CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Techmaster Electronics, Inc.
1070 Joshua Way
Vista, CA 92081
(and satellite locations as listed on the scope)

Fulfills the requirements of

ISO/IEC 17025:2017

and national standard

ANSI/NCSL Z540-1-1994 (R2002)

In the field of

CALIBRATION, DIMENSIONAL MEASUREMENT AND TESTING

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: 29 October 2026

Certificate Number: AC-1736

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)

Techmaster Electronics, Inc.

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CALIBRATION, DIMENSIONAL MEASUREMENT AND TESTING

ISO/IEC 17025 Accreditation Granted: **29 October 2024**

Certificate Number: **AC-1736** Certificate Expiry Date: **29 October 2026**

Satellite Locations in:

Techmaster Electronics, Inc.
1070 Joshua Way
Vista, CA 92081

Techmaster Electronics, Inc.
2225 Martin Ave, Suite I
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Techmaster Electronics, Inc.
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Techmaster Electronics, Inc.
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Services performed at main site laboratory

Techmaster Electronics, Inc.
1070 Joshua Way
Vista, CA 92081

CALIBRATION

Acoustics and Vibration Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meters	(94, 114) dB 1 kHz	0.28 dB	Sound Calibrator

Chemical Quantities Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH – Source [6]	4.01 pH 7.00 PH 10.00 pH	0.017 pH 0.018 pH 0.031 pH	Comparison to Standard Solutions
Conductivity – Source [6]	100 µS/cm 500 µS/cm 1 400 µS/cm 10 000 µS/cm	1.4 µS/cm 6.2 µS/cm 17 µS/cm 120 µS/cm	Comparison to Standard Solutions

Electrical – DC/Low Frequency Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source [1]	Up to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V 220 V to 1.1 kV	6.8 µV/V + 0.48 µV 4.6 µV/V + 0.8 µV 3.2 µV/V + 3.2 µV 2.4 µV/V + 27 µV 4.7 µV/V + 43 µV 6 µV/V + 0.85 mV	Comparison to High Performance Multifunction Calibrator
DC Voltage – Source [1] Fixed Points	1 V 1.018 V 10 V	14 µV 17 µV 35 µV	Comparison to DC Reference Standard

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Electrical – DC/Low Frequency Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Measure [1]	(Up to 200) mV 200 mV to 2 V (2 to 20) V (20 to 200) V 200 V to 1 kV	6.7 µV/V + 0.2 µV 4.3 µV/V + 0.5 µV 4.3 µV/V + 4.8 µV 6.7 µV/V + 98 µV 6.7 µV + 0.63 mV	Comparison to Precision 8.5 Digit Multimeter
DC High Voltage – Measure [1]	Up to 10 kV (10 to 100) kV	0.35 mV/V + 0.09 V 0.63 mV/V + 4.1 V	Comparison to High Voltage Meter
DC Current – Source [1]	Up to 220 µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A	0.003 7 % of reading + 5.8 nA 0.003 1 % of reading + 7.4 nA 0.003 1 % of reading + 44 nA 0.004 % of reading + 0.69 µA 72 µA/A + 14 µA 0.023 % of reading + 0.47 mA	Comparison to High Performance Multifunction Calibrator w/ Transconductance Amplifier
DC Current – Source [1]	330 mA to 1.1 A (1.1 to 3) A (3 to 11) A (11 to 20) A	0.15 mA/A + 44 µA 0.27 mA/A + 0.13 mA 0.39 mA/A + 0.41 mA 0.79 mA/A + 0.41 mA	Comparison to Multi Product Calibrator
DC Current – Source [1] Clamp-On Meters	(10 to 16.5) A (16.5 to 150) A (150 to 1 025) A	0.5 % of reading + 0.55 A 0.5 % of reading + 0.57 A 0.5 % of reading + 0.74 A	Comparison to Multi Product Calibrator w/ Current Coil
DC Power – Source [1] 33 mV to 1 020 V 329.99 mA range 2.9999 A range 20.5 A range	 10 µW to 330 W 10 mW to 3 kW 100 mW to 21 kW	 0.01 % of reading + 1.2 nW 0.04 % of reading 0.1 % of reading	Comparison to Multi Product Calibrator
DC Power – Measure [1]	Up to 10 W (>10 to 15) W (>15 to 100) W (>100 to 150) W	0.043% of reading + 0.074 W 0.043 % of reading + 0.015 W 0.043 % of reading + 0.098 W 0.043 % of reading + 0.15 W	Comparison to Precision Power Analyzer
DC Current – Measure [1]	Up to 200 µA (200 µA to 2) mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A	15 µA/A + 0.49 nA 15 µA/A + 4.8 nA 17 µA/A + 48 nA 59 µA/A + 0.96 µA 0.23 mA/A + 25 µA 0.49 mA/A + 0.36 mA	Comparison to Precision 8.5 Digit Multimeter
DC Current – Measure [1]	(1 to 100) A (100 to 600) A (600 to 1 000) A	85 µA/A 127 µA/A 0.29 % of reading + 0.02 A	Indirect Method Precision 8.5 Digit Multimeter w/ Current Shunts

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Electrical – DC/Low Frequency Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	(1 to 2.2) mV		Comparison to High Performance Multifunction Calibrator w/ Transconductance Amplifier
	(10 to 20) Hz	0.013 % of reading + 7.2 µV	
	(20 to 40) Hz	0.008 3 % of reading + 4.2 µV	
	40 Hz to 20 kHz	0.007 2 % of reading + 4.2 µV	
	(20 to 50) kHz	0.016 % of reading + 4.6 µV	
	(50 to 100) kHz	0.042 % of reading + 5.3 µV	
	(100 to 300) kHz	0.095 % of reading + 10 µV	
	(300 to 500) kHz	0.13 % of reading + 20 µV	
	500 kHz to 1 MHz	0.25 % of reading + 21 µV	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.021 % of reading + 4.9 µV	
	(20 to 40) Hz	0.008 3 % of reading + 4.3 µV	
	40 Hz to 20 kHz	0.007 % of reading + 4.4 µV	
	(20 to 50) kHz	0.017 % of reading + 4.8 µV	
	(50 to 100) kHz	0.042 % of reading + 6.1 µV	
	(100 to 300) kHz	0.092 % of reading + 12 µV	
	(300 to 500) kHz	0.13 % of reading + 22 µV	
	500 kHz to 1 MHz	0.22 % of reading + 33 µV	
	(22 to 220) mV		
	(10 to 20) Hz	0.022 % of reading + 16 µV	
	(20 to 40) Hz	0.006 4 % of reading + 15 µV	
	40 Hz to 20 kHz	0.004 4 % of reading + 10 µV	
	(20 to 50) kHz	0.009 % of reading + 14 µV	
	(50 to 100) kHz	0.028 % of reading + 23 µV	
	(100 to 300) kHz	0.056 % of reading + 35 µV	
	(300 to 500) kHz	0.13 % of reading + 39 µV	
	500 kHz to 1 MHz	0.23 % of reading + 0.12 mV	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.021 % of reading + 0.1 mV	
	(20 to 40) Hz	82 µV/V + 32 µV	
	40 Hz to 20 kHz	39 µV/V + 22 µV	
	(20 to 50) kHz	44 µV/V + 62 µV	
	(50 to 100) kHz	71 µV/V + 55 µV	
	(100 to 300) kHz	0.3 mV/V + 0.12 mV	
	(300 to 500) kHz	0.89 mV/V + 0.3 mV	
	500 kHz to 1 MHz	1.5 mV/V + 0.6 mV	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	(2.2 to 22) V		Comparison to High Performance Multifunction Calibrator w/ Transconductance Amplifier
	(10 to 20) Hz	0.2 mV/V + 1.1 mV	
	(20 to 40) Hz	68 µV/V + 0.63 mV	
	40 Hz to 20 kHz	19 µV/V + 0.7 mV	
	(20 to 50) kHz	44 µV/V + 0.61 mV	
	(50 to 100) kHz	0.006 1 % of reading + 0.65 mV	
	(100 to 300) kHz	0.19 mV/V + 1.9 mV	
	(300 to 500) kHz	0.9 mV/V + 2.8 mV	
	500 kHz to 1 MHz	1.1 mV/V + 11 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.2 mV/V + 11 mV	
	(20 to 40) Hz	44 µV/V + 17 mV	
	40 Hz to 20 kHz	38 µV/V + 4.1 mV	
	(20 to 50) kHz	53 µV/V + 8 mV	
	(50 to 100) kHz	0.11 mV/V + 10 mV	
	(100 to 300) kHz	0.84 mV/V + 19 mV	
	(300 to 500) kHz	4.2 mV/V + 45 mV	
	500 kHz to 1 MHz	7.7 mV/V + 90 mV	
	(220 to 1 100) V		
	40 Hz to 1 kHz	50 µV/V + 27 mV	
	(1 to 20) kHz	0.1 mV/V + 31 mV	
	(20 to 30) kHz	0.41 mV/V + 70 mV	
	(220 to 750) V		
	(30 to 50) kHz	0.45 mV/V + 12 mV	
	(50 to 100) kHz	1.8 mV/V + 21 mV	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	Up to 200 mV		Comparison to Precision 8.5 Digit Multimeter
	(1 to 10) Hz	0.2 mV/V + 29µV	
	(10 to 40) Hz	0.17 mV/V + 5 µV	
	(40 to 100) Hz	0.14 mV/V + 5 µV	
	100 Hz to 2 kHz	0.17 mV/V + 2 µV	
	(2 to 10) kHz	0.17 mV/V + 5 µV	
	(10 to 30) kHz	0.42 mV/V + 10 µV	
	(30 to 100) kHz	0.93 mV/V + 24 µV	
	200 mV to 2 V		
	(1 to 10) Hz	0.19 mV/V + 0.33 mV	
	(10 to 40) Hz	0.15 mV/V + 3 µV	
	(40 to 100) Hz	0.12 mV/V + 24 µV	
	100 Hz to 2 kHz	0.17 mV/V + 24 µV	
	(2 to 10) kHz	0.14 mV/V + 24 µV	
	(10 to 30) kHz	0.27 mV/V + 48 µV	
	(30 to 100) kHz	0.7 mV/V + 0.24 mV	
	(2 to 20) V		
	(1 to 10) Hz	0.18 mV/V + 3.3 mV	
	(10 to 40) Hz	0.14 mV/V + 0.3 mV	
	(40 to 100) Hz	0.11 mV/V + 0.24 mV	
	100 Hz to 2 kHz	0.15 mV/V + 0.24 mV	
	(2 to 10) kHz	0.14 mV/V + 0.24 mV	
	(10 to 30) kHz	0.27 mV/V + 0.48 mV	
	(30 to 100) kHz	0.69 mV/V + 2.4 mV	
	(100 to 300) kHz	3.6 mV/V + 24 mV	
	300 kHz to 1 MHz	12 mV/V + 0.24 mV	
	(20 to 200) V		
	1 to 10 Hz	0.19 mV/V + 58 mV	
	(10 to 40) Hz	0.15 mV/V + 2.7 mV	
	(40 to 100) Hz	0.12 mV/V + 2.4 mV	
	100 Hz to 2 kHz	0.15 mV/V + 2.4 mV	
	(2 to 10) kHz	0.14 mV/V + 2.4 mV	
	(10 to 30) kHz	0.27 mV/V + 4.8 mV	
	(30 to 100) kHz	0.69 mV/V + 24 mV	
	(100 to 300) kHz	3.6 mV/V + 0.24 mV	
	300 kHz to 1 MHz	12 mV/V + 2.4 V	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	200 V to 1 kV (1 to 10) Hz (10 to 40) Hz 40 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	 0.19 mV/V + 84 mV 0.16 mV/V + 24 mV 0.29 mV/V + 24 mV 0.28 mV/V + 48 mV 0.72 mV/V + 0.24 V	Comparison to Precision 8.5 Digit Multimeter
AC High Voltage - Measure [1]	Up to 10 kV (30 to 200) Hz (200 to 450) Hz (450 to 600) Hz (10 to 100) kV (30 to 70) Hz (70 to 200) Hz	 1.4 mV/V + 0.14 V 4.6 mV/V + 0.14V 8.7 mV/V + 0.14V 1.4 mV/V + 0.7 V 17 % of reading + 0.7 V	Comparison to High Voltage Meter
AC Voltage Flatness - Source [1] (Referenced to 1 kHz)	0.3 mV to 3.5 V (10 to 30) Hz 30 Hz to 120 kHz (0.3 to 1.1) mV 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (1.1 to 3) mV 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz 3 mV to 3.5 V 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	 0.35 % of reading 0.12 % of reading 0.24 % of reading + 3 µV 0.47 % of reading + 3 µV 0.7 % of reading + 3 µV 1.8 % of reading + 15 µV 0.12 % of reading + 3 µV 0.35 % of reading + 3 µV 0.58 % of reading + 3 µV 1.8 % of reading + 3 µV 0.12 % of reading + 3 µV 0.24 % of reading + 3 µV 0.47 % of reading + 3 µV 1.2 % of reading + 3 µV	Comparison to High Performance Multifunction Calibrator (Wideband)

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Electrical – DC/Low Frequency Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness – Measure [1]	Up to 3 V (10 to 100) Hz 100 Hz to 10 kHz (10 to 30) kHz 30 kHz to 1 MHz (1 to 10) MHz (10 to 30) MHz (30 to 50) MHz (50 to 70) MHz (70 to 80) MHz (80 to 100) MHz	 0.2 % of reading 0.051% of reading 0.059 % of reading 0.13 % of reading 0.21% of reading 0.26% of reading 0.42 % of reading 0.65 % of reading 0.77% of reading 0.97 % of reading	Indirect Method Precision 8.5 Digit Multimeter w/ Thermal Converters

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	Up to 2.2 mV		Comparison to AC Measurement Standard
	(10 to 20) Hz	1.6 mV/V + 1.6 µV	
	(20 to 40) Hz	1.6 mV/V + 1.6 µV	
	40 Hz to 20 kHz	0.4 mV/V + 1.7 µV	
	(20 to 50) kHz	0.8 mV/V + 2.2 µV	
	(50 to 100) kHz	1.2 mV/V + 2.7 µV	
	(100 to 300) kHz	2.3 mV/V + 4.1 µV	
	(300 to 500) kHz	2.4 mV/V + 8.1 µV	
	500 kHz to 1 MHz	3.5 mV/V + 8.1 µV	
	(2.2 to 7) mV		
	(10 to 20) Hz	0.8 mV/V + 1.4 µV	
	(20 to 40) Hz	0.4 mV/V + 1.5 µV	
	40 Hz to 20 kHz	0.2 mV/V + 1.5 µV	
	(20 to 50) kHz	0.4 mV/V + 2.1 µV	
	(50 to 100) kHz	0.6 mV/V + 2.6 µV	
	(100 to 300) kHz	1.2 mV/V + 4.1 µV	
	(300 to 500) kHz	1.3 mV/V + 6 µV	
	500 kHz to 1 MHz	2 mV/V + 6 µV	
	(7 to 22) mV		
	(10 to 20) Hz	0.3 mV/V + 1.6 µV	
	(20 to 40) Hz	0.3 mV/V + 1.6 µV	
	40 Hz to 20 kHz	0.1 mV/V + 1.7 µV	
	(20 to 50) kHz	0.2 mV/V + 2.3 µV	
	(50 to 100) kHz	0.3 mV/V + 2.7 µV	
	(100 to 300) kHz	0.8 mV/V + 4.1 µV	
	(300 to 500) kHz	0.9 mV/V + 6.1 µV	
	500 kHz to 1 MHz	1.4 mV/V + 6.1 µV	
	(22 to 70) mV		
	(10 to 20) Hz	2 mV/V + 5.3 µV	
	(20 to 40) Hz	80 µV/V + 6.3 µV	
	40 Hz to 20 kHz	40 µV/V + 6.8 µV	
	(20 to 50) kHz	0.1 mV/V + 6.4 µV	
	(50 to 100) kHz	0.23 mV/V + 5.8 µV	
	(100 to 300) kHz	0.5 mV/V + 6 µV	
	(300 to 500) kHz	0.7 mV/V + 9.4 µV	
	500 kHz to 1 MHz	1.1 mV/V + 9 µV	

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Electrical – DC/Low Frequency Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	(70 to 220) mV		Comparison to AC Measurement Standard
	(10 to 20) Hz	0.2 mV/V + 1.6 µV	
	(20 to 40) Hz	80 µV/V + 1.7 µV	
	40 Hz to 20 kHz	40 µV/V + 1.8 µV	
	(20 to 50) kHz	70 µV/V + 2.2 µV	
	(50 to 100) kHz	0.2 mV/V + 2.6 µV	
	(100 to 300) kHz	0.3 mV/V + 4.1 µV	
	(300 to 500) kHz	0.4 mV/V + 8 µV	
	500 kHz to 1 MHz	1 mV/V + 8 µV	
	(220 to 700) mV		
	(10 to 20) Hz	0.21 mV/V + 1.5 µV	
	(20 to 40) Hz	0.21 mV/V + 1.5 µV	
	40 Hz to 20 kHz	30 µV/V + 1.7 µV	
	(20 to 50) kHz	50 µV/V + 2.1 µV	
	(50 to 100) kHz	80 µV/V + 2.6 µV	
	(100 to 300) kHz	0.2 mV/V + 4 µV	
	(300 to 500) kHz	0.3 mV/V + 8 µV	
	500 kHz to 1 MHz	0.3 mV/V + 8 µV	
	700 mV to 2.2 V		
	(10 to 20) Hz	0.2 mV/V + 4.2 µV	
	(20 to 40) Hz	0.62 mV/V + 13 µV	
	40 Hz to 20 kHz	0.17 mV/V + 23 µV	
	(20 to 50) kHz	0.41 mV/V + 16 µV	
	(50 to 100) kHz	0.67 mV/V + 12 µV	
	(100 to 300) kHz	0.16 mV/V + 6 µV	
	(300 to 500) kHz	0.26 mV/V + 4 µV	
	500 kHz to 1 MHz	9 mV/V + 1.1 µV	
	(2.2 to 7) V		
	(10 to 20) Hz	0.2 mV/V + 1.1 µV	
	(20 to 40) Hz	0.7 mV/V + 3.2 µV	
	40 Hz to 20 kHz	0.23 mV/V + 8.4 µV	
	(20 to 50) kHz	0.5 mV/V + 4.4 µV	
	(50 to 100) kHz	0.8 mV/V + 2.7 µV	
	(100 to 300) kHz	0.19 mV/V + 1.1 µV	
	(300 to 500) kHz	0.4 mV/V + 0.5 µV	
	500 kHz to 1 MHz	1.2 mV/V + 0.2 µV	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	(7 to 22) V		Comparison to AC Measurement Standard
	(10 to 20) Hz	0.2 mV/V + 3.7 µV	
	(20 to 40) Hz	0.7 mV/V + 11 µV	
	40 Hz to 20 kHz	0.3 mV/V + 26 µV	
	(20 to 50) kHz	0.5 mV/V + 15 µV	
	(50 to 100) kHz	0.8 mV/V + 9.1 µV	
	(100 to 300) kHz	0.29 mV/V + 4 µV	
	(300 to 500) kHz	0.4 mV/V + 1.9 µV	
	500 kHz to 1 MHz	1.2 mV/V + 0.6 µV	
	(22 to 70) V		
	(10 to 20) Hz	0.2 mV/V + 9.1 µV	
	(20 to 40) Hz	70 µV/V + 27 µV	
	40 Hz to 20 kHz	30 µV/V + 55 µV	
	(20 to 50) kHz	60 µV/V + 32 µV	
	(50 to 100) kHz	90 µV/V + 19 µV	
	(100 to 300) kHz	0.2 mV/V + 9.1 µV	
	(300 to 500) kHz	0.4 mV/V + 4.4 µV	
	500 kHz to 1 MHz	1.2 mV/V + 1.5 µV	
	(70 to 220) V		
	(10 to 20) Hz	0.20 mV/V + 7.1 µV	
	(20 to 40) Hz	70 µV/V + 21 µV	
	40 Hz to 20 kHz	30 µV/V + 45 µV	
	(20 to 50) kHz	70 µV/V + 21 µV	
	(50 to 100) kHz	0.1 mV/V + 14 µV	
	(100 to 300) kHz	0.21 mV/V + 6.8 µV	
	(300 to 500) kHz	0.5 mV/V + 2.8 µV	
	(220 to 700) V		
	(10 to 20) Hz	0.2 mV/V + 77 µV	
	(20 to 40) Hz	0.1 mV/V + 0.16 mV	
	40 Hz to 20 kHz	40 µV/V + 0.37 mV	
	(20 to 50) kHz	0.13 mV/V + 0.12 mV	
	(50 to 100) kHz	0.5 mV/V + 31 µV	
	700 V to 1 kV		
	(10 to 20) Hz	0.2 mV/V + 31 µV	
	(20 to 40) Hz	0.1 mV/V + 62 µV	
	40 Hz to 20 kHz	40 µV/V + 0.16 mV	
	(20 to 50) kHz	0.13 mV/V + 47 µV	
	(50 to 100) kHz	0.5 mV/V + 12 µV	

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Electrical – DC/Low Frequency Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	Up to 10 mV		Comparison to Precision 8.5 Digit Multimeter AC BAND < 2 MHz
	(1 to 40) Hz	3.5 µV/V + 4.6 µV	
	40 Hz to 1 kHz	2.4 µV/V + 3.2 µV	
	(1 to 20) kHz	3.5 µV/V + 4.6 µV	
	(20 to 50) kHz	12 µV/V + 3.2 µV	
	(50 to 100) kHz	58 µV/V + 3.2 µV	
	(100 to 300) kHz	0.47 mV/V + 3.8 µV	
	(10 to 100) mV		
	(1 to 40) Hz	86 µV/V + 4.6 µV	
	40 Hz to 1 kHz	86 µV/V + 2.3 µV	
	(1 to 20) kHz	0.17 mV/V + 2.3 µV	
	(20 to 50) kHz	0.35 mV/V + 2.3 µV	
	(50 to 100) kHz	0.93 mV/V + 2.3 µV	
	(100 to 300) kHz	3.5 mV/V + 12 µV	
	300 kHz to 1 MHz	12 mV/V + 12 µV	
	(1 to 2) MHz	18 mV/V + 12 µV	
	100 mV to 1 V		
	(1 to 40) Hz	92 µV/V + 50 µV	
	40 Hz to 1 kHz	92 µV/V + 31 µV	
	(1 to 10) V		
	(1 to 20) kHz	0.17 mV/V + 31 µV	
	(20 to 50) kHz	0.35 mV/V + 31 µV	
	(50 to 100) kHz	0.93 mV/V + 31 µV	
	(100 to 300) kHz	3.5 mV/V + 0.12 mV	
	300 kHz to 1 MHz	12 mV/V + 0.12 mV	
	(1 to 2) MHz	18 mV/V + 0.12 mV	
	(10 to 100) V		
	(1 to 40) Hz	91 µV/V + 0.14 mV	
	40 Hz to 1 kHz	91 µV/V + 0.14 mV	
	(1 to 20) kHz	0.17 mV/V + 0.14 mV	
	(20 to 50) kHz	0.35 mV/V + 0.14 mV	
	(50 to 100) kHz	0.93 mV/V + 0.14 mV	
	(100 to 300) kHz	3.5 mV/V + 0.16 mV	
	300 kHz to 1 MHz	1.2 mV/V + 0.16 mV	
	(1 to 2) MHz	1.8 mV/V + 0.16 mV	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure [1]	(100 to 750) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	 0.45 mV/V + 2.7 mV 0.45 mV/V + 2.7 mV 0.45 mV/V + 2.7 mV 0.56 mV/V + 2.7 mV 1.5 mV/V + 2.7 mV 4.7 mV/V + 2.7 mV 18 mV/V + 2.7 mV	Comparison to Precision 8.5 Digit Multimeter AC BAND < 2 MHz
AC Voltage - Measure [1]	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz 11 mV to 10 V 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (11 to 100) V 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz (100 to 750) V 45 Hz to 100 kHz	 0.46 mV/V + 47 mV 0.46 mV/V + 24 mV 0.69 mV/V + 24 mV 1.4 mV/V + 24 mV 3.5 mV/V + 24 mV 1 mV/V + 7.5 µV 14 mV/V + 6.5 µV 81 mV/V + 8.6 µV 0.24 V + 9.7 µV 1 mV/V + 0.7 mV 24 mV/V + 0.58 mV 47 mV/V + 0.81 mV 47 mV/V + 0.93 mV 0.18 V + 1.2 mV 1.5 mV/V + 2.7 mV	Comparison to Precision 8.5 Digit Multimeter AC BAND > 2 MHz

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AC Current – Source [1]	(2.2 to 22) mA		Comparison to High Performance Multifunction Calibrator
	(10 to 20) Hz	0.003 4 % of reading + 20 µA	
	(20 to 40) Hz	0.002 5 % of reading + 12 µA	
	40 Hz to 1 kHz	0.007 2 % of reading + 0.95 µA	
	(1 to 5) kHz	0.015 % of reading + 1.5 µA	
	(5 to 10) kHz	0.1 % of reading + 5.1 µA	
	(22 to 220) mA		
	(10 to 20) Hz	0.004 6 % of reading + 0.15 mA	
	(20 to 40) Hz	0.003 5 % of reading + 85 µA	
	40 Hz to 1 kHz	0.006 2 % of reading + 12 µA	
	(1 to 5) kHz	0.014 % of reading + 16 µA	
	(5 to 10) kHz	0.089 % of reading + 38 µA	
	220 mA to 2.2 A		
	20 Hz to 1 kHz	0.18 mA/A + 0.17 mA	
	(1 to 5) kHz	0.32 mA/A + 0.27 mA	
	(5 to 10) kHz	5.1 mA/A + 2.8 mA	
	(2.2 to 11) A		
	40 Hz to 1 kHz	0.3 mA/A + 1.1 mA	
	(1 to 5) kHz	0.74 mA/A + 53 µA	
	(5 to 10) kHz	2.8 mA/A + 0.2 mA	
AC Current – Source [1]	(11 to 20) A		Comparison to Multi Product Calibrator
	(45 to 100) Hz	1.2 mA/A + 5 mA	
	100 Hz to 1kHz	1.5 mA/A + 5 mA	
	(1 to 5) kHz	30 mA/A + 5 mA	
AC Current – Source [1]	(9 to 220) µA		Comparison to High Performance Multifunction Calibrator
	(10 to 20) Hz	0.02 % of reading + 26 nA	
	(20 to 40) Hz	0.01 % of reading + 30 nA	
	40 Hz to 1 kHz	0.01 % of reading + 8.3 nA	
	(1 to 5) kHz	0.02 % of reading + 36 nA	
	(5 to 10) kHz	0.1 % of reading + 63 nA	
	220 µA to 2.2 mA		
	(10 to 20) Hz	0.004 8 % of reading + 1.4 µA	
	(20 to 40) Hz	0.006 1 % of reading + 0.44 µA	
	40 Hz to 1 kHz	0.007 2 % of reading + 95 nA	
	(1 to 5) kHz	0.016 % of reading + 0.18 µA	
	(5 to 10) kHz	0.1 % of reading + 0.65 µA	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source [1] Clamp-On Meters	(10 to 16.5) A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	 0.28 % of reading + 0.16 A 0.79 % of reading + 0.13 A 0.28 % of reading + 0.31 A 0.79 % of reading + 0.16 A 0.29 % of reading + 1.3 A 0.8 % of reading + 1.2 A	Comparison to Multi Product Calibrator w/ Current Coil
AC Power – Source [1] PF = 1 (10 to 45) Hz 33 mV to 32.9999 V (3.3 mA to 2.99999 A) (45 to 65) Hz 33 mV to 1020 V (3.3 mA to 20.5 A)	 110 µW to 99 W 110 µW to 21 kW	 0.19 % of reading 0.15 % of reading	Comparison to Multi Product Calibrator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Measure [1]	Up to 15 W (0.1 to 66) Hz 66 Hz to 1 kHz (> 15 to 30) W (0.1 to 66) Hz 66 Hz to 1 kHz (> 30 to 60) W (0.1 to 66) Hz 66 Hz to 1 kHz (> 60 to 100) W (0.1 to 66) Hz 66 Hz to 1 kHz (> 100 to 150) W (0.1 to 66) Hz 66 Hz to 1 kHz (> 150 to 300) W (0.1 to 66) Hz 66 Hz to 1 kHz (> 300 to 600) W (0.1 to 66) Hz 66 Hz to 1 kHz (> 600 to 1 000) W (0.1 to 66) Hz 66 Hz to 1 kHz (> 1 000 to 2 000) W (0.1 to 66) Hz 66 Hz to 1 kHz	 0.1 % of reading + 0.012 W 0.068 % of reading + 0.018 W 0.1 % of reading + 0.023 W 0.068 % of reading + 0.035 W 0.1 % of reading + 0.046 W 0.068 % of reading + 0.071 W 0.1 % of reading + 0.076 W 0.068 % of reading + 0.12 W 0.1 % of reading + 0.12 W 0.068 % of reading + 0.18 W 0.1 % of reading + 0.24 W 0.068 % of reading + 0.36 W 0.1 % of reading + 0.43 W 0.068 % of reading + 0.71 W 0.1 % of reading + 0.45 W 0.068 % of reading + 1.2 W 0.1 % of reading + 0.81 W 0.068 % of reading + 2.4 W	Comparison to Precision Power Analyzer
Phase – Source [1]	+/- 179.99 (ΔΦ°) (10 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	 0.09° 0.2° 0.39° 1.9° 3.9° 7.8°	Comparison to Multi Product Calibrator
Phase – Measure [1]	(0 to 360)° 10 Hz to 50 kHz (50 to 100) kHz	 0.084° 0.41°	Comparison to Phase Meter Vista, CA

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AC Current – Measure [1]	(1 to 10) A (3 to 5) Hz (5 to 10) Hz 10 Hz to 5 kHz (5 to 10) kHz (10 to 100) A (50 to 60) Hz (100 to 300) A (50 to 60) Hz	 20 mA/A + 6 mA 11 mA/A + 6 mA 1.5 mA/A + 6 mA 3.5 mA/A + 70 mA 0.6 A 0.8 A	Indirect Method Precision 8.5 Digit Multimeter / Shunts
AC Current – Measure [1]	Up to 200 µA 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz 200 µA to 2 mA 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (2 to 20) mA 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (20 to 200) mA 10 Hz to 10 kHz (10 to 30) kHz 200 mA to 2 A 10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (2 to 20) A 10 Hz to 2 kHz (2 to 10) kHz	 0.42 mA/A + 24 nA 0.88 mA/A + 24 nA 4.8 mA/A + 24 nA 0.36 mA/A + 0.24 µA 0.86 mA/A + 0.24 µA 4.8 mA/A + 0.24 µA 0.37 mA/A + 2.4 µA 0.86 mA/A + 2.4 µA 4.8 mA/A + 2.4 µA 0.35 mA/A + 24 µA 0.75 mA/A + 24 µA 0.75 mA/A + 0.25 mA 0.87 mA/A + 0.27 mA 3.6 mA/A + 0.26 mA 0.99 mA/A + 2.4 mA 3.1 mA/A + 2.4 mA	Comparison to Precision 8.5 Digit Multimeter
Resistance – Source [1]	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ	1.7 mΩ/Ω + 35 µΩ 23 µΩ/Ω + 3.3 mΩ 31 µΩ/Ω + 1.9 mΩ 32 µΩ/Ω + 2.8 mΩ 33 µΩ/Ω + 2.3 mΩ 32 µΩ/Ω + 30 mΩ 5 µΩ/Ω + 1.4 Ω 32 µΩ/Ω + 0.3 Ω 33 µΩ/Ω + 0.34 Ω	Comparison to Multi Product Calibrator

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Resistance – Source [1]	(110 to 330) kΩ 330 kΩ 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 330 MΩ to 1.1 GΩ	37 μΩ/Ω + 3.1 Ω 38 μΩ/Ω + 2.6 Ω 71 μΩ/Ω + 36 Ω 0.13 mΩ/Ω + 0.38 kΩ 0.22 mΩ/Ω + 7.4 kΩ 0.42 mΩ/Ω + 32 kΩ 3.6 mΩ/Ω + 0.12 MΩ 18 mΩ/Ω + 0.59 MΩ	Comparison to Multi Product Calibrator
Resistance – Source [1] Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	48 μΩ 0.15 mΩ 0.22 mΩ 0.28 mΩ 0.63 mΩ 1.2 mΩ 2.3 mΩ 7.8 mΩ 15 mΩ 77 mΩ 0.15 Ω 1 Ω 1.9 Ω 16 Ω 40 Ω 0.48 kΩ 1.1 kΩ 12 kΩ	Comparison to High Performance Multiproduct Calibrator
Resistance – Source [1] Fixed Points	0.1 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ	0.56 mΩ 0.29 mΩ 2.3 mΩ 1.8 mΩ 35 mΩ 0.12 Ω 1.3 Ω	Comparison to Four Terminal Pair Resistor Set

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Resistance – Measure [1]	Up to 2Ω (2 to 20) Ω (20 to 200) Ω 200 Ω to 2 kΩ (2 to 20) kΩ (20 to 200) kΩ 200 kΩ to 2 MΩ (2 to 20) MΩ (20 to 200) MΩ 200 MΩ to 2 GΩ	23 μΩ/Ω + 5.9 μΩ 12 μΩ/Ω + 18 μΩ 9.8 μΩ/Ω + 80 μΩ 12 μΩ/Ω + 0.94 mΩ 11 μΩ/Ω + 47 mΩ 11 μΩ/Ω + 60 mΩ 13 μΩ/Ω + 1.2 Ω 28 μΩ/Ω + 0.12 kΩ 0.15 mΩ/Ω + 1.2 kΩ 1.9 mΩ/Ω + 12 kΩ	Comparison to Precision 8.5 Digit Multimeter
LCR Impedance – Source [1]	DC to 1 kHz 100 mΩ 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	 0.42 mΩ 1.3 mΩ 6.3 mΩ 33 mΩ 310 mΩ 3.1 Ω 32 Ω 460 Ω 13 kΩ 33 kΩ	Comparison to Impedance Calibrator
LCR Impedance – Source [1]	(0.1 to 1) kHz 10 pF 100 pF 1 nF 10 nF 100 nF 1 μF 10 μF 100 μF (10 to 50) kHz 10 μH (1 to 10) kHz 100 μH (0.1 to 1) kHz 1 mH 10 mH 100 mH 1 H 10 H	 0.062 pF 0.12 pF 0.001 7 nF 0.024 nF 0.067 nF 0.001 5 μF 0.006 9 μF 0.13 μF 0.12 μH 0.24 μH 0.001 3 mH 0.012 mH 0.12 mH 0.001 2 H 0.012 H	Comparison to Impedance Calibrator

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Impedance – Measure [1]	20 Hz to 1 MHz (1 to 10) mΩ (> 10 to 100) mΩ > 100 mΩ to 1 Ω (> 1 to 10) Ω (> 10 to 100) Ω > 100 Ω to 1 kΩ (> 1 to 10) kΩ (> 10 to 100) kΩ > 100 kΩ to 1 MΩ (> 1 to 10) MΩ (> 10 to 100) MΩ	 12 % of reading + 0.29 mΩ 1.2 % of reading + 0.29 mΩ 0.53 % of reading + 0.29 mΩ 0.41 % of reading + 0.29 mΩ 0.42 % of reading + 0.29 mΩ 0.45 % of reading + 0.29 mΩ 0.54 % of reading + 0.29 mΩ 0.56 % of reading + 0.29 mΩ 1.2 % of reading + 0.29 mΩ 1.3 % of reading + 0.29 mΩ 12 % of reading + 0.29 mΩ	Precision LCR Meter
Capacitance – Source [1] 10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz DC to 50 Hz DC to 20 Hz DC to 6 Hz DC to 2 Hz DC to 0.6 Hz DC to 0.2 Hz	 (220 to 399.9) pF (0.4 to 1.099 9) nF (1.1 to 3.299 9) nF (3.3 to 10.999 9) nF (11 to 32.999 9) nF (33 to 109.999) nF (110 to 329.999) nF (0.33 to 1.099 99) µF (1.1 to 3.299 99) µF (3.3 to 10.999 9) µF (11 to 32.999 9) µF (33 to 109.999) µF (110 to 329.999) µF (0.33 to 1.099 99) mF (1.1 to 3.299 99) mF (3.3 to 10.999 9) mF (11 to 32.999 9) mF (33 to 110) mF	 0.58 % of reading + 12 pF 0.57 % of reading + 12 pF 0.57 % of reading + 12 pF 0.22 % of reading + 27 pF 0.29 % of reading + 0.12 nF 0.29 % of reading + 0.13 nF 0.29 % of reading + 0.35 nF 0.28 % of reading + 1.5 nF 0.29 % of reading + 3.5 nF 0.29 % of reading + 1.3 nF 0.46 % of reading + 36 nF 0.53 % of reading + 0.12 µF 0.53 % of reading + 0.35 µF 0.5 % of reading + 1.5 µF 0.52 % of reading + 3.6 µF 0.51 % of reading + 13 µF 0.86 % of reading + 35 µF 1.3 % of reading + 0.13 mF	Comparison to Multi Product Calibrator
Fixed Capacitance [1] @ 1 kHz	(100 to 500) pF 500 pF to 5 nF (5 to 50) nF (50 to 100) nF (100 to 500) nF 500 nF to 1.5 µF	0.64 pF 3.7 pF 32 pF 63 pF 0.59 nF 0.63 nF	Comparison to Capacitance Standard Set

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Capacitance – Source [1]	1 pF 1 kHz to 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz 10 pF 1 kHz to 13 MHz 100 pF 1 kHz to 10 MHz 13 MHz 1 nF 1 kHz to 4 MHz 5 MHz 10 MHz 13 MHz	 1.2 fF 1.3 fF 1.5 fF 2.8 fF 3.9 fF 12 fF 0.12 pF 0.13 pF 1.2 pF 1.3 pF 2.2 pF 3 pF	Comparison to Standard Air Capacitor Set
Capacitance – Measure [1]	(1 to 10) nF (10 to 100) nF (0.1to 1) µF (1 to 10) µF (10 to 100) µF (100 to 1 000) µF (1 to 10) mF (10 to 100) mF	0.052 pF 0.041 pF 0.37 nF 0.018 µF 0.041 µF 0.56 µF 0.018 mF 0.059 mF	Comparison to Digit Multimeter/LCR Meter
Inductance - Source [1] 0.1 to 1 kHz	200 µH 2 mH 20 mH 200 mH 2 H	0.58 µH 2.4 µH 24 µH 0.24 mH 2.4 mH	Comparison to Standard Value Inductors
Inductance – Measure [1]	0.001 nH to 99.999 999 H Up to 1 kHz 1 kHz to 1 MHz	 0.062 % of reading + 0.007 mH 0.56 % of reading + 0.007 mH	Comparison to Precision LCR Meter

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Devices – Source and Measure [1]	Type C		Comparison to Multi Product Calibrator
	(0 to 150) °C	0.29 °C	
	(150 to 650) °C	0.32 °C	
	(650 to 1 000) °C	0.28 °C	
	(1 000 to 1 800) °C	0.48 °C	
	(1 800 to 2 316) °C	0.71 °C	
	Type E		
	(-250 to -100) °C	0.43 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 350) °C	0.17 °C	
	(350 to 650) °C	0.14 °C	
	(650 to 1 000) °C	0.19 °C	
	Type J		
	(-210 to -100) °C	0.35 °C	
	(-100 to -30) °C	0.2 °C	
	(-30 to 150) °C	0.14 °C	
	(150 to 760) °C	0.19 °C	
	(760 to 1 200) °C	0.26 °C	
	Type K		
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.23 °C	
	(120 to 1 000) °C	0.25 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type N		
	(-200 to -100) °C	0.39 °C	
	(-100 to -25) °C	0.27 °C	
	(-25 to 120) °C	0.23 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.27 °C	
	Type R		
	(0 to 250) °C	0.83 °C	
	(250 to 400) °C	0.42 °C	
	(400 to 1 000) °C	0.31 °C	
	(1 000 to 1 767) °C	0.38 °C	
	Type S		
	(0 to 250) °C	0.55 °C	
	(250 to 1 000) °C	0.34 °C	
	(1 000 to 1 400) °C	0.32 °C	
	(1 400 to 1 767) °C	0.41 °C	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Devices – Source and Measure [1]	Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	 0.63 °C 0.35 °C 0.26 °C 0.22 °C	Comparison to Multi Product Calibrator
Electrical Simulation of RTD Temperature Indicating Devices – Source and Measure [1]	Pt 385 (100 Ω) (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C Pt 3926 (100 Ω) (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C Pt 3916 (100 Ω) (-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C Pt 385 (200 Ω) (-200 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	 0.05 °C 0.07 °C 0.09 °C 0.1 °C 0.12 °C 0.23 °C 0.05 °C 0.07 °C 0.09 °C 0.1 °C 0.12 °C 0.25 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.08 °C 0.09 °C 0.1 °C 0.23 °C 0.04 °C 0.05 °C 0.12 °C 0.13 °C 0.14 °C 0.16 °C	Comparison to Multi Product Calibrator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Temperature Indicating Devices – Source and Measure [1]	Pt 385 (500 Ω) (-200 to -80) °C (-80 to 100) °C (100 to 260) °C (260 to 400) °C (400 to 600) °C (600 to 630) °C Pt 385 (1000 Ω) (-200 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 600) °C (600 to 630) °C PtNi 385 (120 Ω) (Ni 120) (-80 to 100) °C (100 to 260) °C CU 427 (10 Ω) (100 to 260) °C	 0.04 °C 0.05 °C 0.06 °C 0.08 °C 0.09 °C 0.11 °C 0.03 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.23 °C 0.08 °C 0.14 °C 0.3 °C	Comparison to Multi Product Calibrator
Oscilloscopes [1] DC Voltage into 50 Ω load into 1 MΩ load Square Wave into 50 Ω into 1 MΩ Leveled Sine Amplitude Reference @ 50 kHz	 (-6.6 to 6.6) V (-130 to 130) V 10 Hz to 10 kHz 1 mVp-p to 6.6 Vp-p 10 Hz to 1 kHz 1 mVp-p to 130 Vp-p (1 to 10) kHz 1 mVp-p to 130 Vp-p 5 mV to 5.5 V	 0.2 % of reading + 36 µV 0.039 % of reading + 37 µV 0.2 % of reading + 65 µV 0.078 % of reading + 36 µV 0.19 % of reading + 39 µV 15 mV/V + 0.49 mV	Comparison to Multi Product Calibrator

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Oscilloscopes [1]			
Leveled Sine Amplitude	5 mV to 5.5 V		
(relative to 50 kHz)	50 kHz to 100 MHz	14 mV/V + 0.12 mV	
5 mV to 5.5 V	(100 to 300) MHz	17 mV/V + 0.14 mV	
	(300 to 600) MHz	32 mV/V + 0.15 mV	
	(600 to 1100) MHz	40 mV/V + 0.16 mV	
Time Markers			Comparison to
(5-2-1 sequence)			Multi Product Calibrator
into 50 Ω load	(1 to 50) ns	0.001 1 % of reading + 0.048 ps	
	100 ns to 20 ms	0.000 2 % of reading + 7 ps	
	50 ms to 5 s	0.4 % of reading	
Edge Transition Time			
(Rise Time)	< 300 ps	80 ps	
Oscilloscopes [1]			
Square Wave Signal			
10 Hz to 10 kHz	10 Hz to 10 kHz		
into 50 Ω load	1 mVp-p to 6.6 V p-p	2.5 mV/V + 40 µV	Comparison to
into 1 M Ω load	1 mVp-p to 130 V p-p	0.5 mV/V + 5 µV	Oscilloscope Calibrator
DC Signal			
into 50 Ω load	1 mVp-p to 6.6 V p-p	2.5 mV/V + 40 µV	
into 1 MΩ load	1 mVp-p to 130 V p-p	0.5 mV/V + 5 µV	

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Oscilloscopes [1]			Comparison to Oscilloscope Calibrator
Leveled Sine Wave Absolute Amplitude	5 mV to 5.5 V		
	50 kHz Reference	20 mV/V + 0.3 mV	
	50 kHz to 100 MHz	35 mV/V + 0.3 mV	
	(100 to 300) MHz	40 mV/V + 0.3 mV	
	(300 to 500) MHz	55 mV/V + 0.3 mV	
Square Wave Signal Leveled Sine Wave Flatness referenced to 50 kHz reference	(500 to 600) MHz	60 mV/V + 0.3 mV	
	5 mV to 5.5 V		
	10 MHz Reference	20 mV/V + 0.3 mV	
	600 MHz to 1.6 GHz	70 mV/V + 0.3 mV	
Time Markers (5-2-1 sequence) into 50 Ω load	(1.6 to 2.1) GHz	80 mV/V + 0.3 mV	
Fast Edge Mode	(1 to 50) ns	0.001 1 % of reading + 0.048 ps	
	100 ns to 20 ms	0.000 2 % of reading + 7 ps	
	50 ms to 5 s	0.4 % of reading	
Programmable Rise Time	5 s to 50 ms	2.5 µs/s + 5 µHz	
	20 ms to 500 ps	0.33 µs/s	
	(1 to 100) kHz	< 0.15 ns/s to 25 ps	
Rise Time [1] (measurement)	20 ps to 100 µs	81 ns	Comparison to Oscilloscope
Rise Time [1] (measurement)	1 ns to 10 µs	1.2 ns	Comparison to Oscilloscope
	10 µs to 100 µs	2.9 ns	
ESD Simulators Contact Voltage (Positive and Negative)	(1 to 8) kV	1.2 % of reading	Procedure IEC 61000-4-2 (Ed.2, 2008); Multimeters, ESD Target, Attenuator and Oscilloscope
Rise Time	(0.6 to 1) ns	0.000 12 % Δ time reading + 11 ps	
Peak Current	(3.75 to 33) A	2.1 % of reading	
30 ns Current	(2 to 20.8) A	3.4 % of reading	
60 ns Current	(1 to 10.4) A	6.3 % of reading	

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Electrical – DC/Low Frequency Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
ESD Simulators			
Air Discharge Voltage (Positive and Negative)	(0.7 to 1) ns (1 to 30) kV	1.2 % of reading	Procedure IEC 61000-4-2 (Ed.2, 2008); Multimeters, ESD Target, Attenuator and Oscilloscope
Rise Time			
RC Time Constant (at ± 15 kV)	600 ns ± 130 ns 330 pF probe	0.000 12 % A time reading + 11 ps	
	300 ns ± 60 ns 150 pF probe	0.000 12 % A time reading + 11 ps	
EFT/Burst Generator			
Voltage (±)	10 V to 8 kV	2.7 % of reading	Procedure IEC 61000-4-4 (Ed.3, 2012); Fast Rise Oscilloscope w/ EFT Verification Set
Rise Time	5 ns ± 30 %	0.008 % A time reading	
Impulse Duration	50 ns ± 30 %	0.008 % A time reading	
Burst Duration	15 ns ± 20 %	0.008 % A time reading	
Burst Period	300 ms ± 20 %	0.008 % A time reading	
Surge Generator			
Front Time	(1.2 to 50) µs	0.008 % A time reading	Procedure IEC 61000-4-5 (Ed. 3.1, 2017), IEC 61000-4-11 (Ed 3.0, 2020), IEC 61000-4-18 (Ed. 2.0, 2019); Fast Rise Oscilloscope, Current Probes, Oscilloscope Probes
Rise Time			
Open Circuit (±) Short Circuit (±)	(1.2 to 50) µs	0.008 % A time reading	
Time to Half-Value (±)	(20 to 700) µs	0.008 % A time reading	
Open Circuit Voltage (±) Short Circuit Voltage (±)	10 V to 12 kV	2.9 % of reading	
Ring Wave Voltage Ring Wave Rise Time	(0.125 to 3) kA	2.9 % of reading	
	1 kV ± 10 %	2.9 % of reading	
	1.5 µs ± 0.5 µs	0.008 % A time reading	
Gauss Meter [1]	100 G 200 G 500 G 1 000 G	1.4 G 2.5 G 6.4 G 7.7 G	Procedure IEEE Std 1309 (2013); Reference Magnetic Field Block

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Electrical – RF/Microwave Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Attenuation - Source Coaxial, 10 dB Step	(0 to 120) dB 1 kHz 500 MHz 1 GHz	 0.11 dB 0.28 dB 0.39 dB	Comparison to Standard Piston Attenuator
RF Attenuation Source Coaxial, 1 dB Step	DC to 12.4 GHz (0 to 11) dB (12.4 to 18) GHz (0 to 11) dB	 0.6 dB 0.8 dB	Comparison to Standard Electronic Programmable Attenuator
RF Attenuation Source Coaxial, 10 dB Step	DC to 12.4 GHz (0 to 10) dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB (80 to 110) dB (12.4 to 18) GHz (0 to 10) dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB (80 to 110) dB	 0.51 dB 0.71 dB 0.91 dB 1.2 dB 1.5 dB 1.8 dB 2.1 dB 2.4 dB 0.61 dB 0.81 dB 1.2 dB 1.6 dB 2 dB 2.4 dB 2.8 dB 3.2 dB	Comparison to Standard Electronic Programmable Attenuator
RF Absolute Power Source Into 50 Ω 0.001 Hz to 100 kHz SWR 1.2:1 100 kHz to 10 MHz SWR ≤ 1.2:1 (10 to 20) MHz SWR ≤ 1.2:1	 (3 to 10) Vp-p 1 mVp-p to 3Vp-p (3 to 10) Vp-p 1 mVp-p to 3 Vp-p 100 mVp-p to 3 Vp-p (1 to 100) mVp-p	 0.13 dB 0.22 dB 0.41 dB 0.61 dB 0.61 dB 0.91 dB	Comparison to Synthesized Signal Sources
RF Absolute Power Source Into 50 Ω Into 50 Ω/75 Ω	13.01 dBm 1 kHz to 25 MHz 200 Hz to 80 MHz	 0.12 dB 0.18 dB	Comparison to Synthesized Level Generator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power Into 50 Ω, In 2 dB steps Relative to Full Output	200 Hz to 80 MHz (0 to -38) dBm (-40 to -58) dBm (-60 to -98) dBm	 0.21 dB 0.21 dB 0.27 dB	Comparison to Synthesized Level Generator
RF Absolute Power Into 75 Ω, In 2 dB steps Relative to Full Output	(0 to -38) dBm 200 Hz to 25 MHz (25 to 80) MHz (-40 to -58) dBm 200 Hz to 25 MHz (25 to 80) MHz (-60 to -98) dBm 200 Hz to 25 MHz (25 to 80) MHz	 0.21 dB 0.36 dB 0.28 dB 0.54 dB 0.45 dB 1.7 dB	Comparison to Synthesized Level Generator
RF Absolute Power Source Into 50 Ω SWR ≤ 1.6:1 SWR ≤ 1.6:1 SWR ≤ 1.8:1 SWR ≤ 2:1 SWR ≤ 1.6:1 SWR ≤ 1.8:1 SWR ≤ 2:1 SWR ≤ 1.6:1 SWR ≤ 1.8:1 SWR ≤ 2:1 	(+10 to - 10) dBm 10 MHz to 2 GHz (2 to 20) GHz (+5 to -10) dBm 10MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (+2.5 to -10) dBm (40 to 50) GHz (-10 to -60) dBm 10MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz (-60 to -110) dBm 10 MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	 1.5 dB 1.7 dB 0.82 dB 0.96 dB 1.2 dB 2.3 dB 1.2 dB 1.3dB 1.6 dB 2.3 dB 1.8 dB 1.9 dB 2.2 dB 3.3 dB	Comparison to Synthesized Level Generator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power Source Into 50 Ω	(+24 to -48) dBm Up to 300 MHz (+14 to -48) dBm 300 MHz to 3GHz (3 to 4) GHz (-48 to -84) dBm 100 kHz to 10 MHz (10 to 300) MHz 300 MHz to 1.4 GHz (-48 to -74) dBm (1.4 to 4) GHz (-74 to -84) dBm (1.4 to 4) GHz (-84 to -94) dBm 100 kHz to 300 MHz 300 MHz to 4 GHz (-94 to -130) dBm (10 to 128) MHz 300 MHz to 4 GHz	0.06 dB 0.08 dB 0.52 dB 0.52 dB 0.32 dB 0.53 dB 0.53 dB 1 dB 0.53 dB 1 dB 0.73 dB 1.6 dB	Comparison to Synthesized Low Phase Noise Level Generator
RF Absolute Power Source Into 75 Ω	(+14 to -23) dBm Up to 125 MHz (125 to 300) MHz 300 MHz to 1.4 GHz (1.4 to 3) GHz (3 to 4) GHz (-23 dBm to -54) dBm Up to 300 MHz 300 MHz to 4 GHz (-54 to -80) dBm 100 kHz to 300 MHz 300 MHz to 4 GHz (-80 to -90) dBm 100 kHz to 300 MHz 300 MHz to 4 GHz (-90 to -100) dBm 100 kHz to 300 MHz 300 MHz to 4 GHz (-100 to 120) dBm 10 MHz to 4GHz	0.07 dB 0.16 dB 0.26 dB 0.33 dB 0.52 dB 0.16 dB 0.52 dB 0.23 dB 0.54 dB 0.7 dB 1 dB 0.76 dB 1 dB 1.6 dB	Comparison to Synthesized Low Phase Noise Level Generator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Tuned Power – Measure (relative)	100 kHz to 4.2 GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB (4.2 to 18) GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB (18 to 26.5) GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB (26.5 to 50) GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB	 0.14 dB 0.16 dB 0.19 dB 0.21 dB 0.25 dB 0.18 dB 0.2 dB 0.22 dB 0.24 dB 0.28 dB 0.24 dB 0.25 dB 0.27 dB 0.29 dB 0.32 dB 0.2 dB 0.21 dB 0.23 dB 0.25 dB 0.29 dB	Comparison to Measuring Receiver System
Digital Modulation - Measure Carrier Frequency 2 MHz to 2.65 GHz Error Vector Magnitude for Modulation Types: MSK, GMSK, BPSK, DQPSK, Π/4DQPSK, 8PSK, 16QAM, 32 QAM and QPSK Phase Error for Modulation Types: MSK, GMSK, BPSK, DQPSK, Π/4DQPSK, 8PSK, 16QAM, 32 QAM and QPSK	(0 to 15) % (1 to 100) kHz 100 kHz to 1 MHz 1 MHz to 2.65 GHz (0 to 3)° (1 to 100) kHz (0.1 to 1) MHz 1 MHz to 2.65 GHz	 0.33 % of reading 0.51 % of reading 1 % of reading 0.18° 0.34° 0.57°	Comparison to Vector Signal Analyzer

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation - Measure Error Vector Magnitude for FSK Modulation	Modulation Frequency 3.2 kHz 1.152 kHz	 0.54 % of reading 1.5 % of reading	Comparison to Vector Signal Analyzer
Amplitude Modulation - Source (11 to 13.5) MHz 20 Hz to 100 kHz DC to 15 kHz	 Rate:50 Hz to 50 kHz, (5 to 99) % Depth Rate: (20 to 50) Hz (5 to 99) % Depth Rate:9 kHz to 3.2 GHz (0 to 100) % Depth	 0.1 % of reading 0.25 % of reading 5 % of reading	Comparison to AM/FM Test Source, Analog Modulation Sources
Amplitude Modulation - Source DC to 100 kHz	 Rate:250 kHz to 50 GHz (0 to 99) % Depth	 1.2 % of reading + 0.07 AM	Comparison to AM/FM Test Source, Analog Modulation Sources
Amplitude Modulation - Measure 100 kHz to 10 MHz 10 MHz to 3 GHz	 Rate: 50 Hz to 10 kHz, (5 to 99) % Depth 50 Hz to 100 kHz, (20 to 99) % Depth	 0.001 4 % of reading + 0.009 AM 0.001 % of reading + 0.007 AM	Comparison to Microwave Measuring Receiver System
Amplitude Modulation - Measure 10 MHz to 3 GHz (3 to 26.5) GHz (3 to 26.5) GHz (26.5 to 31.15) GHz	 50 Hz to 100 kHz, (5 to 20) % Depth 50 Hz to 100 kHz, (5 to 20) % Depth 50 Hz to 100 kHz, (20 to 99) % Depth 50 Hz to 100kHz, (5 to 20) % Depth (20 to 99) % Depth	 0.001 % of reading + 0.029 AM 0.01 % of reading + 0.052 AM 0.01 % of reading + 0.018 AM 0.08 % of reading + 0.000 2 AM 0.02 % of reading + 0.000 14 AM	Comparison to Microwave Measuring Receiver System

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation - Measure (31.15 to 50) GHz	50 Hz to 100 kHz, (5 to 20) % Depth (20 to 99) % Depth	 0.3 % of reading + 0.000 05 AM 0.07 % of reading + 0.000 046 AM	Comparison to Microwave Measuring Receiver System
Amplitude Modulation - Measure 150 kHz to 10 MHz Rate: 50 Hz to 10 kHz, Depth: 5 % to 99 % Rate: 20 Hz to 10 kHz, Depth: to 99 % 10 MHz to 1.3 GHz Rate: 50 Hz to 50 kHz, Depth: 5 % to 99 % Rate: 20 Hz to 10 kHz, Depth: to 99 % (1.3 to 26.5) GHz Rate: 50 Hz to 10 kHz, Depth: 5 % to 99 % 10 MHz to 26.5 GHz Rate: 20 Hz to 10 kHz, Depth: to 99 %	 (5 to < 10) % Depth (10 to 99) % Depth (5 to < 10) % Depth (10 to 99) % Depth (5 to < 10) % Depth (10 to 99) % Depth (5 to < 10) % Depth (10 to 99) % Depth (5 to < 10) % Depth (10 to 99) % Depth (5 to < 10) % Depth (10 to 99) % Depth	 0.01 % of reading + 0.023 AM 0.06 % of reading + 0.023 AM 0.01 % of reading + 0.035 AM 0.06 % of reading + 0.035 AM 0.01 % of reading + 0.012 AM 0.06 % of reading + 0.012 AM 0.01 % of reading + 0.035 AM 0.06 % of reading + 0.035 AM 0.03 % of reading + 0.018 AM 0.07 % of reading + 0.018 AM 0.03 % of reading + 0.035 AM 0.07 % of reading + 0.035 AM	Comparison to Microwave Measuring Receiver System
Frequency Modulation - Measure 250 kHz to 10 MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz (26.5 to 50.0) GHz	 Rate: 20 Hz to 10 kHz Dev:20 Hz to 40 kHz pk Rate: 50 Hz to 200 kHz Dev:250 Hz to 400 kHz pk Rate: 50 Hz to 200 kHz Dev:250 Hz to 400 kHz pk Rate: 50 Hz to 100 kHz Dev:250 Hz to 400 kHz pk Rate: 20 Hz to 10 kHz Dev:20 Hz to 40 kHz pk	 1.7 % of reading + 5.7 Hz 1.1 % of reading + 6.6 Hz 1.8 % of reading + 5.1 Hz 1.2 % of reading + 6.1 Hz 2.9 % of reading + 4 Hz 1.2 % of reading + 6.4 Hz 4.4 % of reading + 3.8Hz 1.2 % of reading + 7.6 Hz 10 % of reading + 4.2 Hz 1 % of reading + 12 Hz	Comparison to Microwave Measuring Receiver System

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation - Measure			Comparison to Microwave Measuring Receiver System
250 kHz to 10 MHz	Rate: 20 Hz to 10 kHz		
(0 to < 4) kHz pk FM	≤ 40 kHz pk	0.024 FM + 2.4 Hz Pk	
(≥ 4 to < 40) kHz pk FM		0.024 FM + 8 Hz Pk	
10 MHz to 26.5 GHz			
10 MHz to 1.3 GHz	Rate: 50 Hz to 100 kHz		
(0 to < 4) kHz pk FM	≤ 400 kHz pk	0.012 FM + 2.4 Hz Pk	
(≥ 4 to < 40) kHz pk FM		0.012 FM + 14 Hz Pk	
(≥ 40 to < 400) kHz pk FM		0.012 FM + 66 Hz Pk	
(> 1.3 to 6.2) GHz	Rate: 50 Hz to 100 kHz	0.012 FM + 19 Hz Pk	
(0 to < 4) kHz pk FM	≤ 400 kHz pk	0.012 FM + 23 Hz Pk	
(≥ 4 to < 40) kHz pk FM		0.012 FM + 75 Hz Pk	
(≥ 40 to < 400) kHz pk FM			
(> 6.2 to 12.4) GHz			
(0 to < 4) kHz pk FM		0.012 FM + 35 Hz Pk	
(≥ 4 to < 40) kHz pk FM		0.012 FM + 39 Hz Pk	
(≥ 40 to < 400) kHz pk FM		0.012 FM + 91 Hz Pk	
Frequency Modulation - Measure			Comparison to Microwave Measuring Receiver System
(> 12.4 to 18.6) GHz			
(0 to < 4) kHz pk FM		0.012 FM + 51 Hz Pk	
(≥ 4 to < 40) kHz pk FM	Rate: 50 Hz to 100 kHz	0.012 FM + 55 Hz Pk	
(≥ 40 to < 400) kHz pk FM	≤ 400 kHz pk	0.012 FM + 110 Hz Pk	
(> 18.6 to 26.5) GHz			
(0 to < 4) kHz pk FM		0.012 FM + 67 Hz Pk	
(≥ 4 to < 40) kHz pk FM		0.012 FM + 71 Hz Pk	
(≥ 40 to < 400) kHz pk FM		0.012 FM + 130 Hz Pk	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation - Measure 10 MHz to 26.5 GHz 10 MHz to 1.3 GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (>1.3 to 6.2) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 50 Hz to 100 kHz ≤ 400 kHz pk	 0.058 FM + 3.9 Hz Pk 0.058 FM + 8 Hz Pk 0.058 FM + 66 Hz Pk 0.058 FM + 19 Hz Pk 0.058 FM + 23 Hz Pk 0.058 FM + 75 Hz Pk	Comparison to Microwave Measuring Receiver System
Frequency Modulation - Measure (> 6.2 to 12.4) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (> 12.4 to 18.6) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (> 18.6 to 26.5) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 20 Hz to 200 kHz ≤ 400 kHz pk	 0.058 FM + 35 Hz Pk 0.058 FM + 39 Hz Pk 0.058 FM + 91 Hz Pk 0.058 FM + 51 Hz Pk 0.058 FM + 55 Hz Pk 0.058 FM + 110 Hz Pk 0.058 FM + 67 Hz Pk 0.058 FM + 71 Hz Pk 0.058 FM + 130 Hz Pk	Comparison to Microwave Measuring Receiver System

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation - Source			Comparison to AM/FM Test Source
(11 to 13.5) MHz	Rate: DC to 10 kHz Dev.: ≤ 100 kHz peak	0.1 % of reading	
(11 to 13.5) MHz	Rate: DC to 10 kHz Dev.: ≤ 200 kHz peak	0.25 % of reading	
(88 to 108) MHz	Rate: DC to 100 kHz Dev.: ≤ 100 kHz peak	0.1 % of reading	
(88 to 108) MHz	Rate: DC to 100 kHz Dev.: ≤ 200 kHz peak	0.25 % of reading	
(352 to 432) MHz	Rate: DC to 100 kHz Dev.: ≤ 100 kHz peak	0.1 % of reading	
Frequency Modulation - Source			Comparison to Analog Modulation Sources
(352 to 432) MHz	Rate: DC to 100 kHz Dev.: ≤ 200 kHz peak	0.25 % of reading	
9 kHz to 1 GHz	Rate: DC to 150 kHz Dev.: ≤ 200 kHz peak	3 % of reading + 30 Hz	
(1 to 2) GHz	Rate: DC to 150 kHz Dev.: ≤ 400 kHz peak	3 % of reading + 60 Hz	
(2 to 3) GHz	Rate: DC to 150 kHz Dev.: ≤ 400 kHz peak	3 % of reading + 120 Hz	
Frequency Modulation - Source			Comparison to Analog Modulation Sources
1 kHz rate			
Max. Dev. 2 MHz	250 kHz to 1 GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 4 MHz	(1 to 2) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 8 MHz	(2 to 3.2) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 16 MHz	(3.2 to 10) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 32 MHz	(10 to 20) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 64 MHz	(20 to 40) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 128 MHz	(40 to 50) GHz	40 mHz/Hz + 23 Hz	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation - Measure			
> 0.7 rad Dev.	100 kHz to 6.6 GHz	1.2 % of reading + 0.007 1 rad	Comparison to Microwave Measuring Receiver System
> 0.6 rad Dev.	(6.6 to 13.2) GHz	1.2 % of reading + 0.007 1 rad	
> 1.2 rad Dev.	(13.2 to 26.5) GHz	1.2 % of reading + 0.007 3 rad	
> 1.3 rad Dev.	(26.5 to 31.5 GHz	1 % of reading + 0.007 3 rad	
> 2.4 rad Dev.	(31.5 to 50) GHz	1 % of reading + 0.008 rad	
Phase Modulation - Measure			
150 kHz to 10 MHz			
(0 to < 4) rad pk PM	200 Hz to 10 kHz Rate	4.7 % of reading + 0.001 rad	Comparison to Microwave Measuring Receiver System
(≥ 4 to < 40) rad pk PM	≤ 40 rad pk	4.7 % of reading + 0.008 rad	
10 MHz to 1.3 GHz			
(0 to < 4) rad pk PM	200 Hz to 20 kHz Rate	3.5 % of reading + 0.001 rad	
(≥ 4 to < 40) rad pk PM	≤ 400 rad pk	3.5 % of reading + 0.008 rad	
(≥ 40 to < 400) rad pk PM		3.5 % of reading + 0.09 rad	
1.3 to 26.5 GHz			
(0 to < 4) rad pk PM	200 Hz to 20 kHz Rate	3.5 % of reading + 0.001 rad	
(≥ 4 to < 40) rad pk PM	≤ 400 rad pk	3.5 % of reading + 0.008 rad	
(≥ 40 to < 400) rad pk PM		3.5 % of reading + 0.09 rad	
Phase Modulation - Source Rate: 20 Hz to 10 kHz			
Carrier:			
9 kHz to 1 GHz	(0 to 10) rad	0.05 rad + 3 % of reading	Comparison to Analog Modulation Sources
(1 to 2) GHz	(0 to 20) rad	0.1 rad + 3 % of reading	
(2 to 3.2) GHz	(0 to 40) rad	0.2 rad + 3 % of reading	
	Max. Dev.		
250 kHz to 1 GHz	(0 to 20) rad	0.012 rad + 6 % of reading	
(>1 to 2) GHz	(0 to 40) rad	0.012 rad + 6 % of reading	
(>2 to 3.2) GHz	(0 to 80) rad	0.012 rad + 6 % of reading	
(>3.2 to 10) GHz	(0 to 160) rad	0.012 rad + 6 % of reading	
(>10 to 20) GHz	(0 to 320) rad	0.012 rad + 6 % of reading	
(>20 to 40) GHz	(0 to 640) rad	0.012 rad + 6 % of reading	
(>40 to 50) GHz	(0 to 1 280) rad	0.012 rad + 6 % of reading	
Distortion – Measure	(0.01 to 100) % Distortion 250 kHz to 50 GHz	0.065 % of reading	Comparison to Microwave Measuring Receiver System

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Distortion – Measure Fundamental Frequency 20 Hz to 20 kHz (20 to 100) kHz	 (-99 to 0) dB (-99 to 0) dB	 1.2 dB 2.3 dB	Comparison to Distortion Analyzer
Power Reference – Measure 50 MHz	1 mW	5.5 µW	Indirect Method Primary Standards Lab (H75) Thermistor Mount, Power Meter, Precision 8.5-digit Multimeter
Absolute Power – Measure	9 kHz to 4.2 GHz (+20 to -30) dBm 10 MHz to 18 GHz (-20 to -70) dBm 50 MHz to 26.5 GHz (+20 to -30) dBm (26.5 to 50) GHz (+20 to -30) dBm (-20 to -70) dBm	 0.3 % of Reading + 0.65 dB 0.44 % of reading + 0.32 dB 0.24 % of reading + 0.86 dB 0.46 % of reading + 0.94 dB 1.6 % of reading + 0.67 dB	Comparison to RF Power Meters/Sensors
Power Meter – Range Calibration	3 µW 10 µW 30 µW 100 µW 300 µW 1 mW 3 mW 10 mW 30 mW 100 mW	21 nW 19 nW 21 nW 77 nW 0.11 µW 0.29 µW 0.64 µW 6.4 µW 13 µW 0.10 mW	Comparison to Power Meter Range Calibrator w/ Precision DC Voltage Source
Noise Figure – Source	15 dB ENR 10 MHz to 1.5 GHz (1.5 to 3) GHz (3 to 7) GHz (7 to 18) GHz (18 to 26.5) GHz	 0.29 dB 0.25 dB 0.26 dB 0.37 dB 0.42 dB	Comparison to Primary Standards Lab Noise Source
Noise Figure – Measure	100 kHz to 30 MHz >30 MHz to 3 GHz (>3 to 26.5) GHz	0.43 dB 0.42 dB 0.47 dB	Comparison to Noise Figure Measurement System w/ Standard Noise Sources

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Single Sideband Phase Noise - Measure	1 MHz to 26.5 GHz (26.5 to 50) GHz	1.8 dB 1.8 dB	Comparison to Phase Noise Measurement System
Power Sensor Calibration Factor	(-60 to < 0 > to 23) dBm 9 kHz to 10 MHz >10 MHz to 4 GHz (>4 to 10 GHz) (>10 to 18 GHz) (>18 to 26.5 GHz) (>26.5 to 44 GHz) (>44 to 50 GHz)	 1.3 % of reading 1.4 % of reading 1.7 % of reading 1.9 % of reading 3.8 % of reading 5.1 % of reading 7.6 % of reading	Comparison to Signal Sources, Precision Level Source and Tegam System
Current Probes/ Bulk Current Injection Probes Insertion Loss Transfer Impedance	(0 to 100) dB 20Hz to 300 kHz 300 kHz to1 MHz 1 MHz to 3 GHz (0 to 100) dB 20 Hz to 300 kHz 300 kHz to1 MHz 1 MHz to 3 GHz	 1.1 dB 1 dB 1.9 dB 1.1 dB 1 dB 1.9 dB	Comparison to Network/RF Impedance Analyzers, attenuator, type N calibration kit
Transmission S_{12}/S_{21} - Measure Phase and Magnitude	9 kHz to 1.3 GHz (-180 to 180)° (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-60 to -20) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB (1.3 to 3) GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-60 to -20) dB (-70 to -60) dB (1.3 to 3) GHz (-80 to -70) dB (-90 to -80) dB	 0.18 dB (1°) 0.057 dB (0.43°) 0.072 dB (0.8°) 0.086 dB (0.89°) 0.13 dB (1.2°) 0.3 dB (2.4°) 0.92 dB (6.9°) 0.12 dB (4.1°) 0.063 dB (0.48°) 0.077 dB (0.8°) 0.093 dB (0.94°) 0.13 dB (1.2°) 0.32 dB (2.6°) 0.92 dB (7.4°)	Comparison to LF Vector Network Analyzer, Calibration Kits

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Transmission S_{12}/S_{21} - Measure Phase and Magnitude	50 MHz to 2 GHz (-180 to 180)° (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB (2 to 8) GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB (8 to 20) GHz (-180 to 180)° (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB	 0.07 dB (0.46°) 0.054 dB (0.36°) 0.075 dB (0.5°) 0.12 dB (0.83°) 0.29 dB (1.9°) 2.3 dB (5.5°) 5.9 dB (5.7°) 0.09 dB (0.59°) 0.07 dB (0.46°) 0.087 dB (0.57°) 0.1 dB (0.69°) 0.12 dB (0.81°) 0.15 dB (0.98°) 0.22 dB (1.4°) 0.45 dB (3.1°) 1.2 dB (8.7°) 3.4 dB (8.7°) 0.19 dB (1.3°) 0.17 dB (1.1°) 0.18 dB (1.2°) 0.2 dB (1.3°) 0.22 dB (1.4°) 0.24 dB (1.6°) 0.32 dB (2.1°) 0.6 dB (4.1°) 1.6 dB (8.7°) 4.2 dB (11°)	Comparison to Vector Network Analyzer w/ Calibration Kits

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Transmission S_{12}/S_{21} - Measure Phase and Magnitude	(20 to 50) GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB	 0.54 dB (3.7°) 0.5 dB (3.4°) 0.49 dB (3.3°) 0.5 dB (3.4°) 0.52 dB (3.5°) 0.55 dB (3.7°) 0.65 dB (4.4°) 1.1 dB (7.6°) 2.7 dB (8.9°) 6.6 dB (11°)	Comparison to Vector Network Analyzer w/ Calibration Kits
Transmission S_{12}/S_{21} – Measure Magnitude Phase	(-90 to 10) dB (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz </= 0 to </+ 60° 0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	 0.014 dB 0.043 dB 0.11 dB 0.14 dB 0.023° 0.013° 0.064° 0.017°	Comparison to Vector Network Analyzer w/ Calibration Kits
Reflection S_{11}/S_{22} - Measure Phase and Magnitude [2,3]	9 kHz to 1.3 GHz (-180 to 180)° (<0.03) Γ (<0.2) Γ (<0.4) Γ (<0.6) Γ (<0.8) Γ (<1) Γ (1.3 to 3) GHz (<0.03) Γ (<0.2) Γ (<0.4) Γ (<0.6) Γ (<0.8) Γ (<1) Γ	 0.002 3 (1.4°) 0.003 5 (1.4°) 0.006 1 (1.1°) 0.008 3 (0.94°) 0.01 (0.83°) 0.012 (0.7°) 0.005 6 (1.8°) 0.003 5 (1.8°) 0.008 (1.3°) 0.011 (1.2°) 0.013 (1°) 0.016 (0.89°)	Comparison to LF Vector Network Analyzer, Calibration Kits

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Reflection S_{11}/S_{22} – Measure Phase and Magnitude [2,3]	50 MHz to 2 GHz (-180 to 180)° (<0.03) Γ (<0.2) Γ (<0.4) Γ (<0.6) Γ (<0.8) Γ (<1) Γ (2 to 8) GHz (<0.03) Γ (<0.2) Γ (<0.4) Γ (<0.6) Γ (<0.8) Γ (<1) Γ (8 to 20) GHz (<0.03) Γ (<0.2) Γ (<0.4) Γ (<0.6) Γ (<0.8) Γ (<1) Γ (20 to 50) GHz (-180 to 180)° (<0.03) Γ (<0.2) Γ (<0.4) Γ (<0.6) Γ (<0.8) Γ (<1) Γ	 0.01 (3.3°) 0.012 (3.3°) 0.014 (2°) 0.017 (1.6°) 0.021 (1.5°) 0.026 (1.5°) 0.01 (3.5°) 0.012 (3.5°) 0.015 (2.2°) 0.019 (1.8°) 0.024 (1.7°) 0.003 (1.7°) 0.002 4 (7.8°) 0.002 7 (7.8°) 0.003 3 (4.8°) 0.004 2 (4°) 0.053 (3.8°) 0.067 (3.9°) 0.06 (19°) 0.066 (11°) 0.079 (11°) 0.097 (9.3°) 0.12 (8.8°) 0.15 (8.8°)	Comparison to Vector Network Analyzer w/ Calibration Kits
Reflection S_{11}/S_{22} – Measure Magnitude [2,3] Phase	(< 0.03 to < 1) Γ (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz </= 0 to </= 60° (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	 0.011 Γ 0.011 Γ 0.018 Γ 0.023 Γ 0.023° 0.013° 0.064° 0.017°	Comparison to Vector Network Analyzer w/ Calibration Kits

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) 7mm Test Ports Reflection S_{11}/S_{22} – Magnitude [2,3]	</= 0.1 to </= 1 Γ (0.000 3 to 1) GHz (1 to 3) GHz (3 to 6) GHz	 0.003 8 Γ 0.003 9 Γ 0.005 1 Γ	Comparison to Mechanical Calibration Kits and RF Network Analyzer System
Phase	</= 0 to </= 60° (0.000 3 to 1) GHz (1 to 3) GHz (3 to 6) GHz	 2° 2.1° 2.7°	
Network Analyzer System Verification (Corrected Performance) N-Type Test Ports Reflection S_{11}/S_{22} – Magnitude [2,3]	</= 0.1 to </= 1 Γ (0.0003 to 1) GHz (1 to 3) GHz (3 to 8) GHz (8 to 18) GHz	 0.009 Γ 0.001 Γ 0.001 5 Γ 0.004 1 Γ	Comparison to Mechanical Calibration Kits and RF Network Analyzer System
Phase	</= 0 to </= 60° (0.000 3 to 1) GHz (1 to 3) GHz (3 to 8) GHz (8 to 18) GHz	 0.46° 0.64° 0.65° 1.3°	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) 3.5mm Test Ports Reflection S_{11}/S_{22} – Magnitude [2,3]	</= 0.1 to </= 1 Γ (0.045 to 2) G Γ Hz (2 to 20) GHz (20 to 26.5) GHz	 0.000 76 Γ 0.001 Γ 0.003 Γ	Comparison to Mechanical Calibration Kits and RF Network Analyzer System
Phase	</= 0 to </= 60° (0.045 to 2) GHz (2 to 20) GHz (20 to 26.5) GHz	 0.34° 0.36° 0.64°	
Network Analyzer System Verification (Corrected Performance) 2.4mm Test Ports Reflection S_{11}/S_{22} – Magnitude [2,3]	</= 0.1 to </= 1 Γ (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	 0.003 8 Γ 0.003 8 Γ 0.004 4 Γ 0.005 5 Γ	Comparison to Mechanical Calibration Kits and RF Network Analyzer System
Phase	</= 0 to </= 60° (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	 0.96° 1.3° 1.5° 2.3°	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) 7mm Test Ports Transmission $S_{21}/S1_{22}$ – Magnitude	</= 0.1 to </= 1 dB (0.0003 to 1) GHz (1 to 3) GHz (3 to 6) GHz	 0.16 dB 0.16 dB 0.17 dB	Comparison to Mechanical Calibration Kits and RF Network Analyzer System
Phase	</= 0 to </= 60° (0.0003 to 1) GHz (1 to 3) GHz (3 to 6) GHz	 1.4° 1.5° 2.2°	
Network Analyzer System Verification (Corrected Performance) N-Type Test Ports Transmission $S_{21}/S1_{22}$ – Magnitude	</= 0.1 to </= 1 dB (0.0003 to 1) GHz (1 to 3) GHz (3 to 8) GHz (8 to 18) GHz	 0.018 dB 0.019 dB 0.02 dB 0.024 dB	Comparison to Mechanical Calibration Kits and RF Network Analyzer System
Phase	</= 0 to </= 60° (0.0003 to 1) GHz (1 to 3) GHz (3 to 8) GHz (8 to 18) GHz	 0.18° 0.2° 0.23° 0.24°	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) 3.5mm Test Ports Transmission $S_{21}/S1_{22}$ – Magnitude	</= 0.1 to </= 1 dB (0.045 to 2) GHz (2 to 20) GHz (20 to 26.5) GHz	 0.018 dB 0.019 dB 0.032 dB	Comparison to Mechanical Calibration Kits and RF Network Analyzer System
Phase	</= 0 to </= 60° (0.045 to 2) GHz (2 to 20) GHz (20 to 26.5) GHz	 0.18° 0.18° 0.32°	
Network Analyzer System Verification (Corrected Performance) 2.4mm Test Ports Transmission $S_{21}/S1_{22}$– Magnitude	</= 0.1 to </= 1 dB (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	 0.023 dB 0.033dB 0.055 dB 0.068 dB	Comparison to Mechanical Calibration Kits and RF Network Analyzer System
Phase	</= 0 to </= 60° (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	 0.23° 0.41° 0.97° 1.8°	
Scalar Network Analyzer Absolute Log Error Dynamic Accuracy	21 dB (0 to 140) dB	0.04 dB 0.02 dB	Comparison to Scalar Network Analyzer Calibrator
Network Analyzer Dynamic Accuracy	(0 to 140) dB	0.02 dB	Comparison to Dynamic Accuracy Test Set

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Impulse Spectral Amplitude Source			Comparison to Pulse Generator
CISPR Band A	(10 to 150) kHz	0.82 dB	
CISPR Band B	150 kHz to 30 MHz	0.82 dB	
CISPR Band C and D	30 MHz to 1 GHz	1.1 dB	
CISPR Band E	(1 to 18) GHz	1.5 dB	
Sinewave Output for CISPR Checks Source @ 60 dB/µV	(0 to -70) dB		
	100 kHz	0.35 dB	
	(1, 10, and 100) MHz	0.35 dB	
Peak and Average Detector Response	(0 to -70) dB CISPR Band A thru D	1.3 dB	
LISN (Line Impedance Stabilization Network) & AMN (Artificial Mains Network)			Comparison to RF Impedance/Network Analyzers, Calibration Kits
Insertion Loss	(-20 to 0) dB		
	10 Hz to 1 000 MHz	0.25 dB	
Isolation (De-Coupling Factor)	(-90 to 0) dB		
	10 Hz to 1 000 MHz	2.3 dB	
Impedance (Magnitude)	0.1 Ω to 1 kΩ		
	10 Hz to 1 000 MHz	2.4 % of reading	
Impedance (Phase)	(-180 to 180)°		
	10 Hz to 1 000 MHz	2.6°	
CDN (Coupling-Decoupling Network) & ISN (Impedance Stabilization Network)			Comparison to RF Impedance/Network Analyzers, Calibration Kits
Insertion Loss	(-20 to 0) dB		
	10 Hz to 1000 MHz	0.25 dB	
Isolation (De-Coupling Factor)	(-90 to 0) dB		
	10 Hz to 1000 MHz	2.3 dB	
Impedance (Magnitude)	0.1 Ω to 1 kΩ		
	10 Hz to 1 000 MHz	2.4 % of reading	
Impedance (Phase)	(-180 to 180)°		
	10 Hz to 1 000 MHz	2.6°	
LCL (Longitudinal Conversion Loss)	(-20 to 0) dB		
	10 Hz to 1 000 MHz	2.3 dB	

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Length – Dimensional Metrology Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Test, Dial Indicators, Thickness Gages [1]	Up to 4 in	(57 + 0.26*L*) µin	Comparison to Gage Blocks
Calipers [1]	Up to 54 in	(52 + 46*L*) µin	Comparison to Gage Blocks, Standard Rings, Rod Sets
Micrometers [1] (Linearity Only)	Up to 54 in	(52 + 46*L*) µin	Comparison to Gage Blocks, Rod Sets
Pin and Plug Gages [1]	Up to 25 mm	5 µm	Comparison to Micrometer
Pin and Plug Gages	Up to 2.36 in	180 µin	Laser Micrometer & Pin Gages
Height Gages	Up to 12 in	(750 + 4.7*L*) µin	Comparison to Gage Blocks
Depth Gages	Up to 12 in	(160 + 4.1*L*) µin	Comparison to Gage Blocks
Steel Rulers	Up to 48 in	0.036 in	Comparison to Gage Blocks
Tape Measures	Up to 50 ft	0.036 in	Comparison to Gage Blocks
Protractor/Angle	Up to 90°	0.069°	Comparison to Angle Gage Blocks
Roughness Testers [1]	118 µin	3.8 µin	Comparison to Roughness Standard
Roughness Specimens [1]	Up to 118 µin	4.1 µin	Comparison to Surface Roughness Meter
Coating Thickness Gauge[1]	49 µm 117 µm 281 µm 404 µm	2 µm 5.6 µm 9.2 µm 19 µm	Comparison to Plastic Shims

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Mass and Mass Related Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force-Measuring Equipment Tension / Compression	Up to 1 000 lbf (1 000 to 10 000) lbf (10 000 to 20 000) lbf (20 000 to 30 000) lbf (30 000 to 40 000) lbf (40 000 to 50 000) lbf	5.1 lbf 24 lbf 47 lbf 70 lbf 93 lbf 120 lbf	Comparison to Reference Load Cells
Barometric Pressure Measurement	Up to 39 psia	0.014 psi	Comparison to Digital Barometer / Precision Absolute Manometer
Force-Measuring Equipment Tension / Compression	(0.1 to 50) kgf	0.042 mgf/gf + 7.1 gf	Comparison to NIST Class F Weights
Pressure – Source/Pressure gages and transducers [1]	(-12 to 300) psi (300 to 10 000) psi	0.2 psi 1.4 psi	Comparison to Pressure Calibration System
Torque – Measure/Torque Tools [1]	(20 to 200) ozf·in (5 to 50) lbf·in (40 to 400) lbf·in (100 to 1000) lbf·in (25 to 250) lbf·ft (60 to 600) lbf·ft	0.34 % of reading + 0.36 ozf·in 0.34 % of reading + 0.042 lbf·in 0.34 % of reading + 0.24 lbf·in 0.34 % of reading + 0.54 lbf·in 0.34 % of reading + 0.15 lbf·ft 0.34 % of reading + 0.28 lbf·ft	Comparison to Torque Transducers
Torque – Source/Analyzers and Measuring Equipment	(1 to 10) lbf·in (10 to 25) lbf·in (25 to 50) lbf·in (50 to 100) lbf·in (100 to 150) lbf·in (150 to 250) lbf·in	0.021 % of reading + 0.009 lbf·in 0.017 % of reading + 0.011 lbf·in 0.033 % of reading + 0.022 lbf·in 0.035 % of reading + 0.040 lbf·in 0.038 % of reading + 0.042 lbf·in 0.04 % of reading + 0.045 lbf·in	Comparison to Calibration Wheels Standard Weights
Scales & Balances [1,10]	1 mg to 10 g (10 to 500) g (0.5 to 1) kg (1 to 2) kg	0.034 mg 0.7 mg 1.5 mg 2.9 mg	Comparison to ASTM E617 Class 0 weights and internal calibration procedure utilized in the calibration of the weighing system.

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Mass and Mass Related Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales & Balances [1,10]	(2 to 20) kg (20 to 40) kg (40 to 50) kg	2.3 g 4.6 g 5.8 g	Comparison to ASTM E617 Class 6 weights, NIST Class F weights, and internal calibration procedure utilized in the calibration of the weighing system.
Scales & Balances [1]	(0.001 to 0.05) lb (0.1 to 1) lb (1 to 2) lb (2 to 5) lb (5 to 10) lb (10 to 20) lb (20 to 50) lb	0.000 012 lb 0.000 18 lb 0.000 24 lb 0.000 6 lb 0.001 1 lb 0.002 4 lb 0.006 lb	Comparison to NIST Class F weights and internal calibration procedure utilized in the calibration of the weighing system.
Pipettes	(1 to 10) µL (> 10 to 100) µL (> 100 to 1000) µL	0.051 µL 0.079 µL 0.17 µL	Comparison to Pipette Calibration Balances

Thermodynamic Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Radiation (Infrared) [1] Thermometers	(50 to 100)°C (100 to 300)°C (300 to 500)°C	1.7 °C 5.3 °C 8.2 °C	Comparison to Blackbody Source (Flat plate) $\varepsilon = 0.95$, λ = (8 to 14) µm
Relative Humidity – Measure [1]	Up to 90 %RH (90 to 95) %RH	1.6 % RH 2.2 % RH	Comparison to Humidity Probe Monitor
Temperature – Measure [1]	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 420) °C (420 to 650) °C	0.03 °C 0.05 °C 0.07 °C 0.11 °C 0.14 °C	Comparison to Reference Thermometer w/ PRT

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Time and Frequency Vista, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source [1]	1 µHz to 80 MHz	5.8 x 10^{-9} MHz	Comparison to Frequency Synthesizer w/ GPS Reference Signal Generator
Frequency – Source [1]	1 Hz to 50 GHz	5.8 x 10^{-10}GHz	Comparison to Synthesized Sweeper w/ GPS Reference
Frequency – Measure [1]	1 µHz to 12.4 GHz 1 Hz to 50 GHz	5.8 x 10^{-10}GHz 5.8 x 10^{-11} GHz	Comparison to Electronic Counters, Analyzers w/ GPS Reference
Time Interval	50 ns to 999 s	5 ps/s + 0.43 ns	Comparison to Universal Counter w/ GPS Reference
Period [1]	4.44 ns to 10 s	0.012 % of reading + 0.17 ns	Comparison to Universal Counter w/ GPS Reference
Rise/Fall Time – Measure [1]	1 ns to 10 µs 10 µs to 100 µs	1.2 ns 2.9 ns	Comparison to Digital Oscilloscope Or Universal Counter w/ GPS Reference
Pulse Width – Measure [1]	> 5 ns	1.1 ns	Comparison to Universal Counter w/ GPS Reference
Stop Watches – Totalize Method	1s to 24 hr	0.06 % of reading + 44 ms	Comparison to Universal Counter and Synthesizer w/ GPS Reference

TESTING

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Environmental Vista, CA

Specific Tests and/or Properties Measured	Specification, Standard, Method, or Test Technique	Items, Materials or Product Tested	Key Equipment or Technology
Face Velocity Test Airflow Smoke Pattern Test Leak/Backstreaming Test	ISO 14644-1 ISO 16644-2 ISO 14644-3 ISO 16644-7 ANSI/ASHRAE 110 IEST-RP-CC002.4	Flow hood Devices Test	Comparison to ThermalAnemometer Aerosol Generator Digital Aerosol Photometer
Airborne Particle Count Survey Airflow Measurement Airflow Smoke Pattern Test HEPA/ULPA filter leak Test Biological Safety Cabinet Classification	ISO 14644-1 ISO 16644-2 ISO 14644-3 ISO 16644-7 IEST-RP-CC034.2 IEST-RP-CC006.3 NSF/ANSI49-2004 Annex	Biological Safety Cabinet Test	Comparison to Particle Counter Balometer Aerosol Generator Digital Aerosol Photometer Thermal Anemometer
Airflow Measurement Air Pressure Difference Test Airflow Smoke Pattern Test HEPA/ULPA filter leak Test Airborne Particle Count Survey Lighting Level Sound Level Test Temperature Test Humidity Test Temperature/Humidity Uniformity Test Recovery Test	ISO 14644-1 ISO 14644-2 ISO 14644-3 IEST-RP-CC006.3 IEST-RP-CC034.2 ISO/DIS 7726 In-house Method	Clean Room Test	Comparison to Balometer Differential Pressure Meter Digital Aerosol Photometer, Aerosol Generator Particle Counter Light meter Sound level meter Temperature & humidity meter Thermal Anemometer.
Airborne Particle Count Survey Airflow Velocity Laminar Hood HEPA/ULPA filter leak Test Induction Leak/Backstreaming Test Airflow Smoke Pattern Test Lighting Level Sound Level Test	ISO 14644-1 ISO 14644-2 ISO 14644-3 ISO 14644-7 IEST-RP-CC002.4 IEST-RP-CC006.3 IEST-RP-CC034.2 In-house Method	Laminar Air Flow Workstation Test	Comparison to Particle Counter Thermal Anemometer Aerosol Generator Digital Aerosol Photometer Light meter Sound level meter

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CALIBRATION

Acoustics and Vibration Santa Clara, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Vibration	(0.2 to 36) gpk (1 to 20) Hz (20 to 100) Hz (100 to 2500) Hz (2500 to 10 000) Hz	 3.1 % of reading + 0.04 g 3.1 % of reading + 0.04 g 3.1 % of reading + 0.04 g 3.4 % of reading + 0.04 g	Comparison to Vibration Calibrator System

Chemical Quantities Santa Clara, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH – Source [6]	4.01 pH 7.00 PH 10.00 pH	0.017 pH 0.018 pH 0.031 pH	Comparison to Standard Solutions
Conductivity – Source [6]	100 µS/cm 500 µS/cm 1 400 µS/cm 10 000 µS/cm	1.4 µS/cm 6.2 µS/cm 17 µS/cm 120 µS/cm	Comparison to Standard Solutions

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Electrical – DC/Low Frequency Santa Clara, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source [1]	Up to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V 220 V to 1.1 kV	7.5 µV/V + 0.4 µV 5 µV/V + 1 µV 3.5 µV/V + 3.1 µV 3.5 µV/V + 8.1 µV 5 µV/V + 83 µV 6.5 µV/V + 0.68 mV	Comparison to High Performance Multifunction Calibrator
DC Voltage – Measure [1]	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	7.2 µV/V + 0.55 µV 7 µV/V + 0.42 µV 6.9 µV/V + 0.86 µV 9.2 µV/V + 38 µV 9.3 µV/V + 0.13 mV	Comparison to Precision 8.5 Digit Multimeter
DC High Voltage – Measure [1]	Up to 10 kV (10 to 100) kV	0.35 mV/V + 0.09 V 0.63 mV/V + 4.1 V	Comparison to High Voltage Meter
DC Current – Source [1]	Up to 220 µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	40 µA/A + 6 nA 35 µA/A + 7.6 nA 35 µA/A + 48 nA 55 µA/A + 0.74 µA 0.13 mA/A + 13 µA	Comparison to High Performance Multifunction Calibrator
DC Current – Source [1]	330 mA to 1.1 A (1.1 to 3) A (3 to 11) A (11 to 20) A	0.15 mA/A + 44 µA 0.27 mA/A + 0.13 mA 0.39 mA/A + 0.41 mA 0.79 mA/A + 0.41 mA	Comparison to Multi Product Calibrator
DC Current – Source [1] Clamp-On Meters	(10 to 16.5) A (16.5 to 150) A (150 to 1 025) A	0.5 % of reading + 0.55 A 0.5 % of reading + 0.57 A 0.5 % of reading + 0.74 A	Comparison to Multi Product Calibrator w/ Current Coil
DC Power – Source [1] 33 mV to 1 020 V 329.99 mA range 2.9999 A range 20.5 A range	10 µW to 330 W 10 mW to 3 kW 100 mW to 21 kW	0.01 % of reading + 1.2 nW 0.04 % of reading 0.1 % of reading	Comparison to Multi Product Calibrator
DC Current – Measure [1]	Up to 100 nA 100 nA to 1 µA (1 to 10) µA (10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	22 µA/A + 93 pA 18 µA/A + 0.1 nA 28 µA/A + 0.14 nA 30 µA/A + 0.98 nA 30 µA/A + 6.5 nA 30 µA/A + 63 nA 44 µA/A + 1 µA 0.14 mA/A + 12 µA	Comparison to Precision 8.5 Digit Multimeter

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DC Current – Measure [1]	(1 to 100) A (100 to 600) A (600 to 1 000) A	85 µA/A 127 µA/A 0.29 % of reading + 0.02 A	Indirect Method Precision 8.5 Digit Multimeter w/ Current Shunts
AC Voltage – Source [1]	(1 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 (2.2 to 22) 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 (22 to 220) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz 220 mV to 2.2 V (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	 0.55 mV/V + 4.5 µV 0.21 mV/V + 4.5 µV 0.11 mV/V + 4.5 µV 0.37 mV/V + 4.5 µV 0.85 mV/V + 7 µV 1.1 mV/V + 13 µV 1.7 mV/V + 25 µV 3.4 mV/V + 25 µV 0.55 mV/V + 5 µV 0.21 mV/V + 5 µV 0.11 mV/V + 5 µV 0.37 mV/V + 5 µV 0.85 mV/V + 7 µV 1.1 mV/V + 12 µV 1.7 mV/V + 25 µV 3.4 mV/V + 25 µV 0.55 mV/V + 13 µV 0.21 mV/V + 8 µV 0.11 mV/V + 8 µV 0.32 mV/V + 8 µV 0.85 mV/V + 25 µV 1.1 mV/V + 25 µV 1.7 mV/V + 35 µV 3.4 mV/V + 80 µV 0.24 mV/V + 45 µV 90 µV/V + 25 µV 45 µV/V + 21 µV 75 µV/V + 22 µV 0.11 mV/V + 82 µV 0.42 mV/V + 0.11 mV 1 mV/V + 0.22 mV 1.7 mV/V + 0.31 mV	Comparison to High Performance Multifunction Calibrator w/ Transconductance Amplifier

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AC Voltage – Source [1]	(2.2 to 22) V		Comparison to High Performance Multifunction Calibrator w/ Transconductance Amplifier
	(10 to 20) Hz	0.24 mV/V + 0.44 mV	
	(20 to 40) Hz	90 µV/V + 0.24 mV	
	40 Hz to 20 kHz	45 µV/V + 0.19 mV	
	(20 to 50) kHz	75 µV/V + 0.11 mV	
	(50 to 100) kHz	0.1 mV/V + 0.59 mV	
	(100 to 300) kHz	0.28 mV/V + 0.81 mV	
	(300 to 500) kHz	1 mV/V + 2.1 V	
	500 kHz to 1 MHz	1.5 mV/V + 3.3 V	
	(22 to 220) V		
	(10 to 20) Hz	0.24 mV/V + 4.4 mV	
	(20 to 40) Hz	90 µV/V + 2.3 mV	
	40 Hz to 20 kHz	52 µV/V + 1.8 mV	
	(20 to 50) kHz	80 µV/V + 1.9 mV	
	(50 to 100) kHz	0.15 mV/V + 5.3 mV	
	(100 to 300) kHz	0.9 mV/V + 17 mV	
	(300 to 500) kHz	4.4 mV/V + 41 mV	
	500 kHz to 1 MHz	8 mV/V + 81 mV	
	(220 to 250) V		
	(15 to 50) Hz	0.3 mV/V + 17 mV	
	50 Hz to 1 kHz	70 µV/V + 3.9 mV	
	(1 to 20) kHz	0.17 mV/V + 6.8 mV	
	(20 to 30) kHz	0.6 mV/V + 12 mV	
	220 V to 1.1 kV		
	40 Hz to 1 kHz	90 µV/V + 5.3 mV	
	(1 to 20) kHz	0.17 mV/V + 6.8 mV	
	(20 to 30) kHz	0.6 mV/V + 12 mV	
	(220 to 750) V		
	(30 to 50) kHz	0.6 mV/V + 12 mV	
	(50 to 100) kHz	2.3 mV/V + 46 mV	

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AC Voltage – Measure [1]	(1 to 10) mV		Comparison to Precision 8.5 Digit Multimeter
	(1 to 40) Hz	0.36 mV/V + 3.6 µV	
	40 Hz to 1 kHz	0.23 mV/V + 1.4 µV	
	(1 to 20) kHz	0.32 mV/V + 1.7 µV	
	(20 to 50) kHz	1.2 mV/V + 1.6 µV	
	(50 to 100) kHz	5.7 mV/V + 2 µV	
	(100 to 300) kHz	46 mV/V + 2.6 µV	
	(10 to 100) mV		
	(1 Hz to 40) Hz	72 µV/V + 0.85 mV	
	40 Hz to 1 kHz	84 µV/V + 0.26 mV	
	(1 to 20) kHz	0.17 mV/V + 0.26 mV	
	100 mV to 10 V		
	(1 Hz to 40) Hz	71 µV/V + 0.73 mV	
	40 Hz to 1 kHz	80 µV/V + 0.26 mV	
	(1 to 20) kHz	160 µV/V + 0.26 mV	
	(20 to 50) kHz	0.35 mV/V + 0.25 mV	
	(50 to 100) kHz	0.93 mV/V + 0.27 mV	
	(100 to 300) kHz	3.5 mV/V + 1.2 mV	
	300 kHz to 1 MHz	12 mV/V + 1.2 mV	
	(1 to 2) MHz	18 mV/V + 1.2 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.24 mV/V + 4.7 mV	
	40 Hz to 1 kHz	0.15 mV/V + 16 mV	
	(1 to 20) kHz	0.15 mV/V + 17 mV	
	(20 to 50) kHz	0.36 mV/V + 8.6 mV	
	(50 to 100) kHz	1.4 mV/V + 3.9 mV	
	(100 to 300) kHz	4.8 mV/V + 12 mV	
	300 kHz to 1 MHz	18 mV/V + 12 mV	
	100 V to 1 kV		
	(1 to 40) Hz	0.46 mV/V + 50 mV	
	40 Hz to 1 kHz	0.46 mV/V + 28 mV	
	(1 to 20) kHz	0.69 mV/V + 29 mV	
	(20 to 50) kHz	1.5 mV/V + 24 mV	
	(50 to 100) kHz	3.6 mV/V + 24 mV	
AC High Voltage - Measure [1]	Up to 10 kV		Comparison to High Voltage Meter
	(30 to 200) Hz	1.4 mV/V + 0.14 V	
	(200 to 450) Hz	4.6 mV/V + 0.14V	
	(450 to 600) Hz	8.7 mV/V + 0.14V	
	(10 to 100) kV		
	(30 to 70) Hz	1.4 mV/V + 0.7 V	
	(70 to 200) Hz	17 % of reading + 0.7 V	

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AC Voltage Flatness - Source [1] (Referenced to 1 kHz)	0.3 mV to 3.5 V (10 to 30) Hz 30 Hz to 120 kHz (0.3 to 1.1) mV 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (1.1 to 3) mV 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz 3 mV to 3.5 V 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	 0.35 % of reading 0.12 % of reading 0.24 % of reading + 3 µV 0.47 % of reading + 3 µV 0.7 % of reading + 3 µV 1.8 % of reading + 15 µV 0.12 % of reading + 3 µV 0.35 % of reading + 3 µV 0.58 % of reading + 3 µV 1.8 % of reading + 3 µV 0.12 % of reading + 3 µV 0.24 % of reading + 3 µV 0.47 % of reading + 3 µV 1.2 % of reading + 3 µV	Comparison to High Performance Multifunction Calibrator (Wideband)
AC Voltage Flatness – Measure [1]	Up to 3 V (10 to 100) Hz 100 Hz to 10 kHz (10 to 30) kHz 30 kHz to 1 MHz (1 to 10) MHz (10 to 30) MHz (30 to 50) MHz (50 to 70) MHz (70 to 80) MHz (80 to 100) MHz	 0.2 % of reading 0.051% of reading 0.059 % of reading 0.13 % of reading 0.21% of reading 0.26% of reading 0.42 % of reading 0.65 % of reading 0.77% of reading 0.97 % of reading	Indirect Method Precision 8.5 Digit Multimeter w/ Thermal Converters

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AC Voltage – Measure [1]	Up to 10 mV		Comparison to Precision 8.5 Digit Multimeter AC BAND < 2 MHz
	(1 to 40) Hz	3.5 µV/V + 4.6 µV	
	40 Hz to 1 kHz	2.4 µV/V + 3.2 µV	
	(1 to 20) kHz	3.5 µV/V + 4.6 µV	
	(20 to 50) kHz	12 µV/V + 3.2 µV	
	(50 to 100) kHz	58 µV/V + 3.2 µV	
	(100 to 300) kHz	0.47 mV/V + 3.8 µV	
	(10 to 100) mV		
	(1 to 40) Hz	86 µV/V + 4.6 µV	
	40 Hz to 1 kHz	86 µV/V + 2.3 µV	
	(1 to 20) kHz	0.17 mV/V + 2.3 µV	
	(20 to 50) kHz	0.35 mV/V + 2.3 µV	
	(50 to 100) kHz	0.93 mV/V + 2.3 µV	
	(100 to 300) kHz	3.5 mV/V + 12 µV	
	300 kHz to 1 MHz	12 mV/V + 12 µV	
	(1 to 2) MHz	18 mV/V + 12 µV	
	100 mV to 1 V		
	(1 to 40) Hz	92 µV/V + 50 µV	
	40 Hz to 1 kHz	92 µV/V + 31 µV	
	(1 to 10) V		
	(1 to 20) kHz	0.17 mV/V + 31 µV	
	(20 to 50) kHz	0.35 mV/V + 31 µV	
	(50 to 100) kHz	0.93 mV/V + 31 µV	
	(100 to 300) kHz	3.5 mV/V + 0.12 mV	
	300 kHz to 1 MHz	12 mV/V + 0.12 mV	
	(1 to 2) MHz	18 mV/V + 0.12 mV	
	(10 to 100) V		
	(1 to 40) Hz	91 µV/V + 0.14 mV	
	40 Hz to 1 kHz	91 µV/V + 0.14 mV	
	(1 to 20) kHz	0.17 mV/V + 0.14 mV	
	(20 to 50) kHz	0.35 mV/V + 0.14 mV	
	(50 to 100) kHz	0.93 mV/V + 0.14 mV	
	(100 to 300) kHz	3.5 mV/V + 0.16 mV	
	300 kHz to 1 MHz	1.2 mV/V + 0.16 mV	
	(1 to 2) MHz	1.8 mV/V + 0.16 mV	

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AC Voltage - Measure [1]	(100 to 750) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	 0.45 mV/V + 2.7 mV 0.45 mV/V + 2.7 mV 0.45 mV/V + 2.7 mV 0.56 mV/V + 2.7 mV 1.5 mV/V + 2.7 mV 4.7 mV/V + 2.7 mV 18 mV/V + 2.7 mV	Comparison to Precision 8.5 Digit Multimeter AC BAND < 2 MHz
AC Voltage - Measure [1]	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz 11 mV to 10 V 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (11 to 100) V 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz (100 to 750) V 45 Hz to 100 kHz	 0.46 mV/V + 47 mV 0.46 mV/V + 24 mV 0.69 mV/V + 24 mV 1.4 mV/V + 24 mV 3.5 mV/V + 24 mV 1 mV/V + 7.5 µV 14 mV/V + 6.5 µV 81 mV/V + 8.6 µV 0.24 V + 9.7 µV 1 mV/V + 0.7 mV 24 mV/V + 0.58 mV 47 mV/V + 0.81 mV 47 mV/V + 0.93 mV 0.18 V + 1.2 mV 1.5 mV/V + 2.7 mV	Comparison to Precision 8.5 Digit Multimeter AC BAND > 2 MHz

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AC Current – Source [1]	Up to 220 µA		Comparison to High Performance Multifunction Calibrator
	(10 to 20 Hz	0.25 mA/A + 16 nA	
	(20 to 40) Hz	0.16 mA/A + 10 nA	
	40 Hz to 1 kHz	0.12 mA/A + 8 nA	
	(1 to 5) kHz	0.28 mA/A + 12 nA	
	(5 to 10) kHz	1.1 mA/A + 65 nA	
	220 µA to 2.2 mA		
	(10 to 20 Hz	0.25 mA/A + 40 nA	
	(20 to 40) Hz	0.16 mA/A + 36 nA	
	40 Hz to 1 kHz	0.12 mA/A + 36 nA	
	(1 to 5) kHz	0.2 mA/A + 0.11 µA	
	(5 to 10) kHz	1.1 mA/A + 0.65 µA	
	(2.2 to 22) mA		
	(10 to 20 Hz	0.25 mA/A + 0.41 µA	
	(20 to 40) Hz	0.16 mA/A + 0.36 µA	
	40 Hz to 1 kHz	0.12 mA/A + 0.36 µA	
	(1 to 5) kHz	0.2 mA/A + 0.56 µA	
	(5 to 10) kHz	1.1 mA/A + 5.1 µA	
	(22 to 220) mA		
	(10 to 20) Hz	0.25 mA/A + 4.1 µA	
	(20 to 40) Hz	0.16 mA/A + 3.6 µA	
	40 Hz to 1 kHz	0.12 mA/A + 2.6 µA	
	(1 to 5) kHz	0.2 mA/A + 3.6 µA	
	(5 to 10) kHz	1.1 mA/A + 11 µA	
	220 mA to 2.2 A		
	20 Hz to 1 kHz	0.25 mA/A + 36 µA	
	(1 to 5) kHz	0.45 mA/A + 81 µA	
	(5 to 10) kHz	7 mA/A + 0.18 mA	
	(2.2 to 11) A		
	40 Hz to 1 kHz	0.46 mA/A + 0.21 mA	
	(1 to 5) kHz	0.95 mA/A + 0.4 mA	
	(5 to 10) kHz	3.6 mA/A + 0.76 mA	
	(11 to 20) A		
	(45 to 100) Hz	1.2 mA/A + 5 mA	
	100 Hz to 1kHz	1.5 mA/A + 5 mA	
	(1 to 5) kHz	30 mA/A + 5 mA	

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AC Current – Source [1] Clamp-On Meters	(10 to 16.5) A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	 0.28 % of reading + 0.16 A 0.79 % of reading + 0.13 A 0.28 % of reading + 0.31 A 0.79 % of reading + 0.16 A 0.29 % of reading + 1.3 A 0.8 % of reading + 1.2 A	Comparison to Multi Product Calibrator w/ Current Coil
AC Power – Source [1] PF = 1 (10 to 45) Hz 33 mV to 32.9999 V (3.3 mA to 2.99999 A) (45 to 65) Hz 33 mV to 1020 V (3.3 mA to 20.5 A)	 110 µW to 99 W 110 µW to 21 kW	 0.19 % of reading 0.15 % of reading	Comparison to Multi Product Calibrator
Phase – Source [1]	+/- 179.99 (ΔΦ°) (10 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	 0.09° 0.2° 0.39° 1.9° 3.9° 7.8°	Comparison to Multi Product Calibrator

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AC Current – Measure [1]	Up to 100 µA		Comparison to Precision 8.5 Digit Multimeter
	(10 to 20) Hz	4.7 mA/A + 36 nA	
	(20 to 45) Hz	1.8 mA/A + 35 nA	
	(45 to 100) Hz	0.71 mA/A + 35 nA	
	100 Hz to 1 kHz	0.7 mA/A + 35 nA	
	100 µA to 100 mA		
	(10 to 20) Hz	4.7 mA/A + 24 µA	
	(20 to 45) Hz	1.8 mA/A + 24 µA	
	(45 to 100) Hz	0.71 mA/A + 24 µA	
	100 Hz to 5 kHz	0.36 mA/A + 23 µA	
	(5 to 20) kHz	0.71 mA/A + 24 µA	
	100 µA to 100 mA		
	(20 to 50) kHz	4.7 mA/A + 47 µA	
	(50 to 100) kHz	6.5 mA/A + 0.18 mA	
	100 mA to 1 A		
	(10 to 20) Hz	4.7 mA/A + 0.24 mA	
	(20 to 45) Hz	1.9 mA/A + 0.24 mA	
	(45 to 100) Hz	0.95 mA/A + 0.24 mA	
	100 Hz to 5 kHz	1.1 mA/A + 0.26 mA	
	(5 to 20) kHz	3.5 mA/A + 0.24 mA	
	(20 to 50) kHz	12 mA/A + 0.47 mA	
AC Current – Measure [1]	(1 to 10) A		Indirect Method Precision 8.5 Digit Multimeter / Shunts
	(3 to 5) Hz	20 mA/A + 6 mA	
	(5 to 10) Hz	11 mA/A + 6 mA	
	10 Hz to 5 kHz	1.5 mA/A + 6 mA	
	(5 to 10) kHz	3.5 mA/A + 70 mA	
	(10 to 100) A		
	(50 to 60) Hz	0.6 A	
	(100 to 300) A		
	(50 to 60) Hz	0.8 A	
Resistance – Source [1]	Up to 11 Ω	1.7 mΩ/Ω + 35 µΩ	Comparison to Multi Product Calibrator
	(11 to 33) Ω	23 µΩ/Ω + 3.3 mΩ	
	(33 to 110) Ω	31 µΩ/Ω + 1.9 mΩ	
	(110 to 330) Ω	32 µΩ/Ω + 2.8 mΩ	
	330 Ω to 1.1 kΩ	33 µΩ/Ω + 2.3 mΩ	
	(1.1 to 3.3) kΩ	32 µΩ/Ω + 30 mΩ	
	(3.3 to 11) kΩ	5 µΩ/Ω + 1.4 Ω	
	(11 to 33) kΩ	32 µΩ/Ω + 0.3 Ω	
	(33 to 110) kΩ	33 µΩ/Ω + 0.34 Ω	

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Resistance – Source [1]	(110 to 330) kΩ 330 kΩ 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 330 MΩ to 1.1 GΩ	37 μΩ/Ω + 3.1 Ω 38 μΩ/Ω + 2.6 Ω 71 μΩ/Ω + 36 Ω 0.13 mΩ/Ω + 0.38 kΩ 0.22 mΩ/Ω + 7.4 kΩ 0.42 mΩ/Ω + 32 kΩ 3.6 mΩ/Ω + 0.12 MΩ 18 mΩ/Ω + 0.59 MΩ	Comparison to Multi Product Calibrator
Resistance – Source [1] Fixed Points	1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ	0.12 mΩ 0.22 mΩ 0.28 mΩ 0.58 mΩ 1.3 mΩ 2.4 mΩ 10 mΩ 20 mΩ 90 mΩ 0.19 Ω 1.3 Ω 2.5 Ω 24 Ω 47 Ω	Comparison to High Performance Multifunction Calibrator
Resistance – Source [1] Fixed Points	1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	47 Ω 0.47 kΩ 1.3 kΩ 12 kΩ	Comparison to High Performance Multifunction Calibrator
Resistance – Source [1] Fixed Point	0.1 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ	0.56 mΩ 0.29 mΩ 2.3 mΩ 1.8 mΩ 35 mΩ 0.12 Ω 1.3 Ω	Comparison to Four Terminal Pair Resistor Set

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Resistance – Measure [1]	Up to 10 Ω (> 10 to 100) Ω > 100 Ω to 1 kΩ (> 1 to 10) kΩ (> 10 to 100) kΩ > 100 kΩ to 1 MΩ (> 1 to 10) MΩ (> 10 to 100) MΩ > 100 MΩ to 1 GΩ	21 µΩ/Ω + 62 µΩ 17 µΩ/Ω + 0.59 mΩ 15 µΩ/Ω + 0.67 mΩ 15 µΩ/Ω + 6.1 mΩ 15 µΩ/Ω + 62 mΩ 21 µΩ/Ω + 2.4 Ω 45 µΩ/Ω + 0.38 kΩ 0.58 mΩ/Ω + 1.2 kΩ 5.8 mΩ/Ω + 11 kΩ	Comparison to Precision 8.5 Digital Multimeter
Capacitance – Source [1] 10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz DC to 50 Hz DC to 20 Hz DC to 6 Hz DC to 2 Hz DC to 0.6 Hz DC to 0.2 Hz	 (220 to 399.9) pF (0.4 to 1.099 9) nF (1.1 to 3.299 9) nF (3.3 to 10.999 9) nF (11 to 32.999 9) nF (33 to 109.999) nF (110 to 329.999) nF (0.33 to 1.099 99) µF (1.1 to 3.299 99) µF (3.3 to 10.999 9) µF (11 to 32.999 9) µF (33 to 109.999) µF (110 to 329.999) µF (0.33 to 1.099 99) mF (1.1 to 3.299 99) mF (3.3 to 10.999 9) mF (11 to 32.999 9) mF (33 to 110) mF	 0.58 % of reading + 12 pF 0.57 % of reading + 12 pF 0.57 % of reading + 12 pF 0.22 % of reading + 27 pF 0.29 % of reading + 0.12 nF 0.29 % of reading + 0.13 nF 0.29 % of reading + 0.35 nF 0.28 % of reading + 1.5 nF 0.29 % of reading + 3.5 nF 0.29 % of reading + 1.3 nF 0.46 % of reading + 36 nF 0.53 % of reading + 0.12 µF 0.53 % of reading + 0.35 µF 0.5 % of reading + 1.5 µF 0.52 % of reading + 3.6 µF 0.51 % of reading + 13 µF 0.86 % of reading + 35 µF 1.3 % of reading + 0.13 mF	Comparison to Multi Product Calibrator
Fixed Capacitance [1] @ 1 kHz	(100 to 500) pF 500 pF to 5 nF (5 to 50) nF (50 to 100) nF (100 to 500) nF 500 nF to 1.5 µF	0.64 pF 3.7 pF 32 pF 63 pF 0.59 nF 0.63 nF	Comparison to Capacitance Standard Set

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Capacitance – Source [1]	1 pF 1 kHz to 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz 10 pF 1 kHz to 13 MHz 100 pF 1 kHz to 10 MHz 13 MHz 1 nF 1 kHz to 4 MHz 5 MHz 10 MHz 13 MHz	 1.2 fF 1.3 fF 1.5 fF 2.8 fF 3.9 fF 12 fF 0.12 pF 0.13 pF 1.2 pF 1.3 pF 2.2 pF 3 pF	Comparison to Standard Air Capacitor Set
Capacitance – Measure [1]	(1 to 10) nF (10 to 100) nF (0.2to 1) µF (1 to 10) µF (10 to 100) µF (100 to 1 000) µF (1 to 10) mF (10 to 100) mF	0.052 pF 0.041 pF 0.37 nF 0.018 µF 0.041 µF 0.56 µF 0.018 mF 0.059 mF	Comparison to Digit Multimeter/LCR Meter
Inductance – Source [1] 0.1 to 1 kHz	200 µH 2 mH 20 mH 200 mH 2 H	0.58 µH 2.4 µH 24 µH 0.24 mH 2.4 mH	Comparison to Standard Value Inductors
Inductance – Measure [1]	0.001 nH to 99.999 999 H Up to 1 kHz 1 kHz to 1 MHz	 0.062 % of reading + 0.007 mH 0.56 % of reading + 0.007 mH	Comparison to Precision LCR Meter
Electrical Simulation of Thermocouple Indicating Devices – Source and Measure [1]	Type C (0 to 150) °C (150 to 650) °C (650 to 1 000) °C (1 000 to 1 800) °C (1 800 to 2 316) °C	 0.29 °C 0.32 °C 0.28 °C 0.48 °C 0.71 °C	Comparison to Multi Product Calibrator

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Electrical Simulation of Thermocouple Indicating Devices – Source and Measure [1]	Type E		Comparison to Multi Product Calibrator
	(-250 to -100) °C	0.43 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 350) °C	0.17 °C	
	(350 to 650) °C	0.14 °C	
	(650 to 1 000) °C	0.19 °C	
	Type J		
	(-210 to -100) °C	0.35 °C	
	(-100 to -30) °C	0.2 °C	
	(-30 to 150) °C	0.14 °C	
	(150 to 760) °C	0.19 °C	
	(760 to 1 200) °C	0.26 °C	
	Type K		
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.23 °C	
	(120 to 1 000) °C	0.25 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type N		
	(-200 to -100) °C	0.39 °C	
	(-100 to -25) °C	0.27 °C	
	(-25 to 120) °C	0.23 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.27 °C	
	Type R		
	(0 to 250) °C	0.83 °C	
	(250 to 400) °C	0.42 °C	
	(400 to 1 000) °C	0.31 °C	
	(1 000 to 1 767) °C	0.38 °C	
	Type S		
	(0 to 250) °C	0.55 °C	
	(250 to 1 000) °C	0.34 °C	
	(1 000 to 1 400) °C	0.32 °C	
	(1 400 to 1 767) °C	0.41 °C	
	Type T		
	(-250 to -150) °C	0.63 °C	
	(-150 to 0) °C	0.35 °C	
	(0 to 120) °C	0.26 °C	
	(120 to 400) °C	0.22 °C	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Temperature Indicating Devices – Source and Measure [1]	Pt 385 (100 Ω)		Comparison to Multi Product Calibrator
	(-200 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	(630 to 800) °C	0.23 °C	
	Pt 3926 (100 Ω)		
	(-200 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	Pt 3916 (100 Ω)		
	(-200 to -190) °C	0.25 °C	
	(-190 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.06 °C	
	(100 to 260) °C	0.07 °C	
	(260 to 300) °C	0.08 °C	
	(300 to 400) °C	0.09 °C	
	(400 to 600) °C	0.1 °C	
	(600 to 630) °C	0.23 °C	
	Pt 385 (200 Ω)		
	(-200 to 100) °C	0.04 °C	
	(100 to 260) °C	0.05 °C	
	(260 to 300) °C	0.12 °C	
	(300 to 400) °C	0.13 °C	
	(400 to 600) °C	0.14 °C	
	(600 to 630) °C	0.16 °C	
	Pt 385 (500 Ω)		
	(-200 to -80) °C	0.04 °C	
	(-80 to 100) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 400) °C	0.08 °C	
	(400 to 600) °C	0.09 °C	
	(600 to 630) °C	0.11 °C	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Temperature Indicating Devices – Source and Measure [1]	Pt 385 (1000 Ω) (-200 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 600) °C (600 to 630) °C PtNi 385 (120 Ω) (Ni 120) (-80 to 100) °C (100 to 260) °C CU 427 (10 Ω) (100 to 260) °C	 0.03 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.23 °C 0.08 °C 0.14 °C 0.3 °C	Comparison to Multi Product Calibrator
Oscilloscopes [1] – DC Voltage into 50 Ω load into 1 MΩ load Square Wave into 50 Ω load into 1 MΩ load Leveled Sine Amplitude Reference @ 50 kHz	 (-6.6to 6.6) V (-130 to 130) V 10 Hz to 10 kHz 1 mVp-p to 6.6 Vp-p 10 Hz to 1 kHz 1 mVp-p to 130 Vp-p (1 to 10) kHz 1 mVp-p to 130 Vp-p 5 mV to 5.5 V	 0.2 % of reading + 36 µV 0.039 % of reading + 37 µV 0.2 % of reading + 65 µV 0.078 % of reading + 36 µV 0.19 % of reading + 39 µV 1.5 % of reading + 0.49 mV	Comparison to Multi Product Calibrator

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Oscilloscopes [1]			Comparison to Multi Product Calibrator
Leveled Sine Amplitude (relative to 50 kHz)	5 mV to 5.5 V		
	50 kHz to 100 MHz	14 mV/V + 0.12 mV	
	(100 to 300) MHz	17 mV/V + 0.14 mV	
	(300 to 600) MHz	32 mV/V + 0.15 mV	
	(600 to 1100) MHz	40 mV/V + 0.16 mV	
Time Markers (5-2-1 sequence) into 50 Ω load	(1 to 50) ns	0.001 1 % of reading + 0.048 ps	
	100 ns to 20 ms	0.000 2 % of reading + 7 ps	
	50 ms to 5 s	0.4 % of reading	
Edge Transition Time (Rise Time)	< 300 ps	80 ps	
Rise Time [1] (measurement)	20 ps to 100 µs	81 ns	Comparison to Oscilloscope
	1 ns to 10 µs	1.2 ns	
	(10 to 100) µs	2.9 ns	
ESD Simulators Contact Voltage (Positive and Negative)	(1 to 8) kV	1.2 % of reading	Procedure IEC 61000-4-2 (Ed.2, 2008); Multimeters, ESD Target, Attenuator, Oscilloscope
Rise Time	(0.6 to 1) ns	0.000 12 % Δ time reading + 11 ps	
Peak Current	(3.75 to 33) A	2.1 % of reading	
30 ns Current	(2 to 20.8) A	3.4 % of reading	
60 ns Current	(1 to 10.4) A	6.3 % of reading	
ESD Simulators Air Discharge Voltage (Positive and Negative) Rise Time	(0.7 to 1) ns		Procedure IEC 61000-4-2 (Ed.2, 2008); Multimeters, ESD Target, Attenuator, Oscilloscope
	(1 to 30) kV	1.2 % of reading	
RC Time Constant (at ± 15 kV)	600 ns ± 130 ns		
	330 pF probe	0.000 12 % Δ time reading + 11 ps	
	300 ns ± 60 ns		
	150 pF probe	0.000 12 % Δ time reading + 11 ps	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
EFT/Burst Generator			
Voltage (±)	10 V to 8 kV	2.7 % of reading	
Rise Time	5 ns ± 30 %	0.008 % ⧋ time reading	Procedure IEC 61000-4-4 (Ed.3, 2012); Fast Rise Oscilloscope w/ EFT Verification Set
Impulse Duration	50 ns ± 30 %	0.008 % ⧋ time reading	
Burst Duration	15 ns ± 20 %	0.008 % ⧋ time reading	
Burst Period	300 ms ± 20 %	0.008 % ⧋ time reading	
Surge Generator			
Front Time			
Rise Time			
Open Circuit (±)	(1.2 to 50) µs	0.008 % ⧋ time reading	Procedure IEC 61000-4-5 (Ed. 3.1, 2017), IEC 61000-4-11 (Ed 3.0, 2020), IEC 61000-4-18 (Ed. 2.0, 2019); Fast Rise Oscilloscope, Current Probes, Oscilloscope Probes
Short Circuit (±)	(1.2 to 50) µs	0.008 % ⧋ time reading	
Time to Half-Value (±)	(20 to 700) µs	0.008 % ⧋ time reading	
Open Circuit Voltage (±)	10 V to 12 kV	2.9 % of reading	
Short Circuit Voltage (±)	(0.125 to 3) kA	2.9 % of reading	
Ring Wave Voltage	1 kV ± 10 %	2.9 % of reading	
Ring Wave Rise Time	1.5 µs ± 0.5 µs	0.008 % ⧋ time reading	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Attenuation – Source Coaxial, 10 dB Step	(0 to 120) dB 1 kHz 500 MHz 1 GHz	 0.11 dB 0.28 dB 0.39 dB	Comparison to Standard Piston Attenuator
RF Attenuation – Source Coaxial, 1 dB Step	DC to 12.4 GHz (0 to 11) dB (12.4 to 18) GHz (0 to 11) dB	 0.6 dB 0.8 dB	Comparison to Standard Electronic Programmable Attenuator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Attenuation – Source Coaxial, 10 dB Step	DC to 12.4 GHz (0 to 10) dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB (80 to 110) dB	 0.51 dB 0.71 dB 0.91 dB 1.2 dB 1.5 dB 1.8 dB 2.1 dB 2.4 dB	Comparison to Standard Electronic Programmable Attenuator
RF Attenuation – Source Coaxial, 10 dB Step	(12.4 to 18) GHz (0 to 10) dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB (80 to 110) dB	 0.61 dB 0.81 dB 1.2 dB 1.6 dB 2 dB 2.4 dB 2.8 dB 3.2 dB	Comparison to Standard Electronic Programmable Attenuator
RF Absolute Power Source Into 50 Ω 0.001 Hz to 100 kHz SWR 1.2:1 100 kHz to 10 MHz SWR ≤ 1.2:1 (10 to 20) MHz SWR ≤ 1.2:1	 (3 to 10) Vp-p 1 mVp-p to 3Vp-p (3 to 10) Vp-p 1 mVp-p to 3 Vp-p 100 mVp-p to 3 Vp-p (1 to 100) mVp-p	 0.13 dB 0.22 dB 0.41 dB 0.61 dB 0.61 dB 0.91 dB	Comparison to Synthesized Signal Sources
RF Absolute Power Source Into 50 Ω Into 50 Ω/75 Ω	13.01 dBm 1 kHz to 25 MHz 200 Hz to 80 MHz	 0.12 dB 0.18 dB	Comparison to Synthesized Level Generator
RF Absolute Power Into 50 Ω, In 2 dB steps Relative to Full Output	200 Hz to 80 MHz (0 to -38) dBm (-40 to -58) dBm (-60 to -98) dBm	 0.21 dB 0.21 dB 0.27 dB	Comparison to Synthesized Level Generator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power Into 75 Ω, In 2 dB steps Relative to Full Output	(0 to -38) dBm 200 Hz to 25 MHz (25 to 80) MHz (-40 to -58) dBm 200 Hz to 25 MHz (25 to 80) MHz (-60 to -98) dBm 200 Hz to 25 MHz (25 to 80) MHz	 0.21 dB 0.36 dB 0.28 dB 0.54 dB 0.45 dB 1.7 dB	Comparison to Synthesized Level Generator
RF Absolute Power Source Into 50 Ω SWR ≤ 1.6:1 SWR ≤ 1.6:1 SWR ≤ 1.8:1 SWR ≤ 2:1 SWR ≤ 1.6:1 SWR ≤ 1.8:1 SWR ≤ 2:1 SWR ≤ 1.6:1 SWR ≤ 1.8:1 SWR ≤ 2:1	(+10 to - 10) dBm 10 MHz to 2 GHz (2 to 20) GHz (+5 to -10) dBm 10MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (+2.5 to -10) dBm (40 to 50) GHz (-10 to -60) dBm 10MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz (-60 to -110) dBm 10 MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	 1.5 dB 1.7 dB 0.82 dB 0.96 dB 1.2 dB 2.3 dB 1.2 dB 1.3dB 1.6 dB 2.3 dB 1.8 dB 1.9 dB 2.2 dB 3.3 dB	Comparison to Synthesized Level Generator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Tuned Power – Measure (relative)	100 kHz to 4.2 GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB (4.2 to 18) GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB (18 to 26.5) GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB	 0.14 dB 0.16 dB 0.19 dB 0.21 dB 0.25 dB 0.18 dB 0.2 dB 0.22 dB 0.24 dB 0.28 dB 0.24 dB 0.25 dB 0.27 dB 0.29 dB 0.32 dB	Comparison to Measuring Receiver System
RF Tuned Power – Measure (relative)	(26.5 to 50) GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB	 0.2 dB 0.21 dB 0.23 dB 0.25 dB 0.29 dB	Comparison to Measuring Receiver System
Digital Modulation – Measure Carrier Frequency 2 MHz to 2.65 GHz Error Vector Magnitude for Modulation Types: MSK, GMSK, BPSK, DQPSK, Π/4DQPSK, 8PSK, 16QAM, 32 QAM and QPSK Phase Error for Modulation Types: MSK, GMSK, BPSK, DQPSK, Π/4DQPSK, 8PSK, 16QAM, 32 QAM and QPSK	 (0 to 15) % (1 to 100) kHz 100 kHz to 1 MHz 1 MHz to 2.65 GHz (0 to 3)° (1 to 100) kHz (0.1 to 1) MHz 1 MHz to 2.65 GHz	 0.33 % of reading 0.51 % of reading 1 % of reading 0.18° 0.34° 0.57°	Comparison to Vector Signal Analyzer

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation – Measure Error Vector Magnitude for FSK Modulation	Modulation Frequency 3.2 kHz 1.152 kHz	 0.54 % of reading 1.5 % of reading	Comparison to Vector Signal Analyzer
Amplitude Modulation – Source (11 to 13.5) MHz 20 Hz to 100 kHz DC to 15 kHz	 Rate: 50 Hz to 50 kHz, (5 to 99) % Depth Rate: (20 to 50) Hz (5 to 99) % Depth Rate: 9 kHz to 3.2 GHz (0 to 100) % Depth	 0.1 % of reading 0.25 % of reading 5 % of reading	Comparison to AM/FM Test Source, Analog Modulation Sources
Amplitude Modulation – Source DC to 100 kHz	 Rate: 250 kHz to 50 GHz (0 to 99) % Depth	 1.2 % of reading + 0.07 AM	Comparison to AM/FM Test Source, Analog Modulation Sources
Amplitude Modulation – Measure 100 kHz to 10 MHz 10 MHz to 3 GHz	 Rate: 50 Hz to 10 kHz, (5 to 99) % Depth 50 Hz to 100 kHz, (20 to 99) % Depth	 0.001 4 % of reading + 0.009 AM 0.001 % of reading + 0.007 AM	Comparison to Microwave Measuring Receiver System
Amplitude Modulation – Measure 10 MHz to 3 GHz (3 to 26.5) GHz (3 to 26.5) GHz	 50 Hz to 100 kHz, (5 to 20) % Depth 50 Hz to 100 kHz, (5 to 20) % Depth 50 Hz to 100 kHz, (20 to 99) % Depth	 0.001 % of reading + 0.029 AM 0.01 % of reading + 0.052 AM 0.01 % of reading + 0.018 AM	Comparison to Microwave Measuring Receiver System

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Amplitude Modulation – Measure			Comparison to Microwave Measuring Receiver System
150 kHz to 10 MHz			
Rate: 50 Hz to 10 kHz,	(5 to < 10) % Depth	0.01 % of reading + 0.023 AM	
Depth: 5 % to 99 %	(10 to 99) % Depth	0.06 % of reading + 0.023 AM	
Rate: 20 Hz to 10 kHz,	(5 to < 10) % Depth	0.01 % of reading + 0.035 AM	
Depth: to 99 %	(10 to 99) % Depth	0.06 % of reading + 0.035 AM	
10 MHz to 1.3 GHz			
Rate: 50 Hz to 50 kHz,	(5 to < 10) % Depth	0.01 % of reading + 0.012 AM	
Depth: 5 % to 99 %	(10 to 99) % Depth	0.06 % of reading + 0.012 AM	
Rate: 20 Hz to 10 kHz,	(5 to < 10) % Depth	0.01 % of reading + 0.035 AM	
Depth: to 99 %	(10 to 99) % Depth	0.06 % of reading + 0.035 AM	
(1.3 to 26.5) GHz			
Rate: 50 Hz to 10 kHz,	(5 to < 10) % Depth	0.03 % of reading + 0.018 AM	
Depth: 5 % to 99 %	(10 to 99) % Depth	0.07 % of reading + 0.018 AM	
10 MHz to 26.5 GHz			
Rate: 20 Hz to 10 kHz,	(5 to < 10) % Depth	0.03 % of reading + 0.035 AM	
Depth: to 99 %	(10 to 99) % Depth	0.07 % of reading + 0.035 AM	
Frequency Modulation – Measure			Comparison to Microwave Measuring Receiver System
250 kHz to 10 MHz	Rate: 20 Hz to 10 kHz	1.7 % of reading + 5.7 Hz	
	Dev:20 Hz to 40 kHz pk	1.1 % of reading + 6.6 Hz	
10 MHz to 6.6 GHz	Rate: 50 Hz to 200 kHz	1.8 % of reading + 5.1 Hz	
	Dev:250 Hz to 400 kHz pk	1.2 % of reading + 6.1 Hz	
Frequency Modulation – Measure			Comparison to Microwave Measuring Receiver System
(6.6 to 13.2) GHz	Rate: 50 Hz to 200 kHz	2.9 % of reading + 4 Hz	
	Dev:250 Hz to 400 kHz pk	1.2 % of reading + 6.4 Hz	
(13.2 to 26.5) GHz	Rate: 50 Hz to 100 kHz	4.4 % of reading + 3.8 Hz	
	Dev:250 Hz to 400 kHz pk	1.2 % of reading + 7.6 Hz	
Frequency Modulation – Measure			Comparison to Microwave Measuring Receiver System
250 kHz to 10 MHz			
(0 to < 4) kHz pk FM	Rate: 20 Hz to 10 kHz	0.024 FM + 2.4 Hz Pk	
(≥ 4 to < 40) kHz pk FM	≤ 40 kHz pk	0.024 FM + 8 Hz Pk	
10 MHz to 26.5 GHz			

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure 10 MHz to 1.3 GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 50 Hz to 100 kHz ≤ 400 kHz pk	0.012 FM + 2.4 Hz Pk 0.012 FM + 14 Hz Pk 0.012 FM + 66 Hz Pk	Comparison to Microwave Measuring Receiver System
Frequency Modulation – Measure (> 1.3 to 6.2) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (> 6.2 to 12.4) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 50 Hz to 100 kHz ≤ 400 kHz pk	0.012 FM + 19 Hz Pk 0.012 FM + 23 Hz Pk 0.012 FM + 75 Hz Pk 0.012 FM + 35 Hz Pk 0.012 FM + 39 Hz Pk 0.012 FM + 91 Hz Pk	Comparison to Microwave Measuring Receiver System
Frequency Modulation – Measure (> 12.4 to 18.6) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (> 18.6 to 26.5) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 50 Hz to 100 kHz ≤ 400 kHz pk	0.012 FM + 51 Hz Pk 0.012 FM + 55 Hz Pk 0.012 FM + 110 Hz Pk 0.012 FM + 67 Hz Pk 0.012 FM + 71 Hz Pk 0.012 FM + 130 Hz Pk	Comparison to Microwave Measuring Receiver System
Frequency Modulation – Measure 10 MHz to 26.5 GHz 10 MHz to 1.3 GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (>1.3 to 6.2) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 50 Hz to 100 kHz ≤ 400 kHz pk	0.058 FM + 3.9 Hz Pk 0.058 FM + 8 Hz Pk 0.058 FM + 66 Hz Pk 0.058 FM + 19 Hz Pk 0.058 FM + 23 Hz Pk 0.058 FM + 75 Hz Pk	Comparison to Microwave Measuring Receiver System

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure (> 6.2 to 12.4) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (> 12.4 to 18.6) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (> 18.6 to 26.5) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 20 Hz to 200 kHz ≤ 400 kHz pk	 0.058 FM + 35 Hz Pk 0.058 FM + 39 Hz Pk 0.058 FM + 91 Hz Pk 0.058 FM + 51 Hz Pk 0.058 FM + 55 Hz Pk 0.058 FM + 110 Hz Pk 0.058 FM + 67 Hz Pk 0.058 FM + 71 Hz Pk 0.058 FM + 130 Hz Pk	Comparison to Microwave Measuring Receiver System
Frequency Modulation – Source (11 to 13.5) MHz (11 to 13.5) MHz (88 to 108) MHz (88 to 108) MHz (352 to 432) MHz	 Rate: DC to 10 kHz Dev.: ≤ 100 kHz peak Rate: DC to 10 kHz Dev.: ≤ 200 kHz peak Rate: DC to 100 kHz Dev.: ≤ 100 kHz peak Rate: DC to 100 kHz Dev.: ≤ 200 kHz peak Rate: DC to 100 kHz Dev.: ≤ 100 kHz peak	 0.1 % of reading 0.25 % of reading 0.1 % of reading 0.25 % of reading 0.1 % of reading	Comparison to AM/FM Test Source

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Source			Comparison to Analog Modulation Sources
(352 to 432) MHz	Rate: DC to 100 kHz Dev.: ≤ 200 kHz peak	0.25 % of reading	
9 kHz to 1 GHz	Rate: DC to 150 kHz Dev.: ≤ 200 kHz peak	3 % of reading + 30 Hz	
(1 to 2) GHz	Rate: DC to 150 kHz Dev.: ≤ 400 kHz peak	3 % of reading + 60 Hz	
(2 to 3) GHz	Rate: DC to 150 kHz Dev.: ≤ 400 kHz peak	3 % of reading + 120 Hz	
Frequency Modulation – Source			Comparison to Analog Modulation Sources
1 kHz rate			
Max. Dev. 2 MHz	250 kHz to 1 GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 4 MHz	(1 to 2) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 8 MHz	(2 to 3.2) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 16 MHz	(3.2 to 10) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 32 MHz	(10 to 20) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 64 MHz	(20 to 40) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 128 MHz	(40 to 50) GHz	40 mHz/Hz + 23 Hz	
Phase Modulation – Measure			Comparison to Microwave Measuring Receiver System
> 0.7 rad Dev.	100 kHz to 6.6 GHz	1.2 % of reading + 0.007 1 rad	
> 0.6 rad Dev.	(6.6 to 13.2) GHz	1.2 % of reading + 0.007 1 rad	
> 1.2 rad Dev.	(13.2 to 26.5) GHz	1.2 % of reading + 0.007 3 rad	
Phase Modulation – Measure			Comparison to Microwave Measuring Receiver System
150 kHz to 10 MHz			
(0 to < 4) rad pk PM	200 Hz to 10 kHz Rate	4.7 % of reading + 0.001 rad	
(≥ 4 to < 40) rad pk PM	≤ 40 rad pk	4.7 % of reading + 0.008 rad	
10 MHz to 1.3 GHz			
(0 to < 4) rad pk PM	200 Hz to 20 kHz Rate	3.5 % of reading + 0.001 rad	
(≥ 4 to < 40) rad pk PM	≤ 400 rad pk	3.5 % of reading + 0.008 rad	
(≥ 40 to < 400) rad pk PM		3.5 % of reading + 0.09 rad	
Phase Modulation – Measure			Comparison to Microwave Measuring Receiver System
1.3 to 26.5 GHz			
(0 to < 4) rad pk PM	200 Hz to 20 kHz Rate	3.5 % of reading + 0.001 rad	
(≥ 4 to < 40) rad pk PM	≤ 400 rad pk	3.5 % of reading + 0.008 rad	
(≥ 40 to < 400) rad pk PM		3.5 % of reading + 0.09 rad	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Source Rate: 20 Hz to 10 kHz Carrier: 9 kHz to 1 GHz (1 to 2) GHz (2 to 3.2) GHz 250 kHz to 1 GHz (>1 to 2) GHz (>2 to 3.2) GHz (>3.2 to 10) GHz (>10 to 20) GHz (>20 to 40) GHz (>40 to 50) GHz	 (0 to 10) rad (0 to 20) rad (0 to 40) rad Max. Dev. (0 to 20) rad (0 to 40) rad (0 to 80) rad (0 to 160) rad (0 to 320) rad (0 to 640) rad (0 to 1 280) rad	 3 % of reading + 0.05 rad 3 % of reading + 0.1 rad 3 % of reading + 0.2 rad 6 % of reading + 0.012 rad 6 % of reading + 0.012 rad 6 % of reading + 0.012 rad 6 % of reading + 0.012 rad 6 % of reading + 0.012 rad 6 % of reading + 0.012 rad 6 % of reading + 0.012 rad	Comparison to Analog Modulation Sources
Distortion – Measure	(0.01 to 100) % Distortion 250 kHz to 50 GHz	0.065 % of reading	Comparison to Microwave Measuring Receiver System
Distortion – Measure Fundamental Frequency 20 Hz to 20 kHz (20 to 100) kHz	 (-99 to 0) dB (-99 to 0) dB	 1.2 dB 2.3 dB	Comparison to Distortion Analyzer
Power Reference – Measure 50 MHz	50 MHz 1 mW	5.5 µW	Indirect Method Primary Standards Lab (H75) Thermistor Mount, Power Meter, Precision 8.5 Digit Multimeter
Absolute Power – Measure	9 kHz to 4.2 GHz (+20 to -30) dBm 10 MHz to 18 GHz (-20 to -70) dBm 50 MHz to 26.5 GHz (+20 to -30) dBm (26.5 to 50) GHz (+20 to -30) dBm (-20 to -70) dBm	 0.3 % of Reading + 0.65 dB 0.44 % of reading + 0.32 dB 0.24 % of reading + 0.86 dB 0.46 % of reading + 0.94 dB 1.6 % of reading + 0.67 dB	Comparison to RF Power Meters with Sensors

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Power Meter – Range Calibration	3 µW 10 µW 30 µW 100 µW 300 µW 1 mW 3 mW 10 mW 30 mW 100 mW	21 nW 19 nW 21 nW 77 nW 0.11 µW 0.29 µW 0.64 µW 6.4 µW 13 µW 0.1 mW	Comparison to Power Meter Range Calibrator w/ Precision DC Voltage Source
Noise Figure – Source	15 dB ENR 10 MHz to 4 GHz (> 4 to 10) GHz (> 10 to 18) GHz (> 18 to 26.5) GHz	 0.22 dB 0.22 dB 0.22 dB 0.22 dB	Comparison to Noise Source
Noise Figure – Measure	100 kHz to 30 MHz >30 MHz to 3 GHz (>3 to 26.5) GHz	0.43 dB 0.42 dB 0.47 dB	Comparison to Noise Figure Measurement System w/ Standard Noise Sources
Single Sideband Phase Noise - Measure	1 MHz to 26.5 GHz	1.8 dB	Comparison to Phase Noise Measurement System
Current Probes/ Bulk Current Injection Probes Insertion Loss Transfer Impedance	 (0 to 100) dB 20 Hz to 300 kHz 300 kHz to 1 MHz 1 MHz to 3 GHz (0 to 100) dB 20 Hz to 300 kHz 300 kHz to 1 MHz 1 MHz to 3 GHz	 1.1 dB 1 dB 1.9 dB 1.1 dB 1 dB 1.9 dB	Comparison to Network/RF Impedance Analyzers, Attenuator, Type N Calibration Kit

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Transmission S_{12}/S_{21} – Measure Phase and Magnitude	9 kHz to 1.3 GHz (-180 to 180)° (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-60 to -20) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB (1.3 to 3) GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-60 to -20) dB (-70 to -60) dB (1.3 to 3) GHz (-80 to -70) dB (-90 to -80) dB	 0.18 dB (1°) 0.057 dB (0.43°) 0.072 dB (0.8°) 0.086 dB (0.89°) 0.13 dB (1.2°) 0.3 dB (2.4°) 0.92 dB (6.9°) 0.12 dB (4.1°) 0.063 dB (0.48°) 0.077 dB (0.8°) 0.093 dB (0.94°) 0.13 dB (1.2°) 0.32 dB (2.6°) 0.92 dB (7.4°)	Comparison to LF Vector Network Analyzer, Calibration Kits
Transmission S_{12}/S_{21} – Measure Phase and Magnitude	50 MHz to 2 GHz (-180 to 180)° (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB (2 to 8) GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB	 0.07 dB (0.46°) 0.054 dB (0.36°) 0.075 dB (0.5°) 0.12 dB (0.83°) 0.29 dB (1.9°) 2.3 dB (5.5°) 5.9 dB (5.7°) 0.09 dB (0.59°) 0.07 dB (0.46°) 0.087 dB (0.57°) 0.1 dB (0.69°) 0.12 dB (0.81°) 0.15 dB (0.98°) 0.22 dB (1.4°) 0.45 dB (3.1°) 1.2 dB (8.7°) 3.4 dB (8.7°)	Comparison to Vector Network Analyzer w/ Calibration Kits

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Transmission S_{12}/S_{21} – Measure Phase and Magnitude	(8 to 20) GHz (-180 to 180° (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB (20 to 50) GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB	 0.19 dB (1.3°) 0.17 dB (1.1°) 0.18 dB (1.2°) 0.2 dB (1.3°) 0.22 dB (1.4°) 0.24 dB (1.6°) 0.32 dB (2.1°) 0.6 dB (4.1°) 1.6 dB (8.7°) 4.2 dB (11°) 0.54 dB (3.7°) 0.5 dB (3.4°) 0.49 dB (3.3°) 0.5 dB (3.4°) 0.52 dB (3.5°) 0.55 dB (3.7°) 0.65 dB (4.4°) 1.1 dB (7.6°) 2.7 dB (8.9°) 6.6 dB (11°)	Comparison to Vector Network Analyzer w/ Calibration Kits
Reflection S_{11}/S_{22} – Measure Phase and Magnitude [2,3]	9 kHz to 1.3 GHz (-180 to 180)° (< 0.03) Γ (< 0.2) Γ (< 0.4) Γ (< 0.6) Γ (< 0.8) Γ (< 1) Γ (1.3 to 3) GHz (< 0.03) Γ (< 0.2) Γ (< 0.4) Γ (< 0.6) Γ (< 0.8) Γ (< 1) Γ	 0.002 3 (1.4°) 0.003 5 (1.4°) 0.006 1 (1.1°) 0.008 3 (0.94°) 0.01 (0.83°) 0.012 (0.7°) 0.005 6 (1.8°) 0.003 5 (1.8°) 0.008 (1.3°) 0.011 (1.2°) 0.013 (1°) 0.016 (0.89°)	Comparison to LF Vector Network Analyzer, Calibration Kits

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Reflection S_{11}/S_{22} – Measure Phase and Magnitude [2,3]	50 MHz to 2 GHz (-180 to 180)° (< 0.03) Γ (< 0.2) Γ (< 0.4) Γ (< 0.6) Γ (< 0.8) Γ (< 1) Γ (2 to 8) GHz (< 0.03) Γ (< 0.2) Γ (< 0.4) Γ (< 0.6) Γ (< 0.8) Γ (< 1) Γ (8 to 20) GHz (< 0.03) Γ (< 0.2) Γ (< 0.4) Γ (< 0.6) Γ (< 0.8) Γ (< 1) Γ (20 to 50) GHz (-180 to 180)° (< 0.03) Γ (< 0.2) Γ (< 0.4) Γ (< 0.6) Γ (< 0.8) Γ (< 1) Γ	 0.01 (3.3°) 0.012 (3.3°) 0.014 (2°) 0.017 (1.6°) 0.021 (1.5°) 0.026 (1.5°) 0.01 (3.5°) 0.012 (3.5°) 0.015 (2.2°) 0.019 (1.8°) 0.024 (1.7°) 0.003 (1.7°) 0.002 4 (7.8°) 0.002 7 (7.8°) 0.003 3 (4.8°) 0.004 2 (4°) 0.053 (3.8°) 0.067 (3.9°) 0.06 (19°) 0.066 (11°) 0.079 (11°) 0.097 (9.3°) 0.12 (8.8°) 0.15 (8.8°)	Comparison to Vector Network Analyzer w/ Calibration Kits

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) 7mm Test Ports Reflection S_{11}/S_{22} [2,3]			
Magnitude	</= 0.1 to </= 1.0 Γ		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.0003 to 1) GHz	0.003 8 Γ	
	(1 to 3) GHz	0.003 9 Γ	
	(3 to 6) GHz	0.005 1 Γ	
Phase	</= 0 to </= 60°		
	(0.0003 to 1) GHz	2°	
	(1 to 3) GHz	2.1°	
	(3 to 6) GHz	2.7°	
Network Analyzer System Verification (Corrected Performance) N-Type Test Ports Reflection S_{11}/S_{22} [2,3]			
Magnitude	</= 0.1 to </= 1 Γ		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.000 3 to 1) GHz	0.009 Γ	
	(1 to 3) GHz	0.001 Γ	
	(3 to 8) GHz	0.001 5 Γ	
	(8 to 18) GHz	0.004 1 Γ	
Phase	</= 0 to </= 60°		
	(0.000 3 to 1) GHz	0.46°	
	(1 to 3) GHz	0.64°	
	(3 to 8) GHz	0.65°	
	(8 to 18) GHz	1.3°	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) 3.5mm Test Ports Reflection S_{11}/S_{22} [2,3]			
Magnitude	</= 0.1 to </= 1 Γ		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.045 to 2) G Γ Hz	0.000 76 Γ	
	(2 to 20) GHz	0.001 Γ	
	(20 to 26.5) GHz	0.003 Γ	
Phase	</= 0 to </= 60°		
	(0.045 to 2) GHz	0.34°	
	(2 to 20) GHz	0.36°	
	(20 to 26.5) GHz	0.64°	
Network Analyzer System Verification (Corrected Performance) 2.4mm Test Ports Reflection S_{11}/S_{22} [2,3]			
Magnitude [2,3]	</= 0.1 to </= 1.0 Γ		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.045 to 2) GHz	0.003 8 Γ	
	(2 to 20) GHz	0.003 8 Γ	
	(20 to 40) GHz	0.004 4 Γ	
	(40 to 50) GHz	0.005 5 Γ	
Phase	</= 0 to </= 60°		
	(0.045 to 2) GHz	0.96°	
	(2 to 20) GHz	1.3°	
	(20 to 40) GHz	1.5°	
	(40 to 50) GHz	2.3°	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) 7mm Test Ports Transmission $S_{21}/S1_{22}$			
Magnitude	</= 0.1 to </= 1.0 dB		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.000 3 to 1) GHz	0.16 dB	
	(1 to 3) GHz	0.16 dB	
	(3 to 6) GHz	0.17 dB	
Phase	</= 0 to </= 60°		
	(0.000 3 to 1) GHz	1.4°	
	(1 to 3) GHz	1.5°	
	(3 to 6) GHz	2.2°	
Network Analyzer System Verification (Corrected Performance) N-Type Test Ports Transmission $S_{21}/S1_{22}$			
Magnitude	</= 0.1 to </= 1 dB		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.000 3 to 1) GHz	0.018 dB	
	(1 to 3) GHz	0.019 dB	
	(3 to 8) GHz	0.02 dB	
	(8 to 18) GHz	0.024 dB	
Phase	</= 0 to </= 60°		
	(0.000 3 to 1) GHz	0.18°	
	(1 to 3) GHz	0.2°	
	(3 to 8) GHz	0.23°	
	(8 to 18) GHz	0.24°	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) 3.5mm Test Ports Transmission $S_{21}/S1_{22}$			
Magnitude	</= 0.1 to </= 1 dB		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.045 to 2) GHz	0.018 dB	
	(2 to 20) GHz	0.019 dB	
	(20 to 26.5) GHz	0.032 dB	
Phase	</= 0 to </= 60°		
	(0.045 to 2) GHz	0.18°	
	(2 to 20) GHz	0.18°	
	(20 to 26.5) GHz	0.32°	
Network Analyzer System Verification (Corrected Performance) 2.4mm Test Ports Transmission $S_{21}/S1_{22}$			
Magnitude	</= 0.1 to </= 1 dB		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.045 to 2) GHz	0.023 dB	
	(2 to 20) GHz	0.033 dB	
	(20 to 40) GHz	0.055 dB	
	(40 to 50) GHz	0.068 dB	
Phase	</= 0 to </= 60°		
	(0.045 to 2) GHz	0.23°	
	(2 to 20) GHz	0.41°	
	(20 to 40) GHz	0.97°	
	(40 to 50) GHz	1.8°	
Scalar Network Analyzer Absolute Log Error	21 dB	0.04 dB	Comparison to Scalar Network Analyzer Calibrator
Dynamic Accuracy	(0 to 140) dB	0.02 dB	
Network Analyzer Dynamic Accuracy	(0 to 140) dB	0.02 dB	Comparison to Dynamic Accuracy Test Set

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Impulse Spectral Amplitude Source			Comparison to Pulse Generator
CISPR Band A	(10 to 150) kHz	0.82 dB	
CISPR Band B	150 kHz to 30 MHz	0.82 dB	
CISPR Band C and D	30 MHz to 1 GHz	1.1 dB	
CISPR Band E	(1 to 18) GHz	1.5 dB	
Sinewave Output for CISPR Checks Source @ 60 dB/µV	(0 to -70) dB		
	100 kHz	0.35 dB	
	(1, 10, and 100) MHz	0.35 dB	
Peak and Average Detector Response	(0 to -70) dB CISPR Band A thru D	1.3 dB	
LISN (Line Impedance Stabilization Network) & AMN (Artificial Mains Network)			Comparison to RF Impedance/Network Analyzers, Calibration Kits
Insertion Loss	(-20 to 0) dB 10 Hz to 1000 MHz	0.25 dB	
Isolation (De-Coupling Factor)	(-90 to 0) dB 10 Hz to 1 000 MHz	2.3 dB	
Impedance (Magnitude)	0.1 Ω to 1 kΩ 10 Hz to 1000 MHz	2.4 % of reading	
Impedance (Phase)	(-180 to 180)° 10 Hz to 1 000 MHz	2.6°	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
CDN (Coupling-Decoupling Network) & ISN (Impedance Stabilization Network)			
Insertion Loss	(-20 to 0) dB 10 Hz to 1000 MHz	0.25 dB	
Isolation (De-Coupling Factor)	(-90 to 0) dB 10 Hz to 1000 MHz	2.3 dB	Comparison to RF Impedance/Network Analyzers, Calibration Kits
Impedance (Magnitude)	0.1 Ω to 1 kΩ 10 Hz to 1 000 MHz	2.4 % of reading	
Impedance (Phase)	(-180 to 180)° 10 Hz to 1 000 MHz	2.6°	
LCL (Longitudinal Conversion Loss)	(-20 to 0) dB 10 Hz to 1 000 MHz	2.3 dB	

Length – Dimensional Metrology Santa Clara, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Test, Dial Indicators, Thickness Gages [1,2]	Up to 4 in	$(57 + 0.26L)$ µin	Comparison to Gage Blocks
Calipers [1]	Up to 54 in	$(52 + 46L)$ µin	Comparison to Gage Blocks, Standard Rings, Rod Sets
Micrometers [1] (Linearity Only)	Up to 54 in	$(52 + 46L)$ µin	Comparison to Gage Blocks, Rod Sets
Pin and Plug Gages [1]	Up to 25 mm	5 µm	Comparison to Micrometer
Height Gages [2]	Up to 12 in	$(750 + 4.7L)$ µin	Comparison to Gage Blocks
Depth Gages [2]	Up to 12 in	$(160 + 4.1L)$ µin	Comparison to Gage Blocks

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Length – Dimensional Metrology Santa Clara, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Surface Plates [1,2] Overall Flatness	Up to 161 in*DL*	(77 + 0.18*DL*) µin	Comparison to Leveling System
Local Area Flatness	Up to 0.001 in	29 µin	Repeat-O-Meter
Steel Rulers	Up to 48 in	0.036 in	Comparison to Gage Blocks
Tape Measures	Up to 50 ft	0.036 in	Comparison to Gage Blocks
Protractor/Angle	Up to 90°	0.069°	Comparison to Angle Gage Blocks
Thread Plug Gage[2] Minor Diameter	(0.04 to 5.9) in	(76 + 5.8L) µin	Comparison to IAC MasterScanner
Major Diameter	(0.04 to 5.9) in	(76 + 5.8L) µin	
Pitch Diameter	(0.04 to 5.9) in	(40 + 7.7L) µin	
Flank Angle	(≥ 27 to ≤ 80)°	0.11°	
Thread Ring Gage[2] Minor Diameter	(0.1 to 6.3) in	(90 + 4.8*L*) µin	Comparison to IAC MasterScanner
Major Diameter	(0.1 to 6.3) in	(90 + 4.8*L*) µin	
Pitch Diameter	(0.1 to 6.3) in	(40 + 8.5*L*) µin	
Flank Angle	(≥ 27 to ≤ 80)°	0.11°	

Mass and Mass Related Santa Clara, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Barometric Pressure Measurement	Up to 39 psia	0.014 psi	Comparison to Digital Barometer / Precision Absolute Manometer
Force-Measuring Equipment Tension / Compression	(0.1 to 50) kgf	0.042 mgf/gf + 7.1 gf	Comparison to NIST Class F Weights

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Mass and Mass Related Santa Clara, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force-Measuring Standards/Transducers Tension / Compression	Up to 1 000 lbf (> 1 000 to 5 000) lbf (> 5 000 to 10 000) lbf (> 10 000 to 25 000) lbf (> 25 000 to 50 000) lbf (> 50 000 to 75 000) lbf (> 75 000 to 100 000) lbf	1.5 lbf 7.3 lbf 15 lbf 37 lbf 77 lbf 120 lbf 150 lbf	Comparison to Reference Load Cells
Pressure – Source/Pressure gages and transducers [1]	(-12 to 300) psi (300 to 10 000) psi	0.2 psi 1.4 psi	Comparison to Pressure Calibration System
Torque – Measure/Torque tools [1]	(2.5 to 25) lbf·in (5 to 10) lbf·in (10 to 100) lbf·in (5 to 50) lbf·ft (25 to 250) lbf·ft (250 to 600) lbf·ft	0.5 % of reading + 0.03 lbf·in 0.5 % of reading + 0.008 7 lbf·in 0.5 % of reading + 0.067 lbf·in 0.6 % of reading + 0.002 9 lbf·ft 0.5 % of reading + 0.17 lbf·ft 0.6 % of reading + 0.15 lbf·ft	Comparison to Torque Transducers
Torque – Source/Analyzers and measuring equipment	(1 to 10) lbf·in (10 to 25) lbf·in (25 to 50) lbf·in (50 to 100) lbf·in (100 to 150) lbf·in (150 to 250) lbf·in	0.021 % of reading + 0.009 lbf·in 0.017 % of reading + 0.011 lbf·in 0.033 % of reading + 0.022 lbf·in 0.035 % of reading + 0.040 lbf·in 0.038 % of reading + 0.042 lbf·in 0.04 % of reading + 0.045 lbf·in	Comparison to Calibration Wheels Standard Weights
Scales & Balances [1,10]	1 mg to 10 g (10 to 500) g (0.5 to 1) kg (1 to 2) kg	0.034 mg 0.7 mg 1.5 mg 2.9 mg	Comparison to ASTM E617 Class 0 weights and internal calibration procedure utilized in the calibration of the weighing system.
Scales & Balances [1,10]	(2 to 20) kg (20 to 40) kg (40 to 50) kg	2.3 g 4.6 g 5.8 g	Comparison to ASTM E617 Class 6 weights, NIST Class F weights, and internal calibration procedure utilized in the calibration of the weighing system.

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Mass and Mass Related Santa Clara, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales & Balances [1,10]	(0.001 to 0.05) lb (0.1 to 1) lb (1 to 2) lb (2 to 5) lb (5 to 10) lb (10 to 20) lb (20 to 50) lb	0.000 012 lb 0.000 18 lb 0.000 24 lb 0.000 6 lb 0.001 1 lb 0.002 4 lb 0.006 lb	Comparison to NIST Class F weights and internal calibration procedure utilized in the calibration of the weighing system.
Volumetric Recipients (Graduated Volumetric Containers)	(1 to 20) ml (> 20 to 80) ml (> 80 to 220) ml	0.06 ml 0.2 ml 0.23 ml	Comparison to Analytical Balance

Thermodynamic Santa Clara, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Radiation (Infrared) [1] Thermometers	(50 to 100)°C (100 to 300)°C (300 to 500)°C	1.7°C 5.3°C 8.2°C	Comparison to Blackbody Source (Flat plate) $\varepsilon = 0.95$, $\lambda = (8 \text{ to } 14)$
Relative Humidity – Measure [1]	Up to 90 %RH (90 to 95) %RH	1.6 % RH 2.2 % RH	Comparison to Humidity Probe Monitor
Relative Humidity – Measuring equipment	Up to 90 %RH (90 to 95) %RH	1.9 %RH 2.5 %RH	Comparison to Humidity Chamber, Humidity Probe Monitor
Temperature – Measure [1]	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 420) °C (420 to 650) °C	0.03 °C 0.05 °C 0.07 °C 0.11 °C 0.14 °C	Comparison to Reference Thermometer w/ PRT
Temperature – Measuring Equipment	(-70 to 0) °C (0 to 100) °C (100 to 175) °C	1.3 °C 1.5 °C 2.8 °C	Comparison to Reference Chamber and Thermometer w/ PRT

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Time and Frequency Santa Clara, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source [1]	1 µHz to 80 MHz	5.8×10^{-9} MHz	Comparison to Frequency Synthesizer w/ GPS Reference Signal Generator
Frequency – Source [1]	1 Hz to 50 GHz	5.8×10^{-10} GHz	Comparison to Synthesized Sweeper w/ GPS Reference
Frequency – Measure [1]	1 µHz to 12.4 GHz 1 Hz to 50 GHz	5.8×10^{-10}GHz 5.8×10^{-11} GHz	Comparison to Electronic Counters, Analyzers w/ GPS Reference
Time Interval	50 ns to 999 s	5 ps/s +0.43 ns	Comparison to Universal Counter w/ GPS Reference
Period [1]	4.44 ns to 10 s	0.012 % of reading + 0.17 ns	Comparison to Universal Counter w/ GPS Reference
Rise/Fall Time – Measure [1]	1 ns to 10 µs (10 to 100) µs	1.2 ns 2.9 ns	Comparison to Digital Oscilloscope Or Universal Counter w/ GPS Reference
Pulse Width – Measure [1]	> 5 ns	1.1 ns	Comparison to Universal Counter w/ GPS Reference
Stop Watches – Totalize Method	1s to 24 hr	0.06 % of reading + 44 ms	Comparison to Universal Counter and Synthesizer w/ GPS Reference

DIMENSIONAL MEASUREMENT

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1 Dimensional Santa Clara, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Distance Measure [3]	Up to 500 in	0.004 % of reading + 0.053 in	Comparison to Laser Distance Meter
Distance/Linearity Measurement	Up to 610 mm	(19 + 0.7*L*/600) µm	Linear Height Gage

2 Dimensional Santa Clara, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dimensional (Non-Contact)	X axis to 100 mm Y axis to 80 mm	(14 + 7.5*L*/1 000) µm (14 + 7.5*L*/1 000) µm	Comparison to Vision System

TESTING

Environmental Santa Clara, CA

Specific Tests and/or Properties Measured	Specification, Standard, Method, or Test Technique	Items, Materials or Product Tested	Key Equipment or Technology
Face Velocity Test Airflow Smoke Pattern Test Leak/Backstreaming Test	ISO 14644-1 ISO 16644-2 ISO 14644-3 ISO 16644-7 ANSI/ASHRAE 110 IEST-RP-CC002.4	Flow hood Devices Test	Comparison to ThermalAnemometer Aerosol Generator Digital Aerosol Photometer
Airborne Particle Count Survey Airflow Measurement Airflow Smoke Pattern Test HEPA/ULPA filter leak Test Biological Safety Cabinet Classification	ISO 14644-1 ISO 16644-2 ISO 14644-3 ISO 16644-7 IEST-RP-CC034.2 IEST-RP-CC006.3 NSF/ANSI49-2004 Annex	Biological Safety Cabinet Test	Comparison to Particle Counter Balometer Aerosol Generator Digital Aerosol Photometer ThermalAnemometer

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Specific Tests and/or Properties Measured	Specification, Standard, Method, or Test Technique	Items, Materials or Product Tested	Key Equipment or Technology
Airflow Measurement Air Pressure Difference Test Airflow Smoke Pattern Test HEPA/ULPA filter leak Test Airborne Particle Count Survey Lighting Level Sound Level Test Temperature Test Humidity Test Temperature/Humidity Uniformity Test Recovery Test	ISO 14644-1 ISO 14644-2 ISO 14644-3 IEST-RP-CC006.3 IEST-RP-CC034.2 ISO/DIS 7726 In-house Method	Clean Room Test	Comparison to Balometer Differential Pressure Meter Digital Aerosol Photometer, Aerosol Generator Particle Counter Light meter Sound level meter Temperature & humidity meter Thermal Anemometer.
Airborne Particle Count Survey Airflow Velocity Laminar Hood HEPA/ULPA filter leak Test Induction Leak/Backstreaming Test Airflow Smoke Pattern Test Lighting Level Sound Level Test	ISO 14644-1 ISO 14644-2 ISO 14644-3 ISO 14644-7 IEST-RP-CC002.4 IEST-RP-CC006.3 IEST-RP-CC034.2 In-house Method	Laminar Air Flow Workstation Test	Comparison to Particle Counter Thermal Anemometer Aerosol Generator Digital Aerosol Photometer Light meter Sound level meter
Oil Aerosol & Vapor Content [4]	ISO 8573-1 ISO 8573-2 ISO 8573-5	Compressed Air Purity Test	Comparison to Oil Content Analyzer Air Sampler
Humidity / Dew Point Measurement	ISO 8573-3	Compressed Air Purity Test	Comparison to Dew Point Meter & Diffuser
Pressurized Air Particle Content	ISO 8573-4	Compressed Air Purity Test	Comparison to Particle Counter & Diffuser
Viable Microbiological Contaminant [5]	ISO 8573-7	Compressed Air Purity Test	Comparison to Microbiological Sampler

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CALIBRATION

Chemical Quantities Orlando, FL

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH – Source [6]	4.01 pH 7.00 PH 10.00 pH	0.017 pH 0.018 pH 0.031 pH	Comparison to Standard Solutions
Conductivity – Source [6]	100 µS/cm 500 µS/cm 1 400 µS/cm 10 000 µS/cm	1.4 µS/cm 6.2 µS/cm 17 µS/cm 120 µS/cm	Comparison to Standard Solutions

Electrical – DC/Low Frequency Orlando, FL

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source [1]	Up to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V 220 V to 1.1 kV	6.8 µV/V + 0.48 µV 4.6 µV/V + 0.8 µV 3.2 µV/V + 3.2 µV 2.4 µV/V + 27 µV 4.7 µV/V + 43 µV 6 µV/V + 0.85 mV	Comparison to High Performance Multifunction Calibrator
DC Voltage – Measure [1]	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	7.2 µV/V + 0.55 µV 7 µV/V + 0.42 µV 6.9 µV/V + 0.86 µV 9.2 µV/V + 38 µV 9.3 µV/V + 0.13 mV	Comparison to Precision 8.5 Digit Multimeter
DC High Voltage – Measure [1]	Up to 10 kV (10 to 100) kV	0.35 mV/V + 0.09 V 0.63 mV/V + 4.1 V	Comparison to High Voltage Meter

Electrical – DC/Low Frequency Orlando, FL

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source [1]	Up to 220 µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A	0.003 7 % of reading + 5.8 nA 0.003 1 % of reading + 7.4 nA 0.003 1 % of reading + 44 nA 0.004 % of reading + 0.69 µA 72 µA/A + 14 µA 0.023 % of reading + 0.47 mA	Comparison to High Performance Multifunction Calibrator w/ Transconductance Amplifier
DC Current – Source [1]	330 mA to 1.1 A (1.1 to 3) A (3 to 11) A (11 to 20) A	0.15 mA/A + 44 µA 0.27 mA/A + 0.13 mA 0.39 mA/A + 0.41 mA 0.79 mA/A + 0.41 mA	Comparison to Multi Product Calibrator
DC Current – Source [1] Clamp-On Meters	(10 to 16.5) A (16.5 to 150) A (150 to 1 025) A	0.5 % of reading + 0.55 A 0.5 % of reading + 0.57 A 0.5 % of reading + 0.74 A	Comparison to Multi Product Calibrator w/ Current Coil
DC Power – Source [1] 33 mV to 1 020 V 329.99 mA range 2.9999 A range 20.5 A range	 10 µW to 330 W 10 mW to 3 kW 100 mW to 21 kW	 0.01 % of reading + 1.2 nW 0.04 % of reading 0.1 % of reading	Comparison to Multi Product Calibrator
DC Current – Measure [1]	Up to 100 nA 100 nA to 1 µA (1 to 10) µA (10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	22 µA/A + 93 pA 18 µA/A + 0.1 nA 28 µA/A + 0.14 nA 30 µA/A + 0.98 nA 30 µA/A + 6.5 nA 30 µA/A + 63 nA 44 µA/A + 1 µA 0.14 mA/A + 12 µA	Comparison to Precision 8.5 Digit Multimeter
DC Current – Measure [1]	(1 to 100) A (100 to 600) A (600 to 1 000) A	85 µA/A 127 µA/A 0.29 % of reading + 0.02 A	Indirect Method Precision 8.5 Digit Multimeter w/ Current Shunts

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	(1 to 2.2) mV		Comparison to High Performance Multifunction Calibrator w/ Transconductance Amplifier
	(10 to 20) Hz	0.013 % of reading + 7.2 µV	
	(20 to 40) Hz	0.008 3 % of reading + 4.2 µV	
	40 Hz to 20 kHz	0.007 2 % of reading + 4.2 µV	
	(20 to 50) kHz	0.016 % of reading + 4.6 µV	
	(50 to 100) kHz	0.042 % of reading + 5.3 µV	
	(100 to 300) kHz	0.095 % of reading + 10 µV	
	(300 to 500) kHz	0.13 % of reading + 20 µV	
	500 kHz to 1 MHz	0.25 % of reading + 21 µV	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.021 % of reading + 4.9 µV	
	(20 to 40) Hz	0.008 3 % of reading + 4.3 µV	
	40 Hz to 20 kHz	0.007 % of reading + 4.4 µV	
	(20 to 50) kHz	0.017 % of reading + 4.8 µV	
	(50 to 100) kHz	0.042 % of reading + 6.1 µV	
	(100 to 300) kHz	0.092 % of reading + 12 µV	
	(300 to 500) kHz	0.13 % of reading + 22 µV	
	500 kHz to 1 MHz	0.22 % of reading + 33 µV	
	(22 to 220) mV		
	(10 to 20) Hz	0.022 % of reading + 16 µV	
	(20 to 40) Hz	0.006 4 % of reading + 15 µV	
	40 Hz to 20 kHz	0.004 4 % of reading + 10 µV	
	(20 to 50) kHz	0.009 % of reading + 14 µV	
	(50 to 100) kHz	0.028 % of reading + 23 µV	
	(100 to 300) kHz	0.056 % of reading + 35 µV	
	(300 to 500) kHz	0.13 % of reading + 39 µV	
	500 kHz to 1 MHz	0.23 % of reading + 0.12 mV	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.021 % of reading + 0.1 mV	
	(20 to 40) Hz	82 µV/V + 32 µV	
	40 Hz to 20 kHz	39 µV/V + 22 µV	
	(20 to 50) kHz	44 µV/V + 62 µV	
	(50 to 100) kHz	71 µV/V + 55 µV	
	(100 to 300) kHz	0.3 mV/V + 0.12 mV	
	(300 to 500) kHz	0.89 mV/V + 0.3 mV	
	500 kHz to 1 MHz	1.5 mV/V + 0.6 mV	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	(2.2 to 22) V		Comparison to High Performance Multifunction Calibrator w/ Transconductance Amplifier
	(10 to 20) Hz	0.2 mV/V + 1.1 mV	
	(20 to 40) Hz	68 µV/V + 0.63 mV	
	40 Hz to 20 kHz	19 µV/V + 0.7 mV	
	(20 to 50) kHz	44 µV/V + 0.61 mV	
	(50 to 100) kHz	0.006 1 % of reading + 0.65 mV	
	(100 to 300) kHz	0.19 mV/V + 1.9 mV	
	(300 to 500) kHz	0.9 mV/V + 2.8 mV	
	500 kHz to 1 MHz	1.1 mV/V + 11 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.2 mV/V + 11 mV	
	(20 to 40) Hz	44 µV/V + 17 mV	
	40 Hz to 20 kHz	38 µV/V + 4.1 mV	
	(20 to 50) kHz	53 µV/V + 8 mV	
	(50 to 100) kHz	0.11 mV/V + 10 mV	
	(100 to 300) kHz	0.84 mV/V + 19 mV	
	(300 to 500) kHz	4.2 mV/V + 45 mV	
	500 kHz to 1 MHz	7.7 mV/V + 90 mV	
	(220 to 1 100) V		
	40 Hz to 1 kHz	50 µV/V + 27 mV	
	(1 to 20) kHz	0.1 mV/V + 31 mV	
	(20 to 30) kHz	0.41 mV/V + 70 mV	
	(220 to 750) V		
	(30 to 50) kHz	0.45 mV/V + 12 mV	
	(50 to 100) kHz	1.8 mV/V + 21 mV	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	(1 to 10) mV		Comparison to Precision 8.5 Digit Multimeter
	(1 to 40) Hz	0.36 mV/V + 3.6 µV	
	40 Hz to 1 kHz	0.23 mV/V + 1.4 µV	
	(1 to 20) kHz	0.32 mV/V + 1.7 µV	
	(20 to 50) kHz	1.2 mV/V + 1.6 µV	
	(50 to 100) kHz	5.7 mV/V + 2 µV	
	(100 to 300) kHz	46 mV/V + 2.6 µV	
	(10 to 100) mV		
	(1 Hz to 40) Hz	72 µV/V + 0.85 mV	
	40 Hz to 1 kHz	84 µV/V + 0.26 mV	
	(1 to 20) kHz	0.17 mV/V + 0.26 mV	
	100 mV to 10 V		
	(1 Hz to 40) Hz	71 µV/V + 0.73 mV	
	40 Hz to 1 kHz	80 µV/V + 0.26 mV	
	(1 to 20) kHz	160 µV/V + 0.26 mV	
	(20 to 50) kHz	0.35 mV/V + 0.25 mV	
	(50 to 100) kHz	0.93 mV/V + 0.27 mV	
	(100 to 300) kHz	3.5 mV/V + 1.2 mV	
	300 kHz to 1 MHz	12 mV/V + 1.2 mV	
	(1 to 2) MHz	18 mV/V + 1.2 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.24 mV/V + 4.7 mV	
	40 Hz to 1 kHz	0.15 mV/V + 16 mV	
	(1 to 20) kHz	0.15 mV/V + 17 mV	
	(20 to 50) kHz	0.36 mV/V + 8.6 mV	
	(50 to 100) kHz	1.4 mV/V + 3.9 mV	
	(100 to 300) kHz	4.8 mV/V + 12 mV	
	300 kHz to 1 MHz	18 mV/V + 12 mV	
	100 V to 1 kV		
	(1 to 40) Hz	0.46 mV/V + 50 mV	
	40 Hz to 1 kHz	0.46 mV/V + 28 mV	
	(1 to 20) kHz	0.69 mV/V + 29 mV	
	(20 to 50) kHz	1.5 mV/V + 24 mV	
	(50 to 100) kHz	3.6 mV/V + 24 mV	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC High Voltage - Measure [1]	(Up to 10) kV (30 to 200) Hz (200 to 450) Hz (450 to 600) Hz (10 to 100) kV (30 to 70) Hz (70 to 200) Hz	 1.4 mV/V + 0.14 V 4.6 mV/V + 0.14 V 8.7 mV/V + 0.14 V 1.4 mV/V + 0.7 V 17 % of reading + 0.7 V	Comparison to High Voltage Meter
AC Voltage Flatness - Source [1] (Referenced to 1 kHz)	0.3 mV to 3.5 V (10 to 30) Hz 30 Hz to 120 kHz (0.3 to 1.1) mV 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (1.1 to 3) mV 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz 3 mV to 3.5 V 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	 0.35 % of reading 0.12 % of reading 0.24 % of reading + 3 µV 0.47 % of reading + 3 µV 0.7 % of reading + 3 µV 1.8 % of reading + 15 µV 0.12 % of reading + 3 µV 0.35 % of reading + 3 µV 0.58 % of reading + 3 µV 1.8 % of reading + 3 µV 0.12 % of reading + 3 µV 0.24 % of reading + 3 µV 0.47 % of reading + 3 µV 1.2 % of reading + 3 µV	Comparison to High Performance Multifunction Calibrator (Wideband)
AC Voltage Flatness – Measure [1]	Up to 3 V (10 to 100) Hz 100 Hz to 10 kHz (10 to 30) kHz 30 kHz to 1 MHz (1 to 10) MHz (10 to 30) MHz (30 to 50) MHz (50 to 70) MHz (70 to 80) MHz (80 to 100) MHz	 0.2 % of reading 0.051% of reading 0.059 % of reading 0.13 % of reading 0.21% of reading 0.26% of reading 0.42 % of reading 0.65 % of reading 0.77% of reading 0.97 % of reading	Indirect Method Precision 8.5 Digit Multimeter w/ Thermal Converters

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	Up to 2.2 mV		Comparison to AC Measurement Standard
	(10 to 20) Hz	1.6 mV/V + 1.6 µV	
	(20 to 40) Hz	1.6 mV/V + 1.6 µV	
	40 Hz to 20 kHz	0.4 mV/V + 1.7 µV	
	(20 to 50) kHz	0.8 mV/V + 2.2 µV	
	(50 to 100) kHz	1.2 mV/V + 2.7 µV	
	(100 to 300) kHz	2.3 mV/V + 4.1 µV	
	(300 to 500) kHz	2.4 mV/V + 8.1 µV	
	500 kHz to 1 MHz	3.5 mV/V + 8.1 µV	
	(2.2 to 7) mV		
	(10 to 20) Hz	0.8 mV/V + 1.4 µV	
	(20 to 40) Hz	0.4 mV/V + 1.5 µV	
	40 Hz to 20 kHz	0.2 mV/V + 1.5 µV	
	(20 to 50) kHz	0.4 mV/V + 2.1 µV	
	(50 to 100) kHz	0.6 mV/V + 2.6 µV	
	(100 to 300) kHz	1.2 mV/V + 4.1 µV	
	(300 to 500) kHz	1.3 mV/V + 6 µV	
	500 kHz to 1 MHz	2 mV/V + 6 µV	
	(7 to 22) mV		
	(10 to 20) Hz	0.3 mV/V + 1.6 µV	
	(20 to 40) Hz	0.3 mV/V + 1.6 µV	
	40 Hz to 20 kHz	0.1 mV/V + 1.7 µV	
	(20 to 50) kHz	0.2 mV/V + 2.3 µV	
	(50 to 100) kHz	0.3 mV/V + 2.7 µV	
	(100 to 300) kHz	0.8 mV/V + 4.1 µV	
	(300 to 500) kHz	0.9 mV/V + 6.1 µV	
	500 kHz to 1 MHz	1.4 mV/V + 6.1 µV	
	(22 to 70) mV		
	(10 to 20) Hz	2 mV/V + 5.3 µV	
	(20 to 40) Hz	80 µV/V + 6.3 µV	
	40 Hz to 20 kHz	40 µV/V + 6.8 µV	
	(20 to 50) kHz	0.1 mV/V + 6.4 µV	
	(50 to 100) kHz	0.23 mV/V + 5.8 µV	
	(100 to 300) kHz	0.5 mV/V + 6 µV	
	(300 to 500) kHz	0.7 mV/V + 9.4 µV	
	500 kHz to 1 MHz	1.1 mV/V + 9 µV	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	(70 to 220) mV		Comparison to AC Measurement Standard
	(10 to 20) Hz	0.2 mV/V + 1.6 µV	
	(20 to 40) Hz	80 µV/V + 1.7 µV	
	40 Hz to 20 kHz	40 µV/V + 1.8 µV	
	(20 to 50) kHz	70 µV/V + 2.2 µV	
	(50 to 100) kHz	0.2 mV/V + 2.6 µV	
	(100 to 300) kHz	0.3 mV/V + 4.1 µV	
	(300 to 500) kHz	0.4 mV/V + 8 µV	
	500 kHz to 1 MHz	1 mV/V + 8 µV	
	(220 to 700) mV		
	(10 to 20) Hz	0.21 mV/V + 1.5 µV	
	(20 to 40) Hz	0.21 mV/V + 1.5 µV	
	40 Hz to 20 kHz	30 µV/V + 1.7 µV	
	(20 to 50) kHz	50 µV/V + 2.1 µV	
	(50 to 100) kHz	80 µV/V + 2.6 µV	
	(100 to 300) kHz	0.2 mV/V + 4 µV	
	(300 to 500) kHz	0.3 mV/V + 8 µV	
	500 kHz to 1 MHz	0.3 mV/V + 8 µV	
	700 mV to 2.2 V		
	(10 to 20) Hz	0.2 mV/V + 4.2 µV	
	(20 to 40) Hz	0.62 mV/V + 13 µV	
	40 Hz to 20 kHz	0.17 mV/V + 23 µV	
	(20 to 50) kHz	0.41 mV/V + 16 µV	
	(50 to 100) kHz	0.67 mV/V + 12 µV	
	(100 to 300) kHz	0.16 mV/V + 6 µV	
	(300 to 500) kHz	0.26 mV/V + 4 µV	
	500 kHz to 1 MHz	9 mV/V + 1.1 µV	
	(2.2 to 7) V		
	(10 to 20) Hz	0.2 mV/V + 1.1 µV	
	(20 to 40) Hz	0.7 mV/V + 3.2 µV	
	40 Hz to 20 kHz	0.23 mV/V + 8.4 µV	
	(20 to 50) kHz	0.5 mV/V + 4.4 µV	
	(50 to 100) kHz	0.8 mV/V + 2.7 µV	
	(100 to 300) kHz	0.19 mV/V + 1.1 µV	
	(300 to 500) kHz	0.4 mV/V + 0.5 µV	
	500 kHz to 1 MHz	1.2 mV/V + 0.2 µV	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	(7 to 22) V		Comparison to AC Measurement Standard
	(10 to 20) Hz	0.2 mV/V + 3.7 µV	
	(20 to 40) Hz	0.7 mV/V + 11 µV	
	40 Hz to 20 kHz	0.3 mV/V + 26 µV	
	(20 to 50) kHz	0.5 mV/V + 15 µV	
	(50 to 100) kHz	0.8 mV/V + 9.1 µV	
	(100 to 300) kHz	0.29 mV/V + 4 µV	
	(300 to 500) kHz	0.4 mV/V + 1.9 µV	
	500 kHz to 1 MHz	1.2 mV/V + 0.6 µV	
	(22 to 70) V		
	(10 to 20) Hz	0.2 mV/V + 9.1 µV	
	(20 to 40) Hz	70 µV/V + 27 µV	
	40 Hz to 20 kHz	30 µV/V + 55 µV	
	(20 to 50) kHz	60 µV/V + 32 µV	
	(50 to 100) kHz	90 µV/V + 19 µV	
	(100 to 300) kHz	0.2 mV/V + 9.1 µV	
	(300 to 500) kHz	0.4 mV/V + 4.4 µV	
	500 kHz to 1 MHz	1.2 mV/V + 1.5 µV	
	(70 to 220) V		
	(10 to 20) Hz	0.2 mV/V + 7.1 µV	
	(20 to 40) Hz	70 µV/V + 21 µV	
	40 Hz to 20 kHz	30 µV/V + 45 µV	
	(20 to 50) kHz	70 µV/V + 21 µV	
	(50 to 100) kHz	0.1 mV/V + 14 µV	
	(100 to 300) kHz	0.21 mV/V + 6.8 µV	
	(300 to 500) kHz	0.5 mV/V + 2.8 µV	
	(220 to 700) V		
	(10 to 20) Hz	0.2 mV/V + 77 µV	
	(20 to 40) Hz	0.1 mV/V + 0.16 mV	
	40 Hz to 20 kHz	40 µV/V + 0.37 mV	
	(20 to 50) kHz	0.13 mV/V + 0.12 mV	
	(50 to 100) kHz	0.5 mV/V + 31 µV	
	700 V to 1 kV		
	(10 to 20) Hz	0.2 mV/V + 31 µV	
	(20 to 40) Hz	0.1 mV/V + 62 µV	
	40 Hz to 20 kHz	40 µV/V + 0.16 mV	
	(20 to 50) kHz	0.13 mV/V + 47 µV	
	(50 to 100) kHz	0.5 mV/V + 12 µV	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	Up to 10 mV		Comparison to Precision 8.5 Digit Multimeter AC BAND < 2 MHz
	(1 to 40) Hz	3.5 µV/V + 4.6 µV	
	40 Hz to 1 kHz	2.4 µV/V + 3.2 µV	
	(1 to 20) kHz	3.5 µV/V + 4.6 µV	
	(20 to 50) kHz	12 µV/V + 3.2 µV	
	(50 to 100) kHz	58 µV/V + 3.2 µV	
	(100 to 300) kHz	0.47 mV/V + 3.8 µV	
	(10 to 100) mV		
	(1 to 40) Hz	86 µV/V + 4.6 µV	
	40 Hz to 1 kHz	86 µV/V + 2.3 µV	
	(1 to 20) kHz	0.17 mV/V + 2.3 µV	
	(20 to 50) kHz	0.35 mV/V + 2.3 µV	
	(50 to 100) kHz	0.93 mV/V + 2.3 µV	
	(100 to 300) kHz	3.5 mV/V + 12 µV	
	300 kHz to 1 MHz	12 mV/V + 12 µV	
	(1 to 2) MHz	18 mV/V + 12 µV	
	100 mV to 1 V		
	(1 to 40) Hz	92 µV/V + 50 µV	
	40 Hz to 1 kHz	92 µV/V + 31 µV	
	(1 to 10) V		
	(1 to 20) kHz	0.17 mV/V + 31 µV	
	(20 to 50) kHz	0.35 mV/V + 31 µV	
	(50 to 100) kHz	0.93 mV/V + 31 µV	
	(100 to 300) kHz	3.5 mV/V + 0.12 mV	
	300 kHz to 1 MHz	12 mV/V + 0.12 mV	
	(1 to 2) MHz	18 mV/V + 0.12 mV	
	(10 to 100) V		
	(1 to 40) Hz	91 µV/V + 0.14 mV	
	40 Hz to 1 kHz	91 µV/V + 0.14 mV	
	(1 to 20) kHz	0.17 mV/V + 0.14 mV	
	(20 to 50) kHz	0.35 mV/V + 0.14 mV	
	(50 to 100) kHz	0.93 mV/V + 0.14 mV	
	(100 to 300) kHz	3.5 mV/V + 0.16 mV	
	300 kHz to 1 MHz	1.2 mV/V + 0.16 mV	
	(1 to 2) MHz	1.8 mV/V + 0.16 mV	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	(100 to 750) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	 0.45 mV/V + 2.7 mV 0.45 mV/V + 2.7 mV 0.45 mV/V + 2.7 mV 0.56 mV/V + 2.7 mV 1.5 mV/V + 2.7 mV 4.7 mV/V + 2.7 mV 18 mV/V + 2.7 mV	Comparison to Precision 8.5 Digit Multimeter AC BAND < 2 MHz
AC Voltage – Measure [1]	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz 11 mV to 10 V 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (11 to 100) V 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz (100 to 750) V 45 Hz to 100 kHz	 0.46 mV/V + 47 mV 0.46 mV/V + 24 mV 0.69 mV/V + 24 mV 1.4 mV/V + 24 mV 3.5 mV/V + 24 mV 1 mV/V + 7.5 µV 14 mV/V + 6.5 µV 81 mV/V + 8.6 µV 0.24 V + 9.7 µV 1 mV/V + 0.7 mV 24 mV/V + 0.58 mV 47 mV/V + 0.81 mV 47 mV/V + 0.93 mV 0.18 V + 1.2 mV 1.5 mV/V + 2.7 mV	Comparison to Precision 8.5 Digit Multimeter AC BAND > 2 MHz

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source [1]	(2.2 to 22) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (22 to 220) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 220 mA to 2.2 A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	 0.003 4 % of reading + 20 µA 0.002 5 % of reading + 12 µA 0.007 2 % of reading + 0.95 µA 0.015 % of reading + 1.5 µA 0.1 % of reading + 5.1 µA 0.004 6 % of reading + 0.15 mA 0.003 5 % of reading + 85 µA 0.006 2 % of reading + 12 µA 0.014 % of reading + 16 µA 0.089 % of reading + 38 µA 0.18 mA/A + 0.17 mA 0.32 mA/A + 0.27 mA 5.1 mA/A + 2.8 mA 0.3 mA/A + 1.1 mA 0.74 mA/A + 53 µA 2.8 mA/A + 200 µA	Comparison to High Performance Multifunction Calibrator
AC Current – Source [1]	(11 to 20) A (45 to 100) Hz 100 Hz to 1kHz (1 to 5) kHz	 1.2 mA/A + 5 mA 1.5 mA/A + 5 mA 30 mA/A + 5 mA	Comparison to Multi Product Calibrator
AC Current – Source [1]	(9 to 220) µA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 220 µA to 2.2 mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	 0.02 % of reading + 26 nA 0.01 % of reading + 30 nA 0.01 % of reading + 8.3 nA 0.02 % of reading + 36 nA 0.1 % of reading + 63 nA 0.004 8 % of reading + 1.4 µA 0.006 1 % of reading + 0.44 µA 0.007 2 % of reading + 95 nA 0.016 % of reading + 0.18 µA 0.1 % of reading + 0.65 µA	Comparison to High Performance Multifunction Calibrator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source [1] Clamp-On Meters	(10 to 16.5) A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	 0.28 % of reading + 0.16 A 0.79 % of reading + 0.13 A 0.28 % of reading + 0.31 A 0.79 % of reading + 0.16 A 0.29 % of reading + 1.3 A 0.8 % of reading + 1.2 A	Comparison to Multi Product Calibrator w/ Current Coil
AC Power – Source [1] PF = 1 (10 to 45) Hz 33 mV to 32.9999 V (3.3 mA to 2.99999 A) (45 to 65) Hz 33 mV to 1020 V (3.3 mA to 20.5 A)	 110 µW to 99 W 110 µW to 21 kW	 0.19 % of reading 0.15 % of reading	Comparison to Multi Product Calibrator
Phase – Source [1]	+/- 179.99 (ΔΦ°) (10 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	 0.09° 0.2° 0.39° 1.9° 3.9° 7.8°	Comparison to Multi Product Calibrator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure [1]	Up to 100 µA		Comparison to Precision 8.5 Digit Multimeter
	(10 to 20) Hz	4.7 mA/A + 36 nA	
	(20 to 45) Hz	1.8 mA/A + 35 nA	
	(45 to 100) Hz	0.71 mA/A + 35 nA	
	100 Hz to 1 kHz	0.7 mA/A + 35 nA	
	100 µA to 100 mA		
	(10 to 20) Hz	4.7 mA/A + 24 µA	
	(20 to 45) Hz	1.8 mA/A + 24 µA	
	(45 to 100) Hz	0.71 mA/A + 24 µA	
	100 Hz to 5 kHz	0.36 mA/A + 23 µA	
	(5 to 20) kHz	0.71 mA/A + 24 µA	
	100 µA to 100 mA		
	(20 to 50) kHz	4.7 mA/A + 47 µA	
	(50 to 100) kHz	6.5 mA/A + 0.18 mA	
	100 mA to 1 A		
	(10 to 20) Hz	4.7 mA/A + 0.24 mA	
	(20 to 45) Hz	1.9 mA/A + 0.24 mA	
	(45 to 100) Hz	0.95 mA/A + 0.24 mA	
	100 Hz to 5 kHz	1.1 mA/A + 0.26 mA	
	(5 to 20) kHz	3.5 mA/A + 0.24 mA	
	(20 to 50) kHz	12 mA/A + 0.47 mA	
AC Current – Measure [1]	(1 to 10) A		Indirect Method Precision 8.5 Digit Multimeter / Shunts
	(3 to 5) Hz	20 mA/A + 6 mA	
	(5 to 10) Hz	11 mA/A + 6 mA	
	10 Hz to 5 kHz	1.5 mA/A + 6 mA	
	(5 to 10) kHz	3.5 mA/A + 70 mA	
	(10 to 100) A		
	(50 to 60) Hz	0.6 A	
	(100 to 300) A		
	(50 to 60) Hz	0.8 A	
AC High Current - Measure [1]	(50 to 400) Hz		Comparison to Precision 8.5 Digit Multimeter and Current Transformer
	(0.25 to 10) A	0.16 % of reading + 0.011 A	
	(10 to 100) A	0.18 % of reading + 0.0045 A	
	(100 to 400) A	0.21 % of reading + 0.016 A	
	(400 to 600) A	0.21 % of reading + 0.036 A	
	(50 to 60) Hz		
	(600 to 900) A	0.29 % of reading + 0.032 A	
	(900 to 1100) A	0.29 % of reading + 0.048 A	
	(1100 to 1500) A	0.29 % of reading + 0.17 A	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source [1]	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ 330 kΩ 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 330 MΩ to 1.1 GΩ	1.7 mΩ/Ω + 35 μΩ 23 μΩ/Ω + 3.3 mΩ 31 μΩ/Ω + 1.9 mΩ 32 μΩ/Ω + 2.8 mΩ 33 μΩ/Ω + 2.3 mΩ 32 μΩ/Ω + 30 mΩ 5 μΩ/Ω + 1.4 Ω 32 μΩ/Ω + 0.3 Ω 33 μΩ/Ω + 0.34 Ω 37 μΩ/Ω + 3.1 Ω 38 μΩ/Ω + 2.6 Ω 71 μΩ/Ω + 36 Ω 0.13 mΩ/Ω + 0.38 kΩ 0.22 mΩ/Ω + 7.4 kΩ 0.42 mΩ/Ω + 32 kΩ 3.6 mΩ/Ω + 0.12 MΩ 18 mΩ/Ω + 0.59 MΩ	Comparison to Multi Product Calibrator
Resistance – Source [1] Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	48 μΩ 0.15 mΩ 0.22 mΩ 0.28 mΩ 0.63 mΩ 1.2 mΩ 2.3 mΩ 7.8 mΩ 15 mΩ 77 mΩ 0.15 Ω 1 Ω 1.9 Ω 16 Ω 40 Ω 0.48 kΩ 1.1 kΩ 12 kΩ	Comparison to High Performance Multiproduct Calibrator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source [1] Fixed Point (Four-Terminal Pair)	0.1 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ	0.56 mΩ 0.29 mΩ 2.3 mΩ 1.8 mΩ 35 mΩ 0.12 Ω 1.3 Ω	Comparison to Four Terminal Pair Resistor Set
Resistance – Measure [1]	Up to 10 Ω (>10 to 100) Ω >100 Ω to 1 kΩ (>1 to 10) kΩ (>10 to 100) kΩ >100 kΩ to 1 MΩ (>1 to 10) MΩ (>10 to 100) MΩ >100 MΩ to 1 GΩ	21 μΩ/Ω + 62 μΩ 17 μΩ/Ω + 0.59 mΩ 15 μΩ/Ω + 0.67 mΩ 15 μΩ/Ω + 6.1 mΩ 15 μΩ/Ω + 62 mΩ 21 μΩ/Ω + 2.4 Ω 45 μΩ/Ω + 0.38 kΩ 0.58 mΩ/Ω + 1.2 kΩ 5.8 mΩ/Ω + 11 kΩ	Comparison to Precision 8.5 Digital Multimeter
Capacitance – Source [1] 10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz (0 to 50) Hz (0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz	 (220 to 399.9) pF (0.4 to 1.099 9) nF (1.1 to 3.299 9) nF (3.3 to 10.999 9) nF (11 to 32.999 9) nF (33 to 109.999) nF (110 to 329.999) nF (0.33 to 1.099 99) μF (1.1 to 3.299 99) μF (3.3 to 10.999 9) μF (11 to 32.999 9) μF (33 to 109.999) μF (110 to 329.999) μF (0.33 to 1.099 99) mF (1.1 to 3.299 99) mF (3.3 to 10.999 9) mF (11 to 32.999 9) mF (33 to 110) mF	 0.58 % of reading + 12 pF 0.57 % of reading + 12 pF 0.57 % of reading + 12 pF 0.22 % of reading + 27 pF 0.29 % of reading + 0.12 nF 0.29 % of reading + 0.13 nF 0.29 % of reading + 0.35 nF 0.28 % of reading + 1.5 nF 0.29 % of reading + 3.5 nF 0.29 % of reading + 1.3 nF 0.46 % of reading + 36 nF 0.53 % of reading + 0.12 μF 0.53 % of reading + 0.35 μF 0.5 % of reading + 1.5 μF 0.52 % of reading + 3.6 μF 0.51 % of reading + 13 μF 0.86 % of reading + 35 μF 1.3 % of reading + 0.13 mF	Comparison to Multi Product Calibrator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Fixed Capacitance [1] @ 1 kHz	(100 to 500) pF 500 pF to 5 nF (5 to 50) nF (50 to 100) nF (100 to 500) nF 500 nF to 1.5 µF	0.64 pF 3.7 pF 32 pF 63 pF 0.59 nF 0.63 nF	Comparison to Capacitance Standard Set
Capacitance – Source [1]	1 pF 1 kHz to 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz 10 pF 1 kHz to 13 MHz 100 pF 1 kHz to 10 MHz 13 MHz 1 nF 1 kHz to 4 MHz 5 MHz 10 MHz 13 MHz	 1.2 fF 1.3 fF 1.5 fF 2.8 fF 3.9 fF 12 fF 0.12 pF 0.13 pF 1.2 pF 1.3 pF 2.2 pF 3 pF	Comparison to Standard Air Capacitor Set
Capacitance – Measure [1]	(1 to 10) nF (10 to 100) nF (0.3to 1) µF (1 to 10) µF (10 to 100) µF (100 to 1 000) µF (1 to 10) mF (10 to 100) mF	0.052 pF 0.041 pF 0.37 nF 0.018 µF 0.041 µF 0.56 µF 0.018 mF 0.059 mF	Comparison to Digit Multimeter/LCR Meter
Inductance – Source [1]	100 Hz to 1 kHz 200 µH 2 mH 20 mH 200 mH 2 H	 0.58 µH 2.4 µH 24 µH 0.24 mH 2.4 mH	Comparison to Standard Value Inductors
Inductance – Measure [1]	0.001 nH to 99.999 999 H Up to 1 kHz 1 kHz to 1 MHz	 0.062 % of reading + 0.007 mH 0.56 % of reading + 0.007 mH	Comparison to Precision LCR Meter

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Electrical Simulation of Thermocouple Indicating Devices – Source and Measure [1]	Type C (0 to 150) °C (150 to 650) °C (650 to 1 000) °C (1 000 to 1 800) °C (1 800 to 2 316) °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 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	 0.29 °C 0.32 °C 0.28 °C 0.48 °C 0.71 °C 0.43 °C 0.21 °C 0.17 °C 0.14 °C 0.19 °C 0.35 °C 0.2 °C 0.14 °C 0.19 °C 0.26 °C 0.28 °C 0.21 °C 0.23 °C 0.25 °C 0.33 °C 0.39 °C 0.27 °C 0.23 °C 0.18 °C 0.27 °C 0.83 °C 0.42 °C 0.31 °C 0.38 °C 0.55 °C 0.34 °C 0.32 °C 0.41 °C	Comparison to Multi Product Calibrator
Electrical Simulation of Thermocouple Indicating Devices – Source and Measure [1]	Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	 0.63 °C 0.35 °C 0.26 °C 0.22 °C	Comparison to Multi Product Calibrator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Temperature Indicating Devices – Source and Measure [1]	Pt 385 (100 Ω)		Comparison to Multi Product Calibrator
	(-200 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	(630 to 800) °C	0.23 °C	
	Pt 3926 (100 Ω)		
	(-200 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	Pt 3916 (100 Ω)		
	(-200 to -190) °C	0.25 °C	
	(-190 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.06 °C	
	(100 to 260) °C	0.07 °C	
	(260 to 300) °C	0.08 °C	
	(300 to 400) °C	0.09 °C	
	(400 to 600) °C	0.1 °C	
	(600 to 630) °C	0.23 °C	
	Pt 385 (200 Ω)		
	(-200 to 100) °C	0.04 °C	
	(100 to 260) °C	0.05 °C	
	(260 to 300) °C	0.12 °C	
	(300 to 400) °C	0.13 °C	
	(400 to 600) °C	0.14 °C	
	(600 to 630) °C	0.16 °C	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Temperature Indicating Devices – Source and Measure [1]	Pt 385 (500 Ω) (-200 to -80) °C (-80 to 100) °C (100 to 260) °C (260 to 400) °C (400 to 600) °C (600 to 630) °C Pt 385 (1000 Ω) (-200 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 600) °C (600 to 630) °C PtNi 385 (120 Ω) (Ni 120) (-80 to 100) °C (100 to 260) °C CU 427 (10 Ω) (100 to 260) °C	 0.04 °C 0.05 °C 0.06 °C 0.08 °C 0.09 °C 0.11 °C 0.03 °C 0.04 °C 0.05 °C 0.06 °C 0.07 °C 0.23 °C 0.08 °C 0.14 °C 0.3 °C	Comparison to Multi Product Calibrator
Oscilloscopes [1] DC Voltage Into 50 Ω load Into 1 MΩ load Square Wave Into 50 Ω load Into 1 MΩ load Leveled Sine Amplitude Reference @ 50 kHz	 (0 to +/-6.6) V (0 to +/-130) V 10 Hz to 10 kHz 1 mVp-p to 6.6 Vp-p 10 Hz to 1 kHz 1 mVp-p to 130 Vp-p (1 to 10) kHz 1 mVp-p to 130 Vp-p 5 mV to 5.5 V	 0.2 % + 36 µV 0.039 % of reading + 37 µV 0.2 % of reading + 65 µV 0.078 % of reading + 36 µV 0.19 % of reading + 39 µV 15 mV/V + 0.49 mV	Comparison to Multi Product Calibrator, FL

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes [1]			Comparison to Multi Product Calibrator
Leveled Sine Amplitude (relative to 50 kHz)	5 mV to 5.5 V		
	50 kHz to 100 MHz	14 mV/V + 0.12 mV	
	(100 to 300) MHz	17 mV/V + 0.14 mV	
	(300 to 600) MHz	32 mV/V + 0.15 mV	
	(600 to 1100) MHz	40 mV/V + 0.16 mV	
Time Markers (5-2-1 sequence) into 50 Ω load	(1 to 50) ns	0.001 1 % of reading + 0.048 ps	
	100 ns to 20 ms	0.000 2 % of reading + 7 ps	
	50 ms to 5 s	0.4 % of reading	
Edge Transition Time (Rise Time)	< 300 ps	80 ps	
Rise Time [1] (measurement)	20 ps to 100 µs	81 ns	Comparison to Oscilloscope
Rise Time [1] (measurement)	1 ns to 10 µs	1.2 ns	Comparison to Oscilloscope
	(10 to 100) µs	2.9 ns	
ESD Simulators			Procedure IEC 61000-4-2 (Ed.2, 2008); Multimeters, ESD Target, Attenuator,Oscilloscope
Contact Voltage (Positive and Negative)	(1 to 8) kV	1.2 % of reading	
Rise Time	(0.6 to 1) ns	0.000 12 % Δ time reading + 11 ps	
Peak Current	(3.75 to 33) A	2.1 % of reading	
30 ns Current	(2 to 20.8) A	3.4 % of reading	
60 ns Current	(1 to 10.4) A	6.3 % of reading	
ESD Simulators	(0.7 to 1) ns		Procedure IEC 61000-4-2 (Ed.2, 2008); Multimeters, ESD Target, Attenuator,Oscilloscope
Air Discharge Voltage (Positive and Negative)	(1 to 30) kV	1.2 % of reading	
Rise Time	600 ns ± 130 ns		
RC Time Constant (at ± 15 kV)	330 pF probe	0.000 12 % Δ time reading + 11 ps	
	300 ns ± 60 ns		
	150 pF probe	0.000 12 % Δ time reading + 11 ps	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
EFT/Burst Generator			
Voltage (±)	10 V to 8 kV	2.7 % of reading	
Rise Time	5 ns ± 30 %	0.008 % ~~A~~ time reading	Procedure IEC 61000-4-4 (Ed.3, 2012); Fast Rise Oscilloscope w/ EFT Verification Set
Impulse Duration	50 ns ± 30 %	0.008 % ~~A~~ time reading	
Burst Duration	15 ns ± 20 %	0.008 % ~~A~~ time reading	
Burst Period	300 ms ± 20 %	0.008 % ~~A~~ time reading	
Surge Generator			
Front Time			
Rise Time			
Open Circuit (±)	(1.2 to 50) µs	0.008 % ~~A~~ time reading	Procedure IEC 61000-4-5 (Ed. 3.1, 2017), IEC 61000-4-11 (Ed 3.0, 2020), IEC 61000-4-18 (Ed. 2.0, 2019); Fast Rise Oscilloscope, Current Probes, Oscilloscope Probes
Short Circuit (±)	(1.2 to 50) µs	0.008 % ~~A~~ time reading	
Time to Half-Value (±)	(20 to 700) µs	0.008 % ~~A~~ time reading	
Open Circuit Voltage (±)	10 V to 12 kV	2.9 % of reading	
Short Circuit Voltage (±)	(0.125 to 3) kA	2.9 % of reading	
Ring Wave Voltage	1 kV ± 10 %	2.9 % of reading	
Ring Wave Rise Time	1.5 µs ± 0.5 µs	0.008 % ~~A~~ time reading	

Electrical – RF/Microwave Orlando, FL

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Attenuation – Source Coaxial, 10 dB Step	(0 to 120) dB 1 kHz 500 MHz 1 GHz	 0.11 dB 0.28 dB 0.39 dB	Comparison to Standard Piston Attenuator

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Electrical – RF/Microwave Orlando, FL

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Attenuation - Source Coaxial, 1 dB Step	DC to 12.4 GHz (0 to 11) dB (12.4 to 18) GHz (0 to 11) dB	0.6 dB 0.8 dB	Comparison to Standard Electronic Programmable Attenuator
RF Attenuation Source Coaxial, 10 dB Step	DC to 12.4 GHz (0 to 10) dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB (80 to 110) dB	 0.51 dB 0.71 dB 0.91 dB 1.2 dB 1.5 dB 1.8 dB 2.1 dB 2.4 dB	Comparison to Standard Electronic Programmable Attenuator
RF Attenuation Source Coaxial, 10 dB Step	(12.4 to 18) GHz (0 to 10) dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB (80 to 110) dB	 0.61 dB 0.81 dB 1.2 dB 1.6 dB 2 dB 2.4 dB 2.8 dB 3.2 dB	Comparison to Standard Electronic Programmable Attenuator
RF Absolute Power – Source Into 50 Ω 1 mHz to 100 kHz SWR 1.2:1 100 kHz to 10 MHz SWR ≤ 1.2:1 (10 to 20) MHz SWR ≤ 1.2:1	 (3 to 10) Vp-p 1 mVp-p to 3Vp-p (3 to 10) Vp-p 1 mVp-p to 3 Vp-p 100 mVp-p to 3 Vp-p (1 to 100) mVp-p	 0.13 dB 0.22 dB 0.41 dB 0.61 dB 0.61 dB 0.91 dB	Comparison to Synthesized Signal Sources
RF Absolute Power Into 50 Ω, In 2 dB steps Relative to Full Output	200 Hz to 80 MHz (0 to -38) dBm (-40 to -58) dBm (-60 to -98) dBm	 0.21 dB 0.21 dB 0.27 dB	Comparison to Synthesized Level Generator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power Into 75 Ω, In 2 dB steps Relative to Full Output	(0 to -38) dBm 200 Hz to 25 MHz (25 to 80) MHz (-40 to -58) dBm 200 Hz to 25 MHz (25 to 80) MHz (-60 to -98) dBm 200 Hz to 25 MHz (25 to 80) MHz	 0.21 dB 0.36 dB 0.28 dB 0.54 dB 0.45 dB 1.7 dB	Comparison to Synthesized Level Generator
RF Absolute Power – Source Into 50 Ω SWR ≤ 1.6:1 SWR ≤ 1.6:1 SWR ≤ 1.8:1 SWR ≤ 2:1 SWR ≤ 1.6:1 SWR ≤ 1.8:1 SWR ≤ 2:1 SWR ≤ 1.6:1 SWR ≤ 1.8:1 SWR ≤ 2:1	(+10 to - 10) dBm 10 MHz to 2 GHz (2 to 20) GHz (+5 to -10) dBm 10MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (+2.5 to -10) dBm (40 to 50) GHz (-10 to -60) dBm 10MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz (-60 to -110) dBm 10 MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	 1.5 dB 1.7 dB 0.82 dB 0.96 dB 1.2 dB 2.3 dB 1.2 dB 1.3dB 1.6 dB 2.3 dB 1.8 dB 1.9 dB 2.2 dB 3.3 dB	Comparison to Synthesized Level Generator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Tuned Power – Measure (relative)	100 kHz to 4.2 GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB (4.2 to 18) GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB (18 to 26.5) GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB	 0.14 dB 0.16 dB 0.19 dB 0.21 dB 0.25 dB 0.18 dB 0.2 dB 0.22 dB 0.24 dB 0.28 dB 0.24 dB 0.25 dB 0.27 dB 0.29 dB 0.32 dB	Comparison to Measuring Receiver System
RF Tuned Power – Measure (relative)	(26.5 to 50) GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB	 0.2 dB 0.21 dB 0.23 dB 0.25 dB 0.29 dB	Comparison to Measuring Receiver System
Digital Modulation – Measure Carrier Frequency 2 MHz to 2.65 GHz Error Vector Magnitude for Modulation Types: MSK, GMSK, BPSK, DQPSK, Π/4DQPSK, 8PSK, 16QAM, 32 QAM and QPSK Phase Error for Modulation Types: MSK, GMSK, BPSK, DQPSK, Π/4DQPSK, 8PSK, 16QAM, 32 QAM and QPSK	 (0 to 15) % (1 to 100) kHz 100 kHz to 1 MHz 1 MHz to 2.65 GHz (0 to 3)° (1 to 100) kHz (0.1 to 1) MHz 1 MHz to 2.65 GHz	 0.33 % of reading 0.51 % of reading 1 % of reading 0.18° 0.34° 0.57°	Comparison to Vector Signal Analyzer

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation – Measure Error Vector Magnitude for FSK Modulation	Modulation Frequency 3.2 kHz 1.152 kHz	 0.54 % of reading 1.5 % of reading	Comparison to Vector Signal Analyzer
Amplitude Modulation – Source			Comparison to AM/FM Test Source, Analog Modulation Sources
(11 to 13.5) MHz	Rate: 50 Hz to 50 kHz, (5 to 99) % Depth	0.1 % of reading	
20 Hz to 100 kHz	Rate: (20 to 50) Hz (5 to 99) % Depth	0.25 % of reading	
DC to 15 kHz	Rate:9 kHz to 3.2 GHz (0 to 100) % Depth	5 % of reading	
Amplitude Modulation – Measure			Comparison to Microwave Measuring Receiver System
100 kHz to 10 MHz	Rate: 50 Hz to 10 kHz, (5 to 99) % Depth	0.001 4 % of reading + 0.009 AM	
10 MHz to 3 GHz	50 Hz to 100 kHz, (20 to 99) % Depth	0.001 % of reading + 0.007 AM	
Amplitude Modulation – Measure			Comparison to Microwave Measuring Receiver System
10 MHz to 3 GHz	50 Hz to 100 kHz, (5 to 20) % Depth	0.001 % of reading + 0.029 AM	
(3 to 26.5) GHz	50 Hz to 100 kHz, (5 to 20) % Depth	0.01 % of reading + 0.052 AM	
(3 to 26.5) GHz	50 Hz to 100 kHz, (20 to 99) % Depth	0.01 % of reading + 0.018 AM	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure			
150 kHz to 10 MHz			
Rate: 50 Hz to 10 kHz, Depth: 5 % to 99 %	(5 to < 10) % Depth (10 to 99) % Depth	0.01 % of reading + 0.023 AM 0.06 % of reading + 0.023 AM	
Rate: 20 Hz to 10 kHz, Depth: to 99 %	(5 to < 10) % Depth (10 to 99) % Depth	0.01 % of reading + 0.035 A 0.06 % of reading + 0.035 AM	
10 MHz to 1.3 GHz			
Rate: 50 Hz to 50 kHz, Depth: 5 % to 99 %	(5 to < 10) % Depth (10 to 99) % Depth	0.01 % of reading + 0.012 AM 0.06 % of reading + 0.012 AM	Comparison to Microwave Measuring Receiver System
Rate: 20 Hz to 10 kHz, Depth: to 99 %	(5 to < 10) % Depth (10 to 99) % Depth	0.01 % of reading + 0.035 AM 0.06 % of reading + 0.035 AM	
(1.3 to 26.5) GHz			
Rate: 50 Hz to 10 kHz, Depth: 5 % to 99 %	(5 to < 10) % Depth (10 to 99) % Depth	0.03 % of reading + 0.018 AM 0.07 % of reading + 0.018 AM	
10 MHz to 26.5 GHz			
Rate: 20 Hz to 10 kHz, Depth: to 99 %	(5 to < 10) % Depth (10 to 99) % Depth	0.03 % of reading + 0.035 AM 0.07 % of reading + 0.035 AM	
Frequency Modulation – Measure			
250 kHz to 10 MHz	Rate: 20 Hz to 10 kHz Dev:20 Hz to 40 kHz pk	1.7 % of reading + 5.7 Hz 1.1 % of reading + 6.6 Hz	Comparison to Microwave Measuring Receiver System
10 MHz to 6.6 GHz	Rate: 50 Hz to 200 kHz Dev: 250 Hz to 400 kHz pk	1.8 % of reading + 5.1 Hz 1.2 % of reading + 6.1 Hz	
Frequency Modulation – Measure			
(6.6 to 13.2) GHz	Rate: 50 Hz to 200 kHz Dev:250 Hz to 400 kHz pk	2.9 % of reading + 4 Hz 1.2 % of reading + 6.4 Hz	Comparison to Microwave Measuring Receiver System
(13.2 to 26.5) GHz	Rate: 50 Hz to 100 kHz Dev:250 Hz to 400 kHz pk	4.4 % of reading + 3.8Hz 1.2 % of reading + 7.6 Hz	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure 250 kHz to 10 MHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM 10 MHz to 26.5 GHz	Rate: 20 Hz to 10 kHz ≤ 40 kHz pk	0.024 FM + 2.4 Hz Pk 0.024 FM + 8 Hz Pk	Comparison to Microwave Measuring Receiver System
Frequency Modulation – Measure 10 MHz to 1.3 GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 50 Hz to 100 kHz ≤ 400 kHz pk	0.012 FM + 2.4 Hz Pk 0.012 FM + 14 Hz Pk 0.012 FM + 66 Hz Pk	Comparison to Microwave Measuring Receiver System
Frequency Modulation – Measure (> 1.3 to 6.2) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (> 6.2 to 12.4) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 50 Hz to 100 kHz ≤ 400 kHz pk	0.012 FM + 19 Hz Pk 0.012 FM + 23 Hz Pk 0.012 FM + 75 Hz Pk 0.012 FM + 35 Hz Pk 0.012 FM + 39 Hz Pk 0.012 FM + 91 Hz Pk	Comparison to Microwave Measuring Receiver System
Frequency Modulation – Measure (> 12.4 to 18.6) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (> 18.6 to 26.5) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 50 Hz to 100 kHz ≤ 400 kHz pk	0.012 FM + 51 Hz Pk 0.012 FM + 55 Hz Pk 0.012 FM + 110 Hz Pk 0.012 FM + 67 Hz Pk 0.012 FM + 71 Hz Pk 0.012 FM + 130 Hz Pk	Comparison to Microwave Measuring Receiver System

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure 10 MHz to 26.5 GHz 10 MHz to 1.3 GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (>1.3 to 6.2) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 50 Hz to 100 kHz ≤ 400 kHz pk	 0.058 FM + 3.9 Hz Pk 0.058 FM + 8 Hz Pk 0.058 FM + 66 Hz Pk 0.058 FM + 19 Hz Pk 0.058 FM + 23 Hz Pk 0.058 FM + 75 Hz Pk	Comparison to Microwave Measuring Receiver System
Frequency Modulation – Measure (> 6.2 to 12.4) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (> 12.4 to 18.6) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (> 18.6 to 26.5) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 20 Hz to 200 kHz ≤ 400 kHz pk	 0.058 FM + 35 Hz Pk 0.058 FM + 39 Hz Pk 0.058 FM + 91 Hz Pk 0.058 FM + 51 Hz Pk 0.058 FM + 55 Hz Pk 0.058 FM + 110 Hz Pk 0.058 FM + 67 Hz Pk 0.058 FM + 71 Hz Pk 0.058 FM + 130 Hz Pk	Comparison to Microwave Measuring Receiver System

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Frequency Modulation – Source			Comparison to AM/FM Test Source
(11 to 13.5) MHz	Rate: DC to 10 kHz Dev.: ≤ 100 kHz peak	0.1 % of reading	
(11 to 13.5) MHz	Rate: DC to 10 kHz Dev.: ≤ 200 kHz peak	0.25 % of reading	
(88 to 108) MHz	Rate: DC to 100 kHz Dev.: ≤ 100 kHz peak	0.1 % of reading	
(88 to 108) MHz	Rate: DC to 100 kHz Dev.: ≤ 200 kHz peak	0.25 % of reading	
(352 to 432) MHz	Rate: DC to 100 kHz Dev.: ≤ 100 kHz peak	0.1 % of reading	
Frequency Modulation – Source			Comparison to Analog Modulation Sources
(352 to 432) MHz	Rate: DC to 100 kHz Dev.: ≤ 200 kHz peak	0.25 % of reading	
9 kHz to 1 GHz	Rate: DC to 150 kHz Dev.: ≤ 200 kHz peak	3 % of reading + 30 Hz	
(1 to 2) GHz	Rate: DC to 150 kHz Dev.: ≤ 400 kHz peak	3 % of reading + 60 Hz	
(2 to 3) GHz	Rate: DC to 150 kHz Dev.: ≤ 400 kHz peak	3 % of reading + 120 Hz	
Frequency Modulation – Source			Comparison to Analog Modulation Sources
1 kHz rate			
Max. Dev. 2 MHz	250 kHz to 1 GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 4 MHz	(1 to 2) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 8 MHz	(2 to 3.2) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 16 MHz	(3.2 to 10) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 32 MHz	(10 to 20) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 64 MHz	(20 to 40) GHz	40 mHz/Hz + 23 Hz	
Max. Dev. 128 MHz	(40 to 50) GHz	40 mHz/Hz + 23 Hz	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Measure > 0.7 rad Dev. > 0.6 rad Dev. > 1.2 rad Dev.	 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	 1.2 % of reading + 0.007 1 rad 1.2 % of reading + 0.007 1 rad 1.2 % of reading + 0.007 3 rad	Comparison to Microwave Measuring Receiver System
Phase Modulation – Measure 150 kHz to 10 MHz (0 to < 4) rad pk PM (≥ 4 to < 40) rad pk PM 10 MHz to 1.3 GHz (0 to < 4) rad pk PM (≥ 4 to < 40) rad pk PM (≥ 40 to < 400) rad pk PM	 200 Hz to 10 kHz Rate ≤ 40 rad pk 200 Hz to 20 kHz Rate ≤ 400 rad pk	 4.7 % of reading + 0.001 rad 4.7 % of reading + 0.008 rad 3.5 % of reading + 0.001 rad 3.5 % of reading + 0.008 rad 3.5 % of reading + 0.09 rad	Comparison to Microwave Measuring Receiver System
Phase Modulation – Measure 1.3 to 26.5 GHz (0 to < 4) rad pk PM (≥ 4 to < 40) rad pk PM (≥ 40 to < 400) rad pk PM	 200 Hz to 20 kHz Rate ≤ 400 rad pk	 3.5 % of reading + 0.001 rad 3.5 % of reading + 0.008 rad 3.5 % of reading + 0.09 rad	Comparison to Microwave Measuring Receiver System
Phase Modulation – Source Rate: 20 Hz to 10 kHz Carrier: 9 kHz to 1 GHz (1 to 2) GHz (2 to 3.2) GHz 250 kHz to 1 GHz (> 1 to 2) GHz (> 2 to 3.2) GHz (> 3.2 to 10) GHz (> 10 to 20) GHz (> 20 to 40) GHz (> 40 to 50) GHz	 (0 to 10) rad (0 to 20) rad (0 to 40) rad Max. Dev. (0 to 20) rad (0 to 40) rad (0 to 80) rad (0 to 160) rad (0 to 320) rad (0 to 640) rad (0 to 1 280) rad	 3 % of reading + 0.05 rad 3 % of reading + 0.1 rad 3 % of reading + 0.2 rad 6 % of reading + 0.012 rad 6 % of reading + 0.012 rad 6 % of reading + 0.012 rad 6 % of reading + 0.012 rad 6 % of reading + 0.012 rad 6 % of reading + 0.012 rad 6 % of reading + 0.012 rad	Comparison to Analog Modulation Sources
Distortion – Measure	(0.01 to 100) % Distortion 250 kHz to 50 GHz	0.065 % of reading	Comparison to Microwave Measuring Receiver System

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Distortion – Measure Fundamental Frequency 20 Hz to 20 kHz (20 to 100) kHz	 (-99 to 0) dB (-99 to 0) dB	 1.2 dB 2.3 dB	Comparison to Distortion Analyzer
Power Reference – Measure	50 MHz 1 mW	5.5 µW	Indirect Method Primary Standards Lab (H75) Thermistor Mount, Power Meter, Precision 8.5-digit Multimeter
Absolute Power – Measure	9 kHz to 4.2 GHz (+20 to -30) dBm 10 MHz to 18 GHz (-20 to -70) dBm 50 MHz to 26.5 GHz (+20 to -30) dBm (26.5 to 50) GHz (+20 to -30) dBm (-20 to -70) dBm	 0.3 % of Reading + 0.65 dB 0.44 % of reading + 0.32 dB 0.24 % of reading + 0.86 dB 0.46 % of reading + 0.94 dB 1.6 % of reading + 0.67 dB	Comparison to RF Power Meters/Sensors
Power Meter – Range Calibration	3 µW 10 µW 30 µW 100 µW 300 µW 1 mW 3 mW 10 mW 30 mW 100 mW	21 nW 19 nW 21 nW 77 nW 0.11 µW 0.29 µW 0.64 µW 6.4 µW 13 µW 0.10 mW	Comparison to Power Meter Range Calibrator w/ Precision DC Voltage Source
Noise Figure – Source	15 dB ENR 10 MHz to 4 GHz (> 4 to 10) GHz (> 10 to 18) GHz (> 18 to 26.5) GHz	 0.22 dB 0.22 dB 0.22 dB 0.22 dB	Comparison to Noise Source
Noise Figure – Measure	100 kHz to 30 MHz > 30 MHz to 3 GHz (> 3 to 26.5) GHz	0.43 dB 0.42 dB 0.47 dB	Comparison to Noise Figure Measurement System w/ Standard Noise Sources
Single Sideband Phase Noise – Measure	1 MHz to 26.5 GHz	1.8 dB	Comparison to Phase Noise Measurement System

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Current Probes/Bulk Current Injection Probes Insertion Loss Transfer Impedance	(0 to 100) dB 20 Hz to 300 kHz 300 kHz to 1 MHz 1 MHz to 3GHz (0 to 100) dB 20 Hz to 300 kHz 300 kHz to 1 MHz 1 MHz to 3 GHz	 1.1 dB 1 dB 1.9 dB 1.1 dB 1 dB 1.9 dB	Comparison to Network/RF Impedance Analyzers, attenuator, type N calibration kit
Transmission S_{12}/S_{21} – Measure Phase and Magnitude (-180 to 180)°	9 kHz to 1.3 GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-60 to -20) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB (1.3 to 3) GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-60 to -20) dB (-70 to -60) dB (1.3 to 3) GHz (-80 to -70) dB (-90 to -80) dB	 0.18 dB (1°) 0.057 dB (0.43°) 0.072 dB (0.8°) 0.086 dB (0.89°) 0.13 dB (1.2°) 0.3 dB (2.4°) 0.92 dB (6.9°) 0.12 dB (4.1°) 0.063 dB (0.48°) 0.077 dB (0.8°) 0.093 dB (0.94°) 0.13 dB (1.2°) 0.32 dB (2.6°) 0.92 dB (7.4°)	Comparison to LF Vector Network Analyzer, Calibration Kits

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Transmission S_{12}/S_{21} – Measure Phase and Magnitude (-180 to 180)°	50 MHz to 2 GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB (2 to 8) GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB	0.07 dB (0.46°) 0.054 dB (0.36°) 0.075 dB (0.5°) 0.12 dB (0.83°) 0.29 dB (1.9°) 2.3 dB (5.5°) 5.9 dB (5.7°) 0.09 dB (0.59°) 0.07 dB (0.46°) 0.087 dB (0.57°) 0.1 dB (0.69°) 0.12 dB (0.81°) 0.15 dB (0.98°) 0.22 dB (1.4°) 0.45 dB (3.1°) 1.2 dB (8.7°) 3.4 dB (8.7°)	Comparison to Vector Network Analyzer w/ Calibration Kits

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Transmission S_{12}/S_{21} – Measure Phase and Magnitude (-180 to 180)°	(8 to 20) GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB (20 to 50) GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB	 0.19 dB (1.3°) 0.17 dB (1.1°) 0.18 dB (1.2°) 0.2 dB (1.3°) 0.22 dB (1.4°) 0.24 dB (1.6°) 0.32 dB (2.1°) 0.6 dB (4.1°) 1.6 dB (8.7°) 4.2 dB (11°) 0.54 dB (3.7°) 0.5 dB (3.4°) 0.49 dB (3.3°) 0.5 dB (3.4°) 0.52 dB (3.5°) 0.55 dB (3.7°) 0.65 dB (4.4°) 1.1 dB (7.6°) 2.7 dB (8.9°) 6.6 dB (11°)	Comparison to Vector Network Analyzer w/ Calibration Kits
Reflection S_{11}/S_{22} – Measure Phase and Magnitude [2,3] (-180 to 180)°	9 kHz to 1.3 GHz (< 0.03) Γ (< 0.2) Γ (< 0.4) Γ (< 0.6) Γ (< 0.8) Γ (< 1) Γ (1.3 to 3) GHz (< 0.03) Γ (< 0.2) Γ (< 0.4) Γ (< 0.6) Γ (< 0.8) Γ (< 1) Γ	 0.002 3 (1.4°) 0.003 5 (1.4°) 0.006 1 (1.1°) 0.008 3 (0.94°) 0.01 (0.83°) 0.012 (0.7°) 0.005 6 (1.8°) 0.003 5 (1.8°) 0.008 (1.3°) 0.011 (1.2°) 0.013 (1°) 0.016 (0.89°)	Comparison to LF Vector Network Analyzer, Calibration Kits

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Reflection S_{11}/S_{22} – Measure Phase and Magnitude [2,3] (-180 to 180)°	50 MHz to 2 GHz (< 0.03) Γ (< 0.2) Γ (< 0.4) Γ (< 0.6) Γ (< 0.8) Γ (< 1) Γ (2 to 8) GHz (< 0.03) Γ (< 0.2) Γ (< 0.4) Γ (< 0.6) Γ (< 0.8) Γ (< 1) Γ (8 to 20) GHz (< 0.03) Γ (< 0.2) Γ (< 0.4) Γ (< 0.6) Γ (< 0.8) Γ (< 1) Γ	0.01 (3.3°) 0.012 (3.3°) 0.014 (2°) 0.017 (1.6°) 0.021 (1.5°) 0.026 (1.5°) 0.01 (3.5°) 0.012 (3.5°) 0.015 (2.2°) 0.019 (1.8°) 0.024 (1.7°) 0.003 (1.7°) 0.002 4 (7.8°) 0.002 7 (7.8°) 0.003 3 (4.8°) 0.004 2 (4°) 0.053 (3.8°) 0.067 (3.9°)	Comparison to Vector Network Analyzer w/ Calibration Kits
Reflection S_{11}/S_{22} – Measure Phase and Magnitude [2,3] (-180 to 180)°	(20 to 50) GHz (< 0.03) Γ (< 0.2) Γ (< 0.4) Γ (< 0.6) Γ (< 0.8) Γ (< 1) Γ	0.06 (19°) 0.066 (11°) 0.079 (11°) 0.097 (9.3°) 0.12 (8.8°) 0.15 (8.8°)	Comparison to Vector Network Analyzer w/ Calibration Kits

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) 7mm Test Ports Reflection S_{11}/S_{22} [2,3]			
Magnitude	</= 0.1 to </= 1 Γ		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.000 3 to 1) GHz	0.003 8 Γ	
	(1 to 3) GHz	0.003 9 Γ	
	(3 to 6) GHz	0.005 1 Γ	
Phase	</= 0 to </= 60°		
	(0.000 3 to 1) GHz	2°	
	(1 to 3) GHz	2.1°	
	(3 to 6) GHz	2.7°	
Network Analyzer System Verification (Corrected Performance) N-Type Test Ports Reflection S_{11}/S_{22} [2,3]			
Magnitude	</= 0.1 to </= 1 Γ		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.000 3 to 1) GHz	0.009 Γ	
	(1 to 3) GHz	0.001 Γ	
	(3 to 8) GHz	0.001 5 Γ	
	(8 to 18) GHz	0.004 1 Γ	
Phase	</= 0 to </= 60°		
	(0.000 3 to 1) GHz	0.46°	
	(1 to 3) GHz	0.64°	
	(3 to 8) GHz	0.65°	
	(8 to 18) GHz	1.3°	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) 3.5mm Test Ports Reflection S_{11}/S_{22} [2,3]			
Magnitude	</= 0.1 to </= 1 Γ		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.045 to 2) G Γ Hz	0.000 76 Γ	
	(2 to 20) GHz	0.001 Γ	
	(20 to 26.5) GHz	0.003 Γ	
Phase	</= 0 to </= 60°		
	(0.045 to 2) GHz	0.34°	
	(2 to 20) GHz	0.36°	
	(20 to 26.5) GHz	0.64°	
Network Analyzer System Verification (Corrected Performance) 2.4mm Test Ports Reflection S_{11}/S_{22} [2,3]			
Magnitude	</= 0.1 to </= 1 Γ		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.045 to 2) GHz	0.003 8 Γ	
	(2 to 20) GHz	0.003 8 Γ	
	(20 to 40) GHz	0.004 4 Γ	
	(40 to 50) GHz	0.005 5 Γ	
Phase	</= 0 to </= 60°		
	(0.045 to 2) GHz	0.96°	
	(2 to 20) GHz	1.3°	
	(20 to 40) GHz	1.5°	
	(40 to 50) GHz	2.3°	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) 7mm Test Ports Transmission $S_{21}/S1_{22}$			
Magnitude	</= 0.1 to </= 1 dB		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.000 3 to 1) GHz	0.16 dB	
	(1 to 3) GHz	0.16 dB	
	(3 to 6) GHz	0.17 dB	
Phase	</= 0 to </= 60°		
	(0.000 3 to 1) GHz	1.4°	
	(1 to 3) GHz	1.5°	
	(3 to 6) GHz	2.2°	
Network Analyzer System Verification (Corrected Performance) N-Type Test Ports Transmission $S_{21}/S1_{22}$			
Magnitude	</= 0.1 to </= 1 dB		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.000 3 to 1) GHz	0.018 dB	
	(1 to 3) GHz	0.019 dB	
	(3 to 8) GHz	0.02 dB	
	(8 to 18) GHz	0.024 dB	
Phase	</= 0 to </= 60°		
	(0.000 3 to 1) GHz	0.18°	
	(1 to 3) GHz	0.2°	
	(3 to 8) GHz	0.23°	
	(8 to 18) GHz	0.24°	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) 3.5mm Test Ports Transmission $S_{21}/S1_{22}$			
Magnitude	</= 0.1 to </= 1 dB		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.045 to 2) GHz	0.018 dB	
	(2 to 20) GHz	0.019 dB	
	(20 to 26.5) GHz	0.032 dB	
Phase	</= 0 to </= 60°		
	(0.045 to 2) GHz	0.18°	
	(2 to 20) GHz	0.18°	
	(20 to 26.5) GHz	0.32°	
Network Analyzer System Verification (Corrected Performance) 2.4mm Test Ports Transmission $S_{21}/S1_{22}$			
Magnitude	</= 0.1 to </= 1 dB		Comparison to Mechanical Calibration Kits and RF Network Analyzer System
	(0.045 to 2) GHz	0.023 dB	
	(2 to 20) GHz	0.033 dB	
	(20 to 40) GHz	0.055 dB	
	(40 to 50) GHz	0.068 dB	
Phase	</= 0 to </= 60°		
	(0.045 to 2) GHz	0.23°	
	(2 to 20) GHz	0.41°	
	(20 to 40) GHz	0.97°	
	(40 to 50) GHz	1.8°	
Scalar Network Analyzer Absolute Log Error	21 dB	0.04 dB	Comparison to Scalar Network Analyzer Calibrator
Dynamic Accuracy	(0 to 140) dB	0.02 dB	
Network Analyzer Dynamic Accuracy	(0 to 140) dB	0.02 dB	Comparison to Dynamic Accuracy Test Set

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Impulse Spectral Amplitude – Source			Comparison to Pulse Generator
CISPR Band A	(10 to 150) kHz	0.82 dB	
CISPR Band B	150 kHz to 30 MHz	0.82 dB	
CISPR Band C and D	30 MHz to 1 GHz	1.1 dB	
CISPR Band E	(1 to 18) GHz	1.5 dB	
Sinewave Output for CISPR Checks Source @ 60 dB/µV	(0 to -70) dB		
	100 kHz	0.35 dB	
	(1, 10, and 100) MHz	0.35 dB	
Peak and Average Detector Response	(0 to -70) dB CISPR Band A thru D	1.3 dB	
LISN (Line Impedance Stabilization Network) & AMN (Artificial Mains Network)			Comparison to RF Impedance/Network Analyzers, Calibration Kits
Insertion Loss	(-20 to 0) dB 10 Hz to 1 000 MHz	0.25 dB	
Isolation (De-Coupling Factor)	(-90 to 0) dB 10 Hz to 1 000 MHz	2.3 dB	
Impedance (Magnitude)	0.1 Ω to 1 kΩ 10 Hz to 1 000 MHz	2.4 % of reading	
Impedance (Phase)	(-180 to 180)° 10 Hz to 1 000 MHz	2.6°	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
CDN (Coupling-Decoupling Network) & ISN (Impedance Stabilization Network)			Comparison to RF Impedance/Network Analyzers, Calibration Kits
Insertion Loss	(-20 to 0) dB 10 Hz to 1 000 MHz	0.25 dB	
Isolation (De-Coupling Factor)	(-90 to 0) dB 10 Hz to 1 000 MHz	2.3 dB	
Impedance (Magnitude)	0.1 Ω to 1 kΩ 10 Hz to 1 000 MHz	2.4 % of reading	
Impedance (Phase)	(-180 to 180)° 10 Hz to 1 000 MHz	2.6°	
LCL (Longitudinal Conversion Loss)	(-20 to 0) dB 10 Hz to 1 000 MHz	2.3 dB	

Length – Dimensional Metrology Orlando, FL

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Test, Dial Indicators & Thickness Gages [1,2]	Up to 4 in	(57 + 0.26L) µin	Comparison to Gage Blocks
Calipers [1,2]	Up to 54 in	(52 + 46L) µin	Comparison to Gage Blocks, Standard Rings, Rod Sets
Micrometers [1,2] (Linearity Only)	Up to 54 in	(52 + 46L) µin	Comparison to Gage Blocks, Rod Sets
Height Gages [1,2]	Up to 12 in	(750 + 4.7L) µin	Comparison to Gage Blocks, Surface Plate
Depth Gages [1,2]	Up to 12 in	(160 + 4.1L) µin	Comparison to Gage Blocks
Steel Rulers	Up to 48 in	0.036 in	Comparison to Gage Blocks

Length – Dimensional Metrology Orlando, FL

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tape Measures	Up to 50 ft	0.036 in	Comparison to Gage Blocks
Protractor/Angle	Up to 90°	0.069°	Comparison to Angle Gage Blocks

Mass and Mass Related Orlando, FL

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Barometric Pressure Measurement	Up to 39 psia	0.014 psi	Comparisonto Digital Barometer / Precision Absolute Manometer
Force-Measuring Equipment Tension / Compression	(0.1 to 50) kgf	0.042 mgf/gf + 7.1 gf	Comparison to NIST Class F Weights
Force-Measuring Equipment Tension / Compression	Up to 1 000 lbf (1 000 to 10 000) lbf (10 000 to 20 000) lbf (20 000 to 30 000) lbf (30 000 to 40 000) lbf (40 000 to 50 000) lbf	5.1 lbf 24 lbf 47 lbf 70 lbf 93 lbf 120 lbf	Comparison to Reference Load Cells
Pressure – Source/Pressure gages and transducers [1]	(-12 to 300) psi (300 to 10 000) psi	0.2 psi 1.4 psi	Comparison to Pressure Calibration System
Torque – Measure/Torque Tools	(8 to 80) ozf·in (5 to 50) lbf·in (50 to 500) lbf·in (25 to 250) lbf·ft	0.65 % of reading + 0.1 ozf·in 0.003 lbf·in/lbf·in + 0.016 lbf·in 0.002 lbf·in/lbf·in + 0.068 lbf·in 0.006 5 + lbf·ft/lbf·ft + 0.32 lbf·ft	Comparison to Torque Transducers

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Mass and Mass Related Orlando, FL

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales & Balances [4]	0.25 oz 0.5 oz 1 oz 2 oz 4 oz 8 oz 16 oz 1 kg 2 kg 5 lb (1 to 10) lb (10 to 50) lb (50 to 300) lb	0.000 71 oz 0.001 1 oz 0.000 27 oz 0.000 46 oz 0.001 oz 0.002 2 oz 0.002 9 oz 5.8 g 12 g 0.001 8 lb 0.002 6 lb 0.005 9 lb 0.041 lb	Comparison to NIST Class F Weights And internal calibration procedure utilized in the calibration of the weighing system.

Thermodynamic Orlando, FL

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity – Measure [1]	Up to 90 %RH (90 to 95) %RH	1.6 % RH 2.2 % RH	Comparison to Humidity Probe Monitor
Relative Humidity – Measuring equipment	Up to 90 %RH (90 to 95) %RH	1.9 %RH 2.5 %RH	Comparison to Humidity chamber, Humidity Probe Monitor
Temperature – Measure [1]	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 420) °C (420 to 650) °C	0.03 °C 0.05 °C 0.07 °C 0.11 °C 0.14 °C	Comparison to Reference Thermometer w/ PRT
Temperature – Measuring equipment	(-70 to 0) °C (0 to 100) °C (100 to 175) °C	1.3 °C 1.5 °C 2.8 °C	Comparison to Reference Chamber and Thermometer w/ PRT

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Time and Frequency Orlando, FL

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source [1]	1 µHz to 80 MHz	5.8 x 10^{-9} MHz	Comparison to Frequency Synthesizer w/ GPS Reference Signal Generator
Frequency – Source [1]	1 Hz to 50 GHz	5.8 x 10^{-10}GHz	Comparison to Synthesized Sweeper w/ GPS Reference
Frequency – Measure [1]	1 µHz to 12.4 GHz 1 Hz to 50 GHz	5.8 x 10^{-10}GHz 5.8 x 10^{-11} GHz	Comparison to Electronic Counters, Analyzers w/ GPS Reference
Time Interval	50 ns to 999 s	5 parts in 10^{12} s+0.43 ns	Comparison to Universal Counter w/ GPS Reference
Period [1]	4.44 ns to 10 s	0.012 % of reading + 0.17 ns	Comparison to Universal Counter w/ GPS Reference
Rise/Fall Time – Measure [1]	1 ns to 10 µs (10 to 100) µs	1.2 ns 2.9 ns	Comparison to Digital Oscilloscope Or Universal Counter w/ GPS Reference
Pulse Width – Measure [1]	> 5 ns	1.1 ns	Comparison to Universal Counter w/ GPS Reference
Stop Watches – Totalize Method	1s to 24 hr	0.06 % of reading + 44 ms	Comparison to Universal Counter and Synthesizer w/ GPS Reference

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TESTING

Environmental Orlando, FL

Specific Tests and/or Properties Measured	Specification, Standard, Method, or Test Technique	Items, Materials or Product Tested	Key Equipment or Technology
Face Velocity Test Airflow Smoke Pattern Test Leak/Backstreaming Test	ISO 14644-1 ISO 16644-2 ISO 14644-3 ISO 16644-7 ANSI/ASHRAE 110 IEST-RP-CC002.4	Flow hood Devices Test	Comparison to Thermal Anemometer Aerosol Generator Digital Aerosol Photometer
Airborne Particle Count Survey Airflow Measurement Airflow Smoke Pattern Test HEPA/ULPA filter leak Test Biological Safety Cabinet Classification	ISO 14644-1 ISO 16644-2 ISO 14644-3 ISO 16644-7 IEST-RP-CC034.2 IEST-RP-CC006.3 NSF/ANSI49-2004 Annex	Biological Safety Cabinet Test	Comparison to Particle Counter Balometer Aerosol Generator Digital Aerosol Photometer Thermal Anemometer
Airflow Measurement Air Pressure Difference Test Airflow Smoke Pattern Test HEPA/ULPA filter leak Test Airborne Particle Count Survey Lighting Level Sound Level Test Temperature Test Humidity Test Temperature/Humidity Uniformity Test Recovery Test	ISO 14644-1 ISO 14644-2 ISO 14644-3 IEST-RP-CC006.3 IEST-RP-CC034.2 ISO/DIS 7726 In-house Method	Clean Room Test	Comparison to Balometer Differential Pressure Meter Digital Aerosol Photometer, Aerosol Generator Particle Counter Light meter Sound level meter Temperature & humidity meter Thermal Anemometer.
Airborne Particle Count Survey Airflow Velocity Laminar Hood HEPA/ULPA filter leak Test Induction Leak/Backstreaming Test Airflow Smoke Pattern Test Lighting Level Sound Level Test	ISO 14644-1 ISO 14644-2 ISO 14644-3 ISO 14644-7 IEST-RP-CC002.4 IEST-RP-CC006.3 IEST-RP-CC034.2 In-house Method	Laminar Air Flow Workstation Test	Comparison to Particle Counter Thermal Anemometer Aerosol Generator Digital Aerosol Photometer Light meter Sound level meter

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Environmental Orlando, FL

Specific Tests and/or Properties Measured	Specification, Standard, Method, or Test Technique	Items, Materials or Product Tested	Key Equipment or Technology
Oil Aerosol & Vapor Content [4]	ISO 8573-1 ISO 8573-2 ISO 8573-5	Compressed Air Purity Test	Comparison to Oil Content Analyzer Air Sampler
Humidity / Dew Point Measurement	ISO 8573-3	Compressed Air Purity Test	Comparison to Dew Point Meter & Diffuser
Pressurized Air Particle Content	ISO 8573-4	Compressed Air Purity Test	Comparison to Particle Counter & Diffuser
Viable Microbiological Contaminant [5]	ISO 8573-7	Compressed Air Purity Test	Comparison to Microbiological Sampler

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CALIBRATION

Acoustics and Vibration San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meters [1]	125 Hz, 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz 74 dB, 84 dB, 94 dB, 104 dB, 114 dB	0.3 dB	Comparison to Sound Level Calibrator

Chemical Quantities San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH – Source [1, 6]	4.01 pH 7 pH 10 pH	0.016 pH 0.019 pH 0.027 pH	Comparison to Standard Solutions
Conductivity – Source [6]	25 µS/cm 84 µS/cm 500 µS/cm 1 400 µS/cm 12 800 µS/cm	0.38 µS/cm 0.9 µS/cm 4.9 µS/cm 8.3 µS/cm 77 µS/cm	Comparison to Standard Solutions

Electrical – DC/Low Frequency San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source [1]	Up to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V 220 V to 1.1 kV	7.5 µV/V + 0.4 µV 5 µV/V + 0.7 µV 3.5 µV/V + 2.5 µV 3.5 µV/V + 4 µV 5 µV/V + 40 µV 6.5 µV/V + 0.4 mV	Comparison to Multiproduct Calibrator
DC Voltage – Source [1] Fixed Point	10 V	20 µV	Comparison to DC Reference Standard
DC Voltage – Measure [1]	Up to 200 mV 200 mV to 2 V (2 to 20) V (20 to 200) V 200 V to 1 kV	5.0 µV/V + 0.1 µV 3.5 µV/V + 0.4 µV 3.5 µV/V + 4.0 µV 5.5 µV/V + 40 µV 5.5 µV + 1.0 mV	Comparison to Precision 8.5 Digit Multimeter
DC High Voltage – Measure [1]	Up to 10 kV (10 to 100) kV (100 to 150) kV	0.35 mV/V + 0.11 V 1.2 mV/V + 0.4 V 1.1 mV/V + 10 V	Comparison to High Voltage Meter Digital Multimeter
DC Current – Source [1]	Up to 220 µA 220 µA to 2.2 mA 2.2 mA to 22 mA 22 mA to 220 mA 220 mA to 2.2 A	40 µA/A + 6 nA 35 µA/A + 7 nA 35 µA/A + 40 nA 45 µA/A + 0.7 µA 80 µA/A + 12 µA	Comparison to Multiproduct Calibrator
DC Current – Source [1]	2.2 A to 11 A	0.36 mA/A + 0.48 mA	Comparison to Multiproduct Calibrator, Amplifier
DC Current – Source [1]	11 A to 20.5 A	0.78 mA/A + 1.2 mA	Comparison to Multiproduct Calibrator

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Electrical – DC/Low Frequency San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source [1] Clamp-On Meters	(10 to 16.5) A (16.5 to 150) A (150 to 1 025) A	0.54 % of reading + 0.03 A 0.57 % of reading + 0.17 A 0.59 % of reading + 0.61 A	Comparison to Multi Product Calibrator w/ Current Coil
DC Power – Source [1] 33 mV to 1 020 V 329.99 mA range 2.9999 A range 20.5 A range	 10 µW to 330 W 10 mW to 3 kW 100 mW to 21 kW	 0.01 % of reading + 1.2 nW 0.04 % of reading 0.1 % of reading	Comparison to Multi Product Calibrator
DC Power – Source [1] 33 mV to 1 020 V 329.99 mA range 2.9999 A range 20.5 A range	 3.3 mA to 8.999 mA 9 mA to 32.999 mA 33 mA to 89.99 mA 90 mA to 329.99 mA 0.33 A to 0.899 9 A 0.9 A to 2.199 9 A 2.2 A to 4.499 9 A 4.5 A to 11 A	 0.31 mW/W 0.23 mW/W 0.31 mW/W 0.23 mW/W 0.62 mW/W 0.47 mW/W 0.93 mW/W 0.7 mW/W	Comparison to Multi Product Calibrator
DC Current – Measure [1]	Up to 100 nA 100 nA to 1 µA (1 to 10) µA (10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	35 µA/A + 47 pA 24 µA/A + 0.047 nA 24 µA/A + 0.12 nA 24 µA/A + 0.95 nA 24 µA/A + 0.005 9 µA 24 µA/A + 0.059 µA 41 µA/A + 0.59 µA 130 µA/A + 0.012 mA	Comparison to Precision 8.5 Digit Multimeter
DC Current – Measure [1]	Up to 200 µA (200 µA to 2) mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A	12 µA/A + 0.4 nA 12 µA/A + 4 nA 14 µA/A + 40 nA 48 µA/A + 0.8 µA 0.19 mA/A + 16 µA 0.4 mA/A + 0.4 mA	Comparison to Precision 8.5 Digit Multimeter
DC Current – Measure [1]	(20 to 100) A (100 to 600) A (600 to 1 000) A	38 µA/A + 5.9 µA 0.19 % + 0.012 mA 0.32 % + 1.4 mA	Indirect Method Precision 8.5 Digit Multimeter w/ Current Shunts
DC Power – Measure [1]	Up to 10 W (> 10 to 15) W (> 15 to 100) W (> 100 to 150) W	0.043% of reading + 0.074 W 0.043 % of reading + 0.015 W 0.043 % of reading + 0.098 W 0.043 % of reading + 0.15 W	Comparison to Precision Power Analyzer

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	Up to 2.2 mV		Comparison to Multiproduct Calibrator
	(10 to 20) Hz	0.24 mV/V + 4 µV	
	(20 to 40) Hz	90.0 µV/V + 4 µV	
	40 Hz to 20 kHz	80.0 µV/V + 4 µV	
	(20 to 50) kHz	0.2 mV/V + 4 µV	
	(50 to 100) kHz	0.5 mV/V + 5 µV	
	(100 to 300) kHz	1.1 mV/V + 10 µV	
	(300 to 500) kHz	1.4 mV/V + 20 µV	
	500 kHz to 1 MHz	2.7 mV/V + 20 µV	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.24 mV/V + 4 µV	
	(20 to 40) Hz	90 µV/V + 4 µV	
	40 Hz to 20 kHz	80 µV/V + 4 µV	
	(20 to 50) kHz	0.2 mV/V + 4 µV	
	(50 to 100) kHz	0.5 mV/V + 5 µV	
	(100 to 300) kHz	1.1 mV/V + 10 µV	
	(300 to 500) kHz	1.4 mV/V + 20 µV	
	500 kHz to 1 MHz	2.7 mV/V + 20 µV	
	(22 to 220) mV		
	(10 to 20) Hz	0.24 mV/V + 12 µV	
	(20 to 40) Hz	90.0 µV/V + 7 µV	
	40 Hz to 20 kHz	80.0 µV/V + 7 µV	
	(20 to 50) kHz	0.2 mV/V + 7 µV	
	(50 to 100) kHz	0.46 mV/V + 17 µV	
	(100 to 300) kHz	0.9 mV/V + 20 µV	
	(300 to 500) kHz	1.4 mV/V + 25 µV	
	500 kHz to 1 MHz	2.7 mV/V + 45 µV	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.24 mV/V + 40 µV	
	(20 to 40) Hz	90 µV/V + 15 µV	
	40 Hz to 20 kHz	45 µV/V + 8 µV	
	(20 to 50) kHz	75 µV/V + 10 µV	
	(50 to 100) kHz	0.11 mV/V + 30 µV	
	(100 to 300) kHz	0.42 mV/V + 80 µV	
	(300 to 500) kHz	1 mV/V + 0.2 mV	
	500 kHz to 1 MHz	1.7 mV/V + 0.3 mV	

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Electrical – DC/Low Frequency San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source [1]	(2.2 to 22) V		Comparison to Multiproduct Calibrator
	(10 to 20) Hz	0.24 mV/V + 0.4 mV	
	(20 to 40) Hz	90 µV/V + 0.15 mV	
	40 Hz to 20 kHz	45 µV/V + 50 µV	
	(20 to 50) kHz	75 µV/V + 0.1 mV	
	(50 to 100) kHz	0.1 mV/V + 0.2 mV	
	(100 to 300) kHz	0.28 mV/V + 0.6 mV	
	(300 to 500) kHz	1 mV/V + 2 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.24 mV/V + 4 mV	
	(20 to 40) Hz	90 µV/V + 1.5 mV	
	40 Hz to 20 kHz	52 µV/V + 0.6 mV	
	(20 to 50) kHz	80 µV/V + 1 mV	
	(50 to 100) kHz	0.15 mV/V + 2.5 mV	
	(100 to 300) kHz	0.9 mV/V + 16 mV	
	(300 to 500) kHz	4.4 mV/V + 40 mV	
	500 kHz to 1 MHz	8 mV/V + 80 mV	
	220 V to 1.1 kV		
	(15 to 50) Hz	0.3 mV/V + 16 mV	
	50 Hz to 1 kHz	70 µV/V + 3.5 mV	
AC Voltage – Source [1]	220 V to 1.1 kV		Comparison to High Performance Multifunction Calibrator w/ Amplifier
	40 Hz to 1 kHz	90 µV/V + 4 mV	
	(1 to 20) kHz	0.17 mV/V + 6 mV	
	(20 to 30) kHz	0.6 mV/V + 11 mV	
	(220 to 750) V		
	(30 to 50) kHz	0.6 mV/V + 11 mV	
	(50 to 100) kHz	2.3 mV/V + 45 mV	
AC Voltage – Measure [1]	0 to 200 mV		Comparison to Precision 8.5 Digit Multimeter
	1 Hz to 10 Hz	0.17 mV/V + 14 µV	
	10 Hz to 40 Hz	0.14 mV/V + 4 µV	
	40 Hz to 100 Hz	0.12 mV/V + 4 µV	
	100 Hz to 2 kHz	0.11 mV/V + 2 µV	
	2 kHz to 10 kHz	0.14 mV/V + 4 µV	
	10 kHz to 30 kHz	0.34 mV/V + 8 µV	
	30 kHz to 100 kHz	0.77 mV/V + 20 µV	

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AC Voltage – Measure [1]	200 mV to 2 V		Comparison to Precision 8.5 Digit Multimeter
	1 Hz to 10 Hz	0.15 mV/V + 0.12 mV	
	10 Hz to 40 Hz	0.12 mV/V + 20 µV	
	40 Hz to 100 Hz	90 µV/V + 20 µV	
	100 Hz to 2 kHz	75 µV/V + 20 µV	
	2 kHz to 10 kHz	0.11 mV/V + 20 µV	
	10 kHz to 30 kHz	0.22 mV/V + 40 µV	
	30 kHz to 100 kHz	0.57 mV/V + 0.2 mV	
	100 kHz to 300 kHz	3 mV/V + 2 mV	
	300 kHz to 1 MHz	10 mV/V + 20 mV	
	(2 to 20) V		
	1 Hz to 10 Hz	0.15 mV/V + 1.2 mV	
	10 Hz to 40 Hz	0.12 mV/V + 0.2 mV	
	40 Hz to 100 Hz	90 µV/V + 0.2 mV	
	100 Hz to 2 kHz	75 µV/V + 0.2 mV	
	2 kHz to 10 kHz	0.11 mV/V + 0.2 mV	
	10 kHz to 30 kHz	0.22 mV/V + 0.4 mV	
	30 kHz to 100 kHz	0.57 mV/V + 2 mV	
	100 kHz to 300 kHz	3 mV/V + 20 mV	
	300 kHz to 1 MHz	10 mV/V + 0.2 V	
	(20 to 200) V		
	1 Hz to 10 Hz	0.15 mV/V + 12 mV	
	10 Hz to 40 Hz	0.12 mV/V + 2 mV	
	40 Hz to 100 Hz	90 µV/V + 2 mV	
	100 Hz to 2 kHz	75 µV/V + 2 mV	
	2 kHz to 10 kHz	0.11 mV/V + 2 mV	
	10 kHz to 30 kHz	0.22 mV/V + 4 mV	
	30 kHz to 100 kHz	0.57 mV/V + 20 mV	
	100 kHz to 300 kHz	3 mV/V + 0.2 V	
	300 kHz to 1 MHz	10 mV/V + 2 V	
	200 V to 1 kV		
	1 Hz to 10 Hz	0.15 mV/V + 70 mV	
	10 Hz to 40 Hz	0.12 mV/V + 20 mV	
	40 Hz to 10 kHz	0.12 mV/V + 20 mV	
	10 kHz to 30 kHz	0.23 mV/V + 40 mV	
	30 kHz to 100 kHz	0.58 mV/V + 0.2 V	

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AC High Voltage - Measure [1]	(Up to 10) kV (30 to 200) Hz (200 to 450) Hz (450 to 600) Hz (10 to 100) kV (30 to 70) Hz (70 to 200) Hz	 1.4 mV/V + 0.14 V 4.6 mV/V + 0.14V 8.7 mV/V + 0.14 V 1.4 mV/V + 0.7 V 17 % of reading + 0.7 V	Comparison to High Voltage Meter
AC High Voltage - Measure [1]	Up to 10 kV (30 to 200) Hz (200 to 450) Hz (450 to 600) Hz (10 to 100) kV (30 to 70) Hz (70 to 200) Hz (100 to 150) kV (30 to 70) Hz (70 to 200) Hz	 1.4 mV/V + 0.14 V 4.6 mV/V + 0.14 V 8.7 mV/V + 0.14 V 5.9 mV/V + 0.015 kV 8.2 mV/V + 0.011 kV 5.4 mV/V + 0.14 kV 6.7 mV/V + 0.22 kV	Comparison to High Voltage Divider
AC Voltage Flatness - Source [1] (Referenced to 1 kHz)	0.3 mV to 3.5 V (10 to 30) Hz 30 Hz to 120 kHz (0.3 to 1.1) mV 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (1.1 to 3) mV 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz 3 mV to 3.5 V 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	 0.35 % of reading 0.12 % of reading 0.24 % of reading + 3 µV 0.47 % of reading + 3 µV 0.7 % of reading + 3 µV 1.8 % of reading + 15 µV 0.12 % of reading + 3 µV 0.35 % of reading + 3 µV 0.58 % of reading + 3 µV 1.8 % of reading + 3 µV 0.12 % of reading + 3 µV 0.24 % of reading + 3 µV 0.47 % of reading + 3 µV 1.2 % of reading + 3 µV	Comparison to High Performance Multifunction Calibrator (Wideband)

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AC Voltage Flatness – Measure [1]	Up to 3 V (10 to 100) Hz 100 Hz to 10 kHz (10 to 30) kHz 30 kHz to 1 MHz (1 to 10) MHz (10 to 30) MHz (30 to 50) MHz (50 to 70) MHz (70 to 80) MHz (80 to 100) MHz	 0.2 % of reading 0.051 % of reading 0.059 % of reading 0.13 % of reading 0.21 % of reading 0.26 % of reading 0.42 % of reading 0.65 % of reading 0.77 % of reading 0.97 % of reading	Indirect Method Precision 8.5 Digit Multimeter w/ Thermal Converters

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AC Voltage – Measure [1]	Up to 2.2 mV		Comparison to AC Measurement Standard
	(10 to 20) Hz	1.6 mV/V + 1.6 µV	
	(20 to 40) Hz	1.6 mV/V + 1.6 µV	
	40 Hz to 20 kHz	0.4 mV/V + 1.7 µV	
	(20 to 50) kHz	0.8 mV/V + 2.2 µV	
	(50 to 100) kHz	1.2 mV/V + 2.7 µV	
	(100 to 300) kHz	2.3 mV/V + 4.1 µV	
	(300 to 500) kHz	2.4 mV/V + 8.1 µV	
	500 kHz to 1 MHz	3.5 mV/V + 8.1 µV	
	(2.2 to 7) mV		
	(10 to 20) Hz	0.8 mV/V + 1.4 µV	
	(20 to 40) Hz	0.4 mV/V + 1.5 µV	
	40 Hz to 20 kHz	0.2 mV/V + 1.5 µV	
	(20 to 50) kHz	0.4 mV/V + 2.1 µV	
	(50 to 100) kHz	0.6 mV/V + 2.6 µV	
	(100 to 300) kHz	1.2 mV/V + 4.1 µV	
	(300 to 500) kHz	1.3 mV/V + 6 µV	
	500 kHz to 1 MHz	2 mV/V + 6 µV	
	(7 to 22) mV		
	(10 to 20) Hz	0.3 mV/V + 1.6 µV	
	(20 to 40) Hz	0.3 mV/V + 1.6 µV	
	40 Hz to 20 kHz	0.1 mV/V + 1.7 µV	
	(20 to 50) kHz	0.2 mV/V + 2.3 µV	
	(50 to 100) kHz	0.3 mV/V + 2.7 µV	
	(100 to 300) kHz	0.8 mV/V + 4.1 µV	
	(300 to 500) kHz	0.9 mV/V + 6.1 µV	
	500 kHz to 1 MHz	1.4 mV/V + 6.1 µV	
	(22 to 70) mV		
	(10 to 20) Hz	2 mV/V + 5.3 µV	
	(20 to 40) Hz	80 µV/V + 6.3 µV	
	40 Hz to 20 kHz	40 µV/V + 6.8 µV	
	(20 to 50) kHz	0.1 mV/V + 6.4 µV	
	(50 to 100) kHz	0.23 mV/V + 5.8 µV	
	(100 to 300) kHz	0.5 mV/V + 6 µV	
	(300 to 500) kHz	0.7 mV/V + 9.4 µV	
	500 kHz to 1 MHz	1.1 mV/V + 9 µV	

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AC Voltage – Measure [1]	(70 to 220) mV		Comparison to AC Measurement Standard
	(10 to 20) Hz	0.2 mV/V + 1.6 µV	
	(20 to 40) Hz	80 µV/V + 1.7 µV	
	40 Hz to 20 kHz	40 µV/V + 1.8 µV	
	(20 to 50) kHz	70 µV/V + 2.2 µV	
	(50 to 100) kHz	0.2 mV/V + 2.6 µV	
	(100 to 300) kHz	0.3 mV/V + 4.1 µV	
	(300 to 500) kHz	0.4 mV/V + 8 µV	
	500 kHz to 1 MHz	1 mV/V + 8 µV	
	(220 to 700) mV		
	(10 to 20) Hz	0.21 mV/V + 1.5 µV	
	(20 to 40) Hz	0.21 mV/V + 1.5 µV	
	40 Hz to 20 kHz	30 µV/V + 1.7 µV	
	(20 to 50) kHz	50 µV/V + 2.1 µV	
	(50 to 100) kHz	80 µV/V + 2.6 µV	
	(100 to 300) kHz	0.2 mV/V + 4 µV	
	(300 to 500) kHz	0.3 mV/V + 8 µV	
	500 kHz to 1 MHz	0.3 mV/V + 8 µV	
	700 mV to 2.2 V		
	(10 to 20) Hz	0.2 mV/V + 4.2 µV	
	(20 to 40) Hz	0.62 mV/V + 13 µV	
	40 Hz to 20 kHz	0.17 mV/V + 23 µV	
	(20 to 50) kHz	0.41 mV/V + 16 µV	
	(50 to 100) kHz	0.67 mV/V + 12 µV	
	(100 to 300) kHz	0.16 mV/V + 6 µV	
	(300 to 500) kHz	0.26 mV/V + 4 µV	
	500 kHz to 1 MHz	9 mV/V + 1.1 µV	
	(2.2 to 7) V		
	(10 to 20) Hz	0.2 mV/V + 1.1 µV	
	(20 to 40) Hz	0.7 mV/V + 3.2 µV	
	40 Hz to 20 kHz	0.23 mV/V + 8.4 µV	
	(20 to 50) kHz	0.5 mV/V + 4.4 µV	
	(50 to 100) kHz	0.8 mV/V + 2.7 µV	
	(100 to 300) kHz	0.19 mV/V + 1.1 µV	
	(300 to 500) kHz	0.4 mV/V + 0.5 µV	
	500 kHz to 1 MHz	1.2 mV/V + 0.2 µV	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	(7 to 22) V		Comparison to AC Measurement Standard
	(10 to 20) Hz	0.2 mV/V + 3.7 µV	
	(20 to 40) Hz	0.7 mV/V + 11 µV	
	40 Hz to 20 kHz	0.3 mV/V + 26 µV	
	(20 to 50) kHz	0.5 mV/V + 15 µV	
	(50 to 100) kHz	0.8 mV/V + 9.1 µV	
	(100 to 300) kHz	0.29 mV/V + 4 µV	
	(300 to 500) kHz	0.4 mV/V + 1.9 µV	
	500 kHz to 1 MHz	1.2 mV/V + 0.6 µV	
	(22 to 70) V		
	(10 to 20) Hz	0.2 mV/V + 9.1 µV	
	(20 to 40) Hz	70 µV/V + 27 µV	
	40 Hz to 20 kHz	30 µV/V + 55 µV	
	(20 to 50) kHz	60 µV/V + 32 µV	
	(50 to 100) kHz	90 µV/V + 19 µV	
	(100 to 300) kHz	0.2 mV/V + 9.1 µV	
	(300 to 500) kHz	0.4 mV/V + 4.4 µV	
	500 kHz to 1 MHz	1.2 mV/V + 1.5 µV	
	(70 to 220) V		
	(10 to 20) Hz	0.20 mV/V + 7.1 µV	
	(20 to 40) Hz	70 µV/V + 21 µV	
	40 Hz to 20 kHz	30 µV/V + 45 µV	
	(20 to 50) kHz	70 µV/V + 21 µV	
	(50 to 100) kHz	0.1 mV/V + 14 µV	
	(100 to 300) kHz	0.21 mV/V + 6.8 µV	
	(300 to 500) kHz	0.5 mV/V + 2.8 µV	
	(220 to 700) V		
	(10 to 20) Hz	0.2 mV/V + 77 µV	
	(20 to 40) Hz	0.1 mV/V + 0.16 mV	
	40 Hz to 20 kHz	40 µV/V + 0.37 mV	
	(20 to 50) kHz	0.13 mV/V + 0.12 mV	
	(50 to 100) kHz	0.5 mV/V + 31 µV	
	700 V to 1 kV		
	(10 to 20) Hz	0.2 mV/V + 31 µV	
	(20 to 40) Hz	0.1 mV/V + 62 µV	
	40 Hz to 20 kHz	40 µV/V + 0.16 mV	
	(20 to 50) kHz	0.13 mV/V + 47 µV	
	(50 to 100) kHz	0.5 mV/V + 12 µV	

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AC Voltage – Measure [1]	Up to 10 mV		Comparison to Precision 8.5 Digit Multimeter AC BAND < 2 MHz
	(1 to 40) Hz	3.5 µV/V + 4.6 µV	
	40 Hz to 1 kHz	2.4 µV/V + 3.2 µV	
	(1 to 20) kHz	3.5 µV/V + 4.6 µV	
	(20 to 50) kHz	12 µV/V + 3.2 µV	
	(50 to 100) kHz	58 µV/V + 3.2 µV	
	(100 to 300) kHz	0.47 mV/V + 3.8 µV	
	(10 to 100) mV		
	(1 to 40) Hz	86 µV/V + 4.6 µV	
	40 Hz to 1 kHz	86 µV/V + 2.3 µV	
	(1 to 20) kHz	0.17 mV/V + 2.3 µV	
	(20 to 50) kHz	0.35 mV/V + 2.3 µV	
	(50 to 100) kHz	0.93 mV/V + 2.3 µV	
	(100 to 300) kHz	3.5 mV/V + 12 µV	
	300 kHz to 1 MHz	12 mV/V + 12 µV	
	(1 to 2) MHz	18 mV/V + 12 µV	
	100 mV to 1 V		
	(1 to 40) Hz	92 µV/V + 50 µV	
	40 Hz to 1 kHz	92 µV/V + 31 µV	
	(1 to 10) V		
	(1 to 20) kHz	0.17 mV/V + 31 µV	
	(20 to 50) kHz	0.35 mV/V + 31 µV	
	(50 to 100) kHz	0.93 mV/V + 31 µV	
	(100 to 300) kHz	3.5 mV/V + 0.12 mV	
	300 kHz to 1 MHz	12 mV/V + 0.12 mV	
	(1 to 2) MHz	18 mV/V + 0.12 mV	
	(10 to 100) V		
	(1 to 40) Hz	91 µV/V + 0.14 mV	
	40 Hz to 1 kHz	91 µV/V + 0.14 mV	
	(1 to 20) kHz	0.17 mV/V + 0.14 mV	
	(20 to 50) kHz	0.35 mV/V + 0.14 mV	
	(50 to 100) kHz	0.93 mV/V + 0.14 mV	
	(100 to 300) kHz	3.5 mV/V + 0.16 mV	
	300 kHz to 1 MHz	1.2 mV/V + 0.16 mV	
	(1 to 2) MHz	1.8 mV/V + 0.16 mV	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure [1]	(100 to 750) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	 0.45 mV/V + 2.7 mV 0.45 mV/V + 2.7 mV 0.45 mV/V + 2.7 mV 0.56 mV/V + 2.7 mV 1.5 mV/V + 2.7 mV 4.7 mV/V + 2.7 mV 18 mV/V + 2.7 mV	Comparison to Precision 8.5 Digit Multimeter AC BAND < 2 MHz
AC Voltage – Measure [1]	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz 11 mV to 10 V 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (11 to 100) V 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz (100 to 750) V 45 Hz to 100 kHz	 0.46 mV/V + 47 mV 0.46 mV/V + 24 mV 0.69 mV/V + 24 mV 1.4 mV/V + 24 mV 3.5 mV/V + 24 mV 1 mV/V + 7.5 µV 14 mV/V + 6.5 µV 81 mV/V + 8.6 µV 0.24 V + 9.7 µV 1 mV/V + 0.7 mV 24 mV/V + 0.58 mV 47 mV/V + 0.81 mV 47 mV/V + 0.93 mV 0.18 V + 1.2 mV 1.5 mV/V + 2.7 mV	Comparison to Precision 8.5 Digit Multimeter AC BAND > 2 MHz

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source [1]	(9 to 220) µA		Comparison to High Performance Multifunction Calibrator
	10 Hz to 20 Hz	0.25 mA/A + 16 nA	
	20 Hz to 40 Hz	0.16 mA/A + 10 nA	
	40 Hz to 1 kHz	0.12 mA/A + 8 nA	
	1 kHz to 5 kHz	0.28 mA/A + 12 nA	
	5 kHz to 10 kHz	1.1 mA/A + 65 nA	
	220 µA to 2.2 mA		
	10 Hz to 20 Hz	0.25 mA/A + 40 nA	
	20 Hz to 40 Hz	0.16 mA/A + 35 nA	
	40 Hz to 1 kHz	0.12 mA/A + 35 nA	
	1 kHz to 5 kHz	0.2 mA/A + 0.11 µA	
	5 kHz to 10 kHz	1.1 mA/A + 0.65 µA	
	(2.2 to 22) mA		
	10 Hz to 20 Hz	0.25 mA/A + 0.4 µA	
	20 Hz to 40 Hz	0.16 mA/A + 0.35 µA	
	40 Hz to 1 kHz	0.12 mA/A + 0.35 µA	
	1 kHz to 5 kHz	0.2 mA/A + 0.55 µA	
	5 kHz to 10 kHz	1.1 mA/A + 5 µA	
	(22 to 220) mA		
	10 Hz to 20 Hz	0.25 mA/A + 4 µA	
	20 Hz to 40 Hz	0.16 mA/A + 3.5 µA	
	40 Hz to 1 kHz	0.12 mA/A + 2.5 µA	
	1 kHz to 5 kHz	0.2 mA/A + 3.5 µA	
	5 kHz to 10 kHz	1.1 mA/A + 10 µA	
	220 mA to 2.2 A		
	20 Hz to 1 kHz	0.26 mA/A + 35 µA	
	1 kHz to 5 kHz	0.45 mA/A + 80 µA	
	5 kHz to 10 kHz	7 mA/A + 0.16 mA	
AC Current – Source [1]	(2.2 to 11) A		Comparison to High Performance Multifunction Calibrator Amplifier
	40 Hz to 1 kHz	0.46 mA/A + 0.17 mA	
	1 kHz to 5 kHz	0.95 mA/A + 0.38 mA	
	5 kHz to 10 kHz	3.6 mA/A + 0.75 mA	
AC Current – Source [1]	(11 to 20.5) A		Comparison to Multifunction Calibrator
	45 Hz to 100 Hz	0.93 mA/A + 3.9 mA	
	100 Hz to 1 kHz	1.2 mA/A + 3.9 mA	
	1 kHz to 5 kHz	23 mA/A + 3.9 mA	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source [1] Clamp-On Meters	(10 to 16.5) A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	 0.35 % of reading + 0.001 7 A 0.89 % of reading + 0.008 3 A 0.34 % of reading + 0.043 A 0.93 % of reading + 0.043 A 0.33 % of reading + 0.3 A 0.91 % of reading + 0.25 A	Comparison to Multi Product Calibrator w/ Current Coil
AC Power – Source [1] (45 to 65) Hz	(33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (330 to 900) mA 900 mA to 2.2 A (2.2 to 4.5) A (4.5 to 11) A 330 mV to 1.02 kV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (330 to 900) mA 900 mA to 2.2 A (2.2 to 4.5) A (4.5 to 11) A (11 to 20.5) A	 3.1 mW/W 1.9 mW/W 2.7 mW/W 1.9 mW/W 2.7 mW/W 1.9 mW/W 2.7 mW/W 1.9 mW/W 1.9 mW/W 1.2 mW/W 1.9 mW/W 1.2 mW/W 1.9 mW/W 1.2 mW/W 1.6 mW/W 1.2 mW/W 1.5 mW/W	Comparison to Multi Product Calibrator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power - Measure [1]	Up to 15 W (0.1 to 66) Hz 66 Hz to 1 kHz (>15 to 30) W (0.1 to 66) Hz 66 Hz to 1 kHz (>30 to 60) W (0.1 to 66) Hz 66 Hz to 1 kHz (>60 to 100) W (0.1 to 66) Hz 66 Hz to 1 kHz (>100 to 150) W (0.1 to 66) Hz 66 Hz to 1 kHz (>150 to 300) W (0.1 to 66) Hz 66 Hz to 1 kHz (>300 to 600) W (0.1 to 66) Hz 66 Hz to 1 kHz (>600 to 1 000) W (0.1 to 66) Hz 66 Hz to 1 kHz (>1 000 to 2 000) W (0.1 to 66) Hz 66 Hz to 1 kHz	 0.1 % of reading + 0.012 W 0.068 % of reading + 0.018 W 0.1 % of reading + 0.023 W 0.068 % of reading + 0.035 W 0.1 % of reading + 0.046 W 0.068 % of reading + 0.071 W 0.1 % of reading + 0.076 W 0.068 % of reading + 0.12 W 0.1 % of reading + 0.12 W 0.068 % of reading + 0.18 W 0.1 % of reading + 0.24 W 0.068 % of reading + 0.36 W 0.1 % of reading + 0.43 W 0.068 % of reading + 0.71 W 0.1 % of reading + 0.45 W 0.068 % of reading + 1.2 W 0.1 % of reading + 0.81 W 0.068 % of reading + 2.4 W	Comparison to Precision Power Analyzer
Phase – Source [1]	+/- 179.99 (ΔΦ°) (10 to 45) Hz (45 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	 0.09° 0.08° 0.2° 0.39° 1.9° 3.9° 7.8°	Comparison to Multi Product Calibrator
Phase – Measure [1]	(0 to 360)° 10 Hz to 50 kHz (50 to 100) kHz	 0.084° 0.41°	Comparison to Phase Meter

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AC Current – Measure [1]	Up to 200 µA		Comparison to Precision 8.5 Digit Multimeter
	1 Hz to 10 Hz	0.31 mA/A + 20 nA	
	10 Hz to 10 kHz	0.3 mA/A + 20 nA	
	10 kHz to 30 kHz	0.71 mA/A + 20 nA	
	30 kHz to 100 kHz	4 mA/A + 20 nA	
	200 µA to 2 mA		
	1 Hz to 10 Hz	0.31 mA/A + 0.2 µA	
	10 Hz to 10 kHz	0.3 m µA/A + 0.2 µA	
	10 kHz to 30 kHz	0.71 mA/A + 0.2 µA	
	30 kHz to 100 kHz	4 mA/A + 0.2 µA	
	(2 to 20) mA		
	1 Hz to 10 Hz	0.31 mA/A + 2 µA	
	10 Hz to 10 kHz	0.3 mA/A + 2 µA	
	10 kHz to 30 kHz	0.71 mA/A + 2 µA	
	30 kHz to 100 kHz	4 mA/A + 2 µA	
	(20 to 200) mA		
	1 Hz to 10 Hz	0.31 mA/A + 20 µA	
	10 Hz to 10 kHz	0.29 mA/A + 20 µA	
	10 kHz to 30 kHz	0.63 mA/A + 20 µA	
	200 mA to 2 A		
	10 Hz to 2 kHz	0.62 mA/A + 0.2 mA	
	2 kHz to 10 kHz	0.73 mA/A + 0.2 mA	
	10 kHz to 30 kHz	3 mA/A + 0.2 mA	
	(2 to 20) A		
	10 Hz to 2 kHz	0.82 mA/A + 2 mA	
	(2 to 10) kHz	2.5 mA/A + 2 mA	
AC High Current – Measure [1]	(50 to 400) Hz		Comparison to Precision 8.5 Digit Multimeter and Current Shunt
	(10 to 60) A	0.12 % of reading + 0.0029 A	
	(60 to 600) A	0.12 % of reading + 0.0032 A	
	(50 to 60) Hz		
	(600 to 1500) A	0.23 % of reading + 0.02 A	

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Electrical – DC/Low Frequency San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source [1] (Simulated Fixed Points)	1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	95 μΩ/Ω 95 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 10 μΩ/Ω 10 μΩ/Ω 8.5 μΩ/Ω 8.5 μΩ/Ω 8.5 μΩ/Ω 8.5 μΩ/Ω 11 μΩ/Ω 11μΩ/Ω 20 μΩ/Ω 21 μΩ/Ω 40 μΩ/Ω 47 μΩ/Ω 100 μΩ/Ω	Comparison to Multiproduct Calibrator
Resistance – Source [1] (Simulation)	(100 to 330) MΩ 330 M Ω to 1.1 GΩ	2.3 mΩ/Ω + 78 kΩ 11.6 mΩ/Ω + 0.4 MΩ	Comparison to Multifunction Calibrator
Resistance – Source [1] (Simulation)	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ 330 kΩ 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 330 MΩ to 1.1 GΩ	1.7 mΩ/Ω + 35 μΩ 23 μΩ/Ω + 3.3 mΩ 31 μΩ/Ω + 1.9 mΩ 32 μΩ/Ω + 2.8 mΩ 33 μΩ/Ω + 2.3 mΩ 32 μΩ/Ω + 30 mΩ 5 μΩ/Ω + 1.4 Ω 32 μΩ/Ω + 0.3 Ω 33 μΩ/Ω + 0.34 Ω 37 μΩ/Ω + 3.1 Ω 38 μΩ/Ω + 2.6 Ω 71 μΩ/Ω + 36 Ω 0.13 mΩ/Ω + 0.38 kΩ 0.22 mΩ/Ω + 7.4 kΩ 0.42 mΩ/Ω + 32 kΩ 3.6 mΩ/Ω + 0.12 MΩ 18 mΩ/Ω + 0.59 MΩ	Comparison to Multifunction Calibrator
Resistance – Source [1] (Fixed Artifacts)	1 Ω 10 kΩ	8 μΩ/ Ω 4 μΩ/ Ω	Comparison to Resistance Standards

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source [1] Fixed Point (Four-Terminal Pair)	0.1 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ	0.56 mΩ 0.29 mΩ 2.3 mΩ 1.8 mΩ 35 mΩ 0.12 Ω 1.3 Ω	Comparison to Four Terminal Pair Resistor Set
Resistance – Measure [1]	Up to 2Ω (2 to 20) Ω (20 to 200) Ω 200 Ω to 2 kΩ (2 to 20) kΩ (20 to 200) kΩ 200 kΩ to 2 MΩ (2 to 20) MΩ (20 to 200) MΩ 200 MΩ to 2 GΩ (2 to 20) GΩ	17 μΩ/Ω + 4 μΩ 9.5 μΩ/Ω + 14 μΩ 8 μΩ/Ω + 50 μΩ 8 μΩ/Ω + 0.5 mΩ 8 μΩ/Ω + 5 mΩ 8 μΩ/Ω + 50 mΩ 9 μΩ/Ω + 1.0 Ω 17 μΩ/Ω + 10 Ω 65 μΩ/Ω + 1 kΩ 0.18 mΩ/Ω + 100 kΩ 1.5 mΩ/Ω + 10 MΩ	Comparison to Precision 8.5 Digit Multimeter
High Resistance – Measure [1]	100 MΩ to 1GΩ 1 GΩ to 10 GΩ 10 G Ω to 100 GΩ 100 G Ω to 1 TΩ 1 TΩ to 10 TΩ 10 TΩ to 100 TΩ 100 TΩ to 1 PΩ 1 PΩ to 10 PΩ	0.059 % of reading 0.084 % of reading 0.13 % of reading 0.25 % of reading 0.36 % of reading 0.61 % of reading 1.2 % of reading 1.3 % of reading	Comparison to Tera-Ohmmeter

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
LCR Impedance – Source [1]	0.1 Ω 20 Hz to 2 kHz 2 kHz to 4 kHz 4 kHz to 7.5 kHz 7.5 kHz to 10 kHz 1 Ω 20 Hz to 40 kHz 40 kHz to 100 kHz 10 Ω 20 Hz to 100 kHz 100 Ω 20 Hz to 100 kHz 1 kΩ 20 Hz to 100 kHz 10 kΩ 20 Hz to 100 kHz	 0.22 % of reading 0.32 % of reading 0.52 % of reading 1.1 % of reading 0.12 % of reading 0.22 % of reading 0.06 % of reading 0.03 % of reading 0.07 % of reading 0.04 % of reading	Comparison to Impedance Calibrator
LCR Impedance – Source [1]	100 kΩ 20 Hz to 20 kHz 20 kHz to 75 kHz 750 kHz to 100 kHz 1 MΩ 20 Hz to 7.5 kHz 7.5 kHz to 20 kHz 20 kHz to 75 kHz 75 kHz to 100 kHz 10 MΩ 20 Hz to 7.5 kHz 7.5 Hz to 10 kHz 100 MΩ 20 Hz to 400 Hz 400 Hz to 750 Hz 750 Hz to 2 kHz 2 kHz to 4 kHz 4 kHz to 5 kHz	 0.04 % of reading 0.07 % of reading 0.13 % of reading 0.05 % of reading 0.07 % of reading 0.22 % of reading 0.53 % of reading 0.07 % of reading 0.26 % of reading 0.12 % of reading 0.22 % of reading 0.52 % of reading 1.1 % of reading 2.1 % of reading	Comparison to Impedance Calibrator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
LCR Impedance – Source [1]	1 pF		Comparison to Impedance Calibrator, Standard Air Capacitor Set
	1 kHz to 1 MHz	0.043 % of reading	
	1 MHz to 5 MHz	0.11 % of reading	
	5 MHz to 13 MHz	0.41 % of reading	
	10 pF		
	20 Hz to 1 kHz	0.52 % of reading	
	1 kHz to 5 MHz	0.043 % of reading	
	5 MHz to 13 MHz	0.046 % of reading	
	100 pF		
	20 Hz to 1 kHz	0.32 % of reading	
	1 kHz to 5 MHz	0.043 % of reading	
	(5 to 13) MHz	0.066 % of reading	
	1 nF		
	20 Hz to 1 kHz	0.32 % of reading	
	1 kHz to 5 MHz	0.11 % of reading	
	(5 to 13) MHz	0.31 % of reading	
	10 nF		
	20 Hz to 100 kHz	0.11 % of reading	
	100 nF		
	20 Hz to 100 kHz	0.14 % of reading	
	1 µF		
	20 Hz to 100 kHz	0.14 % of reading	
	10 µF		
	20 Hz to 10 kHz	0.14 % of reading	
	100 µF		
	20 Hz to 10 kHz	0.23 % of reading	
	10 µH		
	20 Hz to 100 kHz	0.53 % of reading	
	100 µH		
	20 Hz to 100 kHz	0.53 % of reading	
	1 mH		
	20 Hz to 100 kHz	0.2 % of reading	
	10 mH		
	20 Hz to 100 kHz	0.2 % of reading	
	100 mH		
	20 Hz to 100 kHz	0.2 % of reading	
	1 H		
	20 Hz to 10 kHz	0.24 % of reading	
	10 H		
	20 Hz to 10 kHz	0.24 % of reading	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Impedance – Measure [1]	(10 to 100) mΩ		Precision LCR Meter
	20 Hz to 1 kHz	0.03 % of reading + 0.77 µΩ	
	1 kHz to 1 MHz	0.12 % of reading + 0.31 µΩ	
	(1 to 10) Ω		
	20 Hz to 30 Hz	0.30 % of reading + 13 µΩ	
	30 Hz to 1 MHz	0.16 % of reading + 13 µΩ	
	10 Ω to 1 kΩ		
	20 Hz to 30 Hz	0.30 % of reading + 0.69 mΩ	
	30 Hz to 100 Hz	0.12 % of reading + 0.28 mΩ	
	100 Hz to 1 MHz	0.06 % of reading + 0.13 mΩ	
	(1 to 300) kΩ		
	20 Hz to 30 Hz	0.30 % of reading + 0.69 Ω	
	30 Hz to 100 Hz	0.12 % of reading + 0.28 Ω	
	100 Hz to 1 MHz	0.06 % of reading + 0.13 Ω	
	300 kΩ to 10 MΩ		
	20 Hz to 30 Hz	0.30 % of reading + 0.08 kΩ	
	30 Hz to 1 MHz	0.12 % of reading + 0.03 kΩ	
	10 MΩ to 100 MΩ		
	20 Hz to 1 kHz	0.30 % of reading + 0.76 kΩ	
	1kHz to 1 MHz	0.12 % of reading + 0.3 kΩ	
Capacitance – Source [1] (Simulation)			Comparison to Multi Product Calibrator
10 Hz to 10 kHz	(220 to 399.9) pF	0.58 % of reading + 12 pF	
10 Hz to 10 kHz	(0.4 to 1.099 9) nF	0.57 % of reading + 12 pF	
10 Hz to 3 kHz	(1.1 to 3.299 9) nF	0.57 % of reading + 12 pF	
10 Hz to 1 kHz	(3.3 to 10.999 9) nF	0.22 % of reading + 27 pF	
10 Hz to 1 kHz	(11 to 32.999 9) nF	0.29 % of reading + 0.12 nF	
10 Hz to 1 kHz	(33 to 109.999) nF	0.29 % of reading + 0.13 nF	
10 Hz to 1 kHz	(110 to 329.999) nF	0.29 % of reading + 0.35 nF	
(10 to 600) Hz	(0.33 to 1.099 99) µF	0.28 % of reading + 1.5 nF	
(10 to 300) Hz	(1.1 to 3.299 99) µF	0.29 % of reading + 3.5 nF	
(10 to 150) Hz	(3.3 to 10.999 9) µF	0.29 % of reading + 1.3 nF	
(10 to 120) Hz	(11 to 32.999 9) µF	0.46 % of reading + 36 nF	
(10 to 80) Hz	(33 to 109.999) µF	0.53 % of reading + 0.12 µF	
(0 to 50) Hz	(110 to 329.999) µF	0.53 % of reading + 0.35 µF	
(0 to 20) Hz	(0.33 to 1.099 99) mF	0.5 % of reading + 1.5 µF	
(0 to 6) Hz	(1.1 to 3.299 99) mF	0.52 % of reading + 3.6 µF	
(0 to 2) Hz	(3.3 to 10.999 9) mF	0.51 % of reading + 13 µF	
(0 to 0.6) Hz	(11 to 32.999 9) mF	0.86 % of reading + 35 µF	
(0 to 0.2) Hz	(33 to 110) mF	1.3 % of reading + 0.13 mF	

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Electrical – DC/Low Frequency San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source [1] (Simulation)			Comparison to Multi Product Calibrator
50 Hz to 1 kHz	(330 to 500) pF	3.9 mF/F + 7.8 pF	
50 Hz to 1 kHz	500 pF to 1.1 nF	3.9 mF/F + 7.8 pF	
50 Hz to 1 kHz	(1.1 to 3.3) nF	3.9 mF/F + 7.8 pF	
50 Hz to 1 kHz	(3.3 to 11) nF	3.9 mF/F + 7.8 pF	
50 Hz to 1 kHz	(11 to 33) nF	1.9 mF/F + 78 pF	
50 Hz to 1 kHz	(33 to 110) nF	1.9 mF/F + 78 pF	
50 Hz to 1 kHz	(110 to 330) nF	1.9 mF/F + 0.23 nF	
50 Hz to 1 kHz	330 nF to 1.1 µF	1.9 mF/F + 0.8 nF	
50 Hz to 1 kHz	(1.1 to 3.3) µF	2.7 mF/F + 2.3 nF	
(50 to 400) Hz	(3.3 to 11) µF	2.7 mF/F + 7.8 nF	
(50 to 400) Hz	(11 to 33) µF	3.1 mF/F + 23 nF	
(50 to 200) Hz	(33 to 110) µF	3.9 mF/F + 78 nF	
(50 to 100) Hz	(110 to 330) µF	5.4 mF/F + 0.23 µF	
(50 to 100) Hz	330 µF to 1.1 mF	7.8 mF/F + 0.23 µF	
Fixed Capacitance [1] @ 1 kHz (Artifacts)	(100 to 500) pF	0.64 pF	Comparison to Capacitance Standard Set
	500 pF to 5 nF	3.7 pF	
	(5 to 50) nF	32 pF	
	(50 to 100) nF	63 pF	
	(100 to 500) nF	0.59 nF	
	500 nF to 1.5 µF	0.63 nF	
Capacitance – Measure [1]	up to 100 pF	0.12 % of reading + 0.002 pF	Comparison to Digit Multimeter LCR Meter
	(100 to 1 000) pF	0.12 % of reading + 0.006 pF	
	(1 to 100) nF	0.06 % of reading + 0.05pF	
	(100 to 1 000) nF	0.06 % of reading + 0.02 nF	
	(1 to 100) µF	0.06 % of reading + 0.07 nF	
	(100 to 1 000) µF	0.06 % of reading + 3.4 nF	
	(1 to 110) mF	0.12 % of reading + 0.48 µF	
Inductance – Source [1] (Fixed Artifacts)	100 Hz to 1 kHz		Comparison to Standard Value Inductors
	200 µH	0.58 µH	
	2 mH	2.4 µH	
	20 mH	24 µH	
	200 mH	0.24 mH	
	2 H	2.4 mH	
Inductance – Measure [1]	Up to 100 µH	0.08 % of reading + 0.000 02 µH	Comparison to Precision LCR Meter
	(100 to 1 000) µH	0.08 % of reading + 0.002 3 µH	
	(1 to 100) mH	0.13 % of reading + 0.000 03 mH	
	(0.1 to 1) H	0.12 % of reading + 0.000 059 H	
	(1 to 10) H	0.13% of reading + 0.000 28 H	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Devices – Source and Measure [1]	Type B		Comparison to Multi Product Calibrator
	(600 to 800) °C	0.34 °C	
	(800 to 1 000) °C	0.26 °C	
	(1 000 to 1 550) °C	0.23 °C	
	(1 550 to 1 820) °C	0.26 °C	
	Type C		
	(0 to 150) °C	0.23 °C	
	(150 to 650) °C	0.2 °C	
	(650 to 1 000) °C	0.24 °C	
	(1 000 to 1 800) °C	0.39 °C	
	(1 800 to 2 316) °C	0.65 °C	
	Type E		
	(-250 to -100) °C	0.21 °C	
	(-100 to -25) °C	0.12 °C	
	(-25 to 350) °C	0.11 °C	
	(350 to 650) °C	0.13 °C	
	(650 to 1 000) °C	0.18 °C	
	Type J		
	(-210 to -100) °C	0.21 °C	
	(-100 to -30) °C	0.12 °C	
	(-30 to 150) °C	0.11 °C	
	(150 to 760) °C	0.13 °C	
	(760 to 1 200) °C	0.18 °C	
	Type K		
	(-200 to -100) °C	0.26 °C	
	(-100 to -25) °C	0.14 °C	
	(-25 to 120) °C	0.12 °C	
	(120 to 1 000) °C	0.20 °C	
	(1 000 to 1 372) °C	0.31 °C	
	Type L		
	(-200 to -100) °C	0.29 °C	
	(-100 to 800) °C	0.2 °C	
	(800 to 900) °C	0.13 °C	
	Type N		
	(-200 to -100) °C	0.31 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 120) °C	0.15 °C	
	(120 to 410) °C	0.14 °C	
	(410 to 1 300) °C	0.21 °C	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Temperature Indicating Devices – Source and Measure [1]	Type R		Comparison to Multi Product Calibrator
	(0 to 250) °C	0.44 °C	
	(250 to 400) °C	0.27 °C	
	(400 to 1 000) °C	0.26 °C	
	(1 000 to 1 767) °C	0.31 °C	
	Type S		
	(0 to 250) °C	0.36 °C	
	(250 to 1 000) °C	0.28 °C	
	(1 000 to 1 400) °C	0.29 °C	
	(1 400 to 1 767) °C	0.36 °C	
	Type T		
	(-250 to -150) °C	0.49 °C	
	(-150 to 0) °C	0.19 °C	
	(0 to 120) °C	0.12 °C	
	(120 to 400) °C	0.11 °C	
	Type U		
	(-200 to 0) °C	0.43 °C	
	(0 to 600) °C	0.21 °C	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Temperature Indicating Devices – Source and Measure [1]	Pt 385, 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C Pt 3926, 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C Pt 3916, 100 Ω (-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	 0.04 °C 0.05 °C 0.07 °C 0.08 °C 0.09 °C 0.18 °C 0.04 °C 0.05 °C 0.05 °C 0.08 °C 0.09 °C 0.19 °C 0.03 °C 0.04 °C 0.05 °C 0.05 °C 0.06 °C 0.15 °C 0.08 °C 0.18 °C	Comparison to Multi Product Calibrator
Oscilloscopes [1] DC Voltage Into 50 Ω load Into 1 MΩ load	 (-6.6 to 6.6) V (-130 to 130) V	 1.9 mV/V + 31 µV 0.39 mV/V + 31 µV	Comparison to Multi Product Calibrator
Oscilloscopes [1] Square Wave Into 50 Ω load Into 1 MΩ load	 10 Hz to 10 kHz 1 mVp-p to 6.6 Vp-p 1 mVp-p to 130 Vp-p	 1.9 mV/V + 31 µV 0.77 mV/V + 31 µV	Comparison to Multi ProductCalibrator
Oscilloscopes [1] Wave Generator Square, Sine, Triangle Into 50 Ω load Into 1 MΩ load	 1.8 mVp-p to 2.5 Vp-p 1.8 mVp-p to 55 Vp-p	 23 mV/V + 78 µV 23 mV/V + 78 µV	Comparison to Multi Product Calibrator

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes [1,8] Leveled Sine Wave Source Into 50 Ω load	5 mVp-p to 5.5 Vp-p 50 kHz 50 kHz to 100 MHz 100 to 300 MHz 300 to 600 MHz 50 kHz to 100 MHz 100 to 300 MHz 300 to 600 MHz	 16 mV/V + 0.24 mV 27 mV/V + 0.24 mV 31 mV/V + 0.24 mV 47 mV/V + 0.24 mV 12 mV/V + 78 µV 16 mV/V + 78 µV 31 mV/V + 78 µV	Comparison to Oscilloscope Calibrator
Oscilloscopes [1,8,9] Time Marker Source Into 50 Ω load	5 s to 50 ms 20 ms to 2 ns	1.9 µs/s + 775t 1.9 µs/s	Comparison to Multiproduct Calibrator
Oscilloscopes [1,8] Square Wave Frequency Source	10 Hz to 10 kHz	1.9 µHz/Hz	Comparison to Multiproduct Calibrator
Oscilloscopes [1,8] Leveled Sine Wave Frequency Source	50 kHz to 600 MHz	1.9 µHz/Hz	Comparison to Multiproduct Calibrator
Oscilloscopes [1,8] Wave Generator Frequency Source	10 Hz to 100 kHz	19 µHz/Hz + 12 mHz	Comparison to Multiproduct Calibrator
Rise Time [1] (measurement)	1ns to 10 µs 10 µs to 100 µs	1.2 ns 2.9 ns	Comparison to Oscilloscope

Length – Dimensional Metrology San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Test, Dial Indicators & Thickness Gages [1,2]	Up to 1 in (1 to 4) in	52 µin (47 + 8.7*L*) µin	Comparison to Gage Blocks
Gauge Blocks [2]	Up to 0.05 in (0.05 to 4) in (4 to 12) in	4.7 µin (2.1 + 3.8*L*) µin (1 + 4.3*l*) µIN	Comparison to Gage Blocks, P&W LabMaster®

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Length – Dimensional Metrology San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers [1,2]	Up to 20 in (20 to 54) in	380 µin (310 + 4.2*L* µin	Comparison to Gage Blocks, Standard Rings, Rod Sets
Micrometers [1,2] (Linearity Only)	Up to 1 in (1 to 4) in (4 to 20) in (20 to 36) in (36 to 54) in	35 µin (34 + 2*L*) µin (67 + 2.7*L*) µin (56 + 3.8*L*) µin 790 µin	Comparison to Gage Blocks, Rod Sets
Pin and Plug Gages [2]	Up to 6 in	(5 + 5.3*L*) µin	Comparison to P&W LabMaster®
Ring Gages [2]	Up to 1 in (1 to 6.4) in	(13 + 16*L*) µin (24 + 4.3*L*) µin	Comparison to P&W LabMaster®
Height Gages [1]	Up to 24 in	410 µin	Comparison to Gage Blocks
Depth Micrometers [1,2]	Up to 6 in (6 to 12) in	(42 + 2.3*L*) µin (34 + 5*L*) µin	Comparison to Gage Blocks
Protractor/Angle [1,2]	Up to 90°	1.6′	Comparison to Angle Gage Blocks
Roughness Testers [1]	118 µin	3.9 µin	Comparison to Roughness Standard
Roughness Specimens [1]	Up to 118 µin	4.1 µin	Comparison to Surface Roughness Meter
Coating Thickness Gauge[1]	Up to 100 µm Over 100 to 1500 µm	2.6 µm 2.6 µm + 0.07% of reading	Comparison to Plastic Shims

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Mass and Mass Related San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force-Measuring Equipment Tension / Compression [1]	Up to 1 kgf (1 to 2.5) kgf (2.5 to 5) kgf (5 to 10) kgf (10 to 25) kgf (25 to 50) kgf (50 to 100) kgf (100 to 150) kgf	0.000 19 kgf 0.000 45 kgf 0.000 93 kgf 0.002 kgf 0.004 8 kgf 0.01 kgf 0.018 kgf 0.047 kgf	Comparison to NIST Class F Weights
Force-Measuring Equipment Tension / Compression [1]	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	0.000 46 lbf 0.000 96 lbf 0.002 lbf 0.005 lbf 0.01 lbf 0.017 lbf 0.045 lbf 0.093 lbf	Comparison to Standard weight
Pressure – Source/Pressure Gages and Transducers [1]	(-14 to 20) psi (20 to 100) psi (10 to 300) psi (300 to 1 000) psi (1 000 to 10 000) psi (10 000 to 15 000) psi	0.005 psi 0.02 psi 0.04 psi 0.2 psi 6 psi 9 psi	Comparison to Pressure Calibration System
Torque – Measure/Torque Tools [1]	(20 to 200) ozf·in (5 to 50) lbf·in (40 to 400) lbf·in (100 to 1 000) lbf·in (25 to 250) lbf·ft (60 to 600) lbf·ft (600 to 1 000) lbf·ft	0.57 % of reading + 0.12 ozf·in 0.61 % of reading + 0.004 lbf·in 0.33 % of reading + 0.06 lbf·in 0.27 % of reading + 0.8 lbf·in 0.32 % of reading + 0.05 lbf·ft 0.29 % of reading + 0.58 lbf·ft 0.35 % of reading + 0.74 lbf·ft	Comparison to Torque Transducers
Torque – Source/Analyzers and Measuring equipment	(1 to 10) lbf·in (10 to 25) lbf·in (25 to 50) lbf·in (50 to 100) lbf·in (100 to 150) lbf·in (150 to 250) lbf·in (25 to 250) lbf·ft (250 to 600) lbf·ft (600 to 1 000) lbf·ft	0.04 % of reading + 0.003 lbf·in 0.049 % of reading + 0.005 lbf·in 0.058 % of reading + 0.003 lbf·in 0.06 % of reading + 0.003 lbf·in 0.059 % of reading + 0.006 lbf·in 0.061 % of reading + 0.004 lbf·in 0.046 % of reading + 0.011 lbf·ft 0.052 % of reading + 0.1 lbf·ft 0.042 % of reading + 1.1 lbf·ft	Comparison to Calibration Wheels, Standard Weights

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Mass and Mass Related San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales & Balances [1,10]	(1 to 500) mg (0.5 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g (0.5 to 1) kg (1 to 2) kg	0.014 mg 0.026 mg 0.037 mg 0.058 mg 0.12 mg 0.24 mg 0.47 mg 1.2 mg 3.0 mg 5.3 mg	Comparison to ASTM E617 Class 0 eeights and internal calibration procedure utilized in the calibration of the weighing system.
Scales & Balances [1,10]	(2 to 10) kg (10 to 20) kg (20 to 40) kg (40 to 50) kg	1.2 g 2.8 g 4.9 g 6.2 g	Comparison to ASTM E617 Class 6 weights, NIST Class F weights, and internal calibration procedure utilized in the calibration of the weighing system.
Scales & Balances [1,10]	(0.001 to 0.05) lb (0.1 to 1) lb (1 to 2) lb (2 to 5) lb (5 to 10) lb (10 to 20) lb (20 to 50) lb	0.000 012 lb 0.000 18 lb 0.000 24 lb 0.000 6 lb 0.001 1 lb 0.002 4 lb 0.006 lb	Comparison to NIST Class F Weights and internal calibration procedure utilized in the calibration of the weighing system.

Thermodynamic San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity – Measure [1]	Up to 90 %RH (90 to 95) %RH	1.6 % RH 2.2 % RH	Comparison to Humidity Probe Monitor
Temperature – Measure [1]	(-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 420) °C	0.033 °C 0.058 °C 0.077 °C 0.12 °C	Comparison to Reference Thermometer w/ PRT

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Thermodynamic San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measuring Equipment [1]	(-200 to 0) °C (0 to 100) °C (100 to 420) °C	0.069 °C 0.084 °C 0.43 °C	Comparison to Reference Thermometer w/ PRT and Temperature Dry Block, Micro Bath
Radiation (Infrared) [1] Thermometers	(50 to 100)°C (100 to 300)°C (300 to 500)°C	1.7°C 5.3°C 8.2°C	Comparison to Blackbody Source (Flat plate) $\varepsilon = 0.95$, $\lambda = (8 \text{ to } 14)$ µm

Time and Frequency San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source [1]	10 MHz	1.0×10^{-10} Hz	Comparison to Frequency Standard
Frequency – Source [1]	10 mHz to 2 MHz	1.9 µHz/Hz + 3.8 µHz	Comparison to Multiproduct Calibrator
Frequency – Source[1]	(2 to 80) MHz	5.8×10^{-9} MHz	Comparison to Frequency Synthesizer w/ GPS Reference Signal Generator
Time Interval [1]	50 ns to 999 s	1.3×10^{-9} + 0.14 ns	Comparison to Universal Counter w/ GPS Reference
Period [1]	4.44 ns to 10 s	0.012 % of reading + 0.17 ns	Comparison to Universal Counter w/ GPS Reference
Rise/Fall Time – Measure [1]	1 ns to 10 µs (10 to 100) µs	1.2 ns 2.9 ns	Comparison to Digital Oscilloscope Or Universal Counter w/ GPS Reference
Pulse Width – Measure [1]	> 5 ns	1.1 ns	Comparison to Universal Counter w/ GPS Reference

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Time and Frequency San Antonio, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Stop Watches – Totalize Method [1]	1s to 24 hr	40 ms	Comparison to Universal Counter and Synthesizer w/ GPS Reference

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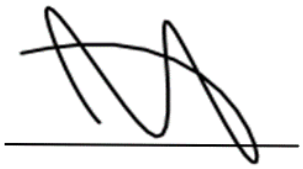
Calibration and Measurement Capability (CMC) is expressed in terms of the measurement parameter, measurement range, expanded uncertainty of measurement and reference standard, method, and/or equipment. The expanded uncertainty of measurement is expressed as the standard uncertainty of the measurement 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. Γ = rho; L = length in inches; DL = diagonal length in inches; ′ = arc-minute.
3. Unitless linear measure.
4. Portions of ISO 8573-5 requiring analysis using gas chromatography are contracted to another accredited laboratory.
5. This analysis is intended to be used in conjunction with the testing per ISO 8573-4 when there is a need to identify solid particles that are also viable, colony-forming units and is contracted to another accredited laboratory.
6. The nominal values listed are approximate.
7. Scope uncertainties do not include estimated contributions to uncertainty from a “best available” unit under test.
8. t = time in seconds
9. The methods used by the laboratory are adopted from OEM-Sourced, MET-CAL, DOD MIDAS, GIDEP-Sourced, CP, TSA and Customer Specific.
10. 0.6R, where R is the resolution of the unit under calibration, will be added to the Measurement Uncertainty (MU) at the time of calibration.



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