



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Transcat – Denver
3251 Lewiston St., Suite 12
Aurora, CO 80011

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 & 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-2489.10



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 – Denver

3251 Lewiston St., Suite 12

Aurora, CO 80011

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CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: September 7, 2025

Certificate Number: AC-2489.10

CALIBRATION

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Acceleration	(0.5 to 1) Hz	1.1 % of reading	Comparison to Master Accelerometer
	(1 to 5) Hz	0.8 % of reading	
	(5 to 10) Hz	0.8 % of reading	
	(10 to 99) Hz	1.2 % of reading	
	100 Hz	0.75 % of reading	
	(101 to 920) Hz	1 % of reading	
	(921 to 5 000) Hz	1.4 % of reading	
	(5 001 to 10 000) Hz	1.8 % of reading	
	(10 to 15) kHz	2.2 % of reading	
(15 to 20) kHz	2.8 % of reading		

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters	4 pH	0.012 pH	Accredited pH Solutions
	7 pH	0.011 pH	
	10 pH	0.012 pH	



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Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters	1 μ S	0.3 μ S	Accredited Conductivity Solutions
	10 μ S	0.3 μ S	
	100 μ S	2.1 μ S	
	1 000 μ S	5 μ S	
	1 413 μ S	4 μ S	
	10 000 μ S	44 μ S	
	100 000 μ S	330 μ S	
	150 000 μ S	570 μ S	
	200 000 μ S	670 μ S	

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		Thermal Converters, HP 3458A 8.5 Digit Multimeter
	10 Hz to 1 MHz	0.06 % of reading	
	(1 to 10) MHz	0.1 % of reading	
	(10 to 30) MHz	0.18 % of reading	
	(30 to 50) MHz	0.41 % of reading	
	(50 to 80) MHz	0.71 % of reading	
DC Current – Source ¹	(80 to 100) MHz	0.84 % of reading	Keithley 263 Calibrator/Source
	Up to 2 pA	0.8 % of reading + 10 fA	
	(2 to 20) pA	0.44 % of reading + 10 fA	
	(20 to 200) pA	0.3 % of reading + 30 fA	
	(0.2 to 2) nA	0.077 % of reading + 100 fA	
	(2 to 20) nA	0.076 % of reading + 1 pA	
DC Current – Source ¹	(20 to 200) nA	0.041 % of reading + 10 pA	Fluke 5730A Multiproduct Calibrator
	(0.2 to 2) μ A	0.029 % of reading + 0.1 nA	
	(2 to 220) μ A	40 μ A/A + 6 nA	
	(0.22 to 2.2) mA	36 μ A/A + 7 nA	
	(2.2 to 22) mA	35 μ A/A + 40 nA	
DC Current – Source ¹	(22 to 220) mA	48 μ A/A + 0.7 μ A	Fluke 5730A/5725A Multiproduct Calibrator with Amplifier
	(0.22 to 2.2) A	80 μ A/A + 12 μ A	
DC Current – Source ¹	(2.2 to 11) A	0.036 % of reading + 0.48 mA	Fluke 5520A Multiproduct Calibrator
DC Current – Source ¹	(11 to 20.5) A	0.082 % of reading + 0.75 mA	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source ¹	(1 to 10) A (10 to 100) A (100 to 300) A	0.01 % of reading 0.06 % of reading 0.12 % of reading	Guideline 9211 Multi-tap DC Current Shunt, Current Source
DC Clamp-on Ammeters (Non-Toroidal Type) Transformer Type Sensor ¹	(20 to 150) A (150 to 1 000) A	0.5 % of reading + 0.14 A 0.51 % of reading + 0.5 A	Fluke 5520A Multiproduct Calibrator, 5500A/COIL 50-turn Coil
DC Current – Measure ¹	Up to 2 pA (2 to 20) pA (20 to 200) pA (0.2 to 2) nA (2 to 20) nA (20 to 200) nA	2.1 % of reading + 6.6 fA 1.9 % of reading + 7 fA 1.9 % of reading + 10 fA 0.3 % of reading + 0.5 pA 0.3 % of reading + 1 pA 0.3 % of reading + 10 pA	Keithley 617 Programmable Electrometer
DC Current – Measure ¹	(0.2 to 1) μA (1 to 10) μA (10 to 100) μA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	25 μA/A + 46 pA 25 μA/A + 0.12 nA 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	Agilent 3458A Opt 002 8.5 Digit Multimeter
DC Current – Measure ¹	(1 to 10) A (10 to 100) A (100 to 300) A	0.01 % of reading 0.06 % of reading 0.12 % of reading	Guideline 9211 Multi-tap DC Current Shunt, Digital Multimeter
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 (0.22 to 2.2) mA (10 to 20) Hz (20 to 40 Hz) 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (2.2 to 22) mA (10 to 20) Hz (20 to 40 Hz) 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.025 % of reading + 16 nA 0.016 % of reading + 10 nA 0.01 % of reading + 8 nA 0.028 % of reading + 12 nA 0.11 % of reading + 65 nA 0.025 % of reading + 40 nA 0.016 % of reading + 35 nA 0.01 % of reading + 35 nA 0.02 % of reading + 0.11 μA 0.11 % of reading + 0.65 μA 0.025 % of reading + 0.4 μA 0.016 % of reading + 0.35 μA 0.01 % of reading + 0.35 μA 0.02 % of reading + 0.55 μA 0.11 % of reading + 5 μA	Fluke 5730A Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(22 to 220) mA (10 to 20) Hz (20 to 40 Hz) 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (2.2 to 3) A (10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.025 % of reading + 4 μA 0.016 % of reading + 3.5 μA 0.01 % of reading + 2.5 μA 0.02 % of reading + 3.5 μA 0.11 % of reading + 10 μA 0.024 % of reading + 35 μA 0.045 % of reading + 80 μA 0.7 % of reading + 0.16 mA 0.18 % of reading + 0.1 mA 0.06 % of reading + 0.1 mA 0.6 % of reading + 1 mA 2.5 % of reading + 5 mA	Fluke 5730A Multiproduct Calibrator
AC Current – Source ¹	(3 to 11) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.06 % of reading + 2 mA 0.1 % of reading + 2 mA 3 % of reading + 2 mA	Fluke 5730A Multiproduct Calibrator, Fluke 5725A Amplifier
AC Current – Source ¹	(11 to 20.5) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.12 % of reading + 5 mA 0.15 % of reading + 5 mA 3 % of reading + 5 mA	Fluke 5520A Multiproduct Calibrator
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 + 0.4 μA 0.78 % of reading + 0.6 μA 0.31 % of reading + 4 μA 0.31 % of reading + 0.2 mA	Fluke 5520A 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	0.3 % of reading + 26 mA 0.83 % of reading + 47 mA 0.35 % of reading + 0.12 A 1.1 % of reading + 0.22 A	Fluke 5520A 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
AC Clamp-on Ammeters (Non-Toroidal Type) Hall Effect Sensor ¹	(20 to 150) A (45z to 65) Hz (65 to 440) Hz (150 to 1 000) A (45 to 65) Hz (65 to 440) Hz	0.57 % of reading + 0.25 A 1 % of reading + 0.25 A 0.6 % of reading + 0.9 A 1.3 % of reading + 0.92 A	Fluke 5520A Multiproduct Calibrator, Fluke 5500A/COIL 50-turn 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 (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	0.46 % 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 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	Agilent 3458A Opt 002 8.5 Digit Multimeter
AC Current – Measure ¹	(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 + 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 20) A (50 to 100) Hz (100 to 300) Hz 300 Hz to 1 kHz (1 to 3) kHz (3 to 4) kHz (4 to 5) kHz	0.02 % of reading 0.03 % of reading 0.03 % of reading 0.06 % of reading 0.07 % of reading 0.09 % of reading	Fluke Y5020 Precision AC Current Shunt, Precision Digital Multimeter
AC Current – Measure ¹	(20 to 100) A (50 to 60) Hz 400 Hz 1 kHz	0.022 % of reading + 5 mA 0.026 % of reading + 5 mA 0.11 % of reading + 1.3 mA	100 A AC Current Shunt, Agilent 3458A 8.5 Digit Multimeter



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance – Measure ¹	1 kHz 20 Ω to 100 kΩ	0.039 % of reading + 10 mΩ	General Radio 1689 Precision LCR Meter
AC Resistance – Measure	50 Hz to 100 kHz (0.1 to 15) Ω 100 Hz to 100 kHz (15 to 420) Ω 100 Hz to 10 kHz (0.42 to 32) kΩ 100 Hz to 100 kHz (32 to 320) kΩ (0.32 to 10) MΩ	0.12 % of reading 0.06 % of reading 0.06 % of reading 0.06 % of reading 0.12 % of reading	Agilent 4284A Precision LCR Meter
AC Resistance – Measure	0.1 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ	0.17 % of reading 0.12 % of reading 0.12 % of reading 0.05 % of reading 0.05 % of reading 0.13 % of reading 0.26 % of reading	Comparison to Impedance Standards
DC Resistance – Source ¹ (Artifacts)	333 μΩ 1 mΩ 10 mΩ 100 mΩ	0.12 % of reading 0.06 % of reading 0.01 % of reading 0.01 % of reading	Guideline 9211 Precision Multi-tap DC Current Shunt
DC Resistance – Source ¹ (Artifacts)	1 Ω 10 kΩ	10 μΩ 54 mΩ	Fluke 742A Resistance Standard
DC Resistance – Source ¹ (Artifacts)	1 GΩ 10 GΩ 100 GΩ 1 TΩ	0.2 % of reading 0.5 % of reading 0.55 % of reading 0.56 % of reading	IET Labs HRRS-Q-8-100k-10 kV Precision Decade Resistor
DC Resistance – Source ¹ (Simulated-Fixed)	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ	40 μΩ 95 μΩ/Ω 95 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 10 μΩ/Ω 10 μΩ/Ω 6.5 μΩ/Ω	Fluke 5730A Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Resistance – Source ¹ (Simulated-Fixed)	1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	6.5 μΩ/Ω 6.5 μΩ/Ω 6.5 μΩ/Ω 8.5 μΩ/Ω 8.5 μΩ/Ω 13 μΩ/Ω 18 μΩ/Ω 40 μΩ/Ω 47 μΩ/Ω 100 μΩ/Ω	Fluke 5730A Multiproduct Calibrator
DC Resistance – Measure ¹	Up to 10 Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 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 characterized with Standard Resistors.
DC Resistance – Measure ¹	(1 to 2) GΩ (2 to 20) GΩ (20 to 200) GΩ	1.7 % of reading + 0.1 MΩ 1.7 % of reading + 1 MΩ 1.8 % of reading + 10 MΩ	Keithley 617 Electrometer
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	7.5 μV/V + 0.4 μV 5 μV/V + 0.7 μV 3.5 μV/V + 2.5 μV 3.5 μV/V + 4 μV 5 μV/V + 40 μV	Fluke 5730A Multiproduct Calibrator
DC Voltage – Source ¹	(220 to 1 100) V	6.5 μV/V + 0.4 mV	Fluke 5730A Multiproduct Calibrator, Fluke 5725A Amplifier
DC High Voltage – Source ¹	(1.1 to 20) kV (20 to 36) kV	0.096 % of reading + 1.1 V 0.096 % of reading + 10 V	High Voltage Source, Vitretek 4700 Digital HV Meter, Vitretek HVL-100 High Voltage Probe



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Measure ¹	(0 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 μ V/V + 0.58 μ V 5.3 μ V/V + 0.58 μ V 7.7 μ V/V + 35 μ V 15 μ V/V + 0.12 mV 18 μ V/V + 0.12 mV 21 μ V/V + 0.12 mV	Agilent 3458A Opt 002 8.5 Digit Multimeter
DC High Voltage – Measure ¹	(1 to 5) kV (5 to 10) kV (10 to 20) kV (20 to 50) kV (50 to 70) kV (70 to 100) kV	0.04 % of reading + 0.26 V 0.04 % of reading + 1.7 V 0.065 % of reading + 1.1 V 0.066 % of reading + 10 V 0.067 % of reading + 28 V 0.069 % of reading + 81 V	Vitrek 4700 Digital HV Meter, Associated High Voltage Probes
AC Voltage – Source ¹	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz (2.2 to 22) mV (10 to 20) Hz (20 to 40) Hz (0.04 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz (22 to 220) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.024 % of reading + 4 μ V 0.009 % of reading + 4 μ V 0.008 % of reading + 4 μ V 0.02 % of reading + 4 μ V 0.05 % of reading + 5 μ V 0.11 % of reading + 10 μ V 0.14 % of reading + 20 μ V 0.27 % of reading + 20 μ V 0.024 % of reading + 4 μ V 0.009 % of reading + 4 μ V 0.008 % of reading + 4 μ V 0.02 % of reading + 4 μ V 0.05 % of reading + 5 μ V 0.11 % of reading + 10 μ V 0.14 % of reading + 20 μ V 0.27 % of reading + 20 μ V 0.024 % of reading + 12 μ V 0.009 % of reading + 7 μ V 0.005 7 % of reading + 7 μ V 0.012 % of reading + 7 μ V 0.031 % of reading + 17 μ V 0.066 % of reading + 20 μ V 0.14 % of reading + 25 μ V 0.27 % of reading + 45 μ V	Fluke 5730A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(0.22 to 2.2) V		Fluke 5730A Multiproduct Calibrator
	(10 to 20) Hz	0.024 % of reading + 40 μV	
	(20 to 40) Hz	0.009 % of reading + 15 μV	
	40 Hz to 20 kHz	0.004 2 % of reading + 8 μV	
	(20 to 50) kHz	0.006 7 % of reading + 10 μV	
	(50 to 100) kHz	0.008 5 % of reading + 30 μV	
	(100 to 300) kHz	0.034 % of reading + 80 μV	
	(300 to 500) kHz	0.1 % of reading + 0.2 mV	
	500 kHz to 1 MHz	0.17 % of reading + 0.3 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.024 % of reading + 0.4 mV	
	(20 to 40) Hz	0.009 % of reading + 0.15 mV	
	40 Hz to 20 kHz	0.004 2 % of reading + 0.05 mV	
	(20 to 50) kHz	0.006 7 % of reading + 0.1 mV	
	(50 to 100) kHz	0.008 3 % of reading + 0.2 mV	
	(100 to 300) kHz	0.026 % of reading + 0.6 mV	
	(300 to 500) kHz	0.1 % of reading + 2 mV	
	500 kHz to 1 MHz	0.15 % of reading + 3.2 mV	
AC Voltage – Source ¹	(22 to 220) V		Fluke 5730A Multiproduct Calibrator, Fluke 5725A Amplifier
	(10 to 20) Hz	0.024 % of reading + 4 mV	
	(20 to 40) Hz	0.009 % of reading + 1.5 mV	
	40 Hz to 20 kHz	0.005 2 % of reading + 0.6 mV	
	(20 to 50) kHz	0.008 % of reading + 1 mV	
	(50 to 100) kHz	0.015 % 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	
	(220 to 750) V		
	(30 to 50) kHz	0.06 % of reading + 11 mV	
	(50 to 100) kHz	0.23 % of reading + 45 mV	
(220 to 1 100) V			
40 Hz to 1 kHz	0.009 % of reading + 4 mV		
(1 to 20) kHz	0.017 % of reading + 6 mV		
(20 to 30) kHz	0.06 % of reading + 11 mV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	Up to 1 mV		Rohde & Schwarz URE3 RMS Voltmeter
	100 kHz to 1 MHz	1.8 % of reading + 2.4 μV	
	(1 to 3) MHz	3.5 % of reading + 2.4 μV	
	(3 to 10) MHz	9.3 % of reading + 2.4 μV	
	(10 to 20) MHz	23 % of reading + 2.4 μV	
	(1 to 3) mV		
	100 kHz to 1 MHz	0.97 % of reading + 2 μV	
	(1 to 3) MHz	3.5 % of reading + 2 μV	
	(3 to 10) MHz	9.3 % of reading + 2 μV	
	(10 to 20) MHz	23 % of reading + 2 μV	
	(3 to 100) mV		
	100 kHz to 1 MHz	0.91 % of reading + 3 μV	
(1 to 3) MHz	1.8 % of reading + 3 μV		
(3 to 10) MHz	2.9 % of reading + 3 μV		
(10 to 20) MHz	6.9 % of reading + 3 μV		
(20 to 30) MHz	14 % of reading + 3 μV		
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 to 4) MHz	8.1 % of reading + 8.1 μV	
	(10 to 100) mV		
	(1 to 40) Hz	0.013 % of reading + 4 μV	
	40 Hz to 1 kHz	0.009 5 % of reading + 2 μV	
	(1 to 20) kHz	0.017 % of reading + 2 μV	
	(20 to 50) kHz	0.037 % of reading + 2 μV	
	(50 to 100) kHz	0.093 % of reading + 2 μV	
	(100 to 300) kHz	0.36 % of reading + 10 μV	
	300 kHz to 1 MHz	1.2 % of reading + 10 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		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(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	
	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		
(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		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC High Voltage – Measure ¹	(0.7 to 5) kV		Vitrek 4700 Digital HV Meter, Associated High Voltage Probes
	(10 to 200) Hz	0.14 % of reading + 0.34 V	
	(200 to 450) Hz	0.47 % of reading + 0.34 V	
	(5 to 10) kV		
	(10 to 200) Hz	0.16 % of reading + 1.9 V	
	(200 to 450) Hz	0.47 % of reading + 1.9 V	
	(10 to 20) kV		
	(30 to 70) Hz	0.16 % of reading + 1.4 V	
	(70 to 200) Hz	1.2 % of reading + 1.4 V	
	(200 to 450) Hz	2.9 % of reading + 1.8 V	
	(20 to 50) kV		
	(30 to 70) Hz	0.16 % of reading + 11 V	
(70 to 200) Hz	1.2 % of reading + 11 V		
(200 to 450) Hz	2.9 % of reading + 21 V		
(50 to 70) kV			
(30 to 70) Hz	0.16 % of reading + 28 V		
(70 to 200) Hz	1.2 % of reading + 28 V		
Capacitance – Source ¹ (Fixed Artifacts)	1 kHz (0.1 to 0.5) nF 0.5 nF to 1.4 μF	0.59 pF 0.12 % of reading + 0.018 pF	Arco SS32 Capacitor Set
Capacitance – Source ¹ (Fixed Artifacts)	1 pF		HP 16380A Series, HP 16830C Series Standard Air Capacitor Set
	1 kHz to 1 MHz	0.32 fF	
	(1 to 2) MHz	0.62 fF	
	(2 to 3) MHz	1.1 fF	
	(3 to 4) MHz	1.6 fF	
	(4 to 5) MHz	2.2 fF	
	(5 to 10) MHz	6.3 fF	
	(10 to 13) MHz	9.3 fF	
	10 pF		
	1 kHz to 5 MHz	2.5 fF	
	(5 to 10) MHz	3.7 fF	
	(10 to 13) MHz	4.5 fF	
	100 pF		
	1 kHz to 3 MHz	27 fF	
	(3 to 4) MHz	31 fF	
(4 to 5) MHz	39 fF		
(5 to 10) MHz	86 fF		
(10 to 13) MHz	0.13 pF		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ (Fixed Artifacts)	1 000 pF		HP 16380A Series, HP 16830C Series Standard Air Capacitor Set
	20 Hz to 1 MHz	0.27 pF	
	(1 to 2) MHz	0.43 pF	
	(2 to 3) MHz	0.74 pF	
	(3 to 4) MHz	1.1 pF	
	(4 to 5) MHz	1.6 pF	
	(5 to 10) MHz	4.8 pF	
	(10 to 13) MHz	7 pF	
	10 nF		
	120 Hz to 10 kHz	2.4 pF	
	(10 to 100) kHz	2.9 pF	
	100 nF		
	120 Hz to 10 kHz	25 pF	
	(10 to 100) kHz	30 pF	
1 μF			
120 Hz to 10 kHz	0.37 nF		
(10 to 100) kHz	1.1 nF		
10 μF			
20 Hz to 1 kHz	3.4 nF		
(1 to 10) kHz	6.1 nF		
(10 to 100) kHz	34 nF		
Dissipation Factor – Source ⁴ (Fixed Artifacts)	1 pF		HP 16380A Series, HP 16830C Series Standard Air Capacitor Set
	1 kHz to 1 MHz	0.000 23	
	(1 to 2) MHz	0.000 15	
	(2 to 3) MHz	0.000 23	
	(3 to 4) MHz	0.000 35	
	(4 to 5) MHz	0.000 50	
	(5 to 10) MHz	0.001 4	
	(10 to 13) MHz	0.002 1	
	10 pF		
	1 kHz to 5 MHz	0.000 15	
	(5 to 10) MHz	0.000 2	
	(10 to 13) MHz	0.000 24	
	100 pF		
	1 kHz to 3 MHz	0.000 12	
(3 to 4) MHz	0.000 13		
(4 to 5) MHz	0.000 15		
(5 to 10) MHz	0.000 4		
(10 to 13) MHz	0.000 6		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dissipation Factor – Source ⁴ (Fixed Artifacts)	1 000 pF 20 Hz to 1 MHz (1 to 2) MHz (2 to 3) MHz (3 to 4) MHz (4 to 5) MHz (5 to 10) MHz (10 to 13) MHz 10 nF 120 Hz to 100 kHz 100 nF 120 Hz to 100 kHz 1 μF 120 Hz to 100 kHz 10 μF 20 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	0.000 12 0.000 15 0.000 25 0.000 38 0.000 53 0.001 5 0.002 1 0.000 23 0.000 29 0.000 41 0.000 29 0.000 7 0.001 8	HP 16380A Series, HP 16830C Series Standard Air Capacitor Set
Capacitance – Source ¹ (Simulated)	10 Hz to 10 kHz (0.19 to 1.1) nF 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 (110 to 330) nF (10 to 600) Hz (0.33 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 (0.33 to 1.1) mF	0.39 % of reading + 7.8 pF 0.39 % of reading + 7.8 pF 0.2 % of reading + 7.8 pF 0.2 % of reading + 78 pF 0.2 % of reading + 0.23 nF 0.2 % of reading + 0.78 nF 0.2 % of reading + 2.3 nF 0.2 % of reading + 7.8 nF 0.32 % of reading + 23 nF 0.35 % of reading + 78 nF 0.37 % of reading + 0.23 μF 0.37 % of reading + 0.78 μF	Fluke 5520A Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ (Simulated)	DC to 6 Hz (1.1 to 3.3) mF	0.35 % of reading + 2.3 μF	Fluke 5520A Multiproduct Calibrator
	DC to 2 Hz (3.3 to 11) mF	0.35 % of reading + 7.8 μF	
	DC to 0.6 Hz (11 to 33) mF	0.58 % of reading + 23 μF	
	DC to 0.2 Hz (33 to 110) mF	0.85 % of reading + 78 μF	
Capacitance – Measure ¹	1 kHz Up to 10 pF	0.47 % of reading + 0.05 pF	General Radio 1689 Precision LCR Meter
	(10 to 100) pF	0.058 % of reading + 0.05 pF	
	(0.1 to 1) μF	0.024 % of reading + 0.05 pF	
	(1 to 100) μF	0.04 % of reading	
	(0.1 to 1) mF	0.24 % of reading	
Capacitance – Measure ¹	1 MHz (10 to 90) pF	0.12 % of reading	Agilent 4284A Precision LCR Meter
	90 pF to 10 nF	0.06 % of reading	
	100 kHz (12 to 90) pF	0.12 % of reading	
	90 pF to 100 nF	0.06 % of reading	
	(0.1 to 100) μF	0.12 % of reading	
Capacitance – Measure ¹	10 kHz (10 to 80) pF	0.12 % of reading	Agilent 4284A Precision LCR Meter
	80 pF to 1 μF	0.06 % of reading	
	400 Hz 10 nF to 10 μF	0.06 % of reading	
	(100 to 120) Hz 10 nF to 100 μF	0.06 % of reading	
	100 μF to 12 mF	0.12 % of reading	
Inductance – Source ¹ (Artifact)	1 kHz 100 mH	0.14 mH	Standard Inductor
Inductance – Measure ¹	100 Hz to 1 kHz (1 to 100) mH	0.04 % of reading + 0.1 μH	Agilent 4284A Precision LCR Meter
	(0.1 to 10) H	0.057 % of reading + 1.4 μH	
	400 Hz 5 μH to 5 mH	0.12 % of reading	
	5 mH to 10 H	0.06 % of reading	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Measure ¹	(100 to 120) Hz (0.12 to 20) mH 20 mH to 10 H 1 kHz 1 μH to 1 mH 10 kHz 5 nH to 120 μH 120 μH to 100 mH	0.12 % of reading 0.06 % of reading 0.12 % of reading 0.12 % of reading 0.06 % of reading	Agilent 4284A Precision LCR Meter
Oscilloscopes ¹			
Amplitude – DC into 50 Ω load	(-5 to 5) V	0.023 % of reading + 19 μV	Fluke 9500B Oscilloscope Calibrator, Fluke 9530 3.2 GHz Active Head, Fluke 9560 Active Head w/ 70 ps Capability
into 1 MΩ load	(-200 to 200) V	0.023 % of reading + 19 μV	
Amplitude – Square Wave Rate: 10 Hz to 10 kHz into 50 Ω load	40 μVp-p to 1 mVp-p 1 mVp-p to 5 Vp-p	0.78 % of reading + 7.8 μV 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	
Time Markers 100 mVp-p to 1 Vp-p into 50 Ω load			
Square Wave	9.009 1 ns to 83 μs 83 μs to 55s	0.19 μs/s 2.3 μs/s	
Sine Wave	450.5 ps to 9.009 ns	0.19 μs/s	
Pulse	900.91 ns to 83 μs 83 μs to 55s	0.19 μs/s 2.3 μs/s	
Triangle Wave	900.91 ns to 83 μs 83 μs to 55s	0.19 μs/s 2.3 μs/s	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ^{1,2} Rise Time into 50 Ω load Rate: 10 Hz to 2 MHz	5 mVp-p to 3 Vp-p 500 ps (nominal) 150 ps (nominal)	290 ps 34 ps	Fluke 9500B Oscilloscope Calibrator, Fluke 9530 3.2 GHz Active Head, Fluke 9550 Active Head w/ 25 ps Capability, Fluke 9560 Active Head w/ 70 ps Capability, Tektronix 067-1330-000 Calibration Fixture
Rate: 10 Hz to 1 MHz	25 mVp-p to 2 Vp-p 70 ps (nominal) 425 mVp-p to 575 mVp-p 25 ps (nominal) 200 mVp-p 16 ps (nominal)	21 ps 5.7 ps 2.1 ps	
Leveled Sine Wave 50 kHz Reference 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 (40 to 90) Ω (90 to 150) Ω (50 to 800) kΩ (0.8 to 1.2) MΩ (1.2 to 12) MΩ	0.39 % of reading 0.083 % of reading 0.39 % of reading 0.39 % of reading 0.083 % of reading 0.39 % of reading	
Input Capacitance Measure	(1 to 35) pF (35 to 95) pF	1.6 % of reading + 0.19 pF 2.3 % of reading + 0.19 pF	
Phase – Source ¹	Up to 180 ° (10 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 20) kHz	0.11 ° 0.2 ° 0.4 ° 1.9 ° 3.9 ° 7.8 °	



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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	11 μ W to 1.1 mW 1.1 mW to 0.11 W (0.11 to 110) W (110 to 330) W	0.024 % of reading 0.027 % of reading 0.024 % of reading 0.018 % of reading	Fluke 5520A Multiproduct Calibrator
(0.33 to 3) A	11 μ W to 110 mW (0.11 to 990) W (0.99 to 3) kW	0.044 % of reading 0.053 % of reading 0.009 6 % of reading	
(3 to 20.5) 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	
AC Power – Source ^{1,3} PF = 1			Fluke 5520A Multiproduct Calibrator
(3.3 to 9) mA	(10 to 65) Hz (0.11 mW to 3) mW 3 mW to 9 W	0.13 % of reading 0.077 % of reading	
(9 to 33) mA	(10 to 65) W (0.3 to 10) mW 10 mW to 33 W	0.089 % of reading 0.077 % of reading	
(33 to 90) mA	(10 to 65) Hz (1 to 30) mW 30 mW to 90 W	0.071 % of reading 0.057 % of reading	
(90 to 330) mA	(10 to 65) Hz (3 to 100) mW 100 mW to 300 W	0.089 % of reading 0.078 % of reading	
(0.33 to 0.9) A	(10 to 65) Hz (11 to 300) mW (0.3 to 900) W	0.071 % of reading 0.081 % of reading	
(0.9 to 2.2) A	(10 to 65) Hz (30 to 720) mW 0.72 W to 2 kW	0.089 % of reading 0.079 % of reading	
AC Power – Source ^{1,3} PF = 1			Fluke 5520A Multiproduct Calibrator
(2.2 to 4.5) A	(10 to 65) Hz 80 mW to 1.4 W 1.4 W to 4.5 kW	0.088 % of reading 0.18 % of reading	
(4.5 to 20.5) A	(10 to 65) Hz 150 mW to 230 kW	0.17 % of reading	

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 B		Ectron 1140A Thermocouple Calibrator/Simulator
	(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	0.095 °C	
	(-90 to 0) °C	0.08 °C	
	(0 to 15) °C	0.076 °C	
	(15 to 890) °C	0.064 °C	
	(890 to 1 000) °C	0.074 °C	
Type J			
(-210 to -180) °C	0.15 °C		
(-180 to -120) °C	0.12 °C		
(-120 to -50) °C	0.093 °C		
(-50 to 990) °C	0.08 °C		
(990 to 1 200) °C	0.094 °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	0.087 °C		
(1 000 to 1 372) °C	0.096 °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 N (-270 to -260) °C (-260 to -200) °C (-200 to -140) °C (-140 to -70) °C (-70 to 25) °C (25 to 160) °C (160 to 1 300) °C Type R (-50 to -30) °C (-30 to 45) °C (45 to 160) °C (160 to 380) °C (380 to 775) °C (775 to 1 768) °C 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	5.4 °C 1.5 °C 0.29 °C 0.18 °C 0.14 °C 0.12 °C 0.11 °C 0.8 °C 0.69 °C 0.49 °C 0.35 °C 0.3 °C 0.26 °C 0.76 °C 0.68 °C 0.49 °C 0.41 °C 0.35 °C 0.31 °C 1.9 °C 0.6 °C 0.36 °C 0.22 °C 0.15 °C 0.095 °C 0.08 °C	Ectron 1140A Thermocouple Calibrator/Simulator
Bandwidth Flatness Measure into VSWR (1.2:1) (wrt Reference Frequency)	5 mVp-p to 5 Vp-p 100 Hz to 300 MHz (300 to 550) MHz 5 mVp-p to 3 Vp-p 550 MHz to 1.1 GHz (1.1 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 3.1 % of reading	Fluke 9500B/3200 Oscilloscope Calibrator, Fluke 9530 3.2 GHz Active Head



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Bandwidth Flatness Measure ¹ into VSWR (1.2:1)	5 mVp-p to 5 Vp-p 100 Hz to 300 MHz (300 to 550) MHz 5 mVp-p to 3 Vp-p 550 MHz to 1.1 GHz (1.1 to 2.5) GHz 5 mVp-p to 2 Vp-p (2.5 to 3) GHz 25 mVp-p to 2 Vp-p (3 to 6) GHz	1.6 % of reading 1.9 % of reading 2.3 % of reading 2.3 % of reading 2.3 % of reading 3.1 % of reading	Fluke 9500B/1100 Oscilloscope Calibrator, Fluke 9560 6 GHz Active Head
AC Voltage – Source ¹ Wide-Band Voltage (50 Ω)	30 Hz to 500 kHz (0.33 to 1.1) mV (1.1 to 3.3) mV (3.3 to 11) mV (11 to 33) mV (33 to 110) mV (110 to 330) mV (0.33 to 1.1) V (1.1 to 3.5) V	0.62 % of reading + 0.78 μV 0.54 % of reading + 1.2 μV 0.054 % of reading + 3.1 μV 0.47 % of reading + 6.2 μV 0.47 % of reading + 16 μV 0.39 % of reading + 39 μV 0.39 % of reading + 0.16 mV 0.31 % of reading + 0.19 mV	Fluke 5730A Multiproduct Calibrator
AC Voltage – Source ¹ Wide-Band Voltage (50 Ω) 1 kHz Reference	(0.33 to 1.1) mV (10 to 30) Hz (30 to 119.99) Hz 120 Hz to 1.199 9 kHz (1.2 to 11.999) kHz (12 to 119.99) kHz 120 Hz to 1.199 9 MHz (1.2 to 2) MHz (2 to 11.9) MHz (12 to 20) MHz (20 to 30) MHz	0.23 % of reading 0.078 % of reading 0.078 % of reading 0.078 % of reading 0.078 % of reading 0.16 % of reading + 1.2 μV 0.16 % of reading + 1.2 μV 0.16 % of reading + 1.2 μV 0.16 % of reading + 1.2 μV 2.1 % of reading + 5.8 μV	Fluke 5730A Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹ Wide-Band Voltage (50 Ω) 1 kHz Reference	(1.1 to 3.3) mV		Fluke 5730A Multiproduct Calibrator
	(10 to 30) Hz	0.23 % of reading	
	(30 to 119.99) Hz	0.078 % of reading	
	120 Hz to 1.199 9 kHz	0.078 % of reading	
	(1.2 to 11.999) kHz	0.078 % of reading	
	(12 to 119.99) kHz	0.078 % of reading	
	120 Hz to 1.199 9 MHz	0.078 % of reading + 1.2 μV	
	(1.2 to 2) MHz	0.078 % of reading + 1.2 μV	
	(2 to 11.9) MHz	0.23 % of reading + 1.2 μV	
	(12 to 20) MHz	0.39 % of reading + 1.2 μV	
	(20 to 30) MHz	1.2 % of reading + 1.2 μV	
	(3.3 to 11) mV		
	(10 to 30) Hz	0.23 % of reading	
	(30 to 119.99) Hz	0.078 % of reading	
	120 Hz to 1.199 9 kHz	0.078 % of reading	
	(1.2 to 11.999) kHz	0.078 % of reading	
	(12 to 119.99) kHz	0.078 % of reading	
	120 Hz to 1.199 9 MHz	0.078 % of reading + 1.2 μV	
	(1.2 to 2) MHz	0.078 % of reading + 1.2 μV	
	(2 to 11.9) MHz	0.16 % of reading + 1.2 μV	
	(12 to 20) MHz	0.31 % of reading + 1.2 μV	
	(20 to 30) MHz	0.78 % of reading + 1.2 μV	
	(11 to 33) mV		
	(10 to 30) Hz	0.23 % of reading	
	(30 to 119.99) Hz	0.078 % of reading	
	120 Hz to 1.199 9 kHz	0.078 % of reading	
	(1.2 to 11.999) kHz	0.078 % of reading	
	(12 to 119.99) kHz	0.078 % of reading	
120 Hz to 1.199 9 MHz	0.078 % of reading + 1.2 μV		
(11 to 16.5) mV			
(1.2 to 2) MHz	0.16 % of reading + 1.2 μV		
(2 to 11.9) MHz	0.23 % of reading + 1.2 μV		
(12 to 20) MHz	0.39 % of reading + 1.2 μV		
(20 to 30) MHz	0.85 % of reading + 1.2 μV		
(16.5 to 33) mV			
(1.2 to 2) MHz	0.078 % of reading + 1.2 μV		
(2 to 11.9) MHz	0.16 % of reading + 1.2 μV		
(12 to 20) MHz	0.31 % of reading + 1.2 μV		
(20 to 30) MHz	0.78 % of reading + 1.2 μV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹ Wide-Band Voltage (50 Ω) 1 kHz Reference	(33 to 110) mV		Fluke 5730A Multiproduct Calibrator
	(10 to 30) Hz	0.23 % of reading	
	(30 to 119.99) Hz	0.078 % of reading	
	120 Hz to 1.199 9 kHz	0.078 % of reading	
	(1.2 to 11.999) kHz	0.078 % of reading	
	(12 to 119.99) kHz	0.078 % of reading	
	120 Hz to 1.199 9 MHz	0.078 % of reading + 1.2 μV	
	(33 to 55) mV		
	(1.2 to 2) MHz	0.16 % of reading + 1.2 μV	
	(2 to 11.9) MHz	0.23 % of reading + 1.2 μV	
	(12 to 20) MHz	0.39 % of reading + 1.2 μV	
	(20 to 30) MHz	0.85 % of reading + 1.2 μV	
	(55 to 110) mV		
	(1.2 to 2) MHz	0.078 % of reading + 1.2 μV	
	(2 to 11.9) MHz	0.16 % of reading + 1.2 μV	
	(12 to 20) MHz	0.31 % of reading + 1.2 μV	
	(20 to 30) MHz	0.78 % of reading + 1.2 μV	
	(110 to 330) V		
	(10 to 30) Hz	0.23 % of reading	
	(30 to 119.99) Hz	0.078 % of reading	
	120 Hz to 1.199 9 kHz	0.078 % of reading	
	(1.2 to 11.999) kHz	0.078 % of reading	
	(12 to 119.99) kHz	0.078 % of reading	
	120 Hz to 1.199 9 MHz	0.078 % of reading + 1.2 μV	
	(110 to 165) mV		
	(1.2 to 2) MHz	0.16 % of reading + 1.2 μV	
	(2 to 11.9) MHz	0.23 % of reading + 1.2 μV	
	(12 to 20) MHz	0.39 % of reading + 1.2 μV	
(20 to 30) MHz	0.85 % of reading + 1.2 μV		
(165 to 330) mV			
(1.2 to 2) MHz	0.078 % of reading + 1.2 μV		
(2 to 11.9) MHz	0.16 % of reading + 1.2 μV		
(12 to 20) MHz	0.31 % of reading + 1.2 μV		
(20 to 30) MHz	0.78 % of reading + 1.2 μV		
(0.33 to 1.1) V			
(10 to 30) Hz	0.23 % of reading		
(30 to 119.99) Hz	0.078 % of reading		
120 Hz to 1.199 9 kHz	0.078 % of reading		
(1.2 to 11.999) kHz	0.078 % of reading		
(12 to 119.99) kHz	0.078 % of reading		
120 Hz to 1.199 9 MHz	0.078 % of reading + 1.2 μV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹ Wide-Band Voltage (50 Ω) 1 kHz Reference	(0.33 to 0.55) V		Fluke 5730A Multiproduct Calibrator
	(1.2 to 2) MHz	0.16 % of reading + 1.2 μV	
	(2 to 11.9) MHz	0.23 % of reading + 1.2 μV	
	(12 to 20) MHz	0.39 % of reading + 1.2 μV	
	(20 to 30) MHz	0.85 % of reading + 1.2 μV	
	(0.55 to 1.1) V		
	(1.2 to 2) MHz	0.078 % of reading + 1.2 μV	
	(2 to 11.9) MHz	0.16 % of reading + 1.2 μV	
	(12 to 20) MHz	0.31 % of reading + 1.2 μV	
	(20 to 30) MHz	0.78 % of reading + 1.2 μV	
	(1.1 to 3.5) V		
	(10 to 30) Hz	0.23 % of reading	
	(30 to 119.99) Hz	0.078 % of reading	
	120 Hz to 1.199 9 kHz	0.078 % of reading	
	(1.2 to 11.999) kHz	0.078 % of reading	
	(12 to 119.99) kHz	0.078 % of reading	
	120 Hz to 1.199 9 MHz	0.078 % of reading + 1.2 μV	
	(1.1 to 1.75) V		
	(1.2 to 2) MHz	0.16 % of reading + 1.2 μV	
	(2 to 11.9) MHz	0.23 % of reading + 1.2 μV	
(12 to 20) MHz	0.39 % of reading + 1.2 μV		
(20 to 30) MHz	0.85 % of reading + 1.2 μV		
(1.75 to 3.5) V			
(1.2 to 2) MHz	0.078 % of reading + 1.2 μV		
(2 to 11.9) MHz	0.16 % of reading + 1.2 μV		
(12 to 20) MHz	0.31 % of reading + 1.2 μV		
(20 to 30) MHz	0.78 % of reading + 1.2 μV		

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment	
Amplitude Modulation – AM Depth Measure ¹	Rate: 50 Hz to 10 kHz	(5 to 99) % Depth	HP 8902A Measuring Receiver	
	Rate: 20 Hz to 10 kHz	150 kHz to 10 MHz		2.4 % Depth
	Rate: 50 Hz to 50 kHz	(> 0 to 99) % Depth		3.5 % Depth
	Rate: 50 Hz to 50 kHz	150 kHz to 10 MHz		1.4 % Depth
	Rate: 50 Hz to 50 kHz	10 MHz to 1.3 GHz		1.9 % Depth
Rate: 50 Hz to 50 kHz	(1.3 to 26.5) GHz			



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – AM Depth Measure ¹ Rate: 20 Hz to 100 kHz	(> 0 to 99) % Depth 10 MHz to 1.3 GHz (1.3 to 26.5) GHz	3.5 % Depth 3.5 % Depth	HP 8902A Measuring Receiver
Frequency Modulation – Measure ¹ Rate: 50 Hz to 10 kHz Rate: 50 Hz to 100 kHz Rate: 20 Hz to 200 kHz	≤ 40 kHz peak 250 kHz to 10 MHz ≤ 400 kHz peak 10 MHz to 26.5 GHz ≤ 400 kHz peak 10 MHz to 26.5 GHz	2.4 % Deviation 1.4 % Deviation 5.8 % Deviation	HP 8902A Measuring Receiver
Phase Modulation – Measure ¹ Rate: 200 Hz to 10 kHz Rate: 200 Hz to 20 kHz	< 40 rad Deviation 150 kHz to 10 MHz < 40 rad Deviation 10 MHz to 26.5 GHz	4.9 % Deviation 3.8 % Deviation	HP 8902A Measuring Receiver
Harmonic Distortion ¹	(-80 to 0) dB 30 Hz to 6.5 GHz (6.5 to 22) GHz (22 to 26.5) GHz	1.7 dB 2.6 dB 3.4 dB	Agilent 8563E Spectrum Analyzer
Total Harmonic Distortion – Measure ¹	(-80 to 0) dB 20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.3 dB	Agilent 8903B Audio Analyzer
AM Total Harmonic Distortion – Measure ¹	(-80 to 0) dB 20 Hz to 100 kHz	2.7 dB	Agilent 8903B Audio Analyzer
Total Harmonic Distortion – Measure ¹ Input Voltage Range 5 Hz to 1.2 MHz < 30 V	0.3 to 100) % THD 10 Hz to 1 MHz (1 to 3) MHz 0.1 % THD (10 to 20) Hz (20 to 30) Hz 30 Hz to 300 kHz (300 to 500) kHz 500 kHz to 1.2 MHz	3 % of reading 6 % of reading 12 % of reading 6 % of reading 3 % of reading 6 % of reading 12 % of reading	Agilent 334A Distortion Analyzer



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Total Harmonic Distortion - Measure ¹ Input Voltage Range 5 Hz to 1.2 MHz > 30 V	(0.3 to 100) % THD 10 Hz to 300 kHz (300 to 500) kHz 500 kHz to 3 MHz 0.1 % THD (20 Hz to 30) Hz 30 Hz to 300 kHz (300 to 500) kHz 500 kHz to 1.2 MHz	3 % of reading 6 % of reading 12 % of reading 12 % of reading 3 % of reading 6 % of reading 12 % of reading	Agilent 334A Distortion Analyzer
Rise Time – Source ^{1,2}	≥ 14 ps	2.4 ps	Pulser
Rise Time – Source ^{1,2}	25 Vp-p 350 ps	64 ps	Tektronix PG509 Rise Time Pulse Generator
Rise Time – Measure	≥ 17 ps	3.9 ps	Sampling System
Absolute RF Power – Measure ¹	100 kHz to 2.6 GHz (-20 to -10) dBm (-10 to 0) dBm (0 to 10) dBm (10 to 20) dBm (20 to 30) dBm (2.6 to 12.2) GHz (-20 to -10) dBm (-10 to 0) dBm (0 to 10) dBm (10 to 20) dBm (20 to 30) dBm	0.11 dB 0.1 dB 0.11 dB 0.11 dB 0.23 dB 0.14 dB 0.13 dB 0.13 dB 0.14 dB 0.25 dB	Agilent 8902A Measuring Receiver, Agilent 11722A Power Sensor, Agilent 11792A Microwave Converter, Agilent 11793A Microwave Converter
Absolute RF Power – Measure ¹	(12.2 to 17.75) GHz (-20 to -10) dBm (-10 to 0) dBm (0 to 10) dBm (10 to 20) dBm (20 to 30) dBm (17.75 to 26.5) GHz (-20 to -10) dBm (-10 to 0) dBm (0 to 5) dBm	0.15 dB 0.14 dB 0.14 dB 0.15 dB 0.25 dB 0.18 dB 0.18 dB 0.18 dB	Agilent 8902A Measuring Receiver, Agilent 11722A Power Sensor, Agilent 11792A Microwave Converter, Agilent 11793A Microwave Converter

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned RF Absolute Power – Measure ¹	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 0.25 dB 0.14 dB 0.14 dB 0.14 dB 0.14 dB	Agilent 8902A Opt 50 Measuring Receiver, Agilent 11722A Power Sensor, Agilent 11792A Microwave Converter, Agilent 11793A Microwave Converter
Tuned RF Relative Power – Measure ¹	2.5 MHz to 26 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	Agilent 8902A Opt 50 Measuring Receiver, Agilent 11722A Power Sensor, Agilent 11792A Microwave Converter, Agilent 11793A Microwave Converter
Reflection (VSWR) ^{1,4} 10 MHz to 18 GHz	(Rho) 0.022 to 0.1 0.1 to 0.2 0.2 to 0.3 0.3 to 0.4	0.022 0.027 0.033 0.042	VSWR Bridge
RF Power – Measure ¹	10 MHz to 18 GHz (-30 to -20) dBm (-20 to 10) dBm (10 to 20) dBm	0.26 dB 0.1 dB 0.17 dB	EPM Power Meter, HP 8481A Power Sensor
RF Power – Measure ¹	100 kHz to 4.2 GHz (-30 to -20) dBm (-20 to 10) dBm (10 to 20) dBm	0.26 dB 0.1 dB 0.17 dB	EPM Power Meter, HP 8482A Power Sensor



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power – Measure ¹	50 MHz to 18 GHz (-30 to -20) dBm (-20 to 10) dBm (10 to 20) dBm (18 to 26.5) GHz (-30 to -20) dBm (-20 to 10) dBm (10 to 20) dBm	0.26 dB 0.1 dB 0.17 dB 0.3 dB 0.18 dB 0.22 dB	EPM Power Meter, HP 8485A Power Sensor
RF Power – Measure ¹	9 kHz to 6 GHz (-60 to -50) dBm (-50 to -40) dBm (-40 to -10) dBm (-10 to 0) dBm (0 to 20) dBm	3.3 dB 0.29 dB 0.17 dB 0.15 dB 0.13 dB	EPM Power Meter, HP E9304A Power Sensor
Amplitude Modulation – Measure ¹ Rate: 50 Hz to 10 kHz Rate: 50 Hz to 100 kHz Rate: 20 Hz to 100 kHz	(5 to 99) % Depth 100 kHz to 10 MHz (20 to 99) % Depth 10 MHz to 3 GHz (5 to 20) % Depth 10 MHz to 3 GHz (3 to 26.5) GHz (20 to 99) % Depth (3 to 26.5) GHz	1 % Depth 0.9 % Depth 3 % Depth 5.2 % Depth 1.9 % Depth	Agilent E4440A PSA Spectrum Analyzer
Amplitude Modulation Distortion – Measure ¹ Rate: 20 Hz to 1 kHz	> 1% Depth 10 kHz to 10 MHz 10 MHz to 26.5 GHz	15 % of reading 16 % of reading	Agilent E4440A PSA Spectrum Analyzer
Frequency Modulation – Measure ¹ Rate: 20 Hz to 10 kHz	Deviation Rate > 0.2 250 kHz to 10 MHz Deviation Rate > 1.2 250 kHz to 10 MHz	1.8 % Deviation 1.3 % Deviation	Agilent E4440A PSA Spectrum Analyzer

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure ¹ Rate: 50 Hz to 200 kHz	Deviation Rate > 0.2 10 MHz to 6.6 GHz Deviation Rate > 0.45 10 MHz to 6.6 GHz Deviation Rate > 0.2 (6.6 to 13.2) GHz Deviation Rate > 0.8 (6.6 to 13.2) GHz Deviation Rate > 0.2 (13.2 to 26.5) GHz Deviation Rate > 16 (13.2 to 26.5) GHz	1.8 % Deviation 1.3 % Deviation 3 % Deviation 1.3 % Deviation 4.8 % Deviation 1.3 % Deviation	Agilent E4440A PSA Spectrum Analyzer
Frequency Modulation Distortion – Measure ¹ Rate: 20 Hz to 1 kHz	Deviation > 500 Hz 1 MHz to 6.6 GHz Deviation > 2.3 kHz (6.6 to 13.2) GHz Deviation > 2.7 kHz (13.2 to 26.5) GHz	14 % of reading 14 % of reading 14 % of reading	Agilent E4440A PSA Spectrum Analyzer
Phase Modulation – Measure ¹	> 0.7 rad 100 kHz to 6.6 GHz > 0.3 rad 100 kHz to 6.6 GHz > 2 rad (6.6 to 13.2) GHz > 0.6 rad (6.6 to 13.2) GHz > 4 rad (13.2 to 26.5) GHz > 1.2 rad (13.2 to 26.5) GHz	1.3 % of reading 3.5 % of reading 1.3 % of reading 3.5 % of reading 1.3 % of reading 3.5 % of reading	Agilent E4440A PSA Spectrum Analyzer
Phase Modulation Distortion – Measure ¹ Rate: (20 to 500) Hz	> 0.8 rad 1 MHz to 6.6 GHz > 1.8 rad (6.6 to 13.2) GHz > 3.5 rad (13.2 to 26.5) GHz	16 % of reading 17 % of reading 15 % of reading	Agilent E4440A PSA Spectrum Analyzer



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation Distortion – Measure ¹ Rate: 500 Hz to 1 kHz	> 0.4 rad 1 MHz to 6.6 GHz > 0.8 rad (6.6 to 13.2) GHz > 1.2 rad (13.2 to 26.5) GHz	15 % of reading 14 % of reading 14 % of reading	Agilent E4440A PSA Spectrum Analyzer
Tuned Relative RF Power – Measure ¹	100 kHz to 3.05 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	0.17 dB 0.1 dB 0.09 dB 0.086 dB 0.081 dB 0.068 dB 0.063 dB 0.046 dB 0.041 dB 0.035 dB 0.03 dB 0.024 dB	Agilent E4440A PSA Spectrum Analyzer
Tuned Relative RF Power – Measure ¹	(3.05 to 6.6) 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	0.29 dB 0.1 dB 0.09 dB 0.086 dB 0.081 dB 0.068 dB 0.063 dB 0.046 dB 0.041 dB 0.035 dB 0.03 dB 0.024 dB	Agilent E4440A PSA Spectrum Analyzer
RF Power – Power Meter Reference	50 MHz 1 mW Reference	0.43 % of reading	HP 478A Thermistor, Agilent 3458A 8.5 Digit Multimeter, HP 432A Analog Power Meter



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned Relative RF Power – Measure ¹	(6.6 to 13.2) GHz		Agilent E4440A PSA Spectrum Analyzer
	(-110 to -100) dBm	0.25 dB	
	(-100 to -90) dBm	0.091 dB	
	(-90 to -80) dBm	0.086 dB	
	(-80 to -70) dBm	0.082 dB	
	(-70 to -60) dBm	0.077 dB	
	(-60 to -50) dBm	0.063 dB	
	(-50 to -40) dBm	0.058 dB	
	(-40 to -30) dBm	0.041 dB	
	(-30 to -20) dBm	0.035 dB	
	(-20 to -10) dBm	0.029 dB	
	(-10 to 0) dBm	0.023 dB	
	(13.2 to 18) GHz		
	(-110 to -100) dBm	0.61 dB	
	(-100 to -90) dBm	0.19 dB	
	(-90 to -80) dBm	0.086 dB	
	(-80 to -70) dBm	0.083 dB	
	(-70 to -60) dBm	0.077 dB	
	(-60 to -50) dBm	0.073 dB	
	(-50 to -40) dBm	0.062 dB	
	(-40 to -30) dBm	0.055 dB	
	(-30 to -20) dBm	0.036 dB	
	(-20 to -10) dBm	0.029 dB	
	(-10 to 0) dBm	0.024 dB	
	(18 to 26.5) GHz		
	(-100 to -90) dBm	0.45 dB	
	(-90 to -80) dBm	0.12 dB	
	(-80 to -70) dBm	0.082 dB	
	(-70 to -60) dBm	0.077 dB	
	(-60 to -50) dBm	0.072 dB	
(-50 to -40) dBm	0.069 dB		
(-40 to -30) dBm	0.054 dB		
(-30 to -20) dBm	0.05 dB		
(-20 to -10) dBm	0.029 dB		
(-10 to 0) dBm	0.023 dB		



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned Absolute RF Power – Measure ¹	100 kHz to 3.05 GHz		Agilent E4440A PSA Spectrum Analyzer
	(-120 to -110) dBm	0.21 dB	
	(-110 to -100) dBm	0.15 dB	
	(-100 to -90) dBm	0.15 dB	
	(-90 to -80) dBm	0.15 dB	
	(-80 to -70) dBm	0.14 dB	
	(-70 to -60) dBm	0.14 dB	
	(-60 to -50) dBm	0.14 dB	
	(-50 to -40) dBm	0.13 dB	
	(-40 to -30) dBm	0.13 dB	
	(-30 to -20) dBm	0.13 dB	
	(-20 to -10) dBm	0.12 dB	
	(-10 to 0) dBm	0.12 dB	
	(3.05 to 6.6) GHz		
	(-120 to -110) dBm	0.32 dB	
	(-110 to -100) dBm	0.18 dB	
	(-100 to -90) dBm	0.18 dB	
	(-90 to -80) dBm	0.18 dB	
	(-80 to -70) dBm	0.17 dB	
	(-70 to -60) dBm	0.17 dB	
	(-60 to -50) dBm	0.17 dB	
	(-50 to -40) dBm	0.16 dB	
	(-40 to -30) dBm	0.16 dB	
	(-30 to -20) dBm	0.16 dB	
	(-20 to -10) dBm	0.16 dB	
	(-10 to 0) dBm	0.16 dB	
	(6.6 to 13.2) GHz		
	(-110 to -100) dBm	0.29 dB	
	(-100 to -90) dBm	0.18 dB	
	(-90 to -80) dBm	0.18 dB	
(-80 to -70) dBm	0.17 dB		
(-70 to -60) dBm	0.17 dB		
(-60 to -50) dBm	0.17 dB		
(-50 to -40) dBm	0.17 dB		
(-40 to -30) dBm	0.16 dB		
(-30 to -20) dBm	0.16 dB		
(-20 to -10) dBm	0.16 dB		
(-10 to 0) dBm	0.16 dB		

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned Absolute RF Power – Measure ¹	(13.2 to 18) GHz		Agilent E4440A PSA Spectrum Analyzer
	(-110 to -100) dBm	0.63 dB	
	(-100 to -90) dBm	0.24 dB	
	(-90 to -80) dBm	0.18 dB	
	(-80 to -70) dBm	0.18 dB	
	(-70 to -60) dBm	0.17 dB	
	(-60 to -50) dBm	0.17 dB	
	(-50 to -40) dBm	0.17 dB	
	(-40 to -30) dBm	0.16 dB	
	(-30 to -20) dBm	0.16 dB	
	(-20 to -10) dBm	0.16 dB	
	(-10 to 0) dBm	0.16 dB	
	(18 to 26.5) GHz		
	(-100 to -90) dBm	0.51 dB	
	(-90 to -80) dBm	0.28 dB	
	(-80 to -70) dBm	0.26 dB	
	(-70 to -60) dBm	0.26 dB	
	(-60 to -50) dBm	0.26 dB	
	(-50 to -40) dBm	0.26 dB	
	(-40 to -30) dBm	0.26 dB	
(-30 to -20) dBm	0.26 dB		
(-20 to -10) dBm	0.25 dB		
(-10 to 0) dBm	0.25 dB		

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle Measuring Devices ⁵	Up to 85°	1.5"	Master Angle Blocks
Angle Measuring Devices ⁵	90°	1.9"	Master Square
Micrometers, Calipers ^{1,5} (Outside, Inside, and Depth)	(0.05 to 48) in	(8+ 8L) μin	Gage Blocks
Anvil Flatness ¹	Up to 1 in	4.5 μin	Optical Flats
Indicators ^{1,5} (Dial and Digital)	Up to 0.05 in	28 μin	Dial Indicator Calibrator
Indicators ^{1,5} (Dial and Digital)	(0.05 to 5) in	(44 + 4L) μin	Horizontal Comparator

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Length – Single Axis ⁵ Outside Measurement	Up to 5 in	(6 + 8L) μin	Horizontal Comparator
Inside Dimension	Up to 5 in	(22 + 3L) μin	
Height Measuring Equipment ^{1,5}	(0.4 to 8) in (8 to 48) in	(29 + 6L) μin (12 + 8L) μin	Gage Blocks
Cylindrical Plug Gages ⁵ Outside Diameter	Up to 5 in	(6 + 8L) μin	Horizontal Comparator
Cylindrical Pin Gages Outside Diameter	(0.004 to 1) in	36 μin	Laser Micrometer
Cylindrical Ring Gages ⁵ Inside Diameter	Up to 5 in	(22 + 3L) μin	Horizontal Comparator
Rulers, Tape Measures ⁵	Up to 16 in	(120 + 10L) μin	Vision System
Thread Plug Gages ⁵ Pitch Diameter, 60°	Up to 1 in (1 to 3) in (3 to 5) in	79 μin 84 μin 94 μin	Universal Length Measuring System, Master Thread Wires
Major Diameter	Up to 5 in	(6 + 8L) μin	Horizontal Comparator
Thread Ring Gages Pitch Diameter	Up to 1 in (1 to 3) in (3 to 5) in	79 μin 84 μin 94 μin	Tactile Fit using Master Thread Plug
Wire Crimpers/Dies Crimp Height	Up to 0.8 in	180 μin	Height Micrometer
Die Diameter	(0.011 to 0.5) in	0.001 2 in	Class Z Pin Gage Set

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force Measuring Equipment	(1 to 200) lbf	0.06 % of reading	Deadweight
Torque Measuring Devices ¹ (Wrenches, Electronic, etc.)	(0.5 to 15) ozf·in (15 to 200) ozf·in (4 to 80) lbf·in (80 to 1 000) lbf·in (20 to 2 000) lbf·ft (1 000 to 5 000) lbf·ft	0.83 % of reading 0.4 % of reading 0.43 % of reading 0.4 % of reading 0.4 % of reading 1 % of reading	Torque Calibration System



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Calibration System (Analyzers, Transducers, etc.)	(0.5 to 16) ozf·in (1 to 40) lbf·in (40 to 260) lbf·in (260 to 3 000) lbf·in	0.83 % of reading 0.08 % of reading 0.07 % of reading 0.07 % of reading	Torque Wheels, Torque Arms, NIST Class F Weights
Torque Multipliers	(150 to 2 700) N·m (110 to 2 000) lbf·ft (2 700 to 4 000) N·m (2 000 to 3 000) lbf·ft (4 000 to 27 000) N·m (3 000 to 20 000) lbf·ft	1.1 % of reading 1.1 % of reading 1.3 % of reading 1.3 % of reading 1.4 % of reading 1.4 % of reading	Torque Calibration System
Torque Angle	45° 90° 135° 180° 360°	0.49° 0.49° 0.49° 0.49°	Torque Angle Fixture
Hydraulic Torque Devices	(150 to 2 700) N·m (110 to 2 000) lbf·ft (2 700 to 4 000) N·m (2 000 to 3 000) lbf·ft (4 000 to 27 000) N·m (3 000 to 20 000) lbf·ft	1.1 % of reading 1.1 % of reading 1.3 % of reading 1.3 % of reading 1.3 % of reading 1.3 % of reading	Torque Calibration System
Scales & Balances ^{1,6} (SI)	(5 to 500) mg (0.5 to 5) g (5 to 10) g (10 to 30) g 30 g to 9 kg (9 to 15) kg	12 µg 40 µg 58 µg 89 µg 0.000 32 % of reading 0.000 34 % of reading	ASTM E617 Class 1 weights and internal calibration procedure utilized for the calibration of the weighing system.
Scales & Balances ^{1,6} (SI)	Up to 100 mg (100 to 500) mg (0.5 to 5) g (5 to 10) g (10 to 20) g (20 to 30) g (30 to 100) g 100 g to 20 kg	16 µg 29 µg 58 µg 82 µg 0.12 mg 0.18 mg 0.35 mg 0.005 9 % of reading	ASTM E617 Class 2 weights and internal calibration procedure utilized for the calibration of the weighing system.
Scales & Balances ^{1,6} (Avoirdupois)	Up to 0.02 lb (0.02 to 1) lb (1 to 5) lb (5 to 977) lb	2.3 mg 0.041 % of reading 0.038 % of reading 0.036 % of reading	NIST Class F weights and internal calibration procedure utilized for the calibration of the weighing system.



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Absolute Pressure Devices	Up to 25 psia (25 to 500) psia	0.001 9 psi 0.006 8 % of reading	Ruska 7250xi Pressure Controller/Calibrator
Pneumatic Pressure Gages	(-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	DHI PPC4 Pressure Controller
Pneumatic Pressure Gages	(-14.7 to 25) psi (25 to 500) psig	0.001 6 psi 0.007 6 % of reading	Ruska 7250xi Pressure Controller/Calibrator
Pneumatic Pressure Gages	(10 to 3 000) psig (3 000 to 30 000) psig	0.38 psi 0.01 % of reading	Comparison to Fluke RPM 4 Reference Pressure Monitor
Hydraulic Pressure Gages	(5 to 15 000) psig	0.02 % of reading	Fluke P3125-PSI Oil Deadweight Tester

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity – Measure ¹	(10 to 30) °C (10 to 90) %RH	1.3 %RH	Temperature/Humidity Indicator/Probe
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	Two-pressure Humidity Generator



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Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Source ¹ (Thermocouple Probes, RTD's, Thermistors)	(-25 to 140) °C (140 to 660) °C	0.06 °C 0.03 °C	Accumac AM1760 Secondary SPRT, Hart 1575 Super Thermometer, Hart Drywell
Temperature – Measure ¹	(-195 to 0) °C (0 to 420) °C (420 to 660) °C	0.001 % of reading + 0.011 °C 0.001 % of reading + 0.025 °C 0.001 % of reading + 0.037 °C	Accumac AM1760 Secondary SPRT, Hart Black Stack
	(-195 to 0) °C (0 to 420) °C (420 to 660) °C	0.001 % of reading + 0.01 °C 0.001 % of reading + 0.02 °C 0.001 % of reading + 0.031 °C	Accumac AM1760 Secondary SPRT, Hart 1575 Super Thermometer
Infrared Temperature – Measuring Equipment ¹	(-15 to 0) °C (0 °C to 50) °C (50 °C to 100) °C (100 °C to 120) °C (120 °C to 200) °C (200 °C to 350) °C (350 °C 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 Source (Plate) ε = (0.9 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 ¹	10 MHz	3.8 pHz/Hz	Fluke 910R GPS Frequency Standard
Stopwatches, Timers ¹	Up to 599 s/mon	58 ms/d	Vibrograf TM-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 (90 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

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rotational Speed – Measure ^{1,5}	(10 to 999.9) rpm (1 000 to 99 999) rpm	0.058 % of reading + 0.12 rpm 0.082 % of reading + 1.2 rpm	Reflective Measure utilizing the Extech 461995 Photo Tachometer.

DIMENSIONAL MEASUREMENT

2 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dimensional Measurement ⁵ 2D	X-Y Axis: Up to 16 in	(120 + 10L) μin	Vision System utilized as the Reference Standard for Dimensional Measurement.
Angles ⁵	Up to 2 in Up to 360° (2 to 16) in Up to 360°	0.072° (0.062 + 0.000 5L)°	Vision System utilized as the Reference Standard for Dimensional Measurement.

3 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dimensional Measurement ⁵ 3D	X: Up to 24 in Y: Up to 24 in Z: Up to 24 in	(90 + 8.8L) μin	Zeiss CONTURA G2 Coordinate Measuring Machine utilized for Dimensional Measurement.
Dimensional Measurement ⁵ 3D	X: Up to 30 in Y: Up to 30 in Z: Up to 24 in	300 μin	Zeiss CONTURA G2 Coordinate Measuring Machine utilized for Dimensional Measurement.
Dimensional Measurement ⁵ 3D	X: Up to 39 in Y: Up to 36 in Z: Up to 24 in	390 μin	Zeiss CONTURA G2 Coordinate Measuring Machine utilized for Dimensional Measurement.

3 Dimensional

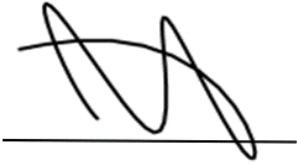
Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dimensional Measurement ⁵ 3D	X: Up to 39 in Y: Up to 48 in Z: Up to 24 in	430 μin	Zeiss CONTURA G2 Coordinate Measuring Machine utilized for Dimensional Measurement.
Dimensional Measurement ⁵ 3D	X: Up to 39 in Y: Up to 54 in Z: Up to 24 in	450 μin	Zeiss CONTURA G2 Coordinate Measuring Machine utilized for Dimensional Measurement.
Dimensional Measurement ⁵ 3D	X: Up to 39 in Y: Up to 62 in Z: Up to 24 in	490 μin	Zeiss CONTURA G2 Coordinate Measuring Machine utilized for Dimensional Measurement.
Angle Measurements ⁵ 3D	X: Up to 1 in Y: Up to 1 in Z: Up to 1 in Up to 360°	12"	Zeiss CONTURA G2 Coordinate Measuring Machine utilized for Dimensional Measurement.
Angle Measurements ⁵ 3D	X: Up to 3 in Y: Up to 3 in Z: Up to 3 in Up to 360°	4.5"	Zeiss CONTURA G2 Coordinate Measuring Machine utilized for Dimensional Measurement.
Angle Measurements ⁵ 3D	X: Up to 12 in Y: Up to 12 in Z: Up to 12 in Up to 360°	1.9"	Zeiss CONTURA G2 Coordinate Measuring Machine utilized for Dimensional Measurement.
Angle Measurements ⁵ 3D	X: Up to 39 in Y: Up to 62 in Z: Up to 24 in Up to 360°	1.6"	Zeiss CONTURA G2 Coordinate Measuring Machine utilized for Dimensional Measurement.

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 stated uncertainty is the laboratory's ability to source a fast rise pulse that is approximately 500 ps, 150 ps, 70 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.
3. 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 the laboratory for more information regarding uncertainties at frequency and power factor combinations other than the ones shown.
4. This parameter is a unitless measurement.
5. " = arc-minute; L = length in inches; rpm = revolutions per minute.

6. The CMC for scales and balances is highly dependent upon the resolution of the unit under test. The CMC presented here does not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
7. The legal entity for this site is Transcat, Inc.
8. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2489.10.



Jason Stine, Vice President

