



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Professional Calibration & Services Co., Ltd.
50/888-50/889 Moo 2, Rungsit-Nakornnayok Rd.
Bungyeetho, Thunyaburee, Pathumthani 12130, Thailand

Fulfills the requirements of

ISO/IEC 17025:2017

In the fields 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: 07 June 2026
Certificate Number: AC-2590



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

Professional Calibration & Services Co., Ltd.
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CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: **June 07, 2026**

Certificate Number: **AC-2590**

CALIBRATION

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Level Meter/Calibrator Source/Measure ¹	94 dB 114 dB	0.17 dB 0.17 dB	Sound Level Calibrator, Sound Level Meter; CP-EL35: Direct and Comparison Measurement
Vibration Meters (160 Hz) ¹ Acceleration (RMS)	Up to 1 m/s ² (> 1 to 5) m/s ² (> 5 to 10) m/s ² (> 10 to 20) m/s ² (> 20 to 30) m/s ² (> 30 to 40) m/s ² (> 40 to 50) m/s ²	0.068 m/s ² 0.13 m/s ² 0.24 m/s ² 0.44 m/s ² 0.63 m/s ² 0.84 m/s ² 1.1 m/s ²	Vibration Calibrator; CP-PL22: Direct Measurement
Velocity (RMS)	Up to 1 mm/s (> 1 to 5) mm/s (> 5 to 10) mm/s (> 10 to 20) mm/s (> 20 to 30) mm/s (> 30 to 40) mm/s (> 40 to 50) mm/s	0.066 mm/s 0.13 mm/s 0.24 mm/s 0.44 mm/s 0.63 mm/s 0.84 mm/s 1.1 mm/s	



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Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Vibration Meters (160 Hz) ¹ Displacement (RMS)	Up to 1 µm (> 1 to 5) µm (> 5 to 10) µm (> 10 to 20) µm (> 20 to 30) µm (> 30 to 40) µm (> 40 to 50) µm	0.068 µm 0.13 µm 0.24 µm 0.44 µm 0.63 µm 0.84 µm 1.1 µm	Vibration Calibrator; CP-PL22: Direct Measurement

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Conductivity Meter ^{1,5}	10 µS/cm 84 µS/cm 1 413 µS/cm 12.88 mS/cm 111.3 mS/cm	0.16 µS/cm 0.58 µS/cm 8.9 µS/cm 0.077 mS/cm 0.62 mS/cm	Standard Conductivity Solution; CP-PL58; ASTM D 1125 and ASTM D 5391
pH Meter ^{1,5}	2 pH 4 pH 7 pH 9 pH 10 pH 12 pH	0.007 1 pH 0.004 2 pH 0.004 2 pH 0.004 2 pH 0.004 2 pH 0.011 pH	Standard pH Buffer Solutions; CP-PL21; ASTM E70 and BS 1647
Turbidity Meter ^{1,5}	10 NTU 100 NTU 500 NTU 1 000 NTU	0.051 NTU 1.1 NTU 3.1 NTU 7.2 NTU	Standard Turbidity Solution; CP-PL30: Direct Measurement
Gas Detector/Analyzer ⁵ Hydrogen Sulfide in Nitrogen	25 µmol/mol	4.1 % of reading	Certified Reference Gases; CP-PL84: Direct Measurement
Carbon Monoxide in Nitrogen	100 µmol/mol	1.1 % of reading	
Methane in Nitrogen	50 % LEL 0.022 mol/mol	1.1 % of reading 1.1 % of reading	
Oxygen in Nitrogen	0.01 mol/mol 0.18 mol/mol 0.21 mol/mol	2.2 % of reading 0.7 % of reading 1.1 % of reading	



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Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gas Detector/Analyzer ⁵ Propane in Nitrogen	50 % LEL 8.5 mmol/mol	1.1 % of reading 1.1 % of reading	Certified Reference Gases; CP-PL84: Direct Measurement
Refractometers ^{1,5} (Brix)	5 % Brix 10 % Brix 20 % Brix 30 % Brix 40 % Brix 50 % Brix 60 % Brix	0.012 % Brix 0.012 % Brix 0.022 % Brix 0.031 % Brix 0.031 % Brix 0.041 % Brix 0.051 % Brix	Sucrose Standard Solution; CP-PL80: Direct Measurement
Refractometers ^{1,5} (Refractive Index)	1.340 26 nD 1.347 82 nD 1.363 84 nD 1.381 15 nD 1.399 86 nD 1.420 06 nD 1.441 9 nD	0.000 081 nD 0.000 081 nD 0.000 081 nD 0.000 081 nD 0.000 081 nD 0.000 081 nD 0.000 081 nD	Sucrose Standard Solution; CP-PL80: Direct Measurement
TDS Meters ⁵	11 mg/l 116 mg/l 478 mg/l 1 382 mg/l	0.043 mg/l 0.52 mg/l 2.1 mg/l 3.9 mg/l	TDS Solution; CP-PL81: Direct Measurement
Salinity Meters ⁵	0.3 g/L NaCl 3.0 g/L NaCl 58.4 g/L NaCl 125 g/L NaCl	1.2 mg/L NaCl 6.5 mg/L NaCl 0.25 g/L NaCl 0.7 g/L NaCl	Salinity Solution; CP-PL82: Direct Measurement
Dissolved Oxygen (DO) Meter	(6 to 13) mg/l	0.037 mg/l	Solubility of Oxygen in distilled water at various temperatures and pressure; CP-PL93: Direct Measurement
Particle Counter Meter ⁵ Air Flow Rate	2.83 lpm 28.3 lpm	0.06 lpm 0.06 lpm	Comparison to Flow Meter
Counting Efficiency	0.3 µm 0.5 µm 1 µm 3 µm 5 µm 10 µm	5.9 % of reading 6 % of reading 6.1 % of reading 7.3 % of reading 8.3 % of reading 17 % of reading	Comparison to Counter and Standard Monosized Polymer Microspheres



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Voltage – Source ¹	Up to 220 mV (0.22 to < 2.2 V) (2.2 to < 11 V) (11 to < 22 V) (22 to < 220 V) (220 to 1 100 V)	9 μ V/V + 0.7 μ V 7.2 μ V/V + 1.2 μ V 7.2 μ V/V + 5 μ V 7.2 μ V/V + 7 μ V 8.2 μ V/V + 90 μ V 9.2 μ V/V + 0.55 mV	Fluke 5700A Multifunction Calibrator; CP-EL79: Direct Measurement
DC Voltage – Source ¹	Up to 330 mV (0.33 to < 3.3) V (3.3 to < 33) V (33 to < 330) V (330 to 1 020) V	24 μ V/V + 2 μ V 14 μ V/V + 2.8 μ V 15 μ V/V + 24 μ V 22 μ V/V + 0.18 mV 22 μ V/V + 1.8 mV	Fluke 5522A Multiproduct Calibrator; CP-EL01: Direct Measurement
DC High Voltage – Source ¹	50 V to 1 kV (> 1 to 6) kV (> 6 to 10) kV	0.5 mV/V + 0.15 V 0.5 mV/V + 0.5 V 0.5 mV/V + 1.8 V	Vitrek 4700 High Voltage Meter, Rek RK2671AM High Voltage Tester CP-EL42: Comparison Measurement
DC Voltage – Measure ¹	Up to 200 mV (0.2 to < 2) V (2 to < 20) V (20 to < 200) V (200 to 1 000) V	8.5 μ V/V + 0.72 μ V 7.1 μ V/V + 1.2 μ V 7.1 μ V/V + 7.5 μ V 12 μ V/V + 92 μ V 12 μ V/V + 0.68 mV	Wavetek 1281 8.5 Digit Multimeter; CP-EL02: Direct Measurement
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	8.5 μ V/V + 0.55 μ V 7 μ V/V + 0.55 μ V 7 μ V/V + 0.75 μ V 9.5 μ V/V + 4 μ V 24 μ V/V + 0.2 mV	Keysight 3458A 8.5 Digit Multimeter; CP-EL66: Direct Measurement
DC Voltage – Measure ¹	Up to 15 V (> 15 to 30) V (> 30 to 60) V (> 60 to 150) V (> 150 to 300) V (> 300 to 600) V	2.4 mV/V + 54 mV 2.4 mV/V + 0.11 V 2.4 mV/V + 0.21 V 2.4 mV/V + 0.54 V 2.4 mV/V + 1.1 V 2.4 mV/V + 2.1 V	Yokogawa WT110 Power Meter; CP-EL04: Direct Measurement
DC High Voltage – Measure ¹	(0.5 to 5) kV (> 5 to 10) kV	0.35 mV/V + 0.5 V 0.35 mV/V + 0.8 V	Vitrek 4700 High Voltage Meter; CP-EL03: Direct Measurement

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC High Voltage – Measure ¹	(> 10 to 20) kV (> 20 to 40) kV (> 40 to 100) kV	1 mV/V + 4 V 1 mV/V + 15 V 1 mV/V + 0.24 kV	Vitrek 4700 High Voltage Meter, HLV-100G/HLV-150 High Voltage Divider; CP-EL03: Direct Measurement
DC Current – Source ¹	Up to 220 μ A (0.22 to < 2.2) mA (2.2 to < 22) mA (22 to < 220) mA (0.22 to 2.2) A	52 μ A/A + 8.1 nA 52 μ A/A + 8.5 nA 52 μ A/A + 85 nA 62 μ A/A + 0.86 μ A 82 μ A/A + 26 μ A	Fluke 5700A Multifunction Calibrator; CP-EL79: Direct Measurement
DC Current – Source ¹	Up to 0.33 mA (0.33 to < 3.3) mA (3.3 to < 33) mA (33 to < 330) mA 330 mA to < 1.1 A (1.1 to < 3) A (3 to < 11) A (11 to 20.5) A	0.18 mA/A + 24 nA 0.12 mA/A + 59 nA 0.12 mA/A + 0.3 μ A 0.12 mA/A + 3.1 μ A 0.24 mA/A + 47 μ A 0.44 mA/A + 48 μ A 0.58 mA/A + 0.91 mA 1.2 mA/A + 1.2 mA	Fluke 5522A Multiproduct Calibrator; CP-EL01: Direct Measurement
DC Current – Source ¹	Up to 100 μ A (> 0.1 to 1) mA (> 1 to 10) mA (> 10 to 50) mA (> 50 to 100) mA (> 100 to 200) mA (> 200 to 500) mA (> 0.5 to 1) A (> 1 to 3) A (> 3 to 20) A (> 20 to 30) A (> 30 to 200) A	60 μ A/A + 30 pA 55 μ A/A + 0.3 nA 55 μ A/A + 3 nA 55 μ A/A + 30 nA 60 μ A/A + 0.2 μ A 50 μ A/A + 2 μ A 50 μ A/A + 15 μ A 50 μ A/A + 15 μ A 50 μ A/A + 0.15 mA 55 μ A/A + 1.2 mA 3.5 mA/A + 1.2 mA 3 mA/A + 16 mA	Standard Resistor, Standard Shunt, Digital Multimeter; CP-EL57: Using Ohm's Law
DC Clamp-On Ammeters ¹	(20.5 to < 150) A (150 to 1 025) A	2.4 mA/A + 0.13 A 2.6 mA/A + 0.2 A	Fluke 5522A Multiproduct Calibrator, 50- turn coil; CP-EL01: Direct Measurement
DC Current – Measure ¹	Up to 200 μ A 200 μ A to < 2 mA (2 to < 20) mA (20 to < 200) mA 200 mA to < 2 A	0.12 mA/A + 5.9 nA 0.12 mA/A + 8.3 nA 0.12 mA/A + 83 nA 0.12 mA/A + 1.4 μ A 0.24 mA/A + 26 μ A	Wavetek 1281 8.5 Digit Multimeter; CP-EL02: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Current – Measure ¹	Up 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	30 μ A /A + 0.2 nA 30 μ A /A + 0.2 nA 30 μ A /A + 1 nA 30 μ A /A + 6 nA 30 μ A /A + 60 nA 50 μ A /A + 0.6 μ A 0.14 mA/A + 20 μ A	Keysight 3458A 8.5 Digit Multimeter; CP-EL66: Direct Measurement
DC Current – Measure ¹	Up to 0.5 A (> 0.5 to 1) A (> 1 to 2) A (> 2 to 5) A (> 5 to 10) A (> 10 to 20) A	2.4 mA/A + 2.9 mA 2.4 mA/A + 6 mA 2.4 mA/A + 7.3 mA 2.4 mA/A + 18 mA 2.4 mA/A + 37 mA 2.4 mA/A + 76 mA	Yokogawa WT110 Power Meter CP-EL04: Direct Measurement
DC Current – Measure ¹	Up to 100 μ A (> 0.1 to 1) mA (> 1 to 10) mA (> 10 to 50) mA (> 50 to 100) mA (> 100 to 200) mA (> 200 to 500) mA (> 0.5 to 1) A (> 1 to 3) A (> 3 to 10) A (> 10 to 20) A (> 20 to 50) A (> 50 to 100) A (> 100 to 500) A (> 500 to 1 000) A	60 μ A/A + 30 pA 55 μ A/A + 0.3 nA 55 μ A/A + 3 nA 55 μ A/A + 30 nA 60 μ A/A + 0.2 μ A 50 μ A/A + 2 μ A 50 μ A/A + 15 μ A 50 μ A/A + 15 μ A 50 μ A/A + 0.12 mA 55 μ A/A + 1.2 mA 55 μ A/A + 1.2 mA 2.4 mA/A 2.4 mA/A 2.4 mA/A 5.8 mA/A	CCCP Standard Resistor Sets 1 m Ω to 100 k Ω Agilent 34330A Shunt, FL-2.0 class 0.5; CP-EL22: Using Ohm's Law
AC/DC Current – Measure ¹ DC	Up to 20 A	0.15 mA/A	Holt Standard HCS-1AF current shunts, Digital multimeter; CP-EL22: Using Ohm's Law
AC	20 mA to 20 A 10 Hz to 10 kHz (> 10 to 50) kHz	0.25 mA/A 1.2 mA/A	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC/DC Current – Measure ¹ DC AC	Up to 30 mA (> 30 to 300) mA (> 0.3 to 3) A (> 3 to 30) A (> 30 to 300) A (45 to 400) Hz Up to 30 mA (> 30 to 300) mA (> 0.3 to 3) A (> 3 to 30) A (> 30 to 300) A	0.012 % of reading + 2 μA 0.012 % of reading + 20 μA 0.012 % of reading + 0.2 mA 0.015 % of reading + 2 mA 0.087 % of reading + 40 mA 0.58 % of reading + 20 μA 0.58 % of reading + 0.2 mA 0.58 % of reading + 5 mA 0.58 % of reading + 20 mA 0.59 % of reading + 0.2 A	GW Instek PCA-1000i Precision Current Shunt; CP-EL78: Direct Measurement
AC/DC Current – Measure ¹ DC AC	(> 300 to 1 000) A (45 to 65) Hz (> 300 to 600) A (> 65 to 400) Hz (> 300 to 600) A	2.4 % of reading + 0.65 A 2.4 % of reading + 3 A 2.5 % of reading + 3 A	Fluke i1010 AC/DC Current Clamp & Fluke 287/289 Digital Multimeter; CP-EL78: Direct Measurement
DC/AC Cutoff Current – Measure ¹ DC AC	Up to 10 mA (> 10 to 100) mA (50, 60) Hz 20 μA to 10 mA (> 10 to 100) mA	0.87 mA/A + 17 μA 1.8 mA/A + 28 μA 7 mA/ A + 26 μA 7 mA/ A + 60 μA	Fluke 289 Multimeter; CP-EL23: Direct Measurement
AC Voltage – Source ¹	(10 to 20) Hz Up to 2.2 mV (2.2 to < 22) mV (22 to < 220) mV (0.22 to < 2.2) V (2.2 to < 22) V (22 to < 220) V	1.2 mV/V + 4.7 μV 0.58 mV/V + 5.6 μV 0.56 mV/V + 14 μV 0.51 mV/V + 90 μV 0.51 mV/V + 0.83 mV 0.51 mV/V + 8.2 mV	Fluke 5700A Multifunction Calibrator; CP-EL79: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(> 20 to 40) Hz		Fluke 5700A Multifunction Calibrator; CP-EL79: Direct Measurement
	Up to 2.2 mV	0.55 mV/V + 4.7 μV	
	(2.2 to < 22) mV	0.24 mV/V + 5.6 μV	
	(22 to < 220) mV	0.22 mV/V + 8.4 μV	
	(0.22 to < 2.2) V	0.17 mV/V + 32 μV	
	(2.2 to < 22) V	0.17 mV/V + 0.27 mV	
	(22 to < 220) V	0.17 mV/V + 3.1 mV	
	> 40 Hz to 20 kHz		
	Up to 2.2 mV	0.52 mV/V + 4.7 μV	
	(2.2 to < 22) mV	0.14 mV/V + 5.6 μV	
	(22 to < 220) mV	0.11 mV/V + 8.4 μV	
	(0.22 to < 2.2) V	79 μV/V + 14 μV	
	(2.2 to < 22) V	79 μV/V + 0.14 mV	
	(22 to < 220) V	83 μV/V + 1.4 mV	
	(> 20 to 50) kHz		
	Up to 2.2 mV	0.71 mV/V + 4.7 μV	
	(2.2 to < 22) mV	0.39 mV/V + 5.6 μV	
	(22 to < 220) mV	0.33 mV/V + 8.4 μV	
	(0.22 to < 2.2) V	0.13 mV/V + 22 μV	
	(2.2 to < 22) V	0.13 mV/V + 0.21 mV	
	(22 to < 220) V	0.23 mV/V + 4.5 mV	
	(> 50 to 100) kHz		
	Up to 2.2 mV	1.4 mV/V + 7.1 μV	
	(2.2 to < 22) mV	0.87 mV/V + 8.5 μV	
(22 to < 220) mV	0.86 mV/V + 27 μV		
(0.22 to < 2.2) V	0.26 mV/V + 74 μV		
(2.2 to < 22) V	0.26 mV/V + 0.39 mV		
(22 to < 220) V	0.51 mV/V + 9.8 mV		
(> 100 to 300) kHz			
Up to 2.2 mV	1.7 mV/V + 14 μV		
(2.2 to < 22) mV	1.2 mV/V + 14 μV		
(22 to < 220) mV	1.2 mV/V + 27 μV		
(0.22 to < 2.2) V	0.44 mV/V + 0.17 mV		
(2.2 to < 22) V	0.51 mV/V + 1.9 mV		
(22 to < 220) V	1.6 mV/V + 91 mV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(> 300 to 500) kHz Up to 2.2 mV (2.2 to < 22) mV (22 to < 220) mV (0.22 to < 2.2) V (2.2 to < 22) V (22 to < 220) V > 500 kHz to 1 MHz Up to 2.2 mV (2.2 to < 22) mV (22 to < 220) mV (0.22 to < 2.2) V (2.2 to < 22) V (22 to < 220) V (15 to 50) Hz (220 to 250) V 50 Hz to 1 kHz (220 to 1100) V	2.7 mV/V + 27 μV 1.8 mV/V + 27 μV 1.8 mV/V + 36 μV 1.1 mV/V + 0.37 mV 1.3 mV/V + 1.4 mV 4.8 mV/V + 91 mV 4.4 mV/V + 27 μV 3.5 mV/V + 27 μV 3.5 mV/V + 81 μV 2.3 mV/V + 0.87 mV 2.8 mV/V + 8.7 mV 12 mV/V + 0.2 V 0.41 mV/V + 18 mV 82 μV/V + 3.8 mV	Fluke 5700A Multifunction Calibrator; CP-EL79: Direct Measurement
AC Voltage – Source ¹	(10 to 45) Hz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V (3.3 to < 33) V > 45 Hz to 10 kHz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V (3.3 to < 33) V (> 10 to 20) kHz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V (3.3 to < 33) V (> 20 to 50) kHz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V (3.3 to < 33) V (33 to < 330) V	0.95 mV/V + 7.1 μV 0.37 mV/V + 9.6 μV 0.35 mV/V + 60 μV 0.36 mV/V + 0.77 mV 0.23 mV/V + 7.1 μV 0.19 mV/V + 9.5 μV 0.18 mV/V + 70 μV 0.18 mV/V + 0.71 mV 0.28 mV/V + 7.1 μV 0.21 mV/V + 9.5 μV 0.23 mV/V + 70 μV 0.28 mV/V + 0.71 mV 1.2 mV/V + 7.1 μV 0.42 mV/V + 9.5 μV 0.36 mV/V + 60 μV 0.41mV/V + 0.71 mV 0.36 mV/V + 7 mV	Fluke 5522A Multiproduct Calibrator CP-EL01: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(> 50 to 100) kHz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V (3.3 to < 33) V (33 to < 330) V (> 100 to 500) kHz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V 45 Hz to 1 kHz (33 to < 330) V (330 to 1 020) V (> 1 to 10) kHz (33 to < 330) V (> 10 to 20) kHz (33 to < 330) V (> 1 to 5) kHz (330 to 1 020) V (> 5 to 10) kHz (330 to 1 020) V	4.1 mV/V + 14 μV 0.94 mV/V + 38 μV 0.82 mV/V + 0.15 mV 1.1 mV/V + 1.9 mV 2.4 mV/V + 58 mV 9.3 mV/V + 58 μV 2.4 mV/V + 81 μV 2.9 mV/V + 0.7 mV 0.23 mV/V + 2.8 mV 0.35 mV/V + 12 mV 0.24 mV/V + 7.2 mV 0.3 mV/V + 7.1 mV 0.3 mV/V + 12 mV 0.35 mV/V + 12 mV	Fluke 5522A Multiproduct Calibrator CP-EL01: Direct Measurement
AC High Voltage – Source ¹	(50 to 60) Hz 50 V to 1 kV (> 1 to 6) kV (> 6 to 10) kV	1.6 mV/V + 0.6 V 1.6 mV/V + 1.8 V 1.6 mV/V + 3.4 V	Vitrek 4700 High Voltage Meter, Rek RK2671AM High Voltage Tester; CP-EL42: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(20 to 40) Hz		Wavetek 1281 8.5 Digit Multimeter CP-EL02: Direct Measurement
	(10 to < 200) mV	0.27 mV/V + 4.7 μV	
	200 mV to < 2 V	0.2 mV/V + 25 μV	
	(2 to < 20) V	0.2 mV/V + 0.24 mV	
	(20 to < 200) V	0.2 mV/V + 2.5 mV	
	(200 to 1 000) V	0.2 mV/V + 14 mV	
	(> 40 to 100) Hz		
	(10 to < 200) mV	0.25 mV/V + 4.7 μV	
	200 mV to < 2 V	0.18 mV/V + 25 μV	
	(2 to < 20) V	0.18 mV/V + 0.24 mV	
	(20 to < 200) V	0.18 mV/V + 2.5 mV	
	(200 to 1 000) V	0.18 mV/V + 14 mV	
	> 100 Hz to 2 kHz		
	(10 to < 200) mV	0.25 mV/V + 2.5 μV	
	200 mV to < 2 V	0.16 mV/V + 24 μV	
	(2 to < 20) V	0.16 mV/V + 0.24 mV	
	(20 to < 200) V	0.16 mV/V + 2.5 mV	
	(200 to 1 000) V	0.18 mV/V + 14 mV	
	(> 2 to 10) kHz		
	(10 to < 200) mV	0.25 mV/V + 4.7 μV	
	200 mV to < 2 V	0.18 mV/V + 24 μV	
	(2 to < 20) V	0.18 mV/V + 0.25 mV	
	(20 to < 200) V	0.18 mV/V + 2.6 mV	
	(200 to 1 000) V	0.18 mV/V + 14 mV	
(> 10 to 30) kHz			
(10 to < 200) mV	0.47 mV/V + 9.3 μV		
200 mV to < 2 V	0.29 mV/V + 47 μV		
(2 to < 20) V	0.29 mV/V + 0.47 mV		
(20 to < 200) V	0.29 mV/V + 4.7 mV		
(200 to 1 000) V	0.25 mV/V + 24 mV		
(> 30 to 100) kHz			
(10 to < 200) mV	0.82 mV/V + 24 μV		
200 mV to < 2 V	0.58 mV/V + 0.24 mV		
(2 to < 20) V	0.58 mV/V + 2.4 mV		
(20 to < 200) V	0.58 mV/V + 24 mV		
(200 to 1 000) V	0.58 mV/V + 0.12 V		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(> 100 to 300) kHz 200 mV to < 2 V (2 to < 20) V (20 to < 200) V > 300 kHz to 1 MHz (2 to < 20) V (20 to < 200) V	3.5 mV/V + 2.4 mV 3.5 mV/V + 24 mV 3.5 mV/V + 0.24 V 12 mV/V + 1.2 mV 12 mV/V + 2.4 V	Wavetek 1281 8.5 Digit Multimeter CP-EL02: Direct Measurement
AC Voltage – Measure ¹	(10 to 20) Hz (1 to 10) mV (> 10 to 100) mV (> 0.1 to 1) V (> 1 to 10) V (> 10 to 100) V (> 20 to 40) Hz (1 to 10) mV (> 10 to 100) mV (> 0.1 to 1) V (> 1 to 10) V (> 10 to 100) V > 40 Hz to 1 kHz (1 to 10) mV (> 10 to 100) mV (0.1 to 1) V (> 1 to 10) V (> 10 to 100) V (> 100 to 700) V (> 1 to 20) kHz (1 to 10) mV (> 10 to 100) mV (> 0.1 to 1) V (> 1 to 10) V (> 10 to 100) V (> 100 to 700) V (> 20 to 50) kHz (1 to 10) mV (> 10 to 100) mV (> 0.1 to 1) V (> 1 to 10) V (> 10 to 100) V (> 100 to 700) V	0.41 mV/V + 4 μV 0.11 mV/V + 5 μV 0.1 mV/V + 50 μV 0.1 mV/V + 0.5 mV 0.24 mV/V + 5 mV 0.38 mV/V + 4 μV 0.1 mV/V + 5 μV 0.1 mV/V + 50 μV 0.1 mV/V + 0.5 mV 0.24 mV/V + 5 mV 0.27 mV/V + 2 μV 0.1 mV/V + 3 μV 0.1 mV/V + 30 μV 0.1 mV/V + 0.3 mV 0.24 mV/V + 3 mV 0.47 mV/V + 30 mV 0.38 mV/V + 4 μV 0.18 mV/V + 5 μV 0.17 mV/V + 30 μV 0.18 mV/V + 0.3 mV 0.24 mV/V + 3 mV 0.7 mV/V + 30 mV 1.2 mV/V + 2 μV 0.36 mV/V + 3 μV 0.36 mV/V + 30 μV 0.36 mV/V + 0.3 mV 0.41 mV/V + 3 mV 1.4 mV/V + 30 mV	Keysight 3458A 8.5 Digit Multimeter CP-EL66: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(> 50 to 100) kHz		Keysight 3458A 8.5 Digit Multimeter CP-EL66: Direct Measurement
	(1 to 10) mV	5.8 mV/V + 2 μV	
	(> 10 to 100) mV	0.94 mV/V + 3 μV	
	(> 0.1 to 1) V	0.93 mV/V + 30 μV	
	(> 1 to 10) V	0.93 mV/V + 0.3 mV	
	(> 10 to 100) V	1.4 mV/V + 3 mV	
	(> 100 to 700) V	3.5 mV/V + 30 mV	
	(> 100 to 300) kHz		
	(1 to 10) mV	47 mV/V + 3 μV	
	(> 10 to 100) mV	3.5 mV/V + 20 μV	
	(> 0.1 to 1) V	3.5 mV/V + 0.2 mV	
	(> 1 to 10) V	3.5 mV/V + 2 mV	
	(> 300 to 500) kHz		
	(1 to 10) mV	15 mV/V + 6 μV	
	(>10 to 100) mV	12 mV/V + 20 μV	
	(>0.1 to 1) V	12 mV/V + 0.2 mV	
	(> 1 to 10) V	12 mV/V + 2 mV	
	(> 0.5 to 1) MHz		
	(1 to 10) mV	15 mV/V + 6 μV	
	(> 10 to 100) mV	12 mV/V + 20 μV	
	(> 0.1 to 1) V	12 mV/V + 0.2 mV	
	(> 1 to 10) V	12 mV/V + 2 mV	
	(> 1 to 4) MHz		
	(1 to 10) mV	82 mV/V + 9 μV	
(> 10 to 100) mV	47 mV/V + 90 μV		
(> 0.1 to 1) V	47 mV/V + 0.9 mV		
(> 1 to 3) V	47 mV/V + 9 mV		
(> 4 to 8) MHz			
(10 to 100) mV	47 mV/V + 0.1 mV		
(> 0.1 to 1) V	47 mV/V + 1 mV		
(> 1 to 3) V	47 mV/V + 10 mV		
(> 8 to 10) MHz			
(10 to 100) mV	180 mV/V + 0.2 mV		
(> 0.1 to 1) V	180 mV/V + 2 mV		
(> 1 to 3) V	180 mV/V + 20 mV		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Measure ¹	(45 to 66) Hz (1 to 15) V (> 15 to 30) V (> 30 to 60) V (> 60 to 150) V (> 150 to 300) V (> 300 to 600) V > 66 Hz to 1 kHz (1 to 15) V (> 15 to 30) V (> 30 to 60) V (> 60 to 150) V (> 150 to 300) V (> 300 to 600) V	1.8 mV/V + 34 mV 1.8 mV/V + 62 mV 1.8 mV/V + 0.13 V 1.8 mV/V + 0.34 V 1.8 mV/V + 0.62 V 1.8 mV/V + 1.3 V 3.5 mV/V + 62 mV 3.5 mV/V + 0.13 V 3.5 mV/V + 0.25 V 3.5 mV/V + 0.62 V 3.5 mV/V + 1.3 V 3.5 mV/V + 2.5 V	Yokogawa WT110 Power Meter CP-EL04: Direct Measurement
AC High Voltage – Measure ¹	(50 to 60) Hz 500 V to 1 kV (> 1 to 5) kV (> 5 to 10) kV (> 10 to 20) kV (> 20 to 40) kV (> 40 to 70) kV (> 70 to 100) kV	1.4 mV/V + 0.6 V 1.4 mV/V + 1.6 V 1.4 mV/V + 3.4 V 5.8 mV/V + 41 V 5.8 mV/V + 80 V 5.8 mV/V + 0.15 kV 5.8 mV/V + 0.3 kV	Vitrek 4700 High Voltage Meter With High Voltage Divider HLV-150; CP-EL03: Direct Measurement
AC Current – Source ¹	(10 to 20) Hz Up to 220 μ A (0.22 to < 2.2) mA (2.2 to < 22) mA (22 to < 220) mA (> 20 to 40) Hz Up to 220 μ A (0.22 to < 2.2) mA (2.2 to < 22) mA (22 to < 220) mA > 40 Hz to 1 kHz Up to 220 μ A (0.22 to < 2.2) mA (2.2 to < 22) mA (22 to < 220) mA	0.72 mA/A + 26 nA 0.73 mA/A + 51 nA 0.71 mA/A + 0.48 μ A 0.71 mA/A + 5 μ A 0.37 mA/A + 21 nA 0.37 mA/A + 42 nA 0.36 mA/A + 0.48 μ A 0.36 mA/A + 4.4 μ A 0.18 mA/A + 17 nA 0.17 mA/A + 42 nA 0.16 mA/A + 0.39 μ A 0.15 mA/A + 5 μ A	Fluke 5700A Multifunction Calibrator; CP-EL79: Direct Measurement

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(> 1 to 5) kHz 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 (> 5 to 10) kHz 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 20 Hz to 1 kHz (0.22 to 2.2) A	0.62 mA/A + 42 nA 0.61 mA/A + 0.41 μA 0.61 mA/A + 4.2 μA 0.61 mA/A + 42 μA 0.76 mA/A + 95 μA 1.7 mA/A + 0.81 nA 1.7 mA/A + 0.81 μA 1.7 mA/A + 8.1 μA 1.7 mA/A + 81 μA 8.6 mA/A + 0.17 mA 0.66 mA/A + 43 μA	Fluke 5700A Multifunction Calibrator; CP-EL79: Direct Measurement
AC Current – Source ¹	(10 to 20) Hz (29 to < 330) μA 330 μA to < 3.3 mA (3.3 to < 33) mA (33 to < 330) mA (> 20 to 45) Hz (29 to < 330) μA 330 μA to < 3.3 mA (3.3 to < 33) mA (33 to < 330) mA > 45 Hz to 1 kHz (29 to < 330) μA 330 μA to < 3.3 mA (3.3 to < 33) mA (33 to < 330) mA 330 mA to < 1.1 A (1.1 to < 3) A (> 1 to 5) kHz (29 to < 330) μA 330 μA to < 3.3 mA (3.3 to < 33) mA (33 to < 330) mA 330 mA to < 1.1 A (1.1 to < 3) A (3 to < 11) A (11 to 20.5) A	2.4 mA/A + 0.12 μA 2.4 mA/A + 0.19 μA 2.1 mA/A + 2.5 μA 2.1 mA/A + 25 μA 1.8 mA/A + 0.12 μA 1.5 mA/A + 0.19 μA 1.1 mA/A + 2.5 μA 1.1 mA/A + 25 μA 1.5 mA/A + 0.12 μA 1.2 mA/A + 0.2 μA 0.48 mA/A + 2.5 μA 0.48 mA/A + 27 μA 0.59 mA/A + 0.12 mA 0.7 mA/A + 0.14 mA 3.5 mA/A + 0.18 μA 2.4 mA/A + 0.26 μA 0.93 mA/A + 2.6 μA 1.2 mA/A + 59 μA 7 mA/A + 1.2 mA 7 mA/A + 1.2 mA 35 mA/A + 2.7 mA 35 mA/A + 5.9 mA	Fluke 5522A Multiproduct Calibrator CP-EL01: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹	(> 5 to 10) kHz (29 to < 330) μ A 330 μ A to < 3.3 mA (3.3 to < 33) mA (33 to < 330) mA 330 mA to < 1.1 A (1.1 to < 3) A (> 10 to 30) kHz (29 to < 330) μ A 330 μ A to < 3.3 mA (3.3 to < 33) mA (33 to < 330) mA (10 to 45) Hz 330 mA to < 1.1 A (1.1 to < 3) A (> 45 to 100) Hz (3 to < 11) A (11 to 20.5) A > 100 Hz to 1 kHz (3 to < 11) A (11 to 20.5) A	9.3 mA/A + 0.24 μ A 5.8 mA/A + 0.37 μ A 2.4 mA/A + 3.8 μ A 2.4 mA/A + 0.12 mA 29 mA/A + 5.8 mA 29 mA/A + 5.8 mA 19 mA/A + 0.47 μ A 12 mA/A + 0.71 μ A 4.7 mA/A + 4.8 μ A 4.7 mA/A + 0.24 mA 2.1 mA/A + 0.12 mA 2.1 mA/A + 0.15 mA 0.71 mA/A + 2.5 mA 1.4 mA/A + 5.9 mA 1.2 mA/A + 2.6 mA 1.8 mA/A + 6 mA	Fluke 5522A Multiproduct Calibrator CP-EL01: Direct Measurement
AC Clamp-On Ammeters ¹	(45 to 65) Hz (20.5 to < 150) A (150 to 1 025) A (> 65 to 440) Hz (20.5 to < 150) A (> 65 to 100) Hz (150 to 1 025) A	3.8 mA/A + 0.13 A 3.8 mA/A + 0.2 A 7 mA/A + 0.15 A 6 mA/A + 0.2 A	Fluke 5522A Multiproduct Calibrator, 50-turn Current Coil CP-EL01: Direct Measurement
AC Current – Measure ¹	10 Hz to 5 kHz (10 to < 200) μ A 200 μ A to < 2 mA (2 to < 20) mA (20 to < 200) mA 10 Hz to 1 kHz 200 mA to < 2 A (> 1 to 5) kHz 200 mA to < 2 A	0.36 mA/A + 25 nA 0.35 mA/A + 0.25 μ A 0.35 mA/A + 2.5 μ A 0.35 mA/A + 25 μ A 0.7 mA/A + 0.48 mA 2.4 mA/A + 0.94 mA	Wavetek 1281 8.5 Digit Multimeter CP-EL02: Direct Measurement

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(10 to 20) Hz (1 to 100) μ A (> 0.1 to 1) mA (> 1 to 10) mA (> 10 to 100) mA (> 0.1 to 1) A (> 20 to 45) Hz (1 to 100) μ A (> 0.1 to 1) mA (> 1 to 10) mA (> 10 to 100) mA (> 0.1 to 1) A (> 45 to 100) Hz (1 to 100) μ A (> 0.1 to 1) mA (> 1 to 10) mA (> 10 to 100) mA (> 0.1 to 1) A (> 100 to 1) kHz (1 to 100) μ A (> 0.1 to 1) mA (> 1 to 10) mA (> 10 to 100) mA (> 0.1 to 1) A (> 1 to 5) kHz (1 to 100) μ A (> 0.1 to 1) mA (> 1 to 10) mA (> 10 to 100) mA (> 0.1 to 1) A	4.7 mA/A + 40 nA 4.7 mA/A + 0.3 μ A 4.7 mA/A + 3 μ A 4.7 mA/A + 30 μ A 4.7 mA/A + 0.3 mA 1.8 mA/A + 40 nA 1.8 mA/A + 0.3 μ A 1.8 mA/A + 3 μ A 1.8 mA/A + 30 μ A 1.9 mA/A + 0.3 mA 0.72 mA/A + 40 nA 0.7 mA/A + 0.3 μ A 0.71 mA/A + 3 μ A 0.71 mA/A + 30 μ A 0.94 mA/A + 0.3 mA 0.72 mA/A + 40 nA 0.38 mA/A + 0.3 μ A 0.36 mA/A + 3 μ A 0.36 mA/A + 30 μ A 1.2 mA/A + 0.3 mA 0.72 mA/A + 40 nA 0.38 mA/A + 0.3 μ A 0.36 mA/A + 3 μ A 0.36 mA/A + 30 μ A 1.2 mA/A + 0.3 mA	Keysight 3458A 8.5 Digit Multimeter CP-EL66: Direct Measurement
AC Current – Measure ¹	(> 5 to 20) kHz (> 0.1 to 1) mA (> 1 to 10) mA (> 10 to 100) mA (> 0.1 to 1) A (>20 to 50) kHz (> 0.1 to 1) mA (> 1 to 10) mA (> 10 to 100) mA (> 0.1 to 1) A	0.72 mA/A + 0.3 μ A 0.71 mA/A + 3 μ A 0.71 mA/A + 30 μ A 3.5 mA/A + 0.3 mA 4.7 mA/A + 0.5 μ A 4.7 mA/A + 5 μ A 4.7 mA/A + 50 μ A 12 mA/A + 0.5 mA	Keysight 3458A 8.5 Digit Multimeter CP-EL66: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	(45 to 66) Hz 1 mA to 0.5 A (> 0.5 to 1) A (> 1 to 2) A (> 2 to 5) A (> 5 to 10) A (> 10 to 20) A 66 Hz to 1 kHz 1 mA to 0.5 A (> 0.5 to 1) A (> 1 to 2) A (> 2 to 5) A (> 5 to 10) A (> 10 to 20) A	1.8 mA/A + 1.1 mA 1.8 mA/A + 2.4 mA 1.8 mA/A + 4.6 mA 1.8 mA/A + 12 mA 1.8 mA/A + 24 mA 1.8 mA/A + 51 mA 3.5 mA/A + 2.1 mA 3.5 mA/A + 4.3 mA 3.5 mA/A + 8.4 mA 3.5 mA/A + 23 mA 3.5 mA/A + 46 mA 3.5 mA/A + 96 mA	Yokogawa WT110 Power Meter CP-EL04: Direct Measurement
AC Current – Measure ¹	Up to 1 kHz (> 1 to 30) A (> 1 to 5) kHz (> 1 to 30) A	3.5 mA/A 5.8 mA/A	Agilent 34330A Shunt, Digital Multimeter CP-EL22: Using Ohm's Law
Weld Machine ¹ DC AC (50 or 60) Hz	(0.1 to 2) kA (> 2 to 20) kA (> 20 to 200) kA (0.1 to 2) kA (> 2 to 20) kA (> 20 to 200) kA	2.4 % of reading + 6 A 2.4 % of reading + 60 A 2.4 % of reading + 1.1 kA 2.4 % of reading + 6 A 2.4 % of reading + 60 A 2.4 % of reading + 0.6 kA	Miyachi MM-123A High Precision Weld Tester CP-EL70: Direct Measurement
DC Voltage – Source ¹ (Fixed Points)	± 100 mV ± 1 V ± 10 V ± 100 V ± 1 000 V	11 μV/V 3.7 μV/V 3.2 μV/V 6.5 μV/V 6.5 μV/V	Keysight 3458A 8.5 Digit Multimeter, Fluke 5700A or Fluke 5522A Calibrator; CP-EL67: Comparison Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹ (Fixed Points)	10 Hz		Keysight 3458A 8.5 Digit Multimeter, Fluke 5700A or Fluke 5522A Calibrator; CP-EL67: Comparison Measurement
	10 mV	0.61 mV/V	
	100 mV	0.13 mV/V	
	1 V	90 μV/V	
	10 V	80 μV/V	
	20 Hz		
	10 mV	0.36 mV/V	
	100 mV	0.12 mV/V	
	1 V	70 μV/V	
	10 V	80 μV/V	
	40 Hz		
	10 mV	0.36 mV/V	
	100 mV	0.1 mV/V	
	1 V	70 μV/V	
	10 V	75 μV/V	
	100 Hz		
	10 mV	0.33 mV/V	
	100 mV	0.1 mV/V	
	1 V	75 μV/V	
	10 V	80 μV/V	
	100 V	70 μV/V	
	700 V	80 μV/V	
	1 kHz		
	10 mV	0.31 mV/V	
	100 mV	0.1 mV/V	
	1 V	70 μV/V	
	10 V	75 μV/V	
	100 V	70 μV/V	
700 V	70 μV/V		
10 kHz			
10 mV	0.31 mV/V		
100 mV	0.1 mV/V		
1 V	70 μV/V		
10 V	75 μV/V		
100 V	70 μV/V		
700 V	70 μV/V		
20 kHz			
10 mV	0.31 mV/V		
100 mV	0.1 mV/V		
1 V	70 μV/V		
10 V	75 μV/V		
100 V	75 μV/V		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹ (Fixed Points)	50 kHz		Keysight 3458A 8.5 Digit Multimeter, Fluke 5700A or Fluke 5522A Calibrator; CP-EL67: Comparison Measurement
	10 mV	0.38 mV/V	
	100 mV	0.12 mV/V	
	1 V	90 μV/V	
	10 V	95 μV/V	
	100 V	90 μV/V	
	100 kHz		
	10 mV	0.79 mV/V	
	100 mV	0.24 mV/V	
	1 V	0.2 mV/V	
	10 V	0.19 mV/V	
	100 V	0.21 mV/V	
	300 kHz		
	10 mV	1.1 mV/V	
	100 mV	0.79 mV/V	
	1 V	0.54 mV/V	
	500 kHz		
	10 mV	1.1 mV/V	
	100 mV	0.81 mV/V	
	1 V	0.69 mV/V	
	1 MHz		
	100 mV	7.2 mV/V	
	1 V	6.6 mV/V	
	2 MHz		
	3 V	5.6 mV/V	
	4 MHz		
	100 mV	7.2 mV/V	
	1 V	6.6 mV/V	
	3 V	5.6 mV/V	
	8 MHz		
100 mV	7.2 mV/V		
1 V	6.6 mV/V		
3 V	5.6 mV/V		
10 MHz			
100 mV	7.2 mV/V		
1 V	6.6 mV/V		
3 V	5.6 mV/V		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Strain Gauge Indicator ¹ 120 Ω, 350 Ω	(0 to 0.5) mV/V		Vishay BLH 625 Precision Calibrator CP-EL63: Direct Measurement
	0	60 nV	
	0.05	0.000 093 mV/V	
	0.1	0.000 13 mV/V	
	0.15	0.000 16 mV/V	
	0.2	0.000 19 mV/V	
	0.25	0.000 22 mV/V	
	0.3	0.000 26 mV/V	
	0.35	0.000 29 mV/V	
	0.4	0.000 32 mV/V	
	0.45	0.000 35 mV/V	
	0.5	0.000 39 mV/V	
	(0 to 1) mV/V		
	0	60 nV	
	0.1	0.000 13 mV/V	
	0.2	0.000 19 mV/V	
	0.3	0.000 26 mV/V	
	0.4	0.000 32 mV/V	
	0.5	0.000 39 mV/V	
	0.6	0.000 45 mV/V	
	0.7	0.000 52 mV/V	
	0.8	0.000 58 mV/V	
	0.9	0.000 65 mV/V	
	1	0.000 71 mV/V	
	(0 to 2) mV/V		
	0	60 nV	
	0.2	0.000 19 mV/V	
0.4	0.000 32 mV/V		
0.6	0.000 45 mV/V		
0.8	0.000 58 mV/V		
1	0.000 71 mV/V		
1.2	0.000 84 mV/V		
1.4	0.000 97 mV/V		
1.6	0.001 1 mV/V		
1.8	0.001 2 mV/V		
2	0.001 4 mV/V		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Strain Gauge Indicator ¹ 120 Ω, 350 Ω	(0 to 5) mV/V		Vishay BLH 625 Precision Calibrator CP-EL63: Direct Measurement
	0	60 nV	
	0.5	0.000 39 mV/V	
	1	0.000 71 mV/V	
	1.5	0.001 mV/V	
	2	0.001 4 mV/V	
	2.5	0.001 7 mV/V	
	3	0.002 mV/V	
	3.5	0.002 3 mV/V	
	4	0.002 7 mV/V	
	4.5	0.003 mV/V	
	5	0.003 3 mV/V	
	(0 to 10) mV/V		
	0	60 nV	
	1	0.000 71 mV/V	
	2	0.001 4 mV/V	
	3	0.002 mV/V	
	4	0.002 7 mV/V	
	5	0.003 3 mV/V	
	6	0.004 mV/V	
7	0.004 6 mV/V		
8	0.005 3 mV/V		
9	0.005 9 mV/V		
10	0.006 6 mV/V		
DC Current – Source ¹ (Fixed Points)	± 100 μA	10 μA/A	Keysight 3458A 8.5 Digit Multimeter, Fluke 5700A or Fluke 5522A Calibrator; CP-EL67: Comparison Measurement
	± 1 mA	9 μA/A	
	± 10 mA	9 μA/A	
	± 100 mA	12 μA/A	
	± 1 A	25 μA/A	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current – Source ¹ (Fixed Points)	10 Hz		Keysight 3458A 8.5 Digit Multimeter, Fluke 5700A or Fluke 5522A Calibrator; CP-EL67: Comparison Measurement
	100 μ A	0.28 mA/A	
	1 mA	0.28 mA/A	
	10 mA	0.12 mA/A	
	100 mA	0.11 mA/A	
	1 A	0.11 mA/A	
	45 Hz		
	100 μ A	0.23 mA/A	
	1 mA	0.33 mA/A	
	10 mA	0.12 mA/A	
	100 mA	0.11 mA/A	
	1 A	0.11 mA/A	
	100 Hz		
	100 μ A	0.22 mA/A	
	1 mA	0.22 mA/A	
	10 mA	0.12 mA/A	
	100 mA	0.11 mA/A	
	1 A	0.11 mA/A	
	1 kHz		
	100 μ A	0.22 mA/A	
1 mA	0.22 mA/A		
10 mA	0.12 mA/A		
100 mA	0.11 mA/A		
1 A	0.11 mA/A		
DC Resistance – Source ¹ (Fixed-Simulated Points)	10 Ω	14 $\mu\Omega/\Omega$	Keysight 3458A 8.5 Digit Multimeter, Fluke 5700A or Fluke 5522A Calibrator; CP-EL67: Comparison Measurement
	100 Ω	12 $\mu\Omega/\Omega$	
	1 k Ω	7 $\mu\Omega/\Omega$	
	10 k Ω	9 $\mu\Omega/\Omega$	
	100 k Ω	10 $\mu\Omega/\Omega$	
	1 M Ω	19 $\mu\Omega/\Omega$	
	10 M Ω	25 $\mu\Omega/\Omega$	
	100 M Ω	90 $\mu\Omega/\Omega$	
1 G Ω	0.33 m Ω/Ω		
Resistance – Source ¹ (Fixed Points)	0 Ω	59 $\mu\Omega$	Fluke 5700A Multifunction Calibrator; CP-EL79: Direct Measurement
	1 Ω	96 $\mu\Omega/\Omega + 0.95 \mu\Omega$	
	1.9 Ω	96 $\mu\Omega/\Omega + 1.7 \mu\Omega$	
	10 Ω	29 $\mu\Omega/\Omega + 3.5 \mu\Omega$	
	19 Ω	28 $\mu\Omega/\Omega + 4 \mu\Omega$	
	100 Ω	18 $\mu\Omega/\Omega + 34 \mu\Omega$	
	190 Ω	18 $\mu\Omega/\Omega + 16 \mu\Omega$	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ (Fixed Points)	1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	14 μΩ/Ω + 0.3 mΩ 14 μΩ/Ω + 0.34 mΩ 13 μΩ/Ω + 2.9 mΩ 13 μΩ/Ω + 3.6 mΩ 15 μΩ/Ω + 20 mΩ 15 μΩ/Ω + 24 mΩ 22 μΩ/Ω + 0.22 Ω 23 μΩ/Ω + 0.3 Ω 42 μΩ/Ω + 6.4 Ω 48 μΩ/Ω + 8.4 Ω 0.12 mΩ/Ω + 70 Ω	Fluke 5700A Multifunction Calibrator; CP-EL79: Direct Measurement
Resistance – Source ¹ (Simulated, 4-wire Mode)	Up to 11 Ω (11 to < 33) Ω (33 to < 110) Ω (110 to < 330) Ω 330 Ω to < 1.1 kΩ (1.1 to < 3.3) kΩ (3.3 to < 11) kΩ (11 to < 33) kΩ (33 to < 110) kΩ	62 μΩ/Ω + 1.2 mΩ 53 μΩ/Ω + 1.8 mΩ 43 μΩ/Ω + 1.7 mΩ 36 μΩ/Ω + 2.4 mΩ 34 μΩ/Ω + 2.4 mΩ 35 μΩ/Ω + 24 mΩ 34 μΩ/Ω + 24 mΩ 35 μΩ/Ω + 0.24 Ω 34 μΩ/Ω + 0.24 Ω	Fluke 5522A Multiproduct Calibrator; CP-EL01: Direct Measurement
Resistance – Source ¹ (Simulated, 2-wire Mode)	(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	38 μΩ/Ω + 7.8 Ω 39 μΩ/Ω + 3.8 Ω 71 μΩ/Ω + 48 Ω 0.16 mΩ/Ω + 0.46 kΩ 0.3 mΩ/Ω + 3.3 kΩ 0.59 mΩ/Ω + 4.6 kΩ 3.5 mΩ/Ω + 0.23 MΩ 18 mΩ/Ω + 0.59 MΩ	Fluke 5522A Multiproduct Calibrator; CP-EL01: Direct Measurement
Resistance – Source ¹ (Fixed Artifacts)	75 μΩ 0.1 mΩ 0.6 mΩ 1 mΩ 2 mΩ 10 mΩ 0.1 Ω 1 Ω 10 Ω 0.1 kΩ 1 kΩ 10 kΩ 100 kΩ	5.8 mΩ/Ω + 60 nΩ 3 mΩ/Ω + 60 nΩ 5.9 mΩ/Ω + 0.1 μΩ 55 μΩ/Ω + 80 nΩ 2.4 mΩ/Ω + 0.1 μΩ 50 μΩ/Ω + 0.1 μΩ 50 μΩ/Ω + 1 μΩ 50 μΩ/Ω + 10 μΩ 55 μΩ/Ω + 0.1 mΩ 55 μΩ/Ω + 1 mΩ 55 μΩ/Ω + 10 mΩ 55 μΩ/Ω + 0.1 Ω 57 μΩ/Ω + 1 Ω	Red-China FL-2.0, Megger 249005, CCCP Standard Resistor Sets 1mΩ to 100kΩ; CP-EL24: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Source ¹ (Variable Artifacts)	100 mΩ to 1 Ω (1 to 10) Ω (10 to 100) Ω (100 to 1 000) Ω (1 to 10) kΩ (10 to 100) kΩ	0.13 mΩ/Ω + 0.27 mΩ 0.13 mΩ/Ω + 0.27 mΩ 0.13 mΩ/Ω + 0.27 mΩ 0.13 mΩ/Ω + 0.35 mΩ 0.13 mΩ/Ω + 1.8 mΩ 0.13 mΩ/Ω + 10 mΩ	Yokogawa 2793, Yokogawa 2786, ESI DB62-11k, ESI DB62-11M Decade Resistors; CP-EL24: Direct Measurement
Resistance – Source ¹ (Variable Artifacts)	100 kΩ to 1 MΩ (> 1 to 10) MΩ (> 10 to 100) MΩ	0.12 mΩ/Ω + 30 Ω 0.12 mΩ/Ω + 0.6 kΩ 0.12 mΩ/Ω + 50 kΩ	General Radio RDS67-A, ESI DB62-11M, Decade Resistor; CP-EL24: Direct Measurement
High Resistance – Source ¹ (Insulation Resistance) (Artifacts) Test Voltage: ± (10 to 10 000) V	1 kΩ 10 kΩ 100 kΩ 1 MΩ 5 MΩ 10 MΩ 20 MΩ 50 MΩ 100 MΩ 500 MΩ 1 GΩ 5 GΩ 10 GΩ 100 GΩ 1 TΩ	1.8 Ω 0.18 kΩ 1.8 kΩ 8.2 kΩ 8.6 kΩ 9.2 kΩ 0.3 MΩ 0.11 MΩ 0.12 MΩ 13 MΩ 14 MΩ 0.13 GΩ 0.19 GΩ 2.6 GΩ 10 GΩ	Yokogawa 279303 Decade Resistance Box, Megger CB101 High Resistance Box, Ohmite SM1 Resistor, 1MΩ to 1TΩ Standard Resistance Box; CP-EL05: Direct Measurement
Surface Resistivity/Resistance Meter, Electrostatic Resistance ¹ (Artifacts) Test Voltage: ± (Up to 100) V	1 kΩ 10 kΩ 100 kΩ 1 MΩ 5 MΩ 10 MΩ 20 MΩ 100 MΩ 1 GΩ 10 GΩ 100 GΩ 1 TΩ	1.8 Ω 0.18 kΩ 1.8 kΩ 18 kΩ 90 kΩ 0.18 MΩ 0.36 MΩ 1.8 MΩ 14 MΩ 0.19 GΩ 2.6 GΩ 10 GΩ	Yokogawa 279303 Decade Resistance Box, Megger CB101 High Resistance Box, Ohmite SM1 Resistor, 1MΩ to 1TΩ Standard Resistance Box; CP-EL05: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance – Measure ¹	Up to 20 Ω (20 to < 200) Ω 200 Ω to < 2 kΩ (2 to < 20) kΩ (20 to < 200) kΩ 200 kΩ to < 2 MΩ (2 to < 20) MΩ (20 to < 200) MΩ 200 MΩ to < 2 GΩ	18 μΩ/Ω + 27 μΩ 13 μΩ/Ω + 0.12 mΩ 11 μΩ/Ω + 1.1 mΩ 11 μΩ/Ω + 12 mΩ 11 μΩ/Ω + 0.14 Ω 17 μΩ/Ω + 5 Ω 35 μΩ/Ω + 0.17 kΩ 0.35 mΩ/Ω + 13 kΩ 3.5 mΩ/Ω + 1.1 MΩ	Wavetek 1281 8.5 Digit Multimeter; CP-EL02: Direct Measurement
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 Ω to 1 MΩ (> 1 to 10) MΩ (> 10 to 100) MΩ > 100 MΩ to 1 GΩ	24 μΩ/Ω + 60 μΩ 18 μΩ/Ω + 0.6 mΩ 16 μΩ/Ω + 0.6 mΩ 16 μΩ/Ω + 6 mΩ 16 μΩ/Ω + 60 mΩ 22 μΩ/Ω + 3 Ω 63 μΩ/Ω + 0.2 kΩ 0.59 mΩ/Ω + 2 kΩ 5.8 mΩ/Ω + 20 kΩ	Keysight 3458A 8.5 Digit Multimeter; CP-EL66: Direct Measurement
Resistance – Measure ¹ Test Current: 100 μA to 200 A	(10 to 75) μΩ (> 75 to 100) μΩ (> 0.1 to 1) mΩ (> 1 to 100) mΩ (> 0.1 to 1) Ω (> 1 to 100) Ω (> 0.1 to 100) kΩ	2 mΩ/Ω 1 mΩ/Ω 92 μΩ/Ω 65 μΩ/Ω 55 μΩ/Ω 60 μΩ/Ω 60 μΩ/Ω	Red-China FL-2.0, Megger 249005, CCCP Standard Resistor Sets 1mΩ-100kΩ, Wavetek 1281, Keysight 3458A, 8.5 Digit Multimeter; CP-EL58: Using DC Voltage Inter- Comparison
Resistance – Measure ¹ (Insulation Resistance) Test Voltage: Up to 5 kV	(1 to 2) kΩ (> 2 to 20) kΩ (> 20 to 200) kΩ > 200 kΩ to 2 MΩ (> 2 to 20) MΩ (> 20 to 200) MΩ > 200 MΩ to 2 GΩ (> 2 to 20) GΩ (> 20 to 200) GΩ > 200 GΩ to 1 TΩ	2.3 mΩ/Ω + 0.4 Ω 2.2 mΩ/Ω + 1 Ω 2.9 mΩ/Ω + 10 Ω 2.9 mΩ/Ω + 0.1 kΩ 2.9 mΩ/Ω + 1 kΩ 3.5 mΩ/Ω + 10 kΩ 3.8 mΩ/Ω + 0.1 MΩ 4.1 mΩ/Ω + 1 MΩ 4 mΩ/Ω + 10 MΩ 4.1 mΩ/Ω + 1 GΩ	Keithley 617 Programmable Electrometer, Fluke 5522A Multiproduct Calibrator, Chroma 19073 Hipot Tester Ω; CP-EL25: Using Ohm's Law

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source ¹ (Simulated)	5 kHz (0.22 to < 0.4) nF 1 kHz (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 100 Hz 330 nF to < 1.1 μF (1.1 to < 3.3) μF (3.3 to < 11) μF (11 to < 33) μF 50 Hz (33 to < 110) μF DC (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	7.2 mF/F + 12 pF 6.3 mF/F + 13 pF 5.9 mF/F + 14 pF 3 mF/F + 13 pF 3 mF/F + 59 pF 3 mF/F + 59 pF 3 mF/F + 0.58 nF 3 mF/F + 1.4 nF 3 mF/F + 6.8 nF 3 mF/F + 13 nF 4.7 mF/F + 68 nF 5.4 mF/F + 0.13 μF 5.4 mF/F + 0.68 μF 5.3 mF/F + 1.3 μF 5.3 mF/F + 6.8 μF 5.3 mF/F + 13 μF 8.7 mF/F + 68 μF 13 mF/F + 0.14 mF	Fluke 5522A Multiproduct Calibrator; CP-EL01: Direct Measurement
Capacitance – Source ¹ (Fixed Artifacts) Test Frequency: 120 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz, 5 MHz, 10 MHz, 13 MHz	1 pF 10 pF 100 pF 1 nF 10 nF 100 nF	1.2 fF 12 fF 0.12 pF 1.2 pF 1.2 pF 1.2 pF	General Radio 1409-F, 1409-L, and 1409-T Standard Capacitors; HP 16380A Standard Air Capacitor Set consisting of 16381A, 16382A, 16483A and 16384A; CP-EL26: Direct Measurement
Inductance – Source ¹ (Fixed Artifacts) Test Frequency: 120 Hz 1 kHz, 10 kHz	(10 μH, 100 μH, 1 mH) (10 mH, 100 mH, 1 H) (1 μH, 10 μH, 100 μH) (1 mH, 10 mH, 100 mH) (1 H, 10 H)	4.2 mH/H 1.5 mH/H 2 mH/H 1.5 mH/H 1.2 mH/H	General Radio 1482-E, 1482-H Standard Inductors; CP-EL26: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Inductance – Source/Measure ¹ Test Frequency: 10 kHz to 1 MHz (10 to 500) kHz (1 to 200) kHz (1 to 20) kHz	Up to < 1 μH (1 to < 10) μH (10 to < 100) μH (100 to < 1 000) μH (1 to < 10) mH (10 to < 100) mH (100 to < 1 000) mH (1 to < 10) H	3.5 mH/H + 0.1 nH 3.5 mH/H + 0.2 nH 3.5 mH/H + 2 nH 1.2 mH/H + 20 nH 1.2 mH/H + 0.2 μH 1.2 mH/H + 2 μH 1.2 mH/H + 20 μH 1.2 mH/H + 2 mH	Standard Inductors, Decade Inductor, Keysight E4980AL Precision LCR Meter; CP-EL65: Resonant Method
Capacitance – Source/Measure ¹	20 Hz to < 1 kHz (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) kHz (1 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 (10 to < 100) kHz (1 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	8 fF 15 fF 0.15 pF 1.5 pF 15 pF 0.2 fF 1.8 fF 15 fF 0.15 pF 1.5 pF 15 pF 0.25 fF 1.6 fF 15 fF 0.15 pF 1.5 pF 15 pF	Standard Capacitors, Keysight E4980AL Precision LCR Meter; CP-EL60: Direct and Comparison Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance – Source/Measure ¹	(100 to < 300) kHz		Standard Capacitors, Keysight E4980AL Precision LCR Meter; CP-EL60: Direct and Comparison Measurement
	(1 to < 10) pF	0.22 fF	
	(10 to < 100) pF	1.6 fF	
	(100 to < 1 000) pF	15 fF	
	(1 to < 10) nF	0.15 pF	
	(10 to < 100) nF	1.5 pF	
	(100 to 1 000) nF	15 pF	
	300 kHz to 1 MHz		
	(1 to < 10) pF	2.5 fF	
	(10 to < 100) pF	1.6 fF	
	(100 to < 1 000) pF	16 fF	
	(1 to < 10) nF	0.15 pF	
	(10 to < 100) nF	1.5 pF	
	(100 to 1 000) nF	15 pF	
	100 Hz to < 1 kHz		
	(1 to < 10) μF	0.15 nF	
	(10 to < 100) μF	20 nF	
100 Hz, 120 Hz			
(0.1 to < 1) mF	0.15 mF		
(1 to < 10) mF	5.5 μF		
(10 to 100) mF	0.22 mF		
1 kHz			
(0.1 to < 1) mF	1 μF		
(1 to 10) mF	10 μF		
Inductance – Source/Measure ¹	100 Hz to < 1 kHz		Standard Inductors, Keysight E4980AL Precision LCR Meter; CP-EL60: Direct and Comparison Measurement
	(10 to < 100) μH	0.4 μH	
	(100 to < 1 000) μH	6.5 μH	
	(1 to < 10) mH	6 μH	
	(10 to < 100) mH	18 μH	
	(100 to 1 000) mH	0.15 mH	
	(1 to 10) kHz		
	(10 to < 100) μH	0.2 μH	
	(100 to < 1 000) μH	0.2 μH	
	(1 to < 10) mH	1.7 μH	
(10 to < 100) mH	6.5 μH		
(100 to < 1 000) mH	95 μH		
(100 to 1 000) Hz			
(1 to 10) H	13 mH		



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Resistance – Source/Measure ¹	100 Hz to < 10 kHz		Standard Resistors, Keysight E4980AL Precision LCR Meter; CP-EL60: Direct and Comparison Measurement
	(100 to < 1 000) mΩ	30 μΩ	
	(1 to < 10) Ω	0.22 mΩ	
	(10 to < 100) Ω	1 mΩ	
	(100 to < 1 000) Ω	10 mΩ	
	(1 to < 10) kΩ	1 Ω	
	(10 to 100) kΩ	1 Ω	
	(10 to < 300) kHz		
	(100 to < 1 000) mΩ	0.2 mΩ	
	(1 to < 10) Ω	0.25 mΩ	
	(10 to < 100) Ω	4.2 mΩ	
	(100 to < 1 000) Ω	40 mΩ	
	(1 to < 10) kΩ	0.4 Ω	
	(10 to 100) kΩ	5 Ω	
	300 kHz to 1 MHz		
	(10 to < 100) mΩ	15 mΩ/Ω + 0.1 μΩ	
(100 to < 1000) mΩ	13 mΩ/Ω + 4 μΩ		
(1 to < 10) Ω	1 mΩ/Ω + 10 μΩ		
(10 to < 100) Ω	0.85 mΩ/Ω + 0.1 mΩ		
(100 to < 1 000) Ω	0.85 mΩ/Ω + 1.5 mΩ		
(1 to < 10) kΩ	0.85 mΩ/Ω + 10 mΩ		
(10 to 100) kΩ	1.6 mΩ/Ω + 0.2 Ω		
Dissipation Factor – Source / Measure ^{1,6}	1 pF		Capacitor Set, Keysight E4980A Precision LCR Meter; CP-EL81: Comparison Measurement
	1 kHz	0.12	
	10 kHz	0.011	
	100 kHz	0.001 9	
	300 kHz	0.004 4	
	1 MHz	0.001 1	
	10 pF		
	100 Hz	0.18	
	120 Hz	0.18	
	1 kHz	0.012	
	10 kHz	0.002	
	100 kHz	0.001 1	
	300 kHz	0.001 4	
	1 MHz	0.001 1	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dissipation Factor – Source / Measure ^{1,6}	100 pF		Capacitor Set, Keysight E4980A Precision LCR Meter; CP-EL81: Comparison Measurement
	100 Hz	0.003	
	120 Hz	0.003	
	1 kHz	0.001 7	
	10 kHz	0.001 1	
	100 kHz	0.000 51	
	300 kHz	0.000 54	
	1 MHz	0.000 52	
	1 nF		
	100 Hz	0.000 75	
	120 Hz	0.000 75	
	1 kHz	0.000 62	
	10 kHz	0.000 51	
	100 kHz	0.000 5	
	300 kHz	0.000 51	
	1 MHz	0.000 51	
	10 nF		
	100 Hz	0.000 53	
	120 Hz	0.000 53	
	1 kHz	0.000 51	
	10 kHz	0.000 5	
	100 kHz	0.000 51	
	300 kHz	0.000 52	
	1 MHz	0.001 1	
	100 nF		
	100 Hz	0.000 5	
	120 Hz	0.000 5	
	1 kHz	0.000 5	
	10 kHz	0.000 51	
	100 kHz	0.001 1	
	300 kHz	0.001 2	
	1 MHz	0.001 7	
1 μF			
100 Hz	0.000 51		
120 Hz	0.000 51		
1 kHz	0.000 51		
10 kHz	0.001 1		
100 kHz	0.001 7		
300 kHz	0.002 8		
1 MHz	0.005 7		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
DC Power – Source ¹	0.108 9 mW to < 1.089 W (0.033 to < 33) V (3.3 to < 33) mA 1.089 mW to < 10.89 W (0.033 to < 33) V (33 to < 330) mA) 10.89 mW to < 99 W (0.033 to < 33) V (0.33 to < 3) A 99 mW to < 660 W (0.033 to < 33) V (3 to 20 A) (0.108 9 to < 33) W (33 to 1 000) V (3.3 to < 33) mA (1.089 to < 330) W (33 to 1 000) V (33 to < 330) mA 10.89 W to < 3 kW (33 to 1 000) V (0.33 to < 3) A 99 W to 20 kW (33 to 1 000) V (3 to 20) A	0.2 mW/W + 90 μW 0.2 mW/W + 0.9 mW 0.2 mW/W + 8 mW 0.6 mW/W + 80 mW 0.2 mW/W + 0.9 mW 0.2 mW/W + 9 mW 0.2 mW/W + 90 mW 0.6 mW/W + 0.9 W	Fluke 5522A Multiproduct Calibrator; CP-EL01: Direct Measurement
DC Power – Source ¹	0.33 W to < 0.544 5 kW (0.033 to < 33) V, (10 to < 16.5) A 0.544 5 W to < 4.95 kW (0.033 to < 33) V, (16.5 to < 150) A 4.95 W to < 33.825 kW (0.033 to < 33) V, (150 to 1 025) A (0.33 to < 16.83) kW (33 to 1 020) V, (10 to < 16.5) A (0.544 5 to < 153) kW (33 to 1 020) V, 16.5 A to < 150 A) 4.95 kW to 1.045 5 MW (33 to 1 020) V, (150 to 1 025) A	3.2 mW/W + 60 mW 3.2 mW/W + 0.6 W 3.2 mW/W + 6 W 3.2 mW/W + 0.6 W 3.2 mW/W + 6 W 3.2 mW/W + 60 W	Fluke 5522A Multiproduct Calibrator, 50-turn Coil; CP-EL01: Direct Measurement

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ¹ (45 to 65) Hz, PF = 1	(1.089 to < 29.7) mW (0.33 to < 3.3) V, (3.3 to < 9) mA	1.2 mW/W + 10 μW	Fluke 5522A Multiproduct Calibrator; CP-EL01: Direct Measurement
	(2.97 to < 108.9) mW (0.33 to < 3.3) V, (9 to < 33) mA)	0.8 mW/W + 10 μW	
	(10.89 to < 297) mW (0.33 to < 3.3) V, (33 to < 90) mA)	1.2 mW/W + 0.1 mW	
	29.7 mW to < 1.089 W (0.33 to < 3.3) V, (90 to < 330) mA	0.8 mW/W + 0.1 mW	
	(0.108 9 to < 2.97) W (0.33 to < 3.3) V, (0.33 to < 0.9) A	1.1 mW/W + 1 mW	
	(0.297 to < 7.26) W (0.33 to < 3.3) V, (0.9 to < 2.2) A	0.9 mW/W + 1 mW	
	(0.726 to < 14.85) W (0.33 to < 3.3) V, (2.2 to < 4.5) A	1.2 mW/W + 1 mW	
	(1.485 to < 66) W (0.33 to < 3.3) V, (4.5 to 20) A	1 mW/W + 10 mW	
	(10.89 to < 297) mW (3.3 to < 33) V, (3.3 to < 9) mA	1.2 mW/W + 10 μW	
	29.7 mW to < 1.089 W (3.3 to < 33) V, (9 to < 33) mA	0.8 mW/W + 0.1 mW	
	(0.108 9 to < 2.97) W (3.3 to < 33) V, (33 to < 90) mA	1.2 mW/W + 0.1 mW	
	(0.297 to < 10.89) W (3.3 to < 33) V, (90 to < 330) mA	0.8 mW/W + 1 mW	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ¹ (45 to 65) Hz, PF = 1	(1.089 to < 29.7) W (3.3 to < 33) V, (0.33 to < 0.9) A	1.1 mW/W + 1 mW	Fluke 5522A Multiproduct Calibrator; CP-EL01: Direct Measurement
	(2.97 to < 72.6) W (3.3 to < 33) V, (0.9 to < 2.2) A	0.9 mW/W + 10 mW	
	(7.26 to < 148.5) W (3.3 to < 33) V, (2.2 to < 4.5) A	1.2 mW/W + 10 mW	
	(14.85 to < 660) W (3.3 to < 33) V, (4.5 to 20) A	1 mW/W + 0.1 W	
	(0.108 9 to < 2.97) W (33 to < 330) V, (3.3 to < 9) mA	1.2 mW/W + 0.1 mW	
	(0.297 to < 10.89) W (33 to < 330) V, (9 to < 33) mA	0.8 mW/W + 1 mW	
	(1.089 to < 29.7) W (33 to < 330) V, (33 to < 90) mA	1.2 mW/W + 1 mW	
	(2.97 to < 108.9) W (33 to < 330) V, (90 to < 330) mA	0.8 mW/W + 10 mW	
	(10.89 to < 297) W (33 to < 330) V, (0.33 to < 0.9) A	1.1 mW/W + 10 mW	
	(29.7 to < 726) W (33 to < 330) V, (0.9 to < 2.2) A	0.9 mW/W + 0.1 W	
	(72.6 to < 1 485) W (33 to < 330) V, (2.2 to < 4.5) A	1.2 mW/W + 0.1 W	
	(148.5 to < 6 600) W (33 to < 330) V, (4.5 to 20) A	1 mW/W + 1 W	
	(1.089 to < 9) W (330 to 1 000) V, (3.3 to < 9) mA	1.2 mW/W + 0.1 mW	
	(2.97 to < 33) W (330 to 1 000) V, (9 to < 33) mA	0.8 mW/W + 1 mW	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ¹ (45 to 65) Hz, PF = 1	(10.89 to < 90) W (330 to 1 000) V, (33 to < 90) mA	1.2 mW/W + 1 mW	Fluke 5522A Multiproduct Calibrator; CP-EL01: Direct Measurement
	(29.7 to < 330) W (330 to 1 000) V, (90 to < 330) mA	0.8 mW/W + 10 mW	
	(108.9 to < 900) W (330 to 1 000) V, (0.33 to < 0.9) A	1.1 mW/W + 10 mW	
AC Power – Source ¹ (45 to 65) Hz, PF = (0.5 to 0.999)	(0.545 to < 29.67) mW (0.33 to < 3.3) V, (3.3 to < 9) mA	4 mW/W + 10 μW	Fluke 5522A Multiproduct Calibrator
	(1.485 to < 108.8) mW (0.33 to < 3.3) V, (9 to < 33) mA	4 mW/W + 10 μW	
	(5.45 to < 296.7) mW (0.33 to < 3.3) V, (33 to < 90) mA	4 mW/W + 0.1 mW	
	14.85 mW to < 1.088 W (0.33 to < 3.3) V, (90 to < 330) mA	4 mW/W + 0.1 mW	
	(54.45 to < 2.967) W (0.33 to < 3.3) V, (0.33 to < 0.9) A	4 mW/W + 1 mW	
	0.148 5 to < 7.252 7) W (0.33 to < 3.3) V, (0.9 to < 2.2) A	4 mW/W + 1 mW	
	(0.363 to < 14.835) W (0.33 to < 3.3) V, (2.2 to < 4.5) A	4 mW/W + 1 mW	
		4 mW/W + 1 mW	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ¹ (45 to 65) Hz, PF = (0.5 to 0.999)	(0.742 5 to < 65.934) W (0.33 to < 3.3) V, (4.5 A to 20) A	4 mW/W + 10 mW	Fluke 5522A Multiproduct Calibrator; CP-EL01: Direct Measurement
	(5.45 to < 296.7) mW (3.3 to < 33) V, (3.3 to < 9) mA	4 mW/W + 10 μW	
	14.85 mW to < 1.088 W (3.3 to < 33) V, (9 to < 33) mA	4 mW/W + 0.1 mW	
	54.45 mW to < 2.967 W (3.3 to < 33) V, (33 to < 90) mA	4 mW/W + 0.1 mW	
	(0.148 5 to < 10.88) W (3.3 to < 33) V, (90 < 330) mA)	4 mW/W + 1 mW	
	(0.544 5 to < 29.67) W (3.3 to < 33) V, (0.33 to < 0.9) A	4 mW/W + 1 mW	
	(1.485 to < 72.527) W (3.3 to < 33) V, (0.9 to < 2.2) A	4 mW/W + 10 mW	
	(3.63 to < 148.35) W (3.3 to < 33) V, (2.2 to < 4.5) A	4 mW/W + 10 mW	
	(7.425 to < 659.34) W (3.3 to < 33) V, (4.5 to 20) A	4 mW/W + 0.1 W	
	54.45 mW to < 2.967 W (33 to < 330) V, (3.3 to < 9) mA	4 mW/W + 0.1 mW	
	(0.148 5 to < 10.88) W (to < 330) V, (9 to < 33) mA	4 mW/W + 1 mW	
	(0.544 5 to < 29.67) W (to < 330) V, (to < 90) mA	4 mW/W + 1 mW	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ¹ (45 to 65) Hz, PF: (0.5 to 0.999)	(1.485 to < 108.8) W (33 to < 330) V, (90 to < 330) mA	4 mW/W + 10 mW	Fluke 5522A Multiproduct Calibrator; CP-EL01: Direct Measurement
	(5.445 to < 296.7) W (33 to < 330) V, (0.33 to < 0.9) A	4 mW/W + 10 mW	
	(14.85 to < 725.27) W (33 to < 330) V, (0.9 to < 2.2) A	4 mW/W + 0.1 W	
	(36.3 to < 1483.5) W (33 to < 330) V, (2.2 to < 4.5) A	4 mW/W + 0.1 W	
	(74.25 to < 6593.4) W (33 to < 330) V, (4.5 to 20) A	4 mW/W + 1 W	
	(0.544 5 to < 8.991) W (330 to 1000) V, (3.3 to < 9) mA	4 mW/W + 0.1 mW	
	(1.485 to < 32.97) W (330 to 1000) V, (9 to < 33) mA	4 mW/W + 1 mW	
	(5.445 to < 89.91) W (330 to 1 000) V, (33 to < 90) mA	4 mW/W + 1 mW	
	(14.85 to < 329.7) W (330 to 1 000) V, (90 to < 330) mA	4 mW/W + 10 mW	
	(54.45 to < 899.1) W (330 to 1 000) V, (0.33 to < 0.9) A	4 mW/W + 10 mW	
	(148.5 to < 2 197.8) W (330 to 1 000) V, (0.9 to < 2.2 A)	4 mW/W + 0.1 W	
	(363 to < 4 495.5) W (330 to 1 000) V, (2.2 to < 4.5) A	4 mW/W + 0.1 W	
	(742.5 to 19 980) W (330 to 1 000) V, (4.5 A to 20) A	4 mW/W + 1 W	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power – Source ¹ (45 to 65) Hz, PF: 1	3.3 W to < 16.83 kW (0.33 to 1 020) V, (10 to < 16.5) A	3.6 mW/W + 0.6 W	Fluke 5522A Multiproduct Calibrator, 50-turn Coil; CP-EL01: Direct Measurement
	5.445 W to < 153 kW (0.33 to 1 020) V, (16.5 to < 150) A	3.6 mW/W + 6 W	
	49.5 W to 1.045 5 MW (0.33 to 1 020) V, (150 to 1 025) A	3.6 mW/W + 60 W	
AC Power – Source ¹ (45 to 65) Hz, Power factor: (0.5 to 0.999)	1.65 W to < 16.813 kW (0.33 to 1 020) V, (10 to < 16.5) A	5 mW/W + 0.6 W	Fluke 5522A Multiproduct Calibrator, 50-turn Coil; CP-EL01: Direct Measurement
	2.723 W to < 152.85 kW (0.33 to 1 020) V, (16.5 to < 150) A	5 mW/W + 6 W	
	24.75 W to 1.044 4 MW (0.33 to 1 020) V, (150 to 1 025) A	5 mW/W + 60 W	
Power Factor – Source 1,4	(45 to 65) Hz		Fluke 5522A Multiproduct Calibrator CP-EL59: Direct Measurement
	(0.174 to 0.485)	0.001 4	
	(0.5 to 0.755)	0.001 3	
	(0.766 to 0.934)	0.000 95	
	(0.94 to 0.999)	0.000 5	
1	0.000 06		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Power Quality, Single and Three Phase ^{1,3,4}			
Voltage – Measure	Up to 1000 V	0.12 % of reading + 5.8 mV	Fluke 435II Power Quality Analyzer; CP-EL64: Comparison Measurement
Current – Measure	10 mA to 1 A (> 1 to 5) A (> 5 to 600) A (> 600 to 6 000) A	1.2 % of reading + 8.2 mA 1.2 % of reading + 5.8 mA 0.58 % of reading + 0.58 A 0.58 % of reading + 5.8 A	
Power Watt (W)	6 000 MW, 50/60 Hz	0.44 % of reading + 0.1 W	
Power VA (VA)	6 000 MW, 50/60 Hz	0.44 % of reading + 0.1 VA	
Power Var	6 000 MW, 50/60 Hz	0.44 % of reading + 0.1 var	
Energy (kWh)	50/60 Hz	0.44 % of reading + 0.1 kWh	
Energy (kVAh)	50/60 Hz	0.44 % of reading + 0.1 kVAh	
Frequency	(42.5 to 69) Hz	1.5 mHz	
Phase Angle	Up to 360°	1.3°	
Power Factor	Up to 1 PF	0.12 % of reading + 0.000 58	
AC Watt-hour Source ¹ (Single Phase)	0.010 89 Wh to 200 kWh Voltage range (0.33 to 1 000) V (45 to 65) Hz, cos φ = 1.0 Current range 3.3 mA to 20 A	1 mWh/Wh	Fluke 5522A Multiproduct Calibrator, Casio HS-70W Stopwatch; CP-EL38: Direct Measurement
Charge Plate Monitor ¹	(-5 to -1) kV -1 kV to 0 V 0 V to 1 kV (1 to 5) kV (> 5 to 10) kV	12 mV/V + 2.6 V 12 mV/V + 2.5 V 12 mV/V + 2.5 V 12 mV/V + 2.6 V 38 mV/V + 36 V	Ion Monitor 91-0210 Charged Plate Monitor; CP-EL41: Direct Measurement
Phase Measure ¹	Up to 360 ° 10 Hz to 10 kHz (10 to 100) kHz	0.01 ° 0.063 °	Agilent 53131A or Agilent 53132A Universal Counter; CP-EL36: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Earth Ground Continuity, Ground Bond ¹ Test Current: (3 to 30) A	0.01 Ω 0.1 Ω 0.2 Ω 0.5 Ω 1 Ω 5 Ω	0.45 mΩ/Ω + 0.6 mΩ 0.45 mΩ/Ω + 0.6 mΩ 0.45 mΩ/Ω + 0.6 mΩ 0.45 mΩ/Ω + 0.6 mΩ 0.45 mΩ/Ω + 0.6 mΩ 0.45 mΩ/Ω + 0.6 mΩ	Standard Resistor DR30A, Current Shunt; CP-EL40: Direct Measurement
Transformer Ratio – Source ¹	(1 to 10 000 000) turns	0.000 12 % of reading	Tegam DT72A Ratio Transformer; CP-EL47: Direct Measurement
Gauss Meter, Tesla Meter ¹ (North and South)	297 G 957 G 1 030 G 2 960 G 5 100 G 10 250 G	13 G 20 G 23 G 53 G 77 G 120 G	F.W. Bell Inc. VA-071A, VA-072A, Magnet 10000 G, Reference Magnet; CP-EL52: Direct Measurement
Gauss – Measure ¹	Up to 2 G (> 2 to 20) G (> 20 to 200) G (> 200 to 2 000) G (> 2 000 to 20 000) G	0.58 % of reading + 0.007 G 0.58 % of reading + 0.07G 0.58 % of reading + 0.3 G 0.58 % of reading + 3 G 0.58 % of reading + 30 G	F.W. Bell 9200, F.W. Bell 5180, Standard Gauss Meter; CP-EL61: Direct Measurement
Oscilloscopes ¹ Square Wave Signal Impedance: 50 Ω @ 10 Hz to 10 kHz Impedance: 1 MΩ 10 Hz to 1 kHz Impedance: 1 MΩ 1 kHz to 10 kHz	1 mVp-p to 25 mVp-p 25 mVp-p to 110 mVp-p 110 mVp-p to 2.2 Vp-p 2.2 Vp-p to 6.6 Vp-p 1 mVp-p to 25 mVp-p 25 mVp-p to 110 mVp-p 110 mVp-p to 2.2 Vp-p 2.2 Vp-p to 11 Vp-p 11 Vp-p to 130 Vp-p 1 mVp-p to 25 mVp-p 25 mVp-p to 110 mVp-p 110 mVp-p to 2.2 Vp-p 2.2 Vp-p to 11 Vp-p 11 Vp-p to 130 Vp-p	2 mV/V + 35 μV 2 mV/V + 35 μV 2 mV/V + 50 μV 2 mV/V + 50 μV 0.4 mV/V + 4 μV 0.4 mV/V + 4 μV 0.4 mV/V + 70 μV 0.4 mV/V + 0.6 mV 0.4 mV/V + 6 mV 2 mV/V + 32 μV 2 mV/V + 32 μV 2 mV/V + 70 μV 2 mV/V + 0.6 mV 2 mV/V + 6 mV	Fluke 5820A Oscilloscope Calibrator; CP-EL28: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ¹ DC Signal Impedance: 50 Ω	0 mV to 25 mV 25 mV to 110 mV 110 mV to 2.2 V 2.2 V to 6.6 V	2 mV/V + 35 μV 2 mV/V + 35 μV 2 mV/V + 50 μV 2 mV/V + 50 μV	Fluke 5820A Oscilloscope Calibrator; CP-EL28: Direct Measurement
DC Signal Impedance: 1 MΩ	0 mV to 25 mV 25 mV to 110 mV 110 mV to 2.2 V 2.2 V to 11 V 11 V to 130 V	0.2 mV/V + 20 μV 0.2 mV/V + 20 μV 0.2 mV/V + 50 μV 0.2 mV/V + 50 μV 0.2 mV/V + 0.7 mV	
Oscilloscope Bandwidth ¹ 5 mVp-p to 5.5 Vp-p	50 kHz to 100 MHz 100 MHz to 300 MHz 300 MHz to 500 MHz 500 MHz to 600 MHz	26 mV/V + 80 μV 28 mV/V + 80 μV 36 mV/V + 80 μV 39 mV/V + 80 μV	Fluke 5820A Oscilloscope Calibrator; CP-EL28: Direct Measurement
5 mVp-p to 3.5 Vp-p	600 MHz to 1.1 GHz	45 mV/V + 80 μV	
Oscilloscopes ¹ Horizontal Deflection Time Markers	5 s 2 s 1 s 0.5 s 0.2 s 0.1 s 50 ms 20 ms 10 ms 5 ms 2 ms 1 ms 0.5 ms 0.2 ms 0.1 ms 50 μs 20 μs 10 μs 5 μs 2 μs 1 μs 0.5 μs 0.2 μs 0.1 μs	2 μs/s + 0.1 ms 2 μs/s + 20 μs 2 μs/s + 6 μs 2 μs/s + 2 μs 2 μs/s + 0.3 μs 2 μs/s + 0.2 ns 2 μs/s + 20 ns 0.26 μs/s + 6 ns 0.26 μs/s + 6 ns 0.26 μs/s + 0.6 ns 0.26 μs/s + 0.6 ns 0.26 μs/s + 0.6 ns 0.26 μs/s + 60 ps 0.26 μs/s + 60 ps 0.26 μs/s + 60 ps 0.26 μs/s + 6 ps 0.26 μs/s + 6 ps 0.26 μs/s + 6 ps 0.26 μs/s + 0.6 ps 0.26 μs/s + 0.6 ps 0.26 μs/s + 0.6 ps 0.26 μs/s + 60 fs 0.26 μs/s + 60 fs 0.26 μs/s + 60 fs	Fluke 5820A Oscilloscope Calibrator; CP-EL28: Direct Measurement

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscopes ¹ Horizontal Deflection Time Markers	50 ns 20 ns 10 ns 5 ns 2 ns	0.26 μs/s + 6 fs 0.26 μs/s + 6 fs 0.26 μs/s + 6 fs 0.26 μs/s + 0.6 fs 0.26 μs/s + 0.6 fs	Fluke 5820A Oscilloscope Calibrator; CP-EL28: Direct Measurement
Temperature – Simulation Resistance Temperature Detector ¹	Pt100 (385) (-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	0.082 °C 0.082 °C 0.1 °C 0.12 °C 0.13 °C 0.16 °C 0.28 °C	Fluke 5522A Multiproduct Calibrator; CP-EL08: Direct Measurement
Temperature – Simulation Thermocouple ¹ (With Internal Cold Junction Compensation)	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 J (-210 to -100) °C (> -100 to -30) °C (> -30 to 150) °C (> 150 to 760) °C (> 760 to 1 200) °C Type T (-250 to -150) °C (> -150 to 0) °C (> 0 to 120) °C (> 120 to 400) °C Type R (0 to 250) °C (> 250 to 400) °C (> 400 to 1 000) °C (> 1 000 to 1 767) °C	0.23 °C 0.21 °C 0.2 °C 0.21 °C 0.21 °C 0.22 °C 0.2 °C 0.2 °C 0.2 °C 0.21 °C 0.34 °C 0.21 °C 0.2 °C 0.2 °C 0.51 °C 0.43 °C 0.42 °C 0.44 °C	Comparison to Fluke 5522A Multiproduct Calibrator, Wavetek 1281 8.5 Digit Multimeter, Fluke 5618B PRT Standard; CP-EL09: Based on EURAMET cg-11



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Simulation Thermocouple ¹ (With Internal Cold Junction Compensation)	Type S (0 to 250) °C	0.54 °C	Comparison to Fluke 5522A Multiproduct Calibrator, Wavetek 1281 8.5 Digit Multimeter, Fluke 5618B PRT Standard; CP-EL09: Based on EURAMET cg-11
	(> 250 to 400) °C	0.48 °C	
	(> 400 to 1 000) °C	0.48 °C	
	(> 1 000 to 1 767) °C	0.49 °C	
	Type E (-250 to -100) °C	0.28 °C	
	(> -100 to -25) °C	0.21 °C	
	(> -25 to 350) °C	0.2 °C	
	(> 350 to 650) °C	0.2 °C	
	(> 650 to 1 000) °C	0.21 °C	
	Type N (-200 to -100) °C	0.27 °C	
	(> -100 to -25) °C	0.22 °C	
	(> -25 to 120) °C	0.21 °C	
	(> 120 to 410) °C	0.21 °C	
	(> 410 to 1 300) °C	0.21 °C	
Temperature – Simulation Thermocouple ¹ (With cold junction compensation)	Type K (-200 to -100) °C	0.3 °C	Fluke 5522A Multiproduct Calibrator; CP-EL18: Based on EURAMET cg-11
	(> -100 to -25) °C	0.2 °C	
	(> -25 to 120) °C	0.19 °C	
	(> 120 to 1 000) °C	0.25 °C	
	(> 1 000 to 1 372) °C	0.35 °C	
	Type J (-210 to -100) °C	0.26 °C	
	(> -100 to -30) °C	0.19 °C	
	(> -30 to 150) °C	0.18 °C	
	(> 150 to 760) °C	0.2 °C	
	(> 760 to 1 200) °C	0.23 °C	
	Type T (-250 to -150) °C	0.52 °C	
	(> -150 to 0) °C	0.18 °C	
	(> 0 to 120) °C	0.47 °C	
	(> 120 to 400) °C	0.26 °C	
	Type R (0 to 250) °C	0.48 °C	
	(> 250 to 400) °C	0.32 °C	
	(> 400 to 1 000) °C	0.3 °C	
	(> 1 000 to 1 767) °C	0.35 °C	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Simulation Thermocouple ¹ (With cold junction compensation)	Type S (0 to 250) °C	0.4 °C	Fluke 5522A Multiproduct Calibrator; CP-EL18: Based on EURAMET cg-11
	(> 250 to 400) °C	0.4 °C	
	(> 400 to 1 000) °C	0.32 °C	
	(> 1 000 to 1 767) °C	0.39 °C	
	Type E (-250 to -100) °C	0.42 °C	
	(> -100 to -25) °C	0.19 °C	
	(> -25 to 350) °C	0.18 °C	
	(> 350 to 650) °C	0.19 °C	
	(> 650 to 1 000) °C	0.22 °C	
	Type N (-200 to -100) °C	0.35 °C	
	(> -100 to -25) °C	0.23 °C	
	(> -25 to 120) °C	0.21 °C	
	Temperature Transmitter ¹ Electrical Output Current (0 to 20) mA, Thermocouple	Type E (-250 to -100) °C	
(> -100 to -25) °C		0.18 °C	
(> -25 to 350) °C		0.18 °C	
(> 350 to 650) °C		0.18 °C	
(> 650 to 1 000) °C		0.21 °C	
Type N (-200 to -100) °C		0.34 °C	
(> -100 to -25) °C		0.21 °C	
(> -25 to 120) °C		0.19 °C	
(> 120 to 410) °C		0.19 °C	
(> 410 to 1 300) °C		0.25 °C	
Type J (-210 to -100) °C		0.24 °C	
(> -100 to -30) °C		0.18 °C	
(> -30 to 150) °C		0.18 °C	
(> 150 to 760) °C		0.18 °C	
(> 760 to 1 200) °C		0.22 °C	
Type K (-200 to -100) °C		0.28 °C	
(> -100 to -25) °C		0.18 °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		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Transmitter ¹ Electrical Output Current (0 to 20) mA, Thermocouple	Type T (-250 to -150) °C (> -150 to 0) °C (> 0 to 120) °C (> 120 to 400) °C Type B (600 to 800) °C (> 800 to 1 000) °C (> 1 000 to 1 550) °C (> 1 550 to 1 820) °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	0.5 °C 0.22 °C 0.17 °C 0.17 °C 0.36 °C 0.29 °C 0.29 °C 0.29 °C 0.46 °C 0.3 °C 0.3 °C 0.34 °C 0.38 °C 0.31 °C 0.31 °C 0.38 °C	Fluke 5522A Multiproduct Calibrator, Fluke 754 Documenting Process Calibrator; CP-EL77: Direct Measurement
Temperature Transmitter ¹ Electrical Output Current (0 to 20) mA, Resistance Temperature Detector (RTD)	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 3916, 100 Ω (JPT) (-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	0.11 °C 0.11 °C 0.13 °C 0.14 °C 0.15 °C 0.16 °C 0.22 °C 0.22 °C 0.12 °C 0.12 °C 0.12 °C 0.13 °C 0.14 °C 0.14 °C 0.14 °C 0.15 °C 0.22 °C	Fluke 5522A Multiproduct Calibrator, Fluke 754 Documenting Process Calibrator; CP-EL77: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Transmitter ¹ Electrical Output Current (0 to 20) mA, Resistance Temperature Detector (RTD)	Pt 385, 1 000 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	0.11 °C 0.11 °C 0.12 °C 0.13 °C 0.13 °C 0.14 °C 0.14 °C 0.22 °C	Fluke 5522A Multiproduct Calibrator, Fluke 754 Documenting Process Calibrator; CP-EL77: Direct Measurement
Temperature Transmitter ¹ Electrical Output Voltage (0 to 10) V, Thermocouple	Type B (600 to 800) °C (> 800 to 1 000) °C (> 1 000 to 1 550) °C (> 1 550 to 1 820) °C Type E (-250 to -100) °C (> -100 to -25) °C (> -25 to 350) °C (> 350 to 650) °C (> 650 to 1 000) °C Type J (-210 to -100) °C (> -100 to -30) °C (> -30 to 150) °C (> 150 to 760) °C (> 760 to 1 200) °C Type K (-200 to -100) °C (> -100 to -25) °C (> -25 to 120) °C (> 120 to 1 000) °C (> 1 000 to 1 372) °C Type N (-200 to -100) °C (> -100 to -25) °C (> -25 to 120) °C (> 120 to 410) °C (> 410 to 1 300) °C	0.35 °C 0.27 °C 0.27 °C 0.27 °C 0.39 °C 0.13 °C 0.13 °C 0.14 °C 0.18 °C 0.22 °C 0.13 °C 0.13 °C 0.15 °C 0.2 °C 0.26 °C 0.15 °C 0.15 °C 0.21 °C 0.32 °C 0.32 °C 0.18 °C 0.16 °C 0.16 °C 0.22 °C	Fluke 5522A Multiproduct Calibrator, Fluke 754 Documenting Process Calibrator; CP-EL77: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Transmitter ¹ Electrical Output Voltage (0 to 10) V, Thermocouple	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	0.45 °C 0.28 °C 0.28 °C 0.32 °C 0.37 °C 0.3 °C 0.3 °C 0.37 °C 0.49 °C 0.19 °C 0.14 °C 0.13 °C	Fluke 5522A Multiproduct Calibrator, Fluke 754 Documenting Process Calibrator; CP-EL77: Direct Measurement
Temperature Transmitter ¹ Electrical Output Voltage (0 to 10) V Resistance Temperature Detector (RTD)	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 3916, 100 Ω (JPT) (-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 Pt 385, 1 000 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	0.045 °C 0.046 °C 0.065 °C 0.082 °C 0.093 °C 0.12 °C 0.19 °C 0.2 °C 0.04 °C 0.06 °C 0.063 °C 0.075 °C 0.087 °C 0.092 °C 0.098 °C 0.19 °C 0.029 °C 0.034 °C 0.045 °C 0.057 °C 0.069 °C 0.081 °C 0.081 °C 0.19 °C	Fluke 5522A Multiproduct Calibrator, Fluke 754 Documenting Process Calibrator; CP-EL77: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Multimeter: up to 7.5 Digits DC Voltage – Source	Up to 200 mV 200 mV to < 2 V (2 to < 20) V (20 to < 200) V (200 to 1 000) V	8.5 $\mu\text{V/V} + 0.72 \mu\text{V}$ 7.1 $\mu\text{V/V} + 1.2 \mu\text{V}$ 7.1 $\mu\text{V/V} + 7.5 \mu\text{V}$ 12 $\mu\text{V/V} + 92 \mu\text{V}$ 12 $\mu\text{V/V} + 0.68 \text{ mV}$	Fluke 5522A Multiproduct Calibrator, Wavetek 1281 8.5 Digit Multimeter CP-EL54: Comparison Measurement
Digital Multimeter: up to 7.5 Digits DC Current – Source	Up to 200 μA 200 μA to < 2 mA (2 to < 20) mA (20 to < 200) mA 200 mA to < 2 A	0.12 mA/A + 5.9 nA 0.12 mA/A + 8.3 nA 0.12 mA/A + 83 nA 0.12 mA/A + 1.4 μA 0.24 mA/A + 26 μA	Fluke 5522A Multiproduct Calibrator, Wavetek 1281 8.5 Digit Multimeter CP-EL54: Comparison Measurement
Digital Multimeter: up to 7.5 Digits AC Voltage – Source	(20 to 40) Hz (10 to < 200) mV 200 mV to < 2 V (2 to < 20) V (20 to < 200) V (200 to 1 000) V (> 40 to 100) Hz (10 to < 200) mV 200 mV to < 2 V 2 to < 20) V (20 to < 200) V (200 to 1 000) V > 100 Hz to 2 kHz (10 to < 200) mV 200 mV to < 2 V (2 to < 20) V (20 to < 200) V (200 to 1 000) V	0.27 mV/V + 4.7 μV 0.2 mV/V + 25 μV 0.2 mV/V + 0.24 mV 0.2 mV/V + 2.5 mV 0.2 mV/V + 14 mV 0.25 mV/V + 4.7 μV 0.18 mV/V + 25 μV 0.18 mV/V + 0.24 mV 0.18 mV/V + 2.5 mV 0.18 mV/V + 14 mV 0.25 mV/V + 2.5 μV 0.16 mV/V + 24 μV 0.16 mV/V + 0.24 mV 0.16 mV/V + 2.5 mV 0.18 mV/V + 14 mV	Fluke 5522A Multiproduct Calibrator, Wavetek 1281 8.5 Digit Multimeter CP-EL54: Comparison Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Multimeter: up to 7.5 Digits AC Voltage – Source	(2 to 10) kHz (10 to < 200) mV 200 mV to < 2 V (2 to < 20) V (20 to < 200) V (200 to 1 000) V (10 to 30) kHz (10 to < 200) mV 200 mV to < 2 V (2 to < 20) V (20 to < 200) V (200 to 1 000) V (> 30 to 100) kHz (10 to < 200) mV 200 mV to < 2 V (2 to < 20) V (20 to < 200) V (200 to 1 000) V (> 100 to 300) kHz 200 mV to < 2 V (2 to < 20) V (20 to < 200) V (> 300 kHz to 1 MHz (2 to < 20) V (20 to < 200) V	0.25 mV/V + 4.7 μV 0.18 mV/V + 24 μV 0.18 mV/V + 0.25 mV 0.18 mV/V + 2.6 mV 0.18 mV/V + 14 mV 0.47 mV/V + 9.3 μV 0.29 mV/V + 47 μV 0.29 mV/V + 0.47 mV 0.29 mV/V + 4.7 mV 0.25 mV/V + 24 mV 0.82 mV/V + 24 μV 0.58 mV/V + 0.24 mV 0.58 mV/V + 2.4 mV 0.58 mV/V + 24 mV 0.58 mV/V + 0.12 V 3.5 mV/V + 2.4 mV 3.5 mV/V + 24 mV 3.5 mV/V + 0.24 V 12 mV/V + 1.2 mV 12 mV/V + 2.4 V	Fluke 5522A Multiproduct Calibrator, Wavetek 1281 8.5 Digit Multimeter CP-EL54: Comparison Measurement
Digital Multimeter: up to 7.5 Digits AC Current – Source	10 Hz to 5 kHz (10 to < 200) μA 200 μA to < 2 mA (2 to < 20) mA (20 to < 200) mA 10 Hz to 1 kHz 200 mA to < 2 A (> 1 to 5) kHz 200 mA to < 2 A	0.36 mA/A + 25 nA 0.35 mA/A + 0.25 μA 0.35 mA/A + 2.5 μA 0.35 mA/A + 25 μA 0.7 mA/A + 0.48 mA 2.4 mA/A + 0.94 mA	Fluke 5522A Multiproduct Calibrator, Wavetek 1281 8.5 Digit Multimeter CP-EL54: Comparison Measurement
Digital Multimeter: up to 7.5 Digits Resistance – Source	Up to 20 Ω (20 to < 200) Ω 200 Ω to < 2 kΩ (2 to < 20) kΩ (20 to < 200) kΩ 200 kΩ to < 2 MΩ (2 to < 20) MΩ	18 μΩ/Ω + 27 μΩ 13 μΩ/Ω + 0.12 mΩ 11 μΩ/Ω + 1.1 mΩ 11 μΩ/Ω + 12 mΩ 11 μΩ/Ω + 0.14 Ω 17 μΩ/Ω + 5 Ω 35 μΩ/Ω + 0.17 kΩ	Fluke 5522A Multiproduct Calibrator, Wavetek 1281 8.5 Digit Multimeter CP-EL54: Comparison Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Multimeter: up to 7.5 Digits Resistance – Source ¹	(20 to < 200) MΩ 200 MΩ to < 2 GΩ	0.35 mΩ/Ω + 13 kΩ 3.5 mΩ/Ω + 1.1 MΩ	Fluke 5522A Multiproduct Calibrator, Wavetek 1281 8.5 Digit Multimeter CP-EL54: Comparison Measurement
Oscilloscope Calibrators ¹ DCV Amplitude 1 MΩ load 50 Ω load	Up to ± 100 mV ± (> 0.1 to 1) mV ± (> 1 to 10) V ± (> 10 to 100) V ± (> 100 to 130) V Up to ± 100 mV ± (> 0.1 to 1) mV ± (> 1 to 6.6) V	8.5 μV/V + 1 μV 7.5 μV/V + 1 μV 7.5 μV/V + 5 μV 9.5 μV/V + 0.1 mV 10 μV/V + 2 mV 0.12 mV/V + 1 μV 0.12 mV/V + 1 μV 0.12 mV/V + 5 μV	Keysight 3458A 8.5 Digit Multimeter CP-EL71: Direct Measurement
Oscilloscope Calibrators ¹ AC Square Wave Amplitude 1 MΩ load 50 Ω load	at 10 Hz, 100 Hz Up to 100 mVp-p (> 0.1 to 1) Vp-p (> 1 to 12) Vp-p at 1 kHz, 5 kHz, 10 kHz Up to 100 mVp-p (> 0.1 to 1) Vp-p (> 1 to 12) Vp-p	0.12 mV/V + 1 μV 0.12 mV/V + 1 μV 0.12 mV/V + 2 μV 0.19 mV/V + 1 μV 0.12 mV/V + 1 μV 0.12 mV/V + 2 μV	Keysight 3458A 8.5 Digit Multimeter; CP-EL71: Direct Measurement
Oscilloscope Calibrators ¹ Edge Amplitude 50 Ω load	at 10 Hz, 100 Hz Up to 100 mVp-p (> 0.1 to 1) Vp-p (> 1 to 12) Vp-p at 1 kHz, 5 kHz, 10 kHz Up to 100 mVp-p (> 0.1 to 1) Vp-p (> 1 to 12) Vp-p	0.12 mV/V + 1 μV 0.12 mV/V + 20 μV 0.12 mV/V + 20 μV 0.19 mV/V + 1 μV 0.12 mV/V + 20 μV 0.12 mV/V + 20 μV	Keysight 3458A 8.5 Digit Multimeter, (Top line & Base line DCV Measure) CP-EL71: Direct Measurement



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Oscilloscope Calibrators ¹ Leveled Sine Wave Amplitude 50 Ω load	Up to 10 mV 50 kHz (> 50 to 100) kHz (> 100 to 300) kHz (> 300 to 500) kHz > 500 kHz to 1 MHz (> 1 to 4) MHz (> 4 to 8) MHz (> 8 to 10) MHz (> 10 to 100) mV 50 kHz (> 50 to 100) kHz (> 100 to 300) kHz (> 300 to 500) kHz > 500 kHz to 1 MHz (> 1 to 4) MHz (> 4 to 8) MHz (> 8 to 10) MHz (> 0.1 to 1) V 50 kHz (> 50 to 100) kHz (> 100 to 300) kHz (> 300 to 500) kHz > 500 kHz to 1 MHz (> 1 to 4) MHz (> 4 to 8) MHz (> 8 to 10) MHz (> 1 to 12) V 50 kHz (> 50 to 100) kHz (> 100 to 300) kHz (> 300 to 500) kHz > 500 kHz to 1 MHz (> 1 to 4) MHz (> 4 to 8) MHz (> 8 to 10) MHz	1.2 mV/V + 3 μV 5.8 mV/V + 3 μV 47 mV/V + 3 μV 14 mV/V + 6 μV 14 mV/V + 6 μV 81 mV/V + 6 μV 1.2 mV/V + 9 μV 24 % of reading + 10 μV 0.38 mV/V + 3 μV 0.94 mV/V + 3 μV 3.5 mV/V + 20 μV 12 mV/V + 20 μV 12 mV/V + 20 μV 47 mV/V + 90 μV 47 mV/V + 0.1 mV 18 % of reading + 0.2 mV 0.38 mV/V + 30 μV 0.94 mV/V + 30 μV 3.5 mV/V + 0.2 mV 12 mV/V + 0.2 mV 12 mV/V + 0.2 mV 47 mV/V + 0.9 mV 47 mV/V + 1 mV 18 % of reading + 2 mV 0.38 mV/V + 0.3 mV 0.94 mV/V + 0.3 mV 3.5 mV/V + 2 mV 12 mV/V + 2 mV 12 mV/V + 2 mV 47 mV/V + 0.9 mV 47 mV/V + 10 mV 18 % of reading + 20 mV	Keysight 3458A 8.5 Digit Multimeter CP-EL71: Direct Measurement

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Multifunction Energy Source/Generator ^{1,4} (45 to 65) Hz, (0.1 to 1) Power Factor			
AC Voltage	50 mV to 150 V (> 150 to 600) V	0.48 mV/V + 1.5 mV 0.48 mV/V + 15 mV	CALMET TS33 Three-phase Power/Energy Automatic Test System CP-EL72: Direct Measurement
AC Current	10 mA to 1 A (> 1 to 12) A	0.48 mA/A + 15 μ A 0.48 mA/A + 0.15 mA	
Frequency	50 mV to 600 V, 10 mA to 12 A (45 to 65) Hz	0.012 % of reading + 15 mHz	
Phase	50 mV to 600 V, 10 mA to 12 A (0 to 360) °	0.012 % of reading + 0.015 °	
Power Factor	50 mV to 600 V, 10 mA to 12 A	0.012 % of reading + 0.001 5	
Active Power	50 mV to 600 V, 10 mA to 12 A 0.5 mW to 7.2 kW	0.05 % of reading	
Reactive Power	50 mV to 600 V, 10 mA to 12 A (0.000 5 to 7 200) Var	0.05 % of reading	
Apparent Power	50 mV to 600 V, 10 mA to 12 A (0.000 5 to 7 200) VA	0.05 % of reading	
Active Energy	50 mV to 600 V, 10 mA to 12 A 0.5 mWh to 7.2 kWh	0.05 % of reading	
Reactive Energy	50 mV to 600 V, 10 mA to 12 A (0.000 5 to 7 200) Var	0.05 % of reading	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Multifunction Energy Source/Generator ¹ (45 to 65) Hz, (0.1 to 1) Power Factor			
Apparent Energy	50 mV to 600 V, 10 mA to 12 A (0.000 5 to 7 200) Vah	0.05 % of reading	CALMET TS33 Three-phase Power/Energy Automatic Test System CP-EL72: Direct Measurement
Meter Error Calibration	50 mV to 600 V 10 mA to 12 A (0.000 5 to 7 200) VAh (0.000 5 to 7 200) Varh (0.000 5 to 7 200) Wh	0.05 % of reading 0.05 % of reading 0.05 % of reading	
Multifunction Energy – Measure ^{1,4} (45 to 65) Hz, (0.1 to 1) Power Factor			
AC Voltage	50 mV to 300 V > 300 V to 600 V	0.48 mV/V + 1 mV 0.48 mV/V + 2 mV	CALMET TS33 Three-phase Power/Energy Automatic Test System (Meter Error Calibration); CP-EL72: Direct Measurement
AC Current	10 mA to 0.12 A (> 0.12 to 1) A (> 1 to 12) A (> 12 to 120) A	0.48 mA/A + 2 μA 0.48 mA/A + 20 μA 0.48 mA/A + 0.2 mA 0.48 mA/A + 2 mA	
Frequency	50 mV to 600 V / 10 mA to 12 A (45 to 65) Hz	0.012% of reading + 15 mHz	
Phase	50 mV to 600 V / 10 mA to 12 A (0 to 360) °	0.012% of reading + 0.025 °	
Power Factor	50 mV to 600 V 10 mA to 12 A (0.1 to 1) PF	0.012 % of reading + 0.001 5	
Active Power	50 mV to 600 V 10 mA to 120 A 0.5 mW to 72 kW	0.05 % of reading	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Multifunction Energy – Measure ¹ (45 to 65) Hz, (0.1 to 1) Power Factor			
Reactive Power	50 mV to 600 V / 10 mA to 120 A (0.5 to 72) kVar	0.05 % of reading	CALMET TS33 Three-phase Power/Energy Automatic Test System (Meter Error Calibration); CP-EL72: Direct Measurement
Apparent Power	50 mV to 600 V / 10 mA to 120 A 0.5 mVA to 72 kVA	0.05 % of reading	
Active Energy	50 mV to 600 V / 10 mA to 120 A 0.5 mWh to 72 kWh	0.05 % of reading	
Reactive Energy	50 mV to 600 V / 10 mA to 120 A 0.5 mVarh to 72 kVarh	0.05 % of reading	
Apparent Energy	50 mV to 600 V 10 mA to 120 A 0.5 mVAh to 72 kVAh	0.05 % of reading	

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned Absolute RF Power – Measure ^{1,2}	2.5 MHz to 1.3 GHz (-127 to < -120) dBm (-120 to < -110) dBm (-110 to < -90) dBm (-90 to < -80) dBm (-80 to < -60) dBm (-60 to < -40) dBm (-40 to < -10) dBm (-10 to 0) dBm	0.3 dB 0.2 dB 0.19 dB 0.18 dB 0.16 dB 0.15 dB 0.13 dB 0.12 dB	HP 11722A Power Sensor, With Agilent 8902A Measuring Receiver; CP-EL31: Direct Measurement



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned Absolute RF Power – Measure ^{1,2}	(> 1.3 to 2.6) GHz (-127 to < -120) dBm (-120 to < -110) dBm (-110 to < -90) dBm (-90 to < -80) dBm (-80 to < -60) dBm (-60 to < -40) dBm (-40 to < -10) dBm (-10 to 0) dBm	0.3 dB 0.2 dB 0.19 dB 0.18 dB 0.16 dB 0.15 dB 0.13 dB 0.12 dB	HP 11722A Power Sensor, Agilent 11793A Down Converter, Agilent 8902A Measuring Receiver; CP-EL31: Direct Measurement
Tuned Absolute RF Power – Measure ^{1,2}	50 MHz to 1.3 GHz (-117 to < -110) dBm (-110 to < -90) dBm (-90 to < -80) dBm (-80 to < -60) dBm (-60 to < -40) dBm (-40 to < -10) dBm (-10 to 10) dBm	0.2 dB 0.19 dB 0.18 dB 0.16 dB 0.15 dB 0.13 dB 0.12 dB	HP 11792A Power Sensor, Agilent 8902A Measuring Receiver; CP-EL31: Direct Measurement
Tuned Absolute RF Power – Measure ^{1,2}	(> 1.3 to 12.4) GHz (-105 to < -100) dBm (-100 to < -80) dBm (-80 to < -60) dBm (-60 to < -40) dBm (-40 to < -20) dBm (-20 to 5) dBm (> 12.4 to 18) GHz (-100 to < -80) dBm (-80 to < -50) dBm (-50 to < -40) dBm (-40 to 5) dBm	0.23 dB 0.22 dB 0.2 dB 0.19 dB 0.18 dB 0.17 dB 0.27 dB 0.25 dB 0.24 dB 0.23 dB	HP 11792A Power Sensor, HP 11793A Down Converter, Agilent 8902A Measuring Receiver; CP-EL31: Direct Measurement



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Tuned Relative RF Power/Attenuation – Measure ^{1,2} (0 dB Reference)	2.5 MHz to 18 GHz (-127 to < -120) dB (-120 to < -110) dB (-110 to < -100) dB (-100 to < -90) dB (-90 to < -80) dB (-80 to < -70) dB (-70 to < -60) dB (-60 to < -50) dB (-50 to < -40) dB (-40 to < -30) dB (-30 to < -20) dB (-20 to < -10) dB (-10 to 0) dB	0.28 dB 0.17 dB 0.16 dB 0.16 dB 0.15 dB 0.12 dB 0.12 dB 0.11 dB 0.1 dB 0.08 dB 0.07 dB 0.07 dB 0.06 dB	HP 11793A Down Converter, Agilent 8902A Measuring Receiver; CP-EL31: Direct Measurement
Absolute Amplitude – Source ^{1,2}	10 Hz to 20.999 MHz (-70 to 8) dBm	0.12 dB	HP 3336C Signal Generator; CP-EL32: Direct Measurement
RF Absolute Power – Source ^{1,2}	250 kHz to 3 GHz (-127 to < -110) dBm (-110 to < -50) dBm (-50 to 13) dBm (> 3 to 6) GHz (-127 to < -110) dBm (-110 to < -50) dBm (-50 to 13) dBm	1.2 dB 0.94 dB 0.72 dB 1.8 dB 1.1 dB 0.94 dB	Agilent E4438C Vector Signal Generator; CP-EL32: Direct Measurement
RF Absolute Power – Source ^{1,2}	(9 to < 250) kHz (-136 to < -100) dBm (-100 to 13) dBm 250 kHz to 2.5 GHz (-136 to < -100) dBm (-100 to 13) dBm (> 2.5 to 3.2) GHz (-136 to < -100) dBm (-100 to 13) dBm (> 3.2 to 4) GHz (-136 to < -100) dBm (-100 to 13) dBm	3.5 dB 1.2 dB 1.2 dB 1.2 dB 1.2 dB 3.5 dB 1.8 dB 3.5 dB 2.4 dB	HP 8648D Synthesized Signal Generator; CP-EL32: Direct Measurement

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Source ^{1,2}	(10 to 50) MHz (-124 to < -84) dBm (-84 to < -54) dBm (-54 to < -14) dBm (-14 to 13) dBm	4.2 dB 3 dB 2.2 dB 1.6 dB	HP 83732B Synthesized Signal Generator, HP 8496B Attenuator; CP-EL32: Direct Measurement
RF Absolute Power – Source ^{1,2}	> 50 MHz to 12.4 GHz (-124 to < -84) dBm (-84 to < -54) dBm (-54 to < -14) dBm (-14 to 13) dBm (> 12.4 to 18) GHz (-124 to < -84) dBm (-84 to < -54) dBm (-54 to < -14) dBm (-14 to 13) dBm	4.1 dB 2.9 dB 2.1 dB 1.3 dB 5.4 dB 3.7 dB 2.6 dB 1.3 dB	HP 83732B Synthesized Signal Generator, HP 8496B Attenuator; CP-EL32: Direct Measurement
RF Absolute Power – Source ^{1,2}	100 kHz to 2.6 GHz (-20 to < 20) dBm (20 to 30) dBm	0.12 dB 0.15 dB	Agilent E4438C, HP 8648D, HP 8665B, HP 83732B, Agilent N9310A Signal Generators with HP 11722A Power Sensor, Agilent 8902A Measuring Receiver, and 11667A Power Splitters; CP-EL32: Comparison Measurement
RF Absolute Power – Source ^{1,2}	50 MHz to < 2 GHz (-20 to 20) dBm (20 to 30) dBm (2 to < 10) GHz (-20 to 20) dBm (20 to 30) dBm (10 to 18) GHz (-20 to 20) dBm (20 to 30) dBm	0.13 dB 0.17 dB 0.21 dB 0.23 dB 0.25 dB 0.27 dB	Agilent E4438C, HP 8648D, HP 8665B, HP 83732B, Agilent N9310A Signal Generators with HP 11792A Power Sensor, Agilent 8902A Measuring Receiver, and 11667A Power Splitters; CP-EL32: Comparison Measurement



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Source ^{1,2}	100 kHz to 4.2 GHz (-10 to < 25) dBm (25 to 35) dBm	0.12 dB 0.26 dB	Agilent E4438C, HP 8648D, HP 8665B, HP 83732B, Agilent N9310A Signal Generators with HP 11792A Power Sensor, Agilent 8902A Measuring Receiver, and 11667A Power Splitters; CP-EL32: Comparison Measurement
RF Absolute Power – Source ^{1,2}	(-60 to < -10) dBm 9 kHz to < 2 GHz (2 to < 4) GHz (4 to < 6) GHz (4 to < 8) GHz (8 to < 14) GHz (14 to < 16) GHz (16 to 18) GHz (-10 to 20) dBm 9 kHz to < 500 MHz 500 MHz to < 1.2 GHz (1.2 to < 2) GHz (2 to < 4) GHz (4 to < 6) GHz (6 to < 8) GHz (8 to < 14) GHz (14 to < 16) GHz (16 to 18) GHz	0.17 dB 0.18 dB 0.2 dB 0.21 dB 0.22 dB 0.26 dB 0.27 dB 0.17 dB 0.17 dB 0.17 dB 0.17 dB 0.19 dB 0.2 dB 0.21 dB 0.25 dB 0.26 dB	Agilent E4438C, HP 8648D, HP 8665B, HP 83732B, Agilent N9310A Signal Generators with Agilent E4412A Power Sensor, Agilent E4419B Power Meter, and 11667A Power Splitters; CP-EL32: Comparison Measurement.



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Source ^{1,2}	(-70 to 10) dBm (10 to < 30) MHz 30 MHz to < 2 GHz (2 to < 4) GHz (4 to < 6) GHz (6 to < 8) GHz (8 to < 11) GHz (11 to 18) GHz (> 10 to 20) dBm (10 to < 30) MHz 30 MHz to < 2 GHz (2 to < 4) GHz (4 to < 6) GHz (6 to < 8) GHz (8 to < 11) GHz (11 to 18) GHz	0.18 dB 0.18 dB 0.18 dB 0.2 dB 0.21 dB 0.22 dB 0.28 dB 0.24 dB 0.23 dB 0.25 dB 0.26 dB 0.26 dB 0.27 dB 0.32 dB	Agilent E4438C, HP 8648D, HP 8665B, HP 83732B, Agilent N9310A Signal Generators with Agilent E4412A Power Sensor, Agilent E4419B Power Meter, and 11667A Power Splitters; CP-EL32: Comparison Measurement
RF Absolute Power – Source ^{1,2}	2.5 MHz to 1.3 GHz (-127 to < -120) dBm (-120 to < -100) dBm (-100 to < -80) dBm (-80 to < -50) dBm (-50 to < -40) dBm (-40 to 0) dBm	0.35 dB 0.27 dB 0.26 dB 0.24 dB 0.23 dB 0.22 dB	Agilent E4438C, HP 8648D, HP 8665B, HP 83732B, Agilent N9310A Signal Generators with HP 11722A Power Sensor, Agilent 8902A Measuring Receiver, and 11667A Power Splitters; CP-EL32: Comparison Measurement
RF Absolute Power – Source ^{1,2}	(> 1.3 to 2.6) GHz (-127 to < -120) dBm (-120 to < -100) dBm (-100 to < -80) dBm (-80 to < -50) dBm (-50 to < -40) dBm (-40 to 0) dBm	0.35 dB 0.27 dB 0.26 dB 0.24 dB 0.23 dB 0.22 dB	Agilent E4438C, HP 8648D, HP 8665B, HP 83732B, Agilent N9310A Signal Generators with HP 11722A Power Sensor, 11793A Down converter, Agilent 8902A Measuring Receiver, and 11667A Power Splitters; CP-EL32: Comparison Measurement



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Source ^{1,2}	50 MHz to 1.3 GHz (-117 to < -110) dBm (-110 to < -90) dBm (-90 to < -80) dBm (-80 to < -60) dBm (-60 to < -40) dBm (-40 to 10) dBm	0.27 dB 0.26 dB 0.25 dB 0.24 dB 0.23 dB 0.22 dB	Agilent E4438C, HP 8648D, HP 8665B, HP 83732B, Agilent N9310A Signal Generators with HP 11792A Power Sensor, Agilent 8902A Measuring Receiver, and 11667A Power Splitters; CP-EL32: Comparison Measurement
RF Absolute Power – Source ^{1,2}	(> 1.3 to 2) GHz (-105 to < -90) dBm (-90 to < -80) dBm (-80 to < -60) dBm (-60 to < -40) dBm (-40 to 5) dBm (> 2 to 4) GHz (-105 to < -80) dBm (-80 to < -50) dBm (-50 to < -40) dBm (-40 to 5) dBm (> 4 to 8) GHz (-105 to < -90) dBm (-90 to < -80) dBm (-80 to < -40) dBm (-40 to 5) dBm (> 8 to 12.4) GHz (-105 to < -80) dBm (-80 to < -50) dBm (-50 to < 5) dBm (> 12.4 to 18) GHz (-105 to < -80) dBm (-80 to < -40) dBm (-40 to < 5) dBm	0.26 dB 0.25 dB 0.24 dB 0.23 dB 0.22 dB 0.27 dB 0.25 dB 0.24 dB 0.23 dB 0.34 dB 0.33 dB 0.32 dB 0.31 dB 0.39 dB 0.38 dB 0.37 dB 0.41 dB 0.4 dB 0.39 dB	Agilent E4438C, HP 8648D, HP 8665B, HP 83732B, Agilent N9310A Signal Generators with HP 11792A Power Sensor, 11793A Down converter, Agilent 8902A Measuring Receiver, and 11667A Power Splitters; CP-EL32: Comparison Measurement

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Low Frequency – Power Source ¹	(-100 to 23) dB < 100 kHz 100 kHz to 5 MHz (> 5 to 20) MHz 10 mVp-p to 10 Vp-p 0.1 Hz to 20 MHz DC	0.12 dB 0.17 dB 0.35 dB 1.2 % of reading + 1.2 mV 2.3 % of reading + 2.3 mV	Agilent 33220A Arbitrary Function Generator, Attenuator; CP-EL73: Direct Measurement
RF Power Meter ¹ (Instrumentation Accuracy)	Zero 3.16 μW 10 μW 31.6 μW 0.1 mW 0.316 mW 1 mW 3.16 mW 10 mW 31.6 mW 0.1 W	6 nW 10 nW 40 nW 0.1 μW 0.4 μW 1 μW 4 μW 10 μW 40 μW 0.1 mW 0.4 mW	Keysight 11683A Power Meter Range calibrator; CP-EL43: Direct Measurement
Output Signal Purity – Measure ¹ (0 to 100) % Distortion Harmonic	9 kHz to 18 GHz (-130 to 30) dBm	1 dB	Keysight 8592L, Keysight 8591E Spectrum Analyzers; Keysight 8902A Measuring Receiver; Keysight 11722A, Keysight 11792A Power Sensors; CP-EL56: Direct Measurement
Non-harmonic	9 kHz to 18 GHz (-130 to 30) dBm	1 dB	
Spurious Response	9 kHz to 18 GHz (-130 to 30) dBm	1 dB	
SSB Phase Noise	9 kHz to 18 GHz (-130 to 30) dBm	1 dB	
Residual FM	250 kHz to 18 GHz	1.4 Hz	
Residual AM	150 kHz to 18 GHz	0.014 % Depth	

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Counter Sensitivity – Source ¹	(-36 to 0) dBm (3.54 to 224) mV 1 MHz to 20 MHz (-50 to 0) dBm (0.707 to 224) mV 10 Hz to 21 MHz 21 MHz to 3 GHz (> 3 to 6) GHz (> 6 to 18) GHz	0.4 dB 0.1 dB 0.71 dB 0.94 dB 1.3 dB	HP 33220A, HP 8665B, Agilent 9310A, HP 83732B, Agilent E4438C Signal Generators; CP-EL06: Direct Measurement
Bandwidth – Source ¹ Resolution Switching	1 Hz to 18 GHz	0.01 dB	HP 83732B Synthesized Signal Generator, HP 8648D Synthesized RF Signal Generator, HP N9310A RF Signal Generator, HP 8665B Signal Generator, E4438C ESG Vector Signal Generator, Efratom PRFS-102 Frequency Standard; CP-EL55: Direct Measurement
Noise Sideband	9 kHz to 18 GHz	0.16 dB	
Residual FM	9 kHz to 18 GHz	1 μHz/Hz	
Scale Fidelity	9 kHz to 18 GHz (-120 to 0) dB	0.12 dB	
Resolution Bandwidth	1 Hz to 18 GHz 3 dB Bandwidth	3.8 mHz/Hz	
Display Average Noise	9 kHz to 18 GHz	0.16 dB	
Residual Response	9 kHz to 18 GHz	0.16 dB	
Spurious Response	9 kHz to 18 GHz	0.16 dB	
Frequency Span	9 kHz to 18 GHz	0.78 nHz/Hz	
Input Attenuation Switching	9 kHz to 18 GHz (0 to 80) dB	0.01 dB	
Oscilloscope Bandwidth – Source ¹	2 mVrms to 1 Vrms 10 MHz to 2 GHz (2 to 6) GHz (6 to 18) GHz	16 mV/V + 9 mV 20 mV/V + 9 mV 30 mV/V + 9 mV	HP 8665B, HP E4438C, HP N9310A, HP 83732B, Agilent E4438C Signal Generators; HP E9304AH18, HP E4412A Power Sensors; CP-EL28: Comparison Measurement



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Source ¹ Frequency Carrier: 150 kHz to < 10 MHz	(5 to < 40) % Depth Rate: (20 to < 50) Hz Rate: 50 Hz to 10 kHz (40 to 99) % Depth Rate: (20 to < 50) Hz Rate: 50 Hz to 10 kHz	3.5 % of reading + 0.014 % Depth 2.4 % of reading + 0.014 % Depth 3.5 % of reading + 0.14 % Depth 2.4 % of reading + 0.14 % Depth	HP 8648D, Agilent E4438C Signal Generator with HP 8902A Measuring Receiver; CP-EL30: Comparison Measurement
Amplitude Modulation – Source ¹ Frequency Carrier: 10 MHz to 1.3 GHz	(5 to < 40) % Depth Rate: (20 to < 50) Hz Rate: 50 Hz to 10 kHz Rate: (> 50 to 100) kHz (40 to 99) % Depth Rate: (20 to < 50) Hz Rate: 50 Hz to 10 kHz Rate: (> 50 to 100) kHz	3.5 % of reading + 0.014 % Depth 1.3 % of reading + 0.014 % Depth 3.5 % of reading + 0.014 % Depth 3.5 % of reading + 0.14 % Depth 1.3 % of reading + 0.14 % Depth 3.5 % of reading + 0.14 % Depth	HP83732B Signal Generator, 11793A Down converter with HP 8902A Measuring Receiver; CP-EL30: Comparison Measurement
Amplitude Modulation – Source ¹ Frequency Carrier: (> 1.3 GHz to 20 GHz)	(5 to < 40) % Depth Rate: (20 to < 50 Hz) Rate: 50 Hz to 50 kHz Rate: (> 50 to 100) kHz (40 to 99) % Depth Rate: (20 to < 50 Hz) Rate: 50 Hz to 50 kHz Rate: (> 50 to 100) kHz	3.5 % of reading + 0.014 % Depth 1.9 % of reading + 0.014% Depth 3.5 % of reading + 0.014 % Depth 3.5 % of reading + 0.14 % Depth 1.9 % of reading + 0.14 % Depth 3.5 % of reading + 0.14 % Depth	HP 83732B Signal Generator, HP 11793A Down Converter with HP 8902A Measuring Receiver; CP-EL30: Comparison Measurement



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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Source ¹ Frequency Carrier: > 250 kHz to 10 MHz Frequency Carrier: > 10 MHz to 1.3 GHz	Deviation: < 5 kHz Rate: 20 Hz to 10 kHz Deviation: (5 to 40) kHz Rate: 20 Hz to 10 kHz Deviation: < 5 kHz Rate: (20 to < 50) Hz Rate: 50 Hz to 100 kHz Rate: (> 100 to 200) kHz Deviation: (5 to < 40) kHz Rate: (20 to < 50) Hz Rate: 50 Hz to 100 kHz Rate: (> 100 to 200) kHz	2.4 % of reading + 1.4 Hz 2.4 % of reading + 14 Hz 5.8 % of reading + 1.4 Hz 1.3 % of reading + 1.4 Hz 5.8 % of reading + 1.4 Hz 5.8 % of reading + 14 Hz 1.3 % of reading + 14 Hz 5.8 % of reading + 14 Hz	HP 8648D, Agilent E4438C Signal Generator with HP 8902A Measuring Receiver; CP-EL30: Comparison Measurement
Frequency Modulation – Source ¹ Frequency Carrier: > 10 MHz to 1.3 GHz Frequency Carrier: (> 1.3 to 18) GHz	Dev: (40 to 400) kHz Rate: (20 to < 50) Hz Rate: 50 Hz to 100 kHz Rate: (> 100 to 200) kHz Deviation: < 5 kHz Rate: (20 to < 50) Hz Rate: 50 Hz to 100 kHz Rate: (> 100 to 200) kHz Deviation: (5 to < 40) kHz Rate: (20 to < 50) Hz Rate: 50 Hz to 100 kHz Rate: (> 100 to 200) kHz Dev: (40 to 400) kHz Rate: (20 to < 50) Hz Rate: 50 Hz to 100 kHz Rate: (> 100 to 200) kHz	5.8 % of reading + 0.14 kHz 1.3 % of reading + 0.14 kHz 5.8 % of reading + 0.14 kHz 5.8 % of reading + 1.4 Hz 1.3 % of reading + 1.4 Hz 5.8 % of reading + 1.4 Hz 5.8 % of reading + 14 Hz 1.3 % of reading + 14 Hz 5.8 % of reading + 14 Hz 5.8 % of reading + 0.14 kHz 1.3 % of reading + 0.14 kHz 5.8 % of reading + 0.14 kHz	HP 8648D Signal Generator, Agilent E4438C Generator, HP 83732B Signal Generator, HP 11793A Down Converter; Comparison Measurement with HP 8902A Measuring Receiver; CP-EL30: Comparison Measurement



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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Source ¹ Frequency Carrier: 250 kHz to 10 MHz Frequency Carrier: > 10 MHz to 18 GHz	Rate: 200 Hz to 10 kHz Deviation: (1 to 4) rad (4 to 40) rad (40 to 400) rad Rate: 200 Hz to 10 kHz Deviation: (1 to 4) rad (4 to 40) rad (40 to 400) rad	4.7 % of reading + 0.001 4 rad 4.7 % of reading + 0.014 rad 4.7 % of reading + 0.14 rad 3.5 % of reading + 0.001 4 rad 3.5 % of reading + 0.014 rad 3.5 % of reading + 0.14 rad	Agilent E4438C, Agilent N9310A, HP 83732B Signal Generator with HP 8902A Measuring Receiver; CP-EL30: Comparison Measurement
Distortion – Source ¹	(0.01 to 100) % Distortion 20 Hz to 20 kHz (-80 to < -70) dB (-70 to < -60) dB (-60 to < -50) dB (-50 to < -40) dB (-40 to 0) dB (0.01 to 100) % Distortion (> 20 to 100) kHz (-80 to < -70) dB (-70 to < -60) dB (-60 to < -50) dB (-50 to < -40) dB (-40 to 0) dB	0.45 dB 0.31 dB 0.05 dB 0.03 dB 0.03 dB 0.48 dB 0.32 dB 0.07 dB 0.05 dB 0.05 dB	HP 8903B Audio Analyzer, Agilent N9310A Generator, Fluke 5522A Multiproduct Calibrator, Wavetek 1281, 8.5 Digit Multimeter, HP34401A 6.5 Digit Multimeter; CP-EL75: Direct Measurement
SINAD – Source ¹	20 Hz to 20 kHz (0 to 40) dB (> 40 to 50) dB (> 50 to 60) dB (> 60 to 70) dB (> 70 to 80) dB (> 20 to 100) kHz (0 to 40) dB (> 40 to 50) dB (> 50 to 60) dB (> 60 to 70) dB (> 70 to 80) dB	0.03 dB 0.03 dB 0.05 dB 0.31 dB 0.45 dB 0.05 dB 0.05 dB 0.07 dB 0.32 dB 0.48 dB	HP 8903B Audio Analyzer, Agilent N9310A Generator, Fluke 5522A Multiproduct Calibrator, Wavetek 1281, 8.5 Digit Multimeter, HP34401A 6.5 Digit Multimeter; CP-EL75: Direct Measurement



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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Signal to Noise – Source ¹	20 Hz to 20 kHz (0 to 40) dB (> 40 to 50) dB (> 50 to 60) dB (> 60 to 70) dB (> 70 to 80) dB (> 20 to 100) kHz (0 to 40) dB (> 40 to 50) dB (> 50 to 60) dB (> 60 to 70) dB (> 70 to 80) dB	0.03 dB 0.03 dB 0.05 dB 0.31 dB 0.45 dB 0.05 dB 0.05 dB 0.07 dB 0.32 dB 0.48 dB	HP 8903B Audio Analyzer, Agilent N9310A Generator, Fluke 5522A Multiproduct Calibrator, Wavetek 1281, 8.5 Digit Multimeter, HP34401A 6.5 Digit Multimeter; CP-EL75: Direct Measurement
Amplitude Modulation – Measure ¹ Frequency Carrier: 150 kHz to 10 MHz	(5 to < 40) % Depth Rate: (20 to < 50) Hz Rate: 50 Hz to 10 kHz (40 to 99) % Depth Rate: (20 to < 50) Hz Rate: 50 Hz to 10 kHz	3.5 % of reading + 0.014 % Depth 2.4 % of reading + 0.014 % Depth 3.5 % of reading + 0.14 % Depth 2.4 % of reading + 0.14 % Depth	HP 8902A Measuring Receiver CP-EL29: Direct Measurement
Amplitude Modulation – Measure ¹ Frequency Carrier: > 10 MHz to 1.3 GHz	(5 to < 40) % Depth Rate: (20 to 50) Hz Rate: 50 Hz to 50 kHz Rate: (> 50 to 100) kHz (40 to 99) % Depth Rate (20 to 50) Hz Rate: 50 Hz to 50 kHz Rate: (> 50 to 100) kHz	3.5 % of reading + 0.014 % Depth 1.3 % of reading + 0.014 % Depth 3.5 % of reading + 0.014 % Depth 3.5 % of reading + 0.14 % Depth 1.3 % of reading + 0.14 % Depth 3.5 % of reading + 0.14 % Depth	HP 8902A Measuring Receiver CP-EL29: Direct Measurement



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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation – Measure ¹ Frequency Carrier: (> 1.3 to 18) GHz	(5 to < 40) % Depth Rate: (20 to 50) Hz Rate: > 50 Hz to 50 kHz Rate: (> 50 to 100) kHz (> 40 to 99) % Depth Rate: (20 to 50) Hz Rate: > 50 Hz to 50 kHz Rate: (> 50 to 100) kHz	3.5 % of reading + 0.014 % Depth 1.9 % of reading + 0.014 % Depth 3.5 % of reading + 0.014 % Depth 3.5 % of reading + 0.14 % Depth 1.9 % of reading + 0.14 % Depth 3.5 % of reading + 0.14 % Depth	HP 8902A Measuring Receiver, HP 11793A Down Converter CP-EL29: Direct Measurement
Amplitude Demodulated Distortion – Measure ¹ Frequency Carrier: 150 kHz to < 1.3 GHz (1.3 to 18) GHz	Rate: 20 Hz to < 100 kHz ≤ 50 % Depth (> 50 to 95) % Depth Rate: 20 Hz to < 100 kHz ≤ 50 % Depth (> 50 to 95) % Depth	0.35 % THD 0.7 % THD 0.9 % THD 1.2 % THD	HP 8902A Measuring Receiver, HP 11793A Down Converter; CP-EL29: Direct Measurement
Frequency Modulation – Measure ¹ Frequency Carrier: > 250 kHz to 10 MHz	Deviation: < 5 kHz Rate: 20 Hz to 10 kHz Deviation: (5 to 40) kHz Rate: 20 Hz to 10 kHz	2.4 % of reading + 1.4 Hz 2.4 % of reading + 14 Hz	HP 8902A Measuring Receiver; CP-EL29: Direct Measurement



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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency Modulation – Measure ¹ Frequency Carrier: > 10 MHz to 1.3 GHz	Deviation: < 5 kHz Rate: (20 to < 50) Hz Rate: 50 Hz to 100 kHz Rate: (> 100 to 200) kHz Deviation: (5 to < 40) kHz Rate: (20 to < 50) Hz Rate: 50 Hz to 100 kHz Rate: (> 100 to 200) kHz Dev: (40 to 400) kHz Rate: (20 to < 50) Hz Rate: 50 Hz to 100 kHz Rate: (> 100 to 200) kHz	5.8 % of reading + 1.4 Hz 1.3 % of reading + 1.4 Hz 5.8 % of reading + 1.4 Hz 5.8 % of reading + 14 Hz 1.3 % of reading + 14 Hz 5.8 % of reading + 14 Hz 5.8 % of reading + 0.14 kHz 1.3 % of reading + 0.14 kHz 5.8 % of reading + 0.14 kHz	HP 8902A Measuring Receiver; CP-EL29: Direct Measurement
Frequency Modulation – Measure ¹ Frequency Carrier: (> 1.3 to 18) GHz	Deviation: < 5 kHz Rate: (20 to < 50) Hz Rate: 50 Hz to 100 kHz Rate: (> 100 to 200) kHz Deviation: (5 to < 40) kHz Rate: (20 to < 50) Hz Rate: 50 Hz to 100 kHz Rate: (> 100 to 200) kHz Dev: (40 to 400) kHz Rate: (20 to < 50) Hz Rate: 50 Hz to 100 kHz Rate: (> 100 to 200) kHz	5.8 % of reading + 1.4 Hz 1.3 % of reading + 1.4 Hz 5.8 % of reading + 1.4 Hz 5.8 % of reading + 14 Hz 1.3 % of reading + 14 Hz 5.8 % of reading + 14 Hz 5.8 % of reading + 0.14 kHz 1.3 % of reading + 0.14 kHz 5.8 % of reading + 0.14 kHz	HP 8902A Measuring Receiver, HP 11793A Down Converter; CP-EL29: Direct Measurement
Frequency Demodulated Distortion – Measure ¹ Frequency Carrier: 400 kHz to <10 MHz Frequency Carrier: 10 MHz to 18 GHz	Rate: 20 Hz to 10 kHz Deviation: ≤ 10 kHz Rate: 20 Hz to 100 kHz Deviation: ≤ 100 kHz	0.12 % THD 0.12 % THD	HP 8902A Measuring Receiver, HP 11793A Down Converter; CP-EL29: Direct Measurement

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Phase Modulation – Measure ¹ Frequency Carrier: 250 kHz to 10 MHz Frequency Carrier: > 10 MHz to 1.3 GHz	Rate: 200 Hz to 10 kHz Deviation: (1 to 4) rad (4 to 40) rad (40 to 400) rad Rate: 200 Hz to 20 kHz Deviation: (1 to 4) rad (4 to 40) rad (40 to 400) rad	4.7 % of reading + 0.001 4 rad 4.7 % of reading + 0.014 rad 4.7 % of reading + 0.14 rad 3.5 % of reading + 0.001 4 rad 3.5 % of reading + 0.014 rad 3.5 % of reading + 0.14 rad	HP 8902A Measuring Receiver; CP-EL29: Direct Measurement
Phase Modulation – Measure ¹ Frequency Carrier: > 10 MHz to 20 GHz	Rate: 200 Hz to 20 kHz Deviation: (1 to 4) rad (4 to 40) rad (40 to 400) rad	3.5 % of reading + 0.001 4 rad 3.5 % of reading + 0.014 rad 3.5 % of reading + 0.14 rad	HP 8902A Measuring Receiver, HP 11793A Down Converter; CP-EL29: Direct Measurement
Phase Demodulated Distortion – Measure ¹ Frequency Carrier: 150 kHz to < 10 MHz Frequency Carrier: 10 MHz to 18 GHz	Rate: 200 Hz to 10 kHz Deviation: ≤ 400 rad Rate: 200 Hz to 20 kHz Deviation: ≤ 400 rad	0.12 % THD 0.12 % THD	HP 8902A Measuring Receiver, HP 11793A Down Converter; CP-EL29: Direct Measurement
Distortion/SINAD/Signal to Noise – Measure 1 (0.001 to 100) % Distortion Distortion SINAD Signal-to-Noise	(-99.99 to 0) dB 20 Hz to 20 kHz (20 to 100) kHz (0 to 99.99) dB 20 Hz to 20 kHz (20 to 100) kHz (0 to 99.99) dB 50 Hz to 100 kHz	1.2 dB 2.4 dB 1.2 dB 2.4 dB 1.2 dB	HP 8903B Audio Analyzer; CP-EL74: Direct Measurement



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Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Measure ^{1,2}	100 kHz to 4.2 GHz (-10 to < 25) dBm (25 to 35) dBm	0.12 dB 0.25 dB	HP 8482H Power Sensor, Agilent E4419B Power Meter
RF Absolute Power- Measure ^{1,2}	(-60 to < -10) dBm 9 kHz to 2 GHz (2 to < 6) GHz (6 to < 14) GHz (14 to < 16) GHz (16 to 18) GHz (-10 to 20) dBm 9 kHz to < 500 MHz 500 MHz to < 1.2 GHz (1.2 to < 2) GHz (2 to < 6) GHz (6 to < 14) GHz (14 to < 16) GHz (16 to 18) GHz	0.17 dB 0.18 dB 0.19 dB 0.23 dB 0.25 dB 0.16 dB 0.16 dB 0.16 dB 0.16 dB 0.18 dB 0.22 dB 0.23 dB	Agilent E9304AH18 Power Sensor, Agilent E4419B Power Meter; CP-EL33: Direct Measurement
RF Absolute Power – Measure ^{1,2}	(> -70 to 10) dBm (10 to < 30) MHz 30 MHz to < 2 GHz (2 to < 6) GHz (6 to < 11) GHz (11 to 18) GHz (> 10 to 20) dBm (10 to < 30) MHz 30 MHz to < 2 GHz (2 to < 6) GHz (6 to < 11) GHz (11 to 18) GHz	0.18 dB 0.17 dB 0.18 dB 0.19 dB 0.25 dB 0.24 dB 0.23 dB 0.23 dB 0.24 dB 0.29 dB	Agilent E4412A Power Sensor and Agilent E4419B Power Meter; CP-EL33: Direct Measurement
RF Absolute Power – Measure ^{1,2}	100 kHz to 2.6 GHz (-20 to < 20) dBm (20 to 30) dBm	0.14 dB 0.16 dB	HP 11722A Power Sensor, Agilent 8902A Measuring Receiver; CP-EL33: Direct Measurement



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RF Absolute Power – Measure ^{1,2}	50 MHz to < 2 GHz (-20 to < 20) dBm (20 to 30) dBm (2 to < 10) GHz (-20 to < 20) dBm (20 to 30) dBm (10 to 18) GHz (-20 to < 20) dBm (20 to 30) dBm	0.15 dB 0.13 dB 0.18 dB 0.16 dB 0.19 dB 0.18 dB	HP 11792A Power Sensor, Agilent 8902A Measuring Receiver; CP-EL33: Direct Measurement
Keysight 11793A Microwave Down Converter ^{1,2} Converted Band Test (Conversion Loss) (RF Frequency = LO Frequency minus 50 MHz) Through Band Test (Insertion loss)	Input level: -5 dBm LO level: +8 dBm Frequency: (2 to 18) GHz Input level: -5 dBm Frequency: 1.27 GHz	1.5 dB 0.25 dB	HP 8902A Measuring Receiver, HP 11792A Sensor Module, HP 83731A, and HP 83732B Signal Sources; CP-EL76: Direct Measurement

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Gauge Blocks	(0.1 to 0.4) mm (> 0.4 to 10) mm (> 10 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm (> 100 to 200) mm (> 200 to 300) mm (> 300 to 400) mm (> 400 to 500) mm	0.13 µm 66 nm 76 nm 0.11 µm 0.13 µm 0.16 µm 0.3 µm 0.44 µm 0.58 µm 0.72 µm	Gage Block Comparator, Master Gauge Block Set; CP-PL23, CP-PL24: Comparison Measurement

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Caliper ¹ (External/Internal/Depth)	Up to 300 mm (> 300 to 450) mm (> 450 to 600) mm (> 600 to 1 000) mm (>1 000 to 1 500) mm (>1 500 to 2 000) mm	5 μm 7 μm 9 μm 14 μm 21 μm 28 μm	Gauge Block Set; CP-PL01: Direct Measurement
Dial Gauge & Digital Indicator ¹	Up to 12.7 mm (> 12.7 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm	0.9 μm 1 μm 1.2 μm 1.4 μm 1.7 μm	Dial Calibration Tester Stand M3; CP-PL14: Direct Measurement
Dial Test Indicator ¹	Up to 1.5 mm	0.7 μm	Dial Calibration Tester Stand M3; CP-PL15 Direct Measurement
Micro-indicator	(-1.5 to 1.5) mm	0.12 μm	Gauge Block Set; CP-PL06 Direct Measurement
Electrical Comparator/ Mu Checker ¹	Up to 500 μm > 500 μm to 1 mm (> 1 to 5) mm (> 5 to 10) mm	0.12 μm 0.14 μm 0.2 μm 0.3 μm	Gauge Block Set; CP-PL51: Direct Measurement
Cylinder Gauge/ Bore Gauge ¹	Up to 18 mm (> 18 to 35) mm (> 35 to 60) mm (> 60 to 100) mm (> 100 to 160) mm (> 160 to 250) mm (> 250 to 400) mm	0.65 μm 0.8 μm 1 μm 1.5 μm 2 μm 2.5 μm 3 μm	Universal Length Measuring Machine, CP-PL17: Direct Measurement based on JIS B 7515
Outside/Inside Micrometer ¹	Up to 25 mm (25 to 50) mm (50 to 75) mm (75 to 100) mm (100 to 125) mm (125 to 150) mm (150 to 175) mm (175 to 200) mm	0.7 μm 0.8 μm 0.9 μm 1 μm 1.2 μm 1.3 μm 1.5 μm 1.6 μm	Gauge Block Set; CP-PL05: Direct Measurement

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Outside/Inside Micrometer ¹	(200 to 225) mm	1.8 μm	Gauge Block Set; CP-PL05: Direct Measurement
	(225 to 250) mm	1.9 μm	
	(250 to 275) mm	2.1 μm	
	(275 to 300) mm	2.2 μm	
	(300 to 325) mm	2.4 μm	
	(325 to 350) mm	2.5 μm	
	(350 to 375) mm	2.7 μm	
	(375 to 400) mm	3 μm	
	(400 to 425) mm	3 μm	
	(425 to 450) mm	3.2 μm	
	(450 to 475) mm	3.3 μm	
	(475 to 500) mm	3.5 μm	
	(500 to 525) mm	3.8 μm	
	(525 to 550) mm	4 μm	
	(550 to 575) mm	4.1 μm	
	(575 to 600) mm	4.3 μm	
	(600 to 625) mm	4.5 μm	
	(625 to 650) mm	4.6 μm	
	(650 to 675) mm	4.9 μm	
	(675 to 700) mm	5 μm	
	(700 to 725) mm	5.2 μm	
	(725 to 750) mm	5.4 μm	
	(750 to 775) mm	5.5 μm	
(775 to 800) mm	5.6 μm		
(800 to 825) mm	5.8 μm		
(825 to 850) mm	6 μm		
(850 to 875) mm	6.1 μm		
(875 to 900) mm	6.5 μm		
(900 to 925) mm	6.7 μm		
(925 to 950) mm	6.8 μm		
(950 to 975) mm	7 μm		
(975 to 1 000) mm	7.1 μm		
High Accuracy Micrometer ¹ (Resolution 0.000 1 mm)	Up to 7.7 mm	0.17 μm	Gauge Block Set; CP-PL75: Direct Measurement
	(>7.7 to 17.6) mm	0.27 μm	
	(>17.6 to 22.8) mm	0.33 μm	
	(>22.8 to 25) mm	0.36 μm	
V-Anvil Micrometer ¹	Up to 10 mm	1.2 μm	Standard Pin Gauges, Gauge Block Set; CP-PL74: Direct Measurement
	(> 10 to 25) mm	1.4 μm	
	(>25 to 40) mm	1.7 μm	

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Indicating Micrometer ¹	Up to 25 mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm	1.3 μm 1.6 μm 2.2 μm 2.8 μm	Gauge Block Set; CP-PL07: Direct Measurement
Depth Micrometer ¹	Up to 25 mm (25 to 50) mm (50 to 75) mm (75 to 100) mm (100 to 125) mm (125 to 150) mm (150 to 175) mm (175 to 200) mm (200 to 225) mm (225 to 250) mm (250 to 275) mm (275 to 300) mm	0.9 μm 1.3 μm 1.4 μm 1.6 μm 1.9 μm 2.2 μm 2.5 μm 2.8 μm 3.1 μm 3.3 μm 3.5 μm 3.8 μm	Gauge Block Set; CP-PL16: Direct Measurement
Gear Tooth Vernier Caliper ¹	Up to 60 mm	15 μm	Gauge Block Set; CP-PL28: Direct Measurement
Height Gauge ¹	Up to 300 mm (> 300 to 600) mm (> 600 to 1 000) mm	8 μm 11 μm 15 μm	Gauge Block Set; CP-PL02: Direct Measurement
Depth Gauge ¹	Up to 200 mm (> 200 to 300) mm (> 300 to 600) mm	7 μm 8 μm 11 μm	Gauge Block Set; CP-PL11: Direct Measurement
Feeler Gauge ¹	Up to 3 mm (> 3 to 20) mm	0.3 μm 0.6 μm	Universal Length Measuring Machine, High Accuracy Micrometer; CP-PL18: Direct Measurement
Thickness Plate ¹ (Calibration Foil)	Up to 3 mm (> 3 to 20) mm	0.3 μm 0.6 μm	Universal Length Measuring Machine High Accuracy Micrometer; CP-PL19: Direct Measurement
Thickness Gauge ¹	Up to 12 mm (> 12 to 100) mm	0.7 μm 1.5 μm	Gauge Block Set; CP-PL13: Direct Measurement

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Holtest/Three-points Internal Micrometer ¹	(3 to 14) mm (> 14 to 20) mm (> 20 to 40) mm (> 40 to 50) mm (> 50 to 75) mm (> 75 to 100) mm (> 100 to 125) mm	1.5 μm 1.8 μm 2 μm 2.2 μm 2.8 μm 3.5 μm 4 μm	Ring Gauges; CP-PL38: Direct Measurement
Coating Thickness Gauge ¹	Up to 252 μm (252 to 2 074) μm (2 074 to 3 039) μm (3 039 to 4 824) μm (4 824 to 9 890) μm (9 890 to 14 000) μm	0.5 μm 0.8 μm 1.4 μm 1.5 μm 1.7 μm 2 μm	Calibration Foils; CP-PL50: Direct Measurement
Setting Rod for Micrometer	Up to 25 mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm (> 100 to 125) mm (> 125 to 150) mm (> 150 to 175) mm (> 175 to 200) mm (> 200 to 225) mm (> 225 to 250) mm (> 250 to 275) mm (> 275 to 300) mm (> 300 to 325) mm (> 325 to 350) mm (> 350 to 375) mm (> 375 to 400) mm (> 400 to 425) mm (> 425 to 450) mm (> 450 to 475) mm (> 475 to 500) mm	0.4 μm 0.5 μm 0.6 μm 0.7 μm 0.9 μm 1 μm 1.2 μm 1.4 μm 1.5 μm 1.7 μm 1.9 μm 2 μm 2.2 μm 2.4 μm 2.5 μm 2.7 μm 2.9 μm 3 μm 3.2 μm 3.4 μm	Gauge Block Set, Universal Length Measuring Machine; CP-PL37: Comparison Measurement
Micrometer Head ¹	Up to 13 mm (> 13 to 25) mm (> 25 to 50) mm	1 μm 1 μm 1.6 μm	Gauge Block Set; CP-PL12: Direct Measurement
Universal Length Measuring Machine ¹	Up to 10 mm (> 10 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm (> 100 to 600) mm	90 nm 0.17 μm 0.35 μm 0.5 μm 0.7 μm 0.85 μm	Gauge Block Set; CP-PL52: Direct Measurement

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Caliper Gauge ¹ (External/ Internal)	Up to 30 mm (> 30 to 100) mm	1.5 µm 3 µm	Gauge Block Set; CP-PL40: Direct Measurement
Caliper Checker, Check Master, Step Gauge	Up to 300 mm (> 300 to 400) mm (> 400 to 500) mm (> 500 to 670) mm	1.1 µm 1.2 µm 1.3 µm 1.4 µm	Gauge Blocks, Lever Probe with Display; CP-PL57: Direct Measurement
Height Master	Up to 300 mm (> 300 to 400) mm (> 400 to 500) mm (> 500 to 600) mm	1.1 µm 1.2 µm 1.3 µm 1.4 µm	Gauge Blocks, Lever Probe with Display; CP-PL92: Direct Measurement
Dial Gauge Tester/Calibration Tester	(> 0 to 5) mm (> 5 to 25) mm	0.5 µm 0.8 µm	Linear Length Gauge; CP-PL39: Direct Measurement
Measuring Microscope, Tool Maker's Microscope ¹ X-axis, Y-axis	Up to 50 mm (> 50 to 100) mm (> 100 to 200) mm (> 200 to 300) mm (> 300 to 400) mm (> 400 to 500) mm	1 µm 1.1 µm 1.2 µm 1.3 µm 3.1 µm 3.7 µm	Gauge Blocks, Glass Scale; CP-PL53: Direct Measurement
Z-axis	Up to 50 mm (> 50 to 100) mm (> 100 to 200) mm	1.1 µm 1.3 µm 1.7 µm	
Profile Projector ¹ X-axis, Y-axis	Up to 50 mm (> 50 to 100) mm (> 100 to 200) mm (> 200 to 300) mm (> 300 to 500) mm	1 µm 1.1 µm 1.2 µm 1.3 µm 2.1 µm	Glass Scale; CP-PL54: Direct Measurement
Micrometer Microscope ¹	Up to 10 mm	1 µm	Glass Scale; CP-PL35: Direct Measurement
Scale Loupe ¹	Up to 100 mm	1.4 µm	Glass Scale; CP-PL32: Direct Measurement

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Plug Gauge	(> 1 to 60) mm (> 60 to 90) mm (> 90 to 125) mm (> 125 to 150) mm	2 μ m 2.1 μ m 2.2 μ m 2.3 μ m	Gauge Block Set, Universal Length Measuring Machine; CP-PL10: Direct Measurement
Thread Ring Gauge	(3 to 30) mm (>30 to 100) mm (> 100 to 150) mm	2 μ m 2.1 μ m 3.1 μ m	Ring Gauge, Universal Length Measuring Machine; CP-PL08: Direct Measurement
Plain Ring Gauge	(1 to 50) mm (> 50 to 100) mm (> 100 to 125) mm (> 125 to 150) mm	0.9 μ m 1.3 μ m 1.5 μ m 1.7 μ m	Ring Gauge, Universal Length Measuring Machine; CP-PL36: Direct Measurement
Plain Plug Gauge, Pin Gauge, (3-wires) (Diameter Measurement)	Up to 10 mm (> 10 to 20) mm (> 20 to 30) mm (> 30 to 40) mm (> 40 to 50) mm (> 50 to 60) mm (> 60 to 70) mm (> 70 to 80) mm (> 80 to 90) mm (> 90 to 100) mm (> 100 to 125) mm (> 125 to 150) mm (> 150 to 175) mm (> 175 to 200) mm (> 200 to 250) mm (> 250 to 300) mm	0.3 μ m 0.4 μ m 0.5 μ m 0.5 μ m 0.7 μ m 0.7 μ m 0.8 μ m 1 μ m 1 μ m 1.1 μ m 1.2 μ m 1.3 μ m 1.4 μ m 1.5 μ m 1.7 μ m 2 μ m	Gauge Block Set, Universal Length Measuring Machine; CP-PL09: Direct Measurement
Plain Snap Gauge, Gap Gauge (External/ Internal)	(1 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 125) mm (> 125 to 175) mm (> 175 to 200) mm (> 200 to 250) mm (> 250 to 300) mm (> 300 to 400) mm (> 400 to 500) mm	0.51 μ m 0.81 μ m 1.2 μ m 1.9 μ m 2.7 μ m 3.1 μ m 3.8 μ m 4.5 μ m 6 μ m 7.5 μ m	Ring Gauge, Gauge Block Set, Universal Length Measuring Machine; CP-PL33: Direct Measurement

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Laser Scan Micrometer ¹	(0.1 to 10) mm (> 10 to 60) mm	0.5 μm 0.7 μm	Pin Gauges, Gauge Block Set; CP-PL34: Direct Measurement
Surface Roughness Testers ¹	Ra 2.94 μm, Rz 9.3 μm	66 nm 0.26 μm	Roughness Specimen; CP-PL55: Direct Measurement
Roughness Specimens	Up to 4 μm (> 4 to 20) μm (> 20 to 100) μm	71 nm 0.28 μm 2.7 μm	Surface Texture Measuring Instrument; CP-PL90: Direct Measurement
Bevel Protractors ¹	Up to 360°	0.012°	Angle Blocks; CP-PL29: Direct Measurement
Measuring Tapes ¹	Up to 5 000 mm (> 5 000 to 10 000) mm (> 10 000 to 20 000) mm (> 20 000 to 30 000) mm (> 30 000 to 40 000) mm (> 40 000 to 50 000) mm	45 μm 46 μm 55 μm 65 μm 75 μm 90 μm	Tape & Scale Measuring Machine, Laser Distance; CP-PL45: Direct Measurement
Rulers ¹	Up to 1 000 mm (> 1 000 to 2 000) mm (> 2 000 to 3 000) mm	14 μm 27 μm 41 μm	Tape & Scale Measuring Machine, Laser Distance; CP-PL44: Direct Measurement
Contour Machines ¹ Straightness X Axis, Z Axis	Up to 1 mm Up to 60 mm (> 60 to 100) mm	0.8 μm 3 μm 3.5 μm	Gauge Blocks, Optical Flat; CP-PL42: Direct Measurement
Roundness Machines ^{1,3}	Up to 200 mmD	1.7 μm	Glass Hemisphere; CP-PL43: Direct Measurement



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Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Coordinate Measuring Machines ¹ Linear Accuracy (X,Y,Z)	Up to 100 mm (>100 to 200) mm (>200 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 1 000) mm	0.4 μm 0.8 μm 1.1 μm 1.4 μm 1.7 μm 2 μm 2.4 μm 2.7 μm 3.1 μm 3.4 μm	Gauge Blocks, Check Master, Master Ball; CP-PL41: Direct Measurement
Chamfer Gauge	Up to 30 mm	1.6 μm	Vision Measuring Machine; CP-PL61: Direct Measurement
Pitch Gauge	Up to 10 mm	1.6 μm	Vision Measuring Machine; CP-PL62: Direct Measurement
Radius Gauge	Up to 50 mm (> 50 to 100) mm	1.6 μm 2 μm	Vision Measuring Machine; CP-PL63: Direct Measurement
Taper Gauge (Scale Type)	Up to 50 mm (> 50 to 100) mm	1.6 μm 2 μm	Vision Measuring Machine; CP-PL64: Direct Measurement
Test Sieve	Up to 50 mm	1.6 μm	Vision Measuring Machine; CP-PL65: Direct Measurement
Angle Block ³	(0.25 to 90)°	14"	Angle Block, Vision Measuring Machine; CP-PL66: Direct Measurement

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sine Bars Roller Distance	Up to 100 mm (> 100 to 200) mm (> 200 to 300) mm	1.6 µm 2 µm 2.5 µm	Vision Measuring Machine, Mu Checker; CP-PL85: Direct Measurement
Parallelism	≤ 0.1 mm	1.2 µm	
Vee Blocks (to 250 mm) Flatness of Bottom Surface	≤ 0.1 mm	1.2 µm	Mu Checker; CP-PL86: Direct Measurement
Flatness of V Surface	≤ 0.1 mm	1.2 µm	
Parallelism Between Bottom Surface and Cylinder on V Surface	≤ 0.1 mm	1.2 µm	
Laser Distance Meter	Up to 10 000 mm (> 10 000 to 20 000) mm	1.3 mm 1.4 mm	Laser Distance Meter Calibration Set; CP-PL88: Comparison Measurement
Working Standard Scale, Glass Scale	Up to 1 mm (> 1 to 100) mm (> 100 to 200) mm (> 200 to 300) mm (> 300 to 500) mm	1 µm 1.1 µm 1.4 µm 1.6 µm 2.5 µm	Standard Scale, Image Measuring Instrument; CP-PL69: Direct and Comparison Measurement
Ultrasonic Thickness Gauge	Up to 50 mm (> 50 to 100) mm (> 100 to 125) mm (> 125 to 150) mm (> 150 to 175) mm (> 175 to 200) mm (> 200 to 250) mm (> 250 to 300) mm (> 300 to 400) mm (> 400 to 500) mm	1.1 µm 2 µm 2.6 µm 3 µm 3.5 µm 4 µm 4.9 µm 5.9 µm 7.8 µm 9.7 µm	Gauge Blocks; CP-PL67: Comparison Measurement
Electronic Level	(0.01 to 5) mm/m	6.5 µm/m	Sine Bar, Gauge Blocks; CP-PL73: Direct Measurement
Precision Level ¹	(0.02 to 0.1) mm/m (0.05 to 0.25) mm/m (0.1 to 0.5) mm/m	6 µm/m 15 µm/m 25 µm/m	Sine Bar, Gauge Blocks; CP-PL73: Direct Measurement



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Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Surface Plates ^{1,3} Overall Flatness Only	Up to 7 000 mmDL	1.9 µm/m	Electronic Level System; CP-PL87: Direct Measurement

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment	
Scales and Balances ¹ Resolution 0.000 1 mg	Up to 2 mg	3.1 µg	OIML Class E2 weight set, OIML Class F1 weight set, OIML Class M1 weight set, and CP-PL04 based on UKAS LAB 14 utilized in the calibration of the weighing system.	
	(2 to 5) mg	3.1 µg		
	(5 to 10) mg	3.9 µg		
	(10 to 20) mg	4.6 µg		
	(20 to 50) mg	6.2 µg		
	(50 to 100) mg	7.7 µg		
	(100 to 200) mg	9.2 µg		
	(200 to 500) mg	13 µg		
	(500 to 1 000) mg	16 µg		
	Resolution 0.001 mg	(1 to 2) g		19 µg
		(2 to 5) g		25 µg
		(5 to 10) g		31 µg
		(10 to 20) g		39 µg
(20 to 50) g		46 µg		
Resolution 0.01 mg	(50 to 100) g	77 µg		
	(100 to 200) g	0.16 mg		
Resolution 0.1 mg	(200 to 500) g	0.4 mg		
	(500 to 1 000) g	0.77 mg		
	(1 to 2) kg	1.6 mg		



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales and Balances ¹	Resolution 0.001 g	(1 to 2) kg	2.5 mg
		(2 to 3) kg	3.2 mg
		(3 to 4) kg	4 mg
		(4 to 5) kg	4.7 mg
		(5 to 6) kg	5.5 mg
		(6 to 7) kg	7.7 mg
		(7 to 10) kg	9.3 mg
		(10 to 12) kg	12 mg
		(12 to 15) kg	16 mg
	Resolution 0.01 g	(20 to 25) kg	59 mg
		(25 to 30) kg	71 mg
		(30 to 40) kg	93 mg
		(40 to 50) kg	0.12 g
	Resolution 0.1 g	(50 to 100) kg	2.3 g
		(100 to 150) kg	3.5 g
		(150 to 200) kg	4.6 g
		(200 to 250) kg	5.8 g
		(250 to 300) kg	6.9 g
		(300 to 350) kg	8.1 g
		(350 to 400) kg	9.2 g
		(400 to 450) kg	11 g
(450 to 500) kg		12 g	
(500 to 1 000) kg	85 g		
			OIML Class E2 weight set, OIML Class F1 weight set, OIML Class M1 weight set, and CP-PL04 based on UKAS LAB 14 utilized in the calibration of the weighing system.

Mass and Mass Related

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	9 µg 9 µg 9 µg 10 µg 10 µg 11 µg 12 µg 13 µg 27 µg 28 µg 30 µg 34 µg 40 µg 50 µg 77 µg 0.15 mg 0.28 mg 0.73 mg 1.5 mg 2.8 mg 11 mg 17 mg 29 mg	Standard Weight Set, Electronic Balances; CP-PL60 based on OIML R-111-1.
Non-OIML Weight ¹	(1 to 20) mg (> 20 to 200) mg (> 0.2 to 2) g (> 2 to 10) g (> 10 to 50) g (> 50 to 100) g (> 100 to 200) g (> 200 to 500) g (> 0.5 to 1) kg (> 1 to 2) kg (> 2 to 5) kg (> 5 to 10) kg (> 10 to 20) kg	10 µg 15 µg 30 µg 50 µg 80 µg 0.15 mg 0.3 mg 0.8 mg 1.5 mg 3 mg 12 mg 17 mg 30 mg	Standard Weight Set; CP-PL94: Base on OIML R-111-1



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Universal Testing Machine ¹ Compression Tension	Up to 500 N (0.5 to 1) kN (1 to 2) kN (2 to 10) kN (10 to 50) kN Up to 1 kN (1 to 3) kN (3 to 50) kN	0.95 % of reading 0.55 % of reading 0.36 % of reading 0.17 % of reading 0.4 % of reading 1.1 % of reading 0.75 % of reading 0.28 % of reading	Force Transducer; CP-PL59 based on ISO 7500-1.
Rockwell Hardness Testing Machine ¹ (Force)	3 kgf 10 kgf 60 kgf 100 kgf 150 kgf	0.025 kgf 0.08 kgf 0.47 kgf 0.78 kgf 1.2 kgf	Direct verification using Force Transducer; CP-PL47 based on ISO 6508-2.
Rockwell Hardness Testing Machine ¹	30 HRC 45 HRC 60 HRC 32 HRBS 60 HRBS 92 HRBS	0.6 HRC 0.6 HRC 0.6 HRC 1 HRBS 0.7 HRBS 0.7 HRBS	Indirect verification using Hardness Test Blocks; CP-PL47 based on ISO 6508-2.
Durometers ³ (Types A, B, C, D, E, M, O, DO, OO, OOO, OOO-S) Indenter Dimensions Length Diameter, Radius Angle Spring Force	Up to 20 mm Up to 20 mm Up to 45° Up to 79 gf (> 79 to 114) gf (> 114 to 198) gf (> 198 to 821) gf (> 821 to 4 533) gf	1.5 µm 1.5 µm 16" 0.26 gf 0.34 gf 0.57 gf 2.3 gf 13 gf	Direct Verification per CP-PL48 using Image Measuring Machine Electronic Balance, Standard Weight (Based on ASTM D 2240)



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Vickers Hardness Testers ¹	100 HV 10 gf 0.1 kgf 1 kgf 500 HV 10 gf 0.1 kgf 1 kgf 700 HV 10 gf 0.1 kgf 1 kgf	8 HV 8 HV 8 HV 21 HV 21 HV 21 HV 24 HV 24 HV 24 HV	Indirect Verification using Hardness Test Blocks; CP-PL46: Direct Measurement
Hand Torque Tools, Torque Wrench, Torque Driver, Torque Nut-runner ¹	Up to 10 N·m (> 10 to 360) N·m	1 % of reading 1.3 % of reading	Torque Tester; CP-PL03 based on ISO 6789.
Torque Meter, Torque Tester ¹	Up to 20 N·m (> 20 to 50) N·m (> 50 to 500) N·m	0.13 % of reading 0.16 % of reading 0.13 % of reading	Arm & Standard Weight Set, Torque Transfer Wrench; CP-PL25: Direct Measurement
Pressure Gauges (Pneumatic & Hydraulic), Digital Pressure Gauges, Differential Pressure Gauges, Manometers, Vacuum Gauges ¹	(-95 to -0.25) kPa (> -0.25 to 0.25) kPa (> 0.25 to 69) kPa (> 69 to 206.9) kPa (> 206.9 to 689.5) kPa (> 689.5 to 2 068.5) kPa (> 2 068.5 to 6 895) kPa (> 6.895 to 20.685) MPa (> 20.685 to 34.474) MPa (> 34.474 to 68.948) MPa	11 Pa 1.6 Pa 98 Pa 70 Pa 0.16 kPa 0.27 kPa 2.3 kPa 2.7 kPa 3.7 kPa 13 kPa	Digital Test Gauge; CP-PL56 based on DKD R-6-1 and DKD R-6-2



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Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Pressure Transducers, Pressure Transmitters ¹ Electrical Output Current	(-95 to -0.25) kPa (> -0.25 to 0.25) kPa (> 0.25 to 69) kPa (> 69 to 206.9) kPa (> 206.9 to 689.5) kPa (> 689.5 to 2 068.5) kPa (> 2 068.5 to 6 895) kPa (> 6.895 to 20.685) MPa (> 20.685 to 34.474) MPa (> 34.474 to 68.948) MPa	50 Pa 1.6 Pa 0.11 kPa 0.12 kPa 0.39 kPa 1.1 kPa 4.2 kPa 11 kPa 19 kPa 38 kPa	Comparison to Digital Test Gauge, Digital Multimeter; CP-PL96 based on DKD R-6-1 and DKD R-6-2
Electrical Output Voltage	(-95 to -0.25) kPa (> -0.25 to 0.25) kPa (> 0.25 to 69) kPa (> 69 to 206.9) kPa (> 206.9 to 689.5) kPa (> 689.5 to 2 068.5) kPa (> 2 068.5 to 6 895) kPa (> 6.895 to 20.685) MPa (> 20.685 to 34.474) MPa (> 34.474 to 68.948) MPa	29 Pa 1.6 Pa 0.1 kPa 68 Pa 0.25 kPa 0.66 kPa 3 kPa 6.6 kPa 11 kPa 24 kPa	
Pressure Switches ¹	(-95 to -0.25) kPa (> -0.25 to 0.25) kPa (> 0.25 to 69) kPa (> 69 to 206.9) kPa (> 206.9 to 689.5) kPa (> 689.5 to 2 068.5) kPa (> 2 068.5 to 6 895) kPa (> 6.895 to 20.685) MPa (> 20.685 to 34.474) MPa (> 34.474 to 68.948) MPa	10 Pa 1.6 Pa 98 Pa 43 Pa 0.16 kPa 0.27 kPa 2.3 kPa 2.7 kPa 3.7 kPa 13 kPa	Comparison to Digital Test Gauge, Digital Multimeter; CP-PL97 based on DKD R-6-1 and DKD R-6-2

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Digital Force Gauges ¹ (Tension and Compression)	Up to 2 N (2 to 5) N (5 to 10) N (10 to 20) N (20 to 50) N (50 to 100) N (100 to 200) N (200 to 300) N (300 to 500) N (500 to 1 000) N	0.18 mN 0.43 mN 1.1 mN 1.8 mN 4.3 mN 11 mN 18 mN 26 mN 51 mN 0.13 N	Standard Weight Set; CP-PL20: Direct Measurement
Spring Tension Gauges ¹	Up to 0.1 N (0.1 to 0.5) N (0.5 to 1.1) N (1.1 to 3) N (3 to 5) N (5 to 10) N (10 to 40) N (40 to 50) N (50 to 200) N (200 to 300) N	0.57 mN 1.2 mN 2.4 mN 12 mN 24 mN 57 mN 0.12 N 0.24 N 0.57 N 1.2 N	Standard Weight Set; CP-PL20: Direct Measurement
Dial Tension Gauges ¹	Up to 50 mN (50 to 100) mN (100 to 200) mN (200 to 300) mN (300 to 500) mN (0.5 to 1) N (1 to 1.5) N (1.5 to 3) N (3 to 5) N (5 to 10) N (10 to 20) N	0.37 mN 0.81 mN 1.7 mN 2.1 mN 3.7 mN 8.1 mN 11 mN 21 mN 37 mN 62 mN 0.13 N	Standard Weight Set; CP-PL20: Direct Measurement
Viscosity and Density Meters ¹ (Dynamic Viscosity) (20 to 50) °C	(24 to 92) mPa·s (74 to 340) mPa·s (260 to 1 500) mPa·s (1 400 to 17 000) mPa·s (7 500 to 92 000) mPa·s	0.41 % of reading 0.49 % of reading 0.55 % of reading 0.79 % of reading 0.82 % of reading	Viscosity Standard Solution; CP-PL49 Direct Measurement
Viscosity and Density Meters ¹ (Kinematic Viscosity) (20 to 50) °C	(30 to 110) mm ² /s (90 to 400) mm ² /s (300 to 1 740) mm ² /s (1 600 to 20 000) mm ² /s (8 500 to 103 000) mm ² /s	0.41 % of reading 0.49 % of reading 0.55 % of reading 0.79 % of reading 0.82 % of reading	Viscosity Standard Solution; CP-PL49 Direct Measurement

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Viscosity Cups – Kinematic Viscosity ¹ (20 to 25) °C	ISO Cups (> 10 to 100) mm ² /s (cSt) (> 100 to 1 000) mm ² /s (cSt)	0.32 % of Reading 0.38 % of Reading	Viscosity Standard Solution; CP-PL72 Direct Measurement based on ASTM D 1200-94, ASTM D 4212-99, ISO 2431 and DIN 53211
	Zahn Cups (> 10 to 100) mm ² /s (cSt) (> 100 to 1 000) mm ² /s (cSt)	0.32 % of Reading 0.38 % of Reading	
	Ford Cups (> 10 to 100) mm ² /s (cSt) (> 100 to 1 000) mm ² /s (cSt)	0.32 % of Reading 0.38 % of Reading	
	Shell Cups (> 10 to 100) mm ² /s (cSt) (> 100 to 1 000) mm ² /s (cSt)	0.32 % of Reading 0.38 % of Reading	
	DIN Cups (> 10 to 100) mm ² /s (cSt) (> 100 to 1 000) mm ² /s (cSt)	0.32 % of Reading 0.38 % of Reading	
Viscosity Cups – Kinematic Viscosity ¹ (20 to 50) °C	Other Cups		Viscosity Standard Solution; In-house Method CP-PL98 Direct Measurement
	Up to 10 s	0.27 % of reading	
	(> 10 to 30) s	4 % of reading	
	(> 30 to 50) s	1.2 % of reading	
	(> 50 to 60) s	1.6 % of reading	
	(> 60 to 70) s	3.2 % of reading	
	(> 70 to 80) s	4.7 % of reading	
	(> 80 to 90) s	6.4 % of reading	
(> 90 to 100) s	10 % of reading		
Hydrometer	(0.6 to 2) g/cm ³	0.15 mg/cm ³	Electronic Balance, Density Standard Ring, Tridecane Solution; CP-PL77 Cuckow Method.
Air Velocity ¹	0 m/s	0.01 m/s	Wind Tunnel, Standard Anemometer; CP-PL26: Comparison Measurement
	2.5 m/s	0.05 m/s	
	5 m/s	0.1 m/s	
	10 m/s	0.19 m/s	
	15 m/s	0.28 m/s	
Flow Meter (Air Flow)	Up to 10 slpm	0.018 slpm	Air Flow Calibrator; CP-PL78: Direct Measurement
	(> 10 to 30) slpm	0.35 slpm	
	(> 30 to 100) slpm	2.7 slpm	
	(> 100 to 200) slpm	3.5 slpm	

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Flow Meter (Air Flow)	Up to 270 L/s (> 270 to 2 700) L/s (> 2 700 to 5 400) L/s (> 5 400 to 8 100) L/s (> 8 100 to 12 150) L/s	75 L/s 78 L/s 83 L/s 125 L/s 140 L/s	Standard Flow Meter Fluke 922; CP-PL78: Direct Measurement
Flow Meter ¹ (Liquid Flow)	Up to 4 400 L/min	0.13 % of reading	Ultrasonic Flow Meter; CP-PL31: Direct Measurement
Volumetric Glass Ware, Volumetric Flask, Volumetric Pipettes, Measuring Pipettes, Piston Pipettes, Burettes, Graduated Cylinders, Beakers, Dilutors, Dispensers, Pycnometers ¹	(10 to 50) µL (50 to 100) µL (100 to 200) µL (200 to 500) µL (500 to 1 000) µL (1 000 to 2 000) µL (2 000 to 5 000) µL (5 000 to 10 000) µL (10 000 to 20 000) µL (20 000 to 50 000) µL (50 to 100) mL (100 to 200) mL (200 to 500) mL (500 to 1 000) mL (1 000 to 2 000) mL	93 nL 0.36 µL 0.36 µL 0.38 µL 0.41 µL 0.46 µL 0.71 µL 1.3 µL 2.5 µL 6 µL 13 µL 25 µL 61 µL 0.12 mL 0.24 mL	Electronic Balances; CP-PL91 Gravimetric Method based on ASTM E 542-01 and ISO 8655-6

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Lux Meter	Up to 5 000 lux	1.6 % of reading	Digital Lux Meter; CP-PL27: Comparison Measurement
Optical Power ¹	Up to 1 mW (> 1 to 10) mW (> 10 to 100) mW	3.5 % of reading + 0.58 µW 3.5 % of reading + 5.8 µW 3.5 % of reading + 58 µW	Optical Power Meter; CP-EL51: Direct Measurement
UV Meter (UVA) UV Meter (UVC)	Up to 500 mW/cm ² Up to 10 000 mJ/cm ² Up to 300 mW/cm ² Up to 3 000 mJ/cm ²	2.9 % of reading 2.9 % of reading	UV Meter Standard; CP-PL68: Comparison Measurement



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Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Total Solar Irradiance / Pyranometer ¹ (Sensitivity or Calibration Factor)	(Sens. 1 to 200) $\mu\text{V/W/m}^2$ (Cal. Factor 0 to 1)	1.6 % of reading	Kipp & Zonan CMP11 and CMP22 Pyranometer; Wavetek 1281 8.5 Digit Multimeter, HP 34401A 6.5 Digit Multimeter, HP 34970A Data Logger; CP-EL53: Comparison Measurement
Gloss Meter ³ 20 ° 60 ° 85 °	87.7 GU 92.7 GU 99.2 GU	1 GU 1 GU 1.2 GU	AMECaL/GT-HG3 Gloss Tile; CP-PL76: Direct Measurement
Luminance Meter	Up to 2 cd/m^2 (> 2 to 20) cd/m^2 (> 20 to 150) cd/m^2 (> 150 to 2 000) cd/m^2	1.1 % of reading + 0.000 58 cd/m^2 1.1 % of reading + 0.005 8 cd/m^2 1.1 % of reading + 0.058 cd/m^2 1.1 % of reading + 0.58 cd/m^2	LS-65 Luminance Integrating Sphere Standard Light Source with Monitor Detector
Color Meter, Color Reader ⁶	White L* a* b* Y x y Black L* a* b* Y x y	0.25 0.1 0.16 0.6 0.006 0.006 0.4 0.15 0.32 0.12 0.006 0.007	Standard Color Plate; CP-PL79: Direct Measurement

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure ¹ (Dry well, Dry Block)	(-30 to 0) °C (> 0 to 200) °C (> 200 to 450) °C (> 450 to 650) °C	0.13 °C 0.14 °C 0.18 °C 0.19 °C	Fluke 5609 PRT, Fluke 5618B PRT, Fluke 5614 PRT, Fluke 5650 TS Type S Thermocouple Probe, Hart 1560 Black Stack with 2562 Module, Wavetek 1281 8.5 Digit Multimeter; CP-EL13: Direct Measurement
Temperature – Measure ¹ (Liquid Bath, Micro Bath)	(-40 to 0) °C (> 0 to 200) °C (> 200 to 450) °C (> 450 to 650) °C	0.05 °C 0.06 °C 0.09 °C 0.09 °C	Fluke 5609 PRT, Fluke 5618B PRT, Fluke 5614 PRT, Fluke 5650 TS Type S Thermocouple Probe, Hart 1560 Black Stack with 2562 Module, Wavetek 1281 8.5 Digit Multimeter; CP-EL13: Direct Measurement
Temperature Controlled Chamber Autoclave ¹ (Measurement)	(100 to 140) °C	0.5 °C	MadgeTech HiTemp140 Datalogger; CP-EL37: Direct Measurement
Humidity Controlled Chamber ¹ (Measurement)	(1 to 10) %RH (> 10 to 20) %RH (> 20 to 40) %RH (> 40 to 70) %RH (> 75 to 95) %RH	0.5 %RH 0.5 %RH 0.5 %RH 0.7 %RH 1 %RH	Baluntech BL783 Chilled Mirror Hygrometer, Temperature/ Humidity Data Logger; CP-EL62: Comparison Measurement
Humidity ¹ (Thermo Hygrometer Measurement)	(20 to 40) %RH (> 40 to 60) %RH (> 60 to 80) %RH (> 80 to 95) %RH	2 %RH 1.7 %RH 1.8 %RH 1.9 %RH	Rotronic HL-NT3-D Temperature/ Humidity Data Logger; CP-EL21: Comparison Measurement



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Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Humidity – Source ¹	(20 to 40) %RH (> 40 to 60) %RH (> 60 to 80) %RH (> 80 to 95) %RH	2 %RH 1.7 %RH 1.8 %RH 1.9 %RH	Rotronic HL-NT3-D Temperature/ Humidity Data Logger; Humidity Source; CP-EL21: Comparison Measurement
Temperature – Source ¹	(-10 to 0) °C (> 0 to 50) °C (> 50 to 100) °C (> 100 to 150) °C	0.33 °C 0.33 °C 0.34 °C 0.34 °C	Fluke 5618B PRT, Rotronic HL-NT3-D Temperature/Humidity Data Logger; Heat Source; CP-EL21: Comparison Measurement
Temperature ¹ (Thermo Hygrograph Measurement)	(-10 to 0) °C (> 0 to 50) °C (> 50 to 100) °C (> 100 to 150) °C	0.66 °C 0.66 °C 0.66 °C 0.66 °C	Comparison to Fluke 5618B PRT, Fluke 5614 PRT; Hart 1560 Black Stack with module 2562, Rotronic HL-NT3-D Temperature/ Humidity Data Logger; CP-EL21: Comparison Measurement
PRT Sensors ¹	(-30 to 0) °C (> 0 to 200) °C (> 200 to 450) °C (> 450 to 650) °C	0.047 °C 0.049 °C 0.077 °C 0.082 °C	Fluke 5609 SPRT, Hart 1560 Black Stack with module 2562, Thermometer Readout; Heat Source; CP-EL39: Comparison Measurement



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Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Controlled Chamber, Hot Air Oven, Incubator, Refrigerator, Low Temperature Furnace ¹	(-40 to 100) °C (> 100 to 200) °C (> 200 to 250) °C (> 250 to 450) °C (> 450 to 700) °C (> 700 to 1 000) °C (> 1 000 to 1 200) °C	0.37 °C 0.4 °C 0.79 °C 1.1 °C 2.5 °C 2.5 °C 3.6 °C	Agilent 34970A/34901A Datalogger ; CP-EL14: Direct Measurement Fluke 5650 Type S Standard Thermocouple Probe (Temperature is at an empty volume at a single spot); CP-EL68: Direct Measurement
Infrared Thermometers ¹	(-15 to 0) °C (> 0 to 50) °C (> 50 to 100) °C (> 100 to 150) °C (> 150 to 200) °C (> 200 to 250) °C (> 250 to 300) °C (> 300 to 350) °C (> 350 to 400) °C (> 400 to 450) °C (> 450 to 500) °C	0.95 °C 0.71 °C 1.3 °C 1.5 °C 1.8 °C 2.2 °C 2.5 °C 2.9 °C 3.3 °C 3.6 °C 4.2 °C	Fluke 5618B PRT, Hart 1560 Black Stack with 2562 Module, Omega BB701, CEM BX-500 Infrared Calibrator (Flat Plate), $\epsilon = 0.95$, $\lambda = (8 \text{ to } 14) \mu\text{m}$; CP-EL16: Comparison Measurement
Temperature Indicator with Surface Sensor/Probe ¹	(35 to 200) °C (> 200 to 400) °C	0.45 °C 0.68 °C	Fluke 5618B PRT, Hart 1560 Black Stack with module 2562, Fluke 3125/2200 Surface Probe Calibrator
Liquid-in-Glass Thermometers ¹	(-30 to 0) °C (> 0 to 40) °C (> 40 to 100) °C (> 100 to 200) °C	0.19 °C 0.18 °C 0.19 °C 0.2 °C	Fluke 5618B PRT, Fluke 5614 PRT, Hart 1560 Black Stack with module 2562; Heat Source; CP-EL15: Direct Measurement



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Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Gauge, Dial Thermometer ¹	(-40 to 25) °C (> 25 to 100) °C (> 100 to 400) °C (> 400 to 650) °C	0.32 °C 0.32 °C 0.4 °C 0.41 °C	Fluke 5609 PRT, Fluke 5618B PRT, Fluke 5614 PRT, Hart 1560 Black Stack with module 2562; Heat Source; CP-EL20: Comparison Measurement
Temperature – Measure ¹	(-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	0.012 °C 0.012 °C 0.013 °C 0.021 °C 0.023 °C 0.028 °C 0.033 °C	Wavetek 1281 8.5 Digit Multimeter, Standard RTD; CP-EL19: Direct Measurement
Temperature – Measure ¹	(-40 to 0) °C (> 0 to 200) °C (> 200 to 450) °C (> 450 to 650) °C	0.13 °C 0.14 °C 0.18 °C 0.19 °C	Fluke 5609 PRT, Fluke 5618B PRT, Fluke 5614 PRT, Fluke 5650 Type S Thermocouple Probe, Hart 1560 Black Stack with module 2562, Wavetek 1281 8.5 Digit Multimeter; CP-EL13: Direct Measurement
Temperature – Measure ¹ Temperature at Single Spot	(> 650 to 700) °C (> 700 to 1 000) °C (> 1 000 to 1 200) °C	2.5 °C 2.5 °C 3.6 °C	Fluke 5609 PRT, Fluke 5618B PRT, Fluke 5614 PRT, Fluke 5650 Type S Thermocouple Probe, Hart 1560 Black Stack with module 2562, Wavetek 1281 8.5 Digit Multimeter; CP-EL68: Direct Measurement



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Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Indicator with Resistance Temperature Detector Sensors ¹ (Pt 100-385, JPt 100-385, Pt 1000-385, Thermistor)	(-45 to 25) °C (> 25 to 100) °C (> 100 to 400) °C (> 400 to 650) °C	0.18 °C 0.19 °C 0.31 °C 0.36 °C	Comparison to Fluke 5609 PRT, Fluke 5618B PRT, Fluke 5614 PRT, Hart 1560 Black Stack with module 2562; Heat Source; CP-EL10: Comparison Measurement
Temperature Indicator with Thermocouple Sensors ¹	Type K (-45 to 25) °C (> 25 to 100) °C (> 100 to 400) °C (> 400 to 650) °C (> 650 to 1 200) °C Type J (-45 to 25) °C (> 25 to 100) °C (> 100 to 400) °C (> 400 to 650) °C (> 650 to 1 200) °C Type T (-45 to 25) °C (> 25 to 100) °C (> 100 to 400) °C	0.27 °C 0.3 °C 0.58 °C 0.9 °C 2.5 °C 0.29 °C 0.4 °C 1.3 °C 2 °C 4 °C 0.27 °C 0.4 °C 1.3 °C	Comparison to Fluke 5609 PRT, Fluke 5618B PRT, Fluke 5614 PRT, Fluke 5650 TS Type S Thermocouple Probe, Hart 1560 Black Stack with module 2562; Heat Source; CP-EL11: Comparison Measurement



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Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Indicator with Thermocouple Sensors ¹	Type R (25 to 100) °C	0.24 °C	Comparison to Fluke 5609 PRT, Fluke 5618B PRT, Fluke 5614 PRT, Fluke 5650 TS Type S Thermocouple Probe, Hart 1560 Black Stack with module 2562; Heat Source; CP-EL11: Comparison Measurement
	(> 100 to 400) °C	0.6 °C	
	(> 400 to 650) °C	0.6 °C	
	(> 650 to 1 200) °C	2.1 °C	
	Type S (25 to 100) °C	0.24 °C	
	(> 100 to 400) °C	0.6 °C	
	(> 400 to 650) °C	0.6 °C	
	(> 650 to 1 200) °C	2.1 °C	
	Type E (-45 to 25) °C	0.29 °C	
	(> 25 to 100) °C	0.4 °C	
	(> 100 to 400) °C	1.3 °C	
	(> 400 to 650) °C	2 °C	
	(> 650 to 1 000) °C	3.5 °C	
Type N (-30 to 25) °C	0.27 °C	Fluke 754 Documenting Process Calibrator; Fluke 5609 PRT, Fluke 5618B, PRT Fluke 5628 PRT, Fluke 5650 TC Standard; Fluke 1560, Fluke 1502A, Temperature Source; CP-EL77: Comparison Measurement with PRT and Standard Thermocouple	
(> 25 to 100) °C	0.3 °C		
(> 100 to 400) °C	0.7 °C		
(> 400 to 650) °C	0.9 °C		
(> 650 to 1 000) °C	2.5 °C		
Temperature Transmitter with Thermocouple Sensor ¹ Electrical Output Current (0 to 20) mA	Types E, J, K, N (-30 to 250) °C		0.48 °C
	(> 250 to 500) °C		0.52 °C
	(> 500 to 750) °C		1.5 °C
	(> 750 to 1 000) °C		1.5 °C
	Type T (-30 to 250) °C		0.48 °C
	(> 250 to 400) °C		0.52 °C
	Type: B (600 to 1 000) °C		1.5 °C
	Type: R, S (0 to 250) °C		0.48 °C
	(> 250 to 500) °C	0.52 °C	
	(> 500 to 750) °C	1.5 °C	
	(> 750 to 1 000) °C	1.5 °C	

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Transmitter with RTD Sensor ¹ Electrical Output Current (0 to 20) mA	Type: Pt 385, 100 Ω (-30 to 130) °C (> 130 to 300) °C (> 300 to 450) °C (> 450 to 600) °C	0.28 °C 0.36 °C 0.4 °C 0.4 °C	Fluke 754 Documenting Process Calibrator; Fluke 5609 PRT, Fluke 5618B, PRT Fluke 5628 PRT, Fluke 5650 TC Standard; Fluke 1560, Fluke 1502A, Temperature Source; CP-EL77: Comparison Measurement with PRT and Standard Thermocouple
Temperature Transmitter with Thermocouple Sensor ¹ Electrical Output Voltage (0 to 10) V	Type: E, J, K, N (-30 to 250) °C (> 250 to 500) °C (> 500 to 750) °C (> 750 to 1 000) °C Type: T (-30 to 250) °C (> 250 to 400) °C Type: B (600 to 1 000) °C Type: R, S (0 to 250) °C (> 250 to 500) °C (> 500 to 750) °C (> 750 to 1 000) °C	0.23 °C 0.29 °C 1.5 °C 1.5 °C 0.23 °C 0.29 °C 1.5 °C 0.23 °C 0.29 °C 1.5 °C 1.5 °C	Fluke 754 Documenting Process Calibrator; Fluke 5609 PRT, Fluke 5618B, PRT Fluke 5628 PRT, Fluke 5650 TC Standard; Fluke 1560, Fluke 1502A, Temperature Source; CP-EL77: Comparison Measurement with PRT and Standard Thermocouple



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Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature Transmitter with RTD Sensor ¹ Electrical Output Voltage (0 to 10) V	Type: Pt 385, 100 Ω (-30 to 130) °C (> 130 to 300) °C (> 300 to 450) °C (> 450 to 600) °C	0.085 °C 0.25 °C 0.28 °C 0.3 °C	Fluke 754 Documenting Process Calibrator; Fluke 5609 PRT, Fluke 5618B, PRT Fluke 5628 PRT, Fluke 5650 TC Standard; Fluke 1560, Fluke 1502A, Temperature Source; CP-EL77: Comparison Measurement with PRT and Standard Thermocouple
Temperature – Measure ¹	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 J (-210 to -100) °C (> -100 to -30) °C (> -30 to 150) °C (> 150 to 760) °C (> 760 to 1 200) °C Type T (-250 to -150) °C (> -150 to 0) (> 0 to 120) °C (> 120 to 400) °C	0.33 °C 0.13 °C 0.13 °C 0.13 °C 0.28 °C 0.26 °C 0.11 °C 0.089 °C 0.078 °C 0.17 °C 0.79 °C 0.13 °C 0.11 °C 0.08 °C	Hart 1560 Black Stack with module 2562; CP-EL19: Direct Measurement



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Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Temperature – Measure ¹	Type R		Hart 1560 Black Stack with module 2562; CP-EL19: Direct Measurement
	(0 to 250) °C	0.92 °C	
	(> 250 to 400) °C	0.47 °C	
	(> 400 to 1 000) °C	0.37 °C	
	(> 1 000 to 1 767) °C	0.4 °C	
	Type S		
	(0 to 250) °C	0.9 °C	
	(> 250 to 400) °C	0.51 °C	
	(> 400 to 1 000) °C	0.42 °C	
	(> 1 000 to 1 767) °C	0.47 °C	
	Type E		
	(-250 to -100) °C	0.52 °C	
	(> -100 to -25) °C	0.089 °C	
	(> -25 to 350) °C	0.065 °C	
	(> 350 to 650) °C	0.065 °C	
(> 650 to 1 000) °C	0.13 °C		
Type N			
(-200 to -100) °C	0.5 °C		
(> -100 to -25) °C	0.2 °C		
(> -25 to 120) °C	0.16 °C		
(> 120 to 410) °C	0.14 °C		
(> 410 to 1 300) °C	0.14 °C		

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Stroboscopes ^{1,3}	(0 to 100) rpm	0.001 3 rpm	Agilent 34401A 6.5 Digit Multimeter; HP 53131A, HP 53132A Universal Counter; CP-EL49: Direct Measurement
	(100 to 1 000) rpm	0.005 9 rpm	
	(> 1 000 to 100 000) rpm	0.058 rpm	
Non-contact Tachometers ^{1,3}	(0 to 100) rpm	0.000 7 rpm	LED, HP 33220A Function Generator, Fluke 5522A Multiproduct Calibrator; CP-EL48: Direct Measurement
	(> 100 to 1 000) rpm	0.07 rpm	
	(> 1 000 to 120 000) rpm	0.08 rpm	

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Contact RPM Measure ^{1,3}	(0 to 999) rpm (> 999 to 99 900) rpm	0.12 % of reading + 0.1 rpm 0.12 % of reading + 1 rpm	Non-contact Tachometer, CP-EL44: Direct Measurement
Accumulated – Measure ¹	Up to 4 999 count (5 000 to 90 000) count	0.03 % of reading + 1.3 count 0.03 % of reading + 2 count	Non-contact Tachometer, CP-EL44: Direct Measurement
Line Speed – Measure ¹	Up to 4 999 m/min (5 000 to 90 000) m/min	0.03 % of reading + 0.2 m/min 0.03 % of reading + 1 m/min	Non-contact Tachometer, CP-EL44: Direct Measurement
Frequency – Measure ¹	10 Hz to 1 MHz	0.21 μ Hz/Hz	Agilent 53181A, Agilent 53131A, Agilent 53132A Universal Counter; CP-EL28: Direct Measurement
Frequency – Source ¹	1 mHz to 20 GHz	0.4 nHz/Hz	Agilent 33220A, HP 8665B, HP 8648D, Agilent N9310A, HP 83732B, Agilent E4438C Signal Generators, with Efratom PRFS-102 Frequency Standard; CP-EL06: Direct Measurement
Frequency Display – Source ¹	1 mHz to 20 GHz	1.2 pHz/Hz	Agilent 33220A, HP 8665B, HP 8648D, Agilent N9310A, HP 83732B, Agilent E4438C Signal Generator; Time base (STD and UUC); CP-EL06: Direct Measurement



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Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Frequency – Source ¹	10 mHz to 120 Hz 120 Hz to < 1.2 kHz (1.2 to < 12) kHz (12 to < 120) kHz 120 kHz to < 1.2 MHz (1.2 to 2) MHz	2.9 μ Hz/Hz + 59 μ Hz 2.9 μ Hz/Hz + 0.59 mHz 2.9 μ Hz/Hz + 5.8 mHz 2.9 μ Hz/Hz + 58 mHz 2.9 μ Hz/Hz + 0.59 Hz 2.9 μ Hz/Hz + 5.8 Hz	Fluke 5522A Multiproduct Calibrator; CP-EL01: Direct Measurement
Frequency – Measure ¹	10 mV to 700 V or 0.1 mA to 1 A (1 to 40) Hz (> 40 to 1 000) Hz (> 1 to 10) kHz (> 10 to 100) kHz (> 0.1 to 1) MHz (> 1 to 10) MHz	0.58 mHz/Hz + 0.12 mHz 0.12 mHz/Hz + 1.2 mHz 0.12 mHz/Hz + 0.12 Hz 0.12 mHz/Hz + 1.2 Hz 0.12 mHz/Hz + 12 Hz 0.12 mHz/Hz + 0.12 kHz	Keysight 3458A 8.5 Digit Multimeter; CP-EL66: Direct Measurement
Frequency – Measure ¹	100 mHz to 20 GHz	0.4 nHz/Hz	Agilent 53131A, Agilent 53132A, Agilent 53181A, HP 5350B Universal Counter; Efratom PRFS-102 Frequency Standard; CP-EL07: Direct Measurement
Frequency – Measure ¹	100 mHz to 10 Hz 10 Hz to 20 GHz	0.21 μ Hz/Hz 45 nHz/Hz	Agilent 53131A, Agilent 53132A, Agilent 53181A, HP 5350B Universal Counter using Internal Time Base; CP-EL07: Direct Measurement
Frequency Display – Measure ¹	100 mHz to 12.4 GHz (12.4 to 20) GHz	20 pHz/Hz 85 pHz/Hz	Agilent 53131A, Agilent 53132A, Agilent 53181A, HP 5350B Universal Counter with together Time Base; CP-EL07: Direct Measurement



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Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Timer, Sweep Time, Stopwatch ¹	Up to 86 400 s	11 μs/s	Agilent 53131A, Agilent 53132A Universal Counter; Agilent 33220A Function Generator, Digital Camera; CP-EL34: Photo Totalize Method
Timer, Sweep Time, Stopwatch ¹	Up to 1 day	1.2 s/day + 40 ms	Casio HS-70W Stopwatch; CP-EL34: Direct Measurement
AC Voltage/Current Frequency – Measure ¹	(10 to 40) Hz > 40 Hz to 1kHz (> 1 to 10) kHz (> 10 to 100) kHz (> 100 to 300) kHz	3.5 mHz/Hz + 90 μHz 1.2 mHz/Hz + 0.1 mHz 1.2 mHz/Hz + 9 mHz 1.2 mHz/Hz + 90 mHz 1.2 mHz/Hz + 0.9 Hz	HP 34401A 6.5 Digit Multimeter, Fluke 289 Digital Multimeter; CP-EL02: Direct Measurement
Pulse – Source ¹	(1 to 500 000) count	0.58 count	Keysight 33220A Signal Generator; CP-EL45: Direct Measurement
Pulse – Measure ¹	(1 to 500 000) count	0.58 count	Agilent 53131A, Agilent 53132A Universal Counter; CP-EL46: Direct Measurement

DIMENSIONAL MEASUREMENT

2 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
2-D Measurement ³ X-Y axis	Up to 300 mm (> 300 to 400) mm (> 400 to 500) mm	(2 + 0.002L) μm (5 + 0.002L) μm (6 + 0.002L) μm	Vision Measuring Machine used as Reference; Customer Drawings and Vision Software; CP-PL70, CP-PL71: Direct Measurement

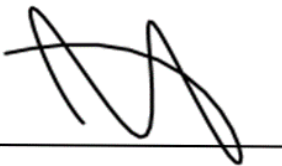
3 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
3-D Measurement ³	X-axis: Up to 700 mm Y-axis: Up to 700 mm Z-axis: Up to 600 mm	(0.8 + 0.008 2L) μm	Coordinate Measuring Machine used as Reference; Customer Drawings and CMM Software; CP-PL95: Direct Measurement

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. RF Power includes mismatch uncertainty and SWR assumption. mismatch calculation was based on specific SWR values. Customer values will vary.
3. D = diameter; " = arc-second; var = Volt-Ampere reactive (the SI allows this unit in lower case); GU = gloss unit; DL = diagonal length; " = arc-second; rpm = revolutions per minute.
4. Power Factor (sometimes noted as PF) is a unitless number between -1 and 1.
5. The Range Values are approximate. Actual Certified Values will be utilized at the time of calibration.
6. The measurand is a unitless measurement.
7. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2590.



Jason Stine, Vice President