



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

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CALIBRATION

Valid To: April 30, 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<sup>1,9</sup>:

I. Acoustical Quantities

Parameter/Range	Frequency	CMC <sup>2</sup> (±)	Comments
Microphone Acoustic Level –  Sensitivity: ¼, ½, & 1 in  Frequency Response: ¼, ½, & 1 in	114 dB @ 250 Hz  20 Hz to 92.2 kHz	0.29 dB  0.30 dB + 0.000 84 dB/kHz	Modal shop acoustic calibration system
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  (0.02 to 20) kHz	0.64 dB  0.12 dB	Acoustic method  Electrical method

## II. Chemical

Parameter/Equipment	Range	CMC <sup>2, 6, 10</sup> ( $\pm$ )	Comments
pH <sup>3</sup> – 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 <sup>3</sup> – Measuring Equipment	1.015 mS/cm 1.408 mS/cm 12.85 mS/cm 111.3 mS/cm	0.0058 mS/cm + 0.6R 0.010 mS/cm + 0.6R 0.087 mS/cm + 0.6R 0.88 mS/cm + 0.6R	Accredited solutions

## III. Dimensional

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

Parameter/Equipment	Range	CMC <sup>2,6</sup> ( $\pm$ )	Comments
Indicators <sup>3</sup> – Dial & Digital	Up to 4 in Up to 100 mm	$(1.4 + 4.5L) \mu\text{in} + 0.6R$ $(54 + 7.6L) \text{nm} + 0.6R$	Gage blocks
Gage Blocks	(0.01 to 4) in (0.5 to 100) mm  (>4 to 8) in	$(1.6 + 3.7L) \mu\text{in}$ $(89 + 3.4L) \text{nm}$  $(16 + 2L) \mu\text{in}$	Twin head comparison  ULM
Linear Displacement	Up to 60 in  Up to 254 M	$(930 + 21L) \mu\text{in}$  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	$(75 + 1.5L) \mu\text{in}$  $(16 + 1.9L) \mu\text{in}$	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	$(16 + 3.9L) \mu\text{in}$	ULM
Ring Gages	Up to 8 in	$(16 + 1.9L) \mu\text{in}$	ULM, master rings and gage blocks
Foils & Thickness Gages	Up to 8 in	$(16 + 1.9L) \mu\text{in}$	ULM
Linear Scales/Reticles	Up to 12 in	0.00051 in	Optical comparator

Parameter/Equipment	Range	CMC <sup>2,6</sup> (±)	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 + 0.6R	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 <sup>2, 11</sup> (±)	Comments
AC Current <sup>3</sup> – 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 <sup>2, 4, 11</sup> (±)	Comments
AC Current <sup>3</sup> – Generate (cont)			
(> 20.5 to 40) A	(45 to 440) Hz	0.46 % + 0.008 A	Fluke 552XA w/ EA002 2/10/50 Coil
(> 40 to 200) A	(45 to 440) Hz	0.53 % + 0.01 A	
(> 200 to 1025) A	(45 to 440) Hz	0.35 % + 0.04 A	
AC Current <sup>3</sup> – 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 %	

Parameter/Range	Frequency	CMC <sup>2, 4, 11</sup> ( $\pm$ )	Comments
AC Voltage <sup>3</sup> – 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 $\mu$ V 0.16 % + 4.0 $\mu$ V 0.17 % + 4.0 $\mu$ V 0.17 % + 4.0 $\mu$ V 0.19 % + 5 $\mu$ V 0.23 % + 10 $\mu$ V 0.29 % + 20 $\mu$ V 0.65 % + 20 $\mu$ V	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 $\mu$ V 0.028 % + 4 $\mu$ V 0.024 % + 4 $\mu$ V 0.054 % + 4 $\mu$ V 0.13 % + 5 $\mu$ V 0.27 % + 10 $\mu$ V 0.36 % + 20 $\mu$ V 0.70 % + 20 $\mu$ V	
(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 $\mu$ V 0.024 % + 7 $\mu$ V 0.015 % + 7 $\mu$ V 0.031 % + 7 $\mu$ V 0.079 % + 17 $\mu$ V 0.17 % + 20 $\mu$ V 0.36 % + 25 $\mu$ V 0.69 % + 45 $\mu$ V	
(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 $\mu$ V 0.011 % + 15 $\mu$ V 0.0053 % + 8 $\mu$ V 0.0084 % + 10 $\mu$ V 0.011 % + 30 $\mu$ V 0.042 % + 80 $\mu$ V 0.12 % + 200 $\mu$ V 0.21 % + 300 $\mu$ V	
(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 $\mu$ V 0.020 % + 150 $\mu$ V 0.0076 % + 50 $\mu$ V 0.015 % + 100 $\mu$ V 0.021 % + 200 $\mu$ V 0.066 % + 0.6 mV 0.18 % + 2 mV 0.30 % + 3.2 mV	

Parameter/Range	Frequency	CMC <sup>2, 4, 11</sup> ( $\pm$ )	Comments
AC Voltage <sup>3</sup> – Generate (cont)			
(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	Fluke 57X0A  *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 <sup>3</sup> – 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 $\mu$ V 0.035 % + 1.1 $\mu$ V 0.12 % + 1.1 $\mu$ V 0.58 % + 1.1 $\mu$ V 4.6 % + 2 $\mu$ V	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 $\mu$ V 0.017 % + 2 $\mu$ V 0.035 % + 2 $\mu$ V 0.093 % + 2 $\mu$ V 0.35 % + 10 $\mu$ V 1.2 % + 10 $\mu$ V 1.7 % + 10 $\mu$ V	
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 $\mu$ V 0.016 % + 20 $\mu$ V 0.035 % + 20 $\mu$ V 0.092 % + 20 $\mu$ V 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 <sup>2, 4, 11</sup> (±)	Comments
AC Voltage <sup>3</sup> – 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
(10 to 30) kV	(30 to 200) Hz	0.22 % IV	Vitrek 4700 high voltage meter with HVP-35 probe
Capacitance <sup>3</sup> – Generate			
(0.19 to 0.4) nF	10 Hz to 10 kHz	0.58 % + 0.01 nF	Fluke 552XA
(0.4 to 1.1) nF	10 Hz to 10 kHz	0.52 % + 0.01 nF	
(1.1 to 3.3) nF	10 Hz to 3 kHz	0.52 % + 0.01 nF	
(3.3 to 11) nF	10 Hz to 1 kHz	0.28 % + 0.01 nF	
(11 to 33) nF	10 Hz to 1 kHz	0.26 % + 0.1 nF	
(33 to 110) nF	10 Hz to 1 kHz	0.26 % + 0.1 nF	
(110 to 330) nF	10 Hz to 1 kHz	0.26 % + 0.3 nF	
(0.33 to 1.1) μF	(10 to 600) Hz	0.26 % + 1 nF	
(1.1 to 3.3) μF	(10 to 300) Hz	0.26 % + 3 nF	
(3.3 to 11) μF	(10 to 150) Hz	0.26 % + 10 nF	
(11 to 33) μF	(10 to 120) Hz	0.41 % + 30 nF	
(33 to 110) μF	(10 to 80) Hz	0.46 % + 0.1 μF	
(110 to 330) μF	(10 to 50) Hz	0.47 % + 0.3 μF	
(0.33 to 1.1) mF	(0 to 20) Hz	0.46 % + 1 μF	
(1.1 to 3.3) mF	(0 to 6) Hz	0.47 % + 3 μF	
(3.3 to 11) mF	(0 to 2) Hz	0.47 % + 10 μF	
(11 to 33) mF	(0 to 0.6) Hz	0.76 % + 30 μF	
(33 to 110) mF	(0 to 0.2) Hz	1.1 % + 0.10 mF	
Oscilloscopes <sup>3</sup> –			
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 <sub>p-p</sub> 10 Hz to 10 kHz	0.29 % IV + 40 μV	
1 MΩ Load	±1 mV to ±130 V <sub>p-p</sub> 10 Hz to 1 kHz	0.12 % IV + 40 μV	

Parameter/Range	Frequency	CMC <sup>2, 4, 11</sup> ( $\pm$ )	Comments
Oscilloscopes <sup>3</sup> – (cont)			
Time Marker into 50 $\Omega$ Load-Source	5 s to 50 ms	29 parts in 10 <sup>6</sup> + 1000 parts in 10 <sup>6</sup> /s	Fluke 552XA/SC1100
	20 ms to 2 ns	2.9 parts in 10 <sup>6</sup>	
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 $\mu$ V 2.5 % + 100 $\mu$ V 4.7 % + 100 $\mu$ V 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 <sup>2, 4, 11</sup> ( $\pm$ )	Comments
Capacitance – Fixed Points	100 pF 1 nF to 1 $\mu$ F	0.059 % 0.016 %	Standard capacitors
Capacitance – Measure	10 pF to 1.1 $\mu$ F	0.018 %	Gen Rad 1615A capacitance bridge
DC Current <sup>3</sup> – Generate	0.1 nA to 220 $\mu$ A (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A  (2.2 to 10) A  (1.1 to 3) A (3 to 11) A (11 to 20) A  (20 to 40) A (40 to 200) A (200 to 1025) A	95 $\mu$ A/A + 6 nA 82 $\mu$ A/A + 7 nA 83 $\mu$ A/A + 40 nA 110 $\mu$ A/A + 0.7 $\mu$ A 99 $\mu$ A/A + 12 $\mu$ A  420 $\mu$ A/A + 480 $\mu$ A  0.039 % + 40 $\mu$ A 0.052 % + 0.33 mA 0.1 % + 0.75 mA  0.45 % + 0.008 A 0.51 % + 0.01 A 0.31 % + 0.04 A	Fluke 5730A      Fluke 5730A/5725A  Fluke 552XA  Fluke 552XA with EA002 2/10/50 Coil

Parameter/Equipment	Range	CMC <sup>2, 4, 11</sup> ( $\pm$ )	Comments
DC Current <sup>3</sup> – Measure	(10 to 100) $\mu$ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	22 $\mu$ A/A + 0.8 nA 21 $\mu$ A/A + 5 nA 21 $\mu$ A/A + 50 nA 35 $\mu$ A/A + 0.5 $\mu$ A 0.011 % + 10 $\mu$ A	HP 3458A, option II
	(1 to 10) A (10 to 20) A	0.032 % + 0.6 mA 0.027 % + 3.3 mA	HP 3458A w/ Fluke Y5020 shunt
DC Voltage <sup>3</sup> – Measure	(0 to 100) mV (0.1 to 1) V (1.0 to 10) V (10 to 100) V (100 to 1000) V	5.2 $\mu$ V/V + 0.3 $\mu$ V 4.1 $\mu$ V/V + 0.3 $\mu$ V 4.0 $\mu$ V/V + 0.5 $\mu$ V 6.2 $\mu$ V/V + 30 $\mu$ V 63 $\mu$ V/V + 0.1 mV*	HP 3458A, option II  *Add 12 mV/V · (V <sub>in</sub> /1000) <sup>2</sup> for input >100 V
	(1 to 10) kV	0.036 % IV + 0.03 V	Vitretek 4700 high voltage meter
	(10 to 30) kV	0.13 % IV	Vitretek 4700 high voltage meter with HVP-35 probe
DC Voltage <sup>3</sup> – 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 $\mu$ V/V + 0.4 $\mu$ V 5.9 $\mu$ V/V + 0.7 $\mu$ V 4.1 $\mu$ V/V + 2.5 $\mu$ V 4.5 $\mu$ V/V + 4 $\mu$ V 5.8 $\mu$ V/V + 40 $\mu$ V 7.8 $\mu$ V/V + 400 $\mu$ V	Fluke 5730A
Inductance – Measure  @ 100 Hz Fixed Values	100 $\mu$ H to 5 H	0.3 %	Standard inductor set w/ GenRad 1632A bridge as transfer standard
Inductance – Generate	100 $\mu$ H to 5.0 H	0.071 %	Gen Rad 1482 standard inductors



Parameter/Equipment	Range	CMC <sup>2, 11</sup> (±)	Comments
Electrical Simulation – Thermocouple Indication and Measure devices <sup>3</sup>			
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	
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	
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	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Electrical Simulation – Thermocouple Indication & Measure Devices <sup>3</sup> (cont)			
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 <sup>3</sup> –			
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	
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	

Parameter/Equipment	Range	CMC <sup>2</sup> (±)	Comments
Electrical Simulation – RTD Indicating Devices <sup>3</sup> – (cont)			
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	Fluke 552XA
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	
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 <sup>2, 4, 11</sup> (±)	Comments
RF Absolute Power <sup>3, 5</sup> – 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 <sup>3, 5</sup> – 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	
(-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	



Parameter/Range	Frequency	CMC <sup>2,4,11</sup> ( $\pm$ )	Comments
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:  (11 to 13.5) MHz Depth: (0 to 99) %	Rate Frequency:  50 Hz to 50 kHz 20 Hz to 100 kHz	0.16 % 0.32 %	HP 11715A AM/FM test source
Amplitude Modulation – Measure  Carrier Frequency:  (0.15 to 10) MHz Depth: (5 to 99) % (0 to 99) %  (10 to 1300) MHz Depth: (5 to 99) %	Rate Frequency:  50 Hz to 10 kHz 20 Hz to 10 kHz  50 Hz to 50 kHz	3.5 % + 1 digit 4.1 % + 1 digit  1.6 % + 1 digit	HP 8902A w/ HP 11722A
Frequency Modulation – Measure  Carrier Frequency:  (0.25 to 10) MHz $\leq$ 40 kHz Peak Deviation  (10 to 1300) MHz $\leq$ 400 kHz Peak Deviation	Rate Frequency:  20 Hz to 10 kHz  50 Hz to 100 kHz 20 Hz to 400 kHz	2.3 % + 1 digit  3.0 % + 1 digit 6.7 % + 1 digit	HP 8902A w/ HP 11722A

Parameter/Range	Frequency	CMC <sup>2, 4, 11</sup> (±)	Comments
Frequency Modulation – Generate  FM Flatness Carrier Frequency:  (11 to 13.5) MHz  (88 to 108) MHz  (352 to 432) MHz	Rate Frequency:  DC to 100 kHz (100 to 200) kHz  DC to 100 kHz (100 to 200) kHz  DC to 100 kHz (100 to 200) kHz	0.33 % 0.43 %  0.34 % 0.43 %  0.34 % 0.43 %	HP 11715A AM/FM test source
Phase Modulation – Measure  Carrier Frequency:  (0.15 to 10) MHz  (10 to 1300) MHz	Rate Frequency:  200 Hz to 10 kHz  200 Hz to 20 kHz	4.8 % + 1 digit  4.6 % + 1 digit	HP 8902A w/ HP 11722A sensor
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
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 <sup>2, 4, 10</sup> (±)	Comments
Torque Wrench	(4.0 to 40) ozf·in *	1.3 % of IV from (10 to 100) % FS	JETCO TED-40
	(2.5 to 25) lbf·in *	0.32 % of IV from (10 to 100) % FS	Larson STWCS
	(10 to 3120) lbf·in *	0.24 % of IV from (10 to 100) % FS	
	(0 to 1000) ozf·in *	0.49 % of IV (10 to 100) % of range	Futek torque system
	(0 to 600) lbf·ft	1.8 lbf·ft (10 to 100) % of range	Note: Ranges indicated by * are related to footnote 3
Acceleration/Vibration – Measuring Equipment			
Voltage Sensitivity, Frequency Response (0.02 to 5000) mV/g	(5 to 99) Hz	2.1 % IV	Modal shop 9155
	100 Hz	1.4 % IV	
	(101 to 920) Hz	1.2 % IV	
	(921 to 5000) Hz	1.8 % IV	
	(5 to 10) kHz	3.0 % IV	
Charge Sensitivity, Frequency Response (0.04 to 100) pC/g	(5 to 99) Hz	2.1 % IV	Modal shop 9155
	100 Hz	1.4 % IV	
	(101 to 920) Hz	1.2 % IV	
	(921 to 5000) Hz	1.8 % IV	
	(5 to 10) kHz	3.0 % IV	
Piezoresistive Sensitivity, Frequency Response (0.000 08 to 100) mV/V/g	(5 to 99) Hz	2.1 % IV	Modal shop 9155
	100 Hz	1.4 % IV	
	(101 to 920) Hz	1.2 % IV	
	(921 to 5000) Hz	1.8 % IV	
	(5 to 10) kHz	3.0 % IV	
Digital Sensitivity, Frequency Response (1 to 500 000) Counts/g	(5 to 99) Hz	2.1 % IV	Modal shop 9155
	100 Hz	1.4 % IV	
	(101 to 920) Hz	1.2 % IV	
	(921 to 5000) Hz	1.8 % IV	
	(5 to 10) kHz	3.0 % IV	

Parameter/Equipment	Range	CMC <sup>2, 4, 10</sup> ( $\pm$ )	Comments
Torque <sup>3</sup> – 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 <sup>3</sup> – Measuring Equipment  Pneumatic    Hydraulic	(-5 to 5) psig  (-14.5 to 50) psig  (-14.5 to 300) psig  (-14.5 to 1000) psig  (10 to 50) psig (51 to 10 000) psig  (0 to 10) inH <sub>2</sub> O	0.0065 % IV + 0.0005 psig  0.0055 % IV + 0.0033 psig  0.0085 % IV + 0.015 psig  0.011 % IV + 0.051 psig  0.0088 psig 0.019 %  0.006 inH <sub>2</sub> O	Pace 6000      Deadweight tester Meriam manometer
Absolute Pressure <sup>3</sup> – 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 + 0.017 psia 0.0064 % IV + 0.052 psia	Pace 6000
Scales and Balances <sup>3</sup> –  Analytical Balances <sup>3</sup>	(0.5 to 629) lb  (1 to 500) mg (0.5 to 10) g (10 to 100) g (100 to 1000) g (1 to 10) kg	0.01 % + 0.6R  0.012 mg + 0.000088 mg/g 0.0094 mg + 0.0051 mg/g 0.034 mg + 0.0027 mg/g 0.02 mg + 0.0029 mg/g 0.014 mg + 0.0029 mg/g	ASTM class 6 weights  ASTM class 1 weights

Parameter/Equipment	Range	CMC <sup>2, 4, 6, 10</sup> (±)	Comments
Mass Measure—	(1 to 5) g	0.09 mg	XE-50
	(5 to 10) g	0.10 mg	XE-50
Fixed Points	(10 to 20) g	0.13 mg	XE-50
	(20 to 50) g	0.16 mg	XE-50
	(50 to 200) g	6.9 mg	PE 1600
	(200 to 500) g	7 mg	PE 1600
	(500 to 1000) g	7.4 mg	PE 1600
	(1 to 2) kg	0.02 g	TCL-6002
	(2 to 5) kg	0.03 g	TCL-6002
	(5 to 10) kg	0.16 g	Setra12000L
	(10 to 20) kg	0.16 g	GP-30K
	1 g	0.09 mg	Mass Comparator, Class 1 weight, Substitution method
	2 g	0.09 mg	
	5 g	0.09 mg	
	10 g	0.10 mg	
	20 g	0.13 mg	
	50 g	0.16 mg	
	100 g	6.9 mg	
200 g	6.9 mg		
500 g	7 mg		
1 kg	7.4 mg		
2 kg	0.02 g		
5 kg	0.03 g		
10 kg	0.16 g		
20 kg	0.16 g		
50 lb	0.00037 lb (170 mg)		
Force <sup>3, 7</sup> – Measuring Equipment	(0.5 to 500) lbf	0.01 % IV + 0.6R	
	(100 to 1000) lbf	0.061 % FS	Load cells
	(200 to 2000) lbf	0.050 % FS	
	(500 to 5000) lbf	0.049 % FS	
	(1000 to 10 000) lbf	0.049 % FS	
	(2500 to 25 000) lbf	0.056 % FS	
	(5000 to 50 000) lbf	0.049 % FS	
	(10 000 to 100 000) lbf	0.064 % FS	
	(50 000 to 500 000) lbf	0.05 % FS	Compression only

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

VIII. Thermodynamics

Parameter/Equipment	Range	CMC <sup>2,10</sup> (±)	Comments
Temperature <sup>3</sup> – Measuring Equipment	(-95 to 150) °C	0.014 °C + 42 µC/°C	Fluke 1502 w/ 5628 PRT in bath
Infrared Temperature <sup>3</sup> – Measure	(25 to 400) °C	0.45 °C + 0.017 °C/°C	Black body
Temperature <sup>3</sup> – Measure	(-95 to 660) °C	0.031 °C + 72 µC/°C	Fluke 1502 w/ 5628 PRT
	(200 to 1200) °C	0.4 °C + 5.2 m°C/°C	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
Relative Humidity – Measuring Equipment	(10 to 95) % RH	0.7 % RH	Thunder Scientific 2500
	11.3 % RH	1.6 % RH	Vaisala HMK15
	33 % RH	1.6 % RH	
	75.5 % RH	2.0 % RH	
	97.7 % RH	2.6 % RH	
Relative Humidity <sup>3</sup> – 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 <sup>2,10</sup> (±)	Comments
Frequency – Measuring Equipment	10 MHz	5.7 x 10 <sup>-12</sup> Hz/Hz	NOVAS WR 2410 GPS receiver

Parameter/Equipment	Range	CMC <sup>2, 10</sup> ( $\pm$ )	Comments
Frequency – Measure	0.01 Hz to 18 GHz	$1.6 \times 10^{-9}$ Hz/Hz	NOVAS WR 2410 GPS receiver w/ Frequency Counter
Period – Measure	1 $\mu$ s to 1000 s	$1.2 \times 10^{-9}$ 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	33 ms	NIST RP 960-12
	(0 to 19.99) s/day	0.039 s/day	Timometer

<sup>1</sup> This laboratory offers commercial calibration service and field calibration service.

<sup>2</sup> 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.

<sup>3</sup> 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.

<sup>4</sup> 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*.

<sup>5</sup> The CMCs do not include mismatches.

<sup>6</sup> 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.

<sup>7</sup> Greater than 100 klb, field service available only.

<sup>8</sup> Repeatability of the Unit Under Test has not been utilized in the calculation of the CMC value for this measurement parameter.



<sup>9</sup> This scope meets A2LA's *P112 Flexible Scope Policy*.

<sup>10</sup> 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.

<sup>11</sup> 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

## **NOVASTAR SOLUTIONS.COM LLC dba NOVASTAR METROLOGY**

*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 1<sup>st</sup> day of May 2023.

A blue ink signature of Trace McInturff, written in a cursive style.

Mr. Trace McInturff, Vice President, Accreditation Services  
For the Accreditation Council  
Certificate Number 1277.01  
Valid to April 30, 2025  
Revised March 28, 2025

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