



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Micro Precision Calibration Pte. Ltd.
Blk 5008 Ang Mo Kio Ave 5, #07-02/03, Tech Place II
Singapore 569874

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

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

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 31 October 2022

Certificate Number: AC-1969.15



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,
ANSI/NCSL Z540-1-1994 (R2002) AND ANSI/NCSL Z540.3-2006 (R2013)**

Micro Precision Calibration Pte. Ltd.

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CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: **October 31, 2022**

Certificate Number: **AC-1969.15**

CALIBRATION

Acoustics and Vibration

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

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 8880 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

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	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 5 μ V/V + 5 μ V	Multi-Function Calibrator
DC Voltage - Measure	(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 μ V/V + 0.3 μ V 5 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 High Voltage ³	(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	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	Multi-Function Calibrator
DC High Current - Source ¹	(2.2 to 11) A	0.17 mA/A	Multi-Product 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, 50 turn Coil
	60 fA to 100 μ A	58 μ A/A + 0.005 8 pA	High-Resistance Meter
DC Current ¹ – Measure	(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 20) A (20 to 300) A	0.14 mA/A 3.2 mA/A	Fluke Shunt w/ Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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 + 0.58·R 0.081 % of Watts output + 0.58·R 0.067 % of Watts output + 0.58·R	Multi-Product Calibrator w/ Transconductance Amplifier
Inductance – Source 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 kΩ (1 to 10) kΩ 10 kΩ to 1 MΩ (1 to 100) MΩ 100 MΩ to 100 GΩ 1 TΩ	15 μΩ 10 μΩ 0.76 mΩ 3.3 mΩ 33 mΩ 50 mΩ 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 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 96 μΩ 91 μΩ/Ω 24 μΩ/Ω 24 μΩ/Ω 10 μΩ/Ω 10 μΩ/Ω 8.5 μΩ/Ω 8.5 μΩ/Ω 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	Multi-Function Calibrator
Resistance – Source ¹	(0 to 10.99) Ω (11 to 32.999) Ω (33 to 109.999) Ω (110 to 329.999) Ω 330 Ω to 1.09999 kΩ	93 μΩ/Ω + 6.2 mΩ 93 μΩ/Ω + 12 mΩ 70 μΩ/Ω + 12 mΩ 70 μΩ/Ω + 12 mΩ 70 μΩ/Ω + 47 mΩ	Multi-Product Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹	(1.1 to 3.29999) kΩ (3.3 to 10.9999) kΩ (11 to 32.9999) kΩ (33 to 109.999) kΩ (110 to 329.999) kΩ 330 kΩ to 1.09999 MΩ (1.1 to 3.29999) MΩ (3.3 to 10.9999) MΩ (11 to 32.9999) MΩ (33 to 109.999) MΩ (110 to 330) MΩ	70 μΩ/Ω + 47 mΩ 70 μΩ/Ω + 0.47 Ω 70 μΩ/Ω + 0.47 Ω 86 μΩ/Ω + 4.7 Ω 93 μΩ/Ω + 4.7 Ω 117 μΩ/Ω + 43 Ω 117 μΩ/Ω + 43 Ω 466 μΩ/Ω + 0.43 kΩ 776 μΩ/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 (1 to 100) 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 584 μΩ/Ω + 2 kΩ 5.8 mΩ/Ω + 14 kΩ 6.9 mΩ/Ω + 0.058 mΩ	Multimeter High-Resistance Meter
Electrical Simulation of Thermocouple Indicating Systems 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 °C 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

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of Thermocouple Indicating Systems 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

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

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) $^{\circ}\text{C}$	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 $^{\circ}\text{C}$	
AC Voltage – Source ¹	200 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

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	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	1.0 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

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 mV/V + 16 mV 4.5 mV/V + 40 mV 8 mV/V + 80 mV 346 $\mu\text{V/V} + 16 \text{ mV}$ 70 $\mu\text{V/V} + 3.5 \text{ mV}$	Multi-Function Calibrator
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 $\mu\text{V/V} + 4.0 \text{ mV}$ 166 $\mu\text{V/V} + 6.0 \text{ mV}$ 0.6 mV/V + 11 mV 0.60 mV/V + 11 mV 2.3 mV/V + 45 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	0.3 mV/V + 3 μV 0.3 mV/V + 1 μV 0.3 mV/V + 1 μV 0.8 mV/V + 1 μV 4.1 mV/V + 1 μV 33 mV/V + 2 μV 0.07 mV/V + 40 μV 0.07 mV/V + 20 μV 0.12 mV/V + 20 μV 0.25 mV/V + 20 μV 0.67 mV/V + 20 μV 26 mV/V + 100 μV 8.4 mV/V + 100 μV 13 mV/V + 100 μV	Multimeter in Synchronous sub-sampled mode

Electrical – DC/Low Frequency

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 sub-sampled mode
	(1 to 40) Hz	0.07 mV/V + 400 μ V	
	40 Hz to 1 kHz	0.07 mV/V + 200 μ V	
	(1 to 20) kHz	0.12 mV/V + 200 μ V	
	(20 to 50) kHz	0.26 mV/V + 200 μ V	
	(50 to 100) kHz	0.67 mV/V + 200 μ V	
	(100 to 300) kHz	2.5 mV/V + 1 mV	
	300 kHz to 1 MHz	8.4 mV/V + 1 mV	
	(1 to 2) MHz	13 mV/V + 1 mV	
	(10 to 100) V		
	(1 to 40) Hz	0.23 mV/V + 4.6 mV	
	40 Hz to 1 kHz	0.23 mV/V + 2.3 mV	
	1 kHz to 20 kHz	0.23 mV/V + 2.3 mV	
	(20 to 50) kHz	0.26 mV/V + 2mV	
	(50 to 100) kHz	0.68 mV/V + 2mV	
	(100 to 300) kHz	2.6 mV/V + 10 mV	
	300 kHz to 1 MHz	8.4 mV/V + 10 mV	
	(100 to 1 000) V		
AC Voltage – Measure ¹	1 to 40) Hz	0.4 mV/V + 40 mV	AC Measurement Standard
	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	1.3 mV/V + 20 mV	
	(50 to 100) kHz	3.1 mV/V + 20 mV	
	(0 to 2.2) mV		
	(10 to 20) Hz	1.7 mV/V + 1.3 μ V	
	(20 to 40) Hz	740 μ V/V + 1.3 μ V	
	40 Hz to 20 kHz	420 μ V/V + 1.3 μ V	
	(20 to 50) kHz	810 μ V/V + 2 μ V	
	(50 to 100) kHz	1.2 mV/V + 2.5 μ V	
	(100 to 300) kHz	2.3 mV/V + 4 μ V	
	(300 to 500) kHz	2.4 mV/V + 8 μ V	
	500 kHz to 1 MHz	3.5 mV/V + 8 μ V	
	(2.2 to 7) mV		
	(10 to 20) Hz	850 μ V/V + 1.3 μ V	
	(20 to 40) Hz	370 μ V/V + 1.3 μ V	
	40 Hz to 20 kHz	210 μ V/V + 1.3 μ V	
	(20 to 50) kHz	400 μ V/V + 2 μ V	
	(50 to 100) kHz	600 μ V/V + 2.5 μ V	
	(100 to 300) kHz	1.2 mV/V + 4 μ V	
	(300 to 500) kHz	1.3 mV/V + 8 μ V	
	500 kHz to 1 MHz	2.3 mV/V + 8 μ V	

Electrical – DC/Low Frequency

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 $\mu\text{V/V} + 8 \mu\text{V}$	
	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 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

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 μV	
	(20 to 40) Hz	66 $\mu\text{V/V}$ + 0.058 μV	
	40 Hz to 20 kHz	24 $\mu\text{V/V}$ + 0.058 μV	
	(20 to 50) kHz	46 $\mu\text{V/V}$ + 0.058 μV	
	(50 to 100) kHz	71 $\mu\text{V/V}$ + 0.058 μV	
	(100 to 300) kHz	160 $\mu\text{V/V}$ + 0.058 μV	
	(300 to 500) kHz	260 $\mu\text{V/V}$ + 0.058 μV	
	500 kHz to 1 MHz	900 $\mu\text{V/V}$ + 0.058 μV	
	(2.2 to 7) V		
	(10 to 20) Hz	200 $\mu\text{V/V}$ + 0.058 μV	
	(20 to 40) Hz	67 $\mu\text{V/V}$ + 0.058 μV	
	40 Hz to 20 kHz	24 $\mu\text{V/V}$ + 0.058 μV	
	(20 to 50) kHz	48 $\mu\text{V/V}$ + 0.058 μV	
	(50 to 100) kHz	81 $\mu\text{V/V}$ + 0.058 μV	
	(100 to 300) kHz	190 $\mu\text{V/V}$ + 0.058 μV	
	(300 to 500) kHz	400 $\mu\text{V/V}$ + 0.058 μV	
	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 μV	
	(20 to 40) Hz	67 $\mu\text{V/V}$ + 0.58 μV	
	40 Hz to 20 kHz	27 $\mu\text{V/V}$ + 0.58 μV	
	(20 to 50) kHz	48 $\mu\text{V/V}$ + 0.58 μV	
	(50 to 100) kHz	81 $\mu\text{V/V}$ + 0.58 μV	
	(100 to 300) kHz	190 $\mu\text{V/V}$ + 0.58 μV	
	(300 to 500) kHz	400 $\mu\text{V/V}$ + 0.58 μV	
	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 μV	
	(20 to 40) Hz	68 $\mu\text{V/V}$ + 0.58 μV	
	40 Hz to 20 kHz	32 $\mu\text{V/V}$ + 0.58 μV	
	(20 to 50) kHz	57 $\mu\text{V/V}$ + 0.58 μV	
	(50 to 100) kHz	94 $\mu\text{V/V}$ + 0.58 μV	
	(100 to 300) kHz	200 $\mu\text{V/V}$ + 0.58 μV	
	(300 to 500) kHz	410 $\mu\text{V/V}$ + 0.58 μV	
	500 kHz to 1 MHz	1.2 mV/V + 0.58 μV	

Electrical – DC/Low Frequency

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 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	68 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	31 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	69 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	98 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(100 to 300) kHz	210 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(300 to 500) kHz	500 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(220 to 700) V		
	(10 to 20) Hz	200 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	99 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	41 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	130 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	500 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(700 to 1 000) V		
	(10 to 20) Hz	200 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 40) Hz	99 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	40 Hz to 20 kHz	38 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(20 to 50) kHz	130 $\mu\text{V/V} + 5.8 \mu\text{V}$	
	(50 to 100) kHz	500 $\mu\text{V/V} + 5.8 \mu\text{V}$	
AC High Voltage – Measure ¹	(1 to 10) kV		High Voltage Meter
	(50 to 100) Hz	0.6 mV/V	
	(10 to 20) kV		
	(50 to 60) Hz	1.5 mV/V	
AC Current – Source ¹	(20 to 50) kV (rms)		Multi-Function Calibrator
	(50 to 60) Hz	1.4 mV/V	
	Up to 220 μA		
	(10 to 20) Hz	250 $\mu\text{A/A} + 16 \text{ nA}$	
	(20 to 40) Hz	160 $\mu\text{A/A} + 10 \text{ nA}$	
	40 Hz to 1 kHz	120 $\mu\text{A/A} + 8 \text{ nA}$	
	(1 to 5) kHz	280 $\mu\text{A/A} + 12 \text{ nA}$	
	(5 to 10) kHz	1.1 mA/A + 65 nA	
	(0.22 to 2.2) mA		
	(10 to 20) Hz	250 $\mu\text{A/A} + 40 \text{ nA}$	
	(20 to 40) Hz	160 $\mu\text{A/A} + 35 \text{ nA}$	
	40 Hz to 1 kHz	120 $\mu\text{A/A} + 35 \text{ nA}$	
	(1 to 5) kHz	200 $\mu\text{A/A} + 110 \text{ nA}$	
	(5 to 10) kHz	1.1 mA/A + 650 nA	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(2.2 to 22) mA		Multi-Function Calibrator
	(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	
AC Current – Source ¹	(1 to 5) kHz	200 μ A/A + 4 μ A	Multi-Function Calibrator w/Transconductance Amplifier
	(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	
	(2.2 to 11) A		
	40 Hz to 1 kHz	460 μ A/A + 170 μ A	
	(1 to 5) kHz	950 μ A/A + 380 μ A	
	(5 to 10) kHz	3.6 mA/A + 750 μ A	
AC Current – Source ¹	(10 to 16.5) A		Multi-Product Calibrator/ Transconductance Amplifier with 50 Turn Coil
	(45 to 65) Hz	3.3 mA/A + 3.5 mA	
	(65 to 440) Hz	9.1 mA/A + 3.5 mA	
	(16.5 to 150) A		
	(45 to 65) Hz	3.3 mA/A + 29 mA	
	(65 to 440) Hz	9.1 mA/A + 31 mA	
AC Current – Measure ¹	(150 to 1000) A		Multimeter in Synchronous sub-sampled mode
	(45 to 65) Hz	3.4 mA/A + 104 mA	
	(65 to 440) Hz	9.1 mA/A + 115 mA	
	(0 to 100) μ A		
AC Current – Measure ¹	(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 1 kHz	0.7 mA/A + 0.035 μ A	

Electrical – DC/Low Frequency

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
	10 mA to 20 A 5 Hz to 100 kHz	0.2 mA/A + 0.58 μ A	
AC Resistance ¹ – Source 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

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	0.60 mΩ/Ω + 5.8 μΩ	Precision LCR Meter
AC Power – Source ^{1,2} 0.1 mW to 11 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 2.2) A (2.2 to 4.5) A (4.5 to 11) A 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	0.31 % of Watts output + 0.58·R 0.2 % of Watts output + 0.58·R 0.27 % of Watts output + 0.58·R 0.2 % of Watts output + 0.58·R 0.27 % of Watts output + 0.58·R 0.2 % of Watts output + 0.58·R 0.27 % of Watts output + 0.58·R 0.2 % of Watts output + 0.58·R 0.20 % 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
AC Power – Source ^{1,2} 0.1 mW to 11 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 2.2) A (2.2 to 4.5) A (4.5 to 11) A	0.36 % of Watts output + 0.58·R 0.26 % of Watts output + 0.58·R 0.32 % of Watts output + 0.58·R 0.26 % of Watts output + 0.58·R 0.32 % of Watts output + 0.58·R 0.26 % of Watts output + 0.58·R 0.32 % of Watts output + 0.58·R 0.26 % of Watts output + 0.58·R	Multi-Product Calibrator
AC Power – Source ^{1,2} 0.1 mW to 11 kW (45 to 65) Hz (PF = 0 to 0.999)	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 + 0.58·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

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ^{1,2} 0.33 mW to 11 kW (45 to 65) Hz PF = 1	(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	0.20 % of Watts output + 0.58·R 0.12 % of Watts output + 0.58·R 0.20 % 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
AC Power – Source ^{1,2} 0.33 mW to 11 kW (45 to 65) Hz (PF = 0 to 0.999)	(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
Capacitance ¹ - Source 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	Multi-Product Calibrator
Capacitance ¹ - Source Fixed Values	(1, 10, 100, 1 000) pF (1 to 13) MHz	0.35 mF/F + 0.58·R	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 + 0.58·R	Capacitance Standard
Capacitance - Measure ¹	0.01 fF to 1 mF 20 Hz to 1 MHz 1 MHz to 30 MHz	0.60 mF/F + 0.005 8 fF 1.2 mF/F + 0.005 8 fF	Precision LCR Meter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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	(0 to 1) mVpp (1 to 21) mVpp (21 to 556) mVpp 556 mV to 210 Vpp	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 Vpp 50 V to 100 Vpp 100 V to 200 Vpp	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 ppm of reading	Oscilloscope Calibrator
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

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pulse – Measure ¹	33 MHz to 3.0 GHz	23 ppm of reading	Digital Oscilloscope

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Noise ¹ (Source and Measure) 1 MHz to 26.5 GHz Offset carrier $\leq$ 100 kHz	(-120 to -70) dBc/Hz	1.2 dB/Hz	Signal Generator, PSA Series Spectrum Analyzer
RF Power Sensors – Calibration Factors	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 % of reading 1.3 % of reading 1.4 % of reading 1.6 % of reading 2.1 % of reading 2.6 % of reading 2.9 % of reading 3 % of reading 4 % of reading 4.7 % of reading	Coaxial Thermistor, Power Sensors, Power Meter
Tuned RF Power, Relative ¹ – Measure	(-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	Measuring Receiver, Power Sensors
RF Power – Absolute ¹ Measure	(-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, 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 9 kHz to 3 GHz	Rate: 100 Hz to 20 kHz Depths: 5 % to 99 %	3.5 % Depth	Signal Generator

Electrical – RF/Microwave

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 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

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: $\leq 50\%$ (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 ¹ – Source 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: $\leq 50\%$ (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

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Modulation – Measure ¹ For 2/3/4/5G			PSA Series Spectrum Analyzer, Signal Generator
Composite Rho ³	450 MHz to 26.5 GHz $\rho = (0.9 \text{ to } 1.0)$	0.001 0	
Error Vector Magnitude (rms)	450 MHz to 26.5 GHz EVM = (0 to 25) %	0.30 % 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 ¹ – Measure 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

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Calipers ^{1,2}	Up to 1 500 mm	$(5.8 + 0.01L) \mu\text{m}$	Gage Blocks
Height Gages ^{1,2}	Up to 1 500 mm	$(0.72 + 0.002 2L) \mu\text{m}$	
Micrometers ² - External, Internal, Depth, Bore	Up to 25 mm (25 to 1 050) mm	$(0.19 + 0.009L) \mu\text{m}$ $(0.37 + 0.013L) \mu\text{m}$	Gage Blocks

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Indicators ^{1,2} Dial Gauge, Dial Test Indicator, LVDTs	Up to 1 mm (1 to 100) mm	0.39 μ m (0.68 + 0.009L) μ m	Universal Measuring Machine, Indicator Tester
	Up to 100 mm	(0.069 + 0.003 4L) μ m	Gage Block, Comparator Stand
Plain Plug Gages / Pin Gages / Thread Wires ^{1,2} (Cylindrical and Taper)	Up to 300 mm	(0.40 + 0.001 6L) μ m	Universal Measuring Machine, Gage Blocks
Plain Ring Gages ² (Cylindrical and Taper)	(1 to 300) mm	(0.35 + 0.002L) μ m	Universal Measuring Machine, Gage Blocks
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) μ m (1.5 + 0.007L) μ 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) μ m (1.3 + 0.005L) μ m	Universal Measuring Machine, Gage Block
Setting Rod, Micrometer Standard, Length Standards ²	Up to 500 mm	(0.49 + 0.002 5L) μ m	Gage block, Measuring machine
Snap Gages ² External / Internal	Up to 500 mm	(0.32 + 0.002 8L) μ m	Universal Measuring Machine, Gage Blocks
Thickness Gauge / Feeler Gauge ²	Up to 25 mm	(0.4 + 0.000 6L) μ m	Universal Measuring Machine, Gage Blocks
Universal Length Measuring Machine ^{1,2}	Up to 100 mm	(0.056 + 0.002 8L) μ m	Gage block
Gage Block – Length ²	(0.5 to 100) mm	(0.068 + 0.001 1L) μ m	Gage block, Linear Length Gauge, Comparator Stand
Gage Block – Length ²	(0.5 to 100) mm (100 to 500) mm	(0.35 + 0.003 5L) μ m (0.28 + 0.009 8L) μ m	Gage block, Universal Measuring Machine
Surface Plates ^{1,2} Overall Flatness Local Area Flatness	D = (150 to 3 600) mm V = (0 to 0.13) mm	(0.5 + 0.001 3D) μ m 0.6 μ m	Level System Repeat-o-meter
Precision Level	Up to 1 mm/m (1 to 2) mm/m	0.85 % of reading + 3.5 μ m/m 1.8 % of reading	Level System
Master Level / Electronic Inclinometer / Angle Meter	Up to 5 mm/m Up to 90 °	1.1 μ m/m 0.000 82 °	Sine Bar, Gage Block
Bevel Protractor	Up to 90 °	2 arcmin	Angle Block

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Comparators and Vision Systems ^{1,2} X, Y, Z Axis	Up to 300 mm	$(1.3 + 0.007L) \mu\text{m}$	Standard Scales and Gage Blocks
Rules and Tape Measures ²	Up to 1 000 mm (1 000 to 50 000) mm	11 μm $0.011L \mu\text{m}$	Gage Blocks, Standard Scale, Scale Loupe
Check Master / Caliper Checker / Height Master / Riser Block ²			
Block Pitch Accuracy	Up to 1 000 mm	$(0.55 + 0.001 1L) \mu\text{m}$	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	$(0.26 + 0.006 9L) \mu\text{m}$	
Calibration Tester / Dial Gauge Tester / Indicator Calibrator ²	Up to 25 mm	$(0.26 + 0.006 9L) \mu\text{m}$	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

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	0.073 % of reading + $0.58 \cdot R$ 0.027 % of reading + $0.58 \cdot R$ 0.057 % 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 + $0.58 \cdot R$ 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 + $0.58 \cdot R$ 0.028 % of reading	Load cell

Mass and Mass Related

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 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 50) kg (50 to 300) kg	0.008 8 mg 0.01 mg 0.011 mg 0.012 mg 0.014 mg 0.016 mg 0.084 mg 0.085 mg 0.089 mg 0.1 mg 0.14 mg 0.26 mg 0.49 mg 1.3 mg 2.6 mg 9.5 mg 0.000 65 % of reading 0.002 6 % of reading	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 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 + 0.58·R 0.048 % of reading 0.028 % of reading 0.031 % of reading 0.014 % of reading	Torque Wheel, Torque Standard, Calibration Arms, Weights

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Tools ¹	Up to 1 500 N·m	0.67 % of reading + 0.058 mN·m	Torque Testers
Pipettes & Micropipettes Burette	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	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
Durometers			
Force	50 N	0.008 N	Electronic Balance, Load Cell Gage Blocks
Extension at zero	Up to 5 mm	0.005 mm	
Indenter Shape Diameter, Radius Angle	Up to 15 mm Up to 90 °	0.004 mm 8 arc min	Profile Projector

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Optical Power ¹ – Measure	(-80 to 10) dBm (700 to 1800) nm	0.17 dB	Optical Test System
Optical Wavelength ¹ – Measure	(700 to 1 650) nm	0.51 ppm 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	1.8 % of reading	Comparison to Standard Light Meter

Photometry and Radiometry

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

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Relative Humidity ¹	(10 to 95) %RH	0.57 %RH	Indicator, Probe w/ Humidity Generator
Infrared Thermometers ¹	(30 to 300) °C	1.9 °C	Black Body Calibrator $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Infrared Thermometers	(5 to 30) °C (30 to 100) °C (100 to 200) °C (200 to 300) °C	1.1 °C 1.4 °C 1.7 °C 2.1 °C	Black Body Calibrator $\epsilon = 1.00$, $\lambda = (8 \text{ to } 14) \mu\text{m}$
Temperature ¹	(-40 to 600) °C	0.04 °C	Thermometer, PRT

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency ¹ - Source	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 ¹ – Measure	0.01 Hz to 26.5 GHz	6.3×10^{-10} Hz/Hz	GPS Receiver, Counter
Time Interval ¹ – Measure	200 ps to 40 s	23 ppm of reading	Digital Oscilloscope
Tachometer	(0 to 100 000) rpm	0.000 6 % of reading + 0.58·R	Signal Generator with Lamp
Stopwatch and Timer ¹	0 to 24 hours	0.86 ms	Frequency Counter
		240 ms	Stopwatch

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Speed - Measure ¹	(0 to 10 000) rpm	1 rpm	Tachometer

DIMENSIONAL MEASUREMENT

1 Dimensional

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 / NOGO 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

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

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

Notes:

1. On-site calibration service is available for this parameter, since on-site conditions are typically more variable than those in the laboratory, larger measurement uncertainties are expected on-site than what is reported on the accredited scope.
2. D = diameter in millimeters, L = length in millimeters, R = resolution of unit under test.
3. The CMC for scales and balances is highly dependent upon the resolution of the unit under test. The uncertainties presented here does not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
4. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-1969.15.



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