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

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CALIBRATION

Valid To: March 31, 2025 Certificate Number: 1277.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations[1, 9]:

I. Acoustical Quantities

Parameter/Range	Frequency	CMC[2] (±)	Comments
Microphone Acoustic Level –			
Sensitivity: ¼, ½, & 1 in	114 dB @ 250 Hz	0.29 dB	Modal shop acoustic calibration system
Frequency Response: ¼, ½, & 1 in	20 Hz to 92.2 kHz	0.30 dB + 0.000 84 dB/kHz	
Sound Level Calibrators – (75 to 124) dB	(0.25 to 1) kHz	0.29 dB	Modal shop acoustic calibration system
Sound Level Meters – (94 to 114) dB	(0.125 to 2) kHz	0.64 dB	Acoustic method
	(0.02 to 20) kHz	0.12 dB	Electrical method

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II. Chemical

Parameter/Equipment	Range	CMC[2, 6, 10] (±)	Comments
pH – Measuring Equipment	4.01 pH unit 7.01 pH unit 10.01 pH unit	0.019 pH unit 0.023 pH unit 0.025 pH unit	Accredited solutions
Conductance – Measuring Equipment	1.015 mS/cm 1.408 mS/cm 12.85 mS/cm 111.3 mS/cm	0.0058 mS/cm + 0.6*R* 0.010 mS/cm + 0.6*R* 0.087 mS/cm + 0.6*R* 0.88 mS/cm + 0.6*R*	Accredited solutions

III. Dimensional

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Micrometers[3]	Up to 36 in	(4.6 + 5.0*L*) µin + 0.6*R*	Gage blocks
Tri-Bore	Up to 5 in	(6.4 + 4.4*L*) µin + 0.6*R*	Ring gage set
Calipers[3]	Up to 36 in	(2.9 + 11*L*) µin + 0.6*R*	Gage blocks
Angle	90° Up to 60°	0.000 43° 0.000 048 °/°	Master square Sine bar/gage blocks
Optical Comparators[3]– Magnification Linear Accuracy Angle	 10× to 100× (0.001 to 6) in (30/60/90/120/150)°	 420 µin 150 µin + 0.6*R* 0.0048° + 0.6*R*	 Magnification scale Glass scale
Cylindrical Gages – Pins, Plugs, Discs	 (0.003 to 4.0) in	 (16 + 1.9*L*) µin	 ULM and gage blocks
Height Gages[3, 8]	Up to 48 in	(48 + 4.5*L*) µin	Gage blocks

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Indicators[3] – Dial & Digital	Up to 4 in Up to 100 mm	(1.4 + 4.5*L*) µin + 0.6*R* (54 + 7.6*L*) nm + 0.6*R*	Gage blocks
Gage Blocks	(0.01 to 4) in (0.5 to 100) mm (>4 to 8) in	(1.6 + 3.7*L*) µin (89 + 3.4*L*) nm (16 + 2*L*) µin	Twin head comparison ULM
Linear Displacement	Up to 60 in Up to 254 M	(930 + 21*L*) µin 0.47 mm	String pot calibration system Measurement Wheel System
Radius Gage	(0.005 to 5) in	0.0012 in	Optical comparator
Threaded Plug Gages – Pitch Diameter (5 to 80 TPI) Major Diameter	 Up to 8 in Up to 6 in	 (75 + 1.5*L*) µin (16 + 1.9*L*) µin	 ULM, thread wires, gage blocks ULM and gage blocks
Thread rings – Pitch Diameter (5 to 80 TPI)	 Up to 6.5 in	 Accuracy of Setting Plug Used	 Thread setting plug
Gage Balls	Up to 4 in	(16 + 3.9*L*) µin	ULM
Ring Gages	Up to 8 in	(16 + 1.9*L*) µin	ULM, master rings and gage blocks
Foils & Thickness Gages	Up to 8 in	(16 + 1.9*L*) µin	ULM
Linear Scales/Reticles	Up to 12 in	0.0013 in	Optical comparator

Parameter/Equipment	Range	CMC[2, 6] (±)	Comments
Durometers –			ASTM D2240
Indenter Extension & Shape	Types A, B, C, D, E, O, OO, and DO		Optical comparator
Diameter	Indenter Diameter	11 µm	
Radius	Tip radius	11 µm	
Angle	Indenter Angle	0.085°	
Extension	Indenter extension length	11 µm	
Indenter Display	Up to 100 Duro Units	0.09 Duro + 0.6*R*	Gage blocks and surface plate
Spring Calibration Force	All scales	0.0013 N	Dual pan balance and weights
Geometric Measurements –			
X Axis	Up to 900 mm	3.9 µm + 0.0043 µm/mm	CMM
Y Axis	Up to 1000 mm	4.0 µm + 0.0043 µm/mm	
Z Axis	Up to 600 mm	3.9 µm + 0.0042 µm/mm	

V. Electrical – DC/Low Frequency

Parameter/Range	Frequency	CMC[2, 11] (±)	Comments
AC Current[3] – Generate			
(0 to 220) µA	(10 to 20) Hz (20 to 40) Hz (40 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	0.031 % + 16 nA 0.020 % + 10 nA 0.014 % + 8 nA 0.033 % + 12 nA 0.13 % + 65 nA	Fluke 5730A
(0.22 to 2.2) mA	(10 to 20) Hz (20 to 40) Hz (40 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	0.031 % + 40 nA 0.020 % + 35 nA 0.013 % + 35 nA 0.027 % + 110 nA 0.13 % + 650 nA	Fluke 5730A
(2.2 to 22) mA	(10 to 20) Hz (20 to 40) Hz (40 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	0.038 % + 400 nA 0.020 % + 350 nA 0.013 % + 350 nA 0.028 % + 550 nA 0.14 % + 5 µA	
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz (40 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	0.031 % + 4 µA 0.021 % + 3.5 µA 0.014 % + 2.5 µA 0.033 % + 3.5 µA 0.14 % + 10 µA	Fluke 5730A/5725A
(0.22 to 2.2) A	(20 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	0.031 % + 35 µA 0.059 % + 80 µA 0.86 % + 160 µA	Fluke 552XA
(2.2 to 10) A	(40 to 1000) Hz (1 to 5) kHz (5 to 10) kHz	0.053 % + 170 µA 0.11 % + 380 µA 0.42 % + 750 µA	
(1.1 to 3) A	(10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.19 % + 0.1 mA 0.062 % + 0.1 mA 0.62 % + 1 mA 2.6 % + 5 mA	
(3 to 11) A	(45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.062 % + 2 mA 0.1 % + 2 mA 2.6 % + 2 mA	
(11 to 20.5) A	(45 to 100) Hz (0.1 to 1) kHz (1 to 5) kHz	0.12 % + 5 mA 0.15 % + 5 mA 3.1 % + 5 mA	

Parameter/Range	Frequency	CMC[2, 4, 11] (±)	Comments
AC Current[3] – Generate (cont)			
(> 20.5 to 40) A (> 40 to 200) A (> 200 to 1025) A	(45 to 440) Hz (45 to 440) Hz (45 to 440) Hz	0.46 % + 0.008 A 0.53 % + 0.01 A 0.35 % + 0.04 A	Fluke 552XA w/ EA002 2/10/50 Coil
AC Current[3] – Measure			
(0 to 100) µA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz	0.51 % + 30 nA 0.21 % + 30 nA 0.13 % + 30 nA 0.13 % + 30 nA	HP 3458A, option II
(0.1 to 1) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz	0.49 % + 0.2 µA 0.21 % + 0.2 µA 0.1 % + 0.2 µA 0.061 % + 0.2 µA 0.085 % + 0.2 µA	
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz	0.49 % + 2 µA 0.17 % + 2 µA 0.085 % + 2 µA 0.061 % + 2 µA 0.069 % + 2 µA	
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz	0.49 % + 20 µA 0.18 % + 20 µA 0.078 % + 20 µA 0.061 % + 20 µA 0.085 % + 20 µA	
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.5 % + 0.2 mA 0.24 % + 0.2 mA 0.15 % + 0.2 mA 0.18 % + 0.2 mA	
(1 to 10) A	(45 to 1000) Hz (1 to 5) kHz	0.03 % 0.08 %	HP 3458A w/ Fluke Y5020A current shunt

Parameter/Range	Frequency	CMC[2, 4, 11] (±)	Comments
AC Voltage[3] – Generate			
(0 to 2.2) mV	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (500 to 1000) kHz	0.16 % + 4.0 µV 0.16 % + 4.0 µV 0.17 % + 4.0 µV 0.17 % + 4.0 µV 0.19 % + 5 µV 0.23 % + 10 µV 0.29 % + 20 µV 0.65 % + 20 µV	Fluke 5730A
(2.2 to 22) mV	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (500 to 1000) kHz	0.063 % + 4 µV 0.028 % + 4 µV 0.024 % + 4 µV 0.054 % + 4 µV 0.13 % + 5 µV 0.27 % + 10 µV 0.36 % + 20 µV 0.70 % + 20 µV	
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (500 to 1000) kHz	0.062 % + 12 µV 0.024 % + 7 µV 0.015 % + 7 µV 0.031 % + 7 µV 0.079 % + 17 µV 0.17 % + 20 µV 0.36 % + 25 µV 0.69 % + 45 µV	
(0.22 to 2.2) V	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (500 to 1000) kHz	0.028 % + 40 µV 0.011 % + 15 µV 0.0053 % + 8 µV 0.0084 % + 10 µV 0.011 % + 30 µV 0.042 % + 80 µV 0.12 % + 200 µV 0.21 % + 300 µV	
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (500 to 1000) kHz	0.051 % + 400 µV 0.020 % + 150 µV 0.0076 % + 50 µV 0.015 % + 100 µV 0.021 % + 200 µV 0.066 % + 0.6 mV 0.18 % + 2 mV 0.30 % + 3.2 mV	

Parameter/Range	Frequency	CMC[2, 4, 11] (±)	Comments
AC Voltage[3] – Generate (cont)			Fluke 57X0A
(22 to 220) V*	(10 to 20) Hz (20 to 40) Hz (40 to 20 000) Hz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	0.050 % + 4 mV 0.019 % + 1.5 mV 0.0091 % + 0.6 mV 0.014 % + 1 mV 0.026 % + 2.5 mV 0.030 % + 16 mV 0.21 % + 40 mV	*220V range subject to 2.2E7 V-Hz limitation
(220 to 1100) V	(40 to 1000) Hz (1 to 20) kHz (20 to 30) kHz	0.0064 % + 4 mV 0.0098 % + 6 mV 0.020 % + 11 mV	Fluke 5730A/5725A
(220 to 750) V	(30 to 50) kHz (50 to 100) kHz	0.014 % + 11 mV 0.033 % + 45 mv	
AC Voltage[3] – Measure			
(0 to 10) mV	(40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.023 % + 1.1 µV 0.035 % + 1.1 µV 0.12 % + 1.1 µV 0.58 % + 1.1 µV 4.6 % + 2 µV	HP 3458A, option II
(10 to 100) mV	(40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 1000) kHz (1 to 2) MHz	0.0087 % + 2 µV 0.017 % + 2 µV 0.035 % + 2 µV 0.093 % + 2 µV 0.35 % + 10 µV 1.2 % + 10 µV 1.7 % + 10 µV	
100 mV to 1 V	(40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 1000) kHz (1 to 2) MHz	0.0081 % + 20 µV 0.016 % + 20 µV 0.035 % + 20 µV 0.092 % + 20 µV 0.35 % + 0.1 mV 1.2 % + 0.1 mV 1.7 % + 0.1 mV	
(1 to 10) V	(40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 1000) kHz	0.0081 % + 0.2 mV 0.016 % + 0.2 mV 0.035 % + 0.2 mV 0.092 % + 0.2 mV 0.35 % + 1 mV 1.2 % + 1 mV	

Parameter/Range	Frequency	CMC[2, 4, 11] (±)	Comments
AC Voltage[3] – Measure (cont)			
(10 to 100) V	(40 to 1000) Hz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.023 % + 2 mV 0.023 % + 2 mV 0.040 % + 2 mV 0.14 % + 2 mV	HP 3458A, option II
(100 to 1000) V	(40 to 1000) Hz	0.51 % + 20 mV	
(1 to 10) kV	(30 to 200) Hz	0.14 % IV + 0.1 V	Vitrek 4700 high voltage meter
Capacitance[3] – Generate			
(0.19 to 0.4) nF (0.4 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 (0.33 to 1.1) µF (1.1 to 3.3) µF (3.3 to 11) µF (11 to 33) µF (33 to 110) µF (110 to 330) µF (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz (10 to 50) Hz (0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz	0.58 % + 0.01 nF 0.52 % + 0.01 nF 0.52 % + 0.01 nF 0.28 % + 0.01 nF 0.26 % + 0.1 nF 0.26 % + 0.1 nF 0.26 % + 0.3 nF 0.26 % + 1 nF 0.26 % + 3 nF 0.26 % + 10 nF 0.41 % + 30 nF 0.46 % + 0.1 µF 0.47 % + 0.3 µF 0.46 % + 1 µF 0.47 % + 3 µF 0.47 % + 10 µF 0.76 % + 30 µF 1.1 % + 0.10 mF	Fluke 552XA
Oscilloscopes –			
Amplitude, DC Signal 50 Ω Load 1 MΩ Load	 (-6.6 to 6.6) V (-130 to 130) V	 0.29 % IV + 40 µV 0.058 % IV + 40 µV	Fluke 552XA/SC1100
Amplitude, Square Wave 50 Ω Load	 ±1 mV to ±6.6 V_{p-p} 10 Hz to 10 kHz	 0.29 % IV + 40 µV	
1 MΩ Load	±1 mV to ±130 V_{p-p} 10 Hz to 1 kHz	0.12 % IV + 40 µV	

Parameter/Range	Frequency	CMC[2, 4, 11] (±)	Comments
Oscilloscopes – (cont)			
Time Marker into 50 Ω Load-Source	5 s to 50 ms	29 parts in 10^6 + 1000 parts in 10^6/s	Fluke 552XA/SC1100
	20 ms to 2 ns	2.9 parts in 10^6	
Leveled Sine Wave Relative to 50 kHz [5 mV to 5.5 V] p-p	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (550 to 1100) MHz (1.1 to 3.2) GHz (3.2 to 6.0) GHz	2.0 % + 100 µV 2.5 % + 100 µV 4.7 % + 100 µV 4.3 % 5.3 % 5.3 %	Fluke 9500B w/ active head(s)
Rise Time	10 Hz to 2 MHz (125 to 175) ps	20 ps	
	10 Hz to 1 MHz (59 to 81) ps	15 ps	

Parameter/Equipment	Range	CMC[2, 4, 11] (±)	Comments
Capacitance – Fixed Points	100 pF 1 nF to 1 µF	0.059 % 0.016 %	Standard capacitors
Capacitance – Measure	10 pF to 1.1 µF	0.018 %	Gen Rad 1615A capacitance bridge
DC Current[3] – Generate	0.1 nA to 220 µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	95 µA/A + 6 nA 82 µA/A + 7 nA 83 µA/A + 40 nA 110 µA/A + 0.7 µA 99 µA/A + 12 µA	Fluke 5730A
	(2.2 to 10) A	420 µA/A + 480 µA	Fluke 5730A/5725A
	(1.1 to 3) A (3 to 11) A (11 to 20) A	0.039 % + 40 µA 0.052 % + 0.33 mA 0.1 % + 0.75 mA	Fluke 552XA
	(20 to 40) A (40 to 200) A (200 to 1025) A	0.45 % + 0.008 A 0.51 % + 0.01 A 0.31 % + 0.04 A	Fluke 552XA with EA002 2/10/50 Coil

Parameter/Equipment	Range	CMC[2, 4, 11] (±)	Comments
DC Current[3] – Measure	(10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A (1 to 10) A (10 to 20) A	22 µA/A + 0.8 nA 21 µA/A + 5 nA 21 µA/A + 50 nA 35 µA/A + 0.5 µA 0.011 % + 10 µA 0.032 % + 0.6 mA 0.027 % + 3.3 mA	HP 3458A, option II HP 3458A w/ Fluke Y5020 shunt
DC Voltage[3] – Measure	(0 to 100) mV (0.1 to 1) V (1.0 to 10) V (10 to 100) V (100 to 1000) V (1 to 10) kV	5.2 µV/V + 0.3 µV 4.1 µV/V + 0.3 µV 4.0 µV/V + 0.5 µV 6.2 µV/V + 30 µV 63 µV/V + 0.1 mV* 0.036 % IV + 0.03 V	HP 3458A, option II *Add 12 mV/V·$(V_{in}/1000)^2$ for input >100 V Vitrek 4700 high voltage meter
DC Voltage[3] – Generate	(0 to 220) mV (0 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 + 0.4 µV 5.9 µV/V + 0.7 µV 4.1 µV/V + 2.5 µV 4.5 µV/V + 4 µV 5.8 µV/V + 40 µV 7.8 µV/V + 400 µV	Fluke 5730A
Inductance – Measure @ 100 Hz Fixed Values	100 µH to 5 H	0.3 %	Standard inductor set w/ GenRad 1632A bridge as transfer standard
Inductance – Generate	100 µH to 5.0 H	0.071 %	Gen Rad 1482 standard inductors
Resistance[3] – Measure	(0 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	15 µΩ/Ω + 0.05 mΩ 13 µΩ/Ω + 0.50 mΩ 10 µΩ/Ω + 5.0 mΩ 10 µΩ/Ω + 50 mΩ 10 µΩ/Ω + 50 mΩ 16 µΩ/Ω + 2.0 Ω 52 µΩ/Ω + 100 Ω 0.051 % + 1.0 kΩ 0.5 % + 10 kΩ	HP 3458A, option II

Parameter/Equipment	Range	CMC[2, 4, 11] (±)	Comments
Resistance[3] – Generate	(1 and 10) mΩ	4.7 µΩ/Ω	L&N reference resistors
	(0.1, 1, 10, 100) Ω (1, 10, 100, 1000) kΩ	4.7 µΩ/Ω 4.7 µΩ/Ω	ESI SR1010 reference resistors
	0 Ω	4.8 µΩ	Copper shorting block
	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	110 µΩ 210 µΩ 270 µΩ 620 µΩ 1.2 mΩ 2.2 mΩ 7.7 mΩ 15 mΩ 77 mΩ 150 mΩ 1.0 Ω 3.1 Ω 23 Ω 48 Ω 480 Ω 1.1 kΩ 13 kΩ	Fluke 5730A
	(0.0001 to 1) TΩ	0.23 % IV. + 0.0011 % IV/GΩ	IET Labs HRRS decade resistor
Resistance[3] – Generate, Fixed Values	(1 and 10) mΩ	4.7 µΩ/Ω	L&N reference resistors
	(0.1, 1, 10, 100) Ω (1, 10, 100, 1000) kΩ	4.7 µΩ/Ω 4.7 µΩ/Ω	ESI SR1010 reference resistors
	0 Ω	4.8 µΩ	Copper shorting block
	1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ	110 µΩ 210 µΩ 270 µΩ 620 µΩ 1.2 mΩ 2.2 mΩ 7.7 mΩ 15 mΩ 77 mΩ	Fluke 5730A

Parameter/Equipment	Range	CMC[2, 11] (±)	Comments
Resistance[3] – Generate, Fixed Values (cont)	19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	150 mΩ 1.0 Ω 3.1 Ω 23 Ω 48 Ω 480 Ω 1.1 kΩ 13 kΩ	Fluke 5730A
Electrical Simulation – Thermocouple Indication and Measure devices[3]			
Type C	(0 to 250) °C (250 to 1000) °C (1000 to 1500) °C (1500 to 1800) °C (1800 to 2000) °C (2000 to 2250) °C (2250 to 2315) °C	0.24 °C 0.19 °C 0.21 °C 0.25 °C 0.27 °C 0.34 °C 0.38 °C	Ectron 1140A
Type E	(-270 to -245) °C (-245 to -195) °C (-195 to -155) °C (-155 to -90) °C (-90 to 1000) °C	1.40 °C 0.21 °C 0.12 °C 0.10 °C 0.09 °C	
Type J	(-210 to -180) °C (-180 to -120) °C (-120 to -50) °C (-50 to 1200) °C	0.14 °C 0.12 °C 0.10 °C 0.09 °C	
Type K	(-255 to -195) °C (-195 to -115) °C (-115 to -55) °C (-55 to 1000) °C (1000 to 1372) °C	0.81 °C 0.15 °C 0.11 °C 0.09 °C 0.10 °C	
Type N	(-200 to -140) °C (-140 to -70) °C (-70 to 25) °C (25 to 160) °C (160 to 1300) °C	0.28 °C 0.18 °C 0.14 °C 0.12 °C 0.11 °C	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Simulation – Thermocouple Indication & Measure Devices[3] (cont)			
Type R	(-30 to 45) °C (45 to 160) °C (160 to 380) °C (380 to 775) °C (775 to 1768) °C	0.66 °C 0.49 °C 0.38 °C 0.34 °C 0.30 °C	Ectron 1140A
Type S	(-30 to 45) °C (45 to 105) °C (105 to 310) °C (310 to 615) °C (615 to 1768) °C	0.67 °C 0.49 °C 0.41 °C 0.37 °C 0.34 °C	
Type T	(-270 to -255) °C (-255 to -240) °C (-240 to -210) °C (-210 to -150) °C (-150 to -40) °C (-40 to 100) °C (100 to 400) °C	2.10 °C 0.57 °C 0.35 °C 0.22 °C 0.14 °C 0.10 °C 0.09 °C	Fluke 552XA
Type U	(-200 to 0) °C (0 to 600) °C	0.65 °C 0.31 °C	
Electrical Simulation – RTD Indicating Devices[3] –			
Pt 385, 100 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.058 °C 0.058 °C 0.085 °C 0.1 °C 0.12 °C 0.12 °C 0.27 °C	Fluke 552XA
Pt 3926, 100 Ω	(-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C	0.058 °C 0.058 °C 0.081 °C 0.1 °C 0.12 °C 0.14 °C	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Simulation – RTD Indicating Devices[3] – (cont)			
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 0.046 °C 0.058 °C 0.069 °C 0.081 °C 0.092 °C 0.1 °C 0.12 °C 0.27 °C	Fluke 552XA
Pt 385, 200 Ω	(-200 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	0.046 °C 0.046 °C 0.046 °C 0.058 °C 0.14 °C 0.15 °C 0.16 °C 0.18 °C	
Pt 385, 500 Ω	(-200 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	0.047 °C 0.058 °C 0.058 °C 0.069 °C 0.093 °C 0.093 °C 0.1 °C 0.13 °C	
Pt 385, 1000 Ω	(-200 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	0.035 °C 0.035 °C 0.046 °C 0.058 °C 0.069 °C 0.081 °C 0.081 °C 0.27 °C	
PtNi 385, 120 Ω	(-80 to 0) °C (0 to 100) °C (100 to 260) °C	0.092 °C 0.092 °C 0.16 °C	
Cu 427, 10 Ω	(-100 to 260) °C	0.35 °C	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Simulation – RTD Indicating Devices[3] – (cont)			
LF Energy	10 J 50 J 100 J 360 J	0.17 J 0.32 J 0.53 J 2.4 J	Fluke impulse 7000 "Gold Standard"

VI. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC[2, 4, 11] (±)	Comments
RF Absolute Power[3, 5] – Measure			
1 mW Reference	50 MHz	1.7 %	HP 8478B sensor w/ HP 432A power meter and type N connector
(-30 to 10) dBm	100 kHz to 4.2 GHz (4.2 to 18) GHz	1.6 % 1.8 %	Power meter w/: 8482A power sensor 8481A power sensor
(10 to 20) dBm	100 kHz to 4.2 GHz (4.2 to 18) GHz	3.3 % 3.8 %	8482A power sensor 8481A power sensor
(-20 to 30) dBm	10 MHz to 18 GHz	3.3 %	Agilent 5532B, N1913A
RF Absolute Power[3, 5] – Generate			
Sine Wave into 50 Ω			
(-48 to 24) dBm	0.001 Hz to 100 kHz	0.035 dB	Fluke 96040B RF reference source
(-48 to 24) dBm	100 kHz to 128 MHz	0.066 dB	
(-48 to 20) dBm	(128 to 300) MHz	0.088 dB	
(-48 to 20) dBm	(0.3 to 1.4) GHz	0.24 dB	
(-48 to 14) dBm	(1.4 to 3) GHz	0.36 dB	
(-17 to 14) dBm	(3 to 4) GHz	0.37 dB	
(-74 to -17) dBm	(3 to 4) GHz	0.61 dB	
(-74 to -48) dBm	(0.1 to 10) MHz	0.24 dB	
(-84 to -48) dBm	(10 to 128) MHz	0.12 dB	
(-74 to -48) dBm	(128 to 300) MHz	0.12 dB	
(-74 to -48) dBm	(0.3 to 1.4) GHz	0.47 dB	

Parameter/Range	Frequency	CMC[2, 4, 11] (±)	Comments
RF Absolute Power[3, 5] – Generate (cont)			Fluke 96040B RF reference source
(-74 to -48) dBm	(1.4 to 3) GHz	0.59 dB	
(-94 to -74) dBm	(0.1 to 10) MHz	0.59 dB	
(-94 to -74) dBm	(1.4 to 3) GHz	1.2 dB	
(-84 to -74) dBm	(128 to 300) MHz	0.35 dB	
(-84 to -74) dBm	(0.3 to 1.4) GHz	0.60 dB	
(-84 to -74) dBm	(3 to 4) GHz	1.2 dB	
(-94 to -84) dBm	(10 to 128) MHz	0.36 dB	
(-94 to -84) dBm	(128 to 300) MHz	0.58 dB	
(-94 to -84) dBm	(0.3 to 1.4) GHz	1.2 dB	
(-130 to -94) dBm	(10 to 128) MHz	0.84 dB	
(-130 to -94) dBm	(128 to 300) MHz	1.8 dB	
(-130 to -94) dBm	(0.3 to 3) GHz	1.8 dB	
RF Tuned Power – Measure			
(-129 to 16) dB	(0.0001 to 18) GHz	0.073 dB + 0.044 %	N5531S System MMR
Amplitude Modulation – Generate			
AM Flatness			
Carrier Frequency:	Rate Frequency:		
(11 to 13.5) MHz	50 Hz to 50 kHz	0.16 %	HP 11715A AM/FM test source
Depth: (0 to 99) %	20 Hz to 100 kHz	0.32 %	
Amplitude Modulation – Measure			
Carrier Frequency:	Rate Frequency:		
(0.15 to 10) MHz			HP 8902A w/ HP 11722A
Depth: (5 to 99) %	50 Hz to 10 kHz	3.5 % + 1 digit	
(0 to 99) %	20 Hz to 10 kHz	4.1 % + 1 digit	
(10 to 1300) MHz			
Depth: (5 to 99) %	50 Hz to 50 kHz	1.6 % + 1 digit	

Parameter/Range	Frequency	CMC[2, 4, 11] (±)	Comments
Frequency Modulation – Measure			
Carrier Frequency:	Rate Frequency:		
(0.25 to 10) MHz ≤ 40 kHz Peak Deviation	20 Hz to 10 kHz	2.3 % + 1 digit	HP 8902A w/ HP 11722A
(10 to 1300) MHz ≤ 400 kHz Peak Deviation	50 Hz to 100 kHz 20 Hz to 400 kHz	3.0 % + 1 digit 6.7 % + 1 digit	
Frequency Modulation – Generate			
FM Flatness Carrier Frequency:	Rate Frequency:		
(11 to 13.5) MHz	DC to 100 kHz (100 to 200) kHz	0.33 % 0.43 %	HP 11715A AM/FM test source
(88 to 108) MHz	DC to 100 kHz (100 to 200) kHz	0.34 % 0.43 %	
(352 to 432) MHz	DC to 100 kHz (100 to 200) kHz	0.34 % 0.43 %	
Phase Modulation – Measure			
Carrier Frequency:	Rate Frequency:		
(0.15 to 10) MHz	200 Hz to 10 kHz	4.8 % + 1 digit	HP 8902A w/ HP 11722A sensor
(10 to 1300) MHz	200 Hz to 20 kHz	4.6 % + 1 digit	
RF Volts – Measure, Fixed Points			
3 V	(1 to 10) MHz (10 to 30) MHz (30 to 50) MHz (50 to 70) MHz (70 to 80) MHz (80 to 100) MHz	0.091 % 0.11 % 0.19 % 0.30 % 0.32 % 0.38 %	HP 11049A thermal voltage converter

Parameter/Range	Frequency	CMC[2, 4, 11](±)	Comments
Distortion – Measure	20 Hz to 20 kHz >20 kHz to 100 kHz >100 kHz to 18 GHz	1.2 dB 2.3 dB 0.23 dB + 0.12 dB/GHz	HP 8903B audio analyzer HP E4440A spectrum analyzer

VII. Mechanical

Parameter/Equipment	Range	CMC[2, 4, 10] (±)	Comments
Torque Wrench	(4.0 to 40) ozf·in (2.5 to 25) lbf·in (10 to 3120) lbf·in (0 to 1000) ozf·in (0 to 600) lbf·ft	1.3 % of IV from (10 to 100) % FS 0.32 % of IV from (10 to 100) % FS 0.24 % of IV from (10 to 100) % FS 0.49 % of IV (10 to 100) % of range 1.8 ft·lbf (10 to 100) % of range	JETCO TED-40 Larson STWCS Futek torque system
Acceleration/Vibration – Measuring Equipment Voltage Sensitivity, Frequency Response (0.02 to 5000) mV/g Charge Sensitivity, Frequency Response (0.04 to 100) pC/g	 (5 to 99) Hz 100 Hz (101 to 920) Hz (921 to 5000) Hz (5 to 10) kHz (5 to 99) Hz 100 Hz (101 to 920) Hz (921 to 5000) Hz (5 to 10) kHz	 2.1 % IV 1.4 % IV 1.2 % IV 1.8 % IV 3.0 % IV 2.1 % IV 1.4 % IV 1.2 % IV 1.8 % IV 3.0 % IV	 Modal shop 9155

Parameter/Equipment	Range	CMC[2, 4, 10] (±)	Comments
Acceleration/Vibration – Measuring Equipment (cont)			
Piezoresistive Sensitivity, Frequency Response (0.000 08 to 100) mV/V/g	(5 to 99) Hz 100 Hz (101 to 920) Hz (921 to 5000) Hz (5 to 10) kHz	2.1 % IV 1.4 % IV 1.2 % IV 1.8 % IV 3.0 % IV	Modal shop 9155
Digital Sensitivity, Frequency Response (1 to 500 000) Counts/g	(5 to 99) Hz 100 Hz (101 to 920) Hz (921 to 5000) Hz (5 to 10) kHz	2.1 % IV 1.4 % IV 1.2 % IV 1.8 % IV 3.0 % IV	
Torque – Measuring Equipment			
Torque Transducers	(0.6 to 42) lbf·ft (42 to 300) lbf·ft (1.7 to 600) lbf·ft	0.012 % IV 0.013 % IV 0.015 % IV	Torque arm/dead weight
Pressure Gauges – Measuring Equipment			
Pneumatic	(-5 to 5) psig	0.0065 % IV + 0.0005 psig	Pace 6000
	(-14.5 to 50) psig	0.0055 % IV + 0.0033 psig	
	(-14.5 to 300) psig	0.0085 % IV + 0.015 psig	
	(-14.5 to 1000) psig	0.011 % IV + 0.051 psig	Deadweight tester
Hydraulic	(10 to 50) psig (51 to 10 000) psig	0.0088 psig 0.019 %	
	(0 to 10) inH_2O	0.006 inH_2O	Meriam manometer

Parameter/Equipment	Range	CMC[2, 4, 6, 10] (±)	Comments
Absolute Pressure – Measuring Equipment and Measure	(9 to 20) psia (0.5 to 80) psia (0.5 to 330) psia (0.5 to 1030) psia	0.0058 % IV + 0.0013 psia 0.0058 % IV + 0.004 psia 0.0063 % IV + 0.0173 psia 0.0064 % IV + 0.052 psia	Pace 6000
Scales and Balances[3] – Analytical Balances[3]	(0.5 to 629) lb (20 to 100) mg (100 to 500) mg (1 to 10) g (10 to 100) g (0.1 to 3) kg	0.01 % + 0.6*R* 0.031 mg + 0.19 mg/g 0.043 mg + 0.076 mg/g 0.033 mg + 0.002 mg/g 0.03 mg + 0.0023 mg/g 0.0034 % + 0.6*R*	ASTM class 6 weights ASTM class 1 weights
Force[3, 7] – Measuring Equipment	(0.5 to 500) lbf (100 to 1000) lbf (200 to 2000) lbf (500 to 5000) lbf (1000 to 10 000) lbf (2500 to 25 000) lbf (5000 to 50 000) lbf (10 000 to 100 000) lbf (50 000 to 500 000) lbf	0.01 % IV + 0.6*R* 0.061 % FS 0.050 % FS 0.049 % FS 0.049 % FS 0.056 % FS 0.049 % FS 0.064 % FS 0.05 % FS	ASTM class 6 weights Load cells Compression only

Parameter/Equipment	Range	CMC[2, 4, 10] (±)	Comments
Rockwell Hardness[3] – Indirect Verification of Superficial Hardness Testers	HRA: Low Medium High HRBW: Low Medium High HRC: Low Medium High HRRW HR15N: Low Medium High HR30N: Low Medium High HR15TW: Low Medium High HR30TW: Low Medium High	 0.54 HRA 0.43 HRA 0.32 HRA 0.83 HRBW 1.0 HRBW 0.79 HRBW 0.86 HRC 1.0 HRC 0.44 HRC 1.6 HRRW 0.99 HR15N 0.80 HR15N 0.97 HR15N 0.49 HR30N 0.78 HR30N 0.38 HR30N 0.52 HR15TW 0.59 HR15TW 0.48 HR15TW 0.97 HR30TW 0.77 HR30TW 0.57 HR30TW	ASTM E18
Universal Testing Machine, Compression Testing Machines, Tension Testing Machines[3]	(0.5 to 500) lbf (100 to 1000) lbf (200 to 2000) lbf (500 to 5000) lbf (1000 to 10 000) lbf (2500 to 25 000) lbf (5000 to 50 000) lbf (10 000 to 100 000) lbf (50 000 to 500 000) lbf	0.011 % IV 0.061 % FS 0.050 % FS 0.058 % FS 0.049 % FS 0.056 % FS 0.056 % FS 0.056 % FS 0.056 % FS	ASTM E4, load cells and dead weights tension and compression Compression only

VIII. Thermodynamics

Parameter/Equipment	Range	CMC[2, 10] (±)	Comments
Temperature[3] – Measuring Equipment	(-95 to 150) °C	0.014 °C + 42 µ°C/°C	Fluke 1502 w/ 5628 PRT in bath
Infrared Temperature[3] – Measure	(25 to 400) °C	0.45 °C + 0.017 °C/°C	Black body
Temperature[3] – Measure	(-95 to 660) °C (200 to 1200) °C	0.031 °C + 72 µ°C/°C 0.4 °C + 5.2 m°C/°C	Fluke 1502 w/ 5628 PRT Type N thermocouple
Thermocouples – Types B, C, E, J, K N, R, S, T, U	(-50 to 660) °C	0.23 °C + 0.12 m°C/°C	Fluke 552XA/ Fluke 1502A/5628
RTDs –	(-50 to 660) °C	0.038 °C	HP3458A/Hart 1502A/ 5628

Parameter/Equipment	Range	CMC[2, 4, 10] (±)	Comments
Relative Humidity – Measuring Equipment	(10 to 95) % RH	0.7 % RH	Thunder Scientific 2500
Relative Humidity[3] – Measuring Equipment	11.3 % RH 33 % RH 75.5 % RH 97.7 % RH	1.6 % RH 1.6 % RH 2.0 % RH 2.6 % RH	Vaisala HMK15
Relative Humidity[3] – Measure	(11.3 to 90) % RH (90 to 97.7) % RH	1.9 % RH 2.5 % RH	Vaisala MI70/HMP77B

IX. Time & Frequency

Parameter/Equipment	Range	CMC[2, 10] (±)	Comments
Frequency – Measuring Equipment	10 MHz	5.7×10^{-12} Hz/Hz	NOVAS WR 2410 GPS receiver
Frequency – Measure	0.01 Hz to 18 GHz	1.6×10^{-9} Hz/Hz	NOVAS WR 2410 GPS receiver w/ Frequency Counter
Period – Measure	1 µs to 1000 s	1.2×10^{-9} s/s	NOVAS WR 2410 GPS receiver w/frequency counter
Rise Time – Measure	(0.35 to 1000) ns	0.40 ns	Oscilloscope
Stopwatches	(0 to 86400) s (0 to 19.99) s/day	33 ms 0.039 s/day	NIST RP 960-12 Timometer

[1] This laboratory offers commercial calibration service and field calibration service.

[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] In the statement of CMC, the value is defined as the percentage of reading unless otherwise indicated; IV represents *Indicated Value* and FS represents *Full Scale*.

[5] The CMCs do not include mismatches.

[6] In the statement of CMC, L represents the length of the unit under test in inches or millimeters, where appropriate; R represents the resolution of the unit under test.

[7] Greater than 100 klbf, field service available only.

[8] Repeatability of the Unit Under Test has not been utilized in the calculation of the CMC value for this measurement parameter.

[9] This scope meets A2LA's *P112 Flexible Scope Policy*.

[10] 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.

[11] 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. CMCs 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

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Livonia, MI

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/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 1st day of May 2023.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 1277.01
Valid to March 31, 2025
Revised August 23, 2023

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