



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Micro Precision Calibration, Inc.

22835 Industrial Place
Grass Valley, CA 95949
(and satellite locations as shown on the scope)

Fulfills the requirements of

ISO/IEC 17025:2017

and national standards

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

In the field of

CALIBRATION and DIMENSIONAL MEASUREMENT

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.

Jason Stine, Vice President

Expiry Date: 31 October 2024

Certificate Number: AC-1969



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)

ANSI/NCSL Z540.3-2006 (R2013)

Micro Precision Calibration, Inc.

22835 Industrial Place
Grass Valley, CA 95949

CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: **October 31, 2024**

Certificate Number: **AC-1969**

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Acoustics and Vibration

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Microphones ¹ Sensitivity	(-80 to -10) dB re. 1V/Pa 1 Hz to 20 kHz	0.084 dB re. 1 V/Pa	Reference Microphone with Sound Calibration System
Microphones ¹ Frequency Response	(-80 to -10) dB re. 1V/Pa (1 to 50) Hz (50 to 95) Hz (95 to 531) Hz 531 Hz to 3 kHz (3 to 9.5) kHz (9.5 to 10) kHz (10 to 10.6) kHz (10.6 to 11.5) kHz (11.5 to 12) kHz (12 to 12.6) kHz (12.6 to 13.5) kHz (13.5 to 14.5) kHz (14.5 to 15) kHz (15 to 16) kHz (16 to 17) kHz (17 to 20) kHz (20 to 40) kHz (40 to 50.2) kHz (50.2 to 63.1) kHz (63.1 to 80) kHz (80 to 100) kHz	0.093 dB 0.056 dB 0.047 dB 0.056 dB 0.065 dB 0.074 dB 0.084 dB 0.093 dB 0.11 dB 0.12 dB 0.14 dB 0.15 dB 0.17 dB 0.22 dB 0.28 dB 0.33 dB 0.34 dB 0.37 dB 0.45 dB 0.54 dB 0.69 dB	Reference Microphone with Sound Calibration System
Sound Level Calibrator ¹	(74 to 124) dB (1 Hz to 20 kHz)	0.084 dB	Reference Microphone with Sound Calibration System
Sound Level Meter ^{1,2}	(74 to 124) dB (1 Hz to 20 kHz)	0.084 dB + 0.58R	Reference Microphone with Sound Calibration System / Sound Level Calibrator

Acoustics and Vibration

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Accelerometers / Velocity Sensors / Displacement Sensors ¹ 0.2 Hz to 5 kHz (5 to 10 kHz)	Sensitivity: (0.04 to 1 000) pC/units (0.04 to 1 000) mV/units	0.46 % of sensitivity 0.64 % of sensitivity	Reference Accelerometer with Vibration System
Vibration ¹ 0.2 Hz to 5 kHz (5 to 10 kHz)	(0 to 200) m/s ²	0.62 % of reading + 0.58R 0.76 % of reading + 0.58R	Reference Accelerometer with Vibration System

Chemical Quantities

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters ^{1,4}	5.00 µS/cm 10.00 µS/cm 100.00 µS/cm 1 500 µS/cm 100 000 µS/cm	0.56 µS/cm 0.56 µS/cm 2.1 µS/cm 4.8 µS/cm 370 µS/cm	Standard Conductivity Solutions
pH Meters ^{1,4}	(4, 7, 10) pH units	0.02 pH unit	Standard pH Solutions
Optical System – Aerosol Particle Counter ²	Particle Size: (0.3, 0.5 1, 2, 3, 5, 10) µm Counting Efficiency (0 to 100) % Flow Rate Up to 100 L/min	6.6 % (Counting Efficiency) 0.35 % of reading	Comparison to Standard Particle Counter Standard Flow Calibrator

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹	(0 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 µV/V + 0.4 µV 3.5 µV/V + 0.7 µV 2.5 µV/V + 2.6 µV 2.5 µV/V + 4 µV 3.5 µV/V + 40 µV 4.5 µV/V + 0.4 mV	Multi-Function Calibrator

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹ Fixed Values	1 V 1.018V 10 V	1.6 μ V 1.6 μ V 4.3 μ V	DC Voltage Reference Standard
DC Voltage Transfer – Measure ¹	100 mV 1V 10 V 100 V 1 kV	0.078 μ V 0.49 μ V 4.3 μ V 48 μ V 0.66 mV	DC Voltage Reference Standard, Reference Divider and NULL Detector
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	2.5 μ V/V + 0.31 μ V 1.5 μ V/V + 0.31 μ V 0.5 μ V/V + 0.51 μ V 2.5 μ V/V + 30 μ V 2.5 μ V/V + 100 μ V	Multimeter
DC High Voltage – Measure ¹	(0 to 5) kV (5 to 10) kV (10 to 70) kV	0.31 mV/V + 0.031 V 0.31 mV/V + 0.065 V 0.44 mV/V + 0.02 V	High Voltage Meter and High Voltage Probe
DC High - Voltage Source ¹	(0 to 5) kV (5 to 10) kV (10 to 70) kV	0.31 mV/V + 0.031 V 0.31 mV/V + 0.065 V 0.44 mV/V + 0.02 V	Comparison with High Voltage Meter and High Voltage Probe
DC Power – Source ¹	0.01 mW to 20.5 kW 33 mV to 1 020 V (0.33 to 330) mA 330 mA to 11 A (11 to 20.5) A	0.03 % of Watts output + 0.58R 0.059 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R	Multi- Product Calibrator w/Amplifier
DC Current – Source ¹	(0 to 220) μ A (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	36 μ A/A + 7.2 nA 32 μ A/A + 41 nA 39 μ A/A + 0.4 μ A 57 μ A/A + 0.7 μ A 72 μ A/A + 12 μ A	Multi-Function Calibrator
DC High Current – Source ¹	(2.2 to 11) A	0.34 mA/A + 480 μ A	Multi-Function Calibrator and Amplifier
	(10 to 20) A	0.3 mA/A + 3 mA	Multi-Product Calibrator with Amplifier
	(20 to 100) A	0.5 mA/A + 30 mA	
	(10 to 16.5) A (16.5 to 1 025) A	2.8 mA/A + 3 mA 2.9 mA/A + 90 mA	Multi-Product Calibrator with w/50-turn Coil

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Measure ¹	(0.1 to 100) nA (0.1 to 1) μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	10 μ A/A + 40 pA 10 μ A/A + 40 pA 10 μ A/A + 70 pA 10 μ A/A + 0.6 nA 10 μ A/A + 4 nA 10 μ A/A + 40 nA 25 μ A/A + 0.4 μ A 0.1 mA/A + 10 μ A	Multimeter
DC Current – Measure ¹	(0 to 15) A (15 to 30) A	40 μ A/A + 0.58 nA 16 μ A/A + 5.8 nA	Multimeter w/Current Shunt
Inductance – Source ¹ (Fixed and Variable Artifacts) 100 Hz to 10 kHz	100 μ H 1 mH 2 mH 50 mH 100 mH 200 mH 2 H 5 H 10 H	0.016 μ H 0.16 μ H 0.33 μ H 8.2 μ H 16 μ H 33 μ H 0.33 mH 0.82 mH 1.6 mH	Standard Inductors
	100 μ H to 10 H	0.41 mH/H + 0.58R	Decade Inductor
Inductance – Measure ¹ 12 Hz to 100 kHz	(0.01 to 100) μ H 100 μ H to 1 mH (1 to 2) mH (2 to 50) mH (50 to 100) mH (100 to 200) mH 200 mH to 5 H (5 to 10) H	0.16 mH/H 0.16 mH/H 0.23 mH/H 0.19 mH/H 0.16 mH/H 0.19 mH/H 0.32 mH/H 0.16 mH/H	Precision LCR Meter w/Standard Inductors
	0.01 μ H to 10 H	0.2 mH/H + 0.058 μ H	RLC Digibridge

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ Fixed Points	0.001 Ω 0.01 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω (1 to 11) M Ω (10 to 110) M Ω (0.1 to 1) G Ω (1 to 10) G Ω (10 to 100) G Ω	1.6 $\mu\Omega/\Omega$ 1.6 $\mu\Omega/\Omega$ 1.3 $\mu\Omega/\Omega$ 1.3 $\mu\Omega/\Omega$ 1.3 $\mu\Omega/\Omega$ 1.3 $\mu\Omega/\Omega$ 1.6 $\mu\Omega/\Omega$ 1.4 $\mu\Omega/\Omega$ 1.6 $\mu\Omega/\Omega$ 3.8 $\mu\Omega/\Omega$ 6.6 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 50 $\mu\Omega/\Omega$ 200 $\mu\Omega/\Omega$	Standard Resistors
Resistance – Source ¹ Fixed Points	0 Ω 1.0 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	50 $\mu\Omega$ 80 $\mu\Omega/\Omega$ 80 $\mu\Omega/\Omega$ 21 $\mu\Omega/\Omega$ 21 $\mu\Omega/\Omega$ 9.1 $\mu\Omega/\Omega$ 9.1 $\mu\Omega/\Omega$ 7.7 $\mu\Omega/\Omega$ 7.7 $\mu\Omega/\Omega$ 7.6 $\mu\Omega/\Omega$ 7.7 $\mu\Omega/\Omega$ 9.1 $\mu\Omega/\Omega$ 9.1 $\mu\Omega/\Omega$ 15 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 31 $\mu\Omega/\Omega$ 40 $\mu\Omega/\Omega$ 95 $\mu\Omega/\Omega$	Multi-Function Calibrator
Resistance – Source ¹	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 to 1.1) k Ω (1.1 to 3.3) k Ω (3.3 to 11) k Ω (11 to 33) k Ω	31 $\mu\Omega/\Omega + 0.78$ m Ω 23 $\mu\Omega/\Omega + 1.2$ m Ω 22 $\mu\Omega/\Omega + 1.2$ m Ω 22 $\mu\Omega/\Omega + 1.6$ m Ω 22 $\mu\Omega/\Omega + 1.7$ m Ω 22 $\mu\Omega/\Omega + 16$ m Ω 22 $\mu\Omega/\Omega + 17$ m Ω 22 $\mu\Omega/\Omega + 160$ m Ω	Multi-Product Calibrator

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹	(33 to 110) kΩ (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 to 1 100) MΩ	22 μΩ/Ω + 170 mΩ 25 μΩ/Ω + 1.6 Ω 25 μΩ/Ω + 1.7 Ω 47 μΩ/Ω + 23 Ω 101 μΩ/Ω + 39 Ω 194 μΩ/Ω + 1.9 kΩ 388 μΩ/Ω + 2.3 kΩ 2.3 mΩ/Ω + 78 kΩ 12 mΩ/Ω + 388 kΩ	Multi-Product Calibrator
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	5 μΩ/Ω + 31 μΩ 3 μΩ/Ω + 0.3 mΩ 2 μΩ/Ω + 0.21 mΩ 2 μΩ/Ω + 2.1 mΩ 2 μΩ/Ω + 21 mΩ 10 μΩ/Ω + 1 Ω 50 μΩ/Ω + 50 Ω 0.5 mΩ/Ω + 1 kΩ 5 mΩ/Ω + 10 kΩ	Multimeter
AC Resistance – Source and Measure ¹ 100 Hz to 100 kHz	0.001 Ω (0.1 to 1) Ω 10 Ω to 100 kΩ	0.13 mΩ 1.5 mΩ/Ω 0.46 mΩ/Ω	Calibration RL Standard
AC Resistance – Source and Measure ¹ 100 Hz to 100 kHz	1 mΩ to 0.2 Ω 0.2 Ω to 100 kΩ 100 kΩ to 10 MΩ	6.9 mΩ/Ω 0.27 mΩ/Ω 3 mΩ/Ω	RLC Digibridge and Calibration RL Standard
Capacitance – Source ¹ 50 Hz to 1 kHz	(0.19 to 0.4) nF (0.4 to 1.1) nF (1.1 nF to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 μF (1.1 to 3.3) μF (3.3 to 11) μF	3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 1.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 78 pF 1.9 mF/F + 233 pF 1.9 mF/F + 780 pF 1.9 mF/F + 2.3 nF 1.9 mF/F + 7.8 nF	Multi-Product Calibrator

Electrical – DC/Low Frequency

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ 50 Hz to 1 kHz	(11 to 33) μ F (33 to 110) μ F (110 to 330) μ F 330 μ F to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	3.1 mF/F + 23 nF 3.5 mF/F + 78 nF 3.5 mF/F + 233 nF 3.5 mF/F + 780 nF 3.5 mF/F + 2.3 μ F 3.5 mF/F + 7.8 μ F 5.8 mF/F + 23 μ F 8.5 mF/F + 78 μ F	Multi-Product Calibrator
Capacitance – Source ¹ Fixed Values	(1, 10, 100, 1 000) pF 1 kHz 1 kHz to 13 MHz (10, 100, 1 000) nF 120 Hz to 100 kHz	2 μ F/F + 0.58R 67 μ F/F + 0.58R 62 μ F/F + 0.58R	Standard Capacitors
Capacitance Transfer – Measure ¹ 12 Hz to 13 MHz	0.001 pF to 1 nF 1 nF to 1.1 μ F	67 μ F/F 62 μ F/F	RLC Digibridge and Standard Capacitors
Capacitance – Measure ¹ 12 Hz to 13 MHz	(0 to 10) pF (10 to 100) pF (100 to 1000) pF (1 to 10) nF (10 to 100) nF (100 to 1000) nF (1 to 10) μ F (10 to 100) μ F (100 to 1000) μ F	0.44 mF/F + 0.000 58 pF 0.25 mF/F + 0.005 8 pF 0.23 mF/F + 0.058 pF 0.23 mF/F + 0.58 pF 0.24 mF/F + 5.8 pF 0.23 mF/F + 58 pF 0.23 mF/F + 0.58 nF 0.23 mF/F + 5.8 nF 0.34 mF/F + 58 nF	Direct measurement using RLC Digibridge
Capacitance – Measure ¹ 50 Hz to 20 kHz	0.001 pF to 1 μ F	5.9 μ F/F + 0.1 aF	Direct measurement using capacitance bridge AH 2700A bridge
Phase – Measure ¹	(0.01 to 360) ° (10 to 60) mV 10 Hz to 10 kHz (10 to 40) kHz (40 to 100) kHz (60 to 250) mV 10 Hz to 40 kHz (40 to 100) kHz (0.25 to 10) V 10 Hz to 40 kHz (40 to 100) kHz	0.23 ° 0.4 ° 0.79 ° 0.07 ° 0.4 ° 0.06 ° 0.4 °	Phase Meter

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase – Measure ¹	(10 to 120) V 10 Hz to 40 kHz (40 to 100) kHz	0.08 ° 0.4 °	Phase Meter
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C 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 L (-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.36 °C 0.29 °C 0.27 °C 0.28 °C 0.27 °C 0.24 °C 0.27 °C 0.41 °C 0.66 °C 0.41 °C 0.18 °C 0.17 °C 0.18 °C 0.21 °C 0.25 °C 0.18 °C 0.17 °C 0.18 °C 0.22 °C 0.29 °C 0.19 °C 0.18 °C 0.24 °C 0.34 °C 0.31 °C 0.24 °C 0.18 °C	Multi-Product Calibrator

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type N		Multi-Product Calibrator
	(-200 to -100) °C	0.34 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.2 °C	
	(120 to 410) °C	0.19 °C	
	(410 to 1 300) °C	0.25 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.3 °C	
	(400 to 1 000) °C	0.29 °C	
	(1 000 to 1 767) °C	0.34 °C	
	Type S		
	(0 to 250) °C	0.39 °C	
	(250 to 1 000) °C	0.31 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.38 °C	
	Type T		
	(-250 to -150) °C	0.51 °C	
	(-150 to 0) °C	0.23 °C	
	(0 to 120) °C	0.18 °C	
	(120 to 400) °C	0.17 °C	
	Type U		
	(-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.25 °C	
Electrical Calibration of RTD Indicators ¹	Pt 385, 100 Ω		Multi-Product Calibrator
	(-200 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.055 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.055 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicators ¹	Pt 3916, 100 Ω		Multi-Product Calibrator
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.032 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.055 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.032 °C	
	(-80 to 0) °C	0.032 °C	
	(0 to 100) °C	0.032 °C	
	(100 to 260) °C	0.04 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.032 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.04 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.063 °C	
	(300 to 400) °C	0.063 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.086 °C	
	Pt 385, 1 k Ω		
	(-200 to -80) °C	0.025 °C	
	(-80 to 0) °C	0.025 °C	
	(0 to 100) °C	0.032 °C	
	(100 to 260) °C	0.04 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.055 °C	
	(400 to 600) °C	0.055 °C	
	(600 to 630) °C	0.18 °C	
	PtNi 385, 100 Ω		
	(-80 to 0) °C	0.063 °C	
	(0 to 100) °C	0.063 °C	
	(100 to 260) °C	0.11 °C	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicators ¹	Cu 427, 10 Ω (-100 to 260) $^{\circ}\text{C}$	0.23 $^{\circ}\text{C}$	Multi-Product Calibrator
AC Voltage – Source ¹	220 μV 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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz 220 mV to 2.2 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	0.37 mV/V + 4 μV 0.31 mV/V + 4 μV 0.31 mV/V + 4 μV 0.35 mV/V + 4 μV 0.61 mV/V + 5 μV 1 mV/V + 10 μV 1.3 mV/V + 20 μV 2.6 mV/V + 20 μV 0.24 mV/V + 4 μV 0.11 mV/V + 4 μV 96 $\mu\text{V/V}$ + 4 μV 0.2 mV/V + 4 μV 0.46 mV/V + 5 μV 0.9 mV/V + 10 μV 1.2 mV/V + 20 μV 2.5 mV/V + 20 μV 0.22 mV/V + 12 μV 86 $\mu\text{V/V}$ + 7 μV 76 $\mu\text{V/V}$ + 7 μV 0.18 mV/V + 7 μV 0.42 mV/V + 17 μV 0.75 mV/V + 20 μV 1.2 mV/V + 25 μV 2.5 mV/V + 45 μV 0.22 mV/V + 40 μV 80 $\mu\text{V/V}$ + 15 μV 40 $\mu\text{V/V}$ + 8 μV 70 $\mu\text{V/V}$ + 10 μV 0.11 mV/V + 30 μV 0.34 mV/V + 8 μV 0.9 mV/V + 0.2 mV 1.5 mV/V + 0.3 mV	Multi-Function Calibrator

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) V		Multi-Function Calibrator
	(10 to 20) Hz	0.22 mV/V + 0.4 mV	
	(20 to 40) Hz	80 μ V/V + 0.15 mV	
	40 Hz to 20 kHz	40 μ V/V + 50 μ V	
	(20 to 50) kHz	70 μ V/V + 0.1 mV	
	(50 to 100) kHz	96 μ V/V + 0.2 mV	
	(100 to 300) kHz	0.26 mV/V + 0.6 mV	
	(300 to 500) kHz	0.9 mV/V + 2 mV	
	500 kHz to 1 MHz	1.3 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.22 mV/V + 4 mV	
	(20 to 40) Hz	80 μ V/V + 1.5 mV	
	40 Hz to 20 kHz	48 μ V/V + 0.6 mV	
	(20 to 50) kHz	76 μ V/V + 1 mV	
	(50 to 100) kHz	0.13 mV/V + 2.5 mV	
	(100 to 300) kHz	0.8 mV/V + 16 mV	
AC Voltage – Source ¹	(300 to 500) kHz	4.2 mV/V + 40 mV	Multi-Function Calibrator with Amplifier
	500 kHz to 1 MHz	7 mV/V + 80 mV	
	(220 to 1 100) V		
	(15 to 50) Hz	0.26 mV/V + 16 mV	
	50 Hz to 1 kHz	61 μ V/V + 3.5 mV	
AC Voltage – Source ¹	(220 to 750) V		Multi-Function Calibrator with Amplifier
	(30 to 50) kHz	0.36 mV/V + 11 mV	
	(50 to 100) kHz	1.3 mV/V + 45 mV	
	(750 to 1 100) V		
	40 Hz to 1 kHz	0.08 mV/V + 4 mV	
	(1 to 20) kHz	0.13 mV/V + 6 mV	
	(20 to 30) kHz	0.36 mV/V + 11 mV	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	22 mV Range (2 mV)		AC/DC Transfer Standard and Multimeter
	10 Hz	0.3 mV/V + 0.58 nV	
	20 Hz	0.3 mV/V + 0.58 nV	
	40 Hz	0.3 mV/V + 0.58 nV	
	100 Hz	0.3 mV/V + 0.58 nV	
	1 kHz	0.3 mV/V + 0.58 nV	
	10 kHz	0.3 mV/V + 0.58 nV	
	20 kHz	0.3 mV/V + 0.58 nV	
	50 kHz	0.3 mV/V + 0.58 nV	
	100 kHz	0.4 mV/V + 0.58 nV	
	300 kHz	0.5 mV/V + 0.58 nV	
	500 kHz	0.6 mV/V + 0.58 nV	
	800 kHz	0.7 mV/V + 0.58 nV	
	1 MHz	0.7 mV/V + 0.58 nV	
	22 mV Range (6 mV)		
	10 Hz	0.21 mV/V + 0.58 nV	
	20 Hz	0.21 mV/V + 0.58 nV	
	40 Hz	0.17 mV/V + 0.58 nV	
	100 Hz	0.16 mV/V + 0.58 nV	
	1 kHz	0.16 mV/V + 0.58 nV	
	10 kHz	0.16 mV/V + 0.58 nV	
	20 kHz	0.16 mV/V + 0.58 nV	
	50 kHz	0.21 mV/V + 0.58 nV	
	100 kHz	0.28 mV/V + 0.58 nV	
	300 kHz	0.4 mV/V + 0.58 nV	
	500 kHz	0.46 mV/V + 0.58 nV	
	800 kHz	0.56 mV/V + 0.58 nV	
	1 MHz	0.6 mV/V + 0.58 nV	
	22 mV Range (10 mV)		
	10 Hz	80 μ V/V + 5.8 nV	
	20 Hz	70 μ V/V + 5.8 nV	
	40 Hz	70 μ V/V + 5.8 nV	
	100 Hz	70 μ V/V + 5.8 nV	
	1 kHz	70 μ V/V + 5.8 nV	
	10 kHz	70 μ V/V + 5.8 nV	
	20 kHz	70 μ V/V + 5.8 nV	
	50 kHz	80 μ V/V + 5.8 nV	
	100 kHz	14 μ V/V + 5.8 nV	
	300 kHz	21 μ V/V + 5.8 nV	
	500 kHz	28 μ V/V + 5.8 nV	
	800 kHz	32 μ V/V + 5.8 nV	
	1 MHz	36 μ V/V + 5.8 nV	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	22 mV Range (20 mV)		AC/DC Transfer Standard and Multimeter
	10 Hz	75 $\mu\text{V/V} + 5.8 \text{ nV}$	
	20 Hz	60 $\mu\text{V/V} + 5.8 \text{ nV}$	
	40 Hz	60 $\mu\text{V/V} + 5.8 \text{ nV}$	
	100 Hz	60 $\mu\text{V/V} + 5.8 \text{ nV}$	
	1 kHz	60 $\mu\text{V/V} + 5.8 \text{ nV}$	
	10 kHz	60 $\mu\text{V/V} + 5.8 \text{ nV}$	
	20 kHz	60 $\mu\text{V/V} + 5.8 \text{ nV}$	
	50 kHz	80 $\mu\text{V/V} + 5.8 \text{ nV}$	
	100 kHz	14 $\mu\text{V/V} + 5.8 \text{ nV}$	
	300 kHz	22 $\mu\text{V/V} + 5.8 \text{ nV}$	
	500 kHz	30 $\mu\text{V/V} + 5.8 \text{ nV}$	
	800 kHz	37 $\mu\text{V/V} + 5.8 \text{ nV}$	
	1 MHz	36 $\mu\text{V/V} + 5.8 \text{ nV}$	
	220 mV Range (20 mV)		
	10 Hz	85 $\mu\text{V/V} + 5.8 \text{ nV}$	
	20 Hz	75 $\mu\text{V/V} + 5.8 \text{ nV}$	
	40 Hz	75 $\mu\text{V/V} + 5.8 \text{ nV}$	
	100 Hz	60 $\mu\text{V/V} + 5.8 \text{ nV}$	
	1 kHz	60 $\mu\text{V/V} + 5.8 \text{ nV}$	
	10 kHz	60 $\mu\text{V/V} + 5.8 \text{ nV}$	
	20 kHz	60 $\mu\text{V/V} + 5.8 \text{ nV}$	
	50 kHz	80 $\mu\text{V/V} + 5.8 \text{ nV}$	
	100 kHz	14 $\mu\text{V/V} + 5.8 \text{ nV}$	
	300 kHz	21 $\mu\text{V/V} + 5.8 \text{ nV}$	
	500 kHz	28 $\mu\text{V/V} + 5.8 \text{ nV}$	
	800 kHz	32 $\mu\text{V/V} + 5.8 \text{ nV}$	
	1 MHz	36 $\mu\text{V/V} + 5.8 \text{ nV}$	
	220 mV Range (60 mV)		
	10 Hz	60 $\mu\text{V/V} + 5.8 \text{ nV}$	
	20 Hz	36 $\mu\text{V/V} + 5.8 \text{ nV}$	
	40 Hz	31 $\mu\text{V/V} + 5.8 \text{ nV}$	
	100 Hz	32 $\mu\text{V/V} + 5.8 \text{ nV}$	
	1 kHz	31 $\mu\text{V/V} + 5.8 \text{ nV}$	
	10 kHz	34 $\mu\text{V/V} + 5.8 \text{ nV}$	
	20 kHz	32 $\mu\text{V/V} + 5.8 \text{ nV}$	
	50 kHz	36 $\mu\text{V/V} + 5.8 \text{ nV}$	
	100 kHz	75 $\mu\text{V/V} + 5.8 \text{ nV}$	
	300 kHz	14 $\mu\text{V/V} + 5.8 \text{ nV}$	
	500 kHz	21 $\mu\text{V/V} + 5.8 \text{ nV}$	
	800 kHz	28 $\mu\text{V/V} + 5.8 \text{ nV}$	
	1 MHz	28 $\mu\text{V/V} + 5.8 \text{ nV}$	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	220 mV Range (100 mV)		AC/DC Transfer Standard and Multimeter
	10 Hz	40 $\mu\text{V/V} + 5.8 \text{ nV}$	
	20 Hz	25 $\mu\text{V/V} + 5.8 \text{ nV}$	
	40 Hz	12 $\mu\text{V/V} + 5.8 \text{ nV}$	
	100 Hz	12 $\mu\text{V/V} + 5.8 \text{ nV}$	
	1 kHz	12 $\mu\text{V/V} + 5.8 \text{ nV}$	
	10 kHz	12 $\mu\text{V/V} + 5.8 \text{ nV}$	
	20 kHz	12 $\mu\text{V/V} + 5.8 \text{ nV}$	
	50 kHz	24 $\mu\text{V/V} + 5.8 \text{ nV}$	
	100 kHz	40 $\mu\text{V/V} + 5.8 \text{ nV}$	
	300 kHz	80 $\mu\text{V/V} + 5.8 \text{ nV}$	
	500 kHz	0.12 mV/V + 5.8 nV	
	800 kHz	0.18 mV/V + 5.8 nV	
	1 MHz	0.18 mV/V + 5.8 nV	
	220 mV Range (200 mV)		
	10 Hz	25 $\mu\text{V/V} + 58 \text{ nV}$	
	20 Hz	20 $\mu\text{V/V} + 58 \text{ nV}$	
	40 Hz	10 $\mu\text{V/V} + 58 \text{ nV}$	
	100 Hz	10 $\mu\text{V/V} + 58 \text{ nV}$	
	1 kHz	10 $\mu\text{V/V} + 58 \text{ nV}$	
	10 kHz	10 $\mu\text{V/V} + 58 \text{ nV}$	
	20 kHz	10 $\mu\text{V/V} + 58 \text{ nV}$	
	50 kHz	20 $\mu\text{V/V} + 58 \text{ nV}$	
	100 kHz	40 $\mu\text{V/V} + 58 \text{ nV}$	
	300 kHz	75 $\mu\text{V/V} + 58 \text{ nV}$	
	500 kHz	0.11 mV/V + 58 nV	
	800 kHz	0.16 mV/V + 58 nV	
	1 MHz	0.18 mV/V + 58 nV	
	700 mV Range (200 mV)		
	10 Hz	25 $\mu\text{V/V} + 58 \text{ nV}$	
	20 Hz	20 $\mu\text{V/V} + 58 \text{ nV}$	
	40 Hz	10 $\mu\text{V/V} + 58 \text{ nV}$	
	100 Hz	10 $\mu\text{V/V} + 58 \text{ nV}$	
	1 kHz	10 $\mu\text{V/V} + 58 \text{ nV}$	
	10 kHz	10 $\mu\text{V/V} + 58 \text{ nV}$	
	20 kHz	10 $\mu\text{V/V} + 58 \text{ nV}$	
	50 kHz	20 $\mu\text{V/V} + 58 \text{ nV}$	
	100 kHz	40 $\mu\text{V/V} + 58 \text{ nV}$	
	300 kHz	75 $\mu\text{V/V} + 58 \text{ nV}$	
	500 kHz	0.11 mV/V + 58 nV	
	800 kHz	0.16 mV/V + 58 nV	
	1 MHz	0.18 mV/V + 58 nV	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	700 mV Range (600 mV)		AC/DC Transfer Standard and Multimeter
	10 Hz	25 $\mu\text{V/V} + 58 \text{ nV}$	
	20 Hz	18 $\mu\text{V/V} + 58 \text{ nV}$	
	40 Hz	6 $\mu\text{V/V} + 58 \text{ nV}$	
	100 Hz	7 $\mu\text{V/V} + 58 \text{ nV}$	
	1 kHz	6.1 $\mu\text{V/V} + 58 \text{ nV}$	
	10 kHz	6 $\mu\text{V/V} + 58 \text{ nV}$	
	20 kHz	6 $\mu\text{V/V} + 58 \text{ nV}$	
	50 kHz	7 $\mu\text{V/V} + 58 \text{ nV}$	
	100 kHz	12 $\mu\text{V/V} + 58 \text{ nV}$	
	300 kHz	25 $\mu\text{V/V} + 58 \text{ nV}$	
	500 kHz	30 $\mu\text{V/V} + 58 \text{ nV}$	
	800 kHz	50 $\mu\text{V/V} + 58 \text{ nV}$	
	1 MHz	60 $\mu\text{V/V} + 58 \text{ nV}$	
	2.2 V Range (0.6 V)		
	10 Hz	25 $\mu\text{V/V} + 58 \text{ nV}$	
	20 Hz	15 $\mu\text{V/V} + 58 \text{ nV}$	
	40 Hz	5 $\mu\text{V/V} + 58 \text{ nV}$	
	100 Hz	5 $\mu\text{V/V} + 58 \text{ nV}$	
	1 kHz	5 $\mu\text{V/V} + 58 \text{ nV}$	
	10 kHz	6.2 $\mu\text{V/V} + 58 \text{ nV}$	
	20 kHz	6 $\mu\text{V/V} + 58 \text{ nV}$	
	50 kHz	7 $\mu\text{V/V} + 58 \text{ nV}$	
	100 kHz	10 $\mu\text{V/V} + 58 \text{ nV}$	
	300 kHz	21 $\mu\text{V/V} + 58 \text{ nV}$	
	500 kHz	25 $\mu\text{V/V} + 58 \text{ nV}$	
	800 kHz	30 $\mu\text{V/V} + 58 \text{ nV}$	
	1 MHz	40 $\mu\text{V/V} + 58 \text{ nV}$	
	2.2 V Range (1 V)		
	10 Hz	25 $\mu\text{V/V} + 58 \text{ nV}$	
	20 Hz	15 $\mu\text{V/V} + 58 \text{ nV}$	
	40 Hz	5 $\mu\text{V/V} + 58 \text{ nV}$	
	100 Hz	5 $\mu\text{V/V} + 58 \text{ nV}$	
	1 kHz	5 $\mu\text{V/V} + 58 \text{ nV}$	
	10 kHz	5 $\mu\text{V/V} + 58 \text{ nV}$	
	20 kHz	5 $\mu\text{V/V} + 58 \text{ nV}$	
	50 kHz	7 $\mu\text{V/V} + 58 \text{ nV}$	
	100 kHz	10 $\mu\text{V/V} + 58 \text{ nV}$	
	300 kHz	20 $\mu\text{V/V} + 58 \text{ nV}$	
	500 kHz	25 $\mu\text{V/V} + 58 \text{ nV}$	
	800 kHz	30 $\mu\text{V/V} + 58 \text{ nV}$	
	1 MHz	40 $\mu\text{V/V} + 58 \text{ nV}$	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	2.2 V Range (2 V)		AC/DC Transfer Standard and Multimeter
	10 Hz	25 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	20 Hz	15 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	100 Hz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	1 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	10 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	20 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	50 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	100 kHz	10 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	300 kHz	20 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz	25 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	800 kHz	30 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	1 MHz	40 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	7 V Range (2 V)		
	10 Hz	25 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	20 Hz	15 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz	8 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	100 Hz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	1 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	10 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	20 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	50 kHz	6 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	100 kHz	10 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	300 kHz	20 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz	25 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	800 kHz	30 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	1 MHz	40 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	7 V Range (6 V)		
	10 Hz	25 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	20 Hz	15 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	100 Hz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	1 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	10 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	20 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	50 kHz	6 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	100 kHz	7 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	300 kHz	20 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz	25 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	800 kHz	30 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	1 MHz	40 $\mu\text{V/V} + 0.58 \mu\text{V}$	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	22 V Range (6 V)		AC/DC Transfer Standard and Multimeter
	10 Hz	25 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	20 Hz	15 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	100 Hz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	1 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	10 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	20 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	50 kHz	6 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	100 kHz	7 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	300 kHz	20 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz	25 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	800 kHz	30 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	1 MHz	40 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	22 V Range (10 V)		
	10 Hz	25 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	20 Hz	15 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	100 Hz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	1 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	10 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	20 kHz	5 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	50 kHz	6 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	100 kHz	8 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	300 kHz	20 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz	25 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	800 kHz	30 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	1 MHz	40 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	22 V Range (20 V)		
	10 Hz	25 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	20 Hz	15 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	100 Hz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	1 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	10 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	20 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	50 kHz	7 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	100 kHz	10 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	300 kHz	20 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	500 kHz	25 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	800 kHz	30 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	1 MHz	40 $\mu\text{V/V} + 5.8 \mu\text{V}$	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	70 V Range (20 V)		AC/DC Transfer Standard and Multimeter
	10 Hz	25 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	20 Hz	15 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	100 Hz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	1 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	10 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	20 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	50 kHz	7 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	100 kHz	10 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	300 kHz	25 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	70 V Range (60 V)		
	10 Hz	25 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	20 Hz	15 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	100 Hz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	1 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	10 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	20 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	50 kHz	8 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	100 kHz	10 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	300 kHz	25 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	220 V Range (60 V)		
	10 Hz	25 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	20 Hz	15 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	100 Hz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	1 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	10 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	20 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	50 kHz	8 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	100 kHz	10 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	300 kHz	30 $\mu\text{V/V} + 5.8 \mu\text{V}$	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	220 V Range (100 V)		AC/DC Transfer Standard and Multimeter
	10 Hz	25 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	20 Hz	15 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	100 Hz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	1 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	10 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	20 kHz	6 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	50 kHz	8 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	100 kHz	15 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	220 V Range (200 V)		
	10 Hz	36 $\mu\text{V/V} + 58 \mu\text{V}$	
	20 Hz	15 $\mu\text{V/V} + 58 \mu\text{V}$	
	40 Hz	8 $\mu\text{V/V} + 58 \mu\text{V}$	
	100 Hz	8 $\mu\text{V/V} + 58 \mu\text{V}$	
	1 kHz	8 $\mu\text{V/V} + 58 \mu\text{V}$	
	10 kHz	8 $\mu\text{V/V} + 58 \mu\text{V}$	
	20 kHz	8 $\mu\text{V/V} + 58 \mu\text{V}$	
	50 kHz	10 $\mu\text{V/V} + 58 \mu\text{V}$	
	100 kHz	15 $\mu\text{V/V} + 58 \mu\text{V}$	
	1 000 V Range (200 V)		
	10 Hz	40 $\mu\text{V/V} + 58 \mu\text{V}$	
	20 Hz	15 $\mu\text{V/V} + 58 \mu\text{V}$	
	40 Hz	8 $\mu\text{V/V} + 58 \mu\text{V}$	
	100 Hz	8 $\mu\text{V/V} + 58 \mu\text{V}$	
	1 kHz	8 $\mu\text{V/V} + 58 \mu\text{V}$	
	10 kHz	8 $\mu\text{V/V} + 58 \mu\text{V}$	
	20 kHz	8 $\mu\text{V/V} + 58 \mu\text{V}$	
	50 kHz	12 $\mu\text{V/V} + 58 \mu\text{V}$	
	100 kHz	30 $\mu\text{V/V} + 58 \mu\text{V}$	
	1 000 V Range (600 V)		
	40 Hz	11 $\mu\text{V/V} + 58 \mu\text{V}$	
	100 Hz	11 $\mu\text{V/V} + 58 \mu\text{V}$	
	1 kHz	11 $\mu\text{V/V} + 58 \mu\text{V}$	
	10 kHz	11 $\mu\text{V/V} + 58 \mu\text{V}$	
	20 kHz	11 $\mu\text{V/V} + 58 \mu\text{V}$	
	50 kHz	11 $\mu\text{V/V} + 58 \mu\text{V}$	
	100 kHz	40 $\mu\text{V/V} + 58 \mu\text{V}$	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	1 000 V Range (1 000 V) 40 Hz 100 Hz 1 kHz 10 kHz 20 kHz 30 kHz	11 $\mu\text{V/V} + 58 \mu\text{V}$ 11 $\mu\text{V/V} + 58 \mu\text{V}$ 11 $\mu\text{V/V} + 58 \mu\text{V}$ 11 $\mu\text{V/V} + 58 \mu\text{V}$ 11 $\mu\text{V/V} + 58 \mu\text{V}$ 11 $\mu\text{V/V} + 58 \mu\text{V}$	AC/DC Transfer Standard and Multimeter
AC Voltage – Measure ¹ (Absolute Measurement)	2.2 mV Range (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 7 mV Range (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 mV Range (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	1.1 mV/V + 0.87 μV 0.49 mV/V + 0.87 μV 0.28 mV/V + 0.87 μV 0.54 mV/V + 1.3 μV 0.8 mV/V + 1.7 μV 1.5 mV/V + 2.7 μV 1.6 mV/V + 4.0 μV 2.1 mV/V + 4.0 μV 0.57 mV/V + 0.87 μV 0.25 mV/V + 0.87 μV 0.14 mV/V + 0.87 μV 0.27 mV/V + 1.3 μV 0.4 mV/V + 1.7 μV 0.8 mV/V + 2.7 μV 0.87 mV/V + 4.0 μV 1.3 mV/V + 4.0 μV 0.19 mV/V + 0.87 μV 0.12 mV/V + 0.87 μV 73 $\mu\text{V/V} + 0.87 \mu\text{V}$ 0.14 mV/V + 1.3 μV 0.21 mV/V + 1.7 μV 0.54 mV/V + 2.7 μV 0.57 mV/V + 4 μV 0.93 mV/V + 4 μV	AC Measurement Standard

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	70 mV Range		AC Measurement Standard
	(10 to 20) Hz	0.16 mV/V + 1 μ V	
	(20 to 40) Hz	80 μ V/V + 1 μ V	
	40 Hz to 20 kHz	43 μ V/V + 1 μ V	
	(20 to 50) kHz	80 μ V/V + 1.3 μ V	
	(50 to 100) kHz	0.17 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.34 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.44 mV/V + 4 μ V	
	500 kHz to 1 MHz	0.73 mV/V + 4 μ V	
	220 mV Range		
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	56 μ V/V + 1 μ V	
	40 Hz to 20 kHz	25 μ V/V + 1 μ V	
	(20 to 50) kHz	46 μ V/V + 1.3 μ V	
	(50 to 100) kHz	0.11 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.16 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.24 mV/V + 4 μ V	
	500 kHz to 1 MHz	0.63 mV/V + 4 μ V	
	700 mV Range		
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	50 μ V/V + 1 μ V	
	40 Hz to 20 kHz	21 μ V/V + 1 μ V	
	(20 to 50) kHz	33 μ V/V + 1.3 μ V	
	(50 to 100) kHz	53 μ V/V + 1.7 μ V	
	(100 to 300) kHz	0.11 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.2 mV/V + 4 μ V	
	500 kHz to 1 MHz	0.6 mV/V + 4 μ V	
	2.2 V Range		
	(10 to 20) Hz	0.13 mV/V + 0.058 μ V	
	(20 to 40) Hz	43 μ V/V + 0.058 μ V	
	40 Hz to 20 kHz	15 μ V/V + 0.058 μ V	
	(20 to 50) kHz	30 μ V/V + 0.058 μ V	
	(50 to 100) kHz	47 μ V/V + 0.058 μ V	
	(100 to 300) kHz	0.1 mV/V + 0.058 μ V	
	(300 to 500) kHz	0.17 mV/V + 0.058 μ V	
	500 kHz to 1 MHz	0.56 mV/V + 0.058 μ V	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	7.0 V Range		AC Measurement Standard
	(10 to 20) Hz	0.13 mV/V + 0.058 μ V	
	(20 to 40) Hz	44 μ V/V + 0.058 μ V	
	40 Hz to 20 kHz	15 μ V/V + 0.058 μ V	
	(20 to 50) kHz	31 μ V/V + 0.058 μ V	
	(50 to 100) kHz	53 μ V/V + 0.058 μ V	
	(100 to 300) kHz	0.12 mV/V + 0.058 μ V	
	(300 to 500) kHz	0.25 mV/V + 0.058 μ V	
	500 kHz to 1 MHz	0.73 mV/V + 0.058 μ V	
	22 V Range		
	(10 to 20) Hz	0.13 mV/V + 0.58 μ V	
	(20 to 40) Hz	44 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	17 μ V/V + 0.58 μ V	
	(20 to 50) kHz	31 μ V/V + 0.58 μ V	
	(50 to 100) kHz	53 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.12 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.25 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.73 mV/V + 0.58 μ V	
	70 V Range		
	(10 to 20) Hz	0.13 mV/V + 0.58 μ V	
	(20 to 40) Hz	45 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	20 μ V/V + 0.58 μ V	
	(20 to 50) kHz	37 μ V/V + 0.58 μ V	
	(50 to 100) kHz	61 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.13 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.27 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.73 mV/V + 0.58 μ V	
	220 V Range		
	(10 to 20) Hz	0.13 mV/V + 5.8 μ V	
	(20 to 40) Hz	45 μ V/V + 5.8 μ V	
	40 Hz to 20 kHz	19 μ V/V + 5.8 μ V	
	(20 to 50) kHz	45 μ V/V + 5.8 μ V	
	(50 to 100) kHz	64 μ V/V + 5.8 μ V	
	(100 to 300) kHz	0.14 mV/V + 5.8 μ V	
	(300 to 500) kHz	0.29 mV/V + 5.8 μ V	
	700 V Range		
	(10 to 20) Hz	0.13 mV/V + 5.8 μ V	
	(20 to 40) Hz	64 μ V/V + 5.8 μ V	
	40 Hz to 20 kHz	26 μ V/V + 5.8 μ V	
	(20 to 50) kHz	80 μ V/V + 5.8 μ V	
	(50 to 100) kHz	0.27 mV/V + 5.8 μ V	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	1 000 V Range (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.13 mV/V + 5.8 μ V 64 μ V/V + 5.8 μ V 25 μ V/V + 5.8 μ V 80 μ V/V + 5.8 μ V 0.27 mV/V + 5.8 μ V	AC Measurement Standard
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	2.2 mV Range (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz 7 mV Range (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz 22 mV Range (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.67 mV/V + 0.06 μ V 0.33 mV/V + 0.06 μ V 0.33 mV/V + 0.06 μ V 0.33 mV/V + 0.06 μ V 0.47 mV/V + 0.67 μ V 0.47 mV/V + 0.67 μ V 0.47 mV/V + 0.67 μ V 1.1 mV/V + 0.67 μ V 2 mV/V + 0.67 μ V 4.7 mV/V + 1.3 μ V 0.67 mV/V + 0.058 μ V 0.33 mV/V + 0.058 μ V 0.33 mV/V + 0.058 μ V 0.33 mV/V + 0.058 μ V 0.47 mV/V + 0.67 μ V 0.47 mV/V + 0.67 μ V 0.47 mV/V + 0.67 μ V 1.1 mV/V + 0.67 μ V 2.5 mV/V + 0.67 μ V 0.67 mV/V + 0.058 μ V 0.33 mV/V + 0.058 μ V 0.33 mV/V + 0.058 μ V 0.33 mV/V + 0.058 μ V 0.47 mV/V + 0.058 μ V 0.47 mV/V + 0.058 μ V 0.47 mV/V + 0.058 μ V 0.67 mV/V + 0.058 μ V 1.1 mV/V + 0.058 μ V 2.5 mV/V + 0.058 μ V	AC Measurement Standard

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	70 mV Range		AC Measurement Standard
	(10 to 30) Hz	0.67 mV/V + 0.58 μ V	
	(30 to 120) Hz	0.33 mV/V + 0.58 μ V	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 120) kHz	0.33 mV/V + 0.58 μ V	
	(120 to 500) kHz	0.33 mV/V + 0.58 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 0.58 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.58 μ V	
	(10 to 20) MHz	1 mV/V + 0.58 μ V	
	(20 to 30) MHz	2.3 mV/V + 0.58 μ V	
	220 mV Range		
	(10 to 30) Hz	0.67 mV/V + 0.58 μ V	
	(30 to 120) Hz	0.27 mV/V + 0.58 μ V	
	120 Hz to 1.2 kHz	0.27 mV/V + 0.58 μ V	
	(1.2 to 120) kHz	0.27 mV/V + 0.58 μ V	
	(120 to 500) kHz	0.27 mV/V + 0.58 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 0.58 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.58 μ V	
	(10 to 20) MHz	1 mV/V + 0.58 μ V	
	(20 to 30) MHz	2.3 mV/V + 0.58 μ V	
	700 mV Range		
	(10 to 30) Hz	0.67 mV/V + 5.8 μ V	
	(30 to 120) Hz	0.2 mV/V + 5.8 μ V	
	120 Hz to 1.2 kHz	0.2 mV/V + 5.8 μ V	
	(1.2 to 120) kHz	0.2 mV/V + 5.8 μ V	
	(120 to 500) kHz	0.2 mV/V + 5.8 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 5.8 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 5.8 μ V	
	(2 to 10) MHz	0.67 mV/V + 5.8 μ V	
	(10 to 20) MHz	1 mV/V + 5.8 μ V	
	(20 to 30) MHz	2.3 mV/V + 5.8 μ V	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	2.2 V Range (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz 7.0 V Range (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.67 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.33 mV/V + 5.8 μ V 0.33 mV/V + 5.8 μ V 0.67 mV/V + 5.8 μ V 1 mV/V + 5.8 μ V 2.3 mV/V + 5.8 μ V 0.67 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.33 mV/V + 5.8 μ V 0.33 mV/V + 5.8 μ V 0.67 mV/V + 5.8 μ V 1 mV/V + 5.8 μ V 2.3 mV/V + 5.8 μ V	AC Measurement Standard
AC High Voltage – Measure ¹	(0 to 1) kV 400 Hz (0 to 50) kV (50 to 60) Hz	1 mV/V + 0.7 V 1 mV/V + 0.7 V	High Voltage Meter and High Voltage Probe
AC High Voltage – Source ¹	(0 to 1) kV 400 Hz (0 to 50) kV (50 to 60) Hz	1 mV/V + 0.7 V 1 mV/V + 0.7 V	Comparison with High Voltage Meter and High Voltage Probe

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} (45 to 65) Hz PF = 1	0.1 mW to 20.5 kW (33 to 330) mV		Multi-Product Calibrator
	(3.3 to 9) mA	0.11 % of Watts output + 0.58R	
	(9 to 33) mA	0.081 % of Watts output + 0.58R	
	(33 to 90) mA	0.11 % of Watts output + 0.58R	
	(90 to 330) mA	0.081 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.1 % of Watts output + 0.58R	
	(0.9 to 3) A	0.088 % of Watts output + 0.58R	
	(3 to 11) A	0.1 % of Watts output + 0.58R	
	(11 to 20.5) A	0.13 % of Watts output + 0.58R	
	330 mV to 1 020 V		
	(3.3 to 9) mA	0.096 % of Watts output + 0.58R	
	(9 to 33) mA	0.066 % of Watts output + 0.58R	
	(33 to 90) mA	0.096 % of Watts output + 0.58R	
	(90 to 330) mA	0.066 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.088 % of Watts output + 0.58R	
	(0.9 to 3) A	0.073 % of Watts output + 0.58R	
	(3 to 11) A	0.096 % of Watts output + 0.58R	
	(11 to 20.5) A	0.15 % of Watts output + 0.58R	
AC Power – Source ^{1,2} (45 to 65) Hz PF = (0 to 0.999)	0.1 mW to 20.5 kW (33 to 330) mV		Multi-Product Calibrator
	(3.3 to 9) mA	0.21 % of Watts output + 0.58R	
	(9 to 33) mA	0.19 % of Watts output + 0.58R	
	(33 to 90) mA	0.21 % of Watts output + 0.58R	
	(90 to 330) mA	0.19 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.2 % of Watts output + 0.58R	
	(0.9 to 3) A	0.19 % of Watts output + 0.58R	
	(3 to 11) A	0.2 % of Watts output + 0.58R	
	(11 to 20.5) A	0.21 % of Watts output + 0.58R	
	330 mV to 1 020 V		
	(3.3 to 9) mA	0.2 % of Watts output + 0.58R	
	(9 to 33) mA	0.19 % of Watts output + 0.58R	
	(33 to 90) mA	0.20 % of Watts output + 0.58R	
	(90 to 330) mA	0.19 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.19 % of Watts output + 0.58R	
	(0.9 to 3) A	0.19 % of Watts output + 0.58R	
	(3 to 11) A	0.2 % of Watts output + 0.58R	
	(11 to 20.5) A	0.23 % of Watts output + 0.58R	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(9 to 220) μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 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 (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	0.23 mA/A + 16 nA 0.14 mA/A + 10 nA 0.11 mA/A + 8.0 nA 0.25 mA/A + 12 nA 0.9 mA/A + 65 nA 0.23 mA/A + 40 nA 0.14 mA/A + 35 nA 0.11 mA/A + 35 nA 0.18 mA/A + 0.11 μ A 0.9 mA/A + 0.65 μ A 0.23 mA/A + 0.40 μ A 0.14 mA/A + 0.35 μ A 0.11 mA/A + 0.35 μ A 0.18 mA/A + 0.50 μ A 0.9 mA/A + 5.0 μ A 0.23 mA/A + 4.0 μ A 0.14 mA/A + 3.5 μ A 0.11 mA/A + 2.6 μ A 0.18 mA/A + 3.5 μ A 0.9 mA/A + 10 μ A 0.25 mA/A + 35 μ A 0.39 mA/A + 80 μ A 6 mA/A + 0.16 mA	Multi-Function Calibrator
AC Current – Source ¹	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.42 mA/A + 0.17 mA 0.85 mA/A + 0.38 mA 3.3 mA/A + 0.75 mA	Multi-Function Calibrator w/Amplifier
AC Current – Source ¹	(2.2 to 20.5) A 50 Hz to 1 kHz (1 to 5) kHz (10 to 20) A (50 to 100) Hz (100 to 400) Hz 400 Hz to 1 kHz	0.51 mA/A + 1 mA 0.5 mA/A + 5.8 mA 1.2 mA/A + 30 mA 2.3 mA/A + 40 mA 3.4 mA/A + 60 mA	Multi-Product Calibrator w/Amplifier

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(20 to 100) A (50 to 100) Hz (100 to 400) Hz 400 Hz to 1 kHz	2 mA/A + 0.15 A 3 mA/A + 0.2 A 4 mA/A + 0.3 A	Multi-Product Calibrator w/Amplifier
AC Current – Source ¹	(10 to 16.5) A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	2.8 mA/A + 3 mA 7.9 mA/A + 3 mA 2.8 mA/A + 25 mA 7.9 mA/A + 27 mA 3 mA/A + 90 mA 8 mA/A + 0.1 A	Multi-Product Calibrator w/50-turn coil
AC Current – Measure ¹	(5 to 100) μ A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 100 μ A to 1 mA (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 (50 to 100) kHz (1 to 10) mA (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 (50 to 100) kHz	4 mA/A + 0.03 μ A 1.5 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A 4 mA/A + 0.2 μ A 1.5 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 0.3 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 4 mA/A + 0.4 μ A 5.5 mA/A + 1.5 μ A 4 mA/A + 2 μ A 1.5 mA/A + 2 μ A 0.6 mA/A + 2 μ A 0.3 mA/A + 2 μ A 0.6 mA/A + 2 μ A 4 mA/A + 4 μ A 5.5 mA/A + 15 μ A	Multimeter

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(10 to 100) mA		Multimeter
	(10 to 20) Hz	4 mA/A + 20 μ A	
	(20 to 45) Hz	1.5 mA/A + 20 μ A	
	(45 to 100) Hz	0.6 mA/A + 20 μ A	
	100 Hz to 5 kHz	0.3 mA/A + 20 μ A	
	(5 to 20) kHz	0.6 mA/A + 20 μ A	
	(20 to 50) kHz	4 mA/A + 40 μ A	
	(50 to 100) kHz	5.5 mA/A + 0.15 mA	
	100 mA to 1 A		
	(10 to 20) Hz	4 mA/A + 0.2 mA	
	(20 to 45) Hz	1.6 mA/A + 0.2 mA	
	(45 to 100) Hz	0.8 mA/A + 0.2 mA	
	100 Hz to 5) kHz	1 mA/A + 0.2 mA	
	(5 to 20) kHz	3 mA/A + 0.2 mA	
	(20 to 50) kHz	10 mA/A + 0.4 mA	
AC Current – Measure ¹	(0.1 to 30) mA		Multimeter and Current Shunt
	(10 to 20) Hz	35 μ A/A	
	20 Hz to 10 kHz	25 μ A/A	
	(10 to 20) kHz	30 μ A/A	
	(20 to 30) kHz	60 μ A/A	
	(30 to 50) kHz	45 μ A/A	
	(50 to 100) kHz	65 μ A/A	
	(30 to 300) mA		
	(10 to 20) Hz	40 μ A/A	
	20 Hz to 10 kHz	30 μ A/A	
	(10 to 20) kHz	35 μ A/A	
	(20 to 30) kHz	70 μ A/A	
	(30 to 50) kHz	55 μ A/A	
	(50 to 100) kHz	85 μ A/A	
	300 mA to 1 A		
	(10 to 20) Hz	45 μ A/A	
	20 Hz to 10 kHz	30 μ A/A	
	(10 to 20) kHz	50 μ A/A	
	(20 to 30) kHz	0.11 mA/A	
	(30 to 50) kHz	0.11 mA/A	
	(50 to 100) kHz	0.2 mA/A	

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(1 to 3) A (10 to 20) Hz 20 Hz to 10 kHz (10 to 20) kHz (20 to 30) kHz (30 to 50) kHz (50 to 100) kHz (3 to 5) A (10 to 20) Hz 20 Hz to 10 kHz (10 to 20) kHz (20 to 30) kHz (30 to 50) kHz (50 to 100) kHz (5 to 10) A (10 to 20) Hz 20 Hz to 10 kHz (10 to 20) kHz (20 to 30) kHz (30 to 50) kHz (10 to 20) A (10 to 20) Hz 20 Hz to 10 kHz (10 to 20) kHz (20 to 30) kHz (30 to 50) kHz	65 μ A/A 40 μ A/A 60 μ A/A 0.12 mA/A 0.12 mA/A 0.2 mA/A 75 μ A/A 45 μ A/A 70 μ A/A 0.17 mA/A 0.17 mA/A 0.31 mA/A 85 μ A/A 50 μ A/A 80 μ A/A 0.13 mA/A 0.13 mA/A 0.13 mA/A 0.07 mA/A 0.1 mA/A 0.16 mA/A 0.15 mA/A	Multimeter and Current Shunt
Oscilloscopes ¹ Rise/Fall Time (10 to 90) % Square Wave 50 Ω or 1 M Ω Load impedance – 10 Hz to 100 kHz	Up to 500 ns (0 to 1) mVpp 1 mV to 5 Vpp (5 to 200) Vpp	4 ps 15 mV/V + 10 μ V 15 mV/V + 10 μ V 10 mV/V + 0.1 mV	Oscilloscope Calibrator, Active Head and Multimeter
Oscilloscopes ¹ Horizontal Deflection Vertical Deflection	180.10 ps to 83 μ s 83 μ s to 55 s (0 to 1) mV 1 mV to 5 V (5 to 200) V	0.29 parts in 10 ⁻⁶ s 3.5 parts in 10 ⁻⁶ s 0.35 mV/V + 25 μ V 0.26 mV/V + 25 μ V 0.35 mV/V + 0.1 mV	Oscilloscope Calibrator, Active Head and Multimeter

Electrical – DC/Low Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ¹ Bandwidth	0.1 Hz to 3.2 GHz (3.2 to 6) GHz (6 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 33) GHz (33 to 34) GHz (34 to 35) GHz (35 to 40) GHz (40 to 45) GHz (45 to 50) GHz	2.7 % of reading 2.7 % of reading 2.8 % of reading 2.9 % of reading 3.3 % of reading 3.7 % of reading 3.8 % of reading 3.8 % of reading 3.8 % of reading 4.7 % of reading 5.4 % of reading	Oscilloscope Calibrator, Active Head and RF Power Sensor

Electrical – RF/Microwave

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pulse Measure ¹ RMS Jitter – Period, Delay and Width	33 MHz to 3.0 GHz	1.4 % of reading + 5 nHz	Wideband Oscilloscope
RF Power Meter – Reference ¹	1 mW 50 MHz	0.51 % of Reading	Power Meter and Power Sensors
RF Power Meter ¹	3 μ W to 100 mW	0.35 % of Watts output + 0.58R	Range Calibrator
RF Power Sensors Calibration Factors ^{1,5}	Referenced to 1 mW (9 to 300) kHz 300 kHz to 50 MHz (50 to 100) MHz (100 to 600) MHz 600 MHz to 1 GHz (1 to 4) GHz (4 to 8) GHz (8 to 12) GHz (12 to 16) GHz (16 to 18) GHz (18 to 26.5) GHz (26.5 to 40) GHz (40 to 67) GHz (67 to 70) GHz	1 % 0.85 % 0.78 % 0.78 % 0.078 % 0.8 % 0.87 % 0.96 % 1 % 1.1 % 2 % 2.7 % 2.4 % 3.4 %	Power Meter, Coaxial Thermistor and Thermocouple Power Sensors

Electrical – RF/Microwave

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned RF Power Level ¹ (Relative – Measure) 100 kHz to 50 GHz	Range: (-127 to 30) dBm Dynamic Range: 0 dB (0 to 10) dB (10 to 20) dB (20 to 30) dB (30 to 40) dB (40 to 50) dB (50 to 60) dB (60 to 70) dB (70 to 80) dB (80 to 90) dB (90 to 100) dB (100 to 110) dB (110 to 120) dB	0.07 dB 0.071 dB 0.072 dB 0.074 dB 0.076 dB 0.079 dB 0.082 dB 0.084 dB 0.087 dB 0.091 dB 0.094 dB 0.098 dB 0.1 dB	Power Sensors with Measuring Receiver, Power Meter and Spectrum Analyzers
Tuned RF Power Level ¹ (Absolute – Measure) 100 kHz to 50 GHz	(20 to 30) dBm (10 to 20) dBm (0 to 10) dBm 0 dBm (-10 to 0) dBm (-20 to -10) dBm (-30 to -20) dBm (-40 to -30) dBm (-50 to -40) dBm (-60 to -50) dBm (-70 to -60) dBm (-80 to -70) dBm (-90 to -80) dBm (-120 to -90) dBm (-127 to -120) dBm	0.082 dB 0.079 dB 0.077 dB 0.075 dB 0.077 dB 0.079 dB 0.082 dB 0.085 dB 0.088 dB 0.091 dB 0.095 dB 0.098 dB 0.10 dB 0.11 dB 0.12 dB	Power Sensors with Measuring Receiver, Power Meter and Spectrum Analyzers
RF Absolute Power – Measure ¹	(0 to 44) dBm 100 kHz to 2 GHz (2 to 4.2) GHz (-10 to 20) dBm 9 kHz to 500 MHz 500 MHz to 1.2 GHz (1.2 to 6) GHz (6 to 14) GHz (14 to 18) GHz	0.17 dB 0.18 dB 0.095 dB 0.1 dB 0.087 dB 0.091 dB 0.1 dB	Power Sensors with Measuring Receiver, Power Meter and Spectrum Analyzers

Electrical – RF/Microwave

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Measure ¹	(-35 to 20) dBm (100 to 300) kHz 300 kHz to 1 MHz (1 to 10) MHz (10 to 100) MHz 100 MHz to 2.4 GHz (2.4 to 12.4) GHz (12.4 to 18) GHz (18 to 26.5) GHz (26.5 to 40) GHz (40 to 50) GHz (50 to 67) GHz (67 to 110) GHz (-60 to -10) dBm 9 kHz to 6 GHz (6 to 14) GHz (14 to 18) GHz (-70 to -20) dBm (10 to 30) MHz 30 MHz to 3 GHz (3 to 10) GHz (10 to 15) GHz (15 to 18) GHz (18 to 26.5) GHz (26.5 to 34) GHz (34 to 40) GHz (40 to 50) GHz	0.091 dB 0.046 dB 0.035 dB 0.037 dB 0.035 dB 0.038 dB 0.04 dB 0.05 dB 0.062 dB 0.067 dB 0.082 dB 0.092 dB 0.083 dB 0.09 dB 0.099 dB 0.085 dB 0.059 dB 0.064 dB 0.074 dB 0.095 dB 0.1 dB 0.11 dB 0.13 dB 0.15 dB	Power Sensors with Measuring Receiver, Power Meter and Spectrum Analyzers
Frequency Modulation Rejection – Measure ¹ 150 kHz to 10 MHz 10 MHz to 26.5 GHz	Rate: 400 HZ to 1 kHz Dev.: ≤ 5 kHz peak Dev.: ≤ 50 kHz peak	0.14 % Deviation 0.14 % Deviation	Measuring Receiver, Spectrum Analyzers
Residuals AM ¹ (rms)	150 kHz to 18 GHz (18 to 26.5) GHz	0.004 % of reading 0.006 % of reading	Measuring Receiver, Spectrum Analyzers
Frequency Modulation Distortion – Measure ¹ Bandwidth: 20 Hz to 250 kHz	150 kHz to 26.5 GHz	0.15 % of reading	Measuring Receiver, Spectrum Analyzers

Electrical – RF/Microwave

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation Deviation Accuracy – Measure ¹ 250 kHz to 10 MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 10 kHz Dev: ≤ 40 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz	0.1 % Modulation 0.2 % Modulation 0.3 % Modulation 0.4% Modulation	Measuring Receiver, Spectrum Analyzers
Amplitude Modulation Rejection – Measure ¹ 150 kHz to 6.6 GHz (6.6 to 26.5) GHz	Rate: 400 Hz to 1 kHz Depth: ≤ 50 %	11 Hz 23 Hz	Measuring Receiver, Spectrum Analyzers
Amplitude Modulation Depth Accuracy – Measure ¹ 150 kHz to 10 MHz 10 MHz to 3 GHz 10 MHz to 3 GHz (3 to 26.5) GHz (3 to 26.5) GHz	Rate: 50 Hz to 10 kHz Depth: (5 to 99) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	0.2 % Modulation 0.2 % Modulation 0.3 % Modulation 0.2 % Modulation 0.5 % Modulation	Measuring Receiver, Spectrum Analyzers
Residuals FM ¹ Bandwidth: 50 Hz to 3 kHz (rms)	150 kHz to 3 GHz (3 to 6.6) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	1.3 Hz 1.8 Hz 2.6 Hz 3.7 Hz	Measuring Receiver, Spectrum Analyzers
Distortion – Measure ¹ 20 Hz to 20 kHz (20 to 100) kHz	(0 to 99.9) dB (50 to 500) kHz (50 to 500) kHz	1.3 dB 2.4 dB	Audio Analyzer
Amplitude Modulation Distortion -Measure ¹ 150 kHz to 18 GHz (18 to 26.5) GHz (18 to 26.5) GHz	Depth (5 to 99) % (5 to 50) % (50 to 95) %	0.14 % Depth 0.4 % Depth 0.6 % Depth	Measuring Receiver, Spectrum Analyzers
Amplitude Modulation Flatness ¹ 10 MHz to 26.5 GHz	Rate: (9 Hz to 10 kHz) Depth: (5 to 99) %	0.15 % Depth	Measuring Receiver, Spectrum Analyzers

Electrical – RF/Microwave

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Measure ¹ 100 kHz to 6.6 GHz 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 200 kHz Deviation: > 0.7 Rad Deviation: > 0.3 Rad Rate: 20 Hz to 200 kHz Deviation: > 2 Rad Deviation: > 0.6 Rad Rate: 20 Hz to 200 kHz Deviation: > 4 Rad Deviation: > 1.2 Rad	0.1 % Modulation 0.2 % Modulation 0.1% Modulation 0.2 % Modulation 0.1 % Modulation 0.2 % Modulation	Measuring Receiver, Spectrum Analyzers
AM Rejection – Measure ¹ 100 kHz to 26.5 GHz	Rate: 50 Hz to 3 kHz Deviation: > 50 % AM at 1 kHz Rate	0.003 Rad	Measuring Receiver, Spectrum Analyzers
Phase Residuals – Measure ¹ (rms) 100 kHz to 26.5 GHz	(0.1 to 25 000) Rad Rate: 50 Hz to 3 kHz	0.001 Rad	Measuring Receiver, Spectrum Analyzers
Phase Distortion ¹ 150 kHz to 26.5 GHz	(0.1 to 25 000) Rad Bandwidth: 20 Hz to 250kHz	0.008 rad	Measuring Receiver, Spectrum Analyzers
Amplitude Modulation – Source ¹ 10 kHz to 13.5 MHz 10 kHz to 13.5 MHz	Rate: 50 Hz to 100 kHz Depths: 5 % to 95 % Rate: 50 Hz to 100 kHz Depths: 95 % to 99 %	0.15 % Depth 0.3 % Depth	AM/FM Test Source
Frequency Modulation – Source ¹ 10 kHz to 432 MHz	Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	0.3 % Modulation	AM/FM Test Source
Harmonic Measurements ¹ 3 Hz to 26.5 GHz (26.5 to 50) GHz	(-90 to 0.01) dB	0.8 dB 1.4 dB	Spectrum Analyzer
Phase Noise – Measure ¹ Offset Frequency ≤ 100 kHz ≤ 1 MHz ≤ 40 MHz	(0 to 10) dB	2.3 dB 3.5 dB 4.5 dB	Phase Noise System
Error Vector Magnitude ^{1,2} (EVM)	(0 to 100) % Error Mod Frequency Span: f ≤ 100 kHz 100 kHz ≤ f ≤ 1 MHz f > 1 MHz	0.43 % Error 0.48 % Error 0.82 % Error	Spectrum Analyzer Vector Signal Analyzer

Electrical – RF/Microwave

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Error ^{1,2} (rms)	(0 to 180) ° Error Mod Frequency Span: f ≤ 100 kHz 100 kHz ≤ f ≤ 1 MHz f > 1 MHz	0.17 ° 0.34 ° 0.57 °	Spectrum Analyzer Vector Signal Analyzer
Frequency Error ¹	(0 to 5) % Error Mod Frequency 1 GHz 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz	0.063 % Error 0.068 % Error 0.079 % Error 0.099 % Error 0.33 % Error 0.39 % Error	Spectrum Analyzer Vector Signal Analyzer
Modulation Accuracy ¹ (Rho)	Mod Frequency Span: f ≤ 100 kHz 0.999 9 ≤ ρ ≤ 1 0.997 5 ≤ ρ < 0.999 9 0.993 6 ≤ ρ < 0.997 5 0.99 ≤ ρ < 0.993 6 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978 Mod Frequency Span: 100 kHz ≤ f ≤ 1 MHz 0.9999 ≤ ρ ≤ 1 0.997 5 ≤ ρ < 0.999 9 0.993 6 ≤ ρ < 0.997 5 0.99 ≤ ρ < 0.993 6 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978 f ≥ 1 MHz 0.999 9 ≤ ρ ≤ 1 0.997 5 ≤ ρ < 0.999 9 0.993 6 ≤ ρ < 0.997 5 0.99 ≤ ρ < 0.993 6 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978	8.6 E-5 ρ 0.000 43 ρ 0.000 68 ρ 0.000 84 ρ 0.001 2 ρ 0.001 6 ρ 9.6 E-5 ρ 0.000 48 ρ 0.000 76 ρ 0.000 94 ρ 0.001 4 ρ 0.001 8 ρ 1.6 E-4 ρ 0.000 82 ρ 0.001 3 ρ 0.001 6 ρ 0.002 4 ρ 0.003 ρ	Spectrum Analyzer Vector Signal Analyzer

Electrical – RF/Microwave

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
CISPR 16 Pulse Response Quasi-Peak Detector Response Band A Band B Band C Band D Quasi-Peak to Peak Detector Relative Response Ratio Band A Bands B, C, D	(0 to 7) dB (1 to 20) Hz (1 to 100) Hz (1 to 100) Hz (1 to 100) Hz (0 to 70) dB 25 Hz 100 Hz	0.26 dB 0.3 dB 0.3 dB 0.3 dB 0.31 dB 0.31 dB	Pulse Generator
CISPR 16 Pulse Response Quasi-Peak to Average Detector Relative Response Ratio Band A Band B Band C, D Absolute Amplitude Band A Band B Band C Quasi-Peak to RMS Relative Band A Band B, C, D	(0 to 70) dB 25 Hz 500 Hz 5 kHz (0 to 70) dB 25 Hz 100 Hz 100 Hz (0 to 70) dB 25 Hz 100 Hz	0.31 dB 0.31 dB 0.31 dB 0.42 dB 0.42 dB 0.55 dB 0.26 dB 0.26 dB	Power Meter and Power Sensor
RF High Power – Measure (1.5 to 1 000) MHz	(0.3 to 100) W	2.4 % of reading	High RF Power Meter and Sensor

Electrical – RF/Microwave

Grass Valley, CA

Parameter/ Equipment	RF Absolute Power Measure ^{1,2}										
Reference Standard, Method, and/or Equipment	Power Sensor, Power Meter and Measuring Receiver										
Range	Expanded Uncertainty of Measurement (+/-)										
Frequency Ranges	Frequency Ranges (uncertainties in dB)										
	9 kHz ≤ f < 100 kHz	100 kHz ≤ f < 10 MHz	10 MHz ≤ f < 30 MHz	30 MHz ≤ f < 500 MHz	500 MHz ≤ f < 1.2 GHz	1.2 GHz ≤ f < 2 GHz	2 GHz ≤ f < 6 GHz	6 GHz ≤ f < 8 GHz	8 GHz ≤ f < 12.4 GHz	12.4 GHz ≤ f < 14 GHz	14 GHz ≤ f < 18 GHz
-70 dBm ≤ P < -60 dBm	-	-	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6

Electrical – RF/Microwave

Grass Valley, CA

Parameter/ Equipment	RF Absolute Power Measure ^{1,2}										
Reference Standard, Method, and/or Equipment	Power Sensor, Power Meter and Measuring Receiver										
Range	Expanded Uncertainty of Measurement (+/-)										
Frequency Ranges	Frequency Ranges (uncertainties in dB)										
	9 kHz ≤ f < 100 kHz	100 kHz ≤ f < 10 MHz	10 MHz ≤ f < 30 MHz	30 MHz ≤ f < 500 MHz	500 MHz ≤ f < 1.2 GHz	1.2 GHz ≤ f < 2 GHz	2 GHz ≤ f < 6 GHz	6 GHz ≤ f < 8 GHz	8 GHz ≤ f < 12.4 GHz	12.4 GHz ≤ f < 14 GHz	14 GHz ≤ f < 18 GHz
-60 dBm ≤ P < -50 dBm	0.37	0.37	0.08	0.08	0.08	0.09	0.1	0.1	0.1	0.09	0.1
-50 dBm ≤ P < -40 dBm	0.13	0.13	0.05	0.05	0.05	0.05	0.06	0.06	0.07	0.06	0.08
-40 dBm ≤ P < -30 dBm	0.06	0.06	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.08
-30 dBm ≤ P < -20 dBm	0.11	0.11	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.09
-20 dBm ≤ P < -10 dBm	0.11	0.09	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.08	0.08
-10 dBm ≤ P < 0 dBm	0.11	0.08	0.05	0.06	0.06	0.05	0.05	0.07	0.07	0.08	0.08
0 dBm ≤ P < 2 dBm	0.04	0.06	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.08	0.08
2 dBm ≤ P < 10 dBm	0.1	0.08	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.08	0.08
10 dBm ≤ P < 15 dBm	0.1	0.1	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.08	0.08
15 dBm ≤ P < 20 dBm	0.1	0.1	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.09	0.09

Electrical – RF/Microwave

Grass Valley, CA

Parameter/ Equipment	RF Absolute Power Measure ^{1,2}									
Reference Standard, Method, and/or Equipment	Power Sensor, Power Meter and Measuring Receiver									
Range	Expanded Uncertainty of Measurement (+/-)									
Frequency Ranges	Frequency Ranges (uncertainties in dB)									
	18 GHz ≤ f < 26.5 GHz	26.5 GHz ≤ f < 33 GHz	33 GHz ≤ f < 40 GHz	40 GHz ≤ f < 45 GHz	45 GHz ≤ f < 50 GHz	50 GHz ≤ f < 55 GHz	55 GHz ≤ f < 60 GHz	60 GHz ≤ f < 67 GHz	67 GHz ≤ f < 70 GHz	
-70 dBm ≤ P < -60 dBm	0.61	0.61	0.61	0.65	0.7	-	-	-	-	
-60 dBm ≤ P < -50 dBm	0.11	0.13	0.2	0.25	0.25	-	-	-	-	
-50 dBm ≤ P < -40 dBm	0.1	0.12	0.13	0.19	0.19	-	-	-	-	
-40 dBm ≤ P < -30 dBm	0.1	0.12	0.13	0.19	0.19	-	-	-	-	

Electrical – RF/Microwave

Grass Valley, CA

Parameter/ Equipment	RF Absolute Power Measure ^{1,2}								
Reference Standard, Method, and/or Equipment	Power Sensor, Power Meter and Measuring Receiver								
Range	Expanded Uncertainty of Measurement (+/-)								
Frequency Ranges	Frequency Ranges (uncertainties in dB)								
	18 GHz ≤ f < 26.5 GHz	26.5 GHz ≤ f < 33 GHz	33 GHz ≤ f < 40 GHz	40 GHz ≤ f < 45 GHz	45 GHz ≤ f < 50 GHz	50 GHz ≤ f < 55 GHz	55 GHz ≤ f < 60 GHz	60 GHz ≤ f < 67 GHz	67 GHz ≤ f < 70 GHz
-30 dBm ≤ P < -20 dBm	0.1	0.12	0.13	0.19	0.19	0.45	0.46	0.46	0.47
-20 dBm ≤ P < -10 dBm	0.09	0.1	0.14	0.15	0.17	0.24	0.24	0.24	0.27
-10 dBm ≤ P < 0 dBm	0.09	0.1	0.14	0.15	0.16	0.24	0.24	0.24	0.26
0 dBm ≤ P < 2 dBm	0.09	0.1	0.13	0.15	0.16	0.24	0.24	0.24	0.26
2 dBm ≤ P < 10 dBm	0.1	0.1	0.13	0.15	0.16	0.24	0.24	0.24	0.26
10 dBm ≤ P < 15 dBm	0.09	0.1	0.13	0.15	0.16	0.24	0.24	0.24	0.26
15 dBm ≤ P < 20 dBm	0.09	0.1	0.13	0.15	0.16	0.24	0.24	0.24	0.27

Electrical – RF/Microwave

Grass Valley, CA

Parameter/ Equipment	(S11 - Reflection) Magnitude Uncertainty ⁵									
Reference Standard, Method, and/or Equipment	Network Analyzer, Calibration Kit and Verification Kit									
Range	Expanded Uncertainty of Measurement (+/-)									
Frequency Ranges	Measured Magnitude (+/- Linear)									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
5 Hz to 300 kHz	0.007	0.007	0.009	0.011	0.014	0.016	0.018	0.022	0.024	0.028
300 kHz to 2 GHz	0.006 1	0.006 2	0.006 4	0.007 2	0.008	0.009	0.012	0.014	0.015	0.016
(2 to 20) GHz	0.016	0.017	0.018	0.018	0.019	0.02	0.022	0.026	0.028	0.031
(20 to 50) GHz	0.032	0.032	0.034	0.034	0.036	0.038	0.044	0.048	0.056	0.064

Electrical – RF/Microwave

Grass Valley, CA

Parameter/ Equipment	(S11 - Reflection) Phase Uncertainty (deg)									
Reference Standard, Method, and/or Equipment	Network Analyzer, Calibration Kit and Verification Kit									
Range	Expanded Uncertainty of Measurement (+/-)									
Frequency Ranges	Measured Magnitude (+/- Degrees)									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
5 Hz to 300 kHz	3.9	2.4	1.8	1.6	1.6	1.6	1.6	1.6	1.6	1.6
300 kHz to 2 GHz	3.6	1.9	1.4	1.1	0.96	0.9	0.92	0.96	0.98	1
(2 to 20) GHz	9.2	4.6	3.3	2.4	2	1.8	1.7	1.7	1.7	1.7
(20 to 50) GHz	16	9.4	6.4	5	4.2	3.8	3.6	3.6	3.6	3.7

Electrical – RF/Microwave

Grass Valley, CA

Parameter/ Equipment	(S21 - Transmission) Magnitude Uncertainty (dB)									
Reference Standard, Method, and/or Equipment	Network Analyzer, Calibration Kit and Verification Kit									
Range	Expanded Uncertainty of Measurement (+/-)									
Frequency Ranges	Measured Magnitude (+/- Linear) ⁵									
	0	3	6	10	20	30	40	50	60	
5 Hz to 300 kHz	0.21	0.21	0.21	0.22	0.22	0.24	0.25	0.38	0.94	
300 kHz to 2 GHz	0.05	0.06	0.06	0.07	0.09	0.11	0.14	0.16	0.27	
(2 to 20) GHz	0.11	0.12	0.13	0.14	0.16	0.18	0.19	0.24	0.28	
(20 to 50) GHz	0.17	0.18	0.2	0.2	0.21	0.42	0.46	0.5	0.54	

Electrical – RF/Microwave

Grass Valley, CA

Parameter/ Equipment	(S21 - Transmission) Phase Uncertainty (deg)									
Reference Standard, Method, and/or Equipment	Network Analyzer, Calibration Kit and Verification Kit									
Range	Expanded Uncertainty of Measurement (+/-)									
Frequency Ranges	Measured Magnitude (+/- Degrees)									
	0	3	6	10	20	30	40	50	60	
5 Hz to 300 kHz	1.3	1.3	1.3	1.4	1.4	1.4	1.6	2.6	3.4	
300 kHz to 2 GHz	0.32	0.4	0.46	0.52	0.72	0.8	1	1.2	1.7	
(2 to 20) GHz	0.7	0.8	0.84	0.9	1	1	1.3	1.6	1.9	
(20 to 50) GHz	2.3	2.5	2.6	2.8	2.9	3	3.2	3.4	3.6	

Length – Dimensional Metrology

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 48 in	$(6.4 + 6.8 \cdot L) \mu\text{in} + 0.58R$	Gage Blocks
Height Gages ^{1,2}	Up to 48 in	$(28 + 1.8 \cdot L) \mu\text{in} + 0.58R$	Gage Blocks
End Measuring Rods ²	(0.05 to 12) in (12 to 72) in	$(3.5 + 0.8L) \mu\text{in}$ $(4.5 + 2.3L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Micrometers ^{1,2} External, Internal, Depth, Bore and Micrometer Head	Length Up to 48 in Flatness Up to 40 μin Parallelism Up to 50 μin	$(3.6 + 6.8 \cdot L) \mu\text{in} + 0.58R$ 4.8 μin 8.4 μin	Gage Blocks, Optical Parallels or Optical Flats
Thread Plug Gages ² (Cylindrical and Taper) Simple Pitch Diameter Major Diameter	(0.04 to 12) in	$(35 + 1L) \mu\text{in}$ $(11 + 1.1L) \mu\text{in}$	Universal Length Measuring Machine, Labmaster®, Thread Wires; Gage Blocks
Thread Ring Gages ² (Cylindrical and Taper) Simple Pitch Diameter Minor Diameter	(0.112 to 6) in	$(59 + 0.46L) \mu\text{in}$ $(13 + 2.7L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks, Labmaster®
Indicators ¹ Dial Gauge, Dial Test Indicator, LVDTs	Up to 4 in	$(12 + 4.6 \cdot L) \mu\text{in} + 0.58R$	Universal Length Measuring Machine, Indicator Tester
	Up to 4 in	$(2.6 + 2.5 \cdot L) \mu\text{in} + 0.58R$	Gage Block, Comparator Stand
Plain Plug Gages ^{1,2} (Cylindrical and Taper)	(0.001 to 12) in	$(12 + 1.6 \cdot L) \mu\text{in}$	Universal Length Measuring Machine, Labmaster®, High-Accuracy Micrometer, Gage Blocks
Gage Blocks ² Length (Deviation of the length at any point from nominal length)	Up to 4 in (4 to 24) in	$(3 + 1L) \mu\text{in}$ $(2.1 + 1.1L) \mu\text{in}$	Gage Blocks, Labmaster®
	Variation in length Up to 0.02 in	5.9 μin	

Length – Dimensional Metrology

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks ² Length (Deviation of the length at any point from nominal length) Variation in length	Up to 4 in (4 to 20) in Up to 0.02 in	$(6.3 + 0.65L) \mu\text{in}$ $(4.3 + 1L) \mu\text{in}$ 5.9 μin	Gage Blocks, Universal Length Measuring Machine
Plain Ring Gages ² (Cylindrical and Taper)	Up to 1 in (1 to 14) in	$(9 + 0.8L) \mu\text{in}$ $(12 + 0.8L) \mu\text{in}$	Universal Length Measuring Machine, Labmaster®, Gage Blocks
Thread Wires ²	Up to 1 in	$(3 + 6L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Rigid Rules & Tape Measures	Up to 40 in (40 to 2 000) in	0.006 5 in $(1.6 \times 10^{-4}L)$ in	Gage Blocks
Optical Comparators and Vision Systems/Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 20 in	$(41 + 0.48L) \mu\text{in}$	Glass Scales
	Up to 20 in	$(19 + 1.9L) \mu\text{in}$	Gage Blocks
Standard Scale / Glass Scales ²	Up to 12 in	$(24 + 1.9L) \mu\text{in}$	Vision System and Glass Scales / Gage Blocks
Precision Level	Up to 1 000 $\mu\text{in/in}$ (1 000 to 2 000) $\mu\text{in/in}$	0.71 % of reading + 3.5 $\mu\text{in/in}$ 1.5 % of reading	Differential level
Master Level / Electronic Inclinator / Angle Meter	5 000 $\mu\text{in/in}$ Up to 90° (4 Quadrant)	1.1 $\mu\text{in/in}$ 0.000 82°	Surface Plate, Gage Blocks, Sine Plate
Inspection Fixtures / Features ² Riser Blocks, Straight Edges, Bar Parallels	Up to 24 in (24 to 72) in	$(6.8 + 1L) \mu\text{in}$ $(25 + 1.5L) \mu\text{in}$	Universal Length Measuring Machine, Electric Comparator, Gage Blocks, Granite Surface Plate, Profile Projector, Hand Tools, Inclinator, Cylindrical Square

Length – Dimensional Metrology

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inspection Fixtures 2D Features ² Angle Block, V-Blocks, Riser Blocks, Straight Edges Parallel Bars, Machine Squares, Precision Squares Radius Gauge, Chamfer Gauge, Taper Gauge Attribute Gauges – Go/No-Go Dedicated Fixture Gauges	Up to 12 in Up to 90°	$(2 + 1.7L) \mu\text{in}$ 0.007 2 arc sec	Vision system, Gage Blocks, Glass Scale
Inspection Fixtures 2D Features ² Angle Block, V-Blocks, Riser Blocks, Straight Edges Parallel Bars, Machine Squares, Precision Squares Radius Gauge, Chamfer Gauge, Taper Gauge Attribute Gauges – Go/No-Go Dedicated Fixture Gauges	Up to 24 in (24 to 72) in Up to 90°	$(6.8 + 1L) \mu\text{in}$ $(25 + 1.5L) \mu\text{in}$ 0.061 arc sec	Universal Length Measuring Machine, Electric Comparator, Gage Blocks, Granite Surface Plate, Hand Tools, Electronic Inclinometer, Cylindrical Square
Surface Plates ^{1,2} Overall Flatness	(6 to 140) inD	$(17 + 0.45D) \mu\text{in}$	Differential level, Planekator
Repeat Reading (local area flatness)	Up to 5 000 μin	19 μin	Repeat-o-meter
Surface Roughness Tester ^{1,8}	Up to 121 $\mu\text{in Ra}$	2.1 μin	Surface Roughness Standard
Precision Step Height Standards	(100 to 1 000) Å (> 1 to 250) kÅ	19 Å 22 Å	Surface Profiler and Standard step
Length Measuring Machine, Linear Measurement ^{1,2}	Up to 24 in	$(3.3 + 2L) \mu\text{in}$	Gage Blocks
Thickness Gauge / Feeler Gauge ^{1,2}	(0.001 to 1) in	$(12 + 0.17L) \mu\text{in}$	Universal Length Measuring Machine, High-Accuracy Micrometer, Gage Block
Snap Gages ² (External / Internal)	(0.001 to 24) in	$(12 + 1.6L) \mu\text{in}$	Universal Length Measuring Machine, Gage Block
Spherical Diameter, Standard Ball, Steel Ball ²	(0.001 to 4) in	$(10 + 1.2L) \mu\text{in}$	Universal Length Measuring Machine, Gage Block

Length – Dimensional Metrology

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Spline Gage External Splines Diameter Major Diameter	(0.1 to 24) in	$(15 + 1.6 \cdot L) \mu\text{in}$ $(12 + 1.9 \cdot L) \mu\text{in}$	Universal Length Measuring Machine, Gage Block, Thread Wires, Spherical Stylus Probes
Spline Gage Internal Spline Diameter Minor Diameter	(0.1 to 24) in	$(15 + 2 \cdot L) \mu\text{in}$ $(11 + 2.2 \cdot L) \mu\text{in}$	Universal Length Measuring Machine, Gage Block, Spherical Stylus Probes

Mass and Mass Related

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Liquid Mass Flow Measuring Equipment ^{1,2} DN6 to DN100 Pipe Size	Up to 68 000 kg/h Up to 150 000 kg/h	0.16 % of reading + 0.58R 0.13 % of reading + 0.58R	Flow Meter
Liquid Volumetric Flow – Measuring Equipment ^{1,2} 12.7 mm to 7.6 m Pipe Size	Up to 1 135 l/min Up to 2 650 l/min	0.16 % of reading + 0.58R 0.13 % of reading + 0.58R	Flow Meter
Piston/Plunger Operated ¹ Volumetric Apparatus (POVA) Pipettes, Syringes, Dilutors, Titrators, Piston/Displacement Burettes (Burets), Dispensers, Liquid Handlers	Up to 20 μL (20 to 50) μL (50 to 100) μL (100 to 200) μL 200 μL to 10 mL (10 to 20) mL (20 to 2 000) mL	0.02 μL 0.043 % of reading 0.026 % of reading 0.019 % of reading 0.015 % of reading 0.014 % of reading 0.012 % of reading	Gravimetric Method referenced to OIML Class E1 Mass Standard and Balances
Volumetric Glassware ¹ Volumetric Apparatus, Flasks, Burettes, Volumetric Dispensers, Cylinders, Graduated Cylinders, Beakers, Vials, & Containers	Up to 10 mL (10 to 20) mL (20 to 2 000) mL	0.001 5 mL 0.014 % of reading 0.012 % of reading	Gravimetric Method referenced to OIML Class E1 Mass Standard and Balances
Pressure / Vacuum Transducers, Transmitters ^{1,2} (Gage, Absolute, Differential)	(-15 to 25) psi (2 to 1 000) psi (6 to 2 465) psi (30 to 12 140) psi	0.001 % of reading + 0.58R 0.002 7 % of reading + 0.58R 0.005 % of reading + 0.58R 0.005 % of reading + 0.58R	Piston Gages
Pressure / Vacuum Transducers, Transmitters ^{1,2} (Gage, Absolute, Differential)	(-15 to 0) psi (0 to 1000) psi (1000 to 10 000) psi (10 000 to 50 000) psi	0.008 2 % of reading + 0.58R 0.007 6 % of reading + 0.58R 0.009 9 % of reading + 0.58R 0.008 % of reading + 0.58R	Pressure Calibrator

Mass and Mass Related

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Vacuum Gages ^{1,2} (Absolute Pressure)	(0.000 1 to 1) Torr (1 to 10) Torr (10 to 1 000) Torr	0.21 % of reading + 0.58R 0.21 % of reading + 0.58R 0.18 % of reading + 0.58R	Vacuum Calibration System
Gas Flow Rate into Vacuum, Helium Leak Detector	(1×10 ⁻¹⁰ to 1×10 ⁻⁵) cc/s	4.5 % of reading	Comparison Method using Mass Spectrometer and Master leak standard
Air Velocity	35.0 ft/min (35 to 300) ft/min (300 to 9 000) ft/min	7.8 % of reading 1.9 % of reading 1.2 % of reading	Anemometer
Air Flow ¹	Up to 2 000 l/min	0.35 % of reading + 0.58R	Standard Flow Sensors
Scales and Balances ^{1,3}	(0 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 1 kg (1 to 2) kg (2 to 5) kg (5 to 10) kg (10 to 100) kg	0.0015 mg 0.0020 mg 0.0025 mg 0.0031 mg 0.0041 mg 0.0051 mg 0.0061 mg 0.0081 mg 0.010 mg 0.013 mg 0.015 mg 0.025 mg 0.051 mg 0.41 mg 0.81 mg 1.5 mg 4.1 mg 8.1 mg 0.82 × 10 ⁻⁶ kg/kg	Standard Weights
Scales and Balances ^{1,3}	(0 to 20) lb (20 to 1 000) lb	51 × 10 ⁻⁶ lb/lb 54 × 10 ⁻⁶ lb/lb	Standard Weights

Mass and Mass Related

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass (Weights) ²	(1 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 1 kg (1 to 2) kg (2 to 5) kg (5 to 10) kg (10 to 50) kg	0.001 5 mg 0.002 mg 0.002 5 mg 0.003 1 mg 0.004 1 mg 0.005 1 mg 0.006 1 mg 0.008 2 mg 0.01 mg 0.013 mg 0.015 mg 0.025 mg 0.051 mg 0.41 mg 0.81 mg 1.5 mg 4.1 mg 8.1 mg 0.82×10^{-6} kg/kg	Standard Weights and Mass Comparator
Torque Tools ¹	5 ozf·in to 200 lbf·in 200 lbf·in to 250 lbf·ft (250 to 1 000) lbf·ft (1 000 to 2 000) lbf·ft	0.33 % of reading 0.34 % of reading 0.34 % of reading 0.4 % of reading	Torque Calibrator
Torque Testers ¹	(15 to 200) ozf·in (4 to 150) lbf·in (2.5 to 250) lbf·ft (50 to 2 000) lbf·ft	0.12 % of reading 0.12 % of reading 0.12 % of reading 0.12 % of reading	Torque Wheel, Torque Standard, Calibration Arms, Weights
Force and Load Cell ¹ (Compression and Tension)	(3 to 10 000) lbf (10 000 to 100 000) lbf (100 000 to 1 000 000) lbf	0.005 % of reading 0.006 % of reading 0.17 % of reading	Load Cell, Standard weights
Dynamic Viscosity ¹ @25 C	(6.2 to 100 000) cP	0.6% of reading	Viscosity Standards

Mass and Mass Related

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Hardness Durometers Indenter Dimensions Length Angle Radius	Up to 0.2 in Up to 90° Up to 0.6 in	200 μ in 0.033° 160 μ in	Direct Verification Gage Blocks Optical Comparator
Spring Force	Up to 0.76 N (0.76 to 1.2) N (1.2 to 2.0) N (2.0 to 8.1) N (8.1 to 44.5) N	0.000 25 N + 0.58R 0.000 52 N + 0.58R 0.001 N + 0.58R 0.004 3 N + 0.58R 0.026 N + 0.58R	Electronic Balance, Load Cell
Hydrometer	(0.7 to 2) g/cm ³	0.000 47 g/cm ³	Weighing Scale / Standard Weight

Photometry and Radiometry

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Wavelength – Measure ¹	(400 to 1 800) nm	0.002 nm	Wavelength Meter
Optical Power – Measure ¹	(850 to 1 650) nm (-40 to 10) dBm	0.14 dB	Optical Test System
Illuminance	Up to 10 000 lux	3.1 % of reading	Comparison to Standard Light Meter
UV Irradiance, Calibration of UV Light Meters	(0.1 to 400) mW/cm ²	2.8 % of reading	Irradiance meter, (200 to 1 100) nm
UV Irradiance / UV Light - Measure	(0.1 to 2 000) mW/cm ²	2.8 % of reading	Irradiance meter
Laser Power – Measuring Equipment λ = (250 to 10 600) nm	10 mW to 10 W	3.3 % of reading + 0.58R	Thermopile Power Sensor Comparison
Laser Power – Measuring Equipment λ = (190 to 11 000) nm	10 mW to 10 W	2.9 of reading + 0.58R	Thermopile Power Sensor Comparison and Multimeter

Thermodynamic

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature ¹	(-200 to 660) °C (660 to 1 100) °C	0.009 °C 0.75 °C	Comparison to Platinum Resistance Thermometers
Standard Platinum Resistance Thermometers			
Triple Point of Water	0.01 °C	0.000 4 °C	Fixed Point Cells using AC bridge
Freeze Point of In	156.5979 °C	0.001 5 °C	
Freeze Point of Zn	419.5266 °C	0.001 6 °C	
Relative Humidity ¹	(10 to 95) %RH	0.65 %RH	Humidity Generator, Humidity Standard
Dew-Point Measuring Equipment ¹	(20 to -35) °C (-35 to -75) °C (-75 to -90) °C	0.24 °C 0.28 °C 0.55 °C	Dew-Point Calibration System
Radiation (Infrared) Thermometers ¹	(-20 to 0) °C (0 to 50) °C (50 to 100) °C (100 to 150) °C	0.48 °C 0.48 °C 0.66 °C 1.1 °C	Blackbody Calibrator $\epsilon = 0.98$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers ¹	5 °C (5 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 450) °C	0.53 °C 0.76 °C 1.4 °C 1.9 °C 2.4 °C 3.0 °C	Blackbody Calibrator $\epsilon = 0.99$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers ¹	100 °C (100 to 200) °C (300 to 400) °C (400 to 600) °C (600 to 800) °C (800 to 1 000) °C	0.63 °C 1.1 °C 1.9 °C 3.0 °C 3.9 °C 4.9 °C	Blackbody Calibrator $\epsilon = 0.995$, $\lambda = (8 \text{ to } 14) \mu\text{m}$

Time and Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	0.1 Hz to 225 MHz 100 MHz to 3 GHz 500 MHz to 46 GHz	2.2×10^{-12} Hz/Hz 2.2×10^{-12} Hz/Hz 5.9×10^{-12} Hz/Hz	GPS Receiver and Counter
Frequency Measuring Equipment ¹	10 MHz	2.2×10^{-12} Hz/Hz	
Frequency Measuring Equipment ¹	0.01 Hz to 10 MHz 10 MHz to 50.0 GHz	2.2×10^{-12} Hz/Hz 2.2×10^{-12} Hz/Hz	GPS Receiver, Signal Generator

Time and Frequency

Grass Valley, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Time Interval – Measure ¹	25 ps/div to 1 000 s/div	0.23 % of reading	Digital Oscilloscope
Photo Tachometer ¹	Up to 100 000 rpm	0.000 25 % of reading + 0.58R	Multi-Product Calibrator, Signal Generator with LED
Contact Tachometer ¹	(55 to 40 000) rpm	0.00 67 % of reading + 0.008 rpm	Tachometer Tester
Timers, Stopwatches, Chronometers ¹	Up to 24 hr	0.86 ms	Frequency Counter
	Up to 24 hr	240 ms	Stopwatch

[Return to Site listing \(top\)](#) [Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

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CALIBRATION

Chemical Quantities

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity ^{1,4}	10 μ S/cm 100 μ S/cm 1 000 μ S/cm 1 412 μ S/cm 10 000 μ S/cm 100 000 μ S/cm	0.62 μ S/cm 2.1 μ S/cm 5.6 μ S/cm 6.4 μ S/cm 51 μ S/cm 460 μ S/cm	Standard Conductivity Solutions
pH ^{1,4}	(4, 7, 10) pH	0.03 pH	Standard pH Solutions

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹	(0 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	8 μ V/V + 2 μ V 5 μ V/V + 3 μ V 4 μ V/V + 5 μ V 4 μ V/V + 8 μ V 5 μ V/V + 62 μ V 7 μ V/V + 470 μ V	Multi-Function Calibrator
DC Voltage Source ¹ Fixed Values	1 V 1.018V 10 V	1.6 μ V/V 1.6 μ V/V 1.2 μ V/V	DC Voltage Standard
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	3 μ V/V + 0.3 μ V 1.8 μ V/V + 0.3 μ V 0.6 μ V/V + 0.5 μ V 3 μ V/V + 30 μ V 3.6 μ V/V + 0.1 mV	Multimeter

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage Measure	Up to 100 mV (0.1 to 1) V (1 to 10) V (10 to 100) V 100 V to 1 kV	1.6 μ V/V 1.5 μ V/V 1.5 μ V/V 1.7 μ V/V 2 μ V/V	Voltage Reference Standard and Multiproduct Calibrator
DC Voltage – Measure ¹ High Voltage	Up to 5 kV (5 to 70) kV	0.35 mV/V + 0.29 V 0.35 mV/V + 1 V	High Voltage Meter
DC Current – Source ¹	(0 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	40 μ A/A + 6 nA 35 μ A/A + 7 nA 35 μ A/A + 40 nA 47 μ A/A + 0.7 μ A 98 μ A/A + 12 μ A	Multi-Function Calibrator
	(0 to 11) A	466 μ A/A + 469 μ A	Multi-Product Calibrator
	(0 to 550) A	3.0 mA/A + 58 mA	Multi-Product Calibrator with 50 turn Coil
DC Current – Measure ¹	1 pA to 100 nA 100 nA to 1 μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	36 μ A/A + 50 pA 25 μ A/A + 50 pA 25 μ A/A + 121 pA 25 μ A/A + 1 nA 25 μ A/A + 7 nA 25 μ A/A + 68 nA 41 μ A/A + 0.7 μ A 128 μ A/A + 14 μ A	Multimeter
Inductance Measure ¹ 12 Hz to 100 kHz	100 μ H to 10 H	0.4 mH/H	RLC Digibridge
Resistance Source ¹ Fixed Points	0.001 Ω 0.01 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω	23 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 3 $\mu\Omega/\Omega$ 6 $\mu\Omega/\Omega$ 6 $\mu\Omega/\Omega$ 6 $\mu\Omega/\Omega$ 13 $\mu\Omega/\Omega$ 4 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$	Standard Resistors
Resistance Source ¹ Fixed Points	1 k Ω 10 k Ω 100 k Ω (1 to 11) M Ω (10 to 110) M Ω (0.1 to 1) G Ω	13 $\mu\Omega/\Omega$ 4 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 5 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$	Standard Resistors

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	40 $\mu\Omega$ 96 $\mu\Omega$ 185 $\mu\Omega$ 240 $\mu\Omega$ 460 $\mu\Omega$ 1.3 m Ω 2.4 m Ω 11 m Ω 21 m Ω 110 m Ω 210 m Ω 1.3 Ω 2.5 Ω 22 Ω 45 Ω 440 Ω 1.1 k Ω 11 k Ω	Multi-Function Calibrator
Resistance – Source ¹	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 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	93 $\mu\Omega/\Omega + 6.2$ m Ω 93 $\mu\Omega/\Omega + 12$ m Ω 70 $\mu\Omega/\Omega + 12$ m Ω 70 $\mu\Omega/\Omega + 12$ m Ω 70 $\mu\Omega/\Omega + 47$ m Ω 70 $\mu\Omega/\Omega + 47$ m Ω 70 $\mu\Omega/\Omega + 0.47$ Ω 70 $\mu\Omega/\Omega + 0.47$ Ω 86 $\mu\Omega/\Omega + 4.7$ Ω	Multi-Product Calibrator
Resistance – Source ¹	(110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω	93 $\mu\Omega/\Omega + 4.7$ Ω 117 $\mu\Omega/\Omega + 43$ Ω 117 $\mu\Omega/\Omega + 43$ Ω 466 $\mu\Omega/\Omega + 0.43$ k Ω 776 $\mu\Omega/\Omega + 0.43$ k Ω 3.9 m $\Omega/\Omega + 4.3$ k Ω 3.9 m $\Omega/\Omega + 13$ k Ω	Multi-Product Calibrator

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	18 $\mu\Omega/\Omega$ + 68 $\mu\Omega$ 15 $\mu\Omega/\Omega$ + 0.7 m Ω 13 $\mu\Omega/\Omega$ + 0.7 m Ω 13 $\mu\Omega/\Omega$ + 7 m Ω 13 $\mu\Omega/\Omega$ + 68 m Ω 18 $\mu\Omega/\Omega$ + 5 Ω 61 $\mu\Omega/\Omega$ + 135 Ω 584 $\mu\Omega/\Omega$ + 2 k Ω 5.8 m Ω/Ω + 14 k Ω	Multimeter
AC Resistance - Source and Measure ¹ 100 Hz to 100 kHz	0.001 Ω (0.1 to 1) Ω 10 Ω to 100 k Ω	0.13 m Ω 1.5 m Ω/Ω 0.46 m Ω/Ω	Calibration RL Standard
	1 m Ω to 0.2 Ω 0.2 Ω to 100 k Ω 100 k Ω to 10 M Ω	6.9 m Ω/Ω 0.27 m Ω/Ω 3 m Ω/Ω	RLC Digibridge and Calibration RL Standard
Capacitance Measure ¹ 12 Hz to 100 kHz	(0.001 to 10) pF (10 to 100) pF 100 pF to 1 mF 100 pF to 1.1 μ F	0.4 mF/F 0.5 mF/F 0.2 mF/F 0.6 mF/F	RLC Digibridge and Standard Capacitors
Phase Measure ¹	(0.01 to 360) $^{\circ}$ (10 to 60) mV 10 Hz to 10 kHz (10 to 40) kHz (40 to 100) kHz	0.23 $^{\circ}$ 0.4 $^{\circ}$ 0.79 $^{\circ}$	Phase Meter
	(60 to 250) mV 10 Hz to 40 kHz (40 to 100) kHz	0.07 $^{\circ}$ 0.4 $^{\circ}$	
Phase Measure ¹	(0.01 to 360) $^{\circ}$ (0.25 to 10) V 10 Hz to 40 kHz (40 to 100) kHz (10 to 120) V 10 Hz to 40 kHz (40 to 100) kHz	0.06 $^{\circ}$ 0.4 $^{\circ}$ 0.08 $^{\circ}$ 0.4 $^{\circ}$	Phase Meter

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	Up to 2.2 mV		Multi-Function Calibrator
	(10 to 20) Hz	240 $\mu\text{V/V} + 4 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 4 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 4 \mu\text{V}$	
	(20 to 50) kHz	200 $\mu\text{V/V} + 4 \mu\text{V}$	
	(50 to 100) kHz	500 $\mu\text{V/V} + 5 \mu\text{V}$	
	(100 to 300) kHz	1.1 mV/V + 10 μV	
	(300 to 500) kHz	1.4 mV/V + 20 μV	
	500 kHz to 1 MHz	2.7 mV/V + 20 μV	
	(2.2 to 22) mV		
	(10 to 20) Hz	240 $\mu\text{V/V} + 4 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 4 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 4 \mu\text{V}$	
	(20 to 50) kHz	200 $\mu\text{V/V} + 4 \mu\text{V}$	
	(50 to 100) kHz	500 $\mu\text{V/V} + 5 \mu\text{V}$	
	(100 to 300) kHz	1.1 mV/V + 10 μV	
	(300 to 500) kHz	1.4 mV/V + 20 μV	
	500 kHz to 1 MHz	2.7 mV/V + 20 μV	
	(22 to 220) mV		
	(10 to 20) Hz	240 $\mu\text{V/V} + 12 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 8 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 8 \mu\text{V}$	
	(20 to 50) kHz	207 $\mu\text{V/V} + 10 \mu\text{V}$	
	(50 to 100) kHz	463 $\mu\text{V/V} + 22 \mu\text{V}$	
	(100 to 300) kHz	0.9 mV/V + 26 μV	
	(300 to 500) kHz	1.4 mV/V + 30 μV	
	500 kHz to 1 MHz	2.7 mV/V + 48 μV	
	220 mV to 2.2 V		
	(10 to 20) Hz	296 $\mu\text{V/V} + 53 \mu\text{V}$	
	(20 to 40) Hz	104 $\mu\text{V/V} + 23 \mu\text{V}$	
	40 Hz to 20 kHz	46 $\mu\text{V/V} + 9 \mu\text{V}$	
	(20 to 50) kHz	83 $\mu\text{V/V} + 12 \mu\text{V}$	
	(50 to 100) kHz	115 $\mu\text{V/V} + 33 \mu\text{V}$	
	(100 to 300) kHz	503 $\mu\text{V/V} + 95 \mu\text{V}$	
	(300 to 500) kHz	1 mV/V + 243 μV	
	500 kHz to 1 MHz	1.7 mV/V + 458 μV	

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) V		Multi-Function Calibrator
	(10 to 20) Hz	296 μ V/V + 529 μ V	
	(20 to 40) Hz	104 μ V/V + 183 μ V	
	40 Hz to 20 kHz	46 μ V/V + 61 μ V	
	(20 to 50) kHz	83 μ V/V + 122 μ V	
	(50 to 100) kHz	106 μ V/V + 243 μ V	
	(100 to 300) kHz	390 μ V/V + 794 μ V	
	(300 to 500) kHz	1 mV/V + 2.3 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.6 mV	
	(22 to 220) V		
	(10 to 20) Hz	296 μ V/V + 5.3 mV	
	(20 to 40) Hz	104 μ V/V + 1.8 mV	
	40 Hz to 20 kHz	52 μ V/V + 0.7 mV	
	(20 to 50) kHz	87 μ V/V + 1.1 mV	
	(50 to 100) kHz	154 μ V/V + 3 mV	
	(100 to 300) kHz	1 mV/V + 16 mV	
AC Voltage – Measure ¹	(300 to 500) kHz	4.5 mV/V + 40 mV	Multimeter
	500 kHz to 1 MHz	8 mV/V + 80 mV	
	(220 to 1 100) V		
	(15 to 50) Hz	346 μ V/V + 16 mV	
	50 Hz to 1 kHz	70 μ V/V + 3.5 mV	
	(0 to 10) mV		
	(1 to 40) Hz	353 μ V/V + 7.7 μ V	
	40 Hz to 1 kHz	241 μ V/V + 7 μ V	
	(1 to 20) kHz	353 μ V/V + 7 μ V	
	(20 to 50) kHz	1.2 mV/V + 7 μ V	
	(50 to 100) kHz	5.8 mV/V + 7 μ V	
	(100 to 300) kHz	46 mV/V + 7.3 μ V	
	(10 to 100) mV		
	(1 to 40) Hz	88 μ V/V + 4.6 μ V	
	40 Hz to 1 kHz	88 μ V/V + 2.3 μ V	
	(1 to 20) kHz	165 μ V/V + 2.3 μ V	
	(20 to 50) kHz	348 μ V/V + 2.3 μ V	
	(50 to 100) kHz	924 μ V/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	

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	100 mV to 10 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 (1 to 2) MHz (10 to 100) V (1 to 40) Hz 40 Hz to 1 kHz 1 kHz 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	88 μ V/V + 463 μ V 88 μ V/V + 234 μ V 165 μ V/V + 234 μ V 348 μ V/V + 234 μ V 924 μ V/V + 234 μ V 3.5 mV/V + 1.2 mV 12 mV/V + 1.2 mV 18 mV/V + 1.2 mV 234 μ V/V + 4.6 mV 234 μ V/V + 2.3 mV 234 μ V/V + 2.3 mV 406 μ V/V + 2.3 mV 1.4 mV/V + 2.3 mV 4.6 mV/V + 12 mV 18 mV/V + 12 mV 463 μ V/V + 47 mV 463 μ V/V + 24 mV 694 μ V/V + 24 mV 1.4 mV/V + 24 mV 3.5 mV/V + 24 mV	Multimeter
	(0 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 7) 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	1.7 mV/V + 1.3 μ V 740 μ V/V + 1.3 μ V 420 μ V/V + 1.3 μ V 810 μ V/V + 2 μ V 1.2 mV/V + 2.5 μ V 2.3 mV/V + 4 μ V 2.4 mV/V + 8 μ V 3.5 mV/V + 8 μ V 850 μ V/V + 1.3 μ V 370 μ V/V + 1.3 μ V 210 μ V/V + 1.3 μ V 400 μ V/V + 2 μ V 600 μ V/V + 2.5 μ V 1.2 mV/V + 4 μ V 1.3 mV/V + 8 μ V 2.3 mV/V + 8 μ V	
AC Voltage – Measure ¹			AC Measurement Standard

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(7 to 22) mV		AC Measurement Standard
	(10 to 20) Hz	290 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(20 to 40) Hz	190 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	40 Hz to 20 kHz	110 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(20 to 50) kHz	210 $\mu\text{V/V} + 2 \mu\text{V}$	
	(50 to 100) kHz	310 $\mu\text{V/V} + 2.5 \mu\text{V}$	
	(100 to 300) kHz	810 $\mu\text{V/V} + 4 \mu\text{V}$	
	(300 to 500) kHz	890 $\mu\text{V/V} + 0 \mu\text{V}$	
	500 kHz to 1 MHz	1.7 mV/V + 8 μV	
	(22 to 70) mV		
	(10 to 20) Hz	240 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	(20 to 40) Hz	120 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	40 Hz to 20 kHz	65 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	(20 to 50) kHz	130 $\mu\text{V/V} + 2 \mu\text{V}$	
	(50 to 100) kHz	260 $\mu\text{V/V} + 2.5 \mu\text{V}$	
	(100 to 300) kHz	510 $\mu\text{V/V} + 4 \mu\text{V}$	
	(300 to 500) kHz	670 $\mu\text{V/V} + 8 \mu\text{V}$	
	500 kHz to 1 MHz	1.1 mV/V + 8 μV	
	(70 to 220) mV		
	(10 to 20) Hz	210 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	(20 to 40) Hz	85 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	40 Hz to 20 kHz	38 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	(20 to 50) kHz	69 $\mu\text{V/V} + 2 \mu\text{V}$	
	(50 to 100) kHz	160 $\mu\text{V/V} + 2.5 \mu\text{V}$	
	(100 to 300) kHz	250 $\mu\text{V/V} + 4 \mu\text{V}$	
	(300 to 500) kHz	380 $\mu\text{V/V} + 8 \mu\text{V}$	
	500 kHz to 1 MHz	1.0 mV/V + 8 μV	
	(220 to 700) mV		
	(10 to 20) Hz	210 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	(20 to 40) Hz	76 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	40 Hz to 20 kHz	33 $\mu\text{V/V} + 1.5 \mu\text{V}$	
	(20 to 50) kHz	51 $\mu\text{V/V} + 2 \mu\text{V}$	
	(50 to 100) kHz	79 $\mu\text{V/V} + 2.5 \mu\text{V}$	
	(100 to 300) kHz	180 $\mu\text{V/V} + 4 \mu\text{V}$	
	(300 to 500) kHz	300 $\mu\text{V/V} + 8 \mu\text{V}$	
	500 kHz to 1 MHz	960 $\mu\text{V/V} + 8 \mu\text{V}$	

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	700 mV to 2.2 V		AC Measurement Standard
	(10 to 20) Hz	200 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	66 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	24 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	46 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	71 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	160 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	260 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	900 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(2.2 to 7) V		
	(10 to 20) Hz	200 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	67 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	24 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	48 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	81 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	190 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	400 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	1.2 mV/V + 0.058 μV	
	(7 to 22) V		
	(10 to 20) Hz	200 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	67 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	27 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	48 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	81 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	190 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	400 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	1.2 mV/V + 0.58 μV	
	(22 to 70) V		
	(10 to 20) Hz	200 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	68 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	32 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	57 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	94 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	200 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	410 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	1.2 mV/V + 0.58 μV	

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(70 to 220) V		AC Measurement Standard
	(10 to 20) Hz	200 μ V/V + 5.8 μ V	
	(20 to 40) Hz	68 μ V/V + 5.8 μ V	
	40 Hz to 20 kHz	31 μ V/V + 5.8 μ V	
	(20 to 50) kHz	69 μ V/V + 5.8 μ V	
	(50 to 100) kHz	98 μ V/V + 5.8 μ V	
	(100 to 300) kHz	210 μ V/V + 5.8 μ V	
	(300 to 500) kHz	500 μ V/V + 5.8 μ V	
	(220 to 700) V		
	(10 to 20) Hz	200 μ V/V + 5.8 μ V	
	(20 to 40) Hz	99 μ V/V + 5.8 μ V	
	40 Hz to 20 kHz	41 μ V/V + 5.8 μ V	
	(20 to 50) kHz	130 μ V/V + 5.8 μ V	
	(50 to 100) kHz	500 μ V/V + 5.8 μ V	
	(700 to 1 000) V		
	(10 to 20) Hz	200 μ V/V + 5.8 μ V	
	(20 to 40) Hz	99 μ V/V + 5.8 μ V	
	40 Hz to 20 kHz	38 μ V/V + 5.8 μ V	
	(20 to 50) kHz	130 μ V/V + 5.8 μ V	
	(50 to 100) kHz	500 μ V/V + 5.8 μ V	
AC Voltage – Measure ¹	Up to 1 kV		High Voltage Meter
	(50 to 60) Hz	0.87 mV/V + 0.52 V	
	400 Hz	0.87 mV/V + 0.52 V	
	(1 to 50) kV		
	(50 to 60) Hz	0.87 mV/V + 1.2 V	
AC Voltage Measure - Flatness ¹ 500 kHz to 30 MHz (Relative to 1 kHz)	(7 to 22) mV		AC Measurement Standard
	500 kHz to 1.2 MHz	0.8 mV/V	
	(1.2 to 2) MHz	0.8 mV/V	
	(2 to 10) MHz	1.2 mV/V	
	(10 to 20) MHz	2 mV/V	
	(20 to 30) MHz	4.3 mV/V	
	22mV to 7 V		
	500 kHz to 1.2 MHz	0.6 mV/V	
	(1.2 to 2) MHz	0.6 mV/V	
	(2 to 10) MHz	1.2 mV/V	
	(10 to 20) MHz	1.8 mV/V	
	(20 to 30) MHz	4.1 mV/V	

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	Up to 220) μ A		Multi-Function Calibrator
	(10 to 20) Hz	250 μ A/A + 16 nA	
	(20 to 40) Hz	160 μ A/A + 10 nA	
	40 Hz to 1 kHz	120 μ A/A + 8 nA	
	(1 to 5) kHz	280 μ A/A + 12 nA	
	(5 to 10) kHz	1.1 mA/A + 65 nA	
	(0.22 to 2.2) mA		
	(10 to 20) Hz	250 μ A/A + 40 nA	
	(20 to 40) Hz	160 μ A/A + 35 nA	
	40 Hz to 1 kHz	120 μ A/A + 35 nA	
	(1 to 5) kHz	200 μ A/A + 110 nA	
	(5 to 10) kHz	1.1 mA/A + 650 nA	
	(2.2 to 22) mA		
	(10 to 20) Hz	250 μ A/A + 400 nA	
	(20 to 40) Hz	160 μ A/A + 350 nA	
	40 Hz to 1 kHz	120 μ A/A + 350 nA	
	(1 to 5) kHz	200 μ A/A + 550 nA	
	(5 to 10) kHz	1.1 mA/A + 5 μ A	
	(22 to 220) mA		
	(10 to 20) Hz	250 μ A/A + 4 μ A	
	(20 to 40) Hz	160 μ A/A + 4 μ A	
	40 Hz to 1 kHz	120 μ A/A + 3 μ A	
	(1 to 5) kHz	200 μ A/A + 4 μ A	
	(5 to 10) kHz	1.1 mA/A + 10 μ A	
	(0.22 to 2.2) A		
	20 Hz to 1 kHz	260 μ A/A + 35 μ A	
	(1 to 5) kHz	450 μ A/A + 80 μ A	
	(5 to 10) kHz	7 mA/A + 160 μ A	
AC Current – Source ¹	(1 to 1 000) A		Multi-Product Calibrator w/50-turn coil
	(45 to 65) Hz	13 mA/A + 0.13 A	
	(65 to 500) Hz	42 mA/A + 0.15 A	
	500 Hz to 1 kHz	233 mA/A + 0.18 A	

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(0 to 100) μ A		Multimeter
	(10 to 20) Hz	4.6 mA/A + 0.035 μ A	
	(20 to 45) Hz	1.7 mA/A + 0.035 μ A	
	(45 to 100) Hz	0.7 mA/A + 0.035 μ A	
	100 Hz to 5 kHz	0.7 mA/A + 0.035 μ A	
	100 μ A to 1 mA		
	(10 to 20) Hz	4.6 mA/A + 0.23 μ A	
	(20 to 45) Hz	1.7 mA/A + 0.23 μ A	
	(45 to 100) Hz	0.7 mA/A + 0.23 μ A	
	100 Hz to 5 kHz	0.4 mA/A + 0.23 μ A	
	(5 to 20) kHz	0.7 mA/A + 0.23 μ A	
	(20 to 50) kHz	4.6 mA/A + 0.46 μ A	
	(50 to 100) kHz	6.4 mA/A + 1.7 μ A	
	(1 to 10) mA		
	(10 to 20) Hz	4.6 mA/A + 2.3 μ A	
	(20 to 45) Hz	1.7 mA/A + 2.3 μ A	
	(45 to 100) Hz	0.7 mA/A + 2.3 μ A	
	100 Hz to 5 kHz	0.4 mA/A + 2.3 μ A	
	(5 to 20) kHz	0.7 mA/A + 2.3 μ A	
	(20 to 50) kHz	4.6 mA/A + 4.6 μ A	
	(50 to 100) kHz	6.4 mA/A + 17 μ A	
	(10 to 100) mA		
	(10 to 20) Hz	4.6 mA/A + 23 μ A	
	(20 to 45) Hz	1.7 mA/A + 23 μ A	
	(45 to 100) Hz	0.7 mA/A + 23 μ A	
	100 Hz to 5 kHz	0.4 mA/A + 23 μ A	
	(5 to 20) kHz	0.7 mA/A + 23 μ A	
	(20 to 50) kHz	4.6 mA/A + 46 μ A	
	(50 to 100) kHz	6.4 mA/A + 0.17 mA	
	100 mA to 1 A		
	(10 to 20) Hz	4.6 mA/A + 0.23 mA	
	(20 to 45) Hz	1.8 mA/A + 0.23 mA	
	(45 to 100) Hz	0.9 mA/A + 0.23 mA	
	100 Hz to 5 kHz	1.2 mA/A + 0.23 mA	
	(5 to 20) kHz	3.5 mA/A + 0.23 mA	
	(20 to 50) kHz	12 mA/A + 0.46 mA	

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ 50 Hz to 1 kHz	(0.19 to 0.5) nF (0.5 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (0.33 to 1.1) μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F (0.33 to 1.1) mF	3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 78 pF 1.9 mF/F + 233 pF 1.9 mF/F + 0.78 nF 2.7 mF/F + 2.3 nF 2.7 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.9 mF/F + 78 nF 5.4 mF/F + 233 nF 7.8 mF/F + 0.26 μ F	Multi-Product Calibrator
	50 pF to 1.2 mF	0.72 mF/F	Standard Capacitor
Inductance – Source ¹ 1 kHz	(1 to 10) mH (10 to 100) mH (0.1 to 1) H (1 to 10) H	0.03 mH 0.15 mH 2 mH 11 mH	Standard Inductor
Inductance – Measure ¹	100 μ H to 10 H 12 Hz to 100 kHz	0.4 mH/H	RLC Digibridge
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C 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	0.36 °C 0.29 °C 0.26 °C 0.28 °C 0.26 °C 0.23 °C 0.27 °C 0.4 °C 0.66 °C 0.4 °C 0.17 °C 0.16 °C 0.17 °C 0.2 °C	Multi-Product Calibrator

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type J		Multi-Product Calibrator
	(-210 to -100) °C	0.24 °C	
	(-100 to -30) °C	0.17 °C	
	(-30 to 150) °C	0.16 °C	
	(150 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.21 °C	
	Type K		
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type S		
	(0 to 250) °C	0.38 °C	
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	
	Type T		
	(-250 to -150) °C	0.5 °C	
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U		
	(-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 100 Ω		Multi-Product Calibrator
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.031 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.039 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.062 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.085 °C	

Electrical – DC/Low Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 1 k Ω (-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C PtNi 385, 120 Ω (Ni120) (-80 to 0) °C (0 to 100) °C (100 to 260) °C Cu 427, 10 Ω (-100 to 260) °C	0.023 °C 0.023 °C 0.031 °C 0.039 °C 0.047 °C 0.054 °C 0.054 °C 0.18 °C 0.062 °C 0.062 °C 0.11 °C 0.23 °C	Multi-Product Calibrator
Oscilloscopes ¹ Bandwidth	100 mHz to 300 MHz (300 to 500) MHz 550 MHz to 3 GHz (3 to 26.5) GHz (26.5 to 50) GHz	2.4 % of reading 3 % of reading 4.1 % of reading 5.8 % of reading 7 % of reading	Oscilloscope Calibrator, Active Head and RF Power Sensor
Oscilloscopes ^{1,2} Square Wave Signal 50 Ω at 1 kHz 1 M Ω at 1 kHz Pulse & Rise Time 0.5, 1 V p-p 1 V p-p Time Mark Output Into 50 ohms Leveled Sine Flatness	+/- 1 mV to 6.6 V 1 mV to 130 V 10 MHz 1 MHz 2 ns to 20 ms 50 ms to 5 s 50 kHz Reference 50 kHz to 100 MHz (100 to 300) MHz	1 mV/V + 40 μ V 4 mV/V + 40 μ V 0.4 ns 0.4 ns (25 + 1 000t) parts in 10 ⁶ 25 parts in 10 ⁶ of reading 2.4 % of reading + 0.3 nV 2.5 % of reading + 0.3 nV 4.3 % of reading + 0.3 nV	Multiproduct Calibrator

Electrical – RF/Microwave

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Sensors – Calibration Factors ⁵	Referenced to 1 mW 100 kHz to 100 MHz 100 MHz to 5 GHz (5 to 10) GHz (10 to 18) GHz	0.14 % 0.97 % 1.3 % 1.4 %	Coaxial Thermistor and Power meter
	Referenced to 1 mW (18 to 26.5) GHz (26.5 to 40) GHz (40 to 50) GHz	2.1 % 2.3 % 4.1 %	Thermistor Power Sensors and Power Meter
RF Power Meter Reference ¹	1 mW 50 MHz	0.7 % of Reading	Power Meter and Thermistor Mount
Tuned RF Power, Relative – Measure ¹ 2.5 MHz to 26.5 GHz	(0 to -3) dB (-3 to 10) dB (-10 to -40) dB (-40 to -50) dB (-50 to -80) dB (-80 to -90) dB (-90 to -110) dB (-110 to -127) dB	0.04 dB 0.03 dB 0.07 dB 0.08 dB 0.09 dB 0.11 dB 0.14 dB 0.2 dB	Measuring Receiver
RF Absolute Power – Measure ^{1,2}	(-70 to 44) dBm 9 kHz to 6 GHz (6 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 33) GHz (33 to 40) GHz (40 to 45) GHz (45 to 50) GHz	0.19 dB 0.23 dB 0.26 dB 0.3 dB 0.37 dB 0.37 dB 0.53 dB 0.54 dB	Power Sensor, Power Meter and Measuring Receiver
Amplitude Modulation – Measure ¹ 50 Hz to 10 kHz 20 Hz to 100 kHz 50 Hz to 50 kHz 20 Hz to 100 kHz	Rate: 150 kHz to 10 MHz Depth: (5 to 99) % Rate: 10 MHz to 1.3 GHz Depth: (5 to 99) %	4 % of reading 4.6 % of reading 3.6 % of reading 4.6 % of reading	Measuring Receiver
Amplitude Modulation – Measure ¹ 50 Hz to 50 kHz 20 Hz to 100 kHz	Rate: (1.3 to 26.5) GHz Depth: (5 to 99) %	3.7 % of reading 4.7 % of reading	Measuring Receiver

Electrical – RF/Microwave

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation Rejection Measure ¹ 150 kHz to 10 MHz 10 MHz to 26.5 GHz	Rate: 400 Hz to 1 kHz Dev.: ≤ 5 kHz peak Dev.: ≤ 50 kHz peak	0.14 % Deviation 0.14 % Deviation	Measuring Receiver
Residuals AM ¹ (rms)	150 kHz to 18 GHz (18 to 26.5) GHz	0.004 % of reading 0.006 % of reading	Measuring Receiver
Frequency Modulation Distortion Measure ¹ Bandwidth: 20 Hz to 250 kHz	150 kHz to 26.5 GHz	0.15 % of reading	Measuring Receiver
Frequency Modulation Deviation Accuracy – Measure ¹ 250 kHz to 10 MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 10 kHz Dev: ≤ 40 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz	0.1 % Modulation 0.2 % Modulation 0.3 % Modulation 0.4% Modulation	Measuring Receiver
Amplitude Modulation Rejection – Measure ^{1,3} 150 kHz to 6.6 GHz (6.6 to 26.5) GHz	Rate: 400 Hz to 1 kHz Depth.: ≤ 50 %	11 Hz 23 Hz	Measuring Receiver
Amplitude Modulation Depth Accuracy Measure ¹ 150 kHz to 10 MHz 10 MHz to 3 GHz 10 MHz to 3 GHz (3 to 26.5) GHz (3 to 26.5) GHz	Rate: 50 Hz to 10 kHz Depth: (5 to 99) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	0.2 % Modulation 0.2 % Modulation 0.3 % Modulation 0.2 % Modulation 0.5 % Modulation	Measuring Receiver
Residuals FM ¹ Bandwidth: 50 Hz to 3 kHz (rms)	150 kHz to 3 GHz (3 to 6.6) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	1.3 Hz 1.8 Hz 2.6 Hz 3.7 Hz	Measuring Receiver

Electrical – RF/Microwave

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Distortion Measure ¹ 20 Hz to 20 kHz (20 to 100) kHz	(0 to 99.9) dB (50 to 500) kHz (50 to 500) kHz	1.3 dB 2.4 dB	Audio Analyzer
Amplitude Modulation Distortion -Measure ¹ 150 kHz to 18 GHz (18 to 26.5) GHz (18 to 26.5) GHz	Depth (5 to 99) % (5 to 50) % (50 to 95) %	0.14 % Depth 0.4 % Depth 0.6 % Depth	Measuring Receiver
Amplitude Modulation Flatness ¹ 10 MHz to 26.5 GHz	Rate: (9 Hz to 10 kHz) Depth: (5 to 99) %	0.15 % Depth	Measuring Receiver
Phase Modulation Measure ¹ 100 kHz to 6.6 GHz 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 200 kHz Deviation: > 0.7 Rad Deviation: > 0.3 Rad Rate: 20 Hz to 200 kHz Deviation: > 2 Rad Deviation: > 0.6 Rad Rate: 20 Hz to 200 kHz Deviation: > 4 Rad Deviation: > 1.2 Rad	0.1 % Modulation 0.2 % Modulation 0.1% Modulation 0.2 % Modulation 0.1 % Modulation 0.2 % Modulation	Measuring Receiver
AM Rejection Measure ¹ 100 kHz to 26.5 GHz	Rate: 50 Hz to 3 kHz Deviation: > 50 % AM at 1 kHz Rate	0.003 Rad	Measuring Receiver
Phase Residuals – Measure (rms) ¹ 100 kHz to 26.5 GHz	(0.1 to 25 000) Rad Rate: 50 Hz to 3 kHz	0.001 Rad	Measuring Receiver
Phase Distortion ¹ 150 kHz to 26.5 GHz	(0.1 to 25 000) Rad Bandwidth: 20 Hz to 250kHz	0.008 rad	Measuring Receiver
Amplitude Modulation - Source ¹ 10 kHz to 13.5 MHz 10 kHz to 13.5 MHz	Rate: 50 Hz to 100 kHz Depths: 5 % to 95 % Rate: 50 Hz to 100 kHz Depths: 95 % to 99 %	0.15 % Depth 0.3 % Depth	AM/FM Test Source
Frequency Modulation - Source ¹ 10 kHz to 432 MHz	Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	0.3 % Modulation	AM/FM Test Source

Electrical – RF/Microwave

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Harmonic Measurements ¹ 3 Hz to 26.5 GHz (26.5 to 50) GHz	(-90 to 0.01) dB	0.8 dB 1.4 dB	Spectrum Analyzer
Phase Noise – Measure ¹ Offset Frequency ≤ 100 kHz ≤ 1 MHz ≤ 40 MHz	(0 to 10) dB	2.3 dB 3.5 dB 4.5 dB	Phase Noise System
RF High Power – Measure (1.5 to 400) MHz	(0.3 to 100) W	2.4 % of reading	High RF Power Meter and Sensor
Phase Modulation – Measure ¹ 200 Hz to 20 kHz	Rate: 10 MHz to 1.3 GHz	7 % of reading	Measuring Receiver
Phase Modulation – Measure ¹ 200 Hz to 20 kHz	Rate: (1.3 to 26.5) GHz	7.4 % of reading	Measuring Receiver
Reflection S11/ S22 – Measure ^{1,5} Type N	(0 to 1.0) lin mag (-180 to 180) ° 5 Hz to 200 MHz 200 MHz to 6 GHz (6 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.028 1.2 ° 0.028 1.4 ° 0.037 1.7 ° 0.037 2.8 ° 0.037 3.4 °	Network Analyzer, Calibration Kit and Verification Kit

Length – Dimensional Metrology

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 8 in (8 to 24 in)	(58 + 2.6·L) μin (62 + 8·L) μin	Gage Blocks
Height Gages ^{1,2}	Up to 24 in	(29 + 2.4·L) μin	Gage Blocks
Gage Blocks ²	Up to 4 in	(3.9 + 1.2·L) μin	ULM, Master Gage Blocks

Length – Dimensional Metrology

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Cylindrical Plug Gages / Pin Gages / Thread Wires ²	Up to 12 in	$(16 + 1.6 \cdot L) \mu\text{in}$	Bench Micrometer, Master Gage Blocks
Cylindrical Ring Gages ²	(0.04 to 6) in	$(15 + 2.2 \cdot L) \mu\text{in}$	Labmaster®, Gage blocks
Thread Plug Gage ² Simple Pitch Diameter Major Diameter	Up to 12 in	$(57 + 2.3 \cdot L) \mu\text{in}$ $(16 + 1.3 \cdot L) \mu\text{in}$	Bench Micrometer, Thread Wires
Thread Ring Gages ² Simple Pitch Diameter Minor Diameter	(0.1 to 6) in	$(60 + 0.46 \cdot L) \mu\text{in}$ $(16 + 2.5 \cdot L) \mu\text{in}$	Labmaster®, Gage blocks, T-Sphere Probe
Indicators ^{1,2} Dial Gauge, Dial Test Indicator, LVDTs	Up to 0.05 in (0.05 to 4) in	16 μin $(32 + 7.8 \cdot L) \mu\text{in}$	Indicator Calibrator
	Up to 4 in	$(2.6 + 2.8 \cdot L) \mu\text{in}$	Gage Block, Comparator Stand
Micrometers ^{1,2}	Up to 1 in (1 to 24) in	$(7.4 + 8.8 \cdot L) \mu\text{in}$ $(20 + 13 \cdot L) \mu\text{m}$	Gage Blocks
Surface Plates ¹ Repeat Reading only	Up to 1 000 μin	19 μin	Repeat-o-Meter
Wafer Thickness	(3.0 to 1 500) nm	0.32 nm	Ellipsometer and Standard Wafers
Precision Step Height Standards	(100 to 1 000) Å (>1 to 250) kÅ	17 Å 17 Å	Surface Profiler and Standard Step

Mass and Mass Related

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure ¹	(0 to 6 000) psi (6 000 to 40 000) psi	0.023 % of reading + 0.002 2 psi 0.024 % of reading + 0.03 psi	Pressure Calibrator Electronic Deadweight Tester
Torque Tools ^{1,2}	Up to 1 100 lbf·ft	0.67 % of reading + 0.58R	Torque System
Torque Testers ^{1,2}	Up to 10 lbf·ft (10 to 40) lbf·ft (40 to 150) lbf·ft (150 to 400) lbf·ft (400 to 1 100) lbf·ft	0.16 % of reading + 0.58R 0.048 % of reading 0.028 % of reading 0.031 % of reading 0.014 % of reading	Torque calibration wheels with Standard weights

Mass and Mass Related

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass (Standard Weight)	(1 to 5) mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg (500 mg to 1 g) (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g	0.003 2 mg 0.004 2 mg 0.005 2 mg 0.006 2 mg 0.008 2 mg 0.011 mg 0.013 mg 0.016 mg 0.021 mg 0.027 mg 0.034 mg 0.048 mg 0.1 mg 0.17 mg 0.29 mg	Standard Weight (E2) and Electronic Balance
Mass (Standard Weight)	10 kg	30 mg	Standard Weight (F1) and Electronic Balance
Scales & Balances ^{1,3} (Platform & Spring)	Up to 5 mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg (500 mg to 1 g) (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g (500 g to 20 kg)	0.009 mg 0.010 mg 0.010 mg 0.011 mg 0.012 mg 0.014 mg 0.016 mg 0.084 mg 0.09 mg 0.09 mg 0.10 mg 0.14 mg 0.26 mg 0.49 mg 1.4 mg 2.9 mg 0.000 6 % of reading	Standard Weight (E2, F1)
Air Velocity	(1 to 88) ft/min (88 to 3 520) ft/min (3 520 to 7 040) ft/min	9.7 % of reading 4.7 % of reading 4.2 % of reading	Alnor CF8570 Anemometer
Force – Compression and Tension ¹ Load Cell	(3 to 10 000) lbf (10 000 to 100 000) lbf	0.006 % of reading 0.006 % of reading	Load Cell

Photometry and Radiometry

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Fiber Optics – Measure ¹ (850, 1 310, 1 550) nm	(-60 to -0.001) dB	5.2 % of reading	Optical Calibration System
Optical Wavelength – Measure ¹	(700 to 1 650) nm	0.007 nm	Wavelength Meter
Optical System – Aerosol Particle Counter Counting Efficiency	(0 to 100) % Counting Efficiency Particle size: (0.1, 0.3, 0.5, 1, 2, 5, 10) µm	6 % of reading	Master Particle Counter

Thermodynamic

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity – Measure ¹	(10 to 95) %RH	1.5 %RH	Humidity Indicator
Radiation (Infrared) Thermometers ¹	(50 to 150) °C (150 to 350) °C (350 to 500) °C	1.1 °C 2.5 °C 5.2 °C	Black Body Calibrator (Flat Plate) $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Temperature – Measure ¹	(-197 to 660) °C	0.04 °C	PRT Probe
Temperature – Measuring Equipment ¹	(35 to 600) °C	0.008 % of reading + 0.1 °C	PRT and Dry Block

Time and Frequency

Richardson, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure	10 MHz	5 parts in 10^{-12}	GPS Receiver
Frequency – Measure ¹	10 Hz to 26.5 GHz	2.5 parts in 10^{-11}	Signal Generator, Measuring Receiver, Counter

[Return to Site listing \(top\)](#) [Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

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CALIBRATION

Acoustics and Vibration

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Vibration ¹ (10 Hz to 5 kHz) Acceleration Velocity Displacement Accelerometers / Velocity Sensors	(0 to 200) m/s ² (0 to 200) mm/s (0 to 200) µm 10 Hz to 5 kHz	0.69 % of reading + 0.004 7 m/s ² 0.69 % of reading + 0.004 7 mm/s 0.69 % of reading + 0.004 7 µm 1 % of sensitivity	Vibration System
Sound Pressure Level – Sound Pressure Calibrator ¹	1 000 Hz (94) dB (114) dB	0.12 dB 0.12 dB	Sound calibrator Sound meter Electronic counter
Sound Pressure Level- Sound Pressure Meter ¹	1 000 Hz 94 dB 114 dB	0.12 dB 0.12 dB	Sound Level Calibrator

Chemical Quantities

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
pH Meters ^{1,4}	(4, 7, 10) pH	0.014 pH	Standard Solutions
Conductivity Meter ^{1,4}	10 µS/cm 100 µS/cm 1 000 µS/cm 1 413 µS/cm 10 000 µS/cm 100 000 µS/cm	0.56 µS/cm 2.3 µS/cm 6.7 µS/cm 8.1 µS/cm 62 µS/cm 592 µS/cm	Comparison to Standard Solutions

Electrical – DC/Low Frequency

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Voltage – Source ¹	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	8 μ V/V + 2 μ V 7 μ V/V + 3 μ V 7 μ V/V + 5 μ V 7 μ V/V + 9 μ V 8 μ V/V + 93 μ V 9 μ V/V + 560 μ V	Multiproduct Calibrator
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1 000) V	11 μ V/V + 6 μ V 10 μ V/V + 2 μ V 10 μ V/V + 2 μ V 12 μ V/V + 2 μ V 12 μ V/V + 6 μ V	Multimeter
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	50 μ A/A + 8 nA 50 μ A/A + 8 nA 50 μ A/A + 80 nA 61 μ A/A + 0.8 μ A 98 μ A/A + 25 μ A	Multiproduct Calibrator
	(2.2 to 11) A	466 μ A/A + 469 μ A	Multiproduct Calibrator
DC Current – Source ¹	(11 to 16.5) A (16.5 to 110) A (110 to 550) A	4.9 mA/A + 58 mA 12 mA/A + 59 mA 24 mA/A + 63 mA	Multiproduct Calibrator with 50 Turn Coil
DC Current – Measure ¹	1 pA to 100 nA 100 nA to 1 μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	36 μ A/A + 50 pA 25 μ A/A + 50 pA 25 μ A/A + 121 pA 25 μ A/A + 1 nA 25 μ A/A + 7 nA 25 μ A/A + 68 nA 41 μ A/A + 0.7 μ A 128 μ A/A + 14 μ A	Multimeter
Resistance – Source ¹ Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω	50 $\mu\Omega$ 96 $\mu\Omega$ 185 $\mu\Omega$ 290 $\mu\Omega$ 530 $\mu\Omega$ 1.9 m Ω 3.5 m Ω 15 m Ω 28 m Ω 140 m Ω 270 m Ω 1.6 Ω	Multiproduct Calibrator

Electrical – DC/Low Frequency

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance – Source ¹ Fixed Points	190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	3 Ω 22 Ω 45 Ω 440 Ω 1.1 k Ω 11 k Ω	Multiproduct Calibrator
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	18 $\mu\Omega/\Omega$ + 68 $\mu\Omega$ 15 $\mu\Omega/\Omega$ + 0.7 m Ω 13 $\mu\Omega/\Omega$ + 0.7 m Ω 13 $\mu\Omega/\Omega$ + 7 m Ω 13 $\mu\Omega/\Omega$ + 68 m Ω 18 $\mu\Omega/\Omega$ + 5 Ω 61 $\mu\Omega/\Omega$ + 135 Ω 584 $\mu\Omega/\Omega$ + 2 k Ω 5.8 m Ω/Ω + 14 k Ω	Multimeter
AC Voltage – Source ¹	(0.2 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	550 $\mu\text{V}/\text{V}$ + 5 μV 210 $\mu\text{V}/\text{V}$ + 5 μV 105 $\mu\text{V}/\text{V}$ + 5 μV 370 $\mu\text{V}/\text{V}$ + 5 μV 850 $\mu\text{V}/\text{V}$ + 7 μV 1.1 mV/V + 13 μV 1.7 mV/V + 25 μV 3.4 mV/V + 25 μV 550 $\mu\text{V}/\text{V}$ + 5 μV 210 $\mu\text{V}/\text{V}$ + 5 μV 105 $\mu\text{V}/\text{V}$ + 5 μV 370 $\mu\text{V}/\text{V}$ + 5 μV 850 $\mu\text{V}/\text{V}$ + 7 μV 1.1 mV/V + 12 μV 1.7 mV/V + 25 μV 3.4 mV/V + 25 μV	Multiproduct Calibrator

Electrical – DC/Low Frequency

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Source ¹	(22 to 220) mV		Multiproduct Calibrator
	(10 to 20) Hz	550 $\mu\text{V/V} + 13 \mu\text{V}$	
	(20 to 40) Hz	210 $\mu\text{V/V} + 9 \mu\text{V}$	
	40 Hz to 20 kHz	105 $\mu\text{V/V} + 9 \mu\text{V}$	
	(20 to 50) kHz	324 $\mu\text{V/V} + 11 \mu\text{V}$	
	(50 to 100) kHz	852 $\mu\text{V/V} + 29 \mu\text{V}$	
	(100 to 300) kHz	1.1 mV/V + 30 μV	
	(300 to 500) kHz	1.7 mV/V + 39 μV	
	500 kHz to 1 MHz	3.4 mV/V + 82 μV	
	220 mV to 2.2 V		
	(10 to 20) Hz	529 $\mu\text{V/V} + 87 \mu\text{V}$	
	(20 to 40) Hz	168 $\mu\text{V/V} + 30 \mu\text{V}$	
	40 Hz to 20 kHz	75 $\mu\text{V/V} + 7 \mu\text{V}$	
	(20 to 50) kHz	125 $\mu\text{V/V} + 17 \mu\text{V}$	
	(50 to 100) kHz	252 $\mu\text{V/V} + 71 \mu\text{V}$	
	(100 to 300) kHz	512 $\mu\text{V/V} + 140 \mu\text{V}$	
	(300 to 500) kHz	1.1 mV/V + 376 μV	
	500 kHz to 1 MHz	2.2 mV/V + 918 μV	
	(2.2 to 22) V		
	(10 to 20) Hz	529 $\mu\text{V/V} + 872 \mu\text{V}$	
	(20 to 40) Hz	168 $\mu\text{V/V} + 271 \mu\text{V}$	
	40 Hz to 20 kHz	75 $\mu\text{V/V} + 70 \mu\text{V}$	
	(20 to 50) kHz	125 $\mu\text{V/V} + 174 \mu\text{V}$	
	(50 to 100) kHz	252 $\mu\text{V/V} + 376 \mu\text{V}$	
	(100 to 300) kHz	572 $\mu\text{V/V} + 1.6 \text{ mV}$	
	(300 to 500) kHz	1.3 mV/V + 4.4 mV	
	500 kHz to 1 MHz	2.7 mV/V + 8.7 mV	
	(22 to 220) V		
	(10 to 20) Hz	529 $\mu\text{V/V} + 8.7 \text{ mV}$	
	(20 to 40) Hz	168 $\mu\text{V/V} + 2.7 \text{ mV}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 0.8 \text{ mV}$	
	(20 to 50) kHz	223 $\mu\text{V/V} + 3.5 \text{ mV}$	
	(50 to 100) kHz	501 $\mu\text{V/V} + 8.2 \text{ mV}$	
	(100 to 300) kHz	1.5 mV/V + 90 mV	
	(300 to 500) kHz	4.7 mV/V + 90 mV	
	500 kHz to 1 MHz	12 mV/V + 190 mV	
	(220 to 1 100) V		
	(15 to 50) Hz	436 $\mu\text{V/V} + 16 \text{ mV}$	
	50 Hz to 1 kHz	80 $\mu\text{V/V} + 3.5 \text{ mV}$	

Electrical – DC/Low Frequency

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Measure ¹	(0 to 10) mV		Multimeter
	(1 to 40) Hz	353 $\mu\text{V/V} + 7.7 \mu\text{V}$	
	40 Hz to 1 kHz	241 $\mu\text{V/V} + 7 \mu\text{V}$	
	(1 to 20) kHz	353 $\mu\text{V/V} + 7 \mu\text{V}$	
	(20 to 50) kHz	1.2 mV/V + 7 μV	
	(50 to 100) kHz	5.8 mV/V + 7 μV	
	(100 to 300) kHz	46 mV/V + 7.3 μV	
	(10 to 100) mV		
	(1 to 40) Hz	88 $\mu\text{V/V} + 4.6 \mu\text{V}$	
	40 Hz to 1 kHz	88 $\mu\text{V/V} + 2.3 \mu\text{V}$	
	(1 to 20) kHz	165 $\mu\text{V/V} + 2.3 \mu\text{V}$	
	(20 to 50) kHz	348 $\mu\text{V/V} + 2.3 \mu\text{V}$	
	(50 to 100) kHz	924 $\mu\text{V/V} + 2.3 \mu\text{V}$	
	(100 to 300) kHz	3.5 mV/V + 12 μV	
	300 kHz to 1 MHz	12 mV/V + 12 μV	
	(1 to 2) MHz	18 mV/V + 12 μV	
	100 mV to 10 V		
	(1 to 40) Hz	88 $\mu\text{V/V} + 463 \mu\text{V}$	
	40 Hz to 1 kHz	88 $\mu\text{V/V} + 234 \mu\text{V}$	
	(1 to 20) kHz	165 $\mu\text{V/V} + 234 \mu\text{V}$	
	(20 to 50) kHz	348 $\mu\text{V/V} + 234 \mu\text{V}$	
	(50 to 100) kHz	924 $\mu\text{V/V} + 234 \mu\text{V}$	
	(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	234 $\mu\text{V/V} + 4.6 \text{ mV}$	
	40 Hz to 1 kHz	234 $\mu\text{V/V} + 2.3 \text{ mV}$	
	1 kHz to 20 kHz	234 $\mu\text{V/V} + 2.3 \text{ mV}$	
	(20 to 50) kHz	406 $\mu\text{V/V} + 2.3 \text{ mV}$	
	(50 to 100) kHz	1.4 mV/V + 2.3 mV	
	(100 to 300) kHz	4.6 mV/V + 12 mV	
	300 kHz to 1 MHz	18 mV/V + 12 mV	
	(100 to 1 000) V		
	(1 to 40) Hz	463 $\mu\text{V/V} + 47 \text{ mV}$	
	40 Hz to 1 kHz	463 $\mu\text{V/V} + 24 \text{ mV}$	
	(1 to 20) kHz	694 $\mu\text{V/V} + 24 \text{ mV}$	
	(20 to 50) kHz	1.4 mV/V + 24 mV	
	(50 to 100) kHz	3.5 mV/V + 24 mV	

Electrical – DC/Low Frequency

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current – Source ¹	(10 to 220) μ A		Multiproduct Calibrator
	(10 to 20) Hz	700 μ A/A + 25 nA	
	(20 to 40) Hz	350 μ A/A + 20 nA	
	40 Hz to 1 kHz	140 μ A/A + 16 nA	
	(1 to 5) kHz	600 μ A/A + 40 nA	
	(5 to 10) kHz	1.6 mA/A + 80 nA	
	(0.22 to 2.2) mA		
	(10 to 20) Hz	700 μ A/A + 40 nA	
	(20 to 40) Hz	350 μ A/A + 35 nA	
	40 Hz to 1 kHz	140 μ A/A + 35 nA	
	(1 to 5) kHz	600 μ A/A + 400 nA	
	(5 to 10) kHz	1.6 mA/A + 800 nA	
	(2.2 to 22) mA		
	(10 to 20) Hz	700 μ A/A + 400 nA	
	(20 to 40) Hz	350 μ A/A + 350 nA	
	40 Hz to 1 kHz	140 μ A/A + 350 nA	
	(1 to 5) kHz	600 μ A/A + 4 μ A	
	(5 to 10) kHz	1.6 mA/A + 8 μ A	
	(22 to 220) mA		
	(10 to 20) Hz	700 μ A/A + 4.0 μ A	
	(20 to 40) Hz	350 μ A/A + 3.5 μ A	
	40 Hz to 1 kHz	140 μ A/A + 3.5 μ A	
	(1 to 5) kHz	600 μ A/A + 40 μ A	
	(5 to 10) kHz	1.6 mA/A + 80 μ A	
	(0.22 to 2.2) A		
	20 Hz to 1 kHz	650 μ A/A + 35 μ A	
	(1 to 5) kHz	750 μ A/A + 80 μ A	
	(5 to 10) kHz	8.5 mA/A + 160 μ A	
AC Current – Source ¹	(2.2 to 11) A		Multi-Product Calibrator
	(45 to 65) Hz	0.47 mA/A + 1.6 mA	
	(65 to 500) Hz	0.78 mA/A + 1.6 mA	
	500 Hz to 1 kHz	2.6 mA/A + 1.6 mA	
AC Current – Source ¹	(11 to 1 000) A		Multi-Product Calibrator w/50 Turn Coil
	(45 to 65) Hz	13 mA/A + 0.13 A	
	(65 to 500) Hz	42 mA/A + 0.15 A	
	500 Hz to 1 kHz	233 mA/A + 0.18 A	

Electrical – DC/Low Frequency

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current – Measure ¹	(0 to 100) μ A		Multimeter
	(10 to 20) Hz	4.6 mA/A + 0.035 μ A	
	(20 to 45) Hz	1.7 mA/A + 0.035 μ A	
	(45 to 100) Hz	0.7 mA/A + 0.035 μ A	
	100 Hz to 5 kHz	0.7 mA/A + 0.035 μ A	
	100 μ A to 1 mA		
	(10 to 20) Hz	4.6 mA/A + 0.23 μ A	
	(20 to 45) Hz	1.7 mA/A + 0.23 μ A	
	(45 to 100) Hz	0.7 mA/A + 0.23 μ A	
	100 Hz to 5 kHz	0.4 mA/A + 0.23 μ A	
	(5 to 20) kHz	0.7 mA/A + 0.23 μ A	
	(20 to 50) kHz	4.6 mA/A + 0.46 μ A	
	(50 to 100) kHz	6.4 mA/A + 1.7 μ A	
	(1 to 10) mA		
	(10 to 20) Hz	4.6 mA/A + 2.3 μ A	
	(20 to 45) Hz	1.7 mA/A + 2.3 μ A	
	(45 to 100) Hz	0.7 mA/A + 2.3 μ A	
	100 Hz to 5 kHz	0.4 mA/A + 2.3 μ A	
	(5 to 20) kHz	0.7 mA/A + 2.3 μ A	
	(20 to 50) kHz	4.6 mA/A + 4.6 μ A	
	(50 to 100) kHz	6.4 mA/A + 17 μ A	
	(10 to 100) mA		
	(10 to 20) Hz	4.6 mA/A + 23 μ A	
	(20 to 45) Hz	1.7 mA/A + 23 μ A	
	(45 to 100) Hz	0.7 mA/A + 23 μ A	
	100 Hz to 5 kHz	0.4 mA/A + 23 μ A	
	(5 to 20) kHz	0.7 mA/A + 23 μ A	
	(20 to 50) kHz	4.6 mA/A + 46 μ A	
	(50 to 100) kHz	6.4 mA/A + 0.17 mA	
	100 mA to 1 A		
	(10 to 20) Hz	4.6 mA/A + 0.23 mA	
	(20 to 45) Hz	1.8 mA/A + 0.23 mA	
	(45 to 100) Hz	0.9 mA/A + 0.23 mA	
	100 Hz to 5 kHz	1.2 mA/A + 0.23 mA	
	(5 to 20) kHz	3.5 mA/A + 0.23 mA	
	(20 to 50) kHz	12 mA/A + 0.46 mA	

Electrical – DC/Low Frequency

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Capacitance – Source ¹ 50 Hz to 1 kHz	(0.19 to 0.5) nF (0.5 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (0.33 to 1.1) μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF (0.33 to 1.1) mF	3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 78 pF 1.9 mF/F + 233 pF 1.9 mF/F + 0.78 nF 2.7 mF/F + 2.3 nF 2.7 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.9 mF/F + 78 nF 5.4 mF/F + 233 nF 7.8 mF/F + 0.26 μF	Multiproduct Calibrator
Capacitance – Source ¹ Fixed Values 50 Hz to 1 kHz	0.1 pF to 10 μF	0.024 mF/F + 0.58·R	Capacitance Set
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C 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	0.36 °C 0.29 °C 0.26 °C 0.28 °C 0.26 °C 0.23 °C 0.27 °C 0.4 °C 0.66 °C 0.4 °C 0.17 °C 0.16 °C 0.17 °C 0.2 °C 0.24 °C 0.17 °C 0.16 °C 0.18 °C 0.21 °C	Multiproduct Calibrator

Electrical – DC/Low Frequency

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Simulation of Thermocouple Indicators ¹	Type K		Multiproduct Calibrator
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type S		
	(0 to 250) °C	0.38 °C	
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	
	Type T		
	(-250 to -150) °C	0.50 °C	
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U		
	(-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	

Electrical – DC/Low Frequency

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 100 Ω		Multiproduct Calibrator
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.031 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	

Electrical – DC/Low Frequency

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 500 Ω		Multiproduct Calibrator
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.039 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.062 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.085 °C	
	Pt 385, 1 k Ω		
	(-200 to -80) °C	0.023 °C	
	(-80 to 0) °C	0.023 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.054 °C	
	(400 to 600) °C	0.054 °C	
	(600 to 630) °C	0.18 °C	
	PtNi 385, 120 Ω (Ni120)		
	(-80 to 0) °C	0.062 °C	
	(0 to 100) °C	0.062 °C	
	(100 to 260) °C	0.11 °C	
	Cu 427, 10 Ω		
	(-100 to 260) °C	0.23 °C	
Oscilloscopes ^{1,2}			Multiproduct Calibrator
Leveled Sine Wave	5 mV to 5 V (Vp-p)	24 mV/V + 300 μ V	
Leveled Sine Flatness 50 kHz ref.	50 kHz to 100 MHz (100 to 300) MHz	38 mV/V + 300 μ V 43 mV/V + 300 μ V	
Square Wave 5 mV to 5.5 V	1 mVp-p to $\pm$ 130 Vp-p	1.6 mV/V + 40 μ V	
Relative to 50 kHz	$\pm$ 1 mVp-p to $\pm$ 6.6 Vp-p	2.8 mV/V + 40 μ V	
Time Marker Output Into 50 Ω	2 ns to 20 ms 50 ms to 5 s	(25 + 1 000t) parts in 10 ⁶ s 27 parts in 10 ⁶ of reading	Multiproduct Calibrator
Oscilloscopes ¹			
Pulse Rise Time 0.5 V, 1 Vp-p 1 Vp-p	10 MHz 1 MHz	100 ps 100 ps	

Electrical - RF/Microwave

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Tuned Power – Measure ¹ 100 kHz to 26.5 GHz	(0.0 to -3) dB (-3 to -10) dB (-10 to -40) dB (-40 to -50) dB (-50 to -80) dB (-80 to -90) dB (-90 to -110) dB (-110 to -127) dB	0.08 dB 0.09 dB 0.14 dB 0.14 dB 0.25 dB 0.35 dB 0.35 dB 0.4 dB	Measuring Receiver and Power Sensors
RF Absolute Power – Measure ¹ 9 kHz to 6 GHz (6 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz	(-70 to +20) dBm	0.19 dB 0.23 dB 0.26 dB 0.3 dB	Power Meter, Measuring Receiver and Power Sensors
Harmonic Measurements ¹	30 Hz to 26.5 GHz	1.5 dB	Spectrum Analyzer
Amplitude Modulation – Measure ¹ AM Depth Accuracy 100 kHz to 10 MHz (Rate: 50 Hz to 10 kHz) 10 MHz to 3 GHz (Rate: 50 Hz to 100 kHz) (3 to 26.5) GHz (Rate: 50 Hz to 100 kHz)	Depth: (5 to 99) % Depth: (20 to 99) % Depth: (5 to 20) % Depth: (20 to 99) % Depth: (5 to 20) %	0.91 % of reading 0.61 % of reading 3 % of reading 1.8 % of reading 5.5 % of reading	Measuring Receiver
Amplitude Modulation – Measure ¹ Flatness 10 MHz to 3 GHz (Rate: 90 Hz to 10 kHz) (3 to 26.5) GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) % Depth: (5 to 99) %	0.37 % of reading 0.49 % of reading	Measuring Receiver

Electrical - RF/Microwave

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Amplitude Modulation – Measure ¹ FM Rejection (50 Hz to 3 kHz BW) 250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz) 10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz) Residual AM 250 kHz to 26.5 GHz	Depths: < 50% Deviations: < 5 kHz Depths: < 50% Deviations: < 50 kHz (50 Hz to 3 kHz BW)	0.17 % Depth 0.44 % Depth 0.012% (rms)	Measuring Receiver
Frequency Modulation – Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz (Rate: 20 Hz to 200 kHz) AM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz Residual AM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: 200 Hz to 400 kHz AM Depths: ≤ 50% (Rate: 400 Hz or 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 13 Hz 25 Hz 49 Hz 1.9 Hz 3.7 Hz 7.4 Hz	Measuring Receiver
Phase Modulation – Measure ¹ PM Deviation Accuracy 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz AM Rejection (50 Hz to 3 kHz BW) 100 kHz to 26.5 GHz	Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad AM Depths: ≤ 50% (Rate: 1 kHz)	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad	Measuring Receiver

Electrical - RF/Microwave

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Phase Modulation – Measure ¹ Residual AM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	(50 Hz to 3 kHz BW)	0.002 1 rad 0.004 1 rad 0.008 1 rad	Measuring Receiver

Length – Dimensional Metrology

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Calipers ^{1,2}	Up to 48 in	$(290 + 8.8L) \mu\text{in}$	Gage Blocks
Height Gages ^{1,2}	Up to 48 in	$(29 + 2.1L) \mu\text{in}$	Gage Blocks
Micrometers ^{1,2}	Up to 1 in (1 to 48) in	$(7.4 + 8.8L) \mu\text{in}$ $(20 + 13L) \mu\text{in}$	Gage Blocks
Indicators ^{1,2} Dial Gages / Dial Thickness Gages / Dial Test Indicators / LVDTs	Up to 0.05 in (1 to 4) in	16 μin $(32 + 7.8L) \mu\text{in}$	Universal Measuring Machine, Indicator Tester
	Up to 4 in	$(2.6 + 2.8L) \mu\text{in}$	Gage Blocks, Comparator Stand
Plug Gages / Pin Gages / Thread Measuring Wires ² (Cylindrical & Taper)	Up to 12 in	$(16 + 1.6L) \mu\text{in}$	Universal Measuring Machine, Gage Blocks
Ring Gages, Plain Cylindrical ²	(0.02 to 2) in (4 to 12) in	$(65 + 1.2L) \mu\text{in}$ $(88 + 1.2L) \mu\text{in}$	Universal Measuring Machine, Gage Blocks, Master Ring Gages
Thread Plug Gages ² Major Diameter Simple Pitch Diameter (Cylindrical & Taper)	(0.04 to 12) in	$(16 + 1.3L) \mu\text{in}$ $(57 + 2.3L) \mu\text{in}$	Universal Measuring Machine, Gage Blocks, Thread Measuring Wires
Thread Ring Gages ² Minor Diameter Simple Pitch Diameter (Cylindrical & Taper)	(0.04 to 4) in	$(16 + 3.5L) \mu\text{in}$ $(60 + 0.54L) \mu\text{in}$	Universal Measuring Machine, Gage Blocks, Master Ring Gages, Thread Calibration Standards
Snap Gages ²	Up to 12 in	$(16 + 1.5L) \mu\text{in}$	Gage blocks, Universal Measuring Machine

Length – Dimensional Metrology

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Thickness Gages / Feeler Gages ²	Up to 1 in	$(16 + 0.016L) \mu\text{in}$	Gage blocks, Universal Measuring Machine
Gage Blocks ²	Up to 4 in (4 to 12) in	$(3.1 + 1.1L) \mu\text{in}$ $(11 + 1.2L) \mu\text{in}$	Gage blocks, Universal Measuring Machine, Gage Block Comparator
Ruler & Tape Measures ^{1,2}	Up to 96 in	0.007 in	Gage Blocks
Optical Comparators / Vision Systems and Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 12 in	$(50 + 6.3 \cdot L) \mu\text{in}$	Glass scales and gage blocks
Master Level / Electronic Inclinator / Angle Meter ^{1,2}	Up to 0.005 in/in Up to 90°	1.1 $\mu\text{in/in}$ 0.000 82°	Sine Bar, Gage Blocks, Surface Plate
Surface Roughness Testers ^{1,2}	3 μm 9.5 μm	0.07 μm 0.22 μm	Roughness Specimen
Surface Plates ¹ Local Area Flatness Only (Repeat Reading)	Up to 1 000 μin	19 μin	Repeat-o-Meter
Inspection Fixtures ² Riser Blocks, Angle Blocks, Straight Edges, Bar Parallels, V-Blocks	Up to 20 in (20 to 40) in	$(11 + 1.1L) \mu\text{in}$ $(21 + 1.3L) \mu\text{in}$	Universal Length Measuring Machine, Electric Comparator, Gage Blocks, Granite Surface Plate, Profile Projector, Hand Tools, Inclinator, Cylindrical Square

Mass and Mass Related

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Pressure	(0.2 to 12 140) psig	0.007 % of reading	Piston Gage
	(0.2 to 1 000) psia	Greater of 0.003 3 % of reading or 3 Pa	Piston Gage
Pressure ¹ (Gage / Absolute / Differential / Vacuum Gages & Transmitters)	(-13 to 0) psi (0 to 0.3) psi (0 to 300) psi (300 to 2 000) psi (2 000 to 10 000) psi	0.11 % of reading + 0.0025 psi 0.0026 % of reading + 0.000 2 psi 0.035 % of reading + 0.025 psi 0.046 % of reading + 0.25 psi 0.049 % of reading + 1 psi	Pressure Calibrator / Pressure Controller & Pressure Module

Mass and Mass Related

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Air Velocity	(80 to 1 400) ft/min (1 400 to 2 900) ft/min (2 900 to 5 900) ft/min	3.2 % of reading 3.1 % of reading 2.4 % of reading	Anemometer
Scales & Balances ^{1,3} (Platform & Spring)	Up to 500 mg 500 mg to 200 g 200 g to 1 kg (1 to 5) kg (5 to 20) kg (20 to 100) kg Up to 1 000 lb	4 µg 0.07 mg 0.8 mg 2 mg 4 mg 19 mg 0.32 lb	Class E1, E2, F and F1 Weights
Scales & Balances ^{1,3} (Platform & Spring)	Up to 500 mg 500 mg to 200 g 200 g to 1 kg (1 to 5) kg (5 to 20) kg (20 to 100) kg Up to 1 000 lb	5 µg 0.14 mg 1.8 mg 13 mg 28 mg 120 mg 0.36 lb	
Mass (Standard Weight)	(1 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g	4 µg 4 µg 9 µg 13 µg 16 µg 21 µg 49 µg 75 µg 140 µg 180 µg	Class 1 Weights, Balance
Mass (Standard Weight)	500 g to 5 kg (5 to 10) kg (10 to 50) kg	0.42 mg 0.55 mg 1.1 mg	Class 4 Weights, Balance
Mass (Standard Weight)	(1 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g	0.08 mg 5 µg 9 µg 14 µg 16 µg 22 µg 49 µg 76 µg 140 µg	Class E2 Weights
Flow – Air ¹	Up to 20 L/min (10 to 1 000) L/min	0.62 % of reading 0.63 % of reading	Standard Flow Sensors

Mass and Mass Related

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Torque Tools ¹	5 ozf·in to 200 lbf·in 200 lbf·in to 250 lbf·ft (250 to 1 000) lbf·ft (1 000 to 2 000) lbf·ft	0.33 % of reading 0.34 % of reading 0.34 % of reading 0.4 % of reading	Torque System with Transducers
Torque Tools ¹	5 ozf·in to 100 lbf·in	0.4 % of reading	Torque Tester with Transducers
Torque Testers ¹	Up to 10 lbf·ft (10 to 40) lbf·ft (40 to 150) lbf·ft (150 to 400) lbf·ft (400 to 1 000) lbf·ft	0.16 % of reading + 0.58R 0.048 % of reading 0.028 % of reading 0.031 % of reading 0.014 % of reading	Torque calibration wheels with Standard weights
Force – Compression and Tension ¹	Up to 600 lbf	0.006 2 % of reading + 0.58R	Standard weights
Load cell	(3 to 10 000) lbf (10 000 to 100 000) lbf	0.006 % of reading 0.006 % of reading	Load cell

Thermodynamic

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Temperature – Measure ¹	(-200 to 420) °C	0.04 °C	PRT Thermometer
Temperature – Measuring Equipment	(-20 to 350) °C (350 to 660) °C	0.065 °C 0.17 °C	PRT Thermometer Comparison
Humidity – Measure ¹	(10 to 40) %RH (40 to 95) %RH	0.7 %RH 1.1 %RH	Humidity Meter
Humidity – Measuring Equipment ¹	(10 to 40) %RH (40 to 95) %RH	1.2 %RH 1.5 %RH	Humidity Meter, Humidity Chamber
Radiation (Infrared) Thermometers ¹	50 °C (50 to 162.5) °C (162.5 to 275) °C (275 to 387.5) °C (387.5 to 500) °C	1.3 °C 2.5 °C 4.2 °C 5 °C 6.2 °C	Black Body Calibrator (Flat Plate) $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$

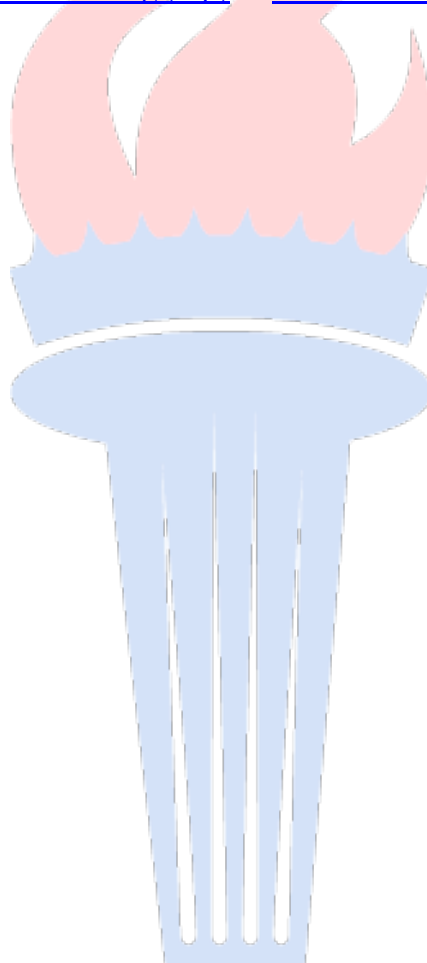
Time and Frequency

Columbus, IN

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency – Source ¹	10 MHz	6.2×10^{-12} Hz/Hz	GPS Receiver, Signal Generator
Frequency – Source ¹	0.01 Hz to 40 GHz	6.3×10^{-12} Hz/Hz	GPS Receiver, Signal Generator
Frequency – Measure ¹	500 MHz to 26.5 GHz	6.3×10^{-10} Hz/Hz	GPS Receiver, Counter
Tachometer ¹	Up to 100 000 rpm	0.000 71 % of reading + 0.005 5 rpm	Signal Generator or Multi-Product Calibrator with Lamp

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)



Services performed at satellite laboratory

Micro Precision Calibration, Inc.

2165 N. Glassell
Orange, CA 92865
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CALIBRATION

Acoustics and Vibration

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Accelerometers	(0.2 to 30) g (5 to 10) Hz 10 Hz to 5 kHz (5 to 10) kHz (10 to 15) kHz (15 to 20) kHz	1.2 % of reading 1 % of reading 1.7 % of reading 2.6 % of reading 3.1 % of reading	Vibration Calibration System
Shock Accelerometers	(20 to 10 000) g	2.5 % of reading	Shock Calibration System

Chemical Quantities

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity ¹	Up to 100 µS/cm Up to 200 µS/cm Up to 1 000 µS/cm Up to 1 413 µS/cm Up to 100 000 µS/cm	0.5 µS/cm 1.5 µS/cm 3.5 µS/cm 4.9 µS/cm 0.4 mS/cm	Standard Conductivity Solutions
pH ¹	(4, 7, 10) pH	0.019 pH	Standard pH Solutions

Electrical – DC/Low Frequency

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Generate ¹	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	10 $\mu\text{V/V} + 0.5 \mu\text{V}$ 6 $\mu\text{V/V} + 0.8 \mu\text{V}$ 4 $\mu\text{V/V} + 3 \mu\text{V}$ 4 $\mu\text{V/V} + 4.5 \mu\text{V}$ 4 $\mu\text{V/V} + 4 \mu\text{V}$ 5 $\mu\text{V/V} + 5 \mu\text{V}$	Multiproduct Calibrator
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1 000) V	6.1 $\mu\text{V/V} + 0.3 \mu\text{V}$ 5.0 $\mu\text{V/V} + 0.3 \mu\text{V}$ 5.0 $\mu\text{V/V} + 0.5 \mu\text{V}$ 7.3 $\mu\text{V/V} + 30 \mu\text{V}$ 26 $\mu\text{V/V} + 100 \mu\text{V}$	Multimeter
DC Voltage – Measure ¹	(1 to 10) kV (10 to 20) kV (21 to 70) kV	0.33 % of reading 0.2 % of reading 0.2 % of reading	High Voltage Meter
pH Meters – Electrical Simulation ¹	(-414.12 to 414.12) mV (0 to 14) pH	6 $\mu\text{V/V} + 0.8 \mu\text{V}$ 0.000 67 pH	Multiproduct Calibrator
DC Current – Generate ¹	(0 to 220) μA 220 μA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	41 $\mu\text{V/V} + 7 \text{ nA}$ 34 $\mu\text{V/V} + 8 \text{ nA}$ 35 $\mu\text{V/V} + 45 \text{ nA}$ 46 $\mu\text{V/V} + 0.8 \mu\text{A}$ 82 $\mu\text{V/V} + 13 \mu\text{A}$	Multiproduct Calibrator
	(2.2 to 11) A (11 to 20) A	0.42 mA/A + 0.56 mA 1.5 mA/A	Multiproduct Calibrator, Amplifier
	(20 to 1 000) A	0.46 % of reading	Multiproduct Calibrator, Transconductance Amplifier w/50 turn coil
DC Current – Measure ¹	Up to 100 nA 100 nA to 1 μA (1 to 10) μA (10 to 100) μA 100 μA to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A (1 to 3) A	30 $\mu\text{A/A} + 0.4 \text{ pA}$ 16 $\mu\text{A/A} + 0.075 \text{ nA}$ 29 $\mu\text{A/A} + 0.061 \text{ nA}$ 22 $\mu\text{A/A} + 0.13 \text{ nA}$ 24 $\mu\text{A/A} + 0.083 \text{ nA}$ 24 $\mu\text{A/A} + 0.16 \text{ nA}$ 43 $\mu\text{A/A} + 0.2 \mu\text{A}$ 0.14 mA/A + 10 μA 2.9 mA/A	Multimeter
	(0.5 to 20) A (1 to 1 000) A	0.2 mA/A 0.014 % of reading	Multimeter with shunt

Electrical – DC/Low Frequency

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Generate ¹ Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	50 $\mu\Omega$ 96 $\mu\Omega/\Omega$ 91 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 18 $\mu\Omega/\Omega$ 18 $\mu\Omega/\Omega$ 37 $\mu\Omega/\Omega$ 46 $\mu\Omega/\Omega$ 0.01 % of reading	Multiproduct Calibrator
Resistance – Generate ¹	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 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 (110 to 330) k Ω (0.33 to 1.1) M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω (0.33 to 1.1) G Ω	31 $\mu\Omega/\Omega + 0.78$ m Ω 23 $\mu\Omega/\Omega + 1.2$ m Ω 22 $\mu\Omega/\Omega + 1.2$ m Ω 22 $\mu\Omega/\Omega + 1.6$ m Ω 22 $\mu\Omega/\Omega + 1.7$ m Ω 22 $\mu\Omega/\Omega + 16$ m Ω 22 $\mu\Omega/\Omega + 17$ m Ω 22 $\mu\Omega/\Omega + 0.16$ Ω 22 $\mu\Omega/\Omega + 0.17$ Ω 25 $\mu\Omega/\Omega + 1.6$ Ω 25 $\mu\Omega/\Omega + 1.7$ Ω 47 $\mu\Omega/\Omega + 23$ Ω 0.10 m $\Omega/\Omega + 39$ Ω 0.2 m $\Omega/\Omega + 1.9$ k Ω 0.38 m $\Omega/\Omega + 2.3$ k Ω 2.3 m $\Omega/\Omega + 78$ k Ω 12 m $\Omega/\Omega + 0.39$ M Ω	Multiproduct Calibrator
Resistance – Measure ¹	(0.1 to 100) Ω (0.1 to 100) k Ω (0.1 to 1) M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	14 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 18 $\mu\Omega/\Omega$ 55 $\mu\Omega/\Omega$ 0.057 % of reading + 1.1 k Ω 0.57 % of reading + 11 k Ω	Multimeter

Electrical – DC/Low Frequency

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance – Measure ¹ 1 kHz	Up to 100 mΩ 100 mΩ to 100 kΩ 100 kΩ to 10 MΩ	8.8 mΩ/Ω + 10 μΩ 0.25 mΩ/Ω 3.1 mΩ/Ω	RLC Digibridge
AC Voltage – Generate ¹	(0.2 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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.055 % of reading + 4.5 μV 0.021 % of reading + 4.5 μV 0.011 % of reading + 4.5 μV 0.037 % of reading + 4.5 μV 0.085 % of reading + 7 μV 0.11 % of reading + 13 μV 0.17 % of reading + 25 μV 0.34 % of reading + 25 μV 0.055 % of reading + 5 μV 0.021 % of reading + 5 μV 0.011 % of reading + 5 μV 0.037 % of reading + 5 μV 0.085 % of reading + 7 μV 0.11 % of reading + 12 μV 0.17 % of reading + 25 μV 0.34 % of reading + 25 μV 0.055 % of reading + 13 μV 0.021 % of reading + 8 μV 0.011 % of reading + 8 μV 0.032 % of reading + 8 μV 0.085 % of reading + 25 μV 0.11 % of reading + 25 μV 0.17 % of reading + 35 μV 0.34 % of reading + 80 μV	Multiproduct Calibrator
AC Voltage – Generate ¹	220 mV to 2.2 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	0.05 % of reading + 80 μV 0.016 % of reading + 25 μV 0.016 % of reading + 6 μV 0.012 % of reading + 16 μV 0.025 % of reading + 70 μV 0.043 % of reading + 130 μV 0.11 % of reading + 350 μV 0.22 % of reading + 850 μV	Multiproduct Calibrator

Electrical – DC/Low Frequency

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Generate ¹	(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	0.05 % of reading + 0.8 mV 0.016 % of reading + 0.25 mV 0.016 % of reading + 0.06 mV 0.012 % of reading + 0.16 mV 0.025 % of reading + 0.35 mV 0.05 % of reading + 1.5 mV 0.13 % of reading + 4.3 mV 0.27 % of reading + 8.5 mV	Multiproduct Calibrator
AC Voltage – Generate ¹ (Subject to 2.2*10 ⁷ V-Hz Limitation)	(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 (15 to 50) Hz 50 Hz to 1 kHz	0.05 % of reading + 8 mV 0.016 % of reading + 2.5 mV 0.016 % of reading + 0.8 mV 0.022 % of reading + 3.5 mV 0.05 % of reading + 8 mV 0.15 % of reading + 90 mV 0.47 % of reading + 90 mV 1.2 % of reading + 190 mV 0.04 % of reading + 16 mV 0.05 % of reading + 4 mV	Multiproduct Calibrator
AC Voltage – Generate ¹ (Subject to 2.2*10 ⁷ V-Hz Limitation)	(220 to 750) V (30 to 50) kHz (50 to 100) kHz (750 to 1 100) V 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.69 mV/V + 13 mV 2.7 mV/V + 53 mV 0.10 mV/V + 9.3 mV 0.19 mV/V + 11 mV 0.69 mV/V + 18 mV	Multiproduct Calibrator with Amplifier
AC Voltage – Measure ¹	(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	0.03 % of reading + 3 μV 0.03 % of reading + 1 μV 0.03 % of reading + 1 μV 0.08 % of reading + 1 μV 0.41 % of reading + 1 μV 3.3 % of reading + 2 μV	Multimeter in synchronous subsampling mode

Electrical – DC/Low Frequency

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Measure ¹	(10 to 100) mV		Multimeter in synchronous subsampled mode
	(1 to 40) Hz	0.007 % of reading + 40 μ V	
	40 Hz to 1 kHz	0.007 % of reading + 20 μ V	
	(1 to 20) kHz	0.012 % of reading + 20 μ V	
	(20 to 50) kHz	0.025 % of reading + 20 μ V	
	(50 to 100) kHz	0.067 % of reading + 20 μ V	
	(100 to 300) kHz	0.26 % of reading + 100 μ V	
	300 kHz to 1 MHz	0.84 % of reading + 100 μ V	
	(1 to 2) MHz	1.3 % of reading + 100 μ V	
	100 mV to 1 V		
	(1 to 40) Hz	0.007 % of reading + 400 μ V	
	40 Hz to 1 kHz	0.007 % of reading + 200 μ V	
	(1 to 20) kHz	0.012 % of reading + 200 μ V	
	(20 to 50) kHz	0.026 % of reading + 200 μ V	
	(50 to 100) kHz	0.067 % of reading + 200 μ V	
	(100 to 300) kHz	0.25 % of reading + 1 mV	
	300 kHz to 1 MHz	0.84 % of reading + 1 mV	
	(1 to 2) MHz	1.3 % of reading + 1 mV	
	(1 to 10) V		
	(1 to 40) Hz	0.007 % of reading + 4 mV	
	40 Hz to 1 kHz	0.007 % of reading + 2 mV	
	(1 to 20) kHz	0.012 % of reading + 2 mV	
	(20 to 50) kHz	0.026 % of reading + 2mV	
	(50 to 100) kHz	0.068 % of reading + 2mV	
	(100 to 300) kHz	0.26 % of reading + 10 mV	
	300 kHz to 1 MHz	0.84 % of reading + 10 mV	
	(1 to 2) MHz	1.3 % of reading + 10 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.017 % of reading + 4 mV	
	40 Hz to 1 kHz	0.017 % of reading + 2 mV	
	(1 to 20) kHz	0.017 % of reading + 2 mV	
	(20 to 50) kHz	0.031 % of reading + 2mV	
	(50 to 100) kHz	0.11 % of reading + 2mV	
	(100 to 300) kHz	0.34 % of reading + 10 mV	
	300 kHz to 1 MHz	1.3 % of reading + 10 mV	
	(100 to 700) V		
	(1 to 40) Hz	0.04 % of reading + 40 mV	
	40 Hz to 1 kHz	0.04 % of reading + 20 mV	
	(1 to 20) kHz	0.06 % of reading + 20 mV	
	(20 to 50) kHz	0.13 % of reading + 20 mV	
	(50 to 100) kHz	0.31 % of reading + 20 mV	

Electrical – DC/Low Frequency

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Measure ¹	(1 to 10) kV (20 to 100) Hz (10 to 20) kV (20 to 100) Hz (20 to 35) kV (rms) (50 to 60) Hz	0.2 % of reading + 0.025 kV 0.6 % of reading + 0.025 kV 0.4 % of reading + 0.11 kV	High Voltage Meter
AC Current Generate ¹	Up to 220 μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 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 (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	0.29 mA/A + 0.020 μ A 0.18 mA/A + 0.013 μ A 0.14 mA/A + 0.011 μ A 0.32 mA/A + 0.015 μ A 1.3 mA/A + 0.075 μ A 0.29 mA/A + 0.084 μ A 0.18 mA/A + 0.064 μ A 0.14 mA/A + 0.064 μ A 0.23 mA/A + 0.14 μ A 1.3 mA/A + 0.75 μ A 0.29 mA/A + 0.84 μ A 0.18 mA/A + 0.64 μ A 0.14 mA/A + 0.64 μ A 0.23 mA/A + 0.81 μ A 1.3 mA/A + 5.8 μ A 0.29 mA/A + 9.2 μ A 0.18 mA/A + 7.2 μ A 0.14 mA/A + 6.7 μ A 0.23 mA/A + 7.2 μ A 1.3 mA/A + 13 μ A 0.30 mA/A + 0.14 mA 0.52 mA/A + 0.12 mA 8.1 mA/A + 0.20 mA	Multiproduct Calibrator
AC Current Generate ¹	(2.2 to 20.5) A 50 Hz to 1 kHz (1 to 5) kHz	0.051 % of reading + 1 mA 0.05 % of reading + 5.8 mA	Multiproduct Calibrator
AC Current Generate ¹	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.53 mA/A + 0.54 mA 1.1 mA/A + 0.67 mA 4.2 mA/A + 1.0 mA	Multiproduct Calibrator with Amplifier

Electrical – DC/Low Frequency

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Generate ¹	(20 to 1 000) A (50 to 400) Hz	0.59 % of reading + 0.04 A	Multiproduct Calibrator w/50 turn coil 5220A
AC Current Measure ¹	(5 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 1 mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (1 to 10) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (10 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (1 to 3) A 3 Hz to 5 kHz (5 to 10) Hz	0.46 % of reading + 0.03 μ A 0.17 % of reading + 0.03 μ A 0.07 % of reading + 0.03 μ A 0.07 % of reading + 0.03 μ A 0.5 % of reading + 0.2 μ A 0.17 % of reading + 0.2 μ A 0.07 % of reading + 0.2 μ A 0.04 % of reading + 0.2 μ A 0.46 % of reading + 2.3 μ A 0.17 % of reading + 2.3 μ A 0.069 % of reading + 2.3 μ A 0.035 % of reading + 2.3 μ A 0.46 % of reading + 23 μ A 0.17 % of reading + 23 μ A 0.069 % of reading + 23 μ A 0.035 % of reading + 23 μ A 0.46 % of reading + 200 μ A 0.18 % of reading + 200 μ A 0.09 % of reading + 200 μ A 0.12 % of reading + 200 μ A 0.12 % of reading + 1.5 mA 0.23 % of reading + 1.6 mA	Multimeter in synchronous subsampled mode
AC Current Measure ¹	(0.001 to 5) A 10 Hz to 5 kHz (5 to 20) A 10 Hz to 5 kHz	0.03 % of reading 0.04 % of reading	Current Shunt
Inductance Measure ¹ 12 Hz to 100 kHz	100 μ H to 10 H	0.4 mH/H	RLC Digibridge

Electrical – DC/Low Frequency

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Generate ¹ 1 kHz	(0.33 to 0.49) nF (0.50 to 1.09) nF (1.10 to 3.29) nF (3.30 to 10.9) nF (11.0 to 32.9) nF (0.01 to 109.9) µF (110 to 329.9) µF (329.9 to 1000) µF (0.33 to 1.09) mF (1.10 to 3.29) mF	3.3 % of reading 1.4 % of reading 0.73 % of reading 0.51 % of reading 0.54 % of reading 0.32 % of reading 0.32 % of reading 0.32 % of reading 0.29 % of reading 0.37 % of reading	Multiproduct Calibrator
Capacitance – Measure/Generate ¹ 1 kHz	10 pF to 1 mF 100 pF to 1.1 µF	0.04 % of reading 0.06 % of reading	RLC Digibridge, Decade Capacitor
Capacitance – Measure/Generate ¹ Fixed Values 1 kHz	(1, 10, 100, 1 000) pF 1 kHz to 5 MHz 5 to 13 MHz	0.1 % of reading 0.4 % of reading	Capacitor Set
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C 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	0.5 °C 0.38 °C 0.34 °C 0.37 °C 0.34 °C 0.29 °C 0.35 °C 0.57 °C 0.95 °C 0.57 °C 0.18 °C 0.16 °C 0.18 °C 0.24 °C 0.31 °C 0.18 °C 0.16 °C 0.19 °C 0.26 °C	Multiproduct Calibrator

Electrical – DC/Low Frequency

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type K		Multiproduct Calibrator
	(-200 to -100) °C	0.37 °C	
	(-100 to -25) °C	0.2 °C	
	(-25 to 120) °C	0.18 °C	
	(120 to 1 000) °C	0.29 °C	
	(1 000 to 1 372) °C	0.45 °C	
	Type N		
	(-200 to -100) °C	0.45 °C	
	(-100 to -25) °C	0.25 °C	
	(-25 to 120) °C	0.22 °C	
	(120 to 410) °C	0.2 °C	
	(410 to 1 300) °C	0.31 °C	
	Type R		
	(0 to 250) °C	0.65 °C	
	(250 to 400) °C	0.4 °C	
	(400 to 1 000) °C	0.37 °C	
	(1 000 to 1 767) °C	0.45 °C	
	Type S		
	(0 to 250) °C	0.53 °C	
	(250 to 1 000) °C	0.41 °C	
	(1 000 to 1 400) °C	0.42 °C	
	(1 400 to 1 767) °C	0.52 °C	
	Type T		
	(-250 to -150) °C	0.71 °C	
	(-150 to 0) °C	0.27 °C	
	(0 to 120) °C	0.18 °C	
	(120 to 400) °C	0.16 °C	
Electrical Calibration of RTD Indicators ¹	Cu 427, 10 Ω		Multiproduct Calibrator
	(-100 to 260) °C	0.3 °C	
	Pt 385, 100 Ω		
	(-200 to 0) °C	0.08 °C	
	(0 to 100) °C	0.08 °C	
	(100 to 400) °C	0.14 °C	
	(400 to 630) °C	0.18 °C	
	(630 to 800) °C	0.25 °C	
	Pt 3926, 100 Ω		
	(-200 to 0) °C	0.05 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 400) °C	0.1 °C	
	(400 to 630) °C	0.12 °C	

Electrical – DC/Low Frequency

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicators ¹	Pt 3916, 100 Ω (-200 to -190) $^{\circ}\text{C}$	0.25 $^{\circ}\text{C}$	Multiproduct Calibrator
	(-190 to 0) $^{\circ}\text{C}$	0.05 $^{\circ}\text{C}$	
	(0 to 300) $^{\circ}\text{C}$	0.08 $^{\circ}\text{C}$	
	(300 to 600) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.23 $^{\circ}\text{C}$	
	Pt 385, 200 Ω (-200 to 100) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.05 $^{\circ}\text{C}$	
	(260 to 600) $^{\circ}\text{C}$	0.14 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.16 $^{\circ}\text{C}$	
	Pt 385, 500 Ω (-200 to 100) $^{\circ}\text{C}$	0.05 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.06 $^{\circ}\text{C}$	
	(260 to 600) $^{\circ}\text{C}$	0.09 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	Pt 385, 1 k Ω (-200 to 0) $^{\circ}\text{C}$	0.03 $^{\circ}\text{C}$	
	(0 to 260) $^{\circ}\text{C}$	0.05 $^{\circ}\text{C}$	
	(260 to 600) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.23 $^{\circ}\text{C}$	
	PtNi 385, 100 Ω (-80 to 100) $^{\circ}\text{C}$	0.08 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.14 $^{\circ}\text{C}$	
Oscilloscopes ¹ Rise/Fall Time (10 to 90) %	500 ns to 100 ms	1.6 ps	Oscilloscope Calibrator, Active Head and Multimeter
Sq Wave 50 Ω or 1 M Ω Load impedance – <10 kHz	40 $\mu\text{Vp-p}$ to 1mVp-p	2.5 % of reading	
	1 mVp-p to 5 Vp-p	0.13 % of reading	
Oscilloscopes ¹ Horizontal Deflection	180.1 ps to 55 s	0.4 parts in 10^{-6} s	Oscilloscope Calibrator, Active Head and Multimeter
Vertical Deflection	1 mVp-p to 200 Vp-p	0.05 % of reading	
Oscilloscopes ¹ Bandwidth	100 MHz to 300 MHz	2.4 % of reading	Oscilloscope Calibrator, Active Head and RF Power Sensor
	(300 to 500) MHz	3 % of reading	
	550 MHz to 3 GHz	4.1 % of reading	
	(3 to 26.5) GHz	5.8 % of reading	
	(26.5 to 50) GHz	7 % of reading	

Electrical – RF/Microwave

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Sensors Calibration Factors ^{1,5}	Referenced to 1 mW (9 to 300) kHz 300 kHz to 50 MHz 50 MHz to 5 GHz (5 to 10) GHz (10 to 18) GHz (18 to 26.5) GHz (26 to 27) GHz (27 to 30) GHz (30 to 34) GHz (34 to 40) GHz (40 to 42) GHz (42 to 48) GHz (48 to 50) GHz	1 % 0.94 % 0.55 % 0.57 % 0.6 % 1.6 % 1.9 % 2.0 % 1.9 % 2 % 2.6 % 2.9 % 3.4 %	Coaxial Thermistor and Thermocouple Power Sensors
Tuned RF Power, Relative Measure ¹ 150 kHz to 26.5 GHz	(-30 to 20) dB (-30 to -130) dB	0.21 dB 0.28 dB	Spectrum Analyzer
RF Power Absolute Measure ¹ 100 kHz to 50 GHz	(-70 to -30) dBm (-30 to 20) dBm	0.64 dB 0.22 dB	Power Meter or Measuring Receiver with Power Sensor
RF Power Generate ¹	(-127 to 13) dBm 10 kHz to 20 MHz (-110 to 10) dBm 20 MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	1.2 dB 1.2 dB 1.3 dB 1.9 dB 2.8 dB	Signal Generator
Amplitude Modulation Measure ¹ 50 Hz to 10 kHz 20 Hz to 10 kHz 50 Hz to 10 kHz 20 Hz to 10 kHz	Rate: 150 kHz to 10 MHz Depth: (5 to 99) % Rate: 10 MHz to 1.3 GHz Depth: (5 to 99) %	2.5 % of reading 3.6 % of reading 1.6 % of reading 3.6 % of reading	Measuring Receiver
Amplitude Modulation Measure ¹ 50 Hz to 50 kHz 20 Hz to 100 kHz	Depth: (5 to 99) % 1.3 GHz to 26.5 GHz	3.6 % Depth 3.2 % Depth	Measuring Receiver with Power Sensor

Electrical – RF/Microwave

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation Rejection Measure ¹ 150 kHz to 6.6 GHz (6.6 to 26.5) GHz	Rate: 400 Hz to 1 kHz Depth.: ≤ 50 %	11 Hz 28 Hz	Measuring Receiver
Amplitude Modulation Depth Accuracy Measure ¹ 150 kHz to 10 MHz 10 MHz to 3 GHz 10 MHz to 3 GHz (3 to 26.5) GHz (3 to 26.5) GHz	Rate: 50 Hz to 10 kHz Depth: (5 to 99) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	0.3 % Modulation 0.3 % Modulation 0.4 % Modulation 0.3 % Modulation 0.6 % Modulation	Measuring Receiver
Residuals FM ¹ Bandwidth: 50 Hz to 3 kHz (rms)	150 kHz to 3 GHz (3 to 6.6) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	1.5 Hz 1.9 Hz 2.7 Hz 3.8 Hz	Measuring Receiver
Amplitude Modulation Distortion Measure ¹ 150 kHz to 18 GHz (18 to 26.5) GHz (18 to 26.5) GHz	(5 to 99) % Depth (5 to 50) % Depth (50 to 95) % Depth	0.21 % Depth 0.5 % Depth 0.6 % Depth	Measuring Receiver
Amplitude Modulation Flatness ¹ 10 MHz to 26.5 GHz	Rate: (9 Hz to 10 kHz) Depth: (5 to 99) %	0.17 % Depth	Measuring Receiver
Amplitude Modulation Flatness ¹ 10 MHz to 26.5 GHz	Rate: (9 Hz to 10 kHz) Depth: (5 to 99) %	0.6 % Modulation	Measuring Receiver
Frequency Modulation Rejection Measure ¹ 150 kHz to 10 MHz 10 MHz to 26.5 GHz	Rate: 400 HZ to 1 kHz Dev.: ≤ 5 kHz peak Dev.: ≤ 50 kHz peak	0.21 % Deviation 0.21 % Deviation	Measuring Receiver
Residuals AM ¹ (rms)	150 kHz to 26.5 GHz	0.17 % of reading	Measuring Receiver

Electrical – RF/Microwave

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation Deviation Accuracy Measure ¹ 250 kHz to 10 MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 10 kHz Dev: ≤ 40 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz	0.2 % Modulation 0.3 % Modulation 0.4 % Modulation 0.5 % Modulation	Measuring Receiver
Frequency Modulation Measure ¹ 20 Hz to 100 kHz 50 Hz to 100 kHz	Rate: (1.3 to 26.5 GHz)	7.7 % of reading 1.3 % of reading	Measuring Receiver with Power Sensor
Harmonic Measurements ¹	30 Hz to 50 GHz	1.5 dB	Spectrum Analyzer
Phase Modulation ¹ 200 Hz to 20 kHz 200 Hz to 20 kHz	Rate: 10 MHz to 1.3 GHz Rate: (1.3 to 26.5) GHz	3.6 % of reading 4.7 % of reading	Measuring Receiver, Power Sensor
Distortion – Measure ¹ (50 to 500) kHz	(0 to 99.9) dB 20 Hz to 20 kHz (20 to 100) kHz	1.3 dB 2.4 dB	Audio Analyzer
Phase Modulation Measure ¹ 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 200 kHz Deviation: > 0.7 Rad Deviation: > 0.3 Rad Rate: 20 Hz to 200 kHz Deviation: > 2 Rad Deviation: > 0.6 Rad Rate: 20 Hz to 200 kHz Deviation: > 4 Rad Deviation: > 1.2 Rad	0.2 % Modulation 0.3 % Modulation 0.2 % Modulation 0.3 % Modulation 0.2 % Modulation 0.3 % Modulation	Measuring Receiver

Electrical – RF/Microwave

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AM Rejection Measure ¹ 100 kHz to 26.5 GHz	Rate: 50 Hz to 3 kHz Deviation: > 50 % AM at 1 kHz Rate	0.004 Rad	Measuring Receiver
Phase Residuals ¹ – Measure (rms) 100 kHz to 26.5 GHz	(0.1 to 25 000) Rad Rate: 50 Hz to 3 kHz	0.008 Rad	Measuring Receiver
Phase Distortion ¹ 150 kHz to 26.5 GHz	(0.1 to 25 000) Rad Bandwidth: 20 Hz to 250kHz	0.47 % of reading	Measuring Receiver

Length – Dimensional Metrology

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 6 in Up to 12 in Up to 24 in Up to 48 in	(300 + 2.4L) μin (360 + 2.4L) μin (450 + 2.4L) μin (510 + 2.4L) μin	Gage Blocks
Height Gages ^{1,2}	(0.10 to 48) in	(48 μin + 10L) μin	Gage Blocks
External Threads, Pitch Diameter ² All English and Metric 60° Threads	(0.01 to 4) in	(61 + 1.2L) μin	Universal length measuring machine and thread wires; three-wire method, gage blocks
Internal Threads ²	(0.1 to 4) in	(66 + 1.2L) μin	Universal length measuring machine, gage blocks
Indicators ¹ Resolution 20μin 50μin 100μin	(0.1 to 4) in	14 μin 30 μin 74 μin	Gage blocks
Micrometers ^{1,2} Resolution 100μin 50μin	(0.1 to 48) in	(66 + 10L) μin (32 + 10L) μin	Gage blocks
Cylindrical Plug/Pin Gages ²	(0.012 to 2.00) in	(12+ 0.34L) μin	Universal Length measuring machine, gage blocks
Rigid Rules & Tape Measures	Up to 72 in	7 300 μin	Gage blocks

Length – Dimensional Metrology

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks ²	Up to 6 in (6 in to 12) in	$(2.1 + 0.5L) \mu\text{in}$ $(5.9 + 1.6L) \mu\text{in}$	Universal length measuring machine, gage blocks
Cylindrical Rings ²	(0.020 to 1) in (1 to 14) in	$(9 + 0.8L) \mu\text{in}$ $(12 + 0.8L) \mu\text{in}$	Universal length measuring machine, gage blocks
Inspection Gages ² “Riser Block” “Angle Block” “Straight Edges” “Bar Parallels” “Fixtures”	Up to 24 in Up to 40 in	$(15 + 1.5L) \mu\text{in}$ $(25 + 1.5L) \mu\text{in}$	Universal Length Measuring Machine, Electric Comparator, Gauge Block, Granite Surface Plate, Profile Projector, hand tools

Mass and Mass Related

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure measuring equipment and transmitters ¹	(-15 to -0.5) psi (0.5 to 300) psi	0.06 % of reading	Pressure Calibrator
Pressure measuring equipment and transmitters ¹	(0.02 to 1 000) psia	0.003 3 % of reading or 0.000 4 psi, whichever is greater	Deadweight Tester and Pressure Calibrator
Pressure measuring equipment and transmitters ¹	(0.02 to 12 140) psig	0.007 % of reading	Deadweight Tester and Pressure Calibrator
Pressure measuring equipment and transmitters ¹	(0.001 to 40 000) psig	0.2 % of reading	Digital Pressure Gage
Torque Tools ¹	(10 to 320) ozf·in (20 to 250) lbf·in (20 to 2 000) lbf·ft	0.3 % of reading 0.4 % of reading 0.5 % of reading	Torque System
Torque Testers and Analyzers	(0.01 to 500) lbf·in (50 to 500) lbf·ft	0.005 1 % + 0.000 026 lbf.in 0.005 2 % of reading	Standard Weights and Torque Arm
POVA (Piston/Plunger Operated Volumetric Apparatus) ¹ Pipettes, Syringes, Dilutors, Titrators, Piston/Displacement Burettes (Burets), Dispensers, Liquid Handlers	(0.1 to 5) μl (5 to 20) μl (20 to 50) μl (50 to 100) μl (100 to 200) μl (200 to 500) μl (0.5 to 1) ml (1 to 5) ml (5 to 10) ml	0.23 μl 0.031 μl 0.061 μl 0.12 μl 0.24 μl 0.59 μl 1.2 μl 2.4 μl 12 μl	Gravimetric Method referenced to ASTM Class 1 Mass Standard and Balances

Mass and Mass Related

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Volumetric Glassware ¹ Volumetric Apparatus, Flasks, Burettes, Volumetric Dispensers, Cylinders, Graduated Cylinders, Beakers, Vials, & Containers	(0.1 to 2) ml (2 to 25) ml (25 to 50) ml (50 to 100) ml (100 to 250) ml (250 to 500) ml (500 to 1 000) ml (1 000 to 2 000) ml	0.29 % of reading 0.12 % of reading 0.1 % of reading 0.08 % of reading 0.06 % of reading 0.04 % of reading 0.03 % of reading 0.03 % of reading	Gravimetric Method referenced to OIML Class E1 Mass Standard and Balances
Scales and Balances ^{1,3}	Up to 500 mg Up to 200 g Up to 1 000 g Up to 5 000 g Up to 20 kg Up to 100 kg	4 µg 0.07 mg 0.8 mg 3.9 mg 4 mg 19 mg	Class E2 weights
	Up to 1 000 lb	0.32 lb	Class E2 weights
Mass	(1 to 500) mg (0.5 to 1) g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 5 kg (5 to 50) kg	0.004 mg 0.004 mg 0.005 mg 0.007 mg 0.011 mg 0.011 mg 0.024 mg 0.026 mg 0.04 mg 0.7mg 3.9 mg 12 mg	Double Substitution using Class E2 Weights
Liquid Flow Measure Flow Rate – Mass DN15 Pipe Size	(300 to 6 000) kg/h	0.11 % of reading	Flow Meter
Gas Flow Meter	(15 to 50 000) sccm	0.31 % of reading	Standard Flow Meter
Force Compression and Tension ¹	(3 to 100 000) lbf	0.006 % of reading	Load Cell

Mass and Mass Related

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Durometers (Types A, B, E & O) Indenter Dimensions Length	Up to 2.5 mm	0.001 6 mm	Partial Direct Verification Durometer Calibrator, Standard Gage Block Set
Spring Force	Up to 8.5 N	0.05 N	
(Types C, D, DO) Indenter Dimensions Length	Up to 2.5 mm	0.001 6 mm	
Spring Force	Up to 44.5 N	0.26 N	

Thermodynamic

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature ¹ Source & Measure	(-200 to 660) °C	0.03 °C	Comparison to Platinum Resistance Thermometers Probe & Direct Measure
Humidity Measuring Equipment ¹	(10 to 95) %RH	0.59 %RH	Humidity Chamber

Time and Frequency

Orange, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	10 MHz	6×10^{-12} Hz/Hz	GPS Receiver
	0.1 Hz to 225 MHz	2.3×10^{-11} Hz/Hz	GPS Receiver, Counter
	100 MHz to 5 GHz	2.3×10^{-11} Hz/Hz	
	500 MHz to 26.5 GHz	1.4×10^{-11} Hz/Hz	
Frequency – Generate ¹	0.01 Hz to 10 MHz	5.7×10^{-11} Hz/Hz	GPS Receiver, Signal Generator
	10 MHz to 50.0 GHz	1.1×10^{-11} Hz/Hz	
Photo Tachometer ¹	(0 to 100 000) rpm	0.001 6 rpm + 0.000 17 % of reading	Signal Generator with Lamp

[Return to Site listing \(top\)](#) [Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

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CALIBRATION

Chemical Quantities

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters ^{1,4}	10 μ S/cm 100 μ S/cm 1000 μ S/cm 1 413 μ S/cm 10 000 μ S/cm 100 000 μ S/cm	0.56 μ S/cm 2.3 μ S/cm 6.7 μ S/cm 8.1 μ S/cm 62 μ S/cm 590 μ S/cm	Standard Conductivity Solutions
pH Meters ^{1,4}	(4, 7, 10) pH	0.014 pH	Standard pH Solutions

Electrical – DC/Low Frequency

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage Generate ¹	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	8 μ V/V + 2 μ V 5 μ V/V + 3 μ V 4 μ V/V + 5 μ V 4 μ V/V + 8 μ V 5 μ V/V + 62 μ V 7 μ V/V + 470 μ V	Multiproduct Calibrator
DC Voltage Generate ¹ Fixed Values	10 V 1.018 V 1.0 V	1.2 μ V/V 1.6 μ V/V 1.6 μ V/V	DC Reference Standard
DC Voltage Measure ¹	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1 000) V	11 μ V/V + 6 μ V 10 μ V/V + 2 μ V 10 μ V/V + 2 μ V 12 μ V/V + 2 μ V 12 μ V/V + 6 μ V	Multimeter
	(0.1 to 10) kV (10 to 100) kV	0.35 mV/V + 0.58 V 0.58 mV/V + 0.67 V	High Voltage Meter

Electrical – DC/Low Frequency

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current Generate ¹	(0 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	40 μ A/A + 6 nA 35 μ A/A + 7 nA 35 μ A/A + 40 nA 47 μ A/A + 0.7 μ A 98 μ A/A + 12 μ A	Multiproduct Calibrator
	(-11 to -0.1) A (0.1 to 11) A	1.7 mA/A	Multiproduct Calibrator
	(2 to 20) A	0.15 % of reading + 1 mA	Multiproduct Calibrator
	(11 to 16.5) A (16.5 to 110) A (110 to 550) A	4.9 mA/A + 58 mA 12 mA/A + 59 mA 24 mA/A + 63 mA	Multiproduct Calibrator 5220A w/50 turn coil
DC Current Measure ¹	1 pA to 100 nA 100 nA to 1 μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	36 μ A/A + 50 pA 25 μ A/A + 50 pA 25 μ A/A + 0.12 μ A 25 μ A/A + 1 nA 25 μ A/A + 7 nA 25 μ A/A + 68 nA 41 μ A/A + 0.7 μ A 0.13 mA/A + 14 μ A	Multimeter
	(1 to 100) A	12 mA	Multimeter with Current Shunt
Resistance Generate ¹ Fixed Points	(1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω (1 to 10) G Ω 10 G Ω to 1 T Ω	0.03 % of reading 0.1 % of reading 0.2 % of reading 0.5 % of reading 1 % of reading	Standard Resistors
Resistance Generate ¹ Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω	50 $\mu\Omega$ 96 $\mu\Omega$ 190 $\mu\Omega$ 240 $\mu\Omega$ 460 $\mu\Omega$ 1.3 m Ω 2.4 m Ω 11 m Ω 21 m Ω 110 m Ω 210 m Ω 1.3 Ω 2.5 Ω	Multiproduct Calibrator

Electrical – DC/Low Frequency

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance Generate ¹ Fixed Points	1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	22 Ω 45 Ω 440 Ω 1.1 kΩ 11 kΩ	Multiproduct Calibrator
Resistance Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	18 μΩ/Ω + 68 μΩ 15 μΩ/Ω + 0.7 mΩ 13 μΩ/Ω + 0.7 mΩ 13 μΩ/Ω + 7 mΩ 13 μΩ/Ω + 68 mΩ 18 μΩ/Ω + 5 Ω 61 μΩ/Ω + 140 Ω 580 μΩ/Ω + 2 kΩ 5.8 mΩ/Ω + 14 kΩ	Multimeter
AC Voltage Generate ¹	(0.2 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	240 μV/V + 4 μV 90 μV/V + 4 μV 80 μV/V + 4 μV 200 μV/V + 4 μV 500 μV/V + 5 μV 1.1 mV/V + 10 μV 1.4 mV/V + 20 μV 2.7 mV/V + 20 μV 240 μV/V + 4 μV 90 μV/V + 4 μV 80 μV/V + 4 μV 200 μV/V + 4 μV 500 μV/V + 5 μV 1.1 mV/V + 10 μV 1.4 mV/V + 20 μV 2.7 mV/V + 20 μV	Multiproduct Calibrator

Electrical – DC/Low Frequency

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Generate ¹	(22 to 220) mV		Multiproduct Calibrator
	(10 to 20) Hz	240 $\mu\text{V/V} + 12 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 8 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 8 \mu\text{V}$	
	(20 to 50) kHz	210 $\mu\text{V/V} + 10 \mu\text{V}$	
	(50 to 100) kHz	460 $\mu\text{V/V} + 22 \mu\text{V}$	
	(100 to 300) kHz	0.9 mV/V + 26 μV	
	(300 to 500) kHz	1.4 mV/V + 30 μV	
	500 kHz to 1 MHz	2.7 mV/V + 48 μV	
	(220 mV to 2.2 V)		
	(10 to 20) Hz	300 $\mu\text{V/V} + 53 \mu\text{V}$	
	(20 to 40) Hz	100 $\mu\text{V/V} + 23 \mu\text{V}$	
	40 Hz to 20 kHz	46 $\mu\text{V/V} + 9 \mu\text{V}$	
	(20 to 50) kHz	83 $\mu\text{V/V} + 12 \mu\text{V}$	
	(50 to 100) kHz	120 $\mu\text{V/V} + 33 \mu\text{V}$	
	(100 to 300) kHz	500 $\mu\text{V/V} + 95 \mu\text{V}$	
	(300 to 500) kHz	1 mV/V + 240 μV	
	500 kHz to 1 MHz	1.7 mV/V + 460 μV	
	(2.2 to 22) V		
	(10 to 20) Hz	300 $\mu\text{V/V} + 530 \mu\text{V}$	
	(20 to 40) Hz	100 $\mu\text{V/V} + 180 \mu\text{V}$	
	40 Hz to 20 kHz	46 $\mu\text{V/V} + 61 \mu\text{V}$	
	(20 to 50) kHz	83 $\mu\text{V/V} + 120 \mu\text{V}$	
	(50 to 100) kHz	110 $\mu\text{V/V} + 240 \mu\text{V}$	
	(100 to 300) kHz	390 $\mu\text{V/V} + 790 \mu\text{V}$	
	(300 to 500) kHz	1 mV/V + 2.3 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.6 mV	
	(22 to 220) V		
	(10 to 20) Hz	300 $\mu\text{V/V} + 5.3 \text{ mV}$	
	(20 to 40) Hz	100 $\mu\text{V/V} + 1.8 \text{ mV}$	
	40 Hz to 20 kHz	52 $\mu\text{V/V} + 0.7 \text{ mV}$	
	(20 to 50) kHz	87 $\mu\text{V/V} + 1.1 \text{ mV}$	
	(50 to 100) kHz	150 $\mu\text{V/V} + 3 \text{ mV}$	
	(100 to 300) kHz	1 mV/V + 16 mV	
	(300 to 500) kHz	4.5 mV/V + 40 mV	
	500 kHz to 1 MHz	8 mV/V + 80 mV	
	(220 to 1 100) V		
	(15 to 50) Hz	350 $\mu\text{V/V} + 16 \text{ mV}$	
	50 Hz to 1 kHz	70 $\mu\text{V/V} + 3.5 \text{ mV}$	

Electrical – DC/Low Frequency

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Measure ¹	(1 to 10) mV		Multimeter in synchronous sub-sampled mode
	(1 to 40) Hz	350 μ V/V + 7.7 μ V	
	40 Hz to 1 kHz	240 μ V/V + 7 μ V	
	(1 to 20) kHz	350 μ V/V + 7 μ V	
	(20 to 50) kHz	1.2 mV/V + 7 μ V	
	(50 to 100) kHz	5.8 mV/V + 7 μ V	
	(100 to 300) kHz	46 mV/V + 7.3 μ V	
	(10 to 100) mV		
	(1 to 40) Hz	88 μ V/V + 4.6 μ V	
	40 Hz to 1 kHz	88 μ V/V + 2.3 μ V	
	(1 to 20) kHz	170 μ V/V + 2.3 μ V	
	(20 to 50) kHz	350 μ V/V + 2.3 μ V	
	(50 to 100) kHz	920 μ V/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 10 V		
	(1 to 40) Hz	88 μ V/V + 460 μ V	
	40 Hz to 1 kHz	88 μ V/V + 230 μ V	
	(1 to 20) kHz	160 μ V/V + 230 μ V	
	(20 to 50) kHz	350 μ V/V + 230 μ V	
	(50 to 100) kHz	920 μ V/V + 230 μ V	
	(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	230 μ V/V + 4.6 mV	
	40 Hz to 1 kHz	230 μ V/V + 2.3 mV	
	1 kHz to 20 kHz	230 μ V/V + 2.3 mV	
	(20 to 50) kHz	410 μ V/V + 2.3 mV	
	(50 to 100) kHz	1.4 mV/V + 2.3 mV	
	(100 to 300) kHz	4.6 mV/V + 12 mV	
	300 kHz to 1 MHz	18 mV/V + 12 mV	
	(100 to 1 000) V		
	(1 to 40) Hz	460 μ V/V + 47 mV	
	40 Hz to 1 kHz	460 μ V/V + 24 mV	
	(1 to 20) kHz	690 μ V/V + 24 mV	
	(20 to 50) kHz	1.4 mV/V + 24 mV	
	(50 to 100) kHz	3.5 mV/V + 24 mV	

Electrical – DC/Low Frequency

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Measure ¹	Up to 1 kV (50 to 60) Hz 100 Hz 400 Hz (1 to 10) kV (50 to 60) Hz (10 to 75) kV (50 to 60) Hz	1.2 mV/V + 0.9 V 12 mV/V + 1 V 4.7 mV/V + 0.62 V 1.2 mV/V + 0.58 V 1.2 mV/V + 0.9 V	High Voltage Meter
AC Current Generate ¹	(10 to 220) μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 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 (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	250 μ A/A + 16 nA 160 μ A/A + 10 nA 120 μ A/A + 8 nA 280 μ A/A + 12 nA 1.1 mA/A + 65 nA 250 μ A/A + 40 nA 160 μ A/A + 35 nA 120 μ A/A + 35 nA 200 μ A/A + 110 nA 1.1 mA/A + 650 nA 250 μ A/A + 400 nA 160 μ A/A + 350 nA 120 μ A/A + 350 nA 200 μ A/A + 550 nA 1.1 mA/A + 5 μ A 250 μ A/A + 4 μ A 160 μ A/A + 4 μ A 120 μ A/A + 3 μ A 200 μ A/A + 4 μ A 1.1 mA/A + 10 μ A 260 μ A/A + 35 μ A 450 μ A/A + 80 μ A 7 mA/A + 160 μ A	Multiproduct Calibrator
AC Current Generate ¹	(2.2 to 20.5) A 50 Hz to 1 kHz (1 to 5) kHz	0.051 % of reading + 1 mA 0.05 % of reading + 5.8 mA	Transconductance Amplifier

Electrical – DC/Low Frequency

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Generate ¹	(11 to 1000) A (45 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz	13 mA/A + 0.13 A 42 mA/A + 0.15 A 233 mA/A + 0.18 A	Multiproduct Calibrator w/50 turn coil
AC Current Measure ¹	(0 to 100) μ A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 100 μ A to 1 mA (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 (50 to 100) kHz (1 to 10) mA (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 (50 to 100) kHz (10 to 100) mA (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 (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	4.6 mA/A + 0.035 μ A 1.7 mA/A + 0.035 μ A 0.7 mA/A + 0.035 μ A 0.7 mA/A + 0.035 μ A 4.6 mA/A + 0.23 μ A 1.7 mA/A + 0.23 μ A 0.7 mA/A + 0.23 μ A 0.4 mA/A + 0.23 μ A 0.7 mA/A + 0.23 μ A 4.6 mA/A + 0.46 μ A 6.4 mA/A + 1.7 μ A 4.6 mA/A + 2.3 μ A 1.7 mA/A + 2.3 μ A 0.7 mA/A + 2.3 μ A 0.4 mA/A + 2.3 μ A 0.7 mA/A + 2.3 μ A 4.6 mA/A + 4.6 μ A 6.4 mA/A + 17 μ A 4.6 mA/A + 23 μ A 1.7 mA/A + 23 μ A 0.7 mA/A + 23 μ A 0.4 mA/A + 23 μ A 0.7 mA/A + 23 μ A 4.6 mA/A + 46 μ A 6.4 mA/A + 0.17 mA 4.6 mA/A + 0.23 mA 1.8 mA/A + 0.23 mA 0.9 mA/A + 0.23 mA 1.2 mA/A + 0.23 mA 3.5 mA/A + 0.23 mA 12 mA/A + 0.46 mA	Multimeter in synchronous sub-sampled mode

Electrical – DC/Low Frequency

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Measure ¹	(0.001 to 100) A 45 Hz to 5 kHz	3.2 mA	Shunt with Multimeter
Capacitance – Source ¹ 50 Hz to 1 kHz	(0.19 to 0.5) nF (0.5 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (0.33 to 1.1) µF (1.1 to 3.3) µF (3.3 to 11) µF (11 to 33) µF (33 to 110) µF (110 to 330) µF (0.33 to 1.1) mF	3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 78 pF 1.9 mF/F + 233 pF 1.9 mF/F + 0.78 nF 2.7 mF/F + 2.3 nF 2.7 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.9 mF/F + 78 nF 5.4 mF/F + 233 nF 7.8 mF/F + 0.26 µF	Multiproduct Calibrator
Electrical Calibration of Thermocouple Indicators ¹	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 L (-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.4 °C 0.17 °C 0.16 °C 0.17 °C 0.2 °C 0.24 °C 0.17 °C 0.16 °C 0.18 °C 0.21 °C 0.28 °C 0.18 °C 0.17 °C 0.23 °C 0.33 °C 0.31 °C 0.23 °C 0.18 °C	Multiproduct Calibrator

Electrical – DC/Low Frequency

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type N		Multiproduct Calibrator
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type B		
	(600 to 800) °C	0.50 °C	
	(800 to 1 000) °C	0.38 °C	
	(1 000 to 1 550) °C	0.34 °C	
	(1 550 to 1 820) °C	0.37 °C	
	Type C		
	(0 to 150) °C	0.34 °C	
	(150 to 650) °C	0.29 °C	
	(650 to 1 000) °C	0.35 °C	
	(1 000 to 1 800) °C	0.57 °C	
	(1 800 to 2 316) °C	0.95 °C	
	Type S		
	(0 to 250) °C	0.38 °C	
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	
	Type T		
	(-250 to -150) °C	0.5 °C	
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U		
	(-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	
Electrical Calibration of RTD Indicators ¹	Cu 427, 10 Ω		Multiproduct Calibrator
	(-100 to 260) °C	0.23 °C	
	PtNi 385, 120 Ω (Ni120)		
	(-80 to 0) °C	0.062 °C	
	(0 to 100) °C	0.062 °C	
	(100 to 260) °C	0.11 °C	

Electrical – DC/Low Frequency

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicators ¹	Pt 385, 100 Ω		Multiproduct Calibrator
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.031 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	

Electrical – DC/Low Frequency

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicators ¹	Pt 385, 500 Ω		Multiproduct Calibrator
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.039 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.062 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.085 °C	
	Pt 385, 1 k Ω		
	(-200 to -80) °C	0.023 °C	
	(-80 to 0) °C	0.023 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.054 °C	
	(400 to 600) °C	0.054 °C	
	(600 to 630) °C	0.18 °C	
Magnetic Flux Density – Measure	(790 to 18 300) G	0.024 % of reading	Gauss Meter
Oscilloscopes ^{1,2}			Multiproduct Calibrator
Level Sine Amp 50 kHz ref.	5 mVp-p to 5 Vp-p	2 % of reading + 300 μ V	
Level Sine Flatness relative to 50 kHz reference	5 mV to 5.5 V		
	50 kHz to 100 MHz	3.5 % of reading + 300 μ V	
	(100 to 300) MHz	4 % of reading + 300 μ V	
Square Wave 1 M Ω , 100 Hz 50 Ω , 1 kHz	(300 to 600) MHz	6 % of reading + 300 μ V	
	1 mVp-p to $\pm$ 130 Vp-p	0.1 % of reading + 40 μ V	
	$\pm$ 1 mVp-p to 6.6 Vp-p	0.25 % of reading + 40 μ V	
Time Marker Output ² Into 50 Ω	2 ns to 20 ms	(25 + 1 000 <i>t</i>) parts in 10 ⁶	
	50 ms to 5 s	25 parts in 10 ⁶ of reading	
Pulse Rise Time 0.5 Vp-p, 1 Vp-p 1 Vp-p	10 MHz	100 ps	
	1 MHz	100 ps	

Electrical – RF/Microwave

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Measure ¹ 9 kHz to 6 GHz (6 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 33) GHz (33 to 40) GHz (40 to 45) GHz (45 to 50) GHz	(-70 to 44) dBm	0.19 dB 0.23 dB 0.26 dB 0.3 dB 0.37 dB 0.37 dB 0.53 dB 0.54 dB	Power Meter, Measuring Receiver, Power Sensors, Spectrum Analyzer
RF Tuned Power - Measure ¹ 100 kHz to 2.6 GHz (2.6 to 6) GHz (6 to 10) GHz (10 to 18) GHz (18 to 26.5) GHz	(-117 to 30) dB	0.2 dB 0.27 dB 0.28 dB 0.29 dB 0.36 dB	Measuring Receiver, Power Sensor
Amplitude Modulation – Measure ¹ AM Depth Accuracy 100 kHz to 10 MHz (Rate: 50 Hz to 10 kHz) 10 MHz to 3 GHz (Rate: 50 Hz to 100 kHz) (3 to 26.5) GHz (Rate: 50 Hz to 100 kHz) Flatness 10 MHz to 3 GHz (Rate: 90 Hz to 10 kHz) (3 to 26.5) GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) % Depth: (20 to 99) % Depth: (5 to 20) % Depth: (20 to 99) % Depth: (5 to 20) % Depth: (5 to 99) % Depth: (5 to 99) %	0.91 % of reading 0.61 % of reading 3 % of reading 1.8 % of reading 5.5 % of reading 0.37 % of reading 0.49 % of reading	Measuring Receiver

Electrical – RF/Microwave

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹ FM Rejection (50 Hz to 3 kHz BW) 250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz) 10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz) Residual AM 250 kHz to 26.5 GHz	Depths: < 50% Deviations: < 5 kHz Depths: < 50% Deviations: < 50 kHz (50 Hz to 3 kHz BW)	0.17 % Depth 0.44 % Depth 0.012 % (rms)	Measuring Receiver
Frequency Modulation – Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz (Rate: 20 Hz to 200 kHz) AM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: 200 Hz to 400 kHz AM Depths: ≤ 50% (Rate: 400 Hz or 1 kHz)	1.3 % of reading 13 Hz 25 Hz 49 Hz	Measuring Receiver
Frequency Modulation – Measure ¹ Residual AM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	(50 Hz to 3 kHz BW)	1.9 Hz 3.7 Hz 7.4 Hz	Measuring Receiver
Phase Modulation – Measure ¹ PM Deviation Accuracy 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz AM Rejection (50 Hz to 3 kHz BW) 100 kHz to 26.5 GHz	Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad AM Depths: ≤ 50% (Rate: 1 kHz)	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad	Measuring Receiver, Power Sensor

Electrical – RF/Microwave

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Measure ¹ Residual AM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	50 Hz to 3 kHz BW	0.002 1 rad 0.004 1 rad 0.008 1 rad	Measuring Receiver, Power Sensor
Distortion – Measure ¹ 20 Hz to 20 kHz 20 Hz to 50 kHz (50 to 100) kHz	80 kHz BW: -80 dB 500 kHz BW: -70 dB 500 kHz BW: -65 dB	0.15 dB 0.17 dB 0.17 dB	Audio Analyzer
Harmonic Measurements ¹	30 Hz to 50 GHz	1 dB	Spectrum Analyzer

Length – Dimensional Metrology

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 48 in	$(290 + 8.8L) \mu\text{in}$	Gage Blocks
Height Gages ^{1,2}	Up to 48 in	$(29 + 2.3L) \mu\text{in}$	Gage Blocks
Micrometers ^{1,2}	Up to 1 in (1 to 48) in	$(7.4 + 8.8L) \mu\text{in}$ $(20 + 13L) \mu\text{in}$	Gage blocks, Optical Parallels
Micrometer Standards / Setting Rod ²	Up to 10 in	$(23 + 1L) \mu\text{in}$	Supermicrometer®, Gage blocks
Indicators ^{1,2} Dial Gauge, Dial Test Indicator, LVDTs	(0.000 1 to 4) in	$(2.6 + 2.8L) \mu\text{in}$	Gage Block, Comparator Stand, LMS
Length Measuring Systems ^{1,2} (Lab Master, Length Measuring Machine, Block Comparator, etc.) Linearity Force	Up to 4 in Up to 48 ozf	$(2.3 + 1L) \mu\text{in}$ 0.12 % of reading + 0.015 ozf	Standard Gage Blocks Standard Load Cell
Thread Plug Gages Major Diameter Simple Pitch Diameter	(0.04 to 10) in (0.04 to 10) in	$(25 + 1.3L) \mu\text{in}$ $(59 + 2.3L) \mu\text{in}$	Supermicrometer®, Gage blocks, Master Plug, Thread Measuring Wires
Cylindrical Plug/Pin Gages ²	Up to 4 in	25 μin	Supermicrometer®, Gage blocks

Length – Dimensional Metrology

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Cylindrical Ring Gages	(0.04 to 10) in	$(64 + 3.6L) \mu\text{in}$	Universal Measuring Machine, Gage blocks
Thread Ring Gages Minor Diameter Simple Pitch Diameter	(0.1 to 6) in (0.1 to 6) in	$(60 + 2.8L) \mu\text{in}$ $(64 + 4L) \mu\text{in}$	Universal Measuring Machine, Gage blocks,
Rigid Rules & Tape Measures	Up to 72 in	0.007 3 in	Gage blocks
Optical Comparators / Vision Systems and Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 12 in	200 μin	Glass scales and gage blocks
Surface Plates ¹ Local Area Flatness Only (Repeat Reading)	Up to 0.001 in	19 μin	Repeat-o-Meter
Gage Block – Length ²	0.01 to 6 in (6 to 12) in	$(4.6 + 0.5L) \mu\text{in}$ $(5.2 + 1.5L) \mu\text{in}$	Gage blocks, Gage Block Comparator

Mass and Mass Related

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure ¹	(-14.5 to 0) psi (0 to 100) psi (100 to 1 000) psi (1000 to 10 000) psi	0.065 % of Reading + 0.000 1 psi 0.034 % of Reading + 0.000 1 psi 0.034 % of Reading 0.057 % of Reading	Fluke pressure calibration system
Torque Tools ¹	(10 to 100) lbf·in (10 to 100) lbf·ft (100 to 1 000) lbf·ft	0.12 % of reading + 0.013 lbf·in 0.12 % of reading + 0.013 lbf·ft 0.13 % of reading	Torque System

Mass and Mass Related

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass	(1 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 5 kg (5 to 10) kg (10 to 20) kg (20 to 31) kg	4 µg 4 µg 9 µg 13 µg 16 µg 21 µg 49 µg 75 µg 140 µg 180 µg 0.42 mg 12 mg 20 mg 36 mg	Standard Weight and Electronic Balance
Scales and Balances ^{1,3} (Platform & Spring)	(1 to 2 000) mg (2000 to 20) g (20 to 200) g (200 to 1 000) g (1 000 to 5 000) g (5 to 20) kg (20 to 100) kg	2.6 µg 20 µg 0.04 mg 0.8 mg 2 mg 4 mg 19 mg	Verification with weights
	Up to 1 lb (1 to 2) lb (2 to 5) lb (5 to 10) lb (10 to 50) lb (50 to 100) lb (100 to 200) lb (200 to 300) lb	0.000 12 lb 0.000 14 lb 0.000 27 lb 0.000 97 lb 0.002 7 lb 0.01 lb 0.014 lb 0.018 lb	Verification with weights

Photometry and Radiometry

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power – Measure ¹	(1310, 1550) nm (-60 to 10) dBm	0.16 dB	Optical Power Sensor
Optical Power – Source ¹	(1310, 1550) nm (-60 to 10) dBm	0.16 dB	Optical Power Sensor, Attenuator and Laser Source

Thermodynamic

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature ¹	(-200 to 660) °C	0.04 °C	Thermometer, PRT
Humidity – Measuring Equipment ¹	(10 to 90) %RH	0.9%RH	Humidity Chamber, Humidity Indicator

Time and Frequency

Beaverton, OR

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source ¹	10 MHz	6.2×10^{-12} Hz/Hz	GPS Receiver
Frequency – Source ¹	0.01 Hz to 40 GHz	6.3×10^{-12} Hz/Hz	GPS Receiver, Signal Generator
Frequency – Measure ¹	1 Hz to 26.5 GHz	6.3×10^{-10} Hz/Hz	GPS Receiver, Counter
Photo Tachometer ¹	(0 to 100 000) rpm	0.000 6 % of reading + 0.000 58 rpm	Signal Generator with Lamp

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

Micro Precision Calibration, Inc.

9831 S 51st Street, Suite C-108
Phoenix, AZ 85044
Norma Vazquez 530-268-1860
norma.vazquez@microprecision.com

CALIBRATION

Chemical Quantities

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters ^{1,8}	100 μ S/cm 1 000 μ S/cm 10 000 μ S/cm	2.3 μ S/cm 6.7 μ S/cm 62 μ S/cm	Standard Conductivity Solutions
pH Meters ^{1,8}	(4, 7, 10) pH	0.012 pH	Standard pH Solutions

Electrical – DC/Low Frequency

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	7.5 μ V/V + 0.4 μ V 5 μ V/V + 0.7 μ V 3.5 μ V/V + 2.6 μ V 3.5 μ V/V + 4 μ V 5 μ V/V + 40 μ V 6.5 μ V/V + 0.4 mV	Multi-Function Calibrator
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1 000) V	6 μ V/V + 0.31 μ V 4 μ V/V + 0.31 μ V 4 μ V/V + 0.51 μ V 6 μ V/V + 30 μ V 6 μ V/V + 100 μ V	Multimeter
DC Voltage – Measure ¹ High Voltage	(1 to 10) kV (10 to 70) kV	0.31 mV/V + 0.065 V 0.44 mV/V + 0.2 V	High Voltage Meter
DC Current – Source ¹	(0 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	40 μ A/A + 6 nA 35 μ A/A + 7 nA 35 μ A/A + 40 nA 45 μ A/A + 0.7 μ A 80 μ A/A + 12 μ A	Multi-Function Calibrator
DC Current – Source ¹	(2.2 to 11) A	0.36 mA/A + 0.48 mA	Multi-Function Calibrator with Amplifier

Electrical – DC/Low Frequency

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source ¹	(11 to 20.5) A	775 μ A/A + 590 μ A	Multi-Product Calibrator
DC Current – Source ¹	(10 to 16.5) A (16.5 to 150) A (150 to 1 025) A	2.8 mA/A + 3.0 mA 2.8 mA/A + 25 mA 3 mA/A + 90 mA	Multi-Function Calibrator with 50 turn Coil
DC Current – Measure ¹	(0 to 100) nA 100 nA to 1 μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	30 μ A/A + 40 pA 20 μ A/A + 40 pA 20 μ A/A + 0.10 nA 20 μ A/A + 0.8 nA 20 μ A/A + 5 nA 20 μ A/A + 50 nA 35 μ A/A + 0.5 μ A 0.11 mA/A + 10 μ A	Multimeter
DC Current – Measure ¹	(0.03 to 20) A (20 to 1 000) A	0.2 mA/A 2.9 mA/A + 14 mA	Multimeter with Shunt
Resistance – Source ¹	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 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 (110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω (330 to 1 110) M Ω	31 $\mu\Omega/\Omega$ + 0.78 m Ω 23 $\mu\Omega/\Omega$ + 1.2 m Ω 22 $\mu\Omega/\Omega$ + 1.2 m Ω 22 $\mu\Omega/\Omega$ + 1.6 m Ω 22 $\mu\Omega/\Omega$ + 1.7 m Ω 22 $\mu\Omega/\Omega$ + 16 m Ω 22 $\mu\Omega/\Omega$ + 17 m Ω 22 $\mu\Omega/\Omega$ + 0.16 Ω 22 $\mu\Omega/\Omega$ + 0.17 Ω 25 $\mu\Omega/\Omega$ + 1.6 Ω 25 $\mu\Omega/\Omega$ + 1.7 Ω 47 $\mu\Omega/\Omega$ + 23 Ω 0.1 m Ω/Ω + 39 Ω 0.2 m Ω/Ω + 1.9 k Ω 0.39 m Ω/Ω + 2.3 k Ω 2.3 m Ω/Ω + 78 k Ω 12 m Ω/Ω + 0.39 M Ω	Multi-Product Calibrator
Resistance – Source ¹ Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω	40 $\mu\Omega$ 95 $\mu\Omega$ 0.18 m Ω 0.23 m Ω 0.44 m Ω	Multi-Function Calibrator

Electrical – DC/Low Frequency

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ Fixed Points	100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	1 m Ω 1.9 m Ω 8.5 m Ω 16 m Ω 85 m Ω 0.16 Ω 1.1 Ω 2.1 Ω 20 Ω 40 Ω 0.4 k Ω 0.89 k Ω 10 k Ω	Multi-Function Calibrator
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	15 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 0.5 m Ω 10 $\mu\Omega/\Omega$ + 0.5 m Ω 10 $\mu\Omega/\Omega$ + 5 m Ω 10 $\mu\Omega/\Omega$ + 50 m Ω 15 $\mu\Omega/\Omega$ + 2 Ω 50 $\mu\Omega/\Omega$ + 0.1 k Ω 0.5 m Ω/Ω + 1 k Ω 5 m Ω/Ω + 10 k Ω	Multimeter
AC Voltage – Source ¹	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (2.2 to 22) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.24 mV/V + 4 μ V 90 μ V/V + 4 μ V 80 μ V/V + 4 μ V 0.2 mV/V + 4 μ V 0.5 mV/V + 5 μ V 1.1 mV/V + 10 μ V 1.4 mV/V + 20 μ V 2.7 mV/V + 20 μ V 0.24 mV/V + 4 μ V 90 μ V/V + 4 μ V 80 μ V/V + 4 μ V 0.2 mV/V + 4 μ V 0.5 mV/V + 5 μ V 1.1 mV/V + 10 μ V 1.4 mV/V + 20 μ V 2.7 mV/V + 20 μ V	Multi-Function Calibrator

Electrical – DC/Low Frequency

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(22 to 220) mV		Multi-Function Calibrator
	(10 to 20) Hz	0.24 mV/V + 12 μ V	
	(20 to 40) Hz	90 μ V/V + 7 μ V	
	40 Hz to 20 kHz	80 μ V/V + 7 μ V	
	(20 to 50) kHz	0.2 mV/V + 7 μ V	
	(50 to 100) kHz	0.46 mV/V + 17 μ V	
	(100 to 300) kHz	0.9 mV/V + 20 μ V	
	(300 to 500) kHz	1.4 mV/V + 25 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 45 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.24 mV/V + 40 μ V	
	(20 to 40) Hz	90 μ V/V + 15 μ V	
	40 Hz to 20 kHz	45 μ V/V + 8 μ V	
	(20 to 50) kHz	75 μ V/V + 10 μ V	
	(50 to 100) kHz	0.11 mV/V + 30 μ V	
	(100 to 300) kHz	0.42 mV/V + 80 μ V	
	(300 to 500) kHz	1 mV/V + 0.2 mV	
	500 kHz to 1 MHz	1.7 mV/V + 0.3 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.24 mV/V + 400 μ V	
	(20 to 40) Hz	90 μ V/V + 0.15 mV	
	40 Hz to 20 kHz	45 μ V/V + 50 μ V	
	(20 to 50) kHz	75 μ V/V + 0.1 mV	
	(50 to 100) kHz	0.1 mV/V + 0.2 mV	
	(100 to 300) kHz	0.28 mV/V + 0.6 mV	
	(300 to 500) kHz	1 mV/V + 2 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.24 mV/V + 4 mV	
	(20 to 40) Hz	90 μ V/V + 1.5 mV	
	40 Hz to 20 kHz	52 μ V/V + 0.6 mV	
	(20 to 50) kHz	80 μ V/V + 1 mV	
	(50 to 100) kHz	0.15 mV/V + 2.5 mV	
	(100 to 300) kHz	0.9 mV/V + 16 mV	
	(300 to 500) kHz	4.4 mV/V + 40 mV	
	500 kHz to 1 MHz	8 mV/V + 80 mV	
	(220 to 1 100) V		
	(15 to 50) Hz	0.3 mV/V + 16 mV	
	50 Hz to 1 kHz	70 μ V/V + 3.5 mV	

Electrical – DC/Low Frequency

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure ¹	(0 to 10) mV		Multimeter
	(1 to 40) Hz	0.3 mV/V + 3 μ V	
	40 Hz to 1 kHz	0.2 mV/V + 1.1 μ V	
	(1 to 20) kHz	0.3 mV/V + 1.1 μ V	
	(20 to 50) kHz	1 mV/V + 1.1 μ V	
	(50 to 100) kHz	5 mV/V + 1.1 μ V	
	(100 to 300) kHz	40 mV/V + 2.0 μ V	
	(10 to 100) mV		
	(1 to 40) Hz	70 μ V/V + 4 μ V	
	40 Hz to 1 kHz	70 μ V/V + 2 μ V	
	(1 to 20) kHz	0.14 mV/V + 2 μ V	
	(20 to 50) kHz	0.3 mV/V + 2 μ V	
	(50 to 100) kHz	0.8 mV/V + 2 μ V	
	(100 to 300) kHz	3 mV/V + 10 μ V	
	300 kHz to 1 MHz	10 mV/V + 10 μ V	
	(1 to 2) MHz	15 mV/V + 10 μ V	
	100 mV to 10 V		
	(1 to 40) Hz	70 μ V/V + 0.4 mV	
	40 Hz to 1 kHz	70 μ V/V + 0.2 mV	
	(1 to 20) kHz	0.14 mV/V + 0.2 mV	
	(20 to 50) kHz	0.3 mV/V + 0.2 mV	
	(50 to 100) kHz	0.8 mV/V + 0.2 mV	
	(100 to 300) kHz	3 mV/V + 1 mV	
	300 kHz to 1 MHz	10 mV/V + 1 mV	
	(1 to 2) MHz	15 mV/V + 1 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.2 mV/V + 4 mV	
	40 Hz to 1 kHz	0.2 mV/V + 2 mV	
	1 kHz to 20 kHz	0.2 mV/V + 2 mV	
	(20 to 50) kHz	0.35 mV/V + 2 mV	
	(50 to 100) kHz	1.2 mV/V + 2 mV	
	(100 to 300) kHz	4 mV/V + 10 mV	
	300 kHz to 1 MHz	15 mV/V + 10 mV	
	(100 to 1 000) V		
	(1 to 40) Hz	0.4 mV/V + 40 mV	
	40 Hz to 1 kHz	0.4 mV/V + 20 mV	
	(1 to 20) kHz	0.6 mV/V + 20 mV	
	(20 to 50) kHz	1.2 mV/V + 20 mV	
	(50 to 100) kHz	3 mV/V + 20 mV	
AC Voltage – Measure ¹ High Voltage	(1 to 70) kV (50 to 60) Hz	1 mV/V + 0.7 V	High Voltage Meter

Electrical – DC/Low Frequency

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(10 to 220) μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (0.22 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 (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 + 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 + 35 nA 0.12 mA/A + 35 nA 0.2 mA/A + 110 nA 1.1 mA/A + 0.65 μ A 0.25 mA/A + 400 nA 0.16 mA/A + 350 nA 0.12 mA/A + 350 nA 0.2 mA/A + 550 nA 1.1 mA/A + 5 μ A	Multi-Function Calibrator
AC Current – Source ¹	(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 (0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.25 mA/A + 4 μ A 0.16 mA/A + 3.5 μ A 0.12 mA/A + 2.6 μ A 0.2 mA/A + 3.5 μ A 1.1 mA/A + 10 μ A 0.26 mA/A + 35 μ A 0.45 mA/A + 80 μ A 7 mA/A + 0.16 mA	Multi-Function Calibrator
AC Current – Source ¹	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.46 mA/A + 170 μ A 0.95 mA/A + 380 μ A 3.6 mA/A + 0.75 mA	Multi-Function Calibrator w/Amplifier
AC Current – Source ¹	(10 to 16.5) A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	2.8 mA/A + 3 mA 7.9 mA/A + 3 mA 2.8 mA/A + 25 mA 7.9 mA/A + 27 mA 3 mA/A + 90 mA 8 mA/A + 0.1 A	Multi-Product Calibrator w/50-turn coil

Electrical – DC/Low Frequency

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(0 to 100) μ A		Multimeter
	(10 to 20) Hz	4 mA/A + 0.03 μ A	
	(20 to 45) Hz	1.5 mA/A + 0.03 μ A	
	(45 to 100) Hz	0.6 mA/A + 0.03 μ A	
	100 Hz to 5 kHz	0.6 mA/A + 0.03 μ A	
	100 μ A to 1 mA		
	(10 to 20) Hz	4 mA/A + 0.2 μ A	
	(20 to 45) Hz	1.5 mA/A + 0.2 μ A	
	(45 to 100) Hz	0.6 mA/A + 0.2 μ A	
	100 Hz to 5 kHz	0.31 mA/A + 0.2 μ A	
	(5 to 20) kHz	0.6 mA/A + 0.2 μ A	
	(20 to 50) kHz	4 mA/A + 0.4 μ A	
	(50 to 100) kHz	5.5 mA/A + 1.5 μ A	
	(1 to 10) mA		
	(10 to 20) Hz	4 mA/A + 2 μ A	
	(20 to 45) Hz	1.5 mA/A + 2 μ A	
	(45 to 100) Hz	0.6 mA/A + 2 μ A	
	100 Hz to 5 kHz	0.31 mA/A + 2 μ A	
	(5 to 20) kHz	0.6 mA/A + 2 μ A	
	(20 to 50) kHz	4 mA/A + 4 μ A	
	(50 to 100) kHz	5.5 mA/A + 15 μ A	
	(10 to 100) mA		
	(10 to 20) Hz	4 mA/A + 20 μ A	
	(20 to 45) Hz	1.5 mA/A + 20 μ A	
	(45 to 100) Hz	0.6 mA/A + 20 μ A	
	100 Hz to 5 kHz	0.31 mA/A + 20 μ A	
	(5 to 20) kHz	0.6 mA/A + 20 μ A	
	(20 to 50) kHz	4 mA/A + 40 μ A	
	(50 to 100) kHz	5.5 mA/A + 0.15 mA	
	100 mA to 1 A		
	(10 to 20) Hz	4 mA/A + 0.2 mA	
	(20 to 45) Hz	1.6 mA/A + 0.2 mA	
	(45 to 100) Hz	0.8 mA/A + 0.2 mA	
	100 Hz to 5 kHz	1 mA/A + 0.2 mA	
	(5 to 20) kHz	3 mA/A + 0.2 mA	
	(20 to 50) kHz	10 mA/A + 0.4 mA	
AC Current – Measure ¹	(0.03 to 20) A (1 to 1 000) Hz	0.69 mA/A	Multimeter with Shunt

Electrical – DC/Low Frequency

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ 50 Hz to 1 kHz	(0.19 to 0.4) nF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (0.33 to 1.1) μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 1.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 78 pF 1.9 mF/F + 233 pF 1.9 mF/F + 0.78 nF 1.9 mF/F + 2.3 nF 1.9 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.5 mF/F + 78 nF 3.5 mF/F + 233 nF 3.5 mF/F + 0.78 μ F 3.5 mF/F + 2.3 μ F 3.5 mF/F + 7.8 μ F 5.8 mF/F + 23 μ F 8.5 mF/F + 78 μ F	Multi-Product Calibrator
Capacitance – Measure ¹ 12 Hz to 100 kHz	Up to 1 000 μ F	1.4 mF/F + 0.000 58 pF	RLC Digibridge
Inductance – Source ¹ 100 Hz to 1 kHz	(1 to 10 mH) (10 to 100) mH (0.1 to 1) H (1 to 10) H	23 mH/H 12 mH/H 7 mH/H 7 mH/H	Standard Decade Inductors
Electrical Calibration of Thermocouple Indicators and Calibrators ¹	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C	0.36 °C 0.29 °C 0.26 °C 0.28 °C	Multi-Product Calibrator

Electrical – DC/Low Frequency

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators and Calibrators ¹	Type C		Multi-Product Calibrator
	(0 to 150) °C	0.26 °C	
	(150 to 650) °C	0.23 °C	
	(650 to 1 000) °C	0.27 °C	
	(1 000 to 1 800) °C	0.4 °C	
	(1 800 to 2 316) °C	0.66 °C	
	Type E		
	(-250 to -100) °C	0.4 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 350) °C	0.16 °C	
	(350 to 650) °C	0.17 °C	
	(650 to 1 000) °C	0.2 °C	
	Type J		
	(-210 to -100) °C	0.24 °C	
	(-100 to -30) °C	0.17 °C	
	(-30 to 150) °C	0.16 °C	
	(150 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.21 °C	
	Type K		
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	

Electrical – DC/Low Frequency

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators and Calibrators ¹	Type S (0 to 250) °C	0.38 °C	Multi-Product Calibrator
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	
	Type T (-250 to -150) °C	0.5 °C	
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U (-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	
Electrical Calibration of RTD Indicators ¹	PtNi 385, 120 Ω (Ni120) (-80 to 0) °C	0.062 °C	Multi-Product Calibrator
	(0 to 100) °C	0.062 °C	
	(100 to 260) °C	0.11 °C	
	Pt 385, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω (-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	

Electrical – DC/Low Frequency

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicators ¹	Pt 385, 200 Ω		Multi-Product Calibrator
	(-200 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.093 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.12 $^{\circ}\text{C}$	
	Pt 385, 500 Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.085 $^{\circ}\text{C}$	
	Pt 385, 1 k Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.18 $^{\circ}\text{C}$	
	Cu 427, 10 Ω		
	(-100 to 260) $^{\circ}\text{C}$	0.23 $^{\circ}\text{C}$	
Oscilloscopes ¹			Multi-Product Calibrator
Amplitude Square Wave Signal			
50 Ω , 10 Hz to 10 kHz	1 mVp-p to 6.6 Vp-p	0.29 % of reading + 46 μV	
1 M Ω , 10 Hz to 10 kHz	1 mVp-p to 130 Vp-p	0.12 % of reading + 46 μV	
Amplitude Sine Wave Signal For Bandwidth Calibration, into 50 Ω			
50 kHz	5 mVp-p to 5.5 Vp-p	2.3 % of reading + 0.35 mV	
50 kHz to 100 MHz	5 mVp-p to 5.5 Vp-p	4 % of reading + 0.35 mV	
(100 to 300) MHz	5 mVp-p to 5.5 Vp-p	4.6 % of reading + 0.35 mV	
(300 to 600) MHz	5 mVp-p to 5.5 Vp-p	6.9 % of reading + 0.35 mV	

Electrical – DC/Low Frequency

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ^{1,2} Rise Time Source 1 kHz to 10 MHz	Up to 300 ps	37 ps	Multi-Product Calibrator
Pulse Width	(4 to 500) ns	5.8 % of reading + 2.3 ns	
Pulse Period	200 ns to 20 ms	2.9 μ s/s	
Time Mark Output into 50 Ω	2 ns to 20 ms 50 ms to 5 s	2.9 μ s/s (25 + 1 000t) parts in 10 ⁶	

Electrical – RF/Microwave

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Tuned Power – Measure ¹ 100 kHz to 2.6 GHz (2.6 to 6) GHz (6 to 10) GHz (10 to 18) GHz (18 to 26.5) GHz	(-117 to 30) dB	0.2 dB	Measuring Receiver and Power Sensors
		0.27 dB	
		0.28 dB	
		0.29 dB	
		0.36 dB	
RF Absolute Power – Measure ¹ 9 kHz to 6 GHz (6 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 33) GHz (33 to 40) GHz (40 to 45) GHz (45 to 50) GHz	(-70 to 44) dBm	0.19 dB	Power Meter, Measuring Receiver and Power Sensors
		0.23 dB	
		0.26 dB	
		0.3 dB	
		0.37 dB	
		0.37 dB	
		0.53 dB	
		0.54 dB	

Electrical – RF/Microwave

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹ AM Depth Accuracy 100 kHz to 10 MHz (Rate: 50 Hz to 10 kHz) 10 MHz to 3 GHz (Rate: 50 Hz to 100 kHz) (3 to 26.5) GHz (Rate: 50 Hz to 100 kHz)	Depth: (5 to 99) % Depth: (20 to 99) % Depth: (5 to 20) % Depth: (20 to 99) % Depth: (5 to 20) %	0.91 % of reading 0.61 % of reading 3 % of reading 1.8 % of reading 5.5 % of reading	Measuring Receiver, Power Sensor
Flatness 10 MHz to 3 GHz (Rate: 90 Hz to 10 kHz) (3 to 26.5) GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) % Depth: (5 to 99) %	0.37 % of reading 0.49 % of reading	
Amplitude Modulation – Measure ¹ FM Rejection (50 Hz to 3 kHz BW) 250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz) 10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz)	Depths: < 50 % Deviations: < 5 kHz Depths: < 50 % Deviations: < 50 kHz	0.17 % Depth 0.44 % Depth	Measuring Receiver, Power Sensor
Residual AM 250 kHz to 26.5 GHz	50 Hz to 3 kHz BW	0.012 % of reading (rms)	

Electrical – RF/Microwave

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz (Rate: 20 Hz to 200 kHz) AM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz Residual AM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: 200 Hz to 400 kHz AM Depths: ≤ 50 % Rate: 400 Hz or 1 kHz 50 Hz to 3 kHz BW	1.3 % of reading 13 Hz 25 Hz 49 Hz 1.9 Hz 3.7 Hz 7.4 Hz	Measuring Receiver
Phase Modulation – Measure ¹ PM Deviation Accuracy AM Rejection (50 Hz to 3 kHz BW) 100 kHz to 26.5 GHz Residual AM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	100 kHz to 6.6 GHz Deviations: > 0.7 rad Deviations: > 0.3 rad (6.6 to 13.2) GHz Deviations: > 0.7 rad Deviations: > 0.3 rad (13.2 to 26.5) GHz Deviations: > 0.7 rad Deviations: > 0.3 rad AM Depths: ≤ 50% (Rate: 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad 0.002 1 rad 0.004 1 rad 0.008 1 rad	Measuring Receiver

Length – Dimensional Metrology

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 48 in	$(29 + 6.3L) \mu\text{in}$	Gage Blocks
Height Gages ^{1,2}	(0 to 48) in	$(28 + 1.8L) \mu\text{in}$	Gage Blocks
Micrometers ^{1,2} External, Internal, Depth, Bore and Micrometer Head	Up to 48 in	$(3.6 + 6.8L) \mu\text{in}$	Gage Blocks, Optical Flat, Universal Length Measuring Machine
Indicators ^{1,2} Dial Gauge, Dial Test Indicator, LVDTs	(0 to 4) in	$(12 + 4.6L) \mu\text{in}$	Universal Measuring Machine, Indicator Tester
	(0 to 4) in	$(2.6 + 2.5L) \mu\text{in}$	Gage Block, Comparator Stand
Plain Plug Gages, Pin Gages, Thread Wires ^{1,2} (Cylindrical and Taper)	(0.001 to 12) in	$(14 + 1.5L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks, High-Accuracy Micrometer
Plain Ring Gages ² (Cylindrical and Taper)	(0.04 to 12) in	$(13 + 2.2L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Thread Plug Gages ² (Cylindrical and Taper) Simple Pitch Diameter Major Diameter	(0.04 to 12) in	$(44 + 2.6L) \mu\text{in}$ $(14 + 1.2L) \mu\text{in}$	Universal Length Measuring Machine, Thread Measuring Wires, Gage Blocks
Thread Ring Gages ² (Cylindrical and Taper) Simple Pitch Diameter Minor Diameter	(0.112 to 12) in	$(59 + 0.48L) \mu\text{in}$ $(15 + 1.2L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks, Master Thread Plug Set
Micrometer Standards, End Measuring Rods ²	(0.001 to 24) in	$(18 + 2.3L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Length Measuring Machine, Linear Measurement ^{1,2}	(0 to 24) in	$(3.3 + 2L) \mu\text{in}$	Gage Blocks
Thickness Gauge / Feeler Gauge ^{1,2}	(0.001 to 1) in	$(12 + 0.17L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Snap Gages ² (External / Internal)	(0.001 to 24) in	$(12 + 1.6L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Spherical Diameter, Standard Ball, Steel Ball ²	(0.001 to 4) in	$(10 + 1.2L) \mu\text{in}$	Universal Length Measuring Machine, Gage Block

Length – Dimensional Metrology

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
External Spline Gage ² Measurement over two balls or pins Major Diameter	(0.1 to 24) in	$(15 + 1.6L) \mu\text{in}$ $(12 + 1.9L) \mu\text{in}$	Universal Length Measuring Machine, Gage Block, Thread Wires, Spherical Stylus Probes
Internal Spline Gage ² Measurement between two balls or pins Minor Diameter	(0.1 to 24) in	$(15 + 2L) \mu\text{in}$ $(11 + 2.2L) \mu\text{in}$	Universal Length Measuring Machine, Gage Block, Spherical Stylus Probes
Surface Plates ¹ Local Area Flatness Only (Repeat Reading)	Up to 0.030 in	15 μin	Repeat-o-Meter

Mass and Mass Related

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure / Vacuum ^{1,2} Transducers, Transmitters (Gage, Absolute, Differential)	(-14.5 to 0) psi (0 to 200) psi (200 to 3 000) psi (3 000 to 10 000) psi (10 000 to 36 500) psi	0.073 % of Reading + 0.000 1 psi 0.047 % of Reading + 0.000 1 psi 0.034 % of reading 0.057 % of reading 0.2 % of reading	Pressure Calibrator, Pressure Modules
Torque Tools ¹	(5 to 50) lbf·in (50 to 500) lbf·in (25 to 250) lbf·ft (100 to 1 000) lbf·ft	0.59 % of reading + 0.036 lbf·in 0.59 % of reading + 0.36 lbf·in 0.59 % of reading + 0.18 lbf·ft 0.59 % of reading + 0.71 lbf·ft	Torque Testers
Mass (Weights)	(1 to 5) mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg	0.003 2 mg 0.004 2 mg 0.005 2 mg 0.006 2 mg 0.008 2 mg 0.011 mg 0.013 mg	Standard Weights and Mass Comparator

Mass and Mass Related

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass (Weights)	500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 20 kg	0.016 mg 0.021 mg 0.026 mg 0.032 mg 0.042 mg 0.052 mg 0.12 mg 0.18 mg 0.42 mg 2.7×10^{-6} kg/kg	Standard Weights and Mass Comparator
Scales & Balances ^{1,3} (Platform & Spring)	Up to 5 mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g 100 g to 20 kg (20 to 500) kg	0.003 1 mg 0.004 1 mg 0.005 1 mg 0.006 1 mg 0.008 2 mg 0.011 mg 0.013 mg 0.016 mg 0.022 mg 0.035 mg 0.057 mg 0.1 mg 0.24 mg 0.48 mg 5.4×10^{-6} kg/kg 2.6×10^{-6} kg/kg	Standard Weight
Air Flow ^{1,2}	Up to 1 000 L/min	0.75 % of reading + 0.58R	Standard Flow Sensors
Force and Load Cell ^{1,2} (Compression and Tension)	Up to 338 lbf	0.006 2 % of reading + 0.58R	Standard weights
	(0 to 100 000) lbf	0.12 % of reading + 0.58R	Load cell

Photometry and Radiometry

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Fiber Optics Power – Measure ¹ (800 to 1 700) nm	(-90 to 3) dBm	0.15 dB	Optical Calibration System

Photometry and Radiometry

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Wavelength - Measure ^{1,2}	(700 to 1 650) nm	4.2 x 10 ⁻⁶ of reading	Wavelength Meter

Thermodynamic

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity – Measure/Source ¹	(10 to 95) %RH	1.3 %RH	Humidity Indicator
Temperature Sources and Generating Equipment ¹ (e.g. Ovens, Chambers, Environmental Rooms, Dry-Well Calibrators, etc.)	(-200 to 660) °C	0.001 % of reading + 0.045 °C	Thermometer
Temperature – Measuring Equipment ¹	(-200 to 660) °C	0.001 % of reading + 0.05 °C	Thermometer, Thermocouple, Dry-Well, Temperature Calibrator
Radiation (Infrared) Thermometers ¹	(25 to 100) °C (100 to 450) °C	0.4 °C 1.3 °C	Omega Blackbody calibrator $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$

Time and Frequency

Phoenix, AZ

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	1 mHz to 50 GHz	6.3 x 10 ⁻¹⁰ Hz/Hz	GPS Receiver, Counter GPS Receiver, Signal Generator, Spectrum Analyzer
Frequency – Source ¹	10 MHz	6.2 x 10 ⁻¹² Hz/Hz	
Frequency – Source ¹	0.01 Hz to 50 GHz	6.3 x 10 ⁻¹² Hz/Hz	GPS Receiver, Signal Generator

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

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Norma Vazquez 530-268-1860
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CALIBRATION

Acoustics and Vibration

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Pressure Level ¹	(74 to 114) dB (125 to 4 000) Hz	0.2 dB	Sound Calibrator, Sound Meter
Vibration ¹ (10 Hz to 5 kHz) Acceleration Velocity Displacement	(0 to 200) m/s ² (0 to 200) mm/s (0 to 200) μ m	0.69 % of reading + 0.004 7 m/s ² 0.69 % of reading + 0.004 7 mm/s 0.69 % of reading + 0.004 7 μ m	Vibration System
Accelerometers / Velocity Sensors/Sensitivity	(0.04 to 1 000) pC/units (0.04 to 1 000) mV/units 10 Hz to 5 kHz	1 % of sensitivity	

Chemical Quantities

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity ^{1,4}	9.8 μ S/cm 100 μ S/cm 998 μ S/cm 1 412 μ S/cm 9 993 μ S/cm 99 998 μ S/cm	0.58 μ S/cm 0.88 μ S/cm 3.5 μ S/cm 3.7 μ S/cm 27 μ S/cm 220 μ S/cm	Standard Conductivity Solutions
pH Indicators ^{1,4}	(4, 7, 10) pH	0.03 pH	Standard pH Solutions

Electrical – DC/Low Frequency

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹ Fixed Values	1.018V 10 V	1.3 μ V 6.6 μ V	DC Voltage Reference Standard
DC Voltage – Source ¹	(0 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 μ V/V + 0.4 μ V 5 μ V/V + 0.7 μ V 3.5 μ V/V + 2.6 μ V 3.5 μ V/V + 4 μ V 5 μ V/V + 40 μ V 6.5 μ V/V + 0.4 mV	Multi-Function Calibrator
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V 100 V to 1 kV	15 μ V/V + 3.0 μ V 14 μ V/V + 0.3 μ V 15 μ V/V + 0.5 μ V 15 μ V/V + 30 μ V 27 μ V/V + 0.1 mV	Multimeter
DC Voltage – Measure ¹ High Voltage	(1 to 10) kV (10 to 20) kV (20 to 70) kV	470 μ V/V + 0.2 V 460 μ V/V + 0.2 V 480 μ V/V + 0.2 V	High Voltage Meter
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	41 μ A/A + 7.2 nA 37 μ A/A + 41 nA 45 μ A/A + 0.40 μ A 53 μ A/A + 0.81 μ A 89 μ A/A + 12 μ A	Multi-Function Calibrator
	Up to 330 μ A 330 μ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 3 A (3 to 11) A (11 to 20.5) A	0.12 mA/A + 16 nA 78 μ A/A + 40 nA 82 μ A/A + 0.43 μ A 0.14 mA/A + 10 μ A 0.16 mA/A + 32 μ A 0.39 mA/A + 0.26 mA 0.78 mA/A + 0.58 mA	Multi-Product Calibrator
	(10 to 16.5) A (16.5 to 150) A (150 to 1 025) A	2.8 mA/A + 3 mA 2.8 mA/A + 25 mA 2.9 mA/A + 90 mA	Multi-Product Calibrator with w/50-turn Coil
DC Current – Measure ¹	Up to 100 μ A 100 μ A to 10 mA (10 to 100) mA 100 mA to 1 A (1 to 100) A	26 μ A/A + 0.4 nA 25 μ A/A + 5 μ A 26 μ A/A + 5 μ A 157 μ A/A + 10 μ A 170 μ A/A	Multimeter/Shunt

Electrical – DC/Low Frequency

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹	(0 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 (110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω (330 to 1 100) M Ω	31 $\mu\Omega/\Omega$ + 0.83 m Ω 23 $\mu\Omega/\Omega$ + 1.2 m Ω 22 $\mu\Omega/\Omega$ + 1.2 m Ω 22 $\mu\Omega/\Omega$ + 1.6 m Ω 22 $\mu\Omega/\Omega$ + 1.7 m Ω 22 $\mu\Omega/\Omega$ + 16 m Ω 22 $\mu\Omega/\Omega$ + 27 m Ω 22 $\mu\Omega/\Omega$ + 0.16 Ω 24 $\mu\Omega/\Omega$ + 1.0 Ω 27 $\mu\Omega/\Omega$ + 1.8 Ω 27 $\mu\Omega/\Omega$ + 1.9 Ω 68 $\mu\Omega/\Omega$ + 55 Ω 113 $\mu\Omega/\Omega$ + 64 Ω 0.54 m Ω/Ω + 2.2 k Ω 0.63 m Ω/Ω + 2.5 k Ω 5.5 m Ω/Ω + 78 k Ω 13 m Ω/Ω + 0.39 M Ω	Multi-Product Calibrator
Resistance – Source ¹ Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	50 $\mu\Omega$ 95 $\mu\Omega$ 0.18 m Ω 0.23 m Ω 0.44 m Ω 1.0 m Ω 1.9 m Ω 8.5 m Ω 16 m Ω 85 m Ω 0.16 Ω 1.1 Ω 2.1 Ω 20 Ω 40 Ω 0.40 k Ω 0.90 k Ω 10 k Ω	Multiproduct Calibrator
Resistance – Source ¹ Fixed Points	(1 to 100) M Ω (100 to 1 000) M Ω (1 to 10) G Ω (10 to 100) G Ω	2.3 m Ω/Ω 2.3 m Ω/Ω 2.3 m Ω/Ω 2.3 m Ω/Ω	High Accuracy Decade

Electrical – DC/Low Frequency

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	180 $\mu\Omega/\Omega$ + 60 $\mu\Omega$ 3.5 m Ω/Ω + 0.6 m Ω 11 m Ω/Ω + 0.6 m Ω 110 m Ω/Ω + 6 m Ω 1.1 Ω/Ω + 57 m Ω 17 Ω/Ω + 2.3 Ω 570 Ω/Ω + 110 Ω 57 k Ω/Ω + 1.1 k Ω 5.7 M Ω/Ω + 11 k Ω	Multimeter
AC Voltage – Source ¹	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (2.2 to 22) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.38 mV/V + 4 μ V 0.31 mV/V + 4 μ V 0.31 mV/V + 4 μ V 0.36 mV/V + 4 μ V 0.64 mV/V + 5 μ V 1.2 mV/V + 10 μ V 1.5 mV/V + 20 μ V 2.8 mV/V + 20 μ V 0.25 mV/V + 4 μ V 0.12 mV/V + 4 μ V 0.1 mV/V + 4 μ V 0.22 mV/V + 4 μ V 0.5 mV/V + 5 μ V 1.1 mV/V + 10 μ V 1.4 mV/V + 20 μ V 2.7 mV/V + 20 μ V 0.24 mV/V + 12 μ V 91 μ V/V + 7 μ V 81 μ V/V + 7 μ V 0.2 mV/V + 7 μ V 0.46 mV/V + 17 μ V 0.9 mV/V + 20 μ V 1.4 mV/V + 25 μ V 2.7 mV/V + 45 μ V	Multi-Function Calibrator

Electrical – DC/Low Frequency

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	220 mV to 2.2 V		Multi-Function Calibrator
	(10 to 20) Hz	0.24 mV/V + 40 μ V	
	(20 to 40) Hz	90 μ V/V + 15 μ V	
	40 Hz to 20 kHz	45 μ V/V + 8 μ V	
	(20 to 50) kHz	75 μ V/V + 10 μ V	
	(50 to 100) kHz	0.11 mV/V + 30 μ V	
	(100 to 300) kHz	0.42 mV/V + 80 μ V	
	(300 to 500) kHz	1 mV/V + 0.2 mV	
	500 kHz to 1 MHz	1.7 mV/V + 0.3 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.24 mV/V + 0.4 mV	
	(20 to 40) Hz	90 μ V/V + 0.15 mV	
	40 Hz to 20 kHz	45 μ V/V + 50 μ V	
	(20 to 50) kHz	75 μ V/V + 0.1 mV	
	(50 to 100) kHz	0.10 mV/V + 0.2 mV	
	(100 to 300) kHz	0.28 mV/V + 0.6 mV	
	(300 to 500) kHz	1 mV/V + 2 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.24 mV/V + 4 mV	
	(20 to 40) Hz	90 μ V/V + 1.5 mV	
AC Voltage – Measure ¹	Up to 10 mV		Multimeter
	(1 to 40) Hz	3.4 μ V/V + 1.7 μ V	
	40 Hz to 1 kHz	2.3 μ V/V + 0.6 μ V	
	(1 to 20) kHz	3.4 μ V/V + 0.6 μ V	
	(20 to 50) kHz	11 μ V/V + 0.6 μ V	
	(50 to 100) kHz	57 μ V/V + 0.6 μ V	
	(100 to 300) kHz	460 μ V/V + 1.2 μ V	

Electrical – DC/Low Frequency

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 50) kHz (50 to 100) kHz 100 kHz to 2 MHz 100 mV to 10 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 (1 to 2) MHz (10 to 100) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	70 $\mu\text{V/V} + 40 \mu\text{V}$ 70 $\mu\text{V/V} + 20 \mu\text{V}$ 0.25 mV/V + 20 μV 4.1 mV/V + 1 μV 13 mV/V + 0.1 mV 860 $\mu\text{V/V} + 0.23 \text{ mV}$ 840 $\mu\text{V/V} + 0.12 \text{ mV}$ 1.6 mV/V + 0.12 mV 3.4 mV/V + 0.12 mV 9.2 mV/V + 0.12 mV 34 mV/V + 0.6 mV 140 mV/V + 0.6 mV 190 mV/V + 0.6 mV 23 mV/V + 2.3 mV 23 mV/V + 1.2 mV 41 mV/V + 1.2 mV 140 mV/V + 1.2 mV 470 mV/V + 5.8 mV 1.7 V/V + 5.8 mV	Multimeter
AC Voltage – Measure ¹	100 V to 1 kV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	350 mV/V + 23 mV 350 mV/V + 12 mV 450 mV/V + 12 mV 960 mV/V + 12 mV 2.4 V/V + 12 mV	Multimeter
AC Voltage – Measure ¹	(1 to 10) kV (20 to 100) Hz (10 to 20) kV (20 to 100) Hz (20 to 35) kV (50 to 60) Hz	25 V 180 V 260 V	High Voltage Meter
AC Current – Source ¹	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	Multi-Function Calibrator

Electrical – DC/Low Frequency

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	220 μ A to 2.2 mA		Multi-Function Calibrator
	(10 to 20) Hz	0.25 mA/A + 40 nA	
	(20 to 40) Hz	0.16 mA/A + 35 nA	
	40 Hz to 1 kHz	0.12 mA/A + 35 nA	
	(1 to 5) kHz	0.2 mA/A + 0.11 μ A	
	(5 to 10) kHz	1.1 mA/A + 0.65 μ A	
	(2.2 to 22) mA		
	(10 to 20) Hz	0.25 mA/A + 0.4 μ A	
	(20 to 40) Hz	0.16 mA/A + 0.35 μ A	
	40 Hz to 1 kHz	0.12 mA/A + 0.35 μ A	
	(1 to 5) kHz	0.2 mA/A + 0.55 μ A	
	(5 to 10) kHz	1.1 mA/A + 5 μ A	
	(22 to 220) mA		
	(10 to 20) Hz	0.25 mA/A + 4 μ A	
	(20 to 40) Hz	0.16 mA/A + 3.5 μ A	
	40 Hz to 1 kHz	0.12 mA/A + 2.6 μ A	
AC Current – Source ¹	(1 to 5) kHz	0.2 mA/A + 3.5 μ A	Multiproduct Calibrator and 50 turn coil
	(5 to 10) kHz	1.1 mA/A + 10 μ A	
	220 mA to 2.2 A		
	20 Hz to 1 kHz	0.27 mA/A + 35 μ A	
	(1 to 5) kHz	0.45 mA/A + 80 μ A	
AC Current – Measure ¹	(5 to 10) kHz	7 mA/A + 0.16 mA	Multimeter
	(1 to 20) A		
	30 Hz to 1 kHz	0.6 mA/A + 1 mA	
	(1 to 3) kHz	1.7 mA/A + 1 mA	
	(3 to 5) kHz	2.8 mA/A + 1 mA	
AC Current – Measure ¹	(10 to 1 000) A		Multimeter
	(45 to 65) Hz	3.7 mA/A + 0.009 A	
	(65 to 400) Hz	9.2 mA/A + 0.1 A	
	Up to 100 μ A		
	(10 to 20) Hz	4.6 mA/A + 0.03 μ A	
AC Current – Measure ¹	(20 to 45) Hz	1.8 mA/A + 0.03 μ A	Multimeter
	45 Hz to 1 kHz	0.78 mA/A + 0.03 μ A	
	100 μ A to 100 mA		
	(10 to 20) Hz	4.6 mA/A + 20 μ A	
	(20 to 45) Hz	1.7 mA/A + 20 μ A	
AC Current – Measure ¹	(45 to 100) Hz	7.3 mA/A + 20 μ A	Multimeter
	100 Hz to 5 kHz	4.2 mA/A + 20 μ A	

Electrical – DC/Low Frequency

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.6 mA/A + 0.2 mA 1.9 mA/A + 0.2 mA 1 mA/A + 0.2 mA 1.2 mA/A + 0.2 mA	Multimeter
Capacitance – Source ¹ 100 Hz to 1 kHz	(0.19 to 0.4) nF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 µF (1.1 to 3.3) µF (3.3 to 11) µF (11 to 33) µF (33 to 110) µF (110 to 330) µF 330 µF to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	3.9 mF/F + 13 pF 3.9 mF/F + 13 pF 3.9 mF/F + 13 pF 1.9 mF/F + 13 pF 1.9 mF/F + 0.13 nF 1.9 mF/F + 0.13 nF 1.9 mF/F + 0.38 nF 1.9 mF/F + 1.3 nF 1.9 mF/F + 3.8 nF 1.9 mF/F + 13 nF 3.1 mF/F + 38 nF 3.5 mF/F + 0.13 µF 3.5 mF/F + 0.38 µF 3.5 mF/F + 1.3 µF 3.5 mF/F + 3.8 µF 3.5 mF/F + 13 µF 5.8 mF/F + 38 µF 8.5 mF/F + 0.13 mF	Multi-Product Calibrator
Capacitance Measure ¹ 12 Hz to 100 kHz	(0 to 1 000) µF	1.4 mF/F + 0.000 58 pF	RLC Digibridge
Electrical Simulation of Thermocouple Indicators ¹	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C 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	0.36 °C 0.29 °C 0.27 °C 0.29 °C 0.27 °C 0.24 °C 0.27 °C 0.41 °C 0.66 °C	Multiproduct Calibrator

Electrical – DC/Low Frequency

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators ¹	Type E		Multi-Product Calibrator
	(-250 to -100) °C	0.41 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 350) °C	0.17 °C	
	(350 to 650) °C	0.18 °C	
	(650 to 1 000) °C	0.21 °C	
	Type J		
	(-210 to -100) °C	0.25 °C	
	(-100 to -30) °C	0.18 °C	
	(-30 to 150) °C	0.17 °C	
	(150 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.22 °C	
	Type K		
	(-200 to -100) °C	0.29 °C	
	(-100 to -25) °C	0.19 °C	
	(-25 to 120) °C	0.18 °C	
	(120 to 1 000) °C	0.24 °C	
	(1 000 to 1 372) °C	0.34 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.24 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.34 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.2 °C	
	(120 to 410) °C	0.19 °C	
	(410 to 1 300) °C	0.25 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.3 °C	
	(400 to 1 000) °C	0.29 °C	
	(1 000 to 1 767) °C	0.34 °C	
	Type S		
	(0 to 250) °C	0.39 °C	
	(250 to 1 000) °C	0.31 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.38 °C	

Electrical – DC/Low Frequency

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators ¹	Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C Type U (-200 to 0) °C (0 to 600) °C	0.51 °C 0.23 °C 0.18 °C 0.17 °C 0.45 °C 0.25 °C	Multi-Product Calibrator
Electrical Simulation of RTD Indicators ¹	Pt 395, 100 Ω (-200 to -80) °C (-80 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 -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C Pt 3916, 100 Ω (-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.04 °C 0.04 °C 0.055 °C 0.07 °C 0.078 °C 0.093 °C 0.18 °C 0.04 °C 0.04 °C 0.055 °C 0.07 °C 0.078 °C 0.093 °C 0.19 °C 0.032 °C 0.04 °C 0.047 °C 0.055 °C 0.063 °C 0.070 °C 0.078 °C 0.18 °C	Multi-Product Calibrator

Electrical – DC/Low Frequency

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicators ¹	Pt 385, 200 Ω		Multi-Product Calibrator
	(-200 to -80) °C	0.032 °C	
	(-80 to 0) °C	0.032 °C	
	(0 to 100) °C	0.032 °C	
	(100 to 260) °C	0.04 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.032 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.04 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.063 °C	
	(300 to 400) °C	0.063 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.086 °C	
	Pt 385, 1 k Ω		
	(-200 to -80) °C	0.025 °C	
	(-80 to 0) °C	0.025 °C	
	(0 to 100) °C	0.032 °C	
	(100 to 260) °C	0.04 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.055 °C	
	(400 to 600) °C	0.055 °C	
	(600 to 630) °C	0.18 °C	
	PtNi 385, 120 Ω (Ni120)		
	(-80 to 0) °C	0.063 °C	
	(0 to 100) °C	0.063 °C	
	(100 to 260) °C	0.11 °C	
	Cu 427, 10 Ω		
	(-100 to 260) °C	0.23 °C	
Inductance – Measure ¹ 12 Hz to 100 kHz	(0 to 10) H	1.4 mH/H + 0.058 μ H	RLC Digibridge
Inductance Source ¹ Fixed Points			Standard Inductors
100 Hz to 10 kHz	100 μ H	0.29 μ H	
100 Hz to 10 kHz	1 mH	1.2 μ H	
100 Hz to 10 kHz	100 mH	120 μ H	
100 Hz to 1 kHz	1 H	1.2 mH	

Electrical – DC/Low Frequency

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ¹ Rise/Fall Time (10 to 90) %	Up to 500 ns	4 ps	Oscilloscope Calibrator, Active Head and Multimeter
Square Wave 50 Ω or 1 M Ω Load impedance – (10 Hz to 100 kHz)	(0 to 1) mVp-p 1 mV to 5 Vp-p (5 to 200) Vp-p	15 mV/V + 10 μ V 15 mV/V + 10 μ V 10 mV/V + 0.1 mV	
Oscilloscopes ¹ Horizontal Deflection	180.1 ps to 83 μ s 83 μ s to 55 s	0.29 parts in 10 ⁻⁶ s 3.5 parts in 10 ⁻⁶ s	Oscilloscope Calibrator, Active Head and Multimeter
Vertical Deflection	(0 to 1) mV 1 mV to 5 V (5 to 200) V	0.35 mV/V + 25 μ V 0.26 mV/V + 25 μ V 0.35 mV/V + 0.1 mV	
Oscilloscopes ¹ Bandwidth	0.1 Hz to 3.2 GHz (3.2 to 6) GHz (6 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 33) GHz (33 to 34) GHz (34 to 35) GHz (35 to 40) GHz (40 to 45) GHz (45 to 50) GHz	2.7 % of reading 2.7 % of reading 2.8 % of reading 2.9 % of reading 3.3 % of reading 3.7 % of reading 3.8 % of reading 3.8 % of reading 3.8 % of reading 4.7 % of reading 5.4 % of reading	Oscilloscope Calibrator, Active Head and RF Power Sensor
Oscilloscope ¹ – DC Vertical Deflection Accuracy into 50 Ω load DC Vertical Deflection Accuracy into 1 M Ω load	(1 to 109.99) mV 110 mV to 6.6 V (1 to 109.99) mV 110 mV to 10.999 V (11 to 130) V	40 μ V 18 mV 40 μ V 25 mV 130 mV	Multi-Product Calibrator
Vertical Deflection Accuracy into 50 Ω load Square Wave Signal < 10kHz	5 mV 10 mV 20 mV 50 mV 100 mV 200 mV 500 mV 1 V	53 μ V 63 μ V 88 μ V 174 μ V 324 μ V 627 μ V 1.4 mV 7 mV	

Electrical – DC/Low Frequency

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscope ¹ Vertical Deflection Accuracy into 1 MΩ load Square Wave Signal < 10kHz	5 mV 10 mV 50 mV 100 mV 200 mV 500 mV 1 V	52 μV 57 μV 71 μV 116 μV 194 μV 570 μV 1.1 mV	Multi-Product Calibrator
Oscilloscope ¹ – Horizontal Cursor Accuracy (Time Base)	(10 to 1) ms 500 μs 200 μs 100 μs (50 to 20) μs (10 to 1) μs 500 ns 200 ns 100 ns (50 to 20) ns (10 to 2) ns	9 μs/cm 21 ns 110 ns 9.5 ns 8 ns 8.7 ns 21 ps 11 ps 9 ps 8 ps 8.7 ps	Multi-Product Calibrator

Electrical – RF/Microwave

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Tuned Power – Measure ¹	150 kHz to 26.5 GHz (20 to -30) dB (-30 to -130) dB	0.15 dB 0.2 dB	Measuring Receiver
RF Power Meter Reference ¹	0.0 dB (1 mW) 50 MHz	0.51 % of reading	Power Meter, Power Sensors
RF Absolute Power – Measure ¹			
(0.0001 to 2) GHz	(-20 to 20) dB	0.05 dB	Power Meter, Power Sensors
(2.0 to 26.5) GHz	(-20 to 20) dB	0.08 dB	
(26.5 to 50) GHz	(-20 to 20) dB	0.13 dB	
(0.5 to 12.4) GHz	(-70 to -20) dB	0.08 dB	
(12.4 to 50) GHz	(-70 to -20) dB	0.1 dB	

Electrical – RF/Microwave

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation Deviation – Generate ¹	Rate: 20 Hz to 200 kHz Dev: ≤ 400 kHz 250 kHz to 6.6 GHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz (6.6 to 13.2) GHz (Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz (13.2 to 26.5) GHz	0.2 % of reading 0.3 % of reading 0.4% of reading	Measuring Receiver Signal Generators
Frequency Modulation Rejection – Measure ¹ 150 kHz to 10 MHz 10 MHz to 26.5 GHz	Rate: 400 HZ to 1 kHz Dev.: ≤ 5 kHz peak Dev.: ≤ 50 kHz peak	0.14 % AM 0.14 % AM	Measuring Receiver
Residuals AM ¹	150 kHz to 18 GHz (18 to 26.5) GHz	0.004 % (rms) 0.006 % (rms)	Measuring Receiver
Frequency Modulation Distortion – Measure ¹ Bandwidth: 20 Hz to 250 kHz	150 kHz to 26.5 GHz	0.15 % of reading	Measuring Receiver
Frequency Modulation – Deviation Accuracy Measure ¹ 250 kHz to 10 MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz	Rate: 20 Hz to 10 kHz Dev: ≤ 40 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz	0.1 % of reading 0.2 % of reading 0.3 % of reading	Measuring Receiver
Frequency Modulation – Deviation Accuracy Measure ¹ (13.2 to 26.5) GHz	Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz	0.4% of reading	Measuring Receiver
Amplitude Modulation Rejection – Measure ¹ Rate: 400 Hz to 1 kHz ≤ 50 % Depth	150 kHz to 6.6 GHz (6.6 to 26.5) GHz	11 Hz 23 Hz	Measuring Receiver

Electrical – RF/Microwave

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Depth Accuracy Measure ¹			
150 kHz to 10 MHz	Rate: 50 Hz to 10 kHz Depth: (5 to 99) %	0.2 % of reading	Measuring Receiver
10 MHz to 3 GHz	Rate: 50 Hz to 100 kHz Depth: (20 to 99) %	0.2 % of reading	
10 MHz to 3 GHz	Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	0.3 % of reading	
3 to 26.5 GHz	Rate: 50 Hz to 100 kHz Depth: (20 to 99) %	0.2 % of reading	
Amplitude Modulation – Depth Accuracy Measure ¹ 3 to 26.5 GHz	Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	0.5 % of reading	Measuring Receiver
Residuals FM ¹ 150 kHz to 3 GHz (3 to 6.6) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Bandwidth: 50 Hz to 3 kHz (rms)	1.3 Hz 1.8 Hz 2.6 Hz 3.7 Hz	Measuring Receiver
Amplitude Modulation Distortion – Measure ¹ 150 kHz to 18 GHz 18 to 26.5 GHz 18 to 26.5 GHz	(5 to 99) % Depth (5 to 50) % Depth (50 to 95) % Depth	0.14 % Depth 0.4 % Depth 0.6 % Depth	Measuring Receiver
Amplitude Modulation – Flatness ¹ 10 MHz to 26.5 GHz	Rate: 9 Hz to 10 kHz (5 to 99) % Depth	0.15 % Depth	Measuring Receiver
Amplitude Modulation – Generate ¹ 150 kHz to 3 MHz	Rate: 50 Hz to 100 kHz (5 to 99) % Depth	0.3 % Depth	Measuring Receiver
(3 to 26.5) GHz	Rate: 50 Hz to 100 kHz (5 to 99) % Depth	0.5 % Depth	

Electrical – RF/Microwave

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Measure ¹ (Phase Residuals, AM Rejection, & Phase Distortion) 100 kHz to 6.6 GHz 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz 100 kHz to 26.5 GHz	Rate: 20 Hz to 200 kHz Deviation: > 0.7 Rad Deviation: > 0.3 Rad Rate: 20 Hz to 200 kHz Deviation: > 2 Rad Deviation: > 0.6 Rad Rate: 20 Hz to 200 kHz Deviation: > 4 Rad Deviation: > 1.2 Rad Rate: 50 Hz to 3 kHz Deviation: > 50 % AM at 1 kHz Rate Deviation: > 1.2 Rad	0.1 % of reading 0.2 % of reading 0.1 % of reading 0.2 % of reading 0.1 % of reading 0.2 % of reading 0.003 Rad	Measuring Receiver
Phase Modulation – Measure ¹ (Phase Residuals, AM Rejection, & Phase Distortion) 100 kHz to 26.5 GHz 150 kHz to 26.5 GHz Bandwidth	(0.1 to 25 000) Rad 50 Hz to 3 kHz (rms) (0.1 to 25 000) Rad 20 Hz to 250 kHz (rms)	0.01 Rad 0.008 rad	Measuring Receiver
Harmonics – Measure ¹	(-90 to 0.01) dB 30 Hz to 50 GHz	1.5 dB	Spectrum Analyzer
Reflection Magnitude $S_{11/22}$ – Measure ^{1,5}	(0.1 to 1) lin mag 300 kHz to 1.3 GHz (1.3 to 3) GHz	0.028 0.028	Network Analyzer, Calibration Kit
Reflection Phase $S_{11/22}$ – Measure ¹	(-180 to 180) ° 300 kHz to 1.3 GHz (1.3 to 3) GHz	1.5 ° 1.5 °	

Electrical – RF/Microwave

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Transmission Magnitude – Phase $S_{21/12}$ Measure ¹ 300 kHz to 3 GHz	(-180 to 180) ° (10 to 0) dB (0 to -10) dB (-10 to -20) dB (-20 to -30) dB (-30 to -40) dB (-40 to -50) dB (-50 to -60) dB (-60 to -70) dB (-70 to -80) dB (-80 to -90) dB	0.069 dB, 1.1 ° 0.069 dB, 1.1 ° 0.07 dB, 1.1 ° 0.07 dB, 1.1 ° 0.09 dB, 1.1 ° 0.13 dB, 1.1 ° 0.29 dB, 2 ° 0.85 dB, 5.9 ° 2.4 dB, 19 ° 6.1 dB, 180 °	Network Analyzer, Calibration Kit
CISPR 16 Pulse Response Quasi-Peak Detector Response Band A Band B Band C Band D Quasi-Peak to Peak Detector Relative Response Ratio Band A Bands B, C, D	(0 to 7) dB (1 to 20) Hz (1 to 100) Hz (1 to 100) Hz (1 to 100) Hz (0 to 70) dB 25 Hz 100 Hz	0.26 dB 0.3 dB 0.3 dB 0.3 dB 0.31 dB 0.31 dB	Pulse Generator
CISPR 16 Pulse Response Quasi-Peak to Average Detector Relative Response Ratio Band A Band B Band C, D	(0 to 70) dB 25 Hz 500 Hz 5 kHz	0.31 dB 0.31 dB 0.31 dB	Pulse Generator
CISPR 16 Pulse Response Absolute Amplitude Band A Band B Band C Quasi-Peak to RMS Relative Band A Band B, C, D	(0 to 70) dB 25 Hz 100 Hz 100 Hz (0 to 70) dB 25 Hz 100 Hz	0.42 dB 0.42 dB 0.55 dB 0.26 dB 0.26 dB	Power Meter and Power Sensor

Length – Dimensional Metrology

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 48 in	$(6.4 + 6.8L) \mu\text{in} + 0.58R$	Gage Blocks
Height Gages ^{1,2}	Up to 48 in	$(28 + 1.8L) \mu\text{in} + 0.58R$	Gage Blocks
Micrometers ^{1,2} External, Internal, Depth, Bore and Micrometer Head	Length Up to 48 in Flatness Up to 40 μin Parallelism Up to 50 μin	$(3.6 + 6.8L) \mu\text{in} + 0.58R$ 4.8 μin 8.4 μin	Gage Blocks, Optical Flat, Optical Parallels
Setting Rod, Micrometer Standard, Length Standards ²	Up to 20 in	$(18 + 2.2L) \mu\text{in}$	Gage Blocks, Universal Length Measuring Machine
Plain External Diameter ^{1,2} (Cylindrical and Taper)	Up to 12 in	$(12 + 1.6L) \mu\text{in}$	Universal Length Measuring Machine, High- Accuracy Micrometer, Gage Blocks
Plain Internal Diameter ² (Cylindrical and Taper)	(0.04 to 12) in	$(13 + 2.2L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks, Master Ring Gage
Thread Plug Gages ² (Cylindrical and Taper) Simple Pitch Diameter Major Diameter	(0.04 to 12) in	$(44 + 2.6L) \mu\text{in}$ $(14 + 1.2L) \mu\text{in}$	Universal Length Measuring Machine, Thread Wires, Gage Blocks
Thread Ring Gages ² (Cylindrical and Taper) Simple Pitch Diameter Minor Diameter	(0.04 to 12) in	$(59 + 0.48L) \mu\text{in}$ $(15 + 1.2L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks, Master Ring Gage, Master Thread Plug Set
Snap Gages ² (External / Internal)	Up to 20 in	$(12 + 1.5L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Spherical Diameter, Standard Ball, Steel Ball ²	Up to 4 in	$(10 + 1.2L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Thickness Gauge / Feeler Gauge ^{1,2}	Up to 1 in	$(12 + 0.17L) \mu\text{in}$	Universal Length Measuring Machine, High- Accuracy Micrometer, Gage Block
Universal Length Measuring Machine, Linear Measurement ^{1,2}	Up to 24 in	$(3.3 + 2L) \mu\text{in}$	Gage Blocks

Length – Dimensional Metrology

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks ² Length (Deviation of the length at any point from nominal length) Variation in length	Up to 4 in (4 to 20) in 0.02 in	$(6.5 + 0.54L) \mu\text{in}$ $(4.9 + 1.7L) \mu\text{in}$ 5.9 μin	Gage Blocks, Universal Length Measuring Machine
Bevel Protractor / Universal Bevel Protractor ^{1,2}	Up to 90° (4 Quadrant)	2"	Angle Blocks, Gage Blocks, Surface Plates
Master Level / Electronic Inclinometer / Angle Meter	Up to 0.005 in/in Up to 90°	1.1 $\mu\text{in/in}$ 0.000 82°	Sine Bar, Gage Blocks, Surface Plate
Optical Comparators and Vision Systems/Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 40 in	$(19 + 2.3L) \mu\text{in}$	Gage Blocks, Standard Scale
Ruler & Tape Measures ^{1,2}	(0 to 40) in (40 to 2 000) in	0.006 5 in $(1.6 \times 10^{-4}L) \text{ in}$	Gage Blocks
Indicators ^{1,2} Dial Gages Dial Thickness Gages Dial Test Indicators /LVDTs	Up to 4 in	$(12 + 4.6L) \mu\text{in} + 0.58R$	Universal Measuring Machine, Indicator Tester
Indicators ^{1,2} Dial Gages Dial Thickness Gages Dial Test Indicators /LVDTs	Up to 4 in	$(2.6 + 2.5L) \mu\text{in} + 0.58R$	Gage Blocks, Comparator Stand
Surface Plates ^{1,2} Repeat Reading (Local area flatness)	(6 to 140) inDL Up to 5 000 μin	$(21 + 1.2D) \mu\text{in}$	Repeat-o-meter

Mass and Mass Related

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Gage ¹ / Absolute & Differential & Vacuum Gauges, Transmitters	(0 to 10 000) psi (10 000 to 40 000) psi	0.05 % of reading + 0.58R 0.2 % of reading + 0.58R	Pressure Calibrator
Torque Tools ¹	1.5 lbf·in to 1 100 lbf·ft	0.54 % of reading	Torque Tester
Torque Tester ^{1,2}	Up to 55 lbf·in (55 to 220) lbf·in (220 to 1 100) lbf·in	0.062 % of reading + 0.58R 0.04 % of reading + 0.58R 0.026 % of reading + 0.58R	Torque Calibration Wheel with Standard Weights

Mass and Mass Related

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass (Weights)	(1 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 1 kg 2 kg 5 kg 10 kg 20 kg	0.008 3 mg 0.008 4 mg 0.008 6 mg 0.008 7 mg 0.009 1 mg 0.009 6 mg 0.01 mg 0.012 mg 0.013 mg 0.015 mg 0.017 mg 0.027 mg 0.052 mg 0.83 mg 1.2 mg 1.7 mg 82 mg 82 mg 83 mg	Standard Weights and Mass Comparator
Scales & Balances ^{1,3}	Up to 20 mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 20 kg (20 to 50) kg	0.001 5 mg 0.002 mg 0.002 5 mg 0.003 1 mg 0.004 1 mg 0.005 1 mg 0.006 1 mg 0.008 1 mg 0.01 mg 0.013 mg 0.015 mg 0.025 mg 0.051 mg 0.13 mg 0.82×10^{-6} kg/kg 1.3×10^{-6} kg/kg	Standard Weights

Mass and Mass Related

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Piston/Plunger Operated Volumetric Apparatus (POVA) ¹ Pipettes, Syringes, Dilutors, Titrators, Piston/Displacement Burettes (Burets), Dispensers, Liquid Handlers	Up to 20 μ L (20 to 50) μ L (50 to 100) μ L (100 to 200) μ L 200 μ L to 10 mL (10 to 20) mL (20 to 2 000) mL	0.02 μ L 0.043 % of reading 0.026 % of reading 0.019 % of reading 0.015 % of reading 0.014 % of reading 0.012 % of reading	Standard Weights and Balances
Volumetric Glassware ¹ Volumetric Apparatus, Flasks, Burettes, Volumetric Dispensers, Cylinders, Graduated Cylinders, Beakers, Vials, & Containers	Up to 10 mL (10 to 20) mL (20 to 2 000) mL	0.001 5 mL 0.014% of reading 0.012% of reading	Standard Weights and Balances
Air Flow	(0.001 to 1 000) L/m	0.85% of reading	Flow Calibrator
Velocity	(1 to 6 800) ft/min	1.7% of reading	Anemometer
Force Compression and Tension ¹	(3 to 10 000) lbf (10 000 to 100 000) lbf (100 000 to 1 000 000) lbf	0.08 % of reading 0.1 % of reading 0.17 % of reading	Load Cell

Photometry and Radiometry

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power ¹ 900 nm to 1 700 nm	(-64 to -0.01) dB (0.01 to 10.00) dB	2.5 % of reading	Optical Power Sensor
Optical Wavelength – Measure ¹	(700 to 1 650) nm	0.007 nm	Wavelength Meter
UV	(0.001 to 10 000) mW	2.6 % of reading	UV Power Meter and Sensor
Illuminance	(0.01 to 2 000) lux	3 % of reading	Light Meter

Thermodynamic

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity – Measure ¹	(10 to 95) %RH	0.7 %RH	Humidity Indicator and Probe
Humidity Measuring Equipment ¹	(10 to 95) %RH	1 %RH	Comparison to Reference Standard Humidity and Humidity Source
Radiation (Infrared) Thermometers ¹	(-30 to 0) °C (0 to 10) °C (10 to 50) °C (50 to 100) °C (100 to 160) °C (160 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 500) °C	0.66 °C 0.31 °C 0.34 °C 0.57 °C 1.1 °C 1.2 °C 1.7 °C 2.2 °C 3 °C	Fluke Black Body Calibrator $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Temperature – Measure ¹	(-40 to 420) °C	0.028 °C	Indicator and RTD Probe
Temperature Measuring Equipment ¹	(-40 to 200) °C	0.049 °C	Comparison to Reference Standard Temperature and Temperature Source

Time and Frequency

Round Rock, TX

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tachometer ¹	(0 to 100 000) rpm	0.000 25 % of reading + 0.58R	Multi-Product Calibrator with Lamp
Frequency – Measure	10 MHz	1.2 parts in 10^{12} Hz	GPS Receiver
Frequency – Measure ¹	10 Hz to 40 GHz	2.5 parts in 10^{11} Hz	Counter, Signal Generator
Frequency – Generate ¹	1 Hz to 50 GHz	1 parts in 10^9 Hz	GPS Receiver, Signal Generators
Period – Generate	(20 to 100) ns >100 ns to 100 ms >100 ms to 1 s (>1 to 10) s (>10 to 100) s (>100 to 200) s	(3.5×10^9) s (2.4×10^9) s (4.5×10^5) s (5.4×10^4) s (1.9×10^2) s (3.1×10^1) s	GPS Receiver, Signal Generator

[Return to Site listing \(top\)](#) [Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

Micro Precision Calibration, Inc.

16 Columbia Drive
Amherst, NH 03031
Norma Vazquez 530-268-1860
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CALIBRATION AND DIMENSIONAL MEASUREMENT

CALIBRATION

Acoustics and Vibration

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Calibrator ¹	(74 to 114) dB (125 Hz to 4 kHz)	0.1 dB	Sound Calibration System
Sound Level Meter ^{1,2}	(74 to 114) dB (125 Hz to 4 kHz)	0.10 dB + 0.58R	Sound Calibration System

Chemical Quantities

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters ^{1,2}	10 µS/cm 100 µS/cm 1 000 µS/cm 1 500 µS/cm 10 000 µS/cm 100 000 µS/cm	0.3 µS/cm 0.9 µS/cm 3 µS/cm 3.2 µS/cm 32 µS/cm 290 µS/cm	Standard Conductivity Solutions
pH Meters ^{1,2}	4 pH 7 pH 10 pH	0.013 pH 0.013 pH 0.013 pH	Standard pH Solutions

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹ Fixed Values	1.018V 10 V	1.3 µV/V + 0.082 µV 1.3 µV/V + 0.06 µV	DC Voltage Reference Standard

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹	(0 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 $\mu\text{V/V}$ + 0.4 μV 5 $\mu\text{V/V}$ + 0.7 μV 3.5 $\mu\text{V/V}$ + 2.6 μV 3.5 $\mu\text{V/V}$ + 4 μV 5 $\mu\text{V/V}$ + 40 μV 6.3 $\mu\text{V/V}$ + 400 μV	Multi-Function Calibrator
DC Voltage – Measure ¹	(0 to 100) mV (0.1 to 1) V (1 to 10) V (10 to 100) V 100 V to 1 kV	6.2 $\mu\text{V/V}$ + 0.3 μV 3.5 $\mu\text{V/V}$ + 0.3 μV 3 $\mu\text{V/V}$ + 0.5 μV 5.1 $\mu\text{V/V}$ + 30 μV 5.1 $\mu\text{V/V}$ + 0.1 mV	Multimeter
DC Voltage – Measure ^{1,3} High Voltage	(1 to 10) kV (10 to 100) kV	0.3 mV/V + 0.031 V 0.58 mV/V + 0.67 V	High Voltage Meter
DC Power – Source ¹	0.01 mW to 20.5 kW 33 mV to 1 020 V (0.33 to 330) mA 330 mA to 11 A (11 to 20.5) A	0.03 % of Watts output + 0.58R 0.059 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R	Multi-Product Calibrator
DC Current – Source ¹	(0 to 220) μA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A	40 $\mu\text{A/A}$ + 6 nA 35 $\mu\text{A/A}$ + 7 nA 35 $\mu\text{A/A}$ + 40 nA 45 $\mu\text{A/A}$ + 0.7 μA 80 $\mu\text{A/A}$ + 12 μA	Multi-Product Calibrator
DC Current – Source ¹	(2.2 to 11) A	360 $\mu\text{A/A}$ + 480 μA	Multi-Function Calibrator and Amplifier
DC Current – Source ¹	(0 to 330) μA 330 μA to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 3.3 A (3.3 to 11) A (11 to 20.5) A	116 $\mu\text{A/A}$ + 16 nA 78 $\mu\text{A/A}$ + 24 nA 78 $\mu\text{A/A}$ + 0.17 μA 78 $\mu\text{A/A}$ + 1.7 μA 155 $\mu\text{A/A}$ + 32 μA 388 $\mu\text{A/A}$ + 270 μA 775 $\mu\text{A/A}$ + 590 μA	Multi-Product Calibrator
DC Current – Source ¹	(10 to 16.5) A (16.5 to 150) A (150 to 1025) A	2.8 mA/A + 3 mA 2.8 mA/A + 25 mA 3 mA/A + 90 mA	Multi-Product Calibrator w/ 50-turn Coil

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Measure ¹	(0 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	30 μ A/A + 40 pA 20 μ A/A + 40 pA 20 μ A/A + 100 pA 20 μ A/A + 0.8 nA 20 μ A/A + 5 nA 20 μ A/A + 50 nA 35 μ A/A + 0.5 μ A 110 μ A/A + 10 μ A	Multimeter
DC Current – Measure ¹	(1 to 20) A (20 to 100) A	107 μ A/A + 58 nA 40 μ A/A + 1.4 μ A	Multimeter with Current Shunt
Resistance – Source ¹ Fixed Points	0 Ω 1.0 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	40 $\mu\Omega$ 95 $\mu\Omega$ 181 $\mu\Omega$ 230 $\mu\Omega$ 437 $\mu\Omega$ 1 m Ω 1.9 m Ω 8.5 m Ω 16 m Ω 85 m Ω 162 m Ω 1.1 Ω 2.1 Ω 20 Ω 40 Ω 400 Ω 893 Ω 10 k Ω	Multiproduct Calibrator
Resistance – Source ¹ Fixed Points	1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω	1.3 $\mu\Omega/\Omega$ 13 $\mu\Omega/\Omega$ 13 $\mu\Omega/\Omega$ 13 $\mu\Omega/\Omega$ 1.4 $\mu\Omega/\Omega$	Standard Resistors

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	15 $\mu\Omega/\Omega$ + 30 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 0.5 m Ω 10 $\mu\Omega/\Omega$ + 0.5 m Ω 10 $\mu\Omega/\Omega$ + 5 m Ω 10 $\mu\Omega/\Omega$ + 50 m Ω 15 $\mu\Omega/\Omega$ + 2 Ω 50 $\mu\Omega/\Omega$ + 100 Ω 500 $\mu\Omega/\Omega$ + 1 k Ω 5 m Ω/Ω + 10 k Ω	Multimeter
Capacitance – Source ¹ 50 Hz to 1 kHz	(220 to 399.9) pF 400 pF to 1.1 nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F 330 μ F to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 1.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 78 pF 1.9 mF/F + 233 pF 1.9 mF/F + 0.78 nF 1.9 mF/F + 2.3 nF 1.9 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.5 mF/F + 78 nF 3.5 mF/F + 233 nF 3.5 mF/F + 0.78 μ F 3.5 mF/F + 2.3 μ F 3.5 mF/F + 7.8 μ F 5.8 mF/F + 23 μ F 8.5 mF/F + 78 μ F	Multi-Product Calibrator
Capacitance – Source ¹ Fixed Values	(1, 10, 100, 1 000) pF 1 kHz to 13 MHz	67 μ F/F + 0.58R	Standard Capacitors
Inductance – Source ¹ 100 Hz to 10 kHz	100 μ H 1 mH 10 mH 100 mH 1 H 2 H 10 H	0.02 μ H 0.2 μ H 2 μ H 20 μ H 0.2 mH 0.4 mH 2 mH	Standard Inductors
Inductance – Source ¹ 100 Hz to 10 kHz	(0 to 1) H	0.41 mH/H + 0.58R	Decade Inductor
Inductance – Measure ¹ 12 Hz to 100 kHz	0.01 μ H to 10 H	0.23 mH/H	Precision LCR Meter w/Standard Inductors

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) °C	0.36 °C	Multi-Product Calibrator
	(800 to 1 000) °C	0.29 °C	
	(1 000 to 1 550) °C	0.26 °C	
	(1 550 to 1 820) °C	0.28 °C	
	Type C (0 to 150) °C	0.26 °C	
	(150 to 650) °C	0.23 °C	
	(650 to 1 000) °C	0.27 °C	
	(1 000 to 1 800) °C	0.4 °C	
	(1 800 to 2 316) °C	0.66 °C	
	Type E (-250 to -100) °C	0.4 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 350) °C	0.16 °C	
	(350 to 650) °C	0.17 °C	
	(650 to 1 000) °C	0.2 °C	
	Type J (-210 to -100) °C	0.24 °C	
	(-100 to -30) °C	0.17 °C	
	(-30 to 150) °C	0.16 °C	
	(150 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.21 °C	
	Type K (-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L (-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N (-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type R (0 to 250) °C	0.46 °C	Multi-Product Calibrator
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type S (0 to 250) °C	0.38 °C	
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	
	Type T (-250 to -150) °C	0.5 °C	
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U (-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	
Electrical Calibration of RTD Indicators ¹	Cu 427, 10 Ω (-100 to 260) °C	0.23 °C	Multi-Product Calibrator
	Pt 385, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicators ¹	Pt 3916, 100 Ω		Multi-Product Calibrator
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.031 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.039 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.062 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.085 °C	
	Pt 385, 1 k Ω		
	(-200 to -80) °C	0.023 °C	
	(-80 to 0) °C	0.023 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.054 °C	
	(400 to 600) °C	0.054 °C	
	(600 to 630) °C	0.18 °C	
	PtNi 385, 100 Ω		
	(-80 to 0) °C	0.062 °C	
	(0 to 100) °C	0.062 °C	
	(100 to 260) °C	0.11 °C	

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	220 μ V to 2.2 mV		Multi-Function Calibrator
	(10 to 20) Hz	240 μ V/V + 4 μ V	
	(20 to 40) Hz	90 μ V/V + 4 μ V	
	40 Hz to 20 kHz	80 μ V/V + 4 μ V	
	(20 to 50) kHz	200 μ V/V + 4 μ V	
	(50 to 100) kHz	500 μ V/V + 5 μ V	
	(100 to 300) kHz	1.1 mV/V + 10 μ V	
	(300 to 500) kHz	1.4 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 20 μ V	
	(2.2 to 22) mV		
	(10 to 20) Hz	240 μ V/V + 4 μ V	
	(20 to 40) Hz	90 μ V/V + 4 μ V	
	40 Hz to 20 kHz	80 μ V/V + 4 μ V	
	(20 to 50) kHz	200 μ V/V + 4 μ V	
	(50 to 100) kHz	500 μ V/V + 5 μ V	
	(100 to 300) kHz	1.1 mV/V + 10 μ V	
	(300 to 500) kHz	1.4 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 20 μ V	
	(22 to 220) mV		
	(10 to 20) Hz	240 μ V/V + 12 μ V	
	(20 to 40) Hz	90 μ V/V + 7 μ V	
	40 Hz to 20 kHz	80 μ V/V + 7 μ V	
	(20 to 50) kHz	200 μ V/V + 7 μ V	
	(50 to 100) kHz	460 μ V/V + 17 μ V	
	(100 to 300) kHz	900 μ V/V + 20 μ V	
	(300 to 500) kHz	1.4 mV/V + 25 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 45 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	240 μ V/V + 40 μ V	
	(20 to 40) Hz	90 μ V/V + 15 μ V	
	40 Hz to 20 kHz	45 μ V/V + 8 μ V	
	(20 to 50) kHz	75 μ V/V + 10 μ V	
	(50 to 100) kHz	110 μ V/V + 30 μ V	
	(100 to 300) kHz	420 μ V/V + 80 μ V	
	(300 to 500) kHz	1 mV/V + 200 μ V	
	500 kHz to 1 MHz	1.7 mV/V + 300 μ V	

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) V		Multi-Function Calibrator
	(10 to 20) Hz	240 $\mu\text{V/V}$ + 400 μV	
	(20 to 40) Hz	90 $\mu\text{V/V}$ + 150 μV	
	40 Hz to 20 kHz	45 $\mu\text{V/V}$ + 50 μV	
	(20 to 50) kHz	75 $\mu\text{V/V}$ + 100 μV	
	(50 to 100) kHz	100 $\mu\text{V/V}$ + 200 μV	
	(100 to 300) kHz	275 $\mu\text{V/V}$ + 600 μV	
	(300 to 500) kHz	1 mV/V + 2 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	240 $\mu\text{V/V}$ + 4 mV	
	(20 to 40) Hz	90 $\mu\text{V/V}$ + 1.5 mV	
	40 Hz to 20 kHz	52 $\mu\text{V/V}$ + 0.6 mV	
	(20 to 50) kHz	80 $\mu\text{V/V}$ + 1.0 mV	
AC Voltage – Source ¹	(50 to 100) kHz	150 $\mu\text{V/V}$ + 2.5 mV	Multi-Function Calibrator with Amplifier
	(100 to 300) kHz	900 $\mu\text{V/V}$ + 16 mV	
	(300 to 500) kHz	4.4 mV/V + 40 mV	
	500 kHz to 1 MHz	8 mV/V + 80 mV	
	(220 to 1 100) V		
	(15 to 50) Hz	300 $\mu\text{V/V}$ + 16 mV	
AC Voltage – Source ¹	50 Hz to 1 kHz	70 $\mu\text{V/V}$ + 3.5 mV	Multi-Function Calibrator with Amplifier
	(220 to 750) V		
	(30 to 50) kHz	600 $\mu\text{V/V}$ + 11 mV	
	(50 to 100) kHz	2.3 mV/V + 45 mV	
	(750 to 1 100) V		
AC Voltage – Measure ¹	40 Hz to 1 kHz	90 $\mu\text{V/V}$ + 4 mV	Multimeter
	(1 to 20) kHz	170 $\mu\text{V/V}$ + 6 mV	
	(20 to 30) kHz	600 $\mu\text{V/V}$ + 11 mV	
	Up to 10 mV		
	(1 to 40) Hz	300 $\mu\text{V/V}$ + 3 μV	
	40 Hz to 1 kHz	200 $\mu\text{V/V}$ + 1.1 μV	
AC Voltage – Measure ¹	(1 to 20) kHz	300 $\mu\text{V/V}$ + 1.1 μV	Multimeter
	(20 to 50) kHz	1 mV/V + 1.1 μV	
	(50 to 100) kHz	5 mV/V + 1.1 μV	
	(100 to 300) kHz	40 mV/V + 2 μV	

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	70 $\mu\text{V/V} + 4 \mu\text{V}$ 70 $\mu\text{V/V} + 2 \mu\text{V}$ 140 $\mu\text{V/V} + 2 \mu\text{V}$ 300 $\mu\text{V/V} + 2 \mu\text{V}$ 800 $\mu\text{V/V} + 2 \mu\text{V}$ 3 mV/V + 10 μV 10 mV/V + 10 μV 15 mV/V + 10 μV	Multimeter
	100 mV to 10 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 (1 to 2) MHz	70 $\mu\text{V/V} + 0.4 \text{ mV}$ 70 $\mu\text{V/V} + 0.2 \text{ mV}$ 140 $\mu\text{V/V} + 0.2 \text{ mV}$ 300 $\mu\text{V/V} + 0.2 \text{ mV}$ 800 $\mu\text{V/V} + 0.2 \text{ mV}$ 3 mV/V + 1 mV 10 mV/V + 1 mV 15 mV/V + 1 mV	
	(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	200 $\mu\text{V/V} + 4 \text{ mV}$ 200 $\mu\text{V/V} + 2 \text{ mV}$ 200 $\mu\text{V/V} + 2 \text{ mV}$ 350 $\mu\text{V/V} + 2 \text{ mV}$ 1.2 mV/V + 2 mV 4 mV/V + 10 mV 15 mV/V + 10 mV	
	(100 to 700) V (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	400 $\mu\text{V/V} + 40 \text{ mV}$ 400 $\mu\text{V/V} + 20 \text{ mV}$ 600 $\mu\text{V/V} + 20 \text{ mV}$ 1.2 mV/V + 20 mV 3 mV/V + 20 mV	
AC High Voltage – Measure ¹	(1 to 70) kV (50 to 60) Hz	1.2 mV/V + 0.9 V	High Voltage Meter

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	2.2 mV Range		AC Measurement Standard
	(10 to 20) Hz	1.1 mV/V + 0.87 μ V	
	(20 to 40) Hz	493 μ V/V + 0.87 μ V	
	40 Hz to 20 kHz	280 μ V/V + 0.87 μ V	
	(20 to 50) kHz	540 μ V/V + 1.3 μ V	
	(50 to 100) kHz	800 μ V/V + 1.7 μ V	
	(100 to 300) kHz	1.5 mV/V + 2.7 μ V	
	(300 to 500) kHz	1.6 mV/V + 4 μ V	
	500 kHz to 1 MHz	2.1 mV/V + 4 μ V	
	7 mV Range		
	(10 to 20) Hz	567 μ V/V + 0.87 μ V	
	(20 to 40) Hz	247 μ V/V + 0.87 μ V	
	40 Hz to 20 kHz	140 μ V/V + 0.87 μ V	
	(20 to 50) kHz	267 μ V/V + 1.3 μ V	
	(50 to 100) kHz	400 μ V/V + 1.7 μ V	
	(100 to 300) kHz	800 μ V/V + 2.7 μ V	
	(300 to 500) kHz	867 μ V/V + 4 μ V	
	500 kHz to 1 MHz	1.3 mV/V + 4 μ V	
	22 mV Range		
	(10 to 20) Hz	193 μ V/V + 0.87 μ V	
	(20 to 40) Hz	120 μ V/V + 0.87 μ V	
	40 Hz to 20 kHz	73 μ V/V + 0.87 μ V	
	(20 to 50) kHz	140 μ V/V + 1.3 μ V	
	(50 to 100) kHz	207 μ V/V + 1.7 μ V	
	(100 to 300) kHz	540 μ V/V + 2.7 μ V	
	(300 to 500) kHz	573 μ V/V + 4 μ V	
	500 kHz to 1 MHz	933 μ V/V + 4 μ V	
	70 mV Range		
	(10 to 20) Hz	160 μ V/V + 1 μ V	
	(20 to 40) Hz	80 μ V/V + 1 μ V	
	40 Hz to 20 kHz	43 μ V/V + 1 μ V	
	(20 to 50) kHz	80 μ V/V + 1.3 μ V	
	(50 to 100) kHz	173 μ V/V + 1.7 μ V	
	(100 to 300) kHz	340 μ V/V + 2.7 μ V	
	(300 to 500) kHz	440 μ V/V + 4 μ V	
	500 kHz to 1 MHz	733 μ V/V + 4 μ V	

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	220 mV Range		AC Measurement Standard
	(10 to 20) Hz	140 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	56 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	25 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	46 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	107 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	160 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	240 $\mu\text{V/V} + 4 \mu\text{V}$	
	500 kHz to 1 MHz	627 $\mu\text{V/V} + 4 \mu\text{V}$	
	700 mV Range		
	(10 to 20) Hz	140 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	50 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	21 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	33 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	53 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	107 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	200 $\mu\text{V/V} + 4 \mu\text{V}$	
	500 kHz to 1 MHz	600 $\mu\text{V/V} + 4 \mu\text{V}$	
	2.2 V Range		
	(10 to 20) Hz	133 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	43 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	15 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	30 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	47 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	100 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	167 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	560 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	7.0 V Range		
	(10 to 20) Hz	133 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	44 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	15 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	31 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	53 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	120 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	253 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	733 $\mu\text{V/V} + 0.058 \mu\text{V}$	

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	22 V Range		AC Measurement Standard
	(10 to 20) Hz	133 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	44 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	17 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	31 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	53 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	120 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	253 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	733 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	70 V Range		
	(10 to 20) Hz	133 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	20 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	37 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	61 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	127 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	267 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	733 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	220 V Range		
	(10 to 20) Hz	133 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	19 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	45 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	64 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(100 to 300) kHz	140 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(300 to 500) kHz	293 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	700 V Range		
	(10 to 20) Hz	133 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	64 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	26 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	80 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	267 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	1 000 V Range		
	(10 to 20) Hz	133 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	64 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	25 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	80 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	267 $\mu\text{V/V} + 5.8 \mu\text{V}$	

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	2.2 mV Range		AC Measurement Standard
	(10 to 30) Hz	667 $\mu\text{V/V} + 0.06 \mu\text{V}$	
	(30 to 120) Hz	333 $\mu\text{V/V} + 0.06 \mu\text{V}$	
	120 Hz to 1.2 kHz	333 $\mu\text{V/V} + 0.06 \mu\text{V}$	
	(1.2 to 120) kHz	333 $\mu\text{V/V} + 0.06 \mu\text{V}$	
	(120 to 500) kHz	467 $\mu\text{V/V} + 0.67 \mu\text{V}$	
	500 kHz to 1.2 MHz	467 $\mu\text{V/V} + 0.67 \mu\text{V}$	
	(1.2 to 2) MHz	467 $\mu\text{V/V} + 0.67 \mu\text{V}$	
	(2 to 10) MHz	1.1 mV/V + 0.67 μV	
	(10 to 20) MHz	2 mV/V + 0.67 μV	
	(20 to 30) MHz	4.7 mV/V + 1.3 μV	
	7 mV Range		
	(10 to 30) Hz	667 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(30 to 120) Hz	333 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	120 Hz to 1.2 kHz	333 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(1.2 to 120) kHz	333 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(120 to 500) kHz	467 $\mu\text{V/V} + 0.67 \mu\text{V}$	
	500 kHz to 1.2 MHz	467 $\mu\text{V/V} + 0.67 \mu\text{V}$	
	(1.2 to 2) MHz	467 $\mu\text{V/V} + 0.67 \mu\text{V}$	
	(2 to 10) MHz	667 $\mu\text{V/V} + 0.67 \mu\text{V}$	
	(10 to 20) MHz	1.1 mV/V + 0.67 μV	
	(20 to 30) MHz	2.5 mV/V + 0.67 μV	
	22 mV Range		
	(10 to 30) Hz	667 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(30 to 120) Hz	333 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	120 Hz to 1.2 kHz	333 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(1.2 to 120) kHz	333 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(120 to 500) kHz	467 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1.2 MHz	467 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(1.2 to 2) MHz	467 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(2 to 10) MHz	667 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(10 to 20) MHz	1.1 mV/V + 0.058 μV	
	(20 to 30) MHz	2.5 mV/V + 0.058 μV	

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	70 mV Range		AC Measurement Standard
	(10 to 30) Hz	667 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(30 to 120) Hz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	120 Hz to 1.2 kHz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(1.2 to 120) kHz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(120 to 500) kHz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1.2 MHz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(1.2 to 2) MHz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(2 to 10) MHz	667 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(10 to 20) MHz	1 mV/V + 0.58 μV	
	(20 to 30) MHz	2.3 mV/V + 0.58 μV	
	220 mV Range		
	(10 to 30) Hz	667 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(30 to 120) Hz	267 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	120 Hz to 1.2 kHz	267 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(1.2 to 120) kHz	267 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(120 to 500) kHz	267 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1.2 MHz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(1.2 to 2) MHz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(2 to 10) MHz	667 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(10 to 20) MHz	1 mV/V + 0.58 μV	
	(20 to 30) MHz	2.3 mV/V + 0.58 μV	
	700 mV Range		
	(10 to 30) Hz	667 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(30 to 120) Hz	200 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	120 Hz to 1.2 kHz	200 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(1.2 to 120) kHz	200 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(120 to 500) kHz	200 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	500 kHz to 1.2 MHz	333 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(1.2 to 2) MHz	333 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(2 to 10) MHz	667 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(10 to 20) MHz	1 mV/V + 5.8 μV	
	(20 to 30) MHz	2.3 mV/V + 5.8 μV	

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	2.2 V Range (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	667 $\mu\text{V/V} + 5.8 \mu\text{V}$ 200 $\mu\text{V/V} + 5.8 \mu\text{V}$ 200 $\mu\text{V/V} + 5.8 \mu\text{V}$ 200 $\mu\text{V/V} + 5.8 \mu\text{V}$ 200 $\mu\text{V/V} + 5.8 \mu\text{V}$ 333 $\mu\text{V/V} + 5.8 \mu\text{V}$ 333 $\mu\text{V/V} + 5.8 \mu\text{V}$ 667 $\mu\text{V/V} + 5.8 \mu\text{V}$ 1 mV/V + 5.8 μV 2.3 mV/V + 5.8 μV	AC Measurement Standard
	7.0 V Range (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	667 $\mu\text{V/V} + 5.8 \mu\text{V}$ 200 $\mu\text{V/V} + 5.8 \mu\text{V}$ 200 $\mu\text{V/V} + 5.8 \mu\text{V}$ 200 $\mu\text{V/V} + 5.8 \mu\text{V}$ 200 $\mu\text{V/V} + 5.8 \mu\text{V}$ 333 $\mu\text{V/V} + 5.8 \mu\text{V}$ 333 $\mu\text{V/V} + 5.8 \mu\text{V}$ 667 $\mu\text{V/V} + 5.8 \mu\text{V}$ 1 mV/V + 5.8 μV 2.3 mV/V + 5.8 μV	
AC Power – Source ^{1,2} (45 to 65) Hz PF = 1	0.1 mW to 20.5 kW (33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A 330 mV to 1 020 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.11 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.11 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.1 % of Watts output + 0.58R 0.088 % of Watts output + 0.58R 0.1 % of Watts output + 0.58R 0.13 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.088 % of Watts output + 0.58R 0.073 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.15 % of Watts output + 0.58R	Multi-Product Calibrator

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} (45 to 65) Hz PF = (0 to 0.999)	0.1 mW to 20.5 kW (33 to 330) mV		Multi-Product Calibrator
	(3.3 to 9) mA	0.21 % of Watts output + 0.58R	
	(9 to 33) mA	0.19 % of Watts output + 0.58R	
	(33 to 90) mA	0.21 % of Watts output + 0.58R	
	(90 to 330) mA	0.19 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.2 % of Watts output + 0.58R	
	(0.9 to 3) A	0.19 % of Watts output + 0.58R	
	(3 to 11) A	0.2 % of Watts output + 0.58R	
	(11 to 20.5) A	0.21 % of Watts output + 0.58R	
	330 mV to 1 020 V		
	(3.3 to 9) mA	0.2 % of Watts output + 0.58R	
	(9 to 33) mA	0.19 % of Watts output + 0.58R	
	(33 to 90) mA	0.2 % of Watts output + 0.58R	
	(90 to 330) mA	0.19 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.19 % of Watts output + 0.58R	
	(0.9 to 3) A	0.19 % of Watts output + 0.58R	
	(3 to 11) A	0.2 % of Watts output + 0.58R	
	(11 to 20.5) A	0.23 % of Watts output + 0.58R	
AC Current – Source ¹	(9 to 220) μ A		Multiproduct Calibrator
	(10 to 20) Hz	250 μ A/A + 16 nA	
	(20 to 40) Hz	160 μ A/A + 10 nA	
	40 Hz to 1 kHz	120 μ A/A + 8.0 nA	
	(1 to 5) kHz	280 μ A/A + 12 nA	
	(5 to 10) kHz	1.1 mA/A + 65 nA	
	220 μ A to 2.2 mA		
	(10 to 20) Hz	250 μ A/A + 40 nA	
	(20 to 40) Hz	160 μ A/A + 35 nA	
	40 Hz to 1 kHz	120 μ A/A + 35 nA	
	(1 to 5) kHz	200 μ A/A + 110 nA	
	(5 to 10) kHz	1.1 mA/A + 650 nA	
	(2.2 to 22) mA		
	(10 to 20) Hz	250 μ A/A + 400 nA	
	(20 to 40) Hz	160 μ A/A + 350 nA	
	40 Hz to 1 kHz	120 μ A/A + 350 nA	
	(1 to 5) kHz	200 μ A/A + 550 nA	
	(5 to 10) kHz	1.1 mA/A + 5 μ A	

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(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	250 μ A/A + 4 μ A 160 μ A/A + 3.5 μ A 120 μ A/A + 2.6 μ A 200 μ A/A + 3.5 μ A 1.1 mA/A + 10 μ A 260 μ A/A + 35 μ A 450 μ A/A + 80 μ A 7 mA/A + 160 μ A	Multiproduct Calibrator
AC Current – Source ¹	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	460 μ A/A + 170 μ A 950 μ A/A + 380 μ A 3.6 mA/A + 750 μ A	Multi-Function Calibrator and Amplifier
AC – Source ¹	1.45 mA to 16.5 A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	2.8 mA/A + 3 mA 7.9 mA/A + 3 mA 2.8 mA/A + 25 mA 7.9 mA/A + 27 mA 3 mA/A + 90 mA 8 mA/A + 100 mA	Multi-Product Calibrator w/50-turn coil
AC Current – Measure ¹	(5 to 100) μ A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 100 μ A to 1 mA (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 (50 to 100) kHz	4 mA/A + 0.03 μ A 1.5 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A 4 mA/A + 0.2 μ A 1.5 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 0.31 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 4 mA/A + 0.4 μ A 5.5 mA/A + 1.5 μ A	Multimeter

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(1 to 10) mA		Multimeter
	(10 to 20) Hz	4 mA/A + 2 μ A	
	(20 to 45) Hz	1.5 mA/A + 2 μ A	
	(45 to 100) Hz	0.6 mA/A + 2 μ A	
	100 Hz to 5 kHz	0.31 mA/A + 2 μ A	
	(5 to 20) kHz	0.6 mA/A + 2 μ A	
	(20 to 50) kHz	4 mA/A + 4 μ A	
	(50 to 100) kHz	5.5 mA/A + 15 μ A	
	(10 to 100) mA		
	(10 to 20) Hz	4 mA/A + 20 μ A	
	(20 to 45) Hz	1.5 mA/A + 20 μ A	
	(45 to 100) Hz	0.6 mA/A + 20 μ A	
	100 Hz to 5 kHz	0.31 mA/A + 20 μ A	
	(5 to 20) kHz	0.6 mA/A + 20 μ A	
	(20 to 50) kHz	4 mA/A + 40 μ A	
	(50 to 100) kHz	5.5 mA/A + 0.15 mA	
	100 mA to 1 A		
	(10 to 20) Hz	4 mA/A + 0.2 mA	
	(20 to 45) Hz	1.6 mA/A + 0.2 mA	
	(45 to 100) Hz	0.8 mA/A + 0.2 mA	
	(100 Hz to 5) kHz	1 mA/A + 0.2 mA	
	(5 to 20) kHz	3 mA/A + 0.2 mA	
	(20 to 50) kHz	10 mA/A + 0.4 mA	
Phase – Measure ¹	(0 to 360)°		Phase Meter
	(10 to 60) mV		
	10 Hz to 10 kHz	0.3°	
	(10 to 40) kHz	0.5°	
Phase – Measure ¹	(40 to 100) kHz	0.8°	Phase Meter
	(0 to 360)°		
	(60 to 250) mV		
	10 Hz to 40 kHz	0.1°	
	(40 to 100) kHz	0.5°	
	(0.25 to 10) V		
	10 Hz to 40 kHz	0.1°	
	(40 to 100) kHz	0.5°	
	(10 to 120) V		
	10 Hz to 40 kHz	0.1°	
	(40 to 100) kHz	0.5°	

Electrical – DC/Low Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase – Source ^{1,4} (3.2 V) Voltage Ratio = 1 1V to 100V Ratio 100V to 1V Ratio	Up to 360 ° 1 Hz to 1 kHz (1 to 6.25) kHz (6.25 to 50) kHz (50 to 100) kHz 1 Hz to 1 kHz 1 kHz to 6.25 kHz 6.25 kHz to 50 kHz 50 kHz to 100 kHz 1 Hz to 1 kHz 1 kHz to 6.25 kHz 6.25 kHz to 50 kHz 50 kHz to 100 kHz	(7 + 0.05R) m° (12 + 0.1R) m° (30 + 0.25R) m° (60 + 0.5R) m° (7 + 0.05R) m° (12 + 0.1R) m° (30 + 0.25R) m° (60 + 0.5R) m° (7 + 0.05R) m° (12 + 0.1R) m° (30 + 0.25R) m° (60 + 0.5R) m°	Phase Standard Ratio= ratio of the larger voltage divided by the smaller voltage
Oscilloscopes ^{1,2} Square Wave Signal 50 Ω at 1 kHz 1 MΩ at 1 kHz Pulse & Rise Time 0.5, 1 V p-p 1 V p-p Time Mark Output Into 50 ohms Leveled Sine Flatness	1 mVp-p to 6.6 Vp-p 1 mVp-p to 130 Vp-p 10 MHz 1 MHz 2 ns to 20 ms 50 ms to 5 s 50 kHz reference 50 kHz to 100 MHz (100 to 600) MHz	2.5 mV/V + 40 μV 8 mV/V to 40 μV 0.4 ns 0.4 ns (25 + 1 000t) parts in 10 ⁶ 25 parts in 10 ⁶ of reading 3 % of reading + 0.3 nV 3.5 % of reading + 0.3 nV 6 % of reading + 0.3 nV	Oscilloscope Calibrator
Oscilloscopes ¹ Bandwidth	50 kHz to 600 MHz 600 MHz to 50 GHz	1.6 % of reading 2.3 % of reading	Oscilloscope Calibrator Power Sensor, Power Meter, Signal Generator

Electrical – RF/Microwave

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Sensors – Calibration Factors ^{1,5}	Referenced to 1 mW (100 to 300) kHz 300 kHz to 50 MHz 50 MHz to 5 GHz (5 to 10) GHz (10 to 18) GHz (18 to 26.5) GHz (26 to 27) GHz (27 to 30) GHz (30 to 34) GHz (34 to 40) GHz (40 to 42) GHz (42 to 48) GHz (48 to 50) GHz	1.5 % 1.3 % 1.2 % 1.2 % 1.2 % 2.3 % 2.5 % 2.6 % 2.5 % 2.5 % 3.2 % 3.5 % 3.8 %	Coaxial Thermistor and Thermocouple Power Sensors
RF Power – Absolute Measure ^{1,4}	-35 dBm < P < -20 dBm 100 kHz < f < 1 MHz 1 MHz < f < 6 GHz -20 dBm < P < 0 dBm 100 kHz < f < 1 MHz 1 MHz < f < 6 GHz	0.8 dB 0.8 dB 0.2 dB 1.3 dB	Comparison with a Standard Power Sensor
RF Power – Absolute Measure ^{1,4}	0 dBm < P < 20 dBm 100 kHz < f < 1 MHz 1 MHz < f < 1.2 GHz 1.2 GHz < f < 6 GHz -35 dBm < P < -20 dBm 10 MHz < f < 12.4GHz 12.4GHz < f < 26.5GHz -20 dBm < P < 0 dBm 10 MHz < f < 12.4GHz 12.4GHz < f < 26.5GHz	0.21 dB 0.13 dB 0.15 dB 0.7 dB 0.72 dB 0.2 dB 0.25 dB	Comparison with a Standard Power Sensor

Electrical – RF/Microwave

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power – Absolute Measure ^{1,4}	0 dBm < P < 20 dBm 10 MHz < f < 12.4GHz 12.4GHz < f < 26.5GHz -70 dBm < P < -60 dBm 10 MHz < f < 18 GHz -60 dBm < P < -50 dBm 10 MHz < f < 1.5 GHz 1.5 GHz < f < 6 GHz 6 GHz < f < 14 GHz 14 GHz < f < 18 GHz (-30 to 20) dB 100 kHz to 2.6 GHz 100 kHz to 4.2 GHz 10 MHz to 16.5 GHz 10 MHz to 26.5 GHz 50 MHz to 50 GHz	0.2 dB 0.25 dB 1.7 dB 0.31 dB 0.35 dB 0.35 dB 0.4 dB 0.83 dB 0.83 dB 0.84 dB 0.84 dB 0.86 dB	Comparison with a Standard Power Sensor
Tuned RF Power, Relative – Measure ¹ 150 kHz to 26.5 GHz	(20.0 to -30) dB (-30 to -130) dB	0.21 dB 0.28 dB	Measuring Receiver
Frequency Modulation Rejection – Measure ¹ 150 kHz to 10 MHz 10 MHz to 26.5 GHz	Rate: 400 HZ to 1 kHz Dev.: ≤ 5 kHz peak Dev.: ≤ 50 kHz peak	0.21 % Deviation 0.21 % Deviation	Measuring Receiver
Residuals AM ¹ (rms)	150 kHz to 18 GHz (18 to 26.5) GHz	0.006 % of reading 0.007 % of reading	Measuring Receiver
Frequency Modulation Distortion- Measure ¹ Bandwidth: 20 Hz to 250 kHz	150 kHz to 26.5 GHz	0.17 % of reading	Measuring Receiver
Frequency Modulation – Deviation Accuracy Measure ¹ 250 kHz to 10 MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 10 kHz Dev: ≤ 40 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz	0.2 % Modulation 0.3 % Modulation 0.4 % Modulation 0.5 % Modulation	Measuring Receiver

Electrical – RF/Microwave

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation Rejection – Measure ¹ 150 kHz to 6.6 GHz (6.6 to 26.5) GHz	Rate: 400 Hz to 1 kHz Depth.: ≤ 50 %	11 Hz 28 Hz	Measuring Receiver
Amplitude Modulation – Depth Accuracy Measure ¹ 150 kHz to 10 MHz 10 MHz to 3 GHz 10 MHz to 3 GHz (3 to 26.5) GHz (3 to 26.5) GHz	Rate: 50 Hz to 10 kHz Depth: (5 to 99) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	0.3 % Modulation 0.3 % Modulation 0.4 % Modulation 0.3 % Modulation 0.6 % Modulation	Measuring Receiver
Residuals FM ¹ Bandwidth: 50 Hz to 3 kHz (rms)	150 kHz to 3 GHz (3 to 6.6) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	1.5 Hz 1.9 Hz 2.7 Hz 3.8 Hz	Measuring Receiver
Amplitude Modulation Distortion -Measure ¹ 150 kHz to 18 GHz (18 to 26.5) GHz (18 to 26.5) GHz	(5 to 99) % Depth (5 to 50) % Depth (50 to 95) % Depth	0.21 % Depth 0.5 % Depth 0.6 % Depth	Measuring Receiver
Amplitude Modulation Flatness ¹ 10 MHz to 26.5 GHz	Rate: (9 Hz to 10 kHz) Depth: (5 to 99) %	0.17 % Depth	Measuring Receiver
Phase Modulation – Measure ¹ 100 kHz to 6.6 GHz 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 200 kHz Deviation: > 0.7 Rad Deviation: > 0.3 Rad Rate: 20 Hz to 200 kHz Deviation: > 2 Rad Deviation: > 0.6 Rad Rate: 20 Hz to 200 kHz Deviation: > 4 Rad Deviation: > 1.2 Rad	0.2 % Modulation 0.3 % Modulation 0.2 % Modulation 0.3 % Modulation 0.2 % Modulation 0.3 % Modulation	Measuring Receiver
AM Rejection- Measure ¹ 100 kHz to 26.5 GHz	Rate: 50 Hz to 3 kHz Deviation: > 50 % AM at 1 kHz Rate	0.004 Rad	Measuring Receiver

Electrical – RF/Microwave

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Residuals – Measure (rms) ¹ 100 kHz to 26.5 GHz	(0.1 to 25 000) Rad Rate: 50 Hz to 3 kHz	0.008 Rad	Measuring Receiver
Phase Distortion ¹ 150 kHz to 26.5 GHz	(0.1 to 25 000) Rad Bandwidth: 20 Hz to 250kHz	0.47% of reading	Measuring Receiver
Harmonic Measurements ¹ 3 Hz to 26.5 GHz (26.5 to 50) GHz	(-90 to 0.01) dB	1.5 dB 2.1 dB	Spectrum Analyzer
Distortion – Measure ¹ 20 Hz to 20 kHz (20 to 100) kHz	(0 to 99.9) dB (50 to 500) kHz (50 to 500) kHz	1.6 dB 2.8 dB	Audio Analyzer

Electrical – RF/Microwave

Amherst, NH

Parameter/ Equipment	S11 - Reflection Magnitude ⁵									
Reference Standard, Method, and/or Equipment	Network Analyzer, Calibration Kit and Verification Kit									
Range	Expanded Uncertainty of Measurement (+/-)									
Frequency	Measured Magnitude (Linear)									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
30 kHz to 300 kHz	0.013	0.013	0.017	0.02	0.027	0.033	0.037	0.045	0.05	0.065
300 kHz to 3 GHz	0.012	0.012	0.012	0.014	0.015	0.018	0.025	0.030	0.033	0.033
(3 to 20) GHz	0.031	0.033	0.035	0.035	0.037	0.04	0.045	0.055	0.06	0.065
(20 to 50) GHz	0.061	0.063	0.067	0.067	0.071	0.038	0.090	0.1	0.13	0.13

Electrical – RF/Microwave

Amherst, NH

Parameter/ Equipment	S11 - Reflection Phase ¹									
Reference Standard, Method, and/or Equipment	Network Analyzer, Calibration Kit and Verification Kit									
Range	Expanded Uncertainty of Measurement (+/-)									
Frequency	Measured Magnitude (Degrees)									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
30 kHz to 300 kHz	8	4.8	3.5	3.5	3.7	3.1	3.1	3.1	3.1	3.1
300 kHz to 3 GHz	7.2	3.6	2.7	2.1	1.8	1.7	1.8	1.8	1.8	2
(3 to 20) GHz	18.5	9.5	6.5	4.7	4	3.5	3.3	3.3	3.3	3.3
(20 to 50) GHz	32	19.5	12.7	10	8.3	7.1	7.1	7.1	7.1	7.3

Electrical – RF/Microwave

Amherst, NH

Parameter/ Equipment	S21 - Transmission Magnitude ⁵									
Reference Standard, Method, and/or Equipment	Network Analyzer, Calibration Kit and Verification Kit									
Range	Expanded Uncertainty of Measurement (+/-)									
Frequency	Measured Magnitude (Linear)									
	0	3	6	10	20	30	40	50	60	
30 kHz to 300 kHz	0.5	0.45	0.45	0.45	0.45	0.5	0.5	0.8	1.9	
300 kHz to 3 GHz	0.12	0.15	0.13	0.15	0.2	0.25	0.3	0.35	0.6	
(3 to 20) GHz	0.25	0.25	0.25	0.3	0.35	0.4	0.4	0.5	0.6	
(20 to 50) GHz	0.35	0.4	0.4	0.4	0.45	0.81	1	1.2	1.3	

Electrical – RF/Microwave

Amherst, NH

Parameter/ Equipment	S21 - Transmission Phase								
Reference Standard, Method, and/or Equipment	Network Analyzer, Calibration Kit and Verification Kit								
Range	Expanded Uncertainty of Measurement (+/-)								
Frequency	Measured Magnitude (Degrees)								
	0	3	6	10	20	30	40	50	60
30 kHz to 300 kHz	2.7	2.7	2.7	2.8	2.8	2.9	3.2	5.2	6.8
300 kHz to 3 GHz	0.7	0.8	1	1.1	1.5	1.6	2	2.4	3.4
(3 to 20) GHz	1.4	1.6	1.7	1.8	2	2	2.6	3.2	3.8
(20 to 50) GHz	4.6	5	5.2	5.6	5.8	6	6.4	6.8	7.2

Length – Dimensional Metrology

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 48 in	$(6.4 + 6.8L) \mu\text{in} + 0.58R$	Gage Blocks
Height Gages ^{1,2}	Up to 48 in	$(28 + 1.8L) \mu\text{in} + 0.58R$	Gage Blocks
Micrometers ^{1,2} External, Internal, Depth, Bore and Micrometer Head	(0 to 48) in	$(3.6 + 6.8L) \mu\text{in} + 0.58R$	Gage Blocks
End Measuring Rods ² Setting Rod, Micrometer Standard, Length Standards	(0.001 to 36) in	$(18 + 2.3L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Indicators, Dial Gauge, Dial Test Indicator, LVDTs ^{1,2}	(0 to 4) in	$(12 + 4.6L) \mu\text{in} + 0.58R$	Universal Length Measuring Machine, Indicator Tester
Indicators, Dial Gauge, Dial Test Indicator, LVDTs ^{1,2}	(0 to 4) in	$(2.6 + 2.5L) \mu\text{in} + 0.58R$	Gage Blocks, Comparator Stand
Plain External Diameter ^{1,2} (Cylindrical and Taper)	Up to 12 in	$(12 + 1.6L) \mu\text{in}$	Gage Blocks, Universal Length Measuring Machine
Plain Internal Diameter ² (Cylindrical and Taper)	(0.04 to 12) in	$(13 + 2.2L) \mu\text{in}$	Gage Blocks, Universal Length Measuring Machine

Length – Dimensional Metrology

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Plug Gages ² (Cylindrical and Taper) Simple Pitch Diameter Major Diameter	Up to 12 in	$(44 + 2.6L) \mu\text{in}$ $(14 + 1.2L) \mu\text{in}$	Gage Blocks, Thread Wires, Universal Length Measuring Machine
Thread Ring Gages ² (Cylindrical and Taper) Simple Pitch Diameter Minor Diameter	(0.1 to 12) in	$(59 + 0.48L) \mu\text{in}$ $(15 + 1.2L) \mu\text{m}$	Gage Blocks, T-Shaped Stylus, Universal Length Measuring Machine
Gage Blocks ² Length (Deviation of the length at any point from nominal length)	Up to 4 in	$(2.6 + 0.6L) \mu\text{in}$	Gage Blocks, Gage Block Comparator
Variation in length	0.02 in	1.3 μin	
Gage Blocks ² Length (Deviation of the length at any point from nominal length)	Up to 4 in (4 to 20) in	$(6.3 + 0.65L) \mu\text{in}$ $(4.3 + 1.0L) \mu\text{in}$	Gage Blocks, Universal Length Measuring Machine
Variation in length	0.02 in	5.9 μin	
Surface Plates ¹ Repeat Reading only (Local area flatness)	Up to 5 000 μin	19 μin	Repeat-o-meter
Snap Gages ² (External / Internal)	Up to 24 in	$(12 + 1.6L) \mu\text{in}$	Gage Blocks, Universal Length Measuring Machine
Spherical Diameter, Standard Ball, Steel Ball ²	Up to 4 in	$(10 + 1.2L) \mu\text{in}$	Gage Blocks, Universal Length Measuring Machine
Thickness Gauge / Feeler Gauge ^{1,2}	(0.001 to 1) in	$(12 + 0.17L) \mu\text{in}$	Gage Blocks, Universal Length Measuring Machine, High-Accuracy Micrometer
Rigid Rules & Tape Measures ^{1,2}	(0 to 40) in (40 to 2 000) in	0.006 5 in $(1.6 \times 10^{-4}L) \text{ in}$	Gage Blocks

Mass and Mass Related

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure / Vacuum ^{1,2} Transducers, Transmitters (Gage, Absolute, Differential)	(-15 to 300) psi (300 to 5 000) psi (5 000 to 10 000) psi	0.033 % of reading + 0.58R 0.056 % of reading + 0.58R 0.010 % of reading + 0.58R	Pressure Calibrator & Pressure Module
Scales and Balances ^{1,3}	(0 to 500) mg 500 mg to 5 g (5 to 10) g (10 to 20) g 20 g to 10 kg (10 to 600) kg	0.005 1 mg 0.017 mg 0.025 mg 0.038 mg 1.3×10^{-6} kg/kg 51×10^{-6} kg/kg	Standard Weights
Mass (Weights) ⁴	(1 to 500) mg 500 mg to 5 g (5 to 10) g (10 to 20) g 20 g to 25 kg	0.005 2 mg 0.017 mg 0.025 mg 0.038 mg 1.3×10^{-6} kg/kg	Weights and Balances
Air Velocity ²	(60 to 6 800) ft/min	1.1 % of reading + 0.58R	Standard Anemometer
Air Flow ^{1,2}	(0 to 2 000) l/min	0.75 % of reading + 0.58R	Standard Flow Sensors
Torque Tools ¹	(5 to 400) ozf·in (2.5 to 200) lbf·in 200 lbf·in to 60 lbf·ft (60 to 600) lbf·ft	0.5 % of reading 0.5 % of reading 0.5 % of reading 0.5 % of reading	Torque Calibrator
Torque Testers, transducers & analyzers ^{1,2}	(0 to 50) lbf·in (50 to 200) lbf·in (200 to 1 100) lbf·in	0.031 lbf·in 0.080 lbf·in 0.27 lbf·in	Torque Wheel, Torque Standard, Calibration Arms, Weights
Force measuring equipment and Load Cells ¹ (Compression and Tension)	(0 to 100 000) lbf	0.071 % of reading + 0.58R	Load Cell
POVA (Piston/Plunger Operated Volumetric Apparatus) ¹ Pipettes, Syringes, Dilutors, Titrators, Piston/Displacement Burettes (Burets), Dispensers, Liquid Handlers	(0.1 to 5) µl (5 to 20) µl (20 to 50) µl (50 to 100) µl (100 to 200) µl (200 to 500) µl (0.5 to 1) ml (1 to 5) ml (5 to 10) ml	2 % of reading 1.3 % of reading 1.3 % of reading 1.6 % of reading 2 % of reading 2 % of reading 2 % of reading 2 % of reading 2 % of reading	Gravimetric Method referenced to OIML Mass Standard and Balances

Mass and Mass Related

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Volumetric Glassware ¹ Volumetric Apparatus, Flasks, Burettes, Volumetric Dispensers, Cylinders, Graduated Cylinders, Beakers, Vials, & Containers	(0.1 to 2) ml (2 to 25) ml (25 to 50) ml (50 to 100) ml (100 to 250) ml (250 to 500) ml (500 to 1 000) ml (1 000 to 2 000) ml	0.35 % of reading 0.16 % of reading 0.15 % of reading 0.12 % of reading 0.11 % of reading 0.1 % of reading 0.1 % of reading 0.1 % of reading	Gravimetric Method referenced to OIML Mass Standard and Balances

Photometry and Radiometry

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power – Measure ¹ 850 nm 1310 nm 1550 nm	(-60 to 6) dB (-110 to 10) dB (-110 to 10) dB	3.4 % of reading + 0.01 dB 3.4 % of reading + 0.01 dB 3.7 % of reading + 0.01 dB	Optical Test System
Optical Wavelength – Measure ¹	(700 to 1 650) nm	3.8 parts in 10 ⁶ of reading	Wavelength Meter

Thermodynamic

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature measuring equipment ¹	(-20 to 660) °C	0.063 °C	Comparison to Standard Thermometers
Relative Humidity Instruments ¹	(10 to 95) %RH	0.57 %RH	Humidity Generator
Radiation (Infrared) Thermometers ¹	-30°C 10°C 32 °C 50 °C 100 °C 150 °C 160°C 200 °C	0.41°C 0.45°C 0.51 °C 0.51 °C 0.65 °C 1.1 °C 1.1°C 1.2 °C	Black Body Calibrators $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$

Thermodynamic

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Radiation (Infrared) Thermometers ¹	300°C 400°C 500°C	1.5°C 2°C 2.8°C	Black Body Calibrator $\varepsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$

Time and Frequency

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹ Fixed Point	10 MHz	6×10^{-11} Hz/Hz	GPS and Frequency Receiver
Frequency – Measure ¹	0.1 Hz to 3 GHz 10 Hz to 46 GHz	7×10^{-11} Hz/Hz 7×10^{-10} Hz/Hz	GPS, Frequency Receiver and Counter
Frequency – Source ¹	0.1 Hz to 10 MHz 10 MHz to 50 GHz	6×10^{-11} Hz/Hz 6×10^{-11} Hz/Hz	GPS, Frequency Receiver and Signal Generator
Photo Tachometer ¹	Up to 100 000 rpm	(0.1×10^{-6}) of reading	Generator with Lamp
Timers, Stopwatches, Chronometers ¹	(0 to 24) hr	0.86 ms	Frequency Counter
	(0 to 24) hr	240 ms	Stopwatch

DIMENSIONAL MEASUREMENT

1 Dimensional

Amherst, NH

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
1D Length Measurement ^{1,2}	Up to 24 in	$(3.3 + 2L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)

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CALIBRATION AND DIMENSIONAL MEASUREMENT

Chemical Quantities

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity ¹	1.49 μ S/cm 99 μ S/cm 1 000 μ S/cm	0.43 μ S/cm 2.1 μ S/cm 2.8 μ S/cm	Standard Conductivity Solutions
pH ^{1,2}	(4, 7, 10) pH	0.03 pH + 0.58R	Standard pH Solutions

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹	(0 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 μ V/V + 0.4 μ V 3.5 μ V/V + 0.70 μ V 2.5 μ V/V + 2.6 μ V 2.5 μ V/V + 4 μ V 3.5 μ V/V + 40 μ V 4.5 μ V/V + 0.4 mV	Multi-Function Calibrator
DC Voltage – Source ¹ Fixed Values	1V 1.018V 10 V	0.96 μ V 0.39 μ V 3.2 μ V	Fluke 732A DC Voltage Standard
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V 100 V to 1 kV	0.66 μ V/V + 1.4 μ V 0.39 μ V/V + 1.0 μ V 0.31 μ V/V + 0.82 μ V 0.39 μ V/V + 1.2 μ V 0.66 μ V/V + 6.0 μ V	DC Voltage Reference Standard, Reference Divider and NULL Detector, Multimeter
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V 100 V to 1 kV	3.5 μ V/V + 0.31 μ V 3.1 μ V/V + 0.31 μ V 2.6 μ V/V + 0.51 μ V 4.5 μ V/V + 30 μ V 4.5 μ V/V + 100 μ V	Multimeter

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Measure ¹ High Voltage	(1 to 60) kV	2 mV/V	Ross VD-60 Voltage Divider
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	35 μ A/A + 6 nA 30 μ A/A + 7 nA 30 μ A/A + 40 nA 40 μ A/A + 0.7 μ A 60 μ A/A + 12 μ A 85 μ A/A + 25 μ A	Multi-Function Calibrator
DC Current – Source ¹	0 to 330 μ A 330 μ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 3.0 A (3.0 to 11 A (11 to 20.5) A	116 μ A/A + 16 nA 78 μ A/A + 24 nA 78 μ A/A + 0.17 μ A 78 μ A/A + 1.7 μ A 155 μ A/A + 32 μ A 388 μ A/A + 270 μ A 775 μ A/A + 590 μ A	Multi-Product Calibrator
DC Current – Source ¹	(10 to 16.5) A (16.5 to 150) A (150 to 1 025) A	2.8 mA/A + 3 mA 2.8 mA/A + 25 mA 3 mA/A + 90 mA	Multi-Product Calibrator with w/50-turn Coil
DC Current – Measure ¹	(0 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	30 μ A/A + 40 pA 15 μ A/A + 40 pA 15 μ A/A + 100 pA 15 μ A/A + 0.8 nA 15 μ A/A + 5 nA 15 μ A/A + 50 nA 30 μ A/A + 0.5 μ A 100 μ A/A + 10 μ A	Multimeter
	(1 to 500) A	0.16 mA/A	Multimeter w/ Current Shunt
	(10 to 550) A	20 mA/A + 0.4A	Current Clamp
Resistance – Source ¹ Fixed Points	1 m Ω 10 m Ω 100 m Ω 1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω	4 $\mu\Omega/\Omega$ 1.6 $\mu\Omega/\Omega$ 1.3 $\mu\Omega/\Omega$ 1.7 $\mu\Omega/\Omega$ 1.7 $\mu\Omega/\Omega$ 1.7 $\mu\Omega/\Omega$ 2 $\mu\Omega/\Omega$ 1.8 $\mu\Omega/\Omega$ 2 $\mu\Omega/\Omega$ 4 $\mu\Omega/\Omega$	Standard Resistors

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ Fixed Points	100 MΩ 1 GΩ 10 GΩ 100 GΩ	0.035 % of reading 0.05 % of reading 0.07 % of reading 0.11 % of reading	Fixed Resistor
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	50 μΩ 95 μΩ/Ω 95 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 10 μΩ/Ω 10 μΩ/Ω 8.5 μΩ/Ω 8.5 μΩ/Ω 8.5 μΩ/Ω 8.5 μΩ/Ω 11 μΩ/Ω 11 μΩ/Ω 20 μΩ/Ω 21 μΩ/Ω 40 μΩ/Ω 47 μΩ/Ω 100 μΩ/Ω	Multi-Function Calibrator
Resistance – Source ¹	(0 to 11) Ω (11 to 110) Ω 110 Ω to 1.1 kΩ (1.1 to 11) kΩ (11 to 110) kΩ 110 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 to 1100) MΩ	31 μΩ/Ω + 0.78 mΩ 23 μΩ/Ω + 1.2 mΩ 22 μΩ/Ω + 1.7 mΩ 22 μΩ/Ω + 17 mΩ 22 μΩ/Ω + 0.17 Ω 25 μΩ/Ω + 1.7 Ω 47 μΩ/Ω + 23 Ω 101 μΩ/Ω + 39 Ω 194 μΩ/Ω + 1.9 kΩ 388 μΩ/Ω + 2.3 kΩ 2.3 mΩ/Ω + 78 kΩ 12 mΩ/Ω + 388 kΩ	Multi-Product Calibrator
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ	15 μΩ/Ω + 50 μΩ 10 μΩ/Ω + 0.5 mΩ 8 μΩ/Ω + 0.5 mΩ 8 μΩ/Ω + 5 mΩ 8 μΩ/Ω + 50 mΩ	HP 3458A Multimeter

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure ¹	100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	12 $\mu\Omega/\Omega$ + 2 Ω 50 $\mu\Omega/\Omega$ + 0.1 k Ω 0.5 m Ω/Ω + 1 k Ω 5 m Ω/Ω + 10 k Ω	HP 3458A Multimeter
AC Voltage – Source ¹	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (2.2 to 22) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz 220 mV to 2.2 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 $\mu\text{V}/\text{V}$ + 4 μV 85 $\mu\text{V}/\text{V}$ + 4 μV 75 $\mu\text{V}/\text{V}$ + 4 μV 180 $\mu\text{V}/\text{V}$ + 4 μV 460 $\mu\text{V}/\text{V}$ + 5 μV 900 $\mu\text{V}/\text{V}$ + 10 μV 1.2 mV/V + 20 μV 2.5 mV/V + 20 μV 220 $\mu\text{V}/\text{V}$ + 4 μV 85 $\mu\text{V}/\text{V}$ + 4 μV 75 $\mu\text{V}/\text{V}$ + 4 μV 180 $\mu\text{V}/\text{V}$ + 4 μV 460 $\mu\text{V}/\text{V}$ + 5 μV 900 $\mu\text{V}/\text{V}$ + 10 μV 1.2 mV/V + 20 μV 2.5 mV/V + 20 μV 220 $\mu\text{V}/\text{V}$ + 12 μV 85 $\mu\text{V}/\text{V}$ + 7 μV 75 $\mu\text{V}/\text{V}$ + 7 μV 180 $\mu\text{V}/\text{V}$ + 7 μV 420 $\mu\text{V}/\text{V}$ + 17 μV 750 $\mu\text{V}/\text{V}$ + 20 μV 1.2 mV/V + 25 μV 2.5 mV/V + 45 μV 220 $\mu\text{V}/\text{V}$ + 40 μV 80 $\mu\text{V}/\text{V}$ + 15 μV 40 $\mu\text{V}/\text{V}$ + 8 μV 70 $\mu\text{V}/\text{V}$ + 10 μV 105 $\mu\text{V}/\text{V}$ + 30 μV 340 $\mu\text{V}/\text{V}$ + 80 μV 900 $\mu\text{V}/\text{V}$ + 200 μV 1.5 mV/V + 300 μV	Multi-Function Calibrator

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) V		Multi-Function Calibrator
	(10 to 20) Hz	220 μ V/V + 400 μ V	
	(20 to 40) Hz	80 μ V/V + 150 μ V	
	40 Hz to 20 kHz	40 μ V/V + 50 μ V	
	(20 to 50) kHz	70 μ V/V + 100 μ V	
	(50 to 100) kHz	95 μ V/V + 200 μ V	
	(100 to 300) kHz	260 μ V/V + 600 μ V	
	(300 to 500) kHz	900 μ V/V + 2 mV	
	500 kHz to 1 MHz	1.3 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	220 μ V/V + 4.0 mV	
	(20 to 40) Hz	80 μ V/V + 1.5 mV	
	40 Hz to 20 kHz	47 μ V/V + 0.6 mV	
	(20 to 50) kHz	75 μ V/V + 1 mV	
	(50 to 100) kHz	130 μ V/V + 2.5 mV	
	(100 to 300) kHz	800 μ V/V + 16 mV	
	(300 to 500) kHz	4.2 mV/V + 40 mV	
	500 kHz to 1 MHz	7 mV/V + 80 mV	
AC Voltage – Measure ¹	(220 to 750) V		Multimeter
	(30 to 50) kHz	0.6 mV/V + 11 mV	
	(50 to 100) kHz	2.3 mV/V + 45 mV	
	220 V to 1.1 kV		
	(15 to 50) Hz	260 μ V/V + 16 mV	
	50 Hz to 1 kHz	60 μ V/V + 3.5 mV	
	Up to 10 mV		
	(1 to 40) Hz	300 μ V/V + 3 μ V	
	40 Hz to 1 kHz	200 μ V/V + 1.1 μ V	
	(1 to 20) kHz	300 μ V/V + 1.1 μ V	
	(20 to 50) kHz	1 mV/V + 1.1 μ V	
	(50 to 100) kHz	5 mV/V + 1.1 μ V	
	(100 to 300) kHz	40 mV/V + 2 μ V	
	(10 to 100) mV		
	(1 to 40) Hz	70 μ V/V + 4 μ V	
	40 Hz to 1 kHz	70 μ V/V + 2 μ V	
	(1 to 20) kHz	140 μ V/V + 2 μ V	
	(20 to 50) kHz	300 μ V/V + 2 μ V	
	(50 to 100) kHz	800 μ V/V + 2 μ V	
	(100 to 300) kHz	3 mV/V + 10 μ V	
	300 kHz to 1 MHz	10 mV/V + 10 μ V	
	(1 to 2) MHz	15 mV/V + 10 μ V	

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	100 mV to 10 V		Multimeter
	(1 to 40) Hz	70 μ V/V + 0.4 mV	
	40 Hz to 1 kHz	70 μ V/V + 0.2 mV	
	(1 to 20) kHz	140 μ V/V + 0.2 mV	
	(20 to 50) kHz	300 μ V/V + 0.2 mV	
	(50 to 100) kHz	800 μ V/V + 0.2 mV	
	(100 to 300) kHz	3 mV/V + 1 mV	
	300 kHz to 1 MHz	10 mV/V + 1 mV	
	(1 to 2) MHz	15 mV/V + 1 mV	
	(10 to 100) V		
	(1 to 40) Hz	200 μ V/V + 4 mV	
	40 Hz to 1 kHz	200 μ V/V + 2 mV	
	(1 to 20) kHz	200 μ V/V + 2 mV	
	(20 to 50) kHz	350 μ V/V + 2 mV	
	(50 to 100) kHz	1.2 mV/V + 2 mV	
	(100 to 300) kHz	4 mV/V + 10 mV	
	300 kHz to 1 MHz	15 mV/V + 10 mV	
AC Voltage – Measure ¹ (Absolute Measurement)	100 V to 1 kV		AC Measurement Standard
	(1 to 40) Hz	400 μ V/V + 40 mV	
	40 Hz to 1 kHz	400 μ V/V + 20 mV	
	(1 to 20) kHz	600 μ V/V + 20 mV	
	(20 to 50) kHz	1.2 mV/V + 20 mV	
	(50 to 100) kHz	3 mV/V + 20 mV	
	2.2 mV Range		
	(10 to 20) Hz	1.1 mV/V + 0.87 μ V	
	(20 to 40) Hz	493 μ V/V + 0.87 μ V	
	40 Hz to 20 kHz	280 μ V/V + 0.87 μ V	
	(20 to 50) kHz	540 μ V/V + 1.3 μ V	
	(50 to 100) kHz	800 μ V/V + 1.7 μ V	
AC Voltage – Measure ¹ (Absolute Measurement)	(100 to 300) kHz	1.5 mV/V + 2.7 μ V	AC Measurement Standard
	(300 to 500) kHz	1.6 mV/V + 4 μ V	
	500 kHz to 1 MHz	2.1 mV/V + 4 μ V	
	7 mV Range		
	(10 to 20) Hz	567 μ V/V + 0.87 μ V	
	(20 to 40) Hz	247 μ V/V + 0.87 μ V	
	40 Hz to 20 kHz	140 μ V/V + 0.87 μ V	
	(20 to 50) kHz	267 μ V/V + 1.3 μ V	
	(50 to 100) kHz	400 μ V/V + 1.7 μ V	
	(100 to 300) kHz	800 μ V/V + 2.7 μ V	
	(300 to 500) kHz	867 μ V/V + 4 μ V	
	500 kHz to 1 MHz	1.3 mV/V + 4 μ V	

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	22 mV Range		AC Measurement Standard
	(10 to 20) Hz	193 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	(20 to 40) Hz	120 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	40 Hz to 20 kHz	73 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	(20 to 50) kHz	140 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	207 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	540 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	573 $\mu\text{V/V} + 4 \mu\text{V}$	
	500 kHz to 1 MHz	933 $\mu\text{V/V} + 4 \mu\text{V}$	
	70 mV Range		
	(10 to 20) Hz	160 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	80 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	43 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	80 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	173 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	340 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	440 $\mu\text{V/V} + 4 \mu\text{V}$	
	500 kHz to 1 MHz	733 $\mu\text{V/V} + 4 \mu\text{V}$	
	220 mV Range		
	(10 to 20) Hz	140 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	56 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	25 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	46 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	107 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	160 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	240 $\mu\text{V/V} + 4 \mu\text{V}$	
	500 kHz to 1 MHz	627 $\mu\text{V/V} + 4 \mu\text{V}$	
	700 mV Range		
	(10 to 20) Hz	140 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	50 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	21 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	33 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	53 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	107 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	200 $\mu\text{V/V} + 4 \mu\text{V}$	
	500 kHz to 1 MHz	600 $\mu\text{V/V} + 4 \mu\text{V}$	

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	2.2 V Range		AC Measurement Standard
	(10 to 20) Hz	133 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	43 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	15 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	30 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	47 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	100 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	167 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	560 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	7 V Range		
	(10 to 20) Hz	133 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	44 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	15 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	31 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	53 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	120 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	253 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	733 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	22 V Range		
	(10 to 20) Hz	133 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	44 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	17 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	31 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	53 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	120 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	253 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	733 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	70 V Range		
	(10 to 20) Hz	133 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	20 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	37 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	61 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	127 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	267 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	733 $\mu\text{V/V} + 0.58 \mu\text{V}$	

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	220 V Range		AC Measurement Standard
	(10 to 20) Hz	133 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	19 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	45 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	64 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(100 to 300) kHz	140 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(300 to 500) kHz	293 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	700 V Range		
	(10 to 20) Hz	133 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	64 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	26 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	80 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	267 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	1 000 V Range		
	(10 to 20) Hz	133 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	64 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	25 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	80 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	267 $\mu\text{V/V} + 5.8 \mu\text{V}$	
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	2.2 mV Range		AC Measurement Standard
	(10 to 30) Hz	667 $\mu\text{V/V} + 0.06 \mu\text{V}$	
	(30 to 120) Hz	333 $\mu\text{V/V} + 0.06 \mu\text{V}$	
	120 Hz to 1.2 kHz	333 $\mu\text{V/V} + 0.06 \mu\text{V}$	
	(1.2 to 120) kHz	333 $\mu\text{V/V} + 0.06 \mu\text{V}$	
	(120 to 500) kHz	467 $\mu\text{V/V} + 0.67 \mu\text{V}$	
	500 kHz to 1.2 MHz	467 $\mu\text{V/V} + 0.67 \mu\text{V}$	
	(1.2 to 2) MHz	467 $\mu\text{V/V} + 0.67 \mu\text{V}$	
	(2 to 10) MHz	1.1 mV/V + 0.67 μV	
	(10 to 20) MHz	2.0 mV/V + 0.67 μV	
	(20 to 30) MHz	4.7 mV/V + 1.3 μV	

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	7 mV Range		AC Measurement Standard
	(10 to 30) Hz	667 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(30 to 120) Hz	333 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	120 Hz to 1.2 kHz	333 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(1.2 to 120) kHz	333 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(120 to 500) kHz	467 $\mu\text{V/V} + 0.67 \mu\text{V}$	
	500 kHz to 1.2 MHz	467 $\mu\text{V/V} + 0.67 \mu\text{V}$	
	(1.2 to 2) MHz	467 $\mu\text{V/V} + 0.67 \mu\text{V}$	
	(2 to 10) MHz	667 $\mu\text{V/V} + 0.67 \mu\text{V}$	
	(10 to 20) MHz	1.1 mV/V + 0.67 μV	
	(20 to 30) MHz	2.5 mV/V + 0.67 μV	
	22 mV Range		
	(10 to 30) Hz	667 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(30 to 120) Hz	333 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	120 Hz to 1.2 kHz	333 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(1.2 to 120) kHz	333 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(120 to 500) kHz	467 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1.2 MHz	467 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(1.2 to 2) MHz	467 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(2 to 10) MHz	667 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(10 to 20) MHz	1.1 mV/V + 0.058 μV	
	(20 to 30) MHz	2.5 mV/V + 0.058 μV	
	70 mV Range		
	(10 to 30) Hz	667 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(30 to 120) Hz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	120 Hz to 1.2 kHz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(1.2 to 120) kHz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(120 to 500) kHz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1.2 MHz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(1.2 to 2) MHz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(2 to 10) MHz	667 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(10 to 20) MHz	1 mV/V + 0.58 μV	
	(20 to 30) MHz	2.3 mV/V + 0.58 μV	

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	220 mV Range		AC Measurement Standard
	(10 to 30) Hz	667 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(30 to 120) Hz	267 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	120 Hz to 1.2 kHz	267 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(1.2 to 120) kHz	267 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(120 to 500) kHz	267 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1.2 MHz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(1.2 to 2) MHz	333 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(2 to 10) MHz	667 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(10 to 20) MHz	1 mV/V + 0.58 μV	
	(20 to 30) MHz	2.3 mV/V + 0.58 μV	
	700 mV Range		
	(10 to 30) Hz	667 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(30 to 120) Hz	200 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	120 Hz to 1.2 kHz	200 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(1.2 to 120) kHz	200 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(120 to 500) kHz	200 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	500 kHz to 1.2 MHz	333 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(1.2 to 2) MHz	333 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(2 to 10) MHz	667 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(10 to 20) MHz	1 mV/V + 5.8 μV	
	(20 to 30) MHz	2.3 mV/V + 5.8 μV	
	2.2 V Range		
	(10 to 30) Hz	667 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(30 to 120) Hz	200 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	120 Hz to 1.2 kHz	200 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(1.2 to 120) kHz	200 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(120 to 500) kHz	200 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	500 kHz to 1.2 MHz	333 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(1.2 to 2) MHz	333 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(2 to 10) MHz	667 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(10 to 20) MHz	1 mV/V + 5.8 μV	
	(20 to 30) MHz	2.3 mV/V + 5.8 μV	

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	7 V Range (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	667 $\mu\text{V/V} + 5.8 \mu\text{V}$ 200 $\mu\text{V/V} + 5.8 \mu\text{V}$ 200 $\mu\text{V/V} + 5.8 \mu\text{V}$ 200 $\mu\text{V/V} + 5.8 \mu\text{V}$ 200 $\mu\text{V/V} + 5.8 \mu\text{V}$ 333 $\mu\text{V/V} + 5.8 \mu\text{V}$ 333 $\mu\text{V/V} + 5.8 \mu\text{V}$ 667 $\mu\text{V/V} + 5.8 \mu\text{V}$ 1.0 mV/V + 5.8 μV 2.3 mV/V + 5.8 μV	AC Measurement Standard
AC Voltage – Measure ¹	(1 to 60) kV (20 to 100) Hz	2 mV/V	Ross VD-60 Voltage Divider
Phase – Measure ¹	(0.01 to 360) $^{\circ}$ (10 to 60) mV 10 Hz to 10 kHz (10 to 40) kHz (40 to 100) kHz (60 to 250) mV 10 Hz to 40 kHz (40 to 100) kHz (0.25 to 10) V 10 Hz to 40 kHz (40 to 100) kHz (10 to 120) V 10 Hz to 40 kHz (40 to 100) kHz	0.23 $^{\circ}$ 0.4 $^{\circ}$ 0.79 $^{\circ}$ 0.07 $^{\circ}$ 0.4 $^{\circ}$ 0.06 $^{\circ}$ 0.4 $^{\circ}$ 0.08 $^{\circ}$ 0.4 $^{\circ}$	Precision Phase Meter
AC Current – Source ¹	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 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	230 $\mu\text{A/A} + 16 \text{ nA}$ 140 $\mu\text{A/A} + 10 \text{ nA}$ 110 $\mu\text{A/A} + 8.0 \text{ nA}$ 250 $\mu\text{A/A} + 12 \text{ nA}$ 900 $\mu\text{A/A} + 65 \text{ nA}$ 230 $\mu\text{A/A} + 40 \text{ nA}$ 140 $\mu\text{A/A} + 35 \text{ nA}$ 110 $\mu\text{A/A} + 35 \text{ nA}$ 180 $\mu\text{A/A} + 110 \text{ nA}$ 900 $\mu\text{A/A} + 650 \text{ nA}$	Multi-Function Calibrator

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(2.2 to 22) mA		Multi-Function Calibrator
	(10 to 20) Hz	250 μ A/A + 400 nA	
	(20 to 40) Hz	140 μ A/A + 350 nA	
	40 Hz to 1 kHz	110 μ A/A + 350 nA	
	(1 to 5) kHz	180 μ A/A + 550 nA	
	(5 to 10) kHz	900 μ A/A + 5.0 μ A	
	(22 to 220) mA		
	(10 to 20) Hz	230 μ A/A + 4.0 μ A	
	(20 to 40) Hz	140 μ A/A + 3.5 μ A	
	40 Hz to 1 kHz	110 μ A/A + 2.6 μ A	
	(1 to 5) kHz	180 μ A/A + 3.5 μ A	
	(5 to 10) kHz	900 μ A/A + 10 μ A	
AC Current – Source ¹	220 mA to 2.2 A		Multi-Product Calibrator w/50-turn coil
	20 Hz to 1 kHz	240 μ A/A + 35 μ A	
	(1 to 5) kHz	390 μ A/A + 80 μ A	
	(5 to 10) kHz	6.0 mA/A + 160 μ A	
	1.45 mA to 16.5 A		
	(45 to 65) Hz	2.8 mA/A + 3 mA	
	(65 to 440) Hz	7.9 mA/A + 3 mA	
	(16.5 to 150) A		
AC Current – Measure ¹	(45 to 65) Hz	2.8 mA/A + 25 mA	Multimeter
	(65 to 440) Hz	7.9 mA/A + 27 mA	
	(150 to 1 025) A		
	(45 to 65) Hz	3 mA/A + 90 mA	
	(65 to 440) Hz	8 mA/A + 100 mA	
	Up to 100 μ A		
	(10 to 20) Hz	4 mA/A + 0.03 μ A	
	(20 to 45) Hz	1.5 mA/A + 0.03 μ A	
	(45 to 100) Hz	0.6 mA/A + 0.03 μ A	
	100 Hz to 5 kHz	0.6 mA/A + 0.03 μ A	
	100 μ A to 100 mA		
	(10 to 20) Hz	4.0 mA/A + 0.2 μ A	
	(20 to 45) Hz	1.5 mA/A + 0.2 μ A	
	(45 to 100) Hz	0.60 mA/A + 0.2 μ A	
	100 Hz to 5 kHz	0.31 mA/A + 0.2 μ A	
	(5 to 20) kHz	0.60 mA/A + 0.2 μ A	
	(20 to 50) kHz	4.0 mA/A + 0.4 μ A	
	(50 to 100) kHz	5.5 mA/A + 1.5 μ A	

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(1 to 10) mA (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 (50 to 100) kHz (10 to 100) mA (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 (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 mA/A + 2 μ A 1.5 mA/A + 2 μ A 0.6 mA/A + 2 μ A 0.31 mA/A + 2 μ A 0.6 mA/A + 2 μ A 4 mA/A + 4 μ A 5.5 mA/A + 15 μ A 4 mA/A + 20 μ A 1.5 mA/A + 20 μ A 0.6 mA/A + 20 μ A 0.31 mA/A + 20 μ A 0.6 mA/A + 20 μ A 40 mA/A + 40 μ A 5.5 mA/A + 0.15 mA 4mA/A + 0.2 mA 1.6 mA/A + 0.2 mA 0.80 mA/A + 0.2 mA 1 mA/A + 0.2 mA 3 mA/A + 0.2 mA 10 mA/A + 0.4 mA	Multimeter
AC High Current – Measure ¹	(1 to 20) A 45 Hz to 1 kHz (1 to 10) kHz (20 to 100) A 45 Hz to 1 kHz	0.16 mA/A 0.16 mA/A 0.16 mA/A	Multimeter w/Current Shunt
AC Resistance – Source ¹ 100 Hz to 100 kHz	0 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω	130 $\mu\Omega$ 170 $\mu\Omega$ 1.5 m Ω 4.7 m Ω 46 m Ω 460 m Ω 4.6 Ω 46 Ω	Calibration RL Standard
AC Resistance – Source and Measure ¹ 100 Hz to 100 kHz	1 m Ω to 10 M Ω	0.5 m Ω/Ω + 0.58 $\mu\Omega$	RLC Digibridge and Calibration RL Standard

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ 50 Hz to 1 kHz	(0.19 to 0.4) nF (0.4 to 1.1) nF (1.1 nF to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF 330 μF to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 1.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 78 pF 1.9 mF/F + 233 pF 1.9 mF/F + 0.78 nF 1.9 mF/F + 2.3 nF 1.9 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.5 mF/F + 78 nF 3.5 mF/F + 233 nF 3.5 mF/F + 0.78 μF 3.5 mF/F + 2.3 μF 3.5 mF/F + 7.8 μF 5.8 mF/F + 23 μF 8.5 mF/F + 78 μF	Multi-Product Calibrator
Capacitance – Source ^{1,2}	(1, 10, 100, 1000) pF (1, 100) nF	2 μF/F + 0.58R 0.000 5% of reading	Fixed Capacitor
Capacitance – Measure ¹	12 Hz to 100 kHz 0.001 pF to 1 nF 1 nF to 1.1 μF 1.1 μF to 1 mF	67 μF/F 62 μF/F 0.1 mF/F	GenRad 1689 RLC Digibridge and Standard Capacitors
Inductance – Source ^{1,2} 100 Hz to 10 kHz	100 μH to 1.111 H	0.41 mH/H + 0.58R	Decade Inductor
Inductance – Measure ¹	12 Hz to 100 kHz 0.01 μH to 10 H	0.2 mH/H + 0.058 μH	GenRad 1689 RLC Digibridge
Electrical Stimulation of Thermocouple Indicators ¹	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C 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	0.36 °C 0.29 °C 0.26 °C 0.28 °C 0.26 °C 0.22 °C 0.26 °C 0.4 °C 0.66 °C	Multi-Product Calibrator

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Stimulation of Thermocouple Indicators ¹	Type E		Multi-Product Calibrator
	(-250 to -100) °C	0.43 °C	
	(-100 to -25) °C	0.14 °C	
	(-25 to 350) °C	0.11 °C	
	(350 to 650) °C	0.14 °C	
	(650 to 1 000) °C	0.18 °C	
	Type J		
	(-210 to -100) °C	0.23 °C	
	(-100 to -30) °C	0.14 °C	
	(-30 to 150) °C	0.11 °C	
	(150 to 760) °C	0.15 °C	
	(760 to 1 200) °C	0.2 °C	
	Type K		
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.16 °C	
	(-25 to 120) °C	0.14 °C	
	(120 to 1 000) °C	0.22 °C	
	(1 000 to 1 372) °C	0.34 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.19 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 410) °C	0.16 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type S		
	(0 to 250) °C	0.38 °C	
	(250 to 1 400) °C	0.49 °C	
	(1 400 to 1 767) °C	0.46 °C	
	Type T		
	(-250 to -150) °C	0.59 °C	
	(-150 to 0) °C	0.54 °C	
	(0 to 400) °C	0.57 °C	

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Stimulation of RTD Indicators ¹	Pt 385, 100 Ω		Multi-Product Calibrator
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.031 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	

Electrical – DC/Low Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Stimulation of RTD Indicators ¹	Pt 385, 500 Ω		Multi-Product Calibrator
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.039 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.062 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.062 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.085 °C	
	Pt 385, 1 k Ω		
	(-200 to -80) °C	0.023 °C	
	(-80 to 0) °C	0.023 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.047 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.054 °C	
	(400 to 600) °C	0.054 °C	
	(600 to 630) °C	0.18 °C	
	PtNi 385, 100 Ω		
	(-80 to 0) °C	0.062 °C	
	(0 to 100) °C	0.062 °C	
	(100 to 260) °C	0.11 °C	
	Cu 427, 10 Ω		
	(-100 to 260) °C	0.23 °C	
Oscilloscopes ^{1,2} Square Wave Signal 50 Ω at 1 kHz 1 M Ω at 1 kHz Pulse & Rise Time 0.5, 1 V (pp) 10 MHz 1 V (pp) 1 MHz Time Mark Output Into 50 ohms	± 1 mVp-p to ± 6.6 Vp-p ± 1 mVp-p to ± 130 Vp-p 0.5, 1 V (pp) 10 MHz 1 V (pp) 1 MHz 2 ns to 20 ms 50 ms to 5 s	1 mV/V + 40 μ V 4 mV/V + 40 μ V 0.4 ns 0.4 ns (25 + 1 000t) parts in 10 ⁶ s 25 parts in 10 ⁶ of reading	Fluke 5500A/SC1100 Multi-Product Calibrator
Oscilloscopes ¹ Leveled Sinewave Flatness	(0.005 to 5.5) V 50 kHz Reference 50 kHz to 100 MHz (100 to 1 000) MHz	2.4 % of reading + 0.3 nV 2.5 % of reading + 0.3 nV 4.3 % of reading + 0.3 nV	Fluke 5500A/SC1100 Multi-Product Calibrator

Electrical – RF/Microwave

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power – Power Meter Reference ¹	1 mW 50 MHz	1.1 % of Reading	Power Meter (432A), Thermistor Mount (8478B) and Multimeter (3458A)
RF Power Meter ^{1,2}	3 μ W to 100 mW	0.35 % of Watts output + 0.58R	Range Calibrator
RF Power Sensors – Calibration Factors ^{1,5}	Referenced to 1 mW (9 to 300) kHz 300 kHz to 50 MHz 50 MHz to 5 GHz (5 to 10) GHz (10 to 18) GHz (18 to 26.5) GHz (26 to 27) GHz (27 to 30) GHz (30 to 34) GHz (34 to 40) GHz (40 to 42) GHz (42 to 48) GHz (48 to 50) GHz	1.1 % 1 % 0.84 % 0.87 % 0.92 % 1.7 % 1.9 % 2 % 1.9 % 2 % 2.6 % 2.9 % 3.4 %	Thermistor Mount and Thermocouple Power Sensors
Tuned RF Power, Relative – Measure ¹ 150 kHz to 26.5 GHz	(-3 to 0) dB (-10 to -3) dB (-40 to -10) dB (-50 to -40) dB (-80 to -50) dB (-90 to -80) dB (-110 to -90) dB (-127 to -110) dB	0.04 dB 0.03 dB 0.07 dB 0.08 dB 0.09 dB 0.11 dB 0.14 dB 0.2 dB	Agilent 8902A Measuring Receiver with Agilent 11722A, Agilent 11793A, Agilent 11792A Power Sensors
RF Absolute Power – Measure ¹	(-30 to 20) dB 100 kHz to 2.6 GHz 100 kHz to 4.2 GHz 10 MHz to 16.5 GHz 10 MHz to 26.5 GHz 50 MHz to 50 GHz	0.6 dB 0.65 dB 0.68 dB 0.69 dB 0.84 dB	Agilent 438A Power Meter, Agilent 8902A Measuring Receiver, Agilent 11722A, Agilent 8482A, Agilent 11792A, Agilent 8485A, Agilent 8487A Power Sensors

Electrical – RF/Microwave

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹	Rate: 150 kHz to 10 MHz (5 to 99) % Depth 50 Hz to 10 kHz 20 Hz to 100 kHz Rate: 10 MHz to 1.3 GHz (5 to 99) % Depth 50 Hz to 50 kHz 20 Hz to 100 kHz	4 % Depth 4.6 % Depth 3.6 % Depth 4.6 % Depth	Agilent 8902A Measuring Receiver Sensor Module
	Rate: 1.3 GHz to 26.5 GHz (5 to 99) % Depth 50 Hz to 50 kHz 20 Hz to 100 kHz	3.7 % Depth 4.7 % Depth	Agilent 8902A Measuring Receiver with Agilent 11793A Power Sensor
Frequency Modulation – Measure ¹	Rate: 250 kHz to 10 MHz Dev: ≤ 40 kHz 20 Hz to 10 kHz Rate: 10 MHz to 1.3 GHz Dev: ≤ 400 kHz 20 Hz to 200 kHz 50 Hz to 100 kHz	3.1 % of reading 7.7 % of reading 1.6 % of reading	Agilent 8902A Measuring Receiver
	Rate: (1.3 to 26.5) GHz 20 Hz to 100 kHz 50 Hz to 100 kHz	7.7 % of reading 1.6 % of reading	Agilent 8902A Measuring Receiver with Agilent 11793A Power Sensor
Phase Modulation – Measure ¹	Rate: 10 MHz to 1.3 GHz 200 Hz to 20 kHz	7 % of reading	Agilent 8902A Measuring Receiver
Phase Modulation – Measure ¹	Rate: 1.3 GHz to 26.5 GHz 200 Hz to 20 kHz	7.4 % of reading	Agilent 8902A Measuring Receiver with Agilent 11793A Power Sensor
Distortion – Measure ¹ 20 Hz to 20 kHz (20 to 100) kHz	(0 to 99.9) dB (50 to 500) kHz (50 to 500) kHz	1.3 dB 2.4 dB	HP 8903B Audio Analyzer
Harmonic Measurements ¹	(-90 to 0.01) dB 3 Hz to 26.5 GHz (26.5 to 50) GHz	1 dB 1.5 dB	Spectrum Analyzer Agilent E4440A HP 8565E
Reflection S11/ S22 – Measure ^{1,5} Type N	(0 to 1.0) -180 ° to 180 ° 300 kHz to 6 GHz (6 to 26.5) GHz (26.5 to 50) GHz	0.028 1.2 ° 0.036 1.4 ° 0.037 1.7 °	HP 8753E, HP 8510C Network Analyzers

Length – Dimensional Metrology

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 48 in	$(6.4 + 6.8L) \mu\text{in} + 0.58R$	Gage Blocks
Height Gages ^{1,2}	Up to 48 in	$(28 + 1.8L) \mu\text{in} + 0.58R$	Gage Blocks
Micrometers ^{1,2} External, Internal, Depth, Bore and Micrometer Head	Up to 48 in	$(3.6 + 6.8L) \mu\text{in} + 0.58R$	Gage Blocks
Indicators ¹ Dial Gauge, Dial Test Indicator, LVDTs	Up to 4 in	$(12 + 4.6L) \mu\text{in} + 0.58R$	Universal Length Measuring Machine, Indicator Tester
Indicators ¹ Dial Gauge, Dial Test Indicator, LVDTs	Up to 4 in	$(2.6 + 2.5L) \mu\text{in} + 0.58R$	Gage Block, Comparator Stand
Length Standards ²	(0.01 to 48) in	$(30 + 5L) \mu\text{in}$	Universal Comparator
Thread Plug Gages ² (Cylindrical and Taper) Simple Pitch Diameter Major Diameter	(0.04 to 12) in	$(44 + 2.6L) \mu\text{in}$ $(14 + 1.2L) \mu\text{in}$	Universal Length Measuring Machine, Thread Wires; Gage Blocks
Thread Ring Gages ² (Cylindrical and Taper) Simple Pitch Diameter Minor Diameter	(0.112 to 12) in	$(59 + 0.48L) \mu\text{in}$ $(15 + 1.2L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks, Master Thread Plug Set
Plain External Diameter ^{1,2} (Cylindrical and Taper)	(0.001 to 12) in	$(12 + 1.6L) \mu\text{in}$	Universal Length Measuring Machine, High-Accuracy Micrometer, Gage Blocks
Plain Internal Diameter ² (Cylindrical and Taper)	(0.04 to 12) in	$(13 + 2.2L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Gage Blocks ² Length (Deviation of the length at any point from nominal length)	(0.05 to 6) in	$(3 + 1.1L) \mu\text{in}$	Labmaster®, Vertical Reference Blocks
Variation in length	Up to 0.02 in	5.9 μin	

Length – Dimensional Metrology

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks ² Length (Deviation of the length at any point from nominal length) Variation in length	(0.05 to 4) in (4 to 20) in Up to 0.02 in	(6.3 + 0.65L) μin (4.3 + 1.0L) μin 5.9 μin	Gage Blocks, Universal Length Measuring Machine
Thread Wires	(0.003 to 0.15) in (4 to 120) T.P.I.	10 μin	Universal Length Measuring Machine, Gage Blocks
Rigid Rules	Up to 20ft	0.002 in + 0.001 in/ft	Glass Scales Steel Rules
Surface Roughness Testers for Ra-Ry ¹	4 μin, 120 μin 250 μin	2.6 μin	Roughness Specimen
Optical Comparators and Vision Systems /Measuring Microscope ¹ X/Y/Z Axis	Up to 12 in	118 μin	Gage Blocks
Surface Plates ¹ Local Area Flatness Only (Repeat Reading)	(12 × 12) in to (72 × 144) in	250 μin	Repeat-o-Meter
Length Measuring Machine, Linear Measurement ^{1,2}	Up to 24 in	(3.3 + 2L) μin	Gage Blocks
Thickness Gauge / Feeler Gauge ^{1,2}	(0.001 to 1) in	(12 + 0.17L) μin	Universal Length Measuring Machine, High-Accuracy Micrometer, Gage Block
Snap Gages ² (External / Internal)	(0.001 to 24) in	(12 + 1.6L) μin	Universal Length Measuring Machine, Gage Block
Spherical Diameter, Standard Ball, Steel Ball ²	(0.001 to 4) in	(10 + 1.2L) μin	Universal Length Measuring Machine, Gage Block
Setting Rod, Micrometer Standard ²	(0.001 to 24) in	(18 + 2.3L) μin	Universal Length Measuring Machine, Gage Blocks

Mass and Mass Related

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure ¹	(-15 to 100) psi (100 to 500) psi	0.01 psi + 0.01 % of reading 0.05 psi + 0.01 % of reading	Pressure Calibrator
	(100 to 10 000) psi	0.01 psi + 0.036 % of reading	Dead Weight Tester
Pressure, Absolute	(0 to 30) psia	0.01 psi + 0.036 % of reading	Pressure Calibrator
Vacuum	(0.01 to 760) Torr	10 % of reading	Reference Vacuum Gage
Torque Tools ¹	1 ozf·in to 1 000 lbf·ft	0.54 % of reading	Torque Calibrators
Torque Analyzers	10 lbf·in to 250 lbf·ft	0.12 % of reading + 1.2R	Torque Arm and Weights
Force ¹ – Compression and Tension	(1 to 500) lbf (500 to 12 000) lbf (12 000 to 50 000) lbf	0.12 lbf 3.5 lbf 0.1 % of reading	Load Stand Proving Ring, Load Cell
Mass ²	Up to 100 mg (100 to 1 000) mg (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 500) g (500 to 1 000) g (1 to 2) kg (2 to 5) kg (5 to 10) kg (10 to 25) kg (25 to 50) kg	1 µg 1.5 µg 3.2 µg 5.5 µg 9.2 µg 12.5 µg 28 µg 50 µg 81 µg 0.5 mg 1 mg 2.5 mg 0.25 g 0.6 g 0.17 × 10 ⁻⁶ kg/kg	Class 1 Weights and Balance
Scales and Balances ^{1,3}	Up to 2 g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 500) g (500 to 1 000) g (1 to 2) kg (2 to 5) kg (5 to 10) kg (10 to 25) kg	3.2 µg 5.5 µg 9.2 µg 13 µg 28 µg 50 µg 81 µg 0.5 mg 1 mg 2.5 mg 0.25 g 0.6 g	Class E1, E2, F and F1 Weights

Mass and Mass Related

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales and Balances ^{1,3}	(0.01 to 50) lb (50 to 100) lb (100 to 500) lb (500 to 1 000) lb	0.013 g 0.03 g 1.5 g 2.4 g	Class E1, E2, F and F1 Weights
POVA (Piston/Plunger Operated Volumetric Apparatus) ¹ Pipettes, Syringes, Dilutors, Titrators, Piston/Displacement Burettes (Burets), Dispensers, Liquid Handlers	(0.1 to 5) µl (5 to 20) µl (20 to 50) µl (50 to 100) µl (100 to 200) µl (200 to 500) µl 500 µl to 1 ml (1 to 5) ml (5 to 10) ml	1.8 % of reading 0.81 % of reading 0.75 % of reading 1 % of reading 1 % of reading 1.3 % of reading 1.3 % of reading 1.3 % of reading 1.3 % of reading	Gravimetric Method referenced to OIML Class E1 Mass Standard and Balances
Volumetric Glassware ¹ Volumetric Apparatus, Flasks, Burettes, Volumetric Dispensers, Cylinders, Graduated Cylinders, Beakers, Vials, & Containers	(0.1 to 2) ml (2 to 25) ml (25 to 50) ml (50 to 100) ml (100 to 250) ml (250 to 500) ml (500 to 1 000) ml (1 000 to 2 000) ml	0.36 % of reading 0.15 % of reading 0.13 % of reading 0.1 % of reading 0.08 % of reading 0.05 % of reading 0.04 % of reading 0.04 % of reading	Gravimetric Method referenced to OIML Class E1 Mass Standard and Balances
Flow	(0.001 to 250) l/min	1.5 % of reading	Standard Flow Sensors
Air Velocity	(400 to 7 400) ft/min	2.6 % of reading	Digital Anemometer

Photometry and Radiometry

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power - Measure (400-1 600) nm	(0 to 1 000) mW	3 % of reading	Newport 818 Photodetector
	(0.01 to 1.0) W (1 to 100) W	2.8 % of reading 4.2 % of reading	Coherent PM-3 Power Meter Coherent LM-10, LM-100 Power Sensors
Optical Wavelength – Measure	(700 to 1 650) nm	0.007 nm	Agilent 86120B Wavelength Meter
UV and Visible Spectrophotometry	(240 to 1 640) nm	0.16 nm	Aqueous Solution and Reference Filters

Thermodynamic

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity – Measure ¹	(10 to 95) %RH	0.72 %RH	Vaisala HMi41 Humidity Indicator
Dew Point	(-80 to 20) °C	1.8 °C	Vaisala MI70/DMP74B Humidity Indicator and Probe
Humidity – Source	(10 to 95) %RH	3 %RH	Espec BTX-475 Chamber
Humidity – Source	11 %RH 33 %RH 75 %RH 97 %RH	0.6 %RH 0.9 %RH 1.1 %RH 1.2 %RH	Saturated Salt Solutions
Radiation (Infrared) Thermometers ¹	(0 to 50) °C (50 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 500) °C	0.76 °C 1 °C 1.4 °C 1.8 °C 2.3 °C 3.1 °C	Blackbody Calibrator (Flat plate) $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers ¹	(0 to 100) °C (100 to 200) °C (300 to 400) °C (400 to 600) °C (600 to 800) °C (800 to 1 000) °C	0.64 °C 1.2 °C 1.9 °C 3 °C 4.2 °C 5.2 °C	Blackbody Calibrator (Cavity shape) $\epsilon = 0.995$, $\lambda = (8 \text{ to } 14) \mu\text{m}$ $T \leq 230$ $\lambda = (0.7 \text{ to } 1.8) \mu\text{m}$ $T > 230$
Temperature – Source	(-80 to 300) °C	0.1 °C	Hart 7013 Bath
Temperature Source	(-70 to 180) °C	0.9 °C	Espec BTX-475 Chamber
Temperature – Measure ¹	(-40 to -200) °C (0 to -40) °C (0 to 160) °C (160 to 230) °C (230 to 420) °C (420 to 660) °C	0.016 °C 0.006 °C 0.009 °C 0.012 °C 0.02 °C 0.039 °C	Hart 5614 PRT Hart 5626 PRT

Time and Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Measuring Equipment ¹	10 MHz	6.1×10^{-12} Hz/Hz	GPS Receiver

Time and Frequency

San Jose, CA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Measuring Equipment ¹	0.01 Hz to 50 GHz	6.1×10^{-12} Hz/Hz	GPS Receiver, Signal Generator
Frequency – Measure ¹	0.01 Hz to 12.4 GHz (12.4 to 50) GHz	2.2×10^{-12} Hz/Hz 5.9×10^{-12} Hz/Hz	GPS Receiver and Counter
Time Interval – Measure ¹	2 ps to 10 s	0.21 % of reading + 0.07 ps	Oscilloscope
Elapsed Time ¹	1 s to 24 hr	0.9 ms	GPS Receiver, Generator, Counter
Photo Tachometer ^{1,2}	Up to 100 000 rpm	0.000 25 % of reading + 0.58R	Multi-Product Calibrator, Signal Generator with LED

DIMENSIONAL MEASUREMENT

Dimensional Measurement 1D

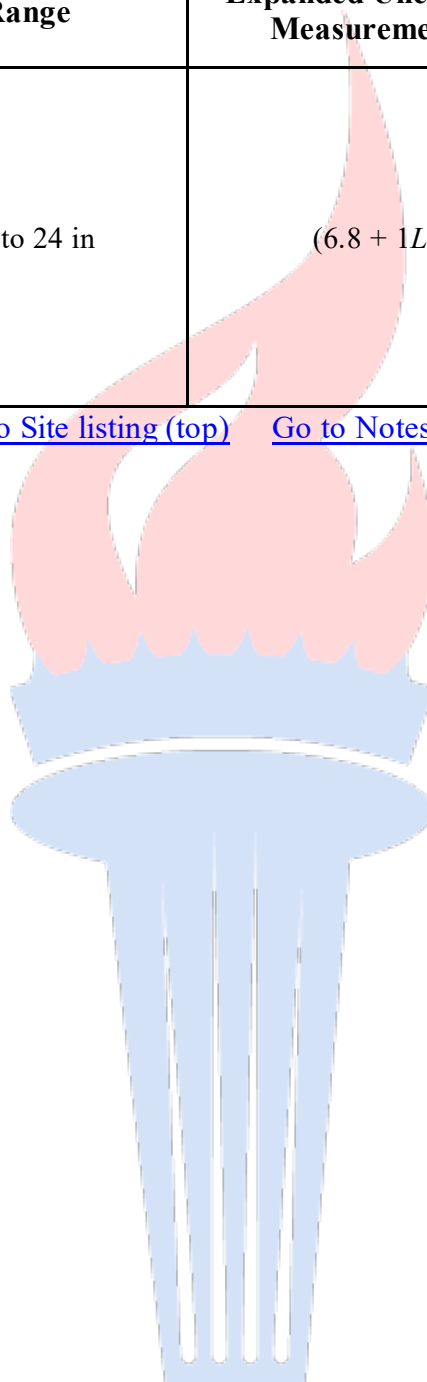
Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inspection Fixtures 1D Features ² Riser Blocks, Straight Edges, Bar Parallels	Up to 24 in	$(6.8 + 1L) \mu\text{in}$	Universal Length Measuring Machine, Electric Comparator, Gage Blocks, Granite Surface Plate, Profile Projector, Hand Tools, Inclinator, Cylindrical Square

Dimensional Measurement 2D

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inspection Fixtures 2D Features ² Angle Block, V-Blocks, Riser Blocks, Straight Edges Parallel Bars, Machine Squares, Precision Squares Radius Gauge, Chamfer Gauge, Taper Gauge Attribute Gauges – Go/NoGo Dedicated Fixture Gauges	Up to 24 in	$(6.8 + 1L) \mu\text{in}$	Universal Length Measuring Machine, Electric Comparator, Gage Blocks, Granite Surface Plate, Profile Projector, Hand Tools, Inclinator, Cylindrical Square

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)



Services performed at satellite laboratory

Micro Precision Calibration, Inc.

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Monroe, WA 98272
Norma Vazquez 530-268-1860
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CALIBRATION

Chemical Quantities

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters ^{1,4}	4.66 μ S/cm 9.40 μ S/cm 100.7 μ S/cm 1,413 μ S/cm 99,890 μ S/cm	0.38 μ S/cm 0.46 μ S/cm 3.8 μ S/cm 7.5 μ S/cm 460 μ S/cm	Standard Conductivity Solutions
pH Meters ^{1,4}	(4, 7, 10) pH	0.016 pH	Standard pH Solutions

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹	(0 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 μ V/V + 0.4 μ V 5 μ V/V + 0.7 μ V 3.5 μ V/V + 2.6 μ V 3.5 μ V/V + 4 μ V 5 μ V/V + 40 μ V 6.5 μ V/V + 0.4 mV	Multi-Function Calibrator
DC Voltage – Source ¹ Fixed Values	1 V 1.018V 10 V	1.7 μ V/V 1.7 μ V/V 1.3 μ V/V	DC Reference Standard
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	3.5 μ V/V + 0.31 μ V 3.1 μ V/V + 0.31 μ V 2.6 μ V/V + 0.51 μ V 4.5 μ V/V + 30 μ V 4.5 μ V/V + 0.1 mV	Multimeter
DC High Voltage – Measure ¹	(0 to 10) kV (10 to 70) kV	0.3 mV/V + 0.031 V 0.4 mV/V + 0.2 V	High Voltage Meter with Probe

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source ¹	(0 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	40 μ A/A + 6 nA 35 μ A/A + 7 nA 35 μ A/A + 40 nA 45 μ A/A + 0.7 μ A 80 μ A/A + 12 μ A	Multi-Function Calibrator
DC High Current – Source ¹	(0 to 11) A (11 to 20) A	0.17 mA/A 0.66 mA/A	Multi-Product Calibrator
	(0 to 1 000) A	2.1 mA/A	Multi-Product
DC Current – Measure ¹	(0 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	30 μ A/A + 40 pA 15 μ A/A + 40 pA 15 μ A/A + 0.1 nA 15 μ A/A + 0.8 nA 15 μ A/A + 5 nA 15 μ A/A + 50 nA 30 μ A/A + 0.5 μ A 100 μ A/A + 10 μ A	Multimeter
	(0 to 50) A (50 to 500) A	0.25 mA/A 1 mA/A + 8.7 mA	Current Shunt w/Multimeter
Inductance – Source ¹ 100 Hz to 10 kHz 100 Hz to 1 kHz	100 μ H 1 mH 10 mH 100 mH 1 H 10 H	0.26 mH/H 0.22 mH/H 0.22 mH/H 0.23 mH/H 0.20 mH/H 0.21 mH/H	Inductors
Inductance – Measure ¹ 12 Hz to 100 kHz	100 μ H to 10 H	0.4 mH/H	RLC Digibridge
Resistance – Source ¹ Fixed Points	0.001 Ω 0.01 Ω 0.1 Ω 1 Ω	200 $\mu\Omega/\Omega$ 60 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$	Standard Resistors
Resistance – Source ¹ Fixed Points	10 Ω 10 k Ω	14 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$	Standard Resistors
Resistance – Source ¹	(1 to 10) M Ω (10 to 100) M Ω (0.1 to 1) G Ω (1 to 10) G Ω (10 to 100) G Ω	0.021 m Ω/Ω 0.1 m Ω/Ω 0.31 m Ω/Ω 3.6 m Ω/Ω 3.8 m Ω/Ω	High Resistor Decade, IET HRRS

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	40 $\mu\Omega$ 95 $\mu\Omega/\Omega$ 91 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 18 $\mu\Omega/\Omega$ 18 $\mu\Omega/\Omega$ 37 $\mu\Omega/\Omega$ 46 $\mu\Omega/\Omega$ 0.1 m Ω/Ω	Multi-Function Calibrator
Resistance – Source ¹	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 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 (110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω (330 to 1 100) M Ω	31 $\mu\Omega/\Omega + 7.8$ m Ω 23 $\mu\Omega/\Omega + 12$ m Ω 22 $\mu\Omega/\Omega + 12$ m Ω 22 $\mu\Omega/\Omega + 16$ m Ω 22 $\mu\Omega/\Omega + 16$ m Ω 22 $\mu\Omega/\Omega + 155$ m Ω 22 $\mu\Omega/\Omega + 78$ m Ω 22 $\mu\Omega/\Omega + 0.78$ Ω 22 $\mu\Omega/\Omega + 0.78$ Ω 25 $\mu\Omega/\Omega + 7.8$ Ω 25 $\mu\Omega/\Omega + 7.8$ Ω 47 $\mu\Omega/\Omega + 116$ Ω 101 $\mu\Omega/\Omega + 194$ Ω 194 $\mu\Omega/\Omega + 1.9$ k Ω 388 $\mu\Omega/\Omega + 2.3$ k Ω 2.3 m $\Omega/\Omega + 78$ k Ω 12 m $\Omega/\Omega + 390$ k Ω	Multi-Product Calibrator

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	15 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 10 $\mu\Omega/\Omega$ + 0.5 m Ω 8 $\mu\Omega/\Omega$ + 0.5 m Ω 8 $\mu\Omega/\Omega$ + 5 m Ω 8 $\mu\Omega/\Omega$ + 50 m Ω 12 $\mu\Omega/\Omega$ + 2 Ω 50 $\mu\Omega/\Omega$ + 0.1 k Ω 0.5 m Ω/Ω + 1 k Ω 5 m Ω/Ω + 10 k Ω	Multimeter
Capacitance – Source ¹ 50 Hz to 1 kHz	(0.19 to 3.3) nF (3.3 to 11) nF (11 to 110) nF (110 to 330) nF 330 nF to 1.1 μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F 330 μ F to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	3.9 mF/F + 7.8 pF 1.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 233 pF 1.9 mF/F + 0.78 nF 1.9 mF/F + 2.3 nF 1.9 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.5 mF/F + 78 nF 3.5 mF/F + 233 nF 3.5 mF/F + 0.78 μ F 3.5 mF/F + 2.3 μ F 3.5 mF/F + 7.8 μ F 5.8 mF/F + 23 μ F 8.5 mF/F + 78 μ F	Multi-Product Calibrator
Capacitance – Source ¹ Fixed Values	(1, 10, 100, 1 000) pF 1 kHz to 5 MHz (5 to 13) MHz	1.1 mF/F 1.4 mF/F	Capacitance Set
	(10, 100, 1 000) nF 120 Hz to 100 kHz	1.1 mF/F	Capacitance Set
Capacitance – Measure ¹ 12 Hz to 100 kHz	Up to 10 pF (10 to 100) pF 100 pF to 1 mF	0.4 mF/F 0.5 mF/F 0.2 mF/F	RLC Digibridge
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) $^{\circ}$ C (800 to 1 000) $^{\circ}$ C (1 000 to 1 550) $^{\circ}$ C (1 550 to 1 820) $^{\circ}$ C	0.36 $^{\circ}$ C 0.29 $^{\circ}$ C 0.26 $^{\circ}$ C 0.28 $^{\circ}$ C	Multi-Product Calibrator

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type C		Multi-Product Calibrator
	(0 to 150) °C	0.26 °C	
	(150 to 650) °C	0.23 °C	
	(650 to 1 000) °C	0.27 °C	
	(1 000 to 1 800) °C	0.4 °C	
	(1 800 to 2 316) °C	0.66 °C	
	Type E		
	(-250 to -100) °C	0.40 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 350) °C	0.16 °C	
	(350 to 650) °C	0.17 °C	
	(650 to 1 000) °C	0.20 °C	
	Type J		
	(-210 to -100) °C	0.24 °C	
	(-100 to -30) °C	0.17 °C	
	(-30 to 150) °C	0.16 °C	
	(150 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.21 °C	
	Type K		
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type S (0 to 250) °C	0.38 °C	Multi-Product Calibrator
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	
	Type T (-250 to -150) °C	0.50 °C	
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U (-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	
Electrical Calibration of RTD Indicators ¹	Cu 427, 10 Ω (-100 to 260) °C	0.23 °C	Multi-Product Calibrator
	Pt 385, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω (-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicators ¹	Pt 385, 200 Ω		Multi-Product Calibrator
	(-200 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.093 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.12 $^{\circ}\text{C}$	
	Pt 385, 500 Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.085 $^{\circ}\text{C}$	
	Pt 385, 1 k Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.18 $^{\circ}\text{C}$	
	PtNi 385, 120 Ω (Ni120)		
	(-80 to 0) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
AC Voltage – Source ¹	200 μV to 2.2 mV		Multi-Function Calibrator
	(10 to 20) Hz	0.24 mV/V + 4 μV	
	(20 to 40) Hz	90 $\mu\text{V/V}$ + 4 μV	
	40 Hz to 20 kHz	80 $\mu\text{V/V}$ + 4 μV	
	(20 to 50) kHz	0.2 mV/V + 4 μV	
	(50 to 100) kHz	0.5 mV/V + 5 μV	
	(100 to 300) kHz	1.1 mV/V + 10 μV	
	(300 to 500) kHz	4 mV/V + 20 μV	
	500 kHz to 1 MHz	2.7 mV/V + 20 μV	

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) mV		Multi-Function Calibrator
	(10 to 20) Hz	0.24 mV/V + 4 μ V	
	(20 to 40) Hz	90 μ V/V + 4 μ V	
	40 Hz to 20 kHz	80 μ V/V + 4 μ V	
	(20 to 50) kHz	0.2 mV/V + 4 μ V	
	(50 to 100) kHz	0.5 mV/V + 5 μ V	
	(100 to 300) kHz	1.1 mV/V + 10 μ V	
	(300 to 500) kHz	1.4 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 20 μ V	
	(22 to 220) mV		
	(10 to 20) Hz	0.24 mV/V + 12 μ V	
	(20 to 40) Hz	90 μ V/V + 7 μ V	
	40 Hz to 20 kHz	80 μ V/V + 7 μ V	
	(20 to 50) kHz	0.2 mV/V + 7 μ V	
	(50 to 100) kHz	0.46 mV/V + 17 μ V	
	(100 to 300) kHz	0.9 mV/V + 20 μ V	
	(300 to 500) kHz	1.4 mV/V + 25 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 45 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.24 mV/V + 40 μ V	
	(20 to 40) Hz	90 μ V/V + 15 μ V	
	40 Hz to 20 kHz	45 μ V/V + 8 μ V	
	(20 to 50) kHz	75 μ V/V + 10 μ V	
	(50 to 100) kHz	0.11 mV/V + 30 μ V	
	(100 to 300) kHz	0.42 mV/V + 80 μ V	
	(300 to 500) kHz	1.1 mV/V + 0.2 mV	
	500 kHz to 1 MHz	1.7 mV/V + 0.3 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.24 mV/V + 0.4 mV	
	(20 to 40) Hz	90 μ V/V + 0.15 mV	
	40 Hz to 20 kHz	45 μ V/V + 50 μ V	
	(20 to 50) kHz	75 μ V/V + 0.1 mV	
	(50 to 100) kHz	0.1 mV/V + 0.2 mV	
	(100 to 300) kHz	0.28 mV/V + 0.6 mV	
	(300 to 500) kHz	1.1 mV/V + 2 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.2 mV	

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(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 (15 to 50) Hz 50 Hz to 1 kHz	0.24 mV/V + 4 mV 90 μ V/V + 1.5 mV 52 μ V/V + 0.6 mV 80 μ V/V + 1 mV 0.15 mV/V + 2.5 mV 0.90 mV/V + 16 mV 4.4 mV/V + 40 mV 8 mV/V + 80 mV 0.3 mV/V + 16 mV 70 μ V/V + 3.5 mV	Multi-Function Calibrator
AC Voltage – Measure ¹	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz 100 mV to 10 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 (1 to 2) MHz	0.3 mV/V + 3 μ V 0.2 mV/V + 1.1 μ V 0.3 mV/V + 1.1 μ V 1 mV/V + 1.1 μ V 5 mV/V + 1.1 μ V 40 mV/V + 2 μ V 70 μ V/V + 4 μ V 70 μ V/V + 2 μ V 0.14 mV/V + 2 μ V 0.3 mV/V + 2 μ V 0.8 mV/V + 2 μ V 3 mV/V + 10 μ V 10 mV/V + 10 μ V 15 mV/V + 10 μ V 70 μ V/V + 0.4 mV 70 μ V/V + 0.2 mV 0.14 mV/V + 0.2 mV 0.3 mV/V + 0.2 mV 0.8 mV/V + 0.2 mV 3 mV/V + 1 mV 10 mV/V + 1 mV 15 mV/V + 1 mV	Multimeter in Synchronous Sub-Sampled Mode

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(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 100 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	0.2 mV/V + 4 mV 0.2 mV/V + 2 mV 0.2 mV/V + 2 mV 0.35 mV/V + 2 mV 1.2 mV/V + 2 mV 4 mV/V + 10 mV 15 mV/V + 10 mV 0.4 mV/V + 40 mV 0.4 mV/V + 20 mV 0.6 mV/V + 20 mV 1.2 mV/V + 20 mV 3 mV/V + 20 mV	Multimeter in Synchronous Sub-Sampled Mode
AC Voltage – Measure ¹ (Absolute Measurement)	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (2.2 to 7) 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 (7 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	1.2 mV/V + 0.87 μ V 0.52 mV/V + 0.87 μ V 0.32 mV/V + 0.87 μ V 0.58 mV/V + 1.3 μ V 0.85 mV/V + 1.7 μ V 1.6 mV/V + 2.7 μ V 1.7 mV/V + 5.3 μ V 2.4 mV/V + 5.3 μ V 0.57 mV/V + 0.87 μ V 0.26 mV/V + 0.87 μ V 0.16 mV/V + 0.87 μ V 0.28 mV/V + 1.3 μ V 0.4 mV/V + 1.7 μ V 0.8 mV/V + 2.7 μ V 0.87 mV/V + 5.3 μ V 1.5 mV/V + 5.3 μ V 0.2 mV/V + 0.87 μ V 0.13 mV/V + 0.87 μ V 80 μ V/V + 0.87 μ V 0.14 mV/V + 1.3 μ V 0.22 mV/V + 1.7 μ V 0.54 mV/V + 2.7 μ V 0.59 mV/V + 5.3 μ V 1.1 mV/V + 5.3 μ V	AC Measurement Standard

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	(22 to 70) mV		AC Measurement Standard
	(10 to 20) Hz	0.16 mV/V + 1 μ V	
	(20 to 40) Hz	81 μ V/V + 1 μ V	
	40 Hz to 20 kHz	45 μ V/V + 1 μ V	
	(20 to 50) kHz	90 μ V/V + 1.3 μ V	
	(50 to 100) kHz	0.18 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.35 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.45 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.73 mV/V + 5.3 μ V	
	(70 to 220) mV		
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	57 μ V/V + 1 μ V	
	40 Hz to 20 kHz	26 μ V/V + 1 μ V	
	(20 to 50) kHz	47 μ V/V + 1.3 μ V	
	(50 to 100) kHz	0.11 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.17 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.26 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.67 mV/V + 5.3 μ V	
	(220 to 700) mV		
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	51 μ V/V + 1 μ V	
	40 Hz to 20 kHz	23 μ V/V + 1 μ V	
	(20 to 50) kHz	35 μ V/V + 1.3 μ V	
	(50 to 100) kHz	54 μ V/V + 1.7 μ V	
	(100 to 300) kHz	0.12 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.2 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.64 mV/V + 5.3 μ V	
	700 mV to 2.2 V		
	(10 to 20) Hz	0.13 mV/V + 0.58 μ V	
	(20 to 40) Hz	44 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	17 μ V/V + 0.58 μ V	
	(20 to 50) kHz	31 μ V/V + 0.58 μ V	
	(50 to 100) kHz	48 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.11 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.18 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.6 mV/V + 0.58 μ V	

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	(2.2 to 7) V		AC Measurement Standard
	(10 to 20) Hz	0.13 mV/V + 0.58 μ V	
	(20 to 40) Hz	45 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	17 μ V/V + 0.58 μ V	
	(20 to 50) kHz	33 μ V/V + 0.58 μ V	
	(50 to 100) kHz	55 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.13 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.27 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.8 mV/V + 0.58 μ V	
	(7 to 22) V		
	(10 to 20) Hz	0.13 mV/V + 5.8 μ V	
	(20 to 40) Hz	45 μ V/V + 5.8 μ V	
	40 Hz to 20 kHz	19 μ V/V + 5.8 μ V	
	(20 to 50) kHz	33 μ V/V + 5.8 μ V	
	(50 to 100) kHz	55 μ V/V + 5.8 μ V	
	(100 to 300) kHz	0.13 mV/V + 5.8 μ V	
	(300 to 500) kHz	0.27 mV/V + 5.8 μ V	
	500 kHz to 1 MHz	0.8 mV/V + 5.8 μ V	
	(22 to 70) V		
	(10 to 20) Hz	0.13 mV/V + 5.8 μ V	
	(20 to 40) Hz	46 μ V/V + 5.8 μ V	
	40 Hz to 20 kHz	22 μ V/V + 5.8 μ V	
	(20 to 50) kHz	39 μ V/V + 5.8 μ V	
	(50 to 100) kHz	64 μ V/V + 5.8 μ V	
	(100 to 300) kHz	0.14 mV/V + 5.8 μ V	
	(300 to 500) kHz	0.27 mV/V + 5.8 μ V	
	500 kHz to 1 MHz	0.8 mV/V + 5.8 μ V	
	(70 to 220) V		
	(10 to 20) Hz	0.13 mV/V + 58 μ V	
	(20 to 40) Hz	46 μ V/V + 58 μ V	
	40 Hz to 20 kHz	22 μ V/V + 58 μ V	
	(20 to 50) kHz	47 μ V/V + 58 μ V	
	(50 to 100) kHz	67 μ V/V + 58 μ V	
	(100 to 300) kHz	0.14 mV/V + 58 μ V	
	(300 to 500) kHz	0.33 mV/V + 58 μ V	
	(220 to 700) V		
	(10 to 20) Hz	0.13 mV/V + 58 μ V	
	(20 to 40) Hz	67 μ V/V + 58 μ V	
	40 Hz to 20 kHz	29 μ V/V + 58 μ V	
	(20 to 50) kHz	87 μ V/V + 58 μ V	
	(50 to 100) kHz	0.34 mV/V + 58 μ V	

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	(700 to 1 000) V (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.13 mV/V + 58 μ V 67 μ V/V + 58 μ V 28 μ V/V + 58 μ V 87 μ V/V + 58 μ V 0.33 mV/V + 58 μ V	AC Measurement Standard
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	600 μ V to 2.2 mV (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (2.2 to 7) mV (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (7 to 22) mV (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.94 mV/V + 0.08 μ V 0.47 mV/V + 0.08 μ V 0.47 mV/V + 0.08 μ V 0.47 mV/V + 0.08 μ V 0.66 mV/V + 0.95 μ V 0.66 mV/V + 0.95 μ V 0.66 mV/V + 0.95 μ V 1.6 mV/V + 0.95 μ V 2.8 mV/V + 0.95 μ V 6.6 mV/V + 1.9 μ V 0.94 mV/V + 0.082 μ V 0.47 mV/V + 0.082 μ V 0.47 mV/V + 0.082 μ V 0.47 mV/V + 0.082 μ V 0.66 μ V/V + 0.95 μ V 0.66 μ V/V + 0.95 μ V 0.66 μ V/V + 0.95 μ V 0.94 μ V/V + 0.95 μ V 1.6 mV/V + 0.95 μ V 3.5 mV/V + 0.95 μ V 0.94 mV/V + 0.082 μ V 0.47 mV/V + 0.082 μ V 0.47 mV/V + 0.082 μ V 0.47 mV/V + 0.082 μ V 0.66 mV/V + 0.082 μ V 0.66 mV/V + 0.082 μ V 0.66 mV/V + 0.082 μ V 0.94 mV/V + 0.082 μ V 1.6 mV/V + 0.082 μ V 3.5 mV/V + 0.082 μ V	AC Measurement Standard

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	(22 to 70) mV		AC Measurement Standard
	(10 to 30) Hz	0.94 mV/V + 0.82 μ V	
	(30 to 120) Hz	0.47 mV/V + 0.82 μ V	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 120) kHz	0.47 mV/V + 0.82 μ V	
	(120 to 500) kHz	0.47 mV/V + 0.82 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.82 μ V	
	(2 to 10) MHz	0.94 mV/V + 0.82 μ V	
	(10 to 20) MHz	1.4 mV/V + 0.82 μ V	
	(20 to 30) MHz	3.3 mV/V + 0.82 μ V	
	(70 to 220) mV		
	(10 to 30) Hz	0.94 mV/V + 0.82 μ V	
	(30 to 120) Hz	0.38 mV/V + 0.82 μ V	
	120 Hz to 1.2 kHz	0.38 mV/V + 0.82 μ V	
	(1.2 to 120) kHz	0.38 mV/V + 0.82 μ V	
	(120 to 500) kHz	0.38 mV/V + 0.82 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.82 μ V	
	(2 to 10) MHz	0.94 mV/V + 0.82 μ V	
	(10 to 20) MHz	1.4 mV/V + 0.82 μ V	
	(20 to 30) MHz	3.3 mV/V + 0.82 μ V	
	(220 to 700) mV		
	(10 to 30) Hz	0.94 mV/V + 8.2 μ V	
	(30 to 120) Hz	0.28 mV/V + 8.2 μ V	
	120 Hz to 1.2 kHz	0.28 mV/V + 8.2 μ V	
	(1.2 to 120) kHz	0.28 mV/V + 8.2 μ V	
	(120 to 500) kHz	0.28 mV/V + 8.2 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 8.2 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 8.2 μ V	
	(2 to 10) MHz	0.94 mV/V + 8.2 μ V	
	(10 to 20) MHz	1.4 mV/V + 8.2 μ V	
	(20 to 30) MHz	3.3 mV/V + 8.2 μ V	

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	700 mV to 2.2 V (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (2.2 to 7) V (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.94 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 1.4 mV/V + 8.2 μV 3.3 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 1.4 mV/V + 8.2 μV 3.3 mV/V + 8.2 μV	AC Measurement Standard
AC High Voltage – Measure ¹	(50 to 60) Hz (1 to 10) kV (10 to 20) kV (20 to 50) kV	0.6 mV/V 1.5 mV/V 1.4 mV/V	High Voltage Meter with Probe
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	0.25 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 + 35 nA 0.12 mA/A + 35 nA 0.2 mA/A + 0.1 μA 1.1 mA/A + 0.65 μA	Multi-Function Calibrator

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(2.2 to 22) mA		Multi-Function Calibrator
	(10 to 20) Hz	0.25 mA/A + 0.4 μ A	
	(20 to 40) Hz	0.16 mA/A + 0.35 μ A	
	40 Hz to 1 kHz	0.12 mA/A + 0.35 μ A	
	(1 to 5) kHz	0.2 mA/A + 0.55 μ A	
	(5 to 10) kHz	1.1 mA/A + 5 μ A	
	(22 to 220) mA		
	(10 to 20) Hz	0.25 mA/A + 4 μ A	
	(20 to 40) Hz	0.16 mA/A + 3.5 μ A	
	40 Hz to 1 kHz	0.12 mA/A + 2.6 μ A	
	(1 to 5) kHz	0.2 mA/A + 3.5 μ A	
	(5 to 10) kHz	1.1 mA/A + 10 μ A	
	220 mA to 2.2 A		
	20 Hz to 1 kHz	0.26 mA/A + 35 μ A	
	(1 to 5) kHz	0.45 mA/A + 80 μ A	
	(5 to 10) kHz	7.0 mA/A + 160 μ A	
AC Current – Source ¹	(29 to 330) μ A		Multi-Product Calibrator
	(10 to 20) Hz	1.6 mA/A + 78 nA	
	(20 to 45) Hz	1.2 mA/A + 78 nA	
	45 Hz to 1 kHz	1 mA/A + 78 nA	
	(1 to 5) kHz	2.3 mA/A + 0.12 μ A	
	(5 to 10) kHz	6.2 mA/A + 0.16 μ A	
	(10 to 30) kHz	12 mA/A + 0.31 μ A	
	330 μ A to 3.3 mA		
	(10 to 20) Hz	1.6 mA/A + 0.12 μ A	
	(20 to 45) Hz	1 mA/A + 0.12 μ A	
	45 Hz to 1 kHz	0.78 mA/A + 0.12 μ A	
	(1 to 5) kHz	1.6 mA/A + 0.16 μ A	
	(5 to 10) kHz	3.9 mA/A + 0.23 μ A	
	(10 to 30) kHz	7.8 mA/A + 0.47 μ A	
	(3.3 to 33) mA		
	(10 to 20) Hz	1.4 mA/A + 1.6 μ A	
	(20 to 45) Hz	0.7 mA/A + 1.6 μ A	
	45 Hz to 1 kHz	0.31 mA/A + 1.6 μ A	
	(1 to 5) kHz	0.62 mA/A + 1.6 μ A	
	(5 to 10) kHz	1.6 mA/A + 2.3 μ A	
	(10 to 30) kHz	3.1 mA/A + 3.1 μ A	

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(33 to 330) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz 330 mA to 1.1 A (10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (1.1 to 3.0) A (10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (3.0 to 11) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (11 to 20.5) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	1.4 mA/A + 16 µA 0.7 mA/A + 16 µA 0.31 mA/A + 16 µA 0.78 mA/A + 39 µA 1.6 mA/A + 78 µA 3.1 mA/A + 0.16 mA 1.4 mA/A + 78 µA 0.39 mA/A + 78 µA 4.7 mA/A + 0.78 mA 19 mA/A + 3.9 mA 1.4 mA/A + 78 µA 0.47 mA/A + 78 µA 4.7 mA/A + 0.78 mA 19 mA/A + 3.9 mA 0.47 mA/A + 1.6 mA 0.78 mA/A + 1.6 mA 23 mA/A + 1.6 mA 0.93 mA/A + 3.9 mA 1.2 mA/A + 3.9 mA 23 mA/A + 3.9 mA	Multi-Product Calibrator
AC Current – Source ¹	(10 to 16.5) A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1000) A (45 to 65) Hz (65 to 440) Hz	3.3 mA/A + 3.5 mA 9.1 mA/A + 3.5 mA 3.3 mA/A + 29 mA 9.1 mA/A + 31 mA 3.4 mA/A + 104 mA 9.2 mA/A + 116 mA	Multi-Product Calibrator w/50-turn coil
AC Current – Measure ¹	(0 to 100) µA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.6 mA/A + 0.035 µA 1.7 mA/A + 0.035 µA 0.7 mA/A + 0.035 µA 0.7 mA/A + 0.035 µA	Multimeter in Synchronous Sub-Sampled Mode

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	100 μ A to 1 mA (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 (50 to 100) kHz (1 to 10) mA (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 (50 to 100) kHz (10 to 100) mA (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 (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	4.6 mA/A + 0.23 μ A 1.7 mA/A + 0.23 μ A 0.7 mA/A + 0.23 μ A 0.4 mA/A + 0.23 μ A 0.7 mA/A + 0.23 μ A 4.6 mA/A + 0.46 μ A 6.4 mA/A + 1.7 μ A 4.6 mA/A + 2.3 μ A 1.7 mA/A + 2.3 μ A 0.7 mA/A + 2.3 μ A 0.4 mA/A + 2.3 μ A 0.7 mA/A + 2.3 μ A 4.6 mA/A + 4.6 μ A 6.4 mA/A + 17 μ A 4.6 mA/A + 23 μ A 1.7 mA/A + 23 μ A 0.7 mA/A + 23 μ A 0.4 mA/A + 23 μ A 0.7 mA/A + 23 μ A 4.6 mA/A + 46 μ A 6.4 mA/A + 0.17 mA 4.6 mA/A + 0.23 mA 1.8 mA/A + 0.23 mA 0.9 mA/A + 0.23 mA 1.2 mA/A + 0.23 mA 3.5 mA/A + 0.23 mA 12 mA/A + 0.46 mA	Multimeter in Synchronous Sub-Sampled Mode
	(0.001 to 5) A (10 Hz to 50) kHz (5 to 20) A (10 Hz to 50) kHz (1 to 100) A 60 Hz	0.3 mA/A 0.4 mA/A 0.4 mA/A	

Electrical – DC/Low Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ^{1,2} Level Sine Amp 50 kHz ref. Square Wave 1 M Ω , 100 Hz 50 Ω , 1 kHz Time Marker Output Into 50 Ω Pulse Rise Time 0.5 V, 1 V p-p 1 Vp-p	5 mVp-p to 5 V p-p 1 mVp-p to 130 Vp-p 1 mVp-p to 6.6 Vp-p 2 ns to 20 ms 50 ms to 5 s 10 MHz 1 MHz	2 % of reading + 300 μ V 0.1 % of reading + 40 μ V 0.25 % of reading + 40 μ V (25 + 1 000 <i>t</i>) parts in 10 ⁶ 25 parts in 10 ⁶ of reading 100 ps 100 ps	Multiproduct Calibrator
Oscilloscopes ¹ Level Sine Flatness relative to 50 kHz reference	5 mV to 5.5 V 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz 600 MHz to 6 GHz (6 to 26.5) GHz	3.5 % of reading + 300 μ V 4 % of reading + 300 μ V 6 % of reading + 300 μ V 2.5 % of reading 3 % of reading	Power Meter, Power Sensors

Electrical – RF/Microwave

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Distortion – Measure ¹ (0 to 99.9) dB 20 Hz to 20 kHz (20 to 100) kHz	(50 to 500) kHz (50 to 500) kHz	1.3 dB 2.4 dB	Audio Analyzer
RF Power Sensors – Calibration Factors ^{1,5}	Referenced to 1 mW 100 kHz to 1.2 GHz (1.2 to 6) GHz (6 to 12) GHz (12 to 26.5) GHz	1.5 % 1.5 % 1.6 % 1.6 %	Thermocouple Power Sensors
Tuned RF Power, Relative – Measure ¹ (20.0 to -30) dB (-30 to -130) dB	150 kHz to 26.5 GHz	0.15 dB 0.2 dB	Measuring Receiver

Electrical – RF/Microwave

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power – Absolute Measure ¹			Power Sensors
10 MHz $\leq$ f < 18 GHz	-70 dBm $\leq$ P < -60 dBm	0.97 dB	
10 MHz $\leq$ f < 18 GHz	-60 dBm $\leq$ P < -50 dBm	0.19 dB	
10 MHz $\leq$ f < 18 GHz	-50 dBm $\leq$ P < -20 dBm	0.14 dB	
100 kHz $\leq$ f < 1 MHz	-35 dBm $\leq$ P < -20 dBm	0.40 dB	
1 MHz $\leq$ f < 6 GHz		0.38 dB	
100 kHz $\leq$ f < 1 MHz	-20 dBm $\leq$ P < 0 dBm	0.11 dB	
1 MHz $\leq$ f < 6 GHz		0.10 dB	
100 kHz $\leq$ f < 1 MHz	0 dBm $\leq$ P < 20 dBm	0.13 dB	
1 MHz $\leq$ f < 1.2 GHz		0.09 dB	
1.2 GHz $\leq$ f < 6 GHz		0.10 dB	
10 MHz $\leq$ f < 12.4GHz	-35 dBm $\leq$ P < -20 dBm	0.33 dB	
12.4GHz $\leq$ f < 26.5GHz		0.35 dB	
10 MHz $\leq$ f < 12.4GHz	-20 dBm $\leq$ P < 0 dBm	0.11 dB	
12.4GHz $\leq$ f < 26.5GHz		0.13 dB	
10 MHz $\leq$ f < 12.4GHz	0 dBm $\leq$ P < 20 dBm	0.12 dB	
12.4GHz $\leq$ f < 26.5GHz		0.13 dB	
Frequency Modulation Rejection – Measure ¹	Rate: 400 HZ to 1 kHz Dev.: $\leq$ 5 kHz peak Dev.: $\leq$ 50 kHz peak	0.14 % AM 0.14 % AM	Measuring Receiver
Residuals AM ¹	150 kHz to 18 GHz (18 to 26.5) GHz	0.004 % (rms) 0.006 % (rms)	Measuring Receiver
Frequency Modulation Distortion - Measure ¹ Bandwidth: 20 Hz to 250 kHz	150 kHz to 26.5 GHz	0.15 % of reading	Measuring Receiver

Electrical – RF/Microwave

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Deviation Accuracy Measure ¹ 250 kHz to 10 MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 10 kHz Dev: ≤ 40 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz	0.1 % of reading 0.2 % of reading 0.3 % of reading 0.4% of reading	Measuring Receiver
Amplitude Modulation Rejection – Measure ¹ 150 kHz to 6.6 GHz (6.6 to 26.5) GHz	Rate: 400 Hz to 1 kHz Depth: ≤ 50 %	11 Hz 23 Hz	Measuring Receiver
Amplitude Modulation – Depth Accuracy Measure ¹ 150 kHz to 10 MHz 10 MHz to 3 GHz 10 MHz to 3 GHz (3 to 26.5) GHz (3 to 26.5) GHz	Rate: 50 Hz to 10 kHz Depth: (5 to 99) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	0.2 % of reading 0.2 % of reading 0.3 % of reading 0.2 % of reading 0.5 % of reading	Measuring Receiver
Residuals FM ¹ Bandwidth: 50 Hz to 3 kHz	150 kHz to 3 GHz (3 to 6.6) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	1.3 Hz (rms) 1.8 Hz (rms) 2.6 Hz (rms) 3.7 Hz (rms)	Measuring Receiver
Amplitude Modulation Distortion -Measure ¹ 150 kHz to 18 GHz (18 to 26.5) GHz (18 to 26.5) GHz	(5 to 99) % Depth (5 to 50) % Depth (50 to 95) % Depth	0.14 % Depth 0.4 % Depth 0.6 % Depth	Measuring Receiver
Amplitude Modulation Flatness ¹ 10 MHz to 26.5 GHz	Rate: (9 Hz to 10 kHz) (5 to 99) % Depth	0.15 % Depth	Measuring Receiver

Electrical – RF/Microwave

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Measure ¹ 100 kHz to 6.6 GHz 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 200 kHz Deviation: > 0.7 Rad Deviation: > 0.3 Rad Rate: 20 Hz to 200 kHz Deviation: > 2 Rad Deviation: > 0.6 Rad Rate: 20 Hz to 200 kHz Deviation: > 4 Rad Deviation: > 1.2 Rad	0.1 % of reading 0.2 % of reading 0.01 % of reading 0.02 % of reading 0.1 % of reading 0.2 % of reading	Measuring Receiver
AM Rejection - Measure ¹ 100 kHz to 26.5 GHz	Rate: 50 Hz to 3 kHz Deviation: > 50 % AM at 1 kHz Rate	0.003 Rad	Measuring Receiver
Phase Residuals – Measure ¹ 100 kHz to 26.5 GHz	(0.1 to 25 000) Rad (rms) Rate: 50 Hz to 3 kHz	0.01 Rad	Measuring Receiver
Phase Distortion ¹ Bandwidth: 20 Hz to 250kHz	(0.1 to 25 000) Rad (rms) 150 kHz to 26.5 GHz	0.008 Rad	
Harmonic Measurements ¹	30 Hz to 40 GHz	1.4 dB	Spectrum Analyzer

Length – Dimensional Metrology

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 48 in	$(6.4 + 6.8L) \mu\text{in} + 0.58R$	Gage Blocks
Height Gages ^{1,2}	Up to 48 in	$(28 + 1.8L) \mu\text{in} + 0.58R$	Gage Blocks
Micrometers ^{1,2} External, Internal, Depth, Bore and Micrometer Head	Length Up to 48 in Flatness Up to 40 μin Parallelism Up to 50 μin	$(3.6 + 6.8L) \mu\text{in} + 0.58R$ 8 μin 11 μin	Gage Blocks, Master Ring, Optical Parallels or Optical Flats
End Measuring Rods ² Setting Rod, Micrometer Standard, Length Standards	Up to 10 in (10 to 48) in	$(19 + 1.8L) \mu\text{in}$ $(18 + 2.3L) \mu\text{in}$	Labmaster®, Gage Blocks, LVDTs

Length – Dimensional Metrology

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
External Threads, All English and Metric 60° Threads ² Pitch Diameter Major Diameter	(0.001 to 4) in	$(35 + 1L) \mu\text{in}$ $(11 + 1.1L) \mu\text{in}$	Universal Length Measuring Machine, Thread Wires; Gage Blocks
Internal Threads ² Pitch Diameter Minor Diameter	(0.05 to 4) in	$(60 + 0.46L) \mu\text{in}$ $(16 + 2.5L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks, Master Thread Plug Set
Indicators ^{1,2} Dial Gauge, Dial Test Indicator, LVDTs	Up to 4 in	$(2.6 + 2.8L) \mu\text{in}$	Gage Blocks
Plain Plug Gages / Pin Gages ^{1,2} (Cylindrical and Taper)	(0.001 to 2) in (2 to 4) in	$(12 + 0.34L) \mu\text{in}$ $(16 + 0.89L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Gage Blocks ²	Up to 6 in (6 to 12) in	$(2.1 + 0.5L) \mu\text{in}$ $(3.1 + 1.5L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Plain Ring Gages ² (Cylindrical and Taper)	Up to 1 in (1 to 10) in	$(9 + 0.8L) \mu\text{in}$ $(12 + 0.8L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Thread Wires ²	Up to 1 in	$(3 + 6L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Rules & Tape Measures	Up to 40 in (40 to 2 00) in	0.006 5 in $(1.6 \times 10^{-4}L) \text{ in}$	Gage Blocks, Standard Scale
Optical Comparators and Vision Systems /Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 20 in	$(19 + 2L) \mu\text{in}$	Glass Scales, Gage Blocks
Glass Scales	Up to 12 in	$(49 + 0.6L) \mu\text{in}$	Vision System, Standard Scale
Surface Plates ^{1,2} Overall Flatness	(6 to 140) inD	$(19 + 0.44D) \mu\text{in}$	Level system
Local Area Flatness (Repeat Reading)	Up to 6 000 μin	$(13 + 1.3D) \mu\text{in}$	Repeat-O-meter

Mass and Mass Related

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure/Vacuum ^{1,2} Transducers, Transmitters (Gage, Absolute, Differential)	(-15 to 0) psig (0 to 10 000) psig	0.039 % of reading + 0.58R 0.029 % of reading + 0.58R	Pressure/Vacuum System
Scales and Balances ^{1,3}	Up to 2 g (2 to 20) g (20 to 200) g 200 g to 1 kg (1 to 5) kg (5 to 20) kg (20 to 100) kg (0 to 750) lb	2.6 µg 20 µg 0.04 mg 0.8 mg 2 mg 4 mg 19 mg 0.32 lb	Class 1, Class 2, Class F Weights
Mass	(1 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 5 kg	4 µg 4 µg 9 µg 13 µg 16 µg 21 µg 49 µg 75 µg 140 µg 180 µg 0.42 mg	Class 1 Weights, Balance
Mass	(5 to 10) kg (10 to 30) kg	0.55 mg 1.1 mg	Class 2, Class 4 Weights, Balance
Flow – Air ¹	(0.003 to 20) l/min (10 to 1 000) l/min (1 000 to 2 000) l/min	0.62 % of reading 0.65 % of reading 0.8 % of reading	Standard Flow Sensors
Torque Tools ¹	5 ozf·in to 200 lbf·in 200 lbf·in to 200 lbf·ft (250 to 600) lbf·ft (600 to 1 000) lbf·ft	0.33 % of reading 0.34 % of reading 0.34 % of reading 0.34 % of reading	Torque System with Transducers
Torque Testers ¹	Up to 200 ozf·in (4 to 150) lbf·in (2.5 to 250) lbf·ft (250 to 1 000) lbf·ft	0.12 % of reading 0.12 % of reading 0.12 % of reading 0.12 % of reading	Torque Wheel, Torque Standard, Calibration Arms, Weights
Force and Load Cell ¹ (Compression and Tension)	(0 to 2.25) lbf (2.25 to 4.5) lbf (4.5 to 11) lbf (11 to 340) lbf	0.01 % of reading + 0.58R 0.007 4 % of reading 0.006 4 % of reading 0.006 2 % of reading	Standard Weights
Force and Load Cell ¹ (Compression and Tension)	(0 to 11 000) lbf (11 000 to 110 000) lbf	0.029 % of reading + 0.58R 0.028 % of reading	Load Cell

Mass and Mass Related

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Cable Tension Meters	(0 to 2 000) lbf	0.029 % of reading + 0.58·R	Load Cell

Thermodynamic

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure ¹	(-200 to 0) °C 0 °C (0 to 230) °C (230 to 420) °C (420 to 670) °C	0.028 °C 0.026 °C 0.028 °C 0.030 °C 0.036 °C	Thermometer, PRT
Temperature – Measuring Equipment ¹	(-40 to 650) °C	0.085 °C	Comparison to Reference Standard Temperature and Temperature Source
Temperature – Measuring Equipment (Environmental)	(-75 to 200) °C	0.82 °C	Comparison to Reference Standard Temperature and Temperature Source
Humidity – Measuring Equipment	(10 to 80) %RH (80 to 95) %RH	1.4 %RH 2.2 %RH	Indicator, Probe w/ Humidity Generator
Radiation (Infrared) Thermometers ¹	50 °C (50 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 500) °C	0.36 °C 0.81 °C 1.2 °C 1.7 °C 2.2 °C 3 °C	Blackbody Calibrator (flat plate) $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers ¹	100 °C (100 to 200) °C (200 to 400) °C (400 to 600) °C (600 to 800) °C (800 to 980) °C	0.74 °C 1.2 °C 2.3 °C 3.5 °C 5 °C 6.2 °C	Blackbody Calibrator (cavity) $\epsilon = 0.99$, $\lambda = (8 \text{ to } 14) \mu\text{m}$

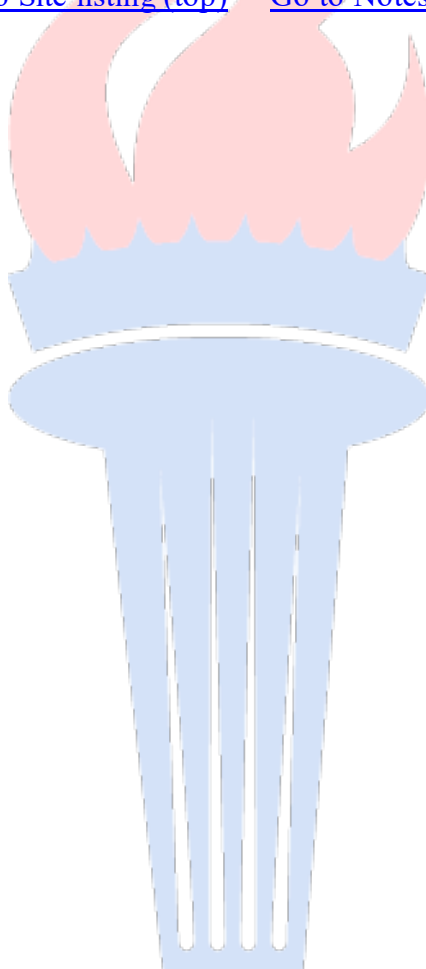
Time and Frequency

Monroe, WA

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	0.1 Hz to 225 MHz 100 MHz to 3 GHz 500 MHz to 26.5 GHz	6×10^{-11} Hz/Hz 6×10^{-11} Hz/Hz 6×10^{-11} Hz/Hz	GPS Receiver and Counter
Frequency – Measure ¹ Fixed Point	10 MHz	6.1×10^{-12} Hz/Hz	GPS Receiver
Frequency – Source ¹	0.01 Hz to 40 GHz	6.2×10^{-12} Hz/Hz	GPS Receiver and Signal Generator
Photo Tachometer ^{1,2}	Up to 100 000 rpm	0.000 25 % of reading + 0.58R	Multi-Product Calibrator, Signal Generator with LED

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)



Services performed at satellite laboratory

Micro Precision Calibration de Mexico S. de R.L. de CV

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CALIBRATION

Acoustics and Vibration

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Sound Level Source ¹	(74 to 104) dB	0.53 dB	Sound Level Calibrator
	114 dB SPL @ (125 to 2 000) Hz	0.53 dB	
	114 dB SPL @ 4 000 Hz	0.55 dB	
Accelerometer ¹	(0.1 to 19) g (100 to 1 000) Hz	4.8 % of reading	Acceleration Meter

Chemical Quantities

Tijuana, BC

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH ¹ – Measure	(4, 7, 10) pH	0.01 pH	Comparison to Standard Solutions
Conductivity ¹ Measure	1 µS/cm	0.44 µS/cm	Comparison to Standard Solutions
	5 µS/cm	0.44 µS/cm	
	10 µS/cm	0.65 µS/cm	
	100 µS/cm	1.12 µS/cm	
	1 015 µS/cm	1.9 µS/cm	
	1 408 µS/cm	2.2 µS/cm	

Electrical – DC/Low Frequency

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Voltage Source ¹	(0 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	12 $\mu\text{V/V} + 0.93 \mu\text{V}$ 9.5 $\mu\text{V/V} + 1.2 \mu\text{V}$ 9.6 $\mu\text{V/V} + 1 \mu\text{V}$ 9.6 $\mu\text{V/V} + 1 \mu\text{V}$ 12 $\mu\text{V/V} + 21 \mu\text{V}$ 14 $\mu\text{V/V} + 0.2 \text{ mV}$	Multiproduct Calibrator
DC Voltage Source ¹	(0 to 330) mV 330 mV to 3.3 V (3.3 to 33) V (33 to 330) V 330 V to 1.1 kV	14 $\mu\text{V/V} + 1 \mu\text{V}$ 12 $\mu\text{V/V} + 2 \mu\text{V}$ 17 $\mu\text{V/V} + 20 \mu\text{V}$ 17 $\mu\text{V/V} + 0.15 \text{ mV}$ 18 $\mu\text{V/V} + 1.5 \text{ mV}$	Multiproduct Calibrator
DC Voltage Source ¹ High Voltage	(0.2 to 10) kV	0.63 mV/V + 6 mV	Power Supply
DC Voltage Measure ¹	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V 100 V to 1 kV	2.8 $\mu\text{V/V} + 0.46 \mu\text{V}$ 5.2 $\mu\text{V/V} + 0.46 \mu\text{V}$ 4.7 $\mu\text{V/V} + 0.96 \mu\text{V}$ 8 $\mu\text{V/V} + 28 \mu\text{V}$ 23 $\mu\text{V/V} + 1.5 \text{ mV}$	Multimeter
DC Voltage Measure ¹ High Voltage	(0.1 to 10) kV (10 to 30) kV	0.35 mV/V + 0.69 V 0.88 mV/V	High Voltage Meter
DC Current – Source ¹	(0 to 220) μA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A	19 $\mu\text{A/A} + 1.4 \text{ nA}$ 15 $\mu\text{A/A} + 2.2 \text{ nA}$ 17 $\mu\text{A/A}$ 21 $\mu\text{A/A}$ 50 $\mu\text{A/A}$ 55 $\mu\text{A/A} + 25 \mu\text{A}$	Multiproduct Calibrator
DC Current – Source ¹	(0 to 330) μA 330 μA to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 3 A (3 to 10) A (11 to 20.5) A	0.15 mA/A + 20 nA 0.1 mA/A + 50 nA 0.1 mA/A + 0.25 μA 0.1 mA/A + 2.5 μA 0.38 mA/A + 40 μA 0.56 mA/A 1.9 mA/A	Multiproduct Calibrator
DC Current – Measure ¹	Up to 100 nA 100 nA to 1 μA (1 to 10) μA (10 to 100) μA 100 μA to 10 mA (10 to 100) mA 100 mA to 1 A	16 $\mu\text{A/A} + 75 \text{ pA}$ 29 $\mu\text{A/A} + 62 \text{ pA}$ 22 $\mu\text{A/A} + 0.14 \text{ nA}$ 24 $\mu\text{A/A} + 0.1 \text{ nA}$ 24 $\mu\text{A/A} + 0.17 \text{ nA}$ 43 $\mu\text{A/A} + 0.2 \mu\text{A}$ 0.14 mA/A + 9.5 μA	Multimeter

Electrical – DC/Low Frequency

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Current – Measure ¹	(1 to 1 000) A	5.5 mA/A	Multiproduct Calibrator with Current Coil Hall Effect
DC Current – Measure ¹	(1 to 15) A (15 to 100) A (100 to 300) A (300 to 1 000) A	0.5 mA/A+1 mA 1 mA/A+0.1 mA 0.05 mA/A+60 mA 0.68 mA/A+33 mA	Shunt Monitored with Multimeter
Inductance – Source ¹ Fixed Points (0.1 to 1) kHz	1.0 mH 20 mH 100 mH 1 H	0.029 % of reading 0.074 % of reading 0.031 % of reading 0.027 % of reading	Inductors
Resistance – Measure ¹	(0 to 1) (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	33 $\mu\Omega/\Omega$ + 68 $\mu\Omega$ 16 $\mu\Omega/\Omega$ + 85 $\mu\Omega$ 18 $\mu\Omega/\Omega$ + 70 $\mu\Omega$ 9 $\mu\Omega/\Omega$ + 0.92 m Ω 10 $\mu\Omega/\Omega$ + 0.13 m Ω 12 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 92 $\mu\Omega/\Omega$ 0.71 m Ω/Ω 6.5 m Ω/Ω	Multimeter
Capacitance – Source ¹ 1 kHz	10 pF to 1.1 μ F	0.19 % of reading	RLC Digibridge and Standard Capacitors
Capacitance – Source ¹ Frequency 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 Hz to 600 Hz 10 Hz to 300 Hz 10 Hz to 150 Hz 10 Hz to 120 Hz 10 Hz to 80 Hz 50 Hz 20 Hz	(190 to 399.9) pF (0.4 to 1.0999) nF (1.1 to 3.299 9) nF (3.3 to 10.999) nF (11 to 32.999) nF (33 to 109.99) nF (110 to 329.99) nF (0.33 to 1.099 9) μ F (1.1 to 3.299 9) μ F (3.3 to 10.999) μ F (11 to 32.999) μ F (33 to 109.99) μ F (110 to 329.99) μ F (0.33 to 1.099 9) mF	4.4 mF/F + 12 pF 4.2 mF/F + 12 pF 10 mF/F 2 mF/F + 15 pF 8 mF/F 2.4 mF/F + 0.11 nF 2.4 mF/F +0.33 nF 2.2 mF/F + 1.2 nF 2.2 mF/F + 3.6 nF 2.3 mF/F + 11 nF 3.6 mF/F + 33 nF 4.1 mF/F + 0.11 μ F 4.1mF/F +0.34 μ F 4 mF/F +1.2 μ F	Multiproduct Calibrator

Electrical – DC/Low Frequency

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Capacitance Source ¹ Frequency 6 Hz 2 Hz 0.6 Hz 0.2 Hz	(1.1 to 3.299 9) mF (3.3 to 10.999) mF (11 to 32.999) mF (33 to 110) mF	3.9 mF/F + 3.5 μ F 4 mF/F + 12 μ F 8.1 mF/F + 35 μ F 12 mF/F + 0.12 mF	Multiproduct Calibrator
Capacitance Source ¹ 60 Hz to 1 kHz	100 pF to 1 nF 1.1 nF to 1 μ F (1.2 to 11.11) μ F	0.16 % of reading 0.14 % of reading 0.06 % of reading	Capacitance Decade Box
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	1.2 m Ω / Ω + 0.008 Ω 1.7 m Ω / Ω 0.18 m Ω / Ω 0.24 m Ω / Ω 90 $\mu\Omega$ / Ω + 0.06 Ω 0.24 m Ω / Ω 90 $\mu\Omega$ / Ω + 0.6 Ω 0.12 m Ω / Ω	Multifunction Calibrator
Resistance Source ¹	(33 to 110) k Ω (110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω 330 M Ω to 1.1 G Ω	0.11 m Ω / Ω + 6 Ω 0.13 m Ω / Ω 0.15 m Ω / Ω + 55 Ω 0.19 m Ω / Ω 0.16 m Ω / Ω 0.41 m Ω / Ω 0.58 m Ω / Ω 3.7 m Ω / Ω 18 m Ω / Ω	Multifunction Calibrator
Resistance Source ¹	50 $\mu\Omega$ 1 m Ω 10 m Ω	0.85 % of reading 0.15 % of reading 0.49 m Ω / Ω	Shunt Resistors
Resistance Source ¹	(1 to 10) M Ω 10 M Ω to 1 G Ω	70 $\mu\Omega$ / Ω 0.18 m Ω / Ω	Decade Resistance Box
Resistance Source ¹	(0 to 1.9) Ω (1.9 to 19) Ω (19 to 190) Ω (0.19 to 1.9) k Ω (1.9 to 19) k Ω (19 to 190) k Ω (0.19 to 1.9) M Ω (1.9 to 19) M Ω (19 to 100) M Ω	96 $\mu\Omega$ / Ω +50 $\mu\Omega$ 26 $\mu\Omega$ / Ω +0.17m Ω 22 $\mu\Omega$ / Ω +0.24 m Ω 17 $\mu\Omega$ / Ω +0.92 m Ω 18 $\mu\Omega$ / Ω 19 $\mu\Omega$ / Ω 30 $\mu\Omega$ / Ω 36 $\mu\Omega$ / Ω +51 Ω 0.2 m Ω / Ω	Multifunction Calibrator

Electrical – DC/Low Frequency

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) °C	0.57 °C	Multiproduct Calibrator
	(800 to 1 550) °C	0.47 °C	
	(1 550 to 1 820) °C	0.46 °C	
	Type C (0 to 1 000) °C	0.37 °C	
	(1 000 to 1 800) °C	0.59 °C	
	(1 800 to 2 316) °C	0.98 °C	
	Type E (-250 to -100) °C	0.58 °C	
	(-100 to 650) °C	0.19 °C	
	(650 to 1 000) °C	0.25 °C	
	Type J (-210 to -100) °C	0.32 °C	
	(-100 to 760) °C	0.2 °C	
	(760 to 1 200) °C	0.27 °C	
	Type K (-200 to -100) °C	0.39 °C	
	(-100 to 120) °C	0.22 °C	
	(120 to 1 000) °C	0.31 °C	
	(1 000 to 1 372) °C	0.46 °C	
	Type L (-200 to -100) °C	0.43 °C	
	(-100 to 800) °C	0.31 °C	
	(800 to 900) °C	0.21 °C	
	Type N (-200 to -100) °C	0.47 °C	
	(-100 to 410) °C	0.26 °C	
	(410 to 1 300) °C	0.32 °C	
	Type R (0 to 250) °C	0.68 °C	
	(250 to 1 000) °C	0.44 °C	
	(1 000 to 1 767) °C	0.49 °C	
	Type S (0 to 250) °C	0.47 °C	
	(250 to 1 400) °C	0.47 °C	
	(1 400 to 1 767) °C	0.54 °C	
	Type T (-250 to -150) °C	0.56 °C	
	(-150 to 0) °C	0.28 °C	
	(0 to 400) °C	0.2 °C	

Electrical – DC/Low Frequency

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type U (-200 to 0) °C (0 to 600) °C	0.65 °C 0.32 °C	Multiproduct Calibrator
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 630) °C (630 to 800) °C	0.05 °C 0.07 °C 0.1 °C 0.12 °C 0.23 °C	Multiproduct Calibrator
	Pt 3926, 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 630) °C	0.05 °C 0.07 °C 0.1 °C 0.12 °C	
	Pt 3916, 100 Ω (-200 to -190) °C (-190 to 0) °C (0 to 300) °C (300 to 600) °C (600 to 630) °C	0.25 °C 0.05 °C 0.08 °C 0.1 °C 0.23 °C	
	Pt 385, 200 Ω (-200 to 100) °C (100 to 260) °C (260 to 600) °C (600 to 630) °C	0.04 °C 0.05 °C 0.14 °C 0.16 °C	
	Pt 385, 500 Ω (-200 to 100) °C (100 to 260) °C (260 to 600) °C (600 to 630) °C	0.05 °C 0.06 °C 0.09 °C 0.11 °C	
	Pt 385, 1 kΩ (-200 to 100) °C (100 to 260) °C (260 to 600) °C (600 to 630) °C	0.03 °C 0.05 °C 0.07 °C 0.23 °C	
	PtNi 385, 100 Ω (-80 to 100) °C (100 to 260) °C	0.08 °C 0.14 °C	
	Cu 427, 10 Ω (-100 to 260) °C	0.3 °C	

Electrical – DC/Low Frequency

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage Source ¹	(0.22 to 220) mV (10 to 40) Hz	0.27 mV/V + 15 µV	Multiproduct Calibrator
	40 Hz to 20 kHz	0.13 mV/V + 12 µV	
	(20 to 100) kHz	1.1 mV/V + 25 µV	
	(100 to 300) kHz	1.3 mV/V + 45 µV	
	(300 to 500) kHz	2 mV/V + 63 µV	
	500 kHz to 1 MHz	3.4 mV/V + 71 µV	
	220 mV to 2.2 V (10 to 20) Hz	0.22 mV/V + 25 µV	
	(20 to 40) Hz	0.1 mV/V + 19 µV	
	40 Hz to 20 kHz	0.28 mV/V + 0.19 mV	
	(20 to 50) kHz	0.56 mV/V + 0.18 mV	
	(50 to 100) kHz	1.6 mV/V + 0.15 mV	
	100 kHz to 1 MHz	3.2 mV/V + 0.32 mV	
	(2.2 to 22) V (10 to 20) Hz	0.23 mV/V + 11 µV	
	(20 to 40) Hz	0.11 mV/V + 10 µV	
	40 Hz to 20 kHz	0.37 mV/V + 10 µV	
	(20 to 50) kHz	0.88 mV/V + 0.44 mV	
	(50 to 100) kHz	2 mV/V + 0.67 mV	
	100 kHz to 1 MHz	4.2 mV/V + 0.63 mV	
	(22 to 220) V (10 to 40) Hz	0.23 mV/V + 2.5 µV	
	40 Hz to 20 kHz	0.11 mV/V	
	(20 to 100) kHz	0.81 µV/V	
AC Voltage Source ¹	220 V to 1.1 kV 50 Hz to 1 kHz	0.11 mV/V + 0.11 mV	Multiproduct Calibrator
	(0 to 33) mV (10 to 45) Hz	0.08 mV/V + 6 µV	
	45 Hz to 10 kHz	0.15 mV/V + 6 µV	
	(10 to 20) kHz	0.2 mV/V + 6 µV	
	(20 to 50) kHz	1 mV/V + 6 µV	
	(50 to 100) kHz	3.5 mV/V + 12 µV	
	(100 to 500) kHz	8 mV/V + 50 µV	
	(33 to 330) mV (10 to 45) Hz	0.3 mV/V + 8 µV	
	45 Hz to 10 kHz	0.15 mV/V + 8 µV	
	(10 to 20) kHz	0.16 mV/V + 8 µV	
	(20 to 50) kHz	0.35 mV/V + 8 µV	
	(50 to 100) kHz	0.8 mV/V + 32 µV	
	(100 to 500) kHz	2 mV/V + 70 µV	

Electrical – DC/Low Frequency

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage Source ¹	330 mV to 3.3 V		Multiproduct Calibrator
	(10 to 45) Hz	0.3 mV/V + 50 μ V	
	45 Hz to 10 kHz	0.15 mV/V + 60 μ V	
	(10 to 20) kHz	0.19 mV/V + 60 μ V	
	(20 to 50) kHz	0.3 mV/V + 50 μ V	
	(50 to 100) kHz	0.7 mV/V + 0.13 mV	
	(100 to 500) kHz	2.4 mV/V + 0.6 mV	
	(3.3 to 33) V		
	(10 to 45) Hz	0.3 mV/V + 0.65 mV	
	45 Hz to 10 kHz	0.15 mV/V + 0.6 mV	
	(10 to 20) kHz	0.24 mV/V + 0.6 mV	
	(20 to 50) kHz	0.35 mV/V + 0.6 mV	
	(50 to 100) kHz	0.9 mV/V + 1.6 V	
	(33 to 330) V		
	45 Hz to 1 kHz	0.19 mV/V + 2 mV	
	(1 to 10) kHz	0.2 mV/V + 6 mV	
	(10 to 20) kHz	0.25 mV/V + 6 mV	
	(20 to 50) kHz	0.3 mV/V + 6 mV	
	(50 to 100) kHz	0.9 mV/V + 50 mV	
AC Voltage Measure ¹	330 V to 1.1 kV		Multimeter in Synchronous Sub-Sampled Mode
	45 Hz to 10 kHz	0.3 mV/V + 10 mV	
	(0.010 to 100 mV		
	1 Hz to 1 kHz	56 μ V/V + 6.1 μ V	
	(1 to 20) kHz	0.14 mV/V + 4.4 μ V	
	(20 to 100) kHz	0.39 V/V + 55 μ V	
	(100 to 300) kHz	1.2 mV/V + 0.48 μ V	
	300 kHz to 1 MHz		
	100 mV to 1 V	11 mV/V + 31 μ V	
	1 Hz to 1 kHz	0.11 mV/V	
	(1 to 20) kHz	0.19 mV/V	
	(20 to 100) kHz	0.95 mV/V	
	(100 to 300) kHz	3.6 mV/V	
	300 kHz to 1 MHz	12 mV/V	
	(1 to 10) V		
	1 Hz to 1 kHz	0.11 mV/V	
	(1 to 20) kHz	0.19 mV/V	
	(20 to 100) kHz	0.95 mV/V	
	(100 to 300) kHz	3.6 mV/V	
	300z to 1 MHz	12 mV/V	
	(1 to 4) MHz	7.7 mV/V + 39 mV	

Electrical – DC/Low Frequency

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage Measure ¹	(10 to 100) V 1 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 1 000) V 1 Hz to 1 kHz (1 to 20) kHz	0.27 mV/V + 1.6 mV 0.26 mV/V + 0.74 mV 0.44 mV/V + 0.74 mV 1.5 mV/V + 1.3 mV 0.54 mV/V + 28 mV 0.81 mV/V + 28 mV	Multimeter in Synchronous Sub-Sampled Mode
AC Voltage Measure ¹ High Voltage	(0.1 to 30) kV (50 to 400) Hz	1.5 mV/V	High Voltage Meter
AC Current Source ¹	(1 to 220) μ A 40 Hz to 1 kHz 220 μ A to 22 mA 40 Hz to 1 kHz (22 to 220) mA 40 Hz to 1 kHz 220 mA to 2.2 A 40 Hz to 1 kHz (2.2 to 11) A 45 Hz to 1 kHz (11 to 20) A 45 Hz to 1 kHz	0.09 mA/A 0.24 mA/A 0.26 mA/A 0.93 mA/A 1.7 mA/A 2.8 mA/A	Multiproduct Calibrator
AC Current Source ¹	(1 to 1 000) A 60 Hz	5.4 mA/A	Multiproduct Calibrator with Coil
AC Current Measure ¹	10 Hz to 1 kHz (1.0 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	0.69 mA/A + 35 nA 0.53 mA/A + 51 nA 0.58 mA/A 0.58 mA/A 1.5 mA/A	Multimeter
Oscilloscope ¹ Level Sine Amp 50 kHz ref. Level Sine Flatness 5 mVp-p to 5.5 Vp-p relative to 50 kHz reference	5 mVp-p to 5 Vp-p 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	20 mV/V + 0.3 mV 15 mV/V + 0.3 mV 20 mV/V + 0.3 mV 40 mV/V + 0.3 mV	Multiproduct Calibrator

Electrical – DC/Low Frequency

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Oscilloscope ^{1,2} Square Wave 1 M Ω , 100 Hz 50 Ω , 1 kHz Time Marker Output Into 50 Ω	± 1 mVp-p to ± 130 Vp-p ± 1 mVp-p to ± 6.6 Vp-p 2 ns to 20 ms 50 ms to 5 s	1 mV/V + 40 μ V 2.5 mV/V + 40 μ V 25 + 1 000 <i>t</i>) parts in 10 ⁶ of reading 25 parts in 10 ⁶ s	Multiproduct Calibrator

Electrical - RF/Microwave

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Tuned Power Measure ¹	(-127 to 30) dBm 10 kHz to 1.3 GHz (1.3 to 2.6) GHz	0.02 dB 0.04 dB	Measuring Receiver, Power Sensor, Microwave Converter
RF Tuned Power Measure ¹	(-10 to 35) dBm 100 kHz to 4.2 GHz (-30 to 20) dBm 10 MHz to 18 GHz	0.045 dB 0.07 dB	Measuring Receiver, Power Sensor, Microwave Converter
RF Absolute Power Measure ¹	(-127 to 30) dBm 10 kHz to 1.3 GHz (1.3 to 2.6) GHz (-10 to 35) dBm 100 kHz to 4.2 GHz (-30 to 20) dBm 10 MHz to 18 GHz (-65 to -30) dBm 10 MHz to 18 GHz	0.0 24 dB 0.044 dB 0.045 dB 0.072 dB 0.087 dB	Power Meter, Measuring Receiver, Power Sensor
RF Power Source ¹	(-127 to 30) dBm 10 kHz to 1.3 GHz (1.3 to 2.6) GHz (-10 to 35) dBm 10 kHz to to 4.2 GHz (-30 to 20) dBm 10 MHz to 18 GHz	0.01 dB 0.1 dB 0.1 dB 0.2 dB	Signal Generator
Amplitude Modulation Measure ¹ 10 Hz to 100 kHz	Rate: 150 kHz to 10 MHz Depth: (5 to 99) %	0.65 % Modulation	Measuring Receiver, Power Sensor

Electrical - RF/Microwave

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Amplitude Modulation Measure ¹ 20 Hz to 100 kHz	Rate: 10 MHz to 1.3 GHz Depth: (5 to 100) %	0.7 % Modulation	Measuring Receiver, Power Sensor
Frequency Modulation Measure ¹ 10 Hz to 100 kHz	Rate: 250 kHz to 2.6 GHz	1.7 % Modulation	Measuring Receiver, Power Sensor
Phase Modulation Measure ¹ 200 Hz to 20 kHz	Rate: 10 MHz to 1.3 GHz	0.36 % Modulation	Measuring Receiver, Power Sensor

Length – Dimensional Metrology

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Calipers ^{1,2}	Up to 40 in	$(310 + 4.1L) \mu\text{in}$	Gage Blocks, Master Step Gage
Micrometers ^{1,2} Depth Micrometers ^{1,2}	Up to 6 in (6 to 24) in	$(52 + 2L) \mu\text{in}$ $(64 + 3L) \mu\text{in}$	Gage Blocks, Rods Set, Optical Parallel
Height Gages ^{1,2}	(0.10 to 40) in	$(23 + 3.2L) \mu\text{in}$	Gage Blocks, Length Rods
Gage Blocks Length	(0.05 to 1) in (1 to 4) in (4 to 12) in	$(4 + 0.8L) \mu\text{in}$ $(3.1 + 1.7L) \mu\text{in}$ $(5.9 + 1.6L) \mu\text{in}$	P & W Labmaster®, Master Gage Blocks
Cylindrical Plain Plug Gages Outside Diameter	Up to 12 in Up to 300 mm Up to 12 in Up to 300 mm	$(19 + 1.2L) \mu\text{in}$ $(0.13 + 0.03L) \mu\text{m}$ $(19 + 1.2L) \mu\text{in}$ $(0.13 + 0.03L) \mu\text{m}$	P & W Labmaster®, Master Gage Blocks
Thread Plug Gage Major Diameter Pitch Diameter	Up to 5 in Up to 5 in	$(58 + 1.2L) \mu\text{in}$ $(82 + 1.2L) \mu\text{in}$	P & W Labmaster®, Thread Wires (Three Wire Method)
Ring Gage Plain Cylindrical	(0.02 to 2.0) in (4.0 to 12.0) in	$(11 + 1.1L) \mu\text{in}$ $(8 + 4L) \mu\text{in}$	P & W Labmaster®, Master Gage Blocks
Thread Ring Gage Minor Diameter Pitch Diameter	(0.02 to 4.0) in (0.13 to 4.0) in	$(21 + 1.2L) \mu\text{in}$ $(35 + 4L) \mu\text{in}$	P & W Labmaster®, Master Gage Blocks
Indicators ² Thickness Gage with Indicator ^{1,2}	Up to 4.0 in Up to 4.0 in	14 μin $(105 + 10L) \mu\text{in}$	P & W Labmaster®, Master Gage Blocks Gage Blocks

Length – Dimensional Metrology

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Length Standards	Up to 12 in Up to 300 mm	$(25 + 0.6L) \mu\text{in}$ $(0.65 + 0.2L) \mu\text{m}$	P & W Labmaster®, Master Gage Blocks
Feeler / Taper Gage	Up to 0.500 in	20 μin	P & W Labmaster®, Master Gage Blocks, Test Indicator
Coating Thickness Measuring Equipment ^{1,6}	Up to 100 μm Up to 4 mils (100 to 1 500) μm (4 to 60) mils	2.5 μm 0.09 mils 4.5 μm 0.18 mils	Coating Thickness Standards
Pin Gage Diameter	Up to 2.00 in	40 μin	P & W Labmaster®, Master Gage Blocks, Laser Scan Micrometer
Master Levels	(4 to 18) in	5.7 arc sec	Surface Plate, Gage Blocks, Sine Plate
Rulers	Up to 40 in Up to 164 ft	$(75+15 L) \mu\text{in}$ $(138+19 L) \mu\text{in}$	Standard Rule, Optical Comparator
Optical Comparators and Visual Systems ¹ Length	Up to 300 mm	1.8 μm	Glass Scale, Gage Blocks
Optical Comparators and Visual Systems ¹ Angle	(0, 30, 45, 60, 90)°	0.001 7°	Angle Blocks
Angle Meters Bevel Protractors	Up to 360°	0.008 5°	Angle Blocks
Laser Scan Micrometers/ Non- Contact Measuring ¹	(1 to 60) mm	75 μin 19 μm	Pin Gages, Laser Standards
Surface Finish Testers ¹	3 μm (108 μin) Ra 9.5 μm (374 μin) Ry	0.062 μm 0.22 μm	Roughness Specimen
Fixture Gages ¹ Radius Gages	Up to 24 in Up to 25 mm Up to 1 in	$(29+0.6L) \mu\text{in}$ 300 μin	Hand Tools, Optical Comparator
Surface Plates ^{1,2} Overall Flatness	Up to (74 x 144 in)	0.14 % of reading + 3.2 arcsec	Surface Plate Kit
Local Area Flatness	(12 in x 12 in) to (72 in x 96 in)	16 μin	Repeat-o-Meter
Linear Displacement ¹	(1 to 120) in	0.001 4 in	Steel Rule, Gage Blocks

Mass and Mass Related

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Rockwell Hardness Testers ¹	(20 to 30) HRC (35 to 55) HRC (60 to 65) HRC (40 to 59) HRBW (60 to 79) HRBW (80 to 100) HRBW (74 to 80) HR15TW (81 to 86) HR15TW (87 to 93) HR15TW (70 to 77) HR15N (78 to 88) HR15N (90 to 92) HR15N (43 to 56) HR30TW (57 to 69) HR30TW (70 to 83) HR30TW (20 to 31) HR45N (37 to 61) HR45N (66 to 72) HR45N	0.44 HRC 0.42 HRC 0.34 HRC 0.39 HRBW 0.32 HRBW 0.4 HRBW 0.3 HR15TW 0.29 HR15TW 0.44 HR15TW 0.41 HR15N 0.42 HR15N 0.52 HR15N 0.6 HR30TW 0.25 HR30TW 0.52 HR30TW 0.5 HR45N 0.51 HR45N 0.2 HR45N	Indirect Verification per ASTM E18
Durometers	(0 to 100) points	0.35 points	Partial Direct Verification (Force only) Gage Blocks and Balance
Pressure Measure ¹	(0.002 to 2) inH ₂ O (-15 to + 0.001) psig (0.001 to 30) psig (15 to 1 000) psig (1 000 to 10 000) psig	320 µinH ₂ O 0.1 % of reading 0.1 % of reading 0.1 % of reading 0.1 % of reading	Pressure Calibrator Pressure System
Torque Tools ¹	Up to 9 lbf·in (5 to 50) lbf·in (25 to 250) lbf·in (5 to 50) lbf·ft (25 to 250) lbf·ft (50 to 500) lbf·ft	0.58 % of reading + 0.006 6 lbf·in 0.52 % of reading + 0.028 lbf·in 0.54 % of reading + 0.13 lbf·in 0.54 % of reading + 0.028 lbf·ft 0.64 % of reading + 0.12 lbf·ft 0.45 % of reading + 0.76 lbf·ft	Torque System
Torque Analyzers, Transducers	(0.1 to 200) lbf·in (15 to 500) lbf·ft	0.08 % of reading 0.17 % of reading	Torque Wheel and Weights
Force ¹ Tension & Compression	Up to 220 kgf	0.019 % of reading + 0.005 3 kgf	Verification with Class F Weight

Mass and Mass Related

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Force ¹ Tension & Compression	(0 to 1 000) lbf (1 000 to 10 000) lbf	0.012 % of reading + 0.43 lbf 0.11 % of reading + 1.3 lbf	Load Cell Comparison
Scales and Balances ^{1,3}	(0 to 300) g	1.5 µg/g + 0.015 mg	ASTM E617 Class 0 utilized for the calibration of the weighing system
	(0 to 100) kg	3.4 µg/g	ASTM E617 Class 1 utilized for the calibration of the weighing system
	(0 to 1 000) kg	0.2 mg/g	ASTM E617 Class M2 utilized for the calibration of the weighing system
Flow Air ¹	Up to 6 000 ml/min	0.65 % of reading + 0.02 ml/min	Flow Calibrator
Air Velocity	(50 to 7 800) ft/min 0.25 to 40 m/s	1 % of reading ± 1 Digit	Reference Anemometer using Air as Medium
Piston/Plunger Operated Volumetric Apparatus ¹ (POVA)	(10 to 20) µl (20 to 50) µl (50 to 100) µl 100 µl to 20 ml	0.77 % of reading 0.4 % of reading 0.21 % of reading 0.14 % of reading	Scale, Weight Set Class 0, Barometer DP97
Other Volumetric Devices ¹	(0.1 to 50) ml (50 to 200) ml (200 to 1 000) ml	32 µl 62 µl 82 µl	
Viscosity @ 25 °C ¹	(1 990 to 200 400) cP	0.52 % of reading	Cannon Viscosity Standards
Mass	(1 to 500) mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1.0 kg 2.0 kg 3.0 kg 5.0 kg	3 µg 4 µg 9 µg 13 µg 16 µg 21 µg 49 µg 75 µg 0.14 mg 0.18 mg 20 mg 20 mg 20 mg 22 mg	Double Substitution using Class 1 Weights

Mass and Mass Related

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Mass	10.0 kg 20.0 kg 33.0 kg	0.2 g 0.23 g 0.23 g	Double Substitution using Class 1 Weights

Photometry and Radiometry

Tijuana, BC

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power – Source ¹	1310 nm (-60 to 10) dBm 1550 nm (-60 to 10) dBm	0.1 dB 0.1 dB	Optical Calibration System
Optical Power – Measure ¹	1300 nm (-60 to 10) dBm 1310 nm (-60 to 10) dBm 1550 nm (-60 to 10) dBm	0.089 dB 0.092 dB 0.1 dB	Optical Calibration System

Thermodynamic

Tijuana, BC

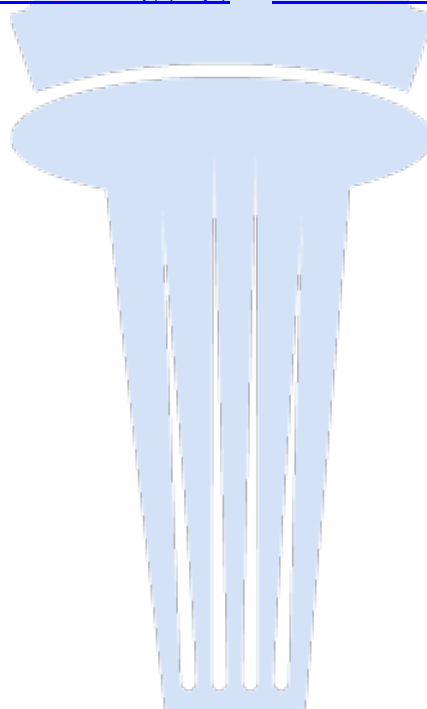
Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Radiation (Infrared) Thermometers ¹	(35 to 100) °C (100 to 200) °C (200 to 350) °C (350 to 500) °C	0.73 °C 1.1 °C 2 °C 3 °C	Precision Infrared Calibrator $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Humidity – Source	11 %RH 33 %RH 75.4 %RH 97 %RH	1.6 %RH 1.7 %RH 1.5 %RH 2 %RH	Saturated Salt Solutions
Humidity – Measure ¹	(11 to 95) %RH	1.6 %RH	Hygrometer
Temperature – Source ¹	(0 to 300) °C	0.17 °C	Drywell
Temperature – Measure ¹	(-20 to 200) °C	0.05 °C	RTD Thermometer

Time and Frequency

Tijuana, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Photo Tachometer ^{1,2}	Up to 100 000 rpm	0.00038 % of reading + 0.13 rpm	Multifunction Calibrator with LED and Series Resistor
Frequency – Measure ¹	1 Hz to 10 MHz	0.12 nHz/Hz + 0.39 nHz	Multimeter
Frequency – Measure ¹	100 Hz to 26.5 GHz	24 pHz/Hz	Frequency Counter and External Time Base
Frequency – Source ¹	0.01 Hz to 1 MHz (1 to 50) MHz	12 μ Hz/Hz 30 μ Hz/Hz	Multifunction Calibrator
	100 kHz to 50 GHz	55 pHz/Hz	RF Generator and External Time Base
Timers, Stopwatches, Chronometers ¹	(0.01 to 86 400) s	24 ms	Frequency Counter
Displacement Velocity ¹	(1 to 50) in/min	0.18 % of reading	Gage Block, Steel Rule & Chronometer

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Services performed at satellite laboratory

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CALIBRATION AND DIMENSIONAL MEASUREMENT

CALIBRATION

Acoustics and Vibration

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Sound Pressure Level – Measure Equipment ¹	(74 to 114) dB (125 to 2 000) Hz 4 000 Hz	0.36 dB 0.72 dB	Comparison to Sound Level Calibrator
Sound Pressure Level – Generators	(30 to 130) dB 31.5 Hz to 8 kHz	0.32 dB 0.28 % of reading	Transfer Method to Sound Level Calibrator and Frequency Meter

Chemical Quantities

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
pH Meters ^{1,4}	(4, 7, 10) pH	0.012 pH	Comparison to Standard Solutions
Conductivity Meters ^{1,4}	1 µS/cm 5 µS/cm 10 µS/cm 100 µS/cm 1 015 µS/cm 1 408 µS/cm	0.48 µS/cm 0.62 µS/cm 0.62 µS/cm 2.1 µS/cm 5.9 µS/cm 7 µS/cm	Comparison to Standard Solutions
Mass Concentration - Refractometers	(0 to 70) % Brix	0.12 % Brix	Comparison to Saturated Solutions

Electrical – DC/Low Frequency

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Voltage – Source ¹	(0 to 220) mV 220 mV to 2.2 V (2.2 to 22) V (22 to 220) V 220 V to 1.1 kV	12 $\mu\text{V/V}$ + 0.93 μV 9.5 $\mu\text{V/V}$ + 1.2 μV 9.6 $\mu\text{V/V}$ + 1 μV 12 $\mu\text{V/V}$ + 21 μV 14 $\mu\text{V/V}$ + 0.2 mV	Multiproduct Calibrator
DC Voltage - Measure ¹	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V 100 V to 1 kV	8.2 $\mu\text{V/V}$ + 0.6 μV 9 $\mu\text{V/V}$ + 0.6 μV 9.3 $\mu\text{V/V}$ + 0.34 μV 12 $\mu\text{V/V}$ + 31 μV 12 $\mu\text{V/V}$ + 37 μV	Multimeter
DC Voltage - Measure ¹ High Voltage	(1 to 2) kV (2 to 20) kV	0.62 mV/V + 0.4 V 0.62 mV/V + 4 V	Voltmeter
DC Current – Source ¹	(0 to 220) μA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A (11 to 20.5) A	19 $\mu\text{A/A}$ + 1.4 nA 15 $\mu\text{A/A}$ + 2.2 nA 17 $\mu\text{A/A}$ 21 $\mu\text{A/A}$ 50 $\mu\text{A/A}$ 95 $\mu\text{A/A}$ + 95 μA 0.12 % of reading	Multiproduct Calibrator
	(10 to 1 000) A	0.22 % of reading	Multiproduct Calibrator with current coil
DC Current - Measure ¹	(0 to 1) μA (1 to 10) μA (10 to 100) μA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	6.8 $\mu\text{A/A}$ + 0.059 nA 2.4 $\mu\text{A/A}$ + 0.063 nA 2.3 $\mu\text{A/A}$ + 0.064 nA 27 $\mu\text{A/A}$ + 2.5 nA 24 $\mu\text{A/A}$ + 0.67 nA 10 $\mu\text{A/A}$ + 0.14 μA 8.5 $\mu\text{A/A}$ + 0.31 μA	Multimeter
	(0 to 100) A (100 to 300) A	1.1 mA/A + 0.67 mA 0.88 mA/A + 42 mA	Shunt Monitored with Multimeter
	(1 to 2 000) A	0.84 % of reading	Comparison to Clamp Meter
Inductance – Source ¹ Fixed Points	(0.1 to 10) kHz 1 mH 10 mH 100 mH 1 H	0.065 % of reading 0.065 % of reading 0.031 % of reading 0.065 % of reading	Standard Inductors

Electrical – DC/Low Frequency

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance - Measure ¹	(0 to 1) Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	53 $\mu\Omega/\Omega$ + 26 $\mu\Omega$ 2.2 $\mu\Omega/\Omega$ + 76 $\mu\Omega$ 6.7 $\mu\Omega/\Omega$ + 32 $\mu\Omega$ 2.9 $\mu\Omega/\Omega$ + 0.41 m Ω 2.9 $\mu\Omega/\Omega$ + 0.42 m Ω 6.6 $\mu\Omega/\Omega$ + 37 m Ω 17 $\mu\Omega/\Omega$ + 1 Ω 78 $\mu\Omega/\Omega$ + 63 Ω 0.3 m Ω/Ω + 2.3 k Ω 2.3 m Ω/Ω + 0.2 M Ω	Multimeter
Capacitance - Source ¹ 50 Hz to 1 kHz	(0.19 to 3.3) nF (3.3 to 330) nF 330 nF to 3.3 μ F (3.3 to 33) μ F (33 to 330) μ F	5 mF/F + 0.01 nF 2.5 mF/F + 0.3 nF 2.5 mF/F + 3 nF 4 mF/F + 30 nF 4.5 mF/F + 0.3 μ F	Multiproduct Calibrator
Capacitance - Source ¹ 50 Hz to 300 Hz	(330 μ F to 3.3 mF (3.3 to 33) mF (33 to 110) mF	4.5 mF/F + 3 μ F 7.5 mF/F + 30 μ F 11 mF/F + 100 μ F	Multiproduct Calibrator
Capacitance – Source ¹ 50 Hz to 1 kHz	10 pF to 1 nF 1 nF to 10 μ F	0.6 % of reading 0.052 % of reading	Capacitance Decade Box
Resistance - Source ¹	(0 to 1.9) Ω (1.9 to 19) Ω (19 to 190) Ω (0.19 to 1.9) k Ω (1.9 to 19) k Ω (19 to 190) k Ω (0.19 to 1.9) M Ω (1.9 to 19) M Ω (19 to 100) M Ω	96 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 26 $\mu\Omega/\Omega$ + 0.17 m Ω 22 $\mu\Omega/\Omega$ + 0.24 m Ω 17 $\mu\Omega/\Omega$ + 0.92 m Ω 18 $\mu\Omega/\Omega$ 19 $\mu\Omega/\Omega$ 30 $\mu\Omega/\Omega$ 36 $\mu\Omega/\Omega$ + 51 Ω 0.2 m Ω/Ω	Multiproduct Calibrator
Resistance - Source ¹	(0 to 100) m Ω 100 m Ω to 1 Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω	0.6 % of reading + 60 $\mu\Omega$ 0.064 % of reading 0.008 7 % of reading 0.003 5 % of reading 0.003 1 % of reading 0.002 8 % of reading 0.002 7 % of reading 0.006 % of reading 0.006 2 % of reading 0.009 2 % of reading	Decade Resistor

Electrical – DC/Low Frequency

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance - Source ¹	100 MΩ to 1 GΩ (1 to 10) GΩ 10 GΩ to 100 GΩ 1.0 TΩ 10.0 TΩ	0.016 % of reading 0.016 % of reading 0.025 % of reading 0.35 % of reading 1.5 % of reading	Decade Resistor
Resistance - Source ¹ Fixed Points	1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	0.1 mΩ/Ω 39 μΩ/Ω 24 μΩ/Ω 18 μΩ/Ω 17 μΩ/Ω 19 μΩ/Ω 27 μΩ/Ω 54 μΩ/Ω 0.2 mΩ/Ω	Multiproduct Calibrator
Electrical Simulation of Thermocouple Indicators ¹ Generate / Measure	Type B (600 to 800) °C (800 to 1 550) °C (1 550 to 1 820) °C Type C (0 to 1 000) °C (1 000 to 1 800) °C (1 800 to 2 316) °C Type E (-250 to -100) °C (-100 to 650) °C (650 to 1 000) °C Type J (-210 to -100) °C (-100 to 760) °C (760 to 1 200) °C Type K (-200 to -100) °C (-100 to 120) °C (120 to 1 000) °C (1 000 to 1 372) °C Type L (-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.57 °C 0.47 °C 0.46 °C 0.37 °C 0.59 °C 0.98 °C 0.58 °C 0.19 °C 0.25 °C 0.32 °C 0.2 °C 0.27 °C 0.39 °C 0.22 °C 0.31 °C 0.47 °C 0.43 °C 0.31 °C 0.21 °C	Multiproduct Calibrator

Electrical – DC/Low Frequency

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Simulation of Thermocouple Indicators ¹ Generate / Measure	Type N (-200 to -100) °C	0.47 °C	Multiproduct Calibrator
	(-100 to 410) °C	0.26 °C	
	(410 to 1 300) °C	0.32 °C	
	Type R (0 to 250) °C	0.68 °C	
	(250 to 1 000) °C	0.44 °C	
	(1 000 to 1 767) °C	0.49 °C	
	Type S (0 to 250) °C	0.58 °C	
	(250 to 1 400) °C	0.47 °C	
	(1 400 to 1 767) °C	0.57 °C	
	Type T (-250 to -150) °C	0.73 °C	
	(-150 to 0) °C	0.28 °C	
	(0 to 400) °C	0.2 °C	
	Type U (-200 to 0) °C	0.65 °C	
	(0 to 600) °C	0.32 °C	
Electrical Simulation of RTD Indicating Systems ¹ Generate / Measure	PT 385, 100 Ω (-200 to 800) °C	0.053 °C	Multimeter and/or Multiproduct Calibrator
	PT 3926, 100 Ω (-200 to 630) °C	0.055 °C	
	PT 3916, 100 Ω (-200 to 630) °C	0.054 °C	
	PT 385, 200 Ω (-200 to 630) °C	0.052 °C	
	PT 385, 500 Ω (-200 to 630) °C	0.058 °C	
	PT 385, 1000 Ω (-200 to 630) °C	0.054 °C	
	PTNi 385, 120 Ω (-80 to 260) °C	0.044 °C	
	CU 427, 10 Ω (-100 to 260) °C	0.071 °C	

Electrical – DC/Low Frequency

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Source ¹	(0 to 220) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz 100 kHz to 1 MHz 220 mV to 2.2 V (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz 100 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 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 kHz to 1 MHz (220 to 750) V (30 to 50) kHz (50 to 100) kHz 220 V to 1.1 kV (15 to 50) Hz 50 Hz to 1 kHz	0.55 mV/V + 13 μ V 0.21 mV/V + 8 μ V 0.11 mV/V + 8 μ V 0.37 mV/V + 8 μ V 0.85 mV/V + 25 μ V 3.4 mV/V + 80 μ V 0.5 mV/V + 80 μ V 0.16 mV/V + 25 μ V 75 μ V/V + 6 μ V 0.12 mV/V + 16 μ V 0.25 mV/V + 70 μ V 2.2 mV/V + 0.85 mV 0.5 mV/V + 0.8 mV 0.16 mV/V + 0.25 mV 75 μ V/V + 0.06 mV 0.12 mV/V + 0.16 mV 0.25 mV/V + 0.35 mV 3.4 mV/V + 8.5 mV 0.5 mV/V + 8 mV 0.16 mV/V + 2.5 mV 80 μ V/V + 0.8 mV 0.22 mV/V + 3.5 mV 0.5 mV/V + 8 mV 16 mV/V + 0.19 V 0.6 mV/V + 11 mV 2.3 mV/V + 45 mV 0.4 mV/V + 16 mV 90 μ V/V + 4 mV	Multiproduct Calibrator
	(0 to 100) mV 1 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 1 MHz	56 μ V + 6.1 μ V 0.16 mV/V + 4.3 μ V 0.40 mV/V + 55 μ V 1.2 mV/V + 0.48 mV 11 mV/V + 32 μ V	
AC Voltage - Measure ¹			Multimeter, Synchronous Sub-Sampled Mode

Electrical – DC/Low Frequency

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage - Measure ¹	100 mV to 1 V		Multimeter, Synchronous Sub-Sampled Mode
	1 Hz to 1 kHz	0.11 mV/V + 0.14 μ V	
	1 kHz to 20 kHz	0.19 mV/V + 1.2 μ V	
	20 kHz to 100 kHz	0.95 mV/V + 0.16 μ V	
	100 kHz to 300 kHz	3.6 mV/V + 0.20 μ V	
	300 kHz to 1 MHz	12 mV/V + 0.12 μ V	
	(1 to 10) V		
	1 Hz to 1 kHz	0.11 mV/V + 4.3 μ V	
	1 kHz to 20 kHz	0.19 mV/V + 0.66 μ V	
	20 kHz to 100 kHz	0.95 mV/V + 0.61 μ V	
	100 kHz to 300 kHz	3.6 mV/V + 0.17 μ V	
	300 kHz to 1 MHz	12 mV/V + 3.5 μ V	
	(1 to 4) MHz	6.0 mV/V + 57 mV	
	(10 to 100) V		
AC Voltage - Measure ¹ High Voltage	1 Hz to 1 kHz	0.27 mV/V + 1.6 mV	Voltmeter
	1 kHz to 20 kHz	0.26 mV/V + 0.75 mV	
	20 kHz to 50 kHz	0.44 mV/V + 0.73 mV	
	50 kHz to 100 kHz	1.5 mV/V + 1.3 mV	
	(100 to 1000) V		
	1 Hz to 1 kHz	0.52 mV/V + 27 mV	
AC Current - Source ¹	1 kHz to 20 kHz	0.79 mV/V + 27 mV	Multiproduct Calibrator
	(50 to 60) Hz		
	(0.5 to 2) kV	0.89 mV/V + 1.4 V	
	(2 to 20) kV	3.3 mV/V + 6.7 V	
	(0 to 22) mA		
	10 Hz to 1 kHz	0.23 mA/A + 15 nA	
	(1 to 10) kHz	0.28 % of reading	
	(22 to 220) mA		
	10 Hz to 1 kHz	1.4 mA/A	
	(1 to 10) kHz	0.17 % of reading + 21 μ A	
AC Current - Source ¹	220 mA to 2.2 A		Multiproduct Calibrator
	40 Hz to 1 kHz	0.38 mA/A + 0.19 mA	
	(1 to 10) kHz	0.65 % of reading	
	(2.2 to 11) A		
	45 Hz to 1 kHz	2.6 mA/A	
	(1 to 5) kHz	3.9 % of Reading	
AC Current - Source ¹	(11 to 20) A		Multiproduct Calibrator with Fluke Coil
	45 Hz to 1 kHz	1.6 mA/A + 4.8 mA	
AC Current - Source ¹	(1 to 1 000) A		Multiproduct Calibrator with Fluke Coil
	(50 to 400) Hz	0.29 % of reading	

Electrical – DC/Low Frequency

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current - Measure ¹	100 pA to 100 μ A 10 Hz to 1 kHz (0.1 to 1) mA 10 Hz to 1 kHz (1 to 10) mA 10 Hz to 1 kHz (10 to 100) mA 10 Hz to 1 kHz (0.1 to 1) A 10 Hz to 1 kHz	16 nA 74 μ A/A + 3.9 nA 73 μ A/A + 5.5 nA 73 μ A/A + 13 nA 0.13 mA/A	Multimeter
	1 Hz to 1 kHz (0.1 to 15) A (15 to 100) A (100 to 300) A	0.27 mA/A 1.1 mA/A 1 mA/A	Shunt monitored with Multimeter
	(1 to 2 000) A 5 Hz to 1 kHz	1.6 % of reading	Comparison to Digital Clamp Meter
Oscilloscope ^{1,2}			
Level Sine Amp 50 kHz ref.	5 mV to 5 V (V pp)	20 mV/V + 0.3 mV	Multiproduct Calibrator
Level Sine Flatness 5 mV to 5.5 V relative to 50 kHz reference	50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	15 mV/V + 0.3 mV 20 mV/V + 0.3 mV 40 mV/V + 0.3 mV	
Square Wave 1 M Ω , 100 Hz 50 Ω , 1 kHz	1 mV to $\pm$ 130 V $\pm$ 1 mV to $\pm$ 6.6 V	1 mV/V + 40 μ V 2.5 mV/V + 40 μ V	
Time Marker Output Into 50 Ω	2 ns to 20 ms 50 ms to 5 s	25 + 1 000 <i>t</i> parts in 10 ⁶ of reading 25 parts in 10 ⁶ s	
Oscilloscope ¹ Pulse Rise Time 5 mV to 2.5 V (p-p)	1 kHz to 10 MHz	100 ps	Multiproduct Calibrator

Electrical - RF/Microwave

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Tuned RF Power Absolute - Measure ¹	(-127 to 0) dBm 150 kHz to 1.3 GHz (-20 to 30) dBm 100 kHz to 2.6 GHz	0.23 dB 0.13 dB	Measuring Receiver and Sensor Module
RF Power Absolute – Source ¹	(-70 to -20) dBm 50 MHz to 50 GHz (-30 to 20) dBm 100 kHz to 4.2 GHz 10 MHz to 18 GHz 50 MHz to 26.5 GHz 50 MHz to 50 GHz (-10 to 35) dBm 100 kHz to 4.2 GHz	0.43 dB 0.21 dB 0.26 dB 0.42 dB 0.42 dB 0.21 dB	Generator Monitored with Power Sensor
RF Power Absolute - Measure ¹	(-70 to -20) dBm 50 MHz to 50 GHz (-30 to 20) dBm 100 kHz to 4.2 GHz 10 MHz to 18 GHz 50 MHz to 26.5 GHz 50 MHz to 50 GHz (-10 to 35) dBm 100 kHz to 4.2 GHz	0.16 dB 0.06 dB 0.083 dB 0.12 dB 0.13 dB 0.064 dB	Power Sensor with Power Meter
Amplitude Modulation - Measure ¹ 50 Hz to 10 kHz 20 Hz to 100 kHz 50 Hz to 50 kHz 20 Hz to 100 kHz	Rate: 150 kHz to 10 MHz Depth: (5 to 99) % Rate: 10 MHz to 1.3 GHz Depth: (5 to 99) %	0.65 % Modulation 0.65 % Modulation 0.65 % Modulation 0.65 % Modulation	Measuring Receiver, Sensor Module
Frequency Modulation - Measure ¹ 20 Hz to 10 kHz 20 Hz to 200 kHz 50 Hz to 100 kHz	Rate: 250 kHz to 10 MHz Dev: ≤ 40 kHz Rate: 10 MHz to 1.3 GHz Dev: ≤ 400 kHz	1.7 % Modulation 1.7 % Modulation 1.7 % Modulation	Measuring Receiver, Sensor Module
Phase Modulation - Measure ¹ 200 Hz to 20 kHz	Rate: 10 MHz to 1.3 GHz	0.36 % Modulation	

Length – Dimensional Metrology

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Height Gages ^{1,2}	(0 to 40) in	$(23 + 3.2L) \mu\text{in}$	Gage Blocks, Check Master
Calipers ^{1,2}	Up to 40 in	$(310 + 4.1L) \mu\text{in}$	Gage Blocks, Check Master
Micrometers ^{1,2} (Internal, External, Depth, Bore)	Up to 8 in (8 to 24) in	$(33 + 1.4L) \mu\text{in}$ $(19 + 5.2L) \mu\text{in}$	Gage Blocks, Rods Set, Ring Gauges
Indicators ^{1,2} (Dial, Digital, Test and LVDTs)	(0 to 4) in	$(4 + 3.3L) \mu\text{in}$	Supermicrometer®, Master Gauge Blocks
Optical Comparators and Visual Systems ^{1,2} Length	Up to 12 in (1 to 24) in	$(50 + 0.19L) \mu\text{in}$ $(79 + 6.4L) \mu\text{in}$	Glass Scale and Gauge Blocks
Optical Comparators and Visual Systems ¹ Angle	30 ° 45 ° 60 ° 90 °	0.036 °	Angle Blocks
Rulers and Tapes	Up to 40 in Up to 164 ft	$(75 + 15L) \mu\text{in}$ $(138 + 19L) \mu\text{in}$	Standard Rule, Optical Comparator
Supermicrometer® Length Parallelism Force Measuring	Up to 1 in (0 to 100) μin Up to 48 ozf	$(4.8 + 3.4L) \mu\text{in}$ 15 μin 2 ozf	Gauge Blocks, Optical Parallel, Force Gage
Angle Meters	(0 to 90) °	0.008 5°	Sine Bar and Gauge Blocks
Thread Plug Gages ² - Pitch Diameter Major Diameter	Major Diameter Up to 12 in Pitch Diameter Up to 12 in	$(65 + 1.2L) \mu\text{in}$ $(78 + 1.2L) \mu\text{in}$	Supermicrometer®, Thread Measuring Wires, Gauge Blocks
Cylindrical Plug Gages & Pin Gages	Up to 12 in	60 μin	Supermicrometer®, Gauge Blocks
Surface Finish Testers Ra Ry	3 μm (108 μin) 9.5 μm (374 μin)	0.07 μm (2.4 μin) 0.22 μm (2.4 μin)	Roughness Specimen
Coating Thickness ^{1,6} - Measuring Equipment	Up to 100 μm Up to 4 mils (100 to 1 500) μm (4 to 60) mils	2.5 μm 0.09 mils 1.5 μm 0.18 mils	Coating Thickness Standards
Feeler and Taper Gages	Up to 0.500 in	20 μin	Supermicrometer®, Master Gauge Blocks, Test Indicator

Length – Dimensional Metrology

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Fixture Gages Radius Gages	Up to 12 in Up to 1 in	300 μ in	Hand Tools, Optical Comparator
Surface Plates ^{1,2} Overall Flatness	(0 to 2 000) arcsec	0.23 % of reading + 0.25 arcsec	Wylar Surface Plate Kit
Local Area Flatness (Repeat Reading)	(-1 000 to 1 000) μ in	16 μ in	Repeat-o-Meter
CMM – Verification ¹ Volumetric Length	Up to 10 in (10 to 20) in (20 to 30) in (30 to 40) in	28 μ in 37 μ in 68 μ in 90 μ in	Master Step Gage, Master Sphere
Extensometers ^{1,2}	Up to 2 in	(49 + 7.6L) μ in	Direct Verification per ASTM E83

Mass and Mass Related

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dynamic Viscosity @ 25 °C ¹	(6.2 to 210 000) cP	0.52 % of reading	Cannon Viscosity Standards
Rockwell Hardness Testers ¹	(20 to 30) HRC (35 to 55) HRC (60 to 65) HRC (40 to 59) HRBW (60 to 79) HRBW (80 to 100) HRBW (70 to 77) HR15N (78 to 88) HR15N (90 to 92) HR15N (20 to 31) HR45N (37 to 61) HR45N (66 to 72) HR45N	0.45 HRC 0.40 HRC 0.40 HRC 1 HRBW 0.70 HRBW 0.51 HRBW 0.55 HR15N 0.5 HR15N 0.55 HR15N 0.55 HR45N 0.5 HR45N 0.50 HR45N	Indirect Verification per ASTM E18

Mass and Mass Related

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Rockwell Hardness Testers ¹	(43 to 56) HR30TW (57 to 69) HR30TW (70 to 83) HR30TW (74 to 80) HR15TW (81 to 86) HR15TW (87 to 93) HR15TW	0.4 HR30TW 0.4 HR30TW 0.45 HR30TW 0.45 HR15TW 0.4 HR15TW 0.4 HR15TW	Indirect Verification per ASTM E18
Micro-indentation ¹ Hardness Testers Vickers Vickers: Repeatability under forces P(gf):	100 ≤ P < 500 (100 to 240) HV (240 to 600) HV > 600 HV 500 ≤ P ≤ 1000 (100 to 240) HV (240 to 600) HV >600 HV	4 HV 11 HV 22 HV 1.7 HV 3.4 HV 9.1 HV	Indirect Verification per ASTM E384
Durometer Shore Spring Force A,B,O Type C,D,DO Type OO Type Indenter dimension Length	Up to 744.39 gf Up to 4079 gf Up to 104.0 gf Up to 0.1 in	2.7 gf 24 gf 0.93 gf 0.000 27 in	Partial direct verification per ASTM 2240 Balance Gage Blocks
Gauge Pressure – Measure ¹	(-15 to 30) psi (0 to 1 000) psi (0 to 10 000) psi	0.03 % of reading + 0.000 64 psi 0.016 % of reading + 0.08 psi 0.015 % of reading + 0.71 psi	Process Calibrator with various Pressure Modules
Torque ¹	(0.01 to 400) ozf·in (0.1 to 5) lbf·in (1.0 to 400) lbf·in (20 to 250) lbf·ft (250 to 600) lbf·ft	0.83 % of reading 0.92 % of reading 0.7 % of reading 0.66 % of reading 0.68 % of reading	Torque System
Torque Analyzers, Transducers	1 ozf·in to 200 lbf·in (16 to 500) lbf·ft	0.08 % of reading 0.14 % of reading	Torque Wheel and Weights
Force – Tension/Compression ¹	Up to 220 kgf	0.019 % of reading + 0.005 3 kgf	Direct Comparison to Dead Weights
	(0 to 1 000) lbf (1 000 to 10 000) lbf	0.012 % of reading + 0.43 lbf 0.11 % of reading + 1.3 lbf	Comparison to Standard Load Cell
Scales and Balances ^{1,3}	Up to 500 g	1.5 µg/g + 0.013 mg	Using Weights ASTM E617 Class 0

Mass and Mass Related

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Scales and Balances ^{1,3}	(0.5 to 100) kg	3.2 µg/g	Using Weights ASTM E617 Class 1
Scales and Balances ^{1,3}	(0.5 to 1 000) kg	0.19 mg/g	Using Weights OIML Class M2
Flow – Air ¹	(0.0010 to 50) L/min	0.42 % of reading	Bios Flow System with Flow Cells

Photometry and Radiometry

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Optical Power – Measure ¹	(1 300, 1 310 & 1 550) nm (-60 to 10) dBm	0.1 dB	EXFO Optical Calibration System
Optical Power – Source ¹	(1 310 & 1 550) nm (-60 to 10) dBm	0.1 dB	EXFO Optical Calibration System

Thermodynamic

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Relative Humidity – Measuring Equipment	11 %RH 33 %RH 75.4 %RH 97 %RH	0.7 %RH 0.7 %RH 0.9 %RH 1.5 %RH	Vaisala Calibrator with Saturated Salt Solutions
	(0 to 100) %RH	0.8 % of reading + 1 %RH	Comparison to Humidity Meter
Relative Humidity – Measure ¹	(0 to 100) %RH	1.2 % of reading + 1.3 %RH	Comparison to Humidity Meter
Temperature – Source ¹	(-20 to 300) °C	0.17 °C	Dry Block Calibrator
Temperature – Measure ¹	(-100 to 800) °C	0.014 % of reading + 0.081 °C	Digital Thermometer
Radiation (Infrared) Thermometers ¹	(35 to 100) °C	0.59 °C	Precision Infrared Calibrator ε= (0.9 to 1.0), λ = (8 to 14) µm
	(100 to 200) °C	1 °C	
	(200 to 300) °C	1.8 °C	
	(300 to 500) °C	2.8 °C	

Time and Frequency

Guadalajara JA.

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Photo Tachometer ^{1,2}	Up to 100 000 rpm	0.000 38 % of reading + 0.013 rpm	Multiproduct Calibrator with LED and Series Resistor
Frequency – Source/Measure ¹	1 mHz to 26.5 GHz	2.5 parts in 10 ¹¹	Frequency Standard, Counter
Frequency – Source ¹	(0.01 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz 120 kHz to 1.2 MHz	3 µHz/Hz + 61 µHz 3 µHz/Hz + 61 µHz 3 µHz/Hz + 120 µHz 3 µHz/Hz + 10 mHz	Multiproduct Calibrator
Frequency – Source ¹	(1.2 to 2) MHz 2 MHz to 6 GHz 10 MHz to 26.5 GHz	3 µHz/Hz + 12 mHz 1.3 µHz/Hz + 0.02 Hz (1.2 x 10 ⁻⁷) Hz + R	Signal Generators
Timers, Stopwatches, Chronometers ¹	1 s to 24 hr	55 ms	Frequency Counter

DIMENSIONAL MEASUREMENT

3 Dimensional

Guadalajara JA.

Specific Tests and / or Properties Measured	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Coordinate Measurements ² 3-Axis Volumetric and Linear Displacement. Fixtures and Part Measurements	Up to 94.5 in	(150 + 2L) µin	Faro CMM Arm

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

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CALIBRATION

Electrical – DC/Low Frequency

Seoul, Korea

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	7.1 μ V/V + 0.4 μ V 4.1 μ V/V + 0.7 μ V 3 μ V/V + 2.5 μ V 3 μ V/V + 4 μ V 4.4 μ V/V + 40 μ V 5.5 μ V/V + 400 μ V	Multifunction Calibrator
DC Voltage Source ¹ Fixed Values	1 V 1.018V 10 V	1.6 μ V/V 1.6 μ V/V 1.2 μ V/V	DC Voltage Standard
DC Voltage Measure ¹	(0.1 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V 100 V to 1 kV	13 μ V/V + 0.3 μ V 11 μ V/V + 0.3 μ V 8 μ V/V + 0.5 μ V 12 μ V/V + 30 μ V 10 μ V/V + 0.1 mV	Multimeter
DC Voltage Measure ¹	(1 to 10) kV	7 V	High Voltage Meter with Probe
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	40 μ A/A + 6 nA 35 μ A/A + 7 nA 35 μ A/A + 40 nA 46 μ A/A + 0.7 μ A 68 μ A/A + 12 μ A 437 μ A/A + 330 μ A	Multiproduct Calibrator
DC High Current – Source ¹	(11 to 20) A (20 to 100) A (100 to 1 000) A	0.3 % of reading + 0.002 A 0.3 % of reading + 0.015 A 0.4 % of reading + 0.05 A	Multiproduct Calibrator with Current Coil

Electrical – DC/Low Frequency

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current Measure ¹	(0.1 to 100) nA (0.1 to 1) μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	84 μ A/A + 40 pA 17 μ A/A + 40 pA 17 μ A/A + 70 pA 17 μ A/A + 0.6 nA 17 μ A/A + 4 nA 17 μ A/A + 40 nA 34 μ A/A + 0.4 μ A 0.12 mA/A + 10 μ A	Multimeter
DC High Current Measure ¹	(1 to 300) A	0.2 mA/A	Current Shunt monitored with Multimeter
Inductance Source ¹ Fixed Points, @ 1 kHz	100 μ H 1 mH 10 mH 100 mH 1 H 10 H	0.045 μ H 0.31 μ H 3.1 μ H 31 μ H 0.32 mH 3.3 mH	Standard Inductors
	100 μ H to 10 H	1.2 mH/H + 0.58R	Decade Inductor
Inductance Measure ¹	100 μ H to 10 H 12 Hz to 1 kHz	0.45 mH/H	RLC Digibridge
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 (110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω	0.11 m Ω / Ω + 8 m Ω 0.11 m Ω / Ω + 15 m Ω 82 $\mu\Omega$ / Ω + 1.4 m Ω 80 $\mu\Omega$ / Ω + 15 m Ω 82 $\mu\Omega$ / Ω + 2 m Ω 82 $\mu\Omega$ / Ω + 60 m Ω 82 $\mu\Omega$ / Ω + 0.6 Ω 82 $\mu\Omega$ / Ω + 0.6 Ω 93 $\mu\Omega$ / Ω + 6 Ω 0.11 m Ω / Ω + 6 Ω 0.13 m Ω / Ω + 55 Ω 0.13 m Ω / Ω + 55 Ω 0.53 m Ω / Ω + 550 Ω 0.87 m Ω / Ω + 550 Ω 4.7 m Ω / Ω + 5.5 k Ω 4.7 m Ω / Ω + 16.5 k Ω	Multiproduct Calibrator

Electrical – DC/Low Frequency

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance Source ¹	(0 to 1.0) Ω (1.0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω (1 to 10) G Ω (10 to 100) G Ω	0.24 m Ω 1.1 m Ω 11 m Ω 12 m Ω 0.12 Ω 1.4 Ω 19 Ω 1.1 k Ω 32 k Ω 1.2 m Ω/Ω 1.3 m Ω/Ω 1.5 m Ω/Ω	Decade Resistance Box
Resistance Source ¹ Fixed Points	0 Ω 1.0 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	50 $\mu\Omega/\Omega$ 91 $\mu\Omega/\Omega$ 91 $\mu\Omega/\Omega$ 27 $\mu\Omega/\Omega$ 27 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 14 $\mu\Omega/\Omega$ 14 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 21 $\mu\Omega/\Omega$ 40 $\mu\Omega/\Omega$ 49 $\mu\Omega/\Omega$ 109 $\mu\Omega/\Omega$	Multifunction Calibrator
Resistance Source ¹ Fixed Points	1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω 10 M Ω	9.9 $\mu\Omega$ 99 $\mu\Omega$ 784 $\mu\Omega$ 7.4 m Ω 51 m Ω 748 m Ω 10 Ω 132 Ω	Standard Resistors

Electrical – DC/Low Frequency

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	7 $\mu\Omega/\Omega$ + 30 $\mu\Omega$ 5 $\mu\Omega/\Omega$ + 0.3 m Ω 3 $\mu\Omega/\Omega$ + 0.2 m Ω 3 $\mu\Omega/\Omega$ + 2 m Ω 4 $\mu\Omega/\Omega$ + 20 m Ω 13 $\mu\Omega/\Omega$ + 1 Ω 60 $\mu\Omega/\Omega$ + 50 Ω 570 $\mu\Omega/\Omega$ + 1 k Ω 7 m Ω/Ω + 10 k Ω	Multimeter
AC Resistance Source and Measure ¹ 100 Hz to 10 kHz	(0.001 to 1) Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω	64 m Ω/Ω 64 m Ω/Ω 64 m Ω/Ω 0.64 $\mu\Omega/\Omega$ 6.4 $\mu\Omega/\Omega$	RLC Digibridge, Standard Resistors
Capacitance Source ¹ at 1 kHz	(330 to 490) pF 490 pF to 1.1 nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 to 1.1 μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F 330 μ F to 1.1 mF	45 mF/F + 0.01 nF 15 mF/F + 0.01 nF 8 mF/F + 0.01 nF 6 mF/F + 0.01 nF 6 mF/F + 0.1 nF 6 mF/F + 0.1 nF 6 mF/F + 0.1 nF 6 mF/F + 0.3 nF 6 mF/F + 1 nF 6 mF/F + 3 nF 6 mF/F + 10 nF 4 mF/F + 30 nF 4.5 mF/F + 100 nF 6 mF/F + 300 nF 11 mF/F + 300 nF	Multiproduct Calibrator
Capacitance Source ¹ Fixed Points 1 kHz	(1, 10, 100, 1 000) pF (10, 100, 1 000) nF	1.3 mF/F 1.3 mF/F	Standard Capacitor Set
Capacitance Measure ¹	1 pF to 1 nF 1 kHz to 1 MHz 1 nF to 1 μ F 1 kHz	0.6 mF/F 1.2 mF/F	Precision LCR Meter, RLC Digibridge

Electrical – DC/Low Frequency

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Stimulation of Thermocouple Indicators ¹	Type E		Multiproduct Calibrator
	(-250 to -100) °C	0.7 °C	
	(-100 to -25) °C	0.23 °C	
	(-25 to 350) °C	0.2 °C	
	(350 to 650) °C	0.22 °C	
	(650 to 1 000) °C	0.3 °C	
	Type J		
	(-210 to -100) °C	0.4 °C	
	(-100 to -30) °C	0.22 °C	
	(-30 to 150) °C	0.2 °C	
	(150 to 760) °C	0.25 °C	
	(760 to 1 200) °C	0.33 °C	
	Type K		
	(-200 to -100) °C	0.46 °C	
	(-100 to -25) °C	0.25 °C	
	(-25 to 120) °C	0.22 °C	
	(120 to 1 000) °C	0.4 °C	
	(1 000 to 1 372) °C	0.56 °C	
	Type S		
	(0 to 250) °C	0.75 °C	
	(250 to 1 000) °C	0.53 °C	
	(1 000 to 1 400) °C	0.52 °C	
	(1 400 to 1 767) °C	0.64 °C	
	Type T		
	(-250 to -150) °C	0.9 °C	
	(-150 to 0) °C	0.33 °C	
	(0 to 120) °C	0.22 °C	
	(120 to 400) °C	0.2 °C	
Electrical Calibration of RTD Indicators ¹	Pt 385, 100 Ω		Multiproduct Calibrator
	(-200 to -80) °C	0.1 °C	
	(-80 to 0) °C	0.1 °C	
	(0 to 100) °C	0.11 °C	
	(100 to 300) °C	0.16 °C	
	(300 to 400) °C	0.17 °C	
	(400 to 630) °C	0.21 °C	
	(630 to 800) °C	0.35 °C	

Electrical – DC/Low Frequency

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicators ¹	Pt 3926, 100 Ω		Multiproduct Calibrator
	(-200 to 0) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(100 to 400) $^{\circ}\text{C}$	0.15 $^{\circ}\text{C}$	
	(400 to 630) $^{\circ}\text{C}$	0.16 $^{\circ}\text{C}$	
	Pt 3916, 100 Ω		
	(-200 to -190) $^{\circ}\text{C}$	0.4 $^{\circ}\text{C}$	
	(-190 to 0) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(0 to 300) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	(300 to 600) $^{\circ}\text{C}$	0.13 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.33 $^{\circ}\text{C}$	
	Pt 385, 200 Ω		
	(-200 to 100) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(260 to 600) $^{\circ}\text{C}$	0.2 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.22 $^{\circ}\text{C}$	
	Pt 385, 500 Ω		
	(-200 to 100) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(260 to 600) $^{\circ}\text{C}$	0.15 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.15 $^{\circ}\text{C}$	
	Pt 385, 1 k Ω		
	(-200 to 0) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(0 to 260) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(260 to 600) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.35 $^{\circ}\text{C}$	
	PtNi 385, 100 Ω		
	(-80 to 100) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.2 $^{\circ}\text{C}$	
	Cu 427, 10 Ω		
	(-100 to 260) $^{\circ}\text{C}$	0.45 $^{\circ}\text{C}$	
AC Voltage Source ¹	220 μV to 2.2 mV		Multiproduct Calibrator
	(10 to 20) Hz	0.65 mV/V + 4 μV	
	(20 to 40) Hz	0.25 mV/V + 4 μV	
	40 Hz to 20 kHz	0.2 mV/V + 4 μV	
	(20 to 50) kHz	0.45 mV/V + 4 μV	
	(50 to 100) kHz	1 mV/V + 5 μV	
	(100 to 300) kHz	1.5 mV/V + 10 μV	
	(300 to 500) kHz	2.2 mV/V + 20 μV	
	500 kHz to 1 MHz	4.5 mV/V + 20 μV	

Electrical – DC/Low Frequency

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Source ¹	(2.2 to 22) mV		Multiproduct Calibrator
	(10 to 20) Hz	0.6 mV/V + 4 μ V	
	(20 to 40) Hz	0.25 mV/V + 4 μ V	
	40 Hz to 20 kHz	0.15 mV/V + 4 μ V	
	(20 to 50) kHz	0.42 mV/V + 4 μ V	
	(50 to 100) kHz	1 mV/V + 5 μ V	
	(100 to 300) kHz	1.5 mV/V + 10 μ V	
	(300 to 500) kHz	2.1 mV/V + 20 μ V	
	500 kHz to 1 MHz	4.5 mV/V + 20 μ V	
	(22 to 220) mV		
	(10 to 20) Hz	0.6 mV/V + 12 μ V	
	(20 to 40) Hz	0.23 mV/V + 7 μ V	
	40 Hz to 20 kHz	0.15 mV/V + 7 μ V	
	(20 to 50) kHz	0.4 mV/V + 7 μ V	
	(50 to 100) kHz	1 mV/V + 17 μ V	
	(100 to 300) kHz	1.5 mV/V + 20 μ V	
	(300 to 500) kHz	2.1 mV/V + 25 μ V	
	500 kHz to 1 MHz	4.5 mV/V + 45 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.55 mV/V + 40 μ V	
	(20 to 40) Hz	0.2 mV/V + 15 μ V	
	40 Hz to 20 kHz	0.16 mV/V + 8 μ V	
	(20 to 50) kHz	0.15 mV/V + 10 μ V	
	(50 to 100) kHz	0.3 mV/V + 30 μ V	
	(100 to 300) kHz	0.6 mV/V + 80 μ V	
	(300 to 500) kHz	1.5 mV/V + 0.2 mV	
	500 kHz to 1 MHz	2.8 mV/V + 0.3 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.55 mV/V + 400 μ V	
	(20 to 40) Hz	0.18 mV/V + 150 μ V	
	40 Hz to 20 kHz	0.16 mV/V + 50 μ V	
	(20 to 50) kHz	0.25 mV/V + 100 μ V	
	(50 to 100) kHz	0.50 mV/V + 200 μ V	
	(100 to 300) kHz	1.5 mV/V + 0.6 mV	
	(300 to 500) kHz	4.8 mV/V + 2 mV	
	500 kHz to 1 MHz	12 mV/V + 3.2 mV	

Electrical – DC/Low Frequency

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Source ¹	(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 (15 to 50) Hz 50 Hz to 1 kHz	0.55 mV/V + 4 mV 0.2 mV/V + 1.5 mV 0.17 mV/V + 0.6 mV 0.25 mV/V + 1 mV 0.51 mV/V + 2.5 mV 1.7 mV/V + 16 mV 6.7 mV/V + 40 mV 15 mV/V + 80 mV 0.51 mV/V + 16 mV 0.51 mV/V + 3.5 mV	Multiproduct Calibrator
AC Voltage Measure ¹	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz 100 mV to 1 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 (1 to 2) MHz	0.46 mV/V + 3 μV 0.35 mV/V + 1.1 μV 0.45 mV/V + 1.1 μV 1.2 mV/V + 1.1 μV 6 mV/V + 1.1 μV 45 mV/V + 1.1 μV 0.25 mV/V + 40 μV 0.15 mV/V + 20 μV 0.2 mV/V + 20 μV 0.5 mV/V + 20 μV 1.2 mV/V + 20 μV 3.6 mV/V + 100 μV 12 mV/V + 100 μV 17 mV/V + 100 μV 0.2 mV/V + 400 μV 0.2 mV/V + 200 μV 0.22 mV/V + 200 μV 0.36 mV/V + 200 μV 1 mV/V + 200 μV 3.5 mV/V + 1 mV 12 mV/V + 1 mV 17 mV/V + 1 mV	Multimeter

Electrical – DC/Low Frequency

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Measure ¹	(1 to 10) V		Multimeter
	(1 to 40) Hz	0.2 mV/V + 4 mV	
	40 Hz to 1 kHz	0.2 mV/V + 2 mV	
	(1 to 20) kHz	0.22 mV/V + 2 mV	
	(20 to 50) kHz	0.4 mV/V + 2 mV	
	(50 to 100) kHz	1 mV/V + 2 mV	
	(100 to 300) kHz	4 mV/V + 10 mV	
	300 kHz to 1 MHz	16 mV/V + 10 mV	
	(1 to 2) MHz	21 mV/V + 10 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.3 mV/V + 4 mV	
	40 Hz to 1 kHz	0.3 mV/V + 2 mV	
	(1 to 20) kHz	0.3 mV/V + 2 mV	
	(20 to 50) kHz	0.45 mV/V + 2 mV	
	(50 to 100) kHz	1.5 mV/V + 2 mV	
	(100 to 300) kHz	5 mV/V + 10 mV	
	300 kHz to 1 MHz	21 mV/V + 10 mV	
	(100 to 700) V		
	(1 to 40) Hz	0.6 mV/V + 40 mV	
	40 Hz to 1 kHz	0.7 mV/V + 20 mV	
	(1 to 20) kHz	1 mV/V + 20 mV	
	(20 to 50) kHz	1.6 mV/V + 20 mV	
	(50 to 100) kHz	3.5 mV/V + 20 mV	
AC High Voltage Measure ¹	(1 to 10) kV 60 Hz	13 mV/V	High Voltage Meter with Probe
AC Current Source ¹	Up to 220 μ A		Multiproduct Calibrator
	(10 to 20) Hz	0.74 mA/A + 16 nA	
	(20 to 40) Hz	0.39 mA/A + 10 nA	
	40 Hz to 1 kHz	0.19 mA/A + 8 nA	
	(1 to 5) kHz	0.70 mA/A + 12 nA	
	(5 to 10) kHz	2 mA/A + 65 nA	
	220 μ A to 2.2 mA		
	(10 to 20) Hz	0.74 mA/A + 40 nA	
	(20 to 40) Hz	0.39 mA/A + 35 nA	
	40 Hz to 1 kHz	0.19 mA/A + 35 nA	
	(1 to 5) kHz	0.67 mA/A + 0.11 μ A	
	(5 to 10) kHz	2 mA/A + 0.65 μ A	

Electrical – DC/Low Frequency

Seoul, Korea

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 (45 to 65) Hz (65 to 500) Hz 500 to 1 kHz	0.74 mA/A + 0.4 μ A 0.39 mA/A + 0.35 μ A 0.19 mA/A + 0.35 μ A 0.67 mA/A + 0.55 μ A 2 mA/A + 5 μ A 0.74 mA/A + 4 μ A 0.39 mA/A + 3.5 μ A 0.19 mA/A + 2.5 μ A 0.67 mA/A + 3.5 μ A 2 mA/A + 10 μ A 0.74 mA/A + 35 μ A 0.87 mA/A + 80 μ A 11 mA/A + 0.16 mA 0.82 mA/A + 2 mA 1.1 mA/A + 2 mA 3 mA/A + 2 mA	Multiproduct Calibrator
	(1 to 550) A 60 Hz	7 mA/A + 0.09 A	Multiproduct Calibrator with Coil
AC Current Measure ¹	(5 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 1 mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (1 to 10) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	6.5 mA/A + 0.03 μ A 2.5 mA/A + 0.03 μ A 1 mA/A + 0.03 μ A 1 mA/A + 0.03 μ A 6 mA/A + 0.2 μ A 2 mA/A + 0.2 μ A 1 mA/A + 0.2 μ A 0.5 mA/A + 0.2 μ A 6 mA/A + 2 μ A 2 mA/A + 2 μ A 1 mA/A + 2 μ A 0.5 mA/A + 2 μ A	Multimeter

Electrical – DC/Low Frequency

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Measure ¹	(10 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz (100 Hz to 5) kHz	6.7 mA/A + 20 μ A 2.4 mA/A + 20 μ A 1 mA/A + 20 μ A 0.5 mA/A + 20 μ A 5 mA/A + 0.2 mA 2 mA/A + 0.2 mA 1 mA/A + 0.2 mA 1.4 mA/A + 0.2 mA	Multimeter
	(1 to 100) A 1 kHz	1.4 mA/A	Current Shunt w/Multimeter
DC Power – Source ¹	0.1 W to 11 kW	3 mW/W	Multi-Function Calibrator
AC Power – Source ¹	0.1 W to 12 kW 60 Hz	2.2 mW/W	Power Energy Calibrator
Oscilloscopes ¹ Square Wave Signal 50 Ω at 1 kHz 1 M Ω at 1 kHz Pulse & Rise Time 0.5, 1 V p-p 1 V p-p Time Mark Output ⁴ Into 50 ohms Leveled Sine Flatness	1 mV to 6.6 V 1 mV to 130 V 10 MHz 1 MHz 2 ns to 20 ms 50 ms to 5 s 50 kHz reference 50 kHz to 100 MHz (100 to 600) MHz 600 MHz to 2.2 GHz (2.2 to 50) GHz	2.6 mV/V + 40 μ V 8 mV/V to 40 μ V 0.4 ns 0.4 ns (25 + 1 000t) parts in 10 ⁶ 25 parts in 10 ⁶ of reading 4 % of reading + 0.3 nV 4 % of reading + 0.3 nV 7 % of reading + 0.3 nV 9 % of reading + 0.3 nV 10 % of reading	Oscilloscope Calibrator, Active Head & RF Power Sensor

Electrical – RF/Microwave

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned RF Power, Relative – Measure ¹ 150 kHz to 26.5 GHz	(-30 to 20.0) dB (-120 to -30) dB	0.25 dB 0.59 dB	Spectrum Analyzer, Measuring Receiver
RF Power Absolute Measure ¹	(-70 to 20) dBm (9 to 300) kHz 300 kHz to 1 MHz 1 MHz to 2 GHz (2 to 6) GHz (6 to 12.4) GHz (12.4 to 18) GHz (18 to 26.5) GHz (26.5 to 40) GHz (40 to 50) GHz	0.1 dB 0.064 dB 0.054 dB 0.055 dB 0.057 dB 0.063 dB 0.07 dB 0.08 dB 0.086 dB	Measuring Receiver with Power Sensor
RF Power Source ¹	(-50 to 20) dBm 1 mHz to 100 kHz 100 kHz to 20 MHz (-110 to 10) dBm 100 kHz to 1.04 GHz (-110 to 10) dBm 10 MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50.0) GHz	0.13 dB 0.47 dB 0.58 dB 0.27 dB 0.33 dB 0.41 dB 0.83 dB	Signal Generator
RF Power Meter Reference ¹	1 mW, 50 MHz	0.51 % of reading	Power Meter and Power Sensor
RF Power Sensor Calibration Factors ^{1,5}	Referenced to 1 mW 9 kHz to 30 MHz (30 to 500) MHz 500 MHz to 1.2 GHz (1.2 to 6) GHz (6 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 33) GHz (33 to 40) GHz (40 to 45) GHz (45 to 50) GHz	1.9 % 1.7 % 1.6 % 1.7 % 1.9 % 2.1 % 2.6 % 2.9 % 3 % 4 % 4.7 %	Power Meter and Power Sensor

Electrical – RF/Microwave

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation ¹ – Depth Accuracy Measure 150 kHz to 10 MHz 10 MHz to 3 GHz 10 MHz to 3 GHz (3 to 26.5) GHz (3 to 26.5) GHz	Rate: 50 Hz to 10 kHz Depth: (5 to 99) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	0.5 % Modulation 0.4 % Modulation 0.5 % Modulation 0.4 % Modulation 0.6 % Modulation	Spectrum Analyzer, Measuring Receiver
Amplitude Modulation – Measure ¹ Flatness 10 MHz to 3 GHz (Rate: 90 Hz to 10 kHz) (3 to 26.5) GHz (Rate: 90 Hz to 10 kHz) FM Rejection (50 Hz to 3 kHz BW) 250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz) 10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz) Residual AM 250 kHz to 26.5 GHz	Depth: (5 to 99) % Depth: (5 to 99) % Depths: < 50% Deviations: < 5 kHz Depths: < 50% Deviations: < 50 kHz (50 Hz to 3 kHz BW)	0.37 % Depth 0.49 % Depth 0.17 % Depth 0.44 % Depth 0.012 % (rms)	PSA Series Spectrum Analyzer
Harmonic Measurements ¹	(≤ -80 to 0.1) dB 30 Hz to 50 GHz	1.5 dB	Spectrum Analyzer
Harmonic Distortion ¹	(0 to 100) dB 20 Hz to 20 kHz (20 to 100) kHz	1.6 dB 2.8 dB	Audio Analyzer

Electrical – RF/Microwave

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation ¹ – Deviation Accuracy Measure 250 kHz to 10 MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 10 kHz Dev: ≤ 40 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz	0.4 % Modulation 0.5 % Modulation 0.5 % Modulation 0.5 % Modulation	PSA Series Spectrum Analyzer, Measuring Receiver
Frequency Modulation – Measure ¹ AM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz Residual FM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	AM Depths: ≤ 50% (Rate: 400 Hz or 1 kHz) (50 Hz to 3 kHz BW)	13 Hz 25 Hz 49 Hz 1.9 Hz 3.7 Hz 7.4 Hz	PSA Series Spectrum Analyzer
Phase Modulation – Measure ¹ PM Deviation Accuracy 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz AM Rejection (50 Hz to 3 kHz BW) 100 kHz to 26.5 GHz Residual PM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad AM Depths: ≤ 50% (Rate: 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad 0.002 1 rad 0.004 1 rad 0.008 1 rad	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation Source ¹ 10 kHz to 13.5 MHz	Rate: 50 Hz to 100 kHz Depths: (5 to 95) %	0.2 % Depth	AM/FM Test Source
10 kHz to 13.5 MHz	Rate: 50 Hz to 100 kHz Depths: (95 to 99) %	0.3 % Depth	
Frequency Modulation Source ¹ 10 kHz to 432 MHz	Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	0.4 % Modulation	AM/FM Test Source
Digital Modulation Source and Measure ¹ EVM, Power Ramp Relative Accuracy	-0.11 ± 0.60 dB	0.26 dB	Signal Generator, Spectrum Analyzer tfa = time frequency analysis
Phase and Frequency Error: Phase Error	(0.01 to 180) °	0.5 °	
Peak Phase Error	-0.11 ± 0.60 dB	2 dB	
Frequency Error	(0.001 to 10) Hz	5 Hz + tfa	
Output RF Spectrum Relative RF Power Uncertainty: Due to Modulation Offsets ≤ 1.2 MHz	(-30 to 10) dB (1 to 15) °	0.26 dB	
Offsets ≥ 1.8 MHz	(3 to 25) °	0.36 dB	
Due to Switching	(-30 to 10) dB (18 to 30) °	0.27 dB	
Absolute RF Power Accuracy	(-30 to 10) dB (18 to 30) °	0.4 dB	
Excess Noise Ratio	(12 to 17) dB 10 MHz 100 MHz 1 GHz 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz 7 GHz 8 GHz	0.19 dB 0.16 dB 0.11 dB 0.12 dB 0.096 dB 0.1 dB 0.12 dB 0.11 dB 0.11 dB 0.11 dB	Noise Sources

Electrical – RF/Microwave

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Excess Noise Ratio	(12 to 17) dB		Noise Sources
	9 GHz	0.11 dB	
	10 GHz	0.11 dB	
	11 GHz	0.12 dB	
	12 GHz	0.15 dB	
	13 GHz	0.11 dB	
	14 GHz	0.15 dB	
	15 GHz	0.14 dB	
	16 GHz	0.14 dB	
	17 GHz	0.14 dB	
	18 GHz	0.1 dB	
	19 GHz	0.094 dB	
	20 GHz	0.11 dB	
	21 GHz	0.099 dB	
	22 GHz	0.096 dB	
	23 GHz	0.11 dB	
	24 GHz	0.11 dB	
	25 GHz	0.099 dB	
	26 GHz	0.1 dB	
	26.5 GHz	0.11 dB	

Electrical – RF/Microwave

Seoul, Korea

Parameter/Equipment	S11 - Reflection Magnitude ^{1,5}									
Reference Standard, Method, and/or Equipment	Network Analyzer, Calibration Kit and Verification Kit									
Range	Expanded Uncertainty of Measurement (+/-)									
Frequency	Measured Magnitude (Linear)									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
9 kHz to 300 kHz	0.02	0.02	0.02	0.03	0.03	0.035	0.04	0.05	0.05	0.07
300 kHz to 3 GHz	0.015	0.015	0.015	0.015	0.015	0.02	0.03	0.03	0.035	0.035
(3 to 20) GHz	0.035	0.035	0.035	0.035	0.04	0.04	0.045	0.055	0.06	0.065
(20 to 50) GHz	0.061	0.065	0.07	0.07	0.073	0.04	0.090	0.1	0.15	0.15

Electrical – RF/Microwave

Seoul, Korea

Parameter/ Equipment	S11 - Reflection Phase ¹									
Reference Standard, Method, and/or Equipment	Network Analyzer, Calibration Kit and Verification Kit									
Range	Expanded Uncertainty of Measurement (+/-)									
Frequency	Measured Magnitude (Degrees)									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
9 kHz to 300 kHz	8	5	3.5	3.5	4	3.5	3.5	3.5	3.5	3.5
300 kHz to 3 GHz	7.5	4	3	2.5	2	2	2	2	2	3
(3 to 20) GHz	20	10	7	5	5	4	4	4	4	4
(20 to 50) GHz	32	20	13	11	10	7.5	7.5	7.5	7.5	7.5

Electrical – RF/Microwave

Seoul, Korea

Parameter/ Equipment	S21 - Transmission Magnitude ^{1,5}									
Reference Standard, Method, and/or Equipment	85054B, 85031B, ET33700, 85056A, 85058B, 85059B Calibration Kits									
Range	Expanded Uncertainty of Measurement (+/-)									
Frequency	Measured Magnitude (Linear)									
	0	3	6	10	20	30	40	50	60	
9 kHz to 300 kHz	05	0.5	0.5	0.5	0.5	0.5	0.5	1	2	
300 kHz to 3 GHz	0.15	0.15	0.15	0.15	0.2	0.3	0.3	0.4	0.7	
(3 to 20) GHz	0.3	0.3	0.3	0.3	0.3	0.5	0.5	0.5	0.8	
(20 to 50) GHz	0.4	0.5	0.5	0.5	0.5	1	1	1.5	1.5	

Electrical – RF/Microwave

Seoul, Korea

Parameter/ Equipment	S21 - Transmission Phase ¹									
Reference Standard, Method, and/or Equipment	Network Analyzer, Calibration Kit and Verification Kit									
Range	Expanded Uncertainty of Measurement (+/-)									
Frequency	Measured Magnitude (Degrees)									
	0	3	6	10	20	30	40	50	60	
9 kHz to 300 kHz	3	3	3	3	3	3	3.5	5.5	7	
300 kHz to 3 GHz	1	1	1	1.5	1.5	2	2	2.5	3.5	

Electrical – RF/Microwave

Seoul, Korea

Parameter/ Equipment	S21 - Transmission Phase ¹								
Reference Standard, Method, and/or Equipment	Network Analyzer, Calibration Kit and Verification Kit								
Range	Expanded Uncertainty of Measurement (+/-)								
Frequency	Measured Magnitude (Degrees)								
	0	3	6	10	20	30	40	50	60
(3 to 20) GHz	1.5	2	2	2	2	2	3	3.5	4
(20 to 50) GHz	5	5	5.5	5.8	5.8	6	6.5	7	7.5

Length – Dimensional Metrology

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 500 mm	$(0.24 + 0.002L) \mu\text{m}$	Gage Blocks
Height Gages ^{1,2}	Up to 500 mm	$(0.13 + 0.002L) \mu\text{m}$	Gage Blocks
Indicators ²	Up to 100 mm	$(0.4 + 0.000 2L) \mu\text{m}$	Gage Blocks
Micrometers ^{1,2}	Up to 500 mm	$(2.5 + 0.000 3L) \mu\text{m}$	Gage Blocks

Mass and Mass Related

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure ¹	(-15 to 200) psi (200 to 1 000) psi (1 000 to 10 000) psi	0.1 psi 0.06 psi 20 psi	Pressure Calibrator
Scales and Balances ^{1,3}	(0 to 5) mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g	0.003 1 mg 0.004 1 mg 0.005 1 mg 0.006 1 mg 0.008 1 mg 0.01 mg 0.013 mg 0.015 mg 0.02 mg 0.026 mg	Standard Weights

Mass and Mass Related

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales and Balances ^{1,3}	(5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 1 kg (1 to 150) kg	0.031 mg 0.041 mg 0.051 mg 0.081 mg 0.15 mg 0.41 mg 8.2 mg 24×10^{-6} kg/kg	Standard Weights
Torque Tools ¹	(0.01 to 10) N·m (10 to 100) N·m (60 to 600) lbf·ft	0.53 % of reading 0.57 % of reading + 0.006 1 N·m 0.5 % of reading	Torque Calibrator

Photometry and Radiometry

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Wavelength Measure ¹	(700 to 1 650) nm	0.007 nm	Wavelength Meter
Optical Power Measure ¹ 850 nm 1 310 nm 1 550 nm	(-6 to -60) dB (-110 to 10) dB (-110 to 10) dB	3.5 % of reading + 0.01 dB 3.5 % of reading + 0.01 dB 3.8 % of reading + 0.01 dB	Optical Test System

Thermodynamic

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Indicating Devices ¹	(-195 to 0) °C (0 to 420) °C	0.043 °C 0.06 °C	Standard Thermometer
Relative Humidity Indicating Devices ¹	(10 to 95) % RH	2.5 % RH	Hygrometer

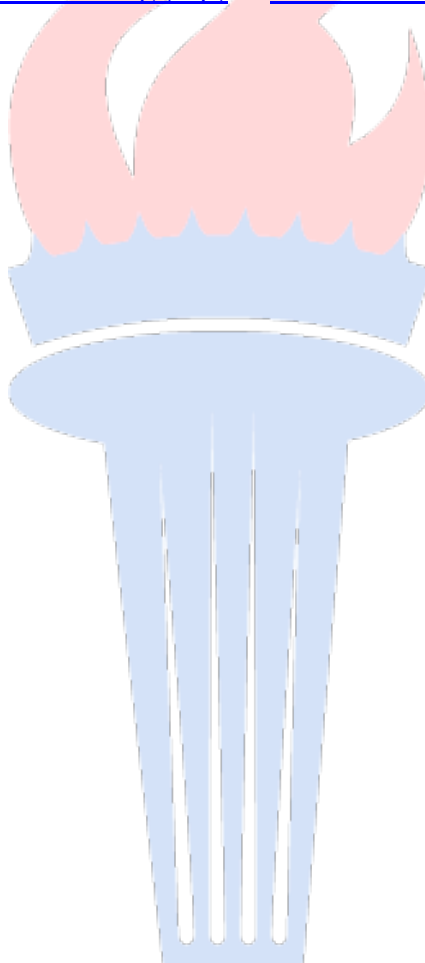
Time and Frequency

Seoul, Korea

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Source ¹	0.1 Hz to 50 GHz	6×10^{-11} Hz/Hz	GPS Receiver, Signal Generator
Frequency Measure ¹ Fixed Point	10 MHz	6×10^{-11} Hz/Hz	GPS Receiver
Frequency Measure ¹	0.1 Hz to 3 GHz 10 Hz to 46 GHz	7×10^{-11} Hz/Hz 7×10^{-10} Hz/Hz	GPS, Frequency Receiver and Counter
Photo Tachometer ^{1,2}	(0.6 to 100 000) rpm	0.000 27 % of reading + 0.58R	Waveform Generator, Multi-product Calibrator with LED

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)



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CALIBRATION

Acoustics and Vibration

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Accelerometers – Measure ¹	(0.1 to 5) g (100 to 1 000) Hz	4.6 % of reading	Direct comparison to standard transducer

Chemical Quantities

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters ^{1,4}	10 µS/cm 100 µS/cm 1 000 µS/cm 1 408 µS/cm	0.55 µS/cm 2.2 µS/cm 5.9 µS/cm 7 µS/cm	Comparison to standard solution
pH Meters ^{1,4}	(4, 7, 10) pH	0.014 pH	Comparison to standard solutions

Electrical – DC/Low Frequency

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100)	12 µV/V + 1 µV 12 µV/V + 1 µV 10 µV/V + 2.2 µV 15 µV/V 14 µV/V + 43 µV 14 µV/V + 43 µV	Direct comparison to Multiproduct Calibrator

Electrical – DC/Low Frequency

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1 000) V	1.8 μ V/V + 0.9 μ V 0.46 μ V/V + 1 μ V 1.1 μ V/V + 0.42 μ V 1.2 μ V/V + 0.48 μ V 6.1 μ V/V + 0.5 mV	Direct comparison to Multimeter
DC High Voltage Measure ¹	(0.1 to 2) kV (2 to 20) kV (20 to 30) kV	78 μ V/V + 0.81 V 0.43 mV/V + 0.46 V 0.11 mV/V + 5.5 V	Comparison to high voltage meter
DC Current – Source ¹	(0 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A (11 to 20.5) A	66 μ A/A + 0.24 μ A 0.01 % of reading 0.023 % of reading 0.056 % of reading 0.17 % of reading	Direct comparison to Multiproduct Calibrator
DC Current – Source ¹	(0 to 1 000) A	0.21 % of reading + 0.01 A	Direct comparison to Multiproduct Calibrator with current coil
DC Current – Measure ¹	(0 to 1) μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	4.3 μ A/A + 0.059 nA 1.8 μ A/A + 0.061 nA 3.9 μ A/A + 0.041 nA 6.7 μ A/A + 0.24 nA 5.7 μ A/A + 0.73 nA 10 μ A/A + 0.04 μ A 0.14 mA/A + 0.013 mA	Direct comparison to Multimeter
	(0 to 15) A (15 to 100) A (100 to 300) A (300 to 1 000) A	0.004 2 % of reading + 0.001 A 0.004 8 % of reading 0.005 8 % of reading 0.038 % of reading	Shunt monitored with Multimeter
	(0 to 2 000) A	0.84 % of reading + 0.1 A	Comparison to Digital Clamp Meter
Resistance – Source ¹	(0 to 1.9) Ω (1.9 to 19) Ω (19 to 190) Ω (0.19 to 1.9) k Ω (1.9 to 19) k Ω (19 to 190) k Ω (0.19 to 1.9) M Ω (1.9 to 19) M Ω (19 to 100) M Ω	96 $\mu\Omega/\Omega$ + 51 $\mu\Omega$ 38 $\mu\Omega/\Omega$ + 0.12 m Ω 21 $\mu\Omega/\Omega$ + 0.39 m Ω 18 $\mu\Omega/\Omega$ + 0.65 m Ω 17 $\mu\Omega/\Omega$ + 0.32 m Ω 22 $\mu\Omega/\Omega$ + 0.69 m Ω 38 $\mu\Omega/\Omega$ + 3.8 Ω 34 $\mu\Omega/\Omega$ + 72 Ω 11 $\mu\Omega/\Omega$ + 0.45 k Ω	Direct comparison to Multiproduct Calibrator

Electrical – DC/Low Frequency

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹	(0 to 100) mΩ (0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω (0.1 to 1) kΩ	0.6 % of reading + 0.1 mΩ 0.064 % of reading 0.008 7 % of reading 0.003 5 % of reading 0.003 1 % of reading	Comparison to Resistor Standards
Resistance – Source ¹	(1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ (1 to 10) GΩ (10 to 100) GΩ 1 TΩ 10 TΩ	0.002 8 % of reading 0.002 7 % of reading 0.006 % of reading 0.006 2 % of reading 0.009 2 % of reading 0.016 % of reading 0.016 % of reading 0.025 % of reading 0.35 % of reading 1.5 % of reading	Comparison to Resistor Standards
Resistance – Measure ¹	(0 to 1) Ω (1 to 10) Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ	53 μΩ/Ω + 26 μΩ 2.2 μΩ/Ω + 76 μΩ 6.7 μΩ/Ω + 32 μΩ 2.9 μΩ/Ω + 0.41 mΩ 2.9 μΩ/Ω + 0.42 mΩ 6.6 μΩ/Ω + 37 mΩ 17 μΩ/Ω + 1 Ω 78 μΩ/Ω + 63 Ω 0.3 mΩ/Ω + 2.3 kΩ 2.3 mΩ/Ω + 0.2 MΩ	Direct comparison to Multimeter

Electrical – DC/Low Frequency

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹	10 Hz to 10 kHz (220 to 399.9) pF 0.4 nF to 1.0999 nF	4.4 mF/F + 12 pF 4.3 mF/F + 12 pF	Direct comparison to Multiproduct Calibrator
	10 Hz to 3 kHz (1.1 to 3.299 9) nF	10 mF/F	
	10 Hz to 1 kHz (3.3 to 10.999) nF	2.3 mF/F + 11 pF	
	10 Hz to 1 kHz (11 to 32.999) nF	8 mF/F	
	10 Hz to 1 kHz (33 to 109.99) nF	2.3 mF/F + 0.11 nF	
	10 Hz to 1 kHz (110 to 329.99) nF	2.3 mF/F + 0.34 nF	
	10 Hz to 600 Hz (0.33 to 1.099 9) μF	2.3 mF/F + 1.2 nF	
	10 Hz to 300 Hz (1.1 to 3.299 9) μF	2.2 mF/F + 3.6 nF	
	10 Hz to 150 Hz (3.3 to 10.999) μF	2.3 mF/F + 11 nF	
	10 Hz to 120 Hz (11 to 32.999) μF	3.6 mF/F + 3.4 nF	
	10 Hz to 80 Hz (33 to 109.99) μF	4.2 mF/F + 0.11 μF	
	0.1 Hz to 50 Hz (110 to 329.99) μF	3.9 mF/F + 0.35 μF	
	0.1 Hz to 20 Hz (0.33 to 1.099 9) mF	3.9 mF/F + 1.2 μF	
	0.1 Hz to 6 Hz (1.1 to 3.299 9) mF	4 mF/F + 3.5 μF	
	0.1 Hz to 2 Hz (3.3 to 10.999) mF	3.9 mF/F + 12 μF	
Capacitance – Source ¹	0.1 Hz to 0.6 Hz (11 to 32.999) mF	8.1 mF/F + 35 μF	Direct comparison to Multiproduct Calibrator
	0.1 Hz to 0.2 Hz (33 to 110) mF	12 mF/F + 0.12 mF	Direct comparison to capacitance decade standard
	(60 to 1 000) Hz (0 to 10) μF	0.052 % of reading + 1 pF	
Inductance – Source ¹ Fixed Points	(0.1 to 10) kHz		Direct Comparison to Standard Inductor
	1.0 mH	0.029 % of reading	
	10 mH	0.029 % of reading	
	100 mH	0.032 % of reading	
	1 H	0.028 % of reading	

Electrical – DC/Low Frequency

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Stimulation of Thermocouple Indicators Generate / Measure ¹	Type B (600 to 800) °C	0.57 °C	Direct comparison to Multiproduct Calibrator
	(800 to 1 550) °C	0.47 °C	
	(1 550 to 1 820) °C	0.46 °C	
	Type C (0 to 1 000) °C	0.37 °C	
	(1 000 to 1 800) °C	0.59 °C	
	(1 800 to 2 316) °C	0.98 °C	
	Type E (-250 to -100) °C	0.58 °C	
	(-100 to 650) °C	0.19 °C	
	(650 to 1 000) °C	0.25 °C	
	Type J (-210 to -100) °C	0.32 °C	
	(-100 to 760) °C	0.2 °C	
	(760 to 1 200) °C	0.27 °C	
	Type K (-200 to -100) °C	0.39 °C	
	(-100 to 120) °C	0.22 °C	
	(120 to 1 000) °C	0.31 °C	
	(1 000 to 1 372) °C	0.47 °C	
	Type L (-200 to -100) °C	0.43 °C	
	(-100 to 800) °C	0.31 °C	
	(800 to 900) °C	0.21 °C	
	Type N (-200 to -100) °C	0.47 °C	
	(-100 to 410) °C	0.26 °C	
	(410 to 1 300) °C	0.32 °C	

Electrical – DC/Low Frequency

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Stimulation of Thermocouple Indicators Generate / Measure ¹	Type R (0 to 250) °C (250 to 1 000) °C (1 000 to 1 767) °C Type S (0 to 250) °C (250 to 1 400) °C (1 400 to 1 767) °C Type T (-250 to -150) °C (-150 to 0) °C (0 to 400) °C Type U (-200 to 0) °C (0 to 600) °C	0.68 °C 0.44 °C 0.49 °C 0.58 °C 0.47 °C 0.57 °C 0.73 °C 0.28 °C 0.2 °C 0.65 °C 0.32 °C	Direct comparison to Multiproduct Calibrator
Electrical Simulation of RTD Indicating Systems ¹	PT 385, 100 Ω (-200 to 800) °C PT 3926, 100 Ω (-200 to 630) °C PT 3916, 100 Ω (-200 to 630) °C PT 385, 200 Ω (-200 to 630) °C PT 385, 500 Ω (-200 to 630) °C PT 385, 1000 Ω (-200 to 630) °C PTNi 385, 120 Ω (-80 to 260) °C CU 427, 10 Ω (-100 to 260) °C	0.006 4 % of reading + 0.053 °C 0.005 % of reading + 0.055 °C 0.005 9 % of reading + 0.054 °C 0.006 % of reading + 0.052 °C 0.006 % of reading + 0.058 °C 0.005 1 % of reading + 0.054 °C 0.002 3 % of reading + 0.044 °C 0.006 5 % of reading + 0.071 °C	Direct comparison to Multiproduct Calibrator
Electrical Simulation of RTD Calibrators Systems ¹	Pt 385, 100 Ω (-200 to 800) °C Pt 3926, 100 Ω (-200 to 630) °C Pt 3916, 100 Ω (-200 to 630) °C Pt 385, 200 Ω (-200 to 630) °C	0.039 °C 0.044 °C 0.041 °C 0.039 °C	Direct Comparison to Multimeter

Electrical – DC/Low Frequency

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Calibrators Systems ¹	Pt 385, 500 Ω (-200 to 630) $^{\circ}\text{C}$	0.053 $^{\circ}\text{C}$	Direct Comparison to Multimeter
	Pt 385, 1000 Ω (-200 to 630) $^{\circ}\text{C}$	0.043 $^{\circ}\text{C}$	
	PtNi 385, 120 Ω (-80 to 260) $^{\circ}\text{C}$	0.042 $^{\circ}\text{C}$	
	Cu 427, 10 Ω (-100 to 260) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
AC Voltage – Source ¹	(0 to 220) mV		Direct comparison to Multiproduct Calibrator
	(10 to 40) Hz	0.33 mV/V + 6.3 μV	
	40 Hz to 20 kHz	0.17 mV/V + 6.8 μV	
	(20 to 100) kHz	1.3 mV/V + 6.1 μV	
	(100 to 300) kHz	1.5 mV/V + 12 μV	
	(300 to 500) kHz	2.4 mV/V + 22 μV	
	500 kHz to 1 MHz	4.9 mV/V + 35 μV	
	220 mV to 2.2 V		
	(10 to 40) Hz	0.44 mV/V + 15 μV	
	40 Hz to 20 kHz	0.1 mV/V + 20 μV	
	(20 to 100) kHz	0.31 mV/V + 0.2 mV	
	(100 to 300) kHz	0.63 mV/V + 0.19 mV	
	(300 to 500) kHz	1.6 mV/V + 0.17 mV	
	500 kHz to 1 MHz	3.7 mV/V + 0.29 mV	
AC Voltage – Source ¹	(2.2 to 22) V		Direct comparison to Multiproduct Calibrator
	(10 to 40) Hz	0.25 mV/V + 0.36 mV	
	40 Hz to 20 kHz	0.19 mV/V	
	(20 to 100) kHz	0.87 mV/V	
	(100 to 300) kHz	2.1 mV/V	
	(300 to 500) kHz	2.1 mV/V	
	500 kHz to 1 MHz	5.2 mV/V	
	(22 to 220) V		
	(10 to 40) Hz	0.26 mV/V + 0.19 mV	
	40 Hz to 20 kHz	0.12 mV/V + 1.2 mV	
	(20 to 100) kHz	0.8 mV/V + 0.32 mV	
	(220 to 1 000) V		
	50 Hz to 1 kHz	0.14 mV/V + 2.1 mV	

Electrical – DC/Low Frequency

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	10 nV to 100 mV		Direct comparison to Multimeter
	1 Hz to 1 kHz	56 μ V + 6.1 μ V	
	(1 to 20) kHz	0.16 mV/V + 4.3 μ V	
	(20 to 100) kHz	0.4 mV/V + 55 μ V	
	(100 to 300) kHz	1.2 mV/V + 0.48 mV	
	300 kHz to 1 MHz	11 mV/V + 32 μ V	
	100 mV to 1 V		
	1 Hz to 1 kHz	0.11 mV/V + 0.14 μ V	
	(1 to 20) kHz	0.19 mV/V + 1.2 μ V	
	(20 to 100) kHz	0.95 mV/V + 0.16 μ V	
AC Voltage – Measure ¹	(100 to 300) kHz	3.6 mV/V + 0.2 μ V	Direct comparison to Multimeter
	300 kHz to 1 MHz	12 mV/V + 0.12 μ V	
	(1 to 10) V		
	1 Hz to 1 kHz	0.11 mV/V + 4.3 μ V	
	(1 to 20) kHz	0.19 mV/V + 0.66 μ V	
	(20 to 100) kHz	0.95 mV/V + 0.61 μ V	
	(100 to 300) kHz	3.6 mV/V + 0.17 μ V	
	300 kHz to 1 MHz	12 mV/V + 3.5 μ V	
	(1 to 4) MHz	6 mV/V + 57 mV	
AC Voltage – Measure ¹	(10 to 100) V		Direct comparison to Multimeter
	1 Hz to 1 kHz	0.27 mV/V + 1.6 mV	
	(1 to 20) kHz	0.26 mV/V + 0.75 mV	
	(20 to 50) kHz	0.44 mV/V + 0.73 mV	
	(50 to 100) kHz	1.5 mV/V + 1.3 mV	
	(100 to 1 000) V		
AC Voltage – Measure ¹	1 Hz to 1 kHz	0.52 mV/V + 27 mV	Direct comparison to Multimeter
	(1 to 20) kHz	0.79 mV/V + 27 mV	
AC High Voltage ¹ 50 Hz to 60 Hz	(0.1 to 2) kV	0.97 mV/V + 0.37 V	Comparison to high voltage meter
	(2 to 20) kV	0.62 mV/V + 1.8 V	
	(20 to 30) kV	0.41 mV/V + 1.5 V	
AC Current – Source ¹	1 nA to 22 mA		Direct comparison to Multiproduct Calibrator
	10 Hz to 1 kHz	0.23 mA/A + 15 nA	
	(1 to 10) kHz	0.28 % of reading	
	(22 to 220) mA		
	10 Hz to 1 kHz	1.4 mA/A	
	(1 to 10) kHz	0.17 % of reading + 21 μ A	
	220 mA to 2.2 A		
	20 Hz to 1 kHz	0.38 mA/A + 0.19 mA	
	(1 to 10) kHz	0.65 % of reading	

Electrical – DC/Low Frequency

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(2.2 to 11) A 45 Hz to 1 kHz (1 to 5) kHz (11 to 20.5) A 45 Hz to 1 kHz (1 to 5) kHz	2.6 mA/A 3.9 % of reading 1.6 mA/A + 4.8 mA 3.1 % of reading	Direct comparison to Multiproduct Calibrator
	(1 to 150) A (45 to 65) Hz (1 to 1 000) A (45 to 440) Hz	0.29 % of reading 0.29 % of reading	Direct comparison to Multiproduct Calibrator with current coil
AC Current – Measure ¹	100 pA to 100 μ A 10 Hz to 1 kHz (0.1 to 1) mA 10 Hz to 1 kHz (1 to 10) mA 10 Hz to 1 kHz (10 to 100) mA 10 Hz to 1 kHz (0.1 to 1) A 10 Hz to 1 kHz	16 nA 74 μ A/A + 3.9 nA 73 μ A/A + 5.5 nA 73 μ A/A + 0.013 nA 0.13 mA/A	Direct Comparison to Multimeter
	1 Hz to 1 kHz (0.1 to 15) A (15 to 100) A (100 to 300) A (300 to 1 000) A	0.027 % of reading 0.11 % of reading 0.1 % of reading 0.081 % of reading	Shunt monitored with Multimeter
AC Current – Measure ¹	(0 to 2 000) A 5 Hz to 1 kHz	1.6 % of reading	Comparison to Digital Clamp Meter
Oscilloscopes ¹			
Level Sine Flatness	5 mV to 5.5 V 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	15 mV/V + 0.3 mV 20 mV/V + 0.3 mV 40 mV/V + 0.3 mV	Direct comparison to Multiproduct Calibrator
Square Wave 1 M Ω , 100 Hz 50 Ω , 1 kHz	$\pm$ 1 mV to $\pm$ 130 V $\pm$ 1 mV to $\pm$ 6.6 V	1 mV/V + 40 μ V 2.5 mV/V + 40 μ V	
Time Marker Output ² Into 50 Ω	2 ns to 5 s	25 μ S/cm/s	
Pulse Rise Time 5 mV to 2.5 V (p-p)	(0 to 300) ps	100 ps	

Electrical – RF/Microwave

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Tuned Power – Measure ¹	(-127 to 20) dBm 150 kHz to 1.3 GHz	0.04 dB	Measuring Receiver, Power Sensor
	(-127 to 30) dBm 150 kHz to 26.5 GHz	0.24 dB	
	(-30 to 20) dBm 10 MHz to 18 GHz	0.12 dB	Power Meter, Power Sensor
RF Absolute Power – Source ¹	(-127 to 13) dBm 250 kHz to 1 GHz	0.12 dB	Signal Generator Monitored with Measuring Receiver
	(-127 to 10) dBm (1 to 3) GHz	0.41 dB	
	(-110 to 2.5) dBm 10 MHz to 50 GHz	0.64 dB	
RF Power – Measure ¹	(-127 to 20) dBm 150 kHz to 1.3 GHz	0.04 dB	Measuring Receiver, Power Sensor
RF Power – Measure ¹	(-127 to 30) dBm 150 kHz to 26.5 GHz	0.24 dB	Measuring Receiver, Power Sensor
	(-30 to 20) dBm 10 MHz to 18 GHz	0.12 dB	Power Meter, Power Sensor
Amplitude Modulation – Measure ¹ 50 Hz to 10 kHz 20 Hz to 100 kHz	Rate: 150 kHz to 10 MHz Depth: (5 to 99) %	1.3 % Modulation	Measuring Receiver, Power Sensor
	Rate: 10 MHz to 1.3 GHz Depth: (5 to 99) %	1.5 % Modulation	
Phase Modulation – Measure ¹ 200 Hz to 20 kHz	Rate: 10 MHz to 1.3 GHz	1.6 % Modulation	Measuring Receiver, Power Sensor
Frequency Modulation – Measure ¹ 20 Hz to 10 kHz	Rate: 250 kHz to 10 MHz Dev: ≤ 40 kHz	1.2 % Modulation	Measuring Receiver, Power Sensor
	Rate: 10 MHz to 1.3 GHz Dev: ≤ 400 kHz	1.4 % Modulation	

Length – Dimensional Metrology

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 40 in	$(310 + 4.1L) \mu\text{in}$	Gage blocks and Check Master
Indicators ^{1,2}	(0 to 4.0) in	$(3.4 + 3L) \mu\text{in}$	Supermicrometer®, Master gage blocks
Micrometers ^{1,2} Length	Up to 8 in (8 to 24) in	$(33 + 1.4L) \mu\text{in}$ $(19 + 5.2L) \mu\text{in}$	Gage Blocks, Gage Rods
Height Gages ^{1,2}	(0 to 40) in	$(23 + 3.2L) \mu\text{in}$	Gage blocks and Check Master
Rules and Tapes ^{1,2}	Up to 40 in Up to 6 ft	$(75 + 15L) \mu\text{in}$ $(140 + 19L) \mu\text{in}$	Comparison to Glass scales
Cylindrical Plain Plug Gages - Outside diameter	Up to 12 in	60 μin	Supermicrometer®, Master Gage Blocks
Thread Plug Gage ² – Major Diameter Pitch Diameter	(0.050 to 12) in (0.050 to 12) in	$(78 + 1.2L) \mu\text{in}$ $(65 + 1.2L) \mu\text{in}$	Supermicrometer®, Thread measuring wires
Feeler/ taper gage	(0.00010 to 4) in	$(18 + 0.3L) \mu\text{in}$	Supermicrometer®, Master gage blocks
Angle Meter (Protractors)	(0 to 90) ° (4 Quadrants)	0.008 5 °	Sine Bar and Gage Blocks
Surface Plates ^{1,2} Overall Flatness	Up to 170 inDL	0.23 % of reading + 0.25"	Surface Plate Measuring System
Local Area Flatness	Up to 0.001 in	16 μin	Repeat-o-meter
Radius Gage	(0 to 6) in	$(110 + 1L) \mu\text{in}$	Optical comparator
Optical Comparators and Visual Systems ^{1,2} Length Error of Indication X, Y and Z Axis	(0 to 24) in	$(50 + 0.19L) \mu\text{in}$	Glass scale and gage blocks
Angle	(0, 30, 45, 60, 90)°	0.001 7°	Angle blocks
Coating Thickness Gauge ⁶ Ferrous and non-ferrous	Up to 60 mils	0.01 mils	Comparison to Plastic Shims

Mass and Mass Related

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Meters ¹ (gage and differential)	(-15 to + 30) psi (0 to 1 000) psi (0 to 10 000) psi	0.03 % of reading + 0.000 64 psi 0.016 % of reading + 0.08 psi 0.015 % of reading + 0.71 psi	Comparison to pressure calibrator systems
Pressure Meters ¹	(0 to 100) psia	0.018 % of reading + 0.003 7 psi	
Torque ¹	(4 to 50) lbf·in (30 to 400) lbf·in (80 to 1 000) lbf·in (20 to 250) lbf·ft (50 to 600) lbf·ft	0.56 % of reading 0.55 % of reading 0.55 % of reading 0.58 % of reading 0.56 % of reading	Torque System
Torque Analyzers and Transducers	Up to 200 lbf·in Up to 370 ft·lbf	0.08 % of reading + 0.001 lbf·in 0.14 % of reading + 0.001 lbf·ft	Direct comparison to torque wheel and dead weights
Force – Tension/Compression ¹	(0 to 1 000) kgf	0.018 % of reading + 1 gf	Direct Comparison to dead weights
Force – Tension/Compression ¹	(0 to 200) kgf (0 to 4 500) kgf (0 to 450 00) kgf	0.071 % of reading + 0.1 gf 0.088 % of reading + 10 gf 0.33 % of reading + 0.1 kgf	Comparison to force transducer
Scales & Balances ^{1,3}	Up to 300 g	1.5 µg/g + 0.015 mg	ASTM E617 Class 0 utilized for the calibration of the weighing system.
	Up to 100 kg	3.4 µg/g	ASTM E617 Class 1 utilized for the calibration of the weighing system.
	Up to 1 000 kg	0.2 mg/g	OIML R111 Class M2 utilized for the calibration of the weighing system.
Mass	(1 to 200) g (200 to 1 000) g (0.1 to 34) kg	4.3 µg/g + 0.13 mg 5.3 µg/g 16 µg/g	Substitution method using reference weight and balance
Piston/Plunger Operated Volumetric Apparatus ¹ (POVA)	(10 to 20) µl (20 to 50) µl (50 to 100) µl 100 µl to 20 ml	0.77 % of reading 0.4 % of reading 0.21 % of reading 0.14 % of reading	Scale, Weight Set Class 0, Barometer DP97
Other Volumetric Devices ¹	(0.1 to 100) ml (0.1 to 34) l	0.13 ml/l 0.2 ml/l + 0.25 ml	Gravimetric method using reference weight & balance
Brinell Hardness Tester ¹	100 HBW 10/3000 200 HBW 10/3000 600 HBW 10/3000	1.2 HBW 2.4 HBW 6.4 HBW	Indirect Verification per ASTM E10

Photometry and Radiometry

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Illuminance-Luxmeters	(0 to 4 000) lux	3.6 % of reading + 0.06 lux	Comparison to Standard Luxmeter

Thermodynamic

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity Measuring Equipment	11 % RH 33 % RH 75 % RH 97 % RH	1.1 %RH 1.1 %RH 1.2 %RH 1.7 %RH	Saturated salt solutions
Relative Humidity Measure ¹	(0 to 100) %RH	0.8 % of reading + 1.2 %RH	Comparison to Humidity Meter
Radiation (Infrared) Thermometers ¹	(35 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 500) °C (500 to 600) °C (600 to 800) °C (800 to 1 000) °C	0.73 °C 1.5 °C 2.2 °C 3.7 °C 4.6 °C 6.2 °C 7.7 °C	Comparison to Infrared Calibrator $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Temperature Measuring Equipment ¹	(-40 to 350) °C (350 to 1 200) °C	0.21 °C 0.22 % of reading	Comparison to Temperature Block Calibrators
Temperature Measure ¹	(-100 to 800) °C	0.014 % of reading + 0.081 °C	Comparison to RTD Thermometer

Time and Frequency

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	1 Hz to 10 MHz	0.12 nHz/Hz+ 0.39 nHz	Direct comparison using Multimeter
	1 MHz to 3 GHz 10 Hz to 26.5 GHz	0.17 nHz/Hz	Direct comparison using Universal Counter & reference frequency standard
Frequency – Source ¹	0.01 Hz to 2 MHz	30 $\mu\text{Hz/Hz}$ + 0.88 mHz	Direct Comparison to Multiproduct Calibrator

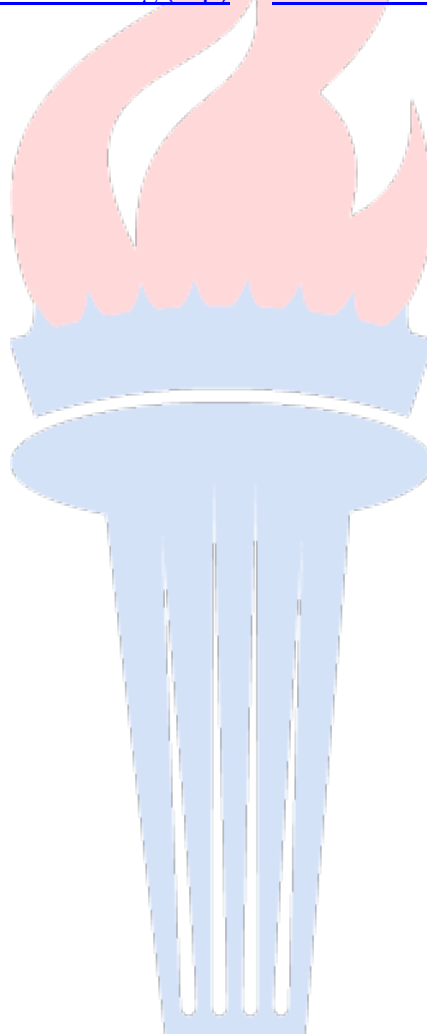
Time and Frequency

Ecatepec de Morelos, EM

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source ¹	250 kHz to 50 GHz	2.1 μ Hz/Hz	Direct Comparison to Signal Generator
Timers/Stop Watches ¹	1 s to 24 hr	55 ms	Method totalize, using universal counter
Angular Frequency – Photo tachometers ¹	(0.6 to 1 000 000) rpm	2.9 parts in $10^5 + 0.31$ rpm	Comparison to Multiproduct Calibrator with LED

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)



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CALIBRATION AND DIMENSIONAL MEASUREMENT

CALIBRATION

Acoustics and Vibration

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Pressure Level ¹ (125 to 4 000) Hz	(74 to 114) dB	0.32 dB	Sound calibrator Sound meter
Vibration ¹ (0.2 Hz to 5 kHz) Acceleration Velocity Displacement	(0 to 200) m/s ² (0 to 200) mm/s (0 to 200) μ m	0.83 % of reading + 0.001 6 m/s ² 0.83 % of reading + 0.001 6 mm/s 0.83 % of reading + 0.001 6 μ m	Vibration System
Accelerometers / Velocity Sensors	0.2 Hz to 5 kHz	1 % of sensitivity	Vibration System

Chemical Quantities

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters ¹	84 μ S/cm 1 413 μ S/cm 12 880 μ S/cm	0.92 μ S/cm 16 μ S/cm 142 μ S/cm	Comparison to Standard Solutions
pH Meters ¹	(4, 7, 10) pH	0.012 pH	Comparison to Standard Solutions

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹ Fixed Values	1 V 1.018V 10 V	1.7 μ V/V 1.7 μ V/V 3.3 μ V/V	DC Reference Standard
DC Voltage – Source ¹	(0 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 μ V/V + 0.4 μ V 3.5 μ V/V + 0.7 μ V 2.5 μ V/V + 2.6 μ V 2.5 μ V/V + 4 μ V 3.5 μ V/V + 40 μ V 4.5 μ V/V + 0.4 mV	Multi-Function Calibrator
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	2.5 μ V/V + 0.31 μ V 1.5 μ V/V + 0.31 μ V 0.5 μ V/V + 0.51 μ V 2.5 μ V/V + 30 μ V 2.5 μ V/V + 100 μ V	Multimeter
DC Voltage – Measure ^{1,3} High Voltage	(1 to 10) kV (10 to 20) kV (20 to 70) kV	0.9 mV/V 0.8 mV/V 0.7 mV/V	High Voltage Meter
DC Current – Source ¹	(0 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	36 μ A/A + 7.2 nA 32 μ A/A + 7 nA 39 μ A/A + 0.4 μ A 57 μ A/A + 0.7 μ A 72 μ A/A + 12 μ A	Multi-Function Calibrator
DC Current – Source ¹	(0 to 330) μ A 330 μ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 3 A (3 to 11) A (11 to 20.5) A	0.12 mA/A + 16 nA 78 μ A/A + 40 nA 82 μ A/A + 0.43 μ A 0.16 mA/A + 10 μ A 0.16 mA/A + 32 μ A 0.39 mA/A + 0.26 mA 0.78 mA/A + 0.58 mA	Multi-Product Calibrator
DC High Current – Source ¹	(2.2 to 11) A	0.34 mA/A + 0.48 mA	Multi-Function Calibrator and Amplifier
	(10 to 16.5) A (16.5 to 150) A (150 to 1 000) A	2.8 mA/A + 3 mA 2.8 mA/A + 25 mA 2.9 mA/A + 90 mA	Multi-Product Calibrator, 50 turn Coil
DC Current – Measure ¹	60 fA to 100 μ A	58 μ A/A + 0.005 8 pA	High-Resistance Meter

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Measure ¹	(0 to 100) nA 100 nA to 1 μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	10 μ A/A + 40 pA 10 μ A/A + 40 pA 10 μ A/A + 70 pA 10 μ A/A + 0.6 nA 10 μ A/A + 4 nA 10 μ A/A + 40 nA 25 μ A/A + 0.4 μ A 0.1 mA/A + 10 μ A	Multimeter
DC Current – Measure ¹	(0 to 1) A (1 to 5) A (5 to 10) A (10 to 20) A (20 to 30) A (30 to 50) A (50 to 100) A (100 to 150) A (150 to 200) A (200 to 300) A	0.44 mA/A + 0.58 μ A 96 μ A/A + 0.58 μ A 53 μ A/A + 0.58 μ A 32 μ A/A + 0.58 μ A 25 μ A/A + 0.58 μ A 36 μ A/A + 1.7 μ A 23 μ A/A + 1.7 μ A 19 μ A/A + 1.7 μ A 83 μ A/A + 2.9 μ A 58 μ A/A + 2.9 μ A	Multimeter with Current Shunt
DC Power – Source ^{1,2} 0.1 mW to 20.5 kW	(33 mV to 1 020 V) (3.3 to 330) mA 330 mA to 11 A (11 to 20.5) A	0.03 % of Watts output + 0.58R 0.059 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R	Multi-Product Calibrator w/ Transconductance Amplifier
Inductance – Source ¹ at 1 kHz	(1 to 10) mH (10 to 100) mH 100 mH to 1 H (1 to 10) H	0.03 mH 0.15 mH 2 mH 11 mH	Decade Inductor
Resistance – Source ¹ Fixed Points	(0 to 0.1) Ω (0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω 10 k Ω to 1 M Ω (1 to 100) M Ω 100 M Ω to 100 G Ω 1 T Ω	15 $\mu\Omega$ 10 $\mu\Omega$ 0.76 m Ω 3.3 m Ω 33 m Ω 50 m Ω 0.05 % of reading 0.13 % of reading 0.5 % of reading 5.8 % of reading	Standard Resistors

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	50 $\mu\Omega$ 95 $\mu\Omega$ 0.15 m Ω 0.21 m Ω 0.4 m Ω 0.91 m Ω 1.7 m Ω 7.7 m Ω 15 m Ω 76 m Ω 0.15 Ω 0.91 Ω 1.7 Ω 15 Ω 31 Ω 0.31 k Ω 0.75 k Ω 9.5 k Ω	Multi-Function Calibrator
Resistance – Source ¹	(0 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 (110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω 330 M Ω to 1.1 G Ω	31 $\mu\Omega/\Omega$ + 0.83 m Ω 23 $\mu\Omega/\Omega$ + 1.2 m Ω 22 $\mu\Omega/\Omega$ + 1.2 m Ω 22 $\mu\Omega/\Omega$ + 1.6 m Ω 22 $\mu\Omega/\Omega$ + 1.7 m Ω 22 $\mu\Omega/\Omega$ + 16 m Ω 22 $\mu\Omega/\Omega$ + 27 m Ω 22 $\mu\Omega/\Omega$ + 0.16 Ω 24 $\mu\Omega/\Omega$ + 1.0 Ω 27 $\mu\Omega/\Omega$ + 1.8 Ω 27 $\mu\Omega/\Omega$ + 1.9 Ω 68 $\mu\Omega/\Omega$ + 55 Ω 0.11 m Ω/Ω + 64 Ω 0.54 m Ω/Ω + 2.2 k Ω 0.63 m Ω/Ω + 2.5 k Ω 5.5 m Ω/Ω + 78 k Ω 13 m Ω/Ω + 0.39 M Ω	Multi-Product Calibrator

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	5 $\mu\Omega/\Omega$ + 31 $\mu\Omega$ 3 $\mu\Omega/\Omega$ + 0.3 m Ω 2 $\mu\Omega/\Omega$ + 0.21 m Ω 2 $\mu\Omega/\Omega$ + 2.1 m Ω 2 $\mu\Omega/\Omega$ + 21 m Ω 10 $\mu\Omega/\Omega$ + 1 Ω 50 $\mu\Omega/\Omega$ + 50 Ω 0.5 m Ω/Ω + 1 k Ω 5 m Ω/Ω + 10 k Ω	Multimeter
Resistance – Measure ¹	(1 to 100) G Ω	6.9 m Ω/Ω + 0.058 m Ω	High-Resistance Meter
Electrical Simulation of Thermocouple Indicating Systems ¹	Type B (600 to 800) $^{\circ}\text{C}$ (800 to 1 000) $^{\circ}\text{C}$ (1 000 to 1 550) $^{\circ}\text{C}$ (1 550 to 1 820) $^{\circ}\text{C}$ Type C (0 to 150) $^{\circ}\text{C}$ (150 to 650) $^{\circ}\text{C}$ (650 to 1 000) $^{\circ}\text{C}$ (1 000 to 1 800) $^{\circ}\text{C}$ (1 800 to 2 316) $^{\circ}\text{C}$ Type E (-250 to -100) $^{\circ}\text{C}$ (-100 to -25) $^{\circ}\text{C}$ (-25 to 350) $^{\circ}\text{C}$ (350 to 650) $^{\circ}\text{C}$ (650 $^{\circ}\text{C}$ to 1 000) $^{\circ}\text{C}$ Type J (-210 to -100) $^{\circ}\text{C}$ (-100 to -30) $^{\circ}\text{C}$ (-30 to 150) $^{\circ}\text{C}$ (150 to 760) $^{\circ}\text{C}$ (760 to 1 200) $^{\circ}\text{C}$ Type K (-200 to -100) $^{\circ}\text{C}$ (-100 to -25) $^{\circ}\text{C}$ (-25 to 120) $^{\circ}\text{C}$ (120 to 1 000) $^{\circ}\text{C}$ (1 000 to 1 372) $^{\circ}\text{C}$	0.36 $^{\circ}\text{C}$ 0.29 $^{\circ}\text{C}$ 0.27 $^{\circ}\text{C}$ 0.29 $^{\circ}\text{C}$ 0.27 $^{\circ}\text{C}$ 0.24 $^{\circ}\text{C}$ 0.27 $^{\circ}\text{C}$ 0.41 $^{\circ}\text{C}$ 0.66 $^{\circ}\text{C}$ 0.41 $^{\circ}\text{C}$ 0.18 $^{\circ}\text{C}$ 0.17 $^{\circ}\text{C}$ 0.18 $^{\circ}\text{C}$ 0.21 $^{\circ}\text{C}$ 0.25 $^{\circ}\text{C}$ 0.18 $^{\circ}\text{C}$ 0.17 $^{\circ}\text{C}$ 0.18 $^{\circ}\text{C}$ 0.22 $^{\circ}\text{C}$ 0.29 $^{\circ}\text{C}$ 0.19 $^{\circ}\text{C}$ 0.18 $^{\circ}\text{C}$ 0.24 $^{\circ}\text{C}$ 0.34 $^{\circ}\text{C}$	Multi-Product Calibrator

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Systems ¹	Type L (-200 to -100) °C (-100 to 800) °C (800 to 900) °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 Type U (-200 to 0) °C (0 to 600) °C	0.31 °C 0.24 °C 0.18 °C 0.34 °C 0.21 °C 0.2 °C 0.19 °C 0.25 °C 0.46 °C 0.3 °C 0.29 °C 0.34 °C 0.39 °C 0.31 °C 0.31 °C 0.38 °C 0.51 °C 0.23 °C 0.18 °C 0.17 °C 0.45 °C 0.25 °C	Multi-Product Calibrator
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 100 Ω (-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	0.04 °C 0.04 °C 0.055 °C 0.07 °C 0.078 °C 0.093 °C 0.18 °C	Multi-Product Calibrator

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 3926, 100 Ω		Multi-Product Calibrator
	(-200 to -80) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.055 $^{\circ}\text{C}$	
	(100 to 300) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.078 $^{\circ}\text{C}$	
	(400 to 630) $^{\circ}\text{C}$	0.093 $^{\circ}\text{C}$	
	Pt 3916, 100 Ω		
	(-200 to -190) $^{\circ}\text{C}$	0.19 $^{\circ}\text{C}$	
	(-190 to -80) $^{\circ}\text{C}$	0.032 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.055 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.063 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.078 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.18 $^{\circ}\text{C}$	
	Pt 385, 200 Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.032 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.032 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.032 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.093 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.12 $^{\circ}\text{C}$	
	Pt 385, 500 Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.032 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.063 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.063 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.086 $^{\circ}\text{C}$	

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 1 k Ω		Multi-Product Calibrator
	(-200 to -80) °C	0.025 °C	
	(-80 to 0) °C	0.025 °C	
	(0 to 100) °C	0.032 °C	
	(100 to 260) °C	0.04 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.055 °C	
	(400 to 600) °C	0.055 °C	
	(600 to 630) °C	0.18 °C	
	PtNi 385, 120 Ω (Ni120)		
	(-80 to 0) °C	0.063 °C	
	(0 to 100) °C	0.063 °C	
	(100 to 260) °C	0.11 °C	
AC Voltage – Source ¹	Cu 427, 10 Ω		Multi-Function Calibrator
	(-100 to 260) °C	0.23 °C	
	200 μ V to 2.2 mV		
	(10 to 20) Hz	0.37 mV/V + 4 μ V	
	(20 to 40) Hz	0.31 mV/V + 4 μ V	
	40 Hz to 20 kHz	0.31 mV/V + 4 μ V	
	(20 to 50) kHz	0.35 mV/V + 4 μ V	
	(50 to 100) kHz	0.61 mV/V + 5 μ V	
	(100 to 300) kHz	1 mV/V + 10 μ V	
	(300 to 500) kHz	1.3 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.6 mV/V + 20 μ V	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.24 mV/V + 4 μ V	
	(20 to 40) Hz	0.11 mV/V + 4 μ V	
	40 Hz to 20 kHz	96 μ V/V + 4 μ V	
	(20 to 50) kHz	0.2 mV/V + 4 μ V	
	(50 to 100) kHz	0.46 mV/V + 5 μ V	
	(100 to 300) kHz	0.9 mV/V + 10 μ V	
	(300 to 500) kHz	1.2 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.5 mV/V + 20 μ V	

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(22 to 220) mV		Multi-Function Calibrator
	(10 to 20) Hz	0.22 mV/V + 12 μ V	
	(20 to 40) Hz	86 μ V/V + 7 μ V	
	40 Hz to 20 kHz	76 μ V/V + 7 μ V	
	(20 to 50) kHz	0.18 mV/V + 7 μ V	
	(50 to 100) kHz	0.42 mV/V + 17 μ V	
	(100 to 300) kHz	0.75 mV/V + 20 μ V	
	(300 to 500) kHz	1.2 mV/V + 25 μ V	
	500 kHz to 1 MHz	2.5 mV/V + 45 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.22 mV/V + 40 μ V	
	(20 to 40) Hz	80 μ V/V + 15 μ V	
	40 Hz to 20 kHz	40 μ V/V + 8 μ V	
	(20 to 50) kHz	70 μ V/V + 10 μ V	
	(50 to 100) kHz	0.11 mV/V + 30 μ V	
	(100 to 300) kHz	0.34 mV/V + 80 μ V	
	(300 to 500) kHz	0.9 mV/V + 0.2 mV	
	500 kHz to 1 MHz	1.5 mV/V + 0.3 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.22 mV/V + 0.4 mV	
	(20 to 40) Hz	80 μ V/V + 0.15 mV	
	40 Hz to 20 kHz	40 μ V/V + 50 μ V	
	(20 to 50) kHz	70 μ V/V + 0.1 mV	
	(50 to 100) kHz	96 μ V/V + 0.2 mV	
	(100 to 300) kHz	0.26 mV/V + 0.6 mV	
	(300 to 500) kHz	0.9 mV/V + 2 mV	
	500 kHz to 1 MHz	1.3 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.22 mV/V + 4 mV	
	(20 to 40) Hz	80 μ V/V + 1.5 mV	
	40 Hz to 20 kHz	48 μ V/V + 0.6 mV	
	(20 to 50) kHz	76 μ V/V + 1 mV	
	(50 to 100) kHz	0.13 mV/V + 2.5 mV	
	(100 to 300) kHz	0.8 mV/V + 16 mV	
	(300 to 500) kHz	4.2 mV/V + 40 mV	
	500 kHz to 1 MHz	7 mV/V + 80 mV	
	(220 to 1 100) V		
	(15 to 50) Hz	0.26 mV/V + 16 mV	
	50 Hz to 1 kHz	61 μ V/V + 3.5 mV	

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(220 to 750) V (30 to 50) kHz (50 to 100) kHz (750 to 1 100) V 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.36 mV/V + 11 mV 1.3 mV/V + 45 mV 81 μ V/V + 4 mV 0.13 mV/V + 6 mV 0.36 mV/V + 11 mV	Multi-Function Calibrator with Amplifier
AC Voltage – Measure ¹	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz 100 mV to 10 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 (1 to 2) MHz (10 to 100) V (1 to 40) Hz 40 Hz to 1 kHz 1 kHz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	0.3 mV/V + 3 μ V 0.2 mV/V + 1.1 μ V 0.3 mV/V + 1.1 μ V 1 mV/V + 1.1 μ V 5 mV/V + 1.1 μ V 40 mV/V + 2 μ V 70 μ V/V + 4 μ V 70 μ V/V + 2 μ V 0.14 mV/V + 2 μ V 0.3 mV/V + 2 μ V 0.8 mV/V + 2 μ V 3 mV/V + 10 μ V 10 mV/V + 10 μ V 15 mV/V + 10 μ V 70 μ V/V + 0.4 mV 70 μ V/V + 0.2 mV 0.14 mV/V + 0.2 mV 0.3 mV/V + 0.2 mV 0.8 mV/V + 0.2 mV 3 mV/V + 1 mV 10 mV/V + 1 mV 15 mV/V + 1 mV 0.2 mV/V + 4 mV 0.2 mV/V + 2 mV 0.2 mV/V + 2 mV 0.35 mV/V + 2 mV 1.2 mV/V + 2 mV 4 mV/V + 10 mV 15 mV/V + 10 mV	Multimeter in Synchronous sub-sampled mode

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(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	0.4 mV/V + 40 mV 0.4 mV/V + 20 mV 0.6 mV/V + 20 mV 1.2 mV/V + 20 mV 3 mV/V + 20 mV	Multimeter in Synchronous sub-sampled mode
AC Voltage – Measure ¹ (Absolute Measurement)	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (2.2 to 7) 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 (7 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 70) 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	1.2 mV/V + 0.87 μ V 0.52 mV/V + 0.87 μ V 0.32 mV/V + 0.87 μ V 0.58 mV/V + 1.3 μ V 0.85 mV/V + 1.7 μ V 1.6 mV/V + 2.7 μ V 1.7 mV/V + 5.3 μ V 2.4 mV/V + 5.3 μ V 0.57 mV/V + 0.87 μ V 0.26 mV/V + 0.87 μ V 0.16 mV/V + 0.87 μ V 0.28 mV/V + 1.3 μ V 0.4 mV/V + 1.7 μ V 0.8 mV/V + 2.7 μ V 0.87 mV/V + 5.3 μ V 1.5 mV/V + 5.3 μ V 0.2 mV/V + 0.87 μ V 0.13 mV/V + 0.87 μ V 80 μ V/V + 0.87 μ V 0.14 mV/V + 1.3 μ V 0.22 mV/V + 1.7 μ V 0.54 mV/V + 2.7 μ V 0.59 mV/V + 5.3 μ V 1.1 mV/V + 5.3 μ V 0.16 mV/V + 1 μ V 81 μ V/V + 1 μ V 45 μ V/V + 1 μ V 90 μ V/V + 1.3 μ V 0.18 mV/V + 1.7 μ V 0.35 mV/V + 2.7 μ V 0.45 mV/V + 5.3 μ V 0.73 mV/V + 5.3 μ V	AC Measurement Standard

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(70 to 220) mV		AC Measurement Standard
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	57 μ V/V + 1 μ V	
	40 Hz to 20 kHz	26 μ V/V + 1 μ V	
	(20 to 50) kHz	47 μ V/V + 1.3 μ V	
	(50 to 100) kHz	0.11 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.17 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.26 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.67 mV/V + 5.3 μ V	
	(220 to 700) mV		
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	51 μ V/V + 1 μ V	
	40 Hz to 20 kHz	23 μ V/V + 1 μ V	
	(20 to 50) kHz	35 μ V/V + 1.3 μ V	
	(50 to 100) kHz	54 μ V/V + 1.7 μ V	
	(100 to 300) kHz	0.12 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.2 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.64 mV/V + 5.3 μ V	
	700 mV to 2.2 V		
	(10 to 20) Hz	0.13 mV/V + 0.58 μ V	
	(20 to 40) Hz	44 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	17 μ V/V + 0.58 μ V	
	(20 to 50) kHz	31 μ V/V + 0.58 μ V	
	(50 to 100) kHz	48 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.11 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.18 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.6 mV/V + 0.58 μ V	
	(2.2 to 7) V		
	(10 to 20) Hz	0.13 mV/V + 0.58 μ V	
	(20 to 40) Hz	45 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	17 μ V/V + 0.58 μ V	
	(20 to 50) kHz	33 μ V/V + 0.58 μ V	
	(50 to 100) kHz	55 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.13 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.27 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.8 mV/V + 0.58 μ V	

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(7 to 22) V		AC Measurement Standard
	(10 to 20) Hz	0.13 mV/V + 5.8 μ V	
	(20 to 40) Hz	45 μ V/V + 5.8 μ V	
	40 Hz to 20 kHz	19 μ V/V + 5.8 μ V	
	(20 to 50) kHz	33 μ V/V + 5.8 μ V	
	(50 to 100) kHz	55 μ V/V + 5.8 μ V	
	(100 to 300) kHz	0.13 mV/V + 5.8 μ V	
	(300 to 500) kHz	0.27 mV/V + 5.8 μ V	
	500 kHz to 1 MHz	0.8 mV/V + 5.8 μ V	
	(22 to 70) V		
	(10 to 20) Hz	0.13 mV/V + 5.8 μ V	
	(20 to 40) Hz	46 μ V/V + 5.8 μ V	
	40 Hz to 20 kHz	22 μ V/V + 5.8 μ V	
	(20 to 50) kHz	39 μ V/V + 5.8 μ V	
	(50 to 100) kHz	64 μ V/V + 5.8 μ V	
	(100 to 300) kHz	0.14 mV/V + 5.8 μ V	
	(300 to 500) kHz	0.27 mV/V + 5.8 μ V	
	500 kHz to 1 MHz	0.8 mV/V + 5.8 μ V	
	(70 to 220) V		
	(10 to 20) Hz	0.13 mV/V + 58 μ V	
	(20 to 40) Hz	46 μ V/V + 58 μ V	
	40 Hz to 20 kHz	22 μ V/V + 58 μ V	
	(20 to 50) kHz	47 μ V/V + 58 μ V	
	(50 to 100) kHz	67 μ V/V + 58 μ V	
	(100 to 300) kHz	0.14 mV/V + 58 μ V	
	(300 to 500) kHz	0.33 mV/V + 58 μ V	
	(220 to 700) V		
	(10 to 20) Hz	0.13 mV/V + 58 μ V	
	(20 to 40) Hz	67 μ V/V + 58 μ V	
	40 Hz to 20 kHz	29 μ V/V + 58 μ V	
	(20 to 50) kHz	87 μ V/V + 58 μ V	
	(50 to 100) kHz	0.34 mV/V + 58 μ V	
	(700 to 1 000) V		
	(10 to 20) Hz	0.13 mV/V + 58 μ V	
	(20 to 40) Hz	67 μ V/V + 58 μ V	
	40 Hz to 20 kHz	28 μ V/V + 58 μ V	
	(20 to 50) kHz	87 μ V/V + 58 μ V	
	(50 to 100) kHz	0.33 mV/V + 58 μ V	

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	Up to 2.2 mV		AC Measurement Standard
	(10 to 30) Hz	0.94 mV/V + 0.08 µV	
	(30 to 120) Hz	0.47 mV/V + 0.08 µV	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.08 µV	
	(1.2 to 120) kHz	0.47 mV/V + 0.08 µV	
	(120 to 500) kHz	0.66 mV/V + 0.95 µV	
	500 kHz to 1.2 MHz	0.66 mV/V + 0.95 µV	
	(1.2 to 2) MHz	0.66 mV/V + 0.95 µV	
	(2 to 10) MHz	1.6 mV/V + 0.95 µV	
	(10 to 20) MHz	2.8 mV/V + 0.95 µV	
	(20 to 30) MHz	6.6 mV/V + 1.9 µV	
	(2.2 to 7) mV		
	(10 to 30) Hz	0.94 mV/V + 0.082 µV	
	(30 to 120) Hz	0.47 mV/V + 0.082 µV	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.082 µV	
	(1.2 to 120) kHz	0.47 mV/V + 0.082 µV	
	(120 to 500) kHz	0.66 mV/V + 0.95 µV	
	500 kHz to 1.2 MHz	0.66 mV/V + 0.95 µV	
	(1.2 to 2) MHz	0.66 mV/V + 0.95 µV	
	(2 to 10) MHz	0.94 mV/V + 0.95 µV	
	(10 to 20) MHz	1.6 mV/V + 0.95 µV	
	(20 to 30) MHz	3.5 mV/V + 0.95 µV	
	(7 to 22) mV		
	(10 to 30) Hz	0.94 mV/V + 0.082 µV	
	(30 to 120) Hz	0.47 mV/V + 0.082 µV	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.082 µV	
	(1.2 to 120) kHz	0.47 mV/V + 0.082 µV	
	(120 to 500) kHz	0.66 mV/V + 0.082 µV	
	500 kHz to 1.2 MHz	0.66 mV/V + 0.082 µV	
	(1.2 to 2) MHz	0.66 mV/V + 0.082 µV	
	(2 to 10) MHz	0.94 mV/V + 0.082 µV	
	(10 to 20) MHz	1.6 mV/V + 0.082 µV	
	(20 to 30) MHz	3.5 mV/V + 0.082 µV	

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	(22 to 70) mV		AC Measurement Standard
	(10 to 30) Hz	0.94 mV/V + 0.82 μ V	
	(30 to 120) Hz	0.47 mV/V + 0.82 μ V	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 120) kHz	0.47 mV/V + 0.82 μ V	
	(120 to 500) kHz	0.47 mV/V + 0.82 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.82 μ V	
	(2 to 10) MHz	0.94 mV/V + 0.82 μ V	
	(10 to 20) MHz	1.4 mV/V + 0.82 μ V	
	(20 to 30) MHz	3.3 mV/V + 0.82 μ V	
	(70 to 220) mV		
	(10 to 30) Hz	0.94 mV/V + 0.82 μ V	
	(30 to 120) Hz	0.38 mV/V + 0.82 μ V	
	120 Hz to 1.2 kHz	0.38 mV/V + 0.82 μ V	
	(1.2 to 120) kHz	0.38 mV/V + 0.82 μ V	
	(120 to 500) kHz	0.38 mV/V + 0.82 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.82 μ V	
	(2 to 10) MHz	0.94 mV/V + 0.82 μ V	
	(10 to 20) MHz	1.4 mV/V + 0.82 μ V	
	(20 to 30) MHz	3.3 mV/V + 0.82 μ V	
	(220 to 700) mV		
	(10 to 30) Hz	0.94 mV/V + 8.2 μ V	
	(30 to 120) Hz	0.28 mV/V + 8.2 μ V	
	120 Hz to 1.2 kHz	0.28 mV/V + 8.2 μ V	
	(1.2 to 120) kHz	0.28 mV/V + 8.2 μ V	
	(120 to 500) kHz	0.28 mV/V + 8.2 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 8.2 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 8.2 μ V	
	(2 to 10) MHz	0.94 mV/V + 8.2 μ V	
	(10 to 20) MHz	1.4 mV/V + 8.2 μ V	
	(20 to 30) MHz	3.3 mV/V + 8.2 μ V	

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	700 mV to 2.2 V (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (2.2 to 7) V (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.94 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 1.4 mV/V + 8.2 μV 3.3 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 1.4 mV/V + 8.2 μV 3.3 mV/V + 8.2 μV	AC Measurement Standard
AC High Voltage – Measure ¹	(1 to 10) kV (50 to 100) Hz (10 to 20) kV (50 to 60) Hz (20 to 50) kV (rms) (50 to 60) Hz	0.6 mV/V 1.5 mV/V 1.4 mV/V	High Voltage Meter
AC Current – Source ¹	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 (0.22 to 2.2) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.23 mA/A + 16 nA 0.14 mA/A + 10 nA 0.11 mA/A + 8 nA 0.25 mA/A + 12 nA 0.9 mA/A + 65 nA 0.23 mA/A + 40 nA 0.14 mA/A + 35 nA 0.11 mA/A + 35 nA 0.18 mA/A + 0.11 μA 0.9 mA/A + 0.65 μA	Multi-Function Calibrator

Electrical – DC/Low Frequency

Singapore

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 (0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.23 mA/A + 0.4 μ A 0.11 mA/A + 0.35 μ A 0.18 mA/A + 0.35 μ A 0.9 mA/A + 0.5 μ A 1.1 mA/A + 5 μ A 0.23 mA/A + 4 μ A 0.14 mA/A + 3.5 μ A 0.11 mA/A + 2.6 μ A 0.18 mA/A + 3.5 μ A 0.9 mA/A + 10 μ A 0.25 mA/A + 35 μ A 0.39 mA/A + 80 μ A 6 mA/A + 0.16 mA	Multi-Function Calibrator
AC Current – Source ¹	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.42 mA/A + 0.17 mA 0.85 mA/A + 0.38 mA 3.3 mA/A + 0.75 mA	Multi-Function Calibrator w/Amplifier
AC Current – Source ¹	(10 to 16.5) A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1000) A (45 to 65) Hz (65 to 440) Hz	2.8 mA/A + 3 mA 7.9 mA/A + 3 mA 2.8 mA/A + 25 mA 7.9 mA/A + 27 mA 3 mA/A + 90 mA 8 mA/A + 0.1 A	Multi-Product Calibrator with 50 Turn Coil
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	4 mA/A + 0.03 μ A 1.5 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A	Multimeter in Synchronous sub-sampled mode

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	100 μ A to 1 mA (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 (50 to 100) kHz (1 to 10) mA 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 (50 to 100) kHz (10 to 100) mA (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 (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 mA/A + 0.2 μ A 1.5 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 0.31 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 4 mA/A + 0.4 μ A 5.5 mA/A + 1.5 μ A 4 mA/A + 2 μ A 1.5 mA/A + 2 μ A 0.6 mA/A + 2 μ A 0.31 mA/A + 2 μ A 0.6 mA/A + 2 μ A 4 mA/A + 4 μ A 5.5 mA/A + 15 μ A 4 mA/A + 20 μ A 1.5 mA/A + 20 μ A 0.6 mA/A + 20 μ A 0.31 mA/A + 20 μ A 0.6 mA/A + 20 μ A 4 mA/A + 40 μ A 5.5 mA/A + 0.15 mA 4 mA/A + 0.2 mA 1.6 mA/A + 0.2 mA 0.8 mA/A + 0.2 mA 1 mA/A + 0.2 mA 3 mA/A + 0.2 mA 10 mA/A + 0.4 mA	Multimeter in Synchronous sub-sampled mode
	10 mA to 20 A 5 Hz to 100 kHz	0.29 mA/A	
AC Resistance – Source ¹ 100 Hz to 100 kHz	0 Ω 0.1 Ω 1.0 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω	15 $\mu\Omega$ 15 $\mu\Omega$ 0.13 m Ω 0.76 m Ω 3.3 m Ω 33 m Ω 0.33 Ω 3.3 Ω	RL Standard

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance – Measure ¹ 20 Hz to 1 MHz	0.01 mΩ to 1 kΩ	0.6 mΩ/Ω + 5.8 μΩ	Precision LCR Meter
AC Power – Source ^{1,2} 0.1 mW to 20.5 kW (45 to 65) Hz PF = 1	(33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A 330 mV to 1 020 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.11 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.11 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.1 % of Watts output + 0.58R 0.088 % of Watts output + 0.58R 0.1 % of Watts output + 0.58R 0.13 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.088 % of Watts output + 0.58R 0.073 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.15 % of Watts output + 0.58R	Multi-Product Calibrator
AC Power – Source ^{1,2} 0.1 mW to 20.5 kW (45 to 65) Hz (PF = 0 to 0.999)	(33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A 330 mV to 1 020 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.21 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.23 % of Watts output + 0.58R	Multi-Product Calibrator

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ 10 Hz to 10 kHz	(0.19 to 0.4) nF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 µF (1.1 to 3.3) µF (3.3 to 11) µF (11 to 33) µF (33 to 110) µF (110 to 330) µF 330 µF to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	3.9 mF/F + 13 pF 3.9 mF/F + 13 pF 3.9 mF/F + 13 pF 1.9 mF/F + 13 pF 1.9 mF/F + 0.13 nF 1.9 mF/F + 0.13 nF 1.9 mF/F + 0.38 nF 1.9 mF/F + 1.3 nF 1.9 mF/F + 3.8 nF 1.9 mF/F + 13 nF 3.1 mF/F + 38 nF 3.5 mF/F + 0.13 µF 3.5 mF/F + 0.38 µF 3.5 mF/F + 1.3 µF 3.5 mF/F + 3.8 µF 3.5 mF/F + 13 µF 5.8 mF/F + 38 µF 8.5 mF/F + 0.13 mF	Multi-Product Calibrator
Capacitance – Source ¹ Fixed Values	(1, 10, 100, 1 000) pF (1 to 13) MHz	0.35 mF/F + 0.58R	Capacitance Standard
Capacitance – Source ¹ Fixed Values 20 Hz to 1 kHz	(2, 100) pF, (1, 1.8, 10, 100) nF (1, 10) µF (1, 10) mF	0.015 mF/F + 0.58R	Capacitance Standard
Capacitance – Measure ¹	0.01 fF to 1 mF 20 Hz to 1 MHz 1 MHz to 30 MHz	0.6 mF/F + 0.005 8 fF 1.2 mF/F + 0.005 8 fF	Precision LCR Meter
Capacitance Dissipation Factor – Source ^{1,5}	1 pF 1 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.002 4 0.002 4 0.000 45 0.000 43 0.000 44 0.000 26 0.000 59 0.000 85	Capacitance Standard

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance Dissipation Factor – Source ^{1,5}	10 pF		Capacitance Standard
	1 kHz	0.000 27	
	1 MHz	0.000 27	
	2 MHz	0.000 16	
	3 MHz	0.000 16	
	4 MHz	0.000 16	
	5 MHz	0.000 16	
	10 MHz	0.000 17	
	13 MHz	0.000 17	
	100 pF		
	1 kHz	0.000 14	
	1 MHz	0.000 14	
	2 MHz	0.000 14	
	3 MHz	0.000 15	
	4 MHz	0.000 15	
	5 MHz	0.000 15	
	10 MHz	0.000 21	
	13 MHz	0.000 28	
	1 000 pF		
	1 kHz	0.000 14	
	1 MHz	0.000 14	
	2 MHz	0.000 15	
	3 MHz	0.000 17	
	4 MHz	0.000 21	
	5 MHz	0.000 25	
	10 MHz	0.000 6	
	13 MHz	0.00 086	
Oscilloscope ¹ – Rise/Fall Time (10 to 90) %	(0 to 1.25) s	1.3 ps	Oscilloscope Calibrator w/ Calibration Head
Oscilloscope ¹ Sq Wave 50 Ω or 1 M Ω Load impedance	Up 1 mVp-p (1 to 21) mVp-p (21 to 556) mVp-p 556 mVp-p to 210 Vp-p	10 mV/V + 10 μ V 1.5 mV/V + 20 μ V 1.5 mV/V + 1.2 μ V 1.3 mV/V + 1.2 μ V	Oscilloscope Calibrator
Oscilloscope ¹ Vertical Deflection (Amplitude)	1 mV to 50 Vp-p (50 to 100) Vp-p (100 to 200) Vp-p	0.25 mV/V + 25 μ V 0.25 mV/V + 26 μ V 0.25 mV/V + 63 μ V	Oscilloscope Calibrator
Oscilloscope ¹ Horizontal Deflection (Time)	150 ps to 50 s	0.39 parts in 10 ⁶ of reading	Oscilloscope Calibrator

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscope ¹ Bandwidth	0.1 Hz to 50 GHz	2.1 % of reading	Oscilloscope Calibrator w/ Calibration Head, Power Sensor
Phase – Measure ¹	(0 to 360) ° (10 to 32) mV 1 Hz to 10 kHz (10 to 100) mV (10 to 50) kHz 50 kHz to 100 MHz 32 mV to 100 V (1 to 10) Hz 10 Hz to 10 kHz 100 mV to 100 V (10 to 50) kHz (50 to 100) kHz 100 kHz to 10 MHz (100 to 320) V (1 to 10) Hz 10 Hz to 5 kHz	0.25 ° 0.43 ° 0.86 ° 0.13 ° 0.071 ° 0.071 ° 0.43 ° 0.43 ° 0.25 ° 0.13 °	Precision Phasemeter

Electrical – RF/Microwave

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pulse – Measure ¹	33 MHz to 3 GHz	23 parts in 10 ⁶ of reading	Digital Oscilloscope
Phase Noise ¹ (Source and Measure) 1 MHz to 26.5 GHz Offset carrier ≤ 100 kHz	(-120 to -70) dBc/Hz	1.2 dB/Hz	Signal Generator, PSA Series Spectrum Analyzer
RF Power Sensors – Calibration Factors ⁵	Referenced at 1 mW 9 kHz to 6 GHz (6 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 33) GHz (33 to 40) GHz (40 to 50) GHz	1.2 % 1.7 % 1.8 % 2.2 % 2.6 % 3 % 2.7 %	Coaxial Thermistor, Power Sensors, w/Power Meter

Electrical – RF/Microwave

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned RF Power, Relative – Measure ¹	(-127 to 30) dB 100 kHz to 2.6 GHz (2.6 to 18) GHz (18 to 26.5) GHz	0.17 dB 0.18 dB 0.2 dB	PSA Series Spectrum Analyzer
RF Power – Absolute Measure ¹	(-60 to 20) dBm 9 kHz to 6 GHz (-35 to 20) dBm (10 to 50) MHz (50 to 100) MHz 100 MHz to 2 GHz (2 to 12.4) GHz (12.4 to 18) GHz (18 to 26.5) GHz (26.5 to 33) GHz (-70 to 20) dBm 10 MHz to 50 GHz	0.053 dB 0.073 dB 0.048 dB 0.047 dB 0.052 dB 0.057 dB 0.065 dB 0.071 dB 0.16 dB	Power Meter, Measuring Receiver, Power Sensors, and Spectrum Analyzers
Voltage Standing Wave Ratio (VSWR) ⁵	Broadband Loads: 2.4 mm (1 to 20) DC to 4 GHz (4 to 20) GHz (20 to 26.5) GHz (26.5 to 50) GHz Sliding loads: 2.4 mm (1 to 20) (4 to 20) GHz (20 to 36) GHz (36 to 40) GHz (40 to 50) GHz	0.018 0.047 0.075 0.12 0.018 0.023 0.029 0.037	Calibration Kit and Network Analyzer
RF Power – Source ¹	(-130 to 16) dBm 9 kHz to 3 GHz (-110 to 10) dBm 20 MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.4 dB 0.26 dB 0.32 dB 0.4 dB 0.83 dB	Signal Generator
Amplitude Modulation – Source ¹ 9 kHz to 3 GHz	Rate: 100 Hz to 20 kHz Depths: 5 % to 99 %	3.5 % Depth	Signal Generator

Electrical – RF/Microwave

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹ AM Depth Accuracy 100 kHz to 10 MHz (Rate: 50 Hz to 10 kHz) 10 MHz to 3 GHz (Rate: 50 Hz to 100 kHz) (3 to 26.5) GHz (Rate: 50 Hz to 100 kHz)	Depth: (5 to 99) % Depth: (20 to 99) % Depth: (5 to 20) % Depth: (20 to 99) % Depth: (5 to 20) %	0.91 % Depth 0.61 % Depth 3.0 % Depth 1.8 % Depth 5.5 % Depth	PSA Series Spectrum Analyzer
Flatness 10 MHz to 3 GHz (Rate: 90 Hz to 10 kHz) (3 to 26.5) GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) % Depth: (5 to 99) %	0.37 % Depth 0.49 % Depth	
AM Rejection (50 Hz to 3 kHz BW) 250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz) 10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz)	Depths: < 50% Deviations: < 5 kHz Depths: < 50% Deviations: < 50 kHz	0.17 % Depth 0.44 % Depth	
Residual AM 250 kHz to 26.5 GHz	(50 Hz to 3 kHz BW)	0.012 % (rms)	
Frequency Modulation – Source ¹ 9 kHz to 3 GHz	Rate: 100 Hz to 20 kHz Dev.: ≤ 100 kHz peak	1.7 % of reading	Signal Generator
Frequency Modulation – Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz (Rate: 20 Hz to 200 kHz)	Deviations: 200 Hz to 400 kHz	1.3 % of reading	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure ¹ FM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	AM Depths: ≤ 50% (Rate: 400 Hz or 1 kHz)	13 Hz 25 Hz 49 Hz	PSA Series Spectrum Analyzer
Frequency Modulation – Measure ¹ Residual FM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	(50 Hz to 3 kHz BW)	1.9 Hz 3.7 Hz 7.4 Hz	PSA Series Spectrum Analyzer
Harmonic Measurements ¹	<-10 dBc 30 Hz to 50 GHz	0.22 dB	Spectrum Analyzer
Phase Modulation – Source ¹ 9 kHz to 3 GHz	Rate: 100 Hz to 20 kHz Deviations: > 0.3 rad	1.7 % of reading	Signal Generator
Phase Modulation – Measure ¹ PM Deviation Accuracy 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz PM Rejection (50 Hz to 3 kHz BW) 100 kHz to 26.5 GHz Residual PM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad AM Depths: ≤ 50% (Rate: 1 kHz) >1 rad (50 Hz to 3 kHz BW)	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad 0.002 1 rad 0.004 1 rad 0.008 1 rad	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation – Measure ¹ For 2/3/4/5G			
Composite Rho ⁵	450 MHz to 26.5 GHz $\rho = (0.9 \text{ to } 1.0)$	0.001	
Error Vector Magnitude (rms)	450 MHz to 26.5 GHz EVM = (0 to 25) %	0.3 % of reading	
Peak Code Domain Error	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Phase error	450 MHz to 26.5 GHz (1 to 15) °	0.71 °	
Frequency Error	3 Hz to 26.5GHz	2.1×10^{-7} Hz/Hz	
I/Q Origin Offset	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Channel Power	450 MHz to 26.5 GHz Power > -70 dBm	0.62 dB	
Distortion – Measure ¹ 20 Hz to 20 kHz 20 Hz to 50 kHz (50 to 100) kHz	80 kHz BW: -80 dB 500 kHz BW: -70 dB 500 kHz BW: -65 dB	0.16 dB 0.33 dB 0.33 dB	Audio Analyzer
High – Power Measuring Equipment ¹	Up to 10 W (10 to 25) W (25 to 100) W	4.3 % of reading + 0.58R 4.2 % of reading + 0.58R 2.8 % of reading + 0.58R	Comparison to RF Power Calorimeter

Length – Dimensional Metrology

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 1 500 mm	$(0.17 + 0.006 \text{ } l) \mu\text{m} + 0.58R$	
Height Gages ^{1,2}	Up to 1 500 mm	$(0.71 + 0.001 \text{ } l) \mu\text{m} + 0.58R$	Gage Blocks

Length – Dimensional Metrology

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Micrometers ^{1,2} External, Internal, Depth, Bore and Micrometer Head	Length Up to 1 500 mm Flatness Up to 15 µm Parallelism Up to 15 µm	(0.091 + 0.006 7l) µm + 0.58R 0.13 µm 0.15 µm	Gage Blocks, Master Ring, Universal Length Measuring Machine, Optical Parallels or Optical Flats
Indicators ^{1,2} Dial Gauge, Dial Test Indicator, LVDTs	Up to 100 mm Up to 100 mm	(0.32 + 0.004 6l) µm + 0.58R (0.069 + 0.002 6l) µm + 0.58R	Universal Measuring Machine, Indicator Tester Gage Block, Comparator Stand
Plain Plug Gages / Pin Gages / Thread Wires ^{1,2} (Cylindrical and Taper)	Up to 300 mm	(0.31 + 0.001 7l) µm	Universal Measuring Machine, Gage Blocks, High-Accuracy Micrometer
Plain Ring Gages ² (Cylindrical and Taper)	(1 to 300) mm	(0.26 + 0.002 2l) µm	Universal Measuring Machine, Gage Blocks
Thread Plug Gages ² (Cylindrical and Taper) Major Diameter Simple Pitch Diameter	Up to 300 mm	(1.1 + 0.004 1l) µm (0.33 + 0.001 7l) µm	Universal Measuring Machine, Gage Block, Thread Measuring Wires, High-Accuracy Micrometer
Thread Ring Gages ² (Cylindrical and Taper) Minor Diameter Simple Pitch Diameter	(3 to 300) mm	(1.3 + 0.002 6l) µm (0.31 + 0.002 6l) µm	Universal Measuring Machine, Gage Block, Master Ring Gage, Thread Calibration Standards
Setting Rod, Micrometer Standard, Length Standards ²	Up to 500 mm	(0.44 + 0.002 3l) µm	Gage block, Measuring machine
Snap Gages ² External / Internal	Up to 500 mm	(0.28 + 0.002 5l) µm	Universal Measuring Machine, Gage Blocks
Thickness Gauge / Feeler Gauge ²	Up to 25 mm	(0.35 + 0.000 53l) µm	Universal Measuring Machine, Gage Blocks
Universal Length Measuring Machine ^{1,2}	Up to 100 mm (100 to 500) mm	(0.057 + 0.001 8l) µm (0.052 + 0.002 0l) µm	Gage block
Gage Block ² Length (Deviation of the length at any point from nominal length) Variation in length	Up to 100 mm Up to 0.5 mm	(0.065 + 0.001 0l) µm 0.032 µm	Gage block, Linear Length Gauge, Comparator Stand

Length – Dimensional Metrology

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Block ² Length (Deviation of the length at any point from nominal length) Variation in length	Up to 100 mm (100 to 500) mm Up to 0.5 mm	$\pm(0.16 + 0.000\ 61l)\ \mu\text{m}$ $\pm(0.11 + 0.001\ 0l)\ \mu\text{m}$ 0.15 μm	Gage block, Universal Measuring Machine
Surface Plates ^{1,2} Overall Flatness Local Area Flatness	(150 to 3 600) mmD Up to 0.13 mm	$(0.49 + 0.001\ 3D)\ \mu\text{m}$ $(0.63 + 0.001\ 2D)\ \mu\text{m}$	Level System Repeat-o-meter
Precision Level	Up to 1 mm/m (1 to 2) mm/m	0.71 % of reading + 3.5 $\mu\text{m}/\text{m}$ 1.5 % of reading	Level System
Master Level / Electronic Inclinometer / Angle Meter	Up to 5 mm/m Up to 90 °	1.1 $\mu\text{m}/\text{m}$ 0.000 82 °	Sine Bar, Gage Block
Bevel Protractor / Universal Bevel Protractor ¹	Up to 90 ° (4 Quadrants)	2 arcmin	Angle Block
Optical Comparators, Vision Systems, and Measuring Microscopes ^{1,2} X, Y, Z Axis	Up to 0.01 mm (0.01 to 500) mm	0.062 μm + 0.58R $(0.12 + 0.001\ 8l)\ \mu\text{m}$ + 0.58R	Standard Scales / Gage Blocks and Step Gage
Rules and Tape Measures ²	Up to 1 000 mm (1 000 to 50 000) mm	11 μm 0.011l μm	Gage Blocks, Standard Scale, Scale Loupe
Check Master / Caliper Checker / Height Master / Riser Block ² Block Pitch Accuracy Parallelism of Block Micrometer Head Accuracy	Up to 1 000 mm Up to 1 000 mm Up to 25 mm	$(0.55 + 0.001\ 1l)\ \mu\text{m}$ 0.6 μm $(0.26 + 0.006\ 9l)\ \mu\text{m}$	Gage Blocks, Electric Comparator, Linear Gage, Precision Height Gages
Calibration Tester / Dial Gauge Tester / Indicator Calibrator ²	Up to 25 mm	$(0.14 + 0.005\ 3l)\ \mu\text{m}$ + 0.58R	Linear Gage
Sine Bar & Sine Plate ²	Up to 300 mm	$(0.35 + 0.001\ 7l)\ \mu\text{m}$	Universal length measuring machine, LVDT w/amplifier, Angle gage block, Gauge block, Precision height gauge

Mass and Mass Related

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure ¹ (Absolute & Differential)	(-15 to 0) psi (0 to 3 000) psi (3 000 to 10 000) psi (10 000 to 36 000) psi	0.073 % of reading + 0.58R 0.027 % of reading + 0.58R 0.057 % of reading 0.049 % of reading	Pressure Calibrator
Vacuum Gauges ¹ (Absolute Pressure)	(0.000 1 to 1 000) torr	0.24 % of reading	MKS PVS-6 System
Force and Load Cell ¹ (Compression and Tension)	Up to 10 N (10 to 20) N (20 to 50) N (50 to 1 500) N	0.010 % of reading + 0.58R 0.007 4 % of reading 0.006 4 % of reading 0.006 2 % of reading	Standard weights
	(0 to 50) kN (50 to 500) kN	0.029 % of reading + 0.58R 0.028 % of reading	Load cell
Scales & Balances ^{1,3} (Platform & Spring)	Up to 20 mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 1 kg (1 to 2) kg (2 to 5) kg (5 to 10) kg (10 to 20) kg (20 to 50) kg (50 to 300) kg	0.0015 mg 0.0020 mg 0.0025 mg 0.0031 mg 0.0041 mg 0.015 mg 0.020 mg 0.026 mg 0.031 mg 0.041 mg 0.051 mg 0.081 mg 0.15 mg 0.41 mg 0.81 mg 1.5 mg 4.1 mg 8.1 mg 15 mg 39 mg 25×10^{-6} kg/kg	Standard Weights

Mass and Mass Related

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass (Weights)	(1 to 5) mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 50 g to 10 kg	0.003 2 mg 0.004 2 mg 0.005 2 mg 0.006 2 mg 0.008 2 mg 0.011 mg 0.013 mg 0.016 mg 0.021 mg 0.027 mg 0.034 mg 0.048 mg 0.078 mg 0.000 17 % of reading	Standard Weight and Electronic Balance
Air Velocity ²	0.01 to 15 m/s	1.3 % of reading	Wind Tunnel
Air Flow ¹	50 mL/min to 1 L/min (1 to 250) L/min	0.64 % of reading 0.4 % of reading	Air Flow Calibrator
Torque Testers ¹	Up to 10 N·m (10 to 50) N·m (50 to 200) N·m (200 to 500) N·m (500 to 1 500) N·m	0.16 % of reading + 0.58R 0.048 % of reading 0.028 % of reading 0.031 % of reading 0.014 % of reading	Torque Wheel, Torque Standard, Calibration Arms, Weights
Torque Tools ¹	Up to 1 500 N·m	0.67 % of reading + 0.058 mN·m	Torque Testers
Pipettes & Micropipettes Burette ¹	Up to 20 µL (20 to 50) µL (50 to 100) µL (100 to 200) µL 200 µL to 10 mL (10 to 20) mL (20 to 2 000) mL	0.02 µL 0.043 % of reading 0.026 % of reading 0.019 % of reading 0.015 % of reading 0.014 % of reading 0.012 % of reading	Analytical Scale Standard Weights
Volumetric Flask ¹	Up to 10 mL (10 to 20) mL (20 to 2 000) mL	0.001 5 mL 0.014 % of reading 0.012 % of reading	Analytical Scale Standard Weights

Mass and Mass Related

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Durometers ²			Direct Verification
Force	Up to 0.76 N (0.76 to 1.2) N (1.2 to 2.0) N (2.0 to 8.1) N (8.1 to 44.5) N	0.000 25 N + 0.58R 0.000 52 N + 0.58R 0.001 N + 0.58R 0.004 3 N + 0.58R 0.026 N + 0.58R	Electronic Balance, Load Cell
Extension at zero	Up to 5 mm	0.005 mm	Gage Blocks
Indenter Shape Diameter, Radius Angle	Up to 15 mm Up to 90°	0.004 mm 8"	Profile Projector

Photometry and Radiometry

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power – Measure ¹	(-80 to 10) dBm (700 to 1800) nm	0.17 dB	Optical Test System
Optical Wavelength – Measure ¹	(700 to 1 650) nm	0.51 parts in 10 ⁶ of reading	Wavelength Meter
Fiber Optic Wavelength – Source ¹	(1 510 to 1 565) nm	0.091 pm	NIST SRM 2519, 2517
Laser Power – Measure ¹ (190 to 1 100) nm	20 mW to 2 W (2 to 10) W	3.3 % of reading 3.5 % of reading	Thermopile Sensor, Silicon Detector w/ Optical Power Meter
Illuminance	(0.01 to 20 000) lux (20 000 to 100 000) lux	1.8 % of reading 4.2 % of reading	Comparison to Standard Light Meter
UV Irradiance, Calibration of UV Light Meters	(0.1 to 100) mW/cm ² (200 to 390) nm (391 to 940) nm (940 to 1 100) nm	3.5 % of reading 2.9 % of reading 5.3 % of reading	Optical Power Meter w/ Power Detectors

Thermodynamic

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity ¹	(10 to 95) %RH	1.2 %RH	Indicator, Probe w/ Humidity Generator
Radiation (Infrared) Thermometers ¹	50 °C (50 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 500) °C	0.36 °C 0.81 °C 1.2 °C 1.7 °C 2.2 °C 3 °C	Black Body Calibrator (Flat plate) $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Temperature ¹	(-40 to 600) °C	0.04 °C	Thermometer, PRT

Time and Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source ¹	10 MHz	6.2×10^{-12} Hz/Hz	GPS Receiver
	0.01 Hz to 40 GHz	6.3×10^{-12} Hz/Hz	GPS Receiver, Signal Generator
Frequency – Measure ¹	0.01 Hz to 26.5 GHz	6.3×10^{-10} Hz/Hz	GPS Receiver, Counter
Time Interval – Measure ¹	200 ps to 40 s	23 parts in 10^6 of reading	Digital Oscilloscope
Tachometer ¹	(0 to 100 000) rpm	0.000 25 % of reading + 0.58R	Multi-Product Calibrator, Signal Generator with LED
Stopwatch and Timer ¹	Up to 24 hr	0.86 ms	Frequency Counter
		240 ms	Stopwatch
Speed – Measure ^{1,2}	Up to 10 000 rpm	1 rpm	Tachometer

DIMENSIONAL MEASUREMENT

1 Dimensional

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Linear Measurements ^{1,2}	Up to 100 mm Up to 1 000 mm	$(0.056 + 0.002\ 8l)\ \mu\text{m}$ $(1.5 + 0.008l)\ \mu\text{m}$	Gage block Standard Scale
Inspection Fixtures / Gages ² Straight Edges Thickness Pads Attribute Gages – GO/NO-GO Dedicated Fixture Gages	Up to 100 mm (100 to 500) mm	$(0.35 + 0.000\ 35l)\ \mu\text{m}$ $(0.28 + 0.000\ 98l)\ \mu\text{m}$	Universal Length Measuring Machine, Precision Height Gage, Electric Comparator, Linear Length Gage, Gage Block, Profile Projector, Sine Bar, Level System

2 Dimensional

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inspection Fixtures / Gages ² Angle Block Parallel Bars Machine Squares Precision Squares Radius Gauge Chamfer Gauge Taper Gauge Dedicated Fixture Gages	Up to 100 mm (100 to 500) mm	$(0.35 + 0.000\ 35l)\ \mu\text{m}$ $(0.28 + 0.000\ 98l)\ \mu\text{m}$	Universal Length Measuring Machine, Precision Height Gage, Electric Comparator, Linear Length Gage, Gage Block, Profile Projector, Sine Bar, Level System

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

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CALIBRATION AND DIMENSIONAL MEASUREMENT

Acoustics and Vibration

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meters ¹	(74 to 114) dB (125 to 4 000) Hz	0.31 dB + 0.58R	Sound calibrator, Sound meter

Chemical Quantities

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters ^{1,4}	84 µS/cm 1 413 µS/cm 12 880 µS/cm	0.92 µS/cm 16 µS/cm 142 µS/cm	Comparison to Standard Solutions
pH Meters ^{1,4}	(4, 7, 10) pH	0.012 pH	Comparison to Standard Solutions

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source Fixed Values	1 V 1.018V 10 V	1.7 µV/V 1.7 µV/V 3.3 µV/V	DC Reference Standard
DC Voltage – Source ¹	(0 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 µV/V + 0.4 µV 5 µV/V + 0.7 µV 3.5 µV/V + 2.6 µV 3.5 µV/V + 4 µV 5 µV/V + 40 µV 6.5 µV/V + 0.4 mV	Multi-Function Calibrator

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1 V (1 to 10) V (20 to 100) V 100 V to 1 kV	6.1 μ V/V + 0.3 μ V 5.0 μ V/V + 0.3 μ V 5.0 μ V/V + 0.5 μ V 7.3 μ V/V + 30 μ V 12 μ V/V + 6 μ V	Multimeter
DC Voltage – Measure ¹ High Voltage	(1 to 10) kV (10 to 20) kV (20 to 70) kV	0.9 mV/V 0.8 mV/V 0.7 mV/V	High Voltage Meter and Probe
DC Current – Source ¹	(0 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	41 μ A/A + 6 nA 36 μ A/A + 7 nA 36 μ A/A + 40 nA 46 μ A/A + 0.7 μ A 82 μ A/A + 12 μ A	Multi-Function Calibrator
DC High Current – Source ¹	(2.2 to 11) A	0.17 mA/A	Multiproduct Calibrator
	(10 to 16.5) A (16.5 to 150) A (150 to 1 000) A	3.3 mA/A + 3.6 mA 3.3 mA/A + 29 mA 3.3 mA/A + 104 mA	Multi-Product Calibrator/ Transconductance Amplifier w/50-turn coil
DC Current – Measure ¹	(0 to 100) nA 100 nA to 1 μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	36 μ A/A + 50 pA 25 μ A/A + 50 pA 25 μ A/A + 121 pA 25 μ A/A + 1 nA 25 μ A/A + 7 nA 25 μ A/A + 68 nA 41 μ A/A + 0.7 μ A 0.13 mA/A + 14 μ A	Multimeter
	(1 to 20) A (20 to 300) A	0.14 mA/A 3.2 mA/A	Shunt w/ Multimeter
DC Power – Source ^{1,2} 33 mV to 1 020 V	0.1 mW to 11 kW (3.3 to 330) mA 330 mA to 4.5 A (4.5 to 11) A	0.039 % of Watts output + 0.58·R 0.081 % of Watts output + 0.58·R 0.067 % of Watts output + 0.58·R	Multi-Product Calibrator w/Amplifier
Inductance – Source ¹ at 1 kHz	(1 to 10) mH (10 to 100) mH 100 mH to 1 H (1 to 10) H	0.03 mH 0.15 mH 2.0 mH 11 mH	Decade Inductor

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ Fixed Points	0 to 0.1) Ω (0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω 10 k Ω to 1 M Ω (1 to 100) M Ω 100 M Ω to 100 G Ω 1 T Ω	15 $\mu\Omega$ 10 $\mu\Omega$ 0.76 m Ω 3.3 m Ω 33 m Ω 50 m Ω 0.05 % of reading 0.13 % of reading 0.5 % of reading 5.8 % of reading	Standard Resistors
Resistance – Source ¹ Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	40 $\mu\Omega$ 96 $\mu\Omega$ 91 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 18 $\mu\Omega/\Omega$ 18 $\mu\Omega/\Omega$ 37 $\mu\Omega/\Omega$ 46 $\mu\Omega/\Omega$ 0.1 m Ω/Ω	Multi-Function Calibrator
Resistance – Source ¹	Up to 10.99 Ω (11 to 32.999) Ω (33 to 109.999) Ω (110 to 329.999) Ω 330 Ω to 1.099 99 k Ω (1.1 to 3.299 99) k Ω (3.3 to 10.999 9) k Ω (11 to 32.999 9) k Ω	93 $\mu\Omega/\Omega$ + 6.2 m Ω 93 $\mu\Omega/\Omega$ + 12 m Ω 70 $\mu\Omega/\Omega$ + 12 m Ω 70 $\mu\Omega/\Omega$ + 12 m Ω 70 $\mu\Omega/\Omega$ + 47 m Ω 70 $\mu\Omega/\Omega$ + 47 m Ω 70 $\mu\Omega/\Omega$ + 0.47 Ω 70 $\mu\Omega/\Omega$ + 0.47 Ω	Multi-Product Calibrator

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹	(33 to 109.999) kΩ (110 to 329.999) kΩ 330 kΩ to 1.099 99 MΩ (1.1 to 3.299 99) MΩ (3.3 to 10.999 9) MΩ (11 to 32.999 9) MΩ (33 to 109.999) MΩ (110 to 330) MΩ	86 μΩ/Ω + 4.7 Ω 93 μΩ/Ω + 4.7 Ω 0.12 mΩ/Ω + 43 Ω 0.12 mΩ/Ω + 43 Ω 0.47 mΩ/Ω + 0.43 kΩ 0.78 mΩ/Ω + 0.43 kΩ 3.9 mΩ/Ω + 4.3 kΩ 3.9 mΩ/Ω + 13 kΩ	Multi-Product Calibrator
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 kΩ (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	18 μΩ/Ω + 68 μΩ 15 μΩ/Ω + 0.7 mΩ 13 μΩ/Ω + 0.7 mΩ 13 μΩ/Ω + 7 mΩ 13 μΩ/Ω + 68 mΩ 18 μΩ/Ω + 5 Ω 61 μΩ/Ω + 135 Ω 0.58 mΩ/Ω + 2 kΩ 5.8 mΩ/Ω + 14 kΩ	Multimeter
Resistance – Measure ¹	(1 to 100) GΩ	6.9 mΩ/Ω + 0.058 mΩ	High-Resistance Meter
Electrical Simulation of Thermocouple Indicators ¹	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 L (-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.4 °C 0.17 °C 0.16 °C 0.17 °C 0.2 °C 0.24 °C 0.17 °C 0.16 °C 0.18 °C 0.21 °C 0.28 °C 0.18 °C 0.17 °C 0.23 °C 0.33 °C 0.31 °C 0.23 °C 0.18 °C	Multi-Product Calibrator

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicators ¹	Type S (0 to 250) °C	0.38 °C	Multi-Product Calibrator
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	
	Type T (-250 to -150) °C	0.5 °C	
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U (-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	
	Type B (600 to 800) °C	0.36 °C	
	(800 to 1 000) °C	0.29 °C	
	(1 000 to 1 550) °C	0.26 °C	
	(1 550 to 1 820) °C	0.28 °C	
	Type N (-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R (0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type C (0 to 150) °C	0.26 °C	
	(150 to 650) °C	0.23 °C	
	(650 to 1 000) °C	0.27 °C	
	(1 000 to 1 800) °C	0.4 °C	
	(1 800 to 2 316) °C	0.66 °C	
	Cu 427, 10 Ω (-100 to 260) °C	0.23 °C	

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 100 Ω		Multi-Product Calibrator
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.031 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 500 Ω		Multi-Product Calibrator
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.039 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.062 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.085 °C	
	Pt 385, 1 k Ω		
	(-200 to -80) °C	0.023 °C	
	(-80 to 0) °C	0.023 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.054 °C	
	(400 to 600) °C	0.054 °C	
	(600 to 630) °C	0.18 °C	
AC Voltage – Source ¹	PtNi 385, 120 Ω (Ni120)		Multi-Function Calibrator
	(-80 to 0) °C	0.062 °C	
	(0 to 100) °C	0.062 °C	
	(100 to 260) °C	0.11 °C	
	200 μ V to 2.2 mV		
	(10 to 20) Hz	0.24 mV/V + 4 μ V	
	(20 to 40) Hz	90 μ V/V + 4 μ V	
	40 Hz to 20 kHz	80 μ V/V + 4 μ V	
	(20 to 50) kHz	0.2 mV/V + 4 μ V	
	(50 to 100) kHz	0.5 mV/V + 5 μ V	
	(100 to 300) kHz	1.1 mV/V + 10 μ V	
	(300 to 500) kHz	1.4 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 20 μ V	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.24 mV/V + 12 μ V	
	(20 to 40) Hz	90 μ V/V + 8 μ V	
	40 Hz to 20 kHz	80 μ V/V + 8 μ V	
	(20 to 50) kHz	0.21 mV/V + 10 μ V	
	(50 to 100) kHz	0.46 mV/V + 22 μ V	
	(100 to 300) kHz	0.9 mV/V + 26 μ V	
	(300 to 500) kHz	1.4 mV/V + 30 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 48 μ V	

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(22 to 220) mV		Multi-Function Calibrator
	(10 to 20) Hz	0.24 mV/V + 12 μ V	
	(20 to 40) Hz	90 μ V/V + 8 μ V	
	40 Hz to 20 kHz	80 μ V/V + 8 μ V	
	(20 to 50) kHz	0.21 mV/V + 10 μ V	
	(50 to 100) kHz	0.46 mV/V + 22 μ V	
	(100 to 300) kHz	0.9 mV/V + 26 μ V	
	(300 to 500) kHz	1.4 mV/V + 30 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 48 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.3 mV/V + 53 μ V	
	(20 to 40) Hz	0.1 mV/V + 23 μ V	
	40 Hz to 20 kHz	46 μ V/V + 9 μ V	
	(20 to 50) kHz	83 μ V/V + 12 μ V	
	(50 to 100) kHz	0.12 mV/V + 33 μ V	
	(100 to 300) kHz	0.5 mV/V + 95 μ V	
	(300 to 500) kHz	1 mV/V + 0.24 mV	
	500 kHz to 1 MHz	1.7 mV/V + 0.46 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.3 mV/V + 0.53 mV	
	(20 to 40) Hz	0.1 mV/V + 0.18 mV	
	40 Hz to 20 kHz	46 μ V/V + 61 μ V	
	(20 to 50) kHz	83 μ V/V + 0.12 mV	
	(50 to 100) kHz	0.11 mV/V + 0.24 mV	
	(100 to 300) kHz	0.39 mV/V + 0.79 mV	
	(300 to 500) kHz	1 mV/V + 2.3 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.6 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.3 mV/V + 5.3 mV	
	(20 to 40) Hz	0.1 mV/V + 1.8 mV	
	40 Hz to 20 kHz	52 μ V/V + 0.7 mV	
	(20 to 50) kHz	87 μ V/V + 1.1 mV	
	(50 to 100) kHz	0.15 mV/V + 3 mV	
	(100 to 300) kHz	1 mV/V + 16 mV	
	(300 to 500) kHz	4.5 mV/V + 40 mV	
	500 kHz to 1 MHz	8 mV/V + 80 mV	
	(220 to 1 100) V		
	(15 to 50) Hz	0.35 mV/V + 16 mV	
	50 Hz to 1 kHz	70 μ V/V + 3.5 mV	

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	750 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	92 μ V/V + 4 mV 0.17 mV/V + 6 mV 0.6 mV/V + 11 mV 0.6 mV/V + 11 mV 2.3 mV/V + 45 mV	Multi-Function Calibrator with Amplifier
AC Voltage – Measure ¹	(0 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 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz 100 mV to 10 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 (1 to 2) MHz (10 to 100) V (1 to 40) Hz 40 Hz to 1 kHz 1 kHz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	0.3 mV/V + 3 μ V 0.3 mV/V + 1 μ V 0.3 mV/V + 1 μ V 0.8 mV/V + 1 μ V 4.1 mV/V + 1 μ V 33 mV/V + 2 μ V 0.07 mV/V + 40 μ V 0.07 mV/V + 20 μ V 0.12 mV/V + 20 μ V 0.25 mV/V + 20 μ V 0.67 mV/V + 20 μ V 26 mV/V + 0.1 mV 8.4 mV/V + 0.1 mV 13 mV/V + 0.1 mV 0.07 mV/V + 0.4 mV 0.07 mV/V + 0.2 mV 0.12 mV/V + 0.2 mV 0.26 mV/V + 0.2 mV 0.67 mV/V + 0.2 mV 2.5 mV/V + 1 mV 8.4 mV/V + 1 mV 13 mV/V + 1 mV 0.23 mV/V + 4.6 mV 0.23 mV/V + 2.3 mV 0.23 mV/V + 2.3 mV 0.26 mV/V + 2mV 0.68 mV/V + 2mV 2.6 mV/V + 10 mV 8.4 mV/V + 10 mV 13 mV/V + 10 mV	Multimeter in Synchronous sub-sampled mode

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(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	0.4 mV/V + 40 mV 0.4 mV/V + 20 mV 0.6 mV/V + 20 mV 1.3 mV/V + 20 mV 3.1 mV/V + 20 mV	Multimeter in Synchronous sub-sampled mode
AC High Voltage – Measure ¹	(1 to 10) kV (50 to 100) Hz (10 to 20) kV (50 to 60) Hz (20 to 35) kV (rms) (50 to 60) Hz	1.5 mV/V + 0.6 V 1.4 mV/V + 0.6 V 1.4 mV/V + 0.6 V	High Voltage Meter and Probe
AC Voltage – Measure ¹ (Absolute Measurement)	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (2.2 to 7) 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 (7 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	1.2 mV/V + 0.87 μV 0.52 mV/V + 0.87 μV 0.32 mV/V + 0.87 μV 0.58 mV/V + 1.3 μV 0.85 mV/V + 1.7 μV 1.6 mV/V + 2.7 μV 1.7 mV/V + 5.3 μV 2.4 mV/V + 5.3 μV 0.57 mV/V + 0.87 μV 0.26 mV/V + 0.87 μV 0.16 mV/V + 0.87 μV 0.28 mV/V + 1.3 μV 0.4 mV/V + 1.7 μV 0.8 mV/V + 2.7 μV 0.87 mV/V + 5.3 μV 1.5 mV/V + 5.3 μV 0.2 mV/V + 0.87 μV 0.13 mV/V + 0.87 μV 80 μV/V + 0.87 μV 0.14 mV/V + 1.3 μV 0.22 mV/V + 1.7 μV 0.54 mV/V + 2.7 μV 0.59 mV/V + 5.3 μV 1.1 mV/V + 5.3 μV	AC Measurement Standard

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	(22 to 70) mV		AC Measurement Standard
	(10 to 20) Hz	0.16 mV/V + 1 μ V	
	(20 to 40) Hz	81 μ V/V + 1 μ V	
	40 Hz to 20 kHz	45 μ V/V + 1 μ V	
	(20 to 50) kHz	90 μ V/V + 1.3 μ V	
	(50 to 100) kHz	0.18 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.35 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.45 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.73 mV/V + 5.3 μ V	
	(70 to 220) mV		
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	57 μ V/V + 1 μ V	
	40 Hz to 20 kHz	26 μ V/V + 1 μ V	
	(20 to 50) kHz	47 μ V/V + 1.3 μ V	
	(50 to 100) kHz	0.11 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.17 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.26 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.67 mV/V + 5.3 μ V	
	(220 to 700) mV		
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	51 μ V/V + 1 μ V	
	40 Hz to 20 kHz	23 μ V/V + 1 μ V	
	(20 to 50) kHz	35 μ V/V + 1.3 μ V	
	(50 to 100) kHz	54 μ V/V + 1.7 μ V	
	(100 to 300) kHz	0.12 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.2 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.64 mV/V + 5.3 μ V	
	700 mV to 2.2 V		
	(10 to 20) Hz	0.13 mV/V + 0.58 μ V	
	(20 to 40) Hz	44 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	17 μ V/V + 0.58 μ V	
	(20 to 50) kHz	31 μ V/V + 0.58 μ V	
	(50 to 100) kHz	48 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.11 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.18 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.6 mV/V + 0.58 μ V	

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	(2.2 to 7) V		AC Measurement Standard
	(10 to 20) Hz	0.13 mV/V + 0.58 µV	
	(20 to 40) Hz	45 µV/V + 0.58 µV	
	40 Hz to 20 kHz	17 µV/V + 0.58 µV	
	(20 to 50) kHz	33 µV/V + 0.58 µV	
	(50 to 100) kHz	55 µV/V + 0.58 µV	
	(100 to 300) kHz	0.13 mV/V + 0.58 µV	
	(300 to 500) kHz	0.27 mV/V + 0.58 µV	
	500 kHz to 1 MHz	0.8 mV/V + 0.58 µV	
	(7 to 22) V		
	(10 to 20) Hz	0.13 mV/V + 5.8 µV	
	(20 to 40) Hz	45 µV/V + 5.8 µV	
	40 Hz to 20 kHz	19 µV/V + 5.8 µV	
	(20 to 50) kHz	33 µV/V + 5.8 µV	
	(50 to 100) kHz	55 µV/V + 5.8 µV	
	(100 to 300) kHz	0.13 mV/V + 5.8 µV	
	(300 to 500) kHz	0.27 mV/V + 5.8 µV	
	500 kHz to 1 MHz	0.8 mV/V + 5.8 µV	
	(22 to 70) V		
	(10 to 20) Hz	0.13 mV/V + 5.8 µV	
	(20 to 40) Hz	46 µV/V + 5.8 µV	
	40 Hz to 20 kHz	22 µV/V + 5.8 µV	
	(20 to 50) kHz	39 µV/V + 5.8 µV	
	(50 to 100) kHz	64 µV/V + 5.8 µV	
	(100 to 300) kHz	0.14 mV/V + 5.8 µV	
	(300 to 500) kHz	0.27 mV/V + 5.8 µV	
	500 kHz to 1 MHz	0.8 mV/V + 5.8 µV	
	(70 to 220) V		
	(10 to 20) Hz	0.13 mV/V + 58 µV	
	(20 to 40) Hz	46 µV/V + 58 µV	
	40 Hz to 20 kHz	22 µV/V + 58 µV	
	(20 to 50) kHz	47 µV/V + 58 µV	
	(50 to 100) kHz	67 µV/V + 58 µV	
	(100 to 300) kHz	0.14 mV/V + 58 µV	
	(300 to 500) kHz	0.33 mV/V + 58 µV	
	(220 to 700) V		
	(10 to 20) Hz	0.13 mV/V + 58 µV	
	(20 to 40) Hz	67 µV/V + 58 µV	
	40 Hz to 20 kHz	29 µV/V + 58 µV	
	(20 to 50) kHz	87 µV/V + 58 µV	
	(50 to 100) kHz	0.34 mV/V + 58 µV	

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	(700 to 1 000) V (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.13 mV/V + 58 µV 67 µV/V + 58 µV 28 µV/V + 58 µV 87 µV/V + 58 µV 0.33 mV/V + 58 µV	AC Measurement Standard
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	600 µV to 2.2 mV (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (2.2 to 7) mV (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (7 to 22) mV (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.94 mV/V + 0.08 µV 0.47 mV/V + 0.08 µV 0.47 mV/V + 0.08 µV 0.47 mV/V + 0.08 µV 0.66 mV/V + 0.95 µV 0.66 mV/V + 0.95 µV 0.66 mV/V + 0.95 µV 1.6 mV/V + 0.95 µV 2.8 mV/V + 0.95 µV 6.6 mV/V + 1.9 µV 0.94 mV/V + 0.082 µV 0.47 mV/V + 0.082 µV 0.47 mV/V + 0.082 µV 0.47 mV/V + 0.082 µV 0.66 mV/V + 0.95 µV 0.66 mV/V + 0.95 µV 0.66 mV/V + 0.95 µV 0.94 mV/V + 0.95 µV 1.6 mV/V + 0.95 µV 3.5 mV/V + 0.95 µV 0.94 mV/V + 0.082 µV 0.47 mV/V + 0.082 µV 0.47 mV/V + 0.082 µV 0.47 mV/V + 0.082 µV 0.66 mV/V + 0.082 µV 0.66 mV/V + 0.082 µV 0.66 mV/V + 0.082 µV 943 µV/V + 0.082 µV 1.6 mV/V + 0.082 µV 3.5 mV/V + 0.082 µV	AC Measurement Standard

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	(22 to 70) mV		AC Measurement Standard
	(10 to 30) Hz	0.94 mV/V + 0.82 µV	
	(30 to 120) Hz	0.47 mV/V + 0.82 µV	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.82 µV	
	(1.2 to 120) kHz	0.47 mV/V + 0.82 µV	
	(120 to 500) kHz	0.47 mV/V + 0.82 µV	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.82 µV	
	(1.2 to 2) MHz	0.47 mV/V + 0.82 µV	
	(2 to 10) MHz	0.94 mV/V + 0.82 µV	
	(10 to 20) MHz	1.4 mV/V + 0.82 µV	
	(20 to 30) MHz	3.3 mV/V + 0.82 µV	
	(70 to 220) mV		
	(10 to 30) Hz	0.94 mV/V + 0.82 µV	
	(30 to 120) Hz	0.38 mV/V + 0.82 µV	
	120 Hz to 1.2 kHz	0.38 mV/V + 0.82 µV	
	(1.2 to 120) kHz	0.38 mV/V + 0.82 µV	
	(120 to 500) kHz	0.38 mV/V + 0.82 µV	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.82 µV	
	(1.2 to 2) MHz	0.47 mV/V + 0.82 µV	
	(2 to 10) MHz	0.94 mV/V + 0.82 µV	
	(10 to 20) MHz	1.4 mV/V + 0.82 µV	
	(20 to 30) MHz	3.3 mV/V + 0.82 µV	
	(220 to 700) mV		
	(10 to 30) Hz	0.94 mV/V + 8.2 µV	
	(30 to 120) Hz	0.28 mV/V + 8.2 µV	
	120 Hz to 1.2 kHz	0.28 mV/V + 8.2 µV	
	(1.2 to 120) kHz	0.28 mV/V + 8.2 µV	
	(120 to 500) kHz	0.28 mV/V + 8.2 µV	
	500 kHz to 1.2 MHz	0.47 mV/V + 8.2 µV	
	(1.2 to 2) MHz	0.47 mV/V + 8.2 µV	
	(2 to 10) MHz	0.94 mV/V + 8.2 µV	
	(10 to 20) MHz	1.4 mV/V + 8.2 µV	
	(20 to 30) MHz	3.3 mV/V + 8.2 µV	

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	700 mV to 2.2 V (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (2.2 to 7) V (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.94 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 1.4 mV/V + 8.2 μV 3.3 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 1.4 mV/V + 8.2 μV 3.3 mV/V + 8.2 μV	AC Measurement Standard
AC Current – Source ¹	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 (0.22 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 + 35 nA 0.12 mA/A + 35 nA 0.2 mA/A + 0.11 μA 1.1 mA/A + 0.65 μA	Multi-Function Calibrator

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

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 (0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.25 mA/A + 0.4 µA 0.16 mA/A + 0.35 µA 0.12 mA/A + 0.35 µA 0.2 mA/A + 0.55 µA 1.1 mA/A + 5 µA 0.25 mA/A + 4 µA 0.16 mA/A + 4 µA 0.12 mA/A + 3 µA 0.2 mA/A + 4 µA 1.1 mA/A + 10 µA 0.26 mA/A + 35 µA 0.45 mA/A + 80 µA 7 mA/A + 0.16 mA	Multi-Function Calibrator
AC Current – Source ¹	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.46 mA/A + 0.17 mA 0.95 mA/A + 0.38 mA 3.6 mA/A + 0.75 mA	Multi-Function Calibrator w/Amplifier
AC Current – Source ¹	(10 to 16.5) A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1000) A (45 to 65) Hz (65 to 440) Hz	3.3 mA/A + 3.5 mA 9.1 mA/A + 3.5 mA 3.3 mA/A + 29 mA 9.1 mA/A + 31 mA 3.4 mA/A + 0.1 A 9.1 mA/A + 0.12 A	Multiproduct Calibrator, Transconductance Amplifier with 50 Turn Coil
AC Current – Measure ¹	Up to 100 µA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 1 kHz	4.6 mA/A + 0.035 µA 1.7 mA/A + 0.035 µA 0.7 mA/A + 0.035 µA 0.7 mA/A + 0.035 µA	Multimeter

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	100 μ A to 1 mA (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 (50 to 100) kHz (1 to 10) mA 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 (50 to 100) kHz (10 to 100) mA (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 (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	4.6 mA/A + 0.23 μ A 1.7 mA/A + 0.23 μ A 0.7 mA/A + 0.23 μ A 0.4 mA/A + 0.23 μ A 0.7 mA/A + 0.23 μ A 4.6 mA/A + 0.46 μ A 6.4 mA/A + 1.7 μ A 4.6 mA/A + 2.3 μ A 1.7 mA/A + 2.3 μ A 0.7 mA/A + 2.3 μ A 0.4 mA/A + 2.3 μ A 0.7 mA/A + 2.3 μ A 4.6 mA/A + 4.6 μ A 6.4 mA/A + 17 μ A 4.6 mA/A + 23 μ A 1.7 mA/A + 23 μ A 0.7 mA/A + 23 μ A 0.4 mA/A + 23 μ A 0.7 mA/A + 23 μ A 4.6 mA/A + 46 μ A 6.4 mA/A + 0.17 mA 4.6 mA/A + 0.23mA 1.8 mA/A + 0.23 mA 0.9 mA/A + 0.23 mA 1.2 mA/A + 0.23 mA 3.5 mA/A + 0.23 mA 12 mA/A + 0.46 mA	Multimeter
	10 mA to 20 A 5 Hz to 100 kHz	0.2 mA/A + 0.58 μ A	
AC Resistance Source ¹ 100 Hz to 100 kHz	0 Ω 0.1 Ω 1.0 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω	15 $\mu\Omega$ 15 $\mu\Omega$ 0.13 m Ω 0.76 m Ω 3.3 m Ω 33 m Ω 0.33 Ω 3.3 Ω	RL Standard

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance – Measure ¹ 20 Hz to 1 MHz	0.01 mΩ to 1 kΩ	0.6 mΩ/Ω + 5.8 μΩ	Precision LCR Meter
AC Power – Source ^{1,2} (45 to 65) Hz PF = 1	0.1 mW to 11 kW (33 to 330) mV) (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A 330 mV to 1 000 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.31 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.27 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.27 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.27 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.16 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R	Multi-Product Calibrator
AC Power – Source ^{1,2} (45 to 65) Hz (PF = 0 to 0.999)	0.1 mW to 11 kW 33 to 330) mV) (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A 330 mV to 1 000 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.36 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.32 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.32 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.32 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.23 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R	Multi-Product Calibrator

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} (45 to 65) Hz PF = 1	0.33 mW to 11 kW (100 to 1 000) V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.16 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R	Multi-Product Calibrator w/Amplifier
AC Power – Source ^{1,2} (45 to 65) Hz (PF = 0 to 0.999)	0.33 mW to 11 kW (100 to 1 000) V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.23 % of Watts output + 0.58R 0.21% of Watts output + 0.58R	Multi-Product Calibrator w/Amplifier
Capacitance Source ¹ 50 Hz to 1 kHz	(0.19 to 0.5) nF (0.5 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (0.33 to 1.1) µF (1.1 to 3.3) µF (3.3 to 11) µF (11 to 33) µF (33 to 110) µF (110 to 330) µF (0.33 to 1.1) mF	3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 78 pF 1.9 mF/F + 0.23 nF 1.9 mF/F + 0.78 nF 2.7 mF/F + 2.3 nF 2.7 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.9 mF/F + 78 nF 5.4 mF/F + 233 nF 7.8 mF/F + 0.26 µF	Multi-Product Calibrator
Capacitance Source ¹ Fixed Values	(1, 10, 100, 1 000) pF 1 kHz to 13 MHz	0.35 mF/F + 0.58·R	Capacitance Set
Capacitance – Source ¹ Fixed Values 20 Hz to 1 kHz	(2, 100) pF, (1, 1.8, 10, 100) nF (1, 10) µF (1, 10) mF	0.015 mF/F + 0.58·R	Capacitance Standard

Electrical – DC/Low Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Measure ¹ 20 Hz to 1 MHz 1 MHz to 30 MHz	0.01 fF to 1 mF 0.01 fF to 1 mF	0.6 mF/F + 0.005 8 fF 1.2 mF/F + 0.005 8 fF	Precision LCR Meter
Oscilloscope ¹ Rise/Fall Time, (10 to 90) %	(0 to 1.25) s	1.3 ps	Oscilloscope Calibrator w/ Calibration Head
Oscilloscope ¹ Square Wave Amplitude, < 10 kHz into 50 Ω or 1 MΩ Load Impedance	Up to 1 mVp-p (1 to 21) mVp-p (21 to 556) mVp-p 556 mVp-p to 210 Vp-p	10 mV/V + 10 μV 1.5 mV/V + 20 μV 1.5 mV/V + 1.2 μV 1.3 mV/V + 1.2 μV	Oscilloscope Calibrator
Oscilloscope ¹ Horizontal Deflection (Time)	150 ps to 50 s	0.39 parts in 10 ⁶ of reading	Oscilloscope Calibrator
Oscilloscope ¹ Vertical Deflection (Amplitude)	1 mVp-p to 50 Vp-p (50 to 100) Vp-p (100 to 200) Vp-p	0.25 mV/V + 25 μV 0.25 mV/V + 26 μV 0.25 mV/V + 63 μV	Oscilloscope Calibrator
Oscilloscope ¹ Bandwidth	0.1 Hz to 50 GHz	2.1 % of reading	Oscilloscope Calibrator w/ Calibration Head, Power Sensor
Time Interval – Measure ¹	200 ps to 40 s	23 parts in 10 ⁶ of reading	Digital Oscilloscope
Phase – Measure ¹	(0 to 36) ° (10 to 32) mV 1 Hz to 10 kHz (10 to 100) mV (10 to 50) kHz 50 kHz to 100 MHz 32 mV to 100 V (1 to 10) Hz 10 Hz to 10 kHz 100 mV to 100 V (10 to 50) kHz (50 to 100) kHz 100 kHz to 10 MHz (100 to 320) V (1 to 10) Hz 10 Hz to 5 kHz	0.25 ° 0.43 ° 0.86 ° 0.13 ° 0.071 ° 0.071 ° 0.43 ° 0.43 ° 0.25 ° 0.13 °	Precision Phasemeter

Electrical – RF/Microwave

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pulse – Measure ¹	33 MHz to 3.0 GHz	23 parts in 10 ⁶ of reading	Digital Oscilloscope
Phase Noise ¹ (Source and Measure) 1 MHz to 26.5 GHz Offset carrier ≤ 100 kHz	(-70 to -120) dBc/Hz	1.2 dB/Hz	Signal Generator, PSA Series Spectrum Analyzer
RF Power Sensors – Calibration Factors ⁵	Referenced at 1 mW 100 kHz to 10 MHz 10 MHz to 1.2 GHz (1.2 to 6) GHz (6 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 33) GHz (33 to 40) GHz (40 to 45) GHz (45 to 50) GHz	1.4 % 1.3 % 1.4 % 1.6 % 2.1 % 2.6 % 2.9 % 3 % 4 % 4.7 %	Coaxial Thermistor, Power Sensors, Power Meter
RF Tuned Power – Measure ¹	(-117 to 30) dB 100 kHz to 2.6 GHz (2.6 to 18) GHz (18 to 26.5) GHz	0.17 dB 0.18 dB 0.2 dB	Measuring Receiver and Power Sensors
RF Absolute Power – Measure ¹	(-70 to 44) dBm 9 kHz to 6 GHz (6 to 18) GHz (18 to 26.5) GHz (26.5 to 33) GHz (33 to 40) GHz (40 to 50) GHz	0.11 dB 0.17 dB 0.18 dB 0.2 dB 0.43 dB 0.5 dB	Power Meter, Measuring Receiver and Power Sensors
RF Power – Source ¹	(-130 to 16) dBm 9 kHz to 3 GHz (-110 to 10) dBm 20 MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.4 dB 0.26 dB 0.32 dB 0.4 dB 0.83 dB	Signal Generator
Amplitude Modulation – Source ¹ 9 kHz to 3 GHz	Rate: 100 Hz to 20 kHz Depths: 5 % to 99 %	3.5 % Depth	Signal Generator

Electrical – RF/Microwave

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹ AM Depth Accuracy 100 kHz to 10 MHz (Rate: 50 Hz to 10 kHz) 10 MHz to 3 GHz (Rate: 50 Hz to 100 kHz) (3 to 26.5) GHz (Rate: 50 Hz to 100 kHz)	Depth: (5 to 99) % Depth: (20 to 99) % Depth: (5 to 20) % Depth: (20 to 99) % Depth: (5 to 20) %	0.91 % Depth 0.61 % Depth 3 % Depth 1.8 % Depth 5.5 % Depth	PSA Series Spectrum Analyzer
Flatness 10 MHz to 3 GHz (Rate: 90 Hz to 10 kHz) (3 to 26.5) GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) % Depth: (5 to 99) %	0.37 % Depth 0.49 % Depth	
AM Rejection (50 Hz to 3 kHz BW) 250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz) 10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz)	Depths: < 50% Deviations: < 5 kHz Depths: < 50% Deviations: < 50 kHz	0.17 % Depth 0.44 % Depth	
Residual AM 250 kHz to 26.5 GHz	(50 Hz to 3 kHz BW)	0.012 % (rms)	
Frequency Modulation – Source ¹ 9 kHz to 3 GHz	Rate: 100 Hz to 20 kHz Dev.: ≤ 100 kHz peak	1.7 % of reading	Signal Generator
Frequency Modulation – Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz (Rate: 20 Hz to 200 kHz)	Deviations: 200 Hz to 400 kHz	1.3 % of reading	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure ¹ FM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz Residual FM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	AM Depths: $\leq 50\%$ (Rate: 400 Hz or 1 kHz) (50 Hz to 3 kHz BW)	13 Hz 25 Hz 49 Hz 1.9 Hz 3.7 Hz 7.4 Hz	PSA Series Spectrum Analyzer
Phase Modulation – Source ¹ 9 kHz to 3 GHz	Rate: 100 Hz to 20 kHz Deviations: > 0.3 rad	1.7 % of reading	Signal Generator
Phase Modulation – Measure ¹ PM Deviation Accuracy PM Rejection (50 Hz to 3 kHz BW) 100 kHz to 26.5 GHz Residual PM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	100 kHz to 6.6 GHz Deviations: > 0.7 rad Deviations: > 0.3 rad (6.6 to 13.2) GHz Deviations: > 0.7 rad Deviations: > 0.3 rad (13.2 to 26.5) GHz Deviations: > 0.7 rad Deviations: > 0.3 rad AM Depths: $\leq 50 \%$ (Rate: 1 kHz) >1 rad (50 Hz to 3 kHz BW)	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad 0.002 1 rad 0.004 1 rad 0.008 1 rad	PSA Series Spectrum Analyzer
Digital Modulation – Measure ^{1,5} For 2/3/4/5G Composite Rho Error Vector Magnitude (rms)	450 MHz to 26.5 GHz $\rho = (0.9 \text{ to } 1.0)$ 450 MHz to 26.5 GHz EVM = (0 to 25) %	0.001 0.3 % of reading	PSA Series Spectrum Analyzer, Signal Generator

Electrical – RF/Microwave

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation – Measure ¹ For 2/3/4/5G Peak Code Domain Error	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	PSA Series Spectrum Analyzer, Signal Generator
Phase error	450 MHz to 26.5 GHz (1 to 15) °	0.71 °	
Frequency Error	3 Hz to 26.5GHz	2.1 x 10 ⁻⁷ Hz/Hz	
I/Q Origin Offset	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Channel Power	450 MHz to 26.5 GHz Power > -70 dBm	0.62 dB	
Harmonic Measurements ¹	<-10 dBc 30 Hz to 50 GHz	1.5 dB	Spectrum Analyzer
Distortion – Measure ¹ 20 Hz to 20 kHz 20 Hz to 50 kHz (50 to 100) kHz	80 kHz BW: -80 dB 500 kHz BW: -70 dB 500 kHz BW: -65 dB	0.16 dB 0.33 dB 0.33 dB	Audio Analyzer

Length – Dimensional Metrology

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 1 500 mm	(0.17 + 0.006 7 <i>l</i>) μm + 0.58 <i>R</i>	Gage Blocks
Height Gages ^{1,2}	Up to 1 500 mm	(0.71 + 0.001 5 <i>l</i>) μm + 0.58 <i>R</i>	Gage Blocks
Gage Blocks – Length ²	(0.5 to 100) mm	(0.068 + 0.001 1 <i>l</i>) μm	Gage Blocks and Gage Block Comparator
Universal Length Measuring Machine ^{1,2}	Up to 100 mm	(0.056 + 0.002 8 <i>l</i>) μm	Gage Blocks
Surface Plates ^{1,2} Overall Flatness	(150 to 3 600) mm <i>D</i>	(0.49 + 0.001 3 <i>D</i>) μm	Level System
Local Area Flatness	Up to 0.13 mm	(0.63 + 0.001 2 <i>D</i>) μm	Repeat-o-meter
Precision Level	Up to 1 mm/m (1 to 2) mm/m	0.85 % of reading + 3.5 μm/m 1.8 % of reading	Level System

Length – Dimensional Metrology

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Master Level / Electronic Inclinometer / Angle Meter	Up to 5 mm/m Up to 90°	1.1 µm/m 0.000 82°	Sine Bar, Gage Block
Bevel Protractor ²	Up to 90°	2"	Angle Block
Indicators ^{1,2} Dial Gauge, Dial Test Indicator, LVDTs	Up to 100 mm	(0.069 + 0.003 4L) µm	Indicator Tester, Gage Block, Comparator Stand
Micrometers ^{1,2} External, Internal, Depth, Bore and Micrometer Head	Up to 1 500 mm	(0.091 + 0.006 7L) µm + 0.58R	Gage Blocks
Ruler & Tape Measures ^{1,2}	Up to 1 000 mm (1 000 to 50 000) mm	11 µm (0.011L) µm	Gage block, Standard Scale, Scale Loupe
Check Master / Caliper Checker / Height Master / Riser Block ²			
Block Pitch Accuracy	Up to 1 000 mm	(0.55 + 0.001 1L) µm	Gage Blocks, Electric Comparator, Linear Gage, Precision Height Gages
Parallelism of Block	Up to 1 000 mm	0.6 µm	
Micrometer Head Accuracy	Up to 25 mm	(0.26 + 0.006 9L) µm	
Calibration Tester / Dial Gauge Tester / Indicator Calibrator ²	Up to 25 mm	(0.26 + 0.006 9L) µm	Linear Gage

Mass and Mass Related

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Gage ^{1,2} (Absolute & Differential)	(-15 to < 0) psi (> 0 to 3 000) psi (3 000 to 10 000) psi	0.073 % of reading + 0.58R 0.027 % of reading + 0.58R 0.057 % of reading	Pressure Calibrator

Mass and Mass Related

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales & Balances ^{1,3} (Platform & Spring)	Up to 5 mg	0.008 8 mg	Standard Weights
	(5 to 20) mg	0.01 mg	
	(20 to 50) mg	0.011 mg	
	(50 to 100) mg	0.012 mg	
	(100 to 200) mg	0.014 mg	
	(200 to 500) mg	0.016 mg	
	500 mg to 1 g	0.084 mg	
	(1 to 2) g	0.085 mg	
	(2 to 5) g	0.089 mg	
	(5 to 10) g	0.1 mg	
	(10 to 20) g	0.14 mg	
	(20 to 50) g	0.26 mg	
	(50 to 100) g	0.49 mg	
	(100 to 200) g	1.3 mg	
	(200 to 500) g	2.6 mg	
	500 g to 1 kg	9.5 mg	
	(1 to 50) kg	0.000 65 % of reading	
	(50 to 300) kg	0.002 6 % of reading	
Mass (Weights)	(1 to 5) mg	0.003 2 mg	Standard Weight and Electronic Balance
	10 mg	0.004 2 mg	
	20 mg	0.005 2 mg	
	50 mg	0.006 2 mg	
	100 mg	0.008 2 mg	
	200 mg	0.011 mg	
	500 mg	0.013 mg	
	1 g	0.016 mg	
	2 g	0.021 mg	
	5 g	0.027 mg	
	10 g	0.034 mg	
	20 g	0.048 mg	
	50 g	0.078 mg	
	50 g to 10 kg	0.000 17 % of reading	
Pipettes & Micropipettes Burette ¹	Up to 20 µL	0.02 µL	Analytical Scale Standard Weights
	(20 to 50) µL	0.043 % of reading	
	(50 to 100) µL	0.026 % of reading	
	(100 to 200) µL	0.019 % of reading	
	200 µL to 10 mL	0.015 % of reading	
	(10 to 20) mL	0.014 % of reading	
	(20 to 2000) mL	0.012 % of reading	

Mass and Mass Related

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Volumetric Flask ¹	Up to 10 mL (10 to 20) mL (20 to 2 000) mL	0.001 5 mL 0.014 % of reading 0.012 % of reading	Analytical Scale Standard Weights
Durometer Hardness Testers ² Force	Up to 0.76 N (0.76 to 1.2) N (1.2 to 2.0) N (2.0 to 8.1) N (8.1 to 44.5) N	0.25 mN + 0.58R 0.52 mN + 0.58R 1 mN + 0.58R 4.3 mN + 0.58R 0.026 N + 0.58R	Direct Verification using Electronic Balance, Load Cell
Extension at zero	Up to 5 mm	0.005 mm	Gage Blocks
Indenter Shape	Up to 15 mm Up to 90°	0.004 mm 8"	Profile Projector
Air Velocity	0.01 to 15 m/s	1.3 % of reading	Wind Tunnel
Torque Testers ¹	Up to 10 N·m (10 to 50) N·m (50 to 200) N·m (200 to 500) N·m (500 to 1 500) N·m	0.16 % of reading + 0.58·R 0.048 % of reading 0.028 % of reading 0.031 % of reading 0.014 % of reading	Torque Wheel, Torque Standard, Calibration Arms, Weights
Torque Tools ¹	Up to 1 500 N·m	0.67 % of reading + 0.058 mN·m	Torque Testers
Force and Load Cell ¹ (Compression and Tension)	Up to 10 N (10 to 20) N (20 to 50) N (50 to 1 500) N	0.01 % of reading + 0.58R 0.007 4 % of reading 0.006 4 % of reading 0.006 2 % of reading	Standard weights
	Up to 50 kN (50 to 500) kN	0.029 % of reading + 0.58R 0.028 % of reading	Load cell

Photometry and Radiometry

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power Measure ¹ (700 to 1800) nm	(-80 to 10) dBm	0.17 dB	Agilent Optical Test System
Optical Wavelength – Measure ¹	(700 to 1 650) nm	0.51 parts in 10 ⁶ of reading	Wavelength Meter
Fiber Optic Wavelength – Source ¹	(1 510 to 1 565) nm	0.091 pm	NIST Wavelength SRM

Photometry and Radiometry

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Laser Power – Measure ¹ (190 to 1 100) nm	20 mW to 2 W (2 to 10) W	3.3 % of reading 3.5 % of reading	Thermopile Sensor, Silicon Detector w/ Optical Power Meter
UV Irradiance, Calibration of UV Light Meters	(0.1 to 100) mW/cm ² (200 to 390) nm (391 to 940) nm (940 to 1 100) nm	3.5 % of reading 2.9 % of reading 5.3 % of reading	Optical Power Meter w/ Power Detectors
Illuminance	(0.01 to 20 000) lux	1.8 % of reading	Comparison to Standard Light Meter

Thermodynamic

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity ¹	(10 to 95) %RH	1.3 %RH	Humidity Indicator and Probe w/ Humidity Generator
Radiation (Infrared) Thermometers ¹	10 °C (10 to 50) °C (50 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C	0.66 °C 0.68 °C 0.82 °C 1.3 °C 1.8 °C 2.3 °C	Black Body Calibrator (Cavity) $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Temperature ¹	(-40 to 600) °C	0.04 °C	Thermometer and PRT

Time and Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source ¹	10 MHz 0.01 Hz to 40 GHz	6.2 x 10 ⁻¹² Hz/Hz 6.3 x 10 ⁻¹² Hz/Hz	GPS Receiver, Signal Generator
Frequency – Measure ¹	0.1 Hz to 26.5 GHz	6.3 x 10 ⁻¹⁰ Hz/Hz	GPS Receiver, Counter
Stopwatch and Timer ¹	Up to 24 hr	0.86 ms	Frequency Counter
Stopwatch and Timer ¹	Up to 24 hr	240 ms	Stopwatch
Speed – Measure ^{1,2}	Up to 10 000 rpm	1 rpm	Tachometer

Time and Frequency

Johor Bahru, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tachometer ^{1,2}	Up to 100 000) rpm	0.000 27 % of reading + 0.58R	Multi-Product Calibrator, Signal Generator with Lamp

DIMENSIONAL MEASUREMENT

Dimensional Measurement 1D

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Linear Measurements ^{1,2}	Up to 100 mm Up to 1 000 mm	(0.056 + 0.002 8I) µm (1.5 + 0.008I) µm	Gage Blocks Standard Scale

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

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CALIBRATION

Acoustics and Vibration

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound-Pressure Level ¹ (125 to 4 000) Hz	(74 to 114) dB	0.33 dB	Sound Calibrator & Frequency Counter

Chemical Quantities

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters ^{1,4}	100 μ S/cm 1 000 μ S/cm 1 400 μ S/cm 100 000 μ S/cm	0.83 μ S/cm 5.4 μ S/cm 8.1 μ S/cm 503 μ S/cm	Comparison to Standard Solutions
pH Meters ^{1,4}	(4, 7, 10) pH	0.012 pH	Comparison to Standard Solutions

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹	(0 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	8.5 μ V/V + 0.4 μ V 5.3 μ V/V + 0.7 μ V 3.6 μ V/V + 2.6 μ V 4.8 μ V/V + 4 μ V 5.3 μ V/V + 40 μ V 6.9 μ V/V + 0.4 mV	Multi-Function Calibrator
DC Voltage – Source ¹ Fixed Values	1 V 1.018 V 10 V	1.7 μ V 1.7 μ V 1.4 μ V	DC Reference Standard

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	6 μ V/V + 0.31 μ V 4 μ V/V + 0.31 μ V 4 μ V/V + 0.51 μ V 6 μ V/V + 30 μ V 6 μ V/V + 0.1 mV	Multimeter
	(1 to 10) kV	0.35 mV/V + 0.035 V	High Voltage Meter
DC Power – Source ^{1,2}	0.1 mW to 11 kW (33 mV to 1020 V) (3.3 to 330) mA 330 mA to 4.5 A (4.5 to 11) A	0.039 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.067 % of Watts output + 0.58R	Multi-Product Calibrator w/Amplifier
DC Current – Source ¹	(0 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	43 μ A/A + 6 nA 38 μ A/A + 7 nA 39 μ A/A + 40 nA 63 μ A/A + 0.7 μ A 81 μ A/A + 12 μ A	Multi-Function Calibrator
DC High Current – Source ¹	(2.2 to 11) A	0.36 mA/A + 0.48 mA	Multi-Function Calibrator with Amplifier
	(10 to 16.5) A (16.5 to 150) A (150 to 550) A	3.3 mA/A + 3.5 mA 3.3 mA/A + 29 mA 3.3 mA/A + 104 mA	Multi-Product Calibrator w/50-turns coil
	(3.2 to 32) A (32 to 105) A (105 to 200) A	2.4 mA/A + 1.2 mA 2.4 mA/A + 9.4 mA 2.4 mA/A + 45 mA	Multi-Product Calibrator w/10 turns coil
	(16 to 160) A (160 to 525) A (525 to 1 000) A	2.4 mA/A + 5.9 mA 2.4 mA/A + 47 mA 2.4 mA/A + 225 mA	Multi-Product Calibrator w/50 turns coil
DC Current – Measure ¹	(0 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	30 μ A/A + 40 pA 20 μ A/A + 40 pA 20 μ A/A + 0.1 nA 20 μ A/A + 0.8 nA 20 μ A/A + 5 nA 20 μ A/A + 50 nA 35 μ A/A + 0.50 μ A 0.11 mA/A + 10 μ A	Multimeter
	(1 to 200) A (100 to 1 000) A	2.2 mA/A 2.8 mA/A	Shunt monitored with Multimeter
Inductance – Source ¹ Fixed Points 100 Hz to 10 kHz	20 mH 200 mH 1 H	23 μ H 0.23 mH 1.2 mH	Standard Inductors

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Source ¹ 100 Hz to 100 kHz	100 μ H to 10 mH (10 to 100) mH 100 mH to 10 H	23 mH/H + 0.58 · R 19 mH/H + 0.58 · R 9.2 mH/H + 0.58 · R	Precision Decade Inductor
Resistance – Source ¹	100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1G Ω (1 to 10) G Ω (10 to 100) G Ω	2.3 m Ω / Ω 5.8 m Ω / Ω 5.8 m Ω / Ω 23 m Ω / Ω 23 m Ω / Ω 23 m Ω / Ω	High Resistance Decade Substituter
Resistance – Source ¹ Fixed Points	0 Ω 1.0 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 0.10 M Ω 0.19 M Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	44 $\mu\Omega$ 97 $\mu\Omega$ 0.18 m Ω 0.25 m Ω 0.48 m Ω 1.3 m Ω 2.4 m Ω 12 m Ω 25 m Ω 0.12 Ω 0.22 Ω 1.4 Ω 2.6 Ω 22 Ω 43 Ω 0.47 k Ω 0.97 k Ω 16 k Ω	Multi-Function Calibrator
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 (110 to 330) k Ω	93 $\mu\Omega$ / Ω + 6.2 m Ω 93 $\mu\Omega$ / Ω + 12 m Ω 70 $\mu\Omega$ / Ω + 12 m Ω 70 $\mu\Omega$ / Ω + 12 m Ω 70 $\mu\Omega$ / Ω + 47 m Ω 70 $\mu\Omega$ / Ω + 47 m Ω 70 $\mu\Omega$ / Ω + 0.47 Ω 70 $\mu\Omega$ / Ω + 0.47 Ω 86 $\mu\Omega$ / Ω + 4.7 Ω 93 $\mu\Omega$ / Ω + 4.7 Ω	Multi-product Calibrator

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹	330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω	117 $\mu\Omega/\Omega$ + 43 Ω 117 $\mu\Omega/\Omega$ + 43 Ω 466 $\mu\Omega/\Omega$ + 0.43 k Ω 776 $\mu\Omega/\Omega$ + 0.43 k Ω 3.9 m Ω/Ω + 4.3 k Ω 3.9 m Ω/Ω + 13 k Ω	Multi-product Calibrator
Resistance – Source ¹ Fixed Points	100 M Ω to 100 G Ω	5.8 m Ω/Ω	Standard Resistors
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	15 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 0.5 m Ω 10 $\mu\Omega/\Omega$ + 0.5 m Ω 10 $\mu\Omega/\Omega$ + 5 m Ω 10 $\mu\Omega/\Omega$ + 50 m Ω 15 $\mu\Omega/\Omega$ + 2 Ω 50 $\mu\Omega/\Omega$ + 0.1 k Ω 0.5 m Ω/Ω + 1 k Ω 5 m Ω/Ω + 10 k Ω	Multimeter
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) $^{\circ}\text{C}$ (800 to 1000) $^{\circ}\text{C}$ (1000 to 1550) $^{\circ}\text{C}$ (1550 to 1820) $^{\circ}\text{C}$ Type C (0 to 150) $^{\circ}\text{C}$ (150 to 650) $^{\circ}\text{C}$ (650 to 1 000) $^{\circ}\text{C}$ (1 000 to 1 800) $^{\circ}\text{C}$ (1 800 to 2 316) $^{\circ}\text{C}$ Type E (-250 to -100) $^{\circ}\text{C}$ (-100 to -25) $^{\circ}\text{C}$ (-25 to 350) $^{\circ}\text{C}$ (350 to 650) $^{\circ}\text{C}$ (650 to 1 000) $^{\circ}\text{C}$ Type J (-210 to -100) $^{\circ}\text{C}$ (-100 to -30) $^{\circ}\text{C}$ (-30 to 150) $^{\circ}\text{C}$ (150 to 760) $^{\circ}\text{C}$ (760 to 1 200) $^{\circ}\text{C}$	0.36 $^{\circ}\text{C}$ 0.29 $^{\circ}\text{C}$ 0.26 $^{\circ}\text{C}$ 0.28 $^{\circ}\text{C}$ 0.26 $^{\circ}\text{C}$ 0.23 $^{\circ}\text{C}$ 0.27 $^{\circ}\text{C}$ 0.4 $^{\circ}\text{C}$ 0.66 $^{\circ}\text{C}$ 0.4 $^{\circ}\text{C}$ 0.17 $^{\circ}\text{C}$ 0.16 $^{\circ}\text{C}$ 0.17 $^{\circ}\text{C}$ 0.2 $^{\circ}\text{C}$ 0.24 $^{\circ}\text{C}$ 0.17 $^{\circ}\text{C}$ 0.16 $^{\circ}\text{C}$ 0.18 $^{\circ}\text{C}$ 0.21 $^{\circ}\text{C}$	Multi-product Calibrator

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type K		Multi-product Calibrator
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
Electrical Calibration of RTD Indicating Systems ¹	Type S		Multi-product Calibrator
	(0 to 250) °C	0.38 °C	
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	
	Type T		
	(-250 to -150) °C	0.5 °C	
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U		
	(-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	
	Pt 395, 100 Ω		
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 3926, 100 Ω		Multi-product Calibrator
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.031 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.039 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.062 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.085 °C	
	Pt 385, 1 k Ω		
	(-200 to -80) °C	0.023 °C	
	(-80 to 0) °C	0.023 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.054 °C	
	(400 to 600) °C	0.054 °C	
	(600 to 630) °C	0.18 °C	

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	PtNi 385, 120 Ω (Ni120) (-80 to 0) $^{\circ}\text{C}$ (0 to 100) $^{\circ}\text{C}$ (100 to 260) $^{\circ}\text{C}$ Cu 427, 10 Ω (-100 to 260) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$ 0.062 $^{\circ}\text{C}$ 0.11 $^{\circ}\text{C}$ 0.23 $^{\circ}\text{C}$	Multi-product Calibrator
AC Voltage – Source ¹	220 μV 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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz 220 mV to 2.2 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	0.38 mV/V + 4 μV 0.31 mV/V + 4 μV 0.31 mV/V + 4 μV 0.36 mV/V + 4 μV 0.64 mV/V + 5 μV 1.2 mV/V + 10 μV 1.5 mV/V + 20 μV 2.8 mV/V + 20 μV 0.25 mV/V + 4 μV 0.12 mV/V + 4 μV 0.1 mV/V + 4 μV 0.22 mV/V + 4 μV 0.5 mV/V + 5 μV 1.1 mV/V + 10 μV 1.4 mV/V + 20 μV 2.7 mV/V + 20 μV 0.24 mV/V + 12 μV 91 $\mu\text{V/V}$ + 7 μV 81 $\mu\text{V/V}$ + 7 μV 0.2 mV/V + 7 μV 0.46 mV/V + 17 μV 0.9 mV/V + 20 μV 1.4 mV/V + 25 μV 2.7 mV/V + 45 μV 0.24 mV/V + 40 μV 90 $\mu\text{V/V}$ + 15 μV 45 $\mu\text{V/V}$ + 8 μV 75 $\mu\text{V/V}$ + 10 μV 0.11 mV/V + 30 μV 0.42 mV/V + 80 μV 1 mV/V + 0.2 mV 1.7 mV/V + 0.3 mV	Multi-Function Calibrator

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) V		Multi-Function Calibrator
	(10 to 20) Hz	0.24 mV/V + 0.4 mV	
	(20 to 40) Hz	90 μ V/V + 0.15 mV	
	40 Hz to 20 kHz	45 μ V/V + 50 μ V	
	(20 to 50) kHz	75 μ V/V + 0.1 mV	
	(50 to 100) kHz	0.10 mV/V + 0.2 mV	
	(100 to 300) kHz	0.28 mV/V + 0.6 mV	
	(300 to 500) kHz	1 mV/V + 2 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.24 mV/V + 4 mV	
	(20 to 40) Hz	90 μ V/V + 1.5 mV	
	40 Hz to 20 kHz	53 μ V/V + 0.6 mV	
	(20 to 50) kHz	81 μ V/V + 1 mV	
AC Voltage – Source ¹	(50 to 100) kHz	0.15 mV/V + 2.5 mV	
	(100 to 300) kHz	0.9 mV/V + 16 mV	
	(300 to 500) kHz	4.4 mV/V + 40 mV	
	500 kHz to 1 MHz	8 mV/V + 80 mV	
	(220 to 1 100) V		
	(15 to 50) Hz	0.3 mV/V + 16 mV	
AC Voltage – Source ¹	50 Hz to 1 kHz	71 μ V/V + 3.5 mV	
	(750 to 1 100) V		Multi-Function Calibrator with Amplifier
	40 Hz to 1 kHz	92 μ V/V + 4 mV	
	(1 to 20) kHz	0.17 mV/V + 6 mV	
	(20 to 30) kHz	0.6 mV/V + 11 mV	
	(220 to 750) V		
AC Voltage – Measure ¹	(30 to 50) kHz	0.6 mV/V + 11 mV	
	(50 to 100) kHz	2.3 mV/V + 45 mV	
	Up to 10 mV		Multimeter
	(1 to 40) Hz	0.3 mV/V + 3 μ V	
	40 Hz to 1 kHz	0.2 mV/V + 1.1 μ V	
	(1 to 20) kHz	0.3 mV/V + 1.1 μ V	
AC Voltage – Measure ¹	(20 to 50) kHz	1 mV/V + 1.1 μ V	
	(50 to 100) kHz	5 mV/V + 1.1 μ V	
	(100 to 300) kHz	40 mV/V + 2 μ V	

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz 100 mV to 10 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 (1 to 2) MHz (10 to 100) V (1 to 40) Hz 40 Hz to 1 kHz 1 kHz 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	70 μ V/V + 4 μ V 70 μ V/V + 2 μ V 0.14 mV/V + 2 μ V 0.3 mV/V + 2 μ V 0.8 mV/V + 2 μ V 3 mV/V + 10 μ V 10 mV/V + 10 μ V 15 mV/V + 10 μ V 70 μ V/V + 0.4 mV 70 μ V/V + 0.2 mV 0.14 mV/V + 0.2 mV 0.3 mV/V + 0.2 mV 0.8 mV/V + 0.2 mV 3 mV/V + 1 mV 10 mV/V + 1 mV 15 mV/V + 1 mV 0.2 mV/V + 4 mV 0.2 mV/V + 2 mV 0.2 mV/V + 2 mV 0.35 mV/V + 2 mV 1.2 mV/V + 2 mV 4 mV/V + 10 mV 15 mV/V + 10 mV 0.4 mV/V + 40 mV 0.4 mV/V + 20 mV 0.6 mV/V + 20 mV 1.2 mV/V + 20 mV 3 mV/V + 20 mV	Multimeter
	Up to 1 kV (50, 60, 400) Hz (1 to 10) kV (50, 60) Hz	1.4 mV/V + 0.7 V 1.4 mV/V + 0.7 V	
AC Voltage – Measure ¹	Up to 1 kV (50, 60, 400) Hz (1 to 10) kV (50, 60) Hz	1.4 mV/V + 0.7 V 1.4 mV/V + 0.7 V	High Voltage Meter

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} (45 to 65) Hz PF = 1	0.1 mW to 11 kW (33 to 330) mV		Multi-Product Calibrator
	(3.3 to 9) mA	0.31 % of Watts output + 0.58R	
	(9 to 33) mA	0.2 % of Watts output + 0.58R	
	(33 to 90) mA	0.27 % of Watts output + 0.58R	
	(90 to 330) mA	0.2 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.27 % of Watts output + 0.58R	
	(0.9 to 2.2) A	0.20 % of Watts output + 0.58R	
	(2.2 to 4.5) A	0.27 % of Watts output + 0.58R	
	(4.5 to 11) A	0.2 % of Watts output + 0.58R	
	330 mV to 1 000 V		
	(3.3 to 9) mA	0.2 % of Watts output + 0.58R	
	(9 to 33) mA	0.12 % of Watts output + 0.58R	
	(33 to 90) mA	0.2 % of Watts output + 0.58R	
	(90 to 330) mA	0.12 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.2 % of Watts output + 0.58R	
	(0.9 to 2.2) A	0.12 % of Watts output + 0.58R	
	(2.2 to 4.5) A	0.16 % of Watts output + 0.58R	
	(4.5 to 11) A	0.12 % of Watts output + 0.58R	
AC Power – Source ^{1,2} (45 to 65) Hz (PF = 0 to 0.999)	0.1 mW to 11 kW (33 to 330) mV		Multi-Product Calibrator
	(3.3 to 9) mA	0.36 % of Watts output + 0.58R	
	(9 to 33) mA	0.26 % of Watts output + 0.58R	
	(33 to 90) mA	0.32 % of Watts output + 0.58R	
	(90 to 330) mA	0.26 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.32 % of Watts output + 0.58R	
	(0.9 to 2.2) A	0.26 % of Watts output + 0.58R	
	(2.2 to 4.5) A	0.32 % of Watts output + 0.58R	
	(4.5 to 11) A	0.26 % of Watts output + 0.58R	
	330 mV to 1 000 V		
	(3.3 to 9) mA	0.26 % of Watts output + 0.58R	
	(9 to 33) mA	0.21 % of Watts output + 0.58R	
	(33 to 90) mA	0.26 % of Watts output + 0.58R	
	(90 to 330) mA	0.21 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.26 % of Watts output + 0.58R	
	(0.9 to 2.2) A	0.21 % of Watts output + 0.58R	
	(2.2 to 4.5) A	0.23 % of Watts output + 0.58R	
	(4.5 to 11) A	0.21 % of Watts output + 0.58R	

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} (45 to 65) Hz PF = 1	0.33 W to 11 kW (100 to 1 000) V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.16 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R	Multi-Product Calibrator w/Amplifier
AC Power – Source ^{1,2} (45 to 65) Hz (PF = 0 to 0.999)	0.33 W to 11 kW (100 to 1 000) V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.23 % of Watts output + 0.58R 0.21% of Watts output + 0.58R	Multi-Product Calibrator w/Amplifier
AC Current – Source ¹	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 (0.22 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 (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 + 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 + 35 nA 0.12 mA/A + 35 nA 0.2 mA/A + 0.11 µA 1.1 mA/A + 0.65 µA 0.25 mA/A + 0.4 µA 0.16 mA/A + 0.35 µA 0.12 mA/A + 0.35 µA 0.2 mA/A + 0.55 µA 1.1 mA/A + 5 µA	Multi-Function Calibrator

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(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	0.25 mA/A + 4 μ A 0.16 mA/A + 3.5 μ A 0.12 mA/A + 2.6 μ A 0.2 mA/A + 3.5 μ A 1.1 mA/A + 10 μ A 0.27 mA/A + 35 μ A 0.45 mA/A + 80 μ A 7 mA/A + 0.16 mA	Multi-Function Calibrator
AC Current – Source ¹	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.48 mA/A + 0.17 mA 0.95 mA/A + 0.38 mA 3.6 mA/A + 0.75 mA	Multi-Function Calibrator w/Amplifier
AC Current – Source ¹	(10 to 16.5) A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 550) A (45 to 65) Hz (65 to 440) Hz	3.3 mA/A + 3.5 mA 9.2 mA/A + 3.5 mA 3.3 mA/A + 29 mA 9.2 mA/A + 31 mA 3.3 mA/A + 104 mA 9.2 mA/A + 115 mA	Multi-Product Calibrator w/50-turns coil
AC Current – Source ¹	(3.2 to 32) A (10 to 100) Hz (100 to 440) Hz (32 to 200) A (10 to 100) Hz (100 to 440) Hz	2.8 mA/A + 4.3 mA 6.5 mA/A + 21 mA 2.8 mA/A + 70 mA 5.7 mA/A + 194 mA	Multi-Product Calibrator with 10 turn coil
AC Current – Source ¹	(16 to 160) A (10 to 100) Hz (160 to 1000) A (10 to 100) Hz	2.8 mA/A + 22 mA 2.8 mA/A + 349 mA	Multi-Product Calibrator with 50 turn coil
AC Current – Measure ¹	Up to 100 μ A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4 mA/A + 0.03 μ A 1.5 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A	Multimeter

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	100 μ A to 1 mA (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 (50 to 100) kHz (1 to 10) mA (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 (50 to 100) kHz (10 to 100) mA (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 (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 mA/A + 0.2 μ A 1.5 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 0.31 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 4 mA/A + 0.4 μ A 5.5 mA/A + 1.5 μ A 4 mA/A + 2 μ A 1.5 mA/A + 2 μ A 0.6 mA/A + 2 μ A 0.31 mA/A + 2 μ A 0.6 mA/A + 2 μ A 4 mA/A + 4 μ A 5.5 mA/A + 15 μ A 4 mA/A + 20 μ A 1.5 mA/A + 20 μ A 0.6 mA/A + 20 μ A 0.31 mA/A + 20 μ A 0.6 mA/A + 20 μ A 4 mA/A + 40 μ A 5.5 mA/A + 0.15 mA 4 mA/A + 0.2 mA 1.6 mA/A + 0.2 mA 0.8 mA/A + 0.2 mA 1 mA/A + 0.2 mA 3 mA/A + 0.2 mA 10 mA/A + 0.4 mA	Multimeter
	(1 to 15) A 45 Hz to 1 kHz (15 to 30) A 45 Hz to 1 kHz (1 to 30) A (1 to 5) kHz	0.024 mA/A + 3.5 mA 0.041 mA/A + 3.5 mA 58 mA	

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ 50 Hz to 1 kHz	(0.33 to 0.5) nF (0.5 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 µF (1.1 to 3.3) µF (3.3 to 11) µF (11 to 33) µF (33 to 110) µF (110 to 330) µF 330 µF to 1.1 mF	3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 78 pF 1.9 mF/F + 233 pF 1.9 mF/F + 0.78 nF 2.7 mF/F + 2.3 nF 2.7 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.9 mF/F + 78 nF 5.4 mF/F + 233 nF 7.8 mF/F + 0.26 µF	Multi-Product Calibrator
Capacitance – Source ¹ Fixed Points @ 1 kHz	(1, 10, 100, 1 000) pF	0.35 mF/F + 0.58 · R	Standard Air Capacitor Set
Capacitance – Source ¹ (100 Hz to 1 kHz)	50 pF to 1 µF	5.8 mF/F + 5.8 pF	Standard Decade Capacitor
Capacitance – Measure ¹ (12 Hz to 100 kHz)	(0 to 10) pF (10 to 100) pF (100 to 1 000) pF (1 to 10) nF (10 to 100) nF (100 to 1 000) nF (1 to 10) µF (10 to 100) µF (100 to 1 000) µF	0.44 mF/F + 0.000 58 pF 0.25 mF/F + 0.005 8 pF 0.23 mF/F + 0.058 pF 0.23 mF/F + 0.58 pF 0.24 mF/F + 5.8 pF 0.23 mF/F + 58 pF 0.23 mF/F + 0.58 nF 0.23 mF/F + 5.8 nF 0.34 mF/F + 58 nF	Direct measurement using RLC Digibridge
AC Resistance – Measure ¹ (12 Hz to 100 kHz)	1 Ω to 10 MΩ	0.23 mΩ/Ω + 0.005 8 mΩ	RLC Digibridge
Inductance – Measure ¹ (12 Hz to 100 kHz)	(0 to 1) H	0.23 mH/H + 0.058 µH	RLC Digibridge
Oscilloscope ¹ Rise/Fall Time (10 to 90) % Square Wave Amplitude, < 10 kHz into 50 Ω or 1 MΩ Load Impedance	(0 to 1.25) s Up to 1 mVp-p (1 to 21) mVp-p (21 to 556) mVp-p 556 mVp-p to 210 Vp-p	1.3 ps 10 mV/V + 10 µV 1.5 mV/V + 20 µV 1.5 mV/V + 1.2 µV 1.3 mV/V + 1.2 µV	Oscilloscope Calibrator and Head

Electrical – DC/Low Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscope ¹ Vertical Deflection (Amplitude)	1 mV to 50 V (50 to 100) V (100 to 200) V	250 μ V/V + 25 μ V 250 μ V/V + 26 μ V 250 μ V/V + 63 μ V	Oscilloscope Calibrator and Head and Multimeter
Oscilloscope ¹ Horizontal Deflection (Time)	150 ps to 50 s	0.39 parts in 10 ⁶ of reading	Oscilloscope Calibrator and Head
Oscilloscope ¹ Bandwidth	0.1 Hz to 50 GHz	2.1 % of reading	Oscilloscope Calibrator, Head, and Power Sensors

Electrical – RF/Microwave

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Tuned Power – Measure ¹	(-117 to 30) dB 100 kHz to 2.6 GHz (2.6 to 18) GHz (18 to 26.5) GHz	0.17 dB 0.18 dB 0.2 dB	Measuring Receiver and Power Sensor
RF Absolute Power – Measure ¹	(-70 to 44) dBm 9 kHz to 100 MHz 100 MHz to 4 GHz (4 to 6) GHz (6 to 8) GHz (8 to 12.4) GHz (12.4 to 18) GHz (18 to 40) GHz (40 to 50) GHz	0.07 dB 0.078 dB 0.094 dB 0.09 dB 0.096 dB 0.12 dB 0.17 dB 0.19 dB	Power Meter, Measuring Receiver, Power Sensors
RF Power Meter Reference ¹	1 mW, 50 MHz	0.057 dB	Power Sensor & Frequency Counter
RF Power – Source ¹	(-145 to 30) dBm 9 kHz to 3 GHz (3 to 20) GHz (20 to 40) GHz	0.6 dB 0.81 dB 1.1 dB	Signal Generators

Electrical – RF/Microwave

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Sensors Calibration Factors ^{1,5}	Referenced at 1 mW 100 kHz to 10MHz 10 MHz to 1.2 GHz (1.2 to 6) GHz (6 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 33) GHz (33 to 40) GHz (40 to 45) GHz (45 to 50) GHz	1.4 % 1.3 % 1.4 % 1.6 % 2.1 % 2.6 % 2.9 % 3 % 4 % 4.7 %	Coaxial Thermistor, Power Sensors, Power Meter
Amplitude Modulation – Measure ¹ AM Depth Accuracy 100 kHz to 10 MHz (Rate: 50 Hz to 10 kHz) 10 MHz to 3 GHz (Rate: 50 Hz to 100 kHz) (3 to 26.5) GHz (Rate: 50 Hz to 100 kHz) Flatness 10 MHz to 3 GHz (Rate: 90 Hz to 10 kHz) (3 to 26.5) GHz (Rate: 90 Hz to 10 kHz) FM Rejection (50 Hz to 3 kHz BW) 250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz) 10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz) Residual AM 250 kHz to 26.5 GHz	Depth: (5 to 99) % Depth: (20 to 99) % Depth: (5 to 20) % Depth: (20 to 99) % Depth: (5 to 20) % Depth: (5 to 99) % Depth: (5 to 99) % Depths: < 50% Deviations: < 5 kHz Depths: < 50% Deviations: < 50 kHz (50 Hz to 3 kHz BW)	0.91 % Depth 0.61 % Depth 3 % Depth 1.8 % Depth 5.5 % Depth 0.37 % Depth 0.49 % Depth 0.17 % Depth 0.44 % Depth 0.012 % (rms)	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz (Rate: 20 Hz to 200 kHz) AM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: 200 Hz to 400 kHz AM Depths: ≤ 50% (Rate: 400 Hz or 1 kHz)	1.3 % of reading 13 Hz 25 Hz 49 Hz	PSA Series Spectrum Analyzer
Frequency Modulation – Measure ¹ Residual FM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	(50 Hz to 3 kHz BW)	1.9 Hz 3.7 Hz 7.4 Hz	PSA Series Spectrum Analyzer
Phase Modulation – Measure ¹ PM Deviation Accuracy 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz AM Rejection (50 Hz to 3 kHz BW) 100 kHz to 26.5 GHz Residual PM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad AM Depths: ≤ 50% (Rate: 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad 0.002 1 rad 0.004 1 rad 0.008 1 rad	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Source ¹ AM Depth Error 100 kHz to 26.5 GHz (f_{mod} : 1 kHz) AM Distortion 100 kHz to 26.5 GHz (f_{mod} : 1 kHz)	Depth: (5 to 80) % Depth: 30 % Depth: 80 %	3.5 % of reading + 1.2 % Depth 1.2 % Depth 2.3 % Depth	Signal Generator
Frequency Modulation – Source ¹ FM Deviation Error 100 kHz to 26.5 GHz (f_{mod} : 10 kHz)	Deviations: ≤ 20 MHz	1.7 % of reading + 23 Hz	Signal Generator
Frequency Modulation – Source ¹ FM Distortion 100 kHz to 26.5 GHz (f_{mod} : 10 kHz)	Deviations: ≤ 4 MHz	0.12 % of reading	Signal Generator
Phase Modulation – Source ¹ PM Deviation Error 100 kHz to 26.5 GHz (f_{mod} : 10 kHz) PM Distortion 100 kHz to 26.5 GHz (f_{mod} : 10 kHz)	Deviations: ≤ 40 rad Deviations: ≤ 40 rad	1.7 % of reading + 0.003 5 rad 0.12 % of reading	Signal Generator
Reflection S_{11}/S_{22} – Measure, Type N ¹	Magnitude (0 to 110) dB (30 to 300) kHz 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz Phase (-180 to 180) ° 30 kHz to 3 GHz (3 to 6) GHz	0.025 dB 0.026 dB 0.033 dB 0.094 dB 0.073 ° 0.25 °	Network Analyzer and Calibration Kit
Transmission S_{12}/S_{21} – Measure, Type N ¹	Magnitude (0 to 110) dB (30 to 300) kHz 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz Phase (-180 to 180) ° 30 kHz to 3 GHz (3 to 6) GHz	0.029 dB 0.028 dB 0.039 dB 0.089 dB 0.073 ° 0.25 °	Network Analyzer and Calibration Kit

Electrical – RF/Microwave

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Distortion – Measure ¹ 20 Hz to 20 kHz 20 Hz to 50 kHz (50 to 100) kHz	80 kHz BW: -80 dB 500 kHz BW: -70 dB 500 kHz BW: -65 dB	0.16 dB 0.33 dB 0.33 dB	Audio Analyzer
Harmonic Distortion ¹ (Source and Measure) 1 kHz to 26.5 GHz	(-100 to 0.01) dB	1.2 dB	Spectrum Analyzer
Phase Noise ¹ (Source and Measure) 100 Hz to 10 MHz Offset carrier ≤ 100 kHz	(-70 to -120) dBc	1.2 dB	Signal Generator Spectrum Analyzer

Length – Dimensional Metrology

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 1 000 mm	$(0.17 + 0.006\ 8l)\ \mu\text{m} + 0.58R$	Gage blocks and Caliper checker
Height Gages ^{1,2}	Up to 1 000 mm	$(0.71 + 0.001\ 8l)\ \mu\text{m} + 0.58R$	Gage Blocks and Caliper Checker
Micrometers ^{1,2} External, Internal, Depth, Bore	Length Up to 1 000 mm Flatness Up to 15 μm Parallelism Up to 15 μm	$(0.088 + 0.006\ 9l)\ \mu\text{m} + 0.58R$ 0.13 μm 0.15 μm	Gauge Blocks, Optical Parallels, Surface Plate, Ring Gages, Gage Block Accessories, Calibration Tester
Rules & Tapes ²	Up to 1 000 mm (1 000 to 50 000) mm	$(17 + 0.011l)\ \mu\text{m}$ $(0.028l)\ \mu\text{m}$	Scale and Tape Calibrator
Indicators ^{1,2} Dial Gauge, Dial Test Indicator	Up to 1 mm (1 to 100) mm	0.39 μm $(0.68 + 0.009l)\ \mu\text{m}$	Universal Measuring Machine, Indicator Tester
LVDTs ²	Up to 100 mm	$(0.069 + 0.003\ 4l)\ \mu\text{m}$	Gage Block, Comparator Stand
Plain Plug Gages / Pin Gages / Thread Wires ^{1,2} (Cylindrical and Taper)	Up to 300 mm	$(0.4 + 0.001\ 6l)\ \mu\text{m}$	Universal Length Measuring Machine & Gauge Blocks
Plain Ring Gages ² (Cylindrical and Taper)	(1 to 300) mm	$(0.35 + 0.002l)\ \mu\text{m}$	Universal Measuring Machine, Gage Blocks, Master Ring Gages

Length – Dimensional Metrology

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Plug Gages ² (Cylindrical and Taper) Major Diameter Simple Pitch Diameter	Up to 150 mm Up to 150 mm	$(0.41 + 0.001\ 4l)\ \mu\text{m}$ $(1.5 + 0.007l)\ \mu\text{m}$	Universal Measuring Machine, Gage Block, Thread Measuring Wires
Thread Ring Gages ² (Cylindrical and Taper) Minor Diameter Simple Pitch Diameter	(3 to 150) mm (3 to 150) mm	$(0.39 + 0.002\ 6l)\ \mu\text{m}$ $(1.3 + 0.005l)\ \mu\text{m}$	Universal Measuring Machine, Gage Block, Master Ring Gage, Thread Calibration Standards
Setting Rod, Micrometer Standard, Length Standards ²	Up to 300 mm	$(0.49 + 0.002\ 5l)\ \mu\text{m}$	Gage block, Universal Measuring Machine
Snap Gages ² External / Internal	Up to 300 mm	$(0.32 + 0.002\ 8l)\ \mu\text{m}$	Universal Measuring Machine, Gage Blocks, Master Ring
Thickness Gauge / Feeler Gauge ²	Up to 25 mm	$(0.4 + 0.000\ 6l)\ \mu\text{m}$	Universal Measuring Machine, Gage Blocks
Gage Block – Length ²	(0.5 to 100) mm (100 to 300) mm	$(0.35 + 0.003\ 5l)\ \mu\text{m}$ $(0.28 + 0.009\ 8l)\ \mu\text{m}$	Gage block, Universal Measuring Machine
Universal Length Measuring Machine (ULM) ^{1,2}	Up to 100 mm (100 to 300) mm	$(0.056 + 0.002\ 8l)\ \mu\text{m}$ $(0.033 + 0.003\ 1l)\ \mu\text{m}$	Gage Blocks
Standard Scale ²	Up to 300 mm	$(1 + 0.003\ 4l)\ \mu\text{m}$	Video Measuring System / Standard Scale
Optical Comparators and Vision Systems/Measuring Microscopes ^{1,2} X, Y, Z Axis	Up to 300 mm	$(1.2 + 0.008l)\ \mu\text{m}$	Standard scales and Gage Blocks
Surface Plates ^{1,2} Repeat Reading (Local Area Flatness Only)	(150 to 3 600) mmD (0 to 0.13) mmV	0.6 μm	Repeat-O-Meter
Roughness Tester ¹	Up to 3 μm Ra	0.1 μm	Roughness standard

Mass and Mass Related

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure ^{1,2}	(-14.5 to 0) psi (0 to 5 800) psi (5 800 to 10 000) psi	0.027 % of reading + 0.58R 0.027 % of reading + 0.58R 0.052 % of reading	Pressure Calibrator, Pressure Modules
Torque Tools ¹	Up to 1 500 N·m	0.67 % of reading + 0.058 mN·m	Torque Testers
Torque Testers ²	Up to 5 N·m (5 to 10) N·m (10 to 25) N·m (25 to 50) N·m	0.093 % of reading + 0.58R 0.093 % of reading 0.049 % of reading 0.066 % of reading	Torque Calibration Wheel with Standard Weights
Scales & Balances ^{1,3} (Platform & Spring)	Up to 5 mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g 100 g to 20 kg (20 to 100) kg	0.010 mg 0.013 mg 0.015 mg 0.020 mg 0.026 mg 0.031 mg 0.041 mg 0.051 mg 0.061 mg 0.082 mg 0.10 mg 0.13 mg 0.15 mg 2.6×10^{-6} kg/kg 25×10^{-6} kg/kg	Standard weights
Mass (Weights)	(1 to 5) mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 100 g to 15 kg	0.01 mg 0.013 mg 0.015 mg 0.02 mg 0.026 mg 0.031 mg 0.041 mg 0.051 mg 0.062 mg 0.082 mg 0.1 mg 0.13 mg 0.16 mg 0.3 mg 0.000 3 % of reading	Standard Weight and Electronic Balance
Air Velocity	(1 to 20) m/s	1.1 % of reading	Air Velocity Meter

Mass and Mass Related

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pipettes & Micropipettes, Burette ¹	Up to 20 μ L (20 to 50) μ L (50 to 100) μ L (100 to 200) μ L 200 μ L to 10 mL (10 to 20) mL (20 to 2 000) mL	0.02 μ L 0.043 % of reading 0.026 % of reading 0.019 % of reading 0.015 % of reading 0.014 % of reading 0.012 % of reading	Analytical Scale Standard Weights
Volumetric Flask ¹	Up to 10 mL (10 to 20) mL (20 to 2 000) mL	0.001 5 mL 0.014 % of reading 0.012 % of reading	Analytical Scale Standard Weights
Force and Load Cell ^{1,2} (Compression and Tension)	Up to 10 N (10 to 20) N (20 to 50) N (50 to 1 000) N	0.01 % of reading + 0.58R 0.007 4 % of reading 0.006 4 % of reading 0.006 2 % of reading	Standard Weights

Photometry and Radiometry

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power Measure ¹ (700 to 1800) nm	(-110 to 10) dB	0.13 dB	Optical Test System
Optical Wavelength Measure ¹	(700 to 1 650) nm	1.2 parts in 10 ⁶ of reading	Wavelength Meter
Fiber Optic Wavelength Source ¹	(1 510 to 1 540) nm	0.13 pm	NIST Wavelength SRM
UV Light Meter	(0.1 to 50) mW/cm ²	3 % of reading	UV Light Source w/_UV Meter
Lux Meter	(0.01 to 200 000) lux	2.3 % of reading	Incandescent Lamp & Illumia Sphere by Comparison to Standard Lux Meter

Thermodynamic

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature ¹	(-50 to 0) °C (0 to 100) °C (100 to 400) °C	0.059 °C 0.04 °C 0.04 °C	Thermometer, PRT

Thermodynamic

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Radiation (Infrared) Thermometers ¹	50 °C (50 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C	0.39 °C 0.62 °C 1.4 °C 2 °C 2.5 °C	Black Body Calibrator $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Relative Humidity ¹	(10 to 40) %RH (40 to 75) %RH (75 to 95) %RH	1.4 %RH 1.5 %RH 1.8 %RH	Humidity Meter w/ Humidity Generator
Relative Humidity ^{1,3} Fixed Points	11 %RH 33 %RH 75 %RH 97 %RH	0.98 %RH 1.1 %RH 1.4 %RH 2.4 %RH	Standard Salt Solutions
Chamber / Oven Temperature – Measure ¹	(-40 to 300) °C	1.5 °C	Datalogger and Thermocouples
Chamber / Oven Humidity – Measure ¹	(10 to 40) %RH (40 to 75) %RH (75 to 95) %RH	1.4 %RH 1.5 %RH 1.8 %RH	Humidity Meter

Time and Frequency

Penang, Malaysia

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source ¹	10 MHz	6.2×10^{-12} Hz/Hz	GPS Receiver and Signal Generator
	0.01 Hz to 40 GHz	6.3×10^{-12} Hz/Hz	
Frequency – Measure	0.01 Hz to 26.5 GHz	6.3×10^{-10} Hz/Hz	GPS Receiver and Counter
Tachometer ^{1,2}	Up to 100 000 rpm	0.000 27 % of reading + 0.58R	Multi-Product Calibrator, Signal Generator with Lamp

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

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CALIBRATION AND DIMENSIONAL MEASUREMENT

CALIBRATION

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meters ¹	94 dB (31.5 to 4 000) Hz (4 000 to 8 000) Hz	0.6 dB 0.76 dB	Comparison to Standard Sound Level Meter
Sound Calibrators ¹	94 dB (31.5 to 4 000) Hz (4 000 to 8 000) Hz	0.6 dB 0.76 dB	Comparison to Standard Sound Level Meter

Chemical Quantities

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Fixed points Conductivity Meters ¹	84 µS/cm 146.48 µS/cm 1 408.2 µS/cm 1 413 µS/cm 12 850 µS/cm 12 880 µS/cm	0.46 µS/cm 0.81 µS/cm 7.8 µS/cm 7.8 µS/cm 71 µS/cm 71 µS/cm	Comparison to Standard Solutions
Conductivity Indicators ¹	Up to 15 µS/cm (15 to 150) µS/cm (150 to 1 500) µS/cm	0.16 µS/cm 1 µS/cm 8 µS/cm	Standard Conductivity Meter
pH Measuring Equipment ¹	(4, 7, 10) pH	0.013 pH unit	Comparison to Standard Solutions

Chemical Quantities

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calibration of Gas Analyzers and Gas Detectors			
CH ₄ in Air	(0.5 to 3.5) cmol/mol	1 % of reading + 0.58R	Comparison to Gas Reference Material
CO in Air	(70 to 700) μmol/mol	1 % of reading + 0.58R	
CO ₂ in N ₂	(500 to 4 500) μmol/mol	1 % of reading + 0.58R	
H ₂ S in N ₂	(10 to 90) μmol/mol	1 % of reading + 0.58R	
NH ₄ in N ₂	(10 to 90) μmol/mol	2 % of reading + 0.58R	
O ₂ in N ₂	(5 to 45) cmol/mol	0.67 % of reading + 0.58R	
CH ₂ O in N ₂	1.20 μmol/mol	3 % of reading	

Electrical – DC/Low Frequency

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage Source ¹	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	8 μV/V + 2 μV 5 μV/V + 3 μV 4 μV/V + 5 μV 4 μV/V + 8 μV 5 μV/V + 62 μV 7 μV/V + 470 μV	Multiproduct Calibrator
DC Voltage Measure ¹	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1 000) V	11 μV/V + 6 μV 10 μV/V + 2 μV 10 μV/V + 2 μV 12 μV/V + 2 μV 12 μV/V + 6 μV	Multimeter
DC Voltage Measure ^{1,2} High Voltage	(1 to 40) kV	2 mV/V + 0.58R	High Voltage Probe with Multimeter
DC Current Source ¹	(0 to 0.22) mA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	40 μA/A + 6 nA 35 μA/A + 7 nA 35 μA/A + 40 nA 47 μA/A + 0.7 μA 98 μA/A + 12 μA	Multiproduct Calibrator
	(2.2 to 11) A	360 μA/A + 480 μA	Multi-Function Calibrator with Amplifier
	(11 to 16.5) A (16.5 to 550) A	2.9 mA/A + 58 mA 3 mA/A + 58 mA	Multiproduct Calibrator with 50 turn coil

Electrical – DC/Low Frequency

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current Measure ¹	(0 to 100) nA 100 nA to 1 μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	36 μ A/A + 50 pA 25 μ A/A + 50 pA 25 μ A/A + 121 pA 25 μ A/A + 1 nA 25 μ A/A + 7 nA 25 μ A/A + 68 nA 41 μ A/A + 0.7 μ A 128 μ A/A + 14 μ A	Multimeter
	(1 to 1 000) A	0.2 mA/A + 0.5 mA	Multimeter with Shunts
DC Power – Source ^{1,2}	0.1 mW to 11 kW (33 mV to 1 020 V) (3.3 to 330) mA 330 mA to 4.5 A (4.5 to 11) A	0.039 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.067 % of Watts output + 0.58R	Multi-Product Calibrator w/Amplifier
Inductance Source ¹ (0.1 to 1) kHz	1.0 mH 100 mH 10 H	1.2 μ H 120 μ H 12 mH	Standard Inductor
Inductance Measure ¹ 12 Hz to 100 kHz	(0 to 10) H	0.23 mH/H + 0.058 μ H	RLC Digibridge
Resistance Source ¹ Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω	40 $\mu\Omega$ 96 $\mu\Omega$ 185 $\mu\Omega$ 240 $\mu\Omega$ 460 $\mu\Omega$ 1.3 m Ω 2.4 m Ω 11 m Ω 21 m Ω	Multiproduct Calibrator
Resistance Source ¹ Fixed Points	10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	110 m Ω 210 m Ω 1.3 Ω 2.5 Ω 22 Ω 45 Ω 440 Ω 1.1 k Ω 11 k Ω	Multiproduct Calibrator

Electrical – DC/Low Frequency

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance Source ¹	(0 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 (110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω	93 $\mu\Omega/\Omega$ + 6.2 m Ω 93 $\mu\Omega/\Omega$ + 12 m Ω 70 $\mu\Omega/\Omega$ + 12 m Ω 70 $\mu\Omega/\Omega$ + 12 m Ω 70 $\mu\Omega/\Omega$ + 47 m Ω 70 $\mu\Omega/\Omega$ + 47 m Ω 70 $\mu\Omega/\Omega$ + 0.47 Ω 70 $\mu\Omega/\Omega$ + 0.47 Ω 86 $\mu\Omega/\Omega$ + 4.7 Ω 93 $\mu\Omega/\Omega$ + 4.7 Ω 117 $\mu\Omega/\Omega$ + 43 Ω 117 $\mu\Omega/\Omega$ + 43 Ω 466 $\mu\Omega/\Omega$ + 0.43 k Ω 776 $\mu\Omega/\Omega$ + 0.43 k Ω 3.9 m Ω/Ω + 4.3 k Ω 3.9 m Ω/Ω + 13 k Ω	Multiproduct Calibrator
Resistance – Source ¹	100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω (0.1 to 1) G Ω (1 to 10) G Ω (10 to 100) G Ω	0.7 m Ω/Ω 0.7 m Ω/Ω 1 m Ω/Ω 2 m Ω/Ω 7 m Ω/Ω 13 m Ω/Ω	Resistance Box
Resistance Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	18 $\mu\Omega/\Omega$ + 68 $\mu\Omega$ 15 $\mu\Omega/\Omega$ + 0.7 m Ω 13 $\mu\Omega/\Omega$ + 0.7 m Ω 13 $\mu\Omega/\Omega$ + 7 m Ω 13 $\mu\Omega/\Omega$ + 68 m Ω 18 $\mu\Omega/\Omega$ + 5 Ω 61 $\mu\Omega/\Omega$ + 135 Ω 584 $\mu\Omega/\Omega$ + 2 k Ω 5.8 m Ω/Ω + 14 k Ω	Multimeter
Grounding Resistance ¹	10 m Ω	5.8 m Ω	Standard Resistor
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) $^{\circ}\text{C}$ (800 to 1 000) $^{\circ}\text{C}$ (1 000 to 1 550) $^{\circ}\text{C}$ (1 550 to 1 820) $^{\circ}\text{C}$	0.36 $^{\circ}\text{C}$ 0.29 $^{\circ}\text{C}$ 0.26 $^{\circ}\text{C}$ 0.28 $^{\circ}\text{C}$	Multiproduct Calibrator

Electrical – DC/Low Frequency

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type C		Multiproduct Calibrator
	(0 to 150) °C	0.26 °C	
	(150 to 650) °C	0.23 °C	
	(650 to 1 000) °C	0.27 °C	
	(1 000 to 1 800) °C	0.4 °C	
	(1 800 to 2 316) °C	0.66 °C	
	Type E		
	(-250 to -100) °C	0.4 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 350) °C	0.16 °C	
	(350 to 650) °C	0.17 °C	
	(650 to 1 000) °C	0.2 °C	
	Type J		
	(-210 to -100) °C	0.24 °C	
	(-100 to -30) °C	0.17 °C	
	(-30 to 150) °C	0.16 °C	
	(150 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.21 °C	
	Type K		
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	

Electrical – DC/Low Frequency

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	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 Type U (-200 to 0) °C (0 to 600) °C	0.38 °C 0.3 °C 0.31 °C 0.37 °C 0.5 °C 0.22 °C 0.17 °C 0.16 °C 0.45 °C 0.24 °C	Multiproduct Calibrator
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 100 Ω (-200 to -80) °C (-80 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 -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C Pt 3916, 100 Ω (-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.039 °C 0.039 °C 0.054 °C 0.07 °C 0.078 °C 0.093 °C 0.18 °C 0.039 °C 0.039 °C 0.054 °C 0.07 °C 0.078 °C 0.093 °C 0.19 °C 0.031 °C 0.039 °C 0.047 °C 0.054 °C 0.062 °C 0.07 °C 0.078 °C 0.18 °C	Multiproduct Calibrator

Electrical – DC/Low Frequency

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 200 Ω		Multiproduct Calibrator
	(-200 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.093 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.12 $^{\circ}\text{C}$	
	Pt 385, 500 Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.085 $^{\circ}\text{C}$	
	Pt 385, 1 k Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	
AC Voltage – Source ¹	(-80 to 0) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	Multiproduct Calibrator
	(0 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.18 $^{\circ}\text{C}$	
	PtNi 385, 120 Ω (Ni120)		
	(-80 to 0) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	Cu 427, 10 Ω		
	(-100 to 260) $^{\circ}\text{C}$	0.23 $^{\circ}\text{C}$	
	Up to 2.2 mV		
	(10 to 20) Hz	240 $\mu\text{V/V} + 4 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 4 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 4 \mu\text{V}$	
	(20 to 50) kHz	200 $\mu\text{V/V} + 4 \mu\text{V}$	
	(50 to 100) kHz	500 $\mu\text{V/V} + 5 \mu\text{V}$	
	(100 to 300) kHz	1.1 mV/V + 10 μV	
	(300 to 500) kHz	1.4 mV/V + 20 μV	
	500 kHz to 1 MHz	2.7 mV/V + 20 μV	

Electrical – DC/Low Frequency

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) mV		Multiproduct Calibrator
	(10 to 20) Hz	240 $\mu\text{V/V} + 4 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 4 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 4 \mu\text{V}$	
	(20 to 50) kHz	200 $\mu\text{V/V} + 4 \mu\text{V}$	
	(50 to 100) kHz	500 $\mu\text{V/V} + 5 \mu\text{V}$	
	(100 to 300) kHz	1.1 mV/V + 10 μV	
	(300 to 500) kHz	1.4 mV/V + 20 μV	
	500 kHz to 1 MHz	2.7 mV/V + 20 μV	
	(22 to 220) mV		
	(10 to 20) Hz	240 $\mu\text{V/V} + 12 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 8 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 8 \mu\text{V}$	
	(20 to 50) kHz	207 $\mu\text{V/V} + 10 \mu\text{V}$	
	(50 to 100) kHz	463 $\mu\text{V/V} + 22 \mu\text{V}$	
	(100 to 300) kHz	0.9 mV/V + 26 μV	
	(300 to 500) kHz	1.4 mV/V + 30 μV	
	500 kHz to 1 MHz	2.7 mV/V + 48 μV	
	220 mV to 2.2 V		
	(10 to 20) Hz	296 $\mu\text{V/V} + 53 \mu\text{V}$	
	(20 to 40) Hz	104 $\mu\text{V/V} + 23 \mu\text{V}$	
	40 Hz to 20 kHz	46 $\mu\text{V/V} + 9 \mu\text{V}$	
	(20 to 50) kHz	83 $\mu\text{V/V} + 12 \mu\text{V}$	
	(50 to 100) kHz	115 $\mu\text{V/V} + 33 \mu\text{V}$	
	(100 to 300) kHz	503 $\mu\text{V/V} + 95 \mu\text{V}$	
	(300 to 500) kHz	1 mV/V + 243 μV	
	500 kHz to 1 MHz	1.7 mV/V + 458 μV	
	(2.2 to 22) V		
	(10 to 20) Hz	296 $\mu\text{V/V} + 529 \mu\text{V}$	
	(20 to 40) Hz	104 $\mu\text{V/V} + 183 \mu\text{V}$	
	40 Hz to 20 kHz	46 $\mu\text{V/V} + 61 \mu\text{V}$	
	(20 to 50) kHz	83 $\mu\text{V/V} + 122 \mu\text{V}$	
	(50 to 100) kHz	106 $\mu\text{V/V} + 243 \mu\text{V}$	
	(100 to 300) kHz	390 $\mu\text{V/V} + 794 \mu\text{V}$	
	(300 to 500) kHz	1 mV/V + 2.3 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.6 mV	

Electrical – DC/Low Frequency

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(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 (15 to 50) Hz 50 Hz to 1 kHz	296 $\mu\text{V/V} + 5.3 \text{ mV}$ 104 $\mu\text{V/V} + 1.8 \text{ mV}$ 52 $\mu\text{V/V} + 0.7 \text{ mV}$ 87 $\mu\text{V/V} + 1.1 \text{ mV}$ 154 $\mu\text{V/V} + 3 \text{ mV}$ 1 $\text{mV/V} + 16 \text{ mV}$ 4.5 $\text{mV/V} + 40 \text{ mV}$ 8 $\text{mV/V} + 80 \text{ mV}$ 346 $\mu\text{V/V} + 16 \text{ mV}$ 70 $\mu\text{V/V} + 3.5 \text{ mV}$	Multiproduct Calibrator
AC Voltage – Measure ¹	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz 100 mV to 10 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 (1 to 2) MHz	353 $\mu\text{V/V} + 7.7 \mu\text{V}$ 241 $\mu\text{V/V} + 7 \mu\text{V}$ 353 $\mu\text{V/V} + 7 \mu\text{V}$ 1.2 $\text{mV/V} + 7 \mu\text{V}$ 5.8 $\text{mV/V} + 7 \mu\text{V}$ 46 $\text{mV/V} + 7.3 \mu\text{V}$ 88 $\mu\text{V/V} + 4.6 \mu\text{V}$ 88 $\mu\text{V/V} + 2.3 \mu\text{V}$ 165 $\mu\text{V/V} + 2.3 \mu\text{V}$ 348 $\mu\text{V/V} + 2.3 \mu\text{V}$ 924 $\mu\text{V/V} + 2.3 \mu\text{V}$ 3.5 $\text{mV/V} + 12 \mu\text{V}$ 12 $\text{mV/V} + 12 \mu\text{V}$ 18 $\text{mV/V} + 12 \mu\text{V}$ 88 $\mu\text{V/V} + 463 \mu\text{V}$ 88 $\mu\text{V/V} + 234 \mu\text{V}$ 165 $\mu\text{V/V} + 234 \mu\text{V}$ 348 $\mu\text{V/V} + 234 \mu\text{V}$ 924 $\mu\text{V/V} + 234 \mu\text{V}$ 3.5 $\text{mV/V} + 1.2 \text{ mV}$ 12 $\text{mV/V} + 1.2 \text{ mV}$ 18 $\text{mV/V} + 1.2 \text{ mV}$	Multimeter in Synchronous sub-sampled mode

Electrical – DC/Low Frequency

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(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	234 μ V/V + 4.6 mV 234 μ V/V + 2.3 mV 234 μ V/V + 2.3 mV 406 μ V/V + 2.3 mV 1.4 mV/V + 2.3 mV 4.6 mV/V + 12 mV 18 mV/V + 12 mV 463 μ V/V + 47 mV 463 μ V/V + 24 mV 694 μ V/V + 24 mV 1.4 mV/V + 24 mV 3.5 mV/V + 24 mV	Multimeter in Synchronous sub-sampled mode
AC Voltage – Measure ^{1,2} High Voltage	(1 to 28) kV rms 60 Hz	2 mV/V + 0.58R	High Voltage Probe
AC Current – Source ¹	Up to 220 μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (0.22 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 (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	250 μ A/A + 16 nA 160 μ A/A + 10 nA 120 μ A/A + 8 nA 280 μ A/A + 12 nA 1.1 mA/A + 65 nA 250 μ A/A + 40 nA 160 μ A/A + 35 nA 120 μ A/A + 35 nA 200 μ A/A + 110 nA 1.1 mA/A + 650 nA 250 μ A/A + 400 nA 160 μ A/A + 350 nA 120 μ A/A + 350 nA 200 μ A/A + 550 nA 1.1 mA/A + 5 μ A 250 μ A/A + 4 μ A 160 μ A/A + 4 μ A 120 μ A/A + 3 μ A 200 μ A/A + 4 μ A 1.1 mA/A + 10 μ A	Multiproduct Calibrator

Electrical – DC/Low Frequency

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	260 μ A/A + 35 μ A 450 μ A/A + 80 μ A 7 mA/A + 160 μ A	Multiproduct Calibrator
	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	460 μ A/A + 170 μ A 950 μ A/A + 380 μ A 3.6 mA/A + 750 μ A	Multi-Function Calibrator w/Amplifier
	(11 to 550) A (45 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz	13 mA/A + 0.13 A 42 mA/A + 0.15 A 233 mA/A + 0.18 A	Multi-Product Calibrator w/50-turn coil
AC Current – Measure ¹	Up to 100 μ A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 100 μ A to 1 mA (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 (50 to 100) kHz (1 to 10) mA (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 (50 to 100) kHz (10 to 100) mA (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 (50 to 100) kHz	4.6 mA/A + 0.035 μ A 1.7 mA/A + 0.035 μ A 0.7 mA/A + 0.035 μ A 0.7 mA/A + 0.035 μ A 4.6 mA/A + 0.23 μ A 1.7 mA/A + 0.23 μ A 0.7 mA/A + 0.23 μ A 0.4 mA/A + 0.23 μ A 0.7 mA/A + 0.23 μ A 4.6 mA/A + 0.46 μ A 6.4 mA/A + 1.7 μ A 4.6 mA/A + 2.3 μ A 1.7 mA/A + 2.3 μ A 0.7 mA/A + 2.3 μ A 0.4 mA/A + 2.3 μ A 0.7 mA/A + 2.3 μ A 4.6 mA/A + 4.6 μ A 6.4 mA/A + 17 μ A 4.6 mA/A + 23 μ A 1.7 mA/A + 23 μ A 0.7 mA/A + 23 μ A 0.4 mA/A + 23 μ A 0.7 mA/A + 23 μ A 4.6 mA/A + 46 μ A 6.4 mA/A + 0.17 mA	Multimeter in Synchronous sub-sampled mode

Electrical – DC/Low Frequency

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	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	4.6 mA/A + 0.23 mA 1.8 mA/A + 0.23 mA 0.9 mA/A + 0.23 mA 1.2 mA/A + 0.23 mA 3.5 mA/A + 0.23 mA 12 mA/A + 0.46 mA	Multimeter in Synchronous sub-sampled mode
AC Current – Measure ¹	(1 to 2 500) A 50 Hz	4 mA/A + 0.058 A	Current Probe
AC Current – Measure ¹	Up to 10 A (45, 60) Hz, 1 kHz	0.1 mA/A + 0.058 mA	AC/DC Current Meter
AC Power – Source ^{1,2} (45 to 65) Hz PF = 1	0.1 mW to 11 kW (33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A 0.1 mW to 11 kW 330 mV to 1 000 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.31 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.27 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.27 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.27 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.16 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R	Multi-Product Calibrator
AC Power – Source ^{1,2} (45 to 65) Hz (PF = 0 to 0.999)	0.1 mW to 11 kW (33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.36 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.32 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.32 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.32 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.32 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R	Multi-Product Calibrator

Electrical – DC/Low Frequency

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} (45 to 65) Hz (PF = 0 to 0.999)	0.1 mW to 11 kW 330 mV to 1 000 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.23 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R	Multi-Product Calibrator
AC Power – Source ^{1,2} (45 to 65) Hz PF = 1	0.33 mW to 11 kW (100 to 1 000) V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.16 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R	Multi-Product Calibrator w/Amplifier
AC Power – Source ^{1,2} (45 to 65) Hz (PF = 0 to 0.999)	0.33 mW to 11 kW (100 to 1 000) V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.23 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R	Multi-Product Calibrator w/Amplifier

Electrical – DC/Low Frequency

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ 50 Hz to 1 kHz	(0.19 to 0.5) nF (0.5 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (0.33 to 1.1) μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F (0.33 to 1.1) mF	3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 78 pF 1.9 mF/F + 233 pF 1.9 mF/F + 0.78 nF 2.7 mF/F + 2.3 nF 2.7 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.9 mF/F + 78 nF 5.4 mF/F + 233 nF 7.8 mF/F + 0.26 μ F	Multiproduct Calibrator
Capacitance Source ^{1,2} Fixed Values @ 1 kHz	(1,10,100,1 000) pF (10,100) nF 1 μ F	0.35 mF/F + 0.58R 0.062 mF/F + 0.58R 0.062 mF/F + 0.58R	Standard capacitor sets
Capacitance - Measure ¹ 12 Hz to 100 kHz	(0 to 1 000) μ F	1.4 mF/F + 0.000 58 pF	RLC Digibridge
Oscilloscope ¹ Square Wave Amplitude, < 10 kHz into 50 Ω or 1 M Ω Load Impedance	(0 to 1) mV(p-p) (1 to 21) mV(p-p) (21 to 556) mV(p-p) (556 mV to 210 V) (p-p)	10 mV/V + 10 μ V 1.5 mV/V + 20 μ V 1.5 mV/V + 1.2 μ V 1.3 mV/V + 1.2 μ V	Oscilloscope Calibrator
Oscilloscope ¹ Vertical Deflection (Amplitude)	$\pm$ (1 mV to 50 V) $\pm$ (50 V to 100 V) $\pm$ (100 V to 200 V)	250 μ V/V + 25 μ V 250 μ V/V + 26 μ V 250 μ V/V + 63 μ V	Oscilloscope Calibrator
Oscilloscope ¹ Horizontal Deflection (Time)	150 ps to 50 s	0.39 parts in 10 ⁶ of reading	Oscilloscope Calibrator
Oscilloscope ¹ Bandwidth	0.1 Hz to 3.2 GHz 3.2 GHz to 50GHz	2.1 % of reading 6 % of reading	Oscilloscope Calibrator w/ Calibration Head, Signal Generator, Power Sensor
Oscilloscopes ¹ Rise/ Fall Time, (10 to 90) %	(0 to 1.25) s	1.3 ps	Oscilloscope Calibrator w/ Calibration Head

Electrical – RF/Microwave

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
SINAD	(0 to 99.99) dB 20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.4 dB	Audio Analyzer
Source Phase Noise Offset carrier= 10 kHz	(-120 to -70) dBc/Hz 1 MHz to 26.5 GHz	1.2 dB/Hz	Measuring Receiver, Power Meter, Power Sensor
Spectrum Analyzer-Measure			
Spurious Responses	(-80 to 10) dB 10 MHz to 26.5 GHz	0.23 dB	Measuring Receiver, Power Meter, Power Sensor, RF Attenuator, Counter
Second Harmonic Distortion		0.22 dB	
Third Order Intermodulation Distortion		0.26 dB	
Gain Compression		0.073 dB	
Frequency Response	(-80 to 10) dBm 50MHz	0.13 dB	
Display Scale Fidelity		0.085 dB	
DC FM Carrier Offset	(0 to 0.5) % offset Dev 1 kHz	0.005 8 % of reading	
RF Tuned Power, Relative Measure ¹	10kHz to 18GHz 0.00 dB (-10.00 to 0) dB (-20.00 to -10.00) dB (-30.00 to -20.00) dB (-40.00 to -30.00) dB (-50.00 to -40.00) dB (-60.00 to -50.00) dB (-70.00 to -60.00) dB (-80.00 to -70.00) dB (-90.00 to -80.00) dB (-100.00 to -90.00) dB (-110.00 to -100.00) dB (-120.00 to -110.00) dB (-130.00 to -120.00) dB (-140.00 to -130.00) dB	0.017 dB 0.024 dB 0.03 dB 0.036 dB 0.041 dB 0.048 dB 0.063 dB 0.069 dB 0.073 dB 0.078 dB 0.083 dB 0.088 dB 0.23 dB 0.65 dB 1.4 dB	Measuring Receiver (Spectrum Analyzer, Power Meter, Power Sensor)

Electrical – RF/Microwave

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Tuned Power, Relative Measure ¹	(18 to 50) GHz: (-1 to -35) dB -1dB to 15dB 15dB to 20dB	0.053 dB 0.059 dB 0.067 dB	Power Meter, Power Sensor
RF Power, Absolute Measure ¹	9 kHz to 6 GHz: (-30 to 20) dBm	0.15 dB	Power Meter, Power Sensor
	10 MHz to 2 GHz (-40 to -30) dBm	0.15 dB	Measuring Receiver (Spectrum Analyzer, Power Meter, Power Sensor)
	(-50 to -40) dBm	0.15 dB	
	(-60 to -50) dBm	0.16 dB	
	(-70 to -60) dBm	0.16 dB	
	(-80 to -70) dBm	0.17 dB	
	(-90 to -80) dBm	0.17 dB	
	(-100 to -90) dBm	0.18 dB	
	(-110 to -100) dBm	0.18 dB	
	(-120 to -110) dBm	0.33 dB	
	(-130 to -120) dBm	0.75 dB	
	(-140 to -130) dBm	1.5 dB	
	(2 to 6) GHz (-40 to -30) dBm	0.19 dB	
	(-50 to -40) dBm	0.2 dB	
	(-60 to -50) dBm	0.2 dB	
	(-70 to -60) dBm	0.21 dB	
	(-80 to -70) dBm	0.21 dB	
	(-90 to -80) dBm	0.22 dB	
	(-100 to -90) dBm	0.22 dB	
	(-110 to -100) dBm	0.25 dB	
	(-120 to -110) dBm	0.5 dB	
	(-130 to -120) dBm	1 dB	
	(-136 to -130) dBm	1.5 dB	
	(6 to 18) GHz) (-30 to 30) dBm	0.18 dB	
	(-40 to -30) dBm	0.19 dB	
	(-50 to -40) dBm	0.2 dB	
	(-90 to -50) dBm	0.22 dB	
	(-100 to -90) dBm	0.39 dB	
	(-110 to -100) dBm	0.83 dB	
	(-119 to -110) dBm	1.5 dB	

Electrical – RF/Microwave

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power, Absolute Measure ¹	(18 GHz to 26.5 GHz) (-35 to 20) dBm	0.17 dB	Power Meter, Power Sensor
	(26.5 GHz to 40 GHz) (-35 to 20) dBm	0.23 dB	
	(40 GHz to 50 GHz) (-35 to 20) dBm	0.27 dB	
RF Power Source ¹	(100 to 250) kHz (-60 to +13) dBm	0.71 dB	Signal Generator
	(-110 to -60) dBm	1.2 dB	
	250 kHz to 1 GHz (-60 to +13) dBm	0.71 dB	
	(-110 to -60) dBm	0.87 dB	
	(1 to 3) GHz (-60 to +13) dBm	0.75 dB	
	(-110 to -60) dBm	1 dB	
	(3 to 4) GHz (-60 to +13) dBm	0.86 dB	
	(-110 to -60) dBm	1 dB	
	(4 to 6) GHz (-60 to +13) dBm	0.97 dB	
	(-110 to -60) dBm	1.4 dB	
	(6 to 20) GHz (-10 to 10) dBm	0.82 dB	
	(-60 to -10) dBm	1.2 dB	
	(-110 to -60) dBm	1.8 dB	
	(20 to 40) GHz (-10 to 10) dBm	1.1 dB	
	(-60 to -10) dBm	1.4 dB	
	(-110 to -60) dBm	2 dB	
	(40 to 50) GHz (-10 to 10) dBm	2 dB	
	(-60 to -10) dBm	2.3 dB	
	(-110 to -60) dBm	2.9 dB	

Electrical – RF/Microwave

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation Measure ¹			
AM Depth Accuracy			
100 kHz to 10 MHz (Rate: 50 Hz to 10 kHz)	Depth: (5 to 99) %	0.91 % Depth	
10 MHz to 3 GHz (Rate: 50 Hz to 100 kHz)	Depth: (20 to 99) % Depth: (5 to 20) %	0.61 % Depth 3 % Depth	
(3 to 26.5) GHz (Rate: 50 Hz to 100 kHz)	Depth: (20 to 99) % Depth: (5 to 20) %	1.8 % Depth 5.5 % Depth	
Flatness			PSA Series Spectrum Analyzer
10 MHz to 3 GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) %	0.37 % Depth	
(3 to 26.5) GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) %	0.49 % Depth	
FM Rejection (50 Hz to 3 kHz BW)			
250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz)	Depths: < 50% Deviations: < 5 kHz	0.17 % Depth	
10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz)	Depths: < 50% Deviations: < 50 kHz	0.44 % Depth	
Residual AM 250 kHz to 26.5 GHz	(50 Hz to 3 kHz BW)	0.012 % of reading (rms)	

Electrical – RF/Microwave

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz (Rate: 20 Hz to 200 kHz) AM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz Residual AM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: 200 Hz to 400 kHz AM Depths: $\leq 50\%$ (Rate: 400 Hz or 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 13 Hz 25 Hz 49 Hz 1.9 Hz 3.7 Hz 7.4 Hz	PSA Series Spectrum Analyzer
Phase Modulation Measure ¹ PM Deviation Accuracy 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz AM Rejection (50 Hz to 3 kHz BW) 100 kHz to 26.5 GHz Residual AM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad AM Depths: $\leq 50\%$ (Rate: 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad 0.002 1 rad 0.004 1 rad 0.008 1 rad	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Reflection S_{11} , S_{22} Measure ¹ Type N 300 kHz to 6 GHz	Magnitude (0 to 110) dB (30 to 300) kHz 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz Phase (-180 to 180) ° 30 kHz to 3 GHz (3 to 6) GHz	0.038 dB 0.033 dB 0.051 dB 0.13 dB 0.073 ° 0.25 °	Network Analyzer and Calibration Kits
Transmission S_{12} , S_{21} Measure ¹ Type N 300 kHz to 6 GHz	Magnitude (0 to 110) dB (30 to 300) kHz 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz Phase (-180 to 180) ° 30 kHz to 3 GHz (3 to 6) GHz	0.046 dB 0.036 dB 0.058 dB 0.12 dB 0.073 ° 0.25 °	Network Analyzer and Calibration Kits
VSWR ^{1,5} 30 kHz to 6 GHz	(1.0 to 3.0)	0.87 % of reading	Network Analyzer and Calibration Kits
Network Analyzer Trace Noise – Magnitude	300 kHz to 50 GHz (0 to 0.02) dB rms	0.000 6 dB	Calibration kit, Attenuator
Trace Noise – Phase	300 kHz to 50 GHz (0 to 0.2) °	0.001 4 ° rms	
Noise Floor	300 kHz to 50 GHz -140 to -80 dBm	1.1 dB	
Crosstalk	300 kHz to 50 GHz (-150 to -90) dB	1.8 dB	
Dynamic Range	300 kHz to 50 GHz (-150 to -90) dB	1.8 dB	
Dynamic Accuracy	300 kHz to 50 GHz (-110 to 0) dB	0.18 dB	

Electrical – RF/Microwave

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation Measure ¹ For 2/3/4/5G			
Composite Rho ⁵	450 MHz to 26.5 GHz $\rho = (0.9 \text{ to } 1.0)$	0.001 1	Spectrum Analyzer, Signal Generator
Error Vector Magnitude (rms)	450 MHz to 26.5 GHz EVM = (0 to 25) %	1 % of reading	
Peak Code Domain Error	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Phase error	450 MHz to 26.5 GHz (1 to 15)°	0.71 °	
Frequency Error	3 Hz to 26.5GHz	2.1×10^{-7} Hz/Hz	
I/Q Origin Offset	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Channel Power	450 MHz to 26.5 GHz Power > -70 dBm	0.62 dB	
Digital Modulation Measure ¹ For 2/3/4/5G			
Output RF Spectrum Relative RF Power Uncertainty			
Due to Modulation Offsets ≤ 1.2 MHz Offsets ≥ 1.8 MHz	-130 dB to 20 dB (1 to 15)° (3 to 25)°	0.26 dB 0.36 dB	Spectrum Analyzer, Signal Generator
Due to Switching	-130 dB to 20 dB (18 to 30)°	0.27 dB	
Absolute RF Power Accuracy	-130 dB to 20 dB (18 to 30)°	0.4 dB	
RF Amplitude – Measure ¹ (Voltage)	2 mVp-p to 5 Vp-p 50 GHz	3.3 mV	Sampling oscilloscope

Length – Dimensional Metrology

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 1 000 mm	$(0.17 + 0.006\ 8l)\ \mu\text{m} + 0.58R$	Gage Blocks
Height Gages ^{1,2}	Up to 1 000 mm	$(0.71 + 0.001\ 8l)\ \mu\text{m} + 0.58R$	Gage Blocks
Micrometer ^{1,2} External, Internal, Depth Bore and Micrometer Head	Up to 1 000 mm	$(0.088 + 0.006\ 9l)\ \mu\text{m} + 0.58R$	Gage Blocks
Indicators ^{1,2} Dial Gages, Dial Thickness Gages, Dial Test Indicators, LVDTs	Up to 100 mm	$(0.069 + 0.002\ 6l)\ \mu\text{m} + 0.58R$	Gage Blocks, Comparator Stand
		$(0.32 + 0.004\ 6l)\ \mu\text{m} + 0.58R$	Universal Measuring Machine, Indicator Tester
Plain External Diameter ^{1,2} (Cylindrical and Taper)	Up to 300 mm	$(0.31 + 0.001\ 7l)\ \mu\text{m}$	Universal Length Measuring Machine, High- Accuracy Micrometer, Gage Blocks
Plain Internal Diameter ² (Cylindrical and Taper)	(1 to 300) mm	$(0.26 + 0.002\ 2l)\ \mu\text{m}$	Universal Length Measuring Machine, Gage Blocks
Thread Plug Gages ² (Cylindrical and Taper) Simple Pitch Diameter Major Diameter	(1 to 300) mm	$(1.1 + 0.004\ 1l)\ \mu\text{m}$ $(0.33 + 0.001\ 7l)\ \mu\text{m}$	Universal Length Measuring Machine, Thread Wires, Gage Blocks
Thread Ring Gages ² (Cylindrical and Taper) Simple Pitch Diameter Minor Diameter	(3 to 300) mm	$(1.3 + 0.002\ 6l)\ \mu\text{m}$ $(0.31 + 0.002\ 6l)\ \mu\text{m}$	Universal Length Measuring Machine, Gage Blocks, Master Thread Plug Set
Setting Rod, Micrometer Standard, Length Standards ²	Up to 500 mm	$(0.44 + 0.002\ 3l)\ \mu\text{m}$	Gage blocks, Universal Length Measuring Machine
Snap Gages ² (External / Internal)	Up to 500 mm	$(0.28 + 0.002\ 5l)\ \mu\text{m}$	Universal Length Measuring Machine, Gage Blocks
Spherical Diameter, Standard Ball, Steel Ball ²	Up to 100 mm	$(0.31 + 0.001\ 0l)\ \mu\text{m}$	Universal Length Measuring Machine, Gage Blocks
Thickness Gauge / Feeler Gauge ^{1,2}	Up to 25 mm	$(0.35 + 0.000\ 53l)\ \mu\text{m}$	Universal Length Measuring Machine, High- Accuracy Micrometer, Gage Block

Length – Dimensional Metrology

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Universal Length Measuring Machine, Linear Measurement ^{1,2}	Up to 100 mm (100 to 500) mm	$(0.057 + 0.001\ 8l)\ \mu\text{m}$ $(0.052 + 0.002\ 0l)\ \mu\text{m}$	Gage Blocks
Optical Comparators and Vision Systems/Coordinate Measuring Machines / Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 1000 mm	$(1.3 + 0.007l)\ \mu\text{m}$	Gage Blocks, Standard Scale
Precision Level, Master Level / Electronic Inclinometer / Angle Meter	Up to 5 mm/m Up to 90° (4 Quadrant)	1.1 $\mu\text{m}/\text{m}$ 0.000 82 °	Sine Bar, Gage Block, Surface Plate
Length Standard	(0 to 1000) mm (1 to 10) m	$(0.06 + 0.000\ 03l)\ \text{mm}$	Grating Measuring Device

Mass and Mass Related

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure ¹	(-100 to 100) kPa 100 kPa to 160 MPa (160 to 200) MPa	0.033 % of reading + 0.58R 0.033 % of reading 0.035 % of reading	Pressure Calibrator
	(-10 to 10) kPa	0.28 % of reading + 0.58R	Differential Pressure Calibrator
Safety Valve	(0 to 200) MPa	0.035 % of reading + 0.005 8 MPa	Pressure Calibrator / Documenting Process Calibrator and Stopwatch
Vacuum Gauges ^{1,2} (Absolute Pressure)	(0.000 001 to 0.005) mbar (0.005 to 0.1) mbar (0.1 to 10) mbar	1.6 % of reading + 0.58R 1.2 % of reading 0.96 % of reading	Vacuum Transducer
Torque Tools ^{1,2}	Up to 2 000 N·m	0.32 % of reading + 0.58R	Torque Testers

Mass and Mass Related

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales & Balances ^{1,3} (Platform & Spring)	Up to 5 mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g 50 g to 10 kg (10 to 320) kg	0.01 mg 0.013 mg 0.015 mg 0.02 mg 0.026 mg 0.031 mg 0.041 mg 0.051 mg 0.061 mg 0.082 mg 0.1 mg 0.13 mg 0.15 mg 2.6 parts in 10 ⁶ kg/kg 25 parts in 10 ⁶ kg/kg	Standard Weights
Force and Load Cell ^{1,2} (Compression and Tension)	Up to 10 N (10 to 500) N 500 N to 3 kN	0.010 % of reading + 0.58R 0.006 2 % of reading + 0.58R 0.008 3 % of reading + 0.58R	Standard Weights
	Up to 300 kN	0.081 % of reading + 0.58R	Standard Load Cells
Mass	(1 to 5) mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 50 g to 20 kg	0.01 mg 0.013 mg 0.015 mg 0.020 mg 0.026 mg 0.031 mg 0.041 mg 0.051 mg 0.061 mg 0.082 mg 0.1 mg 0.13 mg 0.15 mg 2.6 parts in 10 ⁶ kg/kg	Standard Weight and Electronic Balance
Air Flow	(0.005 to 5) L/min (0.5 to 30) L/min	1.1 % of reading 0.54 % of reading	Flow Meter Calibrator
Gas Flow / Air Flow	Up to 100 L/min	0.19 % of Reading + 0.58R	Bell Jar type Gas Flow Meter
Air Velocity	Up to 40 m/s	0.55 m/s + 0.58R	Differential Pressure and Pitot Tube

Mass and Mass Related

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pipettes & Micropipettes Burette ¹	Up to 20 μ L (20 to 50) μ L (50 to 100) μ L (100 to 200) μ L 200 μ L to 10 mL (10 to 20) mL (20 to 2 000) mL	0.02 μ L 0.043 % of reading 0.026 % of reading 0.019 % of reading 0.015 % of reading 0.014 % of reading 0.012 % of reading	Analytical Scale Standard Weights
Volumetric Glassware ¹ Volumetric Apparatus, Flasks, Burettes, Volumetric Dispensers, Cylinders, Graduated Cylinders, Beakers, Vials, & Containers	Up to 10 mL (10 to 20) mL (20 to 2 000) mL	0.001 5 mL 0.014% of reading 0.012% of reading	Analytical Scale, Standard Weights

Photometry and Radiometry

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power Measure ¹ (700 to 1 800) nm	(-80 to 10) dBm	0.17 dB	Agilent optical test system
Optical Wavelength Measure ¹	(700 to 1 650) nm	0.51 parts in 10 ⁶ of reading	Wavelength Meter
Fiber Optic Wavelength Source ¹	(1 525 to 1 565) nm	0.091 pm	NIST Wavelength SRM
Laser Power Measure ¹ (190 to 1 100) nm	20 mW to 2 W (2 to 10) W	3.3 % of reading 3.5 % of reading	Thermopile Sensor, Silicon Detector
Illuminance/UV Illuminance	(300 to 400) nm Up to 1.999 mW/cm ²	29 % of Reading	Light Meter
DCA Optical Filter Frequency Response ¹	(-30 to 0) dB	0.012 dB	Optical test system
Optical Return Loss ¹	< 55 d B < 75 d B	1.2 dB 2.1 dB	Optical test system
DCA Optical Channel RMS Noise ¹	(0 to 500) μ W	0.012 μ W	Optical test system
Optical Source Output power Stability ¹	0 dBm 1 310nm 1 550nm	0.000 37 dB 0.000 47 dB	Optical test system

Photometry and Radiometry

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Attenuation Accuracy Test ¹	(0 to 60) dBm 1 310nm 1 550nm	0.029 dB	Optical test system
Optical Attenuation Repeatability Test ¹	(0 to 60) dBm 1 310nm 1 550nm	0.02 dB	Optical test system
Optical Wavelength Flatness Test ¹	0 dBm 1 310nm 1 550nm	0.02 dB	Optical test system
OSA Resolution Bandwidth Accuracy ¹	0.5 nm 0.2 nm 0.1 nm	0.002 1 nm 0.001 9 nm 0.001 2 nm	Optical test system
OSA power Level Linearity ¹	(-60 to 0) dBm 1 550nm	0.016 dB	Optical test system
OSA Normal Dynamic Range Measure ¹	(30 to 80) dB 0.2 nm 0.4 nm 1.0 nm -0.2 nm -0.4 nm -1.0 nm	0.44 dB 0.52 dB 0.81 dB 0.44 dB 0.57 dB 0.86 dB	Optical test system
DCA Electrical Channel Noise ¹	(0 to 500) mV	0.008 8 mV	Optical test system

Thermodynamic

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity Measuring Equipment ¹	(5 to 97) %RH	2 %RH	Humidity Meter w/ Humidity Generator
Temperature Measure ¹	(-80 to 300) °C (300 to 1 100) °C	0.04 °C 0.64 °C	Thermometer, PRT
	(35 to 650) °C	0.53 °C	Dry Block Temperature Calibrator
Chamber/Oven ¹ Temperature Measure	(-60 to 250) °C	0.6 °C	Datalogger w/RTD
Chamber/Oven ¹ Humidity Measure	(5 to 97) %RH	2 %RH	Humidity Meter

Thermodynamic

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calorimeter	156.52°C 28.53 J/g	0.28 °C 0.32 J/g	Indium for Thermal Analysis

Time and Frequency

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	0.01 Hz to 26.5 GHz	6.3×10^{-10} Hz/Hz	GPS Receiver, Counter
Frequency – Source ¹	10 MHz	6.2×10^{-12} Hz/Hz	GPS Receiver
Frequency – Source ¹	0.01 Hz to 40 GHz	6.3×10^{-12} Hz/Hz	GPS Receiver, Signal Generator
Pulse – Measure ¹	16 ns to 250 s	23 parts in 10^6 of reading	Digital Oscilloscope
Time Interval – Measure ¹	16 ns to 250 s	23 parts in 10^6 of reading	Digital Oscilloscope
Stopwatch and Timer ¹	Up to 24 hr	0.86 ms	Comparison to Frequency Counter
Stopwatch and Timer ¹	Up to 24 hr	240 ms	Comparison to Digital Stopwatch
Speed Measure ^{1,2}	Up to 10 000 rpm	1 rpm	Tachometer
Tachometers ^{1,2}	Up to 100 000 rpm	0.000 27 % of reading + 0.58R	Waveform Generator / Multi-product Calibrator with LED

DIMENSIONAL MEASUREMENT

Dimensional Measurement 1D

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
1D Length	(1 to 10) m	1.5 mm	Steel Tape
1D Length	(10 to 30) m	2.6 mm	Laser Measure

Dimensional Measurement 1D

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inspection Fixtures 1D Features ² Riser Blocks, Straight Edges, Bar Parallel	Up to 100 mm (100 to 500) mm	$(0.31 + 0.000\ 38l)\ \mu\text{m}$ $(0.23 + 0.001\ 0l)\ \mu\text{m}$	Universal Length Measuring Machine, Electric Comparator, Gage Blocks, Granite Surface Plate, Profile Projector, Hand Tools, Inclinator, Cylindrical Square

Dimensional Measurement 2D

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inspection Fixtures 2D Features ² Angle Block, V-Blocks, Riser Blocks, Straight Edges Parallel Bars, Machine Squares, Precision Squares Radius Gauge, Chamfer Gauge, Taper Gauge Attribute Gauges – Go/No-Go Dedicated Fixture Gauges	Up to 100 mm (100 to 500) mm	$(0.31 + 0.000\ 38l)\ \mu\text{m}$ $(0.23 + 0.001\ 0l)\ \mu\text{m}$	Universal Length Measuring Machine, Electric Comparator, Gage Blocks, Granite Surface Plate, Hand Tools, Electronic Inclinator, Cylindrical Square

Dimensional Measurement 3D

Wuxi, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Geometrical Product Specifications (GPS) ²	Up to 600 mm	$(2.8 + 0.0053l)\ \mu\text{m}$	Coordinate Measuring Machine

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

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Chemical Quantities

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Fixed points Conductivity Measure ¹	10 μ S/cm 84 μ S/cm 147 μ S/cm 1 410 μ S/cm	0.15 μ S/cm 1 μ S/cm 1.8 μ S/cm 17 μ S/cm	Comparison to Standard Solutions
pH – Measure ¹	4, 7, 10 pH	0.014 pH	Comparison to Standard Solutions

Electrical – DC/Low Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage Source ¹	10 μ V to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	3.2 μ V/V + 2 μ V 2.6 μ V/V + 3 μ V 2.6 μ V/V + 5 μ V 2.7 μ V/V + 9 μ V 2.7 μ V/V + 93 μ V 2.8 μ V/V + 560 μ V	Multiproduct Calibrator
DC Voltage Source Fixed Points	$\pm$ 1.0 V $\pm$ 1.018 V $\pm$ 10 V	1.7 μ V 1.7 μ V 3.3 μ V	DC Reference Standard
DC Voltage Measure ¹	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1 000) V	11 μ V/V + 6 μ V 10 μ V/V + 2 μ V 10 μ V/V + 2 μ V 12 μ V/V + 2 μ V 12 μ V/V + 6 μ V	Multimeter
DC Voltage Measure ¹ High Voltage	(1 to 10) kV	1.1 mV/V + 1 V	High Voltage Meter

Electrical – DC/Low Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current Source ¹	(0 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	50 μ A/A + 8 nA 50 μ A/A + 8 nA 50 μ A/A + 80 nA 61 μ A/A + 0.8 μ A 98 μ A/A + 25 μ A 360 μ A/A + 480 μ A	Multiproduct Calibrator and Amplifier
	(1 to 16.5) A (16.5 to 110) A (110 to 550) A	4.9 mA/A + 58 mA 12 mA/A + 59 mA 24 mA/A + 63 mA	Multiproduct Calibrator w/ 50 turn coil
DC Current Measure ¹	Up to 100 nA 100 nA to 1 μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	36 μ A/A + 50 pA 25 μ A/A + 50 pA 25 μ A/A + 121 pA 25 μ A/A + 1 nA 25 μ A/A + 7 nA 25 μ A/A + 68 nA 41 μ A/A + 0.7 μ A 128 μ A/A + 14 μ A	Multimeter
	(1 to 5) A (5 to 10) A (10 to 30) A (30 to 50) A (50 to 80) A (80 to 100) A (100 to 200) A	0.12 mA/A + 0.2 mA 0.1 mA/A + 0.2 mA 0.1 mA/A + 0.4 mA 0.1 mA/A + 0.6 mA 0.1 mA/A + 0.9 mA 0.1 mA/A + 1.1 mA 0.65 % of reading	Shunt monitored with multimeter
DC Power – Source ¹	0.1 mW to 11 kW (33 mV to 1020 V) (3.3 to 330) mA 330 mA to 4.5 A (4.5 to 11) A	0.039 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.067 % of Watts output + 0.58R	Multiproduct Calibrator w/Amplifier
Current Line regulation ¹	Up to 3 A	0.18 mA	Digital Multimeter
Current Load regulation ¹	Up to 3 A	0.18 mA	Digital Multimeter
Current Ripple ¹	Up to 3 A	0.03 mA	Oscilloscope
Voltage Line regulation ¹	Up to 10 V	0.65 mV	Digital Multimeter
Voltage Load regulation ¹	Up to 10 V	0.65 mV	Digital Multimeter
Voltage Ripple ¹	Up to 10 V	0.17 mV	Oscilloscope

Electrical – DC/Low Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance Source ¹ Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω	50 $\mu\Omega$ 96 $\mu\Omega$ 185 $\mu\Omega$ 290 $\mu\Omega$ 530 $\mu\Omega$ 1.9 m Ω 3.5 m Ω 15 m Ω 28 m Ω 140 m Ω	Multiproduct Calibrator
Resistance Source ¹ Fixed Points	19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	270 m Ω 1.6 Ω 3 Ω 22 Ω 45 Ω 440 Ω 1.1 k Ω 11 k Ω	Multiproduct Calibrator
Resistance – Source ¹	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 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 (110 to 330) k Ω 0.33 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω	93 $\mu\Omega/\Omega$ + 6.2 m Ω 93 $\mu\Omega/\Omega$ + 12 m Ω 70 $\mu\Omega/\Omega$ + 12 m Ω 70 $\mu\Omega/\Omega$ + 12 m Ω 70 $\mu\Omega/\Omega$ + 47 m Ω 70 $\mu\Omega/\Omega$ + 47 m Ω 70 $\mu\Omega/\Omega$ + 0.47 Ω 70 $\mu\Omega/\Omega$ + 0.47 Ω 86 $\mu\Omega/\Omega$ + 4.7 Ω 93 $\mu\Omega/\Omega$ + 4.7 Ω 117 $\mu\Omega/\Omega$ + 43 Ω 117 $\mu\Omega/\Omega$ + 43 Ω 466 $\mu\Omega/\Omega$ + 0.43 k Ω 776 $\mu\Omega/\Omega$ + 0.43 k Ω 3.9 m Ω/Ω + 4.3 k Ω 3.9 m Ω/Ω + 13 k Ω	Multiproduct Calibrator

Electrical – DC/Low Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure ¹	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 k Ω 1 k Ω to 10 k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	18 $\mu\Omega/\Omega$ + 68 $\mu\Omega$ 15 $\mu\Omega/\Omega$ + 0.7 m Ω 13 $\mu\Omega/\Omega$ + 0.7 m Ω 13 $\mu\Omega/\Omega$ + 7 m Ω 13 $\mu\Omega/\Omega$ + 68 m Ω 18 $\mu\Omega/\Omega$ + 5 Ω 61 $\mu\Omega/\Omega$ + 135 Ω 584 $\mu\Omega/\Omega$ + 2 k Ω 5.8 m Ω/Ω + 14 k Ω	Multimeter
Ground Resistance – Source ¹	10 m Ω	68 $\mu\Omega$	Standard Resistor
Insulation Resistance – Source ¹ (1 000 to 5 000) V	(0.1 to 10) G Ω (10 to 100) G Ω	0.3 % of reading 0.6 % of reading	Precision Decade Resistance Box
Oscilloscope ¹ Square Wave Amplitude, < 10 kHz Into 50 Ω or 1 M Ω Load	Up to 1 mVp-p (1 to 21) mVp-p (21 to 556) mVp-p 556 mV p-p to 210 V p-p	10 mV/V + 10 μ V 1.5 mV/V + 20 μ V 1.5 mV/V + 1.2 μ V 1.3 mV/V + 1.2 μ V	Oscilloscope Calibrator
Oscilloscope ¹ Vertical Deflection (Amplitude)	$\pm$ 1 mV to 50 V $\pm$ (50 to 100) V $\pm$ (100 to 200) V	250 μ V/V + 25 μ V 250 μ V/V + 26 μ V 250 μ V/V + 63 μ V	Oscilloscope Calibrator with Multimeter
Oscilloscope ¹ Horizontal Deflection (Time)	150 ps to 50 s	0.39 parts in 10 ⁶ of reading	Oscilloscope Calibrator w/Head
Oscilloscope ¹ Bandwidth	0.1 Hz to 3.2 GHz 3.2 GHz to 50 GHz	2.1 % of reading 6 % of reading	Oscilloscope Calibrator w/Head, Power Sensor, Signal Generator
Oscilloscope ¹ Rise/Fall Time, (10 to 90) %	(0 to 1.25) s	1.3 ps	Oscilloscope Calibrator w/Head
Inductance – Source/Measure ¹ 100 Hz – 100 kHz	1 mH 100 mH 10 H	1.2 μ H 120 μ H 12 mH	Standard Inductors
Inductance – Measure ¹ 12 Hz to 100 kHz	Up to 10 H	0.23 mH/H + 0.058 μ H	RLC Digibridge

Electrical – DC/Low Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type B		Multiproduct Calibrator
	(600 to 800) °C	0.36 °C	
	(800 to 1 000) °C	0.29 °C	
	(1 000 to 1 550) °C	0.26 °C	
	(1 550 to 1 820) °C	0.28 °C	
	Type C		
	(0 to 150) °C	0.26 °C	
	(150 to 650) °C	0.23 °C	
	(650 to 1 000) °C	0.27 °C	
	(1 000 to 1 800) °C	0.4 °C	
	(1 800 to 2 316) °C	0.66 °C	
	Type E		
	(-250 to -100) °C	0.4 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 350) °C	0.16 °C	
	(350 to 650) °C	0.17 °C	
	(650 to 1 000) °C	0.2 °C	
	Type J		
	(-210 to -100) °C	0.24 °C	
	(-100 to -30) °C	0.18 °C	
	(-30 to 150) °C	0.17 °C	
	(150 to 760) °C	0.23 °C	
	(760 to 1 200) °C	0.21 °C	
	Type K		
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	

Electrical – DC/Low Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type R (0 to 250) °C	0.46 °C	Multiproduct Calibrator
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type S (0 to 250) °C	0.38 °C	
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	
	Type T (-250 to -150) °C	0.5 °C	
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U (-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	
Electrical Calibration of RTD Indicating Systems ¹	Cu 427, 10 Ω (-100 to 260) °C	0.23 °C	Multiproduct Calibrator
	Pt 395, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	

Electrical – DC/Low Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 3916, 100 Ω		Multiproduct Calibrator
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.031 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.039 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.062 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.085 °C	
	Pt 385, 1 k Ω		
	(-200 to -80) °C	0.023 °C	
	(-80 to 0) °C	0.023 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.054 °C	
	(400 to 600) °C	0.054 °C	
	(600 to 630) °C	0.18 °C	
	PtNi 385, 100 Ω		
	(-80 to 0) °C	0.062 °C	
	(0 to 100) °C	0.062 °C	
	(100 to 260) °C	0.11 °C	

Electrical – DC/Low Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	Up to 2.2 mV		Multiproduct Calibrator
	(10 to 20) Hz	550 $\mu\text{V/V} + 5 \mu\text{V}$	
	(20 to 40) Hz	210 $\mu\text{V/V} + 5 \mu\text{V}$	
	40 Hz to 20 kHz	105 $\mu\text{V/V} + 5 \mu\text{V}$	
	(20 to 50) kHz	370 $\mu\text{V/V} + 5 \mu\text{V}$	
	(50 to 100) kHz	850 $\mu\text{V/V} + 7 \mu\text{V}$	
	(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	550 $\mu\text{V/V} + 5 \mu\text{V}$	
	(20 to 40) Hz	210 $\mu\text{V/V} + 5 \mu\text{V}$	
	40 Hz to 20 kHz	105 $\mu\text{V/V} + 5 \mu\text{V}$	
	(20 to 50) kHz	370 $\mu\text{V/V} + 5 \mu\text{V}$	
	(50 to 100) kHz	850 $\mu\text{V/V} + 7 \mu\text{V}$	
	(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	550 $\mu\text{V/V} + 13 \mu\text{V}$	
	(20 to 40) Hz	210 $\mu\text{V/V} + 9 \mu\text{V}$	
	40 Hz to 20 kHz	105 $\mu\text{V/V} + 9 \mu\text{V}$	
	(20 to 50) kHz	324 $\mu\text{V/V} + 11 \mu\text{V}$	
	(50 to 100) kHz	852 $\mu\text{V/V} + 29 \mu\text{V}$	
	(100 to 300) kHz	1.1 mV/V + 30 μV	
	(300 to 500) kHz	1.7 mV/V + 39 μV	
	500 kHz to 1 MHz	3.4 mV/V + 82 μV	
	220 mV to 2.2 V		
	(10 to 20) Hz	529 $\mu\text{V/V} + 87 \mu\text{V}$	
	(20 to 40) Hz	168 $\mu\text{V/V} + 30 \mu\text{V}$	
	40 Hz to 20 kHz	75 $\mu\text{V/V} + 7 \mu\text{V}$	
	(20 to 50) kHz	125 $\mu\text{V/V} + 17 \mu\text{V}$	
	(50 to 100) kHz	252 $\mu\text{V/V} + 71 \mu\text{V}$	
	(100 to 300) kHz	512 $\mu\text{V/V} + 140 \mu\text{V}$	
	(300 to 500) kHz	1.1 mV/V + 376 μV	
	500 kHz to 1 MHz	2.2mV/V + 918 μV	

Electrical – DC/Low Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) V		Multiproduct Calibrator
	(10 to 20) Hz	529 $\mu\text{V/V}$ + 872 μV	
	(20 to 40) Hz	168 $\mu\text{V/V}$ + 271 μV	
	40 Hz to 20 kHz	75 $\mu\text{V/V}$ + 70 μV	
	(20 to 50) kHz	125 $\mu\text{V/V}$ + 174 μV	
	(50 to 100) kHz	252 $\mu\text{V/V}$ + 376 μV	
	(100 to 300) kHz	572 $\mu\text{V/V}$ + 1.6 mV	
	(300 to 500) kHz	1.3 mV/V + 4.4 mV	
	500 kHz to 1 MHz	2.7 mV/V + 8.7 mV	
	(22 to 220) V		
	(10 to 20) Hz	529 $\mu\text{V/V}$ + 8.7 mV	
	(20 to 40) Hz	168 $\mu\text{V/V}$ + 2.7 mV	
	40 Hz to 20 kHz	80 $\mu\text{V/V}$ + 0.8 mV	
	(20 to 50) kHz	223 $\mu\text{V/V}$ + 3.5 mV	
	(50 to 100) kHz	501 $\mu\text{V/V}$ + 8.2 mV	
	(100 to 300) kHz	1.5 mV/V + 90 mV	
	(300 to 500) kHz	4.7 mV/V + 90 mV	
	500 kHz to 1 MHz	12 mV/V + 190 mV	
AC Voltage – Measure ¹	(220 to 1 100) V		Multimeter in synchronous subsampled mode
	(15 to 50) Hz	436 $\mu\text{V/V}$ + 16 mV	
	50 Hz to 1 kHz	80 $\mu\text{V/V}$ + 3.5 mV	
	Up to 10 mV		
	(1 to 40) Hz	353 $\mu\text{V/V}$ + 7.7 μV	
	40 Hz to 1 kHz	241 $\mu\text{V/V}$ + 7 μV	
	(1 to 20) kHz	353 $\mu\text{V/V}$ + 7 μV	
	(20 to 50) kHz	1.2 mV/V + 7 μV	
	(50 to 100) kHz	5.8 mV/V + 7 μV	
	(100 to 300) kHz	46 mV/V + 7.3 μV	
	(10 to 100) mV		
	(1 to 40) Hz	88 $\mu\text{V/V}$ + 4.6 μV	
	40 Hz to 1 kHz	88 $\mu\text{V/V}$ + 2.3 μV	
	(1 to 20) kHz	165 $\mu\text{V/V}$ + 2.3 μV	
	(20 to 50) kHz	348 $\mu\text{V/V}$ + 2.3 μV	
	(50 to 100) kHz	924 $\mu\text{V/V}$ + 2.3 μV	
	(100 to 300) kHz	3.5 mV/V + 12 μV	
	300 kHz to 1 MHz	12 mV/V + 12 μV	
	(1 to 2) MHz	18 mV/V + 12 μV	

Electrical – DC/Low Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	100 mV to 10 V		Multimeter in synchronous subsampled mode
	(1 to 40) Hz	88 $\mu\text{V/V}$ + 463 μV	
	40 Hz to 1 kHz	88 $\mu\text{V/V}$ + 234 μV	
	(1 to 20) kHz	165 $\mu\text{V/V}$ + 234 μV	
	(20 to 50) kHz	348 $\mu\text{V/V}$ + 234 μV	
	(50 to 100) kHz	924 $\mu\text{V/V}$ + 234 μV	
	(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	234 $\mu\text{V/V}$ + 4.6 mV	
	40 Hz to 1 kHz	234 $\mu\text{V/V}$ + 2.3 mV	
	(1 to 20) kHz	234 $\mu\text{V/V}$ + 2.3 mV	
	(20 to 50) kHz	406 $\mu\text{V/V}$ + 2.3 mV	
	(50 to 100) kHz	1.4 mV/V + 2.3 mV	
	(100 to 300) kHz	4.6 mV/V + 12 mV	
	300 kHz to 1 MHz	18 mV/V + 12 mV	
	(100 to 700) V		
	(1 to 40) Hz	463 $\mu\text{V/V}$ + 47 mV	
	40 Hz to 1 kHz	463 $\mu\text{V/V}$ + 24 mV	
	(1 to 20) kHz	694 $\mu\text{V/V}$ + 24 mV	
	(20 to 50) kHz	1.4 mV/V + 24 mV	
	(50 to 100) kHz	3.5 mV/V + 24 mV	
AC Voltage – Measure ¹ High Voltage	(0.5 to 10) kV (50 to 60) Hz	2 mV/V + 1 V	High Voltage Meter
AC Power – Source ^{1,2} (45 to 65) Hz PF = 1	0.1 mW to 11 kW		Multiproduct Calibrator
	(33 to 330) mV		
	(3.3 to 9) mA	0.31 % of Watts output + 0.58R	
	(9 to 33) mA	0.2 % of Watts output + 0.58R	
	(33 to 90) mA	0.27 % of Watts output + 0.58R	
	(90 to 330) mA	0.2 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.27 % of Watts output + 0.58R	
	(0.9 to 2.2) A	0.2 % of Watts output + 0.58R	
	(2.2 to 4.5) A	0.27 % of Watts output + 0.58R	
	(4.5 to 11) A	0.2 % of Watts output + 0.58R	

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} (45 to 65) Hz PF = 1	0.1 mW to 11 kW 330 mV to 1 000 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R 0.16 % of Watts output + 0.58R 0.12 % of Watts output + 0.58R	Multiproduct Calibrator
AC Power – Source ^{1,2} (45 to 65) Hz (PF = 0 to 0.999)	0.1 mW to 11 kW (33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A 0.1 mW to 11 kW 330 mV to 1000 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.36 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.32 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.32 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.32 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.26 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.23 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R	Multi-Product Calibrator
AC Power – Source ^{1,2} (45 to 65) Hz PF = 1	0.33 mW to 11 kW (100 to 1 000) V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.2 % of Watts output + 0.58·R 0.12 % of Watts output + 0.58·R 0.2 % of Watts output + 0.58·R 0.12 % of Watts output + 0.58·R 0.2 % of Watts output + 0.58·R 0.12 % of Watts output + 0.58·R 0.16 % of Watts output + 0.58·R 0.12 % of Watts output + 0.58·R	Multi-Product Calibrator w/Amplifier

Electrical – DC/Low Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} (45 to 65) Hz (PF = 0 to 0.999)	0.33 mW to 11 kW (100 to 1 000) V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.26 % of Watts output + 0.58·R 0.21 % of Watts output + 0.58·R 0.26 % of Watts output + 0.58·R 0.21 % of Watts output + 0.58·R 0.26 % of Watts output + 0.58·R 0.21 % of Watts output + 0.58·R 0.23 % of Watts output + 0.58·R 0.21% of Watts output + 0.58·R	Multi-Product Calibrator w/Amplifier
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 (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	700 µA/A + 25 nA 350 µA/A + 20 nA 140 µA/A + 16 nA 600 µA/A + 40 nA 1.6 mA/A + 80 nA 700 µA/A + 40 nA 350 µA/A + 35 nA 140 µA/A + 35 nA 600 µA/A + 400 nA 1.6 mA/A + 800 nA 700 µA/A + 400 nA 350 µA/A + 350 nA 140 µA/A + 350 nA 600 µA/A + 4 µA 1.6 mA/A + 8 µA 700 µA/A + 4 µA 350 µA/A + 3.5 µA 140 µA/A + 3.5 µA 600 µA/A + 40 µA 1.6 mA/A + 80 µA 650 µA/A + 35 µA 750 µA/A + 80 µA 8.5 mA/A + 160 µA	Multiproduct Calibrator
AC Current – Source ¹	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	460 µA/A + 170 µA 950 µA/A + 380 µA 3.6 mA/A + 750 µA	Multiproduct Calibrator with Amplifier

Electrical – DC/Low Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(11 to 550) A (45 to 65) Hz (65 to 500) Hz 500 Hz to 1 kHz	13 mA/A + 0.13 A 42 mA/A + 0.15 A 233 mA/A + 0.18 A	Multi-Product Calibrator w/50-turn coil
AC Current – Measure ¹	(5 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 1 mA (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 (50 to 100) kHz (1 to 10) mA (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 (50 to 100) kHz (10 to 100) mA (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 (50 to 100) kHz	4.6 mA/A + 0.035 μ A 1.7 mA/A + 0.035 μ A 0.7 mA/A + 0.035 μ A 0.7 mA/A + 0.035 μ A 4.6 mA/A + 0.23 μ A 1.7 mA/A + 0.23 μ A 0.7 mA/A + 0.23 μ A 0.4 mA/A + 0.23 μ A 0.7 mA/A + 0.23 μ A 4.6 mA/A + 0.46 μ A 6.4 mA/A + 1.7 μ A 4.6 mA/A + 2.3 μ A 1.7 mA/A + 2.3 μ A 0.7 mA/A + 2.3 μ A 0.4 mA/A + 2.3 μ A 0.7 mA/A + 2.3 μ A 4.6 mA/A + 4.6 μ A 6.4 mA/A + 17 μ A 4.6 mA/A + 23 μ A 1.7 mA/A + 23 μ A 0.7 mA/A + 23 μ A 0.4 mA/A + 23 μ A 0.7 mA/A + 23 μ A 4.6 mA/A + 46 μ A 6.4 mA/A + 0.17 mA	Multimeter in synchronous subsampled mode
AC Current – Measure ¹	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	4.6 mA/A + 0.23 mA 1.8 mA/A + 0.23 mA 0.9 mA/A + 0.23 mA 1.2 mA/A + 0.23 mA 3.5 mA/A + 0.23 mA 12 mA/A + 0.46 mA	Multimeter in synchronous subsampled mode

Electrical – DC/Low Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ^{1,2} Fixed Values @ 1 kHz	(1, 10, 100, 1 000) pF (10, 100) nF 1 μ F	0.35 mF/F + 0.58R	Standard Capacitor Sets
Capacitance – Source ¹ (Simulation) 50 Hz to 1 kHz	(0.33 to 0.49) nF (0.50 to 1.09) nF (1.10 to 3.29) nF (3.30 to 10.9) nF (11.0 to 32.9) nF (33 to 109) nF (110 to 329) nF (0.33 to 1.09) μ F (1.1 to 3.29) μ F (3.3 to 10.9) μ F (11 to 32.9) μ F (33 to 109.9) μ F (110 to 329.9) μ F (0.33 to 1.09) mF	3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 78 pF 1.9 mF/F + 233 pF 1.9 mF/F + 0.78 nF 2.7 mF/F + 2.3 nF 2.7 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.9 mF/F + 78 nF 5.4 mF/F + 233 nF 7.8 mF/F + 0.26 μ F	Multiproduct Calibrator
Capacitor Dissipation Factor ^{1,5} 1 kHz	Up to 0.000 1	0.000 021	Standard Capacitor

Electrical – RF/Microwave

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
SINAD	(0 to 99.99) dB 20 Hz to 20 kHz (20 to 100) kHz	1.2 dB 2.4 dB	Audio Analyzer

Electrical – RF/Microwave

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Spectrum Analyzer-Measure			
Spurious Responses	10 MHz to 26.5 GHz, (-80 to 0) dB	0.23 dB	Measuring Receiver, Power Meter, Power Sensor, RF Attenuator, Counter
Second Harmonic Distortion		0.22 dB	
Third Order Intermodulation Distortion		0.26 dB	
Gain Compression		0.073 dB	
Frequency Response	(-80 to 10) dBm, 50MHz	0.13 dB	
Display Scale Fidelity	(0 to 0.5) % Dev 1 kHz	0.085 dB	
DC FM Carrier Offset		0.005 8 % of reading	
Source Phase Noise Offset carrier= 10 kHz	(-155 to -70) dBc 1 MHz to 26.5 GHz	1.2 dB/Hz	Measuring Receiver, Power Meter, Power Sensor
RF Tuned Power Measure ¹	10 kHz to 18 GHz 0.00 dB (-10.00 to 0) dB (-20.00 to -10.00) dB (-30.00 to -20.00) dB (-40.00 to -30.00) dB (-50.00 to -40.00) dB (-60.00 to -50.00) dB (-70.00 to -60.00) dB (-80.00 to -70.00) dB (-90.00 to -80.00) dB (-100.00 to -90.00) dB (-110.00 to -100.00) dB (-120.00 to -110.00) dB (-130.00 to -120.00) dB (-140.00 to -130.00) dB	0.017 dB 0.024 dB 0.03 dB 0.036 dB 0.041 dB 0.048 dB 0.063 dB 0.069 dB 0.073 dB 0.078 dB 0.083 dB 0.088 dB 0.23 dB 0.65 dB 1.35 dB	N5531S Measuring Receiver Spectrum Analyzer, Power Meter, Power Sensor
RF Tuned Power Measure ¹	(18 to 50) GHz: (-35 to -1) dB (-1 to 15) dB (15 to 20) dB	0.053 dB 0.059 dB 0.067 dB	Power Meter, Power Sensor(N8487A)
Absolute RF Power Measure ¹	9 kHz to 6 GHz: (-30 to 20) dBm	0.15 dB	Power Meter, Power Sensor(E9304A)

Electrical – RF/Microwave

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Absolute RF Power Measure 1	10 MHz to 2 GHz (-40 to -30) dBm (-50 to -40) dBm (-60 to -50) dBm (-70 to -60) dBm (-80 to -70) dBm (-90 to -80) dBm (-100 to -90) dBm (-110 to -100) dBm (-120 to -110) dBm (-130 to -120) dBm (-140 to -130) dBm	0.15 dB 0.15 dB 0.16 dB 0.16 dB 0.17 dB 0.17 dB 0.18 dB 0.18 dB 0.33 dB 0.75 dB 1.5 dB	N5531S Measuring Receiver (Spectrum Analyzer, Power Meter, Power Sensor)
Absolute RF Power Measure 1	(2 to 6) GHz (-40 to -30) dBm (-50 to -40) dBm (-60 to -50) dBm (-70 to -60) dBm (-80 to -70) dBm (-90 to -80) dBm (-100 to -90) dBm (-110 to -100) dBm (-120 to -110) dBm (-130 to -120) dBm (-136 to -130) dBm	0.19 dB 0.2 dB 0.2 dB 0.21 dB 0.21 dB 0.22 dB 0.22 dB 0.25 dB 0.5 dB 1 dB 1.5 dB	N5531S Measuring Receiver (Spectrum Analyzer, Power Meter, Power Sensor)
Absolute RF Power Measure 1	(6 to 18) GHz (-30 to 30) dBm (-40 to -30) dBm (-50 to -40) dBm (-90 to -50) dBm (-100 to -90) dBm (-110 to -100) dBm (-119 to -110) dBm	0.18 dB 0.19 dB 0.2 dB 0.22 dB 0.39 dB 0.83 dB 1.5 dB	N5531S Measuring Receiver (Spectrum Analyzer, Power Meter, Power Sensor)
Absolute RF Power Measure 1	(18 to 26.5) GHz: (-35 to 20) dBm (26.5 to 40) GHz: (-35 to 20) dBm (40 to 50) GHz: (-35 to 20) dBm	0.17 dB 0.23 dB 0.27 dB	Power Meter, Power Sensor (N8487A)

Electrical – RF/Microwave

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Source ¹	(100 to 250) kHz: (-60 to +13) dBm 0.71 dB (-110 to -60) dBm 1.2 dB 250 kHz to 1 GHz: (-60 to +13) dBm 0.71 dB (-110 to -60) dBm 0.87 dB (1 to 3) GHz: (-60 to +13) dBm 0.75 dB (-110 to -60) dBm 1 dB (3 to 4) GHz: (-60 to +13) dBm 0.86 dB (-110 to -60) dBm 1 dB (4 to 6) GHz: (-60 to +13) dBm 0.97 dB (-110 to -60) dBm 1.4 dB (6 to 20) GHz: (-10 to 10) dBm 0.82 dB (-60 to -10) dBm 1.2 dB (-110 to -60) dBm 1.8 dB (20 to 40) GHz: (-10 to 5) dBm 1.1 dB (-60 to -10) dBm 1.4 dB (-110 to -60) dBm 2 dB (40 to 50) GHz: (-10 to +.5) dBm 2 dB (-60 to -10) dBm 2.3 dB (-110 to -60) dBm 2.9 dB		Signal Generator
Amplitude Modulation Measure ¹ AM Depth Accuracy 100 kHz to 10 MHz (Rate: 50 Hz to 10 kHz) 10 MHz to 3 GHz (Rate: 50 Hz to 100 kHz) (3 to 26.5) GHz (Rate: 50 Hz to 100 kHz)	Depth: (5 to 99) % Depth: (20 to 99) % Depth: (5 to 20) % Depth: (20 to 99) % Depth: (5 to 20) %	0.91 % Depth 0.61 % Depth 3.0 % Depth 1.8 % Depth 5.5 % Depth	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation Measure ¹ Flatness 10 MHz to 3 GHz (Rate: 90 Hz to 10 kHz) (3 to 26.5) GHz (Rate: 90 Hz to 10 kHz) FM Rejection (50 Hz to 3 kHz BW) 250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz) 10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz) Residual AM 250 kHz to 26.5 GHz	Depth: (5 to 99) % Depth: (5 to 99) % Depths: < 50 % Deviations: < 5 kHz Depths: < 50 % Deviations: < 50 kHz 50 Hz to 3 kHz BW	0.37 % Depth 0.49 % Depth 0.17 % Depth 0.44 % Depth 0.012 % (rms)	PSA Series Spectrum Analyzer
Frequency Modulation Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz (Rate: 20 Hz to 200 kHz) AM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz Residual AM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: 200 Hz to 400 kHz AM Depths: ≤ 50% (Rate: 400 Hz or 1 kHz) 50 Hz to 3 kHz BW	1.3 % of reading 13 Hz 25 Hz 49 Hz 1.9 Hz 3.7 Hz 7.4 Hz	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation Measure ¹ PM Deviation Accuracy 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz AM Rejection 50 Hz to 3 kHz BW 100 kHz to 26.5 GHz Residual AM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad AM Depths: ≤ 50% (Rate: 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad 0.002 1 rad 0.004 1 rad 0.008 1 rad	PSA Series Spectrum Analyzer
Reflection S11 / S22 Measure Type N 300 kHz to 6 GHz	Magnitude (0 to 110) dB (30 to 300) kHz 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz Phase (-180 to 180) ° 30 kHz to 3 GHz (3 to 6) GHz	0.038 dB 0.033 dB 0.051 dB 0.13 dB 0.073 ° 0.25 °	Vector Network Analyzer, Calibration kit
Transmission S12 / S21 Measure, Type N 300 kHz to 6 GHz	Magnitude (0 to 110) dB (30 to 300) kHz 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz Phase (-180 to 180) ° 30 kHz to 3 GHz (3 to 6) GHz	0.046 dB 0.036 dB 0.058 dB 0.12 dB 0.073 ° 0.25 °	Vector Network Analyzer, Calibration kit
VSWR ^{1,5} 30 kHz to 6 GHz	(1.0 to 3.0)	0.87 % of reading	Vector Network Analyzer, Calibration kit

Electrical – RF/Microwave

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Network Analyzer Trace Noise – Magnitude	300 kHz to 50 GHz (0 to 0.02) dB rms	0.000 6 dB	Calibration kit, Attenuator
Trace Noise – Phase	300 kHz to 50 GHz (0 to 0.2)°	0.001 4°	
Noise Floor	300 kHz to 50 GHz -140 to -80 dBm	1.1 dB	
Crosstalk	300 kHz to 50 GHz (-150 dB to -90) dB	1.8 dB	
Dynamic Range	300 kHz to 50 GHz (-150 dB to -90) dB	1.8 dB	
Dynamic Accuracy	300 kHz to 50 GHz (-110 to 0) dB	0.18 dB	
Digital Modulation Measure ¹ for 2/3/4/5G			Spectrum Analyzer, Signal Generator
Composite Rho ⁵	450 MHz to 26.5 GHz $\rho = (0.9 \text{ to } 1.0)$	0.001 1	
Error Vector Magnitude (rms)	450 MHz to 26.5 GHz EVM = (0 to 25) %	1 % of reading	
Peak Code Domain Error	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Phase error	450 MHz to 26.5 GHz (1 to 15)°	0.71°	
Frequency Error	3 Hz to 26.5GHz	2.1×10^{-7} Hz/Hz	
I/Q Origin Offset	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Channel Power	450 MHz to 26.5 GHz Power > -70 dBm	0.62 dB	

Electrical – RF/Microwave

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation Measure ¹ for 2/3/4/5G Output RF Spectrum Relative RF Power Uncertainty Due to Modulation Offsets ≤ 1.2 MHz Offsets ≥ 1.8 MHz Absolute RF Power Accuracy	(-130 to 20) dB (1 to 15) ° (3 to 25) ° (-130 to 20) dB (18 to 30) ° (-130 to 20) dB (18 to 30) °	0.26 dB 0.36 dB 0.27 dB 0.4 dB	Spectrum Analyzer, Signal Generator
RF Amplitude Measure (Voltage) @50GHz	2 mVp-p to 5 Vp-p	3.3 mV	Sampling oscilloscope

Length – Dimensional Metrology

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Cylindrical Plug/Pin Gages ²	Up to 25.4 mm	(0.96 + 0.002 5I) μ m	Laser Micrometer
Calipers ^{1,2}	Up to 1 000 mm	(5.8 + 0.009I) μ m	Gage Blocks
Height Gages ^{1,2}	Up to 1 000 mm	(0.72 + 0.002 5I) μ m	
Indicators ^{1,2} Dial Gages / Dial Thickness Gages / Dial Test Indicators / LVDTs	Up to 100 mm	(0.069 + 0.003 4I) μ m	
Micrometer ^{1,2} External, Internal, Depth and Bore	Up to 25 mm (25 to 1 000) mm	(0.2 + 0.009I) μ m (0.37 + 0.013I) μ m	
Optical Comparators and Vision Systems / Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 300 mm	(1.3 + 0.007I) μ m	Gage Blocks, Standard Scale

Mass and Mass Related

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure & Vacuum ¹	(-14.5 to 30) psi (30 to 300) psi (300 to 1 500) psi	0.025 % of reading + 0.003 2 psi 0.077 % of reading + 0.012 psi 0.025 % of reading + 0.15 psi	Multifunction Calibrator, Pressure Calibrator
Torque Tools ¹	(0.15 to 5) N·m	0.65 % of reading	Torque Tester
Torque Testers ^{1,2}	Up to 10 N·m (10 to 35) N·m (35 to 75) N·m	0.13 % of reading + 0.58R 0.041 % of reading 0.021 % of reading	Torque Calibration Wheel with Standard Weights
Scales & Balances ^{1,3}	Up to 5 mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g 20 g to 5 kg (5 to 60) kg (60 to 500) kg	0.014 mg 0.016 mg 0.018 mg 0.022 mg 0.027 mg 0.032 mg 0.042 mg 0.097 mg 0.11 mg 0.12 mg 0.14 mg 0.18 mg 0.001 % of reading 0.008 % of reading 0.058 % of reading	Standard Weights
Durometers /Shore Hardness Tester Force Types A,B,E,O Types C,D,DO Type M Types OO,OOO Type OOO-S	Up to 100 Points Up to 100 Points Up to 100 Points Up to 100 Points Up to 100 Points	0.12 Points 0.06 Points 1.7 Points 0.83 Points 0.43 Points	Partial Direct Verification Standard Weights, Electronic Balance, Load Cell
Force – Compression and Tension ^{1,2}	Up to 10 N (10 to 20) N (20 to 50) N (50 to 100) N (100 to 200) N (200 to 500) N	0.01 % of reading + 0.58R 0.0074 % of reading 0.0064 % of reading 0.019 % of reading 0.018 % of reading 0.013 % of reading	Standard Weights
Air Flow ¹	(1 to 1 000) slpm	1.7 % of reading	Comparison to Master Flowmeter

Photometry and Radiometry

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Absolute Optical Power Measure ¹	-20 dBm, @10 μ W (800 to 1700) nm	0.11 dB	Optical test system
Relative Optical Power Measure ¹	(-60 to 10) dB (800 to 1700) nm	0.028 dB	Optical test system
Optical Wavelength Measure ¹	(1 270 to 1 650) nm	0.001 2 nm	Multi-wavelength Meter
Fiber Optic Wavelength Measuring Equipment ¹	(1 525 to 1 565) nm	0.12 pm	NIST Wavelength SRM 2519
Optical Source Output Power Stability ¹	0 dBm 1 310 nm 1 550 nm	0.000 37 dB 0.000 47 dB	Optical Test System
Optical Attenuation Accuracy ¹	(0 to 60) dBm 1 310 nm 1 550 nm	0.029 dB	Optical Test System
Optical Attenuation Repeatability ¹	(0 to 60) dBm 1 310 nm 1 550 nm	0.02 dB	Optical Test System
Wavelength Flatness ¹	0 dBm 1 310 nm 1 550 nm	0.02 dB	Optical Test System
OSA Resolution Bandwidth Accuracy ¹	0.5 nm 0.2 nm 0.1 nm	0.002 1 nm 0.001 9 nm 0.001 2 nm	Optical Test System
Optical Return Loss Measure ¹	< 55 d B < 75 d B	1.2 dB 2.1 dB	Optical Test System
OSA Power Level Linearity ¹	(-60 to 0) dBm 1550nm	0.016 dB	Optical Test System
OSA Normal Dynamic Range Measure ¹	(30 to 80) dB 0.2 nm 0.4 nm 1.0 nm -0.2 nm -0.4 nm 1.0 nm	0.44 dB 0.52 dB 0.81 dB 0.44 dB 0.57 dB 0.86 dB	Optical Test System

Photometry and Radiometry

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
OSA High Dynamic Range Measure ¹	(30 to 80) dB 0.2 nm 0.4 nm 1.0 nm -0.2 nm -0.4 nm -1.0 nm	0.35 dB 0.62 dB 0.78 dB 0.41 dB 0.41 dB 0.6 dB	Optical Test System
DCA Optical Filter Frequency Response ¹	(-30 to 0) dB	0.012 dB	Optical Test System
DCA Optical Channel RMS Noise ¹	(0 to 500) μ W	0.012 μ W	Optical Test System
DCA Electrical Channel Noise ¹	(0 to 500) mV	0.008 8 mV	Optical Test System

Thermodynamic

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity Measuring Equipment ¹	10 to 90 %RH	2.1 %RH	Humidity Indicator and Probe
Temperature Measuring Equipment ¹	(-80 to 300) °C (300 to 450) °C	0.028 °C 0.1 °C	Drywell Calibrator and SPRT, PRT Probe
Temperature Chamber/Oven ¹	(-100 to 450) °C	0.39 °C	Datalogger with Thermocouples

Time and Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	0.01 Hz to 26.5 GHz	6.3×10^{-10} Hz/Hz	GPS Receiver, Counter
Frequency – Source ¹	1 MHz & 10 MHz	6.2×10^{-12} Hz/Hz	GPS Receiver
Frequency – Source ¹	0.01 Hz to 50 GHz	6.3×10^{-12} Hz/Hz	GPS Receiver, Signal Generator
Time Interval – Measure ¹	100 fs to 1 s	1 % of reading + 1 ps	Oscilloscope

Time and Frequency

Shenzhen, PR China

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Timers, Stopwatches, Chronometers ¹	Up to 3600 s	0.001 5 s	Universal Counter
Jitter – Measure ¹ @ (50 MHz to 50 GHz) @ 24 ns Delay)	(0 to 100) ps	0.2 ps	Oscilloscope
RMS Jitter ¹ 3 GHz	5 ps	0.86 ps	Oscilloscope
Period ¹	(10, 30) ns	0.004 7 ns	Oscilloscope
Delay ¹	(5, 10) ns	0.004 7 ns	Oscilloscope
Width ¹	10 ns	0.004 7 ns	Oscilloscope
Photo Tachometer ^{1,2}	(7 200 to 90 000) rpm	0.000 27 % of reading + 0.58R	Waveform Generator / Multi-product Calibrator

[Return to Site listing \(top\)](#) [Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

Micro Precision Calibration Laboratory (Thailand) Co., Ltd.

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CALIBRATION

Acoustics and Vibration

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Vibration ¹ (0.2 Hz to 10 kHz) Acceleration Velocity Displacement Accelerometers / Velocity Sensors / Displacement Sensors	(0 to 200) m/s ² (0 to 200) mm/s (0 to 200) µm Sensitivity: (0.04 to 1 000) pC/units (0.04 to 1 000) mV/units	0.69 % of reading + 0.004 7 m/s ² 0.69 % of reading + 0.004 7 mm/s 0.69 % of reading + 0.004 7 µm 0.83 % of sensitivity	Vibration System
Sound Level Meter ¹	(74 to 114) dB (125 Hz to 4 kHz)	0.32 dB	Sound Calibrator, Sound Level Meter
Sound Calibrator ¹	(74 to 134) dB (100 Hz to 100 kHz)	0.12 dB	Multimeter w/Conditioning Amplifier and Microphone
Microphones ¹ Frequency Response	(-80 to -10) dB re. 1V/Pa (10 to 80) Hz (80 to 100) Hz 100 Hz to 4 kHz (4 to 8) kHz (8 to 12.6) kHz (12.6 to 16) kHz (16 to 20) kHz (20 to 26) kHz (26 to 32) kHz (32 to 40) kHz (40 to 51) kHz (51 to 64) kHz (64 to 80) kHz	0.13 dB 0.12 dB 0.093 dB 0.12 dB 0.16 dB 0.18 dB 0.26 dB 0.23 dB 0.24 dB 0.25 dB 0.27 dB 0.29 dB 0.31 dB	Reference Microphone with Sound Calibration System

Acoustics and Vibration

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Microphones ¹ Sensitivity	(-80 to -10) dB re. 1V/Pa 10 Hz to 20 kHz	0.093 dB	Reference Microphone with Sound Calibration System

Chemical Quantities

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical System Aerosol Particle Counter Counting Efficiency	(0 to 100) % Particle sizes: (0.1, 0.15, 0.2, 0.25, 0.3, 0.5, 0.7, 1, 2, 3, 5, 10) μm	3.1 % Counting Efficiency	Comparison to Master Particle Counter
Optical System Aerosol Particle Counter Flow Rate	Up to 100 L/min	0.35 % of reading + 0.058 mL/min	Standard Flow Calibrator
Conductivity Meters – Measure ^{1,8}	10 $\mu\text{S/cm}$ 84 $\mu\text{S/cm}$ 500 $\mu\text{S/cm}$ 1 000 $\mu\text{S/cm}$ 1 413 $\mu\text{S/cm}$ 10 000 $\mu\text{S/cm}$ 12 880 $\mu\text{S/cm}$	0.11 $\mu\text{S/cm}$ 1.1 $\mu\text{S/cm}$ 2.6 $\mu\text{S/cm}$ 11 $\mu\text{S/cm}$ 16 $\mu\text{S/cm}$ 110 $\mu\text{S/cm}$ 78 $\mu\text{S/cm}$	Comparison to Standard Solutions
pH Measuring Equipment ^{1,8}	(1.1, 1.67, 4.01, 7.01, 10.01, 11.73) pH	0.012 pH	Comparison to Standard Solutions
Viscosity Measuring Equipment ¹	Kinematic Viscosity (cSt) Up to 50 mm^2/s (50 to 500) mm^2/s (500 to 1 000) mm^2/s (1 000 to 5 000) mm^2/s (5 000 to 12 500) mm^2/s Dynamic Viscosity (cP) Up to 50 $\text{mPa}\cdot\text{s}$ (50 to 500) $\text{mPa}\cdot\text{s}$ (500 to 1 000) $\text{mPa}\cdot\text{s}$ (1 000 to 5 000) $\text{mPa}\cdot\text{s}$ (5 000 to 12 500) $\text{mPa}\cdot\text{s}$ Density (0.7 to 1.2) g/cm^3	0.22 % of reading + 0.58R 0.29 % of reading + 0.58R 0.38 % of reading + 0.58R 0.38 % of reading + 0.58R 0.44 % of reading + 0.58R 0.22 % of reading + 0.58R 0.29 % of reading + 0.58R 0.38 % of reading + 0.58R 0.38 % of reading + 0.58R 0.44 % of reading + 0.58R 0.005 2 % of reading + 0.58R	Comparison to Viscosity Reference Standard

Chemical Quantities

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Viscosity Cup ¹	(0.01 to 50) mm ² /s (50 to 500) mm ² /s (500 to 1 000) mm ² /s (1 000 to 5 000) mm ² /s (5 000 to 12 500) mm ² /s	0.22 % of reading 0.29 % of reading 0.38% of reading 0.38% of reading 0.44% of reading	Comparison to Viscosity Reference Standard, Stop Watch
Refractometer Brix Measuring Equipment ¹	10 %Brix 20 %Brix 30 %Brix 40 %Brix 50 %Brix 60 %Brix	0.012 %Brix + 0.58R 0.021 %Brix + 0.58R 0.031 %Brix + 0.58R 0.031 %Brix + 0.58R 0.04 %Brix + 0.58R 0.05 %Brix + 0.58R	Comparison to Standard Solutions
Refractometer Brix Measuring Equipment ¹ (Reflective Index)	1.347 82 nD 1.363 83 nD 1.381 12 nD 1.399 83 nD 1.420 09 nD 1.441 92 nD	0.006 % of reading + 0.58R 0.006 % of reading + 0.58R 0.006 % of reading + 0.58R 0.006 % of reading + 0.58R 0.006 % of reading + 0.58R 0.006 % of reading + 0.58R	Comparison to Standard Solutions
Calibration of Gas Analyzers and Gas Detectors O ₂ in N ₂	90 µmol/mol 990 µmol/mol 1 cmol/mol 18 cmol/mol	4.8 µmol/mol + 0.58R 20 µmol/mol + 0.58R 0.21 mmol/mol + 0.58R 3.8 mmol/mol + 0.58R	Comparison to Gas Reference Material

Electrical – DC/Low Frequency

Nonthaburi, Thailand

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 to 1 100) V	8.2 µV/V + 0.4 µV 5.1 µV/V + 0.7 µV 3.7 µV/V + 2.6 µV 3.6 µV/V + 4 µV 5.1 µV/V + 40 µV 6.7 µV/V + 0.4 mV	Multi-Function Calibrator
DC Voltage – Source ¹ Fixed Points	1.018 V 10 V	1.9 µV 4.2 µV	DC Voltage Reference Standard
DC Voltage – Measure ¹	Up to 100 mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1 000) V	6.8 µV/V + 0.31 µV 4.1 µV/V + 0.31 µV 4.1 µV/V + 0.51 µV 6.1 µV/V + 30 µV 6.3 µV/V + 0.1 mV	Multimeter

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Measure ¹	100 mV 1 V 10 V 100 V 1 kV	0.71 μ V/V + 2.0 μ V 0.47 μ V/V + 1.7 μ V 0.4 μ V/V + 1.6 μ V 0.47 μ V/V + 1.7 μ V 0.71 μ V/V + 2.0 μ V	Direct transfer with Reference Divider and DC Reference Standard
DC High Voltage ¹ (Source & Measure)	Up to 10 kV (10 to 35) kV	0.35 mV/V + 0.035 V 0.41 mV/V + 0.081 V	Comparison with High Voltage Meter and High Voltage Probe
DC Power – Source ^{1,2} 0.01 mW to 20.5 kW	33 mV to 1 020 V (0.33 to 330) mA 330 mA to 11 A (11 to 20.5) A	0.03 % of Watts output + 0.58R 0.059 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R	Multi-Product Calibrator w/Amplifier
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	41 μ A/A + 6.0 nA 36 μ A/A + 7.0 nA 36 μ A/A + 40 nA 46 μ A/A + 0.70 μ A 82 μ A/A + 12 μ A	Multi-Function Calibrator
DC Current – Source ¹	Up to 11 A	0.36 mA/A + 0.48 mA	Multi-Function Calibrator with Amplifier
DC Current – Source ¹	Up to 330 μ A 330 μ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 3 A (3 to 11) A (11 to 20.5) A	0.12 mA/A + 16 nA 80 μ A/A + 24 nA 80 μ A/A + 0.17 μ A 80 μ A/A + 1.7 μ A 0.16 mA/A + 32 μ A 0.39 mA/A + 0.26 mA 0.78 mA/A + 0.58 mA	Multi-Product Calibrator
DC Current – Source ¹	Up to 16.5 A (16.5 to 150) A (150 to 1 025) A	2.8 mA/A + 3.0 mA 2.8 mA/A + 25 mA 2.9 mA/A + 90 mA	Multi-Product Calibrator w/50-turns coil
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	36 μ A/A + 40 pA 28 μ A/A + 40 pA 28 μ A/A + 0.1 nA 21 μ A/A + 0.8 nA 21 μ A/A + 5 nA 21 μ A/A + 50 nA 36 μ A/A + 0.5 μ A 0.11 mA/A + 10 μ A	Multimeter
DC Current – Measure ¹	(0 to 20) (20 to 2 000) A	0.12 mA/A 0.25 mA/A	Current Shunt /Multimeter

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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 (110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω (330 to 1 100) M Ω	34 $\mu\Omega/\Omega$ + 0.78 m Ω 37 $\mu\Omega/\Omega$ + 1.2 m Ω 26 $\mu\Omega/\Omega$ + 1.2 m Ω 24 $\mu\Omega/\Omega$ + 1.6 m Ω 23 $\mu\Omega/\Omega$ + 1.7 m Ω 24 $\mu\Omega/\Omega$ + 16 m Ω 23 $\mu\Omega/\Omega$ + 17 m Ω 24 $\mu\Omega/\Omega$ + 0.16 Ω 23 $\mu\Omega/\Omega$ + 0.17 Ω 26 $\mu\Omega/\Omega$ + 1.6 Ω 26 $\mu\Omega/\Omega$ + 1.7 Ω 48 $\mu\Omega/\Omega$ + 23 Ω 0.1 m Ω/Ω + 39 Ω 0.21 m Ω/Ω + 1.9 k Ω 0.4 m Ω/Ω + 2.3 k Ω 2.3 m Ω/Ω + 78 k Ω 12 m Ω/Ω + 0.39 k Ω	Multi-Product Calibrator
Resistance – Source ¹ Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	40 $\mu\Omega$ 95 $\mu\Omega$ 0.18 m Ω 0.23 m Ω 0.45 m Ω 1.1 m Ω 2 m Ω 8.9 m Ω 17 m Ω 94 m Ω 0.18 Ω 1.2 Ω 2.2 Ω 21 Ω 42 Ω 0.41 k Ω 0.91 k Ω 10 k Ω	Multi-Function Calibrator
Resistance – Source ¹ Fixed Points	0.05 m Ω 0.1 m Ω 10 m Ω 1 Ω 100 Ω 1 k Ω 10 k Ω	30 $\mu\Omega/\Omega$ 29 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 2.4 $\mu\Omega/\Omega$ 18 $\mu\Omega/\Omega$ 18 $\mu\Omega/\Omega$ 1.5 $\mu\Omega/\Omega$	Standard Resistors

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹	100 k Ω to 1 M Ω (1 to 100) M Ω 100 M Ω to 10 G Ω (10 to 100) G Ω	0.2 m Ω/Ω 0.8 m Ω/Ω 3.1 m Ω/Ω 6 m Ω/Ω	Standard Decade Resistors
Resistance – Measure ¹	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	16 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 13 $\mu\Omega/\Omega$ + 0.5 m Ω 10 $\mu\Omega/\Omega$ + 0.5 m Ω 10 $\mu\Omega/\Omega$ + 5 m Ω 11 $\mu\Omega/\Omega$ + 50 m Ω 16 $\mu\Omega/\Omega$ + 2 Ω 51 $\mu\Omega/\Omega$ + 0.1 k Ω 0.5 m Ω/Ω + 1 k Ω 5 m Ω/Ω + 10 k Ω	Multimeter
Capacitance – Source ¹ 50 Hz to 1 kHz	-(0.19 to 0.4) nF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F 330 μ F to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	3.9 mF/F + 7.8 pF 4 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 2.1 mF/F + 7.8 pF 2 mF/F + 78 pF 2.1 mF/F + 78 pF 2 mF/F + 0.23 nF 2.1 mF/F + 0.78 nF 2 mF/F + 2.3 nF 2.1 mF/F + 7.8 nF 3.2 mF/F + 23 nF 3.7 mF/F + 78 nF 3.6 mF/F + 0.23 μ F 3.5 mF/F + 0.78 μ F 3.5 mF/F + 2.3 μ F 3.5 mF/F + 7.8 μ F 5.8 mF/F + 23 μ F 8.5 mF/F + 78 μ F	Multi-Product Calibrator

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹	1 pF		Standard Air Capacitors
	1 kHz	0.12 mF/F + 0.58R	
	10 kHz	0.12 mF/F + 0.58R	
	100 kHz	0.12 mF/F + 0.58R	
	1 MHz	0.12 mF/F + 0.58R	
	2 MHz	0.17 mF/F + 0.58R	
	10 pF		
	1 kHz	0.12 mF/F + 0.58R	
	10 kHz	0.12 mF/F + 0.58R	
	100 kHz	0.12 mF/F + 0.58R	
	1 MHz	0.12 mF/F + 0.58R	
	2 MHz	0.12 mF/F + 0.58R	
	100 pF		
	1 kHz	0.12 mF/F + 0.58R	
	10 kHz	0.12 mF/F + 0.58R	
	100 kHz	0.12 mF/F + 0.58R	
	1 MHz	0.21 mF/F + 0.58R	
	2 MHz	0.60 mF/F + 0.58R	
	1 000 pF		
	1 kHz	0.12 mF/F + 0.58R	
	10 kHz	0.12 mF/F + 0.58R	
	100 kHz	0.12 mF/F + 0.58R	
	1 MHz	0.12 mF/F + 0.58R	
	2 MHz	0.12 mF/F + 0.58R	
Capacitance – Measure ¹ @ 1 kHz	1 pF to 1 mF	1 mF/F	RLC Digibridge
AC Voltage – Source ¹	220 μV to 2.2 mV		Multi-Function Calibrator
	(10 to 20) Hz	0.94 mV/V + 4 μV	
	(20 to 40) Hz	0.45 mV/V + 4 μV	
	40 Hz to 20 kHz	0.45 mV/V + 4 μV	
	(20 to 50) kHz	0.64 mV/V + 4 μV	
	(50 to 100) kHz	1.1 mV/V + 5 μV	
	(100 to 300) kHz	1.6 mV/V + 10 μV	
	(300 to 500) kHz	2.4 mV/V + 20 μV	
	500 kHz to 1 MHz	3.8 mV/V + 20 μV	

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) mV		Multi-Function Calibrator
	(10 to 20) Hz	0.26 mV/V + 4 μ V	
	(20 to 40) Hz	0.12 mV/V + 4 μ V	
	40 Hz to 20 kHz	0.11 mV/V + 4 μ V	
	(20 to 50) kHz	0.22 mV/V + 4 μ V	
	(50 to 100) kHz	0.51 mV/V + 5 μ V	
	(100 to 300) kHz	1.1 mV/V + 10 μ V	
	(300 to 500) kHz	1.4 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 20 μ V	
	(22 to 220) mV		
	(10 to 20) Hz	0.24 mV/V + 12 μ V	
	(20 to 40) Hz	95 μ V/V + 7 μ V	
	40 Hz to 20 kHz	85 μ V/V + 7 μ V	
	(20 to 50) kHz	0.2 mV/V + 7 μ V	
	(50 to 100) kHz	0.46 mV/V + 17 μ V	
	(100 to 300) kHz	0.94 mV/V + 20 μ V	
	(300 to 500) kHz	1.4 mV/V + 25 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 45 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.24 mV/V + 40 μ V	
	(20 to 40) Hz	93 μ V/V + 15 μ V	
	40 Hz to 20 kHz	50 μ V/V + 8 μ V	
	(20 to 50) kHz	78 μ V/V + 10 μ V	
	(50 to 100) kHz	0.12 mV/V + 30 μ V	
	(100 to 300) kHz	0.45 mV/V + 80 μ V	
	(300 to 500) kHz	1 mV/V + 0.2 mV	
	500 kHz to 1 MHz	1.7 mV/V + 0.3 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.24 mV/V + 0.4 mV	
	(20 to 40) Hz	93 μ V/V + 0.15 mV	
	40 Hz to 20 kHz	50 μ V/V + 50 μ V	
	(20 to 50) kHz	79 μ V/V + 100 μ V	
	(50 to 100) kHz	0.11 mV/V + 0.2 mV	
	(100 to 300) kHz	0.37 mV/V + 0.6 mV	
	(300 to 500) kHz	1 mV/V + 2 mV	
	500 kHz to 1 MHz	1.6 mV/V + 3.2 mV	

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(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 (15 to 50) Hz 50 Hz to 1 kHz	0.24 mV/V + 4 mV 93 μ V/V + 1.5 mV 56 μ V/V + 0.6 mV 83 μ V/V + 1 mV 0.16 mV/V + 2.5 mV 0.9 mV/V + 16 mV 4.4 mV/V + 40 mV 8 mV/V + 80 mV 0.3 mV/V + 16 mV 74 μ V/V + 3.5 mV	Multi-Function Calibrator
AC Voltage – Source ¹	(220 to 750) V (30 to 50) kHz (50 to 100) kHz (220 to 1 100) V 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.6 mV/V + 11 mV 2.3 mV/V + 45 mV 97 μ V/V + 4 mV 0.17 mV/V + 6 mV 0.6 mV/V + 11 mV	Multi-Function Calibrator with Amplifier
AC Voltage – Measure ¹	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	0.33 mV/V + 3 μ V 0.24 mV/V + 1.1 μ V 0.33 mV/V + 1.1 μ V 1 mV/V + 1.1 μ V 5 mV/V + 1.1 μ V 40 mV/V + 2 μ V 88 μ V/V + 4 μ V 82 μ V/V + 2 μ V 0.15 mV/V + 2 μ V 0.3 mV/V + 2 μ V 0.81 mV/V + 2 μ V 3 mV/V + 10 μ V 10 mV/V + 10 μ V 15 mV/V + 10 μ V	Multimeter

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	100 mV to 10 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 (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	75 μ V/V + 0.4 mV 75 μ V/V + 0.2 mV 0.14 mV/V + 0.2 mV 0.3 mV/V + 0.2 mV 0.8 mV/V + 0.2 mV 3 mV/V + 1 mV 10 mV/V + 1 mV 15 mV/V + 1 mV 0.2 mV/V + 4 mV 0.2 mV/V + 2 mV 0.2 mV/V + 2 mV 0.35 mV/V + 2 mV 1.2 mV/V + 2 mV 4 mV/V + 10 mV 15 mV/V + 10 mV 0.4 mV/V + 40 mV 0.4 mV/V + 20 mV 0.6 mV/V + 20 mV 1.2 mV/V + 20 mV 3 mV/V + 20 mV	Multimeter
	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (2.2 to 7) 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	1.1 mV/V + 0.87 μ V 0.51 mV/V + 0.87 μ V 0.29 mV/V + 0.87 μ V 0.55 mV/V + 1.3 μ V 0.81 mV/V + 1.7 μ V 1.5 mV/V + 2.7 μ V 1.6 mV/V + 5.3 μ V 2.4 mV/V + 5.3 μ V 0.57 mV/V + 0.87 μ V 0.26 mV/V + 0.87 μ V 0.16 mV/V + 0.87 μ V 0.28 mV/V + 1.3 μ V 0.41 mV/V + 1.7 μ V 0.82 mV/V + 2.7 μ V 0.89 mV/V + 5.3 μ V 1.6 mV/V + 5.3 μ V	
AC Voltage – Measure ¹			AC Measurement Standard

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(7 to 22) mV		AC Measurement Standard
	(10 to 20) Hz	0.21 mV/V + 0.87 μ V	
	(20 to 40) Hz	0.15 mV/V + 0.87 μ V	
	40 Hz to 20 kHz	0.1 mV/V + 0.87 μ V	
	(20 to 50) kHz	0.16 mV/V + 1.3 μ V	
	(50 to 100) kHz	0.23 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.57 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.62 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	1.2 mV/V + 5.3 μ V	
	(22 to 70) mV		
	(10 to 20) Hz	0.17 mV/V + 1 μ V	
	(20 to 40) Hz	95 μ V/V + 1 μ V	
	40 Hz to 20 kHz	68 μ V/V + 1 μ V	
	(20 to 50) kHz	0.1 mV/V + 1.3 μ V	
	(50 to 100) kHz	0.19 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.39 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.48 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.82 mV/V + 5.3 μ V	
	(70 to 220) mV		
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	62 μ V/V + 1 μ V	
	40 Hz to 20 kHz	34 μ V/V + 1 μ V	
	(20 to 50) kHz	51 μ V/V + 1.3 μ V	
	(50 to 100) kHz	0.11 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.21 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.29 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.75 mV/V + 5.3 μ V	
	(220 to 700) mV		
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	56 μ V/V + 1 μ V	
	40 Hz to 20 kHz	30 μ V/V + 1 μ V	
	(20 to 50) kHz	40 μ V/V + 1.3 μ V	
	(50 to 100) kHz	64 μ V/V + 1.7 μ V	
	(100 to 300) kHz	0.18 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.24 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.73 mV/V + 5.3 μ V	

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	700 mV to 2.2 V		AC Measurement Standard
	(10 to 20) Hz	0.13 mV/V + 0.058 μ V	
	(20 to 40) Hz	46 μ V/V + 0.058 μ V	
	40 Hz to 20 kHz	21 μ V/V + 0.058 μ V	
	(20 to 50) kHz	33 μ V/V + 0.058 μ V	
	(50 to 100) kHz	54 μ V/V + 0.058 μ V	
	(100 to 300) kHz	0.16 mV/V + 0.058 μ V	
	(300 to 500) kHz	0.21 mV/V + 0.058 μ V	
	500 kHz to 1 MHz	0.7 mV/V + 0.058 μ V	
	(2.2 to 7) V		
	(10 to 20) Hz	0.13 mV/V + 0.058 μ V	
	(20 to 40) Hz	47 μ V/V + 0.058 μ V	
	40 Hz to 20 kHz	21 μ V/V + 0.058 μ V	
	(20 to 50) kHz	35 μ V/V + 0.058 μ V	
	(50 to 100) kHz	60 μ V/V + 0.058 μ V	
	(100 to 300) kHz	0.17 mV/V + 0.058 μ V	
	(300 to 500) kHz	0.29 mV/V + 0.058 μ V	
	500 kHz to 1 MHz	0.87 mV/V + 0.058 μ V	
	(7 to 22) V		
	(10 to 20) Hz	0.14 mV/V + 0.58 μ V	
	(20 to 40) Hz	48 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	23 μ V/V + 0.58 μ V	
	(20 to 50) kHz	35 μ V/V + 0.58 μ V	
	(50 to 100) kHz	61 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.17 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.29 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.87 mV/V + 0.58 μ V	
	(22 to 70) V		
	(10 to 20) Hz	0.14 mV/V + 0.58 μ V	
	(20 to 40) Hz	48 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	26 μ V/V + 0.58 μ V	
	(20 to 50) kHz	40 μ V/V + 0.58 μ V	
	(50 to 100) kHz	69 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.14 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.28 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.8 mV/V + 0.58 μ V	

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(70 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 (220 to 700) V (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (700 to 1 000) V (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.14 mV/V + 5.8 μV 50 μV/V + 5.8 μV 28 μV/V + 5.8 μV 50 μV/V + 5.8 μV 76 μV/V + 5.8 μV 0.15 mV/V + 5.8 μV 0.34 mV/V + 5.8 μV 0.14 mV/V + 5.8 μV 69 μV/V + 5.8 μV 34 μV/V + 5.8 μV 95 μV/V + 5.8 μV 0.35 mV/V + 5.8 μV 0.14 mV/V + 5.8 μV 69 μV/V + 5.8 μV 32 μV/V + 5.8 μV 95 μV/V + 5.8 μV 0.35 mV/V + 5.8 μV	AC Measurement Standard
AC High Voltage – Source ¹	Up to 10) kV (50 to 60) Hz	1.4 mV/V + 0.13 V	Comparison with High Voltage Meter and High Voltage Probe
AC High Voltage – Measure ¹	Up to 10) kV (50 to 60) Hz (10 to 30) kV (50 to 60) Hz	1.4 mV/V + 0.13 V 1.2 mV/V + 0.24 V	Comparison with High Voltage Meter and High Voltage Probe
AC Resistance Measure ¹	1 Ω to 1 MΩ 12 Hz to 100 kHz	0.91 mΩ/Ω	RLC Digibridge

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} 0.1 mW to 20.5 kW (45 to 65) Hz PF = 1	(33 to 330) mV		Multi-Product Calibrator
	(3.3 to 9) mA	0.11 % of Watts output + 0.58R	
	(9 to 33) mA	0.081 % of Watts output + 0.58R	
	(33 to 90) mA	0.11 % of Watts output + 0.58R	
	(90 to 330) mA	0.081 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.1 % of Watts output + 0.58R	
	(0.9 to 3) A	0.088 % of Watts output + 0.58R	
	(3 to 11) A	0.1 % of Watts output + 0.58R	
	(11 to 20.5) A	0.13 % of Watts output + 0.58R	
	330 mV to 1 020 V		
	(3.3 to 9) mA	0.096 % of Watts output + 0.58R	
	(9 to 33) mA	0.066 % of Watts output + 0.58R	
	(33 to 90) mA	0.096 % of Watts output + 0.58R	
	(90 to 330) mA	0.066 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.088 % of Watts output + 0.58R	
	(0.9 to 3) A	0.073 % of Watts output + 0.58R	
	(3 to 11) A	0.096 % of Watts output + 0.58R	
	(11 to 20.5) A	0.15 % of Watts output + 0.58R	
AC Power – Source ^{1,2} 0.1 mW to 20.5 kW (45 to 65) Hz (PF = 0 to 0.999)	(33 to 330) mV		Multi-Product Calibrator
	(3.3 to 9) mA	0.21 % of Watts output + 0.58R	
	(9 to 33) mA	0.19 % of Watts output + 0.58R	
	(33 to 90) mA	0.21 % of Watts output + 0.58R	
	(90 to 330) mA	0.19 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.2 % of Watts output + 0.58R	
	(0.9 to 3) A	0.19 % of Watts output + 0.58R	
	(3 to 11) A	0.2 % of Watts output + 0.58R	
	(11 to 20.5) A	0.21 % of Watts output + 0.58R	
	330 mV to 1 020 V		
	(3.3 to 9) mA	0.2 % of Watts output + 0.58R	
	(9 to 33) mA	0.19 % of Watts output + 0.58R	
	(33 to 90) mA	0.2 % of Watts output + 0.58R	
	(90 to 330) mA	0.19 % of Watts output + 0.58R	
	(0.33 to 0.9) A	0.19 % of Watts output + 0.58R	
	(0.9 to 3) A	0.19 % of Watts output + 0.58R	
	(3 to 11) A	0.2 % of Watts output + 0.58R	
	(11 to 20.5) A	0.23 % of Watts output + 0.58R	

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	Up to 220 μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (0.22 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 (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	0.27 mA/A + 16 nA 0.19 mA/A + 10 nA 0.16 mA/A + 8 nA 0.31 mA/A + 12 nA 1.1 mA/A + 65 nA 0.27 mA/A + 40 nA 0.19 mA/A + 35 nA 0.15 mA/A + 35 nA 0.22 mA/A + 0.11 μ A 1.1 mA/A + 0.65 μ A 0.26 mA/A + 0.40 μ A 0.17 mA/A + 0.35 μ A 0.14 mA/A + 0.35 μ A 0.21 mA/A + 0.55 μ A 1.1 mA/A + 5.0 μ A	Multi-Function Calibrator
AC Current – Source ¹	(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 (0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.26 mA/A + 4 μ A 0.18 mA/A + 3.5 μ A 0.14 mA/A + 2.6 μ A 0.21 mA/A + 3.5 μ A 1.1 mA/A + 10 μ A 0.27 mA/A + 35 μ A 0.46 mA/A + 80 μ A 7 mA/A + 0.16 mA	Multi-Function Calibrator
AC Current – Source ¹	(0 to 20.5) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.47 mA/A + 0.17 mA 0.95 mA/A + 0.38 mA 3.6 mA/A + 0.75 mA	Multi-Function Calibrator w/Amplifier, Multi-Product Calibrator
AC Current – Source ¹	Up to 16.5 A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	3.3 mA/A + 3.5 mA 9.1 mA/A + 3.5 mA 3.3 mA/A + 29 mA 9.1 mA/A + 31 mA 3.4 mA/A + 104 mA 9.2 mA/A + 116 mA	Multi-Product Calibrator w/50-turn coil

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	Up to 100 μ A		Multimeter
	(10 to 20) Hz	4 mA/A + 0.03 μ A	
	(20 to 45) Hz	1.5 mA/A + 0.03 μ A	
	(45 to 100) Hz	0.62 mA/A + 0.03 μ A	
	100 Hz to 5 kHz	0.62 mA/A + 0.03 μ A	
	100 μ A to 1 mA		
	(10 to 20) Hz	4 mA/A + 0.2 μ A	
	(20 to 45) Hz	1.5 mA/A + 0.2 μ A	
	(45 to 100) Hz	0.62 mA/A + 0.2 μ A	
	100 Hz to 5 kHz	0.34 mA/A + 0.2 μ A	
	(5 to 20) kHz	0.62 mA/A + 0.2 μ A	
	(20 to 50) kHz	4 mA/A + 0.4 μ A	
	(50 to 100) kHz	5.5 mA/A + 1.5 μ A	
	(1 to 10) mA		
	(10 to 20) Hz	4 mA/A + 2 μ A	
	(20 to 45) Hz	1.5 mA/A + 2 μ A	
	(45 to 100) Hz	0.61 mA/A + 2 μ A	
	100 Hz to 5 kHz	0.32 mA/A + 2 μ A	
	(5 to 20) kHz	0.61 mA/A + 2 μ A	
	(20 to 50) kHz	4 mA/A + 4 μ A	
	(50 to 100) kHz	5.5 mA/A + 15 μ A	
	(10 to 100) mA		
	(10 to 20) Hz	4 mA/A + 20 μ A	
	(20 to 45) Hz	1.5 mA/A + 20 μ A	
	(45 to 100) Hz	0.61 mA/A + 20 μ A	
	100 Hz to 5 kHz	0.32 mA/A + 20 μ A	
	(5 to 20) kHz	0.61 mA/A + 20 μ A	
	(20 to 50) kHz	4 mA/A + 40 μ A	
	(50 to 100) kHz	5.5 mA/A + 0.15 mA	
	100 mA to 1 A		
	(10 to 20) Hz	4 mA/A + 0.2 mA	
	(20 to 45) Hz	1.6 mA/A + 0.2 mA	
	(45 to 100) Hz	0.81 mA/A + 0.2 mA	
	100 Hz to 5 kHz	1 mA/A + 0.2 mA	
	(5 to 20) kHz	3 mA/A + 0.2 mA	
	(20 to 50) kHz	10 mA/A + 0.4 mA	

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	Up to 10 A 5 Hz to 100 kHz (10 to 20) A 45 Hz to 5 kHz (20 to 1 000) A (45 to 400) Hz	0.2 mA/A + 0.58 μ A 0.16 mA/A 0.31 mA/A	Current Shunt with Multimeter, AC Measurement Standard
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C 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 L (-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.36 °C 0.29 °C 0.26 °C 0.28 °C 0.26 °C 0.23 °C 0.27 °C 0.4 °C 0.66 °C 0.4 °C 0.17 °C 0.16 °C 0.17 °C 0.2 °C 0.24 °C 0.17 °C 0.16 °C 0.18 °C 0.21 °C 0.28 °C 0.18 °C 0.17 °C 0.23 °C 0.33 °C 0.31 °C 0.23 °C 0.18 °C	Multi-Product Calibrator

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type N		Multi-Product Calibrator
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type S		
	(0 to 250) °C	0.38 °C	
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	
	Type T		
	(-250 to -150) °C	0.5 °C	
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U		
	(-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 100 Ω		Multi-Product Calibrator
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 3916, 100 Ω		Multi-Product Calibrator
	(-200 to -190) $^{\circ}\text{C}$	0.19 $^{\circ}\text{C}$	
	(-190 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.078 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.18 $^{\circ}\text{C}$	
	Pt 385, 200 Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.093 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.12 $^{\circ}\text{C}$	
	Pt 385, 500 Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.085 $^{\circ}\text{C}$	
	Pt 385, 1 k Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.18 $^{\circ}\text{C}$	
	PtNi 385, 120 Ω (Ni120)		
	(-80 to 0) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	Cu 427, 10 Ω		
	(-100 to 260) $^{\circ}\text{C}$	0.23 $^{\circ}\text{C}$	
Inductance – Measure ¹ 1 kHz	100 μH to 10 H	1.2 mH/H	RLC Digibridge

Electrical – DC/Low Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Source ¹ (Fixed Artifacts) 1 kHz	100 μ H 1 mH 10 mH 100 mH 1 H	0.042 μ H 0.42 μ H 4.2 μ H 20 μ H 0.2 mH	Standard Inductors
Oscilloscopes ¹ Rise/ Fall Time, (10 to 90) %	Up to 1.25 s	1.3 ps	Oscilloscope Calibrator and Active Head
Oscilloscope ¹ Square Wave Amplitude, < 10 kHz into 50 Ω or 1 M Ω Load Impedance	Up to 1 mVp-p (1 to 21) mVp-p (21 to 556) mVp-p 556 mVp-p to 210 Vp-p	10 mV/V + 10 μ V 1.5 mV/V + 20 μ V 1.5 mV/V + 1.2 μ V 1.3 mV/V + 1.2 μ V	Oscilloscope Calibrator and Active Head
Oscilloscope ¹ Horizontal Deflection (Time)	150 ps to 50 s	0.39 parts in 10 ⁶ of reading	Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Vertical Deflection (Amplitude)	Up to 50 Vp-p (50 to 100) Vp-p (100 V to 200) Vp-p	250 μ V/V + 25 μ V 250 μ V/V + 26 μ V 250 μ V/V + 63 μ V	Oscilloscope Calibrator and Active Head
Oscilloscopes – Bandwidth ¹	100 mHz to 50 GHz	2.1 % of reading	Oscilloscope Calibrator w/Active Head, Power Sensor
Phase – Measure ¹ 10 mV to 320 V	(0 to 360) ° 10 Hz to 100 kHz 100 kHz to 10 MHz	0.029° 0.064°	Precision Phasemeter
Tesla Meter / Gauss Meter ²	Up to 18 000 G	1.2 % of reading + 0.58R	Standard Gauss Meter with Probe

Electrical – RF/Microwave

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Tuned Power – Measure ¹	(-120 to 30) dB 100 kHz to 2.6 GHz (2.6 to 18) GHz (18 to 26.5) GHz	0.17 dB 0.18 dB 0.2 dB	Measuring Receiver with Power Sensor

Electrical – RF/Microwave

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Measure ¹	(-70 to 44) dBm (100 to 300) kHz 300 kHz to 1 MHz 1 MHz to 2 GHz (2 to 6) GHz (6 to 12.4) GHz (12.4 to 18) GHz (18 to 26.5) GHz (26.5 to 40) GHz (40 to 50) GHz	0.11 dB 0.064 dB 0.054 dB 0.055 dB 0.057 dB 0.063 dB 0.07 dB 0.08 dB 0.086 dB	Measuring Receiver, Power Meter with Power Sensor
RF Power – Source ¹	(-130 to 16) dBm 10 kHz to 2.56 GHz (-110 to 10) dBm 20 MHz to 2 GHz (2 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.4 dB 0.26 dB 0.32 dB 0.4 dB 0.83 dB	Signal Generators
Distortion – Measure ¹ 20 Hz to 20 kHz 20 Hz to 50 kHz (50 to 100) kHz	80 kHz BW: -80 dB 500 kHz BW: -70 dB 500 kHz BW: -65 dB	1.6 dB 1.6 dB 1.6 dB	Audio Analyzer
Harmonic Distortion ¹ (Source and Measure) 1 kHz to 26.5 GHz	(-100 to 0.01) dB	1.2 dB	Spectrum Analyzer
Phase Noise ¹ (Source and Measure) 1 MHz to 26.5 GHz Offset carrier $\leq$ 100 kHz	(-70 to -120) dBc/Hz	1.2 dB/Hz	Signal Generator, PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹ AM Depth Accuracy 100 kHz to 10 MHz (Rate: 50 Hz to 10 kHz)	Depth: (5 to 99) %	0.91 % Depth	PSA Series Spectrum Analyzer
10 MHz to 3 GHz (Rate: 50 Hz to 100 kHz)	Depth: (20 to 99) % Depth: (5 to 20) %	0.61 % Depth 3 % Depth	
(3 to 26.5) GHz (Rate: 50 Hz to 100 kHz)	Depth: (20 to 99) % Depth: (5 to 20) %	1.8 % Depth 5.5 % Depth	
Flatness 10 MHz to 3 GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) %	0.37 % Depth	
(3 to 26.5) GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) %	0.49 % Depth	
FM Rejection (50 Hz to 3 kHz BW) 250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz)	Depths: < 50 % Deviations: < 5 kHz	0.17 % Depth	
10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz)	Depths: < 50 % Deviations: < 50 kHz	0.44 % Depth	
Residual AM 250 kHz to 26.5 GHz (50 Hz to 3 kHz BW)		0.012 % Depth (rms)	

Electrical – RF/Microwave

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz (Rate: 20 Hz to 200 kHz) AM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz Residual FM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: 200 Hz to 400 kHz AM Depths: ≤ 50% (Rate: 400 Hz or 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 13 Hz 25 Hz 49 Hz 1.9 Hz 3.7 Hz 7.4 Hz	PSA Series Spectrum Analyzer
Phase Modulation – Measure ¹ PM Deviation Accuracy 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz AM Rejection (50 Hz to 3 kHz BW) 100 kHz to 26.5 GHz Residual PM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad AM Depths: ≤ 50% (Rate: 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad 0.002 1 rad 0.004 1 rad 0.008 1 rad	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation – Measure ¹ For 2/3/4/5G Composite Rho ⁵	450 MHz to 26.5 GHz $\rho = (0.9 \text{ to } 1)$	0.001	PSA Series Spectrum Analyzer, Signal Generator
Error Vector Magnitude (rms)	450 MHz to 26.5 GHz EVM = (0 to 25) %	0.3 % of reading	
Peak Code Domain Error	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Phase error	450 MHz to 26.5 GHz (1 to 15) °	0.71 °	
Frequency Error	3 Hz to 26.5GHz	2.1×10^{-7} Hz/Hz	
I/Q Origin Offset	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Channel Power	450 MHz to 26.5 GHz Power > -70 dBm	0.62 dB	
Amplitude Modulation – Source ¹	(11 to 13.5) MHz Rate: 20 Hz to 100 kHz Depth: 0% to 95% Depth: 95% to 99%	0.13 % Depth 0.24 % Depth	AM/FM Test Source
	100 kHz to 26.5 GHz Rate: 1 kHz to 100 kHz Depth: (5 to 80) %	3.5 % of reading + 1.2 % Depth	Signal Generator
Frequency Modulation – Source ¹	(11 to 432) MHz Rate: 20 Hz to 100 kHz Deviations: ≤ 400 kHz	0.29 % Modulation	AM/FM Test Source
	100 kHz to 26.5 GHz Rate: 10 Hz to 10 MHz Deviations: ≤ 20 MHz	1.7 % Modulation + 23 Hz	Signal Generator
Phase Modulation – Source ¹	100 kHz to 26.5 GHz Rate: 10 Hz to 10 MHz Deviations: ≤ 40 rad	1.7 % of reading + 0.003 5 rad	Signal Generator

Electrical – RF/Microwave

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Reflection S11 / S22 – Measure ¹	Magnitude (0 to 110) dB (30 to 300) kHz 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 40) GHz Phase (-180 to 180) ° 30 kHz to 3 GHz (3 to 40) GHz	0.025 dB 0.026 dB 0.033 dB 0.094 dB 0.073 ° 0.25 °	Vector Network Analyzer, Calibration Kit
Transmission S12 / S21 – Measure ¹	Magnitude (0 to 110) dB (30 to 300) kHz 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 40) GHz Phase (-180 to 180) ° 30 kHz to 3 GHz (3 to 40) GHz	0.029 dB 0.028 dB 0.039 dB 0.089 dB 0.073 ° 0.25 °	Vector Network Analyzer, Calibration Kit
RF Power Sensors – Calibration Factors ^{1,5}	Referenced at 1 mW 100 kHz to 10MHz 10 MHz to 1.2 GHz (1.2 to 6) GHz (6 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 33) GHz (33 to 40) GHz (40 to 45) GHz (45 to 50) GHz	1.4 % 1.3 % 1.4 % 1.6 % 2.1 % 2.6 % 2.9 % 3 % 4 % 4.7 %	Coaxial Thermistor, Power Sensors, Power Meter

Electrical – RF/Microwave

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Excess Noise Ratio (ENR) / Noise Source ¹	(4.5 to 17) dB		Noise Source and PSA Series Spectrum Analyzer
	10 MHz to 2 GHz	0.15 dB	
	(3 to 4) GHz	0.14 dB	
	(4 to 5) GHz	0.15 dB	
	(5 to 6) GHz	0.13 dB	
	(6 to 7) GHz	0.16 dB	
	(7 to 10) GHz	0.15 dB	
	(10 to 12) GHz	0.18 dB	
	(12 to 13) GHz	0.19 dB	
	(13 to 16) GHz	0.18 dB	
	(16 to 17) GHz	0.19 dB	
	(17 to 18) GHz	0.2 dB	
	(18 to 19) GHz	0.16 dB	
	(19 to 21) GHz	0.18 dB	
	(21 to 22) GHz	0.19 dB	
	(22 to 23) GHz	0.22 dB	
	(23 to 24) GHz	0.18 dB	
	(24 to 25) GHz	0.16 dB	
	(25 to 26.5) GHz	0.18 dB	

Length – Dimensional Metrology

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 1 500 mm	$(0.17 + 0.006 \text{ } l) \text{ } \mu\text{m} + 0.58R$	Gauge Blocks
Height Gages ^{1,2}	Up to 1 500 mm	$(0.71 + 0.001 \text{ } l) \text{ } \mu\text{m} + 0.58R$	Gage Blocks, Surface Plate,
Micrometers ^{1,2} External, Internal, Depth, Bore and Micrometer Head	Length Up to 1 500 mm	$(0.091 + 0.006 \text{ } l) \text{ } \mu\text{m} + 0.58R$	Gage Blocks, Master Ring, Universal Length Measuring Machine, Optical Parallels or Optical Flats
	Flatness Up to 15 μm	0.13 μm	
	Parallelism Up to 15 μm	0.15 μm	
Indicators ^{1,2} Dial Gauge, Dial Test Indicator, LVDTs	Up to 100 mm	$(0.32 + 0.004 \text{ } l) \text{ } \mu\text{m} + 0.58R$	Universal Length Measuring Machine, Indicator Tester
	Up to 100 mm	$(0.069 + 0.002 \text{ } l) \text{ } \mu\text{m} + 0.58R$	Gage Block, Comparator Stand

Length – Dimensional Metrology

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Plain Plug Gages / Pin Gages / Thread Wires ^{1,2} (Cylindrical and Taper)	Up to 300 mm	$(0.31 + 0.001\ 7l)\ \mu\text{m}$	Universal Length Measuring Machine, High-Accuracy Micrometer, Gage Block
Plain Ring Gages ² (Cylindrical and Taper)	(1 to 300) mm	$(0.26 + 0.002\ 2l)\ \mu\text{m}$	Universal Length Measuring Machine, Master Ring, Gage Block
Thread Plug Gages ² (Cylindrical and Taper) Simple Pitch Diameter Major Diameter	Up to 300 mm	$(1.1 + 0.004\ 1l)\ \mu\text{m}$ $(0.33 + 0.001\ 7l)\ \mu\text{m}$	Universal Length Measuring Machine, High-Accuracy Micrometer, Gage Block, Thread Measuring Wires
Thread Ring Gages ² (Cylindrical and Taper) Simple Pitch Diameter Major Diameter	(3 to 300) mm	$(1.3 + 0.002\ 6l)\ \mu\text{m}$ $(0.31 + 0.002\ 6l)\ \mu\text{m}$	Universal Length Measuring Machine, Gage Block, Master Ring Gage, Thread Calibration Standards
Setting Rod, Micrometer Standard, Length Standards ²	Up to 500 mm	$(0.44 + 0.002\ 3l)\ \mu\text{m}$	Gage block, Universal Measuring Machine
Snap Gages ² (External / Internal)	Up to 500 mm	$(0.28 + 0.002\ 5l)\ \mu\text{m}$	Universal Measuring Machine, Gage Blocks, Master Ring
Thickness / Feeler Gages ²	Up to 25 mm	$(0.35 + 0.000\ 53l)\ \mu\text{m}$	Universal Measuring Machine, Gage Blocks
Coating Thickness Gage ^{1,2}	Up to 300 μm (300 to 5 000) μm	0.36 μm 0.10 % of reading + 0.58R	Standard Calibration Foil
Gage Block ² Length (Deviation of the length at any point from nominal length) Variation in length	Up to 100 mm Up to 0.5 mm	$(0.065 + 0.001\ 0l)\ \mu\text{m}$ 0.032 μm	Gage Block, Gage Block Comparator
Gage Block ² Length (Deviation of the length at any point from nominal length) Variation in length	Up to 100 mm (100 to 500) mm Up to 0.5 mm	$(0.16 + 0.000\ 61l)\ \mu\text{m}$ $(0.11 + 0.001\ 0l)\ \mu\text{m}$ 0.15 μm	Gage Block, Universal Length Measuring Machine

Length – Dimensional Metrology

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Surface Plates ^{1,2} Overall Flatness	(150 to 3 600) mmD	(0.49 + 0.001 3D) µm	Differential level, Planekator
Local Area Flatness (Variation)	Up to 0.13 mmD	(0.63 + 0.001 2D) µm	Repeat-o-meter
Universal Length Measuring Machine (ULM) ^{1,2}	Up to 100 mm (100 to 500) mm	(0.057 + 0.001 8I) µm (0.052 + 0.002 0I) µm	Gage Blocks
Line Scale Calibrator ^{1,2}	Up to 1 000 mm (1 000 to 6 000) mm	(1.5 + 0.008I) µm (0.009 5I) µm	Standard Scale, Precision Ruler, Gage Blocks
Standard Scale ²	Up to 300 mm (300 to 1 000) mm	(1 + 0.001 8I) µm (2.9 + 0.001 8I) µm	Standard Scale, Smart Scope, Line Scale Calibrator
Ruler & Tape Measures ^{1,2} (Comparison Method)	Up to 1 000 mm (1 000 to 50 000) mm	11 µm (0.011I) µm	Standard Scale, Precision Ruler, Line Scale Calibrator
Ruler & Tape Measures ² (Direct Measurement)	Up to 1 000 mm (1 000 to 50 000) mm	(15 + 0.009I) µm (0.024I) µm	Line Scale Calibrator
Precision Level	Up to 1 mm/m (1 to 2) mm/m	0.85 % of reading + 3.5 µm/m 1.8 % of reading	Level System
Master Level / Electronic Inclinometer / Angle Meter	Up to 5 mm/m (0° to 90°) (4 Quadrant)	1.1 µm/m 0.000 82°	Sine Bar, Gage Block, Surface Plate
Roughness Tester ¹	Up to 3.1 µm (Ra) Up to 12.5 µm (Rz) Up to 95 µm (Rsm)	0.032 µm 0.17 µm 0.93 µm	Roughness Standard
Sine Bar & Sine Plate ²	Up to 300 mm	(0.35 + 0.0017I) µm	Universal Measuring Machine, LVDT w/amplifier, Granite Surface Plate Granite Square, Angle Gage Block, Gauge Block, Optical Flat, Precision Height Gauge
Optical Comparators and Vision Systems/Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 1 000 mm	(1.2 + 0.008I) µm	Standard Scales, Gage Blocks

Length – Dimensional Metrology

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Check Master / Caliper Checker / Height Master / Riser Block ²			
Block Pitch Accuracy	Up to 1 000 mm	$(0.55 + 0.001\ 1l)\ \mu\text{m}$	Gage Blocks, Surface Plate, Electric Comparator, Linear Gage, Precision Height Gage
Parallelism of Block	Up to 1 000 mm	0.6 μm	
Micrometer Head Accuracy	Up to 25 mm	$(0.26 + 0.006\ 9l)\ \mu\text{m}$	
Calibration Tester / Dial Gage Tester / Indicator Calibrator ²	Up to 25 mm	$(0.26 + 0.006\ 9l)\ \mu\text{m}$	Linear Gage, Optical Flat
Coordinate Measuring Machine (CMM) ^{1,2}	Up to 1 000 mm	$(0.16 + 0.002\ 1l)\ \mu\text{m}$	Gage Blocks

Mass and Mass Related

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Hardness Testers ¹	HRC		Indirect verification using hardness test blocks
	Low	0.45 HRC	
	Middle		
	High		
	HRBS		
	Low	0.45 HRBS	
	Middle		
	High		
	HRBW		
Low	0.45 HRBW		
Middle			
High			
Scales & Balances ^{1,3} (Platform & Spring)	(0 to 5) mg	0.003 1 mg	Standard Weights
	(5 to 10) mg	0.004 1 mg	
	(10 to 20) mg	0.005 1 mg	
	(20 to 50) mg	0.006 1 mg	
	(50 to 100) mg	0.008 1 mg	
	(100 to 200) mg	0.01 mg	
	(200 to 500) mg	0.013 mg	
	500 mg to 1 g	0.015 mg	
	(1 to 2) g	0.02 mg	

Mass and Mass Related

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales & Balances ^{1,3} (Platform & Spring)	(2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 1 kg (1 to 2) kg (2 to 20) kg (20 to 1 000) kg	0.026 mg 0.031 mg 0.041 mg 0.051 mg 0.081 mg 0.15 mg 0.41 mg 0.81 mg 1.5 mg 2.6×10^{-6} kg/kg 25×10^{-6} kg/kg	Standard Weights
Mass (Weights)	(1 to 5) mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 1 kg (1 to 2) kg (2 to 20) kg	0.008 7 mg 0.009 1 mg 0.009 6 mg 0.01 mg 0.012 mg 0.013 mg 0.015 mg 0.017 mg 0.022 mg 0.027 mg 0.032 mg 0.042 mg 0.052 mg 0.12 mg 0.17 mg 0.91 mg 1.2 mg 1.7 mg 2.6×10^{-6} kg/kg	Standard Weight and Electronic Balance
Torque Tools ¹	(0 to 1 500) N·m	0.67 % of reading + 0.058 mN·m	Torque Testers
Torque Testers ^{1,2}	(0 to 10) N·m (10 to 50) N·m (50 to 200) N·m (200 to 500) N·m (500 to 1 500) N·m	0.16 % of reading + 0.58R 0.048 % of reading 0.028 % of reading 0.031 % of reading 0.014 % of reading	Torque Calibration Wheel with Standard Weight
Force and Load Cell ^{1,2} (Compression and Tension)	(0 to 10) N (10 to 20) N (20 to 50) N (50 to 1 500) N	0.010 % of reading + 0.58R 0.007 4 % of reading 0.006 4 % of reading 0.006 2 % of reading	Standard weights

Mass and Mass Related

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force and Load Cell ^{1,2} (Compression and Tension)	(0 to 50) kN (50 to 500) kN	0.029 % of reading + 0.58R 0.028 % of reading	Load cell
Hardness Durometers ² Spring Force	Up to 0.76 N (0.76 to 1.2) N (1.2 to 2.0) N (2.0 to 8.1) N (8.1 to 44.5) N	0.000 25 N + 0.58R 0.000 52 N + 0.58R 0.001 N + 0.58R 0.004 3 N + 0.58R 0.026 N + 0.58R	Direct Verification Electronic Balance, Load Cell
Extension at zero	(0 to 5) mm	0.005 mm	Gage Blocks
Indenter Shape	(0 to 15) mm (0 to 90)°	0.004 mm 8'	Smart Scope
Pressure Gage ¹ (Absolute & Differential)	(-100 to 125) kPa (25 to 500) kPa (150 to 5 000) kPa (0.04 to 17) MPa (0.2 to 84) MPa	0.003 4 % of reading but not less than 0.000 42 kPa 0.003 9 % of reading but not less than 0.001 9 kPa 0.004 4 % of reading but not less than 0.022 kPa 0.006 8 % of reading but not less than 0.15 kPa 0.009 8 % of reading but not less than 0.56 kPa	Piston gages
Pressure Gage ^{1,2} (Absolute & Differential)	(-100 to 0) kPa (0 to 345) kPa 345 kPa to 2.07 MPa (2.07 to 69) MPa (69 to 250) MPa	0.023 % of reading + 0.58·R 0.018 % of reading + 0.58·R 0.038 % of reading 0.057 % of reading 0.04 % of reading	Pressure Calibrator / Pressure Module
Vacuum Gauges ¹ (Absolute Pressure)	(0.000 1 to 1) torr (1 to 10) torr (10 to 1 000) torr	0.61 % of reading 0.47 % of reading 0.41 % of reading	MKS PVS-6 System

Mass and Mass Related

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Balances (Dead Weight Tester) Hydraulic	(0.04 to 17) MPa (0.2 to 84) MPa	The effective area of the piston-cylinder assembly (A_p): $1.2 \times 10^{-4} \times A_p$ The pressure measured with a pressure balance (P): $1.2 \times 10^{-4} \times P$ The effective area of the piston-cylinder assembly (A_p): $8.4 \times 10^{-5} \times A_p$ The pressure measured with a pressure balance (P): $8.9 \times 10^{-4} \times P$	Piston Gage
Pressure Balances (Dead Weight Tester) Pneumatic:	(5 to 125) kPa (25 to 500) kPa (150 to 5 000) kPa	The effective area of the piston-cylinder assembly (A_p): $6.0 \times 10^{-5} \times A_p$ The pressure measured with a pressure balance (P): $6.6 \times 10^{-5} \times P$ The effective area of the piston-cylinder assembly (A_p): $6.3 \times 10^{-5} \times A_p$ The pressure measured with a pressure balance (P): $6.8 \times 10^{-5} \times P$ The effective area of the piston-cylinder assembly (A_p): $6.6 \times 10^{-5} \times A_p$ The pressure measured with a pressure balance (P): $7.1 \times 10^{-5} \times P$	Piston Gage
Air Flow ^{1,2}	(0 to 33.33) mL/min (50 to 500) mL/min (0.5 to 5) L/min (1 to 30) L/min Up to 50 L/min Up to 100 L/min Up to 500 L/min	0.64 % of reading + 0.58R 0.54 % of reading 0.54 % of reading 0.53 % of reading 0.43 % of reading + 0.11 L/min 0.43 % of reading + 0.21 L/min 0.43 % of reading + 1.1 L/min	Air Flow Calibrator

Mass and Mass Related

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Liquid Flow ¹	Up to 150 L/min	0.16 % of reading + 0.058 mL/min	Comparison to Standard Flow Meter
Air Velocity	(0.2 to 35) m/s	1.3 % of reading	Wind Tunnel, Air Velocity Transducer, Pressure Module
Pipettes & Micropipettes Burette ¹	(0 to 20) µL (20 to 50) µL (50 to 100) µL (100 to 200) µL 200 µL to 10 mL (10 to 20) mL (20 to 2 000) mL	0.02 µL 0.043 % of reading 0.026 % of reading 0.019 % of reading 0.015 % of reading 0.014 % of reading 0.012 % of reading	Analytical Scale Standard Weights
Volumetric Flask ¹	(0 to 10) mL (10 to 20) mL (20 to 2 000) mL	0.001 5 mL 0.014% of reading 0.012% of reading	Analytical Scale Standard Weights

Photometry and Radiometry

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power (Source & Measure) ¹	(450 to 1 800) nm (-110 to 10) dBm	0.11 dB	Optical Test System
Optical Power Stability – Source ¹	(450 to 1 800) nm (-110 to 10) dBm	0.003 7 dB	Optical Test System
Optical Power Linearity – Measure ¹	(450 to 1 800) nm (-110 to 10) dBm	0.018 dB	Optical Test System
Optical Attenuation – Measure ¹ Optical Fixed Attenuators of Fiber Coils	(450 to 1 800) nm (-110 to 10) dBm	0.11 dB	Optical Test System
Optical Attenuation – Measure ¹ Optical Step Attenuators	(450 to 1 800) nm (-110 to 10) dBm	0.11 dB	Optical Test System
Optical Wavelength – (Source & Measure) ¹	(600 to 1 800) nm	0.25 parts in 10 ⁶ of reading	Optical Test System w/ Wavelength Meter
Fiber Optics Wavelength Measuring Equipment ¹	(1 510 to 1 540) nm	0.13 pm	NIST Wavelength SRM 2517A

Photometry and Radiometry

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Laser Optical Power – (Source & Measure) ¹	20 pW to 10 W (190 to 11 000) nm (10 to 100) W (250 to 10 600) nm	1.7 % of output power 2.6 % of output power	Thermopile Sensor, Silicon Detector w/ Optical Power Meter
Illuminance / Lux Meter	Up to 3.762 lx (3.762 to 37.62) lx (37.62 to 376.2) lx 376.2 lux to 3.762 klx (3.762 to 37.62) klx	1.3 % of reading + 0.58R 1.4 % of reading + 0.58R 1.5 % of reading + 0.58R 1.5 % of reading + 0.58R 1.8 % of reading + 0.58R	Comparison to Standard Light Meter
UV Irradiance, Calibration of UV Light Meters	(0.1 to 100) mW/cm ² @ Wavelength 365 nm	2 % of reading	Optical Power Meter w/ Power Detectors
Gloss Meter	(7.5 to 100) GLU 20 ° 60 ° 85 °	1.4 GLU 1.2 GLU 1.2 GLU	Gloss Standard Plate
Color Meter ¹ (Spectral Diffuse Reflectance)	(380 to 780) nm Up to 10 %R (10 to 20) %R (20 to 30) %R (30 to 40) %R (40 to 50) %R (50 to 60) %R (60 to 70) %R (70 to 80) %R (80 to 90) %R (90 to 100) %R	0.12 %R 0.21 %R 0.32 %R 0.43 %R 0.52 %R 0.64 %R 0.70 %R 0.84 %R 0.93 %R 1 %R	Calibration Plate Colors

Photometry and Radiometry

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Brown		Calibration Plate Colors
	Illuminant A		
	x	0.000 31	
	y	0.000 31	
	Y%	0.26	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.24	
	a*	0.092	
	b*	0.12	
	Illuminant C		
	x	0.000 31	
	y	0.000 46	
	Y%	0.24	
	u'	0.000 16	
	v'	0.000 31	
	L*	0.23	
	a*	0.096	
	b*	0.12	
	Illuminant D65		
	x	0.000 31	
	y	0.000 46	
	Y%	0.24	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.23	
	a*	0.11	
	b*	0.12	

Photometry and Radiometry

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Blue		Calibration Plate Colors
	Illuminant A		
	x	0.000 61	
	y	0.000 46	
	Y%	0.20	
	u'	0.000 46	
	v'	0.000 31	
	L*	0.21	
	a*	0.17	
	b*	0.22	
	Illuminant C		
	x	0.000 46	
	y	0.000 46	
	Y%	0.21	
	u'	0.000 31	
	v'	0.000 46	
	L*	0.23	
	a*	0.23	
	b*	0.24	
	Illuminant D65		
	x	0.000 46	
	y	0.000 46	
	Y%	0.21	
	u'	0.000 31	
	v'	0.000 46	
	L*	0.23	
	a*	0.23	
	b*	0.24	

Photometry and Radiometry

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Red		Calibration Plate Colors
	Illuminant A		
	x	0.000 46	
	y	0.000 16	
	Y%	0.21	
	u'	0.000 46	
	v'	0.000 16	
	L*	0.23	
	a*	0.21	
	b*	0.22	
	Illuminant C		
	x	0.000 46	
	y	0.000 46	
	Y%	0.21	
	u'	0.000 31	
	v'	0.000 46	
	L*	0.23	
	a*	0.23	
	b*	0.24	
	Illuminant D65		
	x	0.000 92	
	y	0.000 46	
	Y%	0.17	
	u'	0.000 61	
	v'	0.000 31	
	L*	0.21	
	a*	0.23	
	b*	0.18	

Photometry and Radiometry

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Pink		Calibration Plate Colors
	Illuminant A		
	x	0.000 31	
	y	0.000 31	
	Y%	0.31	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.24	
	a*	0.11	
	b*	0.19	
	Illuminant C		
	x	0.000 46	
	y	0.000 61	
	Y%	0.27	
	u'	0.000 16	
	v'	0.000 46	
	L*	0.24	
	a*	0.14	
	b*	0.19	
	Illuminant D65		
	x	0.000 46	
	y	0.000 61	
	Y%	0.27	
	u'	0.000 16	
	v'	0.000 46	
	L*	0.24	
	a*	0.14	
	b*	0.19	

Photometry and Radiometry

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Orange		Calibration Plate Colors
	Illuminant A		
	x	0.000 31	
	y	0.000 31	
	Y%	0.46	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.29	
	a*	0.12	
	b*	0.18	
	Illuminant C		
	x	0.000 31	
	y	0.000 46	
	Y%	0.41	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.24	
	b*	0.28	
	Illuminant D65		
	x	0.000 31	
	y	0.000 46	
	Y%	0.41	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.14	
	b*	0.18	

Photometry and Radiometry

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Yellow		Calibration Plate Colors
	Illuminant A		
	x	0.000 31	
	y	0.000 31	
	Y%	0.69	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.32	
	a*	0.14	
	b*	0.19	
	Illuminant C		
	x	0.000 46	
	y	0.000 31	
	Y%	0.66	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.32	
	a*	0.15	
	b*	0.18	
	Illuminant D65		
	x	0.000 46	
	y	0.000 31	
	Y%	0.66	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.32	
	a*	0.17	
	b*	0.18	

Photometry and Radiometry

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Light Blue		Calibration Plate Colors
	Illuminant A		
	x	0.00031	
	y	0.00046	
	Y%	0.43	
	u'	0.00031	
	v'	0.00031	
	L*	0.27	
	a*	0.17	
	b*	0.22	
	Illuminant C		
	x	0.00031	
	y	0.00061	
	Y%	0.47	
	u'	0.00016	
	v'	0.00046	
	L*	0.29	
	a*	0.18	
	b*	0.24	
	Illuminant D65		
	x	0.00031	
	y	0.00061	
	Y%	0.47	
	u'	0.00016	
	v'	0.00046	
	L*	0.29	
	a*	0.18	
	b*	0.24	

Photometry and Radiometry

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Green		Calibration Plate Colors
	Illuminant A		
	x	0.00031	
	y	0.00046	
	Y%	0.31	
	u'	0.00016	
	v'	0.00016	
	L*	0.24	
	a*	0.12	
	b*	0.21	
	Illuminant C		
	x	0.00046	
	y	0.00077	
	Y%	0.34	
	u'	0.00016	
	v'	0.00046	
	L*	0.26	
	a*	0.14	
	b*	0.19	
	Illuminant D65		
	x	0.00046	
	y	0.00077	
	Y%	0.34	
	u'	0.00016	
	v'	0.00046	
	L*	0.26	
	a*	0.14	
	b*	0.19	

Photometry and Radiometry

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Light Green		Calibration Plate Colors
	Illuminant A		
	x	0.00031	
	y	0.00031	
	Y%	0.38	
	u'	0.00016	
	v'	0.00016	
	L*	0.27	
	a*	0.11	
	b*	0.18	
	Illuminant C		
	x	0.00046	
	y	0.00046	
	Y%	0.40	
	u'	0.00016	
	v'	0.00031	
	L*	0.27	
	a*	0.12	
	b*	0.18	
	Illuminant D65		
	x	0.00046	
	y	0.00046	
	Y%	0.40	
	u'	0.00031	
	v'	0.00031	
	L*	0.27	
	a*	0.12	
	b*	0.18	

Photometry and Radiometry

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: White		Calibration Plate Colors
	Illuminant A		
	x	0.00031	
	y	0.00031	
	Y%	0.89	
	u'	0.00016	
	v'	0.00016	
	L*	0.35	
	a*	0.10	
	b*	0.18	
	Illuminant C		
	x	0.00031	
	y	0.00046	
	Y%	0.89	
	u'	0.00016	
	v'	0.00031	
	L*	0.35	
	a*	0.14	
	b*	0.19	
	Illuminant D65		
	x	0.00031	
	y	0.00046	
	Y%	0.89	
	u'	0.00016	
	v'	0.00031	
	L*	0.35	
	a*	0.14	
	b*	0.19	

Thermodynamic

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity Measuring Equipment ¹	(10 to 40) %RH (40 to 95) %RH	0.66 %RH 1.1 %RH	Relative humidity sensor & chamber

Thermodynamic

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Measure & Measuring Equipment ¹	(-80 to -40) °C (-40 to 0) °C (0 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 500) °C (500 to 600) °C (600 to 1 100) °C	0.037 °C 0.029 °C 0.032 °C 0.041 °C 0.044 °C 0.048 °C 0.057 °C 1.6 °C	SPRT, Thermocouple, Temperature Calibrator
Radiation (Infrared) Thermometers ¹	(-30 to 0) °C (0 to 10) °C (10 to 50) °C (50 to 100) °C (100 to 160) °C	0.67 °C 0.33 °C 0.36 °C 0.58 °C 1.1 °C	Blackbody Calibrator (flat plate) $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
	100 °C (100 to 200) °C	0.69 °C 1.2 °C	Blackbody Calibrator (cavity) $\epsilon = 0.995$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
	(200 to 400) °C (400 to 600) °C (600 to 800) °C (800 to 1 000) °C	1.9 °C 3.0 °C 4.2 °C 5.2 °C	Blackbody Calibrator (cavity) $\epsilon = 0.995$, $\lambda = (0.7 \text{ to } 1.8) \mu\text{m}$
Temperature Chambers System Calibration & Profiling ¹	(-40 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 300) °C	0.32 °C 0.33 °C 0.38 °C 0.43 °C	Datalogger w/RTD sensors and Datalogger w/Thermocouple sensors

Time and Frequency

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	0.1 Hz to 5 GHz 500 MHz to 26.5 GHz	1.9×10^{-11} Hz/Hz 6.9×10^{-12} Hz/Hz	GPS Receiver and Counter
Frequency Measuring Equipment ¹	(1, 10) MHz	5×10^{-12} Hz/Hz	GPS Receiver
	0.01 Hz to 50 GHz	6.2×10^{-12} Hz/Hz	GPS Receiver and Signal Generator
Tachometer ^{1,2}	Up to 100 000 rpm	0.000 25 % of reading + 0.58R	Multi-Product Calibrator, Signal Generator with LED

DIMENSIONAL MEASUREMENT

Dimensional Measurement 1D

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inspection Fixtures / Gages ² Thickness Pads Chamfer Gauge Taper Gauge Attribute Gages – GO / NOGO Dedicated Fixture Gages	Up to 100 mm (100 to 500) mm (500 to 1 000) mm	$(0.35 + 0.000\ 35l)\ \mu\text{m}$ $(0.28 + 0.000\ 98l)\ \mu\text{m}$ $(0.55 + 0.001\ 1l)\ \mu\text{m}$	Universal Length Measuring Machine, Precision Height Gage, Electric Comparator, Linear Length Gage, Gage Block, Surface Plate, Smart Scope

Dimensional Measurement 2D

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inspection Fixtures / Gages ² Angle Block Straight Edges Parallel Bars Machine Squares Precision Squares Radius Gauge Chamfer Gauge Taper Gauge Attribute Gages – GO / NOGO Dedicated Fixture Gages	Up to 100 mm (100 to 500) mm (500 to 1 000) mm	$(0.35 + 0.000\ 35l)\ \mu\text{m}$ $(0.28 + 0.000\ 98l)\ \mu\text{m}$ $(0.55 + 0.001\ 1l)\ \mu\text{m}$	Universal Length Measuring Machine, Precision Height Gage, Electric Comparator, Linear Length Gage, Gage Block, Surface Plate, Smart Scope, Sine Bar, Differential Level, Granite Square, CMM

Dimensional Measurement 3D

Nonthaburi, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inspection Fixtures / Gages ² Dedicated Fixture Gages	Up to 100 mm (100 to 500) mm (500 to 1 000) mm	$(0.35 + 0.000\ 35l)\ \mu\text{m}$ $(0.28 + 0.000\ 98l)\ \mu\text{m}$ $(0.55 + 0.001\ 1l)\ \mu\text{m}$	Smart Scope, CMM

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Services performed at satellite laboratory

Micro Precision Calibration (India) Private Limited

No. 57, Avadi Road, Sippoy Lane, Karayanchavadi,
Poonamallee, Chennai-600 056. India.

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kumar@microprecision.com www.microprecision.com

CALIBRATION

Chemical Quantities

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity – Measure ¹ Fixed Points	4.93 $\mu\text{S/cm}$ 9.51 $\mu\text{S/cm}$ 145.85 $\mu\text{S/cm}$ 1 409 $\mu\text{S/cm}$ 9 975 $\mu\text{S/cm}$ 100 005 $\mu\text{S/cm}$ 198 800 $\mu\text{S/cm}$	0.13 $\mu\text{S/cm}$ 0.4 $\mu\text{S/cm}$ 1.1 $\mu\text{S/cm}$ 6.1 $\mu\text{S/cm}$ 48 $\mu\text{S/cm}$ 500 $\mu\text{S/cm}$ 2 820 $\mu\text{S/cm}$	Comparison to Standard Solutions
pH – Measure ¹	(4, 7, 10) pH	0.02 pH	Comparison to Standard Solutions

Electrical – DC/Low Frequency

Chennai, India

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 to 1 100) V	7.9 $\mu\text{V/V} + 0.4 \mu\text{V}$ 5.6 $\mu\text{V/V} + 0.7 \mu\text{V}$ 4.3 $\mu\text{V/V} + 2.6 \mu\text{V}$ 4.2 $\mu\text{V/V} + 4.0 \mu\text{V}$ 5.6 $\mu\text{V/V} + 40 \mu\text{V}$ 6.9 $\mu\text{V/V} + 400 \mu\text{V}$	Multi Product Calibrator
DC Voltage – Source Fixed Points	1 V 1.018 V 10 V	14 μV 14 μV 72 μV	DC Reference Standard
DC Voltage – Measure ¹	Up to 100 mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1 000) V	6.1 $\mu\text{V/V} + 0.31 \mu\text{V}$ 4 $\mu\text{V/V} + 0.31 \mu\text{V}$ 4 $\mu\text{V/V} + 0.51 \mu\text{V}$ 6 $\mu\text{V/V} + 30 \mu\text{V}$ 6 $\mu\text{V/V} + 0.1 \text{ mV}$	Multimeter
DC Voltage – Measure ¹ High Voltage	(0.5 to 40) kV	0.58 mV/V+0.58 V	High Voltage Probe with Multimeter

Electrical – DC/Low Frequency

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source ¹	Up to 220 μ A 220 μ A to 22 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	41 μ A/A + 6.0 nA 37 μ A/A + 7.0 nA 37 μ A/A + 40 nA 46 μ A/A + 0.7 μ A 80 μ A/A + 12 μ A	Multi Product Calibrator
DC Current – Source ¹	Up to 330 μ A 330 μ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 3.3 A (3.3 to 11) A (11 to 20.5) A	116 μ A/A + 16 nA 78 μ A/A + 24 nA 78 μ A/A + 0.17 μ A 79 μ A/A + 1.7 μ A 202 μ A/A + 32 μ A 590 μ A/A + 260 μ A 891 μ A/A + 584 μ A	Multi Product Calibrator
DC Current – Source ¹	(10 to 15) A (15 to 1 000) A	5 mA/A + 20 mA 5.1 mA/A + 500 mA	Multi Product Calibrator with 50 Turn Coil
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 10 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	75 μ A/A + 40 pA 22 μ A/A + 40 pA 21 μ A/A + 0.1 nA 21 μ A/A + 0.8 nA 20 μ A/A + 5 nA 20 μ A/A + 50 nA 35 μ A/A + 0.50 μ A 0.11 mA/A + 10 μ A	Multimeter
DC Current Measure ¹ High DC Current	(1 to 30) A (30 to 600) A	15 μ A/A + 58 μ A 7.6 mA/A + 5.8 μ A	Shunt monitored with Multimeter
Resistance – Generate ¹ Variable Values	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	31 $\mu\Omega/\Omega$ + 7.8 m Ω 23.3 $\mu\Omega/\Omega$ + 12 m Ω 22 $\mu\Omega/\Omega$ + 12 m Ω 22 $\mu\Omega/\Omega$ + 16 m Ω 22 $\mu\Omega/\Omega$ + 16 m Ω 22 $\mu\Omega/\Omega$ + 155 m Ω 22 $\mu\Omega/\Omega$ + 78 m Ω 22 $\mu\Omega/\Omega$ + 0.78 Ω 22 $\mu\Omega/\Omega$ + 7.8 Ω	Multi Product Calibrator
Resistance – Generate ¹ Variable Values	(110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω (330 to 1 100) M Ω	25 $\mu\Omega/\Omega$ + 7.8 Ω 25 $\mu\Omega/\Omega$ + 7.8 Ω 47 $\mu\Omega/\Omega$ + 0.12 m Ω 101 $\mu\Omega/\Omega$ + 0.19 m Ω 194 $\mu\Omega/\Omega$ + 1.9 k Ω 388 $\mu\Omega/\Omega$ + 2.3 k Ω 2.3 m Ω/Ω + 78 k Ω 12 m Ω/Ω + 0.39 M Ω	Multi Product Calibrator

Electrical – DC/Low Frequency

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Generate ¹ Fixed Points	1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	98 $\mu\Omega$ 182 $\mu\Omega$ 235 $\mu\Omega$ 445 $\mu\Omega$ 1.1 m Ω 1.2 m Ω 9.8 m Ω 18 m Ω 66 m Ω 181 m Ω 1.2 Ω 2.3 Ω 23 Ω 45 Ω 421 Ω 927 Ω 12 Ω	Multi Product Calibrator
Resistance – Generate ¹ (Fixed Artifacts)	1 Ω 10 k Ω	0.1 m Ω/Ω 0.04 m Ω/Ω	Standard Resistors
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω (0.1 to 1) k Ω (1 to 10) k Ω (10 to 100) k Ω (0.1 to 1) M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	15 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 0.5 m Ω 10 $\mu\Omega/\Omega$ + 0.5 m Ω 10 $\mu\Omega/\Omega$ + 5 m Ω 10 $\mu\Omega/\Omega$ + 50 m Ω 15 $\mu\Omega/\Omega$ + 2.0 Ω 50 $\mu\Omega/\Omega$ + 100 Ω 0.50 m Ω/Ω + 1.0 k Ω 5.0 m Ω/Ω + 10 k Ω	Multimeter

Electrical – DC/Low Frequency

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) °C	0.36 °C	Multi Product Calibrator
	(800 to 1 000) °C	0.29 °C	
	(1 000 to 1 550) °C	0.26 °C	
	(1 550 to 1 820) °C	0.28 °C	
	Type C (0 to 150) °C	0.26 °C	
	(150 to 650) °C	0.23 °C	
	(650 to 1 000) °C	0.27 °C	
	(1 000 to 1 800) °C	0.4 °C	
	(1 800 to 2 316) °C	0.66 °C	
	Type E (-250 to -100) °C	0.4 °C	
	(-100 to 650) °C	0.17 °C	
	(650 to 1 000) °C	0.20 °C	
	Type J (-210 to -100) °C	0.24 °C	
	(-100 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.21 °C	
	Type K (-200 to -100) °C	0.28 °C	
	(-100 to 120) °C	0.18 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L (-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N (-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(1 000 to 1 372) °C	0.24 °C	
	Type R (0 to 250) °C	0.46 °C	
	(250 to 1 400) °C	0.29 °C	
	(1 400 to 1 767) °C	0.33 °C	
	Type S (0 to 250) °C	0.38 °C	
	(250 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	

Electrical – DC/Low Frequency

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type T (-250 to -150) °C (-150 to 0) °C (0 to 400) °C Type U (-200 to -0) °C (0 to 400) °C	0.5 °C 0.22 °C 0.17 °C 0.45 °C 0.24 °C	Multi Product Calibrator
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 1 kΩ (-200 to 100) °C (100 to 260) °C (260 to 600) °C (600 to 630) °C Pt 385, 100 Ω (-80 to 100) °C (100 to 300) °C (300 to 630) °C (630 to 800) °C Cu 427, 10 Ω (-100 to 260) °C	0.03 °C 0.04 °C 0.054 °C 0.18 °C 0.054 °C 0.078 °C 0.093 °C 0.18 °C 0.23 °C	Multi Product Calibrator
AC Voltage – Source ¹	220 μV 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	0.25 mV/V + 4 μV 0.13 mV/V + 4 μV 0.12 mV/V + 4 μV 0.24 mV/V + 4 μV 0.52 mV/V + 5 μV 1.1 mV/V + 10 μV 1.5 mV/V + 20 μV 2.9 mV/V + 20 μV 0.3 mV/V + 4 μV 0.17 mV/V + 4 μV 0.2 mV/V + 4 μV 0.89 mV/V + 4 μV 1.0 mV/V + 5 μV 1.2 mV/V + 10 μV 1.9 mV/V + 20 μV 3 mV/V + 20 μV	Multi Product Calibrator

Electrical – DC/Low Frequency

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(22 to 220) mV		Multi Product Calibrator
	(10 to 20) Hz	0.27 mV/V + 12 μ V	
	(20 to 40) Hz	0.31 mV/V + 7 μ V	
	40 Hz to 20 kHz	0.12 mV/V + 7 μ V	
	(20 to 50) kHz	0.22 mV/V + 7 μ V	
	(50 to 100) kHz	0.47 mV/V + 17 μ V	
	(100 to 300) kHz	0.93 mV/V + 20 μ V	
	(300 to 500) kHz	1.5 mV/V + 25 μ V	
	500 kHz to 1 MHz	3.1 mV/V + 45 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.26 mV/V + 40 μ V	
	(20 to 40) Hz	0.11 mV/V + 15 μ V	
	40 Hz to 20 kHz	0.076 mV/V + 8 μ V	
	(20 to 50) kHz	0.091 mV/V + 10 μ V	
	(50 to 100) kHz	0.13 mV/V + 30 μ V	
	(100 to 300) kHz	0.47 mV/V + 80 μ V	
	(300 to 500) kHz	1.1 mV/V + 0.2 mV	
	500 kHz to 1 MHz	2.2 mV/V + 0.3 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.26 mV/V + 0.4 mV	
	(20 to 40) Hz	0.11 mV/V + 0.15 mV	
	40 Hz to 20 kHz	0.077 mV/V + 50 μ V	
	(20 to 50) kHz	0.092 mV/V + 0.1 mV	
	(50 to 100) kHz	0.14 mV/V + 0.2 mV	
	(100 to 300) kHz	0.35 mV/V + 0.6 mV	
	(300 to 500) kHz	1.1 mV/V + 2 mV	
	500 kHz to 1 MHz	2.3 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.27 mV/V + 4 mV	
	(20 to 40) Hz	0.16 mV/V + 1.5 mV	
	40 Hz to 20 kHz	0.14 mV/V + 0.6 mV	
	(20 to 50) kHz	0.15 mV/V + 1 mV	
	(50 to 100) kHz	0.21 mV/V + 2.5 mV	
	(100 to 200) kHz	0.91 mV/V + 16 mV	
	(300 to 500) kHz	4.4 mV/V + 40 mV	
	500 kHz to 1MHz	8 mV/V + 80 mV	
	(220 to 1 100) V		
	(15 to 50) Hz	0.33 mV/V + 16 mV	
	50 Hz to 1 kHz	148 μ V/V + 3.5 mV	

Electrical – DC/Low Frequency

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	Up to 10 mV		Multimeter
	(1 to 40) Hz	0.3 mV/V + 3 μ V	
	40 Hz to 1 kHz	0.2 mV/V + 1.1 μ V	
	(1 to 20) kHz	0.3 mV/V + 1.1 μ V	
	(20 to 50) kHz	1 mV/V + 1.1 μ V	
	(50 to 100) kHz	5 mV/V + 1.1 μ V	
	(100 to 300) kHz	40 mV/V + 2 μ V	
	(10 to 100) mV		
	(1 to 40) Hz	74 μ V/V + 4 μ V	
	40 Hz to 1 kHz	74 μ V/V + 2 μ V	
	(1 to 20) kHz	0.14 mV/V + 2 μ V	
	(20 to 50) kHz	0.3 mV/V + 2 μ V	
	(50 to 100) kHz	0.8 mV/V + 2 μ V	
	(100 to 300) kHz	3 mV/V + 10 μ V	
	300 kHz to 1 MHz	10 mV/V + 10 μ V	
	(1 to 2) MHz	15 mV/V + 10 μ V	
	100 mV to 10 V		
	(1 to 40) Hz	73 μ V/V + 0.4 mV	
	40 Hz to 1 kHz	71 μ V/V + 0.2 mV	
	(1 to 20) kHz	0.14 mV/V + 0.2 mV	
	(20 to 50) kHz	0.3 mV/V + 0.2 mV	
	(50 to 100) kHz	0.8 mV/V + 0.2 mV	
	(100 to 300) kHz	3 mV/V + 1 mV	
	300 kHz to 1 MHz	10 mV/V + 1 mV	
	(1 to 2) MHz	15 mV/V + 1 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.2 mV/V + 4 mV	
	40 Hz to 1 kHz	0.2 mV/V + 2 mV	
	(1 to 20) kHz	0.2 mV/V + 2 mV	
	(20 to 50) kHz	0.35 mV/V + 2 mV	
	(50 to 100) kHz	1.2 mV/V + 2 mV	
	(100 to 300) kHz	4 mV/V + 10 mV	
	300 kHz to 1 MHz	15 mV/V + 10 mV	
	(100 to 700) V		
	(1 to 40) Hz	0.4 mV/V + 40 mV	
	40 Hz to 1 kHz	0.4 mV/V + 20 mV	
	(1 to 20) kHz	0.6 mV/V + 20 mV	
	(20 to 50) kHz	1.2 mV/V + 20 mV	
	(50 to 100) kHz	3 mV/V + 20 mV	
AC Voltage – Measure ¹ High Voltage	(0 to 28) kV 50 Hz	1.2 V/V + 0.59 V	High Voltage Probe with Multimeter

Electrical – DC/Low Frequency

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(9 to 220) μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 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 (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	0.25 mA/A + 16 nA 0.16 mA/A + 10 nA 0.12 mA/A + 8 nA 0.28 mA/A + 12 nA 0.28 mA/A + 12 nA 0.25 mA/A + 40 nA 0.16 mA/A + 35 nA 0.12 mA/A + 35 nA 0.2 mA/A + 0.11 μ A 1.1 mA/A + 0.65 μ A 0.25 mA/A + 0.4 μ A 0.16 mA/A + 0.35 μ A 0.12 mA/A + 0.35 μ A 0.20 mA/A + 0.55 μ A 1.1 mA/A + 5.0 μ A 0.25 mA/A + 4 μ A 0.16 mA/A + 3.5 μ A 0.12 mA/A + 2.6 μ A 0.2mA/A + 3.5 μ A 1.1 mA/A + 10 μ A 0.27 mA/A + 35 μ A 0.45 mA/A + 80 μ A 7 mA/A + 0.16 mA	Multi Product Calibrator
	(1.1 to 3) A (10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (3 to 11) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (11 to 20.5) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	1.4 mA/A + 78 μ A 0.5 mA/A + 78 μ A 4.7 mA/A + 775 μ A 19 mA/A + 3.9 mA 0.5 mA/A + 1.6 mA 0.8 mA/A + 1.6 mA 23 mA/A + 1.6 mA 0.9mA/A + 3.9 mA 1.2 mA/A + 3.9 mA 23 mA/A + 3.9 mA	

Electrical – DC/Low Frequency

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(10 to 16.5) A (45 to 65) Hz (65 to 440) Hz	3.3 mA/A + 3.5 mA 9.1 mA/A + 3.5 mA	Multi Product Calibrator with 50 Turn Coil
	(16.5 to 150) A (45 to 65) Hz (65 to 440) Hz	3.3 mA/A + 29 mA 9.1 mA/A + 31 mA	
	(150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	3.4 mA/A + 100 mA 9.2 mA/A + 120 mA	
AC Current – Measure ¹	Up to 100 μ A (10 to 20) Hz (20 to 45) Hz 45 Hz to 5 kHz	4 mA/A + 0.03 μ A 1.5 mA/A + 0.03 μ A 0.61 mA/A + 0.03 μ A	Multimeter
	100 μ A to 1 mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz	4 mA/A + 0.2 μ A 1.5 mA/A + 0.2 μ A 0.61 mA/A + 0.2 μ A	
	100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.32 mA/A + 0.2 μ A 0.61 mA/A + 0.2 μ A 4 mA/A + 0.4 μ A 5.5 mA/A + 1.5 μ A	
	(1 to 10) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz	4 mA/A + 2 μ A 1.5 mA/A + 2 μ A 0.61 mA/A + 2 μ A	
	100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.32 mA/A + 2 μ A 0.61 mA/A + 2 μ A 4 mA/A + 4 μ A 5.5 mA/A + 15 μ A	
	(10 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz	4 mA/A + 20 μ A 1.5 mA/A + 20 μ A 0.61 mA/A + 20 μ A	
	100 Hz to 5 kHz (5 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.32 mA/A + 20 μ A 0.61 mA/A + 20 μ A 4 mA/A + 40 μ A 5.5 mA/A + 0.15 mA	

Electrical – DC/Low Frequency

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	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 mA/A + 0.2 mA 1.6 mA/A + 0.2 mA 0.81 mA/A + 0.2 mA 1 mA/A + 0.2 mA 3 mA/A + 0.2 mA 10 mA/A + 0.4 mA	Multimeter
AC Current – Measure ¹	(1 to 15) A 45 Hz to 1 kHz (15 to 30) A 45 Hz to 1 kHz (1 to 30) A (1 to 5) kHz	0.024 mA/A + 3.5 mA 0.041 mA/A + 3.5 mA 58 mA	Multimeter w/Current Shunt
Capacitance – Source ¹ (Simulation)	50 Hz to 1 kHz (0.33 to 0.5) nF (0.5 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (0.33 to 1.1) μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F (0.33 to 1.1) mF	3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 78 pF 1.9 mF/F + 233 pF 1.9 mF/F + 0.78 nF 2.7 mF/F + 2.3 nF 2.7 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.9 mF/F + 78 nF 5.4 mF/F + 233 nF 7.8 mF/F + 0.26 μ F	Multi Product Calibrator
Oscilloscope ¹ Rise/Fall Time	(0 to 1.25) s	1.3 ps	Oscilloscope Calibrator
Oscilloscope ¹ Square Wave Amplitude 50 Ω or 1 M Ω load Impedance $\leq$ 10 kHz	Up to 1 mVp-p (1 to 21) mVp-p (21 to 556) mVp-p 556 mVp-p to 210 Vp-p	10 mV/V + 10 μ V 1.5 mV/V + 20 μ V 1.5 mV/V + 1.2 μ V 1.3 mV/V + 1.2 μ V	Oscilloscope Calibrator
Oscilloscope ¹ Vertical Deflection (Amplitude)	1 mVp-p to 50 Vp-p (50 to 100) Vp-p (100 to 200) Vp-p	250 μ V/V + 25 μ V 250 μ V/V + 26 μ V 250 μ V/V + 63 μ V	Oscilloscope Calibrator Multimeter
Oscilloscope ¹ Horizontal Deflection (Time)	150 ps to 50 s	0.39 parts in 10 ⁶ of reading	Oscilloscope Calibrator

Electrical – DC/Low Frequency

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscope ¹ Bandwidth	0.1 Hz to 50 GHz	2.1 % of reading	Oscilloscope Calibrator, Power Sensor

Electrical – RF/Microwave

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Tuned Power ¹	(-127 to 0) dB Up to 2.6 GHz 2.6 MHz to 26.5 GHz	0.17 dB 0.4 dB	Measuring Receiver, Power Sensor
RF Absolute Power – Measure ¹ (Connector Type N) 100 kHz to 4.2 GHz 10 MHz to 18 GHz 10 MHz to 26.5 GHz 10 MHz to 50 GHz 9 kHz to 6 GHz 10 MHz to 18 GHz	(-30 to 20) dBm (-30 to 20) dBm (-30 to 20) dBm (-30 to 20) dBm (-60 to 20) dBm (-70 to 20) dBm	0.19 dB 0.17 dB 0.17 dB 0.17 dB 0.11 dB 0.24 dB	Power Meter, Measuring Receiver, Power Meter with Power Sensor
RF Power – Generate ¹	(-135 to 30) dBm 250 kHz to 6 GHz (2 to 20) GHz (20 to 40) GHz	0.93 dB 0.81dB 1.1dB	Signal Generator
Amplitude Modulation – Measure ¹ AM Depth Accuracy 100 kHz to 10 MHz (Rate: 50 Hz to 10 kHz) 10 MHz to 3 GHz (Rate: 50 Hz to 100 kHz) (3 to 26.5) GHz (Rate: 50 Hz to 100 kHz)	Depth: (5 to 99) % Depth: (20 to 99) % Depth: (5 to 20) % Depth: (20 to 99) % Depth: (5 to 20) %	0.91 % Depth 0.61 % Depth 3 % Depth 1.8 % Depth 5.5 % Depth	Measuring Receiver with Power Sensor

Electrical – RF/Microwave

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation Measure ¹ FM Rejection (50 Hz to 3 kHz BW) 250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz) 10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz) Residual AM 250 kHz to 26.5 GHz	Depths: < 50% Deviations: < 5 kHz Depths: < 50% Deviations: < 50 kHz (50 Hz to 3 kHz BW)	0.17 % of AM depth 0.44 % of AM depth 0.012 % (rms)	Measuring Receiver with Power Sensor
Frequency Modulation Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz (Rate: 20 Hz to 200 kHz) AM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz Residual FM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: 200 Hz to 400 kHz AM Depths: ≤ 50% (Rate: 400 Hz or 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 13 Hz 25 Hz 49 Hz 1.9 Hz 3.7 Hz 7.4 Hz	Measuring Receiver w/ Power Sensor

Electrical – RF/Microwave

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
PM Deviation Accuracy ^{1,5} 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz AM Rejection (50 Hz to 3 kHz BW) 100 kHz to 26.5 GHz Residual PM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Dev: > 0.7 rad Dev: > 0.3 rad Dev: > 0.7 rad Dev: > 0.3 rad Dev: > 0.7 rad Dev: > 0.3 rad AM Depths: ≤ 50% (Rate: 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad 0.002 1 rad 0.004 1 rad 0.008 1 rad	Measuring Receiver
Reflection S_{11}/S_{22} – Measure ^{1,5} Type N 300 kHz to 6 GHz	(0 to 110) dB (30 to 300) kHz 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz Phase (-180 to 180) ° 30 kHz to 3 GHz (3 to 6) GHz	0.025 dB 0.026 dB 0.033 dB 0.094 dB 0.073 ° 0.25 °	Vector Network Analyzer w/Calibration Kit
Transmission S_{12}/S_{21} – Measure ^{1,5} Type N 300 kHz to 6 GHz	(0 to 110) dB (30 to 300) kHz 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz Phase (-180 to 180) ° 30 kHz to 3 GHz (3 to 6) GHz	0.029 dB 0.028 dB 0.039 dB 0.089 dB 0.073 ° 0.25 °	Vector Network Analyzer w/Calibration Kit

Length – Dimensional Metrology

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 1 000 mm	$(0.17 + 0.006\ 8\ l)\ \mu\text{m} + 0.58\ \text{R}$	Gage Blocks and Caliper Checker
Height Gages ^{1,2}	Up to 1 000 mm	$(0.71 + 0.001\ 8\ l)\ \mu\text{m} + 0.58\ \text{R}$	Gage Blocks and Caliper Checker
Micrometers ^{1,2} External, Internal, Depth	Up to 500 mm	$(0.088 + 0.006\ 9\ l)\ \mu\text{m} + 0.58\ \text{R}$	Gage Blocks, Caliper Checker, Surface Plate, Optical Parallel
Plug & Pin Gages ² Diameter	(0.5 to 40) mm	$(1.2 + 0.001\ 4\ l)\ \mu\text{m}$	Laser Micrometer, Master plug gages
Rulers and Tapes ²	Up to 1 000 mm (1 000 to 50 000) mm	$(18 + 0.009\ l)\ \mu\text{m}$ $(15 + 0.013\ l)\ \mu\text{m}$	Measuring Scale & Tape Calibrator
Indicators ^{1,2}	(0 to 100) mm	$(0.9 + 0.007\ l)\ \mu\text{m}$	Gage blocks, indicator tester
Optical Comparators and Vision Systems ^{1,2} X, Y Axis	Up to 300 mm	$(1.2 + 0.008\ l)\ \mu\text{m}$	Glass Scales
Feeler Gauge/ Thickness Gauge / Width Gauge ²	Up to 25 mm	$(0.64 + 0.000\ 3\ l)\ \mu\text{m}$	Micrometer, Gage Blocks
Snap Gauge, Dial Snap Gauge/Dial Snap Micrometer ²	Up to 100 mm	$(0.14 + 0.003\ 8\ l)\ \mu\text{m}$	Gage Blocks

Mass and Mass Related

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure ¹ Absolute , Differential, Vacuum and Transmitters	(-1 to -0.1) bar (0.1 to 40) bar (1 to 100) bar (100 to 400) bar (400 to 700) bar	0.016 bar 0.02 bar 0.1 bar 0.14 bar 0.23 bar	Digital Pressure Calibrator
Torque Measuring Equipment ¹	Up to 5 N·m (0.1 to 40) N·m (40 to 600) N·m (600 to 1 500) N·m	0.24 % of reading 0.43 % of reading 0.68 % of reading 0.68 % of reading	Torque Calibration System
Scales & Balances ^{1,3}	(1 to 200) g Up to 5 kg Up to 100 kg	0.9 mg 101 mg 2.1 g	Verification w/ weights Class F1 Class F1 Class M1

Mass and Mass Related

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force Compression and Tension ¹	(0.1 to 10) kN (10 to 50) kN	0.6 % of reading 0.3 % of reading	Universal load cell
Air Flow	(10 to 300) mL/min 300 mL/min to 10 L/min 500 mL/min to 50 L/min	1.3 % of reading 1.1 % of reading 1 % of reading	Flow Calibrator with Flow Cell

Photometry and Radiometry

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermopile Power Sensor	(0.01 to 1) W	3.7 % of reading	Air cooled laser sensor and Power Meter

Thermodynamic

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity Measuring Equipment ¹ Fixed Points	11 %RH 33 %RH 75.4 %RH 97 %RH	1.8 %RH 1.6 %RH 1.9 %RH 3.2 %RH	Standard salt solutions
Relative Humidity – Measure ¹	(14 to 75) %RH (75 to 90) %RH	2.5 %RH 3.6 %RH	Humidity Indicator
Temperature – Measure ¹	(-50 to 400) °C	0.16 °C	Thermometer
Radiation (Infrared) Thermometers ¹	(50 to 100) °C (100 to 200) °C (200 to 400) °C	0.68 °C 1.9 °C 3.3 °C	Black body calibrator $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Environmental Chambers ¹ Calibration & Profiling	(-40 to 300) °C	1.5 °C	Datalogger with RTDs

Time and Frequency

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measuring Equipment ¹	0.01 Hz to 10 MHz	0.000 17 % of reading	Synth/Arb Function Generator

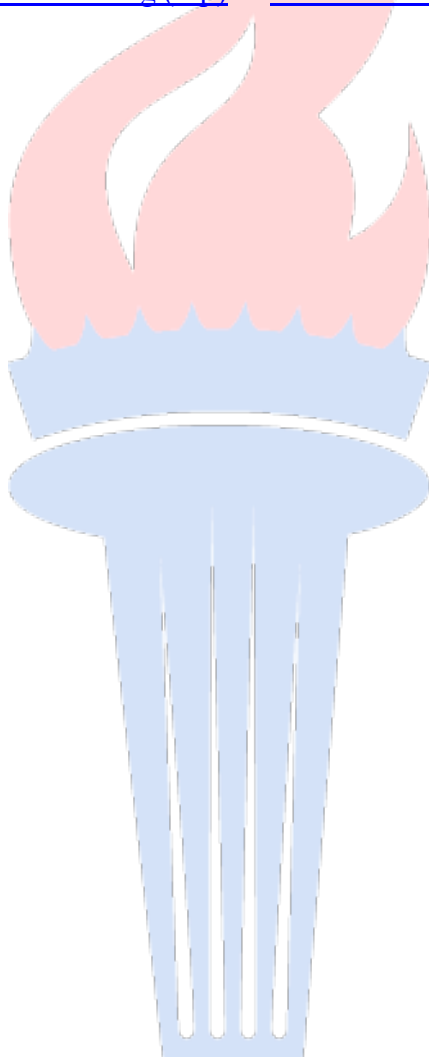
Time and Frequency

Chennai, India

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measuring Equipment ¹	10 MHz to 40 GHz	6.3×10^{-12} Hz/Hz	Synthesized CW Generator
Frequency – Measure ¹	0.1 Hz to 3 GHz 10 MHz to 26.5 GHz	6.7×10^{-6} Hz/Hz 6.3×10^{-10} Hz/Hz	Frequency Counter
Frequency – Measure Fixed Point	10 MHz	6.2×10^{-12} Hz/Hz	Frequency Standard

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)



Services performed at satellite laboratory

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CALIBRATION AND DIMENSIONAL MEASUREMENT

Acoustics and Vibration

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meter ¹	(74 to 114) dB 125 Hz to 4 kHz	0.14 dB	Sound Calibrator, Sound Level Meter
Sound Calibrator ¹	(74 to 124) dB 10 Hz to 20 kHz	0.095 dB	Sound Calibrator, Sound Level Meter / Reference Microphone with Sound Calibration System
Microphones ¹ Sensitivity	(-80 to -10) dB re. 1V/Pa 10 Hz to 20 kHz	0.093 dB	Reference Microphone with Sound Calibration System
Microphones ¹ Frequency Response	(-80 to -10) dB re. 1V/Pa (10 to 80) Hz (80 to 100) Hz 100 Hz to 4 kHz (4 to 8) kHz (8 to 12.6) kHz (12.6 to 16) kHz (16 to 20) kHz	0.13 dB 0.12 dB 0.093 dB 0.12 dB 0.16 dB 0.18 dB 0.26 dB	Reference Microphone with Sound Calibration System
Vibration ¹ 0.2 Hz to 10 kHz Acceleration Velocity Displacement Accelerometers / Velocity Sensors / Displacement Sensors	(0 to 200) m/s ² (0 to 200) mm/s (0 to 200) µm Sensitivity: (0.04 to 1 000) pC/units (0.04 to 1 000) mV/units	1.1 % of reading + 0.012 m/s ² 1.1 % of reading + 0.012 mm/s 1.1 % of reading + 0.012 µm 1 % of sensitivity	Reference Accelerometer with Vibration System

Chemical Quantities

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity – Meter ¹	84 µS/cm 1 000 µS/cm 1 413 µS/cm 111.3 mS/cm	0.66 µS/cm 7.5 µS/cm 11 µS/cm 0.79 mS/cm	Comparison to Standard Solutions
pH – Meter ¹	(4, 7, 10) pH	0.009 1 pH	Comparison to Standard Solutions
Gas Detector, Gas Analyzer	Iso-Butylene 10 parts in 10 ⁶ Iso-Butylene 100 parts in 10 ⁶ CO ₂ 1.5% CO 50 parts in 10 ⁶ H ₂ S 10 parts in 10 ⁶ CH ₄ 50% LEL O ₂ 18% O ₂ 100 parts in 10 ⁶ O ₂ 1 000 parts in 10 ⁶	1.6 parts in 10 ⁶ Concentration 3.4 parts in 10 ⁶ Concentration 0.05 % Concentration 8.2 parts in 10 ⁶ Concentration 1.6 parts in 10 ⁶ Concentration 0.41 % Concentration 2.9 % Concentration 8.7 parts in 10 ⁶ Concentration 72 parts in 10 ⁶ Concentration	Standard Gas
Optical System Aerosol Particle Counter	(0 to 100) % Counting Efficiency Particle sizes (0.1, 0.2, 0.3, 0.5, 1, 2, 5, 10) µm	6 % Counting efficiency	Comparison to Master Particle Counter
Refractometer	Up to 25 % Salinity Up to 50 % Brix	0.15 % Salinity 0.16 % Brix	Comparison to Standard Refractometer
Turbidity Meter ¹	1.01 NTU 15 NTU 100 NTU 750 NTU	0.022 NTU 0.15 NTU 0.77 NTU 6.7 NTU	Comparison to Standard Solutions
Viscometer ¹	1 000 cP 200 000 cP 87 KU	12 cP 2 400 cP 1 KU	Comparison to Standard Solutions

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

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 to 1 100) V	7.5 µV/V + 0.4 µV 5.0 µV/V + 0.7 µV 3.5 µV/V + 2.6 µV 3.5 µV/V + 4 µV 5 µV/V + 40 µV 6.5 µV/V + 0.4 mV	Multi-Function Calibrator

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source Fixed Points	1 V 1.018 V 10 V	2 μ V 2 μ V 6.6 μ V	DC Voltage Reference Standard
DC High Voltage – Source ¹ Electrostatic Field Meter	(0 to 10) kV (10 to 20) kV	0.35 mV/V + 0.03 5 V 0.47 mV/V + 4.7 V	Comparison with High Voltage Meter and High Voltage Probe
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1 000) V	11 μ V/V + 6 μ V 10 μ V/V + 2 μ V 10 μ V/V + 2 μ V 12 μ V/V + 2 μ V 12 μ V/V + 6 μ V	Multimeter
DC High Voltage – Measure ¹	(0 to 10) kV (10 to 20) kV	0.35 mV/V + 0.035 V 0.47 mV/V + 4.7 V	Comparison with High Voltage Meter and High Voltage Probe
DC Power – Source ^{1,2}	0.01 mW to 20.5 kW (33 mV to 1020 V) (0.33 to 330) mA 330 mA to 11 A (11 to 20.5) A	0.030 % of Watts output + 0.58R 0.059 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R	Multi-Product Calibrator
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	41 μ A/A + 7.2 nA 37 μ A/A + 41 nA 45 μ A/A + 0.4 μ A 53 μ A/A + 0.81 μ A 89 μ A/A + 16 μ A	Multi-Function Calibrator
DC Current – Source ¹	Up to 330 μ A 330 μ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 3 A (3 to 11) A (11 to 20.5) A	0.12 mA/A + 16 nA 78 μ A/A + 40 nA 82 μ A/A + 0.43 μ A 0.16 mA/A + 10 μ A 0.16 mA/A + 32 μ A 0.39 mA/A + 0.26 mA 0.78 mA/A + 0.58 mA	Multi-Product Calibrator
DC Current – Source ¹	Up to 16.5 A (16.5 to 150) A (150 to 1 025) A	2.8 mA/A + 3 mA 2.8 mA/A + 25 mA 2.9 mA/A + 90 mA	Multi-Product Calibrator w/50-turns coil

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Measure ¹	Up to 100 nA 100 nA to 1 μ A (1 to 10) μ A (10 to 100) μ A (0.1 to 1) mA (1 to 10) mA	36 μ A/A + 50 pA 25 μ A/A + 50 pA 25 μ A/A + 121 pA 25 μ A/A + 1 nA 25 μ A/A + 7 nA 25 μ A/A + 68 nA	Multimeter
DC Current – Measure ¹	(10 to 100) mA 100 mA to 1 A	41 μ A/A + 0.7 μ A 128 μ A/A + 14 μ A	Multimeter
DC Current – Measure ¹	(1 to 20) A (20 to 150) A (150 to 1 500) A	0.12 mA/A + 0.25 mA 2.9 mA/A + 2.7 mA 2.9 mA/A + 27 mA	Shunt monitored with Multimeter
Resistance – Source ¹	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 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 (110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω (330 to 1 110) M Ω	31 $\mu\Omega/\Omega$ + 0.83 m Ω 23 $\mu\Omega/\Omega$ + 1.2 m Ω 23 $\mu\Omega/\Omega$ + 1.2 m Ω 22 $\mu\Omega/\Omega$ + 1.6 m Ω 22 $\mu\Omega/\Omega$ + 1.7 m Ω 22 $\mu\Omega/\Omega$ + 16 m Ω 22 $\mu\Omega/\Omega$ + 27 m Ω 22 $\mu\Omega/\Omega$ + 0.16 Ω 24 $\mu\Omega/\Omega$ + 1.0 Ω 27 $\mu\Omega/\Omega$ + 1.8 Ω 27 $\mu\Omega/\Omega$ + 1.9 Ω 68 $\mu\Omega/\Omega$ + 55 Ω 0.11 m Ω/Ω + 64 Ω 0.54 m Ω/Ω + 2.2 k Ω 0.63 m Ω/Ω + 2.5 k Ω 5.5 m Ω/Ω + 78 k Ω 13 m Ω/Ω + 0.39 M Ω	Multi-Product Calibrator

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω	50 $\mu\Omega$ 95 $\mu\Omega$ 0.18 m Ω 0.23 m Ω 0.44 m Ω 1 m Ω 1.9 m Ω 8.5 m Ω 16 m Ω 85 m Ω 0.16 Ω 1.1 Ω 2.1 Ω 20 Ω	Multi-Function Calibrator
Resistance – Source ¹ Fixed Points	1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	40 Ω 0.4 k Ω 0.9 k Ω 10 k Ω	Multi-Function Calibrator
Resistance – Source ¹ (Fixed Points)	0.1 m Ω 10 m Ω 100 m Ω	0.25 $\mu\Omega$ 4 $\mu\Omega$ 10 $\mu\Omega$	Resistance Shunts
Resistance – Source ¹ (Fixed Artifacts)	1 Ω 10 k Ω	16 $\mu\Omega$ 85 m Ω	Standard Resistors
Resistance – Source ¹ (Variable Artifact)	(0.01 to 0.1) Ω (0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω (100 to 1 000) Ω (1 to 10) k Ω (10 to 100) k Ω (100 to 1 000) k Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 100 G Ω	147 $\mu\Omega/\Omega$ 125 $\mu\Omega/\Omega$ 78 $\mu\Omega/\Omega$ 61 $\mu\Omega/\Omega$ 32 $\mu\Omega/\Omega$ 32 $\mu\Omega/\Omega$ 76 $\mu\Omega/\Omega$ 2.4 m Ω/Ω 4.1 m Ω/Ω 2.8 m Ω/Ω 6 m Ω/Ω	High-Accuracy Decade Resistor / Resistance Box

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure ¹	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	18 $\mu\Omega/\Omega$ + 68 $\mu\Omega$ 15 $\mu\Omega/\Omega$ + 0.7 m Ω 13 $\mu\Omega/\Omega$ + 0.7 m Ω 13 $\mu\Omega/\Omega$ + 7 m Ω 13 $\mu\Omega/\Omega$ + 68 m Ω 18 $\mu\Omega/\Omega$ + 5 Ω 61 $\mu\Omega/\Omega$ + 135 Ω 584 $\mu\Omega/\Omega$ + 2 k Ω 5.8 m Ω/Ω + 14 k Ω	Multimeter
AC Resistance – Measure ¹ 12 Hz to 100 kHz	Up to 10 k Ω	0.23 m Ω/Ω + 6 $\mu\Omega$	RLC Digibridge
AC Voltage – Source ¹	220 μ V 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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	0.38 mV/V + 4 μ V 0.31 mV/V + 4 μ V 0.31 mV/V + 4 μ V 0.36 mV/V + 4 μ V 0.64 mV/V + 5 μ V 1.2 mV/V + 10 μ V 1.5 mV/V + 20 μ V 2.8 mV/V + 20 μ V 0.25 mV/V + 4 μ V 0.12 mV/V + 4 μ V 0.1 mV/V + 4 μ V 0.22 mV/V + 4 μ V 0.5 mV/V + 5 μ V 1.1 mV/V + 10 μ V 1.4 mV/V + 20 μ V 2.7 mV/V + 20 μ V 0.24 mV/V + 12 μ V 91 μ V/V + 7 μ V 81 μ V/V + 7 μ V 0.2 mV/V + 7 μ V 0.46 mV/V + 17 μ V 0.9 mV/V + 20 μ V 1.4 mV/V + 25 μ V 2.7 mV/V + 45 μ V	Multi-Function Calibrator

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	220 mV to 2.2 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	0.24 mV/V + 40 μ V 90 μ V/V + 15 μ V 45 μ V/V + 8 μ V 75 μ V/V + 10 μ V 0.11 mV/V + 30 μ V 0.42 mV/V + 80 μ V 1 mV/V + 0.2 mV 1.7 mV/V + 0.3 mV	Multi-Function Calibrator
	(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	0.24 mV/V + 0.4 mV 90 μ V/V + 0.15 mV 45 μ V/V + 50 μ V 75 μ V/V + 100 μ V 0.1 mV/V + 0.2 mV 0.28 mV/V + 0.6 mV 1 mV/V + 2 mV 1.5 mV/V + 3.2 mV 0.24 mV/V + 4 mV 90 μ V/V + 1.5 mV 53 μ V/V + 0.6 mV 81 μ V/V + 1 mV 0.15 mV/V + 2.5 mV 0.9 mV/V + 16 mV 4.4 mV/V + 40 mV 8 mV/V + 80 mV	
AC Voltage – Source ¹	(220 to 1 100) V (15 to 50) Hz 50 Hz to 1 kHz	0.3 mV/V + 16 mV 71 μ V/V + 3.5 mV	Multi-Function Calibrator
AC High Voltage – Source ¹	Up to 10 kV (50 to 60) Hz	1.4 mV/V + 0.13 V	Comparison with High Voltage Meter and High Voltage Probe

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz	353 $\mu\text{V/V} + 7.7 \mu\text{V}$ 241 $\mu\text{V/V} + 7 \mu\text{V}$ 353 $\mu\text{V/V} + 7 \mu\text{V}$ 1.2 mV/V + 7 μV 5.8 mV/V + 7 μV 46 mV/V + 7.3 μV 88 $\mu\text{V/V} + 4.6 \mu\text{V}$ 88 $\mu\text{V/V} + 2.3 \mu\text{V}$ 165 $\mu\text{V/V} + 2.3 \mu\text{V}$ 348 $\mu\text{V/V} + 2.3 \mu\text{V}$ 924 $\mu\text{V/V} + 2.3 \mu\text{V}$ 3.5 mV/V + 12 μV 12 mV/V + 12 μV 18 mV/V + 12 μV	Multimeter
	100 mV to 10 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 (1 to 2) MHz	88 $\mu\text{V/V} + 463 \mu\text{V}$ 88 $\mu\text{V/V} + 234 \mu\text{V}$ 165 $\mu\text{V/V} + 234 \mu\text{V}$ 348 $\mu\text{V/V} + 234 \mu\text{V}$ 924 $\mu\text{V/V} + 234 \mu\text{V}$ 3.5 mV/V + 1.2 mV 12 mV/V + 1.2 mV 18 mV/V + 1.2 mV	
AC Voltage – Measure ¹	(10 to 100) V (1 to 40) Hz 40 Hz to 1 kHz 1 kHz 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	234 $\mu\text{V/V} + 4.6 \text{ mV}$ 234 $\mu\text{V/V} + 2.3 \text{ mV}$ 234 $\mu\text{V/V} + 2.3 \text{ mV}$ 406 $\mu\text{V/V} + 2.3 \text{ mV}$ 1.4 mV/V + 2.3 mV 4.6 mV/V + 12 mV 18 mV/V + 12 mV 463 $\mu\text{V/V} + 47 \text{ mV}$ 463 $\mu\text{V/V} + 24 \text{ mV}$ 694 $\mu\text{V/V} + 24 \text{ mV}$ 1.4 mV/V + 24 mV 3.5 mV/V + 24 mV	Multimeter

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

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
	(10 to 20) Hz	1.2 mV/V + 0.87 μ V	
	(20 to 40) Hz	0.52 mV/V + 0.87 μ V	
	40 Hz to 20 kHz	0.32 mV/V + 0.87 μ V	
	(20 to 50) kHz	0.58 mV/V + 1.3 μ V	
	(50 to 100) kHz	0.85 μ V/V + 1.7 μ V	
	(100 to 300) kHz	1.6 mV/V + 2.7 μ V	
	(300 to 500) kHz	1.7 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	2.4 mV/V + 5.3 μ V	
	(2.2 to 7) mV		
	(10 to 20) Hz	0.57 mV/V + 0.87 μ V	
	(20 to 40) Hz	0.26 mV/V + 0.87 μ V	
	40 Hz to 20 kHz	0.16 mV/V + 0.87 μ V	
	(20 to 50) kHz	0.28 mV/V + 1.3 μ V	
	(50 to 100) kHz	0.4 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.8 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.87 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	1.5 mV/V + 5.3 μ V	
	(7 to 22) mV		
	(10 to 20) Hz	0.2 μ V/V + 0.87 μ V	
	(20 to 40) Hz	0.13 mV/V + 0.87 μ V	
	40 Hz to 20 kHz	80 μ V/V + 0.87 μ V	
	(20 to 50) kHz	0.14 mV/V + 1.3 μ V	
	(50 to 100) kHz	0.22 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.54 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.59 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	1.1 mV/V + 5.3 μ V	
	(22 to 70) mV		
	(10 to 20) Hz	0.16 mV/V + 1 μ V	
	(20 to 40) Hz	81 μ V/V + 1 μ V	
	40 Hz to 20 kHz	45 μ V/V + 1 μ V	
	(20 to 50) kHz	90 μ V/V + 1.3 μ V	
	(50 to 100) kHz	0.18 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.35 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.45 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.73 mV/V + 5.3 μ V	

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(70 to 220) mV		AC Measurement Standard
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	57 μ V/V + 1 μ V	
	40 Hz to 20 kHz	26 μ V/V + 1 μ V	
	(20 to 50) kHz	47 μ V/V + 1.3 μ V	
	(50 to 100) kHz	0.11 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.17 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.26 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.67 mV/V + 5.3 μ V	
	(220 to 700) mV		
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	51 μ V/V + 1 μ V	
	40 Hz to 20 kHz	23 μ V/V + 1 μ V	
	(20 to 50) kHz	35 μ V/V + 1.3 μ V	
	(50 to 100) kHz	54 μ V/V + 1.7 μ V	
	(100 to 300) kHz	0.12 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.2 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.64 mV/V + 5.3 μ V	
	700 mV to 2.2 V		
	(10 to 20) Hz	0.13 mV/V + 0.58 μ V	
	(20 to 40) Hz	44 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	17 μ V/V + 0.58 μ V	
	(20 to 50) kHz	31 μ V/V + 0.58 μ V	
	(50 to 100) kHz	48 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.11 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.18 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.6 mV/V + 0.58 μ V	
	(2.2 to 7) V		
	(10 to 20) Hz	0.13 mV/V + 0.58 μ V	
	(20 to 40) Hz	45 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	17 μ V/V + 0.58 μ V	
	(20 to 50) kHz	33 μ V/V + 0.58 μ V	
	(50 to 100) kHz	55 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.13 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.27 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.8 mV/V + 0.58 μ V	

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(7 to 22) V		AC Measurement Standard
	(10 to 20) Hz	0.13 mV/V + 5.8 μ V	
	(20 to 40) Hz	45 μ V/V + 5.8 μ V	
	40 Hz to 20 kHz	19 μ V/V + 5.8 μ V	
	(20 to 50) kHz	33 μ V/V + 5.8 μ V	
	(50 to 100) kHz	55 μ V/V + 5.8 μ V	
	(100 to 300) kHz	0.13 mV/V + 5.8 μ V	
	(300 to 500) kHz	0.27 mV/V + 5.8 μ V	
	500 kHz to 1 MHz	0.8 mV/V + 5.8 μ V	
	(22 to 70) V		
	(10 to 20) Hz	0.13 mV/V + 5.8 μ V	
	(20 to 40) Hz	46 μ V/V + 5.8 μ V	
	40 Hz to 20 kHz	22 μ V/V + 5.8 μ V	
	(20 to 50) kHz	39 μ V/V + 5.8 μ V	
	(50 to 100) kHz	64 μ V/V + 5.8 μ V	
	(100 to 300) kHz	0.14 mV/V + 5.8 μ V	
	(300 to 500) kHz	0.27 mV/V + 5.8 μ V	
	500 kHz to 1 MHz	0.8 mV/V + 5.8 μ V	
	(70 to 220) V		
	(10 to 20) Hz	0.13 mV/V + 58 μ V	
	(20 to 40) Hz	46 μ V/V + 58 μ V	
	40 Hz to 20 kHz	22 μ V/V + 58 μ V	
	(20 to 50) kHz	47 μ V/V + 58 μ V	
	(50 to 100) kHz	67 μ V/V + 58 μ V	
	(100 to 300) kHz	0.14 mV/V + 58 μ V	
	(300 to 500) kHz	0.33 mV/V + 58 μ V	
	(220 to 700) V		
	(10 to 20) Hz	0.13 mV/V + 58 μ V	
	(20 to 40) Hz	67 μ V/V + 58 μ V	
	40 Hz to 20 kHz	29 μ V/V + 58 μ V	
	(20 to 50) kHz	87 μ V/V + 58 μ V	
	(50 to 100) kHz	0.34 mV/V + 58 μ V	
	(700 to 1 000) V		
	(10 to 20) Hz	0.13 mV/V + 58 μ V	
	(20 to 40) Hz	67 μ V/V + 58 μ V	
	40 Hz to 20 kHz	28 μ V/V + 58 μ V	
	(20 to 50) kHz	87 μ V/V + 58 μ V	
	(50 to 100) kHz	0.33 mV/V + 58 μ V	

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness – Measure ¹ (Relative to 1 kHz)	Up to 2.2 mV		AC Measurement Standard
	(10 to 30) Hz	0.94 mV/V + 0.08 µV	
	(30 to 120) Hz	0.47 mV/V + 0.08 µV	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.08 µV	
	(1.2 to 120) kHz	0.47 mV/V + 0.08 µV	
	(120 to 500) kHz	0.66 mV/V + 0.95 µV	
	500 kHz to 1.2 MHz	0.66 mV/V + 0.95 µV	
	(1.2 to 2) MHz	0.66 mV/V + 0.95 µV	
	(2 to 10) MHz	1.6 mV/V + 0.95 µV	
	(10 to 20) MHz	2.8 mV/V + 0.95 µV	
	(20 to 30) MHz	6.6 mV/V + 1.9 µV	
	(2.2 to 7) mV		
	(10 to 30) Hz	0.94 mV/V + 0.082 µV	
	(30 to 120) Hz	0.47 mV/V + 0.082 µV	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.082 µV	
	(1.2 to 120) kHz	0.47 mV/V + 0.082 µV	
	(120 to 500) kHz	0.66 mV/V + 0.95 µV	
	500 kHz to 1.2 MHz	0.66 mV/V + 0.95 µV	
	(1.2 to 2) MHz	0.66 mV/V + 0.95 µV	
	(2 to 10) MHz	0.94 mV/V + 0.95 µV	
	(10 to 20) MHz	1.6 mV/V + 0.95 µV	
	(20 to 30) MHz	3.5 mV/V + 0.95 µV	
	(7 to 22) mV		
	(10 to 30) Hz	0.94 mV/V + 0.082 µV	
	(30 to 120) Hz	0.47 mV/V + 0.082 µV	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.082 µV	
	(1.2 to 120) kHz	0.47 mV/V + 0.082 µV	
	(120 to 500) kHz	0.66 mV/V + 0.082 µV	
	500 kHz to 1.2 MHz	0.66 mV/V + 0.082 µV	
	(1.2 to 2) MHz	0.66 mV/V + 0.082 µV	
	(2 to 10) MHz	0.94 mV/V + 0.082 µV	
	(10 to 20) MHz	1.6 mV/V + 0.082 µV	
	(20 to 30) MHz	3.5 mV/V + 0.082 µV	

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness – Measure ¹ (Relative to 1 kHz)	(22 to 70) mV		AC Measurement Standard
	(10 to 30) Hz	0.94 mV/V + 0.82 μ V	
	(30 to 120) Hz	0.47 mV/V + 0.82 μ V	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 120) kHz	0.47 mV/V + 0.82 μ V	
	(120 to 500) kHz	0.47 mV/V + 0.82 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.82 μ V	
	(2 to 10) MHz	0.94 mV/V + 0.82 μ V	
	(10 to 20) MHz	1.4 mV/V + 0.82 μ V	
	(20 to 30) MHz	3.3 mV/V + 0.82 μ V	
	(70 to 220) mV		
	(10 to 30) Hz	0.94 mV/V + 0.82 μ V	
	(30 to 120) Hz	0.38 mV/V + 0.82 μ V	
	120 Hz to 1.2 kHz	0.38 mV/V + 0.82 μ V	
	(1.2 to 120) kHz	0.38 mV/V + 0.82 μ V	
	(120 to 500) kHz	0.38 mV/V + 0.82 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.82 μ V	
	(2 to 10) MHz	0.94 mV/V + 0.82 μ V	
	(10 to 20) MHz	1.4 mV/V + 0.82 μ V	
	(20 to 30) MHz	3.3 mV/V + 0.82 μ V	
	(220 to 700) mV		
	(10 to 30) Hz	0.94 mV/V + 8.2 μ V	
	(30 to 120) Hz	0.28 mV/V + 8.2 μ V	
	120 Hz to 1.2 kHz	0.28 mV/V + 8.2 μ V	
	(1.2 to 120) kHz	0.28 mV/V + 8.2 μ V	
	(120 to 500) kHz	0.28 mV/V + 8.2 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 8.2 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 8.2 μ V	
	(2 to 10) MHz	0.94 mV/V + 8.2 μ V	
	(10 to 20) MHz	1.4 mV/V + 8.2 μ V	
	(20 to 30) MHz	3.3 mV/V + 8.2 μ V	

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness – Measure ¹ (Relative to 1 kHz)	700 mV to 2.2 V (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (2.2 to 7) V (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.94 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 1.4 mV/V + 8.2 μV 3.3 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 1.4 mV/V + 8.2 μV 3.3 mV/V + 8.2 μV	AC Measurement Standard
AC High Voltage – Measure ¹	Up to 10 kV (45 to 65) Hz (10 to 20) kV (45 to 65) Hz	1.4 mV/V + 0.13 V 2.3 mV/V + 23 V	Comparison with High Voltage Meter and High Voltage Probe
AC Power – Source ^{1,2} (33 to 330) mV) (45 to 65) Hz PF = 1	0.1 mW to 20.5 kW (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.11 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.11 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.1 % of Watts output + 0.58R 0.088 % of Watts output + 0.58R 0.1 % of Watts output + 0.58R 0.13 % of Watts output + 0.58R	Multi-Product Calibrator

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} 330 mV to 1 020 V (45 to 65) Hz PF = 1	0.1 mW to 20.5 kW (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.096 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.088 % of Watts output + 0.58R 0.073 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.15 % of Watts output + 0.58R	Multi-Product Calibrator
AC Power – Source ^{1,2} (33 to 330) mV (45 to 65) Hz PF = (0 to 0.999)	0.1 mW to 20.5 kW (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.21 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R	Multi-Product Calibrator
AC Power – Source ^{1,2} 330 mV to 1 020 V (45 to 65) Hz PF = (0 to 0.999)	0.1 mW to 20.5 kW (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.23 % of Watts output + 0.58R	Multi-Product Calibrator
AC Current – Source ¹	(10 to 220) μ A (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	Multi-Function Calibrator

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(0.22 to 2.2) mA		Multi-Product Calibrator
	(10 to 20) Hz	0.25 mA/A + 40 nA	
	(20 to 40) Hz	0.16 mA/A + 35 nA	
	40 Hz to 1 kHz	0.12 mA/A + 35 nA	
	(1 to 5) kHz	0.2 mA/A + 0.11 μ A	
	(5 to 10) kHz	1.1 mA/A + 0.65 μ A	
	(2.2 to 22) mA		
	(10 to 20) Hz	0.25 mA/A + 0.4 μ A	
	(20 to 40) Hz	0.16 mA/A + 0.35 μ A	
	40 Hz to 1 kHz	0.12 mA/A + 0.35 μ A	
	(1 to 5) kHz	0.2 mA/A + 0.55 μ A	
	(5 to 10) kHz	1.1 mA/A + 5 μ A	
	(22 to 220) mA		
	(10 to 20) Hz	0.25 mA/A + 4 μ A	
	(20 to 40) Hz	0.16 mA/A + 3.5 μ A	
	40 Hz to 1 kHz	0.12 mA/A + 2.6 μ A	
	(1 to 5) kHz	0.2 mA/A + 3.5 μ A	
	(5 to 10) kHz	1.1 mA/A + 10 μ A	
	220 mA to 2.2 A		
	20 Hz to 1 kHz	0.27 mA/A + 35 μ A	
	(1 to 5) kHz	0.45 mA/A + 80 μ A	
	(5 to 10) kHz	7 mA/A + 0.16 mA	
	(1.1 to 3) A		
	(10 to 45) Hz	1.4 mA/A + 78 μ A	
	45 Hz to 1 kHz	0.47 mA/A + 78 μ A	
	(1 to 5) kHz	4.7 mA/A + 0.78 mA	
	(5 to 10) kHz	19 mA/A + 3.9 mA	
	(3 to 11) A		
	(45 to 100) Hz	0.47 mA/A + 1.6 mA	
	100 Hz to 1 kHz	0.78 mA/A + 1.6 mA	
	(1 to 5) kHz	23 mA/A + 1.6 mA	
	(11 to 20.5) A		
	(45 to 100) Hz	0.93 mA/A + 3.9 mA	
	100 Hz to 1 kHz	1.2 mA/A + 3.9 mA	
	(1 to 5) kHz	23 mA/A + 3.9 mA	

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(0 to 16.5) A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	2.8 mA/A + 3 mA 7.9 mA/A + 3 mA 2.8 mA/A + 25 mA 7.9 mA/A + 27 mA 3 mA/A + 90 mA 8 mA/A + 100 mA	Multi-Product Calibrator w/50-turn coil
AC Current – Measure ¹	Up to 100 μ A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 100 μ A to 1 mA (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 (50 to 100) kHz (1 to 10) mA (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 (50 to 100) kHz (10 to 100) mA (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 (50 to 100) kHz	4.6 mA/A + 0.035 μ A 1.7 mA/A + 0.035 μ A 0.7 mA/A + 0.035 μ A 0.7 mA/A + 0.035 μ A 4.6 mA/A + 0.23 μ A 1.7 mA/A + 0.23 μ A 0.7 mA/A + 0.23 μ A 0.4 mA/A + 0.23 μ A 0.7 mA/A + 0.23 μ A 4.6 mA/A + 0.46 μ A 6.4 mA/A + 1.7 μ A 4.6 mA/A + 2.3 μ A 1.7 mA/A + 2.3 μ A 0.7 mA/A + 2.3 μ A 0.4 mA/A + 2.3 μ A 0.7 mA/A + 2.3 μ A 4.6 mA/A + 4.6 μ A 6.4 mA/A + 17 μ A 4.6 mA/A + 23 μ A 1.7 mA/A + 23 μ A 0.7 mA/A + 23 μ A 0.4 mA/A + 23 μ A 0.7 mA/A + 23 μ A 4.6 mA/A + 46 μ A 6.4 mA/A + 0.17 mA	Multimeter

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	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	4.6 mA/A + 0.23 mA 1.8 mA/A + 0.23 mA 0.9 mA/A + 0.23 mA 1.2 mA/A + 0.23 mA 3.5 mA/A + 0.23 mA 12 mA/A + 0.46 mA	Multimeter
AC Current Measure ¹	(0.001 to 20) A 45 Hz to 1 kHz (1 to 5) kHz (20 to 30) A 45 Hz to 1 kHz (1 to 5) kHz (30 to 1 000) A (45 to 400) Hz	0.29 mA/A + 2.1 mA 0.41 mA/A + 2.1 mA 2.1 mA/A + 3.2 mA 2.5 mA/A + 3.2 mA 2.9 mA/A + 105 mA	Shunt with Multimeter
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C 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	0.36 °C 0.29 °C 0.27 °C 0.29 °C 0.27 °C 0.24 °C 0.27 °C 0.41 °C 0.66 °C 0.41 °C 0.18 °C 0.17 °C 0.18 °C 0.21 °C 0.25 °C 0.18 °C 0.17 °C 0.18 °C 0.22 °C	Multi-Product Calibrator

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type K		Multi-Product Calibrator
	(-200 to -100) °C	0.29 °C	
	(-100 to -25) °C	0.19 °C	
	(-25 to 120) °C	0.18 °C	
	(120 to 1 000) °C	0.24 °C	
	(1 000 to 1 372) °C	0.34 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.24 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.34 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.20 °C	
	(120 to 410) °C	0.19 °C	
	(410 to 1 300) °C	0.25 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.30 °C	
	(400 to 1 000) °C	0.29 °C	
	(1 000 to 1 767) °C	0.34 °C	
Electrical Calibration of RTD Indicating Systems ¹	Type S		Multi-Product Calibrator
	(0 to 250) °C	0.39 °C	
	(250 to 1 000) °C	0.31 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.38 °C	
	Type T		
	(-250 to -150) °C	0.51 °C	
	(-150 to 0) °C	0.23 °C	
	(0 to 120) °C	0.18 °C	
	(120 to 400) °C	0.17 °C	
	Type U		
	(-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.25 °C	
	Pt 385, 100 Ω		Multi-Product Calibrator
	(-200 to -80) °C	0.04 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.055 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 3926, 100 Ω		Multi-Product Calibrator
	(-200 to -80) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.055 $^{\circ}\text{C}$	
	(100 to 300) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.078 $^{\circ}\text{C}$	
	(400 to 630) $^{\circ}\text{C}$	0.093 $^{\circ}\text{C}$	
	Pt 3916, 100 Ω		
	(-200 to -190) $^{\circ}\text{C}$	0.19 $^{\circ}\text{C}$	
	(-190 to -80) $^{\circ}\text{C}$	0.032 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.055 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.063 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.078 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.18 $^{\circ}\text{C}$	
	Pt 385, 200 Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.032 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.032 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.032 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.093 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.12 $^{\circ}\text{C}$	
	Pt 385, 500 Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.032 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.063 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.063 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.086 $^{\circ}\text{C}$	

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 1 k Ω (-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C PtNi 385, 120 Ω (Ni120) (-80 to 0) °C (0 to 100) °C (100 to 260) °C Cu 427, 10 Ω (-100 to 260) °C	0.025 °C 0.025 °C 0.032 °C 0.040 °C 0.047 °C 0.055 °C 0.055 °C 0.18 °C 0.063 °C 0.063 °C 0.11 °C 0.23 °C	Multi-Product Calibrator
Inductance – Measure ¹ 12 Hz to 100 kHz	Up to 1 mH (1 to 10) mH (10 to 100) mH (0.1 to 1) H (1 to 10) H	0.2 mH/H + 0.058 μ H 0.3 mH/H + 0.58 μ H 0.2 mH/H + 5.8 μ H 0.2 mH/H + 58 μ H 0.24 mH/H + 0.58 mH	RLC Digibridge
Inductance – Source ¹ (Fixed Artifacts) 1 kHz	(1 to 10 mH) (10 to 100) mH (0.1 to 1) H (1 to 10) H	23 mH/H + 0.058 μ H 19 mH/H + 0.58 μ H 10 mH/H + 5.8 μ H 10 mH/H + 58 μ H	Standard Inductors
Inductance – Source ¹ (Fixed Artifacts) 100 Hz to 10 kHz 100 Hz to 10 kHz 100 Hz to 10 kHz 100 Hz to 10 kHz 100 Hz to 10 kHz 100 Hz to 10 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz	100 μ H 1 mH 10 mH 100 mH 200 mH 500 mH 1 H 10 H	0.29 μ H 1.2 μ H 12 μ H 120 μ H 233 μ H 581 μ H 1.2 mH 12 mH	Standard Inductors
Capacitance – Source ¹ (Simulation) 50 Hz to 1 kHz	(0.19 to 0.4) nF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF	3.9 mF/F + 13 pF 3.9 mF/F + 13 pF 3.9 mF/F + 13 pF 1.9 mF/F + 13 pF 1.9 mF/F + 0.13 nF 1.9 mF/F + 0.13 nF	Multi-Product Calibrator

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ (Simulation) 50 Hz to 1 kHz	(110 to 330) nF 330 nF to 1.1 μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F 330 μ F to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	1.9 mF/F + 0.38 nF 1.9 mF/F + 1.3 nF 1.9 mF/F + 3.8 nF 1.9 mF/F + 13 nF 3.1 mF/F + 38 nF 3.5 mF/F + 0.13 μ F 3.5 mF/F + 0.38 μ F 3.5 mF/F + 1.3 μ F 3.5 mF/F + 3.8 μ F 3.5 mF/F + 13 μ F 5.8 mF/F + 38 μ F 8.5 mF/F + 0.13 mF	Multi-Product Calibrator
Capacitance – Source ¹ (Fixed Artifacts)	100 Hz to 1 000 kHz 1 pF 10 pF 100 pF 1 000 pF 10 Hz to 10 kHz 1 nF 10 nF 100 nF 1 μ F	0.58 mF/F + 0.000 058 pF 0.58 mF/F + 0.000 58 pF 0.58 mF/F + 0.005 8 pF 0.58 mF/F + 0.058 pF 0.23 mF/F + 0.058 pF 0.23 mF/F + 0.58 pF 0.23 mF/F + 5.8 pF 0.23 mF/F + 58 pF	Standard Capacitors
Capacitance – Measure ¹ 12 Hz to 100 kHz	Up to 1 000 μ F	1.1 mF/F + 0.000 58 pF	RLC Digibridge
Oscilloscope ¹ Square Wave Amplitude, < 10 kHz into 50 Ω or 1 M Ω Load Impedance	Up to 1 mVp-p (1 to 21) mVp-p (21 to 556) mVp-p 556 mVp-p to 210 Vp-p	10 mV/V + 10 μ V 1.5 mV/V + 20 μ V 1.5 mV/V + 1.2 μ V 1.3 mV/V + 1.2 μ V	Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Horizontal Deflection (Time)	150 ps to 50 s	0.39 parts in 10 ⁶ of reading	Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Vertical Deflection (Amplitude)	Up to 50 Vp-p (50 to 100) Vp-p (100 to 200) Vp-p	250 μ V/V + 25 μ V 250 μ V/V + 26 μ V 250 μ V/V + 63 μ V	Oscilloscope Calibrator and Active Head
Oscilloscopes – Bandwidth ¹	100 mHz to 50 GHz	2.1 % of reading	Oscilloscope Calibrator w/Active Head, Power Sensor
Oscilloscopes ¹ Rise / Fall Time, (10 to 90) %	(0 to 1.25) s	1.3 ps	Oscilloscope Calibrator with Calibration Head

Electrical – DC/Low Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tesla Meter / Gauss Meter	500 G 5 000 G	1.2 % of reading 0.58 % of reading	Reference Magnets
Moisture Meters	(7 to 25) % Moisture Content	0.26 % Moisture Content	Resistance Standard
Phase – Measure ¹ (10 to 32) mV	(0 to 360) ° 1 Hz to 10 kHz	0.25 °	Precision Phasemeter
(10 to 100) mV	(10 to 50) kHz 50 kHz to 100 MHz	0.43 ° 0.86 °	
32 mV to 100 V	(1 to 10) Hz 10 Hz to 10 kHz	0.13 ° 0.071 °	
100 mV to 100 V	(10 to 50) kHz (50 to 100) kHz 100 kHz to 10 MHz	0.071 ° 0.43 ° 0.43 °	
(100 to 320) V	(1 to 10) Hz 10 Hz to 5 kHz	0.25 ° 0.13 °	

Electrical – RF/Microwave

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Sensors – Calibration Factors ^{1,5}	Referenced to 1 mW 9 kHz to 100 kHz 100 kHz to 10 MHz (10 to 50) MHz 50 MHz to 1 GHz (1 to 4) GHz (4 to 8) GHz (8 to 12) GHz (12 to 15) GHz (15 to 18) GHz	3.9 % 2.1 % 1.5 % 1.5 % 1.7 % 2.5 % 2.6 % 3.1 % 5.5 %	Power Sensors
RF Power Meter ¹ (Reference)	1 mW 50 MHz	0.78 % of Reading	Power Meter and Thermistor Mount
RF Power Meter ¹ (Fixed Points)	(3, 10, 30, 100, 300) μW (1, 3, 10, 30, 100) mW	0.37 % of Watts output + 0.58 · R	Range Calibrator

Electrical – RF/Microwave

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Tuned Power – Measure ¹	(-117 to 30) dB 100 kHz to 2.6 GHz 2.6 to 6) GHz (6 to 10) GHz (10 to 18) GHz (18 to 26.5) GHz	0.2 dB 0.27 dB 0.28 dB 0.29 dB 0.36 dB	Measuring Receiver and Power Sensors
RF Absolute Power – Measure ¹	(-70 to 44) dBm 9 kHz to 2 GHz (2 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 40) GHz (40 to 50) GHz	0.083 dB 0.097 dB 0.12 dB 0.2 dB 0.26 dB 0.36 dB	Power Meter, Measuring Receiver and Power Sensors
RF Power – Source ¹	(-120 to 10) dBm Up to 250 kHz 250 kHz to 4 GHz (4 to 20) GHz (20 to 26.4) GHz	0.14 dB 0.11 dB 0.13 dB 0.16 dB	Signal Generator / Synthesized Sweep Generator
Distortion – Measure ¹ 20 Hz to 22 kHz 20 Hz to 80 kHz 20 Hz to 250 kHz	40 kHz BW: -95 dB 80 kHz BW: -90 dB 250 kHz BW: -84 dB	0.016 dB 0.082 dB 0.24 dB	Audio Analyzer
Amplitude Modulation – Measure ¹ AM Depth Accuracy 100 kHz to 10 MHz (Rate: 50 Hz to 10 kHz) 10 MHz to 3 GHz (Rate: 50 Hz to 100 kHz) (3 to 26.5) GHz (Rate: 50 Hz to 100 kHz) Flatness 10 MHz to 3 GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) % Depth: (20 to 99) % Depth: (5 to 20) % Depth: (20 to 99) % Depth: (5 to 20) % Depth: (5 to 99) %	0.91 % Depth 0.61 % Depth 3.0 % Depth 1.8 % Depth 5.5 % Depth 0.37 % Depth	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹ (3 to 26.5) GHz (Rate: 90 Hz to 10 kHz) FM Rejection (50 Hz to 3 kHz BW) 250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz) 10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz) Residual AM 250 kHz to 26.5 GHz	Depth: (5 to 99) % Depths: < 50% Deviations: < 5 kHz Depths: < 50% Deviations: < 50 kHz (50 Hz to 3 kHz BW)	0.49 % Depth 0.17 % Depth 0.44 % Depth 0.012 % (rms)	PSA Series Spectrum Analyzer
Frequency Modulation – Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz (Rate: 20 Hz to 200 kHz) AM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: 200 Hz to 400 kHz AM Depths: ≤ 50% (Rate: 400 Hz or 1 kHz)	1.3 % of reading 13 Hz 25 Hz 49 Hz	PSA Series Spectrum Analyzer
Frequency Modulation – Measure ¹ Residual FM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	(50 Hz to 3 kHz BW)	1.9 Hz 3.7 Hz 7.4 Hz	PSA Series Spectrum Analyzer
Phase Modulation – Measure ¹ PM Deviation Accuracy 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 0.7 rad Deviations: > 0.3 rad	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Measure ¹ AM Rejection (50 Hz to 3 kHz BW) 100 kHz to 26.5 GHz Residual PM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	AM Depths: $\leq 50\%$ (Rate: 1 kHz) (50 Hz to 3 kHz BW)	0.000 58 rad 0.002 1 rad 0.004 1 rad 0.008 1 rad	PSA Series Spectrum Analyzer
Digital Modulation – Measure ¹ For 2/3/4/5G Composite Rho ⁵ Error Vector Magnitude (rms) Peak Code Domain Error Phase error	450 MHz to 26.5 GHz $\rho = (0.9 \text{ to } 1.0)$ 450 MHz to 26.5 GHz EVM = (0 to 25) % (-80 to 0) dB 450 MHz to 26.5 GHz 450 MHz to 26.5 GHz (1 to 15) °	0.001 0.3 % of reading 1.2 dB 0.71 °	PSA Series Spectrum Analyzer, Signal Generator
Digital Modulation – Measure ¹ For 2/3/4/5G Frequency Error I/Q Origin Offset Channel Power	3 Hz to 26.5GHz (-80 to 0) dB 450 MHz to 26.5 GHz 450 MHz to 26.5 GHz Power > -70 dBm	2.1×10^{-7} Hz/Hz 1.2 dB 0.62 dB	PSA Series Spectrum Analyzer, Signal Generator
Amplitude Modulation – Source ¹	(11 to 13.5) MHz Rate: 20 Hz to 100 kHz Depth: 0% to 95% Depth: 95% to 99%	0.13 % Depth 0.24 % Depth	AM/FM Test Source

Electrical – RF/Microwave

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Source ¹	(11 to 432) MHz Rate: 20 Hz to 100 kHz Deviations: ≤ 400 kHz	0.29 % Modulation	AM/FM Test Source
Reflection S11 / S22 – Measure ¹	Magnitude (0 to 110) dB 45 MHz to 2 GHz (2 to 26.5) GHz Phase (-180 to 180) ° 45 MHz to 2 GHz (2 to 20) GHz (20 to 26.5) GHz	0.55 dB 0.74 dB 0.33 ° 0.74 ° 2.3 °	Network Analyzer and Calibration Kits
Transmission S12 / S21 – Measure ¹	Magnitude (0 to 110) dB 45 MHz to 2 GHz (2 to 8) GHz (8 to 26.5) GHz Phase (-180 to 180) ° 45 MHz to 2 GHz (2 to 20) GHz (20 to 26.5) GHz	0.074 dB 0.084 dB 0.093 dB 0.33 ° 0.74 ° 2.3 °	Network Analyzer and Calibration Kits

Length – Dimensional Metrology

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 1 000 mm	$(0.17 + 0.006\ 8l)\ \mu\text{m} + 0.58R$	Gage Blocks
Height Gages ^{1,2}	Up to 1 000 mm	$(0.71 + 0.001\ 8l)\ \mu\text{m} + 0.58R$	Gage Blocks, Surface Plate
Micrometers ^{1,2} External, Internal, Depth, Bore	Up to 1 050 mm	$(0.088 + 0.006\ 9l)\ \mu\text{m} + 0.58R$	Gage Blocks, Optical Parallels, Surface Plate, Ring Gages
Indicators Dial Gauge, Dial Test Indicator, LVDTs ^{1,2}	Up to 1 mm (1 to 100) mm	0.17 μm $(0.32 + 0.004\ 6l)\ \mu\text{m} + 0.58R$	Universal Length Measuring Machine, Indicator Tester
	Up to 100 mm	$(0.069 + 0.002\ 6l)\ \mu\text{m} + 0.58R$	Gage Block, Comparator Stand
Plain Plug Gages / Pin Gages / Thread Wires ^{1,2} (Cylindrical and Taper)	(0.001 to 300) mm	$(0.19 + 0.002l)\ \mu\text{m}$	Universal Length Measuring Machine, High- Accuracy Micrometer, Gage Blocks

Length – Dimensional Metrology

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Plain Ring Gages ² (Cylindrical and Taper)	(1 to 300) mm	$(0.22 + 0.001\ 7l)\ \mu\text{m}$	Universal Length Measuring Machine, Master Ring, Gage Block
Thread Plug Gages ² (Cylindrical and Taper) Simple Pitch Diameter	(0.001 to 150) mm	$(1.4 + 0.007l)\ \mu\text{m}$	Universal Length Measuring Machine, High-Accuracy Micrometer, Gage Block, Thread Measuring Wires
Major Diameter	(0.001 to 150) mm	$(0.22 + 0.001\ 9l)\ \mu\text{m}$	
Thread Ring Gages ² (Cylindrical and Taper) Simple Pitch Diameter	(1 to 150) mm	$(1.3 + 0.005l)\ \mu\text{m}$	Universal Length Measuring Machine, Gage Block, Master Ring Gage, Thread Calibration Standards
Major Diameter	(1 to 150) mm	$(0.33 + 0.002\ 7l)\ \mu\text{m}$	
Gage Block – Length ²	(0.1 to 100) mm	$(0.068 + 0.001\ 1l)\ \mu\text{m}$	Gage block, Gage Block Comparator
Gage Block – Length ²	(0.1 to 100) mm (100 to 500) mm	$(0.08 + 0.001l)\ \mu\text{m}$ $(0.041 + 0.001\ 3l)\ \mu\text{m}$	Gage block, Universal Length Measuring Machine
Surface Plates ^{1,2} Overall Flatness	(150 to 3 600) mmD	$(0.5 + 0.001\ 3D)\ \mu\text{m}$	Differential Level
Local Area Flatness (Variation)	(0 to 0.13) mm	0.6 μm	Repeat-o-meter
Setting Rod, Micrometer Standard, Length Standards ²	(0.1 to 500) mm	$(0.37 + 0.002\ 7l)\ \mu\text{m}$	Gage block, Universal Length Measuring Machine
Ruler & Tape Measures ^{1,2}	Up to 1 000 mm (1 000 to 50 000) mm	$(15 + 0.007l)\ \mu\text{m}$ 0.022l μm	Gage block, Standard Scale, Scale Loupe, Ruler Calibrator
Precision Level	Up to 1 mm/m (1 to 2) mm/m	0.85 % of reading + 3.5 $\mu\text{m}/\text{m}$ 1.8 % of reading	Differential Level
Master Level / Electronic Inclinometer / Angle Meter	Up to 5 mm/m Up to 90° (4 Quadrant)	1.1 $\mu\text{m}/\text{m}$ 0.000 82°	Sine Bar, Gage Block, Surface Plate
Bevel Protractor / Universal Bevel Protractor ¹	Up to 90° (4 Quadrant)	2'	Standard Angle Block
Roughness Tester ¹	Up to 5 μm Ra Up to 15 μm Rz	0.056 μm Ra 0.4 μm Rz	Roughness Standard

Length – Dimensional Metrology

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sine Bar & Sine Plate ²	Up to 300 mm	$(0.15 + 0.002 \cdot l) \mu\text{m}$	Universal Length Measuring Machine, LVDT w/Amplifier, Granite Surface Plate, Granite, Square, Angle Block, Gage Block, Optical Flat, Precision Height Gauge
Optical Comparators and Vision Systems /Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 300 mm (300 to 600) mm	$(1.6 + 0.007 \cdot l) \mu\text{m}$ $(3.5 + 0.008 \cdot l) \mu\text{m}$	Standard Scales and Gage Blocks
Check Master / Caliper Checker / Height Master / Riser Block ² Block Pitch Accuracy Parallelism of Block Micrometer Head Accuracy	Up to 1 000 mm Up to 1 000 mm Up to 25 mm	$(0.54 + 0.001 \cdot l) \mu\text{m}$ 0.55 μm $(0.14 + 0.01 \cdot l) \mu\text{m}$	Gage Blocks, Surface Plate, Electric Comparator, Linear Gage, Precision Height Gage
Calibration Tester / Dial Gage Tester / Indicator Calibrator ²	Up to 25 mm	$(0.14 + 0.01 \cdot l) \mu\text{m}$	Linear Gage and Optical Flat
Coating Thickness Gauge ¹	Up to 5 000 μm	0.55 μm	Calibration Foils
Thickness Gauge / Feeler Gauge ²	(0.001 to 25) mm	$(0.2 + 0.002 \cdot l) \mu\text{m}$	Universal Measuring Machine, High- Accuracy Micrometer, Gage Blocks
Standard Scale / Glass Scale ²	Up to 300 mm	$(1.4 + 0.001 \cdot l) \mu\text{m}$	Reference Standard Scale, Smart Scope
Coordinate Measuring Machine (CMM) ^{1,2}	X, Y, Z Axis Up to 1 000 mm	$(0.16 + 0.002 \cdot l) \mu\text{m} + 0.58R$	Gage Block, Step Gage, Master Ball

Mass and Mass Related

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Hardness Testers ¹	HRC (Low, Middle, High) HRBW (Low, Middle, High)	0.53 HRC 0.78 HRBW	Indirect Verification ISO 6508-2
Vickers Hardness Tester ¹	232 HV1 550 HV10 712 HV30	3 HV 5.6 HV 4.6 HV	Indirect Verification ISO 6507-2
Hydrometer	(0.7 to 1.5) g/cm ³	0.000 17 g/cm ³	Analytical Balance Standard Thermometer
Pressure Gage / Absolute & Differential & Vacuum Gauges, Transmitters ¹	(-14.5 to 5) psi (5 to 30) psi (30 to 300) psi (300 to 10 000) psi	0.034 % of reading + 0.58R 0.034 % of reading 0.035 % of reading 0.057 % of reading	Pressure Calibrator & Pressure Module
Scales & Balances ^{1,3} (Platform & Spring)	Up to 5 mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g 200 g to 20 kg (20 to 500) kg	0.008 6 mg 0.008 6 mg 0.008 6 mg 0.008 6 mg 0.008 7 mg 0.008 7 mg 0.009 1 mg 0.01 mg 0.013 mg 0.026 mg 0.05 mg 0.1 mg 0.24 mg 0.48 mg 0.96 mg 0.000 5 % of reading 0.000 5 % of reading	Standard Weight

Mass and Mass Related

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass (Weights)	(1 to 5) mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g 100 g to 20 kg	0.003 2 mg 0.004 2 mg 0.005 2 mg 0.006 2 mg 0.008 2 mg 0.011 mg 0.013 mg 0.016 mg 0.021 mg 0.027 mg 0.034 mg 0.048 mg 0.078 mg 0.17 mg 0.000 3 % of reading	Standard Weight and Electronic Balance
Torque Tools ¹	Up to 50 cN·m 50 cN·m to 1 N·m (1 to 60) N·m (60 to 200) N·m (200 to 1 500) N·m	0.6 % of reading + 0.005 8 cN·m 0.3 % of reading + 0.000 58 N·m 0.3 % of reading + 0.000 58 N·m 0.4 % of reading + 0.005 8 N·m 0.68 % of reading + 0.058 N·m	Torque Testers
Torque Testers ¹	Up to 10 N·m (10 to 50) N·m (50 to 200) N·m (200 to 500) N·m (500 to 1 500) N·m	0.16 % of reading + 0.005 8 N·m 0.048 % of reading 0.028 % of reading 0.031 % of reading 0.014 % of reading	Torque Calibration Wheel with Standard Weight
Force and Load Cell ^{1,2} (Compression and Tension)	Up to 10 N (10 to 20) N (20 to 50) N (50 to 1 000) N	0.01 % of reading + 0.58R 0.007 4 % of reading 0.006 4 % of reading 0.006 2 % of reading	Standard weights
	Up to 220 kN (220 to 440) kN	0.046 % of reading + 0.58 N 0.044 % of reading	Load cell
Hardness Durometers			
Force	Up to 50 N	0.008 N	Full Verification using Electronic Balance, Load Cell
Extension at zero	Up to 5 mm	0.005 mm	Gage Blocks
Indenter Shape	Up to 15 mm Up to 90°	0.004 mm 2'	Smart Scope
Flow – Air ¹	10 ml/min to 50 L/min	0.8 % of reading + 0.058 mL/min	Flow Calibrators

Mass and Mass Related

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Air Velocity	(0.2 to 15) m/s	1.3 % of reading	Wind Tunnel
Pipettes & Micropipettes Burette ¹	(0 to 20) μ L (20 to 50) μ L (50 to 100) μ L (100 to 200) μ L 200 μ L to 10 mL (10 to 20) mL (20 to 2 000) mL	0.02 μ L 0.043 % of reading 0.026 % of reading 0.019 % of reading 0.015 % of reading 0.014 % of reading 0.012 % of reading	Analytical Scale Standard Weights
Volumetric Flask ¹	Up to 10 mL (10 to 20) mL (20 to 2 000) mL	0.001 5 mL 0.014 % of reading 0.012 % of reading	Analytical Scale Standard Weights

Photometry and Radiometry

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power ¹ (Source & Measure) (800 to 1 000) nm (1 000 to 1 310) nm (1 310 to 1 700) nm	(-90 to 10) dB (-110 to 10) dB (-110 to 10) dB	2.9 % of reading 2.9 % of reading 2.9 % of reading	Agilent optical test System
Optical Wavelength – Measure ¹	(700 to 1 650) nm	0.005 nm	Wavelength Meter
Optical Wavelength – Generate ¹	(850, 1310, 1550) nm	0.013 nm	Optical laser source
Laser Power – Measure (250 to 10600) nm	100 mW to 20 W	2.4 % of reading	Thermopile Sensor, Silicon Detector
Illuminance	(0.01 to 19 000) lux	1.2 % of reading	Comparison to Standard Light Meter
UV Meter/ Radiometer	(5 to 100) mW/cm ²	2.5 % of reading	Standard UV/Radiometer

Thermodynamic

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity Measuring Equipment, Transmitters ¹	(5 to 40) %RH (40 to 95) %RH	0.83 %RH 1.3 %RH	Compare with Temp. & Humidity Meter
Temperature Measure & Measuring Equipment / Transmitters ¹	(-80 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 420) °C (420 to 1 100) °C	0.027 °C 0.03 °C 0.052 °C 0.14 °C 0.88 °C	SPRT, Thermocouple, Micro Bath, Dry-Well, Temperature Calibrator
Radiation (Infrared) Thermometers ¹	-18 °C (-18 to -10) °C (-10 to 0) °C (0 to 32) °C (32 to 50) °C (50 to 100) °C (100 to 150) °C (150 to 200) °C (200 to 300) °C (300 to 400) °C	1.1 °C 0.51 °C 0.45 °C 0.34 °C 0.4 °C 0.62 °C 1.1 °C 1.2 °C 1.7 °C 2.2 °C	Blackbody Calibrator (cavity) $\varepsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Chambers, System Calibration & Profiling ¹ Temperature Humidity	(-80 to 400) °C (5 to 40) %RH (40 to 95) %RH	0.63 °C 0.83 %RH 1.3 %RH	Datalogger with Thermocouple sensors Relative humidity sensor

Time and Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	0.01 Hz to 225 MHz 225 MHz to 26.5 GHz	6.7×10^{-12} Hz/Hz 6.9×10^{-12} Hz/Hz	GPS Receiver, Counter
Frequency – Source ¹	(1, 10) MHz	6.2×10^{-12} Hz/Hz	GPS Receiver
Frequency – Source ¹	DC to 26.5 GHz	6.3×10^{-12} Hz/Hz	GPS Receiver, Signal Generator
Tachometer ^{1,2}	Up to 100 000 rpm	0.000 25 % of reading + 0.58R	Multi-Product Calibrator, Signal Generator with Lamp
Stopwatch and Timer ¹	Up to 24 hr	0.86 ms	Comparison to Frequency Counter

Time and Frequency

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Stopwatch and Timer ¹	Up to 24 hr	240 ms	Comparison to Digital Stopwatch

DIMENSIONAL MEASUREMENT

1 Dimensional

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Linear Measurements ^{1,2}	Up to 100 mm	$(0.056 + 0.0028l) \mu\text{m}$	Gage block
	Up to 1 000 mm	$(1.5 + 0.008l) \mu\text{m}$	Precision Rule, Standard Scale
Inspection Fixtures /Gages ² Straight Edges Thickness Pads	(0 to 500) mm	$(0.12 + 0.0038l) \mu\text{m}$	Universal Length Measuring Machine, Precision Height Gage, Electric Comparator, Linear Length Gage, Gage Block, Surface Plate, Smart Scope, Sine Bar, Differential Level, Granite Square

2 Dimensional

Ho Chi Minh City, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inspection Fixtures /Gages ² Angle Block Parallel Bars Machine Squares Precision Squares Radius Gauge Chamfer Gauge Taper Gauge Attribute Gages – GO / NOGO Dedicated Fixture Gages	Up to 500 mm	$(0.12 + 0.0038L) \mu\text{m}$	Universal Length Measuring Machine, Precision Height Gage, Electric Comparator, Linear Length Gage, Gage Block, Surface Plate, Smart Scope, Sine Bar, Differential Level, Granite Square

[Return to Site listing \(top\)](#) [Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

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CALIBRATION

Acoustics and Vibration

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Pressure Level – Measure ¹	(125 to 4 000) Hz (74 to 114) dB SPL	0.31 dB	Sound Level Meter, Sound Calibrator, Electronic Counter
Sound Pressure Level – Source ¹	(125 to 2 000) Hz (74, 84, 94, 104, 114) dB SPL 4 000 Hz (74, 84, 94, 104, 114) dB SPL	0.28 dB 0.31 dB	Sound Calibrator
Accelerometers, Velocity Sensors, and Displacement Sensors ¹ Charge Sensitivity Voltage Sensitivity	(1 to 5) G 10 Hz to 10 kHz 0.02 pC - 10 nC / unit 0.02 to 5 000 mV/unit	0.058 % of sensitivity 0.058 % of sensitivity	Reference Accelerometer with Vibration System
Vibration Meter ¹ Acceleration Velocity Displacement	(1, 5) G 10 Hz – 10 kHz (0 to 200) m/s ² (0 to 200) mm/s (0 to 200) µm	0.35 m/s ² 0.11 mm/s 0.045 µm	Reference Vibration Calibration System

Chemical Quantities

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meter ^{1,4} (Measured at 25 °C)	2 µmhos/cm 10 µmhos/cm 85 µmhos/cm 100 µmhos/cm 1 200 µmhos/cm 1 400 µmhos/cm 10 000 µmhos/cm 100 000 µmhos/cm	0.14 µmhos/cm 0.1 µmhos/cm 0.8 µmhos/cm 0.7 µmhos/cm 3 µmhos/cm 5 µmhos/cm 30 µmhos/cm 290 µmhos/cm	Comparison to standard Solutions

Chemical Quantities

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meter – Measure ^{1,4}	4 pH 7 pH 10 pH	0.015 pH 0.014 pH 0.026 pH	Comparison to standard solutions
Gas Analyzers ¹	CO 50 parts in 10 ⁶ 100 parts in 10 ⁶ 500 parts in 10 ⁶ O ₂ 8.0 % O ₂ 18 % O ₂ 20.9 % O ₂ H ₂ S 25 parts in 10 ⁶ H ₂ S CH ₄ 1.25% Methane 25% LEL 2.5% Methane 50% LEL	4.8 % of reading 3.3 % of reading 2.4 % of reading 2 % of reading 1.2 % of reading 0.57 % of reading 8.4 % of reading 2 % of reading 0.5 % LEL 2 % of reading 1 % LEL	Standard Calibration gases

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Generate 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	11 μ V/V + 0.4 μ V 5.1 μ V/V + 0.7 μ V 3 μ V/V + 2.5 μ V 5.4 μ V/V + 4 μ V 9.1 μ V/V + 40 μ V 9.9 μ V/V + 400 μ V	Multiproduct Calibrator
DC Voltage – Generate ¹ Fixed Values	10 V	2.3 μ V/V	DC Reference Standard
DC Voltage – Measure ¹	Up to 100 mV 100 mV to 1V (1 to 10) V (10 to 100) V 100 V to 1 kV	3 μ V/V + 0.3 μ V 1.7 μ V/V + 0.3 μ V 0.6 μ V/V + 0.5 μ V 3 μ V/V + 0.03 mV 3 μ V/V + 0.1 mV	Multimeter

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Measure ¹	Up to 100 mV 100 mV to 1V (1 to 10) V (10 to 100) V 100 V to 1 kV	0.97 μ V/V + 50 nV 0.40 μ V/V + 0.1 μ V 0.11 μ V/V + 0.5 μ V 0.69 μ V/V + 10 μ V 2.4 μ V/V + 50 μ V	Multimeter Transfer Standard
DC High Voltage – Measure ¹	Up to 9 kV (> 9 to 10) kV (> 10 to 30) kV (> 30 to 50) kV (> 50 to 70) kV	0.36 mV/V + 0.03 V 0.47 mV/V + 0.2 V 0.47 mV/V + 0.2 V 0.48 mV/V + 0.2 V 0.51 mV/V + 0.2 V	Voltmeter with High Voltage Probe
DC Power – Generate ¹	0.01 mW to 329 W (> 329 to 2 990) W (> 2.99 to 20) kW	0.33 mW/W 0.29 mW/W 0.70 mW/W	Multiproduct Calibrator
DC Current – Generate 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	43 μ A/A + 6 nA 57 μ A/A + 7 nA 79 μ A/A + 40 nA 51 μ A/A + 0.7 μ A 95 μ A/A + 12 μ A	Multiproduct Calibrator
DC Current – Generate ¹	2 pA 20 pA 200 pA 2 nA 20 nA 200 nA 2 μ A	0.57 mA/A 0.57 mA/A 0.45 mA/A 0.34 mA/A 0.23 mA/A 0.23 mA/A 0.23 mA/A	Multifunction Calibrator with Electrometer Calibration Standard
DC Current – Generate ¹	20 pA 200 pA 2 nA 20 nA 200 nA 2 μ A 20 μ A 200 μ A 2 mA	3.7 mA/A + 10 fA 2.3 mA/A + 30 fA 0.71 mA/A + 100 fA 0.71 mA/A + 1 pA 0.4 mA/A + 10 pA 0.29 mA/A + 100 pA 0.28 mA/A + 1 nA 0.28 mA/A + 10 nA 0.28 mA/A + 100 nA	Calibrator / Source
DC Current – Generate ¹	(1 to 20) A (1 to 100) A	0.34 mA/A + 1 mA 0.41 mA/A + 0.03 A	Multiproduct Calibrator with Transconductance Amplifier
DC Current – Generate ¹	(10 to 16.499 9) A (16.5 to 149.999) A (150 to 1 025) A	2.8 mA/A + 0.002 A 2.8 mA/A + 0.015 A 2.8 mA/A + 0.05 A	Multi-Product Calibrator w/ 50 Turn Coil

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Measure ¹	(0.001 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 1A	79 μ A/A + 0.04 nA 16 μ A/A + 0.04 nA 13 μ A/A + 0.07 nA 12 μ A/A + 0.6 nA 11 μ A/A + 4 nA 11 μ A/A + 40 nA 28 μ A/A + 400 nA 0.11 mA/A + 10 μ A	Multimeter
DC Current – Measure ¹	1 pA 10 pA 100 pA 1 nA 10 nA 100 nA 1 μ A	0.59 mA/A 0.57 mA/A 0.34 mA/A 0.23 mA/A 0.23 mA/A 0.23 mA/A 0.23 mA/A	Multimeter with Electrometer Calibration Standard
DC Current – Measure ¹	(> 1 to 2) A (> 2 to 20) A (> 20 to 100) A (> 100 to 1 000) A	0.12 mA/A 0.12 mA/A 0.18 mA/A 2.9 mA/A	Current Shunt with Multimeter
Resistance – Generate ¹	Up to 10,999 9 Ω (11 to 32.999 9) Ω (33 to 109.999 9) Ω (110 to 329.999 9) Ω 330 Ω to 1.099 999 k Ω (1.1 to 3.299 999) k Ω (3.3 to 10.999 99) k Ω (11 to 32.999 99) k Ω (33 to 109.999 9) k Ω (110 to 329.999 9) k Ω 330 k Ω to 1.099 999 M Ω (1.1 to 3.299 999) M Ω (3.3 to 10.999 99) M Ω (11 to 32.999 99) M Ω (33 to 109.999 9) M Ω (110 to 329.999 9) M Ω (330 to 1 110) M Ω	51 $\mu\Omega/\Omega$ + 1 m Ω 41 $\mu\Omega/\Omega$ + 1.5 m Ω 32 $\mu\Omega/\Omega$ + 1.4 m Ω 31 $\mu\Omega/\Omega$ + 2 m Ω 31 $\mu\Omega/\Omega$ + 2 m Ω 25 $\mu\Omega/\Omega$ + 20 m Ω 25 $\mu\Omega/\Omega$ + 20 m Ω 25 $\mu\Omega/\Omega$ + 0.2 Ω 33 $\mu\Omega/\Omega$ + 0.2 Ω 35 $\mu\Omega/\Omega$ + 2 Ω 0.11 m Ω/Ω + 2 Ω 0.11 m Ω/Ω + 30 Ω 0.66 m Ω/Ω + 50 Ω 0.68 m Ω/Ω + 2.5 k Ω 5.7 m Ω/Ω + 3 k Ω 6.3 m Ω/Ω + 100 k Ω 15 m Ω/Ω + 500 k Ω	Multiproduct Calibrator

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Generate ¹ (Fixed Points)	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	54 $\mu\Omega$ 97 $\mu\Omega/\Omega$ 91 $\mu\Omega/\Omega$ 25 $\mu\Omega/\Omega$ 25 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 9 $\mu\Omega/\Omega$ 9 $\mu\Omega/\Omega$ 9 $\mu\Omega/\Omega$ 9 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 13 $\mu\Omega/\Omega$ 19 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 43 $\mu\Omega/\Omega$ 51 $\mu\Omega/\Omega$ 130 $\mu\Omega/\Omega$	Multifunction Calibrator
Resistance – Generate ¹ (Variable Artifact)	(1 to 10) Ω (> 10 to 100) Ω (> 100 to 1 000) Ω (> 1 to 100) k Ω > 100 k Ω to 10 M Ω (> 10 to 100) M Ω (> 100 to 1 000) M Ω (> 1 to 10) G Ω (> 10 to 100) G Ω	0.13 m Ω/Ω + 2 m Ω 0.12 m Ω/Ω + 2 m Ω 0.11 m Ω/Ω + 2 m Ω 0.57 m Ω/Ω + 50 m Ω 2.3 m Ω/Ω 2.5 m Ω/Ω 2.3 m Ω/Ω 2.4 m Ω/Ω 2.7 m Ω/Ω	Precision Decade DC Resistance Box
Resistance – Generate ¹ (Fixed Artifacts)	0.001 Ω 0.01 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω 10 M Ω	23 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 19 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 2.5 $\mu\Omega/\Omega$ 27 $\mu\Omega/\Omega$	Standard Resistors

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure ¹	$1 \mu\Omega$ to 1Ω (1 to 10) Ω (10 to 100) Ω 100Ω to $1 \text{ k}\Omega$ (1 to 10) $\text{k}\Omega$ (10 to 100) $\text{k}\Omega$ $100 \text{ k}\Omega$ to $1 \text{ M}\Omega$ (1 to 10) $\text{M}\Omega$ (10 to 100) $\text{M}\Omega$ $100 \text{ M}\Omega$ to $1 \text{ G}\Omega$	$16 \mu\Omega/\Omega$ $1.5 \mu\Omega/\Omega$ $1 \mu\Omega/\Omega$ $0.96 \mu\Omega/\Omega$ $0.66 \mu\Omega/\Omega$ $0.79 \mu\Omega/\Omega$ $5.7 \mu\Omega/\Omega$ $13 \mu\Omega/\Omega$ $84 \mu\Omega/\Omega$ $0.52 \text{ m}\Omega/\Omega$	Multimeter
Resistance – Measure ¹	$1 \text{ k}\Omega$ to $16 \text{ T}\Omega$	0.82 % of reading	High Resistance Meter
AC Resistance – Measure and Generate ¹ 12 Hz to 100 kHz	Up to 0.2Ω $> 0.2 \Omega$ to $100 \text{ k}\Omega$ $> 100 \text{ k}\Omega$ to $10 \text{ M}\Omega$	$0.35 \text{ m}\Omega/\Omega$ $0.1 \text{ m}\Omega/\Omega$ $0.35 \text{ m}\Omega/\Omega$	Precision RLC Digibridge
AC Resistance – Measure and Generate ¹ 12 Hz to 100 kHz	0.1Ω 100 Hz 120 Hz 1 kHz 10 kHz 100 kHz 1Ω 100 Hz 120 Hz 1 kHz 10 kHz 100 kHz 10Ω 100 Hz 120 Hz 1 kHz 10 kHz 100 kHz 100Ω 100 Hz 120 Hz 1 kHz 10 kHz 100 kHz	$1.2 \text{ m}\Omega/\Omega$ $0.97 \text{ m}\Omega/\Omega$ $1.3 \text{ m}\Omega/\Omega$ $1.2 \text{ m}\Omega/\Omega$ $0.66 \text{ m}\Omega/\Omega$ $0.34 \text{ m}\Omega/\Omega$ $0.34 \text{ m}\Omega/\Omega$ $0.34 \text{ m}\Omega/\Omega$ $0.31 \text{ m}\Omega/\Omega$ $0.67 \text{ m}\Omega/\Omega$ $0.3 \text{ m}\Omega/\Omega$ $0.3 \text{ m}\Omega/\Omega$ $0.29 \text{ m}\Omega/\Omega$ $0.3 \text{ m}\Omega/\Omega$ $0.51 \text{ m}\Omega/\Omega$ $0.28 \text{ m}\Omega/\Omega$ $0.28 \text{ m}\Omega/\Omega$ $0.28 \text{ m}\Omega/\Omega$ $0.28 \text{ m}\Omega/\Omega$ $0.33 \text{ m}\Omega/\Omega$	Calibration RL Standard

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance – Measure and Generate ¹ 12 Hz to 100 kHz	1 k Ω		Calibration RL Standard
	100 Hz	0.28 m Ω/Ω	
	120 Hz	0.28 m Ω/Ω	
	1 kHz	0.28 m Ω/Ω	
	10 kHz	0.28 m Ω/Ω	
	100 kHz	0.38 m Ω/Ω	
	10 k Ω		
	100 Hz	0.30 m Ω/Ω	
	120 Hz	0.30 m Ω/Ω	
	1 kHz	0.29 m Ω/Ω	
	10 kHz	0.28 m Ω/Ω	
	100 kHz	0.65 m Ω/Ω	
	100 k Ω		
	100 Hz	0.30 m Ω/Ω	
	120 Hz	0.29 m Ω/Ω	
	1 kHz	0.28 m Ω/Ω	
	10 kHz	0.29 m Ω/Ω	
	100 kHz	3.9 m Ω/Ω	
AC Resistance – Source ¹ (Fixed Artifacts)	10 Ω		Four Terminal Pair Standard Resistor Set
	1 MHz	0.35 m Ω/Ω	
	2 MHz	0.13 m Ω/Ω	
	3 MHz	0.15 m Ω/Ω	
	4 MHz	0.13 m Ω/Ω	
	5 MHz	0.14 m Ω/Ω	
	10 MHz	0.32 m Ω/Ω	
	13 MHz	0.16 m Ω/Ω	
	100 Ω		
	1 MHz	0.35 m Ω/Ω	
	2 MHz	0.15 m Ω/Ω	
	3 MHz	0.14 m Ω/Ω	
	4 MHz	0.12 m Ω/Ω	
	5 MHz	0.12 m Ω/Ω	
	10 MHz	0.39 m Ω/Ω	
	13 MHz	0.47 m Ω/Ω	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance – Source ¹ (Fixed Artifacts)	1 k Ω		Four Terminal Pair Standard Resistor Set
	100 kHz	0.36 m Ω/Ω	
	1 MHz	0.14 m Ω/Ω	
	2 MHz	0.14 m Ω/Ω	
	3 MHz	0.13 m Ω/Ω	
	4 MHz	0.12 m Ω/Ω	
	5 MHz	0.29 m Ω/Ω	
	10 MHz	0.22 m Ω/Ω	
	13 MHz	0.38 m Ω/Ω	
	10 k Ω		
	100 kHz	0.36 m Ω/Ω	
	1 MHz	0.16 m Ω/Ω	
	100 k Ω		
	100 kHz	0.35 m Ω/Ω	
	1 MHz	0.12 m Ω/Ω	
Capacitance – Measure ¹ 12 Hz to 100 kHz	Up to 10 pF	0.37 mF/F	Precision RLC Digibridge
	(10 to 100) pF	0.2 mF/F	
	(100 to 400) pF	0.11 mF/F	
	(400 to 1 600) pF	0.11 mF/F	
	(1 600 to 6 400) pF	0.1 mF/F	
	6 400 pF to 25 nF	0.1 mF/F	
	(25 to 100) nF	0.13 mF/F	
	(100 to 400) nF	0.1 mF/F	
	(400 to 1 600) nF	0.11 mF/F	
	1 600 nF to 6 μ F	0.1 mF/F	
Capacitance – Measure ¹ 12 Hz to 100 kHz	(6 to 25) μ F	0.11 mF/F	Precision RLC Digibridge
	(25 to 100) μ F	0.13 mF/F	
	(100 to 1 000) μ F	0.35 mF/F	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Generate ¹ (Simulation) 50 Hz to 1 kHz	(190 to 399) 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) μ F (1.1 to 3.299 99) μ F (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	4.6 mF/F 6.6 mF/F 3.4 mF/F 2.4 mF/F 1.6 mF/F 1.8 mF/F 1.6 mF/F 1.6 mF/F 2.0 mF/F 2.3 mF/F 2 mF/F 1.8 mF/F 2.3 mF/F 2.9 mF/F 2.6 mF/F 3 mF/F 2.1 mF/F 2.7 mF/F	Multi-Product Calibrator
Capacitance – Generate ¹ (Fixed Artifacts)	1 pF 1 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz 10 pF 1 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.2 mF/F 0.11 mF/F 0.25 mF/F 0.52 mF/F 0.66 mF/F 0.88 mF/F 2.5 mF/F 3.8 mF/F 97 μ F/F 130 μ F/F 95 μ F/F 76 μ F/F 130 μ F/F 150 μ F/F 260 μ F/F 390 μ F/F	Standard Air Capacitor Set

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Generate ¹ (Fixed Artifacts)	100 pF		Standard Air Capacitor Set
	1 kHz	42 μ F/F	
	1 MHz	0.12 mF/F	
	2 MHz	0.13 mF/F	
	3 MHz	0.1 mF/F	
	4 MHz	0.14 mF/F	
	5 MHz	0.20 mF/F	
	10 MHz	0.36 mF/F	
	13 MHz	0.5 mF/F	
	1 000 pF		
	1 kHz	57 μ F/F	
	1 MHz	0.12 mF/F	
	2 MHz	0.19 mF/F	
	3 MHz	0.32 mF/F	
	4 MHz	0.47 mF/F	
	5 MHz	0.64 mF/F	
	10 MHz	1.9 mF/F	
	13 MHz	2.9 mF/F	
	10 nF		
	0.12 kHz	42 μ F/F	
	1 kHz	89 μ F/F	
	10 kHz	69 μ F/F	
	100 kHz	85 μ F/F	
	100 nF		
	0.12 kHz	110 μ F/F	
	1 kHz	79 μ F/F	
	10 kHz	110 μ F/F	
	100 kHz	110 μ F/F	
	1 μ F		
	0.12 kHz	90 μ F/F	
	1 kHz	0.12 mF/F	
	10 kHz	0.11 mF/F	
	100 kHz	0.44 mF/F	
Inductance – Measure ¹ 12 Hz to 100 kHz	Up to 100 μ H > 100 μ H to 1 H (> 1 to 16) H	0.12 mH/H 0.12 mH/H 0.12 mH/H	Precision RLC Digibridge

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Generate ¹ (Fixed Artifacts)	1 μ H		Standard Inductors
	1 kHz	30 mH/H	
	10 μ H		
	100 Hz	22 mH/H	
	200 Hz	22 mH/H	
	400 Hz	4.3 mH/H	
	1 kHz	1.8 mH/H	
	10 kHz	1 mH/H	
	100 kHz	1.5 mH/H	
	100 μ H		
	100 Hz	0.26 mH/H	
	200 Hz	0.25 mH/H	
	400 Hz	0.23 mH/H	
	1 kHz	0.17 mH/H	
	10 kHz	0.19 mH/H	
	1 mH		
	100 Hz	0.13 mH/H	
	200 Hz	0.13 mH/H	
	400 Hz	0.13 mH/H	
	1 kHz	0.12 mH/H	
	10 kHz	0.17 mH/H	
	10 mH		
	100 Hz	0.13 mH/H	
	200 Hz	0.13 mH/H	
	400 Hz	0.13 mH/H	
	1 kHz	0.13 mH/H	
	10 kHz	0.13 mH/H	
	100 mH		
	100 Hz	0.12 mH/H	
	200 Hz	0.12 mH/H	
	400 Hz	0.12 mH/H	
	1 kHz	0.1 mH/H	
	10 kHz	0.13 mH/H	
	1 H		
	100 Hz	0.11 mH/H	
	200 Hz	0.11 mH/H	
	400 Hz	0.1 mH/H	
	1 kHz	0.11 mH/H	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Generate ¹ (Fixed Artifacts)	2 H 100 Hz 200 Hz 400 Hz 1 kHz	0.3 mH/H 0.3 mH/H 0.3 mH/H 0.3 mH/H	Standard Inductors
	10 H 100 Hz 200 Hz 400 Hz 1 kHz	0.12 mH/H 0.2 mH/H 0.12 mH/H 0.13 mH/H	
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) °C (> 800 to 1 000) °C (> 1 000 to 1 550) °C (> 1 550 to 1 820) °C	0.48 °C 0.38 °C 0.34 °C 0.29 °C	Multi-Product Calibrator
	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	0.26 °C 0.22 °C 0.26 °C 0.43 °C 0.71 °C 0.43 °C 0.14 °C 0.11 °C 0.15 °C 0.18 °C 0.23 °C 0.14 °C 0.11 °C 0.15 °C 0.2 °C 0.26 °C 0.14 °C 0.11 °C 0.15 °C 0.34 °C	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type L (-200 to -100) °C (> -100 to 800) °C (> 800 to 900) °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 Type U (-200 to 0) °C (> 0 to 600) °C	0.42 °C 0.29 °C 0.19 °C 0.34 °C 0.19 °C 0.17 °C 0.16 °C 0.24 °C 0.54 °C 0.32 °C 0.29 °C 0.34 °C 0.53 °C 0.34 °C 0.32 °C 0.38 °C 0.54 °C 0.2 °C 0.14 °C 0.11 °C 0.63 °C 0.31 °C	Multi-Product Calibrator
Electrical Calibration of RTD Indicating Systems ¹	Cu 427, 10 Ω (-100 to 260) °C Pt Ni 385, 100 Ω (-80 to 0) °C (> 0 to 100) °C (> 100 to 260) °C	0.34 °C 0.068 °C 0.079 °C 0.15 °C	Multi-Product Calibrator

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 100 Ω		Multi-Product Calibrator
	(-200 to -80) °C	0.045 °C	
	(> -80 to 0) °C	0.057 °C	
	(> 0 to 100) °C	0.079 °C	
	(> 100 to 300) °C	0.091 °C	
	(> 300 to 400) °C	0.1 °C	
	(> 400 to 630) °C	0.11 °C	
	(> 630 to 800) °C	0.24 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.045 °C	
	(> -80 to 0) °C	0.057 °C	
	(> 0 to 100) °C	0.079 °C	
	(> 100 to 300) °C	0.091 °C	
	(> 300 to 400) °C	0.1 °C	
	(> 400 to 630) °C	0.11 °C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.28 °C	
	(> -190 to -80) °C	0.045 °C	
	(> -80 to 0) °C	0.057 °C	
	(> 0 to 100) °C	0.068 °C	
	(> 100 to 260) °C	0.068 °C	
	(> 260 to 300) °C	0.091 °C	
	(> 300 to 600) °C	0.091 °C	
	(> 600 to 630) °C	0.24 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.034 °C	
	(> -80 to 0) °C	0.034 °C	
	(> 0 to 100) °C	0.045 °C	
	(> 100 to 260) °C	0.045 °C	
	(> 260 to 300) °C	0.12 °C	
	(> 300 to 400) °C	0.14 °C	
	(> 400 to 600) °C	0.14 °C	
	(> 600 to 630) °C	0.16 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.034 °C	
	(> -80 to 0) °C	0.045 °C	
	(> 0 to 100) °C	0.057 °C	
	(> 100 to 260) °C	0.068 °C	
	(> 260 to 300) °C	0.079 °C	
	(> 300 to 400) °C	0.079 °C	
	(> 400 to 600) °C	0.091 °C	
	(> 600 to 630) °C	0.1 °C	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 1 k Ω (-200 to -80) °C (> -80 to 0) °C (> 0 to 100) °C (> 100 to 260) °C (> 260 to 300) °C (> 300 to 400) °C (> 400 to 600) °C (> 600 to 630) °C	0.034 °C 0.034 °C 0.034 °C 0.045 °C 0.057 °C 0.057 °C 0.068 °C 0.25 °C	Multi-Product Calibrator
AC Voltage – Generate ¹	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 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 (0.5 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 (100 to 300) kHz (300 to 500) kHz (0.5 to 1) MHz	0.45 mV/V + 4 μ V 0.39 mV/V + 4 μ V 0.33 mV/V + 4 μ V 0.38 mV/V + 4 μ V 0.66 mV/V + 5 μ V 1.2 mV/V + 10 μ V 1.5 mV/V + 20 μ V 2.9 mV/V + 20 μ V 0.26 mV/V + 4 μ V 0.12 mV/V + 4 μ V 0.12 mV/V + 4 μ V 0.22 mV/V + 4 μ V 0.55 mV/V + 5 μ V 1 mV/V + 10 μ V 1.4 mV/V + 20 μ V 2.9 mV/V + 20 μ V 0.25 mV/V + 12 μ V 0.1 mV/V + 7 μ V 0.086 mV/V + 7 μ V 0.21 mV/V + 7 μ V 0.48 mV/V + 17 μ V 0.85 mV/V + 20 μ V 1.4 mV/V + 25 μ V 2.8 mV/V + 45 μ V	Multifunction Calibrator

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Generate ¹	220 mV to 2.2 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 (0.5 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 (0.5 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 (220 to 1 100) V (15 to 50) Hz 50 Hz to 1 kHz	0.25 mV/V + 40 μ V 96 μ V/V + 15 μ V 55 μ V/V + 8 μ V 85 μ V/V + 10 μ V 0.12 mV/V + 30 μ V 0.39 mV/V + 80 μ V 1 mV/V + 200 μ V 1.7 mV/V + 300 μ V 0.25 mV/V + 400 μ V 93 μ V/V + 150 μ V 47 μ V/V + 50 μ V 80 μ V/V + 100 μ V 0.11 mV/V + 200 μ V 0.29 mV/V + 600 μ V 1 mV/V + 2 mV 1.5 mV/V + 3.2 mV 0.25 mV/V + 4 mV 93 μ V/V + 1.5 mV 55 μ V/V + 0.6 mV 86 μ V/V + 1 mV 0.15 mV/V + 2.5 mV 70 μ V/V + 3.5 mV 70 μ V/V + 3.5 mV	Multifunction Calibrator
	Up to 1 100 V 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz Up to 750 V (30 to 50) kHz (50 to 100) kHz	110 μ V/V + 4 mV 150 μ V/V + 6 mV 440 μ V/V + 11 mV 0.44 mV/V + 11 mV 1.6 mV/V + 45 mV	
AC Voltage – Generate ¹			Multifunction Calibrator with Amplifier

Electrical – DC/Low Frequency

Calamba City, Philippines

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
	(1 to 20) Hz	1.9 mV/V + 1.3 μ V	
	(20 to 40) Hz	0.88 mV/V + 1.3 μ V	
	40 Hz to 20 kHz	0.62 mV/V + 1.3 μ V	
	(20 to 50) kHz	1 mV/V + 2 μ V	
	(50 to 100) kHz	1.5 mV/V + 2.5 μ V	
	(100 to 300) kHz	2.6 mV/V + 4 μ V	
	(300 to 500) kHz	2.8 mV/V + 8 μ V	
	500 kHz to 1 MHz	3.8 mV/V + 6 μ V	
	(2.2 to 7) mV		
	(1 to 20) Hz	0.96 mV/V + 1.3 μ V	
	(20 to 40) Hz	0.43 mV/V + 1.3 μ V	
	40 Hz to 20 kHz	0.25 mV/V + 1.3 μ V	
	(20 to 50) kHz	0.46 mV/V + 2 μ V	
	(50 to 100) kHz	0.69 mV/V + 2.5 μ V	
	(100 to 300) kHz	1.4 mV/V + 4 μ V	
	(300 to 500) kHz	1.5 mV/V + 8 μ V	
	500 kHz to 1 MHz	2.3 mV/V + 6 μ V	
	(7 to 22) mV		
	(1 to 20) Hz	0.34 mV/V + 1.3 μ V	
	(20 to 40) Hz	0.21 mV/V + 1.3 μ V	
	40 Hz to 20 kHz	0.13 mV/V + 1.3 μ V	
	(20 to 50) kHz	0.24 mV/V + 2 μ V	
	(50 to 100) kHz	0.36 mV/V + 2.5 μ V	
	(100 to 300) kHz	0.94 mV/V + 4 μ V	
	(300 to 500) kHz	1 mV/V + 8.6 μ V	
	500 kHz to 1 MHz	1.6 mV/V + 8.6 μ V	
	(22 to 70) mV		
	(1 to 20) Hz	0.29 mV/V + 1.5 μ V	
	(20 to 40) Hz	0.15 mV/V + 1.5 μ V	
	40 Hz to 20 kHz	0.089 mV/V + 1.5 μ V	
	(20 to 50) kHz	0.15 mV/V + 2 μ V	
	(50 to 100) kHz	0.32 mV/V + 2.5 μ V	
	(100 to 300) kHz	0.63 mV/V + 4 μ V	
	(300 to 500) kHz	0.82 mV/V + 6 μ V	
	500 kHz to 1 MHz	1.3 mV/V + 6 μ V	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage– Measure ¹	(70 to 220) mV		AC Measurement Standard
	(1 to 20) Hz	0.24 mV/V + 1.5 μ V	
	(20 to 40) Hz	98 μ V/V + 1.5 μ V	
	40 Hz to 20 kHz	45 μ V/V + 1.5 μ V	
	(20 to 50) kHz	82 μ V/V + 2 μ V	
	(50 to 100) kHz	0.19 mV/V + 2.5 μ V	
	(100 to 300) kHz	0.28 mV/V + 4 μ V	
	(300 to 500) kHz	0.43 mV/V + 6 μ V	
	500 kHz to 1 MHz	1.1 mV/V + 6 μ V	
	(220 to 700) mV		
	(1 to 20) Hz	0.24 mV/V + 1.5 μ V	
	(20 to 40) Hz	88 μ V/V + 1.5 μ V	
	40 Hz to 20 kHz	37 μ V/V + 1.5 μ V	
	(20 to 50) kHz	58 μ V/V + 2 μ V	
	(50 to 100) kHz	93 μ V/V + 2.5 μ V	
	(100 to 300) kHz	0.19 mV/V + 4 μ V	
	(300 to 500) kHz	0.34 mV/V + 6 μ V	
	500 kHz to 1 MHz	1 mV/V + 6 μ V	
	700 mV to 2.2 V		
	(1 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	76 μ V/V	
	40 Hz to 20 kHz	26 μ V/V	
	(20 to 50) kHz	52 μ V/V	
	(50 to 100) kHz	80 μ V/V	
	(100 to 300) kHz	0.17 mV/V	
	(300 to 500) kHz	0.29 mV/V	
	500 kHz to 1 MHz	0.98 mV/V	
	(2.2 to 7) V		
	(1 to 20) Hz	0.29 mV/V	
	(20 to 40) Hz	77 μ V/V	
	40 Hz to 20 kHz	26 μ V/V	
	(20 to 50) kHz	53 μ V/V	
	(50 to 100) kHz	91 μ V/V	
	(100 to 300) kHz	0.20 mV/V	
	(300 to 500) kHz	0.43 mV/V	
	500 kHz to 1 MHz	1.3 mV/V	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage– Measure ¹	(7 to 22) V (1 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 70) V (1 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 (70 to 220) V (1 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz (220 to 700) V (1 to 100) Hz 100 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (700 to 1 000) V (1 to 100) Hz 100 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.29 mV/V 80 μ V/V 29 μ V/V 53 μ V/V 91 μ V/V 0.2 mV/V 0.43 mV/V 1.3 mV/V 0.29 mV/V 80 μ V/V 29 μ V/V 53 μ V/V 91 μ V/V 0.2 mV/V 0.43 mV/V 1.3 mV/V 0.23 mV/V 79 μ V/V 37 μ V/V 77 μ V/V 0.11 mV/V 0.24 mV/V 50 μ V/V 47 μ V/V 0.14 mV/V 0.46 mV/V 48 μ V/V 49 μ V/V 0.15 mV/V 0.45 mV/V	AC Measurement Standard
AC Voltage– Measure ¹	(1 to 5) kV (50 to 60) Hz (>5 to 30) kV (50 to 60) Hz (>30 to 50) kV (50 to 60) Hz	1.2 mV/V + 0.4 V 1.2 mV/V + 0.4 V 1.2 mV/V + 0.4 V	High Voltage Meter with Probe

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	Up to 10 mV		Multimeter
	1 Hz to 1 kHz	0.23 mV/V+ 1.1 μ V	
	(1 to 20) kHz	0.34 mV/V+ 1.1 μ V	
	(20 to 100) kHz	0.57 % of reading + 1.1 μ V	
	(100 to 300) kHz	4.5 % of reading + 2 μ V	
	300 kHz to 1 MHz	1.4 % of reading + 5 μ V	
	(1 to 8) MHz	7.9 % of reading + 7 μ V	
	(10 to 100) mV		
	1 Hz to 1 kHz	86 μ V/V+ 2 μ V	
	(1 to 20) kHz	0.16 mV/V+ 2 μ V	
	(20 to 100) kHz	0.91 mV/V+ 2 μ V	
	(100 to 300) kHz	0.34 % of reading + 10 μ V	
	300 kHz to 1 MHz	1.1 % of reading + 10 μ V	
	(1 to 4) MHz	4.5 % of reading + 70 μ V	
	(4 to 8) MHz	4.5 % of reading + 80 μ V	
	(8 to 10) MHz	17 % of reading + 100 μ V	
	100 mV to 1 V		
	1 Hz to 1 kHz	82 μ V/V+ 20 μ V	
	(1 to 20) kHz	0.16 mV/V+ 20 μ V	
	(20 to 50) kHz	0.34 mV/V+ 20 μ V	
	(50 to 100) kHz	0.91 mV/V+ 20 μ V	
	(100 to 300) kHz	0.34 % of reading + 100 μ V	
	300 kHz to 1 MHz	1.1 % of reading + 100 μ V	
	(1 to 4) MHz	4.5 % of reading + 700 μ V	
	(4 to 8) MHz	4.5 % of reading + 800 μ V	
	(8 to 10) MHz	17 % of reading + 1 mV	
	(1 to 10) V		
	(1 to 40) Hz	93 μ V/V+ 0.4 mV	
	40 Hz to 1 kHz	85 μ V/V+ 0.2 mV	
	(1 to 20) kHz	0.16 mV/V+ 0.2 mV	
	(20 to 50) kHz	0.34 mV/V+ 0.2 mV	
	(50 to 100) kHz	0.91 mV/V+ 0.2 mV	
	(100 to 300) kHz	0.34 % of reading + 1 mV	
	300 kHz to 1 MHz	1.1 % of reading + 1 mV	
	(1 to 2) MHz	1.7 % of reading + 1 mV	
	(2 to 4) MHz	4.5 % of reading + 7 mV	
	(4 to 8) MHz	4.5 % of reading + 8 mV	
	(8 to 10) MHz	17 % of reading + 10 mV	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(10 to 100) V 1 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 1 000) V 1 Hz to 1 kHz (1 to 20) kHz	0.23 mV/V + 2 mV 0.40 mV/V + 2 mV 0.14 % of reading + 2 mV 0.45 mV/V + 20 mV 0.68 mV/V + 20 mV	Multimeter
AC Voltage – Measure ¹	Up to 100 mV Up to 1 kHz (1 to 20) kHz (20 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz 100 mV to 1 V Up to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 300 kHz to 1 MHz (1 to 10) V Up to 10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 4) kHz (4 to 8) kHz (8 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	41 µV/V 43 µV/V 43 µV/V 44 µV/V 110 µV/V 30 µV/V 32 µV/V 36 µV/V 38 µV/V 57 µV/V 0.11 mV/V 0.38 mV/V 53 µV/V 40 µV/V 39 µV/V 31 µV/V 31 µV/V 32 µV/V 31 µV/V 31 µV/V 39 µV/V 40 µV/V 73 µV/V 0.13 mV/V 0.44 mV/V	Multimeter Transfer Standard

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(10 to 100) V		Multimeter Transfer Standard
	Up to 10 Hz	33 μ V/V	
	(10 to 20) Hz	34 μ V/V	
	(20 to 40) Hz	40 μ V/V	
	40 Hz to 1 kHz	50 μ V/V	
	(100 to 1 000) V		
AC Voltage – Measure ¹	Up to 10) Hz	34 μ V/V	AC/DC Transfer Standard
	(10 to 20) Hz	41 μ V/V	
	22 mV Range (2 mV)		
	(10 to 20) Hz	3.5 mV/V	
	(20 to 40) Hz	2.6 mV/V	
	40 Hz to 20 kHz	2.6 mV/V	
	(20 to 50) kHz	2.6 mV/V	
	(50 to 100) kHz	3.1 mV/V	
	(100 to 300) kHz	4 mV/V	
	(300 to 500) kHz	7.2 mV/V	
	500 kHz to 1 MHz	8 mV/V	
	2 mV Range (10 mV)		
	(10 to 20) Hz	0.52 mV/V	
	(20 to 40) Hz	0.45 mV/V	
	40 Hz to 20 kHz	0.45 mV/V	
	(20 to 50) kHz	0.49 mV/V	
	(50 to 100) kHz	0.82 mV/V	
	(100 to 300) kHz	1.1 mV/V	
	(300 to 500) kHz	1.9 mV/V	
	500 kHz to 1 MHz	2.4 mV/V	
	22 mV Range (20 mV)		
	(10 to 20) Hz	0.46 mV/V	
	(20 to 40) Hz	0.27 mV/V	
	40 Hz to 20 kHz	0.24 mV/V	
	(20 to 50) kHz	0.36 mV/V	
	(50 to 100) kHz	0.74 mV/V	
	(100 to 300) kHz	1.1 mV/V	
	(300 to 500) kHz	1.8 mV/V	
	500 kHz to 1 MHz	2.1 mV/V	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage– Measure ¹	220 mV Range (20 mV)		AC/DC Transfer Standard
	(10 to 20) Hz	0.57 mV/V	
	(20 to 40) Hz	0.35 mV/V	
	40 Hz to 20 kHz	0.31 mV/V	
	(20 to 50) kHz	0.37 mV/V	
	(50 to 100) kHz	0.74 mV/V	
	(100 to 300) kHz	1.1 mV/V	
	(300 to 500) kHz	1.8 mV/V	
	500 kHz to 1 MHz	3.1 mV/V	
	220 mV Range (100 mV)		
	(10 to 20) Hz	0.34 mV/V	
	(20 to 40) Hz	0.12 mV/V	
	40 Hz to 20 kHz	0.082 mV/V	
	(20 to 50) kHz	0.16 mV/V	
	(50 to 100) kHz	0.24 mV/V	
	(100 to 300) kHz	0.72 mV/V	
	(300 to 500) kHz	0.97 mV/V	
	500 kHz to 1 MHz	0.99 mV/V	
	220 mV Range (200 mV)		
	(10 to 20) Hz	0.32 mV/V	
	(20 to 40) Hz	0.11 mV/V	
	40 Hz to 20 kHz	0.067 mV/V	
	(20 to 50) kHz	0.16 mV/V	
	(50 to 100) kHz	0.24 mV/V	
	(100 to 300) kHz	0.72 mV/V	
	(300 to 500) kHz	0.97 mV/V	
	500 kHz to 1 MHz	0.99 mV/V	
	700 mV Range (200 mV)		
	(10 to 20) Hz	0.35 mV/V	
	(20 to 40) Hz	0.11 mV/V	
	40 Hz to 20 kHz	0.082 mV/V	
	(20 to 50) kHz	0.16 mV/V	
	(50 to 100) kHz	0.24 mV/V	
	(100 to 300) kHz	0.72 mV/V	
	(300 to 500) kHz	0.97 mV/V	
	500 kHz to 1 MHz	0.99 mV/V	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage– Measure ¹	700 mV Range (600 mV)		AC/DC Transfer Standard
	(10 to 20) Hz	0.32 mV/V	
	(20 to 40) Hz	0.085 mV/V	
	40 Hz to 20 kHz	0.041 mV/V	
	(20 to 50) kHz	0.071 mV/V	
	(50 to 100) kHz	0.097 mV/V	
	(100 to 300) kHz	0.22 mV/V	
	(300 to 500) kHz	0.68 mV/V	
	500 kHz to 1 MHz	0.88 mV/V	
	2.2 V Range (600 mV)		
	(10 to 20) Hz	0.32 mV/V	
	(20 to 40) Hz	0.085 mV/V	
	40 Hz to 20 kHz	0.041 mV/V	
	(20 to 50) kHz	0.071 mV/V	
	(50 to 100) kHz	0.097 mV/V	
	(100 to 300) kHz	0.22 mV/V	
	(300 to 500) kHz	0.68 mV/V	
	500 kHz to 1 MHz	0.88 mV/V	
	2.2 V Range (1 V)		
	(10 to 20) Hz	0.31 mV/V	
	(20 to 40) Hz	0.095 mV/V	
	40 Hz to 20 kHz	0.061 mV/V	
	(20 to 50) kHz	0.082 mV/V	
	(50 to 100) kHz	0.097 mV/V	
	(100 to 300) kHz	0.2 mV/V	
	(300 to 500) kHz	0.68 mV/V	
	500 kHz to 1 MHz	0.72 mV/V	
	2.2 V Range (2 V)		
	(10 to 20) Hz	0.03 mV/V	
	(20 to 40) Hz	0.074 mV/V	
	40 Hz to 20 kHz	0.032 mV/V	
	(20 to 50) kHz	0.067 mV/V	
	(50 to 100) kHz	0.082 mV/V	
	(100 to 300) kHz	0.19 mV/V	
	(300 to 500) kHz	0.68 mV/V	
	500 kHz to 1 MHz	0.71 mV/V	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage– Measure ¹	7 V Range (2 V)		AC/DC Transfer Standard
	(10 to 20) Hz	0.3 mV/V	
	(20 to 40) Hz	0.085 mV/V	
	40 Hz to 20 kHz	0.048 mV/V	
	(20 to 50) kHz	0.078 mV/V	
	(50 to 100) kHz	0.093 mV/V	
	(100 to 300) kHz	0.19 mV/V	
	(300 to 500) kHz	0.7 mV/V	
	500 kHz to 1 MHz	0.075 mV/V	
	7 V Range (6 V)		
	(10 to 20) Hz	0.3 mV/V	
	(20 to 40) Hz	0.074 mV/V	
	40 Hz to 20 kHz	0.023 mV/V	
	(20 to 50) kHz	0.067 mV/V	
	(50 to 100) kHz	0.082 mV/V	
	(100 to 300) kHz	0.19 mV/V	
	(300 to 500) kHz	0.68 mV/V	
	500 kHz to 1 MHz	0.73 mV/V	
	22 V Range (10 V)		
	(10 to 20) Hz	0.3 mV/V	
	(20 to 40) Hz	0.077 mV/V	
	40 Hz to 20 kHz	0.037 mV/V	
	(20 to 50) kHz	0.067 mV/V	
	(50 to 100) kHz	0.082 mV/V	
	(100 to 300) kHz	0.19 mV/V	
	(300 to 500) kHz	0.69 mV/V	
	500 kHz to 1 MHz	0.77 mV/V	
	22 V Range (20 V)		
	(10 to 20) Hz	0.3 mV/V	
	(20 to 40) Hz	0.074 mV/V	
	40 Hz to 20 kHz	0.043 mV/V	
	(20 to 50) kHz	0.067 mV/V	
	(50 to 100) kHz	0.082 mV/V	
	(100 to 300) kHz	0.019 mV/V	
	(300 to 500) kHz	0.69 mV/V	
	500 kHz to 1 MHz	0.77 mV/V	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage– Measure ¹	70 V Range (20 V)		AC/DC Transfer Standard
	(10 to 20) Hz	0.3 mV/V	
	(20 to 40) Hz	0.077 mV/V	
	40 Hz to 20 kHz	0.048 mV/V	
	(20 to 50) kHz	0.079 mV/V	
	(50 to 100) kHz	0.099 mV/V	
	(100 to 300) kHz	0.2 mV/V	
	70 V Range (60 V)		
	(10 to 20) Hz	0.3 mV/V	
	(20 to 40) Hz	0.074 mV/V	
	40 Hz to 20 kHz	0.037 mV/V	
	(20 to 50) kHz	0.082 mV/V	
	(50 to 100) kHz	0.11 mV/V	
	(100 to 300) kHz	0.21 mV/V	
	220 V Range (60 V)		
	(10 to 20) Hz	0.3 mV/V	
	(20 to 40) Hz	0.091 mV/V	
	40 Hz to 20 kHz	0.067 mV/V	
	(20 to 50) kHz	0.11 mV/V	
	(50 to 100) kHz	0.11 mV/V	
	(100 to 300) kHz	0.21 mV/V	
	220 V Range (100 V)		
	(10 to 20) Hz	0.3 mV/V	
	(20 to 40) Hz	0.085 mV/V	
	40 Hz to 20 kHz	0.052 mV/V	
	(20 to 50) kHz	0.11 mV/V	
	(50 to 100) kHz	0.11 mV/V	
	220 V Range (200 V)		
	(10 to 20) Hz	0.3 mV/V	
	(20 to 40) Hz	0.084 mV/V	
	40 Hz to 20 kHz	0.05 mV/V	
	(20 to 50) kHz	0.1 mV/V	
	(50 to 100) kHz	0.11 mV/V	
	1 000 V Range (200 V)		
	(40 to 100) Hz	0.3 mV/V	
	(20 to 40) Hz	0.11 mV/V	
	40 Hz to 20 kHz	0.067 mV/V	
	(20 to 50) kHz	0.11 mV/V	
	(50 to 100) kHz	0.12 mV/V	
	1 000 V Range (1 000 V)		
	40 Hz to 20 kHz	0.05 mV/V	
	(20 to 30) kHz	0.097 mV/V	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Measure Flatness ¹ 500 kHz to 30 MHz (Relative to 1 kHz)	600 μ V to 2.2 mV		AC Measurement Standard
	500 kHz to 1.2 MHz	0.9 mV/V + 1 μ V	
	(1.2 to 2) MHz	0.9 mV/V + 1 μ V	
	(2 to 10) MHz	2 mV/V + 1 μ V	
	(10 to 20) MHz	3.5 mV/V + 1 μ V	
	(20 to 30) MHz	8.1 mV/V + 2 μ V	
	(2.2 to 7) mV		
	500 kHz to 1.2 MHz	0.9 mV/V + 1 μ V	
	(1.2 to 2) MHz	0.9 mV/V + 1 μ V	
	(2 to 10) MHz	1.2 mV/V + 1 μ V	
	(10 to 20) MHz	2.1 mV/V + 1 μ V	
	(20 to 30) MHz	4.3 mV/V + 1 μ V	
AC Power – Generate ¹ (45 to 65 Hz) PF=1	500 kHz to 1.2 MHz	0.08 mV/V	Multiproduct Calibrator
	(1.2 to 2) MHz	0.08 mV/V	
	(2 to 10) MHz	0.12 mV/V	
	(10 to 20) MHz	0.21 mV/V	
	(20 to 30) MHz	0.45 mV/V	
	22mV to 7 V		
	500 kHz to 1.2 MHz	0.08 mV/V	
	(1.2 to 2) MHz	0.08 mV/V	
	(2 to 10) MHz	0.12 mV/V	
	(10 to 20) MHz	0.21 mV/V	
	(20 to 30) MHz	0.44 mV/V	
AC Current – Generate ¹	0.1 mW to 329 W	0.12 mW/W	Multifunction Calibrator
	>329 W to 2.99 kW	1.2 mW/W	
	(>2.99 to 20) kW	1 mW/W	
	220 μ A		
	(10 to 20) Hz	0.27 mA/A + 16 nA	
	(20 to 40) Hz	0.16 mA/A + 10 nA	
	40 Hz to 1 kHz	0.13 mA/A + 8 nA	
	(1 to 5) kHz	0.29 mA/A + 12 nA	
	(5 to 10) kHz	1 mA/A + 65 nA	
	220 μ A to 2.2 mA		
	(10 to 20) Hz	0.27 mA/A + 40 nA	
	(20 to 40) Hz	0.16 mA/A + 35 nA	
	40 Hz to 1 kHz	0.13 mA/A + 35 nA	
	(1 to 5) kHz	0.21 mA/A + 110 nA	
	(5 to 10) kHz	1 mA/A + 650 nA	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Generate 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 1 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.27 mA/A+ 400 nA 0.16 mA/A+ 350 nA 0.13 mA/A + 350 nA 0.21 mA/A+ 550 nA 1 mA/A + 40 nA 0.27 mA/A+ 4 µA 0.17 mA/A+ 3.5 µA 0.13 mA/A+ 2.5 µA 0.21 mA/A+ 3.5 µA 1 mA/A + 10 µA 0.27 mA/A+ 35 µA 0.44 mA/A+ 80 µA 6.8 mA/A + 160 µA	Multifunction Calibrator
AC Current – Generate ¹	(29 to 329.99) µA 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 30 kHz 330 µA to 3.299 9 mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 30) kHz (3.3 to 32.999) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 30) kHz	1.8 mA/A+ 0.1 µA 1.4 mA/A+ 1 µA 1.4 mA/A+ 0.2 µA 6.8 mA/A+ 0.2 µA 14 mA/A+ 0.4 µA 1.8 mA/A+ 0.2 µA 1.1 mA/A+ 0.2 µA 1.1 mA/A+ 0.2 µA 4.5 mA/A+ 0.3 µA 9.1 mA/A+ 0.6 µA 1.7 mA/A+ 2 µA 849 µA/A+ 2 µA 736 µA/A+ 2 µA 1.8 mA/A+ 3 µA 3.6 mA/A+ 4 µA	Multi-Product Calibrator

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Generate ¹	(33 to 329.99) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 330 mA to 2.999 99 A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (3 to 20.5) A (45 to 100) Hz (100 Hz to 1 kHz) (1 to 5) kHz	1.7 mA/A + 20 μ A 850 μ A/A + 20 μ A 906 μ A/A + 50 μ A 1.8 mA/A + 100 μ A 3.6 mA/A + 200 μ A 1.7 mA/A + 100 μ A 1.7 mA/A + 100 μ A 1.7 mA/A + 1 000 μ A 5.7 mA/A + 5 000 μ A 22.6 mA/A + 5 000 μ A 1.1 mA/A + 0.005 mA 1.5 mA/A + 0.005 mA 28 mA/A + 0.005 mA	Multi-Product Calibrator
AC Current – Generate ¹	(1 to 11) A 40 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz	587 μ A/A + 170 μ A 1 mA/A + 380 μ A 3.8 mA/A + 750 μ A	Multifunction Calibrator with Amplifier
AC Current – Generate ¹	(1 to 20) A 30 Hz to 5 kHz	0.69 mA/A + 1 mA	Multifunction Calibrator with Transconductance Amplifier
AC Current – Generate ¹	(10 to 1 000) A (45 to 65) Hz (65 to 440) Hz	3.2 mA/A + 0.009 A 8.9 mA/A + 0.1 A	Multi-Product Calibrator with 50-turn Current Coil
AC Current – Measure ¹	10 μ A 10 Hz to 1 kHz (10 to 100) μ A 10 Hz to 1 kHz (0.1 to 1) mA 10 Hz to 1 kHz (1 to 10) mA 10 Hz to 1 kHz (10 to 100) mA 10 Hz to 1 kHz (0.1 to 1) A 10 Hz to 1 kHz	1 mA/A + 30 nA 0.69 mA/A + 30 nA 0.36 mA/A + 0.2 μ A 0.36 mA/A + 2 μ A 0.36 mA/A + 20 μ A 1.1 mA/A + 200 μ A	Multimeter

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(0.1 to 10) mA		Current Shunt with AC Measurement Standard
	(10 to 20) Hz	56 μ A/A	
	20 Hz to 1 kHz	43 μ A/A	
	(1 to 10) kHz	48 μ A/A	
	(10 to 30) kHz	59 μ A/A	
	(30 to 100) kHz	95 μ A/A	
	(10 to 20) mA		
	(10 to 20) Hz	54 μ A/A	
	20 Hz to 1 kHz	43 μ A/A	
	(1 to 10) kHz	48 μ A/A	
	(10 to 30) kHz	59 μ A/A	
	(30 to 100) kHz	96 μ A/A	
	(20 to 100) mA		
	(10 to 20) Hz	52 μ A/A	
	20 Hz to 1 kHz	43 μ A/A	
	(1 to 10) kHz	46 μ A/A	
	(10 to 30) kHz	63 μ A/A	
	(30 to 100) kHz	0.12 mA/A	
	100 mA to 1 A		
	(10 to 20) Hz	61 μ A/A	
	20 Hz to 1 kHz	48 μ A/A	
	(1 to 10) kHz	50 μ A/A	
	(10 to 30) kHz	109 μ A/A	
	(30 to 100) kHz	0.29 mA/A	
AC Current – Measure ¹	(1 to 2) A		Current Shunt with AC Measurement Standard
	(10 to 20) Hz	74 μ A/A	
	20 Hz to 1 kHz	54 μ A/A	
	(1 to 10) kHz	59 μ A/A	
	(10 to 30) kHz	0.12 mA/A	
	(30 to 100) kHz	0.29 mA/A	
	10 A		
	(10 to 20) Hz	0.11 mA/A	
	(20 to 40) Hz	0.079 mA/A	
	40 Hz to 10 kHz	0.13 mA/A	
	(10 to 20) kHz	0.16 mA/A	
	(20 to 50) kHz	0.21 mA/A	
AC Current – Measure ¹	20 A		Current Shunt with AC Measurement Standard
	(10 to 20) Hz	0.16 mA/A	
	(20 to 40) Hz	0.11 mA/A	
	40 Hz to 10 kHz	0.11 mA/A	
	(10 to 20) kHz	0.2 mA/A	
	(20 to 50) kHz	0.25 mA/A	

Electrical – DC/Low Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	30 Hz to 5 kHz (0.1 to 60) A (60 to 1 000) A	0.93 % of reading 0.7 % of reading	Current Probe with Multimeter
Phase Measure ¹	(0 to 360) ° 10 Hz to 5 kHz (5 to 40) kHz (40 to 100) kHz	0.058 ° 0.11 ° 0.79 °	Phasemeter
Oscilloscopes ¹ Horizontal Deflection (Time)	> 450.5 ps to 10 ns (> 10 to 100) ns > 100 ns to 55 s	14 µs/s 11 µs/s 13 µs/s	Oscilloscope Calibrator
Oscilloscopes ¹ Square Wave 50 Ω, 1 MΩ – Load Impedance ≤ 10 kHz	6 mVp-p (> 6 to 60) mVp-p > 60 mVp-p to 60 Vp-p	0.5 % of reading 0.15 % of reading 0.12 % of reading	Oscilloscope Calibrator
Oscilloscopes ¹ Vertical Deflection (Amplitude)	Up to 1 mV (> 1 to 6) mV > 6 mV to 200 V	0.053 % of reading + 25 µV 0.037 % of reading + 25 µV 0.028 % of reading + 25 µV	Oscilloscope Calibrator with Multimeter
Oscilloscopes ¹ Bandwidth	100 mHz to 300 MHz (> 300 to 550) MHz > 550 MHz to 1.1 GHz (> 1.1 to 3.2) GHz	2.3 % of reading 2.8 % of reading 4 % of reading 4.5 % of reading	Oscilloscope Calibrator with Calibration Head
Oscilloscopes ¹ Bandwidth	(3 to 26.5) GHz (26.5 to 50) GHz	5.4 % of reading 6.3 % of reading	Synthesized Sweeper with Power Sensor
Oscilloscopes ¹ Rise / Fall Time (10 to 90) %	13 ps to 3.5 s	57 ps	Oscilloscope Calibrator with Calibration Head
Magnetic Flux Density – Measure	Up to 30 000 G	0.17 % of reading	Gauss Meter

Electrical – RF/Microwave

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Sensors – Calibration Factors ^{1,5}	Referenced to 1 mW 100 kHz to 10 MHz (10 to 50) MHz (30 to 500) MHz 500 MHz to 1.2 GHz (1.2 to 6) GHz (6 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 33) GHz (34 to 35) GHz (35 to 40) GHz (40 to 45) GHz (45 to 50) GHz (50 to 67) GHz	1 % 1 % 1.1 % 1.1 % 1.1 % 1.1 % 1.4 % 1.7 % 2.2 % 2 % 2 % 2.9 % 3.3 % 2.8 %	Power Sensors
Tuned RF Power Relative – Measure ¹ 100 kHz to 26.5 GHz	(-30 to 20) dB (-130 to -30) dB	0.12 dB 0.2 dB	Spectrum Analyzer, Power Meter, Power Sensor with Measuring Receiver
RF Power Absolute – Measure ¹	(-35 to 20) dBm	1.7 % of reading	Agilent System with Power Meter, Power Sensors
RF Power Absolute – Measure ¹	(-35 to 20) dBm 100 kHz ≤ f < 6 GHz 10 MHz < f < 33 GHz 50 MHz < f < 50 GHz 10 MHz < f < 67 GHz	0.036 dB 0.036 dB 0.19 dB 0.031 dB	Power Sensor with Power Meter, Power Sensor with Measuring Receiver
RF Power Absolute – Measure ¹	(-30 to 20) dBm 100 MHz < f < 18 GHz 100 MHz ≤ f < 26.5 GHz 50 MHz ≤ f < 26.5 GHz (-60 to 20) dBm 9 kHz ≤ f ≤ 6 GHz	0.75 % of reading 0.75 % of reading 0.04 dB 0.11 dB	Power Sensor
RF Power Absolute – Measure ¹	(-70 to -20) dBm 100 MHz ≤ f < 18GHz 50 MHz ≤ f < 26.5GHz	0.07 dB 0.12 dB	Power Sensor
RF Power – Generate ¹ 9 kHz to 10 MHz 10 MHz to 2 GHz	(-50 to 20) dBm (-127 to 13) dBm	0.3 dB 0.5 dB	Signal Generator
RF Power – Generate ¹	(-110 to 20) dBm 10 MHz to 2 GHz	0.7 dB	Signal Generator

Electrical – RF/Microwave

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power – Generate ¹	(-110 to 20) dBm 2 MHz to 20 GHz (20 to 40) GHz (-20 to 10) dBm (40 to 50) GHz (-35 to 20) dBm (50 to 67) GHz	0.8 dB 1 dB 1 dB 2 dB	Synthesized Swept-Signal Generator
Amplitude Modulation Depth – Measure ¹			
100 kHz to 10 MHz	Rate: 50 Hz to 10 kHz Depth: (20 to 99) %	1 % of reading	Spectrum Analyzer, Measuring Receiver
10 MHz to 3 GHz	Rate: 50 Hz to 100 kHz Depth: (20 to 99) %	0.6 % of reading	
10 MHz to 3 GHz	Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	2.8 % of reading	
(3 to 26.5) GHz	Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	5.1 % of reading	
Amplitude Modulation – Rejection Measure ¹			
150 kHz to 6.6 GHz (6.6 to 26.5) GHz	Rate: 400 Hz to 1 kHz Depth.: ≤ 50 %	0.1 Hz 0.1 Hz	Spectrum Analyzer, Measuring Receiver
Amplitude Modulation – Distortion Measure ¹			
1 MHz to 10 MHz 10 MHz to 26.5 GHz	Rate: 50 Hz to 3 kHz Depth: ≥ 3 % Depth: ≥ 1 %	0.02 % of reading 0.02 % of reading	Spectrum Analyzer, Measuring Receiver
Amplitude Modulation Flatness – Measure ¹			
10 MHz to 3 GHz 3 MHz to 26.5 GHz	Rate: 90 Hz to 10 kHz Depth: (5 to 99) %	0.45 % of reading 0.91 % of reading	Spectrum Analyzer, Measuring Receiver
Amplitude Modulation – Generate ¹			
(11 to 13.5) MHz	Depths: < 95%	0.15 % of reading	AM/FM Test Source
(11 to 13.5) MHz	Depths: < 99%	0.31 % of reading	
(11 to 13.5) MHz	Rate: 20 Hz to 100 kHz Depth: 50%	0.002 % of reading	
(11 to 13.5) MHz	Rate: 20 Hz to 100 kHz Depth: 95%	0.004 % of reading	

Electrical – RF/Microwave

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Measure ¹ 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 200 kHz Deviation: > 0.7 Rad Deviation: > 0.3 Rad Rate: 20 Hz to 200 kHz Deviation: > 2 Rad Deviation: > 0.6 Rad Rate: 20 Hz to 200 kHz Deviation: > 4 Rad Deviation: > 1.2 Rad	1.2 % of reading 3.5 % of reading 1.5 % of reading 3.5 % of reading 1.2 % of reading 3.5 % of reading	Spectrum Analyzer, Measuring Receiver
Phase Residuals – Measure ¹ 1 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviation: ≥ 0.4 rad to < 1.2 rad ≥ 1.2 rad Deviation: ≥ 0.8 rad to < 2.2 rad ≥ 2.2 rad Deviation: ≥ 1.5 rad to < 4.5 rad ≥ 4.5 rad	0.35 % of reading 0.14 % of reading 0.35 % of reading 0.14 % of reading 0.35 % of reading 0.14 % of reading	Spectrum Analyzer, Measuring Receiver
Phase Distortion – Measure ¹ 1 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviation: ≥ 1 rad to < 3 rad ≥ 1.2 rad Deviation: ≥ 2 rad to < 6 rad ≥ 6 rad Deviation: ≥ 4 rad to < 10 rad ≥ 10 rad	0.35 % of reading 0.14 % of reading 0.35 % of reading 0.14 % of reading 0.35 % of reading 0.14 % of reading	Spectrum Analyzer, Measuring Receiver
Frequency Modulation – FM Deviation Measure ¹ 30 Hz to 50 GHz 10 MHz to 3 GHz (3 to 26.5) GHz	Rate: 20 Hz to 10 kHz Dev.: ≤ 40 kHz Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz	0.3 % of reading 0.3 % of reading 0.4 % of reading	Spectrum Analyzer, Measuring Receiver

Electrical – RF/Microwave

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – FM Rejection Measure ¹ 250 kHz to 10 MHz 250 kHz to 10 MHz	Rate: 50 Hz to 200 kHz Dev.: ≤ 5 kHz peak Dev.: ≤ 50 kHz peak	0.15 % AM Depth 0.2 % AM Depth	Spectrum Analyzer, Measuring Receiver
Frequency Modulation – FM Distortion Measure ¹ 1 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviation: ≥ 600 Hz to < 2 kHz ≥ 2.0 kHz Deviation: ≥ 1.4 kHz to < 3.5 kHz ≥ 3.5 kHz Deviation: ≥ 2.5 kHz to < 7 kHz ≥ 7 kHz	0.4 % of reading 0.1 % of reading 0.4 % of reading 0.1 % of reading 0.4 % of reading 0.1 % of reading	Spectrum Analyzer, Measuring Receiver
Residuals – FM Bandwidth ¹ 150 kHz to 3 GHz	50 Hz to 3 kHz (rms)	1.7 Hz	Spectrum Analyzer, Measuring Receiver
Frequency Modulation – Generate ¹ (11 to 13.5) MHz (88 to 108) MHz (352 to 432) MHz	Deviation : > 12.5 kHz Deviation : > 100 kHz Deviation : > 400 kHz	0.14 % of reading 0.14 % of reading 0.4 % of reading	AM/FM Test Source
FM Distortion – Generate ¹ 11 MHz to 13.5 MHz 88 MHz to 108 MHz 352 MHz to 432 MHz	Deviation : > 12.5 kHz Deviation : > 12.5 kHz Deviation : > 400 kHz	0.008 2 % of reading 0.007 % of reading 0.005 % of reading	AM/FM Test Source
Harmonic – Measure ¹	(-90 to 0.01) dB 30 Hz to 50 GHz	1.5 dB	Spectrum Analyzer
Audio Distortion – Measure ¹	(0 to 99.9) dB 20 Hz to 20 kHz (>20 to 100) kHz	1.2 dB 1.2 dB	Audio Analyzer

Electrical – RF/Microwave

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Voltage Standing Waveform Ratio– Measure Reflection Coefficient	(0.01 to 66) dB 45 MHz to 2 GHz (2 to 8) GHz (8 to 20) GHz (20 to 26.5) GHz (26.5 to 50) GHz	0.005 dB 0.007 dB 0.007 dB 0.008 dB 0.01 dB	Network Analyzer w/ S-Parameter Test Set, Calibration Kit
Return Loss	(0.01 to 66) dB	0.17 dB	
Excess Noise Ratio (ENR) ¹ Frequency: ENR Limits	(12 to 16) dB 10 MHz 100 MHz 1 GHz 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz 7 GHz 8 GHz 9 GHz 10 GHz 11 GHz 12 GHz	0.13 dB 0.13 dB 0.12 dB 0.12 dB 0.13 dB 0.11 dB 0.14 dB 0.13 dB 0.13 dB 0.13 dB 0.15 dB 0.15 dB 0.16 dB 0.15 dB	Noise Source with Calibration Kit
Excess Noise Ratio (ENR) ¹ Frequency: ENR Limits	(14 to 17) dB 13 GHz 14 GHz 15 GHz 16 GHz 17 GHz 18 GHz 19 GHz 20 GHz 21 GHz 22 GHz 23 GHz 24 GHz 25 GHz 26 GHz 26.5 GHz	0.15 dB 0.15 dB 0.16 dB 0.17 dB 0.17 dB 0.17 dB 0.14 dB 0.15 dB 0.15 dB 0.16 dB 0.19 dB 0.15 dB 0.14 dB 0.15 dB 0.15 dB	Noise Source with Calibration Kit

Length – Dimensional Metrology

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Indicators ^{1,2}	Up to 1 in (> 1 to 2) in (> 2 to 3) in (> 3 to 4) in	(6.2 + 0.19L) μin (5.6 + 0.99L) μin (6 + 0.74L) μin (5.6 + 0.87L) μin	Indicator calibrator Gage Block, Universal Measuring Machine
Indicators ^{1,2}	Up to 100 mm (> 100 to 150) mm (> 151 to 200) mm	(0.07 + 0.001I) μm (0.38 + 0.000 56I) μm (0.47 + 0.000 5I) μm	Indicator Calibrator, Gage Block, Universal Length Measuring Machine
Micrometers ^{1,2} Outside, Inside, Depth	Up to 4 in (> 4 to 8) in (> 8 to 20) in (> 20 to 48) in	(6.8 + 0.78L) μin (2.6 + 3.9L) μin (29 + 7.2L) μin (105 + 2.5L) μin	Indicator Calibrator, Gage Block, Universal Length Measuring Machine
Micrometers ^{1,2} Outside, Inside, Depth	Up to 100 mm (> 100 to 500) mm (> 500 to 1 000) mm (> 1 000 to 2 000) mm	(0.1 + 0.001 6I) μm (0.078 + 0.002I) μm (0.75 + 0.001 3I) μm (0.95 + 0.000 052I) μm	Gage blocks, optical flat
Calipers ^{1,2}	Up to 4 in (> 4 to 6) in (> 6 to 12) in (> 12 to 24) in (> 24 to 48) in	(120 + 0.04L) μin (120 + 0.01L) μin (120 + 0.31L) μin (110 + 0.48L) μin (110 + 0.62L) μin	Gage Blocks
Calipers ^{1,2}	Up to 100 mm (> 100 to 200) mm (> 200 to 300) mm (> 300 to 600) mm (> 600 to 1 000) mm (> 1 000 to 2 000) mm	(1.9 + 0.006 1I) μm (2.3 + 0.000 1I) μm (2.2 + 0.000 6I) μm (1.9 + 0.001 5I) μm (3 + 0.000 18I) μm (2 + 0.000 51I) μm	Gage Blocks
Height Gages ^{1,2}	Up to 4 in (> 4 to 6) in (> 6 to 12) in (> 12 to 24) in (> 24 to 48) in	(4.2 + 2.5L) μin (0.39 + 2.7L) μin (4.4 + 1.9L) μin (9 + 2.4L) μin (55 + 0.6L) μin	Gage Blocks
Height Gages ^{1,2}	Up to 150 mm (> 150 to 300) mm (> 300 to 600) mm (> 600 to 1 200) mm	(0.09 + 0.002 1I) μm (0.07 + 0.002I) μm (0.46 + 0.003 4I) μm (2.3 + 0.000 8I) μm	Gage Blocks
Steel Rules/Tape Measure ¹	Up to 20 in (20 to 2000) in Up to 1 000 mm (1 000 to 50 000) mm	120 μin (100 + 0.8L) μin 0.023 μm (23 + 0.000 007I) μm	Gage Blocks

Length – Dimensional Metrology

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gage Blocks ²	Up to 12 in	$(1.8 + 1.7L) \mu\text{in}$	Gage Blocks
Gage Blocks ²	Up to 0.5 mm (> 0.5 to 100) mm (> 100 to 500) mm	$0.11 \mu\text{m}$ $(0.056 + 0.0009L) \mu\text{m}$ $(0.54 + 0.0005L) \mu\text{m}$	Gage blocks
Micrometer Rods/ Length Standards ²	Up to 4 in (> 4 to 8) in (> 8 to 20) in (> 20 to 48) in	$(3.8 + 0.74L) \mu\text{in}$ $(2.4 + 2.6L) \mu\text{in}$ $(4.4 + 1.5L) \mu\text{in}$ $(1.5 + 1.7L) \mu\text{in}$	Universal measuring machine, gage blocks, height gage
Micrometer Rods/ Length Standards ²	Up to 100 mm (> 100 to 500) mm (> 500 to 1000) mm	$(0.06 + 0.0017L) \mu\text{m}$ $(0.24 + 0.0011L) \mu\text{m}$ $(0.36 + 0.0014L) \mu\text{m}$	Universal measuring machine, gage blocks, height gage
Cylindrical Plug Gages ²	Up to 1 in (> 1 to 4) in (> 4 to 6) in (> 6 to 12) in	$(3.6 + 0.94L) \mu\text{in}$ $(3.7 + 0.99L) \mu\text{in}$ $(6 + 0.41L) \mu\text{in}$ $(4 + 1.9L) \mu\text{in}$	Universal measuring machine, gage blocks
Cylindrical Plug Gages ²	Up to 0.5 mm (> 0.5 to 100) mm (> 100 to 500) mm	$0.1 \mu\text{m}$ $(0.07 + 0.00056L) \mu\text{m}$ $(0.03 + 0.0015L) \mu\text{m}$	Universal measuring machine, gage blocks
Ring Gages ² , Cylindrical & Tapered	(0.01 to 1) in (> 1 to 4) in (> 4 to 6) in (> 6 to 12) in	$(3.1 + 0.1L) \mu\text{in}$ $(2.2 + 0.9L) \mu\text{in}$ $(3.1 + 0.6L) \mu\text{in}$ $(3.6 + 1.2L) \mu\text{in}$	Vision System, Universal Measuring Machine, Gage Blocks, Gaging Amplifier
Ring Gages ² , Cylindrical & Tapered	Up to 3 mm (> 3 to 100) mm (> 100 to 500) mm	$(0.11 + 0.014L) \mu\text{m}$ $(0.04 + 0.0013L) \mu\text{m}$ $(0.03 + 0.0015L) \mu\text{m}$	Vision System, Universal Measuring Machine, Gage Blocks, Gaging Amplifier
Optical Comparators and Vision Systems ^{1,2} X Axis, Y Axis	Up to 12 in	$(11 + 1.8L) \mu\text{in}$	Glass Scales
Z Axis (Vision Systems)	Up to 12 in	$(11 + 1.8L) \mu\text{in}$	Gage Blocks
Optical Comparators and Vision Systems ^{1,2} X Axis, Y Axis	Up to 300 mm	$(0.19 + 0.0074L) \mu\text{m}$	Glass Scales
Z Axis (Vision Systems)	Up to 300 mm	$(0.18 + 0.0073L) \mu\text{m}$	Gage Blocks
Glass Scales ²	Up to 12 in Up to 300 mm	$(9 + 1.7L) \mu\text{in}$ $(0.18 + 0.0072L) \mu\text{m}$	Vision System

Length – Dimensional Metrology

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Coordinating Measuring Machine (CMM) ^{1,2} X Axis, Y Axis Z Axis (Contact)	Up to 4 in Up to 1 000 mm	$(17 + 1.3L) \mu\text{in}$ $(0.22 + 0.001 6l) \mu\text{m}$	Gage Block, Step Gage, Master Ball
Inspection Fixtures / Gauges ² 1D Features / Artifacts Thickness Pads Attribute Gauges – Go/No-Go Dedicated Fixture Gauges	Up to 12 in (> 12 to 24) in (> 24 to 48) in Up to 300 mm (> 300 to 600) mm (> 600 to 1 200) mm	$(0.9 + 1.7L) \mu\text{in}$ $(9 + 2.4L) \mu\text{in}$ $(54 + 0.6L) \mu\text{in}$ $(0.09 + 0.000 6l) \mu\text{m}$ $(0.46 + 0.003 4l) \mu\text{m}$ $(1.5 + 0.000 8l) \mu\text{m}$	Universal Length Measuring Machine, Supermicrometer [®] , Height Gauge, Caliper
Inspection Fixtures / Gauges ² 2D Features / Artifacts Angle Block, Straight Edges Parallel Bars, Machine Squares, Precision Squares Radius Gauge, Chamfer Gauge, Taper Gauge, Angle Gage Attribute Gauges – Go/No-Go Dedicated Fixture Gauges	Up to 12 in Up to 300 mm	$(1.6 + 1.6L) \mu\text{in}$ $(0.09 + 0.000 6l) \mu\text{m}$	Vision System
	Up to 12 in Up to 300 mm (> 300 to 1 000) mm	$(12 + 0.39L) \mu\text{in}$ $(0.29 + 0.004 9l) \mu\text{m}$ $(1.5 + 0.0008 l) \mu\text{m}$	Universal Length Measuring Machine, Supermicrometer [®] , Height Gauge, Caliper
Surface Plates ^{1,2} Overall Flatness	Up to 170 inDL	12 μin	Leveling System, Planekator
Repeat Reading (local area flatness)	Up to 0.001 in	17 μin	Repeat-o-meter
Thread Wires ²	(4 to 120) TPI (0.004 7 to 0.145) in (0.5 to 10) Pitch (0.2 to 10) mm	$(3.2 + 1.1L) \mu\text{in}$ $(0.09 + 0.001l) \mu\text{m}$	Universal Length Measuring Machine, Gage Blocks
Thread Ring Gages ² (Cylindrical and Taper) Pitch Diameter (5 to 80) TPI (0.2 to 10) mm Pitch Minor Diameter	 (0.1 to 4) in (0.3 to 100) mm (0.1 to 4) in (0.3 to 100) mm	 $(13 + 0.7L) \mu\text{in}$ $(0.23 + 0.005l) \mu\text{m}$ $(12 + 0.8L) \mu\text{in}$ $(0.23 + 0.005l) \mu\text{m}$	Universal Length Measuring Machine, High-Accuracy Micrometer, Gage Blocks, Thread Measuring Wires

Length – Dimensional Metrology

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Threaded Plugs ² Pitch Diameter TPI: (5 to 80) in Pitch: (0.2 to 10) mm Major Diameter	Up to 4 in Up to 100 mm Up to 6 in Up to 100 mm	$(13 + 0.7L) \mu\text{in}$ $(0.23 + 0.005I) \mu\text{m}$ $(12 + 0.8L) \mu\text{in}$ $(0.33 + 0.005I) \mu\text{m}$	Universal Length Measuring Machine, Gage Blocks, Thread wires using three-wire method Universal Length Measuring Machine, Gage Blocks
Coating Thickness Gages ^{1,2} Ferrous and Non-Ferrous	Up to 1 500 μm (1 500 to 5 000) μm	0.13 μm 0.055 μm	Thickness standards Gage Block
Ultrasonic Thickness Gage	(0.05 to 500) mm	$(2.6 + 0.000\ 000\ 54I) \mu\text{m}$	Gage Block
Thickness Foils	Up to 5 000 μm	$(0.22 + 0.0045 I) \mu\text{m}$	Thickness Standards Supermicrometer [®] , Gage Blocks
Bore Micrometers, Bore Gages ²	Up to 8 in	$(4.8 + 0.31L) \mu\text{in}$	Master Ring Gauge, Universal Length Measuring Machine, Gauge Blocks
Precision Level/ Master Level	Up to 20 div	0.001 2 div	Gage Block, Surface Plate, Angle Block, Sine Bar
Base Flatness	(0 to 0.1) in	9.8 μin	Height Gauge, Indicator
Protractor	Up to 90° (4 Quadrant)	0.000 24°	Angle Block

Mass and Mass Related

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Tools ¹	(0.2 to 80) cN·m (0.02 to 1) N·m (0.2 to 10) N·m (1.2 to 60) N·m (30 to 1 500) N·m	0.16 % of reading 0.15 % of reading 0.12 % of reading 0.11 % of reading 0.15 % of reading	Torque Calibrator System
Torque Tester – Measuring Equipment ¹	(3 to 200) ozf·in (1 to 50) lbf·ft (> 50 to 500) lbf·ft (> 500 to 1 500) lbf·ft	0.008 7 % of reading 0.04 % of reading 0.018 % of reading 0.019 % of reading	Calibration Wheel, Calibration Arms, Standard Calibration Weights

Mass and Mass Related

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Instruments (Gage/Vacuum/Absolute) Transducers, Transmitters ¹	(20 to 100) mTorr (100 to 500) mTorr (500 to 1 000) mTorr	1 mTorr 2 mTorr 2.6 mTorr	Pressure Gauge Control
	(-1 to 1) psi (-5 to 5) psi (-15 to 0) psi (0 to 30) psia (0 to 50) psi	0.000 38 psi 0.002 8 psi 0.006 9 psi 0.001 9 psi 0.001 6 psi	Process Calibrator with pressure modules
	Up to 0.25 inH ₂ O (0.25 to 1) inH ₂ O	0.000 2 inH ₂ O 0.003 5 inH ₂ O	Pressure Calibrator with Pressure Modules
	(10 to 10 000) psi	0.004 2 % of reading	Deadweight Tester
	(1 000 to 15 000) psi (1 000 to 35 000) psi	0.067 % of reading 0.06 % of reading	Comparison to Digital Pressure Test Gauge
Scales and Balances ^{1,3}	Up to 2 g Up to 5 g Up to 300 g Up to 500 g Up to 1 000 g Up to 5 000 g Up to 10 kg Up to 20 kg Up to 30 kg Up to 100 kg Up to 150 kg Up to 300 kg Up to 500 kg Up to 1 000 kg Up to 8 000 kg	1.3 µg 2.2 µg 0.01 mg 0.06 mg 0.7 mg 0.7 mg 8 mg 6 mg 58 mg 0.08 g 0.09 g 0.85 g 0.005 kg 0.007 kg 0.8 kg	Standard Weights and internal calibration procedure utilized in the calibration of the weighing system.

Mass and Mass Related

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass Determination ¹	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1 kg 2 kg 5 kg 10 kg 20 kg 50 kg	5.8 µg 5.8 µg 5.8 µg 5.8 µg 5.8 µg 5.8 µg 5.8 µg 5.8 µg 6.0 µg 6.4 µg 6.4 µg 7.7 µg 15 µg 17 µg 25 µg 42 µg 0.1 mg 0.13 mg 0.2 mg 0.8 mg 1.2 mg 2.5 mg 12 mg 61 mg	Standard Weights, Balance
Air Velocity ¹	(0.001 to 30 000) m/s	1.3 % of reading	Comparison to Master Air Flow Meter
Force – Compression/Tension ¹	(0.01 to 1 000) lbf (600 to 30 000) lbf (30 000 to 100 000) lbf (100 000 to 500 000) lbf	0.006 % of reading 0.003 % of reading 0.63 % of reading 0.28 % of reading	Load Cell System, Standard Weights
Durometer (Shore) Spring Force	Up to 8.5 N Up to 44.5 N	0.014 N 0.034 N	Partial Verification using Standard Weights, Standard Balance
Indenter Extension Length	up to 1 in	57 µin	Gauge Blocks
Rockwell Hardness and Rockwell Superficial Hardness Tester ¹	HRC Low Middle High	0.44 HRC 0.45 HRC 0.43 HRC	Indirect Verification per ASTM E18 with Hardness Test Blocks

Mass and Mass Related

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Hardness and Rockwell Superficial Hardness Tester ¹	HRD Low Middle High	0.44 HRD 0.36 HRD 0.36 HRD	Indirect Verification per ASTM E18 using Hardness Test Blocks
Flow – Air ¹	0.01 ml/min to 50 L/min (100 to 1 000) L/min	0.63 % of reading 1.3 % of reading	Comparison to Panasonic Mass Flow Meter
Flow – Liquid ¹	(0.01 to 50 L/min (50 to 250) L/min	0.013 % of reading 0.1% of reading	Balance and Timer Flow Calibration System
Volumetric Glassware ¹ Volumetric Apparatus, Flasks, Burettes, Volumetric Dispensers, Cylinders, Graduated Cylinders, Beakers, Vials, & Containers	Up to 20 000 µL Up to 5 000 mL	0.034 µL 0.002 9 mL	Standard test weights, standard balance
Hydrometer ⁶	(0.7 to 2.00) SpGr	0.000 28-SpGr	Weighing Scale
Particle – Air Counting Efficiency	(0 to 100) % Counting Efficiency Particle sizes (0.1, 0.2, 0.4, 0.5, 1.0, 2.4, 4.0, 5.0, 8.0, 10) µm	6 % Counting Efficiency	Comparison to standard filter
Viscosity Meter ^{1,3,4} (15 to 40) °C	> 10 mPa·s (10.1 to 100) mPa·s (101 to 1 000) mPa·s (1 001 to 10 000) mPa·s (10 001 to 100 000) mPa·s (100 001 to 250 000) mPa·s	0.27 % of reading 0.31 % of reading 0.36 % of reading 0.44 % of reading 0.49 % of reading 0.53 % of reading	Cannon series N Fluid Standards mPa·s = cP
Viscosity Cups ¹ Efflux time (Flow, Ford, ISO, Zahn, etc.) (15 to 40) °C	(5 to 11 500) cSt (10 to 120) s	1% of reading	Certified Viscosity Reference Standard and Timer

Photometry and Radiometry

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Light Meter Illuminance	Up to 2 000 lux (> 2 000 to 30 000) lux	2.1 % of reading 2.3 % of reading	Comparison to Standard Lux Meter, Light Meter
Luminance	Up to 10,000 cd/m ²	3.3 % of reading	
UV Irradiance Calibration of UV Light Meter	(220 to 280) nm Up to 1 W/cm ² (280 to 315) nm Up to 1 W/cm ² (315 to 400) nm Up to 1 W/cm ²	3.9 % of reading 3.9 % of reading 3.9 % of reading	Comparison with Reference Radiometer / UV Meter
Laser Power – Measure Wavelength: (190 to 1 100) nm	100 µW to 1 000 mW (1 to 10) W	2.9 % of reading 2.9 % of reading	Comparison with Reference Power Meter and sensor
Laser Energy – Measure Wavelength: (190 to 1 100) nm	0.1 µJ to 15 J	2.9 % of reading	Comparison with Reference Energy Meter and sensor
Optical Power – Measure ¹ Wavelength: (750 to 1 800) nm	(-80 to 10) dB	0.11 dB	Agilent Optical Test System
Optical Wavelength – Measure ¹	(480 to 1 000) nm (1 000 to 1 650) nm	0.002 nm 0.003 9 nm	Agilent Wavelength Meter
Optical Wavelength – Generate ¹	850 nm (1 310, 1 550) nm (1 525 to 1 575) nm	11 nm 17 nm 0.34 nm	Keysight 81689A Tunable Laser

Thermodynamic

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity – Source ¹	11 % RH 33 % RH 75 % RH 97 % RH	0.75 % RH 1.1 % RH 1.4 % RH 1.7 % RH	Using Vaisala Humidity Calibrator - Saturated salt Solutions
Humidity – Source ¹	(10 to 40) %RH (40 to 90) %RH (90 to 98) %RH	0.7 %RH 1 %RH 1.9 %RH	Using Chamber/Humidity Generator, Comparison with Humidity Meter
Humidity – Measure ¹	(10 to 40) %RH (40 to 90) %RH (90 to 98) %RH	0.7 %RH 1 %RH 1.9 %RH	Humidity Meter

Thermodynamic

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure ¹	(-197 to 231) °C (> 231°C to 419) °C (> 419°C to 660) °C	0.013 °C 0.013 °C 0.017 °C	PRT w/ Temperature Meter
Temperature Measuring Equipment ¹	(-70 to 180) °C (-20 to 125) °C (50 to 650) °C	0.012 °C 0.013 °C 0.016 °C	Chamber, Bath, Drywell Calibrator, Metrology Well, PRT, Temperature Meter
Radiation (Infrared) Thermometers ¹	(> -20 to 0) °C (> 0 to 100) °C (> 100 to 200) °C (> 200 to 300) °C (> 300 to 400) °C (> 400 to 600) °C	0.29 °C 0.49 °C 0.75 °C 1.1 °C 1.5 °C 2.5 °C	Black body calibrator $\epsilon = 0.98$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Temperature Enclosure Profile ¹	(-70 to 650) °C	0.032 °C	Datalogger with RTD/ Thermocouple Probe
Humidity Enclosure Profile ¹	(10 to 40) %RH (40 to 90) %RH (90 to 98) %RH	0.7 %RH 1 %RH 1.9 %RH	Humidity Probe and Indicator

Time and Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	0.01 Hz to 225 MHz 100 MHz to 3 GHz	8.1×10^{-10} Hz/Hz 7.5×10^{-10} Hz/Hz	GPS Receiver, Counter
Frequency – Measure ¹	(10 to 525) MHz 500 MHz to 26.5 GHz	3.5×10^{-8} Hz/Hz 3.3×10^{-8} Hz/Hz	GPS Receiver, Counter
Frequency – Measure ¹	9 kHz to 50GHz	5.7×10^{-10} Hz/Hz	GPS Receiver, Spectrum Analyzer
Frequency – Measure ¹ Fixed Point	10 MHz	1.3×10^{-11} Hz/Hz	GPS Receiver, Counter
Frequency – Generate ¹	0.01 Hz to 10 MHz	5.7×10^{-6} Hz/Hz	GPS Receiver, Signal Generator
Frequency – Generate ¹	100 kHz to 10 MHz 10 MHz to 1 GHz (1 to 6) GHz	1.1×10^{-7} Hz/Hz 5.7×10^{-9} Hz/Hz 5.7×10^{-10} Hz/Hz	Signal Generator
Frequency – Generate ¹	(6 to 20) GHz (20 to 50) GHz	2.4×10^{-8} Hz/Hz 2.3×10^{-8} Hz/Hz	GPS Receiver, Signal Generators

Time and Frequency

Calamba City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Generate ¹	0.01 Hz to 2 MHz	47 μ Hz/Hz	Multi-Product Calibrator
Frequency – Generate ¹	10 Hz to 1.1999 MHz	0.12 mHz/Hz	Multi-Function Calibrator
Tachometer ¹ Contact	(5 to 7 999) rpm (8 000 to 24 999) rpm (25 000 to 99 999) rpm	0.012 % of reading + 0.58R 0.004 % of reading + 0.58R 0.002 % of reading + 0.58R	Comparison to Master Tachometer
Tachometer ¹ Non-Contact	Up to 100 000 rpm	8 parts in 10 ⁶ + 0.58R	Function Generator with LED, Frequency Counter
Timer, Stopwatches, and Chronometers ¹	Up to 24 hr	0.055 s	Frequency Counters
Timer, Stopwatches, and Chronometers ¹	Up to 24 hr	11 μ s/s + 0.045 s	Stopwatch

[Return to Site listing \(top\)](#) [Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

Micro Precision Calibration Cebu, Inc.

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Kenneth Ellett II Phone: +6332 234 3643
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CALIBRATION

Acoustics and Vibration

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Pressure Level ¹	(74 to 114) dB SPL (125 to 4 000) Hz	0.31 dB	Sound Level Meter, Sound Calibrator, Electronic Counter
Sound Pressure Level – Source ¹	(74, 84, 94, 104, 114) dB SPL (125 to 2 000) Hz (74, 84, 94, 104, 114) dB SPL 4 000 Hz	0.28 dB 0.31 dB	Sound Calibrator

Chemical Quantities

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity – Measure ^{1,3,4}	1.74 µmhos/cm 1.92 µmhos/cm 10.3 µmhos/cm 84 µmhos/cm 147 µmhos/cm 1 006 µmhos/cm 1 420 µmhos/cm 10 030 µmhos/cm	0.18 µmhos/cm 0.17 µmhos/cm 0.15 µmhos/cm 0.6 µmhos/cm 0.5 µmhos/cm 2.9 µmhos/cm 4.9 µmhos/cm 29 µmhos/cm	Comparison to Standard Solutions
pH – Measure ^{1,3,4}	4 pH 7 pH 10 pH	0.014 pH 0.013 pH 0.035 pH	Comparison to Standard Solutions

Chemical Quantities

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gas Analyzer ^{1,4}	CO 50 parts in 10 ⁶ 100 parts in 10 ⁶ 500 parts in 10 ⁶	4.8 % of reading 3.3 % of reading 2.4 % of reading	Standard Calibration Gases
	O ₂ 8.0 % O ₂ 18 % O ₂ 20.9 % O ₂	2 % of reading 1.2 % of reading 0.57 % of reading	
	H ₂ S 25 parts in 10 ⁶ H ₂ S	8.4 % of reading	
	CH ₄ 1.25% Methane 25% LEL	2 % of reading 0.5 % LEL	
	2.5% Methane 50% LEL	2 % of reading 1 % LEL	
Particle Counters – Air	(0 to 100) % Counting Efficiency Particle sizes (0.1, 0.2, 0.4, 0.5, 1.0, 2.4, 4.0, 5.0, 8.0, 10) µm	6 % Counting Efficiency	Comparison to Standard Filter

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

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	11 µV/V + 0.4 µV 5.1 µV/V + 0.7 µV 3.0 µV/V + 2.5 µV 5.4 µV/V + 4 µV 9.1 µV/V + 40 µV 10 µV/V + 0.4 mV	Multifunction Calibrator
DC Voltage – Measure ¹	Up to 100 mV 100 mV to 1V (1 to 10) V (10 to 100) V 100 V to 1 kV	3 µV/V + 0.3 µV 1.7 µV/V + 0.3 µV 0.6 µV/V + 0.5 µV 2.9 µV/V + 0.03 mV 3.9 µV/V + 0.1 mV	Multimeter

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Measure ¹	Up to 100 mV 100 mV to 1V (1 to 10) V (10 to 100) V 100 V to 1 kV	0.97 μ V/V + 50 nV 0.4 μ V/V + 0.1 μ V 0.11 μ V/V + 0.5 μ V 0.69 μ V/V + 10 μ V 2.4 μ V/V + 50 μ V	Multimeter Transfer Standard
DC Voltage – Measure ¹ High Voltage	Up to 9 kV (> 9 to 10) kV (> 10 to 30) kV (> 30 to 50) kV (> 50 to 70) kV	0.36 mV/V + 0.03 V 0.47 mV/V + 0.2 V 0.47 mV/V + 0.2 V 0.48 mV/V + 0.2 V 0.51 mV/V + 0.2 V	High Voltage Meter with Probe
DC Power – Generate ¹	0.01 mW to 329 W (> 329 to 2 990) W (> 2.99 to 20) kW	0.33 mW/W 0.29 mW/W 0.7 mW/W	Multi-Product Calibrator
DC Current – Generate 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	43 μ V/V + 6 nA 57 μ V/V + 7 nA 79 μ V/V + 40 51 μ V/V + 0.7 μ A 95 μ V/V + 12 μ A	Multifunction Calibrator
DC Current – Generate ¹	20 pA 200 pA 2 nA 20 nA 200 nA 2 μ A 20 μ A 200 μ A 2 mA	3.7 mA/A + 10 fA 2.3 mA/A + 30 fA 0.71 mA/A + 0.1 pA 0.71 mA/A + 1 pA 0.4 mA/A + 10 pA 0.29 mA/A + 0.1 nA 0.28 mA/A + 1 nA 0.28 mA/A + 10 nA 0.28 mA/A + 0.1 μ A	Calibrator / Source
DC Current – Generate ¹	(1 to 20) A (1 to 100) A	0.34 mA/A + 1 mA 0.41 mA/A + 30 mA	Multifunction Calibrator with Transconductance Amplifier
DC Current – Generate ¹	(10 to 16.499 9) A (16.5 to 149.999) A (150 to 1 025) A	2.8 mA/A + 2 mA 2.8 mA/A + 15 mA 2.8 mA/A + 50 mA	Multi-Product Calibrator w/ 50 Turn Coil
DC Current – Measure ¹	(0.001 to 100) nA (1 to 10) μ A 100 μ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1A	79 μ A/A + 40 pA 13 μ A/A + 0.6 nA 11 μ A/A + 4 nA 11 μ A/A + 40 nA 28 μ A/A + 0.4 μ A 0.11 mA/A + 10 μ A	Multimeter

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Measure ¹	(> 1 to 2) A (> 2 to 20) A (> 20 to 100) A (> 100 to 1 000) A	120 μ A/A 120 μ A/A 180 μ A/A 2.9 mV/V	Current Shunt with Multimeter
Resistance – Generate ¹ (Simulation)	Up to 10.999 9 Ω (11 to 32.999 9) Ω (33 to 109.999 9) Ω (110 to 329.999 9) Ω 330 Ω to 1.099 999 k Ω (1.1 to 3.299 999) k Ω (3.3 to 10.999 99) k Ω (11 to 32.999 99) k Ω (33 to 109.999 9) k Ω (110 to 329.999 9) k Ω 330 k Ω to 1.099 999 M Ω (1.1 to 3.299 999) M Ω (3.3 to 10.999 99) M Ω (11 to 32.999 99) M Ω (33 to 109.999 9) M Ω (110 to 329.999 9) M Ω (330 to 1 110) M Ω	51 $\mu\Omega/\Omega$ + 1 m Ω 41 $\mu\Omega/\Omega$ + 1.5 m Ω 32 $\mu\Omega/\Omega$ + 1.4 m Ω 31 $\mu\Omega/\Omega$ + 2 m Ω 31 $\mu\Omega/\Omega$ + 2 m Ω 25 $\mu\Omega/\Omega$ + 20 m Ω 25 $\mu\Omega/\Omega$ + 20 m Ω 25 $\mu\Omega/\Omega$ + 0.2 Ω 33 $\mu\Omega/\Omega$ + 0.2 Ω 35 $\mu\Omega/\Omega$ + 2 Ω 0.11 m Ω/Ω + 2 Ω 0.11 m Ω/Ω + 30 Ω 0.66 m Ω/Ω + 50 Ω 0.68 m Ω/Ω + 2.5 k Ω 5.7 m Ω/Ω + 3 k Ω 6.3 m Ω/Ω + 100 k Ω 15 m Ω/Ω + 500 k Ω	Multi-Product Calibrator
Resistance – Generate ¹ (Fixed Points)	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	54 $\mu\Omega$ 97 $\mu\Omega/\Omega$ 93 $\mu\Omega/\Omega$ 41 $\mu\Omega/\Omega$ 31 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 9 $\mu\Omega/\Omega$ 9 $\mu\Omega/\Omega$ 9 $\mu\Omega/\Omega$ 9 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 21 $\mu\Omega/\Omega$ 85 $\mu\Omega/\Omega$ 71 $\mu\Omega/\Omega$ 610 $\mu\Omega/\Omega$ 580 $\mu\Omega/\Omega$	Multifunction Calibrator

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Generate ¹ (Variable Artifact)	(1 to 10) Ω (> 10 to 100) Ω (> 100 to 1000) Ω (> 1 to 100) k Ω > 100 k Ω to 10 M Ω (> 10 to 100) M Ω (> 100 to 1000) M Ω (> 1 to 10) G Ω (> 10 to 100) G Ω	130 $\mu\Omega/\Omega$ + 2 m Ω 120 $\mu\Omega/\Omega$ + 2 m Ω 110 $\mu\Omega/\Omega$ + 2 m Ω 570 $\mu\Omega/\Omega$ + 50 m Ω 2.3 m Ω/Ω 2.5 m Ω/Ω 2.3 m Ω/Ω 2.4 m Ω/Ω 2.7 m Ω/Ω	Precision Decade DC Resistance Box
Resistance – Generate ¹ (Fixed Artifacts)	0.001 Ω 0.01 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω 10 M Ω	23 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 19 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 2.5 $\mu\Omega/\Omega$ 27 $\mu\Omega/\Omega$	Standard Resistors
Resistance – Measure ¹	1 $\mu\Omega$ to 1 Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	16 $\mu\Omega/\Omega$ 1.5 $\mu\Omega/\Omega$ 1 $\mu\Omega/\Omega$ 0.96 $\mu\Omega/\Omega$ 0.66 $\mu\Omega/\Omega$ 0.79 $\mu\Omega/\Omega$ 5.7 $\mu\Omega/\Omega$ 13 $\mu\Omega/\Omega$ 84 $\mu\Omega/\Omega$ 0.52 m Ω/Ω	Multimeter
AC Resistance – Measure ¹ 12 Hz to 100 kHz	Up to 0.2 Ω (> 0.2 to 25) Ω > 100 k Ω to 10 M Ω	0.35 m Ω/Ω 0.1 m Ω/Ω 0.35 m Ω/Ω	RLC Digibridge with AC Resistors

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance –Generate ¹	0.1 Ω		Calibration RL Standard
	100 Hz	1.2 m Ω/Ω	
	120 Hz	0.97 m Ω/Ω	
	1 kHz	1.3 m Ω/Ω	
	10 kHz	1.2 m Ω/Ω	
	100 kHz	0.66 m Ω/Ω	
	1 Ω		
	100 Hz	0.34 m Ω/Ω	
	120 Hz	0.34 m Ω/Ω	
	1 kHz	0.34 m Ω/Ω	
	10 kHz	0.31 m Ω/Ω	
	100 kHz	0.67 m Ω/Ω	
	10 Ω		
	100 Hz	0.3 m Ω/Ω	
	120 Hz	0.3 m Ω/Ω	
	1 kHz	0.29 m Ω/Ω	
	10 kHz	0.30 m Ω/Ω	
	100 kHz	0.51 m Ω/Ω	
	100 Ω		
	100 Hz	0.28 m Ω/Ω	
	120 Hz	0.28 m Ω/Ω	
	1 kHz	0.28 m Ω/Ω	
	10 kHz	0.28 m Ω/Ω	
	100 kHz	0.33 m Ω/Ω	
	1 k Ω		
	100 Hz	0.28 m Ω/Ω	
	120 Hz	0.28 m Ω/Ω	
	1 kHz	0.28 m Ω/Ω	
	10 kHz	0.28 m Ω/Ω	
	100 kHz	0.38 m Ω/Ω	
	10 k Ω		
	100 Hz	0.3 m Ω/Ω	
	120 Hz	0.3 m Ω/Ω	
	1 kHz	0.29 m Ω/Ω	
	10 kHz	0.28 m Ω/Ω	
	100 kHz	0.65 m Ω/Ω	
	100 k Ω		
	100 Hz	0.3 m Ω/Ω	
	120 Hz	0.29 m Ω/Ω	
	1 kHz	0.28 m Ω/Ω	
	10 kHz	0.29 m Ω/Ω	
	100 kHz	3.9 m Ω/Ω	

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Measure ¹ 12 Hz to 100 kHz	Up to 10 pF (10 to 100) pF (100 to 400) pF (400 to 1 600) pF (1 600 to 6 400) pF 6 400 pF to 25 nF (25 to 100) nF (100 to 400) nF (400 to 1 600) nF 1 600 nF to 6 µF (6 to 25) µF (25 to 100) µF (100 to 1 000) µF	0.37 mF/F 0.2 mF/F 0.11 mF/F 0.11 mF/F 0.1 mF/F 0.1 mF/F 0.13 mF/F 0.1 mF/F 0.11 mF/F 0.1 mF/F 0.11 mF/F 0.13 mF/F 0.35 mF/F	Precision RLC Digibridge
Capacitance – Generate ¹ (Simulation) 50 Hz to 1 kHz	(190 to 399) 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 (0.33 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	4.6 mF/F 6.6 mF/F 3.4 mF/F 2.4 mF/F 1.6 mF/F 1.8 mF/F 1.6 mF/F 1.6 mF/F 2 mF/F 2.3 mF/F 2 mF/F 1.8 mF/F 2.3 mF/F 2.9 mF/F 2.6 mF/F 3 mF/F 2.1 mF/F 2.7 mF/F	Multi-Product Calibrator

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Generate ¹ (Fixed Artifacts)	1 pF		Standard Air Capacitor Set
	1 kHz	0.2 mF/F	
	1 MHz	0.11 mF/F	
	2 MHz	0.25 mF/F	
	3 MHz	0.52 mF/F	
	4 MHz	0.66 mF/F	
	5 MHz	0.88 mF/F	
	10 MHz	2.5 mF/F	
	13 MHz	3.8 mF/F	
	10 pF		
	1 kHz	97 μ F/F	
	1 MHz	130 μ F/F	
	2 MHz	95 μ F/F	
	3 MHz	76 μ F/F	
	4 MHz	130 μ F/F	
	5 MHz	150 μ F/F	
	10 MHz	260 μ F/F	
	13 MHz	390 μ F/F	
	100 pF		
	1 kHz	42 μ F/F	
	1 MHz	0.12 mF/F	
	2 MHz	0.13 mF/F	
	3 MHz	0.1 mF/F	
	4 MHz	0.14 mF/F	
	5 MHz	0.2 mF/F	
	10 MHz	0.36 mF/F	
	13 MHz	0.5 mF/F	
	1 000 pF		
	1 kHz	57 μ F/F	
	1 MHz	0.12 mF/F	
	2 MHz	0.19 mF/F	
	3 MHz	0.32 mF/F	
	4 MHz	0.47 mF/F	
	5 MHz	0.64 mF/F	
	10 MHz	1.9 mF/F	
	13 MHz	2.9 mF/F	
	10 nF		
	0.12 kHz	42 μ F/F	
	1 kHz	89 μ F/F	
	10 kHz	69 μ F/F	
	100 kHz	85 μ F/F	

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Generate ¹ (Fixed Artifacts)	100 nF		Standard Air Capacitor Set
	0.12 kHz	110 μ F/F	
	1 kHz	79 μ F/F	
	10 kHz	110 μ F/F	
	100 kHz	110 μ F/F	
	1 μ F		
	0.12 kHz	90 μ F/F	
	1 kHz	0.12 mF/F	
	10 kHz	0.11 mF/F	
	100 kHz	0.44 mF/F	
	Up to 100 μ H	0.12 mH/H	
	> 100 μ H to 1 H	0.12 mH/H	
Inductance – Measure ¹ 12 Hz to 100 kHz	(> 1 to 16) H	0.12 mH/H	Precision RLC Digibridge
Inductance – Generate ¹ (Fixed Artifacts)	1 μ H		Standard Inductors
	1 kHz	30 mH/H	
	10 μ H		
	100 Hz	22 mH/H	
	200 Hz	22 mH/H	
	400 Hz	4.3 mH/H	
	1 kHz	1.8 mH/H	
	10 kHz	1 mH/H	
	100 kHz	1.5 mH/H	
	100 μ H		
	100 Hz	0.26 mH/H	
	200 Hz	0.25 mH/H	
	400 Hz	0.23 mH/H	
	1 kHz	0.17 mH/H	
	10 kHz	0.19 mH/H	
	1 mH		
	100 Hz	0.13 mH/H	
	200 Hz	0.13 mH/H	
	400 Hz	0.13 mH/H	
	1 kHz	0.12 mH/H	
	10 kHz	0.17 mH/H	
	10 mH		
	100 Hz	0.13 mH/H	
	200 Hz	0.13 mH/H	
	400 Hz	0.13 mH/H	
	1 kHz	0.13 mH/H	
	10 kHz	0.13 mH/H	

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Generate ¹ (Fixed Artifacts)	100 mH		Standard Inductors
	100 Hz	0.12 mH/H	
	200 Hz	0.12 mH/H	
	400 Hz	0.12 mH/H	
	1 kHz	0.1 mH/H	
	10 kHz	0.13 mH/H	
	1 H		
	100 Hz	0.11 mH/H	
	200 Hz	0.11 mH/H	
	400 Hz	0.11 mH/H	
	1 kHz	0.11 mH/H	
	2 H		
	100 Hz	0.69 mH/H	
	200 Hz	0.3 mH/H	
	400 Hz	0.3 mH/H	
	1 kHz	0.3 mH/H	
	10 H		
	100 Hz	0.12 mH/H	
	200 Hz	0.2 mH/H	
	400 Hz	0.12 mH/H	
	1 kHz	0.13 mH/H	
Electrical Calibration of Thermocouple Indicators ¹	Type B		Multi-Product Calibrator
	(600 to 800) °C	0.48 °C	
	(> 800 to 1 000) °C	0.38 °C	
	(> 1 000 to 1 550) °C	0.34 °C	
	(> 1 550 to 1 820) °C	0.29 °C	
	Type C		
	(0 to 150) °C	0.26 °C	
	(> 150 to 650) °C	0.22 °C	
	(> 650 to 1 000) °C	0.26 °C	
	(> 1 000 to 1 800) °C	0.43 °C	
	(> 1 800 to 2 316) °C	0.71 °C	
	Type E		
	(-250 to -100) °C	0.43 °C	
	(> -100 to -25) °C	0.14 °C	
	(> -25 to 350) °C	0.11 °C	
	(> 350 to 650) °C	0.14 °C	
	(> 650 to 1 000) °C	0.18 °C	

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type J		Multi-Product Calibrator
	(-210 to -100) °C	0.23 °C	
	(> -100 to -30) °C	0.14 °C	
	(> -30 to 150) °C	0.11 °C	
	(> 150 to 760) °C	0.15 °C	
	(> 760 to 1 200) °C	0.2 °C	
	Type K		
	(-200 to -100) °C	0.26 °C	
	(> -100 to -25) °C	0.14 °C	
	(> -25 to 120) °C	0.11 °C	
	(> 120 to 1 000) °C	0.15 °C	
	(> 1 000 to 1 372) °C	0.34 °C	
	Type L		
	(-200 to -100) °C	0.42 °C	
	(> -100 to 800) °C	0.29 °C	
	(> 800 to 900) °C	0.19 °C	
	Type N		
	(-200 to -100) °C	0.34 °C	
	(> -100 to -25) °C	0.19 °C	
	(> -25 to 120) °C	0.17 °C	
	(> 120 to 410) °C	0.16 °C	
	(> 410 to 1 300) °C	0.24 °C	
	Type R		
	(0 to 250) °C	0.54 °C	
	(> 250 to 400) °C	0.32 °C	
	(> 400 to 1 000) °C	0.29 °C	
	(> 1 000 to 1 767) °C	0.34 °C	
	Type S		
	(0 to 250) °C	0.53 °C	
	(> 250 to 1 000) °C	0.34 °C	
	(> 1 000 to 1 400) °C	0.32 °C	
	(> 1 400 to 1 767) °C	0.38 °C	
	Type T		
	(-250 to -150) °C	0.54 °C	
	(> -150 to 0) °C	0.2 °C	
	(> 0 to 120) °C	0.14 °C	
	(> 120 to 400) °C	0.11 °C	
	Type U		
	(-200 to 0) °C	0.63 °C	
	(> 0 to 600) °C	0.31 °C	

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Cu 427, 10 Ω (-100 to 260) °C	0.34 °C	Multiproduct Calibrator
	Pt 385, 100 Ω (-200 to -80) °C	0.045 °C	
	(> -80 to 0) °C	0.057 °C	
	(> 0 to 100) °C	0.079 °C	
	(> 100 to 300) °C	0.91 °C	
	(> 300 to 400) °C	0.1 °C	
	(> 400 to 630) °C	0.11 °C	
	(> 630 to 800) °C	0.24 °C	
	Pt 3926, 100 Ω (-200 to -80) °C	0.045 °C	
	(> -80 to 0) °C	0.057 °C	
	(> 0 to 100) °C	0.079 °C	
	(> 100 to 300) °C	0.091 °C	
	(> 300 to 400) °C	0.1 °C	
	(> 400 to 630) °C	0.11 °C	
	Pt 3916, 100 Ω (-200 to -190) °C	0.28 °C	
	(> -190 to -80) °C	0.0456 °C	
	(> -80 to 0) °C	0.057 °C	
	(> 0 to 100) °C	0.068 °C	
	(> 100 to 260) °C	0.068 °C	
	(> 260 to 300) °C	0.079 °C	
	(> 300 to 400) °C	0.091 °C	
	(> 400 to 600) °C	0.091 °C	
	(> 600 to 630) °C	0.24 °C	
	Pt 385, 200 Ω (-200 to -80) °C	0.034 °C	
	(> -80 to 0) °C	0.034 °C	
	(> 0 to 100) °C	0.045 °C	
	(> 100 to 260) °C	0.045 °C	
	(> 260 to 300) °C	0.12 °C	
	(> 300 to 400) °C	0.14 °C	
	(> 400 to 600) °C	0.14 °C	
	(> 600 to 630) °C	0.16 °C	

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 500 Ω		Multiproduct Calibrator
	(-200 to -80) °C	0.034 °C	
	(> -80 to 0) °C	0.045 °C	
	(> 0 to 100) °C	0.057 °C	
	(> 100 to 260) °C	0.068 °C	
	(> 260 to 300) °C	0.079 °C	
	(> 300 to 400) °C	0.079 °C	
	(> 400 to 600) °C	0.091 °C	
	(> 600 to 630) °C	0.1 °C	
	Pt 385, 1 k Ω		
	(-200 to -80) °C	0.034 °C	
	(> -80 to 0) °C	0.034 °C	
	(> 0 to 100) °C	0.034 °C	
	(> 100 to 260) °C	0.045 °C	
	(> 260 to 300) °C	0.057 °C	
	(> 300 to 400) °C	0.057 °C	
	(> 400 to 600) °C	0.068 °C	
	(> 600 to 630) °C	0.25 °C	
	Pt Ni 385, 100 Ω		
	(-80 to 0) °C	0.091 °C	
	(> 0 to 100) °C	0.091 °C	
	(> 100 to 260) °C	0.16 °C	
AC Voltage – Generate ¹	Up to 2.2 mV		Multifunction Calibrator
	(10 to 20) Hz	0.45 mV/V + 4 μ V	
	(20 to 40) Hz	0.39 mV/V + 4 μ V	
	40 Hz to 20 kHz	0.33 mV/V + 4 μ V	
	(20 to 50) kHz	0.38 mV/V + 4 μ V	
	(50 to 100) kHz	0.66 mV/V + 5 μ V	
	(100 to 300) kHz	1.2 mV/V + 10 μ V	
	(300 to 500) kHz	1.5 mV/V + 20 μ V	
	(0.5 to 1) MHz	2.9 mV/V + 20 μ V	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.26 mV/V + 4 μ V	
	(20 to 40) Hz	0.12 mV/V + 4 μ V	
	40 Hz to 20 kHz	0.12 mV/V + 4 μ V	
	(20 to 50) kHz	0.22 mV/V + 4 μ V	
	(50 to 100) kHz	0.55 mV/V + 5 μ V	
	(100 to 300) kHz	1 mV/V + 10 μ V	
	(300 to 500) kHz	1.4 mV/V + 20 μ V	
	(0.5 to 1) MHz	2.9 mV/V + 20 μ V	

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Generate ¹	(22 to 220) mV		Multifunction Calibrator
	(10 to 20) Hz	0.25 mV/V + 12 μ V	
	(20 to 40) Hz	0.1 mV/V + 7 μ V	
	40 Hz to 20 kHz	0.086 mV/V + 7 μ V	
	(20 to 50) kHz	0.21 mV/V + 7 μ V	
	(50 to 100) kHz	0.48 mV/V + 17 μ V	
	(100 to 300) kHz	0.85 mV/V + 20 μ V	
	(300 to 500) kHz	1.4 mV/V + 25 μ V	
	(0.5 to 1) MHz	2.8 mV/V + 45 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.25 mV/V + 40 μ V	
	(20 to 40) Hz	96 μ V/V + 15 μ V	
	40 Hz to 20 kHz	55 μ V/V + 8 μ V	
	(20 to 50) kHz	85 μ V/V + 10 μ V	
	(50 to 100) kHz	0.12 mV/V + 30 μ V	
	(100 to 300) kHz	0.39 mV/V + 80 μ V	
	(300 to 500) kHz	1 mV/V + 200 μ V	
	(0.5 to 1) MHz	1.7 mV/V + 300 μ V	
	(2.2 to 22) V		
	(10 to 20) Hz	0.25 mV/V + 400 μ V	
	(20 to 40) Hz	93 μ V/V + 150 μ V	
	40 Hz to 20 kHz	47 μ V/V + 50 μ V	
	(20 to 50) kHz	80 μ V/V + 100 μ V	
	(50 to 100) kHz	0.11 mV/V + 200 μ V	
	(100 to 300) kHz	0.29 mV/V + 600 μ V	
	(300 to 500) kHz	1 mV/V + 2 mV	
	(0.5 to 1) MHz	1.5 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.25 mV/V + 4 mV	
	(20 to 40) Hz	93 μ V/V + 1.5 mV	
	40 Hz to 20 kHz	55 μ V/V + 0.6 mV	
	(20 to 50) kHz	86 μ V/V + 1 mV	
	(50 to 100) kHz	0.15 mV/V + 2.5 mV	
	(220 to 1 100) V		
	(15 to 50) Hz	70 μ V/V + 3.5 mV	
	50 Hz to 1 kHz	70 μ V/V + 3.5 mV	

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage– Generate ¹	Up to 1 100 V 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz Up to 750 V (30 to 50) kHz (50 to 100) kHz	110 μ V/V + 4 mV 150 μ V/V + 6 mV 440 μ V/V + 11 mV 0.44 mV/V + 11 mV 1.6 mV/V + 45 mV	Multifunction Calibrator with Amplifier
AC Voltage– Measure ¹	Up to 2.2 mV (1 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 7) mV (1 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 (7 to 22) mV (1 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	1.9 mV/V + 1.3 μ V 0.88 mV/V + 1.3 μ V 0.62 mV/V + 1.3 μ V 1 mV/V + 2 μ V 1.5 mV/V + 2.5 μ V 2.6 mV/V + 4 μ V 2.8 mV/V + 8 μ V 3.8 mV/V + 6 μ V 0.96 mV/V + 1.3 μ V 0.43 mV/V + 1.3 μ V 0.25 mV/V + 1.3 μ V 0.46 mV/V + 2 μ V 0.69 mV/V + 2.5 μ V 1.4 mV/V + 4 μ V 1.5 mV/V + 8 μ V 2.3 mV/V + 6 μ V 0.34 mV/V + 1.3 μ V 0.21 mV/V + 1.3 μ V 0.13 mV/V + 1.3 μ V 0.24 mV/V + 2 μ V 0.36 mV/V + 2.5 μ V 0.94 mV/V + 4 μ V 1 mV/V + 8.6 μ V 1.6 mV/V + 8.6 μ V	AC Measurement Standard

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage– Measure ¹	(22 to 70) mV		AC Measurement Standard
	(1 to 20) Hz	0.29 mV/V + 1.5 μ V	
	(20 to 40) Hz	0.15 mV/V + 1.5 μ V	
	40 Hz to 20 kHz	0.089 mV/V + 1.5 μ V	
	(20 to 50) kHz	0.15 mV/V + 2 μ V	
	(50 to 100) kHz	0.32 mV/V + 2.5 μ V	
	(100 to 300) kHz	0.63 mV/V + 4 μ V	
	(300 to 500) kHz	0.82 mV/V + 6 μ V	
	500 kHz to 1 MHz	1.3 mV/V + 6 μ V	
	(70 to 220) mV		
	(1 to 20) Hz	0.24 mV/V + 1.5 μ V	
	(20 to 40) Hz	98 μ V/V + 1.5 μ V	
	40 Hz to 20 kHz	45 μ V/V + 1.5 μ V	
	(20 to 50) kHz	82 μ V/V + 2 μ V	
	(50 to 100) kHz	0.19 mV/V + 2.5 μ V	
	(100 to 300) kHz	0.28 mV/V + 4 μ V	
	(300 to 500) kHz	0.43 mV/V + 6 μ V	
	500 kHz to 1 MHz	1.1 mV/V + 6 μ V	
	(220 to 700) mV		
	(1 to 20) Hz	0.24 mV/V + 1.5 μ V	
	(20 to 40) Hz	88 μ V/V + 1.5 μ V	
	40 Hz to 20 kHz	37 μ V/V + 1.5 μ V	
	(20 to 50) kHz	58 μ V/V + 2 μ V	
	(50 to 100) kHz	93 μ V/V + 2.5 μ V	
	(100 to 300) kHz	0.19 mV/V + 4 μ V	
	(300 to 500) kHz	0.34 mV/V + 6 μ V	
	500 kHz to 1 MHz	1 mV/V + 6 μ V	
	700 mV to 2.2 V		
	(1 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	76 μ V/V	
	40 Hz to 20 kHz	26 μ V/V	
	(20 to 50) kHz	52 μ V/V	
	(50 to 100) kHz	80 μ V/V	
	(100 to 300) kHz	0.17 mV/V	
	(300 to 500) kHz	0.29 mV/V	
	500 kHz to 1 MHz	0.98 mV/V	

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage– Measure ¹	(2.2 to 7) V		AC Measurement Standard
	(1 to 20) Hz	0.29 mV/V	
	(20 to 40) Hz	77 μ V/V	
	40 Hz to 20 kHz	26 μ V/V	
	(20 to 50) kHz	53 μ V/V	
	(50 to 100) kHz	91 μ V/V	
	(100 to 300) kHz	0.2 mV/V	
	(300 to 500) kHz	0.43 mV/V	
	500 kHz to 1 MHz	1.3 mV/V	
	(7 to 22) V		
	(1 to 20) Hz	0.29 mV/V	
	(20 to 40) Hz	80 μ V/V	
	40 Hz to 20 kHz	29 μ V/V	
	(20 to 50) kHz	53 μ V/V	
	(50 to 100) kHz	91 μ V/V	
	(100 to 300) kHz	0.2 mV/V	
	(300 to 500) kHz	0.43 mV/V	
	500 kHz to 1 MHz	1.3 mV/V	
	(22 to 70) V		
	(1 to 20) Hz	0.29 mV/V	
	(20 to 40) Hz	80 μ V/V	
	40 Hz to 20 kHz	29 μ V/V	
	(20 to 50) kHz	53 μ V/V	
	(50 to 100) kHz	91 μ V/V	
	(100 to 300) kHz	0.20 mV/V	
	(300 to 500) kHz	0.43 mV/V	
	500 kHz to 1 MHz	1.3 mV/V	
	(70 to 220) V		
	(1 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	79 μ V/V	
	40 Hz to 20 kHz	37 μ V/V	
	(20 to 50) kHz	77 μ V/V	
	(50 to 100) kHz	0.11 mV/V	
	(100 to 500) kHz	0.24 mV/V	
	(220 to 700) V		
	(1 to 100) Hz	50 μ V/V	
	100 Hz to 20 kHz	47 μ V/V	
	(20 to 50) kHz	0.14 mV/V	
	(50 to 100) kHz	0.46 mV/V	

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage– Measure ¹	(700 to 1 000) V (1 to 100) Hz 100 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	48 μ V/V 49 μ V/V 0.15 mV/V 0.45 mV/V	AC Measurement Standard
AC Voltage– Measure High Voltage	(1 to 5) kV (50 to 60) Hz (>5 to 30) kV (50 to 60) Hz (>30 to 50) kV (50 to 60) Hz	1.2 mV/V + 0.4 V 1.2 mV/V + 0.4 V 1.2 mV/V + 0.4 V	High Voltage Meter with Probe
AC Voltage – Measure ¹	Up to 10 mV 1 Hz to 1 kHz (1 to 20) kHz (20 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 8) MHz (10 to 100) mV 1 Hz to 1 kHz (1 to 20) kHz (20 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz 100 mV to 1 V 1 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 4) MHz (4 to 8) MHz (8 to 10) MHz	230 μ V/V+ 1.1 μ V 340 μ V/V+ 1.1 μ V 0.57 % of reading + 1.1 μ V 4.5 % of reading + 2 μ V 1.4 % of reading + 5 μ V 7.9 % of reading + 7 μ V 86 μ V/V+ 2 μ V 160 μ V/V+ 2 μ V 910 μ V/V+ 2 μ V 0.34 % of reading + 10 μ V 1.1 % of reading + 10 μ V 4.5 % of reading + 70 μ V 4.5 % of reading + 80 μ V 17 % of reading + 100 μ V 82 μ V/V+ 20 μ V 160 μ V/V+ 20 μ V 340 μ V/V+ 20 μ V 910 μ V/V+ 20 μ V 0.34 % of reading + 100 μ V 1.1 % of reading + 100 μ V 4.5 % of reading + 700 μ V 4.5 % of reading + 800 μ V 17 % of reading + 1 mV	Multimeter

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(1 to 10) V		Multimeter
	(1 to 40) Hz	93 $\mu\text{V/V} + 0.4 \text{ mV}$	
	40 Hz to 1 kHz	85 $\mu\text{V/V} + 0.2 \text{ mV}$	
	(1 to 20) kHz	160 $\mu\text{V/V} + 0.2 \text{ mV}$	
	(20 to 50) kHz	340 $\mu\text{V/V} + 0.2 \text{ mV}$	
	(50 to 100) kHz	910 $\mu\text{V/V} + 0.2 \text{ mV}$	
	(100 to 300) kHz	0.34 % of reading + 1 mV	
	300 kHz to 1 MHz	1.1 % of reading + 1 mV	
	(1 to 2) MHz	1.7 % of reading + 1 mV	
	(2 to 4) MHz	4.5 % of reading + 7 mV	
	(4 to 8) MHz	4.5 % of reading + 8 mV	
	(8 to 10) MHz	17 % of reading + 10 mV	
	(10 to 100) V		
	1 Hz to 20 kHz	230 $\mu\text{V/V} + 2 \text{ mV}$	
AC Voltage – Measure ¹	(20 to 50) kHz	400 $\mu\text{V/V} + 2 \text{ mV}$	Multimeter Transfer Standard
	(50 to 100) kHz	0.14 % of reading + 2 mV	
	(100 to 1 000) V		
	1 Hz to 1 kHz	450 $\mu\text{V/V} + 20 \text{ mV}$	
	(1 to 20) kHz	680 $\mu\text{V/V} + 20 \text{ mV}$	
	Up to 100 mV		
	Up to 1 kHz	41 $\mu\text{V/V}$	
	(1 to 20) kHz	43 $\mu\text{V/V}$	
	(20 to 100) kHz	43 $\mu\text{V/V}$	
	(100 to 300) kHz	44 $\mu\text{V/V}$	
AC Voltage – Measure ¹	300 kHz to 1 MHz	0.11 mV/V	Multimeter Transfer Standard
	100 mV to 1 V		
	Up to 1 kHz	30 $\mu\text{V/V}$	
	(1 to 20) kHz	32 $\mu\text{V/V}$	
	(20 to 50) kHz	36 $\mu\text{V/V}$	
	(50 to 100) kHz	38 $\mu\text{V/V}$	
	(100 to 300) kHz	57 $\mu\text{V/V}$	
	(300 to 500) kHz	0.11 mV/V	
	300 kHz to 1 MHz	0.38 mV/V	

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(1 to 10) V Up to 10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 4) kHz (4 to 8) kHz (8 to 10) kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz	53 μ V/V 40 μ V/V 39 μ V/V 31 μ V/V 31 μ V/V 32 μ V/V 31 μ V/V 31 μ V/V 39 μ V/V 40 μ V/V 73 μ V/V 0.13 mV/V 0.44 mV/V	Multimeter Transfer Standard
	(10 to 100) V Up to 10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (100 to 1 000) V Up to 10 Hz (10 to 20) Hz	33 μ V/V 34 μ V/V 40 μ V/V 50 μ V/V 34 μ V/V 41 μ V/V	
AC Power – Generate ¹ (45 to 65) Hz, PF= 1	0.1 mW to 329 W > 329 W to 2.99 kW (> 2.99 to 20) kW	0.12 mW/W 1.3 mW/W 1 mW/W	Multiproduct Calibrator
AC Current – Generate ¹	Up to 220 μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.27 mA/A + 16 nA 0.16 mA/A + 10 nA 0.13 mA/A + 8 nA 0.29 mA/A + 12 nA 1 mA/A + 65 nA	Multifunction Calibrator
	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	0.27 mA/A + 40 nA 0.16 mA/A + 35 nA 0.13 mA/A + 35 nA 0.21 mA/A + 110 nA 1 mA/A + 650 nA	

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Generate 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 1 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.27 mA/A + 400 nA 0.16 mA/A + 350 nA 0.13 mA/A + 350 nA 0.21 mA/A + 550 nA 1 mA/A + 40 nA 0.27 mA/A + 4 µA 0.17 mA/A + 3.5 µA 0.13 mA/A + 2.5 µA 0.21 mA/A + 3.5 µA 1 mA/A + 10 µA 0.27 mA/A + 35 µA 0.44 mA/A + 80 µA 6.8 mA/A + 160 µA	Multifunction Calibrator
AC Current – Generate ¹	(1 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.59 mA/A + 170 µA 1 mA/A + 380 µA 3.8 mA/A + 750 µA	Multifunction Calibrator with Amplifier
AC Current – Generate ¹	29 µA to 329.99 µA 10 Hz to 20 Hz 20 Hz to 40 Hz 40 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 30 kHz 330 µA to 3.2999 mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 30) kHz 3.30 mA to 32.999 mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 30) kHz	1.8 mA/A + 0.1 µA 1.4 mA/A + 1 µA 1.4 mA/A + 0.2 µA 6.8 mA/A + 0.2 µA 14 mA/A + 0.4 µA 1.8 mA/A + 0.2 µA 1.1 mA/A + 0.2 µA 1.1 mA/A + 0.2 µA 4.5 mA/A + 0.3 µA 9.1 mA/A + 0.6 µA 1.7 mA/A + 2 µA 0.85 mA/A + 2 µA 0.74 mA/A + 2 µA 1.8 mA/A + 3 µA 3.6 mA/A + 4 µA	Multi-Product Calibrator

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Generate ¹	(33 to 329.99) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 330 mA to 2.999 99 A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (3 to 20.5) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	1.7 mA/A+ 20 μ A 0.85 mA/A+ 20 μ A 0.91 mA/A+ 50 μ A 1.8 mA/A+ 100 μ A 3.6 mA/A+ 200 μ A 1.7 mA/A+ 100 μ A 1.7 mA/A+ 100 μ A 1.7 mA/A+ 1 mA 5.7 mA/A+ 5 mA 23 mA/A+ 5 mA 1.1 mA/A + 5 mA 1.5 mA/A + 5 mA 22 mA/A + 5 mA	Multi-Product Calibrator
AC Current – Generate ¹	(1 to 20) A 30 Hz to 5 kHz	0.69 mA/A+ 1 mA	Multifunction Calibrator with Transconductance Amplifier
AC Current – Generate ¹	(10 to 1 000) A (45 to 65) Hz (65 to 440) Hz	3.2 mA/A+ 0.09 A 8.9 mA/A + 0.1 A	Multi-Product Calibrator with Fluke 50-turn Current Coil
AC Current – Measure ¹	10 Hz to 1 kHz Up 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	1 mA/A + 30 nA 0.69 mA/A + 30 nA 0.36 mA/A + 0.2 μ A 0.36 mA/A + 2 μ A 0.36 mA/A + 20 μ A 1.1 mA/A + 200 μ A	Multimeter
AC Current – Measure ¹	100 mA to 1 A (10 to 20) Hz 20 Hz to 1 kHz (1 to 10) kHz (10 to 30) kHz (30 to 100) kHz	61 μ A/A 48 μ A/A 50 μ A/A 110 μ A/A 290 μ A/A	Current shunt with AC Measurement Standard

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(1 to 2) A (10 to 20) Hz 20 Hz to 1 kHz (1 to 10) kHz (10 to 30) kHz (30 to 100) kHz 10 A (10 to 20) Hz (20 to 40) Hz 40 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz 20 A (10 to 20) Hz (20 to 40) Hz 40 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz	74 μ A/A 54 μ A/A 59 μ A/A 0.12 mA/A 0.29 mA/A 0.11 mA/A 0.079 mA/A 0.13 mA/A 0.16 mA/A 0.21 mA/A 0.16 mA/A 0.11 mA/A 0.11 mA/A 0.2 mA/A 0.25 mA/A	Current shunt with AC Measurement Standard
AC Current – Measure ¹	30 Hz to 5 kHz (0.1 to 60) A (60 to 1 000) A	0.93 % of reading 0.7 % of reading	Current Probe with Multimeter
Oscilloscopes ¹ Square Wave 50 Ω , 1 M Ω – Load Impedance $\leq$ 10 kHz	6 mVp-p (> 6 to 60) mVp-p > 60 mVp-p to 60 Vp-p	0.5 % of reading 0.15 % of reading 0.12 % of reading	Oscilloscope Calibrator
Oscilloscopes ¹ Vertical Deflection (Amplitude)	Up to 1 mV (> 1 mV to 6) mV > 6 mV to 200 V	0.053 % of reading + 25 μ V 0.037 % of reading + 25 μ V 0.028 % of reading + 25 μ V	Oscilloscope Calibrator with Multimeter
Oscilloscopes ¹ Horizontal Deflection (Time)	> 450.5 ps to 10 ns (> 10 to 100) ns > 100 ns to 55 s	14 μ s/s 11 μ s/s 13 μ s/s	Oscilloscope Calibrator
Oscilloscopes ¹ Bandwidth	100 MHz to 300 MHz (> 300 to 550) MHz > 550 MHz to 1.1 GHz (> 1.1 to 3.2) GHz	2.3 % of reading 2.8 % of reading 4 % of reading 4.5 % of reading	Oscilloscope Calibrator with Calibration Head
Oscilloscopes ¹ Bandwidth	50 MHz to 26.5 GHz	2.5 % of reading	Synthesized Sweeper with Power Sensor

Electrical – DC/Low Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ¹ Rise / Fall Time (10 to 90) %	13 ps to 3.5 s	57 ps	Oscilloscope Calibrator with Calibration Head

Electrical – RF/Microwave

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power – Generate ¹	(-50 to 20) dBm 9 kHz to 10 MHz	0.3 dB	Signal Generator
	(-127 to 13) dBm 10 MHz to 2 GHz	0.5 dB	
	(-110 to 20) dBm 10 MHz to 2 GHz	0.7 dB	
RF Power – Generate ¹	(-110 to 20) dBm 2 MHz to 20 GHz	0.8 dB	Synthesized Swept-Signal Generator
	(-110 to 20) dBm 20 MHz to 40 GHz	1 dB	
	(-20 to 10) dBm 40 MHz to 50 GHz	1.9 dB	
Amplitude Modulation Depth – Measure ¹ 100 kHz to 10 MHz	Rate: 50 Hz to 10 kHz Depth: (20 to 99) %	1 % of reading	Measuring Receiver, Spectrum Analyzer
10 MHz to 3 GHz	Rate: 50 Hz to 100 kHz Depth: (20 to 99) %	0.6 % of reading	
10 MHz to 3 GHz	Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	2.8 % of reading	
Amplitude Modulation Depth – Measure ¹ (3 to 26.5) GHz	Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	5.1 % of reading	Measuring Receiver, Spectrum Analyzer
Amplitude Modulation Rejection – Measure ¹ 150 kHz to 6.6 GHz (6.6 to 26.5) GHz	Rate: 400 Hz to 1 kHz Depth.: ≤ 50 %	0.1 Hz 0.1 Hz	Measuring Receiver, Spectrum Analyzer

Electrical – RF/Microwave

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation Distortion – Measure ¹ 1 MHz to 10 MHz 10 MHz to 26.5 GHz	Rate: 50 Hz to 3 kHz Depth: $\geq 3\%$ Depth: $\geq 1\%$	0.02 % of reading 0.02 % of reading	Measuring Receiver, Spectrum Analyzer
Amplitude Modulation Flatness ¹ 10 MHz to 3 GHz 3 MHz to 26.5 GHz	Rate: 90 Hz to 10 kHz Depth: (5 to 99) %	0.45 % of reading 0.91 % of reading	Measuring Receiver, Spectrum Analyzer
Amplitude Modulation – Generate ¹ 11 MHz to 13.5 MHz	Depths: $< 95\%$ Depths: $< 99\%$	0.15 % of reading 0.31 % of reading	AM/FM Test Source
AM Distortion – Generate ¹ 11 MHz to 13.5 MHz	Rate: 20 Hz to 100 kHz Depth: 50% Rate: 20 Hz to 100 kHz Depth: 95%	0.002 % of reading 0.004 % of reading	AM/FM Test Source
Phase Modulation – Measure ¹ 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 200 kHz Deviation: > 0.7 Rad Deviation: > 0.3 Rad Rate: 20 Hz to 200 kHz Deviation: > 2 Rad Deviation: > 0.6 Rad Rate: 20 Hz to 200 kHz Deviation: > 4 Rad Deviation: > 1.2 Rad	1.2 % of reading 3.5 % of reading 1.5 % of reading 3.5 % of reading 1.2 % of reading 3.5 % of reading	Measuring Receiver, Spectrum Analyzer
Phase Residuals – Measure ¹ 1 MHz to 6.6 GHz (6.6 to 13.2) GHz	Deviation: (≥ 0.4 to < 1.2) rad ≥ 1.2 rad Deviation: (≥ 0.8 to < 2.2) rad ≥ 2.2 rad	0.35 % of reading 0.14 % of reading 0.35 % of reading 0.14 % of reading	Measuring Receiver, Spectrum Analyzer

Electrical – RF/Microwave

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Residuals – Measure ¹ (13.2 to 26.5) GHz	Deviation: (≥ 1.5 to < 4.5) rad ≥ 4.5 rad	0.35 % of reading 0.14 % of reading	Measuring Receiver, Spectrum Analyzer
Phase Distortion ¹ 1 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviation: (≥ 1 to < 3) rad ≥ 1.2 rad Deviation: (≥ 2 to < 6) rad ≥ 6 rad Deviation: (≥ 4 to < 10) rad ≥ 10 rad	0.35 % of reading 0.14 % of reading 0.35 % of reading 0.14 % of reading 0.35 % of reading 0.14 % of reading	Measuring Receiver, Spectrum Analyzer
Frequency Modulation Deviation Accuracy – Measure ¹ 30 Hz to 50 GHz 10 MHz to 3 GHz (3 to 26.5) GHz	Rate: 20 Hz to 10 kHz Dev.: ≤ 40 kHz Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz	0.3 % of reading 0.3 % of reading 0.4 % of reading	Measuring Receiver, Spectrum Analyzer
Frequency Modulation Rejection – Measure ¹ 250 kHz to 10 MHz	Rate: 50 Hz to 200 kHz Dev.: ≤ 5 kHz peak Dev.: ≤ 50 kHz peak	0.15 % AM Depth 0.2 % AM Depth	Measuring Receiver, Spectrum Analyzer
Frequency Modulation Distortion – Measure ¹ 1 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviation: ≥ 600 Hz to < 2 kHz ≥ 2.0 kHz Deviation: (≥ 1.4 to < 3.5) kHz ≥ 3.5 kHz Deviation: (≥ 2.5 to < 7) kHz ≥ 7 kHz	0.4 % of reading 0.1 % of reading 0.4 % of reading 0.1 % of reading 0.4 % of reading 0.1 % of reading	Measuring Receiver, Spectrum Analyzer

Electrical – RF/Microwave

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Residuals – FM Bandwidth ¹ 150 kHz to 3 GHz (rms)	50 Hz to 3 kHz	1.7 Hz	Measuring Receiver, Spectrum Analyzer
Frequency Modulation – Generate ¹ (11 to 13.5) MHz (88 to 108) MHz (352 to 432) MHz	Deviation - > 12.5 kHz Deviation - > 100 kHz Deviation - > 400 kHz	0.14 % of reading 0.14 % of reading 0.4 % of reading	AM/FM Test Source
FM Distortion – Generate ¹ (11 to 13.5) MHz (88 to 108) MHz (352 to 432) MHz	Deviation - > 12.5 kHz Deviation - > 12.5 kHz Deviation - > 400 kHz	0.008 2 % of reading 0.007 % of reading 0.005 % of reading	AM/FM Test Source
Harmonic – Measure ¹	(-90 to 0.1) dB 30 Hz to 50 GHz	1.5 dB	Spectrum Analyzer
Harmonic – Distortion ¹	(-80 to -65) dB 20 Hz to 20 kHz (20 to 100) kHz	1.7 dB 2.4 dB	Audio Analyzer

Length – Dimensional Metrology

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Indicators ^{1,2} 100 µin resolution	(0.05 to 0.4) in (> 0.4 to 1) in (> 1 to 2) in (> 2 to 3) in (> 3 to 4) in	(23 + 0.13L) µin (23 + 0.12L) µin (23 + 0.17L) µin (23 + 0.2L) µin (24 + 0.2L) µin	Indicator Calibrator, Gage Block, Universal Length Measuring Machine
50 µin resolution	(0.05 to 0.4) in (> 0.4 to 1) in (> 1 to 2) in (> 2 to 3) in (> 3 to 4) in	(12 + 0.24L) µin (12 + 0.22L) µin (13 + 0.3L) µin (13 + 0.33L) µin (13 + 0.33L) µin	
20 µin resolution	(0.05 to 0.4) in (> 0.4 to 1) in (> 1 to 2) in (> 2 to 3) in (> 3 to 4) in	(6.7 + 0.44L) µin (6.7 + 0.37L) µin (7.3 + 0.47L) µin (7.7 + 0.48L) µin (8.4 + 0.48L) µin	

Length – Dimensional Metrology

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Indicators ^{1,2} 0.01 µm resolution	0.01 µm to 10 mm (> 10 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm (> 100 to 150) mm (> 150 to 200) mm	(0.14 + 0.001 <i>l</i>) µm (0.13 + 0.001 <i>l</i>) µm (0.13 + 0.001 <i>l</i>) µm (0.12 + 0.001 <i>l</i>) µm (0.12 + 0.001 <i>l</i>) µm (0.11 + 0.001 <i>l</i>) µm (0.07 + 0.001 <i>l</i>) µm	Indicator Calibrator, Gage Block, Universal Length Measuring Machine
1 µm resolution	(0.5 to 10) mm (> 10 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm (> 100 to 150) mm	(0.23 + 0.000 9 <i>l</i>) µm (0.23 + 0.000 9 <i>l</i>) µm (0.22 + 0.000 9 <i>l</i>) µm (0.21 + 0.001 <i>l</i>) µm (0.21 + 0.001 <i>l</i>) µm (0.19 + 0.001 <i>l</i>) µm	
5 µm resolution	(> 150 to 200) mm (> 0.5 to 10) mm (> 10 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm (> 100 to 150) mm (> 150 to 200) mm	(0.15 + 0.001 <i>l</i>) µm (1.1 + 0.000 47 <i>l</i>) µm (1.1 + 0.000 48 <i>l</i>) µm (1.1 + 0.000 49 <i>l</i>) µm (1.1 + 0.000 5 <i>l</i>) µm (1.1 + 0.000 52 <i>l</i>) µm (1.1 + 0.000 54 <i>l</i>) µm (1 + 0.000 57 <i>l</i>) µm	
10 µm resolution	(0.5 to 10) mm (> 10 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm (> 100 to 150) mm (> 150 to 200) mm	(2.2 + 0.000 26 <i>l</i>) µm (2.2 + 0.000 27 <i>l</i>) µm (2.2 + 0.000 28 <i>l</i>) µm (2.2 + 0.000 28 <i>l</i>) µm (2.2 + 0.000 29 <i>l</i>) µm (2.2 + 0.000 31 <i>l</i>) µm (2.2 + 0.000 33 <i>l</i>) µm	

Length – Dimensional Metrology

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Micrometers ^{1,2} (Outside, Inside, Depth)	Up to 1) in (> 1 to 2) in (> 2 to 3) in (> 3 to 4) in (> 4 to 5) in (> 5 to 6) in (> 6 to 7) in (> 7 to 8) in (> 8 to 10) in (> 10 to 12) in (> 12 to 16) in (> 16 to 20) in (> 20 to 24) in (> 24 to 28) in (> 28 to 32) in (> 32 to 36) in (> 36 to 48) in	(12 + 0.008 6L) μ in (12 + 0.21L) μ in (13 + 0.32L) μ in (13 + 0.42L) μ in (14 + 0.48L) μ in (14 + 0.57L) μ in (14 + 0.61L) μ in (14 + 0.67L) μ in (120 + 0.13L) μ in (130 + 0.15L) μ in (160 + 0.14L) μ in (200 + 0.15L) μ in (230 + 0.16L) μ in (270 + 0.16L) μ in (290 + 0.17L) μ in (340 + 0.16L) μ in (360 + 0.19L) μ in	Gage blocks, optical flat, pin gauge, monochromatic light source
Micrometers ^{1,2} (Outside, Inside, Depth)	(0.5 to 10) mm (> 10 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm (> 100 to 150) mm (> 150 to 200) mm (> 200 to 250) mm (> 250 to 300) mm (> 300 to 400) mm (> 400 to 500) mm (> 500 to 600) mm (> 600 to 700) mm (> 700 to 800) mm (> 800 to 900) mm (> 900 to 2 000) mm	(0.2 + 0.004 5I) μ m (0.17 + 0.000 39I) μ m (0.14 + 0.000 7I) μ m (0.13 + 0.001 4I) μ m (0.07 + 0.002 1I) μ m (0.21 + 0.000 4I) μ m (0.11 + 0.001 2I) μ m (0.23 + 0.000 76I) μ m (0.14 + 0.000 21I) μ m (0.22 + 0.000 11I) μ m (0.24 + 0.001 2I) μ m (0.26 + 0.000 21I) μ m (0.28 + 0.001 2I) μ m (0.3 + 0.001 2I) μ m (0.33 + 0.001 2I) μ m (0.3 + 0.002 2I) μ m	Gage Blocks, Optical Flat, Pin Gauge, Monochromatic Light Source
Calipers ^{1,2}	Up to 4 in (> 4 to 6) in (> 6 to 12) in (> 12 to 24) in (> 24 to 48) in	(110 + 0.1L) μ in (110 + 0.2L) μ in (110 + 0.8L) μ in (110 + 0.9L) μ in (90 + 1.6L) μ in	Gage Blocks

Length – Dimensional Metrology

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 100 mm (> 100 to 200) mm (> 200 to 300) mm (> 300 to 600) mm (> 600 to 1 000) mm (> 1 000 to 2 000) mm	(2.3 + 0.000 4 <i>L</i>) μm (2.3 + 0.000 1 <i>L</i>) μm (2.3 + 0.000 6 <i>L</i>) μm (2.1 + 0.001 <i>L</i>) μm (1.7 + 0.001 4 <i>L</i>) μm (1.7 + 0.002 4 <i>L</i>) μm	Gage Blocks
Height Gages ^{1,2}	Up to 4 in (> 4 to 6) in (> 6 to 12) in (> 12 to 24) in (> 24 to 48) in	(4 + 1.6 <i>L</i>) μin (5 + 3.3 <i>L</i>) μin (13 + 2.1 <i>L</i>) μin (13 + 2.1 <i>L</i>) μin (5 + 2.4 <i>L</i>) μin	Gage Blocks, Surface Plate
Height Gages ^{1,2}	Up to 150 mm (> 150 to 300) mm (> 300 to 600) mm (> 600 to 1 200) mm	(0.2 + 0.003 <i>L</i>) μm (0.2 + 0.002 <i>L</i>) μm (0.5 + 0.002 <i>L</i>) μm (1.1 + 0.002 <i>L</i>) μm	Gage Blocks, Surface Plate
Steel Rules	Up to 20 in (20 to 2 000) in Up to 1 000 mm (1 000 to 50 000) mm	120 μin (100 + 0.8 <i>L</i>) μin 0.023 mm (74 + 0.000 85 <i>L</i>) μm	Gage Blocks
Gage Blocks ²	(0.05 to 12) in	(4 + 1.1 <i>L</i>) μin	Gage Blocks, Gage Block Comparator
Gage Blocks ²	Up to 0.5 mm (0.5 to 100) mm (>100 to 500) mm	0.093 μm (0.056 + 0.000 9 <i>L</i>) μm (0.08 + 0.001 6 <i>L</i>) μm	Gage Blocks, Gage Block Comparator
Micrometer Rods/ Length Standards ^{1,2}	(> 0.05 to 0.4) in (> 0.4 to 1) in (> 1 to 2) in (> 2 to 3) in (> 3 to 4) in (> 4 to 5) in (> 5 to 6) in (> 6 to 7) in (> 7 to 8) in (> 8 to 10) in (> 10 to 12) in (> 12 to 16) in (> 16 to 20) in (> 20 to 48) in	(4.3 + 0.1 <i>L</i>) μin (4.2 + 0.5 <i>L</i>) μin (24 + 2.2 <i>L</i>) μin (5.9 + 6.2 <i>L</i>) μin (24 + 2.2 <i>L</i>) μin (4.6 + 3.6 <i>L</i>) μin (4.9 + 1.7 <i>L</i>) μin (1.8 + 2.8 <i>L</i>) μin (6.8 + 3.5 <i>L</i>) μin (16 + 4.8 <i>L</i>) μin (8.6 + 2.3 <i>L</i>) μin (18 + 1.6 <i>L</i>) μin (9.7 + 2.2 <i>L</i>) μin (12 + 2.1 <i>L</i>) μin	Universal Length Measuring Machine, Gage Blocks, Height Gage

Length – Dimensional Metrology

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Micrometer Rods/ Length Standards ^{1,2}	(0 to 10) mm (> 10 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm (> 100 to 150) mm (> 150 to 200) mm (> 200 to 250) mm (> 250 to 300) mm (> 300 to 400) mm (> 400 to 500) mm (> 500 to 1 000) mm	(0.16 + 0.000 6 <i>l</i>) μm (0.18 + 0.002 <i>l</i>) μm (0.24 + 0.000 2 <i>l</i>) μm (0.13 + 0.003 6 <i>l</i>) μm (0.26 + 0.001 9 <i>l</i>) μm (0.45 + 0.000 2 <i>l</i>) μm (0.36 + 0.001 3 <i>l</i>) μm (0.54 + 0.001 1 <i>l</i>) μm (0.36 + 0.002 1 <i>l</i>) μm (0.67 + 0.001 4 <i>l</i>) μm (0.78 + 0.001 4 <i>l</i>) μm (0.83 + 0.001 5 <i>l</i>) μm	Universal Length Measuring Machine, Gage Blocks, Height Gage
Cylindrical Plug Gages ²	(0.01 to 0.825) in (0.825 to 1.51) in (1.51 to 2.51) in (2.51 to 4.51) in (4.51 to 6.51) in (6.51 to 9.51) in (9.51 to 12.51) in	(4 + 0.6 <i>L</i>) μin (3 + 1.9 <i>L</i>) μin (4 + 1.6 <i>L</i>) μin (3 + 2 <i>L</i>) μin (4 + 1.6 <i>L</i>) μin (10 + 0.8 <i>L</i>) μin (12 + 1.9 <i>L</i>) μin	Universal Length Measuring Machine, Gage Blocks
Cylindrical Plug Gages ²	(0.001 to 20.96) mm (20.96 to 38.35) mm (38.35 to 63.75) mm (63.75 to 114.55) mm (114.55 to 165.35) mm (165.35 to 228.85) mm (228.85 to 300) mm	(0.2 + 0.000 8 <i>l</i>) μm (0.2 + 0.001 7) μm (0.1 + 0.003 3 <i>l</i>) μm (0.1 + 0.003 <i>l</i>) μm (0.6 + 0.000 5 <i>l</i>) μm (0.5 + 0.000 4 <i>l</i>) μm (0.3 + 0.001 7 <i>l</i>) μm	Universal Length Measuring Machine, Gage Blocks
Ring Gages, Cylindrical & Tapered ²	(0.01 to 0.825) in (0.825 to 1.51) in (1.51 to 2.51) in (2.51 to 4.51) in (4.51 to 6.51) in (6.51 to 9.51) in (9.51 to 12.51) in	(4 + 0.6 <i>L</i>) μin (3 + 1.9 <i>L</i>) μin (4 + 1.6 <i>L</i>) μin (3 + 2 <i>L</i>) μin (4 + 1.6 <i>L</i>) μin (10 + 0.8 <i>L</i>) μin (12 + 1.9 <i>L</i>) μin	Universal Length Measuring Machine, Gage Blocks
Ring Gages, Cylindrical & Tapered ²	(0.254 to 20.96) mm (20.96 to 38.35) mm (38.35 to 63.75) mm (63.75 to 114.55) mm (114.55 to 165.35) mm (165.35 to 228.85) mm (228.85 to 300) mm	(0.2 + 0.000 8 <i>l</i>) μm (0.2 + 0.001 7 <i>l</i>) μm (0.1 + 0.003 3 <i>l</i>) μm (0.2 + 0.003 <i>l</i>) μm (0.6 + 0.000 5 <i>l</i>) μm (0.5 + 0.000 4 <i>l</i>) μm (0.3 + 0.001 7 <i>l</i>) μm	Universal Length Measuring Machine, Gage Blocks

Length – Dimensional Metrology

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Comparators and Vision Systems ^{1,2} X Axis Y Axis Z Axis (Vision Systems) X Axis Y Axis Z Axis (Vision Systems)	Up to 12 in Up to 12 in Up to 12 in Up to 300 mm Up to 300 mm Up to 300 mm	$(11 + 1.8L) \mu\text{in}$ $(11 + 1.8L) \mu\text{in}$ $(11 + 1.8L) \mu\text{in}$ $(0.19 + 0.0074L) \mu\text{m}$ $(0.19 + 0.0074L) \mu\text{m}$ $(0.18 + 0.0073L) \mu\text{m}$	Glass Scales, Gage Blocks
Inspection Fixtures / Gauges ² 1D Features / Artifacts Thickness Pads Attribute Gauges – Go/No-Go Dedicated Fixture Gauges	Up to 12 in Up to 300 mm	$(1.5 + 2.6L) \mu\text{in}$ $(0.23 + 0.000049L) \mu\text{m}$	Universal Length Measuring Machine, Supermicrometer [®] , Gage Blocks
Inspection Fixtures / Gauges ² 2D Features / Artifacts Angle Block, Straight Edges Parallel Bars, Machine Squares, Precision Squares Radius Gauge, Chamfer Gauge, Taper Gauge Attribute Gauges – Go/No-Go Dedicated Fixture Gauges	Up to 12 in Up to 300 mm	$(1.6 + 1.6L) \mu\text{in}$ $(0.09 + 0.0006L) \mu\text{m}$	Vision System, Gage Blocks
Surface Plates ^{1,2} Overall Flatness Repeat Reading (local area flatness)	Up to 170 inDL Up to 0.001 in	11 μin 12 μin	Leveling System, Planekator Repeat-o-meter
Thread Wires ²	(4 to 120) TPI (0.004 to 0.154) in M1.25 to M10 (0.2 to 10) mm	$(3.2 + 1.1L) \mu\text{in}$ $(0.09 + 0.001L) \mu\text{m}$	Universal Length Measuring Machine, Gage Blocks
Thread Ring Gages	(4 to 120) TPI Up to 0.5 in M1.25 to M10 Up to 10 mm	59 μin 0.33 μm	Setting thread plugs

Length – Dimensional Metrology

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Threaded Plugs ² Pitch Diameter TPI: (5 to 80) in Pitch: (0.2 to 10) mm Major Diameter	Up to 4.00 in Up to 100 mm Up to 6 in Up to 100 mm	$(13 + 0.7L) \mu\text{in}$ $(0.23 + 0.005L) \mu\text{m}$ $(12 + 0.8L) \mu\text{in}$ $(0.33 + 0.005L) \mu\text{m}$	Universal Length Measuring Machine, Gage Blocks, Thread Wires using three-wire method
Coating Thickness ¹ – Ferrous and Non-Ferrous	Up to 1 500 μm (1 500 to 5 000) μm	0.13 μm 0.055 μm	Thickness Standards
Bore Micrometers, Bore Gages ²	Up to 8 in	$(3 + 1.1L) \mu\text{in}$	Master Ring Gage, Universal Length Measuring Machine
Precision Level/ Master Level	Up to 20 div	0.001 2 div	Gage Block, Surface Plate, Angle Block, Sine Bar
Base Flatness	(0 to 0.1) in	14 μin	Height Gauge, Indicator
Protractor	Up to 90° (4 Quadrant)	0.000 58°	Angle Block

Mass and Mass Related

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Durometer Spring Force	Up to 8.5 N Up to 44.5 N	0.014 N 0.034 N	Partial Direct Verification Standard weights, standard balance
Indenter extension length	Up to 1 in	57 μin	Gauge Blocks
Torque – Measure ¹	(0.02 to 1) N·m (0.2 to 10) N·m (1.2 to 60) N·m (30 to 1 500) N·m	0.15 % of reading 0.12 % of reading 0.11 % of reading 0.15 % of reading	Torque calibrator system
Torque Tester ¹ Measuring Equipment	(3 to 150) ozf·in (2 to 50) lbf·ft (> 50 to 500) lbf·ft (> 500 to 1 500) lbf·ft	0.049 % of reading 0.054 % of reading 0.052 % of reading 0.15 % of reading	Calibration wheel, arms standard, calibration weights

Mass and Mass Related

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Measurement Gage/Vacuum/Absolute Transducers, Transmitters ¹	(-1 to 1) psi (-5 to 5) psi (-15 to 0) psi (0 to 30) psia (0 to 50) psi Up to 0.25 in H ₂ O (0.25 to 1) inH ₂ O	0.000 58 psi 0.002 8 psi 0.006 9 psi 0.002 psi 0.001 9 psi 0.000 2 in H ₂ O 0.0035 inH ₂ O	Calibrator with pressure modules
	(10 to 10 000) psi	0.004 2 % of reading	Dead weight tester
	(1 000 to 15 000) psi	0.067 % of reading	Digital pressure gauge
Scales and Balances ^{1,3}	Up to 2 g	4.4 µg	Verification with standard weights
	Up to 5 g	6.7 µg	
	Up to 300 g	0.010 mg	
	Up to 500 g	0.06 mg	
	Up to 1 000 g	0.7 mg	
	Up to 5 000 g	0.7 mg	
	Up to 10 kg	8 mg	
	Up to 20 kg	6 mg	
	Up to 30 kg	58 mg	
	Up to 100 kg	0.08 g	
	Up to 150 kg	0.09 g	
	Up to 300 kg	0.85 g	
	Up to 500 kg	0.005 kg	
	Up to 1 000 kg	0.007 kg	
	Up to 8 000 kg	0.8 kg	

Mass and Mass Related

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass Determination ¹	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1 kg 2 kg 5 kg 10 kg 20 kg 50 kg	7 µg 9 µg 7 µg 7 µg 7 µg 7 µg 8 µg 9 µg 11 µg 13 µg 10 µg 20 µg 25 µg 30 µg 37 µg 61 µg 100 µg 0.29 mg 1.8 mg 4 mg 3 mg 28 mg 36 mg 0.28 g	Standard weights and balance
Air Velocity ¹	(0.01 to 8 000) ft/min	1.4 % of reading	Comparison to Master Velocity Meter
Force ¹ Compression & Tension	(0.01 to 500) lbf (500 to 1 000) lbf (600 to 30 000) lbf (30 000 to 100 000) lbf (100 000 to 500 000) lbf	0.006 6 % of reading 0.013 % of reading 0.003 % of reading 0.63 % of reading 0.28 % of reading	Load cell system standard weights
Rockwell Hardness and Rockwell Superficial Hardness Tester ¹	HRC Low Medium High HRD Low Medium High	0.44 HRC 0.45 HRC 0.43 HRC 0.44 HRD 0.36 HRD 0.36 HRD	Indirect Verification per ASTM E18 using Hardness Test Blocks
Air Flow ¹	0.01 ml/min to 50 L/min (100 to 1 000) L/min	0.63 % of reading 1.3 % of reading	Flow Calibrator

Mass and Mass Related

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Liquid Flow ¹	(0.01 to 50) L/min	0.013 % of reading	Balance and timer Flow Calibration System
Viscosity ¹ @ 25 °C	19.11 cP 67.24 cP 240.5 cP 845.0 cP 1613 cP 6021 cP 20470 cP 206300 cP	0.06 cP 0.22 cP 1.00 cP 4.8 cP 9.2 cP 34 cP 140 cP 1400 cP	Cannon series N fluid standards
Volume	Up to 20 000 µL Up to 5 000 mL	0.034 µL 0.002 9 mL	Standard test weights, standard balance
Hydrometer ⁶	(0.7 to 2.00) SpGr	0.002 8 SpGr	Weighing Scale

Photometry and Radiometry

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Illuminance	(0.1 to 2 000) lux (>2 000 to 30 000) lux	2.6 % of reading 2.3 % of reading	Comparison to standard light meter
Optical Power – Measure ¹	(-80 to 10) dB (750 to 1800) nm	0.11 dB	Optical Test System
Optical Wavelength – Measure ¹	(480 to 1 000) nm (1 000 to 1 650) nm	0.002 nm 0.003 9 nm	Wavelength Meter
Fiber Optics Wavelength ¹ Measuring Equipment	850 nm (1 310, 1 550) nm (1 525 to 1 575) nm	11 nm 17 nm 0.34 nm	Tunable Laser

Thermodynamic

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity Measuring Equipment ¹	11 %RH 33 %RH 75 %RH 97 %RH	0.7 %RH 1 %RH 1.3 %RH 1.6 %RH	Saturated salt solutions
Humidity – Measure ¹	(20 to 40) %RH (40 to 95) %RH	0.5 %RH 1 %RH	Humidity Probe

Thermodynamic

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure ^{1,3}	(-197 to 231) °C (> 231 to 419) °C (> 419 to 660) °C	0.011 °C 0.013 °C 0.022 °C	PRT w/ Thermometer
Temperature Measuring Equipment ¹	(-20 to 125) °C (50 to 650) °C	0.017 °C 0.02 °C	Chamber, Bath, Drywell Calibrator, Metrology Well, PRT w/ Thermometer
Radiation (Infrared) Thermometers ¹	(> -20 to 0) °C (> 0 to 100) °C (> 100 to 200) °C (> 200 to 300) °C (> 300 to 400) °C (> 400 to 600) °C	0.63 °C 0.9 °C 2.2 °C 3.6 °C 5.2 °C 8 °C	Black body calibrator $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Enclosure Profile ¹	(-70 to 0) °C (0 to 200) °C (200 to 650) °C (10 to 40) %RH (40 to 90) %RH (90 to 95) %RH	0.015 °C 0.038 °C 0.054 °C 0.5 % RH 0.9 % RH 1.1 % RH	Datalogger with Humidity Probe

Time and Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	0.1 Hz to 225MHz 100 MHz to 3 GHz (3 to 10) GHz (10 to 26.5) GHz 9 kHz to 50GHz	8.1×10^{-10} Hz/Hz 7.5×10^{-10} Hz/Hz 3.5×10^{-8} Hz/Hz 3.3×10^{-8} Hz/Hz 1.1×10^{-7} GHz	GPS Receiver, Counter
Frequency – Measure ¹ Fixed Point	10 MHz	1.3×10^{-11} Hz/Hz	GPS Receiver
Frequency – Generate ¹ Measuring Equipment	0.01 Hz to 10 MHz	5.7×10^{-6} MHz	GPS Receiver, Signal Generator
	100 kHz to 10 MHz 10 MHz to 1GHz (1 to 6) GHz	1.1×10^{-7} Hz/Hz 5.7×10^{-9} Hz/Hz 5.7×10^{-10} Hz/Hz	Signal Generator
	(6 to 20) GHz (20 to 50) GHz	2.4×10^{-8} Hz/Hz 2.3×10^{-8} Hz/Hz	GPS Receiver, Signal Generator
Frequency – Generate ¹ Measuring Equipment	0.01 Hz to 2 MHz	47 μ Hz/Hz	Multiproduct Calibrator

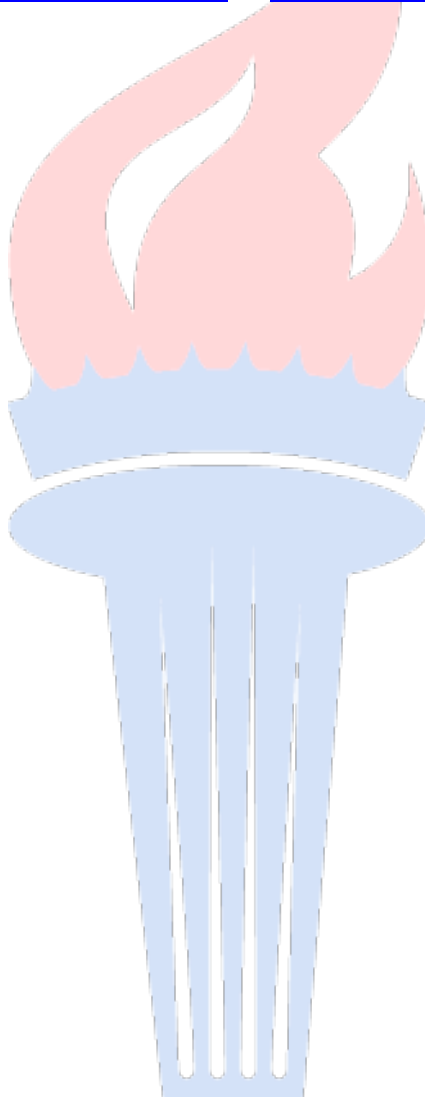
Time and Frequency

Lapu-Lapu City, Philippines

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency –Generate ¹ Measuring Equipment	10 Hz to 1.1999 MHz	0.12 mHz/Hz	Multiproduct Calibrator
Tachometer ^{1,2}	Up to 100 000 rpm	0.007 rpm	Function generator with LED, Frequency Counter

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)



Services performed at satellite laboratory

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CALIBRATION

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	7.5 μ V/V + 0.4 μ V 5 μ V/V + 0.7 μ V 3.5 μ V/V + 2.6 μ V 3.5 μ V/V + 4.0 μ V 5 μ V/V + 40 μ V 6.5 μ V/V + 0.4 mV	Multi-Function Calibrator
DC Voltage – Measure ¹	(0 to 100) mV 100 mV to 1.0 V (1.0 to 10) V (10 to 100) V (100 to 1 000) V	5 μ V/V + 0.31 μ V 4 μ V/V + 0.31 μ V 4 μ V/V + 0.51 μ V 6 μ V/V + 30 μ V 6 μ V/V + 100 μ V	Multimeter
DC High Voltage – Measure ¹	(0.1 to 10) kV	0.46 mV/V + 0.4 V	High Voltage Meter
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	40 μ A/A + 6 nA 35 μ A/A + 7 nA 35 μ A/A + 40 nA 45 μ A/A + 0.7 μ A 80 μ A/A + 12 μ A	Multi-Function Calibrator
	Up to 330 μ A 330 μ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 3.3 A (3.3 to 11) A (11 to 20.5) A	120 μ A/A + 16 nA 78 μ A/A + 24 nA 78 μ A/A + 0.17 μ A 78 μ A/A + 1.7 μ A 160 μ A/A + 32 μ A 390 μ A/A + 270 μ A 780 μ A/A + 590 μ A	Multi-Product Calibrator
DC Current – Source ¹	(10 to 16.5) A (16.5 to 150) A (150 to 1 025) A	2.8 mA/A + 3.0 mA 2.8 mA/A + 25 mA 3 mA/A + 90 mA	Multi-Product Calibrator with 50 turn coil

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Measure ¹	0.01 fA to 2 pA (2 to 20) pA (20 to 200) pA 200 pA to 2 nA (2 to 20) nA (20 to 200) nA 200 nA to 2 µA (2 to 20) µA (20 to 200) µA 200 µA to 2 mA (2 to 20) mA	10 mA/A + 3 fA 5 mA/A + 3 fA 5 mA/A + 5 fA 2 mA/A + 300 fA 2 mA/A + 500 fA 2 mA/A + 5 pA 1 mA/A + 50 pA 0.5 mA/A + 500 pA 0.5 mA/A + 5 nA 0.5 mA/A + 50 nA 0.5 mA/A + 500 nA	Femto/Pico Ammeter
DC Current – Measure ¹	(0 to 100) nA (0.1 to 1) µA (1 to 10) µA (10 to 100) µA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	30 µA/A + 40 pA 20 µA/A + 40 pA 20 µA/A + 100 pA 20 µA/A + 0.80 nA 20 µA/A + 5.0 nA 20 µA/A + 50 nA 35 µA/A + 0.5 µA 110 µA/A + 10 µA	Multimeter
DC Current – Measure ¹	(0.4 to 2) A (2 to 20) A (20 to 100) A	31 µA/A + 0.58 µA 28 µA/A + 5.8 µA 42 µA/A + 58 µA	Shunt with Multimeter
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 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	95 µΩ/Ω 95 µΩ/Ω 23 µΩ/Ω 23 µΩ/Ω 10 µΩ/Ω 10 µΩ/Ω 8.5 µΩ/Ω 8.5 µΩ/Ω 8.5 µΩ/Ω 8.5 µΩ/Ω 11 µΩ/Ω 11 µΩ/Ω 20 µΩ/Ω 21 µΩ/Ω 40 µΩ/Ω 47 µΩ/Ω 100 µΩ/Ω	Multi-Function Calibrator

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ (Simulation)	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 (110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω (330 to 1 100) M Ω	31 $\mu\Omega/\Omega$ + 0.78 m Ω 23 $\mu\Omega/\Omega$ + 1.2 m Ω 22 $\mu\Omega/\Omega$ + 1.2 m Ω 22 $\mu\Omega/\Omega$ + 1.6 m Ω 22 $\mu\Omega/\Omega$ + 1.7 m Ω 22 $\mu\Omega/\Omega$ + 16 m Ω 22 $\mu\Omega/\Omega$ + 17 m Ω 22 $\mu\Omega/\Omega$ + 0.16 Ω 22 $\mu\Omega/\Omega$ + 0.17 Ω 25 $\mu\Omega/\Omega$ + 1.6 Ω 25 $\mu\Omega/\Omega$ + 1.7 Ω 47 $\mu\Omega/\Omega$ + 23 Ω 100 $\mu\Omega/\Omega$ + 39 Ω 190 $\mu\Omega/\Omega$ + 1.9 k Ω 390 $\mu\Omega/\Omega$ + 2.3 k Ω 2.3 m Ω/Ω + 78 k Ω 12 m Ω/Ω + 390 k Ω	Multi-Product Calibrator
Resistance – Source ¹ (Variable Artifact)	(10 to 100) M Ω 100 M Ω to 1 G Ω (1 to 10) G Ω (10 to 100) G Ω 100 G Ω to 1 T Ω (1 to 10) T Ω	0.37 m Ω/Ω + 0.39 Ω 1.2 m Ω/Ω 2.4 m Ω/Ω 6.8 m Ω/Ω 6.9 m Ω/Ω + 0.13 k Ω 38 m Ω/Ω	Decade Resistor
Resistance – Measure ¹	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	15 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 0.5 m Ω 10 $\mu\Omega/\Omega$ + 0.5 m Ω 10 $\mu\Omega/\Omega$ + 5 m Ω 10 $\mu\Omega/\Omega$ + 50 m Ω 15 $\mu\Omega/\Omega$ + 2 Ω 50 $\mu\Omega/\Omega$ + 0.1 k Ω 0.5 m Ω/Ω + 1 k Ω 5 m Ω/Ω + 10 k Ω	Multimeter
Oscilloscopes ¹ Horizontal Deflection (Time)	150 ps to 50 s	0.39 parts in 10 ⁶ of reading	Multi-Product Calibrator, Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Square Wave Amplitude $\leq$ 10 kHz into 50 Ω or 1 M Ω Load Impedance	Up to 1 mVp-p (1 to 21) mVp-p (21 to 556) mVp-p 556 mVp-p to 210 Vp-p	10 mV/V + 10 μ V 1.5 mV/V + 20 μ V 1.5 mV/V + 1.2 μ V 1.3 mV/V + 1.2 μ V	Oscilloscope Calibrator and Active Head

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes Vertical Deflection (Amplitude)	Up to 50 Vp-p (50 to 100) Vp-p (100 to 200) Vp-p	250 $\mu\text{V/V} + 25 \mu\text{V}$ 250 $\mu\text{V/V} + 26 \mu\text{V}$ 250 $\mu\text{V/V} + 63 \mu\text{V}$	Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Bandwidth	100 mHz to 26.5 GHz	2.1 % of reading	Oscilloscope Calibrator w/Active Head, Power Sensor
Oscilloscopes ¹ Rise/Fall Time, (10 to 90) %	Up to 1.25 s	1.3 ps	Oscilloscope Calibrator and Active Head
Capacitance – Source ¹ (Simulation) 50 Hz to 1 kHz	(0.19 to 3.3) nF (3.3 to 11) nF (11 to 110) nF (110 to 330) nF 330 nF to 1.1 μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF 330 μF to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	3.9 mF/F + 7.8 pF 1.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 230 pF 1.9 mF/F + 0.78 nF 1.9 mF/F + 2.3 nF 1.9 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.5 mF/F + 78 nF 3.5 mF/F + 230 nF 3.5 mF/F + 0.78 μF 3.5 mF/F + 2.3 μF 3.5 mF/F + 7.8 μF 5.8 mF/F + 23 μF 8.5 mF/F + 78 μF	Multi-Product Calibrator
Capacitance – Source ¹ (Fixed Artifacts) 1 kHz to 13 MHz	1 pF 10 pF 100 pF 1 000 pF	0.35 mF/F 0.35 mF/F 0.35 mF/F 0.35 mF/F	Standard Capacitors
Capacitance – Source ¹ (Variable Artifact) 120 Hz to 100 kHz	(10 to 100) pF 100 pF to 1 μF	0.53 mF/F 0.26 mF/F	Standard Capacitors
Capacitance – Measure ¹ 12 Hz to 100 kHz	0.1 pF to 1 000 μF	0.51 mF/F	RLC Digibridge
Inductance – Measure ¹ 12 Hz to 100 kHz	100 μH to 10 H	0.35 mH/H	RLC Digibridge
Inductance – Source ¹ (Fixed Artifacts) 1 kHz	1 mH 10 mH 100 mH 1 H 10 H	0.36 μH 3.6 μH 0.15 mH 0.29 mH 2.9 mH	Standard Inductors

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type B		Multi-Product Calibrator
	(600 to 800) °C	0.36 °C	
	(800 to 1 000) °C	0.29 °C	
	(1 000 to 1 550) °C	0.26 °C	
	(1 550 to 1 820) °C	0.28 °C	
	Type C		
	(0 to 150) °C	0.26 °C	
	(150 to 650) °C	0.23 °C	
	(650 to 1 000) °C	0.27 °C	
	(1 000 to 1 800) °C	0.4 °C	
	(1 800 to 2 316) °C	0.66 °C	
	Type E		
	(-250 to -100) °C	0.4 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 350) °C	0.16 °C	
	(350 to 650) °C	0.17 °C	
	(650 to 1 000) °C	0.2 °C	
	Type J		
	(-210 to -100) °C	0.24 °C	
	(-100 to -30) °C	0.17 °C	
	(-30 to 150) °C	0.16 °C	
	(150 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.21 °C	
	Type K		
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type R (0 to 250) °C	0.46 °C	Multi-Product Calibrator
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type S (0 to 250) °C	0.38 °C	
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	
	Type T (-250 to -150) °C	0.5 °C	
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U (-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	
Electrical Calibration of RTD Indicating Systems ¹	Cu 427, 10 Ω (-100 to 260) °C	0.23 °C	Multiproduct Calibrator
	Pt 385, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 3916, 100 Ω		Multiproduct Calibrator
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.031 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.039 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.062 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.085 °C	
	Pt 385, 1 k Ω		
	(-200 to -80) °C	0.023 °C	
	(-80 to 0) °C	0.023 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.054 °C	
	(400 to 600) °C	0.054 °C	
	(600 to 630) °C	0.18 °C	
	PtNi 385, 120 Ω (Ni120)		
	(-80 to 0) °C	0.062 °C	
	(0 to 100) °C	0.062 °C	
	(100 to 260) °C	0.11 °C	

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	220 μ V to 2.2 mV		Multi-Function Calibrator
	(10 to 20) Hz	240 μ V/V + 4 μ V	
	(20 to 40) Hz	90 μ V/V + 4 μ V	
	40 Hz to 20 kHz	80 μ V/V + 4 μ V	
	(20 to 50) kHz	200 μ V/V + 4 μ V	
	(50 to 100) kHz	500 μ V/V + 5 μ V	
	(100 to 300) kHz	1.1 mV/V + 10 μ V	
	(300 to 500) kHz	1.4 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 20 μ V	
	(2.2 to 22) mV		
	(10 to 20) Hz	240 μ V/V + 4 μ V	
	(20 to 40) Hz	90 μ V/V + 4 μ V	
	40 Hz to 20 kHz	80 μ V/V + 4 μ V	
	(20 to 50) kHz	200 μ V/V + 4 μ V	
	(50 to 100) kHz	500 μ V/V + 5 μ V	
	(100 to 300) kHz	1.1 mV/V + 10 μ V	
	(300 to 500) kHz	1.4 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 20 μ V	
	(22 to 220) mV		
	(10 to 20) Hz	240 μ V/V + 4 μ V	
	(20 to 40) Hz	90 μ V/V + 4 μ V	
	40 Hz to 20 kHz	80 μ V/V + 4 μ V	
	(20 to 50) kHz	200 μ V/V + 4 μ V	
	(50 to 100) kHz	500 μ V/V + 5 μ V	
	(100 to 300) kHz	1.1 mV/V + 10 μ V	
	(300 to 500) kHz	1.4 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 20 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	240 μ V/V + 12 μ V	
	(20 to 40) Hz	90 μ V/V + 7 μ V	
	40 Hz to 20 kHz	80 μ V/V + 7 μ V	
	(20 to 50) kHz	210 μ V/V + 7 μ V	
	(50 to 100) kHz	460 μ V/V + 17 μ V	
	(100 to 300) kHz	900 μ V/V + 20 μ V	
	(300 to 500) kHz	1.4 mV/V + 25 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 45 μ V	

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) V		Multi-Function Calibrator
	(10 to 20) Hz	240 $\mu\text{V/V}$ + 400 μV	
	(20 to 40) Hz	90 $\mu\text{V/V}$ + 150 μV	
	40 Hz to 20 kHz	45 $\mu\text{V/V}$ + 50 μV	
	(20 to 50) kHz	75 $\mu\text{V/V}$ + 100 μV	
	(50 to 100) kHz	100 $\mu\text{V/V}$ + 200 μV	
	(100 to 300) kHz	280 $\mu\text{V/V}$ + 600 μV	
	(300 to 500) kHz	1 mV/V + 2 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	240 $\mu\text{V/V}$ + 40 mV	
	(20 to 40) Hz	90 $\mu\text{V/V}$ + 1.5 mV	
	40 Hz to 20 kHz	52 $\mu\text{V/V}$ + 0.6 mV	
	(20 to 50) kHz	80 $\mu\text{V/V}$ + 1 mV	
	(50 to 100) kHz	150 $\mu\text{V/V}$ + 2.5 mV	
	(100 to 300) kHz	900 $\mu\text{V/V}$ + 16 mV	
	(300 to 500) kHz	4.4 mV/V + 40 mV	
	500 kHz to 1 MHz	8 mV/V + 80 mV	
AC Voltage – Measure ¹ (Absolute Measurement)	(220 to 1 100) V		AC Measurement Standard
	(15 to 50) Hz	300 $\mu\text{V/V}$ + 16 mV	
	50 Hz to 1 kHz	70 $\mu\text{V/V}$ + 3.5 mV	
	2.2 mV Range		
	(10 to 20) Hz	1.1 mV/V + 0.87 μV	
	(20 to 40) Hz	490 $\mu\text{V/V}$ + 0.87 μV	
	40 Hz to 20 kHz	280 $\mu\text{V/V}$ + 0.87 μV	
	(20 to 50) kHz	540 $\mu\text{V/V}$ + 1.3 μV	
	(50 to 100) kHz	800 $\mu\text{V/V}$ + 1.7 μV	
	(100 to 300) kHz	1.5 mV/V + 2.7 μV	
	(300 to 500) kHz	1.6 mV/V + 5.3 μV	
	500 kHz to 1 MHz	2.3 mV/V + 5.3 μV	
	7 mV Range		
	(10 to 20) Hz	570 $\mu\text{V/V}$ + 0.87 μV	
	(20 to 40) Hz	250 $\mu\text{V/V}$ + 0.87 μV	
	40 Hz to 20 kHz	140 $\mu\text{V/V}$ + 0.87 μV	
	(20 to 50) kHz	270 $\mu\text{V/V}$ + 1.3 μV	
	(50 to 100) kHz	400 $\mu\text{V/V}$ + 1.7 μV	
	(100 to 300) kHz	800 $\mu\text{V/V}$ + 2.7 μV	
	(300 to 500) kHz	870 $\mu\text{V/V}$ + 5.3 μV	
	500 kHz to 1 MHz	1.5 mV/V + 5.3 μV	

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	22 mV Range		AC Measurement Standard
	(10 to 20) Hz	190 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	(20 to 40) Hz	130 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	40 Hz to 20 kHz	73 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	(20 to 50) kHz	140 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	207 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	540 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	590 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	1.1 mV/V + 5.3 μV	
	70 mV Range		
	(10 to 20) Hz	160 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	80 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	43 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	87 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	170 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	340 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	450 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	730 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	220 mV Range		
	(10 to 20) Hz	140 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	57 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	25 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	46 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	110 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	170 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	250 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	670 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	700 mV Range		
	(10 to 20) Hz	140 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	51 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	22 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	34 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	53 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	120 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	200 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	640 $\mu\text{V/V} + 5.3 \mu\text{V}$	

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	2.2 V Range		AC Measurement Standard
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	44 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	16 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	31 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	47 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	110 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	170 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	600 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	7 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	16 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	32 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	54 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	130 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	270 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	22 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	18 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	32 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	54 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	270 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	70 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	21 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	38 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	63 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	270 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.58 \mu\text{V}$	

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Absolute Measurement)	220 V Range		AC Measurement Standard
	(10 to 20) Hz	130 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	21 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	46 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	65 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(100 to 300) kHz	140 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(300 to 500) kHz	330 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	700 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	66 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	27 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	87 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	330 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	1 000 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	66 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	25 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	87 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	330 $\mu\text{V/V} + 5.8 \mu\text{V}$	
AC Voltage – Measure ¹ (Relative Measurement)	2.2 mV Range		AC Measurement Standard
	(10 to 20) Hz	73 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	(20 to 40) Hz	43 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	40 Hz to 20 kHz	38 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	(20 to 50) kHz	45 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	57 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	150 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	480 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	1.7 mV/V + 5.3 μV	
	7 mV Range		
	(10 to 20) Hz	55 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	(20 to 40) Hz	26 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	40 Hz to 20 kHz	24 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	(20 to 50) kHz	29 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	38 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	87 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	300 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	1.3 mV/V + 5.3 μV	

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Relative Measurement)	22 mV Range		AC Measurement Standard
	(10 to 20) Hz	48 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	(20 to 40) Hz	27 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	40 Hz to 20 kHz	24 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	(20 to 50) kHz	30 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	38 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	73 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	250 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	1 mV/V + 5.3 μV	
	70 mV Range		
	(10 to 20) Hz	41 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	20 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	17 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	24 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	36 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	80 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	190 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	650 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	220 mV Range		
	(10 to 20) Hz	41 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	19 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	16 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	16 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	35 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	80 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	190 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	630 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	700 mV Range		
	(10 to 20) Hz	41 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	19 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	16 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	16 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	35 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	80 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	180 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	630 $\mu\text{V/V} + 5.3 \mu\text{V}$	

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Relative Measurement)	2.2 V Range		AC Measurement Standard
	(10 to 20) Hz	41 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	19 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	15 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	15 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	33 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	73 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	150 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	590 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	7 V Range		
	(10 to 20) Hz	41 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	19 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	15 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	17 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	43 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	100 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	250 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	22 V Range		
	(10 to 20) Hz	41 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	20 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	15 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	17 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	43 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	100 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	250 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	70 V Range		
	(10 to 20) Hz	41 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	21 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	17 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	18 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	45 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	100 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	260 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.58 \mu\text{V}$	

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ (Relative Measurement)	220 V Range		AC Measurement Standard
	(10 to 20) Hz	41 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	21 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	17 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	23 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	46 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(100 to 300) kHz	110 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(300 to 500) kHz	320 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	700 V Range		
	(10 to 20) Hz	42 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	22 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	17 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	73 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	330 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	1 000 V Range		
	(10 to 20) Hz	42 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	22 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	17 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	73 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	330 $\mu\text{V/V} + 5.8 \mu\text{V}$	
AC High Voltage – Measure ¹	(1 to 10) kV (50 to 60) Hz	1.8 mV/V	High Voltage Meter
AC Voltage Flatness – Measure ¹ (Relative to 1 kHz)	2.2 mV Range		AC Measurement Standard
	(10 to 30) Hz	0.67 mV/V + 0.058 μV	
	(30 to 120) Hz	0.33 mV/V + 0.058 μV	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.058 μV	
	(1.2 to 120) kHz	0.33 mV/V + 0.058 μV	
	(120 to 500) kHz	0.47 mV/V + 0.67 μV	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.67 μV	
	(1.2 to 2) MHz	0.47 mV/V + 0.67 μV	
	(2 to 10) MHz	1.1 mV/V + 0.67 μV	
	(10 to 20) MHz	2 mV/V + 0.67 μV	
	(20 to 30) MHz	4.7 mV/V + 1.3 μV	

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness – Measure ¹ (Relative to 1 kHz)	7 mV Range		AC Measurement Standard
	(10 to 30) Hz	0.67 mV/V + 0.058 μ V	
	(30 to 120) Hz	0.33 mV/V + 0.058 μ V	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.058 μ V	
	(1.2 to 120) kHz	0.33 mV/V + 0.058 μ V	
	(120 to 500) kHz	0.47 mV/V + 0.67 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.67 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.67 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.67 μ V	
	(10 to 20) MHz	1.1 mV/V + 0.67 μ V	
	(20 to 30) MHz	2.5 mV/V + 0.67 μ V	
	22 mV Range		
	(10 to 30) Hz	0.67 mV/V + 0.058 μ V	
	(30 to 120) Hz	0.33 mV/V + 0.058 μ V	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.058 μ V	
	(1.2 to 120) kHz	0.33 mV/V + 0.058 μ V	
	(120 to 500) kHz	0.47 mV/V + 0.058 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.058 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.058 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.058 μ V	
	(10 to 20) MHz	1.1 mV/V + 0.058 μ V	
	(20 to 30) MHz	2.5 mV/V + 0.058 μ V	
	70 mV Range		
	(10 to 30) Hz	0.67 mV/V + 0.58 μ V	
	(30 to 120) Hz	0.33 mV/V + 0.58 μ V	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 120) kHz	0.33 mV/V + 0.58 μ V	
	(120 to 500) kHz	0.33 mV/V + 0.58 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 0.58 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.58 μ V	
	(10 to 20) MHz	1 mV/V + 0.58 μ V	
	(20 to 30) MHz	2.3 mV/V + 0.58 μ V	

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness – Measure ¹ (Relative to 1 kHz)	220 mV Range		AC Measurement Standard
	(10 to 30) Hz	0.67 mV/V + 0.58 μ V	
	(30 to 120) Hz	0.27 mV/V + 0.58 μ V	
	120 Hz to 1.2 kHz	0.27 mV/V + 0.58 μ V	
	(1.2 to 120) kHz	0.27 mV/V + 0.58 μ V	
	(120 to 500) kHz	0.27 mV/V + 0.58 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 0.58 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.58 μ V	
	(10 to 20) MHz	1 mV/V + 0.58 μ V	
	(20 to 30) MHz	2.3 mV/V + 0.58 μ V	
	700 mV Range		
	(10 to 30) Hz	0.67 mV/V + 5.8 μ V	
	(30 to 120) Hz	0.2 mV/V + 5.8 μ V	
	120 Hz to 1.2 kHz	0.2 mV/V + 5.8 μ V	
	(1.2 to 120) kHz	0.2 mV/V + 5.8 μ V	
	(120 to 500) kHz	0.2 mV/V + 5.8 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 5.8 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 5.8 μ V	
	(2 to 10) MHz	0.67 mV/V + 5.8 μ V	
	(10 to 20) MHz	1 mV/V + 5.8 μ V	
	(20 to 30) MHz	2.3 mV/V + 5.8 μ V	
	2.2 V Range		
	(10 to 30) Hz	0.67 mV/V + 5.8 μ V	
	(30 to 120) Hz	0.2 mV/V + 5.8 μ V	
	120 Hz to 1.2 kHz	0.2 mV/V + 5.8 μ V	
	(1.2 to 120) kHz	0.2 mV/V + 5.8 μ V	
	(120 to 500) kHz	0.2 mV/V + 5.8 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 5.8 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 5.8 μ V	
	(2 to 10) MHz	0.67 mV/V + 5.8 μ V	
	(10 to 20) MHz	1 mV/V + 5.8 μ V	
	(20 to 30) MHz	2.3 mV/V + 5.8 μ V	

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness – Measure ¹ (Relative to 1 kHz)	7 V Range (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.67 mV/V + 5.8 μV 0.2 mV/V + 5.8 μV 0.2 mV/V + 5.8 μV 0.2 mV/V + 5.8 μV 0.2 mV/V + 5.8 μV 0.33 mV/V + 5.8 μV 0.33 mV/V + 5.8 μV 0.67 mV/V + 5.8 μV 1 mV/V + 5.8 μV 2.3 mV/V + 5.8 μV	AC Measurement Standard
AC Current – Measure ¹	Up to 100 μA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 100 μA to 1 mA (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 (50 to 100) kHz (1 to 10) mA (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 (50 to 100) kHz	4 mA/A + 0.03 μA 1.5 mA/A + 0.03 μA 0.6 mA/A + 0.03 μA 0.6 mA/A + 0.03 μA 4 mA/A + 0.2 μA 1.5 mA/A + 0.2 μA 0.6 mA/A + 0.0 μA 0.31 mA/A + 0.2 μA 0.6 mA/A + 0.2 μA 4 mA/A + 0.4 μA 5.5 mA/A + 1.5 μA 4 mA/A + 2 μA 1.5 mA/A + 2 μA 0.6 mA/A + 2 μA 0.31 mA/A + 2 μA 0.6 mA/A + 2 μA 4 mA/A + 4 μA 5.5 mA/A + 15 μA	Multimeter

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(10 to 100) mA (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 (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 mA/A + 20 μ A 1.5 mA/A + 20 μ A 0.6 mA/A + 20 μ A 0.31 mA/A + 20 μ A 0.6 mA/A + 20 μ A 4 mA/A + 40 μ A 5.5 mA/A + 150 μ A 4 mA/A + 200 mA 1.6 mA/A + 0.2 mA 0.8 mA/A + 0.2 mA 1 mA/A + 0.2 mA 3 mA/A + 0.2 mA 10 mA/A + 0.4 mA	Multimeter
AC Current – Measure ¹	Up to 10 A 5 Hz to 100 kHz (10 to 20) A 5 Hz to 100 kHz	0.2 mA/A + 0.58 μ A 0.2 mA/A + 0.58 μ A	Current Shunt with Multimeter, AC Measurement Standard
AC Current – Source ¹	220 μ A Range (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 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 (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	250 μ A/A + 16 nA 160 μ A/A + 10 nA 120 μ A/A + 8 nA 280 μ A/A + 12 nA 1.1 mA/A + 65 nA 250 μ A/A + 40 nA 160 μ A/A + 35 nA 120 μ A/A + 35 nA 200 μ A/A + 110 nA 1.1 mA/A + 650 nA 250 μ A/A + 400 nA 160 μ A/A + 350 nA 120 μ A/A + 350 nA 200 μ A/A + 550 nA 1.1 mA/A + 5 μ A	Multi-Function Calibrator

Electrical – DC/Low Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(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 1 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	250 μ A/A + 4 μ A 160 μ A/A + 3.5 μ A 120 μ A/A + 2.6 μ A 200 μ A/A + 3.5 μ A 1.1 mA/A + 10 μ A 260 μ A/A + 35 μ A 450 μ A/A + 80 μ A 7 mA/A + 160 μ A	Multi-Function Calibrator
AC Current – Source ¹	(1.1 to 3) A (10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (3 to 11) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (11 to 20.5) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	1.4 mA/A + 78 μ A 0.5 mA/A + 78 μ A 4.7 mA/A + 775 μ A 19 mA/A + 3.9 mA 0.5 mA/A + 1.6 mA 0.8 mA/A + 1.6 mA 23 mA/A + 1.6 mA 0.9 mA/A + 3.9 mA 1.2 mA/A + 3.9 mA 23 mA/A + 3.9 mA	Multi-Product Calibrator
AC Current – Source ¹	1.45 mA to 16.5 A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	3.3 mA/A + 3.5 mA 9.1 mA/A + 3.5 mA 3.3 mA/A + 29 mA 9.1 mA/A + 31 mA 3.4 mA/A + 100 mA 9.2 mA/A + 120 mA	Multi-Product Calibrator with 50-turn coil

Electrical – RF/Microwave

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned RF Power, Relative – Measure ¹ 100 kHz to 50 GHz	(20 to 30) dBm	0.068 dB	Measuring Receiver with Power Sensor
	(10 to 20) dBm	0.066 dB	
	(0 to 10) dBm	0.064 dB	
	0 dBm	0.063 dB	
	(-10 to 0) dBm	0.064 dB	
	(-20 to -10) dBm	0.066 dB	
	(-30 to -20) dBm	0.068 dB	
	(-40 to -30) dBm	0.071 dB	
	(-50 to -40) dBm	0.073 dB	
	(-60 to -50) dBm	0.076 dB	
	(-70 to -60) dBm	0.079 dB	
	(-80 to -70) dBm	0.083 dB	
	(-90 to -80) dBm	0.086 dB	
	(-100 to -90) dBm	0.09 dB	
	(-110 to -100) dBm	0.09 dB	
	(-120 to -110) dBm	0.13 dB	
	(-127 to -120) dBm	0.16 dB	
RF Power, Absolute – Measure ¹ 100 kHz to 50 GHz	(20 to 30) dBm	0.15 dB	Power Meter with Power Sensor
	(10 to 20) dBm	0.14 dB	
	(0 to 10) dBm	0.14 dB	
	0 dBm	0.14 dB	
	(-10 to 0) dBm	0.14 dB	
	(-20 to -10) dBm	0.14 dB	
	(-30 to -20) dBm	0.15 dB	
	(-40 to -30) dBm	0.15 dB	
	(-50 to -40) dBm	0.16 dB	
	(-60 to -50) dBm	0.16 dB	
	(-70 to -60) dBm	0.17 dB	
	(-80 to -70) dBm	0.17 dB	
	(-90 to -80) dBm	0.18 dB	
	(-100 to -90) dBm	0.18 dB	
	(-110 to -100) dBm	0.18 dB	
	(-120 to -110) dBm	0.23 dB	
	(-127 to -120) dBm	0.26 dB	

Electrical – RF/Microwave

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power, Absolute – Measure ¹	(-70 to 44) dBm 9 kHz to 10 MHz (10 to 100) MHz 100 MHz to 2 GHz (2 to 12.4) GHz (12.4 to 18) GHz (18 to 26.5) GHz (26.5 to 40) GHz (40 to 50) GHz	0.1 dB 0.054 dB 0.052 dB 0.056 dB 0.062 dB 0.069 dB 0.079 dB 0.085 dB	Power Meter with Power Sensor
RF Power – Source ¹	100 kHz to 2.6 GHz (-127 to 10) dBm 10 MHz to 2 GHz (10 to 13) dBm (-10 to 10) dBm (-60 to -10) dBm (-110 to -60) dBm (2 to 20) GHz (10 to 13) dBm (-10 to 10) dBm (-60 to -10) dBm (-110 to -60) dBm (20 to 26.5) GHz (-10 to 10) dBm (-60 to -10) dBm (-110 to -60) dBm	1.2 dB 1.2 dB 0.6 dB 0.9 dB 0.9 dB 1.3 dB 0.7 dB 1 dB 1.5 dB 0.9 dB 1.2 dB 1.7 dB	Signal Generator
Harmonic Distortion – Measure ¹	< -79 dB 30 Hz to 50 GHz	0.8 dB	Spectrum Analyzer
Amplitude Modulation – Measure ¹ AM Depth Accuracy 150 kHz to 10 MHz (Rate: 50 Hz to 10 kHz) (Rate: 20 Hz to 10 kHz) 10 MHz to 1.3 GHz (Rate: 50 Hz to 50 kHz) (Rate: 20 Hz to 100 kHz) (1.3 to 26.5) GHz (Rate: 50 Hz to 50 kHz) 10 MHz to 26.5 GHz (Rate: 20 Hz to 100 kHz)	Depth: (5 to 99) % Depth: (0 to 99) % Depth: (5 to 99) % Depth: (0 to 99) % Depth: (5 to 99) % Depth: (0 to 99) %	2 % of reading + 1 digit 3 % of reading + 1 digit 1 % of reading + 1 digit 3 % of reading + 1 digit 1.5 % of reading + 1 digit 3 % of reading + 1 digit	Measuring Receiver

Electrical – RF/Microwave

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹ Flatness 10 MHz to 26.5 GHz (Rate: 90 Hz to 10 kHz) FM Rejection (50 Hz to 3 kHz BW) 250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz) 10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz) Residual AM 250 kHz to 26.5 GHz	Depth: (20 to 80) % Deviations: < 5 kHz Deviations: < 50 kHz 50 Hz to 3 kHz BW	0.3 % of reading + 1 digit 0.2 % AM Depth 0.2 % AM Depth 0.01 % residual (rms)	Measuring Receiver
Frequency Modulation – Measure ¹ FM Deviation Accuracy 250 kHz to 10 MHz (Rate: 20 Hz to 10 kHz) 10 MHz to 1.3 GHz (Rate: 50 Hz to 100 kHz) (Rate: 20 Hz to 200 kHz) (1.3 to 26.5) GHz (Rate: 50 Hz to 100 kHz) (Rate: 20 Hz to 200 kHz) AM Rejection (50 Hz to 3 kHz BW) 150 kHz to 26.5 GHz (Rate: 400 Hz or 1 kHz) Residual FM (0 to 100) MHz 100 MHz to 1.3 GHz (1.3 to 6.2) GHz (6.2 to 12.4) GHz (12.4 to 18.6) GHz (18.6 to 26.5) GHz	Deviation: ≤ 40 kHz Deviation: ≤ 400 kHz Deviation: ≤ 400 kHz Deviation: ≤ 400 kHz Deviation: ≤ 400 kHz AM Depths: ≤ 50% 50 Hz to 3 kHz BW	2 % of reading + 1 digit 1 % of reading + 1 digit 5 % of reading + 1 digit 1 % of reading + 1 digit 5 % of reading + 1 digit 20 Hz (peak deviation) 1 Hz (rms) 8 Hz (rms) 17 Hz (rms) 33 Hz (rms) 49 Hz (rms) 65 Hz (rms)	Measuring Receiver
Phase Modulation – Measure ¹ PM Deviation Accuracy 150 kHz to 10 MHz 10 MHz to 1.3 GHz (1.3 to 26.5) GHz	Rate: 200 Hz to 20 kHz	4 % of reading + 1 digit 3 % of reading + 1 digit 3 % of reading + 1 digit	Measuring Receiver

Length – Dimensional Metrology

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 1 000 mm	$(0.17 + 0.006\ 8l)\ \mu\text{m} + 0.58R$	Gage Blocks
Height Gages ^{1,2}	Up to 1 000 mm	$(0.71 + 0.0015l)\ \mu\text{m} + 0.58R$	Gage Blocks, Surface Plate
Indicators, Dial Gauge, Dial Test Indicator, LVDTs ^{1,2}	Up to 100 mm	$(0.32 + 0.004\ 6l)\ \mu\text{m} + 0.58R$	Indicator Tester
Indicators, Dial Gauge, Dial Test Indicator, LVDTs ^{1,2}	Up to 100 mm	$(0.069 + 0.002\ 6l)\ \mu\text{m} + 0.58R$	Gage Blocks, Comparator Stand
Micrometer ^{1,2} External, Internal, Depth, Bore and Micrometer Head	Up to 1 050 mm	$(0.088 + 0.006\ 9l)\ \mu\text{m} + 0.58R$	Gage Blocks

Mass and Mass Related

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Tools ¹	(0.15 to 10) Nm (10 to 400) Nm	0.06 % of reading 0.63 % of reading	Torque System
Pressure / Vacuum ^{1,2} Transducers, Transmitters (Gage, Absolute, Differential)	(-13.5 to < 0) psi (> 0 to 500) psi	0.053 % of reading + 0.58R 0.022 % of reading + 0.58R	Pressure Calibrator & Process Calibrator
Scales and Balances ^{1,3}	Up to 5 mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g 10 g to 10 kg	10 μg 13 μg 16 μg 21 μg 26 μg 31 μg 41 μg 51 μg 62 μg 82 μg 0.11 mg 2.8 $\mu\text{g/g} + 15\mu\text{g}$	OIML Class F1 and internal calibration procedure utilized in the calibration of the weighing system.
Scales and Balances ^{1,3}	(10 to 120) kg	7.9 $\mu\text{g/g}$	OIML Class F2 and internal calibration procedure utilized in the calibration of the weighing system.

Mass and Mass Related

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass Determination (SI)	1 mg	10 µg	Standard Weights, Balance
	2 mg	10 µg	
	5 mg	10 µg	
	10 mg	13 µg	
	20 mg	15 µg	
	50 mg	20 µg	
	100 mg	25 µg	
	200 mg	31 µg	
	500 mg	41 µg	
	1 g	50 µg	
	2 g	50 µg	
	5 g	60 µg	
	10 g	80 µg	
	20 g	100 µg	
	50 g	160 µg	
	100 g	200 µg	
	200 g	400 µg	
	500 g	1.5 mg	
	1 kg	2.7 mg	
	2 kg	5.2 mg	
	5 kg	13 mg	

Photometry and Radiometry

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power – Source/Measure ¹	(750 to 1 800) nm (-80 to 10) dBm	0.11 dB	Optical Test System
Optical Wavelength – Source/Measure ¹	(700 to 1 650) nm	3.8×10^{-6} nm/nm	Optical Test System with Wavelength Meter

Thermodynamic

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity Measuring Equipment ¹	(10 to 33) %RH	1.5 %RH	Comparison to Master Hygrometer
	(33 to 75) %RH	1.7 %RH	
	(75 to 95) %RH	2.5 %RH	

Thermodynamic

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Measure & Measuring Equipment ¹	(-70 to 0) °C 0 °C (0 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 650) °C (650 to 1 100)	0.034 °C 0.032 °C 0.036 °C 0.042 °C 0.35 °C 0.4 °C 0.63 °C	Thermometer and Temperature Calibrator
Temperature Chambers System Calibration and Profiling ¹	(-70 to 0) °C (0 to 300) °C	0.16 °C 0.17 °C	Datalogger with RTD sensors or Thermocouple sensors
Humidity Chambers System Calibration and Profiling ¹	(10 to 33) %RH (33 to 75) %RH (75 to 95) %RH	1.5 %RH 1.7 %RH 2.5 %RH	Humidity Indicator w/Probe, Humidity Calibrator
Temperature Chambers System Calibration and Profiling ¹	(-40 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 300) °C	0.32 °C 0.33 °C 0.38 °C 0.43 °C	Datalogger w/RTD sensors and Datalogger w/Thermocouple sensors

Time and Frequency

Hsinchu City, Taiwan.

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	10 Hz to 50 GHz	6.1×10^{-11} Hz/Hz	GPS Receiver, Universal Counter
Frequency Measuring Equipment ¹	1 MHz 10 MHz 10 mHz to 50 GHz	5×10^{-12} Hz/Hz 6.2×10^{-12} Hz/Hz	GPS Receiver, Signal Generator
Time Interval – Measure ¹	2 ps to 1 s	0.13 % of reading + 0.063 ps	Digital Oscilloscope

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

Micro Precision Calibration

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CALIBRATION

Electrical – DC/Low Frequency

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Voltage – Generate	Up to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	10 μ V/V + 0.5 μ V 6 μ V/V + 0.8 μ V 4 μ V/V + 3 μ V 4 μ V/V + 4.5 μ V 4 μ V/V + 4 μ V 4 μ V/V + 5 μ V	Multiproduct Calibrator
DC Voltage – Measure ¹	Up to 100 mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1 000) V	6.1 μ V/V + 0.3 μ V 5 μ V/V + 0.3 μ V 5 μ V/V + 0.5 μ V 7.3 μ V/V + 30 μ V 26 μ V/V + 100 μ V	Multimeter
DC High Voltage – Measure ¹	(1 to 10) kV (10 to 20) kV (21 to 70) kV	0.1 % of reading + 4 V 0.3 % of reading 0.6 % of reading	High Voltage Meter
DC Current – Generate ¹	Up to 220 μ A 220 μ A to 22 mA (22 to 220) mA 220 mA to 2.2 A	41 nA/A + 7 nA 34 nA/A + 8 nA 34 nA/A + 45 nA 46 nA/A + 0.8 μ A	Multiproduct Calibrator
	(2.2 to 11) A (1 to 500) A	82 nA/A + 13 μ A 0.26 % of reading	Multiproduct Calibrator w/ 50 turn coil
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 10 mA	16 μ A/A + 0.075 nA 29 μ A/A + 0.061 nA 22 μ A/A + 0.13 nA 24 μ A/A + 0.083 nA 24 μ A/A + 0.16 nA	Multimeter
DC Current – Measure ¹	(10 to 100) mA 100 mA to 1 A	43 μ A/A + 0.20 μ A 0.14 mA/A + 10 μ A	Multimeter
High DC Current – Measure ¹	(1 to 100) A	0.04% of reading	Shunt w/ Multimeter

Electrical – DC/Low Frequency

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance – Generate ¹ (Simulation)	Up to 11 Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 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 (110 to 330) k Ω 0.33 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω 330 M Ω to 1.1 G Ω	0.12 % of reading + 0.008 Ω 0.17 % of reading 0.018 % of reading 0.024 % of reading 0.009 % of reading + 0.06 Ω 0.024 % of reading 0.009 % of reading + 0.6 Ω 0.012 % of reading 0.011 % of reading + 6 Ω 0.013 % of reading 0.015 % of reading + 55 Ω 0.019 % of reading 0.016 % of reading 0.041 % of reading 0.058 % of reading 0.37 % of reading 1.8 % of reading	Multiproduct Calibrator
Resistance – Generate ¹ (Fixed Points)	1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	0.009 1 % of reading 0.002 4 % of reading 0.002 4 % of reading 0.001 % of reading 0.001 % of reading 0.000 85 % of reading 0.000 85 % of reading 0.000 85 % of reading 0.000 85 % of reading 0.001 % of reading 0.001 % of reading 0.001 8 % of reading 0.001 8 % of reading 0.003 7 % of reading 0.004 6 % of reading 0.01 % of reading	Multiproduct Calibrator
Resistance – Measure ¹	(1 to 10) Ω (10 to 100) Ω 100 Ω to 100 k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	19 $\mu\Omega/\Omega$ + 60 $\mu\Omega$ 15 $\mu\Omega/\Omega$ + 0.6 m Ω 13 $\mu\Omega/\Omega$ + 0.6 m Ω 18 $\mu\Omega/\Omega$ + 2.4 Ω 59 $\mu\Omega/\Omega$ + 0.12 k Ω 0.057 % of reading + 1.1 k Ω 0.057 % of reading + 11 k Ω	Multimeter

Electrical – DC/Low Frequency

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Capacitance – Generate ¹ (Simulation)	(0.33 to 0.49) nF (0.50 to 1.09) nF (1.10 to 3.29) nF (3.30 to 10.9) nF (11.0 to 32.9) nF (33 to 109.9) μ F (110 to 329.9) μ F (0.33 to 1.09) μ F (1.10 to 3.29) μ F	3.3 % of reading 1.4 % of reading 0.73 % of reading 0.51 % of reading 0.54 % of reading 0.32 % of reading 0.32 % of reading 0.29 % of reading 0.37 % of reading	Multiproduct Calibrator
Inductance – Generate ¹ (Fixed Artifacts) 1 kHz	5 mH 100 mH 1 H	0.059 % of reading 0.062 % of reading 0.082 % of reading	Standard Inductors
Electrical Calibration of Thermocouple Indicators ¹	Type E (-250 to -100) °C (-100 to 650) °C (650 to 1 000) °C Type J (-210 to -100) °C (-100 to 760) °C (760 to 1 200) °C Type K (-200 to -100) °C (-100 to 120) °C (120 to 1 000) °C (1 000 to 1 372) °C Type S (0 to 250) °C (250 to 1 400) °C (1 400 to 1 767) °C Type T (-250 to -150) °C (-150 to 0) °C (0 to 400) °C	0.57 °C 0.18 °C 0.24 °C 0.31 °C 0.19 °C 0.26 °C 0.37 °C 0.18 °C 0.29 °C 0.46 °C 0.53 °C 0.42 °C 0.52 °C 0.71 °C 0.27 °C 0.16 °C	Multiproduct Calibrator
Electrical Simulation of RTD Indicating Systems ¹	Cu 427, 10 Ω (-100 to 260) °C	0.23 °C	Multiproduct Calibrator

Electrical – DC/Low Frequency

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Simulation of RTD Indicating Systems ¹	Pt 385, 100 Ω		Multiproduct Calibrator
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.031 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	

Electrical – DC/Low Frequency

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Simulation of RTD Indicating Systems ¹	Pt 385, 500 Ω		Multiproduct Calibrator
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.039 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.062 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.085 °C	
	Pt 385, 1 k Ω		
	(-200 to -80) °C	0.023 °C	
	(-80 to 0) °C	0.023 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.054 °C	
AC Voltage – Generate ¹	(400 to 600) °C	0.054 °C	Multiproduct Calibrator
	(600 to 630) °C	0.18 °C	
	Pt Ni 385, 120 Ω (Ni 120)		
	(-80 to 0) °C	0.062 °C	
	(0 to 100) °C	0.062 °C	
	(100 to 260) °C	0.11 °C	
AC Voltage – Generate ¹	Up to 220 mV		Multiproduct Calibrator
	(10 to 20) Hz	0.055 % of reading + 13 μ V	
	(20 to 40) Hz	0.021 % of reading + 8 μ V	
	40 Hz to 20 kHz	0.011 % of reading + 8 μ V	
	(20 to 50) kHz	0.037 % of reading + 8 μ V	
	(50 to 100) kHz	0.085 % of reading + 25 μ V	
	100 kHz to 1 MHz	0.34 % of reading + 80 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.05 % of reading + 80 μ V	
	(20 to 40) Hz	0.016 % of reading + 25 μ V	
	40 Hz to 20 kHz	75 μ V/V + 6 μ V	
	(20 to 50) kHz	0.012 % of reading + 16 μ V	
	(50 to 100) kHz	0.025 % of reading + 70 μ V	
	100 kHz to 1 MHz	0.22 % of reading + 0.85 mV	

Electrical – DC/Low Frequency

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Generate ¹	(2.2 to 22) V		Multiproduct Calibrator
	(10 to 20) Hz	0.05 % of reading + 0.8 mV	
	(20 to 40) Hz	0.016 % of reading + 0.25 mV	
	40 Hz to 20 kHz	75 μ V/V + 0.06 mV	
	(20 to 50) kHz	0.012 % of reading + 0.16 mV	
	(50 to 100) kHz	0.025 % of reading + 0.35 mV	
	100 kHz to 1 MHz	0.34 % of reading + 8.5 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.05 % of reading + 8 mV	
	(20 to 40) Hz	0.016 % of reading + 2.5 mV	
	40 Hz to 20 kHz	80 μ V/V + 0.8 mV	
	(20 to 50) kHz	0.022 % of reading + 3.5 mV	
	(50 to 100) kHz	0.05 % of reading + 8 mV	
	100 kHz to 1 MHz	0.27 % of reading + 190 mV	
	(220 to 750) V		
	(10 to 20) Hz	0.05 % of reading + 8 mV	
	(20 to 40) Hz	0.016 % of reading + 2.5 mV	
	40 Hz to 20 kHz	80 μ V/V + 0.8 mV	
AC Voltage – Measure ¹	(20 to 50) kHz	0.022 % of reading + 3.5 mV	Multimeter
	(50 to 100) kHz	0.05 % of reading + 8 mV	
	100 kHz to 300 kHz	0.2 % of reading + 90 mV	
	(220 to 1 100) V		
	(15 to 50) Hz	0.04 % of reading + 16 mV	
	50 Hz to 1 kHz	90 μ V/V + 4 mV	
	Up to 10 mV		
	(1 to 40) Hz	0.03 % of reading + 3 μ V	
	40 Hz to 1 kHz	0.02 % of reading + 2 μ V	
	(1 to 20) kHz	0.03 % of reading + 2 μ V	
	(20 to 50) kHz	0.12 % of reading + 2 μ V	
	(50 to 100) kHz	0.58 % of reading + 2 μ V	
	(100 to 300) kHz	4.6 % of reading + 2 μ V	
	10 mV to 10 V		
	(1 to 40) Hz	80 μ V/V + 0.4 mV	
	40 Hz to 1 kHz	80 μ V/V + 0.2 mV	
	(1 to 20) kHz	0.02 % of reading + 0.2 mV	
	(20 to 50) kHz	0.03 % of reading + 0.2 mV	
	(50 to 100) kHz	0.09 % of reading + 0.2 mV	
	(100 to 300) kHz	0.35 % of reading + 1 mV	
	300 kHz to 1 MHz	1.2 % of reading + 1 mV	
	(1 to 2) MHz	1.7 % of reading + 1 mV	

Electrical – DC/Low Frequency

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Measure ¹	(10 to 100) V (1 to 40) Hz 40 Hz to 1 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	0.02 % of reading + 4 mV 0.02 % of reading + 2 mV 0.04 % of reading + 2 mV 0.14 % of reading + 2 mV 0.46 % of reading + 10 mV 1.7 % of reading + 10 mV 0.05 % of reading + 40 mV 0.05 % of reading + 20 mV 0.07 % of reading + 20 mV 0.14 % of reading + 20 mV 0.35 % of reading + 20 mV	Multimeter in synchronous sub-sampled mode
AC Voltage – Measure ¹ (50 to 60) Hz	(1 to 10) kV (10 to 50) kV	0.2 % of reading + 0.025 kV 0.6 % of reading + 0.11 kV	High Voltage Meter
AC Current – Generate ¹ 40 Hz to 1 kHz	(1 to 220) μ A 220 μ A to 22 mA (22 to 220) mA 220 mA to 2.2 A	0.026 % of reading + 9.1 nA 0.023 % of reading + 400 nA 0.024 % of reading + 2.8 μ A 0.038 % of reading + 40 μ A	Multiproduct Calibrator
AC Current – Generate ¹	(2.2 to 11) A 45 Hz to 65Hz 65 Hz to 500Hz 500 Hz to 1kHz	0.097 % of reading + 2 000 μ A 0.15 % of reading + 2 000 μ A 0.43 % of reading + 2 000 μ A	Multiproduct Calibrator
AC Current – Generate ¹ (50 to 70) Hz	(1 to 500) A	0.26 % of reading	Multiproduct Calibrator w/50 turn coil

Electrical – DC/Low Frequency

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current – Measure ¹	Up to 100 μ A (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz 100 μ A to 1 mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (1 to 10) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (10 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % of reading + 0.03 μ A 0.18 % of reading + 0.03 μ A 0.068 % of reading + 0.03 μ A 0.46 % of reading + 0.23 μ A 0.17 % of reading + 0.23 μ A 0.069 % of reading + 0.23 μ A 0.035 % of reading + 0.23 μ A 0.46 % of reading + 2.3 μ A 0.17 % of reading + 2.3 μ A 0.069 % of reading + 2.3 μ A 0.035 % of reading + 2.3 μ A 0.46 % of reading + 23 μ A 0.17 % of reading + 23 μ A 0.069 % of reading + 23 μ A 0.035 % of reading + 23 μ A 0.46 % of reading + 200 μ A 0.19 % of reading + 200 μ A 0.1 % of reading + 200 μ A 0.12 % of reading + 200 μ A	Multimeter
AC Current – Measure ¹	(1 to 100) A (50 to 400) Hz	2.6 % of reading	Shunt monitored w/ Multimeter
Oscilloscope ¹ Level Sine Amplitude	5 mVp-p to 5 Vp-p 50 kHz Reference 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	2 % of reading + 300 μ V 3.5 % of reading + 300 μ V 4 % of reading + 300 μ V 6 % of reading + 300 μ V	Oscilloscope Calibrator
Level Sine Flatness Relative to 50 kHz Reference	5 mVp-p to 5.5 Vp-p 50 kHz to 100 MHz (100 to 300) MHz (300 to 600) MHz	1.6 % of reading + 100 μ V 2 % of reading + 100 μ V 4 % of reading + 100 μ V	

Electrical – DC/Low Frequency

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Oscilloscope ¹ Square Wave into 1 M Ω load into 50 Ω load Time Markers into 50 Ω load Pulse Rise Time	10 Hz to 10 kHz 1 mVp-p to 260 Vp-p 1 mVp-p to 13.2 Vp-p 2 ns to 20 ms 50 ms to 5 s 0.5 V, 1 Vp-p 10 MHz 1 MHz	0.06 % of reading + 5 μ V 0.25 % of reading + 40 μ V 0.33 parts in 10 ⁶ s 2.5 parts in 10 ⁶ s + 5 μ Hz 100 ps 100 ps	Oscilloscope Calibrator
Oscilloscope ¹ Bandwidth	Up to 6 Vp-p 50 kHz to 300 MHz (2 to 50) GHz	72 mV 0.09 % of reading	Power Sensors

Electrical - RF/Microwave

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Tuned Power, Relative – Measure ¹ (2.5 MHz to 26.5 GHz)	(-10 to 0) dB (-20 to -10) dB (-40 to -10) dB (-50 to -40) dB (-80 to -50) dB (-90 to -80) dB (-110 to -90) dB (-127 to -110) dB	0.06 dB 0.08 dB 0.11 dB 0.14 dB 0.2 dB 0.26 dB 0.3 dB 0.4 dB	Measuring Receiver, Power Sensor
RF Power Absolute RF – Measure ¹ 100 kHz to 4.2 GHz 10 MHz to 18 GHz 10 MHz to 18 GHz 10 MHz to 26.5 GHz 10 MHz to 50 GHz	(-30 to 20) dBm (-70 to -20) dBm (-30 to 20) dBm (-30 to 20) dBm (-30 to 20) dBm	0.06 dB 0.09 dB 0.06 dB 0.07 dB 0.08 dB	Power Meter or Measuring Receiver, w/ Power Sensor

Electrical - RF/Microwave

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Power – Generate ¹	(-127 to 13) dBm 10 kHz to 20 MHz 20 MHz to 2 GHz (-110 to 10) dBm (2 to 20) GHz (20 to 50) GHz	1.2 dB 1.2 dB 1.3 dB 1.9 dB	Signal Generator
Amplitude Modulation – Measure ¹ 150 kHz to 10 MHz	Depth: (5 to 99) % Rate: 50 Hz to 10 kHz Rate: 20 Hz to 100 kHz	2.5 % Depth 3.6 % Depth	Measuring Receiver
Amplitude Modulation – Measure ¹ 10 MHz to 1300 MHz (1.3 to 26.5) GHz	Depth: (5 to 99) % Rate: 50 Hz to 50 kHz Rate: 20 Hz to 100 kHz Depth: (5 to 99) % Rate: 20 Hz to 100 kHz	1.6 % Depth 3.6 % Depth 3.7 % Depth	Measuring Receiver, Power Sensor
Frequency Modulation – Measure ¹ 50 Hz to 10 kHz 50 Hz to 100 kHz 20 Hz to 200 kHz	Rate: 250 kHz to 10 MHz Dev: ≤ 40 kHz Rate: 10 MHz to 1.3 GHz Dev: ≤ 400 kHz	2.5 % Deviation 7.7 % Deviation 1.8 % Deviation	Measuring Receiver
Frequency Modulation – Measure ¹ 20 Hz to 100 kHz 50 Hz to 100 kHz	(0.2 to ≤ 100) % Deviation Rate: (1.3 to 26.5) GHz	7.7 % Deviation 1.8 % Deviation	Measuring Receiver, Power Sensor
Harmonic Measurements ¹ 30 Hz to 50 GHz	(-90 to 0) dB	1.5 dB	Spectrum Analyzer
Phase Modulation ¹ Rate: 200 Hz to 20 kHz	(0.2 to ≤ 100) % Deviation 10 MHz to 1.3 GHz	3.6 % Deviation	Measuring Receiver
Phase Modulation ¹ Rate: 200 Hz to 20 kHz	(0.2 to ≤ 100) % Deviation (1.3 to 26.5) GHz	4.3 % Deviation	Measuring Receiver, Power Sensor
Distortion – Measure ¹ (50 to 500) kHz (50 to 500) kHz	(0 to 99.9) dB 20 Hz to 20 kHz (20 to 100) kHz	1.3 dB 2.4 dB	Audio Analyzer

Length – Dimensional Metrology

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Calipers ^{1,2}	Up to 48 in	$(6.4 + 6.8L) \mu\text{in} + 0.58R$	Gage Blocks
Height Gages ^{1,2}	Up to 48 in	$(28 + 1.8L) \mu\text{in} + 0.58R$	Gage blocks, surface plate
Plain External Diameter ^{1,2} (Cylindrical and Taper)	(0.001 to 12) in	$(12 + 1.6L) \mu\text{in}$	Universal Length Measuring Machine, High-Accuracy Micrometer, Gage Blocks
Plain Internal Diameter ² (Cylindrical and Taper)	(0.04 to 12) in	$(13 + 2.2L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks, Master Ring Gage
Thread Plug Gages ² (Cylindrical and Taper) Simple Pitch Diameter	(0.04 to 12) in	$(44 + 2.6L) \mu\text{in}$	Universal length measuring machine and thread wires
Major Diameter	(0.04 to 12) in	$(14 + 1.2L) \mu\text{in}$	
Thread Ring Gages ² (Cylindrical and Taper) Simple Pitch Diameter	(0.112 to 12) in	$(59 + 0.48L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks, Master Thread Plug Set
Minor Diameter	(0.112 to 12) in	$(15 + 1.2L) \mu\text{in}$	
Indicators Dial Gauge, Dial Test Indicator, LVDTs ¹	Up to 4 in	$(12 + 4.6L) \mu\text{in} + 0.58R$	Universal Length Measuring Machine, Indicator Tester
	Up to 4 in	$(2.6 + 2.5L) \mu\text{in} + 0.58R$	Gage Block, Comparator Stand
End Measuring Rods	Up to 20 in	$(18 + 2.2L) \mu\text{in}$	Universal length measuring machine, Gage Blocks
Micrometers ^{1,2} Length External, Internal, Depth, Bore and Micrometer Head	Up to 48 in	$(3.6 + 6.8L) \mu\text{in} + 0.58R$	Gage blocks
Optical Comparators and Vision Systems/Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 20 in	$(19 + 1.9L) \mu\text{in}$	Gage Blocks
Gage Blocks ²	(0.05 to 4) in	$(6.3 + 0.65L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
	(4 to 20) in	$(4.3 + 1L) \mu\text{in}$	
Universal Length Measuring Machine, Linear Measurement ^{1,2}	Up to 24 in	$(3.3 + 2L) \mu\text{in}$	Gage Blocks

Length – Dimensional Metrology

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Thickness Gauge / Feeler Gauge ^{1,2}	(0.001 to 1) in	$(12 + 0.17L) \mu\text{in}$	Universal Length Measuring Machine, High-Accuracy Micrometer, Gage Block
Snap Gages ² (External / Internal)	(0.001 to 24) in	$(12 + 1.6L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Spherical Diameter, Standard Ball, Steel Ball ²	(0.001 to 4) in	$(10 + 1.2L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Inspection Fixtures 1D Features ² Riser Blocks, Length Bars, Step Height	Up to 48 in	$(7.6 + 0.84L) \mu\text{in}$	Universal Length Measuring Machine, Electric Comparator, Gage Blocks, Profile Projector, Granite Surface Plate
Inspection Fixtures 2D Features ² Angle Block, V-Blocks, Straight Edges Parallel Bars, Sine Bar, Sine Plate, Machine Squares, Precision Squares Radius Gauge, Chamfer Gauge, Taper Gauge Attribute Gauges – Go/No-Go Dedicated Fixture Gauges	Up to 48 in	$(7.6 + 0.84L) \mu\text{in}$	Universal Length Measuring Machine, Electric Comparator, Gage Blocks, Granite Surface Plate, Hand Tools, Profile Projector, Electronic Inclinator, Cylindrical Square, Sine Bar

Mass and Mass Related

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Torque Tools ¹	(4 to 400) ozf·in (0.5 to 50) lbf·in (1.5 to 150) lbf·in (4 to 400) lbf·in (6 to 600) lbf·ft	0.83 % of reading 0.92 % of reading 0.7 % of reading 0.66 % of reading 0.68 % of reading	Torque System

Mass and Mass Related

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Scales and Balances ^{1,3}	Up to 500 mg 500 mg to 200 g (200 to 1 000) g (1 000 to 5 000) g (5 to 20) kg	4 µg 0.07 mg 0.8 mg 2 mg 4 mg	Class 1 weights, Class 2 weights
Scales and Balances ^{1,3}	Up to 50 lb (50 to 100) lb (100 to 500) lb (500 to 1 000) lb	0.003 2 lb 0.006 4 lb 0.034 lb 0.066 lb	Class F weights
Pressure – Measuring Equipment ¹	(-15 to -0.001) psi (0.001 to 100) psi (100 to 1 000) psi (1 000 to 10 000) psi	0.1 % of reading 0.1 % of reading 0.09 % of reading 0.15 % of reading	Pressure Transducers
Pressure – Measuring Equipment ¹	(-7 to -0.000 1) in H ₂ O (0.000 1 to 7) in H ₂ O (0.000 1 to 30) psi (30 to 200) psi (201 to 600) psi (601 to 1 500) psi (1 501 to 3 000) psi	0.01 % of reading 0.01 % of reading 0.0042 % of reading 0.04 % of reading 0.06 % of reading 0.043 % of reading 0.032 % of reading	Pressure Indicators
Force – Compression and Tension	(0.01 to 500) lbf	0.83 % of reading	Class F weights with stand
Air Flow ¹	(0.001 to 150) l/min	0.9 % of reading	Standard Flow Sensors

Thermodynamic

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Humidity – Measuring Equipment ¹	(10 to 95) %RH	1 % RH	Comparison to Humidity Indicator w/Probe
Temperature – Measuring Equipment	(-200 to 660) °C	0.043 °C	Comparison to SPRT Probe

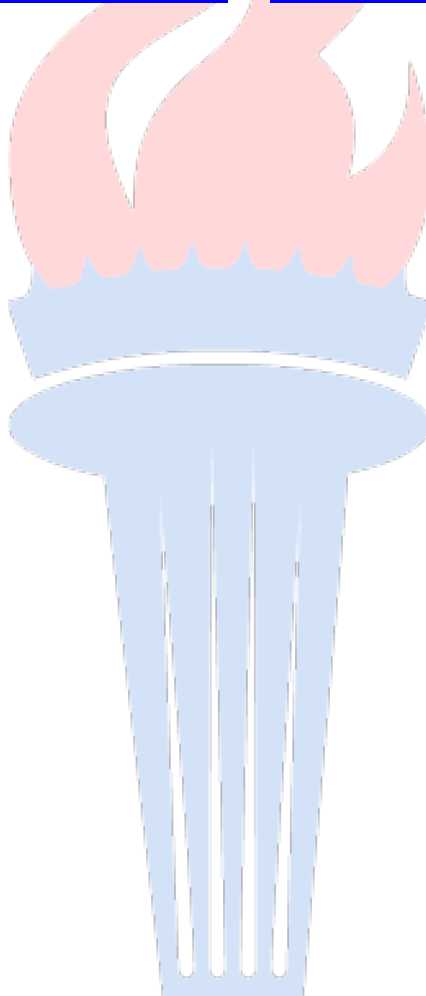
Time and Frequency

Thonotosassa, FL

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency Sources	0.1 Hz to 225 MHz	2.3×10^{-11} Hz/Hz	GPS Receiver, Counter
Frequency Sources	225 MHz to 50 GHz	6.3×10^{-10} Hz/Hz	Counter, Spectrum Analyzer, GPS 10 MHz
Frequency Measuring Equipment ¹	0.01 Hz to 10 MHz 10 MHz to 50 GHz	5.7×10^{-11} Hz/Hz 1.1×10^{-11} Hz/Hz	GPS Receiver, Signal Generator
Frequency Measuring Equipment ¹	10 MHz	6×10^{-12} Hz/Hz	GPS Receiver

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)



Services performed at satellite laboratory

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CALIBRATION

Acoustics and Vibration

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Sound Pressure Level ¹ (125 to 2 000) Hz (2 000 to 4 000) Hz (125 to 4 000) Hz	114 dB 114 dB (74 to 114) dB SPL	0.2 dB 0.31 dB 0.45 dB	Sound calibrator Sound meter Electronic counter

Chemical Quantities

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Conductivity Meters ^{1,4}	2 µS/cm 10 µS/cm 100 µS/cm 1 410 µS/cm 10 000 µS/cm	0.15 µS/cm 0.17 µS/cm 0.8 µS/cm 5.1 µS/cm 34 µS/cm	Standard Conductivity Solutions
pH Meters ^{1,4}	4 pH 7 pH 10 pH	0.016 pH 0.016 pH 0.016 pH	Standard pH Solutions

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Voltage – Source ¹ Fixed Values	1.018V 10 V	1.9 µV/V 1.3 µV/V	DC Reference Standard

Electrical – DC/Low Frequency

Nijmegen, Netherlands

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 μ V/V + 0.48 μ V 3.5 μ V/V + 0.81 μ V 2.5 μ V/V + 4.2 μ V 2.5 μ V/V + 5.1 μ V 3.5 μ V/V + 62 μ V 4.5 μ V/V + 500 μ V	Multiproduct Calibrator
DC Voltage – Measure	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	3.5 μ V/V + 0.3 μ V 3.1 μ V/V + 0.3 μ V 2.6 μ V/V + 0.54 μ V 4.5 μ V/V + 30 μ V 4.5 μ V/V + 0.1 mV	Multimeter
DC Voltage – Measure	(1 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	1.6 μ V/V 1.5 μ V/V 1.5 μ V/V 1.7 μ V/V 2 μ V/V	DC Reference Standard, Multiproduct Calibrator
DC Voltage – Measure High Voltage ¹	(0.1 to 10) kV (10 to 30) kV	0.4 mV/V + 0.42 V 0.1 % of reading	High Voltage Meter
DC Current – Source ¹	Up to 2 pA (2 to 20) pA (20 to 200) pA 200 pA to 2 nA (2 to 20) nA (20 to 200) nA 200 nA to 2 μ A (2 to 20) μ A (20 to 200) μ A 200 μ A to 2 mA (2 to 20) mA	0.38 % of reading + 10 fA 0.33 % of reading + 10 fA 0.2 % of reading + 30 fA 0.063 % of reading + 0.1 pA 0.063 % of reading + 1 pA 0.035 % of reading + 10 pA 0.025 % of reading + 0.1 nA 0.025 % of reading + 1 nA 0.025 % of reading + 10 nA 0.025 % of reading + 0.1 μ A 0.15 % of reading + 1 μ A	Calibrator/Source
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	41 μ A/A + 7 nA 34 μ A/A + 8 nA 35 μ A/A + 45 nA 46 μ A/A + 0.8 μ A 82 μ A/A + 13 μ A	Multifunction Calibrator
DC Current – Source ¹	(0.33 to 20.5) A	0.78 mA/A + 0.58 mA	Multiproduct Calibrator
DC High Current – Source ¹	(2.2 to 11) A	0.17 mA/A	Transconductance Amplifier
	(10 to 16.5) A (16.5 to 150) A (150 to 1025) A	3.2 mA/A + 3.5 mA 3.2 mA/A + 29 mA 3.4 mA/A + 0.10 A	Multiproduct Calibrator with 50 turn Coil

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
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 (1 to 10) A (10 to 20) A	30 μ A/A + 40 pA 15 μ A/A + 40 pA 15 μ A/A + 100 pA 15 μ A/A + 0.8 nA 15 μ A/A + 5 nA 15 μ A/A + 50 nA 30 μ A/A + 0.50 μ A 90 μ A/A 60 μ A/A 0.14 mA/A	Multimeter, Standard Resistor Set
	(20 to 100) A	0.5 mA/A	Shunt, Multimeter
Inductance – Source ¹ (Fixed Artifacts) 1 kHz to 10 kHz	(1 to 10) mH (10 to 100) mH	23 mH/H 12 mH/H	Standard Inductor
Inductance – Source ¹ (Variable Artifact) 1 kHz & 10 kHz	100 mH to 10 H	9 mH/H	Decade Inductor
Inductance – Measure ¹ 12 Hz to 100 kHz	100 μ H to 10 H	0.4 mH/H	RLC Digibridge
Resistance – Source ¹ (Fixed Artifacts)	0.01 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω (1 to 10) M Ω 10 M Ω to 1 G Ω	8 $\mu\Omega/\Omega$ 8 $\mu\Omega/\Omega$ 15 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 0.17 m Ω/Ω 0.16 m Ω/Ω 10 $\mu\Omega/\Omega$ 0.17 m Ω/Ω 0.17 m Ω/Ω 2.5 m Ω/Ω	Standard Resistors
Resistance – Source ¹ (Fixed Points)	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω	40 $\mu\Omega$ 95 $\mu\Omega/\Omega$ 95 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$	Multifunction Calibrator

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance – Source ¹ (Fixed Points)	10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	8.5 μΩ/Ω 8.5 μΩ/Ω 10 μΩ/Ω 10 μΩ/Ω 18 μΩ/Ω 18 μΩ/Ω 37 μΩ/Ω 46 μΩ/Ω 0.1 mΩ/Ω	Multifunction Calibrator
Resistance – Measure ¹	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 k Ω (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	15 μΩ/Ω + 52 μΩ 10 μΩ/Ω + 0.5 mΩ 9 μΩ/Ω + 0.73 mΩ 8.1 μΩ/Ω + 5.5 mΩ 9.3 μΩ/Ω + 81 mΩ 12 μΩ/Ω + 2 Ω 50 μΩ/Ω + 0.1 kΩ 0.5 mΩ/Ω + 1.1 kΩ 5 mΩ/Ω + 11 kΩ	Multimeter
Resistance – Measure ¹	(1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ (1 to 10) GΩ (10 to 100) GΩ 100 GΩ to 1 TΩ (1 to 10) TΩ (10 to 100) TΩ 100 TΩ to 1 PΩ	3.4 mΩ/Ω 0.12 mΩ/Ω 0.17 mΩ/Ω 0.79 mΩ/Ω 0.56 mΩ/Ω 0.55 mΩ/Ω 2.3 mΩ/Ω 0.65 mΩ/Ω 0.56 mΩ/Ω	Teraohmmeter
AC Resistance – Source/Measure ¹ 100 Hz to 100 kHz	0.001 Ω (0.1 to 1) Ω 10 Ω to 100 kΩ	0.13 mΩ 1.5 mΩ/Ω 0.46 mΩ/Ω	RL Standard
	(0.01 to 0.2) Ω 0.2 Ω to 100 kΩ 100 kΩ to 10 MΩ	6.9 mΩ/Ω 0.27 mΩ/Ω 3 mΩ/Ω	RLC Digibridge with RL Standard
Phase – Measure ¹	(0 to 180) ° (10 to 32) mV 1 Hz to 10 kHz (10 to 50) kHz 32 mV to 100 V 1 Hz to 50 kHz (100 to 320) V 1 Hz to 5 kHz	0.2 ° 0.35 ° 0.11 ° 0.2 °	Phase Meter

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Capacitance – Source ¹ (Simulation)			Multiproduct Calibrator
10 Hz to 10 kHz	(0.19 to 0.399 9) nF	3.9 mF/F + 7.8 pF	
10 Hz to 10 kHz	(0.4 to 1.099 9) nF	3.9 mF/F + 7.8 pF	
10 Hz to 3 kHz	(1.1 to 3.299 9) nF	3.9 mF/F + 7.8 pF	
10 Hz to 1 kHz	(3.3 to 10.999 9) nF	1.9 mF/F + 7.8 pF	
10 Hz to 1 kHz	(11 to 32.999 9) nF	1.9 mF/F + 7.8 pF	
10 Hz to 1 kHz	(33 to 109.999) nF	1.9 mF/F + 7.8 pF	
10 Hz to 1 kHz	(110 to 329.999) nF	1.9 mF/F + 0.23 nF	
10 Hz to 600 Hz	(0.33 to 1.099 99) μ F	1.9 mF/F + 0.78 nF	
10 Hz to 300 Hz	(1.1 to 3.299 99) μ F	1.9 mF/F + 2.3 nF	
10 Hz to 150 Hz	(3.3 to 10.999 9) μ F	1.9 mF/F + 7.8 nF	
10 Hz to 120 Hz	(11 to 32.999 9) μ F	3.1 mF/F + 23 nF	
10 Hz to 80 Hz	(33 to 109.999) μ F	3.5 mF/F + 78 nF	
0 to 50 Hz	(110 to 329.999) μ F	3.5 mF/F + 0.23 μ F	
0 to 20 Hz	(0.33 to 1.099 99) mF	3.5 mF/F + 0.78 μ F	
0 to 6 Hz	(1.1 to 3.299 99) mF	3.5 mF/F + 2.3 μ F	
0 to 2 Hz	(3.3 to 10.999 9) mF	3.5 mF/F + 7.8 μ F	
0 to 0.6 Hz	(11 to 32.999 9) mF	3.5 mF/F + 23 μ F	
0 to 0.2 Hz	(33 to 110) mF	8.5 mF/F + 78 μ F	
Capacitance – Source ¹ (Fixed Artifacts)			Capacitance Set
120 Hz to 100 kHz			
1 000 nF		1.1 mF/F	
100 nF		1.1 mF/F	
10 nF		1.1 mF/F	
1 kHz to 5 MHz			
1 000 pF		1.1 mF/F	
100 pF		1.1 mF/F	
10 pF		1.1 mF/F	
1 pF		1.1 mF/F	
(5 to 13) MHz			
1 000 pF		1.4 mF/F	
100 pF		1.4 mF/F	
10 pF		1.4 mF/F	
1 pF		1.4 mF/F	
Capacitance – Measure ¹ 12 Hz to 100 kHz			RLC Digibridge
	(0.001 to 10) pF	0.4 mF/F	
	(10 to 100) pF	0.5 mF/F	Decade Capacitor, RLC Digibridge
	100 pF to 1 mF	0.2 mF/F	
	100 pF to 1.1 μ F	0.6 mF/F	

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) °C	0.36 °C	Multiproduct Calibrator
	(800 to 1 000) °C	0.29 °C	
	(1 000 to 1 550) °C	0.26 °C	
	(1 550 to 1 820) °C	0.28 °C	
	Type C (0 to 150) °C	0.26 °C	
	(150 to 650) °C	0.23 °C	
	(650 to 1 000) °C	0.27 °C	
	(1 000 to 1 800) °C	0.4 °C	
	(1 800 to 2 316) °C	0.66 °C	
	Type E (-250 to -100) °C	0.4 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 350) °C	0.16 °C	
	Type E (350 to 650) °C	0.17 °C	
	(650 to 1 000) °C	0.2 °C	
	Type J (-210 to -100) °C	0.24 °C	
	(-100 to -30) °C	0.17 °C	
	(-30 to 150) °C	0.16 °C	
	(150 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.21 °C	
	Type K (-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L (-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type N		Multiproduct Calibrator
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type S		
	(0 to 250) °C	0.38 °C	
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	
	Type T		
	(-250 to -150) °C	0.5 °C	
Electrical Calibration of RTD Indicating Systems ¹	(-150 to 0) °C	0.22 °C	Multiproduct Calibrator
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U		
	(-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	
	Pt 385, 100 Ω		
	(-200 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3 926, 100 Ω		
	(-200 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 300) °C	0.068 °C	
	(300 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 200 Ω		Multiproduct Calibrator
	(-200 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 600) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.12 $^{\circ}\text{C}$	
	Pt 385, 500 Ω		
	(-200 to 100) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(260 to 600) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.085 $^{\circ}\text{C}$	
	Pt 385, 1 k Ω		
	(-200 to 0) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	
	(0 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 600) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
AC Voltage – Source ¹	(600 to 630) $^{\circ}\text{C}$	0.18 $^{\circ}\text{C}$	
	Pt Ni 385, 100 Ω		
	(-80 to 100) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	Cu 427, 10 Ω		
	(-100 to 260) $^{\circ}\text{C}$	0.23 $^{\circ}\text{C}$	
	220 μV to 2.2 mV		
	(10 to 20) Hz	0.22 mV/V + 4 μV	
	(20 to 40) Hz	0.085 mV/V + 4 μV	
	40 Hz to 20 kHz	0.075 mV/V + 4 μV	
	(20 to 50) kHz	0.18 mV/V + 4 μV	
	(50 to 100) kHz	0.46 mV/V + 5 μV	
	(100 to 300) kHz	0.90 mV/V + 10 μV	
	(300 to 500) kHz	1.2 mV/V + 20 μV	
	500 kHz to 1 MHz	2.5 mV/V + 20 μV	
	(2.2 to 22) mV		Multiproduct Calibrator
	(10 to 20) Hz	0.22 mV/V + 4 μV	
	(20 to 40) Hz	0.085 mV/V + 4 μV	
	40 Hz to 20 kHz	0.075 mV/V + 4 μV	
	(20 to 50) kHz	0.18 mV/V + 4 μV	
	(50 to 100) kHz	0.46 mV/V + 5 μV	
	(100 to 300) kHz	0.9 mV/V + 10 μV	
	(300 to 500) kHz	1.2 mV/V + 20 μV	
	500 kHz to 1 MHz	2.5 mV/V + 20 μV	

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Source ¹	(22 to 220) mV		Multifunction Calibrator
	(10 to 20) Hz	0.22 mV/V + 12 µV	
	(20 to 40) Hz	0.085 mV/V + 8 µV	
	40 Hz to 20 kHz	0.075 mV/V + 8 µV	
	(20 to 50) kHz	0.19 mV/V + 10 µV	
	(50 to 100) kHz	0.42 mV/V + 22 µV	
	(100 to 300) kHz	0.8 mV/V + 26 µV	
	(300 to 500) kHz	1.2 mV/V + 30 µV	
	500 kHz to 1 MHz	2.5 mV/V + 48 µV	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.22 mV/V + 53 µV	
	(20 to 40) Hz	0.085 mV/V + 23 µV	
	40 Hz to 20 kHz	0.075 mV/V + 9 µV	
	(20 to 50) kHz	0.19 mV/V + 12 µV	
	(50 to 100) kHz	0.42 mV/V + 33 µV	
	(100 to 300) kHz	0.8 mV/V + 95 µV	
	(300 to 500) kHz	1.2 mV/V + 250 µV	
	500 kHz to 1 MHz	2.5 mV/V + 460 µV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.22 mV/V + 0.53 mV	
	(20 to 40) Hz	0.085 mV/V + 0.18 mV	
	40 Hz to 20 kHz	0.075 mV/V + 0.061 mV	
	(20 to 50) kHz	0.19 mV/V + 0.12 mV	
	(50 to 100) kHz	0.42 mV/V + 0.24 mV	
	(100 to 300) kHz	0.8 mV/V + 0.79 mV	
	(300 to 500) kHz	1.2 mV/V + 2.3 mV	
	500 kHz to 1 MHz	2.5 mV/V + 3.6 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.28 mV/V + 5.3 mV	
	(20 to 40) Hz	0.095 mV/V + 1.8 mV	
	40 Hz to 20 kHz	0.048 mV/V + 0.7 mV	
	(20 to 50) kHz	0.083 mV/V + 1.1 mV	
	(50 to 100) kHz	0.14 mV/V + 3 mV	
	(100 to 300) kHz	0.85 mV/V + 16 mV	
	(300 to 500) kHz	4.2 mV/V + 40 mV	
	500 kHz to 1 MHz	7 mV/V + 80 mV	
	(220 to 1 100) V		
	(15 to 50) Hz	0.31 mV/V + 16 mV	
	50 Hz to 1 kHz	0.06 mV/V + 4 mV	

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Source ¹	(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	0.082 mV/V + 4 mV 0.13 mV/V + 6 mV 0.36 mV/V + 11 mV 0.36 mV/V + 11 mV 1.3 mV/V + 45 mV	Multifunction Calibrator w/ Transconductance Amplifier
AC Voltage – Measure ¹	2.2 mV Range (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 7 mV Range (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 mV Range (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	1.9 mV/V + 1.3 µV 0.87 mV/V + 1.3 µV 0.54 mV/V + 1.3 µV 0.95 mV/V + 2 µV 1.4 mV/V + 2.5 µV 2.6 mV/V + 4 µV 2.8 mV/V + 8 µV 3.8 mV/V + 8 µV 1 mV/V + 1.3 µV 0.43 mV/V + 1.3 µV 0.26 mV/V + 1.3 µV 0.46 mV/V + 2 µV 0.69 mV/V + 2.5 µV 1.4 mV/V + 4 µV 1.5 mV/V + 8 µV 2.3 mV/V + 8 µV 0.33 mV/V + 1.3 µV 0.21 mV/V + 1.3 µV 0.13 mV/V + 1.3 µV 0.24 mV/V + 2 µV 0.36 mV/V + 2.5 µV 0.94 mV/V + 4 µV 1 mV/V + 8 µV 1.6 mV/V + 8 µV	Multimeter

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Measure ¹	70 mV Range		Multimeter
	(10 to 20) Hz	0.28 mV/V + 1.5 μ V	
	(20 to 40) Hz	0.14 mV/V + 1.5 μ V	
	40 Hz to 20 kHz	0.08 mV/V + 1.5 μ V	
	(20 to 50) kHz	0.14 mV/V + 2 μ V	
	(50 to 100) kHz	0.31 mV/V + 2.5 μ V	
	(100 to 300) kHz	0.6 mV/V + 4 μ V	
	(300 to 500) kHz	0.79 mV/V + 8 μ V	
	500 kHz to 1 MHz	1.3 mV/V + 8 μ V	
	220 mV Range		
	(10 to 20) Hz	0.24 mV/V + 1.5 μ V	
	(20 to 40) Hz	0.1 mV/V + 1.5 μ V	
	40 Hz to 20 kHz	0.05 mV/V + 1.5 μ V	
	(20 to 50) kHz	0.08 mV/V + 2.0 μ V	
	(50 to 100) kHz	0.19 mV/V + 2.5 μ V	
	(100 to 300) kHz	0.28 mV/V + 4 μ V	
	(300 to 500) kHz	0.43 mV/V + 8 μ V	
	500 kHz to 1 MHz	1.1 mV/V + 8 μ V	
	700 mV Range		
	(10 to 20) Hz	0.24 mV/V + 1.5 μ V	
	(20 to 40) Hz	0.09 mV/V + 1.5 μ V	
	40 Hz to 20 kHz	0.04 mV/V + 1.5 μ V	
	(20 to 50) kHz	0.06 mV/V + 2 μ V	
	(50 to 100) kHz	0.1 mV/V + 2.5 μ V	
	(100 to 300) kHz	0.19 mV/V + 4 μ V	
	(300 to 500) kHz	0.34 mV/V + 8 μ V	
	500 kHz to 1 MHz	1 mV/V + 8 μ V	
	2.2 V Range		
	(10 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	0.08 mV/V	
	40 Hz to 20 kHz	0.03 mV/V	
	(20 to 50) kHz	0.05 mV/V	
	(50 to 100) kHz	0.08 mV/V	
	(100 to 300) kHz	0.17 mV/V	
	(300 to 500) kHz	0.29 mV/V	
	500 kHz to 1 MHz	1 mV/V	

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Measure ¹	7 V Range		Multimeter
	(10 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	0.08 mV/V	
	40 Hz to 20 kHz	0.03 mV/V	
	(20 to 50) kHz	0.05 mV/V	
	(50 to 100) kHz	0.09 mV/V	
	(100 to 300) kHz	0.21 mV/V	
	(300 to 500) kHz	0.43 mV/V	
	500 kHz to 1 MHz	1.3 mV/V	
	22 V Range		
	(10 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	0.08 mV/V	
	40 Hz to 20 kHz	0.03 mV/V	
	(20 to 50) kHz	0.05 mV/V	
	(50 to 100) kHz	0.09 mV/V	
	(100 to 300) kHz	0.2 mV/V	
	(300 to 500) kHz	0.43 mV/V	
	500 kHz to 1 MHz	1.3 mV/V	
	70 V Range		
	(10 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	0.08 mV/V	
	40 Hz to 20 kHz	0.04 mV/V	
	(20 to 50) kHz	0.07 mV/V	
	(50 to 100) kHz	0.1 mV/V	
	(100 to 300) kHz	0.22 mV/V	
	(300 to 500) kHz	0.45 mV/V	
	500 kHz to 1 MHz	1.3 mV/V	
	220 V Range		
	(10 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	0.08 mV/V	
	40 Hz to 20 kHz	0.04 mV/V	
	(20 to 50) kHz	0.08 mV/V	
	(50 to 100) kHz	0.11 mV/V	
	(100 to 300) kHz	0.24 mV/V	
	(300 to 500) kHz	0.5 mV/V	

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Measure ¹	700 V Range (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz 1 000 V Range (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.23 mV/V 0.11 mV/V 0.05 mV/V 0.14 mV/V 0.45 mV/V 0.23 mV/V 0.11 mV/V 0.05 mV/V 0.14 mV/V 0.45 mV/V	Multimeter
AC Voltage Flatness – Measure ¹ 500 kHz to 30 MHz (Relative to 1 kHz)	600 μ V to 2.2 mV 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (2.2 to 7) mV 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (7 to 22) mV 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz 22 mV to 7 V 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	1 mV/V + 1 μ V 1 mV/V + 1 μ V 1 mV/V + 1 μ V 1 mV/V + 1 μ V 1 mV/V + 1 μ V 0.9 mV/V + 1 μ V 0.9 mV/V + 1 μ V 1.3 mV/V + 1 μ V 2.1 mV/V + 1 μ V 4.4 mV/V + 1 μ V 0.9 mV/V 0.9 mV/V 1.2 mV/V 2.1 mV/V 4.4 mV/V 0.7 mV/V 0.7 mV/V 1.2 mV/V 1.9 mV/V 4.2 mV/V	Multimeter
AC High Voltage – Measure ¹ 50/60 Hz	(1 to 10) kV (10 to 30) kV	1.4 mV/V + 55 mV 0.17 % of reading	High Voltage Meter

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current – Source ¹	(9 to 220) μ A		Multiproduct Calibrator
	(10 to 20) Hz	0.23 mA/A + 16 nA	
	(20 to 40) Hz	0.14 mA/A + 10 nA	
	40 Hz to 1 kHz	0.11 mA/A + 8 nA	
	(1 to 5) kHz	0.25 mA/A + 12 nA	
	(5 to 10) kHz	0.9 mA/A + 65 nA	
	220 μ A to 2.2 mA		
	(10 to 20) Hz	0.23 mA/A + 40 nA	
	(20 to 40) Hz	0.14 mA/A + 35 nA	
	40 Hz to 1 kHz	0.11 mA/A + 35 nA	
	(1 to 5) kHz	0.18 mA/A + 0.11 μ A	
	(5 to 10) kHz	0.9 mA/A + 0.65 μ A	
	(2.2 to 22) mA		
	(10 to 20) Hz	0.23 mA/A + 0.4 μ A	
	(20 to 40) Hz	0.14 mA/A + 0.35 μ A	
	40 Hz to 1 kHz	0.11 mA/A + 0.35 μ A	
	(1 to 5) kHz	0.18 mA/A + 0.55 μ A	
	(5 to 10) kHz	0.9 mA/A + 5 μ A	
	(22 to 220) mA		
	(10 to 20) Hz	0.23 mA/A + 4 μ A	
	(20 to 40) Hz	0.14 mA/A + 3.5 μ A	
	40 Hz to 1 kHz	0.11 mA/A + 2.5 μ A	
	(1 to 5) kHz	0.18 mA/A + 3.5 μ A	
	(5 to 10) kHz	0.9 mA/A + 10 μ A	
	220 mA to 2.2 A		
	20 Hz to 1 kHz	0.24 mA/A + 35 μ A	
	(1 to 5) kHz	0.39 mA/A + 80 μ A	
	(5 to 10) kHz	6 mA/A + 0.16 mA	
AC Current – Source ¹	(2.2 to 11) A		Multiproduct Calibrator w/ Transconductance Amplifier
	40 Hz to 1 kHz	0.71 mA/A + 0.17 mA	
	(1 to 5) kHz	1.1 mA/A + 0.38 mA	
	(5 to 10) kHz	3.8 mA/A + 0.75 mA	
AC Current – Source ¹	(0.33 to 20.5) A		Multiproduct Calibrator
	(50 to 100) Hz	2.5 mA/A	
	(100 to 400) Hz	4 mA/A	
	400 Hz to 1 kHz	6 mA/A	

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current – Source ¹	(10 to 16.5) A		Multiproduct Calibrator with 50 Turn Coil
	(45 to 65) Hz	3.3 mA/A + 3.5 mA	
	(65 to 400) Hz	9.1 mA/A + 29 mA	
	(16.5 to 150) A		
	(45 to 65) Hz	3.3 mA/A + 3.5 mA	
	(65 to 400) Hz	9.1 mA/A + 31 mA	
AC Current – Measure ¹	(150 to 1 025) A		Multimeter in Synchronous Sub-Sampled Mode
	(45 to 65) Hz	3.4 mA/A + 0.1 A	
	(65 to 400) Hz	9.2 mA/A + 0.12 A	
	(5 to 100) µA		
	(10 to 20) Hz	4.6 mA/A + 0.03 µA	
	(20 to 45) Hz	1.7 mA/A + 0.03 µA	
	(45 to 100) Hz	0.7 mA/A + 0.03 µA	
	100 Hz to 5 kHz	0.7 mA/A + 0.03 µA	
	100 µA to 1 mA		
	(10 to 20) Hz	4.5 mA/A + 0.2 µA	
	(20 to 45) Hz	1.7 mA/A + 0.2 µA	
	(45 to 100) Hz	0.7 mA/A + 0.2 µA	
	100 Hz to 5 kHz	0.4 mA/A + 0.2 µA	
	(5 to 20) kHz	0.7 mA/A + 0.2 µA	
	(20 to 50) kHz	4.5 mA/A + 0.4 µA	
	(50 to 100) kHz	6.2 mA/A + 1.5 µA	
	(1 to 10) mA		
	(10 to 20) Hz	4.5 mA/A + 2 µA	
	(20 to 45) Hz	1.7 mA/A + 2 µA	
	(45 to 100) Hz	0.7 mA/A + 2 µA	
	100 Hz to 5 kHz	0.3 mA/A + 2 µA	
	(5 to 20) kHz	0.7 mA/A + 2 µA	
	(20 to 50) kHz	4.5 mA/A + 4 µA	
	(50 to 100) kHz	6.2 mA/A + 15 µA	

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current – Measure ¹	(10 to 100) mA (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 (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	4.5 mA/A + 20 μ A 1.7 mA/A + 20 μ A 0.7 mA/A + 20 μ A 0.3 mA/A + 20 μ A 0.7 mA/A + 20 μ A 4.5 mA/A + 40 μ A 6.2 mA/A + 150 μ A 4.6 mA/A + 0.2 mA 1.8 mA/A + 0.2 mA 0.9 mA/A + 0.2 mA 1.2 mA/A + 0.2 mA 3.4 mA/A + 0.2 mA 11 mA/A + 0.4 mA	Multimeter in Synchronous Sub-Sampled Mode
	(0.01 to 5) A (10 Hz to 50) kHz (5 to 20) A (10 Hz to 50) kHz	0.3 mA/A 0.4 mA/A	AC Current Shunts
Oscilloscopes ¹ Rise/Fall Time, (10 to 90) % Sq Wave 50 Ω or 1 M Ω Load impedance – <10 kHz Horizontal Deflection (Time) Vertical Deflection (Amplitude)	150 ps 40 μ Vp-p to 1mVp-p 1 mVp-p to 5 Vp-p 180.1 ps to 55 s	1.6 ps 2.5 % of reading 0.13 % of reading 0.4 parts in 10 ⁻⁶ s	Oscilloscope Calibrator w/ Head
Oscilloscopes ¹ Bandwidth	$\pm$ 1 mV to $\pm$ 200 V	0.05 % of reading	Multimeter
Oscilloscopes ¹ Bandwidth	$\pm$ 1 mV to $\pm$ 200 V 100 mHz to 300 MHz (300 to 500) MHz 550 MHz to 3 GHz	2.4 % of reading 3 % of reading 4.1 % of reading	Oscilloscope Calibrator w/ Head

Electrical – DC/Low Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Oscilloscopes ¹ Bandwidth	± 1 mV to ± 200 V (3 to 26.5) GHz (26.5 to 50) GHz	5.8 % of reading 7 % of reading	Power Meter and Power Sensor

Electrical - RF/Microwave

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Distortion – Measure ¹ (50 to 500) kHz	(0 to 99.9) dB 20 Hz to 20 kHz (20 to 100) kHz	1.1 dB 2.1 dB	Audio Analyzer
Pulse – Measure ¹ RMS Jitter – Period, Delay and Width	33 MHz to 3.0 GHz	1.4 % of reading + 5 ps	Oscilloscope
RF Power Sensors – Calibration Factors ^{1,5}	Referenced to 1 mW (9 to 100) kHz (100 to 300) kHz 300 kHz to 50 MHz 50 MHz to 5 GHz (5 to 10) GHz (10 to 18) GHz (18 to 26.5) GHz (26 to 27) GHz (27 to 30) GHz (30 to 34) GHz (34 to 40) GHz (40 to 42) GHz (42 to 48) GHz (48 to 50) GHz	1 % 1 % 0.94 % 0.55 % 0.57 % 0.6 % 1.6 % 1.9 % 2 % 1.9 % 2 % 2.6 % 2.9 % 3.4 %	Thermocouple Power Sensors
RF Power Meter Reference Power Output ¹	1 mW 50 MHz	0.51 % of reading	Power Meter with Sensor
RF Power Meter Power Measurement ¹	3 µW to 100 mW	0.35 % of reading	Range Calibrator

Electrical - RF/Microwave

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Voltage Standing Wave Ratio (VSWR) ⁵	Broadband Load: (3.5mm and 2.4mm) DC to 2 GHz 2 to 3 GHz 3 to 8 GHz 8 to 20 GHz 20 to 26.5 GHz 26.5 to 50 GHz Broadband Load: (3.5mm and 2.4mm) 4 to 20 GHz 20 to 36 GHz 36 to 40 GHz 40 to 50 GHz	0.012 0.015 0.029 0.037 0.047 0.12 0.018 0.023 0.029 0.037	Network Analyzer, Calibration Kit
Tuned RF Power, Relative – Measure ¹	100 kHz to 50 GHz (-127 to -120) dBm (-120 to -110) dBm (-110 to -100) dBm (-100 to -90) dBm (-90 to -80) dBm (-80 to -70) dBm (-70 to -60) dBm (-60 to -50) dBm (-50 to -40) dBm (-40 to -30) dBm (-30 to -20) dBm (-20 to -10) dBm (-10 to 0) dBm (0 to 10) dBm (10 to 20) dBm (20 to 30) dBm	0.13 dB 0.09 dB 0.09 dB 0.086 dB 0.083 dB 0.079 dB 0.076 dB 0.073 dB 0.071 dB 0.068 dB 0.066 dB 0.064 dB 0.063 dB 0.064 dB 0.066 dB 0.068 dB	Measuring Receiver, Power Sensor, Power Meter and Spectrum Analyzer
RF Power Absolute Measure ^{1,2}	100 kHz to 50 GHz (-127 to -120) dBm (-120 to -110) dBm (-110 to -80) dBm (-80 to -60) dBm (-60 to -40) dBm (-40 to -20) dBm (-20 to 10) dBm (10 to 30) dBm (20 to 30) dBm	0.26 dB 0.23 dB 0.18 dB 0.17 dB 0.16 dB 0.15 dB 0.14 dB 0.15 dB 0.15 dB	Power Sensor, Measuring Receiver, Power Meter and Spectrum Analyzer

Electrical - RF/Microwave

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Power Absolute Measure ^{1,2}	$-60 \text{ dBm} \leq P < -40 \text{ dBm}$ $9 \text{ kHz} \leq f < 6 \text{ GHz}$	0.15 dB	Power Sensor
	$-40 \text{ dBm} \leq P < -30 \text{ dBm}$ $9 \text{ kHz} \leq f < 6 \text{ GHz}$	0.13 dB	
	$-30 \text{ dBm} \leq P < 0 \text{ dBm}$ $9 \text{ kHz} \leq f < 6 \text{ GHz}$	0.11 dB	
	$0 \text{ dBm} \leq P < 20 \text{ dBm}$ $9 \text{ kHz} \leq f < 6 \text{ GHz}$	0.1 dB	
RF Power Absolute Measure ^{1,2}	$-35 \text{ dBm} \leq P < -20 \text{ dBm}$ $50 \text{ MHz} \leq f < 14 \text{ GHz}$	0.36 dB	Power Sensor
	$14 \text{ GHz} \leq f < 33 \text{ GHz}$	0.37 dB	
	$33 \text{ GHz} \leq f < 40 \text{ GHz}$	0.38 dB	
	$40 \text{ GHz} \leq f < 50 \text{ GHz}$	0.39 dB	
	$-20 \text{ dBm} \leq P < 0 \text{ dBm}$ $50 \text{ MHz} \leq f < 14 \text{ GHz}$	0.09 dB	
	$14 \text{ GHz} \leq f < 33 \text{ GHz}$	0.14 dB	
	$33 \text{ GHz} \leq f < 40 \text{ GHz}$	0.15 dB	
	$40 \text{ GHz} \leq f < 50 \text{ GHz}$	0.16 dB	
	$0 \text{ dBm} \leq P < 20 \text{ dBm}$ $50 \text{ MHz} \leq f < 14 \text{ GHz}$	0.09 dB	
	$14 \text{ GHz} \leq f < 33 \text{ GHz}$	0.14 dB	
	$33 \text{ GHz} \leq f < 40 \text{ GHz}$	0.15 dB	
	$40 \text{ GHz} \leq f < 50 \text{ GHz}$	0.17 dB	
Frequency Modulation Rejection – Measure ¹ 150 kHz to 10 MHz 10 MHz to 26.5 GHz	Rate: 400 HZ to 1 kHz Dev.: $\leq 5 \text{ kHz peak}$ Dev.: $\leq 50 \text{ kHz peak}$	0.14 % Deviation 0.14 % Deviation	Measuring Receiver
Residuals AM ¹	150 kHz to 18 GHz (18 to 26.5) GHz	0.004 % Deviation (rms) 0.006 % Deviation (rms)	Measuring Receiver
Frequency Modulation Distortion- Measure ¹ Bandwidth: 20 Hz to 250 kHz	150 kHz to 26.5 GHz	0.15 % Distortion	Measuring Receiver

Electrical - RF/Microwave

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency Modulation – Deviation Accuracy Measure ¹ 250 kHz to 10 MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 10 kHz Dev: ≤ 40 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz Rate: 50 Hz to 200 kHz Dev: ≤ 400 kHz	0.1 % Deviation 0.2 % Deviation 0.3 % Deviation 0.4% Deviation	Measuring Receiver
Amplitude Modulation Rejection – Measure ¹	Rate: 400 Hz to 1 kHz Depth: ≤ 50 % 150 kHz to 6.6 GHz (6.6 to 26.5) GHz	11 Hz 23 Hz	Measuring Receiver
Amplitude Modulation – Depth Accuracy Measure ¹ 150 kHz to 10 MHz 10 MHz to 3 GHz 10 MHz to 3 GHz (3 to 26.5) GHz (3 to 26.5) GHz	Rate: 50 Hz to 10 kHz Depth: (5 to 99) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	0.2 % Depth 0.2 % Depth 0.3 % Depth 0.2 % Depth 0.5 % Depth	Measuring Receiver
Residuals FM Bandwidth ¹ 50 Hz to 3 kHz	150 kHz to 3 GHz (3 to 6.6) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	1.3 Hz (rms) 1.8 Hz (rms) 2.6 Hz (rms) 3.7 Hz (rms)	Measuring Receiver
Amplitude Modulation Distortion – Measure ¹ 150 kHz to 18 GHz (18 to 26.5) GHz (18 to 26.5) GHz	(5 to 99) % Depth (5 to 50) % Depth (50 to 95) % Depth	0.14 % Depth 0.4 % Depth 0.6 % Depth	Measuring Receiver
Amplitude Modulation Flatness ¹ 10 MHz to 26.5 GHz	Rate: (9 Hz to 10 kHz) (5 to 99) % Depth	0.15 % Depth	Measuring Receiver

Electrical - RF/Microwave

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Phase Modulation – Measure ¹ 100 kHz to 6.6 GHz 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 200 kHz Deviation: > 0.7 Rad Deviation: > 0.3 Rad Rate: 20 Hz to 200 kHz Deviation: > 2 Rad Deviation: > 0.6 Rad Rate: 20 Hz to 200 kHz Deviation: > 4 Rad Deviation: > 1.2 Rad	0.1 % of reading 0.2 % of reading 0.1 % of reading 0.2 % of reading 0.1 % of reading 0.2 % of reading	Measuring Receiver
AM Rejection – Measure ¹ 100 kHz to 26.5 GHz	Rate: 50 Hz to 3 kHz Deviation: > 50 % AM at 1 kHz Rate	0.003 Rad	Measuring Receiver
Phase Residuals – Measure ¹ 100 kHz to 26.5 GHz	(0.1 to 25 000) Rad (rms) Rate: 50 Hz to 3 kHz	0.01 Rad	Measuring Receiver
Phase Distortion ¹ 150 kHz to 26.5 GHz	(0.1 to 25 000) Rad (rms) Bandwidth: 20 Hz to 250 kHz	0.008 rad	Measuring Receiver
Amplitude Modulation – Source ¹ 10 kHz to 13.5 MHz 10 kHz to 13.5 MHz	Rate: 50 Hz to 100 kHz Depths: 5 % to 95 % Rate: 50 Hz to 100 kHz Depths: 95 % to 99 %	0.6 % Depth 0.6 % Depth	AM/FM Test Set
Frequency Modulation – Source ¹ 10 kHz to 432 MHz	Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	0.6 % Deviation	AM/FM Test Set
Harmonic Measurements ¹	(-90 to 0.01) dB 3 Hz to 26.5 GHz (26.5 to 50) GHz	0.8 dB 1.4 dB	Spectrum Analyzer
Error Vector Magnitude ^{1,2} (EVM)	(0 to 100) % Error Mod Frequency Span: f ≤ 100 kHz 100 kHz ≤ f ≤ 1 MHz f > 1 MHz	0.43 % Error 0.48 % Error 0.82 % Error	Vector Signal Analyzer

Electrical - RF/Microwave

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Phase Error ^{1,2}	(0 to 180) ° Error Mod Frequency Span: $f \leq 100 \text{ kHz}$ $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$ $f > 1 \text{ MHz}$	0.17° Error (rms) 0.34° Error (rms) 0.57° Error (rms)	Vector Signal Analyzer
Frequency Error ¹	(0 to 5) ° Error Mod Frequency 1 GHz 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz	0.063 % Error 0.068 % Error 0.079 % Error 0.099 % Error 0.33 % Error 0.39 % Error	Vector Signal Analyzer
Modulation Accuracy ¹ (Rho)	Mod Frequency Span: $f \leq 100 \text{ kHz}$ $0.9999 \leq \rho \leq 1$ $0.9975 \leq \rho < 0.9999$ $0.9936 \leq \rho < 0.9975$ $0.99 \leq \rho < 0.9936$ $0.978 \leq \rho < 0.99$ $0.96 \leq \rho < 0.978$	$8.6 \text{ E-}5 \rho$ 0.00043ρ 0.00068ρ 0.00084ρ 0.0012ρ 0.0016ρ	Vector Signal Analyzer
Modulation Accuracy ¹ (Rho)	Mod Frequency Span: $100 \text{ kHz} \leq f \leq 1 \text{ MHz}$ $0.9999 \leq \rho \leq 1$ $0.9975 \leq \rho < 0.9999$ $0.9936 \leq \rho < 0.9975$ $0.99 \leq \rho < 0.9936$ $0.978 \leq \rho < 0.99$ $0.96 \leq \rho < 0.978$	$9.6 \text{ E-}5 \rho$ 0.00048ρ 0.00076ρ 0.00094ρ 0.0014ρ 0.0018ρ	Vector Signal Analyzer
Modulation Accuracy ¹ (Rho)	Mod Frequency Span $f \geq 1 \text{ MHz}$ $0.9999 \leq \rho \leq 1$ $0.9975 \leq \rho < 0.9999$ $0.9936 \leq \rho < 0.9975$ $0.99 \leq \rho < 0.9936$ $0.978 \leq \rho < 0.99$ $0.96 \leq \rho < 0.978$	$1.6 \text{ E-}4 \rho$ 0.00082ρ 0.0013ρ 0.0016ρ 0.0024ρ 0.003ρ	Vector Signal Analyzer

Electrical - RF/Microwave

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
S Parameters ^{1,5} – Magnitude and Phase for S ₁₁ , S ₁₂ , S ₂₁ , S ₂₂ Reflection S ₁₁ /S ₂₂ Measure lin mag	(0.01 to 1) lin 30 kHz to 2 GHz (-180 to 180) ° (2 to 20) GHz (-180 to 180) ° (20 to 50) GHz (-180 to 180) °	0.016 1 ° 0.03 1.7 ° 0.06 3.7 °	Network Analyzer, Calibration Kit
Reflection Magnitude ^{1,5} S ₁₁ /S ₂₂ – Measure	(0.01 to 1) lin mag 30 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz	0.005 0.007 0.014	
Reflection Phase ¹ S ₁₁ /S ₂₂ – Measure	(-180 to 180) ° 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz	1.5 ° 0.95 ° 0.95 °	Network Analyzer, Calibration Kit
Insertion Delay ¹	220 MHz to 6 GHz	2 μs	Network Analyzer, Calibration Kit
Group Delay Flatness ¹ F ₀ = +/- 21MHz	220 MHz to 6 GHz	5 ns	Network Analyzer, Calibration Kit
S Parameters – Magnitude and Phase ¹ S ₁₁ , S ₁₂ , S ₂₁ , S ₂₂ Transmission ¹ S ₁₂ / S ₂₁ – Measure	30 kHz to 2 GHz (0 to 20) dB (-180 to 180) ° (20 to 40) dB (-180 to 180) ° (40 to 60) dB (-180 to 180) ° (2 to 20) GHz (0 to 20) dB (-180 to 180) ° (20 to 40) dB (-180 to 180) ° (40 to 60) dB (-180 to 180) °	(0.05 to 0.09) dB (0.32 to 0.72) ° (0.1 to 0.14) dB (0.72 to 1) ° (0.14 to 0.27) dB (1 to 1.7) ° (0.11 to 0.16) dB (0.70 to 1) ° (0.16 to 0.19) dB (1 to 1.3) ° (0.09 to 0.15) dB (1.28 to 1.9) °	Network Analyzer, Calibration Kit
S Parameters – Magnitude and Phase ¹ S ₁₁ , S ₁₂ , S ₂₁ , S ₂₂ Transmission ¹ S ₁₂ / S ₂₁ – Measure	(20 to 50) GHz (0 to 20) dB (-180 to 180) ° (20 to 40) dB (-180 to 180) ° (40 to 60) dB (-180 to 180) °	0.21 dB (2.3 to 2.9) ° 0.46 dB (2.9 to 3.2) ° 0.54 dB (3.2 to 3.6) °	Network Analyzer, Calibration Kit

Length – Dimensional Metrology

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Calipers ^{1,2}	Up to 6 in (6 to 12) in (12 to 24) in (24 to 48) in Up to 1 000 mm	$(280 + 4.3L) \mu\text{in}$ $(280 + 2.1L) \mu\text{in}$ $(290 + 1.6L) \mu\text{in}$ $(290 + 1L) \mu\text{in}$ $(2.4 + 0.007L) \mu\text{m}$	Gage Blocks
Height Gages ^{1,2}	Up to 48 in Up to 1 000 mm	$(49 + 1.1L) \mu\text{in}$ $(1.2 + 0.0009L) \mu\text{m}$	Gage Blocks, Surface Plate
Micrometers ^{1,2} Resolution: 100 μin 50 μin 10 μin	Up to 48 in Up to 48 in Up to 48 in	$(38 + 1.4L) \mu\text{in}$ $(28 + 1.2L) \mu\text{in}$ $(8.4 + 1.6L) \mu\text{in}$	Gage Blocks
Indicators ¹ Resolution: 20 μin 50 μin 100 μin 500 μin 1 000 μin	Up to 4 in Up to 4 in Up to 4 in Up to 4 in Up to 4 in	14 μin 30 μin 60 μin 280 μin 567 μin	Gage Blocks
Pin Gages, Diameter ²	Up to 2 in	$(13 + 0.4L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Gage Blocks ²	Up to 6 in	$(1.6 + 2.1L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Cylindrical Rings ²	Up to 1 in (1 to 14) in Up to 300 mm	$(9 + 1L) \mu\text{in}$ $(13 + 1L) \mu\text{in}$ $(0.4 + 0.003L) \mu\text{m}$	Universal Length Measuring Machine, Gage Blocks
Thread Wires ²	Up to 0.15 in (4 to 120) TPI	$(4 + 5D) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Profile Projector/ Measuring Microscope ^{1,2} X, Y Axis – Length	Up to 20 in Up to 300 mm	$(74 + 1.3L) \mu\text{in}$ $(1.1 + 0.008L) \mu\text{m}$	Gage Blocks, Glass Scales

Mass and Mass Related

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Pressure/Vacuum ¹	(-14.5 to 500) psig (500 to 2000) psig (2000 to 10 000) psig	0.042 % of reading + 0.58R 0.048 % of reading + 0.58R 0.1 % of reading + 0.58R	Process Calibrator with pressure modules
Pressure ¹	(0.01 to 1 000) psig	0.065 % of reading + 0.58R	Pressure Calibrator
Scales and Balances ^{1,3}	Up to 20 mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 1 kg (1 to 2) kg (2 to 5) kg (5 to 10) kg (10 to 20) kg (20 to 50) kg (50 to 100) kg	3.6 µg 4.8 µg 6 µg 7.2 µg 10 µg 12 µg 15 µg 20 µg 27 µg 38 µg 68 µg 0.13 mg 0.26 mg 0.65 mg 1.3 mg 2.6 mg 6.5 mg 0.19 g 0.36 g 4.1 g 8.7 g	OIML Class E1, E2, F and F1 Weights, and internal calibration procedure utilized in the calibration of the weighing system.
Mass Determination (SI)	Up to 50 mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 5 kg	1.8 µg 2.2 µg 2.7 µg 3.2 µg 4.2 µg 5.3 µg 6.6 µg 10 µg 16 µg 27 µg 60 µg 0.12 mg 0.18 mg 0.42 mg	OIML Class E1 Weights, Balance
Mass Determination (SI)	(5 to 10) kg (10 to 50) kg	0.55 mg 1.1 mg	OIML Class 4 Weights, Balance

Mass and Mass Related

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Torque Tools ¹	(0.015 to 815) Nm	0.54 % of reading	Torque System
Torque Testers ¹	(15 to 200) ozf·in (4 to 150) lbf·in (2.5 to 250) lbf·ft	0.13 % of reading 0.13 % of reading 0.13 % of reading	Torque Wheel, Torque Standard, Calibration Arms, Weights
Force – Compression and Tension ¹	Up to 50 kN (50 to 500) kN	0.035 % of reading + 0.58R 0.034 % of reading + 0.58R	Load Cell

Photometry and Radiometry

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Optical Power – Measure ¹ (800 to 1000) nm (1000 to 1310) nm (1310 to 1700) nm	(-90 to 10) dB (-110 to 10) dB (-110 to 10) dB	2.9 % of reading 2.9 % of reading 2.9 % of reading	Agilent Optical Test System
Optical Wavelength – Measure ¹	(700 to 1 650) nm	3.8 μm/m	Wavelength Meter

Thermodynamic

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Temperature – Measure ¹	(-200 to 500) °C	0.02 °C	Thermometer, PRT
Relative Humidity – Measure ¹	(10 to 90) %RH	0.65 % of reading + 0.41 %RH	Humidity Indicator and Probe
Radiation (Infrared) Thermometers ¹	(50 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 500) °C	1.2 °C 2.3 °C 3.6 °C 4.7 °C 6 °C	Black Body Calibrator (Flat Plate) $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers ¹	100 °C (100 to 200) °C (200 to 400) °C (400 to 600) °C (600 to 800) °C (800 to 982) °C	1.3 °C 2.4 °C 4.7 °C 7.1 °C 9.5 °C 12 °C	Black Body Calibrator (Cavity) $\epsilon = 0.99$, $\lambda = (8 \text{ to } 14) \mu\text{m}$

Time and Frequency

Nijmegen, Netherlands

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency – Measure ¹	0.1 Hz to 225 MHz 100 MHz to 3 GHz 500 MHz to 40 GHz	6×10^{-11} Hz/Hz 6×10^{-11} Hz/Hz 6×10^{-11} Hz/Hz	GPS Receiver, Counter
Frequency – Measure ¹	(40 to 50) GHz	10×10^{-8} Hz/Hz	GPS Receiver, Spectrum Analyzer
Frequency – Measure ¹ (Fixed Point)	10 MHz	5×10^{-11} Hz/Hz	GPS Receiver
Frequency – Source ¹	0.01 Hz to 10 MHz	5×10^{-11} Hz/Hz	GPS Receiver, Signal Generator
Frequency – Source ¹	10 MHz to 50.0 GHz	5×10^{-11} Hz/Hz	GPS Receiver, Signal Generator
Time Interval – Measure ¹	25 ps to 1 s	1.2 % of reading + 5 ps	Oscilloscope
Photo Tachometer ^{1,2}	Up to 100 000 rpm	0.000 17 % of reading + 0.001 6 rpm	Function Generator with Lamp

[Return to Site listing \(top\)](#) [Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

TISSCO / Micro Precision Calibration

Street # 11, Gate 74, Bldg 163, Salwa Industrial Area
Doha, State of Qatar

Contact: Joe Mannix Retuerne Phone: +74 33173062
joe.m@tissco-qatar.com www.microprecision.com

CALIBRATION

Acoustics and Vibration

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Accelerometers and Vibration Meters, Acceleration 30 Hz to 2 kHz	(0.01 to 19.99) g	2.8 % of reading	Accelerometer System
Sound Pressure Level (SPL) and Dosimeters ¹ 1 kHz Frequency	94 / 114 dB	0.27 dB	Sound Level Calibrator, Sound Level Meter

Chemical Quantities

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Measure ^{1,4}	10 µS/cm 148 µS/cm 501 µS/cm 1 418 µS/cm 10 000 µS/cm	0.15 µS/cm 7.5 µS/cm 3 µS/cm 7.5 µS/cm 45 µS/cm	Comparison to Standard Solutions
pH Measure ^{1,4}	4, 7, 10 pH	0.02 pH	Comparison to Standard Solutions
Turbidity Measure ¹	< 0.1 NTU 25 NTU 50 NTU 100 NTU 175 NTU	0.013 NTU 0.81 NTU 1.6 NTU 3.3 NTU 5.8 NTU	ISO/IEC 17034 Accredited Turbidity Solutions

Electrical – DC/Low Frequency

Doha, Qatar

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	20 μ V/V + 0.7 μ V 0.91 mV/V + 1.1 μ V 20 μ V/V + 4 μ V 0.12 mV/V + 7.4 μ V 0.11 mV/V + 91 μ V 20 μ V/V + 0.57 mV	Multiproduct Calibrator
DC High Voltage Source ¹	(1.1 to 20) kV (20 to 70) kV	0.7 mV/V 0.8 mV/V	High Voltage Tester with High Voltage Meter
DC Voltage Measure ¹	10 nV to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	20 μ V/V 30 μ V/V 20 μ V/V 20 μ V/V 20 μ V/V	Multimeter
DC High Voltage Measure ¹	(1 to 70) kV	0.7 μ V/V	High Voltage Meter
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	50 μ A/A + 7 nA 0.26 mA/A + 8 nA 0.29 mA/A + 45 nA 60 μ A/A + 1 μ A 0.22 mA/A + 14 μ A	Multiproduct Calibrator
High DC Current Source ¹	(2 to 11) A 500 A	0.69 mA/A + 0.4 mA 1.4 mA/A	Multiproduct Calibrator with Coil
	1 000 A	1.8 mA/A	Multiproduct Calibrator with Coil
DC Current Measure ¹	(1 pA to 100) μ A 100 μ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1 A	67 μ A/A 56 μ A/A 56 μ A/A 77 μ A/A 0.25 mA/A	Multimeter
High DC Current Measure ¹	(1 to 50) A (50 to 100) A (100 to 500) A (500 to 1 000) A	1.6 mA/A 3.7 mA/A 3.7 mA/A 3.7 mA/A	Multimeter with Shunt
Resistance Source ¹	10 $\mu\Omega$ 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	1.1 m Ω / Ω 0.68 m Ω / Ω 0.26 m Ω / Ω 0.16 m Ω / Ω 0.17 m Ω / Ω 0.18 m Ω / Ω	Multiproduct Calibrator

Electrical – DC/Low Frequency

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance Source ¹	(3.3 to 11) k Ω (11 to 33) k Ω (33 to 110) k Ω (110 to 330) k Ω 330 k Ω to 1.1 M Ω (1.1 to 3.3) M Ω (3.3 to 11) M Ω (11 to 33) M Ω (33 to 110) M Ω (110 to 330) M Ω	0.42 m Ω/Ω 0.19 m Ω/Ω 0.19 m Ω/Ω 0.16 m Ω/Ω 0.23 m Ω/Ω 0.42 m Ω/Ω 0.16 m Ω/Ω 1.2 m Ω/Ω 6.3 m Ω/Ω 5.7 m Ω/Ω	Multiproduct Calibrator
Resistance Source ¹ Fixed Points	1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω 10 M Ω 100 M Ω	0.14 m Ω/Ω 40 $\mu\Omega/\Omega$ 30 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 30 $\mu\Omega/\Omega$ 90 $\mu\Omega/\Omega$ 0.67 m Ω/Ω	Multiproduct Calibrator
Resistance Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	40 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 50 $\mu\Omega/\Omega$ 30 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 60 $\mu\Omega/\Omega$ 0.11 m Ω/Ω 0.58 m Ω/Ω 5.7 m Ω/Ω	Multimeter
Capacitance Source ¹ 1 kHz	(330 to 500) pF 500 pF to 1.1 nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F	38 mF/F 17 mF/F 9.4 mF/F 6.7 mF/F 6.7 mF/F 3.9 mF/F 4.0 mF/F 3.9 mF/F 4 mF/F 5 mF/F 5.1 mF/F	Multiproduct Calibrator
Capacitance – Source ¹ 1 kHz	(33 to 110) μ F (110 to 330) μ F 330 μ F to 1.1 mF	6.8 mF/F 9.1 mF/F 2.1 mF/F	Multiproduct Calibrator

Electrical – DC/Low Frequency

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type B		Multiproduct Calibrator
	(600 to 800) °C	0.5 °C	
	(800 to 1 000) °C	0.39 °C	
	(1 000 to 1 550) °C	0.34 °C	
	(1 550 to 1 850) °C	0.37 °C	
	Type C		
	(0 to 150) °C	0.34 °C	
	(150 to 650) °C	0.29 °C	
	(650 to 1 000) °C	0.35 °C	
	(1 000 to 1 800) °C	0.57 °C	
	(1 800 to 2 316) °C	0.95 °C	
	Type E		
	(-250 to -100) °C	0.57 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 350) °C	0.16 °C	
	(350 to 650) °C	0.18 °C	
	(650 to 1 000) °C	0.24 °C	
	Type J		
	(-210 to -100) °C	0.31 °C	
	(-100 to -30) °C	0.18 °C	
	(-30 to 150) °C	0.16 °C	
	(150 to 760) °C	0.19 °C	
	(760 to 1 200) °C	0.26 °C	
	Type K		
	(-200 to -100) °C	0.37 °C	
	(-100 to -25) °C	0.2 °C	
	(-25 to 120) °C	0.18 °C	
	(120 to 1 000) °C	0.3 °C	
	(1 000 to 1 372) °C	0.45 °C	
	Type L		
	(-200 to -100) °C	0.42 °C	
	(-100 to 800) °C	0.29 °C	
	(800 to 900) °C	0.19 °C	
	Type N		
	(-200 to -100) °C	0.45 °C	
	(-100 to -25) °C	0.25 °C	
	(-25 to 120) °C	0.22 °C	
	(120 to 410) °C	0.2 °C	
	(410 to 1 300) °C	0.31 °C	

Electrical – DC/Low Frequency

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type R (0 to 250) °C	0.65 °C	Multiproduct Calibrator
	(250 to 1 000) °C	0.4 °C	
	(1 000 to 1 400) °C	0.37 °C	
	(1 400 to 1 767) °C	0.45 °C	
	Type S (0 to 250) °C	0.53 °C	
	(250 to 1 000) °C	0.41 °C	
	(1 000 to 1 400) °C	0.42 °C	
	(1 400 to 1 767) °C	0.52 °C	
	Type T (-250 to -150) °C	0.71 °C	
	(-150 to 0) °C	0.27 °C	
	(0 to 120) °C	0.18 °C	
	(120 to 400) °C	0.16 °C	
	Type U (-200 to 0) °C	0.63 °C	
	(0 to 600) °C	0.31 °C	
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 100 Ω (-200 to 0) °C	0.06 °C	Multiproduct Calibrator
	(0 to 100) °C	0.08 °C	
	(100 to 300) °C	0.1 °C	
	(30 to 400) °C	0.11 °C	
	(400 to 630) °C	0.14 °C	
	(630 to 800) °C	0.26 °C	
	Pt 3926, 100 Ω (-200 to 0) °C	0.06 °C	
	(0 to 100) °C	0.08 °C	
	(100 to 300) °C	0.1 °C	
	(300 to 400) °C	0.11 °C	
	(400 to 600) °C	0.14 °C	
	Pt 3916, 100 Ω (-200 to -190) °C	0.28 °C	
	(-190 to -80) °C	0.05 °C	
	(-80 to 0) °C	0.06 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.12 °C	
	(600 to 630) °C	0.26 °C	

Electrical – DC/Low Frequency

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 200 Ω		Multiproduct Calibrator
	(-200 to 0) $^{\circ}\text{C}$	0.05 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.05 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.06 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.14 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.15 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.16 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.18 $^{\circ}\text{C}$	
	Pt 385, 500 Ω		
	(-200 to 0) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.05 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.06 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.08 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.13 $^{\circ}\text{C}$	
	Pt 385, 1 k Ω		
	(-200 to 0) $^{\circ}\text{C}$	0.04 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.05 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.06 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(300 to 600) $^{\circ}\text{C}$	0.08 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.26 $^{\circ}\text{C}$	
	PtNi 385, 100 Ω		
	(-80 to 0) $^{\circ}\text{C}$	0.09 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.09 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.16 $^{\circ}\text{C}$	
	Cu 427, 10 Ω		
	(-100 to 260) $^{\circ}\text{C}$	0.34 $^{\circ}\text{C}$	
AC Voltage Source ¹	Up to 2.2 mV		Multiproduct Calibrator
	(10 to 40) Hz	2.1 mV/V + 5.1 μV	
	40 Hz to 20 kHz	1.5 mV/V + 5.1 μV	
	(20 to 50) kHz	2.5 mV/V + 5.1 μV	
	(50 to 100) kHz	7.9 mV/V + 7.9 μV	
	(100 to 500) kHz	2.4 mV/V + 29 μV	
	500 MHz to 1 MHz	6.1 mV/V + 29 μV	

Electrical – DC/Low Frequency

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Source ¹	(2.2 to 22) mV		Multiproduct Calibrator
	(10 to 20) Hz	0.64 mV/V + 1.7 μ V	
	(20 to 40) Hz	0.27 mV/V + 5.7 μ V	
	40 Hz to 20 kHz	0.17 mV/V + 5.7 μ V	
	(20 to 50) kHz	0.46 mV/V + 5.7 μ V	
	(50 to 100) kHz	1 mV/V + 7.9 μ V	
	(100 to 300) kHz	1.4 mV/V + 14 μ V	
	(300 to 500) kHz	2.1 mV/V + 29 μ V	
	500 kHz to 1 MHz	4.3 mV/V + 29 μ V	
	(22 to 220) mV		
	(10 to 20) Hz	0.63 mV/V + 15 μ V	
	(20 to 40) Hz	0.24 mV/V + 9.1 μ V	
	40 Hz to 20 kHz	0.13 mV/V + 9.1 μ V	
	(20 to 50) kHz	0.38 mV/V + 9.1 μ V	
	(50 to 100) kHz	1 mV/V + 29 μ V	
	(100 to 300) kHz	1.3 mV/V + 29 μ V	
	(300 to 500) kHz	2 mV/V + 40 μ V	
	500 kHz to 1 MHz	4 mV/V + 91 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.57 mV/V + 91 μ V	
	(20 to 40) Hz	0.18 mV/V + 29 μ V	
	40 Hz to 20 kHz	90 μ V/V + 6.8 μ V	
	(20 to 50) kHz	0.14 mV/V + 18 μ V	
	(50 to 100) kHz	0.3 mV/V + 80 μ V	
	(100 to 300) kHz	0.51 mV/V + 0.15 mV	
	(300 to 500) kHz	1.3 mV/V + 0.4 mV	
	500 kHz to 1 MHz	2.6 mV/V + 0.97 mV	
	(2.2 to 22) V		
	(10 to 20) Hz	0.57 mV/V + 0.9 mV	
	(20 to 40) Hz	0.18 mV/V + 0.3 mV	
	40 Hz to 20 kHz	90 μ V/V + 0.1 mV	
	(20 to 50) kHz	0.16 mV/V + 0.2 mV	
	(50 to 100) kHz	0.34 mV/V + 0.4 mV	
	(100 to 300) kHz	0.73 mV/V + 1.7 mV	
	(300 to 500) kHz	1.5 mV/V + 4.9 mV	
	500 kHz to 1 MHz	3.2 mV/V + 9.2 mV	

Electrical – DC/Low Frequency

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Source ¹	(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 (220 to 750) V (30 to 50) kHz (50 to 100) kHz 220 V to 1.1 kV (15 to 50) Hz 50 Hz to 1 kHz	0.57 mV/V + 9.1 mV 0.18 mV/V + 2.8 mV 0.09 mV/V + 0.9 mV 0.26 mV/V + 4 mV 0.59 mV/V + 9.1 mV 0.48 mV/V + 13 mV 1.8 mV/V + 51 mV 0.45 mV/V + 18 mV 90 μ V/V + 4 mV	Multiproduct Calibrator
High AC Voltage Source ¹	(1.1 to 20) kV 50 Hz (20 to 50) kV 50 Hz	0.7 mV/V 0.8 mV/V	High Voltage Tester, High Voltage Meter
AC Voltage Measure ¹	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz 100 mV to 10 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	0.9 mV/V + 3.4 μ V 0.3 mV/V + 1.2 μ V 0.4 mV/V + 1.2 μ V 1.2 mV/V + 1.2 μ V 6.1 mV/V + 1.2 μ V 50 mV/V + 2.3 μ V 0.1 mV/V + 4.5 μ V 0.1 mV/V + 2.3 μ V 0.2 mV/V + 2.3 μ V 0.3 mV/V + 2.3 μ V 1.0 mV/V + 2.3 μ V 3.7 mV/V + 12 μ V 12 mV/V + 12 μ V 17 mV/V + 0.1 mV 0.1 mV/V + 0.5 mV 0.1 mV/V + 0.2 mV 0.2 mV/V + 0.2 mV 0.4 mV/V + 0.2 mV 1 mV/V + 0.2 mV 3.7 mV/V + 1.1 mV 13 mV/V + 1.1 mV	Multimeter in Synchronous sub-sampled mode

Electrical – DC/Low Frequency

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Measure ¹	(10 to 100) V		Multimeter in Synchronous sub-sampled mode
	(1 to 40) Hz	0.3 mV/V + 4.5 mV	
	40 Hz to 1 kHz	0.3 mV/V + 2.3 mV	
	(1 to 20) kHz	0.3 mV/V + 2.3 mV	
	(20 to 50) kHz	0.5 mV/V + 2.3 mV	
	(50 to 100) kHz	1.6 mV/V + 2.3 mV	
	(100 to 300) kHz	4.6 mV/V + 12 mV	
	300 kHz to 1 MHz	17 mV/V + 12 mV	
	100 V to 1 kV		
	(1 to 40) Hz	0.5 mV/V + 46 mV	
	40 Hz to 1 kHz	0.5 mV/V + 23 mV	
	(1 to 20) kHz	0.7 mV/V + 23 mV	
	(20 to 50) kHz	1.4 mV/V + 23 mV	
	(50 to 100) kHz	3.4 mV/V + 23 mV	
High AC Voltage Measure ¹	(1 to 20) kV		High Voltage Meter
	(50 to 100) Hz	3.8 mV/V	
	(20 to 50) kV		
	(50 to 60) Hz	6.1 mV/V	
AC Current Source ¹	Up to 220 μ A		Multiproduct Calibrator
	(10 to 20) Hz	0.5 mA/A + 20 nA	
	(20 to 40) Hz	0.3 mA/A + 10 nA	
	40 Hz to 1 kHz	0.2 mA/A + 10 nA	
	(1 to 5) kHz	0.7 mA/A + 20 nA	
	(5 to 10) kHz	1.9 mA/A + 90 nA	
	220 μ A to 2.2 mA		
	(10 to 20) Hz	0.4 mA/A + 60 nA	
	(20 to 40) Hz	0.2 mA/A + 50 nA	
	40 Hz to 1 kHz	0.2 mA/A + 50 nA	
	(1 to 5) kHz	0.5 mA/A + 0.15 μ A	
	(5 to 10) kHz	1.5 mA/A + 0.91 μ A	
	(2.2 to 22) mA		
	(10 to 20) Hz	0.4 mA/A + 0.57 μ A	
	(20 to 40) Hz	0.2 mA/A + 0.45 μ A	
	40 Hz to 1 kHz	0.2 mA/A + 0.45 μ A	
	(1 to 5) kHz	0.4 mA/A + 0.79 μ A	
	(5 to 10) kHz	1.4 mA/A + 6.8 μ A	

Electrical – DC/Low Frequency

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Source ¹	(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	1.3 mA/A + 5.7 μ A 0.6 mA/A + 4.6 μ A 0.6 mA/A + 3.4 μ A 2.7 mA/A + 4.6 μ A 6.7 mA/A + 14 μ A 0.4 mA/A + 50 μ A 0.6 mA/A + 0.11 mA 9.2 mA/A + 0.23 mA	Multiproduct Calibrator
AC Current Source ¹	(2.2 to 11) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.9 mA/A + 2.3 mA 2.4 mA/A + 2.3 mA 5.6 mA/A + 2.3 mA	Multiproduct Calibrator
AC Current Source ¹	(11 to 20) A 30 Hz to 5 kHz	0.96 mA/A	Multiproduct Calibrator with Amplifier
AC Current Source ¹	(20 to 1 000) A 30 Hz to 1 kHz (1 to 5) kHz	6.3 mA/A 1.1 mA/A	Multiproduct Calibrator with 50-turn coil and Amplifier
AC Current Measure ¹	Up to 100 μ A (10 to 20) Hz (20 to 45) Hz 45 Hz to 5 kHz 100 μ A to 1 mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (1 to 10) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz (10 to 100) mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.6 mA/A + 30 nA 1.8 mA/A + 30 nA 0.9 mA/A + 30 nA 4.5 mA/A + 0.23 μ A 1.7 mA/A + 0.23 μ A 0.7 mA/A + 0.23 μ A 0.5 mA/A + 0.23 μ A 4.5 mA/A + 2.3 μ A 1.7 mA/A + 2.3 μ A 0.7 mA/A + 2.3 μ A 0.5 mA/A + 2.3 μ A 4.5 mA/A + 20 μ A 1.7 mA/A + 20 μ A 0.7 mA/A + 20 μ A 0.5 mA/A + 20 μ A	Multimeter

Electrical – DC/Low Frequency

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Measure ¹	100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.7 mA/A + 0.23 mA 2.2 mA/A + 0.23 mA 1.5 mA/A + 0.23 mA 1.6 mA/A + 0.23 mA	Multimeter
AC Power – Measure ¹	(0 to 9.999) kW (9 to 99.9) kW (100 to 999.9) kW (1 to 9.999) MW	1 % of reading + 0.008 kW 1 % of reading + 0.08 kW 1 % of reading + 0.8 kW 1 % of reading + 0.008 MW	Power Analyzer
Power Factor ¹	(0 to 1) PF	0.04 PF	Power Analyzer
Loop & RCD – Measure ¹ Line Voltage Line Frequency Loop Compensation Loop Impedance RCD Current RCD Trip Time	(200 to 260) Vrms (45 to 65) Hz (0 to 9.999) Ω (0.05 to 1 800) Ω (10 to 2 500) mA (10 to 100) ms (100 to 2 000) ms	3.2 mV/V 3.4 mHz/Hz 3.2 m Ω / Ω + 0.34 Ω 3.2 m Ω / Ω + 7 m Ω 0.32 mA/A + 11 μ A 0.63 ms 0.63 ms	Insulation Tester
Insulation Resistance Measure ¹ Insulation Test Voltage	500 V to 2 kV 100 k Ω to 5 M Ω 1 kV (10 to 90) M Ω 6 kV (100 to 190) M Ω (1 to 9) G Ω 10 kV (10 to 100) G Ω	0.57 % of reading 0.57 % of reading 0.57 % of reading 0.59 % of reading 0.58 % of reading	Insulation Tester
Oscilloscopes ¹ Leveled Sine Wave 50 kHz reference Level Sine Flatness Relative to 50 kHz Square Wave 10 Hz to 10 kHz 1 M Ω 50 Ω	5 mVp-p to 5 Vp-p 5 mVp-p to 5.5 Vp-p 50 kHz to 100 MHz (100 to 300) MHz 1.8 mVp-p to 55 Vp-p 1.8 mVp-p to 2.5 Vp-p	23 mV/V + 0.34 mV 20 mV/V + 0.12 mV 26 mV/V + 0.12 mV 36 mV/V + 0.12 mV 34 mV/V + 0.12 mV	Multiproduct Calibrator

Electrical – DC/Low Frequency

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ¹ Time Marker Output Into 50 Ω	2 ns to 20 ms 50 ms to 5 s	2.8×10^{-6} s 0.11 % of reading	Multiproduct Calibrator
Pulse Rise Time (10, 25, 100, 250) mVp-p (1, 2.5) Vp-p	20 ms to 200 ns 50 Hz to 5 MHz	2.9×10^{-6} s	

Electrical – RF/Microwave

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Tuned Power Source ¹ Connector Type N	(-100 to 0) dB Up to 1.3 GHz Up to 26.5 GHz	0.34 dB 0.68 dB	Measuring Receiver and Power Sensor
RF Absolute Power Source ¹ Connector Type N 50 MHz to 26.5 GHz	(-110 to -70) dB (-70 to -50) dB (-50 to -10) dB (-10 to 0) dB (10 to 20) dB	0.66 dB 0.26 dB 0.15 dB 0.08 dB 1.1 dB	Power Meter and Power Sensor
Phase Modulation Measure ¹ 200 Hz to 20 kHz	Rate: 10 MHz to 1.3 GHz	4.1 % of reading	Measuring Receiver
Amplitude Modulation Measure ¹ 50 Hz to 10 kHz 20 Hz to 100 kHz 50 Hz to 50 kHz 20 Hz to 100 kHz	Rate: 150 kHz to 10 MHz Depth: (5 to 99) % Rate: 10 MHz to 1.3 GHz Depth: (5 to 99) %	2.1 % of reading 3.1 % of reading 1.1 % of reading 3.1 % of reading	Measuring Receiver
Frequency Modulation Measure ¹ 20 Hz to 10 kHz 20 Hz to 200 kHz 50 Hz to 100 kHz	Rate: 250 kHz to 10 MHz Dev: ≤ 40 kHz Rate: 10 MHz to 1.3GHz Dev: ≤ 400 kHz	2 % of reading 5 % of reading 1.1 % of reading	Measuring Receiver

Length – Dimensional Metrology

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2} 0.01 mm Resolution 0.02 mm Resolution 0.05 mm Resolution	(0.5 to 1 000) mm (0.5 to 1 000) mm (0.5 to 1 000) mm	(5.6 + 0.001 <i>l</i>) μm (12 + 0.000 6 <i>l</i>) μm (29 + 0.000 2 <i>l</i>) μm	Gage Blocks, Length Rods
Cylindrical Gages ² Plugs & Pins	Up to 100 mm (0.02 to 2) in	(0.39 + 0.002 <i>l</i>) μm 32 μin	Universal Length Measuring Machine, Gage Blocks
Fixture Gages ² X-Axis Y-Axis Z- Axis	250 mm 150 mm 150 mm	(2.4 + 0.005 <i>l</i>) μm (1.5 + 0.015 <i>l</i>) μm (1.6 + 0.014 <i>l</i>) μm	Video Measuring System
Coating Thickness ⁶ Ferrous & Non-Ferrous	(0 to 59) mil (0 to 1 496) μm	0.13 mil 3.5 μm	Thickness Standards
Gage Blocks ² (Length Only)	Up to 100 mm	(0.14 + 0.003 <i>l</i>) μm	Universal Length Measuring Machine, Gage Blocks
Height Gages, Length Only ¹ Dial Digital Vernier	Up to 1 000 mm Up to 1 000 mm Up to 1 000 mm	9.3 μm 9.3 μm 13 μm	Gage Blocks
Indicators ^{1,2} Resolution: 0.001 mm 0.002 mm 0.005 mm 0.01 mm 0.02 mm	(0.08 to 100) mm (0.08 to 100) mm (0.08 to 100) mm (0.08 to 100) mm (0.08 to 100) mm	(0.6 + 0.000 8 <i>l</i>) μm (1.1 + 0.000 4 <i>l</i>) μm (2.8 + 0.000 2 <i>l</i>) μm (5.7 + 0.000 1 <i>l</i>) μm (11 + 0.000 04 <i>l</i>) μm	Digital Indicator Calibrator, Gage Blocks
Length Standards ²	Up to 200 mm	(0.2 + 0.004 <i>l</i>) μm	Universal Measuring Length Machine, Gage Blocks
Micrometers ^{1,2} Resolution 0.0001 mm 0.001 mm 0.01 mm	Up to 900 mm Up to 900 mm Up to 900 mm	(0.21 + 0.006 <i>l</i>) μm (0.48 + 0.006 <i>l</i>) μm (5.49 + 0.002 <i>l</i>) μm	Gage Blocks
Optical Comparators & Visual Systems ^{1,2} X & Y Axis	Up to 100 mm Up to 12 in	(0.96 + 0.007 <i>l</i>) μm (160 + 0.001 <i>l</i>) μin	Gage Blocks, Glass Scales
Portable Gaging – Rulers ²	Up to 2 000 mm	(290 + 0.000 1 <i>l</i>) μm	Gage Blocks
Sieves or Mesh Openings ²	(1 to 125) mm (20 to 900) μm	(4.7 + 0.001 <i>l</i>) μm (3.7 + 0.002 <i>l</i>) μm	Video Measuring Machine

Length – Dimensional Metrology

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Surface Plates – Local Area Flatness Only ¹	Up to 250 µm	1.4 µm	Repeat-O-Meter

Mass and Mass Related

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque – Measure ¹	(0.1 to 1) Nm (1 to 25) Nm (8 to 150) Nm (30 to 1 500) Nm (1 500 to 3 390) Nm	0.86 % of reading 0.73 % of reading 0.41 % of reading 0.38 % of reading 0.31 % of reading	Torque System
Scales & Balances ^{1,3} Micro & Analytical Balances	Up to 500 mg 500 mg to 2 g (2 to 5) g (5 to 50) g (55 to 200) g (200 to 500) g	5 µg 9 µg 12 µg 59 µg 0.1 mg 0.23 mg	OIML Class E-1 Weights
Scales & Balances ^{1,3} Precision Balances	500 g to 1 kg (1 to 5) kg (5 to 10) kg (10 to 20) kg (20 to 30) kg	1.1 mg 3.9 mg 10 mg 11mg 82 mg	OIML Class E-1 Weights
Scales & Balances ^{1,3} Industrial Balances	Up to 300 kg (500 to 1 000) kg (1 000 to 2 500) kg (2 500 to 5 000) kg	0.75 g 47 g 0.29 kg 0.81 kg	OIML Class F1 Weights
Pressure ¹ Digital (Pneumatic)	(-0.83 to 0.01) mbar (0.01 to 800) mbar 800 mbar to 20 bar	-0.42 mbar + 0.92 % of reading 0.42 mbar + 0.16 % of reading 0.035 % of reading	Pressure Calibrator
	0.35 to 1 bar (1 to 210) bar	0.026 % of reading 0.025 % of reading	Pressure Controller
Digital (Hydraulic)	0.01 to 900 bar (900 to 1 800) bar (1 800 to 2 700) bar	0.018 % of reading 0.026 % of reading 0.027 % of reading	Pressure Controller
Pressure Safety Valve Testing	(0.01 to 300) bar	0.018 % of reading	Pressure Controller
Dead Weight Pressure	0.01 to 55 bar (55 to 1 100) bar	0.015 % of reading 0.01 % of reading	Dead Weight Pressure Standard

Mass and Mass Related

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force ¹ Compression	0.1 to 200 kN (200 to 3 000) kN (1 to 5 000) kN	0.13 % of reading 0.3 % of reading 0.5 % of reading	Comparison to Standard Load Cell
Force ¹ Tension	0.1 to 200 kN (200 to 1 700) kN	0.13 % of reading 0.52 % of reading	
Force ¹ Stability	1 to 2 000 kN	0.16 % of reading	
Mass Determination (SI)	1 mg (2 to 50) mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g	6 µg 7 µg 8 µg 9 µg 11 µg 13 µg 10 µg 20 µg 20 µg 30 µg 80 µg	OIML Class E-1 with Balance
Mass Determination (SI)	100 g 200 g 500 g 1 kg 2 kg 5 kg 10 kg	60 µg 0.1 mg 5.7 mg 5.7 mg 5.8 mg 6.4 mg 57 mg	OIML Class E-1 with Balance
Mass Determination (SI)	(20 to 25) kg	0.29 g	Class F1 with Balance
Concrete Hammer ¹ Impact Energy	(10 to 100) N/mm ²	1.8 N/mm ²	Test Anvil ASTM C805
Air Flow – Measure ¹	(0.005 to 10) slpm (10 to 50) slpm	0.88 % of reading 0.78 % of reading	BIOS Standard Flow Calibrator
POVA (Piston/Plunger Operated Volumetric Apparatus) ¹ Pipettes, Syringes, Dilutors, Titrators, Piston/Displacement Burettes (Burets), Dispensers, Liquid Handlers	(0.1 to 20) µl 20 µl to 10 ml	0.1 % of reading + 0.013 µl 0.091 % of reading + 0.029 µl	Gravimetric Method referenced to OIML Class E1 Mass Standard and Balances

Mass and Mass Related

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Volumetric Glassware ¹ Volumetric Apparatus, Flasks, Burettes, Volumetric Dispensers, Cylinders, Graduated Cylinders, Beakers, Vials, & Containers	(1 to 2) ml (2 to 25) ml (25 to 50) ml (50 to 100) ml (100 to 250) ml (250 to 500) ml (500 to 1 000) ml (1 000 to 2 000) ml	0.29 % of reading 0.12 % of reading 0.1 % of reading 0.08 % of reading 0.06 % of reading 0.04 % of reading 0.03 % of reading 0.03 % of reading	ISO 4787 Gravimetric Method referenced to OIML Class E1 Mass Standard and Balances
Water Flow – Measure ¹ DN6 to DN100 Pipe Size Flow Rate - Mass	15 000 kg/h	0.11 % of reading	Coriolis Flow Meter
Water Flow – Measure ¹ 12.7 mm to 7.6 meter Pipe Size Flow Velocity	1 500 LPM	1.8 % of reading	Ultrasonic Flow Meter

Photometry and Radiometry

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power – Measure ¹ 850 nm 1 310 nm 1 550 nm	(6 to -60) dB (10 to -110) dB (10 to -110) dB	4.8 % of reading + 0.01 dB 4.6 % of reading+ 0.01 dB 4.6 % of reading+ 0.01 dB	Laser Source, Tunable Laser, Optical Attenuator, Optical Power Sensor
Optical Wavelength – Measure ¹	(700 to 1 650) nm	3.9 % of reading	Multi-Wavelength Meter

Thermodynamic

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity – Source ¹	11 %RH 33 %RH 75 %RH 97 %RH	1.6 %RH 1.7 %RH 1.7 %RH 2 %RH	Saturated Salt Solutions
Humidity – Source	(11 to 95) %RH	2.2 %RH	Humidity Generator Chamber

Thermodynamic

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure ¹	(-196 to 231) °C (231 to 419) °C (419 to 660) °C	0.022 °C 0.045 °C 0.066 °C	RTD Probe with Meter
Temperature – Source ¹	Up to 1 200 °C	2.4 °C	Dry Block Calibrator with Thermocouple
Radiation (Infrared) Thermometers ¹	(-25 to 0) °C (0 to 50) °C (50 to 100) °C	0.81 °C 0.84 °C 0.98 °C	Blackbody Calibrator (Cavity) $\epsilon = 0.98, \lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers ¹	(100 to 250) °C (250 to 750) °C (750 to 950) °C	2.4 °C 4.7 °C 7.1 °C	Blackbody Calibrator (Cavity) $\epsilon = 0.99, \lambda = (8 \text{ to } 14) \mu\text{m}$
Oven ¹	Up to 400 °C	1.7 °C	RTD Probe with Meter
Furnace ¹	Up to 1 200 °C	3.3 °C	TC Type-S with Multifunction Calibrator
Chamber Profiling ¹	Up to 400 °C	0.81 °C	TC Type-K with Datalogger

Time and Frequency

Doha, Qatar

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure Fixed Point	1 MHz 10 MHz	5.9×10^{-10} Hz 5.9×10^{-10} Hz	GPS Reference Receiver
Frequency – Measure	DC to 1 MHz (1 to 225) MHz	2.7×10^{-4} Hz 4.6×10^{-8} Hz	Counter, GPS Reference Receiver
Photo-Tachometer – Measure ^{1,2}	Up to 1 000 rpm (1 000 to 100 000) rpm	0.16 rpm 1.7 rpm	Signal Generator with LED

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)

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CALIBRATION AND DIMENSIONAL MEASUREMENT

CALIBRATION

Acoustics and Vibration

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Sound Pressure Level – Measure Equipment ¹	(94 & 114) dB @ 1 kHz	0.69 dB	Comparison to Sound Level Calibrator
Sound Pressure Level – Source	(30 to 130) dB 31.5 Hz to 8 kHz	0.75 dB 0.28 % of reading	Transfer Method to Sound Level Calibrator and Frequency Meter

Chemical Quantities

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Hydrogen Potential – pH Meters	2 pH 4 pH 7 pH 10 pH	0.011 pH 0.011 pH 0.011 pH 0.011 pH	Standard Solutions and Thermometer
Conductivity - Measure	10 µS/cm 100 µS/cm 1 015 µS/cm 1 408 µS/cm	0.57 µS/cm 2.3 µS/cm 8.2 µS/cm 11 µS/cm	Standard Solutions and Thermometer

Electrical – DC/Low Frequency

Mexicali, BC

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 22) V (22 to 220) V (220 to 1 100) V	12 $\mu\text{V/V} + 0.93 \mu\text{V}$ 9.5 $\mu\text{V/V} + 1.2 \mu\text{V}$ 9.6 $\mu\text{V/V} + 1 \mu\text{V}$ 12 $\mu\text{V/V} + 21 \mu\text{V}$ 14 $\mu\text{V/V} + 0.2 \text{ mV}$	Multiproduct Calibrator
DC Voltage – Measure ¹	Up to 100 mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1 000) V	2.0 $\mu\text{V/V} + 0.57 \mu\text{V}$ 5.2 $\mu\text{V/V} + 0.57 \mu\text{V}$ 4.7 $\mu\text{V/V} + 1 \mu\text{V}$ 8 $\mu\text{V/V} + 28 \mu\text{V}$ 23 $\mu\text{V/V} + 1.5 \text{ mV}$	Multimeter
DC Voltage – Measure ¹ High Voltage	(0.1 to 10) kV (10 to 30) kV	0.71 mV/V + 0.24 V 0.9 mV/V	High Voltage Meter System
DC Current – Source ¹	Up to 220 μA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA (0.22 to 2.2) A (2.2 to 11) A	19 $\mu\text{A/A} + 1.4 \text{ nA}$ 15 $\mu\text{A/A} + 2.2 \text{ nA}$ 17 $\mu\text{A/A}$ 21 $\mu\text{A/A}$ 50 $\mu\text{A/A}$ 95 $\mu\text{A/A} + 95 \mu\text{A}$	Multiproduct Calibrator
	(11 to 1 000) A	0.22 % of reading	Multiproduct Calibrator with Current Coil
DC Current – Measure ¹	Up to 1 μA (1 to 10) μA (10 to 100) μA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	16 $\mu\text{A/A} + 75 \text{ pA}$ 29 $\mu\text{A/A} + 62 \text{ pA}$ 22 $\mu\text{A/A} + 0.14 \text{ nA}$ 24 $\mu\text{A/A} + 0.1 \text{ nA}$ 24 $\mu\text{A/A} + 0.17 \text{ nA}$ 43 $\mu\text{A/A} + 0.2 \mu\text{A}$ 0.14 mA/A + 9.5 μA	Multimeter
	(1 to 15) A (15 to 100) A (100 to 300) A	0.5 mA/A + 1 mA 1 mA/A + 0.1 mA 0.9 mA/A + 42 mA	Shunt Monitored with Multimeter
	(10 to 2 000) A	0.85 % of reading	Clamp Meter
Inductance – Source ¹ (Fixed Artifacts) (0.1 to 10) kHz	1 mH 20 mH 100 mH 1 H	0.029 % of reading 0.074 % of reading 0.031 % of reading 0.027 % of reading	Standard Inductors

Electrical – DC/Low Frequency

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Capacitance – Source ¹ (Simulation) Frequency 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 Hz to 600 Hz 10 Hz to 300 Hz 10 Hz to 150 Hz 10 Hz to 120 Hz 10 Hz to 80 Hz 50 Hz 20 Hz 6 Hz 2 Hz 0.6 Hz 0.2 Hz	(190 to 399.9) pF (0.4 to 1.099 9) nF (1.1 to 3.299 9) nF (3.3 to 10.999) nF (11 to 32.999) nF (33 to 109.99) nF (110 to 329.99) nF (0.33 to 1.099 9) μ F (1.1 to 3.299 9) μ F (3.3 to 10.999) μ F (11 to 32.999) μ F (33 to 109.99) μ F (110 to 329.99) μ F (0.33 to 1.099 9) mF (1.1 to 3.299 9) mF (3.3 to 10.999) mF (11 to 32.999) mF (33 to 110) mF	4.4 mF/F + 12 pF 4.2 mF/F + 12 pF 10 mF/F 2 mF/F + 15 pF 8 mF/F 2.4 mF/F + 0.11nF 2.4 mF/F + 0.33nF 2.2 mF/F + 1.2 nF 2.2 mF/F + 3.6 nF 2.3 mF/F + 11 nF 3.6 mF/F + 33 nF 4.1 mF/F + 0.11 μ F 4.1 mF/F + 0.34 μ F 4 mF/F + 1.2 μ F 3.9 mF/F + 3.5 μ F 4 mF/F + 12 μ F 8.1 mF/F + 35 μ F 12 mF/F + 0.12mF	Multiproduct Calibrator
Capacitance – Source ¹ (Variable Artifact)	10 pF to 1.111 1 μ F	0.6 % of reading	Decade Capacitor
Resistance – Source ¹ (Simulation)	Up to 1.9 Ω (1.9 to 19) Ω (19 to 190) Ω (0.19 to 1.9) k Ω (1.9 to 19) k Ω (19 to 190) k Ω (0.19 to 1.9) M Ω (1.9 to 19) M Ω (19 to 100) M Ω	96 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 26 $\mu\Omega/\Omega$ + 0.17 m Ω 22 $\mu\Omega/\Omega$ + 0.24 m Ω 17 $\mu\Omega/\Omega$ + 0.92 m Ω 18 $\mu\Omega/\Omega$ 19 $\mu\Omega/\Omega$ 30 $\mu\Omega/\Omega$ 36 $\mu\Omega/\Omega$ + 51 Ω 0.2 m Ω/Ω	Multiproduct Calibrator
Resistance – Source ¹ (Variable Artifact)	Up to 1 000 m Ω 1 Ω to 100 M Ω 100 M Ω to 1 G Ω	0.24 m Ω 0.014 % of reading 0.018 % of reading	Decade Resistor

Electrical – DC/Low Frequency

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance – Measure ¹	Up to 1 Ω (1 to 10) Ω (10 to 100) Ω (0.1 to 1) k Ω (1 to 10) k Ω (10 to 100) k Ω (0.1 to 1) M Ω (1 to 10) M Ω (10 to 100) M Ω (0.1 to 1) G Ω	33 $\mu\Omega/\Omega$ + 68 $\mu\Omega$ 16 $\mu\Omega/\Omega$ + 85 $\mu\Omega$ 18 $\mu\Omega/\Omega$ + 70 $\mu\Omega$ 9 $\mu\Omega/\Omega$ + 0.92 m Ω 10 $\mu\Omega/\Omega$ + 0.13 m Ω 12 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 92 $\mu\Omega/\Omega$ 0.71 m Ω/Ω 6.5 m Ω/Ω	Multimeter
Electrical Simulation of Thermocouple – Source / Measure ¹	Type B (600 to 800) $^{\circ}\text{C}$ (800 to 1 550) $^{\circ}\text{C}$ (1 550 to 1 820) $^{\circ}\text{C}$ Type C (0 to 1 000) $^{\circ}\text{C}$ (1 000 to 1 800) $^{\circ}\text{C}$ (1 800 to 2 316) $^{\circ}\text{C}$ Type E (-250 to -100) $^{\circ}\text{C}$ (-100 to 650) $^{\circ}\text{C}$ (650 to 1 000) $^{\circ}\text{C}$ Type J (-210 to -100) $^{\circ}\text{C}$ (-100 to 760) $^{\circ}\text{C}$ (760 to 1 200) $^{\circ}\text{C}$ Type K (-200 to -100) $^{\circ}\text{C}$ (-100 to 120) $^{\circ}\text{C}$ (120 to 1 000) $^{\circ}\text{C}$ (1 000 to 1 372) $^{\circ}\text{C}$ Type L (-200 to -100) $^{\circ}\text{C}$ (-100 to 800) $^{\circ}\text{C}$ (800 to 900) $^{\circ}\text{C}$ Type N (-200 to -100) $^{\circ}\text{C}$ (-100 to 410) $^{\circ}\text{C}$ (410 to 1 300) $^{\circ}\text{C}$	0.57 $^{\circ}\text{C}$ 0.47 $^{\circ}\text{C}$ 0.46 $^{\circ}\text{C}$ 0.37 $^{\circ}\text{C}$ 0.59 $^{\circ}\text{C}$ 0.98 $^{\circ}\text{C}$ 0.58 $^{\circ}\text{C}$ 0.19 $^{\circ}\text{C}$ 0.25 $^{\circ}\text{C}$ 0.32 $^{\circ}\text{C}$ 0.2 $^{\circ}\text{C}$ 0.27 $^{\circ}\text{C}$ 0.39 $^{\circ}\text{C}$ 0.22 $^{\circ}\text{C}$ 0.31 $^{\circ}\text{C}$ 0.47 $^{\circ}\text{C}$ 0.43 $^{\circ}\text{C}$ 0.31 $^{\circ}\text{C}$ 0.21 $^{\circ}\text{C}$ 0.47 $^{\circ}\text{C}$ 0.26 $^{\circ}\text{C}$ 0.32 $^{\circ}\text{C}$	Multiproduct Calibrator

Electrical – DC/Low Frequency

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Simulation of Thermocouple – Source / Measure ¹	Type R (0 to 250) °C (250 to 1 000) °C (1 000 to 1 767) °C Type S (0 to 250) °C (250 to 1 400) °C (1 400 to 1 767) °C Type T (-250 to -150) °C (-150 to 0) °C (0 to 400) °C Type U (-200 to 0) °C (0 to 600) °C	0.68 °C 0.44 °C 0.49 °C 0.58 °C 0.47 °C 0.57 °C 0.73 °C 0.28 °C 0.2 °C 0.65 °C 0.32 °C	Multiproduct Calibrator
Electrical Calibration of RTD – Source ¹	Pt 385, 100 Ω (-200 to 800) °C Pt 3926, 100 Ω (-200 to 630) °C Pt 3916, 100 Ω (-200 to 630) °C Pt 385, 200 Ω (-200 to 630) °C Pt 385, 500 Ω (-200 to 630) °C Pt 385, 1000 Ω (-200 to 630) °C PtNi 385, 120 Ω (-80 to 260) °C CU 427, 10 Ω (-100 to 260) °C	0.02 % of reading + 0.27 °C 0.008 3 % of reading + 0.14 °C 0.025 % of reading + 0.27 °C 0.015 % of reading + 0.19 °C 0.008 8 % of reading + 0.14 °C 0.026 % of reading + 0.27 °C 0.019 % of reading + 0.17 °C 0.35 °C	Multiproduct Calibrator
Electrical Calibration of RTD – Measure ¹	Pt 385, 100 Ω (-200 to 800) °C Pt 3926, 100 Ω (-200 to 630) °C Pt 3916, 100 Ω (-200 to 630) °C Pt 385, 200 Ω (-200 to 630) °C Pt 385, 500 Ω (-200 to 630) °C	0.039 °C 0.044 °C 0.041 °C 0.039 °C 0.054 °C	Multimeter

Electrical – DC/Low Frequency

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Calibration of RTD – Measure ¹	Pt 385, 1000 Ω (-200 to 630) $^{\circ}\text{C}$	0.043 $^{\circ}\text{C}$	Multimeter
	PtNi 385, 120 Ω (-80 to 260) $^{\circ}\text{C}$	0.042 $^{\circ}\text{C}$	
	CU 427, 10 Ω (-100 to 260) $^{\circ}\text{C}$	0.044 $^{\circ}\text{C}$	
AC Voltage – Source ¹	(0.22 to 220) mV		Multiproduct Calibrator
	(10 to 40) Hz	0.27 mV/V + 15 μV	
	40 Hz to 20 kHz	0.13 mV/V + 12 μV	
	(20 to 100) kHz	1.1 mV/V + 25 μV	
	(100 to 300) kHz	1.3 mV/V + 45 μV	
	(300 to 500) kHz	2 mV/V + 63 μV	
	500 kHz to 1 MHz	4.4 mV/V + 71 μV	
	220 mV to 2.2 V		
	(10 to 40) Hz	0.22 mV/V + 25 μV	
	40 Hz to 20 kHz	0.1 mV/V + 19 μV	
	(20 to 100) kHz	0.28 mV/V + 0.19 mV	
	(100 to 300) kHz	0.56 mV/V + 0.18 mV	
	(300 to 500) kHz	1.6 mV/V + 0.15 mV	
	500 kHz to 1 MHz	3.2 mV/V + 0.32 mV	
	(2.2 to 22) V		
	(10 to 40) Hz	0.23 mV/V + 11 μV	
	40 Hz to 20 kHz	0.11 mV/V + 10 μV	
	(20 to 100) kHz	0.37 mV/V + 10 μV	
	(100 to 300) kHz	0.88 mV/V + 0.44 mV	
	(300 to 500) kHz	2 mV/V + 0.67 mV	
	500 kHz to 1 MHz	4.2 mV/V + 0.63 mV	
AC Voltage – Measure ¹	(22 to 220) V		Multimeter
	(10 to 40) Hz	0.23 mV/V + 2.5 μV	
	40 Hz to 20 kHz	0.11 mV/V	
	(20 to 100) kHz	0.81 mV/V	
	220 V to 1.1 kV		
	50 Hz to 1 kHz	0.11 mV/V + 0.11 mV	
	(0.01 to 100) mV		
	1 Hz to 1 kHz	56 μV + 6.1 μV	
	1 kHz to 20) kHz	0.14 mV/V + 4.4 μV	
	20 kHz to 100) kHz	0.39 mV/V + 55 μV	
	100 kHz to 300) kHz	1.2 mV/V + 0.48 mV	
	300 kHz to 1 MHz	11 mV/V + 31 μV	

Electrical – DC/Low Frequency

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Measure ¹	100 mV to 1 V		Multimeter, Synchronous Sub-Sampled Mode
	1 Hz to 1 kHz	0.11 mV/V	
	(1 to 20) kHz	0.19 mV/V	
	(20 to 100) kHz	0.95 mV/V	
	(100 to 300) kHz	3.6 mV/V	
	300 kHz to 1 MHz	12 mV/V	
	(1 to 10) V		
	1 Hz to 1 kHz	0.11 mV/V	
	(1 to 20) kHz	0.19 mV/V	
	(20 to 100) kHz	0.95 mV/V	
	(100 to 300) kHz	3.6 mV/V	
	300 kHz to 1 MHz	12 mV/V	
	(1 to 4) MHz	7.7 mV/V + 39 mV	
	(10 to 100) V		
	1 Hz to 1 kHz	0.27 mV/V + 1.6 mV	
	(1 to 20) kHz	0.26 mV/V + 0.74 mV	
	(20 to 50) kHz	0.44 mV/V + 0.74 mV	
	(50 to 100) kHz	1.5 mV/V + 1.3 mV	
	(100 to 1 000) V		
	1 Hz to 1 kHz	0.54 mV/V + 28 mV	
	(1 to 20) kHz	0.81 mV/V + 28 mV	
AC Voltage – Measure ¹ High Voltage	(0.1 to 30) kV (50 to 400) Hz	1.5 mV/V	High Voltage Meter System
AC Current – Source ¹	0.9 μ A to 22 mA		Multiproduct Calibrator
	10 Hz to 1 kHz	0.22 mA/A + 13 nA	
	(1 to 10) kHz	0.27 % of reading	
	(22 to 220) mA		
	10 Hz to 1 kHz	0.35 mA/A	
	(1 to 10) kHz	0.27 % of reading + 1.0 μ A	
	(0.22 to 2.2) A		
	40 Hz to 1 kHz	0.96 mA/A	
	(1 to 10) kHz	1.3 % of reading	
	(2.2 to 11) A		
	45 Hz to 1 kHz	1.7 mA/A	
	(1 to 5) kHz	4.5 % of reading	
	(11 to 20) A		
	45 Hz to 1 kHz	2.8 mA/A	
	(1 to 5) kHz	3.5 % of reading	
AC Current – Source ¹	(20 to 1 000) A (50 to 100) Hz	0.3 % of reading	Multiproduct Calibrator with Current Coil

Electrical – DC/Low Frequency

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current – Measure ¹	10 Hz to 1 kHz (1.0 to 100) μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	0.69 mA/A + 35 nA 0.53 mA/A + 51 nA 0.58 mA/A 0.58 mA/A 1.5 mA/A	Multimeter
AC Current – Measure ¹	10 Hz to 1 kHz (1 to 15) A (15 to 100) A (100 to 300) A	0.51 mA/A + 1.0 mA 1.0 mA/A + 2.6 mA 0.88 mA/A + 46 mA	Shunt Monitored with Multimeter
AC Current – Measure ¹	(1 to 2 000) A (5 to 500) Hz	1.6 % of reading	Clamp Meter

Electrical - RF/Microwave

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Power – Measure ¹	(-127 to 30) dBm 10 kHz to 1.3 GHz (1.3 to 2.6) GHz (-10 to 35) dBm 100 kHz to 4.2 GHz (-30 to 20) dBm 10 MHz to 18 GHz	0.024 dB 0.044 dB 0.045 dB 0.072 dB	Measuring Receiver, Sensor Module, Power Sensors
RF Power – Source ¹	(-127 to 30) dBm 10 kHz to 1.3 GHz (1.3 to 2.6) GHz (-10 to 35) dBm 100 kHz to 4.2 GHz (-30 to 20) dBm 10 MHz to 18 GHz	0.1 dB 0.1 dB 0.1 dB 0.2 dB	Signal Generators Monitored with Measuring Receiver, Sensor Module, Power Sensors
RF Relative Power – Measure ¹	(-127 to 30) dBm 10 kHz to 1.3 GHz (1.3 to 2.6) GHz (-10 to 35) dBm 100 kHz to 4.2 GHz (-30 to 20) dBm 10 MHz to 18 GHz	0.02 dB 0.04 dB 0.045 dB 0.07 dB	Measuring Receiver, Sensor Module, Power Sensors

Electrical - RF/Microwave

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Amplitude Modulation – Measure ¹ 10 Hz to 100 kHz	Rate: 150 kHz to 10 MHz Depth: (5 to 99) %	0.65 % Modulation	Measuring Receiver, Sensor Module
Frequency Modulation – Measure ¹ 10 Hz to 100 kHz	Rate: 250 kHz to 2.6 GHz	1.7 % Modulation	Measuring Receiver, Sensor Module
Phase Modulation – Measure ¹ 200 Hz to 20 kHz	Rate: 10 MHz to 1.3 GHz	0.36 % Modulation	Measuring Receiver, Sensor Module

Length – Dimensional Metrology

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Height Gages ²	Up to 40 in	$(23 + 3.2L) \mu\text{in}$	Gage Blocks, Master Step Gage, Surface Plate
Calipers ^{1,2}	Up to 40 in	$(310 + 4.1L) \mu\text{in}$	Gage Blocks, Master Step Gage
Micrometers ²	Up to 8 in (8 to 24) in	$(33 + 1.4L) \mu\text{in}$ $(19 + 5.2L) \mu\text{in}$	Gage Blocks, Rod Set
Indicators ²	Up to 4 in	$(3.3 + 5.4L) \mu\text{in}$	Indicator Calibrator, Gage Blocks
Optical Comparators and Visual Systems ¹ Length	Up to 24 in	$(79 + 6.4L) \mu\text{in}$	Glass Scale, Gage Blocks
Optical Comparators and Visual Systems ¹ Angle	4 Quadrants (0 to 90)°	0.001 7°	Angle Blocks
Rulers and Tapes	Up to 40 in (0 to 164) ft	$(75 + 15L) \mu\text{in}$ $(138 + 19L) \mu\text{in}$	Glass Scale, Steel Ruler, Optical Comparator
Angle Meters	Up to 360°	0.008 5°	Sine Bar and Gage Blocks
Thread Plug Gages ² Pitch Diameter Major Diameter	Up to 5 in	33 μin $(14 + 3L) \mu\text{in}$	Supermicrometer®, Thread Measuring Wires and Gage Blocks
Laser Scan Micrometers/ Non- Contact Measuring	(1 to 60) mm	0.21 μm	Pin Gages, Laser Standards

Length – Dimensional Metrology

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Cylindrical Plugs and Disc Gages ²	Up to 10 in	$(14 + 3L) \mu\text{in}$	Supermicrometer®, Gage Blocks
Master Levels ²	(4 to 18) in	5.7"	Surface Plate, Gage Blocks, Sine Plate
Surface Finish Testers Ra Rz	3 μm 9.5 μm	0.062 μm 0.22 μm	Roughness Specimen
Coating Thickness Measuring Equipment ^{1,6}	Up to 100 mils	0.014 mils	Plastic Shims
Feeler and Taper Gages	Up to 1 in	18 μin	Supermicrometer®, Gage Blocks
Radius and Form Gages	Up to 6 in	$(110 + 1L) \mu\text{in}$	Optical Comparator
Surface Plates ^{1,2} Local Area Flatness	(12 in x 12 in) to (72 in x 96 in)	16 μin	Repeat-o-Meter
Overall Flatness	(12 in x 12 in) to (74 x 144 in)	0.08 % of reading + 7.4"	Wyler Surface Plate Kit
CMM – Verification Volumetric Length	Up to 40 in	$(24 + 2.5L) \mu\text{in}$	Master Step Gage, Master Sphere
Linear Displacement of Universal Testing Machines	Up to 40 in	$(58 + 2.4L) \mu\text{in}$	Gage Blocks, Master Step Gage or Steel Rule

Mass and Mass Related

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dynamic Viscosity	(6.2 to 100 000) cP	0.65 % of reading	Cannon Viscosity Standards
Shore Durometers Spring Force	(0 to 100) points	0.35 points	Partial Verification using Gage Blocks and Balance

Mass and Mass Related

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Rockwell Hardness Testers ¹	(20 to 30) HRC (35 to 55) HRC (60 to 65) HRC (40 to 59) HRBW (60 to 79) HRBW (80 to 100) HRBW (70 to 77) HR15N (78 to 88) HR15N (90 to 92) HR15N	0.4 HRC 0.4 HRC 0.33 HRC 0.65 HRBW 0.4 HRBW 0.4 HRBW 0.41 HR15N 0.41 HR15N 0.52 HR15N	Indirect Verification per ASTM E18 using Hardness Test Blocks.
Rockwell Hardness Testers ¹	(20 to 31) HR45N (37 to 61) HR45N (66 to 72) HR45N (43 to 56) HR30TW (57 to 69) HR30TW (70 to 83) HR30TW (74 to 80) HR15TW (81 to 86) HR15TW (87 to 93) HR15TW (70 to 83) HREW (84 to 90) HREW (93 to 100) HREW	0.35 HR45N 0.3 HR45N 0.25 HR45N 0.6 HR30TW 0.25 HR30TW 0.25 HR30TW 0.3 HR15TW 0.3 HR15TW 0.45 HR15TW 0.2 HREW 0.55 HREW 0.55 HREW	Indirect Verification per ASTM E18 using Hardness Test Blocks.
Gauge Pressure – Measure ¹	(-15 to 30) psi (30 to 1 000) psi (1 000 to 10 000) psi	0.03 % of reading + 0.000 64 psi 0.016 % of reading + 0.08 psi 0.015 % of reading + 0.71 psi	Process Calibrator with Pressure Modules
Torque ¹	(0.01 to 160) ozf·in (0.1 to 250) lbf·in (0.01 to 50) lbf·ft (0.1 to 250) lbf·ft (1 to 500) lbf·ft	0.45 % of reading 0.75 % of reading 0.65 % of reading 0.65 % of reading 0.88 % of reading + 1.4 lbf·ft	Torque System
Torque – Analyzers, Transducers	1 ozf·in to 200 lbf·in (16 to 50) lbf·ft	0.08 % of reading 0.17 % of reading	Torque Wheel and Weights
Force – Tension	Up to 500 lbf	0.011 % of reading + 0.001 lbf	NIST Class F Weights
Force ¹ Tension & Compression	Up to 1 000 lbf (1 000 to 10 000) lbf	0.041 % of reading + 0.45 lbf 0.088 % of reading	Load Cell Comparison

Mass and Mass Related

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Class I Balances and Scales ¹ Resolution: (0.01, 0.1 & 1) mg 0.01 g	Up to 200 g Up to 1 000 g	5.9 µg/g + 2.5 µg 0.83 mg	ASTM Class 0 Weights
Class II Balances and Scales ¹ Resolution: 0.1 g 1 g 0.01 kg 0.1 kg	Up to 1 000 g Up to 10 kg Up to 100 kg Up to 500 kg	58 mg 90 µg/g + 0.6 mg 0.16 mg/g + 5.8 mg 0.16 mg/g + 59 mg	ASTM E617 Class 0 and Class 3 Weights; OIML Class M2 Weights
Class III & IV Balances and Scales ¹ Resolution: 1 g 1 kg	Up to 1 000 g Up to 1 000 kg	0.58 g 0.58 kg	OIML Class M2 Weights
Flow – Air ¹	Up to 5 000 ml/min (2 000 to 9 500) ml/min (5 000 to 50 000) ml/min	0.42 % of reading 0.41 % of reading 0.41 % of reading	Bios Flow System with Flow Cells

Photometry and Radiometry

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Fiber Optic Power – Measure ¹ (1310, 1550) nm	(-110 to 10) dBm	0.25 dB	EXFO Optical Calibration System
Fiber Optic Power – Source ¹ (1310, 1550) nm	(-110 to 10) dBm	0.34 dB	EXFO Optical Calibration System
Fiber Optic Relative Power – Measure ¹ (1310, 1550) nm	(-110 to 10) dB	0.25 dB	EXFO Optical Calibration System

Thermodynamic

Mexicali, BC

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity – Humidity Meters without Probe	Up to 100 %RH	0.8 % of reading + 1 %RH	Humidity Meter, Environmental Chamber
Humidity – Measure ¹	Up to 100 %RH	0.81 % of reading + 0.85 %RH	Humidity Meter

Thermodynamic

Mexicali, BC

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity – Humidity Meters with Probe	11 %RH 33 %RH 75.4 %RH 97 %RH	0.7 %RH 0.7 %RH 0.9 %RH 1.5 %RH	Saturated Salt Solutions
Temperature – Source ¹	(-20 to 300) °C	0.15 °C	Dry Block Calibrator
Temperature – Measure ¹	(-200 to 300) °C	0.022 % of reading + 0.05 °C	Digital Thermometer w/ PRT
Radiation (Infrared) Thermometers ¹	(35 to 100) °C (100 to 200) °C (200 to 350) °C (350 to 500) °C	0.73 °C 1.1 °C 2 °C 3 °C	Precision Infrared Calibrator $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$

Time and Frequency

Mexicali, BC

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Tachometer ^{1,2}	(0 to 100 000) rpm	0.000 38 % of reading + 0.013 rpm	Multiproduct Calibrator
Frequency – Measure ¹	1 Hz to 10 MHz	0.12 nHz/Hz + 0.39 nHz	Multimeter
	100 Hz to 26.5 GHz	24 pHz/Hz	Frequency Counter and External Time Base
Frequency – Source ¹	10 Hz to 1.2 MHz	0.012 % of reading	Multiproduct Calibrator
	100 kHz to 50 GHz	55 pHz/Hz	RF Generator and External Time Base
Timers, Stopwatches, Chronometers ¹	1 s to 24 hr	24 ms	Comparison to Frequency Counter

DIMENSIONAL MEASUREMENT

3 Dimensional

Mexicali, BC

Specific Tests and / or Properties Measured	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Fixtures and Part Measurements ²	(300 x 500 x 300) mm	(11 + 0.1L) μm	Coordinate Measurement 3-Axis Volumetric and Linear Displacement

[Return to Site listing \(top\)](#) [Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

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CALIBRATION

Acoustics and Vibration

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meter ¹	(74 to 114) dB (125 Hz to 4 kHz)	0.13 dB	Sound Level Calibrator
Sound Level Calibrator ^{1,2}	(74 to 124) dB 20 Hz to 20 kHz	0.11 dB	Reference Microphone, Sound Calibration System
Microphones ¹ Sensitivity	(-80 to -10) dB re. 1V/Pa 20 Hz to 20 kHz	0.11 dB	Reference Microphone, Sound Calibration System
Microphones ¹ Frequency Response	(-80 to -10) dB re. 1V/Pa (20 to 50) Hz (50 to 80) Hz (80 to 500) Hz (500 to 2 500) Hz (2.5 to 10) kHz (10 to 12.5) kHz (12.5 to 16) kHz (16 to 20) kHz	0.12 dB 0.09 dB 0.08 dB 0.09 dB 0.1 dB 0.14 dB 0.23 dB 0.34 dB	Reference Microphone, Sound Calibration System
Accelerometers / Velocity Sensors / Displacement Sensors ¹ (0.2 Hz to 10 kHz)	Sensitivity: (0.04 to 1 000) pC/units (0.04 to 1 000) mV/units	0.54 % of sensitivity	Reference Accelerometer, Vibration System
Vibration ¹ Acceleration (0.2 Hz to 10 kHz) Velocity (0.2 Hz to 10 kHz) Displacement (0.2 Hz to 10 kHz) (0.2 to 100) Hz	Up to 200 m/s ² Up to 200 mm/s Up to 200 µm (0.2 to 20) mm	0.69 % of reading + 0.004 7 m/s ² 0.69 % of reading + 0.004 7 mm/s 0.69 % of reading + 0.004 7 µm 0.72 % of reading + 0.001 6 mm	Reference Accelerometer, Vibration System

Acoustics and Vibration

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Shock and Drop Tester ¹ 700 mHz to 5 000 Hz	Up to 500 G	1.9 % of reading + 0.002 2 G	Reference Accelerometer, Vibration System

Chemical Quantities

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meters ^{1,4}	84 μ S/cm 1 000 μ S/cm 1 413 μ S/cm 111.3 mS/cm	0.67 μ S/cm 7.5 μ S/cm 11 μ S/cm 0.79 mS/cm	Comparison to Standard Solutions
pH Meters ^{1,4}	4 pH 7 pH 10 pH	0.009 1 pH 0.009 1 pH 0.014 pH	Comparison to Standard Solutions
Gas Detector, Gas Analyzer	10 parts in 10 ⁶ Isobutylene 100 parts in 10 ⁶ Isobutylene 1 % CO ₂ 50 parts in 10 ⁶ CO 10 parts in 10 ⁶ H ₂ S 50 % LEL CH ₄ 18 % O ₂ 10 parts in 10 ⁶ O ₂ 100 parts in 10 ⁶ O ₂ 1 000 parts in 10 ⁶ O ₂	0.27 parts in 10 ⁶ Isobutylene 2.6 parts in 10 ⁶ Isobutylene 0.024 % CO ₂ 1.1 parts in 10 ⁶ CO 0.25 parts in 10 ⁶ H ₂ S 0.059 % CH ₄ 0.42 % O ₂ 0.61 parts in 10 ⁶ Concentration 6.9 parts in 10 ⁶ Concentration 57 parts in 10 ⁶ Concentration	Standard Gas
Optical System Aerosol Particle Counter	(0 to 100) % Counting Efficiency Particle sizes (0.3, 0.5, 1, 2, 5, 10) μ m Flow Rate (5 to 500) ml/min (0.3 to 30) l/min (10 to 100) l/min	3.7 % Counting efficiency 0.36 % of reading 0.38 % of reading + 0.000 6 l/min 0.63 % of reading	Comparison to Master Particle Counter Standard Flow Calibrator
Refractometer	(0 to 25) % Salt (0 to 60) % Brix	0.12 % Salt 0.12 % Brix	Comparison to Standard Refractometer
Turbidity Meter ¹	1.01 NTU 15 NTU 100 NTU 750 NTU	0.022 NTU 0.15 NTU 0.84 NTU 7.4 NTU	Comparison to Standard Solutions

Chemical Quantities

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Viscometer ¹	1 000 cP 200 000 cP 87 KU	3.3 cP 1 012 cP 0.35 KU	Comparison to Standard Solutions
ORP ¹	240 mV 470 mV	11 mV 11 mV	Comparison to Standard Solutions

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

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 to 1 100) V	7.5 μ V/V + 0.4 μ V 5 μ V/V + 0.7 μ V 3.5 μ V/V + 2.6 μ V 3.5 μ V/V + 4 μ V 5 μ V/V + 40 μ V 6.5 μ V/V + 0.4 mV	Multi-Function Calibrator
DC Voltage – Source (Fixed Points)	1 V 1.018 V 10 V	2 μ V 2 μ V 6.6 μ V	DC Voltage Reference Standard
DC High Voltage – Source ¹ Electrostatic Field Meter	Up to 10 kV (10 to 20) kV	0.3 mV/V + 31 mV 0.47 mV/V + 4.7 V	Comparison with High Voltage Meter
DC Voltage – Measure ¹	Up to 100 mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1 000) V	6.0 μ V/V + 0.31 μ V 4.0 μ V/V + 0.31 μ V 4.0 μ V/V + 0.51 μ V 6.0 μ V/V + 30 μ V 6.0 μ V/V + 0.1 mV	Multimeter
DC Voltage – Measure ¹	Up to 10 kV (10 to 20) kV (10 to 35) kV	0.3 mV/V + 31 mV 0.47 mV/V + 4.7 V 0.47 mV/V + 11 V	High Voltage Meter
DC Power Source ^{1,2}	0.01 mW to 20.5 kW 33 mV to 1 020 V (0.33 to 330) mA 330 mA to 11 A (11 to 20.5) A	0.03 % of Watts output + 0.58R 0.059 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R	Multi-Product Calibrator
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	40 μ A/A + 6 nA 35 μ A/A + 7 nA 35 μ A/A + 40 nA 45 μ A/A + 0.7 μ A 80 μ A/A + 12 μ A	Multi-Function Calibrator

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Source ¹	Up to 330 μ A 330 μ A to 3.3 mA (3.3 to 33) mA (33 to 330) mA 330 mA to 3.3 A (3.3 to 11) A (11 to 20.5) A	116 μ A/A + 16 nA 78 μ A/A + 24 nA 78 μ A/A + 0.17 μ A 78 μ A/A + 1.7 μ A 155 μ A/A + 32 μ A 388 μ A/A + 270 μ A 775 μ A/A + 590 μ A	Multi-Product Calibrator
DC Current – Source ¹	(10 to 16.5) A (16.5 to 150) A (150 to 1 025) A	2.8 mA/A + 3 mA 2.8 mA/A + 25 mA 3 mA/A + 90 mA	Multi-Product Calibrator with coil
DC Current – Source ¹	Up to 120 A	3.5 mA/A + 3 mA	DC Power Supply, Multimeter and Current Transducer
DC Current – Measure ¹	1 pA 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	30 μ A/A + 40 pA 20 μ A/A + 40 pA 20 μ A/A + 100 pA 20 μ A/A + 0.8 nA 20 μ A/A + 5 nA 20 μ A/A + 50 nA 35 μ A/A + 0.5 μ A 110 μ A/A + 10 μ A	Multimeter
DC Current – Measure ¹	(1 to 20) A (20 to 150) A (150 to 1 500) A	0.12 mA/A + 0.25 mA 0.61 mA/A + 2.7 mA 0.16 mA/A + 27 mA	Shunt monitored with Multimeter
DC Current – Measure ¹	Up to 1 000 A	3 mA/A + 41 mA	Current transducer with Multimeter
Resistance – Source ¹ (Simulation)	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 (110 to 330) k Ω	31 $\mu\Omega/\Omega$ + 0.78 m Ω 23 $\mu\Omega/\Omega$ + 1.2 m Ω 22 $\mu\Omega/\Omega$ + 1.2 m Ω 22 $\mu\Omega/\Omega$ + 1.6 m Ω 22 $\mu\Omega/\Omega$ + 1.7 m Ω 22 $\mu\Omega/\Omega$ + 16 m Ω 22 $\mu\Omega/\Omega$ + 17 m Ω 22 $\mu\Omega/\Omega$ + 0.16 Ω 22 $\mu\Omega/\Omega$ + 0.17 Ω 25 $\mu\Omega/\Omega$ + 1.6 Ω	Multi-Product Calibrator

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ (Simulation)	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 to 1 110) MΩ	25 μΩ/Ω + 1.7 Ω 47 μΩ/Ω + 23 Ω 101 μΩ/Ω + 39 Ω 194 μΩ/Ω + 1.9 kΩ 388 μΩ/Ω + 2.3 kΩ 2.3 mΩ/Ω + 78 kΩ 12 mΩ/Ω + 388 kΩ	Multi-Product Calibrator
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	40 μΩ 95 μΩ 181 μΩ 230 μΩ 437 μΩ 1 mΩ 1.9 mΩ 8.5 mΩ 16 mΩ 85 mΩ 162 mΩ 1.1 Ω 2.1 Ω 20 Ω 40 Ω 400 Ω 893 Ω 10 kΩ	Multi-Function Calibrator
Resistance – Source ¹ (Fixed Artifacts)	0.1 mΩ 10 mΩ 100 mΩ	0.25 μΩ 4 μΩ 38 μΩ	Resistance Shunts
Resistance – Source ¹ (Fixed Artifacts)	1 Ω 10 kΩ	13 μΩ 77 mΩ	Standard Resistors
Resistance – Source ¹ (Variable Artifact)	(0.01 to 0.1) Ω (0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω (100 to 1000) Ω (1 to 10) kΩ (10 to 100) kΩ (100 to 1 000) kΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 100 GΩ	147 μΩ/Ω 125 μΩ/Ω 78 μΩ/Ω 61 μΩ/Ω 32 μΩ/Ω 32 μΩ/Ω 76 μΩ/Ω 2.4 mΩ/Ω 4.1 mΩ/Ω 2.8 mΩ/Ω 6 mΩ/Ω	High-Accuracy Decade Resistor / Resistance Box

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure ¹	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	15 $\mu\Omega/\Omega$ + 50 $\mu\Omega$ 12 $\mu\Omega/\Omega$ + 0.5 m Ω 10 $\mu\Omega/\Omega$ + 0.5 m Ω 10 $\mu\Omega/\Omega$ + 5 m Ω 10 $\mu\Omega/\Omega$ + 50 m Ω 15 $\mu\Omega/\Omega$ + 2 Ω 50 $\mu\Omega/\Omega$ + 100 Ω 500 $\mu\Omega/\Omega$ + 1 k Ω 5 m Ω/Ω + 10 k Ω	Multimeter
Resistance – Measure ¹	(0 to 1) Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω	39 $\mu\Omega/\Omega$ + 29 $\mu\Omega$ 27 $\mu\Omega/\Omega$ + 32 $\mu\Omega$ 24 $\mu\Omega/\Omega$ + 130 $\mu\Omega$ 24 $\mu\Omega/\Omega$ + 1.3 m Ω 24 $\mu\Omega/\Omega$ + 13 m Ω 24 $\mu\Omega/\Omega$ + 260 m Ω 32 $\mu\Omega/\Omega$ + 2.9 Ω	Nano Volt / Micro Ohm Meter
AC Resistance – Measure ¹ 12 Hz to 100 kHz	(0 to 10) k Ω	0.23 m Ω/Ω + 6 $\mu\Omega$	RLC Digibridge
Transformer Ratio – Source ¹ 50 Hz to 1 MHz ⁵	(0.001 to 1.110) Ratio 50 Hz to 1 kHz (1 to 10) kHz (10 to 100) kHz	0.24 parts in 10 ⁶ + 0.000 000 63 5.3 parts in 10 ⁶ + 0.000 000 6 57 parts in 10 ⁶ + 0.000 000 6	Decade Transformer
AC Voltage – Source ¹	220 μ V 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 μ V 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	240 μ V/V + 4 μ V 90 μ V/V + 4 μ V 80 μ V/V + 4 μ V 200 μ V/V + 4 μ V 500 μ V/V + 5 μ V 1.1 mV/V + 10 μ V 1.4 mV/V + 20 μ V 2.7 mV/V + 20 μ V 240 μ V/V + 4 μ V 90 μ V/V + 4 μ V 80 μ V/V + 4 μ V 200 μ V/V + 4 μ V 500 μ V/V + 5 μ V 1.1 mV/V + 10 μ V 1.4 mV/V + 20 μ V 2.7 mV/V + 20 μ V	Multi-Function Calibrator

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(22 to 220) mV		Multi-Function Calibrator
	(10 to 20) Hz	240 $\mu\text{V/V} + 12 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 7 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 7 \mu\text{V}$	
	(20 to 50) kHz	200 $\mu\text{V/V} + 7 \mu\text{V}$	
	(50 to 100) kHz	460 $\mu\text{V/V} + 17 \mu\text{V}$	
	(100 to 300) kHz	900 $\mu\text{V/V} + 20 \mu\text{V}$	
	(300 to 500) kHz	1.4 mV/V + 25 μV	
	500 kHz to 1 MHz	2.7 mV/V + 45 μV	
	220 mV to 2.2 V		
	(10 to 20) Hz	240 $\mu\text{V/V} + 40 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 15 \mu\text{V}$	
	40 Hz to 20 kHz	45 $\mu\text{V/V} + 8 \mu\text{V}$	
	(20 to 50) kHz	75 $\mu\text{V/V} + 10 \mu\text{V}$	
	(50 to 100) kHz	110 $\mu\text{V/V} + 30 \mu\text{V}$	
	(100 to 300) kHz	420 $\mu\text{V/V} + 80 \mu\text{V}$	
	(300 to 500) kHz	1 mV/V + 200 μV	
	500 kHz to 1 MHz	1.7 mV/V + 300 μV	
	(2.2 to 22) V		
	(10 to 20) Hz	240 $\mu\text{V/V} + 400 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 150 \mu\text{V}$	
	40 Hz to 20 kHz	45 $\mu\text{V/V} + 50 \mu\text{V}$	
	(20 to 50) kHz	75 $\mu\text{V/V} + 100 \mu\text{V}$	
	(50 to 100) kHz	100 $\mu\text{V/V} + 200 \mu\text{V}$	
	(100 to 300) kHz	275 $\mu\text{V/V} + 600 \mu\text{V}$	
	(300 to 500) kHz	1 mV/V + 2 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.2 mV	
	(22 to 220) V		
	(10 to 20) Hz	240 $\mu\text{V/V} + 4 \text{ mV}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 1.5 \text{ mV}$	
	40 Hz to 20 kHz	52 $\mu\text{V/V} + 0.6 \text{ mV}$	
	(20 to 50) kHz	80 $\mu\text{V/V} + 1 \text{ mV}$	
	(50 to 100) kHz	150 $\mu\text{V/V} + 2.5 \text{ mV}$	
	(100 to 300) kHz	900 $\mu\text{V/V} + 16 \text{ mV}$	
	(300 to 500) kHz	4.4 mV/V + 40 mV	
	500 kHz to 1 MHz	8 mV/V + 80 mV	
	(220 to 1 100) V		
	(15 to 50) Hz	300 $\mu\text{V/V} + 16 \text{ mV}$	
	50 Hz to 1 kHz	70 $\mu\text{V/V} + 3.5 \text{ mV}$	

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(220 to 1 020) V 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	233 μ V/V + 9.7 mV 194 μ V/V + 9.7 mV 233 μ V/V + 9.7 mV	Multi-Product Calibrator
AC High Voltage – Source ¹	Up to 10 kV (50 to 60) Hz	1.4 mV/V + 0.13 V	Comparison with High Voltage Meter
AC Voltage – Measure ¹	Up to 10 mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (10 to 100) mV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz (1 to 2) MHz 100 mV to 10 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 (1 to 2) MHz (10 to 100) V (1 to 40) Hz 40 Hz to 1 kHz 1 kHz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz	300 μ V/V + 3 μ V 200 μ V/V + 1.1 μ V 300 μ V/V + 1.1 μ V 1 mV/V + 1.1 μ V 5 mV/V + 1.1 μ V 40 mV/V + 2 μ V 70 μ V/V + 4 μ V 70 μ V/V + 2 μ V 140 μ V/V + 2 μ V 300 μ V/V + 2 μ V 800 μ V/V + 2 μ V 3 mV/V + 10 μ V 10 mV/V + 10 μ V 15 mV/V + 10 μ V 70 μ V/V + 0.4 mV 70 μ V/V + 0.2 mV 140 μ V/V + 0.2 mV 300 μ V/V + 0.2 mV 800 μ V/V + 0.2 mV 3 mV/V + 1 mV 10 mV/V + 1 mV 15 mV/V + 1 mV 200 μ V/V + 4 mV 200 μ V/V + 2 mV 200 μ V/V + 2 mV 350 μ V/V + 2 mV 1.2 mV/V + 2 mV 4 mV/V + 10 mV 15 mV/V + 10 mV	Multimeter

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(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	400 μ V/V + 40 mV 400 μ V/V + 20 mV 600 μ V/V + 20 mV 1.2 mV/V + 20 mV 3 mV/V + 20 mV	Multimeter
AC Voltage Measure ¹	Up to 10 kV (45 to 65) Hz (10 to 20) kV (45 to 65) Hz (20 to 30) kV (45 to 65) Hz	1.4 mV/V + 0.13 V 2.3 mV/V + 23 V 4.6 mV/V + 70 V	High Voltage Meter
AC Voltage – Measure ¹	Up to 2.2 mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (2.2 to 7) 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 (7 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	1.2 mV/V + 0.87 μ V 0.52 mV/V + 0.87 μ V 0.32 mV/V + 0.87 μ V 0.58 mV/V + 1.3 μ V 0.85 μ V/V + 1.7 μ V 1.6 mV/V + 2.7 μ V 1.7 mV/V + 5.3 μ V 2.4 mV/V + 5.3 μ V 0.57 mV/V + 0.87 μ V 0.26 mV/V + 0.87 μ V 0.16 mV/V + 0.87 μ V 0.28 mV/V + 1.3 μ V 0.4 mV/V + 1.7 μ V 0.8 mV/V + 2.7 μ V 0.87 mV/V + 5.3 μ V 1.5 mV/V + 5.3 μ V 0.2 mV/V + 0.87 μ V 0.13 mV/V + 0.87 μ V 80 μ V/V + 0.87 μ V 0.14 mV/V + 1.3 μ V 0.22 mV/V + 1.7 μ V 0.54 mV/V + 2.7 μ V 0.59 mV/V + 5.3 μ V 1.1 mV/V + 5.3 μ V	AC Measurement Standard

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(22 to 70) mV		AC Measurement Standard
	(10 to 20) Hz	0.16 mV/V + 1 μ V	
	(20 to 40) Hz	81 μ V/V + 1 μ V	
	40 Hz to 20 kHz	45 μ V/V + 1 μ V	
	(20 to 50) kHz	90 μ V/V + 1.3 μ V	
	(50 to 100) kHz	0.18 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.35 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.45 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.73 mV/V + 5.3 μ V	
	(70 to 220) mV		
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	57 μ V/V + 1 μ V	
	40 Hz to 20 kHz	26 μ V/V + 1 μ V	
	(20 to 50) kHz	47 μ V/V + 1.3 μ V	
	(50 to 100) kHz	0.11 mV/V + 1.7 μ V	
	(100 to 300) kHz	0.17 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.26 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.67 mV/V + 5.3 μ V	
	(220 to 700) mV		
	(10 to 20) Hz	0.14 mV/V + 1 μ V	
	(20 to 40) Hz	51 μ V/V + 1 μ V	
	40 Hz to 20 kHz	23 μ V/V + 1 μ V	
	(20 to 50) kHz	35 μ V/V + 1.3 μ V	
	(50 to 100) kHz	54 μ V/V + 1.7 μ V	
	(100 to 300) kHz	0.12 mV/V + 2.7 μ V	
	(300 to 500) kHz	0.2 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	0.64 mV/V + 5.3 μ V	
	700 mV to 2.2 V		
	(10 to 20) Hz	0.13 mV/V + 0.58 μ V	
	(20 to 40) Hz	44 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	17 μ V/V + 0.58 μ V	
	(20 to 50) kHz	31 μ V/V + 0.58 μ V	
	(50 to 100) kHz	48 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.11 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.18 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.6 mV/V + 0.58 μ V	

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(2.2 to 7) V		AC Measurement Standard
	(10 to 20) Hz	0.13 mV/V + 0.58 μ V	
	(20 to 40) Hz	45 μ V/V + 0.58 μ V	
	40 Hz to 20 kHz	17 μ V/V + 0.58 μ V	
	(20 to 50) kHz	33 μ V/V + 0.58 μ V	
	(50 to 100) kHz	55 μ V/V + 0.58 μ V	
	(100 to 300) kHz	0.13 mV/V + 0.58 μ V	
	(300 to 500) kHz	0.27 mV/V + 0.58 μ V	
	500 kHz to 1 MHz	0.8 mV/V + 0.58 μ V	
	(7 to 22) V		
	(10 to 20) Hz	0.13 mV/V + 5.8 μ V	
	(20 to 40) Hz	45 μ V/V + 5.8 μ V	
	40 Hz to 20 kHz	19 μ V/V + 5.8 μ V	
	(20 to 50) kHz	33 μ V/V + 5.8 μ V	
	(50 to 100) kHz	55 μ V/V + 5.8 μ V	
	(100 to 300) kHz	0.13 mV/V + 5.8 μ V	
	(300 to 500) kHz	0.27 mV/V + 5.8 μ V	
	500 kHz to 1 MHz	0.8 mV/V + 5.8 μ V	
	(22 to 70) V		
	(10 to 20) Hz	0.13 mV/V + 5.8 μ V	
	(20 to 40) Hz	46 μ V/V + 5.8 μ V	
	40 Hz to 20 kHz	22 μ V/V + 5.8 μ V	
	(20 to 50) kHz	39 μ V/V + 5.8 μ V	
	(50 to 100) kHz	64 μ V/V + 5.8 μ V	
	(100 to 300) kHz	0.14 mV/V + 5.8 μ V	
	(300 to 500) kHz	0.27 mV/V + 5.8 μ V	
	500 kHz to 1 MHz	0.8 mV/V + 5.8 μ V	
	(70 to 220) V		
	(10 to 20) Hz	0.13 mV/V + 58 μ V	
	(20 to 40) Hz	46 μ V/V + 58 μ V	
	40 Hz to 20 kHz	22 μ V/V + 58 μ V	
	(20 to 50) kHz	47 μ V/V + 58 μ V	
	(50 to 100) kHz	67 μ V/V + 58 μ V	
	(100 to 300) kHz	0.14 mV/V + 58 μ V	
	(300 to 500) kHz	0.33 mV/V + 58 μ V	
	(220 to 700) V		
	(10 to 20) Hz	0.13 mV/V + 58 μ V	
	(20 to 40) Hz	67 μ V/V + 58 μ V	
	40 Hz to 20 kHz	29 μ V/V + 58 μ V	
	(20 to 50) kHz	87 μ V/V + 58 μ V	
	(50 to 100) kHz	0.34 mV/V + 58 μ V	

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(700 to 1 000) V (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.13 mV/V + 58 μ V 67 μ V/V + 58 μ V 29 μ V/V + 58 μ V 87 μ V/V + 58 μ V 0.33 mV/V + 58 μ V	AC Measurement Standard
AC Voltage Flatness – Measure ¹ (Relative to 1 kHz)	Up to 2.2 mV (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (2.2 to 7) mV (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (7 to 22) mV (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.94 mV/V + 0.08 μ V 0.47 mV/V + 0.08 μ V 0.47 mV/V + 0.08 μ V 0.47 mV/V + 0.08 μ V 0.66 mV/V + 0.95 μ V 0.66 mV/V + 0.95 μ V 0.66 mV/V + 0.95 μ V 1.6 mV/V + 0.95 μ V 2.8 mV/V + 0.95 μ V 6.6 mV/V + 1.9 μ V 0.94 mV/V + 0.082 μ V 0.47 mV/V + 0.082 μ V 0.47 mV/V + 0.082 μ V 0.47 mV/V + 0.082 μ V 0.66 mV/V + 0.95 μ V 0.66 mV/V + 0.95 μ V 0.66 mV/V + 0.95 μ V 0.94 mV/V + 0.95 μ V 1.6 mV/V + 0.95 μ V 3.5 mV/V + 0.95 μ V 0.94 mV/V + 0.082 μ V 0.47 mV/V + 0.082 μ V 0.47 mV/V + 0.082 μ V 0.47 mV/V + 0.082 μ V 0.66 mV/V + 0.082 μ V 0.66 mV/V + 0.082 μ V 0.66 mV/V + 0.082 μ V 0.94 mV/V + 0.082 μ V 1.6 mV/V + 0.082 μ V 3.5 mV/V + 0.082 μ V	AC Measurement Standard

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness – Measure ¹ (Relative to 1 kHz)	(22 to 70) mV		AC Measurement Standard
	(10 to 30) Hz	0.94 mV/V + 0.82 μ V	
	(30 to 120) Hz	0.47 mV/V + 0.82 μ V	
	120 Hz to 1.2 kHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 120) kHz	0.47 mV/V + 0.82 μ V	
	(120 to 500) kHz	0.47 mV/V + 0.82 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.82 μ V	
	(2 to 10) MHz	0.94 mV/V + 0.82 μ V	
	(10 to 20) MHz	1.4 mV/V + 0.82 μ V	
	(20 to 30) MHz	3.3 mV/V + 0.82 μ V	
	(70 to 220) mV		
	(10 to 30) Hz	0.94 mV/V + 0.82 μ V	
	(30 to 120) Hz	0.38 mV/V + 0.82 μ V	
	120 Hz to 1.2 kHz	0.38 mV/V + 0.82 μ V	
	(1.2 to 120) kHz	0.38 mV/V + 0.82 μ V	
	(120 to 500) kHz	0.38 mV/V + 0.82 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.82 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.82 μ V	
	(2 to 10) MHz	0.94 mV/V + 0.82 μ V	
	(10 to 20) MHz	1.4 mV/V + 0.82 μ V	
	(20 to 30) MHz	3.3 mV/V + 0.82 μ V	
	(220 to 700) mV		
	(10 to 30) Hz	0.94 mV/V + 8.2 μ V	
	(30 to 120) Hz	0.28 mV/V + 8.2 μ V	
	120 Hz to 1.2 kHz	0.28 mV/V + 8.2 μ V	
	(1.2 to 120) kHz	0.28 mV/V + 8.2 μ V	
	(120 to 500) kHz	0.28 mV/V + 8.2 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 8.2 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 8.2 μ V	
	(2 to 10) MHz	0.94 mV/V + 8.2 μ V	
	(10 to 20) MHz	1.4 mV/V + 8.2 μ V	
	(20 to 30) MHz	3.3 mV/V + 8.2 μ V	

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Flatness – Measure ¹ (Relative to 1 kHz)	700 mV to 2.2 V (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (2.2 to 7) V (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.94 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 1.4 mV/V + 8.2 μV 3.3 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.28 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.47 mV/V + 8.2 μV 0.94 mV/V + 8.2 μV 1.4 mV/V + 8.2 μV 3.3 mV/V + 8.2 μV	AC Measurement Standard
AC Power – Source ^{1,2} 0.1 mW to 20.5 kW (45 to 65) Hz PF = 1	(33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A 330 mV to 1 020 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.11 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.11 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.1 % of Watts output + 0.58R 0.088 % of Watts output + 0.58R 0.1 % of Watts output + 0.58R 0.13 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.088 % of Watts output + 0.58R 0.073 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.15 % of Watts output + 0.58R	Multi-Product Calibrator

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} 0.1 mW to 20.5 kW (45 to 65) Hz (PF = 0 to 0.999)	(33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.21 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R	Multi-Product Calibrator
AC Power – Source ^{1,2} 0.1 mW to 20.5 kW (45 to 65) Hz (PF = 0 to 0.999)	330 mV to 1 020 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.23 % of Watts output + 0.58R	Multi-Product Calibrator
AC Current – Source ¹	(10 to 220) μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (0.22 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 (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	250 μ A/A + 16 nA 160 μ A/A + 10 nA 120 μ A/A + 8 nA 280 μ A/A + 12 nA 1.1 mA/A + 65 nA 250 μ A/A + 40 nA 160 μ A/A + 35 nA 120 μ A/A + 35 nA 200 μ A/A + 110 nA 1.1 mA/A + 650 nA 250 μ A/A + 400 nA 160 μ A/A + 350 nA 120 μ A/A + 350 nA 200 μ A/A + 550 nA 1.1 mA/A + 5 μ A	Multi-Function Calibrator

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(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 (0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (2.2 to 11) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz (11 to 20) A (45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	250 μ A/A + 4 μ A 160 μ A/A + 3.5 μ A 120 μ A/A + 2.6 μ A 200 μ A/A + 3.5 μ A 1.1 mA/A + 10 μ A 260 μ A/A + 35 μ A 450 μ A/A + 80 μ A 7 mA/A + 160 μ A 0.5 mA/A + 1.6 mA 0.8 mA/A + 1.6 mA 24 mA/A + 1.6 mA 0.9 mA/A + 3.9 mA 1.2 mA/A + 3.9 mA 24 mA/A + 3.9 mA	Multi-Product Calibrator
AC Current – Source ¹	1.45 mA to 16.5 A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	3.3 mA/A + 3.5 mA 9.1 mA/A + 3.5 mA 3.3 mA/A + 29 mA 9.1 mA/A + 31 mA 3.4 mA/A + 100 mA 9.2 mA/A + 120 mA	Multi-Product Calibrator w/50-turn coil
AC Current – Measure ¹	Up to 100 μ A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 100 μ A to 1 mA (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 (50 to 100) kHz	4 mA/A + 0.03 μ A 1.5 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A 4 mA/A + 0.2 μ A 1.5 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 0.31 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 4 mA/A + 0.4 μ A 5.5 mA/A + 1.5 μ A	Multimeter

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(1 to 10) mA		Multimeter
	(10 to 20) Hz	4 mA/A + 2 μ A	
	(20 to 45) Hz	1.5 mA/A + 2 μ A	
	(45 to 100) Hz	0.6 mA/A + 2 μ A	
	100 Hz to 5 kHz	0.31 mA/A + 2 μ A	
	(5 to 20) kHz	0.6 mA/A + 2 μ A	
	(20 to 50) kHz	4 mA/A + 4 μ A	
	(50 to 100) kHz	5.5 mA/A + 15 μ A	
	(10 to 100) mA		
	(10 to 20) Hz	4 mA/A + 20 μ A	
	(20 to 45) Hz	1.5 mA/A + 20 μ A	
	(45 to 100) Hz	0.60 mA/A + 20 μ A	
	100 Hz to 5 kHz	0.31 mA/A + 20 μ A	
	(5 to 20) kHz	0.6 mA/A + 20 μ A	
	(20 to 50) kHz	4 mA/A + 40 μ A	
	(50 to 100) kHz	5.5 mA/A + 0.15 mA	
	100 mA to 1 A		
	(10 to 20) Hz	4 mA/A + 0.2 mA	
	(20 to 45) Hz	1.6 mA/A + 0.2 mA	
	(45 to 100) Hz	0.8 mA/A + 0.2 mA	
	100 Hz to 5) kHz	1 mA/A + 0.2 mA	
	(5 to 20) kHz	3 mA/A + 0.2 mA	
	(20 to 50) kHz	10 mA/A + 0.4 mA	
AC Current – Measure ¹	1 mA to 20 A		Shunt with Multimeter
	45 Hz to 1 kHz	0.29 mA/A + 2.1 mA	
	(1 to 5) kHz	0.41 mA/A + 2.1 mA	
	(20 to 30) A		
	45 Hz to 1 kHz	2.1 mA/A + 3.2 mA	
	(1 to 5) kHz	2.5 mA/A + 3.2 mA	
AC Current – Measure ¹	(30 to 1 000) A		Current Transducer with Multimeter
	(45 to 400) Hz	2.9 mA/A + 105 mA	
AC Current – Measure ¹	Up to 700 A (50 to 400) Hz	9.6 mA/A + 9.3 mA	
Electrical Calibration of Thermocouple Indicators ¹	Type B		Multi-Product Calibrator
	(600 to 800) °C	0.36 °C	
	(800 to 1 000) °C	0.29 °C	
	(1 000 to 1 550) °C	0.26 °C	
	(1 550 to 1 820) °C	0.28 °C	

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type C		Multi-Product Calibrator
	(0 to 150) °C	0.26 °C	
	(150 to 650) °C	0.23 °C	
	(650 to 1 000) °C	0.27 °C	
	(1 000 to 1 800) °C	0.4 °C	
	(1 800 to 2 316) °C	0.66 °C	
	Type E		
	(-250 to -100) °C	0.4 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 350) °C	0.16 °C	
	(350 to 650) °C	0.17 °C	
	(650 to 1 000) °C	0.2 °C	
	Type J		
	(-210 to -100) °C	0.24 °C	
	(-100 to -30) °C	0.17 °C	
	(-30 to 150) °C	0.16 °C	
	(150 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.21 °C	
	Type K		
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type S (0 to 250) °C	0.38 °C	Multi-Product Calibrator
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	
	Type T (-250 to -150) °C	0.5 °C	
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U (-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 100 Ω (-200 to -80) °C	0.039 °C	Multi-Product Calibrator
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω (-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 200 Ω		Multi-Product Calibrator
	(-200 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.093 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.12 $^{\circ}\text{C}$	
	Pt 385, 500 Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.085 $^{\circ}\text{C}$	
	Pt 385, 1 k Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.18 $^{\circ}\text{C}$	
	Cu 427, 10 Ω		
	(-100 to 260) $^{\circ}\text{C}$	0.23 $^{\circ}\text{C}$	
	PtNi 385, 120 Ω (Ni120)		
	(-80 to 0) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
Inductance – Measure ¹ 12 Hz to 100 kHz	(0.1 to 1) mH	0.2 mH/H + 0.058 μH	RLC Digibridge
	(1 to 10) mH	0.3 mH/H + 0.58 μH	
	(10 to 100) mH	0.2 mH/H + 5.8 μH	
	(0.1 to 1) H	0.2 mH/H + 58 μH	
	(1 to 10) H	0.24 mH/H + 0.58 mH	
Inductance – Measure ¹ 100 kHz to 1 MHz	Up to 1 μH	1.2 mH/H + 0.005 8 nH	Precision LCR Meter
	(1 to 10) μH	1.2 mH/H + 0.058 nH	
	(10 to 100) μH	1.2 mH/H + 0.58 nH	
	100 μH to 1 mH	1.2 mH/H + 0.005 8 μH	

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Source ¹ (Fixed Artifacts) 1 kHz	(1 to 10 mH) (10 to 100) mH (0.1 to 1) H (1 to 10) H	23 mH/H + 0.058 μ H 19 mH/H + 0.58 μ H 10 mH/H + 5.8 μ H 10 mH/H + 58 μ H	Standard Inductors
Inductance – Source ¹ (Fixed Artifacts) 100 Hz to 1 MHz 100 Hz to 1 MHz 100 Hz to 500 kHz 100 Hz to 200 kHz 100 Hz to 10 kHz 100 Hz to 10 kHz 100 Hz to 10 kHz 100 Hz to 10 kHz 100 Hz to 1 kHz 100 Hz to 1 kHz	10 μ H 50 μ H 100 μ H 1 mH 10 mH 100 mH 200 mH 500 mH 1 H 10 H	0.001 7 μ H 0.008 5 μ H 0.017 μ H 0.17 μ H 1.7 μ H 17 μ H 34 μ H 85 μ H 0.17 mH 1.8 mH	Standard Inductors
Capacitance – Source ¹ (Simulation) 50 Hz to 1 kHz	(0.19 to 0.4) nF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF (0.33 to 1.1) μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 3.9 mF/F + 7.8 pF 1.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 78 pF 1.9 mF/F + 233 pF 1.9 mF/F + 0.78 nF 1.9 mF/F + 2.3 nF 1.9 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.5 mF/F + 78 nF 3.5 mF/F + 233 nF 3.5 mF/F + 0.78 μ F 3.5 mF/F + 2.3 μ F 3.5 mF/F + 7.8 μ F 5.8 mF/F + 23 μ F 8.5 mF/F + 78 μ F	Multi-Product Calibrator
Capacitance – Source ¹ (Fixed Artifacts)	100 Hz to 13 MHz 1 pF 10 pF 100 pF 1 000 pF	0.58 mF/F + 0.000 058 pF 0.58 mF/F + 0.000 58 pF 0.58 mF/F + 0.005 8 pF 0.58 mF/F + 0.058 pF	Standard Capacitors

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ (Fixed Artifacts)	10 Hz to 100 kHz 1 nF 10 nF 100 nF 1 μF	0.23 mF/F + 0.058 pF 0.23 mF/F + 0.58 pF 0.23 mF/F + 5.8 pF 0.23 mF/F + 58 pF	Standard Capacitors
Capacitance – Measure ¹	(0 to 1 000) μF 12 Hz to 100 kHz 100 kHz to 1 MHz 1 MHz to 30 MHz	1.1 mF/F + 0.58R 0.38 mF/F + 0.58R 0.89 mF/F + 0.58R	RLC Digibridge / Precision LCR Meter
Capacitance Dissipation Factor – Source ^{1,5} (Fixed Artifacts)	1 pF 1 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz 10 pF 1 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz 100 pF 1 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.002 8 0.002 8 0.000 52 0.000 5 0.000 51 0.000 31 0.000 68 0.000 98 0.000 32 0.000 32 0.000 19 0.000 19 0.000 19 0.000 19 0.000 2 0.000 2 0.000 17 0.000 17 0.000 17 0.000 18 0.000 18 0.000 18 0.000 18 0.000 25 0.000 33	Capacitance Standards

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance Dissipation Factor – Source ^{1,5} (Fixed Artifacts)	1 000 pF 1 kHz 1 MHz 2 MHz 3 MHz 4 MHz 5 MHz 10 MHz 13 MHz	0.000 17 0.000 17 0.000 18 0.000 2 0.000 25 0.000 29 0.000 7 0.000 99	Capacitance Standards
Oscilloscopes ¹ Square Wave Amplitude, < 10 kHz into 50 Ω or 1 M Ω Load Impedance	Up to 1 mVp-p (1 to 21) mVp-p (21 to 556) mVp-p 556 mVp-p to 210 Vp-p	10 mV/V + 10 μ V 1.5 mV/V + 20 μ V 1.5 mV/V + 1.2 μ V 1.3 mV/V + 1.2 μ V	Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Horizontal Deflection (Time)	150 ps to 50 s	0.39 parts in 10 ⁶ of reading	Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Vertical Deflection (Amplitude)	Up to 50 Vp-p (50 to 100) Vp-p (100 to 200) Vp-p	250 μ V/V + 25 μ V 250 μ V/V + 26 μ V 250 μ V/V + 63 μ V	Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Bandwidth	100 mHz to 50 GHz	2.1 % of reading	Oscilloscope Calibrator, Signal Generator, Power Sensor
Oscilloscopes ¹ Rise / Fall Time (10 to 90) %	Up to 1.25 s	1.3 ps	Oscilloscope Calibrator and Active Head
Magnetic Field – Source	500 G 5 000 G Up to 8 000 G	0.17 % of reading 0.17 % of reading 1.2 % of reading + 0.58R	Reference Magnets / Standard Gauss Meter with Probe
Magnetic Field – Measure	Up to 24 000 G	1.2 % of reading + 0.58R	Standard Gauss Meter with Probe
Moisture Meters	(7 to 25) % Moisture Content	0.26 % Moisture Content	Electrical Simulation Resistance Standard

Electrical – DC/Low Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase – Measure ¹ (10 to 32) mV	(0 to 360) ° 1 Hz to 10 kHz	0.25 °	Precision Phasemeter
(10 to 100) mV	(10 to 50) kHz 50 kHz to 10 MHz	0.43 ° 0.86 °	
32 mV to 100 V	(1 to 10) Hz 10 Hz to 10 kHz	0.13 ° 0.071 °	
100 mV to 100 V	(10 to 50) kHz (50 to 100) kHz 100 kHz to 10 MHz	0.071 ° 0.43 ° 0.43 °	
(100 to 320) V	(1 to 10) Hz 10 Hz to 5 kHz	0.25 ° 0.13 °	

Electrical – RF/Microwave

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Power Sensors – Calibration Factors	Referenced at 1 mW 9 kHz to 100 kHz 100 kHz to 10 MHz (10 to 50) MHz 50 MHz to 1 GHz (1 to 4) GHz (4 to 8) GHz (8 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 40) GHz (40 to 50) GHz	2.3 % CF 1.6 % CF 1.6 % CF 1.6 % CF 1.6 % CF 2.1 % CF 2.8 % CF 4.3 % CF 4.4 % CF 4.6 % CF 6.2 % CF	Power Sensors, Power Meter, Coaxial Thermistor
RF Power Meter Reference ¹	1 mW 50 MHz	0.26 % of Reading	Power Meter and Thermistor Mount
RF Power Meter ¹ (Fixed Points)	(3, 10, 30, 100, 300) μW (1, 3, 10, 30, 100) mW	0.37 % of Watts output + 0.58R	Range Calibrator

Electrical – RF/Microwave

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Tuned Power – Measure ¹	(-117 to 30) dB 100 kHz to 2.6 GHz (2.6 to 6) GHz (6 to 10) GHz (10 to 18) GHz (18 to 26.5) GHz	0.2 dB 0.27 dB 0.28 dB 0.29 dB 0.36 dB	Measuring Receiver and Power Sensors
RF Absolute Power – Measure ¹	(-70 to 44) dBm 9 kHz to 2 GHz (2 to 14) GHz (14 to 18) GHz (18 to 26.5) GHz (26.5 to 40) GHz (40 to 50) GHz	0.056 dB 0.057 dB 0.059 dB 0.12 dB 0.17 dB 0.23 dB	Power Meter, Measuring Receiver and Power Sensors
RF Power – Source ¹	(-120 to 10) dBm Up to 250 kHz 250 kHz to 4 GHz (4 to 20) GHz (20 to 40) GHz	0.095 dB 0.11 dB 0.13 dB 0.16 dB	Signal Generator / Synthesized Sweep Generator
Distortion – Measure ¹ 20 Hz to 22 kHz 20 Hz to 80 kHz 20 Hz to 250 kHz	40 kHz BW: -95 dB 80 kHz BW: -90 dB 250 kHz BW: -84 dB	0.016 dB 0.082 dB 0.24 dB	Audio Analyzer
Amplitude Modulation – Measure ¹ AM Depth Accuracy 100 kHz to 10 MHz Rate: 50 Hz to 10 kHz 10 MHz to 3 GHz Rate: 50 Hz to 100 kHz (3 to 26.5) GHz Rate: 50 Hz to 100 kHz	Depth: (5 to 99) % Depth: (20 to 99) % Depth: (5 to 20) % Depth: (20 to 99) % Depth: (5 to 20) %	0.91 % of reading 0.61 % of reading 3 % of reading 1.8 % of reading 5.5 % of reading	Spectrum Analyzer
Amplitude Modulation – Measure ¹ Flatness 10 MHz to 3 GHz Rate: 90 Hz to 10 kHz (3 to 26.5) GHz Rate: 90 Hz to 10 kHz	Depth: (5 to 99) % Depth: (5 to 99) %	0.37 % of reading 0.49 % of reading	Spectrum Analyzer

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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹ FM Rejection 50 Hz to 3 kHz BW 250 kHz to 10 MHz Rate: 400 Hz or 1 kHz 10 MHz to 26.5 GHz Rate: 400 Hz or 1 kHz Residual AM 250 kHz to 26.5 GHz	Depths: < 50 % Deviations: < 5 kHz Depths: < 50 % Deviations: < 50 kHz 50 Hz to 3 kHz BW	0.17 % Depth 0.44 % Depth 0.012 % (rms)	Spectrum Analyzer
Frequency Modulation – Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz Rate: 20 Hz to 200 kHz AM Rejection 50 Hz to 3 kHz BW 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz Residual AM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: 200 Hz to 400 kHz AM Depths: ≤ 50 % Rate: 400 Hz or 1 kHz 50 Hz to 3 kHz BW	1.3 % of reading 13 Hz 25 Hz 49 Hz 1.9 Hz 3.7 Hz 7.4 Hz	Spectrum Analyzer
Phase Modulation – Measure ¹ PM Deviation Accuracy 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz AM Rejection, 50 Hz to 3 kHz BW 100 kHz to 26.5 GHz	Deviations: > 0.7 rad Deviations: > 0.3 rad Deviations: > 2 rad Deviations: > 0.6 rad Deviations: > 4 rad Deviations: > 1.2 rad AM Depths: ≤ 50%, Rate: 1 kHz, <1 rad	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad	Spectrum Analyzer

Electrical – RF/Microwave

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Measure ¹ Residual PM 50 Hz to 3 kHz BW	<1 rad 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	0.002 1 rad 0.004 1 rad 0.008 1 rad	Spectrum Analyzer
Phase – Measure ¹ (10 to 32) mV (10 to 100) mV 32 mV to 100 V 100 mV to 100 V (100 to 320) V	(0 to 360) ° 1 Hz to 10 kHz (10 to 50) kHz 50 kHz to 100 MHz (1 to 10) Hz 10 Hz to 10 kHz (10 to 50) kHz (50 to 100) kHz 100 kHz to 10 MHz (1 to 10) Hz 10 Hz to 5 kHz	0.25 ° 0.43 ° 0.86 ° 0.13 ° 0.071 ° 0.071 ° 0.43 ° 0.43 ° 0.25 ° 0.13 °	Phasemeter
Digital Modulation – Measure ¹ For 2/3/4/5G Composite Rho ³ Error Vector Magnitude (rms) Peak Code Domain Error Phase error Frequency Error I/Q Origin Offset	$\rho = (0.9 \text{ to } 1.0)$ 450 MHz to 26.5 GHz EVM = (0 to 25) % 450 MHz to 26.5 GHz (-80 to 0) dB 450 MHz to 26.5 GHz (1 to 15) ° 450 MHz to 26.5 GHz 3 Hz to 26.5GHz (-80 to 0) dB 450 MHz to 26.5 GHz	0.001 ° 0.3 % of reading 1.2 dB 0.71 ° 2.1×10^{-7} Hz/Hz 1.2 dB	PSA Series Spectrum Analyzer, Signal Generator

Electrical – RF/Microwave

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation – Measure ¹ For 2/3/4/5G Channel Power	Power > -70 dBm 450 MHz to 26.5 GHz	0.62 dB	PSA Series Spectrum Analyzer, Signal Generator
Amplitude Modulation – Source ¹	(11 to 13.5) MHz Rate: 20 Hz to 100 kHz Depth: (0 to 95) % Depth: (95 to 99) %	0.13 % Depth 0.24 % Depth	AM/FM Test Source
Amplitude Modulation – Source ¹	AM Depth Error 250 kHz to 26.5 GHz (f_{mod} : 1 kHz) Depth: (5 to 80) % AM Distortion 250 kHz to 26.5 GHz (f_{mod} : 1 kHz) Depth: 30 % Depth: 80 %	2.4 % of reading + 1.2 % Depth 1.8 % Depth 2.4 % Depth	Signal Generator
Frequency Modulation – Source ¹	(11 to 432) MHz Rate: 20 Hz to 100 kHz Deviations: ≤ 400 kHz	0.29 % Modulation	AM/FM Test Source
Frequency Modulation – Source ¹	FM Deviation Error 250 kHz to 26.5 GHz (f_{mod} : 100 kHz) Deviations: ≤ 20 MHz FM Distortion 250 kHz to 26.5 GHz (f_{mod} : 100 kHz) Deviations: ≤ 4 MHz	0.46 % of reading 0.12 % of reading	Signal Generator
Phase Modulation – Source ¹	PM Deviation Error 250 kHz to 26.5 GHz (f_{mod} : 10 kHz) Deviations: ≤ 40 rad PM Distortion 250 kHz to 26.5 GHz (f_{mod} : 10 kHz) Deviations: ≤ 40 rad	1.9 % of reading 1.1 % of reading	Signal Generator
Pulse – Source ¹ RMS Jitter – Period, Delay and Width	33 MHz to 3 GHz	12 ps	Pulse Generator

Electrical – RF/Microwave

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Harmonic Distortion ¹ (Source and Measure) 1 kHz to 26.5 GHz	(-100 to 0.01) dB	0.86 dB	Spectrum Analyzer
Phase Noise ¹ (Source and Measure) 1 MHz to 26.5 GHz Offset carrier $\leq$ 100 kHz	(-120 to -70) dBc/Hz	1.3 dBc/Hz	Signal Generator Spectrum Analyzer
Voltage Standing Wave Ratio (VSWR) ⁵	(1 to 20) 9 kHz to 3 GHz (3 to 6) GHz (6 to 8.5) GHz (8.5 to 26.5) GHz	0.022 0.034 0.071 0.074	Calibration Kit and Network Analyzer
Reflection S11/ S22 – Measure ¹ Type N	Magnitude (0 to 110) dB 9 kHz to 3 GHz (3 to 6) GHz (6 to 8.5) GHz (8.5 to 26.5) GHz Phase (-180 to 180)° 9 kHz to 3 GHz (3 to 6) GHz (6 to 8.5) GHz (8.5 to 26.5) GHz	0.013 dB 0.034 dB 0.071 dB 0.074 dB 0.15° 0.25° 0.26° 2.3°	Network Analyzer and Calibration Kits
Transmission S12/ S21 – Measure ¹ Type N	Magnitude (0 to 110) dB 9 kHz to 3 GHz (3 to 6) GHz (6 to 8.5) GHz (8.5 to 26.5) GHz Phase (-180 to 180)° 9 kHz to 3 GHz (3 to 6) GHz (6 to 8.5) GHz (8.5 to 26.5) GHz	0.016 dB 0.022 dB 0.073 dB 0.093 dB 0.15° 0.26° 0.26° 2.3°	Network Analyzer and Calibration Kits

Length – Dimensional Metrology

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 1 500 mm	(0.17 + 0.006 l) μ m + 0.58R	Gage Blocks

Length – Dimensional Metrology

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Height Gages ^{1,2}	Up to 1 500 mm	$(0.71 + 0.001\ 5l)\ \mu\text{m} + 0.58R$	Gage Blocks, Surface Plate, Dial Test Indicator
Micrometers ^{1,2} External, Internal, Depth, Bore and Micrometer Head	Up to 1 500 mm	$(0.091 + 0.006\ 7l)\ \mu\text{m} + 0.58R$	Gage Blocks, Optical Parallels, Surface Plate, Ring Gages, Gage Block Accessories, Calibration Tester, Universal Length Measuring Machine
Indicators, Dial Gauge, Dial Test Indicator, LVDTs ^{1,2}	Up to 1mm Up to 100 mm	$0.32\ \mu\text{m}$ $(0.32 + 0.004\ 6l)\ \mu\text{m} + 0.58R$	Universal Length Measuring Machine, Indicator Tester
Indicators, Dial Gauge, Dial Test Indicator, LVDTs ^{1,2}	Up to 100 mm	$(0.069 + 0.002\ 6l)\ \mu\text{m} + 0.58R$	Gage Block, Comparator Stand
Plain External Diameter ^{1,2} (Cylindrical and Taper)	Up to 300 mm	$(0.31 + 0.001\ 7l)\ \mu\text{m}$	Universal Length Measuring Machine, High- Accuracy Micrometer, Gage Blocks
Plain Internal Diameter ² (Cylindrical and Taper)	(1 to 300) mm	$(0.26 + 0.002\ 2l)\ \mu\text{m}$	Universal Length Measuring Machine, Gage Blocks
Thread Plug Gages ² (Cylindrical and Taper) Simple Pitch Diameter Major Diameter	(1 to 300) mm	$(1.1 + 0.004\ 1l)\ \mu\text{m}$ $(0.33 + 0.001\ 7l)\ \mu\text{m}$	Universal Length Measuring Machine, Thread Wires, Gage Blocks
Thread Ring Gages ² (Cylindrical and Taper) Simple Pitch Diameter Minor Diameter	(3 to 300) mm	$(1.3 + 0.002\ 6l)\ \mu\text{m}$ $(0.31 + 0.002\ 6l)\ \mu\text{m}$	Universal Length Measuring Machine, Gage Blocks, Master Thread Plug Set
Gage Blocks ² Length (Deviation of the length at any point from nominal length)	(0.1 to 100) mm	$(0.065 + 0.001\ 0l)\ \mu\text{m}$	Gage Blocks, Gage Block Comparator
Variation in length	(0 to 0.5) mm	$0.032\ \mu\text{m}$	
Gage Blocks ² Length (Deviation of the length at any point from nominal length)	(0.1 to 100) mm (100 to 500) mm	$(0.16 + 0.000\ 61l)\ \mu\text{m}$ $(0.11 + 0.001l)\ \mu\text{m}$	Gage Blocks, Universal Length Measuring Machine
Variation in length	(0 to 0.5) mm	$0.15\ \mu\text{m}$	

Length – Dimensional Metrology

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Check Master / Caliper Checker / Height Master / Riser Block ² Block Pitch Accuracy	Up to 1 000 mm	$(0.54 + 0.001l) \mu\text{m}$	Gage Blocks, Surface Plate, Electric Comparator, Linear Gage, Precision Height Gages
Parallelism of Block	Up to 1 000 mm	0.55 μm	
Micrometer Head Accuracy	Up to 25 mm	$(0.24 + 0.0025l) \mu\text{m}$	
Calibration Tester / Dial Gauge Tester / Indicator Calibrator ²	Up to 25 mm	$(0.24 + 0.0025l) \mu\text{m}$	Linear Gage and Optical Flat
Inspection Fixtures 1D Features ² Riser Blocks, Straight Edges, Bar Parallels	Up to 100 mm (100 to 500) mm	$(0.31 + 0.00038l) \mu\text{m}$ $(0.23 + 0.0010l) \mu\text{m}$	Universal Length Measuring Machine, Precision Height Gage, Electric Comparator, Linear Length Gage, Gage Blocks, Surface Plate, Smart Scope, Sine Bar, Differential Level, Granite Square
Inspection Fixtures 2D Features ² Angle Block, V-Blocks, Riser Blocks, Straight Edges Parallel Bars, Machine Squares, Precision Squares Radius Gauge, Chamfer Gauge, Taper Gauge Attribute Gauges – Go/No-Go Dedicated Fixture Gauges	Up to 300 mm	$(1.3 + 0.00038l) \mu\text{m}$	Vision system, Gage Blocks, Glass Scale
Inspection Fixtures 2D Features ² Angle Block, V-Blocks, Riser Blocks, Straight Edges Parallel Bars, Machine Squares, Precision Squares Radius Gauge, Chamfer Gauge, Taper Gauge Attribute Gauges – Go/No-Go Dedicated Fixture Gauges	Up to 100 mm (100 to 500) mm	$(0.31 + 0.00038l) \mu\text{m}$ $(0.23 + 0.0010l) \mu\text{m}$	Universal Length Measuring Machine, Precision Height Gage, Electric Comparator, Linear Length Gage, Gage Block, Surface Plate, Smart Scope, Sine Bar, Differential Level, Granite Square
Coating Thickness Gauge ¹	Up to 5 000 μm	0.55 μm	Calibration Foils

Length – Dimensional Metrology

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Ultrasonic Coating Thickness Gauge	Up to 500 mm	$(0.17 + 0.006\ 7l)\ \mu\text{m} + 0.58R$	Gage Blocks
Thickness Gauge / Feeler Gauge ²	Up to 25 mm	$(0.35 + 0.000\ 53l)\ \mu\text{m}$	Universal Measuring Machine, High- Accuracy Micrometer, Gage Blocks
Coordinate Measuring Machine (CMM) ^{1,2} X, Y, Z Axis	Up to 1 000 mm	$(0.16 + 0.002\ 1l)\ \mu\text{m} + 0.58R$	Gage Block, Step Gage, Master Ball
Glass Scale ²	Up to 300 mm	$(1.4 + 0.001\ 7l)\ \mu\text{m}$	Reference Standard Scale, Smart Scope
Snap Gages ² (External / Internal)	(0.001 to 500) mm	$(0.26 + 0.002\ 2l)\ \mu\text{m}$	Universal Length Measuring Machine, Gage Blocks
Spherical Diameter, Standard Ball, Steel Ball ²	(0.1 to 100) mm	$(0.31 + 0.001\ 0l)\ \mu\text{m}$	Universal Length Measuring Machine, Gage Blocks
Universal Length Measuring Machine ^{1,2} Linear Measurement	Up to 100 mm (100 to 500) mm	$(0.057 + 0.002\ 7l)\ \mu\text{m}$ $(0.022 + 0.003\ 1l)\ \mu\text{m}$	Gage Blocks

Mass and Mass Related

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Hardness Testers ¹	HRC Low Middle High	0.53 HRC	Indirect Verification using Reference hardness test blocks
	HRBW Low Middle High	0.78 HRBW	
Vickers Hardness Tester ¹	232 HV1 550 HV10 712 HV30	3 HV 5.6 HV 4.6 HV	Indirect Verification using reference hardness test blocks
Hydrometer	(0.7 to 1.5) g/cm ³	0.000 17 g/cm ³	Analytical Balance, Standard Thermometer

Mass and Mass Related

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Gage ^{1,2} Absolute & Differential & Vacuum Gauges, Transmitters	(-1245 to 1245) Pa (-2490 to 2490) Pa (600 to 1 100) Pa abs (-14.5 to 0) psi (0.001 to 30) psi (30 to 300) (300 to 3 000) psi (3 000 to 10 000) psi	0.019 % of reading + 0.58R 0.016 % of reading + 0.58 Pa 0.011 % of reading 0.024 % of reading + 0.58R 0.081 % of reading 0.006 4 % of reading + 0.002 2 psi 0.014 % of reading 0.029 % of reading	Pressure Calibrator & Pressure Module
Scales & Balances ^{1,3} (Platform & Spring)	(0 to 5) mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g	0.003 1 mg 0.004 1 mg 0.005 1 mg 0.006 1 mg 0.008 1 mg 0.01 mg 0.013 mg 0.015 mg	Standard Weights
Scales & Balances ^{1,3} (Platform & Spring)	(1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g 200 g to 20 kg (20 to 500) kg	0.02 mg 0.026 mg 0.031 mg 0.041 mg 0.051 mg 0.081 mg 0.15 mg 0.82 parts in 10 ⁶ kg/kg 25 parts in 10 ⁶ kg/kg	Standard Weights
Mass Determination (SI)	(1 to 5) mg (5 to 10) mg (10 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g 200 g to 20 kg	0.003 2 mg 0.004 2 mg 0.005 2 mg 0.006 2 mg 0.008 2 mg 0.01 mg 0.013 mg 0.015 mg 0.02 mg 0.026 mg 0.031 mg 0.041 mg 0.051 mg 0.081 mg 0.15 mg 0.82 parts in 10 ⁶ kg/kg	Standard Weight, Mass Comparator

Mass and Mass Related

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Tools ¹	Up to 50 cN·m (0.50 to 1) N·m (1 to 60) N·m (60 to 200) N·m (200 to 1 500) N·m	0.090 % of reading + 0.014 cN·m 0.072 % of reading + 0.001 5 N·m 0.040 % of reading + 0.002 0 N·m 0.029 % of reading + 0.16 N·m 0.012 % of reading + 0.18 N·m	Torque Testers
Torque Testers ^{1,2}	Up to 10 N·m (10 to 50) N·m (50 to 200) N·m (200 to 500) N·m (500 to 1 500) N·m	0.064 % of reading + 0.58R 0.040 % of reading + 0.58R 0.027 % of reading + 0.58R 0.016 % of reading + 0.58R 0.011 % of reading + 0.58R	Torque Calibration Wheel with Standard Weight
Force and Load Cell ^{1,2} (Compression and Tension)	Up to 10 N (10 to 20) N (20 to 50) N (50 to 1 000) N	0.01 % of reading + 0.58R 0.007 4 % of reading 0.006 4 % of reading 0.006 2 % of reading	Standard weights
	Up to 220 kN (220 to 440) kN	0.14 % of reading + 0.58 N 0.14 % of reading	Load cell
Hardness Durometers ²			
Spring Force	Up to 50 N	0.008 N	Full Verification using Electronic Balance, Load Cell
Extension at zero	Up to 5 mm	0.005 mm	Gage Blocks
Indenter Shape	Up to 15 mm Up to 90°	0.003 mm 2'	Smart Scope
Air Flow ^{1,2}	(5 to 500) ml/min (0.3 to 30) l/min (10 to 100) l/min	0.36 % of reading 0.38 % of reading + 0.000 6 l/min 0.63 % of reading	Flow Calibrators
Air Velocity	(0.01 to 15) m/s	1.4 % of reading	Wind Tunnel
Pipettes & Micropipettes Burette ¹	Up to 20 µL (20 to 50) µL (50 to 100) µL (100 to 200) µL 200 µL to 10 mL (10 to 20) mL (20 to 2 000) mL	0.02 µL 0.043 % of reading 0.026 % of reading 0.019 % of reading 0.015 % of reading 0.014 % of reading 0.012 % of reading	Analytical Scale, Standard Weights
Volumetric Flask ¹	Up to 10 mL (10 to 20) mL (20 to 2 000) mL	0.001 5 mL 0.014 % of reading 0.012 % of reading	Analytical Scale, Standard Weights

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
UV Meter/ Radiometer	(0.001 to 1) W/cm ²	2.3 % of reading	Standard UV/Radiometer
Gloss Meter ¹ 20°, 60°, 85°	Up to 100 GU	1.3 GU	Gloss Standards
Illuminance Measuring Equipment	(0.01 to 19 000) lux	1.8 % of reading	Comparison with Chroma Meter
Light Box Illuminance Temperature Color	Up to 20 000 lx 2856 K	1.6 % of reading + 0.58R 35 K	Comparison to Master Chroma Meter
Color Meter (Spectral Diffuse Reflectance)	(380 to 780) nm (10 to 20) %R (20 to 30) %R (30 to 40) %R (40 to 50) %R (50 to 60) %R (60 to 70) %R (70 to 80) %R (80 to 90) %R (90 to 100) %R	0.19 %R 0.24 %R 0.34 %R 0.35 %R 0.47 %R 0.51 %R 0.6 %R 0.66 %R 0.72 %R	Calibration Plate Colors
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: White Illuminant A x y Y% u' v' L* a* b* Illuminant C x y Y% u' v' L* a* b*	0.000 31 0.000 31 0.87 0.000 31 0.000 16 0.35 0.11 0.24 0.000 46 0.000 61 0.89 0.000 16 0.000 46 0.35 0.13 0.24	Calibration Plate Colors

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: White		Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	y	0.000 61	
	Y%	0.89	
	u'	0.000 16	
	v'	0.000 31	
	L*	0.35	
	a*	0.13	
	b*	0.24	
	Illuminant D50		
	x	0.000 46	
	y	0.000 46	
	Y%	0.87	
	u'	0.000 16	
	v'	0.000 31	
	L*	0.35	
	a*	0.12	
	b*	0.24	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Brown		Calibration Plate Colors
	Illuminant A		
	x	0.000 31	
	Y	0.000 31	
	Y%	0.26	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.24	
	a*	0.092	
	b*	0.15	
	Illuminant C		
	x	0.000 46	
	y	0.000 46	
	Y%	0.24	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.23	
	a*	0.092	
	b*	0.15	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Brown		Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	y	0.000 46	
	Y%	0.24	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.23	
	a*	0.11	
	b*	0.15	
	Illuminant D50		
	x	0.000 46	
	y	0.000 46	
	Y%	0.26	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.23	
	a*	0.092	
	b*	0.15	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Green		Calibration Plate Colors
	Illuminant A		
	x	0.000 46	
	y	0.000 46	
	Y%	0.27	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.24	
	a*	0.15	
	b*	0.22	
	Illuminant C		
	x	0.000 46	
	y	0.000 77	
	Y%	0.31	
	u'	0.000 16	
	v'	0.000 46	
	L*	0.26	
	a*	0.14	
	b*	0.21	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Green		Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	Y	0.000 77	
	Y%	0.31	
	u'	0.000 16	
	v'	0.000 46	
	L*	0.26	
	a*	0.14	
	b*	0.21	
	Illuminant D50		
	x	0.000 46	
	Y	0.000 77	
	Y%	0.31	
	u'	0.000 16	
	v'	0.000 31	
	L*	0.26	
	a*	0.14	
	b*	0.22	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Deep Pink		Calibration Plate Colors
	Illuminant A		
	x	0.000 31	
	y	0.000 31	
	Y%	0.31	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.24	
	a*	0.11	
	b*	0.22	
	Illuminant C		
	x	0.000 46	
	y	0.000 77	
	Y%	0.29	
	u'	0.000 16	
	v'	0.000 46	
	L*	0.24	
	a*	0.14	
	b*	0.22	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Deep Pink		Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	y	0.000 77	
	Y%	0.27	
	u'	0.000 31	
	v'	0.000 46	
	L*	0.24	
	a*	0.14	
	b*	0.22	
	Illuminant D50		
	x	0.000 46	
	y	0.000 61	
	Y%	0.29	
	u'	0.000 31	
	v'	0.000 46	
	L*	0.24	
	a*	0.12	
	b*	0.22	
Calibration Plate Colors	Color: Yellow		Calibration Plate Colors
	Illuminant A		
	x	0.000 31	
	y	0.000 31	
	Y%	0.67	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.32	
	a*	0.13	
	b*	0.19	
	Illuminant C		
	x	0.000 46	
	y	0.000 31	
	Y%	0.63	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.32	
	a*	0.15	
	b*	0.18	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Yellow		Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	y	0.000 31	
	Y%	0.63	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.32	
	a*	0.15	
	b*	0.18	
	Illuminant D50		
	x	0.000 46	
	y	0.000 31	
	Y%	0.64	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.32	
	a*	0.15	
	b*	0.18	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Cyan		Calibration Plate Colors
	Illuminant A		
	x	0.000 46	
	y	0.000 46	
	Y%	0.41	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.18	
	b*	0.27	
	Illuminant C		
	x	0.000 31	
	y	0.000 77	
	Y%	0.46	
	u'	0.000 16	
	v'	0.000 46	
	L*	0.29	
	a*	0.18	
	b*	0.27	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Cyan		Calibration Plate Colors
	Illuminant D65		
	x	0.000 31	
	y	0.000 77	
	Y%	0.46	
	u'	0.000 16	
	v'	0.000 46	
	L*	0.29	
	a*	0.18	
	b*	0.27	
	Illuminant D50		
	x	0.000 46	
	y	0.000 77	
	Y%	0.46	
	u'	0.000 16	
	v'	0.000 46	
	L*	0.29	
	a*	0.17	
	b*	0.27	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Yellow Green		Calibration Plate Colors
	Illuminant A		
	x	0.000 31	
	y	0.000 31	
	Y%	0.38	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.26	
	a*	0.12	
	b*	0.19	
	Illuminant C		
	x	0.000 46	
	y	0.000 61	
	Y%	0.4	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.14	
	b*	0.18	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Yellow Green		Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	y	0.000 61	
	Y%	0.4	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.14	
	b*	0.18	
	Illuminant D50		
	x	0.000 46	
	y	0.000 46	
	Y%	0.4	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.14	
	b*	0.18	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Red		Calibration Plate Colors
	Illuminant A		
	x	0.000 46	
	y	0.000 16	
	Y%	0.24	
	u'	0.000 46	
	v'	0.000 16	
	L*	0.24	
	a*	0.2	
	b*	0.24	
	Illuminant C		
	x	0.000 92	
	y	0.000 46	
	Y%	0.2	
	u'	0.000 61	
	v'	0.000 31	
	L*	0.23	
	a*	0.21	
	b*	0.21	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Red		Calibration Plate Colors
	Illuminant D65		
	x	0.000 92	
	y	0.000 46	
	Y%	0.2	
	u'	0.000 61	
	v'	0.000 31	
	L*	0.23	
	a*	0.21	
	b*	0.21	
	Illuminant D50		
	x	0.000 46	
	y	0.000 16	
	Y%	0.24	
	u'	0.000 46	
	v'	0.000 16	
	L*	0.24	
	a*	0.18	
	b*	0.24	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Purple		Calibration Plate Colors
	Illuminant A		
	x	0.000 61	
	y	0.000 46	
	Y%	0.21	
	u'	0.000 46	
	v'	0.000 31	
	L*	0.21	
	a*	0.18	
	b*	0.27	
	Illuminant C		
	x	0.000 46	
	y	0.000 61	
	Y%	0.23	
	u'	0.000 31	
	v'	0.000 46	
	L*	0.23	
	a*	0.23	
	b*	0.27	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Purple		Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	y	0.000 61	
	Y%	0.23	
	u'	0.000 31	
	v'	0.000 46	
	L*	0.23	
	a*	0.23	
	b*	0.27	
	Illuminant D50		
	x	0.000 61	
	y	0.000 61	
	Y%	0.23	
	u'	0.000 46	
	v'	0.000 46	
	L*	0.23	
	a*	0.2	
	b*	0.27	
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Orange		Calibration Plate Colors
	Illuminant A		
	x	0.000 31	
	y	0.000 31	
	Y%	0.43	
	u'	0.000 31	
	v'	0.000 16	
	L*	0.27	
	a*	0.12	
	b*	0.18	
	Illuminant C		
	x	0.000 46	
	y	0.000 46	
	Y%	0.38	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.12	
	b*	0.19	

Photometry and Radiometry

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Color Meter – Colorimetric @ 2° and 10° Observers ⁵	Color: Orange		Calibration Plate Colors
	Illuminant D65		
	x	0.000 46	
	y	0.000 46	
	Y%	0.38	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.12	
	b*	0.19	
	Illuminant D50		
	x	0.000 31	
	y	0.000 46	
	Y%	0.4	
	u'	0.000 31	
	v'	0.000 31	
	L*	0.27	
	a*	0.12	
	b*	0.18	
Optical Power ¹ (Source & Measure)			Agilent optical test System
(800 to 1 000) nm	(-90 to 10) dB	0.12 dB	
(1 000 to 1 310) nm	(-110 to 10) dB	0.12 dB	
(1 310 to 1 700) nm	(-110 to 10) dB	0.12 dB	
Optical Wavelength – Measure ¹	(700 to 1 650) nm	0.005 nm	Wavelength Meter
Optical Wavelength – Generate ¹	(1 310, 1 550) nm	0.013 nm	Optical laser source
Laser Power Measure	(250 to 10 600) nm 10 mW to 10 W (10 to 30) W	1.8 % of reading + 0.04 mW 2.7 % of reading	Thermopile Sensor, Silicon Detector

Thermodynamic

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity Measuring Equipment, Transmitters ¹	(10 to 40) %RH (40 to 95) %RH	0.83 %RH 1.3 %RH	Comparison to Temp/Humidity Meter

Thermodynamic

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Measure & Measuring Equipment, Transmitters ¹	(-80 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 420) °C (420 to 1 100) °C	0.027 °C 0.03 °C 0.052 °C 0.14 °C 0.88 °C	SPRT, Thermocouple, Micro Bath, Dry-Well, Temperature Calibrator
Radiation (Infrared) Thermometers ¹	-18 °C (-17.9 to 0) °C (0.1 to 32) °C (32.1 to 50) °C (50.1 to 100) °C (100.1 to 150) °C (150.1 to 200) °C	0.84 °C 0.93 °C 1.2 °C 1.3 °C 1.6 °C 2.2 °C 2.7 °C	Omega Blackbody Calibrator (Plate) $\varepsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers ¹	(32 to 50) °C (50.1 to 100) °C (100.1 to 200) °C (200.1 to 300) °C (300.1 to 400) °C	1.6 °C 2 °C 2.9 °C 3.8 °C 4.8 °C	Ametek Blackbody Calibrator (Plate) $\varepsilon = 0.96$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Chambers, Dry Oven, Furnace, Autoclave, Incubator, Vacuum Oven, System Calibration & Profiling ¹ Temperature Humidity	(-80 to 400) °C (10 to 40) %RH (40 to 95) %RH	0.63 °C 0.83 %RH 1.3 %RH	Datalogger with Thermocouple Sensors and Relative Humidity Sensor

Time and Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	0.01 Hz to 225 MHz 225 MHz to 26.5 GHz	6.7×10^{-12} Hz/Hz 6.9×10^{-12} Hz/Hz	GPS Receiver, Counter
Frequency – Source ¹	(1, 10) MHz	6.2×10^{-12} Hz/Hz	GPS Receiver
	Hz to 40 GHz	6.3×10^{-12} Hz/Hz	GPS Receiver, Signal Generator
Tachometer ¹	(0 to 100 000) rpm	0.000 2 % of reading + 0.58R	Signal Generator with Lamp
Stopwatch and Timer ¹	(0 to 24) hours	0.86 ms	Frequency Counter

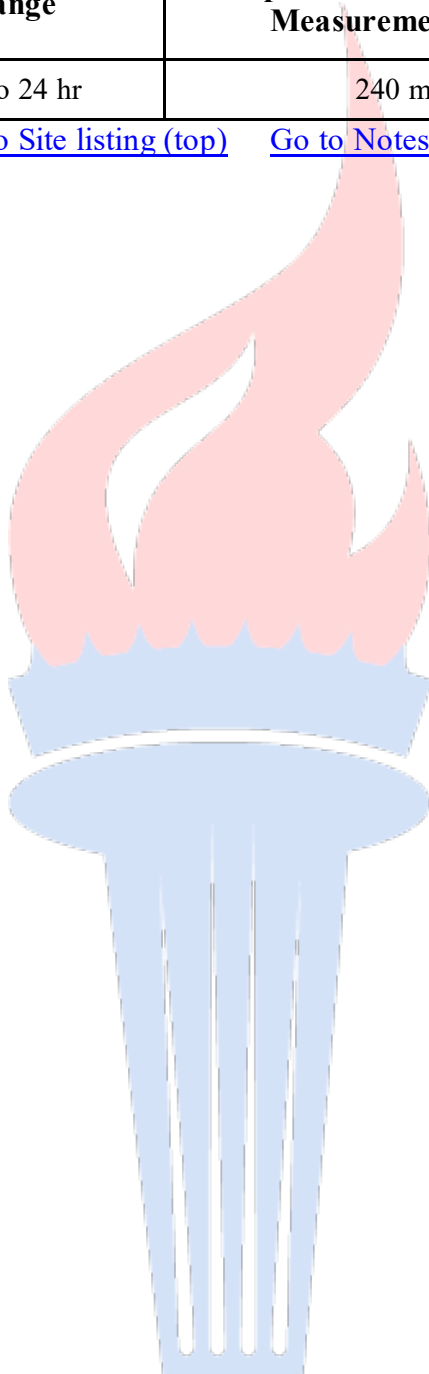
Time and Frequency

Bac Ninh Province, Vietnam

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Stopwatch and Timer ¹	Up to 24 hr	240 ms	Stopwatch

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)



Services performed at satellite laboratory

Micro Precision Calibration, Inc.

12071 Tejon Street, Suite #100
Westminster, CO 80234
Norma Vazquez 530-268-1860
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CALIBRATION

Chemical Quantities

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity ¹	9.8 μ S/cm 100 μ S/cm 998 μ S/cm 1 412 μ S/cm 9 993 μ S/cm 99 998 μ S/cm	0.58 μ S/cm 0.88 μ S/cm 3.5 μ S/cm 3.7 μ S/cm 27 μ S/cm 220 μ S/cm	Standard Conductivity Solutions
pH ¹	(4, 7, 10) pH	0.03 pH	Standard pH Solutions

Electrical – DC/Low Frequency

Westminster, CO

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 22) V (22 to 220) V 220 V to 1.1 kV	9.8 μ V/V + 0.6 μ V 11 μ V/V + 1 μ V 8.3 μ V/V + 3.5 μ V 8.3 μ V/V + 80 μ V 8.8 μ V/V + 0.5 mV	Multiproduct Calibrator
DC Voltage – Measure ¹	Up to 100 mV 100 mV to 1V (1 to 10) V (10 to 100) V 100 V to 1 kV	18 μ V/V + 3 μ V 10 μ V/V + 0.3 μ V 10 μ V/V + 0.5 μ V 9 μ V/V + 30 μ V 10 μ V/V + 0.1 mV	Multimeter
DC Power – Source ¹ Up to 1 000 V	Up to 20 kW	0.06 % of reading + 0.58R	Multi-Product Calibrator
DC Voltage – Measure ¹ High Voltage	(1 to 10) kV (10 to 20) kV (20 to 70) kV	1 mV/V + 4 V 4 mV/V 6 mV/V	High Voltage Meter

Electrical – DC/Low Frequency

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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	80 μ A/A + 8 nA 67 μ A/A + 8 nA 68 μ A/A + 80 nA 73 μ A/A + 0.8 μ A 74 μ A/A + 25 μ A 85 μ A/A + 25 μ A	Multiproduct Calibrator
	(1 to 1 000) A	3.7 mA/A	Multiproduct Calibrator with 50 turn Coil
DC Current – Measure ¹	Up to 100 μ A 100 μ A to 10 mA (10 to 100) mA 100 mA to 1 A	12 μ A/A + 0.4 mA 13 μ A/A + 5 μ A 16 μ A/A + 5 μ A 97 μ A/A + 10 μ A	Multimeter
Resistance – Source ¹ (Fixed Points)	1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	55 $\mu\Omega/\Omega$ 26 $\mu\Omega/\Omega$ 15 $\mu\Omega/\Omega$ 14 $\mu\Omega/\Omega$ 15 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 14 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 14 $\mu\Omega/\Omega$ 14 $\mu\Omega/\Omega$ 15 $\mu\Omega/\Omega$ 13 $\mu\Omega/\Omega$ 16 $\mu\Omega/\Omega$ 18 $\mu\Omega/\Omega$ 44 $\mu\Omega/\Omega$ 0.1 m Ω/Ω	Multiproduct Calibrator
Resistance – Measure ¹	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 k Ω 1 k Ω to 10 k Ω 10 k Ω to 100 k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 1 G Ω	28 $\mu\Omega/\Omega$ 17 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 15 $\mu\Omega/\Omega$ 25 $\mu\Omega/\Omega$ 71 $\mu\Omega/\Omega$ 0.6 m Ω/Ω 0.7 m Ω/Ω	Multimeter

Electrical – DC/Low Frequency

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	Up to 2.2 mV		Multiproduct Calibrator
	(10 to 20) Hz	0.6 mV/V + 4.5 μ V	
	(20 to 40) Hz	0.21 mV/V + 4.5 μ V	
	40 Hz to 20 kHz	0.11 mV/V + 4.5 μ V	
	(20 to 50) kHz	0.37 mV/V + 4.5 μ V	
	(50 to 100) kHz	0.85 mV/V + 7.0 μ V	
	(100 to 300) kHz	1.1 mV/V + 13 μ V	
	(300 to 500) kHz	1.7 mV/V + 25 μ V	
	500 kHz to 1 MHz	3.4 mV/V + 25 μ V	
	(2.2 to 22) mV		
	(10 to 20) Hz	0.6 mV/V + 5 μ V	
	(20 to 40) Hz	0.21 mV/V + 5 μ V	
	40 Hz to 20 kHz	0.11 mV/V + 5 μ V	
	(20 to 50) kHz	0.37 mV/V + 5 μ V	
	(50 to 100) kHz	0.85 mV/V + 7 μ V	
	(100 to 300) kHz	1.1 mV/V + 12 μ V	
	(300 to 500) kHz	1.7 mV/V + 25 μ V	
	500 kHz to 1 MHz	3.4 mV/V + 25 μ V	
	(22 to 220) mV		
	(10 to 20) Hz	0.55 mV/V + 13 μ V	
	(20 to 40) Hz	0.21 mV/V + 8 μ V	
	40 Hz to 20 kHz	0.11 mV/V + 8 μ V	
	(20 to 50) kHz	0.32 mV/V + 8 μ V	
	(50 to 100) kHz	0.85 mV/V + 25 μ V	
	(100 to 300) kHz	1.1 mV/V + 25 μ V	
	(300 to 500) kHz	1.7 mV/V + 35 μ V	
	500 kHz to 1 MHz	3.4 mV/V + 80 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	0.5 mV/V + 80 μ V	
	(20 to 40) Hz	0.16 mV/V + 25 μ V	
	40 Hz to 20 kHz	0.75 mV/V + 6 μ V	
	(20 to 50) kHz	0.12 mV/V + 16 μ V	
	(50 to 100) kHz	0.25 mV/V + 70 μ V	
	(100 to 300) kHz	0.43 mV/V + 0.13 mV	
	(300 to 500) kHz	1.1 mV/V + 0.35 mV	
	500 kHz to 1 MHz	2.2 mV/V + 0.85 mV	

Electrical – DC/Low Frequency

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) V		Multiproduct Calibrator
	(10 to 20) Hz	0.5 mV/V + 0.8 mV	
	(20 to 40) Hz	0.16 mV/V + 0.25 mV	
	40 Hz to 20 kHz	0.75 mV/V + 0.06 mV	
	(20 to 50) kHz	0.12 mV/V + 0.16 mV	
	(50 to 100) kHz	0.25 mV/V + 0.35 mV	
	(100 to 300) kHz	0.5 mV/V + 1.5 mV	
	(300 to 500) kHz	1.3 mV/V + 4.3 mV	
	500 kHz to 1 MHz	2.7 mV/V + 8.5 mV	
	(22 to 220) V		
	(10 to 20) Hz	0.5 mV/V + 8 mV	
	(20 to 40) Hz	0.16 mV/V + 2.5 mV	
	40 Hz to 20 kHz	0.80 mV/V + 0.8 mV	
	(20 to 50) kHz	0.22 mV/V + 3.5 mV	
	(50 to 100) kHz	0.50 mV/V + 8 mV	
	100 kHz to 1 MHz	16 mV/V + 0.19 V	
AC Voltage – Measure ¹	(220 to 750) V		Multimeter
	(30 to 50) kHz	0.6 mV/V + 11 mV	
	(50 to 100) kHz	2.3 mV/V + 45 mV	
	220 V to 1.1 kV		
	(15 to 50) Hz	0.4 mV/V + 16 mV	
	50 Hz to 1 kHz	90 μ V/V + 4 mV	
	Up to 10 mV		
	(1 to 40) Hz	0.3 mV/V + 3 μ V	
	40 Hz to 1 kHz	0.2 mV/V + 2 μ V	
	(1 to 20) kHz	0.3 mV/V + 2 μ V	
	(20 to 50) kHz	1.2 mV/V + 2 μ V	
	(50 to 100) kHz	5.8 mV/V + 2 μ V	
	(100 to 300) kHz	46 mV/V + 2 μ V	
	10 mV to 10 V		
	(1 to 40) Hz	80 μ V/V + 0.4 mV	
	40 Hz to 1 kHz	80 μ V/V + 0.2 mV	
	(1 to 20) kHz	0.2 mV/V + 0.2 mV	
	(20 to 50) kHz	0.3 mV/V + 0.2 mV	
	(50 to 100) kHz	0.9 mV/V + 0.2 mV	
	(100 to 300) kHz	3.5 mV/V + 1 mV	
	300 kHz to 1 MHz	12 mV/V + 1 mV	
	(1 to 2) MHz	17 mV/V + 1 mV	

Electrical – DC/Low Frequency

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(10 to 100) V (1 to 40) Hz 40 Hz to 1 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz 300 kHz to 1 MHz 100 V to 1 kV (1 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.2 mV/V + 4 mV 0.2 mV/V + 2 mV 0.4 mV/V + 2 mV 1.4 mV/V + 2 mV 4.6 mV/V + 10 mV 17 mV/V + 10 mV 0.5 mV/V + 40 mV 0.5 mV/V + 20 mV 0.7 mV/V + 20 mV 1.4 mV/V + 20 mV 3.5 mV/V + 20 mV	Multimeter
AC High Voltage – Measure ¹	(1 to 10) kV (20 to 100) Hz (10 to 20) kV (20 to 100) Hz (20 to 35) kV (50 to 60) Hz	2 mV/V + 25 V 6 mV/V + 25 V 4 mV/V + 0.11 kV	High Voltage Meter
AC Power Source ¹ (45 to 65) Hz	0.1 mW to 20 kW PF=1 PF=0.866	0.1 % of reading + 0.58R 0.15 % of reading + 0.58R	Multi-Product Calibrator
AC Current – Source ¹	(1 to 220) μ A 40 Hz to 1 kHz 220 μ A to 22 mA 40 Hz to 1 kHz (22 to 220) mA 40 Hz to 1 kHz 220 mA to 2.2 A 40 Hz to 1 kHz	0.9 mA/A 0.24 mA/A 0.26 mA/A 0.93 mA/A	Multiproduct Calibrator
AC Current – Source ¹	(1 to 1 000) A 60 Hz	5.4 mA/A	Multiproduct Calibrator with Coil
AC Current – Measure ¹	Up to 100 μ A (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz	4.6 mA/A + 0.03 μ A 1.8 mA/A + 0.03 μ A 0.78 mA/A + 0.03 μ A	Multimeter

Electrical – DC/Low Frequency

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	100 μ A to 100 mA (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz 100 mA to 1 A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4.6 mA/A + 20 μ A 1.7 mA/A + 20 μ A 7.3 mA/A + 20 μ A 4.2 mA/A + 20 μ A 4.6 mA/A + 200 μ A 1.9 mA/A + 200 μ A 1 mA/A + 200 μ A 1.2 mA/A + 200 μ A	Multimeter
Capacitance – Source ¹ (Simulation) 1 kHz	(330 to 490) pF 490 pF to 1.1 nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF (110 to 330) nF 330 nF to 1.1 μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F 330 μ F to 1.1 μ F (1.1 to 3.3) μ F	33 mF/F 14 mF/F 7.3 mF/F 5.1 mF/F 5.4 mF/F 1.9 mF/F + 78 pF 1.9 mF/F + 0.23 nF 1.9 mF/F + 0.78 nF 2.7 mF/F + 2.3 nF 2.7 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.2 mF/F 3.2 mF/F 2.9 mF/F 3.7 mF/F	Multiproduct Calibrator
	50 pF to 1.2 mF	0.72 mF/F	Decade Capacitor
Inductance – Source ¹ (Variable Artifact) 1 kHz	(1 to 10) mH (10 to 100) mH (0.1 to 1) H (1 to 10) H	0.03 mH 0.15 mH 2 mH 11 mH	Decade Inductor
Electrical Stimulation of Thermocouple Indicators ¹	Type E (-250 to -100) $^{\circ}$ C (-100 to 650) $^{\circ}$ C (650 to 1 000) $^{\circ}$ C Type J (-210 to -100) $^{\circ}$ C (-100 to 760) $^{\circ}$ C (760 to 1 200) $^{\circ}$ C	0.31 $^{\circ}$ C 0.23 $^{\circ}$ C 0.21 $^{\circ}$ C 0.29 $^{\circ}$ C 0.21 $^{\circ}$ C 0.19 $^{\circ}$ C	Multiproduct Calibrator

Electrical – DC/Low Frequency

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Stimulation of Thermocouple Indicators ¹	Type K		Multiproduct Calibrator
	(-200 to -100) °C	0.32 °C	
	(-100 to 1 000) °C	0.29 °C	
	(1 000 to 1 372) °C	0.36 °C	
	Type S		
	(0 to 250) °C	0.38 °C	
	(250 to 1 400) °C	0.49 °C	
	(1 400 to 1 767) °C	0.46 °C	
	Type T		
	(-250 to -150) °C	0.59 °C	
Electrical Stimulation of RTD Indicators ¹	(-150 to 0) °C	0.54 °C	Multiproduct Calibrator
	(0 to 400) °C	0.57 °C	
	Pt 395, 100 Ω		
	(-200 to 0) °C	0.05 °C	
	(0 to 100) °C	0.05 °C	
	(100 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 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 0) °C	0.05 °C	
	(0 to 300) °C	0.08 °C	
	(300 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 600) °C	0.14 °C	
	(600 to 630) °C	0.16 °C	
	Pt 385, 500 Ω		
	(-200 to 100) °C	0.05 °C	
	(100 to 260) °C	0.06 °C	
	(260 to 600) °C	0.09 °C	
	(600 to 630) °C	0.11 °C	

Electrical – DC/Low Frequency

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Stimulation of RTD Indicators ¹	Pt 385, 1 k Ω (-200 to 100) °C (100 to 260) °C (260 to 600) °C (600 to 630) °C PtNi 385, 100 Ω (-80 to 100) °C (100 to 260) °C Cu 427, 10 Ω (-100 to 260) °C	0.03 °C 0.05 °C 0.07 °C 0.23 °C 0.08 °C 0.14 °C 0.3 °C	Multiproduct Calibrator
Oscilloscopes ^{1,2} Square Wave Signal into 50 Ω load into 1 M Ω load Pulse & Rise Time 0.5, 1 V p-p 1 V p-p Time Mark Output into 50 Ω load Leveled Sine Flatness	1 kHz ± 1 mVp-p to ± 6.6 Vp-p ± 1 mVp-p to ± 130 Vp-p 10 MHz 1 MHz 2 ns to 20 ms 50 ms to 5 s 50 kHz Reference 50 kHz to 100 MHz (100 to 600) MHz	1 mV/V + 40 μ V 4 mV/V + 40 μ V 0.4 ns 0.4 ns (25 + 1 000t) μ s/s 25 μ s/s 2.4 % of reading + 0.3 nV 2.5 % of reading + 0.3 nV 4.3 % of reading + 0.3 nV	Multiproduct Calibrator

Electrical – RF/Microwave

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Distortion – Measure ¹ 20 Hz to 20 kHz 20 Hz to 50 kHz (50 to 100) kHz	80 kHz BW: -80 dB 500 kHz BW: -70 dB 500 kHz BW: -65 dB	0.15 dB 0.17 dB 0.17 dB	Audio Analyzer

Electrical – RF/Microwave

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned RF Power, Relative – Measure ¹ 2.5 MHz to 26.5 GHz	(0 to -3) dB (-3 to 10) dB (-10 to -40) dB (-40 to -50) dB (-50 to -80) dB (-80 to -90) dB (-90 to -110) dB (-110 to -127) dB	0.04 dB 0.03 dB 0.07 dB 0.08 dB 0.09 dB 0.11 dB 0.14 dB 0.2 dB	Measuring Receiver with Power Sensor
RF Absolute Power – Measure ¹ 100 kHz to 2.6 GHz 100 kHz to 4.2 GHz 10 MHz to 16.5 GHz 10 MHz to 26.5 GHz 50 MHz to 50 GHz	(-30 to 20) dB	0.6 dB 0.65 dB 0.68 dB 0.69 dB 0.84 dB	Power Meter or Measuring Receiver with Power Sensor
Amplitude Modulation – Measure ¹ 50 Hz to 10 kHz 20 Hz to 100 kHz 50 Hz to 50 kHz 20 Hz to 100 kHz	Rate: 150 kHz to 10 MHz Depth: (5 to 99) % Rate: 10 MHz to 1.3 GHz Depth: (5 to 99) %	4 % of reading 4.6 % of reading 3.6 % of reading 4.6 % of reading	Measuring Receiver with Power Sensor
Amplitude Modulation – Measure ¹ 50 Hz to 50 kHz 20 Hz to 100 kHz	Rate: (1.3 to 26.5) GHz Depth: (5 to 99) %	3.7 % of reading 4.7 % of reading	Measuring Receiver with Power Sensor
Frequency Modulation – Measure ¹ 20 Hz to 10 kHz 20 Hz to 200 kHz 50 Hz to 100 kHz	Rate: 250 kHz to 10 MHz Dev: ≤ 40 kHz Rate: 10 MHz to 1.3 GHz Dev: ≤ 400 kHz	3.1 % of reading 7.7 % of reading 1.6 % of reading	Measuring Receiver
Frequency Modulation – Measure ¹ 20 Hz to 100 kHz 50 Hz to 100 kHz	Rate: (1.3 to 26.5) GHz	7.7 % of reading 1.6 % of reading	Measuring Receiver with Power Sensor
Phase Modulation – Measure ¹ 200 Hz to 20 kHz	Rate: 10 MHz to 1.3 GHz	7 % of reading	Measuring Receiver

Electrical – RF/Microwave

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Measure ¹ 200 Hz to 20 kHz	Rate: (1.3 to 26.5) GHz	7.4 % of reading	Measuring Receiver with Power Sensor
Reflection S11/ S22 – Measure ^{1,5} Type N	(0 to 1) lin mag (-180 to 180) ° 5 Hz to 200 MHz 200 MHz to 6 GHz (6 to 20) GHz (20 to 40) GHz (40 to 50) GHz	0.028 1.2 ° 0.028 1.4 ° 0.037 1.7 ° 0.037 2.8 ° 0.037 3.4 °	Network Analyzer, S-Parameter Test Set, Transmission/Reflection Test Set, Calibration Kit

Length – Dimensional Metrology

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 8 in (8 to 24) in	(58 + 2.6L) μin (62 + 8L) μin	Gage Blocks
Height Gages ^{1,2}	Up to 24 in	(210 + 13.4L) μin	Gage Blocks
Gage Blocks ²	Up to 4 in	(5.7 + 0.5L) μin	Universal Length Measurement Machine, Master Gage Blocks
Plain & Taper Plug Gages and Pin Gages ²	Up to 12 in	(33 + 1.2L) μin	Bench Micrometer, Master Gage Blocks
Thread Plug Gage ^{1,2} Pitch Diameter Major Diameter	Up to 5 in Up to 5 in	(48 + 1.2L) μin (47 + 1.2L) μin	Bench Micrometer, Thread Wires
Dial & Test LVDTs, Indicators ¹ 20 μin resolution 50 μin resolution 100 μin resolution	(0.1 to 4) in (0.1 to 4) in (0.1 to 4) in	20 μin 44 μin 84 μin	Indicator Calibrator, Master Gage Blocks
Micrometers ^{1,2} External, Internal, Depth, Bore	Up to 1 in (1 to 24) in	(25 + 10L) μin (82 + 10L) μin	Gage Blocks

Length – Dimensional Metrology

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Ring Gauges ² Cylindrical & Tapered	(0.02 to 10) in	$(97 + 1.2L) \mu\text{in}$	Bench Micrometer, Gage Blocks
Calibration Tester / Dial Gauge Tester / Indicator Calibrator ²	Up to 1 in	$(25 + 10L) \mu\text{in}$	Linear Gage and Optical Flat
Surface Plates ¹ {(12 × 12) in to (72 × 144) in} Repeat Reading only	Up to 0.001 in	250 μin	Repeat-o-Meter

Mass and Mass Related

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Gage / Absolute & Differential, Vacuum Gauges/Transmitters ¹	(0.001 to 100) psi (100 to 1 500) psi (1 500 to 10 000) psi	0.06 % of reading 0.05 % of reading 0.21 % of reading	Pressure Calibrator/Indicator
Torque Testers – Measuring Equipment ¹	(0.1 to 40) N·m (40 to 1 500) N·m	0.59 % of reading 0.88 % of reading	Torque System
Mass (Standard Weight Class: F2, M1, M2, M3)	(1 to 500) mg	0.08 mg	Class E2 Weights
	1 g	0.004 mg	Double Substitution using Standard Weights, Electronic Balance
	2 g	0.009 mg	
	5 g	0.013 mg	
	10 g	0.016 mg	
	20 g	0.021 mg	
	50 g	0.049 mg	
	100 g	0.075 mg	
	200 g	0.14 mg	
	10 kg	8.9 mg	Class F1 Weights
Scales & Balances ^{1,3} (Platform & Spring)	Up to 200 g 200 g to 1 kg (1 to 5) kg (5 to 20) kg	0.14 mg 1.4 mg 13 mg 25 mg	Class E2 and E1 Weights
Hydrometer	(0.7 to 1.5) g/cm ³	0.000 17 g/cm ³	Analytical Balance Standard Thermometer
Air Velocity	Up to 15 m/s	1.3 % of reading + 0.005 8 m/s	Wind Tunnel

Photometry and Radiometry

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Fiber Optics Power – Measure ¹ Wavelength: (850, 1 310, 1 550) nm	(-60 to -0.001) dB	5.2 % of reading	Optical Calibration System
Optical Wavelength – Measure ¹	(700 to 1 650) nm	0.007 nm	Wavelength Meter
UV Meter/ Radiometer	(0.001 to 10 000) mW	2.6 % of reading	UV Power Meter, Power Sensor

Thermodynamic

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity Measuring Equipment/Transmitters ¹	(20 to 90) %RH	2 %RH	Humidity Indicator
Radiation (Infrared) Thermometers ¹	(0 to 150) °C (150 to 500) °C	1 °C 2 °C	Black Body Calibrator $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Temperature Measure & Measuring Equipment/Transmitters ¹	(-197 to 660) °C	0.04 °C	Comparison to PRT Probe w/ Temperature Meter

Time and Frequency

Westminster, CO

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tachometer ^{1,2}	Up to 100 000 rpm	0.000 6 % of reading + 0.000 58 rpm	Signal Generator with Lamp
Frequency – Measure	10 MHz	5 parts in 10^{12}	GPS Receiver
Frequency – Measure ¹	10 Hz to 26.5 GHz	2.5 parts in 10^{11}	Signal Generator, Measuring Receiver, Counter

[Return to Site listing \(top\)](#) [Go to Notes \(bottom\)](#)

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CALIBRATION

Acoustics and Vibration

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meter ¹	(74 to 114) dB (125 Hz to 4 kHz)	0.34 dB	Sound Calibrator, Sound Level Meter
Sound Calibrator ¹	(74 to 114) dB (125 Hz to 4 kHz)	0.22 dB	Sound Level Meter

Chemical Quantities

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity – Meter ¹	1.0 µS/cm 10 µS/cm 100 µS/cm 1 413 µS/cm 100 000 µS/cm	0.57 µS/cm 0.57 µS/cm 2.3 µS/cm 3 µS/cm 70 µS/cm	Comparison to Standard Solutions
pH – Meters ¹	(4, 7, 10) pH	0.012 pH	Comparison to Standard Solutions

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source (Fixed Points)	1.018 V 10 V	1.4 µV/V 1.3 µV/V	DC Voltage Reference Standard

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

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	7.5 $\mu\text{V/V}$ + 0.4 μV 5 $\mu\text{V/V}$ + 0.7 μV 3.5 $\mu\text{V/V}$ + 2.6 μV 3.5 $\mu\text{V/V}$ + 4 μV 5 $\mu\text{V/V}$ + 40 μV 6.5 $\mu\text{V/V}$ + 0.4 mV	Multi-Function Calibrator
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	5 $\mu\text{V/V}$ + 0.31 μV 4 $\mu\text{V/V}$ + 0.31 μV 4 $\mu\text{V/V}$ + 0.51 μV 6 $\mu\text{V/V}$ + 30 μV 6 $\mu\text{V/V}$ + 0.1 mV	Multimeter
DC Voltage – Measure	100 mV 1 V 10 V 100 V 1 kV	1.5 $\mu\text{V/V}$ + 0.012 μV 1.4 $\mu\text{V/V}$ + 0.012 μV 1.3 $\mu\text{V/V}$ + 0.012 μV 1.4 $\mu\text{V/V}$ + 0.012 μV 1.5 $\mu\text{V/V}$ + 0.012 μV	DC Voltage Reference Standard, Reference Divider and NULL Detector
DC High Voltage – Measure ¹	Up to 10 kV (10 to 35) kV (35 to 70) kV	0.3 mV/V + 0.031 V 0.35 mV/V + 0.07 V 0.4 mV/V + 14 V	Comparison with High Voltage Meter and High Voltage Probe
DC Current – Source ¹	Up to 2 pA (2 to 20) pA (20 to 200) pA 200 pA to 2 nA (2 to 20) nA (20 to 200) nA 200 nA to 2 μA (2 to 20) μA (20 to 200) μA 200 μA to 2 mA (2 to 20) mA	0.38 % of reading + 10 fA 0.33 % of reading + 10 fA 0.2 % of reading + 30 fA 0.063 % of reading + 0.1 pA 0.063 % of reading + 1 pA 0.035 % of reading + 10 pA 0.025 % of reading + 0.1 nA 0.025 % of reading + 1 nA 0.025 % of reading + 10 nA 0.025 % of reading + 0.1 μA 0.15 % of reading + 1 μA	Calibrator/Source
DC Current – Source ¹	Up to 220 μA 220 μA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	40 $\mu\text{A/A}$ + 6 nA 35 $\mu\text{A/A}$ + 7 nA 35 $\mu\text{A/A}$ + 40 nA 45 $\mu\text{A/A}$ + 0.7 μA 80 $\mu\text{A/A}$ + 12 μA	Multi-Function Calibrator
DC High Current – Source ¹	(2.2 to 11) A	0.36 mA/A + 0.48 mA	Multi-Function Calibrator with Amplifier
DC High Current – Source ¹	(11 to 20.5) A	0.78 mA/A + 0.6 mA	Multi-Product Calibrator
DC High Current – Source ¹	Up to 16.5 A (16.5 to 150) A (150 to 1 025) A	3.2 mA/A + 3.5 mA 3.2 mA/A + 29 mA 3.4 mA/A + 104 mA	Multi-Product Calibrator w/50-turns coil

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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	30 μ A/A + 40 pA 20 μ A/A + 40 pA 20 μ A/A + 100 pA 20 μ A/A + 0.8 nA 20 μ A/A + 5.0 nA 20 μ A/A + 50 nA 35 μ A/A + 0.5 μ A 110 μ A/A + 10 μ A	Multimeter
DC Current – Measure ¹	Up to 3 mA (3 to 500) mA 500 mA to 20 A (20 to 300) A	8.6 μ A/A + 58 pA 11 μ A/A + 5.8 nA 16 μ A/A + 1.1 μ A 100 μ A/A + 5.8 μ A	Multimeter w/Resistance Standard, Current Shunt
DC Power – Source ^{1,2} 0.01 mW to 20.5 kW	33 mV to 1 020 V (0.33 to 330) mA 330 mA to 11 A (11 to 20.5) A	0.03 % of Watts output + 0.58R 0.059 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R	Multi-Product Calibrator w/Amplifier
Inductance – Source ¹ (Artifacts) 100 Hz & 10 kHz	100 μ H to 10 H	0.42 mH/H	Decade Inductor and Standard Inductor
Inductance – Measure ¹ 12 Hz to 100 kHz	100 μ H to 10 H	0.23 mH/H	RLC Digibridge
Resistance – Source ¹ (Artifacts)	(0.01 to 0.1) Ω (0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω (1 to 10) G Ω (10 to 100) G Ω	0.31 m Ω / Ω 36 $\mu\Omega$ / Ω 9 $\mu\Omega$ / Ω 7 $\mu\Omega$ / Ω 2.2 $\mu\Omega$ / Ω 2.2 $\mu\Omega$ / Ω 0.23 m Ω / Ω 0.2 m Ω / Ω 0.8 m Ω / Ω 0.8 m Ω / Ω 3.1 m Ω / Ω 3.1 m Ω / Ω 6 m Ω / Ω	Standard Resistance, Decade Resistor

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ (Fixed Points)	0 Ω 1.0 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	40 $\mu\Omega$ 95 $\mu\Omega/\Omega$ 95 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 21 $\mu\Omega/\Omega$ 40 $\mu\Omega/\Omega$ 47 $\mu\Omega/\Omega$ 100 $\mu\Omega/\Omega$	Multi-Function Calibrator
Resistance – Measure ¹	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	15 $\mu\Omega/\Omega + 50 \mu\Omega$ 12 $\mu\Omega/\Omega + 0.5 \text{ m}\Omega$ 10 $\mu\Omega/\Omega + 0.5 \text{ m}\Omega$ 10 $\mu\Omega/\Omega + 5 \text{ m}\Omega$ 10 $\mu\Omega/\Omega + 50 \text{ m}\Omega$ 15 $\mu\Omega/\Omega + 2 \Omega$ 50 $\mu\Omega/\Omega + 0.1 \text{ k}\Omega$ 0.5 $\text{m}\Omega/\Omega + 1 \text{ k}\Omega$ 5 $\text{m}\Omega/\Omega + 10 \text{ k}\Omega$	Multimeter
Resistance – Measure ¹	Up to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω (1 to 10) G Ω (10 to 100) G Ω 100 G Ω to 1 T Ω (1 to 10) T Ω (10 to 100) T Ω (100 to 1000) T Ω	0.060 $\text{m}\Omega/\Omega + 0.58 \Omega$ 0.12 $\text{m}\Omega/\Omega + 0.58 \Omega$ 0.12 $\text{m}\Omega/\Omega + 0.58 \Omega$ 0.17 $\text{m}\Omega/\Omega + 0.58 \text{ k}\Omega$ 0.56 $\text{m}\Omega/\Omega + 0.58 \text{ k}\Omega$ 0.56 $\text{m}\Omega/\Omega + 0.58 \text{ k}\Omega$ 0.55 $\text{m}\Omega/\Omega + 0.58 \text{ M}\Omega$ 2.3 $\text{m}\Omega/\Omega + 0.58 \text{ M}\Omega$ 0.65 $\text{m}\Omega/\Omega + 0.58 \text{ M}\Omega$ 0.56 $\text{m}\Omega/\Omega + 0.58 \text{ M}\Omega$	Teraohmmeter
AC Resistance – Source and Measure ¹ 100 Hz to 100 kHz	0.001 Ω (0.1 to 1) Ω 10 Ω to 100 k Ω	0.13 $\text{m}\Omega$ 1.5 $\text{m}\Omega/\Omega$ 0.46 $\text{m}\Omega/\Omega$	RL Standard

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance – Source and Measure ¹ 100 Hz to 100 kHz	(0.01 to 0.2) Ω 0.2 Ω to 100 k Ω 100 k Ω to 10 M Ω	6.9 m Ω/Ω 0.27 m Ω/Ω 3 m Ω/Ω	RLC Digibridge with RL Standard
Phase – Measure ¹ 10 mV to 320 V	(0 to 360) $^{\circ}$ 10 Hz to 100 kHz 100 kHz to 10 MHz	0.029 $^{\circ}$ 0.064 $^{\circ}$	Precision Phase Meter
Capacitance – Source ¹ (Simulation) 50 Hz to 1 kHz	(0.19 to 3.3) nF (3.3 to 11) nF (11 to 110) nF (110 to 330) nF 330 nF to 1.1 μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F 330 μ F to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	3.9 mF/F + 7.8 pF 1.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 230 pF 1.9 mF/F + 0.78 nF 1.9 mF/F + 2.3 nF 1.9 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.5 mF/F + 78 nF 3.5 mF/F + 230 nF 3.5 mF/F + 0.78 μ F 3.5 mF/F + 2.3 μ F 3.5 mF/F + 7.8 μ F 5.8 mF/F + 23 μ F 8.5 mF/F + 78 μ F	Multi-Product Calibrator
Capacitance – Source ¹ (Fixed Artifacts) 1 kHz to 13 MHz	1 pF 10 pF 100 pF 1 000 pF	0.35 mF/F 0.35 mF/F 0.35 mF/F 0.35 mF/F	Standard Capacitors
Capacitance – Source ¹ (Fixed Artifacts) 120 Hz to 100 kHz	(10 to 100) pF 100 pF to 1 μ F	0.53 mF/F 0.26 mF/F	Standard Capacitors
Capacitance – Measure ¹ 12 Hz to 100 kHz	Up to 1 000 μ F	0.2 mF/F + 0.000 58 pF	RLC Digibridge

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type B		Multi-Product Calibrator
	(600 to 800) °C	0.36 °C	
	(800 to 1 000) °C	0.29 °C	
	(1 000 to 1 550) °C	0.26 °C	
	(1 550 to 1 820) °C	0.28 °C	
	Type C		
	(0 to 150) °C	0.26 °C	
	(150 to 650) °C	0.23 °C	
	(650 to 1 000) °C	0.27 °C	
	(1 000 to 1 800) °C	0.4 °C	
	(1 800 to 2 316) °C	0.66 °C	
	Type E		
	(-250 to -100) °C	0.4 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 350) °C	0.16 °C	
	(350 to 650) °C	0.17 °C	
	(650 to 1 000) °C	0.2 °C	
	Type J		
	(-210 to -100) °C	0.24 °C	
	(-100 to -30) °C	0.17 °C	
	(-30 to 150) °C	0.16 °C	
	(150 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.21 °C	
	Type K		
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type R (0 to 250) °C	0.46 °C	Multi-Product Calibrator
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type S (0 to 250) °C	0.38 °C	
	(250 to 1 000) °C	0.30 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	
	Type T (-250 to -150) °C	0.5 °C	
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U (-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	
Electrical Calibration of RTD Indicating Systems ¹	Cu 427, 10 Ω (-100 to 260) °C	0.23 °C	Multi-Product Calibrator
	Pt Ni 385, 120 Ω (Ni 120) (-80 to 0) °C	0.062 °C	
	(0 to 100) °C	0.062 °C	
	(100 to 260) °C	0.11 °C	
	Pt 385, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 3916, 100 Ω		Multi-Product Calibrator
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.031 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.093 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 600) °C	0.11 °C	
	(600 to 630) °C	0.12 °C	
	Pt 385, 500 Ω		
	(-200 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.039 °C	
	(100 to 260) °C	0.047 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.062 °C	
	(400 to 600) °C	0.07 °C	
	(600 to 630) °C	0.085 °C	
	Pt 385, 1 k Ω		
	(-200 to -80) °C	0.023 °C	
	(-80 to 0) °C	0.023 °C	
	(0 to 100) °C	0.031 °C	
	(100 to 260) °C	0.039 °C	
	(260 to 300) °C	0.047 °C	
	(300 to 400) °C	0.054 °C	
	(400 to 600) °C	0.054 °C	
	(600 to 630) °C	0.18 °C	

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	220 μ V to 2.2 mV		Multi-Function Calibrator
	(10 to 20) Hz	240 μ V/V + 4 μ V	
	(20 to 40) Hz	90 μ V/V + 4 μ V	
	40 Hz to 20 kHz	80 μ V/V + 4 μ V	
	(20 to 50) kHz	200 μ V/V + 4 μ V	
	(50 to 100) kHz	500 μ V/V + 5 μ V	
	(100 to 300) kHz	1.1 mV/V + 10 μ V	
	(300 to 500) kHz	1.4 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 20 μ V	
	(2.2 to 22) mV		
	(10 to 20) Hz	240 μ V/V + 4 μ V	
	(20 to 40) Hz	90 μ V/V + 4 μ V	
	40 Hz to 20 kHz	80 μ V/V + 4 μ V	
	(20 to 50) kHz	200 μ V/V + 4 μ V	
	(50 to 100) kHz	500 μ V/V + 5 μ V	
	(100 to 300) kHz	1.1 mV/V + 10 μ V	
	(300 to 500) kHz	1.4 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 20 μ V	
	(22 to 220) mV		
	(10 to 20) Hz	240 μ V/V + 12 μ V	
	(20 to 40) Hz	90 μ V/V + 8 μ V	
	40 Hz to 20 kHz	80 μ V/V + 8 μ V	
	(20 to 50) kHz	210 μ V/V + 10 μ V	
	(50 to 100) kHz	460 μ V/V + 22 μ V	
	(100 to 300) kHz	0.9 mV/V + 26 μ V	
	(300 to 500) kHz	1.4 mV/V + 30 μ V	
	500 kHz to 1 MHz	2.7 mV/V + 48 μ V	
	220 mV to 2.2 V		
	(10 to 20) Hz	300 μ V/V + 53 μ V	
	(20 to 40) Hz	100 μ V/V + 23 μ V	
	40 Hz to 20 kHz	46 μ V/V + 9 μ V	
	(20 to 50) kHz	83 μ V/V + 12 μ V	
	(50 to 100) kHz	120 μ V/V + 33 μ V	
	(100 to 300) kHz	500 μ V/V + 95 μ V	
	(300 to 500) kHz	1 mV/V + 240 μ V	
	500 kHz to 1 MHz	1.7 mV/V + 460 μ V	

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) V		Multi-Function Calibrator
	(10 to 20) Hz	300 $\mu\text{V/V}$ + 530 μV	
	(20 to 40) Hz	100 $\mu\text{V/V}$ + 180 μV	
	40 Hz to 20 kHz	46 $\mu\text{V/V}$ + 61 μV	
	(20 to 50) kHz	83 $\mu\text{V/V}$ + 120 μV	
	(50 to 100) kHz	110 $\mu\text{V/V}$ + 240 μV	
	(100 to 300) kHz	390 $\mu\text{V/V}$ + 790 μV	
	(300 to 500) kHz	1 mV/V + 2.3 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.6 mV	
	(22 to 220) V		
	(10 to 20) Hz	300 $\mu\text{V/V}$ + 5.3 mV	
	(20 to 40) Hz	100 $\mu\text{V/V}$ + 1.8 mV	
	40 Hz to 20 kHz	52 $\mu\text{V/V}$ + 0.7 mV	
	(20 to 50) kHz	87 $\mu\text{V/V}$ + 1.1 mV	
	(50 to 100) kHz	150 $\mu\text{V/V}$ + 3 mV	
	(100 to 300) kHz	1 mV/V + 16 mV	
	(300 to 500) kHz	4.5 mV/V + 40 mV	
	500 kHz to 1 MHz	8 mV/V + 80 mV	
AC Voltage – Source ¹	(220 to 1 100) V		Multi-Function Calibrator with Amplifier
	(15 to 50) Hz	350 $\mu\text{V/V}$ + 16 mV	
	50 Hz to 1 kHz	70 $\mu\text{V/V}$ + 3.5 mV	
	(220 to 750) V		
	(30 to 50) kHz	0.6 mV/V + 11 mV	
	(50 to 100) kHz	2.3 mV/V + 45 mV	
	(220 to 1 100) V		
	40 Hz to 1 kHz	92 $\mu\text{V/V}$ + 4 mV	
	(1 to 20) kHz	170 $\mu\text{V/V}$ + 6 mV	
	(20 to 30) kHz	0.6 mV/V + 11 mV	

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	2.2 mV Range		AC Measurement Standard
	(10 to 20) Hz	1.1 mV/V + 0.87 μ V	
	(20 to 40) Hz	490 μ V/V + 0.87 μ V	
	40 Hz to 20 kHz	280 μ V/V + 0.87 μ V	
	(20 to 50) kHz	540 μ V/V + 1.3 μ V	
	(50 to 100) kHz	800 μ V/V + 1.7 μ V	
	(100 to 300) kHz	1.5 mV/V + 2.7 μ V	
	(300 to 500) kHz	1.6 mV/V + 5.3 μ V	
	500 kHz to 1 MHz	2.3 mV/V + 5.3 μ V	
	7 mV Range		
	(10 to 20) Hz	570 μ V/V + 0.87 μ V	
	(20 to 40) Hz	250 μ V/V + 0.87 μ V	
	40 Hz to 20 kHz	140 μ V/V + 0.87 μ V	
	(20 to 50) kHz	270 μ V/V + 1.3 μ V	
	(50 to 100) kHz	400 μ V/V + 1.7 μ V	
	(100 to 300) kHz	800 μ V/V + 2.7 μ V	
	(300 to 500) kHz	870 μ V/V + 5.3 μ V	
	500 kHz to 1 MHz	1.5 mV/V + 5.3 μ V	
	22 mV Range		
	(10 to 20) Hz	190 μ V/V + 0.87 μ V	
	(20 to 40) Hz	130 μ V/V + 0.87 μ V	
	40 Hz to 20 kHz	73 μ V/V + 0.87 μ V	
	(20 to 50) kHz	140 μ V/V + 1.3 μ V	
	(50 to 100) kHz	210 μ V/V + 1.7 μ V	
	(100 to 300) kHz	540 μ V/V + 2.7 μ V	
	(300 to 500) kHz	590 μ V/V + 5.3 μ V	
	500 kHz to 1 MHz	1.1 mV/V + 5.3 μ V	
	70 mV Range		
	(10 to 20) Hz	160 μ V/V + 1 μ V	
	(20 to 40) Hz	80 μ V/V + 1 μ V	
	40 Hz to 20 kHz	43 μ V/V + 1 μ V	
	(20 to 50) kHz	87 μ V/V + 1.3 μ V	
	(50 to 100) kHz	170 μ V/V + 1.7 μ V	
	(100 to 300) kHz	340 μ V/V + 2.7 μ V	
	(300 to 500) kHz	450 μ V/V + 5.3 μ V	
	500 kHz to 1 MHz	730 μ V/V + 5.3 μ V	

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	220 mV Range		AC Measurement Standard
	(10 to 20) Hz	140 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	57 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	25 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	46 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	110 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	170 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	250 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	670 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	700 mV Range		
	(10 to 20) Hz	140 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	51 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	22 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	34 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	53 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	120 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	200 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	640 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	2.2 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	44 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	16 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	31 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	47 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	110 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	170 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	600 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	7 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	16 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	32 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	54 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	130 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	260 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.058 \mu\text{V}$	

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	22 V Range		AC Measurement Standard
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	18 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	32 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	54 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	270 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	70 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	21 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	38 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	63 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	270 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	220 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	21 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	46 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	65 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(100 to 300) kHz	140 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(300 to 500) kHz	330 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	700 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	66 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	27 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	87 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	330 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	1 000 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	66 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	25 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	87 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	330 $\mu\text{V/V} + 5.8 \mu\text{V}$	

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	2.2 mV Range		AC Measurement Standard
	(10 to 30) Hz	0.67 mV/V + 0.058 μ V	
	(30 to 120) Hz	0.33 mV/V + 0.058 μ V	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.058 μ V	
	(1.2 to 120) kHz	0.33 mV/V + 0.058 μ V	
	(120 to 500) kHz	0.47 mV/V + 0.67 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.67 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.67 μ V	
	(2 to 10) MHz	1.1 mV/V + 0.67 μ V	
	(10 to 20) MHz	2.0 mV/V + 0.67 μ V	
	(20 to 30) MHz	4.7 mV/V + 1.3 μ V	
	7 mV Range		
	(10 to 30) Hz	0.67 mV/V + 0.058 μ V	
	(30 to 120) Hz	0.33 mV/V + 0.058 μ V	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.058 μ V	
	(1.2 to 120) kHz	0.33 mV/V + 0.058 μ V	
	(120 to 500) kHz	0.47 mV/V + 0.67 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.67 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.67 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.67 μ V	
	(10 to 20) MHz	1.1 mV/V + 0.67 μ V	
	(20 to 30) MHz	2.5 mV/V + 0.67 μ V	
	22 mV Range		
	(10 to 30) Hz	0.67 mV/V + 0.058 μ V	
	(30 to 120) Hz	0.33 mV/V + 0.058 μ V	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.058 μ V	
	(1.2 to 120) kHz	0.33 mV/V + 0.058 μ V	
	(120 to 500) kHz	0.47 mV/V + 0.058 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.058 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.058 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.058 μ V	
	(10 to 20) MHz	1.1 mV/V + 0.058 μ V	
	(20 to 30) MHz	2.5 mV/V + 0.058 μ V	

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	70 mV Range		AC Measurement Standard
	(10 to 30) Hz	0.67 mV/V + 0.58 μ V	
	(30 to 120) Hz	0.33 mV/V + 0.58 μ V	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 120) kHz	0.33 mV/V + 0.58 μ V	
	(120 to 500) kHz	0.33 mV/V + 0.58 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 0.58 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.58 μ V	
	(10 to 20) MHz	1 mV/V + 0.58 μ V	
	(20 to 30) MHz	2.3 mV/V + 0.58 μ V	
	220 mV Range		
	(10 to 30) Hz	0.67 mV/V + 0.58 μ V	
	(30 to 120) Hz	0.27 mV/V + 0.58 μ V	
	120 Hz to 1.2 kHz	0.27 mV/V + 0.58 μ V	
	(1.2 to 120) kHz	0.27 mV/V + 0.58 μ V	
	(120 to 500) kHz	0.27 mV/V + 0.58 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 0.58 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.58 μ V	
	(10 to 20) MHz	1 mV/V + 0.58 μ V	
	(20 to 30) MHz	2.3 mV/V + 0.58 μ V	
	700 mV Range		
	(10 to 30) Hz	0.67 mV/V + 5.8 μ V	
	(30 to 120) Hz	0.2 mV/V + 5.8 μ V	
	120 Hz to 1.2 kHz	0.2 mV/V + 5.8 μ V	
	(1.2 to 120) kHz	0.2 mV/V + 5.8 μ V	
	(120 to 500) kHz	0.2 mV/V + 5.8 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 5.8 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 5.8 μ V	
	(2 to 10) MHz	0.67 mV/V + 5.8 μ V	
	(10 to 20) MHz	1 mV/V + 5.8 μ V	
	(20 to 30) MHz	2.3 mV/V + 5.8 μ V	

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	2.2 V Range (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.67 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.33 mV/V + 5.8 μ V 0.33 mV/V + 5.8 μ V 0.67 mV/V + 5.8 μ V 1 mV/V + 5.8 μ V 2.3 mV/V + 5.8 μ V	AC Measurement Standard
	2.2 V Range (10 to 30) Hz (30 to 120) Hz 120 Hz to 1.2 kHz (1.2 to 120) kHz (120 to 500) kHz 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.67 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.2 mV/V + 5.8 μ V 0.33 mV/V + 5.8 μ V 0.33 mV/V + 5.8 μ V 0.67 mV/V + 5.8 μ V 1 mV/V + 5.8 μ V 2.3 mV/V + 5.8 μ V	
AC High Voltage – Measure ¹	Up to 10 kV (50 to 60) Hz (10 to 30) kV (50 to 60) Hz (30 to 40) kV (50 to 60) Hz (40 to 70) kV (50 to 60) Hz	1.2 mV/V + 0.12 V 1 mV/V + 0.21 V 4 mV/V + 0.06 V 4 mV/V + 0.11 V	Comparison with High Voltage Meter and High Voltage Probe
AC Current – Source ¹	Up to 220 μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	250 μ A/A + 16 nA 160 μ A/A + 10 nA 120 μ A/A + 8 nA 280 μ A/A + 12 nA 1.1 mA/A + 65 nA	Multi-Function Calibrator

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(0.22 to 2.2) mA		Multi-Function Calibrator
	(10 to 20) Hz	250 μ A/A + 40 nA	
	(20 to 40) Hz	160 μ A/A + 35 nA	
	40 Hz to 1 kHz	120 μ A/A + 35 nA	
	(1 to 5) kHz	200 μ A/A + 110 nA	
	(5 to 10) kHz	1.1 mA/A + 650 nA	
	(2.2 to 22) mA		
	(10 to 20) Hz	250 μ A/A + 400 nA	
	(20 to 40) Hz	160 μ A/A + 350 nA	
	40 Hz to 1 kHz	120 μ A/A + 350 nA	
	(1 to 5) kHz	200 μ A/A + 550 nA	
	(5 to 10) kHz	1.1 mA/A + 5 μ A	
	(22 to 220) mA		
	(10 to 20) Hz	250 μ A/A + 4 μ A	
	(20 to 40) Hz	160 μ A/A + 4 μ A	
	40 Hz to 1 kHz	120 μ A/A + 3 μ A	
	(1 to 5) kHz	200 μ A/A + 4 μ A	
	(5 to 10) kHz	1.1 mA/A + 10 μ A	
	(0.22 to 2.2) A		
	20 Hz to 1 kHz	260 μ A/A + 35 μ A	
	(1 to 5) kHz	450 μ A/A + 80 μ A	
	(5 to 10) kHz	7 mA/A + 160 μ A	
AC Current – Source ¹	(2.2 to 20.5) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	460 μ A/A + 170 μ A 950 μ A/A + 380 μ A 3.6 mA/A + 750 μ A	Multi-Function Calibrator w/Amplifier, Multi-Product Calibrator
AC Current – Source ¹	Up to 16.5 A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	3.3 mA/A + 3.5 mA 9.1 mA/A + 3.5 mA 3.3 mA/A + 29 mA 9.1 mA/A + 31 mA 3.4 mA/A + 104 mA 9.2 mA/A + 116 mA	Multi-Product Calibrator w/50-turn coil

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	Up to 100 μ A		Multimeter
	(10 to 20) Hz	4 mA/A + 0.03 μ A	
	(20 to 45) Hz	1.5 mA/A + 0.03 μ A	
	(45 to 100) Hz	0.6 mA/A + 0.03 μ A	
	100 Hz to 5 kHz	0.6 mA/A + 0.03 μ A	
	100 μ A to 1 mA		
	(10 to 20) Hz	4 mA/A + 0.2 μ A	
	(20 to 45) Hz	1.5 mA/A + 0.2 μ A	
	(45 to 100) Hz	0.6 mA/A + 0.2 μ A	
	100 Hz to 5 kHz	0.31 mA/A + 0.2 μ A	
	(5 to 20) kHz	0.6 mA/A + 0.2 μ A	
	(20 to 50) kHz	4 mA/A + 0.4 μ A	
	(50 to 100) kHz	5.5 mA/A + 1.5 μ A	
	(1 to 10) mA		
	(10 to 20) Hz	4 mA/A + 2 μ A	
	(20 to 45) Hz	1.5 mA/A + 2 μ A	
	(45 to 100) Hz	0.6 mA/A + 2 μ A	
	100 Hz to 5 kHz	0.31 mA/A + 2 μ A	
	(5 to 20) kHz	0.6 mA/A + 2 μ A	
	(20 to 50) kHz	4 mA/A + 4 μ A	
	(50 to 100) kHz	5.5 mA/A + 15 μ A	
	(10 to 100) mA		
	(10 to 20) Hz	4 mA/A + 20 μ A	
	(20 to 45) Hz	1.5 mA/A + 20 μ A	
	(45 to 100) Hz	0.6 mA/A + 20 μ A	
	100 Hz to 5 kHz	0.31 mA/A + 20 μ A	
	(5 to 20) kHz	0.6 mA/A + 20 μ A	
	(20 to 50) kHz	4 mA/A + 40 μ A	
	(50 to 100) kHz	5.5 mA/A + 150 μ A	
	100 mA to 1 A		
	(10 to 20) Hz	4 mA/A + 0.2 mA	
	(20 to 45) Hz	1.6 mA/A + 0.2 mA	
	(45 to 100) Hz	0.8 mA/A + 0.2 mA	
	(100 Hz to 5) kHz	1 mA/A + 0.2 mA	
	(5 to 20) kHz	3 mA/A + 0.2 mA	
	(20 to 50) kHz	10 mA/A + 0.4 mA	
AC Current – Measure ¹	Up to 10 A		Current Shunt with Multimeter, AC Measurement Standard
	(5 Hz to 100) kHz	0.2 mA/A + 0.58 μ A	
	(10 to 20) A		
	(5 Hz to 100) kHz	0.2 mA/A + 0.58 μ A	

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} 0.1 mW to 20.5 kW (45 to 65) Hz PF = 1	(33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A 330 mV to 1 020 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.11 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.11 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.1 % of Watts output + 0.58R 0.088 % of Watts output + 0.58R 0.1 % of Watts output + 0.58R 0.13 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.088 % of Watts output + 0.58R 0.073 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.15 % of Watts output + 0.58R	Multi-Product Calibrator
AC Power – Source ^{1,2} 0.1 mW to 20.5 kW (45 to 65) Hz (PF = 0 to 0.999)	(33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A 330 mV to 1 020 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.21 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.23 % of Watts output + 0.58R	Multi-Product Calibrator
Oscilloscopes ¹ Rise/ Fall Time, (10 to 90) %	Up to 1.25 s	1.3 ps	Oscilloscope Calibrator and Active Head

Electrical – DC/Low Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscope ¹ Square Wave Amplitude, < 10 kHz into 50 Ω or 1 M Ω Load Impedance	Up to 1 mVp-p (1 to 21) mVp-p (21 to 556) mVp-p 556 mVp-p to 210 Vp-p	10 mV/V + 10 μ V 1.5 mV/V + 20 μ V 1.5 mV/V + 1.2 μ V 1.3 mV/V + 1.2 μ V	Oscilloscope Calibrator and Active Head
Oscilloscope ¹ Horizontal Deflection (Time)	150 ps to 50 s	0.39 part per 10 ⁶ of reading	Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Vertical Deflection (Amplitude)	Up to 50 Vp-p (50 to 100) Vp-p (100 to 200) Vp-p	250 μ V/V + 25 μ V 250 μ V/V + 26 μ V 250 μ V/V + 63 μ V	Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Bandwidth	100 MHz to 50 GHz	2.1 % of reading	Oscilloscope Calibrator w/Active Head, Power Sensor

Electrical – RF/Microwave

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Distortion – Measure ¹	(-99.99 to 0) dB 20 Hz to 20 kHz (20 to 100) kHz	1.1 dB 2.1 dB	Audio Analyzer
RF Power Sensors – Calibration Factors ^{1,5}	Referenced to 1 mW (9 to 100) kHz (100 to 300) kHz 300 kHz to 50 MHz 50 MHz to 5 GHz (5 to 10) GHz (10 to 18) GHz (18 to 26.5) GHz (26 to 27) GHz (27 to 30) GHz (30 to 34) GHz (34 to 40) GHz (40 to 42) GHz (42 to 48) GHz (48 to 50) GHz	1 % 1 % 0.94 % 0.55 % 0.57 % 0.6 % 1.6 % 1.9 % 2 % 1.9 % 2 % 2.6 % 2.9 % 3.4 %	Thermocouple Power Sensors
RF Power Power Meter Reference ¹	1 mW, 50 MHz	0.51 % of reading	Power Meter with Power Sensor

Electrical – RF/Microwave

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned RF Power, Absolute – Measure ¹ 100 kHz to 50 GHz	(20 to 30) dBm	0.15 dB	Measuring Receiver with Power Sensor
	(10 to 20) dBm	0.14 dB	
	(0 to 10) dBm	0.14 dB	
	0 dBm	0.14 dB	
	(-10 to 0) dBm	0.14 dB	
	(-20 to -10) dBm	0.14 dB	
	(-30 to -20) dBm	0.15 dB	
	(-40 to -30) dBm	0.15 dB	
	(-50 to -40) dBm	0.16 dB	
	(-60 to -50) dBm	0.16 dB	
	(-70 to -60) dBm	0.17 dB	
	(-80 to -70) dBm	0.17 dB	
	(-90 to -80) dBm	0.18 dB	
	(-100 to -90) dBm	0.18 dB	
	(-110 to -100) dBm	0.18 dB	
	(-120 to -110) dBm	0.23 dB	
	(-127 to -120) dBm	0.26 dB	
Tuned RF Power, Relative – Measure ¹ 100 kHz to 50 GHz	(20 to 30) dBm	0.068 dB	Measuring Receiver with Power Sensor
	(10 to 20) dBm	0.066 dB	
	(0 to 10) dBm	0.064 dB	
	0 dBm	0.063 dB	
	(-10 to 0) dBm	0.064 dB	
	(-20 to -10) dBm	0.066 dB	
	(-30 to -20) dBm	0.068 dB	
	(-40 to -30) dBm	0.071 dB	
	(-50 to -40) dBm	0.073 dB	
	(-60 to -50) dBm	0.076 dB	
	(-70 to -60) dBm	0.079 dB	
	(-80 to -70) dBm	0.083 dB	
	(-90 to -80) dBm	0.086 dB	
	(-100 to -90) dBm	0.09 dB	
	(-110 to -100) dBm	0.09 dB	
	(-120 to -110) dBm	0.13 dB	
	(-127 to -120) dBm	0.16 dB	

Electrical – RF/Microwave

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹ AM Depth Accuracy 100 kHz to 10 MHz (Rate: 50 Hz to 10 kHz)	Depth: (5 to 99) %	0.91 % Depth	PSA Series Spectrum Analyzer
10 MHz to 3 GHz (Rate: 50 Hz to 100 kHz)	Depth: (20 to 99) % Depth: (5 to 20) %	0.61 % Depth 3 % Depth	
(3 to 26.5) GHz (Rate: 50 Hz to 100 kHz)	Depth: (20 to 99) % Depth: (5 to 20) %	1.8 % Depth 5.5 % Depth	
Flatness 10 MHz to 3 GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) %	0.37 % Depth	
(3 to 26.5) GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) %	0.49 % Depth	
FM Rejection (50 Hz to 3 kHz BW) 250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz)	Depths: < 50% Deviations: < 5 kHz	0.17 % Depth	
10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz)	Depths: < 50% Deviations: < 50 kHz	0.44 % Depth	
Residual AM 250 kHz to 26.5 GHz (50 Hz to 3 kHz BW)		0.012 % (rms)	

Electrical – RF/Microwave

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz (Rate: 20 Hz to 200 kHz) AM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz Residual FM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: 200 Hz to 400 kHz AM Depths: ≤ 50% (Rate: 400 Hz or 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 13 Hz 25 Hz 49 Hz 1.9 Hz 3.7 Hz 7.4 Hz	PSA Series Spectrum Analyzer
Phase Modulation – Measure ¹ PM Deviation Accuracy AM Rejection (50 Hz to 3 kHz BW) 100 kHz to 26.5 GHz Residual PM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	100 kHz to 6.6 GHz Deviations: > 0.7 rad Deviations: > 0.3 rad (6.6 to 13.2) GHz Deviations: > 0.7 rad Deviations: > 0.3 rad (13.2 to 26.5) GHz Deviations: > 0.7 rad Deviations: > 0.3 rad AM Depths: ≤ 50% (Rate: 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad 0.002 1 rad 0.004 1 rad 0.008 1 rad	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation – Measure ¹ For 2/3/4/5G			
Composite Rho ₃	450 MHz to 26.5 GHz $\rho = (0.9 \text{ to } 1)$	0.001 ρ	PSA Series Spectrum Analyzer, Signal Generator
Error Vector Magnitude (rms)	450 MHz to 26.5 GHz EVM = (0 to 25) %	0.3 % of reading	
Peak Code Domain Error	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Phase error	(1 to 15) ° 450 MHz to 26.5 GHz	0.71 °	
Frequency Error	3 Hz to 26.5GHz	2.1×10^{-7} Hz/Hz	
I/Q Origin Offset	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Channel Power	Power > -70 dBm 450 MHz to 26.5 GHz	0.62 dB	
Amplitude Modulation – Source ¹	(11 to 13.5) MHz Rate: 20 Hz to 100 kHz Depth: 0% to 95% Depth: 95% to 99%	0.13 % Depth 0.24 % Depth	AM/FM Test Source
	100 kHz to 26.5 GHz Rate: 1 kHz to 100 kHz Depth: (5 to 80) %	3.5 % of reading + 1.2 % Depth	Signal Generator
Frequency Modulation – Source ¹	(11 to 432) MHz Rate: 20 Hz to 100 kHz Deviations: ≤ 400 kHz	0.29 % Modulation	AM/FM Test Source
	100 kHz to 26.5 GHz Rate: 10 Hz to 10 MHz Deviations: ≤ 20 MHz	1.7 % Modulation + 23 Hz	Signal Generator
Phase Modulation – Source ¹	100 kHz to 26.5 GHz Rate: 10 Hz to 10 MHz Deviations: ≤ 40 rad	1.7 % of reading + 0.003 5 rad	Signal Generator

Electrical – RF/Microwave

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Harmonic Measurements ¹	(0 to -100) dB 3 Hz to 3 GHz (3 to 6.6) GHz (6.6 to 50) GHz	0.2 dB 0.66 dB 0.8 dB	Spectrum Analyzer
Error Vector Magnitude ^{1,2} (EVM)	(0 to 100) % Error Mod Frequency Span: f ≤ 100 kHz 100 kHz ≤ f ≤ 1 MHz f > 1 MHz	0.43 % Error 0.48 % Error 0.82 % Error	Vector Signal Analyzer
Phase Error ^{1,2} (rms)	(0 to 180) ° Error Mod Frequency Span: f ≤ 100kHz 100kHz ≤ f ≤ 1MHz f > 1MHz	0.17 ° Error 0.34 ° Error 0.57 ° Error	Vector Signal Analyzer
Frequency Error ¹	(0 to 5) % Error Mod Frequency 1 GHz 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz	0.063 % Error 0.068 % Error 0.079 % Error 0.099 % Error 0.33 % Error 0.39 % Error	Vector Signal Analyzer
Modulation Accuracy ¹ (Rho)	Mod Frequency Span: f ≤ 100kHz 0.999 9 ≤ ρ ≤ 1 0.997 5 ≤ ρ < 0.999 9 0.993 6 ≤ ρ < 0.997 5 0.99 ≤ ρ < 0.993 6 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978	8.6 E-5 ρ 0.000 43 ρ 0.000 68 ρ 0.000 84 ρ 0.001 2 ρ 0.001 6 ρ	Vector Signal Analyzer
Modulation Accuracy ¹ (Rho)	Mod Frequency Span: 100 kHz ≤ f ≤ 1 MHz 0.999 9 ≤ ρ ≤ 1 0.997 5 ≤ ρ < 0.999 9 0.993 6 ≤ ρ < 0.997 5 0.99 ≤ ρ < 0.993 6 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978	9.6 E-5 ρ 0.000 48 ρ 0.000 76 ρ 0.000 94 ρ 0.001 4 ρ 0.001 8 ρ	Vector Signal Analyzer

Electrical – RF/Microwave

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Modulation Accuracy ¹ (Rho)	Mod Frequency Span $f > 1 \text{ MHz}$ $0.9999 \leq \rho \leq 1$ $0.9975 \leq \rho < 0.9999$ $0.9936 \leq \rho < 0.9975$ $0.99 \leq \rho < 0.9936$ $0.978 \leq \rho < 0.99$ $0.96 \leq \rho < 0.978$	$1.6 \times 10^{-4} \rho$ 0.00082ρ 0.0013ρ 0.0016ρ 0.0024ρ 0.003ρ	Vector Signal Analyzer
S Parameters ^{1,5} Magnitude and Phase for S11, S12, S21, S22 Reflection S11/S22 Measure	30 kHz to 2.0 GHz (0.01 to 1) lin (-180 to 180) ° (2.0 to 20) GHz (0.01 to 1) lin (-180 to 180) ° (20 to 50) GHz (0.01 to 1) lin (-180 to 180) °	0.016 1 ° 0.03 1.7 ° 0.06 3.7 °	Network Analyzer, Calibration Kit
Reflection Magnitude ^{1,5} S11/22 – Measure	(0.01 to 1) lin 30 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz	0.005 0.007 0.014	Network Analyzer, Calibration Kit
Reflection Phase ^{1,5} S11/22 – Measure	(-180 to 180) ° 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz	1.5 ° 0.95 ° 0.95 °	Network Analyzer, Calibration Kit
Insertion Delay ¹	220 MHz to 6 GHz	2 µs	Network Analyzer, Calibration Kit
Group Delay Flatness ¹ F0= +/- 21MHz	220 MHz to 6 GHz	5 ns	Network Analyzer, Calibration Kit

Electrical – RF/Microwave

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
S Parameters – Magnitude and Phase for S11, S12, S21, S22 Transmission ¹ S12/ S21 – Measure	30 kHz to 2.0 GHz		Network Analyzer, Calibration Kit
	(0 to 20) dB	0.09 dB	
	(-180 to 180) °	0.72 °	
	(20 to 40) dB	0.14 dB	
	(-180 to 180) °	1 °	
	(40 to 60) dB	0.27 dB	
	(-180 to 180) °	1.7 °	
	(2.0 to 20) GHz		
	(0 to 20) dB	0.16 dB	
	(-180 to 180) °	1 °	
S Parameters – Magnitude and Phase for S11, S12, S21, S22 Transmission ¹ S12/ S21 – Measure	(20 to 40) dB	0.19 dB	Network Analyzer, Calibration Kit
	(-180 to 180) °	1.3 °	
	(40 to 60) dB	0.15 dB	
	(-180 to 180) °	1.9 °	
	(20 to 50) GHz		
	(0 to 20) dB	0.21 dB	
	(-180 to 180) °	2.9 °	
	(20 to 40) dB	0.46 dB	
	(-180 to 180) °	3.2 °	
	(40 to 60) dB	0.54 dB	
	(-180 to 180) °	3.6 °	

Length – Dimensional Metrology

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 1 500 mm	$(0.18 + 0.013l) \mu\text{m} + 0.58R$	Gage Blocks
Height Gages ^{1,2}	Up to 1 500 mm	$(0.72 + 0.002 2l) \mu\text{m} + 0.58R$	Gage Blocks
Micrometers ^{1,2} External, Internal, Depth, Bore and Micrometer Head	Up to 1 050 mm	$(0.064 + 0.013l) \mu\text{m} + 0.58R$	Gage Blocks, Master Ring, Universal Length Measuring Machine

Length – Dimensional Metrology

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Comparators and Vision Systems /Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 300 mm	$(1.1 + 0.008L) \mu\text{m} + 0.58R$	Standard Scales and Gage Blocks

Mass and Mass Related

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure ^{1,2} (Absolute & Differential)	(-14.5 to 500) psi (500 to 2 000) psi (2 000 to 10 000) psi	0.033 % of reading + 0.58R 0.035 % of reading + 0.58R 0.057 % of reading + 0.58R	Pressure Calibrator & Pressure Module
Scales and Balances ^{1,3}	(0 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g 50 g to 20 kg	1.5 μg 2 μg 2.6 μg 3.1 μg 13 μg 15 μg 20 μg 26 μg 33 μg 47 μg 77 μg $1.4 \times 10^{-6} \text{ kg/kg}$	Standard Weights (Class E1, E2)
Mass (Weights)	(0.05 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g 50 g to 20 kg	1.7 μg 2.2 μg 2.7 μg 3.2 μg 13 μg 15 μg 21 μg 26 μg 33 μg 47 μg 77 μg $1.4 \times 10^{-6} \text{ kg/kg}$	Standard Weights (Class E1, E2), Mass Comparator
Torque Tools ¹	(0 to 814) N·m	0.54 % of reading + 0.058 mN·m	Torque Testers

Mass and Mass Related

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Testers ^{1,2} Torque Calibrator	Up to 10 N·m (10 to 50) N·m (50 to 200) N·m (200 to 500) N·m (500 to 1 000) N·m	0.064 % of reading + 0.58R 0.04 % of reading + 0.58R 0.027 % of reading + 0.58R 0.016 % of reading + 0.58R 0.011 % of reading + 0.58R	Torque Calibration Wheel with Standard Weight
Force and Load Cell ^{1,2} (Compression and Tension)	(0 to 10) N (10 to 20) N (20 to 50) N (50 to 1 000) N	0.008 5 % of reading + 0.58R 0.006 8 % of reading + 0.58R 0.006 3 % of reading + 0.58R 0.006 2 % of reading + 0.58R	Standard weights
	(0 to 50) kN (50 to 500) kN	0.035 % of reading + 0.58R 0.034 % of reading + 0.58R	Load cell
Liquid Flow Meters	Up to 200 ml/min	0.14 % of reading + 0.58R	Gravimetric Method using Balance, Stopwatch
Liquid Flow Meters	(0.1 to 150) ml/min	0.66 % of reading	Comparison to Standard Flow Meter

Photometry and Radiometry

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power ¹ (Source & Measure)	(450 to 1 800) nm (-110 to 10) dBm	0.11 dB	Optical Test System
Optical Wavelength ¹ (Source & Measure)	(700 to 1 650) nm	3.8×10^{-6} nm/nm	Optical Test System w/ Wavelength Meter

Thermodynamic

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure ¹	(-200 to 400) °C	0.035 °C	Thermometer Probe
Humidity Measuring Equipment ¹	(10 to 90) %RH	0.72 %RH	Humidity Indicator w/ Probe, Humidity Calibrator

Thermodynamic

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Radiation (Infrared) Thermometers ¹	(50 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 500) °C	1.2 °C 2.3 °C 3.6 °C 4.7 °C 6 °C	Blackbody Calibrator (Flat Plate) $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers ¹	100 °C (100 to 200) °C (200 to 400) °C (400 to 600) °C (600 to 800) °C (800 to 982) °C	1.3 °C 2.4 °C 4.7 °C 7.1 °C 9.5 °C 12 °C	Blackbody Calibrator (cavity) $\epsilon = 0.99$, $\lambda = (8 \text{ to } 14) \mu\text{m}$

Time and Frequency

Munich-Puchheim, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	10 Hz to 50 GHz	6.1×10^{-11} Hz/Hz	GPS Receiver, Counter
Frequency Measuring Equipment ¹	(1, 10) MHz	5×10^{-12} Hz/Hz	GPS Receiver, Signal Generator
	0.01 Hz to 50 GHz	6.2×10^{-12} Hz/Hz	
Time Interval – Measure ¹	20 ps to 50 s	0.47 % of reading	Digital Oscilloscope
Pulse – Measure ¹ RMS Jitter – Period, Delay and Width	33 MHz to 3.0 GHz	1.4 % of reading + 5 ps	Digital Oscilloscope
Tachometer ^{1,2}	(0 to 100 000) rpm	0.000 23 % of reading + 0.58R	Signal Generator w/lamp

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

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CALIBRATION

Acoustics and Vibration

Manaus, Brasil

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Pressure Level – Measure Equipment ¹ Frequencies (125, 250, 500, 1 000, 2 000, 4 000) Hz	74 dB 84 dB 94 dB 104 dB 114 dB	0.65 dB 0.65 dB 0.75 dB 0.65 dB 0.75 dB	Sound Level Calibrator
Sound Pressure Level – Generators ¹	(74 to 114) dB SPL 31.5 Hz to 8 kHz	0.83 dB 2.8 mHz/Hz	Sound Level Calibrator, Sound Level Meter, Universal Counter

Chemical Quantities

Manaus, Brasil

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters ^{1,4}	4 pH 7 pH 10 pH	0.02 pH 0.02 pH 0.03 pH	pH Buffers
Conductivity Meters ^{1,4}	100 µS/cm 1 000 µS/cm 1 413 µS/cm	2.1 µS/cm 5.9 µS/cm 7 µS/cm	Conductivity Standard Solutions

Electrical – DC/Low Frequency

Manaus, Brasil

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 22) V (22 to 220) V 220 V to 1.1 kV	13 µV/V + 0.8 µV 9.2 µV/V + 1.2 µV 9.1 µV/V + 1.3 µV 11 µV/V + 22 µV 13 µV/V + 0.15 mV	Multiproduct Calibrator

Electrical – DC/Low Frequency

Manaus, Brasil

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Measure ¹	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V (100 to 1 000) V	4.1 $\mu\text{V/V} + 0.6 \mu\text{V}$ 9.6 $\mu\text{V/V} + 0.6 \mu\text{V}$ 10 $\mu\text{V/V}$ 14 $\mu\text{V/V} + 35 \mu\text{V}$ 14 $\mu\text{V/V} + 38 \mu\text{V}$	Multimeter
DC Voltage – Measure ¹ High Voltage	(1 to 10) kV	0.46 mV/V + 0.4 V	High Voltage Meter
DC Current – Source ¹	Up to 220 μA (0.22 to 2.2) mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 20.5) A	0.12 mA/A + 1 nA 68 $\mu\text{A/A} + 11.6 \text{ nA}$ 72 $\mu\text{A/A} + 1.7 \text{ nA}$ 90 $\mu\text{A/A}$ 0.14 mA/A 1.8 mA/A	Multiproduct Calibrator
DC Current – Clamp on Meters ¹	(10 to 1 000) A	2.4 mA/A	Multiproduct Calibrator and Current Coil
DC Current – Measure ¹	Up to 1 μA (1 to 10) μA (10 to 100) μA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	7.4 $\mu\text{A/A} + 58 \text{ pA}$ 2 $\mu\text{A/A} + 64 \text{ pA}$ 2.1 $\mu\text{A/A} + 62 \text{ pA}$ 27 $\mu\text{A/A} + 2.5 \text{ nA}$ 24 $\mu\text{A/A} + 0.66 \text{ nA}$ 10 $\mu\text{A/A} + 0.14 \mu\text{A}$ 9.3 $\mu\text{A/A} + 0.25 \mu\text{A}$	Multimeter
DC Current – Measure ¹	Up to 10 A Up to 100 A	5.5 $\mu\text{A/A} + 54 \mu\text{A}$ 0.41 mA/A + 0.13 mA	Multimeter, Current Shunt
DC Current – Measure ¹	(1 to 2 000) A	8.6 mA/A	Clamp Meter
Inductance – Source ¹ (Fixed Artifacts)	(0.1 to 10) kHz 1 mH 10 mH 100 mH 1 H	0.29 μH 2.6 μH 26 μH 0.27 mH	Standard Inductors
Resistance – Measure ¹	Up to 1 Ω (1 to 10) Ω (10 to 100) Ω 1200 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	59 $\mu\Omega/\Omega + 25 \mu\Omega$ 8.7 $\mu\Omega/\Omega + 76 \mu\Omega$ 16 $\mu\Omega/\Omega$ 1.8 $\mu\Omega/\Omega + 1.5 \text{ m}\Omega$ 3.1 $\mu\Omega/\Omega + 0.21 \text{ m}\Omega$ 6.5 $\mu\Omega/\Omega$ 19 $\mu\Omega/\Omega$ 90 $\mu\Omega/\Omega$ 0.28 m Ω/Ω 1.9 m Ω/Ω	Multimeter

Electrical – DC/Low Frequency

Manaus, Brasil

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ (Simulation) Allowable Frequency 50 Hz to 1 kHz	(0.22 to 3.3) nF (3.3 to 330) nF 330 nF to 3.3 μ F (3.3 to 33) μ F (33 to 330) μ F	5 mF/F + 10 pF 2.5 mF/F + 0.3 nF 2.5 mF/F + 3 nF 4 mF/F + 30 nF 4.5 mF/F + 0.3 μ F	Multiproduct Calibrator
Capacitance – Source ¹ (Simulation) Allowable Frequency 50 Hz to 300 Hz	(330 μ F to 3.3 mF (3.3 to 33) mF (33 to 110) mF	4.5 mF/F + 3 μ F 7.5 mF/F + 30 μ F 11 mF/F + 0.1 mF	Multiproduct Calibrator
Capacitance – Source ¹ (Fixed Artifacts)	270 pF 1 kHz 1 nF 1 kHz 100 nF 1 kHz 10 μ F 100 Hz 1 kHz 1 000 μ F 100 Hz 1 kHz	31 fF 0.12 pF 12 pF 4.6 nF 3.1 nF 1.2 μ F 2.3 μ F	Standard Capacitors
Resistance – Source ¹ (Simulation)	Up to 1.9 Ω (1.9 to 19) Ω (19 to 190) Ω (0.19 to 1.9) k Ω (1.9 to 19) k Ω (19 to 190) k Ω (0.19 to 1.9) M Ω (1.9 to 19) M Ω (19 to 100) M Ω	0.1 m Ω / Ω + 64 $\mu\Omega$ 30 $\mu\Omega$ / Ω + 0.18 m Ω 20 $\mu\Omega$ / Ω + 0.33 m Ω 17 $\mu\Omega$ / Ω + 1 m Ω 16 $\mu\Omega$ / Ω + 2.9 m Ω 20 $\mu\Omega$ / Ω 32 $\mu\Omega$ / Ω 69 $\mu\Omega$ / Ω 0.19 m Ω / Ω	Multiproduct Calibrator
Resistance – Source ¹ (Variable Artifacts)	Up to 100 m Ω 100 m Ω to 1 Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω (1 to 10) G Ω	1.2 m Ω 1.3 m Ω 0.12 m Ω / Ω + 2.6 $\mu\Omega$ 0.12 m Ω / Ω + 3.1 $\mu\Omega$ 0.12 m Ω / Ω 0.12 m Ω / Ω 0.12 m Ω / Ω 0.37 m Ω / Ω 1.3 m Ω / Ω 2.4 m Ω / Ω 6.2 m Ω / Ω 5.8 m Ω / Ω	Decade Resistors

Electrical – DC/Low Frequency

Manaus, Brasil

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) °C	0.56 °C	Multiproduct Calibrator, Multimeter
	(800 to 1 550) °C	0.46 °C	
	(1 550 to 1 820) °C	0.45 °C	
	Type C (0 to 1 000) °C	0.37 °C	
	(1 000 to 1 800) °C	0.59 °C	
	(1 800 to 2 316) °C	0.98 °C	
	Type E (-250 to -100) °C	0.58 °C	
	(-100 to 650) °C	0.19 °C	
	(650 to 1 000) °C	0.25 °C	
	Type J (-210 to -100) °C	0.32 °C	
	(-100 to 760) °C	0.2 °C	
	(760 to 1 200) °C	0.27 °C	
	Type K (-200 to -100) °C	0.39 °C	
	(-100 to 120) °C	0.22 °C	
	(120 to 1 000) °C	0.31 °C	
	(1 000 to 1 372) °C	0.47 °C	
	Type L (-200 to -100) °C	0.43 °C	
	(-100 to 800) °C	0.31 °C	
	(800 to 900) °C	0.2 °C	
	Type N (-200 to -100) °C	0.47 °C	
	(-100 to 410) °C	0.26 °C	
	(410 to 1 300) °C	0.32 °C	
	Type R (0 to 250) °C	0.68 °C	
	(250 to 1 000) °C	0.44 °C	
	(1 000 to 1 767) °C	0.49 °C	
	Type S (0 to 250) °C	0.57 °C	
	(250 to 1 400) °C	0.47 °C	
	(1 400 to 1 767) °C	0.56 °C	
	Type T (-250 to -150) °C	0.73 °C	
	(-150 to 0) °C	0.28 °C	
	(0 to 400) °C	0.19 °C	

Electrical – DC/Low Frequency

Manaus, Brasil

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type U (-200 to 0) °C (0 to 600) °C	0.65 °C 0.32 °C	Multiproduct Calibrator, Multimeter
Electrical Calibration of RTD Indicators ¹	PT 385, 100 Ω (-200 to 800) °C PT 3926, 100 Ω (-200 to 630) °C PT 3916, 100 Ω (-200 to 630) °C PT 385, 200 Ω (-200 to 630) °C PT 385, 500 Ω (-200 to 630) °C PT 385, 1000 Ω (-200 to 630) °C PTNi 385, 120 Ω (-80 to 260) °C CU 427, 10 Ω (-100 to 260) °C	0.053 °C 0.055 °C 0.054 °C 0.052 °C 0.058 °C 0.054 °C 0.044 °C 0.071 °C	Multiproduct Calibrator, Multimeter
AC Voltage – Source ¹	Up to 220 mV 10 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz 220 mV to 2.2 V 10 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz (2.2 to 22) V 10 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 500 kHz 500 kHz to 1 MHz	0.43 mV/V + 7.2 μV 0.19 mV/V + 7.7 μV 1.3 mV/V + 7.2 μV 1.7 mV/V + 15 μV 2.7 mV/V + 27 μV 5.5 mV/V + 37 μV 0.34 mV/V + 24 μV 0.10 mV/V + 25 μV 0.29 mV/V + 0.21 mV 0.68 mV/V + 0.22 mV 1.9 mV/V + 0.18 mV 3.8 mV/V + 0.39 mV 0.36 mV/V + 10 μV 0.19 mV/V 0.86 mV/V 2.1 mV/V 2.3 mV/V 5.1 mV/V	Multiproduct Calibrator

Electrical – DC/Low Frequency

Manaus, Brasil

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(22 to 220) V 10 Hz to 40 Hz 40 Hz to 20 kHz 20 kHz to 100 kHz (220 to 1000) V 50 Hz to 1 kHz	0.35 mV/V + 0.1 mV 0.12 mV/V + 1.2 mV 0.78 mV/V + 0.58 mV 0.17 mV/V + 7.8 mV	Multiproduct Calibrator
AC Voltage – Measure ¹	Up to 100 mV 1 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 1 MHz 1 MHz to 4 MHz 100 mV to 1 V 1 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 1 MHz (1 to 10) V 1 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 100 kHz 100 kHz to 300 kHz 300 kHz to 1 MHz (1 to 4) MHz (10 to 100) V 1 Hz to 1 kHz 1 kHz to 20 kHz 20 kHz to 50 kHz 50 kHz to 100 kHz (100 to 1 000) V 1 Hz to 1 kHz 1 kHz to 20 kHz	56 µV + 6.1 µV 0.18 mV/V + 4 µV 0.39 mV/V + 56 µV 0.29 mV/V + 0.47 mV 12 mV/V + 29 µV 52 mV/V + 0.76 mV 0.11 mV/V + 0.1 µV 0.19 mV/V + 2.8 µV 0.95 mV/V + 0.51 µV 3.5 mV/V + 88 µV 12 mV/V + 35 µV 0.11 mV/V + 1.4 µV 0.19 mV/V + 6.6 µV 0.95 mV/V + 2.4 µV 3.7 mV/V + 56 µV 12 mV/V + 0.54 V 6.3 mV/V + 54 mV 0.27 mV/V + 1.6 mV 0.26 mV/V + 0.72 mV 0.44 mV/V + 0.71 mV 1.5 mV/V + 1.3 mV 0.61 mV/V + 36 mV 0.82 mV/V + 35 mV	Multimeter
AC Voltage – Measure ¹ High Voltage	(50 to 60) Hz (1 to 10) kV	1.8 mV/V	High Voltage Meter

Electrical – DC/Low Frequency

Manaus, Brasil

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current - Source ¹	Up to 22 mA 10 Hz to 1 kHz (1 to 10) kHz 22 to 220 mA 10 Hz to 1 kHz 1 kHz to 10 kHz 220 mA to 2.2 A 40 Hz to 1 kHz 1 kHz to 10 kHz 2.2 A to 11 A 45 Hz to 1 kHz 1 kHz to 5 kHz 11A to 20 A 45 Hz to 1 kHz 1 kHz to 5 kHz	0.27 mA/A + 14 nA 0.32 % of reading 1.4 mA/A 0.21 % of reading + 20 µA 0.47 mA/A + 0.17 mA 1 % of reading 2.6 mA/A 3.9 % of reading 1.5 mA/A + 7.8 mA 3.2 % of reading	Multiproduct Calibrator
AC Current – Clamp on Meters ¹	(1 to 1 000) A (50 to 400) Hz	3 mA/A	Multiproduct Calibrator with Current Coil
AC Current – Measure ¹	100 pA to 100 µA 10 Hz to 1 kHz (0.1 to 1) mA 10 Hz to 1 kHz (1 to 10) mA 10 Hz to 1 kHz (10 to 100) mA 10 Hz to 1 kHz (0.1 to 1) A 10 Hz to 1 kHz	17 nA 80 µA/A + 9.2 nA 85 µA/A + 3.5 nA 80 µA/A + 54 nA 0.1 mA/A	Multimeter
AC Current – Measure ¹	10 Hz to 1 kHz (1 to 10) A (1 to 100) A	23 µA/A + 1 mA 0.42 mA/A + 0.13 mA	Multimeter, Current Shunt
AC Current – Measure ¹	(1 to 2 000) A 10 Hz to 1 kHz	21 mA/A	Clamp Meter

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned RF Power Absolute – Measure ¹	(-127 to 0) dBm 150 kHz to 1.3 GHz (-20 to 30) dBm 100 kHz to 2.6 GHz	0.23 dB 0.13 dB	Measuring Receiver System, Sensor Module, Microwave Converter
RF Power Absolute – Source ¹	(-70 to -20) dBm 50 MHz to 26.5 GHz (-30 to 20) dBm 100 kHz to 4.2 GHz 10 MHz to 18 GHz (-60 to 20) dBm 9 kHz to 6 GHz	0.22 dB 0.21 dB 0.21 dB 0.21 dB	Signal Generators, Power Meter, Power Sensor
RF Power Absolute – Measure ¹	(-70 to -20) dBm 50 MHz to 26.5 GHz (-30 to 20) dBm 100 kHz to 4.2 GHz 10 MHz to 18 GHz (-60 to 20) dBm 9 kHz to 6 GHz	0.09 dB 0.066 dB 0.061 dB 0.069 dB	Power Meter, Power Sensors
Amplitude Modulation – Measure ¹ 50 Hz to 10 kHz 20 Hz to 100 kHz	Rate: 150 kHz to 10 MHz Depth: (5 to 99) %	0.65 % Modulation 0.65 % Modulation	Measuring Receiver System
Amplitude Modulation – Measure ¹ 50 Hz to 50 kHz 20 Hz to 100 kHz 20 Hz to 10 kHz 20 Hz to 200 kHz 50 Hz to 100 kHz	Rate: 10 MHz to 1.3 GHz Depth: (5 to 99) % Rate: 250 kHz to 10 MHz Dev: 40 kHz Rate: 10 MHz to 1.3 GHz Dev: 400 kHz	0.65 % Modulation 0.65 % Modulation 1.7 % Modulation 1.7 % Modulation 1.7 % Modulation	Measuring Receiver System
Phase Modulation – Measure ¹ 200 Hz to 20 kHz	Rate: 10 MHz to 1. GHz	0.36 % Modulation	Measuring Receiver System

Length – Dimensional Metrology

Manaus, Brasil

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Height Gages ^{1,2}	Up to 34 in	$(25 + 5.1L) \mu\text{in}$	Gauge Blocks, Surface Plate
Calipers ^{1,2}	Up to 34 in	$(310 + 2.1L) \mu\text{in}$	Gauge Blocks
Micrometer s ^{1,2} (Internal, External, Depth)	Up to 34 in	$(33 + 5.1L) \mu\text{in}$	Gauge Blocks, Micrometer Standards, Optical Parallel
Indicators ^{1,2} (Dial, Digital, Test and LVDTs)	Up to 4 in	$(3.3 + 5.4L) \mu\text{in}$	Indicator Calibrator, Gauge Blocks
Optical Comparators and Visual Systems ^{1,2} Length Angle	Up to 24 in (30, 45, 60, 90)°	$(79 + 6.4L) \mu\text{in}$ 0.006 6°	Glass Scale Angle Blocks
Rulers and Tapes ²	Up to 164 ft	$(340 + 27L) \mu\text{in}$	Steel Rule
Angle Meters	4 Quadrants Up to 90°	0.008 5°	Sine Bar, Gauge Blocks
Cylindrical Plug Gages & Pin Gages ² Class ZZ, C & D	Up to 1 in	$(7.9 + 3.1L) \mu\text{in}$	High Resolution Micrometer, Gauge Blocks
Surface Finish Testers ¹	3 μm Ra 9.5 μm Ry	0.064 μm 0.25 μm	Roughness Specimen Set
Coating Thickness Measuring Equipment ^{1,6}	Up to 30 mils	0.041 mils	Plastic Shims
Surface Plates ¹ Local Flatness	Up to 1000 μin	46 μin	Repeat-O-Meter

Mass and Mass Related

Manaus, Brasil

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Hardness Testers ¹	HRC Low Middle High	0.38 HRC 0.34 HRC 0.33 HRC	Indirect Verification per ASTM E18 using Hardness Blocks
	HRBW Low Middle High	0.46 HRBW 0.4 HRBW 0.57 HRBW	

Mass and Mass Related

Manaus, Brasil

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gauge Pressure – Measure ¹	(-13 to 0) psi (0 to 5) psi (0 to 500) psi (0 to 5 000) psi (0 to 10 000) psi	0.001 5 psi 0.034 % of reading + 0.000 16 psi 0.03 % of reading + 0.01 psi 0.039 % of reading + 0.14 psi 0.028 % of reading + 1.5 psi	Process Calibrator, Pressure Modules
Absolute Pressure – Measure ¹	(0 to 15) psi (0 to 300) psi	0.028 % of reading + 0.001 1 psi 0.032 % of reading + 0.011 psi	Process Calibrator, Pressure Modules
Torque Tools and Wrenches ¹	(1 to 10) lbf.in (10 to 100) lbf.in (25 to 250) lbf.in	0.58 % of reading 0.58 % of reading 0.59 % of reading	Torque Analyzers and Transducers
Torque Analyzers and Transducers	(1 to 226) lbf.in	0.062 % of reading	Torque Wheel and Dead Weight Set
Force – Compression and Tension Devices ¹	Up to 500 lbf Up to 1 000 lbf	0.26 % of reading + 0.01 lbf 0.28 % of reading + 0.02 lbf	Load Cell Comparison
Scales and Balances ^{1,3}	Up to 300 g	1 µg/g + 0.22 mg	ASTM E617 Class 0 weights
Scales and Balances ^{1,3}	(0.1 to 25) kg	7 µg/g	ASTM E617 Class 2 weights
Scales and Balances ^{1,3}	(20 to 200) kg	0.067 mg/g	OIML Class M1 weights

Thermodynamic

Manaus, Brasil

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity – Measuring Equipment with probe	11 %RH 33 %RH 75.4 %RH 97 %RH	1.3 %RH 1.5 %RH 2 %RH 2.2 %RH	Accredited Saturated Salt Solutions, Vaisala Humidity Calibrator
Relative Humidity – Measure ¹	0 to 100 %RH	0.4 % of std indication + 2.6 %RH	Humidity/Temp Meter
Temperature – Source ¹	(20 to 482) °C	0.44 °C	Dry Block Calibrator
Temperature – Measure ¹	(-20 to 300) °C	0.14 °C	Digital Thermometer

Thermodynamic

Manaus, Brasil

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Radiation (Infrared) Thermometers ¹	(50 to 150) °C (150 to 250) °C (250 to 350) °C (350 to 500) °C	1.5 °C 2.2 °C 3 °C 4.2 °C	Precision Infrared Calibrator $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$

Time and Frequency

Manaus, Brasil

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Photo Tachometer ^{1,2}	Up to 100 000 rpm	0.002 9 % of reading + 0.012 rpm	Multiproduct Calibrator
Frequency – Measure ¹	1 mHz to 20 GHz	0.83 nHz/Hz	Frequency Counter, Rubidium Frequency Standard
Frequency – Source ¹	10 Hz to 1.2 MHz	14 $\mu\text{Hz/Hz}$	Multiproduct Calibrator
	1 mHz to 26.5 GHz	0.83 nHz/Hz	Signal Generators, Rubidium Frequency Standard
Timers and Stopwatches ¹	1 s to 24 hr	55 ms	Frequency Counter, Signal Generator

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)

Services performed at satellite laboratory

Micro Precision Calibration de Mexico S. de R.L. de CV

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CALIBRATION AND DIMENSIONAL MEASUREMENT

CALIBRATION

Acoustics and Vibration

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Pressure Level/Sound Level Meter, @ 1 kHz	(94 & 114) dB	0.3 dB	Sound Level Calibrator

Chemical Quantities

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Meters ^{1,8}	(4, 7, 10) pH unit	0.03 pH unit	pH Buffers
Conductivity Meters ^{1,8}	10 μ S/cm 100 μ S/cm 1 000 μ S/cm 1 408 μ S/cm	0.62 μ S/cm 2.1 μ S/cm 5.6 μ S/cm 6.4 μ S/cm	Conductivity Standard Solutions
Mass Concentration – Refractometers	Up to 70 % Brix	0.12 % Brix	Balance, Sucrose

Electrical – DC/Low Frequency

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Generate 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 to 1 100) V	7.6 μ V/V + 0.5 μ V 5 μ V/V + 0.8 μ V 3.4 μ V/V + 2.3 μ V 3.4 μ V/V+2.3 μ V 6.4 μ V/V 7.8 μ V/V	Direct comparison to Fluke multi-calibrator

Electrical – DC/Low Frequency

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Measure ¹	Up to 100 mV 100 mV to 1V (1 to 10) V (10 to 100) V (100 to 1 000) V	8.3 $\mu\text{V/V} + 0.67 \mu\text{V}$ 9.0 $\mu\text{V/V} + 0.60 \mu\text{V}$ 9.3 $\mu\text{V/V} + 0.34 \mu\text{V}$ 12 $\mu\text{V/V} + 29 \mu\text{V}$ 12 $\mu\text{V/V} + 11 \mu\text{V}$	Direct comparison to DMM
DC High Voltage – Measure ¹	(100 to 1 000) V (1 000 to 20 000) V	0.5 mV/V + 0.7 V 3 mV/V + 7.2 V	Comparison to high voltage meter
DC Current – Generate ¹	Up to 22 mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A (11 to 20.5) A	58 $\mu\text{A/A} + 1.2 \text{ nA}$ 0.018 % of reading 0.007 9 % of reading 0.047 % of reading 0.13 % of reading	Direct comparison to Fluke multi-calibrator
DC Current – Generate ¹	(0.1 to 1 000) A	0.46 % of reading	Comparison to Fluke multi-calibrator with current coil
DC Current – Measure ¹	Up to 1 μA (1 to 10) μA (10 to 100) μA (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	11 $\mu\text{A/A} + 0.075 \text{ nA}$ 24 $\mu\text{A/A} + 0.063 \text{ nA}$ 26 $\mu\text{A/A} + 0.036 \text{ nA}$ 24 $\mu\text{A/A} + 0.03 \text{ nA}$ 24 $\mu\text{A/A} + 0.17 \text{ nA}$ 43 $\mu\text{A/A} + 0.20 \mu\text{A}$ 0.14 mA/A + 0.01 mA	Direct comparison to DMM
DC Current – Measure ¹	Up to 10 A (10 to 75) A (75 to 300) A (300 to 1 000) A	0.007 8 % of reading 0.006 3 % of reading 0.007 6 % of reading 0.038 % of reading	Shunt monitored with DMM
DC Current – Measure ¹	(0.1 to 2 000) A	0.84 % of reading	Comparison to digital clamp meter
Resistance – Generate ¹	(0 to 1.9) Ω (1.9 to 19) Ω (19 to 190) Ω (0.19 to 1.9) k Ω (1.9 to 19) k Ω (19 to 190) k Ω (0.19 to 1.9) M Ω (1.9 to 19) M Ω (19 to 100) M Ω	62 $\mu\Omega/\Omega + 43 \mu\Omega$ 23 $\mu\Omega/\Omega + 83 \mu\Omega$ 8.2 $\mu\Omega/\Omega + 0.4 \text{ m}\Omega$ 9 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 22 $\mu\Omega/\Omega$ 0.1 m $\Omega/\Omega + 37 \Omega$ 80 $\mu\Omega/\Omega$ 0.12 m Ω/Ω	Comparison to Fluke multi-calibrator

Electrical – DC/Low Frequency

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment	
Resistance – Generate ¹	(0.1 to 100) mΩ (0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ (1 to 10) GΩ (10 to 100) GΩ 1 TΩ 10 TΩ	2 % of reading 0.2 % of reading 0.004 7 % of reading 0.003 2 % of reading 0.003 1 % of reading 0.003 2 % of reading 0.003 1 % of reading 0.006 2 % of reading 0.006 3 % of reading 0.006 3 % of reading 0.016 % of reading 0.016 % of reading 0.034 % of reading 0.78 % of reading 1.5 % of reading	Comparison to resistor standards	
Resistance – Measure ¹	(0 to 1) Ω (1 to 10) Ω (10 to 100) Ω (0.1 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ	48 μΩ/Ω + 25 μΩ 2.7 μΩ/Ω + 70 μΩ 6.6 μΩ/Ω + 32 μΩ 2.9 μΩ/Ω + 0.4 mΩ 2.9 μΩ/Ω + 0.42 mΩ 6.5 μΩ/Ω + 36 mΩ 17 μΩ/Ω + 1 Ω 77 μΩ/Ω + 61 Ω 0.28 mΩ/Ω + 2.1 kΩ 1.4 mΩ/Ω + 0.12 MΩ	Direct comparison to DMM	
Capacitance – Generate ¹ Frequency	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 Hz to 1 kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz (0.1 to 50) Hz (0.1 to 20) 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) nF (11 to 32.999) nF (33 to 109.99) nF (110 to 329.99) nF (0.33 to 1.099 9) μF (1.1 to 3.299 9) μF (3.3 to 10.999) μF (11 to 32.999) μF (33 to 109.99) μF (110 to 329.99) μF (0.33 to 1.099 9) mF	2.8 mF/F + 8 pF 2.6 mF/F + 8 pF 6.9 mF/F 1.1 mF/F + 13 pF 5.4 mF/F 1.5 mF/F + 85 pF 1.7 mF/F + 0.21 nF 1.5 mF/F 1.5 mF/F + 2.5 nF 1.6 mF/F + 8 nF 2.6 mF/F + 21 nF 2.9 mF/F + 69 nF 2.9 mF/F + 0.22 μF 2.7 mF/F + 0.88 μF	Comparison to Fluke multi-calibrator

Electrical – DC/Low Frequency

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Generate ¹ Frequency (0.1 to 6) Hz (0.1 to 2) Hz (0.1 to 0.6) Hz (0.1 to 0.2) Hz	(1.1 to 3.299 9) mF (3.3 to 10.999) mF (11 to 32.999) mF (33 to 110) mF	2.7 mF/F + 2.4 μF 2.7 mF/F + 7.7 μF 5.5 mF/F + 23 μF 7.8 mF/F + 78 μF	Comparison to Fluke multi-calibrator
Capacitance – Generate ¹ (60 to 1 000) Hz	10 pF to 1 nF 1 nF to 10 μF	0.06 % of reading 0.055 % of reading	Direct comparison to capacitance decade
Inductance – Generate ^{1,8} Fixed Points (0.1 to 10) kHz	1.0 mH 10 mH 100 mH 1 H	0.029 % of reading 0.029 % of reading 0.032 % of reading 0.028 % of reading	Direct comparison to standard inductor
Electrical Calibration of Thermocouple Indicators ¹ Generate / Measure	Type B (600 to 800) °C (800 to 1 550) °C (1 550 to 1 820) °C Type C (0 to 1 000) °C (1 000 to 1 800) °C (1 800 to 2 316) °C Type E (-250 to -100) °C (-100 to 650) °C (650 to 1 000) °C Type J (-210 to -100) °C (-100 to 760) °C (760 to 1 200) °C Type K (-200 to -100) °C (-100 to 120) °C (120 to 1 000) °C (1 000 to 1 372) °C Type L (-200 to -100) °C (-100 to 800) °C (800 to 900) °C	0.54 °C 0.43 °C 0.42 °C 0.36 °C 0.58 °C 0.97 °C 0.58 °C 0.19 °C 0.25 °C 0.32 °C 0.2 °C 0.27 °C 0.38 °C 0.21 °C 0.3 °C 0.46 °C 0.43 °C 0.3 °C 0.2 °C	Comparison to Fluke multi-calibrator

Electrical – DC/Low Frequency

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹ Generate / Measure	Type N (-200 to -100) °C	0.46 °C	Comparison to Fluke multi-calibrator
	(-100 to 410) °C	0.26 °C	
	(410 to 1 300) °C	0.32 °C	
	Type R (0 to 250) °C	0.67 °C	
	(250 to 1 000) °C	0.42 °C	
	(1 000 to 1 767) °C	0.48 °C	
	Type S (0 to 250) °C	0.56 °C	
	(250 to 1 400) °C	0.46 °C	
	(1 400 to 1 767) °C	0.55 °C	
	Type T (-250 to -150) °C	0.73 °C	
	(-150 to 0) °C	0.28 °C	
	(0 to 400) °C	0.19 °C	
	Type U (-200 to 0) °C	0.65 °C	
	(0 to 600) °C	0.31 °C	
Electrical Simulation of RTD Indicating Systems ¹	Pt 385, 100 Ω (-200 to 800) °C	0.039 °C	Comparison to Fluke multi-calibrator
	Pt 3926, 100 Ω (-200 to 630) °C	0.041 °C	
	Pt 3916, 100 Ω (-200 to 630) °C	0.042 °C	
	Pt 385, 200 Ω (-200 to 630) °C	0.04 °C	
	Pt 385, 500 Ω (-200 to 630) °C	0.048 °C	
	Pt 385, 1 000 Ω (-200 to 630) °C	0.042 °C	
	PtNi 385, 120 Ω (-80 to 260) °C	0.042 °C	
	Cu 427, 10 Ω (-100 to 260) °C	0.071 °C	

Electrical – DC/Low Frequency

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Calibrators Systems ¹	Pt 385, 100 Ω (-200 to 800) °C	0.039 °C	Comparison to DMM
	Pt 3926, 100 Ω (-200 to 630) °C	0.044 °C	
	Pt 3916, 100 Ω (-200 to 630) °C	0.041 °C	
	Pt 385, 200 Ω (-200 to 630) °C	0.039 °C	
	Pt 385, 500 Ω (-200 to 630) °C	0.053 °C	
	Pt 385, 1000 Ω (-200 to 630) °C	0.043 °C	
	PtNi 385, 120 Ω (-80 to 260) °C	0.042 °C	
	Cu 427, 10 Ω (-100 to 260) °C	0.043 °C	

Electrical – DC/Low Frequency

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Generate ¹	Up to 220 mV		Direct comparison to Fluke multi-calibrator
	(10 to 40) Hz	0.28 mV/V + 4.0 μ V	
	(40 to 20) kHz	0.093 mV/V + 4.2 μ V	
	(20 to 100) kHz	0.54 mV/V + 10 μ V	
	(100 to 300) kHz	0.89 mV/V + 20 μ V	
	(300 to 500) kHz	1.4 mV/V + 20 μ V	
	500 kHz to 1 MHz	2.8 mV/V + 20 μ V	
	220 mV to 2.2 V		
	(10 to 40) Hz	0.24 mV/V + 12 μ V	
	40 Hz to 20 kHz	41 μ V/V + 15 μ V	
	(20 to 100) kHz	76 μ V/V + 0.10 mV	
	(100 to 300) kHz	0.38 mV/V + 0.12 mV	
	(300 to 500) kHz	1.0 mV/V + 0.10 mV	
	500 kHz to 1 MHz	1.6 mV/V + 0.26 μ V	
	(2.2 to 22) V		
	(10 to 40) Hz	0.26 mV/V + 26 μ V	
	40 Hz to 20 kHz	57 μ V/V	
	(20 to 100) kHz	0.13 mV/V	
	(100 to 300) kHz	0.30 mV/V	
	(300 to 500) kHz	1.1 mV/V	
	500 kHz to 1 MHz	1.7 mV/V	
	(22 to 220) V		
	(10 to 40) Hz	0.25 mV/V	
	40 Hz to 20 kHz	57 μ V/V	
	(20 to 100) kHz	0.22 mV/V	
	(220 to 1 000) V		
	50 Hz to 1 kHz	77 μ V/V + 4.1 mV	

Electrical – DC/Low Frequency

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	Up to 100 mV		Direct comparison to DMM
	10 Hz to 1 kHz	59 μ V + 6.1 μ V	
	(1 to 20) kHz	0.14 mV/V + 4.4 μ V	
	(20 to 100) kHz	0.39 mV/V + 55 μ V	
	(100 to 300) kHz	1.2 mV/V + 0.48 mV	
	300 kHz to 1 MHz	11 mV/V + 31 μ V	
	100 mV to 1 V		
	0.01 to 1 kHz	0.11 mV/V + 0.11 μ V	
	(1 to 20) kHz	0.19 mV/V + 79 nV	
	(20 to 100) kHz	1.0 mV/V + 6.4 μ V	
	(100 to 300) kHz	3.6 mV/V + 19 nV	
	300 kHz to 1 MHz	12 mV/V + 0.28 μ V	
	(1 to 10) V		
	Up to 1 kHz	0.11 mV/V + 4.4 μ V	
	(1 to 20) kHz	0.19 mV/V + 28 nV	
AC High Voltage – Measure ¹	(20 to 100) kHz	0.94 mV/V + 64 μ V	Comparison to high voltage meter
	(100 to 300) kHz	3.6 mV/V + 5 nV	
	300 kHz to 1 MHz	11 mV/V + 1 μ V	
	(10 to 100) V		
	Up to 1 kHz	0.27 mV/V + 1.6 mV	
	(1 to 20) kHz	0.26 mV/V + 0.74 mV	
	(20 to 50) kHz	0.44 mV/V + 0.74 mV	
	(50 to 100) kHz	1.5 mV/V + 1.3 mV	
	(100 to 1000) V		
	Up to 1 kHz	0.54 mV/V + 28 mV	
	(1 to 20) kHz	0.81 mV/V + 28 mV	

Electrical – DC/Low Frequency

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Generate ¹	0 to 22 mA 10 Hz to 1 kHz (1 to 10) kHz (22 to 220) mA 10 Hz to 1 kHz (1 to 10) kHz 220 mA to 2.2 A 40 Hz to 1 kHz (1 to 10) kHz (2.2 to 11) A 45 Hz to 1 kHz (1 to 5) kHz (11 to 20.5) A 45 Hz to 1 kHz (1 to 5) kHz	0.14 mA/A 0.13 % of reading 0.28 mA/A 0.11 % of reading + 5 μ A 0.28 mA/A 0.70 % of reading 1.8 mA/A 1.2 % of reading 1.4 mA/A + 1.2 mA 4.2 % of reading	Direct comparison to Fluke multi-calibrator
AC Current – Generate ¹	(20 to 1 000) A (50 to 400) Hz	0.26 % of reading	Comparison to Fluke multi-calibrator with current coil
AC Current – Measure ¹ Up to 1 kHz	0 to 100 μ A (0.1 to 1) mA (1 to 10) mA (10 to 100) mA (0.1 to 1) A	11 nA 77 μ A/A + 3.7 nA 80 μ A/A 80 μ A/A 0.1 mA/A	Direct comparison to DMM
AC Current – Measure ¹ Up to 1 kHz	Up to 10 A (10 to 75) A (75 to 300) A (300 to 1 000) A	0.11 % of reading 0.15 % of reading 0.085 % of reading 0.08 % of reading	Shunt monitored with DMM
AC Current – Measure ¹	(0 to 2 000) A Up to 1 kHz	1.6 % of reading	Comparison to digital clamp meter

Length – Dimensional Metrology

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 40 in	(306 + 4 L) μ in	Gage blocks & check master
Indicators ^{1,2}	Up to 4 in	(5.4 + 3.1 L) μ in	Indicator Calibrator, master gage blocks

Length – Dimensional Metrology

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Micrometers ² (Internal, External, Depth, Bore)	Up to 8 in (8 to 24) in	$(33 + 1.4L) \mu\text{in}$ $(10 + 5.7L) \mu\text{in}$	Gage blocks & gage rods
Flatness Parallelism	51 μin 24 in	3.9 μin 4.5 μin	Optical Parallels
Height Gages ²	Up to 40 in	$(24 + 3.1L) \mu\text{in}$	Gage blocks and check master
Rules & Tapes ²	Up to 40 in Up to 164 ft	$(48 + 6L) \mu\text{in} + 0.58R$ $(138 + 11L) \mu\text{in} + 0.58R$	Comparison to glass scales
Gauge Blocks – Length ²	Up to 12 in	$(6.4 + 1.8L) \mu\text{in}$	P & W Labmaster®, master gage blocks
Cylindrical Plain Plug Gages Outside Diameter ²	Up to 12 in	$(4 + 1.2L) \mu\text{in}$	P & W Labmaster®, master gage blocks
Thread Plug Gage ² Major Diameter Pitch Diameter	Up to 12 in Up to 12 in	$(4.1 + 1.2L) \mu\text{in}$ $(47 + 0.13L) \mu\text{in}$	P & W Labmaster® & thread measuring wires
Thread Ring Gage Minor Diameter Pitch Diameter	Up to 12 in Up to 12 in	$(11 + 0.78L) \mu\text{in}$ $(40 + 0.51L) \mu\text{in}$	Labmaster®, master ring gage, master gage blocks
Ring Gage ² Plain Cylindrical	Up to 12 in	$(14 + 1.3 L) \mu\text{in}$	Labmaster®, master rings & master gage blocks
Micrometers/Length Standards ²	Up to 12 in	$(4 + 1.2L) \mu\text{in}$	Labmaster®, master gage blocks
Feeler/Taper Gage ²	Up to 0.5 in	$(20 + 0.56L) \mu\text{in}$	Supermicrometer® and Master gage blocks
Angle Meter (Protractor)	Up to 90°	0.009 2°	Sine bar & gage blocks
Supermicrometer® ^{1,2} Length	Up to 1 in	$(6.1 + 9.7L) \mu\text{in}$	Gage blocks & optical parallel
Surface Plates ^{1,2} Local Area Flatness	0.001 in	16 μin	Repeat-o-meter
Overall Flatness	(12 x 12) to (70 x 140) in	0.19 % of reading + 3.2"	Wyler surface plate measuring system
Radius Gage ²	Up to 6 in	$(195 + 0.61L) \mu\text{in}$	Optical comparator

Length – Dimensional Metrology

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
CMM ^{1,2} 3D Length – Error of Indication	Up to 40 in	$(22 + 9.3L) \mu\text{in}$	ISO 10360-2: 2001: Checker master
Probing Error	0.786 80 in	25 μin	Master sphere
Optical Comparators & Visual Systems ^{1,2} X & Y Axis Length	Up to 0.5 in	$(83 + 0.12L) \mu\text{in}$	Glass scale & gage blocks
Error of Indication	Up to 24 in	$(117 + 10.7L) \mu\text{in}$	
Angle	(30, 45, 60, 90)°	0.006 1°	Angle blocks
Coating Thickness Gauge Ferrous and Non-Ferrous ⁶	Up to 60 mils	0.043 mils	Comparison to standard shims

Mass and Mass Related

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Piston/Plunger Operated Volumetric Apparatus ¹ (POVA)	100 μl to 20 ml	0.19 % of reading	Scale, Weight Set Class 0, Barometer
Other Volumetric Devices ¹	Up to 100 ml (0.1 to 34) l	0.13 ml/l 0.2 ml/l + 0.25 ml	Gravimetric method using reference weight & balance
Gauge Pressure ¹	(-15 to + 30) psi Up to 1 000 psi Up to 10 000 psi	0.03 % of reading + 0.000 64 psi 0.016 % of reading + 0.08 psi 0.012 % of reading + 0.89 psi	Comparison to Fluke pressure calibrator systems
Air Velocity	Up to 20 m/s	1.5 % of reading + 0.15 m/s	Comparison to standard anemometer with wind tunnel
Scales & Balances ¹	Up to 30) g Up to 100 kg Up to 1 000 kg	1.8 $\mu\text{g/g}$ + 0.018 mg 4 $\mu\text{g/g}$ 0.23 mg/g	Comparison to weights ASTM Class 0 ASTM Class 1 OIML Class M2
Mass Determination	Up to 100 g (1 to 34) kg	0.16 mg 64 $\mu\text{g/g}$ + 51 mg	Substitution method using reference weight & balance
Air Flow ¹	Up to 500 ml/min 500 ml/min to 10 l/min (10 to 50) l/min	0.33 % of reading + 0.58R 0.32 % of reading 0.31 % of reading	Comparison to flow calibrator system

Mass and Mass Related

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque ¹	(5 to 140) ozf·in 140 ozf·in to 50 lbf·in (50 to 400) lbf·in (400 to 1 000) lbf·in 1 000 lbf·in to 600 lbf·ft	1.3 % of reading 0.47 % of reading 0.48 % of reading 0.48 % of reading 0.6 % of reading	CDI torque system
Torque Analyzers, Torque Transducer	Up to 200 lbf·in 200 lbf·in to 370 lbf·ft	0.08 % of reading+ 0.58R 0.14 % of reading	Direct comparison to torque wheel & dead weights
Force – Tension & Compression	Up to 1 000 kgf	0.018 % of reading + 0.58R	Direct comparison to dead weights
	Up to 450 kgf (450 to 4 500) kgf (4 500 to 45 000) kgf	0.033 % of reading + 0.58R 0.089 % of reading 0.17 % of reading	Comparison to force transducer
Dynamic Viscosity ¹	(6.236 to 146.1) mPa·s (65.27 to 2 966) mPa·s (168.4 to 34 500) mPa·s (439 to 88 170) mPa·s (12 890 to 204 300) mPa·s	0.54 % of reading 0.65 % of reading 0.51 % of reading 0.66 % of reading 0.48 % of reading	Comparison to Cannon viscosity standards
Rockwell Hardness Testers ¹	HRC < 35 HRC (≥ 35 and < 60) HRC ≥ 60 HRC HRBW < 60 HRBW (≥ 60 and < 80) HRBW ≥ 80 HRBW HR15N < 78 HR15N (≥ 78 and < 90) HR15N ≥ 90 HR15N HR45N < 37 HR45N (≥ 37 and < 66) HR45N ≥ 66 HR45N	0.26 HRC 0.26 HRC 0.25 HRC 0.45 HRBW 0.32 HRBW 0.43 HRBW 0.43 HR15N 0.45 HR15N 0.53 HR15N 0.4 HR45N 0.34 HR45N 0.33 HR45N	Indirect Verification PER ASTM E18 using hardness test blocks.

Mass and Mass Related

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Rockwell Hardness Testers ¹	HR30TW < 57 HR30TW (≥ 57 and < 70) HR30TW ≥ 70 HR30TW HR15TW < 81 HR15TW (≥ 81 and < 87) HR15TW ≥ 87 HR15TW	0.58 HR30TW 0.35 HR30TW 0.28 HR30TW 0.48 HR15TW 0.4 HR15TW 0.34 HR15TW	Indirect Verification PER ASTM E18 using hardness test blocks.
Durometers Spring Force Types A,B,O Types C,D,DO Type OO Indenter dimension Length	Up to 744.39 gf Up to 4079 gf Up to 104 gf Up to 0.1 in	2.7 gf 24 gf 0.93 gf 270 μm	Partial direct verification per ASTM 2240 Durometer calibrator Gauge Blocks

Thermodynamic

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity – Measuring Equipment	11 %RH 33 %RH 75 %RH 97 %RH	1.3 %RH 1.4 %RH 1.9 %RH 2.1 %RH	Vaisala Calibrator
Relative Humidity – Measure ¹	Up to 100 % RH	1.6 % RH	Comparison to humidity meter
Radiation (Infrared) Thermometers ¹	(35 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 500) °C	1.1 °C 1.6 °C 2.4 °C 3.7 °C	Black Body Source Flat Plate ε = 0.95, λ = (8 to 14) μm
Radiation (Infrared) Thermometers ¹	(500 to 600) °C (600 to 800) °C (800 to 1 000) °C	3.9 °C 4.4 °C 7 °C	Black Body Source Cavity ε = 0.99, λ = (8 to 14) μm
Temperature – Measuring Equipment ¹	(-40 to 325) °C (325 to 600) °C (600 to 1 200) °C	0.14 °C 3.5 °C 5.1 °C	Comparison to temperature blocks calibrators
Temperature – Measure ¹	(-80 to 300) °C	0.13 °C	Comparison to RTD thermometer

Time and Frequency

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	1 Hz to 10 MHz	0.12 nHz/Hz + 0.4 nHz	Direct comparison using DMM
Frequency – Measure ¹	1 MHz to 3 GHz	4.6 nHz/Hz + 0.41 mHz	Using universal counter
Frequency – Generate ¹	Up to 2 MHz	9 µHz/Hz	Direct comparison to Fluke multi-calibrator
Timers/Stop Watches ¹	Up to 24 hr	55 ms	Totalize Method using universal counter
Angular Frequency – Photo Tachometers ^{1,2}	Up to 1 000 000 rpm	0.000 3 % of reading + 0.57 rpm	Comparison to Fluke multi-calibrator with LED

DIMENSIONAL MEASUREMENT

2D Dimensional Measurement

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dimensional Measurement 2D	Up to 200 mm	233 µm /m + 1.2 µm	Optical Comparator

3D Dimensional Measurement

Silao, GT

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dimensional Measurement 3D	Up to 1 500 mm	101 µm /m + 18 µm	CMM

[Return to Site listing \(top\)](#)

[Go to Notes \(bottom\)](#)

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CALIBRATION

Acoustics and Vibration

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meter ¹	(74 to 114) dB (125 Hz to 4 kHz)	0.34 dB	Sound Calibrator, Sound Level Meter
Sound Calibrator ¹	(74 to 114) dB (125 Hz to 4 kHz)	0.22 dB	Sound Level Meter

Chemical Quantities

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity – Meter ^{1,4,8}	1 µS/cm 10 µS/cm 100 µS/cm 1 413 µS/cm 100 000 µS/cm	0.57 µS/cm 0.57 µS/cm 2.3 µS/cm 3 µS/cm 70 µS/cm	Comparison to Standard Solutions
pH – Meters ^{1,4,8}	4 pH 7 pH 10 pH	0.012 pH 0.012 pH 0.012 pH	Comparison to Standard Solutions

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source Fixed Points	1.018V 10 V	1.4 µV/V 1.3 µV/V	DC Voltage Reference Standard

Electrical – DC/Low Frequency

Timisoara, Romania

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	7.5 $\mu\text{V/V}$ + 0.4 μV 5 $\mu\text{V/V}$ + 0.7 μV 3.5 $\mu\text{V/V}$ + 2.6 μV 3.5 $\mu\text{V/V}$ + 4 μV 5 $\mu\text{V/V}$ + 40 μV 6.5 $\mu\text{V/V}$ + 0.4 mV	Multi-Function Calibrator
DC Voltage – Measure ¹	Up to 100 mV 100 mV to 1 V (1 to 10) V (20 to 100) V 100 V to 1 kV	5 $\mu\text{V/V}$ + 0.31 μV 4 $\mu\text{V/V}$ + 0.31 μV 4 $\mu\text{V/V}$ + 0.51 μV 6 $\mu\text{V/V}$ + 30 μV 6 $\mu\text{V/V}$ + 0.1 mV	Multimeter
DC Voltage – Measure	100 mV 1 V 10 V 100 V 1 kV	1.5 $\mu\text{V/V}$ + 0.012 μV 1.4 $\mu\text{V/V}$ + 0.012 μV 1.3 $\mu\text{V/V}$ + 0.012 μV 1.4 $\mu\text{V/V}$ + 0.012 μV 1.5 $\mu\text{V/V}$ + 0.012 μV	DC Voltage Reference Standard, Reference Divider and NULL Detector
DC High Voltage – Measure ¹	Up to 10 kV (10 to 35) kV (35 to 70) kV	0.3 mV/V + 0.031 V 0.35 mV/V + 0.07 V 0.4 mV/V + 14 V	Comparison with High Voltage Meter and High Voltage Probe
DC Current – Source ¹	Up to 2 pA (2 to 20) pA (20 to 200) pA 200 pA to 2 nA (2 to 20) nA (20 to 200) nA 200 nA to 2 μA (2 to 20) μA (20 to 200) μA 200 μA to 2 mA (2 to 20) mA	0.38 % of reading + 10 fA 0.33 % of reading + 10 fA 0.2 % of reading + 30 fA 0.063 % of reading + 0.1 pA 0.063 % of reading + 1 pA 0.035 % of reading + 10 pA 0.025 % of reading + 0.1 nA 0.025 % of reading + 1 nA 0.025 % of reading + 10 nA 0.025 % of reading + 0.1 μA 0.15 % of reading + 1 μA	Calibrator/Source
DC Current – Source ¹	Up to 220 μA 220 μA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	40 $\mu\text{A/A}$ + 6 nA 35 $\mu\text{A/A}$ + 7 nA 35 $\mu\text{A/A}$ + 40 nA 45 $\mu\text{A/A}$ + 0.7 μA 80 $\mu\text{A/A}$ + 12 μA	Multi-Function Calibrator
DC Current – Source ¹	(2.2 to 11) A	360 $\mu\text{A/A}$ + 480 μA	Multi-Function Calibrator with Amplifier
DC Current – Source ¹	(11 to 20.5) A	780 $\mu\text{A/A}$ + 600 μA	Multi-Product Calibrator

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC High Current – Source ¹	Up to 16.5 A (16.5 to 150) A (150 to 1 025) A	3.2 mA/A + 3.5 mA 3.2 mA/A + 29 mA 3.4 mA/A + 104 mA	Multi-Product Calibrator w/50-turns coil
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	30 μ A/A + 40 pA 20 μ A/A + 40 pA 20 μ A/A + 100 pA 20 μ A/A + 0.8 nA 20 μ A/A + 5.0 nA 20 μ A/A + 50 nA 35 μ A/A + 0.5 μ A 110 μ A/A + 10 μ A	Multimeter
DC Current – Measure ¹	Up to 3 mA (3 to 500) mA 500 mA to 20 A (20 to 300) A	8.6 μ A/A + 58 pA 11 μ A/A + 5.8 nA 16 μ A/A + 1.1 μ A 100 μ A/A + 5.8 μ A	Multimeter w/Resistance Standard, Current Shunt
DC Power – Source ^{1,2} 0.01 mW to 20.5 kW	33 mV to 1 020 V (0.33 to 330) mA 330 mA to 11 A (11 to 20.5) A	0.03 % of Watts output + 0.58R 0.059 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R	Multi-Product Calibrator w/Amplifier
Inductance – Source ¹ 100 Hz & 10 kHz (Artifacts-Variable and Fixed)	100 μ H to 10 H	0.42 mH/H	Decade Inductor and Standard Inductor
Inductance – Measure ¹ 12 Hz to 100 kHz	100 μ H to 10 H	0.23 mH/H	RLC Digibridge
Resistance – Source ¹ (Variable Artifact)	(0.01 to 0.1) Ω (0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω (1 to 10) G Ω (10 to 100) G Ω	0.31 m Ω / Ω 36 $\mu\Omega$ / Ω 9 $\mu\Omega$ / Ω 7 $\mu\Omega$ / Ω 2.2 $\mu\Omega$ / Ω 2.2 $\mu\Omega$ / Ω 0.23 m Ω / Ω 0.2 m Ω / Ω 0.8 m Ω / Ω 0.8 m Ω / Ω 3.1 m Ω / Ω 3.1 m Ω / Ω 6 m Ω / Ω	Standard Resistance, Decade Resistor

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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	40 μΩ 95 μΩ/Ω 95 μΩ/Ω 23 μΩ/Ω 23 μΩ/Ω 10 μΩ/Ω 10 μΩ/Ω 8.5 μΩ/Ω 8.5 μΩ/Ω 8.5 μΩ/Ω 8.5 μΩ/Ω 11 μΩ/Ω 11 μΩ/Ω 20 μΩ/Ω 21 μΩ/Ω	Multi-Function Calibrator
Resistance – Source ¹ Fixed Points	10 MΩ 19 MΩ 100 MΩ	40 μΩ/Ω 47 μΩ/Ω 100 μΩ /Ω	Multi-Function Calibrator
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 k Ω to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ	15 μΩ/Ω + 50 μΩ 12 μΩ/Ω + 0.5 mΩ 10 μΩ/Ω + 0.5 mΩ 10 μΩ/Ω + 5 mΩ 10 μΩ/Ω + 50 mΩ 15 μΩ/Ω + 2 Ω 50 μΩ/Ω + 0.1 kΩ 0.5 mΩ/Ω + 1 kΩ 5 mΩ/Ω + 10 kΩ	Multimeter
Resistance – Measure ¹	Up to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ (1 to 10) GΩ (10 to 100) GΩ 100 GΩ to 1 TΩ (1 to 10) TΩ (10 to 100) TΩ (100 to 1 000) TΩ	0.06 mΩ/Ω + 0.58 Ω 0.12 mΩ/Ω + 0.58 Ω 0.12 mΩ/Ω + 0.58 Ω 0.17 mΩ/Ω + 0.58 kΩ 0.56 mΩ/Ω + 0.58 kΩ 0.56 mΩ/Ω + 0.58 kΩ 0.55 mΩ/Ω + 0.58 MΩ 2.3 mΩ/Ω + 0.58 MΩ 0.65 mΩ/Ω + 0.58 MΩ 0.56 mΩ/Ω + 0.58 MΩ	TeraOhm Meter
AC Resistance – Source and Measure ¹ 100 Hz to 100 kHz	0.001 Ω (0.1 to 1) Ω 10 Ω to 100 kΩ	0.13 mΩ 1.5 mΩ/Ω 0.46 mΩ/Ω	RL Standard

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance – Source and Measure ¹ 100 Hz to 100 kHz	(0.01 to 0.2) Ω 0.2 Ω to 100 k Ω 100 k Ω to 10 M Ω	6.9 m Ω/Ω 0.27 m Ω/Ω 3 m Ω/Ω	RLC Digibridge with RL Standard
Phase – Measure ¹ 10 mV to 320 V	(0 to 360) $^{\circ}$ 10 Hz to 100 kHz 100 kHz to 10 MHz	0.029 $^{\circ}$ 0.064 $^{\circ}$	Precision Phasemeter
Capacitance – Source ¹ 50 Hz to 1 kHz (Simulation)	(0.19 to 3.3) nF (3.3 to 11) nF (11 to 110) nF (110 to 330) nF 330 nF to 1.1 μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F	3.9 mF/F + 7.8 pF 1.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 230 pF 1.9 mF/F + 0.78 nF 1.9 mF/F + 2.3 nF 1.9 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.5 mF/F + 78 nF	Multi-Product Calibrator
Capacitance – Source ¹ 50 Hz to 1 kHz (Simulation)	(110 to 330) μ F 330 μ F to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	3.5 mF/F + 230 nF 3.5 mF/F + 0.78 μ F 3.5 mF/F + 2.3 μ F 3.5 mF/F + 7.8 μ F 5.8 mF/F + 23 μ F 8.5 mF/F + 78 μ F	Multi-Product Calibrator
Capacitance – Source ¹ (Fixed Artifacts) 1 kHz to 13 MHz	(1, 10, 100, 1 000) pF	0.35 mF/F	Standard Capacitors
Capacitance – Source ¹ (Fixed Artifacts) 120 Hz to 100 kHz	(10 to 100) pF 100 pF to 1 μ F	0.53 mF/F 0.26 mF/F	Standard Capacitors
Capacitance – Measure ¹ 12 Hz to 100 kHz	Up to 1 000 μ F	0.2 mF/F + 0.000 58 pF	RLC Digibridge
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) $^{\circ}$ C (800 to 1 000) $^{\circ}$ C (1 000 to 1 550) $^{\circ}$ C (1 550 to 1 820) $^{\circ}$ C Type C (0 to 150) $^{\circ}$ C (150 to 650) $^{\circ}$ C (650 to 1 000) $^{\circ}$ C (1 000 to 1 800) $^{\circ}$ C (1 800 to 2 316) $^{\circ}$ C	0.36 $^{\circ}$ C 0.29 $^{\circ}$ C 0.26 $^{\circ}$ C 0.28 $^{\circ}$ C 0.26 $^{\circ}$ C 0.23 $^{\circ}$ C 0.27 $^{\circ}$ C 0.4 $^{\circ}$ C 0.66 $^{\circ}$ C	Multi-Product Calibrator

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type E		Multi-Product Calibrator
	(-250 to -100) °C	0.4 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 350) °C	0.16 °C	
	(350 to 650) °C	0.17 °C	
	(650 to 1 000) °C	0.2 °C	
	Type J		
	(-210 to -100) °C	0.24 °C	
	(-100 to -30) °C	0.17 °C	
	(-30 to 150) °C	0.16 °C	
	(150 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.21 °C	
	Type K		
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type S		
	(0 to 250) °C	0.38 °C	
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type T (-250 to -150) °C	0.5 °C	Multi-Product Calibrator
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U (-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	
Electrical Calibration of RTD Indicating Systems ¹	Cu 427, 10 Ω (-100 to 260) °C	0.23 °C	Multi-Product Calibrator
	PtNi 385, 120 Ω (Ni120) (-80 to 0) °C	0.062 °C	
	(0 to 100) °C	0.062 °C	
	(100 to 260) °C	0.11 °C	
	Pt 385, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω (-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 200 Ω		Multi-Product Calibrator
	(-200 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.093 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.12 $^{\circ}\text{C}$	
	Pt 385, 500 Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.085 $^{\circ}\text{C}$	
	Pt 385, 1 k Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.18 $^{\circ}\text{C}$	
AC Voltage – Source ¹	220 μV to 2.2 mV		Multi-Function Calibrator
	(10 to 20) Hz	240 $\mu\text{V/V} + 4 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 4 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 4 \mu\text{V}$	
	(20 to 50) kHz	200 $\mu\text{V/V} + 4 \mu\text{V}$	
	(50 to 100) kHz	500 $\mu\text{V/V} + 5 \mu\text{V}$	
	(100 to 300) kHz	1.1 mV/V + 10 μV	
	(300 to 500) kHz	1.4 mV/V + 20 μV	
	500 kHz to 1 MHz	2.7 mV/V + 20 μV	

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) mV		Multi-Function Calibrator
	(10 to 20) Hz	240 $\mu\text{V/V} + 4 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 4 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 4 \mu\text{V}$	
	(20 to 50) kHz	200 $\mu\text{V/V} + 4 \mu\text{V}$	
	(50 to 100) kHz	500 $\mu\text{V/V} + 5 \mu\text{V}$	
	(100 to 300) kHz	1.1 mV/V + 10 μV	
	(300 to 500) kHz	1.4 mV/V + 20 μV	
	500 kHz to 1 MHz	2.7 mV/V + 20 μV	
	(22 to 220) mV		
	(10 to 20) Hz	240 $\mu\text{V/V} + 12 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 8 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 8 \mu\text{V}$	
	(20 to 50) kHz	210 $\mu\text{V/V} + 10 \mu\text{V}$	
	(50 to 100) kHz	460 $\mu\text{V/V} + 22 \mu\text{V}$	
	(100 to 300) kHz	0.9 mV/V + 26 μV	
	(300 to 500) kHz	1.4 mV/V + 30 μV	
	500 kHz to 1 MHz	2.7 mV/V + 48 μV	
	220 mV to 2.2 V		
	(10 to 20) Hz	300 $\mu\text{V/V} + 53 \mu\text{V}$	
	(20 to 40) Hz	100 $\mu\text{V/V} + 23 \mu\text{V}$	
	40 Hz to 20 kHz	46 $\mu\text{V/V} + 9 \mu\text{V}$	
	(20 to 50) kHz	83 $\mu\text{V/V} + 12 \mu\text{V}$	
	(50 to 100) kHz	120 $\mu\text{V/V} + 33 \mu\text{V}$	
	(100 to 300) kHz	500 $\mu\text{V/V} + 95 \mu\text{V}$	
	(300 to 500) kHz	1 mV/V + 240 μV	
	500 kHz to 1 MHz	1.7 mV/V + 460 μV	
	(2.2 to 22) V		
	(10 to 20) Hz	300 $\mu\text{V/V} + 530 \mu\text{V}$	
	(20 to 40) Hz	100 $\mu\text{V/V} + 180 \mu\text{V}$	
	40 Hz to 20 kHz	46 $\mu\text{V/V} + 61 \mu\text{V}$	
	(20 to 50) kHz	83 $\mu\text{V/V} + 120 \mu\text{V}$	
	(50 to 100) kHz	110 $\mu\text{V/V} + 240 \mu\text{V}$	
	(100 to 300) kHz	390 $\mu\text{V/V} + 790 \mu\text{V}$	
	(300 to 500) kHz	1 mV/V + 2.3 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.6 mV	

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(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 (15 to 50) Hz 50 Hz to 1 kHz	300 $\mu\text{V/V} + 5.3 \text{ mV}$ 100 $\mu\text{V/V} + 1.8 \text{ mV}$ 52 $\mu\text{V/V} + 0.7 \text{ mV}$ 87 $\mu\text{V/V} + 1.1 \text{ mV}$ 150 $\mu\text{V/V} + 3 \text{ mV}$ 1 $\text{mV/V} + 16 \text{ mV}$ 4.5 $\text{mV/V} + 40 \text{ mV}$ 8 $\text{mV/V} + 80 \text{ mV}$ 350 $\mu\text{V/V} + 16 \text{ mV}$ 70 $\mu\text{V/V} + 3.5 \text{ mV}$	Multi-Function Calibrator
AC Voltage – Source ¹	(220 to 750) V (30 to 50) kHz (50 to 100) kHz (220 to 1 100) V 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.6 $\text{mV/V} + 11 \text{ mV}$ 2.3 $\text{mV/V} + 45 \text{ mV}$ 92 $\mu\text{V/V} + 4 \text{ mV}$ 170 $\mu\text{V/V} + 6 \text{ mV}$ 0.6 $\text{mV/V} + 11 \text{ mV}$	Multi-Function Calibrator with Amplifier
AC Voltage – Measure ¹	2.2 mV Range (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 7 mV Range (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	1.1 $\text{mV/V} + 0.87 \mu\text{V}$ 490 $\mu\text{V/V} + 0.87 \mu\text{V}$ 280 $\mu\text{V/V} + 0.87 \mu\text{V}$ 540 $\mu\text{V/V} + 1.3 \mu\text{V}$ 800 $\mu\text{V/V} + 1.7 \mu\text{V}$ 1.5 $\text{mV/V} + 2.7 \mu\text{V}$ 1.6 $\text{mV/V} + 5.3 \mu\text{V}$ 2.3 $\text{mV/V} + 5.3 \mu\text{V}$ 570 $\mu\text{V/V} + 0.87 \mu\text{V}$ 250 $\mu\text{V/V} + 0.87 \mu\text{V}$ 140 $\mu\text{V/V} + 0.87 \mu\text{V}$ 270 $\mu\text{V/V} + 1.3 \mu\text{V}$ 400 $\mu\text{V/V} + 1.7 \mu\text{V}$ 800 $\mu\text{V/V} + 2.7 \mu\text{V}$ 870 $\mu\text{V/V} + 5.3 \mu\text{V}$ 1.5 $\text{mV/V} + 5.3 \mu\text{V}$	AC Measurement Standard

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	22 mV Range		AC Measurement Standard
	(10 to 20) Hz	190 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	(20 to 40) Hz	130 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	40 Hz to 20 kHz	73 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	(20 to 50) kHz	140 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	210 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	540 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	590 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	1.1 mV/V + 5.3 μV	
	70 mV Range		
	(10 to 20) Hz	160 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	80 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	43 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	87 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	170 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	340 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	450 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	730 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	220 mV Range		
	(10 to 20) Hz	140 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	57 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	25 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	46 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	110 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	170 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	250 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	670 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	700 mV Range		
	(10 to 20) Hz	140 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	51 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	22 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	34 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	53 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	120 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	200 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	640 $\mu\text{V/V} + 5.3 \mu\text{V}$	

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	2.2 V Range		AC Measurement Standard
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	44 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	16 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	31 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	47 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	110 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	170 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	600 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	7.0 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	16 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	32 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	54 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	130 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	260 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	22 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	18 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	32 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	54 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	270 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	70 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	21 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	38 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	63 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	270 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.58 \mu\text{V}$	

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	220 V Range		AC Measurement Standard
	(10 to 20) Hz	130 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	21 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	46 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	65 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(100 to 300) kHz	140 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(300 to 500) kHz	330 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	700 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	66 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	27 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	87 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	330 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	1 000 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	66 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	25 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	87 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	330 $\mu\text{V/V} + 5.8 \mu\text{V}$	
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	2.2 mV Range		AC Measurement Standard
	(10 to 30) Hz	0.67 mV/V + 0.058 μV	
	(30 to 120) Hz	0.33 mV/V + 0.058 μV	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.058 μV	
	(1.2 to 120) kHz	0.33 mV/V + 0.058 μV	
	(120 to 500) kHz	0.47 mV/V + 0.67 μV	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.67 μV	
	(1.2 to 2) MHz	0.47 mV/V + 0.67 μV	
	(2 to 10) MHz	1.1 mV/V + 0.67 μV	
	(10 to 20) MHz	2.0 mV/V + 0.67 μV	
	(20 to 30) MHz	4.7 mV/V + 1.3 μV	

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	7 mV Range		AC Measurement Standard
	(10 to 30) Hz	0.67 mV/V + 0.058 μ V	
	(30 to 120) Hz	0.33 mV/V + 0.058 μ V	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.058 μ V	
	(1.2 to 120) kHz	0.33 mV/V + 0.058 μ V	
	(120 to 500) kHz	0.47 mV/V + 0.67 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.67 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.67 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.67 μ V	
	(10 to 20) MHz	1.1 mV/V + 0.67 μ V	
	(20 to 30) MHz	2.5 mV/V + 0.67 μ V	
	22 mV Range		
	(10 to 30) Hz	0.67 mV/V + 0.058 μ V	
	(30 to 120) Hz	0.33 mV/V + 0.058 μ V	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.058 μ V	
	(1.2 to 120) kHz	0.33 mV/V + 0.058 μ V	
	(120 to 500) kHz	0.47 mV/V + 0.058 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.058 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.058 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.058 μ V	
	(10 to 20) MHz	1.1 mV/V + 0.058 μ V	
	(20 to 30) MHz	2.5 mV/V + 0.058 μ V	
	70 mV Range		
	(10 to 30) Hz	0.67 mV/V + 0.58 μ V	
	(30 to 120) Hz	0.33 mV/V + 0.58 μ V	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 120) kHz	0.33 mV/V + 0.58 μ V	
	(120 to 500) kHz	0.33 mV/V + 0.58 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 0.58 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.58 μ V	
	(10 to 20) MHz	1 mV/V + 0.58 μ V	
	(20 to 30) MHz	2.3 mV/V + 0.58 μ V	

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	220 mV Range		AC Measurement Standard
	(10 to 30) Hz	0.67 mV/V + 0.58 μ V	
	(30 to 120) Hz	0.27 mV/V + 0.58 μ V	
	120 Hz to 1.2 kHz	0.27 mV/V + 0.58 μ V	
	(1.2 to 120) kHz	0.27 mV/V + 0.58 μ V	
	(120 to 500) kHz	0.27 mV/V + 0.58 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 0.58 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.58 μ V	
	(10 to 20) MHz	1 mV/V + 0.58 μ V	
	(20 to 30) MHz	2.3 mV/V + 0.58 μ V	
	700 mV Range		
	(10 to 30) Hz	0.67 mV/V + 5.8 μ V	
	(30 to 120) Hz	0.2 mV/V + 5.8 μ V	
	120 Hz to 1.2 kHz	0.2 mV/V + 5.8 μ V	
	(1.2 to 120) kHz	0.2 mV/V + 5.8 μ V	
	(120 to 500) kHz	0.2 mV/V + 5.8 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 5.8 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 5.8 μ V	
	(2 to 10) MHz	0.67 mV/V + 5.8 μ V	
	(10 to 20) MHz	1 mV/V + 5.8 μ V	
	(20 to 30) MHz	2.3 mV/V + 5.8 μ V	
	2.2 V Range		
	(10 to 30) Hz	0.67 mV/V + 5.8 μ V	
	(30 to 120) Hz	0.2 mV/V + 5.8 μ V	
	120 Hz to 1.2 kHz	0.2 mV/V + 5.8 μ V	
	(1.2 to 120) kHz	0.2 mV/V + 5.8 μ V	
	(120 to 500) kHz	0.2 mV/V + 5.8 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 5.8 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 5.8 μ V	
	(2 to 10) MHz	0.67 mV/V + 5.8 μ V	
	(10 to 20) MHz	1 mV/V + 5.8 μ V	
	(20 to 30) MHz	2.3 mV/V + 5.8 μ V	
AC High Voltage – Measure ¹	Up to 10 kV		Comparison with High Voltage Meter and High Voltage Probe
	(50 to 60) Hz	1.2 mV/V + 0.12 V	
	(10 to 30) kV		
	(50 to 60) Hz	1 mV/V + 0.21 V	
	(30 to 40) kV		
	(50 to 60) Hz	4 mV/V + 0.06 V	
	(40 to 70) kV		
	(50 to 60) Hz	4 mV/V + 0.11 V	

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	Up to 220 μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	250 μ A/A + 16 nA 160 μ A/A + 10 nA 120 μ A/A + 8 nA 280 μ A/A + 12 nA 1.1 mA/A + 65 nA	Multi-Function Calibrator
AC Current – Source ¹	(0.22 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 (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 (0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	250 μ A/A + 40 nA 160 μ A/A + 35 nA 120 μ A/A + 35 nA 200 μ A/A + 110 nA 1.1 mA/A + 650 nA 250 μ A/A + 400 nA 160 μ A/A + 350 nA 120 μ A/A + 350 nA 200 μ A/A + 550 nA 1.1 mA/A + 5 μ A 250 μ A/A + 4 μ A 160 μ A/A + 4 μ A 120 μ A/A + 3 μ A 200 μ A/A + 4 μ A 1.1 mA/A + 10 μ A 260 μ A/A + 35 μ A 450 μ A/A + 80 μ A 7 mA/A + 160 μ A	Multi-Function Calibrator
AC Current – Source ¹	Up to 20.5 A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	460 μ A/A + 170 μ A 950 μ A/A + 380 μ A 3.6 mA/A + 750 μ A	Multi-Function Calibrator w/Amplifier, Multi-Product Calibrator
AC Current – Source ¹	Up to 16.5 A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	3.3 mA/A + 3.5 mA 9.1 mA/A + 3.5 mA 3.3 mA/A + 29 mA 9.1 mA/A + 31 mA 3.4 mA/A + 104 mA 9.2 mA/A + 116 mA	Multi-Product Calibrator w/50-turn coil

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	Up to 100 μ A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4 mA/A + 0.03 μ A 1.5 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A	Multimeter
	100 μ A to 1 mA (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 (50 to 100) kHz (1 to 10) mA (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 (50 to 100) kHz (10 to 100) mA (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 (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 mA/A + 0.2 μ A 1.5 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 0.31 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 4 mA/A + 0.4 μ A 5.5 mA/A + 1.5 μ A 4 mA/A + 2 μ A 1.5 mA/A + 2 μ A 0.6 mA/A + 2 μ A 0.31 mA/A + 2 μ A 0.6 mA/A + 2 μ A 4 mA/A + 4 μ A 5.5 mA/A + 15 μ A 4 mA/A + 20 μ A 1.5 mA/A + 20 μ A 0.6 mA/A + 20 μ A 0.31 mA/A + 20 μ A 0.6 mA/A + 20 μ A 4 mA/A + 40 μ A 5.5 mA/A + 150 μ A 4 mA/A + 0.2 mA 1.6 mA/A + 0.2 mA 0.8 mA/A + 0.2 mA 1 mA/A + 0.2 mA 3 mA/A + 0.2 mA 10 mA/A + 0.4 mA	
AC Current – Measure ¹	Up to 10 A (5 Hz to 100) kHz (10 to 20) A (5 Hz to 100) kHz	0.2 mA/A + 0.58 μ A 0.2 mA/A + 0.58 μ A	Current Shunt with Multimeter, AC Measurement Standard

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} 0.1 mW to 20.5 kW (45 to 65) Hz PF = 1	(33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A 330 mV to 1 020 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.11 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.11 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.1 % of Watts output + 0.58R 0.088 % of Watts output + 0.58R 0.1 % of Watts output + 0.58R 0.13 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.088 % of Watts output + 0.58R 0.073 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.15 % of Watts output + 0.58R	Multi-Product Calibrator
AC Power – Source ^{1,2} 0.1 mW to 20.5 kW (45 to 65) Hz (PF = 0 to 0.999)	(33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A 330 mV to 1 020 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.21 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.23 % of Watts output + 0.58R	Multi-Product Calibrator
Oscilloscopes ¹ Rise/ Fall Time, (10 to 90) %	(0 to 1.25) s	1.3 ps	Oscilloscope Calibrator and Active Head

Electrical – DC/Low Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscope ¹ Square Wave Amplitude, < 10 kHz into 50 Ω or 1 M Ω Load Impedance	Up to 1 mVp-p (1 to 21) mVp-p (21 to 556) mVp-p 556 mVp-p to 210 Vp-p	10 mV/V + 10 μ V 1.5 mV/V + 20 μ V 1.5 mV/V + 1.2 μ V 1.3 mV/V + 1.2 μ V	Oscilloscope Calibrator and Active Head
Oscilloscope ¹ Horizontal Deflection (Time)	150 ps to 50 s	0.39 part per 10 ⁶ of reading	Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Vertical Deflection (Amplitude)	Up to 50 Vp-p (50 to 100) Vp-p (100 to 200) Vp-p	250 μ V/V + 25 μ V 250 μ V/V + 26 μ V 250 μ V/V + 63 μ V	Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Bandwidth	100 MHz to 50 GHz	2.1 % of reading	Oscilloscope Calibrator w/Active Head, Power Sensor

Electrical – RF/Microwave

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Distortion – Measure ¹	(-99.99 to 0) dB 20 Hz to 20 kHz (20 to 100) kHz	1.1 dB 2.1 dB	Audio Analyzer
RF Power Sensors – Calibration Factors ^{1,5}	Referenced to 1 mW (9 to 100) kHz (100 to 300) kHz 300 kHz to 50 MHz 50 MHz to 5 GHz (5 to 10) GHz (10 to 18) GHz (18 to 26.5) GHz (26 to 27) GHz (27 to 30) GHz (30 to 34) GHz (34 to 40) GHz (40 to 42) GHz (42 to 48) GHz (48 to 50) GHz	1 % 1 % 0.94 % 0.55 % 0.57 % 0.6 % 1.6 % 1.9 % 2 % 1.9 % 2 % 2.6 % 2.9 % 3.4 %	Thermocouple Power Sensors
RF Power Meter Reference ¹	1 mW 50 MHz	0.51 % of reading	Power Meter with Power Sensor

Electrical – RF/Microwave

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned RF Power, Absolute – Measure ¹ 100 kHz to 50 GHz	(20 to 30) dBm	0.15 dB	Measuring Receiver with Power Sensor
	(10 to 20) dBm	0.14 dB	
	(0 to 10) dBm	0.14 dB	
	0 dBm	0.14 dB	
	(-10 to 0) dBm	0.14 dB	
	(-20 to -10) dBm	0.14 dB	
	(-30 to -20) dBm	0.15 dB	
	(-40 to -30) dBm	0.15 dB	
	(-50 to -40) dBm	0.16 dB	
	(-60 to -50) dBm	0.16 dB	
	(-70 to -60) dBm	0.17 dB	
	(-80 to -70) dBm	0.17 dB	
	(-90 to -80) dBm	0.18 dB	
	(-100 to -90) dBm	0.18 dB	
	(-110 to -100) dBm	0.18 dB	
	(-120 to -110) dBm	0.23 dB	
	(-127 to -120) dBm	0.26 dB	
Tuned RF Power, Relative – Measure ¹ 100 kHz to 50 GHz	(20 to 30) dBm	0.068 dB	Measuring Receiver with Power Sensor
	(10 to 20) dBm	0.066 dB	
	(0 to 10) dBm	0.064 dB	
	0 dBm	0.063 dB	
	(-10 to 0) dBm	0.064 dB	
	(-20 to -10) dBm	0.066 dB	
	(-30 to -20) dBm	0.068 dB	
	(-40 to -30) dBm	0.071 dB	
	(-50 to -40) dBm	0.073 dB	
	(-60 to -50) dBm	0.076 dB	
	(-70 to -60) dBm	0.079 dB	
	(-80 to -70) dBm	0.083 dB	
	(-90 to -80) dBm	0.086 dB	
	(-100 to -90) dBm	0.09 dB	
	(-110 to -100) dBm	0.09 dB	
	(-120 to -110) dBm	0.13 dB	
	(-127 to -120) dBm	0.16 dB	

Electrical – RF/Microwave

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹ AM Depth Accuracy 100 kHz to 10 MHz (Rate: 50 Hz to 10 kHz)	Depth: (5 to 99) %	0.91 % Depth	PSA Series Spectrum Analyzer
10 MHz to 3 GHz (Rate: 50 Hz to 100 kHz)	Depth: (20 to 99) % Depth: (5 to 20) %	0.61 % Depth 3 % Depth	
(3 to 26.5) GHz (Rate: 50 Hz to 100 kHz)	Depth: (20 to 99) % Depth: (5 to 20) %	1.8 % Depth 5.5 % Depth	
Flatness 10 MHz to 3 GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) %	0.37 % Depth	
(3 to 26.5) GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) %	0.49 % Depth	
FM Rejection (50 Hz to 3 kHz BW) 250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz)	Depths: < 50% Deviations: < 5 kHz	0.17 % Depth	
10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz)	Depths: < 50% Deviations: < 50 kHz	0.44 % Depth	
Residual AM 250 kHz to 26.5 GHz	(50 Hz to 3 kHz BW)	0.012 % (rms)	

Electrical – RF/Microwave

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz (Rate: 20 Hz to 200 kHz) AM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz Residual FM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: 200 Hz to 400 kHz AM Depths: ≤ 50% (Rate: 400 Hz or 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 13 Hz 25 Hz 49 Hz 1.9 Hz 3.7 Hz 7.4 Hz	PSA Series Spectrum Analyzer
Phase Modulation – Measure ¹ PM Deviation Accuracy AM Rejection (50 Hz to 3 kHz BW) 100 kHz to 26.5 GHz Residual PM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	100 kHz to 6.6 GHz Deviations: > 0.7 rad Deviations: > 0.3 rad (6.6 to 13.2) GHz Deviations: > 0.7 rad Deviations: > 0.3 rad (13.2 to 26.5) GHz Deviations: > 0.7 rad Deviations: > 0.3 rad AM Depths: ≤ 50% (Rate: 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad 0.002 1 rad 0.004 1 rad 0.008 1 rad	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation – Measure ¹ For 2/3/4/5G Composite Rho3	450 MHz to 26.5 GHz $\rho = (0.9 \text{ to } 1.0)$	0.001 ρ	PSA Series Spectrum Analyzer, Signal Generator
Error Vector Magnitude (rms)	450 MHz to 26.5 GHz EVM = (0 to 25) %	0.3 % of reading	
Peak Code Domain Error	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Phase error	(1 to 15) ° 450 MHz to 26.5 GHz	0.71 °	
Frequency Error	3 Hz to 26.5GHz	2.1×10^{-7} Hz/Hz	
I/Q Origin Offset	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Channel Power	Power > -70 dBm 450 MHz to 26.5 GHz	0.62 dB	
Amplitude Modulation – Source ¹	(11 to 13.5) MHz Rate: 20 Hz to 100 kHz Depth: 0 % to 95 % Depth: 95 % to 99 %	0.13 % Depth 0.24 % Depth	AM/FM Test Source
Amplitude Modulation – Source ¹	100 kHz to 26.5 GHz Rate: 1 kHz to 100 kHz Depth: (5 to 80) %	3.5 % of reading + 1.2 % Depth	Signal Generator
Frequency Modulation – Source ¹	(11 to 432) MHz Rate: 20 Hz to 100 kHz Deviations: ≤ 400 kHz	0.29 % Modulation	AM/FM Test Source
Frequency Modulation – Source ¹	100 kHz to 26.5 GHz Rate: 10 Hz to 10 MHz Deviations: ≤ 20 MHz	1.7 % Modulation + 23 Hz	Signal Generator
Phase Modulation – Source ¹	100 kHz to 26.5 GHz Rate: 10 Hz to 10 MHz Deviations: ≤ 40 rad	1.7 % of reading + 0.003 5 rad	Signal Generator

Electrical – RF/Microwave

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Harmonic Measurements ¹	(0 to -100) dB 3 Hz to 3 GHz (3 to 6.6) GHz (6.6 to 50) GHz	0.2 dB 0.66 dB 0.8 dB	Spectrum Analyzer
Error Vector Magnitude ^{1,2} (EVM)	(0 to 100) % Error Mod Frequency Span: f ≤ 100 kHz 100 kHz ≤ f ≤ 1 MHz f > 1 MHz	0.43 % 0.48 % 0.82 %	Vector Signal Analyzer
Phase Error ^{1,2} (rms)	(0 to 180) ° Error Mod Frequency Span: f ≤ 100kHz 100kHz ≤ f ≤ 1MHz f > 1MHz	0.17 ° 0.34 ° 0.57 °	Vector Signal Analyzer
Frequency Error ¹	(0 to 5) % Error Mod Frequency 1 GHz 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz	0.063 % Error 0.068 % Error 0.079 % Error 0.099 % Error 0.33 % Error 0.39 % Error	Vector Signal Analyzer
Modulation Accuracy ¹ (Rho)	Mod Frequency Span: f ≤ 100kHz 0.999 9 ≤ ρ ≤ 1 0.997 5 ≤ ρ < 0.999 9 0.993 6 ≤ ρ < 0.997 5 0.99 ≤ ρ < 0.993 6 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978	0.000 086 ρ 0.000 43 ρ 0.000 68 ρ 0.000 84 ρ 0.001 2 ρ 0.001 6 ρ	Vector Signal Analyzer
Modulation Accuracy ¹ (Rho)	Mod Frequency Span: 100 kHz ≤ f ≤ 1 MHz 0.999 9 ≤ ρ ≤ 1 0.997 5 ≤ ρ < 0.999 9 0.993 6 ≤ ρ < 0.997 5 0.99 ≤ ρ < 0.993 6 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978	0.000 096 ρ 0.000 48 ρ 0.000 76 ρ 0.000 94 ρ 0.001 4 ρ 0.001 8 ρ	Vector Signal Analyzer

Electrical – RF/Microwave

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Modulation Accuracy ¹ (Rho)	Mod Frequency Span $f > 1 \text{ MHz}$ $0.9999 \leq \rho \leq 1$ $0.9975 \leq \rho < 0.9999$ $0.9936 \leq \rho < 0.9975$ $0.99 \leq \rho < 0.9936$ $0.978 \leq \rho < 0.99$ $0.96 \leq \rho < 0.978$	0.00016 ρ 0.00082 ρ 0.0013 ρ 0.0016 ρ 0.0024 ρ 0.003 ρ	Vector Signal Analyzer
S Parameters ^{1,5} Magnitude and Phase for S11, S12, S21, S22 Reflection S11/S22 Measure	30 kHz to 2.0 GHz (0.01 to 1) lin (-180 to 180) ° (2.0 to 20) GHz (0.01 to 1) lin (-180 to 180) ° (20 to 50) GHz (0.01 to 1) lin (-180 to 180) °	0.016 1 ° 0.03 1.7 ° 0.06 3.7 °	Network Analyzer, Calibration Kit
Reflection Magnitude ^{1,5} S11/22 – Measure	(0.01 to 1) lin 30 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz	0.005 0.007 0.014	Network Analyzer, Calibration Kit
Reflection Phase ^{1,5} S11/22 – Measure	(-180 to 180) ° 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz	1.5 ° 0.95 ° 0.95 °	Network Analyzer, Calibration Kit
Insertion Delay ¹	220 MHz to 6 GHz	2 μs	Network Analyzer, Calibration Kit
Group Delay Flatness ¹ F0= +/- 21MHz	220 MHz to 6 GHz	5 ns	Network Analyzer, Calibration Kit

Electrical – RF/Microwave

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
S Parameters – Magnitude and Phase for S11, S12, S21, S22 Transmission ¹ S12/ S21 – Measure	30 kHz to 2 GHz (0 to 20) dB (-180 to 180) ° (20 to 40) dB (-180 to 180) ° (40 to 60) dB (-180 to 180) ° (2 to 20) GHz (0 to 20) dB (-180 to 180) ° (20 to 40) dB (-180 to 180) ° (40 to 60) dB (-180 to 180) °	0.09 dB 0.72 ° 0.14 dB 1 ° 0.27 dB 1.7 ° 0.16 dB 1 ° 0.19 dB 1.3 ° 0.15 dB 1.9 °	Network Analyzer, Calibration Kit
S Parameters – Magnitude and Phase for S11, S12, S21, S22 Transmission ¹ S12/ S21 – Measure	(20 to 50) GHz (0 to 20) dB (-180 to 180) ° (20 to 40) dB (-180 to 180) ° (40 to 60) dB (-180 to 180) °	0.21 dB 2.9 ° 0.46 dB 3.2 ° 0.54 dB 3.6 °	Network Analyzer, Calibration Kit

Length – Dimensional Metrology

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 1 500 mm	$(0.18 + 0.013L) \mu\text{m} + 0.58R$	Gage Blocks
Height Gages ^{1,2}	Up to 1 500 mm	$(0.72 + 0.002 2L) \mu\text{m} + 0.58R$	Gage Blocks
Micrometers ^{1,2} External, Internal, Depth, Bore and Micrometer Head	Up to 1 050 mm	$(0.064 + 0.013L) \mu\text{m} + 0.58R$	Gage Blocks, Master Ring, Universal Length Measuring Machine
Optical Comparators and Vision Systems /Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 300 mm	$(1.1 + 0.008L) \mu\text{m} + 0.58R$	Standard Scales and Gage Blocks

Mass and Mass Related

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure ^{1,2} (Absolute & Differential)	(-14.5 to 500) psi (500 to 2 000) psi (2 000 to 10 000) psi	0.033 % of reading + 0.58R 0.035 % of reading + 0.58R 0.057 % of reading + 0.58R	Pressure Calibrator & Pressure Module
Scales and Balances ^{1,3}	Up to 20 mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g 50 g to 20 kg	1.5 µg 2 µg 2.6 µg 3.1 µg 13 µg 15 µg 20 µg 26 µg 33 µg 47 µg 77 µg 1.4 g/kg	Standard Weights (Class E1, E2)
Mass (Weights)	(0.05 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g 50 g to 20 kg	1.7 µg 2.2 µg 2.7 µg 3.2 µg 13 µg 15 µg 21 µg 26 µg 33 µg 47 µg 77 µg 1.4 g/kg	Standard Weights (Class E1, E2), Mass Comparator
Torque Tools ¹	(0 to 814) N·m	0.54 % of reading + 0.058 mN·m	Torque Testers
Torque Testers ^{1,2} Torque Calibrator	Up to 10 N·m (10 to 50) N·m (50 to 200) N·m (200 to 500) N·m (500 to 1 000) N·m	0.064 % of reading + 0.58R 0.04 % of reading + 0.58R 0.027 % of reading + 0.58R 0.016 % of reading + 0.58R 0.011 % of reading + 0.58R	Torque Calibration Wheel with Standard Weight
Force and Load Cell ^{1,2} (Compression and Tension)	Up to 10 N (10 to 20) N (20 to 50) N (50 to 1 000) N	0.008 5 % of reading + 0.58R 0.006 8 % of reading + 0.58R 0.006 3 % of reading + 0.58R 0.006 2 % of reading + 0.58R	Standard weights
Force and Load Cell ^{1,2} (Compression and Tension)	Up to 50 kN (50 to 500) kN	0.035 % of reading + 0.58R 0.034 % of reading + 0.58R	Load cell
Liquid Flow Meters	Up to 200 ml/min	0.14 % of reading + 0.58R	Balance and Stopwatch

Mass and Mass Related

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Liquid Flow Meters	(0.10 to 150) ml/min	0.66 % of reading	Standard Flow Meter

Photometry and Radiometry

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power ¹ (Source & Measure)	(450 to 1 800) nm (-110 to 10) dBm	0.11 dB	Optical Test System
Optical Wavelength ¹ (Source & Measure)	(700 to 1 650) nm	3.8×10^{-6} nm/nm	Optical Test System w/ Wavelength Meter

Thermodynamic

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure ¹	(-200 to 400) °C	0.035 °C	Thermometer Probe
Humidity Measuring Equipment ¹	(10 to 90) %RH	0.72 %RH	Humidity Indicator w/Probe, Humidity Calibrator
Radiation (Infrared) Thermometers ¹	(50 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 500) °C	1.2 °C 2.3 °C 3.6 °C 4.7 °C 6 °C	Blackbody Calibrator (Flat Plate) $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers ¹	100 °C (100 to 200) °C (200 to 400) °C (400 to 600) °C (600 to 800) °C (800 to 982) °C	1.3 °C 2.4 °C 4.7 °C 7.1 °C 9.5 °C 12 °C	Blackbody Calibrator (cavity) $\epsilon = 0.99$, $\lambda = (8 \text{ to } 14) \mu\text{m}$

Time and Frequency

Timisoara, Romania

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	10 Hz to 50 GHz	61 pHz/Hz	GPS Receiver and Counter
Frequency Measuring Equipment ¹	(1, 10) MHz	5 pHz/Hz	GPS Receiver, Signal Generator
Frequency Measuring Equipment ¹	0.01 Hz to 50 GHz	6.2 pHz/Hz	GPS Receiver, Signal Generator
Time Interval – Measure ¹	20 ps to 50 s	0.47 % of reading	Digital Oscilloscope
Pulse – Measure ¹ RMS Jitter – Period, Delay and Width	33 MHz to 3 GHz	1.4 % of reading + 5 ps	Digital Oscilloscope
Tachometer ^{1,2}	Up to 100 000 rpm	0.000 23 % of reading + 0.58R	Signal Generator with Lamp

[Return to Site listing \(top\)](#) [Go to Notes \(bottom\)](#)

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CALIBRATION

Acoustics and Vibration

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meter ¹	(74 to 114) dB (125 Hz to 4 kHz)	0.34 dB	Sound Calibrator, Sound Level Meter
Sound Calibrator ¹	(74 to 114) dB (125 Hz to 4 kHz)	0.22 dB	Sound Level Meter

Chemical Quantities

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity – Meter ^{1,4,8}	1 µS/cm 10 µS/cm 100 µS/cm 1 413 µS/cm 100 000 µS/cm	0.57 µS/cm 0.57 µS/cm 2.3 µS/cm 3 µS/cm 70 µS/cm	Comparison to Standard Solutions
pH – Meters ^{1,4,8}	4 pH 7 pH 10 pH	0.012 pH 0.012 pH 0.012 pH	Comparison to Standard Solutions

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source Fixed Points	1.018V 10 V	1.4 µV/V 1.3 µV/V	DC Voltage Reference Standard

Electrical – DC/Low Frequency

Berlin, Germany

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	7.5 $\mu\text{V/V} + 0.4 \mu\text{V}$ 5 $\mu\text{V/V} + 0.7 \mu\text{V}$ 3.5 $\mu\text{V/V} + 2.6 \mu\text{V}$ 3.5 $\mu\text{V/V} + 4 \mu\text{V}$ 5 $\mu\text{V/V} + 40 \mu\text{V}$ 6.5 $\mu\text{V/V} + 0.4 \text{ mV}$	Multi-Function Calibrator
DC Voltage – Measure ¹	Up to 100 mV 100 mV to 1 V (1 to 10) V (20 to 100) V 100 V to 1 kV	5 $\mu\text{V/V} + 0.31 \mu\text{V}$ 4 $\mu\text{V/V} + 0.31 \mu\text{V}$ 4 $\mu\text{V/V} + 0.51 \mu\text{V}$ 6 $\mu\text{V/V} + 30 \mu\text{V}$ 6 $\mu\text{V/V} + 0.1 \text{ mV}$	Multimeter
DC Voltage – Measure	100 mV 1 V 10 V 100 V 1 kV	1.5 $\mu\text{V/V} + 0.012 \mu\text{V}$ 1.4 $\mu\text{V/V} + 0.012 \mu\text{V}$ 1.3 $\mu\text{V/V} + 0.012 \mu\text{V}$ 1.4 $\mu\text{V/V} + 0.012 \mu\text{V}$ 1.5 $\mu\text{V/V} + 0.012 \mu\text{V}$	DC Voltage Reference Standard, Reference Divider and NULL Detector
DC High Voltage – Measure ¹	Up to 10 kV (10 to 35) kV (35 to 70) kV	0.3 mV/V + 0.031 V 0.35 mV/V + 0.07 V 0.4 mV/V + 14 V	Comparison with High Voltage Meter and High Voltage Probe
DC Current – Source ¹	Up to 2 pA (2 to 20) pA (20 to 200) pA 200 pA to 2 nA (2 to 20) nA (20 to 200) nA 200 nA to 2 μA (2 to 20) μA (20 to 200) μA 200 μA to 2 mA (2 to 20) mA	0.38 % of reading + 10 fA 0.33 % of reading + 10 fA 0.2 % of reading + 30 fA 0.063 % of reading + 0.1 pA 0.063 % of reading + 1 pA 0.035 % of reading + 10 pA 0.025 % of reading + 0.1 nA 0.025 % of reading + 1 nA 0.025 % of reading + 10 nA 0.025 % of reading + 0.1 μA 0.15 % of reading + 1 μA	Calibrator/Source
DC Current – Source ¹	Up to 220 μA 220 μA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	40 $\mu\text{A/A} + 6 \text{ nA}$ 35 $\mu\text{A/A} + 7 \text{ nA}$ 35 $\mu\text{A/A} + 40 \text{ nA}$ 45 $\mu\text{A/A} + 0.7 \mu\text{A}$ 80 $\mu\text{A/A} + 12 \mu\text{A}$	Multi-Function Calibrator
DC High Current – Source ¹	(2.2 to 11) A	360 $\mu\text{A/A} + 480 \mu\text{A}$	Multi-Function Calibrator with Amplifier
DC High Current – Source ¹	(11 to 20.5) A	780 $\mu\text{A/A} + 600 \mu\text{A}$	Multi-Product Calibrator

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC High Current – Source ¹	Up to 16.5 A (16.5 to 150) A (150 to 1 025) A	3.2 mA/A + 3.5 mA 3.2 mA/A + 29 mA 3.4 mA/A + 104 mA	Multi-Product Calibrator w/50-turns coil
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	30 μ A/A + 40 pA 20 μ A/A + 40 pA 20 μ A/A + 100 pA 20 μ A/A + 0.8 nA 20 μ A/A + 5.0 nA 20 μ A/A + 50 nA 35 μ A/A + 0.5 μ A 110 μ A/A + 10 μ A	Multimeter
DC Current – Measure ¹	Up to 3 mA (3 to 500) mA 500 mA to 20 A (20 to 300) A	8.6 μ A/A + 58 pA 11 μ A/A + 5.8 nA 16 μ A/A + 1.1 μ A 100 μ A/A + 5.8 μ A	Multimeter w/Resistance Standard, Current Shunt
DC Power – Source ^{1,2} 0.01 mW to 20.5 kW	33 mV to 1 020 V (0.33 to 330) mA 330 mA to 11 A (11 to 20.5) A	0.03 % of Watts output + 0.58R 0.059 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R	Multi-Product Calibrator w/Amplifier
Inductance – Source ¹ 100 Hz & 10 kHz (Artifacts-Variable and Fixed)	100 μ H to 10 H	0.42 mH/H	Decade Inductor and Standard Inductor
Inductance – Measure ¹ 12 Hz to 100 kHz	100 μ H to 10 H	0.23 mH/H	RLC Digibridge
Resistance – Source ¹ (Variable Artifact)	(0.01 to 0.1) Ω (0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω (1 to 10) G Ω (10 to 100) G Ω	0.31 m Ω / Ω 36 $\mu\Omega$ / Ω 9 $\mu\Omega$ / Ω 7 $\mu\Omega$ / Ω 2.2 $\mu\Omega$ / Ω 2.2 $\mu\Omega$ / Ω 0.23 m Ω / Ω 0.2 m Ω / Ω 0.8 m Ω / Ω 0.8 m Ω / Ω 3.1 m Ω / Ω 3.1 m Ω / Ω 6 m Ω / Ω	Standard Resistance, Decade Resistor

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω 190 k Ω 1 M Ω 1.9 M Ω 10 M Ω 19 M Ω 100 M Ω	40 $\mu\Omega$ 95 $\mu\Omega/\Omega$ 95 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 20 $\mu\Omega/\Omega$ 21 $\mu\Omega/\Omega$ 40 $\mu\Omega/\Omega$ 47 $\mu\Omega/\Omega$ 100 $\mu\Omega/\Omega$	Multi-Function Calibrator
Resistance – Measure ¹	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	15 $\mu\Omega/\Omega + 50 \mu\Omega$ 12 $\mu\Omega/\Omega + 0.5 \text{ m}\Omega$ 10 $\mu\Omega/\Omega + 0.5 \text{ m}\Omega$ 10 $\mu\Omega/\Omega + 5 \text{ m}\Omega$ 10 $\mu\Omega/\Omega + 50 \text{ m}\Omega$ 15 $\mu\Omega/\Omega + 2 \Omega$ 50 $\mu\Omega/\Omega + 0.1 \text{ k}\Omega$ 0.5 $\text{m}\Omega/\Omega + 1 \text{ k}\Omega$ 5 $\text{m}\Omega/\Omega + 10 \text{ k}\Omega$	Multimeter
Resistance – Measure ¹	Up to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω (1 to 10) G Ω (10 to 100) G Ω 100 G Ω to 1 T Ω (1 to 10) T Ω (10 to 100) T Ω (100 to 1 000) T Ω	0.06 $\text{m}\Omega/\Omega + 0.58 \Omega$ 0.12 $\text{m}\Omega/\Omega + 0.58 \Omega$ 0.12 $\text{m}\Omega/\Omega + 0.58 \Omega$ 0.17 $\text{m}\Omega/\Omega + 0.58 \text{ k}\Omega$ 0.56 $\text{m}\Omega/\Omega + 0.58 \text{ k}\Omega$ 0.56 $\text{m}\Omega/\Omega + 0.58 \text{ k}\Omega$ 0.55 $\text{m}\Omega/\Omega + 0.58 \text{ M}\Omega$ 2.3 $\text{m}\Omega/\Omega + 0.58 \text{ M}\Omega$ 0.65 $\text{m}\Omega/\Omega + 0.58 \text{ M}\Omega$ 0.56 $\text{m}\Omega/\Omega + 0.58 \text{ M}\Omega$	TeraOhm Meter
AC Resistance – Source and Measure ¹ 100 Hz to 100 kHz	0.001 Ω (0.1 to 1) Ω 10 Ω to 100 k Ω	0.13 $\text{m}\Omega$ 1.5 $\text{m}\Omega/\Omega$ 0.46 $\text{m}\Omega/\Omega$	RL Standard

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance – Source and Measure ¹ 100 Hz to 100 kHz	(0.01 to 0.2) Ω 0.2 Ω to 100 k Ω 100 k Ω to 10 M Ω	6.9 m Ω/Ω 0.27 m Ω/Ω 3 m Ω/Ω	RLC Digibridge with RL Standard
Phase – Measure ¹ 10 mV to 320 V	(0 to 360) $^{\circ}$ 10 Hz to 100 kHz 100 kHz to 10 MHz	0.029 $^{\circ}$ 0.064 $^{\circ}$	Precision Phasemeter
Capacitance – Source ¹ 50 Hz to 1 kHz (Simulation)	(0.19 to 3.3) nF (3.3 to 11) nF (11 to 110) nF (110 to 330) nF 330 nF to 1.1 μ F (1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F	3.9 mF/F + 7.8 pF 1.9 mF/F + 7.8 pF 1.9 mF/F + 78 pF 1.9 mF/F + 230 pF 1.9 mF/F + 0.78 nF 1.9 mF/F + 2.3 nF 1.9 mF/F + 7.8 nF 3.1 mF/F + 23 nF 3.5 mF/F + 78 nF	Multi-Product Calibrator
Capacitance – Source ¹ 50 Hz to 1 kHz (Simulation)	(110 to 330) μ F 330 μ F to 1.1 mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	3.5 mF/F + 230 nF 3.5 mF/F + 0.78 μ F 3.5 mF/F + 2.3 μ F 3.5 mF/F + 7.8 μ F 5.8 mF/F + 23 μ F 8.5 mF/F + 78 μ F	Multi-Product Calibrator
Capacitance – Source ¹ (Fixed Artifacts) 1 kHz to 13 MHz	(1, 10, 100, 1 000) pF	0.35 mF/F	Standard Capacitors
Capacitance – Source ¹ (Fixed Artifacts) 120 Hz to 100 kHz	(10 to 100) pF 100 pF to 1 μ F	0.53 mF/F 0.26 mF/F	Standard Capacitors
Capacitance – Measure ¹ 12 Hz to 100 kHz	Up to 1 000 μ F	0.2 mF/F + 0.000 58 pF	RLC Digibridge
Electrical Calibration of Thermocouple Indicators ¹	Type B (600 to 800) $^{\circ}$ C (800 to 1 000) $^{\circ}$ C (1 000 to 1 550) $^{\circ}$ C (1 550 to 1 820) $^{\circ}$ C Type C (0 to 150) $^{\circ}$ C (150 to 650) $^{\circ}$ C (650 to 1 000) $^{\circ}$ C (1 000 to 1 800) $^{\circ}$ C (1 800 to 2 316) $^{\circ}$ C	0.36 $^{\circ}$ C 0.29 $^{\circ}$ C 0.26 $^{\circ}$ C 0.28 $^{\circ}$ C 0.26 $^{\circ}$ C 0.23 $^{\circ}$ C 0.27 $^{\circ}$ C 0.4 $^{\circ}$ C 0.66 $^{\circ}$ C	Multi-Product Calibrator

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type E		Multi-Product Calibrator
	(-250 to -100) °C	0.4 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 350) °C	0.16 °C	
	(350 to 650) °C	0.17 °C	
	(650 to 1 000) °C	0.2 °C	
	Type J		
	(-210 to -100) °C	0.24 °C	
	(-100 to -30) °C	0.17 °C	
	(-30 to 150) °C	0.16 °C	
	(150 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.21 °C	
	Type K		
	(-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L		
	(-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N		
	(-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R		
	(0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type S		
	(0 to 250) °C	0.38 °C	
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of Thermocouple Indicators ¹	Type T (-250 to -150) °C	0.5 °C	Multi-Product Calibrator
	(-150 to 0) °C	0.22 °C	
	(0 to 120) °C	0.17 °C	
	(120 to 400) °C	0.16 °C	
	Type U (-200 to 0) °C	0.45 °C	
	(0 to 600) °C	0.24 °C	
Electrical Calibration of RTD Indicating Systems ¹	Cu 427, 10 Ω (-100 to 260) °C	0.23 °C	Multi-Product Calibrator
	PtNi 385, 120 Ω (Ni120) (-80 to 0) °C	0.062 °C	
	(0 to 100) °C	0.062 °C	
	(100 to 260) °C	0.11 °C	
	Pt 385, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	(630 to 800) °C	0.18 °C	
	Pt 3926, 100 Ω (-200 to -80) °C	0.039 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.054 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.078 °C	
	(400 to 630) °C	0.093 °C	
	Pt 3916, 100 Ω (-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.031 °C	
	(-80 to 0) °C	0.039 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.054 °C	
	(260 to 300) °C	0.062 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Calibration of RTD Indicating Systems ¹	Pt 385, 200 Ω		Multi-Product Calibrator
	(-200 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.093 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.11 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.12 $^{\circ}\text{C}$	
	Pt 385, 500 Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.07 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.085 $^{\circ}\text{C}$	
	Pt 385, 1 k Ω		
	(-200 to -80) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	
	(-80 to 0) $^{\circ}\text{C}$	0.023 $^{\circ}\text{C}$	
	(0 to 100) $^{\circ}\text{C}$	0.031 $^{\circ}\text{C}$	
	(100 to 260) $^{\circ}\text{C}$	0.039 $^{\circ}\text{C}$	
	(260 to 300) $^{\circ}\text{C}$	0.047 $^{\circ}\text{C}$	
	(300 to 400) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(400 to 600) $^{\circ}\text{C}$	0.054 $^{\circ}\text{C}$	
	(600 to 630) $^{\circ}\text{C}$	0.18 $^{\circ}\text{C}$	
AC Voltage – Source ¹	220 μV to 2.2 mV		Multi-Function Calibrator
	(10 to 20) Hz	240 $\mu\text{V}/\text{V} + 4 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V}/\text{V} + 4 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V}/\text{V} + 4 \mu\text{V}$	
	(20 to 50) kHz	200 $\mu\text{V}/\text{V} + 4 \mu\text{V}$	
	(50 to 100) kHz	500 $\mu\text{V}/\text{V} + 5 \mu\text{V}$	
	(100 to 300) kHz	1.1 mV/V + 10 μV	
	(300 to 500) kHz	1.4 mV/V + 20 μV	
	500 kHz to 1 MHz	2.7 mV/V + 20 μV	

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(2.2 to 22) mV		Multi-Function Calibrator
	(10 to 20) Hz	240 $\mu\text{V/V} + 4 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 4 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 4 \mu\text{V}$	
	(20 to 50) kHz	200 $\mu\text{V/V} + 4 \mu\text{V}$	
	(50 to 100) kHz	500 $\mu\text{V/V} + 5 \mu\text{V}$	
	(100 to 300) kHz	1.1 mV/V + 10 μV	
	(300 to 500) kHz	1.4 mV/V + 20 μV	
	500 kHz to 1 MHz	2.7 mV/V + 20 μV	
	(22 to 220) mV		
	(10 to 20) Hz	240 $\mu\text{V/V} + 12 \mu\text{V}$	
	(20 to 40) Hz	90 $\mu\text{V/V} + 8 \mu\text{V}$	
	40 Hz to 20 kHz	80 $\mu\text{V/V} + 8 \mu\text{V}$	
	(20 to 50) kHz	210 $\mu\text{V/V} + 10 \mu\text{V}$	
	(50 to 100) kHz	460 $\mu\text{V/V} + 22 \mu\text{V}$	
	(100 to 300) kHz	0.9 mV/V + 26 μV	
	(300 to 500) kHz	1.4 mV/V + 30 μV	
	500 kHz to 1 MHz	2.7 mV/V + 48 μV	
	220 mV to 2.2 V		
	(10 to 20) Hz	300 $\mu\text{V/V} + 53 \mu\text{V}$	
	(20 to 40) Hz	100 $\mu\text{V/V} + 23 \mu\text{V}$	
	40 Hz to 20 kHz	46 $\mu\text{V/V} + 9 \mu\text{V}$	
	(20 to 50) kHz	83 $\mu\text{V/V} + 12 \mu\text{V}$	
	(50 to 100) kHz	120 $\mu\text{V/V} + 33 \mu\text{V}$	
	(100 to 300) kHz	500 $\mu\text{V/V} + 95 \mu\text{V}$	
	(300 to 500) kHz	1 mV/V + 240 μV	
	500 kHz to 1 MHz	1.7 mV/V + 460 μV	
	(2.2 to 22) V		
	(10 to 20) Hz	300 $\mu\text{V/V} + 530 \mu\text{V}$	
	(20 to 40) Hz	100 $\mu\text{V/V} + 180 \mu\text{V}$	
	40 Hz to 20 kHz	46 $\mu\text{V/V} + 61 \mu\text{V}$	
	(20 to 50) kHz	83 $\mu\text{V/V} + 120 \mu\text{V}$	
	(50 to 100) kHz	110 $\mu\text{V/V} + 240 \mu\text{V}$	
	(100 to 300) kHz	390 $\mu\text{V/V} + 790 \mu\text{V}$	
	(300 to 500) kHz	1 mV/V + 2.3 mV	
	500 kHz to 1 MHz	1.5 mV/V + 3.6 mV	

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(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 (15 to 50) Hz 50 Hz to 1 kHz	300 $\mu\text{V/V} + 5.3 \text{ mV}$ 100 $\mu\text{V/V} + 1.8 \text{ mV}$ 52 $\mu\text{V/V} + 0.7 \text{ mV}$ 87 $\mu\text{V/V} + 1.1 \text{ mV}$ 150 $\mu\text{V/V} + 3 \text{ mV}$ 1 $\text{mV/V} + 16 \text{ mV}$ 4.5 $\text{mV/V} + 40 \text{ mV}$ 8 $\text{mV/V} + 80 \text{ mV}$ 350 $\mu\text{V/V} + 16 \text{ mV}$ 70 $\mu\text{V/V} + 3.5 \text{ mV}$	Multi-Function Calibrator
AC Voltage – Source ¹	(220 to 750) V (30 to 50) kHz (50 to 100) kHz (220 to 1 100) V 40 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.6 $\text{mV/V} + 11 \text{ mV}$ 2.3 $\text{mV/V} + 45 \text{ mV}$ 92 $\mu\text{V/V} + 4 \text{ mV}$ 170 $\mu\text{V/V} + 6 \text{ mV}$ 0.6 $\text{mV/V} + 11 \text{ mV}$	Multi-Function Calibrator with Amplifier
AC Voltage – Measure ¹	2.2 mV Range (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 7 mV Range (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	1.1 $\text{mV/V} + 0.87 \mu\text{V}$ 490 $\mu\text{V/V} + 0.87 \mu\text{V}$ 280 $\mu\text{V/V} + 0.87 \mu\text{V}$ 540 $\mu\text{V/V} + 1.3 \mu\text{V}$ 800 $\mu\text{V/V} + 1.7 \mu\text{V}$ 1.5 $\text{mV/V} + 2.7 \mu\text{V}$ 1.6 $\text{mV/V} + 5.3 \mu\text{V}$ 2.3 $\text{mV/V} + 5.3 \mu\text{V}$ 570 $\mu\text{V/V} + 0.87 \mu\text{V}$ 250 $\mu\text{V/V} + 0.87 \mu\text{V}$ 140 $\mu\text{V/V} + 0.87 \mu\text{V}$ 270 $\mu\text{V/V} + 1.3 \mu\text{V}$ 400 $\mu\text{V/V} + 1.7 \mu\text{V}$ 800 $\mu\text{V/V} + 2.7 \mu\text{V}$ 870 $\mu\text{V/V} + 5.3 \mu\text{V}$ 1.5 $\text{mV/V} + 5.3 \mu\text{V}$	AC Measurement Standard

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	22 mV Range		AC Measurement Standard
	(10 to 20) Hz	190 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	(20 to 40) Hz	130 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	40 Hz to 20 kHz	73 $\mu\text{V/V} + 0.87 \mu\text{V}$	
	(20 to 50) kHz	140 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	210 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	540 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	590 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	1.1 mV/V + 5.3 μV	
	70 mV Range		
	(10 to 20) Hz	160 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	80 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	43 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	87 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	170 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	340 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	450 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	730 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	220 mV Range		
	(10 to 20) Hz	140 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	57 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	25 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	46 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	110 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	170 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	250 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	670 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	700 mV Range		
	(10 to 20) Hz	140 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 40) Hz	51 $\mu\text{V/V} + 1 \mu\text{V}$	
	40 Hz to 20 kHz	22 $\mu\text{V/V} + 1 \mu\text{V}$	
	(20 to 50) kHz	34 $\mu\text{V/V} + 1.3 \mu\text{V}$	
	(50 to 100) kHz	53 $\mu\text{V/V} + 1.7 \mu\text{V}$	
	(100 to 300) kHz	120 $\mu\text{V/V} + 2.7 \mu\text{V}$	
	(300 to 500) kHz	200 $\mu\text{V/V} + 5.3 \mu\text{V}$	
	500 kHz to 1 MHz	640 $\mu\text{V/V} + 5.3 \mu\text{V}$	

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	2.2 V Range		AC Measurement Standard
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	44 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	16 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	31 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	47 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	110 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	170 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	600 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	7.0 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	40 Hz to 20 kHz	16 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(20 to 50) kHz	32 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(50 to 100) kHz	54 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(100 to 300) kHz	130 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	(300 to 500) kHz	260 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.058 \mu\text{V}$	
	22 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	18 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	32 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	54 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	270 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	70 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	40 Hz to 20 kHz	21 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(20 to 50) kHz	38 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(50 to 100) kHz	63 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(100 to 300) kHz	130 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	(300 to 500) kHz	270 $\mu\text{V/V} + 0.58 \mu\text{V}$	
	500 kHz to 1 MHz	800 $\mu\text{V/V} + 0.58 \mu\text{V}$	

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	220 V Range		AC Measurement Standard
	(10 to 20) Hz	130 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	45 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	21 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	46 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	65 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(100 to 300) kHz	140 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(300 to 500) kHz	330 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	700 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	66 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	27 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	87 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	330 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	1 000 V Range		
	(10 to 20) Hz	130 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	66 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	25 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	87 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	330 $\mu\text{V/V} + 5.8 \mu\text{V}$	
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	2.2 mV Range		AC Measurement Standard
	(10 to 30) Hz	0.67 mV/V + 0.058 μV	
	(30 to 120) Hz	0.33 mV/V + 0.058 μV	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.058 μV	
	(1.2 to 120) kHz	0.33 mV/V + 0.058 μV	
	(120 to 500) kHz	0.47 mV/V + 0.67 μV	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.67 μV	
	(1.2 to 2) MHz	0.47 mV/V + 0.67 μV	
	(2 to 10) MHz	1.1 mV/V + 0.67 μV	
	(10 to 20) MHz	2.0 mV/V + 0.67 μV	
	(20 to 30) MHz	4.7 mV/V + 1.3 μV	

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	7 mV Range		AC Measurement Standard
	(10 to 30) Hz	0.67 mV/V + 0.058 μ V	
	(30 to 120) Hz	0.33 mV/V + 0.058 μ V	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.058 μ V	
	(1.2 to 120) kHz	0.33 mV/V + 0.058 μ V	
	(120 to 500) kHz	0.47 mV/V + 0.67 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.67 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.67 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.67 μ V	
	(10 to 20) MHz	1.1 mV/V + 0.67 μ V	
	(20 to 30) MHz	2.5 mV/V + 0.67 μ V	
	22 mV Range		
	(10 to 30) Hz	0.67 mV/V + 0.058 μ V	
	(30 to 120) Hz	0.33 mV/V + 0.058 μ V	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.058 μ V	
	(1.2 to 120) kHz	0.33 mV/V + 0.058 μ V	
	(120 to 500) kHz	0.47 mV/V + 0.058 μ V	
	500 kHz to 1.2 MHz	0.47 mV/V + 0.058 μ V	
	(1.2 to 2) MHz	0.47 mV/V + 0.058 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.058 μ V	
	(10 to 20) MHz	1.1 mV/V + 0.058 μ V	
	(20 to 30) MHz	2.5 mV/V + 0.058 μ V	
	70 mV Range		
	(10 to 30) Hz	0.67 mV/V + 0.58 μ V	
	(30 to 120) Hz	0.33 mV/V + 0.58 μ V	
	120 Hz to 1.2 kHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 120) kHz	0.33 mV/V + 0.58 μ V	
	(120 to 500) kHz	0.33 mV/V + 0.58 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 0.58 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.58 μ V	
	(10 to 20) MHz	1 mV/V + 0.58 μ V	
	(20 to 30) MHz	2.3 mV/V + 0.58 μ V	

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹ Flatness (Relative to 1 kHz)	220 mV Range		AC Measurement Standard
	(10 to 30) Hz	0.67 mV/V + 0.58 μ V	
	(30 to 120) Hz	0.27 mV/V + 0.58 μ V	
	120 Hz to 1.2 kHz	0.27 mV/V + 0.58 μ V	
	(1.2 to 120) kHz	0.27 mV/V + 0.58 μ V	
	(120 to 500) kHz	0.27 mV/V + 0.58 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 0.58 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 0.58 μ V	
	(2 to 10) MHz	0.67 mV/V + 0.58 μ V	
	(10 to 20) MHz	1 mV/V + 0.58 μ V	
	(20 to 30) MHz	2.3 mV/V + 0.58 μ V	
	700 mV Range		
	(10 to 30) Hz	0.67 mV/V + 5.8 μ V	
	(30 to 120) Hz	0.2 mV/V + 5.8 μ V	
	120 Hz to 1.2 kHz	0.2 mV/V + 5.8 μ V	
	(1.2 to 120) kHz	0.2 mV/V + 5.8 μ V	
	(120 to 500) kHz	0.2 mV/V + 5.8 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 5.8 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 5.8 μ V	
	(2 to 10) MHz	0.67 mV/V + 5.8 μ V	
	(10 to 20) MHz	1 mV/V + 5.8 μ V	
	(20 to 30) MHz	2.3 mV/V + 5.8 μ V	
	2.2 V Range		
	(10 to 30) Hz	0.67 mV/V + 5.8 μ V	
	(30 to 120) Hz	0.2 mV/V + 5.8 μ V	
	120 Hz to 1.2 kHz	0.2 mV/V + 5.8 μ V	
	(1.2 to 120) kHz	0.2 mV/V + 5.8 μ V	
	(120 to 500) kHz	0.2 mV/V + 5.8 μ V	
	500 kHz to 1.2 MHz	0.33 mV/V + 5.8 μ V	
	(1.2 to 2) MHz	0.33 mV/V + 5.8 μ V	
	(2 to 10) MHz	0.67 mV/V + 5.8 μ V	
	(10 to 20) MHz	1 mV/V + 5.8 μ V	
	(20 to 30) MHz	2.3 mV/V + 5.8 μ V	
AC High Voltage – Measure ¹	Up to 10 kV		Comparison with High Voltage Meter and High Voltage Probe
	(50 to 60) Hz	1.2 mV/V + 0.12 V	
	(10 to 30) kV		
	(50 to 60) Hz	1 mV/V + 0.21 V	
	(30 to 40) kV		
	(50 to 60) Hz	4 mV/V + 0.06 V	
	(40 to 70) kV		
	(50 to 60) Hz	4 mV/V + 0.11 V	

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	Up to 220 μ A (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	250 μ A/A + 16 nA 160 μ A/A + 10 nA 120 μ A/A + 8 nA 280 μ A/A + 12 nA 1.1 1.1 mA/A + 65 nA	Multi-Function Calibrator
AC Current – Source ¹	(0.22 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 (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 (0.22 to 2.2) A 20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	250 μ A/A + 40 nA 160 μ A/A + 35 nA 120 μ A/A + 35 nA 200 μ A/A + 110 nA 1.1 mA/A + 650 nA 250 μ A/A + 400 nA 160 μ A/A + 350 nA 120 μ A/A + 350 nA 200 μ A/A + 550 nA 1.1 mA/A + 5 μ A 250 μ A/A + 4 μ A 160 μ A/A + 4 μ A 120 μ A/A + 3 μ A 200 μ A/A + 4 μ A 1.1 mA/A + 10 μ A 260 μ A/A + 35 μ A 450 μ A/A + 80 μ A 7 mA/A + 160 μ A	Multi-Function Calibrator
AC Current – Source ¹	Up to 20.5 A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	460 μ A/A + 170 μ A 950 μ A/A + 380 μ A 3.6 mA/A + 750 μ A	Multi-Function Calibrator w/Amplifier, Multi-Product Calibrator
AC Current – Source ¹	Up to 16.5 A (45 to 65) Hz (65 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 440) Hz (150 to 1 025) A (45 to 65) Hz (65 to 440) Hz	3.3 mA/A + 3.5 mA 9.1 mA/A + 3.5 mA 3.3 mA/A + 29 mA 9.1 mA/A + 31 mA 3.4 mA/A + 104 mA 9.2 mA/A + 116 mA	Multi-Product Calibrator w/50-turn coil

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	Up to 100 μ A (10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	4 mA/A + 0.03 μ A 1.5 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A 0.6 mA/A + 0.03 μ A	Multimeter
	100 μ A to 1 mA (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 (50 to 100) kHz (1 to 10) mA (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 (50 to 100) kHz (10 to 100) mA (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 (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 mA/A + 0.2 μ A 1.5 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 0.31 mA/A + 0.2 μ A 0.6 mA/A + 0.2 μ A 4 mA/A + 0.4 μ A 5.5 mA/A + 1.5 μ A 4 mA/A + 2 μ A 1.5 mA/A + 2 μ A 0.6 mA/A + 2 μ A 0.31 mA/A + 2 μ A 0.6 mA/A + 2 μ A 4 mA/A + 4 μ A 5.5 mA/A + 15 μ A 4 mA/A + 20 μ A 1.5 mA/A + 20 μ A 0.6 mA/A + 20 μ A 0.31 mA/A + 20 μ A 0.6 mA/A + 20 μ A 4 mA/A + 40 μ A 5.5 mA/A + 150 μ A 4 mA/A + 0.2 mA 1.6 mA/A + 0.2 mA 0.8 mA/A + 0.2 mA 1 mA/A + 0.2 mA 3 mA/A + 0.2 mA 10 mA/A + 0.4 mA	
AC Current – Measure ¹	Up to 10 A (5 Hz to 100) kHz (10 to 20) A (5 Hz to 100) kHz	0.2 mA/A + 0.58 μ A 0.2 mA/A + 0.58 μ A	Current Shunt with Multimeter, AC Measurement Standard

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} 0.1 mW to 20.5 kW (45 to 65) Hz PF = 1	(33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A 330 mV to 1 020 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.11 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.11 % of Watts output + 0.58R 0.081 % of Watts output + 0.58R 0.1 % of Watts output + 0.58R 0.088 % of Watts output + 0.58R 0.1 % of Watts output + 0.58R 0.13 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.066 % of Watts output + 0.58R 0.088 % of Watts output + 0.58R 0.073 % of Watts output + 0.58R 0.096 % of Watts output + 0.58R 0.15 % of Watts output + 0.58R	Multi-Product Calibrator
AC Power – Source ^{1,2} 0.1 mW to 20.5 kW (45 to 65) Hz (PF = 0 to 0.999)	(33 to 330) mV (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A 330 mV to 1 020 V (3.3 to 9) mA (9 to 33) mA (33 to 90) mA (90 to 330) mA (0.33 to 0.9) A (0.9 to 3) A (3 to 11) A (11 to 20.5) A	0.21 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.21 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.19 % of Watts output + 0.58R 0.2 % of Watts output + 0.58R 0.23 % of Watts output + 0.58R	Multi-Product Calibrator
Oscilloscopes ¹ Rise/ Fall Time, (10 to 90) %	(0 to 1.25) s	1.3 ps	Oscilloscope Calibrator and Active Head

Electrical – DC/Low Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscope ¹ Square Wave Amplitude, < 10 kHz into 50 Ω or 1 M Ω Load Impedance	Up to 1 mVp-p (1 to 21) mVp-p (21 to 556) mVp-p 556 mVp-p to 210 Vp-p	10 mV/V + 10 μ V 1.5 mV/V + 20 μ V 1.5 mV/V + 1.2 μ V 1.3 mV/V + 1.2 μ V	Oscilloscope Calibrator and Active Head
Oscilloscope ¹ Horizontal Deflection (Time)	150 ps to 50 s	0.39 part per 10 ⁶ of reading	Oscilloscope Calibrator and Active Head
Oscilloscopes ¹ Vertical Deflection (Amplitude)	Up to 50 Vp-p (50 to 100) Vp-p (100 to 200) Vp-p	250 μ V/V + 25 μ V 250 μ V/V + 26 μ V 250 μ V/V + 63 μ V	Oscilloscope Calibrator and Active Head
Oscilloscope ¹ Bandwidth	0.1 Hz to 50 GHz	2.1 % of reading	Oscilloscope Calibrator, w/Active Head, Power Sensor

Electrical – RF/Microwave

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Distortion – Measure ¹	(-99.99 to 0) dB 20 Hz to 20 kHz (20 to 100) kHz	1.1 dB 2.1 dB	Audio Analyzer
RF Power Sensors – Calibration Factors ^{1,5}	Referenced to 1 mW (9 to 100) kHz (100 to 300) kHz 300 kHz to 50 MHz 50 MHz to 5 GHz (5 to 10) GHz (10 to 18) GHz (18 to 26.5) GHz (26 to 27) GHz (27 to 30) GHz (30 to 34) GHz (34 to 40) GHz (40 to 42) GHz (42 to 48) GHz (48 to 50) GHz	1 % 1 % 0.94 % 0.55 % 0.57 % 0.6 % 1.6 % 1.9 % 2 % 1.9 % 2 % 2.6 % 2.9 % 3.4 %	Thermocouple Power Sensors
RF Power - Power Meter Reference ¹	1 mW, 50 MHz	0.51 % of reading	Power Meter with Power Sensor

Electrical – RF/Microwave

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned RF Power, Absolute – Measure ¹ 100 kHz to 50 GHz	(20 to 30) dBm	0.15 dB	Measuring Receiver with Power Sensor
	(10 to 20) dBm	0.14 dB	
	(0 to 10) dBm	0.14 dB	
	0 dBm	0.14 dB	
	(-10 to 0) dBm	0.14 dB	
	(-20 to -10) dBm	0.14 dB	
	(-30 to -20) dBm	0.15 dB	
	(-40 to -30) dBm	0.15 dB	
	(-50 to -40) dBm	0.16 dB	
	(-60 to -50) dBm	0.16 dB	
	(-70 to -60) dBm	0.17 dB	
	(-80 to -70) dBm	0.17 dB	
	(-90 to -80) dBm	0.18 dB	
	(-100 to -90) dBm	0.18 dB	
	(-110 to -100) dBm	0.18 dB	
	(-120 to -110) dBm	0.23 dB	
	(-127 to -120) dBm	0.26 dB	
Tuned RF Power, Relative – Measure ¹ 100 kHz to 50 GHz	(20 to 30) dBm	0.068 dB	Measuring Receiver with Power Sensor
	(10 to 20) dBm	0.066 dB	
	(0 to 10) dBm	0.064 dB	
	0 dBm	0.063 dB	
	(-10 to 0) dBm	0.064 dB	
	(-20 to -10) dBm	0.066 dB	
	(-30 to -20) dBm	0.068 dB	
	(-40 to -30) dBm	0.071 dB	
	(-50 to -40) dBm	0.073 dB	
	(-60 to -50) dBm	0.076 dB	
	(-70 to -60) dBm	0.079 dB	
	(-80 to -70) dBm	0.083 dB	
	(-90 to -80) dBm	0.086 dB	
	(-100 to -90) dBm	0.09 dB	
	(-110 to -100) dBm	0.09 dB	
	(-120 to -110) dBm	0.13 dB	
	(-127 to -120) dBm	0.16 dB	

Electrical – RF/Microwave

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹			PSA Series Spectrum Analyzer
AM Depth Accuracy 100 kHz to 10 MHz (Rate: 50 Hz to 10 kHz)	Depth: (5 to 99) %	0.91 % Depth	
10 MHz to 3 GHz (Rate: 50 Hz to 100 kHz)	Depth: (20 to 99) % Depth: (5 to 20) %	0.61 % Depth 3 % Depth	
(3 to 26.5) GHz (Rate: 50 Hz to 100 kHz)	Depth: (20 to 99) % Depth: (5 to 20) %	1.8 % Depth 5.5 % Depth	
Flatness 10 MHz to 3 GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) %	0.37 % Depth	
(3 to 26.5) GHz (Rate: 90 Hz to 10 kHz)	Depth: (5 to 99) %	0.49 % Depth	
FM Rejection (50 Hz to 3 kHz BW)			
250 kHz to 10 MHz (Rate: 400 Hz or 1 kHz)	Depths: < 50% Deviations: < 5 kHz	0.17 % Depth	
10 MHz to 26.5 GHz (Rate: 400 Hz or 1 kHz)	Depths: < 50% Deviations: < 50 kHz	0.44 % Depth	
Residual AM 250 kHz to 26.5 GHz	(50 Hz to 3 kHz BW)	0.012 % (rms)	

Electrical – RF/Microwave

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure ¹ FM Deviation Accuracy 250 kHz to 26.5 GHz (Rate: 20 Hz to 200 kHz) AM Rejection (50 Hz to 3 kHz BW) 150 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz Residual FM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Deviations: 200 Hz to 400 kHz AM Depths: $\leq 50\%$ (Rate: 400 Hz or 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 13 Hz 25 Hz 49 Hz 1.9 Hz 3.7 Hz 7.4 Hz	PSA Series Spectrum Analyzer
Phase Modulation – Measure ¹ PM Deviation Accuracy AM Rejection (50 Hz to 3 kHz BW) 100 kHz to 26.5 GHz Residual PM 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	100 kHz to 6.6 GHz Deviations: > 0.7 rad Deviations: > 0.3 rad (6.6 to 13.2) GHz Deviations: > 0.7 rad Deviations: > 0.3 rad (13.2 to 26.5) GHz Deviations: > 0.7 rad Deviations: > 0.3 rad AM Depths: $\leq 50\%$ (Rate: 1 kHz) (50 Hz to 3 kHz BW)	1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 1.3 % of reading 3.7 % of reading 0.000 58 rad 0.002 1 rad 0.004 1 rad 0.008 1 rad	PSA Series Spectrum Analyzer

Electrical – RF/Microwave

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation – Measure ¹ For 2/3/4/5G Composite Rho3	450 MHz to 26.5 GHz $\rho = (0.9 \text{ to } 1.0)$	0.001 ρ	PSA Series Spectrum Analyzer, Signal Generator
Error Vector Magnitude (rms)	450 MHz to 26.5 GHz EVM = (0 to 25) %	0.3 % of reading	
Peak Code Domain Error	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Phase error	(1 to 15) ° 450 MHz to 26.5 GHz	0.71 °	
Frequency Error	3 Hz to 26.5GHz	2.1×10^{-7} Hz/Hz	
I/Q Origin Offset	(-80 to 0) dB 450 MHz to 26.5 GHz	1.2 dB	
Channel Power	Power > -70 dBm 450 MHz to 26.5 GHz	0.62 dB	
Amplitude Modulation – Source ¹	(11 to 13.5) MHz Rate: 20 Hz to 100 kHz Depth: 0 % to 95 %	0.13 % Depth	AM/FM Test Source
Amplitude Modulation – Source ¹	Depth: 95 % to 99 % 100 kHz to 26.5 GHz Rate: 1 kHz to 100 kHz Depth: (5 to 80) %	0.24 % Depth 3.5 % of reading + 1.2 % Depth	Signal Generator
Frequency Modulation – Source ¹	(11 to 432) MHz Rate: 20 Hz to 100 kHz Deviations: ≤ 400 kHz	0.29 % Modulation	AM/FM Test Source
	100 kHz to 26.5 GHz Rate: 10 Hz to 10 MHz Deviations: ≤ 20 MHz	1.7 % Modulation + 23 Hz	Signal Generator
Phase Modulation – Source ¹	100 kHz to 26.5 GHz Rate: 10 Hz to 10 MHz Deviations: ≤ 40 rad	1.7 % of reading + 0.003 5 rad	Signal Generator

Electrical – RF/Microwave

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Harmonic Measurements ¹	(0 to -100) dB 3 Hz to 3 GHz (3 to 6.6) GHz (6.6 to 50) GHz	0.2 dB 0.66 dB 0.8 dB	Spectrum Analyzer
Error Vector Magnitude ^{1,2} (EVM)	(0 to 100) % Error Mod Frequency Span: f ≤ 100 kHz 100 kHz ≤ f ≤ 1 MHz f > 1 MHz	0.43 % 0.48 % 0.82 %	Vector Signal Analyzer
Phase Error ^{1,2} (rms)	(0 to 180) ° Error Mod Frequency Span: f ≤ 100kHz 100kHz ≤ f ≤ 1MHz f > 1MHz	0.17 ° 0.34 ° 0.57 °	Vector Signal Analyzer
Frequency Error ¹	(0 to 5) % Error Mod Frequency 1 GHz 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz	0.063 % Error 0.068 % Error 0.079 % Error 0.099 % Error 0.33 % Error 0.39 % Error	Vector Signal Analyzer
Modulation Accuracy ¹ (Rho)	Mod Frequency Span: f ≤ 100kHz 0.999 9 ≤ ρ ≤ 1 0.997 5 ≤ ρ < 0.999 9 0.993 6 ≤ ρ < 0.997 5 0.99 ≤ ρ < 0.993 6 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978	0.000 086 ρ 0.000 43 ρ 0.000 68 ρ 0.000 84 ρ 0.001 2 ρ 0.001 6 ρ	Vector Signal Analyzer
Modulation Accuracy ¹ (Rho)	Mod Frequency Span: 100 kHz ≤ f ≤ 1 MHz 0.999 9 ≤ ρ ≤ 1 0.997 5 ≤ ρ < 0.999 9 0.993 6 ≤ ρ < 0.997 5 0.99 ≤ ρ < 0.993 6 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978	0.000 096 ρ 0.000 48 ρ 0.000 76 ρ 0.000 94 ρ 0.001 4 ρ 0.001 8 ρ	Vector Signal Analyzer

Electrical – RF/Microwave

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Modulation Accuracy ¹ (Rho)	Mod Frequency Span $f > 1 \text{ MHz}$ $0.9999 \leq \rho \leq 1$ $0.9975 \leq \rho < 0.9999$ $0.9936 \leq \rho < 0.9975$ $0.99 \leq \rho < 0.9936$ $0.978 \leq \rho < 0.99$ $0.96 \leq \rho < 0.978$	0.00016 ρ 0.00082 ρ 0.0013 ρ 0.0016 ρ 0.0024 ρ 0.003 ρ	Vector Signal Analyzer
S Parameters ^{1,5} Magnitude and Phase for S11, S12, S21, S22 Reflection S11/S22 Measure	30 kHz to 2.0 GHz (0.01 to 1) lin (-180 to 180) ° (2.0 to 20) GHz (0.01 to 1) lin (-180 to 180) ° (20 to 50) GHz (0.01 to 1) lin (-180 to 180) °	0.016 1 ° 0.03 1.7 ° 0.06 3.7 °	Network Analyzer, Calibration Kit
Reflection Magnitude ^{1,5} S11/22 – Measure	(0.01 to 1) lin 30 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz	0.005 0.007 0.014	Network Analyzer, Calibration Kit
Reflection Phase ^{1,5} S11/22 – Measure	(-180 to 180) ° 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz	1.5 ° 0.95 ° 0.95 °	Network Analyzer, Calibration Kit
Insertion Delay ¹	220 MHz to 6 GHz	2 μs	Network Analyzer, Calibration Kit
Group Delay Flatness ¹ F0= +/- 21MHz	220 MHz to 6 GHz	5 ns	Network Analyzer, Calibration Kit

Electrical – RF/Microwave

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
S Parameters – Magnitude and Phase for S11, S12, S21, S22 Transmission ¹ S12/ S21 – Measure	30 kHz to 2 GHz (0 to 20) dB (-180 to 180) ° (20 to 40) dB (-180 to 180) ° (40 to 60) dB (-180 to 180) ° (2 to 20) GHz (0 to 20) dB (-180 to 180) ° (20 to 40) dB (-180 to 180) ° (40 to 60) dB (-180 to 180) °	0.09 dB 0.72 ° 0.14 dB 1 ° 0.27 dB 1.7 ° 0.16 dB 1 ° 0.19 dB 1.3 ° 0.15 dB 1.9 °	Network Analyzer, Calibration Kit
S Parameters – Magnitude and Phase for S11, S12, S21, S22 Transmission ¹ S12/ S21 – Measure	(20 to 50) GHz (0 to 20) dB (-180 to 180) ° (20 to 40) dB (-180 to 180) ° (40 to 60) dB (-180 to 180) °	0.21 dB 2.9 ° 0.46 dB 3.2 ° 0.54 dB 3.6 °	Network Analyzer, Calibration Kit

Length – Dimensional Metrology

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 1 500 mm	$(0.18 + 0.013L) \mu\text{m} + 0.58R$	Gage Blocks
Height Gages ^{1,2}	Up to 1 500 mm	$(0.72 + 0.002 2L) \mu\text{m} + 0.58R$	Gage Blocks
Micrometers ^{1,2} External, Internal, Depth, Bore and Micrometer Head	Up to 1 050 mm	$(0.064 + 0.013L) \mu\text{m} + 0.58R$	Gage Blocks, Master Ring, Universal Length Measuring Machine
Optical Comparators and Vision Systems /Measuring Microscope ^{1,2} X, Y, Z Axis	Up to 300 mm	$(1.1 + 0.008L) \mu\text{m} + 0.58R$	Standard Scales and Gage Blocks

Mass and Mass Related

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure ^{1,2} (Absolute & Differential)	(-14.5 to 500) psi (500 to 2 000) psi (2 000 to 10 000) psi	0.033 % of reading + 0.58R 0.035 % of reading + 0.58R 0.057 % of reading + 0.58R	Pressure Calibrator & Pressure Module
Scales and Balances ^{1,3}	Up to 20 mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g 50 g to 20 kg	1.5 µg 2 µg 2.6 µg 3.1 µg 13 µg 15 µg 20 µg 26 µg 33 µg 47 µg 77 µg 1.4 g/kg	Standard Weights (Class E1, E2)
Mass Determination (SI)	(0.05 to 20) mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g 50 g to 20 kg	1.7 µg 2.2 µg 2.7 µg 3.2 µg 13 µg 15 µg 21 µg 26 µg 33 µg 47 µg 77 µg 1.4 g/kg	Standard Weights (Class E1, E2), Mass Comparator
Torque Tools ¹	(0 to 814) N·m	0.54 % of reading + 0.058 mN·m	Torque Testers
Torque Testers ^{1,2} Torque Calibrator	Up to 10 N·m (10 to 50) N·m (50 to 200) N·m (200 to 500) N·m (500 to 1 000) N·m	0.064 % of reading + 0.58R 0.04 % of reading + 0.58R 0.027 % of reading + 0.58R 0.016 % of reading + 0.58R 0.011 % of reading + 0.58R	Torque Calibration Wheel with Standard Weight
Force and Load Cell ^{1,2} (Compression and Tension)	Up to 10 N (10 to 20) N (20 to 50) N (50 to 1 000) N	0.008 5 % of reading + 0.58R 0.006 8 % of reading + 0.58R 0.006 3 % of reading + 0.58R 0.006 2 % of reading + 0.58R	Standard weights
Force and Load Cell ^{1,2} (Compression and Tension)	Up to 50 kN (50 to 500) kN	0.035 % of reading + 0.58R 0.034 % of reading + 0.58R	Load cell

Mass and Mass Related

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Liquid Flow Meters	Up to 200 ml/min	0.14 % of reading + 0.58R	Gravimetric Method using Balance, Stopwatch
Liquid Flow Meters	(0.10 to 150) ml/min	0.66 % of reading	Comparison to Standard Flow Meter

Photometry and Radiometry

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power ¹ (Source & Measure)	(450 to 1 800) nm (-110 to 10) dBm	0.11 dB	Optical Test System
Optical Wavelength ¹ (Source & Measure)	(700 to 1 650) nm	3.8×10^{-6} nm/nm	Optical Test System w/ Wavelength Meter

Thermodynamic

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure ¹	(-200 to 400) °C	0.035 °C	Thermometer Probe
Humidity Measuring Equipment ¹	(10 to 90) %RH	0.72 %RH	Humidity Indicator w/Probe, Humidity Calibrator
Radiation (Infrared) Thermometers ¹	(50 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 500) °C	1.2 °C 2.3 °C 3.6 °C 4.7 °C 6 °C	Blackbody Calibrator (Flat Plate) $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers ¹	100 °C (100 to 200) °C (200 to 400) °C (400 to 600) °C (600 to 800) °C (800 to 982) °C	1.3 °C 2.4 °C 4.7 °C 7.1 °C 9.5 °C 12 °C	Blackbody Calibrator (cavity) $\epsilon = 0.99$, $\lambda = (8 \text{ to } 14) \mu\text{m}$

Time and Frequency

Berlin, Germany

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Measure ¹	10 Hz to 50 GHz	61 pHz/Hz	GPS Receiver and Counter
Frequency Measuring Equipment ¹	(1, 10) MHz	5 pHz/Hz	GPS Receiver, Signal Generator
Frequency Measuring Equipment ¹	0.01 Hz to 50 GHz	6.2 pHz/Hz	GPS Receiver, Signal Generator
Time Interval – Measure ¹	20 ps to 50 s	0.47 % of reading	Digital Oscilloscope
Pulse – Measure ¹ RMS Jitter – Period, Delay and Width	33 MHz to 3 GHz	1.4 % of reading + 5 ps	Digital Oscilloscope
Tachometer ^{1,2}	Up to 100 000 rpm	0.000 23 % of reading + 0.58R	Signal Generator with Lamp

Services performed at satellite laboratory

Micro Precision Ltd.

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CALIBRATION

Acoustics and Vibration

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Sound Pressure Level ¹ (125 to 2 000) Hz (2 000 to 4 000) Hz (125 to 4 000) Hz	114 dB 114 dB (74 to 114) dB SPL	0.2 dB 0.31 dB 0.45 dB	Sound Calibrator, Sound Meter, Electronic Counter

Chemical Quantities

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Conductivity Meters ^{1,4}	2 µS/cm 10 µS/cm 100 µS/cm 1 410 µS/cm 10 000 µS/cm	0.15 µS/cm 0.17 µS/cm 0.8 µS/cm 5.1 µS/cm 34 µS/cm	Standard Conductivity Solutions
pH Meters ^{1,4}	(4, 7, 10) pH	0.016 pH	Standard pH Solutions

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Voltage – Source ¹ (Fixed Values)	1.018V 10 V	1.9 µV/V 1.3 µV/V	DC Reference Standard
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 µV/V + 0.48 µV 3.5 µV/V + 0.81 µV 2.5 µV/V + 4.2 µV 2.5 µV/V + 5.1 µV 3.5 µV/V + 62 µV 4.5 µV/V + 500 µV	Multiproduct Calibrator

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
DC Voltage – Measure	Up to 100 mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	3.5 $\mu\text{V/V} + 0.3 \mu\text{V}$ 3.1 $\mu\text{V/V} + 0.3 \mu\text{V}$ 2.6 $\mu\text{V/V} + 0.54 \mu\text{V}$ 4.5 $\mu\text{V/V} + 30 \mu\text{V}$ 4.5 $\mu\text{V/V} + 0.1 \text{ mV}$	Digital Multimeter
DC Voltage – Measure	(1 to 100) mV 100 mV to 1 V (1 to 10) V (10 to 100) V 100 V to 1 kV	1.6 $\mu\text{V/V}$ 1.5 $\mu\text{V/V}$ 1.5 $\mu\text{V/V}$ 1.7 $\mu\text{V/V}$ 2 $\mu\text{V/V}$	DC Reference Standard, Multiproduct Calibrator
DC Voltage – Measure High Voltage ¹	(0.1 to 10) kV (10 to 30) kV	0.4 mV/V + 0.42 V 0.1 % of reading	High Voltage Meter
DC Current – Source ¹	Up to 2 pA (2 to 20) pA (20 to 200) pA 200 pA to 2 nA (2 to 20) nA (20 to 200) nA 200 nA to 2 μA (2 to 20) μA (20 to 200) μA 200 μA to 2 mA (2 to 20) mA	0.38 % of reading + 10 fA 0.33 % of reading + 10 fA 0.2 % of reading + 30 fA 0.063 % of reading + 0.1 pA 0.063 % of reading + 1 pA 0.035 % of reading + 10 pA 0.025 % of reading + 0.1 nA 0.025 % of reading + 1 nA 0.025 % of reading + 10 nA 0.025 % of reading + 0.1 μA 0.15 % of reading + 1 μA	Calibrator/Source
DC Current – Source ¹	Up to 220 μA 220 μA to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A	41 $\mu\text{A/A} + 7 \text{ nA}$ 34 $\mu\text{A/A} + 8 \text{ nA}$ 35 $\mu\text{A/A} + 45 \text{ nA}$ 46 $\mu\text{A/A} + 0.8 \mu\text{A}$ 82 $\mu\text{A/A} + 13 \mu\text{A}$	Multifunction Calibrator
DC Current – Source ¹	(0.33 to 20.5) A	0.78 mA/A + 0.58 mA	Multiproduct Calibrator
DC High Current – Source ¹	(2.2 to 11) A	0.17 mA/A	Transconductance Amplifier
	(10 to 16.5) A	3.2 mA/A + 3.5 mA	Multiproduct Calibrator with 50 turn Coil
	(16.5 to 150) A (150 to 1025) A	3.2 mA/A + 29 mA 3.4 mA/A + 0.10 A	

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
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 (1 to 10) A (10 to 20) A	30 μ A/A + 40 pA 15 μ A/A + 40 pA 15 μ A/A + 100 pA 15 μ A/A + 0.8 nA 15 μ A/A + 5 nA 15 μ A/A + 50 nA 30 μ A/A + 0.5 μ A 90 μ A/A 60 μ A/A 0.14 mA/A	Digital Multimeter, Standard Resistor Set
	(20 to 100) A	0.5 mA/A	Shunt, Digital Multimeter
Inductance – Source ¹ (Artifacts) 1 kHz to 10 kHz	(1 to 10) mH (10 to 100) mH	23 mH/H 12 mH/H	Standard Inductors
Inductance – Source ¹ (Variable Artifact) 1 kHz & 10 kHz	100 mH to 10 H	9 mH/H	Decade Inductor
Inductance – Measure ¹ 12 Hz to 100 kHz	100 μ H to 10 H	0.4 mH/H	RLC Digibridge
Resistance – Source ¹ (Fixed Artifacts)	0.01 Ω 0.1 Ω 1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω (1 to 10) M Ω 10 M Ω to 1 G Ω	8 $\mu\Omega/\Omega$ 8 $\mu\Omega/\Omega$ 15 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 0.17 m Ω/Ω 0.16 m Ω/Ω 10 $\mu\Omega/\Omega$ 0.17 m Ω/Ω 0.17 m Ω/Ω 2.5 m Ω/Ω	Standard Resistors
Resistance – Source ¹ (Fixed Points)	0 Ω 1.0 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 k Ω 1.9 k Ω 10 k Ω 19 k Ω 100 k Ω	40 $\mu\Omega$ 95 $\mu\Omega/\Omega$ 95 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 8.5 $\mu\Omega/\Omega$ 10 $\mu\Omega/\Omega$	Multifunction Calibrator

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance – Source ¹ (Fixed Points)	190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	10 μΩ/Ω 18 μΩ/Ω 18 μΩ/Ω 37 μΩ/Ω 46 μΩ/Ω 0.1 mΩ/Ω	Multifunction Calibrator
Resistance – Measure ¹	Up to 10 Ω (10 to 100) Ω 100 Ω to 1 k Ω (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	15 μΩ/Ω + 52 μΩ 10 μΩ/Ω + 0.50 mΩ 9 μΩ/Ω + 0.73 mΩ 8.1 μΩ/Ω + 5.5 mΩ 9.3 μΩ/Ω + 81 mΩ 12 μΩ/Ω + 2 Ω 50 μΩ/Ω + 0.1 kΩ 0.5 mΩ/Ω + 1.1 kΩ 5 mΩ/Ω + 11 kΩ	Digital Multimeter
Resistance – Measure ¹	(1 to 10) MΩ (10 to 100) MΩ 100 MΩ to 1 GΩ (1 to 10) GΩ (10 to 100) GΩ 100 GΩ to 1 TΩ (1 to 10) TΩ (10 to 100) TΩ 100 TΩ to 1 PΩ	3.4 mΩ/Ω 0.12 mΩ/Ω 0.17 mΩ/Ω 0.79 mΩ/Ω 0.56 mΩ/Ω 0.55 mΩ/Ω 2.3 mΩ/Ω 0.65 mΩ/Ω 0.56 mΩ/Ω	Tera-Ohmmeter
AC Resistance – Source and Measure ¹ 100 Hz to 100 kHz	0.001 Ω (0.1 to 1) Ω 10 Ω to 100 kΩ	0.13 mΩ 1.5 mΩ/Ω 0.46 mΩ/Ω	RL Standard
	(0.01 to 0.2) Ω 0.2 Ω to 100 kΩ 100 kΩ to 10 MΩ	6.9 mΩ/Ω 0.27 mΩ/Ω 3 mΩ/Ω	RLC Digibridge with RL Standard
Phase – Measure ¹	(0 to 180) ° (10 to 32) mV 1 Hz to 10 kHz (10 to 50) kHz 32 mV to 100 V 1 Hz to 50 kHz (100 to 320) V 1 Hz to 5 kHz	0.2 ° 0.35 ° 0.11 ° 0.2 °	Phase Meter

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Capacitance – Source ¹ (Simulation)			Multiproduct Calibrator
10 Hz to 10 kHz	(0.19 to 0.399 9) nF	3.9 mF/F + 7.8 pF	
10 Hz to 10 kHz	(0.4 to 1.099 9) nF	3.9 mF/F + 7.8 pF	
10 Hz to 3 kHz	(1.1 to 3.299 9) nF	3.9 mF/F + 7.8 pF	
10 Hz to 1 kHz	(3.3 to 10.999 9) nF	1.9 mF/F + 7.8 pF	
10 Hz to 1 kHz	(11 to 32.999 9) nF	1.9 mF/F + 78 pF	
10 Hz to 1 kHz	(33 to 109.999) nF	1.9 mF/F + 78 pF	
10 Hz to 1 kHz	(110 to 329.999) nF	1.9 mF/F + 233 pF	
10 Hz to 600 Hz	(0.33 to 1.099 99) μ F	1.9 mF/F + 0.78 nF	
10 Hz to 300 Hz	(1.1 to 3.299 99) μ F	1.9 mF/F + 2.3 nF	
10 Hz to 150 Hz	(3.3 to 10.999 9) μ F	1.9 mF/F + 7.8 nF	
10 Hz to 120 Hz	(11 to 32.999 9) μ F	3.1 mF/F + 23 nF	
10 Hz to 80 Hz	(33 to 109.999) μ F	3.5 mF/F + 78 nF	
0 to 50 Hz	(110 to 329.999) μ F	3.5 mF/F + 233 nF	
0 to 20 Hz	(0.33 to 1.099 99) mF	3.5 mF/F + 0.78 μ F	
0 to 6 Hz	(1.1 to 3.299 99) mF	3.5 mF/F + 2.3 μ F	
0 to 2 Hz	(3.3 to 10.999 9) mF	3.5 mF/F + 7.8 μ F	
0 to 0.6 Hz	(11 to 32.999 9) mF	3.5 mF/F + 23 μ F	
0 to 0.2 Hz	(33 to 110) mF	8.5 mF/F + 78 μ F	
Capacitance – Source ¹ (Artifacts) Fixed Values	(1, 10, 100, 1 000) pF	1.1 mF/F	Capacitance Set
	1 kHz to 5 MHz (5 to 13) MHz	1.4 mF/F	
Capacitance – Measure ¹ 12 Hz to 100 kHz	(10, 100, 1 000) nF 120 Hz to 100 kHz	1.1 mF/F	Capacitance Set
	(0.001 to 10) pF (10 to 100) pF 100 pF to 1 mF	0.4 mF/F 0.5 mF/F 0.2 mF/F	RLC Digibridge
	100 pF to 1.1 μ F	0.6 mF/F	Decade Capacitor
Electrical Simulation of Thermocouple Indicators ¹	Type B (600 to 800) °C	0.36 °C	Multiproduct Calibrator
	(800 to 1 000) °C	0.29 °C	
	(1 000 to 1 550) °C	0.26 °C	
	(1 550 to 1 820) °C	0.28 °C	
	Type C (0 to 150) °C	0.26 °C	
	(150 to 650) °C	0.23 °C	
	(650 to 1 000) °C	0.27 °C	
	(1 000 to 1 800) °C	0.4 °C	
	(1 800 to 2 316) °C	0.66 °C	

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Simulation of Thermocouple Indicators ¹	Type E (-250 to -100) °C	0.4 °C	Multiproduct Calibrator
	(-100 to -25) °C	0.17 °C	
	(-25 to 350) °C	0.16 °C	
	Type E (350 to 650) °C	0.17 °C	
	(650 to 1 000) °C	0.2 °C	
	Type J (-210 to -100) °C	0.24 °C	
	(-100 to -30) °C	0.17 °C	
	(-30 to 150) °C	0.16 °C	
	(150 to 760) °C	0.18 °C	
	(760 to 1 200) °C	0.21 °C	
	Type K (-200 to -100) °C	0.28 °C	
	(-100 to -25) °C	0.18 °C	
	(-25 to 120) °C	0.17 °C	
	(120 to 1 000) °C	0.23 °C	
	(1 000 to 1 372) °C	0.33 °C	
	Type L (-200 to -100) °C	0.31 °C	
	(-100 to 800) °C	0.23 °C	
	(800 to 900) °C	0.18 °C	
	Type N (-200 to -100) °C	0.33 °C	
	(-100 to -25) °C	0.21 °C	
	(-25 to 120) °C	0.19 °C	
	(120 to 410) °C	0.18 °C	
	(410 to 1 300) °C	0.24 °C	
	Type R (0 to 250) °C	0.46 °C	
	(250 to 400) °C	0.29 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type S (0 to 250) °C	0.38 °C	
	(250 to 1 000) °C	0.3 °C	
	(1 000 to 1 400) °C	0.31 °C	
	(1 400 to 1 767) °C	0.37 °C	

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Simulation of Thermocouple Indicators ¹	Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C Type U (-200 to 0) °C (0 to 600) °C	0.5 °C 0.22 °C 0.17 °C 0.16 °C 0.45 °C 0.24 °C	Multiproduct Calibrator
Electrical Simulation of RTD Indicating Systems ¹	Pt 385, 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 630) °C (630 to 800) °C Pt 3 926, 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 400) °C (400 to 630) °C Pt 3916, 100 Ω (-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 300) °C (300 to 600) °C (600 to 630) °C Pt 385, 200 Ω (-200 to 100) °C (100 to 260) °C (260 to 600) °C (600 to 630) °C Pt 385, 500 Ω (-200 to 100) °C (100 to 260) °C (260 to 600) °C (600 to 630) °C Pt 385, 1 kΩ (-200 to 0) °C (0 to 260) °C (260 to 600) °C (600 to 630) °C	0.039 °C 0.054 °C 0.078 °C 0.093 °C 0.18 °C 0.039 °C 0.054 °C 0.078 °C 0.093 °C 0.19 °C 0.031 °C 0.039 °C 0.068 °C 0.078 °C 0.18 °C 0.031 °C 0.039 °C 0.11 °C 0.12 °C 0.039 °C 0.047 °C 0.07 °C 0.085 °C 0.023 °C 0.039 °C 0.054 °C 0.18 °C	Multiproduct Calibrator

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Electrical Simulation of RTD Indicating Systems ¹	Pt Ni 385, 100 Ω (-80 to 100) $^{\circ}\text{C}$ (100 to 260) $^{\circ}\text{C}$ Cu 427, 10 Ω (-100 to 260) $^{\circ}\text{C}$	0.062 $^{\circ}\text{C}$ 0.11 $^{\circ}\text{C}$ 0.23 $^{\circ}\text{C}$	Multiproduct Calibrator
AC Voltage – Source ¹	220 μV 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 (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz 220 mV to 2.2 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	0.22 mV/V + 4 μV 0.085 mV/V + 4 μV 0.075 mV/V + 4 μV 0.18 mV/V + 4 μV 0.46 mV/V + 5 μV 0.9 mV/V + 10 μV 1.2 mV/V + 20 μV 2.5 mV/V + 20 μV 0.22 mV/V + 4 μV 0.085 mV/V + 4 μV 0.075 mV/V + 4 μV 0.18 mV/V + 4 μV 0.46 mV/V + 5 μV 0.9 mV/V + 10 μV 1.2 mV/V + 20 μV 2.5 mV/V + 20 μV 0.22 mV/V + 12 μV 0.085 mV/V + 8 μV 0.075 mV/V + 8 μV 0.19 mV/V + 10 μV 0.42 mV/V + 22 μV 0.8 mV/V + 26 μV 1.2 mV/V + 30 μV 2.5 mV/V + 48 μV 0.22 mV/V + 53 μV 0.085 mV/V + 23 μV 0.075 mV/V + 9 μV 0.19 mV/V + 12 μV 0.42 mV/V + 33 μV 0.8 mV/V + 95 μV 1.2 mV/V + 250 μV 2.5 mV/V + 460 μV	Multifunction Calibrator

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Source ¹	(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 (15 to 50) Hz 50 Hz to 1 kHz	0.22 mV/V + 0.53 mV 0.085 mV/V + 0.18 mV 0.075 mV/V + 0.061 mV 0.19 mV/V + 0.12 mV 0.42 mV/V + 0.24 mV 0.8 mV/V + 0.79 mV 1.2 mV/V + 2.3 mV 2.5 mV/V + 3.6 mV 0.28 mV/V + 5.3 mV 0.095 mV/V + 1.8 mV 0.048 mV/V + 0.7 mV 0.083 mV/V + 1.1 mV 0.14 mV/V + 3 mV 0.85 mV/V + 16 mV 4.2 mV/V + 40 mV 7 mV/V + 80 mV 0.31 mV/V + 16 mV 0.06 mV/V + 4 mV	Multifunction Calibrator
AC Voltage – Source ¹	(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	0.082 mV/V + 4 mV 0.13 mV/V + 6 mV 0.36 mV/V + 11 mV 0.36 mV/V + 11 mV 1.3 mV/V + 45 mV	Multifunction Calibrator w/ Transconductance Amplifier
AC Voltage – Measure ¹	2.2 mV Range (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	1.9 mV/V + 1.3 μ V 0.87 mV/V + 1.3 μ V 0.54 mV/V + 1.3 μ V 0.95 mV/V + 2 μ V 1.4 mV/V + 2.5 μ V 2.6 mV/V + 4 μ V 2.8 mV/V + 8 μ V 3.8 mV/V + 8 μ V	Digital Multimeter

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Measure ¹	7 mV Range		Digital Multimeter
	(10 to 20) Hz	1 mV/V + 1.3 μ V	
	(20 to 40) Hz	0.43 mV/V + 1.3 μ V	
	40 Hz to 20 kHz	0.26 mV/V + 1.3 μ V	
	(20 to 50) kHz	0.46 mV/V + 2 μ V	
	(50 to 100) kHz	0.69 mV/V + 2.5 μ V	
	(100 to 300) kHz	1.4 mV/V + 4 μ V	
	(300 to 500) kHz	1.5 mV/V + 8 μ V	
	500 kHz to 1 MHz	2.3 mV/V + 8 μ V	
	22 mV Range		
	(10 to 20) Hz	0.33 mV/V + 1.3 μ V	
	(20 to 40) Hz	0.21 mV/V + 1.3 μ V	
	40 Hz to 20 kHz	0.13 mV/V + 1.3 μ V	
	(20 to 50) kHz	0.24 mV/V + 2 μ V	
	(50 to 100) kHz	0.36 mV/V + 2.5 μ V	
	(100 to 300) kHz	0.94 mV/V + 4 μ V	
	(300 to 500) kHz	1 mV/V + 8 μ V	
	500 kHz to 1 MHz	1.6 mV/V + 8 μ V	
	70 mV Range		
	(10 to 20) Hz	0.28 mV/V + 1.5 μ V	
	(20 to 40) Hz	0.14 mV/V + 1.5 μ V	
	40 Hz to 20 kHz	0.08 mV/V + 1.5 μ V	
	(20 to 50) kHz	0.14 mV/V + 2 μ V	
	(50 to 100) kHz	0.31 mV/V + 2.5 μ V	
	(100 to 300) kHz	0.6 mV/V + 4 μ V	
	(300 to 500) kHz	0.79 mV/V + 8 μ V	
	500 kHz to 1 MHz	1.3 mV/V + 8 μ V	
	220 mV Range		
	(10 to 20) Hz	0.24 mV/V + 1.5 μ V	
	(20 to 40) Hz	0.1 mV/V + 1.5 μ V	
	40 Hz to 20 kHz	0.05 mV/V + 1.5 μ V	
	(20 to 50) kHz	0.08 mV/V + 2 μ V	
	(50 to 100) kHz	0.19 mV/V + 2.5 μ V	
	(100 to 300) kHz	0.28 mV/V + 4 μ V	
	(300 to 500) kHz	0.43 mV/V + 8 μ V	
	500 kHz to 1 MHz	1.1 mV/V + 8 μ V	

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Measure ¹	700 mV Range		Digital Multimeter
	(10 to 20) Hz	0.24 mV/V + 1.5 μ V	
	(20 to 40) Hz	0.09 mV/V + 1.5 μ V	
	40 Hz to 20 kHz	0.04 mV/V + 1.5 μ V	
	(20 to 50) kHz	0.06 mV/V + 2 μ V	
	(50 to 100) kHz	0.1 mV/V + 2.5 μ V	
	(100 to 300) kHz	0.19 mV/V + 4 μ V	
	(300 to 500) kHz	0.34 mV/V + 8 μ V	
	500 kHz to 1 MHz	1 mV/V + 8 μ V	
	2.2 V Range		
	(10 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	0.08 mV/V	
	40 Hz to 20 kHz	0.03 mV/V	
	(20 to 50) kHz	0.05 mV/V	
	(50 to 100) kHz	0.08 mV/V	
	(100 to 300) kHz	0.17 mV/V	
	(300 to 500) kHz	0.29 mV/V	
	500 kHz to 1 MHz	1 mV/V	
	7.0 V Range		
	(10 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	0.08 mV/V	
	40 Hz to 20 kHz	0.03 mV/V	
	(20 to 50) kHz	0.05 mV/V	
	(50 to 100) kHz	0.09 mV/V	
	(100 to 300) kHz	0.21 mV/V	
	(300 to 500) kHz	0.43 mV/V	
	500 kHz to 1 MHz	1.3 mV/V	
	22 V Range		
	(10 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	0.08 mV/V	
	40 Hz to 20 kHz	0.03 mV/V	
	(20 to 50) kHz	0.05 mV/V	
	(50 to 100) kHz	0.09 mV/V	
	(100 to 300) kHz	0.2 mV/V	
	(300 to 500) kHz	0.43 mV/V	
	500 kHz to 1 MHz	1.3 mV/V	

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage – Measure ¹	70 V Range		Digital Multimeter
	(10 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	0.08 mV/V	
	40 Hz to 20 kHz	0.04 mV/V	
	(20 to 50) kHz	0.07 mV/V	
	(50 to 100) kHz	0.1 mV/V	
	(100 to 300) kHz	0.22 mV/V	
	(300 to 500) kHz	0.45 mV/V	
	500 kHz to 1 MHz	1.3 mV/V	
	220 V Range		
	(10 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	0.08 mV/V	
	40 Hz to 20 kHz	0.04 mV/V	
	(20 to 50) kHz	0.08 mV/V	
	(50 to 100) kHz	0.11 mV/V	
	(100 to 300) kHz	0.24 mV/V	
	(300 to 500) kHz	0.5 mV/V	
	700 V Range		
	(10 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	0.11 mV/V	
	40 Hz to 20 kHz	0.05 mV/V	
	(20 to 50) kHz	0.14 mV/V	
	(50 to 100) kHz	0.45 mV/V	
	1 000 V Range		
	(10 to 20) Hz	0.23 mV/V	
	(20 to 40) Hz	0.11 mV/V	
	40 Hz to 20 kHz	0.05 mV/V	
	(20 to 50) kHz	0.14 mV/V	
	(50 to 100) kHz	0.45 mV/V	
AC Voltage Flatness – Measure ¹ 500 kHz to 30 MHz (Relative to 1 kHz)	600 μ V to 2.2 mV 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	1 mV/V + 1 μ V 1 mV/V + 1 μ V 2.1 mV/V + 1 μ V 3.6 mV/V + 1 μ V 8.1 mV/V + 1 μ V	Digital Multimeter

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage Flatness – Measure ¹ 500 kHz to 30 MHz (Relative to 1 kHz)	(2.2 to 7) mV 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz (7 to 22) mV 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz 22 mV to 7 V 500 kHz to 1.2 MHz (1.2 to 2) MHz (2 to 10) MHz (10 to 20) MHz (20 to 30) MHz	0.9 mV/V + 1 µV 0.9 mV/V + 1 µV 1.3 mV/V + 1 µV 2.1 mV/V + 1 µV 4.4 mV/V + 1 µV 0.9 mV/V 0.9 mV/V 1.2 mV/V 2.1 mV/V 4.4 mV/V 0.7 mV/V 0.7 mV/V 1.2 mV/V 1.9 mV/V 4.2 mV/V	Digital Multimeter
AC High Voltage – Measure ¹ 50/60 Hz	(1 to 10) kV (10 to 30) kV	1.4 mV/V + 55 mV 0.17 % of reading	High Voltage Meter
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 (2.2 to 22) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.23 mA/A + 16 nA 0.14 mA/A + 10 nA 0.11 mA/A + 8 nA 0.25 mA/A + 12 nA 0.9 mA/A + 65 nA 0.23 mA/A + 40 nA 0.14 mA/A + 35 nA 0.11 mA/A + 35 nA 0.18 mA/A + 0.11 µA 0.9 mA/A + 0.65 µA 0.23 mA/A + 0.4 µA 0.14 mA/A + 0.35 µA 0.11 mA/A + 0.35 µA 0.18 mA/A + 0.55 µA 0.9 mA/A + 5 µA	Multiproduct Calibrator

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current – Source ¹	(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	0.23 mA/A + 4 μ A 0.14 mA/A + 3.5 μ A 0.11 mA/A + 2.5 μ A 0.18 mA/A + 3.5 μ A 0.9 mA/A + 10 μ A 0.24 mA/A + 35 μ A 0.39 mA/A + 80 μ A 6 mA/A + 0.16 mA	Multiproduct Calibrator
AC Current – Source ¹	(2.2 to 11) A 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.71 mA/A + 0.17 mA 1.1 mA/A + 0.38 mA 3.8 mA/A + 0.75 mA	Multiproduct Calibrator w/ Transconductance Amplifier
AC Current – Source ¹	(0.33 to 20.5) A (50 to 100) Hz (100 to 400) Hz 400 Hz to 1 kHz	2.5 mA/A 4 mA/A 6 mA/A	Multiproduct Calibrator
AC Current – Source ¹	(10 to 16.5) A (45 to 65) Hz (65 to 400) Hz (16.5 to 150) A (45 to 65) Hz (65 to 400) Hz (150 to 1 025) A (45 to 65) Hz (65 to 400) Hz	3.3 mA/A + 3.5 mA 9.1 mA/A + 29 mA 3.3 mA/A + 3.5 mA 9.1 mA/A + 31 mA 3.4 mA/A + 0.1 A 9.2 mA/A + 0.12 A	Multiproduct Calibrator with 50 Turn Coil

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current – Measure ¹	(5 to 100) μ A		Multimeter in Synchronous Sub-Sampled Mode
	(10 to 20) Hz	4.6 mA/A + 0.03 μ A	
	(20 to 45) Hz	1.7 mA/A + 0.03 μ A	
	(45 to 100) Hz	0.7 mA/A + 0.03 μ A	
	100 Hz to 5 kHz	0.7 mA/A + 0.03 μ A	
	100 μ A to 1 mA		
	(10 to 20) Hz	4.5 mA/A + 0.2 μ A	
	(20 to 45) Hz	1.7 mA/A + 0.2 μ A	
	(45 to 100) Hz	0.7 mA/A + 0.2 μ A	
	100 Hz to 5 kHz	0.4 mA/A + 0.2 μ A	
	(5 to 20) kHz	0.7 mA/A + 0.2 μ A	
	(20 to 50) kHz	4.5 mA/A + 0.4 μ A	
	(50 to 100) kHz	6.2 mA/A + 1.5 μ A	
	(1 to 10) mA		
	(10 to 20) Hz	4.5 mA/A + 2 μ A	
	(20 to 45) Hz	1.7 mA/A + 2 μ A	
	(45 to 100) Hz	0.7 mA/A + 2 μ A	
	100 Hz to 5 kHz	0.3 mA/A + 2 μ A	
	(5 to 20) kHz	0.7 mA/A + 2 μ A	
	(20 to 50) kHz	4.5 mA/A + 4 μ A	
	(50 to 100) kHz	6.2 mA/A + 15 μ A	
	(10 to 100) mA		
	(10 to 20) Hz	4.5 mA/A + 20 μ A	
	(20 to 45) Hz	1.7 mA/A + 20 μ A	
	(45 to 100) Hz	0.7 mA/A + 20 μ A	
	100 Hz to 5 kHz	0.3 mA/A + 20 μ A	
	(5 to 20) kHz	0.7 mA/A + 20 μ A	
	(20 to 50) kHz	4.5 mA/A + 40 μ A	
	(50 to 100) kHz	6.2 mA/A + 150 μ A	
	100 mA to 1 A		
	(10 to 20) Hz	4.6 mA/A + 0.2 mA	
	(20 to 45) Hz	1.8 mA/A + 0.2 mA	
	(45 to 100) Hz	0.9 mA/A + 0.2 mA	
	(100 Hz to 5) kHz	1.2 mA/A + 0.2 mA	
	(5 to 20) kHz	3.4 mA/A + 0.2 mA	
	(20 to 50) kHz	11 mA/A + 0.4 mA	
AC Current – Measure ¹	(0.01 to 5) A		AC Current Shunts
	(10 Hz to 50) kHz	0.3 mA/A	
	(5 to 20) A		
	(10 Hz to 50) kHz	0.4 mA/A	

Electrical – DC/Low Frequency

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Oscilloscopes ¹ Rise/Fall Time, (10 to 90) %	150 ps	1.6 ps	Oscilloscope Calibrator w/ Head
Sq Wave 50 Ω or 1 M Ω Load impedance – <10 kHz	40 μ Vp-p to 1mVp-p	2.5 % of reading	
Horizontal Deflection (Time)	1 mVp-p to 5 Vp-p	0.13 % of reading	
Vertical Deflection (Amplitude)	180.1 ps to 55 s	0.4 parts in 10 ⁻⁶ s	
Oscilloscopes ¹ Bandwidth	$\pm$ (1 mV to 200 V)	0.05 % of reading	Digital Multimeter
Oscilloscopes ¹ Bandwidth	$\pm$ (1 mV to 200 V) 100 mHz to 300 MHz (300 to 500) MHz 550 MHz to 3 GHz	2.4 % of reading 3 % of reading 4.1 % of reading	Oscilloscope Calibrator w/ Head
Oscilloscopes ¹ Bandwidth	$\pm$ (1 mV to 200 V) (3 to 26.5) GHz (26.5 to 50) GHz	5.8 % of reading 7 % of reading	Power Meter, Power Sensor

Electrical - RF/Microwave

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Distortion – Measure ¹ (50 to 500) kHz	(0 to 99.9) dB 20 Hz to 20 kHz (20 to 100) kHz	1.1 dB 2.1 dB	Audio Analyzer
Pulse – Measure ¹ RMS Jitter – Period, Delay and Width	33 MHz to 3 GHz	1.4 % of reading + 5 ps	Oscilloscope

Electrical - RF/Microwave

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Power Sensors – Calibration Factors ^{1,5}	Referenced to 1 mW (9 to 100) kHz (100 to 300) kHz 300 kHz to 50 MHz 50 MHz to 5 GHz (5 to 10) GHz (10 to 18) GHz (18 to 26.5) GHz (26 to 27) GHz (27 to 30) GHz (30 to 34) GHz (34 to 40) GHz (40 to 42) GHz (42 to 48) GHz (48 to 50) GHz	1 % 1 % 0.94 % 0.55 % 0.57 % 0.6 % 1.6 % 1.9 % 2 % 1.9 % 2 % 2.6 % 2.9 % 3.4 %	Thermocouple Power Sensors
RF Power Meter ¹ Reference Power Output	1 mW 50 MHz	0.51 % of reading	Power Meter w/ Sensor
RF Power Meter ¹ Power Measurement	3 µW to 100 mW	0.35 % of reading	Range Calibrator
Voltage Standing Wave Ratio (VSWR) ⁵	Broadband Load: (3.5mm and 2.4mm) DC to 2 GHz 2 to 3 GHz 3 to 8 GHz 8 to 20 GHz 20 to 26.5 GHz 26.5 to 50 GHz Broadband Load: (3.5mm and 2.4mm) 4 to 20 GHz 20 to 36 GHz 36 to 40 GHz 40 to 50 GHz	0.012 0.015 0.029 0.037 0.047 0.12 0.018 0.023 0.029 0.037	Network Analyzer, Calibration Kit

Electrical - RF/Microwave

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Tuned RF Power, Relative – Measure ¹	100 kHz to 50 GHz (-127 to -120) dBm (-120 to -110) dBm (-110 to -100) dBm (-100 to -90) dBm (-90 to -80) dBm (-80 to -70) dBm (-70 to -60) dBm (-60 to -50) dBm (-50 to -40) dBm (-40 to -30) dBm (-30 to -20) dBm (-20 to -10) dBm (-10 to 0) dBm (0 to 10) dBm (10 to 20) dBm (20 to 30) dBm	0.13 dB 0.09 dB 0.09 dB 0.086 dB 0.083 dB 0.079 dB 0.076 dB 0.073 dB 0.071 dB 0.068 dB 0.066 dB 0.064 dB 0.063 dB 0.064 dB 0.066 dB 0.068 dB	Measuring Receiver, Power Sensor, Power Meter, Spectrum Analyzer
RF Power Absolute – Measure ^{1,2}	100 kHz to 50 GHz (-127 to -120) dBm (-120 to -110) dBm (-110 to -80) dBm (-80 to -60) dBm (-60 to -40) dBm (-40 to -20) dBm (-20 to 10) dBm (10 to 30) dBm (20 to 30) dBm	0.26 dB 0.23 dB 0.18 dB 0.17 dB 0.16 dB 0.15 dB 0.14 dB 0.15 dB 0.15 dB	Measuring Receiver, Power Sensor, Power Meter, Spectrum Analyzer
RF Power Absolute – Measure ^{1,2}	-60 dBm ≤ P < -40 dBm 9 kHz ≤ f < 6 GHz -40 dBm ≤ P < -30 dBm 9 kHz ≤ f < 6 GHz -30 dBm ≤ P < 0 dBm 9 kHz ≤ f < 6 GHz 0 dBm ≤ P < 20 dBm 9 kHz < f < 6 GHz	0.15 dB 0.13 dB 0.11 dB 0.1 dB	Power Sensor, Power Meter

Electrical - RF/Microwave

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
RF Power Absolute – Measure ^{1,2}	$-35 \text{ dBm} \leq P < -20 \text{ dBm}$ $50 \text{ MHz} \leq f < 14 \text{ GHz}$ $14 \text{ GHz} \leq f < 33 \text{ GHz}$ $33 \text{ GHz} \leq f < 40 \text{ GHz}$ $40 \text{ GHz} \leq f < 50 \text{ GHz}$ $-20 \text{ dBm} \leq P < 0 \text{ dBm}$ $50 \text{ MHz} \leq f < 14 \text{ GHz}$ $14 \text{ GHz} \leq f < 33 \text{ GHz}$ $33 \text{ GHz} \leq f < 40 \text{ GHz}$ $40 \text{ GHz} \leq f < 50 \text{ GHz}$ $0 \text{ dBm} \leq P < 20 \text{ dBm}$ $50 \text{ MHz} \leq f < 14 \text{ GHz}$ $14 \text{ GHz} \leq f < 33 \text{ GHz}$ $33 \text{ GHz} \leq f < 40 \text{ GHz}$ $40 \text{ GHz} \leq f < 50 \text{ GHz}$	0.36 dB 0.37 dB 0.38 dB 0.39 dB 0.09 dB 0.14 dB 0.15 dB 0.16 dB 0.09 dB 0.14 dB 0.15 dB 0.17 dB	Power Sensor, Power Meter
Frequency Modulation Rejection – Measure ¹ 150 kHz to 10 MHz 10 MHz to 26.5 GHz	Rate: 400 Hz to 1 kHz Dev.: $\leq 5 \text{ kHz peak}$ Dev.: $\leq 50 \text{ kHz peak}$	0.14 % Deviation 0.14 % Deviation	Measuring Receiver
Residuals – Amplitude Modulation ¹	150 kHz to 18 GHz (18 to 26.5) GHz	0.004 % Deviation (rms) 0.006 % Deviation (rms)	Measuring Receiver
Frequency Modulation Distortion – Measure ¹ Bandwidth: 20 Hz to 250 kHz	150 kHz to 26.5 GHz	0.15 % Distortion	Measuring Receiver
Frequency Modulation – Deviation Accuracy – Measure ¹ 250 kHz to 10 MHz 10 MHz to 6.6 GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 10 kHz Dev: $\leq 40 \text{ kHz}$ Rate: 50 Hz to 200 kHz Dev: $\leq 400 \text{ kHz}$ Rate: 50 Hz to 200 kHz Dev: $\leq 400 \text{ kHz}$ Rate: 50 Hz to 200 kHz Dev: $\leq 400 \text{ kHz}$	0.1 % Deviation 0.2 % Deviation 0.3 % Deviation 0.4% Deviation	Measuring Receiver
Amplitude Modulation Rejection – Measure ¹	Rate: 400 Hz to 1 kHz Depth.: $\leq 50 \%$ 150 kHz to 6.6 GHz (6.6 to 26.5) GHz	11 Hz 23 Hz	Measuring Receiver

Electrical - RF/Microwave

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Amplitude Modulation – Depth Accuracy – Measure ¹ 150 kHz to 10 MHz 10 MHz to 3 GHz 10 MHz to 3 GHz (3 to 26.5) GHz (3 to 26.5) GHz	Rate: 50 Hz to 10 kHz Depth: (5 to 99) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) % Rate: 50 Hz to 100 kHz Depth: (20 to 99) % Rate: 50 Hz to 100 kHz Depth: (5 to 20) %	0.2 % Depth 0.2 % Depth 0.3 % Depth 0.2 % Depth 0.5 % Depth	Measuring Receiver
Residuals FM Bandwidth ¹ 50 Hz to 3 kHz	150 kHz to 3 GHz (3 to 6.6) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz	1.3 Hz (rms) 1.8 Hz (rms) 2.6 Hz (rms) 3.7 Hz (rms)	Measuring Receiver
Amplitude Modulation Distortion – Measure ¹ 150 kHz to 18 GHz (18 to 26.5) GHz (18 to 26.5) GHz	(5 to 99) % Depth (5 to 50) % Depth (50 to 95) % Depth	0.14 % Depth 0.4 % Depth 0.6 % Depth	Measuring Receiver
Amplitude Modulation Flatness ¹ 10 MHz to 26.5 GHz	Rate: (9 Hz to 10 kHz) (5 to 99) % Depth	0.15 % Depth	Measuring Receiver
Phase Modulation – Measure ¹ 100 kHz to 6.6 GHz 100 kHz to 6.6 GHz (6.6 to 13.2) GHz (6.6 to 13.2) GHz (13.2 to 26.5) GHz (13.2 to 26.5) GHz	Rate: 20 Hz to 200 kHz Deviation: > 0.7 Rad Deviation: > 0.3 Rad Rate: 20 Hz to 200 kHz Deviation: > 2 Rad Deviation: > 0.6 Rad Rate: 20 Hz to 200 kHz Deviation: > 4 Rad Deviation: > 1.2 Rad	0.1 % of reading 0.2 % of reading 0.1 % of reading 0.2 % of reading 0.1 % of reading 0.2 % of reading	Measuring Receiver
AM Rejection – Measure ¹ 100 kHz to 26.5 GHz	Rate: 50 Hz to 3 kHz Deviation: > 50 % AM at 1 kHz Rate	0.003 Rad	Measuring Receiver
Phase Residuals – Measure ¹ 100 kHz to 26.5 GHz	(0.1 to 25 000) Rad (rms) Rate: 50 Hz to 3 kHz	0.01 Rad	Measuring Receiver

Electrical - RF/Microwave

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Phase Distortion ¹ 150 kHz to 26.5 GHz	(0.1 to 25 000) Rad (rms) Bandwidth: 20 Hz to 250 kHz	0.008 rad	Measuring Receiver
Amplitude Modulation – Source ¹ 10 kHz to 13.5 MHz	Rate: 50 Hz to 100 kHz Depths: 5 % to 95 %	0.6 % Depth	AM/FM Test Set
10 kHz to 13.5 MHz	Rate: 50 Hz to 100 kHz Depths: 95 % to 99 %	0.6 % Depth	
Frequency Modulation – Source ¹ 10 kHz to 432 MHz	Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	0.6 % Deviation	AM/FM Test Set
Harmonic Measurements ¹	(-90 to 0.01) dB 3 Hz to 26.5 GHz (26.5 to 50) GHz	0.8 dB 1.4 dB	Spectrum Analyzer
Error Vector Magnitude ^{1,2} (EVM)	(0 to 100) % Error Mod Frequency Span: f ≤ 100 kHz 100 kHz ≤ f ≤ 1 MHz f > 1 MHz	0.43 % Error 0.48 % Error 0.82 % Error	Vector Signal Analyzer
Phase Error ^{1,2}	(0 to 180) ° Error Mod Frequency Span: f ≤ 100 kHz 100 kHz ≤ f ≤ 1 MHz f > 1 MHz	0.17 ° Error (rms) 0.34 ° Error (rms) 0.57 ° Error (rms)	Vector Signal Analyzer
Frequency Error ¹	(0 to 5) ° Error Mod Frequency 1 GHz 2 GHz 3 GHz 4 GHz 5 GHz 6 GHz	0.063 % Error 0.068 % Error 0.079 % Error 0.099 % Error 0.33 % Error 0.39 % Error	Vector Signal Analyzer
Modulation Accuracy ¹ (Rho)	Mod Frequency Span: f ≤ 100 kHz 0.999 9 ≤ ρ ≤ 1 0.997 5 ≤ ρ < 0.999 9 0.993 6 ≤ ρ < 0.997 5 0.99 ≤ ρ < 0.993 6 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978	0.000 086 ρ 0.000 43 ρ 0.000 68 ρ 0.000 84 ρ 0.001 2 ρ 0.001 6 ρ	Vector Signal Analyzer

Electrical - RF/Microwave

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Modulation Accuracy ¹ (Rho)	Mod Frequency Span: 100 kHz ≤ f ≤ 1 MHz 0.999 9 ≤ ρ ≤ 1 0.997 5 ≤ ρ < 0.999 9 0.993 6 ≤ ρ < 0.997 5 0.99 ≤ ρ < 0.993 6 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978	0.000 096 ρ 0.000 48 ρ 0.000 76 ρ 0.000 94 ρ 0.001 4 ρ 0.001 8 ρ	Vector Signal Analyzer
Modulation Accuracy ¹ (Rho)	Mod Frequency Span f ≥ 1 MHz 0.999 9 ≤ ρ ≤ 1 0.997 5 ≤ ρ < 0.999 9 0.993 6 ≤ ρ < 0.997 5 0.99 ≤ ρ < 0.993 6 0.978 ≤ ρ < 0.99 0.96 ≤ ρ < 0.978	0.000 16 ρ 0.000 82 ρ 0.001 3 ρ 0.001 6 ρ 0.002 4 ρ 0.003 ρ	Vector Signal Analyzer
S Parameters ^{1,5} – Magnitude and Phase for S ₁₁ , S ₁₂ , S ₂₁ , S ₂₂ Reflection S ₁₁ /S ₂₂ Measure lin mag	(0.01 to 1) lin 30 kHz to 2 GHz (-180 to 180) ° (2 to 20) GHz (-180 to 180) ° (20 to 50) GHz (-180 to 180) °	0.016 1 ° 0.03 1.7 ° 0.06 3.7 °	Network Analyzer, Calibration Kit
Reflection Magnitude ^{1,5} S ₁₁ /S ₂₂ – Measure	(0.01 to 1) lin mag 30 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz	0.005 0.007 0.014	Network Analyzer, Calibration Kit
Reflection Phase ¹ S ₁₁ /S ₂₂ – Measure	(-180 to 180) ° 300 kHz to 1.3 GHz (1.3 to 3) GHz (3 to 6) GHz	1.5 ° 0.95 ° 0.95 °	Network Analyzer, Calibration Kit
Insertion Delay ¹	220 MHz to 6 GHz	2 μs	Network Analyzer, Calibration Kit
Group Delay Flatness ¹ F0= +/- 21MHz	220 MHz to 6 GHz	5 ns	Network Analyzer, Calibration Kit

Electrical - RF/Microwave

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
S Parameters – Magnitude and Phase ¹ S ₁₁ , S ₁₂ , S ₂₁ , S ₂₂ Transmission ¹ S ₁₂ / S ₂₁ – Measure	30 kHz to 2 GHz (0 to 20) dB (-180 to 180) ° (20 to 40) dB (-180 to 180) ° (40 to 60) dB (-180 to 180) ° (2 to 20) GHz (0 to 20) dB (-180 to 180) ° (20 to 40) dB (-180 to 180) ° (40 to 60) dB (-180 to 180) °	(0.05 to 0.09) dB (0.32 to 0.72) ° (0.1 to 0.14) dB (0.72 to 1) ° (0.14 to 0.27) dB (1 to 1.7) ° (0.11 to 0.16) dB (0.70 to 1) ° (0.16 to 0.19) dB (1 to 1.3) ° (0.09 to 0.15) dB (1.28 to 1.9) °	Network Analyzer, Calibration Kit
S Parameters – Magnitude and Phase ¹ S ₁₁ , S ₁₂ , S ₂₁ , S ₂₂ Transmission ¹ S ₁₂ / S ₂₁ – Measure	(20 to 50) GHz (0 to 20) dB (-180 to 180) ° (20 to 40) dB (-180 to 180) ° (40 to 60) dB (-180 to 180) °	(0.17 to 0.21) dB (2.3 to 2.9) ° (0.41 to 0.46) dB (2.9 to 3.2) ° (0.46 to 0.54) dB (3.2 to 3.6) °	Network Analyzer, Calibration Kit

Length – Dimensional Metrology

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Calipers ^{1,2}	Up to 6 in (6 to 12) in (12 to 24) in (24 to 48) in Up to 1 000 mm	(280 + 4.3 <i>L</i>) μin (280 + 2.1 <i>L</i>) μin (290 + 1.6 <i>L</i>) μin (290 + 1.0 <i>L</i>) μin (2.4 + 0.007 <i>L</i>) μm	Gage Blocks
Height Gages ^{1,2}	Up to 48 in Up to 1 000 mm	(49 + 1.1 <i>L</i>) μin (1.2 + 0.000 9 <i>L</i>) μm	Gage Blocks, Surface Plate
Micrometers ^{1,2} Resolution 100 μin 50 μin 10 μin	Up to 48 in Up to 48 in Up to 48 in	(38 + 1.4 <i>L</i>) μin (28 + 1.2 <i>L</i>) μin (8.4 + 1.6 <i>L</i>) μin	Gage Blocks

Length – Dimensional Metrology

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Indicators ¹ Resolution: 20 µin 50 µin 100 µin 500 µin 1 000 µin	Up to 4 in Up to 4 in Up to 4 in Up to 4 in Up to 4 in	14 µin 30 µin 60 µin 280 µin 567 µin	Gage Blocks
Pin Gages, Diameter ²	Up to 2 in	$(13 + 0.4L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Gage Blocks ²	Up to 6 in	$(1.6 + 2.1L) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Cylindrical Rings ²	Up to 1 in (1 to 14) in Up to 300 mm	$(9 + 1L) \mu\text{in}$ $(13 + 1L) \mu\text{in}$ $(0.4 + 0.003L) \mu\text{m}$	Universal Length Measuring Machine, Gage Blocks
Thread Wires ²	Up to 0.15 in (4 to 120) TPI	$(4 + 5D) \mu\text{in}$	Universal Length Measuring Machine, Gage Blocks
Profile Projector/ Measuring Microscope – Length ^{1,2}	Up to 20 in Up to 300 mm	$(74 + 1.3L) \mu\text{in}$ $(1.1 + 0.008L) \mu\text{m}$	Gage Blocks, Glass Scales

Mass and Mass Related

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Pressure/Vacuum ¹	(-14.5 to 500) psig (500 to 2000) psig (2000 to 10 000) psig	0.042 % of reading + 0.58R 0.048 % of reading + 0.58R 0.1 % of reading + 0.58R	Process Calibrator with Pressure Modules
Pressure ¹	(0.01 to 1 000) psig	0.065 % of reading + 0.58R	Pressure Calibrator

Mass and Mass Related

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Scales and Balances ^{1,3}	Up to 20 mg (20 to 50) mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 1 kg (1 to 2) kg (2 to 5) kg (5 to 10) kg (10 to 20) kg (20 to 50) kg (50 to 100) kg	3.6 µg 4.8 µg 6 µg 7.2 µg 10 µg 12 µg 15 µg 20 µg 27 µg 38 µg 68 µg 0.13 mg 0.26 mg 0.65 mg 1.3 mg 2.6 mg 6.5 mg 0.19 g 0.36 g 4.1 g 8.7 g	OIML Class E1, E2, F1, F2 Weights and internal calibration procedure utilized in the calibration of the weighing system.
Mass Determination	Up to 50 mg (50 to 100) mg (100 to 200) mg (200 to 500) mg 500 mg to 1 g (1 to 2) g (2 to 5) g (5 to 10) g (10 to 20) g (20 to 50) g (50 to 100) g (100 to 200) g (200 to 500) g 500 g to 5 kg	1.8 µg 2.2 µg 2.7 µg 3.2 µg 4.2 µg 5.3 µg 6.6 µg 10 µg 16 µg 27 µg 60 µg 0.12 mg 0.18 mg 0.42 mg	OIML Class E1 Weights, Balance
Mass Determination	(5 to 10) kg (10 to 50) kg	0.55 mg 1.1 mg	ASTM E617 Class 4 Weights, Balance
Torque Tools ¹	(0.015 to 815) Nm	0.54 % of reading	Torque Calibration System
Torque Testers ¹	(15 to 200) ozf·in (4 to 150) lbf·in (2.5 to 250) lbf·ft	0.13 % of reading 0.13 % of reading 0.13 % of reading	Torque Wheel, Torque Standard, Calibration Arms, Weights

Mass and Mass Related

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Force – Compression and Tension ¹	Up to 50 kN (50 to 500) kN	0.035 % of reading + 0.58R 0.034 % of reading + 0.58R	Load Cell

Photometry and Radiometry

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Optical Power – Measure ¹ (800 to 1 000) nm (1 000 to 1 310) nm (1 310 to 1 700) nm	(-90 to 10) dB (-110 to 10) dB (-110 to 10) dB	2.9 % of reading 2.9 % of reading 2.9 % of reading	Agilent Optical Test System
Optical Wavelength – Measure ¹	(700 to 1 650) nm	3.8 μ m/m	Wavelength Meter

Thermodynamic

Guildford, England

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Temperature ¹	(-200 to 500) °C	0.02 °C	Comparison to Thermometer Probe
Relative Humidity ¹	(10 to 90) %RH	0.65 % of reading + 0.41 %RH	Humidity Indicator and Probe
Radiation (Infrared) Thermometers ¹	(50 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 500) °C	1.2 °C 2.3 °C 3.6 °C 4.7 °C 6 °C	Black Body Calibrator (Flat Plate) $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Radiation (Infrared) Thermometers ¹	100 °C (100 to 200) °C (200 to 400) °C (400 to 600) °C (600 to 800) °C (800 to 982) °C	1.3 °C 2.4 °C 4.7 °C 7.1 °C 9.5 °C 12 °C	Black Body Calibrator (Cavity) $\epsilon = 0.99$, $\lambda = (8 \text{ to } 14) \mu\text{m}$

Time and Frequency

Guildford, England

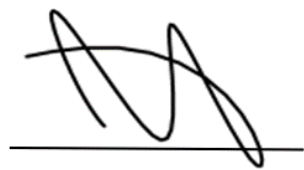
Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Frequency – Measure ¹	0.1 Hz to 225 MHz 100 MHz to 3 GHz 500 MHz to 40 GHz	60 pHz/Hz 60 pHz/Hz 60 pHz/Hz	GPS Receiver, Counter
Frequency – Measure ¹	(40 to 50) GHz	0.1 μ Hz/Hz	GPS Receiver, Spectrum Analyzer
Frequency – Measure ¹ (Reference Point)	10 MHz	50 pHz/Hz	GPS Receiver
Frequency – Source ¹	10 mHz to 10 MHz 10 MHz to 50 GHz	50 pHz/Hz 50 pHz/Hz	GPS Receiver, Signal Generator
Time Interval – Measure ¹	25 ps to 1 s	1.2 % of reading + 5 ps	Oscilloscope
Photo Tachometer ^{1,2}	Up to 100 000 rpm	0.000 17 % of reading + 0.001 6 rpm	Signal Generator w/ Lamp

[Return to Site listing \(top\)](#)

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:

- 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.
- D = diagonal length, f = frequency, L = length or diameter in inches, l = length or diameter in millimeters, P = power, R = resolution (or readability) of the unit under test, t = time in seconds, V = variation, W = applied weight; rpm = revolutions per minute.
- The CMC for scales and balances is highly dependent upon the resolution of the unit under test. The uncertainties presented here do not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
- The values of the solutions reflected in this scope of accreditation are the approximate reference value at a reference temperature of 25 °C as taken from the certificate of accreditation and will vary with change in temperature.
- Unitless linear measure.
- 1 mil = 0.001 inch., SpGr refers to specific gravity or relative density.
- Adjustable threaded rings are adjusted for a tactile fit using threaded setting plug verified using a Universal Length Measuring Machine followed by a measurement of the minor diameter.
- Nominal values are approximate. The actual values will be utilized at the time of calibration.
- This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1969.



Jason Stine, Vice President