



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

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CALIBRATION

Valid To: June 30, 2024

Certificate Number: 3759.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations^{1, 7}:

I. Chemical Quantities

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
Conductivity – Measure	10 µS/cm 1000 µS/cm 10 mS/cm	0.69 µS/cm 9.1 µS/cm 52 µS/cm	Standard solutions
pH – Measure	(4, 7, 10) pH	0.02 pH	Standard solutions

II. Dimensional

Parameter/Equipment	Range	CMC ² (±)	Comments
Sine Plate, and 90° Angle Plate (Flatness)	Up to 12 in	67 µin	Indicator
Digital Protractor and Clinometer	Up to 360°	0.016°	Sine plate, gage blocks, and angle plate

Parameter/Equipment	Range	CMC ^{2,3} (±)	Comments
Optical Protractor, Weathervane, and Protractor	Up to 360°	0.078°	Optical comparator
Sine Plate	Up to 75°	1.1"	Gage blocks, angle blocks, surface plate, and indicator
90° Angle Plate	90°	0.0013°	Comparison to cylindrical square with indicator
Tool Maker's Microscope – Angle	Up to 45°	5.3'	Angle blocks
Length (X-Y axis)	Up to 2 in	150 μin	Gage blocks
Gage Blocks, Ring Gages, and Plug Gages	Up to 11 in	(11 + 1.6L) μin	Comparison to gage blocks with Labmaster™
Height Transfer Standard	Up to 40 in	(44+1.3L) μin	Comparison to gage blocks with indicator
Indicators, Feeler Gages, Bore Gages 2 Contact, and LVDT	Up to 11 in	(18 + 1.9L) μin	Labmaster™
Gaging Amplifier Micrometers, Calipers, Height Gages, Rules, and Laser Distance Meters	(0.001 to 0.1) in Up to 12 in (12 to 84) in	8 μin (19 + 14L) μin (160 + 0.78L) μin	Gage blocks
Measuring Tapes	Up to 30 ft	(0.017 + 0.0016L) in	Master rule
Bore Gages 3 Contact	(0.275 to 5) in	(55 + 1.8L) μin	Ring gages

Parameter/Equipment	Range	CMC ² (±)	Comments
Position Transducers	Up to 30 in Up to 20 ft	0.0034 in 0.036 ft	Height gage, DMM Laser Distance Meter, DMM
Micrometer (Flatness)	Up to 2 in	9.6 μin	Optical flats
Surface Plate, Fixed Points	18 in 60 in	31 μin 78 μin	Repeat-o-meter Planekator
Optical Comparator – X-Y Linearity (2D)	Up to 12 in	90 μin	Master reticule
Magnification (2D)	10x, 20x, 25x, 31.25x, 50x, 62.5x	430 μin	Magnification reticule

III. Dimensional Testing/Calibration⁹

Parameter/Equipment	Range	CMC ² (±)	Comments
Length (2D) Angle	Up to 8 in Up to 90°	430 μin 0.084°	Optical comparator
Length (2D) Angle	Up to 2 in Up to 45°	150 μin 0.013°	Toolmaker's microscope

IV. Electrical – DC/Low Frequency

Parameter/Range	Frequency	CMC ^{2,4,5} (±)	Comments
AC Voltage Level Flatness – 1 V (Into 50 Ω)	DC to 10 Hz	0.009 %	Ballantine 1395B-1 thermal converter
	(10 to 100) Hz	0.0069 %	
100 Hz to 10 kHz	0.0071 %		
(10 to 30) kHz	0.0070 %		
(30 to 100) kHz	0.0078 %		
(100 to 300) kHz	0.009 %		
300 kHz to 1 MHz	0.01 %		
(1 to 3) MHz	0.022 %		
(3 to 8) MHz	0.031 %		
(8 to 10) MHz	0.042 %		
(10 to 20) MHz	0.06 %		
(20 to 30) MHz	0.08 %		
(30 to 50) MHz	0.18 %		
(50 to 70) MHz	0.3 %		
(70 to 80) MHz	0.32 %		
(80 to 100) MHz	0.38 %		
3 V (Into 50 Ω)	DC to 10 Hz	0.009 %	
	(10 to 100) Hz	0.0069 %	
	100 Hz to 10 kHz	0.0069 %	
	(10 to 30) kHz	0.0069 %	
	(30 to 100) kHz	0.0075 %	
	(100 to 300) kHz	0.008 %	
	300 kHz to 1 MHz	0.010 %	
	(1 to 3) MHz	0.021 %	
	(3 to 8) MHz	0.031 %	
	(8 to 10) MHz	0.041 %	
	(10 to 20) MHz	0.06 %	
	(20 to 30) MHz	0.08 %	
	(30 to 50) MHz	0.18 %	
	(50 to 70) MHz	0.30 %	
(70 to 80) MHz	0.32 %		
(80 to 100) MHz	0.38 %		

Parameter/Range	Frequency	CMC ^{2, 4, 5} (±)	Comments
AC Current – Measuring Equipment and Measure			
(0.02 to 0.22) mA	10 Hz to 10 kHz	0.0071 %	Fluke 5790B and A40 shunts
(0.22 to 2.2) mA	10 Hz to 10 kHz	0.0057 %	
(2.2 to 22) mA	10 Hz to 10 kHz	0.0054 %	
(22 to 220) mA	10 Hz to 10 kHz	0.0062 %	
(0.22 to 2.2) A	10 Hz to 10 kHz	0.0073 %	
(2.2 to 20) A	10 Hz to 10 kHz	0.012 %	
(20 to 120) A	(10 to 300) Hz	0.094 %	Fluke 5700A, Fluke 52120A
Clamp-On Meter –			
(2 to 1000) A	10 Hz to 10 kHz	0.61 %	Fluke 52120A w/ 5500A/coil
(1000 to 3000) A	(10 to 300) Hz	0.77 %	Fluke 52120A w/ 52120A/coil 3KA
DC Resistance – Measure and Generate			
	333 μΩ to 1 mΩ (1 to 10) mΩ (10 to 100) mΩ	69 μΩ/Ω 63 μΩ/Ω 23 μΩ/Ω	Guildline 9211 Fluke 8508A with standard resistors
	(0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 kΩ	11 μΩ/Ω 12 μΩ/Ω 8.4 μΩ/Ω 5.1 μΩ/Ω	
	(1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ (1 to 10) GΩ (10 to 100) GΩ	3.6 μΩ/Ω 4.4 μΩ/Ω 7.9 μΩ/Ω 11 μΩ/Ω 9.2 μΩ/Ω 18 μΩ/Ω 210 μΩ/Ω 360 μΩ/Ω	

Parameter/Equipment	Range	CMC ^{2, 4} , (±)	Comments
DC Resistance – Measure	(0.01 to 0.1) Ω (0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	7.0 mΩ/Ω 0.72 mΩ/Ω 89 μΩ/Ω 25 μΩ/Ω 16 μΩ/Ω 15 μΩ/Ω 16 μΩ/Ω 24 μΩ/Ω 83 μΩ/Ω 0.65 mΩ/Ω 6.5 mΩ/Ω	Agilent 3458A-opt 2
DC Resistance – Generate, Fixed Points	1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	94 μΩ/Ω 93 μΩ/Ω 29 μΩ/Ω 30 μΩ/Ω 16 μΩ/Ω 17 μΩ/Ω 9.4 μΩ/Ω 11 μΩ/Ω 9.8 μΩ/Ω 11 μΩ/Ω 12 μΩ/Ω 13 μΩ/Ω 21 μΩ/Ω 22 μΩ/Ω 42 μΩ/Ω 51 μΩ/Ω 190 μΩ/Ω	Fluke 5700A/EP

Parameter/Equipment	Range	CMC ^{2, 4, 5} (±)	Comments		
DC Current – Measuring Equipment	(2 to 20) nA	0.0053 %	ESR SR 1050 with voltage source		
	(20 to 200) nA	0.0043 %			
	(0.2 to 2) μA	0.0048 %			
	Clamp-On Only	(2 to 220) μA	73 μA/A	Fluke 5700A/EP	
		220 μA to 2.2 mA	40 μA/A		
		(2.2 to 22) mA	41 μA/A		
(22 to 220) mA		52 μA/A			
Clamp-On Only	220 mA to 2.2 A	78 μA/A	Fluke 5700A/EP with 5725A		
	(2.2 to 11) A	450 μA/A			
	(11 to 20.5) A	1.2 mA/A	Fluke 5522A		
	(0.1 to 2) A (2 to 120) A	(10 to 16.5) A (16.5 to 150) A (150 to 1000) A (1000 to 2500) A	0.016 %	Fluke 52120A and 5700A/EP	
			0.015 %		
			0.35 %		
0.31 %					
DC Current – Measure	(2 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 (1 to 10) A (10 to 100) A (100 to 300) A	0.30 %	Fluke 5500A/coil		
		0.77 %			
		DC Current – Measure	(2 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 (1 to 10) A (10 to 100) A (100 to 300) A	0.0051 %	Guildline 9211A
				0.0015 %	
				0.0018 %	
				0.0017 %	
				0.0021 %	
				0.0025 %	
				0.0024 %	
				0.0061 %	
0.012 %					

Parameter/Range	Frequency	CMC ^{2, 4, 5} (±)	Comments
AC Voltage – Measure (cont)			
(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	0.20 mV/V 91 μV/V 45 μV/V 77 μV/V 0.17 mV/V 0.28 mV/V 0.40 mV/V 0.59 mV/V	Fluke 5790B
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	0.19 mV/V 67 μV/V 24 μV/V 67 μV/V 91 μV/V 0.15 mV/V 0.24 mV/V 0.59 mV/V	
(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	0.19 mV/V 68 μV/V 26 μV/V 45 μV/V 75 μV/V 0.18 mV/V 0.36 mV/V 0.59 mV/V	
(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	0.19 mV/V 66 μV/V 34 μV/V 64 μV/V 92 μV/V 0.20 mV/V	
(220 to 1000) V	(20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	94 μV/V 39 μV/V 0.13 mV/V 0.45 mV/V	
(1 to 42) kV	60 Hz	0.72 %	HV divider with DMM

Parameter/Range	Frequency	CMC ^{2, 4, (±)}	Comments
AC Voltage – Generate			
(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 500 kHz to 1 MHz	0.63 mV/V 0.43 mV/V 0.38 mV/V 0.59 mV/V 0.95 mV/V 2.0 mV/V 2.9 mV/V 4.5 mV/V	Fluke 5700A/EP
(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	0.42 mV/V 0.18 mV/V 0.14 mV/V 0.27 mV/V 0.62 mV/V 1.0 mV/V 1.6 mV/V 3.4 mV/V	
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	0.37 mV/V 0.13 mV/V 59 μV/V 0.12 mV/V 0.18 mV/V 0.48 mV/V 1.2 mV/V 2.2 mV/V	
(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	0.37 mV/V 0.13 mV/V 59 μV/V 0.12 mV/V 0.17 mV/V 0.41 mV/V 1.3 mV/V 2.3 mV/V	
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.37 mV/V 0.13 mV/V 69 μV/V 0.13 mV/V 0.21 mV/V	
(220 to 1100) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.11 mV/V 0.16 mV/V 0.46 mV/V	
(220 to 750) V	(30 to 50) kHz (50 to 100) kHz	0.47 mV/V 1.7 mV/V	Fluke 5700A/EP with 5725A

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
AC Voltage – Wideband Generate (0 to 1.1) mV (1.1 to 3) mV (3 to 11) mV (11 to 33) mV (33 to 110) mV (110 to 330) mV 330 mV to 1.1 V (1.1 to 3.5) V	30 Hz to 500 kHz 30 Hz to 500 kHz 30 Hz to 500 kHz 30 Hz to 500 kHz 30 Hz to 500 kHz 30 Hz to 500 kHz 30 Hz to 500 kHz 30 Hz to 500 kHz	6.4 mV/V 5.8 mV/V 4.5 mV/V 3.9 mV/V 3.9 mV/V 3.3 mV/V 3.3 mV/V 2.5 mV/V	Fluke 5700A/EP
AC Voltage – Wideband Amplifier Flatness (0 to 2.2) mV (2.2 to 7.0) mV (7.0 to 22) mV (22 to 70) mV (70 to 220) mV (220 to 700) mV 700 mV to 2.2 V (2.2 to 7.0) V	10 Hz to 30 MHz 10 Hz to 30 MHz 10 Hz to 30 MHz 10 Hz to 30 MHz 10 Hz to 30 MHz 10 Hz to 30 MHz 10 Hz to 30 MHz 10 Hz to 30 MHz	0.12 % 0.099 % 0.061 % 0.060 % 0.048 % 0.037 % 0.036 % 0.037 %	Fluke 5790B
Capacitance – Measure (0 to 10) pF (10 to 100) pF (100 to 1000) pF (1 to 10) nF (10 to 100) nF (100 to 1000) nF 0.1 pF to 1 nF (1 to 10) nF (10 to 100) nF 100 nF to 99.999 mF	1 kHz 1 kHz 1 kHz 1 kHz 1 kHz 1 kHz 12 Hz to 1 kHz 12 Hz to 10 kHz 13 Hz to 10 kHz 12 Hz to 10 kHz	23 μF/F 10 μF/F 10 μF/F 17 μF/F 34 μF/F 240 μF/F 0.027 % 0.024 % 0.025 % 0.026 %	AH 2500A GenRad 1689M

Parameter/Range	Frequency	CMC ^{2, 4, 5} (±)	Comments
Power – Generate (0.1 to 4000) W	(50 to 400) Hz	0.065 %	Rotek 811A
(2 to 33) kW	20 Hz to 1 kHz	0.12 %	Fluke 5700A-EP, 5790A & 52120A. Krohn-Hite 6620A

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of RTD Devices Indicating Systems –			
Pt 385, 100 Ω	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.059 °C 0.082 °C 0.11 °C 0.12 °C 0.14 °C 0.27 °C	Fluke 5522A
Pt 3926, 100 Ω	(-200 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 630) °C	0.059 °C 0.082 °C 0.11 °C 0.14 °C	
Pt 3916, 100 Ω	(-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.29 °C 0.048 °C 0.059 °C 0.07 °C 0.082 °C 0.094 °C 0.11 °C 0.12 °C 0.27 °C	
Pt 385, 200 Ω	(-200 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.048 °C 0.059 °C 0.14 °C 0.16 °C 0.17 °C 0.19 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of RTD Devices Indicating Systems – (cont)			
Pt 385, 500 Ω	(-200 to -80) °C (-80 to 100) °C (100 to 260) °C (260 to 400) °C (400 to 600) °C (600 to 630) °C	0.048 °C 0.059 °C 0.071 °C 0.094 °C 0.11 °C 0.27 °C	Fluke 5522A
Pt 385, 1000 Ω	(-200 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 600) °C (600 to 630) °C	0.037 °C 0.048 °C 0.059 °C 0.071 °C 0.084 °C 0.27 °C	
PtNi 385, 120 Ω	(-80 to 100) °C (100 to 260) °C	0.093 °C 0.17 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.35 °C	
Electrical Calibration of Thermocouple Devices and Indicating Systems –			
Type B	(600 to 1820) °C	0.36 °C	Fluke 5522A
Type C	(0 to 2316) °C	0.32 °C	
Type E	(-250 to 1000) °C	0.19 °C	
Type J	(-210 to 1200) °C	0.19 °C	
Type K	(-200 to 1372) °C	0.21 °C	
Type N	(-200 to 1300) °C	0.23 °C	
Type R	(0 to 1767) °C	0.4 °C	
Type S	(0 to 1767) °C	0.43 °C	
Type T	(-250 to 400) °C	0.19 °C	
Type E, J, K, R, S, & T	(-250 to 1350) °C	0.085 °C	Ice point with standard mV source

IV. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2, 4, 5} (±)	Comments
Square Wave Signal – Generate			
1 mV to 10 V _(pk-pk)	50 Ω at 1 kHz	0.21 %	Fluke 9500B
1 mV to 210 V _(pk-pk)	1 MΩ at 1 kHz	0.14 %	
Single Sideband Phase Noise – Measure	1 MHz to 3 GHz (3 to 6.6) GHz (6.6 to 22) GHz (22 to 26.5) GHz	1.4 dBc/Hz 2.2 dBc/Hz 2.7 dBc/Hz 3.2 dBc/Hz	Spectrum analyzer with phase noise measurement option
Residual FM – Measure	2.5 MHz to 26.5 GHz 1 MHz to 26.5 GHz	1.8 Hz/rms 3.4 Hz/rms	N5531S measuring receiver E4440A spectrum analyzer
Residual FM – Generate			
≥ 3 kHz Bandwidth	100 kHz to 6 GHz	1.3 Hz/rms	SMA 100A signal generator
Phase Modulation – Measure			
20 Hz to 20 kHz	150 kHz to 26.5 GHz	1.3 %	N5531S measuring receiver
Amplitude Modulation – Measure (Depth: 0 % to 100 %)			
50 Hz to 100 kHz	100 kHz to 10 MHz 10 MHz to 3 GHz (3 to 26.5) GHz	1.1 % 1.2 % 1.9 %	N5531S measuring receiver
Amplitude Modulation – Generate (Depth 0 % to 100 %)			
1 Hz to 270 kHz	<5 MHz	1.8 %	MXG signal generator
DC to 10 kHz	5 MHz to 31.8 GHz	2.6 %	

Parameter/Equipment	Frequency	CMC ^{2,5} (±)	Comments
Frequency Modulation – Measure 20 Hz to 10 kHz (FM Deviation ≤40 kHz _{peak}) 20 Hz to 200 kHz (FM Deviation ≤400 kHz _{peak})	250 kHz to 6.6 GHz (6.6 to 26.5) GHz	1.2 % 1.2 %	N5531S measuring receiver
Pulse Modulation – Measure On/Off Ratio Rise/Fall Time	1 MHz to 18 GHz 10 MHz to 18 GHz	1.2 dB 9 ns	E4440B spectrum analyzer HF oscilloscope, pulse generator & crystal detector
Harmonic Distortion Measure – (Distortion Range: 0.1% to 100%) 5 Hz to 600 kHz	Harmonics: 10 Hz to 3 MHz	0.31 dB	Clarke Hess 7600 distortion analyzer

Parameter/Range	Frequency	CMC ^{2, 4, 6} (\pm)	Comments
RF Absolute Power – Generate (50 Ω Output)			
(+10 to -70) dBm	10 MHz to 26.5 GHz	0.32 dBm + <i>M</i>	MXG signal generator monitored by power sensors
(+23 to -53) dBm	0.01 Hz to 80 MHz	0.13 dBm + <i>M</i>	
(24 to -48) dBm	10 Hz to 100 kHz	0.04 dBm + <i>M</i>	9640A-LPNX signal generator
(24 to -48) dBm	100 kHz to 128 MHz	0.065 dBm + <i>M</i>	
(-48 to -74) dBm (-74 to -94) dBm	100 kHz to 10 MHz 100 kHz to 10 MHz	0.23 dBm + <i>M</i> 0.61 dBm + <i>M</i>	
(-48 to -84) dBm (-84 to -94) dBm (-94 to -130) dBm	(10 to 128) MHz	0.12 dBm + <i>M</i> 0.37 dBm + <i>M</i> 0.83 dBm + <i>M</i>	
(20 to -48) dBm (-48 to -74) dBm (-74 to -84) dBm (-84 to -94) dBm (-94 to -130) dBm	128 MHz to 0.3 GHz	0.09 dBm + <i>M</i> 0.12 dBm + <i>M</i> 0.35 dBm + <i>M</i> 0.61 dBm + <i>M</i> 1.7 dBm + <i>M</i>	
(20 to -48) dBm (-48 to -74) dBm (-74 to -84) dBm (-84 to -94) dBm (-94 to -130) dBm	(0.3 to 1.4) GHz	0.25 dBm + <i>M</i> 0.49 dBm + <i>M</i> 0.61 dBm + <i>M</i> 1.2 dBm + <i>M</i> 1.7 dBm + <i>M</i>	
(14 to -48) dBm (-48 to -74) dBm (-74 to -94) dBm (14 to -130) dBm	(1.4 to 3.0) GHz	0.36 dBm + <i>M</i> 0.61 dBm + <i>M</i> 1.1 dBm + <i>M</i> 1.7 dBm + <i>M</i>	
(14 to -17) dBm (-17 to -74) dBm (-74 to -84) dBm	(3.0 to 4.0) GHz	0.38 dBm + <i>M</i> 0.61 dBm + <i>M</i> 1.2 dBm + <i>M</i>	

Parameter/Range	Frequency	CMC ^{2, 4, 5, 6} (\pm)	Comments
RF Absolute Power – Measure			
0 dBm	50 MHz	0.03 dBm + <i>M</i>	5790B/AF
50 Ω (+20 to +35) dBm	100 kHz to 18 GHz	0.25 dBm + <i>M</i>	Power meter with power sensors
(-30 to +20) dBm	100 kHz to 26.5 GHz	0.077 dBm + <i>M</i>	
(-70 to -30) dBm	10 MHz to 26.5 GHz	0.095 dBm + <i>M</i>	
Flatness – (50 kHz Reference)			
10 mV to 5 V	50 kHz to 100 MHz (100 to 550) MHz (550 to 1100) MHz (1.1 to 3.2) GHz	2.2 % 3.7 % 4.8 % 6.0 %	9500 B w/9530
Reflection Coefficient –			
(0.005 to 0.5)	5 MHz to 2 GHz	0.011	VSWR bridge and spectrum analyzer ρ is the reflection coefficient.

Parameter/Range	Frequency	CMC ^{2, 4, 6} (\pm)	Comments	
Relative Power – Measure				
(0 to -10) dB	10 MHz to 26.5 GHz	0.026 dB + <i>M</i>	N5531S measuring receiver	
(-10 to -20) dB		0.032 dB + <i>M</i>		
(-20 to -30) dB		0.037 dB + <i>M</i>		
(-30 to -40) dB		0.043 dB + <i>M</i>		
(-40 to -50) dB		0.052 dB + <i>M</i>		
(-50 to -60) dB		0.069 dB + <i>M</i>		
(-60 to -70) dB		0.073 dB + <i>M</i>		
(-70 to -80) dB		0.09 dB + <i>M</i>		
(-80 to -90) dB		0.11 dB + <i>M</i>		
(-90 to -100) dB		0.14 dB + <i>M</i>		
(-100 to -110) dB	10 MHz to 19.2 GHz	0.11 dB + <i>M</i>		
(-110 to -120) dB	10 MHz to 13.2 GHz	0.37 dB + <i>M</i>		
(-120 to -127) dB		0.45 dB + <i>M</i>		
RF Attenuation (10 dB Step) – Generate				
10 dB	DC to 18 GHz	0.011 dB	10 dB step attenuator	
20 dB		0.015 dB		
30 dB		0.020 dB		
40 dB		0.022 dB		
50 dB		0.029 dB		
60 dB		0.033 dB		
70 dB		0.082 dB		
80 dB		0.082 dB		
90 dB		0.095 dB		
100 dB		0.086 dB		
110 dB		0.11 dB		
120 dB		DC to 1 GHz		0.32 dB

Parameter/Range	Frequency	CMC ^{2, 4, 6} (±)	Comments
RF Attenuation (1 dB Step) – Generate			
1 dB	DC to 18 GHz	0.019 dB	1 dB step attenuator
2 dB		0.019 dB	
3 dB		0.033 dB	
4 dB		0.028 dB	
5 dB		0.020 dB	
6 dB		0.017 dB	
7 dB		0.039 dB	
8 dB		0.033 dB	
9 dB		0.023 dB	
10 dB		0.048 dB	
11 dB	DC to 1 GHz	0.020 dB	
12 dB		0.16 dB	
RF Attenuation – Measure			
(0 to -100) dB	10 Hz to 3 GHz	0.61 dB	Spectrum analyzer
	(3 to 13) GHz	1.8 dB	
	(13 to 22) GHz	2.5 dB	
	(22 to 26.5) GHz	3.2 dB	
(0 to -40) dB	100 kHz to 4.2 GHz	0.027 dB	Power meter with Sensor

V. Fluid Quantities

Parameter/Equipment	Range	CMC ^{2, 5, 8} (±)	Comments
Air Velocity – Measure	(30 to 250) ft/min	1.3 %	Wind tunnel, MKS differential pressure transducer
	(250 to 1500) ft/min	1.6 %	
	(1500 to 9000) ft/min	1.4 %	
Flow – Measuring Equipment			
Gas	1 sccm to 120 slpm	0.39 %	DHI molbloc system

Parameter/Equipment	Range	CMC ^{2, 5, 8} (±)	Comments
Volume – Measure	(10 to 100) mL (100 to 2000) mL (2000 to 4000) mL (1 to 5) gal	0.028 mL 0.088 mL 1.1 mL 0.55 in ³	Gravimetric
Fixed Points	5 gal 25 gal	0.0096 gal 0.012 gal	Prover volumetric transfer

VI. Mechanical

Parameter/Equipment	Range	CMC ^{2, 5, 8} (±)	Comments
Force – Compression and Tension	(0 to 50) lbf (50 to 500) lbf (0 to 500) lbf (100 to 3000) lbf (250 to 10 000) lbf (1000 to 25 000) lbf (1000 to 50 000) lbf (2000 to 100 000) lbf	0.34 % 0.32 % 0.054% 0.92 lbf 1.4 lbf 3.4 lbf 9.8 lbf 8.5 lbf	Class F weights Load cell, proving rings
Durometer Calibration – (Type A, D)			ASTM D2240-15 Sections 7-9
Indenter Extension and Shape –			
Diameter	Up to 0.105 in	0.000 32 in	Optical comparator
Radius	Up to 0.125 in	0.000 32 in	
Angle	25° to 40°	0.084°	
Extension	Up to 0.105 in	0.000 32 in	
Indenter Display	(0 to 100) durometer units	0.13 durometer units	Gage blocks
Spring Calibration – Force	Up to 45 N	0.033 N	Durocalibrator

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
Mass - Measure	(1 to 50) mg (50 to 500) mg (500 mg to 2 g) (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 1 kg (1 to 2) kg (2 to 5) kg (5 to 10) kg (10 to 25) kg	2.8 µg 2.7 µg 4.3 µg 4.6 µg 18 µg 19 µg 32 µg 30 µg 37 µg 0.16 mg 0.33 mg 1.6 mg 1.9 mg 3.2 mg 61 mg	Double substitution with Class E1 weights
Mass – Measure, Fixed Points	25 kg 10 kg 5 kg 2 kg 1 kg 500 g 200 g 100 g 50 g 20 g 10 g 5 g 2 g 1 g 500 mg 200 mg 100 mg 50 mg 20 mg 10 mg 5 mg 1 mg	61 mg 3.2 mg 1.9 mg 1.6 mg 0.33 mg 0.16 mg 37 µg 30 µg 32 µg 19 µg 18 µg 4.6 µg 4.3 µg 4.3 µg 2.7 µg 2.7 µg 2.7 µg 2.8 µg 2.8 µg 2.8 µg 2.8 µg 2.8 µg	Double substitution with Class E1 weights

Parameter/Equipment	Range	CMC ^{2, 5, 8} (±)	Comments
Shock – Measure	(20 to 10 000) g	1.3 %	Standard accelerometer
Acceleration – Measure	(5 to 10) Hz (10 to 99) Hz 100 Hz (101 to 920) Hz 921 Hz to 5 kHz (5 to 10) kHz (10 to 15) kHz	1.2 % 0.75 % 0.53 % 0.71 % 0.98 % 1.9 % 0.8 %	Accelerometer
Torque – Measure	(5 to 50) ozf·in (20 to 200) ozf·in (5 to 50) lbf·in (40 to 400) lbf·in (100 to 1000) lbf·in (25 to 250) lbf·ft (60 to 600) lbf·ft	0.38 % 0.38 % 0.30 % 0.30 % 0.32 % 0.30 % 0.34 %	Torque tester
Torque – Measuring Equipment	(5 to 50) ozf·in (20 to 200) ozf·in (5 to 50) lbf·in (40 to 400) lbf·in (100 to 1000) lbf·in (25 to 250) lbf·ft (60 to 600) lbf·ft (100 to 1000) lbf·ft	0.25 % 0.22 % 0.17 % 0.17 % 0.20 % 0.16 % 0.17 % 0.16 %	Wheels/weights

Parameter/Equipment	Range	CMC ^{2, 5, 8} (±)	Comments
Balances & Scales	(>1000 to 1500) lb	0.62 lb	Comparison to ASTM Class 1 weights or NIST Class F weights
	(>600 to 1000) lb	0.27 lb	
	(>500 to 600) lb	0.12 lb	
	(>400 to 500) lb	0.09 lb	
	(>200 to 400) lb	0.05 lb	
	(>100 to 200) lb	0.025 lb	
	(>50 to 100) lb	0.016 lb	
	(>0 to 50) lb	0.006 lb	
	(>25 to 50) kg	0.22 g	
	(>10 to 25) kg	0.13 g	
	(>5 to 10) kg	4.5 mg	
	(>2 to 5) kg	2.6 mg	
	(>1 to 2) kg	2.7 mg	
	>500 g to 1 kg	2.1 mg	
	(>300 to 500) g	0.32 mg	Comparison to NIST Class F weights with substitution loads
	(>200 to 300) g	0.16 mg	
	(>100 to 200) g	0.11 mg	
	(>50 to 100) g	84 µg	
	(>20 to 50) g	51 µg	
	(>10 to 20) g	0.11 mg	
	(>5 to 10) g	27 µg	
	(>2 to 5) g	6.8 µg	
	(>1 to 2) g	6.7 µg	
	>500 mg to 1 g	11 µg	
	Up to 500 mg	5.4 µg	
	(1000 to 5000) lb	1.3 lb	

Parameter/Equipment	Range	CMC ^{2, 5, 8} (±)	Comments
Pressure – Measure and Measuring Equipment			
Vacuum	(0 to 0.2) psi (0.2 to 14.7) psi	0.000 096 psi 0.0027 %	RPM4 Ruska deadweight tester
Pneumatic Absolute	Vacuum to 500 mTorr (0.2 to 50) psia (50 to 200) psia (200 to 1000) psia (58 to 12 000) psi	73 mTorr 0.0017 % 0.0019 % 0.0019 % 0.0036 %	Hastings DV-6R Ruska deadweight tester DHI deadweight tester
Pneumatic Gage	(0 to 0.2) psig (0.2 to 50) psig (50 to 200) psig (200 to 1000) psig 1000 psig to 80 MPa	0.000 11 psi 0.0014 % 0.0016 % 0.0019 % 0.0036 %	RPM4 Ruska deadweight tester DHI deadweight tester
Hydraulic (Absolute and Gage)	(290 to 30 000) psi (725 to 72 500) psi	0.0041 % 0.013 %	DHI deadweight tester
Deadweight Tester	(0 to 10 000) psi	0.0033 %	Cross-float
Durocalibrators	A Scale D Scale	0.095 duro units 0.016 duro units	ASTM Class 1 weights
Duro Test Blocks	A and D Scale	0.88 duro units	Durometer

VII. Thermodynamics

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
Relative Humidity – Measure	Up to 90 % RH (90 to 100) % RH	1.4 % RH 2.1 % RH	Vaisala HM70/ HMP77B

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
Relative Humidity – Measuring Equipment	(10 to 95) % RH	0.6 % RH	Thunder Scientific 2500
Dew Point	(-10 to 70) °C	0.26 °C	Thunder Scientific 2500 with Hum-Cal software
Temperature – Measure	(-200 to 661) °C (660 to 1000) °C (1000 to 1100) °C (1100 to 1200) °C (1200 to 1450) °C	0.0049 °C 0.77 °C 0.98 °C 1.5 °C 2.3 °C	SPRT Type S TC
Temperature – Measuring Equipment	(-80 to 550) °C (-10 to 122) °C (150 to 1000) °C (1000 to 1100) °C (1100 to 1200) °C	0.0094 °C 0.4 °C 0.42 °C 0.91 °C 1.4 °C	SPRT with Fluke 7381 bath RTD with drywell Type S TC with drywell
Surface Probe	(35 to 400) °C	0.35 °C	RTD with surface calibrator
Infrared Thermometers	(-15 to 120) °C (35 to 500) °C	0.21 °C 0.22 °C	RTD with Fluke IR calibrator

VIII. Time & Frequency

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
Time Marker & Period	500 ps to 5 ns 5 ns to 10 s	30 μs/s 9 μs/s	Fluke 9500B

Parameter/Equipment	Range	CMC ^{2, 5, 8} (±)	Comments
RPM – Photo Generate – Strobe Tachometer Tester	Up to 150 000 RPM	0.008 RPM	Frequency counter with light pickup
Optical Measure – Tachometer	Up to 150 000 RPM	0.016 RPM	Signal generator with strobe
Contact Measure – Tachometer	(10 to 190) RPM (200 to 50 000) RPM	0.12 % 0.0088 %	Ideal Aerosmith 1921 tachometer tester
Frequency – Measuring Equipment			
Fixed	10 MHz	9.1 parts in 10 ¹² Hz	Fluke 910R GPS
Variable	1 µHz to 80 MHz	1.3 part in 10 ¹¹ Hz	Signal generator locked to Fluke 910R
	10 MHz to 32 GHz	2.8 parts in 10 ¹¹ Hz	Signal generator locked to Fluke 910R
Frequency – Measure	10 nHz to 6 GHz	3.8 parts in 10 ¹² Hz	Frequency counter locked to Fluke 910R
	(6 to 26.5) GHz	2.8 parts in 10 ¹¹ Hz	Measuring receiver locked to Fluke 910R
Stopwatch/Timer	15 s to 24 hr	0.6 s	Fluke 910R GPS

Parameter/Equipment	Range	CMC ^{2, 8} (\pm)	Comments
Time – Measure ≤ 17.5 ps	<200 kHz	28 ps	Tektronix 11801C with SD 24
Rise Time – Measuring Equipment ≤ 150 ps	1 kHz to 10 MHz	180 ps	Fluke 9500B

¹ This laboratory offers commercial 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 In the statement of CMC, L is the numerical value of the nominal length of the device measured in inches.

⁴ 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 are expressed as either a specific value that covers the full range or as a fraction of the reading plus a fixed floor specification.

⁵ In the statement of CMC the values listed with percent (%) are percent of reading or generated value unless otherwise noted.

⁶ In the statement of CMC, M is the mismatch uncertainty for the unit under test.

⁷ This scope meets A2LA's *P112 Flexible Scope Policy*.

⁸ The type of instrument or material being calibrated is defined by the parameter. This indicates the laboratory is capable of calibrating instruments that measure or generate the values in the ranges indicated for the listed measurement parameter.

⁹ 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.



Accredited Laboratory

A2LA has accredited

SOUTHWEST RESEARCH INSTITUTE

San Antonio, TX

for technical competence in the field of

Calibration

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 ANSI/NCSL 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 24th day of May 2022.

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

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 3759.01
Valid to June 30, 2024

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