



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Constellation PowerLabs LLC
301 Hurricane Creek Road
Piedmont, SC 29673

Fulfills the requirements of

ISO/IEC 17025:2017

and national standard

ANSI/NCSL Z540-1-1994 (R2002)

In the fields of

CALIBRATION and DIMENSIONAL MEASUREMENT

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

Jason Stine, Vice President

Expiry Date: 18 September 2024
Certificate Number: ACT-1235



This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017.
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).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

AND

ANSI/NCSL Z540-1-1994 (R2002)

Constellation PowerLabs LLC

301 Hurricane Creek Road
 Piedmont, SC 29673
 David Nowakowski 610-380-2651

CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: **September 18, 2024**

Certificate Number: **ACT-1235**

CALIBRATION

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meters 2 x 10 ⁻⁵ Pa @1kHz	94 dB 114 dB	0.68 dB 0.72 dB	Dwyer SMC-1 Sound Calibrator

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH meters	4 pH 7 pH 10 pH	0.04 pH 0.06 pH 0.06 pH	pH solutions
Conductivity meters	10 µS/cm 100 µS/cm 1000 µS/cm	0.2 µS/cm 0.9 µS/cm 3.8 µS/cm	Conductivity solutions



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹	(0 to 330) mV 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V (330 to 1 000) V	20 μ V/V + 1 μ V 16 μ V/V + 2 μ V 14 μ V + 20 μ V 21 μ V/V + 150 μ V 21 μ V + 1.5 mV	Fluke 5522A Multiproduct Calibrator
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1 000) V	9 μ V/mV + 0.3 μ V 7 μ V/V + 0.3 μ V 10 μ V/V + 0.5 μ V 10 μ V/V + 30 μ V 16 μ V/V + 0.1 mV	Keysight 3458A Multimeter
DC High Voltage Measure ¹	(1 to 35) kV (20 to 100) kV	3.8 V + 2.3 % of reading 6.4 V + 0.12 % of reading	Multimeter and High Voltage Probe
	(2.1 to 24) kV	7.4 V + 2 % of reading	Sensitive Research ESH-29 Electrostatic Voltmeter
DC Current – Source ¹ Range Locked	(0 to 330) μ A (0 to 3.3) mA (0 to 33) mA (0 to 3) A (0 to 11A) (0 to 20) A	0.015 % of reading + 0.2 nA 0.01 % of reading + 50 nA 0.01 % of reading + 250 nA 0.01 % of reading + 2.6 μ A 0.038 % of reading + 41 μ A 0.065 % of reading + 500 μ A .1 % of reading + 750 μ A	Fluke 5522A Multiproduct Calibrator
DC Current – Measure ¹	(0 to 100) μ A 100 μ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	26 μ A/A + .8 nA 32 μ A/A +5 nA 26 μ A/A + 50 nA 38 μ A/A + 500 nA 0.012 % of reading + 10 μ A	Keysight 3458A Multimeter
	(1 to 2) A (2 to 10) A	0.001 2 % of reading + 0.45 mA 0.007 2 % of reading + 0.1 A	Rigol DM3068 Multimeter
	(3 to 30) A (30 to 150) A	0.2 mA/A + 5.1 mA 0.1 mA/A + 18 mA	Current Shunts w/ Agilent 34401A Multimeter



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(3.3 to 33) mV		Fluke 5522A Multiproduct Calibrator
	(10 to 45) Hz	0.069 % of reading + 6 μV	
	45 Hz to 10 kHz	0.01 % of reading + 8 μV	
	(10 to 20) kHz	0.02 % of reading + 6 μV	
	(20 to 50) kHz	0.12 % of reading + 6 μV	
	(50 to 100) kHz	0.4 % of reading + 12 μV	
	(100 to 450) kHz	0.92 % of reading + 12 μV	
	(33 to 330) mV		
	(10 to 45) Hz	0.03 % of reading + 11 μV	
	45 Hz to 10 kHz	0.15 % of reading + 8 μV	
	(10 to 20) kHz	0.036 % of reading + 8 μV	
	(20 to 50) kHz	0.02 % of reading + 8 μV	
(50 to 100) kHz	0.083 % of reading + 32 μV		
(100 to 500) kHz	0.21 % of reading + 70 μV		
AC Voltage – Source ¹	330 mV to 3.3 V		Fluke 5522A Multiproduct Calibrator
	(10 to 45) Hz	0.041 % of reading + 50 μV	
	45 Hz to 10 kHz	0.021 % of reading + 60 μV	
	(10 to 20) kHz	0.02 % of reading + 60 μV	
	(20 to 50) kHz	0.04 % of reading + 50 μV	
	(50 to 100) kHz	0.082 % of reading + 125 μV	
	(100 to 500) kHz	0.24 % of reading + 600 μV	
	(3.3 to 33) V		
	(10 to 45) Hz	0.033 % of reading + 650 μV	
	45 Hz to 10 kHz	0.017 % of reading + 600 μV	
	(10 to 20) kHz	0.027 % of reading + 600 μV	
	(20 to 50) kHz	0.04 % of reading + 600 μV	
	(50 to 90) kHz	0.1 % of reading + 1.6 mV	
	(33 to 330) V		
	45 Hz to 1 kHz	0.021 % of reading + 2 mV	
	(1 to 10) kHz	0.021 % of reading + 6 0mV	
	(10 to 20) kHz	0.028 % of reading + 6 0mV	
	(20 to 50) kHz	0.033 % of reading + 6 0mV	
	(50 to 100) kHz	0.22 % of reading + 50 mV	
	(330 to 1 000) V		
	45 Hz to 1 kHz	0.031 % of reading + 10 mV	
(1 to 5) kHz	0.026 % of reading + 10 mV		
(5 to 10) kHz	0.031 % of reading + 10 mV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	Up to 10 mV		Keysight 3458A Multimeter
	(1 to 40) Hz	0.03 % of reading + 5 μV	
	40 Hz to 1 kHz	0.024 % of reading + 11 μV	
	(1 to 20) kHz	0.025 % of reading + 11 μV	
	(20 to 50) kHz	0.09 % of reading + 11 μV	
	(50 to 100) kHz	0.47 % of reading + 11 μV	
	(100 to 300) kHz	3.7 % of reading + 2 mV	
	(10 to 100) mV		
	(1 to 40) Hz	0.012 % of reading + 4 μV	
	40 Hz to 1 kHz	0.009% of reading + 8 μV	
	(1 to 20) kHz	0.013 % of reading + 19 μV	
	(20 to 50) kHz	0.022 % of reading + 3 μV	
	(50 to 100) kHz	0.031 % of reading + 3 μV	
	(100 to 300) kHz	0.1 % of reading + 2 μV	
	300kHz to 1 MHz	1.2 % of reading + 10 μV	
	(1 to 2) MHz	1.7 % of reading + 10 μV	
	100 mV to 1V		
	(1 to 40) Hz	0.009 % of reading + 40 μV	
	40 Hz to 1 kHz	0.011 % of reading + 40 μV	
	(1 to 20) kHz	0.048 % of reading + 20 μV	
	(20 to 50) kHz	0.04 % of reading + 20 μV	
	(50 to 100) kHz	0.093 % of reading + 20 μV	
	(100 to 300) kHz	0.35 % of reading + 100 μV	
	300 kHz to 1MHz	1.2 % of reading + 100 μV	
	(1 to 2) MHz	1.7 % of reading + 100 μV	
	(1 to 10) V		
	(1 to 40) Hz	0.008 4 % of reading + 400 μV	
	40 Hz to 1 kHz	0.008 2 % of reading + 200 μV	
	(1 to 20) kHz	0.016 % of reading + 200 μV	
	(20 to 50) kHz	0.035 % of reading + 200 μV	
(50 to 100) kHz	0.092 % of reading + 200 μV		
(100 to 300) kHz	0.35 % of reading + 1 mV		
300 kHz to 2 MHz	1.2 % of reading + 1 mV		
(10 to 100) V			
(1 to 40) Hz	0.013 % of reading + 4 mV		
40 Hz to 1 kHz	0.025 % of reading + 4 mV		
(1 to 20) kHz	0.024 % of reading + 2 mV		
(20 to 50) kHz	0.066 % of reading + 2 mV		
(50 to 100) kHz	0.15 % of reading + 2 mV		
(100 to 300) kHz	0.48 % of reading + 10 mV		
300kHz to 1MHz	1.8 % of reading + 10 mV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	100 V to 1 kV (1 to 40) Hz 40 Hz to 1 kHz 1 kHz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.05 % of reading + 30 mV 0.049 % of reading + 15 mV 0.076 % of reading + 15 mV 0.16 % of reading + 15 mV 0.37 % of reading + 15 mV	Keysight 3458A Multimeter
AC High Voltage Measure ¹	60 Hz (1 to 35) kV (20 to 90) kV	3.3 V + 5.8% of reading 56 V + 1.1 % of reading	Multimeter and High Voltage Probe
	60 Hz (2.1 to 24) kV	7 V + 2.1% of reading	Sensitive Research ESH-29 Electrostatic Voltmeter
AC Current – Source ¹	(33 to 330) μ A (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz 330 μ A to 3.3 mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (3.3 to 33) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (33 to 330) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.29 % of reading + 0.1 μ A 0.21 % of reading + 0.1 μ A 0.16 % of reading + 0.1 μ A 0.38 % of reading + 0.15 μ A 1.1 % of reading + 0.2 μ A 2 % of reading + 0.4 μ A 0.25 % of reading + 0.2 μ A 0.2 % of reading + 0.18 μ A 0.22 % of reading + 0.15 μ A 0.28 % of reading + 0.2 μ A 0.58 % of reading + 0.3 μ A 1 % of reading + 0.6 μ A 0.23 % of reading + 2 μ A 0.11 % of reading + 2 μ A 0.093 % of reading + 2 μ A 0.1 % of reading + 2 μ A 0.22 % of reading + 3 μ A 0.54 % of reading + 4 μ A 0.25 % of reading + 20 μ A 0.11 % of reading + 20 μ A 0.041 % of reading + 20 μ A 0.1 % of reading + 50 μ A 0.26 % of reading + 100 μ A 0.53 % of reading + 200 μ A	Fluke 5522A Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	330 mA to 1.1 A	0.29 % of reading + 100 μ A	Fluke 5522A Multiproduct Calibrator
	(10 to 45) Hz	0.2 % of reading + 100 μ A	
	45 Hz to 1 kHz	0.7 % of reading + 1 mA	
	(1 to 5) kHz	3 % of reading + 5 mA	
	(5 to 10) kHz		
	(1.1 to 3) A	0.3 % of reading + 100 μ A	
	(10 to 45) Hz	0.1 % of reading + 100 μ A	
	45 Hz to 1 kHz	0.7 % of reading + 1 mA	
	(1 to 5) kHz	2.8 % of reading + 5 mA	
	(5 to 10) kHz		
	(3 to 10) A	0.11 % of reading + 2 mA	
	(45 to 100) Hz	0.19 % of reading + 2 mA	
100 Hz to 1 kHz	3.1 % of reading + 2 mA		
(1 to 5) kHz			
(10 to 20) A	0.2 % of reading + 5 mA	Keysight 3458A Multimeter	
(45 to 100) Hz	0.2 % of reading + 5 mA		
100 Hz to 1 kHz	3.4 % of reading + 5 mA		
(1 to 5) kHz			
5 to 100 μ A	0.46 % of reading + .03 μ A		
(10 to 20) Hz	0.17 % of reading + .03 μ A		
(20 to 45) Hz	0.07 % of reading + .03 μ A		
(45 to 100) Hz	0.07 % of reading + .03 μ A		
100 Hz to 5 kHz			
100 μ A to 1 mA	0.52 % of reading + 0.3 μ A		
(10 to 20) Hz	0.2 % of reading + 0.3 μ A		
(20 to 45) Hz	0.1 % of reading + 0.3 μ A		
(45 to 100) Hz	0.091 % of reading + 0.3 μ A		
100 Hz to 5 kHz			
(1 to 10) mA	0.46 % of reading + 2 μ A		
(10 to 20) Hz	0.15 % of reading + 2 μ A		
(20 to 45) Hz	0.07 % of reading + 2 μ A		
(45 to 100) Hz	0.034 % of reading + 2 μ A		
100 Hz to 5 kHz	0.07 % of reading + 2 μ A		
(5 to 20) kHz	0.44 % of reading + 4 μ A		
(20 to 50) kHz	0.63 % of reading + 15 μ A		
(50 to 100) kHz			



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(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 (20 to 50) kHz (50 to 100) kHz 100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (1 to 20) kHz (20 to 50) kHz	0.39 % of reading + 20 μ A 0.2 % of reading + 20 μ A 0.12 % of reading + 20 μ A 0.1 % of reading + 20 μ A 0.12 % of reading + 20 μ A 0.45 % of reading + 40 μ A 0.65 % of reading + 150 μ A 0.46 % of reading + 200 μ A 0.26 % of reading + 200 μ A 0.11 % of reading + 200 μ A 0.13 % of reading + 200 μ A 0.35 % of reading + 200 μ A 1.2 % of reading + 400 μ A	Keysight 3458A Multimeter
AC Current – Measure ¹	(1 to 3) A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.41 % of reading + 1.8 mA 0.17 % of reading + 1.8 mA 0.17 % of reading + 1.8 mA 0.23 % of reading + 1.8 mA	Agilent 34401A Multimeter
AC Current – Measure ¹	(3 to 10) A (5 to 10) Hz 10 Hz to 5 kHz	0.44 % of reading + 10 mA 0.25 % of reading + 6 mA	Fluke 45 Multimeter
Resistance – Source ¹ Simulation	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 k Ω (1.1 to 3.3) k Ω (3.3 to 11) k Ω (11 to 33) k Ω (33 to 110) k Ω (110 to 330) k Ω (.330 to 1.1) M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω	40 $\mu\Omega/\Omega$ + 1 m Ω 34 $\mu\Omega/\Omega$ + 1.5 m Ω 28 $\mu\Omega$ + 1.4 m Ω 29 $\mu\Omega/\Omega$ + 2 m Ω 27 $\mu\Omega/\Omega$ + 1.9 m Ω 29 $\mu\Omega$ + 20 m Ω 26 $\mu\Omega/\Omega$ + 20 m Ω 28 m Ω/Ω + 0.2 Ω 29 m Ω/Ω + 0.2 Ω 32 m Ω/Ω + 2 Ω 29 $\mu\Omega/\Omega$ + 2 Ω 60 $\mu\Omega/\Omega$ + 30 Ω 0.014 % of reading + 50 Ω 0.028 % of reading + 2.5 k Ω 0.05 % of reading + 3 k Ω	Fluke 5522A Multiproduct Calibrator
Resistance – Source ¹ Simulation	(110 to 330) M Ω (330 to 1 100) M Ω	0.32 % of reading + 100 k Ω 1.6 % of reading + 500 k Ω	Fluke 5522A Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ Fixed	0.001 Ω 0.01 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ 1 GΩ 10 GΩ 100 GΩ 1 TΩ	0.000 074 Ω 0.000 6 Ω 0.000 6 Ω 0.001 7 mΩ 0.017 Ω 0.035 Ω 0.012 kΩ 0.12 kΩ 0.13 kΩ 0.027 MΩ 0.03 MΩ 0.24 MΩ 0.01 GΩ 0.12 GΩ 1.2 GΩ 0.2 TΩ	Standard Resistors
Resistance – Measure ¹	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1GΩ	14 μΩ/Ω + 0.1 mΩ 17 μΩ/Ω + 0.6 mΩ 78 μΩ/Ω + 0.4 mΩ 15 mΩ/Ω + 5 mΩ 15 mΩ/Ω + 48 mΩ 19 mΩ/Ω + 2.5 Ω 78 Ω/Ω + 98 Ω 660 Ω/Ω + 1.1 kΩ 7.5 kΩ/MΩ + 0.3 MΩ	Keysight 3458A Multimeter (NPLC 100)
Capacitance – Source ¹ Simulation	(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	5.3 pF/nF + 13 pF 5.4 pF/nF + 13 pF 6.1 pF/nF + 14 pF 3 pF/nF + 15 pF 2.9 pF/nF + 0.1 nF 3 pF/nF + 0.1 nF 3.9 pF/nF + 0.2 nF 2.7 nF/μF + 1.4 nF 3 nF/μF + 3.4 nF 2.7 nF/μF + 1.4 nF 4.5 nF/μF + 38 nF 5.1 nF/μF + 0.1 μF	Fluke 5522A Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ Simulation	(110 to 330) μ F (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	5.1 nF/ μ F + 0.4 μ F 86 nF/ μ F + 0.6 mF 4.8 μ F/mF + 5.7 μ F 4 μ F/mF + 25 μ F 8.4 μ F/mF + 49 μ F 14 μ F/mF + 75 μ F	Fluke 5522A Multiproduct Calibrator
Capacitance – Source ¹ Fixed, 1 kHz	0.001 μ F (0.01 to 1) μ F	0.000 02 μ F 23 nF/ μ F + 0.2 nF	Standard Capacitor Decade Capacitor
Inductance – Source ¹ Variable, 1 kHz	(1 to 1 000) mH (1 to 10) H	0.01 mH/mH + 0.015 mH 9 mH/H + 7 mH	Decade Inductor
Electrical Simulation of RTD Indicating Devices ¹	Pt 385, 100 Ω (-200 to -80) $^{\circ}$ C (-80 to 0) $^{\circ}$ C (0 to 100) $^{\circ}$ C (100 to 300) $^{\circ}$ C (300 to 400) $^{\circ}$ C (400 to 630) $^{\circ}$ C (630 to 800) $^{\circ}$ C Pt 385, 1 000 Ω (-200 to 0) $^{\circ}$ C (0 to 100) $^{\circ}$ C (100 to 260) $^{\circ}$ C (260 to 300) $^{\circ}$ C (300 to 600) $^{\circ}$ C (600 to 630) $^{\circ}$ C Pt 3916, 100 Ω (-200 to -190) $^{\circ}$ C (-190 to -80) $^{\circ}$ C (-80 to 0) $^{\circ}$ C (0 to 100) $^{\circ}$ C (100 to 260) $^{\circ}$ C (260 to 300) $^{\circ}$ C (300 to 400) $^{\circ}$ C (400 to 600) $^{\circ}$ C (600 to 630) $^{\circ}$ C	0.07 $^{\circ}$ C 0.07 $^{\circ}$ C 0.08 $^{\circ}$ C 0.09 $^{\circ}$ C 0.1 $^{\circ}$ C 0.13 $^{\circ}$ C 0.23 $^{\circ}$ C 0.03 $^{\circ}$ C 0.05 $^{\circ}$ C 0.05 $^{\circ}$ C 0.09 $^{\circ}$ C 0.08 $^{\circ}$ C 0.26 $^{\circ}$ C 0.28 $^{\circ}$ C 0.07 $^{\circ}$ C 0.08 $^{\circ}$ C 0.09 $^{\circ}$ C 0.07 $^{\circ}$ C 0.09 $^{\circ}$ C 0.09 $^{\circ}$ C 0.11 $^{\circ}$ C 0.11 $^{\circ}$ C 0.24 $^{\circ}$ C	Fluke 5522A Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicating Devices ¹	Pt 3926, 100 Ω		Fluke 5522A Multiproduct Calibrator
	(-200 to 0) °C	0.06 °C	
	(0 to 100) °C	0.08 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.13 °C	
Electrical Simulation of Thermocouples Indicating Devices - Measure/Source ¹	Cu 427, 10 Ω		Fluke 5522A Multiproduct Calibrator
	(-100 to 260) °C	0.45 °C	
	Type B		
	(600 to 800) °C	0.46 °C	
	(800 to 1 000) °C	0.43 °C	
	(1 000 to 1 550) °C	0.34 °C	
	(1 550 to 1 820) °C	0.35 °C	
	Type C		
	(0 to 150) °C	0.33 °C	
	(150 to 650) °C	0.29 °C	
	(650 to 1 000) °C	0.35 °C	
	(1 000 to 1 800) °C	0.52 °C	
	(1 800 to 2 316) °C	0.86 °C	
	Type E		
	(-250 to -100) °C	0.51 °C	
	(-100 to -25) °C	0.25 °C	
	(-25 to 350) °C	0.21 °C	
	(350 to 650) °C	0.21 °C	
	(650 to 1 000) °C	0.31 °C	
	Type J		
	(-210 to -100) °C	0.28 °C	
	(-100 to -30) °C	0.18 °C	
	(-30 to 150) °C	0.19 °C	
	(150 to 760) °C	0.2 °C	
(760 to 1 200) °C	0.28 °C		
Type K			
(-200 to -100) °C	0.34 °C		
(-100 to -25) °C	0.18 °C		
(-25 to 120) °C	0.2 °C		
(120 to 1 000) °C	0.29 °C		
(1 000 to 1 372) °C	0.47 °C		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouples Indicating Devices - Measure/Source ¹	Type L		Fluke 5522A Multiproduct Calibrator
	(-200 to -100) °C	0.39 °C	
	(-100 to 800) °C	0.3 °C	
	(800 to 900) °C	0.21 °C	
	Type N		
	(-200 to -100) °C	0.42 °C	
	(-100 to -25) °C	0.24 °C	
	(-25 to 120) °C	0.22 °C	
	(120 to 410) °C	0.21 °C	
	(410 to 1 300) °C	0.29 °C	
	Type R		
	(0 to 250) °C	0.8 °C	
	(250 to 400) °C	0.7 °C	
	(400 to 1 000) °C	0.7 °C	
	(1 000 to 1 767) °C	0.7 °C	
	Type S		
(0 to 250) °C	0.7 °C		
(250 to 1 000) °C	0.7 °C		
(1 000 to 1 400) °C	0.7 °C		
(1 400 to 1767) °C	0.7 °C		
Type T			
(-250 to -150) °C	0.62 °C		
(-150 to 0) °C	0.25 °C		
(0 to 120) °C	0.19 °C		
(120 to 400) °C	0.18 °C		
Type U			
(-200 to 0) °C	0.58 °C		
(0 to 600) °C	0.32 °C		

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks	Up to 1 in (1 to 4) in	3.4 μin (1.7 + 1.5L) μin	Mahr 130B-24 Gage Block Comparator, Grade 00 Gage Blocks
Calipers ^{1,2}	(0 to 24) in (24 to 48) in (48 to 80) in	(590 + 7.6L) μin (780 + 1.4L) μin (780 + 8.9L) μin	Gage Blocks
Outside Micrometer ^{1,2}	Up to 36 in	(55 + 27L) μin	

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inside Micrometer 3-point ^{1,2}	Up to 10 in	$(93 + 12L) \mu\text{in}$	Ring Gages
Tubular Inside Micrometer ^{1,2}	Up to 18 in Up to 48 in	$(120 + 4.1L) \mu\text{in}$ $(360 + 3.5L) \mu\text{in}$	Trimos Horizon ULM Trimos V4 Electronic Height Gage
Length Standards ^{1,2}	(0 to 8) in (0 to 40) in (0 to 240) in	$(96 + 4.6L) \mu\text{in}$ $(120 + 6.2L) \mu\text{in}$ $(59 + 22L) \mu\text{in}$	Trimos Horizon ULM Trimos V4 Elect Height Gage B & S Validator CMM
Feeler Gages/Thickness Shims ^{1,2}	Up to 0.2 in	$(25 + 9L) \mu\text{in}$	Trimos THV
Indicators ^{1,2} Dial/Digital/Test Incremental Probes/LVDT's	Up to 4 in Up to 1 in	$(93 + 4L) \mu\text{in}$ $(69 + 2L) \mu\text{in}$	Gage Blocks
Linear Measurement Devices ^{1,2}	Up to 48 in	$(530 + 12L) \mu\text{in}$	
Height Gages ^{1,2}	Up to 48 in	$(55 + 4L) \mu\text{in}$	
Inclinometers/ Levels ²	Up to 45 °	$(1.1 + 0.06L) \text{ } ^{\circ}$	Gage Blocks, Sine Plate
CMM Spheres & Gage ² Balls (Diameter)	(0.1 to 1) in	21 μin	Trimos LabConcept Premium ULM
Roundness ² (Geometric Form)	Up to 10 in	3.3 μin	Federal 6100 Form Scan
Radius Gages ²	Up to 3 in	$(120 + 30L) \mu\text{in}$	OGP SmartScope Vision System
Thread Rings – Adjustable ² Minor Diameter Pitch	Up to 6.5 in Up to 6.5 in	$(50 + 15L) \mu\text{in}$ $(240 + 79L) \mu\text{in}$	Thread Set Plug or Trimos V4 Thread Set Plug
Thread Pitch Gages – Leaf Style ²	Up to 0.25 in	$(140 + 2\ 800L) \mu\text{in}$	OGP SmartScope Vision System
Thread and Gear Wires ²	Up to 0.15 in	$(15 + 15L) \mu\text{in}$	Trimos LabConcept
Ring Gages ² X Class XX Class	(0.38 to 8) in (0.38 to 8) in	$(28 + 6.4L) \mu\text{in}$ $(14 + 7.6L) \mu\text{in}$	Trimos Horizon Trimos LabConcept
Class X Ring Gages ^{1,2}	(0.18 to 4) in	$(19 + 5.6L) \mu\text{in}$	Trimos THV
Class Z & ZZ Pin Gages ²	Up to 1 in	$(38 + 5.9L) \mu\text{in}$	Lasermike

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Class ZZ Pin Gages ^{1,2}	Up to 1 in	$(19 + 8.5L) \mu\text{in}$	Trimos THV
Cylindrical Plugs and Pin Gages ² (Z, ZZ, X, Y class)	Up to 8 in	$(27 + 5.3L) \mu\text{in}$	Trimos Horizon
Class X, XX Cylindrical Plugs and Pin Gages ²	Up to 8 in	$(14 + 6L) \mu\text{in}$	Trimos LabConcept
Thread Plug Gages ^{1,2} Pitch Diameter Major Diameter	Up to 6 in	$(54 + 17L) \mu\text{in}$ $(50 + 16L) \mu\text{in}$	Trimos Horizon ULM Trimos Horizon ULM
Steel Rules ^{1,2}	Up to 72 in	$(5\ 100 + 15L) \mu\text{in}$	Gage Blocks
Tape Measures/Steel Rules ²	Up to 120 in	$(4\ 800 + 4L) \mu\text{in}$	Renishaw LM15 Linear Measuring Device
Optical Comparators ^{1,2}	Up to 12 in X Axis Y Axis	$(80 + 23L) \mu\text{in}$ $(73 + 23L) \mu\text{in}$	Glass Scales Magnification Scales
Measuring Microscopes ^{1,2}	Up to 2 in X Axis Y Axis	$(57 + 10L) \mu\text{in}$ $(61 + 3.3L) \mu\text{in}$	Glass Scales
Surface Finish ² (Roughness Gages)	Up to 300 μin	$(3.5 + 0.03L) \mu\text{in}$	Mahr Contour/Surface Analyzer
Surface Plate ¹ Overall Flatness	(43 to 161) in diagonal	$1.5 \mu\text{in/in} + 0.85 \mu\text{in}$	Wyler Level System
Local Area Flatness (Repeat Reading)	Up to 0.001 in	33 μin	Indicator/Probe
Surface Texture	(0 to 32) μin (cutoff: 0.03 in)	4.5 μin	Mahr Pocket Surf using ASME B89.3.7-2013
Vision Systems ^{1,2}	12 x 12 in X Axis Y Axis	$(65 + 1.4L) \mu\text{in}$ $(69 + 3.3L) \mu\text{in}$	Glass Scales
Torque Arms/Wheels	Up to 2.5 in Up to 5 in Up to 20 in Up to 40 in	1 100 μin 720 μin 1 200 μin 1 600 μin	B & S CMM

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Vacuum ¹	(-30 to 0) inHg	0.009 inHg	Additel 681 Pressure Gage
Pressure – Pneumatic ¹	(0 to 200) psig	0.009 psi	Pneumatic Deadweight Tester (Nitrogen)
Pressure – Pneumatic ¹	(0 to 300) psig	0.07 psi	Druck DPI 611 Calibrator
Low Pressure – Pneumatic ¹	(0 to 1) inH ₂ O	0.001 inH ₂ O	Heise AM2-1 Pressure Module
Low Pressure – Pneumatic ¹	(0 to 10) inH ₂ O	0.001 7 inH ₂ O / inH ₂ O + 0.011 inH ₂ O	Heise HM2-1 Pressure Module
Low Pressure – Pneumatic ¹	(0 to 25) inH ₂ O	0.013 inH ₂ O	Heise HM2-2 Pressure Module
Pressure, Absolute/ Barometric – Pneumatic ¹	(0 to 100) psia	0.042 psi	Heise HM2-2 Pressure Module
Pressure – Hydraulic ¹	(0 to 5 000) psig	0.000 16 psi/psi + 2.8 psi	Druck iDOS UPM Pressure Module
	(0 to 10 000) psig	0.000 3 psi/psi + 0.05 psi	Deadweight Tester
	(0 to 40 000) psig	0.000 65 psi/psi + 24 psi	Additel ADT681 Hydraulic Pressure Test Gauge
Rockwell and Superficial Hardness Testers ¹	HRA Low Middle High HRBW Low Middle High HRC Low Middle High HR15N Low Middle High	1.1 HRA 1.1 HRA 0.64 HRA 0.99 HRBW 1.1 HRBW 1.3 HRBW 0.8 HRC 0.82 HRC 0.95 HRC 0.6 HR15N 0.3 HR15N 0.7 HR15N	Indirect Verification per ASTM E18 using Test Blocks

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment		
Rockwell and Superficial Hardness Testers ¹	HR30N Low Middle High	0.6 HR30N 0.6 HR30N 0.3 HR30N	Indirect Verification per ASTM E18 using Test Blocks		
	HR45N Low Middle High	0.5 HR45N 0.5 HR45N 0.4 HR45N			
	HR15T Low Middle High	1.6 HR15T 1.2 HR15T 1.1 HR15T			
	HR30T Low Middle High	1.7 HR30T 1.2 HR30T 1 HR30T			
	HR45T Low Middle High	1.7 HR45T 1.2 HR45T 1.2 HR45T			
	HR15YW Low Mid High	0.4 HR15YW 0.4 HR15YW 0.5 HR15YW			
	Vickers Hardness Testers ¹	402 HV		24 HV	Indirect Verification per ASTM E92 using Test Blocks
		434 HV		17 HV	
		503 HV		22 HV	
		695 HV		26 HV	
		716 HV		28 HV	
	Knoop Hardness Testers ¹	537 HK		40 HK	
Brinell Hardness Testers ¹	252 HBW	4.6 HBW	Indirect Verification per ASTM E10 using Test Blocks		
	502 HBW	16 HBW			
Force Gages ¹	(1 to 500) lbf	0.27 lbf	Comparison using NIST Class F Weights		
Force – Testing Machines (Load Cells with Indicators), Dynamometers ¹	(100 to 1 000) lbf (1000 to 10 000) lbf (10 000 to 25 000) lbf	0.22 lbf 1.8 lbf 3.7 lbf	Comparison using Master Load Cells		



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Tools ¹	(5 to 50) ozf·in (15 to 200) ozf·in (4 to 50) lbf·in (30 to 400) lbf·in (80 to 1 000) lbf·in (20 to 250) lbf·ft (60 to 600) lbf·ft (100 to 1 000) lbf·ft (200 to 2 000) lbf·ft	0.12 % of reading 0.4 % of reading + 0.17 ozf·in 0.48 % of reading + 0.045 lbf·in 0.1 % of reading + 0.41 lbf·in 0.1 % of reading + 0.5 lbf·in 0.1 % of reading + 0.17 lbf·ft 0.15 % of reading + 0.51 lbf·ft 0.1 % of reading + 0.65 lbf·ft 0.1 % of reading + 1.6 lbf·ft	Reference Transducers, Digital Torque Tester
Torque Transducers and Testers ¹	(5 to 50) ozf·in (15 to 200) ozf·in (4 to 50) lbf·in (30 to 400) lbf·in (80 to 1 000) lbf·in (20 to 250) lbf·ft (60 to 600) lbf·ft (100 to 1 000) lbf·ft (200 to 2 000) lbf·ft	0.12 % of reading 0.1 % of reading + 0.0032 ozf·in 0.12 % of reading 0.02% of reading + 0.013 lbf·in 0.018 % of reading 0.025 % of reading + 0.0085 lbf·ft 0.005 % of reading + 0.02 lbf·ft 0.006 % of reading + 0.29 lbf·ft 0.011 % of reading + 0.55 lbf·ft	Lever Arms & Wheels, Dead Weights
Scales and Balances ^{1,3}	(1 to 210) g	0.005 4 mg/g + 0.078 mg	Class 1 Weight Set NIST HB 44
Scales and Balances ^{1,3}	Up to 4 110 g	0.088 mg/g + 13 mg	Class 6 Weight Set NIST HB 44
Scales and Balances ^{1,3}	(0.500 to 30.000) lb	0.001 1 lb/lb + 0.021 lb	Class 6 & Class F Weights NIST HB 44
Scales and Balances ^{1,3}	(0.5 to 250.0) lb (250 to 1 000) lb	0.000 12 lb/lb + 0.022 lb 0.000 11 lb/lb + 0.22 lb	Class F Weights NIST HB 44

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature/Humidity - Measure	(10 to 95) %RH (5 to 45) °C	0.86 %RH 0.000 76 °C/°C + 0.16 °C	Rotronic HP32 Temperature/Humidity Meter
Temperature – Measure ¹	(-90 to 420) °C	0.000 085 1 °C/°C + 0.089 °C	Pt100-385 4-wire RTD w/ Process Calibrator

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure ¹	(400-500) °C	0.004 3 °C/°C + 0.24 °C	Pt100-385 3-wire RTD w/ Process Calibrator
Temperature – Source/Measure ¹	(-10 to 350) °C	0.001 2 °C/°C + 0.22 °C	Fluke 5522A Multiproduct Calibrator w/ Pt100-385 4-wire RTD Ice Point/Dry Block Calibrator
Infrared Thermometers ^{1,4}	20 °C 100 °C 200 °C 300 °C 400 °C 500 °C	2.1 °C 1.9 °C 4.2 °C 3.9 °C 7.5 °C 9.7 °C	Isotech Dry Block calibrator w/Blackbody Target (Cavity) $\epsilon = 0.95, \lambda = (8 \text{ to } 14) \mu\text{m}$

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tachometers – Non Contact (Photo) ¹	(60 to 96 000) rpm	0.000 03 rpm/rpm + 0.2 rpm	Fluke 5522A Multiproduct Calibrator
Tachometers – Contact ¹	(250 to 5 000) rpm	0.000 15 rpm/rpm + 2.8 rpm	Ideal Tachometer Tester
Stopwatches and Timers ¹	Up to 1 200 s	480 ms	NIST Time Signal
Frequency – Source ¹	(0.01 to 119.99) Hz (120 to 1 199.9) Hz (1.2 to 11.999) kHz (12 to 119.99) kHz (120 to 1199.9) kHz (1.2 to 2) MHz (2 to 100) MHz	0.8 $\mu\text{Hz}/\text{Hz}$ + 0.3 mHz 3.1 $\mu\text{Hz}/\text{Hz}$ + 51 μHz 2.9 Hz/kHz + 5.8 mHz 2.9 Hz/kHz + 6 mHz 2.9 Hz/kHz + 6 mHz 0.2 Hz/MHz + 58 Hz 3.2 Hz/MHz	Fluke 5522A Multiproduct Calibrator
Frequency – Measure	1 Hz to 10 MHz	0.6 mHz/Hz + 5.4 mHz	Keysight 3458A Multimeter

DIMENSIONAL MEASUREMENT

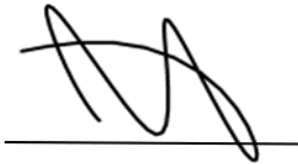
2 Dimensional

Specific Tests and / or Properties Measured	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Inspection/Dimensional Measurement by CMM	X Axis (0 to 36) in Y Axis (0 to 48) in Z Axis (0 to 32) in	5.7 $\mu\text{in/in}$ + 23 μin 7.3 $\mu\text{in/in}$ + 21 μin 6.1 $\mu\text{in/in}$ + 31 μin	B & S Global CMM PC-DMIS CAD ++ Customer Drawing or CAD Model CMM Application Software

Calibration and Measurement Capability (CMC) is expressed in terms of the measurement parameter, measurement range, expanded uncertainty of measurement and reference standard, method, and/or equipment. The expanded uncertainty of measurement is expressed as the standard uncertainty of the measurement multiplied by a coverage factor of 2 ($k=2$), corresponding to a confidence level of approximately 95%.

Notes:

1. On-site calibration service is available for this parameter, since on-site conditions are typically more variable than those in the laboratory, larger measurement uncertainties are expected on-site than what is reported on the accredited scope.
2. L = length in inches.
3. The CMC for scales and balances are highly dependent upon the resolution of the unit under test. The uncertainty presented here does not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
4. The nominal values listed are approximate.
5. This scope is formatted as part of a single document including Certificate of Accreditation No. ACT-1235.



Jason Stine, Vice President

