



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Techmaster Electronics, Inc.
1070 Joshua Way
Vista, CA 92081
(and satellite locations as listed on the scope)

Fulfills the requirements of

ISO/IEC 17025:2017

and national standard

ANSI/NCSL Z540-1-1994 (R2002)

In the field of

CALIBRATION and TESTING

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 29 October 2022
Certificate Number: AC-1736



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).

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

Techmaster Electronics, Inc.

1070 Joshua Way
Vista, CA 92081

Ernesto Matamoros Phone: 760-536-0227 ext. 405

Email: quality.mx@techmaster.us Website: www.techmastertest.com

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

CALIBRATION AND TESTING

Valid to: **October 29, 2022**

Certificate Number: **AC-1736**

CALIBRATION

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 2 500) 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 | 0.017 pH 0.015 pH 0.031 pH | Standard Solutions Vista, CA Fremont, CA Orlando, FL |



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Chemical Quantities

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|-----------------------|--|---|---|
| Conductivity - Source | (445 to 3 900) $\mu\text{S}/\text{cm}$ | 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 ¹ | Up to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V 220 V to 1.1 kV | 6.8 $\mu\text{V}/\text{V}$ + 0.48 μV 4.6 $\mu\text{V}/\text{V}$ + 0.8 μV 3.2 $\mu\text{V}/\text{V}$ + 3.2 μV 2.4 $\mu\text{V}/\text{V}$ + 27 μV 4.7 $\mu\text{V}/\text{V}$ + 43 μV 6 $\mu\text{V}/\text{V}$ + 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 $\mu\text{V}/\text{V}$ + 0.4 μV 5 $\mu\text{V}/\text{V}$ + 1 μV 3.5 $\mu\text{V}/\text{V}$ + 3.1 μV 3.5 $\mu\text{V}/\text{V}$ + 8.1 μV 5 $\mu\text{V}/\text{V}$ + 83 μV 6.5 $\mu\text{V}/\text{V}$ + 0.68 mV | High Performance Multifunction Calibrator Fremont, CA Orlando, FL |
| DC Voltage – Source ¹ Fixed Points | 1 V 1.018 V 10 V | 14 μV 17 μV 35 μV | DC Reference Standard Vista, CA |
| DC Voltage – Measure ¹ | Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV | 7.2 $\mu\text{V}/\text{V}$ + 0.55 μV 7 $\mu\text{V}/\text{V}$ + 0.42 μV 6.9 $\mu\text{V}/\text{V}$ + 0.86 μV 9.2 $\mu\text{V}/\text{V}$ + 38 μV 9.3 $\mu\text{V}/\text{V}$ + 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 $\mu\text{V}/\text{V}$ + 0.2 μV 4.3 $\mu\text{V}/\text{V}$ + 0.5 μV 4.3 $\mu\text{V}/\text{V}$ + 4.8 μV 6.7 $\mu\text{V}/\text{V}$ + 98 μV 6.7 μV + 0.63 mV | Precision 8.5 Digit Multimeter Vista CA |

Electrical – DC/Low Frequency

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---|--|---|
| DC Voltage – Measure ¹ | (1 to 40) kV | 5 mV/V | High Voltage Probe with Digital Multimeter Vista, CA Fremont, CA Orlando, FL |
| DC Current – Source ¹ | Up to 220 μ A 220 μ 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 μ A 72 μ A/A + 14 μ A 0.023 % of reading + 0.47 mA | High Performance Multifunction Calibrator w/ Transconductance Amplifier Vista, CA |
| DC Current – Source ¹ | Up to 220 μ A 220 μ A to 2.2 mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A | 40 μ A/A + 6 nA 35 μ A/A + 7.6 nA 35 μ A/A + 48 nA 55 μ A/A + 0.74 μ A 0.13 mA/A + 13 μ A | High Performance Multifunction Calibrator Fremont, CA Orlando, FL |
| DC Current – Source ¹ | 330 mA to 1.1 A (1.1 to 3) A (3 to 11) A (11 to 20) A | 0.15 mA/A + 44 μ 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 ¹ 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 ¹ 33 mV to 1 020 V 329.99 mA range 2.999 9 A range 20.5 A range | 10 μ 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 ¹ | Up to 100 nA 100 nA to 1 μ A (1 to 10) μ A (10 to 100) μ A 100 μ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A | 22 μ A/A + 93 pA 18 μ A/A + 0.1 nA 28 μ A/A + 0.14 nA 30 μ A/A + 0.98 nA 30 μ A/A + 6.5 nA 30 μ A/A + 63 nA 44 μ A/A + 1 μ A 0.14 mA/A + 12 μ A | Precision 8.5 Digit Multimeter 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 |
|-----------------------------------|---|---|---|
| DC Current – Measure ¹ | (2 to 200) μ A (200 μ A to 2) mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A | 15 μ A/A + 0.49 nA 15 μ A/A + 4.8 nA 17 μ A/A + 48 nA 59 μ A/A + 0.96 μ A 0.23 mA/A + 25 μ A 0.49 mA/A + 0.36 mA | Precision 8.5 Digit Multimeter Vista, CA |
| DC Current – Measure ¹ | (1 to 100) A (100 to 600) A (600 to 2 000) A | 85 μ A/A 127 μ A/A 0.29 % of reading + 0.02 A | Precision 8.5 Digit Multimeter w/ Current Shunts Vista, CA Fremont, CA Orlando, FL |
| AC Voltage – Source ¹ | (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 μ V 0.008 3 % of reading + 4.2 μ V 0.007 2 % of reading + 4.2 μ V 0.016 % of reading + 4.6 μ V 0.042 % of reading + 5.3 μ V 0.095 % of reading + 10 μ V 0.13 % of reading + 20 μ V 0.25 % of reading + 21 μ V 0.021 % of reading + 4.9 μ V 0.008 3 % of reading + 4.3 μ V 0.007 % of reading + 4.4 μ V 0.017 % of reading + 4.8 μ V 0.042 % of reading + 6.1 μ V 0.092 % of reading + 12 μ V 0.13 % of reading + 22 μ V 0.22 % of reading + 33 μ V 0.022 % of reading + 16 μ V 0.006 4 % of reading + 15 μ V 0.004 4 % of reading + 10 μ V 0.009 % of reading + 14 μ V 0.028 % of reading + 23 μ V 0.056 % of reading + 35 μ V 0.13 % of reading + 39 μ V 0.23 % of reading + 0.12 mV | High Performance Multifunction Calibrator w/ Transconductance Amplifier Vista, CA |



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Electrical – DC/Low Frequency

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



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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 μV | |
| | (20 to 40) Hz | 0.21 mV/V + 4.5 μV | |
| | 40 Hz to 20 kHz | 0.11 mV/V + 4.5 μV | |
| | (20 to 50) kHz | 0.37 mV/V + 4.5 μV | |
| | (50 to 100) kHz | 0.85 mV/V + 7 μV | |
| | (100 to 300) kHz | 1.1 mV/V + 13 μV | |
| | (300 to 500) kHz | 1.7 mV/V + 25 μV | |
| | 500 kHz to 1 MHz | 3.4 mV/V + 25 μV | |
| | (2.2 to 22) mV | | |
| | (10 to 20) Hz | 0.55 mV/V + 5 μV | |
| | (20 to 40) Hz | 0.21 mV/V + 5 μV | |
| | 40 Hz to 20 kHz | 0.11 mV/V + 5 μV | |
| | (20 to 50) kHz | 0.37 mV/V + 5 μV | |
| | (50 to 100) kHz | 0.85 mV/V + 7 μV | |
| | (100 to 300) kHz | 1.1 mV/V + 12 μV | |
| | (300 to 500) kHz | 1.7 mV/V + 25 μV | |
| | 500 kHz to 1 MHz | 3.4 mV/V + 25 μV | |
| | (22 to 220) mV | | |
| | (10 to 20) Hz | 0.55 mV/V + 13 μV | |
| | (20 to 40) Hz | 0.21 mV/V + 8 μV | |
| | 40 Hz to 20 kHz | 0.11 mV/V + 8 μV | |
| | (20 to 50) kHz | 0.32 mV/V + 8 μV | |
| | (50 to 100) kHz | 0.85 mV/V + 25 μV | |
| | (100 to 300) kHz | 1.1 mV/V + 25 μV | |
| | (300 to 500) kHz | 1.7 mV/V + 35 μV | |
| | 500 kHz to 1 MHz | 3.4 mV/V + 80 μV | |
| 220 mV to 2.2 V | | | |
| (10 to 20) Hz | 0.24 mV/V + 45 μV | | |
| (20 to 40) Hz | 90 μV/V + 25 μV | | |
| 40 Hz to 20 kHz | 45 μV/V + 21 μV | | |
| (20 to 50) kHz | 75 μV/V + 22 μV | | |
| (50 to 100) kHz | 0.11 mV/V + 82 μV | | |
| (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 μV/V + 0.24 mV | |
| | 40 Hz to 20 kHz | 45 μV/V + 0.19 mV | |
| | (20 to 50) kHz | 75 μV/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 μV/V + 2.3 mV | |
| | 40 Hz to 20 kHz | 52 μV/V + 1.8 mV | |
| | (20 to 50) kHz | 80 μV/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 μV/V + 3.9 mV | |
| | (1 to 20) kHz | 0.17 mV/V + 6.8 mV | |
| | (20 to 30) kHz | 0.6 mV/V + 12 mV | |
| | 220 V to 1.1 kV | | |
| 40 Hz to 1 kHz | 90 μV/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 μV/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 | | |



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Electrical – DC/Low Frequency

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|-----------------------------------|-----------------------|---|---|
| AC Voltage – Measure ¹ | (1 to 10) mV | | Precision 8.5 Digit Multimeter Fremont, CA Orlando, FL |
| | (1 to 40) Hz | 0.36 mV/V + 3.6 μV | |
| | 40 Hz to 1 kHz | 0.23 mV/V + 1.4 μV | |
| | (1 to 20) kHz | 0.32 mV/V + 1.7 μV | |
| | (20 to 50) kHz | 1.2 mV/V + 1.6 μV | |
| | (50 to 100) kHz | 5.7 mV/V + 2 μV | |
| | (100 to 300) kHz | 46 mV/V + 2.6 μV | |
| | (10 to 100) mV | | |
| | (1 Hz to 40) Hz | 72 μV/V + 0.85 mV | |
| | 40 Hz to 1 kHz | 84 μV/V + 0.26 mV | |
| | (1 to 20) kHz | 0.17 mV/V + 0.26 mV | |
| | 100 mV to 10 V | | |
| | (1 Hz to 40) Hz | 71 μV/V + 0.73 mV | |
| | 40 Hz to 1 kHz | 80 μV/V + 0.26 mV | |
| | (1 to 20) kHz | 160 μV/V + 0.26 mV | |
| | (20 to 50) kHz | 0.35 mV/V + 0.25 mV | |
| | (50 to 100) kHz | 0.93 mV/V + 0.27 mV | |
| | (100 to 300) kHz | 3.5 mV/V + 1.2 mV | |
| | 300 kHz to 1 MHz | 12 mV/V + 1.2 mV | |
| | (1 to 2) MHz | 18 mV/V + 1.2 mV | |
| | (10 to 100) V | | |
| | (1 to 40) Hz | 0.24 mV/V + 4.7 mV | |
| | 40 Hz to 1 kHz | 0.15 mV/V + 16 mV | |
| | (1 to 20) kHz | 0.15 mV/V + 17 mV | |
| (20 to 50) kHz | 0.36 mV/V + 8.6 mV | | |
| (50 to 100) kHz | 1.4 mV/V + 3.9 mV | | |
| (100 to 300) kHz | 4.8 mV/V + 12 mV | | |
| 300 kHz to 1 MHz | 18 mV/V + 12 mV | | |
| (100 to 1 000) V | | | |
| (1 to 40) Hz | 0.46 mV/V + 50 mV | | |
| 40 Hz to 1 kHz | 0.46 mV/V + 28 mV | | |
| (1 to 20) kHz | 0.69 mV/V + 29 mV | | |
| (20 to 50) kHz | 1.5 mV/V + 24 mV | | |
| (50 to 100) kHz | 3.6 mV/V + 24 mV | | |
| AC Voltage – Measure ¹ | (1 to 40) kV 60 Hz | 77 mV /V | High Voltage Probe with Digital Multimeter 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 Voltage – Measure ¹ | Up to 200 mV | | Precision 8.5 Digit Multimeter Vista, CA |
| | (1 to 10) Hz | 0.2 mV/V + 29 μV | |
| | (10 to 40) Hz | 0.17 mV/V + 5 μV | |
| | (40 to 100) Hz | 0.14 mV/V + 5 μV | |
| | 100 Hz to 2 kHz | 0.17 mV/V + 2 μV | |
| | (2 to 10) kHz | 0.17 mV/V + 5 μV | |
| | (10 to 30) kHz | 0.42 mV/V + 10 μV | |
| | (30 to 100) kHz | 0.93 mV/V + 24 μV | |
| | 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 μV | |
| | (40 to 100) Hz | 0.12 mV/V + 24 μV | |
| | 100 Hz to 2 kHz | 0.17 mV/V + 24 μV | |
| | (2 to 10) kHz | 0.14 mV/V + 24 μV | |
| | (10 to 30) kHz | 0.27 mV/V + 48 μV | |
| | (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 | | |



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Electrical – DC/Low Frequency

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|--|---|---|
| AC Voltage – Measure ¹ | 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 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 |



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Electrical – DC/Low Frequency

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|-----------------------------------|--------------------|---|---|
| AC Voltage – Measure ¹ | 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 | | |



ANSI National Accreditation Board

Electrical – DC/Low Frequency

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



ANSI National Accreditation Board

Electrical – DC/Low Frequency

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|-----------------------------------|---------------------|---|---|
| AC Voltage – Measure ¹ | (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 | | |



ANSI National Accreditation Board

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 μ V/V + 4.6 μ V | |
| | 40 Hz to 1 kHz | 2.4 μ V/V + 3.2 μ V | |
| | (1 to 20) kHz | 3.5 μ V/V + 4.6 μ V | |
| | (20 to 50) kHz | 12 μ V/V + 3.2 μ V | |
| | (50 to 100) kHz | 58 μ V/V + 3.2 μ V | |
| | (100 to 300) kHz | 0.47 mV/V + 3.8 μ V | |
| | (10 to 100) mV | | |
| | (1 to 40) Hz | 86 μ V/V + 4.6 μ V | |
| | 40 Hz to 1 kHz | 86 μ V/V + 2.3 μ V | |
| | (1 to 20) kHz | 0.17 mV/V + 2.3 μ V | |
| | (20 to 50) kHz | 0.35 mV/V + 2.3 μ V | |
| | (50 to 100) kHz | 0.93 mV/V + 2.3 μ V | |
| | (100 to 300) kHz | 3.5 mV/V + 12 μ V | |
| | 300 kHz to 1 MHz | 12 mV/V + 12 μ V | |
| | (1 to 2) MHz | 18 mV/V + 12 μ V | |
| | 100 mV to 1 V | | |
| | (1 to 40) Hz | 92 μ V/V + 50 μ V | |
| | 40 Hz to 1 kHz | 92 μ V/V + 31 μ V | |
| | (1 to 10) V | | |
| | (1 to 20) kHz | 0.17 mV/V + 31 μ V | |
| | (20 to 50) kHz | 0.35 mV/V + 31 μ V | |
| | (50 to 100) kHz | 0.93 mV/V + 31 μ 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 μ V/V + 0.14 mV | |
| 40 Hz to 1 kHz | 91 μ V/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 | | |



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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 ¹ | (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 ¹ | (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 | 0.003 4 % of reading + 20 μA 0.002 5 % of reading + 12 μA 0.007 2 % of reading + 0.95 μA 0.015 % of reading + 1.5 μA 0.1 % of reading + 5.1 μA 0.004 6 % of reading + 0.15 mA 0.003 5 % of reading + 85 μA 0.006 2 % of reading + 12 μA 0.014 % of reading + 16 μA 0.089 % of reading + 38 μA 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 μA 2.8 mA/A + 200 μA | High Performance Multifunction Calibrator Vista, CA |
| AC Current – Source ¹ | (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 ¹ | (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 μA (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 | High Performance Multifunction Calibrator Fremont, CA Orlando, FL |

Electrical – DC/Low Frequency

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment | | |
|---------------------|---|---|--|-------------------|---|
| AC Current – Source | 220 μ A to 2.2 mA (10 to 20 Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz | 0.25 mA/A + 40 nA 0.16 mA/A + 36 nA 0.12 mA/A + 36 nA 0.2 mA/A + 0.11 μ A 1.1 mA/A + 0.65 μ A | High Performance Multifunction Calibrator Fremont, CA Orlando, FL | | |
| | (2.2 to 22) mA (10 to 20 Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz | 0.25 mA/A + 0.41 μ A 0.16 mA/A + 0.36 μ A 0.12 mA/A + 0.36 μ A 0.2 mA/A + 0.56 μ A 1.1 mA/A + 5.1 μ A | | | |
| | (22 to 220) mA (10 to 20 Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz | 0.25 mA/A + 4.1 μ A 0.16 mA/A + 3.6 μ A 0.12 mA/A + 2.6 μ A 0.2 mA/A + 3.6 μ A 1.1 mA/A + 11 μ A | | | |
| | 220 mA to 2.2 A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz | 0.25 mA/A + 36 μ A 0.45 mA/A + 81 μ A 7 mA/A + 0.18 mA | | | |
| | (2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz | 0.46 mA/A + 0.21 mA 0.95 mA/A + 0.4 mA 3.6 mA/A + 0.76 mA | | | |
| | (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 | | | |
| | AC Power – Source ¹ PF = 1 (10 to 45) Hz 33 mV to 32.9999 V (3.3 mA to 2.99999 A) | 110 μ W to 99 W | | 0.19 % of reading | Multi Product Calibrator Vista, CA Fremont, CA Orlando, FL |
| | (45 to 65) Hz 33 mV to 1020 V (3.3 mA to 20.5 A) | 110 μ W to 99 W | | 0.15 % of reading | |



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Electrical – DC/Low Frequency

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|--|--|---|
| Phase – Source ¹ (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 ° 0.2 ° 0.39 ° 1.9 ° 3.9 ° 7.8 ° | Multi Product Calibrator Vista, CA Fremont, CA Orlando, FL |
| 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 ¹ | Up to 100 μ A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz 100 μ A 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 μ A 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 μ A 1.8 mA/A + 24 μ A 0.71 mA/A + 24 μ A 0.36 mA/A + 23 μ A 0.71 mA/A + 24 μ A 4.7 mA/A + 47 μ A 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 |



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Electrical – DC/Low Frequency

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|-----------------------------------|---|--|--|
| AC Current – Measure ¹ | (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 |
| AC Current - Measure | Up to 200 μ A 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz 200 μ A to 2 mA 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (2 to 20) mA 10 Hz to 10 kHz (10 to 30) kHz (30 to 100) kHz (20 to 200) mA 10 Hz to 10 kHz (10 to 30) kHz 200 mA to 2 A 10 Hz to 2 kHz (2 to 10) kHz (10 to 30) kHz (2 to 20) A 10 Hz to 2 kHz (2 to 10) kHz | 0.42 mA/A + 24 nA 0.88 mA/A + 24 nA 4.8 mA/A + 24 nA 0.36 mA/A + 0.24 μ A 0.86 mA/A + 0.24 μ A 4.8 mA/A + 0.24 μ A 0.37 mA/A + 2.4 μ A 0.86 mA/A + 2.4 μ A 4.8 mA/A + 2.4 μ A 0.35 mA/A + 24 μ A 0.75 mA/A + 24 μ A 0.75 mA/A + 0.25 mA 0.87 mA/A + 0.27 mA 3.6 mA/A + 0.26 mA 0.99 mA/A + 2.4 mA 3.1 mA/A + 2.4 mA | Precision 8.5 Digit Multimeter Vista CA |
| Resistance – Source ¹ | Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω 330 Ω to 1.1 k Ω (1.1 to 3.3) k Ω (3.3 to 11) k Ω (11 to 33) k Ω (33 to 110) k Ω | 1.7 m Ω / Ω + 35 $\mu\Omega$ 23 $\mu\Omega$ / Ω + 3.3 m Ω 31 $\mu\Omega$ / Ω + 1.9 m Ω 32 $\mu\Omega$ / Ω + 2.8 m Ω 33 $\mu\Omega$ / Ω + 2.3 m Ω 32 $\mu\Omega$ / Ω + 30 m Ω 5 $\mu\Omega$ / Ω + 1.4 Ω 32 $\mu\Omega$ / Ω + 0.3 Ω 33 $\mu\Omega$ / Ω + 0.34 Ω | Multi Product Calibrator 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 |
|--|---|---|--|
| Resistance – Source ¹ | (110 to 330) kΩ 330 kΩ to 1.1 MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ 330 MΩ to 1.1 GΩ | 37 μΩ/Ω + 3.1 Ω 38 μΩ/Ω + 2.6 Ω 71 μΩ/Ω + 36 Ω 0.13 mΩ/Ω + 0.38 kΩ 0.22 mΩ/Ω + 7.4 kΩ 0.42 mΩ/Ω + 32 kΩ 3.6 mΩ/Ω + 0.12 MΩ 18 mΩ/Ω + 0.59 MΩ | Multi Product Calibrator Vista, CA Fremont, CA Orlando, FL |
| Resistance – Source ¹ Fixed Points | 0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ | 48 μΩ 0.15 mΩ 0.22 mΩ 0.28 mΩ 0.63 mΩ 1.2 mΩ 2.3 mΩ 7.8 mΩ 15 mΩ 77 mΩ 0.15 Ω 1 Ω 1.9 Ω 16 Ω 40 Ω 0.48 kΩ 1.1 kΩ 12 kΩ | High Performance Multifunction Calibrator Vista, CA |
| Resistance – Source ¹ Fixed Points | 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ | 0.12 mΩ 0.22 mΩ 0.28 mΩ 0.58 mΩ 1.3 mΩ 2.4 mΩ 10 mΩ 20 mΩ 90 mΩ 0.19 Ω 1.3 Ω 2.5 Ω | High Performance Multifunction Calibrator 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 |
|---|--|---|---|
| Resistance – Source ¹ Fixed Points | 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ | 24 Ω 47 Ω 0.47 kΩ 1.3 kΩ 12 kΩ | High Performance Multifunction Calibrator Fremont, CA Orlando, FL |
| Resistance – Source ¹ 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 ¹ | 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 | 21 μΩ/Ω + 62 μΩ 17 μΩ/Ω + 0.59 mΩ 15 μΩ/Ω + 0.67 mΩ 15 μΩ/Ω + 6.1 mΩ 15 μΩ/Ω + 62 mΩ 21 μΩ/Ω + 2.4 Ω 45 μΩ/Ω + 0.38 kΩ 0.58 mΩ/Ω + 1.2 kΩ 5.8 mΩ/Ω + 11 kΩ | Precision 8.5 Digit Multimeter Fremont, CA Orlando, FL |
| Resistance – Measure ¹ | 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 Digit Multimeter Vista, CA |
| Capacitance – Source ¹ 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 | (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 | 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 | Multi Product Calibrator 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 |
|--|--|--|---|
| Capacitance – Source ¹ (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz (0 to 50) Hz (0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz | (3.3 to 10.999 9) μ F (11 to 32.999 9) μ F (33 to 109.999) μ F (110 to 329.999) μ F (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 | 0.29 % of reading + 1.3 nF 0.46 % of reading + 36 nF 0.53 % of reading + 0.12 μ F 0.53 % of reading + 0.35 μ F 0.5 % of reading + 1.5 μ F 0.52 % of reading + 3.6 μ F 0.51 % of reading + 13 μ F 0.86 % of reading + 35 μ F 1.3 % of reading + 0.13 mF | Multi Product Calibrator Vista, CA Fremont, CA Orlando, FL |
| Fixed Capacitance @ 1 kHz | (100 to 500) pF 500 pF to 5 nF (5 to 50) nF (50 to 100) nF (100 to 500) nF 500 nF to 1.5 μ F | 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 ¹ | 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 ¹ | 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 |



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Electrical – DC/Low Frequency

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---|--|---|
| Capacitance - Measure | (1 to 10) nF (10 to 100) nF (0.1 to 1) μF (1 to 10) μF (10 to 100) μF (100 to 1 000) μF (1 to 10) mF (10 to 100) mF | 0.052 pF 0.041 pF 0.37 nF 0.018 μF 0.041 μF 0.56 μF 0.018 mF 0.059 mF | Digit Multimeter/LCR Meter Vista, CA Fremont, CA Orlando, FL |
| Inductance - Source 0.1 to 1 kHz | 200 μH 2 mH 20 mH 200 mH 2 H | 0.58 μH 2.4 μH 24 μH 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 ¹ | 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 | 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 | Multi Product Calibrator 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 |
|--|--|---|---|
| <p>Electrical Simulation of Thermocouple Indicating Devices – Source and Measure ¹</p> | <p>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 Type R (0 to 250) °C (250 to 400) °C (400 to 1 000) °C (1 000 to 1 767) °C Type S (0 to 250) °C (250 to 1 000) °C (1 000 to 1 400) °C (1 400 to 1 767) °C Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C</p> | <p>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 0.83 °C 0.42 °C 0.31 °C 0.38 °C 0.55 °C 0.34 °C 0.32 °C 0.41 °C 0.63 °C 0.35 °C 0.26 °C 0.22 °C</p> | <p>Multi Product Calibrator Vista, CA Fremont, CA Orlando, FL</p> |
| <p>Electrical Simulation of RTD Temperature Indicating Devices – Source and Measure ¹</p> | <p>Pt 385 (100 Ω) (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C Pt 3926 (100 Ω) (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C</p> | <p>0.05 °C 0.07 °C 0.09 °C 0.1 °C 0.12 °C 0.23 °C 0.05 °C 0.07 °C 0.09 °C 0.1 °C 0.12 °C</p> | <p>Multi Product Calibrator Vista, CA Fremont, CA Orlando, FL</p> |

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 ¹ | Pt 3916 (100 Ω) | | Multi Product Calibrator Vista, CA Fremont, CA Orlando, FL |
| | (-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 | |
| | Pt 385 (200 Ω) | | |
| | (-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 | | |



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Electrical – DC/Low Frequency

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---|--|---|
| Oscilloscopes ¹ - 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 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) | (0 to +/-6.6) V (0 to +/-130) V 1 mV to 6.6 Vpp 1 mV to 130 Vpp 1 mV to 130 Vpp 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 | 0.2 % + 36 μV 0.039 % of reading + 37 μV 0.2 % of reading + 65 μV 0.078 % of reading + 36 μV 0.19 % of reading + 39 μV 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 | 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 | 2.5 mV/V + 40 μV 0.5 mV/V + 5 μV 2.5 mV/V + 40 μV 0.5 mV/V + 5 μV | Oscilloscope Calibrator Vista, CA |



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Electrical – DC/Low Frequency

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|--|--|--|
| Oscilloscopes - Leveled Sine Wave | 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 | 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 | Oscilloscope Calibrator Vista, CA |
| Square Wave Signal Leveled Sine Wave Flatness referenced to 50 kHz reference | 5 mV to 5.5 V 10 MHz Reference 600 MHz to 1.6 GHz (1.6 to 2.1) GHz | 20 mV/V + 0.3 mV 70 mV/V + 0.3 mV 80 mV/V + 0.3 mV | |
| Time Markers (5-2-1 sequence) into a 50 Ω load | (1 to 50) ns 100 ns to 20 ms 50 ms to 5 s | 0.001 1 % of reading + 0.048 ps 0.000 2 % of reading + 7 ps 0.4 % of reading | |
| Fast Edge Mode | 5 s to 50 ms 20 ms to 500 ps | 2.5 μs/s + 5 μHz 0.33 μs/s | |
| Programmable Rise Time | (1 to 100) kHz | < 0.15 ns/s +/- 25 ps | |
| Rise Time (measurement) | 20 ps to 100 μs | 81 ns | |

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 |



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Electrical – RF/Microwave

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---|---|--|
| 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 |
| 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 |



ANSI National Accreditation Board

Electrical – RF/Microwave

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---|---|---|
| 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 | Vista, CA Fremont, CA Orlando, FL |
| 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 |
| RF Absolute Power Source Into 50 Ω SWR \leq 1.6:1 SWR \leq 1.6:1 SWR \leq 1.8:1 SWR \leq 2.0:1 SWR \leq 1.6:1 SWR \leq 1.8:1 SWR \leq 2.0:1 SWR \leq 1.6:1 SWR \leq 1.8:1 SWR \leq 2.0:1 | (+10 to -10) dBm 10 MHz to 2 GHz (2 to 20) GHz (+5 to -10) dBm 10MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (+2.5 to -10) dBm (40 to 50) GHz (-10 to -60) dBm 10MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz (-60 to -110) dBm 10 MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz | 1.5 dB 1.7 dB 0.82 dB 0.96 dB 1.2 dB 2.3 dB 1.2 dB 1.3dB 1.6 dB 2.3 dB 1.8 dB 1.9 dB 2.2 dB 3.3 dB | Synthesized Level Generator Vista, CA Fremont, CA Orlando, FL |



ANSI National Accreditation Board

Electrical – RF/Microwave

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment | | |
|---|--|---|--|---------|--|
| RF Absolute Power Source Into 50 Ω | (+24 to -48) dBm Up to 300 MHz | 0.06 dB | Synthesized Low Phase Noise Level Generator Vista, CA | | |
| | (+14 to -48) dBm 300 MHz to 3GHz (3 to 4) GHz | 0.08 dB 0.52 dB | | | |
| | (-48 to -84) dBm 100 kHz to 10 MHz (10 to 300) MHz | 0.52 dB 0.32 dB | | | |
| | 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 | | | |
| | (-84 to -94) dBm 100 kHz to 300 MHz | 0.53 dB | | | |
| | 300 MHz to 4 GHz | 1 dB | | | |
| | (-94 to -130) dBm (10 to 128) MHz | 0.73 dB | | | |
| | 300 MHz to 4 GHz | 1.6 dB | | | |
| | RF Absolute Power Source Into 75 Ω | (+14 to -23) dBm Up to 125 MHz | | 0.07 dB | Synthesized Low Phase Noise Level Generator Vista, CA |
| | | (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 | | | | |



ANSI National Accreditation Board

Electrical – RF/Microwave

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---|--|--|
| RF Tuned Power – Measure (relative) | 100 kHz to 4.2 GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB (4.2 to 18) GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB (18 to 26.5) GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB (26.5 to 50) GHz (+30 to 0) dB (0 to -30) dB (-30 to -60) dB (-60 to -90) dB (-90 to -129) dB | 0.14 dB 0.16 dB 0.19 dB 0.21 dB 0.25 dB 0.18 dB 0.2 dB 0.22 dB 0.24 dB 0.28 dB 0.24 dB 0.25 dB 0.27 dB 0.29 dB 0.32 dB 0.2 dB 0.21 dB 0.23 dB 0.25 dB 0.29 dB | Measuring Receiver System Vista, CA Fremont, CA Orlando, FL |
| 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 | (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 | 0.33 % of reading 0.51 % of reading 1 % of reading 0.18 ° 0.34 ° 0.57 ° | Vector Signal Analyzer Vista, CA Fremont, CA Orlando, FL |

Electrical – RF/Microwave

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---|---|--|
| Digital Modulation - Measure Error Vector Magnitude for FSK Modulation | Modulation Frequency 3.2 kHz 1.152 kHz | 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) % Depth Rate: (20 to 50) Hz (5 to 99) % Depth Rate:9 kHz to 3.2 GHz (0 to 100) % Depth | 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) % Depth | 1.2 % of reading + 0.07 AM | AM/FM Test Source, Analog Modulation Sources Vista, CA Fremont, CA |
| Amplitude Modulation - Measure ³ 100 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 |
| Amplitude Modulation - Measure ³ 10 MHz to 3 GHz (3 to 26.5) GHz (3 to 26.5) GHz | 50 Hz to 100 kHz, (5 to 20) % Depth 50 Hz to 100 kHz, (5 to 20) % Depth 50 Hz to 100 kHz, (20 to 99) % Depth | 0.001 % of reading + 0.029 AM 0.01 % of reading + 0.052 AM 0.01 % of reading + 0.018 AM | Microwave Measuring Receiver System 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 |
|---|--|--|--|
| Amplitude Modulation - Measure (26.5 to 31.15) GHz (31.15 to 50) GHz | 50 Hz to 100kHz, (5 to 20) % Depth (20 to 99) % Depth 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 0.3 % of reading + 0.000 05 AM 0.07 % of reading + 0.000 046 AM | Microwave Measuring Receiver System Vista, CA |
| 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 |
| 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 |

Electrical – RF/Microwave

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---|--|--|
| 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 |
| 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 |



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Electrical – RF/Microwave

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



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Electrical – RF/Microwave

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|--|---|--|
| 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 | Analog Modulation Sources Vista, CA Fremont, CA Orlando, FL |
| 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 |

Electrical – RF/Microwave

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|------------------------------------|--|---|---|
| Power Reference- Measure 50 MHz | 1 mW | 5.5 μ W | 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 μ W 10 μ W 30 μ W 100 μ W 300 μ W 1 mW 3 mW 10 mW 30 mW 100 mW | 21 nW 19 nW 21 nW 77 nW 0.11 μ W 0.29 μ W 0.64 μ W 6.4 μ W 13 μ W 0.10 mW | Power Meter Range Calibrator w/ Precision DC Voltage Source Vista, CA Fremont, CA Orlando, FL |
| 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 |

Electrical – RF/Microwave

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|---|---|---|
| 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 |
| ESD Simulators Contact Voltage (Positive and Negative) | (1 to 8) kV | 1.2 % of reading | Multimeters, ESD Target, Attenuator and Oscilloscope |
| Rise Time | (0.6 to 1) ns | 0.000 12 % Δ time reading + 11 ps | Vista, CA Fremont, CA Orlando, FL |
| Peak Current | (3.75 to 33) A | 2.1 % of reading | |
| 30 ns Current | (2 to 20.8) A | 3.4 % of reading | |
| 60 ns Current | (1 to 10.4) A | 6.3 % of reading | |



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Electrical – RF/Microwave

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|--|--|--|
| ESD Simulators Air Discharge Voltage (Positive and Negative) Rise Time RC Time Constant (at ± 15 kV) | (0.7 to 1) ns (1 to 30) kV 600 ns ± 130 ns 330 pF probe 300 ns ± 60 ns 150 pF probe | 1.2 % of reading 0.000 12 % Δ time reading + 11 ps 0.000 12 % Δ time reading + 11 ps | Multimeters, ESD Target, Attenuator and Oscilloscope Vista, CA Fremont, CA Orlando, FL |
| EFT/Burst Generator Voltage (±) Rise Time Impulse Duration Burst Duration Burst Period | 10 V to 8 kV 5 ns ± 30 % 50 ns ± 30 % 15 ns ± 20 % 300 ms ± 20 % | 2.7 % of reading 0.008 % Δ time reading 0.008 % Δ time reading 0.008 % Δ time reading 0.008 % Δ time reading | Fast Rise Oscilloscope w/ EFT Verification Set Vista, CA Fremont, CA Orlando, FL |
| Current Probes and Bulk Current Injection Probes Insertion Loss Transfer Impedance | (0 to 1) dB 20 Hz to 300 kHz 300 kHz to 400 MHz (0 to 1) dB 20 Hz to 300 kHz 300 kHz to 400 MHz | 0.09 dB 0.09 dB 0.02 dB 0.02 dB | Network/RF Impedance Analyzers Vista, CA Fremont, CA Orlando, FL |
| Surge Generator Front Time Rise Time Open Circuit (±) Short Circuit (±) Time to Half-Value (±) Open Circuit Voltage (±) Short Circuit Voltage (±) Ring Wave Voltage Ring Wave Rise Time | (1.2 to 50) μs (1.2 to 50) μs (20 to 700) μs 10 V to 12 kV (0.125 to 3) kA 1 kV ± 10 % 1.5 μs ± 0.5 μs | 0.008 % Δ time reading 0.008 % Δ time reading 0.008 % Δ time reading 2.9 % of reading 2.9 % of reading 2.9 % of reading 0.008 % Δ time reading | Fast Rise Oscilloscope, Current Probes, Oscilloscope Probes 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 | 10 kHz to 1.3 GHz (-180 to 180) ° | | LF Vector Network Analyzer, Calibration Kits Vista, CA Fremont, CA Orlando, FL |
| | (0 to 10) dB | 0.18 dB (1 °) | |
| | (-10 to 0) dB | 0.057 dB (0.43 °) | |
| | (-20 to -10) dB | 0.072 dB (0.8 °) | |
| | (-60 to -20) dB | 0.086 dB (0.89 °) | |
| | (-70 to -60) dB | 0.13 dB (1.2 °) | |
| | (-80 to -70) dB | 0.3 dB (2.4 °) | |
| | (-90 to -80) dB | 0.92 dB (6.9 °) | |
| | (1.3 to 3) GHz | | |
| | (0 to 10) dB | 0.12 dB (4.1 °) | |
| | (-10 to 0) dB | 0.063 dB (0.48 °) | |
| | (-20 to -10) dB | 0.077 dB (0.8 °) | |
| | (-60 to -20) dB | 0.093 dB (0.94 °) | |
| | (-70 to -60) dB | 0.13 dB (1.2 °) | |
| Transmission S_{12}/S_{21} - Measure Phase and Magnitude | (1.3 to 3) GHz | | Vector Network Analyzer w/ Calibration Kits Vista, CA Fremont, CA Orlando, FL |
| | (-80 to -70) dB | 0.32 dB (2.6 °) | |
| | (-90 to -80) dB | 0.92 dB (7.4 °) | |
| | 50 MHz to 2 GHz (-180 to 180) ° | | |
| | (0 to 10) dB | 0.07 dB (0.46 °) | |
| | (-10 to 0) dB | 0.054 dB (0.36 °) | |
| | (-20 to -10) dB | 0.075 dB (0.5 °) | |
| | (-30 to -20) dB | 0.12 dB (0.83 °) | |
| | (-40 to -30) dB | 0.29 dB (1.9 °) | |
| | (-50 to -40) dB | 2.3 dB (5.5 °) | |
| | (-60 to -50) dB | 5.9 dB (5.7 °) | |
| | (2 to 8) GHz | | |
| | (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 °) | | |



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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 | (8 to 20) GHz (-180 to 180) ° (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 (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB | 0.19 dB (1.3 °) 0.17 dB (1.1 °) 0.18 dB (1.2 °) 0.2 dB (1.3 °) 0.22 dB (1.4 °) 0.24 dB (1.6 °) 0.32 dB (2.1 °) 0.6 dB (4.1 °) 1.6 dB (8.7 °) 4.2 dB (11 °) | Vector Network Analyzer w/ Calibration Kits Vista, CA Fremont, CA Orlando, FL |
| | (20 to 40) 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 (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB | 0.54 dB (3.7 °) 0.5 dB (3.4 °) 0.49 dB (3.3 °) 0.5 dB (3.4 °) 0.52 dB (3.5 °) 0.55 dB (3.7 °) 0.65 dB (4.4 °) 1.1 dB (7.6 °) 2.7 dB (8.9 °) 6.6 dB (11 °) | |
| 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 $\leq + 60$ ° 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 |



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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 ^{2,4} | 10 kHz to 1.3 GHz (-180 to 180) ° | | LF Vector Network Analyzer, Calibration Kits Vista, CA Fremont, CA Orlando, FL |
| | (<0.03) Γ | 0.002 3 (1.4 °) | |
| | (<0.2) Γ | 0.003 5 (1.4 °) | |
| | (<0.4) Γ | 0.006 1 (1.1 °) | |
| | (<0.6) Γ | 0.008 3 (0.94 °) | |
| | (<0.8) Γ | 0.01 (0.83 °) | |
| | (<1) Γ | 0.012 (0.7 °) | |
| | (1.3 to 3) GHz | | |
| | (<0.03) Γ | 0.005 6 (1.8 °) | |
| | (<0.2) Γ | 0.003 5 (1.8 °) | |
| | (<0.4) Γ | 0.008 (1.3 °) | |
| | (<0.6) Γ | 0.011 (1.2 °) | |
| | (<0.8) Γ | 0.013 (1 °) | |
| | (<1) Γ | 0.016 (0.89 °) | |
| Reflection S_{11}/S_{22} - Measure Phase and Magnitude ^{2,4} | 50 MHz to 2 GHz (-180 to 180) ° | | Vector Network Analyzer w/ Calibration Kits Vista, CA Fremont, CA Orlando, FL |
| | (<0.03) Γ | 0.01 (3.3 °) | |
| | (<0.2) Γ | 0.012 (3.3 °) | |
| | (<0.4) Γ | 0.014 (2 °) | |
| | (<0.6) Γ | 0.017 (1.6 °) | |
| | (<0.8) Γ | 0.021 (1.5 °) | |
| | (<1) Γ | 0.026 (1.5 °) | |
| | (2 to 8) GHz | | |
| | (<0.03) Γ | 0.01 (3.5 °) | |
| | (<0.2) Γ | 0.012 (3.5 °) | |
| | (<0.4) Γ | 0.015 (2.2 °) | |
| | (<0.6) Γ | 0.019 (1.8 °) | |
| | (<0.8) Γ | 0.024 (1.7 °) | |
| | (<1) Γ | 0.003 (1.7 °) | |
| | (8 to 20) GHz | | |
| | (<0.03) Γ | 0.002 4 (7.8 °) | |
| | (<0.2) Γ | 0.002 7 (7.8 °) | |
| | (<0.4) Γ | 0.003 3 (4.8 °) | |
| | (<0.6) Γ | 0.004 2 (4 °) | |
| | (<0.8) Γ | 0.053 (3.8 °) | |
| | (<1) Γ | 0.067 (3.9 °) | |

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 ^{2,4} | (20 to 40) GHz (-180 to 180) ° (<0.03) Γ (<0.2) Γ (<0.4) Γ (<0.6) Γ (<0.8) Γ (<1) Γ | 0.06 (19 °) 0.066 (11 °) 0.079 (11 °) 0.097 (9.3 °) 0.12 (8.8 °) 0.15 (8.8 °) | Vector Network Analyzer w/ Calibration Kits Vista, CA Fremont, CA Orlando, FL |
| Reflection S_{11}/S_{22} – Measure Magnitude ⁴ | (<0.03 to <1) Γ (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz | 0.011 Γ 0.011 Γ 0.018 Γ 0.023 Γ | Vector Network Analyzer w/ Calibration Kits Vista, CA |
| Phase | ≤ 0 to ≤ 60 ° (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz | 0.023 ° 0.013 ° 0.064 ° 0.017 ° | |
| Network Analyzer System Verification (Corrected Performance) 7mm Test Ports Reflection S_{11}/S_{22} – Magnitude ⁴ | ≤ 0.1 to ≤ 1.0 Γ (0.0003 to 1) GHz (1 to 3) GHz (3 to 6) GHz | 0.003 8 Γ 0.003 9 Γ 0.005 1 Γ | Mechanical Calibration Kits and RF Network Analyzer System Verification Kits Vista, CA Fremont, CA Orlando, FL |
| Phase | ≤ 0 to ≤ 60 ° (0.0003 to 1) GHz (1 to 3) GHz (3 to 6) GHz | 1.97 ° 2.1 ° 2.7 ° | |
| Network Analyzer System Verification (Corrected Performance) N-Type Test Ports Reflection S_{11}/S_{22} – Magnitude ⁴ | ≤ 0.1 to ≤ 1.0 Γ (0.0003 to 1) GHz (1 to 3) GHz (3 to 8) GHz (8 to 18) GHz | 0.009 Γ 0.001 Γ 0.001 5 Γ 0.004 1 Γ | Mechanical Calibration Kits and RF Network Analyzer System Verification Kits Vista, CA Fremont, CA Orlando, FL |
| Phase | ≤ 0 to ≤ 60 ° (0.000 3 to 1) GHz (1 to 3) GHz (3 to 8) GHz (8 to 18) GHz | 0.46 ° 0.64 ° 0.65 ° 1.3 ° | |



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| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|--|---|---|
| Network Analyzer System Verification (Corrected Performance) 3.5mm Test Ports Reflection S_{11}/S_{22} – Magnitude ⁴ Phase | ≤ 0.1 to $\leq 1.0 \Gamma$ (0.045 to 2) G Γ Hz (2 to 20) GHz (20 to 26.5) GHz ≤ 0 to $\leq 60^\circ$ (0.045 to 2) GHz (2 to 20) GHz (20 to 26.5) GHz | 0.000 76 Γ 0.001 Γ 0.003 Γ 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 ⁴ Phase | ≤ 0.1 to $\leq 1.0 \Gamma$ (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz ≤ 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 Γ 0.003 8 Γ 0.004 4 Γ 0.005 5 Γ 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 |
| Network Analyzer System Verification (Corrected Performance) 7mm Test Ports Transmission S_{21}/S_{12} – Magnitude Phase | ≤ 0.1 to ≤ 1.0 dB (0.0003 to 1) GHz (1 to 3) GHz (3 to 6) GHz ≤ 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 $^\circ$ 1.5 $^\circ$ 2.2 $^\circ$ | 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 Transmission S_{21}/S_{12} – Magnitude Phase | ≤ 0.1 to ≤ 1.0 dB (0.0003 to 1) GHz (1 to 3) GHz (3 to 8) GHz (8 to 18) GHz ≤ 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_{12} – Magnitude Phase | ≤ 0.1 to ≤ 1.0 dB (0.045 to 2) GHz (2 to 20) GHz (20 to 26.5) GHz ≤ 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 |
| Network Analyzer System Verification (Corrected Performance) 2.4mm Test Ports Transmission S_{21}/S_{12} – Magnitude Phase | ≤ 0.1 to ≤ 1.0 dB (0.045 to 2) GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz ≤ 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 |

Electrical – RF/Microwave

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|--|---|--|
| 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 | (10 to 150) kHz 150 kHz to 30 MHz 30 MHz to 1 GHz (1 to 18) GHz | 0.82 dB 0.82 dB 1.1 dB 1.5 dB | CISPR Pulse Generator Vista, CA Fremont, CA Orlando, FL |
| Sinewave Output for CISPR Checks Source @ 60 dB/ μ V | (0 to -70) dB 100 kHz (1, 10, and 100) MHz | 0.35 dB 0.35 dB | |
| Peak and Average Detector Response | (0 to -70) dB CISPR Band A thru D | 1.3 dB | |
| 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 |
| Isolation (De-Coupling Factor) | (-90 to 0) dB 10 Hz to 1 000 MHz | 2.3 dB | Vista, CA Fremont, CA Orlando, FL |
| Impedance (Magnitude) | 0.1 Ω to 1 k Ω 10 Hz to 1000 MHz | 2.4 % of reading | |
| Impedance (Phase) | (-180 to 180) $^{\circ}$ 10 Hz to 1 000 MHz | 2.6 $^{\circ}$ | |

Electrical – RF/Microwave

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---------------------------------------|---|---|
| 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 | |

Length – Dimensional Metrology

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|----------------|---|--|
| Indicators ¹ | (0 to 4) in | 0.26 μin/in + 57 μin | Gage Blocks Vista, CA Fremont, CA |
| Calipers ¹ | (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 ¹ (Linearity Only) | (0 to 54) in | 46 μin/in + 52 μin | Gage Blocks, Rod Sets Vista, CA Fremont, CA |
| Pin and Plug Gages ¹ | (0.3 to 30) mm | 5 μm | Micrometer Vista, CA Fremont, CA |

Length – Dimensional Metrology

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|----------------------------------|--|--|
| Micrometers and Thickness Gages | Up to 7 in | $(58 + 10L) \mu\text{in}$ | Grade 1 Gage Block Set Orlando, FL |
| Calipers - External Diameter Internal Diameter | Up to 12 in | $(68 + 24.2L) \mu\text{in}$ | Grade 1 Gage Block Set Vista, CA Fremont, CA |
| Height Gages | Up to 12 in | $(750 + 4.7L) \mu\text{in}$ | Gage Blocks Vista, CA Fremont, CA Orlando, FL |
| Depth Gages | Up to 12 in | $(160 + 4.1L) \mu\text{in}$ | |
| Dial Indicators | Up to 2 in | $(1\ 100 + 18L) \mu\text{in}$ | Gage Blocks Vista, CA Fremont, CA Orlando, FL |
| Surface Flatness | (12 X 12) in to (72 X 144) in | $(250 + 0.21L) \mu\text{in}$ | Leveling System Orlando, FL |
| 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 ³ | Up to 500 in | 0.053 in + 0.004 % of reading | Fluke 419D Laser Distance Meter Fremont, CA |



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Mass and Mass Related

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--------------------------------|--|---|---|
| Force | (0.1 to 20) kgf | 0.024 kgf/kgf | NIST Class F Weights Vista, CA Fremont, CA Orlando, FL |
| Force Tension / Compression | Up to 1 000 lbf (1 000 to 10 000) lbf (10 000 to 20 000) lbf (20 000 to 30 000) lbf (30 000 to 40 000) lbf (40 000 to 50 000) lbf | 54 lbf 57 lbf 67 lbf 81 lbf 97 lbf 120 lbf | Reference Load Cells Vista, CA Fremont, CA Orlando, FL |
| Pressure – Source ¹ | (-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 ¹ | (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 |
| 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 |
| Torque – Source | (1 to 10) lbf·in (10 to 25) lbf·in (25 to 50) lbf·in (50 to 100) lbf·in (100 to 150) lbf·in (150 to 250) lbf·in | 0.021 % of reading + 0.009 lbf·in 0.017 % of reading + 0.011 lbf·in 0.033 % of reading + 0.022 lbf·in 0.035 % of reading + 0.040 lbf·in 0.038 % of reading + 0.042 lbf·in 0.04 % of reading + 0.045 lbf·in | Calibration Wheels Standard Weights Vista, CA Fremont, CA Orlando, FL |
| Scales & Balances ¹ | 1 mg to 10 g (10 to 500) g 1 kg 2 kg 20 kg 40 kg 50 kg | 2.3 mg + 0.6R 81 mg + 0.6R 1.5 mg + 0.6R 2.9 mg + 0.6R 2300 mg + 0.6R 4600 mg + 0.6R 5800 mg + 0.6R | NIST Class F Weights Vista, CA Fremont, CA |



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Mass and Mass Related

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|---|---|--|--|
| Scales & Balances ¹ | (0.001 to 0.05) lb (0.1 to 1) lb 2 lb 5 lb 10 lb 20 lb 50 lb | 5.2 mg + 0.6R 8.9 mg + 0.6R 9.1 mg + 0.6R 23 mg + 0.6R 45 mg + 0.6R 91 mg + 0.6R 230 mg + 0.6R | NIST Class F Weights Vista, CA Fremont, CA |
| Scales & Balances ⁴ | 0.25 oz 0.5 oz 1 oz 2 oz 4 oz 8 oz 16 oz 1 kg 2 kg 5 lb (1 to 10) lb (10 to 50) lb (50 to 300) lb | 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 |
| Volumetric Recipients (Graduated Volumetric Containers) | (1 to 20) ml (>20 to 80) ml (>80 to 220) ml | 0.06 ml 0.2 ml 0.23 ml | Analytical Balance Vista, CA |

Thermodynamic

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--|--|---|--|
| Relative Humidity – Measure ¹ | (0 to 80) %RH | 2 %RH | Humidity Probe Monitor Vista, CA Fremont, CA Orlando, FL |
| Temperature - Measure | (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 420) °C (420 to 650) °C | 0.03 °C 0.05 °C 0.07 °C 0.11 °C 0.14 °C | Reference Thermometer w/ PRT Vista, CA Fremont, CA Orlando, FL |

Time and Frequency

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

Time and Frequency

| Parameter/Equipment | Range | Expanded Uncertainty of Measurement (+/-) | Reference Standard, Method, and/or Equipment |
|--------------------------------|--------------|---|---|
| Pulse Width - Measure | > 5 ns | 1.1 ns | Universal Counter w/ GPS Reference Vista, CA Fremont, CA Orlando, FL |
| Stop Watches – Totalize Method | 1 s to 24 hr | 0.000 6 % of reading + 0.044 s | Universal Counter and Synthesizer w/ GPS Reference Vista, CA Fremont, CA Orlando, FL |

TESTING

Environmental

| Specific Tests and/or Properties Measured | Specification, Standard, Method, or Test Technique | Items, Materials or Product Tested | Key Equipment or Technology |
|---|---|------------------------------------|---|
| Face Velocity Test Airflow Smoke Pattern Test Leak/Backstreaming Test | ISO 14644-4 ANSI/ASHRAE 110 IEST-RP-CC002.4 | Flow hood Devices Test | Thermal Anemometer Aerosol Generator Digital Aerosol Photometer Vista, CA Fremont, CA Orlando, FL |
| Airborne Particle Count Survey Airflow Measurement Airflow Smoke Pattern Test HEPA/ULPA filter leak Test Biological Safety Cabinet Classification | ISO 14644-1 ISO 14644-4 IEST-RP-CC034.2 IEST-RP-CC006.3 NSF/ANSI49-2004 Annex | Biological Safety Cabinet Test | Particle Counter Balometer Aerosol Generator Digital Aerosol Photometer Thermal Anemometer Vista, CA Fremont, CA Orlando, FL |

Environmental

| Specific Tests and/or Properties Measured | Specification, Standard, Method, or Test Technique | Items, Materials or Product Tested | Key Equipment or Technology |
|--|---|------------------------------------|--|
| Airflow Measurement Air Pressure Difference Test Airflow Smoke Pattern Test HEPA/ULPA filter leak Test Airborne Particle Count Survey Lighting Level Sound Level Test Temperature Test Humidity Test Temperature/Humidity Uniformity Test Recovery Test | ISO 14644-1 ISO 14644-3 ISO 14644-4 IEST-RP-CC006.3 IEST-RP-CC034.2 | Clean Room Test | Balometer Differential Pressure Meter Digital Aerosol Photometer, Aerosol Generator Particle Counter Light Level meter Sound meter Temperature & humidity meter Thermal anemometer. Vista, CA Fremont, CA Orlando, FL |
| Airborne Particle Count Survey Airflow Velocity Laminar Hood HEPA/ULPA filter leak Test Induction Leak/Backstreaming Test Airflow Smoke Pattern Test Lighting Level Sound Level Test | ISO 14644-1 ISO 14644-4 IEST-RP-CC002.4 IEST-RP-CC006.3 IEST-RP-CC034.2 | Laminar Air Flow Workstation Test | Particle Counter Thermal Anemometer Aerosol Generator Digital Aerosol Photometer Light Level meter Sound meter Vista, CA Fremont, CA Orlando, FL |
| Oil Aerosol & Vapor Content ⁵ | ISO 8573-1 ISO 8573-2 ISO 8573-5 | Compressed Air Purity Test | Oil Content Analyzer Air Sampler Vista, CA Fremont, CA Orlando, FL |
| Humidity / Dew Point Measurement | ISO 8573-3 | | Dew Point Meter & Diffuser Vista, CA Fremont, CA Orlando, FL |
| Pressurized Air Particle Content | ISO 8573-4 | | Particle Counter & Diffuser Vista, CA Fremont, CA Orlando, FL |

Environmental

| Specific Tests and/or Properties Measured | Specification, Standard, Method, or Test Technique | Items, Materials or Product Tested | Key Equipment or Technology |
|---|--|------------------------------------|--|
| Viable Microbiological Contaminant ⁶ | ISO 8573-7 | | Microbiological Sampler 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. The CMC for scales and balances are highly dependent upon the resolution of the unit under test. The uncertainty presented here does not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
4. Unitless linear measure.
5. Portions of ISO 8573-5 requiring analysis using gas chromatography are contracted to another accredited laboratory.
6. This analysis is intended to be used in conjunction with the testing per ISO 8573-4 when there is a need to identify solid particles that are also viable, colony-forming units and is contracted to another accredited laboratory.
7. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1736.



R. Douglas Leonard Jr., VP, PILR SBU

