



# 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](http://www.anab.org).

A handwritten signature in black ink, appearing to read 'R. Douglas Leonard Jr.', is positioned above a horizontal line.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 07 June 2022

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.**  
50/888-50/889 Moo 2, Rungsit-Nakornnayok Rd.  
Bungyeetho, Thunyaburee, Pathumthani 12130, Thailand  
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## CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: **June 07, 2022**

Certificate Number: **AC-2590**

### CALIBRATION

#### Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Vibration Meter <sup>1</sup>	Acceleration@ 160 Hz		Vibration Calibrator
	(0 to 10) m/s <sup>2</sup> (RMS)	0.22 m/s <sup>2</sup>	
	(> 10 to 20) m/s <sup>2</sup> (RMS)	0.44 m/s <sup>2</sup>	
	(> 20 to 30) m/s <sup>2</sup> (RMS)	0.6 m/s <sup>2</sup>	
	(> 30 to 40) m/s <sup>2</sup> (RMS)	0.8 m/s <sup>2</sup>	
	(> 40 to 50) m/s <sup>2</sup> (RMS)	1 m/s <sup>2</sup>	
	Velocity @ 160 Hz		
	(0 to 10) mm/s(RMS)	0.22 mm/s	
	(> 10 to 20) mm/s(RMS)	0.44 mm/s	
	(> 20 to 30) mm/s(RMS)	0.6 mm/s	
	(> 30 to 40) mm/s(RMS)	0.8 mm/s	
	(> 40 to 50) mm/s(RMS)	1 mm/s	
	Displacement@160 Hz		
	(0 to 10) μm (RMS)	0.22 μm	
	(> 10 to 20) μm (RMS)	0.44 μm	
(> 20 to 30) μm (RMS)	0.6 μm		
(> 30 to 40) μm (RMS)	0.8 μm		
(> 40 to 50) μm (RMS)	1 μm		
Sound level meter <sup>1</sup>	94 dB 114 dB	0.17 dB 0.17 dB	General Tool Sound Level Calibrator



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**Chemical Quantities**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
pH Meter <sup>1</sup>	4 pH 7 pH 10 pH	0.018 pH 0.018 pH 0.018 pH	pH Buffer Solution ASTM E70 and BS 1647
Conductivity Meter <sup>1</sup>	84 µS/cm 1 413 µS/cm 12.88 mS/cm 111.3 mS/cm	1.2 µS/cm 15 µS/cm 0.12 mS/cm 1.2 mS/cm	Conductivity Solution ASTM D 1125 and ASTM D 5391
Turbidity Meter <sup>1</sup>	10 NTU 100 NTU 500 NTU 1 000 NTU	0.072 NTU 0.72 NTU 4 NTU 7 NTU	Turbidity Solution

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
DC Voltage - Source <sup>1</sup>	0 mV (Shorted) (> 0 to < 330) mV 330 mV to < 3.3 V (3.3 to < 33) V (33 to < 330) V (330 to 1 020) V	0.7 µV 24 µV/V + 2 µV 14 µV/V + 2.8 µV 15 µV/V + 24 µV 22 µV/V + 0.18 mV 22 µV/V + 1.8 mV	Fluke 5522A Multiproduct Calibrator
DC Voltage - Source <sup>1</sup>	50 V to 1 kV (> 1 to 6) kV (> 6 to 10) kV	3.7 mV/V + 2.5 V 3.6 mV/V + 2.5 V 3.5 mV/V + 2.6 V	Rek RK2671AM Voltage Tester, Zentech 900A
DC Voltage - Measure <sup>1</sup>	(0 to < 200) mV 200 mV to < 2 V (2 to < 20) V (20 to < 200) V (200 to 1 000) V	8.5 µV/V + 0.72 µV 7.1 µV/V + 1.2 µV 7.1 µV/V + 7.5 µV 12 µV/V + 92 µV 12 µV/V + 0.68 mV	Wavetek 1281 Multimeter
DC Voltage - Measure <sup>1</sup>	(0 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
DC Voltage - Measure <sup>1</sup>	(0 to 4) V (> 4 to 48) V (> 48 to 300) V	1.2 % of reading + 1 mV 1.2 % of reading + 10 mV 1.2 % of reading + 0.1 V	HP 8903B Audio Analyzer



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
DC High Voltage - Measure <sup>1</sup>	(0.5 to 5) kV (> 5 to 10) kV	0.35 mV/V + 0.5 V 0.35 mV/V + 0.5 V	Vitrex 4700 High Voltage Meter
DC High Voltage - Measure <sup>1</sup>	(10 to < 20) kV (> 20 to 40) kV (> 40 to 100) kV	5.8 mV/V + 18 V 5.8 mV/V + 19 V 5.8 mV/V + 19 V	Vitrex 4700 High Voltage Meter With High Voltage Divider HLV-100G
DC Current – Source <sup>1</sup>	0 mA (Opened) (> 0 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	0.58 nA 0.18 mA/A + 24 nA 0.12 mA/A + 59 nA 0.12 mA/A + 0.3 µA 0.12 mA/A + 3.1 µA 0.24 mA/A + 47 µA 0.44 mA/A + 48 µA 0.58 mA/A + 0.91 mA 1.2 mA/A + 1.2 mA	Fluke 5522A Multiproduct Calibrator
DC Current – Source <sup>1</sup>	(0 to 100) µA (> 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 µA/A+ 30 pA 55 µA/A+ 0.3 nA 55 µA/A+ 3 nA 55 µA/A+ 30 nA 60 µA/A+ 0.2 µA 50 µA/A+ 2 µA 50 µA/A+ 15 µA 50 µA/A+ 15 µA 50 µA/A+ 0.15 mA 55 µA/A+ 1.2 mA 3.5 mA/A+ 1.2 mA 3 mA/A+ 16 mA	Standard Resistor, Standard Shunt, Digital Multimeter, Using Ohm's Law
DC Clamp-On Ammeters <sup>1</sup>	(20.5 to < 150) A (150 to 1 025) A	5.8 mA/A + 0.21 A 5.9 mA/A + 1.5 A	Fluke 5522A Multiproduct Calibrator with 50 turn coil
DC Current - Measure <sup>1</sup>	(0 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	Wavetek 1281 Multimeter
DC Current - Measure <sup>1</sup>	(0 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



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
DC Current - Measure <sup>1</sup>	(0 to 100) $\mu$ 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 30) A (> 30 to 50) A (> 50 to 100) A (> 100 to 500) A (> 500 to 1 000) A	60 $\mu$ A/A + 0.03 nA 55 $\mu$ A/A + 0.3 nA 55 $\mu$ A/A + 3 nA 55 $\mu$ A/A + 30 nA 60 $\mu$ A/A + 0.2 $\mu$ A 50 $\mu$ A/A + 2 $\mu$ A 50 $\mu$ A/A + 15 $\mu$ A 50 $\mu$ A/A + 15 $\mu$ A 50 $\mu$ A/A + 0.12 mA 55 $\mu$ A/A + 1.2 mA 55 $\mu$ A/A + 1.2 mA 3.5 mA/A 2.4 mA/A 2.4 mA/A 2.4 mA/A 5.8 mA/A	CCCP Standard Resistor Sets 1 m $\Omega$ -100 k $\Omega$ Agilent 34330A Shunt, FL-2.0 class 0.5
AC/DC Current Measure <sup>1</sup>	DC (0 to 20) A AC (0.02 to 20) A 10 Hz to 10 kHz (>10 to 50) kHz	0.15 mA/A 0.25 mA/A 1.2 mA/A	Holt Standard HCS-1AF current shunts With multimeter
DC/AC cutoff current - Measure <sup>1</sup>	DC (0 to 10) mA (>10 to 100) mA	0.87 mA/A + 17 $\mu$ A 1.8 mA/A + 28 $\mu$ A	Fluke 289 Multimeter
DC/AC cutoff current - Measure <sup>1</sup>	AC: @ (50, 60) Hz (0.02 to 10) mA (>10 to 100) mA	7 mA/ A + 26 $\mu$ A 7 mA/ A + 60 $\mu$ A	Fluke 289 Multimeter
AC Voltage – Source <sup>1</sup>	(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	0.95 mV/V + 7.1 $\mu$ V 0.37 mV/V + 9.6 $\mu$ V 0.35 mV/V + 60 $\mu$ V 0.36 mV/V + 0.77 mV 0.23 mV/V + 7.1 $\mu$ V 0.19 mV/V + 9.5 $\mu$ V 0.18 mV/V + 70 $\mu$ V 0.18 mV/V + 0.71 mV 0.28 mV/V + 7.1 $\mu$ V 0.21 mV/V + 9.5 $\mu$ V 0.23 mV/V + 70 $\mu$ V 0.28 mV/V + 0.71 mV	Fluke 5522A Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment		
AC Voltage – Source <sup>1</sup>	(> 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	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		
	(>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	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			
	(>100 to 500) kHz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V	9.3 mV/V + 58 μV 2.4 mV/V + 81 μV 2.9 mV/V + 0.7 mV			
	45 Hz to 1 kHz (33 to < 330) V (330 to 1 020) V	0.23 mV/V + 2.8 mV 0.35 mV/V + 12 mV			
	(>1 to 10) kHz (33 to < 330) V	0.24 mV/V + 7.2 mV			
	(>10 to 20) kHz (33 to < 330) V	0.3 mV/V + 7.1 mV			
	AC Voltage – Source <sup>1</sup>	(> 1 to 5) kHz (330 to 1 020) V		0.3 mV/V + 12 mV	Fluke 5522A Multiproduct Calibrator
		(> 5 to 10) kHz (330 to 1 020) V		0.35 mV/V + 12 mV	
	AC Voltage – Source <sup>1</sup>	(50, 60) Hz 50 V to 1 kV (> 1 to 6) kV (> 6 to 10) kV		6.2 mV/V + 1.3 V 5.8 mV/V + 2.6 V 5.8 mV/V + 2.7 V	Zentech 900A High Voltage Meter, Rek RK2671AM Voltage Tester
		AC Voltage - Measure <sup>1</sup>		(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	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



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure <sup>1</sup>	(> 40 to 100) Hz		Wavetek 1281 Multimeter
	(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		
(> 100 to 300) kHz			
200 mV to < 2 V	3.5 mV/V + 2.4 mV		
(2 to < 20) V	3.5 mV/V + 24 mV		
(20 to < 200) V	3.5 mV/V + 0.24 V		
> 300 kHz to 1 MHz			
(2 to < 20) V	12 mV/V + 1.2 mV		
(20 to < 200) V	12 mV/V + 2.4 V		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure <sup>1</sup>	(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	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	Yokogawa WT110 Power Meter
	> 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	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	
AC High Voltage - Measure <sup>1</sup>	(50 to 60) Hz (0.5 to 1) kV (> 1 to 5) kV (> 5 to 10) kV	1.4 mV/V + 0.2 V 1.4 mV/V + 0.5 V 1.4 mV/V + 0.6 V	Vitrex 4700 High Voltage Meter
AC High Voltage - Measure <sup>1</sup>	(50 to 60) Hz (1 to < 20) kV (20 to 35) kV (> 35 to 40) kV	58 mV/V + 0.24 V 58 mV/V + 0.24 V 58 mV/V + 0.24 V	Zentech 900A High Voltage Meter with Fluke 80K-40 High Voltage Probe
AC Current - Source <sup>1</sup>	(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	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	Fluke 5522A Multiproduct Calibrator



**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Current - Source <sup>1</sup>	(> 1 to 5) kHz		Fluke 5522A Multiproduct Calibrator
	(29 to < 330) $\mu$ A	3.5 mA/A + 0.18 $\mu$ A	
	330 $\mu$ A to < 3.3 mA	2.4 mA/A + 0.26 $\mu$ A	
	(3.3 to < 33) mA	0.93 mA/A + 2.6 $\mu$ A	
	(33 to < 330) mA	1.2 mA/A + 59 $\mu$ A	
	330 mA to < 1.1 A	7 mA/A + 1.2 mA	
	(1.1 to < 3) A	7 mA/A + 1.2 mA	
	(3 to < 11) A	35 mA/A + 2.7 mA	
	(11 to 20.5) A	35 mA/A + 5.9 mA	
	(> 5 to 10) kHz		
	(29 to < 330) $\mu$ A	9.3 mA/A + 0.24 $\mu$ A	
	330 $\mu$ A to < 3.3 mA	5.8 mA/A + 0.37 $\mu$ A	
	(3.3 to < 33) mA	2.4 mA/A + 3.8 $\mu$ A	
	(33 to < 330) mA	2.4 mA/A + 0.12 mA	
	330 mA to < 1.1 A	29 mA/A + 5.8 mA	
(1.1 to < 3) A	29 mA/A + 5.8 mA		
(> 10 to 30) kHz			
(29 to < 330) $\mu$ A	19 mA/A + 0.47 $\mu$ A		
330 $\mu$ A to < 3.3 mA	12 mA/A + 0.71 $\mu$ A		
(3.3 to < 33) mA	4.7 mA/A + 4.8 $\mu$ A		
(33 to < 330) mA	4.7 mA/A + 0.24 mA		
(10 to 45) Hz			
330 mA to < 1.1 A	2.1 mA/A + 0.12 mA		
(1.1 to < 3) A	2.1 mA/A + 0.15 mA		
(> 45 to 100) Hz			
(3 to < 11) A	0.71 mA/A + 2.5 mA		
(11 to 20.5) A	1.4 mA/A + 5.9 mA		
> 100 Hz to 1 kHz			
(3 to < 11) A	1.2 mA/A + 2.6 mA		
(11 to 20.5) A	1.8 mA/A + 6 mA		
AC Clamp-On Ammeters <sup>1</sup>	(45 to 65) Hz		Fluke 5522A Multiproduct Calibrator with 50 turn coil
	(20.5 to < 150) A	6.7 mA/A + 0.35 A	
	(150 to 1 025) A	6.7 mA/A + 1.4 A	
	(> 65 to 440) Hz		
	(20.5 to < 150) A	13 mA/A + 0.35 A	
(> 65 to 100) Hz			
(150 to 1 025) A	12 mA/A + 1.4 A		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Current – Measure <sup>1</sup>	10 Hz to 5 kHz (10 to < 200) $\mu$ A 200 $\mu$ 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 $\mu$ A 0.35 mA/A + 2.5 $\mu$ A 0.35 mA/A + 25 $\mu$ A 0.7 mA/A + 0.48 mA 2.4 mA/A + 0.94 mA	Wavetek 1281 Multimeter
AC Current – Measure <sup>1</sup>	(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
AC Current – Measure <sup>1</sup>	DC 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
Resistance - Source <sup>1</sup>	Resistance (4 Wire) 0 $\Omega$ (Shorted) (> 0 to < 11) $\Omega$ (11 to < 33) $\Omega$ (33 to < 110) $\Omega$ (110 to < 330) $\Omega$ 330 $\Omega$ to < 1.1 k $\Omega$ (1.1 to < 3.3) k $\Omega$ (3.3 to < 11) k $\Omega$ (11 to < 33) k $\Omega$ (33 to < 110) k $\Omega$	0.63 $\mu\Omega$ 62 $\mu\Omega/\Omega$ + 1.2 m $\Omega$ 53 $\mu\Omega/\Omega$ + 1.8 m $\Omega$ 43 $\mu\Omega/\Omega$ + 1.7 m $\Omega$ 36 $\mu\Omega/\Omega$ + 2.4 m $\Omega$ 34 $\mu\Omega/\Omega$ + 2.4 m $\Omega$ 35 $\mu\Omega/\Omega$ + 24 m $\Omega$ 34 $\mu\Omega/\Omega$ + 24 m $\Omega$ 35 $\mu\Omega/\Omega$ + 0.24 $\Omega$ 34 $\mu\Omega/\Omega$ + 0.24 $\Omega$	Fluke 5522A Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Resistance - Source <sup>1</sup>	Resistance (2 Wire) (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
Resistance – Source <sup>1</sup> Fixed Points	75 μΩ 0.1 mΩ 1 mΩ 10 mΩ 100 mΩ 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ	5.8 mΩ/Ω + 60 nΩ 3 mΩ/Ω + 60 nΩ 55 μΩ/Ω + 80 nΩ 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-100kΩ
Resistance – Source <sup>1</sup>	(0.1 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, 2786 Decade Resistor
Resistance – Source <sup>1</sup>	(0.1 to 1) MΩ (> 1 to 10) MΩ (> 1 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 Decade Resistor



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Resistance, - Source High Resistance, Insulation Resistance <sup>1</sup>	Test voltage @ ± (10 to 5 000) V 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	0.18 kΩ 1.8 kΩ 8.2 kΩ 8.6 kΩ 9.2 kΩ 0.30 MΩ 0.11 MΩ 0.12 MΩ 13 MΩ 14 MΩ 0.13 GΩ 0.19 GΩ 2.6 GΩ 10 GΩ	Megger CB101, Ohmite SM1 Resistor And Standard Resistance Box, 1M-1T
Surface resistivity/resistance meter, Electrostatic Resistance <sup>1</sup>	Test voltage @ ± (Up to 100) V 1 MΩ 5 MΩ 10 MΩ 20 MΩ 100 MΩ 1 GΩ 10 GΩ	18 kΩ 90 kΩ 0.18 MΩ 0.36 MΩ 1.8 MΩ 0.014 GΩ 0.19 GΩ	Yokogawa 2786 Decade Resistor, Megger CB101, Ohmite SM1 Resistor
Resistance - Measure <sup>1</sup>	(0 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 Test voltage @ 10 V (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 Multimeter



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Resistance - Measure <sup>1</sup>	Test current @ 0.1 mA to 200 A 75 $\mu\Omega$ 0.1 m $\Omega$ 1 m $\Omega$ 10 m $\Omega$ , 100 m $\Omega$ , 1 $\Omega$ 10 $\Omega$ , 100 $\Omega$ 1 k $\Omega$ , 10 k $\Omega$ , 100 k $\Omega$	2 m $\Omega/\Omega$ 1 m $\Omega/\Omega$ 65 $\mu\Omega/\Omega$ 55 $\mu\Omega/\Omega$ 60 $\mu\Omega/\Omega$ 60 $\mu\Omega/\Omega$	Red-China FL-2.0, Megger 249005, CCCP Standard Resistor Sets 1m $\Omega$ -100k $\Omega$ , Wavetek 1281 Digital Multimeter, DC Voltage Inter- Comparison
Resistance-Measure Insulation Resistance <sup>1</sup>	Test voltage @ (up to 5) kV (1 to 2) k $\Omega$ (> 2 to 20) k $\Omega$ (> 20 to 200) k $\Omega$ > 200 k $\Omega$ to 2 M $\Omega$ (> 2 to 20) M $\Omega$ (> 20 to 200) M $\Omega$ > 200 M $\Omega$ to 2 G $\Omega$ (> 2 to 20) G $\Omega$ (> 20 to 200) G $\Omega$	2.3 m $\Omega/\Omega$ + 0.4 $\Omega$ 1.8 m $\Omega/\Omega$ + 1 $\Omega$ 2.9 m $\Omega/\Omega$ + 10 $\Omega$ 2.9 m $\Omega/\Omega$ + 0.1 k $\Omega$ 2.9 m $\Omega/\Omega$ + 1 k $\Omega$ 3.5 m $\Omega/\Omega$ + 10 k $\Omega$ 18 m $\Omega/\Omega$ + 0.1 M $\Omega$ 18 m $\Omega/\Omega$ + 1 M $\Omega$ 18 m $\Omega/\Omega$ + 10 M $\Omega$	Keithley 617 Multimeter, Fluke 5522A Multiproduct Calibrator, Chroma 19073 Hipot Tester
Capacitance - Source <sup>1</sup>	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 $\mu$ F (1.1 to < 3.3) $\mu$ F (3.3 to < 11) $\mu$ F (11 to < 33) $\mu$ F 50 Hz (33 to < 110) $\mu$ F	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 $\mu$ F	Fluke 5522A Multiproduct Calibrator



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**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Capacitance - Source <sup>1</sup>	DC (110 to < 330) $\mu$ F 330 $\mu$ F to < 1.1 mF (1.1 to < 3.3) mF (3.3 to < 11) mF (11 to < 33) mF (33 to 110) mF	5.4 mF/F + 0.68 $\mu$ F 5.3 mF/F + 1.3 $\mu$ F 5.3 mF/F + 6.8 $\mu$ F 5.3 mF/F + 13 $\mu$ F 8.7 mF/F + 68 $\mu$ F 13 mF/F + 0.14 mF	Fluke 5522A Multiproduct Calibrator
Capacitance – Source <sup>1</sup> 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	Capacitors GR, 1409-F, GR, 1409-L, GR 1409-T, HP 16380A set consisting of 16381A, 16382A, 16483A and 16384A
Inductance – Source <sup>1</sup> Test Frequency @ 120 Hz  1 kHz, 10 kHz	(10 $\mu$ H, 100 $\mu$ H, 1 mH) (10 mH, 100 mH, 1 H)  (1 $\mu$ H, 10 $\mu$ H, 100 $\mu$ H) (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	Standard Inductors, GR 1482-E, GR 1482-H
Capacitance - Measure <sup>1</sup>	@ (0.1 to 10) 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 100) kHz (100 to < 1 000) pF (1 to < 10) nF (10 to < 100) nF (100 to < 1 000) nF	1.2 mF/F 1.2 mF/F 1.2 mF/F 1.2 mF/F 1.2 mF/F 1.2 mF/F 1.2 mF/F 1.2 mF/F 1.2 mF/F 1.2 mF/F	HP 4263B LCR Meter
Capacitance – Source / Measure <sup>1</sup>	@ (20 Hz to < 1 kHz) (10 to < 100) pF (100 to < 1000) pF (1 to < 10) nF (10 to < 100) nF (100 to < 1000) nF	0.7 mF/F + 0.1 fF 0.35 mF/F + 1 fF 0.35 mF/F + 10 fF 0.35 mF/F + 0.1 pF 0.35 mF/F + 1 pF	Precision LCR Meter Keysight E4980AL



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Capacitance – Source / Measure <sup>1</sup>	@ (1 to < 10) kHz		Precision LCR Meter Keysight E4980AL
	(1 to < 10) pF	0.7 mF/F + 0.01 fF	
	(10 to < 100) pF	0.35 mF/F + 0.1 fF	
	(100 to < 1 000) pF	0.35 mF/F + 1 fF	
	(1 to < 10) nF	0.35 mF/F + 10 fF	
	(10 to < 100) nF	0.35 mF/F + 0.1 pF	
	(100 to < 1 000) nF	0.35 mF/F + 1 pF	
	@ (10 to < 100) kHz		
	(1 to < 10) pF	0.55 mF/F + 0.01 fF	
	(10 to < 100) pF	0.35 mF/F + 0.1 fF	
	(100 to < 1 000) pF	0.35 mF/F + 1 fF	
	(1 to < 10) nF	0.35 mF/F + 10 fF	
	(10 to < 100) nF	0.35 mF/F + 0.1 pF	
	(100 to < 1 000) nF	0.35 mF/F + 1pF	
	@ (100 to < 300) kHz		
	(1 to < 10) pF	0.5 mF/F + 0.01 fF	
	(10 to < 100) pF	0.3 mF/F + 0.1 fF	
	(100 to < 1 000) pF	0.3 mF/F + 1 fF	
	(1 to < 10) nF	0.35 mF/F + 10 fF	
	(10 to < 100) nF	0.35 mF/F + 0.1 pF	
	(100 to < 1 000) nF	0.5 mF/F + 1 pF	
	@ (0.3 to 1) MHz		
	(1 to < 10) pF	0.55 mF/F + 0.01 fF	
	(10 to < 100) pF	0.3 mF/F 0.1 fF	
	(100 to < 1 000) pF	0.3 mF/F + 1 fF	
	(1 to < 10) nF	0.35 mF/F + 10 fF	
	(10 to < 100) nF	0.35 mF/F + 0.1 pF	
	(100 to < 1 000) nF	0.57 mF/F + 1 pF	
@ (100 Hz to < 1 kHz)			
(1 to < 10) μF	2 mF/F + 50 pF		
(10 to < 100) μF	2 mF/F + 0.3 nF		
@ 100 Hz, 120 Hz			
(0.1 to < 1) mF	2.8 mF/F + 10 nF		
(1 to < 10) mF	18 mF/F + 0.1 μF		
(10 to 100) mF	120 mF/F + 1 μF		
@ 1 kHz			
(0.1 to < 1) mF	5.1 mF/F + 10 nF		
(1 to < 10) mF	35 mF/F + 0.1 μF		
(10 to 100) mF	280 mF/F + 1 μF		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Inductance - Measure <sup>1</sup>	@ (0.1 to 10) kHz 0.01 μH to < 0.1 mH (0.1 to < 1) mH (1 to < 10) mH (10 to < 100) mH 100 mH to < 1 H (1 to 10) H	1.2 mH/H 1.2 mH/H 1.2 mH/H 1.2 mH/H 1.2 mH/H 1.2 mH/H	HP 4263B LCR Meter
Inductance – Source / Measure <sup>1</sup>	@ (100 Hz to <1 kHz) (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) kHz (10 to < 100) μH (100 to < 1 000) μH (1 to < 10) mH (10 to < 100) mH (100 to < 1 000) mH @ (100 to 1k) Hz (1 H to 10 H) @ (100 Hz to < 10 kHz) (100 to < 1000) mΩ (1 to < 10) Ω (10 to < 100) Ω (100 to < 1 000) Ω (1 to < 10) kΩ (10 to 100) kΩ @ (10 to < 300) kHz (100 to < 1 000) mΩ (1 to < 10) Ω (10 to < 100) Ω (100 to < 1000) Ω (1 to < 10) kΩ (10 to 100) kΩ	1.6 mH/H + 0.1 nH 0.63 mH/H + 1 nH 0.22 mH/H + 10 nH 0.33 mH/H + 0.1 μH 0.37 mH/H + 1 μH 1.4 mH/H + 0.1 nH 1.8 mH/H + 1 nH 0.27 mH + 10 nH 0.91 mH/H + 0.1 μH 5 mH/H + 1 μH 0.34 mH/H + 0.1 mH 1.5 mΩ/Ω + 4 μΩ 1 mΩ/Ω + 10 μΩ 0.85 mΩ/Ω + 0.1 mΩ 0.85 mΩ/Ω + 1.5 mΩ 0.85 mΩ/Ω + 10 mΩ 0.85 mΩ/Ω + 0.2 Ω 1.5 mΩ/Ω + 4 μΩ 4.9 mΩ/Ω + 10 μΩ 3.3 mΩ/Ω + 0.1 mΩ 0.85 mΩ/Ω + 1.5 mΩ 0.85 mΩ/Ω + 10 mΩ 1.6 mΩ/Ω + 0.2 Ω	Precision LCR Meter Keysight E4980AL





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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 <sup>1</sup>	@ (0.3 to 1) MHz (100 to < 1000) mΩ (1 to < 10) Ω (10 to < 100) Ω (100 to < 1 000) Ω (1 to < 10) kΩ (10 to 100) kΩ	13 mΩ/Ω + 4 μΩ 1 mΩ/Ω + 10 μΩ 0.85 mΩ/Ω + 0.1 mΩ 0.85 mΩ/Ω + 1.5 mΩ 0.85 mΩ/Ω + 10 mΩ 1.6 mΩ/Ω + 0.2 Ω	Precision LCR Meter Keysight E4980AL
DC Power - Source <sup>1</sup>	(1 to < 336.6) W 33 mV to 1 020 V, (0.33 to < 330) mA 336.6 W to < 3.06 kW 33 mV to 1 020 V, (0.33 to < 3) A (3.06 to 20.91) kW 33 mV to 1 020 V, (3 to 20.5) A	0.27 mW/W + 95 mW  0.26 mW/W + 0.86 W  0.81 mW/W + 0.76 W	Fluke 5522A Multiproduct Calibrator
DC Power - Source <sup>1</sup>	(20.91 to < 153) kW 33 mV to 1 020 V, (20.5 to < 150) A 153 kW to < 1.046 MW 33 mV to 1 020 V, (150 to < 1 025) A	6.6 mW/W + 7.6 W  6.6 mW/W + 7.6 W	Fluke 5522A Multiproduct Calibrator with 50 turn coil
AC Power – Source <sup>1</sup> Single Phase, PF = 1 @ 45 Hz to 65 Hz	(1 to < 9.18) W 330 mV to 1 020 V, (3.3 to < 9) mA (9.18 to < 33.66) W 330 mV to 1 020 V, (9 to < 33) mA (33.66 to < 91.8) W 330 mV to 1 020 V, (33 to < 90) mA (91.8 to < 336.6) W 330 mV to 1 020 V, (90 to < 330) mA (336.6 to < 918) W 330 mV to 1 020 V, (0.33 to < 0.90) A	1.5 mW/W + 7.6 mW  1.1 mW/W + 7.6 mW  1.5 mW/W + 7.6 mW  1.1 mW/W + 76 mW  1.4 mW/W + 76 mW	Fluke 5522A Multiproduct Calibrator

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Power – Source <sup>1</sup> Single Phase, PF = 1 @ 45 Hz to 65 Hz	918 W to < 2.24 kW 330 mV to 1 020 V, (0.9 to < 2.2) A	1.2 mW/W + 0.76 W	Fluke 5522A Multiproduct Calibrator
	(2.24 to < 4.59) kW 330 mV to 1 020 V, (2.2 A to < 4.5) A	1.5 mW/W + 0.76 W	
	(4.59 to 20.91) kW 330 mV to 1 020 V, (4.5 to 20.5) A	1.3 mW/W + 0.76 W	
AC Power – Source <sup>1</sup> Single Phase, PF = 1 @ 45 Hz to 65 Hz	(20.91 to < 153) kW 33 mV to 1020 V, (20.5 to < 150) A	13 mW/W + 7.6 W	Fluke 5522A Multiproduct Calibrator with 50 turn coil
	153 kW to < 1.046 MW 33 mV to 1 020 V, (150 to < 1 025) A	13 mW/W + 7.6 W	
DC/AC Power DC Power-Source <sup>1</sup>	0.108 9 mW to < 1.089 W (0.033 to < 33) V (3.3 to < 33) mA	0.2 mW/W + 90 μW	Fluke 5522A Multiproduct Calibrator
	1.089 mW to < 10.89 W (0.033 to < 33) V (33 to < 330) mA)	0.2 mW/W + 0.9 mW	
	10.89 mW to < 99 W (0.033 to < 33) V (0.33 to < 3) A	0.2 mW/W + 8 mW	
DC/AC Power DC Power-Source <sup>1</sup>	99 mW to < 660 W (0.033 to < 33) V 3 A to 20 A)	0.6 mW/W + 80 mW	Fluke 5522A Multiproduct Calibrator
	(0.108 9 to < 33) W (33 to 1000) V (3.3 to < 33) mA	0.2 mW/W + 0.9 mW	
	(1.089 to < 330) W (33 to 1 000) V (33 to < 330) mA	0.2 mW/W + 9 mW	
	10.89 W to < 3 kW (33 to 1 000) V (0.33 to < 3) A	0.2 mW/W + 90 mW	
	99 W to 20 kW (33 to 1 000) V (3 to 20) A	0.6 mW/W + 0.9 W	

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
DC/AC Power DC Power-Source <sup>1</sup>	0.33 W to < 0.544 5 kW (0.033 to < 33) V, (10 to < 16.5) A	3.2 mW/W + 60 mW	Fluke 5522A Multiproduct Calibrator with 50 Turns coil
	0.544 5 W to < 4.950 kW (0.033 to < 33) V, (16.5 to < 150) A	3.2 mW/W + 0.6 W	
	4.95 W to < 33.825 kW (0.033 to < 33) V, (150 to 1 025) A	3.2 mW/W + 6 W	
	(0.33 to < 16.83) kW (33 to 1 020) V, (10 to < 16.5) A	3.2 mW/W + 0.6 W	
	(0.544 5 to < 153) kW (33 to 1020) V, (16.5 A to < 150 A)	3.2 mW/W + 6 W	
	4.95 kW to 1.0455 MW (33 to 1020) V, (150 to 1025) A	3.2 mW/W + 60 W	
AC Power-Source <sup>1</sup> @ (45 to 65) Hz Power factor: 1.000	(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
	(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	



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Power-Source <sup>1</sup> @ (45 to 65) Hz Power factor: 1.000	(1.485 to < 66) W (0.33 to < 3.3) V, (4.5 to 20) A	1 mW/W + 10 mW	Fluke 5522A Multiproduct Calibrator
	(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	
	(0.1089 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	
	(1.089 to < 29.7) W (3.3 to < 33) V, (0.33 to < 0.9) A	1.1 mW/W + 1 mW	
	(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	
	(0.1089 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	

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Power-Source <sup>1</sup> @ (45 to 65) Hz Power factor: 1.000	(10.89 to < 297) W (33 to < 330) V, (0.33 to < 0.9) A	1.1 mW/W + 10 mW	Fluke 5522A Multiproduct Calibrator
	(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	
	(10.89 to < 90) W (330 to 1 000) V, (33 to < 90) mA	1.2 mW/W + 1 mW	
	(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	
	(297 to < 2 200) W (330 to 1 000) V, (0.9 to < 2.2) A	0.9 mW/W + 0.1 W	
	(726 to < 4 500) W (330 to 1 000) V, (2.2 to < 4.5) A	1.2 mW/W + 0.1 W	
	(1 485 to 20 000) W (330 to 1 000) V, (4.5 to 20) A	1 mW/W + 1 W	
	AC Power-Source <sup>1</sup> @ (45 to 65) Hz Power factor: (0.500 to 0.999)	(0.545 to < 29.67) mW (0.33 to < 3.3) V, (3.3 to < 9) mA	
(1.485 to < 108.8) mW (0.33 to < 3.3) V, (9 to < 33) mA		4 mW/W + 10 μW	

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
<p style="text-align: center;">AC Power-Source<sup>1</sup> @ (45 to 65) Hz Power factor: (0.500 to 0.999)</p>	(5.45 to < 296.7) mW (0.33 to < 3.3) V, (33 to < 90) mA	4 mW/W + 0.1 mW	Fluke 5522A Multiproduct Calibrator
	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	
	0.1485 to < 7.2527) 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	
	(0.7425 to < 65.934) W (0.33 to < 3.3) V, (4.5 A to 20) A	4 mW/W + 10 mW	
	(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	

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
<p>AC Power-Source<sup>1</sup> @ (45 to 65) Hz Power factor: (0.500 to 0.999)</p>	54.45 mW to < 2.967 W (33 to < 330) V, (3.3 to < 9) mA	4 mW/W + 0.1 mW	<p>Fluke 5522A Multiproduct Calibrator</p>
	(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	
	(1.485 to < 108.8) W (33 to < 330) V, (90 to < 330) mA	4 mW/W + 10 mW	
	(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	

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Power-Source <sup>1</sup> @ (45 to 65) Hz Power factor: (0.500 to 0.999)	(148.5 to < 2197.8) W (330 to 1 000) V, (0.9 to < 2.2) A (363 to < 4 495.5) W (330 to 1 000) V, (2.2 to < 4.5) A (742.5 to 19 980) W (330 to 1 000) V, (4.5 A to 20) A	4 mW/W + 0.1 W  4 mW/W + 0.1 W  4 mW/W + 1 W	Fluke 5522A Multiproduct Calibrator
AC Power-Source <sup>1</sup> @ (45 to 65) Hz Power factor: 1.000	3.3 W to < 16.83 kW (0.33 to 1 020) V, (10 to < 16.5) A 5.445 W to < 153 kW (0.33 to 1 020) V, (16.5 to < 150) A 49.5 W to 1.045 5 MW (0.33 to 1 020) V, (150 to 1 025) A	3.6 mW/W + 0.6 W  3.6 mW/W + 6 W  3.6 mW/W + 60 W	Fluke 5522A Multiproduct Calibrator with 50 turn coil
AC Power-Source <sup>1</sup> @ (45 to 65) Hz Power factor: (0.500 to 0.999)	1.65 W to < 16.813 kW (0.33 to 1 020) V, (10 to < 16.5) A 2.723 W to < 152.85 kW (0.33 to 1 020) V, (16.5 to < 150) A 24.75 W to 1.044 4 MW (0.33 to 1 020) V, (150 to 1 025) A	5 mW/W + 0.6 W  5 mW/W + 6 W  5 mW/W + 60 W	Fluke 5522A Multiproduct Calibrator with 50 turn coil
Power Factor-Source <sup>1</sup>	@ (45 to 65) Hz (0.174 to 0.485) PF (0.500 to 0.755) PF (0.766 to 0.934) PF (0.940 to 0.999) PF 1.000 PF	0.001 4 PF 0.001 3 PF 0.000 95 PF 0.000 5 PF 0.000 06 PF	Fluke 5522A Multiproduct Calibrator
Digital Multimeter: up to 7.5 Digits DC Voltage – Source <sup>1</sup>	(0 to < 200) mV 200 mV to < 2 V (2 to < 20) V (20 to < 200) V (200 to 1 000) V	8.5 μV/V + 0.72 μV 7.1 μV/V + 1.2 μV 7.1 μV/V + 7.5 μV 12 μV/V + 92 μV 12 μV/V + 0.68 mV	Fluke 5522A Multiproduct Calibrator with Wavetek 1281 Multimeter





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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 Current – Source <sup>1</sup>	(0 to < 200) $\mu$ A 200 $\mu$ 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 $\mu$ A 0.24 mA/A + 26 $\mu$ A	Fluke 5522A Multiproduct Calibrator with Wavetek 1281 Multimeter
Digital Multimeter: up to 7.5 Digits AC Voltage – Source <sup>1</sup>	(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 (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 1000) V	0.27 mV/V + 4.7 $\mu$ V 0.2 mV/V + 25 $\mu$ V 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 $\mu$ V 0.18 mV/V + 25 $\mu$ V 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 $\mu$ V 0.16 mV/V + 24 $\mu$ V 0.16 mV/V + 0.24 mV 0.16 mV/V + 2.5 mV 0.18 mV/V + 14 mV 0.25 mV/V + 4.7 $\mu$ V 0.18 mV/V + 24 $\mu$ V 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 $\mu$ V 0.29 mV/V + 47 $\mu$ V 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 $\mu$ V 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	Fluke 5522A Multiproduct Calibrator with Wavetek 1281 Multimeter



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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 <sup>1</sup>	(> 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 10 Hz to 5 kHz (10 to < 200) $\mu$ A 200 $\mu$ A to < 2 mA (2 to < 20) mA (20 to < 200) mA	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  0.36 mA/A + 25 nA 0.35 mA/A + 0.25 $\mu$ A 0.35 mA/A + 2.5 $\mu$ A 0.35 mA/A + 25 $\mu$ A	Fluke 5522A Multiproduct Calibrator with Wavetek 1281 Multimeter
Digital Multimeter: up to 7.5 Digits AC Current – Source <sup>1</sup>	10 Hz to 1 kHz 200 mA to < 2 A (>1 to 5) kHz 200 mA to < 2 A	0.7 mA/A + 0.48 mA  2.4 mA/A + 0.94 $\mu$ A	Fluke 5522A Multiproduct Calibrator with Wavetek 1281 Multimeter
Digital Multimeter: up to 7.5 Digits Resistance – Source <sup>1</sup>	(0 to < 20) $\Omega$ (20 to < 200) $\Omega$ 200 $\Omega$ to < 2 k $\Omega$ (2 to < 20) k $\Omega$ (20 to < 200) k $\Omega$ 200 k $\Omega$ to < 2 M $\Omega$ (2 to < 20) M $\Omega$	18 $\mu\Omega/\Omega$ + 27 $\mu\Omega$ 13 $\mu\Omega/\Omega$ + 0.12 m $\Omega$ 11 $\mu\Omega/\Omega$ + 1.1 m $\Omega$ 11 $\mu\Omega/\Omega$ + 12 m $\Omega$ 11 $\mu\Omega/\Omega$ + 0.14 $\Omega$ 17 $\mu\Omega/\Omega$ + 5 $\Omega$ 35 $\mu\Omega/\Omega$ + 0.17 k $\Omega$	Fluke 5522A Multiproduct Calibrator with Wavetek 1281 Multimeter
Digital Multimeter: up to 7.5 Digits Resistance – Source <sup>1</sup>	Test voltage @ 10 V (20 to < 200) M $\Omega$ 200 M $\Omega$ to < 2 G $\Omega$	0.35 m $\Omega/\Omega$ + 13 k $\Omega$ 3.5 m $\Omega/\Omega$ + 1.1 M $\Omega$	Fluke 5522A Multiproduct Calibrator with Wavetek 1281 Multimeter
AC Watt-hour Source <sup>1</sup> Single phase	0.010 89 Wh to 200 kWh Voltage range (0.33 to 1 000) V @ 50 Hz, cos $\phi$ = 1.0 Current range 3.3 mA to 20 A	1 mWh/Wh	Fluke 5522A Multiproduct Calibrator Stop Watch Casio HS-70W
Charge Plate Monitor <sup>1</sup>	(-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
Phase Meter <sup>1</sup>	(0 to 360) $^{\circ}$ 10 Hz to 10 kHz (10 to 100) kHz	0.01 $^{\circ}$ 0.063 $^{\circ}$	Agilent 53131A Counter



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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 <sup>1</sup>	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
Pulse - Source <sup>1</sup> Pulse - Measure <sup>1</sup> Transformer ratio-Source <sup>1</sup>	(1 to 500 000) counts (1 to 500 000) counts (1 to 10 000 000) turns	0.58 count 0.58 count 0.000 12 % of reading	33120A Generator 53131A Counter DT72A Ratio Transformer
Gauss Meter, Tesla Meter <sup>1</sup> (North and South)	(Up to 10) G (> 10 to 500) G (> 500 to 3 000) G (> 3 000 to 10 000) G	0.58 G 0.58 G 1.6 G 3 G	F.W. Bell Inc. VA-071A, VA-072A Reference Magnet
Gauss – Measure <sup>1</sup>	(0 to 2) G (> 2 to 20) G (> 20 to 200) G (> 0.2 to 2) kG (> 2 to 20) kG	0.58 % of reading + 7 mG 0.58 % of reading + 70 mG 0.58 % of reading + 0.3 G 0.58 % of reading + 3 G 0.58 % of reading + 30 G	F.W. Bell Inc. 9200, Gauss Meter
Oscilloscopes <sup>1</sup> Square Wave Signal Impedance: 50 Ω @ 10 Hz to 10 kHz  Impedance: 1 MΩ @ 10 Hz to 1 kHz	1.8 mVp-p to < 1.0 Vp-p 1.8 mVp-p to < 2.2 Vp-p  1.8 mVp-p to < 1 Vp-p (1 to < 105) Vp-p	2 mV/V + 0.1 mV 2 mV/V + 0.1 mV  2 mV/V + 0.1 mV 2 mV/V + 1.2 mV	Fluke 5500A w Opt. SC300 Multiproduct Calibrator, 5522A Multiproduct Calibrator
Oscilloscopes <sup>1</sup> Vertical Deflection DC	0 mV (Shorted) (> 0 to < 330) mV 330 mV to < 3.3 V (3.3 to < 33) V (33 to < 330) V (330 to 1 020) V	0.91 μV 16 μV/V + 1.9 μV 9 μV/V + 0.58 mV 10 μV/V + 0.58 mV 14 μV/V + 0.59 mV 14 μV/V + 1.3 mV	Fluke 5522A Multiproduct Calibrator
Oscilloscope Bandwidth <sup>1</sup> @ 50 kHz to 300 MHz	(-70 to 20) dBm (6 to 12) mVp-p > 12 mVp-p to 5.5 Vp-p	0.35 dB 0.25 dB	Agilent 8665B Signal Generator
Oscilloscope AC Voltage Output Signal-Measure <sup>1</sup>	(0 to 10) Vp-p	0.16 mV/V + 0.24 mV	Wavetek 1281 Multimeter
Oscilloscope <sup>1</sup> Rise Time/Fall Time	<400 ps	28 ps	Fluke 5500A w Opt. SC300 Multiproduct Calibrator



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Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Oscilloscope Horizontal Deflection: Time Mark <sup>1</sup>	5 s	5.8 ms/s + 0.058 ms	Fluke 5500A w Opt. SC300 Multiproduct Calibrator
	2 s	2.4 ms/s + 0.058 ms	
	1 s	1.2 ms/s + 0.058 ms	
	0.5 s	0.61 ms/s + 5.8 μs	
	0.2 s	0.26 ms/s + 5.8 μs	
	0.1 s	0.15 ms/s + 5.8 μs	
	50 ms	87 μs/s + 0.58 μs	
	20 ms	52 μs/s + 0.58 μs	
	10 ms	41 μs/s + 0.58 μs	
	5 ms	35 μs/s + 0.058 μs	
	2 ms	32 μs/s + 0.058 μs	
	1 ms	30 μs/s + 0.058 μs	
	0.5 ms	30 μs/s + 5.8 ns	
	0.2 ms	30 μs/s + 5.8 ns	
	0.1 ms	29 μs/s + 5.8 ns	
	50 μs	30 μs/s + 0.58 ns	
	20 μs	30 μs/s + 0.58 ns	
10 μs	30 μs/s + 0.58 ns		
Oscilloscope Horizontal Deflection: Time Mark <sup>1</sup>	5 μs	29 μs/s + 0.058 ns	Fluke 5500A w Opt. SC300 Multiproduct Calibrator
	2 μs	29 μs/s + 0.058 ns	
	1 μs	29 μs/s + 0.058 ns	
	0.5 μs	29 μs/s + 5.8 ps	
	0.2 μs	29 μs/s + 5.8 ps	
	0.1 μs	29 μs/s + 5.8 ps	
	50 ns	29 μs/s + 0.58 ps	
	20 ns	29 μs/s + 0.58 ps	
	10 ns	29 μs/s + 0.58 ps	
	5 ns	29 μs/s + 0.058 ps	
	2 ns	29 μs/s + 0.058 ps	
1ns	29 μs/s + 0.058 ps		
Temperature-Simulation Resistance Temperature Detector <sup>1</sup>	Pt100 (385)		Fluke 5522A Multiproduct Calibrator
	(-200 to - 80) °C	0.082 °C	
	(> - 80 to 0) °C	0.082 °C	
	(> 0 to 100) °C	0.1 °C	
	(> 100 to 300) °C	0.12 °C	
	(> 300 to 400) °C	0.13 °C	
	(> 400 to 630) °C	0.16 °C	
(> 630 to 800) °C	0.28 °C		

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Temperature-Simulation Thermocouple <sup>1</sup> (With 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	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	Fluke 5522A Multiproduct Calibrator
Temperature-Simulation Thermocouple <sup>1</sup> (With cold junction compensation)	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 400) °C (> 400 to 1 000) °C (> 1 000 to 1 767) °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 N (-200 to -100) °C (> -100 to -25) °C (> -25 to 120) °C (> 120 to 410) °C (> 410 to 1 300) °C	0.47 °C 0.39 °C 0.39 °C 0.39 °C 0.49 °C 0.42 °C 0.42 °C 0.42 °C 0.28 °C 0.21 °C 0.2 °C 0.2 °C 0.21 °C 0.27 °C 0.22 °C 0.21 °C 0.21 °C 0.21 °C	Fluke 5522A Multiproduct Calibrator

**Electrical – DC/Low Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Temperature-Simulation Thermocouple <sup>1</sup> (Without cold junction compensation)	Type K		Fluke 5522A Multiproduct Calibrator
	(-200 to -100) °C	0.14 °C	
	(> -100 to -25) °C	0.1 °C	
	(> -25 to 120) °C	0.09 °C	
	(> 120 to 1 000) °C	0.1 °C	
	(> 1 000 to 1 372) °C	0.11 °C	
	Type J		
	(-210 to -100) °C	0.13 °C	
	(> -100 to -30) °C	0.09 °C	
	(> -30 to 150) °C	0.09 °C	
	(> 150 to 760) °C	0.09 °C	
	(> 760 to 1 200) °C	0.1 °C	
	Type T		
(-250 to -150) °C	0.29 °C		
(> -150 to 0) °C	0.11 °C		
(> 0 to 120) °C	0.09 °C		
(> 120 to 400) °C	0.09 °C		
Temperature-Simulation Thermocouple <sup>1</sup> (Without cold junction compensation)	Type R		Fluke 5522A Multiproduct Calibrator
	(0 to 250) °C	0.33 °C	
	(> 250 to 400) °C	0.2 °C	
	(> 400 to 1 000) °C	0.19 °C	
	(> 1 000 to 1 767) °C	0.19 °C	
	Type S		
	(0 to 250) °C	0.32 °C	
	(> 250 to 400) °C	0.21 °C	
	(> 400 to 1 000) °C	0.2 °C	
	(> 1 000 to 1 767) °C	0.21 °C	
	Type E		
	(-250 to -100) °C	0.21 °C	
	(> -100 to -25) °C	0.09 °C	
	(> -25 to 350) °C	0.09 °C	
	(> 350 to 650) °C	0.08 °C	
	(> 650 to 1 000) °C	0.09 °C	
	Type N		
	(-200 to -100) °C	0.2 °C	
(> -100 to -25) °C	0.11 °C		
(> -25 to 120) °C	0.11 °C		
(> 120 to 410) °C	0.1 °C		
(> 410 to 1 300) °C	0.11 °C		

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation - Source <sup>1</sup> Frequency Carrier (150 kHz to <10 MHz) Modulation Rate (20 to <50) Hz  Modulation Rate 50 Hz to 10 kHz	Modulation Depth AM (5 to <40) % Depth AM (>40 to 99) % Depth  AM (5 to <40) % Depth AM (>40 to 99) % Depth	3.6 % of reading + 0.014 % Depth 3.6 % of reading + 0.14 % Depth  2 % of reading + 0.014 % Depth 2 % of reading + 0.14 % Depth	HP8648D, Agilent E4438C Signal Generator, Comparison Measurement with HP 8902A Measuring Receiver
Amplitude Modulation – Source <sup>1</sup> Frequency Carrier (10 MHz to 1.3 GHz) Modulation Rate 20 Hz to <50 Hz (>50 to 100) kHz  Modulation Rate 50 Hz to 50 kHz	Modulation Depth AM (5 to <40) % Depth AM (>40 to 99) % Depth  AM (5 to <40) % Depth AM (>40 to 99) % Depth	3.6 % of reading + 0.014 % Depth 3.6 % of reading + 0.14 % Depth  2 % of reading + 0.014 % Depth 2 % of reading + 0.14 % Depth	HP8648D, Agilent E4438C Signal Generator, Comparison Measurement with HP 8902A Measuring Receiver
Amplitude Modulation – Source <sup>1</sup> Frequency Carrier (>1.3 GHz to 20 GHz) Modulation Rate 20 Hz to <50 Hz, (>50 to 100) kHz  Modulation Rate 50 Hz to 50 kHz	Modulation Depth AM (5 to <40) % Depth AM (>40 to 99) % Depth  AM (5 to <40) % Depth AM (>40 to 99) % Depth	3.9% of reading + 0.014 % Depth 3.9 % of reading + 0.14 % Depth  2.5 % of reading + 0.014 % Depth 2.5 % of reading + 0.14 % Depth	HP83732B Signal Generator, 11793A Down converter, Comparison Measurement with HP 8902A Measuring Receiver
Frequency Modulation – Source <sup>1</sup> Frequency Carrier (250 kHz to 10 MHz) Modulation Rate 20 Hz to 10 kHz	FM Deviation <5 kHz (5 to 40) kHz	2.5 % of reading + 0.001 4 kHz 2.5 % of reading + 0.014 kHz	HP 8648D Signal Generator, Agilent E4438C Generator, HP83732B Signal Generator, 11793A Down converter,



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**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Frequency Modulation - Source <sup>1</sup> Frequency Carrier (>10 MHz to 1.3 GHz) Modulation Rate 50 Hz to 100 kHz	FM Deviation <5 kHz (5 to < 40) kHz (40 to 400) kHz	1.4 % of reading + 0.001 4 kHz 1.4 % of reading + 0.014 kHz 1.4 % of reading + 0.14 kHz	Comparison Measurement with HP 8902A Measuring Receiver
Frequency Modulation - Source <sup>1</sup> Frequency Carrier (>10 MHz to 1.3 GHz)  Modulation Rate (20 to < 50) Hz (>100 to 200) kHz	FM Deviation <5 kHz (5 to < 40) kHz (40 to 400) kHz	5.9 % of reading + 0.001 4 kHz 5.9 % of reading + 0.014 kHz 5.9 % of reading + 0.14 kHz	HP 8648D Signal Generator, Agilent E4438C Generator, HP83732B Signal Generator, 11793A Down converter, Comparison Measurement with HP 8902A Measuring Receiver
Frequency Modulation - Source <sup>1</sup> Frequency Carrier (>1.3 to 20) GHz Modulation Rate 50 Hz to 100 kHz  Modulation Rate (20 to < 50) Hz (>100 to 200) kHz	FM Deviation <5 kHz (5 to < 40) kHz (40 to 400) kHz  FM Deviation <5 kHz (5 to < 40) kHz (40 to 400) kHz	1.5 % of reading + 0.001 4 kHz 1.5 % of reading + 0.014 kHz 1.5 % of reading + 0.14 kHz  5.9 % of reading + 0.001 4 kHz 5.9 % of reading + 0.014 kHz 5.9 % of reading + 0.14 kHz	
Phase Modulation - Source <sup>1</sup> Frequency Carrier (250 kHz to 10 MHz)	Phase Deviation ≤ 400 Radians Modulation Rate : 200 Hz to 10 kHz	4.7 % of reading + 0.14 Radian	HP 8656B Signal Generator, Agilent N9310A Generator, HP 83732B Signal Generator HP 8902A Measuring Receiver
Phase Modulation - Source <sup>1</sup> Frequency Carrier (> 10 MHz to 20 GHz)	Phase Deviation (1 to 4) rad (4 to 40) rad (40 to 400) rad	3.6 % of reading + 0.001 4 rad 3.6 % of reading + 0.014 rad 3.6 % of reading + 0.14 rad	





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**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Distortion/Sinad/ Signal to noise - Source Distortion <sup>1</sup>	(0.01 to 100) %Distortion @ 20 Hz to 20 kHz (0 to -40) dB (<-40 to -60) dB (<-60 to -80) dB	0.000 6 dB 0.019 dB 0.072 dB	HP 8903B Audio Analyzer, Agilent N9310A Generator,5522A Multiproduct Calibrator, Wavetek 1281, 34401A Multimeter
	(0.01 to 100) %Distortion @ > 20 kHz to 100 kHz (0 to -40) dB (<-40 to -60) dB (<-60 to -80) dB	0.000 6 dB 0.038 dB 0.16 dB	
Distortion/Sinad/ Signal to noise – Source Sinad <sup>1</sup>	@ 20 Hz to 20 kHz (0 to 40) dB (>40 to 50) dB (>50 to 80) dB	0.000 6 dB 0.019 dB 0.06 dB	HP 8903B Audio Analyzer, Agilent N9310A Generator,5522A Multiproduct Calibrator, Wavetek 1281, 34401A Multimeter
	@ (>20 to 100) kHz (0 to 40) dB (>40 to 60) dB (>60 to 80) dB	0.000 6 dB 0.012 dB 0.16 dB	
Distortion/Sinad/ Signal to noise – Source Signal to noise <sup>1</sup>	@ 20 Hz to 20 kHz (0 to 40) dB (>40 to 50) dB (>50 to 80) dB	0.000 8 dB 0.019 dB 0.06 dB	HP 8903B Audio Analyzer, Agilent N9310A Generator,5522A Multiproduct Calibrator, Wavetek 1281, 34401A Multimeter
	@ (>20 to 100) kHz (0 to 40) dB (>40 to 60) dB (>60 to 80) dB	0.012 dB 0.038 dB 0.16 dB	
Amplitude Modulation - Measure <sup>1</sup> Frequency Carrier (150 kHz to 10 MHz) Modulation Rate (20 to 50) Hz	AM (5 to <40) % Depth AM (40 to 99) % Depth	3.5 % of reading + 0.014 % Depth 3.5 % of reading + 0.14% Depth	HP 8902A Measuring Receiver
Modulation Rate >50 Hz to 10 kHz	AM (5 to <40) % Depth AM (40 to 99) % Depth	2.4 % of reading + 0.014 % Depth 2.4 % of reading + 0.14 % Depth	HP 8902A Measuring Receiver
Frequency Carrier >10 MHz to 1.3 GHz Modulation Rate >50 Hz to 50 kHz	AM (5 to <40) % Depth AM (40 to 99) % Depth	1.3 % of reading + 0.014 % Depth 1.3 % of reading + 0.14% Depth	HP 8902A Measuring Receiver
Modulation Rate (>50 to 100) kHz	AM (5 to <40) % Depth AM (40 to 99) % Depth	3.5 % of reading + 0.014 % Depth 3.5 % of reading + 0.14 % Depth	HP 8902A Measuring Receiver

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation - Measure <sup>1</sup> Frequency Carrier (>1.3 to 20) GHz Modulation Rate (20 to 50) Hz	AM (5 to <40) % Depth AM (40 to 99) % Depth	3.5 % of reading + 0.014 % Depth 3.5 % of reading + 0.14 % Depth	HP 8902A Measuring Receiver, HP11793A Down Converter
Modulation Rate >50 Hz to 50 kHz	AM (5 to <40) % Depth AM (40 to 99) % Depth	1.9 % of reading + 0.014 % Depth 1.9 % of reading + 0.14 % Depth	
Modulation Rate (>50 to 100) kHz	AM (5 to <40) % Depth AM (40 to 99) % Depth	3.5 % of reading + 0.014 % Depth 3.5 % of reading + 0.14 % Depth	
Frequency Modulation - Measure <sup>1</sup> Frequency Carrier (250 kHz to 10 MHz) Modulation Rate 20 Hz to 10 kHz	FM Deviation < 5 kHz (5 to 40) kHz	2.4 % of reading + 0.0014 kHz 2.4 % of reading + 0.014 kHz	HP 8902A Measuring Receiver
Frequency Carrier >10 MHz to 1.3 GHz Modulation Rate 50 Hz to 100 kHz  Modulation Rate (20 to <50) Hz (>100 to 200) kHz	FM Deviation <5 kHz (5 to <40) kHz (40 to 400) kHz  FM Deviation <5 kHz (5 to < 40) kHz (40 to 400) kHz	1.3 % of reading + 0.0014 kHz 1.3 % of reading + 0.014 kHz 1.3 % of reading + 0.14 kHz  5.8 % of reading + 0.0014 kHz 5.8 % of reading + 0.014 kHz 5.8 % of reading + 0.14 kHz	
Frequency Carrier (>1.3 to 20) GHz Modulation Rate 50 Hz to 100 kHz  Modulation Rate (20 to <50) Hz (>100 to 200) kHz	FM Deviation <5 kHz (5 to < 40) kHz (40 to 400) kHz  FM Deviation <5 kHz (5 to < 40) kHz (40 to 400) kHz	1.3 % of reading + 0.0014 kHz 1.3 % of reading + 0.014 kHz 1.3 % of reading + 0.14 kHz  5.8 % of reading + 0.0014 kHz 5.8 % of reading + 0.014 kHz 5.8 % of reading + 0.14 kHz	HP 8902A Measuring Receiver, HP11793A Down Converter
Phase Modulation - Measure <sup>1</sup> Frequency Carrier (250 kHz to 10 MHz) Modulation Rate 200 Hz to 10 kHz	Phase Deviation (1 to 4) rad (4 to 40) rad (40 to 400) rad	4.7 % of reading + 0.0014 rad 4.7 % of reading + 0.014 rad 4.7 % of reading + 0.14 rad	HP 8902A Measuring Receiver



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**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Frequency Carrier (>10 MHz to 20 GHz) Modulation Rate 200 Hz to 20 kHz	Phase Deviation (1 to 4) rad (4 to 40) rad (40 to 400) rad	3.5 % of reading + 0.0014 rad 3.5 % of reading + 0.014 rad 3.5% of reading + 0.14 rad	HP 8902A Measuring Receiver, HP11793A Down Converter
Distortion/SINAD/ Signal to noise - Measure <sup>1</sup>	Distortion (0.001 to 100) %, (-99.99 to 0) dB 20 Hz to 20 kHz (20 to 100) kHz SINAD (0 to 99.99) dB 20 Hz to 20 kHz (20 to 100) kHz Signal to noise (0 to 99.99) dB 50 Hz to 100 kHz	1.2 dB 2.3 dB 1.2 dB 2.3 dB 1.2 dB	HP 8903B Audio Analyzer
RF Absolute Power-Measure <sup>1,2</sup>	10 MHz to 2 GHz (-60 to -10) dBm (>2 to 6) GHz (-10 to 20) dBm	0.14 dB 0.15 dB	E9301A power sensor and Power meter or spectrum analyzer
RF Absolute Power-Measure <sup>1,2</sup>	(25 to 35) dBm 100 kHz to 1.2 GHz (>1.2 to 4.2) GHz	0.19 dB 0.2 dB	8482H power sensor and Power meter or spectrum analyzer
RF Absolute Power-Measure <sup>1,2</sup>	(-70 to -20) dBm (10 to 30) MHz 30 MHz to <6 GHz (6 to <14) GHz (14 to 18) GHz	0.21 dB 0.13 dB 0.2 dB 0.29 dB	8481D power sensor and Power meter or spectrum analyzer
RF Absolute Power-Measure <sup>1,2</sup>	(-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	0.12 dB 0.14 dB 0.16 dB 0.17 dB 0.19 dB	E9304AH18 power sensor and Power meter or spectrum analyzer



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**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
RF Absolute Power-Measure <sup>1,2</sup>	(>-10 to 20) dBm 9 kHz to 2 GHz (2 to <6 ) GHz (6 to <14) GHz (14 to <16) GHz (16 to 18) GHz (-70 to 20) dBm (10 to <30) MHz 30 MHz to <2 GHz (2 to <6) GHz (6 to <11) GHz (11 to 18) GHz	0.13 dB 0.14 dB 0.16 dB 0.18 dB 0.2 dB 0.15 dB 0.13dB 0.15 dB 0.17 dB 0.25 dB	E4412A power sensor and Power meter or spectrum analyzer
Absolute Tuned RF Power - Measure <sup>1,2</sup>	100 kHz to 1 GHz (-10 to 30) dBm (<-10 to -20) dBm (>1 to 2.6) GHz (-20 to 30) dBm	0.092 dB 0.096 dB 0.098 dB	11722A power sensor and 8902A Measuring receiver or spectrum analyzer
Absolute Tuned RF Power - Measure <sup>1,2</sup>	50 MHz to 6 GHz (-20 to 30) dBm (>6 to 10) GHz (-20 to 30) dBm (>10 to 20) GHz (-20 to 30) dBm	0.14 dB 0.17 dB 0.23 dB	11792A power sensor and 8902A Measuring receiver or spectrum analyzer
Relative Tuned RF Power - Measure <sup>1,2</sup>	2.5 MHz to 1.3 GHz 0 dB (-10 to < 0) dB (-20 to < -10) dB (-40 to < -20) dB (-50 to < -40) dB (-80 to < -50) dB (-110 to < -80) dB (-127 to < -110) dB	0.061 dB 0.081 dB 0.098 dB 0.11 dB 0.13 dB 0.15 dB 0.2 dB 0.22 dB	11722A power sensor and 8902A Measuring receiver or spectrum analyzer

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Relative Tuned RF Power - Measure <sup>1,2</sup>	0 dB		11792A power sensor and 8902A Measuring receiver or spectrum analyzer
	50 MHz to 1.3 GHz (-30 to < 0) dB	0.038 dB	
	50 MHz to 1.3 GHz (>1.3 to 6) GHz	0.09 dB	
	(>6 to 20) GHz	0.096 dB	
	(-80 to <-30) dB	0.11 dB	
	50 MHz to 1.3 GHz	0.14 dB	
	(>1.3 to 6) GHz	0.14 dB	
	(>6 to 20) GHz	0.15 dB	
Absolute Amplitude - Source <sup>1,2</sup>	(-127 to <-80) dB		HP 3336C Signal Generator
	50 MHz to 1.3 GHz	0.21 dB	
	(>1.3 to 6) GHz	0.22 dB	
	(>6 to 20) GHz	0.22 dB	
RF Absolute Power- Source <sup>1,2</sup>	10 Hz to 60 MHz (-70 to 8) dBm	0.12 dB	E4438C Signal Generator
	250 kHz to 2.5 GHz (-50 to 13) dBm	0.72 dB	
	(<-50 to -136) dBm	0.94 dB	
	(>2.5 to 6) GHz (-50 to 13) dBm	0.72 dB	
	(<-50 to -136) dBm	0.94 dB	
RF Absolute Power- Source <sup>1,2</sup>	9 kHz to 2.5 GHz (-136 to 13) dBm	1.2 dB	8648D Signal Generator
	(>2.5 to 3.2) GHz (-100 to 13) dBm	1.8 dB	
	(<-100 to -136) dBm	3.5 dB	
	(>3.2 to 4) GHz (-100 to 13) dBm	2.3 dB	
	(<-100 to -136) dBm	3.5 dB	
RF Absolute Power- Source <sup>1,2</sup>	10 MHz to 10 GHz (-127 to 30) dBm	1.2 dB	83732B Signal Generator
	(>10 to 15) GHz (-100 to 13) dBm	1.8 dB	
	(<-100 to -127) dBm	3.5 dB	
	(>15 to 20) GHz (-100 to 13) dBm	2.3 dB	
	(<-100 to -127) dBm	3.5 dB	

**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
RF Absolute Power- Source <sup>1,2</sup>	100 kHz to 2.6 GHz (-20 to 30) dBm	0.2 dB	E4438C, 8648D, 83732B Signal Generator; Comparison measurement with 11722A power sensor and 8902A Measuring receiver
RF Absolute Power- Source <sup>1,2</sup>	50 MHz to 6 GHz (-20 to 30) dBm (>6 to 10) GHz (-20 to 30) dBm (>10 to 20) GHz (-20 to 30) dBm	0.25 dB 0.26 dB 0.29 dB	E4438C, 8648D, 83732B Signal Generator; Comparison measurement with 11792A power sensor and 8902A Measuring receiver
RF Absolute Power- Source <sup>1,2</sup>	10 MHz to 2 GHz (-60 to -10) dBm (>2 to 6) GHz (-10 to 20) dBm	0.21 dB 0.28 dB	E4438C, 8648D, HP8665B, 83732B Signal Generator; Comparison measurement with E9301A power sensor and Power meter
RF Absolute Power- Source <sup>1,2</sup>	(25 to 35) dBm 100 kHz to 1.2 GHz (>1.2 to 4.2) GHz	0.19 dB 0.22 dB	E4438C, 8648D, HP8665B, 83732B Signal Generator Comparison measurement with 8482H power sensor and Power meter
RF Absolute Power- Source <sup>1,2</sup>	(-70 to -20) dBm (10 to 30) MHz 30 MHz to <6 GHz (6 to <14) GHz (14 to 18) GHz	0.2 dB 0.27 dB 0.41 dB 0.46 dB	E4438C, 8648D, HP8665B, 83732B Signal Generator; Comparison measurement with 8481D power sensor and Power meter
RF Absolute Power- Source <sup>1,2</sup>	(-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	0.2 dB 0.28 dB 0.42 dB 0.43 dB 0.43 dB	E4438C, 8648D, HP8665B,83732B Signal Generator; Comparison measurement with E9304AH18 power sensor and Power meter



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**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
RF Absolute Power- Source <sup>1,2</sup>	(-10 to 20) dBm 9 kHz to 2 GHz (2 to <6) GHz (6 to <14) GHz (14 to <16) GHz (16 to 18) GHz	0.21 dB 0.28 dB 0.42 dB 0.43 dB 0.43 dB	E4438C, 8648D, HP8665B,83732B Signal Generator; Comparison measurement with E9304AH18 power sensor and Power meter
RF Absolute Power- Source <sup>1,2</sup>	(-70 to 20) dBm 10 MHz to <30 MHz 30 MHz to <2 GHz (2 to <6) GHz (6 to <11) GHz (11 to 18) GHz	0.2 dB 0.2 dB 0.28 dB 0.38 dB 0.44 dB	E4438C, 8648D, HP8665B, 83732B Signal Generator; Comparison measurement with E4412A power sensor and Power meter
Relative RF Power- Source <sup>1,2</sup>	2.5 MHz to 1.3 GHz 0 dB (-20 to < 0) dB (-40 to < -20) dB (-80 to < -40) dB (-100 to < -80) dB (-120 to < -100) dB (-127 to < -120) dB	0.19 dB 0.20 dB 0.21 dB 0.23 dB 0.27 dB 0.28 dB 0.29 dB	E4438C, 8648D, HP8665B, HP83732B Signal Generator; Comparison measurement with 11722A power sensor and 8902A Measuring receiver
Relative RF Power- Source <sup>1,2</sup>	(-30 to 0) dB 50 MHz to 1.3 GHz (>1.3 to 6) GHz (>6 to 10) GHz (>10 to 20) GHz (-80 to <-30) dB 50 MHz to 1.3 GHz (>1.3 to 6) GHz (>6 to 10) GHz (>10 to 20) GHz (-127 to <-80) dB 50 MHz to 1.3 GHz (>1.3 to 6) GHz (>6 to 10) GHz (>10 to 20) GHz	0.22 dB 0.31 dB 0.36 dB 0.49 dB 0.24 dB 0.33 dB 0.38 dB 0.49 dB 0.3 dB 0.37 dB 0.41 dB 0.51 dB	E4438C, 8648D, HP8665B, HP83732B Signal Generator; Comparison measurement with 11792A power sensor and 8902A Measuring Receiver



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Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
RF Power meter <sup>1</sup> Instrumentation Accuracy	3.16 $\mu$ W 10 $\mu$ W 31.6 $\mu$ W 100 $\mu$ W 0.316 mW 1 mW 3.16 mW 10 mW 31.6 mW 100 mW	2.9 mW/W + 0.58 $\mu$ W 2.9 mW/W + 0.58 $\mu$ W 2.9 mW/W + 5.8 $\mu$ W 2.9 mW/W + 5.8 $\mu$ W 2.9 mW/W + 58 $\mu$ W 2.9 mW/W + 58 $\mu$ W 2.9 mW/W + 0.58 $\mu$ W 2.9 mW/W + 0.58 $\mu$ W 2.9 mW/W + 5.8 $\mu$ W 2.9 mW/W + 5.8 $\mu$ W	11683A Range calibrator
Phase Source <sup>1</sup>	(0 to 90) ° (> 90 to 180) °	0.23 ° 0.24 °	3336C Signal Generator
Resolution bandwidth switching, Noise sideband, Residual FM, Scale fidelity, Resolution Bandwidth, Display average noise, Residual response, Spurious response Frequency Span -Source <sup>1,3</sup>	9 kHz to 20 GHz (-130 to 30) dBm	0.087 dB 0.16 dB $1.4 \times 10^{-12} f + 5.8$ mHz 0.16 dB $1.4 \times 10^{-12} f + 0.58$ Hz 0.16 dB 0.15 dB 0.16 dB $1.4 \times 10^{-12} f + 0.58$ Hz	HP 83732B Synthesized Signal Generator, HP 8648D, N9310A, 8665B, 8656B Synthesized Signal Generator
Output Signal Purity, Harmonic, Non-Harmonic, Spurious, AM Distortion, FM Distortion, PM Distortion, Residual FM, DC FM Frequency error, -Measure <sup>1,3</sup>	9 kHz to 20 GHz (-130 to 30) dBm (0 to 100) % Distortion	0.12 dB 0.12 dB 0.16 dB 0.16 dB 0.35 % Distortion 0.12 % Distortion 0.12 % Distortion $1.4 \times 10^{-12} f + 5.8$ mHz $1.4 \times 10^{-12} f + 5.8$ mHz	8592L, 8591E Spectrum Analyzer, Measuring Receiver 8902A with power sensors 11722A, 11792A
Oscilloscope Bandwidth <sup>1</sup> >300 MHz to 18 GHz	6 mVp-p to 6Vp-p	0.28 dB	Signal Generator HP 8656B, HP 8665B, Agilent N9310A, HP 83732B



**Electrical – RF/Microwave**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Frequency Counter Sensitivity–Source <sup>1</sup>	(-50 to 0) dBm 0.01 Hz to 1MHz (0.707 to 224) mV	0.18 dB	Signal Generators HP 33120A, 8656B, 8665B, Agilent N9310A, 83732B Measuring Receiver 8902A with sensors 1722A, 11792A
	(-50 to 0) dBm >1MHz to 20 GHz (0.707 to 224) mV	0.11 dB	

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Gauge Block	(0.5 to 10) mm	0.066 µm	Gauge Block Set
	(> 10 to 25) mm	0.076 µm	
	(> 25 to 50) mm	0.11 µm	
	(> 50 to 75) mm	0.13 µm	
	(> 75 to 100) mm	0.16 µm	
	(> 100 to 200) mm	0.3 µm	
	(> 200 to 300) mm	0.44 µm	
	(> 300 to 400) mm	0.58 µm	
Caliper <sup>1</sup> (External/Internal/Depth)	Up to 300 mm	0.016 mm	Gauge Block Set
	(> 300 to 450) mm	0.018 mm	
	(> 450 to 600) mm	0.021 mm	
	(> 600 to 1 000) mm	0.03 mm	
Dial Gauge & Digital Indicator <sup>1</sup>	Up to 12.7 mm	1.5 µm	Digital Indicator Testing Stand M3 JIS-B 7503
	(> 12.7 to 25) mm	1.7 µm	
	(> 25 to 50) mm	2.1 µm	
	(> 50 to 75) mm	2.7 µm	
	(> 75 to 100) mm	3.3 µm	
Dial Test Indicator <sup>1</sup>	Up to 1.5 mm	1 µm	Digital Indicator Testing Stand M3 JIS-B 7533
Microindicator	(-1.5 to 1.5) mm	0.12 µm	Gauge Block Set JIS-B 7519
Electrical Comparator/ Mu Checker <sup>1</sup>	(0 to 500) µm	0.12 µm	Gauge Block Set JIS B 7536
	> 500 µm to 1 mm	0.14 µm	
	(> 1 to 5) mm	0.2 µm	
	(> 5 to 10) mm	0.3 µm	

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Cylinder Gauge/ Bore Gauge <sup>1</sup>	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 JIS B 7515
Outside/Inside Micrometer <sup>1</sup>	(0 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	1 μm 1.6 μm 2.2 μm 2.9 μm 3.5 μm 4.2 μm 4.9 μm 5.6 μm 6.2 μm 6.9 μm 7.6 μm 8.2 μm 8.9 μm 9.6 μm 11 μm 11 μm 12 μm 13 μm 13 μm 14 μm	Gauge Block Set
High Accuracy Micrometer <sup>1</sup> (Resolution 0.000 1 mm)	Up to 7.7 mm (>7.7 to 17.6) mm (>17.6 to 22.8) mm (>22.8 to 25) mm	0.13 μm 0.17 μm 0.19 μm 0.2 μm	Gauge Block Set
V-Anvil Micrometer <sup>1</sup>	Up to 25 mm (>25 to 50) mm	1.2 μm 1.8 μm	Standard Pin Gauge, Gauge Block Set
Indicating Micrometer <sup>1</sup>	(0 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm	1 μm 1.8 μm 2.5 μm 3 μm	Gauge Block Set JIS B 7520

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Depth Micrometer <sup>1</sup>	(0 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	2 μm 2.5 μm 3 μm 3.5 μm 4 μm 4.5 μm 5 μm 5.5 μm 6 μm 6.5 μm 7 μm 7.5 μm	Gauge Block Set JIS B 7544
Gear Tooth Vernier Caliper <sup>1</sup>	Up to 60 mm	15 μm	Gauge Block Set JIS B 7531
Height Gauge <sup>1</sup>	Up to 300 mm (> 300 to 600) mm (> 600 to 1 000) mm	15 μm 21 μm 30 μm	Gauge Block Set
Depth Gauge <sup>1</sup>	Up to 150 mm (> 150 to 200) mm (> 200 to 300) mm (> 300 to 600) mm	14 μm 15 μm 16 μm 21 μm	Gauge Block Set JIS B 7518
Feeler Gauge <sup>1</sup>	(0.01 to 3) mm (> 3 to 20) mm	0.3 μm 0.8 μm	Universal Length Measuring Machine JIS B 7524
Thickness Plate <sup>1</sup> (Calibration Foil)	(0.025 to 3) mm (> 3 to 20) mm	1.5 μm 2 μm	Universal Length Measuring Machine JIS B 7524
Thickness Gauge <sup>1</sup>	Up to 12 mm (> 12 to 100) mm	1.5 μm 3 μm	Gauge Block Set
Holtest/Three-points internal micrometer <sup>1</sup>	(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 Gauge

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Coating Thickness Gauge <sup>1</sup>	25 µm	0.5 µm	Calibration Foil
	51 µm	0.5 µm	
	127 µm	0.5 µm	
	171 µm	0.5 µm	
	240 µm	0.5 µm	
	499 µm	0.8 µm	
	724 µm	0.8 µm	
	1 024 µm	0.8 µm	
	1 592 µm	0.8 µm	
	2 074 µm	0.8 µm	
	3 039 µm	1.4 µm	
	4 820 µm	1.5 µm	
	9 890 µm	1.7 µm	
14 000 µm	2 µm		
Setting Rod for micrometer	(0 to 25) mm	0.4 µm	Gauge block set and universal length measuring machine
	(> 25 to 50) mm	0.5 µm	
	(> 50 to 75) mm	0.6 µm	
	(> 75 to 100) mm	0.7 µm	
	(> 100 to 125) mm	0.9 µm	
	(> 125 to 150) mm	1 µm	
	(> 150 to 175) mm	1.2 µm	
	(> 175 to 200) mm	1.4 µm	
	(> 200 to 225) mm	1.5 µm	
	(> 225 to 250) mm	1.7 µm	
	(> 250 to 275) mm	1.9 µm	
	(> 275 to 300) mm	2 µm	
	(> 300 to 325) mm	2.2 µm	
	(> 325 to 350) mm	2.4 µm	
	(> 350 to 375) mm	2.5 µm	
	(> 375 to 400) mm	2.7 µm	
(> 400 to 425) mm	2.9 µm		
(> 425 to 450) mm	3 µm		
(> 450 to 475) mm	3.2 µm		
(> 475 to 500) mm	3.4 µm		
Micrometer Head <sup>1</sup>	(0 to 13) mm	1 µm	Gauge block set JIS B 7502
	(> 13 to 25) mm	1 µm	
	(> 25 to 50) mm	1.6 µm	

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Universal Length Measuring Machine <sup>1</sup>	(0 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	0.11 μm 0.19 μm 0.35 μm 0.5 μm 0.7 μm 1.4 μm 2 μm 2.7 μm 3.4 μm	Gauge block Set ISO 3611
Caliper Gauge <sup>1</sup> (External/Internal)	Up to 30 mm (> 30 to 100) mm	3 μm 4 μm	Gauge Block Set
Dial Gauge Tester/Calibration Tester	(0 to 5) mm (> 5 to 25) mm	0.5 μm 0.8 μm	Linear Length Gauge
Measuring microscope/tool maker's microscope <sup>1</sup> , measuring accuracies of respective axis, x-axis direction and y-axis direction	(0 to 50) mm (> 50 to 200) mm (> 200 to 300) mm	1.2 μm 2.5 μm 3 μm	Glass Scale JIS B 7153
Profile Projector <sup>1</sup> , measuring accuracies of respective axis, x-axis direction and y-axis direction	(0 to 50) mm (> 50 to 200) mm (> 200 to 300) mm	1.2 μm 2.5 μm 3 μm	Glass Scale JIS B 7184
Micrometer microscope <sup>1</sup>	Up to 10 mm	1 μm	Glass Scale JIS B 7150
Scale Lupe <sup>1</sup>	Up to 100 mm	1.4 μm	Glass Scale
Thread Plug Gauge	(> 1 to 10) mm (> 10 to 100) mm (> 100 to 125) mm (> 125 to 150) mm	2.3 μm 2.5 μm 2.7 μm 3 μm	Gauge block set and universal length measuring machine, EURAMET cg-10
Thread Ring Gauge	(3 to 30) mm (>30 to 100) mm (> 100 to 150) mm	2 μm 2.5 μm 3 μm	Ring gauge and universal length measuring machine EURAMET cg-10
Plain Ring Gauge	(1 to 20) mm (> 20 to 50) mm (> 50 to 70) mm (> 70 to 80) mm (> 80 to 100) mm (> 100 m to 125) mm (> 125 to 150) mm	0.66 μm 0.81 μm 1.1 μm 1.3 μm 1.6 μm 1.9 μm 2.3 μm	Ring gauge and universal length measuring machine

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Plain Plug Gauge / Pin Gauge/ 3-wires (Diameter measurement)	(> 0 to 10) mm	0.4 $\mu$ m	Gauge block set and universal length measuring machine JIS B 7420 and JIS B 0271
	(> 10 to 20) mm	0.63 $\mu$ m	
	(> 20 to 30) mm	0.52 $\mu$ m	
	(> 30 to 40) mm	0.66 $\mu$ m	
	(> 40 to 50) mm	0.81 $\mu$ m	
	(> 50 to 60) mm	1 $\mu$ m	
	(> 60 to 70) mm	1.1 $\mu$ m	
	(> 70 to 80) mm	1.3 $\mu$ m	
	(> 80 to 90) mm	1.4 $\mu$ m	
	(> 90 to 100) mm	1.6 $\mu$ m	
	(> 100 to 125) mm	1.9 $\mu$ m	
	(> 125 to 150) mm	2.3 $\mu$ m	
	(> 150 to 175) mm	2.7 $\mu$ m	
(> 175 to 200) mm	3.1 $\mu$ m		
(> 200 to 250) mm	3.8 $\mu$ m		
(> 250 to 300) mm	4.5 $\mu$ m		
Plain snap gauge / gap gauge (External/ Internal)	(1 to 25) mm	0.51 $\mu$ m	Ring gauge, gauge block set and universal length measuring machine
	(> 25 to 50) mm	0.81 $\mu$ m	
	(> 50 to 75) mm	1.2 $\mu$ m	
	(> 75 to 125) mm	1.9 $\mu$ m	
	(> 125 to 175) mm	2.7 $\mu$ m	
	(> 175 to 200) mm	3.1 $\mu$ m	
	(> 200 to 250) mm	3.8 $\mu$ m	
	(> 250 to 300) mm	4.5 $\mu$ m	
(> 300 to 400) mm	6 $\mu$ m		
(> 400 to 500) mm	7.5 $\mu$ m		
Laser Scan Micrometer <sup>1</sup>	(0.1 to 10) mm	0.62 $\mu$ m	Pin Gauge and gauge block set
	(> 10 to 60) mm	1 $\mu$ m	
Surface Roughness Testers <sup>1</sup>	2.94 $\mu$ mRa, 9.3 $\mu$ mRz	0.066 $\mu$ m	Roughness Specimen JIS B 0651
		0.26 $\mu$ m	
Bevel Protractors <sup>1</sup>	(0 to 90) °	2.2 minutes	Angle Blocks
Measuring Tapes <sup>1</sup>	(0 to 8 000) mm	0.045 mm	Tape & Scale Measuring Machine
	(>8 000 to 10 000) mm	0.046 mm	
	(>10 000 to 20 000) mm	0.055 mm	
	(>20 000 to 30 000) mm	0.065 mm	
	(>30 000 to 40 000) mm	0.075 mm	
Rulers <sup>1</sup>	(0 to 1 000) mm	0.03 mm	Tape & Scale Measuring Machine
	(> 1 000 to 2 000) mm	0.055 mm	

**Length – Dimensional Metrology**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Contour Machines Straightness <sup>1</sup> X Axis Z Axis	(0 to 1) mm (0 to 100) mm (0 to 60) mm	0.000 8 mm 0.003 mm 0.001 6 mm	Gauge Blocks
Roundness machines <sup>1,3</sup>	Up to 200 mmD	0.000 09 mm	Glass Hemisphere
Coordinate Measuring Machines <sup>1</sup> (1D, 2D, 3D)	(0 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	1.5 μm 3 μm 4 μm 5.5 μm 7 μm 8 μm 9.5 μm 11 μm 12 μm 14 μm	Gauge Blocks
Chamfer Gauge	Up to 30 mm	0.002 mm	Image Measuring Instrument
Pitch Gauge	Up to 10 mm	0.002 mm	Image Measuring Instrument
Radius Gauge	Up to 50 mm (>50 to 100) mm	0.002 mm 0.004 mm	Image Measuring Instrument
Taper Gauge (Scale Type)	Up to 50 mm (>50 to 100) mm	0.002 mm 0.004 mm	Image Measuring Instrument
Test Sieve	Up to 50 mm	0.002 mm	Image Measuring Instrument
Angle Block	(0.25 to 90) °	20 sec	Angle Block / Image Measuring Instrument
Working Standard Scale/ Glass Scale	Up to 50 mm (>100 to 200) mm	0.001 5 mm 0.002 mm	Standard Scale / Image Measuring Instrument
Ultrasonic Thickness Gauge	Up to 50 mm (>50 to 100) mm	0.001 6 mm 0.002 5 mm	Gauge Blocks
Electric Level/ Precision Level <sup>1</sup>	(0.01 to 5) mm/m (0.02 to 0.10) mm/m (0.05 to 0.25) mm/m (0.10 to 0.50) mm/m	0.006 5 mm/m 0.006 mm/m 0.015 mm/m 0.025 mm/m	Sine bar and Gauge block

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Balance/Scale <sup>1</sup>	Up to 120 g	0.18 mg	Weight Set UKAS LAB 14
	(> 120 to 220) g	0.32 mg	
	(> 220 to 320) g	0.46 mg	
	(> 320 to 500) g	0.7 mg	
	(> 500 to 600) g	0.84 mg	
	(> 600 to 1 000) g	1.4 mg	
	(> 1 000 to 1 200) g	1.7 mg	
	(> 1 200 to 1 500) g	1.8 mg	
	(> 1 500 to 2 000) g	2.8 mg	
	(> 2 000 to 3 000) g	6.2 mg	
	(> 3 000 to 5 000) g	8.6 mg	
	(> 5 000 to 6 000) g	11 mg	
	(> 6 to 10) kg	28 mg	
	(> 10 to 20) kg	52 mg	
(> 20 to 30) kg	87 mg		
Balance/Scale <sup>1</sup>	(> 30 to 60) kg	1.6 g	Weight Set UKAS LAB 14
	(> 60 to 100) kg	2.9 g	
	(> 100 to 150) kg	4.1 g	
	(> 150 to 300) kg	8 g	
	(> 300 to 500) kg	43 g	
	(> 500 to 1 000) kg	85 g	
Mass <sup>1</sup>	50 mg	0.09 mg	Standard Weight Set OIML R-111-1
	100 mg	0.09 mg	
	200 mg	0.09 mg	
	500 mg	0.09 mg	
	1 g	0.09 mg	
	2 g	0.09 mg	
	5 g	0.09 mg	
	10 g	0.09 mg	
	20 g	0.1 mg	
	50 g	0.1 mg	
	100 g	0.13 mg	
	200 g	0.21 mg	
	500 g	0.9 mg	
	1 kg	1.6 mg	
	2 kg	3 mg	
	5 kg	82 mg	
10 kg	86 mg		
20 kg	96 mg		





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**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Universal Testing Machine <sup>1</sup> (Tension and Compression)	Up to 10 N (> 10 to 100) N (> 100 to 500) N > 500 N to 1 kN (> 1 to 10) kN (> 10 to 50) kN	0.6 N 1 N 4 N 0.0079 kN 0.042 kN 0.11 kN	Force Transducer ISO 7500-1
Rockwell Hardness Testing Machine <sup>1</sup> (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	Force Transducer
Rockwell Hardness Testing Machine <sup>1</sup>	30 HRC 45 HRC 60 HRC  32 HRBS 60 HRBS 92 HRBS	0.68 HRC 0.68 HRC 0.68 HRC  0.7 HRBS 0.7 HRBS 0.7 HRBS	Test Block ISO 6508-2 Indirect Verification
Durometer (Force Only) <sup>1</sup> Types A, B, E, & O Types C, D, & DO Type M	Up to 100 Duro	0.23 Duro	Durometer Tester ASTMD 2240
Vickers Hardness Testers <sup>1</sup>	700 HV  0.01 kgf 0.1 kgf 1kgf	25 HV	Indirect Verification using Hardness Blocks
Hand Torque Tools <sup>1</sup> Torque Wrench <sup>1</sup> , Torque Driver <sup>1</sup>	(0 to 10) N·m (> 10 to 20) N·m (> 20 to 200) N·m (>200 to 360) N·m	1 % of reading 1.3 % of reading 1.3 % of reading 1.3 % of reading	Torque Tester ISO 6789
Torque Meter/Torque Tester <sup>1</sup>	(0 to 1) N·m (>1 to 10) N·m (>10 to 20) N·m (>20 to 50) N·m (>50 to 100) N·m (>100 to 200) N·m (>200 to 300) N·m (>300 to 400) N·m (>400 to 500) N·m	0.0015 N·m 0.013 N·m 0.065 N·m 0.085 N·m 0.15 N·m 0.25 N·m 0.35 N·m 0.48 N·m 0.6 N·m	Arm & Standard Weight Set, Torque Transfer Wrench

**Mass and Mass Related**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Pressure Gauge <sup>1</sup> (Pneumatic &Hydraulic), Digital Pressure Gauge, Pressure Transducer, Differential Pressure Gauge, Pressure Transmitter, Manometer, Pressure Switch Vacuum Gauge	(-89.6 to -0.249) kPa (>-0.249 to 0.250) kPa (> 0.250 to 69) kPa (> 69 to 206.8) kPa (> 206.8 to 689.5) kPa (> 689.5 to 2 068) kPa (> 2 068 to 6 895) kPa (> 6.895 to 20.684) MPa (> 20.684 to 34.473) MPa (> 34.473 to 68.947) MPa	0.082 kPa 0.000 62 kPa 0.022 kPa 0.097 kPa 0.13 kPa 0.94 kPa 1.3 kPa 2.6 kPa 6 kPa 0.02 MPa	Digital Test Gauge DKD R-6-1 and DKD R-6-2
Push-Pull Force Gauge <sup>1</sup>	(0 to 4.9) N (> 4.9 to 9.8) N (> 9.8 to 19.6) N (> 19.6 to 29.4) N (> 29.4 to 49) N (> 49 to 98) N (> 98 to 196) N (> 196 to 294) N (> 294 to 490) N (> 490 to 980) N	0.012 N 0.024 N 0.059 N 0.059 N 0.15 N 0.25 N 0.59 N 0.69 N 0.69 N 0.69 N	Standard Weight Set
Digital Force Gauge <sup>1</sup>	(0 to 4.9) N (> 4.9 to 9.8) N (> 9.8 to 19.6) N (> 19.6 to 49) N (> 49 to 98) N (> 98 to 196) N (> 196 to 294) N (> 294 to 490) N (> 490 to 980) N	0.001 N 0.01 N 0.01 N 0.01 N 0.059 N 0.061 N 0.063 N 0.071 N 0.11 N	Standard Weight Set
Tension Gauge <sup>1</sup>	(0 to 0.49) N (> 0.49 to 0.98) N (> 0.98 to 2) N (> 2 to 4.9) N (> 4.9 to 9.8) N (> 9.8 to 29.4) N (> 29.4 to 49) N (> 49 to 98) N (> 98 to 196) N	0.002 5 N 0.005 9 N 0.029 N 0.059 N 0.15 N 0.29 N 0.59 N 0.59 N 1.2 N	Standard Weight Set
Tension Gauge <sup>1</sup>	(> 196 to 294) N (> 294 to 490) N (> 490 to 980) N	2.9 N 2.9 N 5.9 N	Standard Weight Set

### Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Dial Tension Gauge <sup>1</sup>	(0 to 0.29) N (> 0.29 to 0.49) N (> 0.49 to 0.98) N (> 0.98 to 1.5) N (> 1.5 to 2.9) N (> 2.9 to 4.9) N (> 4.9 to 9.8) N (> 9.8 to 19.6) N	0.002 5 N 0.004 9 N 0.012 N 0.014 N 0.025 N 0.059 N 0.059 N 0.12 N	Standard Weight Set
Viscosity Meter <sup>1</sup> Kinematic Viscosity	8.665 mm <sup>2</sup> /s (cSt) 33.21 mm <sup>2</sup> /s (cSt) 119.9 mm <sup>2</sup> /s (cSt) 230.4 mm <sup>2</sup> /s (cSt) 1 239 mm <sup>2</sup> /s (cSt) 11 960 mm <sup>2</sup> /s (cSt) 62 240 mm <sup>2</sup> /s (cSt)	1 % of reading 1 % of reading 1 % of reading 1 % of reading 0.8 % of reading 0.8 % of reading 0.8 % of reading	Viscosity Solution Standard / Stop Watch
Hydrometer	(0.600 to 2.000) g/cm <sup>3</sup>	0.001 2 g/cm <sup>3</sup>	Cuckow's method
Air Velocity <sup>1</sup>	2.5 m/s 5 m/s 10 m/s 15 m/s	0.25 m/s 0.25 m/s 0.25 m/s 0.42 m/s	Wind Tunnel and standard anemometer
Flow Meter (Air Flow)	Up to 5 L/min (>5 to 10) L/min (10 to 25) L/min (25 to 50) L/min (50 to 100) L/min	0.005 5 L/min 0.008 L/min 0.12 L/min 5.2 L/min 14 L/min	Digital Test Gauge
Flow Meter <sup>1</sup> (Liquid flow)	(0 to 1 000) L/min	0.25 % of reading	Ultrasonic flow meter

### 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
Optical Power <sup>1</sup>	(0 to 1) mW (>1 to 10) mW (>10 to 100) mW	3.5 % of reading + 0.58μW 3.5 % of reading + 5.8μW 3.5 % of reading + 58μW	Optical Power Meter
UV Meter (UVA) <sup>1</sup>	(5 to 500) mW/cm <sup>2</sup>	5 % of reading	UV Meter Standard

**Photometry and Radiometry**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Total Solar Irradiance / Pyranometer <sup>1</sup> Sensitivity	(1 to 200) $\mu\text{V}/\text{W}/\text{m}^2$	2.5 % of reading	Kipp & Zonan CMP11 Pyranometer Wavetek 1281 & 34401A Multimeter
Gloss Meter 20° 60° 85°	87.7 GU 92.7 GU 99.2 GU	1 GU 1 GU 1.2 GU	Gloss Tile AMECaL/GT-HG3
Color Meter / Color Reader	White L* a* b* Y x y Black L* a* b* Y x y	1.2 % of reading 1.7 % of reading 1.3 % of reading 1.2 % of reading 1.4 % of reading 0.55 % of reading 1.2 % of reading 1.5 % of reading 1.4 % of reading 1.2 % of reading 1 % of reading 0.77 % of reading	Glossy Tile

**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Temperature indicator with Sensor Thermocouples <sup>1</sup>	Type K (> 650 to 1 200) °C Type J (> 650 to 1 200) °C Type R (> 650 to 1 200) °C Type S (> 650 to 1 200) °C Type N (> 650 to 1 200) °C Type E (> 650 to 1 000) °C	2 °C 3.8 °C 4 °C 4 °C 2 °C 3.2 °C	Fluke 5650 Thermocouple, Hart 1560, w module 2566 Thermometer Readout, Multimeter Wavetek 1281



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**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Temperature-Measure Resistance Temperature Detector Pt100 (385) <sup>1</sup>	(-200 to -80) °C	0.012 °C	Hart 1560 Thermometer, w module 2562 Scanner, Wavetek 1281 Multimeter
	(> -80 to 0) °C	0.012 °C	
	(> 0 to 100) °C	0.013 °C	
	(> 100 to 300) °C	0.021 °C	
	(> 300 to 400) °C	0.023 °C	
	(> 400 to 630) °C	0.028 °C	
	(> 630 to 800) °C	0.033 °C	
Thermocouple <sup>1</sup> (Without cold junction compensation)	Type K		Hart 1560 Thermometer, w module 2566 Scanner, Wavetek 1281 Multimeter
	(-200 to -100) °C	0.1 °C	
	(> -100 to -25) °C	0.06 °C	
	(> -25 to 120) °C	0.06 °C	
	(> 120 to 1 000) °C	0.06 °C	
	(> 1 000 to 1 372) °C	0.07 °C	
	Type J		
	(-210 to -100) °C	0.09 °C	
	(> -100 to -30) °C	0.06 °C	
	(> -30 to 150) °C	0.06 °C	
	(> 150 to 760) °C	0.05 °C	
	(> 760 to 1 200) °C	0.06 °C	
	Type T		
	(-250 to -150) °C	0.2 °C	
	(> -150 to 0) °C	0.07 °C	
	(> 0 to 120) °C	0.06 °C	
	(> 120 to 400) °C	0.06 °C	
	Type R		
	(0 to 250) °C	0.24 °C	
	(> 250 to 400) °C	0.15 °C	
	(> 400 to 1 000) °C	0.13 °C	
	(> 1 000 to 1 767) °C	0.12 °C	
	Type S		
(0 to 250) °C	0.24 °C		
(> 250 to 400) °C	0.15 °C		
(> 400 to 1 000) °C	0.14 °C		
(> 1 000 to 1 767) °C	0.14 °C		
Type E			
(-250 to -100) °C	0.14 °C		
(> -100 to -25) °C	0.05 °C		
(> -25 to 350) °C	0.06 °C		
(> 350 to 650) °C	0.05 °C		
(> 650 to 1 000) °C	0.06 °C		

**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Thermocouple <sup>1</sup> (Without cold junction compensation)	Type N (-200 to -100) °C (> -100 to -25) °C (> -25 to 120) °C (> 120 to 410) °C (> 410 to 1 300) °C	0.14 °C 0.08 °C 0.07 °C 0.06 °C 0.06 °C	Hart 1560 Thermometer, w module 2566 Scanner, Wavetek 1281 Multimeter
Temperature indicator with Sensor Resistance Temperature Detector <sup>1</sup>	Pt100 (385) (-30 to 25) °C (> 25 to 100) °C (> 100 to 400) °C (> 400 to 650) °C	0.18 °C 0.17 °C 0.17 °C 0.19 °C	Fluke SPRT 5609, Hart 1560 Thermometer, w module 2562 Scanner, Wavetek 1281 Multimeter, Burns Engr. 12001-C-9-6-2-A PRT
Temperature indicator with Sensor Thermocouples <sup>1</sup>	Type K (-30 to 25) °C (> 25 to 100) °C (> 100 to 400) °C (> 400 to 650) °C Type J (-30 to 25) °C (> 25 to 100) °C (> 100 to 400) °C (> 400 to 650) °C Type T (-30 to 25) °C (> 25 to 100) °C (> 100 to 400) °C Type R (25 to 100) °C (> 100 to 400) °C (> 400 to 650) °C Type S (25 to 100) °C (> 100 to 400) °C (> 400 to 650) °C Type E (-30 to 25) °C (> 25 to 100) °C (> 100 to 400) °C (> 400 to 650) °C	0.26 °C 0.3 °C 0.45 °C 0.9 °C 0.27 °C 0.4 °C 1.3 °C 1.3 °C 0.27 °C 0.4 °C 1.3 °C 0.44 °C 1.5 °C 2.3 °C 0.47 °C 1.5 °C 2.3 °C 0.27 °C 0.4 °C 1.3 °C 2 °C	Hart 1560 Thermometer, w module 2566 Scanner, Wavetek 1281 Multimeter



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**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Temperature indicator with Sensor Thermocouples <sup>1</sup>	Type N (-30 to 25) °C (> 25 to 100) °C (> 100 to 400) °C (> 400 to 650) °C	0.26 °C 0.3 °C 0.7 °C 0.9 °C	Hart 1560 Thermometer, w module 2566 Scanner, Wavetek 1281 Multimeter
Temperature Gauge & Dial Thermometer <sup>1</sup>	(-30 to 25) °C (> 25 to 100) °C (> 100 to 400) °C (> 400 to 650) °C	0.32 °C 0.32 °C 0.33 °C 0.33 °C	Fluke SPRT 5609, Hart 1560 Thermometer, w module 2562 Scanner, Wavetek 1281 Multimeter, Burns Engr. 12001-C-9-6-2-A PRT, Burns Engr. 12001 PRT
Temperature Measure <sup>1</sup> (Dry well, Dry Block)	(-30 to 0) °C (> 0 to 200) °C (> 200 to 450) °C (> 450 to 650) °C	0.12 °C 0.14 °C 0.18 °C 0.18 °C	Fluke PRT 5609, Hart 1560 Thermometer, w module 2562 Scanner, Wavetek 1281 Multimeter
Temperature Measure <sup>1</sup> (Liquid Bath, Micro Bath)	(-30 to 0) °C (> 0 to 200) °C (> 200 to 450) °C (> 450 to 650) °C	0.05 °C 0.06 °C 0.08 °C 0.08 °C	Fluke PRT 5609, Hart 1560 Thermometer, w module 256 Scanner 2, Wavetek 1281 Multimeter
Temperature Measure <sup>1</sup> (Temperature Source)	(-30 to 0) °C (> 0 to 200) °C (> 200 to 450) °C (> 450 to 650) °C	0.12 °C 0.14 °C 0.18 °C 0.18 °C	Fluke PRT 5609, Hart 1560 Thermometer, w module 2562 Scanner, Wavetek 1281 Multimeter
Temperature Controlled Chamber Hot Air Oven, Incubator, Refrigerator, Low temperature <sup>1</sup>	(-40 to 0) °C (> 0 to 50) °C (> 50 to 100) °C (> 100 to 250) °C (>250 to 450) °C	0.49 °C 0.62 °C 0.62 °C 0.79 °C 1 °C	Agilent 34970A Datalogger, Graphtec GL220 / thermocouple
Temperature Controlled Chamber Autoclave <sup>1</sup>	(100 to 140) °C	0.5 °C	Madgetech HiTemp140 datalogger
Humidity Controlled Chamber <sup>1</sup>	(20 to 40) %RH (> 40 to 60) %RH (> 60 to 95) %RH	1.2 %RH 1.4 %RH 1.6 %RH	Rotronic HL-NT3-D Temperature/ Humidity Data Logger, (Relative humidity in an empty working-volume at a single spot)



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**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Temperature <sup>1</sup> , Thermo Hygrometer Measurement	(-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	Wavetek 1281 Multimeter, Burns Engr. 12001-C-9-6- 2-A PRT, Burns Engr. 12001 PRT Rotronic HL-NT3-D Temperature/ Humidity Data Logger
Humidity <sup>1</sup> , Thermo Hygrometer Measurement	(20 to 40) %RH (> 40 to 60) %RH (> 60 to 80) %RH (> 80 to 95) %RH	1.5 %RH 1.7 %RH 1.8 %RH 1.9 %RH	Rotronic HL-NT3-D Temperature/ Humidity Data Logger
Temperature <sup>1</sup> , 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	Wavetek 1281 Multimeter, Burns Engr. 12001-C-9-6- 2-A Burns Engr. 12001 PRT Rotronic HL-NT3-D Temperature/ Humidity Data Logger
Humidity <sup>1</sup> , Thermo Hygrograph Measurement	(20 to 40) %RH (> 40 to 60) %RH (> 60 to 80) %RH (> 80 to 95) %RH	1.6 %RH 1.7 %RH 1.9 %RH 2 %RH	Rotronic HL-NT3-D Temperature/ Humidity Data Logger
IR Temperature-Source <sup>1</sup>	(-15 to 50) °C (50 to 100) °C (> 100 to 300) °C (> 300 to 500) °C	0.5 °C 0.5 °C 0.57 °C 0.85 °C	Wavetek 1281 Multimeter, Burns Engr. 12001-C-9-6- 2-A PRT, Burns Engr. 12001 PRT, CEM BX-500 Infrared Calibrator, Fluke 9142 Dry-Well Calibrator $\lambda = 8$ to $14 \mu\text{m}$ , $\epsilon = 0.95$
Temperature Indicator with Surface Sensor/Probe <sup>1</sup>	(35 to 200) °C (> 200 to 400) °C	0.45 °C 0.68 °C	Wavetek 1281 Multimeter, Burns Engr. 12001-C-9-6- 2-A PRT, Fluke 3125/2200 Surface Probe Calibrator
Liquid in Glass Thermometer <sup>1</sup> s	(-30 to 0) °C (> 0 to 40) °C (> 40 to 100) °C (> 100 to 200) °C	0.06 °C 0.06 °C 0.04 °C 0.04 °C	Fluke PRT 5609, Hart 1560 Thermometer, w module 2562 Scanner





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**Thermodynamic**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
PRT Sensor <sup>1</sup>	(-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 0.079 °C	Fluke PRT 5609, Hart 1560 Thermometer, w module 2562 Scanner

**Time and Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Stroboscopes <sup>1</sup>	(0 to 100) rpm (0 to 1 000) rpm (> 1 000 to 100 000) rpm	0.001 3 rpm 0.005 9 rpm 0.058 rpm	Agilent 34401A Multimeter, HP 53131A Counter
Tachometer, RPM – Measure <sup>1</sup> Non-Contact	(0 to 100) rpm (> 100 to 1 000) rpm (> 1 000 to 120 000) rpm	0.005 9 rpm 0.058 rpm 0.58 rpm	LED + HP 33120A Function Generator, Fluke 5522A Multiproduct Calibrator
Frequency Output Signal-Measure <sup>1,3</sup>	10 Hz to 1 MHz	$1.4 \times 10^{-12} f + 13 \mu\text{Hz}$	Agilent 53131A Counter
Frequency - Source <sup>1,3</sup>	(20 to 100) Hz > 100 Hz to 1 kHz (> 1 to 10) kHz (> 10 to 100) kHz > 100 kHz to 1 MHz (> 1 to 10) MHz (> 10 to 60) MHz	$1.4 \times 10^{-12} f + 0.58 \text{ nHz}$ $1.4 \times 10^{-12} f + 5.8 \text{ nHz}$ $1.4 \times 10^{-12} f + 58 \text{ nHz}$ $1.4 \times 10^{-12} f + 0.58 \mu\text{Hz}$ $1.4 \times 10^{-12} f + 5.8 \mu\text{Hz}$ $1.4 \times 10^{-12} f + 58 \mu\text{Hz}$ $1.4 \times 10^{-12} f + 0.58 \text{ mHz}$	3336C Generator, 50 ohm, 75 ohm, with Efratom PRFS-102 Frequency Standard
Frequency - Source <sup>1</sup>	100 uHz to 100 Hz > 100 Hz to 1 kHz (> 1 to 10) kHz (> 10 to 100) kHz > 100 kHz to 1 MHz (> 1 to 15) MHz	$12 \mu\text{Hz/Hz} + 0.58 \text{ nHz}$ $12 \mu\text{Hz/Hz} + 5.8 \text{ nHz}$ $12 \mu\text{Hz/Hz} + 58 \text{ nHz}$ $12 \mu\text{Hz/Hz} + 0.58 \mu\text{Hz}$ $12 \mu\text{Hz/Hz} + 5.8 \mu\text{Hz}$ $12 \mu\text{Hz/Hz} + 58 \mu\text{Hz}$	33120A Counter Sine wave, Square wave, Triangle, Ramp, Generator



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**Time and Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Frequency - Source <sup>1,3</sup>	(20 to 100) Hz > 100 Hz to 1 kHz (> 1 to 10) kHz (> 10 to 100) kHz > 100 kHz to 1 MHz (> 1 to 10) MHz (> 10 to 100) MHz > 100 MHz to 1GHz (> 1 to 3) GHz (> 3 to 6) GHz (>6 to 20) GHz	$1.4 \times 10^{-12} f + 0.58 \text{ nHz}$ $1.4 \times 10^{-12} f + 5.8 \text{ nHz}$ $1.4 \times 10^{-12} f + 58 \text{ nHz}$ $1.4 \times 10^{-12} f + 0.58 \text{ }\mu\text{Hz}$ $1.4 \times 10^{-12} f + 5.8 \text{ }\mu\text{Hz}$ $1.4 \times 10^{-12} f + 58 \text{ }\mu\text{Hz}$ $1.4 \times 10^{-12} f + 0.58 \text{ mHz}$ $1.4 \times 10^{-12} f + 5.8 \text{ mHz}$ $1.4 \times 10^{-12} f + 58 \text{ mHz}$ $1.4 \times 10^{-12} f + 58 \text{ mHz}$ $1.4 \times 10^{-12} f + 58 \text{ mHz}$	N9310A Generator, HP83732B Generator, 8665B Generator with Efratom PRFS-102 Frequency Standard
Frequency – Measure <sup>1,3</sup>	(0.1 to 10) Hz (> 10 to 100) Hz > 100 Hz to 1 kHz (> 1 to 10) kHz (> 10 to 100) kHz > 100 kHz to 1 MHz (> 1 to 10) MHz (> 10 to 100) MHz > 100 MHz to 1 GHz (> 1 to 5) GHz (>5 to 20) GHz	$1.4 \times 10^{-12} f + 0.14 \text{ nHz}$ $1.4 \times 10^{-12} f + 1.4 \text{ nHz}$ $1.4 \times 10^{-12} f + 13 \text{ nHz}$ $1.4 \times 10^{-12} f + 0.13 \text{ }\mu\text{Hz}$ $1.4 \times 10^{-12} f + 1.3 \text{ }\mu\text{Hz}$ $1.4 \times 10^{-12} f + 13 \text{ }\mu\text{Hz}$ $1.4 \times 10^{-12} f + 0.13 \text{ mHz}$ $1.4 \times 10^{-12} f + 1.3 \text{ mHz}$ $1.4 \times 10^{-12} f + 13 \text{ mHz}$ $1.4 \times 10^{-12} f + 0.13 \text{ Hz}$ $1.4 \times 10^{-12} f + 0.58 \text{ Hz}$	Agilent 53131A Counter 53181A Counter, 5350B Counter with Efratom PRFS-102 Frequency Standard
Period - Measure <sup>1,3</sup>	10 s to 0.2 ns	$1.4 \times 10^{-12} f + 0.058 \text{ ns}$	
Frequency - Source <sup>1</sup>	(0.01 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	$2.9 \text{ }\mu\text{Hz/Hz} + 59 \text{ }\mu\text{Hz}$ $2.9 \text{ }\mu\text{Hz/Hz} + 0.59 \text{ mHz}$ $2.9 \text{ }\mu\text{Hz/Hz} + 5.8 \text{ mHz}$ $2.9 \text{ }\mu\text{Hz/Hz} + 58 \text{ mHz}$ $2.9 \text{ }\mu\text{Hz/Hz} + 0.59 \text{ Hz}$ $2.9 \text{ }\mu\text{Hz/Hz} + 5.8 \text{ Hz}$	Fluke 5522A Multiproduct Calibrator
Timer/Sweep time /Stopwatch <sup>1</sup>	(0.5 to 60) s (> 1 to 2) min (> 2 to 3) min (> 3 to 4) min (> 4 to 5) min (> 5 to 10) min (> 10 to 30) min (> 30 to 60) min (> 60 to 90) min (> 90 to 120) min	58 ns 58 ns 58 ns 58 ns 58 ns 58 ns 58 ns 58 ns 58 ns 58 ns	Agilent 53131A Counter with HP 33120A Multimeter

**Time and Frequency**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
ACV/ACA (frequency) -Measure <sup>1,3</sup>	(10 to 40) Hz >40 Hz to 1kHz (>1 to 10) kHz (>10 to 100) kHz (>100 to 300) kHz	$3.5 \times 10^{-4} f + 0.09$ mHz $1.2 \times 10^{-4} f$ 0.1 mHz $1.2 \times 10^{-4} f + 9$ mHz $1.2 \times 10^{-4} f + 0.09$ Hz $1.2 \times 10^{-4} f + 0.9$ Hz	HP 34401A Multimeter, Fluke 289 Multimeter

**DIMENSIONAL MEASUREMENT**

**1 Dimensional**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Length - Measure	Up to 50 mm (>50 to 200) mm	0.001 5 mm 0.002 mm	Image Measuring Instrument

**2 Dimensional**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle - Measure	(0.1 to 360) °	20 sec	Image Measuring Instrument

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
3.  $f$  = measured frequency,  $D$  = diameter.
4. This scope is formatted as part of a single document including Certificate of Accreditation No. AC-2590.



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