CERTIFICATE OF ACCREDITATION

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Hereby attests that

Transcat - Houston
16115 Park Row, Suite 150
Houston, TX 77084

Fulfills the requirements of

ISO/IEC 17025:2017

and national standards

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

In the 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.

Jason Stine, Vice President

Expiry Date: 07 September 2025
Certificate Number: AC-2489.02

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

AND

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

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CALIBRATION

Valid to: **September 7, 2025** Certificate Number: **AC-2489.02**

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source/Measure	Up to 1 pA (1 to 10) pA (10 to 100) pA (0.1 to 1) nA (1 to 10) nA (10 to 100) nA (0.1 to 1) µA (1 to 10) µA	1.1 % of reading + 7 fA 0.52 % of reading + 7 fA 0.16 % of reading + 3 fA 0.057 % of reading + 0.2 pA 0.055 % of reading + 2 pA 0.055 % of reading + 20 pA 0.051 % of reading + 0.3 nA 0.05 % of reading + 2 nA	Keithley 6430 Sub-femtoamp Remote SourceMeter
DC Current – Source/Measure	Up to 100 nA (0.1 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 (1 to 10) A (10 to 20) A (20 to 30) A (30 to 100) A	1.5 pA 21 µA/A 7.2 µA/A 6.5 µA/A 2.8 µA/A 5.1 µA/A 2 µA/A 2.4 µA/A 4.8 µA/A 4 µA/A 10 µA/A 36 µA/A	Standard Shunts, Current Source

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source/Measure [1]	Up to 1.0 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	HP 3458A opt 002 8.5 Digit Multimeter, Current Source
DC Current – Measure [1]	(1 to 3) A (3 to 10) A	0.096 % of reading + 0.47 mA 0.12 % of reading + 0.62 mA	Fluke 8846A 6.5 Digit Multimeter
DC Current – Measure [1]	(10 to 100) A	0.15 mA/A + 2 mA	Ohms Labs CS-100 Precision Shunt, Agilent 3458A 8.5 Digit Multimeter
DC Clamp-on Ammeters (Non-Toroidal Type) Transformer Type Sensor [1]	(20 to 150) A (150 to 1 000) A (1 000 to 5 000) A	0.51 % of reading + 0.14 A 0.51 % of reading + 0.5 A 0.58 % of reading	Fluke 5520A Multiproduct Calibrator, Fluke 5500A/COIL, Fluke 55120A Transconductance Amplifier, 1 kA and 6 kA Coils
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	 0.031 % 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 µA 0.11 % of reading + 0.65 µA 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 + 0.55 µA 0.11 % of reading + 5 µA	Fluke 5720A Multiproduct Calibrator

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	 0.033 % of reading + 4 µA 0.018 % of reading + 3.5 µA 0.014 % of reading + 2.5 µA 0.021 % of reading + 3.5 µA 0.11 % of reading + 10 µA 0.027 % of reading + 35 µA 0.046 % of reading + 80 µA 0.7 % of reading + 0.16 mA	Fluke 5720A Multiproduct Calibrator
AC Current – Source [1]	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	 0.048 % of reading + 0.17 mA 0.096 % of reading + 0.38 mA 0.36 % of reading + 0.75 mA	Fluke 5720A 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	 0.095 % of reading + 3.9 mA 0.12 % of reading + 3.9 mA 2.3 % of reading + 3.9 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 + 0.31 µA 0.78 % of reading + 0.47 µA 0.31 % of reading + 3.1 µA 0.31 % of reading + 0.16 mA	Fluke 5520A Multiproduct Calibrator
AC Clamp-on Ammeter (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, 1 kA Coil
AC Clamp-on Ammeter (Non-Toroidal Type) Hall Effect Sensor [1]	(20 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 000) A (45 to 65) Hz (65 to 440) Hz	 0.57 % 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, 1 kA Coil

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Clamp-on Ammeter (Non-Toroidal Type) Hall Effect Sensor [1]	(1 to 6) kA (10 to 300) Hz (1 to 2) kA (300 to 440) Hz (2 to 6) kA (300 to 440) Hz	0.6 % of reading 0.8 % of reading 0.66 % of reading	Fluke 5520A Multiproduct Calibrator, Fluke 52120A Transconductance Amplifier, 6 kA Coil
AC Current – Measure [1]	Up to 100 µA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz (0.1 to 1) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (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
AC Current – Measure [1]	(1 to 3) A 10 Hz to 5 kHz (5 to 10) kHz (3 to 10) A 10 Hz to 5 kHz	 0.12 % of reading + 1.4 mA 0.27 % of reading + 16 mA 0.13 % of reading + 4.7 mA	Fluke 8846A 6.5 Digit Multimeter
AC Current – Measure [1]	10 A to 100 A (50 to 60) Hz 400 Hz 1 kHz	 0.22 mA/A + 5 mA 0.26 mA/A + 5 mA 1.1 mA/A + 1.3 mA	Agilent 3458A opt 002 8.5 Digit Multimeter, Ohms Lab CS-100 Current Shunt

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source/Measure (Fixed Points)	0 V (floor) 100 mV 1 V 10 V 19 V 100 V 1 000 V	59 nV 0.81 µV/V 0.31 µV/V 0.24 µV/V 1 µV/V 0.26 µV/V 0.81 µV/V	Ratio Metric with Zener
DC Voltage – Source/Measure (Fixed Points)	100 mV 1 V 10 V	5.5 µV/V 0.5 µV/V 0.2 µV/V	DC Reference Cells
DC Voltage – Measure	(0 to 200) mV (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 1 050) V	1.9 µV/V + 0.11 µV 1.6 µV/V + 0.39 µV 1.4 µV/V + 3.9 µV 2.8 µV/V + 39 µV 2.9 µV/V + 0.47 mV	Fluke 8508 8.5 Digit Multimeter
DC Voltage – Source/Measure [1] (Variable Points)	(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 µV/V + 0.58 µV 5.3 µV/V + 0.58 µV 5.3 µV/V + 0.58 µV 7.7 µV/V + 35 µV 15 µV/V + 0.12 mV 18 µV/V + 0.12 mV 21 µV/V + 0.12 mV	Agilent 3458A opt 002 8.5 Digit Multimeter, Fluke 5720A Multiproduct Calibrator
DC High Voltage – Measure [1]	(1 to 10) kV (10 to 20) kV (20 to 30) kV (30 to 40) kV (40 to 50) kV (50 to 60) kV (60 to 70) kV (70 to 80) kV (80 to 90) kV (90 to 100) kV	0.039 % of reading + 92 mV 0.038 % of reading + 2.4 V 0.041 % of reading + 2.4 V 0.047 % of reading + 2.4 V 0.056 % of reading + 2.4 V 0.071 % of reading + 2.4 V 0.089 % of reading + 2.4 V 0.12 % of reading + 2.5 V 0.15 % of reading + 2.5 V 0.17 % of reading + 2.5 V	Vitrek 4700 High Voltage Meter; HVL-35, HVL-70, HVL-100 High Voltage Probes
AC Voltage – Source [1]	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.16 % of reading + 4 µV 0.1 % of reading + 4 µV 0.078 % of reading + 4 µV 0.13 % of reading + 4 µV 0.17 % of reading + 5 µV 0.33 % of reading + 10 µV 0.47 % of reading + 20 µV 0.58 % of reading + 20 µV	Fluke 5720A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	(2.2 to 22) mV		Fluke 5720A Multiproduct Calibrator
	(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	0.005 % of reading + 8 µV	
	(20 to 50) kHz	0.008 % of reading + 10 µV	
	(50 to 100) kHz	0.012 % of reading + 30 µV	
	(100 to 300) kHz	0.043 % of reading + 80 µV	
	(300 to 500) kHz	0.1 % of reading + 0.2 mV	
	500 kHz to 1 MHz	0.18 % of reading + 0.3 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.028 % of reading + 0.4 mV	
	(20 to 40) Hz	0.01 % of reading + 0.15 mV	
	40 Hz to 20 kHz	0.004 9 % of reading + 50 µV	
	(20 to 50) kHz	0.008 3 % 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	0.006 % of reading + 0.6 mV	
	(20 to 50) kHz	0.009 3 % of reading + 1 mV	
	(50 to 100) kHz	0.016 % of reading + 2.5 mV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	(22 to 220) V		Fluke 5720A Multiproduct Calibrator
	(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 + 40 mV	
	(220 to 750) V		
	(30 to 50) kHz	0.061 % of reading + 11 mV	
	(50 to 100) kHz	0.23 % of reading + 45 mV	
	(220 to 1 100) V		
	40 Hz to 1 kHz	0.011 % of reading + 4 mV	
	(1 to 20) kHz	0.017 % of reading + 6 mV	
	(20 to 30) kHz	0.061 % of reading + 11 mV	
AC Voltage – Measure [1]	Up to 10 mV		Agilent 3458A opt 002 8.5 Digit Multimeter
	(1 to 40) Hz	0.04 % of reading + 3.5 µV	
	40 Hz to 1 kHz	0.03 % of reading + 1.2 µV	
	(1 to 20) kHz	0.04 % of reading + 1.2 µV	
	(20 to 50) kHz	0.15 % of reading + 1.2 µV	
	(50 to 100) kHz	0.59 % of reading + 1.2 µV	
	(100 to 300) kHz	4.6 % of reading + 2.3 µV	
	(0.3 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 + 4.6 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	

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 2) MHz	1.8 % of reading + 0.12 mV	
	(2 to 4) MHz	4.6 % of reading + 0.81 mV	
	(4 to 8) MHz	4.6 % of reading + 0.92 mV	
	(8 to 10) MHz	17 % of reading + 1.2 mV	
	(1 to 10) V		
	(1 to 40) Hz	0.009 5 % of reading + 0.46 mV	
	40 Hz to 1 kHz	0.023 % of reading + 0.23 mV	
	(1 to 20) kHz	0.017 % of reading + 0.23 mV	
	(20 to 50) kHz	0.036 % of reading + 0.23 mV	
	(50 to 100) kHz	0.093 % of reading + 0.23 mV	
	(100 to 300) kHz	0.35 % of reading + 1.2 mV	
	300 kHz to 1 MHz	1.2 % of reading + 1.2 mV	
	(1 to 2) MHz	1.8 % of reading + 1.2 mV	
	(2 to 4) MHz	4.6 % of reading + 8.1 mV	
	(4 to 8) MHz	4.6 % of reading + 9.2 mV	
	(8 to 10) MHz	17 % of reading + 12 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.024 % of reading + 4.6 mV	
	40Hz to 1 kHz	0.024 % of reading + 2.3 mV	
	(1 to 20) kHz	0.024 % of reading + 2.3 mV	
	(20 to 50) kHz	0.041 % of reading + 2.3 mV	
	(50 to 100) kHz	0.14 % of reading + 2.3 mV	
	(100 to 300) kHz	0.46 % of reading + 12 mV	
	300 kHz to 1 MHz	1.7 % of reading + 12 mV	
	(100 to 700) V		
	(1 to 40) Hz	0.048 % of reading + 46 mV	
	40 Hz to 1 kHz	0.048 % of reading + 23 mV	
	(1 to 20) kHz	0.071 % of reading + 23 mV	
	(20 to 50) kHz	0.19 % of reading + 23 mV	
	(50 to 100) kHz	0.35 % of reading + 23 mV	
AC High Voltage – Measure [1]	(0.7 to 5) kHz		Vitrek 4700 High Voltage Meter; HVL-35, HVL-70, HVL-100 High Voltage Probes
	10 mHz to 10 Hz	0.14 % of reading + 0.17 V	
	(10 to 30) Hz	0.12 % of reading + 0.29 V	
	(30 to 50) Hz	0.099 % of reading + 0.37 V	
	(50 to 70) Hz	0.068 % of reading + 0.37 V	
	(70 to 100) Hz	0.099 % of reading + 0.37 V	
	(100 to 200) Hz	0.099 % of reading + 0.37 V	
	(200 to 450) Hz	0.48 % of reading + 0.17 V	
	(450 to 600) Hz	0.87 % of reading + 0.17 V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC High Voltage – Measure [1]	(5 to 30) kV		Vitrek 4700 High Voltage Meter; HVL-35, HVL-70, HVL-100 High Voltage Probes
	10 mHz to 10 Hz	0.19 % of reading + 2.4 V	
	(10 to 30) Hz	0.13 % of reading + 2.4 V	
	(30 to 50) Hz	0.11 % of reading + 2.4 V	
	(50 to 70) Hz	0.077 % of reading + 2.4 V	
	(70 to 100) Hz	0.11 % of reading + 2.4 V	
	(100 to 200) Hz	0.11 % of reading + 2.4 V	
	(200 to 450) Hz	0.7 % of reading + 2.4 V	
	(450 to 600) Hz	1.4 % of reading + 2.4 V	
	(30 to 50) kV		
	10 mHz to 10 Hz	0.24 % of reading + 2.5 V	
	(10 to 30) Hz	0.18 % of reading + 2.5 V	
	(30 to 50) Hz	0.13 % of reading + 2.5 V	
	(50 to 70) Hz	0.1 % of reading + 2.5 V	
	(70 to 100) Hz	0.13 % of reading + 2.5 V	
	(100 to 200) Hz	0.69 % of reading + 2.5 V	
	(200 to 450) Hz	2.9 % of reading + 2.5 V	
	(50 to 70) kV		
	10 mHz to 10 Hz	0.37 % of reading + 2.6 V	
	(10 to 30) Hz	0.26 % of reading + 2.6 V	
	(30 to 50) Hz	0.16 % of reading + 2.6 V	
	(50 to 70) Hz	0.16 % of reading + 2.6 V	
	(70 to 100) Hz	1.2 % of reading + 2.6 V	
	(100 to 200) Hz	1.2 % of reading + 2.6 V	
	(200 to 450) Hz	17 % of reading + 2.6 V	
Capacitance – Source [1] (Simulation)	10 Hz to 10 kHz		Fluke 5522A Multiproduct Calibrator
	(0.22 to 0.3999) nF	0.39% of reading + 7.8 pF	
	(0.40 to 1.0999) nF	0.39% of reading + 7.8 pF	
	10 Hz to 3kHz		
	(1.1 to 3.2999) nF	0.39% of reading + 7.8 pF	
	10 Hz to 1kHz		
	(3.3 to 10.9999) nF	0.21% of reading + 7.8 pF	
	(11 to 32.9999) nF	0.21% of reading + 78 pF	
	(33 to 109.999) nF	0.21% of reading + 78 pF	
	(110 to 329.999) nF	0.21% of reading + 0.23 nF	
	10 Hz to 600 Hz		
	(0.33 to 1.0999) µF	0.21% of reading + 0.78 nF	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source [1] (Simulation)	10 Hz to 300 Hz (1.1 to 3.29999) µF 10 Hz to 150 Hz (3.3 to 10.9999) µF 10 Hz to 120 Hz (11 to 32.9999) µF 10 Hz to 80 Hz (33 to 109.999) µF DC to 50 Hz (110 to 329.999) µF DC to 20 Hz (0.33 to 10.9999) mF DC to 6 Hz (1.1 to 3.29999) mF DC to 2 Hz (3.3 to 10.9999) mF DC to 0.6 Hz (11 to 32.9999) mF DC to 0.2 Hz (33 to 110) mF	0.21% of reading + 2.3 nF 0.21% of reading + 7.8 nF 0.32% of reading + 23 nF 0.35% of reading + 78 nF 0.35% of reading + 0.23 µF 0.35% of reading + 0.78 µF 0.35% of reading + 2.3 µF 0.35% of reading + 7.8 µF 0.58% of reading + 23 µF 0.85% of reading + 78 µF	Fluke 5522A Multiproduct Calibrator
Capacitance – Measure [1] 10 Hz to 1 MHz (Fixed Points)	0.33 mF 0.8 mF 1 mF 1.2 mF 3 mF 3.3 mF 8 mF 10 mF 12 mF 30 mF 80 mF 100 mF	0.048 % of reading 0.027 % of reading 0.024 % of reading 0.023 % of reading 0.018 % of reading 0.017 % of reading 0.016 % of reading 0.016 % of reading 0.016 % of reading 0.015 % of reading 0.014 % of reading 0.014 % of reading	Time/Charge Method utilizing the HP 3458A 8.5 Digit Multimeter.
Capacitance – Measure 10 Hz to 1 MHz (Fixed Points)	0.1 pF 100 kHz 1 MHz 1 pF 10 kHz 100 kHz 1 MHz 2 MHz	 1.4 % of reading 1.8 % of reading 1.4 % of reading 0.37 % of reading 0.44 % of reading 1.1 % of reading	Agilent E4980A LCR Meter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Measure 10 Hz to 1 MHz (Fixed Points)	10 pF		Agilent E4980A LCR Meter
	1 kHz	1.4 % of reading	
	10 kHz	0.28 % of reading	
	100 kHz	0.28 % of reading	
	1 MHz	0.3 % of reading	
	2 MHz	0.75 % of reading	
	100 pF		
	100 Hz	2.1 % of reading	
	1 kHz	0.23 % of reading	
	10 kHz	0.17 % of reading	
	100 kHz	0.21 % of reading	
	1 MHz	0.23 % of reading	
	2 MHz	0.3 % of reading	
	1 nF		
	20 Hz	1.8 % of reading	
	100 Hz	0.3 % of reading	
	1 kHz	0.1 % of reading	
	10 kHz	0.1 % of reading	
	100 kHz	0.1 % of reading	
	1 MHz	0.14 % of reading	
	2 MHz	0.53 % of reading	
	10 nF		
	20 Hz	0.31 % of reading	
	100 Hz	0.12 % of reading	
	1 kHz	0.092 % of reading	
	10 kHz	0.092 % of reading	
	100 kHz	0.092 % of reading	
	1 MHz	0.25 % of reading	
	2 MHz	0.67 % of reading	
	100 nF		
	20 Hz	0.16 % of reading	
	100 Hz	0.092 % of reading	
	1 kHz	0.092 % of reading	
	10 kHz	0.092 % of reading	
	100 kHz	0.18 % of reading	
	1 MHz	0.33 % of reading	
	2 MHz	0.97 % of reading	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Measure 10 Hz to 1 MHz (Fixed Points)	1 µF 20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 10 µF 20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 100 µF 20 Hz 100 Hz 1 kHz 10 kHz	 0.15 % of reading 0.092 % of reading 0.092 % of reading 0.18 % of reading 0.25 % of reading 0.79 % of reading 0.15 % of reading 0.092 % of reading 0.16 % of reading 0.28 % of reading 0.73 % of reading 0.16 % of reading 0.17 % of reading 0.29 % of reading 0.8 % of reading	Agilent E4980A LCR Meter
DC Resistance – Source/Measure	Up to 100 µΩ (0.1 Ω to 1) mΩ (1 to 10) mΩ (10 to 100) mΩ (0.1 to 1) Ω	0.63 nΩ 7.1 µΩ/Ω 1.9 µΩ/Ω 3.8 µΩ/Ω 0.49 µΩ/Ω	Standard Resistors, Current Source, Digital Multimeter
DC Resistance – Source/Measure	(1 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	0.49 µΩ/Ω 0.98 µΩ/Ω 1.2 µΩ/Ω 2.7 µΩ/Ω 0.35 µΩ/Ω 1.9 µΩ/Ω 6.6 µΩ/Ω 14 µΩ/Ω	Standard Resistors, MI 6242B Resistance Bridge
Resistance Ratio	1 Ω to 1 kΩ	0.16 µΩ/Ω	MI 6242B Resistance Bridge

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Resistance – Source/Measure [1]	Up to 10 Ω (10 to 100) Ω (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, Decade Resistor
DC Resistance – Source/Measure [1]	(1 to 10) GΩ (10 to 100) GΩ (0.1 to 1) TΩ (1 to 10) TΩ (10 to 100) TΩ	0.73 % of reading + 10 kΩ 0.74 % of reading + 0.1 MΩ 0.75 % of reading + 1 MΩ 0.19 % of reading + 10 MΩ 0.59 % of reading + 0.1 GΩ	Keithley 6430 Sub-Femtoamp Remote Sourcemeter, Voltage Source
DC Resistance – Source	1 GΩ	53 µΩ/Ω	Standard Resistor
DC Resistance – Source [1]	100 Ω to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ (1 to 10) GΩ (10 to 100) GΩ (0.1 to 1) TΩ	0.037 % of reading 0.037 % of reading + 1.2 µΩ/Ω/V 0.12 % of reading + 1.2 µΩ/Ω/V 0.23 % of reading + 1.2 µΩ/Ω/V 0.59 % of reading + 1.2 µΩ/Ω/V 1.2 % of reading + 1.2 µΩ/Ω/V 1.2 % of reading + 1.2 µΩ/Ω/V	IET HRRS-B-7-100k-10kV High Resistance Substituter
DC Resistance – Measure	(0.1 to 1) GΩ (1 to 20) GΩ	53 µΩ/Ω + 0.11 MΩ 0.23 mΩ/Ω + 1.1 MΩ	Double Substitution Method using Standard Resistors and Fluke 8508 8.5 Digit Multimeter.
Impedance – Measure [3]	0.1 Ω 1 kHz 10 kHz 100 kHz 1 MHz 1 Ω 20 Hz 100 Hz 1 kHz 10 kHz 100 kHz 1 MHz 2 MHz	 1.8 % of reading 1.6 % of reading 1 % of reading 1.5 % of reading 0.67 % of reading 0.43 % of reading 0.33 % of reading 0.32 % of reading 0.31 % of reading 0.38 % of reading 0.92 % of reading	Agilent E4980A LCR Meter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Impedance – Measure [3]	10 Ω		Agilent E4980A LCR Meter
	20 Hz	0.29 % of reading	
	100 Hz	0.2 % of reading	
	1 kHz	0.17 % of reading	
	10 kHz	0.19 % of reading	
	100 kHz	0.19 % of reading	
	1 MHz	0.27 % of reading	
	2 MHz	0.67 % of reading	
	100 Ω		
	20 Hz	0.16 % of reading	
	100 Hz	0.092 % of reading	
	1 kHz	0.092 % of reading	
	10 kHz	0.12 % of reading	
	100 kHz	0.12 % of reading	
	1 MHz	0.2 % of reading	
	2 MHz	0.53 % of reading	
	1 kΩ		
	20 Hz	0.15 % of reading	
	100 Hz	0.092 % of reading	
	1 kHz	0.092 % of reading	
	10 kHz	0.092 % of reading	
	100 kHz	0.092 % of reading	
	1 MHz	0.14 % of reading	
	2 MHz	0.3 % of reading	
	10 kΩ		
	20 Hz	0.15 % of reading	
	100 Hz	0.092 % of reading	
	1 kHz	0.092 % of reading	
	10 kHz	0.092 % of reading	
	100 kHz	0.1 % of reading	
	1 MHz	0.29 of reading	
	2 MHz	0.87 of reading	
	100 kΩ		
	20 Hz	0.17 % of reading	
	100 Hz	0.1 % of reading	
	1 kHz	0.1 % of reading	
	10 kHz	0.17 % of reading	
	100 kHz	0.28 % of reading	
	1 MHz	0.38 % of reading	
	2 MHz	1.3 % of reading	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Flatness Relative to 1 kHz 7 V / 3.2 V	10 Hz 20 Hz 50 Hz 105 Hz 200 Hz 2 kHz 10 kHz 20 kHz 50 kHz 100 kHz 200 kHz 500 kHz 700 kHz 1 MHz 1.2 MHz 2 MHz 3 MHz 4 MHz 6 MHz 8 MHz 9 MHz 10 MHz	0.009 % of reading 0.008% of reading 0.006 % of reading 0.007 % of reading 0.006 % of reading 0.006 % of reading 0.006 % of reading 0.008 % of reading 0.007 % of reading 0.007 % of reading 0.007 % of reading 0.009 % of reading 0.013 % of reading 0.016 % of reading 0.016 % of reading 0.021 % of reading 0.024 % of reading 0.028% of reading 0.031 % of reading 0.034 % of reading 0.034 % of reading 0.034 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator
Flatness Relative to 1 kHz 7 V / 3.2 V	12 MHz 15 MHz 17 MHz 20 MHz 23 MHz 26 MHz 28 MHz 30 MHz 35 MHz 40 MHz 45 MHz 50 MHz	0.042 % of reading 0.046 % of reading 0.052 % of reading 0.062 % of reading 0.087 % of reading 0.1 % of reading 0.11 % of reading 0.12 % of reading 0.15 % of reading 0.17 % of reading 0.20 % of reading 0.25 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Flatness Relative to 1 kHz 2.2 V / 2 V	10 Hz 20 Hz 50 Hz 105 Hz 200 Hz 2 kHz 10 kHz 20 kHz 50 kHz 100 kHz 200 kHz 500 kHz 700 kHz 1 MHz 1.2 MHz 2 MHz 3 MHz 4 MHz 6 MHz 8 MHz 9 MHz 10 MHz 12 MHz 15 MHz 17 MHz 20 MHz	0.012 % of reading 0.012 % of reading 0.007 % of reading 0.008 % of reading 0.006 % of reading 0.007 % of reading 0.007 % of reading 0.008 % of reading 0.007% of reading 0.007 % of reading 0.007 % of reading 0.009 % of reading 0.014 % of reading 0.017 % of reading 0.017 % of reading 0.021 % of reading 0.026 % of reading 0.029 % of reading 0.033 % of reading 0.037 % of reading 0.036 % of reading 0.036 % of reading 0.045 % of reading 0.049 % of reading 0.054 % of reading 0.065 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator
Flatness Relative to 1 kHz 2.2 V / 2 V	23 MHz 26 MHz 28 MHz 30 MHz 35 MHz 40 MHz 45 MHz 50 MHz	0.045 % of reading 0.049 % of reading 0.054 % of reading 0.065 % of reading 0.089 % of reading 0.1 % of reading 0.12 % of reading 0.12 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Flatness Relative to 1 kHz 2.2 V / 1 V	10 Hz 20 Hz 50 Hz 105 Hz 200 Hz 2 kHz 10 kHz 20 kHz 50 kHz 100 kHz 200 kHz 500 kHz 700 kHz 1 MHz 1.2 MHz 2 MHz 3 MHz 4 MHz 6 MHz 8 MHz 9 MHz 10 MHz 12 MHz 15 MHz 17 MHz 20 MHz 23 MHz 26 MHz 28 MHz	0.014 % of reading 0.013 % of reading 0.008 % of reading 0.009 % of reading 0.007 % of reading 0.007 % of reading 0.007 % of reading 0.008 % of reading 0.007 % of reading 0.007 % of reading 0.007 % of reading 0.009 % of reading 0.014 % of reading 0.017 % of reading 0.017 % of reading 0.022 % of reading 0.027 % of reading 0.031 % of reading 0.035 % of reading 0.039 % of reading 0.04 % of reading 0.04 % of reading 0.049 % of reading 0.052 % of reading 0.056 % of reading 0.066 % of reading 0.049 % of reading 0.052 % of reading 0.056 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator
Flatness Relative to 1 kHz 2.2 V / 1 V	30 MHz 35 MHz 40 MHz 45 MHz 50 MHz	0.066 % of reading 0.09 % of reading 0.11 % of reading 0.12 % of reading 0.13 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Flatness Relative to 1 kHz 0.7 V / 0.64 V	10 Hz 20 Hz 50 Hz 105 Hz 200 Hz 2 kHz 10 kHz 20 kHz 50 kHz 100 kHz 200 kHz 500 kHz 700 kHz 1 MHz 1.2 MHz 2 MHz 3 MHz 4 MHz 6 MHz 8 MHz 9 MHz 10 MHz 12 MHz 15 MHz 17 MHz 20 MHz 23 MHz 26 MHz	0.017 % of reading 0.016 % of reading 0.009 % of reading 0.01 % of reading 0.008 % of reading 0.007 % of reading 0.007 % of reading 0.009 % of reading 0.008 % of reading 0.008 % of reading 0.008 % of reading 0.01 % of reading 0.015 % of reading 0.018 % of reading 0.018 % of reading 0.023 % of reading 0.028 % of reading 0.032 % of reading 0.037 % of reading 0.041 % of reading 0.042 % of reading 0.042 % of reading 0.052 % of reading 0.055 % of reading 0.059 % of reading 0.069 % of reading 0.052 % of reading 0.055 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator
Flatness Relative to 1 kHz 0.7 V / 0.64 V	28 MHz 30 MHz 35 MHz 40 MHz 45 MHz 50 MHz	0.059 % of reading 0.069 % of reading 0.093 % of reading 0.11 % of reading 0.12 % of reading 0.13 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Flatness Relative to 1 kHz 0.7 V / 0.32 V	10 Hz 20 Hz 50 Hz 105 Hz 200 Hz 2 kHz 10 kHz 20 kHz 50 kHz 100 kHz 200 kHz 500 kHz 700 kHz 1 MHz 1.2 MHz 2 MHz 3 MHz 4 MHz 6 MHz 8 MHz 9 MHz 10 MHz 12 MHz 15 MHz 17 MHz 20 MHz 23 MHz 26 MHz 28 MHz 30 MHz	0.014 % of reading 0.014 % of reading 0.008 % of reading 0.008 % of reading 0.007 % of reading 0.008 % of reading 0.007 % of reading 0.009 % of reading 0.008 % of reading 0.008 % of reading 0.008 % of reading 0.010 % of reading 0.015 % of reading 0.017 % of reading 0.018 % of reading 0.022 % of reading 0.028 % of reading 0.031 % of reading 0.034 % of reading 0.038 % of reading 0.038 % of reading 0.038 % of reading 0.049 % of reading 0.053 % of reading 0.060 % of reading 0.071 % of reading 0.049 % of reading 0.053 % of reading 0.06 % of reading 0.071 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator
Flatness Relative to 1 kHz 0.7 V / 0.32 V	35 MHz 40 MHz 45 MHz 50 MHz	0.094 % of reading 0.11 % of reading 0.12 % of reading 0.13 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Flatness Relative to 1 kHz 0.22 V / 0.1 V	10 Hz 20 Hz 50 Hz 105 Hz 200 Hz 2 kHz 10 kHz 20 kHz 50 kHz 100 kHz 200 kHz 500 kHz 700 kHz 1 MHz 1.2 MHz 2 MHz 3 MHz 4 MHz 6 MHz 8 MHz 9 MHz 10 MHz 12 MHz 15 MHz 17 MHz 20 MHz 23 MHz 26 MHz 28 MHz 30 MHz	0.018 % of reading 0.017 % of reading 0.01 % of reading 0.01 % of reading 0.008 % of reading 0.008 % of reading 0.008 % of reading 0.009 % of reading 0.009 % of reading 0.009 % of reading 0.009 % of reading 0.01 % of reading 0.016 % of reading 0.019 % of reading 0.019 % of reading 0.023 % of reading 0.03 % of reading 0.034 % of reading 0.038 % of reading 0.043 % of reading 0.043 % of reading 0.044 % of reading 0.055 % of reading 0.059 % of reading 0.064 % of reading 0.075 % of reading 0.055 % of reading 0.059 % of reading 0.064 % of reading 0.075 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator
Flatness Relative to 1 kHz 0.22 V / 0.1 V	35 MHz 40 MHz 45 MHz 50 MHz	0.098 % of reading 0.12 % of reading 0.13 % of reading 0.14 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Flatness Relative to 1 kHz 0.07 V / 32 mV	10 Hz 20 Hz 50 Hz 105 Hz 200 Hz 2 kHz 10 kHz 20 kHz 50 kHz 100 kHz 200 kHz 500 kHz 700 kHz 1 MHz 1.2 MHz 2 MHz 3 MHz 4 MHz 6 MHz 8 MHz 9 MHz 10 MHz 12 MHz 15 MHz 17 MHz 20 MHz 23 MHz 26 MHz 28 MHz 30 MHz	0.019 % of reading 0.018 % of reading 0.009 % of reading 0.01 % of reading 0.008 % of reading 0.009 % of reading 0.009 % of reading 0.01 % of reading 0.009 % of reading 0.009 % of reading 0.01 % of reading 0.011 % of reading 0.016 % of reading 0.02 % of reading 0.02 % of reading 0.024 % of reading 0.031 % of reading 0.034 % of reading 0.039 % of reading 0.044 % of reading 0.044 % of reading 0.045 % of reading 0.057 % of reading 0.063 % of reading 0.07 % of reading 0.08 % of reading 0.057 % of reading 0.063 % of reading 0.07 % of reading 0.08 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator
Flatness Relative to 1 kHz 0.07 V / 32 mV	35 MHz 40 MHz 45 MHz 50 MHz	0.1 % of reading 0.12 % of reading 0.13 % of reading 0.14 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Flatness Relative to 1 kHz 22 mV / 10 mV	10 Hz 20 Hz 50 Hz 105 Hz 200 Hz 2 kHz 10 kHz 20 kHz 50 kHz 100 kHz 200 kHz 500 kHz 700 kHz 1 MHz 1.2 MHz 2 MHz 3 MHz 4 MHz 6 MHz 8 MHz 9 MHz 10 MHz 12 MHz 15 MHz 17 MHz 20 MHz 23 MHz 26 MHz 28 MHz 30 MHz	0.022 % of reading 0.021 % of reading 0.011 % of reading 0.011 % of reading 0.009 % of reading 0.009 % of reading 0.009 % of reading 0.01 % of reading 0.01 % of reading 0.01 % of reading 0.01 % of reading 0.012 % of reading 0.017 % of reading 0.021 % of reading 0.021 % of reading 0.025 % of reading 0.033 % of reading 0.037 % of reading 0.043 % of reading 0.048 % of reading 0.049 % of reading 0.05 % of reading 0.063 % of reading 0.068 % of reading 0.073 % of reading 0.084 % of reading 0.063 % of reading 0.068 % of reading 0.073% of reading 0.084 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator
Flatness Relative to 1 kHz 22 mV / 10 mV	35 MHz 40 MHz 45 MHz 50 MHz	0.11 % of reading 0.12 % of reading 0.14 % of reading 0.15 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Flatness Relative to 1 kHz 7 mV / 3.2 mV	10 Hz 20 Hz 50 Hz 105 Hz 200 Hz 2 kHz 10 kHz 20 kHz 50 kHz 100 kHz 200 kHz 500 kHz 700 kHz 1 MHz 1.2 MHz 2 MHz 3 MHz 4 MHz 6 MHz 8 MHz 9 MHz 10 MHz 12 MHz 15 MHz 17 MHz 20 MHz 23 MHz 26 MHz 28 MHz 30 MHz	0.022 % of reading 0.022 % of reading 0.01 % of reading 0.011 % of reading 0.009 % of reading 0.01 % of reading 0.01 % of reading 0.011 % of reading 0.01 % of reading 0.01 % of reading 0.01 % of reading 0.012 % of reading 0.018 % of reading 0.021 % of reading 0.021 % of reading 0.025 % of reading 0.034 % of reading 0.036 % of reading 0.042 % of reading 0.047 % of reading 0.048 % of reading 0.049 % of reading 0.063 % of reading 0.069 % of reading 0.076 % of reading 0.087 % of reading 0.063 % of reading 0.069 % of reading 0.076 % of reading 0.087 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator
Flatness Relative to 1 kHz 7 mV / 3.2 mV	35 MHz 40 MHz 45 MHz 50 MHz	0.11 % of reading 0.13 % of reading 0.14 % of reading 0.15 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Flatness Relative to 1 kHz 2.2 mV / 1 mV	10 Hz 20 Hz 50 Hz 105 Hz 200 Hz 2 kHz 10 kHz 20 kHz 50 kHz 100 kHz 200 kHz 500 kHz 700 kHz 1 MHz 1.2 MHz 2 MHz 3 MHz 4 MHz 6 MHz 8 MHz 9 MHz 10 MHz 12 MHz 15 MHz 17 MHz 20 MHz 23 MHz 26 MHz 28 MHz 30 MHz	0.025 % of reading 0.024 % of reading 0.011 % of reading 0.012 % of reading 0.01 % of reading 0.01 % of reading 0.01 % of reading 0.011 % of reading 0.01 % of reading 0.011 % of reading 0.011 % of reading 0.013 % of reading 0.018 % of reading 0.022 % of reading 0.022 % of reading 0.026 % of reading 0.036 % of reading 0.039 % of reading 0.045 % of reading 0.051 % of reading 0.052 % of reading 0.053 % of reading 0.068 % of reading 0.073 % of reading 0.079 % of reading 0.09 % of reading 0.068 % of reading 0.073 % of reading 0.079 % of reading 0.09 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator
Flatness Relative to 1 kHz 2.2 mV / 1 mV	35 MHz 40 MHz 45 MHz 50 MHz	0.11 % of reading 0.13 % of reading 0.14 % of reading 0.15 % of reading	Fluke 5790B AC Measurement Standard, EL1100 3 V Thermal converter, 4 dB attenuator, 10 dB attenuator, (3) 20 dB attenuators, Fluke 5730A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Low Frequency – AC/DC Difference Measurement (Voltage)	2 mV		Fluke 792A AC/DC Transfer Standard
	10 Hz	0.56 mV/V	
	20 Hz	0.35 mV/V	
	40 Hz	0.45 mV/V	
	100 Hz	0.39 mV/V	
	1 kHz	0.34 mV/V	
	10 kHz	0.32 mV/V	
	20 kHz	0.32 mV/V	
	50 kHz	0.35 mV/V	
	100 kHz	0.44 mV/V	
	300 kHz	0.51 mV/V	
	500 kHz	0.61 mV/V	
	800 kHz	0.75 mV/V	
	1 MHz	0.76 mV/V	
	6 mV		
	10 Hz	0.23 mV/V	
	20 Hz	0.23 mV/V	
	40 Hz	0.23 mV/V	
	100 Hz	0.19 mV/V	
	1 kHz	0.18 mV/V	
	10 kHz	0.17 mV/V	
	20 kHz	0.2 mV/V	
	50 kHz	0.22 mV/V	
	100 kHz	0.3 mV/V	
	300 kHz	0.41 mV/V	
	500 kHz	0.49 mV/V	
	800 kHz	0.58 mV/V	
	1 MHz	0.63 mV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Low Frequency – AC/DC Difference Measurement (Voltage)	10 mV		Fluke 792A AC/DC Transfer Standard
	10 Hz	0.11 mV/V	
	20 Hz	0.11 mV/V	
	40 Hz	89 µV/V	
	100 Hz	0.14 mV/V	
	1 kHz	88 µV/V	
	10 kHz	0.11 mV/V	
	20 kHz	83 µV/V	
	50 kHz	0.1 mV/V	
	100 kHz	0.16 mV/V	
	300 kHz	0.22 mV/V	
	500 kHz	0.3 mV/V	
	800 kHz	0.33 mV/V	
	1 MHz	0.42 mV/V	
	20 mV		
	10 Hz	84 µV/V	
	20 Hz	68 µV/V	
	40 Hz	64 µV/V	
	100 Hz	0.11 mV/V	
	1 kHz	67 µV/V	
	10 kHz	81 µV/V	
	20 kHz	62 µV/V	
	50 kHz	0.11 mV/V	
	100 kHz	0.16 mV/V	
	300 kHz	0.22 mV/V	
	500 kHz	0.31 mV/V	
	800 kHz	0.38 mV/V	
	1 MHz	0.39 mV/V	
	60 mV		
	10 Hz	0.1 mV/V	
	20 Hz	45 µV/V	
	40 Hz	35 µV/V	
	100 Hz	33 µV/V	
	1 kHz	32 µV/V	
	10 kHz	37 µV/V	
	20 kHz	35 µV/V	
	50 kHz	40 µV/V	
	100 kHz	77 µV/V	
	300 kHz	0.15 mV/V	
	500 kHz	0.22 mV/V	
	800 kHz	0.29 mV/V	
	1 MHz	0.3 mV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Low Frequency – AC/DC Difference Measurement (Voltage)	0.1 V		Fluke 792A AC/DC Transfer Standard
	10 Hz	46 µV/V	
	20 Hz	29 µV/V	
	40 Hz	21 µV/V	
	100 Hz	15 µV/V	
	1 kHz	14 µV/V	
	10 kHz	26 µV/V	
	20 kHz	29 µV/V	
	50 kHz	30 µV/V	
	100 kHz	45 µV/V	
	300 kHz	90 µV/V	
	500 kHz	0.13 mV/V	
	800 kHz	0.19 mV/V	
	1 MHz	0.2 mV/V	
	0.2 V		
	10 Hz	35 µV/V	
	20 Hz	21 µV/V	
	40 Hz	29 µV/V	
	100 Hz	16 µV/V	
	1 kHz	12 µV/V	
	10 kHz	20 µV/V	
	20 kHz	17 µV/V	
	50 kHz	28 µV/V	
	100 kHz	48 µV/V	
	300 kHz	76 µV/V	
	500 kHz	0.11 mV/V	
	800 kHz	0.16 mV/V	
	1 MHz	0.19 mV/V	
	0.6 V		
	10 Hz	28 µV/V	
	20 Hz	24 µV/V	
	40 Hz	7.6 µV/V	
	100 Hz	8.7 µV/V	
	1 kHz	9.2 µV/V	
	10 kHz	7.8 µV/V	
	20 kHz	9.7 µV/V	
	50 kHz	8.6 µV/V	
	100 kHz	30 µV/V	
	300 kHz	26 µV/V	
	500 kHz	47 µV/V	
	800 kHz	60 µV/V	
	1 MHz	81 µV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Low Frequency – AC/DC Difference Measurement (Voltage)	1V		Fluke 792A AC/DC Transfer Standard
	10 Hz	29 µV/V	
	20 Hz	18 µV/V	
	40 Hz	6.5 µV/V	
	100 Hz	6.7 µV/V	
	1 kHz	7 µV/V	
	10 kHz	6 µV/V	
	20 kHz	6 µV/V	
	50 kHz	8.2 µV/V	
	100 kHz	14 µV/V	
	300 kHz	22 µV/V	
	500 kHz	35 µV/V	
	800 kHz	36 µV/V	
	1 MHz	48 µV/V	
	2 V		
	10 Hz	25 µV/V	
	20 Hz	15 µV/V	
	40 Hz	6.6 µV/V	
	100 Hz	6.4 µV/V	
	1 kHz	6.5µV/V	
	10 kHz	6.2 µV/V	
	20 kHz	6.8 µV/V	
	50 kHz	7.9 µV/V	
	100 kHz	14 µV/V	
	300 kHz	33 µV/V	
	500 kHz	33 µV/V	
	800 kHz	32 µV/V	
	1 MHz	45 µV/V	
	6 V		
	10 Hz	32 µV/V	
	20 Hz	16 µV/V	
	40 Hz	5.6 µV/V	
	100 Hz	6.1 µV/V	
	1 kHz	5.8 µV/V	
	10 kHz	6.3 µV/V	
	20 kHz	5.8 µV/V	
	50 kHz	6.5 µV/V	
	100 kHz	9.4 µV/V	
	300 kHz	20 µV/V	
	500 kHz	27 µV/V	
	800 kHz	33 µV/V	
	1 MHz	42 µV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Low Frequency – AC/DC Difference Measurement (Voltage)	10 V		Fluke 792A AC/DC Transfer Standard
	10 Hz	26 µV/V	
	20 Hz	15 µV/V	
	40 Hz	5.5 µV/V	
	100 Hz	6.3 µV/V	
	1 kHz	5.9 µV/V	
	10 kHz	5.5 µV/V	
	20 kHz	5.6 µV/V	
	50 kHz	7.3 µV/V	
	100 kHz	9.6 µV/V	
	300 kHz	20 µV/V	
	500 kHz	35 µV/V	
	800 kHz	56 µV/V	
	1 MHz	81 µV/V	
	20 V		
	10 Hz	37 µV/V	
	20 Hz	17 µV/V	
	40 Hz	8 µV/V	
	100 Hz	7.9 µV/V	
	1 kHz	7.7 µV/V	
	10 kHz	7.9 µV/V	
	20 kHz	7.8 µV/V	
	50 kHz	8.9 µV/V	
	100 kHz	12 µV/V	
	300 kHz	22 µV/V	
	500 kHz	28 µV/V	
	800 kHz	37 µV/V	
	1 MHz	55 µV/V	
	60 V		
	10 Hz	36 µV/V	
	20 Hz	17 µV/V	
	40 Hz	7.1 µV/V	
	100 Hz	6.9 µV/V	
	1 kHz	7.3 µV/V	
	10 kHz	7.0 µV/V	
	20 kHz	7.7 µV/V	
	50 kHz	15 µV/V	
	100 kHz	11 µV/V	
	300 kHz	33 µV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Low Frequency – AC/DC Difference Measurement (Voltage)	100 V		Fluke 792A AC/DC Transfer Standard
	10 Hz	27 µV/V	
	20 Hz	15 µV/V	
	40 Hz	7.2 µV/V	
	100 Hz	6.9 µV/V	
	1 kHz	7 µV/V	
	10 kHz	7.1 µV/V	
	20 kHz	7.6 µV/V	
	50 kHz	12 µV/V	
	100 kHz	18 µV/V	
	200 V		
	10 Hz	44 µV/V	
	20 Hz	17 µV/V	
	40 Hz	10 µV/V	
	100 Hz	10 µV/V	
	1 kHz	9.7 µV/V	
	10 kHz	9.8 µV/V	
	20 kHz	10.3 µV/V	
	50 kHz	12 µV/V	
	100 kHz	19 µV/V	
	600 V		
	10 Hz	54 µV/V	
	20 Hz	29 µV/V	
	40 Hz	14 µV/V	
	100 Hz	15 µV/V	
	1 kHz	13 µV/V	
	10 kHz	18 µV/V	
	20 kHz	20 µV/V	
	50 kHz	32 µV/V	
	100 kHz	72 µV/V	
	1 000 V		
	10 Hz	54 µV/V	
	20 Hz	22 µV/V	
	40 Hz	13 µV/V	
	100 Hz	12 µV/V	
	1 kHz	13 µV/V	
	10 kHz	16 µV/V	
	20 kHz	22 µV/V	
	50 kHz	47 µV/V	
	100 kHz	67 µV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure (Current w/ Voltage Output Reading)	0.1 mA		Fluke 792A AC/DC Transfer Standard, Fluke A40 Current Shunts
	10 Hz	75 µV/V	
	20 Hz	70 µV/V	
	40 Hz	61 µV/V	
	400 Hz	59 µV/V	
	1 kHz	56 µV/V	
	5 kHz	73 µV/V	
	10 kHz	83 µV/V	
	20 kHz	0.12 mV/V	
	30 kHz	0.16 mV/V	
	0.2 mA		
	10 Hz	95 µV/V	
	20 Hz	56 µV/V	
	40 Hz	59 µV/V	
	400 Hz	45 µV/V	
	1 kHz	43 µV/V	
	5 kHz	69 µV/V	
	10 kHz	81 µV/V	
	20 kHz	0.12 mV/V	
	30 kHz	0.19 mV/V	
	0.3 mA		
	10 Hz	71 µV/V	
	20 Hz	70 µV/V	
	40 Hz	49 µV/V	
	400 Hz	47 µV/V	
	1 kHz	47 µV/V	
	5 kHz	47 µV/V	
	10 kHz	49 µV/V	
	20 kHz	68 µV/V	
	30 kHz	0.12 mV/V	
	1 mA		
	10 Hz	56 µV/V	
	20 Hz	47 µV/V	
	40 Hz	41 µV/V	
	400 Hz	34 µV/V	
	1 kHz	30 µV/V	
	5 kHz	34 µV/V	
	10 kHz	37 µV/V	
	20 kHz	43 µV/V	
	30 kHz	36 µV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure (Current w/ Voltage Output Reading)	2 mA		Fluke 792A AC/DC Transfer Standard, Fluke A40 Current Shunts
	10 Hz	54 µV/V	
	20 Hz	42 µV/V	
	40 Hz	46 µV/V	
	400 Hz	38 µV/V	
	1 kHz	38 µV/V	
	5 kHz	39 µV/V	
	10 kHz	41 µV/V	
	20 kHz	41 µV/V	
	30 kHz	48 µV/V	
	3 mA		
	10 Hz	51 µV/V	
	20 Hz	40 µV/V	
	40 Hz	35 µV/V	
	400 Hz	33 µV/V	
	1 kHz	33 µV/V	
	5 kHz	32 µV/V	
	10 kHz	32 µV/V	
	20 kHz	38 µV/V	
	30 kHz	44 µV/V	
	10 mA		
	10 Hz	0.1 mV/V	
	20 Hz	53 µV/V	
	40 Hz	38 µV/V	
	400 Hz	37 µV/V	
	1 kHz	32 µV/V	
	5 kHz	31 µV/V	
	10 kHz	32 µV/V	
	20 kHz	42 µV/V	
	30 kHz	63 µV/V	
	20 mA		
	10 Hz	0.14 mV/V	
	20 Hz	84 µV/V	
	40 Hz	78 µV/V	
	400 Hz	77 µV/V	
	1 kHz	76 µV/V	
	5 kHz	76 µV/V	
	10 kHz	76 µV/V	
	20 kHz	78 µV/V	
	30 kHz	93 µV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure (Current w/ Voltage Output Reading)	30 mA		Fluke 792A AC/DC Transfer Standard, Fluke A40 Current Shunts
	10 Hz	0.15 mV/V	
	20 Hz	92 µV/V	
	40 Hz	72 µV/V	
	400 Hz	66 µV/V	
	1 kHz	66 µV/V	
	5 kHz	67 µV/V	
	10 kHz	73 µV/V	
	20 kHz	85 µV/V	
	30 kHz	0.11 mV/V	
	0.1 A		
	10 Hz	0.14 mV/V	
	20 Hz	64 µV/V	
	40 Hz	53 µV/V	
	400 Hz	51 µV/V	
	1 kHz	48 µV/V	
	5 kHz	48 µV/V	
	10 kHz	49 µV/V	
	20 kHz	61 µV/V	
	30 kHz	78 µV/V	
	0.2 A		
	10 Hz	0.15 mV/V	
	20 Hz	58 µV/V	
	40 Hz	39 µV/V	
	400 Hz	37 µV/V	
	1 kHz	40 µV/V	
	5 kHz	34 µV/V	
	10 kHz	33 µV/V	
	20 kHz	49 µV/V	
	30 kHz	68 µV/V	
	0.3 A		
	10 Hz	0.12 mV/V	
	20 Hz	56 µV/V	
	40 Hz	43 µV/V	
	400 Hz	33 µV/V	
	1 kHz	32 µV/V	
	5 kHz	31 µV/V	
	10 kHz	36 µV/V	
	20 kHz	43 µV/V	
	30 kHz	72 µV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure (Current w/ Voltage Output Reading)	0.5 A		Fluke 792A AC/DC Transfer Standard, Fluke A40 Current Shunts
	10 Hz	0.26 mV/V	
	20 Hz	51 µV/V	
	40 Hz	75 µV/V	
	400 Hz	50 µV/V	
	1 kHz	45 µV/V	
	5 kHz	37 µV/V	
	10 kHz	29 µV/V	
	20 kHz	47 µV/V	
	30 kHz	79 µV/V	
	1 A		
	10 Hz	98 µV/V	
	20 Hz	50 µV/V	
	40 Hz	38 µV/V	
	400 Hz	39 µV/V	
	1 kHz	35 µV/V	
	5 kHz	39 µV/V	
	10 kHz	48 µV/V	
	20 kHz	80 µV/V	
	30 kHz	0.12 mV/V	
	2 A		
	10 Hz	0.11 mV/V	
	20 Hz	56 µV/V	
	40 Hz	42 µV/V	
	400 Hz	37 µV/V	
	1 kHz	35 µV/V	
	5 kHz	42 µV/V	
	10 kHz	43 µV/V	
	20 kHz	55 µV/V	
	30 kHz	0.11 mV/V	
	3 A		
	10 Hz	0.13 mV/V	
	20 Hz	66 µV/V	
	40 Hz	57 µV/V	
	400 Hz	56 µV/V	
	1 kHz	55 µV/V	
	5 kHz	61 µV/V	
	10 kHz	63 µV/V	
	20 kHz	83 µV/V	
	30 kHz	0.14 mV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure (Current w/ Voltage Output Reading)	5 A		Fluke 792A AC/DC Transfer Standard, Fluke A40 Current Shunts
	10 Hz	0.13 mV/V	
	20 Hz	67 µV/V	
	40 Hz	56 µV/V	
	400 Hz	61 µV/V	
	1 kHz	53 µV/V	
	5 kHz	58 µV/V	
	10 kHz	69 µV/V	
	20 kHz	88 µV/V	
	30 kHz	0.18 mV/V	
	10 A		
	10 Hz	0.15 mV/V	
	20 Hz	84 µV/V	
	40 Hz	65 µV/V	
	400 Hz	64 µV/V	
	1 kHz	62 µV/V	
	5 kHz	62 µV/V	
	10 kHz	62 µV/V	
	20 kHz	0.1 mV/V	
	30 kHz	0.15 mV/V	
	20 A		
	10 Hz	0.15 mV/V	
	20 Hz	0.12 mV/V	
	40 Hz	81 µV/V	
	400 Hz	81 µV/V	
	1 kHz	77 µV/V	
	5 kHz	77 µV/V	
	10 kHz	77 µV/V	
	20 kHz	0.13 mV/V	
	30 kHz	0.18 mV/V	
	100 A		
	10 Hz	0.16 mV/V	
	20 Hz	0.16 mV/V	
	40 Hz	96 µV/V	
	400 Hz	86 µV/V	
	1 kHz	86 µV/V	
	5 kHz	0.12 mV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	2 mV		Fluke 792A AC/DC Transfer Standard
	10 Hz	0.56 mV/V	
	20 Hz	0.35 mV/V	
	40 Hz	0.45 mV/V	
	100 Hz	0.39 mV/V	
	1 kHz	0.34 mV/V	
	10 kHz	0.32 mV/V	
	20 kHz	0.32 mV/V	
	50 kHz	0.35 mV/V	
	100 kHz	0.44 mV/V	
	300 kHz	0.51 mV/V	
	500 kHz	0.61 mV/V	
	800 kHz	0.75 mV/V	
	1 MHz	0.76 mV/V	
	6 mV		
	10 Hz	0.23 mV/V	
	20 Hz	0.23 mV/V	
	40 Hz	0.23 mV/V	
	100 Hz	0.19 mV/V	
	1 kHz	0.18 mV/V	
	10 kHz	0.17 mV/V	
	20 kHz	0.2 mV/V	
	50 kHz	0.22 mV/V	
	100 kHz	0.3 mV/V	
	300 kHz	0.41 mV/V	
	500 kHz	0.49 mV/V	
	800 kHz	0.58 mV/V	
	1 MHz	0.63 mV/V	
	10 mV		
	10 Hz	0.11 mV/V	
	20 Hz	0.11 mV/V	
	40 Hz	89 µV/V	
	100 Hz	0.14 mV/V	
	1 kHz	88 µV/V	
	10 kHz	0.11 mV/V	
	20 kHz	83 µV/V	
	50 kHz	0.1 mV/V	
	100 kHz	0.16 mV/V	
	300 kHz	0.22 mV/V	
	500 kHz	0.3 mV/V	
	800 kHz	0.33 mV/V	
	1 MHz	0.42 mV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	20 mV		Fluke 792A AC/DC Transfer Standard
	10 Hz	84 µV/V	
	20 Hz	68 µV/V	
	40 Hz	64 µV/V	
	100 Hz	0.11 mV/V	
	1 kHz	67 µV/V	
	10 kHz	81 µV/V	
	20 kHz	62 µV/V	
	50 kHz	0.11 mV/V	
	100 kHz	0.16 mV/V	
	300 kHz	0.22 mV/V	
	500 kHz	0.31 mV/V	
	800 kHz	0.38 mV/V	
	1 MHz	0.39 mV/V	
	60 mV		
	10 Hz	0.1 mV/V	
	20 Hz	45 µV/V	
	40 Hz	35 µV/V	
	100 Hz	33 µV/V	
	1 kHz	32 µV/V	
	10 kHz	37 µV/V	
	20 kHz	35 µV/V	
	50 kHz	40 µV/V	
	100 kHz	77 µV/V	
	300 kHz	0.15 mV/V	
	500 kHz	0.22 mV/V	
	800 kHz	0.29 mV/V	
	1 MHz	0.3 mV/V	
	0.1 V		
	10 Hz	46 µV/V	
	20 Hz	29 µV/V	
	40 Hz	21 µV/V	
	100 Hz	15 µV/V	
	1 kHz	14 µV/V	
	10 kHz	26 µV/V	
	20 kHz	29 µV/V	
	50 kHz	30 µV/V	
	100 kHz	45 µV/V	
	300 kHz	90 µV/V	
	500 kHz	0.13 mV/V	
	800 kHz	0.19 mV/V	
	1 MHz	0.2 mV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	0.2 V		Fluke 792A AC/DC Transfer Standard
	10 Hz	35 µV/V	
	20 Hz	21 µV/V	
	40 Hz	29 µV/V	
	100 Hz	16 µV/V	
	1 kHz	12 µV/V	
	10 kHz	20 µV/V	
	20 kHz	17 µV/V	
	50 kHz	28 µV/V	
	100 kHz	48 µV/V	
	300 kHz	76 µV/V	
	500 kHz	0.11 mV/V	
	800 kHz	0.16 mV/V	
	1 MHz	0.19 mV/V	
	0.6 V		
	10 Hz	28 µV/V	
	20 Hz	24 µV/V	
	40 Hz	7.6 µV/V	
	100 Hz	8.7 µV/V	
	1 kHz	9.2 µV/V	
	10 kHz	7.8 µV/V	
	20 kHz	9.7 µV/V	
	50 kHz	8.6 µV/V	
	100 kHz	30 µV/V	
	300 kHz	26 µV/V	
	500 kHz	47 µV/V	
	800 kHz	60 µV/V	
	1 MHz	81 µV/V	
	1 V		
	10 Hz	29 µV/V	
	20 Hz	18 µV/V	
	40 Hz	6.5 µV/V	
	100 Hz	6.7 µV/V	
	1 kHz	7 µV/V	
	10 kHz	6 µV/V	
	20 kHz	6 µV/V	
	50 kHz	8.2 µV/V	
	100 kHz	14 µV/V	
	300 kHz	22 µV/V	
	500 kHz	35 µV/V	
	800 kHz	36 µV/V	
	1 MHz	48 µV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	2 V		Fluke 792A AC/DC Transfer Standard
	10 Hz	25 µV/V	
	20 Hz	15 µV/V	
	40 Hz	6.6 µV/V	
	100 Hz	6.4 µV/V	
	1 kHz	6.5µV/V	
	10 kHz	6.2 µV/V	
	20 kHz	6.8 µV/V	
	50 kHz	7.9 µV/V	
	100 kHz	14 µV/V	
	300 kHz	33 µV/V	
	500 kHz	33 µV/V	
	800 kHz	32 µV/V	
	1 MHz	45 µV/V	
	6 V		
	10 Hz	32 µV/V	
	20 Hz	16 µV/V	
	40 Hz	5.6 µV/V	
	100 Hz	6.1 µV/V	
	1 kHz	5.8 µV/V	
	10 kHz	6.3 µV/V	
	20 kHz	5.8 µV/V	
	50 kHz	6.5 µV/V	
	100 kHz	9.4 µV/V	
	300 kHz	20 µV/V	
	500 kHz	27 µV/V	
	800 kHz	33 µV/V	
	1 MHz	42 µV/V	
	10 V		
	10 Hz	26 µV/V	
	20 Hz	15 µV/V	
	40 Hz	5.5 µV/V	
	100 Hz	6.3 µV/V	
	1 kHz	5.9 µV/V	
	10 kHz	5.5 µV/V	
	20 kHz	5.6 µV/V	
	50 kHz	7.3 µV/V	
	100 kHz	9.6 µV/V	
	300 kHz	20 µV/V	
	500 kHz	35 µV/V	
	800 kHz	56 µV/V	
	1 MHz	81 µV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	20 V		Fluke 792A AC/DC Transfer Standard
	10 Hz	37 µV/V	
	20 Hz	17 µV/V	
	40 Hz	8 µV/V	
	100 Hz	7.9 µV/V	
	1 kHz	7.7 µV/V	
	10 kHz	7.9 µV/V	
	20 kHz	7.8 µV/V	
	50 kHz	8.9 µV/V	
	100 kHz	12 µV/V	
	300 kHz	22 µV/V	
	500 kHz	28 µV/V	
	800 kHz	37 µV/V	
	1 MHz	55 µV/V	
	60 V		
	10 Hz	36 µV/V	
	20 Hz	17 µV/V	
	40 Hz	7.1 µV/V	
	100 Hz	6.9 µV/V	
	1 kHz	7.3 µV/V	
	10 kHz	7.0 µV/V	
	20 kHz	7.7 µV/V	
	50 kHz	15 µV/V	
	100 kHz	11 µV/V	
	300 kHz	33 µV/V	
	100 V		
	10 Hz	27 µV/V	
	20 Hz	15 µV/V	
	40 Hz	7.2 µV/V	
	100 Hz	6.9 µV/V	
	1 kHz	7 µV/V	
	10 kHz	7.1 µV/V	
	20 kHz	7.6 µV/V	
	50 kHz	12 µV/V	
	100 kHz	18 µV/V	
	200 V		
	10 Hz	44 µV/V	
	20 Hz	17 µV/V	
	40 Hz	10 µV/V	
	100 Hz	10 µV/V	
	1 kHz	9.7 µV/V	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure	200 V		Fluke 792A AC/DC Transfer Standard
	10 kHz	9.8 µV/V	
	20 kHz	10 µV/V	
	50 kHz	12 µV/V	
	100 kHz	19 µV/V	
	600 V		
	10 Hz	54 µV/V	
	20 Hz	29 µV/V	
	40 Hz	14 µV/V	
	100 Hz	15 µV/V	
	1 kHz	13 µV/V	
	10 kHz	18 µV/V	
	20 kHz	20 µV/V	
	50 kHz	32 µV/V	
	100 kHz	72 µV/V	
	1 000 V		
	10 Hz	54 µV/V	
	20 Hz	22 µV/V	
	40 Hz	13 µV/V	
	100 Hz	12 µV/V	
	1 kHz	13 µV/V	
	10 kHz	16 µV/V	
	20 kHz	22 µV/V	
	50 kHz	47 µV/V	
	100 kHz	67 µV/V	
Inductance – Measure [3]	1 µH		Agilent E4980A LCR Meter
	10 kHz	1.6 % of reading	
	100 kHz	0.36 % of reading	
	1 MHz	0.27 % of reading	
	2 MHz	0.66 % of reading	
	10 µH		
	10 kHz	0.37 % of reading	
	100 kHz	0.2 % of reading	
	1 MHz	0.2 % of reading	
	2 MHz	0.3 % of reading	
	100 µH		
	1 kHz	0.4 % of reading	
	10 kHz	0.2 % of reading	
	100 kHz	0.12 % of reading	
	1 MHz	0.14 % of reading	
	2 MHz	0.72 % of reading	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Measure [3]	1 mH		Agilent E4980A LCR Meter
	100 Hz	0.55 % of reading	
	1 kHz	0.18 % of reading	
	10 kHz	0.12 % of reading	
	100 kHz	0.092 % of reading	
	1 MHz	0.23 % of reading	
	2 MHz	0.88 % of reading	
	10 mH		
	20 Hz	0.85 % of reading	
	100 Hz	0.22 % of reading	
	1 kHz	0.092 % of reading	
	10 kHz	0.092 % of reading	
	100 kHz	0.1 % of reading	
	1 MHz	0.35 % of reading	
	2 MHz	1.3 % of reading	
	100 mH		
	20 Hz	0.28 % of reading	
	100 Hz	0.1 % of reading	
	1 kHz	0.092 % of reading	
	10 kHz	0.092 % of reading	
	100 kHz	0.21 % of reading	
	1 MHz	0.88 % of reading	
	1 H		
	20 Hz	0.16 % of reading	
	100 Hz	0.092 % of reading	
	1 kHz	0.092 % of reading	
	10 kHz	0.1 % of reading	
	100 kHz	0.31 % of reading	
	10 H		
	20 Hz	0.15 % of reading	
	100 Hz	0.092 % of reading	
	1 kHz	0.1 % of reading	
	10 kHz	0.21 % of reading	
	100 kHz	0.69 % of reading	
	100 H		
	20 Hz	0.15 % of reading	
	100 Hz	0.10 % of reading	
	1 kHz	0.15 % of reading	
	10 kHz	0.62 % of reading	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Harmonics – Source [1,3]			Fluke 6105A Electrical Power Quality Calibrator
Carrier Range: 0.25A	Up to 75 mA		
	(16 to 850) Hz	61 µA/A + 21 µA	
	850 Hz to 6.5 kHz	0.46 mA/A + 22 µA	
Carrier Range: 0.5A	Up to 0.15 A		
	(16 to 850) Hz	70 µA/A + 21 µA	
	850 Hz to 6.5 kHz	0.46 mA/A + 23 µA	
Carrier Range: 1 A	Up to 0.3 A		
	(16 to 850) Hz	70 µA/A + 29 µA	
	850 Hz to 6.5 kHz	0.46 mA/A + 29 µA	
Carrier Range: 2 A	Up to 0.6 A		
	(16 to 850) Hz	70 µA/A + 0.1 mA	
	850 Hz to 6.5 kHz	0.46 mA/A + 0.1 mA	
Carrier Range: 5 A	Up to 1.5 A		
	(16 to 850) Hz	70 µA/A + 0.1 mA	
	850 Hz to 6.5 kHz	0.46 mA/A + 0.1 mA	
Carrier Range: 10 A	Up to 3 A		
	(16 to 850) Hz	74 µA/A + 0.29 mA	
	850 Hz to 6.5 kHz	0.46 mA/A + 0.29 mA	
Carrier Range: 20 A	Up to 6 A		
	(16 to 850) Hz	75 µA/A + 0.45 mA	
	850 Hz to 6.5 kHz	0.46 mA/A + 0.45 mA	
AC Voltage Harmonics – Source [1,3]			Fluke 6105A Electrical Power Quality Calibrator
Carrier Range: 23 V	Up to 6.9 V		
	(16 to 850) Hz	58 µV/V + 1 mV	
	850 Hz to 6.5 kHz	0.52 mV + 1 mV	
Carrier Range: 90 V	Up to 90 V		
	(16 to 850) Hz	69 µV/V + 6 mV	
	850 Hz to 6.5 kHz	0.52 mV + 6 mV	
Carrier Range: 360 V	Up to 108 V		
	(16 to 850) Hz	69 µV/V + 13 mV	
	850 Hz to 6.5 kHz	0.52 mV + 13 mV	
Carrier Range: 650 V	Up to 195 V		
	(16 to 850) Hz	70 µV/V + 22 mV	
	850 Hz to 6.5 kHz	0.52 mV/V + 22 mV	
Carrier Range: 1 008 V	Up to 302 V		
	(16 to 850) Hz	70 µV/V + 33 mV	
	850 Hz to 6.5 kHz	0.52 mV/V + 33 mV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes [1,4]			
Amplitude – DC			
into 50 Ω load	(-5 to 5) V	0.023 % of reading + 19 µV	
into 1 MΩ load	(-200 to 200) V	0.023 % of reading + 19 µV	
Amplitude – Square Wave			
Rate: 10 Hz to 10 kHz			
into 50 Ω load	40 µVp-p to 1 mVp-p	0.78 % of reading + 7.8 µV	
	1 mVp-p to 5 Vp-p	0.078 % of reading + 7.8 µV	
into 1 MΩ load	40 µVp-p to 1 mVp-p	0.78 % of reading + 7.8 µV	
Rate: 10 Hz to 100 kHz			
into 50 Ω load	1 mVp-p to 5 Vp-p	0.16 % of reading + 7.8 µV	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
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	9.009 1 ns to 83 µs	0.19 µs/s	
Square Wave	83 µs to 55s	2.3 µs/s	
	450.5 ps to 9.009 ns	0.19 µs/s	
Sine Wave			
	900.91 ns to 83 µs	0.19 µs/s	
Pulse	83 µs to 55s	2.3 µs/s	
	900.91 ns to 83 µs	0.19 µs/s	
Triangle Wave	83 µs to 55s	2.3 µs/s	
Rise Time			
into 50 Ω load	5 mVp-p to 3 Vp-p		
Rate: 10 Hz to 2 MHz	500 ps (nominal)	290 ps	
	150 ps (nominal)	34 ps	
Rate: 10 Hz to 1 MHz	25 mVp-p to 2 Vp-p		
	70 ps (nominal)	21 ps	
	425 mVp-p to 575 mVp-p		
	25 ps (nominal)	5.7 ps	
	200 mVp-p		
	16 ps (nominal)	2.1 ps	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes [1,4]			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
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	0.39 % of reading	
	(40 to 90) Ω	0.083 % of reading	
	(90 to 150) Ω	0.39 % of reading	
	(50 to 800) kΩ	0.39 % of reading	
	(0.8 to 1.2) MΩ	0.083 % of reading	
	(1.2 to 12) MΩ	0.39 % of reading	
Input Capacitance Measure	(1 to 35) pF	1.6 % of reading + 0.19 pF	
	(35 to 95) pF	2.3 % of reading + 0.19 pF	
Bandwidth Flatness Measure [1] into VSWR (1.2:1) (wrt Reference Frequency)	5 mVp-p to 5 Vp-p		Fluke 9500B/3200 Oscilloscope Calibrator, Fluke 9530 3.2 GHz Active Head
	100 Hz to 300 MHz	1.6 % of reading	
	(300 to 550) MHz	1.9 % of reading	
	5 mVp-p to 3 Vp-p		
	550 MHz to 1.1 GHz	2.7 % of reading	
	(1.1 to 2.5) GHz	3.1 % of reading	
	5 mVp-p to 2 Vp-p		
	(2.5 to 3.2) GHz	3.1 % of reading	
Bandwidth Flatness Measure [1] into VSWR (1.2:1) (wrt Reference Frequency)	5 mVp-p to 5 Vp-p		Fluke 9500B/1100 Oscilloscope Calibrator, Fluke 9560 Active Head w/ 70 ps Capability
	100 Hz to 300 MHz	1.6 % of reading	
	(300 to 550) MHz	1.9 % of reading	
	5 mVp-p to 3 Vp-p		
	550 MHz to 1.1 GHz	2.3 % of reading	
	(1.1 to 2.5) GHz	2.3 % of reading	
	5 mVp-p to 2 Vp-p		
	(2.5 to 3.2) GHz	2.3 % of reading	
	25 mVp-p to 2 Vp-p		
	(3 to 6) GHz	3.1 % of reading	
Risetime – Source	≥ 14 ps	2.9 ps	Pulser System
Risetime – Measure	≤ 500 ps	2.5 ps	Agilent 83484A, 86100C Oscilloscope Mainframe

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	0.09 °C	
	(-90 to 0) °C	0.08 °C	
	(0 to 15) °C	0.08 °C	
	(15 to 890) °C	0.06 °C	
	(890 to 1 000) °C	0.07 °C	
	Type J		
	(-210 to -180) °C	0.15 °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	0.09 °C	
	(1 000 to 1 372) °C	0.1 °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		Ectron 1140A Thermocouple Calibrator/Simulator
	(-270 to -260) °C	5.4 °C	
	(-260 to -200) °C	1.5 °C	
	(-200 to -140) °C	0.29 °C	
	(-140 to -70) °C	0.18 °C	
	(-70 to 25) °C	0.14 °C	
	(25 to 160) °C	0.12 °C	
	(160 to 1 300) °C	0.11 °C	
	Type R		
	(-50 to -30) °C	0.8 °C	
	(-30 to 45) °C	0.69 °C	
	(45 to 160) °C	0.49 °C	
	(160 to 380) °C	0.35 °C	
	(380 to 775) °C	0.3 °C	
	(775 to 1 768) °C	0.26 °C	
	Type S		
	(-50 to -30) °C	0.76 °C	
	(-30 to 45) °C	0.68 °C	
	(45 to 105) °C	0.49 °C	
	(105 to 310) °C	0.41 °C	
	(310 to 615) °C	0.35 °C	
	(615 to 1 768) °C	0.31 °C	
	Type T		
	(-270 to -255) °C	1.9 °C	
	(-255 to -240) °C	0.6 °C	
	(-240 to -210) °C	0.36 °C	
	(-210 to -150) °C	0.22 °C	
	(-150 to -40) °C	0.15 °C	
	(-40 to 100) °C	0.09 °C	
	(100 to 400) °C	0.08 °C	
DC Power – Source [1,5]			Fluke 5520A Multiproduct Calibrator
(0.33 to 330) mA	11 µW to 330 µW	0.018 % of reading	
(0.33 to 3) A	11 W to 3 kW	0.017 % of reading	
(3 to 20.5) A	99 mW to 20.9 kW	0.054 % of reading	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source [1,5]			Fluke 5520A Multiproduct Calibrator
PF = 1			
3.3 mA to 3 A	(10 to 45) Hz 0.11 mW to 99 W	0.18 % of reading	
3.3 mA to 20.5 A	(45 to 65) Hz 0.11 mW to 20.9 kW	0.14 % of reading	
33 mA to 3 A	(65 to 500) Hz 11 mW to 3.06 kW	0.16 % of reading	
33 mA to 20.5 A	500 Hz to 1 kHz 11 mW to 20.9 kW	0.17 % of reading	
(3 to 20.5) A	(65 to 500) Hz 9.9 W to 20.9 kW	0.16 % of reading	
AC Power – Source [1,4]			Fluke 6105A Electrical Power Quality Calibrator
PF = 1			
(0.5 to 20) A	(16 to 850) Hz 23 W to 13 kW	0.024 % of reading	
Phase – Source [1]	(0 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 30) kHz	 0.11 ° 0.2 ° 0.39 ° 1.9 ° 3.9 ° 7.8 °	Fluke 5520A Multiproduct Calibrator
Phase – Source			Clark-Hess 5600 Phase Standard (equal amplitude)
5 V	(0 to 360) ° 1 Hz to 5 kHz (5 to 50) kHz (50 to 200) kHz	 0.004 ° 0.008 4 ° 0.033 °	
Phase – Source			Clark-Hess 5600 Phase Standard (ratio independent)
50 mV to 100 V	(0 to 360) ° 1 Hz to 1 kHz (1 to 5) kHz (5 to 50) kHz (50 to 200) kHz	 0.004 4 ° 0.007 7 ° 0.012 ° 0.028 °	
(100 to 120) V	1 Hz to 1 kHz (1 to 5) kHz (5 to 50) kHz (50 to 200) kHz	0.012 ° 0.024 ° 0.036 ° 0.094 °	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase – Measure	(0 to 360) ° 1 Hz to 10 kHz (10 to 50) kHz (50 to 100) kHz (100 to 200) kHz	 0.002 3 ° 0.002 7 ° 0.01 ° 0.012 °	Phase Verification Bridge Set (1:1)
ESD Simulators Rise Time Air Discharge Voltage (Positive and Negative) Peak Current Measure Delayed Current Measure	 Up to 2 ns Up to 25 kV (25 to 30) kV Up to 40 A Up to 40 A	 120 ps 1.2 % of reading + 2.3 V 1.2 % of reading + 23 V 6.8 % of reading 6.8 % of reading	Oscilloscope, IEC ESD Target, Electrostatic Voltmeter; IEC/EN 61000-4-2:2008, ISO 10605:2008
Dips and Interrupts – Measure	Ratio: (0 to 100) % (0 to 360) °	 1.3 % of reading	Agilent Infinity Oscilloscope
Electrical Fast Transients – Measure	(0.25 to 4) kV	2.6 % of reading	Agilent Infinity Oscilloscope, Haefely HV Attenuators
Harmonic Flicker – Measure	(100 to 230) V (50 to 400) Hz	3.6 % of reading	Tektronix TDS1012B Oscilloscope, Keysight DMM, CNS HFC-II Load, Ohms Lab CS100 Shunt
Surge – Measure (Open)	(0.25 to 4) kV	1.3 % of reading	Agilent Infinity Oscilloscope, Tektronix 6015A HV Probe
Surge – Measure (Short)	(0.25 to 4) kV	1.4 % of reading	Agilent Infinity Oscilloscope, Tegam RF Current Probe
Impulse – Source (60 dBu nominal)	Band A (10 to 150) kHz Band B 150 kHz to 30 MHz Band C & D 30 MHz to 1 GHz	 13 % of reading 13 % of reading 20 % of reading	Schwarzbeck IGLK 2914 High Power Pulse Generator

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure Rate: 50 Hz to 10 kHz 20 Hz to 10 kHz	(5 to 99) % Depth 150 kHz to 10 MHz	2.4 % Depth	HP 8902 Measuring Receiver
Amplitude Modulation – Measure 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	(> 0 to 99) % Depth 150 kHz 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	3.5 % Depth 1.4% Depth 3.5% Depth 1.9% Depth 3.5% Depth	HP 8902 Measuring Receiver
Frequency Modulation – Measure 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 8902 Measuring Receiver
Phase Modulation – Measure Rate: 200 Hz to 10 kHz Rate: 200 Hz to 20 kHz	< 40 Rad Deviation 250 kHz to 10 MHz < 40 Rad Deviation 10 MHz to 26.5 GHz	4.9 % Deviation 3.8 % Deviation	HP 8902 Measuring Receiver
RF Power – Measure (Noise Figure)	(-40 to 0) dB 10 MHz to 26.5 GHz	0.4 dB	Keysight E4440A Spectrum Analyzer w/ Opt 219 Personality Module, Keysight 346C Noise Source
RF Power – Transfer Measure	(-20 to 10) dBm 9 kHz to 18 GHz > 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-thru Standard Tegam 1830A Network Analyzer Calibration Kit

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 > 50 MHz to 4.2 GHz (> 4.2 GHz 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-thru Standard Tegam 1830A Network Analyzer Calibration Kit
Absolute RF Power – Measure	50 MHz 1 mW Reference	 4.3 µW	HP 478A Thermistor, Tegam 1830A RF Power Meter
Absolute RF Power – Measure [1]	(-35 to 20) dBm DC to 100 MHz > 100 MHz to 2.4 GHz (> 2.4 to 12.4) GHz (> 12.4 to 18) GHz (> 18 to 26.5) GHz (> 26.5 to 40) GHz (> 40 to 50) GHz	 0.08 dB 0.08 dB 0.09 dB 0.1 dB 0.11 dB 0.13 dB 0.17 dB	R&S® NRP50T Power Sensors; NRX Power Meter
Relative RF Power – Measure [8]	(-30 to 20) dBm DC to 50 GHz	 0.04 dB	R&S® NRP50T Power Sensors; NRX Power Meter
Tuned RF Power – Measure	30 MHz to 26.5 GHz (-114 to -78) dBm (-78 to -58) dBm (-58 to 0) dBm	 4.8 % of reading 4 % of reading 3.5 % of reading	Keysight E4440A Spectrum Analyzer, Agilent E4419B Power Meter, Keysight N5532A Power Sensor
Tuned Relative RF Power – Measure	30 MHz to 26.5 GHz (-114 to -78) dBm (-78 to -58) dBm (-58 to 0) dBm	 3.4 % of reading 2.3 % of reading 1.1 % of reading	Keysight E4440A Spectrum Analyzer, Agilent E4419B Power Meter, Keysight N5532A Power Sensor
Attenuation – Source	30 MHz 10 dB 20 dB 30 dB 40 dB 50 dB	 0.016 dB 0.023 dB 0.026 dB 0.026 dB 0.026 dB	Agilent 11812A Verification Kit

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sine Flatness (RF)	9 kHz to 6 GHz	0.073 dB	Agilent E4418B Power Meter, Agilent E9304A Power Sensor
Signal Source Phase Noise – Measure 1 MHz to 50 GHz	10 mHz ≤ offset ≤ 1 MHz 1 MHz ≤ offset ≤ 30 MHz offset > 30 MHz	1.6 dB 2 dB 3 dB	Rhode & Schwarz FSWP Phase Noise Analyzer
Spectral Analysis – Measure (Amplitude) (w/o pre-amp)	(-127 to 30) dBm 3 Hz to 3 GHz (3.0 to 6.6) GHz (6.6 to 13.2) GHz (13.2 to 22) GHz (22 to 26.5) GHz (26.5 to 40) GHz (33 to 50) GHz	 0.9 dB 1.1 dB 1.4 dB 1.4 dB 1.7 dB 3.6 dB 3.6 dB	Keysight E4440A Spectrum Analyzer, Keysight 11970A/11970Q Mixers
Thermal Noise – Source ENR	5 dB, 15 dB, or 21 dB 10 MHz 100 MHz 1 GHz 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz 7 GHz 8 GHz 9 GHz 10 GHz 11 GHz 12 GHz 13 GHz 14 GHz 15 GHz 16 GHz 17 GHz 18 GHz 19 GHz 20 GHz	 0.15 dB 0.14 dB 0.14 dB 0.15 dB 0.13 dB 0.13 dB 0.15 dB 0.14 dB 0.14 dB 0.14 dB 0.19 dB 0.18 dB 0.18 dB 0.18 dB 0.19 dB 0.19 dB 0.2 dB 0.2 dB 0.19 dB 0.2 dB 0.2 dB 0.21 dB	HP 346C Noise Source, Noise Test Set, Noise Figure Analyzer

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermal Noise – Source ENR	5 dB, 15 dB, or 21 dB 21 GHz 22 GHz 23 GHz 24 GHz 25 GHz 26 GHz 26.5 GHz	 0.2 dB 0.21 dB 0.24 dB 0.21 dB 0.2 dB 0.21 dB 0.21 dB	HP 346C Noise Source, Noise Test Set, Noise Figure Analyzer
Tuned RF Absolute Power – Measure [1]	2.5 MHz to 26.5 GHz (-127 to -120) dBm (-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	 0.26 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	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
RF Impedance – Measure	5 Hz to 3 GHz 1 Ω to 2 kΩ	 3 % of reading	Keysight E5061B Vector Network Analyzer
RF Current – Measure (Insertion Loss)	(-90 to 10) dB 10 kHz to 400 MHz	 2.9 dB	Keysight E5061B Vector Network Analyzer, FCC BCICF-1 Cal Fixture

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Current – Measure (Transfer Z)	(-90 to 10) dB 10 kHz to 400 MHz	2.2 dB	Keysight E5061B Vector Network Analyzer, FCC BCICF-1 Cal Fixture
Transmission Longitudinal Conversion Loss	(-90 to 10) dB 10 kHz to 100 MHz	5.6 % of reading	Schaffner BCS-1000 Bridge, Keysight E5061B Vector Network Analyzer
S-Parameter S11-S22 – Measure [6] (0 to 1) Lin Mag (BNC)	(-90 to 10) dB 10 Hz to 100 kHz 100 kHz to 10 MHz	 0.03 0.03	Agilent E5061B Vector Network Analyzer, Agilent 8550CK Calibration Kit
S-Parameter S11-S22 – Measure [6] (0 to 1) Lin Mag (7 mm)	(-90 to 10) dB 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz	 0.006 0.007 0.013	Agilent 8753ES Network Analyzer, Agilent 8550C Calibration Kit
S-Parameter S11-S22 – Measure [6] (0 to 1) Lin Mag (N-type)	(-90 to 10) dB (10 to 500) MHz 500 MHz to 2 GHz	 0.025 0.017	Agilent N5230A Network Analyzer, Agilent N4690C Ecal Calibration Kit
S-Parameter S11-S22 – Measure [6] (0 to 1) Lin Mag (3.5 mm)	(-90 to 10) dB (10 to 500) MHz 500 MHz to 2 GHz (2 to 26.5) GHz	 0.026 0.025 0.076	Agilent N5230A Network Analyzer, Agilent N4692C Ecal Calibration Kit
S-Parameter S11-S22 – Measure [6] (0 to 1) Lin Mag (2.9 mm)	(-90 to 10) dB (10 to 500) MHz 500 MHz to 2 GHz (2 to 26.5) GHz	 0.026 0.025 0.076	Agilent N5230A Network Analyzer, Agilent N4692C Ecal Calibration Kit
S-Parameter S11-S22 – Measure [6] (0 to 1) Lin Mag (2.4 mm)	(-90 to 10) dB 50 MHz to 50 GHz	 0.22	Agilent N5225A Microwave Network Analyzer, Agilent N4692C Ecal Calibration Kit

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
S-Parameter S21-S12 – Measure (BNC)	(-50 to 10) dB 10 Hz to 100 kHz 100 kHz to 10 MHz (10 to 500) MHz	 0.57 dB 0.37 dB 0.36 dB	Agilent E5061B Vector Network Analyzer, Agilent 8550CK Calibration Kit
S-Parameter S21-S12 – Measure (7 mm)	(-50 to 10) dB 300 kHz to 1.3 GHz (1.3 to 3) GHz	 0.24 dB 0.25 dB	Agilent 8753ES Network Analyzer, Agilent 85050C Calibration Kit
S-Parameter S21-S12 – Measure (N-type)	(-30 to 10) dB (10 to 500) MHz (-50 to 10) dB (10 to 500) MHz (-50 to 10) dB 500 MHz to 2 GHz (2 to 18) GHz	 0.43 dB 2.6 dB 0.17 dB 0.39 dB	Agilent N5230A Network Analyzer, Agilent N4690C Ecal Calibration Kit
S-Parameter S21-S12 – Measure (3.5 mm)	(-30 to 10) dB (10 to 500) MHz (-50 to 10) dB (10 to 500) MHz (-50 to 10) dB 500 MHz to 2 GHz (2 to 26.5) GHz	 0.5 dB 2.6 dB 0.28 dB 0.79 dB	Agilent N5230A Network Analyzer, Agilent N4692C Ecal Calibration Kit
S-Parameter S21-S12 – Measure (2.9 mm)	(-30 to 10) dB (10 to 500) MHz (-50 to 10) dB (10 to 500) MHz (-50 to 10) dB 500 MHz to 2 GHz (2 to 26.5) GHz (26.5 to 40) GHz	 0.49 dB 2.7 dB 0.28 dB 0.79 dB 0.82 dB	Agilent N5230A Network Analyzer, Agilent N4692C Ecal Calibration Kit
S-Parameter S21-S12 – Measure (2.4 mm)	(-30 to 10) dB (50 to 500) MHz (-50 to 10) dB (50 to 500) MHz (-50 to 10) dB 500 MHz to 2 GHz (2 to 26.5) GHz (26.5 to 50) GHz	 0.24 dB 0.93 dB 0.14 dB 0.56 dB 0.86 dB	Agilent N5225A Microwave Network Analyzer, Agilent 85056D Calibration Kit
Harmonic Distortion – Measure	20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.3 dB	Agilent 8903A Audio Analyzer

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Risetime – Measure	≤ 500 ps	2.5 ps	Agilent 83484A, 86100C Oscilloscope Mainframe
Total Harmonic Distortion CW, Modulation	5 Hz to 500 kHz 500 kHz to 1 MHz	18 % of reading + 0.13 % THD 29 % of reading + 0.7 % THD	Krohn-Hite 6900B Distortion Analyzer
Harmonic Distortion	100 kHz to 2.9 GHz (2.9 to 6.5) GHz (6.5 to 13.2) GHz (13.2 to 22) GHz (22 to 26.5) GHz	1.7 dB 1.9 dB 2.6 dB 2.9 dB 3.7 dB	Spectrum Analyzer

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle Measuring Devices Protractors, Inclinometers, Squares, Angle Gages [7]	0.005 6" to 5° (5 to 20)° (20 to 35)° (35 to 45)° (45 to 60)° (60 to 75)° (75 to 85)° 90°	1.9″ 2.8″ 4.5″ 6.1″ 10.3″ 22″ 67″ 2.8″	10 in Sine Bar, Gage Blocks Granite Master Square
Micrometers and Calipers [1,2] (Outside, Inside, Depth)	(0.05 to 1) in (1 to 9) in (9 to 15) in (15 to 40) in	(13 + 1*L*) µin (9 + 4*L*) µin (10 + 4*L*) µin (16 + 4*L*) µin	Comparison to Gage Blocks
Anvil Flatness [1]	Up to 1 in Diameter	4.5 µin	Optical Flats
Anvil Parallelism [1]	Up to 1 in	4.5 µin	Optical Parallels
Bore Gages [1,2]	(0.125 to 0.25) in (0.25 to 1) in (1 to 6) in	33 µin 33 µin (26 + 7*L*) µin	Characterized Rings
Dial Indicators [1,2]	Up to 1 (1 to 6) in	(10 + 2*L*) µin (5 + 5*L*) µin	Comparison to Gage Blocks
Length Single Axis [2] Outside Dimension	(0 to 1) in (1.0 to 7) in (7 to 21) in	(6 + 1*L*) µin (4.3 + 3.5*L*) µin (1 + 4*L*) µin	Universal Length Measuring Machine

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Length Single Axis Inside Dimension	(0.04 to 0.125) in (0.125 to 0.25) in (0.25 to 1) in (1 to 2.5) in (2.5 to 10) in (10 to 14) in	(9 + 1*L*) µin (9 + 1*L*) µin (9 + 1*L*) µin (10 + 3*L*) µin (14 + 3*L*) µin (23 + 3*L*) µin	Universal Length Measuring Machine
Height Gages [1,2]	Up to 1 in (1 to 9) in (9 to 15) in (15 to 40) in	(13 + 1*L*) µin (9 + 4*L*) µin (10 + 4*L*) µin (14 + 4*L*) µin	Comparison to Gage Blocks
Thread Wires	2 TPI to 120 TPI (0.008 to 0.5) in	12 µin	Universal Length Measuring Machine
Cylindrical Plug Gages [2] Outside Diameter	Up to 1 in (1 to 7) in	12 µin (10 + 3*L*) µin	Universal Length Measuring Machine
Cylindrical Ring Gages [2] Inside Diameter	(0.04 to 0.125) in (0.125 to 0.25) in (0.25 to 1) in (1 to 2.5) in (2.5 to 10) in (10 to 14) in	(9 + 3*L*) µin (9 + 3*L*) µin (9 + 3*L*) µin (9 + 3*L*) µin (14 + 3*L*) µin (25 + 3*L*) µin	Universal Length Measuring Machine, Working Reference Rings
Pin Gages Outside Diameter	(0.004 to 0.5) in (0.5 to 1) in	53 µin 53 µin	Laser Micrometer
Step Height	Up to 1 in	32 µin	Gage Amplifier, Probe, Gage Blocks
Thread Plug Gages [2] Pitch Diameter 60° Thread Major Diameter	Up to 1 in (1 to 4) in (4 to 7) in Up to 1 in (1 to 7) in	79 µin 80 µin 83 µin 13 µin (10 + 3*L*) µin	Universal Length Measuring Machine, Thread Wires
Tapered Thread Plug Gage Pitch Diameter Standoff	Up to 3 in Up to 1 in	90 µin 31 µin	Universal Length Measuring Machine Gage Blocks, Amplifier

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Ring Gages Inner Pitch Diameter	Up to 1 in (1 to 4) in (4 to 7) in	79 µin 80 µin 83 µin	Master Plug Uncertainty

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass Determination (Metric)	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g	64 µg 64 µg 97 µg 84 µg 73 µg 64 µg 65 µg 76 µg 78 µg 83 µg 0.16 mg 0.13 mg 0.14 mg 0.16 mg 0.11 mg 0.35 mg 0.39 mg 1 mg	Echelon III
Mass Determination (Metric)	1 kg 2 kg 4 kg 5 kg 6 kg 7 kg 8 kg 16 kg 32 kg	1.6 mg 10 mg 12 mg 13 mg 15 mg 16 mg 18 mg 98 mg 0.21 g	Echelon III

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Balances and Scales [1,7]	Up to 1 g (1 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g (500 to 1) kg (1 to 2) kg (2 to 4) kg (4 to 5) kg (5 to 6) kg (6 to 7) kg	76 µg 0.15 mg 0.35 mg 0.56 mg 1 mg 1.6 mg 10 mg 12 mg 13 mg 15 mg 16 mg	ASTM E617 Class 1 & Class 2 weights and internal calibration procedure utilized in the calibration of the weighing system.
Balances and Scales [1,7]	(7 to 8) kg (8 to 16) kg (16 to 32) kg (32 to 64) kg (64 to 114) kg	18 mg 98 mg 0.21 g 0.45 g 0.6 g	ASTM E617 Class 1 & Class 2 weights and internal calibration procedure utilized in the calibration of the weighing system.
Force Measuring Instruments (Tension Only)	Up to 2 lbf (2 to 5) lbf (5 to 10) lbf (10 to 20) lbf (20 to 50) lbf (50 to 100) lbf (100 to 200) lbf (200 to 300) lbf	0.0013 lbf 0.002 lbf 0.004 lbf 0.011 lbf 0.042 lbf 0.06 lbf 0.078 lbf 0.11 lbf	NIST Class F Weights, Hangers
Wire Crimpers/Dies Pull Test Crimp Height Die Diameter	 Up to 200 lbf Up to 0.8 in (0.011 to 0.5) in	 0.51 lbf 180 µin 0.001 2 in	 Mark 10 Pull Tester Mitutoyo 342-371-30 Class Z Pin Gauge Set
Pneumatic Absolute Pressure Devices	(0.2 to 1.45) psia (0.2 to 100) psia (0.2 to 1 000) psia	0.001 7 % of reading + 0.000 29 psi 0.001 7 % of reading + 0.000 29 psi 0.001 9 % of reading	Ruska 2465 Gas Piston Gauge
Pneumatic Absolute Pressure Devices	(1.45 to 50) psia (50 to 1 000) psia	0.001 7 % of reading + 0.000 014 psi 0.002 2 % of reading	DHI FPG 7601 Absolute Piston Gauge
Pneumatic Pressure Devices	(-14.7 to -0.2) psig (0.2 to 100) psig (100 to 1 000) psig	0.001 7 % of reading + 0.000 008 psi 0.001 7 % of reading + 0.000 008 psi 0.001 9 % of reading	Ruska 2465 Gas Piston Gauge
Pneumatic Pressure Devices	(-60 to 60) inH_2O	0.002 9 % of reading	DHI FPG 7601 Absolute Piston Gauge

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Hydraulic Pressure Devices	(72.5 to 7 250) psig (200 to 20 000) psig (20 000 to 72 500) psig	0.002 % of reading + 0.002 9 psi 0.003 % of reading + 0.007 3 psi 0.006 % of reading + 0.015 psi	DHI PG7000 Piston Gauge
Determination of Piston Area	(0.2 to 100) psi (100 to 1 000) psi	0.001 1% of reading 0.001 7 % of reading	Ruska 2465 Gas Piston Gauge
Determination of Piston Area	(72.5 to 7 250) psig (200 to 20 000) psig (20 000 to 72 500) psig	0.001 7 % of reading 0.002 6 % of reading 0.005 1 % of reading	DHI PG7000 Piston Gauge (Gas to 6 000 psi)
Hydraulic Pressure Devices [1]	(00 to 16 200) psig	0.001 % of reading	Hydraulic Deadweight Tester
Pneumatic Absolute Pressure – Source	(0.000 27 to 0.005 1) Pa (0.000 7 to 0.027) Pa	22 % of reading 8 % of reading	Ion Gauge
	(0.028 to 2 500) Pa	0.05 % of reading + 0.07 Pa	Capacitive Diaphragm Gauge
Gas Flow Devices	(1 to 10) sccm	0.22 % of reading + 0.004 2 sccm	Fluke Molbloc 1E1 Mass Flow Calibration System
	(0 to 20) sccm (20 to 200) sccm	0.05 sccm 0.25 % of reading + 0.001 7 sccm	Fluke Molbloc 1E2 Mass Flow Calibration System
	(0 to 0.2) slpm (0.2 to 2) slpm	0.000 5 slpm 0.25 % of reading + 0.000 02 slpm	Fluke Molbloc 1E3 Mass Flow Calibration System
	(0 to 2) slpm (2 to 20) slpm	0.005 slpm 0.25 % of reading + 0.001 6 slpm	Fluke Molbloc 1E4 Mass Flow Calibration System
	(0 to 5) slpm (5 to 50) slpm	0.017 slpm 0.34 % of reading	Fluke Molbloc 3E4 Mass Flow Calibration System
	(50 to 100) slpm	0.48 % of reading	(2) Fluke Molblocs 3E4 Mass Flow Calibration System
Torque Driver, Torque Wrenches [1]	15 lbf·oz to 400 lbf·in (15 to 200) lbf·oz (4 to 50) lbf·in (30 to 400) lbf·in (80 to 1 000) lbf·in (20 to 250) lbf·ft (60 to 600) lbf·ft	1.15 % of reading 0.68 % of reading 0.46 % of reading 0.46 % of reading 0.46 % of reading 0.46 % of reading 0.48 % of reading	CDI Torque System

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity – Measure [1]	(-40 to 10) °C (10 to 90) %RH (90 to 99) %RH (10 to 30) °C (10 to 90) %RH (90 to 99) %RH (30 to 180) °C (10 to 90) %RH (90 to 99) %RH	 3.5 % RH 4.6 % RH 1.3 % RH 2.4 % RH 3.5 % RH 4.6 % RH	Master Thermohygrometer
Humidity Measuring Instruments	(-10 to 15) °C (10 to 75) %RH (75 to 95) %RH (15 to 35) °C (10 to 95) %RH (35 to 70) °C (10 to 50) %RH (50 to 70) %RH (70 to 95) %RH	 0.5 %RH 0.65 %RH 0.5 %RH 0.5 %RH 0.7 %RH 0.85 %RH	Thunder Scientific 2900 Two-Pressure Humidity Generator
Humidity Measuring Instruments [1]	(5 to 40) °C (10 to 95) %RH	 2.1 %RH	HygroCal 100 Humidity Calibrator, BioMerieux 416045 Humidity Sensor
Temperature Measuring Instruments	(-20 to 100) °C (100 to 300) °C (300 to 420) ° (420 to 660) °C	0.019 °C 0.039 °C 0.41 °C 0.59 °C	Metrology Wells, SPRT, Super Thermometer
Temperature – Measure [1]	(-195 to 0) ºC (0 to 160) °C (160 to 420) ° (420 to 660) °C	0.015 ºC 0.015 ºC 0.02 ºC 0.032 °C	SPRT, Super Thermometer
Temperature – Measure [1]	(660 to 1 000) °C	8.7 °C	Type K Thermocouple Probe w/ Reader
Infrared Temperature Measuring Devices [1]	(-15 to 0) °C (0 to 50) °C (50 to 100) °C (100 to 120) °C (120 to 200) °C (200 to 350) °C (350 to 500) °C	0.8 °C 0.65 °C 0.7 °C 0.76 °C 0.95 °C 1.6 °C 2.1 °C	Black Body Source (Flat Plate) ε = (0.9 to 1), λ = (8 to 14) µm
Isothermal Block Verification [1]	Ambient (~ 23 °C)	0.02 °C	Thermocouple Half Junction

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source/Measure [8]	10 MHz	3.7 pHz/Hz	Fluke 910R GPS Frequency Standard
Non-contact Rate of Rotation [1,2]	(5 to 100) rpm (100 to 1 000) rpm (1 000 to 10 000) rpm (10 000 to 100 000) rpm (100 000 to 200 000) rpm	0.012 % of reading + 0.001 2 rpm 0.012 % of reading + 0.012 rpm 0.012 % of reading + 0.12 rpm 0.014 % of reading + 1.2 rpm 0.014 % of reading + 12 rpm	Comparison to Master Non-contact/Laser Tachometer
Frequency – Measure	1 Hz to 10 kHz 10 kHz to 10 MHz (10 to 225) MHz 225 MHz to 50 GHz	19 pHz/Hz + 4.5 µHz 19 pHz/Hz + 18 µHz 19 pHz/Hz + 0.64 mHz 0.21 µHz/Hz + 0.12 Hz	Agilent 53132A Universal Counter, Fluke 910R GPS Frequency Standard, Keysight PSA E4440A Spectrum Analyzer
Period – Measure	(1 to 100) s	45 µs	Agilent 53132A Universal Counter, Fluke 910R GPS Frequency Standard
Stopwatches, Timers	Up to 19.99 s/d	58 ms/d	Helmut Klein/Vibrograf TM-4500 Timometer
AC Duty Cycle – Source [1] Square Wave < 3.3 Vp-p Freq: 10 mHz to 100 kHz	10 µs to 100 s (1 to 10) % Duty Cycle (10 to 49) % Duty Cycle 50 % Duty Cycle (51 to 90) % Duty Cycle (90 to 99) % Duty Cycle	 0.039 % of reading + 78 ns 0.62 % of reading + 78 ns 0.001 6 % of reading + 78 ns 0.62 % of reading + 78 ns 0.039 % of reading + 78 ns	Fluke 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; ″ = arc-second; rpm = revolutions per minute.
3. As frequency & amplitude deviate from the listed values, uncertainty may be higher than stated. If needed, contact laboratory for more information regarding uncertainties at frequency and range combinations other than the ones shown.
4. The stated uncertainty is the laboratory's ability to source a fast rise pulse that is approximately 500 ps, 125 ps, and 25 ps. In the typical application of measuring rise time of an oscilloscope, this value is one of the contributing factors, but other factors are derived from the DUT. The known source rise time is mathematically removed from the total measured rise time measured on the DUT.
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. This parameter is a unitless measurement.

7. The CMC for scales and balances is highly dependent upon the resolution of the unit under test. The CMC presented here does not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
8. Uncertainty values of derivatives of 10 MHz will differ due to resolution, noise, and gating errors.
9. The legal entity for this location is Transcat, Inc.
10. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2489.02. The legal entity name of the client is Transcat, Inc.

Jason Stine, Vice President