



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

American Calibration Inc.

**4410 Route 176, Suite 11
Crystal Lake, IL 60014**

Fulfills the requirements of

ISO/IEC 17025:2017

and national standard

ANSI/NCSL Z540-1-1994 (R2002)

In the fields of

**CALIBRATION, DIMENSIONAL MEASUREMENT and
TESTING**

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.

A handwritten signature in black ink, appearing to be 'J. Stine', is positioned above a horizontal line.

Jason Stine, Vice President
Expiry Date: 06 August 2026
Certificate Number: ACT-1886



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)

American Calibration Inc.

4410 Route 176, Suite 11
Crystal Lake, IL 60014
Jimmy McGue 815-356-5839

CALIBRATION, DIMENSIONAL MEASUREMENT AND TESTING

Valid to: **August 6, 2026**

Certificate Number: **ACT-1886**

CALIBRATION

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Accelerometer ¹ Voltage Sensitivity – Frequency Response (100 mV/g) (Up to 800 g payload)	7 Hz to 10 Hz 7 Hz to 30 Hz (30 to 2000) Hz (2 to 10) kHz	7.44 % of reading 5 % of reading 6.09 % of reading 7.21 % of reading	Accelerometer Calibrator, Reference Accelerometer Utilizing Back-to-Back Method
Sound Level Meters ¹	1 kHz 94 dB 114 dB	0.76 dB 0.76 dB	Acoustic Calibrator

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters ^{1,7}	4 pH 7 pH 10 pH 12 pH	0.017 pH 0.023 pH 0.052 pH 0.045 pH	Accredited pH Solutions
Conductivity Meters ^{1,7}	10 µS/cm 100 µS/cm 1 000 µS/cm 1 400 µS/cm 10 000 µS/cm 100 mS/cm	0.65 µS/cm 2.9 µS/cm 20 µS/cm 28 µS/cm 0.19 mS/cm 1.8 mS/cm	Accredited Conductivity Solutions

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Refractometers ^{1,7}	(10 to 60) °Bx	0.94 °Bx	Reference Sucrose Solutions
Viscosity ^{1,7}	500 cP	39 cP	Reference Viscosity Solution
Carbon Dioxide (CO ₂) Analyzers ^{1,7} CO ₂ Concentration in Gas	0 % CO ₂ 5 % CO ₂ 20 % CO ₂	0.26 % CO ₂ 0.17 % CO ₂ 0.59 % CO ₂	Comparison to Vaisala GMP221 CO ₂ Sensor

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Measure ¹	Up to 10 µA (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 30) A	26 pA/µA + 0.42 nA 10 pA/µA + 0.41 nA 9.5 nA/mA + 4.3 nA 14 nA/mA + 42 nA 57 nA/mA + 1 µA 0.13 mA/A + 0.1 mA 0.24 mA/A + 0.41 mA 0.55 mA/A + 4.4 mA	Fluke 8588A Reference Multimeter
DC Current – Source ¹	(0 to 220) µA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	55 pA/µA + 6 nA 38 nA/mA + 7 nA 41 nA/mA + 40 nA 57 nA/mA + 0.7 µA 0.1 mA/A + 12 µA	Fluke 5730A Multiproduct Calibrator
DC Current – Source ^{1,2}	Up to 120 µA (0.12 to 1.2) mA (1.2 to 12) mA (12 to 120) mA (0.12 to 1.2) A (1.2 to 3.1) A (3.1 to 12) A (12 to 30.2) A	98 pA/µA + 5 nA 83 nA/mA + 12 nA 80 nA/mA + 63 nA 79 nA/mA + 0.63 µA 0.12 mA/A + 8 µA 0.23 mA/A + 12 µA 0.23 mA/A + 0.2 mA 0.8 mA/A + 0.39 mA	Fluke 5560A Multiproduct Calibrator
DC Clamp-on Meters ¹	(12 to 1 000) A	24.5 mA/A + 0.5 A	Fluke 5502A Multiproduct Calibrator, 50-turn Coil



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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	Up to 1 A (3 to 5) Hz (5 to 10) Hz 10 Hz to 5 kHz (1 to 3) A (3 to 5) Hz (5 to 10) Hz 10 Hz to 5 kHz	12 mA 40 mA 1.8 mA 40 mA 14 mA 8.5 mA	Keysight 34401A 6.5 Digit Multimeter
AC Current – Measure ¹	(3 to 5) A (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz	17.3 mA/A + 2.8 mA 9.3 mA/A + 3 mA 4.9 mA/A + 6.6 mA	Fluke 289 Digital Multimeter
	(5 to 10) A (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz	17.3 mA/A + 6.3 mA 9.3 mA/A + 6.6 mA 4.9 mA/A + 12 mA	
Magnetic Inspection Unit ¹ AC Current – Measure	(500 to 10 000) A	15 A/kA + 13 A	Ammeter, Current Shunt
AC Current – Source ¹	(9 to 220) μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (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 (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	0.28 nA/ μ A + 16 nA 0.19 nA/ μ A + 10 nA 0.11 nA/ μ A + 8 nA 0.35 nA/ μ A + 12 nA 1.2 nA/ μ A + 65 nA 0.29 μ A/mA + 40 nA 0.19 μ A/mA + 35 nA 0.12 μ A/mA + 35 nA 0.25 μ A/mA + 0.11 μ A 1.3 μ A/mA + 0.65 μ A 0.29 μ A/mA + 0.4 μ A 0.19 μ A/mA + 0.35 μ A 0.12 μ A/mA + 0.35 μ A 0.25 μ A/mA + 0.55 μ A 1.3 μ A/mA + 5 μ A	Fluke 5730A 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	(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 (0.22 to 2.2) A (20 to 1 000) Hz (1 to 5) kHz (5 to 10) kHz	0.29 μ A/mA + 4 μ A 0.16 μ A/mA + 3.5 μ A 0.13 μ A/mA + 2.5 μ A 0.24 μ A/mA + 3.5 μ A 1.3 μ A/mA + 10 μ A 0.32 mA/A + 35 μ A 0.55 mA/A + 80 μ A 7.9 mA/A + 0.16 mA	Fluke 5730A Multiproduct Calibrator
AC Current – Source ^{1,2}	Up to 120 μ A (3 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (0.12 to 1.2) mA (3 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (1.2 to 12) mA (3 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (12 to 120) mA (3 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.2 nA/ μ A + 8 nA 0.2 nA/ μ A + 8 nA 0.2 nA/ μ A + 8 nA 1.3 nA/ μ A + 31 nA 4 nA/ μ A + 1 μ A 0.2 μ A/mA + 0.1 μ A 0.2 μ A/mA + 0.1 μ A 0.2 μ A/mA + 0.1 μ A 1.3 μ A/mA + 0.1 μ A 4 μ A/mA + 4 μ A 0.2 μ A/mA + 0.8 μ A 0.2 μ A/mA + 0.8 μ A 0.2 μ A/mA + 1 μ A 1.3 μ A/mA + 1 μ A 4 μ A/mA + 8 μ A 0.2 μ A/mA + 8 μ A 0.2 μ A/mA + 4 μ A 0.2 μ A/mA + 7 μ A 1.3 μ A/mA + 8 μ A 4 μ A/mA + 78 μ A	Fluke 5560A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ^{1,2}	(0.12 to 1.2) A		Fluke 5560A Multiproduct Calibrator
	(3 to 45) Hz	0.19 mA/A + 78 μA	
	45 Hz to 1 kHz	0.19 mA/A + 39 μA	
	(1 to 5) kHz	0.19 mA/A + 63 μA	
	(5 to 10) kHz	1.9 mA/A + 0.24 mA	
	(10 to 30) kHz	3.9 mA/A + 0.24 mA	
	(1.2 to 3.1) A		
	(3 to 45) Hz	0.3 mA/A + 0.38 mA	
	45 Hz to 1 kHz	0.3 mA/A + 0.24 mA	
	(1 to 5) kHz	0.3 mA/A + 0.24 mA	
	(5 to 10) kHz	2 mA/A + 0.38 mA	
	(3.1 to 12) A		
	(3 to 45) Hz	0.3 mA/A + 0.78 mA	
	45 Hz to 1 kHz	0.3 mA/A + 0.38 mA	
	(1 to 5) kHz	0.3 mA/A + 0.62 mA	
(5 to 10) kHz	2 mA/A + 0.78 mA		
(12 to 30.2) A			
(3 to 45) Hz	0.8 mA/A + 7.8 mA		
45 Hz to 1 kHz	0.6 mA/A + 6.2 mA		
(1 to 5) kHz	4 mA/A + 6.2 mA		
AC Clamp-on Meters ¹	60 Hz (12 to 1 000) A	6.1 mA/A + 0.52 A	Fluke 5502A Multiproduct Calibrator, 50-turn Coil
Resistance – Source ¹ (Fixed Artifacts)	0.1 mΩ	58 nΩ	Precision Resistance Standard
	1 mΩ	0.58 μΩ	
	10 mΩ	5.8 μΩ	
	100 mΩ	58 μΩ	
Resistance – Source ¹ (Fixed Artifacts)	500 kΩ	5.8 kΩ	Resistance Test Box
	1 MΩ	12 kΩ	
	5 MΩ	58 kΩ	
	10 MΩ	0.12 MΩ	
	25 MΩ	0.29 MΩ	
	50 MΩ	0.58 MΩ	
	100 MΩ	1.2 MΩ	
	500 MΩ	5.8 MΩ	
	1 GΩ	12 MΩ	
	2 GΩ	25 MΩ	
	50 GΩ	0.58 GΩ	
	100 GΩ	1.2 GΩ	
	200 GΩ	2.3 GΩ	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ (Synthesized-Fixed)	1 Ω	0.11 mΩ	Fluke 5730A Multiproduct Calibrator
	1.9 Ω	0.11 mΩ	
	10 Ω	28 μΩ	
	19 Ω	29 μΩ	
	100 Ω	12 μΩ	
	190 Ω	12 μΩ	
	1 kΩ	7.7 mΩ	
	1.9 kΩ	7.9 mΩ	
	10 kΩ	7.7 mΩ	
	19 kΩ	7.9 mΩ	
	100 kΩ	10 mΩ	
	190 kΩ	10 mΩ	
	1 MΩ	16 Ω	
	1.9 MΩ	22 Ω	
10 MΩ	47 Ω		
19 MΩ	68 Ω		
100 MΩ	0.15 kΩ		
Resistance – Source ^{1,2} (Synthesized-Fixed)	Up to 12 Ω	21 μΩ/Ω + 0.8 mΩ	Fluke 5560A Multiproduct Calibrator
	(12 to 120) Ω	20 μΩ/Ω + 0.8 mΩ	
	(0.12 to 1.2) kΩ	20 mΩ/kΩ + 1.6 mΩ	
	(1.2 to 12) kΩ	20 mΩ/kΩ + 16 mΩ	
	(12 to 120) kΩ	20 mΩ/kΩ + 0.16 Ω	
	(0.12 to 1.2) MΩ	20 Ω/MΩ + 10 mΩ	
	(1.2 to 12) MΩ	28 Ω/MΩ + 30 mΩ	
	(12 to 120) MΩ	0.33 kΩ/MΩ + 2 kΩ	
(120 to 1 200) MΩ	3.2 Ω/MΩ + 78 kΩ		
Resistance – Measure ¹	Up to 1 Ω	17 μΩ/Ω + 4 μΩ	Fluke 8588A Reference Multimeter
	(1 to 10) Ω	11 μΩ/Ω + 14 μΩ	
	(10 to 100) Ω	9.2 μΩ/Ω + 54 μΩ	
	100 Ω to 1 kΩ	9.2 μΩ/Ω + 0.49 mΩ	
	(1 to 10) kΩ	9.3 μΩ/Ω + 4.9 mΩ	
	(10 to 100) kΩ	9.5 μΩ/Ω + 49 mΩ	
	100 kΩ to 1 MΩ	11 μΩ/Ω + 0.92 Ω	
	(1 to 10) MΩ	20 μΩ/Ω + 99 Ω	
	(10 to 100) MΩ	0.12 mΩ/Ω + 10 kΩ	
	100 MΩ to 1 GΩ	1.3 mΩ/Ω + 1 MΩ	



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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 – Source ^{1,2}	Pt 385, 100 Ω		Fluke 7526A Precision Process Calibrator
	(-200 to -80) °C	0.013 °C	
	(-80 to 0) °C	0.02 °C	
	(0 to 100) °C	0.02 °C	
	(100 to 300) °C	0.024 °C	
	(300 to 400) °C	0.026 °C	
	(400 to 630) °C	0.033 °C	
	(630 to 800) °C	0.038 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.013 °C	
	(-80 to 0) °C	0.015 °C	
	(0 to 100) °C	0.017 °C	
	(100 to 300) °C	0.022 °C	
	(200 to 400) °C	0.026 °C	
	(400 to 630) °C	0.032 °C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.01 °C	
	(-190 to -80) °C	0.013 °C	
	(-80 to 0) °C	0.015 °C	
	(0 to 100) °C	0.017 °C	
	(100 to 300) °C	0.022 °C	
	(300 to 400) °C	0.026 °C	
	(400 to 600) °C	0.031 °C	
	(600 to 630) °C	0.33 °C	
Pt 385, 200 Ω			
(-200 to -80) °C	0.053 °C		
(-80 to 0) °C	0.056 °C		
(0 to 100) °C	0.06 °C		
(100 to 260) °C	0.06 °C		
(260 to 300) °C	0.069 °C		
(300 to 400) °C	0.071 °C		
(400 to 630) °C	0.088 °C		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicating Devices – Source ^{1,2}	Pt 385, 500 Ω		Fluke 7526A Precision Process Calibrator
	(-200 to 0) °C	0.025 °C	
	(0 to 100) °C	0.028 °C	
	(100 to 300) °C	0.034 °C	
	(300 to 400) °C	0.038 °C	
	(400 to 630) °C	0.045 °C	
	Pt 385, 1 000 Ω		
	(-200 to 0) °C	0.015 °C	
	(0 to 100) °C	0.018 °C	
	(100 to 300) °C	0.024 °C	
(300 to 400) °C	0.026 °C		
(400 to 630) °C	0.033 °C		
Ni 120, 120 Ω			
(-80 to 260) °C	0.009 °C		
Cu 427, 10 Ω			
(-100 to 260) °C	0.11 °C		
Capacitance – Measure ¹	(1 to 5) nF	0.1 nF	Fluke 87 Digital Multimeter
	(5 to 50) nF	1 nF	
	(50 to 500) nF	10 nF	
	500 nF to 5 μF	0.15 nF	
Capacitance – Measure ¹ (1 kHz)	100 pF to 1 μF	5.65 pF/nF + 1.2 nF	B&K Precision 885 LCR/ESR Meter
Capacitance – Measure ¹ (50, 60) Hz	Up to 2 nF	0.094 % of reading + 1.2 pF	Fluke 8588A Reference Multimeter
	(1.8 to 20) nF	0.075 % of reading + 1.8 pF	
	(18 to 200) nF	0.044 % of reading + 10 pF	
	(0.18 to 2) μF	0.02 % of reading + 60 pF	
	(1.8 to 20) μF	0.045 % of reading + 1.2 nF	
	(18 to 200) μF	0.049 % of reading + 2.6 nF	
	(0.18 to 2) mF	0.064 % of reading + 0.11 μF	
	(1.8 to 20) mF	0.074 % of reading + 1.1 μF	
(18 to 200) mF	0.07 % of reading + 1.1 μF		
Capacitance – Source ^{1,2} (Synthesized)	Up to 1.2 nF	0.09 % of reading + 2 pF	Fluke 5560A Multiproduct Calibrator
	(1.2 to 12) nF	0.09 % of reading + 4 pF	
	(12 to 120) nF	0.1 % of reading + 24 pF	
	(0.12 to 1.2) μF	0.1 % of reading + 0.23 nF	
	(1.2 to 12) μF	0.1 % of reading + 2.3 nF	
	(12 to 120) μF	0.12 % of reading + 19.4 nF	
	(0.12 to 1.2) mF	0.2 % of reading + 0.19 μF	
	(1.2 to 12) mF	0.2 % of reading + 2.3 μF	
(12 to 120) mF	0.39 % of reading + 23.3 μF		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Source ¹ (Variable Artifact)	(1 to 10) mH (10 to 100) mH 100 mH to 1 H (1 to 10) H	23 μH/mH 12 μH/mH 8.7 μH/mH 9 mH/H	Decade Inductor
Inductance – Source ^{1,2} (Artifacts)	1 kHz Up to 120 μH (0.12 to 1.2) mH 110 Hz (1.2 to 12) mH 100 Hz (12 to 120) mH 10 Hz (0.12 to 1.2) H 3 Hz (1.2 to 12) H 2 Hz (12 to 120) H	0.16 % of reading + 0.16 μH 0.09 % of reading + 0.78 μH 0.09 % of reading + 7.8 μH 0.09 % of reading + 78 μH 0.12 % of reading + 0.78 mH 0.16 % of reading + 7.8 mH 0.19 % of reading + 78 mH	Fluke 5560A Multiproduct Calibrator
Inductance – Measure (1 kHz)	100 μH to 1 H	2.7 μH/mH + 1.2 mH	B&K Precision 885 LCR/ESR Meter
DC Voltage – Source ¹	(0 to 220) mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	7.5 nV/mV + 0.4 μV 5.5 μV/V + 0.7 μV 3.6 μV/V + 2.5 μV 3.6 μV/V + 4 μV 5.6 μV/V + 40 μV 7.7 μV/V + 0.4 mV	Fluke 5730A Multiproduct Calibrator
DC Voltage – Source ^{1,2}	(0 to 120) mV (0.12 to 1.2) V (1.2 to 12) V (12 to 120) V (120 to 1 020) V	9.5 nV/mV + 0.62 μV 6.5 μV/V + 0.78 μV 6.3 μV/V + 7.8 μV 8.8 μV/V + 78 μV 8.7 μV/V + 0.78 mV	Fluke 5560A Multiproduct Calibrator
DC Voltage – Measure ¹	(0 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1 000) V	8 μV/V + 0.21 μV 3 μV/V + 0.4 μV 3 μV/V + 0.7 μV 4.4 μV/V + 29 μV 4.7 μV/V + 0.48 mV	Fluke 8588A Reference Multimeter
DC High Voltage – Measure ¹	100 V to 10 kV (10 to 35) kV (35 to 90) kV	0.036 % of reading + 40 mV 0.041 % of reading + 0.91 V 0.064 % of reading + 1 V	Vitretek 4700 Precision High Voltage Meter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(0.22 to 2.2) mV		Fluke 5730A Multiproduct Calibrator
	(10 to 20) Hz	0.8 μV/mV + 4 μV	
	(20 to 40) Hz	0.8 μV/mV + 4 μV	
	40 Hz to 20 kHz	0.75 μV/mV + 4 μV	
	(20 to 50) kHz	0.8 μV/mV + 4 μV	
	(50 to 100) kHz	1 μV/mV + 5 μV	
	(100 to 300) kHz	0.7 μV/mV + 10 μV	
	(300 to 500) kHz	3.1 μV/mV + 20 μV	
	500 kHz to 1 MHz	4.3 μV/mV + 20 μV	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.29 μV/mV + 4 μV	
	(20 to 40) Hz	0.13 nV/mV + 4 μV	
	40 Hz to 20 kHz	0.12 nV/mV + 4 μV	
	(20 to 50) kHz	0.25 μV/mV + 4 μV	
	(50 to 100) kHz	0.6 μV/mV + 5 μV	
	(100 to 300) kHz	1.2 μV/mV + 10 μV	
	(300 to 500) kHz	1.7 μV/mV + 20 μV	
	500 kHz to 1 MHz	3.3 μV/mV + 20 μV	
	(22 to 220) mV		
	(10 to 20) Hz	0.75 μV/mV + 7 μV	
	(20 to 40) Hz	0.11 μV/mV + 7 μV	
	40 Hz to 20 kHz	0.07 μV/mV + 7 μV	
	(20 to 50) kHz	0.14 μV/mV + 7 μV	
	(50 to 100) kHz	0.36 μV/mV + 17 μV	
	(100 to 300) kHz	0.75 μV/mV + 20 μV	
	(300 to 500) kHz	1.5 μV/mV + 25 μV	
	500 kHz to 1 MHz	3.3 μV/mV + 45 μV	
	(0.22 to 2.2) V		
(10 to 20) Hz	0.12 mV/V + 15 μV		
(20 to 40) Hz	0.11 mV/V + 15 μV		
40 Hz to 20 kHz	61 μV/V + 8 μV		
(20 to 50) kHz	88 μV/V + 10 μV		
(50 to 100) kHz	0.14 mV/V + 30 μV		
(100 to 300) kHz	0.55 mV/V + 80 μV		
(300 to 500) kHz	2.5 mV/V + 0.2 mV		
500 kHz to 1 MHz	3.2 mV/V + 0.3 mV		



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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	(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 (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 (220 to 1 100) V (15 to 50) Hz 50 Hz to 1 kHz	0.28 mV/V + 0.4 mV 0.11 mV /V + 0.15 mV 57 μV/V + 50 μV 84 μV/V + 0.1 mV 0.54 mV/V + 0.2 mV 0.62 mV/V + 0.6 mV 2.4 mV/V + 2 mV 3.2 mV/V + 3.2 mV 0.28 mV/V + 4 mV 0.11 mV/V = 1.5 mV 82 μV/V + 0.6 mV 0.3 mV/V + 1 mV 0.19 mV/V + 2.5 mV 0.38 mV/V + 16 mV 0.13 mV/V + 3.5 mV	Fluke 5730A Multiproduct Calibrator
AC Voltage – Source ^{1,2}	(1 to 12) mV (3 to 5) Hz (5 to 10) Hz 10 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (12 to 120) mV (3 to 5) Hz (5 to 10) Hz 10 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz	2 μV/mV + 6 μV 0.7 μV/mV + 6 μV 0.13 μV/mV + 5 μV 0.3 μV/mV + 5 μV 1.3 μV/mV + 12 μV 6.3 μV/mV + 24 μV 6.3 μV/mV + 24 μV 2 μV/V + 6 μV 0.73 μV/mV + 6 μV 0.12 μV/V + 5 μV 0.27 μV/V + 7 μV 0.64 μV/V + 16 μV 1.6 μV/V + 24 μV 1.6 μV/mV + 24 μV	Fluke 5560A Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ^{1,2}	(0.12 to 1.2) V		Fluke 5560A Multiproduct Calibrator
	(3 to 5) Hz	2.1 mV/V + 59 μV	
	(5 to 10) Hz	0.71 mV/V + 55 μV	
	(10 to 40) Hz	0.12 mV/V + 47 μV	
	40.01 Hz to 20 kHz	0.12 mV/V + 6.2 μV	
	(20 to 50) kHz	0.24 mV/V + 11 μV	
	(50 to 100) kHz	0.55 mV/V + 31 μV	
	(100 to 300) kHz	1.6 mV/V + 63 μV	
	(300 to 500) kHz	1.5 mV/V + 63 μV	
	(1.2 to 12) V		
	(3 to 5) Hz	2 mV/V + 0.6 mV	
	(5 to 10) Hz	0.7 mV/V + 0.6 mV	
	(10 to 40) Hz	0.12 mV/V + 0.3 mV	
	40.01 Hz to 20 kHz	0.12 mV/V + 40 μV	
	(20 to 50) kHz	0.24 mV/V + 40 μV	
	(50 to 100) kHz	0.56 mV/V + 0.1 mV	
	(100 to 300) kHz	1.7 mV/V + 0.5 mV	
	(300 to 500) kHz	1.7 mV/V + 0.5 mV	
	(12 to 120) V		
	(3 to 5) Hz	2 mV/V + 5.9 mV	
	(5 to 10) Hz	0.7 mV/V + 5.9 mV	
	(10 to 40) Hz	0.12 mV/V + 2.8 mV	
	40.01 Hz to 20 kHz	0.12 mV/V + 0.4 mV	
	(20 to 50) kHz	0.24 mV/V + 0.4 mV	
(50 to 100) kHz	0.57 mV/V + 1 mV		
(120 to 300) V			
(3 to 5) Hz	2 mV/V + 59 mV		
(5 to 10) Hz	0.7 mV/V + 59 mV		
10 Hz to 20 kHz	0.12 mV/V + 6.2 mV		
(20 to 50) kHz	0.24 mV/V + 6.2 mV		
(50 to 100) kHz	1.3 mV/V + 9.7 mV		
(300 to 1 020) V			
(3 to 5) Hz	2 mV/V + 59 mV		
(5 to 10) Hz	0.7 mV/V + 59 mV		
10 Hz to 10 kHz	0.12 mV/V + 63 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 2.2 mV		Fluke 5790A AC Measurement Standard
	(10 to 20) Hz	1.3 mV/V + 1 μV	
	(20 to 40) Hz	0.6 mV/V + 1 μV	
	40 Hz to 20 kHz	0.38 mV/V + 1 μV	
	(20 to 50) kHz	0.66 mV/V + 1.6 μV	
	(50 to 100) kHz	0.94 mV/V + 1.9 μV	
	(100 to 300) kHz	1.8 mV/V + 3.1 μV	
	(300 to 500) kHz	2 mV/V + 6.2 μV	
	500 kHz to 1 MHz	4 mV/V + 6.2 μV	
	(2.2 to 7) mV		
	(10 to 20) Hz	0.66 mV/V + 1 μV	
	(20 to 40) Hz	0.31 mV/V + 1 μV	
	40 Hz to 20 kHz	0.19 mV/V + 1 μV	
	(20 to 50) kHz	0.33 mV/V + 1.6 μV	
	(50 to 100) kHz	0.48 mV/V + 1.9 μV	
	(100 to 300) kHz	0.97 mV/V + 3.1 μV	
	(300 to 500) kHz	1.1 mV/V + 6.2 μV	
	500 kHz to 1 MHz	2.8 mV/V + 6.2 μV	
	(7 to 22) mV		
	(10 to 20) Hz	0.9 mV/V + 1 μV	
	(20 to 40) Hz	0.38 mV/V + 1 μV	
	40 Hz to 20 kHz	0.22 mV/V + 1 μV	
	(20 to 50) kHz	0.21 mV/V + 1.6 μV	
	(50 to 100) kHz	0.28 mV/V + 1.9 μV	
	(100 to 300) kHz	0.73 mV/V + 3.1 μV	
	(300 to 500) kHz	0.85 mV/V + 6.2 μV	
	500 kHz to 1 MHz	2.1 mV/V + 6.2 μV	
	(22 to 70) mV		
(10 to 20) Hz	0.47 mV/V + 1.2 μV		
(20 to 40) Hz	0.45 mV/V + 1.2 μV		
40 Hz to 20 kHz	0.28 mV/V + 1.2 μV		
(20 to 50) kHz	0.18 mV/V + 1.6 μV		
(50 to 100) kHz	0.26 mV/V + 1.9 μV		
(100 to 300) kHz	0.56 mV/V + 3.1 μV		
(300 to 500) kHz	0.77 mV/V + 6.2 μV		
500 kHz to 1 MHz	1.1 mV/V + 6.2 μV		



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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	(70 to 220) mV		Fluke 5790A AC Measurement Standard
	(10 to 20) Hz	0.96 mV/V + 1.2 μV	
	(20 to 40) Hz	0.59 mV/V + 1.2 μV	
	40 Hz to 20 kHz	0.26 mV/V + 1.2 μV	
	(20 to 50) kHz	0.31 mV/V + 1.6 μV	
	(50 to 100) kHz	0.44 mV/V + 1.9 μV	
	(100 to 300) kHz	0.59 mV/V + 3.1 μV	
	(300 to 500) kHz	1.1 mV/V + 6.2 μV	
	500 kHz to 1 MHz	1.9 mV/V + 6.2 μV	
	(220 to 700) mV		
	(10 to 20) Hz	2.4 mV/V + 1.2 μV	
	(20 to 40) Hz	2.2 mV/V + 1.2 μV	
	40 Hz to 20 kHz	1.1 mV/V + 1.2 μV	
	(20 to 50) kHz	1.5 mV/V + 1.6 μV	
	(50 to 100) kHz	0.82 mV/V + 1.9 μV	
	(100 to 300) kHz	2.4 mV/V + 3.1 μV	
	(300 to 500) kHz	1.2 mV/V + 6.2 μV	
	500 kHz to 1 MHz	1.9 mV/V + 6.2 μV	
	(0.7 to 2.2) V		
	(10 to 20) Hz	0.15 mV/V	
	(20 to 40) Hz	53 μV/V	
	40 Hz to 20 kHz	23 μV/V	
	(20 to 50) kHz	40 μV/V	
	(50 to 100) kHz	60 μV/V	
	(100 to 300) kHz	0.15 mV/V	
	(300 to 500) kHz	0.24 mV/V	
	500 kHz to 1 MHz	0.94 mV/V	
	(2.2 to 7) V		
(10 to 20) Hz	60 μV/V		
(20 to 40) Hz	55 μV/V		
40 Hz to 20 kHz	26 μV/V		
(20 to 50) kHz	42 μV/V		
(50 to 100) kHz	69 μV/V		
(100 to 300) kHz	0.17 mV/V		
(300 to 500) kHz	0.36 mV/V		
500 kHz to 1 MHz	1.2 mV/V		



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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	(7 to 22) V		Fluke 5790A AC Measurement Standard
	(10 to 20) Hz	0.29 mV/V	
	(20 to 40) Hz	65 μ V/V	
	40 Hz to 20 kHz	45 μ V/V	
	(20 to 50) kHz	44 μ V/V	
	(50 to 100) kHz	68 μ V/V	
	(100 to 300) kHz	0.17 mV/V	
	(300 to 500) kHz	0.36 mV/V	
	500 kHz to 1 MHz	1.2 mV/V	
	(22 to 70) V		
	(10 to 20) Hz	0.64 mV/V	
	(20 to 40) Hz	0.27 mV/V	
	40 Hz to 20 kHz	62 μ V/V	
	(20 to 50) kHz	0.14 mV/V	
	(50 to 100) kHz	0.19 mV/V	
	(100 to 300) kHz	0.45 mV/V	
	(300 to 500) kHz	0.5 mV/V	
	500 kHz to 1 MHz	1.2 mV/V	
	(70 to 220) V		
	(10 to 20) Hz	3.3 mV/V	
	(20 to 40) Hz	0.2 mV/V	
	40 Hz to 20 kHz	0.15 mV/V	
	(20 to 50) kHz	0.23 mV/V	
	(50 to 100) kHz	0.39 mV/V	
	(100 to 300) kHz	0.31 mV/V	
	(300 to 500) kHz	0.56 mV/V	
	(220 to 700) V		
	(10 to 20) Hz	0.95 mV/V	
(20 to 40) Hz	0.79 mV/V		
40 Hz to 20 kHz	0.9 mV/V		
(20 to 50) kHz	6.1 mV/V		
(50 to 100) kHz	6.6 mV/V		
(700 to 1 000) V			
(10 to 20) Hz	0.32 mV/V		
(20 to 40) Hz	1.1 mV/V		
40 Hz to 20 kHz	1.3 mV/V		
(20 to 50) kHz	1.5 mV/V		
(50 to 100) kHz	6.6 mV/V		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (relative to 1 kHz)	Up to 2.2 mV		Fluke 5790A AC Measurement Standard with Wideband Option
	500 kHz to 1.2 MHz	0.08 % of reading + 1 μV	
	(1.2 to 2) MHz	0.08 % of reading + 1 μV	
	(2 to 10) MHz	0.16 % of reading + 1 μV	
	(10 to 20) MHz	0.27 % of reading + 1 μV	
	(20 to 30) MHz	0.62 % of reading + 1.6 μV	
	(2.2 to 7) mV		
	500 kHz to 1.2 MHz	0.11 % of reading + 1 μV	
	(1.2 to 2) MHz	0.14 % of reading + 1 μV	
	(2 to 10) MHz	0.16 % of reading + 1 μV	
	(10 to 20) MHz	0.18 % of reading + 1 μV	
	(20 to 30) MHz	0.62 % of reading + 1 μV	
	(7 to 22) mV		
	500 kHz to 1.2 MHz	0.22 % of reading	
	(1.2 to 2) MHz	0.18 % of reading	
	(2 to 10) MHz	0.24 % of reading	
	(10 to 20) MHz	0.52 % of reading	
	(20 to 30) MHz	0.74 % of reading	
	(22 to 70) mV		
	500 kHz to 1.2 MHz	0.22 % of reading	
	(1.2 to 2) MHz	0.23 % of reading	
	(2 to 10) MHz	0.39 % of reading	
	(10 to 20) MHz	0.7 % of reading	
	(20 to 30) MHz	0.7 % of reading	
(70 to 220) mV			
500 kHz to 1.2 MHz	0.32 % of reading		
(1.2 to 2) MHz	0.34 % of reading		
(2 to 10) MHz	0.49 % of reading		
(10 to 20) MHz	0.62 % of reading		
(20 to 30) MHz	0.84 % of reading		
(220 to 700) mV			
500 kHz to 1.2 MHz	0.31 % of reading		
(1.2 to 2) MHz	0.28 % of reading		
(2 to 10) MHz	0.43 % of reading		
(10 to 20) MHz	0.47 % of reading		
(20 to 30) MHz	0.65 % of reading		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (relative to 1 kHz)	(0.7 to 2.2) V		Fluke 5790A AC Measurement Standard with Wideband Option
	500 kHz to 1.2 MHz	0.07 % of reading	
	(1.2 to 2) MHz	0.13 % of reading	
	(2 to 10) MHz	0.2 % of reading	
	(10 to 20) MHz	0.25 % of reading	
	(20 to 30) MHz	0.42 % of reading	
	(2.2 to 7) V		
	500 kHz to 1.2 MHz	0.05 % of reading	
	(1.2 to 2) MHz	0.05 % of reading	
	(2 to 10) MHz	0.11 % of reading	
(10 to 20) MHz	0.16 % of reading		
(20 to 30) MHz	0.36 % of reading		
AC High Voltage – Measure ¹	60 Hz		Vitretek 4700 Precision High Voltage Meter
	10 V to 10 kV	0.14 % of reading + 0.12 V	
	(10 to 35) kV	0.12 % of reading + 0.84 V	
	(35 to 70) kV	0.14 % of reading + 1.4 V	
Phase – Measure ¹	Up to 360 °		Clarke-Hess 6000A Precision Phase Meter
	5 Hz to 2 kHz	0.026 °	
	(2 to 5) kHz	0.037 °	
	(5 to 10) kHz	0.051 °	
	(10 to 50) kHz	0.062 °	
50 kHz to 1 MHz	0.24 °		
Phase – Source ^{1,2}	(0 to 360) °		Fluke 5560A Multiproduct Calibrator
	(3 to 65) Hz	0.1 °	
	(1 to 360) °		
	(65 to 500) Hz	0.2 °	
	(2 to 360) °		
	500 Hz to 1 kHz	0.4 °	
	(3 to 360) °		
	(1 to 5) kHz	1.9 °	
	(4 to 360) °		
	(5 to 10) kHz	3.9 °	
(5 to 360) °			
(10 to 30) kHz	7.8 °		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators – Source/Measure ¹	Type B		Fluke 7526A Precision Process Calibrator
	(600 to 800) °C	0.36 °C	
	(800 to 1 550) °C	0.29 °C	
	(1 550 to 1 820) °C	0.22 °C	
	Type C		
	(0 to 1 000) °C	0.16 °C	
	(1 000 to 1 800) °C	0.23 °C	
	(1 800 to 2 000) °C	0.27 °C	
	(2 000 to 2 316) °C	0.36 °C	
	Type E		
	(-250 to -200) °C	0.26 °C	
	(-200 to -100) °C	0.12 °C	
	(-100 to 0) °C	0.09 °C	
	(0 to 600) °C	0.08 °C	
	(600 to 1 000) °C	0.1 °C	
	Type J		
	(-210 to -100) °C	0.14 °C	
	(-100 to 800) °C	0.09 °C	
	(800 to 1 200) °C	0.1 °C	
	Type K		
	(-250 to -200) °C	0.47 °C	
	(-200 to -100) °C	0.16 °C	
	(-100 to 800) °C	0.1 °C	
	(800 to 1 372) °C	0.13 °C	
Type L			
(-200 to 0) °C	0.1 °C		
(0 to 900) °C	0.09 °C		
Type N			
(-250 to -200) °C	0.74 °C		
(-200 to -100) °C	0.23 °C		
(-100 to 0) °C	0.12 °C		
(0 to 100) °C	0.11 °C		
(100 to 800) °C	0.1 °C		
(800 to 1 300) °C	0.12 °C		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators – Source/Measure ¹	Type R		Fluke 7526A Precision Process Calibrator
	(-50 to -25) °C	0.56 °C	
	(-25 to 0) °C	0.46 °C	
	(0 to 100) °C	0.4 °C	
	(100 to 400) °C	0.29 °C	
	(400 to 600) °C	0.22 °C	
	(600 to 1 000) °C	0.21 °C	
	(1 000 to 1 600) °C	0.19 °C	
	(1 600 to 1 767) °C	0.23 °C	
	Type S		
	(-50 to -25) °C	0.52 °C	
	(-25 to 0) °C	0.44 °C	
	(0 to 100) °C	0.39 °C	
	(100 to 400) °C	0.3 °C	
	(400 to 600) °C	0.23 °C	
(600 to 1 000) °C	0.22 °C		
(1 000 to 1 600) °C	0.22 °C		
(1 600 to 1 767) °C	0.27 °C		
Type T			
(-250 to -200) °C	0.36 °C		
(-200 to -100) °C	0.16 °C		
(-100 to 0) °C	0.11 °C		
(0 to 200) °C	0.09 °C		
(200 to 400) °C	0.09 °C		
Oscilloscopes ¹			Fluke 5500A w/SC300 Multiproduct Calibrator
Amplitude			
50 Ω Load	1.8 mVp-p to 2.2 Vp-p	2.3 mV/V + 0.81 mV	
1 MΩ Load	1.8 mVp-p to 105 Vp-p	2.7 mV/V + 81 μV	
Bandwidth (relative to 50 kHz)			
50 Ω load	50 kHz to 100 MHz	5.2 % of reading + 0.38 V	
	(100 to 300) MHz	5.9 % of reading + 0.37 V	
Risetime			
50 Ω load	Nominal: (250 to 350) ps	100 ps	
Gauss Meters / Hall Effect Meters			Helmholtz Coil, Power Supply
	(-5 to 5) Gs	0.1 Gs	
	(-10 to 10) Gs	0.2 Gs	
	(-20 to 20) Gs	0.4 Gs	
	(-50 to 50) Gs	1 Gs	
	(-100 to 100) Gs	2 Gs	

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Measure ^{1,3}	(-23 to +10) dBm 100 MHz ≤ f < 6 GHz 6 GHz ≤ f ≤ 18 GHz (> 10 to 20) dBm 100 MHz ≤ f < 500 MHz 500 MHz ≤ f < 1.2 GHz 1.2 GHz ≤ f < 6 GHz 6 GHz ≤ f ≤ 18 GHz (-30 to -10) dBm 100 kHz ≤ f < 10 MHz 10 MHz ≤ f < 1.2 GHz 1.2 GHz ≤ f ≤ 4.2 GHz (> -10 to +20) dBm 100 kHz ≤ f < 10 MHz 10 MHz ≤ f < 1.2 GHz 1.2 GHz ≤ f ≤ 4.2 GHz	0.08 dB 0.16 dB 0.18 dB 0.17 dB 0.18 dB 0.19 dB 0.1 dB 0.18 dB 0.11 dB 0.17 dB 0.17 dB 0.17 dB	Agilent E4418B RF Power Meter, Agilent 8481A Power Sensor
Distortion – Measure ¹	(-80 to 0) dB 20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.3 dB	Agilent 8903B Audio Analyzer
Absolute Power – Source ^{1,3} into 50 Ω	(0.05 to 10) V _{p-p} Up to 100 kHz 100 kHz to 1 MHz (1 to 15) MHz	60 mV 75 mV 92 mV	Agilent 33120A Arbitrary Function Generator
Absolute Power – Measure ¹ (-120 to 20) dBm	(-120 to 20) dBm 10 MHz to 1.3 GHz	1 dB	Rigol DSA1030A-TG Spectrum Analyzer
Tuned RF Power – Measure ¹ 2.5 MHz to 1.3 GHz	(-115 to 0) dBm (-127 to -115) dBm	2 dB 1.3 dB	Agilent 8902A Modulation Analyzer, Agilent 11722A Power Sensor
Frequency Modulation – Measure ¹			
Freq: 250 kHz to 10 MHz	Deviation: ≤ 40 kHz Rate: 20 Hz to 10 kHz	0.41 kHz	Agilent 8902A Modulation Analyzer
Freq: 10 MHz to 1.3 GHz	Deviation: ≤ 40 kHz Rate: 20 Hz to 100 kHz	1.5 kHz	
Freq: 10 MHz to 1.3 GHz	Deviation: ≤ 40 kHz Rate: 20 Hz to 200 kHz	5.9 kHz	



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹ Freq: 150 kHz to 10 MHz	Depth: (5 to 99) % Rate: 50 Hz to 10 kHz	2.5 % Depth	Agilent 8902A Modulation Analyzer
	Depth: (5 to 99) % Rate: 20 Hz to 10 kHz	3.7 % Depth	
Freq: 10 MHz to 1.3 GHz	Depth: (5 to 99) % Rate: 50 Hz to 50 kHz	1.5 % Depth	
	Depth: (5 to 99) % Rate: 20 Hz to 100 kHz	3.7 % Depth	
Attenuation – Source Coaxial, Fixed ¹ 3 dB	DC to 8 GHz, SWR < 1.25:1 (8 to 12.4) GHz, SWR < 1.3:1	0.35 dB 0.35 dB	Agilent 8491A Coaxial Fixed Attenuator with Type-N
Attenuation – Source Coaxial, Fixed ¹ 6 dB	DC to 8 GHz, SWR < 1.2:1 (8 to 12.4) GHz, SWR < 1.3:1	0.47 dB 0.47 dB	Agilent 8491A Coaxial Fixed Attenuator with Type-N
10 dB	DC to 8 GHz, SWR < 1.2:1 (8 to 12.4) GHz, SWR < 1.3:1	0.7 dB 0.7 dB	
20 dB	DC to 8 GHz, SWR < 1.2:1 (8 to 12.4) GHz, SWR < 1.3:1	0.7 dB 0.7 dB	
	DC to 8 GHz, SWR < 1.2:1 (8 to 12.4) GHz, SWR < 1.3:1	0.7 dB 0.7 dB	



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Attenuation – Source Coaxial, Fixed ¹ 30 dB 60 dB	DC to 8 GHz, SWR < 1.2:1 (8 to 12.5) GHz, SWR < 1.3:1 DC to 8 GHz, SWR < 1.2:1 (8 to 12.5) GHz, SWR < 1.3:1	1.2 dB 1.2 dB 2.3 dB 2.3 dB	Agilent 8491A Coaxial Fixed Attenuator with Type-N
Thermal Noise Figure System – Measure ¹ (0 to 30 dB)	10 MHz to 1.5 GHz SWR 1.7:1 ENR (14 to 16) dB	0.3 dB	Agilent 8970A Noise Figure Meter, Agilent 346B Noise Source
Thermal Noise Figure System – Generate ¹ ENR (14 to 16) dB	10 MHz to 18 GHz SWR 1.25:1	0.003 2 dB/GHz + 0.27 dB	Agilent 346B Noise Source

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inside Micrometers ^{1,5} (0.001 in Resolution)	Up to 4 in (4 to 20) in (20 to 36) in (36 to 60) in	580 μin (560 + 2.1L) μin (500 + 4.6L) μin (400 + 6.7L) μin	Gage Blocks
Feeler Gages	Up to 0.25 in Up to 6 mm	20 μin 0.51 μm	Gages Blocks, Universal Length Measuring Machine
Surveillance Micrometer Masters ⁵	(1 to 12) in (25 to 300) mm	(5.5 + 11L) μin (0.14 + 0.011L) μm	Gages Blocks, Universal Length Measuring Machine

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Taper Thread Plugs Pitch Diameter	Up to 3 in	130 μin	Thread Measuring Wires, Taper Block, Universal Length Measuring Machine
Major Diameter	Up to 3 in	100 μin	Taper Block, Universal Length Measuring Machine
Length at Notch	Up to 3 in	250 μin	Gage Blocks, Height Gage
Radius Gage	(0 to 0.5) in	260 μin	Vision System
Rulers	Up to 24 in	0.005 8 in	Vision System
Steel Tape ¹	Up to 10 m	250 μm	Master Tape
Vision System X-Y Linearity	Up to 18 in	100 μin	Master Grid, Gage Blocks
Z Linearity	Up to 4 in	52 μin	
Levels ¹ Base Flatness Parallelism	Up to 12 in	100 μin	Height Transfer Standard, Gage Blocks, Surface Plate
Metal / X-Ray Detector Standards ^{4,5}	(0.031 5 to 0.28) in	(5.5 + 11L) μin	Universal Length Measuring Machine
Gage Blocks ⁵	(0.01 to 5) in	(7 + 1.3L) μin	Gage Block Comparator, Master Gage Blocks
Gage Blocks ⁵	(5 to 12) in	(2.3 + 2.4L) μin	P&W LMU 175 Labmaster Universal, Master Gage Blocks
Laser Micrometer ¹ (1 μin Resolution)	(0.01 to 2) in	23 μin	XXX Pin Gages
Angle Blocks ⁴	(1 to 45)°	0.2 "/° + 14"	Sine Block, Height Transfer Standard, Surface Plate

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Bench / Super Micrometers / Universal Length Measuring Machine ⁵			
Linearity	Up to 4 in	$(3 + 22L) \mu\text{in}$	Gage Blocks
Anvil Parallelism	25 μin TIR	4 μin	Optical Flats w/ Monochromatic Light
Force	2 ozf 4 ozf 8 ozf 16 ozf 40 ozf	0.019 ozf 0.021 ozf 0.027 ozf 0.74 ozf 0.78 ozf	Digital Force Gage
Snap Gages ¹	(0.05 to 4) in	22 μin	Gage Blocks
Pin Gages / Cylindrical Plug Gages	(0.01 to 2) in	46 μin	Laser Micrometer
Pin Gages / Cylindrical Plug Gages ⁵	Up to 2 in (1.9 to 18) in	$(6.9 + 10D) \mu\text{in}$ $(4.7 + 11D) \mu\text{in}$	Universal Length Measuring Machine
Cylindrical Rings ⁵	(0.275 to 13.25) in	$(41 + 11D) \mu\text{in}$	Master Rings, Universal Length Measuring Machine
Thread Wires ⁵	Up to 0.144 34 in	$(11 + 1.3D) \mu\text{in}$	Universal Length Measuring Machine
Measuring Rods ⁵	(1 to 12) in (12 to 18) in (18 to 59) in	$(5.5 + 11L) \mu\text{in}$ $(1.7 + 12L) \mu\text{in}$ $(91 + 13L) \mu\text{in}$	Gage Blocks, Universal Length Measuring Machine
Height Masters ⁵			
Micrometer Linearity	Up to 1 in	66 μin	Height Transfer Standard, Gage Blocks, Surface Plate
Step Height, Top/Bottom	(1 to 24) in	$(43 + 2L) \mu\text{in}$	
Step Parallelism	Up to 100 μin	84 μin	
Thread Plugs ⁵			
Pitch Diameter (5 to 100) TPI	Up to 8 in	$(76 + 7.7D) \mu\text{in}$	Thread Wires, Universal Length Measuring Machine
Thread Rings ¹	Up to 2 in	340 μin	Master Thread Plugs
Solid Thread Rings ⁵ (5.5 to 40) TPI (0.7 to 4.5) Pitch	(0.125 to 4) in	$(23 + 6.8L) \mu\text{in}$	P&W LMU 175 Labmaster Universal. Class XX Master Ring Gage

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
External Spline Gages ⁵ Measurement over Pins	Up to 8 in	$(180 + 30D) \mu\text{in}$	Gear Wires, Universal Length Measuring Machine
Circular Tooth Thickness Major Diameter	Up to 8 in Up to 8 in	$(120 + 20L) \mu\text{in}$ $(30 + 16D) \mu\text{in}$	Vision System Universal Length Measuring Machine
Chamfer Gages / Countersink Gages ¹	Up to 3 in	540 μin	Master Cylindrical Rings
Bore Gages ¹ (0.000 1 in Resolution)	(0.25 to 6) in (1 to 8) in	190 μin 0.002 % of reading + 1 800 μin	Master Cylindrical Rings, Bore Gage Calibrator
Calipers ^{1,5} (0.000 5 in Resolution) (0.001 in Resolution)	(0.05 to 24) in (0.05 to 12) in (12 to 80) in	470 μin 800 μin $(600 + 19L) \mu\text{in}$	Gage Blocks, End Measuring Rod, Surface Plate
Outside Micrometers ^{1,5} 50 μin Resolution 100 μin Resolution 100 μin Resolution 0.001 in Resolution	Up to 1 in Up to 1 in (1 to 12) in (12 to 20) in	$(35 + 8.8L) \mu\text{in}$ $(66 + 19L) \mu\text{in}$ $(770 + 26L) \mu\text{in}$ $(1\ 600 + 106L) \mu\text{in}$	Gage Blocks, End Measuring Rods, Surface Plate
Depth Micrometers ^{1,5} (0.000 1 in Resolution) (0.001 in Resolution)	Up to 12 in Up to 12 in	$(88 + 4L) \mu\text{in}$ $(890 + 23L) \mu\text{in}$	Gage Blocks, Surface Plate
V-Anvil OD Micrometers ^{1,5} 100 μin Resolution 500 μin Resolution	(0.4 to 1) in (1.25 to 4) in	60 μin $(330 + 54L) \mu\text{in}$	Cylindrical Plug Gages, Pin Gages
Ultrasonic Thickness Gage ^{1,5}	Up to 12 in	$(760 + 13L) \mu\text{in}$	Gage Blocks
Dial / Digital Indicators ¹ 10 μin resolution 20 μin resolution 50 μin resolution 100 μin resolution 500 μin resolution 0.001 in resolution	(-0.015 to 0.015) in (-0.001 to 0.001) in Up to 2 in Up to 2 in Up to 2 in Up to 2 in	7.3 μin 13 μin 61 μin 110 μin 300 μin 1 200 μin	Gage Blocks, Indicator Calibrator, Surface Plate
Test Indicators ¹	50 μin to 0.01 in	61 μin	Indicator Calibrator, Surface Plate
Height Gages ^{1,5}	Up to 12 in (12 to 36) in	$(35 + 5L) \mu\text{in}$ $(280 + 12L) \mu\text{in}$	Gage Blocks, Surface Plate, Measuring Rods

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Linear Scales ¹	(1 to 142) in	7 μin/in + 0.009 5 μin	Measuring Rods
Extensometers ¹ 50 μin resolution	Up to 2 in	140 μin	Micrometer Head
Extensometers ¹ 10 μin resolution	Up to 2 in	61 μin	Extensometer Calibrator
Optical Comparators ¹ Magnification	10 X to 100 X	210 μin	Glass Scale
Linearity (10 μin Resolution)	Up to 18 in	0.001 5 % of reading + 59 μin	Glass Scale
Angularity	Up to 30°	2'10"	Angle Blocks
Coating Thickness Measuring Systems ¹	Up to 0.018 in	7.7 % of reading	Ferrous Coated Thickness Standards
Protractors	Up to 180°	0.06°	Height Transfer Standard, Sine Block, Surface Plate
Microscopes ¹	Up to 2 in	160 μin	Glass Scale
Profilometers ¹	118 μin 123 μin	3.1 μin 3.1 μin	Roughness Standard
Surface Roughness Specimen (Ra)	(10 to 500) μin	3.7 μin	Surface Finish Analyzer
Roundness Measuring System ¹ Radial Error	Up 5 in	5.5 μin	Precision Ball
Coordinate Measuring Machines ⁵ Linear Accuracy	(0.5 to 24.5) in	(88 + 7L) μin	Step Gage, Ball Bars, and ASME B89.4.1 utilized in the calibration of this system parameter.
Volumetric Accuracy	(9 to 25) in	209 μin	
Squareness	(0.25 to 11.75) in	362 μin	
Coordinate Measuring Machines ⁵ Linear Accuracy	(0.5 to 39) in	(20 + 4L) μin	Gage Blocks and ISO 10360-2 utilized in the calibration of this system parameter.

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Surface Plates ^{1,5} Overall Flatness	Up to 68 inDL	$(5 + 0.5DL) \mu\text{in}$	In accordance with ASME B89.3.7 using Optodyne LDDM Laser Measurement System
Local Area Flatness	Up to 0.03 in	16 μin	Repeat Reading Gage
Optical Flats	Up to 100 μin	5 μin	Optical Flat, Monochromatic Light
Inclinometers	Up to 45°	0.06°	Sine Plate and Gage Blocks
Crosshead Displacement	(0.2 to 2) in	0.001 5 in/in + 1 800 μin	Dial Depth Indicator and ASTM E2309 utilized in the calibration of this parameter.
Laser Interferometer System (Device for Measuring Displacement w/out Atmospheric Compensation)	Up to 80 in	$(0.95 + 0.72L) \mu\text{in}$	Master Laser Interferometer per ASME B89.1.8, Back-to-Back Method.
Laser Interferometer System Flatness	Up to 100 μin	5.5 μin	Flatness Master

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Aqueous Volumetric Flow Rate ¹ (Inline)	Up to 65 gpm Up to 150 gpm	0.2 % of reading + 0.6 gpm 0.2 % of reading + 0.3 gpm	Comparison to Coriolis Meter
Aqueous Volumetric Flow Rate ¹ (Non-Intrusive)	(100 to 500) gpm (150 to 900) gpm	1.84 % of reading + 0.64 gpm 1.8 % of reading + 0.65 gpm	Comparison to Ultrasonic Transducers
Volumetric Gas Flow Meters, Rotameters	(2 to 20) sccm (10 to 100) sccm (100 to 1 000) sccm (0.5 to 5) slpm (5 to 50) slpm	1 % of reading + 0.6 sccm 1 % of reading + 0.9 sccm 0.81 % of reading + 5.5 sccm 0.14 % of reading + 0.3 slpm 1 % of reading + 0.4 slpm	Comparison to Thermal Volumetric Flow Sensors
Gas Flow Velocity	(50 to 6 000) ft/min	1.3 % of reading + 2 ft/min	Master Anemometer, Open Jet Wind Tunnel
Metal Detectors – Magnetic Separation ¹	(0.5 to 6) lbf	0.37 lbf	Digital Magnetic Pull Tester



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force Gauges ¹	Up to 21.5 lbf (10 to 110) lbf (50 to 1 050) lbf	0.035 % of reading + 0.000 93 lbf 0.043 % of reading + 0.007 3 lbf 0.051 % of reading + 0.073 lbf	NIST Class F Weights, Weight Hanger
Force Machines – Tension ¹	(5 to 50) lbf (76 to 500) lbf (290 to 3 000) lbf (480 to 5 000) lbf (261 to 10 000) lbf (3 000 to 30 000) lbf (3 000 to 60 000) lbf (3 000 to 120 000) lbf (10 000 to 300 000) lbf	0.025 lbf 0.25 lbf 0.61 lbf 2.2 lbf 4.2 lbf 6.5 lbf 12 lbf 0.03 % of reading + 16 lbf 0.02 % of reading + 8 lbf	Load Cell w/ Indicator and ASTM E74 utilized in the calibration of this system.
Force Machines – Compression ¹	(5 to 50) lbf (48 to 500) lbf (88 to 3 000) lbf (450 to 5 000) lbf (1 000 to 10 000) lbf (3 000 to 30 000) lbf (6 000 to 60 000) lbf (60 000 to 120 000) lbf (19 000 to 300 000) lbf (52 000 to 800 000) lbf	0.03 lbf 0.25 lbf 0.61 lbf 2.3 lbf 7.5 lbf 6.4 lbf 17 lbf 0.03 % of reading + 16 lbf 0.02 % of reading + 6 lbf 0.03 % of reading + 10 lbf	Load Cell w/ Indicator and ASTM E74 utilized in the calibration of this system.
Ductility Tester, Olsen Cup Tester ¹	(300 to 6 000) lbf (6 000 to 30 000) lbf	7.5 lbf 17 lbf	Master Load Cell w/ Indicator and ASTM E74 utilized in the calibration of this system.
Load Cell – Tension ¹	(5 to 50) lbf (76 to 500) lbf (290 to 3 000) lbf (480 to 5 000) lbf (261 to 10 000) lbf (3 000 to 30 000) lbf (3 000 to 60 000) lbf (3 000 to 120 000) lbf (10 000 to 300 000) lbf	0.025 lbf 0.25 lbf 0.61 lbf 2.2 lbf 4.2 lbf 6.5 lbf 12 lbf 0.03 % of reading + 16 lbf 0.02 % of reading + 6 lbf	Master Load Cell w/ Indicator and ASTM E74 utilized in the calibration of this system.
Load Cell – Compression ¹	(5 to 50) lbf (48 to 500) lbf (88 to 3 000) lbf (450 to 5 000) lbf (1 000 to 10 000) lbf (3 000 to 30 000) lbf (6 000 to 60 000) lbf	0.03 lbf 0.25 lbf 0.61 lbf 2.3 lbf 7.5 lbf 6.4 lbf 17 lbf	Master Load Cell w/ Indicator and ASTM E74 utilized in the calibration of this system.



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Load Cell – Compression ¹	(60 000 to 120 000) lbf (19 000 to 300 000) lbf (52 000 to 800 000) lbf	0.03 % of reading + 16 lbf 0.02 % of reading + 6 lbf 0.03 % of reading + 10 lbf	Master Load Cell w/ Indicator and ASTM E74 utilized in the calibration of this system.
Rockwell Hardness Testers ¹	HRA Low Middle High HRBW Low Middle High HRC Low Middle High HRE Low High HRF Low High HRGw Low High HRHw Low High HRLw Low High HRMw Low High HRRw Low High	0.44 HRA 0.38 HRA 0.26 HRA 0.74 HRBW 0.69 HRBW 0.59 HRBW 0.41 HRC 0.36 HRC 0.36 HRC 0.62 HRE 0.55 HRE 0.69 HRF 0.62 HRF 1.1 HRGw 0.91 HRGw 0.87 HRHw 0.45 HRHw 0.9 HRLw 0.46 HRLw 0.69 HRMw 0.51 HRMw 0.58 HRRw 0.58 HRRw	Indirect verification per ASTM E18 using Hardness Blocks



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Superficial Rockwell Hardness Testers ¹	HR15N		Indirect verification per ASTM E18 using Hardness Blocks
	Low	0.13 HR15N	
	Middle	0.16 HR15N	
	High	0.1 HR15N	
	HR30N		
	Low	0.67 HR30N	
	Middle	0.59 HR30N	
	High	0.51 HR30N	
	HR45N		
	Low	0.49 HR45N	
	Middle	0.57 HR45N	
	High	0.5 HR45N	
	HR15TW		
	Low	0.69 HR15TW	
	Middle	0.62 HR15TW	
High	0.4 HR15TW		
HR30TW			
Low	0.52 HR30TW		
Middle	0.45 HR30TW		
High	0.44 HR30TW		
HR45TW			
Low	0.49 HR45TW		
Middle	0.46 HR45TW		
High	0.62 HR45TW		
HR15Yw			
Low	0.83 HR15Yw		
High	0.8 HR45Yw		
Brinell Hardness Testers ¹	(500 to 3 000) kgf	6.7 kgf	Direct verification per ASTM E10, ASTM E74; Class A Proving Ring

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Brinell Hardness Testers ¹ Verification	HBW2.5/62.5		Indirect verification per ASTM E10 using Hardness Standards,
	Low	2.8 HBW2.5/62.5	
	High	6.1 HBW2.5/62.5	
	HBW2.5/187.5		
	Low	2.3 HBW2.5/187.5	
	High	16 HBW2.5/187.5	
	HBW5/750		
	Low	4.9 HBW5/750	
	High	16 HBW5/750	
	HBW10/500		
	Low	0.63 HBW10/500	
	High	2.1 HBW10/500	
	HBW10/1500		
	Low	1.2 HBW10/1 500	
High	3.2 HBW10/1 500		
HBW10/3000	Low	3.3 HBW10/3 000	
	High	13 HBW10/3 000	
Indenter Error	Up to 0.1 mm	57 µm	Stage Micrometer
Brinell Scope ¹	(0 to 7) mm	6.7 µm	Stage Micrometer
Vickers Hardness Tester – Force ¹	10 gf	1.1 gf	Direct verification per ASTM E92 / ISO 6507-2 using Force Gage
	25 gf	1.1 gf	
	50 gf	1.1 gf	
	100 gf	1.1 gf	
	200 gf	1.1 gf	
	300 gf	2.3 gf	
	500 gf	3.4 gf	
	1 kgf	6.6 gf	
	2 kgf	13 gf	
	5 kgf	33 gf	
	10 kgf	66 gf	
	20 kgf	0.13 kgf	
	30 kgf	0.2 kgf	
	50 kgf	0.33 kgf	



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Knoop Hardness Tester – Force ¹	10 gf	1.1 gf	Direct verification per ASTM E92 / ISO 6507-2 using Force Gage
	25 gf	1.1 gf	
	50 gf	1.1 gf	
	100 gf	1.1 gf	
	200 gf	1.1 gf	
	300 gf	2.3 gf	
	500 gf	3.4 gf	
	1 kgf	6.1 gf	
	3 kgf	11 gf	
	10 kgf	11 gf	
	15 kgf	11 gf	
	30 kgf	11 gf	
	45 kgf	11 gf	
	60 kgf	33 gf	
100 kgf	33 gf		
150 kgf	33 gf		
Rockwell Hardness Tester – Force ¹	3 kgf	8 gf	Direct Verification per ASTM E18 using Load Cell w/ Indicator
	10 kgf	24 gf	
	15 kgf	0.21 kgf	
	30 kgf	0.22 kgf	
	45 kgf	0.23 kgf	
	60 kgf	0.25 kgf	
	100 kgf	0.31 kgf	
150 kgf	0.41 kgf		
Rockwell Hardness Testers – Indenter Depth ¹	(0.1 to 200) μm	0.3 μm	Comparison with LVDT Probe w/ Indicator
Rockwell Hardness Testers – Hysteresis ¹ B, E, F, G, H and K Scale	100 Rockwell Units	0.31 HR	Direct verification using Blunt Indenter and Flat Anvil
	All Other Scales	130 Rockwell Units	

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Vickers Hardness Tester ¹	< 240 HV 0.01 > 600 HV 0.01 < 240 HV 0.025 > 600 HV 0.025 < 240 HV 0.05 > 600 HV 0.05 < 240 HV 0.1 > 600 HV 0.1 < 240 HV 0.2 > 600 HV 0.2 < 240 HV 0.3 > 600 HV 0.3 < 240 HV 0.5 > 600 HV 0.5 < 240 HV 1 > 600 HV 1 < 240 HV 5 (240 to 600) HV 5 > 600 HV 5 < 240 HV 10 (240 to 600) HV 10 > 600 HV 10 < 240 HV 30 (240 to 600) HV 30 > 600 HV 30	12 HV 0.01 44 HV 0.01 11 HV 0.025 33 HV 0.025 11 HV 0.05 30 HV 0.05 11 HV 0.1 28 HV 0.1 9 HV 0.2 22 HV 0.2 9 HV 0.3 21 HV 0.3 8 HV 0.5 20 HV 0.5 7 HV 1 17 HV 1 6 HV 5 13 HV 5 22 HV 5 5 HV 10 10 HV 10 17 HV 10 7 HV 30 11 HV 30 18 HV 30	Indirect verification per ASTM E92 / ISO 6507-2 using Hardness Blocks
Knoop Hardness Tester ¹	< 250 HK 0.01 > 650 HK 0.01 < 250 HK 0.025 > 650 HK 0.025 < 250 HK 0.05 > 650 HK 0.05 < 250 HK 0.1 > 650 HK 0.1 < 250 HK 0.2 > 650 HK 0.2 < 250 HK 0.3 > 650 HK 0.3 < 250 HK 0.5 > 650 HK 0.5 < 250 HK 1 > 650 HK 1	9 HK 0.01 35 HK 0.01 9 HK 0.025 24 HK 0.025 9 HK 0.05 22 HK 0.05 9 HK 0.1 21 HK 0.1 7 HK 0.2 17 HK 0.2 7 HK 0.3 21 HK 0.3 7 HK 0.5 18 HK 0.5 8 HK 1 18 HK 1	Indirect verification per ASTM E92 / ISO 6507-2 using Hardness Blocks

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Durometers Spring Force Only Types A, B, O Types D, C, DO	(10 to 90) Duro (10 to 90) Duro	0.7 Duro 0.6 Duro	Partial Direct Verification per ASTM D2240-02B using Durometer Calibrator.
Duro Calibrator Types A, B, O Types D, C, DO	(1.3 to 8.05) N (4.445 to 44.45) N	0.033 N 0.046 % of reading + 0.03 N	Comparison to Digital Force Gage
Pneumatic Pressure Gages ¹	(-0.25 to 0.25) in H ₂ O (-30 to 30) in H ₂ O (20 to 200) in H ₂ O	0.07 % of reading + 0.004 1 inH ₂ O 0.002 9 inH ₂ O 0.72 in H ₂ O	Setra & Meriam Calibrator
Pneumatic Pressure Gages	(> 0 to 36) psig (> 0 to 145) psig (> 0 to 500) psig	0.008 5 % of reading + 0.007 2 psi 0.006 5 % of reading + 0.01 psi 0.008 7 % of reading + 0.019 psi	Fluke 6270A Pressure Controller with Associated Module
Pneumatic/Hydraulic Pressure Gages ¹	(10 to 2000) psig (100 to 10 000) psig	0.18 % of reading + 0.27 psi 0.075 % of reading + 0.52 psi	Deadweight Testers
Pneumatic/Hydraulic Pressure Gages ¹	(0 to 30) psig (0 to 300) psig (0 to 300) psia (0 to 500) psig (0 to 1 000) psig (1 000 to 10 000) psig (5 000 to 50 000) psig (10 000 to 100 000) psig	0.1 % of reading 0.1 % of reading 0.1 % of reading 0.3 psi 0.03 % of reading + 0.54 psi 0.05 % of reading + 17 psi 0.05 % of reading + 58 psi 0.04 % of reading + 380 psi	Comparison to High Accuracy Pressure Gage, Pressure Calibrator
Absolute Pneumatic Pressure Gages	(> 0 to 17.4) psia	0.001 5 % of reading + 0.007 7 psi	Fluke 6270A Pressure Controller with Associated Module
Vacuum Gage	(-14.7 to < 0) psiv	0.034 % of reading + 0.008 7 psi	Fluke 6270A Pressure Controller with Associated Module
Vacuum Gage ¹	(-660 to < 0) mmHg	0.1 % of reading	Pressure Calibrator
Conventional Mass NIST Class F (Metric)	(1 to 40) g (40 to 100) g (100 to 220) g (0.22 to 3.1) kg 500 g 1 kg 5 kg 10 kg 20 kg	0.000 6 % of reading + 20 µg 0.000 4 % of reading + 0.11 mg 0.000 5 % of reading + 0.17 mg 0.000 13 % of reading + 36 mg 27 mg 27 mg 36 mg 39 mg 0.49 g	Comparison to ASTM E617 Class 1 Weights, Balance

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conventional Mass NIST Class F (Avoirdupois)	0.5 lb 1 lb 2 lb 5 lb 10 lb 20 lb 25 lb 50 lb	26 mg 27 mg 27 mg 14 mg 21 mg 31 mg 37 mg 1.6 g	Comparison to ASTM E617 Class 1 Weights, Balance
Scales and Balances ^{1,6} Metric (SI)	Up to 40 g (40 to 100) g (100 to 220) g (220 to 2 100) g (2 100 to 4 200) g (4 200 to 14 200) g (14 200 to 32 000) g	0.000 4 % of reading + 14 µg 0.000 4 % of reading + 16 µg 0.000 5 % of reading + 3.2 µg 0.000 7 % of reading + 3.6 mg 0.000 7 % of reading + 3.1 mg 0.000 3 % of reading + 2.7 mg 0.000 3 % of reading + 30 mg	ASTM E617 Class 1 weights and NIST Handbook 44 utilized for the calibration of the weighing system.
Scales and Balances ^{1,6} Avoirdupois	Up to 10 lb (10 to 50) lb (50 to 250) lb (250 to 500) lb (500 to 1 000) lb	0.008 % of reading + 0.002 lb 0.15 % of reading + 0.001 lb 0.008 % of reading + 0.01 lb 0.006 % of reading + 0.05 lb 0.016 % of reading + 0.18 lb	ASTM E617 Class 3 weights, NIST Class F Weights, and NIST Handbook 44 utilized for the calibration of the weighing system.
Pipettes	(2 to 100) µl (100 to 1 000) µl (1 000 to 10 000) µl	0.37 µl 0.036 % of reading + 0.33 µl 0.005 7 % of reading + 0.61 µl	Analytical Balance
Moisture Analyzers ^{1,6} Weighing System	Up to 220 g	0.000 4 % of reading + 0.14 mg	ASTM E617 Class 1 weights and NIST Handbook 44 utilized for the calibration of the weighing system.
Temperature	160 °C	2.5 °C	Reference Thermometer
Torque Watch ¹	(0.5 to 2.5) ozf·in (2 to 10) ozf·in (6 to 43) ozf·in (30 to 215) ozf·in	0.3 % of reading + 0.08 ozf·in 0.2 % of reading + 0.07 ozf·in 0.2 % of reading + 0.3 ozf·in 0.2 % of reading + 3 ozf·in	Torque Watch Calibrator
Torque Devices ¹	(2.5 to 25) lbf·in (25 to 250) lbf·in (100 to 1 000) lbf·in (25 to 250) lbf·ft (80 to 800) lbf·ft (100 to 1 000) lbf·ft (500 to 5 000) lbf·ft	0.54 % of reading + 0.05 lbf·in 0.64 % of reading + 0.02 lbf·in 0.76 % of reading + 0.24 lbf·in 1.2 % of reading + 0.05 lbf·in 2 lbf·ft 1.1 % of reading + 0.84 lbf·in 1.1 % of reading + 9.1 lbf·in	Torque Wrench Calibration System



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Analyzers, Torque Transducers ¹	(2.5 to 25) lbf·in (25 to 250) lbf·in (100 to 1 000) lbf·in (300 to 3 000) lbf·in (100 to 1 200) lbf·ft	0.4 % of reading 0.004 % of reading + 0.13 lbf·in 0.06 % of reading + 0.066 lbf·in 0.04 % of reading + 0.11 lbf·in 0.024 % of reading + 0.07 lbf·ft	NIST Class F Weights, Torque Wheel, Torque Arm
Torque Watch Calibrators ¹ Masses	0.5 oz 2 oz 8.5 oz 42.5 oz	0.000 004 oz 0.000 012 oz 0.001 3 oz 0.001 4 oz	ASTM E617 Class 1 Weights, Balance
Dial	13.25° 76.75°	0.58° 0.58°	Masses
Hydrometers ^{1,5}	(0.9 to 1) SG (1.2 to 1.4) SG	0.001 7 SG 0.002 9 SG	Comparison to Reference Hydrometer per ASTM E126-19

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gloss Meters ^{1,5}	93.5 GU, 20° 95.4 GU, 60° 99.6 GU, 85°	1.2 GU 0.65 GU 0.58 GU	Per ASTM D523-08 using Gloss Standards
Spectrophotometers Total Hemispherical Diffuse Reflectance ² (8°:t)	(360 to 390) nm (400 to 830) nm	0.37 % of reading 0.27 % of reading	Ultra-White Ceramic Reflectance Standard, ΔE CIELAB values reported.
Xenon arc Weathering Instruments ¹ Illuminance (380 to 780) nm	Up to 240 000 lux	4.8 % of reading	Atlas XenoCal BST Measure and Calibration Sensor
Xenon arc Weathering Instruments ¹ Irradiance (300 to 800) nm	Up to 1 300 W/m ²	8.2 % of reading	Atlas XenoCal 300-800 Measure and Calibration Sensor

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermometers ¹	(-196 to 0) °C (0 to 420) °C (420 to 660) °C	0.008 % of reading + 0.031 °C 0.001 % of reading + 0.031 °C 0.005 % of reading + 0.01 °C	Comparison to SPRT
Humidity Indicators ¹ (at 23 ± 5 °C)	11 % RH 33 % RH 75 % RH 98 % RH	1.7 % RH 1.5 % RH 1.9 % RH 2.8 % RH	Vaisala HMK15 Humidity Calibrator, Accredited Salts
Thermohygrometer Humidity	(10 to 95) % RH	0.16 % of reading + 0.67 % RH	Thunder Scientific 1200 Two-Pressure Humidity Generator
Temperature	(10 to 60) °C	0.12 °C	
Radiation (Infrared) Thermometers ¹	35 °C 100 °C 200 °C 350 °C 500 °C	0.47 °C 0.66 °C 0.95 °C 1.7 °C 2.1 °C	Fluke 4181 Black Body Source (flat plate) $\epsilon = 0.95, \lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers ¹	100 °C 250 °C 400 °C 550 °C 700 °C 850 °C 982 °C	2.3 °C 2.6 °C 3.4 °C 4 °C 4.8 °C 5.6 °C 6.5 °C	Omega BB-4A Black Body Source (cavity) $\epsilon = 0.99, \lambda = (8 \text{ to } 14) \mu\text{m}$
Ovens, Incubators, Stirred Water Baths, Fridges ¹	(0 to 100) °C (0 to 600) °C (-190 to 0) °C (0 to 1 300) °C	0.16 % of reading + 2.8 °C 0.5 % of reading + 2.8 °C 0.07 % of reading + 2.7 °C 0.65 % of reading + 2.8 °C	Process Calibrator, Type K Thermocouple Probe
Ovens, Incubators, Stirred Water Baths, Fridges ¹	(-50 to 0) °C (0 to 500) °C	0.8 % of reading + 0.5 °C 0.6 % of reading + 0.5 °C	Process Calibrator, Pt 100 RTD Probe
Thermocouples and Thermometers ¹	(-15 to 110) °C (50 to 350) °C (350 to 600) °C	0.41 °C 0.77 °C 0.1 % of reading + 0.25 °C	Dry Block Calibrator
Xenon Arc Weathering Instruments ¹ Surface Temperature	(20 to 120) °C	0.084 % of reading + 1.2 °C	Atlas XenoCal BST Measure and Calibration Sensor
Non-contact Tachometer ^{1,5}	(60 to 100 000) rpm	0.025 % of reading	Function Generator, LED Light Source
Contact Tachometers ^{1,5}	(10 to 10 000) rpm	0.67 % of reading + 2.5 rpm	Tachometer Standard



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Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Stopwatches, Timers ¹	Up to 48 h	40 ms	Function Generator, Frequency Counter
Stopwatches, Timers ¹	Up to 1 d	53 ms/d	Timometer
Frequency – Source ¹	10 mHz to 120 Hz 120 Hz to 1.2 kHz (1.2 to 12) kHz (12 to 120) kHz 120 kHz to 1.2 MHz (1.2 to 2) MHz	13 mHz 0.13 Hz 1.3 Hz 13 Hz 0.13 kHz 1.3 kHz	Fluke 5502A Multiproduct Calibrator
Frequency – Source ¹ Sine and Square Triangle and Ramp	100 μHz to 15 MHz 100 μHz to 100 kHz	0.002 5 % of reading 0.002 5 % of reading	Agilent 33120A Arbitrary Function Generator
Frequency – Source ¹	(2 to 8.4) GHz	12 Hz	Anritsu MG3691A RF/Microwave Signal Generator
Frequency – Measure ¹ into 50 Ω load into 1 MΩ load into 50 Ω load	(10 to 525) MHz 10 Hz to 80 MHz (10 to 100) MHz (0.1 to 1) GHz (1 to 10) GHz (10 to 20) GHz	10.7 mHz/Hz + 1.8 Hz 19.3 nHz/Hz + 1.2 Hz 1.2 Hz/MHz + 1 Hz 0.12 kHz/GHz + 1 Hz 1.2 kHz/GHz + 1 Hz 8 kHz/GHz + 1 Hz	HP 5350B Frequency Counter
Frequency – Measure ¹	10 Hz to 10 MHz	0.013 % of reading + 5 mHz	Keysight 3458A 8.5 Digit Multimeter
Frequency – Time Based Aging ¹	10 MHz	1 pHz/Hz	Fluke 910R GPS Controlled Atomic Clock
Rotational Viscometers ^{1,5}	(2 to 2 000) rpm	1.5 rpm	Optical Tachometer
Crosshead Speed ¹	(0.2 to 2) in/min	0.07 % of reading + 0.005 3 in/min	Stopwatch, Depth Indicator, and ASTM E2658 utilized in the calibration of this parameter.

DIMENSIONAL MEASUREMENT

1 Dimensional

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dimensional Measurement – 1D ⁵	Up to 12 in (12 to 18) in	(5.5 + 11L) μin (2.7 + 12L) μin	Universal Length Measuring Machine utilized as the reference standard for these measurements.
Dimensional Measurement – 1D ⁵	Up to 24 in	(260 + 4D) μin	Vision System utilized as the reference standard for these measurements.
Flatness Measurement ⁵ Up to 4 inD	Up to 100 μin	10 μin	ZyGo Verifier QPZ Laser Interferometer utilized as the reference standard for flatness measurements.

3 Dimensional

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dimensional Measurement – 3D ⁵	X = Up to 18 in Y = Up to 20 in Z = Up to 16 in	(320 + 6L) μin (320 + 6L) μin (320 + 9L) μin	Coordinate Measuring Machine utilized as the reference standard for these measurements.

TESTING

Mechanical

Specific Tests and/or Properties Measured	Specification, Standard, Method, or Test Technique	Items, Materials or Product Tested	Key Equipment or Technology
Rockwell Hardness	ASTM E18	HRA, HRB, HRC	Rockwell Hardness Tester
Rockwell Superficial Hardness	ASTM E18	HR15N, HR30N, HR45N, HR15TW, HR30TW, HR45TW	Rockwell Hardness Tester

Mechanical

Specific Tests and/or Properties Measured	Specification, Standard, Method, or Test Technique	Items, Materials or Product Tested	Key Equipment or Technology
Brinell Hardness	ASTM E10	BHN	Brinell Hardness Tester
Micro-Hardness	ASTM E384	Knoop, Vickers	Micro-Hardness Tester

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. This laboratory calibration services in its laboratory and on-site at customer-designated locations. 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. The uncertainty does not include gage R&R study, and the unit under test resolution. Larger measurement uncertainties are expected.
3. Mismatch uncertainty is not considered in the CMC as it is DUT dependent. Higher uncertainties will be reported based on DUT VSWR.
4. This calibration is only applicable to the dimensional properties. The metallurgical properties/composition of the test spheres are not tested.
5. L = length in inches; D = diameter in inches; " = arc-second; DL = diagonal length; GU = gloss unit; rpm = revolutions per minute; SG = specific gravity.
6. The CMC for scales and balances is highly dependent upon the resolution of the unit under test. The CMC 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.
7. The values in the Range column are Nominal values. The actual certified values will be used at the time of calibration, along with the associated measurement Uncertainty.
8. This scope is formatted as part of a single document including Certificate of Accreditation No. ACT-1886.



Jason Stine, Vice President

