



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

Ming Deng Metrology Services (Thailand) Co., Ltd.
46 Soi Serithai 81/2
Serithai Road, Kannayao
Bangkok 10230, Thailand
(and satellite location as shown on the scope)

Fulfills the requirements of

ISO/IEC 17025:2017

and

ANSI/NCSL Z540-1-1994 (R2002)

In the fields of

CALIBRATION and DIMENSIONAL MEASUREMENT

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

Jason Stine, Vice President

Expiry Date: 27 October 2025

Certificate Number: ACT-2515



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

AND

ANSI/NCSL Z540-1-1994 (R2002)

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

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

CALIBRATION & DIMENSIONAL MEASUREMENT

Valid to: **October 27, 2025**

Certificate Number: **ACT-2515**

Satellite locations in:

Singapore



ANSI National Accreditation Board

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

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Serithai Road, Kannayao
Bangkok 10230, Thailand
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CALIBRATION

Acoustics and Vibration

Bangkok, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Sound Meter	@1 kHz (94, 114) dB	0.2 dB	Comparison to Sound Calibrator

Chemical Quantities

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
pH Measuring Instruments ^{1,5}	4 pH 7 pH 10 pH	0.06 pH 0.06 pH 0.12 pH	Comparison to Certified Reference Material
Conductivity Measuring ^{1,5} Instruments	84 µS/cm 1 413 µS/cm 12.88 mS/cm	1 % of reading + 0.1 µS/cm 1.5 % of reading + 0.6 µS/cm 1.5 % of reading + 0.01 mS/cm	Comparison to Certified Reference Material
Refractometer ¹	5 %Brix 10 %Brix 30 %Brix 60 %Brix	0.07 %Brix	Comparison to Certified Reference Material
Gas Detector ¹ Oxygen (O ₂) Methane (CH ₄) Hydrogen sulphide (H ₂ S) Carbon Monoxide (CO)	18 cmol / mol 2.2 mmol/ mol 25 µmol/mol 100 µmol/mol	0.3 cmol / mol 0.4 mmol/ mol 2 µmol/mol 1.6 µmol/mol	Comparison to Standard Gas (CRM)
Breath Alcohol Analyzer /Tester	20.0 mg % 50.0 mg %	0.8 mg % 1 mg %	Comparison to Ethanol in Air



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment	
DC Current Measure	(0 to 200) μ A 200 μ A to 2 mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A	13 μ A/A + 0.62 nA 13 μ A/A + 6.1 nA 14 μ A/A + 61 nA 47 μ A/A + 0.96 μ A 0.18 mA/A + 16 μ A 0.39 mA/A + 0.36 mA	Comparison to 8508A Multimeter	
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	Comparison to 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 (2.2 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	Comparison to 5700A / 5522A Multi Product Calibrator	
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 + 0.017 μ A 78 μ A/A + 0.04 μ A 78 μ A/A + 0.22 μ A 78 μ A/A + 2 μ A 0.16 mA/A + 31 μ A 0.3 mA/A + 66 μ A 0.39 mA/A + 0.39 mA 0.78 mA/A + 0.58 mA	Comparison to 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 0.329 % of reading + 0.06 A 0.29 % of reading + 0.082 A 0.3 % of reading + 0.082 A	Comparison to 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	0.33 % of reading + 0.031 A 0.92 % of reading + 0.034 A 0.33 % of reading + 0.065 A 0.92 % of reading + 0.066 A 0.33 % of reading + 0.12 A 0.92 % of reading + 0.13 A 0.34 % of reading + 0.12 A 0.92 % of reading + 0.13 A	Comparison to 5522A Multi Product Calibrator with Current Coil



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current Measure	<200 μ A 10 Hz to 10 kHz <2 mA 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 Fluke 8508A
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 Fluke 8508A
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	Comparison to HP 3457A/Fluke 189



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Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	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	Comparison to HP 3457A/Fluke 189
AC Current Source	$\leq 220 \mu\text{A}$ (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	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	Comparison to 5700A/5522A Multi Product Calibrator
AC Current Source	(2.2 to 22) mA (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 (220 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 + 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	Comparison to 5700A/5522A Multi Product Calibrator
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	0.16 % of reading + 0.13 mA 0.042 % of reading + 0.1 mA 0.47 % of reading + 0.8 mA 2 % of reading + 3.9 mA	Comparison to 5522A Multi Product Calibrator



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current Source	(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	0.048 % of reading + 1.7 mA 0.079 % of reading + 1.7 mA 2.4 % of reading + 1.7 mA 0.094 % of reading + 3.9 mA 0.12 % of reading + 4 mA 2.4 % of reading + 4 mA	Comparison to 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 (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	0.16 % of reading + 0.087 μ A 0.12 % of reading + 0.085 μ A 0.1 % of reading + 0.085 μ A 0.24 % of reading + 0.12 μ A 0.63 % of reading + 0.16 μ A 1.3 % of reading + 0.32 μ A 0.16 % of reading + 0.14 μ A 0.1 % of reading + 0.13 μ A 0.079 % of reading + 0.13 μ A 0.16 % of reading + 0.17 μ A 0.39 % of reading + 0.24 μ A 0.78 % of reading + 0.47 μ A 0.14 % of reading + 1.7 μ A 0.071 % of reading + 1.7 μ A 0.033 % of reading + 1.7 μ A 0.063 % of reading + 1.7 μ A 0.16 % of reading + 2.5 μ A 0.32 % of reading + 3.3 μ A 0.14 % of reading + 17 μ A 0.071 % of reading + 17 μ A 0.034 % of reading + 20 μ A 0.079 % of reading + 41 μ A 0.16 % of reading + 78 μ A 0.32 % of reading + 0.16 mA	Comparison to 5522A Multi Product Calibrator



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current Source ¹	(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	0.16 % of reading + 0.13 mA 0.042 % of reading + 0.1 mA 0.47 % of reading + 0.8 mA 1.9 % of reading + 3.9 mA 0.048 % of reading + 1.7 mA 0.079 % of reading + 1.7 mA 2.4 % of reading + 1.7 mA 0.094 % of reading + 3.9 mA 0.12 % of reading + 4 mA 2.4 % of reading + 4 mA	Comparison to 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	21 μΩ/Ω 0.11 μΩ/Ω 0.83 μΩ/Ω 8.3 mΩ/Ω 83 mΩ/Ω 0.83 Ω/Ω 10.3 Ω/Ω 0.17 kΩ/Ω 7.1 kΩ/Ω 0.27 MΩ/Ω 23 MΩ/Ω	Comparison to 8508A Multimeter
Resistance Measure ¹	0 Ω (0 to 30) Ω (30 to 300) Ω 300 Ω to 3 kΩ (3 to 30) kΩ (30 to 300) kΩ 300 kΩ to 3 MΩ (3 to 30) MΩ (30 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	Comparison to 3457A Multimeter
Resistance Measure ¹	300 MΩ to 1 GΩ	19 % of reading + 1.4 MΩ	Comparison to 3457A Multimeter



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance Measuring Instruments	0 Ω	40 μΩ	Comparison to 5700A Multi Product Calibrator
	1 Ω	86 μΩ/Ω + 8.6 μΩ	
	1.9 Ω	86 μΩ/Ω + 7.6 μΩ	
	10 Ω	26 μΩ/Ω + 8.6 μΩ	
	19 Ω	24 μΩ/Ω + 8.6 μΩ	
	100 Ω	16 μΩ/Ω + 58 μΩ	
	190 Ω	16 μΩ/Ω + 58 μΩ	
	1 kΩ	12 μΩ/Ω + 0.58 mΩ	
	1.9 kΩ	12 μΩ/Ω + 0.58 mΩ	
	10 kΩ	12 μΩ/Ω + 7.6 mΩ	
	19 kΩ	12 μΩ/Ω + 7 mΩ	
	100 kΩ	13 μΩ/Ω + 58 mΩ	
	190 kΩ	13 μΩ/Ω + 71 mΩ	
	1 MΩ	21 μΩ/Ω + 0.58 Ω	
	1.9 MΩ	20 μΩ/Ω + 0.58 Ω	
10 MΩ	37 μΩ/Ω + 54 Ω		
19 MΩ	44 μΩ/Ω + 52 Ω		
100 MΩ	0.11 mΩ/Ω + 0.94 kΩ		
Resistance Measuring Instruments ¹	(0 to 11) Ω	54 μΩ/Ω + 0.8 mΩ	Comparison to 5522A Multi Product Calibrator
	(11 to 33) Ω	46 μΩ/Ω + 1.2 mΩ	
	(33 to 110) Ω	35 μΩ/Ω + 1.1 mΩ	
	(110 to 330) Ω	26 μΩ/Ω + 1.8 mΩ	
	330 Ω to 1.1 kΩ	24 μΩ/Ω + 1.8 mΩ	
	(1.1 to 3.3) kΩ	25 μΩ/Ω + 18 mΩ	
	(3.3 to 11) kΩ	24 μΩ/Ω + 18 mΩ	
	(11 to 33) kΩ	25 μΩ/Ω + 17 mΩ	
	(33 to 110) kΩ	24 μΩ/Ω + 0.17 Ω	
	110 kΩ to 1.1 MΩ	27 μΩ/Ω + 1.7 Ω	
	(1.1 to 3.3) MΩ	49 μΩ/Ω + 25 Ω	
	(3.3 to 11) MΩ	0.1 mΩ/Ω + 41 Ω	
	(11 to 33) MΩ	0.21 mΩ/Ω + 2 kΩ	
	(33 to 110) MΩ	0.4 mΩ/Ω + 2.3 kΩ	
	(110 to 330) MΩ	2.4 mΩ/Ω + 78 kΩ	
(330 to 1 100) MΩ	12 mΩ/Ω + 0.39 MΩ		

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance Simulation of RTD Temperature Measuring Instrumentation	Pt 385, 100Ω		Comparison to 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		



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance Simulation of RTD Temperature Measuring Instrumentation	Pt 385, 1000 Ω		Comparison to 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	
	Ni 120, 120 Ohm		
	(-80 to 0) °C	0.08°C	
	(0 to 100) °C	0.08°C	
	(100 to 260) °C	0.12°C	
Source and Measure Resistance Simulation of RTD Temperature Measuring Instrumentation ¹	Pt 385, 100Ω		Comparison to 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		
Resistance Simulation of RTD Temperature Measuring Instrumentation ¹	Pt385, 500Ω		Comparison to 725 Process Calibrator
	(-200 to 500) °C	0.36 °C	
	(500 to 630) °C	0.47 °C	
	Pt 385, 1 000 Ω		
	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		



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	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 % of reading + 0.58 GΩ	Comparison to 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	Comparison to 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	Comparison to 3457A/189 Multimeter
DC High Voltage Measure ¹	(0 to 10) kV	5.8 mV/V + 4.0 V	Comparison to 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	Comparison to 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 μV 8.9 μV/V + 6.6 μV 11 μV/V + 61 μV 15 μV/V + 0.13 mV 15 μV/V + 1.4 mV	Comparison to 5522A Multi Product Calibrator

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage Measure	<200 mV		Comparison to 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 μ V	
	(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		



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage Measure ¹	<30 mV		Comparison to 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 + 4.7 V		
(1 to 10) kHz	0.47 % of reading + 4.7 V		



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC High Voltage Measure ¹	(0 to 10) kV (50 to 60) Hz	1.2 % of reading + 6.6 V	Comparison to 149-10A 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 100v 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	Comparison to 5700A/5522A Multi Product Calibrator



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage Source	220 mV to 2.2 V		Comparison to 5700A/5522A 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		



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage Source ¹	(1 to 33) mV		Comparison to 5522A Multi Product Calibrator
	(10 to 45) Hz	0.091 % of reading + 4.9 μV	
	45 Hz to 10 kHz	0.017 % of reading + 4.8 μV	
	(10 to 20) kHz	0.02 % of reading + 4.8 μV	
	(20 to 50) kHz	0.08 % of reading + 5 μV	
	(50 to 100) kHz	0.28 % of reading + 10 μV	
	(100 to 450) kHz	0.63 % of reading + 39 μV	
	(33 to 330) mV		
	(10 to 45) Hz	0.026 % of reading + 6.8 μV	
	45 Hz to 10 kHz	0.012 % of reading + 7 μV	
	(10 to 20) kHz	0.014% of reading + 7 μV	
	(20 to 50) kHz	0.028% of reading + 7 μV	
	(50 to 100) kHz	0.063 % of reading + 26 μV	
	(100 to 500) kHz	0.16 % of reading + 61 μV	
	330 mV to 3.3 V		
	(10 to 45) Hz	0.024 % of reading + 44 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 + 43 μV	
	(50 to 100) kHz	0.055 % of reading + 0.1 mV	
	(100 to 500) kHz	0.19 % of reading + 0.48 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 + 0.48 mV		
(20 to 50) kHz	0.028 % of reading + 0.48 mV		
(50 to 100) kHz	0.07 % of reading + 1.3 mV		
(33 to 330) V			
45 Hz to 1kHz	0.16 % of reading + 1.8 mV		
(1 to 10) kHz	0.016 % of reading + 4.8 mV		
(10 to 20) kHz	0.019 % of reading + 4.8 mV		
(20 to 50) kHz	0.024 % of reading + 4.7 mV		
(50 to 100) kHz	0.16 % of reading + 39 mV		
(330 to 1 000) V			
45 Hz to 1kHz	0.024 % of reading + 7.9 mV		
(1 to 5) kHz	0.019 % of reading + 7.9 mV		
(5 to 10) kHz	0.024 % of reading + 8 mV		



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Millivolt Simulation of Thermocouple Temperature Measuring Instrumentation	Type B		Comparison to 5522A Multi Product Calibrator
	(600 to 800) °C	0.44 °C	
	(800 to 1 000) °C	0.34 °C	
	(1 000 to 1 500) °C	0.3 °C	
	(1 550 to 1 820) °C	0.33 °C	
	Type C		
	(0 to 150) °C	0.3 °C	
	(150 to 650) °C	0.26 °C	
	(650 to 1 000) °C	0.31 °C	
	(1 000 to 1 800) °C	0.5 °C	
	(1 800 to 2 316) °C	0.84 °C	
	Type E		
	(-250 to -100) °C	0.5 °C	
	(-100 to -25) °C	0.16 °C	
	(-25 to 350) °C	0.14 °C	
	(350 to 650) °C	0.16 °C	
	(650 to 1 000) °C	0.21 °C	
	Type J		
	(-210 to -100) °C	0.27 °C	
	(-100 to -30) °C	0.16 °C	
	(-30 to 150) °C	0.14 °C	
	(150 to 760) °C	0.17 °C	
	(760 to 1 200) °C	0.23 °C	
	Type K		
(-200 to -100) °C	0.33 °C		
(-100 to -25) °C	0.18 °C		
(-25 to 120) °C	0.16 °C		
(120 to 1 000) °C	0.26 °C		
(1 000 to 1 372) °C	0.4 °C		
Type L			
(-200 to -100) °C	0.37 °C		
(-100 to 800) °C	0.26 °C		
(800 to 900) °C	0.17 °C		
Type N			
(-200 to -100) °C	0.4 °C		
(-100 to -25) °C	0.22 °C		
(-25 to 120) °C	0.19 °C		
(120 to 410) °C	0.18 °C		
(410 to 1 300) °C	0.27 °C		



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Millivolt Simulation of Thermocouple Temperature Measuring Instrumentation	Type R (0 to 250) °C	0.48 °C	Comparison to 5522A Multi Product Calibrator
	(250 to 400) °C	0.28 °C	
	(400 to 1 000) °C	0.26 °C	
	(1 000 to 1 767) °C	0.3 °C	
	Type S (0 to 250) °C	0.47 °C	
	(250 to 1 000) °C	0.36 °C	
	(1 000 to 1 400) °C	0.37 °C	
	(1 400 to 1 767) °C	0.46 °C	
	Type T (-250 to -150) °C	0.63 °C	
	(-150 to 0) °C	0.24 °C	
	(0 to 120) °C	0.16 °C	
	(120 to 400) °C	0.14 °C	
	Type U (-200 to 0) °C	0.56 °C	
(0 to 600) °C	0.27 °C		
Source and Measure Millivolt Simulation of Thermocouple Temperature Measuring Instrumentation ¹	Type B (600 to 800) °C	2.2 °C	Comparison to 725 Process Calibrator
	(800 to 1 000) °C	1.8 °C	
	(1 000 to 1 800) °C	1.4 °C	
	Type E (-200 to 0) °C	0.9 °C	
	(0 to 950) °C	0.7 °C	
	Type J (-200 to 0) °C	1 °C	
	(0 to 1 200) °C	0.7 °C	
	Type K (-200 to 0) °C	1.2 °C	
	(0 to 1370) °C	0.7 °C	
	Type L (-200 to 0) °C	0.85 °C	
	(0 to 900) °C	0.7 °C	
	Type N (-200 to 0) °C	1.5 °C	
	(0 to 400) °C	0.9 °C	



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Source and Measure Millivolt Simulation of Thermocouple Temperature Measuring Instrumentation ¹	Type R (-20 to 0) °C	2.5 °C	Comparison to 725 Process Calibrator
	(0 to 500) °C	1.8 °C	
	(500 to 1 750) °C	1.4 °C	
	Type S (-20 to 0) °C	2.5 °C	
	(0 to 500) °C	1.8 °C	
	(500 to 1 750) °C	1.5 °C	
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 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	(0.22 to 0.4) nF	0.4 % of reading + 7.8 pF	Comparison to 5522A Multi Product Calibrator
	(0.4 to 1.1) nF	0.4% of reading + 9.7 pF	
	(1.1 to 3.3) nF	0.4 % of reading + 9.7 pF	
	(3.3 to 11) nF	0.21 % of reading + 0.059 nF	
	(11 to 110) nF	0.17 % of reading + 0.059 nF	
	(110 to 330) nF	0.21 % of reading + 0.63 nF	
	(0.33 to 1.1) µF	0.21 % of reading + 5.9 nF	
	(1.1 to 3.3) µF	0.21 % of reading + 6.3 nF	
	(3.3 to 11) µF	0.21 % of reading + 59 nF	
	(11 to 33) µF	0.32 % of reading + 63 nF	
	(33 to 110) µF	0.38 % of reading + 0.59 µF	
	(110 to 330) µF	0.37 % of reading + 0.63 µF	
DC Power Source ¹ PF = 1	(0 to 90) W	0.018 % of reading + 6 mW	Comparison to 5522A Multi Product Calibrator
	(90 to 150) W	0.018 % of reading + 6 mW	
	(150 to 600) W	0.018 % of reading + 6 mW	
	600 W to 6 kW	0.055 % of reading + 60 mW	
	(6 to 12) kW	0.055 % of reading + 0.58 W	



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Power Source ¹ (45 to 65) Hz PF = 1, Single Phase	(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 + 5.8 mW 0.071 % of reading + 5.8 mW 0.071 % of reading + 5.8 mW 0.079 % of reading + 58 mW 0.0.79 % of reading + 0.58 W	Comparison to 5522A Multi Product Calibrator
AC Power Source ¹ 400 Hz PF = 1, Single Phase	(0.1 to 2 000) W	0.14 % of reading + 0.59 W	Comparison to 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 10 kHz (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	Comparison to Standard Air Capacitor
LCR Meters ¹ Resistance (100 to 999.9) Hz 1 kHz (>1 to 100) kHz (100 to 999.9) Hz 1 kHz >1 kHz to 100 kHz (100 to 999.9) Hz 1 kHz (>1 to 100) kHz (100 to 999.9) Hz 1 kHz 1 kHz	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	Comparison to Decade Resistance Box



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
LCR Meters ¹ Inductance 1 000 Hz	1 μH 10 μH 100 μH 1 mH 10 mH 100 mH 1 H 10 H	0.0012 μH 0.0012 μH 0.12 μH 0.0012 mH 0.012 mH 0.12 mH 0.0012 H 0.012 H	Decade Inductance
AC Inductance Measure/Decade Inductor ¹	(100 to 999.99) μH (1 to 9.99) mH (10 to 99.99) mH (100 to 999.99) mH (1 to 10) H	0.24 μH 2.6 μH 0.046 mH 0.12 mH 1.8 mH	Comparison to LCR HiTester Hioki 3522-50 LCR Meter
AC Capacitance Measure/Decade Capacitance ¹	(100 to 999.99) pF (1 to 9.99) nF (10 to 99.99) nF (100 to 999.99) nF (1 to 10) μF	0.19 pF 1.00 pF 9.56 pF 0.095 nF 0.95 nF	Comparison to LCR HiTester Hioki 3522-50 LCR Meter
AC Resistance Measure/Decade Resistance ¹	(10 to 99.99) mΩ (100 to 999.99) mΩ (1 to 9.99) Ω (10 to 99.99) Ω (100 to 999.99) Ω (1 to 10) kΩ	0.012 mΩ 0.11 mΩ 1.1 mΩ 9.7 mΩ 0.097 Ω 0.97 Ω	Comparison to LCR HiTester Hioki 3522-50 LCR Meter
Oscilloscopes DC Signal 50 Ω Impedance 1 MΩ Impedance Square Wave Signal 50 Ω at 1 kHz Source 1 MΩ at 1 kHz Source Leveled Sine Wave Amplitude: 5 mVp-p to 5.5 Vp-p	(0 to ± 6.6) V (0 to ± 130) V 1 mVp-p to 6.6 Vp-p 1 mVp-p to 130 Vp-p 5 mVp-p to 5.5 Vp-p (50 kHz Reference) (50 kHz to 100 MHz) (100 to 300 MHz) (300 to 600 MHz)	0.3 % of reading + 47 μV 0.12 % of reading + 47 μV 0.3 % of reading + 47 μV 0.12 % of reading + 47 μV 2.4 % of reading + 347 μV 4.1 % of reading + 347 μV 4.7 % of reading + 347 μV 7 % of reading + 347 μV	Comparison to Fluke 5522A Multi Product Calibrator

Electrical – DC/Low Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Oscilloscopes Time Marker into 50 Ω ²	5 s to 50 ms 20 ms to 2 ns	(23 + t*1 000) ps 2.9 ps	Comparison to Fluke 5522A Multi Product Calibrator
Rise Time	≤ 300 ps	30 ps	
Gauss Tesla Meter	20 mT 100 mT 1 000 mT	0.23 mT 0.87 mT 5.8 mT	Comparison to Reference Magnets

Length – Dimensional Metrology

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
External Micrometers ¹ Linearity	(0 to 300) mm (300 to 600) mm (600 to 1 000) mm	0.1 μm 1 μm 2 μm	Comparison to Gauge Block
External Micrometers ¹ Flatness Up to 25 mm diameter	(0 to 0.5) μm	0.2 μm	Comparison to Optical Parallel or Optical Flat
External Micrometers ¹ Parallelism Up to 50 mm diameter	(0 to 0.5) μm	0.2 μm	Comparison to Optical Parallel
Calipers ¹	(0 to 1 000) mm (1 000 to 2 000) mm	1 μm 20 μm	Comparison to Gauge Block and Caliper Checker
(Digital/Dial) Caliper Gauge ¹	(0 to 150) mm	0.001 mm	Comparison to Gauge Block or Ring Gauge
Depth Micrometers ¹	(0 to 300) mm	1 μm	Comparison to Gauge Block
Stick/ Inside Micrometers	(0 to 600) mm	1 μm	Comparison to Universal Length Measuring Machine (ULM)
Stick/ Inside Micrometers ¹	(0 to 1 000) mm	3 μm	Comparison to Gauge Blocks
Internal Micrometers ¹ 2 leg type	(0 to 200) mm	1 μm	Comparison to Ring Gauge or Gauge Block
Micrometer Heads	(0 to 100) mm	1 μm	Comparison to Universal Length Measuring Machine (ULM)

Length – Dimensional Metrology

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Micrometer Heads ¹	(0 to 50) mm	1 μm	Comparison to Gauge Blocks
Calibration Testers ¹	(0 to 100) mm	0.3 μm	Comparison to Linear Gauge and Gauge Block
Calibration Testers ¹	(0 to 50) mm	0.3 μm	Comparison to Gauge Blocks and Digimatic Indicator
Height Masters ¹			
Micrometer Linearity	(0 to 25) mm	0.3 μm	Comparison to Comparison with Gauge Block
Height	(0 to 300) mm	0.6 μm	
Parallelism	(300 to 600) mm	1 μm	
	(0 to 0.02) mm	0.2 μm	
Screw Thread Micrometers ¹	(0 to 100) mm	1 μm	Comparison to Gauge Block or Pin Gauge
Caliper Checkers, Depth Micro Checker ¹	(0 to 630) mm	0.6 μm	Comparison with Gauge Block
Height Gauges ¹	(0 to 1 000) mm	3 μm	Comparison to Gauge Block or Caliper Checker
Linear Height Gauges ¹	(0 to 1 000) mm	1 μm	Comparison to Gauge Block or Caliper Checker
Setting Master for Linear Height Gauges ¹	(0 to 25) mm	0.4 μm	Comparison to Gauge Block or Universal Length Measuring Machine (ULM)
Depth Gauges ¹	(0 to 600) mm	6 μm	Comparison to Gauge Block
MU Checker	Up to 5 mm	0.2 μm	Comparison to Gauge Block or Calibration Tester
Dial Indicator ¹	Up to 10 mm	0.6 μm	Comparison to Dial Gauge Calibrator
Dial Test Indicator ¹	Up to 3 mm	0.5 μm	Comparison to Dial Gauge Calibrator
Digimatic Indicator ¹	(0 to 30) mm	1.3 μm	Comparison to Gauge Block
Linear Gauge	(30 to 100) mm	1.4 μm	
	(100 to 150) mm	2 μm	
Digital/Dial Thickness Gauges ¹	(0 to 100) mm	1 μm	Comparison to Gauge Block

Length – Dimensional Metrology

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dial Gauge Calibrator ¹	(0 to 100) mm	0.2 μm	Comparison to Gauge Block or Mu Checker
Dial Depth Gauges ¹	(0 to 200) mm	2 μm	Comparison to Gauge Block
Plain Plug Gauge / Pin Gauge (External Diameter, Enteral Length)	(0 to 25) mm	0.7 μm	Comparison to Outside Micrometer, Gage Block
Plain Plug Gauge / Pin Gauge (External Diameter, Enteral Length)	(1 to 25) mm	0.3 μm	Comparison to Universal Length Measuring Machine (ULM), Gauge Block
	(>25 to 50) mm	0.4 μm	
	(>50 to 100) mm	0.5 μm	
	(>100 to 150) mm	0.7 μm	
	(>150 to 200) mm	0.8 μm	
	(>200 to 300) mm	0.9 μm	
Plain Plug Gauge / Pin Gauge Circularity	(0 to 1) mm	0.03 μm	Comparison to Roundness Tester Machine
Thread Wires External Diameter	Up to 10 mm	0.3 μm	Comparison to Universal Length Measuring Machine (ULM), Gauge Block
Thread Wires Circularity	(0 to 1) mm	0.03 μm	Comparison to Roundness Tester Machine
Plain Ring Gauges Snap Gauge (Internal Diameter, Internal Length)	(>1 to 50) mm	0.5 μm	Comparison to Universal Length Measuring Machine (ULM), Master Ring Gauge
	(>50 to 150) mm	0.6 μm	
	(>150 to 200) mm	0.7 μm	
	(>200 to 250) mm	0.9 μm	
Plain Ring Gauges Circularity	(0 to 1) mm	0.03 μm	Comparison to Roundness Tester Machine
Threaded Plug Gauges Major Diameter	(1 to 50) mm	0.8 μm	Comparison to Universal Length Measuring Machine (ULM)
	(50 to 100) mm	1 μm	
	(100 to 150) mm	1.3 μm	
Threaded Plug Gauges Pitch Diameter	(1 to 50) mm	1.6 μm	Comparison to Universal Length Measuring Machine (ULM), Thread Wires
	(50 to 100) mm	1.6 μm	
	(100 to 150) mm	1.7 μm	
Tapered Ring Gauge Diameter	Up to 100 mm	1.3 μm	Comparison to Universal Length Measuring Machine (ULM)
Tapered Ring Gauge Step Height	Up to 75mm	2 μm	Comparison to Micrometer

Length – Dimensional Metrology

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Tapered Plug Gauge Diameter	Up to 75 mm	1.2 μm	Comparison to Universal Length Measuring Machine (ULM)
Tapered Plug Gauge Step Height	Up to 75 mm	2 μm	Comparison to Micrometer
Tapered Thread Plug Gauges Pitch Diameter	Up to 150 mm	3.1 μm	Comparison to Universal Length Measuring Machine (ULM)
Tapered Thread Plug Gauges Taper	(0 to 10) $^{\circ}$	4 $^{\circ}$	Comparison to Profile Projector
Tapered Thread Plug Gauges Step Height	Up to 75 mm	2 μm	Comparison to Micrometer
Thread Ring Gauges Minor Diameter	Up to 50 mm (50 to 100) mm	2.5 μm 3.2 μm	Comparison to Digimatic Holtest, Inside Micrometer
Thread Ring Gauges Pitch Diameter	Up to 50 mm (50 to 100) mm	1.1 μm 1.6 μm	Comparison to Universal Length Measuring Machine (ULM), Master Thread Plug Gauge
	(1 to 3) mm	0.9 μm	
Tapered Thread Ring Gauges Step Height	Up to 75 mm	2 μm	Comparison to Micrometer
Tapered Thread Ring Gauges Pitch Diameter	Up to 100 mm	1.6 μm	Comparison to Universal Length Measuring Machine (ULM), Probing System
Feeler Gauges/ Shim Stock/ Calibration Foil ¹	Up to 10 mm	0.3 μm	Comparison to Universal Length Measuring Machine (ULM) Gauge Block
Feeler Gauges/ Shim Stock/ Calibration Foil ¹	Up to 10 mm	0.6 μm	Comparison to Outside Micrometer, Gauge Block
Coating Thickness Gauge	Up to 1 500 μm	0.9 μm	Comparison to Coating Thickness Standard
Surface Plates ¹ Overall Flatness Local Area Flatness (Repeat Reading)	Up to 4 m Diagonal Up to 0.1 μm	1.5 μm 1 μm	Comparison to Planekator (Straight Edge) or Mu-Checker Repeat-O-Meter

Length – Dimensional Metrology

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Dial Gauge Stands ¹ Flatness	Up to 1 mm	0.3 µm	Comparison to Mu-Checker or Dial Test Indicator or Optical Flats
Profile Projectors ¹			Comparison to
X-Y axis Linearity	(0 to 50) mm	1.4 µm	Glass Scale
	(50 to 100) mm	2.1 µm	
	(100 to 200) mm	3 µm	
	(200 to 300) mm	3.4 µm	
	(300 to 400) mm	4.6 µm	
X-Y axis Linearity	(400 to 500) mm	4.9 µm	Gauge Block
	(0 to 50) mm	0.6 µm	
	(50 to 100) mm	0.8 µm	
	(100 to 200) mm	1.5 µm	
	(200 to 300) mm	2.1 µm	
Measuring Microscopes ¹	(300 to 400) mm	2.7 µm	Comparison to
	(400 to 500) mm	3.3 µm	
	(0 to 10) mm	0.8 µm	
	(10 to 50) mm	1.4 µm	
	(50 to 100) mm	2.1 µm	
X-Y axis Linearity	(100 to 200) mm	3.0 µm	Glass Scale
	(200 to 300) mm	3.4 µm	
	(300 to 400) mm	4.6 µm	
	(400 to 500) mm	4.9 µm	
	(0 to 50) mm	0.6 µm	
(50 to 100) mm	0.8 µm		
(100 to 200) mm	1.5 µm		
(200 to 300) mm	2.1 µm		
(300 to 400) mm	2.7 µm		
X-Y axis Linearity	(400 to 500) mm	3.3 µm	Pin Gauge
	(0 to 25) mm	0.8 µm	
Z axis Linearity	(25 to 50) mm	1.1 µm	Gauge Block
	(0 to 50) mm	0.6 µm	
	(50 to 100) mm	0.8 µm	
	(100 to 200) mm	1.5 µm	
	(200 to 300) mm	2.1 µm	

Length – Dimensional Metrology

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Profile Projectors ¹ Magnification)	5X 10X 20X 50X 100X	0.04 % magnification 0.02 % magnification 0.01 % magnification 0.01 % magnification 0.01 % magnification	Comparison to Master Ball
Rotation Angle	(0 to 360) ^o	2'	Crosshair Angle
Bore Gauges	(0 to 300) mm	1 μm	Comparison to Height Setting Micrometer or Micrometer
Holtest / Borematic	(2 to 50) mm (50 to 100) mm (100 to 150) mm	1 μm 1 μm 2 μm	Comparison to Setting Ring Gauge
Straight Edges ¹	Up to 1 000 mm	0.2 μm	Comparison to Mu-Checker or Dial Test Indicator
Steel Rules	(0 to 1 500) mm (1 500 to 2 000) mm	0.01 mm 0.06 mm	Comparison to Linear Scale or Profile Projector
Measuring Tape / Textile Tape	(0 to 5) m (>5 to 10) m (>10 to 20) m (>20 to 50) m	0.14 mm 0.29 mm 0.57 mm 1.43 mm	Comparison to Linear Scale
Squares ¹ To 450 mm / 18 in Lengths Parallelism/Straightness Squareness	(0 to 10) mm (0 to 450) mm	0.7 μm 3 μm	Comparison to Granite Square
Universal Length Measuring Machines (ULM) ¹	(0 to 50) mm (>50 to 100) mm (>100 to 125) mm (>125 to 150) mm (>150 to 175) mm (>175 to 200) mm (>200 to 250) mm (>250 to 300) mm (>300 to 400) mm (>400 to 500) mm	0.15 μm 0.17 μm 0.35 μm 0.36 μm 0.36 μm 0.38 μm 0.41 μm 0.43 μm 0.48 μm 0.55 μm	Comparison to Gauge Block
Micrometer Setting (End) Rods	(25 to 1 00) mm (100 to 1 000) mm	0.3 μm 0.5 μm	Comparison to Mu-Checker and Gauge Block
Bevel Protractors Up to 300 mm	0 to 360 ^o	3'	Comparison to Profile Projector or Angle Gauge

Length – Dimensional Metrology

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Inclinometers	(0 to 90)°	0.05°	Comparison to Angle Gauge
Analog Levels to 300 mm	(0 to 0.10) mm/m	0.01 mm/m	Comparison to Sine bar and Gauge Block
Gauge Block Comparators ¹	(0.5 to 100) mm	0.05 μm	Comparison to Gauge Block
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 ¹ (Dissimilar & Similar Material)	(>100 to 125) mm (>125 to 150) mm (>150 to 175) mm	0.12 μm 0.13 μm 0.15 μm	Comparison to Gauge Block Comparator or Gauge Block Grade K
Long Gage Blocks ¹ (Dissimilar & Similar Material)	(>100 to 125) mm (>125 to 150) mm (>150 to 175) mm (>175 to 200) mm (>200 to 250) mm (>250 to 300) mm (>300 to 400) mm (>400 to 500) mm	0.2 μm 0.21 μm 0.22 μm 0.24 μm 0.27 μm 0.3 μm 0.37 μm 0.45 μm	Comparison to Universal Length Measuring Machine (ULM) or Gauge Block Grade K
Angle Block	(0 to 360)°	15"	Comparison to CMM
Optical Flats/Parallels Flatness Thickness Parallelism	To 10 μm To 1 mm	0.05 μm 0.3 μm 0.04 μm	Comparison to Optical Flat
Sine Bars Roll Distance Parallelism	(25 to 300) mm (0 to 0.01) mm	0.4 μm 1 μm	Comparison to Gauge Block and Dial Test Indicator Universal Length Measuring Machine (ULM)
Vee Blocks ¹ To 150 mm Lengths Parallelism of Top Parallelism of Vee Squareness of Sides Centrality of Vee	(0 to 0.01) mm	1 μm	Comparison to Dial Test Indicator
Parallels Straightedge ¹	Up to 1 000 mm	1.7 μm	Comparison to Dial Test Indicator and Surface Plate

Length – Dimensional Metrology

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Bench Centers ¹ Height Centrality	Up to 1 000 mm Up to 200 mm	1.4 µm	Comparison to Concentric Gauge
Surface Roughness Testers ¹	Up to 1 000 µm	0.019 µm	Comparison to Roughness Standard
Surface Roughness Standards	Up to 15 µm	0.02 µm	Comparison to Roughness Tester
Roundness Measuring Machines ¹ Relative error of Magnification Rotation accuracy in radius Rotation accuracy in axial	(0 to 20) mm (0 to 5) mm (0 to 5) / 75 mm	1.2 % magnification 0.027 µm 0.044 µm	Comparison to Glass Hemisphere, Gauge Block, Optical Flat, Magnification Checker, Ring Gauge
Magnification Checker (for Roundness Machines)	(0 to 0.4) mm	0.3 µm	Comparison to Mu Checker
Contour Measuring Machines ¹ Radius	Z-Axis (0 to 40) mm X-Axis (0 to 100) mm Up to 12.5 mm	2.4 µm 2.4 µm 0.5 µm	Comparison to Contour Standard, Master Ball Unit
Dimensional Air Gauges ¹	Up to 5 mm	0.5 µm	Comparison to Gauge Block or Dial Gauge
Coordinate Measuring Machines ¹ Length Probing Angle	X: (0 to 1 500) mm Y: (0 to 1 500) mm Z: (0 to 1 000) mm (0 to 10) µm (0 to 90) °	1.5 µm 0.04 µm 4 ''	Comparison to Gauge Blocks, Step Gage, Sphere
Glass Scale	(0 to 100) mm (0 to 200) mm (0 to 300) mm	1.4 µm 1.6 µm 2.1 µm	Comparison to Profile Projector
Parallel Bar ¹	Up to 300 mm	0.8 µm	Comparison to Dial Test or Micrometer
Laser Scan Micrometer ¹	(0 to 25) mm	0.5 µm	Comparison to Pin Gauge
Linear Scale ¹	(0 to 1 500) mm	0.023 mm	Comparison to Long Gauge Block

Mass and Mass Related

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Scales and Balances ^{1,4}	(0 to 20) g	0.026 mg	Comparison to Standard Weight
	Up to 200 g	0.12 mg	
	Up to 400 g	0.72 mg	
	Up to 1 000 g	0.0019 g	
	Up to 2 000 g	0.0029 g	
	Up to 5000 g	0.0064 g	
	Up to 10 kg	0.01 g	
	Up to 50 kg	0.1 g	
	Up to 300 kg	0.01 kg	
	Up to 1 000 kg	0.030 kg	
	Up to 2 000 kg	0.036 kg	
Torque Wrenches ¹	(0 to 10) N·m	0.014 N·m	Comparison to Torque Transducer
	(10 to 50) N·m	0.3 N·m	
	(50 to 200) N·m	0.61 N·m	
	(200 to 500) N·m	1.5 N·m	
	(500 to 1 000) N·m	3.6 N·m	
	Up to 2 000 N·m	26 N·m	
Torque Meter / Gauge ¹	Up to 2 N·m	0.06 cN·m	Comparison to Torque Arm or Torque Transducer
	Up to 10 N·m	0.006 N·m	
	(10 to 100) N·m	0.013 N·m	
	(100 to 1 000) N·m	0.06 N·m	
Force Testing Machines ¹ and Load Cells Compression and Tension ¹	(0 to 10) N	0.006 N	Direct measurement to reference load cell or Standard Weight
	(10 to 100) N	0.043 N	
	(100 to 1 000) N	0.5 N	
	(1 to 5) kN	0.003 kN	
	(5 to 10) kN	0.005 kN	
	(10 to 50) kN	0.009 kN	
	(50 to 100) kN	0.06 kN	
	(100 to 250) kN	0.08 kN	
(250 to 500) kN	0.42 kN		
Force Gauges	(0 to 100) N	0.006 N	Comparison to Reference Masses
	(100 to 200) N	0.06 N	
	(200 to 500) N	0.06 N	
	(500 to 1 000) N	0.6 N	
	(1 000 to 5 000) N	0.9 N	
Universal Length Measuring Machines (ULM) ¹ Force	(0 to 5) N	0.1 N	Comparison to Load Cell, Force Gage

Mass and Mass Related

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Rockwell Hardness Testers ¹	Force (15 to 150) kgf Indenter Angle 120° Indenter Radius 0.2 mm Indenter Ball Diameter 1.587 5 mm 3.175 mm Hardness (10 to 100) HRBW (20 to 95) HRA (10 to 70) HRC (70 to 94) HR15N (67 to 93) HR15T (42 to 86) HR30N (29 to 82) HR30T (20 to 77) HR45N (10 to 72) HR45T	0.12 kgf 3' 0.003 mm 0.001 5 mm 0.001 5 mm 0.7 HRBW 0.6 HRA 0.4 HRC 0.5 HR15N 0.9 HR15T 0.9 HR30N 0.7 HR30T 0.7 HR45N 0.7 HR45T	Direct or Indirect Verification Hardness Test Block
Brinell Hardness Testers ¹	(100 to 600) HBW	4 HBW	Indirect Verification Hardness Test Block
Vickers Hardness Testers ¹	Force (100 to 50 000) gf Indenter Angle (136, 148.11)° Indenter Length (0 to 1 000) µm Hardness (100 to 1 000) HV	0.9 gf 3' 0.6 µm 3.7 HV	Direct or Indirect Verification Loadcell, Micrometer, Profile Projector, Glass Scale
Hardness Test Block ¹ Rockwell	(20 to 95) HRA (10 to 100) HRB (10 to 70) HRC Up to 100 HR15N Up to 100 HR15T Up to 100 HR30N Up to 100 HR30T Up to 100 HR45N Up to 100 HR45T	0.8 HRA 1.9 HRB 0.9 HRC 0.8 HR15N 0.7 HR15T 1.3 HR30N 1 HR30T 1.3 HR45N 0.8 HR45T	Comparison to Rockwell Hardness Tester Machine

Mass and Mass Related

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Hardness Test Block ¹ Vicker	(50 to 450) HV0.1 (50 to 900) HV0.2 (50 to 1 000) HV0.3 (50 to 1 500) HV0.5 (50 to 1 500) HV1 (50 to 1 500) HV5 (50 to 1 500) HV10	8.4 HV 9.4 HV 7 HV 4.5 HV 4 HV 6.6 HV 7.4 HV	Comparison to Micro Hardness Tester Machine
Durometer Force (expressed as degrees or percentage of scale pointer rotation)	(0 to 100) %	0.065 %	Comparison to Standard Weight
Pressure/ Vacuum Gauges/ Standard Pressure Gauge/Digital Test Gauge ¹	(-1 to 0) bar (0 to 0.7) bar (0.7 to 70) bar	0.006 bar 0.12 mbar 2.2 mbar	Comparison to Pneumatic Pressure Calibrator
Pressure/ Vacuum Gauges/ Standard Pressure Gauge/Digital Test Gauge ¹	(70 to 700) bar (700 to 1 500) bar (10 to 1 000) bar	0.09 bar 0.6 bar 0.038 bar	Comparison to Hydraulic Gage Comparison / Dead Weight Tester
Mass Artifacts	(1, 2, 5) mg 10 mg 20 mg 50 mg 100 mg (200, 500) mg, 1 g	0.008 mg 0.009 mg 0.009 mg 0.01 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 1.2 mg 1.3 mg 2 mg 5 mg 10 mg	OIML R111:2004 ABBA Method to Class F1
Mass Artifacts	20 kg 50 kg	61 mg 74 mg	OIML R111:2004 ABBA Method to Class F2



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Mass and Mass Related

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
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	Comparison to Standard Flow Meter
Volumetric Flow Rate ¹ Gas	(0.01 to 10) SCCM (10 to 500) SCCM (0.5 to 50) LPM (50 to 500) LPM	0.051 ml/min 2.8 ml/min 0.37 l/min 4.3 l/min	Comparison to Standard Flow Meter
Burette	(1 to 10) ml (>10 to 25) ml (>25 to 50) ml (>50 to 100) ml	0.003 7 ml 0.006 5 ml 0.01 ml 0.019 ml	Comparison to Precision Balance ASTM E542-01
Graduated Pipette	(0.1 to 1) ml (>1 to 5) ml (>5 to 10) ml (>10 to 25) ml	0.002 6 ml 0.003 ml 0.004 1 ml 0.006 7 ml	Comparison to Precision Balance ASTM E542-01
Measuring Cylinder	(1 to 25) ml (>25 to 50) ml (>50 to 100) ml (>100 to 200) ml (>200 to 500) ml (>500 to 1 000) ml (>1 000 to 2 000) ml	0.015 ml 0.021 ml 0.033 ml 0.046 ml 0.083 ml 0.17 ml 0.33 ml	Comparison to Precision Balance ASTM E542-01
Volumetric Flask	(1 to 10) ml (>10 to 25) ml (>25 to 50) ml (>50 to 100) ml (>100 to 200) ml (>200 to 500) ml (>500 to 1 000) ml (>1 000 to 2 000) ml	0.006 ml 0.006 8 ml 0.011 ml 0.018 ml 0.029 ml 0.064 ml 0.13 ml 0.26 ml	Comparison to Precision Balance ASTM E542-01
Volumetric Pipette	(1 to 5) ml (>5 to 10) ml (>10 to 25) ml (>25 to 50) ml (>50 to 100) ml	0.003 ml 0.003 9 ml 0.006 5 ml 0.011 ml 0.017 ml	Comparison to Precision Balance ASTM E542-01
Micropipette	(10 to 100) µl (>100 to 500) µl (>500 to 1 000) µl (>1 000 to 5 000) µl (>5 000 to 10 000) µl	0.12 µl 0.21 µl 0.5 µl 0.74 µl 1.1 µl	Comparison to Precision Balance ISO 8655-6



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Mass and Mass Related

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Syringes	(10 to 100) μ l (>100 to 500) μ l (>500 to 1 000) μ l (>1 000 to 5 000) μ l (>5 000 to 10 000) μ l	0.13 μ l 0.23 μ l 0.52 μ l 0.78 μ l 1.3 μ l	Comparison to Precision Balance
Beaker / Erlenmeyer	(1 to 25) ml (>25 to 50) ml (>50 to 100) ml (>100 to 250) ml (>250 to 500) ml (>500 to 1 000) ml (>1 000 to 2 000) ml	0.031 ml 0.043 ml 0.066 ml 0.11 ml 0.14 ml 0.27 ml 0.53 ml	Comparison to Precision Balance
Dispenser	(1 to 5) ml (>5 to 10) ml (>10 to 25) ml (>25 to 50) ml (>50 to 100) ml (>100 to 200) ml	0.000 7 ml 0.001 1 ml 0.002 1 ml 0.003 4 ml 0.006 ml 0.014 ml	Comparison to Precision Balance
Viscosity Cup / Dip-type Viscosity cup	(0 to 250) sec	0.49 sec	Comparison to Viscosity standard oil, Stopwatch, Digital Thermometer
Rotational Viscometer	(5 to 100) mPa·s (100 to 1 000) mPa·s (1 000 to 5 000) mPa·s (5 000 to 12 500) mPa·s (12 500 to 30 000) mPa·s (30 000 to 60 000) mPa·s (60 000 to 100 000) mPa·s	0.57 % of reading 0.65 % of reading 0.74 % of reading 0.81 % of reading 0.83 % of reading 0.81 % of reading 0.82 % of reading	Comparison to Viscosity standard oil, Digital Thermometer

Photometry and Radiometry

Bangkok, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Lux/Light Meter	(0 to 200) lux (200 to 1 000) lux (1 000 to 2 000) lux (2 000 to 36 000) lux	2.2 lux 9 lux 19 lux 56 lux	Comparison to Lux Meter
UVA Meter ¹ Wavelength (290 to 390) nm	(0 to 20) mW/cm ²	0.074 mW/cm ²	Comparison to UVA Meter

Photometry and Radiometry

Bangkok, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
UVC Meter ¹ Wavelength (200 to 290) nm	(0 to 20) mW/cm ²	0.074 mW/cm ²	Comparison to UVC Meter
Spectrometer ¹ Wavelength	219 nm 242 nm 260 nm 279 nm 287 nm 334 nm 360 nm 418 nm 447 nm 453 nm 458 nm 473 nm 537 nm 642 nm	0.18 nm	Comparison to Holmium Glass Filter
Holmium filter	431 nm 472 nm 513 nm 529 nm 573 nm 585 nm 685 nm 741 nm 749 nm 807 nm 879 nm	0.18 nm	
Spectrophotometer ¹ Photometric	235 nm 257 nm 313 nm 350 nm	0.0076 Abs	Comparison to Potassium Dichromate Filter
UV	440 nm 465 nm	0.0042 Abs	Neutral Density Glass Filter
Visible	546.1 nm 590 nm		
	635 nm		



ANSI National Accreditation Board

Photometry and Radiometry

Bangkok, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Colorimeter ^{1,6}	White Color		Comparison to Color Disk
	Observer 2°, Illuminant D65		
	L*	0.31	
	a*	0.12	
	b*	0.25	
	Y%	0.70	
	x	0.0004	
	y	0.0052	
	Observer 10°, Illuminant D65		
	L*	0.31	
	a*	0.11	
	b*	0.24	
	Y%	0.71	
	x	0.00050	
y	0.00043		
Colorimeter ^{1,6}	Black Color		Comparison to Color Disk
	Observer 2°, Illuminant D65		
	L*	0.13	
	a*	0.074	
	b*	0.13	
	Y%	0.047	
	x	0.00041	
	y	0.00064	
	Observer 10°, Illuminant D65		
	L*	0.22	
	a*	0.06	
	b*	0.13	
	Y%	0.05	
	x	0.00041	
y	0.00055		



ANSI National Accreditation Board

Photometry and Radiometry

Bangkok, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Colorimeter ^{1,6}	Red Color		Comparison to Color Disk
	Observer 2°, Illuminant D65		
	L*	0.19	
	a*	0.14	
	b*	0.17	
	Y%	0.16	
	x	0.000 84	
	y	0.000 41	
	Observer 10°, Illuminant D65		
	L*	0.19	
	a*	0.13	
	b*	0.17	
	Y%	0.16	
	x	0.000 74	
y	0.000 41		
Colorimeter ^{1,6}	Green Color		Comparison to Color Disk
	Observer 2°, Illuminant D65		
	L*	0.31	
	a*	0.25	
	b*	0.32	
	Y%	0.24	
	x	0.006 9	
	y	0.001 1	
	Observer 10°, Illuminant D65		
	L*	0.31	
	a*	0.25	
	b*	0.32	
	Y%	0.24	
	x	0.006 9	
y	0.001 1		



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Photometry and Radiometry

Bangkok, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Colorimeter ^{1,6}	Blue Color		Comparison to Color Disk
	Observer 2°, Illuminant D65		
	L*	0.31	
	a*	0.25	
	b*	0.32	
	Y%	0.24	
	x	0.006 9	
	y	0.001 1	
	Observer 10°, Illuminant D65		
	L*	0.31	
	a*	0.25	
	b*	0.32	
	Y%	0.24	
	x	0.006 9	
y	0.001 1		
Colorimeter ^{1,6}	Yellow Color		Comparison to Color Disk
	Observer 2°, Illuminant D65		
	L*	0.31	
	a*	0.25	
	b*	0.32	
	Y%	0.24	
	x	0.006 9	
	y	0.001 1	
	Observer 10°, Illuminant D65		
	L*	0.31	
	a*	0.25	
	b*	0.32	
	Y%	0.24	
	x	0.006 9	
y	0.001 1		



ANSI National Accreditation Board

Thermodynamic

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Temperature Measure ¹ System Accuracy Tests of Chambers, Ovens, Freezers, Incubators, or Refrigerators	(-40 to 100) °C (100 to 200) °C (200 to 300) °C (300 to 400) °C (400 to 600) °C	1.2 °C 1.7 °C 2.8 °C 3 °C 3.9 °C	Comparison to Datalogger with Thermocouple Sensors
Humidity Measure ¹ System Accuracy Tests of Chambers, Ovens, Freezers, Incubators, or Refrigerators	(20 to 85) %RH	3.5 %RH	Comparison to Datalogger with Humidity Sensors
Temperature Measure ¹ 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 °C 1.8 °C 3.3 °C 2.8 °C	Comparison to Datalogger with Thermocouple Sensors
Infrared (IR) Thermometers	50 °C 100 °C 200 °C 400 °C 500 °C 600 °C 800 °C 1 100 °C 1 200 °C	1.7 °C 1.8 °C 2 °C 2.9 °C 2.1 °C 3 °C 4.4 °C 2.2 °C 2.5 °C	Comparison to Blackbody Source and reference thermocouple thermometer $\epsilon = 0.95, \lambda = (8 \text{ to } 14) \mu\text{m}$
Thermohygrometers	(30 to 95) %RH @ 25 °C (15 to 45) °C @ 50 %RH	1.5 %RH 0.1 °C	Comparison to Rotronic Thermohygrometer Reference PRT with Yokogawa Display
IPRT/PRT/RTD Probe ¹	(-40 to 0) °C (0 to 150) °C (150 to 300) °C	0.012 °C 0.018 °C 0.031 °C	Comparison to Semi-SPRT and Liquid Bath / Temperature bath
	(-40 to 140) °C (140 to 600) °C	0.027 °C 0.18 °C	Comparison to Semi-SPRT and Dry Block
Dry Block Calibrators	(-20 to 650) °C	0.18 °C	Comparison to Reference PRT
Surface Type Thermocouple Based Temperature Measuring Systems ¹ (Up to 60 mm long)	(50 to 350) °C	1.3 °C	Comparison to Surface Probe Calibrator
Base Metal Thermocouple Based Temperature Measuring Systems ¹	Types E, J, K, N, & T (-20 to 95) °C (95 to 200) °C	0.23 °C 0.47 °C	Comparison to Temperature Baths



ANSI National Accreditation Board

Thermodynamic

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Base Metal Thermocouple Based Temperature Measuring Systems ¹	Types E, J, K, N, & T (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C (1 000 to 1 200) °C	0.39 °C 1 °C 2 °C 3.3 °C 4.9 °C	Comparison to Dry Block
Noble Metal Thermocouple Based Temperature Measuring Systems ¹	Types B, R, & S (-20 to 95) °C (95 to 200) °C	0.1 °C 0.15 °C	Comparison to Temperature Baths
Noble Metal Thermocouple Based Temperature Measuring Systems ¹	Types B, R, & S (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C (1 000 to 1 200) °C	0.24 °C 0.51 °C 1.5 °C 2.4 °C 4.1 °C	Comparison to Dry Block
Thermocouple Sensors ¹	Type E (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C Type J (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C Type K (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C (1 000 to 1 200) °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 3.5 °C 0.4 °C 1.1 °C 2 °C 3.3 °C 0.4 °C 1.1 °C 2 °C 3.3 °C 5 °C 0.4 °C 1.1 °C 2 °C 3.3 °C	Comparison to Dry Block

Thermodynamic

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Thermocouple Sensors ¹	Type R (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C (1 000 to 1 200) °C Type S (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C (1 000 to 1 200) °C Type T (-20 to 140) °C (140 to 400) °C	0.24 °C 0.55 °C 1.5 °C 2.4 °C 4.1 °C 0.24 °C 0.55 °C 1.5 °C 2.4 °C 4.1 °C 0.4 °C 1 °C	Comparison to Dry Block
Thermocouple Sensors ¹	Type E (-20 to 95) °C (95 to 200) °C Type J (-20 to 95) °C (95 to 200) °C Type K (-20 to 95) °C (95 to 200) °C Type N (-20 to 95) °C (95 to 200) °C Type R (-20 to 95) °C (95 to 200) °C Type S (-20 to 95) °C (95 to 200) °C Type T (-20 to 95) °C (95 to 200) °C	0.24 °C 0.47 °C 0.24 °C 0.47 °C 0.24 °C 0.47 °C 0.24 °C 0.47 °C 0.1 °C 0.16 °C 0.1 °C 0.16 °C 0.24 °C 0.47 °C	Comparison to Temperature Baths
Analog and Digital Thermometers ¹	(-20 to 140) °C (140 to 600) °C (600 to 1 200) °C	0.047 °C 0.14 °C 3 °C	Comparison to Comparison with Semi-SPRT with indicator standard thermocouple or Dry block or Liquid Bath

Thermodynamic

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Liquid in Glass Thermometers Scale Graduation: 0.1°C	(-20 to 200) °C	0.1 °C	Comparison to Reference PRT with Temperature Baths
Autoclaves ¹	(110 to 130) °C	0.73 °C	Comparison to Data Logger

Time and Frequency

Bangkok, Thailand

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Tachometers ¹ 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	Comparison to 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	Comparison to Digital Motor Monitored with non-contact Tachometer
RPM Measurement ¹	(0 to 99 900) rpm	0.083 rpm	Comparison to Tachometer
Frequency Measuring Instruments ¹ (Source)	(0.01 to 99.99) Hz (100 to 119.9) Hz (120 to 1 199.9) 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	Comparison to 5522A Multi Product Calibrator
Frequency Measuring Instruments ¹ (Measure)	0.5 Hz to 15 MHz	0.001 1 % of reading + 6 µHz	Comparison to Universal Counter
Timers and Stopwatches ¹	1 s to 120 min	0.11 s	Comparison to Frequency Counter/Timer

DIMENSIONAL MEASUREMENT

1 Dimensional

Bangkok, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Length ³	X: (0 to 680) mm	0.4 μm	Comparison to Universal Length Measuring Machine (ULM)
1D Geometric Dimensional Measurements of Jigs, Fixtures, Gauges, and First Artefacts ³	X: (0 to 700) mm Y: (0 to 600) mm Z: (0 to 600) mm	2.6 μm	Comparison to Coordinate Measuring Machine (CMM)
Length	X: (0 to 680) mm	0.4 μm	Comparison to Universal Length Measuring Machine (ULM)
Dimensional Measurements of Jigs, Fixtures, Gauges, and First Artifacts	X: (0 to 25) mm X: (25 to 250) mm	0.6 μm 2 μm	Comparison to Micrometer or Gauge Block or Linear Length Gauge or Digimatic Indicator

2 Dimensional

Bangkok, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Angle Measurements of Jigs, Fixtures, Gauges, and First Artefacts, Angle ³	(0 to 360)°	2.5'	Comparison to Profile Projector (Optical Comparator)
Dimensional Measurements of Jigs, Fixtures, Gauges, and First Artefacts	X: (0 to 250) mm Y: (0 to 150) mm	2 μm	Comparison to Profile Projector
Geometric Dimensional Measurements of Jigs, Fixtures, Gauges, First Artefacts Angle ³	(0 to 360)°	52"	Comparison to Coordinate Measuring Machine (CMM)

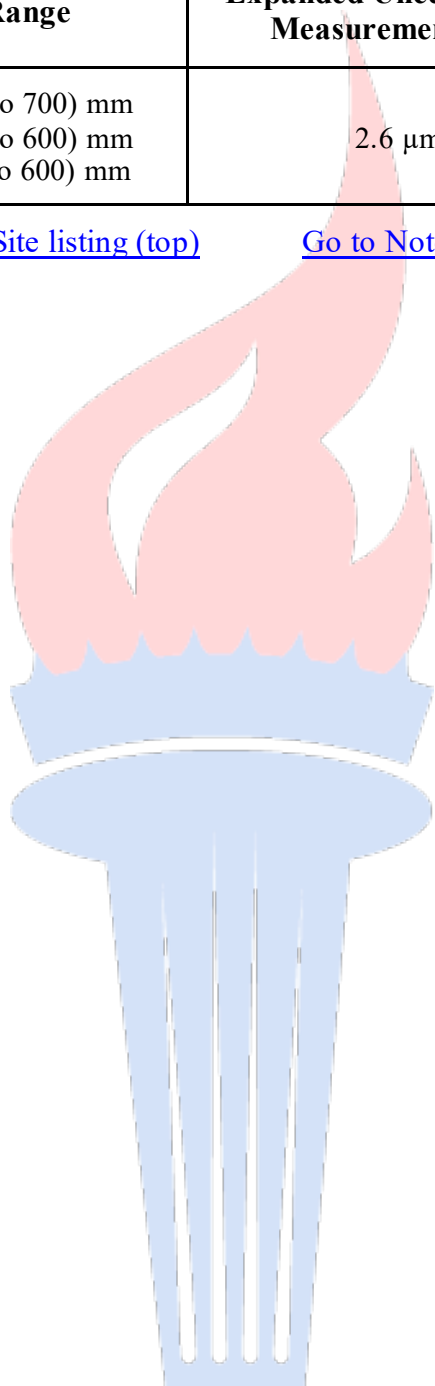
3 Dimensional

Bangkok, Thailand

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
3D Geometric Dimensional Measurements of Jigs, Fixtures, Gauges, and First Artefacts ³	X: (0 to 700) mm Y: (0 to 600) mm Z: (0 to 600) mm	2.6 μm	Comparison to Coordinate Measuring Machine (CMM)

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CALIBRATION

Chemical Quantities

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
pH Measuring Instruments ^{1,5}	4 pH 7 pH 10 pH	0.07 pH 0.07 pH 0.12 pH	Comparison to Certified Reference Material
Conductivity Measuring Instruments ^{1,5}	84 µS/cm 1 413 µS/cm 12.88 mS/cm	1.5 % of reading + 1.2 µS/cm 1.5 % of reading + 6.3 µS/cm 1.5 % of reading + 0.06 mS/cm	Comparison to Certified Reference Material
Refractometers ^{1,5}	(5, 10, 30, & 60) %Brix	0.3 %Brix	Comparison to Certified Reference Material

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance Source ¹			
10 Hz to 10 kHz	(0.22 to 0.4) nF	0.39 % of reading + 0.007 8 nF	Comparison to Multiproduct Calibrator
10 Hz to 10 kHz	(0.4 to 1.1) nF	0.39 % of reading + 0.007 9 nF	
10 Hz to 3 kHz	(1.1 to 3.3) nF	0.39 % of reading + 0.007 9 nF	
10 Hz to 1 kHz	(3.3 to 11) nF	0.2 % of reading + 0.011 nF	
10 Hz to 1 kHz	(11 to 33) nF	0.2 % of reading + 0.011 nF	
10 Hz to 1 kHz	(33 to 110) nF	0.2 % of reading + 0.011 nF	
10 Hz to 1 kHz	(110 to 330) nF	0.21 % of reading + 0.84 nF	
10 Hz to 600 Hz	(0.33 to 1.1) µF	0.2 % of reading + 1.1 nF	



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Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance Source ¹ 10 Hz to 300 Hz 10 Hz to 150 Hz 0 Hz to 120 Hz 10 Hz to 80 Hz (0 to 50) Hz (0 to 20) Hz (0 to 6) Hz (0 to 2) Hz (0 to 0.6) Hz (0 to 0.2) Hz	(1.1 to 3.3) μ F (3.3 to 11) μ F (11 to 33) μ F (33 to 110) μ F (110 to 330) μ F (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 50) mF	0.2 % of reading + 7.4 nF 0.2 % of reading + 13 nF 0.32 % of reading + 26 nF 0.35 % of reading + 0.11 μ F 0.37 % of reading + 0.84 μ F 0.35 % of reading + 1.1 μ F 0.37 % of reading + 8.4 μ F 0.35 % of reading + 11 μ F 0.59 % of reading + 24 μ F 0.86 % of reading + 78 μ F	Comparison to Multiproduct Calibrator
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	0.012 % of reading + 0.02 μ A 0.007 8 % of reading + 0.05 μ A 0.007 8 % of reading + 0.3 μ A 0.007 8 % of reading + 3 μ A 0.016 % of reading + 0.04 mA 0.03 % of reading + 0.04 mA 0.039 % of reading + 0.4 mA 0.078 % of reading + 0.6 mA	Comparison to Multiproduct Calibrator
DC Current Measure ¹	(0 to 200) μ A (0.2 to 2) mA (2 to 20) mA (20 to 200) mA (0.2 to 2) A (2 to 20) A	0.001 3 % of reading + 0.32 nA 0.001 3 % of reading + 3.2 nA 0.001 4 % of reading + 32 nA 0.004 7 % of reading + 0.63 μ A 0.018 % of reading + 13 μ A 0.039 % of reading + 0.32 mA	Comparison to Precision Digital Multimeter
DC Current Clamp Meters ¹	(0 to 16.5) A (16.5 to 55) A (55 to 150) A (150 to 550) A (550 to 1 000) A	0.01 % of reading + 58 mA 0.02 % of reading + 58 mA 0.03 % of reading + 58 mA 0.04 % of reading + 0.14 A 0.08 % of reading + 0.14 A	Comparison to Multiproduct Calibrator and Coil
AC Current Source ¹	(29 to 330) μ A (10 to 45) Hz 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (10 to 30) kHz	0.16 % of reading + 0.1 μ A 0.1 % of reading + 0.09 μ A 0.24 % of reading + 0.14 μ A 0.63 % of reading + 0.19 μ A 1.3 % of reading + 0.32 μ A	Comparison to Multiproduct Calibrator



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Source ¹	(0.33 to 3.3) mA		Comparison to Multiproduct Calibrator
	(10 to 45) Hz	0.16 % of reading + 0.15 μA	
	45 Hz to 1 kHz	0.08 % of reading + 0.2 μA	
	(1 to 5) kHz	0.16 % of reading + 0.23 μA	
	(5 to 10) kHz	0.39 % of reading + 0.28 μA	
	(10 to 30) kHz	0.78 % of reading + 0.5 μA	
	(3.3 to 33) mA		
	(10 to 45) Hz	0.14 % of reading + 2.5 μA	
	45 Hz to 1 kHz	0.04 % of reading + 1.6 μA	
	(1 to 5) kHz	0.07 % of reading + 1.7 μA	
	(5 to 10) kHz	0.16 % of reading + 2.4 μA	
	(10 to 30) kHz	0.32 % of reading + 3.2 μA	
	(33 to 330) mA		
	(10 to 45) Hz	0.14 % of reading + 0.04 mA	
	45 Hz to 1 kHz	0.04 % of reading + 0.05 mA	
	(1 to 5) kHz	0.08 % of reading + 0.05 mA	
	(5 to 10) kHz	0.16 % of reading + 0.08 mA	
	(10 to 30) kHz	0.32 % of reading + 0.16 mA	
	(0.33 to 3) A		
	(10 to 45) Hz	0.14 % of reading + 0.1309 mA	
	45 Hz to 1 kHz	0.05 % of reading + 0.94 mA	
(1 to 5) kHz	0.47 % of reading + 0.789 mA		
(5 to 10) kHz	2 % of reading + 3.9 mA		
(3 to 11) A			
(45 to 100) Hz	0.05 % of reading + 1.6 mA		
100 Hz to 1 kHz	0.08 % of reading + 1.6 mA		
(1 to 5) kHz	2.4 % of reading + 1.7 mA		
(11 to 20.5) A			
(45 to 100) Hz	0.1 % of reading + 3.9 mA		
(0.1 to 1) kHz	0.12 % of reading + 3.9 mA		
(1 to 5) kHz	2.4 % of reading + 3.9 mA		

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Measure ¹ (in laboratory)	(30 to 200) μ A 10 Hz to 10 kHz (0.2 to 2) mA 10 Hz to 10 kHz (2 to 20) mA 10 Hz to 10 kHz (20 to 200) mA 10 Hz to 10 kHz (0.2 to 2) A 10 Hz to 2 kHz (2 to 10) kHz (2 to 20.5) A 50 Hz to 2 kHz (2 to 5) kHz	0.049 % of reading + 0.019 μ A 0.029 % of reading + 0.19 μ A 0.029 % of reading + 1.9 μ A 0.028 % of reading + 19 μ A 0.057 % of reading + 0.19 mA 0.067 % of reading + 0.19 mA 0.072 % of reading + 1.9 mA 0.20 % of reading + 1.9 mA	Comparison to Precision Digital Multimeter
AC Current Measure ¹ (onsite)	(0.3 to 30) mA (20 to 45) Hz (46 to 100) Hz 101 Hz to 20 kHz (21 to 30) kHz (30 to 300) mA (20 Hz to 45) Hz (46 to 100) Hz 101 Hz to 20 kHz (21 to 30) kHz (0.3 to 1) A (20 to 45) Hz (46 to 100) Hz 101 Hz to 10 kHz (1 to 3) A 45 Hz to 5 kHz (3 to 10) A 45 Hz to 1 kHz	1.1 % of reading + 0.033 mA 0.44 % of reading + 0.033 mA 0.39 % of reading + 0.033 mA 1.3 % of reading + 0.033 mA 1.1 % of reading + 0.33 mA 0.44 % of reading + 0.33 mA 0.39 % of reading + 0.33 mA 1.3% of reading + 0.33 mA 1.2 % of reading + 3.3 mA 0.56 % of reading + 3.3 mA 0.50 % of reading + 3.3 mA 0.18 % of reading + 2.2 mA 2.9 % of reading + 12 mA	Comparison to Precision Digital Multimeter
AC Current Clamp Meters ¹	(10 to 16.5) A (45 to 65) Hz (65 to 100) Hz (100 to 440) Hz (16.5 to 150) A (45 to 65) Hz (65 to 100) Hz (100 to 440) Hz	0.33 % of reading + 58 mA 0.92 % of reading + 58 mA 0.93 % of reading + 58 mA 0.34 % of reading + 65 mA 0.92 % of reading + 67 mA 0.95 % of reading + 77 mA	Comparison to Multiproduct Calibrator and Coil



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Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Clamp Meters ¹	(150 to 1 000) A (45 to 65) Hz (65 to 100) Hz (100 to 440) Hz	0.34 % of reading + 0.19 A 0.92 % of reading + 0.19 A 1.2 % of reading + 0.26 A	Comparison to Multiproduct Calibrator and Coil
Fixed Resistance Source ¹	1 mΩ 10 mΩ 100 mΩ 1 Ω 10 Ω	0.008 1 mΩ 0.021 mΩ 0.081 mΩ 0.59 mΩ 5.9 mΩ	Comparison to Standard Resistors
Resistance Source ¹	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to 330) Ω (0.33 to 1.1) kΩ (1.1 to 3.3) kΩ (3.3 to 11) kΩ (11 to 33) kΩ (33 to 110) kΩ (110 to 330) kΩ (0.33 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	0.003 2 % of reading + 7.8 mΩ 0.002 4 % of reading + 12 mΩ 0.002 2 % of reading + 12 mΩ 0.002 2 % of reading + 16 mΩ 0.002 2 % of reading + 16 mΩ 0.002 2 % of reading + 0.16 Ω 0.002 2 % of reading + 80 mΩ 0.002 2 % of reading + 0.78 Ω 0.002 2 % of reading + 0.8 Ω 0.002 5 % of reading + 8 Ω 0.002 5 % of reading + 8 Ω 0.004 7 % of reading + 0.12 kΩ 0.01 % of reading + 0.3 kΩ 0.02 % of reading + 2.3 kΩ 0.039 % of reading + 12 kΩ 0.24 % of reading + 0.22 MΩ 1.2 % of reading + 0.44 MΩ	Comparison to Multiproduct Calibrator
Fixed Resistance Measured	1 mΩ 10 mΩ	0.5 μΩ 2 μΩ	Comparison to Multi Product Calibrator & Precision Digital Multimeter
Resistance Measure ¹	(0 to 2) Ω (2 to 20) Ω (20 to 200) Ω (0.2 to 2) kΩ (2 to 20) kΩ (20 to 200) kΩ (0.2 to 2) MΩ (2 to 20) MΩ	0.001 8 % of reading + 3.9 μΩ 0.000 94 % of reading + 31 μΩ 0.000 78 % of reading + 50 μΩ 0.000 78 % of reading + 0.49 mΩ 0.000 78 % of reading + 4.9 mΩ 0.000 78 % of reading + 48 mΩ 0.000 94 % of reading + 0.94 Ω 0.002 % of reading + 94 Ω	Comparison to Precision Digital Multimeter



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance Measure ¹ (High Voltage)	(2 to 20) MΩ (20 to 200) MΩ (0.2 to 2) GΩ (2 to 20) GΩ	0.001 6 % of reading + 9.4 Ω 0.006 3 % of reading + 0.94 kΩ 0.018 % of reading + 0.094 MΩ 0.15 % of reading + 9.4 MΩ	Comparison to Precision Digital Multimeter
RTD Indicating Instruments ¹	PT385, 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C PT3926, 100 Ω (-200 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C PT385, 200 Ω (-200 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 630) °C PT385, 1 000 Ω (-200 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 630) °C PT3916, 100 Ω (-200 to -190) °C (-190 to -80) °C (-80 to 0) °C (0 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	0.07 °C 0.08 °C 0.091 °C 0.097 °C 0.11 °C 0.19 °C 0.07 °C 0.08 °C 0.091 °C 0.097 °C 0.11 °C 0.066 °C 0.066 °C 0.07 °C 0.11 °C 0.12 °C 0.14 °C 0.063 °C 0.066 °C 0.07 °C 0.075 °C 0.08 °C 0.19 °C 0.21 °C 0.066 °C 0.07 °C 0.08 °C 0.085 °C 0.091 °C 0.097 °C 0.19 °C	Comparison to Multiproduct Calibrator



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
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	0.001 6 % of reading + 2 μV 0.000 9 % of reading + 9 μV 0.001 % of reading + 78 μV 0.001 4 % of reading + 0.72 mV 0.001 4 % of reading + 1.4 mV	Comparison to Multiproduct Calibrator
DC Voltage Measure ¹	(0 to 200) mV (0.2 to 2) V (2 to 20) V (20 to 200) V (200 to 1 000) V	0.000 51 % of reading + 0.094 μV 0.000 35 % of reading + 0.43 μV 0.000 35 % of reading + 4.1 μV 0.000 55 % of reading + 40 μV 0.000 55 % of reading + 0.49 mV	Comparison to Precision Digital Multimeter
AC Voltage Source ¹	(1.0 to 33) mV (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz (33 to 330) mV (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz (0.33 to 3.3) V (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) Hz (20 to 50) kHz (50 to 100) kHz (100 to 500) kHz (3.3 to 33) V (10 to 45) Hz 45 Hz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.063 % of reading + 6 μV 0.012 % of reading + 5 μV 0.016 % of reading + 5 μV 0.078 % of reading + 5 μV 0.28 % of reading + 10 μV 0.63 % of reading + 40 μV 0.024 % of reading + 9 μV 0.012 % of reading + 7 μV 0.013 % of reading + 7 μV 0.028 % of reading + 7 μV 0.063 % of reading + 25 μV 0.16 % of reading + 55 μV 0.024 % of reading + 0.08 mV 0.012 % of reading + 0.06 mV 0.015 % of reading + 0.06 mV 0.024 % of reading + 0.06 mV 0.055 % of reading + 0.1 mV 0.19 % of reading + 0.5 mV 0.024 % of reading + 0.6 mV 0.012 % of reading + 0.6 mV 0.019 % of reading + 0.6 mV 0.028 % of reading + 0.6 mV 0.07 % of reading + 1.3 mV	Comparison to Multiproduct Calibrator



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Source ¹	(33 to 330) V 45 Hz to 1 kHz 1 kHz to 10 kHz (10 to 20) kHz (20 to 50) kHz (50 to 100) kHz (330 to 1 000) V 45 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.015 % of reading + 3.1 mV 0.016 % of reading + 5.8 mV 0.020 % of reading + 6 mV 0.024 % of reading + 6.7 mV 0.16 % of reading + 39 mV 0.024 % of reading + 8.9 mV 0.02 % of reading + 9.2 mV 0.024 % of reading + 9.5 mV	Comparison to Multiproduct Calibrator
AC Voltage Measure (in laboratory)	(1 to 200) mV (10 to 40) Hz (40 Hz to 100) Hz (0.1 to 2) kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (0.2 to 2) V (10 to 40) Hz (40 to 100) Hz (0.1 to 2) kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz (2 to 20) V (10 to 40) Hz (40 to 100) Hz (0.1 to 2) kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz (100 to 300) kHz (20 to 200) V (40 to 100) Hz (0.1 to 2) kHz (2 to 10) kHz (10 to 30) kHz (30 to 100) kHz	0.013 % of reading + 4 μV 0.011 % of reading + 4 μV 0.011 % of reading + 2 μV 0.013 % of reading + 4 μV 0.031 % of reading + 7.8 μV 0.067 % of reading + 19 μV 0.011 % of reading + 21 μV 0.008 5% of reading + 20 μV 0.007 0 % of reading + 20 μV 0.011 % of reading + 20 μV 0.021 % of reading + 40 μV 0.051 % of reading + 0.19 mV 0.24 % of reading + 1.9 mV 0.78 % of reading + 19 mV 0.011 % of reading + 0.2 mV 0.008 6 % of reading + 0.2 mV 0.007 0 % of reading + 0.2 mV 0.011 % of reading + 0.2 mV 0.021 % of reading + 0.4 mV 0.051 % of reading + 1.9 mV 0.24% of reading + 19 mV 0.008 6 % of reading + 2 mV 0.007 0 % of reading + 2 mV 0.011 % of reading + 2 mV 0.021 % of reading + 4 mV 0.051 % of reading + 19 mV	Comparison to Precision Digital Multimeter



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Measure (in laboratory)	(200 to 1 000) V 40 Hz to 10 kHz	0.011 % of reading + 20 mV	Comparison to Precision Digital Multimeter
AC Voltage Measure ¹ (onsite)	(1 to 30) mV		Comparison to Precision Digital Multimeter
	(20 to 45) Hz	0.7 % of reading + 16 μV	
	(45 Hz to 100) Hz	0.29 % of reading + 16 μV	
	(0.1 to 20) kHz	0.21 % of reading + 16 μV	
	(20 to 100) kHz	0.81 % of reading + 27 μV	
	(100 to 300) kHz	3.7 % of reading + 0.12 mV	
	(0.3 to 1) MHz	12 % of reading + 0.77 mV	
	(30 to 300) mV		
	(20 to 45) Hz	0.7 % of reading + 0.16 mV	
	(45 to 100) Hz	0.29 % of reading + 0.16 mV	
	(0.1 to 20) kHz	0.21 % of reading + 0.16 mV	
	(20 to 100) kHz	0.81 % of reading + 0.27 mV	
	(100 to 300) kHz	3.7 % of reading + 1.2 mV	
	(0.3 to 1) MHz	12 % of reading + 7.7 mV	
	(0.3 to 3) V		
	(20 to 45) Hz	0.7 % of reading + 1.6 mV	
(45 to 100) Hz	0.29 % of reading + 1.6 mV		
(0.1 to 20) kHz	0.21 % of reading + 1.6 mV		
(20 to 100) kHz	0.81 % of reading + 2.7 mV		
(100 to 300) kHz	3.7 % of reading + 12 mV		
(0.3 to 1) MHz	12 % of reading + 77 mV		
(3 to 30) V			
(20 to 45) Hz	0.7 % of reading + 16 mV		
(45 to 100) Hz	0.29 % of reading + 16 mV		
(0.1 to 20) kHz	0.21 % of reading + 16 mV		
(20 to 100) kHz	0.81 % of reading + 27 mV		
(100 to 300) kHz	3.7 % of reading + 0.12 V		
(0.3 to 1 MHz)	12 % of reading + 0.77 V		
(30 to 300) V			
(20 to 45) Hz	0.77 % of reading + 0.16 V		
(45 to 100) Hz	0.36 % of reading + 0.16 V		
(0.1 to 20) kHz	0.28 % of reading + 0.16 V		
(20 to 100) kHz	1.3 % of reading + 0.45 V		
(300 to 750) V			
45 Hz to 10 kHz	0.07 % of reading + 0.26 V		
DC Power Source ¹	(0 to 90) W (90 to 600) W (0.6 to 6) kW (6 to 12) kW	0.018 % of reading + 8 mW 0.018 % of reading + 0.08 W 0.055 % of reading + 0.8 W 0.070 % of reading + 8 W	Comparison to Multiproduct Calibrator

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Power Source ¹	(45 to 65) Hz (0.2 to 33) W (33 to 90) W (90 to 300) W (300 to 900) W (0.9 to 1.5) kW (1.5 to 9) kW (9 to 12) kW 400 Hz (100 to 1350) W	0.063% of reading + 0.76 mW 0.086 % of reading + 0.76 mW 0.07 % of reading + 7.6 mW 0.078 % of reading + 7.6 mW 0.078 % of reading + 76 mW 0.094 % of reading + 76 mW 0.078 % of reading + 0.76 W 0.088 % of reading + 0.5 W	Comparison to Multiproduct Calibrator
High Voltage Measure ¹	AC (50 to 60) Hz (0.5 to 10) kV DC (0.5 to 10) kV	1.2 % of reading + 6.2 V 0.58 % of reading + 3.6 V	Comparison to Digital High Voltage Meter
Insulation/Resistivity Tester ¹	(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	0.12 % of reading + 5.8 Ω 0.12 % of reading + 58 Ω 0.12 % of reading + 0.58 kΩ 0.18 % 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 1.2 % of reading + 58 MΩ	Comparison to High Decade Resistor Box
LCR Meter ¹ Capacitance	@ 120 Hz 1 pF 10 pF 100 pF 1000 pF 10 nF 100 nF 1 μF @ 1 kHz 1 pF 10 pF 100 pF 1000 pF 10 nF 100 nF 1 μF	0.0014 pF 0.012 pF 0.13 pF 1.2 pF 0.013 nF 0.14 nF 0.0014 μF 0.0014 pF 0.012 pF 0.13 pF 1.2 pF 0.013 nF 0.13 nF 0.0013 μF	Comparison to Standard Capacitors



ANSI National Accreditation Board

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
LCR Meter ¹ Capacitance	@ 10 kHz		Comparison to Standard Capacitors
	1 pF	0.0013 pF	
	10 pF	0.012 pF	
	100 pF	0.13 pF	
	1000 pF	1.2 pF	
	10 nF	0.013 nF	
	100 nF	0.14 nF	
	1 μF	0.0022 μF	
	@ 100 kHz		
	1 pF	0.0014 pF	
	10 pF	0.014 pF	
	100 pF	0.14 pF	
	1000 pF	1.3 pF	
	10 nF	0.015 nF	
LCR Meter ¹ Resistance	@ 120 Hz		Comparison to Standard Resistors
	10 Ω	0.019 Ω	
	100 Ω	0.11 Ω	
	1 kΩ	1.2 Ω	
	10 kΩ	11 Ω	
	@ 1 kHz		
	10 Ω	0.013 Ω	
	100 Ω	0.11 Ω	
	1 kΩ	1.2 Ω	
	10 kΩ	11 Ω	
	100 kΩ	0.11 kΩ	
	@ 10 kHz		
	10 Ω	0.013 Ω	
	100 Ω	0.11 Ω	
	1 kΩ	1.2 Ω	
	@ 100 kHz		
	10 Ω	0.022 Ω	
	100 Ω	0.17	
	1 kΩ	1.2 Ω	

Electrical – DC/Low Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermocouple Indicating Instruments ¹	Type E (-250 to 1 000) °C	0.42 °C	Comparison to Multiproduct Calibrator
	Type J (-210 to 1 200) °C	0.28 °C	
	Type K (-200 to 1 372) °C	0.34 °C	
	Type N (-200 to 1 300) °C	0.4 °C	
	Type R (0 to 1 767) °C	0.76 °C	
	Type S (0 to 1 767) °C	0.71 °C	
	Type T (-250 to 400) °C	0.51 °C	

Length – Dimensional Metrology

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
External Micrometer ¹ Linearity	(0 to 200) mm (200 to 500) mm (500 to 1 000) mm	0.9 µm 2.3 µm 3.2 µm	Comparison to Gauge Blocks
External Micrometers ¹ Flatness Up to 25 mm diameter	(0 to 0.5) µm	0.2 µm	Comparison to Optical Parallel or Optical Flat, Dial Test Indicator
External Micrometers ¹ Parallelism Up to 50 mm diameter	(0 to 1) µm	0.1 µm	Comparison to Optical Parallel, Dial Test Indicator
Depth Micrometer	(0 to 300) mm	1 µm	Comparison to Gauge Blocks
Internal & Stick Micrometer ¹	(0 to 200) mm (200 to 500) mm (500 to 1 000) mm	2 µm 3.8 µm 7 µm	Comparison to Gauge Blocks
Internal Micrometer ¹ (2-leg type)	(0 to 300) mm	1.8 µm	Comparison to Gauge Blocks, Ring Gauges
Micrometer Head	(0 to 50) mm	0.9 µm	Comparison to Universal Length Measuring Machine or Gauge Blocks

Length – Dimensional Metrology

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Screw Thread Micrometer ¹	(0 to 300) mm	1 μm	Comparison to Gauge Block or Pin Gauge
Caliper ¹	(0 to 600) mm (601 to 1 000) mm (1001 to 2 000) mm	3 μm 7 μm 26 μm	Comparison to Caliper Checker or Gauge Block
Caliper Gauge ¹	(0 to 500) mm	1 μm	Comparison to Gauge Blocks
Caliper Checker ¹ (Step Gauges) Depth Micrometer Checker	(0 to 630) mm	0.9 μm	Comparison to Gauge Blocks, Mu Checker
Optical Flats/Parallels Flatness Thickness	Up to 10 μm	0.1 μm 0.4 μm	Comparison to Optical Flat
Optical Flats/ Parallels Parallelism	Up to 1 mm	0.1 μm	Comparison to Gauge Block Comparator
Gauge Block Comparator ^{1,4}	(0.5 to 10) mm (10 to 25) mm (25 to 50) mm (50 to 75) mm (75 to 100) mm	0.04 + (1×10 ⁻⁶ L) μm	Comparison to Gauge Blocks
Gauge Blocks Length (Dissimilar & Similar Material)	(0.5 to 10) mm (10 to 25) mm (25 to 50) mm (50 to 75) mm (75 to 100) mm	0.05 μm 0.06 μm 0.08 μm 0.1 μm 0.12 μm	Comparison to Gauge Block Comparator with 1 mm Probe Radius
Long Gauge Blocks (Dissimilar & Similar Material)	(>100 to 125) mm (>125 to 150) mm (>150 to 175) mm	0.19 μm 0.20 μm 0.22 μm	Comparison to Gauge Block Comparator, Gauge Block Grade K
Long Gage Blocks (Dissimilar & Similar Material)	(>100 to 125) mm (>125 to 150) mm (>150 to 175) mm (>175 to 200) mm (>200 to 250) mm (>250 to 300) mm (>300 to 400) mm (>400 to 500) mm	0.36 μm 0.37 μm 0.38 μm 0.39 μm 0.42 μm 0.44 μm 0.51 μm 0.57 μm	Comparison to Universal Length Measuring Machine (ULM), Gauge Block Grade K
Height Gauge ¹	(0 to 600) mm	9 μm	Comparison to Caliper Checker
Height Gauge ¹	(600 to 1 000) mm	7 μm	Comparison to Gauge Block

Length – Dimensional Metrology

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Linear Height Gauge ¹ Length Setting Master Height Setting Master Parallelism	(0 to 1 000) mm (0 to 30) mm (0 to 10) µm	2 µm 2 µm 0.4 µm	Comparison to Gauge Blocks, Mu Checker
Height Master ¹ Micrometer Head Length Parallelism Riser Block	(0 to 25) mm (0 to 600) mm (0 to 10) µm (0 to 300) mm	0.9 µm	Comparison to Gauge Blocks, Mu Checker
Vernier Depth Gauge ¹	(0 to 600) mm (600 to 1 000) mm	7 µm 15 µm	Comparison to Gauge Blocks
Dial Depth Gauge ¹	(0 to 200) mm	2 µm	Comparison to Gauge Blocks
Mu Checker	(0 to 5) mm	0.2 µm	Comparison to Gauge Blocks or Calibration Tester
Dial Indicator ¹	Up to 100 mm	0.5 µm	Comparison to Dial Gauge Calibrator
Dial Test Indicator ¹	(0 to 3) mm	0.5 µm	Comparison to Dial Gauge Calibrator
Digimatic Indicator ¹ Linear Gauge	Up to 100 mm	1.7 µm	Comparison to Dial Gauge Calibrator
Digimatic Indicator ¹ Linear Gauge	Up to 100 mm	0.7 µm	Comparison to Gauge Blocks
Dial Thickness Gauge ¹	(0 to 200) mm	1 µm	Comparison to Gauge Blocks
Dial Gauge Stand / Comparator stand ¹	(0 to 1) mm	0.4 µm	Comparison to Dial Test Indicator
Dial Gauge Calibrator ¹	(0 to 100) mm	0.5 µm	Comparison to Gauge Blocks
Calibration Tester ¹	(0 to 100) mm	0.3 µm	Comparison to Gauge Blocks
Bore Gauge	(0 to 600) mm	2 µm	Comparison to Height Setting Micrometer
Holtest/ Borematic	(0 to 200) mm	1 µm	Comparison to Setting Ring Gauge or Universal Length Measuring Machine

Length – Dimensional Metrology

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Steel Rule	(0 to 300) mm Up to 600 mm Up to 1 000 mm Up to 1 200 mm	0.009 mm 0.014 mm 0.021 mm 0.026 mm	Comparison to Profile Projector
Steel Rule	(0 to 1 500) mm (1 500 to 2 000) mm	0.07 mm 0.08 mm	Comparison with Reference Ruler
Straight Edge ¹	Up to 1 200 mm	2 µm	Comparison to Mu-Checker or Dial Test Indicator
Surface Plate ^{1,2} Overall Flatness	Up to 2 500 mm×2 000 mm	1 µm	Comparison to Planekator (Straight Edge)
Local Area Flatness (Repeat Readings)	Up to 0.1 µm		
Profile Projector ¹ Optical Comparators	Up to 300 mm	2 µm	Comparison to Glass Scale
Universal Length Measuring Machine ¹ Length	(0 to 500) mm (>500 to 1 000) mm	0.2 µm 1.2 µm	Comparison to Gauge Blocks
Setting Rod	Up to 100 mm Up to 400 mm Up to 600 mm Up to 1 000 mm	0.8 µm 1.2 µm 1.1 µm 1.4 µm	Comparison to Gauge Blocks and Mu-Checker
Bevel Protractor	Up to 300 mm (0 to 360)°	1.5 µm 5'	Comparison to Dial Test Indicator, Angle Blocks or
Bevel Protractor	Up to 300 mm (0 to 360)°	33'	Comparison to Profile Projector
Precision Levels Spirit Level Inclinometer Level Gauge	0.01 mm/m to 1 cm/m (0 to 35)°	0.1 Division 0.1°	Comparison to Sine Plate, Gauge Blocks
Measuring Microscope ¹	(0 to 300) mm	2 µm	Comparison to Glass Scale
Sine Bars	(0 to 300) mm	0.5 µm	Comparison to Universal Length Measuring Machine, Millitron

Length – Dimensional Metrology

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Vee Blocks Flatness Squareness Parallelism of Vee	(0 to 1.2) mm	4 µm	Comparison to Levelling Plate, Square, Indicator
Precision Squares	(0 to 450) mm	3 µm	Comparison to Granite Square
Parallel Bars	(0 to 1.2) mm	2 µm	Comparison to Dial Indicator, Mu Checker, Micrometer
Centre Bench ¹	(0 to 1.2) mm	3 µm	Comparison to Height Master, Gauge Blocks, Mu Checker
Coating Thickness Gauge	Up to 1 500 µm	0.9 µm	Comparison to Thickness Standards
Roughness Machine ¹	(0.3 to 3) µm	0.021 µm	Comparison to Roughness Specimen
Roughness Specimen ¹	(0.3 to 3) mm	0.021 µm	Comparison to Roughness Machine
Feeler Gauge Shim Shock Calibration Foil	Up to 5 mm	0.4 µm	Comparison to Universal Length Measuring Machine
Plain Ring Gauge / Snap Gauge, (Internal Diameter, Internal Length)	(>1 to 50) mm (>50 to 100) mm (>100 to 150) mm (>150 to 200) mm	0.5 µm 0.6 µm 0.7 µm 0.9 µm	Comparison to Universal Length Measuring Machine, Master Ring Gauge
Thread Wires Diameter	Up to 10 mm	0.4 µm	Comparison to Universal Length Measuring Machine
Plain Plug Gauge / Pin Gauge	Up to 10 mm (10 to 100) mm (100 to 200) mm	0.5 µm 0.8 µm 1 µm	Comparison to Universal Length Measuring Machine
Thread Plug Gauge (> M1 to M50) Pitch Diameter Major Diameter Pitch	(1 to 200) mm	1.8 µm 0.5 µm 6 µm	Comparison to Universal Length Measuring Machine, Thread Wires
Adjustable Thread Rings Pitch Diameter (tactile fit) Minor Diameter	(0 to 100) mm	2 µm	Comparison to ULM, Internal Micrometer

Length – Dimensional Metrology

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Solid Thread Ring Gauge Pitch Diameter (tactile fit) Minor Diameter	Up to 2.5 mm (1.2 to 2.5) mm	N/A 2 μ m	Comparison to Thread Setting Plug, Internal Micrometer
Solid Thread Ring Gauge (> M2.5 to M100) Pitch Diameter (measured) Minor Diameter	(2.5 to 100) mm	1 μ m 0.8 μ m	Comparison to Universal Length Measuring Machine
Coordinate Measuring Machine ¹	Up to 1 500 mm	0.82 μ m	Comparison to Gauge Block, Step Gauge
Glass Scale	(0 to 150) mm	3.9 μ m	Comparison to Profile Projector
Tapered Ring Gauge Diameter	Up to 100 mm	1.3 μ m	Comparison to Universal Length Measuring Machine (ULM)
Tapered Ring Gauge Step Height	Up to 75 mm	2 μ m	Comparison to Micrometer
Tapered Plug Gauge Diameter	Up to 75 mm	1.2 μ m	Comparison to Universal Length Measuring Machine (ULM)
Tapered Plug Gauge Step Height	Up to 75 mm	2 μ m	Comparison to Micrometer
Tapered Thread Plug Gauges Pitch Diameter	Up to 150 mm	3.1 μ m	Comparison to Universal Length Measuring Machine (ULM)
Tapered Thread Plug Gauges Taper	(0 to 10) $^{\circ}$	4 $^{\circ}$	Comparison to Profile Projector
Tapered Thread Plug Gauges Step Height	Up to 75 mm	2.2 μ m	Comparison to Micrometer
Tapered Thread Ring Gauges Step Height	Up to 75 mm	2.2 μ m	Comparison to Micrometer
Tapered Thread Ring Gauges Pitch Diameter	Up to 100 mm	1.6 μ m	Comparison to Universal length Measuring Machine (ULM), Probing System
Measuring Tape / Textile Tape	(0 to 5) m (>5 to 10) m (>10 to 20) m (>20 to 50) m	0.13 mm 0.24 mm 0.25 mm 3 mm	Comparison to Steel Rule

Length – Dimensional Metrology

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Laser Scan Micrometer ¹	(0 to 25) mm	0.5 μm	Comparison to Pin Gauge

Mass and Mass Related

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Force Gauge ¹	(0 to 5) kgf (5 to 200) kgf	0.000 6 kgf 0.06 kgf	Comparison to Masses
Force Gauge ¹	(0 to 50) kN	0.01 kN	Comparison to Load Cells
Universal Length Measuring Machine ¹ Force	(0 to 5) N	0.1 N	Comparison to Force Gauge
Force Testing Machines ¹ and Load Cells Compression and Tension ¹	(0 to 10) N	0.006 N	Direct measurement to reference load cell or Standard Weight
	(10 to 100) N	0.06 N	
	(100 to 1 000) N	2.3 N	
	(1 to 5) kN	0.005 kN	
	(5 to 10) kN	0.001 kN	
	(10 to 50) kN	0.048 kN	
	(50 to 100) kN (100 to 250) kN	0.11 kN 0.05 kN	
Masses	(1, 2, 5, 10, 20 ,50) mg	0.04 mg	Comparison to Analytical Balance, Mass
	(100, 200, 500) mg	0.05 mg	
	1 g	0.06 mg	
	2 g	0.07 mg	
	5 g	0.08 mg	
	10 g	0.13 mg	
	20 g	0.14 mg	
	50 g	0.21 mg	
	100 g	0.28 mg	
	200 g	0.40 mg	
	500 g	2.0 mg	
	1 kg	3.0 mg	
	2 kg	6 mg	
	5 kg	22 mg	
	10kg	20 mg	
20 kg	37 mg		

Mass and Mass Related

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Scales and Balances ^{1,4}	(0 to 210) g Up to 400 g Up to 1 200 g Up to 6 Kg Up to 30 Kg Up to 80 Kg Up to 150 Kg Up to 400 Kg	0.000 7 g 0.000 63 g 0.002 5 g 0.000 09 kg 0.001 kg 0.0025 kg 0.008 kg 0.017 kg	Comparison to Masses
Torque Tools ¹	(0 to 0.4) N·m (0.4 to 2) N·m (2 to 10) N·m (10 to 60) N·m (60 to 100) N·m (100 to 200) N·m (200 to 600) N·m (600 to 1 000) N·m	0.011 N·m 0.007 N·m 0.036 N·m 0.20 N·m 0.31 N·m 0.8 N·m 1.8 N·m 3.6 N·m	Comparison to Torque Transducers
Torque Meter/Gauge	(0 to 150) kgf·cm	0.06 kgf·cm	Comparison to Torque Arm, Masses
Durometers ¹ (Force only) Types A, B, E & O Types C, D, & DO	(0 to 100)°	0.3°	Comparison to Standard Weight
Rockwell Hardness Testers ¹	(10 to 100) HRBW (20 to 95) HRA (10 to 70) HRC	0.5 HRBW 0.5 HRA 0.5 HRC	Comparison to Hardness Test Blocks
Vickers Hardness Testers ¹	(100 to 1000) HV	0.5 % of reading	Comparison to Hardness Test Blocks
Brinell Hardness Testers ¹	(100 to 600) HBW	1 % of readings	Comparison to Hardness Test Blocks
Pressure Gauges ¹	(-0.9 to 70) Bar (70.1 –to 340) Bar (0 –to 2 700) Bar	0.21 % of full scale 0.25 % of full scale 0.04 % of full scale	Comparison to Pressure Calibrator Dead Weight Tester
Air Flow Meters ¹	Up to 500 SCCM Up to 50 LPM Up to 500 LPM	7.5 mL/min 0.5 L/min 2.6 L/min	Comparison to Flowmeters

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Lux/Light Meters	(0 to 100) lux (100 to 500) lux (500 to 5 000) lux (5 000 to 30 000) lux	2.1 lux 8.1 lux 87 lux 541 lux	Comparison to Lux Meter

Thermodynamic

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Enclosures ¹ Chamber / Oven / Freezers System Accuracy Test	(-70 to 100) °C (100 to 200) °C	1.3 °C 2.7 °C	Comparison to Datalogger, Thermocouples
Furnace ¹ System Accuracy Test	(200 to 800) °C	3 °C	Comparison to Datalogger, Thermocouples
Thermometers ¹ (except liquid in glass)	(-35 to 90) °C (90 to 150) °C (150 to 500) °C	0.11 °C 0.67 °C 1.6 °C	Comparison to PRT Sensor, Dry Block Calibrator
Surface Style Thermometer	(30 to 300) °C	2.6 °C	Comparison to Flat Plate Calibrator
Dry Block Calibrators	(-20 to 150) °C (150 to 500) °C	0.12 °C 0.17 °C	Comparison to PRT sensor
Thermohygrometer Instruments	(18 to 70) °C (40 to 85) %RH	1 °C 6 %RH	Comparison to Reference Thermohygrometer
RTD Based Temperature Measuring Systems ¹	(-20 to 95) °C (95 to 200) °C	0.06 °C 0.08 °C	Comparison to Temperature Baths
RTD Based Temperature Measuring Systems ¹	(-20 to 140) °C (140 to 400) °C (400 to 600) °C	0.22 °C 0.5 °C 1.5 °C	Comparison to Dry Block
Base Metal Thermocouple Based Temperature Measuring Systems ¹	Types E, J, K, N, & T (-20 to 95) °C (95 to 200) °C	0.28 °C 0.5 °C	Comparison to Temperature Baths
Base Metal Thermocouple Based Temperature Measuring Systems ¹	Types E, J, K, N, & T (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C (1 000 to 1 200) °C	0.42 °C 1.1 °C 2 °C 4.7 °C 4.9 °C	Comparison to Dry Block



ANSI National Accreditation Board

Thermodynamic

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Noble Metal Thermocouple Based Temperature Measuring Systems ¹	Types R, & S (-20 to 95) °C (95 to 200) °C	0.17 °C 0.21 °C	Comparison to Temperature Baths
Noble Metal Thermocouple Based Temperature Measuring Systems ¹	Types R, & S (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C (1 000 to 1 200) °C	0.27 °C 0.53 °C 1.5 °C 4.2 °C 4.2 °C	Comparison to Dry Block
Thermocouple Sensors ¹	Type E (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C Type J (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C Type K (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C (1 000 to 1 200) °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 0.4 °C 1.1 °C 2 °C 3.3 °C 0.42 °C 1.1 °C 2 °C 4.7 °C 5 °C 0.4 °C 1.1 °C 2.1 °C 3.3 °C	Comparison to Dry Block

Thermodynamic

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thermocouple Sensors ¹	Type R (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C (1 000 to 1 200) °C Type S (-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C (1 000 to 1 200) °C Type T (-20 to 140) °C (140 to 400) °C	0.27 °C 0.57 °C 1.5 °C 4.2 °C 4.2 °C 0.27 °C 0.58 °C 1.5 °C 4.2 °C 4.2 °C 0.4 °C 1.1 °C	Comparison to Dry Block
Thermocouple Sensors ¹	Type E (-20 to 95) °C (95 to 200) °C Type J (-20 to 95) °C (95 to 200) °C Type K (-20 to 95) °C (95 to 200) °C Type N (-20 to 95) °C (95 to 200) °C Type R (-20 to 95) °C (95 to 200) °C Type S (-20 to 95) °C (95 to 200) °C Type T (-20 to 95) °C (95 to 200) °C	0.24 °C 0.48 °C 0.24 °C 0.48 °C 0.28 °C 0.5 °C 0.24 °C 0.48 °C 0.18 °C 0.22 °C 0.18 °C 0.22 °C 0.24 °C 0.48 °C	Comparison to Temperature Baths
Infrared (IR) Thermometers	(15 to 140) °C	1.5 °C	Comparison to Blackbody Source and reference thermocouple thermometer $\epsilon = 0.95, \lambda = (8 \text{ to } 14) \mu\text{m}$

Time and Frequency

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Stopwatches and Timers 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	7.7 ms 8.0 ms 9.0 ms 9.4 ms 9.9 ms 12 ms 27 ms 53 ms 79 ms 0.11 s	Comparison to Reference Stopwatch, Universal Counter
Tachometers ¹ Non-Contact	(1 to 99.99) rpm (100 to 999.9) rpm (1 000 to 29 999) rpm (30 000 to 99 999) rpm	0.02 rpm 0.06 rpm 0.6 rpm 0.9 rpm	Comparison to Multiproduct Calibrator with LED
Frequency Source ¹	(0.01 to 99.99) Hz (100 to 119.99) Hz (120 to 1199.9) Hz (1.2 to 11.99) kHz (12 to 119.99) kHz (120 to 1 199.99) kHz (1.2 to 2.0) MHz	0.000 2 % of reading + 8.6 μHz 0.000 2 % of reading + 76 μHz 0.000 2 % of reading + 0.76 mHz 0.000 2 % of reading + 7.6 mHz 0.000 2 % of reading + 76 mHz 0.000 2 % of reading + 0.76 Hz 0.000 2 % of reading + 0.99 Hz	Comparison to Multiproduct Calibrator
Frequency Measure ¹	0.5 Hz to 15 MHz	0.001 1 % of reading + 6 μHz	Comparison to Frequency Counter

DIMENSIONAL MEASUREMENT

1 Dimensional

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Layout Measurement Length	X Axis (0 to 300) mm Y Axis (0 to 100) mm	0.5 μm	Comparison to Optical Comparator or Universal Length Measuring Machine

2 Dimensional

Singapore

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Layout Measurement Angle	(0 to 360)°	4'	Comparison to Optical Comparator

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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, L = length in meters
3. Results and uncertainties are also available in US Customary units of measure.
4. The CMC for scales and balances are highly dependent upon the resolution of the unit under test. The uncertainty presented here does not include the resolution of the unit under test. The resolution will be included in the reported measurement uncertainty at the time of calibration.
5. Nominal values are approximate.
6. Unitless linear measure.
7. Johor, Malaysia site withdrawn as of 07/17/2023 until further notice.
8. This scope is formatted as part of a single document including Certificate of Accreditation No. ACT-2515. Site specific sections are identified by city and suffix (AC-2515.xx) for convenience.



Jason Stine, Vice President

