



CERTIFICATE OF ACCREDITATION

ANSI National Accreditation Board
11617 Coldwater Road, Fort Wayne, IN 46845 USA

This is to certify that

Keysight Technologies Inc. Service Center
1220 E. Campbell Road
Richardson, TX 75081

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

ISO/IEC 17025:2017

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 activities to which this accreditation applies

AC-1498.04

Certificate Number



ANAB Approval

Certificate Valid Through: 11/16/2020
Version No. 003 Issued: 08/14/2019



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).



ANSI National Accreditation Board

**SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017,
ANSI/NCSL Z540-1-1994 (R2002) AND ANSI/NCSL Z540.3-2006 (R2013)**

Keysight Technologies, Inc. Service Center

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CALIBRATION

Valid to: November 16, 2020

Certificate Number: AC-1498.04

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 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 μ V/V + 0.54 μ V 5 μ V/V + 0.8 μ V 3.5 μ V/V + 0.4 μ V 3.6 μ V/V + 4.5 μ V 5.3 μ V/V + 23 μ V 7.1 μ V/V + 0.3 mV	Fluke 5720A or 5730A Multiproduct Calibrator with Fluke 5725A Amplifier
DC Voltage – Source ¹ Fixed Values	100 mV 1 V 10 V 100 V 1 000 V	320 nV 2.6 μ V 25 μ V 260 μ V 5.9 mV	Fluke 57x0A Multiproduct Calibrator disciplined with HP 3458A/100 NPLC Option 002 Multimeter
DC Voltage – 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	4.1 μ V/V + 0.36 μ V 3.7 μ V/V + 0.35 μ V 3.1 μ V/V + 0.59 μ V 5.3 μ V + 36 μ V 5.3 μ V/V + 0.12 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 μ V/V + 62 nV 0.37 μ V/V + 124 nV 62 nV/V + 0.62 μ V 0.62 μ V/V + 12 μ V 1.9 μ V/V + 63 μ V	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 Multiproduct Calibrator
DC Current - Source ¹	(2.2 to 11) A	280 μ A/A + 41 μ A	Fluke 5720A Multiproduct Calibrator with Fluke 5725A Amplifier
DC Current - Source ¹	100 μ A 1 mA 10 mA 100 mA 1 A	1.3 nA 9.6 nA 94 nA 2.2 μ A 36 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	0.57 % of reading + 21 mA 0.57 % of reading + 145 mA 0.57 % of reading + 510 mA	Fluke 5520A Multiproduct Calibrator, Fluke Current 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
	(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
DC Current - Measure ¹	(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 Fixed Points	0 Ω	0.25 mΩ	Fluke 5720A Multiproduct Calibrator
	1 Ω	0.27 mΩ	
	1.9 Ω	0.31 mΩ	
	10 Ω	0.34 mΩ	
	19 Ω	2.5 mΩ	
	100 Ω	2.7 mΩ	
	190 Ω	3.3 mΩ	
	1 kΩ	9.3 mΩ	
	1.9 kΩ	31 mΩ	
	10 kΩ	93 mΩ	
	19 kΩ	0.19 Ω	
	100 kΩ	1.2 Ω	
	190 kΩ	2.2 Ω	
	1 MΩ	20 Ω	
	1.9 MΩ	42 Ω	
	10 MΩ	0.4 kΩ	
19 MΩ	1.5 kΩ		
100 MΩ	12 kΩ		
Resistance – Source ¹ Fixed Points	0 Ω	21 μΩ	Fluke 57x0A Multiproduct Calibrator disciplined with HP 3458A Multimeter
	10 Ω	86 μΩ	
	100 Ω	830 μΩ	
	1 kΩ	7.4 mΩ	
	10 kΩ	74 mΩ	
	100 kΩ	740 mΩ	
	1 MΩ	7.7 Ω	
	10 MΩ	140 Ω	
100 MΩ	18 kΩ		
Resistance – Source ¹	(0 to 11) Ω	33 μΩ/Ω + 8.3 mΩ	Fluke 5520A Multiproduct Calibrator
	(11 to 110) Ω	25 μΩ/Ω + 12.5 mΩ	
	110 Ω to 1.1 kΩ	23 μΩ/Ω + 17 mΩ	
	(1.1 to 3.3) kΩ	23 μΩ/Ω + 170 mΩ	
	(3.3 to 11) kΩ	23 μΩ/Ω + 84 mΩ	
	(11 to 110) kΩ	23 μΩ/Ω + 0.84 Ω	
	110 kΩ to 1.1 MΩ	27 μΩ/Ω + 8 Ω	
	(1.1 to 3.3) MΩ	50 μΩ/Ω + 125 Ω	
	(3.3 to 11) MΩ	0.11 mΩ/Ω + 0.2 kΩ	
	(11 to 33) MΩ	0.21 mΩ/Ω + 2 kΩ	
	(33 to 110) MΩ	0.41 mΩ/Ω + 2.8 kΩ	
(110 to 330) MΩ	2.5 mΩ/Ω + 83 kΩ		
(330 to 1 100) MΩ	13 mΩ/Ω + 0.4 MΩ		

Electrical - DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure ¹	(0 to 12) Ω (10 to 120) Ω 100 Ω to 1.2 k Ω (1 to 12) k Ω (10 to 120) k Ω 100 k Ω to 1.2 M Ω (1 to 12) M Ω (10 to 120) M Ω 100 M Ω to 1.2 G Ω	18 $\mu\Omega/\Omega$ + 20 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 0.6 m Ω 9.6 $\mu\Omega/\Omega$ + 0.6 m Ω 9.6 $\mu\Omega/\Omega$ + 6 m Ω 9.6 $\mu\Omega/\Omega$ + 60 m Ω 15 $\mu\Omega/\Omega$ + 2.4 Ω 60 $\mu\Omega/\Omega$ + 120 Ω 0.6 m Ω/Ω + 1.2 k Ω 6 m Ω/Ω	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 $\mu\text{V}/\text{V}$ + 4.1 μV 94 $\mu\text{V}/\text{V}$ + 4.1 μV 83 $\mu\text{V}/\text{V}$ + 4.1 μV 210 $\mu\text{V}/\text{V}$ + 4.1 μV 520 $\mu\text{V}/\text{V}$ + 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 $\mu\text{V}/\text{V}$ + 4.1 μV 94 $\mu\text{V}/\text{V}$ + 4.1 μV 83 $\mu\text{V}/\text{V}$ + 4.1 μV 210 $\mu\text{V}/\text{V}$ + 4.1 μV 520 $\mu\text{V}/\text{V}$ + 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 $\mu\text{V}/\text{V}$ + 39 μV 94 $\mu\text{V}/\text{V}$ + 16 μV 83 $\mu\text{V}/\text{V}$ + 8.7 μV 200 $\mu\text{V}/\text{V}$ + 10 μV 470 $\mu\text{V}/\text{V}$ + 210 μV 930 $\mu\text{V}/\text{V}$ + 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 (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 mV/V + 39 μV 94 μV/V + 16 μV 46 μV/V + 9 μV 78 μV/V + 10 μV 100 μV/V + 70 μV 290 μV/V + 80 μV 1.1 mV/V + 200 μV 1.8 mV/V + 300 μV	Fluke 5720A Multiproduct Calibrator
	(2.2 to 22) 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	251 μV/V + 390 μV 93 μV/V + 156 μV 47 μV/V + 48 μV 78 μV/V + 107 μV 113 μV/V + 42 μV 432 μV/V + 97 μV 1 mV/V + 2.1 mV 1.6 mV/V + 3.3 mV	
AC Voltage – Source ¹	(22 to 220) 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	250 μV/V + 4.17 mV 94 μV/V + 1.6 mV 549 μV/V + 0.68 mV 83 μV/V + 1.1 mV 156 μV/V + 2.6 mV 941 μV/V + 16 mV 4.6 mV/V + 41.7 mV 8.3 mV/V + 834 mV	Fluke 5720A Multiproduct Calibrator with Fluke 5725A Amplifier
	(220 to 1 100) V 40 Hz to 20 kHz (20 to 50) kHz	313 μV/V + 17 mV 73 μV/V + 3.7 mV	
AC Voltage – Source ¹	(220 to 1 100) V 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz (220 to 750) V (30 to 50) kHz (50 to 100) kHz	80 μV/V + 18 mV 173 μV/V + 5.3 mV 625 μV/V + 12 mV 634 μV/V + 5.5 mV 2.4 mV/V + 28 mV	

Electrical - DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	Up to 2.2 mV		Fluke 5730A Multiproduct Calibrator
	(10 to 20) Hz	250 $\mu\text{V/V} + 4.1 \mu\text{V}$	
	(20 to 40) Hz	94 $\mu\text{V/V} + 4.1 \mu\text{V}$	
	40 Hz to 20 kHz	83 $\mu\text{V/V} + 4.1 \mu\text{V}$	
	(20 to 50) kHz	210 $\mu\text{V/V} + 4.1 \mu\text{V}$	
	(50 to 100) kHz	520 $\mu\text{V/V} + 4.1 \mu\text{V}$	
	(100 to 300) kHz	1.1 mV/V + 4.1 μV	
	(300 to 500) kHz	1.5 mV/V + 4.1 μV	
	500 kHz to 1 MHz	2.8 mV/V + 4.1 μV	
	(2.2 to 22) mV		
	(10 to 20) Hz	250 $\mu\text{V/V} + 4.1 \mu\text{V}$	
	(20 to 40) Hz	94 $\mu\text{V/V} + 4.1 \mu\text{V}$	
	40 Hz to 20 kHz	83 $\mu\text{V/V} + 4.1 \mu\text{V}$	
	(20 to 50) kHz	210 $\mu\text{V/V} + 4.1 \mu\text{V}$	
	(50 to 100) kHz	520 $\mu\text{V/V} + 4.1 \mu\text{V}$	
	(100 to 300) kHz	1.1 mV/V + 4.1 μV	
	(300 to 500) kHz	1.4 mV/V + 4.1 μV	
	500 kHz to 1 MHz	2.8 mV/V + 4.1 μV	
	(22 to 220) mV		
	(10 to 20) Hz	250 $\mu\text{V/V} + 39 \mu\text{V}$	
	(20 to 40) Hz	94 $\mu\text{V/V} + 16 \mu\text{V}$	
	40 Hz to 20 kHz	60 $\mu\text{V/V} + 7 \mu\text{V}$	
	(20 to 50) kHz	120 $\mu\text{V/V} + 8 \mu\text{V}$	
	(50 to 100) kHz	320 $\mu\text{V/V} + 18 \mu\text{V}$	
	(100 to 300) kHz	680 $\mu\text{V/V} + 20 \mu\text{V}$	
	(300 to 500) kHz	1.5 mV/V + 20 μV	
	500 kHz to 1 MHz	2.8 mV/V + 50 μV	
	220 mV to 2.2 V		
(10 to 20) Hz	250 mV/V + 39 μV		
(20 to 40) Hz	94 $\mu\text{V/V} + 16 \mu\text{V}$		
40 Hz to 20 kHz	43 $\mu\text{V/V} + 8.8 \mu\text{V}$		
(20 to 50) kHz	70 $\mu\text{V/V} + 10 \mu\text{V}$		
(50 to 100) kHz	89 $\mu\text{V/V} + 30 \mu\text{V}$		
(100 to 300) kHz	350 $\mu\text{V/V} + 83 \mu\text{V}$		
(300 to 500) kHz	1.1 mV/V + 190 μV		
500 kHz to 1 MHz	1.8 mV/V + 300 μV		

Electrical - DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	2.2V to 22V (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	251 $\mu\text{V}/\text{V}$ + 392 μV 93.8 $\mu\text{V}/\text{V}$ + 15.6 μV 43.9 $\mu\text{V}/\text{V}$ + 48.3 μV 69.7 $\mu\text{V}/\text{V}$ + 107 μV 86.3 $\mu\text{V}/\text{V}$ + 213 μV 265 $\mu\text{V}/\text{V}$ + 623 μV 10.4 mV/V + 2.08 mV 1.56 mV/V + 3.33 mV	Fluke 5730A Multiproduct Calibrator
	22 V to 220 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	250 $\mu\text{V}/\text{V}$ + 4.17 μV 93.8 $\mu\text{V}/\text{V}$ + 15.6 mV 53.9 $\mu\text{V}/\text{V}$ + 0.68 mV 83.3 $\mu\text{V}/\text{V}$ + 1.05 mV 156 $\mu\text{V}/\text{V}$ + 2.62 mV 941 $\mu\text{V}/\text{V}$ + 16 mV 4.58 mV/V + 41.7 mV 8.33 mV/V + 83.4 mV	
AC Voltage – Source ¹	220 V to 1.1 kV 15 Hz to 50 Hz 50 Hz to 1 kHz	313 $\mu\text{V}/\text{V}$ + 16.6 μV 72.9 $\mu\text{V}/\text{V}$ + 3.65 mV	Fluke 5730A Multiproduct Calibrator with Fluke 5725A Amplifier
AC Voltage – Source ¹	220 V to 1.1 kV 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz 220 V to 750 V (30 to 50) kHz (50 to 100) kHz	79.6 $\mu\text{V}/\text{V}$ + 18.3 mV 173 $\mu\text{V}/\text{V}$ + 5.3 mV 625 $\mu\text{V}/\text{V}$ + 11.5 mV 634 $\mu\text{V}/\text{V}$ + 5.45 mV 2.4 mV/V + 28 mV	Fluke 5730A Multiproduct Calibrator with Fluke 5725A Amplifier
AC Voltage – Source Fixed Values, Fixed Frequencies ¹	0.01 V 1 kHz 20 kHz 100 kHz 300 kHz 1 MHz 4 MHz	890 nV 1.2 μV 8.5 μV 66 μV 21 μV 140 μV	Fluke 5700A or Fluke 5720A Multiproduct Calibrator disciplined with Keysight 3458A Multimeter

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	0.1 V		Fluke 5700A or Fluke 5720A Multiproduct Calibrator disciplined with Keysight 3458A Multimeter
	1 kHz	4.6 μV	
	20 kHz	6.9 μV	
	100 kHz	36 μV	
	300 kHz	68 μV	
	1 MHz	170 μV	
	4 MHz	670 μV	
	8 MHz	690 μV	
	10 MHz	2.3 mV	
	1 V		
	1 kHz	40 μV	
	20 kHz	43 μV	
	50 kHz	130 μV	
	100 kHz	200 μV	
	300 kHz	600 μV	
	500 kHz	1.7 mV	
	1 MHz	1.7 mV	
	4 MHz	6.7 mV	
	8 MHz	6.9 mV	
	10 MHz	25 mV	
	3V		
	100 kHz	560 μV	
	(2, 4, 8) MHz	21 mV	
	10 MHz	75 mV	
	10 V		
	10 Hz	550 μV	
	20 Hz	380 μV	
	40 Hz	310 μV	
	200 Hz	504 μV	
	500 Hz	495 μV	
	1 kHz	400 μV	
	10 kHz	620 μV	
	20 kHz	640 μV	
50 kHz	1.2 mV		
100 kHz	1.3 mV		
300 kHz	5.1 mV		
500 kHz	16 mV		
1 MHz	19 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	100 V 1 kHz 20 kHz 50 kHz 100 kHz 700 V 1 kHz	4.1 mV 7.9 mV 7.5 mV 23 mV 60 mV	Fluke 5700A or Fluke 5720A Multiproduct Calibrator disciplined with Keysight 3458A Multimeter
AC Voltage Flatness - Source ¹	300 μV to 3.5 V (10 to 30) Hz 30 Hz to 120 kHz 300 μV to 1.1 mV 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz 1.1 μV to 3 mV 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	2.7 mV/V 1.4 mV/V 4.6 mV/V 6.2 mV/V 8 mV/V 24 mV/V 2.2 mV/V 3.7 mV/V 5.5 mV/V 14 mV/V	Fluke 5720A, Fluke 5700A, or Fluke 5700A-03 Multiproduct Calibrator (referenced to 1 kHz)
AC Voltage Flatness - Source ¹	3 mV to 3.5 V 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	1.2 mV/V 2.1 mV/V 3.8 mV/V 8.6 mV/V	Fluke 5720A, Fluke 5700A, or Fluke 5700A-03 Multiproduct Calibrator (referenced to 1 kHz)
AC Voltage Flatness – Measure ¹	(-60 to 25) dBm 9 kHz to 2 GHz	0.026 dB	Agilent N1914A Power Meter, Agilent E9304A Power Sensor, 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 $\mu\text{V}/\text{V}$ + 4.1 μV	
	40 Hz to 1 kHz	70 $\mu\text{V}/\text{V}$ + 2.1 μV	
	(1 to 20) kHz	0.14 mV/V + 2.3 μV	
	(20 to 50) kHz	0.3 V/V + 2.6 μV	
	(50 to 100) kHz	0.8 mV/V + 2.3 μV	
	(100 to 300) kHz	3 mV/V + 15 μV	
	300 kHz to 1 MHz	10 mV/V + 28 μV	
	(1 to 2) MHz	15 mV/V + 20 μV	
	(2 to 4) MHz	40 mV/V + 74 μV	
	(4 to 8) MHz	40 mV/V + 83 μV	
	(8 to 10) MHz	0.15 V/V + 0.11 mV	
	100 mV to 1 V		
	(1 to 40) Hz	70 $\mu\text{V}/\text{V}$ + 41 μV	
	40 Hz to 1 kHz	70 $\mu\text{V}/\text{V}$ + 21 μV	
	(1 to 20) kHz	0.14 mV/V + 22 μV	
	(20 to 50) kHz	0.3 mV/V + 22 μV	
	(50 to 100) kHz	0.8 mV/V + 22 μV	
	(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 μV	
	(1 to 10) V		
	(1 to 40) Hz	70 $\mu\text{V}/\text{V}$ + 0.42 mV	
	40 Hz to 1 kHz	70 $\mu\text{V}/\text{V}$ + 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 20Hz to 20 MHz	3 % of reading	Keysight DSO8104A Oscilloscope
AC Current Source ¹	(0 to 220) μ A 10 to 20 Hz 20 to 40 Hz 40 Hz to 1 kHz 1 to 5 kHz 5 to 10 kHz 220 μ A 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 μ A/A + 17 nA 150 μ A/A + 10 nA 108 μ A/A + 8.4 nA 266 μ A/A + 12.5 nA 915 μ A/A + 66 nA 233 μ A/A + 42 nA 150 μ A/A + 34 nA 108 μ A/A + 34 nA 183 μ A/A + 109 nA 915 μ A/A + 655 nA 233 μ A/A + 422 nA 149 μ A/A + 342 nA 108 μ A/A + 343 nA 183 μ A/A + 588 nA 915 μ A/A + 5 μ A 233 μ A/A + 4.2 μ A 149 μ A/A + 3.4 μ A 108 μ A/A + 2.6 μ A 183 μ A/A + 3.4 μ A 915 μ A/A + 10 μ A	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	(0 to 0.33) mA 10 to 30 kHz (0.33 to 3.3) mA 10 to 30 kHz (3.3 to 33) mA 10 to 30 kHz (33 to 330) mA 10 to 30 kHz (2.2 to 20.5) A 45 to 100 Hz 100 Hz to 1 kHz 1 to 5 kHz	10 mA/A + 330 nA 6.6 mA/A + 550 nA 2.7 mA/A + 2.7 μ A 2.7 mA/A + 160 μ A 830 mA/A + 4.2 mA 1.1 mA/A + 3.9 mA 21 mA/A + 1 mA	Fluke 552xA 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 100 Hz 100 Hz to 440 Hz (100 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 0.33 % of reading + 50 mA 0.85 % of reading + 3.6 mA 0.85 % of reading + 29 mA 0.85 % of reading + 100 mA 0.85 % of reading + 3.6 mA 0.85 % of reading + 28 mA 1 % of reading + 0.25 A	Fluke 552xA Multiproduct Calibrator, Fluke Current Coil
AC Current - Source Fixed Values	1 kHz 10 μ A 100 μ A 1 mA 10 mA 100 mA 1 A	7.4 nA 17 nA 110 nA 1.1 μ A 11 μ A 210 μ A	Fluke 5700A or Fluke 5720A Multiproduct Calibrator disciplined with Keysight 3458A Multimeter

Electrical - DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(5 to 100) uA		Keysight 3458A Multimeter
	(10 to 20) Hz	0.46% + 0.039 uA	
	(20 to 45) Hz	0.17% + 0.040 uA	
	(45 to 100) Hz	0.065% + 0.040 uA	
	100 Hz to 5 kHz	0.67% + 0.040 uA	
	100uA to 1mA		
	(10 to 20) Hz	0.46% + 0.25 uA	
	(20 to 45) Hz	0.17% + 0.26 uA	
	(45 to 100) Hz	0.067 % + 0.26 uA	
	100 Hz to 5 kHz	0.033% + 0.27 uA	
	(5 to 20) kHz	0.067% + 0.26 uA	
	(20 to 50) kHz	0.46% + 0.48 uA	
	(50 to 100) kHz	0.63% + 1.7 uA	
	AC Current – Measure ¹	(1 to 10) mA	
(10 to 20) Hz		0.46 % + 2.5 uA	
(20 to 45) Hz		0.17% + 2.5 uA	
(45 to 100) Hz		0.067% + 2.7 uA	
100 Hz to 5 kHz		0.033% + 2.7 uA	
(5 to 20) kHz		0.067% + 2.6 uA	
(20 to 50) kHz		0.46% + 4.7 uA	
(50 to 100) kHz		0.63% + 17 uA	
(10 to 100) mA			
(10 to 20) Hz		0.46% + 25 uA	
(20 to 45) Hz		0.17% + 26 uA	
(45 to 100) Hz		0.067% + 26 uA	
100 Hz to 5 kHz		0,033% + 27 uA	
(5 to 20) kHz		0.067% + 26 uA	
(20 to 50) kHz		0.46 % + 47 uA	
(50 to 100) kHz		0.63% + 0.17 mA	
100 mA to 1 A			
(10 to 20) Hz		0.46% + 0.29 mA	
(20 to 45) Hz		0.18% + 0.32 mA	
(45 to 100) Hz		0.085% + 0.34 mA	
100 Hz to 5 kHz		0.11% + 0.34 mA	
(5 to 20) kHz		0.34% + 0.30 mA	
(20 to 50) kHz		1.1% + 0.49 mA	
(1 to 3) A			
(3 to 10) Hz		1.3% + 2.1 mA	
(10 to 40) Hz		0.39% + 2.2 mA	
40 Hz to 300 kHz		0.17% + 2.1 mA	

Electrical - DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹	1 mΩ	0.75 % of reading	Standard Resistor Sets 16074A 42030A 16340A 16353A
	10 mΩ	1.1 % of reading	
	100 mΩ	7 % of reading	
	1 Ω	63 μΩ/Ω	
	10 Ω	38 μΩ/Ω	
	100 Ω	30 μΩ/Ω	
	1 kΩ	29 μΩ/Ω	
	10 kΩ	29 μΩ/Ω	
	100 kΩ	2.1 μΩ/Ω	
	1 MΩ	8 μΩ/Ω	
	10 MΩ	16 μΩ/Ω	
	100 MΩ	96 μΩ/Ω	
	1 GΩ	240 μΩ/Ω	
	10 GΩ	590 μΩ/Ω	
100 GΩ	560 μΩ/Ω		
Capacitance – Source ¹ Fixed Points	1 pF		Agilent 16380A, Agilent 16380C Standard Air Capacitor Set, BNC 4 Terminal Pair
	1 kHz to 1 MHz	0.19 fF	
	(1 to 2) MHz	0.31 fF	
	(2 to 3) MHz	0.49 fF	
	(3 to 4) MHz	0.68 fF	
	(4 to 5) MHz	0.9 fF	
	(5 to 10) MHz	2.5 fF	
	(10 to 13) MHz	3.7 fF	
	10 pF		
	1 kHz to 1 MHz	2 fF	
	(1 to <10) MHz	1.5 fF	
	10 MHz	2 fF	
	(>10 to 13) MHz	2.2 fF	
	100 pF		
	1 kHz to 3 MHz	14 fF	
	(3 to 4) MHz	17 fF	
(4 to 5) MHz	20 fF		
(5 to 10) MHz	37 fF		
(10 to 13) MHz	53 fF		

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

Electrical - DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dissipation Factor – Source Fixed Points ¹	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 Thermocouples 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 1800) °C	0.53 °C	
	(1 800 to 2316) °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 1000) °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 Thermocouples 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	0.5 °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	0.66 °C	
	(-150 to 0) °C	0.26 °C	
(0 to 120) °C	0.18 °C		
(120 to 400) °C	0.16 °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 Rate: (0.05 to 10) kHz Rate: (0.05 to 50) kHz Rate: (0.05 to 10) kHz	(> 0 to 99) % Depth		Agilent 8902A Measuring Receiver
	(0.15 to 10) MHz	2.1 % Depth	
	(0.01 to 1.3) GHz	1.1 % Depth	
	(1.3 to 26.5) GHz	1.6 % Depth	
Amplitude Modulation – Measure ¹ Rate: (0.05 to 10) kHz Rate: (0.05 to 100) kHz	(> 0 to 99) % Depth		Agilent E444xA with Opt. 233 Spectrum Analyzer
	(0.1 to 10) MHz	0.8 % Depth	
	(0.01 to 3) GHz	0.5 % Depth	
	(3 to 26.5) GHz	1.5 % Depth	
	(26.5 to 31.15) GHz	1.9 % Depth	
	(31.5 to 50) GHz	6.1 % Depth	



Electrical - RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure ¹ Rate: (0.02 to 10) kHz Rate: (0.05 to 100) kHz	≤ 40 kHz _{Peak} (0.25 to 10) MHz	2.2 % Deviation	HP 8902A Measuring Receiver
	≤ 400 kHz _{Peak} (0.01 to 26.5) GHz	1.2 % Deviation	
Frequency Modulation – Measure ¹ Rate: (0.02 to 10) kHz Rate: (0.05 to 200) kHz	≤ 400 kHz _{Peak} (0.25 to 10) MHz (0.01 to 50) GHz	1.1 % Deviation 1.1 % Deviation	E444xA with Opt. 233 Spectrum Analyzer

DIGITAL MODULATION RF QUALITY¹

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 % of reading 0.48 % of reading 0.82 % of reading	HP 89441A Vector Signal Analyzer
Phase Error	Up to 180 ° rms Mod Frequency Span: f ≤ 100kHz 100kHz ≤ f ≤ 1MHz f > 1MHz	0.17 ° 0.34 ° 0.57 °	



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Electrical - RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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
Modulation Accuracy (Rho)	Mod Frequency Span: f ≤ 100kHz 0.9999 ≤ ρ ≤ 1 0.9975 ≤ ρ < 0.9999 0.9936 ≤ ρ < 0.9975 0.99 ≤ ρ < 0.9936 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978 Mod Frequency Span: 100 kHz ≤ f ≤ 1 MHz 0.9999 ≤ ρ ≤ 1 0.9975 ≤ ρ < 0.9999 0.9936 ≤ ρ < 0.9975 0.99 ≤ ρ < 0.9936 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978 Mod Frequency Span: f > 1MHz 0.9999 ≤ ρ ≤ 1 0.9975 ≤ ρ < 0.9999 0.9936 ≤ ρ < 0.9975 0.99 ≤ ρ < 0.9936 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978	8.6 E-5 ρ 0.000 43 ρ 0.000 68 ρ 0.000 84 ρ 0.001 2 ρ 0.001 6 ρ 9.6 E-5 ρ 0.000 48 ρ 0.000 76 ρ 0.000 94 ρ 0.001 4 ρ 0.001 8 ρ 1.6 E-4 ρ 0.000 82 ρ 0.001 3 ρ 0.001 6 ρ 0.002 4 ρ 0.003 ρ	HP 89441A Vector Signal Analyzer
Phase Modulation – Measure ¹	(0.15 to 10) MHz Rate: (0.02 to 10) kHz < 40 Radians Deviation (0.01 to 26.5) GHz Rate: (0.2 to 20) kHz < 40 Radians Deviation	4.1 % Deviation 3.1 % Deviation	HP 8902A Measuring Receiver



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Electrical - RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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 (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	3.1 % Deviation 1 % Deviation 3.1 % Deviation 1 % Deviation 3.1 % Deviation 1 % Deviation 3.1 % Deviation 1 % Deviation 3.1 % Deviation 1 % Deviation 3.1 % Deviation 1 % Deviation	Keysight E444xA with Opt. 233 Spectrum Analyzer
Distortion Measure ¹	(-99 to 0) dB 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	0.08 dB 0.07 dB 0.08 dB 0.09 dB 0.1 dB 0.12 dB 0.15 dB	HP 8902A Measuring Receiver with HP 11722A or with HP 11792A and HP 11793A Power Sensor



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Electrical - RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned RF Power - Relative – Measure ¹ 2.5 MHz to 26.5 GHz	(-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	0.16 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
RF Absolute Power - Source ¹ 50 MHz	(-11 to -1) dB (-30 to -10) dB (-50 to -40) dB -60 dB (-90 to -70) 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
RF Absolute Power – Source ¹	$0.02\text{ V} \leq V < 7\text{ V}$ $f < 10\text{ MHz}$ $10\text{ MHz} \leq f \leq 50\text{ MHz}$ $50\text{ MHz} \leq f \leq 80\text{ MHz}$ $V \leq 10\text{ mV}$ $20\text{ Hz} \leq f \leq 20\text{ kHz}$ $20\text{ kHz} < f \leq 50\text{ kHz}$ $50\text{ kHz} < f \leq 100\text{ kHz}$ $100\text{ kHz} < f \leq 300\text{ kHz}$ $10\text{ mV} < V \leq 100\text{ mV}$ $20\text{ Hz} \leq f \leq 40\text{ Hz}$ $40\text{ Hz} \leq f \leq 1\text{ kHz}$ $1\text{ kHz} < f \leq 20\text{ kHz}$ $20\text{ kHz} < f \leq 50\text{ kHz}$ $50\text{ kHz} < f \leq 100\text{ kHz}$ $100\text{ kHz} < f \leq 300\text{ kHz}$ $100\text{ mV} < V \leq 1\text{ V}$ $20\text{ Hz} \leq f \leq 1\text{ kHz}$ $1\text{ kHz} < f \leq 20\text{ kHz}$ $20\text{ kHz} < f \leq 50\text{ kHz}$ $50\text{ kHz} < f \leq 100\text{ kHz}$ $100\text{ kHz} < f \leq 300\text{ kHz}$	0.082 dB 0.16 dB 0.4 dB 0.017 mV 0.021 mV 0.05 mV 0.38 mV 0.029 mV 0.028 mV 0.032 mV 0.045 mV 0.08 mV 0.3 mV 0.7 mV 0.72 mV 0.79 mV 1.3 mV 3.7 mV	Function Generator and DVM Agilent 33250A, Agilent 33120A, Agilent 3458A Multimeter



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Electrical - RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Source	$1\text{ V} < V \leq 3.5\text{ V}$ $20\text{ Hz} \leq f \leq 40\text{ Hz}$ $40\text{ Hz} \leq f \leq 1\text{ kHz}$ $1\text{ kHz} < f \leq 20\text{ kHz}$ $20\text{ kHz} < f \leq 50\text{ kHz}$ $50\text{ kHz} < f \leq 100\text{ kHz}$ $100\text{ kHz} < f \leq 300\text{ kHz}$	2.2 mV 2.1 mV 2.2 mV 2.5 mV 4 mV 13 mV	Function Generator and DVM Agilent 33250A, Agilent 33120A, Agilent 3458A Multimeter
RF Absolute Power – Source ¹	$7\text{dBm} \geq P \geq 0\text{ dBm}$ $0.3\text{ MHz} \leq f \leq 1.1\text{ GHz}$ $1.1\text{ GHz} \leq f \leq 2.985\text{ GHz}$ $2.985\text{ GHz} < f \leq 4\text{ GHz}$ $4\text{ GHz} < f \leq 6\text{ GHz}$ $0\text{ dBm} > P \geq -25\text{ dBm}$ $0.3\text{ MHz} \leq f \leq 1.1\text{ GHz}$ $1.1\text{ GHz} \leq f \leq 2.985\text{ GHz}$ $2.985\text{ GHz} < f \leq 4\text{ GHz}$ $4\text{ GHz} < f \leq 6\text{ GHz}$ $-25\text{ dBm} > P \geq -70\text{ dBm}$ $0.3\text{ MHz} \leq f \leq 1.1\text{ GHz}$ $1.1\text{ GHz} \leq f \leq 2.985\text{ GHz}$ $2.985\text{ GHz} < f \leq 4\text{ GHz}$ $4\text{ GHz} < f \leq 6\text{ GHz}$ $-70\text{ dBm} > P \geq -95\text{ dBm}$ $0.3\text{ MHz} \leq f \leq 1.1\text{ GHz}$ $1.1\text{ GHz} \leq f \leq 2.985\text{ GHz}$ $2.985\text{ GHz} < f \leq 4\text{ GHz}$ $4\text{ GHz} < f \leq 6\text{ GHz}$ $-95\text{ dBm} > P \geq -125\text{ dBm}$ $0.3\text{ MHz} \leq f \leq 1.1\text{ GHz}$ $1.1\text{ GHz} \leq f \leq 2.985\text{ GHz}$ $2.985\text{ GHz} < f \leq 4\text{ GHz}$ $4\text{ GHz} < f \leq 6\text{ GHz}$	0.49 dB 0.58 dB 0.69 dB 0.79 dB 0.49 dB 0.59 dB 0.69 dB 0.8 dB 0.50 dB 0.59 dB 0.69 dB 0.8 dB 0.5 dB 0.6 dB 0.7 dB 0.8 dB 0.51 dB 0.6 dB 0.7 dB 1.5 dB	Signal Source PSG, ESG



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Electrical - RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermal Noise – Source ENR ¹	5 dB, 15 dB, or 21 dB		HP 346B opt. 002 346B/N4001A opt. 001, 346B opt. 004 346C/N4002A Noise Source
	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		
Thermal Noise – Source ENR ¹	5 dB, 15 dB, or 21 dB		HP 346B opt. 002 346B/N4001A opt. 001, 346B opt. 004 346C/N4002A Noise Source
	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 Analyzers ¹ Carrier 1 GHz	(-167 to -89) dBc/Hz		Wenzel 500-13438C/D Oscillator
	Offsets:		
	(10 to 100) Hz	0.5 dB	
	(0.1 to 100) kHz	0.36 dB	
	(0.1 to 1) MHz	0.48 dB	
(1 to 10) MHz	0.53 dB		
Rise Time Measure ¹	10 Hz to 1 GHz 300 ps to 1 μs	8.1 ps	DSO9104A Oscilloscope



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Electrical - RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pulse - Source Transition Time ¹	<100 ps	0.13 ns	HP 8133A Pulse Generator
Width	150 ps to 10 ns (10 to 100) ns 100 μs to 10 ms (10 to 100) ms 100 ms to 0.99) ms	0.13 ns (0.013* Width) + 1.2 ns (0.013*Width) + 0.14 μs (0.012 * Width) + 2 ns (0.012*Width) + 0.19 μs	HP 8161A Pulse Generator
RMS Jitter - Period, Delay and Width	33 MHz to 3 GHz	10 ps	HP 8133A Pulse Generator
Phase Noise for Signal Sources ¹			Keysight E5500 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	
Offset Frequency	$10\text{dB} > (L_{REF} - L_{DUT}) \geq 5\text{dB}$		
≤ 100 kHz	≤ 100 MHz	± 2.8 dB	
≤ 100 kHz	100 MHz < f ≤ 26.5 MHz	± 2.9 dB	
≤ 1 MHz	50 kHz < f ≤ 26.5 GHz	± 2.9 dB	
≤ 10 MHz	50 kHz < f ≤ 26.5 GHz	± 5.2 dB	
< 100 MHz	50 kHz < f ≤ 26.5 GHz	± 5.3 dB	
Offset Frequency	$5\text{dB} > (L_{REF} - L_{DUT}) \geq 3\text{dB}$		
≤ 100 kHz	≤ 100 MHz	± 3.2 dB	
≤ 100 kHz	100 MHz < f ≤ 26.5 GHz	± 3.3 dB	
≤ 1 MHz	50 kHz < f ≤ 26.5 GHz	± 3.3 dB	
≤ 10 MHz	50 kHz < f ≤ 26.5 GHz	± 5.4 dB	
< 100 MHz	50 kHz < f ≤ 26.5 GHz	± 5.5 dB	
Offset Frequency	$3\text{dB} > (L_{REF} - L_{DUT}) \geq 0\text{dB}$		
≤ 100 kHz	≤ 100 MHz	± 4.3 dB	
≤ 100 kHz	100 MHz < f ≤ 26.5 GHz	± 4.3 dB	
≤ 1 MHz	50 kHz < f ≤ 26.5 GHz	± 4.3 dB	
≤ 10 MHz	50 kHz < f ≤ 26.5 GHz	± 6.1 dB	
< 100 MHz	50 kHz < f ≤ 26.5 GHz	± 6.2 dB	



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Electrical - RF/Microwave

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

PARAMETER	Attenuation - Source ¹										
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



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PARAMETER	Attenuation - Source ¹										
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 ¹											
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



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PARAMETER	Attenuation - Measure ¹									
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 ¹										
REFERENCE STANDARD OR EQUIPMENT	8482A, 8485A, 8487A, 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
0 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 Power Measure ¹										
REFERENCE STANDARD OR EQUIPMENT	8482A, 8485A, 8487A, 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 Power Measure ¹				
REFERENCE STANDARD OR EQUIPMENT	8482A, 8485A, 8487A, 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) ¹									
REFERENCE STANDARD OR EQUIPMENT	85054B, 85031B, 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

PARAMETER	(S11 - Reflection) Phase Uncertainty (deg)									
REFERENCE STANDARD OR EQUIPMENT	85054B, 85031B, 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



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PARAMETER	(S21 - Transmission) Magnitude Uncertainty (dB) ¹								
REFERENCE STANDARD OR EQUIPMENT	85054B, 85031B, 85056A, 85058B								
	Measured Magnitude (+/- Linear)								
Freq:	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

PARAMETER	(S21 - Transmission) Phase Uncertainty (deg) ¹								
REFERENCE STANDARD OR EQUIPMENT	85054B, 85031B, 85056A, 85058B								
	Measured Magnitude (+/- Degrees)								
Freq:	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

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency - Source ¹	10 MHz	6.5 x 10 ⁻¹¹ Hz	Symmetricon 8040C GPS Disciplined

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency - Measure ¹	(10 to 100) Hz (100 to 1 000) Hz 1 kHz to 12.4 GHz 50 MHz to 26.5 GHz	71 pHz/Hz + 0.15 nHz 68 pHz/Hz + 0.5 nHz 67 pHz/Hz 30 pHz/Hz + 3.75 Hz	HP 53132A Counter

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. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1498.04.



Vice President

