CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Transcat – Philadelphia
100 Dobbs Lane, Suite 108-110
Cherry Hill, NJ 08034

Fulfills the requirements of

ISO/IEC 17025:2017

and the 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.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 07 September 2023
Certificate Number: AC-2489.03

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)

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CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: **September 7, 2023** Certificate Number: **AC-2489.03**

CALIBRATION

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH – Measuring Equipment [1]	4 pH 7 pH 10 pH	0.011 pH 0.011 pH 0.012 pH	Certified Reference Material
Conductivity Meters – Measuring Equipment	5 µS/cm 10 µS/cm 100 µS/cm 1000 µS/cm 10 000 µS/cm 100 000 µS/cm 150 000 µS/cm	0.35 µS/cm 0.35 µS/cm 0.84 µS/cm 3.5 µS/cm 38 µS/cm 310 µS/cm 610 µS/cm	Certified Reference Material

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source [1]	Up to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V	8.5 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	Fluke 5700A/EP Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source [1]	(220 to 1 000) V	7.6 µV/V + 0.4 mV	Fluke 5700A/EP Multiproduct Calibrator, Fluke 5725A Amplifier
DC Voltage – Measure [1]	Up to 100 mV 100 mV to 1 V (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 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	0.035 % of reading + 35 mV	Vitrek 4700 Digital HV Meter
	(10 to 35) kV	0.031 % of reading + 81 mV	Vitrek 4700 Digital HV Meter, Vitrek HVP-35 High Voltage Probe
	(35 to 70) kV	0.038 % of reading + 0.23 V	Vitrek 4700 Digital HV Meter, Vitrek HVL-70 High Voltage Probe
	(70 to 100) kV	0.063 % of reading + 0.35 V	Vitrek 4700 Digital HV Meter, Vitrek HVL-100 High Voltage Probe
DC Voltage – Source/Measure [1]	Up to 100 mV 100 mV to 1 V (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 5.3 µV/V + 0.58 µV 7.7 µV/V + 35 µV 15 µV/V + 0.12 mV 18 µV/V + 0.12 nV 21 µV/V + 0.12 mV	Fluke 5700A/EP Multiproduct Calibrator, Fluke 5725A Amplifier, Characterized with Agilent 3458A Opt.002 8.5 Digit Multimeter
AC Voltage – Source [1]	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	 0.16 % of reading + 4 µV 0.16 % of reading + 4 µV 0.1 % of reading + 4 µV 0.12 % of reading + 4 µV 0.17 % of reading + 5 µV 0.33 % of reading + 10 µV 0.47 % of reading + 20 µV 0.58 % of reading + 20 µV	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]	(2.2 to 22) mV		Fluke 5700A/EP Multiproduct Calibrator
	(10 to 20) Hz	0.044 % of reading + 4 µV	
	(20 to 40) Hz	0.035 % of reading + 4 µV	
	40 Hz to 20 kHz	0.015 % of reading + 4 µV	
	(20 to 50) kHz	0.031 % of reading + 4 µV	
	(50 to 100) kHz	0.059 % of reading + 5 µV	
	(100 to 300) kHz	0.12 % of reading + 10 µV	
	(300 to 500) kHz	0.16 % of reading + 20 µV	
	500 kHz to 1 MHz	0.3 % of reading + 20 µV	
	(22 to 220) mV		
	(10 to 20) Hz	0.028 % of reading + 12 µV	
	(20 to 40) Hz	0.017 % of reading + 7 µV	
	40 Hz to 20 kHz	0.01 % of reading + 7 µV	
	(20 to 50) kHz	0.021 % of reading + 7 µV	
	(50 to 100) kHz	0.047 % of reading + 17 µV	
	(100 to 300) kHz	0.092 % of reading + 20 µV	
	(300 to 500) kHz	0.14 % of reading + 25 µV	
	500 kHz to 1 MHz	0.28 % of reading + 45 µV	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.028 % of reading + 40 µV	
	(20 to 40) Hz	0.016 % of reading + 15 µV	
	40 Hz to 20 kHz	0.006 % of reading + 8 µV	
	(20 to 50) kHz	0.008 % of reading + 10 µV	
	(50 to 100) kHz	0.012 % of reading + 30 µV	
	(100 to 300) kHz	0.043 % of reading + 80 µV	
	(300 to 500) kHz	0.1 % of reading + 0.2 mV	
	500 kHz to 1 MHz	0.18 % of reading + 0.3 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.028 % of reading + 0.4 mV	
	(20 to 40) Hz	0.016 % of reading + 0.15 mV	
	40 Hz to 20 kHz	0.005 % of reading + 50 µV	
	(20 to 50) kHz	0.008 % of reading + 0.1 mV	
	(50 to 100) kHz	0.011 % of reading + 0.2 mV	
	(100 to 300) kHz	0.03 % of reading + 0.6 mV	
	(300 to 500) kHz	0.1 % of reading + 2 mV	
	500 kHz to 1 MHz	0.17 % of reading + 3.2 mV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	(22 to 220) V		Fluke 5700A/EP Multiproduct Calibrator
	(10 to 20) Hz	0.028 % of reading + 4 mV	
	(20 to 40) Hz	0.01 % of reading + 1.5 mV	
	40 Hz to 20 kHz	0.006 % of reading + 0.6 mV	
	(20 to 50) kHz	0.009 % of reading + 1 mV	
	(50 to 100) kHz	0.016 % of reading + 2.5 mV	
	(100 to 300) kHz	0.09 % of reading + 16 mV	
	(300 to 500) kHz	0.44 % of reading + 40 mV	
	500 kHz to 1 MHz	0.8 % of reading + 80 mV	
AC Voltage – Source [1]	(220 to 750) V		Fluke 5700A/EP Multiproduct Calibrator, Fluke 5725A Amplifier
	(30 to 50) kHz	0.061 % of reading + 11 mV	
	(50 to 100) kHz	0.23 % of reading + 45 mV	
	(220 to 1 100) V		
	40 Hz to 1 kHz	0.011 % of reading + 4 mV	
	(1 to 20) kHz	0.017 % of reading + 6 mV	
	(20 to 30) kHz	0.061 % of reading + 11 mV	
AC Voltage – Measure [1]	Up to 10 mV		Agilent 3458A Opt. 002 8.5 Digit Multimeter
	(1 to 40) Hz	0.04 % of reading + 3.5 µV	
	40 Hz to 1 kHz	0.03 % of reading + 1.2 µV	
	(1 to 20) kHz	0.04 % of reading + 1.2 µV	
	(20 to 50) kHz	0.15 % of reading + 1.2 µV	
	(50 to 100) kHz	0.59 % of reading + 1.2 µV	
	(100 to 300) kHz	4.6 % of reading + 2.3 µV	
	300 kHz to 1 MHz	1.5 % of reading + 5.8 µV	
	1 MHz to 4 MHz	8.1 % of reading + 8.1 µV	
	(10 to 100) mV		
	(1 to 40) Hz	0.013 % of reading + 4.6 µV	
	40 Hz to 1 kHz	0.009 7 % of reading + 2.3 µV	
	(1 to 20) kHz	0.017 % of reading + 2.3 µV	
	(20 to 50) kHz	0.038 % of reading + 2.3 µV	
	(50 to 100) kHz	0.093 % of reading + 2.3 µV	
	(100 to 300) kHz	0.36 % of reading + 12 µV	
	300 kHz to 1 MHz	1.2 % of reading + 12 µV	
	(1 to 2) MHz	1.8 % of reading + 12 µV	
	(2 to 4) MHz	4.7 % of reading + 81 µV	
	(4 to 8) MHz	4.7 % of reading + 92 µV	
	(8 to 10) MHz	17 % of reading + 0.12 mV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	(0.1 to 1) V		Agilent 3458A Opt. 002 8.5 Digit Multimeter
	(1 to 40) Hz	0.008 8 % of reading + 46 µV	
	40 Hz to 1 kHz	0.008 3 % of reading + 23 µV	
	(1 to 20) kHz	0.017 % of reading + 23 µV	
	(20 to 50) kHz	0.036 % of reading + 23 µV	
	(50 to 100) kHz	0.093 % of reading + 23 µV	
	(100 to 300) kHz	0.35 % of reading + 0.12 mV	
	300 kHz to 1 MHz	1.2 % of reading + 0.12 mV	
	(1 to 2) MHz	1.8 % of reading + 0.12 mV	
	(2 to 4) MHz	4.6 % of reading + 0.81 mV	
	(4 to 8) MHz	4.6 % of reading + 0.92 mV	
	(8 to 10) MHz	17 % of reading + 1.2 mV	
	(1 to 10) V		
	(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 + 1.2 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	
	40Hz 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	
	(100 to 700) V		
	(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 High Voltage – Measure [1]	700 V to 10 kV		Vitrek 4700 Digital HV Meter
	(30 to 200) Hz	0.014 % of reading + 2.1 V	
	(200 to 450) Hz	0.46 % of reading + 2.1 V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC High Voltage – Measure [1]	(10 to 35) kV (30 to 200) Hz (200 to 450) Hz	 0.12 % of reading + 37 V 0.71 % of reading + 37 V	Vitrek 4700 Digital HV Meter, Vitrek HVP-35 High Voltage Probe
	(35 to 70) kV (30 to 100) Hz (100 to 200) Hz	 0.12 % of reading + 55 V 0.69 % of reading + 55 V	Vitrek 4700 Digital HV Meter, Vitrek HVL-70 High Voltage Probe
	(70 to 75) kV (30 to 70) Hz (70 to 200) Hz	 0.15 % of reading + 0.16 kV 1.2 % of reading + 0.16 kV	Vitrek 4700 Digital HV Meter, Vitrek HVL-100 High Voltage Probe
Capacitance – Source [1]	10 Hz to 10 kHz 190 pF to 1.1 nF	 0.39 % of reading + 7.8 pF	Fluke 5522A Multiproduct Calibrator
Capacitance – Source [1]	10 Hz to 3 kHz (1.1 to 3.3) nF 10 Hz to 1 kHz (3.3 to 11) nF (11 to 110) nF 10 Hz to 1 kHz (110 to 330) nF (10 to 600) Hz 330 nF to 1.1 µF (10 to 300) Hz (1.1 to 3.3) µF (10 to 150) Hz (3.3 to 11) µF (10 to 120) Hz (11 to 33) µF (10 to 80) Hz (33 to 110) µF DC to 50 Hz (110 to 330) µF DC to 20 Hz 330 µF to 1.1 mF DC to 6 Hz (1.1 to 3.3) mF DC to 2 Hz (3.3 to 11) mF	 0.39 % of reading + 7.8 pF 0.21 % of reading + 7.8 pF 0.21 % of reading + 78 pF 0.21 % of reading + 0.23 nF 0.21 % of reading + 0.78 nF 0.21 % of reading + 2.3 nF 0.2 % of reading + 7.8 nF 0.32 % of reading + 23 nF 0.36 % of reading + 78 nF 0.36 % of reading + 0.23 µF 0.35 % of reading + 0.78 µF 0.35 % of reading + 2.3 µF 0.35 % of reading + 7.8 µF	Fluke 5522A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source [1]	DC to 0.6 Hz (11 to 33) mF DC to 0.2 Hz (33 to 110) mF	0.58 % of reading + 23 µF 0.85 % of reading + 78 µF	Fluke 5522A Multiproduct Calibrator
Capacitance – Measure [1]	100 Hz to 1 kHz Up to 10 pF (10 to 100) pF 100 pF to 1 µF (1 to 100) µF 100 µF to 1 mF	 0.5 % of reading + 0.05 pF 0.59 % of reading + 0.05 pF 0.024 % of reading + 0.05 pF 0.12 % of reading 0.24 % of reading	GR 1689-M Precision Impedance Meter
DC Current – Source [1]	220 nA to 220 µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	41 µA/A + 6 nA 36 µA/A + 7 nA 36 µA/A + 40 nA 57 µA/A + 0.7 µA 0.2 mA/A + 12 µA	Fluke 5700A/EP Multiproduct Calibrator
DC Current – Source [1]	(2.2 to 11) A	0.4 mA/A + 0.48 mA	Fluke 5700A/EP Multiproduct Calibrator, Fluke 5725A Amplifier
	(11 to 20.5) 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	0.51 % of reading + 0.14 A 0.51 % of reading + 0.5 A	Fluke 5520A Multiproduct Calibrator, 5500A/COIL 50-turn Coil
DC Current – Source/Measure [1]	Up to 100 µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	33 µA/A + 0.92 nA 29 µA/A + 5.8 nA 29 µA/A + 58 nA 46 µA/A + 0.58 µA 0.013 % of reading + 12 µA	Current Source, Characterized with Agilent 3458A Opt.002 8.5 Digit Multimeter
	(1 to 100) A	0.012 % of reading + 0.5 mA	Ohms Labs CS-100 Current Shunt, Agilent 3458A Opt. 002 8.5 Digit Multimeter
	(100 to 1 500) A	0.29 % of reading + 25 nA	Empro WT-1500-50 Current Shunt, Agilent 3458A Opt. 002 8.5 Digit Multimeter
DC Clamp-on Ammeter (Non-Toroidal Type) Hall Effect Sensor [1]	(20 to 1 000) A	0.58 % of reading + 0.52 A	Fluke 5522A Multiproduct Calibrator, Fluke 5500A/Coil 50-turn Coil

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Clamp-on Ammeter (Non-Toroidal Type) Hall Effect Sensor [1]	(1 to 5) kA	0.58 % of reading	Fluke 5522A Multiproduct Calibrator, Fluke 52120A Amplifier, 3 kA Coil, 6 kA Coil
AC Current – Source [1]	Up to 220 µA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 220 µA to 2.2 mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	 0.03 % of reading + 16 nA 0.019 % of reading + 10 nA 0.015 % of reading + 8 nA 0.03 % of reading + 12 nA 0.11 % of reading + 65 nA 0.03 % of reading + 40 nA 0.018 % of reading + 35 nA 0.013 % of reading + 35 nA 0.021 % of reading + 0.11 µA 0.11 % of reading + 0.65 µA	Fluke 5700A/EP Multiproduct Calibrator
AC Current – Source [1]	(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 (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 220 mA to 2.2 A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	 0.039 % of reading + 0.4 µA 0.019 % of reading + 0.35 µA 0.014 % of reading + 0.35 µA 0.021 % of reading + 0.5 µA 0.11 % of reading + 5 µA 0.033 % of reading + 4 µA 0.018 % of reading + 3.5 µA 0.014 % of reading + 2.5 µA 0.021 % of reading + 3.5 µA 0.11 % of reading + 10 µA 0.027 % of reading + 35 µA 0.046 % of reading + 80 µA 0.7 % of reading + 0.16 mA	Fluke 5700A/EP Multiproduct Calibrator
	(2.2 to 11) A (40 to 100) Hz (1 to 5) kHz (5 to 10) kHz	 0.048 % of reading + 0.17 mA 0.096 % of reading + 0.38 mA 0.36 % of reading + 0.75 mA	Fluke 5700A/EP Multiproduct Calibrator, Fluke 5725A Amplifier
	(11 to 20.5) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	 0.092 % of reading + 3.9 mA 0.12 % of reading + 3.9 mA 2.3 % of reading + 3.9 mA	Fluke 5522A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source [1]	(20.5 to 40) A (1 to 5) kHz	3.3 % of reading + 11 mA	Two Fluke 5522A Multiproduct Calibrators in Parallel
AC Current – Source [1] Extended Frequency Ranges	(29 to 330) µA (10 to 30) kHz (0.33 to 3.3) mA (10 to 30) kHz (3.3 to 33) mA (10 to 30) kHz (33 to 330) mA (10 to 30) kHz	1.2 % of reading + 0.31 µA 0.78 % of reading + 0.47 µA 0.31 % of reading + 3 µA 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 + 0.29A	Fluke 5520A Multiproduct Calibrator, 5500A/COIL 50-turn 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	Fluke 5520A Multiproduct Calibrator, 5500A/COIL 50-turn Coil
	(10 to 300) Hz (1 to 6) kA (30 to 440) Hz (1 to 2) kA (2 to 6) kA	0.6 % of reading 0.8 % of reading 0.66 % of reading	Fluke 5522A Multiproduct Calibrator, Fluke 52120A Amplifier, 3 kA Coil, 6 kA Coil
AC Current – Measure [1]	Up to 100 µA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz (0.1 to 1) mA (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 0.46 % of reading + 0.23 µA 0.17 % of reading + 0.23 µA 0.07 % of reading + 0.23 µA 0.038 % of reading + 0.23 µA	Agilent 3458A Opt. 002 8.5 Digit Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure [1]	(1 to 10) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (10 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (0.1 to 1) A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	 0.46 % of reading + 2.3 µA 0.17 % of reading + 2.3 µA 0.071 % of reading + 2.3 µA 0.038 % of reading + 2.3 µA 0.48 % of reading + 23 µA 0.17 % of reading + 23 µA 0.071 % of reading + 23 µA 0.037 % of reading + 23 µA 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	Agilent 3458A Opt. 002 8.5 Digit Multimeter
AC Current – Measure [1]	(1 to 10) A (50 to 999) Hz 1 kHz (10 to 100) A (50 to 100) Hz (100 to 999) Hz 1 kHz	 0.05 % of reading + 1.3 mA 0.12 % of reading + 1.3 mA 0.038 % of reading + 2.3 mA 0.42 % of reading + 2.3 mA 0.13 % of reading + 2.3 mA	Ohms Labs CS-100 Current Shunt, Agilent 3458A Opt. 002 8.5 Digit Multimeter
DC Resistance – Source [1] (Fixed Artifacts)	1 mΩ 10 mΩ 100 mΩ 1 Ω 100 Ω	59 µΩ/Ω 58 µΩ/Ω 58 µΩ/Ω 58 µΩ/Ω 1.3 µΩ/Ω	Standard Resistors
DC Resistance – Source [1] (Variable Artifact)	(2 to 10) GΩ (20 to 100) GΩ 200 GΩ to 1 TΩ	0.58 % of reading + 1.2 µΩ/Ω/V 1.2 % of reading + 2.3 µΩ/Ω/V 2.6 % of reading + 5.8 µΩ/Ω/V	IET HRRS-B-7-100k-5kV Decade Resistor (V is the DUT Voltage)
DC Resistance – Source/Measure [1]	250 µΩ to 4 mΩ (4 to 40) mΩ (40 to 400) mΩ 400 mΩ to 4 Ω 4 Ω to 400 kΩ	85 µΩ/Ω 25 µΩ/Ω 20 µΩ/Ω 16 µΩ/Ω 5 µΩ/Ω	Fluke 1594A Bridge in Ratio Mode, Characterized Resistors

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Resistance – Source/Measure [1]	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	18 µΩ/Ω + 58 µΩ 15 µΩ/Ω + 0.58 mΩ 13 µΩ/Ω + 0.58 mΩ 12 µΩ/Ω + 5.8 mΩ 13 µΩ/Ω + 58 mΩ 21 µΩ/Ω + 2.3 Ω 62 µΩ/Ω + 0.12 kΩ 0.059 % of reading + 1.2 kΩ 0.82 % of reading + 12 kΩ	Agilent 3458A Opt. 002 8.5 Digit Multimeter Decade Resistors
AC Resistance – Measure [1]	10 Ω to 100 kΩ 12 Hz to 99.9 kHz	0.039 % of reading + 10 mΩ	GenRad 1689M Precision Impedance Meter
Inductance – Source [1] (Fixed Artifacts)	1 kHz 1 mH 10 mH 100 mH 1 H	 0.13 % of reading 0.13 % of reading 0.13 % of reading 0.13 % of reading	Standard Inductors
Inductance – Measure [1]	100 Hz to 1 kHz (1 to 10) mH 10 mH to 10 H	 0.041 % of reading + 100 nH 0.035 % of reading + 1.4 µH	GenRad 1689M Precision Impedance Meter
Electrical Simulation of Thermocouple Indicating Devices – Measure/Source [1]	Type B (250 to 350) °C (350 to 445) °C (445 to 580) °C (580 to 750) °C (750 to 1 000) °C (1 000 to 1 820) °C	 1.2 °C 0.9 °C 0.71 °C 0.55 °C 0.45 °C 0.35 °C	Ectron 1140A Thermocouple Calibrator/Simulator
Electrical Simulation of Thermocouple Indicating Devices – Measure/Source [1]	Type C (0 to 250) °C (250 to 1 000) °C (1 000 to 1 500) °C (1 500 to 1 800) °C (1 800 to 2 000) °C (2 000 to 2 250) °C (2 250 to 2 315) °C	 0.24 °C 0.19 °C 0.21 °C 0.24 °C 0.27 °C 0.33 °C 0.37 °C	Ectron 1140A Thermocouple Calibrator/Simulator

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 E		Ectron 1140A Thermocouple Calibrator/Simulator
	(-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	
	Type J		
	(-210 to -180) °C	0.13 °C	
	(-180 to -120) °C	0.11 °C	
	(-120 to -50) °C	0.09 °C	
	(-50 to 990) °C	0.08 °C	
	(990 to 1 200) °C	0.08 °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	

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 S (-50 to -30) °C (-30 to 45) °C (45 to 105) °C (105 to 310) °C (310 to 615) °C (615 to 1 768) °C 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	 0.76 °C 0.68 °C 0.49 °C 0.31 °C 0.35 °C 0.31 °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
DC Power – Source [1] 330 µW to 330 mA 330 mA to 3 A	 11 µW to 1.1 mW (1.1 to 110) mW 110 mW to 110 W (110 to 330) W 11 µW to 110 mW 110 mW to 990 W 990 W to 3 kW	 0.024 % of reading 0.027 % of reading 0.024 % of reading 0.018 % of reading 0.044 % of reading 0.053 % of reading 0.01 % of reading	Fluke 5520A Multiproduct Calibrator
DC Power – Source [1] (3 to 20) A	 99 mW to 0.99 W 0.99 W to 6.8 kW (6.8 to 20.5) kW	 0.088 % of reading 0.07 % of reading 0.04 % of reading	Fluke 5520A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source [1,2]			Fluke 5520A Multiproduct Calibrator
PF = 1			
(3.3 to 9) mA	(10 to 65) Hz		
	(0.11 mW to 3) mW	0.13 % of reading	
	3 mW to 9 W	0.077 % of reading	
(9 to 33) mA	(10 to 65) W		
	(0.3 to 10) mW	0.089 % of reading	
	10 mW to 33 W	0.077 % of reading	
(33 to 90) mA	(10 to 65) Hz		
	(1 to 30) mW	0.071 % of reading	
	30 mW to 90 W	0.057 % of reading	
(90 to 330) mA	(10 to 65) Hz		
	(3 to 100) mW	0.089 % of reading	
	100 mW to 300 W	0.078 % of reading	
(330 to 900) mA	(10 to 65) Hz		
	(11 to 300) mW	0.071 % of reading	
	(0.3 to 900) W	0.081 % of reading	
900 mA to 2.2 A	(10 to 65) Hz		
	(30 to 720) mW	0.089 % of reading	
	0.72 W to 2 kW	0.079 % of reading	
(2.2 to 4.5) A	(10 to 65) Hz		
	80 mW to 1.4 W	0.088 % of reading	
	1.4 W to 4.5 kW	0.18 % of reading	
(4.5 to 20.5) A	(10 to 65) Hz		
	150 mW to 20 kW	0.17 % of reading	
Phase – Source [1]	Up to 180°		Fluke 5520A Multiproduct Calibrator
	(10 to 65) Hz	0.11°	
	(65 to 500) Hz	0.2°	
	500 Hz to 1 kHz	0.4°	
	(1 to 5) kHz	1.9°	
	(5 to 10) kHz	3.9°	
	(10 to 20) kHz	7.8°	
Oscilloscopes [1,3]			Fluke 9500B/3200 3.2 GHz High-Performance Oscilloscope Calibrator
Amplitude – DC			
into 50 Ω load	(-5 to 5) V	0.023 % of reading + 19 µV	
into 1 MΩ load	(-200 to 200) V	0.023 % of reading + 19 µV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes [1,3]			
Amplitude – Square Wave			
Rate: 10 Hz to 10 kHz			
into 50 Ω load	40 µVp-p to 1 mVp-p	0.78 % of reading + 7.8 µV	
	1 mVp-p to 5 Vp-p	0.078 % of reading + 7.8 µV	
into 1 MΩ load	40 µVp-p to 1 mVp-p	0.78 % of reading + 7.8 µV	
Rate: 10 Hz to 100 kHz			
into 50 Ω load	1 mVp-p to 5 Vp-p	0.16 % of reading + 7.8 µV	
into 1 MΩ load	1 mVp-p to 200 Vp-p	0.78 % of reading + 7.8 µV	Fluke 9500B/3200 3.2 GHz High-Performance Oscilloscope Calibrator, Fluke 9530 3.2 GHz Active Head, Fluke 9550 Active Head w/ 25 ps Capability, Fluke 9560 6 GHz Active Head, Tektronix 067-1330-000 Calibration Fixture
Time Markers			
100 mVp-p to 1 Vp-p			
into 50 Ω load			
Square Wave	9.009 1 ns to 83 µs	0.19 µs/s	
	83 µs to 55s	2.3 µs/s	
Sine Wave	450.5 ps to 9.009 ns	0.19 µs/s	
Pulse	900.91 ns to 83 µs	0.19 µs/s	
	83 µs to 55s	2.3 µs/s	
Triangle Wave	900.91 ns to 83 µs	0.19 µs/s	
	83 µs to 55s	2.3 µs/s	
Rise Time			
into 50 Ω load	5 mVp-p to 3 Vp-p		
Rate: 10 Hz to 2 MHz	500 ps (nominal)	290 ps	
	150 ps (nominal)	35 ps	
Rate: 10 Hz to 1 MHz	25 mVp-p to 2 Vp-p		
	70 ps (nominal)	24 ps	
	425 mVp-p to 575 mVp-p		
	25 ps (nominal)	6.7 ps	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes [1,3]			
Leveled Sine Wave 50 kHz Reference			Fluke 9500B/3200 3.2 GHz High-Performance Oscilloscope Calibrator, Fluke 9530 3.2 GHz Active Head, Fluke 9550 Active Head w/ 25 ps Capability, Fluke 9560 6 GHz Active Head, Tektronix 067-1330-000 Calibration Fixture
into 50 Ω load	5 mVp-p to 5 Vp-p 50 kHz to 10 MHz	1.2 % of reading	
Input Impedance Measure	(10 to 40) Ω	0.39 % of reading	
	(40 to 90) Ω	0.083 % of reading	
	(90 to 150) Ω	0.39 % of reading	
	(50 to 800) kΩ	0.39 % of reading	
	(0.8 to 1.2) MΩ	0.083 % of reading	
	(1.2 to 12) MΩ	0.39 % of reading	
Input Capacitance Measure	(1 to 35) pF	1.6 % of reading + 0.19 pF	
	(35 to 95) pF	2.3 % of reading + 0.19 pF	
Bandwidth Flatness Measure [1] into VSWR (1.2:1) (wrt Reference Frequency)	5 mVp-p to 5 Vp-p 100 mHz to 300 MHz	1.6 % of reading	Fluke 9500B/3200 3.2 GHz High-Performance Oscilloscope Calibrator, Fluke 9530 3.2 GHz Active Head
	(300 to 550) MHz	1.9 % of reading	
	5 mVp-p to 3 Vp-p 550 MHz to 1.1 GHz	2.7 % of reading	
	(1.1 to 2.5) GHz	3.1 % of reading	
	5 mVp-p to 2 Vp-p (2.5 to 3.2) GHz	3.1 % of reading	
Total Harmonic Distortion – Measure	(-80 to 0) dB 20 Hz to 20 kHz	1.1 dB	Agilent 8903A Audio Analyzer
	(20 to 100) kHz	2 dB	
Total Harmonic Distortion – Measure (0.3 to 100) %	< 30 V 10 Hz to 1 MHz	3 % Distortion	HP 334A Distortion Analyzer
	(1 to 3) MHz	6 % Distortion	
	> 30 V 10 Hz to 300 kHz	3 % Distortion	
	(300 to 500) kHz	6 % Distortion	
	500 kHz to 3 MHz	12 % Distortion	
0.1 %	< 30 V (10 to 20) Hz	12 % Distortion	
	(20 to 30) Hz	6 % Distortion	
	30 Hz to 300 kHz	3 % Distortion	
	(300 to 500) kHz	6 % Distortion	
	500 kHz to 1.2 MHz	12 % Distortion	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Total Harmonic Distortion – Measure 0.1 %	> 30 V (20 to 30) Hz 30 Hz to 300 kHz (300 to 500) kHz 500 kHz to 1.2 MHz	 12 % Distortion 3 % Distortion 6 % Distortion 12 % Distortion	HP 334A Distortion Analyzer

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
S11/S22 Reflection Coefficients Magnitude – Measure [1,7] (Linear)	(10 to 700) MHz ≤ 0.25 lin (> 0.25 to 0.5) lin (> 0.5 to ≤ 0.7) lin (> 0.7 to ≤ 1) lin 700 MHz to 24 GHz ≤ 0.25 lin (> 0.25 to 0.5) lin (> 0.5 to ≤ 0.7) lin (> 0.7 to ≤ 1) lin (24 to 33) GHz ≤ 0.25 lin (> 0.25 to 0.5) lin (> 0.5 to ≤ 0.7) lin (> 0.7 to ≤ 1) lin (33 to 50) GHz ≤ 0.25 lin (> 0.25 to 0.5) lin (> 0.5 to ≤ 0.7) lin (> 0.7 to ≤ 1) lin	 0.012 0.013 0.014 0.016 0.006 2 0.006 6 0.076 0.097 0.019 0.019 0.022 0.023 0.019 0.019 0.022 0.023	R&S® ZVA50 Vector Network Analyzer, Calibration Kits
S11/S22 Reflection Coefficients Phase – Measure [1]	(10 to 700) MHz ≤ 0.25 lin (> 0.25 to 0.5) lin (> 0.5 to ≤ 0.7) lin (> 0.7 to ≤ 1) lin	 4° 2° 2° 1°	R&S® ZVA50 Vector Network Analyzer, Calibration Kits

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
S11/S22 Reflection Coefficients Phase – Measure [1] (Linear)	700 MHz to 24 GHz ≤ 0.25 lin (> 0.25 to 0.5) lin (> 0.5 to ≤ 0.7) lin (> 0.7 to ≤ 1) lin (24 to 50) GHz ≤ 0.25 lin (> 0.25 to 0.5) lin (> 0.5 to ≤ 0.7) lin (> 0.7 to ≤ 1) lin	 4° 1° 1° 1° 11° 3° 2° 2°	R&S® ZVA50 Vector Network Analyzer, Calibration Kits
S21/S12 Transmission Coefficients Magnitude – Measure [1] (dB)	(10 to 700) MHz (-90 to ≤ -80) dB (-80 to ≤ -70) dB (-70 to ≤ -60) dB (-60 to ≤ -50) dB (-50 to ≤ -40) dB (-40 to ≤ -30) dB (-30 to ≤ -20) dB (-20 to ≤ -10) dB (-10 to ≤ 0) dB 700 MHz to 24 GHz (-80 to ≤ -70) dB (-70 to ≤ -60) dB (-60 to ≤ -50) dB (-50 to ≤ -40) dB (-40 to ≤ -30) dB (-30 to ≤ -20) dB (-20 to ≤ -10) dB (-10 to ≤ 0) dB (24 to 33) GHz (-80 to ≤ -70) dB (-70 to ≤ -60) dB (-60 to ≤ -50) dB (-50 to ≤ -40) dB (-40 to ≤ -30) dB (-30 to ≤ -20) dB (-20 to ≤ -10) dB (-10 to ≤ 0) dB	 0.56 dB 0.21 dB 0.13 dB 0.12 dB 0.12 dB 0.12 dB 0.12 dB 0.12 dB 0.12 dB 0.55 dB 0.19 dB 0.08 dB 0.06 dB 0.05 dB 0.05 dB 0.05 dB 0.06 dB 0.56 dB 0.21 dB 0.11 dB 0.1 dB 0.1 dB 0.1 dB 0.1 dB 0.1 dB	R&S® ZVA50 Vector Network Analyzer, Calibration Kits

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
S12/S21 Transmission Coefficients Magnitude – Measure [1] (dB)	(33 to 50) GHz (-80 to ≤ -70) dB (-70 to ≤ -60) dB (-60 to ≤ -50) dB (-50 to ≤ -40) dB (-40 to ≤ -30) dB (-30 to ≤ -20) dB (-20 to ≤ -10) dB (-10 to ≤ 0) dB	 0.56 dB 0.21 dB 0.11 dB 0.1 dB 0.1 dB 0.1 dB 0.1 dB 0.1 dB	R&S® ZVA50 Vector Network Analyzer, Calibration Kits
S21/S12 Transmission Coefficients Phase – Measure [1] (dB)	(10 to 700) MHz (-90 to ≤ -40) dB (-40 to ≤ -30) dB (-30 to ≤ -20) dB (-20 to ≤ -10) dB (-10 to ≤ 0) dB 700 MHz to 24 GHz (-80 to ≤ -40) dB (-40 to ≤ -30) dB (-30 to ≤ -20) dB (-20 to ≤ -10) dB (-10 to ≤ 0) dB (24 to 33) GHz (-80 to ≤ -40) dB (-40 to ≤ -30) dB (-30 to ≤ -20) dB (-20 to ≤ -10) dB (-10 to ≤ 0) dB (33 to 50) GHz (-80 to ≤ -40) dB (-40 to ≤ -30) dB (-30 to ≤ -20) dB (-20 to ≤ -10) dB (-10 to ≤ 0) dB	 180° 52° 14° 4.5° 1° 180° 23° 7.2° 2.6° 0.6° 180° 52° 14° 4.5° 1° 180° 52° 14° 4.5° 1°	R&S® ZVA50 Vector Network Analyzer, Calibration Kits
Absolute RF Power – Measure [8]	8 kHz to 18 GHz (-70 to 23) dBm	 0.18 dB	R&S® NRP18A Power Sensor, NRX Power Meter

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Absolute RF Power – Measure [8]	(-35 to 20) dBm DC to 100 MHz > 100 MHz to 2.4 GHz (> 2.4 to 12.4) GHz (> 12.4 to 18) GHz (>18 to 26.5) GHz (>26.5 to 40) GHz (>40 to 50) GHz	 0.08 dB 0.08 dB 0.09 dB 0.1 dB 0.11 dB 0.13 dB 0.17 dB	R&S® NRP18A R&S® NRP50T Power Sensors; NRX Power Meter
Relative RF Power – Measure [8]	(-30 to 20) dBm DC to 50 GHz	 0.04 dB	R&S® NRP18T R&S® NRP50T Power Sensors; NRX Power Meter
Amplitude Modulation – AM Depth Measure (Absolute) Rate: 10 Hz to 150 kHz	100 kHz to 50 GHz Up to 100 % Depth	0.5 % of reading	R&S® FSMR Measuring Receiver (B2, B4, B24)
Amplitude Modulation – AM Depth Measure (Flatness reference to 1 kHz) Rate: 10 Hz to 150 kHz	100 kHz to 50 GHz Up to 100 % Depth	0.3 % of reading	R&S® FSMR Measuring Receiver (B2, B4, B24)
Frequency Modulation – FM Deviation Measure Rate: 10 Hz to 5 MHz	100 kHz to 50 GHz Dev ≤ 5 MHz	1.2 % of reading	R&S® FSMR Measuring Receiver (B2, B4, B24)
Phase Modulation – Deviation Measure Rate: 10 Hz to 5 MHz	100 kHz to 50 GHz Dev ≤ 10 000 rad	1.2 % of reading	R&S® FSMR Measuring Receiver (B2, B4, B24)
Single-sideband Phase Noise – Source/Measure [8]	1 MHz to 50 GHz 10 mHz ≤ Offset < 1 MHz 1 MHz ≤ Offset ≤ 30 MHz Offset > 30 MHz	 1.8 dB 2.3 dB 3.5 dB	R&S® FSWP50 Phase Noise Analyzer (B1, B24, B320, K70)
Adjacent Channel Leakage Ratio (ACLR) [8] Signal Noise > 16 dB	DC to 50 GHz (-90 to -70) dB (-70 to 0) dB	 0.18 dB 0.14 dB	R&S® FSWP50 Phase Noise Analyzer

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Error Vector Magnitude (EVM) [8] Rate: Up to 320 MHz	100 kHz to 6 GHz FSK/ASK/PSK/APSK/ MSK/16QAM/64QAM/ 128QAM/256QAM/ 1024QAM	2.3 % of reading	R&S® FSWP50 Phase Noise Analyzer
Relative Tuned RF Power – Measure [1]	100 kHz to 22 GHz (-120 to -110) dBm (-110 to -100) dBm (-100 to -90) dBm (-90 to -80) dBm (-80 to -70) dBm (-70 to -60) dBm (-60 to -50) dBm (-50 to -40) dBm (-40 to -30) dBm (-30 to -20) dBm (-20 to -10) dBm (-10 to 0) dBm (22 to 40) GHz (-120 to -110) dBm (-110 to -100) dBm (-100 to -90) dBm (-90 to -80) dBm (-80 to -70) dBm (-70 to -60) dBm (-60 to -50) dBm (-50 to -40) dBm (-40 to -30) dBm (-30 to -20) dBm (-20 to -10) dBm (-10 to 0) dBm	 0.67 dB 0.22 dB 0.13 dB 0.12 dB 0.11 dB 0.11 dB 0.11 dB 0.11 dB 0.088 dB 0.086 dB 0.084 dB 0.083 dB 0.68 dB 0.23 dB 0.14 dB 0.13 dB 0.13 dB 0.12 dB 0.12 dB 0.12 dB 0.092 dB 0.09 dB 0.088 dB 0.086 dB	R&S® FSMR Measuring Receiver

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Tuned RF Power – Measure [1]	(40 to 50) GHz (-120 to -110) dBm (-110 to -100) dBm (-100 to -90) dBm (-90 to -80) dBm (-80 to -70) dBm (-70 to -60) dBm (-60 to -50) dBm (-50 to -40) dBm (-40 to -30) dBm (-30 to -20) dBm (-20 to -10) dBm (-10 to 0) dBm	 0.69 dB 0.26 dB 0.19 dB 0.18 dB 0.17 dB 0.17 dB 0.16 dB 0.16 dB 0.11 dB 0.11 dB 0.1 dB 0.1 dB	R&S® FSMR Measuring Receiver
Absolute Tuned RF Power – Measure [1]	100 kHz to 22 GHz (-120 to -110) dBm (-110 to -100) dBm (-100 to -90) dBm (-90 to -80) dBm (-80 to -70) dBm (-70 to -60) dBm (-60 to -50) dBm (-50 to -40) dBm (-40 to -30) dBm (-30 to -20) dBm (-20 to -10) dBm (-10 to 0) dBm (22 to 40) GHz (-120 to -110) dBm (-110 to -100) dBm (-100 to -90) dBm (-90 to -80) dBm (-80 to -70) dBm (-70 to -60) dBm (-60 to -50) dBm (-50 to -40) dBm (-40 to -30) dBm (-30 to -20) dBm (-20 to -10) dBm (-10 to 0) dBm	 0.68 dB 0.25 dB 0.17 dB 0.16 dB 0.16 dB 0.16 dB 0.16 dB 0.16 dB 0.14 dB 0.14 dB 0.14 dB 0.14 dB 0.69 dB 0.26 dB 0.19 dB 0.18 dB 0.18 dB 0.18 dB 0.18 dB 0.18 dB 0.16 dB 0.16 dB 0.16 dB 0.16 dB	R&S® FSMR Measuring Receiver; R&S® NRP18T R&S® NRP50T Power Sensors; NRX Power Meter

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Absolute Tuned RF Power – Measure [1]	(40 to 50) GHz (-120 to -110) dBm (-110 to -100) dBm (-100 to -90) dBm (-90 to -80) dBm (-80 to -70) dBm (-70 to -60) dBm (-60 to -50) dBm (-50 to -40) dBm (-40 to -30) dBm (-30 to -20) dBm (-20 to -10) dBm (-10 to 0) dBm	 0.71 dB 0.31 dB 0.25 dB 0.25 dB 0.24 dB 0.24 dB 0.23 dB 0.23 dB 0.2 dB 0.2 dB 0.2 dB 0.2 dB	R&S® FSMR Measuring Receiver; R&S® NRP18T R&S® NRP50T Power Sensors; NRX Power Meter
Absolute Tuned RF Power – Measure	2.5 MHz to 26.5 GHz (-127 to -120) dB (-120 to -110) dB (-110 to -100) dB (-100 to -90) dB (-90 to -80) dB (-80 to -70) dB (-70 to -60) dB (-60 to -50) dB (-50 to -40) dB (-40 to -30) dB (-30 to -20) dB (-20 to -10) dB (-10 to -0) dB	 0.26 dB 0.26 dB 0.26 dB 0.26 dB 0.26 dB 0.25 dB 0.25 dB 0.25 dB 0.25 dB 0.14 dB 0.14 dB 0.14 dB 0.14 dB	HP 8902A Opt. 050 Measuring Receiver; HP 11722A, HP 11792A, HP 11793A Power Sensors
Relative Tuned RF Power – Measure	2.5 MHz to 26.5 GHz (-127 to -120) dB (-120 to -110) dB (-110 to -100) dB (-100 to -90) dB (-90 to -80) dB (-80 to -70) dB (-70 to -60) dB (-60 to -50) dB (-50 to -40) dB (-40 to -30) dB (-30 to -20) dB (-20 to -10) dB (-10 to -0) dB	 0.23 dB 0.23 dB 0.23 dB 0.23 dB 0.22 dB 0.084 dB 0.081 dB 0.074 dB 0.071 dB 0.068 dB 0.064 dB 0.06 dB 0.056 dB	HP 8902A Opt. 050 Measuring Receiver; HP 11722A, HP 11792A, HP 11793A Power Sensors

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle Measuring Devices, Protractors, Inclinometers, Squares, Angle Gages [4]	(0.005 6 to 5)° (5 to 20)° (20 to 35)° (35 to 45)° (45 to 60)° (60 to 75)° (75 to 85)° 90°	3.2″ 6.1″ 11″ 15″ 25″ 54″ 166″ 1.1″	5 in Sine Bar, Gage Blocks, Surface Plate Master Square, Surface Plate
Calipers, Micrometers [1,4] Travel (Outside, Inside, Depth, Step) Anvil Flatness Anvil Parallelism	Up to 1 in (1 to 9) in (4 to 15) in (15 to 40) in Up to 1 in diameter Up to 1 in diameter	(16 + 1L) µin (11 + 4L) µin (13 + 4.5L) µin (15 + 4.6L) µin 4.4 µin 8.2 µin	B89.1 Grade 00 Gage Blocks B89.1 Grade 0 Gage Blocks Optical Flats Optical Parallels
Dial/Digital Indicators, LVDT's, Gage Amplifiers	Up to 2 in (2 to 6) in	(17 + 1L) µin (18 + 2.2L) µin	Universal Length Measuring Machine
Length – Single Axis [4] Outside Dimension	Up to 1 in (1 to 7) in (7 to 12) in (12 to 24) in	(6 + 1.3L) µin (4.5 + 4L) µin (2 + 4L) µin (24 + 5L) µin	Universal Length Measuring Machine Gage Amp, Gage Blocks
Length – Single Axis [4] Inside Dimension Outside Dimension	(0.04 to 1) in (1 to 2.5) in (2.5 to 10) in Up to 1 in (1 to 7) in (7 to 12) in	11 µin 11 µin (18 + 3L) µin (6 + 1L) µin (4 + 3.5L) µin 4L µin	Universal Length Measuring Machine
Height Gages [1,4]	Up to 4 in (4 to 44) in	110 µin (94 + 3L) µin	Gage Blocks, Surface Plate
Parallelism, Flatness, Straightness	Up to 12 in (12 to 24) in (24 to 36) in (36 to 48) in	45 µin 55 µin 67 µin 160 µin	Gage Amplifier, Surface Plate
Squareness	Up to 12 in	100 µin	Gage Amplifier, Surface Plate

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Cylindrical Plug Gages Outside Diameter	 Up to 1 in (1 to 7) in	 12 µin (9 + 3*L*) µin	Universal Length Measuring Machine
Cylindrical Ring Gages Inside Diameter	 Up to 2.5 in (2.5 to 10) in (10 to 14) in	 11 µin (18 + 3*L*) µin (38 + 3*L*) µin	Universal Length Measuring Machine
Thread Plug Gages [4] Pitch Diameter Major Diameter	 Up to 1 in (1 to 7) in (7 to 12) in Up to 1 in (1 to 7) in	 79 µin 80 µin 83 µin 13 µin (10 + 3*L*) µin	Universal Length Measuring Machine, Thread Wires Universal Length Measuring Machine
Thread Ring Gages [4] Inner Pitch Diameter	 Up to 1 in (1 to 4) in (4 to 7) in	 79 µin 80 µin 83 µin	Master Thread Setting Plug Uncertainty
Thread Wires (2 to 120) TPI	(0.008 to 0.5) in	12 µin	Universal Length Measuring Machine
Measuring Tapes, Rulers [1,4]	Up to 3 ft (3 to 12) ft (12 to 100) ft	0.003 5 in (0.003 4 + 25*L*) µin (0.007 2 + 12*L*) µin	Glass Rule
Measuring Tapes, Rulers [4]	Up to 1 ft (1 to 3) ft (3 to 1 000) ft	(463 + 2*L*) µin (410 + 6*L*) µin (18*L*) µin	Single Axis Vision System
Optical Comparators [1,4] X, Y Length Magnification	 Up to 12 in 10X to 50X	 (100 + 20*L*) µin (240 + 21*L*) µin	 Calibration Grids Magnification Checker

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gas Flow Devices	(2 to 200) sccm (0.2 to 40) slpm (40 to 80) slpm (80 to 100) slpm	0.33 % of reading 0.23 % of reading 0.32 % of reading 0.57 % of reading	Fluke molbloc Laminar Flow Element Gas Flow Calibration System

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gas Flow Devices	(100 to 300) slpm (300 to 1 200) slpm	0.6 % of reading 0.81 % of reading	Fluke molbloc Sonic Nozzle Gas Flow Calibration System
Force Gages (Tension and Compression)	Up to 5 lbf (5 to 10) lbf (10 to 20) lbf (20 to 30) lbf (30 to 100) lbf	0.001 1 lbf 0.002 lbf 0.005 8 lbf 0.009 3 lbf 0.061 lbf	Characterized NIST Class F Weights
Force Gages (Tension and Compression)	Up to 5 lbf (5 to 10) lbf (10 to 20) lbf (20 to 30) lbf (30 to 100) lbf	0.001 2 lbf 0.002 3 lbf 0.006 2 lbf 0.009 9 lbf 0.063 lbf	NIST Class F Weights
Mass Determination Metric (SI)	1 mg 2 mg 3 mg 5 mg 10 mg 20 mg 30 mg 50 mg 100 mg 200 mg 300 mg 500 mg 1 g 2 g 3 g 5 g 10 g 20 g 30 g 50 g 100 g	1.6 µg 1.6 µg 1.6 µg 1.6 µg 1.6 µg 1.6 µg 1.6 µg 1.6 µg 1.6 µg 1.6 µg 1.6 µg 1.6 µg 2.2 µg 2.5 µg 3.2 µg 3.8 µg 5.5 µg 8 µg 9.9 µg 8.8 µg 20 µg	Echelon II

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass Determination Metric (SI)	200 g 300 g 500 g 1 kg 2 kg 3 kg 5 kg 10 kg 20 kg 25 kg	41 µg 40 µg 86 µg 0.17 mg 0.52 mg 0.85 mg 1 mg 2.4 mg 5 mg 7.5 mg	Echelon II
Mass Determination Metric (SI)	1 mg 2 mg 3 mg 5 mg 10 mg 20 mg 30 mg 50 mg 100 mg 200 mg 300 mg 500 mg 1 g 2 g 3 g 5 g 10 g 20 g 30 g 50 g 100 g 200 g 300 g 500 g 1 kg 2 kg 3 kg 5 kg 10 kg 20 kg 25 kg	4.2 µg 4.2 µg 4.2 µg 4.2 µg 4.2 µg 4.2 µg 4.2 µg 4.2 µg 4.2 µg 4.2 µg 4.2 µg 4.2 µg 11 µg 11 µg 12 µg 12 µg 17 µg 25 µg 26 µg 38 µg 80 µg 0.17 mg 0.24 mg 0.38 mg 0.8 mg 1.8 mg 2.8 mg 4 mg 5.7 mg 17 mg 23 mg	Echelon III

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass Determination Avoirdupois	0.0312 5 oz 0.062 5 oz 0.125 oz 0.25 oz 0.5 oz 1 oz 2 oz 4 oz 8 oz 1 lb 2 lb 5 lb 7.5 lb 10 lb 15 lb 20 lb 25 lb 50 lb	7.4 µg 12 µg 13 µg 17 µg 24 µg 31 µg 43 µg 93 µg 0.17 mg 0.25 mg 0.5 mg 1.8 mg 2.8 mg 2.9 mg 4.6 mg 5.3 mg 6.7 mg 17 mg	Echelon III
Rockwell Hardness Testers [1]	HRC Scale Low Middle High HRBw Scale Low Middle High	 0.78 HRC 0.59 HRC 0.43 HRC 1.1 HRBw 1 HRBw 1 HRBw	Indirect verification per ASTM E18 using Hardness Test Blocks.
Durometers Spring Force Only Type A, B, E, O Type D, C, DO	 Up to 100 Duro Up to 100 Duro	 0.31 Duro 0.16 Duro	Durometer Calibrator
Torque Wrenches, Torque Drivers, Torque Indicators [1]	(3 to 80) ozf·in 15 ozf·in to 600 lbf·ft 5 lbf·in to 800 lbf·ft	1.7 % of reading 0.5 % of reading 1 % of reading	Torque Calibrators
Hydraulic Torque Devices [1] (1 000 to 10 000) psig	(270 to 2 700) N·m (2 700 to 4 000) N·m (200 to 2 000) lbf·ft (2 000 to 20 000) lbf·ft	1.3 % of reading 1.3 % of reading 1.3 % of reading 1.3 % of reading	Torque Calibration System

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Multipliers [1]	(270 to 2 700) N·m (2 700 to 4 000) N·m (200 to 2 000) lbf·ft (2 000 to 20 000) lbf·ft	1.5 % of reading 1.5 % of reading 1.5 % of reading 1.5 % of reading	Torque Calibration System
Torque Angle [1]	45° 90° 135° 180° 360°	0.35° 0.35° 0.35° 0.35° 0.35°	Torque Angle Fixture
Torque Calibration Equipment	5 ozf·in to 2.5 lbf·in (2.5 to 50) lbf·in	0.09 % of reading 0.05 % of reading	Torque Wheel, Master Weights
	50 lbf·in to 250 lbf·ft	0.06 % of reading	Torque Butterfly, Master Weights
Balances and Scales [1,5] Metric (SI)	Up to 500 mg 500 mg to 2 g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 1 kg (1 to 2) kg (2 to 5) kg (5 to 10) kg (10 to 20) kg (20 to 30) kg (30 to 40) kg (40 to 50) kg (50 to 60) kg (60 to 70) kg (70 to 80) kg (80 to 100) kg	2.5 µg 6.2 µg 6.7 µg 11 µg 16 µg 27 µg 58 µg 0.11 mg 0.27 mg 0.54 mg 1.8 mg 3 mg 6.6 mg 14 mg 20 mg 27 mg 25 mg 26 mg 28 mg 29 mg 30 mg	Characterized ASTM E617 Class 1 weights and internal calibration procedure utilized for the calibration of the weighing system.
Balances and Scales [1,5] Metric (SI)	Up to 5 g (5 to 10) g (10 to 20) g (20 to 30) g (30 to 50) g (50 to 100) g	32 µg 44 µg 59 µg 88 µg 0.15 mg 0.29 mg	Characterized ASTM E617 Class 2 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 and Scales [1,5] Metric (SI)	(100 to 200) g (200 to 300) g (300 to 500) g (500 to 1 000) g (1 to 2) kg (2 to 3) kg (3 to 5) kg (5 to 6) kg (6 to 7) kg (7 to 8) kg (8 to 9) kg (9 to 10) kg	0.58 mg 0.89 mg 1.5 mg 3 mg 6.2 mg 9 mg 15 mg 18 mg 21 mg 24 mg 27 mg 30 mg	Characterized ASTM E617 Class 2 weights and internal calibration procedure utilized for the calibration of the weighing system.
Balances and Scales [1,5] Metric (SI)	Up to 250 g (250 to 500) g 500 g to 750 kg	0.023 % of reading 0.017 % of reading 0.012 % of reading	NIST Class F weights and internal calibration procedure utilized for the calibration of the weighing system.
Balances and Scales [1,5] Avoirdupois	Up to 0.5 lb (0.5 to 1) lb (1 to 1 700) lb	0.023 % of reading 0.017 % of reading 0.012 % of reading	
Volumetric Devices	1 mL to 5 L	0.2 % of reading + 20 µL	Gravimetric method utilizing Balances.
Pneumatic Absolute Pressure	Up to 30 psia (30 to 300) psia (300 to 1 000) psia	0.002 6 psi 0.008 8 % of reading 0.01 % of reading	Fluke RPM4 Reference Pressure Monitor with Pressure Source.
Pneumatic Gauge Pressure [1]	(-15 to 3) psig (3 to 500) psig	0.015 % of reading 0.006 5 % of reading	Cosa Instruments T3500/3 Pressure Calibrator
Pneumatic Gauge Pressure	(-60 to -22) inH_2O (-22 to 22) inH_2O (22 to 60) inH_2O (60 to 72) inH_2O (72 to 804) inH_2O	0.009% of reading + 150 µinH_2O 0.002 2 inH_2O 0.009% of reading + 150 µinH_2O 0.006 7 inH_2O 0.009% of reading + 150 µinH_2O	Fluke PPC4 Pressure Controller/Calibrator
	(-15 to 30) psig (30 to 1 000) psig	0.002 1 psi 0.007 % of reading	Fluke RPM4 Reference Pressure Monitor with Pressure Source.
Hydraulic Pressure [1]	(50 to 15 000) psia	0.011 % of reading + 0.002 6 psi	Ametek T-150 Deadweight Tester, Fluke RPM4 Reference Pressure Monitor
Hydraulic Pressure [1]	(50 to 15 000) psig	0.011 % of reading	Ametek T-150 Deadweight Tester

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Illuminance	(5.4 to 10 764) lx (10 764 to 21 258) lx (21 258 to 32 300) lx	1.1 % of reading 1.7 % of reading 2.1 % of reading	Standard Lamp

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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 70) %RH (70 to 95) %RH	 0.5 %RH 0.65 %RH 0.5 %RH 0.5 %RH 0.7 %RH 0.85 %RH	Humidity Generator
Humidity – Measure [1]	(10 to 30) °C (10 to 90) %RH	 1.3 %RH	Vaisala HMI41/HMP46 Temp/Humidity Indicator/Probe
Temperature – Source	(-100 to 0) °C (0 to 150) °C (150 to 420) °C (420 to 650) °C	0.014 °C 0.001 % of reading + 0.024 °C 0.001 % of reading + 0.036 °C 0.001 % of reading + 0.078 °C	Metrology Wells, SPRT, Hart Black Stack
Thermocouple Measuring System	(600 to 1 000) °C (1 000 to 1450) °C	0.94 °C 2.9 °C	Metrology Furnace, Hart 5650 Type S Thermocouple Probe, DMM
Temperature – Measure [1]	(-195 to 0) °C (0 to 420) °C (420 to 650) °C	0.012 °C 0.001 % of reading + 0.02 °C 0.001 % of reading + 0.028 °C	SPRT, Hart Black Stack
Temperature – Measure [1]	(600 to 1 000) °C (1 000 to 1450) °C	0.94 °C 2.9 °C	Hart 5650 Type S Thermocouple Probe, DMM
SPRT/PRT/RTD Calibration by Comparison [6]	-195 °C	3.4 mK	$NBPLN_2$, SPRT, Superthermometer
	-78 °C -38 °C 0 °C	3.2 mK 2.9 mK 2.9 mK	Precision Bath, SPRT, Superthermometer

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
SPRT/PRT/RTD Calibration by Comparison [6]	0.01 °C	1.5 mK	Triple Point of Water Cell
	100 °C 156 °C 231 °C 300 °C 420 °C	3.6 mK 4.6 mK 6 mK 5.8 mK 8.4 mK	Precision Bath, SPRT, Superthermometer
	(-100 to 420) °C	0.003 % of reading + 5.9 mK	Precision Bath, SPRT, Superthermometer
Infrared Temperature Measuring Equipment	(-15 to 0) °C (0 to 50) °C (50 to 100) °C (100 to 120) °C (120 to 200) °C (200 to 350) °C (350 to 500) °C	0.8 °C 0.65 °C 0.7 °C 0.76 °C 0.95 °C 1.6 °C 2.1 °C	Blackbody Sources (flat plate) ε = (0.1 to 1), λ = (8 to 14) µm

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source/Measure	10 MHz	5.8 nHz/Hz	Rubidium Frequency Oscillator
Frequency – Source/Measure [1]	10 MHz	2.1 µHz/Hz	Agilent 53132A Frequency Counter
Stopwatches, Timers [1]	Up to 599 s/mon	58 ms/day	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 µs to 100 s (10 to 49) % Duty Cycle 10 µs to 100 s 50 % Duty Cycle 10 µs to 100 s (51 to 90) % Duty Cycle 10 µs to 100 s (91 to 99) % Duty Cycle 10 µs to 100 s	0.62 % of reading + 78 ns 0.039 % of reading + 78 ns 0.001 6 % of reading + 78 ns 0.039 % of reading + 78 ns 0.62 % of reading + 78 ns	Fluke 5522A Multiproduct Calibrator

DIMENSIONAL MEASUREMENT

1 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dimensional Measurement – 1D	X-Axis Up to 1 in (1 to 3) in (3 to 6) in Y-Axis Up to 2 in (2 to 3) in (3 to 5) in	 210 µin 370 µin 480 µin 360 µin 410 µin 560 µin	Optical Comparator utilized as Reference for Length Measurement Inspection.

2 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dimensional Measurement – 2D	Up to 180°	0.008°	Optical Comparator utilized as Reference for Angle Measurement Inspection.
Dimensional Measurement – 2D	Up to 1 in (1 to 3) in (3 to 6) in	260 µin 450 µin 590 µin	Optical Comparator utilized as Reference for Radius Measurement Inspection.

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. 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.
3. The stated uncertainty is the laboratory's ability to source a fast rise pulse that is approximately 500 ps, 125 ps, and 25 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 DUT. The known source rise time is mathematically removed from the total measured rise time measured on the DUT.
4. L = length in inches; DL = diagonal length in inches; ″ = arc-second.
5. 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.
6. $NBPLN_2$ = Boiling Point of Liquid Nitrogen.
7. The Uncertainty for this measurand is a Unitless measure.
8. Mismatch due to the effect of device-under-test (DUT) and instruments is not included in the Scope CMC, but will be included in the Measurement Uncertainty (MU) on the calibration certificate.

9. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2489.03.

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