



# 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 Japan G.K.**  
**9-1, Takakura-cho, Hachioji-shi**  
**Tokyo, 192-8550 Japan**

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

**ISO/IEC 17025:2005**

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-1930  
Certificate Number

  
ANAB Approval

Certificate Valid: 02/06/2018-03/15/2019  
Version No. 006 Issued: 02/06/2018



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,

## Keysight Technologies Japan G.K.

9-1, Takakura-cho, Hachioji-shi

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## CALIBRATION

Valid to: **March 15, 2019**Certificate Number: **AC-1930**

## 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 $\mu$ V/V + 0.41 $\mu$ V 4.7 $\mu$ V/V + 0.62 $\mu$ V 3.1 $\mu$ V/V + 2.3 $\mu$ V 3.1 $\mu$ V/V + 4.5 $\mu$ V 4.7 $\mu$ V/V + 39 $\mu$ V 6.2 $\mu$ V/V + 0.39 mV	Fluke 5720A Multi Product Calibrator
DC Voltage - Source	100 mV 1 V 10 V 100 V 1 kV	3.5 $\mu$ V/V 2.5 $\mu$ V/V 0.87 $\mu$ V/V 2.1 $\mu$ V/V 3.9 $\mu$ V/V	Fluke 5720A Multi Product Calibrator, + Keysight 3458A <sup>2</sup> Multimeter
DC Voltage - Source	10 V	0.8 $\mu$ V/V	Fluke 732A Voltage Standard
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	7.1 $\mu$ V/V + 0.38 $\mu$ V 6.1 $\mu$ V/V + 0.37 $\mu$ V 6.1 $\mu$ V/V + 0.81 $\mu$ V 8.1 $\mu$ V/V + 36 $\mu$ V 20 $\mu$ V/V + 0.13 mV	Keysight 3458A Multimeter
DC Voltage – Measure Fixed Values	100 mV 1 V 10 V 100 V 1 kV	3.4 $\mu$ V/V 2.3 $\mu$ V/V 0.85 $\mu$ V/V 2.1 $\mu$ V/V 3.8 $\mu$ V/V	



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Current - Source	Up to 220 $\mu$ A 220 $\mu$ A to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 10) A	39 $\mu$ A/A + 5 nA 31 $\mu$ A/A + 6 nA 31 $\mu$ A/A + 39 nA 39 $\mu$ A/A + 0.62 $\mu$ A 70 $\mu$ A/A + 12 $\mu$ A 0.28 mA/A + 0.38 mA	Fluke 5720A Multi Product Calibrator
DC Current - Source	(10 to 20.5) A	0.78 mA/A + 0.59 mA	Fluke 5520A Multi Product Calibrator
DC Current - Source	100 $\mu$ A 1 mA 10 mA 100 mA 1 A	6.4 $\mu$ A/A 7.0 $\mu$ A/A 7.3 $\mu$ A/A 13 $\mu$ A/A 55 $\mu$ A/A	Fluke 5720A Multi Product Calibrator + Keysight 3458A <sup>2</sup> Multimeter
DC Current - Measure	(10 to 100) $\mu$ A 100 $\mu$ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1.1 A	25 $\mu$ A/A + 1 nA 25 $\mu$ A/A + 6.6 nA 25 $\mu$ A/A + 65 nA 40 $\mu$ A/A + 0.66 $\mu$ A 0.12 mA/A + 12 $\mu$ A	Keysight 3458A Multimeter
DC Current – Measure Fixed Values	100 $\mu$ A 1 mA 10 mA 100 mA 1 A	6.2 $\mu$ A/A 6.5 $\mu$ A/A 6.9 $\mu$ A/A 12 $\mu$ A/A 44 $\mu$ A/A	
DC Dissipated Power	(1 to 300) A	85 $\mu$ A/A	Guildline 9230 Shunt + Keysight 3458A Multimeter
DC Dissipated Power	Shunt 100 k $\Omega$ Shunt 1 M $\Omega$ Shunt 10 M $\Omega$ Shunt 100 M $\Omega$ Shunt 1 G $\Omega$ Shunt 10 G $\Omega$ Shunt 100 G $\Omega$	4 $\mu$ A/A + 0.2 nA 4 $\mu$ A/A + 72 pA 7 $\mu$ A/A + 9 pA 70 $\mu$ A/A + 0.6 pA 1 $\mu$ A/A + 0.1 fA 0.43 mA/A + 4 fA 0.1 mA/A + 9.5 fA	Keysight 16353A Shunt + Keysight 3458A Multimeter
	(1 to 20) A	0.53 mA/A	Keysight 16353J Shunt + Keysight 3458A Multimeter



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Voltage - with Divider	Up to 1 mV 1 mV (1 to 10) mV 10 mV	8.6 mV/V + 3 nV 10 nV 7.5 mV/V + 5 nV 76 nV	Fluke 5720A Multi Product Calibrator + Voltage divider
DC Voltage - with Divider	(1 to 3) kV	0.11 mV/V	Keysight 16332A High Voltage Divider + Keysight 3458A Multimeter
Resistance - Source	1 Ω 10 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ	6 μΩ/Ω 1.7 μΩ/Ω 22 μΩ/Ω 7.1 μΩ/Ω 3.5 μΩ/Ω 3 μΩ/Ω 2.9 μΩ/Ω 3.4 μΩ/Ω	Fluke 742A Resistance Standards Fluke 5720A Multi Product Calibrator
Resistance - Source	1 MΩ 10 MΩ 100 MΩ 1.9 Ω 19 Ω 190 Ω 1.9 kΩ 19 kΩ 190 kΩ 1.9 MΩ 19 MΩ	4.3 μΩ/Ω 12 μΩ/Ω 55 μΩ/Ω 14 μΩ/Ω 6.7 μΩ/Ω 3.4 μΩ/Ω 3 μΩ/Ω 3.4 μΩ/Ω 4.2 μΩ/Ω 4.6 μΩ/Ω 17 μΩ/Ω	Fluke 742A Resistance Standards Fluke 5720A Multi Product Calibrator
Resistance - Source	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ 330 kΩ to 1.1 MΩ (1.1 to 3.3) MΩ	31 μΩ/Ω + 0.78 mΩ 23 μΩ/Ω + 1.2 mΩ 22 μΩ/Ω + 1.1 mΩ 22 μΩ/Ω + 1.6 mΩ 22 μΩ/Ω + 1.6 mΩ 22 μΩ/Ω + 16 mΩ 22 μΩ/Ω + 16 mΩ 22 μΩ/Ω + 0.16 Ω 22 μΩ/Ω + 0.16 Ω 25 μΩ/Ω + 1.6 Ω 25 μΩ/Ω + 1.6 Ω 47 μΩ/Ω + 23 Ω	Fluke 5520A Multi Product Calibrator



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance - Source	(3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ 330 MΩ to 1.1 GΩ	0.10 mΩ/Ω + 39 Ω 0.19 mΩ/Ω + 1.9 kΩ 0.39 mΩ/Ω + 2.3 kΩ 2.3 mΩ/Ω + 78 kΩ 12 mΩ/Ω + 0.39 MΩ	Fluke 5520A Multi Product Calibrator
Resistance – Source Fixed Values	1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	18 μΩ/Ω 4.2 μΩ/Ω 3.3 μΩ/Ω 1.8 μΩ/Ω 1.6 μΩ/Ω 2.4 μΩ/Ω 5.2 μΩ/Ω 15 μΩ/Ω 0.12 mΩ/Ω	Fluke 5720A Multi Product Calibrator + Keysight 3458A <sup>2</sup> Multimeter
Resistance - Measure	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ	14 μΩ/Ω + 54 μΩ 12 μΩ/Ω + 540 μΩ 10 μΩ/Ω + 0.53 mΩ 10 μΩ/Ω + 5.3 mΩ 10 μΩ/Ω + 53 mΩ 14 μΩ/Ω + 1.8 Ω 41 μΩ/Ω + 81 Ω	Keysight 3458A Multimeter
Resistance - Measure	(10 to 100) MΩ 100 MΩ to 1 GΩ	0.39 mΩ/Ω + 2.4 kΩ 3.9 mΩ/Ω + 0.18 MΩ	Keysight 3458A Multimeter
Resistance – Measure Fixed Values	1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	17 μΩ/Ω 3.7 μΩ/Ω 3 μΩ/Ω 1.7 μΩ/Ω 1.6 μΩ/Ω 2.3 μΩ/Ω 5.1 μΩ/Ω 15 μΩ/Ω 0.12 mΩ/Ω	Keysight 3458A Multimeter
AC Current - Source	Up to 220 μA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.23 mA/A + 16 nA 0.16 mA/A + 9.3 nA 0.11 mA/A + 7.8 nA 0.27 mA/A + 12 nA 1 mA/A + 62 nA	Fluke 5720A Multi Product Calibrator

**Electrical – DC/Low Frequency**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment	
AC Current - Source	220 $\mu$ 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	0.23 mA/A + 40 nA 0.16 mA/A + 32 nA 0.11 mA/A + 31 nA 0.19 mA/A + 0.10 $\mu$ A 1 mA/A + 0.62 $\mu$ A	Fluke 5720A Multi Product Calibrator	
	(2.2 to 22) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.23 mA/A + 0.39 $\mu$ A 0.16 mA/A + 0.31 $\mu$ A 0.11 mA/A + 0.31 $\mu$ A 0.19 mA/A + 0.54 $\mu$ A 1 mA/A + 4.7 $\mu$ A		
	(22 to 220) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.23 mA/A + 4 $\mu$ A 0.16 mA/A + 3.1 $\mu$ A 0.11 mA/A + 2.3 $\mu$ A 0.19 mA/A + 3.1 $\mu$ A 1 mA/A + 9.3 $\mu$ A		
	220 mA to 2.2 A 20 Hz - 1 kHz (1 to 5) kHz (5 to 10) kHz	0.25 mA/A + 32 $\mu$ A 0.39 mA/A + 78 $\mu$ A 6.2 mA/A + 0.16 mA		
	(2.2 to 11) A 40 Hz - 1 kHz (1 to 5) kHz (5 to 10) kHz	0.36 mA/A + 0.17 mA 0.74 mA/A + 0.37 mA 2.8 mA/A + 0.64 mA		
	100 $\mu$ A @ 1 kHz 1 mA @ 1 kHz 10 mA @ 1 kHz 100 mA @ 1 kHz 1 A @ 1 kHz	0.12 $\mu$ A/A 0.1 $\mu$ A/A 0.1 $\mu$ A/A 0.1 $\mu$ A/A 0.13 $\mu$ A/A		Fluke 5720A Multi Product Calibrator + Keysight 3458A <sup>2</sup> Multimeter
	Up to 100 $\mu$ A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz	4 mA/A + 0.03 $\mu$ A 1.5 mA/A + 0.03 $\mu$ A 0.61 mA/A + 0.03 $\mu$ A 0.61 mA/A + 0.02 $\mu$ A		Keysight 3458A Multimeter



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current - Measure	100 $\mu$ A to 1 mA		Keysight 3458A Multimeter
	(10 to 20) Hz	4 mA/A + 0.2 $\mu$ A	
	(20 to 45) Hz	1.5 mA/A + 0.2 $\mu$ A	
	(45 to 100) Hz	0.61 mA/A + 0.2 $\mu$ A	
	100 Hz to 5 kHz	0.31 mA/A + 0.2 $\mu$ A	
	(1 to 10) mA		
	(10 to 20) Hz	4 mA/A + 2 $\mu$ A	
	(20 to 45) Hz	1.5 mA/A + 2 $\mu$ A	
	(45 to 100) Hz	0.61 mA/A + 2 $\mu$ A	
	100 Hz to 5 kHz	0.31 mA/A + 2 $\mu$ A	
	(10 to 100) mA		
	(10 to 20) Hz	4 mA/A + 20 $\mu$ A	
(20 to 45) Hz	1.5 mA/A + 20 $\mu$ A		
(45 to 100) Hz	0.61 mA/A + 20 $\mu$ A		
100 Hz to 5 kHz	0.31 mA/A + 20 $\mu$ A		
100 mA to 1.05 A			
(10 to 20) Hz	4 mA/A + 0.2 mA		
(20 to 45) Hz	1.6 mA/A + 0.2 mA		
(45 to 100) Hz	0.81 mA/A + 0.2 mA		
100 Hz to 5 kHz	1 mA/A + 0.2 mA		
AC Current – Measure Fixed Values	100 $\mu$ A @ 1 kHz 1 mA @ 1 kHz 10 mA @ 1 kHz 100 mA @ 1 kHz 1 A @ 1 kHz	0.11 $\mu$ A/A 0.1 $\mu$ A/A 0.1 $\mu$ A/A 0.1 $\mu$ A/A 0.14 $\mu$ A/A	Keysight 3458A Multimeter
AC Dissipated Power	(1 to 10) A (1 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz	2 mA/A 1 mA/A 8 mA/A	Guildline 9230 Shunt + Keysight 3458A Multimeter
AC Voltage - Source	Up 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	0.23 mV/V + 3.9 $\mu$ V 90 $\mu$ V/V + 3.9 $\mu$ V 78 $\mu$ V/V + 3.9 $\mu$ V 0.19 mV/V + 3.9 $\mu$ V 0.47 mV/V + 4.7 $\mu$ V 1 mV/V + 9.3 $\mu$ V 1.3 mV/V + 19 $\mu$ V 2.6 mV/V + 19 $\mu$ V	Fluke 5720A Multi Product Calibrator

**Electrical – DC/Low Frequency**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Source	(22 to 220) mV		Fluke 5720A Multi Product Calibrator
	(10 to 20) Hz	0.23 mV/V + 12 $\mu$ V	
	(20 to 40) Hz	89 $\mu$ V/V + 6.2 $\mu$ V	
	40 Hz to 20 kHz	78 $\mu$ V/V + 6.2 $\mu$ V	
	(20 to 50) kHz	0.19 mV/V + 6.3 $\mu$ V	
	(50 to 100) kHz	0.47 mV/V + 16 $\mu$ V	
	(100 to 300) kHz	0.9 mV/V + 19 $\mu$ V	
	(300 to 500) kHz	1.3 mV/V + 23 $\mu$ V	
	500 kHz to 1 MHz	2.6 mV/V + 47 $\mu$ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.23 mV/V + 39 $\mu$ V	
	(20 to 40) Hz	85 $\mu$ V/V + 16 $\mu$ V	
	40 Hz to 20 kHz	40 $\mu$ V/V + 8.5 $\mu$ V	
	(20 to 50) kHz	70 $\mu$ V/V + 10 $\mu$ V	
	(50 to 100) kHz	0.1 mV/V + 32 $\mu$ V	
	(100 to 300) kHz	0.39 mV/V + 78 $\mu$ V	
	(300 to 500) kHz	0.93 mV/V + 0.19 mV	
	500 kHz to 1 MHz	1.6 mV/V + 0.31 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.23 mV/V + 0.39 mV	
	(20 to 40) Hz	85 $\mu$ V/V + 0.16 mV	
	40 Hz to 20 kHz	40 $\mu$ V/V + 59 $\mu$ V	
	(20 to 50) kHz	70 $\mu$ V/V + 98 $\mu$ V	
	(50 to 100) kHz	93 $\mu$ V/V + 0.2 mV	
	(100 to 300) kHz	0.25 mV/V + 0.62 mV	
	(300 to 500) kHz	0.93 mV/V + 1.9 mV	
	500 kHz to 1 MHz	1.4 mV/V + 3.1 mV	
	(22 to 220) V		
(10 to 20) Hz	0.23 mV/V + 3.9 mV		
(20 to 40) Hz	85 $\mu$ V/V + 1.6 mV		
40 Hz to 20 kHz	50 $\mu$ V/V + 0.59 mV		
(20 to 50) kHz	78 $\mu$ V/V + 1 mV		
(50 to 100) kHz	0.14 mV/V + 2.4 mV		
(100 to 300) kHz	0.85 mV/V + 16 mV		
(300 to 500) kHz	4.2 mV/V + 39 mV		
500 kHz to 1 MHz	7.8 mV/V + 78 mV		
(220 to 750) V			
(30 to 50) kHz	0.47 mV/V + 9 mV		
(50 to 100) kHz	1.8 mV/V + 35 mV		





Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Source	220 V to 1.1 kV (15 to 50) Hz 50 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.28 mV/V + 16 mV 66 $\mu$ V/V + 3.8 mV 0.13 mV/V + 5.2 mV 0.47 mV/V + 9 mV	Fluke 5720A Multi Product Calibrator
AC Voltage - Source Fixed Values	10 mV @ 1 kHz 0.1 V @ 1 kHz 1.0 V @ 1 kHz 10 V @ 20 Hz 10 V @ 1 kHz 10 V @ 20 kHz 10 V @ 100 kHz 10 V @ 1 MHz 100 V @ 1 kHz 700 V @ 1 kHz	0.23 mV/V 73 $\mu$ V/V 44 $\mu$ V/V 44 $\mu$ V/V 40 $\mu$ V/V 57 $\mu$ V/V 68 $\mu$ V/V 0.33 mV/V 56 $\mu$ V/V 53 $\mu$ V/V	Fluke 5720A Multi Product Calibrator + Keysight 3458A <sup>2</sup> Multimeter
AC Voltage - Measure	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 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (10 to 100) 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 2) MHz (2 to 4) MHz (4 to 8) MHz (8 to 10) MHz	0.3 mV/V + 3 $\mu$ V 0.2 mV/V + 1.1 $\mu$ V 0.3 mV/V + 1.1 $\mu$ V 1 mV/V + 1.1 $\mu$ V 1 mV/V + 5 $\mu$ V 12 mV/V + 5.1 $\mu$ V 70 mV/V + 8.6 $\mu$ V 0.2 V/V + 15 $\mu$ V 0.72 mV/V + 4.2 $\mu$ V 0.07 mV/V + 2.4 $\mu$ V 0.14 mV/V + 2.4 $\mu$ V 0.30 mV/V + 2.7 $\mu$ V 0.80 mV/V + 3.4 $\mu$ V 3.0 mV/V + 10 $\mu$ V 10 mV/V + 12 $\mu$ V 15 mV/V + 27 $\mu$ V 40 mV/V + 86 $\mu$ V 40 mV/V + 0.15 mV 0.15 V/V + 0.21 mV	Keysight 3458A Multimeter

**Electrical – DC/Low Frequency**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Measure	100 mV to 1 V		Keysight 3458A Multimeter
	(1 to 40) Hz	0.07 mV/V + 41 μV	
	40 Hz to 1 kHz	0.07 mV/V + 21 μV	
	(1 to 20) kHz	0.14 mV/V + 21 μV	
	(20 to 50) kHz	0.3 mV/V + 22 μV	
	(50 to 100) kHz	0.8 mV/V + 24 μV	
	(100 to 300) kHz	3.0 mV/V + 0.1 mV	
	300 kHz to 1 MHz	10 mV/V + 0.11 mV	
	(1 to 2) MHz	15 mV/V + 0.16 mV	
	(2 to 4) MHz	40 mV/V + 0.75 mV	
	(4 to 8) MHz	40 mV/V + 1 mV	
	(8 to 10) MHz	0.15 V/V + 10 mV	
	(1 to 10) V		
	(1 to 40) Hz	0.07 mV/V + 0.4 mV	
	40 Hz to 1 kHz	0.07 mV/V + 0.2 mV	
	(1 to 20) kHz	0.14 mV/V + 0.2 mV	
	(20 to 50) kHz	0.3 mV/V + 0.21 mV	
	(50 to 100) kHz	0.8 mV/V + 0.22 mV	
	(100 to 300) kHz	3 mV/V + 1 mV	
	300 kHz to 1 MHz	10 mV/V + 1 mV	
	(1 to 2) MHz	15 mV/V + 1.3 mV	
	(2 to 4) MHz	40 mV/V + 7.2 mV	
	(4 to 8) MHz	40 mV/V + 9 mV	
	(8 to 10) MHz	0.15V/V + 12 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.2 mV/V + 4 mV	
	40 Hz to 1 kHz	0.2 mV/V + 2.1 mV	
	(1 to 20) kHz	0.2 mV/V + 2.1 mV	
	(20 to 50) kHz	0.35 mV/V + 2.1 mV	
	(50 to 100) kHz	1.2 mV/V + 2.2 mV	
(100 to 300) kHz	4 mV/V + 10 mV		
300 kHz to 1 MHz	15 mV/V + 10 mV		
(100 to 750) V			
(1 to 40) Hz	0.4 mV/V + 40 mV		
40 Hz to 1 kHz	0.4 mV/V + 20 mV		
(1 to 20) kHz	0.6 mV/V + 20 mV		
(20 to 50) kHz	1.2 mV/V + 21 mV		
(50 to 100) kHz	3 mV/V + 22 mV		



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Measure Fixed Values	10 mV @ 1 kHz 0.1 V @ 1 kHz 1.0 V @ 1 kHz 10 V @ 20 Hz 10 V @ 1 kHz 10 V @ 20 kHz 10 V @ 100 kHz 10 V @ 1 MHz 100 V @ 1 kHz 700 V @ 1 kHz	0.21 mV/V 60 μV/V 43 μV/V 43 μV/V 40 μV/V 56 μV/V 66 μV/V 0.33 mV/V 52 μV/V 73 μV/V	Keysight 3458A Multimeter
AC Voltage Flatness - Measure ACV Measurement Device	(0.2 to 3) V 10 Hz to 1 MHz (1 to 3) MHz (3 to 8) MHz (8 to 10) MHz (10 to 20) MHz (20 to 30) MHz (30 to 50) MHz (50 to 70) MHz (70 to 80) MHz	0.1 mV/V 0.25 mV/V 0.35 mV/V 0.45 mV/V 0.70 mV/V 1 mV/V 2 mV/V 3.5 mV/V 4 mV/V	HP 11051A, 11050A, 11049A Thermal Voltage Converter
ACV Source Flatness	(0.2 to 3) V 10 Hz to 1 MHz (1 to 5) MHz (5 to 10) MHz (10 to 30) MHz (30 to 50) MHz (50 to 80) MHz	1 mV/V 1.6 mV/V 2 mV/V 4 mV/V 6 mV/V 9 mV/V	HP 11051A, 11050A, 11049A Thermal Voltage Converter
4 TP Resistance - Source Resistance	1 mΩ 1 Hz to 1 kHz 10 mΩ 1 Hz to 1 kHz 100 mΩ 1 Hz to 1 kHz 1 Ω 1 Hz to 1 kHz	0.8 mΩ/Ω 0.3 mΩ/Ω 0.3 mΩ/Ω 0.3 mΩ/Ω	Keysight 42030A, 42040A Standard Resistor



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
4 TP Resistance - Source Resistance	10 Ω		Keysight 42030A, 42040A Standard Resistor
	1 Hz to 1 kHz	0.2 mΩ/Ω	
	1 kHz to 1 MHz	0.6 mΩ/Ω	
	2 MHz	0.6 mΩ/Ω	
	3 MHz	0.8 mΩ/Ω	
	4 MHz	0.8 mΩ/Ω	
	5 MHz	1.5 mΩ/Ω	
	10 MHz	4.5 mΩ/Ω	
	13 MHz	6.5 mΩ/Ω	
	100 Ω		
	1 Hz to 1 kHz	0.2 mΩ/Ω	
	1 kHz to 1 MHz	0.35 mΩ/Ω	
	2 MHz	0.45 mΩ/Ω	
	3 MHz	0.6 mΩ/Ω	
	4 MHz	0.6 mΩ/Ω	
	5 MHz	0.6 mΩ/Ω	
	10 MHz	2 mΩ/Ω	
	13 MHz	3 mΩ/Ω	
	1 kΩ		
	1 Hz to 1 kHz	0.05 mΩ/Ω	
	(1 to 100) kHz	0.35 mΩ/Ω	
	100 kHz to 1 MHz	0.35 mΩ/Ω	
	2 MHz	0.35 mΩ/Ω	
	3 MHz	0.35 mΩ/Ω	
	4 MHz	0.4 mΩ/Ω	
	5 MHz	0.5 mΩ/Ω	
	10 MHz	2 mΩ/Ω	
	13 MHz	3 mΩ/Ω	
	10 kΩ		
	1 Hz to 1 kHz	0.05 mΩ/Ω	
	(1 to 100) kHz	0.2 mΩ/Ω	
	100 kHz to 1 MHz	0.35 mΩ/Ω	
	100 kΩ		
1 Hz to 1 kHz	0.1 mΩ/Ω		
(1 to 100) kHz	0.35 mΩ/Ω		
100 kHz to 1 MHz	1.2 mΩ/Ω		



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Reactance	10 Ω		Keysight 42030A, 42040A Standard Resistor
	1 Hz to 1 kHz	0.005 Ω	
	1 kHz to 1 MHz	0.005 Ω	
	2 MHz	0.008 Ω	
	3 MHz	0.008 Ω	
	4 MHz	0.008 Ω	
	5 MHz	0.008 Ω	
	10 MHz	0.025 Ω	
	13 MHz	0.045 Ω	
	100 Ω		
	1 Hz to 1 kHz	0.05 Ω	
	1 kHz to 1 MHz	0.05 Ω	
	2 MHz	0.05 Ω	
	3 MHz	0.05 Ω	
	4 MHz	0.05 Ω	
	5 MHz	0.05 Ω	
	10 MHz	0.1 Ω	
13 MHz	0.1 Ω		
Susceptance	1 kΩ		Keysight 42030A, 42040A Standard Resistor
	1 Hz to 1 kHz	0.5 μS	
	(1 to 100) kHz	0.05 μS	
	100 kHz to 1 MHz	0.5 μS	
	2 MHz	0.5 μS	
	3 MHz	0.5 μS	
	4 MHz	0.5 μS	
	5 MHz	0.5 μS	
	10 MHz	0.8 μS	
	13 MHz	0.8 μS	
	10 kΩ		
	1 Hz to 1 kHz	0.05 μS	
	(1 to 100) kHz	0.05 μS	
	100 kHz to 1 MHz	0.05 μS	
	100 kΩ		
	1 Hz to 1 kHz	0.005 μS	
	(1 to 100) kHz	0.005 μS	
100 kHz to 1 MHz	0.006 μS		



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment	
4 TP Capacitance - Source Capacitance	1 pF		Keysight 16380A/C Standard Capacitor	
	20 Hz to 1 MHz	0.14 mF/F		
	2 MHz	0.25 mF/F		
	3 MHz	0.47 mF/F		
	4 MHz	0.72 mF/F		
	5 MHz	1.1 mF/F		
	10 MHz	3.5 mF/F		
	13 MHz	5.5 mF/F		
	10 pF			
	20 Hz to 1 MHz	0.1 mF/F		
	(2, 3, 4) MHz	0.1 mF/F		
	5 MHz	0.11 mF/F		
	10 MHz	0.16 mF/F		
	13 MHz	0.26 mF/F		
	100 pF			
	20 Hz to 1 MHz	0.1 mF/F		
	2 MHz	0.1 mF/F		
	3 MHz	0.11 mF/F		
	4 MHz	0.13 mF/F		
	5 MHz	0.14 mF/F		
	10 MHz	0.32 mF/F		
	13 MHz	0.52 mF/F		
	1 nF			
	20 Hz to 100 kHz	0.12 mF/F		
	100 kHz to 1 MHz	0.31 mF/F		
	1 MHz	0.12 mF/F		
	2 MHz	0.23 mF/F		
3 MHz	0.32 mF/F			
4 MHz	0.42 mF/F			
5 MHz	0.62 mF/F			
10 MHz	2 mF/F			
13 MHz	3 mF/F			
10 nF				
20 Hz to 1 kHz	0.1 mF/F			
(10, 100) kHz	0.1 mF/F			
100 nF				
20 Hz to 1 kHz	0.1 mF/F			
(10, 100) kHz	0.1 mF/F			



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
4 TP Capacitance - Source Capacitance	1 $\mu$ F	0.1 mF/F	Keysight 16380A/C Standard Capacitor
	20 Hz to 1 kHz (10, 100) kHz	0.11 mF/F	
	10 $\mu$ F	0.12 mF/F	
	20 Hz to 1 kHz 10 kHz 100 kHz	0.22 mF/F 0.76 mF/F	
Dissipation Factor <sup>5</sup>	1 pF	0.0001	Keysight 16380A/C Standard Capacitor
	20 Hz to 3 MHz	0.0002	
	4 MHz	0.0003	
	5 MHz	0.0007	
	10 MHz	0.001	
	13 MHz	0.0001	
	10 pF	0.0002	
	20 Hz to 10 MHz	0.0001	
	13 MHz	0.0002	
	100 pF	0.0001	
	20 Hz to 5 MHz	0.0002	
	10 MHz	0.0003	
	13 MHz	0.0001	
	1 nF	0.0002	
	20 Hz to 2 MHz	0.0003	
	(3, 4) MHz	0.0007	
	5 MHz	0.001	
	10 MHz	0.0001	
	13 MHz	0.0001	
	10 nF	0.0001	
20 Hz to 100 kHz	0.0001		
100 nF	0.0001		
20 Hz to 100 kHz	0.0001		
1 $\mu$ F	0.0001		
20 Hz to 10 kHz	0.0002		
100 kHz	0.0001		
10 $\mu$ F	0.0004		
20 Hz to 1 kHz	0.0009		
10 kHz			
100 kHz			



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Capacitance - Source	(190 to 400) pF 400 pF to 1.1 nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF 330 μF to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF 33 mF to 110 mF	3.9 mF/F + 8 pF 3.9 mF/F + 8 pF 3.9 mF/F + 8 pF 1.9 mF/F + 8 pF 1.9 mF/F + 80 pF 1.9 mF/F + 80 pF 1.9 mF/F + 0.25 nF 1.9 mF/F + 0.8 nF 1.9 mF/F + 2.5 nF 1.9 mF/F + 8 nF 3.1 mF/F + 25 nF 3.5 mF/F + 80 nF 3.5 mF/F + 0.25 μF 3.5 mF/F + 0.8 μF 3.5 mF/F + 2.5 μF 3.5 mF/F + 8 μF 5.8 mF/F + 25 μF 8.5 mF/F + 80 μF	Fluke 5520A Multi Product Calibrator
Capacitance - Measure	20 Hz (1 to 10) nF 10 nF to 100 μF 100 μF to 1 mF (1 to 10) mF 50 Hz (1 to 10) nF 10 nF to 100 μF 100 μF to 1 mF (1 to 10) mF 100 Hz 100 pF to 1 nF (1 to 10) nF 10 nF to 10 μF (10 to 100) μF 100 μF to 1 mF (1 to 10) mF	16 mF/F 1.2 mF/F 2 mF/F 5.2 mF/F 4.8 mF/F 1.2 mF/F 2.4 mF/F 8.1 mF/F 20 mF/F 2.1 mF/F 0.63 mF/F 1.8 mF/F 2.8 mF/F 12 mF/F	Keysight E4980A LCR Meter, Agilent 4284A LCR Meter





Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Capacitance - Measure	120 Hz		Keysight E4980A LCR Meter, Agilent 4284A LCR Meter
	100 pF to 1 nF	15 mF/F	
	(1 to 10) nF	1.6 mF/F	
	10 nF to 10 μF	0.62 mF/F	
	(10 to 100) μF	1.8 mF/F	
	100 μF to 1 mF	3.1 mF/F	
	(1 to 10) mF	14 mF/F	
	1 kHz		
	(10 to 100) pF	12 mF/F	
	(1 to 10) nF	1.4 mF/F	
	10 nF to 1 μF	0.61 mF/F	
	(1 to 10) μF	1.4 mF/F	
	(10 to 100) μF	1.7 mF/F	
	100 μF to 1 mF	6.1 mF/F	
	10 kHz		
	(1 to 10) pF	10 mF/F	
	(10 to 100) pF	1.2 mF/F	
	100 pF to 100 nF	0.61 mF/F	
	100 nF to 10 μF	1.4 mF/F	
	(10 to 100) μF	5.1 mF/F	
	100 kHz		
	(1 to 100) pF	1.5 mF/F	
	100 pF to 10 nF	0.6 mF/F	
	10 nF to 1 μF	1.3 mF/F	
(1 to 10) μF	4.2 mF/F		
1 MHz			
(1 to 10) pF	3 mF/F		
(10 to 100) pF	1.2 mF/F		
100 pF to 1 nF	0.6 mF/F		
(1 to 100) nF	1.3 mF/F		
2 MHz			
(1 to 10) pF	3.6 mF/F		
(10 to 100) pF	1.2 mF/F		
(1 to 10) nF	2.3 mF/F		
(10 to 100) nF	4.7 mF/F		
Capacitance – Measure	DC 200 μF to 110 mF	0.2 mF/F	Keysight 3458A Multimeter + Fluke 5720A Multi Product Calibrator



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Simulation of Thermocouple Indicators	Type J		Fluke 5520A Multi Product Calibrator
	(-210 to -100) °C	0.25 °C	
	(-100 to 760) °C	0.15 °C	
	(760 to 1 200) °C	0.2 °C	
	Type K		
	(-200 to -100) °C	0.3 °C	
(-100 to 120) °C	0.15 °C		
(120 to 1 000) °C	0.25 °C		
(1 000 to 1 372) °C	0.35 °C		

Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Amplitude Modulation – Measure 4 Freq:100 kHz to 10 MHz Rate:50 Hz to 10 kHz	Modulation Depth		Keysight E4448A Spectrum Analyzer
	(5 to 99) %	0.87 %/% + 0.03 %	
	(5 to 20) %	2.9 %/% + 0.03 %	
	(20 to 99) %	0.58 %/% + 0.03 %	
	(5 to 20) %	5.2 %/% + 0.03 %	
Freq: (3 to 26.5) GHz Rate:50 Hz to 100 kHz	(20 to 99) %	1.7 %/% + 0.03 %	
	(5 to 20) %	7.9 %/% + 0.03 %	
Freq: (26.5 to 31.15) GHz Rate:50 Hz to 100 kHz	(20 to 99) %	2.2 %/% + 0.03 %	
	(5 to 20) %	30 %/% + 0.03 %	
Freq: (31.15 to 50) GHz Rate:50 Hz to 100 kHz	(20 to 99) %	6.9 %/% + 0.03 %	



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency Modulation – Measure 4 Freq: 250 kHz to 10 MHz Rate: 20 Hz to 10 kHz Deviation: 20 Hz to 10 kHz	Deviation / Rate: 0.2 - 1.2 > 1.2	1.8 %/% 1.2 %/%	Keysight E4448A Spectrum Analyzer
Freq: 10 MHz to 6.6 GHz Rate: 50 Hz to 200 kHz Deviation: 250 Hz to 400 kHz	0.2-0.45 > 0.45	1.8 %/% 1.2 %/%	
Freq: (6.6 to 13.2) GHz Rate: 50 Hz to 200 kHz Deviation: 250 Hz to 400 kHz	0.2-8 > 8	2.9 %/% 1.2 %/%	
Freq: (13.2 to 31.15) GHz Rate: 50 Hz to 200 kHz Deviation: 250 Hz to 400 kHz	0.2-16 16	4.4 %/% 1.2 %/%g	
Freq: (31.15 to 50) GHz Rate: 50 Hz to 200 kHz Deviation: 250 Hz to 400 kHz	0.2-32 > 32	9.8 %/% 1.2 %/%	



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
<p>Digital Modulation – Measure - Carrier: 2 MHz to 50 GHz</p> <p>Error Vector Magnitude for Modulation Types: TETRA, PDC, NADC, PHS, EDGE, CDMA2000A/C, WCDMA 3GPP, BPSK, QPSK, <math>\pi/4</math>DQPSK, 16QAM, 32QAM, 64QAM and 256QAM</p> <p>Phase Error for Modulation Types: GMS, MSK, GMSK, BPSK, DQPSK, 8PSK, QPSK, <math>\pi/4</math>DQPSK, 16QAM, 32QAM, 64QAM and 256QAM</p> <p>Frequency Error for Modulation Types: DECT and FSK</p>	<p>Mod Frequency Span: (1 to 100) kHz 100 kHz to 1 MHz (1 to 10) MHz</p> <p>Mod Frequency Span: (1 to 100) kHz 100 kHz to 1 MHz 1 MHz to 10 MHz</p> <p>Symbol Rate: 3.2 kHz 1.152 MHz</p>	<p>0.33 % RMS 0.52 % RMS 1 % RMS</p> <p>0.2° RMS 0.35° RMS 0.58° RMS</p> <p>0.5 % RMS 1.5 % RMS</p>	<p>Agilent 89441A Vector Signal Analyzer + Converter</p>
RF Power - Measure	0 dBm (1 mW) 50 MHz	3 $\mu$ W	Keysight 8478A Power Meter, 478B Power Sensor



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Power - Measure	(-35 to 15) dBm	0.08 dB	Keysight N848xA Series Power Sensor
	(100 to 300) kHz	0.05 dB	
	300 kHz to 6 GHz	0.06 dB	
	(6 to 7) GHz	0.07 dB	
	(7 to 12.4) GHz	0.08 dB	
	(12.4 to 18) GHz	0.1 dB	
	(18 to 26) GHz	0.21 dB	
	(26 to 40) GHz	0.25 dB	
	(40 to 50) GHz		
	(15 to 20) dBm	0.09 dB	
	(100 to 300) kHz	0.06 dB	
	300 kHz to 6 GHz	0.07 dB	
	(6 to 12.4) GHz	0.08 dB	
	(12.4 to 18) GHz	0.1 dB	
	(18 to 26) GHz	0.21 dB	
(26 to 40) GHz	0.25 dB		
(40 to 50) GHz			
	(-30 to 20) dBm		Keysight V8486A Power Sensor+ Adaptor
	(50 to 70) GHz	0.32 dB	
	(-70 to -30) dBm		Keysight 848xD series Power Sensor
	(10 to 30) MHz	0.08 dB	
	30 MHz to 3 GHz	0.06 dB	
	(3 to 7) GHz	0.07 dB	
	(7 to 12.4) GHz	0.08 dB	
	(12.4 to 18) GHz	0.1 dB	
	(18 to 25) GHz	0.12 dB	
	(25 to 26) GHz	0.13 dB	
	(26 to 26.5) GHz	0.16 dB	
	(26.5 to 40) GHz	0.36 dB	
	(40 to 50) GHz	0.46 dB	



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Power - Measure	(-30 to -20) dBm (10 to 30) MHz 30 MHz to 2 GHz (2 to 3) GHz (3 to 7) GHz (7 to 12.4) GHz (12.4 to 18) GHz (18 to 25) GHz (25 to 26.5) GHz (26.5 to 40) GHz (40 to 50) GHz	0.08 dB 0.07 dB 0.11 dB 0.12 dB 0.13 dB 0.14 dB 0.15 dB 0.16 dB 0.36 dB 0.46 dB	Keysight 848xD series Power Sensor
	(-60 to -10) dBm 9 kHz to 7 GHz (7 to 10) GHz (10 to 16) GHz (16 to 18) GHz (-10 to 0) dBm 9 kHz to 6 GHz (6 to 15) GHz (15 to 16) GHz (16 to 18) GHz (0 to 20) dBm 9 kHz to 6 GHz (6 to 15) GHz (15 to 16) GHz (16 to 18) GHz (-50 to 0) dBm 9 kHz to 3 GHz (3 to 10) GHz (10 to 16) GHz (16 to 24) GHz	0.16 dB 0.17 dB 0.18 dB 0.19 dB 0.13 dB 0.15 dB 0.16 dB 0.17 dB 0.11 dB 0.13 dB 0.14 dB 0.15 dB 0.2 dB 0.21 dB 0.22 dB 0.23 dB	Keysight E9304A-H18 Power Sensor



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Power - Measure	(0 to 10) dBm 9 kHz to 6 GHz	0.18 dB	Keysight E9304A-H19, E9300A-H25 Power Sensor
	(6 to 10) GHz	0.19 dB	
	(10 to 15) GHz	0.2 dB	
	(15 to 24) GHz	0.21 dB	
	(10 to 30) dBm 9 kHz to 8 GHz	0.16 dB	
	(8 to 10) GHz	0.17 dB	
	(10 to 15) GHz	0.18 dB	
	(15 to 22) GHz	0.19 dB	
	(22 to 24) GHz	0.2 dB	
	(-30 to 10) dBm (100 to 300) kHz	0.1 dB	
(300 to 500) kHz	0.09 dB		
500 kHz to 3 GHz	0.05 dB		
	(10 to 20) dBm (100 to 300) kHz	0.18 dB	Keysight 8483A 75Ω Power Sensor
	(300 to 500) kHz	0.17 dB	
	500 kHz to 3 GHz	0.16 dB	
RF Power – Measure - Flatness	(- 10 to 0) dBm 100 kHz to 13.2 GHz (13.2 to 26.5) GHz	0.026 dB 0.03 dB	Keysight E9304A Power Sensor
RF Power – Measure - Linearity	(- 10 to 0) dBm 100 kHz to 13.2 GHz (13.2 to 26.5) GHz	0.12 % of reading 0.15 % of reading	Keysight E4448A Spectrum Analyzer
RF Power – Source	50 MHz, 1 mW	2.3 μW	Agilent E4419B Power Meter
Tuned RF Power Absolute – Measure	2.5 MHz to 26.5 GHz (10 to -30) dBm	0.15 dB	Agilent 8902A Measuring Receiver + 11722A / + 11792A + 11793A Sensors
	(-30 to -60) dBm	0.17 dB	
	(-60 to -100) dBm	0.19 dB	
	2.5 MHz to 2.6 GHz (-100 to -120) dBm	0.2 dB	
	2.5 MHz to 1.3 GHz (-110 to -120 dBm)	0.21 dB	



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Tuned RF Power Relative – Measure	100 kHz to 31.15 GHz		Keysight E4448A Spectrum Analyzer
	(10 to -10) dBm	0.023 dB	
	(-10 to -30) dBm	0.029 dB	
	(-30 to -60) dBm	0.046 dB	
	(-60 to -75) dBm	0.068 dB	
	100 kHz to 19.2 GHz		
	(-75 to -90) dBm	0.096 dB	
	100 kHz to 3.05 GHz		
	(-90 to -110) dBm	0.1 dB	
	(-110 to -120) dBm	0.18 dB	
	(-120 to -130) dBm	0.3 dB	
	(-130 to -140) dBm	0.44 dB	
	(3.05 to 6.6) GHz		
	(-90 to -103) dBm	0.1 dB	
	(-103 to -113) dBm	0.18 dB	
	(-113 to -123) dBm	0.3 dB	
	(-123 to -133) dBm	0.44 dB	
	(6.6 to 13.2) GHz		
	(-90 to -100) dBm	0.1 dB	
	(-100 to -110) dBm	0.17 dB	
	(-110 to -120) dBm	0.3 dB	
	(-120 to -130) dBm	0.43 dB	
	(13.2 to 19.2) GHz		
	(-90 to -98) dBm	0.1 dB	
(-98 to -108) dBm	0.17 dB		
(-108 to -118) dBm	0.3 dB		
(-118 to -128) dBm	0.43 dB		
(19.2 to 31.15) GHz			
(-75 to -86) dBm	0.096 dB		
(-86 to -96) dBm	0.17 dB		
(-96 to -106) dBm	0.3 dB		
(-106 to -116) dBm	0.43 dB		
(-116 to -126) dBm	0.43 dB		





Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Tuned RF Power Relative – Measure	(31.15 to 41) GHz		Keysight E4448A Spectrum Analyzer
	(10 to -10) dBm	0.026 dB	
	(-10 to -30) dBm	0.031 dB	
	(-30 to -60) dBm	0.048 dB	
	(-60 to -76) dBm	0.16 dB	
	(-76 to -86) dBm	0.29 dB	
	(-86 to -96) dBm	0.43 dB	
	(-96 to -106) dBm	0.43 dB	
	(41 to 45) GHz		
	(10 to -10) dBm	0.16 dB	
	(-10 to -30) dBm	0.16 dB	
	(-30 to -60) dBm	0.17 dB	
	(-60 to -70) dBm	0.17 dB	
	(-70 to -80) dBm	0.22 dB	
	(-80 to -90) dBm	0.33 dB	
	(-90 to -100) dBm	0.46 dB	
	(45 to 50) GHz		
	(10 to -10) dBm	0.28 dB	
(-10 to -30) dBm	0.28 dB		
(-30 to -58) dBm	0.28 dB		
(-58 to -68) dBm	0.32 dB		
(-68 to -78) dBm	0.4 dB		
(-78 to -88) dBm	0.51 dB		
RF Power Sensor - Calibration Factors (%) <sup>4</sup>	(9 to 30) kHz	0.64	Agilent 848x series, Keysight N848x series, E9304A Keysight 8478B Power Sensor
	(30 to 50) kHz	0.57	
	50 kHz to 10 MHz	0.5	
	(10 to 100) MHz	0.54	
	100 MHz to 6 GHz	0.62	
	(6 to 13) GHz	0.86	
	(13 to 18) GHz	1.2	
	(18 to 20) GHz	1.5	
	(20 to 26.5) GHz	1.7	
	(26.5 to 33) GHz	1.8	
	(33 to 40) GHz	1.9	
	(40 to 45) GHz	2.5	
(45 to 50) GHz	2.7		

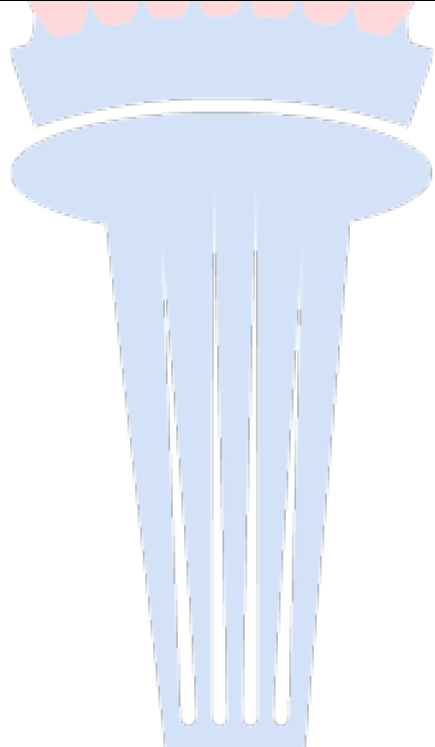


Phase Noise for Signal Analyzers Carrier 1 GHz	Phase Noise Measurement dBc/Hz		
	Offset: 100 Hz		
	-96 ≤ PN		0.96 dB
	-100 ≤ PN ≤ -96		0.97 dB
	-102 ≤ PN ≤ -100		0.99 dB
	-104 ≤ PN ≤ -102		1 dB
	-106 ≤ PN ≤ -104		1.1 dB
	-108 ≤ PN ≤ -106		1.3 dB
	-110 ≤ PN ≤ -108		1.7 dB
	-113 ≤ PN ≤ -110		2.6 dB
	Offset: 1 kHz		
	-115 ≤ PN		0.71 dB
	-121 ≤ PN < -115		0.73 dB
	-123 ≤ PN < -121		0.77 dB
	-125 ≤ PN < -123		0.85 dB
	-129 ≤ PN < -125		1.3 dB
	-130 ≤ PN < -129		1.6 dB
	-133 ≤ PN < -130		2.6 dB
	Offset: 10 kHz		
	-126 ≤ PN		0.43 dB
	-129 ≤ PN < -126		0.44 dB
	-132 ≤ PN < -129		0.46 dB
	-135 ≤ PN < -132		0.53 dB
	-138 ≤ PN < -135		0.73 dB
	-142 ≤ PN < -138		1.4 dB
	-145 ≤ PN < -142		2.5 dB
	Offset: 30 kHz		
	-112 ≤ PN		0.56 dB
-132 ≤ PN < -112		0.56 dB	
-134 ≤ PN < -132		0.58 dB	
-137 ≤ PN < -134		0.63 dB	
-140 ≤ PN < -137		0.81 dB	
-143 ≤ PN < -140		1.3 dB	
-144 ≤ PN < -143		1.5 dB	
-147 ≤ PN < -144		2.5 dB	
Offset: 100 kHz			
-131 ≤ PN		0.55 dB	
-132 ≤ PN < -131		0.55 dB	
-136 ≤ PN < -132		0.57 dB	
-139 ≤ PN < -136		0.63 dB	
-142 ≤ PN < -139		0.81 dB	
-145 ≤ PN < -142		1.3 dB	
-146 ≤ PN < -145		1.5 dB	
-149 ≤ PN < -146		2.5 dB	
			Wenzel 500-13438C Phase Noise Source



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Phase Noise for Signal Analyzers Carrier 1 GHz  Phase Noise Measurement dBc/Hz	Offset: 1 MHz		Wenzel 500-13438D Phase Noise Source
	-139 ≤ PN	0.55 dB	
	-142 ≤ PN < -139	0.56 dB	
	-145 ≤ PN < -142	0.57 dB	
	-148 ≤ PN < -143	0.63 dB	
	-150 ≤ PN < -148	0.73 dB	
	-152 ≤ PN < -150	0.92 dB	
	-155 ≤ PN < -152	1.5 dB	
	-158 ≤ PN < -155	2.5 dB	
	Offsets: 9.9 and 10 MHz		
	-136 ≤ PN	0.69 dB	
	-156 ≤ PN < -136	0.79 dB	
	-158 ≤ PN < -156	0.91 dB	
	-159 ≤ PN < -158	1 dB	
-162 ≤ PN < -159	1.5 dB		
-165 ≤ PN < -162	2.5 dB		





Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Phase Noise for Signal Sources	Carrier Frequency: $f$ Offset Frequency: $f_{offset}$		
$(L_{REF} - L_{DUT}) \geq 10\text{dB}$ $f_{offset} \leq 100\text{ kHz}$ $100\text{ kHz} < f_{offset} \leq 1\text{ MHz}$ $1\text{ MHz} < f_{offset} < 100\text{ MHz}$	$f \leq 26.5\text{ GHz}$ $50\text{ kHz} < f \leq 26.5\text{ GHz}$ $50\text{ kHz} < f \leq 26.5\text{ GHz}$	2.3 dB 2.3 dB 4.6 dB	Keysight E5500 Phase Noise Measurement System
$10\text{dB} > (L_{REF} - L_{DUT}) \geq 5\text{dB}$ $f_{offset} \leq 100\text{ kHz}$ $f_{offset} \leq 100\text{ kHz}$ $100\text{ kHz} < f_{offset} \leq 1\text{ MHz}$ $1\text{ MHz} < f_{offset} \leq 10\text{ MHz}$ $10\text{ MHz} < f_{offset} < 100\text{ MHz}$	$f \leq 100\text{ MHz}$ $100\text{ MHz} < f \leq 26.5\text{ MHz}$ $50\text{ kHz} < f \leq 26.5\text{ GHz}$ $50\text{ kHz} < f \leq 26.5\text{ GHz}$ $50\text{ kHz} < f \leq 26.5\text{ GHz}$	2.8 dB 2.9 dB 2.9 dB 5.2 dB 5.3 dB	
$5\text{dB} > (L_{REF} - L_{DUT}) \geq 3\text{ dB}$ $f_{offset} \leq 100\text{ kHz}$ $f_{offset} \leq 100\text{ kHz}$ $100\text{ kHz} < f_{offset} \leq 1\text{ MHz}$ $1\text{ MHz} < f_{offset} \leq 10\text{ MHz}$ $10\text{ MHz} < f_{offset} < 100\text{ MHz}$	$f \leq 100\text{ MHz}$ $100\text{ MHz} < f \leq 26.5\text{ GHz}$ $50\text{ kHz} < f \leq 26.5\text{ GHz}$ $50\text{ kHz} < f \leq 26.5\text{ GHz}$ $50\text{ kHz} < f \leq 26.5\text{ GHz}$	3.2 dB 3.3 dB 3.3 dB 5.4 dB 5.5 dB	
$3\text{dB} > (L_{REF} - L_{DUT}) \geq 0\text{ dB}$ $f_{offset} \leq 100\text{ kHz}$ $100\text{ kHz} < f_{offset} \leq 1\text{ MHz}$ $1\text{ MHz} < f_{offset} \leq 10\text{ MHz}$ $10\text{ MHz} < f_{offset} < 100\text{ MHz}$	$f \leq 26.5\text{ GHz}$ $50\text{ kHz} < f \leq 26.5\text{ GHz}$ $50\text{ kHz} < f \leq 26.5\text{ GHz}$ $50\text{ kHz} < f \leq 26.5\text{ GHz}$	4.3 dB 4.3 dB 6.1 dB 6.2 dB	



Attenuation – Source	1 dB - 11 dB	
	1 MHz to 1.5 GHz	0.01 dB
	(1.5 to 2) GHz	0.02 dB
	(2 to 8) GHz	0.03 dB
	(8 to 10) GHz	0.04 dB
	(10 to 12) GHz	0.05 dB
	(12 to 14) GHz	0.05 dB
	(14 to 16) GHz	0.06 dB
	(16 to 18) GHz	0.08 dB
	10 dB to 40 dB	
	(1 to 500) MHz	0.01 dB
	500 MHz to 1.5 GHz	0.01 dB
	(1.5 to 2) GHz	0.02 dB
	(2 to 3) GHz	0.03 dB
	(3 to 8) GHz	0.04 dB
	(8 to 14) GHz	0.06 dB
	(14 to 18) GHz	0.07 dB
	50 dB	
	1 MHz to 1.5 GHz	0.02 dB
	(1.5 to 3) GHz	0.03 dB
	(3 to 8) GHz	0.04 dB
	(8 to 12) GHz	0.06 dB
	(12 to 18) GHz	0.07 dB
	60 dB	
	1 MHz to 1.5 GHz	0.03 dB
	(1.5 to 3) GHz	0.04 dB
	(3 to 8) GHz	0.05 dB
	(8 to 18) GHz	0.07 dB
	70 dB	
	(1 to 500) MHz	0.04 dB
500 MHz to 2 GHz	0.05 dB	
(2 to 8) GHz	0.06 dB	
(8 to 10) GHz	0.08 dB	
(10 to 18) GHz	0.13 dB	
80 dB		
(1 to 500) MHz	0.06 dB	
500 MHz to 2 GHz	0.09 dB	
(2 to 10) GHz	0.1 dB	
(10 to 18) GHz	0.25 dB	
90 dB		
(1 to 10) MHz	0.4 dB	
10 MHz to 6 GHz	0.3 dB	
(6 to 8) GHz	0.65 dB	
(8 to 18) GHz	1 dB	

Keysight  
8494H, 8496H  
Step Attenuator



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Attenuation – Source	100 dB		Keysight 8494H, 8496H Step Attenuator
	(1 to 10) MHz	0.7 dB	
	10 MHz to 8 GHz	0.5 dB	
	(8 to 10) GHz	0.6 dB	
	(10 to 12) GHz	1.5 dB	
	(12 to 18) GHz	1.8 dB	
	110 dB		
	(1 to 10) MHz	2 dB	
10 MHz to 4 GHz	1.3 dB		
(4 to 8) GHz	1.5 dB		
(8 to 10) GHz	3 dB		
(10 to 18) GHz	4 dB		
Reflection S11/S22 - Measure <sup>4</sup> Type-N 9 kHz to 10 MHz Reflection phase: Uncertainty calculated as: arcsine(Ur/Γ). If equation is undefined, Uncertainty is 180 degrees	(0 to 0.46)	0.003	Keysight E5071C Network Analyzer + Keysight 85054B Calibration Kit
	(0.47 to 0.67)	0.0035	
	(0.68 to 0.8)	0.004	
	(0.81 to 0.9)	0.0045	
	(0.91 to 0.98)	0.005	
	(0.98 to 1)	0.0055	
Reflection S11/S22 - Measure <sup>4</sup> Type-N 10 MHz to 6 GHz	(0 to 0.35)	0.0055	Keysight E5071C Network Analyzer + Keysight 85054B Calibration Kit
	(0.36 to 0.5)	0.006	
	(0.51 to 0.59)	0.0065	
	(0.6 to 0.65)	0.007	
	(0.66 to 0.71)	0.0075	
	(0.72 to 0.75)	0.008	
	(0.76 to 0.8)	0.0085	
	(0.81 to 0.83)	0.009	
	(0.84 to 0.87)	0.0095	
	(0.88 to 0.9)	0.01	
	(0.91 to 0.96)	0.011	
(0.97 to 1)	0.012		



**ANSI-ASQ National Accreditation Board**

**Electrical - RF/Microwave**

<b>Parameter / Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method and/or Equipment</b>
Reflection S11/S22 - Measure <sup>4</sup> Type-N (6 to 8.5) GHz	(0 to 0.27)	0.0055	Keysight E5071C Network Analyzer + Keysight 85054B Calibration Kit
	(0.28 to 0.4)	0.006	
	(0.41 to 0.47)	0.0065	
	(0.48 to 0.52)	0.007	
	(0.53 to 0.56)	0.0075	
	(0.57 to 0.6)	0.008	
	(0.61 to 0.63)	0.0085	
	(0.64 to 0.66)	0.009	
	(0.67 to 0.69)	0.0095	
	(0.7 to 0.72)	0.01	
	(0.73 to 0.77)	0.011	
	(0.78 to 0.81)	0.012	
	(0.82 to 0.85)	0.013	
(0.86 to 0.89)	0.014		
(0.9 to 0.93)	0.015		
(0.94 to 0.97)	0.016		
(0.98 to 1)	0.017		
Reflection S11/S22 – Measure <sup>4</sup> Type-N 10 MHz to 2 GHz	(0 to 0.43)	0.003	Keysight E8361C Network Analyzer + Keysight 85054B Calibration Kit
	(0.44 to 0.66)	0.0035	
	(0.67 to 0.79)	0.004	
	(0.8 to 0.9)	0.0045	
	(0.91 to 0.98)	0.005	
	(0.99 to 1)	0.0055	
Reflection S11/S22 – Measure <sup>4</sup> (2 to 18) GHz	(0 to 0.25)	0.0055	Keysight E8361C Network Analyzer + Keysight 85054B Calibration Kit
	(0.26 to 0.39)	0.006	
	(0.4 to 0.46)	0.0065	
	(0.47 to 0.51)	0.007	
	(0.52 to 0.56)	0.0075	
	(0.57 to 0.59)	0.008	
	(0.6 to 0.63)	0.0085	
	(0.64 to 0.66)	0.009	
	(0.67 to 0.69)	0.0095	
	(0.7 to 0.72)	0.01	
	(0.73 to 0.77)	0.011	
	(0.78 to 0.81)	0.012	
	(0.82 to 0.85)	0.013	
	(0.86 to 0.89)	0.014	
	(0.9 to 0.93)	0.015	
	(0.94 to 0.97)	0.016	
(0.98 to 1)	0.017		



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Reflection S11/S22 – Measure <sup>4</sup> 3.5 mm 9 kHz to 10 MHz	(0 to 0.4)	0.003	Keysight E5071C Network Analyzer + Keysight 85052B Calibration Kit
	(0.41 to 0.54)	0.0035	
	(0.55 to 0.63)	0.004	
	(0.64 to 0.71)	0.0045	
	(0.72 to 0.77)	0.005	
	(0.78 to 0.82)	0.0055	
	(0.83 to 0.87)	0.006	
	(0.88 to 0.92)	0.0065	
	(0.93 to 0.96)	0.007	
Reflection S11/S22 – Measure <sup>4</sup> 10 MHz to 6 GHz	(0.97 to 1)	0.0075	Keysight E5071C Network Analyzer + Keysight 85052B Calibration Kit
	(0 to 0.31)	0.0045	
	(0.32 to 0.41)	0.005	
	(0.42 to 0.47)	0.0055	
	(0.48 to 0.52)	0.006	
	(0.53 to 0.56)	0.0065	
	(0.57 to 0.6)	0.007	
	(0.61 to 0.63)	0.0075	
	(0.64 to 0.66)	0.008	
	(0.67 to 0.69)	0.0085	
	(0.7 to 0.72)	0.009	
	(0.73 to 0.75)	0.0095	
	(0.76 to 0.77)	0.01	
	(0.78 to 0.82)	0.011	
	(0.83 to 0.86)	0.012	
	(0.87 to 0.9)	0.013	
	(0.91 to 0.94)	0.014	
(0.95 to 0.97)	0.015		
(0.98 to 1)	0.016		





Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Reflection S11/S22 – Measure <sup>4</sup> (6 to 8.5) GHz	(0 to 0.27)	0.0045	Keysight E5071C Network Analyzer + Keysight 85052B Calibration Kit
	(0.28 to 0.36)	0.005	
	(0.37 to 0.42)	0.0055	
	(0.43 to 0.47)	0.006	
	(0.48 to 0.5)	0.0065	
	(0.51 to 0.54)	0.007	
	(0.55 to 0.56)	0.0075	
	(0.57 to 0.59)	0.008	
	(0.6 to 0.62)	0.0085	
	(0.63 to 0.64)	0.009	
	(0.65 to 0.66)	0.0095	
	(0.67 to 0.69)	0.01	
	(0.7 to 0.73)	0.011	
	(0.74 to 0.77)	0.012	
	(0.78 to 0.80)	0.013	
	(0.81 to 0.84)	0.014	
(0.85 to 0.87)	0.015		
(0.88 to 0.9)	0.016		
(0.91 to 0.93)	0.017		
(0.94 to 0.96)	0.018		
(0.97 to 1)	0.02		
Reflection S11/S22 – Measure <sup>4</sup> 10 MHz to 2 GHz	(0 to 0.03)	0.003	Keysight E8361C Network Analyzer + Keysight 85052B Calibration Kit
	(0.04 to 0.15)	0.0035	
	(0.16 to 0.25)	0.004	
	(0.26 to 0.34)	0.0045	
	(0.34 to 0.41)	0.005	
	(0.42 to 0.47)	0.0055	
	(0.48 to 0.53)	0.006	
	(0.54 to 0.58)	0.0065	
	(0.59 to 0.63)	0.007	
	(0.64 to 0.68)	0.0075	
	(0.69 to 0.73)	0.008	
	(0.74 to 0.77)	0.0085	
	(0.78 to 0.81)	0.009	
	(0.82 to 0.85)	0.0095	
	(0.86 to 0.89)	0.01	
	(0.9 to 0.96)	0.011	
(0.97 to 1)	0.012		



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Reflection S11/S22 – Measure <sup>4</sup> (2 to 20) GHz	(0 to 0.06)	0.005	Keysight E8361C Network Analyzer + Keysight 85052B Calibration Kit
	(0.07 to 0.12)	0.0055	
	(0.13 to 0.16)	0.006	
	(0.17 to 0.21)	0.0065	
	(0.22 to 0.25)	0.007	
	(0.26 to 0.28)	0.0075	
	(0.29 to 0.31)	0.008	
	(0.32 to 0.34)	0.0085	
	(0.35 to 0.37)	0.009	
	(0.38 to 0.4)	0.0095	
	(0.41 to 0.43)	0.01	
	(0.44 to 0.47)	0.011	
	(0.48 to 0.52)	0.012	
	(0.53 to 0.56)	0.013	
	(0.57 to 0.6)	0.014	
	(0.61 to 0.64)	0.015	
	(0.65 to 0.68)	0.016	
	(0.69 to 0.71)	0.017	
(0.72 to 0.74)	0.018		
(0.75 to 0.78)	0.019		
(0.79 to 0.81)	0.02		
(0.82 to 0.87)	0.022		
(0.88 to 0.95)	0.025		
(0.96 to 1)	0.03		

**Electrical - RF/Microwave**

<b>Parameter / Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method and/or Equipment</b>
Reflection S11/S22 – Measure <sup>4</sup> (20 to 26.5) GHz	(0 to 0.02)	0.005	Keysight E8361C Network Analyzer + Keysight 85052B Calibration Kit
	(0.03 to 0.08)	0.0055	
	(0.09 to 0.13)	0.006	
	(0.14 to 0.17)	0.0065	
	(0.18 to 0.21)	0.007	
	(0.22 to 0.25)	0.0075	
	(0.26 to 0.28)	0.008	
	(0.29 to 0.31)	0.0085	
	(0.32 to 0.34)	0.009	
	(0.35 to 0.37)	0.0095	
	(0.38 to 0.4)	0.01	
	(0.41 to 0.44)	0.011	
	(0.45 to 0.49)	0.012	
	(0.5 to 0.53)	0.013	
	(0.54 to 0.57)	0.014	
	(0.58 to 0.61)	0.015	
	(0.62 to 0.65)	0.016	
(0.66 to 0.68)	0.017		
(0.69 to 0.72)	0.018		
(0.73 to 0.75)	0.019		
(0.76 to 0.78)	0.02		
(0.79 to 0.84)	0.022		
(0.85 to 0.92)	0.025		
(0.93 to 1)	0.03		
Reflection S11/S22 – Measure <sup>4</sup> 2.4 mm 10 MHz to 2 GHz	(0 to 0.1)	0.006	Keysight E8361C Network Analyzer + Keysight 85056A Calibration Kit
	(0.11 to 0.22)	0.0065	
	(0.23 to 0.32)	0.007	
	(0.33 to 0.4)	0.0075	
	(0.41 to 0.47)	0.008	
	(0.48 to 0.53)	0.0085	
	(0.54 to 0.59)	0.009	
	(0.6 to 0.65)	0.0095	
	(0.66 to 0.7)	0.01	
	(0.71 to 0.8)	0.011	
	(0.81 to 0.89)	0.012	
	(0.9 to 0.97)	0.013	
	(0.98 to 1)	0.014	



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Reflection S11/S22 – Measure <sup>4</sup> (2 to 20) GHz	(0 to 0.06)	0.006	Keysight E8361C Network Analyzer + Keysight 85056A Calibration Kit
	(0.06 to 0.13)	0.0065	
	(0.14 to 0.2)	0.007	
	(0.21 to 0.26)	0.0075	
	(0.27 to 0.32)	0.008	
Reflection S11/S22 – Measure <sup>4</sup> (2 to 20) GHz	(0.33 to 0.37)	0.0085	Keysight E8361C Network Analyzer + Keysight 85056A Calibration Kit
	(0.38 to 0.42)	0.009	
	(0.43 to 0.46)	0.0095	
	(0.47 to 0.51)	0.01	
	(0.52 to 0.59)	0.011	
	(0.6 to 0.66)	0.012	
	(0.67 to 0.73)	0.013	
	(0.74 to 0.8)	0.014	
	(0.81 to 0.86)	0.015	
	(0.87 to 0.93)	0.016	
Reflection S11/S22 – Measure <sup>4</sup> (20 to 40) GHz	(0.94 to 0.98)	0.017	Keysight E8361C Network Analyzer + Keysight 85056A Calibration Kit
	(0.98 to 1)	0.018	
	(0 to 0.05)	0.0095	
	(0.06 to 0.1)	0.01	
	(0.11 to 0.19)	0.011	
	(0.2 to 0.27)	0.012	
	(0.28 to 0.33)	0.013	
	(0.34 to 0.39)	0.014	
	(0.4 to 0.45)	0.015	
	(0.46 to 0.5)	0.016	
	(0.51 to 0.55)	0.017	
	(0.56 to 0.6)	0.018	
	(0.61 to 0.64)	0.019	
(0.65 to 0.68)	0.02		
(0.69 to 0.76)	0.022		
(0.77 to 0.87)	0.025		
(0.88 to 1)	0.03		



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Reflection S11/S22 – Measure <sup>4</sup> (40 to 50) GHz	(0 to 0.06)	0.012	Keysight E8361C Network Analyzer + Keysight 85056A Calibration Kit
	(0.07 to 0.15)	0.013	
	(0.16 to 0.21)	0.014	
	(0.22 to 0.28)	0.015	
	(0.29 to 0.33)	0.016	
	(0.34 to 0.38)	0.017	
	(0.39 to 0.43)	0.018	
	(0.44 to 0.47)	0.019	
	(0.48 to 0.51)	0.02	
	(0.52 to 0.59)	0.022	
	(0.6 to 0.69)	0.025	
	(0.7 to 0.84)	0.03	
	(0.85 to 0.98)	0.035	
(0.98 to 1)	0.04		
Reflection S11/S22 – Measure <sup>4</sup> N75 30 kHz to 1.3 GHz	(0 to 0.01)	0.0045	Agilent 8753ES Network Analyzer + Keysight 85036B Calibration Kit
	(0.01 to 0.04)	0.005	
	(0.04 to 0.10)	0.0055	
	(0.10 to 0.14)	0.006	
	(0.14 to 0.19)	0.0065	
	(0.19 to 0.23)	0.007	
	(0.23 to 0.31)	0.008	
	(0.31 to 0.38)	0.009	
	(0.38 to 0.46)	0.01	
	(0.46 to 0.53)	0.011	
	(0.53 to 0.59)	0.012	
	(0.59 to 0.66)	0.013	
	(0.66 to 0.73)	0.014	
	(0.73 to 0.79)	0.015	
	(0.79 to 0.86)	0.016	
	(0.86 to 0.92)	0.017	
(0.92 to 0.99)	0.018		
(0.99 to 1)	0.019		



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Reflection S11/S22 – Measure <sup>4</sup> (1.3 to 3) GHz	(0 to 0.07)	0.008	Agilent 8753ES Network Analyzer + Keysight 85036B Calibration Kit
	(0.07 to 0.14)	0.009	
	(0.14 to 0.20)	0.01	
	(0.20 to 0.26)	0.011	
	(0.26 to 0.32)	0.012	
	(0.32 to 0.37)	0.013	
	(0.37 to 0.41)	0.014	
	(0.41 to 0.46)	0.015	
	(0.46 to 0.5)	0.016	
	(0.5 to 0.54)	0.017	
	(0.54 to 0.58)	0.018	
	(0.58 to 0.62)	0.019	
	(0.62 to 0.66)	0.02	
	(0.66 to 0.73)	0.022	
	(0.73 to 0.80)	0.024	
(0.80 to 0.86)	0.026		
(0.86 to 0.93)	0.028		
(0.93 to 1)	0.03		
Transmission S21/S12 - Measure Type-N 9 kHz to 10 MHz Transmission phase Uncertainty is calculated as: $\arcsine(10^{(Ur/20)} - 1)$ If equation is undefined, Uncertainty is 180 degrees.	(-90 to -86) dB	8 dB	Keysight E5071C Network Analyzer + Keysight 85054B Calibration Kit
	(-86 to -82) dB	6 dB	
	(-82 to -79) dB	4 dB	
	(-79 to -77) dB	3 dB	
	(-77 to -75) dB	2.5 dB	
	(-75 to -72) dB	2 dB	
	(-72 to -68) dB	1.5 dB	
	(-68 to -66) dB	1 dB	
	(-66 to -63) dB	0.8 dB	
	(-63 to -59) dB	0.6 dB	
	(-59 to -51) dB	0.4 dB	
	(-51 to -39) dB	0.2 dB	
	(-39 to -37) dB	0.1 dB	
	(-37 to -33) dB	0.09 dB	
	(-33 to -30) dB	0.08 dB	
	(-30 to -25) dB	0.07 dB	
	(-25 to -20) dB	0.06 dB	
(-20 to -11) dB	0.05 dB		
(-11 to 9) dB	0.04 dB		
(9 to 10) dB	0.05 dB		



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Transmission S21/S12 - Measure Type-N 10 MHz to 3 GHz	(-90 to -87) dB	3 dB	Keysight E5071C Network Analyzer + Keysight 85054B Calibration Kit
	(-87 to -80) dB	2 dB	
	(-80 to -78) dB	1 dB	
	(-78 to -74) dB	0.8 dB	
	(-74 to -70) dB	0.6 dB	
	(-70 to -66) dB	0.4 dB	
	(-66 to -60) dB	0.3 dB	
	(-60 to -54) dB	0.2 dB	
	(-54 to -43) dB	0.15 dB	
	(-43 to -38) dB	0.1 dB	
	(-38 to -34) dB	0.09 dB	
	(-34 to -30) dB	0.08 dB	
	(-30 to -25) dB	0.07 dB	
	(-25 to -20) dB	0.06 dB	
(-20 to -10) dB	0.05 dB		
(-10 to 8) dB	0.04 dB		
(8 to 10) dB	0.05 dB		
Transmission S21/S12 - Measure Type-N (3 to 6) GHz	(-90 to -87) dB	3 dB	Keysight E5071C Network Analyzer + Keysight 85054B Calibration Kit
	(-87 to -80) dB	2 dB	
	(-80 to -79) dB	1 dB	
	(-79 to -77) dB	0.9 dB	
	(-77 to -76) dB	0.8 dB	
	(-76 to -74) dB	0.7 dB	
	(-74 to -72) dB	0.6 dB	
	(-72 to -70) dB	0.5 dB	
	(-70 to -66) dB	0.4 dB	
	(-66 to -59) dB	0.3 dB	
	(-59 to -52) dB	0.2 dB	
	(-52 to -36) dB	0.15 dB	
	(-36 to -31) dB	0.1 dB	
	(-31 to -25) dB	0.09 dB	
(-25 to -16) dB	0.08 dB		
(-16 to 10) dB	0.07 dB		



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Transmission S21/S12 - Measure Type-N (6 to 8.5) GHz	(-90 to -85) dB	3 dB	Keysight E5071C Network Analyzer + Keysight 85054B Calibration Kit
	(-85 to -78) dB	2 dB	
	(-78 to -77) dB	1 dB	
	(-77 to -76) dB	0.9 dB	
	(-76 to -75) dB	0.8 dB	
	(-75 to -73) dB	0.7 dB	
	(-73 to -71) dB	0.6 dB	
	(-71 to -68) dB	0.5 dB	
	(-68 to -64) dB	0.4 dB	
	(-64 to -57) dB	0.3 dB	
	(-57 to -47) dB	0.2 dB	
	(-47 to -19) dB	0.15 dB	
(-19 to 10) dB	0.1 dB		
Transmission S21/S12 - Measure Type-N 10 MHz to 2 GHz	(-90 to -87) dB	16 dB	Keysight E8361C Network Analyzer + Keysight 85054B Calibration Kit
	(-87 to -84) dB	14 dB	
	(-84 to -81) dB	12 dB	
	(-81 to -78) dB	10 dB	
	(-78 to -74) dB	8 dB	
	(-74 to -70) dB	6 dB	
	(-70 to -67) dB	4 dB	
	(-67 to -63) dB	3 dB	
	(-63 to -60) dB	2 dB	
	(-60 to -56) dB	1.5 dB	
	(-56 to -54) dB	1 dB	
	(-54 to -51) dB	0.8 dB	
	(-51 to -47) dB	0.6 dB	
	(-47 to -40) dB	0.4 dB	
	(-40 to -29) dB	0.2 dB	
	(-29 to -25) dB	0.1 dB	
	(-25 to -18) dB	0.08 dB	
(-18 to -8) dB	0.06 dB		
(-8 to 9) dB	0.04 dB		
(9 to 10) dB	0.05 dB		
Transmission S21/S12 - Measure Type-N (2 to 18) GHz	(-90 to -81) dB	2 dB	Keysight E8361C Network Analyzer + Keysight 85054B Calibration Kit
	(-81 to -80) dB	1 dB	
	(-80 to -79) dB	0.9 dB	
	(-79 to -77) dB	0.8 dB	
	(-77 to -74) dB	0.7 dB	





Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Transmission S21/S12 - Measure Type-N (2 to 18) GHz	(-74 to -71) dB	0.5 dB	Keysight E8361C Network Analyzer + Keysight 85054B Calibration Kit
	(-71 to -64) dB	0.4 dB	
	(-64 to -61) dB	0.3 dB	
	(-61 to -49) dB	0.2 dB	
	(-49 to -45) dB	0.15 dB	
	(-45 to -39) dB	0.14 dB	
	(-39 to -30) dB	0.13 dB	
	(-30 to -14) dB	0.12 dB	
	(-14 to 5) dB	0.11 dB	
	(5 to 7) dB	0.12 dB	
	(7 to 9) dB	0.14 dB	
Transmission S21/S12 - Measure 3.5 mm 9 kHz to 10 MHz	(-90 to -86) dB	8 dB	Keysight E5071C Network Analyzer + Keysight 85052B Calibration Kit
	(-86 to -82) dB	6 dB	
	(-82 to -75) dB	4 dB	
	(-75 to -67) dB	2 dB	
	(-67 to -61) dB	1 dB	
	(-61 to -59) dB	0.5 dB	
	(-59 to -56) dB	0.4 dB	
	(-56 to -51) dB	0.3 dB	
	(-51 to -47) dB	0.2 dB	
	(-47 to -39) dB	0.15 dB	
	(-39 to -37) dB	0.1 dB	
	(-37 to -33) dB	0.09 dB	
	(-33 to -30) dB	0.08 dB	
	(-30 to -25) dB	0.07 dB	
	(-25 to -20) dB	0.06 dB	
	(-20 to -11) dB	0.05 dB	
(-11 to 8) dB	0.04 dB		
(8 to 10) dB	0.05 dB		

**Electrical - RF/Microwave**

<b>Parameter / Equipment</b>	<b>Range</b>	<b>Expanded Uncertainty of Measurement (+/-)</b>	<b>Reference Standard, Method and/or Equipment</b>
Transmission S21/S12 - Measure 3.5 mm 10 MHz to 3 GHz	(-90 to -87) dB	3 dB	Keysight E5071C Network Analyzer + Keysight 85052B Calibration Kit
	(-87 to -80) dB	2 dB	
	(-80 to -78) dB	1 dB	
	(-78 to -74) dB	0.8 dB	
	(-74 to -70) dB	0.6 dB	
	(-70 to -66) dB	0.4 dB	
	(-66 to -59) dB	0.3 dB	
	(-59 to -53) dB	0.2 dB	
	(-53 to -40) dB	0.15 dB	
	(-40 to -36) dB	0.1 dB	
Transmission S21/S12 - Measure 3.5 mm 10 MHz to 3 GHz	(-36 to -32) dB	0.09 dB	Keysight E5071C Network Analyzer + Keysight 85052B Calibration Kit
	(-32 to -27) dB	0.08 dB	
	(-27 to -21) dB	0.07 dB	
	(-21 to -10) dB	0.06 dB	
	(-10 to 8) dB	0.05 dB	
Transmission S21/S12 - Measure 3.5 mm (3 to 6) GHz	(8 to 10) dB	0.06 dB	Keysight E5071C Network Analyzer + Keysight 85052B Calibration Kit
	(-90 to -87) dB	3 dB	
	(-87 to -80) dB	2 dB	
	(-80 to -77) dB	1 dB	
	(-77 to -74) dB	0.8 dB	
	(-74 to -70) dB	0.6 dB	
	(-70 to -66) dB	0.4 dB	
	(-66 to -59) dB	0.3 dB	
	(-59 to -52) dB	0.2 dB	
	(-52 to -34) dB	0.15 dB	
	(-34 to -24) dB	0.1 dB	
	(-24 to -22) dB	0.09 dB	
	(-22 to -6) dB	0.08 dB	
(-6 to 6) dB	0.07 dB		
(6 to 10) dB	0.08 dB		



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Transmission S21/S12 - Measure 3.5 mm (6 to 8.5) GHz	(-90 to -85) dB	3 dB	Keysight E5071C Network Analyzer + Keysight 85052B Calibration Kit
	(-85 to -78) dB	2 dB	
	(-78 to -76) dB	1 dB	
	(-76 to -73) dB	0.8 dB	
	(-73 to -68) dB	0.6 dB	
	(-68 to -64) dB	0.4 dB	
	(-64 to -57) dB	0.3 dB	
	(-57 to -47) dB	0.2 dB	
	(-47 to -43) dB	0.15 dB	
	(-43 to -39) dB	0.14 dB	
	(-39 to -33) dB	0.13 dB	
	(-33 to -24) dB	0.12 dB	
	(-24 to -6) dB	0.11 dB	
(-6 to 6) dB	0.1 dB		
(6 to 10) dB	0.11 dB		
Transmission S21/S12 - Measure 3.5 mm (6 to 8.5) GHz	(-90 to -87) dB	16 dB	Keysight E5071C Network Analyzer + Keysight 85052B Calibration Kit
	(-87 to -84) dB	14 dB	
	(-84 to -81) dB	12 dB	
	(-81 to -78) dB	10 dB	
	(-78 to -74) dB	8 dB	
	(-74 to -70) dB	6 dB	
	(-70 to -63) dB	4 dB	
(-63 to -56) dB	2 dB		
Transmission S21/S12 - Measure 3.5 mm 10 MHz to 2 GHz	(-56 to -54) dB	1 dB	Keysight E8361C Network Analyzer + Keysight 85052B Calibration Kit
	(-54 to -51) dB	0.8 dB	
	(-51 to -47) dB	0.6 dB	
	(-47 to -44) dB	0.4 dB	
	(-44 to -38) dB	0.3 dB	
	(-38 to -33) dB	0.2 dB	
	(-33 to -21) dB	0.15 dB	
	(-21 to -18) dB	0.1 dB	
	(-18 to -14) dB	0.09 dB	
	(-14 to -9) dB	0.08 dB	
	(-9 to 9) dB	0.07 dB	
(9 to 10) dB	0.08 dB		



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Transmission S21/S12 - Measure 3.5 mm (2 to 20) GHz	(-90 to -81) dB	2 dB	Keysight E8361C Network Analyzer + Keysight 85052B Calibration Kit
	(-81 to -78) dB	1 dB	
	(-78 to -74) dB	0.8 dB	
	(-74 to -67) dB	0.6 dB	
	(-67 to -64) dB	0.4 dB	
	(-64 to -56) dB	0.3 dB	
	(-56 to -40) dB	0.25 dB	
	(-40 to -35) dB	0.2 dB	
	(-35 to -27) dB	0.19 dB	
	(-27 to -18) dB	0.18 dB	
	(-18 to -10) dB	0.17 dB	
	(-10 to -5) dB	0.16 dB	
	(-5 to 3) dB	0.15 dB	
	(3 to 7) dB	0.18 dB	
(7 to 10) dB	0.25 dB		
Transmission S21/S12 - Measure 3.5 mm (20 to 26.5) GHz	(-90 to -85) dB	6 dB	Keysight E8361C Network Analyzer + Keysight 85052B Calibration Kit
	(-85 to -77) dB	4 dB	
	(-77 to -70) dB	2 dB	
	(-70 to -64) dB	1 dB	
	(-64 to -59) dB	0.6 dB	
	(-59 to -52) dB	0.4 dB	
	(-52 to -45) dB	0.3 dB	
	(-45 to -18) dB	0.25 dB	
	(-18 to -10) dB	0.2 dB	
	(-10 to -4) dB	0.19 dB	
	(-4 to 0) dB	0.18 dB	
	(0 to 1) dB	0.17 dB	
	(1 to 3) dB	0.18 dB	
	(3 to 6) dB	0.2 dB	
(6 to 10) dB	0.28 dB		



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Transmission S21/S12 - Measure 2.4 mm 10 MHz to 2 GHz	(-90 to -87) dB	16 dB	Keysight E8361C Network Analyzer + Keysight 85056A Calibration Kit
	(-87 to -84) dB	14 dB	
	(-84 to -81) dB	12 dB	
	(-81 to -78) dB	10 dB	
	(-78 to -74) dB	8 dB	
	(-74 to -70) dB	6 dB	
	(-70 to -63) dB	4 dB	
	(-63 to -60) dB	2 dB	
	(-60 to -56) dB	1.5 dB	
	(-56 to -54) dB	1 dB	
	(-54 to -51) dB	0.8 dB	
	(-51 to -49) dB	0.6 dB	
	(-49 to -47) dB	0.5 dB	
	(-47 to -38) dB	0.4 dB	
	(-38 to -33) dB	0.2 dB	
	(-33 to -27) dB	0.15 dB	
(-27 to -21) dB	0.12 dB		
(-21 to -13) dB	0.1 dB		
(-13 to -8) dB	0.08 dB		
(-8 to 8) dB	0.07 dB		
(8 to 10) dB	0.08 dB		
Transmission S21/S12 - Measure 2.4 mm (2 to 20) GHz	(-90 to -81) dB	2 dB	Keysight E8361C Network Analyzer + Keysight 85056A Calibration Kit
	(-81 to -78) dB	1 dB	
	(-78 to -74) dB	0.8 dB	
	(-74 to -69) dB	0.6 dB	
	(-69 to -64) dB	0.4 dB	
	(-64 to -55) dB	0.3 dB	
	(-55 to -39) dB	0.2 dB	
	(-39 to -34) dB	0.15 dB	
	(-34 to -25) dB	0.14 dB	
	(-25 to -16) dB	0.13 dB	
	(-16 to -9) dB	0.12 dB	
	(-9 to -4) dB	0.11 dB	
	(-4 to 3) dB	0.1 dB	
	(3 to 6) dB	0.12 dB	
(6 to 10) dB	0.2 dB		



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Transmission S21/S12 - Measure 2.4 mm (20 to 40) GHz	(-90 to -87) Db	6 dB	Keysight E8361C Network Analyzer + Keysight 85056A Calibration Kit
	(-87 to -84) dB	5 dB	
	(-84 to -80) dB	4 dB	
	(-80 to -74) dB	3 dB	
	(-74 to -64) dB	1.6 dB	
	(-64 to -62) dB	0.6 dB	
	(-62 to -57) dB	0.5 dB	
	(-57 to -49) dB	0.4 dB	
	(-49 to -39) dB	0.3 dB	
	(-39 to -34) dB	0.25 dB	
	(-34 to -26) dB	0.24 dB	
	(-26 to -17) dB	0.23 dB	
	(-17 to -10) dB	0.22 dB	
	(-10 to -5) dB	0.21 dB	
	(-5 to -2) dB	0.2 dB	
(-2 to 1) dB	0.19 dB		
(1 to 7) dB	0.25 dB		
(7 to 10) dB	0.35 dB		
Transmission S21/S12 - Measure 2.4 mm (40 to 50) GHz	(-90 to -85) dB	8 dB	Keysight E8361C Network Analyzer + Keysight 85056A Calibration Kit
	(-85 to -80) dB	6 dB	
	(-80 to -72) dB	4 dB	
	(-72 to -69) dB	2 dB	
	(-69 to -64) dB	1.7 dB	
	(-64 to -60) dB	0.8 dB	
	(-60 to -57) dB	0.6 dB	
	(-57 to -51) dB	0.5 dB	
	(-51 to -42) dB	0.4 dB	
	(-42 to -39) dB	0.3 dB	
	(-39 to -35) dB	0.29 dB	
	(-35 to -29) dB	0.28 dB	
	(-29 to -20) dB	0.27 dB	
	(-20 to -12) dB	0.26 dB	
	(-12 to -6) dB	0.25 dB	
(-6 to 3) dB	0.24 dB		
(3 to 8) dB	0.3 dB		
(8 to 10) dB	0.4 dB		



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Transmission S21/S12 - Measure N75 30 kHz to 1.3 GHz	(-70 to -68) dB	0.5 dB	Agilent 8753ES Network Analyzer + Keysight 85036B Calibration Kit
	(-68 to -65) dB	0.4 dB	
	(-65 to -60) dB	0.3 dB	
	(-60 to -55) dB	0.2 dB	
	(-55 to -53) dB	0.15 dB	
	(-53 to -50) dB	0.14 dB	
	(-50 to -47) dB	0.13 dB	
	(-47 to -40) dB	0.12 dB	
	(-40 to -31) dB	0.11 dB	
	(-31 to -21) dB	0.1 dB	
	(-21 to -12) dB	0.09 dB	
	(-12 to -6) dB	0.08 dB	
	(-6 to 3) dB	0.07 dB	
	(3 to 7) dB	0.15 dB	
(7 to 10) dB	0.4 dB		
Transmission S21/S12 - Measure N75 (1.3 to 3) GHz	(-70 to -67) dB	3 dB	Agilent 8753ES Network Analyzer + Keysight 85036B Calibration Kit
	(-67 to -64) dB	2.5 dB	
	(-64 to -58) dB	2 dB	
	(-58 to -55) dB	1.4 dB	
	(-55 to -52) dB	1.3 dB	
	(-52 to -45) dB	1.2 dB	
	(-45 to -33) dB	1.1 dB	
	(-33 to -19) dB	1 dB	
	(-19 to -10) dB	0.9 dB	
	(-10 to -6) dB	0.8 dB	
	(-6 to 5) dB	0.7 dB	
	(5 to 6) dB	1.5 dB	
	(6 to 9) dB	3.5 dB	
(9 to 10) dB	6 dB		
CISPR 16 Pulse Response	Quasi-Peak Detector Response		Schwarzbeck IGUU2916 Pulse Generator
	Band A/ (1 to 100) Hz	0.23 dB	
	Band B/ (1 to 20) Hz	0.23 dB	
	Band C/ (1 to 20) Hz	0.3 dB	
	Band D/ (1 to 20) Hz	0.3 dB	
	Quasi-Peak to Peak detector relative response ratio		
Band A / 25 Hz	0.21 dB		
Band B,C,D / 100 Hz	0.21 dB		



Electrical - RF/Microwave

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
CISPR 16 Pulse Response	Quasi-Peak to Average detector relative response ratio Band A / 25 Hz Band B / 500 Hz Band C, D / 5 kHz Quasi-Peak to RMS Relative Band A / 25 Hz Band B, C, D / 100 Hz	0.21 dB 0.21 dB 0.21 dB 0.21 dB 0.21 dB 0.21 dB	Schwarzbeck IGUU2916 Pulse Generator
	Quasi-Peak absolute amplitude Band A / 25 Hz Band B / 100 Hz Band C / 100 Hz	0.35 dB 0.35 dB 0.51 dB	Agilent E4419B Power Meter + Keysight E9304A Power Sensor
Pulse – Measure Period, Delay, Width, Rise-Fall Time and Jitter	10 ps to 1 ns 1 ns to 100 ns 100 ns to 1 $\mu$ s	11 ms/s +1.3 ps 12 ps 1.5 ms/s + 1.1 ps	Agilent 86100C Oscilloscope
Pulse – Measure Period, Delay, Width, Rise-Fall Time and Jitter	100 ns to 0.5 s (0.5 to 10) s (10 to 100) s	650 ps 65 ps/s + 700 ps 80 ps/s + 700 ps	Agilent 5071A Frequency Standard +Keysight 53132A Counter
Thermal Noise – Source ENR		0.052 dB	346B opt 002 Noise Source for APC-7
Thermal Noise – Source ENR	5 dB, 15 dB or 21 dB	0.063 dB at $\leq$ 18 GHz 0.056 dB at $>$ 18 GHz	346B opt 001 or N4001A opt 001 Noise Source for Type-N male sources 346B opt 004 Noise Source for Type-N female sources 346C or N4002A Noise Source for APC-3.5 sources





Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency – Source	(1, 5, 10) MHz (0.01 to 10) Hz 10 Hz to 12.4 GHz	$1.5 \times 10^{-12}$ Hz/Hz $2 \times 10^{-11}$ Hz/Hz $1.5 \times 10^{-11}$ Hz/Hz	Keysight 53132A Counter
Frequency – Source	(12.4 to 46) GHz	1.9 Hz	Keysight 53132A Counter + Agilent 5071A Cesium Frequency Standard
Time Interval – Measure	10 ps to 1 ns 1 ns to 100 ns 100 ns to 1 us	11 ms/s + 1.3 ps 12 ps 1.5 ms/s + 1.1 ps	Agilent 86100C Oscilloscope
	100 ns to 1 s (1 to 10) s (10 to 100) s	650 ps 65 ps/s + 700 ps 80 ps/s + 700 ps	Agilent 5071A Frequency Standard + Keysight 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. Enhanced process by including the 3458A measurement system (Gold Standard) to accomplish reduced measurement uncertainty
3. Unless otherwise indicated, % = % modulation.
4. Calibration Factor, Dissipation Factor, and Reflection are linear unitless measures
5. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1930.

  
 Vice President

