, 7} (±)	Comments
AC Current ³ – Generate			
(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	0.16 % + 16 nA 0.15 % + 10 nA 0.10 % + 8.0 nA 0.33 % + 12 nA 0.73 % + 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	0.099 % + 40 nA 0.088 % + 35 nA 0.072 % + 35 nA 0.31 % + 0.11 µA 0.71 % + 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	0.093 % + 0.40 µA 0.081 % + 0.35 µA 0.072 % + 0.35 µA 0.31 % + 0.55 µA 0.71 % + 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	0.092 % + 4.0 µA 0.081 % + 3.5 µA 0.078 % + 2.5 µA 0.32 % + 3.5 µA 0.71 % + 10 µA	
220 mA to 2.2 A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.61 % + 35 µA 0.40 % + 80 µA 2.0 % + 1.6 mA	Fluke 5720A
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.11 % + 0.17 mA 0.25 % + 0.38 mA 1.0 % + 0.75 mA	plus 5725A
(11 to 20.5) A	(40 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.19 % + 5.9 mA 0.21 % + 5.9 mA 3.7 % + 5.9 mA	Fluke 5520A- SC1100

Parameter/Range	Frequency	CMC ^{2, 4, 7} (±)	Comments
AC Current ³ – Measure			
(0 to 200) µA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	550 µA/A + 20 nA 550 µA/A + 20 nA 750 µA/A + 20 nA 0.46 % + 20 nA	Fluke 8508A
200 µA to 2 mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	330 µA/A + 0.20 µA 320 µA/A + 0.20 µA 750 µA/A + 0.20 µA 0.46 % + 0.20 µA	
(2 to 20) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	330 µA/A + 2.0 µA 320 µA/A + 2.0 µA 750 µA/A + 2.0 µA 0.46 % + 2.0 µA	
(20 to 100) mA	(30 to 50) kHz (50 to 100) kHz	0.48 % + 20 µA 0.48 % + 20 µA	HP 3458A, option II
(20 to 200) mA	(1 to 10) Hz 10 Hz to 10 kHz (10 to 30) kHz	330 µA/A + 20 µA 290 µA/A + 20 µA 690 µA/A + 20 µA	Fluke 8508A
100 mA to 1 A	(30 to 50) kHz	1.2 % + 0.40 mA	HP 3458A, option II
200 mA to 2 A	10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz	690 µA/A + 0.20 mA 820 µA/A + 0.20 mA 0.35 % + 0.20 mA	Fluke 8508A
(2 to 20) A	10 Hz to 2 kHz (2 to 10) kHz	920 µA/A + 2.0 mA 0.29 % + 2.0 mA	
(20 to 100) A (100 to 200) A (200 to 1200) A	(30 to 1000) Hz (30 to 1000) Hz (30 to 1000) Hz	0.58 % + 20 mA 0.35 % + 20 mA 0.36 % + 200 mA	Fluke 8508A w/ AEMC SR704

III. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2, 4} (±)	Comments
RF Power ³ – Transfer Reference 1 mW	(0.01 to 10) MHz (0.01 to 4.2) GHz (0.01 to 10) GHz (10 to 18) GHz	1.8 % 1.9 % 1.7 % 2.3 %	F1119C/1805B 1807A/1805B
RF Power – Measure @ 1 mW	50 MHz 1000 MHz	0.35 % 0.65 %	478A opt H75 w/ 432A
Attenuation ³ – (+16 to -129) dB (+16 to -134) dB (+16 to -140) dB (+16 to -135) dB (+16 to -129) dB (+16 to -121) dB	100 kHz to 2 MHz (2 to 10) MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 19.2) GHz (19.2 to 26.5) GHz	0.08 dB + 0.005 dB/10 dB Step	Keysight N5531S, add 0.031dB each time you switch between ranges



Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Amplitude Modulation ³ – Measure			
Rate: 20 Hz to 10 kHz Depth: (5 to 99) %	100 kHz to 10 MHz	0.98 %	Keysight N5531S
Rate: 50 Hz to 100 kHz Depth: (20 to 99) %	10 MHz to 3 GHz	0.71 %	
Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	10 MHz to 3 GHz	3.0 %	
Rate: 50 Hz to 100 kHz Depth: (20 to 99) %	(3 to 26.5) GHz	1.8 %	
Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	(3 to 26.5) GHz	5.4 %	
Frequency Modulation ³ – Measure			
Rates: 20 Hz to 10 kHz Deviations: 200 Hz to 40 kHz peak	250 kHz to 10 MHz	1.8 %	Keysight N5531S
Rates: 50 Hz to 200 kHz Deviations: 250 Hz to 400 kHz peak	10 MHz to 6.6 GHz	1.8 %	
Rates: 50 Hz to 200 kHz Deviations: 250 Hz to 400 kHz peak	(6.6 to 13.2) GHz	3.0 %	
Rates: 50 Hz to 200 kHz Deviations: 250 Hz to 400 kHz peak	(13.2 to 26.5) GHz	4.6 %	
Rates: 50 Hz to 200kHz Deviations 250Hz to 400kHz peak ⁶	250 kHz to 26.5 GHz	1.2 %	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Phase Modulation ³ – Measure > 0.7 Radians Rate: 200 Hz to 20 kHz > 0.3 Radians Rate: 200 Hz to 20 kHz > 2.0 Radians Rate: 200 Hz to 20 kHz > 0.6 Radians Rate: 200 Hz to 20 kHz > 4.0 Radians Rate: 200 Hz to 20 kHz > 1.2 Radians Rate: 200 Hz to 20 kHz	100 kHz to 6.6 GHz 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz (13.2 to 26.5) GHz	1 % 3.5 % 1.3 % 3.5 % 1.3 % 3.5 %	Keysight N5531S
Modulation Rate ³ – Measure Amplitude Modulation Rate: 20 Hz to 10 kHz Depth: > 20% Rate: 20 Hz to 100 kHz Depth: > 20% Frequency & Phase Modulation Rate: 20 Hz to 10 kHz Rate: 20 Hz to 200 kHz	100 kHz to 10 MHz 10 MHz to 26.5 GHz 100 kHz to 10 MHz 10 MHz to 26.5 GHz	72 mHz 72 mHz 72 mHz 72 mHz	Keysight N5531S



IV. Mechanical

Parameter/Equipment	Range	CMC ^{2, 4, 5} (±)	Comments
Scales & Balances ³	(1 to 500) mg (1 to 500) g 200 g to 10 kg (10 to 200) kg (1/32 to 32) oz (0.5 to 50) lb (20 to 970) lb	6 µg + 0.6R 30 µg/g + 0.6R 22 µg/g + 0.6R 0.040 % + 0.6R 0.019 % + 0.6R 0.029 % + 0.6R 0.033 % + 0.6R	Class 0 weights Class 0 weights Class 2 weights Class F weights Class F weights Class F weights Class F weights
Pressure ³ – Measure/Measuring Equipment	(0 to 50) psia (-14.5 to 500) psig (500 to 4000) psi (0 to 35) inHg (0 to 1500) psi (0 to 10 000) psi	180 µBar/Bar + 8.4 µBar 200 µBar/Bar + 50 µBar 0.036 % + 0.04 psi 0.03 inHg 1.9 psi 4.9 psi	Druck Pace6000 Dead weight tester M1900/3 Pressure calibrator DP1620, PM620- 06A, PM620-165G, PM620-22A
Torque – Watches & Transducers	(6 to 250) cm·gf (250 to 1000) cm·gf (1 to 80) in·ozf (5 to 400) in·lbf (30 to 300) ft·lbf (300 to 4000) ft·lbf	0.60 % + 1 digit 0.60 % + 1 digit 0.06 % + 1 digit 0.06 % + 1 digit 0.04 % + 1 digit 0.04 % + 1 digit	Calibrated weights, torque wheels & arms



Parameter/Equipment	Range	CMC ^{2, 4, 5} (±)	Comments
Torque – Wrenches & Drivers	(4 to 20) in·ozf (2 to 10) in·lbf (5 to 50) in·lbf (25 to 250) in·lbf (100 to 1000) in·lbf (25 to 250) ft·lbf (0 to 100) ft·lbf (100 to 2000) ft·lbf (2000 to 4000) ft·lbf	0.88 % 1.1 % 1.0 % 1.0 % 1.0 % 1.0 % 0.60 % 0.60 % 0.60 %	BMX LTT10I TTPM-41, 2000- 400-02 AKO torque tester
Force ³ – Measuring Equipment	(1 to 500) gf (0.5 to 200) kgf (1 to 921) lbf	0.04 % + 1 digit 0.05 % + 1 digit 0.08 % + 1 digit	Calibrated weights
Force – Tension/Compression Measure	(0 to 550) lbf	370 µg/g	Morehouse ultra-precision loadcell
Speed Measuring Devices ³ – Radar X, K, KA Bands			
Measure	(10.5 to 36.1) GHz	0.11 GHz	VOCAR HR
Tuning Forks – Measure	(200 to 15 000) Hz	0.12 % (≈ 0.22 MPH)	
Speed – Simulate	(15 to 140) MPH	1.0 %	
Accelerometers	(0.5 to 10) Hz (5 to 9) Hz (10 to 99) Hz 100 Hz (101 to 920) Hz 921 Hz to 5 kHz (5 to 10) kHz (10 to 15) kHz (15 to 20) kHz	1.3 % 2.2 % 1.3 % 1.1 % 1.2 % 1.5 % 2.1 % 2.6 % 3.6 %	The Modal Shop Long stroke 9155D



V. Optical Quantities

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Power ³ – Measure (5 to -60) dBm	(850, 1310, 1555) nm	3.7 %	IQS-1502-Q1

VI. Thermodynamics

Parameter/Equipment	Range	CMC ² (±)	Comments
Humidity ³ – Measure	(10 to 90) % RH	1.0 % RH	HMI41/HMP46
Humidity – Measuring Equipment	(10 to 95) % RH	0.36 % RH	Thunder Scientific 2500S
Temperature ³ – Measure	(-196 to 0) °C (0 to 420) °C	40 mK 50 mK	PRT 5614

VII. Time & Frequency

Parameter/Equipment	Range	CMC ² (±)	Comments
Frequency – Measuring Equipment Fixed	(5, 10) MHz	1.6 parts in 10 ¹² Hz	Fluke 910R
Frequency – Measure	1 mHz to 26.5 GHz	1.6 parts in 10 ¹² Hz + 1 LSD	Agilent 53131A Keysight N5531S Fluke 910R

¹ This laboratory offers commercial calibration services 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 percentage refers to percent of reading unless stated otherwise.

⁵ In the statement of CMC, L is the numerical value of the nominal length in inches and R is the numerical value of the resolution of the device under test.

⁶ Ratio of Frequency deviations to modulation rate must be greater than the following:

250 kHz to 10 MHz: >1.2 ,
10 MHz to 6.6 GHz > 0.45 ,
6.6 GHz to 13.2 GHz > 8 ,
13.2 GHz to 26.5 GHz > 16 .

⁷ The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.



Accredited Laboratory

A2LA has accredited

CASCADE ENGINEERING SERVICES, INC.

Redmond, WA

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/NCCL Z540-1-1994 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 23rd day of March 2018.

A handwritten signature in black ink, written over a horizontal line.

President and CEO
For the Accreditation Council
Certificate Number 2560.01
Valid to September 30, 2019

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