SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017
ANSI/NCSL Z540-1-1994 & ANSI/NCSL Z540.3-2006

CONSTELLATION POWERLABS
301 Hurricane Creek Road
Piedmont, SC 29673
David Nowakowski Phone: 610 506-0426

CALIBRATION

Valid To: August 30, 2027 Certificate Number: 2044.05

In recognition of the successful completion of the A2LA evaluation process (including an assessment of the organization's compliance with R205 – A2LA's Calibration Program Requirements), accreditation is granted to this laboratory to perform the following calibrations[1, 7]:

I. Dimensional

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Calipers	Up to 36 in (36 to 48) in (48 to 80) in	$(4 + 8L + 0.6R)$ µin $(780 + 1.5L)$ µin $(780 + 8.9L)$ µin	Comparison to gage blocks
Feeler Gages/Thickness Shims[3]	Up to 0.026 in Up to 0.2 in	40 µin $(25 + 9L)$ µin	ULM
Gage Blocks	Up to 1 in (1 to 4) in	3.4 µin $(1.7 + 1.5L)$ µin	Master gage blocks, comparator
Indicators[3] Dial/Digital Test Incremental Probes /LVDT's	 Up to 1 in Up to 1 in	 60 µin $(69 + 1.6L)$ µin	 Gage blocks
Length Standards[3]	Up to 18 in Up to 40 in	$(96 + 4.6L)$ µin $(120 + 6.2L)$ µin	ULM Electronic height gage
Micrometers[3] Outside Inside 3-Point Tubular Inside	 Up to 36 in Up to 10 in Up to 18 in Up to 48 in	 $(4 + 8L + 0.6R)$ µin $(93 + 12L)$ µin $(31 + 2.8L)$ µin $(360 + 3.5L)$ µin	 Gage blocks Ring gages ULM, height gage

5202 Presidents Court, Suite 220 | Frederick, MD 21703-8515 | Phone: 301 644 3248 | Fax: 240 454 9449 | www.A2LA.org

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Linear Measurement Devices[3]	Up to 48 in	(530 + 12*L*) µin	Gage blocks
Height Gages[3]	Up to 48 in	(55 + 3.8*L*) µin	Gage blocks
Inclinometers/ Levels	Up to 45 °	(1.1 + 0.06*L*) "/°	Gage blocks, sine plate
CMM Spheres & Gage Balls (Diameter)	(0.1 to 1) in	21 µin	ULM
Radius Gages	Up to 3 in	(120 + 30*L*) µin	Vision system
Adjustable Thread Rings[9]	Up to 6.5 in	XX (Set Plug Tolerance)	Set using master plug gages. ASME/ANSI B1.2-1983 & ASME/ANSI B1.3- 2007
Thread Pitch Gages – Leaf Style	Up to 0.25 in	(130 + 2400*L*) µin	Vision system
Thread & Gear Wires	Up to 0.15 in	(15 + 15*L*) µin	ULM
Ring Gages			
X Class	(0.18 to 4) in (> 4 to 8) in	(19 + 6.7*L*) µin (28 + 6.5*L*) µin	ULM
XX Class	(0.38 to 8) in	(15 + 5*L*) µin	
Class Z & ZZ Pin Gages			
Class Z Class ZZ	Up to 1 in Up to 1 in	(38 + 6*L*) µin (19 + 8.5*L*) µin	Laser micrometer ULM

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Cylindrical Plugs/Pin Gages			
Class Z, ZZ, Y	Up to 8 in	(32 + 3.5*L*) µin	ULM
Class X, XX	Up to 8 in	(14 + 6.2*L*) µin	
Go/No-Go Gages	Up to 1 in	22 µin	ULM
Thread Plug Gages			
Pitch Diameter	Up to 6 in	180 µin	ULM, gage blocks, thread wires
Major Diameter	Up to 6 in	40 µin	
Tape Measures/Steel Rules	Up to 120 in	(2200 + 12*L*) µin	ULM
Optical Comparators[3]			
X Axis	Up to 12 in	(57 + 10*L*) µin	Glass scales, magnification scales
Y Axis		(61 + 3.3*L*) µin	
Magnification	Up to 100X	(57 + 10*L*) µin	
Measuring Microscopes[3]			
X Axis	Up to 12 in	(57 + 10*L*) µin	Glass scales
Y Axis		(61 + 3.3*L*) µin	
Surface Finish, Roughness Gages	Up to 300 µin	(3.5 + 0.03*L*) µin	Surface roughness standards
Surface Plate[3]			
Overall Flatness	(43 to 161) in diagonal	1.5 µin/in + 0.85 µin	Electronic level system
Local Area Flatness (Repeat Reading)	Up to 0.001 in	33 µin	Indicator/probe
Vision Systems[3]			
X Axis	12 x 12 in	(130 + 3.1*L*) µin	Glass scales
Y Axis		(130 + 1.1*L*) µin	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Torque Arms/Wheels	Up to 2.5 in Up to 5 in Up to 10 in Up to 20 in Up to 40 in	1100 µin 840 µin 9400 µin 1200 µin 1500 µin	CMM

III. Dimensional Testing/Calibration

Parameter/Equipment	Range	CMC[2] (±)	Comments
Length – 3D (Fixtures, Drawings) X Y Z	 Up to 36 in Up to 48 in Up to 32 in	 5.7 µin/in + 23 µin 7.3 µin/in + 21 µin 6.1 µin/in + 31 µin	 CMM

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
DC Voltage – Generate[3]	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	7.5 µV/V + 0.4 µV 5 µV/V + 0.7 µV 3.5 µV/V + 2.5 µV 3.5 µV/V + 4.4 µV 5 µV/V + 40 µV 6.5 µV/V + 400 µV	Precision multi-function calibrator
DC Voltage – Measure[3]	(0 to 200) mV 200 mV to 2 V (2 to 20) V (20 to 200) V (200 to 1000) V	4.5µV/V + 0.11 µV 3 µV/V + 0.41 µV 3 µV/V + 5 µV 4.5 µV/V + 41 µV 4.5 µV/V + 0.5 mV	Long scale multimeter
DC High Voltage Measure [3]	(1 to 100) kV	1 %	Kilovolt meter
DC Current – Generate[3]	(0 to 220) µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A (11 to 20.5) A	40 µA/A + 6 nA 35 µA/A + 7.2 nA 35 µA/A + 41 nA 45 µA/A + 0.7 µA 80 µA/A + 12 µA 360 µA/A + 480 µA 0.1 % + 750 µA	Precision multi-function calibrator
DC Current – Measure[3]	(0 to 200) µA 200 µA to 2 mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A (20 to 100) A	12 µA/A + 0.4 nA 12 µA/A + 4 nA 13 µA/A + 41 nA 36 µA/A + 0.8 µA 170 µA/A + 17 µA 380 µA/A + 500 µA 0.25 % + 350 µA	Long scale multimeter Current shunts w/ multimeter
DC Current – Generate Current Clamps Using Coil	(10 to 16.5) A (16.5 to 100) A (100 to 150) A (150 to 1025) A	0.77 % + 0.02 A 0.38 % + 0.14 A 0.39 % + 0.14 A 0.40 % + 0.5 A	Precision multi-function calibrator & 50-turn coil Note: current output range may be limited due to exceeding compliance voltage.

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Voltage[3] – Generate			
(0.22 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	0.025 % + 4 µV 91 µV/V + 4 µV 90 µV/V + 4 µV 0.02 % + 4 µV 0.053 % + 5 µV 0.11 % + 10 µV 0.14 % + 20 µV 0.27 % + 20 µV	Precision multi-function calibrator
(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	0.028 % + 4 µV 94 µV/V + 4 µV 84 µV/V + 4 µV 0.02 % + 4 µV 0.05 % + 5 µV 0.11 % + 10 µV 0.14 % + 20 µV 0.27 % + 20 µV	
(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	0.024 % + 12 µV 91 µV/V + 7 µV 81 µV/V + 7 µV 0.02 % + 8 µV 0.046 % + 17 µV 0.09 % + 20 µV 0.14 % + 25 µV 0.27 % + 45 µV	
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	0.024 % + 44 µV 90 µV/V + 18 µV 48 µV/V + 8 µV 80 µV/V + 12 µV 110 µV/V + 35 µV 0.042 % + 80 µV 0.1 % + 200 µV 0.17 % + 300 µV	
(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	0.024 % + 420 µV 90 µV/V + 150 µV 45 µV/V + 80 µV 75 µV/V + 140 µV 100 µV/V + 350 µV 0.028 % + 600 µV 0.1 % + 2 mV 0.15 % + 3.2 mV	

Parameter/Range	Frequency	CMC[2, 4, 5] (±)	Comments
AC Voltage[3] – Generate (cont)			
(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 (300 to 500) kHz 500 kHz to 1 MHz	0.024 % + 4.1 mV 91 µV/V + 1.5 mV 53 µV/V + 0.8 mV 82 µV/V + 1.5 mV 0.015 % + 3.4 mV 0.09 % + 16 mV 0.44 % + 40 mV 0.8 % + 80 mV	Voltage limited to 2.2×10^7 Volt-Hertz
(220 to 250) V	(15 to 50) Hz	0.03 % + 16 mV	
(220 to 1100) V	50 Hz to 1 kHz	71 µV/V + 3.7 mV	
(220 to 1100) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	90 µV/V + 4.5 mV 0.017 % + 6 mV 0.06 % + 11 mV	With precision amplifier
(220 to 750) V	(30 to 50) kHz (50 to 100) kHz	0.06 % + 11 mV 0.23 % + 45 mV	
AC Voltage – Measure[3]			
(1 to 12) mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.03 % + 3 µV 0.02 % + 1.1 µV 0.03 % + 1.1 µV 0.1 % + 1.1 µV 0.5 % + 1.1 µV 4 % + 2 µV	Long scale multimeter
(12 to 120) mV	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	72 µV/V + 4 µV 72 µV/V + 2 µV 0.014 % + 2 µV 0.033 % + 2.5 µV 0.08 % + 2 µV 0.3 % + 10 µV 1 % + 10 µV 1.5 % + 10 µV	

Parameter/Range	Frequency	CMC[2, 4, 5] (±)	Comments
AC Voltage – Measure (cont)[3]			
(0.12 to 1.2) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	72 µV/V + 40 µV 72 µV/V + 20 µV 0.014 % + 20 µV 0.03 % + 20 µV 0.08 % + 20 µV 0.3 % + 100 µV 1 % + 100 µV 1.5 % + 100 µV	Long scale multimeter
(1.2 to 12) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	72 µV/V + 0.4 mV 72 µV/V + 0.2 mV 0.014 % + 0.2 mV 0.03 % + 0.2 mV 0.08 % + 0.2 mV 0.3 % + 1 mV 1 % + 1 mV 1.5 % + 1 mV	
(12 to 120) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.02 % + 4 mV 0.02 % + 2 mV 0.02 % + 2 mV 0.04 % + 2 mV 0.12 % + 2 mV 0.4 % + 10 mV 1.5 % + 10 mV	
(120 to 700) V	(1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.04 % + 40 mV 0.04 % + 20 mV 0.06 % + 20 mV 0.12 % + 20 mV 0.3 % + 20 mV	
AC High Voltage – Measure[3]			
(1 to 50) kV RMS (1 to 50) kV pk/√2	50 & 60 Hz	1 % 1 %	Kilovolt meter

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Current[3] – Generate			
(10 to 220) µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.025 % + 16 nA 0.016 % + 10 nA 0.012 % + 8 nA 0.028 % + 12 nA 0.11 % + 65 nA	Precision multi-function calibrator
(0.22 to 2.2) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.025 % + 40 nA 0.016 % + 35 nA 0.012 % + 35 nA 0.02 % + 110 nA 0.11 % + 650 nA	
(2.2 to 22) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.025 % + 400 nA 0.016 % + 350 nA 0.012 % + 350 nA 0.02 % + 550 nA 0.11 % + 5 µA	
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.025 % + 4 µA 0.016 % + 3.5 µA 0.012 % + 2.5 µA 0.02 % + 3.5 µA 0.11 % + 10 µA	
(0.22 to 2.2) A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.026 % + 39 µA 0.045 % + 80 µA 0.7 % + 160 µA	
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.046 % + 170 µA 0.095 % + 380 µA 0.36 % + 750 µA	Precision multi-function calibrator with precision amplifier
(29 to 330) µA	(10 to 30) kHz	1.6 % + 0.4 µA	Precision multi-function calibrator
(0.33 to 3.3) mA	(10 to 30) kHz	1 % + 0.6 µA	
(3.3 to 33) mA	(10 to 30) kHz	0.4 % + 4 µA	
(33 to 330) mA	(10 to 30) kHz	0.4 % + 200 µA	
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.12 % + 5 mA 0.15 % + 5 mA 3 % + 5 mA	

Parameter/Range	Frequency	CMC[2, 5] (±)	Comments
AC Current[3]– Generate (cont)			
Current Clamps using Coil (Toroidal):			
(45 to 65) Hz	(10 to 16.5) A (16.5 to 100) A (100 to 150) A (150 to 1025) A	0.16 % + 0.040 A 0.25 % + 0.048 A 0.18 % + 0.30 A 0.26 % + 0.33 A	Multifunction calibrator with 50 turn coil & digital multimeter
(65 to 440) Hz	(10 to 16.5) A (16.5 to 100) A (100 to 150) A (150 to 1025) A	0.48 % + 0.040 A 0.72 % + 0.069 A 0.53 % + 0.31 A 0.98 % + 0.40 A	Note: current output range may be limited due to exceeding compliance voltage.
Current Clamps Using Coil (Non-Toroidal):			
(45 to 65) Hz	(10 to 16.5) A (16.5 to 100) A (100 to 150) A (150 to 1025) A	0.40 % + 0.05 A 0.40 % + 0.25 A 0.43 % + 0.25 A 0.44 % + 0.91 A	Precision multi-function calibrator & 50-turn coil
(65 to 440) Hz	(10 to 16.5) A (16.5 to 100) A (100 to 150) A (150 to 1025) A	0.70 % + 0.05 A 0.77 % + 0.25 A 0.79 % + 0.25 A 1.1 % + 0.93 A	Note: current output range may be limited due to exceeding compliance voltage.
AC Current – Measure[3]			
(2 to 200) µA	10 Hz to 10 kHz	0.048 % + 20 nA	Long scale multimeter
200 µA to 2 mA	10 Hz to 10 kHz	0.028 % + 220 nA	
(2 to 20) mA	10 Hz to 10 kHz	0.028 % + 2.2 µA	
(20 to 200) mA	10 Hz to 10 kHz	0.025 % + 21 µA	
200 mA to 2 A	10 Hz to 2 kHz (2 to 10) kHz	0.06 % + 200 µA 0.071 % + 210 µA	
(2 to 20) A	10 Hz to 2 kHz (1 to 10) kHz	0.08 % + 2 mA 0.25 % + 2 mA	

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
Resistance – Generate[3] Variable	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ (0.330 to 1.1) MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ (330 to 1100) MΩ	40 µΩ/Ω + 1 mΩ 30 µΩ/Ω + 1.5 mΩ 28 µΩ/Ω + 1.4 mΩ 28 µΩ/Ω + 2 mΩ 28 µΩ/Ω + 2 mΩ 28 µΩ/Ω + 20 mΩ 28 µΩ/Ω + 20 mΩ 28 µΩ/Ω + 200 mΩ 28 µΩ/Ω + 200 mΩ 32 µΩ/Ω + 2 Ω 32 µΩ/Ω + 2 Ω 60 µΩ/Ω + 30 Ω 0.013 % + 50 Ω 0.025 % + 2.5 kΩ 0.05 % + 3 kΩ 0.3 % + 100 kΩ 1.5 % + 500 kΩ	Precision multi-function calibrator
Resistance – Generate[3], Fixed	0.001 Ω 0.01 Ω 0.1 Ω (100 to 1000) kΩ (1 to 10) MΩ (10 to 100) MΩ (100 to 1000) MΩ (1 to 10) GΩ (10 to 100) GΩ (100 to 1000) GΩ 0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	1.1 µΩ 510 µΩ/Ω 310 µΩ/Ω 0.031 % 0.031 % 0.11 % 0.21 % 0.51 % 1.1 % 1.1 % 55 µΩ 110 µΩ/Ω 98 µΩ/Ω 23 µΩ/Ω 23 µΩ/Ω 10 µΩ/Ω 10 µΩ/Ω 8.5 µΩ/Ω 8.5 µΩ/Ω 8.5 µΩ/Ω 8.5 µΩ/Ω 11 µΩ/Ω 11 µΩ/Ω 20 µΩ/Ω 21 µΩ/Ω 40 µΩ/Ω 47 µΩ/Ω 100 µΩ/Ω	Standard resistors High resistance decade box

Parameter/Equipment	Range	CMC[2, 5] (±)	Comments
Resistance – Measure[3]	(0 to 2) Ω (2 to 20) Ω (20 to 200) Ω 200 Ω to 2 kΩ (2 to 20) kΩ (20 to 200) kΩ (200 kΩ to 2 MΩ 2 to 20 MΩ 20 to 200 MΩ 200 MΩ to 2 GΩ	15 μΩ/Ω + 4.1 μΩ 9 μΩ/Ω + 15 μΩ 7.5 μΩ/Ω + 50 μΩ 7.5 μΩ/Ω + 500 μΩ 7.5 μΩ/Ω + 5 mΩ 7.5 μΩ/Ω + 0.05 Ω 8.5 μΩ/Ω + 1 Ω 15 μΩ/Ω + 11 Ω 60 μΩ/Ω + 1 kΩ 150 μΩ/Ω + 100 kΩ	Long scale multimeter
Capacitance – Generate[3]	(0.19 to 0.3999) nF (0.4 to 1.0999) nF (1.1 to 3.2999) nF (3.3 to 10.9999) nF (11 to 32.9999) nF (33 to 109.999) nF (110 to 329.999) nF (0.33 to 1.099 99) μF (1.1 to 3.299 99) μF (3.3 to 10.9999) μF (11 to 32.9999) μF (33 to 109.9999) μF (110 to 329.9999) μF (0.33 to 1.099 99) mF (1.1 to 3.2999) mF (3.3 to 10.9999) mF (11 to 32.9999) mF (33 to 110) mF	0.5 % + 0.01 nF 0.5 % + 0.01 nF 0.5 % + 0.01 nF 0.25 % + 0.01 nF 0.25 % + 0.1 nF 0.25 % + 0.1 nF 0.25 % + 0.3 nF 0.25 % + 1 nF 0.25 % + 3 nF 0.25 % + 10 nF 0.4 % + 30 nF 0.45 % + 100 nF 0.45 % + 300 nF 0.45 % + 1 μF 0.45 % + 3 μF 0.45 % + 10 μF 0.75 % + 30 μF 1.1 % + 100 μF	Precision multi-function calibrator

Parameter/Range	Frequency	CMC[2, 4, 5] (±)	Comments
Capacitance – Measure			
(10 to 100) pF	1 kHz	0.42 %	Precision impedance meter
(100 to 1000) pF	1 kHz	0.051 %	
1 nF to 10 µF	1 kHz	0.021 %	
(10 to 100) µF	1 kHz	0.052 %	
100 µF to 1 mF	1 kHz	0.82 %	
(10 to 100) pF	750 Hz to 1 kHz	1.1 %	
	(1 to 5) kHz	0.58 %	
	(5 to 10) kHz	0.87 %	
100 pF to 1 nF	(250 to 500) Hz	0.34 %	
	500 Hz to 10 kHz	0.21 %	
(1 to 10) nF	(50 to 250) Hz	0.34 %	
	250 Hz to 2.5 kHz	0.043 %	
	(2.5 to 7.5) kHz	0.081 %	
	(7.5 to 10) kHz	0.051 %	
	(10 to 50) kHz	0.18 %	
	(50 to 100) kHz	0.33 %	
(10 to 100) nF	(12 to 50) Hz	0.28 %	
	(50 to 100) Hz	0.061 %	
	(100 to 250) Hz	0.046 %	
	250 Hz to 2.5 kHz	0.032 %	
	(2.5 to 5) kHz	0.041 %	
	(5 to 10) kHz	0.051 %	
	(10 to 50) kHz	0.18 %	
	(50 to 100) kHz	0.33 %	
100 nF to 1 µF	(12 to 50) Hz	0.091 %	
	(50 to 100) Hz	0.052 %	
	(100 to 250) Hz	0.041 %	
	250 Hz to 2.5 kHz	0.032 %	
	(2.5 to 5) kHz	0.041 %	
	(5 to 10) kHz	0.052 %	
	(10 to 25) kHz	0.18 %	
	(25 to 50) kHz	0.37 %	
(1 to 10) µF	(12 to 50) Hz	0.11 %	
	(50 to 100) Hz	0.052 %	
	(100 to 250) Hz	0.041 %	
	250 Hz to 2.5 kHz	0.034 %	
	(2.5 to 5) kHz	0.074 %	
	(5 to 7.5) kHz	0.14 %	
	(7.5 to 10) kHz	0.19 %	

Parameter/Range	Frequency	CMC[2, 4, 5] (±)	Comments
Capacitance – Measure (cont)			
(10 to 100) µF	(12 to 50) Hz (50 to 100) Hz (100 to 250) Hz 250 Hz to 1 kHz (1 to 2.5) kHz	0.12 % 0.059 % 0.048 % 0.071 % 0.22 %	Precision impedance meter
100 µF to 1 mF	(12 to 50) Hz (50 to 100) Hz (100 to 250) Hz (250 Hz to 500) Hz 500 Hz to 1 kHz	0.13 % 0.18 % 0.32 % 0.62 % 0.92 %	
(1 to 10) mF	(12 to 50) Hz	0.47 %	
AC Resistance – Measure			
(0.1 to 1) Ω (1 to 10) Ω 10 Ω to 100 kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ	1 kHz 1 kHz 1 kHz 1 kHz 1 kHz	0.64 % 0.074 % 0.022 % 0.036 % 0.29 %	Precision impedance meter
(0.1 to 1) Ω	250 Hz to 2.5 kHz	1.3 %	
(1 to 10) Ω	(12 to 50) Hz (50 to 250) Hz 250 Hz to 2.5 kHz (2.5 to 5) kHz (5 to 10) kHz (10 to 50) kHz	0.53 % 0.27 % 0.14 % 0.21 % 0.27 % 1.1 %	
10 Ω to 10 kΩ	(12 to 50) Hz (50 to 250) Hz 250 Hz to 2.5 kHz (2.5 to 10) kHz (10 to 50) kHz (50 to 100) kHz	0.091 % 0.052 % 0.032 % 0.052 % 0.18 % 0.33 %	
(10 to 100) kΩ	(12 to 50) Hz (50 to 250) Hz 250 Hz to 1 kHz (1 to 2.5) kHz (2.5 to 5) kHz (5 to 10) kHz	0.091 % 0.051 % 0.031 % 0.041 % 0.081 % 0.19 %	

Parameter/Range	Frequency	CMC[2, 4, 5] (±)	Comments
AC Resistance – Measure (cont)			
100 kΩ to 1 MΩ	(12 to 50) Hz (50 to 100) Hz (100 to 250) Hz 250 Hz to 1 kHz (1 to 2.5) kHz (2.5 to 5) kHz (5 to 10) kHz	0.21 % 0.11 % 0.084 % 0.06 % 0.089 % 0.21 % 0.48 %	Precision impedance meter
(1 to 10) MΩ	(50 to 100) Hz (100 to 250) Hz 250 Hz to 1 kHz (1 to 2.5) kHz	1 % 0.75 % 0.54 % 0.97 %	
Inductance – Measure			
200 µH to 1 mH 1 mH to 10 H	1 kHz 1 kHz	0.071 % 0.021 %	Precision impedance meter
200 µH to 1 mH	500 Hz to 1 kHz (1 to 10) kHz (10 to 50) kHz (50 to 100) kHz	0.29 % 0.071 % 0.18 % 0.33 %	
(1 to 10) mH	(50 to 100) Hz (100 to 250) Hz (250 to 500) Hz 500 Hz to 10 kHz (10 to 25) kHz	1.1 % 0.36 % 0.096 % 0.052 % 0.18 %	
(10 to 100) mH	(12 to 50) Hz (50 to 100) Hz (100 to 250) Hz 250 Hz to 2.5 kHz (2.5 to 10) kHz	1.1 % 0.11 % 0.044 % 0.031 % 0.051 %	
100 mH to 10 H	(12 to 50) Hz (50 to 100) Hz (100 to 250) Hz 250 Hz to 1 kHz	0.14 % 0.057 % 0.043 % 0.032 %	

Parameter/Equipment	Range	CMC[2] (±)	Comments
Electrical Calibration of Thermocouple Devices[3] –			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.44 °C 0.34 °C 0.3 °C 0.33 °C	Precision multi-function calibrator with temperature generation
Type C	(0 to 150) °C (150 to 650) °C (650 to 1000) °C (1000 to 1800) °C (1800 to 2316) °C	0.3 °C 0.26 °C 0.31 °C 0.5 °C 0.84 °C	
Type E	(-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1000) °C	0.5 °C 0.16 °C 0.14 °C 0.16 °C 0.21 °C	
Type J	(-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1200) °C	0.27 °C 0.16 °C 0.14 °C 0.17 °C 0.23 °C	
Type K	(-200 to -100) °C (-100 to -30) °C (-25 to 120) °C (120 to 1000) °C (1000 to 1372) °C	0.33 °C 0.18 °C 0.16 °C 0.26 °C 0.4 °C	
Type N	(-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1300) °C	0.4 °C 0.22 °C 0.19 °C 0.18 °C 0.27 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.57 °C 0.35 °C 0.33 °C 0.4 °C	
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.47 °C 0.36 °C 0.37 °C 0.46 °C	

Parameter/Equipment	Range	CMC[2, 4] (±)	Comments
Electrical Calibration of Thermocouple Devices[3] – (cont)			
Type T	(-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.63 °C 0.24 °C 0.16 °C 0.14 °C	Precision multi-function calibrator with temperature generation
Type U	(-200 to 0) °C (0 to 600) °C	0.56 °C 0.27 °C	
Oscilloscope[3] –			
50 Ω Load	(0 to 6.6) V	0.25 % + 40 µV	Precision multi-function calibrator with waveform generation
1 MΩ Load	(0 to 130) V	0.05 % + 40 µV	
Squarewave Signal:			
50 Ω @ 1 kHz	1.8 mV to 2.2 V_{pk-pk}	0.25 % + 40 µV	
1 MΩ @ 10 Hz to 1 kHz	1.8 mV to 105 V_{pk-pk}	0.1 % + 40 µV	
1 MΩ @ (1 to 10) kHz	1.8 mV to 105 V_{pk-pk}	0.25 % + 40 µV	
Level Sine Wave:			
Amplitude (50 kHz Reference)	50 kHz 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	2 % + 300 µV 3.5 % + 300 µV 4 % + 300 µV 6 % + 300 µV	
Flatness (50 kHz Reference)	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	1.5 % + 100 µV 2 % + 100 µV 4 % + 100 µV	
Time Markers – Generate & Period Into a 50 Ω Load	5 s to 50 ms 20 ms to 2 ns	(25 + 1000t) parts in 10^6 2.5 parts in 10^6	t is the time in seconds
Rise Time:			
≤ 2 MHz	(24 to 300) ps	+0 ps / -100 ps	
> 2 MHz	(24 to 350) ps	+0 ps / -100 ps	

Parameter/Equipment	Range	CMC[2, 4, 5] (±)	Comments
Oscilloscope[3] – (cont) Wave Generator Amplitude: 1 MΩ 50 Ω Frequency Time Interval – Measure	 1.8 mV to 55 Vpk – pk 1.8 mV to 2.5 Vpk – pk 10 Hz to 100 kHz 100 ps to 100 µs	 3 % + 100 µV 3 % + 100 µV 25 parts in 10^6 + 15 mHz 0.1 % Δt + 10 ps	 Precision multi-function calibrator with waveform generation Δt is the nominal time interval

V. Mechanical

Parameter/Equipment	Range	CMC[2, 4, 8] (±)	Comments
Low Pressure– Differential[3]	Up to 1 in H_2O (1 to 10) in H_2O (10 to 25) in H_2O	0.0008 in H_2O 0.008 in H_2O 0.016 in H_2O	Pressure modules
Pressure, Gauge – Measure & Measuring Equipment [3]	Down to -13 psig Up to 100 psig (100 to 300) psig (300 to 1000) psig (1000 to 10 000) psig (10 000 to 40 000) psig	0.050 % 0.015 % 0.017 % 0.012 % 0.025 % 40 psi	Pressure calibrator Dead weight tester Hydraulic pressure test gauge
Pressure, Absolute[3]– Measure & Measuring Equipment	Up to 100 psia (100 to 1000) psia	0.035 % 0.014 %	Pressure calibrator

Parameter/Equipment	Range	CMC[2] (±)	Comments
Rockwell & Superficial Hardness Testers[3]			
HRA	Low Middle High	0.32 HRA 0.21 HRA 0.22 HRA	Indirect verification per ASTM E18 & test blocks
HRBW	Low Middle High	0.42 HRBW 0.35 HRBW 0.44 HRBW	
HRC	Low Middle High	0.41 HRC 0.38 HRC 0.34 HRC	
HR15N	Low Middle High	0.41 HR15N 0.42 HR15N 0.53 HR15N	
HR30N	Low Middle High	0.32 HR30N 0.5 HR30N 0.55 HR30N	
HR45N	Low Middle High	0.6 HR45N 0.7 HR45N 0.2 HR45N	
HR15T	Low Middle High	0.46 HR15TW 0.41 HR15TW 0.33 HR15TW	
HR30T	Low Middle High	0.57 HR30TW 0.28 HR30TW 0.24 HR30TW	
HR45T	Low Middle High	0.71 HR45TW 0.5 HR45TW 0.39 HR45TW	
Vickers Hardness Testers[3]	$\leq$ 402 HV (403 to 694) HV $\geq$ 694 HV	12 HV 8.6 HV 14 HV	Indirect verification per ASTM E92 & test blocks

Parameter/Equipment	Range	CMC[2, 4, 8] (±)	Comments
Knoop Hardness Testers[3]	(100 to 900) HK	20 HK	Indirect verification per ASTM E92 & test blocks
Brinell Hardness Testers[3]	(200 to 399) HBW (400 to 600) HBW	1.6 HBW 8.0 HBW	Indirect verification per ASTM E10 & test blocks
Force – Testing Machines (Load Cells with Indicators), Dynamometers	(100 to 1000) lbf (1000 to 10 000) lbf (10 000 to 25 000) lbf	0.80 lbf 2.6 lbf 6.4 lbf	Comparison using precision load cells
Force by Mass	(1 to 500) lbf	0.073 %	Class F weights
Torque Tools[3]	(5 to 20) ozf·in (0.1 to 2000) lbf·ft	1.1 % 0.59 %	Torque calibrator, torque transducers,
Torque Transducers	(5 to 50) oz·in (15 to 200) oz·in (5 to 50) lbf·in (4 to 60) lbf·ft (61 to 500) lbf·ft (501 to 2000) lbf·ft	0.200 % 0.10 % 0.054 % 0.054 % 0.059 % 0.070 %	Standard weights, torque arms
Scales & Balances[3]	Up to 1 g (1 to 20) g (20 to 55) g (50 to 100) g (100 to 200) g (200 to 210) g (> 210 to 500) g (500 to 1000) g (1000 to 2000) g (2000 to 3000) g (3000 to 4110) g Up to 10 lbs (10 to 60) lbs (60 to 800) lbs (800 to 1000) lbs	0.000 034 g 0.000 10 g 0.000 20 g 0.000 40 g 0.000 79 g 0.0010 g 0.005 g 0.01 g 0.02 g 0.22 g 0.28 g 0.012 lbs 0.025 lbs 0.29 lbs 0.61 lbs	Reference weights

VI. Thermodynamics

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Temperature – Measuring Equipment	(-10 to 125) °C (125 to 250) °C (250 to 500) °C	0.057 °C 0.058 °C 0.14 °C	Precision thermometer with standard PRT & precision temperature source
Temperature – Measure[3]	(-39 to 420) °C (420 to 500) °C	0.051 °C 0.11 °C	Precision thermometer with PRT/indicator
Humidity – Measuring Equipment[3]	(10 to 95) % RH	0.90 % RH	Precision thermo-hygrometer
Infrared Temperature – Measuring Equipment	(-15 to 120) °C (120 to 200) °C (200 to 350) °C (350 to 500) °C	0.66 °C 0.97 °C 1.6 °C 2.1 °C	Primary infrared temperature blackbody sources Ɛ = 0.9 to 1.0 l = (8 to 14) µm

VII. Time & Frequency

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Frequency – Measuring Equipment	1 mHz to 100 MHz	± 190 nHz/Hz	Externally referenced signal generator
Frequency – Measure	(0.001 to 0.01) Hz (0.01 to 0.1) Hz (0.1 to 1) Hz (1 to 10) Hz (10 to 100) Hz 100 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz 100 kHz to 1 MHz (1 to 10) MHz (10 to 100) MHz	1.9 nHz 19 nHz 0.19 µHz 1.9 µHz 19 µHz 0.19 mHz 1.9 mHz 19 mHz 0.19 Hz 1.9 Hz 19 Hz	Precision frequency counter .

Parameter/Equipment	Range	CMC[2, 8] (±)	Comments
Rotational Speed[10] –			
Measuring Equipment	(1 to 10) rpm	± 330 µrpm/rpm	Externally referenced signal generator, LED
Non-Contact / Optical Tachometer	(10 to 250 000 rpm)	± 1 µrpm/rpm	
Tachometers – Contact[3]	(250 to 5000) rpm	0.000 15 rpm/rpm + 2.8 rpm	Ideal tachometer tester .
Time Interval – Timers & Stop Watches[3]	1 s to 24 hrs	0.047 s	Universal frequency counter with a signal generator

[1] This laboratory offers commercial 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 CMC found on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the actual uncertainty introduced by the item being calibrated, (e.g., resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC

[4] In the statement of CMC, L is the numerical value of the nominal length of the device measured in inches, R is the resolution of the device under test, and % is the percentage of the reading.

[5] 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.

[6] The CMC associated with Temperature – Measuring Equipment, Thermocouples does not include inhomogeneity of the test thermocouple.

[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] Adjustable thread rings are set to applicable specifications using calibrated master set plug gages.

[10] The CMC does not include the resolution of the device under test.

Accredited Laboratory

A2LA has accredited

CONSTELLATION POWERLABS LLC

Piedmont, SC

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, the requirements of ANSI/NCSL Z540.3-2006, 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 29th day of August 2024.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2044.05
Valid to August 30, 2027

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