



CERTIFICATE OF ACCREDITATION

ANSI-ASQ National Accreditation Board

500 Montgomery Street, Suite 625, Alexandria, VA 22314, 877-344-3044

This is to certify that

Ming Deng Metrology Services (Thailand) Co., Ltd.

46 Soi Serithai 81/2

Serithai Road, Kannayao

Bangkok 10230, Thailand

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

ISO/IEC 17025:2005

while demonstrating technical competence in the field of

CALIBRATION AND TESTING

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

ACT-2515

Certificate Number


ANAB Approval

Certificate Valid: 06/12/2018-10/27/2019
Version No. 003 Issued: 06/12/2018



This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. 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 17025:2005

Ming Deng Metrology Services (Thailand) Co., Ltd.

46 Soi Serithai 81/2
 Serithai Road, Kannayao
 Bangkok 10230, Thailand
 John Peh

CALIBRATION & TESTING

Valid to: **October 27, 2019**

Certificate Number: **ACT-2515**

Chemical Quantities

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
pH Measuring Instruments ¹	4 pH 7 pH 10 pH	0.06 pH 0.06 pH 0.12 pH	Aqueous Solutions
Conductivity Measuring ¹ Instruments	84 µS 1 413 µS 12.88 mS	1 % of reading + 0.1 µS/cm 1.5 % of reading + 0.6 µS/cm 1.5 % of reading + 0.01 mS/cm	Aqueous Solutions
Refractometer ¹	5 %Brix 10 %Brix 30 %Brix 60 %Brix	0.07 %Brix	Aqueous Solutions

Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
DC Current Measure	(0 to 200) µA 200 µA to 2 mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A	13 µA/A + 0.62 nA 13µA/A + 6.1 nA 14 µA/A + 61 nA 47 µA/A + 0.96 uA 0.18 mA/A + 16 µA 0.39 mA/A + 0.36 mA	8508A Multimeter



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment	
DC Current Measure ¹	(0 to 300) μ A 300 μ A to 3 mA (3 to 30) mA (30 to 300) mA 300 mA to 1 A (1 to 10) A	0.47 mA/A + 0.052 μ A 0.47 mA/A + 0.3 μ A 0.47 mA/A + 2.9 μ A 0.93 mA/A + 52 μ A 0.93 mA/A + 0.73 mA 0.58 mA/A + 4.4 mA	3457A / 189 Multimeter	
DC Current Source	(0 to 220) μ A 220 μ A to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (1.1 to 3) A (3 to 11) A (11 to 20.5) A	47 μ A/A + 7.8 nA 47 μ A/A + 7.9 nA 47 μ A/A + 78 nA 55 μ A/A + 0.78 μ A 74 μ A/A + 24 μ A 0.3 mA/A + 31 μ A 0.39 mA/A + 0.39 mA 0.78 mA/A + 0.59 mA	5700A / 5522A Multi Product Calibrator	
DC Current Clamp Meters	(20 to 55) A (55 to 150) A (150 to 550) A (550 to 1 025) A	0.29 % + 19 mA 0.3 % + 0.06 A 0.3 % + 0.59 A 0.3 % + 0.59 A	5522A Multi Product Calibrator with Current Coil	
DC Current Source ¹	(0 to 330) μ A (0.33 to 3.3) mA (3.3 to 33) mA (33 to 330) mA (0.33 to 1.1) A (1.1 to 3) A (3 to 11) A (11 to 20.5) A	0.12 mA/A + 0.016 μ A 78 μ A/A + 0.039 μ A 78 μ A/A + 0.2 μ A 78 μ A/A + 2 μ A 0.016 mA/A + 31 μ A 0.3 mA/A + 31 μ A 0.39 mA/A + 0.7 mA 0.78 mA/A + 0.59 mA	5522A Multi Product Calibrator	
DC Current Clamp Meters ¹	(20 to 55) A (55 to 150) A (150 to 550) A (550 to 1 025) A	0.29 % of reading + 19 mA 0.3 % of reading + 0.06 A 0.3 % of reading + 0.59 A 0.3 % of reading + 0.59 A	5522A Multi Product Calibrator with Current Coil	
AC Current Clamp Meters ¹	45 Hz to 65 Hz 65 Hz to 440 Hz 45 Hz to 65 Hz 65 Hz to 440 Hz 45 Hz to 65 Hz 65 Hz to 440 Hz 45 Hz to 65 Hz 65 Hz to 440 Hz	(20 to 55) A (20 to 55) A (55 to 150) A (55 to 150) A (150 to 550) A (150 to 550) A (550 to 1 025) A (550 to 1 025) A	0.34 % of reading + 0.03 A 0.95 % of reading + 0.032 A 0.34 % of reading + 0.065 A 0.95 % of reading + 0.066 A 0.35 % of reading + 0.59 A 1.2 % of reading + 0.59 A 0.36 % of reading + 0.59 A 1.2 % of reading + 0.59 A	5522A Multi Product Calibrator with Current Coil



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
AC Current Measure	<200 μ A 10 Hz to 10 kHz <2mA 10 Hz 10 Hz to 10 kHz	0.049 % of reading + 0.021 μ A 0.031 % of reading + 0.2 μ A 0.029 % of reading + 0.2 μ A	Direct Measurement with a precision multimeter
AC Current Measure	<20 mA 10 Hz 10 Hz to 10 kHz <200 mA 10 Hz 10 Hz to 10 kHz <2A 10 Hz to 2 kHz (2 to 10) kHz <20A 50 Hz to 2 kHz (2 to 10) kHz	0.031 % of reading + 2 μ A 0.029 % of reading + 2 μ A 0.031 % of reading + 20 μ A 0.028 % of reading + 20 μ A 0.057 % of reading + 0.2 mA 0.067 % of reading + 0.2 mA 0.072 % of reading + 2 mA 0.2 % of reading + 2 mA	Direct Measurement with a precision multimeter
AC Current Measure ¹	0 to 5 mA (20 to 45) Hz 45 Hz to 1 kHz (1 to 20) kHz (20 to 100) kHz 5 mA to 30 mA (20 to 45) Hz (46 to 100) Hz (101 to 400) Hz 401 Hz to 20 kHz (21 to 100) kHz (30 to 300) mA (20 to 45) Hz (46 to 100) Hz (101 to 400) Hz 401 Hz to 20 kHz (21 to 100) kHz 300 mA to 1A (20 to 45) Hz (46 to 100) Hz (101 to 400) Hz 401 Hz to 20 kHz	1.2 % of reading + 3.1 μ A 0.87 % of reading + 3.1 μ A 0.87 % of reading + 3.2 μ A 2.3 % of reading + 5.5 μ A 1.1 % of reading + 34 μ A 0.44 % of reading + 34 μ A 0.39 % of reading + 34 μ A 0.39 % of reading + 34 μ A 1.3 % of reading + 47 μ A 1.1 % of reading + 0.34 mA 0.44 % of reading + 0.34 mA 0.39 % of reading + 0.34 mA 0.39 % of reading + 0.34 mA 1.3 % of reading + 0.47 mA 1.2 % of reading + 3.3 mA 0.56 % of reading + 3.3 mA 0.5 % of reading + 3.3 mA 0.5 % of reading + 3.3 mA	Direct Measurement with a AC Current Source



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
AC Current Measure ¹	(1 to 10) A 45 Hz to 1 kHz (1 to 20) kHz	1.8 % of reading + 11 mA 5.8 % of reading + 15 mA	Direct Measurement with a AC Current Source
AC Current Source	≤ 220 μA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 220 μA to 2.2 mA (10 to 20) Hz (20 to 30) Hz (30 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (2.2 to 22) mA 10 Hz (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (>22 to 220) mA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (33 to 330) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.063 % of reading + 30 nA 0.034 % of reading + 21nA 0.015 % of reading +19 nA 0.055 % of reading + 40nA 0.15 % of reading + 78 nA 0.063 % of reading + 40 nA 0.034 % of reading +32nA 0.034 % of reading +32nA 0.015 % of reading + 33 nA 0.055 % of reading + 0.39 μA 0.15 % of reading +0.78 μA 0.063 % of reading + 0.41 μA 0.063 % of reading + 0.51 μA 0.034 % of reading + 0.32 μA 0.015 % of reading + 0.32 μA 0.055 % of reading + 3.9 μA 0.14 % of reading + 7.8 μA 0.063 % of reading + 3.9 μA 0.034 % of reading + 3.1 μA 0.016 % of reading + 3.1 μA 0.055 % of reading + 39 μA 0.14 % of reading + 78 μA 0.14 % of reading + 16 μA 0.07 % of reading + 16 μA 0.033 % of reading + 16 μA 0.078 % of reading + 39 μA 0.16 % of reading + 78 μA 0.31 % of reading + 0.16 mA	5700A Multi Product Calibrator



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
AC Current Source	(0.33 to 3) A (10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (3 to 11) A 45 Hz to 100 Hz (0.1 to 1) kHz (1 to 5) kHz (11 to 20.5) A 45 Hz to 100 Hz (0.1 to 1) kHz (1 to 5) kHz	0.14 % of reading + 0.13 mA 0.048 % of reading + 0.085 mA 0.47 % of reading + 0.78 mA 1.94 % of reading + 3.9 mA 0.048 % of reading + 1.6 mA 0.079 % of reading + 1.6 mA 2.4 % of reading + 1.6 mA 0.094 % of reading + 3.9 mA 0.12 % of reading + 3.9 mA 2.4 % of reading + 3.9 mA	5522A Multi Product Calibrator
AC Current Source ¹	(29 to 330) μ A (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (0.33 to 3.3) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (3.3 to 33) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.16 % of reading + 0.08 μ A 0.12 % of reading + 0.079 μ A 0.098 % of reading + 0.079 μ A 0.24 % of reading + 0.12 μ A 0.62 % of reading + 0.16 μ A 1.3 % of reading + 0.31 μ A 0.16 % of reading + 0.12 μ A 0.098 % of reading + 0.12 μ A 0.078 % of reading + 0.12 μ A 0.16 % of reading + 0.16 μ A 0.39 % of reading + 0.24 μ A 0.78 % of reading + 0.47 μ A 0.14 % of reading + 1.6 μ A 0.07 % of reading + 1.6 μ A 0.032 % of reading + 1.6 μ A 0.063 % of reading + 1.6 μ A 0.16 % of reading + 2.4 μ A 0.31 % of reading + 3.1 μ A	5522A Multi Product Calibrator



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
AC Current Source ¹	(33 to 330) mA (10 to 20) Hz (20 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz (0.33 to 3) A (10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (3 to 11) A 45 Hz to 100 Hz (100 to 1) kHz (1 to 5) kHz (11 to 20.5) A 45 Hz to 100 Hz (100 to 1) kHz (1 to 5) kHz	0.14 % of reading + 16 μA 0.071 % of reading + 16 μA 0.032 % of reading + 16 μA 0.078 % of reading + 39 μA 0.16 % of reading + 78 μA 0.31 % of reading + 0.16 mA 0.14 % of reading + 0.23 mA 0.047 % of reading + 0.11 mA 0.47 % of reading + 0.78 mA 1.94 % of reading + 3.9 mA 0.048 % of reading + 1.7 mA 0.078 % of reading + 1.7 mA 2.4 % of reading + 1.7 mA 0.094 % of reading + 3.9 mA 0.12 % of reading + 3.9 mA 2.4 % of reading + 3.9 mA	5522A Multi Product Calibrator
Resistance Measure	(0 to 2) Ω (2 to 20) Ω (20 to 200) Ω 200 Ω to 2 kΩ (2 to 20) kΩ (20 to 200) kΩ 200 kΩ to 2 MΩ (2 to 20) MΩ (20 to 200) MΩ 200 MΩ to 2 GΩ (2 to 20) GΩ	17 μΩ/Ω + 7.4 μΩ 9.3 μΩ/Ω + 44 μΩ 7.8 μΩ/Ω + 0.24 mΩ 7.8 μΩ/Ω + 2.5 mΩ 7.8 μΩ/Ω + 26 mΩ 7.8 μΩ/Ω + 0.4 Ω 9.3 μΩ/Ω + 7.6 Ω 20 μΩ/Ω + 0.14 kΩ 62 μΩ/Ω + 3.34 kΩ 0.18 mΩ/Ω + 0.13 MΩ 1.4 mΩ/Ω + 9.3 MΩ	8508A Multimeter
Resistance Measure ¹	0 Ω (0 Ω to 30) Ω (30 Ω to 300) Ω 300 Ω to 3 kΩ (3 kΩ to 30) kΩ (30 kΩ to 300) kΩ 300 kΩ to 3 MΩ (3 MΩ to 30) MΩ (30 MΩ to 300) MΩ	4 mΩ 87 μΩ/Ω + 4.1 mΩ 64 μΩ/Ω + 9.2 mΩ 58 μΩ/Ω + 8.4 mΩ 58 μΩ/Ω + 0.84 Ω 58 μΩ/Ω + 9.4 Ω 76 μΩ/Ω + 0.17 kΩ 0.47 mΩ/Ω + 8.1 kΩ 1.9 % of reading + 0.81 MΩ	3457A Multimeter



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Resistance Measure ¹	300 MΩ to 1 GΩ	19 % of reading + 1.4MΩ	3457A Multimeter
Resistance Source Fixed Points	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	40 μΩ 86 μΩ/Ω + 8.6 μΩ 86 μΩ/Ω + 7.6 μΩ 26 μΩ/Ω + 8.6 μΩ 24 μΩ/Ω + 8.6 μΩ 16 μΩ/Ω + 58 μΩ 16 μΩ/Ω + 58 μΩ 12 μΩ/Ω + 0.58 mΩ 12 μΩ/Ω + 0.58 mΩ 12 μΩ/Ω + 7.6 mΩ 12 μΩ/Ω + 7 mΩ 13 μΩ/Ω + 58 mΩ 13 μΩ/Ω + 71 mΩ 21 μΩ/Ω + 0.58 Ω 20 μΩ/Ω + 0.58 Ω 37 μΩ/Ω + 54 Ω 44 μΩ/Ω + 52 Ω 0.11 mΩ/Ω + 0.94 kΩ	5700A Multi Product Calibrator
Resistance Source ¹	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω 110 Ω to 1.1 kΩ (1.1 to 11) kΩ (11 to 110) kΩ 110 kΩ to 1.1 MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ (330 to 1 100) MΩ	35 μΩ/Ω + 0.8 mΩ 47 μΩ/Ω + 1.2 mΩ 35 μΩ/Ω + 1.1 mΩ 26 μΩ/Ω + 1.7 mΩ 25 μΩ/Ω + 17 mΩ 25 μΩ/Ω + 0.17 Ω 27 μΩ/Ω + 1.7 Ω 49 μΩ/Ω + 24 Ω 0.11 mΩ/Ω + 40 Ω 0.21 mΩ/Ω + 2 kΩ 0.4 mΩ/Ω + 2.6 kΩ 2.4 mΩ/Ω + 78kΩ 12 mΩ/Ω + 0.39 MΩ	5522A Multi Product Calibrator



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Resistance Simulation of RTD Temperature Measuring Instrumentation	Pt 385, 100Ω		5522A Multi Product Calibrator
	(-200 to -80) °C	0.07 °C	
	(-80 to 0) °C	0.07°C	
	(0 to 100) °C	0.08 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.11 °C	
	(630 to 800) °C	0.19°C	
	Pt 3926, 100 Ω		
	(-200 to -80) °C	0.07 °C	
	(-80 to 0) °C	0.07°C	
	(0 to 100) °C	0.08 °C	
	(100 to 300) °C	0.09 °C	
	(300 to 400) °C	0.1 °C	
	(400 to 630) °C	0.11°C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.2 °C	
	(-190 to -80) °C	0.07 °C	
	(-80 to 0) °C	0.07 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 260) °C	0.08 °C	
	(260 to 300) °C	0.08 °C	
	(300 to 400) °C	0.09°C	
	(400 to 600) °C	0.1 °C	
	(600 to 630) °C	0.19 °C	
	Pt 385, 200 Ω		
	(-200 to -80) °C	0.07 °C	
	(-80 to 0) °C	0.07 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) °C	0.07 °C	
(300 to 400) °C	0.11°C		
(400 to 600) °C	0.12°C		
(600 to 630) °C	0.14 °C		
PT 385, 500Ω			
(-200 to -80) °C	0.07°C		
(-80 to 0) °C	0.07°C		
(0 to 100) °C	0.07°C		
(100 to 260) °C	0.07°C		
(260 to 300) °C	0.08°C		
(300 to 400) °C	0.08°C		
(400 to 630) °C	0.09°C		
(630 to 800) °C	0.1°C		



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Resistance Simulation of RTD Temperature Measuring Instrumentation	Pt 385, 1000 Ω		5522A Multi Product Calibrator
	(-200 to -80) °C	0.06°C	
	(-80 to 0) °C	0.06°C	
	(0 to 100) °C	0.07°C	
	(100 to 260) °C	0.07°C	
	(260 to 300) °C	0.07°C	
	(300 to 400) °C	0.08°C	
	(400 to 630) °C	0.08°C	
	(630 to 800) °C	0.19°C	
	Ni120, 120 Ohm		
	(-80 to 0) °C	0.08°C	
	(0 to 100) °C	0.08°C	
	(100 to 260) °C	0.12°C	
Cu427, 10 Ohm			
(-100 to 260) °C	0.24°C		
Resistance Simulation of RTD Temperature Measuring Instrumentation ¹	Pt 385, 100Ω		725 Process Calibrator
	(-200 to 800) °C	0.39 °C	
	Pt 3926, 100 Ω		
	(-200 to 630) °C	0.36 °C	
	Pt 3916, 100 Ω		
	(-200 to 630) °C	0.36 °C	
	Pt 385, 200 Ω		
	(-200 to 250) °C	0.24 °C	
(250 to 630) °C	0.93 °C		
Pt385 ,500Ω			
(-200 to 500) □C	0.36 °C		
(500 to 630) □C	0.47 °C		
Resistance Simulation of RTD Temperature Measuring Instrumentation ¹	Pt 385, 1000 Ω		725 Process Calibrator
	For Measurement		
	(-200 to 100) °C	0.24 °C	
	(100 to 630) °C	0.36 °C	
	For Source		
	(-200 to 100) °C	0.24 °C	
	(100 to 630) °C	0.24 °C	
Ni120, 120 Ω			
(-80 to 260) °C	0.24 °C		



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
High Resistance ¹ Insulation Testers, Surface Resistivity Meters	(0 to 1) kΩ (1 to 10) kΩ (10 to 100) kΩ (0.1 to 1) MΩ (1 to 10) MΩ (10 to 100) MΩ (0.1 to 1) GΩ (1 to 10) GΩ (10 to 100) GΩ (0.1 to 1) TΩ	0.12 % of reading + 0.58 Ω 0.12 % of reading + 5.8 Ω 0.12 % of reading + 58 Ω 0.12 % of reading + 0.58 kΩ 1.2 % of reading + 5.8 kΩ 1.2 % of reading + 58 kΩ 1.2 % of reading + 0.58 MΩ 1.2 % of reading + 5.8 MΩ 2.3 % of reading + 58 MΩ 4.00 % of reading + 0.58 GΩ	High Voltage Decade Resistance Box
DC Voltage Measure	(0 to 200) mV 200 mV to 2 V (2 to 20) V (20 to 200) V (200 to 1 000) V	5.1 μV/V + 0.42 μV 3.5 μV/V + 1.4 μV 3.5 μV/V + 18 μV 5.5 μV/V + 0.12 mV 5.5 μV/V + 1.9 mV	8508A Multimeter
DC Voltage Measure ¹	(0 to 30) mV (30 to 300) mV 300 mV to 3.3 V (3.3 to 33) V (33 to 330) V (330 to 1 000) V	52 μV/V + 4.4 μV 41 μV/V + 7.1 μV 29 μV/V + 28 μV 47 μV/V + 38 mV 64 μV/V + 4.4 mV 1.2 mV/V + 0.26 V	3457A/189 Multimeter
DC High Voltage ¹	(0 to 10) kV	5.8 mV/V + 4.0 V	149-10A High Voltage Meter
DC Voltage Source	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	7.8 μV/V + 0.63 μV 6.3 μV/V + 1.1 μV 6.3 μV/V + 6.6 μV 6.24 μV/V + 9.4 μV 7.1 μV/V + 97 μV 8.6 μV/V + 0.75 mV	5700A Multi Product Calibrator
DC Voltage Source ¹	(0 to 330) mV (0.33 to 3.3) V (3.3 to 33) V (33 to 330) V (330 to 1 000) V	16 μV/V + 1.4 μV 9.2 μV/V + 1.7 μV 11 μV/V + 17 μV 15 μV/V + 0.13 mV 15 μV/V + 1.4 mV	5522A Multi Product Calibrator



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
AC Voltage Measure	<200 mV		8508A Multimeter
	(10 to 40) Hz	0.013 % of reading + 5.8 μ V	
	(40 to 100) Hz	0.011 % of reading + 5.3 μ V	
	100 Hz to 2 kHz	0.011 % of reading + 4 μ V	
	(2 to 10) kHz	0.013 % of reading + 5.2 μ V	
	(10 to 30) kHz	0.031 % of reading + 8.5 μ V	
	(30 to 100) kHz	0.067 % of reading + 21 μ V	
	200 mV to 2 V		
	(1 to 10) Hz	0.015 % of reading + 0.12 mV	
	(10 to 40) Hz	0.011 % of reading + 32 μ V	
	(40 to 100) Hz	0.008 5 % of reading + 39 μ V	
	100 Hz to 2 kHz	0.007% of reading + 31 μ V	
	(2 to 10) kHz	0.011 % of reading + 31 uV	
	(10 to 30) kHz	0.021 % of reading + 46 μ V	
	(30 to 100) kHz	0.05 % of reading + 0.20mV	
	(100 to 300) kHz	0.24 % of reading + 1.9 mV	
	300 kHz to 1 MHz	0.78 % of reading + 19 mV	
	(2 to 20) V		
	(40 to 100) Hz	0.0086 % of reading + 0.57 mV	
	100 to 2 kHz	0.007 % of reading + 0.33 mV	
	(2 to 10) kHz	0.011 % of reading + 0.37 mV	
	(10 to 30) kHz	0.021 % of reading + 0.47 mV	
	(30 to 100) kHz	0.051 % of reading + 2.0 mV	
	(100 to 300) kHz	0.24 % or reading + 19 mV	
300 kHz to 1 MHz	0.78% of reading + 0.19 V		
(20 to 200) V			
(40 to 100) Hz	0.0086 % of reading + 3.2 mV		
100 Hz to 2 kHz	0.007% of reading + 3.2 mV		
(2 to 10) kHz	0.011 % of reading + 3.2 mV		
(10 to 30) kHz	0.021 % of reading + 4.7 mV		
(30 to 100) kHz	0.051 % of reading + 20 mV		
(200 to 1 000) V			
(10 to 40) Hz	0.011 % of reading + 35 mV		
40 Hz to 10 kHz	0.011 % of reading + 34 mV		
(10 to 30) kHz	0.021 % of reading + 47 mV		



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
AC Voltage Measure ¹	<30 mV		3457A/189 Multimeter
	(20 Hz to 45) Hz	0.76 % of reading + 20 μV	
	(45 Hz to 100) Hz	0.36 % of reading + 20 μV	
	(100 Hz to 400) Hz	0.27 % of reading + 20 μV	
	400 Hz to 20 kHz	0.28 % of reading + 20 μV	
	(20 kHz to 100) kHz	0.89 % of reading + 32 μV	
	(100 kHz to 300) kHz	3.8 % of reading + 0.12 mV	
	300 kHz to 1 MHz	12 % of reading + 0.77 mV	
	(30 to 300) mV		
	(20 to 45) Hz	0.76 % of reading + 0.2 mV	
	(45 to 400) Hz	0.27 % of reading + 0.2 mV	
	400 Hz to 20 kHz	0.28 % of reading + 0.2 mV	
	(20 to 100) kHz	0.88 % of reading + 0.32 mV	
	(100 to 300) kHz	3.8 % of reading + 1.2 mV	
	300 kHz to 1 MHz	12 % of reading + 8.4 mV	
	300 mV to 3 V		
	(20 to 45) Hz	0.76 % of reading + 2 mV	
	(45 to 100) Hz	0.36 % of reading + 2 mV	
	(100 to 400) Hz	0.27 % of reading + 2 mV	
	400 Hz to 20 kHz	0.28 % of reading + 2.1 mV	
	(20 to 100) kHz	0.88 % of reading + 3.2 mV	
	(100 to 300) kHz	3.8 % of reading + 12 mV	
	300 kHz to 1 MHz	12 % of reading + 78 mV	
	(3 to 30) V		
	(20 to 45) Hz	0.76 % of reading + 20 mV	
	(45 to 100) Hz	0.36 % of reading + 20 mV	
	(100 Hz to 400) Hz	0.27 % of reading + 20 mV	
	400 Hz to 20 kHz	0.28 % of reading + 20 mV	
(20 to 100) kHz	0.88 % of reading + 32 mV		
(100 to 300) kHz	3.8 % of reading + 0.12 V		
300 kHz to 1 MHz	12 % of reading + 0.77 V		
(30 to 300) V			
(20 to 45) Hz	0.84 % of reading + 0.2 V		
(45 to 100) Hz	0.44 % of reading + 0.2 V		
(100 to 400) Hz	0.35 % of reading + 0.2 V		
400 Hz to 20 kHz	0.36 % of reading + 0.2 V		
(20 to 100) kHz	1.4 % of reading + 0.5 V		
(300 to 1 000) V			
45 Hz to 1 kHz	0.47 % of reading + 4.7V		
(1 to 10) kHz	0.47 % of reading + 4.7V		



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
AC High Voltage ¹	(0 to 10) kV (50 Hz to 60) Hz	1.2 % of reading + 6.6 V	High Voltage Meter
AC Voltage Source	(0.22 to 2.2) mV (10 to 20) Hz (20 to 50) Hz 50 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (2.2 to 22) mV (10 to 20) Hz (20 to 30) Hz (30 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz (22 to 220) mV (10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz 500 kHz to 1 MHz 220 mV to 2.2 V (10 Hz to 20) Hz (20 Hz to 40) Hz (40 Hz to 50) Hz (50 Hz to 60) Hz 60 Hz to 10 kHz	0.15 % of reading + 3.9 μV 0.11 % of reading + 3.9 μV 0.11 % of reading + 3.9 μV 0.11 % of reading + 4.0 μV 0.19 % of reading + 3.9 μV 0.26 % of reading + 6.3 μV 0.45 % of reading + 12 μV 0.66 % of reading + 24 μV 0.85 % of reading + 31 μV 0.048 % of reading + 4.7 μV 0.021 % of reading + 4.7 μV 0.021 % of reading + 4.7 μV 0.013 % of reading + 4.7 μV 0.033 % of reading + 4.7 μV 0.075 % of reading + 6.2 μV 0.29 % of reading + 12 μV 0.31 % of reading + 24 μV 0.57 % of reading + 31 μV 0.047 % of reading + 13 μV 0.019 % of reading + 7.8 μV 0.009 % of reading + 7.8 μV 0.029 % of reading + 7.8 μV 0.07 % of reading + 24 μV 0.28 % of reading + 24 μV 0.3 % of reading + 31 μV 0.52 % of reading + 78 μV 0.047 % of reading + 78 μV 0.015 % of reading + 24 μV 0.007 % of reading + 6.2 μV 0.007 % of reading + 5.7 μV 0.007 % of reading + 5.6 μV	5700A Multi Product Calibrator



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
AC Voltage Source	220 mV to 2.2 V		5700A Multi Product Calibrator
	(10 to 20) kHz	0.007 % of reading + 5.7 μ V	
	(20 to 50) kHz	0.011 % of reading + 16 μ V	
	(50 to 100) kHz	0.022 % of reading + 62 μ V	
	(100 to 300) kHz	0.041 % of reading + 0.12 mV	
	(300 to 500) kHz	0.095 % of reading + 0.31 mV	
	500 kHz to 1 MHz	0.19 % of reading + 0.78 mV	
	2.2 to 22 V		
	10 Hz	0.047 % of reading + 0.79 mV	
	(10 to 20) Hz	0.047 % of reading + 0.78 mV	
	(20 to 30) Hz	0.014 % of reading + 0.24 mV	
	(30 to 40) Hz	0.014 % of reading + 0.24 mV	
	(40 to 50) Hz	0.007% of reading + 59 μ V	
	(50 to 60) Hz	0.007% of reading + 57 μ V	
	(60 to 400) Hz	0.007% of reading + 58 μ V	
	400 Hz to 1 kHz	0.007% of reading + 56 μ V	
	(1 to 5) kHz	0.007% of reading + 57 μ V	
	(5 to 10) kHz	0.007% of reading + 55 μ V	
	(10 to 20) kHz	0.007% of reading + 57 μ V	
	(20 to 50) kHz	0.012 % of reading + 0.16 mV	
	(50 to 100) kHz	0.022 % of reading + 0.31 mV	
	(100 to 300) kHz	0.053 % of reading + 1.4 mV	
	(300 to 500) kHz	0.12 % of reading + 3.9 mV	
	500 kHz to 1 MHz	0.24 % of reading + 7 mV	
	22 to 220 V		
	(10 to 20) Hz	0.047 % of reading + 7.8 mV	
	(20 to 40) Hz	0.015 % of reading + 2.4 mV	
	(40 to 50) Hz	0.0074 % of reading + 0.81 mV	
(50 to 60) Hz	0.0074 % of reading + 0.81 mV		
(60 to 400) Hz	0.0074 % of reading + 0.78 mV		
400 Hz to 1 kHz	0.0074 % of reading + 0.79 mV		
(1 to 5) kHz	0.0074 % of reading + 0.81 mV		
(5 to 10) kHz	0.0074 % of reading + 0.79 mV		
(10 to 20) kHz	0.0074 % of reading + 0.8 mV		
(20 to 50) kHz	0.02 % of reading + 3.1 mV		
(50 to 100) kHz	0.047 % of reading + 7.8 mV		



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
AC Voltage Source ¹	(1 to 33) mV		5522A Multi Product Calibrator
	(10 to 45) Hz	0.064 % of reading + 4.7 μV	
	45 Hz to 10 kHz	0.017 % of reading + 4.7 μV	
	(10 to 20) kHz	0.02 % of reading + 4.7 μV	
	(20 to 50) kHz	0.08 % of reading + 4.8 μV	
	(50 to 100) kHz	0.28 % of reading + 9.7 μV	
	(100 to 450) kHz	0.63 % of reading + 39 μV	
	(33 to 330) mV		
	(10 to 45) Hz	0.024 % of reading + 6.3 μV	
	45 Hz to 10 kHz	0.012 % of reading + 6.3 μV	
	(10 to 20) kHz	0.014% of reading + 6.3 μV	
	(20 to 50) kHz	0.028% of reading + 6.3 μV	
	(50 to 100) kHz	0.063 % of reading + 25 μV	
	(100 to 500) kHz	0.16 % of reading + 55 μV	
	330 mV to 3.3) V		
	(10 to 45) Hz	0.024 % of reading +43 μV	
	45 Hz to 10 kHz	0.012 % of reading + 49 μV	
	(10 to 20) kHz	0.015 % of reading + 50 μV	
	(20 to 50) kHz	0.024 % of reading + 40 μV	
	(50 to 100) kHz	0.055 % of reading + 99 μV	
	(>100 to 500) kHz	0.19 % of reading + 0.47 mV	
	(3.3 to 33) V		
	(10 to 45) Hz	0.024 % of reading + 0.51 mV	
	45 Hz to 10 kHz	0.012 % of reading + 0.47 mV	
	(10 to 20) kHz	0.019 % of reading + 0.47 mV	
	(20 to 50) kHz	0.028 % of reading + 0.47 mV	
	(50 to 100) kHz	0.072 % of reading + 1.5 mV	
	(33 to 330) V		
45 Hz to 1kHz	0.16 % of reading + 1.6 mV		
(1 to 10) kHz	0.016 % of reading + 4.7 mV		
(10 to 20) kHz	0.02 % of reading + 4.7 mV		
(20 to 50) kHz	0.024 % of reading + 4.7 mV		
(50 to 100) kHz	0.16 % of reading + 39 mV		
(330 to 1000) V			
45 Hz to 1kHz	0.024 % of reading + 7.9 mV		
(1 to 5) kHz	0.02 % of reading + 8.4 mV		
(5 to 10) kHz	0.024 % of reading + 8 mV		



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Millivolt Simulation of Thermocouple Temperature Measuring Instrumentation	Type B		5522A Multi Product Calibrator
	(600 to 800) °C	1.8 °C	
	(800 to 1 000) °C	1.8 °C	
	(1 000 to 1 500) °C	1.7 °C	
	(1 550 to 1 820) °C	1.8 °C	
	Type C		
	(0 to 150) °C	1.7 °C	
	(150 to 650) °C	1.7 °C	
	(650 to 1 000) °C	1.7 °C	
	(1 000 to 1 800) °C	1.8 °C	
	(1 800 to 2 316) °C	1.9 °C	
	Type E		
	(-250 to -100) °C	0.5 °C	
	(-100 to 25) °C	0.3 °C	
	(-25 to 350) °C	0.3 °C	
	(350 to 650) °C	0.3 °C	
	(650 to 1 000) °C	0.3 °C	
	Type J		
	(-210 to -100) °C	0.3 °C	
	(-100 to 30) °C	0.3 °C	
	(-30 to 150) °C	0.3 °C	
	(150 to 760) °C	0.3 °C	
	(760 to 1 200) °C	0.3 °C	
	Type K		
(-200 to -100) °C	0.4 °C		
(-100 to -25) °C	0.3 °C		
(-25 to 120) °C	0.3 °C		
(120 to 1 000) °C	0.4 °C		
(1 000 to 1 372) °C	0.4 °C		
Type L			
(-200 to -100) °C	1.8 °C		
(-100 to 800) °C	1.7 °C		
(800 to 900) °C	1.7 °C		
Type N			
(-200 to -100) °C	0.5 °C		
(-100 to -25) °C	0.4 °C		
(-25 to 120) °C	0.4 °C		
(120 to 410) °C	0.4 °C		
(410 to 1 300) °C	0.4 °C		



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Millivolt Simulation of Thermocouple Temperature Measuring Instrumentation	Type R (0 to 250) °C	2.5 °C	5522A Multi Product Calibrator
	(250 to 400) °C	2.4 °C	
	(400 to 1 000) °C	2.4 °C	
	(1 000 to 1 767) °C	2.4 °C	
	Type S (0 to 250) °C	2.4 °C	
	(250 to 1 000) °C	2.4 °C	
	(1 000 to 1 400) °C	2.4 °C	
	(1 400 to 1 767) °C	2.4 °C	
	Type T (-250 to -150)	0.6 °C	
	(-150 to 0) °C	0.3 °C	
	(0 to 120) °C	0.3 °C	
	(120 to 400) °C	0.3 °C	
	Type U (-200 to 0) °C	1.8 °C	
	(0 to 600) °C	1.7 °C	
	Millivolt Simulation of ¹ Thermocouple Temperature Measuring Instrumentation	Type B (600 to 800) °C	
(800 to 1 000) °C		2.8 °C	
(1 000 to 1 800) °C		2.5 °C	
Type E (-200 to 0) °C		1.1 °C	
(0 to 950) °C		0.8 °C	
Type J (-200 to 0) °C		1.2 °C	
(0 to 1 200) °C		0.9 °C	
Type K (-200 to 0) °C		1.4 °C	
(0 to 1370) °C		1 °C	
Type L (-200 to 0) °C		2 °C	
(0 to 900) °C		1.9 °C	
Type N (-200 to 0) °C		1.8 °C	
(0 to 400) °C		1.1 °C	



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Millivolt Simulation of ¹ Thermocouple Temperature Measuring Instrumentation	Type R (-20 to 0) °C (0 to 500) °C (500 to 1 750) °C Type S (-20 to 0) °C (0 to 500) °C (500 to 1 750) °C Type T (-200 to 0) °C (0 to 400) °C Type U (-200 to 0) °C (0 to 400) °C	3.9 °C 3.3 °C 3 °C 3.8 °C 3.3 °C 3.1 °C 1.2 °C 1 °C 2.1 °C 1.9 °C	725 Process Calibrator
Capacitance Source ¹ 10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz 50 Hz 20 Hz 6 Hz 2 Hz 0.6 Hz 0.2 Hz	(0.19 to 0.4) nF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 110) nF (110 to 330) nF (0.33 to 1.1) μF (1.1 to 3.3) μF (3.3 to 11) μF (11 to 33) μF (33 to 110) μF (110 to 330) μF (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	2 % of reading + 7.8 pF 0.63% of reading + 7.8 pF 0.46 % of reading + 7.8 pF 0.21 % of reading + 9.7 pF 0.21 % of reading + 97 pF 0.21 % of reading + 0.63 nF 0.21 % of reading + 0.97 nF 0.21 % of reading + 6.3 nF 0.21 % of reading + 9.7 nF 0.32 % of reading + 62 nF 0.38 % of reading + 97 nF 0.37 % of reading + 0.63 μF 0.36 % of reading + 1.1 μF 0.35 % of reading + 6.3 μF 0.35 % of reading + 9.7 μF 0.59 % of reading + 24 μF 0.85 % of reading + 78 μF	5522A Multi Product Calibrator
DC Power Source ¹	(0 to 90) W (90 to 150) W (150 to 600) W 600 W to 6 kW (6 to 12) kW	0.018 % of reading + 1 mW 0.018 % of reading + 7.1 mW 0.018 % of reading + 7.6 mW 0.055 % of reading + 58 mW 0.07 % of reading + 0.58 W	5522A Multi Product Calibrator



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
AC Power Source ¹ (45 to 65) Hz	(0 to 90) W (90 to 150) W (150 to 600) W 600 W to 6 kW (6 to 12) kW	0.071 % of reading + 2.2 mW 0.071 % of reading + 7.6 mW 0.079 % of reading + 12 mW 0.079 % of reading + 58 mW 0.079 % of reading + 0.58 W	5522A Multi Product Calibrator
LCR Meters ¹ Capacitance (1 to 10) kHz (10.01 to 100) kHz (100 to 999.9) Hz (1 to 10) kHz (10.01 to 100) kHz (100 to 999.9) Hz (1 to 10) kHz (10.01 to 100) kHz (100 to 999.9) Hz (1 to 10) kHz (10.01 to 100) kHz 100 Hz to 10kHz (10.01 to 100) kHz 100 Hz to 10 kHz 100 Hz to 10 kHz	1 pF 1 pF 10 pF 10 pF 10 pF 100 pF 100 pF 100 pF 1000 pF 1000 pF 1000 pF 10 nF 10 nF 100 nF 1 μF	0.12 % of reading + 0.000 14 pF 0.59 % of reading + 0.000 14 pF 0.12% of reading + 0.000 14 pF 0.12 % of reading + 0.000 14 pF 0.48 % of reading + 0.001 3 pF 0.12% of reading + 0.013 pF 0.12% of reading + 0.013 pF 0.37% of reading + 0.013 pF 0.12% of reading + 0.014 pF 0.12% of reading + 0.014 pF 0.36% of reading + 0.014 pF 0.12 % of reading + 0.001 3 nF 0.35 % of reading + 0.0013 nF 0.12 % of reading + 0.013 nF 0.19 % of reading + 0.14 nF	Standard Air Capacitor
LCR Meters ¹ Resistance (100 to 999.9) Hz 1kHz (>1 to 100) kHz (100 to 999.9) Hz 1kHz >1kHz to 100kHz (100 to 999.9) Hz 1kHz (>1 to 100) kHz (100 to 999.9) Hz 1kHz 1kHz	10 Ω 10 Ω 10 Ω 100 Ω 100 Ω 100 Ω 1 kΩ 1 kΩ 1 kΩ 10k Ω 10 kΩ 100 kΩ	0.033 % of reading + 2.4 mΩ 0.033 % of reading + 2.4 mΩ 0.33 % of reading + 2.4 mΩ 0.033 % of reading + 2.4 mΩ 0.033 % of reading + 2.4 mΩ 0.24% of reading + 2.4 mΩ 0.033 % of reading + 0.058 Ω 0.033% of reading + 0.058 Ω 0.24% of reading + 0.058 Ω 0.033 % of reading + 0.058 Ω 0.033 % of reading + 0.058 Ω 0.052 % of reading + 0.58 Ω	Decade Resistance Box



Electrical – DC/Low Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Oscilloscopes DC Signal 50 Ω Impedance 1 MΩ Impedance	0 to ± 6.6 V 0 to ± 130 V	0.3 % of reading + 47 μV 0.12 % of reading + 47 μV	Fluke 5522A Multi Product Calibrator
Square Wave Signal 50 Ω at 1 kHz Source 1 MΩ at 1 kHz Source	1 mV to 6.6 Vp-p 1 mV to 130 Vp-p	0.3 % of reading + 47 μV 0.12 % of reading + 47 μV	
Leveled Sine Wave Amplitude: 5 mV to 5.5 Vpp	5 mV to 5.5 Vp-p (50 kHz Reference) (50 kHz to 100 MHz) (100 to 300 MHz) (300 to 600 MHz)	2.4 % of reading + 347 μV 4.1 % of reading + 347 μV 4.7 % of reading + 347 μV 7 % of reading + 347 μV	
Time Marker into 50Ω ₂	5 s to 50 ms 20 ms to 2 ns	(23 + t*1 000) ps 2.9 ps	
Rise Time	≤ 300 ps	30 ps	

Length – Dimensional metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
External Micrometers ¹ Linearity	(0 to 300) mm (300 to 600) mm (600 to 1 000) mm	0.5 μm 1 μm 3 μm	Gauge Block
External Micrometers ¹ Flatness	Up to 50 mm diameter	0.3 μm	Optical Parallel or Optical Flat
External Micrometers ¹ Parallelism	Up to 25 mm diameter	0.9 μm	Optical Parallel or Optical Flat
Calipers ¹	(0 to 1 000) mm	8 μm	Gauge Block and Caliper Checker
Caliper Gauge ¹	(0 to 150) mm	0.02 mm	Gauge Block or Ring Gauge
Depth Micrometers	(0 to 300) mm	1 μm	Gauge Block



Length – Dimensional metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Stick/ Inside Micrometers	(0 to 1 000) mm	1 µm	Universal Length Measuring Machine (ULM)
Internal Micrometers 2 leg type	(0 to 200) mm	1 µm	Ring Gauge or Gauge Block
Micrometer Heads	(0 to 100) mm	1.2 µm	Universal Length Measuring Machine (ULM) or Gauge Block
Calibration Testers	(0 to 100) mm	0.7 µm	Linear Gauge or Gauge Block
Height Masters			
Micrometer Linearity	(0 to 25) mm	0.4 µm	Comparison with Gauge Block
Height	(0 to 300) mm	0.7 µm	
Parallelism	(0 to 0.02) mm	0.4 µm	
Screw Thread Micrometers	(0 to 100) mm	1 µm	Gauge Block or Pin Gauge
Caliper Checkers (Step Gauges)	(0 to 630) mm	0.8 µm	Comparison with Gauge Block
Height Gauges	(0 to 600) mm	10 µm	Gauge Block or Caliper Checker
Linear Height Gauges ¹	(0 to 1 000) mm	2 µm	Gauge Block or Caliper Checker
Setting Master for Linear Height Gauges	(0 to 25) mm	0.4 µm	Gauge Block or Universal Length Measuring Machine (ULM)
Depth Gauges	(0 to 600) mm	5 µm	Gauge Block
MU Checker	Up to 5 mm	0.2 µm	Gauge Block or Calibration Tester
Dial Indicator	Up to 100 mm	0.5 µm	Dial Gauge Calibrator
Dial Test Indicator	Up to 3 mm	0.5 µm	Dial Gauge Calibrator
Digimatic Indicator ¹ Linear Gauge	(0 to 30) mm (30 to 100) mm	0.6 µm	Gauge Block
Dial Thickness Gauges	(0 to 100) mm	3 µm	Gauge Block
Dial Gauge Calibrator	(0 to 100) mm	0.2 µm	Gauge Block or Mu Checker



Length – Dimensional metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Dial Depth Gauges	(0 to 100) mm	2 μ m	Gauge Block
Plain Plug Gauge / Pin Gauge Diameter	Up to 25 mm (25 to 50) mm (50 to 75) mm (75 to 100) mm (100 to 150) mm (150 to 200) mm (150 to 200) mm (200 to 250) mm (250 to 300) mm (300 to 350) mm	0.4 μ m 0.5 μ m 0.7 μ m 0.9 μ m 1.2 μ m 1.6 μ m 2 μ m 2.3 μ m 2.7 μ m 3.1 μ m	Universal Length Measuring Machine (ULM)
Plain Plug Gauge / Pin Gauge Circularity	(0 mm to 1) mm	0.06 μ m	Universal Length Measuring Machine (ULM)
Thread Wires Diameter	Up to 10 mm	0.4 μ m	Universal Length Measuring Machine (ULM)
Thread Wires Circularity	(0 mm to 1) mm	0.06 μ m	Roundness Tester
Plain Ring Gauges Diameter	(1 to 25) mm (25 to 50) mm (50 to 75) mm (75 to 100) mm (100 to 125) mm (125 to 150) mm (150 to 175) mm (175 to 200) mm	0.5 μ m 0.6 μ m 0.8 μ m 0.9 μ m 1.1 μ m 1.3 μ m 1.4 μ m 1.6 μ m	Universal Length Measuring Machine (ULM), Setting Ring Gauge
Plain Ring Gauges Circularity	(0 to 1) mm	0.06 μ m	Roundness Tester Machine
Threaded Plug Gauges Major Diameter	(1 to 50) mm (50 to 100) mm (100 to 150) mm	0.8 μ m 1 μ m 1.3 μ m	Universal Length Measuring Machine (ULM)
Tapered Ring Gauge Diameter	Up to 100 mm	1.3 μ m	Universal Length Measuring Machine (ULM)
Tapered Ring Gauge Step Height	Up to 75mm	2 μ m	Micrometer



Length – Dimensional metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Tapered Plug Gauge Diameter	Up to 100 mm	1.2 µm	Universal Length Measuring Machine (ULM)
Tapered Plug Gauge Step Height	Up to 75 mm	2 µm	Micrometer
Threaded Plug Gauges Pitch Diameter	(1 to 50) mm (50 to 100) mm (100 to 150) mm	0.9 µm 1.1 µm 1.6 µm	Universal Length Measuring Machine (ULM), Thread Wires
Tapered Thread Plug Gauges Pitch Diameter	Up to 150 mm	3.1 µm	Universal Length Measuring Machine (ULM)
Tapered Thread Plug Gauges Taper	(0 to 10) Deg	4 min	Profile Projector
Tapered Thread Plug Gauges Step Height	Up to 75 mm	2 µm	Micrometer
Thread Ring Gauges Minor Diameter	(3 to 50) mm (50 to 100) mm	2.5 µm 3.2 µm	Digimatic Holtest , Inside Micrometer
Thread Ring Gauges Pitch Diameter	(3 to 50) mm (50 to 100) mm	1.1 µm 1.6 µm	Universal Length Measuring Machine (ULM)
	Setting Only	0.9 µm	
Tapered Thread Ring Gauges Step Height	Up to 75 mm	2 µm	Micrometer
Tapered Thread Ring Gauges Pitch Diameter	Up to 100 mm	1.6 µm	Universal Length Measuring Machine (ULM), Probing System
Feeler Gauges/ Shim Stock/ Calibration Foil	(0 to 5) mm	0.4 µm	Universal Length Measuring Machine (ULM)
Coating Thickness Gauge	Up to 1 000 µm	1.6 µm	Coating Thickness Standard
Surface Plates ¹ Overall Flatness Local Area Flatness (Repeat Reading)	To 4 m Diagonal	1.5 µm	Planekator (Straight Edge) or Mu-Checker



Length – Dimensional metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Dial Gauge Stands ¹ Flatness	Up to 1 mm	0.4 μm	Mu-Checker or Dial Test Indicator
Profile Projectors ¹ (Optical Comparators) Linearity Magnification Angle	(0 to 500) mm 10X, 20X, 50X, 100X (0 to 180) Deg.	2 μm 0.02 % magnification 2.5 min	Glass Scale
Measuring Microscopes ¹ Linearity	(0 to 500) mm	2 μm	Glass Scale
Bore Gauges	(0 to 300) mm	1 μm	Height Setting Micrometer or Micrometer
Holtest / Bormatic	(2 to 50) mm (50 to 100) mm (100 to 150) mm	1 μm 1.5 μm 2 μm	Setting Ring Gauge
Straight Edges	1 000 mm	0.8 μm	Mu-Checker or Dial Test Indicator
Steel Rules	(0 to 1 500) mm	0.07 mm	Linear Scale or Profile Projector
Measuring Tape / Textile Tape	Up to 50 m	0.17 mm	Linear Scale or Profile Projector
Squares To 450 mm / 18 in Lengths Parallelism Squareness	(0 to 10) mm (0 to 450) mm	2.3 μm 4 μm	Granite Square
Universal Length Measuring Machines (ULM) ¹	(0 to 100) mm	0.26 μm	Gauge Block
Micrometer Setting (End) Rods	(25 to 1 000) mm	0.6 μm	Mu-Checker and Gauge Block
Analog Protractors Up to 300 mm	0 to 360 °	3 s	Profile Projector or Angle Gauge
Inclinometers	(0 to 45) °	0.2 °	Angle Gauge
Analog Levels to 300 mm	(0 to 0.01) mm/m	0.01 mm/m	Sine bar and Gauge Block
Gauge Block Comparators	(0 to 1) mm	0.05 μm	Gauge Block



Length – Dimensional metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Gauge Blocks (Dissimilar & Similar Material)	(0.5 to 10) mm (10 to 25) mm (25 to 50) mm (50 to 75) mm (75 to 100) mm	0.06 μm 0.07 μm 0.09 μm 0.11 μm 0.13 μm	Comparison with Grade K
Long Gage Blocks (Dissimilar & Similar Material)	125 mm 150 mm 175 mm	0.37 μm 0.4 μm 0.46 μm	Gauge Block Comparator
	125 mm 150 mm 175 mm 200 mm 250 mm 300 mm 400 mm 500 mm	0.46 μm 0.48 μm 0.5 μm 0.52 μm 0.57 μm 0.62 μm 0.73 μm 0.84 μm	Universal Length Measuring Machine (ULM)
Angle Block	(0.25 to 90) °	15 s	CMM
Optical Flats/Parallels Flatness Thickness Parallelism	To 10 μm To 1 mm	0.1 μm 0.4 μm 0.1 μm	Optical Flat
Sine Bars Roll Distance Parallelism	(25 to 300) mm (0 to 0.01) mm	1.9 μm 2.5 μm	Gauge Block and Dial Test Indicator Universal Length Measuring Machine (ULM)
Vee Blocks To 150 mm Lengths Parallelism of Top Parallelism of Vee Squareness of Sides Centrality of Vee	(0 to 0.01) mm	4 μm	Dial Test Indicator
Parallels Straightedge	1 000 mm	2.5 μm	Dial Test Indicator and Surface Plate
Bench Centers Height Centrality	600 mm 200 mm	3 μm	Concentric Gauge
Surface Roughness Testers ¹	1 000 μm	0.019 μm	Roughness Standard
Surface Roughness Standards	15 μm	0.02 μm	Roughness Tester



Length – Dimensional metrology

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Roundness Machines ¹	To 200 mm	0.03 μm	Glass Hemisphere
Magnification Checker (for Roundness Machines)	(0 to 0.4) mm	0.7 mm	Mu Checker
Contour Measuring Machines ¹	Straightness X Axis 100 mm Z Axis 60 mm	0.8 μm 3 μm 0.9 μm	Contour Standard
Dimensional Air Gauges ¹	5 mm	0.5 μm	Gauge Block or Dial Gauge
Coordinate Measuring Machines ¹	X: (0 to 1 500) mm Y: (0 to 1 500) mm Z: (0 to 1 000) mm	1.5 μm	Gauge Blocks, Step Gage

Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Scales and Balances ¹	(0 to 100) g (100 to 200) g (200 to 1000) g (1 to 100) kg (100 to 1 000) kg	0.01 mg 0.03 mg 0.1 mg 2 mg 2 g	Standard Weight
Torque Wrenches ¹	(0 to 1 000) Nm	0.014 Nm	Torque Transducer
Torque Meter / ¹ Gauge	Up to 2 Nm Up to 10 Nm (10 to 100) Nm	0.13 cNm 0.006 Nm 0.013 Nm	Torque Arm or Torque Transducer
Force Testing Machines ¹ and Load Cells Compression and Tension ¹	(0 to 10) N (10 to 100) N (100 to 1 000) N (1 to 5) kN (5 to 10) kN (10 to 50) kN (50 to 100) kN (100 to 250) kN	0.006 N 0.06N 2.3 N 0.005 kN 0.001 kN 0.048 kN 0.11 kN 0.05 kN	Direct measurement to reference load cell or Standard Weight



Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Force Gauges	(0 to 100) N (100 to 200) N (>200 to 500) N (>500 to 1 000) N (>1 000 to 5 000) N	0.007 N 0.07 N 0.07 N 0.7 N 1.1 N	Reference Masses
Rockwell Hardness Testers ¹	HRBW HRA HRC	0.5 HRBW 0.5 HRA 0.5 HRC	Hardness Test Block
Brinell Hardness Testers ¹	(100 to 600) HB	3.7 HB	Hardness Test Block
Vickers Hardness Testers ¹	(100 HV to 1 000) HV	1.1 HV	Hardness Test Block
Durometer Force (expressed as degrees or percentage of scale pointer rotation)	(0 to 100) Deg (%)	0.12 Deg (%)	Standard Weight
Pressure/Vacuum Gauges ¹	(-1 to 0) bar (0 to 20) bar	7.6 mbar 0.02 bar	Pneumatic Pressure Calibrator
	(20 to 1 000) bar (1 000 to 1 500) bar	0.3 bar 6 bar	Hydraulic Gage Comparison
Mass Artifacts	1, 2, 5 mg 10 mg 20 mg 50 mg 100 mg 200, 500 mg, 1 g	0.004 mg 0.005 mg 0.007 mg 0.008 mg 0.01 mg 0.02 mg	OIML R111:2004 ABBA Method to Class F1
Mass Artifacts	2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1 kg 2 kg 5 kg 10 kg	0.03 mg 0.04 mg 0.04 mg 0.05 mg 0.07 mg 0.1 mg 0.2 mg 0.5 mg 1 mg 2 mg 5 mg 10 mg	OIML R111:2004 ABBA Method to Class F1



Mass and Mass Related

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
	20 kg	61 mg	OIML R111:2004 ABBA Method to Class F2
Mass Flow Rate ¹	(0.5 to 592) mg/min (0.5 to 59.2) g/min (60 to 592) g/min	0.8 % of reading + 2.5 mg/min 0.8 % of reading + 0.25 g/min 0.8 % of reading + 2.1 g/min	Standard Flow Meter
Volumetric Flow Rate ¹ Gas	(5 to 500) CCM (0.5 to 50) LPM (50 to 500) LPM	0.8 % of reading + 2 ml/min 0.6 % of reading + 0.21 l/min 0.8 % of reading + 1.8 l/min	Standard Flow Meter

Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Infrared Thermometers (8 to 14) μm	(50 to 350) °C	2.4 °C	Blackbody Source and reference thermocouple thermometer
Temperature Measure System Accuracy Tests of Chambers, Ovens, Freezers, Incubators, or Refrigerators	(-40 to 100) °C (100 to 200) °C (200 to 600) °C	0.9°C 1.9 °C 3.5 °C	Datalogger with Thermocouple Sensors
Temperature Measure System Accuracy Tests of Enclosures or Furnaces	(-40 to 100) °C (100 to 200) °C (200 to 600) °C (600 to 1 000) °C	1 1.8 3.3 2.8	Datalogger with Thermocouple Sensors
Thermohygrometers	(30 to 95) %RH @ 25 °C (15 to 45) °C @ 50 %RH	3.1 %RH 0.8 °C	Reference Thermohygrometer
RTD Based Temperature Measuring Systems	(-20 to 95) °C	0.06 °C	Temperature Baths
	(95 to 200) °C	0.08 °C	
	(-20 to 140) °C (140 to 400) °C (400 to 600) °C	0.22 °C 0.5 °C 1.5 °C	Dry Block
Dry Block Calibrators	(-20 to 400) °C (400 to 650) °C	0.17 °C 1.4 °C	Reference PRT
Surface Type Thermocouple Based Temperature Measuring Systems (Up to 60mm long)	(50 to 350) °C	2.3 °C	Surface Probe Calibrator



Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Thermocouple Based Temperature Measuring Systems	Base Metal; Types E, J, K, N, & T (-20 to 95) °C (95 to 200) °C	0.23 °C 0.47 °C	Temperature Baths
	Base Metal; Types E, J, K, N, & T (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C	0.39 °C 1 °C 2 °C 3.3 °C	Dry Block
	Noble Metal Types B, R, & S (-20 to 95) °C (95 to 200) °C	0.1 °C 0.15 °C	Temperature Baths
	Noble Metal Types B, R, & S (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C	0.24 °C 0.51 °C 1.5 °C 2.4 °C	Dry Block
Thermocouple Based Temperature Measuring Systems	Type J (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C	0.4 °C 1.1 °C 2 °C 3.3 °C	Dry Block
	Type K (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C	0.4 °C 1.1 °C 2 °C 3.3 °C	
	Type N (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C	0.4 °C 1.1 °C 2 °C 3.3 °C	



Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Thermocouple Sensors	Type E (-20 to 95) °C	0.24 °C	Temperature Baths
	(95 to 200) °C	0.47 °C	
	Type J (-20 to 95) °C	0.24 °C	
	(95 to 200) °C	0.47 °C	
	Type K (-20 to 95) °C	0.24 °C	
	(95 to 200) °C	0.47 °C	
	Type N (-20 to 95) °C	0.24 °C	
	(95 to 200) °C	0.47 °C	
	Type R (-20 to 95) °C	0.1 °C	
	(95 to 200) °C	0.16 °C	
	Type S (-20 to 95) °C	0.1 °C	
	(95 to 200) °C	0.16 °C	
	Type T (-20 to 95) °C	0.24 °C	
	(95 to 200) °C	0.47 °C	
Thermocouple Sensors	Type E (-20 to 140) °C	-0.4 °C	Dry Block
	(140 to 400) °C	1.1 °C	
	(400 to 600) °C	2 °C	
	(600 to 1 000) °C	3.5 °C	
	Type R (-20 to 140) °C	0.24 °C	
	(140 to 400) °C	0.55 °C	
	(400 to 600) °C	1.5 °C	
	(600 to 1 000) °C	2.4 °C	
	Type S (-20 to 140) °C	0.24 °C	
	(140 to 400) °C	0.55 °C	
	(400 to 600) °C	1.5 °C	
	(600 to 1 000) °C	2.4 °C	
	Type T (-20 to 140) °C	0.4 °C	
	(140 to 400) °C	1 °C	



Thermodynamic

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Analog and Digital Thermometers	(-20 to 95) °C (95 to 200) °C	0.1 °C 0.1 °C	Reference PRT with Temperature Baths
Analog and Digital Thermometers	(-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C	0.2 °C 0.5 °C 1.5 °C 2.3 °C	Dry Block
Liquid in Glass Thermometers Scale Graduation: 0.1 °C	(-20 to 200) °C	0.1 °C	Reference PRT with Temperature Baths

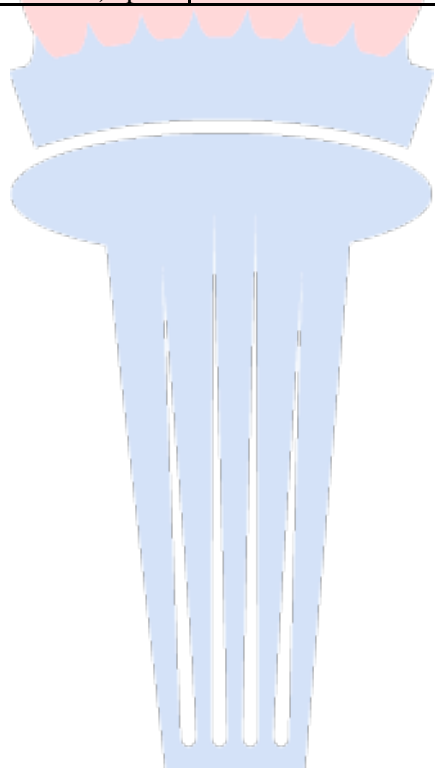
Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Frequency Measuring Instruments	(0.01 to 99.99) Hz (100 to 119.9) Hz (120 to 1199.9) Hz (1.2 to 11.99) kHz (12 to 119.9) kHz 120 kHz to 1.19 MHz (1.2 to 2) MHz	1.6 μHz/Hz + 8.6 μHz 1.6 μHz/Hz + 71 μHz 1.6 μHz/Hz + 0.49 mHz 1.6 μHz/Hz + 4.9 mHz 1.6 μHz/Hz + 40 mHz 1.6 μHz/Hz + 0.49 Hz 1.6 μHz/Hz + 0.8 Hz	5520A Multi Product Calibrator
Frequency Measuring ¹ Instruments	(0.01 to 99.99) Hz (100 to 119.9) Hz (120 to 1199.9) Hz (1.2 to 11.99) kHz (12 to 119.9) kHz 120 kHz to 1.19 MHz (1.2 to 2) MHz	1.6 μHz/Hz + 8.6 μHz 1.6 μHz/Hz + 71 μHz 1.6 μHz/Hz + 0.49 mHz 1.6 μHz/Hz + 4.9 mHz 1.6 μHz/Hz + 40 mHz 1.6 μHz/Hz + 0.49 Hz 1.6 μHz/Hz + 0.8 Hz	5520A Multi Product Calibrator
Timers and Stopwatches	1 s to 1 min (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	4.2 μs/Sec + 6.6 ms 0.25 ms/min + 6.8 ms 0.26 ms/min + 8.6 ms 0.26 ms/min + 8.1 ms 0.26 ms/min + 7.6 ms 0.26 ms/min + 9 ms 0.25 ms/min + 8.2 ms 0.25 ms/min + 8.2 ms 0.25 ms/min + 8.5 ms 0.25 ms/min + 9.8 ms	Frequency Counter/Timer



Time and Frequency

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
Timers and Stopwatches ¹	1 s to 1 min (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	4.2 μ s/s + 6.6 ms 0.25 ms/min + 6.8 ms 0.26 ms/min + 8.6 ms 0.26 ms/min + 8.1 ms 0.26 ms/min + 7.6 ms 0.26 ms/min + 9 ms 0.25 ms/min + 8.2 ms 0.25 ms/min + 8.2 ms 0.25 ms/min + 8.5 ms 0.25 ms/min + 9.8 ms	Frequency Counter/Timer
Tachometers RPM Meter Non-Contact	(1 to 999.99) rpm (1 000 to 9 999.9) rpm (10 000 to 99 999) rpm	0.006 rpm 0.06 rpm 0.6 rpm	Digital Motor monitored with non-contact Tachometer Frequency Source and LED
Tachometers Contact Type	(1 to 9 999.9) rpm (10 000 to 99 999) rpm	0.06 rpm 0.6 rpm	





TESTING

Dimensional

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/to)	Reference Standard, Method and/or Equipment
1D/2D Measurements Length	X: (0 to 680) mm	0.4 μm	Universal Length Measuring Machine (ULM)
1D/2D Geometric Dimensional Measurements of Jigs, Fixtures, Gauges, and First Artefacts	X: (0 to 150) mm Y: (0 to 50) mm Angle: (180 deg.)	3.5 μm 3.5 min	Profile Projector (Optical Comparator)
1D/2D/3D Geometric Dimensional Measurements of Jigs, Fixtures, Gauges, and First Artefacts	X: (0 to 700) mm Y: (0 to 600) mm Z: (0 to 600) mm	2.6 μm	Coordinate Measuring Machine (CMM)

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. *t* = time in seconds.
3. This scope is formatted as part of a single document including Certificate of Accreditation No. ACT-2515.



Vice President

