CERTIFICATE OF ACCREDITATION

ANSI National Accreditation Board

11617 Coldwater Road, Fort Wayne, IN 46845 USA

This is to certify that

Keysight Technologies Inc. Service Center

4729 154th Place NE, Building 87, Room 1437
Redmond, WA 98052

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

ISO/IEC 17025:2017

and national standards

ANSI/NCSL Z540-1-1994 (R2002) and
ANSI/NCSL Z540.3-2006 (R2013)

while demonstrating technical competence in the field of

CALIBRATION

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

AC-1498.17
Certificate Number

ANAB Approval

Certificate Valid Through: 11/16/2020
Version No. 003 Issued: 09/27/2019

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

ANSI National Accreditation Board

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

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CALIBRATION

Valid to: **November 16, 2020** Certificate Number: **AC-1498.17**

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 + 0.54 µV 5 µV/V + 0.8 µV 3.5 µV/V + 0.4 µV 3.6 µV/V + 4.5 µV 5.3 µV/V + 23 µV 7.1 µV/V + 0.3 mV	Fluke 5720A or 5730A Multiproduct Calibrator with Fluke 5725A Amplifier
DC Voltage - Source Fixed Values	100 mV 1 V 10 V 100 V 1 000 V	320 nV 2.6 µV 25 µV 260 µV 5.9 mV	Fluke 57x0A Multiproduct Calibrator disciplined with HP 3458A/100 NPLC Option 002 Multimeter
DC Voltage - Measure	(0 to 0.1) V (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1 000) V	4.1 µV/V + 0.36 µV 3.7 µV/V + 0.35 µV 3.1 µV/V + 0.59 µV 5.3 µV + 36 µV 5.3 µV/V + 0.12 mV	Keysight 3458A/100 NPLC Option 002 Multimeter
DC Current - Source	(>0 to 220) µA 220 µA to 22 mA (22 to 100) mA (100 to 220) mA 220 mA to 1 A (1 to 2.2) A	35 µA/A 29 µA/A 37 µA/A 50 µA/A - 1.2 µA 59 µA/A + 12 µA 120 µA/A - 42 µA	Fluke 5720A Multiproduct Calibrator
DC Current - Source	(2.2 to 11) A	280 µA/A + 41 µA	Fluke 5720A Multiproduct Calibrator with Fluke 5725A Amplifier

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current - Source	100 µA 1 mA 10 mA 100 mA 1 A	1.3 nA 9.6 nA 94 nA 2.2 µA 36 µA	Fluke 57x0A Multiproduct Calibrator disciplined with HP 3458A/100 NPLC Option 002 Multimeter
DC Current - Measure	(0 to 100) nA (0.1 to 1) µA (1 to 10) µA (10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	42 µA/A + 50 pA 21 µA/A + 50 pA 25 µA/A + 0.11 nA 25 µA/A + 0.85 nA 22 µA/A + 6.4 nA 23 µA/A + 59 nA 41 µA/A + 0.6 µA 125 µA/A + 12 µA	Keysight 3458A Multimeter
DC Dissipated Power - 300 mA to Full Power	(0.01 to 15) A	76 µA/A	Guildline 9230-15, Keysight 3458A, Electronic Load
	(15 A to 100) A	75.5 µA/A	Guildline 9230-100, Keysight 3458A, Electronic Load
	(100 A to 300) A	130 µA/A	Guildline 9230-300, Keysight 3458A, Electronic Load
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	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 0.4 kΩ	Fluke 5720A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance - Source Fixed Points	19 MΩ 100 MΩ	1.5 kΩ 12 kΩ	Fluke 5720A Multiproduct Calibrator
Resistance - Source Fixed Points	0 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	21 µΩ 86 µΩ 830 µΩ 7.4 mΩ 74 mΩ 740 mΩ 7.7 Ω 140 Ω 18 kΩ	Fluke 57x0A Multiproduct Calibrator disciplined with HP 3458A Multimeter
Resistance – Measure	(0 to 12) Ω (10 to 120) Ω 100 Ω to 1.2 kΩ (1 to 12) kΩ (10 to 120) kΩ 100 k Ω to 1.2 MΩ (1 to 12) MΩ (10 to 120) MΩ 100 MΩ to 1.2 GΩ	18 µΩ/ Ω + 20 µΩ 12 µΩ/Ω + 0.6 mΩ 9.6 µΩ/Ω + 0.6 mΩ 9.6 µΩ/Ω + 6 mΩ 9.6 µΩ/Ω + 60 mΩ 15 µΩ/Ω + 2.4 Ω 60 µΩ/Ω + 120 Ω 0.6 mΩ/Ω + 1.2 kΩ 6 mΩ/Ω	Keysight 3458A Multimeter
AC Voltage - Source	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (2.2 to 22) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	 250 µV/V + 4.1 µV 94 µV/V + 4.1 µV 83 µV/V + 4.1 µV 210 µV/V + 4.1 µV 520 µV/V + 4.1 µV 1.1 mV/V + 4.1 µV 1.5 mV/V + 4.1 µV 2.8 mV/V + 4.1 µV 250 µV/V + 4.1 µV 94 µV/V + 4.1 µV 83 µV/V + 4.1 µV 210 µV/V + 4.1 µV 520 µV/V + 4.1 µV 1.1 mV/V + 4.1 µV 1.4 mV/V + 4.1 µV 2.8 mV/V + 4.1 µV	Fluke 5720A Multiproduct 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 Multiproduct Calibrator
	(10 to 20) Hz	250 µV/V + 39 µV	
	(20 to 40) Hz	94 µVV + 16 µV	
	40 Hz to 20 kHz	83 µV/V + 8.7 µV	
	(20 to 50) kHz	200 µV/V + 10 µV	
	(50 to 100) kHz	470 µV/V + 210 µV	
	(100 to 300) kHz	930 µV/V + 600 µV	
	(300 to 500) kHz	1.5 mV/V + 190 µV	
	500 kHz to 1 MHz	2.8 mV/V + 300 µV	
	220 mV to 2.2 V		
	(10 to 20) Hz	251 µV/V + 39 µV	
	(20 to 40) Hz	94 µVV + 16 µV	
	40 Hz to 20 kHz	46 µV/V + 9 µV	
	(20 to 50) kHz	78 µV/V + 10 µV	
	(50 to 100) kHz	103 µV/V + 204 µV	
	(100 to 300) kHz	287 µV/V + 611 µV	
	(300 to 500) kHz	1.0 mV/V + 2.1 mV	
	500 kHz to 1 MHz	1.6 mV/V + 3.3 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	251 µV/V + 390 µV	
	(20 to 40) Hz	93 µV/V + 156 µV	
	40 Hz to 20 kHz	47 µV/V + 48 µV	
	(20 to 50) kHz	78 µV/V + 107 µV	
	(50 to 100) kHz	113 µV/V + 42 µV	
	(100 to 300) kHz	432 µV/V + 97 µV	
	(300 to 500) kHz	1 mV/V + 2.1 mV	
	500 kHz to 1 MHz	1.6 mV/V + 3.3 mV	
	(22 to 220) V		
	(10 to 20) Hz	250 µV/V + 4.17 mV	
	(20 to 40) Hz	93.8 µV/V + 1.56 mV	
	40 Hz to 20 kHz	53.9 µV/V + 0.68 mV	
	(20 to 50) kHz	83.3 µV/V + 1.05 mV	
	(50 to 100) kHz	156 µV/V + 2.62 mV	
	(100 to 300) kHz	941 µV/V + 16 mV	
	(300 to 500) kHz	4.58 mV/V + 41.7 mV	
	500 kHz to 1 MHz	8.33 mV/V + 83.4 mV	
	(220 to 1 100) V		
	40 Hz to 20 kHz	313 µV/V + 16.6 mV	
	(20 to 50) kHz	73 µV/V + 3.65 mV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Source	220 V to 1 100 V 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz 220 V to 750 V (30 to 50) kHz (50 to 100) kHz	 79.6 µV/V + 18.3 mV 173 µV/V + 5.3 mV 625 µV/V + 11.5 mV 634 µV/V + 5.45 mV 2.42 mV/V + 28 mV	Fluke 5720A Multiproduct Calibrator with Fluke 5725A Amplifier
AC Voltage – Source, Fixed Values, Fixed Frequencies	0.01 V 1 kHz 20 kHz 100 kHz 300 kHz 1 MHz 4 MHz 0.1 V 1 kHz 20 kHz 100 kHz 300 kHz 1 MHz 4 MHz 8 MHz 10 MHz 1 V 1 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 1 MHz 4 MHz 8 MHz 10 MHz 3V 100 kHz (2, 4, 8) MHz 10 MHz	 890 nV 1.2 µV 8.5 µV 66 µV 21 µV 140 µV 4.6 µV 6.9 µV 36 µV 68 µV 170 µV 670 µV 690 µV 2.3 mV 40 µV 43 µV 130 µV 200 µV 600 µV 1.7 mV 1.7 mV 6.7 mV 6.9 mV 25 mV 560 µV 21 mV 75 mV	Fluke 57x0A Multiproduct Calibrator disciplined with HP 3458A Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source, Fixed Values, Fixed Frequencies	10 V 10 Hz 20 Hz 40 Hz 200 Hz 500 Hz 1 kHz 10 kHz 20 kHz 50 kHz 100 kHz 300 kHz 500 kHz 1 MHz 100 V 1 kHz 20 kHz 50 kHz 100 kHz 700 V 1 kHz	 550 µV 380 µV 310 µV 504 µV 495 µV 400 µV 620 µV 640 µV 1.2 mV 1.3 mV 5.1 mV 16 mV 19 mV 4.1 mV 7.9 mV 7.5 mV 23 mV 60 mV	Fluke 57x0A Multiproduct Calibrator disciplined with HP 3458A Multimeter
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 Multiproduct Calibrator (referenced to 1 kHz)

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness - Measure	Up to 3 V		Agilent 11049A, Agilent 11050A, Agilent 11051A Thermal Voltage Converters
	10 Hz	0.2 mV/V + 6.9 µV	
	100 Hz	80 µV/V + 5.5 µV	
	(10, 30) kHz	80 µV/V + 3.2 µV	
	100 kHz	0.1 mV/V + 8 µV	
	300 kHz	0.1 mV/V + 5.2 µV	
	1 MHz	0.1 mV/V + 6.5 µV	
	3 MHz	1.3 mV/V + 59 µV	
	8 MHz	1.3 mV/V + 0.11 mV	
	10 MHz	1.3 mV/V + 91 µV	
	20 MHz	2.5 mV/V + 0.21 mV	
	30 MHz	2.5 mV/V + 0.24 mV	
	50 MHz	6.1 mV/V + 0.34 mV	
	70 MHz	9 mV/V + 0.24 mV	
	80 MHz	11 mV/V + 0.79 mV	
	100 MHz	13 mV/V + 0.94 mV	
AC Voltage - Measure	Up to 10 mV		Keysight 3458A Multimeter
	(1 to 40) Hz	0.3 mV/V + 3.1 µV	
	40 Hz to 1 kHz	0.2 mV/V + 1.2 µV	
	(1 to 20) kHz	0.3 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	0.3 V/V + 2.6 µV	
	(50 to 100) kHz	0.8 mV/V + 2.3 µV	
	(100 to 300) kHz	3 mV/V + 15 µV	
	300 kHz to 1 MHz	10 mV/V + 28 µV	
	(1 to 2) MHz	15 mV/V + 20 µV	
	(2 to 4) MHz	40 mV/V + 74 µV	
	(4 to 8) MHz	40 mV/V + 83 µV	
	(8 to 10) MHz	0.15 V/V + 0.11 mV	

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	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	0.3 mV/V + 22 µV	
	(50 to 100) kHz	0.8 mV/V + 22 µV	
	(100 to 300) kHz	3 mV/V + 0.12 mV	
	300 kHz to 1 MHz	10 mV/V + 0.3 mV	
	(1 to 2) MHz	15 mV/V + 0.21 mV	
	(2 to 4) MHz	40 mV/V + 0.73 mV	
	(4 to 8) MHz	40 mV/V + 0.83 mV	
	(8 to 10) MHz	0.15 V/V + 1 mV	
	(1 to 10) V		
	(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	0.3 mV/V + 0.25 mV	
	(50 to 100) kHz	0.8 mV/V + 0.22 mV	
	(100 to 300) kHz	3 mV/V + 1.1 mV	
	300 kHz to 1 MHz	10 mV/V + 1.1 mV	
	(1 to 2) MHz	15 mV/V + 1.1 mV	
	(2 to 4) MHz	40 mV/V + 7.1 mV	
	(4 to 8) MHz	40 mV/V + 8.1 mV	
	(8 to 10) MHz	0.15 mV/V + 11 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.2 mV/V + 4.1 mV	
	40 Hz to 20 kHz	0.2 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	0.4 mV/V + 31 mV	
	40 Hz to 1 kHz	0.4 mV/V + 16 mV	
	(1 to 20) kHz	0.6 mV/V + 16 mV	
	(20 to 50) kHz	1.2 mV/V + 16 mV	
	(50 to 100) kHz	3 mV/V + 15 mV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Source	0 to 220 µA		Fluke 5720A or 5730A Multiproduct Calibrator
	10 to 20 Hz	230 µA/A + 17 nA	
	20 to 40 Hz	150 µA/A + 10 nA	
	40 Hz to 1 kHz	108 µA/A + 8.4 nA	
	1 to 5 kHz	266 µA/A + 12.5 nA	
	5 to 10 kHz	915 µA/A + 66 nA	
	220 µA to 2.2 mA		
	10 to 20 Hz	233 µA/A + 42 nA	
	20 to 40 Hz	150 µA/A + 34 nA	
	40 Hz to 1 kHz	108 µA/A + 34 nA	
	1 to 5 kHz	183 µA/A + 109 nA	
	5 to 10 kHz	915 µA/A + 655 nA	
	(2.2 to 22) mA		
	10 to 20 Hz	233 µA/A + 422 nA	
	20 to 40 Hz	149 µA/A + 342 nA	
	40 Hz to 1 kHz	108 µA/A + 343 nA	
	1 to 5 kHz	183 µA/A + 588 nA	
	5 to 10 kHz	915 µA/A + 5 µA	
	(22 to 220) mA		
	10 to 20 Hz	233 µA/A + 4.2 µA	
	20 to 40 Hz	149 µA/A + 3.4 µA	
	40 Hz to 1 kHz	108 µA/A + 2.6 µA	
	1 to 5 kHz	183 µA/A + 3.4 µA	
	5 to 10 kHz	915 µA/A + 10 µA	
	(0.22 to 2.2) A		
	20 Hz to 1 kHz	249 µA/A + 34 µA	
	1 to 5 kHz	383 µA/A + 83 µA	
	5 to 10 kHz	5.8 mA/A + 166 µA	
	(2.2 to 11) A		
	20 Hz to 1 kHz	332 µA/A + 149 µA	
	1 to 5 kHz	707 µA/A + 320 µA	
	5 to 10 kHz	2.8 mA/A + 600 µA	
AC Current – Source Fixed Values	1 kHz		Fluke 5700A or Fluke 5720A Multiproduct Calibrator disciplined with Keysight 3458A Multimeter
	10 uA	7.4 nA	
	100 uA	17 nA	
	1 mA	110 nA	
	10 mA	1.1 µA	
	100 mA	11 µA	
	1 A	210 µA	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current - Measure	(5 to 100) uA		Keysight 3458A Multimeter
	(10 to 20) Hz	0.46 % of reading + 0.039 uA	
	(20 to 45) Hz	0.17 % of reading + 0.04 uA	
	(45 to 100) Hz	0.065 % of reading + 0.04 uA	
	100 Hz to 5 kHz	0.67 % of reading + 0.04 uA	
	100uA to 1mA		
	(10 to 20) Hz	0.46 % of reading + 0.25 uA	
	(20 to 45) Hz	0.17 % of reading + 0.26 uA	
	(45 to 100) Hz	0.067 % of reading + 0.26 uA	
	100 Hz to 5 kHz	0.033 % of reading + 0.27 uA	
	(5 to 20) kHz	0.067 % of reading + 0.26 uA	
	(20 to 50) kHz	0.46 % of reading + 0.48 uA	
	(50 to 100) kHz	0.63 % of reading + 1.7 uA	
	(1 to 10) mA		
	(10 to 20) Hz	0.46 % of reading + 2.5 uA	
	(20 to 45) Hz	0.17 % of reading + 2.5 uA	
	(45 to 100) Hz	0.067 % of reading + 2.7 uA	
	100 Hz to 5 kHz	0.033 % of reading + 2.7 uA	
	(5 to 20) kHz	0.067 % of reading + 2.6 uA	
	(20 to 50) kHz	0.46 % of reading + 4.7 uA	
	(50 to 100) kHz	0.63 % of reading + 17 uA	
	(10 to 100) mA		
	(10 to 20) Hz	0.46 % of reading + 25 uA	
	(20 to 45) Hz	0.17 % of reading + 26 uA	
	(45 to 100) Hz	0.067 % of reading + 26 uA	
	100 Hz to 5 kHz	0.033 % of reading + 27 uA	
	(5 to 20) kHz	0.067 % of reading + 26 uA	
	(20 to 50) kHz	0.46 % of reading + 47 uA	
	(50 to 100) kHz	0.63 % of reading + 0.17 mA	
	100 mA to 1 A		
	(10 to 20) Hz	0.46 % of reading + 0.29 mA	
	(20 to 45) Hz	0.18 % of reading + 0.32 mA	
	(45 to 100) Hz	0.085 % of reading + 0.34 mA	
	100 Hz to 5 kHz	0.11% of reading + 0.34 mA	
	(5 to 20) kHz	0.34 % of reading + 0.3 mA	
	(20 to 50) kHz	1.1 % of reading + 0.49 mA	

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure Rate: (0.05 to 10) kHz Rate: (0.05 to 50) kHz Rate: (0.05 to 10) kHz	(> 0 to 99) % Depth (0.15 to 10) MHz (0.01 to 1.3) GHz (1.3 to 26.5) GHz	 2.1 % Depth 1.1 % Depth 1.6 % Depth	Agilent 8902A Measuring Receiver
Amplitude Modulation – Measure Rate: (0.05 to 10) kHz Rate: (0.05 to 100) kHz	(> 0 to 99) % Depth (0.1 to 10) MHz (0.01 to 3) GHz (3 to 26.5) GHz (26.5 to 31.15) GHz (31.5 to 50) GHz	 0.8 % Depth 0.5 % Depth 1.5 % Depth 1.9 % Depth 6.1 % Depth	Agilent E444xA with Opt. 233 Spectrum Analyzer
Frequency Modulation – Measure Rate: (0.02 to 10) kHz Rate: (0.05 to 100) kHz	≤ 40 kHz $_{Peak}$ (0.25 to 10) MHz ≤ 400 kHz $_{Peak}$ (0.01 to 26.5) GHz	 2.2 % Deviation 1.2 % Deviation	Agilent 8902A Measuring Receiver
Frequency Modulation – Measure Rate: (0.02 to 10) kHz Rate: (0.05 to 200) kHz	≤ 400 kHz $_{Peak}$ (0.25 to 10) MHz (0.01 to 50) GHz	 1.1 % Deviation 1.1 % Deviation	Agilent E444xA with Opt. 233 Spectrum Analyzer
Phase Modulation – Measure	(0.15 to 10) MHz Rate: (0.02 to 10) kHz, <40 Radians Deviation (0.01 to 26.5) GHz Rate: (0.2 to 20) kHz <40 Radians Deviation	 4.1 % Deviation 3.1 % Deviation	Agilent 8902A Measuring Receiver
Phase Modulation – Measure	100 kHz to 6.6 GHz Deviations: (0.3 to 7) rad Deviations: > 7 rad (6.6 to 13.2) GHz Deviations: (0.6 to 2) rad (13.2 to 26.5) GHz Deviations: > 2 rad Deviations: (1.2 to 4) rad (26.5 to 31.5) GHz Deviations: > 4 rad Deviations: (1.3 to 4) rad (31.5 to 50) GHz Deviations: > 4 rad Deviations (2.4 to 8) rad Deviations: > 8 rad	 3.1 % Deviation 1 % Deviation 3.1 % Deviation 1 % Deviation 3.1 % Deviation 1 % Deviation 3.1 % Deviation 1 % Deviation 3.1 % Deviation 1 % Deviation	Agilent E444xA with Opt. 233 Spectrum Analyzer

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Distortion Measure	(-99 to 0) dB 20 Hz to 20 kHz (20 to 100) kHz	 1.2 dB 2.4 dB	HP 8903A/B Audio Analyzer

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

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
EVM	Mod Frequency Span: f ≤ 100kHz 100kHz ≤ f ≤ 1MHz f > 1MHz	 0.43 % of reading 0.48 % of reading 0.82 % of reading	HP 89441A Vector Signal Analyzer
Phase Error	Up to 180 ° rms Mod Frequency Span: f ≤ 100kHz 100kHz ≤ f ≤ 1MHz f > 1MHz	 0.17 ° rms 0.34 ° rms 0.57 ° rms	HP 89441A Vector Signal Analyzer
Frequency Error	Mod Frequency 1 GHz 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz	 0.063 % of reading 0.068 % of reading 0.079 % of reading 0.099 % of reading 0.33 % of reading 0.39 % of reading	HP 89441A Vector Signal Analyzer

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rho	Mod Frequency Span: f ≤ 100kHz 0.9999 ≤ Rho ≤ 1 0.9975 ≤ Rho < 0.9999 0.9936 ≤ Rho < 0.9975 0.99 ≤ Rho < 0.9936 0.978 ≤ Rho < 0.99 0.96 ≤ Rho < 0.978 Mod Frequency Span: 100 kHz ≤ f ≤ 1 MHz 0.9999 ≤ Rho ≤ 1 0.9975 ≤ Rho < 0.9999 0.9936 ≤ Rho < 0.9975 0.99 ≤ Rho < 0.9936 0.978 ≤ Rho < 0.99 0.96 ≤ Rho < 0.978 Mod Frequency Span: f > 1MHz 0.9999 ≤ Rho ≤ 1 0.9975 ≤ Rho < 0.9999 0.9936 ≤ Rho < 0.9975 0.99 ≤ Rho < 0.9936 0.978 ≤ Rho < 0.99 0.96 ≤ Rho < 0.978	8.6 E-5 ρ 0.000 43 ρ 0.000 68 ρ 0.00 084 ρ 0.001 2 ρ 0.001 6 ρ 9.6 E-5 ρ 0.000 48 ρ 0.000 76 ρ 0.000 94 ρ 0.001 4 ρ 0.001 8 ρ 1.6 E-4 ρ 0.000 82 ρ 0.001 3 ρ 0.001 6 ρ 0.002 4 ρ 0.003 ρ	HP 89441A Vector Signal Analyzer
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 Measuring Receiver with HP 11722A or with HP 11792A and HP 11793A Power Sensor

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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	0.08 dB 0.07 dB 0.08 dB 0.09 dB 0.1 dB 0.12 dB 0.15 dB 0.16 dB	HP 8902A Measuring Receiver with HP 11722A or with HP 11792A and HP 11793A Power Sensor
Tuned RF Power - Relative – Measure 2.5 MHz to 26.5 GHz	(-80 to -71) dBm (-90 to -80) dBm (-100 to -90) dBm (-110 to -100) dBm (-120 to -110) dBm (-127 to -120) dBm	0.17 dB 0.19 dB 0.22 dB 0.23 dB 0.27 dB 0.3 dB	HP 8902A Measuring Receiver with HP 11722A or with HP 11792A and HP 11793A Power Sensor
RF Absolute Power - Source	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 100 mV < V ≤ 1 V 20 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 0.05 mV 0.38 mV 0.029 mV 0.028 mV 0.032 mV 0.045 mV 0.08 mV 0.3 mV 0.7 mV 0.72 mV 0.79 mV 1.3 mV 3.7 mV	Function Generator and DVM Agilent 33250A, Agilent 33120A, Agilent 3458A Multimeter

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power - Source	1 V < V ≤ 3.5 V		Function Generator and DVM Agilent 33250A, Agilent 33120A, Agilent 3458A Multimeter
	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 mV	
	100 kHz < f ≤ 300 kHz	13 mV	
RF Absolute Power - Source	7dBm ≥ P ≥ 0 dBm		Signal Source and Step Attenuators PSG, ESG, 8496G/H and 8494G/H
	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	0.5 dB	
	1.1 GHz ≤ f ≤ 2.985 GHz	0.59 dB	
	2.985 GHz < f ≤ 4 GHz	0.69 dB	
	4 GHz < f ≤ 6 GHz	0.8 dB	
	-70 dBm > P ≥ -95 dBm		
	0.3 MHz ≤ f ≤ 1.1 GHz	0.5 dB	
	1.1 GHz ≤ f ≤ 2.985 GHz	0.6 dB	
	2.985 GHz < f ≤ 4 GHz	0.7 dB	
	4 GHz < f ≤ 6 GHz	0.8 dB	
	-95 dBm > P ≥ -125 dBm		
	0.3 MHz ≤ f ≤ 1.1 GHz	0.51 dB	
	1.1 GHz ≤ f ≤ 2.985 GHz	0.6 dB	
	2.985 GHz < f ≤ 4 GHz	0.7 dB	
	4 GHz < f ≤ 6 GHz	1.5 dB	
Rise Time Source	2 kHz to 2 MHz (200 to 300) ps	37 ps	Fluke 55xxA + SC600/1100 Multifunction Calibrator
	(2 to 10) MHz (200 to 350) ps	37 ps	
Pulse - Source Width	150 ps to 10 ns	0.13 ns	HP 8133A Pulse Generator

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pulse - Source Width	(10 to 100) ns 100 µs to 10 ms (10 to 100) ms (100 to 0.99) ms	(0.013 * Width) + 1.2 ns (0.013 * Width) + 0.14 µs (0.012 * Width) + 2 ns (0.012 * Width) + 0.19 µs	HP 8161A Pulse Generator
RMS Jitter - Period, Delay and Width	33 MHz to 3 GHz	10 ps	HP 8133A Pulse Generator

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

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

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

PARAMETER	Attenuation - Measure[1]									
REFERENCE STANDARD OR EQUIPMENT	N5230A/C + cal kit									
	Attenuation Levels (dB)									
Frequency Ranges	20	30	40	50	60	70	80	90	100	110
10 MHz ≤ f < 50 MHz	0.042	0.053	0.089	0.17	0.12	0.14	0.17	0.18	0.18	0.19
50 MHz ≤ f < 500 MHz	0.042	0.053	0.063	0.095	0.097	0.11	0.12	0.14	0.14	0.16
500 MHz ≤ f < 2 GHz	0.044	0.051	0.06	0.085	0.1	0.11	0.1	0.11	0.12	0.14
2 GHz ≤ f < 8 GHz	0.061	0.051	0.078	0.11	0.14	0.19	0.15	0.2	0.2	0.25
8 GHz ≤ f < 12 GHz	0.066	0.068	0.089	0.15	0.19	0.25	0.21	0.26	0.29	0.33
12 GHz ≤ f < 18 GHz	0.074	0.074	0.096	0.16	0.34	0.39	0.35	0.4	0.41	0.47
18 GHz ≤ f < 20 GHz	0.074	0.082	0.096							
20 GHz ≤ f < 26.5 GHz	0.12	0.12	0.12							
26.5 GHz ≤ f < 30 GHz	0.13	0.13	0.15							
30 GHz ≤ f < 40 GHz	0.14	0.15	0.17							
40 GHz ≤ f < 50 GHz	0.2	0.21	0.24							

PARAMETER	RF Power Measure[1]									
REFERENCE STANDARD OR EQUIPMENT	8482A, 8485A, 8487A, N8481B, N8482B, N9030A, E444xA, E9300A, E9304A, N8485A									
	Frequency Ranges (uncertainties in dB)									
Power 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 < 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	0.088	0.088	0.088	0.088	0.088	0.088	0.093	0.093
-130 dBm ≤ P < -110 dBm	0.13	0.13	0.079	0.079	0.079	0.079	0.079	0.079	0.084	0.084
-110 dBm ≤ P < -90 dBm	0.12	0.12	0.060	0.060	0.060	0.060	0.06	0.066	0.066	0.066
-90 dBm ≤ P < -30 dBm	0.12	0.12	0.049	0.049	0.049	0.049	0.049	0.049	0.057	0.057
-30 dBm ≤ P < -20 dBm	0.13	0.13	0.038	0.038	0.038	0.038	0.038	0.038	0.048	0.048
-20 dBm ≤ P < -10 dBm	0.13	0.13	0.038	0.038	0.038	0.038	0.038	0.038	0.048	0.048
-10 dBm ≤ P < 0 dBm	0.099	0.099	0.038	0.038	0.038	0.038	0.038	0.038	0.048	0.048
0 dBm ≤ P < 2 dBm	0.039	0.039	0.038	0.038	0.038	0.038	0.038	0.038	0.048	0.048
2 dBm ≤ P < 15 dBm	0.096	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.048	0.048
15 dBm ≤ P < 20 dBm	0.096	0.096	0.054	0.054	0.054	0.054	0.054	0.054	0.061	0.061
20 dBm ≤ P < 30 dBm	0.096	0.081	0.081	0.081	0.083	0.091	0.097	0.097	0.097	0.11
30 dBm ≤ P < 35 dBm		0.090	0.087	0.087	0.087	0.095	0.1	0.11	0.1	0.12
35 dBm ≤ P < 44 dBm		0.090	0.087	0.087	0.087	0.095	0.1	0.1	0.1	0.12

PARAMETER	RF Power Measure[1]							
REFERENCE STANDARD OR EQUIPMENT	8482A, 8485A, 8487A, N8481B, N8482B, N9030A, E444xA, E9300A, E9304A, N8485A, U8489A							
	Frequencies / Frequency Ranges (uncertainties in dB)							
Power 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	51 GHz ≤ f ≤ 55 GHz	56 GHz ≤ f ≤ 65 GHz	65 GHz ≤ f ≤ 67 GHz
-140 dBm ≤ P < -130 dBm	0.1	0.1	0.1	0.12	0.12			
-130 dBm ≤ P < -110 dBm	0.097	0.087	0.087	0.088	0.088			
-110 dBm ≤ P < -90 dBm	0.082	0.078	0.078	0.078	0.078			
-90 dBm ≤ P < -30 dBm	0.075	0.062	0.062	0.063	0.063			
-30 dBm ≤ P < -20 dBm	0.068	0.055	0.055	0.056	0.056			
-20 dBm ≤ P < -10 dBm	0.068	0.055	0.055	0.055	0.055	0.18	0.16	0.13
-10 dBm ≤ P < 0 dBm	0.068	0.055	0.055	0.056	0.056	0.18	0.16	0.13
0 dBm ≤ P < 2 dBm	0.068	0.055	0.055	0.056	0.056	0.18	0.16	0.13
2 dBm ≤ P < 15 dBm	0.068	0.055	0.055	0.056	0.056	0.18	0.16	0.13
15 dBm ≤ P < 20 dBm	0.078	0.067	0.067	0.068	0.068	0.18	0.16	0.13
20 dBm ≤ P < 30 dBm	0.11	0.12	0.13	0.16	0.17			

PARAMETER	(S11 - Reflection) Magnitude Uncertainty (lin) [1]
REFERENCE STANDARD OR EQUIPMENT	Reflection Coefficient 85054B, 85031B, ET33700, 85056A, 85058B

	Measured Magnitude (+/- Linear)									
Freq	≤ 0.1	> 0.1 to ≤ 0.2	> 0.2 to ≤ 0.3	> 0.3 to ≤ 0.4	> 0.4 to ≤ 0.5	> 0.5 to ≤ 0.6	> 0.6 to ≤ 0.7	> 0.7 to ≤ 0.8	> 0.8 to ≤ 0.9	> 0.9 to ≤ 1
(30 to 300) kHz	0.005 3	0.005 7	0.006 5	0.007 9	0.009 6	0.012	0.014	0.017	0.021	0.025
300 kHz to 20 MHz	0.002 4	0.002 6	0.002 9	0.00 28	0.003 1	0.003 5	0.003 9	0.004 3	0.004 6	0.004 9
(0.02 to 2) GHz	0.000 54	0.000 62	0.000 7	0.0008 1	0.000 93	0.001 1	0.001 2	0.001 4	0.001 6	0.001 7
(2 to 8) GHz	0.000 78	0.000 82	0.000 89	0.000 98	0.001 1	0.001 2	0.001 4	0.001 5	0.001 7	0.001 9
(8 to 20) GHz	0.001 4	0.001 4	0.001 5	0.001 5	0.001 6	0.001 7	0.001 8	0.002	0.002 3	0.002 6
(20 to 26.5) GHz	0.001 9	0.001 9	0.001 9	0.002	0.002	0.002 1	0.002 3	0.002 5	0.002 7	0.003 1
(26.5 to 40) GHz	0.003 9	0.004 1	0.004 4	0.004 9	0.005 6	0.006 6	0.007 7	0.009 1	0.011	0.012
(40 to 50) GHz	0.005 2	0.005 4	0.005 8	0.006 3	0.007	0.008 1	0.009 5	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) [1]
REFERENCE STANDARD OR EQUIPMENT	Reflection Coefficient 85054B, 85031B, ET33700, 85056A, 85058B

	Measured Magnitude (+/- Degrees)									
Freq:	≤ 0.1	> 0.1 to ≤ 0.2	> 0.2 to ≤ 0.3	> 0.3 to ≤ 0.4	> 0.4 to ≤ 0.5	> 0.5 to ≤ 0.6	> 0.6 to ≤ 0.7	> 0.7 to ≤ 0.8	> 0.8 to ≤ 0.9	> 0.9 to ≤ 1
(30 to 300) kHz	42	42	42	42	42	42	42	42	42	42
300 kHz to 20 MHz	0.91	0.55	0.43	0.38	0.34	0.32	0.3	0.29	0.28	0.27
(0.02 to 2) GHz	0.31	0.17	0.13	0.11	0.1	0.1	0.098	0.098	0.1	0.1
(2 to 8) GHz	0.45	0.24	0.17	0.14	0.12	0.12	0.11	0.11	0.11	0.11
(8 to 20) GHz	0.81	0.42	0.29	0.23	0.19	0.16	0.15	0.14	0.13	0.13
(20 to 26.5) GHz	1.1	0.55	0.38	0.29	0.24	0.2	0.18	0.17	0.17	0.17
(26.5 to 40) GHz	2.3	1.3	1	0.93	0.9	0.91	0.93	0.94	0.96	0.99
(40 to 50) GHz	3.1	1.7	1.3	1.2	1.1	1.1	1.1	1.2	1.2	1.2
(50 to 67) GHz	7.7	3.8	2.6	1.9	1.6	1.3	1.2	1	0.95	0.88

PARAMETER	(S21 - Transmission) Magnitude Uncertainty (dB) [1]
REFERENCE STANDARD OR EQUIPMENT	85054B, 85031B, ET33700, 85056A, 85058B

	Measured Magnitude (+/- Linear)								
Freq:	10 to ≤ 0	> 0 to ≤ 3	> 3 to ≤ 6	>-6 to ≤ 10	> 10 to ≤ 20	> 20 to ≤ 30	> 30 to ≤ 40	> 40 to ≤ 50	> 50 to ≤ 60
(30 to 300) kHz	0.047	0.047	0.047	0.047	0.026	0.027	0.029	0.032	0.065
300 kHz to 45 MHz	0.018	0.021	0.023	0.027	0.026	0.027	0.029	0.032	0.065
(45 to 130) MHz	0.016	0.015	0.015	0.017	0.02	0.03	0.052	0.074	0.13
(0.13 to 1.25) GHz	0.031	0.034	0.034	0.034	0.034	0.034	0.035	0.044	0.093
(1.25 to 4) GHZ	0.031	0.034	0.034	0.034	0.034	0.034	0.034	0.035	0.044
(4 to 5) GHz	0.032	0.035	0.035	0.035	0.035	0.035	0.035	0.036	0.045
(5 to 26.5) GHz	0.034	0.036	0.036	0.036	0.036	0.036	0.037	0.037	0.038
(26.5 to 40) GHz	0.037	0.039	0.039	0.039	0.039	0.039	0.04	0.04	0.048
(40 to 50) GHz	0.04	0.043	0.043	0.043	0.043	0.043	0.043	0.044	0.051
(50 to 67) GHz	0.094	0.094	0.095	0.096	0.099	0.11	0.14	0.28	0.78

PARAMETER	(S21 - Transmission) Phase Uncertainty (deg) [1]
REFERENCE STANDARD OR EQUIPMENT	85054B, 85031B, ET33700, 85056A, 85058B

	Measured Magnitude (+/- Degrees)								
Freq:	10 to ≤ 0	> 0 to ≤ 3	> 3 to ≤ 6	> 6 to ≤ -0	> 10 to ≤ 20	> 20 to ≤ 30	> 30 to ≤ 40	> 40 to ≤ 50	> 50 to ≤ 60
(30 to 300) kHz	0.46	0.46	0.46	0.46	0.23	0.23	0.23	0.23	0.58
300 kHz to 45 MHz	0.62	0.62	0.62	0.62	0.23	0.23	0.23	0.23	0.58
(45 to 130) MHz	0.16	0.16	0.16	0.17	0.19	0.26	0.66	0.6	0.92
(0.13 to 1.25) GHz	0.37	0.37	0.37	0.37	0.38	0.38	0.38	0.41	0.68
(1.25 to 4) GHZ	0.42	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.46
(4.0 to 5) GHz	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.53
(5 to 26.5) GHz	0.89	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
(26.5 to 40) GHz	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
(40 to 50) GHz	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
(50 to 67) GHz	0.63	0.63	0.64	0.66	0.67	0.76	0.97	1.9	5.5

Mm Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure	(-50 to <0) °C (≥0 to ≤60) °C (>60 to 120) °C	0.5 °C 0.35 °C 0.52 °C	Vaisala HM70 Thermohygrometer

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency - Source	10 MHz	6.5 x 10-11 Hz	Symmetricom 8040 Rubidium Standard
Frequency - Measure	(10 to 100) Hz (100 to 1 000) Hz 1 kHz to 12.4 GHz 50 MHz to 26.5 GHz	71 pHz/Hz + 0.15 nHz 68 pHz/Hz + 0.5 nHz 67 pHz/Hz 30 pHz/Hz + 3.75 Hz	HP 53132A Counter, Symmetricom 8040 Rubidium Standard

Calibration and Measurement Capability (CMC) is expressed in terms of the measurement parameter, measurement range, expanded uncertainty of measurement and reference standard, method, and/or equipment. The expanded uncertainty of measurement is expressed as the standard uncertainty of the measurement multiplied by a coverage factor of 2 (k=2), corresponding to a confidence level of approximately 95%.

Notes:

1. On-site calibration service is available for this parameter, since on-site conditions are typically more variable than those in the laboratory, larger measurement uncertainties are expected on-site than what is reported on the accredited scope.
2. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1498.17.

Vice President