



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

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CALIBRATION

Valid To: January 31, 2025

Certificate Number: 2724.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations^{1, 8}:

I. Acoustical Quantities

Parameter/Range	Frequency	CMC ^{2,9} (±)	Comments
Sound Level – Generate: (94 to 114) dB	(125 to 2000) Hz	0.52 dB	GenRad 1986
Measure: (84 to 114) dB	(50 to 2000) Hz	0.52 dB	Bruel & Kjaer 2610/ 4160

II. Chemical Quantities

Parameter/Equipment	Range	CMC ^{2,9} (±)	Comments
Conductivity – Measuring Equipment	5 µS 10 µS 100 µS 1000 µS	0.62 µS 0.62 µS 2.1 µS 4.6 µS	Standard conductivity solutions
pH – Measuring Equipment	4 pH units 7 pH units 10 pH units	0.012 pH units 0.013 pH units 0.015 pH units	Standard buffer solutions

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
Gas Detection Equipment –			Calibration gases:
C ₂ H ₆	0.005 %	2.2 %	Ethane
C ₅ H ₁₂	0.35 %	2.0 %	Pentane
CH ₄	1 %	7 %	Methane
	1.45 %	4.8 %	
	2.5 %	2.0 %	
CO	0.001 %	5.1 %	Carbon monoxide
	0.006 %	5.2 %	
	0.01 %	1.7 %	
	0.2 %	2.1 %	
	2.5 %	3.2 %	
CO ₂	0.05 %	2.6 %	Carbon dioxide
	0.1 %	2.5 %	
	5 %	2.4 %	
	10 %	2.2 %	
H	0.01 %	5.3 %	Hydrogen
	2 %	4.8 %	
H ₂ S	0.0020 %	11 %	Hydrogen sulfide
	0.0025 %	2.6 %	
O ₂	0.1 %	2.5 %	Oxygen
	0.4 %	15 %	
	5 %	3.2 %	
	15 %	0.54 %	
	19 %	0.63 %	
	20 %	2.5 %	
	20.9 %	2.4 %	
SO ₂	0.001 %	1.1 %	Sulfur dioxide

III. Dimensional

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
UMM, Supermicrometer™	Up to 11.5 in	$(10 + 0.7L) \mu\text{in}$	Gage blocks
Bore Micrometer (Intramic)	(0.10 to 6.5) in	$40 \mu\text{in} + 0.6R$	Ring gage
Calipers ³	Up to 40 in	$(20 + 7L) \mu\text{in} + 0.6R$	Gage blocks
Cylindrical Square – Squareness	Up to 12 in	$24 \mu\text{in}$	Federal comparator 232, surface plate
Dial Indicator ³	(0.01 to 2) in	$170 \mu\text{in}$	Dial indicator checker
Length Standards	Up to 50 in	$(10 + 2.0L) \mu\text{in}$	Laser measurement machine (LMM)
Feeler Gages	Up to 0.06 in	$0.1 \% IV + 20 \mu\text{in}$	Gage blocks, or LMM & gage blocks
Height Gages	Up to 48 in	$61 \mu\text{in} + 9.6 \mu\text{in/in}$	Gage blocks, federal comparator 232

Parameter/Equipment	Range	CMC ^{2, 6, 9} (\pm)	Comments
Micrometers ³ – Inside Outside Depth	Up to 1 in (1 to 4) in (4 to 6) in (6 to 24) in (24 to 36) in Up to 36 in Up to 12 in	11 $\mu\text{in} + 0.6R$ 26 $\mu\text{in} + 0.6R$ 37 $\mu\text{in} + 0.6R$ 85 $\mu\text{in} + 0.6R$ 120 $\mu\text{in} + 0.6R$ 12 $\mu\text{in/in} + 0.6R$ 12 $\mu\text{in/in} + 0.6R$	Gage blocks, LMM
Stage Micrometer Standard	(0.004 to 2) in	20 $\mu\text{in} + 10 \mu\text{in/in}$	LMM/Agilent 5519A laser
Optical Comparator ³ – Length Magnification, (Only for Overlay & Lens Systems) Angle	Up to 11 in 10 \times to 100 \times Up to 45 $^\circ$	100 μin 0.6 M 0.033 $^\circ$	Gage blocks, magnification balls M is resolution of the overlay
Outside Diameter – Pins/Plugs Spheres/Balls	Up to 10 in Up to 6 in	15 $\mu\text{in} + 3 \mu\text{in/in}$ 15 $\mu\text{in} + 3 \mu\text{in/in}$	Pratt & Whitney Supermic TM
Protractors	Up to 90 $^\circ$	0.01 $^\circ$	Sine plate, gage blocks, cylindrical square
Paint Coat Thickness – Thin Film Shims Paint Thickness Gauge	(0.001 to 0.060) in	0.1 % IV + 20 μin 100 $\mu\text{in} + 0.6R$	LMM, gage blocks Calibrated shims
Roughness ³ Measure Generate	(< 1 to 200) $\mu\text{in Ra}$ 38, 120 $\mu\text{in Ra}$	2 % IV + 2.0 $\mu\text{in Ra}$ 1 % IV + 2.0 $\mu\text{in Ra}$	Roughness tester Roughness standards

Parameter/Equipment	Range	CMC ^{2,6} (\pm)	Comments
Ultrasonic Thickness Gages	Up to 5 in	100 μ in + 0.6R	LMM, gage blocks
Rulers ³	(1 to 120) in	0.005 % IV + 0.6R	LMM
Sine Plate, Sine Bar, Fixed Points	5 in 10 in 20 in	190 μ in 160 μ in 450 μ in	Angle blocks, gage blocks, federal comparator 232
Levels –			
Digital	120 in	0.25°	Sine plate, gage blocks
Bubble	96 in	0.6R	
Tape Measure	Up to 300 ft	0.01 % + 0.6R	LMM
Flatness ³	(2 to 6) in	6 μ in	Optical flat
Surface Plate ³ (Flatness Only)	72 in \times 240 in	100 μ in	Autocollimator
Thread Rings	Up to 1.5 in (1.5 to 4) in (4 to 6) in Minor Diameter	220 μ in 270 μ in 320 μ in 200 μ in	Master thread plugs Plain pins/plugs, bore plugs, optical comparator
Thread Wires	(4 to 80) TPI	14 μ in	LMM, Pratt & Whitney Supermic TM , gage blocks
Thread Plugs	(0.1 to 4) in (4 to 80) TPI	75 μ in 75 μ in	Pratt & Whitney Supermic TM , gage blocks, master thread wires

Parameter/Equipment	Range	CMC ² (±)	Comments
Ring Gages	(0.25 to 8.0) in	15 μin + 2 μin/in	Pratt & Whitney Supermic™, gage blocks, master ring gages

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range ⁴	CMC ^{2, 6, 10} (±)	Comments
DC Voltage ³ – Generate	(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	7 μV/V + 0.5 μV 4 μV/V + 0.8 μV 3 μV/V + 3 μV 3 μV/V + 5 μV 4 μV/V + 50 μV 6 μV/V + 500 μV	Fluke 5730A
	100.0 mV 1.0 V 10.0 V 100.0 V	0.9 μV/V 0.8 μV/V 0.75 μV/V 0.8 μV/V	Fluke 732A array
	1000.0 V	0.9 μV/V	Fluke 732A, 752A
DC Voltage ³ – Measure	(0 to 120) mV (0.1 to 1.2) V (1.0 to 12) V (10 to 120) V (100 to 1050) V	5 μV/V + 1 μV 4 μV/V + 1 μV 4 μV/V + 2 μV 6 μV/V + 30 μV 18 μV/V + 100 μV	Agilent 3458A
	10.00 V	1.0 μV/V	Fluke 732A array
	(0.5 to 10) kV (10 to 100) kV	0.04 % IV + 0.03 V 0.075 % IV + 0.3 V	Vitretek 4700A w/ HVL-100

Parameter/Equipment	Range ⁴	CMC ^{2, 6, 10} (\pm)	Comments
DC Current ³ – Measure	(2 to 20) A	0.01 % IV	Fluke Y5020, HP 3458A
	(10 to 100) A (30 to 300) A	0.05 % IV 0.1 % IV	Guildline 9211A, Agilent 3458A
	(12 to 120) μ A (0.12 to 1.2) mA (1.2 to 12) mA (12 to 120) mA (0.12 to 1.2) A	20 μ A/A + 800 pA 20 μ A/A + 5.0 nA 20 μ A/A + 50 nA 35 μ A/A + 500 nA 0.011 % IV + 10 μ A	Agilent 3458A
DC Current ³ – Generate	(0 to 220) μ A (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	42 μ A/A + 7 nA 35 μ A/A + 8 nA 35 μ A/A + 50 nA 45 μ A/A + 0.8 μ A 70 μ A/A + 15 μ A	Fluke 5730A
	(2.0 to 11) A	340 μ A/A + 480 μ A	Fluke 5730A w/ Fluke 5725A
	(10 to 100) A	0.10 %	Guildline 9211A, Agilent 3458A, Valhalla 2555A
Resistance – Ratio Measurement	1:1 (0.1 Ω to 10 k Ω) 0.1:1 to 10:1 (0.1 Ω to 10 k Ω)	1.0 parts in 10 ⁶ 1.4 parts in 10 ⁶	MI 6010, MI 6000
	100:1 (10 k Ω to 100 M Ω)	2.0 parts in 10 ⁶	w/ MI 6011 extender
Resistance ³ – Measure	(0.0 to 12) Ω (10 to 120) Ω (0.10 to 1.2) k Ω (1.0 to 12) k Ω (10 to 120) k Ω (0.10 to 1.2) M Ω (1.0 to 12) M Ω (10 to 120) M Ω	15 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 500 $\mu\Omega$ 10 $\mu\Omega/\Omega$ + 500 $\mu\Omega$ 10 $\mu\Omega/\Omega$ + 5 m Ω 10 $\mu\Omega/\Omega$ + 50 m Ω 15 $\mu\Omega/\Omega$ + 2 Ω 50 $\mu\Omega/\Omega$ + 100 Ω 0.05 % IV + 1000 Ω	Agilent 3458A

Parameter/Equipment	Range ⁴	CMC ^{2,10} (\pm)	Comments
Resistance ³ – Generate	10 000.00 Ω	0.5 $\mu\Omega/\Omega$	ESI SR-104
	1.0 Ω	0.5 $\mu\Omega/\Omega$	Leeds & Northrup 4210
	1.0 Ω (Nominal)	95 $\mu\Omega/\Omega$	Fluke 5730A
	1.9 Ω	95 $\mu\Omega/\Omega$	
	10 Ω	25 $\mu\Omega/\Omega$	
	19 Ω	25 $\mu\Omega/\Omega$	
	100 Ω	11 $\mu\Omega/\Omega$	
	190 Ω	11 $\mu\Omega/\Omega$	
	1 k Ω	7.2 $\mu\Omega/\Omega$	
	1.9 k Ω	7.2 $\mu\Omega/\Omega$	
	10 k Ω	7 $\mu\Omega/\Omega$	
	19 k Ω	7 $\mu\Omega/\Omega$	
	100 k Ω	8 $\mu\Omega/\Omega$	
	190 k Ω	10 $\mu\Omega/\Omega$	
	1.0 M Ω	14 $\mu\Omega/\Omega$	
	1.9 M Ω	17 $\mu\Omega/\Omega$	
	10.0 M Ω	37 $\mu\Omega/\Omega$	
19.0 M Ω	47 $\mu\Omega/\Omega$		
100.0 M Ω	110 $\mu\Omega/\Omega$		
Low Resistance (Earth Resistance) – Generate	100 m Ω to 4.99 Ω	0.3 % + 0.01 Ω	Fluke 5320A
	(5 to 29.9) Ω	0.2 % + 0.01 Ω	
	(30 to 199.9) Ω	0.2 % + 0.01 Ω	
	(200 to 499.9) Ω	0.2 % + 0.01 Ω	
	500 Ω to 1.999 k Ω	0.2 %	
	(2 to 4.99) k Ω	0.2 %	
(5 to 10) k Ω	0.2 %		
High Resistance (Insulation Resistance – Generate)	(10 to 39.99) k Ω	0.2 %	Fluke 5320A
	(40 to 99.99) k Ω	0.2 %	
	(100 to 199.99) k Ω	0.2 %	
	(200 to 999.99) k Ω	0.2 %	
	(1 to 9.999) M Ω	0.3 %	
	(10 to 999.9) M Ω	0.5 %	
	(1 to 10.0) G Ω	1.0 %	
	100 G Ω	3.0 %	
High Resistance (Insulation Resistance) – Source with R Multiplier	(0.35 to 99.99) G Ω	1.0 % + <i>r</i>	Fluke 5320A <i>r</i> is the uncertainty of resistor to be multiplied by 1000.
	(100 to 999.9) G Ω	2.0 % + <i>r</i>	
	(1 to 10) T Ω	3.0 % + <i>r</i>	

Parameter/Equipment	Range ⁴	CMC ^{2,10} (±)	Comments
Ground Bond Resistance – Decade Source, Fixed Points	25 mΩ 50 mΩ 100 mΩ 330 mΩ 500 mΩ 1 Ω 1.8 Ω 5.0 Ω 10.0 Ω 18.0 Ω 50.0 Ω 100 Ω 180 Ω 500 Ω 1 kΩ 1.8 kΩ	5 mΩ 5 mΩ 5 mΩ 7 mΩ 8 mΩ 10 mΩ 18 mΩ 30 mΩ 60 mΩ 100 mΩ 300 mΩ 500 mΩ 1 Ω 2.5 Ω 5 Ω 10 Ω	Fluke 5320A

Parameter/Range ⁴	Frequency	CMC ^{2,10} (±)	Comments
AC Voltage ³ – Generate (0 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	270 μV/V + 5 μV 110 μV/V + 5 μV 90 μV/V + 5 μV 230 μV/V + 5 μV 540 μV/V + 6 μV 1200 μV/V + 12 μV 1500 μV/V + 25 μV 3100 μV/V + 25 μV	Fluke 5730A
(2.0 to 22) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	270 μV/V + 5 μV 110 μV/V + 5 μV 90 μV/V + 5 μV 230 μV/V + 5 μV 540 μV/V + 6 μV 1200 μV/V + 12 μV 1500 μV/V + 25 μV 3100 μV/V + 25 μV	

Parameter/Range ⁴	Frequency	CMC ^{2, 10} (±)	Comments
AC Voltage ³ – Generate (cont)			
(20 to 220) mV	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	270 μV/V + 15 μV 110 μV/V + 8 μV 66 μV/V + 8 μV 140 μV/V + 8 μV 380 μV/V + 20 μV 700 μV/V + 25 μV 1500 μV/V + 30 μV 2900 μV/V + 60 μV	Fluke 5730A
(0.20 to 2.2) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	270 μV/V + 50 μV 100 μV/V + 20 μV 46 μV/V + 10 μV 77 μV/V + 12 μV 97 μV/V + 40 μV 370 μV/V + 100 μV 1100 μV/V + 250 μV 1800 μV/V + 400 μV	
(2.0 to 22) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	270 μV/V + 500 μV 100 μV/V + 200 μV 46 μV/V + 70 μV 77 μV/V + 120 μV 97 μV/V + 250 μV 290 μV/V + 800 μV 1100 μV/V + 2500 μV 1600 μV/V + 4000 μV	
(20 to 220) V	(10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	270 μV/V + 5 mV 100 μV/V + 2 mV 60 μV/V + 0.7 mV 95 μV/V + 1.2 mV 170 μV/V + 3 mV 1000 μV/V + 20 mV 5200 μV/V + 50 mV 9000 μV/V + 100 mV	
(200 to 250) V	(15 to 50) Hz	320 μV/V + 20 mV	
1100 V	(50 to 1000) Hz	75 μV/V + 4 mV	
(200 to 1100) V	(40 to 1000) Hz (1 to 20) kHz (20 to 30) kHz	80 μV/V + 4 mV 130 μV/V + 6 mV 360 μV/V + 11 mV	Fluke 5730A w/ Fluke 5725A
(200 to 750) V	(30 to 50) kHz (50 to 100) kHz	360 μV/V + 11 mV 1300 μV/V + 45 mV	

Parameter/Range ⁴	Frequency	CMC ^{2, 6, 10} (\pm)	Comments
AC Voltage ^{3, 5} – Measure			
(0 to 2.2) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 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 % IV + 1.3 μ V 0.074 % IV + 1.3 μ V 0.042 % IV + 1.3 μ V 0.081 % IV + 2.0 μ V 0.12 % IV + 2.5 μ V 0.23 % IV + 4.0 μ V 0.24 % IV + 8.0 μ V 0.35 % IV + 8.0 μ V	Fluke 5790A
(2.2 to 7.0) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 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 % IV + 1.3 μ V 0.037 % IV + 1.3 μ V 0.021 % IV + 1.3 μ V 0.04 % IV + 2.0 μ V 0.06 % IV + 2.5 μ V 0.12 % IV + 4.0 μ V 0.13 % IV + 8.0 μ V 0.23 % IV + 8.0 μ V	
(7.0 to 22.0) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 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 % IV + 1.3 μ V 0.019 % IV + 1.3 μ V 0.011 % IV + 1.3 μ V 0.021 % IV + 2.0 μ V 0.031 % IV + 2.5 μ V 0.081 % IV + 4.0 μ V 0.089 % IV + 8.0 μ V 0.17 % IV + 8.0 μ V	
(22 to 70) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 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 % IV + 1.5 μ V 0.012 % IV + 1.5 μ V 65 μ V/V + 1.5 μ V 0.013 % IV + 2.0 μ V 0.026 % IV + 2.5 μ V 0.051 % IV + 4.0 μ V 0.067 % IV + 8.0 μ V 0.11 % IV + 8.0 μ V	
(70 to 220) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 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 % IV + 1.5 μ V 85 μ V/V + 1.5 μ V 38 μ V/V + 1.5 μ V 69 μ V/V + 2.0 μ V 0.016 % IV + 2.5 μ V 0.025 % IV + 4.0 μ V 0.038 % IV + 8.0 μ V 0.1 % IV + 8.0 μ V	

Parameter/Range ⁴	Frequency	CMC ^{2, 6, 10} (\pm)	Comments
AC Voltage ^{3, 5} – Measure (cont)			
(220 to 700) mV	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 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 % IV + 1.5 μ V 76 μ V/V + 1.5 μ V 33 μ V/V + 1.5 μ V 51 μ V/V + 2.0 μ V 79 μ V/V + 2.5 μ V 0.018 % IV + 4.0 μ V 0.03 % IV + 8.0 μ V 0.096 % IV + 8.0 μ V	Fluke 5790A
(0.7 to 2.2) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.02 % IV 66 μ V/V 24 μ V/V 46 μ V/V 71 μ V/V 0.016 % IV 0.026 % IV 0.09 % IV	
(2.2 to 7.0) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.02 % IV 67 μ V/V 24 μ V/V 48 μ V/V 81 μ V/V 0.019 % IV 0.04 % IV 0.12 % IV	
(70 to 220) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.02 % IV 68 μ V/V 31 μ V/V 69 μ V/V 98 μ V/V 0.021 % IV 0.05 % IV	
(220 to 700) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.02 % IV 96 μ V/V 39 μ V/V 0.012 % IV 0.04 % IV	

Parameter/Range ⁴	Frequency	CMC ^{2, 6, 10} (\pm)	Comments
AC Voltage ^{3, 5} – Measure (cont)			
(700 to 1000) V	(10 to 19.99) Hz (20 to 39.99) Hz (0.040 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.02 % IV 96 μ V/V 37 μ V/V 0.012 % IV 0.04 % IV	Fluke 5790A
(0 to 10) kV	60 Hz	0.15 % IV + 0.1 V	Vitretek 4700A w/ HVL-100
(10 to 75) kV	60 Hz	0.15 % IV + 0.6 V	
AC Current ³ – Measure			
(0 to 120) μ A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 1) kHz	0.4 % IV + 30 pA 0.15 % IV + 30 pA 0.06 % IV + 30 pA 0.06 % IV + 30 pA	Agilent 3458A
(0.12 to 1.2) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.4 % IV + 200 pA 0.15 % IV + 200 pA 0.06 % IV + 200 pA 0.03 % IV + 200 pA	
(1.2 to 12) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.4 % IV + 2 μ A 0.15 % IV + 2 μ A 0.06 % IV + 2 μ A 0.03 % IV + 2 μ A	
(12 to 120) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.15 % IV + 20 μ A 0.06 % IV + 20 μ A 0.03 % IV + 20 μ A 0.06 % IV + 20 μ A	
(0.12 to 2.2) A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (0.1 to 5) kHz	0.4 % IV + 200 μ A 0.16 % IV + 200 μ A 0.08 % IV + 200 μ A 0.1 % IV + 200 μ A	Fluke Y5020, HP 3458A
(2 to 20) A	(50 to 100) Hz 300 Hz 1 kHz 3 kHz 4 kHz 5 kHz	0.016 % IV 0.019 % IV 0.027 % IV 0.051 % IV 0.063 % IV 0.075 % IV	Fluke Y5020, HP 3458A

Parameter/Range ⁴	Frequency	CMC ^{2, 6, 10} (\pm)	Comments
AC Current ³ – Measure (cont) (20 to 1200) A	60 Hz 400 Hz	0.05 % IV 0.09 % IV	Weston 327 current transformer, Fluke Y5020, HP 3458A
AC Current ³ – Generate (0 to 220) μ A	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	280 μ A/A + 20 nA 180 μ A/A + 12 nA 120 μ A/A + 10 nA 320 μ A/A + 15 nA 1100 μ A/A + 80 nA	Fluke 5730A
(0.2 to 2.2) mA	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	280 μ A/A + 50 nA 180 μ A/A + 40 nA 120 μ A/A + 40 nA 220 μ A/A + 130 nA 1100 μ A/A + 800 nA	
(2.0 to 22) mA	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	280 μ A/A + 500 nA 180 μ A/A + 400 nA 120 μ A/A + 400 nA 220 μ A/A + 700 nA 1100 μ A/A + 6000 nA	
(20 to 220) mA	(10 to 20) Hz (20 to 40) Hz (0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	280 μ A/A + 5 μ A 180 μ A/A + 4 μ A 120 μ A/A + 3 μ A 220 μ A/A + 4 μ A 1100 μ A/A + 12 μ A	
(0.2 to 2.2) A	(0.02 to 1) kHz (1 to 5) kHz (5 to 10) kHz	280 μ A/A + 40 μ A 460 μ A/A + 100 μ A 7000 μ A/A + 200 μ A	
(2.0 to 11) A	(0.04 to 1) kHz (1 to 5) kHz (5 to 10) kHz	400 μ A/A + 170 μ A 850 μ A/A + 380 μ A 3300 μ A/A + 750 μ A	

Parameter/Range ⁴	Frequency	CMC ^{2, 6, 10} (\pm)	Comments
AC Current ³ – Generate (cont)			
(2 to 20) A	(50 to 100) Hz 300 Hz 1 kHz 3 kHz 4 kHz 5 kHz	160 μ A/A 190 μ A/A 270 μ A/A 510 μ A/A 630 μ A/A 750 μ A/A	Fluke Y5020, HP 3458A, Fluke 5725A
(20 to 100) A	60 Hz	500 μ A/A	Fluke Y5020, HP 3458A, Weston 327 CT, Vahalla 2555A
Capacitance ³ – Generate			
1000 pF	1000 Hz	5.0 μ F/F	GenRad 1404A
(330 to 500) pF (0.5 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (0.330 to 1.10) μ F (1.1 to 3.3) μ F	(50 to 1000) Hz	0.5 % IV + 10 pF 0.5 % IV + 10 pF 0.5 % IV + 10 pF 0.5 % IV + 10 pF 0.25 % IV + 100 pF 0.25 % IV + 100 pF 0.25 % IV + 300 pF 0.25 % IV + 1 nF 0.35 % IV + 3 nF	Fluke 5500A
(3.3 to 11) μ F (11 to 33) μ F	(50 to 400) Hz	0.35 % IV + 10 nF 0.4 % IV + 30 nF	
(33 to 110) μ F	(50 to 200) Hz	0.5 % IV + 100 nF	
(110 to 330) μ F (0.330 to 1.1) mF	(50 to 100) Hz	0.7 % IV + 300 nF 1 % IV + 300 nF	

Parameter/Range ⁴	Frequency	CMC ^{2, 6, 10} (\pm)	Comments
Capacitance ³ – Measure			
(0.1 to 1000) pF	1 kHz	0.01 % IV + 30 fF	GenRad 1620A
(0 to 1) nF	(0.050 to 2) kHz	0.1 % IV + 10 fF	Fluke PM6304C
(1 to 10) nF		0.1 % IV + 100 fF	
(10 to 100) nF		0.1 % IV + 1 pF	
(0.1 to 1) μ F		0.1 % IV + 10 pF	
(1 to 10) μ F		0.1 % IV + 100 pF	
(10 to 100) μ F		0.1 % IV + 1 nF	
(0.1 to 1) mF		0.1 % IV + 10 nF	
(1 to 10) mF		0.1 % IV + 100 nF	
(10 to 100) mF		0.1 % IV + 1 μ F	
(0.1 to 1) F		0.1 % IV + 10 μ F	
(1 to 10) F		0.1 % IV + 100 μ F	
(10 to 31.8) F		0.1 % IV + 1 mF	
(0.1 to 10.0) pF		10 Hz to 100 kHz	
	100 kHz to 1 MHz	0.60 % IV	
	(1 to 2) MHz	0.80 % IV	
(10 to 100) pF	10 Hz to 1 MHz	0.12 % IV	
	(1 to 2) MHz	0.35 % IV	
(0.1 to 1) nF	10 Hz to 1 kHz	0.17 % IV	
	(1 to 10) kHz	0.18 % IV	
	(10 to 100) kHz	0.23 % IV	
	100 kHz to 1 MHz	0.41 % IV	
	(1 to 2) MHz	0.46 % IV	
(1 to 100) nF	10 Hz to 1 kHz	0.10 % IV	
	(1 to 10) kHz	0.19 % IV	
(0.1 to 10) μ F	(10 to 100) Hz	0.10 % IV	
	100 Hz to 1 kHz	0.19 % IV	
	(1 to 10) kHz	0.57 % IV	
	(10 to 100) kHz	1 % IV	
Inductance ³ – Measure			
(0.00 to 1.00) mH	(0.050 to 2) kHz	0.1 % IV + 10 nH	Fluke PM6304C
(1.00 to 10) mH		0.1 % IV + 100 nH	
(10 to 100) mH		0.1 % IV + 1 μ H	
(0.100 to 1.00) mH		0.1 % IV + 10 μ H	
(1 to 9.9999) H		0.1 % IV + 100 μ H	
(10 to 99.999) H		0.1 % IV + 1 mH	
(100 to 999.99) H		0.1 % IV + 10 mH	

Parameter/Range ⁴	Frequency	CMC ^{2, 6, 10} (\pm)	Comments
Inductance ³ – Measure (cont)			
Up to 1 μ H	(1 to 10) kHz (10 to 100) kHz 100 kHz to 1 MHz (1 to 2) MHz	1.9 % IV 0.42 % IV 0.31 % IV 0.48 % IV	Keysight E4980A
(1 to 10) μ H	(1 to 10) kHz 10 kHz to 1 MHz (1 to 2) MHz	0.42 % IV 0.24 % IV 0.40 % IV	
(10 to 100) μ H	100 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz 100 kHz to 1 MHz (1 to 2) MHz	0.47 % IV 0.23 % IV 0.14 % IV 0.16 % IV 0.34 % IV	
(0.1 to 1) mH	(20 to 100) Hz 100 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz 100 kHz to 1 MHz (1 to 2) MHz	0.64 % IV 0.22 % IV 0.15 % IV 0.13 % IV 0.27 % IV 0.44 % IV	
(1 to 10) mH	(20 to 100) Hz 100 Hz to 10 kHz (10 to 100) kHz 100 kHz to 1 MHz (1 to 2) MHz	0.13 % IV 0.11 % IV 0.24 % IV 1 % IV 1.2 % IV	
(10 to 100) mH	(20 to 100) Hz 100 Hz to 10 kHz (10 to 100) kHz 100 kHz to 1 MHz (1 to 2) MHz	0.13 % IV 0.11 % IV 0.24 % IV 1 % IV 1.2 % IV	
(0.1 to 1) H	20 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	0.11 % IV 0.13 % IV 0.36 % IV	
(1 to 10) H	(20 to 100) Hz 100 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	0.11 % IV 0.13 % IV 0.24 % IV 0.79 % IV	
(10 to 100) H	(20 to 100) Hz 100 Hz to 1 kHz (1 to 10) kHz	0.13 % IV 0.17 % IV 0.71 % IV	

Parameter/Equipment	Range	CMC ^{2,6} (\pm)	Comments
Oscilloscopes ³ –			
Amplitude DC – DC Signal 50 Ω Load 1 M Ω Load	(0 to 6.6) V (0 to 130) V	0.25 % IV + 100 μ V 0.25 % IV + 100 μ V	Fluke 5500A w/ SC600 scope option
Amplitude – Square Wave 50 Ω Load 1 M Ω Load	1 mV _{p-p} to 6.6 V _{p-p} 1 mV _{p-p} to 130 V _{p-p}	0.25 % IV + 100 μ V 0.25 % IV + 100 μ V	
Leveled Sine Wave – (Into 50 Ω Load)	50 kHz Reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	2 % IV + 300 μ V 3.5 % IV + 300 μ V 4 % IV + 300 μ V 6 % IV + 300 μ V	
Flatness @ 50 kHz Reference	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	1.5 % IV + 100 μ V 2 % IV + 100 μ V 4 % IV + 100 μ V	
Time Marker – (Into 50 Ω Load)	5 s to 50 ms 20 ms to 1 ns	(25 + 1000t) μ s/s 2.5 μ s/s	t is the numerical value of the time in seconds
Edge Spec (Rise Time)	(200 to 300) ps 1 kHz to 2 MHz	900 ps	
	(200 to 350) ps (2 to 10) MHz	900 ps	
Amplitude Flatness	0.1 Hz to 50 kHz (0.050 to 100) MHz (100 to 250) MHz (250 to 550) MHz	1.5 % IV 1.5 % IV 3 % IV 4 % IV	Referenced to 50 kHz
Thermocouple Simulation – Generate & Measure			
Type B	(600 to 800) °C (800 to 1550) °C (1550 to 1820) °C	0.35 °C 0.28 °C 0.22 °C	Fluke 7526A
Type E	(-250 to -200) °C (-200 to -100) °C (-100 to 0) °C (0 to 600) °C (600 to 1000) °C	0.25 °C 0.12 °C 0.09 °C 0.08 °C 0.10 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Thermocouple Simulation – Generate & Measure (cont)			
Type J	(-210 to -100) °C (-100 to 800) °C (800 to 1200) °C	0.14 °C 0.09 °C 0.10 °C	Fluke 7526A
Type K	(-250 to -200) °C (-200 to -100) °C (-100 to 800) °C (800 to 1372) °C	0.46 °C 0.16 °C 0.10 °C 0.13 °C	
Type N	(-205 to -200) °C (-200 to -100) °C (-100 to 0) °C (0 to 100) °C (100 to 800) °C (800 to 1300) °C	0.73 °C 0.23 °C 0.12 °C 0.11 °C 0.10 °C 0.12 °C	
Type R	(-50 to -25) °C (-25 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 600) °C (600 to 1000) °C (1000 to 1600) °C (1600 to 1767) °C	0.55 °C 0.45 °C 0.39 °C 0.28 °C 0.22 °C 0.21 °C 0.19 °C 0.23 °C	
Type S	(-50 to -25) °C (-25 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 600) °C (600 to 1600) °C (1600 to 1767) °C	0.51 °C 0.43 °C 0.38 °C 0.29 °C 0.23 °C 0.22 °C 0.26 °C	
Type T	(-250 to -200) °C (-200 to -100) °C (-100 to 0) °C (0 to 400) °C	0.35 °C 0.16 °C 0.11 °C 0.09 °C	
Type U	(-200 to 0) °C (0 to 600) °C	0.16 °C 0.10 °C	

V. Fluid Quantities

Parameter/Equipment	Range	CMC ^{2,6,9} (±)	Comments
Specific Gravity – Measuring Equipment	(1.00 to 1.43) SPG	0.0011 SPG	Hydrometer set
Gas Flow – Measuring Equipment & Measure	(0.3 to 100) SCFM (0 to 60 000) sccm	0.5 % IV 0.5 % IV or 0.04 sccm	DHI Molbloc sonic nozzle system DHI Molbloc flow calibrator
Leak Rate ³ – Measure	Down to 1.0 ⁻⁸ ATM cc/s He at 21°C	6.0 % IV	Leak detector standard
Volume – Measuring Equipment (e.g. Flasks, Graduated Cylinders)	(1 to 10 000) mL	0.065 % IV	Mass comparators

VI. Mechanical

Parameter/Equipment	Range	CMC ² (±)	Comments
Indirect Verification of Rockwell Hardness ³	HRBW: Low Medium High HRC: Low Medium High	1.2 HRBW 1.5 HRBW 1.3 HRBW 0.75 HRC 0.75 HRC 0.75 HRC	Hardness blocks

Parameter/Equipment	Range	CMC ^{2, 6, 9} (\pm)	Comments
Pressure Gages, Controllers, Transducers ³ –			
Pneumatic	(0 to 3) in H ₂ O (> 3 to 30) in H ₂ O	0.000 27 in H ₂ O 0.009 % IV	Ruska 7250LP
	(0.2 to 1000) psig (0.2 to 1000) psia	0.005 % IV 0.005 % IV + 0.0005 psia	Ruska 2465 dead weight tester
	(0 to 10 000) psig	0.08 % FS	Fluke 700P31
Hydraulic	(40 to 20 000) psig	0.01 % IV	DH Instruments 50316 dead weight tester
Vacuum –			
Gages	(10 to 1000) mmHg	0.005 % IV + 0.03 mmHg	Ruska 2465 dead weight tester
Controllers & Transducers	(0.1 to 100) mmHg	0.1 % IV	MKS vacuum system
Force ³ – Tension & Compression, Measure & Measuring Equipment	(0.1 to 1000) lbf (100 to 100 000) lbf	0.01 % IV 0.06 % IV	Dead weight Load cells
Scales & Balances ³	Up to 5 g Up to 100 g Up to 500 g Up to 5000 g Up to 26 100 g	0.023 mg 0.048 mg 0.3 mg 3.0 mg 3.0 mg	Weights or weight sets
Tachometer ³ –			
Optical Pickup	(1 to 30 000) rpm	0.012 % IV + 0.6R	Agilent 33250A
Torque – Measuring Equipment	(0.1 to 10 000) lbf·ft	0.11 % IV	Dead weight, torque arms

Parameter/Equipment	Range	CMC ^{2,6,9} (±)	Comments
Mass ³ – Fixed Points	5000 g 3000 g 2000 g 1000 g 500 g 300 g 200 g 100 g 50 g 30 g 20 g 10 g 5 g 3 g 2 g 1 g 0.5 g 0.3 g 0.2 g 0.1 g 50 mg 30 mg 20 mg 10 mg 5 mg 3 mg 2 mg 1 mg	1.5 mg 2.6 mg 1.1 mg 0.22 mg 0.20 mg 0.11 mg 0.10 mg 0.10 mg 36 µg 20 µg 20 µg 7.0 µg 4.6 µg 4.4 µg 3.4 µg 2.3 µg 1.3 µg 4.0 µg 4.0 µg 2.4 µg 2.4 µg 2.4 µg 2.4 µg 2.4 µg 2.2 µg 2.8 µg 3.0 µg 2.2 µg	Class S mass set
	Up to 2500 lb	0.01 % IV	Class F weights
Torque Arms	(5 to 120) in	0.01 in	Gage blocks, LMM
Torque – Measure ³	(0.2 to 6500) lbf·ft	0.5 % IV	Torque cells
Vibration – Voltage Sensitivity, Frequency Response	(5 to 9) Hz (10 to 99) Hz 100 Hz (101 to 920) Hz (921 to 5000) Hz (5001 to 10 000) Hz (10 000 to 15 000) Hz	1.9 % IV 1.4 % IV 1.0 % IV 1.2 % IV 1.6 % IV 2.1 % IV 2.5 % IV	Modal Shop TMS 9155 sensor calibration system

VII. Optical Quantities

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
Illuminance – Light Meters	(2 to 500) fc	2.7 % IV	Optronic OL 220P

VIII. Thermodynamics

Parameter/Equipment	Range	CMC ^{2,9} (±)	Comments
Dew Point – Measuring Equipment	(-90 to 10) °C dp	0.25 °C dp	Thunder Scientific 3900
Temperature – Measuring Equipment Triple Point Cell	0.010 °C	0.000 12 °C	Fluke (Hart) 5901A-G
Temperature ³ – Measure	(0 to 100) °C (0 to 1000) °C (1000 to 1450) °C (-200 to 660) °C	0.01 °C 0.8 °C 4.2 °C 0.008 °C	Hart black stack w/ thermistor Hart Scientific 5650 Type “S” Thermocouple w/ Fluke 7526A Rosemount 162CE PRT w/ Fluke 1594A
Humidity – Measuring Equipment	(10 to 95) % RH	0.5 % RH	Thunder Scientific 2900
Temperature – Measuring Equipment w/ Dry Blocks	(-40 to 140) °C (35 to 100) °C (100 to 300) °C (300 to 600) °C (600 to 1200) °C	0.055 °C 0.055 °C 0.091 °C 0.45 °C 2.6 °C	Hart Scientific 9107 w/ Rosemount 162CE PRT & Fluke 1594A Hart Scientific 9122 w/ Rosemount 162CE PRT & Fluke 1594A Hart Scientific 9150 w/ 5650 Type “S” thermocouple & Fluke 7526A

Parameter/Equipment	Range	CMC ^{2,9} (±)	Comments
Temperature IR – Measuring Equipment Black Body	(-15 to 120) °C	1.0 °C	Hart Scientific 4180 IR target
	(35 to 200) °C	1.0 °C	Hart Scientific 4181 IR target $\lambda = (8 \text{ to } 14) \mu\text{m}$ $\epsilon = 0.9 \text{ to } 1.0$
	(> 200 to 350) °C	2.0 °C	
	(> 350 to 500) °C	3.0 °C	
Temperature – Measuring Equipment w/ Calibration Bath	(-40 to 100) °C	0.014 °C	Hart Scientific 7040 oil bath w/ Rosemount 162CE PRT & Fluke 1594A
	(0.0 to 100) °C	0.010 °C	Hart Scientific 7040 oil bath w/ Hart Blackstack & thermistor
	(100 to 180) °C	0.014 °C	Hart Scientific 6045 oil bath w/ Rosemount 162CE PRT & Fluke 1594A
	(170 to 500) °C	0.021 °C	Hart Scientific 6050 oil bath w/ Rosemount 162CE PRT & Fluke 1594A

IX. Time & Frequency

Parameter/Equipment	Range	CMC ^{2,9} (±)	Comments
Stop Watches & Timers ³	(0.2 to 10 000) s	1.8 parts in 10 ⁷ + trigger error	HP 53131A
	(+10 to -10) s/day	0.05 s/day	Timometer TM4500
Frequency – Measuring Equipment	10 000 000 Hz	50 pHz/Hz	TrueTime XL-DC GPS receiver
	0.01 Hz to 80 MHz	2 μ Hz/Hz	Agilent 33250A
		10 nHz/Hz	33250A synchronized w/ GPS
	(0.1 to 3000) MHz	2 μ Hz/Hz	Agilent 8648C
10 nHz/Hz		8648C synchronized w/ GPS	

Parameter/Equipment	Range	CMC ^{2,9} (\pm)	Comments
Frequency – Measure	10 MHz	100 pHz/Hz	TrueTime XL-DC GPS receiver
	0.1 Hz to 225 MHz	0.19 μ Hz/Hz	Agilent 53131A frequency counter
		1 nHz/Hz	53131A synchronized w/ GPS
	(0.1 to 3000) MHz	0.19 μ Hz/Hz	Agilent 53131A channel 3
		1 nHz/Hz	53131A synchronized w/ GPS

¹ This laboratory offers commercial calibration service and field calibration service where noted.

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. Please note the actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the Calibration and Measurement Capability Uncertainty (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 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 Where ranges are not specified, the CMC stated is for the cardinal points only.

⁵ This calibration is performed in Absolute Measure Mode.

⁶ In the statement of CMC, percentages are to be read as percent of reading unless noted otherwise, IV is defined as the indicated value, FS is defined as full scale, L is the numerical value of the nominal length of the device measured in inches, D is the diameter of the device in inches; R is the resolution of the unit under test.

⁷ Contact the laboratory for information on availability of service for specific gasses not listed, gasses that are not listed are not considered accredited services.

⁸ This scope meets A2LA's *P112 Flexible Scope Policy*.

⁹ 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.

¹⁰ 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

ENERGY NORTHWEST STANDARDS LABORATORY

Richland, WA

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 the requirements of ANSI/NC SL 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 8th day of February 2023

A blue ink signature of Mr. Trace McInturff, written over a horizontal line.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2724.01
Valid to January 31, 2025

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