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
1131 Warner Road
Tempe AZ 85284

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-1498.05
Certificate Number

ANAB Approval

Certificate Valid: 08/08/2017-11/16/2018
Version No. 001 Issued: 08/08/2017

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).

ANSI-ASQ National Accreditation Board

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 Center
1131 Warner Road
Tempe, AZ 85284
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CALIBRATION

Valid to: **November 16, 2018** Certificate Number: **AC-1498.05**

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage - Source	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 µV/V + 0.5 µV 5 µV/V + 0.8 µV 3 µV/V + 4 µV 4 µV/V + 5 µV 5 µV/V + 20 µV 7 µV/V + 0.3 mV	Fluke 5720A or 5730A with Fluke 5725A
DC Voltage - Source Fixed Values	100 mV 1 V 10 V	0.75 µV 4.1 µV 37 µV	Fluke 5700A or Fluke 5720A disciplined with HP 3458A
DC Voltage - Measure	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V 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	HP 3458A/100 PLC Option 002
DC Current - Source	Up to 220 µA 220 µA to 2.2 mA (2.2 to 22) mA (22 to 100) mA (100 to 220) mA	36 µA/A + 9 nA 33 µA/A + 8 nA 34 µA/A + 40 nA 42 µA/A + 0.68 µA 51 µA/A	Fluke 5720A
	220 mA to 1 A (1 to 2.2) A (2.2 to 11) A	76 µA/A + 12 µA 1.5 mA/A + 66 µA 0.30 mA/A + 0.40 mA	Fluke 5720A with Fluke 5725A
	100 µA	1.6 nA	Fluke 5700A/5720A disciplined with HP 3458A

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current - Measure	(10 to 100) µA 100 µA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1.1 A	20 µA/A 20 µA/A + 0.10 µA 20 µA/A + 60 nA 35 µA/A + 0.60 µA 0.11 mA/A + 11 µA	HP 3458A
DC Dissipated Power - 300 mA to Full Power	Shunt 15 A 100 mΩ, 25 W	0.14 mΩ/Ω	Guildline 9230-15
	Shunt 100A 10 mΩ, 100 W	0.14 mΩ/Ω	Guildline 9230-100
	Shunt 300A 10 mΩ, 90 W	0.12 mΩ/Ω	Guildline 9230-300
Resistance - Source Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 k Ω 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 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 0.40 kΩ 1.5 kΩ 12 kΩ	Fluke 5720A
	10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	0.17 mΩ 1.3 mΩ 7 mΩ 70 mΩ 0.69 Ω 10 Ω 0.27 kΩ 7.3 kΩ	Fluke 5700A/5720A disciplined with HP 3458A

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Source	Up to 22 mV		Fluke 5720A
	(10 to 20) Hz	0.25 mV/V + 12 µV	
	(20 to 40) Hz	95 µV/V + 7.3 µV	
	40 Hz to 20 kHz	86 µV/V + 7.3 µV	
	(20 to 50) kHz	0.18 mV/V + 9.4 µV	
	(50 to 100) kHz	0.49 mV/V + 16 µV	
	(100 to 300) kHz	0.88 mV/V + 20 µV	
	(300 to 500) kHz	1.4 mV/V + 33 µV	
	500 kHz to 1 MHz	2.7 mV/V + 0.48 mV	
	(22 to 220) mV		
	(10 to 20) Hz	0.27 mV/V + 4.5 µV	
	(20 to 40) Hz	0.13 mV/V + 4.5 µV	
	40 Hz to 20 kHz	0.11 mV/V + 4.5 µV	
	(20 to 50) kHz	0.27 mV/V + 4.5 µV	
	(50 to 100) kHz	0.54 mV/V + 5.3 µV	
	(100 to 300) kHz	1.2 mV/V + 10 µV	
	(300 to 500) kHz	1.7 mV/V + 24 µV	
	500 kHz to 1 MHz	3 mV/V + 24 µV	
	220 mV to 2.2 V		Fluke 5720A
	(10 to 20) Hz	0.25 mV/V + 39 µV	
	(20 to 40) Hz	99 µV/V + 15 µV	
	40 Hz to 20 kHz	63 µV/V + 5.9 µV	
	(20 to 50) kHz	86 µV/V + 8.3 µV	
	(50 to 100) kHz	0.11 mV/V + 30 µV	
	(100 to 300) kHz	0.41 mV/V + 78 µV	
	(300 to 500) kHz	0.99 mV/V + 0.20 mV	
	500 kHz to 1 MHz	1.6 mV/V + 0.32 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.26 mV/V + 0.42 mV	
	(20 to 40) Hz	0.11 mV/V + 0.15 mV	
	40 Hz to 20 kHz	67 µV/V + 44 µV	
	(20 to 50) kHz	91 µV/V + 90 µV	
	(50 to 100) kHz	1.1 µV/V + 0.21 mV	
	(100 to 300) kHz	2.9 µV/V + 0.65 mV	
	(300 to 500) kHz	1.1 mV/V + 2 mV	
	500 kHz to 1 MHz	1.6 mV/V + 3.3 mV	
	(22 to 100) V		
	(10 to 20) Hz	0.24 mV/V + 3.9 mV	
	(20 to 40) Hz	0.10 mV/V + 1.5 mV	
	40 Hz to 20 kHz	69 µV/V + 0.43 mV	
	(20 to 50) kHz	98 µV/V + 0.91 mV	
	(50 to 100) kHz	0.16 mV/V + 2.4 mV	
	(100 to 300) kHz	0.87 mV/V + 16 mV	
	(300 to 500) kHz	0.43 mV/V + 39 mV	
	500 kHz to 1 MHz	7.9 mV/V + 79 mV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Source	(100 to 220) V		Fluke 5720A, Fluke 5720A with Fluke 5725A Amplifier
	(10 to 20) Hz	0.24 mV/V + 3.9 mV	
	(20 to 40) Hz	0.10 mV/V + 1.5 mV	
	40 Hz to 20 kHz	69 µV/V + 0.43 mV	
	(20 to 50) kHz	0.17 mV/V + 0.56 mV	
	(50 to 100) kHz	0.21 mV/V + 1.9 mV	
	(100 to 300) kHz	0.87 mV/V + 16 mV	
	(300 to 500) kHz	0.43 mV/V + 39 mV	
	500 kHz to 1 MHz	7.9 mV/V + 79 mV	
	(0 to 250) V		Fluke 5700A or Fluke 5720A disciplined with HP 3458A
	(15 to 50) Hz	0.31 mV/V + 17 mV	
	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	
AC Voltage - Source	(220 to 750) V		Fluke 5700A or Fluke 5720A disciplined with HP 3458A
	(30 to 50) kHz	0.52 mV/V + 8.6 mV	
	(50 to 100) kHz	1.9 mV/V + 37 mV	
AC Voltage - Source Fixed Values, Fixed Frequencies	0.01 V		Fluke 5700A or Fluke 5720A disciplined with HP 3458A
	1 kHz	2.7 µV	
	20 kHz	2.8 µV	
	100 kHz	3.6 µV	
	300 kHz	4.6 µV	
	0.1 V		
	1 kHz	4.6 µV	
	20 kHz	4.6 µV	
	100 kHz	17 µV	
	300 kHz	22 µV	
	1 V		
	1 kHz	37 µV	
	20 kHz	37 µV	
	50 kHz	42 µV	
	100 kHz	65 µV	
	300 kHz	0.14 mV	
	500 kHz	0.24 mV	
	1 MHz	0.66 mV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Source Fixed Values, Fixed Frequencies	10 V 10 Hz 20 Hz 40 Hz 200 Hz 500 Hz	 0.67 mV 0.60 mV 0.42 mV 0.42 mV 0.42 mV	Fluke 5700A or Fluke 5720A disciplined with HP 3458A
AC Voltage Flatness - Source	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 3 mV to 3.5 V 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 1.2 mV/V 2.1 mV/V 3.8 mV/V 8.6 mV/V	Fluke 5720A, Fluke 5700A, or Fluke 5700A-03 (referenced to 1 kHz)
AC Voltage Flatness - Source Fixed Points	0.1 V at 1 MHz 1 V at 1 MHz	94 µV 0.73 mV	Fluke 5700A or Fluke 5720A disciplined with HP 3458A
AC Voltage Flatness - Measure	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	 0.20 mV/V + 6.9 µV 80 µV/V + 5.5 µV 80 µV/V + 3.2 µV 0.10 mV/V + 8 µV 0.10 mV/V + 5.2 µV 0.10 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

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure	Up to 10 mV		HP 3458A
	(1 to 40) Hz	0.30 mV/V + 3.1 µV	
	40 Hz to 1 kHz	0.20 mV/V + 1.2 µV	
	(1 to 20) kHz	0.30 mV/V + 1.7 µV	
	(20 to 50) kHz	1 mV/V + 1.6 µV	
	(50 to 100) kHz	5 mV/V + 1.3 µV	
	(100 to 300) kHz	40 mV/V + 2.1 µV	
	300 kHz to 1 MHz	12 mV/V + 6.6 µV	
	(1 to 4) MHz	70 mV/V + 7.5 µV	
	(4 to 8) MHz	20 mV/V + 8.2 µV	
	(10 to 100) mV		
	(1 to 40) Hz	70 µV/V + 4.1 µV	
	40 Hz to 1 kHz	70 µV/V + 2.1 µV	
	(1 to 20) kHz	0.14 mV/V + 2.3 µV	
	(20 to 50) kHz	0.30 V/V + 2.6 µV	
	(50 to 100) kHz	0.80 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 µV/V + 41 µV	
	40 Hz to 1 kHz	70 µV/V + 21 µV	
	(1 to 20) kHz	0.14 mV/V + 22 µV	
	(20 to 50) kHz	0.30 mV/V + 22 µV	
	(50 to 100) kHz	0.80 mV/V + 22 µV	
	(100 to 300) kHz	3 mV/V + 0.12 mV	
	300 kHz to 1 MHz	10 mV/V + 0.30 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	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure	(1 to 10) V		HP 3458A
	(1 to 40) Hz	70 µV/V + 0.42 mV	
	40 Hz to 1 kHz	70 µV/V + 0.22 mV	
	(1 to 20) kHz	0.14 mV/V + 0.24 mV	
	(20 to 50) kHz	0.30 mV/V + 0.25 mV	
	(50 to 100) kHz	0.80 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	
	(10 to 100) V		
	(1 to 40) Hz	0.20 mV/V + 4.1 mV	
	40 Hz to 20 kHz	0.20 mV/V + 2.6 mV	
	(20 to 50) kHz	0.35 mV/V + 2.4 mV	
	(50 to 100) kHz	1.2 mV/V + 2.1 mV	
	(100 to 300) kHz	4 mV/V + 11 mV	
	300 kHz to 1 MHz	15 mV/V + 50 mV	
	(100 to 750) V		
	(1 to 40) Hz	0.40 mV/V + 31 mV	
	40 Hz to 1 kHz	0.40 mV/V + 16 mV	
	(1 to 20) kHz	0.60 mV/V + 16 mV	
	(20 to 50) kHz	1.2 mV/V + 16 mV	
	(50 to 100) kHz	3 mV/V + 15 mV	
AC Voltage - Measure	Up to 1 mV		URE3
	0.02 Hz to 100 kHz	6 mV/V + 90 nV	
	100 kHz to 1 MHz	16 mV/V + 2 µV	
	(1 to 3) MHz	30 mV/V + 9 µV	
	(3 to 10) MHz	90 mV/V + 7 µV	
	(10 to 20) MHz	0.22 V/V + 20 µV	
	(1 to 3) mV		
	0.02 Hz to 100 kHz	6 mV/V + 30 nV	
	100 kHz to 1 MHz	7 mV/V + 5 µV	
	(1 to 3) MHz	33 mV/V + 10 µV	
	(3 to 10) MHz	93 mV/V + 8 µV	
	(10 to 20) MHz	0.24 V/V + 5 µV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure	(3 to 10) mV		URE3
	0.02 Hz to 100 kHz	6 mV/V + 10 nV	
	100 kHz to 1 MHz	8 mV/V + 8 µV	
	(1 to 3) MHz	16 mV/V + 20 µV	
	(3 to 10) MHz	26 mV/V + 50 µV	
	(10 to 20) MHz	65 mV/V + 90 µV	
AC Current - Source	Up to 220 µA		Fluke 5720A
	(10 to 20) Hz	0.16 mA/A + 63 nA	
	(20 to 40) Hz	89 µA/A + 62 nA	
	40 Hz to 1 kHz	60 µA/A + 62 nA	
	(1 to 5) kHz	0.18 mA/A + 62 nA	
	(5 to 10) kHz	0.10 mA/A + 90 nA	
	220 µA to 2.2 mA		
	(10 to 20) Hz	0.27 mA/A + 56 nA	
	(20 to 40) Hz	0.20 mA/A + 51 nA	
	40 Hz to 1 kHz	0.16 mA/A + 52 nA	
	(1 to 5) kHz	0.23 mA/A + 0.12 µA	
	(5 to 10) kHz	1.1 mA/A + 0.67 µA	
	(2.2 to 22) mA		
	(10 to 20) Hz	0.27 mA/A + 0.56 µA	
	(20 to 40) Hz	0.21 mA/A + 0.51 µA	
	40 Hz to 1 kHz	0.16 mA/A + 0.52 µA	
	(1 to 5) kHz	0.23 mA/A + 0.71 µA	
	(5 to 10) kHz	1.1 mA + 5.1 µA	
	(22 to 220) mA		
	(10 to 20) Hz	0.28 mA/A + 3.9 µA	
	(20 to 40) Hz	0.21 mA/A + 3 µA	
	40 Hz to 1 kHz	0.17 mA/A + 2.2 µA	
	(1 to 5) kHz	0.24 mA/A + 3.1 µA	
	(5 to 10) kHz	1.1 mA/A + 10 µA	
	220 mA to 1 A		
	20 Hz to 1 kHz	0.30 mA/A + 32 µA	
	(1 to 5) kHz	0.44 mA/A + 83 µA	
	(5 to 10) kHz	0.67 mA/A + 72 µA	
	(1 to 2.2) A		
	20 Hz to 1 kHz	0.35 mA/A + 26 µA	
	(1 to 5) kHz	0.55 mA/A + 72 µA	
	(5 to 10) kHz	0.67 mA/A + 72 µA	
	(2.2 to 11) A		
	40 Hz to 1 kHz	0.4 mA/A + 0.13 mA	
	(1 to 5) kHz	0.88 mA/A + 0.29 mA	
	(5 to 10) kHz	3.1 mA/A + 0.64 mA	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current - Source Fixed Values	1 kHz 10 uA 100 uA 1 mA 10 mA 100 mA 1 A	 5.1 pA 11 pA 110 pA 1 µA 11 µA 120 µA	Fluke 5700A or Fluke 5720A disciplined with HP 3458A
AC Current - Measure	Up to 100 µA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz 100 µA 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 (10 to 100) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz 100 mA 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 nA 1.5 mA/A + 31 nA 0.60 mA/A + 31 nA 4 mA/A + 0.31 µA 0.15 mA/A + 0.21 µA 0.60 mA/A + 0.21 µA 4 mA/A + 3.1 µA 1.5 mA/A + 2.1 µA 0.60 mA/A + 2.1 µA 4 mA/A + 31 µA 1.5 mA/A + 21 µA 0.60 mA/A + 21 µA 4 mA/A + 0.22 mA 1.6 mA/A + 0.22 mA 0.80 mA/A + 0.22 mA 1 mA/A + 0.22 mA	HP 3458A
Resistance - Source DC to 1 MHz, Direct Measurement	0.1 Ω (1, 10) Ω 100 Ω (1, 10, 100) kΩ	10 mΩ/Ω 1 mΩ/Ω 0.30 mΩ/Ω 0.30 mΩ/Ω	Agilent 16074A
Resistance - Source DC to 1 MHz Direct Measurement	1 mΩ 10 mΩ 100 mΩ 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ	4.2 mΩ/Ω 3.8 mΩ/Ω 4.0 mΩ/Ω 3.8 mΩ/Ω 5.0 mΩ/Ω 23 mΩ/Ω 11 mΩ/Ω 2.4 mΩ/Ω 3.1 mΩ/Ω	HP 42030A, HP 42040A

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance - Source Direct Measure 1 kHz	(1, 10, 100) pF (1, 10, 100) nF 1 µF	0.10 mF/F	Agilent 16380A, Agilent 16380C Standard Air Capacitor Set, BNC 4 Terminal Pair
Capacitance - Source Algorithmic Derivation	1 pF 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz (10, 100) pF (1, 2) MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz 1 nF 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	 50 µF/F 60 µF/F 1 mF/F 2 mF/F 3 mF/F 10 mF/F 15 mF/F 0.25 mF/F 3 mF/F 4 mF/F 6 mF/F 15 mF/F 20 mF/F 0.50 mF/F 0.60 mF/F 1 mF/F 1.5 mF/F 2 mF/F 5 mF/F 7 mF/F	Agilent 16380A, Agilent 16380C Standard Air Capacitor Set, BNC 4 Terminal Pair
Capacitance - Source Substitution Method 120 Hz to 10 kHz 100 kHz	(0.01, 0.1, 1) µF (0.01, 0.1) µF 1 µF	0.25 mF/F 0.50 mF/F 1 mF/F	
Capacitance - Source Direct Measure 10 Hz to 1 kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz	 (3.3 to 33) nF 330 nF to 110 µF (110 to 330) µF (3.3 to 11) µF	 4 mF/F 4 mF/F 4 mF/F 4 mF/F	

Electromagnetic - RF/Microwave

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty (±)]	Reference Standard or Equipment
Amplitude Modulation - Measure			HP 8902
rate: 50 Hz to 10 kHz, depth: 5 % to 99 %	150 kHz to 10 MHz (5 to 10) % (10 to 99) %	 0.025AM + 0.03 % 0.025AM + 0.14 %	
rate: 20 Hz to 10 kHz, depth: to 99 %	150 kHz to 10 MHz (5 to 10) % (10 to 99) %	 0.038AM + 0.03 % 0.038AM + 0.13 %	
rate: 50 Hz to 50 kHz, depth: 5 % to 99 %	10 MHz to 1.3 GHz (5 to 10) % (10 to 99) %	 0.012AM + 0.033 % 0.012AM + 0.17 %	
rate: 20 Hz to 100 kHz, depth: to 99 %	10 MHz to 1.3 GHz (5 to 10) % (10 to 99) %	 0.038AM + 0.03 % 0.037AM + 0.16 %	
rate: 50 Hz to 10 kHz, depth: 5 % to 99 %	(1.3 to 26.5) GHz (5 to 10) % (10 to 99) %	 0.019AM + 0.029 % 0.019AM + 0.14 %	with HP 11793A
rate: 20 Hz to 10 kHz, depth: to 99 %	10 MHz to 26.5 GHz (5 to 10) % (10 to 99) %	 0.038AM + 0.03 % 0.038AM + 0.11 %	
Frequency Modulation - Measure			
rate: 20 Hz to 10 kHz, ≤40 kHz	250 kHz to 10 MHz (0 to 4) kHz $_{Peak}$ FM (4 to 40) kHz $_{Peak}$ FM	 0.024*FM* + 2.6 Hz $_{Peak}$ 0.024*FM* + 10 Hz $_{Peak}$	
rate: 50 Hz to 100 kHz, ≤400 kHz	10 MHz to 1.3 GHz (0 to 4) kHz $_{Peak}$ FM (4 to 40) kHz $_{Peak}$ FM (40 to 400) kHz $_{Peak}$ FM	 0.012*FM* + 2.6 Hz $_{Peak}$ 0.012*FM* + 12 Hz $_{Peak}$ 0.012*FM* + 110 Hz $_{Peak}$	
rate: 50 Hz to 100 kHz, ≤400 kHz	(1.3 to 6.2) GHz (0 to 4) kHz $_{Peak}$ FM (4 to 40) kHz $_{Peak}$ FM (40 to 400) kHz $_{Peak}$ FM	 0.009 9*FM* + 10 Hz $_{Peak}$ 0.012*FM* + 12 Hz $_{Peak}$ 0.012*FM* + 100 Hz $_{Peak}$	HP 8902
rate: 50 Hz to 100 kHz, ≤400 kHz	(6.2 to 12.4) GHz (0 to 4) kHz $_{Peak}$ FM (4 to 40) kHz $_{Peak}$ FM (40 to 400) kHz $_{Peak}$ FM	 0.007 5*FM* + 24 Hz $_{Peak}$ 0.012*FM* + 12 Hz $_{Peak}$ 0.012*FM* + 85 Hz $_{Peak}$	
rate: 50 Hz to 100 kHz, ≤400 kHz	(12.4 to 18.6) GHz (0 to 4) kHz $_{Peak}$ FM (4 to 40) kHz $_{Peak}$ FM (40 to 400) kHz $_{Peak}$ FM	 0.004 9*FM* + 52 Hz $_{Peak}$ 0.011*FM* + 36 Hz$_{Peak}$ 0.012*FM* + 110 Hz$_{Peak}$	

Electromagnetic - RF/Microwave

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty (±)]	Reference Standard or Equipment
Frequency Modulation - Measure			HP 8902
rate: 50 Hz to 100 kHz, ≤400 kHz	(18.6 to 26.5) GHz		
	(0 to 4) kHz $_{Peak}$ FM	0.003 5*FM* + 80 Hz$_{Peak}$	
	(4 to 40) kHz $_{Peak}$ FM	0.011*FM* + 46 Hz$_{Peak}$	
	(40 to 400) kHz $_{Peak}$ FM	0.012*FM* + 100 Hz$_{Peak}$	
rate: 20 Hz to 200 kHz, ≤400 kHz	10 MHz to 1.3 GHz		
	(0 to 4) kHz $_{Peak}$ FM	0.059FM + 2.8 Hz$_{Peak}$	
	(4 to 40) kHz $_{Peak}$ FM	0.059FM + 14 Hz$_{Peak}$	
	(40 to 400) kHz $_{Peak}$ FM	0.059FM + 120 Hz$_{Peak}$	
rate: 20 Hz to 200 kHz, ≤400 kHz	(1.3 to 6.2) GHz		
	(0 to 4) kHz $_{Peak}$ FM	0.058FM + 5.2 Hz $_{Peak}$	
	(4 to 40) kHz $_{Peak}$ FM	0.059FM + 14 Hz $_{Peak}$	
	(40 to 400) kHz $_{Peak}$ FM	0.059FM + 120 Hz $_{Peak}$	
rate: 20 Hz to 200 kHz, ≤400 kHz	(6.2 to 12.4) GHz		
	(0 to 4) kHz $_{Peak}$ FM	0.055FM + 15 Hz $_{Peak}$	
	(4 to 40) kHz $_{Peak}$ FM	0.059FM + 14 Hz $_{Peak}$	
	(40 to 400) kHz $_{Peak}$ FM	0.059FM + 120 Hz $_{Peak}$	
Frequency Modulation - Measure			HP 8902 with HP 11793A
rate: 20 Hz to 200 kHz, ≤400 kHz	(12.4 to 18.6) GHz		
	(0 to 4) kHz $_{Peak}$ FM	0.05FM + 37 Hz $_{Peak}$	
	(4 to 40) kHz $_{Peak}$ FM	0.059FM + 15 Hz $_{Peak}$	
	(40 to 400) kHz $_{Peak}$ FM	0.059FM + 120 Hz $_{Peak}$	
rate: 20 Hz to 200 kHz, ≤400 kHz	(18.6 to 26.5) GHz		
	(0 to 4) kHz $_{Peak}$ FM	0.045FM + 60 Hz $_{Peak}$	
	(4 to 40) kHz $_{Peak}$ FM	0.059FM + 16 Hz $_{Peak}$	
	(40 to 400) kHz $_{Peak}$ FM	0.059FM + 120 Hz $_{Peak}$	

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)

Electromagnetic - RF/Microwave

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty (±)]	Reference Standard or Equipment
Error Vector Magnitude (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 º rms 0.34 º rms 0.57 º rms	
Frequency Error	Mod Frequency 1 GHz 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz	 0.063 % 0.068 % 0.079 % 0.099 % 0.33 % 0.39 %	
Modulation Accuracy (Rho)	Mod Frequency Span: f ≤ 100kHz 0.999 9 ≤ ρ ≤ 1 0.997 5 ≤ ρ< 0.999 9 0.993 6 ≤ ρ< 0.997 5 0.99 ≤ ρ< 0.993 6 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	
	Mod Frequency Span: 100 kHz ≤ f ≤ 1 MHz 0.999 9 ≤ ρ≤ 1 0.997 5 ≤ ρ< 0.999 9 0.993 6 ≤ ρ< 0.997 5 0.99 ≤ ρ< 0.993 6 0.978 ≤ ρ< 0.99 0.96 ≤ ρ< 0.978	 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	
Modulation Accuracy (Rho)	Mod Frequency Span: f > 1MHz 0.999 9 ≤ ρ ≤ 1 0.997 5 ≤ ρ< 0.999 9 0.993 6 ≤ ρ< 0.997 5 0.99 ≤ ρ< 0.993 6 0.978 ≤ ρ< 0.99 0.96 ≤ ρ< 0.978	 1.6 E-4 ρ 0.000 82 ρ 0.001 3 ρ 0.001 6 ρ 0.002 4 ρ 0.003 0 ρ	HP 89441A Vector Signal Analyzer

Electromagnetic - RF/Microwave

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty (±)]	Reference Standard or Equipment
Tuned RF Power - Absolute - Measure 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 with HP 11722A or with HP 11792A and HP 11793A
Tuned RF Power - Relative – Measure 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 with HP 11722A or with HP 11792A and HP 11793A
RF Absolute Power - Source	0.02 V ≤ V < 7 V f < 10 MHz 10 MHz ≤ f ≤ 50 MHz 50 MHz ≤ f ≤ 80 MHz V ≤ 10mV 20 Hz ≤ f ≤ 20 kHz 20 kHz < f ≤ 50 kHz 50 kHz < f ≤ 100 kHz 100 kHz < f ≤ 300 kHz 10 mV < V ≤ 100 mV 20 Hz ≤ f ≤ 40 Hz 40 Hz ≤ f ≤ 1 kHz 1 kHz < f ≤ 20 kHz 20 kHz < f ≤ 50 kHz 50 kHz < f ≤ 100 kHz 100 kHz < f ≤ 300 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

Electromagnetic - RF/Microwave

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty (±)]	Reference Standard or Equipment
RF Absolute Power - Source	100 mV < V ≤ 1 V		Function Generator and DVM Agilent 33250A, Agilent 33120A, Agilent 3458A
	20 Hz ≤ f ≤ 1 kHz	0.7 mV	
	1 kHz < f ≤ 20 kHz	0.72 mV	
	20 kHz < f ≤ 50 kHz	0.79 mV	
	50 kHz < f ≤ 100 kHz	1.3 mV	
	100 kHz < f ≤ 300 kHz	3.7 mV	
	1 V < V ≤ 3.5 V		
	20 Hz ≤ f ≤ 40 Hz	2.2 mV	
	40 Hz ≤ f ≤ 1 kHz	2.1 mV	
	1 kHz < f ≤ 20 kHz	2.2 mV	
	20 kHz < f ≤ 50 kHz	2.5 mV	
	50 kHz < f ≤ 100 kHz	4.0 mV	
	100 kHz < f ≤ 300 kHz	13 mV	
RF Absolute Power - Source	7dBm ≥ P ≥ 0 dBm		Signal Source PSG, ESG
	0.3 MHz ≤ f ≤ 1.1 GHz	0.49 dB	
	1.1 GHz ≤ f ≤ 2.985 GHz	0.58 dB	
	2.985 GHz < f ≤ 4 GHz	0.69 dB	
	4 GHz < f ≤ 6 GHz	0.79 dB	
	0 dBm > P ≥ -25 dBm		
	0.3 MHz ≤ f ≤ 1.1 GHz	0.49 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	
	-25 dBm > P ≥ -70 dBm		
	0.3 MHz ≤ f ≤ 1.1 GHz	0.50 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	

Electromagnetic - RF/Microwave

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty (±)]	Reference Standard or Equipment
Pulse - Measure RMS Jitter - Period, Delay and Width	33 MHz to 3 GHz	6.6 pS	HP 54124T or HP 86100 with 86107A
Phase Noise for Signal Sources			E5500 System
$(L_{REF} - L_{DUT}) \geq 10$dB Offset Frequency			
≤ 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	
10dB > $(L_{REF} - L_{DUT}) \geq 5$dB Offset Frequency			
≤ 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	
5dB > $(L_{REF} - L_{DUT}) \geq 3$dB Offset Frequency			
≤ 100 kHz	≤ 100 MHz	± 3.2 dB	
≤ 100 kHz	100 MHz < f ≤ 26.5G Hz	± 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	
3dB > $(L_{REF} - L_{DUT}) \geq 0$dB Offset Frequency			
≤ 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	

Electromagnetic - RF/Microwave

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty (±)]	Reference Standard or Equipment
Phase Noise for Signal Sources **3 dB > (L_{REF} - L_{DUT}) ≥ 0 dB** **Offset Frequency**			
≤ 100 kHz	≤ 100 MHz	± 4.3 dB	E5500 System
≤ 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	
Pulse - Source Transition Time	<100 ps	0.13 ns	HP 8133A
Width	150 ps to 10 ns	0.13 ns	HP 8161A
	(10 to 100) ns	(0.013 * Width) + 1.2 ns	
	100 µs to 10 ms	(0.013 * Width) + 0.14 µs	
	(10 to 100) ms	(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	HP 8133A
Attenuation - Source Coaxial, 1 dB Steps (0 to 11) dB	0 dB		HP 8496G w/ Type-N(f)
	50 MHz to 2 GHz	0.03 dB	
	(2 to 4) GHz	0.03 dB	
	1 dB		
	50 MHz to 2 GHz	0.03 dB	
	(2 to 4) GHz	0.03 dB	
	2 dB		
	50 MHz to 2 GHz	0.03 dB	
	(2 to 4) GHz	0.03 dB	
	3 dB		
	50 MHz to 2 GHz	0.03 dB	
	(2 to 4) GHz	0.03 dB	
	4 dB		
	50 MHz to 2 GHz	0.03 dB	
	(2 to 4) GHz	0.03 dB	
	5 dB		
	50 MHz to 2 GHz	0.03 dB	
	(2 to 4) GHz	0.03 dB	

Electromagnetic - RF/Microwave

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty (±)]	Reference Standard or Equipment
Attenuation - Source Coaxial, 1 dB Steps (0 to 11) dB	6 dB 50 MHz to 2 GHz (2 to 4) GHz 7 dB 50 MHz to 2 GHz (2 to 4) GHz 8 dB 50 MHz to 2 GHz (2 to 4) GHz 9 dB 50 MHz to 2 GHz (2 to 4) GHz 10 dB 50 MHz to 2 GHz (2 to 4) GHz 11 dB 50 MHz to 2 GHz (2 to 4) GHz	 0.03 dB 0.03 dB 0.03 dB 0.03 dB 0.03 dB 0.03 dB 0.03 dB 0.03 dB 0.03 dB 0.03 dB 0.03 dB 0.03 dB	HP 8496G With Type-N(f)
Attenuation – Source Coaxial, 10 dB Steps	0 dB 50 MHz to 2 GHz (2 to 4) GHz 10 dB 50 MHz to 2 GHz (2 to 4) GHz 20 dB 50 MHz to 2 GHz (2 to 4) GHz 30 dB 50 MHz to 2 GHz (2 to 4) GHz 40 dB 50 MHz to 2 GHz (2 to 4) GHz 50 dB 50 MHz to 2 GHz (2 to 4) GHz 60 dB 50 MHz to 2 GHz (2 to 4) GHz 70 dB 50 MHz to 2 GHz (2 to 4) GHz 80 dB 50 MHz to 2 GHz (2 to 4) GHz	 0.03 dB 0.03 dB 0.03 dB 0.03 dB 0.03 dB 0.03 dB 0.04 dB 0.04 dB 0.06 dB 0.05 dB 0.06 dB 0.06 dB 0.07 dB 0.06 dB 0.07 dB 0.06 dB 0.09 dB 0.07 dB	HP 8496G With Type-N(f)

Electromagnetic - RF/Microwave

Parameter/ Equipment	Range	Calibration and Measurement Capability [Expressed as Uncertainty (±)]	Reference Standard or Equipment
Attenuation – Source Coaxial, 10 dB Steps	90 dB 50 MHz to 2 GHz (2 to 4) GHz 100 dB 50 MHz to 2 GHz (2 to 4) GHz 110 dB 50 MHz to 2 GHz (2 to 4) GHz	 0.09 dB 0.08 dB 0.1 dB 0.08 dB 0.11 dB 0.08 dB	HP 8496G With Type-N(f)
Attenuation - Source Coaxial, Fixed	3 dB DC to 2 GHz, SWR < 1.25:1 (2 to 4) GHz, SWR < 1.2:1 (4 to 18) GHz, SWR < 1.2:1	 0.03 dB 0.03 dB 0.06 dB	HP 8491A/B With Type-N
Attenuation - Source Coaxial, Fixed	6 dB DC to 2 GHz, SWR < 1.25:1 (2 to 4) GHz, SWR < 1.2:1 (4 to 18) GHz, SWR < 1.2:1	 0.03 dB 0.03 dB 0.06 dB	HP 8491A/B With Type-N
	10 dB DC to 2 GHz, SWR < 1.25:1 (2 to 4) GHz, SWR < 1.2:1 (4 to 18) GHz, SWR < 1.2:1	 0.03 dB 0.03 dB 0.06 dB	
	20 dB DC to 2 GHz, SWR < 1.25:1 (2 to 4) GHz, SWR < 1.2:1 (4 to 18) GHz, SWR < 1.2:1	 0.03 dB 0.03 dB 0.06 dB	

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

Range	Measured Magnitude (+/- Linear)									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
20 MHz 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	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
20 MHz 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)								
	0	3	6	10	20	30	40	50	60
(20 to 130) MHz	0.016	0.015	0.015	0.017	0.02	0.03	0.052	0.074	0.13
130 MHz 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)								
	0	3	6	10	20	30	40	50	60
(20 to 130) MHz	0.16	0.16	0.16	0.17	0.19	0.26	0.66	0.6	0.92
130 MHz 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

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency - Source	5 MHz, 10 MHz	50 pHz/Hz	Datum 8040
Frequency - Measure	1 Hz to 40 GHz	50 pHz/Hz	HP 53132A, HP 5352B

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. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1498.05.