



CERTIFICATE OF ACCREDITATION

ANSI-ASQ National Accreditation Board

500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

Keysight Technologies, Inc. Service Center

2840 Emerick Blvd., Suite A-4

Bethlehem PA 18020

has been assessed by ANAB
and meets the requirements of international standard

ISO/IEC 17025:2005

and national standards

ANSI/NCSL Z540-1-1994 (R2002) and

ANSI/NCSL Z540.3-2006 (R2013)

while demonstrating technical competence in the field of

CALIBRATION

Refer to the accompanying Scope of Accreditation for information regarding the types of calibrations to which this accreditation applies.

AC-1498.09

Certificate Number


ANAB Approval

Certificate Valid: 06/16/2018-11/16/2020
Version No. 003 Issued: 06/16/2018



This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. 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 17025:2005,
ANSI/NCSL Z540-1-1994 (R2002), AND ANSI/NCSL Z540.3-2006 (R2013)**

Keysight Technologies, Inc. Service Centers

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CALIBRATION

Valid to: November 16, 2020

Certificate Number: AC-1498.09

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹	Up to 220 mV (0.22 to 2.2) V (2.2 to 11) V (11 to 22) V (22 to 220) V (0.22 to 1.1) kV	7 μV/V + 0.16 μV 5 μV/V + 0.15 μV 3 μV/V + 0.32 μV 4 μV/V + 5 μV 5 μV/V + 14 μV 7 μV/V + 41 μV	Fluke 5720A or 5730A Multiproduct Calibrator with Fluke 5725A Amplifier
DC Voltage - Source Fixed Values ¹	100 mV 1 V 10 V 100 V 1000 V	0.72 μV 2.9 μV 2.6 μV 0.5 mV 7.3 mV	Fluke 57x0A Multiproduct Calibrator disciplined with HP 3458A/100 NPLC Option 002 Multimeter
DC Voltage - Measure ¹	Up to 100 mV (0.1 to 1) V (1 to 10) V (10 to 100) V (0.1 to 1) kV	5.6 μV/V + 1.5 μV 5.2 μV/V + 1.2 μV 4.7 μV/V + 2.5 μV 6.6 μV/V + 45 μV 19 μV/V + 0.16 mV	Keysight 3458A/100 NPLC Option 002 Multimeter
DC Voltage Transfer – Measure ¹	(0 to 0.1) V (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1 000) V	0.62 μV/V + 62 nV 0.37 μV/V + 124 nV 62 nV/V + 0.62 μV 0.62 μV/V + 12.4 μV 1.85 μV/V + 63 μV	Keysight 3458A Multimeter



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current - Source ¹	(0 to 220) μ A 220 μ A to 22 mA (22 to 100) mA (100 to 220) mA 220 mA to 1 A (1 to 2.2) A	35 μ A/A 29 μ A/A 37 μ A/A 50 μ A/A - 1.2 μ A 59 μ A/A + 12 μ A 120 μ A/A - 42 μ A	Fluke 5720A or 5730A Multiproduct Calibrator
DC Current - Source ¹	(2.2 to 11) A	280 μ A/A + 41 μ A	Multiproduct Calibrator and Fluke 5725A Amplifier
DC Current - Source ¹	100 μ A 1 mA 10 mA 100 mA 1 A	1.9 nA 16 nA 0.16 μ A 2.3 μ A 49 μ A	Fluke 57x0A Multiproduct Calibrator disciplined with HP 3458A/100 NPLC Option 002 Multimeter
DC Current – Source ¹	(10 to 20) A (20 to 200) A (200 to 1 000) A	0.53% + 22 mA 0.54% + 0.15 A 0.54% + 0.52 A	Fluke 552xA Multiproduct Calibrator with 50 turn coil
DC Current – Measure ¹	(0 to 100) nA (0.1 to 1) μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	42 μ A/A + 50 pA 21 μ A/A + 50 pA 25 μ A/A + 0.11 nA 25 μ A/A + 0.85 nA 22 μ A/A + 6.4 nA 23 μ A/A + 59 nA 41 μ A/A + 0.6 μ A 125 μ A/A + 12 μ A	Keysight 3458A Multimeter
DC Current – Measure ¹	(1 to 3) A	1.4 mA/A + 0.74 mA	Keysight 34401A Multimeter
DC Current - Measure ¹	(0.01 to 15) A	76 μ A/A	Guildline 9230-15, Keysight 3458A, Electronic Load
	(15 A to 100) A	75.5 μ A/A	Guildline 9230-100, Keysight 3458A, Electronic Load
	(100 A to 300) A	130 μ A/A	Guildline 9230-300, Keysight 3458A, Electronic Load



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹	(0 to 11) Ω (11 to 110) Ω (0.11 to 1.1) kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 110) kΩ (0.11 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 to 1 100) MΩ	33 μΩ/Ω + 8.3 mΩ 25 μΩ/Ω + 12.5 mΩ 23 μΩ/Ω + 17 mΩ 23 μΩ/Ω + 170 mΩ 23 μΩ/Ω + 84 mΩ 23 μΩ/Ω + 0.84 Ω 27 μΩ/Ω + 8 Ω 50 μΩ/Ω + 125 Ω 110 μΩ/Ω + 0.2 kΩ 210 μΩ/Ω + 2 kΩ 410 μΩ/Ω + 2.8 kΩ 2.5 mΩ/Ω + 83 kΩ 12.5 mΩ/Ω + 0.4 MΩ	Fluke 552xA Multiproduct Calibrator
Resistance – Source Fixed Points ¹	0 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	21 μΩ 89 μΩ 0.86 mΩ 7.5 mΩ 75 mΩ 0.75 Ω 8 Ω 0.15 kΩ 24 kΩ	Fluke 57x0A Multiproduct Calibrator disciplined with Keysight 3458A Multimeter
Resistance – Source Fixed Points ¹	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	0.25 mΩ 0.27 mΩ 0.31 mΩ 0.34 mΩ 2.5 mΩ 2.7 mΩ 3.3 mΩ 9.3 mΩ 31 mΩ 93 mΩ 0.19 Ω 1.2 Ω 2.2 Ω 20 Ω 42 Ω	Fluke 5720A Multiproduct Calibrator



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source Fixed Points ¹	10 MΩ 19 MΩ 100 MΩ	0.4 kΩ 1.5 kΩ 12 kΩ	Fluke 5720A Multiproduct Calibrator
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ	22 μΩ/Ω + 90 μΩ 19 μΩ/Ω + 0.88 mΩ 16 μΩ/Ω + 0.95 mΩ 16 μΩ/Ω + 9.5 mΩ 16 μΩ/Ω + 95 mΩ 22 μΩ/Ω + 3 Ω 65 μΩ/Ω + 132 Ω 624 μΩ/Ω + 4.5 kΩ 6.2 mΩ/Ω + 0.35 MΩ	Keysight 3458A Multimeter
AC Voltage – Source ¹	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz 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	250 μV/V + 4.1 μV 94 μV/V + 4.1 μV 83 μV/V + 4.1 μV 210 μV/V + 4.1 μV 520 μV/V + 4.1 μV 1.1 mV/V + 4.1 μV 1.5 mV/V + 4.1 μV 2.8 mV/V + 4.1 μV 250 μV/V + 4.1 μV 94 μV/V + 4.1 μV 83 μV/V + 4.1 μV 210 μV/V + 4.1 μV 520 μV/V + 4.1 μV 1.1 mV/V + 4.1 μV 1.4 mV/V + 4.1 μV 2.8 mV/V + 4.1 μV 250 μV/V + 39 μV 94 μV/V + 16 μV 83 μV/V + 8.7 μV 200 μV/V + 10 μV 470 μV/V + 210 μV 930 μV/V + 600 μV 1.5 mV/V + 190 μV 2.8 mV/V + 300 μV	Fluke 5720A Multiproduct Calibrator



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	220 mV to 2.2 V		Fluke 5720A Multiproduct Calibrator
	(10 to 20) Hz	250 mV/V + 39 μV	
	(20 to 40) Hz	94 μV/V + 16 μV	
	40 Hz to 20 kHz	46 μV/V + 9 μV	
	(20 to 50) kHz	78 μV/V + 10 μV	
	(50 to 100) kHz	100 μV/V + 70 μV	
	(100 to 300) kHz	290 μV/V + 80 μV	
	(300 to 500) kHz	1.1 mV/V + 200 μV	
	500 kHz to 1 MHz	1.8 mV/V + 300 μV	
	(2.2 to 22) V		
	(10 to 20) Hz	250 μV/V + 390 μV	
	(20 to 40) Hz	93 μV/V + 160 μV	
	40 Hz to 20 kHz	47 μV/V + 48 μV	
	(20 to 50) kHz	78 μV/V + 100 μV	
	(50 to 100) kHz	110 μV/V + 70 μV	
(100 to 300) kHz	430 μV/V + 97 μV		
(300 to 500) kHz	1 mV/V + 2.1 mV		
500 kHz to 1 MHz	1.6 mV/V + 3.3 mV		
AC Voltage – Source ¹	(22 to 220) V		Fluke 5720A Multiproduct Calibrator with Fluke 5725A Amplifier
	40 Hz to 20 kHz	54 μV/V + 65 μV	
	(20 to 50) kHz	83 μV/V + 34 μV	
	(50 to 100) kHz	155 μV/V + 2.9 μV	
	(100 to 300) kHz	940 μV/V + 180 μV	
	(300 to 500) kHz	4.6 mV/V + 40 μV	
	500 kHz to 1 MHz	8.3 mV/V + 8.4 μV	
	(220 to 1 100) V		
	40 Hz to 20 kHz	310 μV/V + 20 μV	
	(20 to 50) kHz	73 μV/V	
	to 1 100 V		
	40 Hz to 1 kHz	78 μV/V + 14 mV	
	(1 to 20) kHz	170 μV/V	
	(20 to 30) kHz	620 μV/V	
	to 750 V		
(30 to 50) kHz	620 μV/V		
(50 to 100) kHz	2.35 mV/V		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Source Fixed Values, Fixed Frequencies ¹	(0 to 250) V (15 to 50) Hz	0.31 mV/V + 17 mV	Fluke 5700A or Fluke 5720A Multiproduct Calibrator disciplined with Keysight 3458A Multimeter
	250 V to 1.1 kV 50 Hz to 1 kHz	87 μV/V + 2.9 mV	
	220 V to 1.1 kV 40 Hz to 1 kHz	0.91 mV/V + 2.9 mV	
	(1 to 20) kHz	0.91 mV/V + 2.9 mV	
	(20 to 30) kHz	5.1 mV/V + 9.6 mV	
	(220 to 750) V (30 to 50) kHz (50 to 100) kHz	0.52 mV/V + 8.6 mV 1.9 mV/V + 37 mV	
AC Voltage - Source ¹ Fixed Values, Fixed Frequencies	0.01 V		Fluke 5700A or Fluke 5720A Multiproduct Calibrator disciplined with Keysight 3458A Multimeter
	1 kHz	2.8 μV	
	20 kHz	2.9 μV	
	100 kHz	9 μV	
	300 kHz	66 μV	
	0.1 V		
	1 kHz	5.7 μV	
	20 kHz	7.8 μV	
	100 kHz	37 μV	
	300 kHz	69 μV	
	1 V		
	1 kHz	55 μV	
	20 kHz	69 μV	
	50 kHz	0.13 mV	
	100 kHz	0.21 mV	
300 kHz	0.6 mV		
500 kHz	1.7 mV		
3V			
100 kHz	0.57 mV		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Source ¹ Fixed Values, Fixed Frequencies	10 V		Fluke 5700A or Fluke 5720A Multiproduct Calibrator disciplined with Keysight 3458A Multimeter
	10 Hz	0.78 mV	
	20 Hz	0.59 mV	
	40 Hz	0.52 mV	
	200 Hz	0.59 mV	
	500 Hz	0.59 mV	
	1 kHz	0.49 mV	
	10 kHz	0.68 mV	
	20 kHz	0.68 mV	
	50 kHz	1.3 mV	
	100 kHz	1.6 mV	
	300 kHz	5.1 mV	
	500 kHz	16 mV	
	1 MHz	19 mV	
	100 V		
1 kHz	8.4 mV		
20 kHz	12 mV		
50 kHz	14 mV		
100 kHz	34 mV		
700 V			
1 kHz	77 mV		
AC Voltage Flatness - Source	300 μ V to 3.5 V (10 to 30) Hz	2.7 mV/V	Fluke 5720A, Fluke 5700A, or Fluke 5700A-03 Multiproduct Calibrator (referenced to 1 kHz)
	30 Hz to 120 kHz	1.4 mV/V	
	300 μ V to 1.1 mV 120 kHz to 2 MHz	4.6 mV/V	
	(2 to 10) MHz	6.2 mV/V	
	(10 to 20) MHz	8 mV/V	
	(20 to 30) MHz	24 mV/V	
	1.1 μ V to 3 mV 120 kHz to 2 MHz	2.2 mV/V	
	(2 to 10) MHz	3.7 mV/V	
	(10 to 20) MHz	5.5 mV/V	
	(20 to 30) MHz	14 mV/V	
	3 mV to 3.5 V 120 kHz to 2 MHz	1.2 mV/V	
	(2 to 10) MHz	2.1 mV/V	
(10 to 20) MHz	3.8 mV/V		
(20 to 30) MHz	8.6 mV/V		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness - Measure ¹	Up to 3 V 10 Hz 100 Hz (10, 30) kHz 100 kHz 300 kHz 1 MHz 3 MHz 8 MHz 10 MHz 20 MHz 30 MHz 50 MHz 70 MHz 80 MHz 100 MHz	0.2 mV/V + 6.9 μV 80 μV/V + 5.5 μV 80 μV/V + 3.2 μV 0.1 mV/V + 8 μV 0.1 mV/V + 5.2 μV 0.1 mV/V + 6.5 μV 1.3 mV/V + 59 μV 1.3 mV/V + 0.11 mV 1.3 mV/V + 91 μV 2.5 mV/V + 0.21 mV 2.5 mV/V + 0.24 mV 6.1 mV/V + 0.34 mV 9 mV/V + 0.24 mV 11 mV/V + 0.79 mV 13 mV/V + 0.94 mV	Agilent 11049A, Agilent 11050A, Agilent 11051A Thermal Voltage Converters 3458A Multimeter
AC Voltage Flatness - Measure ¹ (Relative to 1 kHz)	9 kHz to 2 GHz (-60 to 24) dBm	0.26 dB	Agilent E9304A Power Sensor, Agilent N1914A Power Meter, Agilent 8491B Attenuator, Agilent 3458A Multimeter
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 (100 to 300) kHz 300 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz	0.3 mV/V + 3.1 μV 0.2 mV/V + 1.2 μV 0.3 mV/V + 1.7 μV 1 mV/V + 1.6 μV 5 mV/V + 1.3 μV 40 mV/V + 2.1 μV 12 mV/V + 6.6 μV 70 mV/V + 7.5 μV 20 mV/V + 8.2 μV	Keysight 3458A Multimeter



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(10 to 100) mV		Keysight 3458A Multimeter
	(1 to 40) Hz	70 μ V/V + 4.1 μ V	
	40 Hz to 1 kHz	70 μ V/V + 2.1 μ V	
	(1 to 20) kHz	0.14 mV/V + 2.3 μ V	
	(20 to 50) kHz	0.3 V/V + 2.6 μ V	
	(50 to 100) kHz	0.8 mV/V + 2.3 μ V	
	(100 to 300) kHz	3 mV/V + 15 μ V	
	300 kHz to 1 MHz	10 mV/V + 28 μ V	
	(1 to 2) MHz	15 mV/V + 20 μ V	
	(2 to 4) MHz	40 mV/V + 74 μ V	
	(4 to 8) MHz	40 mV/V + 83 μ V	
	(8 to 10) MHz	0.15 V/V + 0.11 mV	
	(0.1 to 1) V		
	(1 to 40) Hz	70 μ V/V + 41 μ V	
	40 Hz to 1 kHz	70 μ V/V + 21 μ V	
	(1 to 20) kHz	0.14 mV/V + 22 μ V	
	(20 to 50) kHz	0.3 mV/V + 22 μ V	
	(50 to 100) kHz	0.8 mV/V + 22 μ V	
	(100 to 300) kHz	3 mV/V + 0.12 mV	
	300 kHz to 1 MHz	10 mV/V + 0.3 mV	
	(1 to 2) MHz	15 mV/V + 0.21 mV	
	(2 to 4) MHz	40 mV/V + 0.73 mV	
	(4 to 8) MHz	40 mV/V + 0.83 mV	
	(8 to 10) MHz	0.15 V/V + 1 mV	
	(1 to 10) V		
	(1 to 40) Hz	70 μ V/V + 0.42 mV	
	40 Hz to 1 kHz	70 μ V/V + 0.22 mV	
	(1 to 20) kHz	0.14 mV/V + 0.24 mV	
	(20 to 50) kHz	0.3 mV/V + 0.25 mV	
	(50 to 100) kHz	0.8 mV/V + 0.22 mV	
(100 to 300) kHz	3 mV/V + 1.1 mV		
300 kHz to 1 MHz	10 mV/V + 1.1 mV		
(1 to 2) MHz	15 mV/V + 1.1 mV		
(2 to 4) MHz	40 mV/V + 7.1 mV		
(4 to 8) MHz	40 mV/V + 8.1 mV		
(8 to 10) MHz	0.15 mV/V + 11 mV		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(10 to 100) V (1 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (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	0.2 mV/V + 4.1 mV 0.2 mV/V + 2.6 mV 0.35 mV/V + 2.4 mV 1.2 mV/V + 2.1 mV 4 mV/V + 11 mV 15 mV/V + 50 mV 0.4 mV/V + 31 mV 0.4 mV/V + 16 mV 0.6 mV/V + 16 mV 1.2 mV/V + 16 mV 3 mV/V + 15 mV	Keysight 3458A Multimeter
AC Voltage – Measure ¹	1 mV to 8 V 20 Hz to 20 MHz	3 % of reading	Keysight DSO8104A Oscilloscope
AC Current Source ¹	0 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 (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	230 μA/A + 17 nA 150 μA/A + 10 nA 108 μA/A + 8.4 nA 266 μA/A + 12.5 nA 915 μA/A + 66 nA 233 μA/A + 42 nA 150 μA/A + 34 nA 108 μA/A + 34 nA 183 μA/A + 109 nA 915 μA/A + 655 nA 233 μA/A + 422 nA 149 μA/A + 342 nA 108 μA/A + 343 nA 183 μA/A + 588 nA 915 μA/A + 5 μA 233 μA/A + 4.2 μA 149 μA/A + 3.4 μA 108 μA/A + 2.6 μA 183 μA/A + 3.4 μA 915 μA/A + 10 μA	Fluke 5720A or 5730A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Source ¹	(0.22 to 2.2) A 20 Hz to 1 kHz 1 to 5 kHz 5 to 10 kHz (2.2 to 11) A 20 Hz to 1 kHz 1 to 5 kHz 5 to 10 kHz	249 μ A/A + 34 μ A 383 μ A/A + 83 μ A 5.8 mA/A + 166 μ A 332 μ A/A + 149 μ A 707 μ A/A + 320 μ A 2.8 mA/A + 600 μ A	Fluke 5720A or 5730A Multiproduct Calibrator
AC Current – Source ¹	(10 to 20) A 45 Hz to 65 Hz 65 Hz to 440 Hz (20 to 100) A 45 Hz to 65 Hz 65 Hz to 440 Hz (200 to 1 000) A 45 Hz to 65 Hz 65 Hz to 100 Hz 100 Hz to 440 Hz	0.3 % of reading + 27 mA 0.88 % of reading - 1 mA 0.3 % of reading + 27 mA 0.85 % of reading + 28 mA 0.33 % of reading + 60 mA 0.86 % of reading + 90 mA 1 % of reading - 0.17 A	Fluke 552xA Multiproduct Calibrator with 50 turn coil
AC Current - Source Fixed Values ¹	1 kHz 10 μ A 100 μ A 1 mA 10 mA 100 mA 1 A	5.1 pA 11 pA 110 pA 1 μ A 11 μ A 120 μ A	Fluke 57X0A Multiproduct Calibrator disciplined with Keysight 3458A Multimeter
AC Current - Measure ¹	Up to 100 μ A (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (0.1 to 1) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 10) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz	4 mA/A + 31 nA 1.5 mA/A + 31 nA 0.6 mA/A + 31 nA 4 mA/A + 0.31 μ A 0.15 mA/A + 0.21 μ A 0.6 mA/A + 0.21 μ A 4 mA/A + 3.1 μ A 1.5 mA/A + 2.1 μ A 0.6 mA/A + 2.1 μ A	Keysight 3458A Multimeter



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current - Measure ¹	10 to 100) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (0.1 to 1.05) A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4 mA/A + 31 μ A 1.5 mA/A + 21 μ A 0.6 mA/A + 21 μ A 4 mA/A + 0.22 mA 1.6 mA/A + 0.22 mA 0.8 mA/A + 0.22 mA 1 mA/A + 0.22 mA	Keysight 3458A Multimeter
Resistance - Source DC to 1 MHz, Direct Measurement ¹	0.1 Ω (1, 10) Ω 100 Ω (1, 10, 100) k Ω	10 m Ω / Ω 1 m Ω / Ω 0.30 m Ω / Ω 0.30 m Ω / Ω	Agilent 16074A RL Standard
Resistance Source, High Resistance ¹	1 G Ω 10 G Ω 100 G Ω	0.23 M Ω 2.7 M Ω 24 M Ω	Agilent 16340A RC Calibration Fixture
Capacitance – Source Fixed Points ¹	1 pF 1 kHz, 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz 10 pF 1 kHz (1 to 10) MHz 10 MHz 13 MHz 100 pF 1 kHz to 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.19 fF 0.31 fF 0.49 fF 0.68 fF 0.9 fF 2.5 fF 3.7 fF 2 fF 1.5 fF 2 fF 2.2 fF 14 fF 17 fF 20 fF 37 fF 53 fF	Agilent 16380A, Agilent 16380C Standard Air Capacitor Set, BNC 4 Terminal Pair



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source Fixed Points ¹	1 000 pF 1 kHz, 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz 10 nF 120 Hz to 100 kHz 100 nF 120 Hz to 100 kHz 1 μF 120 Hz to 10 kHz 100 kHz	0.14 pF 0.21 pF 0.31 pF 0.47 pF 0.64 pF 1.9 pF 2.9 pF 1.5 pF 15 pF 0.15 nF 0.17 nF	Agilent 16380A, Agilent 16380C Standard Air Capacitor Set, BNC 4 Terminal Pair
Capacitance - Source ¹	0.19 to 3.29 nF 3.3 to 10.99 nF 11 to 109.99 nF 110 to 329.99 nF 0.33 to 1.099 μF	3.2 mA/A + 8.3 pA 1.6 mA/A + 8.3 pA 1.6 mA/A + 83 pA 1.6 mA/A + 0.25 nA 1.6 mA/A + 0.83 nA	Fluke 5520A or 5522A Multiproduct Calibrator
Capacitance - Source ¹	1.1 to 3.299 μF 3.3 to 10.99 μF 11 to 32.99 μF 33 to 109.99 μF 110 to 329.99 μF 0.33 to 1.099 mF 1.1 to 3.299 mF 3.3 to 10.00 mF 11 to 32.99 mF 33 to 110 mF	1.6 mA/A + 2.5 nA 1.6 mA/A + 8.3 nA 2.5 mA/A + 25 nA 2.8 mA/A + 84 nA 2.8 mA/A + 0.25 μA 4 mA/A + 1.2 μA 4 mA/A + 3.6 μA 4 mA/A + 12 μA 8.3 mA/A + 36 μA 12 mA/A + 0.11 mA	Fluke 5520A or 5522A Multiproduct Calibrator
Dissipation Factor – Source Fixed Points ^{1,2}	1 pF 1 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.002 7 0.000 17 0.000 39 0.000 2 0.000 15 0.000 21 0.000 57 0.000 84	Agilent 16380A, Agilent 16380C Standard Air Capacitor Set, BNC 4 Terminal Pair



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dissipation Factor – Source Fixed Points ^{1,2}	10 pF		Agilent 16380A, Agilent 16380C Standard Air Capacitor Set, BNC 4 Terminal Pair
	1 kHz	0.000 042	
	1 MHz	0.000 026	
	2 MHz	0.000 073	
	(3 to 4) MHz	0.000 067	
	5 MHz	0.000 097	
	10 MHz	0.000 076	
	13 MHz	0.000 095	
	100 pF		
	1 kHz	0.000 023	
	1 MHz	0.000 021	
	2 MHz	0.000 069	
	3 MHz	0.000 055	
	4 MHz	0.000 065	
	5 MHz	0.000 072	
	10 MHz	0.000 16	
	13 MHz	0.000 24	
	1 000 pF		
	1 kHz	0.000 02	
	1 MHz	0.000 031	
	2 MHz	0.000 075	
	3 MHz	0.000 1	
	4 MHz	0.001 6	
	5 MHz	0.000 22	
	10 MHz	0.000 58	
	13 MHz	0.000 86	
	10 nF		
	120 Hz	0.000 025	
	1 kHz	0.000 02	
	(10 to 100) kHz	0.000 021	
	100 nF		
	120 Hz	0.000 03	
	1 kHz	0.000 02	
10 kHz	0.000 12		
100 kHz	0.000 031		
1 μF			
120 Hz	0.000 042		
1 kHz	0.000 02		
10 kHz	0.000 031		
100 kHz	0.000 055		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators ¹	Type B		Fluke 5520A, Fluke 5522A Multiproduct Calibrator
	(600 to 800) °C	0.47 °C	
	(800 to 1 000) °C	0.36 °C	
	(1 000 to 1 550) °C	0.32 °C	
	(1 550 to 1 820) °C	0.35 °C	
	Type C		
	(0 to 150) °C	0.32 °C	
	(150 to 650) °C	0.28 °C	
	(650 to 1 000) °C	0.33 °C	
	(1 000 to 1 800) °C	0.53 °C	
	(1 800 to 2 316) °C	0.88 °C	
	Type E		
	(-250 to -100) °C	0.53 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 350) °C	0.16 °C	
	(350 to 650) °C	0.18 °C	
	(650 to 1 000) °C	0.23 °C	
	Type J		
	(-210 to -100) °C	0.29 °C	
	(-100 to -30) °C	0.18 °C	
	(-30 to 150) °C	0.16 °C	
	(150 to 760) °C	0.19 °C	
	(760 to 1 200) °C	0.25 °C	
	Type K		
(-200 to -100) °C	0.35 °C		
(-100 to -25) °C	0.2 °C		
(-25 to 120) °C	0.18 °C		
(120 to 1 000) °C	0.28 °C		
(1 000 to 1 372) °C	0.42 °C		
Type L			
(-200 to -100) °C	0.39 °C		
(-100 to 800) °C	0.28 °C		
(800 to 900) °C	0.19 °C		
Type N			
(-200 to -100) °C	0.42 °C		
(-100 to -25) °C	0.24 °C		
(-25 to 120) °C	0.21 °C		
(120 to 410) °C	0.2 °C		
(410 to 1 300) °C	0.29 °C		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators ¹	Type R		Fluke 5520A, Fluke 5522A Multiproduct Calibrator
	(0 to 250) °C	0.6 °C	
	(250 to 400) °C	0.37 °C	
	(400 to 1 000) °C	0.35 °C	
	(1 000 to 1 767) °C	0.42 °C	
	Type S		
	(0 to 250) °C	0.50 °C	
	(250 to 1 000) °C	0.38 °C	
	(1 000 to 1 400) °C	0.39 °C	
	(1 400 to 1 767) °C	0.49 °C	
	Type T		
	(-250 to -150) °C	0.26 °C	
	(-150 to 0) °C	0.18 °C	
	(0 to 120) °C	0.16 °C	
(120 to 400) °C	0.66 °C		
Type U			
(-200 to 0) °C	0.59 °C		
(0 to 600) °C	0.29 °C		

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹ (0.15 to 10) MHz (0.01 to 1.3) GHz (1.3 to 26.5) GHz	Rate: (0.05 to 10) kHz Rate: (0.05 to 50) kHz Rate: (0.05 to 10) kHz	2.1 % Depth 1.1 % Depth 1.6 % Depth	Agilent 8902A Measuring Receiver
Amplitude Modulation – Measure ¹ (0.1 to 10) MHz (0.01 to 3) GHz (3 to 26.5) GHz (26.5 to 31.15) GHz (31.5 to 50) GHz	Rate: (0.05 to 10) kHz Rate: (0.05 to 100) kHz	0.8 % Depth 0.5 % Depth 1.5 % Depth 1.9 % Depth 6.1 % Depth	Agilent E444xA with Opt. 233 Spectrum Analyzer
Frequency Modulation – Measure ¹ (0.25 to 10) MHz (0.01 to 26.5) GHz	Rate: (0.02 to 10) kHz Rate: (0.05 to 100) kHz	2.2 % Deviation 1.2 % Deviation	HP 8902A Measuring Receiver



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure ¹ (0.25 to 10) MHz (0.01 to 50) GHz	Rate: (0.02 to 10) kHz Rate: (0.05 to 200) kHz	1.1 % Deviation 1.1 % Deviation	E444xA with Opt. 233 Spectrum Analyzer

DIGITAL MODULATION RF QUALITY		
PARAMETER/EQUIPMENT	MODULATION TYPES	FREQUENCY RANGE
Digital Modulation RF Quality Measure – Carrier 2 MHz to 44 GHz	TETRA, PDC, NADC, PHS, EDGE, CDMA 200A/C, WCDMA, 3GPP, QPSK, BPSK, PI/4 DQPSK, 16QAM, 256QAM, DECT, PHP, GSM, 2FSK, 4FSK, GMSK, MSK, DQPSK, 8PSK, 32QAM FSK	2 MHz to 2.65 GHz using the VSA directly (2.65 to 44) GHz. The digitally modulated RF signal needs to be down-converted with an external Mixer and a Local Oscillator L.O. center frequency = (RF-150 MHz)

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Error Vector Magnitude ² (EVM)	Mod Frequency Span: f ≤ 100kHz 100kHz ≤ f ≤ 1MHz f > 1MHz	0.43 % 0.48 % 0.82 %	HP 89441A Vector Signal Analyzer
Phase Error	Mod Frequency Span: f ≤ 100kHz 100kHz ≤ f ≤ 1MHz f > 1MHz	0.17 ° rms 0.34 ° rms 0.57 ° rms	HP 89441A Vector Signal Analyzer
Frequency Error	Mod Frequency 1 GHz 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz	0.063 % of reading 0.068 % of reading 0.079 % of reading 0.099 % of reading 0.33 % of reading 0.39 % of reading	HP 89441A Vector Signal Analyzer



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Modulation Accuracy (Rho)	Mod Frequency Span: f ≤ 100kHz		HP 89441A Vector Signal Analyzer
	0.9999 ≤ ρ ≤ 1	8.6 E-5 ρ	
	0.9975 ≤ ρ < 0.9999	0.000 43 ρ	
	0.9936 ≤ ρ < 0.9975	0.000 68 ρ	
	0.99 ≤ ρ < 0.9936	0.000 84 ρ	
	0.978 ≤ ρ < 0.99	0.001 2 ρ	
	0.96 ≤ ρ < 0.978	0.001 6 ρ	
	Mod Frequency Span: 100 kHz ≤ f ≤ 1 MHz		
	0.9999 ≤ ρ ≤ 1	9.6 E-5 ρ	
	0.9975 ≤ ρ < 0.9999	0.000 48 ρ	
	0.9936 ≤ ρ < 0.9975	0.000 76 ρ	
	0.99 ≤ ρ < 0.9936	0.000 94 ρ	
	0.978 ≤ ρ < 0.99	0.001 4 ρ	
	0.96 ≤ ρ < 0.978	0.001 8 ρ	
	Mod Frequency Span: f > 1MHz		
0.9999 ≤ ρ ≤ 1	1.6 E-4 ρ		
0.9975 ≤ ρ < 0.9999	0.000 82 ρ		
0.9936 ≤ ρ < 0.9975	0.001 3 ρ		
0.99 ≤ ρ < 0.9936	0.001 6 ρ		
0.978 ≤ ρ < 0.99	0.002 4 ρ		
0.96 ≤ ρ < 0.978	0.003 ρ		
Phase Modulation – Measure ¹	(0.15 to 10) MHz Rate: (0.02 to 10) kHz (0.01 to 26.5) GHz Rate: (0.2 to 20) kHz	4.1 % Deviation 3.1 % Deviation	HP 8902A Measuring Receiver
Phase Modulation – Measure ¹	100 kHz to 6.6 GHz Deviations: (0.3 to 7) rad Deviations: > 7 rad (6.6 to 13.2) GHz Deviations: (0.6 to 2) rad (13.2 to 26.5) GHz Deviations: > 2 rad Deviations: (1.2 to 4) rad	3.1 % Deviation 1 % Deviation 3.1 % Deviation 1 % Deviation 3.1 % Deviation	Keysight E444xA with Opt. 233 Spectrum Analyzer



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Measure ¹	(26.5 to 31.5) GHz Deviations: > 4 rad Deviations: (1.3 to 4) rad (31.5 to 50) GHz Deviations: > 4 rad Deviations (2.4 to 8) rad Deviations: > 8 rad	1 % Deviation 3.1 % Deviation 1 % Deviation 3.1 % Deviation 1 %	Keysight E444xA with Opt. 233 Spectrum Analyzer
Distortion Measure ¹	20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.4 dB	HP 8903A/B Audio Analyzer
RF Power - Power Meter Reference ¹	1 mW 50 MHz	0.32 % of reading	Agilent 432A or N432A Power Meter, Agilent 478A Option H75 or H76 Power Sensor
Tuned RF Power - Absolute - Measure ¹ 2.5 MHz to 26.5 GHz	(-22 to +10) dBm (-42 to -22) dBm (-50 to -42) dBm (-60 to -50) dBm (-72 to -60) dBm (-80 to -72) dBm (-92 to -80) dBm (-102 to -92) dBm (-110 to -102) dBm (-120 to -110) dBm (-127 to -120) dBm	0.17 dB 0.18 dB 0.2 dB 0.21 dB 0.22 dB 0.23 dB 0.24 dB 0.27 dB 0.28 dB 0.31 dB 0.34 dB	HP 8902A Measuring Receiver with HP 11722A or with HP 11792A and HP 11793A Power Sensor
Tuned RF Power - Relative – Measure ¹ 2.5 MHz to 26.5 GHz	(+2 to +10) dBm (-12 to +2) dBm (-22 to -12) dBm (-31 to -22) dBm (-40 to -31) dBm (-50 to -40) dBm (-61 to -50) dBm (-71 to -61) dBm (-80 to -71) dBm (-90 to -80) dBm (-100 to -90) dBm (-110 to -100) dBm (-120 to -110) dBm (-127 to -120) dBm	0.08 dB 0.07 dB 0.08 dB 0.09 dB 0.1 dB 0.12 dB 0.15 dB 0.16 dB 0.17 dB 0.19 dB 0.22 dB 0.23 dB 0.27 dB 0.3 dB	HP 8902A Measuring Receiver with HP 11722A or with HP 11792A and HP 11793A Power Sensor



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Sensors Cal Factors ¹	9 kHz to 10 MHz	0.69 % of reading	E9304A Power Sensor
RF Power Sensors Cal Factors ¹	10 MHz 30 MHz 50 MHz 100 MHz 300 MHz to 3 GHz 4 GHz 5 GHz (6 to 7) GHz 8 GHz 9 GHz 10 GHz 11 GHz 12 GHz 12.4 GHz (13 to 15) GHz 16 GHz 17 GHz 18 GHz (19 to 26) GHz 26.5 GHz 27 GHz (28 to 29) GHz 30 GHz (31 to 32) GHz 33 GHz (34 to 40) GHz 41 GHz (42 to 44) GHz (45 to 47) GHz (48 to 50) GHz	0.58 % of reading 0.54 % of reading 0.41 % of reading 0.51 % of reading 0.6 % of reading 0.61 % of reading 0.67 % of reading 0.68 % of reading 0.7 % of reading 0.79 % of reading 0.82 % of reading 0.79 % of reading 0.76 % of reading 0.8 % of reading 0.79 % of reading 0.87 % of reading 0.91 % of reading 0.97 % of reading 1.5 % of reading 1.6 % of reading 1.7 % of reading 1.8 % of reading 1.7 % of reading 1.8 % of reading 1.7 % of reading 1.8 % of reading 2.4 % of reading 2.5 % of reading 2.6 % of reading 2.5 % of reading	Keysight PNA-X Network Analyzer, 2.4, 3.5 mm Calibration Kits, Reference Power Sensors
RF Absolute Power - Source ¹ 50 MHz	(-1 to -11) dB (-10 to -30) dB (-40 to -50) dB -60 dB (-70 to -90) dB -100 dB -110 dB	0.025 dB 0.025 dB 0.027 dB 0.028 dB 0.033 dB 0.04 dB 0.048 dB	Signal Source and Step Attenuators PSG, ESG, 8496G/H and 8494G/H



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power - Source ¹	$0.02 \text{ V} \leq V < 7 \text{ V}$ $f < 10 \text{ MHz}$ $10 \text{ MHz} \leq f \leq 50 \text{ MHz}$ $50 \text{ MHz} \leq f \leq 80 \text{ MHz}$ $V \leq 10 \text{ mV}$ $20 \text{ Hz} \leq f \leq 20 \text{ kHz}$ $20 \text{ kHz} < f \leq 50 \text{ kHz}$ $50 \text{ kHz} < f \leq 100 \text{ kHz}$ $100 \text{ kHz} < f \leq 300 \text{ kHz}$ $10 \text{ mV} < V \leq 100 \text{ mV}$ $20 \text{ Hz} \leq f \leq 40 \text{ Hz}$ $40 \text{ Hz} \leq f \leq 1 \text{ kHz}$ $1 \text{ kHz} < f \leq 20 \text{ kHz}$ $20 \text{ kHz} < f \leq 50 \text{ kHz}$ $50 \text{ kHz} < f \leq 100 \text{ kHz}$ $100 \text{ kHz} < f \leq 300 \text{ kHz}$	 0.082 dB 0.16 dB 0.4 dB 0.017 mV 0.021 mV 0.050 mV 0.38 mV 0.029 mV 0.028 mV 0.032 mV 0.045 mV 0.08 mV 0.30 mV	Function Generator and DVM Agilent 33250A, Agilent 33120A, Agilent 3458A Multimeter
RF Absolute Power – Source ¹	$100 \text{ mV} < V \leq 1 \text{ V}$ $20 \text{ Hz} \leq f \leq 1 \text{ kHz}$ $1 \text{ kHz} < f \leq 20 \text{ kHz}$ $20 \text{ kHz} < f \leq 50 \text{ kHz}$ $50 \text{ kHz} < f \leq 100 \text{ kHz}$ $100 \text{ kHz} < f \leq 300 \text{ kHz}$ $1 \text{ V} < V \leq 3.5 \text{ V}$ $20 \text{ Hz} \leq f \leq 40 \text{ Hz}$ $40 \text{ Hz} \leq f \leq 1 \text{ kHz}$ $1 \text{ kHz} < f \leq 20 \text{ kHz}$ $20 \text{ kHz} < f \leq 50 \text{ kHz}$ $50 \text{ kHz} < f \leq 100 \text{ kHz}$ $100 \text{ kHz} < f \leq 300 \text{ kHz}$	 0.7 mV 0.72 mV 0.79 mV 1.3 mV 3.7 mV 2.2 mV 2.1 mV 2.2 mV 2.5 mV 4.0 mV 13 mV	Function Generator and DVM Agilent 33250A, Agilent 33120A, Agilent 3458A Multimeter
RF Absolute Power – Source ¹	$7 \text{ dBm} \geq P \geq 0 \text{ dBm}$ $0.3 \text{ MHz} \leq f \leq 1.1 \text{ GHz}$ $1.1 \text{ GHz} \leq f \leq 2.985 \text{ GHz}$ $2.985 \text{ GHz} < f \leq 4 \text{ GHz}$ $4 \text{ GHz} < f \leq 6 \text{ GHz}$ $0 \text{ dBm} > P \geq -25 \text{ dBm}$ $0.3 \text{ MHz} \leq f \leq 1.1 \text{ GHz}$ $1.1 \text{ GHz} \leq f \leq 2.985 \text{ GHz}$ $2.985 \text{ GHz} < f \leq 4 \text{ GHz}$ $4 \text{ GHz} < f \leq 6 \text{ GHz}$	 0.49 dB 0.58 dB 0.69 dB 0.79 dB 0.49 dB 0.59 dB 0.69 dB 0.8 dB	Signal Source PSG, ESG, E4438C, E4428C



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Source ¹	-25 dBm > P ≥ -70 dBm		Signal Source PSG, ESG, E4438C, E4428C
	0.3 MHz ≤ f ≤ 1.1 GHz	0.5 dB	
	1.1 GHz ≤ f ≤ 2.985 GHz	0.59 dB	
	2.985 GHz < f ≤ 4 GHz	0.69 dB	
	4 GHz < f ≤ 6 GHz	0.8 dB	
	-70 dBm > P ≥ -95 dBm		
	0.3 MHz ≤ f ≤ 1.1 GHz	0.5 dB	
	1.1 GHz ≤ f ≤ 2.985 GHz	0.6 dB	
	2.985 GHz < f ≤ 4 GHz	0.7 dB	
	4 GHz < f ≤ 6 GHz	0.8 dB	
	-95 dBm > P ≥ -125 dBm		
	0.3 MHz ≤ f ≤ 1.1 GHz	0.51 dB	
1.1 GHz ≤ f ≤ 2.985 GHz	0.6 dB		
2.985 GHz < f ≤ 4 GHz	0.7 dB		
4 GHz < f ≤ 6 GHz	1.5 dB		
Rise Time - Source ¹	1 kHz to 2 MHz (200 to 300) ps	37 ps	Fluke 55xxA + SC600/1100 Multiproduct Calibrator
	(2 to 10) MHz (200 to 350) ps	37 ps	
Rise Time – Measure ¹	300 μs to 1 ps Up to 1 GHz	8.1 ps	DSO 9104A Oscilloscope
Pulse – Source Transition Time ¹	<100 ps	0.13 ns	HP 8133A Pulse Generator
Width	150 ps to 10 ns	0.13 ns	
	(10 to 100) ns	(0.013 * Width) + 1.2 ns	
	100 μs to 10 ms (10 to 100) ms	(0.013 * Width) + 0.14 μs (0.012 * Width) + 2 ns	
	(100 to 0.99) ms	(0.012 * Width) + 0.19 μs	
RMS Jitter - Period, Delay and Width	33 MHz to 3 GHz	10 ps	



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermal Noise – ENR	5 dB, 15 dB, or 21 dB		HP 346B opt. 002 346B/N4001A opt. 001 346B opt. 004 346C/N4002A
	0.01 GHz	0.06 dB	
	0.1 GHz	0.06 dB	
	1 GHz	0.11 dB	
	2 GHz	0.07 dB	
	3 GHz	0.07 dB	
	4 GHz	0.06 dB	
	5 GHz	0.06 dB	
	6 GHz	0.06 dB	
	7 GHz	0.06 dB	
	8 GHz	0.07 dB	
	9 GHz	0.06 dB	
	10 GHz	0.09 dB	
	11 GHz	0.07 dB	
	12 GHz	0.07 dB	
	13 GHz	0.07 dB	
	14 GHz	0.06 dB	
	15 GHz	0.06 dB	
	16 GHz	0.06 dB	
	17 GHz	0.07 dB	
	18 GHz	0.06 dB	
19 GHz	0.13 dB		
20 GHz	0.14 dB		
21 GHz	0.14 dB		
22 GHz	0.16 dB		
23 GHz	0.17 dB		
24 GHz	0.14 dB		
25 GHz	0.13 dB		
26 GHz	0.15 dB		
26.5 GHz	0.15 dB		
Phase Noise for Signal Sources ¹			E5500 System Phase Noise System
Offset Frequency	$(L_{REF} - L_{DUT}) \geq 10\text{dB}$		
≤ 100 kHz	≤ 100 MHz	± 2.3 dB	
≤ 100 kHz	100 MHz < f ≤ 26.5 GHz	± 2.3 dB	
≤ 1 MHz	50 kHz < f ≤ 26.5 GHz	± 2.3 dB	
≤ 10 MHz	50 kHz < f ≤ 26.5 GHz	± 4.6 dB	
< 100 MHz	50 kHz < f ≤ 26.5 GHz	± 4.6 dB	





Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Noise for Signal Sources ¹			
Offset Frequency	$10\text{dB} > (L_{\text{REF}} - L_{\text{DUT}}) \geq 5\text{dB}$		
≤ 100 kHz	≤ 100 MHz	± 2.8 dB	
≤ 100 kHz	$100\text{ MHz} < f \leq 26.5\text{ MHz}$	± 2.9 dB	
≤ 1 MHz	$50\text{ kHz} < f \leq 26.5\text{ GHz}$	± 2.9 dB	
≤ 10 MHz	$50\text{ kHz} < f \leq 26.5\text{ GHz}$	± 5.2 dB	
< 100 MHz	$50\text{ kHz} < f \leq 26.5\text{ GHz}$	± 5.3 dB	
Offset Frequency	$5\text{dB} > (L_{\text{REF}} - L_{\text{DUT}}) \geq 3\text{dB}$		
≤ 100 kHz	≤ 100 MHz	± 3.2 dB	
≤ 100 kHz	$100\text{ MHz} < f \leq 26.5\text{ GHz}$	± 3.3 dB	
≤ 1 MHz	$50\text{ kHz} < f \leq 26.5\text{ GHz}$	± 3.3 dB	
≤ 10 MHz	$50\text{ kHz} < f \leq 26.5\text{ GHz}$	± 5.4 dB	
< 100 MHz	$50\text{ kHz} < f \leq 26.5\text{ GHz}$	± 5.5 dB	
Offset Frequency	$3\text{dB} > (L_{\text{REF}} - L_{\text{DUT}}) \geq 0\text{dB}$		
≤ 100 kHz	≤ 100 MHz	± 4.3 dB	E5500 System Phase Noise System
≤ 100 kHz	$100\text{ MHz} < f \leq 26.5\text{ GHz}$	± 4.3 dB	
≤ 1 MHz	$50\text{ kHz} < f \leq 26.5\text{ GHz}$	± 4.3 dB	
≤ 10 MHz	$50\text{ kHz} < f \leq 26.5\text{ GHz}$	± 6.1 dB	
< 100 MHz	$50\text{ kHz} < f \leq 26.5\text{ GHz}$	± 6.2 dB	
Offset Frequency	$3\text{ dB} > (L_{\text{REF}} - L_{\text{DUT}}) \geq 0\text{ dB}$		
≤ 100 kHz	≤ 100 MHz	± 4.3 dB	
≤ 100 kHz	$100\text{ MHz} < f \leq 255\text{ MHz}$	± 4.6 dB	
≤ 100 kHz	$255\text{ MHz} < f \leq 600\text{ MHz}$	± 4.6 dB	
≤ 100 kHz	$600\text{ MHz} < f \leq 1.8\text{ GHz}$	± 4.5 dB	
≤ 100 kHz	$1.8\text{ GHz} < f \leq 3.2\text{ GHz}$	± 4.5 dB	
≤ 100 kHz	$3.2\text{ GHz} < f \leq 10\text{ GHz}$	± 4.8 dB	
≤ 100 kHz	$10\text{ GHz} < f \leq 20\text{ GHz}$	± 4.8 dB	
≤ 100 kHz	$20\text{ GHz} < f \leq 26.5\text{ GHz}$	± 4.5 dB	
≤ 1 MHz	$50\text{ kHz} < f \leq 26.5\text{ GHz}$	± 4.7 dB	
≤ 10 MHz	$50\text{ kHz} < f \leq 26.5\text{ GHz}$	± 6.2 dB	
< 100 MHz	$50\text{ kHz} < f \leq 26.5\text{ GHz}$	± 6.2 dB	



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Noise for Signal Analyzers ¹ Carrier 1 GHz Offsets: 0.1 kHz 1 kHz 10 kHz 30 kHz	Phase Noise Measurement dBc/Hz		Wenzel 500-13438C Oscillator
	-84 ≥ PN ≤ -94	1.1 dB	
	-94 < PN ≤ -95	1.2 dB	
	-95 < PN ≤ -98	1.4 dB	
	-98 < PN ≤ -100	1.8 dB	
	-100 < PN ≤ -102	2.4 dB	
	-102 < PN ≤ -105	3.4 dB	
	-78 ≥ PN ≤ -115	0.75 dB	
	-115 < PN ≤ -121	0.82 dB	
	-121 < PN ≤ -123	0.91 dB	
	-123 < PN ≤ -125	1.1 dB	
	-125 < PN ≤ -129	1.9 dB	
	-129 < PN ≤ -130	2.1 dB	
	-130 < PN ≤ -133	3.3 dB	
	-90 ≥ PN ≤ -129	0.43 dB	
	-129 < PN ≤ -132	0.45 dB	
	-132 < PN ≤ -135	0.54 dB	
	-135 < PN ≤ -138	0.74 dB	
	-138 < PN ≤ -142	1.2 dB	
	-142 < PN ≤ -145	2.1 dB	
	-106 ≥ PN ≤ -112	0.56 dB	
	-112 < PN ≤ -132	0.57 dB	
	-132 < PN ≤ -134	0.59 dB	
	-134 < PN ≤ -137	0.65 dB	
	-137 < PN ≤ -140	0.82 dB	
	-140 < PN ≤ -143	1.3 dB	
	-143 < PN ≤ -144	1.5 dB	
-144 < PN ≤ -147	2.1 dB		



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Noise for Signal Analyzers ¹ Carrier 1 GHz Offsets: 100 kHz	Phase Noise (PN) Measurement dBc/Hz -102 ≥ PN ≤ -131 -131 < PN ≤ -132 -132 < PN ≤ -136 -136 < PN ≤ -139 -139 < PN ≤ -142 -142 < PN ≤ -145 -145 < PN ≤ -146 -146 < PN ≤ -149	0.55 dB 0.56 dB 0.58 dB 0.64 dB 0.81 dB 1.3 dB 1.5 dB 2.1 dB	Wenzel 500-13438C Oscillator
1 MHz	-120 ≥ PN ≤ -139 -139 < PN ≤ -142 -142 < PN ≤ -145 -143 < PN ≤ -148 -148 < PN ≤ -150 -150 < PN ≤ -152 -152 < PN ≤ -155 -155 < PN ≤ -158	0.55 dB 0.56 dB 0.58 dB 0.64 dB 0.74 dB 0.93 dB 1.5 dB 2.1 dB	
9.9 and 10 MHz	-131 ≥ PN ≤ -136 -136 < PN ≤ -156 -156 < PN ≤ -158 -158 < PN ≤ -159 -159 < PN ≤ -162 -162 < PN ≤ -165	0.69 dB 0.79 dB 0.91 dB 1 dB 1.5 dB 2.1 dB	



PARAMETER	Attenuation - Source										
REFERENCE STANDARD OR EQUIPMENT	8494H										
Frequency Ranges (uncertainties in dB)											
Attenuation Level	1	2	3	4	5	6	7	8	9	10	11
20 Hz ≤ f < 300 kHz	0.002 8	0.002 7	0.002 7	0.002 8	0.002 9	0.002 8	0.002 9	0.002 8	0.002 8	0.002 8	0.003 3
300 kHz ≤ f < 80 MHz	0.002 9	0.002 8	0.002 8	0.003	0.003	0.003	0.003	0.003 4	0.003 7	0.003 7	0.003 8
80 MHz ≤ f < 1 GHz	0.005 4	0.005 4	0.005 4	0.005 3	0.005 4	0.005 4	0.005 1	0.005 4	0.005 4	0.005 9	0.005 3
1 GHz ≤ f < 4 GHz	0.066	0.068	0.068	0.069	0.071	0.071	0.072	0.073	0.073	0.074	0.074
4 GHz ≤ f < 10 GHz	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.11	0.11	0.11	0.11
10 GHz ≤ f < 14 GHz	0.14	0.14	0.14	0.14	0.15	0.14	0.14	0.15	0.15	0.14	0.14
14 GHz ≤ f ≤ 18 GHz	0.19	0.18	0.19	0.17	0.2	0.19	0.19	0.19	0.18	0.19	0.2

PARAMETER	Attenuation - Source										
REFERENCE STANDARD OR EQUIPMENT	8496H										
Attenuation Levels (dB)											
Frequency Ranges	10	20	30	40	50	60	70	80	90	100	110
1 kHz ≤ f < 100 MHz	0.0037	0.0071	0.052	0.064	0.049	0.089	0.083	0.12	0.14	0.16	0.2
100 MHz ≤ f < 300 MHz	0.0042	0.0092	0.058	0.071	0.055	0.089	0.083	0.12	0.14	0.17	0.18
300 MHz ≤ f < 500 MHz	0.0073	0.014	0.065	0.079	0.062	0.096	0.088	0.13	0.14	0.18	0.19
500 MHz ≤ f < 1 GHz	0.0073	0.016	0.082	0.086	0.071	0.1	0.094	0.13	0.15	0.22	0.24
1 GHz ≤ f < 4 GHz	0.0096	0.02	0.097	0.1	0.086	0.11	0.1	0.15	0.16	0.22	0.24
4 GHz ≤ f < 8 GHz	0.011	0.023	0.1	0.11	0.089	0.15	0.14	0.19	0.21	0.36	0.37
8 GHz ≤ f < 10 GHz	0.016	0.032	0.12	0.13	0.11	0.19	0.18	0.27	0.28	0.42	0.45
10 GHz ≤ f < 12 GHz	0.019	0.039	0.12	0.12	0.1	0.16	0.15	0.2	0.23	0.38	0.46
12 GHz ≤ f < 14 GHz	0.022	0.045	0.14	0.14	0.12	0.2	0.19	0.27	0.29	0.43	0.51
14 GHz ≤ f < 18 GHz	0.032	0.063	0.14	0.14	0.12	0.21	0.2	0.27	0.29	0.36	0.5
18 GHz	0.039	0.075	0.16	0.17	0.14	0.26	0.24	0.34	0.36	0.56	0.58



PARAMETER	Attenuation - Measure											
REFERENCE STANDARD OR EQUIPMENT	N5230A/C + cal kit											
Attenuation Levels (dB)												
Frequency Ranges	0	1	2	3	4	5	6	7	8	9	10	11
10 MHz ≤ f < 300 MHz	0.028	0.03	0.031	0.03	0.032	0.033	0.032	0.034	0.035	0.035	0.035	0.037
300 MHz ≤ f < 2 GHz	0.028	0.03	0.032	0.032	0.033	0.034	0.034	0.036	0.037	0.037	0.037	0.039
2 GHz ≤ f < 8 GHz	0.047	0.048	0.049	0.049	0.051	0.052	0.052	0.054	0.055	0.055	0.054	0.057
8 GHz ≤ f < 12 GHz	0.052	0.053	0.055	0.054	0.056	0.057	0.056	0.059	0.06	0.06	0.059	0.062
12 GHz ≤ f < 18 GHz	0.059	0.061	0.062	0.061	0.064	0.065	0.064	0.067	0.067	0.068	0.067	0.07
18 GHz ≤ f < 20 GHz				0.061			0.064				0.067	
20 GHz ≤ f < 30 GHz				0.11			0.11				0.12	
30 GHz ≤ f < 40 GHz				0.12			0.13				0.13	
40 GHz ≤ f < 50 GHz				0.18			0.19				0.2	

PARAMETER	Attenuation - Measure										
REFERENCE STANDARD OR EQUIPMENT	N5230A/C + cal kit										
Attenuation Levels (dB)											
Frequency Ranges	20	30	40	50	60	70	80	90	100	110	
10 MHz ≤ f < 50 MHz	0.042	0.053	0.089	0.17	0.12	0.14	0.17	0.18	0.18	0.19	
50 MHz ≤ f < 500 MHz	0.042	0.053	0.063	0.095	0.097	0.11	0.12	0.14	0.14	0.16	
500 MHz ≤ f < 2 GHz	0.044	0.051	0.06	0.085	0.1	0.11	0.1	0.11	0.12	0.14	
2 GHz ≤ f < 8 GHz	0.061	0.051	0.078	0.11	0.14	0.19	0.15	0.2	0.2	0.25	
8 GHz ≤ f < 12 GHz	0.066	0.068	0.089	0.15	0.19	0.25	0.21	0.26	0.29	0.33	
12 GHz ≤ f < 18 GHz	0.074	0.074	0.096	0.16	0.34	0.39	0.35	0.4	0.41	0.47	
18 GHz ≤ f < 20 GHz	0.074	0.082	0.096								
20 GHz ≤ f < 26.5 GHz	0.12	0.12	0.12								
26.5 GHz ≤ f < 30 GHz	0.13	0.13	0.15								
30 GHz ≤ f < 40 GHz	0.14	0.15	0.17								
40 GHz ≤ f < 50 GHz	0.2	0.21	0.24								



PARAMETER	RF Absolute Power Measure										
REFERENCE STANDARD OR EQUIPMENT	8482A, 8485A, 8487A, V8486A, N8481B, N8482B, N9030A, E444xA, E9300A, E9304A, N8485A										
	Frequency Ranges (uncertainties in dB)										
Frequency Range	9 kHz ≤ f < 100 kHz	100 kHz ≤ f < 10 MHz	10 MHz ≤ f < 30 MHz	30 MHz ≤ f < 500 MHz	500 MHz ≤ f < 1.2 GHz	1.2 GHz ≤ f < 2 GHz	2 GHz ≤ f < 6 GHz	6 GHz ≤ f < 8 GHz	8 GHz ≤ f < 12.4 GHz	12.4 GHz ≤ f < 14 GHz	14 GHz ≤ f < 18 GHz
-140 dBm ≤ P < -130 dBm	0.15	0.15	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
-130 dBm ≤ P < -110 dBm	0.13	0.13	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
-110 dBm ≤ P < -90 dBm	0.12	0.12	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.07
-90 dBm ≤ P < -30 dBm	0.12	0.12	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06
-30 dBm ≤ P < -20 dBm	0.11	0.11	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05
-20 dBm ≤ P < -10 dBm	0.11	0.09	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05
-10 dBm ≤ P < 0 dBm	0.11	0.08	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
-1 dBm ≤ P < 2 dBm	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05
2 dBm ≤ P < 10 dBm	0.1	0.08	0.06	0.06	0.06	0.09	0.09	0.09	0.09	0.09	0.1
10 dBm ≤ P < 15 dBm	0.1	0.1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
15 dBm ≤ P < 20 dBm	0.1	0.1	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
20 dBm ≤ P < 30 dBm	0.16	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.11	0.12	0.12
30 dBm ≤ P < 35 dBm		0.08	0.08	0.08	0.08	0.1	0.1	0.1	0.11	0.12	0.12
35 dBm ≤ P < 44 dBm		0.09	0.08	0.08	0.08	0.09	0.09	0.1	0.1	0.1	0.11





PARAMETER	RF Absolute Power Measure										
REFERENCE STANDARD OR EQUIPMENT	8482A, 8485A, 8487A, V8486A, N8481B, N8482B, N9030A, E444xA, E9300A, E9304A, N8485A										
	Frequencies / Frequency Ranges (uncertainties in dB)										
Frequency Range	18 GHz ≤ f ≤ 26.5 GHz	26.5 GHz ≤ f ≤ 33 GHz	33 GHz ≤ f < 40 GHz	40 GHz ≤ f < 45 GHz	45 GHz ≤ f ≤ 50 GHz	f = 51 GHz	52 GHz ≤ f ≤ 54 GHz	f = 55 GHz	56 GHz ≤ f ≤ 59 GHz	f = 60 GHz	f = 61 GHz
-140 dBm ≤ P < -130 dBm	0.1	0.1	0.1	0.12	0.12						
-130 dBm ≤ P < -110 dBm	0.1	0.09	0.09	0.09	0.09						
-110 dBm ≤ P < -90 dBm	0.08	0.08	0.08	0.08	0.08						
-90 dBm ≤ P < -30 dBm	0.07	0.06	0.06	0.06	0.06						
-30 dBm ≤ P < -20 dBm	0.07	0.05	0.05	0.06	0.06	0.34	0.33	0.29	0.34	0.3	0.34
-20 dBm ≤ P < -10 dBm	0.07	0.05	0.05	0.06	0.06	0.34	0.33	0.29	0.34	0.3	0.34
-10 dBm ≤ P < 0 dBm	0.07	0.06	0.06	0.06	0.06	0.34	0.33	0.29	0.34	0.3	0.34
-1 dBm ≤ P < 2 dBm	0.07	0.05	0.05	0.06	0.06	0.34	0.33	0.29	0.34	0.3	0.34
2 dBm ≤ P < 10 dBm	0.13	0.15	0.15	0.21	0.23	0.34	0.33	0.29	0.34	0.3	0.34
10 dBm ≤ P < 15 dBm	0.07	0.06	0.06	0.06	0.06	0.34	0.34	0.3	0.34	0.3	0.35
15 dBm ≤ P < 20 dBm	0.08	0.07	0.07	0.07	0.07	0.34	0.34	0.3	0.34	0.3	0.35
20 dBm ≤ P < 30 dBm	0.172										

PARAMETER	RF Absolute Power Measure				
REFERENCE STANDARD OR EQUIPMENT	8482A, 8485A, 8487A, V8486A, N8481B, N8482B, N9030A, E444xA, E9300A, E9304A, N8485A				
	Frequencies / Frequency Ranges (uncertainties in dB)				
Frequency Range	f = 62 GHz	63 GHz ≤ f ≤ 64 GHz	f = 65 GHz	f = 66 GHz	f = 67 GHz
-30 dBm ≤ P < -20 dBm	0.34	0.33	0.29	0.35	0.36
-20 dBm ≤ P < -10 dBm	0.34	0.33	0.29	0.35	0.36
-10 dBm ≤ P < 0 dBm	0.34	0.33	0.29	0.35	0.36
-1 dBm ≤ P < 2 dBm	0.34	0.33	0.29	0.35	0.36
2 dBm ≤ P < 10 dBm	0.34	0.33	0.29	0.35	0.36
10 dBm ≤ P < 15 dBm	0.34	0.34	0.2	0.36	0.36
15 dBm ≤ P < 20 dBm	0.34	0.34	0.2	0.36	0.36





PARAMETER	(S11 - Reflection) Magnitude Uncertainty (lin)									
REFERENCE STANDARD OR EQUIPMENT	85054B, 85031B, ET33700, 85056A, 85058B									
Freq	Measured Magnitude (+/- Linear)									
	≤ 0.1	> 0.1 to ≤ 0.2	> 0.2 to ≤ 0.3	> 0.3 to ≤ 0.4	> 0.4 to ≤ 0.5	> 0.5 to ≤ 0.6	> 0.6 to ≤ 0.7	> 0.7 to ≤ 0.8	> 0.8 to ≤ 0.9	> 0.9 to ≤ 1
(0.02 to 2) GHz	0.00054	0.00062	0.0007	0.00081	0.00093	0.0011	0.0012	0.0014	0.0016	0.0017
(2 to 8) GHz	0.00078	0.00082	0.00089	0.00098	0.0011	0.0012	0.0014	0.0015	0.0017	0.0019
(8 to 20) GHz	0.0014	0.0014	0.0015	0.0015	0.0016	0.0017	0.0018	0.002	0.0023	0.0026
(20 to 26.5) GHz	0.0019	0.0019	0.0019	0.002	0.002	0.0021	0.0023	0.0025	0.0027	0.0031
(26.5 to 40) GHz	0.0039	0.0041	0.0044	0.0049	0.0056	0.0066	0.0077	0.0091	0.011	0.012
(40 to 50) GHz	0.0052	0.0054	0.0058	0.0063	0.007	0.0081	0.0095	0.011	0.013	0.015
(50 to 67) GHz	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.018	0.018	0.019

PARAMETER	(S11 - Reflection) Phase Uncertainty (deg)									
REFERENCE STANDARD OR EQUIPMENT	85054B, 85031B, ET33700, 85056A, 85058B									
Freq:	Measured Magnitude (+/- Degrees)									
	≤ 0.1	> 0.1 to ≤ 0.2	> 0.2 to ≤ 0.3	> 0.3 to ≤ 0.4	> 0.4 to ≤ 0.5	> 0.5 to ≤ 0.6	> 0.6 to ≤ 0.7	> 0.7 to ≤ 0.8	> 0.8 to ≤ 0.9	> 0.9 to ≤ 1
(0.02 to 2) GHz	0.31	0.17	0.13	0.11	0.1	0.1	0.098	0.098	0.1	0.1
(2 to 8) GHz	0.45	0.24	0.17	0.14	0.12	0.12	0.11	0.11	0.11	0.11
(8 to 20) GHz	0.81	0.42	0.29	0.23	0.19	0.16	0.15	0.14	0.13	0.13
(20 to 26.5) GHz	1.1	0.55	0.38	0.29	0.24	0.2	0.18	0.17	0.17	0.17
(26.5 to 40) GHz	2.3	1.3	1	0.93	0.9	0.91	0.93	0.94	0.96	0.99
(40 to 50) GHz	3.1	1.7	1.3	1.2	1.1	1.1	1.1	1.2	1.2	1.2
(50 to 67) GHz	7.7	3.8	2.6	1.9	1.6	1.3	1.2	1	0.95	0.88



PARAMETER	(S21 - Transmission) Magnitude Uncertainty (dB)								
REFERENCE STANDARD OR EQUIPMENT	85054B, 85031B, ET33700, 85056A, 85058B								
Freq:	Measured Magnitude (+/- Linear)								
	10 to ≤ 0	> 0 to ≤ 3	> 3 to ≤ 6	> 6 to ≤ 10	> 10 to ≤ 20	> 20 to ≤ 30	> 30 to ≤ 40	> 40 to ≤ 50	> 50 to ≤ 60
(20 to 130) MHz	0.016	0.015	0.015	0.017	0.02	0.03	0.052	0.074	0.13
(0.13 to 1.25) GHz	0.031	0.034	0.034	0.034	0.034	0.034	0.035	0.044	0.093
(1.25 to 4) GHz	0.031	0.034	0.034	0.034	0.034	0.034	0.034	0.035	0.044
(4 to 5) GHz	0.032	0.035	0.035	0.035	0.035	0.035	0.035	0.036	0.045
(5 to 26.5) GHz	0.034	0.036	0.036	0.036	0.036	0.036	0.037	0.037	0.038
(26.5 to 40) GHz	0.037	0.039	0.039	0.039	0.039	0.039	0.04	0.04	0.048
(40 to 50) GHz	0.04	0.043	0.043	0.043	0.043	0.043	0.043	0.044	0.051
(50 to 67) GHz	0.094	0.094	0.095	0.096	0.099	0.11	0.14	0.28	0.78

PARAMETER	(S21 - Transmission) Phase Uncertainty (deg)								
REFERENCE STANDARD OR EQUIPMENT	85054B, 85031B, ET33700, 85056A, 85058B								
Freq:	Measured Magnitude (+/- Degrees)								
	10 to ≤ 0	> 0 to ≤ 3	> 3 to ≤ 6	> 6 to ≤ 10	> 10 to ≤ 20	> 20 to ≤ 30	> 30 to ≤ 40	> 40 to ≤ 50	> 50 to ≤ 60
(20 to 130) MHz	0.16	0.16	0.16	0.17	0.19	0.26	0.66	0.6	0.92
(0.13 to 1.25) GHz	0.37	0.37	0.37	0.37	0.38	0.38	0.38	0.41	0.68
(1.25 to 4) GHz	0.42	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.46
(4.0 to 5) GHz	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.53
(5 to 26.5) GHz	0.89	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
(26.5 to 40) GHz	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
(40 to 50) GHz	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
(50 to 67) GHz	0.63	0.63	0.64	0.66	0.67	0.76	0.97	1.9	5.5



Length – Dimensional metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,3}	(0 to 12) in (>12 to 60) in	(310 + 3L) μin (310 + 8L) μin	Gage Blocks
Outside Diameter Micrometer ^{1,3}	(0 to 12) in (>12 to 48) in	(30 + 10L) μin (100 + 10L) μin	Gage Blocks
Inside Diameter Micrometer ^{1,3}	(0 to 12) in	(30 + 10L) μin	Gage Blocks
Depth Micrometer ^{1,3}	(0 to 12) in	(30 + 10L) μin	Gage Blocks
Digital Indicators	(0 to 1) in. (>1 to 2) in. (>2 to 6) in.	48 μin. 51 μin. 107 μin.	Gage Blocks + Accessories, Surface Plate
Dial Indicators	(0 to 1) in. (>1 to 6) in.	65 μin. 624 μin	
Height Gages ^{1,3}	(0 to 48) in.	(315 + 7L) μin	Gage Blocks, Surface Plate

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Wrenches/Screwdrivers ¹	(10 to 100) ozf-in (6.2 to 10) lbf-ft	0.7 % of reading 0.7 lbf-in	AWS 3001 HIOS HP-100
Scales and Balances ¹	(5 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 300) g (> 300 to 500) g > 500 g to 1 kg (> 1 to 2) kg (> 2 to 5) kg (> 5 to 10) kg	0.099 mg 0.025 mg 0.039 mg 0.065 mg 0.15 mg 0.277 mg 0.548 mg 0.83 mg 3.4 mg 6.6 mg 16 mg 35 mg 67 mg	Class 1, F1 Weights



Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Time Interval - Measure ¹	10 ns to 10 s	2.9 ns	HP 5334B Counter connected to Time base (HP 5071A or Datum 8040)
Frequency - Source ¹	10 MHz	65 pHz/Hz	Symmetricon 8040 Frequency Standard
Frequency - Measure ¹	(10 to 100) Hz (100 to 1 000) Hz 1 kHz to 12.4 GHz	71 pHz/Hz + 0.15 nHz 68 pHz/Hz + 0.5 nHz 67 pHz/Hz	Agilent 53132A Counter Symmetricon 8040C Frequency Standard
	(12.4 to 26.5) GHz	30 pHz/Hz + 3.72 Hz	Agilent 53151A Counter, Symmetricon 8040C Frequency Standard

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. Unitless linear measure.
3. L = length in inches.
4. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1489.09.


 Vice President

