



# CERTIFICATE OF ACCREDITATION

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

This is to certify that

**Techmaster Electronics, Inc.**  
**2453 Cades Way, Suite C**  
**Vista, CA 92081**  
**(and satellite locations as listed on the scope)**

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

**ISO/IEC 17025:2017**

and national standard

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

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-1736

Certificate Number



ANAB Approval

Certificate Valid Through: 10/29/2020  
Version No. 009 Issued: 02/04/2020



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  
AND ANSI/NCSL Z540-1-1994 (R2002)**

**Techmaster Electronics, Inc.**

2453 Cades Way, Suite C  
Vista, CA 92081

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Services performed at satellite locations as indicated  
46782 Lakeview Blvd. Fremont, CA 94538  
6925 Lake Ellenor Drive, Suite 134 Orlando, FL 32809

**CALIBRATION**

Valid to: **October 29, 2020**

Certificate Number: **AC-1736**

**Acoustics and Vibration**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Vibration	(0.2 to 36) gpk (1 to 20) Hz (20 to 100) Hz (100 to 2500) Hz (2500 to 10 000) Hz	3.1 % of reading + 0.04 g 3.1 % of reading + 0.04 g 3.1 % of reading + 0.04 g 3.4 % of reading + 0.04 g	Vibration Calibrator System  Orlando, FL

**Chemical Quantities**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH - Source	4.01 pH 7.00 PH 10.00 pH	0.014 pH 0.027 pH 0.024 pH	Standard Solutions  Vista, CA Fremont, CA Orlando, FL
Conductivity - Source	(445 to 3 900) µS	1 % of calibrated value	Standard Solutions  Vista, CA Fremont, CA Orlando, FL



**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage - Source <sup>1</sup>	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	0.65 % of reading + 0.58 $\mu$ V 4.6 $\mu$ V/V + 0.8 $\mu$ V 3.2 $\mu$ V/V + 3.2 $\mu$ V 2.4 $\mu$ V/V + 27 $\mu$ V 4.7 $\mu$ V/V + 43 $\mu$ V 6 $\mu$ V/V + 0.85 mV	High Performance Multifunction Calibrator  Vista, CA
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	7.5 $\mu$ V/V + 0.4 $\mu$ V 5 $\mu$ V/V + 1 $\mu$ V 3.5 $\mu$ V/V + 3.1 $\mu$ V 3.5 $\mu$ V/V + 8.1 $\mu$ V 5 $\mu$ V/V + 83 $\mu$ V 6.5 $\mu$ V/V + 0.68 mV	High Performance Multifunction Calibrator  Fremont, CA Orlando, FL
DC Voltage - Source <sup>1</sup> Fixed Points	1 V 1.018 V 10 V	14 $\mu$ V 17 $\mu$ V 35 $\mu$ V	DC Reference Standard  Vista, CA
DC Voltage - Measure <sup>1</sup>	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	7.2 $\mu$ V/V + 0.55 $\mu$ V 7 $\mu$ V/V + 0.42 $\mu$ V 6.9 $\mu$ V/V + 0.86 $\mu$ V 9.2 $\mu$ V/V + 38 $\mu$ V 9.3 $\mu$ V/V + 0.13 mV	Precision 8.5 Digit Multimeter  Fremont, CA Orlando, FL
	(2 to 200) mV 200 mV to 2 V (2 to 20) V (20 to 200) V 200 V to 1 kV	6.7 $\mu$ V/V + 0.20 $\mu$ V 4.3 $\mu$ V/V + 0.50 $\mu$ V 4.3 $\mu$ V/V + 4.8 $\mu$ V 6.7 $\mu$ V/V + 98 $\mu$ V 6.7 $\mu$ V + 0.63 mV	Precision 8.5 DigitMultimeter  Vista CA
	(1 to 40) kV	5 mV/V	High Voltage Probe with Digital Multimeter  Vista, CA Fremont, CA Orlando, FL
DC Current - Source <sup>1</sup>	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 11) A	0.003 7 % of reading + 5.8 nA 0.003 1 % of reading + 7.4 nA 0.003 1 % of reading + 44 nA 0.004 % of reading + 0.69 $\mu$ A 72 $\mu$ A/A + 14 $\mu$ A 0.023 % of reading + 0.47 mA	High Performance Multifunction Calibrator w/ Transconductance Amplifier  Vista, CA



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
	Up to 220 $\mu$ A 220 $\mu$ A to 2.2 mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	40 $\mu$ A/A + 6 nA 35 $\mu$ A/A + 7.6 nA 35 $\mu$ A/A + 48 nA 55 $\mu$ A/A + 0.74 $\mu$ A 0.13 mA/A + 13 $\mu$ A	High Performance Multifunction Calibrator  Fremont, CA Orlando, FL
DC Current - Source <sup>1</sup>	330 mA to 1.1 A (1.1 to 3) A (3 to 11) A (11 to 20) A	0.15 mA/A + 44 $\mu$ A 0.27 mA/A + 0.13 mA 0.39 mA/A + 0.41 mA 0.79 mA/A + 0.41 mA	Multi Product Calibrator  Vista, CA Fremont, CA Orlando, FL
DC Current - Source <sup>1</sup> Clamp-On Ammeters	(20 to 150) A (150 to 1 025) A	0.05 % of reading + 3.1 mA 0.1 % of reading	Multi Product Calibrator w/ Current Coil  Vista, CA Fremont, CA Orlando, FL
DC Power - Source <sup>1</sup> 33 mV to 1 020 V 329.99 mA range 2.9999 A range 20.5 A range	10 $\mu$ W to 330 W 10 mW to 3 kW 100 mW to 21 kW	0.01 % of reading + 1.2 nW 0.04 % of reading 0.1 % of reading	Multi Product Calibrator  Vista, CA Fremont, CA Orlando, FL
DC Current - Measure <sup>1</sup>	Up to 100 nA 100 nA to 1 $\mu$ A (1 to 10) $\mu$ A (10 to 100) $\mu$ A 100 $\mu$ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	22 $\mu$ A/A + 93 pA 18 $\mu$ A/A + 0.1 nA 28 $\mu$ A/A + 0.14 nA 30 $\mu$ A/A + 0.98 nA 30 $\mu$ A/A + 6.5 nA 30 $\mu$ A/A + 63 nA 44 $\mu$ A/A + 1 $\mu$ A 0.14 mA/A + 12 $\mu$ A	Precision 8.5 Digit Multimeter  Fremont, CA Orlando, FL
	(2 to 200) $\mu$ A (200 $\mu$ A to 2) mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A	15 $\mu$ A/A + 0.49 nA 15 $\mu$ A/A + 4.8 nA 17 $\mu$ A/A + 48 nA 59 $\mu$ A/A + 0.96 $\mu$ A 0.23 mA/A + 25 $\mu$ A 0.49 mA/A + 0.36 mA	Precision 8.5 Digit Multimeter  Vista, CA



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## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
	(1 to 100) A (100 to 600) A	85 $\mu$ A/A 127 $\mu$ A/A	Precision 8.5 Digit Multimeter w/ Current Shunts  Vista, CA Fremont, CA Orlando, FL
AC Voltage - Source <sup>1</sup>	(1 to 2.2) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (2.2 to 22) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (22 to 220) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (22 to 220) mV (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.013 % of reading + 7.2 $\mu$ V 0.008 3 % of reading + 4.2 $\mu$ V 0.007 2 % of reading + 4.2 $\mu$ V 0.016 % of reading + 4.6 $\mu$ V 0.042 % of reading + 5.3 $\mu$ V 0.095 % of reading + 10 $\mu$ V 0.13 % of reading + 20 $\mu$ V 0.25 % of reading + 21 $\mu$ V 0.021 % of reading + 4.9 $\mu$ V 0.008 3 % of reading + 4.3 $\mu$ V 0.007 % of reading + 4.4 $\mu$ V 0.017 % of reading + 4.8 $\mu$ V 0.042 % of reading + 6.1 $\mu$ V 0.092 % of reading + 12 $\mu$ V 0.13 % of reading + 22 $\mu$ V 0.22 % of reading + 33 $\mu$ V 0.022 % of reading + 16 $\mu$ V 0.006 4 % of reading + 15 $\mu$ V 0.004 4 % of reading + 10 $\mu$ V 0.009 % of reading + 14 $\mu$ V 0.028 % of reading + 23 $\mu$ V 0.056 % of reading + 35 $\mu$ V 0.13 % of reading + 39 $\mu$ V 0.23 % of reading + 0.12 mV	High Performance Multifunction Calibrator w/ Transconductance Amplifier  Vista, CA

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Source <sup>1</sup>	220 mV to 2.2 V		High Performance Multifunction Calibrator w/ Transconductance Amplifier  Vista, CA
	(10 to 20) Hz	0.021 % of reading + 0.1 mV	
	(20 to 40) Hz	82 $\mu$ V/V + 32 $\mu$ V	
	40 Hz to 20 kHz	39 $\mu$ V/V + 22 $\mu$ V	
	(20 to 50) kHz	44 $\mu$ V/V + 62 $\mu$ V	
	(50 to 100) kHz	71 $\mu$ V/V + 55 $\mu$ V	
	(100 to 300) kHz	0.3 mV/V + 0.12 mV	
	(300 to 500) kHz	0.89 mV/V + 0.3 mV	
	500 kHz to 1 MHz	1.5 mV/V + 0.6 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.2 mV/V + 1.1 mV	
	(20 to 40) Hz	68 $\mu$ V/V + 0.63 mV	
	40 Hz to 20 kHz	19 $\mu$ V/V + 0.7 mV	
	(20 to 50) kHz	44 $\mu$ V/V + 0.61 mV	
	(50 to 100) kHz	0.006 1 % + 0.65 mV	
	(100 to 300) kHz	0.19 mV/V + 1.9 mV	
	(300 to 500) kHz	0.9 mV/V + 2.8 mV	
	500 kHz to 1 MHz	1.1 mV/V + 11 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.2 mV/V + 11 mV	
	(20 to 40) Hz	44 $\mu$ V/V + 17 mV	
	40 Hz to 20 kHz	38 $\mu$ V/V + 4.1 mV	
	(20 to 50) kHz	53 $\mu$ V/V + 8 mV	
	(50 to 100) kHz	0.11 mV/V + 10 mV	
	(100 to 300) kHz	0.84 mV/V + 19 mV	
	(300 to 500) kHz	4.2 mV/V + 45 mV	
	500 kHz to 1 MHz	7.7 mV/V + 90 mV	
	(220 to 1 100) V		
40 Hz to 1 kHz	50 $\mu$ V/V + 27 mV		
(1 to 20) kHz	0.1 mV/V + 31 mV		
(20 to 30) kHz	0.41 mV/V + 70 mV		
(220 to 750) V			
(30 to 50) kHz	0.45 mV/V + 12 mV		
(50 to 100) kHz	1.8 mV/V + 21 mV		



**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source	(1 to 2.2) mV		High Performance Multifunction Calibrator w/ Transconductance Amplifier  Fremont, CA Orlando, FL
	(10 to 20) Hz	0.55 mV/V + 4.5 $\mu$ V	
	(20 to 40) Hz	0.21 mV/V + 4.5 $\mu$ V	
	40 Hz to 20 kHz	0.11 mV/V + 4.5 $\mu$ V	
	(20 to 50) kHz	0.37 mV/V + 4.5 $\mu$ V	
	(50 to 100) kHz	0.85 mV/V + 7 $\mu$ V	
	(100 to 300) kHz	1.1 mV/V + 13 $\mu$ V	
	(300 to 500) kHz	1.7 mV/V + 25 $\mu$ V	
	500 kHz to 1 MHz	3.4 mV/V + 25 $\mu$ V	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.55 mV/V + 5 $\mu$ V	
	(20 to 40) Hz	0.21 mV/V + 5 $\mu$ V	
	40 Hz to 20 kHz	0.11 mV/V + 5 $\mu$ V	
	(20 to 50) kHz	0.37 mV/V + 5 $\mu$ V	
	(50 to 100) kHz	0.85 mV/V + 7 $\mu$ V	
	(100 to 300) kHz	1.1 mV/V + 12 $\mu$ V	
	(300 to 500) kHz	1.7 mV/V + 25 $\mu$ V	
	500 kHz to 1 MHz	3.4 mV/V + 25 $\mu$ V	
	(22 to 220) mV		
	(10 to 20) Hz	0.55 mV/V + 13 $\mu$ V	
	(20 to 40) Hz	0.21 mV/V + 8 $\mu$ V	
	40 Hz to 20 kHz	0.11 mV/V + 8 $\mu$ V	
	(20 to 50) kHz	0.32 mV/V + 8 $\mu$ V	
	(50 to 100) kHz	0.85 mV/V + 25 $\mu$ V	
	(100 to 300) kHz	1.1 mV/V + 25 $\mu$ V	
	(300 to 500) kHz	1.7 mV/V + 35 $\mu$ V	
	500 kHz to 1 MHz	3.4 mV/V + 80 $\mu$ V	
	220 mV to 2.2 V		
(10 to 20) Hz	0.24 mV/V + 45 $\mu$ V		
(20 to 40) Hz	90 $\mu$ V/V + 25 $\mu$ V		
40 Hz to 20 kHz	45 $\mu$ V/V + 21 $\mu$ V		
(20 to 50) kHz	75 $\mu$ V/V + 22 $\mu$ V		
(50 to 100) kHz	0.11 mV/V + 82 $\mu$ V		
(100 to 300) kHz	0.42 mV/V + 0.11 mV		
(300 to 500) kHz	1 mV/V + 0.22 mV		
500 kHz to 1 MHz	1.7 mV/V + 0.31 mV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source	(2.2 to 22) V		High Performance Multifunction Calibrator w/ Transconductance Amplifier  Fremont, CA Orlando, FL
	(10 to 20) Hz	0.24 mV/V + 0.44 mV	
	(20 to 40) Hz	90 $\mu$ V/V + 0.24 mV	
	40 Hz to 20 kHz	45 $\mu$ V/V + 0.19 mV	
	(20 to 50) kHz	75 $\mu$ V/V + 0.11 mV	
	(50 to 100) kHz	0.1 mV/V + 0.59 mV	
	(100 to 300) kHz	0.28 mV/V + 0.81 mV	
	(300 to 500) kHz	1 mV/V + 2.1 V	
	500 kHz to 1 MHz	1.5 mV/V + 3.3 V	
	(22 to 220) V		
	(10 to 20) Hz	0.24 mV/V + 4.4 mV	
	(20 to 40) Hz	90 $\mu$ V/V + 2.3 mV	
	40 Hz to 20 kHz	52 $\mu$ V/V + 1.8 mV	
	(20 to 50) kHz	80 $\mu$ V/V + 1.9 mV	
	(50 to 100) kHz	0.15 mV/V + 5.3 mV	
	(100 to 300) kHz	0.9 mV/V + 17 mV	
	(300 to 500) kHz	4.4 mV/V + 41 mV	
	500 kHz to 1 MHz	8 mV/V + 81 mV	
	(220 to 250) V		
	(15 to 50) Hz	0.3 mV/V + 17 mV	
	50 Hz to 1 kHz	70 $\mu$ V/V + 3.9 mV	
	220 V to 1.1 kV		
	40 Hz to 1 kHz	90 $\mu$ V/V + 5.3 mV	
	(1 to 20) kHz	0.17 mV/V + 6.8 mV	
	(20 to 30) kHz	0.6 mV/V + 12 mV	
	(220 to 750) V		
	(30 to 50) kHz	0.6 mV/V + 12 mV	
(50 to 100) kHz	2.3 mV/V + 46 mV		
220 V to 1.1 kV			
40 Hz to 1 kHz	90 $\mu$ V/V + 5.3 mV		
(1 to 20) kHz	0.17 mV/V + 6.8 mV		
(20 to 30) kHz	0.6 mV/V + 12 mV		
(220 to 750) V			
(30 to 50) kHz	0.6 mV/V + 12 mV		
(50 to 100) kHz	2.3 mV/V + 46 mV		



**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure <sup>1</sup>	(1 to 10) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (10 to 100) mV (1 Hz to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz 100 mV to 10 V (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz (10 to 100) V (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 (100 to 1 000) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.36 mV/V + 3.6 μV 0.23 mV/V + 1.4 μV 0.32 mV/V + 1.7 μV 1.2 mV/V + 1.6 μV 5.7 mV/V + 2 μV 46 mV/V + 2.6 μV 72 μV/V + 0.85 mV 84 μV/V + 0.26 mV 0.17 mV/V + 0.26 mV 0.35 mV/V + 0.25 mV 0.93 mV/V + 0.27 mV 3.5 mV/V + 1.2 mV 12 mV/V + 1.2 mV 18 mV/V + 1.2 mV 0.24 mV/V + 4.7 mV 0.15 mV/V + 16 mV 0.15 mV/V + 17 mV 0.36 mV/V + 8.6 mV 1.4 mV/V + 3.9 mV 4.8 mV/V + 12 mV 18 mV/V + 12 mV 0.46 mV/V + 50 mV 0.46 mV/V + 28 mV 0.69 mV/V + 29 mV 1.5 mV/V + 24 mV 3.6 mV/V + 24 mV	Precision 8.5 Digit Multimeter  Fremont, CA Orlando, FL
AC Voltage - Measure <sup>1</sup>	(1 to 40) kV 60 Hz	77 mV /V	High Voltage Probe with Digital Multimeter  Vista, CA Fremont, CA Orlando, FL

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure <sup>1</sup>	Up to 200 mV		Precision 8.5 Digit Multimeter w/ Current Shunts  Vista, CA
	(1 to 10) Hz	0.2 mV/V + 29 $\mu$ V	
	(10 to 40) Hz	0.17 mV/V + 5 $\mu$ V	
	(40 to 100) Hz	0.14 mV/V + 5 $\mu$ V	
	100 Hz to 2 kHz	0.17 mV/V + 2 $\mu$ V	
	(2 to 10) kHz	0.17 mV/V + 5 $\mu$ V	
	(10 to 30) kHz	0.42 mV/V + 10 $\mu$ V	
	(30 to 100) kHz	0.93 mV/V + 24 $\mu$ V	
	200 mV to 2 V		
	(1 to 10) Hz	0.19 mV/V + 0.33 mV	
	(10 to 40) Hz	0.15 mV/V + 3 $\mu$ V	
	(40 to 100) Hz	0.12 mV/V + 24 $\mu$ V	
	100 Hz to 2 kHz	0.17 mV/V + 24 $\mu$ V	
	(2 to 10) kHz	0.14 mV/V + 24 $\mu$ V	
	(10 to 30) kHz	0.27 mV/V + 48 $\mu$ V	
	(30 to 100) kHz	0.7 mV/V + 0.24 mV	
	(2 to 20) V		
	(1 to 10) Hz	0.18 mV/V + 3.3 mV	
	(10 to 40) Hz	0.14 mV/V + 0.3 mV	
	(40 to 100) Hz	0.11 mV/V + 0.24 mV	
	100 Hz to 2 kHz	0.15 mV/V + 0.24 mV	
	(2 to 10) kHz	0.14 mV/V + 0.24 mV	
	(10 to 30) kHz	0.27 mV/V + 0.48 mV	
	(30 to 100) kHz	0.69 mV/V + 2.4 mV	
	(100 to 300) kHz	3.6 mV/V + 24 mV	
	300 kHz to 1 MHz	12 mV/V + 0.24 mV	
	(20 to 200) V		
	1 to 10 Hz	0.19 mV/V + 58 mV	
(10 to 40) Hz	0.15 mV/V + 2.7 mV		
(40 to 100) Hz	0.12 mV/V + 2.4 mV		
100 Hz to 2 kHz	0.15 mV/V + 2.4 mV		
(2 to 10) kHz	0.14 mV/V + 2.4 mV		
(10 to 30) kHz	0.27 mV/V + 4.8 mV		
(30 to 100) kHz	0.69 mV/V + 24 mV		
(100 to 300) kHz	3.6 mV/V + 0.24 mV		
300 kHz to 1 MHz	12 mV/V + 2.4 V		



# ANSI National Accreditation Board

## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure <sup>1</sup>	200 V to 1 kV (1 to 10) Hz (10 to 40) Hz 40 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz	0.19 mV/V + 84 mV 0.16 mV/V + 24 mV 0.29 mV/V + 24 mV 0.28 mV/V + 48 mV 0.72 mV/V + 0.24 V	Precision 8.5 Digit Multimeter w/ Current Shunts  Vista, CA
AC Voltage Flatness - Source (Referenced to 1 kHz)	0.3 mV to 3.5 V (10 to 30) Hz 30 Hz to 120 kHz (0.3 to 1.1) mV 120 kHz to 2 MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (1.1 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	0.35 % of reading 0.12 % of reading 0.24 % of reading + 3 μV 0.47 % of reading + 3 μV 0.7 % of reading + 3 μV 1.8 % of reading + 15 μV 0.12 % of reading + 3 μV 0.35 % of reading + 3 μV 0.58 % of reading + 3 μV 1.8 % of reading + 3 μV 0.12 % of reading + 3 μV 0.24 % of reading + 3 μV 0.47 % of reading + 3 μV 1.2 % of reading + 3 μV	High Performance Multifunction Calibrator (Wideband)  Vista, CA Fremont, CA Orlando, FL
AC Voltage Flatness - Measure	Up to 3 V (10 to 100) Hz 100 Hz to 10 kHz (10 to 30) kHz 30 kHz to 1 MHz (1 to 10) MHz (10 to 30) MHz (30 to 50) MHz (50 to 70) MHz (70 to 80) MHz (80 to 100) MHz	0.2 % of reading 0.051 % of reading 0.059 % of reading 0.13 % of reading 0.21 % of reading 0.26 % of reading 0.42 % of reading 0.65 % of reading 0.77 % of reading 0.97 % of reading	Precision 8.5 Digit Multimeter w/ Thermal Converters  Vista, CA Fremont, CA Orlando, FL

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure <sup>1</sup>	Up to 2.2 mV		AC Measurement Standard  Vista, CA Orlando, FL
	(10 to 20) Hz	1.6 mV/V + 1.6 μV	
	(20 to 40) Hz	1.6 mV/V + 1.6 μV	
	40 Hz to 20 kHz	0.4 mV/V + 1.7 μV	
	(20 to 50) kHz	0.8 mV/V + 2.2 μV	
	(50 to 100) kHz	1.2 mV/V + 2.7 μV	
	(100 to 300) kHz	2.3 mV/V + 4.1 μV	
	(300 to 500) kHz	2.4 mV/V + 8.1 μV	
	500 kHz to 1 MHz	3.5 mV/V + 8.1 μV	
	(2.2 to 7) mV		
	(10 to 20) Hz	0.8 mV/V + 1.4 μV	
	(20 to 40) Hz	0.4 mV/V + 1.5 μV	
	40 Hz to 20 kHz	0.2 mV/V + 1.5 μV	
	(20 to 50) kHz	0.4 mV/V + 2.1 μV	
	(50 to 100) kHz	0.6 mV/V + 2.6 μV	
	(100 to 300) kHz	1.2 mV/V + 4.1 μV	
	(300 to 500) kHz	1.3 mV/V + 6 μV	
	500 kHz to 1 MHz	2 mV/V + 6 μV	
	(7 to 22) mV		
	(10 to 20) Hz	0.3 mV/V + 1.6 μV	
	(20 to 40) Hz	0.3 mV/V + 1.6 μV	
	40 Hz to 20 kHz	0.1 mV/V + 1.7 μV	
	(20 to 50) kHz	0.2 mV/V + 2.3 μV	
	(50 to 100) kHz	0.3 mV/V + 2.7 μV	
	(100 to 300) kHz	0.8 mV/V + 4.1 μV	
	(300 to 500) kHz	0.9 mV/V + 6.1 μV	
	500 kHz to 1 MHz	1.4 mV/V + 6.1 μV	
	(22 to 70) mV		
	(10 to 20) Hz	2 mV/V + 5.3 μV	
	(20 to 40) Hz	80 μV/V + 6.3 μV	
40 Hz to 20 kHz	40 μV/V + 6.8 μV		
(20 to 50) kHz	0.1 mV/V + 6.4 μV		
(50 to 100) kHz	0.23 mV/V + 5.8 μV		
(100 to 300) kHz	0.5 mV/V + 6 μV		
(300 to 500) kHz	0.7 mV/V + 9.4 μV		
500 kHz to 1 MHz	1.1 mV/V + 9 μV		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure <sup>1</sup>	(70 to 220) mV		AC Measurement Standard  Vista, CA Orlando, FL
	(10 to 20) Hz	0.2 mV/V + 1.6 $\mu$ V	
	(20 to 40) Hz	80 $\mu$ V/V + 1.7 $\mu$ V	
	40 Hz to 20 kHz	40 $\mu$ V/V + 1.8 $\mu$ V	
	(20 to 50) kHz	70 $\mu$ V/V + 2.2 $\mu$ V	
	(50 to 100) kHz	0.2 mV/V + 2.6 $\mu$ V	
	(100 to 300) kHz	0.3 mV/V + 4.1 $\mu$ V	
	(300 to 500) kHz	0.4 mV/V + 8 $\mu$ V	
	500 kHz to 1 MHz	1 mV/V + 8 $\mu$ V	
	(220 to 700) mV		
	(10 to 20) Hz	0.21 mV/V + 1.5 $\mu$ V	
	(20 to 40) Hz	0.21 mV/V + 1.5 $\mu$ V	
	40 Hz to 20 kHz	30 $\mu$ V/V + 1.7 $\mu$ V	
	(20 to 50) kHz	50 $\mu$ V/V + 2.1 $\mu$ V	
	(50 to 100) kHz	80 $\mu$ V/V + 2.6 $\mu$ V	
	(100 to 300) kHz	0.2 mV/V + 4 $\mu$ V	
	(300 to 500) kHz	0.3 mV/V + 8 $\mu$ V	
	500 kHz to 1 MHz	0.3 mV/V + 8 $\mu$ V	
	700 mV to 2.2 V		
	(10 to 20) Hz	0.2 mV/V + 4.7 $\mu$ V	
	(20 to 40) Hz	0.62 mV/V + 13 $\mu$ V	
	40 Hz to 20 kHz	0.17 mV/V + 23 $\mu$ V	
	(20 to 50) kHz	0.41 mV/V + 16 $\mu$ V	
	(50 to 100) kHz	0.67 mV/V + 12 $\mu$ V	
	(100 to 300) kHz	0.16 mV/V + 6 $\mu$ V	
	(300 to 500) kHz	0.26 mV/V + 4 $\mu$ V	
	500 kHz to 1 MHz	9 mV/V + 1.1 $\mu$ V	
	(2.2 to 7) V		
	(10 to 20) Hz	0.2 mV/V + 1.1 $\mu$ V	
	(20 to 40) Hz	0.7 mV/V + 3.2 $\mu$ V	
40 Hz to 20 kHz	0.23 mV/V + 8.4 $\mu$ V		
(20 to 50) kHz	0.5 mV/V + 4.4 $\mu$ V		
(50 to 100) kHz	0.8 mV/V + 2.7 $\mu$ V		
(100 to 300) kHz	0.19 mV/V + 1.1 $\mu$ V		
(300 to 500) kHz	0.4 mV/V + 0.5 $\mu$ V		
500 kHz to 1 MHz	1.2 mV/V + 0.2 $\mu$ V		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure <sup>1</sup>	(7 to 22) V		AC Measurement Standard  Vista, CA Orlando, FL
	(10 to 20) Hz	0.2 mV/V + 3.7 μV	
	(20 to 40) Hz	0.7 mV/V + 11 μV	
	40 Hz to 20 kHz	0.3 mV/V + 26 μV	
	(20 to 50) kHz	0.5 mV/V + 15 μV	
	(50 to 100) kHz	0.8 mV/V + 9.1 μV	
	(100 to 300) kHz	0.29 mV/V + 4 μV	
	(300 to 500) kHz	0.4 mV/V + 1.9 μV	
	500 kHz to 1 MHz	1.2 mV/V + 0.6 μV	
	(22 to 70) V		
	(10 to 20) Hz	0.2 mV/V + 9.1 μV	
	(20 to 40) Hz	70 μV/V + 27 μV	
	40 Hz to 20 kHz	30 μV/V + 55 μV	
	(20 to 50) kHz	60 μV/V + 32 μV	
	(50 to 100) kHz	90 μV/V + 19 μV	
	(100 to 300) kHz	0.2 mV/V + 9.1 μV	
	(300 to 500) kHz	0.4 mV/V + 4.4 μV	
	500 kHz to 1 MHz	1.2 mV/V + 1.5 μV	
	(70 to 220) V		
	(10 to 20) Hz	0.20 mV/V + 7.1 μV	
	(20 to 40) Hz	70 μV/V + 21 μV	
	40 Hz to 20 kHz	30 μV/V + 45 μV	
	(20 to 50) kHz	70 μV/V + 21 μV	
	(50 to 100) kHz	0.1 mV/V + 14 μV	
	(100 to 300) kHz	0.21 mV/V + 6.8 μV	
	(300 to 500) kHz	0.5 mV/V + 2.8 μV	
	(220 to 700) V		
	(10 to 20) Hz	0.2 mV/V + 77 μV	
	(20 to 40) Hz	0.1 mV/V + 0.16 mV	
	40 Hz to 20 kHz	40 μV/V + 0.37 mV	
(20 to 50) kHz	0.13 mV/V + 0.12 mV		
(50 to 100) kHz	0.5 mV/V + 31 μV		
700 V to 1 kV			
(10 to 20) Hz	0.2 mV/V + 31 μV		
(20 to 40) Hz	0.1 mV/V + 62 μV		
40 Hz to 20 kHz	40 μV/V + 0.16 mV		
(20 to 50) kHz	0.13 mV/V + 47 μV		
(50 to 100) kHz	0.5 mV/V + 12 μV		



**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure	Up to 10 mV		Precision 8.5 Digit Multimeter ACBAND < 2 MHz  Vista, CA Fremont, CA Orlando, FL
	(1 to 40) Hz	3.5 $\mu\text{V}/\text{V}$ + 4.6 $\mu\text{V}$	
	40 Hz to 1 kHz	2.4 $\mu\text{V}/\text{V}$ + 3.2 $\mu\text{V}$	
	(1 to 20) kHz	3.5 $\mu\text{V}/\text{V}$ + 4.6 $\mu\text{V}$	
	(20 to 50) kHz	12 $\mu\text{V}/\text{V}$ + 3.2 $\mu\text{V}$	
	(50 to 100) kHz	58 $\mu\text{V}/\text{V}$ + 3.2 $\mu\text{V}$	
	(100 to 300) kHz	0.47 mV/V + 3.8 $\mu\text{V}$	
	(10 to 100) mV		
	(1 to 40) Hz	86 $\mu\text{V}/\text{V}$ + 4.6 $\mu\text{V}$	
	40 Hz to 1 kHz	86 $\mu\text{V}/\text{V}$ + 2.3 $\mu\text{V}$	
	(1 to 20) kHz	0.17 mV/V + 2.3 $\mu\text{V}$	
	(20 to 50) kHz	0.35 mV/V + 2.3 $\mu\text{V}$	
	(50 to 100) kHz	0.93 mV/V + 2.3 $\mu\text{V}$	
	(100 to 300) kHz	3.5 mV/V + 12 $\mu\text{V}$	
	300 kHz to 1 MHz	12 mV/V + 12 $\mu\text{V}$	
	(1 to 2) MHz	18 mV/V + 12 $\mu\text{V}$	
	100 mV to 1 V		
	(1 to 40) Hz	92 $\mu\text{V}/\text{V}$ + 50 $\mu\text{V}$	
	40 Hz to 1 kHz	92 $\mu\text{V}/\text{V}$ + 31 $\mu\text{V}$	
	(1 to 10) V		
	(1 to 20) kHz	0.17 mV/V + 31 $\mu\text{V}$	
	(20 to 50) kHz	0.35 mV/V + 31 $\mu\text{V}$	
	(50 to 100) kHz	0.93 mV/V + 31 $\mu\text{V}$	
	(100 to 300) kHz	3.5 mV/V + 0.12 mV	
	300 kHz to 1 MHz	12 mV/V + 0.12 mV	
	(1 to 2) MHz	18 mV/V + 0.12 mV	
	(10 to 100) V		
	(1 to 40) Hz	91 $\mu\text{V}/\text{V}$ + 0.14 mV	
40 Hz to 1 kHz	91 $\mu\text{V}/\text{V}$ + 0.14 mV		
(1 to 20) kHz	0.17 mV/V + 0.14 mV		
(20 to 50) kHz	0.35 mV/V + 0.14 mV		
(50 to 100) kHz	0.93 mV/V + 0.14 mV		
(100 to 300) kHz	3.5 mV/V + 0.16 mV		
300 kHz to 1 MHz	1.2 mV/V + 0.16 mV		
(1 to 2) MHz	1.8 mV/V + 0.16 mV		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure	(100 to 750) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.45 mV/V + 2.7 mV 0.45 mV/V + 2.7 mV 0.45 mV/V + 2.7 mV 0.56 mV/V + 2.7 mV 1.5 mV/V + 2.7 mV 4.7 mV/V + 2.7 mV 18 mV/V + 2.7 mV	Precision 8.5 Digit Multimeter ACBAND < 2 MHz  Vista, CA Fremont, CA Orlando, FL
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 11 mV to 10 V 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (11 to 100) V 45 Hz to 100 kHz 100 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz (100 to 750) V 45 Hz to 100 kHz	0.46 mV/V + 47 mV 0.46 mV/V + 24 mV 0.69 mV/V + 24 mV 1.4 mV/V + 24 mV 3.5 mV/V + 24 mV 1 mV/V + 7.5 μV 14 mV/V + 6.5 μV 81 mV/V + 8.6 μV 0.24 V + 9.7 μV 1 mV/V + 0.7 mV 24 mV/V + 0.58 mV 47 mV/V + 0.81 mV 47 mV/V + 0.93 mV 0.18 V + 1.2 mV 1.5 mV/V + 2.7 mV	Precision 8.5 Digit Multimeter ACBAND > 2 MHz  Vista, CA Fremont, CA Orlando, FL
AC Current - Source <sup>1</sup>	(9 to 220) μA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 220 μA to 2.2 mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.02 % of reading + 26 nA 0.01 % of reading + 30 nA 0.01 % of reading + 8.3 nA 0.02 % of reading + 36 nA 0.1 % of reading + 63 nA  0.004 8 % of reading + 1.4 μA 0.006 1 % of reading + 0.44 μA 0.007 2 % of reading + 95 nA 0.016 % of reading + 0.18 μA 0.1 % of reading + 0.65 μA	High Performance Multifunction Calibrator  Vista, CA



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## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current - Source <sup>1</sup>	(2.2 to 22) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (22 to 220 mA) (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 220 mA to 2.2 A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz	0.003 4 % of reading + 20 $\mu$ A 0.002 5 % of reading + 12 $\mu$ A 0.007 2 % of reading + 0.95 $\mu$ A 0.015 % of reading + 1.5 $\mu$ A 0.1 % of reading + 5.1 $\mu$ A 0.004 6 % of reading + 0.15 mA 0.003 5 % of reading + 85 $\mu$ A 0.006 2 % of reading + 12 $\mu$ A 0.014 % of reading + 16 $\mu$ A 0.089 % of reading + 38 $\mu$ A 0.18 mA/A + 0.17 mA 0.32 mA/A + 0.27 mA 5.1 mA/A + 2.8 mA 0.3 mA/A + 1.1 mA 0.74 mA/A + 53 $\mu$ A	High Performance Multifunction Calibrator  Vista, CA
AC Current - Source <sup>1</sup>	(11 to 20) A (45 to 100) Hz 100 Hz to 1kHz (1 to 5) kHz	1.2 mA/A + 5 mA 1.5 mA/A + 5 mA 30 mA/A + 5 mA	Multi Product Calibrator  Vista, CA
AC Current - Source <sup>1</sup>	(20 to 150) A (10 to 100) Hz (100 to 440) Hz (150 to 1 025) A (45 to 100) Hz (100 to 440) Hz	0.1 % of reading + 8.2 mA 0.24 % of reading + 39 mA 0.11 % of reading + 78 mA 0.78 % of reading + 0.2 A	Multi Product Calibrator w/ Current Coil  Vista, CA Fremont, CA Orlando, FL
AC Current – Source	Up to 220 $\mu$ A (10 to 20 Hz) (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 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	0.25 mA/A + 16 nA 0.16 mA/A + 10 nA 0.12 mA/A + 8 nA 0.28 mA/A + 12 nA 1.1 mA/A + 65 nA 0.25 mA/A + 40 nA 0.16 mA/A + 36 nA 0.12 mA/A + 36 nA 0.2 mA/A + 0.11 $\mu$ A 1.1 mA/A + 0.65 $\mu$ A	High Performance Multifunction Calibrator  Fremont, CA Orlando, FL



# ANSI National Accreditation Board

## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source	(2.2 to 22) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (22 to 220) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 220 mA to 2.2 A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (11 to 20) A (45 to 100) Hz 100 Hz to 1kHz (1 to 5) kHz	0.25 mA/A + 0.41 $\mu$ A 0.16 mA/A + 0.36 $\mu$ A 0.12 mA/A + 0.36 $\mu$ A 0.2 mA/A + 0.56 $\mu$ A 1.1 mA/A + 5.1 $\mu$ A 0.25 mA/A + 4.1 $\mu$ A 0.16 mA/A + 3.6 $\mu$ A 0.12 mA/A + 2.6 $\mu$ A 0.2 mA/A + 3.6 $\mu$ A 1.1 mA/A + 11 $\mu$ A 0.25 mA/A + 36 $\mu$ A 0.45 mA/A + 81 $\mu$ A 7 mA/A + 0.18 mA 0.46 mA/A + 0.21 mA 0.95 mA/A + 0.4 mA 3.6 mA/A + 0.76 mA 1.2 mA/A + 5 mA 1.5 mA/A + 5 mA 30 mA/A + 5 mA	High Performance Multifunction Calibrator  Fremont, CA Orlando, FL
AC Power - Source <sup>1</sup> PF = 1 (10 to 45) Hz 33 mV to 32.9999 V (3.3 mA to 2.99999 A)  (45 to 65) Hz 33 mV to 1020 V (3.3 mA to 20.5 A)	110 $\mu$ W to 99 W  110 $\mu$ W to 99 W	0.19 % of reading  0.15 % of reading	Multi Product Calibrator  Vista, CA Fremont, CA Orlando, FL
Phase - Source <sup>1</sup> (10 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	(+/- 179.99) ( $\Delta\Phi^\circ$ )	0.09 $^\circ$ 0.2 $^\circ$ 0.39 $^\circ$ 1.9 $^\circ$ 3.9 $^\circ$ 7.8 $^\circ$	Multi Product Calibrator  Vista, CA Fremont, CA Orlando, FL

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase – Measure 10 mV to 630 Vrms	(0 to 360) ° 5 Hz to 2 kHz 2 kHz to 5kHz 5 kHz to 10 kHz 10 kHz to 50 kHz	0.023 ° 0.036 ° 0.045 ° 0.058 °	Phase Meter  Vista, Ca
AC Current - Measure <sup>1</sup>	Up to 100 µA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz 100 µA to 100 mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz 100 µA to 100 mA (20 to 50) kHz (50 to 100) kHz 100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz	4.7 mA/A + 36 nA 1.8 mA/A + 35 nA 0.71 mA/A + 35 nA 0.7 mA/A + 35 nA 4.7 mA/A + 24 µA 1.8 mA/A + 24 µA 0.71 mA/A + 24 µA 0.36 mA/A + 23 µA 0.71 mA/A + 24 µA 4.7 mA/A + 47 µA 6.5 mA/A + 0.18 mA 4.7 mA/A + 0.24 mA 1.9 mA/A + 0.24 mA 0.95 mA/A + 0.24 mA 1.1 mA/A + 0.26 mA 3.5 mA/A + 0.24 mA 12 mA/A + 0.47 mA	Precision 8.5 Digit Multimeter  Fremont, CA Orlando, FL
AC Current - Measure <sup>1</sup>	(1 to 10) A (3 to 5) Hz (5 to 10) Hz 10 to 5 kHz (5 to 10) kHz (10 to 100) A (50 to 60) Hz (100 to 300) A (50 to 60) Hz	20 mA/A + 6 mA 11 mA/A + 6 mA 1.5 mA/A + 6 mA 3.5 mA/A + 70 mA  0.6 A  0.8 A	Precision 8.5 Digit Multimeter / Shunts  Vista, CA Fremont, CA Orlando, FL



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current - Measure	Up to 200 $\mu$ A		Precision 8.5 DigitMultimeter  Vista CA
	10 Hz to 10 kHz	0.42 mA/A + 24 nA	
	(10 to 30) kHz	0.88 mA/A + 24 nA	
	(30 to 100) kHz	4.8 mA/A + 24 nA	
	200 $\mu$ A to 2 mA		
	10 Hz to 10 kHz	0.36 mA/A + 0.24 $\mu$ A	
	(10 to 30) kHz	0.86 mA/A + 0.24 $\mu$ A	
	(30 to 100) kHz	4.8 mA/A + 0.24 $\mu$ A	
	2 to 20 mA		
	10 Hz to 10 kHz	0.37 mA/A + 2.4 $\mu$ A	
	(10 to 30) kHz	0.86 mA/A + 2.4 $\mu$ A	
	(30 to 100) kHz	4.8 mA/A + 2.4 $\mu$ A	
	20 to 200 mA		
	10 Hz to 10 kHz	0.35 mA/A + 24 $\mu$ A	
(10 to 30) kHz	0.75 mA/A + 24 $\mu$ A		
200 mA to 2 A			
10 Hz to 2 kHz	0.75 mA/A + 0.25 mA		
(2 to 10) kHz	0.87 mA/A + 0.27 mA		
(10 to 30) kHz	3.6 mA/A + 0.26 mA		
2 to 20 A			
10 Hz to 2 kHz	0.99 mA/A + 2.4 mA		
(2 to 10) kHz	3.1 mA/A + 2.4 mA		
Resistance - Source <sup>1</sup>	Up to 11 $\Omega$	1.7 m $\Omega$ / $\Omega$ + 35 $\mu\Omega$	Multi Product Calibrator  Vista, CA Fremont, CA Orlando, FL
	(11 to 33) $\Omega$	23 $\mu\Omega$ / $\Omega$ + 3.3 m $\Omega$	
	(33 to 110) $\Omega$	31 $\mu\Omega$ / $\Omega$ + 1.9 m $\Omega$	
	(110 to 330) $\Omega$	32 $\mu\Omega$ / $\Omega$ + 2.8 m $\Omega$	
	330 $\Omega$ to 1.1 k $\Omega$	33 $\mu\Omega$ / $\Omega$ + 2.3 m $\Omega$	
	(1.1 to 3.3) k $\Omega$	32 $\mu\Omega$ / $\Omega$ + 30 m $\Omega$	
	(3.3 to 11) k $\Omega$	5 $\mu\Omega$ / $\Omega$ + 1.4 $\Omega$	
	(11 to 33) k $\Omega$	32 $\mu\Omega$ / $\Omega$ + 0.3 $\Omega$	
	(33 to 110) k $\Omega$	33 $\mu\Omega$ / $\Omega$ + 0.34 $\Omega$	
	(110 to 330) k $\Omega$	37 $\mu\Omega$ / $\Omega$ + 3.1 $\Omega$	
	330 k $\Omega$ to 1.1 M $\Omega$	38 $\mu\Omega$ / $\Omega$ + 2.6 $\Omega$	
	(1.1 to 3.3) M $\Omega$	71 $\mu\Omega$ / $\Omega$ + 36 $\Omega$	
	(3.3 to 11) M $\Omega$	0.13 m $\Omega$ / $\Omega$ + 0.38 k $\Omega$	
	(11 to 33) M $\Omega$	0.22 m $\Omega$ / $\Omega$ + 7.4 k $\Omega$	
	(33 to 110) M $\Omega$	0.42 m $\Omega$ / $\Omega$ + 32 k $\Omega$	
	(110 to 330) M $\Omega$	3.6 m $\Omega$ / $\Omega$ + 0.12 M $\Omega$	
330 M $\Omega$ to 1.1 G $\Omega$	18 m $\Omega$ / $\Omega$ + 0.59 M $\Omega$		





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## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance - Source <sup>1</sup> Fixed Points	0 Ω	48 μΩ	High Performance Multifunction Calibrator  Vista, CA
	1 Ω	0.15 mΩ	
	1.9 Ω	0.22 mΩ	
	10 Ω	0.28 mΩ	
	19 Ω	0.63 mΩ	
	100 Ω	1.2 mΩ	
	190 Ω	2.3 mΩ	
	1 kΩ	7.8 mΩ	
	1.9 kΩ	15 mΩ	
	10 kΩ	77 mΩ	
	19 kΩ	0.15 Ω	
	100 kΩ	1 Ω	
	190 kΩ	1.9 Ω	
	1 MΩ	16 Ω	
1.9 MΩ	40 Ω		
Resistance - Source <sup>1</sup> Fixed Points	10 MΩ	0.48 kΩ	High Performance Multifunction Calibrator  Vista, CA
	19 MΩ	1.1 kΩ	
	100 MΩ	12 kΩ	
Resistance - Source <sup>1</sup> Fixed Points	1 Ω	0.12 mΩ	High Performance Multifunction Calibrator  Fremont, CA Orlando, FL
	1.9 Ω	0.22 mΩ	
	10 Ω	0.28 mΩ	
	19 Ω	0.58 mΩ	
	100 Ω	1.3 mΩ	
	190 Ω	2.4 mΩ	
	1 kΩ	10 mΩ	
	1.9 kΩ	20 mΩ	
	10 kΩ	90 mΩ	
	19 kΩ	0.19 Ω	
	100 kΩ	1.3 Ω	
	190 kΩ	2.5 Ω	
	1 MΩ	24 Ω	
	1.9 MΩ	47 Ω	
	10 MΩ	0.47 kΩ	
	19 MΩ	1.3 kΩ	
100 MΩ	12 kΩ		



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## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment	
Resistance - Source <sup>1</sup> Fixed Point (Four-Terminal Pair)	0.1 Ω 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ	0.56 mΩ 0.29 mΩ 2.3 mΩ 1.8 mΩ 35 mΩ 0.12 Ω 1.3 Ω	Four Terminal Pair Resistor Set  Vista, CA Fremont, CA Orlando, FL	
Resistance - Measure <sup>1</sup>	Up 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 (10 to 100) MΩ 100 MΩ to 1 GΩ	22 μΩ/Ω + 62 μΩ 18 μΩ/Ω + 0.61 mΩ 16 μΩ/Ω + 0.73 mΩ 15 μΩ/Ω + 13 mΩ 15 μΩ/Ω + 67 mΩ 21 μΩ/Ω + 2.7 Ω 46 μΩ/Ω + 0.39 kΩ 0.56 mΩ/Ω + 1.2 kΩ 6 mΩ/Ω + 12 kΩ	Precision 8.5 Digit Multimeter  Fremont, CA Orlando, FL	
Resistance - Measure <sup>1</sup>	Up to 2Ω (2 to 20) Ω (20 to 200) Ω 200 Ω to 2 kΩ (2 to 20) kΩ (20 to 200) kΩ 200 kΩ to 2 MΩ (2 to 20) MΩ (20 to 200) MΩ 200 MΩ to 2 GΩ	23 μΩ/Ω + 5.9 μΩ 12 μΩ/Ω + 18 μΩ 9.8 μΩ/Ω + 80 μΩ 12 μΩ/Ω + 0.94 mΩ 11 μΩ/Ω + 47 mΩ 11 μΩ/Ω + 60 mΩ 13 μΩ/Ω + 1.2 Ω 28 μΩ/Ω + 0.12 kΩ 0.15 mΩ/Ω + 1.2 kΩ 1.9 mΩ/Ω + 12 kΩ	Precision 8.5 DigitMultimeter  Vista, CA	
Capacitance - Source <sup>1</sup>	10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz (0 to 50) Hz	(220 to 399.9) pF (0.4 to 1.099 9) nF (1.1 to 3.299 9) nF (3.3 to 10.999 9) nF (11 to 32.999 9) nF (33 to 109.999) nF (110 to 329.999) nF (0.33 to 1.099 99) μF (1.1 to 3.299 99) μF (3.3 to 10.999 9) μF (11 to 32.999 9) μF (33 to 109.999) μF (110 to 329.999) μF	0.58 % of reading + 12 pF 0.57 % of reading + 12 pF 0.57 % of reading + 12 pF 0.22 % of reading + 27 pF 0.29 % of reading + 0.12 nF 0.29 % of reading + 0.13 nF 0.29 % of reading + 0.35 nF 0.28 % of reading + 1.5 nF 0.29 % of reading + 3.5 nF 0.29 % of reading + 1.3 nF 0.46 % of reading + 36 nF 0.53 % of reading + 0.12 μF 0.53 % of reading + 0.35 μF	Multi Product Calibrator  Vista, CA Fremont, CA Orlando, FL



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance - Source <sup>1</sup> (0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz	(0.33 to 1.099 99) mF (1.1 to 3.299 99) mF (3.3 to 10.999 9) mF (11 to 32.999 9) mF (33 to 110) mF	0.5 % of reading + 1.5 $\mu$ F 0.52 % of reading + 3.6 $\mu$ F 0.51 % of reading + 13 $\mu$ F 0.86 % of reading + 35 $\mu$ F 1.3 % of reading + 0.13 mF	Multi Product Calibrator  Vista, CA Fremont, CA Orlando, FL
Fixed Capacitance	(100 to 500) pF @ 1 kHz 500 pF to 5 nF @ 1 kHz (5 to 50) nF @ 1 kHz (50 to 100) nF @ 1 kHz (100 to 500) nF @ 1 kHz 500 nF to 1.5 $\mu$ F @ 1 kHz	0.64 pF 3.7 pF 32 pF 63 pF 0.59 nF 0.63 nF	Capacitance Standard Set  Vista, CA Fremont, CA Orlando, FL
Capacitance - Source <sup>1</sup>	1 pF 10 pF 100 pF 1 nF	1.2 fF 12 fF 0.12 pF 1.2 pF	Standard Air Capacitor Set  Vista, CA Fremont, CA Orlando, FL
Capacitance - Source <sup>1</sup>	1 pF (1 to 3) MHz 4 MHz 5 MHz 10 MHz 13 MHz 10 pF (1 to 13) MHz 100 pF (1 to 10) MHz 13 MHz 1 nF (1 to 4) MHz 5 MHz 10 MHz 13 MHz	1.2 fF 1.3 fF 1.5 fF 2.8 fF 3.9 fF 12 fF 0.12 pF 0.13 pF 1.2 pF 1.3 pF 2.2 pF 3 pF	Standard Air Capacitor Set  Vista, CA Fremont, CA Orlando, FL
Capacitance - Measure	(1 to 10) nF (10 to 100) nF (0.1 to 1) $\mu$ F (1 to 10) $\mu$ F (10 to 100) $\mu$ F (100 to 1 000) $\mu$ F (1 to 10) mF (10 to 100) mF	0.052 pF 0.041 pF 0.37 nF 0.018 $\mu$ F 0.041 $\mu$ F 0.56 $\mu$ F 0.018 mF 0.059 mF	Digit Multimeter/LCR Meter  Vista, CA Fremont, CA Orlando, FL



# ANSI National Accreditation Board

## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance - Source  0.1 to 1 kHz	200 μH 2 mH 20 mH 200 mH 2 H	0.58 μH 2.4 uH 24 uH 0.24 mH 2.4 mH	Standard Value Inductors  Vista, CA Fremont, CA Orlando, FL
Inductance - Measure	0.001 nH to 99.999 999 H Up to 1 kHz 1 kHz to 1 MHz	0.062 % of reading + 0.007 mH 0.56 % of reading + 0.007 mH	Precision LCR Meter  Vista, CA Fremont, CA Orlando, FL
Electrical Simulation of Thermocouple Indicating Devices – Source and Measure <sup>1</sup>	Type C (0 to 150) °C (150 to 650) °C (650 to 1 000) °C (1 000 to 1 800) °C (1 800 to 2 316) °C Type E (-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1 000) °C Type J (-210 to -100) °C (-100 to -30) °C (-30 to 150) °C (150 to 760) °C (760 to 1 200) °C Type K (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1 000) °C (1 000 to 1 372) °C Type N (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1 300) °C	0.29 °C 0.32 °C 0.28 °C 0.48 °C 0.71 °C 0.43 °C 0.21 °C 0.17 °C 0.14 °C 0.19 °C 0.35 °C 0.2 °C 0.14 °C 0.19 °C 0.26 °C 0.28 °C 0.21 °C 0.23 °C 0.25 °C 0.33 °C 0.39 °C 0.27 °C 0.23 °C 0.18 °C 0.27 °C	Multi Product Calibrator  Vista, CA Fremont, CA Orlando, FL



# ANSI National Accreditation Board

## Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Devices – Source and Measure <sup>1</sup>	Type R		Multi Product Calibrator  Vista, CA Fremont, CA Orlando, FL
	(0 to 250) °C	0.83 °C	
	(250 to 400) °C	0.42 °C	
	(400 to 1 000) °C	0.31 °C	
	(1 000 to 1 767) °C	0.38 °C	
	Type S		
	(0 to 250) °C	0.55 °C	
	(250 to 1 000) °C	0.34 °C	
	(1 000 to 1 400) °C	0.32 °C	
	(1 400 to 1 767) °C	0.41 °C	
	Type T		
	(-250 to -150) °C	0.63 °C	
	(-150 to 0) °C	0.35 °C	
(0 to 120) °C	0.26 °C		
(120 to 400) °C	0.22 °C		
Electrical Simulation of RTD Temperature Indicating Devices – Source and Measure <sup>1</sup>	Pt 385 (100 Ω)		Multi Product Calibrator  Vista, CA Fremont, CA Orlando, FL
	(-200 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	(630 to 800) °C	0.23 °C	
	Pt 3926 (100 Ω)		
	(-200 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	
	Pt 3916 (100 Ω)		
	(-200 to -190) °C	0.25 °C	
	(-190 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.05 °C	
	(0 to 100) °C	0.06 °C	
	(100 to 260) °C	0.07 °C	
	(260 to 300) °C	0.08 °C	
	(300 to 400) °C	0.09 °C	
(400 to 600) °C	0.1 °C		
(600 to 630) °C	0.23 °C		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Temperature Indicating Devices – Source and Measure <sup>1</sup>	Pt 385 (200 Ω)		Multi Product Calibrator  Vista, CA Fremont, CA Orlando, FL
	(-200 to 100) °C	0.04 °C	
	(100 to 260) °C	0.05 °C	
	(260 to 300) °C	0.12 °C	
	(300 to 400) °C	0.13 °C	
	(400 to 600) °C	0.14 °C	
	(600 to 630) °C	0.16 °C	
	Pt 385 (500 Ω)		
	(-200 to -80) °C	0.04 °C	
	(-80 to 100) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 400) °C	0.08 °C	
	(400 to 600) °C	0.09 °C	
	(600 to 630) °C	0.11 °C	
	Pt 385 (1 000 Ω)		
	(-200 to 0) °C	0.03 °C	
(0 to 100) °C	0.04 °C		
(100 to 260) °C	0.05 °C		
(260 to 300) °C	0.06 °C		
(300 to 600) °C	0.07 °C		
(600 to 630) °C	0.23 °C		
PtNi 385 (120 Ω) (Ni 120)			
(-80 to 100) °C	0.08 °C		
(100 to 260) °C	0.14 °C		
CU 427 (10 Ω)			
(100 to 260) °C	0.3 °C		
Oscilloscopes <sup>1</sup> - DC Voltage Into 50 Ω Into 1 MΩ  Square Wave Into 50 Ω 10 Hz to 10 kHz  Into 1 MΩ 10 Hz to 1 kHz (1 to 10) kHz	(0 to +/-6.6) V	0.2 % + 36 μV	Multi Product Calibrator  Vista, CA Fremont, CA Orlando, FL
	(0 to +/-130) V	0.039 % of reading + 37 μV	
	1 mV to 6.6 Vpp	0.2 % of reading + 65 μV	
	1 mV to 130 Vpp	0.078 % of reading + 36 μV	
	1 mV to 130 Vpp	0.19 % of reading + 39 μV	





Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes <sup>1</sup> -  Leveled Sine Amplitude Reference @ 50 kHz  Leveled Sine Amplitude (relative to 50 kHz) 5 mV to 5.5 V  Time Markers (5-2-1 sequence) into 50 Ω  Edge Transition Time (Rise Time)	5 mV to 5.5 V  50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz (600 to 1 100) MHz  (1 to 50) ns 100 nS to 20 ms 50 ms to 5 s  <300 ps	15 mV/V + 0.49 mV  14 mV/V + 0.12 mV 17 mV/V + 0.14 mV 32 mV/V + 0.15 mV 40 mV/V + 0.16 mV  0.001 1 % of reading + 0.048 ps 0.000 2 % of reading + 7 ps 0.4 % of reading  80 ps	Multi Product Calibrator  Vista, CA Fremont, CA Orlando, FL
Oscilloscopes - Square Wave Signal 10 Hz to 10 kHz 50 Ω 1 M Ω DC Signal Into 50Ω Into 1MΩ  Leveled Sine Wave  Square Wave Signal Leveled Sine Wave Flatness referenced to 50 kHz reference  Time Markers (5-2-1 sequence) into a 50 Ω load	1 mV to 6.6 V p-p 1 mV to 130 V p-p  1 mV to 6.6 V p-p 1 mV to 130 V p-p  Absolute Amplitude 5 mV to 5.5 V 50 kHz Reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 500) MHz (500 to 600) MHz  5 mV to 5.5 V 10 MHz Reference 600 MHz to 1.6 GHz (1.6 to 2.1) GHz  (1 to 50) ns 100 nS to 20 ms 50 ms to 5 s	2.5 mV/V + 40 μV 0.5 mV/V + 5 μV  2.5 mV/V + 40 μV 0.5 mV/V + 5 μV  20 mV/V + 0.3 mV 35 mV/V + 0.3 mV 40 mV/V + 0.3 mV 55 mV/V + 0.3 mV 60 mV/V + 0.3 mV  20 mV/V + 0.3 mV 70 mV/V + 0.3 mV 80 mV/V + 0.3 mV  0.001 1 % of reading + 0.048 ps 0.000 2 % of reading + 7 ps 0.4 % of reading	Oscilloscope Calibrator  Fremont, CA



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes - Fast Edge Mode	5 s to 50 ms 20 ms to 500 ps	2.5 $\mu$ s/s + 5 $\mu$ Hz 0.33 $\mu$ s/s	Oscilloscope Calibrator  Fremont, CA
Programmable Rise Time	(1 to 100) kHz	< 0.15 ns/s +/- 25 ps	
Rise Time (measurement)	20 ps to 100 $\mu$ s	81 ns	Oscilloscope  Vista, CA Fremont, CA Orlando, FL

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Attenuation - Source Coaxial, 10 dB Step	(0 to 120) dB 1 kHz 500 MHz 1 GHz	0.11 dB 0.28 dB 0.39 dB	Standard Piston Attenuator  Vista, CA Fremont, CA Orlando, FL
RF Attenuation Source Coaxial, 1 dB Step	DC to 12.4 GHz (0 to 11) dB (12.4 to 18) GHz (0 to 11) dB	0.6 dB 0.8 dB	Standard Electronic Programmable Attenuator  Fremont, CA Orlando, FL Vista, CA
RF Attenuation Source Coaxial, 10 dB Step	DC to 12.4 GHz (0 to 10) dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB (80 to 110) dB	0.51 dB 0.71 dB 0.91 dB 1.2 dB 1.5 dB 1.8 dB 2.1 dB 2.4 dB	Standard Electronic Programmable Attenuator  Fremont, CA Orlando, FL Vista, CA



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Attenuation Source Coaxial, 10 dB Step	(12.4 to 18) GHz (0 to 10) dB 20 dB 30 dB 40 dB 50 dB 60 dB 70 dB (80 to 110) dB	0.61 dB 0.81 dB 1.2 dB 1.6 dB 2 dB 2.4 dB 2.8 dB 3.2 dB	Standard Electronic Programmable Attenuator  Fremont, CA Orlando, FL Vista, CA
RF Absolute Power Source Into 50 Ω 0.001 Hz to 100 kHz SWR 1.2:1  100 kHz to 10 MHz SWR ≤ 1.2:1  (10 to 20) MHz SWR ≤ 1.2:1	(3 to 10) Vpp 1 mVpp to 3Vpp  (3 to 10) Vpp 1 mVpp to 3 Vpp  100 mVpp to 3 Vpp (1 to 100) mVpp	0.13 dB 0.22 dB  0.41 dB 0.61 dB  0.61 dB 0.91 dB	Synthesized Signal Sources  Vista, CA Fremont, CA Orlando, FL
RF Absolute Power Source Into 50 Ω Into 50 Ω/75 Ω	13.01 dBm 1 kHz to 25 MHz 200 Hz to 80 MHz	0.12 dB 0.18 dB	Synthesized Level Generator  Vista, CA Fremont, CA Orlando, FL
RF Absolute Power Into 50 Ω, In 2 dB steps Relative to Full Output	200 Hz to 80 MHz (0 to -38) dBm (-40 to -58) dBm (-60 to -98) dBm	0.21 dB 0.21 dB 0.27 dB	
RF Absolute Power Into 75 Ω, In 2 dB steps Relative to Full Output	(0 to -38) dBm 200 Hz to 25 MHz (25 to 80) MHz (-40 to -58) dBm 200 Hz to 25 MHz (25 to 80) MHz (-60 to -98) dBm 200 Hz to 25 MHz (25 to 80) MHz	0.21 dB 0.36 dB  0.28 dB 0.54 dB  0.45 dB 1.7 dB	Synthesized Level Generator  Vista, CA Fremont, CA Orlando, FL



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power Source Into 50 Ω SWR ≤ 1.6:1	(+10 to -10) dBm 10 MHz to 2 GHz	1.5 dB	Synthesized Level Generator  Vista, CA Fremont, CA Orlando, FL
	(2 to 20) GHz	1.7 dB	
SWR ≤ 1.6:1	(+5 to -10) dBm 10MHz to 2 GHz	0.82 dB	
SWR ≤ 1.8:1	(2 to 20) GHz	0.96 dB	
SWR ≤ 2.0:1	(20 to 40) GHz	1.2 dB	
SWR ≤ 2.0:1	(+2.5 to -10) dBm (40 to 50) GHz	2.3 dB	
SWR ≤ 1.6:1	(-10 to -60) dBm 10MHz to 2 GHz	1.2 dB	
SWR ≤ 1.8:1	(2 to 20) GHz	1.3dB	
SWR ≤ 2.0:1	(20 to 40) GHz	1.6 dB	
SWR ≤ 2.0:1	(40 to 50) GHz	2.3 dB	
SWR ≤ 1.6:1	(-60 to -110) dBm 10 MHz to 2 GHz	1.8 dB	Synthesized Low Phase Noise Level Generator  Vista, CA
SWR ≤ 1.8:1	(2 to 20) GHz	1.9 dB	
SWR ≤ 2.0:1	(20 to 40) GHz	2.2 dB	
SWR ≤ 2.0:1	(40 to 50) GHz	3.3 dB	
RF Absolute Power Source Into 50 Ω	(+24 to -48) dBm Up to 300 MHz	0.06 dB	
	(+14 to -48) dBm 300 MHz to 3GHz (3 to 4) GHz	0.08 dB 0.52 dB	
RF Absolute Power Source Into 50 Ω	(-48 to -84) dBm 100 kHz to 10 MHz (10 to 300) MHz	0.52 dB 0.32 dB	Synthesized Low Phase Noise Level Generator  Vista, CA
	300 MHz to 1.4 GHz	0.53 dB	
	(-48 to -74) dBm (1.4 to 4) GHz	0.53 dB	
	(-74 to -84) dBm (1.4 to 4) GHz	1 dB	
RF Absolute Power Source Into 50 Ω	(-84 to -94) dBm 100 kHz to 300 MHz 300 MHz to 4 GHz	0.53 dB 1 dB	Synthesized Low Phase Noise Level Generator  Vista, CA
	(-94 to -130) dBm (10 to 128) MHz	0.73 dB	
	300 MHz to 4 GHz	1.6 dB	



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## Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power Source Into 75 Ω	(+14 to -23) dBm		Synthesized Low Phase Noise Level Generator  Vista, CA
	Up to 125 MHz	0.07 dB	
	(125 to 300) MHz	0.16 dB	
	300 MHz to 1.4 GHz	0.26 dB	
	(1.4 to 3) GHz	0.33 dB	
	(3 to 4) GHz	0.52 dB	
	(-23 dBm to -54) dBm		
	Up to 300 MHz	0.16 dB	
	300 MHz to 4 GHz	0.52 dB	
	(-54 to -80) dBm		
	100 kHz to 300 MHz	0.23 dB	
	300 MHz to 4 GHz	0.54 dB	
	(-80 to -90) dBm		
	100 kHz to 300 MHz	0.7 dB	
300 MHz to 4 GHz	1 dB		
(-90 to -100) dBm			
100 kHz to 300 MHz	0.76 dB		
300 MHz to 4 GHz	1 dB		
(-100 to 120) dBm			
10 MHz to 4GHz	1.6 dB		
RF Tuned Power – Measure (relative)	Up to 4.2 GHz		Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL
	30 to -90 dB	0.4 % of reading + 0.22 dB	
	-90 to -114 dB	0.38 % of reading + 0.62 dB	
	-106 to -129 dB	0.28 % of reading + 1 dB	
	4GHz to 26.5 GHz		
	30 to -90 dB	2 % of reading + 0.97 dB	
	-90 to -114 dB	0.83 % of reading + 2.9 dB	
	-106 to -129 dB	0.8 % of reading + 3.6 dB	
	26.5 GHz to 50 GHz		
	30 to -90 dB	2.2 % of reading + 1.1 dB	
	-90 to -114 dB	0.93 % of reading + 3.4 dB	
	-106 to -129 dB	0.88 % of reading + 4 dB	



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation - Measure Carrier Frequency 2 MHz to 2.65 GHz  Error Vector Magnitude for Modulation Types: MSK, GMSK, BPSK, DQPSK, Π/4DQPSK, 8PSK, 16QAM, 32 QAM and QPSK  Phase Error for Modulation Types: MSK, GMSK, BPSK, DQPSK, Π/4DQPSK, 8PSK, 16QAM, 32 QAM and QPSK  Error Vector Magnitude for FSK Modulation	(1 to 100) kHz 100 kHz to 1 MHz 1 MHz to 2.65 GHz  (1 to 100) kHz (0.1 to 1) MHz 1 MHz to 2.65 GHz  Modulation Frequency 3.2 kHz 1.152 kHz	0.33 % of reading 0.51 % of reading 1 % of reading  0.18 ° 0.34 ° 0.57 °  0.54 % of reading 1.5 % of reading	Vector Signal Analyzer  Vista, CA Fremont, CA Orlando, FL
Amplitude Modulation - Source (11 to 13.5) MHz  20 Hz to 100 kHz  DC to 15 kHz	Rate:50 Hz to 50 kHz, (5 to 99) %  Rate: (20 to 50) Hz (5 to 99) %  Rate:9 kHz to 3.2 GHz (0 to 100) %	0.1 % of reading  0.25 % of reading  5 % of reading	AM/FM Test Source, Analog Modulation Sources  Vista, CA Fremont, CA Orlando, FL
Amplitude Modulation - Source DC to 100 kHz	Rate:250 kHz to 50 GHz (0 to 99) %	1.2 % of reading + 0.07 AM	AM/FM Test Source, Analog Modulation Sources  Vista, CA Fremont, CA
Amplitude Modulation - Measure <sup>3</sup> 100 kHz to 10 MHz  10 MHz to 3 GHz	Rate: 50 Hz to 10 kHz, (5 to 99) % Depth  50 Hz to 100 kHz, (20 to 99) % Depth	0.001 4 % of reading + 0.009 AM  0.001 % of reading + 0.007 AM	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL





Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation - Measure <sup>3</sup> 10 MHz to 3 GHz	50 Hz to 100 kHz, (5 to 20) % Depth	0.001 % of reading + 0.029 AM	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL
(3 to 26.5) GHz	50 Hz to 100 kHz, (5 to 20) % Depth	0.01 % of reading + 0.052 AM	
(3 to 26.5) GHz	50 Hz to 100 kHz, (20 to 99) % Depth	0.01 % of reading + 0.018 AM	
Amplitude Modulation - Measure (26.5 to 31.15) GHz	50 Hz to 100kHz, (5 to 20) % Depth (20 to 99) % Depth	0.08 % of reading + 0.000 2 AM 0.02 % of reading + 0.000 14 AM	Microwave Measuring Receiver System  Vista, CA
(31.15 to 50) GHz	50 Hz to 100kHz, (5 to 20) % Depth (20 to 99) % Depth	0.3 % of reading + 0.000 05 AM 0.07 % of reading + 0.000 046 AM	
Amplitude Modulation - Measure 150 kHz to 10 MHz Rate: 50 Hz to 10 kHz, Depth: 5 % to 99 % Rate: 20 Hz to 10 kHz, Depth: to 99 % 10 MHz to 1.3 GHz Rate: 50 Hz to 50 kHz, Depth: 5 % to 99 % Rate: 20 Hz to 10 kHz, Depth: to 99 % (1.3 to 26.5) GHz Rate: 50 Hz to 10 kHz, Depth: 5 % to 99 % 10 MHz to 26.5 GHz Rate: 20 Hz to 10 kHz, Depth: to 99 %	(5 to < 10) % Depth (10 to 99) % Depth (5 to < 10) % Depth (10 to 99) % Depth  (5 to < 10) % Depth (10 to 99) % Depth (5 to < 10) % Depth (10 to 99) % Depth  (5 to < 10) % Depth (10 to 99) % Depth  (5 to < 10) % Depth (10 to 99) % Depth	0.023 AM + 0.01 % of reading 0.023 AM + 0.06 % of reading 0.035 AM + 0.01 % of reading 0.035 AM + 0.06 % of reading  0.012 AM + 0.01 % of reading 0.012 AM + 0.06 % of reading 0.035 AM + 0.01 % of reading 0.035 AM + 0.06 % of reading  0.018 AM + 0.03 % of reading 0.018 AM + 0.07 % of reading  0.035 AM + 0.03 % of reading 0.035 AM + 0.07 % of reading	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation - Measure 250 kHz to 10 MHz  10 MHz to 6.6 GHz	Rate: 20 Hz to 10 kHz Dev:20 Hz to 40 kHz pk  Rate: 50 Hz to 200 kHz Dev:250 Hz to 400 kHz pk	1.7 % of reading + 5.7 Hz 1.1 % of reading + 6.6 Hz  1.8 % of reading + 5.1 Hz 1.2 % of reading + 6.1 Hz	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL
Frequency Modulation - Measure (6.6 to 13.2) GHz  (13.2 to 26.5) GHz	Rate: 50 Hz to 200 kHz Dev:250 Hz to 400 kHz pk  Rate: 50 Hz to 100 kHz Dev:250 Hz to 400 kHz pk	2.9 % of reading + 4 Hz 1.2 % of reading + 6.4 Hz  4.4 % of reading + 3.8Hz 1.2 % of reading + 7.6 Hz	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL
Frequency Modulation - Measure (26.5 to 50.0) GHz	Rate: 20 Hz to 10 kHz Dev:20 Hz to 40 kHz pk	10 % of reading + 4.2 Hz 1 % of reading + 12 Hz	Microwave Measuring Receiver System  Vista, CA
Frequency Modulation - Measure 250 kHz to 10 MHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM 10 MHz to 26.5 GHz	Rate: 20 Hz to 10 kHz ≤ 40 kHz pk	0.024 FM + 2.4 Hz Pk 0.024 FM + 8 Hz Pk	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL
Frequency Modulation - Measure 10 MHz to 1.3 GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 50 Hz to 100 kHz ≤ 400 kHz pk	0.012 FM + 2.4 Hz Pk 0.012 FM + 14 Hz Pk 0.012 FM + 66 Hz Pk	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL
Frequency Modulation - Measure (>1.3 to 6.2) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (> 6.2 to 12.4) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 50 Hz to 100 kHz ≤ 400 kHz pk	0.012 FM + 19 Hz Pk 0.012 FM + 23 Hz Pk 0.012 FM + 75 Hz Pk  0.012 FM + 35 Hz Pk 0.012 FM + 39 Hz Pk 0.012 FM + 91 Hz Pk	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation - Measure (> 12.4 to 18.6) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (> 18.6 to 26.5) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 50 Hz to 100 kHz ≤ 400 kHz pk	0.012 FM + 51 Hz Pk 0.012 FM + 55 Hz Pk 0.012 FM + 110 Hz Pk  0.012 FM + 67 Hz Pk 0.012 FM + 71 Hz Pk 0.012 FM + 130 Hz Pk	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL
Frequency Modulation - Measure 10 MHz to 26.5 GHz 10 MHz to 1.3 GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (>1.3 to 6.2) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 50 Hz to 100 kHz ≤ 400 kHz pk	0.058 FM + 3.9 Hz Pk 0.058 FM + 8 Hz Pk 0.058 FM + 66 Hz Pk  0.058 FM + 19 Hz Pk 0.058 FM + 23 Hz Pk 0.058 FM + 75 Hz Pk	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL
Frequency Modulation - Measure (> 6.2 to 12.4) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (> 12.4 to 18.6) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM (> 18.6 to 26.5) GHz (0 to < 4) kHz pk FM (≥ 4 to < 40) kHz pk FM (≥ 40 to < 400) kHz pk FM	Rate: 20 Hz to 200 kHz ≤ 400 kHz pk	0.058 FM + 35 Hz Pk 0.058 FM + 39 Hz Pk 0.058 FM + 91 Hz Pk  0.058 FM + 51 Hz Pk 0.058 FM + 55 Hz Pk 0.058 FM + 110 Hz Pk  0.058 FM + 67 Hz Pk 0.058 FM + 71 Hz Pk 0.058 FM + 130 Hz Pk	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation - Source (11 to 13.5) MHz	Rate: DC to 10 kHz Dev.: ≤ 100 kHz peak	0.1 % of reading	AM/FM Test Source  Vista, CA Fremont, CA Orlando, FL
(11 to 13.5) MHz	Rate: DC to 10 kHz Dev.: ≤ 200 kHz peak	0.25 % of reading	
(88 to 108) MHz	Rate: DC to 100 kHz Dev.: ≤ 100 kHz peak	0.1 % of reading	
(88 to 108) MHz	Rate: DC to 100 kHz Dev.: ≤ 200 kHz peak	0.25 % of reading	
(352 to 432) MHz	Rate: DC to 100 kHz Dev.: ≤ 100 kHz peak	0.1 % of reading	
Frequency Modulation - Source (352 to 432) MHz	Rate: DC to 100 kHz Dev.: ≤ 200 kHz peak	0.25 % of reading	Analog Modulation Sources  Vista, CA Fremont, CA Orlando, FL
9 kHz to 1 GHz	Rate: DC to 150 kHz Dev.: ≤ 200 kHz peak	3 % of reading + 30 Hz	
(1 to 2) GHz	Rate: DC to 150 kHz Dev.: ≤ 400 kHz peak	3 % of reading + 60 Hz	
(2 to 3) GHz	Rate: DC to 150 kHz Dev.: ≤ 400 kHz peak	3 % of reading + 120 Hz	
Frequency Modulation - Source 1 kHz rate Max. Dev. 2 MHz Max. Dev. 4 MHz Max. Dev. 8 MHz Max. Dev. 16 MHz Max. Dev. 32 MHz Max. Dev. 64 MHz Max. Dev. 128 MHz	250 kHz to 1 GHz (1 to 2) GHz (2 to 3.2) GHz (3.2 to 10) GHz (10 to 20) GHz (20 to 40) GHz (40 to 50) GHz	40 mHz/Hz + 23 Hz	Analog Modulation Sources  Vista, CA Fremont, CA Orlando, FL



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation - Measure >0.7 rad Dev. >0.6 rad Dev. >1.2 rad Dev.	100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	1.2 % of reading + 0.0071 rad 1.2 % of reading + 0.0071 rad 1.2 % of reading + 0.0073 rad	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL
Phase Modulation - Measure >1.3 Rad Dev. >2.4 Rad Dev.	(26.5 to 31.5 GHz (31.5 to 50) GHz	1 % of reading + 0.0073 rad 1 % of reading + 0.008 rad	Microwave Measuring Receiver System  Vista, CA
Phase Modulation - Measure 150 kHz to 10 MHz (0 to < 4) rad pk PM (≥ 4 to < 40) rad pk PM 10 MHz to 1.3 GHz (0 to < 4) rad pk PM (≥ 4 to < 40) rad pk PM (≥ 40 to < 400) rad pk PM	200 Hz to 10 kHz Rate ≤ 40 rad pk  200 Hz to 20 kHz Rate ≤ 400 rad pk	4.7 % of reading + 0.001 Rad 4.7 % of reading + 0.008 Rad  3.5 % of reading + 0.001 Rad 3.5 % of reading + 0.008 Rad 3.5 % of reading + 0.09 Rad	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL
Phase Modulation - Measure 1.3 to 26.5 GHz (0 to < 4) rad pk PM (≥ 4 to < 40) rad pk PM (≥ 40 to < 400) rad pk PM	200 Hz to 20 kHz Rate ≤ 400 rad pk	3.5 % of reading + 0.001 Rad 3.5 % of reading + 0.008 Rad 3.5 % of reading + 0.09 Rad	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL
Phase Modulation - Source Rate: 20 Hz to 10 kHz Carrier: 9 kHz to 1 GHz (1 to 2) GHz (2 to 3.2) GHz  250 kHz to 1 GHz (>1 to 2) GHz (>2 to 3.2) GHz (>3.2 to 10) GHz (>10 to 20) GHz (>20 to 40) GHz (>40 to 50) GHz	(0 to 10) rad (0 to 20) rad (0 to 40) rad  Max. Dev. (0 to 20) rad (0 to 40) rad (0 to 80) rad (0 to 160) rad (0 to 320) rad (0 to 640) rad (0 to 1280) rad	0.05 rad + 3 % of reading 0.1 rad + 3 % of reading 0.2 rad + 3 % of reading  0.012 rad + 6 % of reading 0.012 rad + 6 % of reading 0.012 rad + 6 % of reading 0.012 rad + 6 % of reading 0.012 rad + 6 % of reading 0.012 rad + 6 % of reading 0.012 rad + 6 % of reading	Analog Modulation Sources  Vista, CA Fremont, CA Orlando, FL



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## Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase - Measure	(0 to 360) ° 10 Hz to 50 kHz (50 to 100) kHz	0.084 ° 0.41 °	Phase Meter  Vista, CA
Distortion - Measure	(0.01 to 100) % Distortion 250 kHz to 50 GHz	0.065 % of reading	Microwave Measuring Receiver System  Vista, CA Fremont, CA Orlando, FL
Distortion - Measure Fundamental Frequency 20 Hz to 20 kHz (20 to 100) kHz	(0 to -99) dB (0 to -99) dB	1.2 dB 2.3 dB	Distortion Analyzer  Vista, CA Fremont, CA Orlando, FL
Power Reference- Measure 50 MHz	1 mW	5.5 μW	Primary Standards Lab (H75) Thermistor Mount, Power Meter, Precision 8.5-digit Multimeter  Vista, CA Fremont, CA Orlando, FL
Absolute Power - Measure	100 kHz to 4.2 GHz (+20 to -30) dBm 10 MHz to 18 GHz (-20 to -70) dBm 50 MHz to 26.5 GHz (+20 to -30) dBm (26.5 to 50) GHz (+20 to -30) dBm (-20 to -70) dBm	0.3 % of Reading + 0.65 db 0.44 % of reading + 0.32 db 0.24 % of reading + 0.86 db 0.46 % of reading + 0.94 dB 1.6 % of reading + 0.67 dB	RF Power Meters/Sensors  Vista, CA Fremont, CA Orlando, FL
Power Meter – Range Calibration	3 μW 10 μW 30 μW 100 μW 300 μW 1 mW 3 mW 10 mW 30 mW 100 mW	21 nW 19 nW 21 nW 77 nW 0.11 μW 0.29 μW 0.64 μW 6.4 μW 13 μW 0.10 mW	Power Meter Range Calibrator w/ Precision DC Voltage Source  Vista, CA Fremont, CA Orlando, FL





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## Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Noise Figure - Source	15 dB ENR 10 MHz to 4 GHz (>4 to 10) GHz (>10 to 18) GHz (>18 to 26.5) GHz	0.11 dB 0.14 dB 0.18 dB 0.17 dB	Primary Standards Lab Noise Source  Vista, CA
Noise Figure - Source	15 dB ENR 10 MHz to 4 GHz (>4 to 10) GHz (>10 to 18) GHz (>18 to 26.5) GHz	0.22 dB	Noise Source  Fremont, CA Orlando, FL
Noise Figure - Measure	100 kHz to 30 MHz >30 MHz to 3 GHz (>3 to 26.5) GHz	0.43 dB 0.42 dB 0.47 dB	Noise Figure Measurement System w/ Standard Noise Sources  Vista, CA Fremont, CA Orlando, FL
Single Sideband Phase Noise - Measure	1 MHz to 26.5 GHz	1.8 dB	Phase Noise Measurement System  Vista, CA Fremont, CA Orlando, FL
Single Sideband Phase Noise - Measure	(26.5 to 50) GHz	1.8 dB	Phase Noise Measurement System  Vista, CA
Power Sensor Calibration Factor	(-60 to 20) dB (9 to 100) kHz 100 kHz to 10 MHz 10 MHz to 4.2 GHz 50MHz to 10 GHz (10 to 18) GHz (18 to 26.5) GHz (26.5 to 30) GHz (30 to 40) GHz (40 to 50) GHz	0.42 dB 0.22 dB 0.54 dB 0.91 dB 0.93 dB 1 dB 1.2 dB 2.1 dB 2.5 dB	Bolometric Mounts, Gold Standard Power Sensors, AC Measurement Standard, Signal Sources and Precision Level Source  Vista, CA

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
ESD Simulators Contact Voltage (Positive and Negative)	(1 to 8) kV	1.2 % of reading	Multimeters, ESD Target, Attenuator and Oscilloscope  Vista, CA Fremont, CA Orlando, FL
Rise Time	(0.6 to 1) ns	0.000 12 % $\Delta$ time rdg + 11 ps	
Peak Current	(3.75 to 33) A	2.1 % of reading	
30 ns Current 60 ns Current	(2 to 20.8) A (1 to 10.4) A	3.4 % of reading 6.3 % of reading	
ESD Simulators Air Discharge Voltage (Positive and Negative) Rise Time	(1 to 30) kV	1.2 % of reading	Multimeters, ESD Target, Attenuator and Oscilloscope  Vista, CA Fremont, CA Orlando, FL
RC Time Constant (at $\pm 15$ kV)	(0.7 to 1) ns	0.00012 % $\Delta$ time reading + 11 ps	
	600 ns $\pm$ 130 ns for 330 pF probe 300 ns $\pm$ 60 ns for 150 pF probe	0.00012 % $\Delta$ time reading + 11 ps 0.00012 % $\Delta$ time reading + 11 ps	
EFT/Burst Generator Voltage ( $\pm$ ) Rise Time Impulse Duration Burst Duration Burst Period	10 V to 8 kV 5 ns $\pm$ 30 % 50 ns $\pm$ 30 % 15 ns $\pm$ 20 % 300 ms $\pm$ 20 %	2.7 % of reading 0.008 % $\Delta$ time reading 0.008 % $\Delta$ time reading 0.008 % $\Delta$ time reading 0.008 % $\Delta$ time reading	Fast Rise Oscilloscope w/ EFT Verification Set  Vista, CA Fremont, CA Orlando, FL
Current Probes and Bulk Current Injection Probes Insertion Loss	(0 to 1) dB 20 Hz to 300 kHz 300 kHz to 400 MHz	0.09 dB 0.09 dB	Network/RF Impedance Analyzers  Vista, CA Fremont, CA Orlando, FL
Transfer Impedance	(0 to 1) dB 20 Hz to 300 kHz 300 kHz to 400 MHz	0.02 dB 0.02 dB	



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Surge Generator Front Time Rise Time Open Circuit ( $\pm$ ) Short Circuit ( $\pm$ ) Time to Half-Value ( $\pm$ ) Open Circuit Voltage ( $\pm$ ) Short Circuit Voltage ( $\pm$ ) Ring Wave Voltage Ring Wave Rise Time	(1.2 to 50) $\mu$ s (1.2 to 50) $\mu$ s (20 to 700) $\mu$ s 10 V to 12 kV (0.125 to 3) kA 1 kV $\pm$ 10 % 1.5 $\mu$ s $\pm$ 0.5 $\mu$ s	0.008 % $\Delta$ time reading 0.008 % $\Delta$ time reading 0.008 % $\Delta$ time reading 2.9 % of reading 2.9 % of reading 2.9 % of reading 0.008 % $\Delta$ time reading	Fast Rise Oscilloscope, Current Probes, Oscilloscope Probes  Vista, CA Fremont, CA Orlando, FL
Transmission $S_{12}/S_{21}$ - Measure Phase and Magnitude	10 kHz to 1.3 GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-60 to -20) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB	0.18 dB (1 $^\circ$ ) 0.057 dB (0.43 $^\circ$ ) 0.072 dB (0.8 $^\circ$ ) 0.086 dB (0.89 $^\circ$ ) 0.13 dB (1.2 $^\circ$ ) 0.3 dB (2.4 $^\circ$ ) 0.92 dB (6.9 $^\circ$ )	LF Vector Network Analyzer, Calibration Kits  Vista, CA Fremont, CA Orlando, FL
Transmission $S_{12}/S_{21}$ - Measure Phase and Magnitude	(1.3 to 3) GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-60 to -20) dB (-70 to -60) dB (1.3 to 3) GHz (-80 to -70) dB (-90 to -80) dB	0.12 dB (4.1 $^\circ$ ) 0.063 dB (0.48 $^\circ$ ) 0.077 dB (0.8 $^\circ$ ) 0.093 dB (0.94 $^\circ$ ) 0.13 dB (1.2 $^\circ$ ) 0.32 dB (2.6 $^\circ$ ) 0.92 dB (7.4 $^\circ$ )	LF Vector Network Analyzer, Calibration Kits  Vista, CA Fremont, CA Orlando, FL
Transmission $S_{12}/S_{21}$ - Measure Phase and Magnitude	50 MHz to 2 GHz (0 to 10) dB (-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB	0.07 dB (0.46 $^\circ$ ) 0.054 dB (0.36 $^\circ$ ) 0.075 dB (0.5 $^\circ$ ) 0.12 dB (0.83 $^\circ$ ) 0.29 dB (1.9 $^\circ$ ) 2.3 dB (5.5 $^\circ$ ) 5.9 dB (5.7 $^\circ$ )	Vector Network Analyzer w/ Calibration Kits  Vista, CA Fremont, CA Orlando, FL



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## Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Transmission $S_{12}/S_{21}$ - Measure Phase and Magnitude	(2 to 8) GHz		Vector Network Analyzer w/ Calibration Kits  Vista, CA Fremont, CA Orlando, FL
	(0 to 10) dB	0.09 dB (0.59 °)	
	(-10 to 0) dB	0.07 dB (0.46 °)	
	(-20 to -10) dB	0.087 dB (0.57 °)	
	(-30 to -20) dB	0.1 dB (0.69 °)	
	(-40 to -30) dB	0.12 dB (0.81 °)	
	(-50 to -40) dB	0.15 dB (0.98 °)	
	(-60 to -50) dB	0.22 dB (1.4 °)	
	(-70 to -60) dB	0.45 dB (3.1 °)	
	(-80 to -70) dB	1.2 dB (8.7 °)	
	(-90 to -80) dB	3.4 dB (8.7 °)	
	(8 to 20) GHz		
	(0 to 10) dB	0.19 dB (1.3 °)	
	(-10 to 0) dB	0.17 dB (1.1 °)	
	(-20 to -10) dB	0.18 dB (1.2 °)	
	(-30 to -20) dB	0.2 dB (1.3 °)	
	(-40 to -30) dB	0.22 dB (1.4 °)	
	(-50 to -40) dB	0.24 dB (1.6 °)	
	(-60 to -50) dB	0.32 dB (2.1 °)	
	(-70 to -60) dB	0.6 dB (4.1 °)	
	(-80 to -70) dB	1.6 dB (8.7 °)	
	(-90 to -80) dB	4.2 dB (11 °)	
	(20 to 40) GHz		
	(0 to 10) dB	0.54 dB (3.7 °)	
	(-10 to 0) dB	0.5 dB (3.4 °)	
	(-20 to -10) dB	0.49 dB (3.3 °)	
	(-30 to -20) dB	0.5 dB (3.4 °)	
	(-40 to -30) dB	0.52 dB (3.5 °)	
	(-50 to -40) dB	0.55 dB (3.7 °)	
	(-60 to -50) dB	0.65 dB (4.4 °)	
(-70 to -60) dB	1.1 dB (7.6 °)		
(-80 to -70) dB	2.7 dB (8.9 °)		
(-90 to -80) dB	6.6 dB (11 °)		



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## Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Transmission $S_{12}/S_{21}$ – Measure  Magnitude    Phase	(-90 to 10) dB (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz </= 0 to </+ 60 ° 0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.014 dB 0.043 dB 0.11 dB 0.14 dB  0.023 ° 0.013 ° 0.064 ° 0.017 °	Vector Network Analyzer w/ Calibration Kits  Vista, CA
Reflection $S_{11}/S_{22}$ - Measure Phase and Magnitude <sup>2</sup>	10 kHz to 1.3 GHz (<0.03) $\Gamma$ (<0.2) $\Gamma$ (<0.4) $\Gamma$ (<0.6) $\Gamma$ (<0.8) $\Gamma$ (<1) $\Gamma$ (1.3 to 3) GHz (<0.03) $\Gamma$ (<0.2) $\Gamma$ (<0.4) $\Gamma$ (<0.6) $\Gamma$ (<0.8) $\Gamma$ (<1) $\Gamma$	0.002 3 lin (1.4 deg) 0.003 5 lin (1.4 deg) 0.006 1 lin (1.1 deg) 0.008 3 lin (0.94 deg) 0.01 lin (0.83 deg) 0.012 lin (0.7 deg)  0.005 6 lin (1.8 deg) 0.003 5 lin (1.8 deg) 0.008 lin (1.3 deg) 0.011 lin (1.2 deg) 0.013 lin (1 deg) 0.016 lin (0.89 deg)	LF Vector Network Analyzer, Calibration Kits  Vista, CA Fremont, CA Orlando, FL
Reflection $S_{11}/S_{22}$ – Measure Phase and Magnitude <sup>2</sup>	50 MHz to 2 GHz (<0.03) $\Gamma$ (<0.2) $\Gamma$ (<0.4) $\Gamma$ (<0.6) $\Gamma$ (<0.8) $\Gamma$ (<1) $\Gamma$	0.01 lin (3.3 deg) 0.012 lin (3.3 deg) 0.014 lin (2 deg) 0.017 lin (1.6 deg) 0.021 lin (1.5 deg) 0.026 lin (1.5 deg)	Vector Network Analyzer w/ Calibration Kits  Vista, CA Fremont, CA Orlando, FL
Reflection $S_{11}/S_{22}$ – Measure Phase and Magnitude <sup>2</sup>	(2 to 8) GHz (<0.03) $\Gamma$ (<0.2) $\Gamma$ (<0.4) $\Gamma$ (<0.6) $\Gamma$ (<0.8) $\Gamma$ (<1) $\Gamma$	0.01 lin (3.5 deg) 0.012 lin (3.5 deg) 0.015 lin (2.2 deg) 0.019 lin (1.8 deg) 0.024 lin (1.7 deg) 0.003 lin (1.7 deg)	Vector Network Analyzer w/ Calibration Kits  Vista, CA Fremont, CA Orlando, FL



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Reflection $S_{11}/S_{22}$ – Measure Phase and Magnitude <sup>2</sup>	(8 to 20) GHz ( $<0.03$ ) $\Gamma$ ( $<0.2$ ) $\Gamma$ ( $<0.4$ ) $\Gamma$ ( $<0.6$ ) $\Gamma$ ( $<0.8$ ) $\Gamma$ ( $<1$ ) $\Gamma$ (20 to 40) GHz ( $<0.03$ ) $\Gamma$ ( $<0.2$ ) $\Gamma$ ( $<0.4$ ) $\Gamma$ ( $<0.6$ ) $\Gamma$ ( $<0.8$ ) $\Gamma$ ( $<1$ ) $\Gamma$	0.0024 lin (7.8 deg) 0.0027 lin (7.8 deg) 0.0033 lin (4.8 deg) 0.0042 lin (4 deg) 0.053 lin (3.8 deg) 0.067 lin (3.9 deg) 0.06 lin (19 deg) 0.066 lin (11 deg) 0.079 lin (11 deg) 0.097 lin (9.3 deg) 0.12 lin (8.8 deg) 0.15 lin (8.8 deg)	Vector Network Analyzer w/ Calibration Kits  Vista, CA Fremont, CA Orlando, FL
Reflection $S_{11}/S_{22}$ – Measure Magnitude <sup>4</sup>  Phase	( $<0.03$ to $<1$ ) $\Gamma$ (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz $\leq 0$ to $\leq 60^\circ$ (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.011 $\Gamma$ 0.011 $\Gamma$ 0.018 $\Gamma$ 0.023 $\Gamma$ 0.023 $^\circ$ 0.013 $^\circ$ 0.064 $^\circ$ 0.017 $^\circ$	Vector Network Analyzer w/ Calibration Kits  Vista, CA
Network Analyzer System Verification (Corrected Performance) 7mm Test Ports Reflection $S_{11}/S_{22}$ – Magnitude <sup>4</sup>  Phase	$\leq 0.1$ to $\leq 1.0$ $\Gamma$ (0.0003 to 1) GHz (1 to 3) GHz (3 to 6) GHz $\leq 0$ to $\leq 60^\circ$ (0.0003 to 1) GHz (1 to 3) GHz (3 to 6) GHz	0.003 8 $\Gamma$ 0.003 9 $\Gamma$ 0.005 1 $\Gamma$ 1.97 $^\circ$ 2.1 $^\circ$ 2.7 $^\circ$	Mechanical Calibration Kits and RF Network Analyzer System Verification Kits  Vista, CA Fremont, CA Orlando, FL





Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) N-Type Test Ports Reflection $S_{11}/S_{22}$ –Magnitude <sup>4</sup>  Phase	$\leq 0.1$ to $\leq 1.0 \Gamma$ (0.0003 to 1) GHz (1 to 3) GHz (3 to 8) GHz (8 to 18) GHz  $\leq 0$ to $\leq 60^\circ$ (0.0003 to 1) GHz (1 to 3) GHz (3 to 8) GHz (8 to 18) GHz	0.009 $\Gamma$ 0.001 $\Gamma$ 0.001 5 $\Gamma$ 0.004 1 $\Gamma$  0.46 $^\circ$ 0.64 $^\circ$ 0.65 $^\circ$ 1.3 $^\circ$	Mechanical Calibration Kits and RF Network Analyzer System Verification Kits  Vista, CA Fremont, CA Orlando, FL
Network Analyzer System Verification (Corrected Performance) 3.5mm Test Ports Reflection $S_{11}/S_{22}$ –Magnitude <sup>4</sup>  Phase	$\leq 0.1$ to $\leq 1.0$ (0.045 to 2) G $\Gamma$ Hz (2 to 20) GHz (20 to 26.5) GHz  $\leq 0$ to $\leq 60^\circ$ (0.045 to 2) GHz (2 to 20) GHz (20 to 26.5) GHz	0.000 76 $\Gamma$ 0.001 $\Gamma$ 0.003 $\Gamma$  0.34 $^\circ$ 0.36 $^\circ$ 0.64 $^\circ$	Mechanical Calibration Kits and RF Network Analyzer System Verification Kits  Vista, CA Fremont, CA Orlando, FL
Network Analyzer System Verification (Corrected Performance) 2.4mm Test Ports Reflection $S_{11}/S_{22}$ –Magnitude <sup>4</sup>  Phase	$\leq 0.1$ to $\leq 1.0 \Gamma$ (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz  $\leq 0$ to $\leq 60^\circ$ (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.003 8 $\Gamma$ 0.003 8 $\Gamma$ 0.004 4 $\Gamma$ 0.005 5 $\Gamma$  0.96 $^\circ$ 1.3 $^\circ$ 1.5 $^\circ$ 2.3 $^\circ$	Mechanical Calibration Kits and RF Network Analyzer System Verification Kits  Vista, CA Fremont, CA Orlando, FL



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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) 7mm Test Ports Transmission $S_{21}/S_{122}$ – Magnitude  Phase	$\leq 0.1$ to $\leq 1.0$ dB (0.0003 to 1) GHz (1 to 3) GHz (3 to 6) GHz  $\leq 0$ to $\leq 60^\circ$ (0.0003 to 1) GHz (1 to 3) GHz (3 to 6) GHz	0.16 dB 0.16 dB 0.17 dB  1.43 ° 1.5 ° 2.2 °	Mechanical Calibration Kits and RF Network Analyzer System Verification Kits  Vista, CA Fremont, CA Orlando, FL
Network Analyzer System Verification (Corrected Performance) N-Type Test Ports Transmission $S_{21}/S_{122}$ – Magnitude  Phase	$\leq 0.1$ to $\leq 1.0$ dB (0.0003 to 1) GHz (1 to 3) GHz (3 to 8) GHz (8 to 18) GHz  $\leq 0$ to $\leq 60^\circ$ (0.0003 to 1) GHz (1 to 3) GHz (3 to 8) GHz (8 to 18) GHz	0.018 dB 0.019 dB 0.02 dB 0.024 dB  0.18 ° 0.2 ° 0.23 ° 0.24 °	Mechanical Calibration Kits and RF Network Analyzer System Verification Kits  Vista, CA Fremont, CA Orlando, FL
Network Analyzer System Verification (Corrected Performance) 3.5mm Test Ports Transmission $S_{21}/S_{122}$ – Magnitude  Phase	$\leq 0.1$ to $\leq 1.0$ dB (0.045 to 2) GHz (2 to 20) GHz (20 to 26.5) GHz  $\leq 0$ to $\leq 60^\circ$ (0.045 to 2) GHz (2 to 20) GHz (20 to 26.5) GHz	0.018 dB 0.019 dB 0.032 dB  0.18 ° 0.18 ° 0.32 °	Mechanical Calibration Kits and RF Network Analyzer System Verification Kits  Vista, CA Fremont, CA Orlando, FL



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## Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer System Verification (Corrected Performance) 2.4mm Test Ports Transmission $S_{21}/S_{12}$ – Magnitude  Phase	$\leq 0.1$ to $\leq 1.0$ dB (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz  $\leq 0$ to $\leq 60^\circ$ (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.023 dB 0.033dB 0.055 dB 0.068 dB  0.23 ° 0.41 ° 0.97 ° 1.8 °	Mechanical Calibration Kits and RF Network Analyzer System Verification Kits  Vista, CA Fremont, CA Orlando, FL
Scalar Network Analyzer  Absolute Log Error  Dynamic Accuracy	21 dB  (0 to 140) dB	0.04 dB  0.02 dB	Scalar Network Analyzer Calibrator  Vista, CA Fremont, CA Orlando, FL
Network Analyzer  Dynamic Accuracy	(0 to 140) dB	0.02 dB	Dynamic Accuracy Test Set Vista, CA Fremont, CA Orlando, FL
Impulse Spectral Amplitude Source CISPR Band A CISPR Band B CISPR Band C and D CISPR Band E  Sinewave Output for CISPR Checks Source @ 60 dB/ $\mu$ V  Peak and Average Detector Response	(10 to 150) kHz 150 kHz to 30 MHz 30 MHz to 1 GHz (1 to 18) GHz  (0 to -70) dB 100 kHz (1, 10, and 100) MHz  (0 to -70) dB CISPR Band A thru D	0.82 dB 0.82 dB 1.1 dB 1.5 dB  0.35 dB 0.35 dB  1.3 dB	CISPR Pulse Generator  Vista, CA Fremont, CA Orlando, FL



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
LISN (Line Impedance Stabilization Network) & AMN (Artificial Mains Network) Insertion Loss	(-20 to 0) dB 10 Hz to 1000 MHz	0.25 dB	RF Impedance/Network Analyzers, Calibration Kits, Calibration Fixtures  Vista, CA Fremont, CA Orlando, FL
Isolation (De-Coupling Factor)	(-90 to 0) dB 10 Hz to 1 000 MHz	2.3 dB	
Impedance (Magnitude)	0.1 Ω to 1 kΩ 10 Hz to 1000 MHz	2.4 %	
Impedance (Phase)	(-180 to 180) ° 10 Hz to 1 000 MHz	2.6 °	
CDN (Coupling-Decoupling Network) & ISN (Impedance Stabilization Network) Insertion Loss	(-20 to 0) dB 10 Hz to 1000 MHz	0.25 dB	RF Impedance/Network Analyzers, Calibration Kits, Calibration Fixtures  Vista, CA Fremont, CA Orlando, FL
Isolation (De-Coupling Factor)	(-90 to 0) dB 10 Hz to 1000 MHz	2.3 dB	
Impedance (Magnitude)	0.1 Ω to 1 kΩ 10 Hz to 1 000 MHz	2.4 % of reading	
Impedance (Phase)	(-180 to 180) ° 10 Hz to 1 000 MHz	2.6 °	
LCL (Longitudinal Conversion Loss)	(-20 to 0) dB 10 Hz to 1 000 MHz	2.3 dB	
Biconical Antennas <sup>3</sup> – 1 Meter Distance 3 Meter Distance 10 Meter Distance	(-135 to 21) dB (25 to 300) MHz	0.94 dB	Standard Site Method, Horizontal Polarization, Vertical Polarization, Swept Frequency Analyzer and Source  Fremont, CA
Log Periodic Antennas <sup>3</sup> – 1 Meter Distance 3 Meter Distance 10 Meter Distance	(-135 to 21) dB 80 MHz to 6 GHz	0.83 dB	Standard Site Method, Horizontal Polarization, Vertical Polarization, Swept Frequency Analyzer and Source  Fremont, CA



# ANSI National Accreditation Board

## Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Hybrid Antennas <sup>3</sup> – 1 Meter Distance 3 Meter Distance 10 Meter Distance	(-135 to 21) dB 20 MHz to 6 GHz	1.1 dB	Standard Site Method, Horizontal Polarization, Vertical Polarization, Swept Frequency Analyzer and Source  Fremont, CA
Horn Antennas <sup>3</sup>  1 Meter Distance   3 Meter Distance	(-135 to 21) dB 170 MHz to 3 GHz 700 MHz to 18 GHz (-135 to 21) dB (1 to 18) GHz (18 to 26.5) GHz (26.5 to 40) GHz	0.58 dB 0.9 dB 1.1 dB 1.2 dB 1.3 dB	Standard Site Method, Horizontal Polarization, Vertical Polarization, Network Analyzer and Calibration Kit  Fremont, CA
Antenna VSWR <sup>3</sup>	(-135 to 21) dB 20 MHz to 1 GHz (1 to 20) GHz (20 to 40) GHz	0.77 dB 0.89 dB 1.1 dB	Network Analyzer with Calibration Kit  Fremont, CA
NSA Measurement <sup>3</sup>	(-135 to 21) dB (30 to 200) MHz 200 MHz to 1 GHz	0.99 dB 0.95 dB	Swept Frequency Analyzer and Source, Standard Antenna Pair  Fremont, CA
Antenna Symmetry <sup>3</sup>	(-1 to 1) dB 30 MHz to 6 GHz @ (-110 to 20) dB	0.26 dB + 0.012 % of reading	Agilent E4440A Spectrum Analyzer, Agilent E8257D Signal Generator, Sunol Sciences JB6 Antenna  Fremont, CA

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers <sup>1</sup>	(0 to 54) in	46 μin/in + 52 μin	Gage Blocks, Standard Rings, Rod Sets  Vista, CA Fremont, CA Orlando, FL
Micrometers and Thickness Gages <sup>1</sup> (Linearity Only)	(0 to 54) in	46 μin/in + 52 μin	Gage Blocks, Rod Sets  Vista, CA Fremont, CA
Indicators <sup>1</sup>	(0 to 4) in	0.26 μin/in + 57 μin	Gage Blocks  Vista, CA Fremont, CA
Pin and Plug Gages <sup>1</sup>	(0.3 to 30) mm	5 μm	Micrometer  Vista, CA Fremont, CA
Micrometers and Thickness Gages	Up to 7 in	(58 + 10L) μin	Grade 1 Gage Block Set  Orlando, FL
Calipers - External Diameter Internal Diameter	Up to 12 in	(68 + 24.2L) μin	Grade 1 Gage Block Set  Vista, CA Fremont, CA
Height Gages	Up to 12 in	(750 + 4.7L) μin	Gage Blocks
Depth Gages	Up to 12 in	(160 + 4.1L) μin	Vista, CA Fremont, CA Orlando, FL
Dial Indicators	Up to 2 in	(1 100 + 18L) μin	Gage Blocks Vista, CA Fremont, CA Orlando, FL
Surface Flatness	(12 X 12) in to (72 X 144) in	(250 + 0.21L) μin	Leveling System  Orlando, FL



**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Steel Rulers	Up to 48 in	0.036 in	Gage Blocks Vista, CA Fremont, CA Orlando, FL
Tape Measures	Up to 50 ft	0.036 in	Gage Blocks Vista, CA Fremont, CA Orlando, FL
Distance <sup>3</sup>	Up to 500 in	0.053 in + 0.004 % of reading	Fluke 419D Laser Distance Meter Fremont, CA

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force	(0 to 20) kgf	0.024 kgf/kgf	NIST Class F Weights Vista, CA Fremont, CA Orlando, FL
Pressure - Source <sup>1</sup>	(-12 to 300) psi (300 to 10 000) psi	0.2 psi 9.5 psi	Pressure Calibration System Vista, CA Fremont, CA Orlando, FL
Torque - Measure <sup>1</sup>	(2.5 to 25) lbf·in (5 to 10) lbf·in (10 to 100) lbf·in (5 to 50) lbf·ft (25 to 250) lbf·ft (250 to 600) lbf·ft	0.03 lbf·in + 0.5 % of reading 0.008 7 lbf·in + 0.5 % of reading 0.067 lbf·in + 0.5 % of reading 0.002 9 lbf·ft + 0.6 % of reading 0.17 lbf·ft + 0.5 % of reading 0.15 lbf·ft + 0.6 % of reading	Torque Transducers Vista, CA Fremont, CA

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque - Measure	(5 to 50) lbf·in (50 to 500) lbf·in (10 to 100) lbf·ft (100 to 750) lbf·ft	0.016 lbf·in + 0.003 lbf·in 0.068 lbf·in + 0.002 lbf·in 0.39 lbf·ft + 0.001 lbf·ft 2.9 lbf·ft + 0.001 lbf·ft	Torque Transducers  Orlando, FL
Scales & Balances <sup>1</sup>	10 mg to 100 g 1 kg 2 kg (5 to 10) lb (10 to 20) lb (20 to 100) lb (100 to 356) lb	0.15 g 0.23 g 0.3 g 0.15 lb 0.14 lb 0.18 lb 0.12 lb	NIST Class F Weights  Vista, CA Fremont, CA
Scales & Balances	0.25 oz 0.5 oz 1 oz 2 oz 4 oz 8 oz 16 oz 1 kg 2 kg 5 lbs (1 to 10) lbs (10 to 50) lbs (50 to 300) lbs	0.000 71 oz 0.001 1 oz 0.000 27 oz 0.000 46 oz 0.001 oz 0.002 2 oz 0.002 9 oz 5.8 g 12 g 0.001 8 lb 0.002 6 lb 0.005 9 lb 0.041 lb	NIST Class F Weights  Orlando, FL

**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity - Measure <sup>1</sup>	(0 to 80) %RH	2 %RH	Humidity Probe Monitor  Vista, CA Fremont, CA Orlando, FL



**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature - Measure	(-200 to 0) °C	0.03 °C	Reference Thermometer w/ PRT  Vista, CA Fremont, CA Orlando, FL
	(0 to 100) °C	0.05 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 420) °C	0.11 °C	
	(420 to 650) °C	0.14 °C	

**Time and Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency - Source <sup>1</sup>	1 μHz to 80 MHz	5.1 x 10 <sup>-12</sup> MHz	Frequency Synthesizer w/ GPS Reference  Vista, CA Fremont, CA Orlando, FL
Frequency - Source <sup>1</sup>	10 MHz to 50 GHz	5.1 x 10 <sup>-12</sup> GHz	Synthesized Sweeper w/ GPS Reference  Vista, CA Fremont, CA Orlando, FL
Frequency – Measure <sup>1</sup>	1 μHz to 12.4 GHz 1 Hz to 50 GHz	5.1 x 10 <sup>-12</sup> GHz 5.1 x 10 <sup>-12</sup> GHz	Electronic Counters, Analyzers w/ GPS Reference  Vista, CA Fremont, CA Orlando, FL
Time Interval	50 ns to 999 s	5 parts in 10 <sup>12</sup> s+ 0.43 ns	Universal Counter w/ GPS Reference  Vista, CA Fremont, CA Orlando, FL

**Time and Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Period	4.44 ns to 10 s	0.012 % of reading + 0.17 ns	Universal Counter w/ GPS Reference  Vista, CA Fremont, CA Orlando, FL
Rise/Fall Time - Measure	> 2 ns	0.076 ns	Digital Oscilloscope  Vista, CA Fremont, CA Orlando, FL
Pulse Width - Measure	> 5 ns	1.1 ns	Universal Counter w/ GPS Reference  Vista, CA Fremont, CA Orlando, FL
Stop Watches – Totalize Method	1s to 24 hrs	0.000 6 % of reading + 0.044 s	Universal Counter and Synthesizer w/ GPS Reference  Vista, CA Fremont, CA Orlando, FL

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.  $\Gamma = \rho$
3. Performed at Open Area Test Site (OATS) in Morgan, CA.
4. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1736.




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Vice President

