



# CERTIFICATE OF ACCREDITATION

**The ANSI National Accreditation Board**

Hereby attests that

**Transcat-Pittsburgh**  
454 Berlin Plank Road  
Somerset, PA 15501

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 field of

**CALIBRATION**

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](http://www.anab.org).

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 07 September 2025  
Certificate Number: AC-2489.15



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-Pittsburgh**

454 Berlin Plank Road

Somerset, PA 15501

Dennis Kuhn 814-701-2316

**CALIBRATION**

Valid to: **September 7, 2025**

Certificate Number: **AC-2489.15**

**Chemical Quantities**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters	4 pH	0.012 pH	Standard Solutions
	7 pH	0.011 pH	
	10 pH	0.012 pH	
Conductivity Meters	1 $\mu$ S	0.3 $\mu$ S	Standard Solutions
	10 $\mu$ S	0.3 $\mu$ S	
	100 $\mu$ S	2.1 $\mu$ S	
	1 000 $\mu$ S	5 $\mu$ S	
	1 413 $\mu$ S	4 $\mu$ S	
	10 000 $\mu$ S	44 $\mu$ S	
	100 000 $\mu$ S	330 $\mu$ S	
150 000 $\mu$ S	570 $\mu$ S		
200 000 $\mu$ S	670 $\mu$ S		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source <sup>1</sup>	(0 to 220) mV	8.6 $\mu$ V/V + 0.4 $\mu$ V	Fluke 5700A/EP Multiproduct Calibrator
	(0.22 to 2.2) V	5.1 $\mu$ V/V + 0.7 $\mu$ V	
	(2.2 to 11) V	4 $\mu$ V/V + 2.5 $\mu$ V	
	(11 to 22) V	3.9 $\mu$ V/V + 4 $\mu$ V	
	(22 to 220) V	6.2 $\mu$ V/V + 40 $\mu$ V	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
	220 V to 1.1 kV	7.6 $\mu\text{V}/\text{V}$ + 0.4 mV	Fluke 5700A/5725A Multiproduct Calibrator with Amplifier
DC Voltage – Measure <sup>1</sup>	(0 to 100) mV (0.1 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 $\mu\text{V}/\text{V}$ + 0.58 $\mu\text{V}$ 5.3 $\mu\text{V}/\text{V}$ + 0.58 $\mu\text{V}$ 5.3 $\mu\text{V}/\text{V}$ + 0.58 $\mu\text{V}$ 7.7 $\mu\text{V}/\text{V}$ + 35 $\mu\text{V}$ 15 $\mu\text{V}/\text{V}$ + 0.12 mV 18 $\mu\text{V}/\text{V}$ + 0.12 mV 21 $\mu\text{V}/\text{V}$ + 0.12 mV	Agilent 3458A Opt 002 8.5 Digit Multimeter
DC High Voltage – Measure <sup>1</sup>	(1 to 10) kV (10 to 20) kV (20 to 70) kV (70 to 100) kV	0.04 % of reading + 92 mV 0.09 % of reading + 2.4 V 0.09 % of reading + 2.4 V 0.17 % of reading + 2.5 V	Vitretek 4700 Digital HV Meter, Associated High Voltage Probes
DC Current – Source <sup>1</sup>	(0.22 to 220) $\mu\text{A}$ (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	40 $\mu\text{A}/\text{A}$ + 6 nA 36 $\mu\text{A}/\text{A}$ + 7 nA 35 $\mu\text{A}/\text{A}$ + 40 nA 48 $\mu\text{A}/\text{A}$ + 0.7 $\mu\text{A}$ 84 $\mu\text{A}/\text{A}$ + 12 $\mu\text{A}$	Fluke 5700A/EP Multiproduct Calibrator
DC Current – Source <sup>1</sup>	(2.2 to 11) A	0.036 % of reading + 0.48 mA	Fluke 5700A/5725A Multiproduct Calibrator with Amplifier
	(11 to 20.5) A	0.093 % of reading + 0.58 mA	Fluke 5522A Multiproduct Calibrator
DC Current – Measure <sup>1</sup>	Up to 100 $\mu\text{A}$ (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	33 $\mu\text{A}/\text{A}$ + 0.92 nA 29 $\mu\text{A}/\text{A}$ + 5.8 nA 29 $\mu\text{A}/\text{A}$ + 58 nA 46 $\mu\text{A}/\text{A}$ + 0.58 $\mu\text{A}$ 0.013 % of reading + 12 $\mu\text{A}$	Agilent 3458A Opt 002 8.5 Digit Multimeter
	(1 to 10) A (10 to 100) A (100 to 300) A	0.012 % of reading + 58 $\mu\text{A}$ 0.059 % of reading + 0.58 mA 0.12 % of reading + 1.7 mA	Agilent 3458A Opt 002 8.5 Digit Multimeter, Guideline Current Shunt
DC Clamp-on Ammeters (Non-Toroidal Type) Transformer Type Sensor <sup>1</sup>	(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



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source <sup>1</sup>	Up to 2.2 mV		Fluke 5700A/EP Multiproduct Calibrator
	(10 to 20) Hz	0.16 % of reading + 4 μV	
	(20 to 40) Hz	0.1 % of reading + 4 μV	
	40 Hz to 20 kHz	0.078 % of reading + 4 μV	
	(20 to 50) kHz	0.13 % of reading + 4 μV	
	(50 to 100) kHz	0.17 % of reading + 5 μV	
	(100 to 300) kHz	0.33 % of reading + 10 μV	
	(300 to 500) kHz	0.47 % of reading + 20 μV	
	500 kHz to 1 MHz	0.58 % of reading + 20 μV	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.042 % of reading + 4 μV	
	(20 to 40) Hz	0.03 % of reading + 4 μV	
	40 Hz to 20 kHz	0.014 % of reading + 4 μV	
	(20 to 50) kHz	0.03 % of reading + 4 μV	
	(50 to 100) kHz	0.058 % 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	0.27 % of reading + 20 μV	
	(22 to 220) mV		
	(10 to 20) Hz	0.028 % of reading + 12 μV	
	(20 to 40) Hz	0.011 % of reading + 7 μV	
	40 Hz to 20 kHz	0.008 5 % 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	0.091 % 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		
(0.22 to 2.2) V			
(10 to 20) Hz	0.027 % of reading + 40 μV		
(20 to 40) Hz	0.01 % of reading + 15 μV		
40 Hz to 20 kHz	0.004 8 % 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		



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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source <sup>1</sup>	(2.2 to 22) V		Fluke 5700A/EP Multiproduct Calibrator
	(10 to 20) Hz	0.028 % of reading + 0.4 mV	
	(20 to 40) Hz	0.01 % of reading + 0.15 mV	
	40 Hz to 20 kHz	0.0049 % of reading + 50 μV	
	(20 to 50) kHz	0.0083 % 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	
	(22 to 220) V		
	(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	0.0056 % of reading + 0.6 mV	
	(20 to 50) kHz	0.0093 % 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 <sup>1</sup>	(220 to 750) V		Fluke 5700A/5725A Multiproduct Calibrator with Amplifier
	(30 to 50) kHz	0.061 % of reading + 11 mV	
	(50 to 100) kHz	0.23 % of reading + 45 mV	
	(220 to 1100) 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 <sup>1</sup>	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	
	(0.3 to 1) MHz	1.5 % of reading + 5.8 μV	
(1 to 4) MHz	8.1 % of reading + 8.1 μV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure <sup>1</sup>	(10 to 100) mV		Agilent 3458A Opt 002 8.5 Digit Multimeter
	(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	
	(0.1 to 1) V		
	(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 + 81 μV	
	(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	0.01 % 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		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure <sup>1</sup>	(10 to 100) V (1 to 40) Hz 40Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (100 to 700) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.024 % of reading + 4.6 mV 0.024 % of reading + 2.3 mV 0.024 % of reading + 2.3 mV 0.041 % of reading + 2.3 mV 0.14 % of reading + 2.3 mV 0.46 % of reading + 12 mV 1.7 % of reading + 12 mV 0.048 % of reading + 46 mV 0.048 % of reading + 23 mV 0.071 % of reading + 23 mV 0.19 % of reading + 23 mV 0.35 % of reading + 23 mV	Agilent 3458A Opt 002 8.5 Digit Multimeter
AC High Voltage – Measure <sup>1</sup>	(0.7 to 10) kV (20 to 100) Hz (100 to 400) Hz (10 to 30) kV (30 to 70) Hz (70 to 200) Hz (200 to 450) Hz (30 to 50) kV (30 to 70) Hz (70 to 200) Hz (200 to 450) Hz (50 to 70) kV (30 to 70) Hz (70 to 200) Hz	0.14 % of reading + 0.37 V 0.48 % of reading + 0.17 V 0.11 % of reading + 2.4 V 0.7 % of reading + 2.4 V 1.4 % of reading + 2.4 V 0.13 % of reading + 2.5 V 0.7 % of reading + 2.5 V 2.9 % of reading + 2.5 V 0.16 % of reading + 2.6 V 1.2 % of reading + 2.6 V	Vitretek 4700 Digital HV Meter, Associated High Voltage Probes
AC Current – Source <sup>1</sup>	Up to 220 $\mu$ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (0.22 to 2.2) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.031 % 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 $\mu$ A 0.11 % of reading + 0.65 $\mu$ A	Fluke 5700A/EP 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 <sup>1</sup>	(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	0.039 % 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	Fluke 5700A/EP Multiproduct Calibrator		
	(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	0.033 % of reading + 0.4 μA 0.018 % of reading + 0.35 μA 0.014 % of reading + 0.35 μA 0.021 % of reading + 0.55 μA 0.11 % of reading + 5 μA			
	(0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.027 % of reading + 35 μA 0.046 % of reading + 80 μA 0.7 % of reading + 0.16 mA			
	(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			
	(11 to 20) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.095 % of reading + 3.9 mA 0.12 % of reading + 3.9 mA 2.3 % of reading + 3.9 mA		Fluke 5522A Multiproduct Calibrator	
	AC Current – Source <sup>1</sup> Extended Frequency Ranges	(29 to 330) μA (10 to 30) kHz		1.2 % of reading + 0.31 μA	Fluke 5522A Multiproduct Calibrator
		(0.33 to 3.3) mA (10 to 30) kHz		0.78 % of reading + 0.47 μA	
		(3.3 to 33) mA (10 to 30) kHz		0.31 % of reading + 3.1 μA	
		(33 to 330) mA (10 to 30) kHz		0.31 % of reading + 0.16 mA	
	AC Clamp-on Ammeters (Toroidal Type) Transformer Type Sensor <sup>1</sup>	(20 to 150) A (45 to 65) Hz (65 to 440) Hz		0.34 % of reading + 26 mA 0.95 % of reading + 47 mA	Fluke 5522A Multiproduct Calibrator, 5500A/COIL 50-turn Coil
(150 to 1 000) A (45 to 65) Hz		0.38 % of reading + 0.12 A			
(65 to 440) Hz		1.2 % of reading + 0.22 A			





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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 <sup>1</sup>	(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	0.66 % of reading + 0.25 A 1.2 % of reading + 0.25 A 0.68 % of reading + 0.90 A 1.4 % of reading + 0.92 A	Fluke 5522A Multiproduct Calibrator, 5500A/COIL 50-turn Coil
AC Current – Measure <sup>1</sup>	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 (0.1 to 1) A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % of reading + 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 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
	(1 to 3) A 10 Hz to 5 kHz (5 to 10) kHz (3 to 10) A 10 Hz to 5 kHz	0.24 % of reading + 0.1 mA 1.2 % of reading + 0.1 mA 0.81 % of reading + 0.4 mA	Fluke 8846A 6.5 Digit Multimeter
Resistance – Source <sup>1</sup> (Simulation)	Up to 11 Ω (11 to 33) Ω (33 to 111) Ω (110 to 330) Ω (0.33 to 1.1) kΩ (1.1 to 3.3) kΩ	32 µΩ/Ω + 0.78 mΩ 24 µΩ/Ω + 1.2 mΩ 22 µΩ/Ω + 1.1 mΩ 22 µΩ/Ω + 1.6 mΩ 22 µΩ/Ω + 1.6 mΩ 22 µΩ/Ω + 1.6 mΩ	Fluke 5522A Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source <sup>1</sup> (Simulation)	(3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ (0.33 to 1.1) MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ (0.33 to 1.1) GΩ	22 μΩ/Ω + 1.6 mΩ 22 μΩ/Ω + 0.16 Ω 22 μΩ/Ω + 0.16 Ω 27 μΩ/Ω + 1.6 Ω 26 μΩ/Ω + 1.6 Ω 66 μΩ/Ω + 23 Ω 0.1 mΩ/Ω + 39 Ω 0.19 mΩ/Ω + 1.9 kΩ 0.41 mΩ/Ω + 2.3 kΩ 2.3 mΩ/Ω + 78 kΩ 0.12 Ω/Ω + 0.39 MΩ	Fluke 5522A Multiproduct Calibrator
Resistance – Source <sup>1</sup> (Variable Artifact)	(10 to 100) MΩ (0.1 to 1) GΩ (1 to 10) GΩ (10 to 100) GΩ (0.1 to 1) TΩ	0.082 % of reading 0.24 % of reading 0.42 % of reading 0.82 % of reading 2.4 % of reading	High Resistance Decade Box (up to 5 kV)
Resistance – Measure <sup>1</sup>	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 0.59 % of reading + 1.2 kΩ 0.82 % of reading + 12 kΩ	Agilent 3458A Opt 002 8.5 Digit Multimeter
Electrical Simulation of Thermocouple Indicating Devices – Source/Measure <sup>1</sup>	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C Type E (-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1 000) °C Type J (-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1 200) °C	0.35 °C 0.28 °C 0.24 °C 0.26 °C 0.39 °C 0.13 °C 0.12 °C 0.13 °C 0.17 °C 0.21 °C 0.13 °C 0.12 °C 0.14 °C 0.18 °C	Fluke 5522A Multiproduct Calibrator

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Devices – Source/Measure <sup>1</sup>	Type K (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1 000) °C (1 000 to 1 372) °C Type N (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1 300) °C Type R (0 to 250) °C (250 to 400) °C (400 to 1 000) °C (1 000 to 1 767) °C Type S (0 to 250) °C (250 to 1 000) °C (1 000 to 1 400) °C (1 400 to 1 767) °C Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	0.26 °C 0.15 °C 0.13 °C 0.21 °C 0.31 °C 0.31 °C 0.18 °C 0.15 °C 0.15 °C 0.21 °C 0.46 °C 0.29 °C 0.26 °C 0.32 °C 0.45 °C 0.30 °C 0.29 °C 0.36 °C 0.49 °C 0.19 °C 0.13 °C 0.12 °C	Fluke 5522A Multiproduct Calibrator
Electrical Simulation of RTD Indicating Devices – Source <sup>1</sup>	Pt 385, 100 Ω (-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.039 °C 0.039 °C 0.054 °C 0.07 °C 0.078 °C 0.093 °C 0.18 °C	Fluke 5522A Multiproduct Calibrator

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Power – Source <sup>1</sup>	(0.33 to 330) mA 11 μW to 1.1 mW (1.1 to 110) mW (0.11 to 110) W (110 to 330) W (0.33 to 3) A 11 μW to 110 mW (0.11 to 990) W 1 W to 3 kW (3 to 20.5) A 99 mW to 0.99 W 0.99 W to 6.8 kW (6.8 to 20.5) kW	0.024 % 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 0.088 % of reading 0.07 % of reading 0.04 % of reading	Fluke 5522A Multiproduct Calibrator
AC Power – Source <sup>1,5</sup> (10 to 65) Hz (PF=1)	(3.3 to 9.0) mA (0.11 to 3) mW 3 mW to 9 W (9 to 33) mA (0.3 to 10) mW 10 mW to 33 W (33 to 90) mA (1 to 30) mW 30 mW to 90 W (90 to 330) mA (3 to 100) mW (0.1 to 300) W (0.33 to 0.9) A (11 to 300) mW (0.3 to 900) W (0.9 to 2.2) A (30 to 720) mW 0.72 W to 2 kW (2.2 to 4.5) A 80 mW to 1.4 W 1.4 W to 4.5 kW (4.5 to 20.5) A (0.15 to 6.7) W 6.7 W to 20 kW	0.13 % of reading 0.077 % of reading 0.089 % of reading 0.077 % of reading 0.071 % of reading 0.057 % of reading 0.089 % of reading 0.078 % of reading 0.071 % of reading 0.081 % of reading 0.089 % of reading 0.079 % of reading 0.088 % of reading 0.18 % of reading 0.17 % of reading 0.17 % of reading	Fluke 5522A Multiproduct Calibrator

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase – Source <sup>1</sup>	(0 to 180)°		Fluke 5522A Multiproduct Calibrator
	(10 to 65) Hz	0.11°	
	(65 to 500) Hz	0.21°	
	500 Hz to 1 kHz	0.39°	
	(1 to 5) kHz	1.9°	
Capacitance – Source <sup>1</sup>	(5 to 10) kHz	3.9°	Fluke 5522A Multiproduct Calibrator
	(10 to 30) kHz	7.8°	
	10 Hz to 10 kHz		
	(220 to 400) pF	0.4 % of reading + 7.8 pF	
	(0.4 to 1.1) nF	0.4 % of reading + 7.8 pF	
	10 Hz to 3 kHz		
	(1.1 to 3.3) nF	0.4 % of reading + 7.8 pF	
	10 Hz to 1 kHz		
	(3.3 to 11) nF	0.21 % of reading + 7.8 pF	
	(11 to 33) nF	0.2 % of reading + 78 pF	
	(33 to 110) nF	0.21 % of reading + 78 pF	
	10 Hz to 1 kHz		
	(110 to 330) nF	0.2 % of reading + 0.23 nF	
	(10 to 600) Hz		
	(0.33 to 1.1) μF	0.21 % of reading + 0.78 nF	
	(10 to 300) Hz		
	(1.1 to 3.3) μF	0.21 % of reading + 2.3 nF	
	(10 to 150) Hz		
	(3.3 to 11) μF	0.2 % of reading + 7.8 nF	
	(10 to 120) Hz		
(11 to 33) μF	0.32 % of reading + 23 nF		
(10 to 80) Hz			
(33 to 110) μF	0.37 % of reading + 78 nF		
DC to 50 Hz			
(110 to 330) μF	0.38 % of reading + 0.23 μF		
DC to 20 Hz			
(0.33 to 1.1) mF	0.35 % of reading + 0.78 μF		
DC to 6 Hz			
(1.1 to 3.3) mF	0.35 % of reading + 2.3 μF		
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		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Measure <sup>1</sup>	60 Hz to 1 kHz Up to 10 pF (10 to 100) pF (0.1 to 1) $\mu$ F (1 to 100) $\mu$ F (0.1 to 1) mF	0.47 % of reading + 14 fF 0.062 % of reading + 14 fF 0.027 % of reading + 14 fF 0.035 % of reading + 18 fF 0.24 % of reading + 18 fF	GR 1689-9700 5 Precision Impedance Meter
Scope Voltage – Source <sup>1</sup> DC Signal into 50 $\Omega$ into 1 M $\Omega$	(-5.0 to 5.0) V (-200 to 200) V	0.023 % of reading + 19 $\mu$ V 0.023 % of reading + 19 $\mu$ V	Fluke 9500B Oscilloscope Calibrator
Scope Voltage – Source <sup>1</sup> Square Wave 10 Hz to 100 kHz into 50 $\Omega$ 10 Hz to 10 kHz into 1 M $\Omega$ 10 Hz to 100 kHz into 1 M $\Omega$	40 $\mu$ Vp-p to 1 mVp-p 1 mVp-p to 5 Vp-p 40 $\mu$ Vp-p to 1 mVp-p 1 mVp-p to 200 Vp-p	0.78 % of reading + 7.8 $\mu$ V 0.078 % of reading + 7.8 $\mu$ V 0.78 % of reading + 7.8 $\mu$ V 0.078 % of reading + 7.8 $\mu$ V	Fluke 9500B Oscilloscope Calibrator, Fluke 9530 Active Head, Fluke 9560 Active Head
Scope – Time Markers <sup>1</sup> 100 mVp-p to 1 Vp-p (into 50 $\Omega$ ) Square Wave Sine Wave Pulse Triangle Wave	9.009 1 ns to 83 $\mu$ s 83 $\mu$ s to 55 s 450.5 ps to 9.009 ns 900.91 ns to 83 $\mu$ s 83 $\mu$ s to 55 s 900.91 ns to 83 $\mu$ s 83 $\mu$ s to 55 s	0.19 $\mu$ s/s 2.3 $\mu$ s/s 0.19 $\mu$ s/s 0.19 $\mu$ s/s 2.3 $\mu$ s/s 0.19 $\mu$ s/s 2.3 $\mu$ s/s	Fluke 9500B Oscilloscope Calibrator, Fluke 9530 Active Head, Fluke 9560 Active Head
Scope Rise Time – Source <sup>1,4</sup> (into 50 $\Omega$ ) 10 Hz to 2 MHz 10 Hz to 1 MHz	5 mVp-p to 3 Vp-p 500 ps (Nominal) 150 ps (Nominal) 25 mVp-p to 2 Vp-p 70 ps (Nominal)	290 ps 34 ps 21 ps	Fluke 9500B Oscilloscope Calibrator with Fluke 9530 Active Head

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scope Levelled Sine Wave – Source <sup>1</sup> (50 kHz Ref. Frequency) into 50 Ω	5 mVp-p to 5 Vp-p 50 kHz to 10 MHz	1.2 % of reading	Fluke 9500B Oscilloscope Calibrator with Fluke 9530 Active Head
Scope Bandwidth/Flatness – Source <sup>1</sup> into VSWR (1.2:1) (wrt Reference Frequency)	5 mVp-p to 5 Vp-p 100 MHz 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 Oscilloscope Calibrator, Fluke 9530 Active Head
Scope Input Impedance – Measure <sup>1</sup>	(10 to 40) Ω (40 to 90) Ω (90 to 150) Ω (50 to 800) kΩ 800 kΩ 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	Fluke 9500B Oscilloscope Calibrator
Scope Input Capacitance – Measure <sup>1</sup>	(1 to 35) pF (35 to 95) pF	1.6 % of reading + 0.19 pF 2.3 % of reading + 0.19 pF	Fluke 9500B Oscilloscope Calibrator

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Relative Power – Sinewave Flatness <sup>1</sup> (Relative Power)	10 MHz to 18 GHz (-40 to 0) dBm (0 to 10) dBm (10 to 20) dBm 50 MHz to 26.5 GHz (-40 to 00) dBm (0 to 10) dBm (10 to 20) dBm	0.21 dB 0.34 dB 0.51 dB 0.25 dB 0.39 dB 0.56 dB	Agilent E4419B EPM Power Meter, Agilent E4412A Power Sensor, Agilent E4413A Power Sensor

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Measure <sup>1</sup> 100 pW to 100 mW	10 MHz to 1 GHz (-70 to -60) dBm (-60 to -50) dBm (-50 to -40) dBm (-40 to 0) dBm (0 to 10) dBm (10 to 20) dBm 1 GHz to 18 GHz (-70 to -60) dBm (-60 to -50) dBm (-50 to -40) dBm (-40 to 0) dBm (0 to 10) dBm (10 to 20) dBm 50 MHz to 26.5 GHz (-70 to -60) dBm (-60 to -50) dBm (-50 to -40) dBm (-40 to 0) dBm (0 to 10) dBm (10 to 20) dBm	6.9 dB 1.4 dB 0.24 dB 0.17 dB 0.34 dB 0.51 dB 6.9 dB 1.4 dB 0.25 dB 0.19 dB 0.36 dB 0.53 dB 6.9 dB 1.4 dB 0.27 dB 0.22 dB 0.39 dB 0.56 dB	Agilent E4419B EPM Power Meter, Agilent E4412A Power Sensor, Agilent E4413A Power Sensor
Amplitude Modulation – AM Depth Measure <sup>1</sup> Rate 50 Hz to 10 kHz Rate: 20 Hz to 10 kHz Rate: 50 Hz to 50 kHz Rate: 20 Hz to 100 kHz Rate: 50 Hz to 50 kHz Rate 20 Hz to 100 kHz	(5 to 99) % Depth (0.15 to 10) MHz (> 0 to 99) % Depth (0.15 to 10) MHz (5 to 99) % Depth (0.01 to 1.3) GHz (> 0 to 99) % Depth (0.01 to 1.3) GHz (5 to 99) % Depth (1.3 to 26.5) GHz (> 0 to 99) % Depth (1.3 to 26.5) GHz	2.4 % Depth 3.5 % Depth 1.4 % Depth 3.5 % Depth 1.9 % Depth 3.5 % Depth	HP 8902A Measuring Receiver, HP 11722A Power Sensor
FM Modulation – Measure <sup>1</sup> 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, HP 11722A Power Sensor



**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Measure <sup>1</sup> Rate: 200 Hz to 10 kHz	Up to 4 rad 150 kHz to 10 MHz (4 to 40) rad	4.2 % of reading + 0.03 rad	HP 8902A Measuring Receiver, HP 11722A Power Sensor
	150 kHz to 10 MHz (40 to 400) rad	4.2 % of reading + 0.03 rad	
	150 kHz to 10 MHz	4.2 % of reading + 0.1 rad	
Phase Modulation – Measure <sup>1</sup> Rate: 200 Hz to 10 kHz	< 40 Radians Deviation (0.15 to 10) MHz	4.9% Deviation	HP 8902A Measuring Receiver, HP 11722A Power Sensor, HP 11792A Microwave Converter, HP 11793A Microwave Converter
Rate: 200 Hz to 20 kHz	< 40 Radians Deviation (0.01 to 26.5) GHz	3.8% Deviation	
Harmonic Distortion	(-80 to 0) dBc 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 <sup>1</sup>	(-80 to 0) dB 20 Hz to 20 kHz (20 to 100) kHz	1.1 dB 2 dB	Agilent 8903B Audio Analyzer
AM Total Harmonic Distortion – Measure <sup>1</sup>	(-80 to 0) dB 20 Hz to 20 kHz 20 kHz to 100 kHz	1.2 dB 2.3 dB	
Absolute RF Power – Measure <sup>1</sup>	1 mW, 50 MHz Reference	0.43 % of reading	Agilent 478A- H75 Coaxial Thermistor Mount, HP 432A Power Meter, Agilent 3458A 8.5 Digit Multimeter
Absolute RF Power – Measure <sup>1</sup>	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	0.11 dB 0.1 dB 0.11 dB 0.11 dB 0.23 dB	HP 8902A Measuring Receiver, HP 11722A Power Sensor



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Absolute RF Power – Measure <sup>1</sup>	(2.6 to 12.2) GHz		HP 8902A Measuring Receiver, HP 11722A Power Sensor, HP 11792A Microwave Converter, HP 11793A Microwave Converter
	(-20 to -10) dBm	0.14 dB	
	(-10 to 0) dBm	0.13 dB	
	(0 to 10) dBm	0.13 dB	
	(10 to 20) dBm	0.14 dB	
	(20 to 30) dBm	0.25 dB	
	(12.2 to 17.75) GHz		
	(-20 to -10) dBm	0.15 dB	
	(-10 to 0) dBm	0.14 dB	
	(0 to 10) dBm	0.14 dB	
	(10 to 20) dBm	0.15 dB	
	(20 to 30) dBm	0.25 dB	
	(17.75 to 26.5) GHz		
	(-20 to -10) dBm	0.18 dB	
	(-10 to 0) dBm	0.18 dB	
(0 to 5) dBm	0.18 dB		
Reflection (VSWR) <sup>1,7</sup> 10 MHz to 18 GHz	(Rho)	(Rho)	VSWR Bridge
	0.022 to 0.1	0.022	
	0.1 to 0.2	0.027	
	0.2 to 0.3	0.033	
	0.3 to 0.4	0.042	
Relative Tuned RF Power – Measure <sup>1</sup>	2.5 MHz to 26.5 GHz		HP 8902A Measuring Receiver, HP 11722A Power Sensor, HP 11793A Microwave Converter
	(-127 to -120) dB	0.056 dB	
	(-120 to -110) dB	0.06 dB	
	(-110 to -100) dB	0.064 dB	
	(-100 to -90) dB	0.068 dB	
	(-90 to -80) dB	0.071 dB	
	(-80 to -70) dB	0.074 dB	
	(-70 to -60) dB	0.081 dB	
	(-60 to -50) dB	0.084 dB	
	(-50 to -40) dB	0.22 dB	
	(-40 to -30) dB	0.23 dB	
	(-30 to -20) dB	0.23 dB	
	(-20 to -10) dB	0.23 dB	
	(-10 to 0) dB	0.23 dB	

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – AM Depth Measure <sup>1,6</sup> Rate: 50 Hz to 10 kHz	150 kHz to 10 MHz (5 to 99) % Depth	2.4 % Depth	HP 8902A Measuring Receiver HP 8902A, HP 11793A Measuring Receiver Microwave Converter
	Rate: 20 Hz to 10 kHz 150 kHz to 10 MHz (5 to 99) % Depth	3.5 % Depth	
	Rate: 50 Hz to 50 kHz 10 MHz to 1.3 GHz (5 to 99) % Depth	1.3 % Depth	
Amplitude Modulation – AM Depth Measure <sup>1,6</sup> Rate: 20 Hz to 100 kHz	10 MHz to 1.3 GHz (0 to 99) % Depth	3.5 % Depth	HP 8902A Measuring Receiver, HP 11793A Microwave Converter
	Rate: 50 Hz to 50 kHz (1.3 to 26.5) GHz (0 to 99) % Depth	1.8 % Depth	
	Rate: 20 Hz to 100 kHz (1.3 to 26.5) GHz (0 to 99) % Depth	3.5 % Depth	
Frequency Modulation – Deviation Measure <sup>1,6</sup> Rate: 20 Hz to 10 kHz	250 kHz to 10 MHz Dev/Rate ≤ 40 kHz peak	2.3 % Deviation	HP 8902A Measuring Receiver
	Rate: 50 Hz to 100 kHz 10 MHz to 1.3 GHz Dev/Rate ≤ 400 kHz peak	1.2 % Deviation	
Frequency Modulation – Deviation Measure <sup>1,6</sup> Rate: 20 Hz to 200 kHz	10 MHz to 1.3 GHz Dev/Rate ≤ 4 kHz peak	5.8 % Deviation	HP 8902A Measuring Receiver, HP 11793A Microwave Converter
	Rate: 50 Hz to 100 kHz (1.3 to 26.5) GHz Dev/Rate ≤ 400 kHz peak	1.2 % Deviation	
	Rate: 20 Hz to 200 kHz (1.3 to 26.5) GHz Dev/Rate ≤ 400 kHz peak	5.8 % Deviation	
RF Power – Transfer Measure	(-20 to 10) dBm 100 kHz to 10 MHz > 10 MHz to 10 GHz (> 10 to 18) GHz	0.97 % of reading 1.2 % of reading 1.5 % of reading	Tegam 2505A Microwave Calibration Feed-through Standard, Tegam 1830A RF Power Meter



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**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power – Transfer Measure	(-20 to 10) dBm (10 to 50) MHz > 10 MHz to 4.2 GHz (> 4.2 to 12.2) GHz (> 12.2 to 17.75) GHz (> 17.75 to 33) GHz (> 33 to 44) GHz (> 44 to 50) GHz	1.5 % of reading 1.5 % of reading 1.8 % of reading 2 % of reading 2.7 % of reading 3.4 % of reading 4.8 % of reading	Tegam 2510A Microwave Calibration Feed-through Standard, Tegam 1830A RF Power Meter
Tuned RF Absolute 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 Measuring Receiver, HP 11722A Power Sensor, HP 11792A Microwave Converter, HP 11793A Microwave Converter

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Micrometers <sup>1,2</sup>	(0.05 to 1) in (1 to 9) in (4 to 15) in (15 to 40) in	(13 + 1L) μin (9 + 4L) μin (14 + 4L) μin (20 + 4L) μin	ASME B89 Grade 0 Gage Blocks, ASME B89 Grade 0 Long Blocks
Anvil Flatness <sup>1</sup>	Up to 1 in Diameter	6.3 μin	Optical Flats
Anvil Parallelism <sup>1</sup>	Up to 1 in Diameter	6.3 μin	Optical Parallel
Calipers <sup>1,2</sup>	(0.05 to 1) in (1 to 9) in (4 to 15) in (15 to 40) in	(13 + 1L) μin (9 + 4L) μin (14 + 4L) μin (20 + 4L) μin	ASME B89 Grade 0 Gage Blocks, ASME B89 Grade 0 Long Blocks
Jaw Parallelism <sup>1</sup>	Up to 1 in	59 μin	Pin Gages

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Height Measure, Height Gages <sup>1,2</sup>	(0.05 to 1) in (1 to 9) in (4 to 15) in (15 to 40) in	57 μin (54 + 2L) μin (48 + 3L) μin (34 + 4L) μin	ASME B89 Grade 0 Gage Blocks, Gage Amp w/Probe, Surface Plate
Single Axis Length <sup>2</sup>	up to 4 in (4 to 10) in	(15 + 3L) μin (14 + 4L) μin	Super-micrometer, ASME B89 Grade 0 Gage Blocks
Plain Plugs, Pin Gages <sup>2</sup>	Up to 1 in	(15 + 3 L) μin	Super-micrometer, ASME B89 Grade 0 Gage Blocks
Threaded Plug Gage <sup>2</sup> Outer Pitch Diameter, 60°  Major Diameter	Up to 5 in (5 to 10)  up to 4 in (4 to 10) in	110 μin 110 μin  (15 + 3 L) μin (14 + 4 L) μin	Super-micrometer, ASME B89 Grade 0 Gage Blocks, Thread Wires
Rulers and Tapes	up to 25 in (2 to 4) ft (4 to 6) ft (6 to 8) ft (8 to 22) ft (22 to 48) ft (48 to 1 000) ft	0.003 5 in 0.004 5 in 0.006 7 in 0.009 3in 100 μin/in 110 μin/in 120 μin/in	Magnified Glass Rule
Surface Plates <sup>1</sup> Local Area Flatness Only	Up to 0.001 in	65 μin	Gage Amp w/Probe, Level Plate
	Up to 0.001 in	33 μin	Repeat-o-Meter
Surface Parallelism <sup>1</sup>	Up to 18 in	120 μin	Gage Amp w/Probe, Surface Plate
Surface Straightness <sup>1</sup>	Up to 18 in	120 μin	Gage Amp w/Probe, Surface Plate

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force – Source <sup>1</sup>	(0.1 to 915) lbf	0.024 % of reading + 0.001 2 lbf	NIST Class F Weights



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Wrenches <sup>1</sup>	(0.2 to 10) N·m (0.4 to 20) N·m (2 to 100) N·m (4 to 200) N·m (8 to 400) N·m (25 to 1 100) N·m	1 % of reading 1 % of reading 1 % of reading 1 % of reading 1 % of reading 1 % of reading	Stahlwille Torque Transducers
	(900 to 2 000) lbf·ft	1.5 % of reading	CDI 200-14-02 Torque Transducer
Torque Transducers <sup>1</sup>	0.156 lbf·in to 150 lbf·ft	0.17 % of reading	Torque Arms/Wheels, NIST Class F Weights
Pneumatic Pressure – Source/Measure <sup>1</sup> (Absolute)	(0 to 15) psia (15 to 30) psia	0.001 5 psi 0.01 % of reading	Mensor CPC6000 Pressure Controller
	(30 to 50) psia	0.006 6 % of reading + 0.005 7 psi	Fluke 6270A Pressure Controller
	(50 to 300) psia (300 to 1 000) psia	0.004 5 % of reading + 0.006 4 psi 0.005 2 % of reading + 0.001 5 psi	Fluke PPC4 Pressure Controller
Pneumatic Pressure – Source/Measure <sup>1</sup> (Gauge)	(-14.7 to 0) psig	0.006 2 % of reading + 0.000 1 psi	Fluke PPC4 Pressure Controller
	(0 to 1) psig	0.000 1 psi	Mensor CPC6000 Pressure Controller
	(1 to 1 000) psig	0.006 2 % of reading + 0.000 1 psi	Fluke PPC4 Pressure Controller
Hydraulic Pressure – Source/Measure <sup>1</sup>	(15 to 800) psig (800 to 16 000) psig	0.025 % of reading + 0.005 psi 0.02 % of reading + 0.095 psi	Fluke P3125-DWT Deadweight Tester
Balances, Scales <sup>1,4</sup> (SI)	Up to 500 mg	12 µg	ASTM E617 Class 1 weights and internal calibration procedure utilized for the calibration of the weighing system.
	500 mg to 5 g	40 µg	
	5 g to 10 g	58 µg	
	10 g to 30 g	89 µg	
	30 g to 16 kg	0.000 32 % of reading	
Balances, Scales <sup>1,4</sup> (Avoirdupois)	Up to 0.018 oz	12 µg	ASTM E617 Class 1 weights and internal calibration procedure utilized for the calibration of the weighing system.
	(0.018 to 0.18) oz	40 µg	
	(0.18 to 0.35) oz	58 µg	
	(0.35 to 0.7) oz	89 µg	
	0.7 oz to 35 lb	0.000 32 % of reading	
Balances, Scales <sup>1,4</sup> (SI)	Up to 8 g	2 mg	NIST Class F weights and internal calibration procedure utilized for the calibration of the weighing system.
	(8 to 226) g	0.024 % of reading	
	(226 to 453) g	0.018 % of reading	
	453 g to 5 kg	0.012 % of reading	
	(5 to 6) kg	0.01 % of reading	
	(6 to 415) kg	0.012 % of reading	

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Balances, Scales <sup>1,4</sup> (Avoirdupois)	Up to 0.25 oz (0.25 to 8) oz (0.5 to 1) lb (1 to 11) lb (11 to 14) lb (14 to 915) lb	2 mg 0.024% of reading 0.018% of reading 0.012% of reading 0.010% of reading 0.012% of reading	NIST Class F weights and internal calibration procedure utilized for the calibration of the weighing system.

**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Source <sup>1</sup>	(-30 to 0) °C (0 to 125) °C (-15 to 50) °C (50 to 100) °C (100 to 350) °C	0.04 °C 0.046 °C 0.59 °C 0.17 °C 0.14 °C	Water Baths, Dry-well Calibrators, SPRT
Temperature – Measure <sup>1</sup>	(-195 to 0) °C (0 to 420) °C (420 to 660) °C	0.027 °C 0.007 5 % of reading + 0.027 °C 0.008 % of reading + 0.024 °C	Fluke 1523 Reference Thermometer, Fluke 5626 PRT
Humidity – Measure <sup>1</sup> (15 to 25 °C)	(0 to 90) %RH	1.3 % RH	Vaisala MI70/HMP76B Temp/Humidity Probe
Infrared Temperature – Measuring Equipment <sup>1</sup>	(-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 – Reference <sup>1</sup>	10 MHz	640 pHz/Hz	Rubidium Oscillator
Frequency – Measure <sup>1</sup>	10 mHz to 100 kHz 100 kHz to 10 MHz (10 to 100) MHz (100 to 225) MHz	4.8 mHz 0.45 Hz 4.5 Hz 10 Hz	HP 53132A Universal Counter w/Rubidium Oscillator


**Time and Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure <sup>1</sup>	225 MHz to 1 GHz (1 to 10) GHz (10 to 50) GHz	0.86 Hz 7.5 Hz 37 Hz	Agilent E4448A Spectrum Analyzer w/Rubidium Oscillator
Frequency – Source <sup>1</sup>	0.01 Hz to 2 MHz	2 $\mu$ Hz/Hz + 8 $\mu$ Hz	Fluke 5522A Multiproduct Calibrator
	10 mHz to 100 kHz 100 kHz to 20 MHz	2 mHz 18 mHz	HP 3325B Synthesizer/Function Generator, w/Rubidium Oscillator
	250 kHz to 1 GHz (1 to 50) GHz	0.74 Hz 37 Hz	Agilent E8257D Analog Frequency Generator, w/Rubidium Oscillator
Stopwatches, Timers <sup>1</sup>	Up to 24 hr	0.02 % of reading + 38 ms	Fluke 5522A Multiproduct Calibrator, HP 53132A Universal Counter
Photo Tachometers <sup>1</sup>	(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	Comparison to Extech 461995 Laser Tachometer
AC Duty Cycle – Source <sup>1</sup> Square Wave: < 3.3 Vp-p Freq: 0.1 Hz to 100 kHz	(1 to 10) % Duty Cycle 10 $\mu$ s to 100 s (10 to 49) % Duty Cycle 10 $\mu$ s to 100 s 50 % Duty Cycle 10 $\mu$ s to 100 s (51 to 90) % Duty Cycle 10 $\mu$ s to 100 s (90 to 99) % Duty Cycle 10 $\mu$ s 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

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



- Notes:
1. On-site calibration service is available for this parameter, since on-site conditions are typically more variable than those in the laboratory, larger measurement uncertainties are expected on-site than what is reported on the accredited scope.
  2.  $L$  = length in inches.
  3. The stated uncertainty is the laboratory's ability to source a fast rise pulse that is approximately 250 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. 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.
  5. The uncertainties shown are for the most favorable conditions. There is an increase in uncertainty that corresponds to the laboratory's AC voltage and current uncertainties at different frequencies other than the ones shown. Power factors (PF) other than the one shown contribute to the power uncertainty. PF is related to the cosine of phase. Therefore, uncertainties track the laboratory's phase uncertainty closely at PF near one, but are magnified heavily as PF approaches zero. The lab may also report reactive power, apparent power, and power factor under this accreditation. If needed, contact laboratory for more information regarding uncertainties at frequency and power factor combinations other than the ones shown.
  6. In addition to the percent of reading value for the CMC, 1 Least Significant Digit will be added at the time of calibration.
  7. This is a unitless measurement.
  8. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2489.15.



Jason Stine, Vice President

