



CERTIFICATE OF ACCREDITATION

ANSI National Accreditation Board

11617 Coldwater Road, Fort Wayne, IN 46845 USA

This is to certify that

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

has been assessed by ANAB and meets the requirements of international standard

ISO/IEC 17025:2017

while demonstrating technical competence in the field of

CALIBRATION and DIMENSIONAL MEASUREMENT

Refer to the accompanying Scope of Accreditation for information regarding the types of activities to which this accreditation applies

AC-2590

Certificate Number


ANAB Approval

Certificate Valid Through: 06/07/2020
Version No. 003 Issued: 04/05/2019



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
Mr. Anupan Tochua +66 21506641

CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: June 07, 2020

Certificate Number: AC-2590

CALIBRATION

Acoustics and Vibration

Table with 4 columns: Parameter/Equipment, Range, Expanded Uncertainty of Measurement (+/-), Reference Standard, Method, and/or Equipment. Rows include Vibration Meter and Sound level meter.



Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
pH Meter ¹	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 ¹	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 ¹	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 ¹	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 ¹	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 ¹	(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 ¹	(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 ¹	500 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	Zentech 900A High Voltage Meter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
DC Voltage - Measure ¹	(1 to < 20) kV (20 to 35) kV (> 35 to 40) kV	24 mV/V + 0.58 V 12 mV/V + 0.58 V 24 mV/V + 0.58 V	Zentech 900A High Voltage Meter with Fluke 80K-40 High Voltage Probe
DC Current – Source ¹	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 Clamp-On Ammeters ¹	(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 ¹	(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 ¹	(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
DC Current - Measure ¹	(0 to 30) A (> 30 to 50) A (> 50 to 100) A (> 100 to 500) A (> 500 to 1 000) A	3.5 mA/A 2.4 mA/A 2.4 mA/A 2.4 mA/A 5.8 mA/A	Agilent 34330A Shunt, FL-2.0 class 0.5
AC/DC Current Measure ¹	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 ¹	DC (0 to 10) mA (>10 to 100) mA	0.87 mA/A + 17 μA 1.8 mA/A + 28 μA	Fluke 289 Multimeter



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
DC/AC cutoff current - Measure ¹	AC: @ (50, 60) Hz (0.02 to 10) mA (>10 to 100) mA	7 mA/ A + 26 μ A 7 mA/ A + 60 μ A	Fluke 289 Multimeter
AC Voltage – Source ¹	(10 to 45) Hz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V (3.3 to < 33) V > 45 Hz to 10 kHz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V (3.3 to < 33) V (>10 to 20) kHz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V (3.3 to < 33) V (> 20 to 50) kHz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V (3.3 to < 33) V (33 to < 330) V (>50 to 100) kHz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V (3.3 to < 33) V (33 to < 330) V (>100 to 500) kHz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V 45 Hz to 1 kHz (33 to < 330) V (330 to 1 020) V (>1 to 10) kHz (33 to < 330) V (>10 to 20) kHz (33 to < 330) V	0.95 mV/V + 7.1 μ V 0.37 mV/V + 9.6 μ V 0.35 mV/V + 60 μ V 0.36 mV/V + 0.77 mV 0.23 mV/V + 7.1 μ V 0.19 mV/V + 9.5 μ V 0.18 mV/V + 70 μ V 0.18 mV/V + 0.71 mV 0.28 mV/V + 7.1 μ V 0.21 mV/V + 9.5 μ V 0.23 mV/V + 70 μ V 0.28 mV/V + 0.71 mV 1.2 mV/V + 7.1 μ V 0.42 mV/V + 9.5 μ V 0.36 mV/V + 60 μ V 0.41 mV/V + 0.71 mV 0.36 mV/V + 7 mV 4.1 mV/V + 14 μ V 0.94 mV/V + 38 μ V 0.82 mV/V + 0.15 mV 1.1 mV/V + 1.9 mV 2.4 mV/V + 58 mV 9.3 mV/V + 58 μ V 2.4 mV/V + 81 μ V 2.9 mV/V + 0.7 mV 0.23 mV/V + 2.8 mV 0.35 mV/V + 12 mV 0.24 mV/V + 7.2 mV 0.3 mV/V + 7.1 mV	Fluke 5522A Multiproduct Calibrator



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Voltage – Source ¹	(> 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 ¹	(50, 60) Hz 50 V to 1 kV	6.2 mV/V + 1.3 V	Zentech 900A High Voltage Meter, Rek RK2671AM Voltage Tester
	(> 1 to 6) kV	5.8 mV/V + 2.6 V	
	(> 6 to 10) kV	5.8 mV/V + 2.7 V	
AC Voltage - Measure ¹	(20 to 40) Hz (10 to < 200) mV	0.27 mV/V + 4.7 μV	Wavetek 1281 Multimeter
	200 mV to < 2 V	0.2 mV/V + 25 μV	
	(2 to < 20) V	0.2 mV/V + 0.24 mV	
	(20 to < 200) V	0.2 mV/V + 2.5 mV	
	(200 to 1 000) V	0.2 mV/V + 14 mV	
	(> 40 to 100) Hz (10 to < 200) mV	0.25 mV/V + 4.7 μV	
	200 mV to < 2 V	0.18 mV/V + 25 μV	
	(2 to < 20) V	0.18 mV/V + 0.24 mV	
	(20 to < 200) V	0.18 mV/V + 2.5 mV	
	(200 to 1 000) V	0.18 mV/V + 14 mV	
	> 100 Hz to 2 kHz (10 to < 200) mV	0.25 mV/V + 2.5 μV	
	200 mV to < 2 V	0.16 mV/V + 24 μV	
	(2 to < 20) V	0.16 mV/V + 0.24 mV	
	(20 to < 200) V	0.16 mV/V + 2.5 mV	
	(200 to 1 000) V	0.18 mV/V + 14 mV	
	(> 2 to 10) kHz (10 to < 200) mV	0.25 mV/V + 4.7 μV	
	200 mV to < 2 V	0.18 mV/V + 24 μV	
	(2 to < 20) V	0.18 mV/V + 0.25 mV	
	(20 to < 200) V	0.18 mV/V + 2.6 mV	
	(200 to 1 000) V	0.18 mV/V + 14 mV	
(> 10 to 30) kHz (10 to < 200) mV	0.47 mV/V + 9.3 μV		
200 mV to < 2 V	0.29 mV/V + 47 μV		
(2 to < 20) V	0.29 mV/V + 0.47 mV		
(20 to < 200) V	0.29 mV/V + 4.7 mV		
(200 to 1 000) V	0.25 mV/V + 24 mV		

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Voltage - Measure ¹	(> 30 to 100) kHz (10 to < 200) mV 200 mV to < 2 V (2 to < 20) V (20 to < 200) V (200 to 1 000) V (> 100 to 300) kHz 200 mV to < 2 V (2 to < 20) V (20 to < 200) V > 300 kHz to 1 MHz (2 to < 20) V (20 to < 200) V	0.82 mV/V + 24 μV 0.58 mV/V + 0.24 mV 0.58 mV/V + 2.4 mV 0.58 mV/V + 24 mV 0.58 mV/V + 0.12 V 3.5 mV/V + 2.4 mV 3.5 mV/V + 24 mV 3.5 mV/V + 0.24 V 12 mV/V + 1.2 mV 12 mV/V + 2.4 V	Wavetek 1281 Multimeter
AC Voltage - Measure ¹	(45 to 66) Hz (1 to 15) V (> 15 to 30) V (> 30 to 60) V (> 60 to 150) V (> 150 to 300) V (> 300 to 600) V > 66 Hz to 1 kHz (1 to 15) V (> 15 to 30) V (> 30 to 60) V (> 60 to 150) V (> 150 to 300) V (> 300 to 600) V	1.8 mV/V + 34 mV 1.8 mV/V + 62 mV 1.8 mV/V + 0.13 V 1.8 mV/V + 0.34 V 1.8 mV/V + 0.62 V 1.8 mV/V + 1.3 V 3.5 mV/V + 62 mV 3.5 mV/V + 0.13 V 3.5 mV/V + 0.25 V 3.5 mV/V + 0.62 V 3.5 mV/V + 1.3 V 3.5 mV/V + 2.5 V	Yokogawa WT110 Power Meter
AC Voltage - Measure ¹	(50 to 60) Hz 500 V to 1 kV (> 1 to 6) kV (> 6 to 10) kV	5.9 mV/V + 2.7 V 5.8 mV/V + 2.6 V 5.8 mV/V + 2.6 V	Zentech 900A High Voltage Meter
AC Voltage - Measure ¹	(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



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Current - Source ¹	(10 to 20) Hz		Fluke 5522A Multiproduct Calibrator
	(29 to < 330) μ A	2.4 mA/A + 0.12 μ A	
	330 μ A to < 3.3 mA	2.4 mA/A + 0.19 μ A	
	(3.3 to < 33) mA	2.1 mA/A + 2.5 μ A	
	(33 to < 330) mA	2.1 mA/A + 25 μ A	
	(> 20 to 45) Hz		
	(29 to < 330) μ A	1.8 mA/A + 0.12 μ A	
	330 μ A to < 3.3 mA	1.5 mA/A + 0.19 μ A	
	(3.3 to < 33) mA	1.1 mA/A + 2.5 μ A	
	(33 to < 330) mA	1.1 mA/A + 25 μ A	
	> 45 Hz to 1 kHz		
	(29 to < 330) μ A	1.5 mA/A + 0.12 μ A	
	330 μ A to < 3.3 mA	1.2 mA/A + 0.2 μ A	
	(3.3 to < 33) mA	0.48 mA/A + 2.5 μ A	
	(33 to < 330) mA	0.48 mA/A + 27 μ A	
	330 mA to < 1.1 A	0.59 mA/A + 0.12 mA	
	(1.1 to < 3) A	0.7 mA/A + 0.14 mA	
	(> 1 to 5) kHz		
	(29 to < 330) μ A	3.5 mA/A + 0.18 μ A	
	330 μ A to < 3.3 mA	2.4 mA/A + 0.26 μ A	
	(3.3 to < 33) mA	0.93 mA/A + 2.6 μ A	
	(33 to < 330) mA	1.2 mA/A + 59 μ 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) μ A	9.3 mA/A + 0.24 μ A	
	330 μ A to < 3.3 mA	5.8 mA/A + 0.37 μ A	
	(3.3 to < 33) mA	2.4 mA/A + 3.8 μ 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) μ A	19 mA/A + 0.47 μ A		
330 μ A to < 3.3 mA	12 mA/A + 0.71 μ A		
(3.3 to < 33) mA	4.7 mA/A + 4.8 μ A		
(33 to < 330) mA	4.7 mA/A + 0.24 mA		



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Current - Source ¹	(10 to 45) Hz 330 mA to < 1.1 A (1.1 to < 3) A (> 45 to 100) Hz (3 to < 11) A (11 to 20.5) A > 100 Hz to 1 kHz (3 to < 11) A (11 to 20.5) A	2.1 mA/A + 0.12 mA 2.1 mA/A + 0.15 mA 0.71 mA/A + 2.5 mA 1.4 mA/A + 5.9 mA 1.2 mA/A + 2.6 mA 1.8 mA/A + 6 mA	Fluke 5522A Multiproduct Calibrator
AC Clamp-On Ammeters ¹	(45 to 65) Hz (20.5 to < 150) A (150 to 1 025) A (> 65 to 440) Hz (20.5 to < 150) A (> 65 to 100) Hz (150 to 1 025) A	6.7 mA/A + 0.35 A 6.7 mA/A + 1.4 A 13 mA/A + 0.35 A 12 mA/A + 1.4 A	Fluke 5522A Multiproduct Calibrator with 50 turn coil
AC Current – Measure ¹	10 Hz to 5 kHz (10 to < 200) μA 200 μA to < 2 mA (2 to < 20) mA (20 to < 200) mA 10 Hz to 1 kHz 200 mA to < 2 A (> 1 to 5) kHz 200 mA to < 2 A	0.36 mA/A + 25 nA 0.35 mA/A + 0.25 μA 0.35 mA/A + 2.5 μA 0.35 mA/A + 25 μA 0.7 mA/A + 0.48 mA 2.4 mA/A + 0.94 mA	Wavetek 1281 Multimeter
AC Current – Measure ¹	(45 to 66) Hz 1 mA to 0.5 A (> 0.5 to 1) A (> 1 to 2) A (> 2 to 5) A (> 5 to 10) A (> 10 to 20) A 66 Hz to 1 kHz 1 mA to 0.5 A (> 0.5 to 1) A (> 1 to 2) A (> 2 to 5) A (> 5 to 10) A (> 10 to 20) A	1.8 mA/A + 1.1 mA 1.8 mA/A + 2.4 mA 1.8 mA/A + 4.6 mA 1.8 mA/A + 12 mA 1.8 mA/A + 24 mA 1.8 mA/A + 51 mA 3.5 mA/A + 2.1 mA 3.5 mA/A + 4.3 mA 3.5 mA/A + 8.4 mA 3.5 mA/A + 23 mA 3.5 mA/A + 46 mA 3.5 mA/A + 96 mA	Yokogawa WT110 Power Meter



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Current – Measure ¹	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 ¹	Resistance (4 Wire) 0 Ω (Shorted) (> 0 to < 11) Ω (11 to < 33) Ω (33 to < 110) Ω (110 to < 330) Ω 330 Ω to < 1.1 kΩ (1.1 to < 3.3) kΩ (3.3 to < 11) kΩ (11 to < 33) kΩ (33 to < 110) kΩ 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	0.63 μΩ 62 μΩ/Ω + 1.2 mΩ 53 μΩ/Ω + 1.8 mΩ 43 μΩ/Ω + 1.7 mΩ 36 μΩ/Ω + 2.4 mΩ 34 μΩ/Ω + 2.4 mΩ 35 μΩ/Ω + 24 mΩ 34 μΩ/Ω + 24 mΩ 35 μΩ/Ω + 0.24 Ω 34 μΩ/Ω + 0.24 Ω 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 ¹	(0.001, 0.01, 0.1) Ω (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 0.13 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



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Resistance, - Source High Resistance, Insulation Resistance ¹	Test voltage @ ± (10 to 5 000) V 10 kΩ 100 kΩ 1 MΩ 5 MΩ 10 MΩ 20 MΩ 100 MΩ 1 GΩ 10 GΩ	0.18 kΩ 1.8 kΩ 18 kΩ 76 kΩ 0.18 MΩ 0.3 MΩ 1.8 MΩ 0.014 GΩ 0.19 GΩ	Megger CB101, Ohmite SM1 Resistor
Surface resistivity/resistance meter, Electrostatic Resistance ¹	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 ¹	(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

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Resistance-Measure Insulation Resistance ¹	Test voltage @ (up to 5) kV (1 to 2) kΩ (> 2 to 20) kΩ (> 20 to 200) kΩ > 200 kΩ to 2 MΩ (> 2 to 20) MΩ (> 20 to 200) MΩ > 200 MΩ to 2 GΩ (> 2 to 20) GΩ (> 20 to 200) GΩ	2.3 mΩ/Ω + 0.4 Ω 1.8 mΩ/Ω + 1 Ω 2.9 mΩ/Ω + 10 Ω 2.9 mΩ/Ω + 0.1 kΩ 2.9 mΩ/Ω + 1 kΩ 3.5 mΩ/Ω + 10 kΩ 18 mΩ/Ω + 0.1 MΩ 18 mΩ/Ω + 1 MΩ 18 mΩ/Ω + 10 MΩ	Keithley 617 Multimeter, Fluke 5522A Multiproduct Calibrator, Chroma 19073 Hipot Tester
Capacitance - Source ¹	5 kHz (0.22 to < 0.4) nF 1 kHz (0.4 to < 1.1) nF (1.1 to < 3.3) nF (3.3 to < 11) nF (11 to < 33) nF (33 to < 110) nF (110 to < 330) nF 100 Hz 330 nF to < 1.1 μF (1.1 to < 3.3) μF (3.3 to < 11) μF (11 to < 33) μF 50 Hz (33 to < 110) μF DC (110 to < 330) μF 330 μF to < 1.1 mF (1.1 to < 3.3) mF (3.3 to < 11) mF (11 to < 33) mF (33 to 110) mF	7.2 mF/F + 12 pF 6.3 mF/F + 13 pF 5.9 mF/F + 14 pF 3 mF/F + 13 pF 3 mF/F + 59 pF 3 mF/F + 59 pF 3 mF/F + 0.58 nF 3 mF/F + 1.4 nF 3 mF/F + 6.8 nF 3 mF/F + 13 nF 4.7 mF/F + 68 nF 5.4 mF/F + 0.13 μF 5.4 mF/F + 0.68 μF 5.3 mF/F + 1.3 μF 5.3 mF/F + 6.8 μF 5.3 mF/F + 13 μF 8.7 mF/F + 68 μF 13 mF/F + 0.14 mF	Fluke 5522A Multiproduct Calibrator
Capacitance – Source ¹ 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



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Inductance – Source ¹ Test Frequency @ 120 Hz 1 kHz, 10 kHz	(10 μH, 100 μH, 1 mH) (10 mH, 100 mH, 1 H) (1 μH, 10 μH, 100 μH) (1 mH, 10 mH, 100 mH) (1 H, 10 H)	4.2 mH/H 1.5 mH/H 2 mH/H 1.5 mH/H 1.2 mH/H	Standard Inductors, GR 1482-E, GR 1482-H
Capacitance - Measure ¹	@ (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	HP 4263B LCR Meter
Inductance - Measure ¹	@ (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
DC Power - Source ¹	(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 ¹	(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



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Power – Source ¹ 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	1.5 mW/W + 7.6 mW	Fluke 5522A Multiproduct Calibrator
	(9.18 to < 33.66) W 330 mV to 1 020 V, (9 to < 33) mA	1.1 mW/W + 7.6 mW	
	(33.66 to < 91.8) W 330 mV to 1 020 V, (33 to < 90) mA	1.5 mW/W + 7.6 mW	
	(91.8 to < 336.6) W 330 mV to 1 020 V, (90 to < 330) mA	1.1 mW/W + 76 mW	
	(336.6 to < 918) W 330 mV to 1 020 V, (0.33 to < 0.90) A	1.4 mW/W + 76 mW	
	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	
	(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 ¹ 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 ¹	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	



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
DC/AC Power DC Power-Source ¹	99 mW to < 660 W (0.033 to < 33) V 3 A to 20 A) (0.1089 to < 33) W (33 to 1000) V (3.3 to < 33) mA (1.089 to < 330) W (33 to 1 000) V (33 to < 330) mA 10.89 W to < 3 kW (33 to 1 000) V (0.33 to < 3) A 99 W to 20 kW (33 to 1 000) V (3 to 20) A	0.6 mW/W + 80 mW 0.2 mW/W + 0.9 mW 0.2 mW/W + 9 mW 0.2 mW/W + 90 mW 0.6 mW/W + 0.9 W	Fluke 5522A Multiproduct Calibrator
DC/AC Power DC Power-Source ¹	0.33 W to < 0.544 5 kW (0.033 to < 33) V, (10 to < 16.5) A 0.5445 W to < 4.950 kW (0.033 to < 33) V, (16.5 to < 150) A 4.95 W to < 33.825 kW (0.033 to < 33) V, (150 to 1 025) A (0.33 to < 16.83) kW (33 to 1 020) V, (10 to < 16.5) A (0.5445 to < 153) kW (33 to 1020) V, 16.5 A to < 150 A) 4.95 kW to 1.0455 MW (33 to 1020) V, (150 to 1025) A	3.2 mW/W + 60 mW 3.2 mW/W + 0.6 W 3.2 mW/W + 6 W 3.2 mW/W + 0.6 W 3.2 mW/W + 6 W 3.2 mW/W + 60 W	Fluke 5522A Multiproduct Calibrator with 50 Turns coil
AC Power-Source ¹ @ (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 (2.97 to < 108.9) mW (0.33 to < 3.3) V, (9 to < 33) mA)	1.2 mW/W + 10 μW 0.8 mW/W + 10 μW	Fluke 5522A Multiproduct Calibrator



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Power-Source ¹ @ (45 to 65) Hz Power factor: 1.000	(10.89 to < 297) mW (0.33 to < 3.3) V, (33 to < 90) mA	1.2 mW/W + 0.1 mW	Fluke 5522A Multiproduct Calibrator
	29.7 mW to < 1.089 W (0.33 to < 3.3) V, (90 to < 330) mA	0.8 mW/W + 0.1 mW	
	(0.1089 to < 2.97) W (0.33 to < 3.3) V, (0.33 to < 0.9) A	1.1 mW/W + 1 mW	
	(0.297 to < 7.26) W (0.33 to < 3.3) V, (0.9 to < 2.2) A	0.9 mW/W + 1 mW	
	(0.726 to < 14.85) W (0.33 to < 3.3) V, (2.2 to < 4.5) A	1.2 mW/W + 1 mW	
	(1.485 to < 66) W (0.33 to < 3.3) V, (4.5 to 20) A	1 mW/W + 10 mW	
	(10.89 to < 297) mW (3.3 to < 33) V, (3.3 to < 9) mA	1.2 mW/W + 10 μW	
	29.7 mW to < 1.089 W (3.3 to < 33) V, (9 to < 33) mA	0.8 mW/W + 0.1 mW	
	(0.1089 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	



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Power-Source ¹ @ (45 to 65) Hz Power factor: 1.000	(14.85 to < 660) W (3.3 to < 33) V, (4.5 to 20) A	1 mW/W +0.1 W	Fluke 5522A Multiproduct Calibrator
	(0.108 9 to < 2.97) W (33 to < 330) V, (3.3 to < 9) mA	1.2 mW/W + 0.1 mW	
	(0.297 to < 10.89) W (33 to < 330) V, (9 to < 33) mA	0.8 mW/W + 1 mW	
	(1.089 to < 29.7) W (33 to < 330) V, (33 to < 90) mA	1.2 mW/W + 1 mW	
	(2.97 to < 108.9) W (33 to < 330) V, (90 to < 330) mA	0.8 mW/W + 10 mW	
	(10.89 to < 297) W (33 to < 330) V, (0.33 to < 0.9) A	1.1 mW/W + 10 mW	
	(29.7 to < 726) W (33 to < 330) V, (0.9 to < 2.2) A	0.9 mW/W + 0.1 W	
	(72.6 to < 1 485) W (33 to < 330) V, (2.2 to < 4.5) A	1.2 mW/W + 0.1 W	
	(148.5 to < 6 600) W (33 to < 330) V, (4.5 to 20) A	1 mW/W +1 W	
	(1.089 to < 9) W (330 to 1 000) V, (3.3 to < 9) mA	1.2 mW/W + 0.1 mW	
	(2.97 to < 33) W (330 to 1 000) V, (9 to < 33) mA	0.8 mW/W + 1 mW	
	(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	



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Power-Source ¹ @ (45 to 65) Hz Power factor: 1.000	(297 to < 2 200) W (330 to 1 000) V, (0.9 to < 2.2) A	0.9 mW/W + 0.1 W	Fluke 5522A Multiproduct Calibrator
	(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 ¹ @ (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	4 mW/W + 10 μW	Fluke 5522A Multiproduct Calibrator
	(1.485 to < 108.8) mW (0.33 to < 3.3) V, (9 to < 33) mA	4 mW/W + 10 μW	
	(5.45 to < 296.7) mW (0.33 to < 3.3) V, (33 to < 90) mA	4 mW/W + 0.1 mW	
	14.85 mW to < 1.088 W (0.33 to < 3.3) V, (90 to < 330) mA	4 mW/W + 0.1 mW	
	(54.45 to < 2.967) W (0.33 to < 3.3) V, (0.33 to < 0.9) A	4 mW/W + 1 mW	
	0.1485 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	



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Power-Source ¹ @ (45 to 65) Hz Power factor: (0.500 to 0.999)	(0.148 5 to < 10.88) W (3.3 to < 33) V, (90 < 330) mA	4 mW/W + 1 mW	Fluke 5522A Multiproduct Calibrator
	(0.544 5 to < 29.67) W (3.3 to < 33) V, (0.33 to < 0.9) A	4 mW/W + 1 mW	
	(1.485 to < 72.527) W (3.3 to < 33) V, (0.9 to < 2.2) A	4 mW/W + 10 mW	
	(3.63 to < 148.35) W (3.3 to < 33) V, (2.2 to < 4.5) A	4 mW/W + 10 mW	
	(7.425 to < 659.34) W (3.3 to < 33) V, (4.5 to 20) A	4 mW/W +0.1 W	
	54.45 mW to < 2.967 W (33 to < 330) V, (3.3 to < 9) mA	4 mW/W + 0.1 mW	
	(0.148 5 to < 10.88) W (to < 330) V, (9 to < 33) mA	4 mW/W + 1 mW	
	(0.544 5 to < 29.67) W (to < 330) V, (to < 90) mA	4 mW/W + 1 mW	
	(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	



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Power-Source ¹ @ (45 to 65) Hz Power factor: (0.500 to 0.999)	(0.544 5 to < 8.991) W (330 to 1000) V, (3.3 to < 9) mA	4 mW/W + 0.1 mW	Fluke 5522A Multiproduct Calibrator
	(1.485 to < 32.97) W (330 to 1000) V, (9 to < 33) mA	4 mW/W + 1 mW	
	(5.445 to < 89.91) W (330 to 1 000) V, (33 to < 90) mA	4 mW/W + 1 mW	
	(14.85 to < 329.7) W (330 to 1 000) V, (90 to < 330) mA	4 mW/W + 10 mW	
	(54.45 to < 899.1) W (330 to 1 000) V, (0.33 to < 0.9) A	4 mW/W + 10 mW	
	(148.5 to < 2197.8) W (330 to 1 000) V, (0.9 to < 2.2) A	4 mW/W + 0.1 W	
	(363 to < 4 495.5) W (330 to 1 000) V, (2.2 to < 4.5) A	4 mW/W + 0.1 W	
	(742.5 to 19 980) W (330 to 1 000) V, (4.5 A to 20) A	4 mW/W + 1 W	
AC Power-Source ¹ @ (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	3.6 mW/W + 0.6 W	Fluke 5522A Multiproduct Calibrator with 50 turn coil
	5.445 W to < 153 kW (0.33 to 1 020) V, (16.5 to < 150) A	3.6 mW/W + 6 W	
	49.5 W to 1.045 5 MW (0.33 to 1 020) V, (150 to 1 025) A	3.6 mW/W + 60 W	
AC Power-Source ¹ @ (45 to 65) Hz Power factor: (0.500 to 0.999)	1.65 W to < 16.813 kW (0.33 to 1 020) V, (10 to < 16.5) A	5 mW/W + 0.6 W	Fluke 5522A Multiproduct Calibrator with 50 turn coil
	2.723 W to < 152.85 kW (0.33 to 1 020) V, (16.5 to < 150) A	5 mW/W + 6 W	



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Power-Source ¹ @ (45 to 65) Hz Power factor: (0.500 to 0.999)	24.75 W to 1.044 4 MW (0.33 to 1 020) V, (150 to 1 025) A	5 mW/W + 60 W	Fluke 5522A Multiproduct Calibrator with 50 turn coil
Digital Multimeter: up to 7.5 Digits DC Voltage – Source ¹	(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
Digital Multimeter: up to 7.5 Digits DC Current – Source ¹	(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	Fluke 5522A Multiproduct Calibrator with Wavetek 1281 Multimeter
Digital Multimeter: up to 7.5 Digits AC Voltage – Source ¹	(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 (00 to 1 000) V	0.27 mV/V + 4.7 μV 0.2 mV/V + 25 μV 0.2 mV/V + 0.24 mV 0.2 mV/V + 2.5 mV 0.2 mV/V + 14 mV 0.25 mV/V + 4.7 μV 0.18 mV/V + 25 μV 0.18 mV/V + 0.24 mV 0.18 mV/V + 2.5 mV 0.18 mV/V + 14 mV 0.25 mV/V + 2.5μV 0.16 mV/V + 24 μV 0.16 mV/V + 0.24 mV 0.16 mV/V + 2.5 mV 0.18 mV/V + 14 mV 0.25 mV/V + 4.7 μV 0.18 mV/V + 24 μV 0.18 mV/V + 0.25 mV 0.18 mV/V + 2.6 mV 0.18 mV/V + 14 mV	Fluke 5522A Multiproduct Calibrator with Wavetek 1281 Multimeter



ANSI National Accreditation Board

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 ¹	(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 (> 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) μ A 200 μ A to < 2 mA (2 to < 20) mA (20 to < 200) mA	0.47 mV/V + 9.3 μ V 0.29 mV/V + 47 μ 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 μ 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 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 μ A 0.35 mA/A + 2.5 μ A 0.35 mA/A + 25 μ A	Fluke 5522A Multiproduct Calibrator with Wavetek 1281 Multimeter
Digital Multimeter: up to 7.5 Digits AC Current – Source ¹	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 μ A	Fluke 5522A Multiproduct Calibrator with Wavetek 1281 Multimeter
Digital Multimeter: up to 7.5 Digits Resistance – Source ¹	(0 to < 20) Ω (20 to < 200) Ω 200 Ω to < 2 k Ω (2 to < 20) k Ω (20 to < 200) k Ω 200 k Ω to < 2 M Ω (2 to < 20) M Ω	18 $\mu\Omega/\Omega$ + 27 $\mu\Omega$ 13 $\mu\Omega/\Omega$ + 0.12 m Ω 11 $\mu\Omega/\Omega$ + 1.1 m Ω 11 $\mu\Omega/\Omega$ + 12 m Ω 11 $\mu\Omega/\Omega$ + 0.14 Ω 17 $\mu\Omega/\Omega$ + 5 Ω 35 $\mu\Omega/\Omega$ + 0.17 k Ω	Fluke 5522A Multiproduct Calibrator with Wavetek 1281 Multimeter
Digital Multimeter: up to 7.5 Digits Resistance – Source ¹	Test voltage @ 10 V (20 to < 200) M Ω 200 M Ω to < 2 G Ω	0.35 m Ω/Ω + 13 k Ω 3.5 m Ω/Ω + 1.1 M Ω	Fluke 5522A Multiproduct Calibrator with Wavetek 1281 Multimeter



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
AC Watt-hour Source ¹ Single phase	0.010 89 Wh to 200 kWh Voltage range (0.33 to 1 000) V @ 50 Hz, cos φ = 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 ¹	(-5 to -1) kV -1 kV to 0 V 0 V to 1 kV (1 to 5) kV (>5 to 10) kV	12 mV/V + 2.6 V 12 mV/V + 2.5 V 12 mV/V + 2.5 V 12 mV/V + 2.6 V 38 mV/V + 36 V	Ion Monitor 91-0210 Charged Plate Monitor
Phase Meter ¹	(0 to 360) ° 10 Hz to 10 kHz (10 to 100) kHz	0.01 ° 0.063 °	Agilent 53131A Counter
Earth Ground Continuity, Ground bond ¹	Test current max 30 A 0.1 Ω 0.2 Ω 0.5 Ω	0.58 % of reading 0.58 % of reading 0.58 % of reading	Standard Resistor DR30A, current shunt
Pulse - Source ¹ Pulse - Measure ¹ Transformer ratio-Source ¹	(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 ¹ (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
Oscilloscopes ¹ 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 ¹ 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



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Oscilloscope Bandwidth ¹ @ 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 ¹	(0 to 10) Vp-p	0.16 mV/V + 0.24 mV	Wavetek 1281 Multimeter
Oscilloscope ¹ Rise Time/Fall Time	<400 ps	28 ps	Fluke 5500A w Opt. SC300 Multiproduct Calibrator
Oscilloscope Horizontal Deflection: Time Mark ¹	5 s 2 s 1 s 0.5 s 0.2 s 0.1 s 50 ms 20 ms 10 ms 5 ms 2 ms 1 ms 0.5 ms 0.2 ms 0.1 ms 50 μs 20 μs 10 μs 5 μs 2 μs 1 μs 0.5 μs 0.2 μs 0.1 μs 50 ns 20 ns 10 ns 5 ns 2 ns 1 ns	5.8 ms/s + 0.058 ms 2.4 ms/s + 0.058 ms 1.2 ms/s + 0.058 ms 0.61 ms/s + 5.8 μs 0.26 ms/s + 5.8 μs 0.15 ms/s + 5.8 μs 87 μs/s + 0.58 μs 52 μs/s + 0.58 μs 41 μs/s + 0.58 μs 35 μs/s + 0.058 μs 32 μs/s + 0.058 μs 30 μs/s + 0.058 μs 30 μs/s + 5.8 ns 30 μs/s + 5.8 ns 29 μs/s + 5.8 ns 30 μs/s + 0.58 ns 30 μs/s + 0.58 ns 30 μs/s + 0.58 ns 29 μs/s + 0.058 ns 29 μs/s + 0.058 ns 29 μs/s + 0.058 ns 29 μs/s + 5.8 ps 29 μs/s + 5.8 ps 29 μs/s + 5.8 ps 29 μs/s + 0.58 ps 29 μs/s + 0.58 ps 29 μs/s + 0.58 ps 29 μs/s + 0.058 ps 29 μs/s + 0.058 ps 29 μs/s + 0.058 ps	Fluke 5500A w Opt. SC300 Multiproduct Calibrator



Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Temperature-Simulation Resistance Temperature Detector ¹	Pt100 (385) (-200 to - 80) °C (> - 80 to 0) °C (> 0 to 100) °C (> 100 to 300) °C (> 300 to 400) °C (> 400 to 630) °C (> 630 to 800) °C	0.082 °C 0.082 °C 0.1 °C 0.12 °C 0.13 °C 0.16 °C 0.28 °C	Fluke 5522A Multiproduct Calibrator
Temperature-Simulation Thermocouple ¹ (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 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	0.23 °C 0.21 °C 0.2 °C 0.21 °C 0.21 °C 0.22 °C 0.2 °C 0.2 °C 0.2 °C 0.21 °C 0.34 °C 0.21 °C 0.2 °C 0.2 °C 0.47 °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	Fluke 5522A Multiproduct Calibrator



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Temperature-Simulation Thermocouple ¹ (With cold junction compensation)	Type N		Fluke 5522A Multiproduct Calibrator
	(-200 to -100) °C	0.27 °C	
	(> -100 to -25) °C	0.22 °C	
	(> -25 to 120) °C	0.21 °C	
	(> 120 to 410) °C	0.21 °C	
	(> 410 to 1 300) °C	0.21 °C	
Temperature-Simulation Thermocouple ¹ (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	
	Type R		
	(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		



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Temperature-Simulation Thermocouple ¹ (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	0.2 °C 0.11 °C 0.11 °C 0.1 °C 0.11 °C	Fluke 5522A Multiproduct Calibrator

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation - Source ¹ Frequency Carrier (150 kHz to 10 MHz)	Modulation Rate (20 to < 50) Hz AM (5 to 30) % Depth AM (> 30 to 99) % Depth Modulation Rate : 50 Hz to 10 kHz AM (5 to 30) % Depth AM (> 30 to 99) % Depth	3.5 % of reading. + 0.014 % Depth 3.5 % of reading. + 0.14 % Depth 2.4 % of reading. + 0.014 % Depth 2.4 % of reading. + 0.14 % Depth	HP 8656B Signal Generator, Agilent N9310A Generator, HP 8902A Measuring Receiver
Amplitude Modulation - Source ¹ Frequency Carrier (> 10 MHz to 3 GHz)	Modulation Rate : 20 Hz to < 50 Hz AM (5 to 30) % Depth AM (> 30 to 99) % Depth Modulation Rate : 50 Hz to 50 kHz AM (5 to 30) % Depth AM (> 30 to 99) % Depth Modulation Rate (> 50 to 100) kHz AM (5 to 30) % Depth AM (> 30 to 99) % Depth	3.5 % of reading. + 0.014 % Depth 3.5 % of reading. + 0.14 % Depth 1.2 % of reading. + 0.014 % Depth 1.2 % of reading. + 0.14 % Depth 3.5 % of reading. + 0.014 % Depth 3.5 % of reading. + 0.14 % Depth	Agilent N9310A Generator, HP 8902A Measuring Receiver HP83732B
Amplitude Modulation - Source ¹ Frequency Carrier (> 1.3 to 20) GHz	Modulation Rate (20 to 50) Hz AM (5 to 30) % Depth AM (> 30 to 99) % Depth Modulation Rate > 50 Hz to 50 kHz AM (5 to 30) % Depth AM (> 30 to 99) % Depth	3.5 % of reading. + 0.014%Depth 3.5 % of reading. + 0.14 % Depth 1.8 % of reading. + 0.014 %Depth 1.8 % of reading. + 0.14 % Depth	HP 8902A Measuring Receiver w/11722A, 11792A



ANSI National Accreditation Board

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation - Source ¹ Frequency Carrier (> 1.3 to 20) GHz	Modulation Rate (> 50 to 100) kHz AM (5 to 30) % Depth AM (> 30 to 99) %Depth	3.5 % of reading. + 0.014 %Depth 3.5 % of reading. + 0.14 % Depth	HP 8902A Measuring Receiver w/11722A, 11792A
Frequency Modulation - Source ¹ Frequency Carrier (250 kHz to 10 MHz)	FM Deviation ≤ 40 kHz Modulation Rate : 20 Hz to 10 kHz FM Deviation ≤ 400 kHz Modulation Rate (20 to < 50) Hz 50 Hz to 100 kHz	2.4 % of reading + 0.014 kHz 5.8 % of reading + 0.14 kHz 1.2 % of reading + 0.14 kHz	HP 8656B Signal Generator, Agilent N9310A Generator, HP 8902A Measuring Receiver
Frequency Modulation - Source ¹ Frequency Carrier >10MHz to 20 GHz	FM Deviation ≤ 40 kHz Modulation Rate : 20 Hz to 10 kHz FM Deviation ≤ 400 kHz Modulation Rate : (20 to < 50) Hz 50 Hz to 100 kHz	2.4 % of reading + 0.014 kHz 5.8 % of reading + 0.14 kHz 1.2 % of reading + 0.14 kHz	HP 8656B Signal Generator, Agilent N9310A Generator, HP 8902A Measuring Receiver
Phase Modulation - Source ¹ 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 ¹ Frequency Carrier (> 10 MHz to 20 GHz)	Phase Deviation ≤ 400 Radians Modulation Rate : 200 Hz to 20 kHz	3.5 % of reading + 0.14 Radian	
Distortion/Sinad/ Signal to noise - Source Distortion ¹	(0.01 to 100) %Distortion @ 20 Hz to 20 kHz (0 to -40) dB (<-40 to -60) dB (<-60 to -80) dB	0.006 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	0.012 dB 0.038 dB 0.16 dB	



ANSI National Accreditation Board

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Distortion/Sinad/ Signal to noise – Source Sinad ¹	@ 20 Hz to 20 kHz (0 to 40) dB (>40 to 50) dB (>50 to 80) dB	0.006 dB 0.019 dB 0.072 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	
Distortion/Sinad/ Signal to noise – Source Signal to noise ¹	@ 20 Hz to 20 kHz (0 to 40) dB (>40 to 50) dB (>50 to 80) dB	0.006 dB 0.019 dB 0.072 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 ¹ Frequency Carrier (150 kHz to 10 MHz)	Modulation Rate (20 to 50) Hz AM (5 to 30) % Depth AM (> 30 to 99) %Depth	3.5 % of reading. + 0.014 % Depth 3.5 % of reading. + 0.14 % Depth	HP 8902A Measuring Receiver, HP 11722A, 11792A Power Sensor
	Modulation Rate : > 50 Hz to 10 kHz AM (5 to 30) % Depth AM (> 30 to 99) %Depth	2.4 % of reading. + 0.014 % Depth 2.4 % of reading. + 0.14 % Depth	
Frequency Carrier (> 10 MHz to 1300 MHz)	Modulation Rate (20 to 50) Hz AM (5 to 30) % Depth AM (> 30 to 99) %Depth	3.5 % of reading. + 0.014 % Depth 3.5 % of reading. + 0.14 % Depth	
	Modulation Rate : > 50 Hz to 50 kHz AM (5 to 30) % Depth AM (> 30 to 99) %Depth	1.2 % of reading. + 0.014 % Depth 1.2 % of reading. + 0.14 % Depth	
	Modulation Rate (> 50 to 100) kHz AM (5 to 30) % Depth AM (> 30 to 99) %Depth	3.5 % of reading. + 0.014 % Depth 3.5 % of reading. + 0.14 % Depth	



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Amplitude Modulation - Measure ¹ Frequency Carrier (> 1.3 to 20) GHz	Modulation Rate (20 to 50) Hz AM (5 to 30) % Depth (> 30 to 99) %Depth Modulation Rate : > 50 Hz to 50 kHz AM (5 to 30) % Depth (> 30 to 99) %Depth Modulation Rate (> 50 to 100) kHz AM (5 to 30) % Depth AM (> 30 to 99) %Depth	3.5 % of reading, + 0.014 % Depth 3.5 % of reading, + 0.14 % Depth 1.8 % of reading, + 0.014 %Depth 1.8 % of reading, + 0.14 % Depth 3.5 % of reading, + 0.014 %Depth 3.5 % of reading, + 0.14 % Depth	HP 8902A Measuring Receiver, HP 11722A, 11792A Power Sensor
Frequency Modulation -Measure ¹ Frequency Carrier (250 kHz to 10 MHz) Frequency Carrier (> 10 MHz to 20 GHz)	FM Deviation ≤40 kHz Modulation Rate : 20 Hz to 10 kHz FM Deviation ≤40 kHz Modulation Rate (20 to 50) Hz Modulation Rate > 50 Hz to 100 kHz	2.4 % of reading + 0.014 kHz 5.8 % of reading + 0.14 kHz 1.2 % of reading + 0.14 kHz	HP 8902A Measuring Receiver, HP 11722A, 11792A Power Sensor
Phase Modulation - Measure ¹ Frequency Carrier (250 kHz to 10 MHz) Frequency Carrier (> 10 MHz to 20 GHz)	Phase Deviation ≤400 Radians Modulation Rate : 200 Hz to 10 kHz Phase Deviation ≤400 Radians Modulation Rate : 200 Hz to 20 kHz	4.7 % of reading + 0.14 Radian 3.5 % of reading + 0.14 Radian	HP 8902A Measuring Receiver, HP 11722A, 11792A Power Sensor
Distortion/SINAD/ Signal to noise - Measure ¹ Distortion ¹	(0.01 to 100) %Distortion 20 Hz to 20 kHz (0 to -40) dB (<-40 to -60) dB (<-60 to -80) dB (0.01 to 100) %Distortion > 20 kHz to 100 kHz (0 to -40) dB (<-40 to -60) dB (<-60 to -80) dB	0.006 dB 0.019 dB 0.072 dB 0.012 dB 0.038 dB 0.16 dB	HP 8903B Audio Analyzer, Agilent N9310A Signal Generator Fluke 5522A Multiproduct Calibrator, 1281,34401A Multimeter



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Distortion/SINAD/ Signal to noise – Measure SINAD ¹	@ 20 Hz to 20 kHz (0 to 40) dB (>40 to 50) dB (>50 to 80) dB	0.006 dB 0.019 dB 0.072 dB	HP 8903B Audio Analyzer, Agilent N9310A Signal Generator Fluke 5522A Multiproduct Calibrator, 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	
Distortion/SINAD/ Signal to noise – Measure Signal to noise ¹	@ 20 Hz to 20 kHz (0 to 40) dB (>40 to 50) dB (>50 to 80) dB	0.006 dB 0.019 dB 0.072 dB	HP 8903B Audio Analyzer, Agilent N9310A Signal Generator Fluke 5522A Multiproduct Calibrator, 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	
RF Power-Source ¹ 10 Hz to 20 MHz	(-70 to 8) dBm	0.12 dB	HP 3336C Generator
RF Tuned Power- Measure ¹	2.5 MHz to 20 GHz 0 dB (-10 to 0) dB (-20 to -10) dB (-30 to -20) dB (-40 to -30) dB (-50 to -40) dB (-60 to -50) dB (-70 to -60) dB (-80 to -70) dB (-90 to -80) dB (-100 to -90) dB (-110 to -100) dB (-120 to -110) dB (-127 to -120) dB	0.001 dB 0.052 dB 0.076 dB 0.079 dB 0.083 dB 0.11 dB 0.11 dB 0.13 dB 0.12 dB 0.17 dB 0.18 dB 0.15 dB 0.16 dB 0.17 dB	HP 8902A Measuring Receiver, HP 11722A, 11792A Power Sensors, HP 8591E, HP 8592L, Spectrum Analyzers
RF Absolute Power- Measure ¹	100 kHz to 4.2 GHz (25 to 35) dBm	0.051 dB	HP 437B Power Meter, HP 8482H Power Sensor
RF Absolute Power- Measure ¹	10 MHz to 6 GHz (-60 to < -10) dBm (-10 to < 0) dBm (0 to 20) dBm	0.15 dB 0.13 dB 0.1 dB	HP E9301A Power Sensor



Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
RF Absolute Power- Measure ¹	100 kHz to 2.6 GHz (-10 to 30) dBm (< -20 to -10) dBm	0.024 dB 0.036 dB	HP 8902A Measuring Receiver, HP 11722A Power Sensor
RF Absolute Power- Measure ¹	10MHz to 20 GHz (-10 to 30) dBm (< -20 to -10) dBm	0.024 dB 0.036 dB	HP 8902A Measuring Receiver, HP 11792A Power Sensor
RF Power- Source ¹	9 kHz to 20 GHz (-139 to 13) dB	1.2 dB	Agilent N9310A, HP83732B Generator
RF Power- Source ¹	DC to 20 GHz (-20 to 0) dB (-40 to < -20) dB (-60 to < -40) dB (-100 to < -60) dB (-110 to < -100) dB	0.35 dB 0.46 dB 0.58 dB 0.69 dB 0.81 dB	Agilent N9310A, HP 83732B Generator, HP 8665B Generator, w Atten 8494B, 8496B
RF Power- Source ¹	100 kHz to 20 GHz (-20 to 30) dBm 2.5 MHz to 20 GHz (0 to 30) dBm (-10 to < 0) dB (-20 to < -10) dB (-30 to < -20) dB (-40 to < -30) dB (-50 to < -40) dB (-60 to < -50) dB (-70 to < -60) dB (-80 to < -70) dB (-90 to < -80) dB (-100 to < -90) dB (-110 to < -100) dB (-120 to < -110) dB (-127 to < -120) dB	0.024 dB 0.024 dB 0.052 dB 0.076 dB 0.079 dB 0.083 dB 0.11 dB 0.11 dB 0.13 dB 0.12 dB 0.17 dB 0.18 dB 0.15 dB 0.16 dB 0.17 dB	HP 83732B Signal Generator, 8902A Measuring Receiver 11722A, 11792A Power Sensor
Noise Figure - Measure ¹	Tuning Frequency: 10 MHz to 1.8 GHz Noise Figure and Gain: (0.1 to 9) dB (> 9 to 20) dB Noise Source Drive: 28 VDC	$1.4 \times 10^{-12} f + 0.058\text{MHz}$ 0.025 dB 0.063 dB 0.12 $\mu\text{V/V} + 91 \mu\text{V}$	N9310A Generator HP 8902A Measuring Receiver, HP 11722A Power Sensor, HP8591E Spectrum Analyzer, 1281 Multimeter



ANSI National Accreditation Board

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
RF Power meter ¹	3.16 μ W 10 μ W 31.6 μ W 100 μ W 0.316 mW 1 mW 3.16 mW 10 mW 31.6 mW 100 mW	2.5mW/W + 0.58nW 2.5mW/W + 0.58nW 2.5mW/W + 5.8nW 2.5mW/W + 5.8nW 2.5mW/W + 58nW 2.5mW/W + 58nW 2.5mW/W + 0.58 μ W 2.5mW/W + 0.58 μ W 2.5mW/W + 5.8 μ W 2.5mW/W + 5.8 μ W	11683A Range calibrator
Phase Source ¹	(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 ¹	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 ¹	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 ¹ >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 ¹	(-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 (> 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	0.066 µm 0.076 µm 0.11 µm 0.13 µm 0.16 µm 0.3 µm 0.44 µm 0.58 µm 0.72 µm	Gauge Block Set
Caliper ¹ (External/Internal/Depth)	Up to 300 mm (> 300 to 450) mm (> 450 to 600) mm (> 600 to 1 000) mm	0.016 mm 0.018 mm 0.021 mm 0.03 mm	Gauge Block Set
Dial Gauge & Digital Indicator ¹	Up to 12.7 mm (> 12.7 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm	1.5 µm 1.7 µm 2.1 µm 2.7 µm 3.3 µm	Digital Indicator Testing Stand M3 JIS-B 7503
Dial Test Indicator ¹	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 ¹	(0 to 500) µm > 500 µm to 1 mm (> 1 to 5) mm (> 5 to 10) mm	0.12 µm 0.14 µm 0.2 µm 0.3 µm	Gauge Block Set JIS B 7536

Length – Dimensional metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Cylinder Gauge/ Bore Gauge ¹	Up to 18 mm (> 18 to 35) mm (> 35 to 60) mm (> 60 to 100) mm (> 100 to 160) mm (> 160 to 250) mm (> 250 to 400) mm	0.65 μm 0.8 μm 1 μm 1.5 μm 2 μm 2.5 μm 3 μm	Universal Length Measuring Machine JIS B 7515
Outside/Inside Micrometer ¹	(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
Indicating Micrometer ¹	(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 ¹	(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 ¹	Up to 60 mm	15 μm	Gauge Block Set JIS B 7531
Height Gauge ¹	Up to 300 mm (> 300 to 600) mm (> 600 to 1 000) mm	15 μm 21 μm 30 μm	Gauge Block Set
Depth Gauge ¹	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 ¹	(0.01 to 3) mm (> 3 to 20) mm	0.3 μm 0.8 μm	Universal Length Measuring Machine JIS B 7524
Thickness Plate ¹ (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 ¹	Up to 12 mm (> 12 to 100) mm	1.5 μm 3 μm	Gauge Block Set
Holtest/Three-points internal micrometer ¹	(3 to 14) mm (> 14 to 20) mm (> 20 to 40) mm (> 40 to 50) mm (> 50 to 75) mm (> 75 to 100) mm (> 100 to 125) mm	1.5 μm 1.8 μm 2 μm 2.2 μm 2.8 μm 3.5 μm 4 μm	Ring Gauge

Length – Dimensional metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Coating Thickness Gauge ¹	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 ¹	(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 ¹	(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 ¹ (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 ¹ , measuring accuracies of respective axis, x-axis direction and y-axis direction	(0 to 50) mm (> 50 to 200) mm	1.2 μm 2.5 μm	Glass Scale JIS B 7153
Profile Projector ¹ , measuring accuracies of respective axis, x-axis direction and y-axis direction	(0 to 50) mm (> 50 to 200) mm	1.2 μm 2.5 μm	Glass Scale JIS B 7184
Micrometer microscope ¹	Up to 10 mm	1 μm	Glass Scale JIS B 7150
Scale Lupe ¹	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 (> 10 to 20) mm (> 20 to 30) mm (> 30 to 40) mm (> 40 to 50) mm (> 50 to 60) mm (> 60 to 70) mm (> 70 to 80) mm (> 80 to 90) mm (> 90 to 100) mm (> 100 to 125) mm (> 125 to 150) mm (> 150 to 175) mm (> 175 to 200) mm (> 200 to 250) mm (> 250 to 300) mm	0.4 μm 0.63 μm 0.52 μm 0.66 μm 0.81 μm 1 μm 1.1 μm 1.3 μm 1.4 μm 1.6 μm 1.9 μm 2.3 μm 2.7 μm 3.1 μm 3.8 μm 4.5 μm	Gauge block set and universal length measuring machine JIS B 7420 and JIS B 0271
Plain snap gauge / gap gauge (External/ Internal)	(1 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 100 to 125) mm (> 125 to 175) mm (> 175 to 200) mm (> 200 to 250) mm (> 250 to 300) mm (> 300 to 400) mm (> 400 to 500) mm	0.51 μm 0.81 μm 1.2 μm 1.9 μm 2.7 μm 3.1 μm 3.8 μm 4.5 μm 6 μm 7.5 μm	Ring gauge, gauge block set and universal length measuring machine
Laser Scan Micrometer ¹	(0.1 to 10) mm (> 10 to 60) mm	0.62 μm 1 μm	Pin Gauge and gauge block set
Surface Roughness Testers ¹	2.94 μm Ra, 9.3 μm Rz	0.066 μm 0.26 μm	Roughness Specimen JIS B 0651
Bevel Protractors ¹	(0 to 90) °	2.2 minutes	Angle Blocks
Measuring Tapes ¹	(0 to 8 000) mm (>8 000 to 10 000) mm (>10 000 to 20 000) mm (>20 000 to 30 000) mm (>30 000 to 40 000) mm (>40 000 to 50 000) mm	0.045 mm 0.046 mm 0.055 mm 0.065 mm 0.075 mm 0.09 mm	Tape & Scale Measuring Machine
Rulers ¹	(0 to 1 000) mm (> 1 000 to 2 000) mm	0.03 mm 0.055 mm	Tape & Scale Measuring Machine

Length – Dimensional metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Contour Machines Straightness ¹ X Axis Z Axis	(0 to 1) mm (0 to 100) mm (0 to 60) mm	0.000 8 mm 0.006 6 mm 0.001 6 mm	Gauge Blocks
Roundness machines ^{1,2}	Up to 200 mmD	0.000 09 mm	Glass Hemisphere
Coordinate Measuring Machines ¹	(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

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Balance/Scale ¹	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 ¹	(> 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 ¹	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		



Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Universal Testing Machine ¹ (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 ¹ (Force)	3 kgf 10 kgf 60 kgf 100 kgf 150 kgf	0.025 kgf 0.08 kgf 0.47 kgf 0.78 kgf 1.2 kgf	Force Transducer
Rockwell Hardness Testing Machine ¹	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) ¹ 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 ¹	700 HV 0.01 kgf 0.1 kgf 1kgf	25 HV	Indirect Verification using Hardness Blocks
Hand Torque Tools ¹ Torque Wrench ¹ , Torque Driver ¹	(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 ¹	(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 ¹ (Pneumatic & Hydraulic), Digital Pressure Gauge, Pressure Transducer, Differential Pressure Gauge, Pressure Transmitter, Manometer, Pressure Switch Vacuum Gauge	(-89.6 to 0) kPa (> 0 to 206.8) kPa (> 206.8 to 2 068) kPa (> 2.068 to 68.94) MPa	0.082 kPa 0.097 kPa 0.94 kPa 0.065 MPa	Digital Test Gauge DKD R-6-1 and DKD R-6-2
Differential Pressure Gauges ¹	(-250 to 0) Pa (0 to 250) Pa	0.62 Pa	Pressure Calibrator
Push-Pull Force Gauge ¹	(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 ¹	(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 ¹	(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

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Tension Gauge ¹	(> 196 to 294) N (> 294 to 490) N (> 490 to 980) N	2.9 N 2.9 N 5.9 N	Standard Weight Set
Dial Tension Gauge ¹	(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 ¹	7.748 cP 101.4 cP 1 037 cP 10 930 cP 88 910 cP	0.15 cP 2.5 cP 16 cP 1.2 P 9.3 P	Viscosity Solution ASTM D 4212
Air Velocity ¹	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 ¹ (Liquid flow)	(0 to 1 000) l/m	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 ¹	(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) ¹	(5 to 500) mW/cm ²	5 % of reading	UV Meter Standard
Total Solar Irradiance / Pyranometer ¹ Sensitivity	(1 to 200) μV/W/m ²	2.5 % of reading	Kipp & Zonan CMP11 Pyranometer Wavetek 1281 & 34401A Multimeter

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Temperature indicator with Sensor Thermocouples ¹	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	4 °C 4 °C 4 °C 4 °C 4 °C 4 °C 4 °C	Fluke 5650 Thermocouple, Hart 1560, w module 2566 Thermometer Readout, Multimeter Wavetek 1281
Temperature-Measure Resistance Temperature Detector Pt100 (385) ¹	(-200 to -80) °C (> -80 to 0) °C (> 0 to 100) °C (> 100 to 300) °C (> 300 to 400) °C (> 400 to 630) °C (> 630 to 800) °C	0.012 °C 0.012 °C 0.013 °C 0.021 °C 0.023 °C 0.028 °C 0.033 °C	Hart 1560 Thermometer, w module 2562 Scanner, Wavetek 1281 Multimeter
Thermocouple ¹ (Without cold junction compensation)	Type K (-200 to -100) °C (> -100 to -25) °C (> -25 to 120) °C (> 120 to 1 000) °C (> 1 000 to 1 372) °C Type J (-210 to -100) °C (> -100 to -30) °C (> -30 to 150) °C (> 150 to 760) °C (> 760 to 1 200) °C Type T (-250 to -150) °C (> -150 to 0) °C (> 0 to 120) °C (> 120 to 400) °C Type R (0 to 250) °C (> 250 to 400) °C (> 400 to 1 000) °C (> 1 000 to 1 767) °C	0.1 °C 0.06 °C 0.06 °C 0.06 °C 0.07 °C 0.09 °C 0.06 °C 0.06 °C 0.05 °C 0.06 °C 0.2 °C 0.07 °C 0.06 °C 0.06 °C 0.24 °C 0.15 °C 0.13 °C 0.12 °C	Hart 1560 Thermometer, w module 2566 Scanner, Wavetek 1281 Multimeter

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Thermocouple ¹ (Without cold junction compensation)	Type S (0 to 250) °C	0.24 °C	Hart 1560 Thermometer, w module 2566 Scanner, Wavetek 1281 Multimeter
	(> 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	
	Type N (-200 to -100) °C	0.14 °C	
	(> -100 to -25) °C	0.08 °C	
	(> -25 to 120) °C	0.07 °C	
(> 120 to 410) °C	0.06 °C		
(> 410 to 1 300) °C	0.06 °C		
Temperature indicator with Sensor Resistance Temperature Detector ¹	Pt100 (385) (-30 to 25) °C	0.18 °C	Fluke SPRT 5609, Hart 1560 Thermometer, w module 2562 Scanner, Wavetek 1281 Multimeter, Burns Engr. 12001-C-9-6-2-A PRT
	(> 25 to 100) °C	0.17 °C	
	(> 100 to 400) °C	0.17 °C	
	(> 400 to 650) °C	0.19 °C	
Thermocouples ¹	Type K (-30 to 25) °C	0.27 °C	Hart 1560 Thermometer, w module 2566 Scanner, Wavetek 1281 Multimeter
	(> 25 to 100) °C	0.44 °C	
	(> 100 to 400) °C	1.5 °C	
	(> 400 to 650) °C	2.3 °C	
	Type J (-30 to 25) °C	0.27 °C	
	(> 25 to 100) °C	0.44 °C	
	(> 100 to 400) °C	1.5 °C	
	(> 400 to 650) °C	2.3 °C	
	Type T (-30 to 25) °C	0.27 °C	
	(> 25 to 100) °C	0.44 °C	
	(> 100 to 400) °C	1.5 °C	
	Type R (25 to 100) °C	0.44 °C	
(> 100 to 400) °C	1.5 °C		
(> 400 to 650) °C	2.3 °C		

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Thermocouples ¹	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 Type N (-30 to 25) °C (> 25 to 100) °C (> 100 to 400) °C (> 400 to 650) °C	0.47 °C 1.5 °C 2.3 °C 0.27 °C 0.44 °C 1.5 °C 2.3 °C 0.27 °C 0.44 °C 1.5 °C 2.3 °C	Hart 1560 Thermometer, w module 2566 Scanner, Wavetek 1281 Multimeter
Temperature Gauge & Dial Thermometer ¹	(-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 ¹ (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 ¹ (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 ¹ (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 ¹	(-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 ¹	(100 to 140) °C	0.5 °C	Madgetech HiTemp140 datalogger



Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Temperature ¹ , 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 ¹ , 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 ¹ , Thermo Hygrograph Measurement	(-10 to 0) °C (> 0 to 50) °C (> 50 to 100) °C (> 100 to 150) °C	0.66 °C 0.66 °C 0.66 °C 0.66 °C	Wavetek 1281 Multimeter, Burns Engr. 12001-C-9-6- 2-A Burns Engr. 12001 PRT Rotronic HL-NT3-D Temperature/ Humidity Data Logger
Humidity ¹ , 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 ¹	(-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	Fluke 4180 Infrared Calibrator Wavetek 1281 Multimeter, Burns Engr. 12001-C-9-6- 2-A PRT, Burns Engr. 12001 PRT, CEM BX-500 Infrared Calibrator $\lambda = 8$ to $14 \mu\text{m}$, $\epsilon = 0.95$
Temperature Indicator with Surface Sensor/Probe ¹	(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 ¹ 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



Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
PRT Sensor ¹	(-30 to 0) °C (> 0 to 200) °C (> 200 to 450) °C (> 450 to 650) °C	0.047 °C 0.049 °C 0.077 °C 0.079 °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 ¹	(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 ¹ 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 ^{1,2}	10 Hz to 1 MHz	$1.4 \times 10^{-12} f + 13 \mu\text{Hz}$	Agilent 53131A Counter
Frequency - Source ¹	(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 ¹	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



Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+ /-)	Reference Standard, Method, and/or Equipment
Frequency - Source ¹	(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 ¹	(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 ¹	10 s to 0.2 ns	$1.4 \times 10^{-12} f + 0.058 \text{ ns}$	
Frequency - Source ¹	(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 ¹	(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 ^{1,2}	(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

Dimensional Measurement 1D

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

Dimensional Measurement 2D

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


 Vice President
