



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Transcat – Los Angeles
1503 E. Orangethorpe Ave., Unit A
Fullerton, CA 92831

Fulfills the requirements of

ISO/IEC 17025:2017

and national standards

ANSI/NCSL Z540-1-1994 (R2002) AND
ANSI/NCSL Z540.3-2006 (R2013)

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: 07 September 2025
Certificate Number: AC-2489.08



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)

ANSI/NCSL Z540.3-2006 (R2013)

Transcat – Los Angeles

1503 E. Orangethorpe Ave., Unit A

Fullerton, CA 92831

Mathew Bundy 657-217-3684

CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: September 7, 2025

Certificate Number: AC-2489.08

CALIBRATION

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Measuring Equipment – Measure and Generate	125 Hz to 2 kHz		GenRad 1986 Sound Level Calibrator
	(74 to 104) dB	0.46 dB	
	114 dB	0.36 dB	
	4 kHz		
	(74 to 104) dB	0.73 dB	
	114 dB	0.62 dB	

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH – Measuring Equipment ^{1,8}	4 pH	0.011 pH	Standard Buffer Solutions
	7 pH	0.011 pH	
	10 pH	0.012 pH	
Conductivity Meters ⁸	10 µS/cm	0.5 µS/cm	Standard Solutions
	100 µS/cm	2.2 µS/cm	
	1 000 µS/cm	3.7 µS/cm	
	10 000 µS/cm	36 µS/cm	
	100 000 µS/cm	440 µS/cm	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sine Wave Flatness ¹	Up to 3 V 10 Hz to 1 MHz (1 to 10) MHz (10 to 30) MHz (30 to 50) MHz (50 to 80) MHz (80 to 100) MHz	0.06 % of reading 0.1 % of reading 0.18 % of reading 0.41 % of reading 0.71 % of reading 0.84 % of reading	Thermal Voltage Converters
DC Current – Measure/Source 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	33 μ A/A + 0.92 nA 29 μ A/A + 5.8 nA 29 μ A/A + 58 nA 46 μ A/A + 0.58 μ A 0.013 % of reading + 12 μ A	Agilent 3458A 8.5 Digit Multimeter w/ Current Source
	(1 to 100) A	0.012 % of reading + 0.5 mA	Ohms Labs CS-100 Precision Shunt w/ Agilent 3458A 8.5 Digit Multimeter
	(100 to 580) A	0.29 mA/A + 0.58 mA	DC Current Shunts w/ DMM and Current Source
DC Current – Measure ¹	(580 to 1 000) A	0.29 mA/A + 0.5 mA	DC Current Shunt w/ DMM
DC Current – Source ¹	(0 to 220) μ A 220 μ A to 2.2 mA (2.2 to 22) mA (22 to 220) mA 0.22 A to 2.2 A (2.2 to 11) A	40 μ A/A + 6 nA 36 μ A/A + 7 nA 35 μ A/A + 40 nA 48 μ A/A + 0.7 μ A 84 μ A/A + 12 μ A 0.036 % of reading + 0.48 mA	Fluke 5700A-EP Multiproduct Calibrator, w/ Fluke 5725A Amplifier
DC Current – Source ¹	(11 to 20) A	0.096 % of reading + 0.58 mA	Fluke 5522A Multiproduct Calibrator
DC Clamp-on Ammeters (Non-Toroidal Type) Transformer Type Sensor ¹	(20 to 150) A (150 to 1 000) A	0.58 % of reading + 0.14 A 0.58 % of reading + 0.52 A	Fluke 5520A/1100 Multiproduct Calibrator w/ Fluke 5500A/Coil

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	Up to 100 μ A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % of reading + 35 nA 0.17 % of reading + 35 nA 0.072 % of reading + 35 nA 0.072 % of reading + 35 nA	Agilent 3458A 8.5 Digit Multimeter
	100 μ A to 1 mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % of reading + 0.23 μ A 0.17 % of reading + 0.23 μ A 0.071 % of reading + 0.23 μ A 0.038 % of reading + 0.23 μ A	
	(1 to 10) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % of reading + 2.3 μ A 0.17 % of reading + 2.3 μ A 0.071 % of reading + 2.3 μ A 0.038 % of reading + 2.3 μ A	
	(10 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.48 % of reading + 23 μ A 0.17 % of reading + 23 μ A 0.071 % of reading + 23 μ A 0.037 % of reading + 23 μ A	
	100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % of reading + 0.23 mA 0.19 % of reading + 0.23 mA 0.097 % of reading + 0.23 mA 0.12 % of reading + 0.23 mA	
	Up to 10 A 50 Hz to 1 kHz 1 kHz	0.015 % of reading + 1.3 mA 0.12 % of reading + 1.3 mA	
	10 A to 100 A (50 to 100) Hz 100 Hz to 1 kHz 1 kHz	0.038 % of reading + 2.3 mA 0.14 % of reading + 2.3 mA 0.12 % of reading + 2.3 mA	
AC Current – Measure ¹	Up to 10 A 50 Hz to 1 kHz 1 kHz	0.015 % of reading + 1.3 mA 0.12 % of reading + 1.3 mA	Ohms Labs CS-100 Precision Shunt w/ Agilent 3458A 8.5 Digit Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	Up to 220 μ A		Fluke 5700A-EP Multiproduct Calibrator
	(10 to 20) Hz	0.031 % of reading + 16 nA	
	(20 to 40) Hz	0.019 % of reading + 10 nA	
	40 Hz to 1 kHz	0.015 % of reading + 8 nA	
	(1 to 5) kHz	0.03 % of reading + 12 nA	
	(5 to 10) kHz	0.11 % of reading + 65 nA	
	(0.22 to 2.2) mA		
	(10 to 20) Hz	0.03 % of reading + 40 nA	
	(20 to 40) Hz	0.018 % of reading + 35 nA	
	40 Hz to 1 kHz	0.013 % of reading + 35 nA	
	(1 to 5) kHz	0.021 % of reading + 0.11 μ A	
	(5 to 10) kHz	0.11 % of reading + 0.65 μ A	
	(2.2 to 22) mA		
	(10 to 20) Hz	0.039 % of reading + 0.4 μ A	
	(20 to 40) Hz	0.019 % of reading + 0.35 μ A	
	40 Hz to 1 kHz	0.014 % of reading + 0.35 μ A	
	(1 to 5) kHz	0.021 % of reading + 0.55 μ A	
	(5 to 10) kHz	0.11 % of reading + 5 μ A	
AC Current – Source ¹	(22 to 220) mA		Fluke 5700A-EP Multiproduct Calibrator w/ Fluke 5725A Amplifier
	(10 to 20) Hz	0.033 % of reading + 4 μ A	
	(20 to 40) Hz	0.018 % of reading + 3.5 μ A	
	40 Hz to 1 kHz	0.014 % of reading + 2.5 μ A	
	(1 to 5) kHz	0.021 % of reading + 3.5 μ A	
AC Current – Source ¹	(5 to 10) kHz	0.11 % of reading + 10 μ A	Fluke 5522A Multiproduct Calibrator
	(0.22 to 2.2) A		
	20 Hz to 1 kHz	0.027 % of reading + 35 μ A	
	(1 to 5) kHz	0.046 % of reading + 80 μ A	
	(5 to 10) kHz	0.7 % of reading + 0.16 mA	
AC Current – Source ¹	(2.2 to 11) A		Ohms Labs CS-100 Precision Shunt w/ Agilent 3458A 8.5 Digit Multimeter and Current Source
	40 Hz to 1 kHz	0.048 % of reading + 0.17 mA	
	(1 to 5) kHz	0.096 % of reading + 0.38 mA	
	(5 to 10) kHz	0.36 % of reading + 0.75 mA	
AC Current – Source ¹	(11 to 20.5) A		Ohms Labs CS-100 Precision Shunt w/ Agilent 3458A 8.5 Digit Multimeter and Current Source
	(45 to 100) Hz	0.092 % of reading + 3.9 mA	
	100 Hz to 1 kHz	0.12 % of reading + 3.9 mA	
	(1 to 5) kHz	2.3 % of reading + 3.9 mA	
AC Current – Source ¹	(10 to 100) A		Ohms Labs CS-100 Precision Shunt w/ Agilent 3458A 8.5 Digit Multimeter and Current Source
	(50 to 60) Hz	0.22 mA/A + 5 mA	
	400 Hz	0.26 mA/A + 5 mA	
	1 kHz	1.1 mA/A + 1.3 mA	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source Extended Frequency Ranges ¹	29 μ A to 329.99 μ A (10 to 30) kHz 330 μ A to 3.299 mA (10 to 30) kHz 3.3 mA to 32.99 mA (10 to 30) kHz 33 mA to 329.99 mA (10 to 30) kHz	1.2 % of reading + 0.31 μ A 0.78 % of reading + 0.47 μ A 0.31 % of reading + 3.1 μ A 0.31 % of reading + 0.16 mA	Fluke 5522A Multiproduct Calibrator
AC Clamp-on Ammeters (Toroidal Type) Transformer Type Sensor ¹	(20 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 000) A (45 to 65) Hz (65 to 440) Hz	0.34 % of reading + 35 mA 0.95 % of reading + 66 mA 0.38 % of reading + 0.17 A 1.2 % of reading + 0.29 A	Fluke 5522A Multiproduct Calibrator w/ Fluke 5500A/Coil
AC Clamp-on Ammeters (Non-Toroidal Type) Hall Effect Sensor ¹	(20 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 000) A (45 to 65) Hz (65 to 440) Hz	0.66 % of reading + 0.26 A 1.2 % of reading + 0.29 A 0.68 % of reading + 1 A 1.4 % of reading + 1.1 A	
DC Resistance – Measure/Source ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	18 $\mu\Omega/\Omega$ + 58 $\mu\Omega$ 15 $\mu\Omega/\Omega$ + 0.58 m Ω 13 $\mu\Omega/\Omega$ + 0.58 m Ω 12 $\mu\Omega/\Omega$ + 5.8 m Ω 13 $\mu\Omega/\Omega$ + 58 m Ω 21 $\mu\Omega/\Omega$ + 2.3 Ω 62 $\mu\Omega/\Omega$ + 120 Ω 0.059 % of reading + 1.2 k Ω 0.82 % of reading + 12 k Ω	Agilent 3458A 8.5 Digit Multimeter w/ Decade Resistor
DC Resistance – Source ^{1,8} (Fixed Artifacts)	1 m Ω	50 $\mu\Omega/\Omega$	L&N 4223B Standard Resistor
	10 m Ω	52 $\mu\Omega/\Omega$	L&N 4222B Standard Resistor
	100 m Ω	0.15 m Ω/Ω	L&N 4015B Standard Resistor

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Resistance – Source (Variable Artifact) ^{1,8}	(100 to 1 000) kΩ (1 to 10) MΩ (10 to 100) MΩ (100 to 1 000) MΩ (1 to 10) GΩ (10 to 100) GΩ (100 to 1 000) GΩ	0.037 % of reading 0.037 % of reading + 1.2 μΩ/Ω/V 0.12 % of reading + 1.2 μΩ/Ω/V 0.24 % of reading + 1.2 μΩ/Ω/V 0.58 % of reading + 1.2 μΩ/Ω/V 1.2 % of reading + 2.3 μΩ/Ω/V 1.2 % of reading + 5.8 μΩ/Ω/V	IET HRRS-B-3-1G-5KV Decade Resistor
DC Resistance – RTD Measure ¹	(0 to 25) Ω (25 to 400) Ω 400 to 1 kΩ (1 to 40) kΩ	42 μΩ 1.3 μΩ/Ω 4.1 μΩ/Ω 10 μΩ/Ω	Hart 1590 Super Thermometer Readout
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	8.8 μV/V + 0.4 μV 5.1 μV/V + 0.7 μV 4 μV/V + 2.5 μV 3.9 μV/V + 4 μV 6.2 μV/V + 40 μV 7.6 μV/V + 0.4 mV	Fluke 5700A-EP Multiproduct Calibrator
DC Voltage – Measure ¹	Up to 100 mV (0.1 to 10) V (10 to 100) V (100 to 500) V (500 to 800) V (800 to 1 000) V	8.3 μV/V + 0.58 μV 5.3 μV/V + 0.58 μV 7.7 μV/V + 35 μV 15 μV/V + 0.12 mV 18 μV/V + 0.12 mV 21 μV/V + 0.12 mV	Agilent 3458A Opt. 002 8.5 Digit Multimeter
DC High Voltage – Measure ¹	(1 to 10) kV (10 to 35) kV (35 to 70) kV (70 to 100) kV	0.04 % of reading + 40 mV 0.064 % of reading + 66 mV 0.088 % of reading + 80 mV 0.17 % of reading + 0.92 V	Vitretek 4700 DVM w/ Associated High Voltage Probes
AC Voltage – Measure ¹	Up to 1 mV 100 kHz to 1 MHz (1 to 3) MHz (3 to 10) MHz (10 to 20) MHz (1 to 3) mV 100 kHz to 1 MHz (1 to 3) MHz (3 to 10) MHz (10 to 20) MHz	1.8 % of reading + 2.4 μV 3.5 % of reading + 2.4 μV 9.3 % of reading + 2.4 μV 23 % of reading + 2.4 μV 0.97 % of reading + 2 μV 3.5 % of reading + 2 μV 9.3 % of reading + 2 μV 23 % of reading + 2 μV	Rohde & Schwarz URE3 RMS Voltmeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(3 to 100) mV 100 kHz to 1 MHz (1 to 3) MHz (3 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.91 % of reading + 3 μ V 1.8 % of reading + 3 μ V 2.9 % of reading + 3 μ V 7 % of reading + 3 μ V 14 % of reading + 3 μ V	Rohde & Schwarz URE3 RMS Voltmeter
AC Voltage – Measure ¹	Up to 10 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 4) MHz (10 to 100) 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 (2 to 4) MHz (4 to 8) MHz (8 to 10) MHz (0.1 to 1) 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 (2 to 4) MHz (4 to 8) MHz (8 to 10) MHz	0.04 % of reading + 3.5 μ V 0.03 % of reading + 1.2 μ V 0.04 % of reading + 1.2 μ V 0.15 % of reading + 1.2 μ V 0.59 % of reading + 1.2 μ V 4.6 % of reading + 2.3 μ V 1.5 % of reading + 5.8 μ V 8.1 % of reading + 8.1 μ V 0.013 % of reading + 4.8 μ V 0.009 7 % of reading + 2.3 μ V 0.017 % of reading + 2.3 μ V 0.038 % of reading + 2.3 μ V 0.093 % of reading + 2.3 μ V 0.36 % of reading + 12 μ V 1.2 % of reading + 12 μ V 1.8 % of reading + 12 μ V 4.7 % of reading + 81 μ V 4.7 % of reading + 92 μ V 17 % of reading + 0.12 mV 0.008 8 % of reading + 46 μ V 0.008 3 % of reading + 23 μ V 0.017 % of reading + 23 μ V 0.036 % of reading + 23 μ V 0.093 % of reading + 23 μ V 0.35 % of reading + 0.12 mV 1.2 % of reading + 0.12 mV 1.8 % of reading + 0.12 mV 4.6 % of reading + 0.81 mV 4.6 % of reading + 0.92 mV 17 % of reading + 1.2 mV	Agilent 3458A 8.5 Digit Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(1 to 10) V		Agilent 3458A 8.5 Digit Multimeter
	(1 to 40) Hz	0.009 5 % of reading + 0.46 mV	
	40 Hz to 1 kHz	0.023 % of reading + 0.23 mV	
	(1 to 20) kHz	0.017 % of reading + 0.23 mV	
	(20 to 50) kHz	0.036 % of reading + 0.23 mV	
	(50 to 100) kHz	0.093 % of reading + 0.23 mV	
	(100 to 300) kHz	0.35 % of reading + 1.2 mV	
	300 kHz to 1 MHz	1.2 % of reading + 1.2 mV	
	(1 to 2) MHz	1.8 % of reading + 2 mV	
	(2 to 4) MHz	4.6 % of reading + 8.1 mV	
	(4 to 8) MHz	4.6 % of reading + 9.2 mV	
	(8 to 10) MHz	17 % of reading + 12 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.024 % of reading + 4.6 mV	
	40 Hz to 1 kHz	0.024 % of reading + 2.3 mV	
	(1 to 20) kHz	0.024 % of reading + 2.3 mV	
	(20 to 50) kHz	0.041 % of reading + 2.3 mV	
	(50 to 100) kHz	0.14 % of reading + 2.3 mV	
	(100 to 300) kHz	0.46 % of reading + 12 mV	
	300 kHz to 1 MHz	1.7 % of reading + 12 mV	
AC Voltage – Measure ¹	(100 to 700) V		Fluke 8508A 8.5 Digit Multimeter
	(1 to 40) Hz	0.048 % of reading + 46 mV	
	40 Hz to 1 kHz	0.048 % of reading + 23 mV	
	(1 to 20) kHz	0.071 % of reading + 23 mV	
	(20 to 50) kHz	0.19 % of reading + 23 mV	
	(50 to 100) kHz	0.35 % of reading + 23 mV	
AC Voltage – Measure ¹	(700 to 1 050) V		Vitrek 4700 DVM w/ Associated High Voltage Probes
	(1 to 10) Hz	0.034 % of reading + 62 mV	
	(10 to 40) Hz	0.03 % of reading + 19 mV	
	40 Hz to 10 kHz	0.03 % of reading + 19 mV	
	(10 to 30) kHz	0.11 % of reading + 39 mV	
	(30 to 100) kHz	0.16 % of reading + 0.19 V	
AC High Voltage – Measure/Source ¹	(1 to 10) kV		
	(10 to 200) Hz	0.14 % of reading + 0.17 V	
	(200 to 450) Hz	0.46 % of reading + 0.17 V	
	(450 to 600) Hz	0.86 % of reading + 0.17 V	
	(10 to 35) kV		
	(30 to 200) Hz	0.11 % of reading + 0.81 V	
	(200 to 450) Hz	0.7 % of reading + 0.81 V	
	(450 to 600) Hz	1.45 % of reading + 0.81 V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC High Voltage – Measure/Source ¹	(35 to 70) kV (30 to 100) Hz (100 to 450) Hz (450 to 600) Hz (70 to 100) kV (30 to 100) Hz (100 to 450) Hz (450 to 600) Hz	0.14 % of reading + 1.0 V 0.7 % of reading + 1.0 V 2.9 % of reading + 1.0 V 0.21 % of reading + 1.3 V 1.2 % of reading + 1.3 V 17 % of reading + 1.3 V	Vitrek 4700 DVM w/ Associated High Voltage Probes
AC Voltage – Source ¹	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 o 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (2.2 to 22) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 o 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (22 to 220) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 o 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.16 % of reading + 4 μ V 0.1 % of reading + 4 μ V 0.078 % of reading + 4 μ V 0.13 % of reading + 4 μ V 0.17 % of reading + 5 μ V 0.33 % of reading + 10 μ V 0.47 % of reading + 20 μ V 0.58 % of reading + 20 μ V 0.042 % of reading + 4 μ V 0.03 % of reading + 4 μ V 0.014 % of reading + 4 μ V 0.3 % of reading + 4 μ V 0.058 % of reading + 5 μ V 0.12 % of reading + 10 μ V 0.16 % of reading + 20 μ V 0.27 % of reading + 20 μ V 0.028 % of reading + 12 μ V 0.011 % of reading + 7 μ V 0.008 5 % of reading + 7 μ V 0.021 % of reading + 7 μ V 0.047 % of reading + 17 μ V 0.091 % of reading + 20 μ V 0.14 % of reading + 25 μ V 0.28 % of reading + 45 μ V	Fluke 5700A-EP Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	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	0.027 % of reading + 40 μ V 0.01 % of reading + 15 μ V 0.004 8 % of reading + 8 μ V 0.008 % of reading + 10 μ V 0.012 % of reading + 30 μ V 0.043 % of reading + 80 μ V 0.1 % of reading + 0.2 mV 0.18 % of reading + 0.3 mV	Fluke 5700A-EP Multiproduct Calibrator
	(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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.028 % of reading + 0.4 mV 0.01 % of reading + 0.15 mV 0.004 9 % of reading + 50 μ V 0.008 3 % of reading + 0.1 mV 0.011 % of reading + 0.2 mV 0.03 % of reading + 0.6 mV 0.1 % of reading + 2 mV 0.17 % of reading + 3.2 mV 0.028 % of reading + 4 mV 0.01 % of reading + 1.5 mV 0.005 6 % of reading + 0.6 mV 0.009 3 % of reading + 1 mV 0.016 % of reading + 2.5 mV 0.09 % of reading + 16 mV 0.44 % of reading + 40 mV 0.8 % of reading + 80 mV	
AC Voltage – Source ¹	(220 to 1 100) V 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz (30 to 50) kHz (50 to 100) kHz	0.011 % of reading + 4 mV 0.017 % of reading + 6 mV 0.061 % of reading + 11 mV 0.061 % of reading + 11 mV 0.23 % of reading + 45 mV	Fluke 5700A-EP Calibrator w/ Fluke 5725A Amplifier
Capacitance – Measure ¹	1 kHz Up to 10 pF (10 to 100) pF 100 pF to 25 μ F (25 to 100) μ F (100 to 1 000) μ F	0.47 % of reading + 0.05 pF 0.06 % of reading + 0.05 pF 0.02 % of reading + 0.05 pF 0.03 % of reading 0.24 % of reading	GenRad 1689-9700 RLC Digibridge

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Measure	0.1 pF		Agilent E4980A LCR Meter
	100 kHz	1.4 % of reading	
	1 MHz	1.8 % of reading	
	1 pF		
	10 kHz	1.4 % of reading	
	100 kHz	0.37 % of reading	
	1 MHz	0.44 % of reading	
	2 MHz	1.1 % of reading	
	10 pF		
	1 kHz	1.4 % of reading	
	10 kHz	0.28 % of reading	
	100 kHz	0.28 % of reading	
	1 MHz	0.3 % of reading	
	2 MHz	0.75 % of reading	
	100 pF		
	100 Hz	2.1 % of reading	
	1 kHz	0.23 % of reading	
	10 kHz	0.18 % of reading	
	100 kHz	0.21 % of reading	
	1 MHz	0.23 % of reading	
	2 MHz	0.3 % of reading	
	1 nF		
	20 Hz	1.8 % of reading	
	100 Hz	0.3 % of reading	
	1 kHz	0.1 % of reading	
	10 kHz	0.1 % of reading	
	100 kHz	0.1 % of reading	
	1 MHz	0.14 % of reading	
	2 MHz	0.53 % of reading	
	10 nF		
	20 Hz	0.31 % of reading	
	100 Hz	0.12 % of reading	
	1 kHz	0.1 % of reading	
	10 kHz	0.1 % of reading	
	100 kHz	0.1 % of reading	
	1 MHz	0.25 % of reading	
	2 MHz	0.67 % of reading	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Measure	100 nF		Agilent E4980A LCR Meter
	20 Hz	0.16 % of reading	
	100 Hz	0.1 % of reading	
	1 kHz	0.1 % of reading	
	10 kHz	0.1 % of reading	
	100 kHz	0.18 % of reading	
	1 MHz	0.33 % of reading	
	2 MHz	0.97 % of reading	
	1 μ F		
	20 Hz	0.15 % of reading	
	100 Hz	0.09 % of reading	
	1 kHz	0.09 % of reading	
	10 kHz	0.18 % of reading	
	100 kHz	0.25 % of reading	
	1 MHz	0.79 % of reading	
	10 μ F		
	20 Hz	0.15 % of reading	
	100 Hz	0.09 % of reading	
	1 kHz	0.16 % of reading	
	10 kHz	0.28 % of reading	
	100 kHz	0.73 % of reading	
	100 μ F		
	20 Hz	0.16 % of reading	
	100 Hz	0.17 % of reading	
	1 kHz	0.29 % of reading	
	10 kHz	0.8 % of reading	
Capacitance – Source ¹ (Simulation)	190 pF to 1.1 nF	0.39 % of reading + 7.8 pF	Fluke 5520A/1100 Multiproduct Calibrator
	(1.1 to 3.3) nF	0.39 % of reading + 7.8 pF	
	(3.3 to 11) nF	0.21 % of reading + 7.8 pF	
	(11 to 110) nF	0.21 % of reading + 78 pF	
	(110 to 330) nF	0.21 % of reading + 0.23 nF	
	330 nF to 1.1 μ F	0.2 % of reading + 0.78 nF	
	(1.1 to 3.3) μ F	0.2 % of reading + 2.3 nF	
	(3.3 to 11) μ F	0.2 % of reading + 7.8 nF	
	(11 to 33) μ F	0.32 % of reading + 23 nF	
	(33 to 110) μ F	0.35 % of reading + 78 nF	
	(110 to 330) μ F	0.35 % of reading + 0.23 μ F	
	330 μ F to 1.1 mF	0.35 % of reading + 0.78 μ F	
	(1.1 to 3.3) mF	0.35 % of reading + 2.3 μ F	
	(3.3 to 11) mF	0.35 % of reading + 7.8 μ F	
	(11 to 33) mF	0.59 % of reading + 23 μ F	
	(33 to 110) mF	0.86 % of reading + 78 μ F	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ^{1,8} (Fixed Artifacts)	1 kHz 1 nF 2 nF 5 nF 10 nF 20 nF 50 nF 0.1 µF 0.2 µF 0.5 µF 1 µF	0.32 pF 0.59 pF 1.4 pF 2.7 pF 5.4 pF 13 pF 38 pF 76 pF 0.19 nF 0.38 nF	GenRad 1409 Series Standard Capacitors, GenRad 1689-9700 RLC Digibridge
Inductance – Measure ¹	100 Hz to 1 kHz (1 to 10) mH 10 mH to 10 H	0.026 % of reading + 0.1 µH 0.026 % of reading + 1.4 µH	GenRad 1689-9700 RLC Digibridge
Inductance – Measure	1 µH 10 kHz 100 kHz 1 MHz 2 MHz 10 µH 10 kHz 100 kHz 1 MHz 2 MHz 100 µH 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz 1 mH 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	1.6 % of reading 0.36 % of reading 0.27 % of reading 0.66 % of reading 0.37 % of reading 0.20 % of reading 0.20 % of reading 0.30 % of reading 0.40 % of reading 0.20 % of reading 0.12 % of reading 0.14 % of reading 0.72 % of reading 0.55 % of reading 0.18 % of reading 0.12 % of reading 0.09 % of reading 0.23 % of reading 0.88 % of reading	Agilent E4980A LCR Meter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Measure	10 mH		Agilent E4980AL LCR Meter
	20 Hz	0.85 % of reading	
	100 Hz	0.22 % of reading	
	1 kHz	0.09 % of reading	
	10 kHz	0.09 % of reading	
	100 kHz	0.10 % of reading	
	1 MHz	0.35 % of reading	
	2 MHz	1.3 % of reading	
	100 mH		
	20 Hz	0.28 % of reading	
	100 Hz	0.10 % of reading	
	1 kHz	0.09 % of reading	
	10 kHz	0.09 % of reading	
	100 kHz	0.21 % of reading	
	1 MHz	0.88 % of reading	
	1 H		
	20 Hz	0.16 % of reading	
	100 Hz	0.09 % of reading	
	1 kHz	0.09 % of reading	
	10 kHz	0.10 % of reading	
	100 kHz	0.31 % of reading	
	10 H		
	20 Hz	0.15 % of reading	
	100 Hz	0.10 % of reading	
	1 kHz	0.11 % of reading	
	10 kHz	0.21 % of reading	
	100 kHz	0.69 % of reading	
	100 H		
	20 Hz	0.15 % of reading	
	100 Hz	0.10 % of reading	
	1 kHz	0.15 % of reading	
	10 kHz	0.62 % of reading	
AC Resistance – Measure	0.1 Ω		Agilent E4980A LCR Meter
	1 kHz	1.8 % of reading	
	10 kHz	1.6 % of reading	
	100 kHz	1.0 % of reading	
	1 MHz	1.5 % of reading	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance – Measure	1 Ω		Agilent E4980A LCR Meter
	20 Hz	0.67 % of reading	
	100 Hz	0.43 % of reading	
	1 kHz	0.33 % of reading	
	10 kHz	0.32 % of reading	
	100 kHz	0.31 % of reading	
	1 MHz	0.38 % of reading	
	2 MHz	0.92 % of reading	
	10 Ω		
	20 Hz	0.29 % of reading	
	100 Hz	0.20 % of reading	
	1 kHz	0.17 % of reading	
	10 kHz	0.19 % of reading	
	100 kHz	0.19 % of reading	
	1 MHz	0.27 % of reading	
	2 MHz	0.67 % of reading	
	100 Ω		
	20 Hz	0.16 % of reading	
	100 Hz	0.09 % of reading	
	1 kHz	0.09 % of reading	
	10 kHz	0.12 % of reading	
	100 kHz	0.12 % of reading	
	1 MHz	0.2 % of reading	
	2 MHz	0.53 % of reading	
	1 k Ω		
	20 Hz	0.15 % of reading	
	100 Hz	0.09 % of reading	
	1 kHz	0.09 % of reading	
	10 kHz	0.09 % of reading	
	100 kHz	0.09 % of reading	
	1 MHz	0.14 % of reading	
	2 MHz	0.3 % of reading	
	10 k Ω		
	20 Hz	0.15 % of reading	
	100 Hz	0.09 % of reading	
	1 kHz	0.09 % of reading	
	10 kHz	0.09 % of reading	
	100 kHz	0.1 % of reading	
	1 MHz	0.29 % of reading	
	2 MHz	0.87 % of reading	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance – Measure	100 k Ω		Agilent E4980AL LCR Meter
	20 Hz	0.17 % of reading	
	100 Hz	0.1 % of reading	
	1 kHz	0.1 % of reading	
	10 kHz	0.17 % of reading	
	100 kHz	0.28 % of reading	
	1 MHz	0.38 % of reading	
Inductance – Source ¹ (Fixed Artifacts)	2 MHz	1.3 % of reading	Standard Inductors characterized with GenRad 1689-9700 RLC DigiBridge
	100 μ H	25 nH	
	1 mH	0.25 μ H	
	10 mH	2.5 μ H	
	100 mH	25 μ H	
	1 H	0.25 mH	
Electrical Simulation of Thermocouple Indicating Devices – Measure/Source ¹	10 H	2.5 mH	Ectron 1140A Thermocouple Calibrator/Simulator
	Type B		
	(250 to 350) °C	1.2 °C	
	(350 to 445) °C	0.9 °C	
	(445 to 580) °C	0.71 °C	
	(580 to 750) °C	0.55 °C	
	(750 to 1 000) °C	0.45 °C	
	(1 000 to 1 820) °C	0.35 °C	
	Type C		
	(0 to 250) °C	0.24 °C	
	(250 to 1 000) °C	0.19 °C	
	(1 000 to 1 500) °C	0.21 °C	
	(1 500 to 1 800) °C	0.24 °C	
	(1 800 to 2 000) °C	0.27 °C	
	(2 000 to 2 250) °C	0.33 °C	
	(2 250 to 2 315) °C	0.37 °C	
	Type E		
	(-270 to -245) °C	1.6 °C	
	(-245 to -195) °C	0.24 °C	
	(-195 to -155) °C	0.12 °C	
	(-155 to -90) °C	0.09 °C	
	(-90 to 0) °C	0.08 °C	
	(0 to 15) °C	0.08 °C	
	(15 to 890) °C	0.06 °C	
	(890 to 1 000) °C	0.07 °C	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Devices – Measure/Source ¹	Type J		Ectron 1140A Thermocouple Calibrator/Simulator
	(-210 to -180) °C	0.15 °C	
	(-180 to -120) °C	0.12 °C	
	(-120 to -50) °C	0.09 °C	
	(-50 to 990) °C	0.08 °C	
	(990 to 1 200) °C	0.09 °C	
	Type K		
	(-270 to -255) °C	2.5 °C	
	(-255 to -195) °C	0.85 °C	
	(-195 to -115) °C	0.16 °C	
	(-115 to -55) °C	0.12 °C	
	(-55 to 1 000) °C	0.09 °C	
	(1 000 to 1 372) °C	0.1 °C	
	Type N		
	(-270 to -260) °C	5.4 °C	
	(-260 to -200) °C	1.5 °C	
	(-200 to -140) °C	0.29 °C	
	(-140 to -70) °C	0.18 °C	
	(-70 to 25) °C	0.14 °C	
	(25 to 160) °C	0.12 °C	
	(160 to 1 300) °C	0.11 °C	
	Type R		
	(-50 to -30) °C	0.8 °C	
	(-30 to 45) °C	0.69 °C	
	(45 to 160) °C	0.49 °C	
	(160 to 380) °C	0.35 °C	
	(380 to 775) °C	0.3 °C	
	(775 to 1 768) °C	0.26 °C	
	Type S		
	(-50 to -30) °C	0.76 °C	
	(-30 to 45) °C	0.68 °C	
	(45 to 105) °C	0.49 °C	
	(105 to 310) °C	0.41 °C	
	(310 to 615) °C	0.35 °C	
	(615 to 1 768) °C	0.31 °C	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Devices – Measure/Source ¹	Type T (-270 to -255) °C (-255 to -240) °C (-240 to -210) °C (-210 to -150) °C (-150 to -40) °C (-40 to 100) °C (100 to 400) °C	1.9 °C 0.6 °C 0.36 °C 0.22 °C 0.15 °C 0.09 °C 0.08 °C	Ectron 1140A Thermocouple Calibrator/Simulator
Scope Voltage – Source ¹ DC Signal into 50 Ω into 1 MΩ	(-5.0 to 5.0) V (-200 to 200) V	0.023 % of reading + 19 μV 0.023 % of reading + 19 μV	Fluke 9500B Oscilloscope Calibrator
Scope Voltage – Source ¹ Square Wave 10 Hz to 100 kHz into 50 Ω 10 Hz to 10 kHz into 1 MΩ 10 Hz to 100 kHz into 1 MΩ	40 μVp-p to 1 mVp-p 1 mVp-p to 5 Vp-p 40 μVp-p to 1 mVp-p 1 mVp-p to 200 Vp-p	0.78 % of reading + 7.8 μV 0.08 % of reading + 7.8 μV 0.78 % of reading + 7.8 μV 0.08 % of reading + 7.8 μV	Fluke 9500B Oscilloscope Calibrator
Scope – Time Markers ¹ 100 mVp-p to 1 Vp-p (into 50 Ω) Square Wave Sine Wave Pulse Triangle Wave	9.009 1 ns to 83 μs 83 μs to 55 s 450.5 ps to 9.009 ns 900.91 ns to 83 μs 83 μs to 55 s 900.91 ns to 83 μs 83 μs to 55 s	0.19 μs/s 2.3 μs/s 0.19 μs/s 0.19 μs/s 2.3 μs/s 0.19 μs/s 2.3 μs/s	Fluke 9500B Oscilloscope Calibrator
Rise Time – Measure ¹	≥ 350 ps	28 ps	Rigol MSO8104 Digital Oscilloscope
Scope Rise Time – Source ^{1,4} (into 50 Ω) 10 Hz to 2 MHz 10 Hz to 1 MHz	5 mVp-p to 3 Vp-p 500 ps (Nominal) 150 ps (Nominal) 25 mVp-p to 2 Vp-p 70 ps (Nominal)	290 ps 35 ps 24 ps	Fluke 9500B Oscilloscope Calibrator with Fluke 9530 Active Head

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scope Rise Time – Source ^{1,4} (into 50 Ω) 10 Hz to 1 MHz	425 mVp-p to 2 Vp-p 25 ps (Nominal)	6.7 ps	Fluke 9500B Oscilloscope Calibrator with Fluke 9530 Active Head
Scope Leveled Sine Wave – Source ¹ (50 kHz Ref. Frequency) into 50 Ω	5 mVp-p to 5 Vp-p 50 kHz to 10 MHz	1.2 % of reading	Fluke 9500B Oscilloscope Calibrator with Fluke 9530 Active Head
Scope Bandwidth/Flatness – Source ¹ into VSWR (1.2:1) (wrt Reference Frequency)	5 mVp-p to 5 Vp-p 0.1 Hz to 300 MHz (300 to 550) MHz 5 mVp-p to 3 Vp-p 550 MHz to 2.5 GHz 5 mVp-p to 2 Vp-p (2.5 to 3.2) GHz	1.6 % of reading 1.9 % of reading 2.7 % of reading 3.1 % of reading	Fluke 9500B Oscilloscope Calibrator with Fluke 9530 Active Head
Scope Input Impedance – Measure ¹	(10 to 40) Ω (40 to 90) Ω (90 to 150) Ω (50 to 800) k Ω 800 k Ω to 1.2 M Ω (1.2 to 12) M Ω	0.39 % of reading 0.08 % of reading 0.39 % of reading 0.39 % of reading 0.08 % of reading 0.39 % of reading	Fluke 9500B Oscilloscope Calibrator
Scope Input Capacitance – Measure ¹	(1 to 35) pF (35 to 95) pF	1.6 % of reading + 0.19 pF 2.3 % of reading + 0.19 pF	Fluke 9500B/3200 Oscilloscope Calibrator
AC Voltage Harmonics – Source ^{1,3} Carrier Range: 45 V Carrier Range: 90 V Carrier Range: 180 V	Up to 13.5 V (16 to 850) Hz 850 Hz to 6.5 kHz Up to 27 V (16 to 850) Hz 850 Hz to 6.5 kHz Up to 54 V (16 to 850) Hz 850 Hz to 6.5 kHz	67 μ V/V + 2 mV 0.52 mV + 2 mV 69 μ V/V + 2 mV 0.52 mV + 2 mV 69 μ V/V + 6 mV 0.52 mV + 6 mV	Fluke 6105A Electrical Power Quality Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Harmonics – Source ^{1,3} Carrier Range: Up to 360 V Carrier Range: 650 V Carrier Range: 1 008 V	Up to 108 V (16 to 850) Hz 850 Hz to 6.5 kHz Up to 195 V (16 to 850) Hz 850 Hz to 6.5 kHz Up to 302 V (16 to 850) Hz 850 Hz to 6.5 kHz	69 μ V/V + 13 mV 0.52 mV/V + 13 mV 70 μ V/V + 22 mV 0.52 mV/V + 22 mV 70 μ V/V + 33 mV 0.52 mV/V + 33 mV	Fluke 6105A Electrical Power Quality Calibrator
AC Current Harmonics – Source ^{1,3} Carrier Range: 0.25 A Carrier Range: 0.5 A Carrier Range: 1 A Carrier Range: 2 A Carrier Range: 5 A Carrier Range: 10 A Carrier Range: 20 A	Up to 75 mA (16 to 850) Hz 850 Hz to 6.5 kHz Up to 0.15 A (16 to 850) Hz 850 Hz to 6.5 kHz Up to 0.3 A (16 to 850) Hz 850 Hz to 6.5 kHz Up to 0.6 A (16 to 850) Hz 850 Hz to 6.5 kHz Up to 1.5 A (16 to 850) Hz 850 Hz to 6.5 kHz Up to 3 A (16 to 850) Hz 850 Hz to 6.5 kHz Up to 6 A (16 to 850) Hz 850 Hz to 6.5 kHz	61 μ A/A + 21 μ A 0.46 mA/A + 22 μ A 70 μ A/A + 21 μ A 0.46 mA/A + 23 μ A 70 μ A/A + 29 μ A 0.46 mA/A + 29 μ A 70 μ A/A + 0.1 mA 0.46 mA/A + 0.1 mA 70 μ A/A + 0.1 mA 0.46 mA/A + 0.1 mA 74 μ A/A + 0.29 mA 0.46 mA/A + 0.29 mA 75 μ A/A + 0.45 mA 0.46 mA/A + 0.45 mA	Fluke 6105A Electrical Power Quality Calibrator
LF Phase – Source ¹	(0 to 90) ° (10 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.09 ° 0.2 ° 0.39 ° 1.9 ° 3.9 ° 7.8 °	Fluke 5520A/1100 Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Power – Source ¹ (0.33 to 330) mA (0.33 to 3) A (3 to 20.5) A	11 μ W to 330 W 11 W to 3 kW 99 mW to 20.9 kW	0.018 % of reading 0.017 % of reading 0.054 % of reading	Fluke 5520A/1100 Multiproduct Calibrator
AC Power – Source 1,4 PF = 1 3.3 mA to 3 A 3.3 mA to 20.5 A 33 mA to 3 A 33 mA to 20.5 A (3 to 20.5) A	(10 to 45) Hz 0.11 mW to 99 W (45 to 65) Hz 0.11 mW to 20.9 kW (65 to 500) Hz 11 mW to 3.06 kW 500 Hz to 1 kHz 11 mW to 20.9 kW (65 to 500) Hz 9.9 W to 20.9 kW	0.18 % of reading 0.14 % of reading 0.16 % of reading 0.17 % of reading 0.16 % of reading	Fluke 5520A/11 Multiproduct Calibrator
AC Power – Source ^{1,5} PF = 1 (0.5 to 20) A	(65 to 850) Hz 23 W to 13 kW	0.024 % of reading	Fluke 6105A Electrical Power Quality Calibrator

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Attenuation – Source ¹	DC to 12.4 GHz		Agilent 8496H Programmable Attenuator w/ Type -N
	1 dB	0.3 dB	
	2 dB	0.3 dB	
	3 dB	0.4 dB	
	4 dB	0.4 dB	
	5 dB	0.5 dB	
	6 dB	0.5 dB	
	7 dB	0.6 dB	
	8 dB	0.6 dB	
	9 dB	0.6 dB	
	10 dB	0.6 dB	
	11 dB	0.7 dB	
	(12.4 to 18) GHz		
	1 dB	0.7 dB	
	2 dB	0.7 dB	
	3 dB	0.7 dB	
	4 dB	0.7 dB	
	5 dB	0.8 dB	
	6 dB	0.8 dB	
	7 dB	0.8 dB	
	8 dB	0.8 dB	
	9 dB	0.9 dB	
	10 dB	0.9 dB	
	11 dB	0.5 dB	
Attenuation – Source ¹	DC to 12.4 GHz		Agilent 8496H Programmable Attenuator w/ Type -N
	10 dB	0.5 dB	
	20 dB	0.7 dB	
	30 dB	0.9 dB	
	40 dB	1.2 dB	
	50 dB	1.5 dB	
	60 dB	1.8 dB	
	70 dB	2.1 dB	
	80 dB	2.4 dB	
	90 dB	2.7 dB	
	100 dB	3 dB	
	110 dB	3.3 dB	

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Attenuation – Source ¹	(12.4 to 18) GHz		Agilent 8496H Programmable Attenuator w/ Type -N
	10 dB	0.6 dB	
	20 dB	0.8 dB	
	30 dB	1.2 dB	
	40 dB	1.6 dB	
	50 dB	2 dB	
	60 dB	2.4 dB	
	70 dB	2.8 dB	
	80 dB	3.2 dB	
	90 dB	3.6 dB	
	100 dB	4 dB	
	110 dB	4.4 dB	
RF Absolute Power – Measure ¹	10 Hz to 20 kHz (-10 to 30) dBm	0.13 % of reading	Fluke 8846A Multimeter
	9 kHz to 18 GHz (-60 to 20) dBm	2.6 % of reading	Agilent E9304A-H18 RF Power Sensor w/ RF Power Meter
	(18 to 40) GHz (-70 to -30) dBm	3.8 % of reading	Agilent 8487D RF Power Sensor w/ RF Power Meter
	(40 to 50) GHz (-70 to -30) dBm	5.5 % of reading	
	(18 to 40) GHz (-30 to 20) dBm	4.4 % of reading	Agilent 8487D RF Power Sensor w/ RF Power Meter
	(40 to 50) GHz (-30 to 20) dBm	5.5 % of reading	
RF Absolute Power – Source ¹	30 MHz to 50 GHz (20 to 30) dBm	4.8 % of reading	Agilent E5532A-550 RF Power Sensor Module w/ RF Power Meter
	(-70 to -10) dBm		Agilent E8257D Analog Signal Generator
	250 kHz to 2 GHz	0.8 dB	
	(2 to 20) GHz	1.1 dB	
	(20 to 40) GHz	1.2 dB	
	(40 to 50) GHz	1.8 dB	
	(-10 to 0) dBm		
	250 kHz to 2 GHz	0.7 dB	
	(2 to 20) GHz	0.9 dB	
	(20 to 40) GHz	1.1 dB	
	(40 to 50) GHz	1.1 dB	

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Source ¹	(0 to 10 dBm)		Agilent E8257D Analog Signal Generator
	250 kHz to 2 GHz	0.7 dB	
	(2 to 20) GHz	0.9 dB	
	(20 to 40) GHz	1.1 dB	
	(40 to 50) GHz	1.5 dB	
	(10 to 14 dBm)		
	250 kHz to 2 GHz	0.7 dB	
	(2 to 20) GHz	0.9 dB	
	(20 to 40) GHz	1.2 dB	
	(14 to 19 dBm)		
	250 kHz to 2 GHz	0.9 dB	
	(2 to 20) GHz	0.9 dB	
	(20 to 40) GHz	1.2 dB	
RF Relative Power – Measure ¹ (Tuned RF Level)	100 kHz to 50 GHz		Agilent E4448A Spectrum Analyzer
	(-10 to 0) dB	0.02 dB	
	(-20 to -10) dB	0.02 dB	
	(-30 to -20) dB	0.03 dB	
	(-40 to -30) dB	0.04 dB	
	(-50 to -40) dB	0.04 dB	
	(-60 to -50) dB	0.09 dB	
	(-70 to -60) dB	0.10 dB	
	(-80 to -70) dB	0.14 dB	
	(-90 to -80) dB	0.15 dB	
	100 kHz to 45 GHz		
	(-100 to -90) dB	0.16 dB	
	(-110 to -100) dB	0.29 dB	
	100 kHz to 31.15 GHz		
	(-120 to -110) dB	0.29 dB	
	(-130 to -120) dB	0.29 dB	
S11/S22 Reflection Magnitude – Measure ¹ (Linear)	9 kHz to 10 MHz		Agilent E5071C Network Analyzer (Corrected with Agilent 85032F Calibration Kit)
	(0 to 0.5) lin	0.009	
	(0.5 to 1) lin	0.019	
	10 MHz to 9 GHz		
	(0 to 0.5) lin	0.012	Agilent E5235A Network Analyzer (Corrected with Agilent 85056K Calibration Kit)
	(0.5 to 1) lin	0.022	
	50 MHz to 2 GHz		
	(0 to 0.5) lin	0.015	
	(0.5 to 1) lin	0.023	
	(2 to 40) GHz		
	(0 to 0.5) lin	0.028	
	(0.5 to 1) lin	0.04	

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
S12/S21 Transmission Magnitude – Measure ¹ (dB)	9 kHz to 10 MHz (-30 to 0) dB (-60 to -30) dB	0.09 dB 0.45 dB	Agilent E5071C Network Analyzer (Corrected with Agilent 85032F Calibration Kit)
	10 MHz to 9 GHz (-30 to 0) dB (-60 to -30) dB	0.09 dB 0.26 dB	
	(10 to 500) MHz (-30 to 0) dB (-60 to -30) dB	0.07 dB 1.6 dB	Agilent E5235A Network Analyzer (Corrected with Agilent 85056K Calibration Kit)
	500 MHz to 2 GHz (-30 to 0) dB (-60 to -30) dB (2 to 50) GHz (-30 to 0) dB (-60 to -30) dB	0.05 dB 0.18 dB 0.14 dB 0.55 dB	
Amplitude Modulation – AM Depth Measure ¹ Rate: 100 kHz to 20 MHz	50 Hz to 10 kHz (5 to 99) % Depth	0.9 % Depth	Agilent E4448A Spectrum Analyzer
10 MHz to 3 GHz	50 Hz to 100 kHz (5 to 20) % Depth (20 to 99) % Depth	0.8 % Depth 2.6 % Depth	
(3 to 26.5) GHz	50 Hz to 100 kHz (5 to 20) % Depth (20 to 99) % Depth	1.6 % Depth 4.5 % Depth	
(26.5 to 31.15) GHz	50 Hz to 100 kHz (5 to 20) % Depth (20 to 99) % Depth	2.1 % Depth 6.8 % Depth	
Amplitude Modulation – AM Depth Measure ¹ Rate: (31.15 to 50) GHz	50 Hz to 100 kHz (5 to 20) % Depth (20 to 99) % Depth	6 % Depth 26 % Depth	Agilent E4448A Spectrum Analyzer

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation Distortion – Measure ¹ 100 kHz to 10 kHz 10 MHz to 26.5 GHz (26.5 to 50) GHz	20 Hz to 1 kHz > 1 % > 3 % 20 Hz to 1 kHz > 1 % > 3 % 20 Hz to 1 kHz > 1 % > 3 % > 5 %	0.85 % of reading 0.42 % of reading 1 % of reading 0.5 % of reading 6.2 % of reading 2 % of reading 1.5 % of reading	Agilent E4448A Spectrum Analyzer
Amplitude Modulation – AM Depth – Source ¹ 250 kHz to 50 GHz	(0 to 90) % Depth	6.6 % Depth	Agilent E8257D Analog Signal Generator
Frequency Modulation Deviation – Measure ¹ Rate: 250 kHz to 10 MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 31.15) GHz (31.5 to 50) GHz	20 Hz to 10 kHz Dev/Rate > 0.2 Dev/Rate > 1.2 50 Hz to 200 kHz Dev/Rate > 0.2 Dev/Rate > 0.45 50 Hz to 200 kHz Dev/Rate > 0.2 Dev/Rate > 8 50 Hz to 200 kHz Dev/Rate > 0.2 Dev/Rate > 16 50 Hz to 200 kHz Dev/Rate > 0.2 Dev/Rate > 32	1.5 % Deviation 1 % Deviation 1.5 % Deviation 1 % Deviation 2.5 % Deviation 1 % Deviation 3.8 % Deviation 1 % Deviation 8.5 % Deviation 1 % Deviation	Agilent E4448A Spectrum Analyzer
Frequency Modulation Distortion – Measure ¹ 1 MHz to 6.6 GHz	20 Hz to 1 kHz Dev 500 Hz to 2 kHz Dev ≥ 2 kHz	0.3 % of reading 0.11 % of reading	Agilent E4448A Spectrum Analyzer

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation Distortion – Measure ¹ (6.6 to 13.2) GHz (13.2 to 31.15) GHz (31.5 to 50) GHz	20 Hz to 1 kHz Dev > 2.3 kHz Dev ≥ 4.5 kHz 20 Hz to 1 kHz Dev > 2.7 kHz Dev ≥ 6 kHz 20 Hz to 1 kHz Dev > 4 kHz Dev ≥ 12 kHz	0.3 % of reading 0.11 % of reading 0.31 % of reading 0.12 % of reading 0.32 % of reading 0.14 % of reading	Agilent E4448A Spectrum Analyzer
Frequency Modulation – Deviation Source ¹ 250 kHz to 50 GHz	DC to 10 MHz Dev ≤ 128 MHz	3.9 % Deviation	Agilent E8257D Analog Signal Generator
Phase Modulation Deviation – Measure ¹ Rate: 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz (26.5 to 31.15) GHz (31.15 to 50) GHz	> 0.7 rad > 0.3 rad > 2 rad > 0.6 rad > 4.0 rad > 1.2 rad > 4 rad > 1.3 rad > 8 rad > 2.4 rad	1.1 % Deviation 3.2 % Deviation 1.1 % Deviation 3.2 % Deviation 1.1 % Deviation 3.2 % Deviation 1.1 % Deviation 3.2 % Deviation 1.1 % Deviation 3.2 % Deviation	
Phase Modulation Distortion – Measure ¹ 1 MHz to 6.6 GHz (6.6 to 13.2) GHz	(20 to 500) Hz > 0.8 rad ≥ 2.5 rad 500 Hz to 1 kHz > 0.4 rad ≥ 1.0 rad (20 to 500) Hz > 1.8 rad ≥ 5.5 rad 500 Hz to 1 kHz ≥ 0.8 rad ≥ 2.5 rad	0.31 % of reading 0.13 % of reading 0.31 % of reading 0.13 % of reading 0.31 % of reading 0.13 % of reading 0.31 % of reading 0.13 % of reading	Agilent E4448A Spectrum Analyzer

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation Distortion – Measure ¹ (13.2 to 31.15) GHz (31.15 to 50) GHz	(20 to 500) Hz > 3.5 rad ≥ 10 rad (20 to 500) Hz > 7.5 rad ≥ 19 rad 500 Hz to 1 kHz > 3 rad ≥ 8 rad	0.31 % of reading 0.13 % of reading 0.31 % of reading 0.13 % of reading 0.31 % of reading 0.13 % of reading	Agilent E4448A Spectrum Analyzer
Phase Modulation Distortion – Source ¹	(250 to 500) MHz (0 to 10) rad 500 MHz to 1 GHz (0 to 20) rad (1 to 2) GHz (0 to 40) rad (2 to 3.2) GHz (0 to 80) rad (3.2 to 10) GHz (0 to 160) rad (10 to 20) GHz (0 to 320) rad (20 to 40) GHz (0 to 640) rad (40 to 50) GHz (0 to 1 280) rad	5.8 % of reading 5.8 % of reading 5.8 % of reading 5.8 % of reading 5.8 % of reading 5.8 % of reading 5.8 % of reading 5.8 % of reading	Agilent E8257D Analog Signal Generator
Single Sideband Phase Noise – Measure ¹ CW Frequency:	Markers: 100 Hz to 1 MHz 100 Hz to 1 MHz 100 Hz to 1 MHz 100 Hz to 1 MHz 100 Hz to 1 MHz 100 Hz to 1 MHz	0.6 dB 1 dB 1.6 dB 1.7 dB 1.1 dB 1.4 dB	Agilent E4448A Spectrum Analyzer
Total Harmonic Distortion – Measure ¹ (-100 to 0) dB	10 Hz to 100 kHz 20 Hz to 20 kHz (20 to 100) kHz	8.4 % of reading 1.1 dB 2 dB	Agilent U8903A Audio Analyzer

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Total Harmonic Distortion – Measure ¹ Rate: 5 Hz to 600 kHz Level: (0.3 to 100) %	10 Hz to 1 MHz (1 to 3) MHz	3 % of reading 6 % of reading	Agilent 334A Distortion Analyzer

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle Measuring Devices ² (Protractors, Inclinometers, Squares, Angle Gages)	5° (5 to 20)° (20 to 35)° (35 to 45)° (45 to 60)° (60 to 75)° (75 to 85)°	1.4" 2.1" 3.5" 4.9" 8.3" 18" 54"	10 in Sine Bar, Gage Blocks, Surface Plate
	≥ 90°	1.9"	Master Square, Surface Plate
Micrometers ^{1,2} Outside, Inside, Depth	(0.05 to 1) in (1 to 9) in	(13 + 1L) μin (9 + 4L) μin	Grade 0 Gage Blocks
	(5 to 15) in (15 to 40) in	(11 + 4L) μin (16 + 4L) μin	Long Gage Blocks
Anvil Flatness	Up to 1 inD	3.9 μin	Optical Flats
Anvil Parallelism	Up to 1 inD	6.3 μin	Optical Parallels
Calipers ^{1,2} Outside, Inside, Depth, Step	(0.05 to 1) in (1 to 9) in	(13 + 1L) μin (9 + 4L) μin	Grade 0 Gage Blocks
	(5 to 15) in (15 to 40) in	(11 + 4L) μin (16 + 4L) μin	Long Gage Blocks
Linear Displacement ²	Up to 12 ft	(1 + 2.1L) μin	Laser Interferometer
Dial Indicators ^{1,2}	Up to 1 in (1 to 6) in	(10 + 2L) μin (5 + 6L) in	Gage Blocks

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Length – Single Axis ² Outside Dimension	Up to 1 in (1 to 7) in (7 to 12) in	(6.1 + 1L) μin (4.5 + 3.5L) μin (2 + 4L) μin	Universal Length Measuring Machine
Inside Dimension	(0.04 to 1) in (1 to 2.5) in (2.5 to 10) in (10 to 14) in	(9 + 1L) μin (10 + 3L) μin (15 + 3L) μin (26 + 3L) μin	
Length – Single Axis ² Outside Dimension	Up to 1 in (1 to 4) in (4 to 24) in	13 μin (10 + 3L) μin (10 + 4.5L) μin	24 in Laser Length Measuring Machine
Height Measuring Equipment ²	(0.05 to 1) in (1 to 9) in (5 to 15) in (15 to 40) in	(13 + 1L) μin (9 + 4L) μin (11 + 4L) μin (16 + 4L) μin	Gage Blocks, Surface Plate
Rulers ²	Up to 12 in (12 to 26) in	(130 + 10L) μin (80 + 15L) μin	
Measuring Tapes and Rulers ²	Up to 1 ft (1 to 3) ft (3 to 1 000) ft	(460 + 3L) μin (390 + 9L) μin (20L) μin	Accu-Gage Single Axis Vision System
Plug Gages ² (Outside Diameter)	Up to 1 in (1 to 7) in	12 μin (10 + 3L) μin	Universal Length Measuring Machine
Pin Gages ² (Outside Diameter)	(0.003 to 1) in	30 μin	Laser Micrometer
Laser Micrometers ^{1,2}	Up to 0.1 in (0.1 to 0.4) in (0.4 to 1) in	13 μin 8 μin (11 + 5L) μin	Characterized Master Pin Gages
Threaded Plugs ² Pitch Diameter – 60° Thread	Up to 1 in (1 to 4) in (4 to 7) in	79 μin 80 μin 83 μin	Universal Length Measuring Machine, Thread Wires
Major Diameter	Up to 1 in (1 to 7) in	13 μin (10 + 3L) μin	
Step Height	Up to 1 in	32 μin	Gage Probe, Amplifier, Gage Blocks

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Threaded Rings Inner Pitch Diameter	Up to 1 in (1 to 4) in (4 to 7) in	79 μ in 80 μ in 83 μ in	Master Plug Uncertainty
Plain Ring Gages ² Inside Diameter	(0.04 to 1) in (1 to 2.5) in (2.5 to 10) (10 to 14) in	(9 + 1L) μ in (10 + 3L) μ in (15 + 3L) μ in (26 + 3L) μ in	Universal Length Measuring Machine

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force Measuring Equipment ¹	(0.03 to 600) lbf	0.017 % of reading	NIST Class F Weights
Force Measuring Equipment ¹	(0 to 500) lbf (500 to 2 000) lbf (2 000 to 10 000) lbf (10 000 to 25 000) lbf (25 000 to 100 000) lbf	0.29 lbf 0.13 lbf 1.5 lbf 3.5 lbf 3.8 lbf	Load Cells
Mass Determination (SI)	30 kg 25 kg 20 kg 10 kg 5 kg 3 kg 2 kg 1 kg 500 g 300 g 200 g 100 g 50 g 30 g 20 g 10 g	7.9 mg 6.9 mg 6.5 mg 2.8 mg 2 mg 1.5 mg 0.56 mg 0.27 mg 0.12 mg 54 μ g 56 μ g 39 μ g 11 μ g 9.3 μ g 7.2 μ g 8.2 μ g	Echelon II

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass Determination (SI)	5 g 3 g 2 g 1 g 500 mg 300 mg 200 mg 100 mg 50 mg 30 mg 20 mg 10 mg 5 mg 3 mg 2 mg 1 mg	4.5 µg 4.4 µg 4.7 µg 4.2 µg 2.3 µg 2.3 µg 2.3 µg 2.3 µg 2.3 µg 2.3 µg 2.3 µg 2.3 µg 2.3 µg 2.3 µg 2.3 µg 2.3 µg	Echelon II
Mass Determination (SI)	50 kg 30 kg 25 kg 20 kg 10 kg 5 kg 3 kg 2 kg 1 kg 500 g 300 g 200 g 100 g 50 g 30 g 20 g 10 g 5 g 3 g 2 g 1 g	31 mg 24 mg 21 mg 17 mg 5.2 mg 4.7 mg 3.1 mg 1.6 mg 0.8 mg 0.38 mg 0.23 mg 0.16 mg 93 µg 38 µg 26 µg 24 µg 17 µg 11 µg 11 µg 12 µg 11 µg	Echelon III

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass Determination (SI)	500 mg 300 mg 200 mg 100 mg 50 mg 30 mg 20 mg 10 mg 5 mg 3 mg 2 mg 1 mg	4.4 µg 4.4 µg 4.4 µg 4.4 µg 4.4 µg 4.4 µg 4.4 µg 4.4 µg 4.4 µg 4.4 µg 4.4 µg 4.4 µg	Echelon III
Mass Determination (Avoirdupois)	50 lb 30 lb 20 lb 10 lb 5 lb 3 lb 2 lb 1 lb 8 oz 4 oz 2 oz 1 oz 0.5 oz	17 mg 5.3 mg 5.7 mg 3.3 mg 1.7 mg 1.7 mg 0.5 mg 0.25 mg 0.17 mg 95 µg 42 µg 29 µg 23 µg	Echelon III
Torque Tools ¹	15 ozf·in to 2 000 lbf·ft	1 % of reading	CDI Torque Measuring System
Torque Transducers, Torque Analyzers ⁹	(5 to 100) ozf·in (5 to 100) lbf·in (100 to 1 000) lbf·in (50 to 600) lbf·ft	0.06 % of reading 0.033 % of reading 0.015 % of reading 0.05 % of reading	Torque Wheels, Torque Arms, Master Weights
Balances ^{1,7} Metric (SI)	(1 to 500) mg 500 mg to 5 g (5 to 20) g (20 to 30) g 30 g to 5 kg (5 to 50) kg	6.3 µg 0.022 mg 0.033 mg 0.51 mg 0.000 19 % of reading 0.000 2 % of reading	ASTM E617 Class 1 (characterized) weights and internal calibration procedure utilized for the calibration of the weighing system.

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Balances ^{1,7} Metric (SI)	(1 to 500) mg 500 mg to 5 g (5 to 20) g (20 to 30) g 30 g to 50 kg	12 µg 4 µg 60 µg 90 µg 0.000 32 % of reading	ASTM E617 Class 1 (non-characterized) weights and internal calibration procedure utilized for the calibration of the weighing system.
Balance/Scales ^{1,7} Avoirdupois	(0.5 to 16) oz (16 to 24) oz (24 to 29) oz (29 to 31) oz 1 lb (2 to 1 000) lb	0.024 % of reading 0.017 % of reading 0.014 % of reading 0.012 % of reading 0.018 % of reading 0.012 % of reading	NIST Class F weights (non-characterized) and internal calibration procedure utilized for the calibration of the weighing system.
Absolute Pressure – Source ¹	(0 to 14.7) psia (14.7 to 139.7) psia (139.7 to 2 514.7) psia	0.002 5 psi 0.001 % of reading + 0.007 5 psi 0.007 % of reading	Fluke/Ruska 7250xi Pressure Controller/Calibrator
Pressure – Source Pneumatic ¹	(-14.7 to 0) psig (0 to 125) psig (125 to 2 500) psig	0.001 3 psi 0.001 4 % of reading + 0.007 psi 0.007 % of reading	Fluke/Ruska 7250xi Pressure Controller/Calibrator
Pressure – Source Pneumatic ¹	(-60 to -22) inH ₂ O (-22 to 22) inH ₂ O (22 to 60) inH ₂ O (60 to 72) inH ₂ O (72 to 804) inH ₂ O	0.009 % of reading + 0.000 15 inH ₂ O 0.002 2 inH ₂ O 0.009 % of reading + 0.000 15 inH ₂ O 0.006 7 inH ₂ O 0.009 % of reading + 0.000 15 inH ₂ O	Fluke/DHI PPC4-ui Pressure Measurement System
Pressure – Source Pneumatic ¹	Up to 6 000 psig	0.72 psi	Comparison to Mensor 2101 Digital Pressure Indicator
Pressure – Source Pneumatic ¹	Up to 10 000 psig	1.2 psi	Comparison to Mensor CPR2550 Digital Pressure Indicator
Pressure – Source Hydraulic ¹	(5 to 1 500) psig (1 500 to 15 000) psig	0.008 % of reading 0.008 % of reading	Ametek T-150 Dead Weight Tester
Pressure – Source Hydraulic ¹	(1 000 to 25 000) psig	15 psi	Comparison to Heise 901B Digital Pressure Indicator
Pressure – Source Hydraulic ¹	(500 to 40 000) psig	0.006 3 % of reading	Fluke/Ruska 2450 Hydraulic Deadweight Tester

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity – Measure ¹	(10 to 30) °C (20 to 90) % RH	1.3 % RH	Vaisala HMI41/HMP46 Thermohygrometer
Relative Humidity – Source	(-10 to 15) °C (10 to 75) % RH (75 to 95) %RH (15 to 35) °C (10 to 95) %RH (35 to 70) °C (10 to 50) %RH (50 to 75) %RH (75 to 95) %RH	0.5 %RH 0.65 %RH 0.5 %RH 0.5 %RH 0.7 %RH 0.85 %RH	Thunder Scientific 2500 Two-Pressure Humidity Generator
Temperature – Measure ¹	(-195 to 660) °C	0.003 % of reading + 0.009 °C	Hart 5628 PRT w/ Black Stack Thermometer Indicator
	(600 to 1 000) °C (1 000 to 1 200) °C	0.93 °C 1.2 °C	Accu-Mac AM1210 Type S Reference Thermocouple w/ Hart 2565 Thermocouple Module and Black Stack
Temperature – Source	(-80 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 300) °C	0.003 % of reading + 0.014 °C 0.003 % of reading + 0.017 °C 0.003 % of reading + 0.025 °C 0.003 % of reading + 0.035 °C	Hart 5628 PRT w/ Black Stack and Fluke 7381, 7321, and 6331 Baths
	(300 to 425) °C (425 to 660) °C	0.003 % of reading + 0.043 °C 0.003 % of reading + 0.06 °C	Hart 5628 PRT w/ Black Stack and Fluke 9173 Dry Well
Temperature – Source	(660 to 1 200) °C	3.1 °C	Accu-Mac AM1210 Type S Reference Thermocouple w/ Hart 2565 Thermocouple Module, Black Stack and Furnace

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure and Measuring Equipment	10 MHz	3.7 pHz/Hz	Fluke 910R GPS Frequency Secondary Standard
Frequency – Measure and Measuring Equipment ¹	(0.1 to 1) s 1 Hz to 1 kHz 10 kHz to 10 MHz (10 to 225) MHz	45 μ s 1.4 nHz/Hz + 4.5 μ s 1.4 nHz/Hz 1.4 nHz/Hz	HP 53131A (10) Frequency Counter, Fluke 910R GPS Frequency Secondary Standard
Frequency – Source ¹ (Sine, Square, Triangle)	1 μ Hz to 80 MHz	0.000 23 % of reading	Agilent 33250A Function Generator
Stopwatches/Timers	Up to 599 s/mon	59 ms/d	Vibrograf 4500 Timometer
AC Duty Cycle – Source ¹ Square Wave: < 3.3 Vp-p Freq: 0.1 Hz to 100 kHz	(1 to 10) % Duty Cycle 10 μ s to 100 s (10 to 49) % Duty Cycle 10 μ s to 100 s 50 % Duty Cycle 10 μ s to 100 s (51 to 90) % Duty Cycle 10 μ s to 100 s (90 to 99) % Duty Cycle 10 μ s to 100 s	0.039 % of reading + 78 ns 0.62 % of reading + 78 ns 0.001 6 % of reading + 78 ns 0.62 % of reading + 78 ns 0.039 % of reading + 78 ns	Fluke 5522A Multiproduct Calibrator

DIMENSIONAL MEASUREMENT

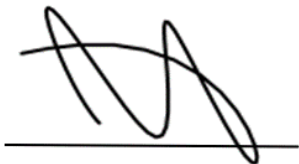
2 Dimensional

Specific Tests and / or Properties Measured	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Angle Measurement	Up to 12 in (0 to 360)°	0.015°	OGP Flash-500 Vision System utilized for Angle Measurements
2D Length Measurement ² (X-Y Axis)	Up to 19 in x 17 in Up to 12 in (12 to 26) in	(130 + 10L) μ in (80 + 15L) μ in	OGP Flash-500 Vision System utilized for Dimensional Measurements

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; D = diameter in inches; " = arc-second.
3. As frequency & amplitude deviate from the listed values, uncertainty may be higher than stated. If needed, contact laboratory for more information regarding uncertainties at frequency and range combinations other than the ones shown.
4. The stated uncertainty is the laboratory's ability to source a fast rise pulse that is approximately 500 ps, 150 ps, or 70 ps. In the typical application of measuring rise time of an oscilloscope, this value is one of the contributing factors, but other factors are derived from the UUT. The known source rise time is mathematically removed from the total observed UUT rise time.
5. The uncertainties shown are for the most favorable conditions. There is an increase in uncertainty that corresponds to the laboratory's AC voltage and current uncertainties at different frequencies other than the ones shown. Power factors (PF) other than the one shown contribute to the power uncertainty. PF is related to the cosine of phase. Therefore, uncertainties track the laboratory's phase uncertainty closely at PF near one but are magnified heavily as PF approaches zero. The lab may also report reactive power, apparent power, and power factor under this accreditation. If needed, contact laboratory for more information regarding uncertainties at frequency and power factor combinations other than the ones shown.
6. The reference standards found in this parameter are used for the calibration of pressure gages, pressure transducers, pressure transmitters and for cross-floating comparison calibration method for deadweight testers.
7. 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.
8. The values listed in the Range column are approximate. The certified values and corresponding Measurement Uncertainty (MU) will be reported at the time of calibration.
9. The resolution of the device under test (DUT) will be added to the Measurement Uncertainty (MU) at the time of calibration, which is stated as $0.6R$ (where R = resolution).
10. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2489.08.



Jason Stine, Vice President