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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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	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

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) µA 200 µA to 2 mA (2 to 20) mA (20 to 200) mA 200 mA to 2 A (2 to 20) A	13 µA/A + 0.62 nA 13µA/A + 6.1 nA 14 µA/A + 61 nA 47 µA/A + 0.96 µA 0.18 mA/A + 16 µA 0.39 mA/A + 0.36 mA	8508A Multimeter

Electrical – DC/Low Frequency **Bangkok, Thailand**

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

Electrical – DC/Low Frequency **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Current Measure	<200 µA 10 Hz to 10 kHz <2 mA 10 Hz 10 Hz to 10 kHz	0.049 % of reading + 0.021 µA 0.031 % of reading + 0.2 µA 0.029 % of reading + 0.2 µA	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 µA 0.029 % of reading + 2 µA 0.031 % of reading + 20 µA 0.028 % of reading + 20 µA 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 µA 0.87 % of reading + 3.1 µA 0.87 % of reading + 3.2 µA 2.3 % of reading + 5.5 µA 1.1 % of reading + 34 µA 0.44 % of reading + 34 µA 0.39 % of reading + 34 µA 0.39 % of reading + 34 µA 1.3 % of reading + 47 µA 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	HP 3457A/Fluke 189

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	HP 3457A/Fluke 189
AC Current Source	≤ 220 µA (10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz 220 µA to 2.2 mA (10 to 20) Hz (20 to 30) Hz (30 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz (2.2 to 22) mA (10 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 + 30 nA 0.034 % of reading + 21nA 0.015 % of reading +19 nA 0.055 % of reading + 40nA 0.15 % of reading + 78 nA 0.063 % of reading + 40 nA 0.034 % of reading +32nA 0.034 % of reading +32nA 0.015 % of reading + 33 nA 0.055 % of reading + 0.39 µA 0.15 % of reading +0.78 µA 0.063 % of reading + 0.51 µA 0.034 % of reading + 0.32 µA 0.015 % of reading + 0.32 µA 0.055 % of reading + 3.9 µA 0.14 % of reading + 7.8 µA 0.063 % of reading + 3.9 µA 0.034 % of reading + 3.1 µA 0.016 % of reading + 3.1 µA 0.055 % of reading + 39 µA 0.14 % of reading + 78 µA 0.14 % of reading + 16 µA 0.07 % of reading + 16 µA 0.033 % of reading + 16 µA 0.078 % of reading + 39 µA 0.16 % of reading + 78 µA 0.31 % of reading + 0.16 mA	5700A/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	 0.14 % of reading + 0.13 mA 0.048 % of reading + 0.085 mA 0.47 % of reading + 0.78 mA 1.94 % of reading + 3.9 mA	5522A Multi Product Calibrator

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 + 1.6 mA 0.079 % of reading + 1.6 mA 2.4 % of reading + 1.6 mA 0.094 % of reading + 3.9 mA 0.12 % of reading + 3.9 mA 2.4 % of reading + 3.9 mA	5522A Multi Product Calibrator
AC Current Source [1]	(29 to 330) µA (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 + 0.08 µA 0.12 % of reading + 0.079 µA 0.098 % of reading + 0.079 µA 0.24 % of reading + 0.12 µA 0.62 % of reading + 0.16 µA 1.3 % of reading + 0.31 µA 0.16 % of reading + 0.12 µA 0.098 % of reading + 0.12 µA 0.078 % of reading + 0.12 µA 0.16 % of reading + 0.16 µA 0.39 % of reading + 0.24 µA 0.78 % of reading + 0.47 µA 0.14 % of reading + 1.6 µA 0.07 % of reading + 1.6 µA 0.032 % of reading + 1.6 µA 0.063 % of reading + 1.6 µA 0.16 % of reading + 2.4 µA 0.31 % of reading + 3.1 µA 0.14 % of reading + 16 µA 0.071 % of reading + 16 µA 0.032 % of reading + 16 µA 0.078 % of reading + 39 µA 0.16 % of reading + 78 µA 0.31 % of reading + 0.16 mA	5522A Multi Product Calibrator

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	 0.14 % of reading + 0.23 mA 0.047 % of reading + 0.11 mA 0.47 % of reading + 0.78 mA 1.94 % of reading + 3.9 mA 0.048 % of reading + 1.7 mA 0.078 % of reading + 1.7 mA 2.4 % of reading + 1.7 mA 0.094 % of reading + 3.9 mA 0.12 % of reading + 3.9 mA 2.4 % of reading + 3.9 mA	5522A Multi Product Calibrator
Resistance Measure	(0 to 2) Ω (2 to 20) Ω (20 to 200) Ω 200 Ω to 2 kΩ (2 to 20) kΩ (20 to 200) kΩ 200 kΩto 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	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	3457A Multimeter
Resistance Measure [1]	300 MΩ to 1 GΩ	19 % of reading + 1.4 MΩ	3457A Multimeter

Electrical – DC/Low Frequency **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Resistance Measuring Instruments	0 Ω 1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	40 µΩ 86 µΩ/Ω + 8.6 µΩ 86 µΩ/Ω + 7.6 µΩ 26 µΩ/Ω + 8.6 µΩ 24 µΩ/Ω + 8.6 µΩ 16 µΩ/Ω + 58 µΩ 16 µΩ/Ω + 58 µΩ 12 µΩ/Ω + 0.58 mΩ 12 µΩ/Ω + 0.58 mΩ 12 µΩ/Ω + 7.6 mΩ 12 µΩ/Ω + 7 mΩ 13 µΩ/Ω + 58 mΩ 13 µΩ/Ω + 71 mΩ 21 µΩ/Ω + 0.58 Ω 20 µΩ/Ω + 0.58 Ω 37 µΩ/Ω + 54 Ω 44 µΩ/Ω + 52 Ω 0.11 mΩ/Ω + 0.94 kΩ	5700A Multi Product Calibrator
Resistance Measuring Instruments [1]	(0 to 11) Ω (11 to 33) Ω (33 to 110) Ω 110 Ω to 1.1 kΩ (1.1 to 11) kΩ (11 to 110) kΩ 110 kΩ to 1.1 MΩ (1.1 to 3.3) MΩ (3.3 to 11) MΩ (11 to 33) MΩ (33 to 110) MΩ (110 to 330) MΩ (330 to 1 100) MΩ	35 µΩ/Ω + 0.8 mΩ 47 µΩ/Ω + 1.2 mΩ 35 µΩ/Ω + 1.1 mΩ 26 µΩ/Ω + 1.7 mΩ 25 µΩ/Ω + 17 mΩ 25 µΩ/Ω + 0.17 Ω 27 µΩ/Ω + 1.7 Ω 49 µΩ/Ω + 24 Ω 0.11 mΩ/Ω + 40 Ω 0.21 mΩ/Ω + 2 kΩ 0.4 mΩ/Ω + 2.6 kΩ 2.4 mΩ/Ω + 78 kΩ 12 mΩ/Ω + 0.39 MΩ	5522A Multi Product Calibrator
Resistance Simulation of RTD Temperature Measuring Instrumentation	Pt 385, 100Ω (-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C	 0.07 °C 0.07°C 0.08 °C 0.09 °C 0.1 °C 0.11 °C 0.19°C	5522A Multi Product Calibrator

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 3926, 100 Ω		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) ºC	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) ºC	0.08 °C	
	(260 to 300) ºC	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) ºC	0.07 °C	
	(0 to 100) °C	0.07 °C	
	(100 to 300) ºC	0.07 °C	
	(300 to 400) °C	0.11°C	
	(400 to 600) °C	0.12°C	
	(600 to 630) °C	0.14 °C	
	PT 385, 500Ω		
	(-200 to -80) °C	0.07°C	
	(-80 to 0) °C	0.07°C	
	(0 to 100) °C	0.07°C	
	(100 to 260) °C	0.07°C	
	(260 to 300) °C	0.08°C	
	(300 to 400) °C	0.08°C	
	(400 to 630) °C	0.09°C	
	(630 to 800) °C	0.1°C	

Electrical – DC/Low Frequency **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 (-200 to -80) °C (-80 to 0) ºC (0 to 100) ºC (100 to 260) ºC (260 to 300) °C (300 to 400) °C (400 to 630) °C (630 to 800) °C Ni 120, 120 Ohm (-80 to 0) °C (0 to 100) °C (100 to 260) °C Cu 10, 10 Ohm (-100 to 260) °C	 0.06°C 0.06°C 0.07°C 0.07°C 0.07°C 0.08°C 0.08°C 0.19°C 0.08°C 0.08°C 0.12°C 0.24°C	5522A Multi Product Calibrator
Source and Measure Resistance Simulation of RTD Temperature Measuring Instrumentation [1]	Pt 385, 100Ω (-200 to 800) °C Pt 3926, 100 Ω (-200 to 630) °C Pt 3916, 100 Ω (-200 to 630) °C Pt 385, 200 Ω (-200 to 250) °C (250 to 630) °C Pt385, 500Ω (-200 to 500) °C (500 to 630) °C	 0.39 °C 0.36 °C 0.36 °C 0.24 °C 0.93 °C 0.36 °C 0.47 °C	725 Process Calibrator
Resistance Simulation of RTD Temperature Measuring Instrumentation [1]	Pt 385, 1000 Ω For Measurement (-200 to 100) °C (100 to 630) ºC For Source (-200 to 100) °C (100 to 630) °C Ni120, 120 Ω (-80 to 260) ºC	 0.24 °C 0.36 °C 0.24 °C 0.24 °C 0.24 °C	725 Process Calibrator

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	High Voltage Decade Resistance Box
DC Voltage Measure	(0 to 200) mV 200 mV to 2 V (2 to 20) V (20 to 200) V (200 to 1 000) V	5.1 µV/V + 0.42 µV 3.5 µV/V + 1.4 µV 3.5 µV/V + 18 µV 5.5 µV/V + 0.12 mV 5.5 µV/V + 1.9 mV	8508A Multimeter
DC Voltage Measure [1]	(0 to 30) mV (30 to 300) mV 300 mV to 3.3 V (3.3 to 33) V (33 to 330) V (330 to 1 000) V	52 µV/V + 4.4 µV 41 µV/V + 7.1 µV 29 µV/V + 28 µV 47 µV/V + 38 mV 64 µV/V + 4.4 mV 1.2 mV/V + 0.26 V	3457A/189 Multimeter
DC High Voltage Measure [1]	(0 to 10) kV	5.8 mV/V+ 4.0 V	149-10A High Voltage Meter
DC Voltage Source	(0 to 220) mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1 100) V	7.8 µV/V + 0.63 µV 6.3 µV/V + 1.1 µV 6.3 µV/V + 6.6 µV 6.24 µV/V + 9.4 µV 7.1 µV/V + 97 µV 8.6 µV/V + 0.75 mV	5700A Multi Product Calibrator
DC Voltage Source [1]	(0 to 330) mV (0.33 to 3.3) V (3.3 to 33) V (33 to 330) V (330 to 1 000) V	16 µV/V + 1.4 µV 9.2 µV/V +1.7 µV 11 µV/V + 17 µV 15 µV/V + 0.13 mV 15 µV/V + 1.4 mV	5522A Multi Product Calibrator

Electrical – DC/Low Frequency **Bangkok, Thailand**

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

Electrical – DC/Low Frequency **Bangkok, Thailand**

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

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	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	5700A/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 Source	220 mV to 2.2 V		5700A/5522A Multi Product Calibrator
	(10 to 20) kHz	0.007 % or reading + 5.7 µV	
	(20 to 50) kHz	0.011 % of reading + 16µV	
	(50 to 100) kHz	0.022 % of reading + 62 µV	
	(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 µV	
	(50 to 60) Hz	0.007% of reading + 57 µV	
	(60 to 400) Hz	0.007% of reading + 58 µV	
	400 Hz to 1 kHz	0.007% of reading + 56 µV	
	(1 to 5) kHz	0.007% of reading + 57 µV	
	(5 to 10) kHz	0.007% of reading + 55 µV	
	(10 to 20) kHz	0.007% of reading + 57 µV	
	(20 to 50) kHz	0.012 % of reading + 0.16 mV	
	(50 to 100) kHz	0.022 % of reading + 0.31 mV	
	(100 to 300) kHz	0.053 % of reading + 1.4 mV	
	(300 to 500) kHz	0.12 % of reading + 3.9 mV	
	500 kHz to 1 MHz	0.24 % of reading + 7 mV	
	22 to 220 V		
	(10 to 20) Hz	0.047 % of reading + 7.8 mV	
	(20 to 40) Hz	0.015 % of reading + 2.4 mV	
	(40 to 50) Hz	0.0074 % of reading + 0.81 mV	
	(50 to 60) Hz	0.0074 % of reading + 0.81 mV	
	(60 to 400) Hz	0.0074 % of reading + 0.78 mV	
	400 Hz to 1 kHz	0.0074 % of reading + 0.79 mV	
	(1 to 5) kHz	0.0074 % of reading + 0.81 mV	
	(5 to 10) kHz	0.0074 % of reading + 0.79 mV	
	(10 to 20) kHz	0.0074 % of reading + 0.8 mV	
	(20 to 50) kHz	0.02 % of reading + 3.1 mV	
	(50 to 100) kHz	0.047 % of reading + 7.8 mV	

Electrical – DC/Low Frequency **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
AC Voltage Source [1]	(1 to 33) mV		5522A Multi Product Calibrator
	(10 to 45) Hz	0.064 % of reading + 4.7 µV	
	45 Hz to 10 kHz	0.017 % of reading + 4.7 µV	
	(10 to 20) kHz	0.02 % of reading + 4.7 µV	
	(20 to 50) kHz	0.08 % of reading + 4.8 µV	
	(50 to 100) kHz	0.28 % of reading + 9.7 µV	
	(100 to 450) kHz	0.63 % of reading + 39 µV	
	(33 to 330) mV		
	(10 to 45) Hz	0.024 % of reading + 6.3 µV	
	45 Hz to 10 kHz	0.012 % of reading + 6.3 µV	
	(10 to 20) kHz	0.014% of reading + 6.3 µV	
	(20 to 50) kHz	0.028% of reading + 6.3 µV	
	(50 to 100) kHz	0.063 % of reading + 25 µV	
	(100 to 500) kHz	0.16 % of reading + 55 µV	
	330 mV to 3.3 V		
	(10 to 45) Hz	0.024 % of reading +43 µV	
	45 Hz to 10 kHz	0.012 % of reading + 49 µV	
	(10 to 20) kHz	0.015 % of reading + 50 µV	
	(20 to 50) kHz	0.024 % of reading + 40 µV	
	(50 to 100) kHz	0.055 % of reading + 99 µV	
	(100 to 500) kHz	0.19 % of reading + 0.47 mV	
	(3.3 to 33) V		
	(10 to 45) Hz	0.024 % of reading + 0.51 mV	
	45 Hz to 10 kHz	0.012 % of reading + 0.47 mV	
	(10 to 20) kHz	0.019 % of reading + 0.47 mV	
	(20 to 50) kHz	0.028 % of reading + 0.47 mV	
	(50 to 100) kHz	0.072 % of reading + 1.5 mV	
	(33 to 330) V		
	45 Hz to 1kHz	0.16 % of reading + 1.6 mV	
	(1 to 10) kHz	0.016 % of reading + 4.7 mV	
	(10 to 20) kHz	0.02 % of reading + 4.7 mV	
	(20 to 50) kHz	0.024 % of reading + 4.7 mV	
	(50 to 100) kHz	0.16 % of reading + 39 mV	
	(330 to 1 000) V		
	45 Hz to 1kHz	0.024 % of reading + 7.9 mV	
	(1 to 5) kHz	0.02 % of reading + 8.4 mV	
	(5 to 10) kHz	0.024 % of reading + 8 mV	

Electrical – DC/Low Frequency **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Millivolt Simulation of Thermocouple Temperature Measuring Instrumentation	Type B		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	

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 (250 to 400) °C (400 to 1 000) °C (1 000 to 1 767) °C Type S (0 to 250) °C (250 to 1 000) °C (1 000 to 1 400) °C (1 400 to 1 767) °C Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C Type U (-200 to 0) °C (0 to 600) °C	 0.48 °C 0.28 °C 0.26 °C 0.3 °C 0.47 °C 0.36 °C 0.37 °C 0.46 °C 0.63 °C 0.24 °C 0.16 °C 0.14 °C 0.5 6°C 0.27 °C	5522A Multi Product Calibrator
Source and Measure Millivolt Simulation of Thermocouple Temperature Measuring Instrumentation [1]	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 800) °C Type E (-200 to 0) °C (0 to 950) °C Type J (-200 to 0) °C (0 to 1 200) °C Type K (-200 to 0) °C (0 to 1370) °C Type L (-200 to 0) °C (0 to 900) °C Type N (-200 to 0) °C (0 to 400) °C	 2.2 °C 1.8 °C 1.4 °C 0.9 °C 0.7 °C 1 °C 0.7 °C 1.2 °C 0.7 °C 0.85 °C 0.7 °C 1.5 °C 0.9 °C	725 Process Calibrator

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 (0 to 500) °C (500 to 1 750) °C Type S (-20 to 0) °C (0 to 500) °C (500 to 1 750) °C Type T (-200 to 0) °C (0 to 400) °C Type U (-200 to 0) ºC (0 to 400) ºC	 2.5 °C 1.8 °C 1.4 °C 2.5 °C 1.8 °C 1.5 °C 1 °C 0.8 °C 1.1 °C 0.75 °C	725 Process Calibrator
Capacitance Source [1] 10 Hz to 10 kHz 10 Hz to 10 kHz 10 Hz to 3 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz 10 Hz to 1 kHz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz 50 Hz 20 Hz 6 Hz 2 Hz 0.6 Hz 0.2 Hz	 (0.22 to 0.4) nF (0.4 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 110) nF (110 to 330) nF (0.33 to 1.1) µF (1.1 to 3.3) µF (3.3 to 11) µF (11 to 33) µF (33 to 110) µF (110 to 330) µF (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	 2 % of reading + 7.8 pF 0.63% of reading + 7.8 pF 0.46 % of reading + 7.8 pF 0.21 % of reading + 9.7 pF 0.21 % of reading + 97 pF 0.21 % of reading + 0.63 nF 0.21 % of reading + 0.97 nF 0.21 % of reading + 6.3 nF 0.21 % of reading + 9.7 nF 0.32 % of reading + 62 nF 0.38 % of reading + 97 nF 0.37 % of reading + 0.63 µF 0.36 % of reading + 1.1 µF 0.35 % of reading + 6.3 µF 0.35 % of reading + 9.7 µF 0.59 % of reading + 24 µF 0.85 % of reading + 78 µF	5522A Multi Product Calibrator
DC Power Source [1] PF = 1	(0 to 90) W (90 to 150) W (150 to 600) W 600 W to 6 kW (6 to 12) kW	0.018 % of reading + 1 mW 0.018 % of reading + 7.1 mW 0.018 % of reading + 7.6 mW 0.055 % of reading + 58 mW 0.07 % of reading + 0.58 W	5522A Multi Product Calibrator

Electrical – DC/Low Frequency **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 + 2.2 mW 0.071 % of reading + 7.6 mW 0.079 % of reading + 12 mW 0.079 % of reading + 58 mW 0.0.79 % of reading + 0.58 W	5522A Multi Product Calibrator
AC Power Source [1] 400 Hz PF = 1, Single Phase	(0.1 to 2 000) W	0.045 % of reading + 0.58mW	5522A Multi Product Calibrator
LCR Meters [1] Capacitance (1 to 10) kHz (10.01 to 100) kHz (100 to 999.9) Hz (1 to10) kHz (10.01 to100) kHz (100 to 999.9) Hz (1 to 10) kHz (10.01 to 100) kHz (100 to 999.9) Hz (1 to10) kHz (10.01 to100) 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	Standard Air Capacitor
LCR Meters [1] Resistance (100 to 999.9) Hz 1 kHz (>1 to100) kHz (100 to 999.9) Hz 1 kHz >1 kHz to100 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	Decade Resistance Box

Electrical – DC/Low Frequency **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
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	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	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	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 Time Marker into 50 Ω[2] Rise Time	 (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) 5 s to 50 ms 20 ms to 2 ns ≤ 300 ps	 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 (23 + t*1 000) ps 2.9 ps 30 ps	Fluke 5522A Multi Product Calibrator
Gauss Tesla Meter	20 mT 100 mT 1 000 mT	0.23 mT 0.87 mT 5.8 mT	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	Gauge Block
External Micrometers [1] Flatness Up to 25 mm diameter	(0 to 0.5) µm	0.2 µm	Optical Parallel or Optical Flat
External Micrometers [1] Parallelism Up to 50 mm diameter	(0 to 0.5) µm	0.2 µm	Optical Parallel
Calipers [1]	(0 to 1 000) mm (1 000 to 2 000) mm	1 µm 20 µm	Gauge Block and Caliper Checker
(Digital/Dial) Caliper Gauge[1]	(0 to 150) mm	0.001 mm	Gauge Block or Ring Gauge
Depth Micrometers [1]	(0 to 300) mm	1 µm	Gauge Block
Stick/ Inside Micrometers	(0 to 600) mm	1 µm	Universal Length Measuring Machine (ULM)
Stick/ Inside Micrometers [1]	(0 to 1 000) mm	3 µm	Gauge Blocks
Internal Micrometers [1] 2 leg type	(0 to 200) mm	1 µm	Ring Gauge or Gauge Block
Micrometer Heads	(0 to 100) mm	1 µm	Universal Length Measuring Machine (ULM)
Micrometer Heads [1]	(0 to 50) mm	1 µm	Gauge Blocks
Calibration Testers [1]	(0 to 100) mm	0.3 µm	Linear Gauge and Gauge Block
Calibration Testers [1]	(0 to 50) mm	0.3 µm	Gauge Blocks and Digimatic Indicator
Height Masters [1] Micrometer Linearity Height Parallelism	 (0 to 25) mm (0 to 300) mm (300 to 600) mm (0 to 0.02) mm	 0.3 µm 0.6 µm 1 µm 0.2 µm	Comparison with Gauge Block
Screw Thread Micrometers [1]	(0 to 100) mm	1 µm	Gauge Block or Pin Gauge
Caliper Checkers, Depth Micro Checker [1]	(0 to 630) mm	0.6 µm	Comparison with Gauge Block

Length – Dimensional Metrology **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Height Gauges [1]	(0 to 1 000) mm	3 µm	Gauge Block or Caliper Checker
Linear Height Gauges [1]	(0 to 1 000) mm	1 µm	Gauge Block or Caliper Checker
Setting Master for Linear Height Gauges [1]	(0 to 25) mm	0.4 µm	Gauge Block or Universal Length Measuring Machine (ULM)
Depth Gauges [1]	(0 to 600) mm	6 µm	Gauge Block
MU Checker	Up to 5 mm	0.2 µm	Gauge Block or Calibration Tester
Dial Indicator [1]	Up to 10 mm	0.6 µm	Dial Gauge Calibrator
Dial Test Indicator [1]	Up to 3 mm	0.5 µm	Dial Gauge Calibrator
Digimatic Indicator [1] Linear Gauge	(0 to 30) mm (30 to 100) mm (100 to 150) mm	1.3 µm 1.4 µm 2 µm	Gauge Block
Digital/Dial Thickness Gauges [1]	(0 to 100) mm	1 µm	Gauge Block
Dial Gauge Calibrator [1]	(0 to 100) mm	0.2 µm	Gauge Block or Mu Checker
Dial Depth Gauges [1]	(0 to 200) mm	2 µm	Gauge Block
Plain Plug Gauge / Pin Gauge (External Diameter, Enteral Length)	(0 to 25) mm	0.7 µm	Outside Micrometer, Gage Block
Plain Plug Gauge / Pin Gauge (External Diameter, Enteral Length)	(1 to 25) mm (>25 to 50) mm (>50 to 100) mm (>100 to 150) mm (>150 to 200) mm (>200 to 300) mm (>300 to 400) mm	0.3 µm 0.4 µm 0.5 µm 0.7 µm 0.8 µm 0.9 µm 1.1 µm	Universal Length Measuring Machine (ULM), Gauge Block
Plain Plug Gauge / Pin Gauge Circularity	(0 to 1) mm	0.03 µm	Roundness Tester Machine
Thread Wires External Diameter	Up to 10 mm	0.3 µm	Universal Length Measuring Machine (ULM), Gauge Block

Length – Dimensional Metrology **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Thread Wires Circularity	(0 to 1) mm	0.03 µm	Roundness Tester Machine
Plain Ring Gauges Snap Gauge (Internal Diameter, Internal Length)	(>1 to 50) mm (>50 to 150) mm (>150 to 200) mm (>200 to 250) mm	0.5 µm 0.6 µm 0.7 µm 0.9 µm	Universal Length Measuring Machine (ULM), Master Ring Gauge
Plain Ring Gauges Circularity	(0 to 1) mm	0.03 µm	Roundness Tester Machine
Threaded Plug Gauges Major Diameter	(1 to 50) mm (50 to 100) mm (100 to 150) mm	0.8 µm 1 µm 1.3 µm	Universal Length Measuring Machine (ULM)
Threaded Plug Gauges Pitch Diameter	(1 to 50) mm (50 to 100) mm (100 to 150) mm	1.6 µm 1.6 µm 1.7 µm	Universal Length Measuring Machine (ULM), Thread Wires
Tapered Ring Gauge Diameter	Up to 100 mm	1.3 µm	Universal Length Measuring Machine (ULM)
Tapered Ring Gauge Step Height	Up to 75mm	2 µm	Micrometer
Tapered Plug Gauge Diameter	Up to 75 mm	1.2 µm	Universal Length Measuring Machine (ULM)
Tapered Plug Gauge Step Height	Up to 75 mm	2 µm	Micrometer
Tapered Thread Plug Gauges Pitch Diameter	Up to 150 mm	3.1 µm	Universal Length Measuring Machine (ULM)
Tapered Thread Plug Gauges Taper	(0 to 10)°	4‘	Profile Projector
Tapered Thread Plug Gauges Step Height	Up to 75 mm	2 µm	Micrometer
Thread Ring Gauges Minor Diameter	Up to 50 mm (50 to 100) mm	2.5 µm 3.2 µm	Digimatic Holtest, Inside Micrometer
Thread Ring Gauges Pitch Diameter	Up to 50 mm (50 to 100) mm	1.1 µm 1.6 µm	Universal Length Measuring Machine (ULM) Master Thread Plug Gauge
	(1 to 3) mm	0.9 µm	

Length – Dimensional Metrology **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Tapered Thread Ring Gauges Step Height	Up to 75 mm	2 µm	Micrometer
Tapered Thread Ring Gauges Pitch Diameter	Up to 100 mm	1.6 µm	Universal Length Measuring Machine (ULM), Probing System
Feeler Gauges/ Shim Stock/ Calibration Foil [1]	(1 to 10) mm	0.3 µm	Universal Length Measuring Machine (ULM) Gauge Block
Feeler Gauges/ Shim Stock/ Calibration Foil [1]	(1 to 10) mm	0.6 µm	Outside Micrometer, Gauge Block
Coating Thickness Gauge	Up to 1 500 µm	0.9 µm	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	Planekator (Straight Edge) or Mu-Checker Repeat-O-Meter
Dial Gauge Stands [1] Flatness	Up to 1 mm	0.3 µm	Mu-Checker or Dial Test Indicator or Optical Flats
Profile Projectors [1] X-Y axis Linearity X-Y axis Linearity	 (0 to 50) mm (50 to 100) mm (100 to 200) mm (200 to 300) mm (300 to 400) mm (400 to 500) mm (0 to 50) mm (50 to 100) mm (100 to 200) mm (200 to 300) mm (300 to 400) mm (400 to 500) mm	 1.4 µm 2.1 µm 3 µm 3.4 µm 4.6 µm 4.9 µm 0.6 µm 0.8 µm 1.5 µm 2.1 µm 2.7 µm 3.3 µm	 Glass Scale Gauge Block
Profile Projectors [1] Magnification) Rotation Angle	5X 10X 20X 50X 100X (0 to 360)°	0.04 % magnification 0.02 % magnification 0.01 % magnification 0.01 % magnification 0.01 % magnification 2'	Master Ball Crosshair Angle

Length – Dimensional Metrology **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Measuring Microscopes [1]			
X-Y axis Linearity	(0 to 10) mm (10 to 50) mm (50 to 100) mm (100 to 200) mm (200 to 300) mm (300 to 400) mm (400 to 500) mm	0.8 µm 1.4 µm 2.1 µm 3.0 µm 3.4 µm 4.6 µm 4.9 µm	Glass Scale
X-Y axis Linearity	(0 to 50) mm (50 to 100) mm (100 to 200) mm (200 to 300) mm (300 to 400) mm (400 to 500) mm	0.6 µm 0.8 µm 1.5 µm 2.1 µm 2.7 µm 3.3 µm	Gauge Block or
X-Y axis Linearity	(0 to 25) mm (25 to 50) mm	0.8 µm 1.1 µm	Pin Gauge
Z axis Linearity	(0 to 50) mm (50 to 100) mm (100 to 200) mm (200 to 300) mm	0.6 µm 0.8 µm 1.5 µm 2.1 µm	Gauge Block
Bore Gauges	(0 to 300) mm	1 µm	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	Setting Ring Gauge
Straight Edges [1]	Up to 1 000 mm	0.2 µm	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	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	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	Granite Square

Length – Dimensional Metrology **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
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	Gauge Block
Micrometer Setting (End) Rods	(25 to 1 00) mm (100 to 1 000) mm	0.3 µm 0.5 µm	Mu-Checker and Gauge Block
Bevel Protractors Up to 300 mm	0 to 360 º	3 ‘	Profile Projector or Angle Gauge
Inclinometers	(0 to 90) °	0.05 °	Angle Gauge
Analog Levels to 300 mm	(0 to 0.10) mm/m	0.01 mm/m	Sine bar and Gauge Block
Gauge Block Comparators [1]	(0.5 to 100) mm	0.05 µm	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	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	Universal Length Measuring Machine (ULM) or Gauge Block Grade K
Angle Block	(0 to 360)°	15“	CMM

Length – Dimensional Metrology **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Optical Flats/Parallels Flatness Thickness Parallelism	To 10 µm To 1 mm	0.05 µm 0.3 µm 0.04 µm	Optical Flat
Sine Bars Roll Distance Parallelism	(25 to 300) mm (0 to 0.01) mm	0.4 µm 1 µm	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	Dial Test Indicator
Parallels Straightedge [1]	Up to 1 000 mm	1.7 µm	Dial Test Indicator and Surface Plate
Bench Centers [1] Height Centrality	Up to 1 000 mm Up to 200 mm	1.4 µm	Concentric Gauge
Surface Roughness Testers [1]	Up to 1 000 µm	0.019 µm	Roughness Standard
Surface Roughness Standards	Up to 15 µm	0.02 µm	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	Glass Hemisphere, Gauge Block, Optical Flat, Magnification Checker, Ring Gauge
Magnification Checker (for Roundness Machines)	(0 to 0.4) mm	0.3 µm	Mu Checker
Contour Measuring Machines [1] Radius	Z-Axis (0 to 100 mm X-Axis (0 to 60 mm Range?	2.4 µm 2.4 µm 0.5 µm	Contour Standard, Master Ball Unit
Dimensional Air Gauges [1]	Up to 5 mm	0.5 µm	Gauge Block or Dial Gauge

Length – Dimensional Metrology **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
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 ’’	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	Profile Projector
Parallel Bar [1]	Up to 300 mm	0.8 µm	Dial Test or Micrometer
Laser Scan Micrometer[1]	(0 to 25) mm	0.5 µm	Pin Gauge

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 Up to 200 g Up to 400 g Up to 1 000 g Up to 2 000 g Up to 5000 g Up to 10 kg Up to 50 kg Up to 300 kg Up to 1 000 kg Up to 2 000 kg	0.026 mg 0.12 mg 0.72 mg 0.0019 g 0.0029 g 0.0064 g 0.01 g 0.1 g 0.01 kg 0.030 kg 0.036 kg	Standard Weight
Torque Wrenches [1]	(0 to 10) N·m (10 to 50) N·m (50 to 200) N·m (200 to 500) N·m (500 to 1 000) N·m	0.014 N·m 0.3 N·m 0.61 N·m 1.5 N·m 3.6 N·m	Torque Transducer
Torque Meter / Gauge [1]	Up to 2 N·m Up to 10 N·m (10 to 100) N·m (100 to 1 000) N·m	0.06 cN·m 0.006 N·m 0.013 N·m 0.06 N·m	Torque Arm or Torque Transducer

Mass and Mass Related **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Force Testing Machines[1] and Load Cells Compression and Tension [1]	(0 to 10) N (10 to 100) N (100 to 1 000) N (1 to 5) kN (5 to 10) kN (10 to 50) kN (50 to 100) kN (100 to 250) kN (250 to 500) kN	0.006 N 0.043 N 0.5 N 0.003 kN 0.005 kN 0.009 kN 0.06 kN 0.08 kN 0.42 kN	Direct measurement to reference load cell or Standard Weight
Force Gauges	(0 to 100) N (100 to 200) N (200 to 500) N (500 to 1 000) N (1 000 to 5 000) N	0.006 N 0.06 N 0.06 N 0.6 N 0.9 N	Reference Masses
Universal Length Measuring Machines (ULM) [1] Force	(0 to 5) N	0.1 N	Load Cell, Force Gage
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

Mass and Mass Related **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
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	Rockwell Hardness Tester Machine
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	Micro Hardness Tester Machine
Durometer Force (expressed as degrees or percentage of scale pointer rotation)	(0 to 100) %	0.065 %	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	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	Hydraulic Gage Comparison / Dead Weight Tester

Mass and Mass Related **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
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
Mass Flow Rate [1]	(0.5 to 592) mg/min (0.5 to 59.2) g/min (60 to 592) g/min	0.8 % of reading + 2.5 mg/min 0.8 % of reading + 0.25 g/min 0.8 % of reading + 2.1 g/min	Standard Flow Meter
Volumetric Flow Rate [1] Gas	(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	Standard Flow Meter
Gas Detector[1] Oxygen (0_2) Methane (CH_4) Hydrogen sulphide (H2S) Carbon Monoxide (CO)	18 cmol / mol 2.2 mmol/ mol 25 µmol/mol 100 µmol/mol	0.3 cmol / mol 0.4 mmol/ mol 2.0 µmol/mol 1.6 µmol/mol	Standard Gas (CRM)
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	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	Precision Balance ASTM E542-01

Mass and Mass Related **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
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	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	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	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	Precision Balance ISO 8655-6
Syringes	(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	0.13 µl 0.23 µl 0.52 µl 0.78 µl 1.3 µl	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	Precision Balance

Mass and Mass Related **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
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	Precision Balance
Viscosity Cup / Dip-type Viscosity cup	(15 to 250) sec	0.49 sec	Viscosity standard oil, Stopwatch, Digital Thermometer
Rotational Viscometer	(5 to 100) (100 to 1 000) (1 000 to 5 000) (5 000 to 12 500) (12 500 to 30 000) (30 000 to 60 000) (60 000 to 100 000)	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	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	Lux Meter
UVA Meter [1] Wavelength (290 to 390) nm	(0 to 20) mW/cm^2	0.074 mW/cm^2	UVA Meter
UVC Meter [1] Wavelength (200 to 290) nm	(0 to 20) mW/cm^2	0.074 mW/cm^2	UVC Meter

Photometry and Radiometry **Bangkok, Thailand**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Spectrometer[1] Wavelength Holmium filter	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	Holmium Glass Filter
Didymium 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 UV	235 nm 257 nm 313 nm 350 nm	0.0076 Abs	Potassium Dichromate Filter
Visible	440 nm 465 nm 546.1 nm 590 nm 635 nm	0.0042 Abs	Neutral Density Glass Filter

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 600) ºC	0.9 ºC 1.9 ºC 3.5 ºC	Datalogger with Thermocouple Sensors
Humidity Measure [1] System Accuracy Tests of Chambers, Ovens, Freezers, Incubators, or Refrigerators	(20 to 85) %RH	3.5 %RH	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	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	Blackbody Source and reference thermocouple thermometer $\varepsilon = 0.95$, $\lambda = (8 \text{ to } 14)$ µm
Thermohygrometers	(30 to 95) %RH @ 25 °C (15 to 45) °C @ 50 %RH	1.5 %RH 0.1 ºC	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 ºC 0.018 ºC 0.031 ºC	Semi-SPRT and Liquid Bath / Temperature bath
	(-40 to 140) °C (140 to 600) °C	0.027 ºC 0.18 ºC	Semi-SPRT and Dry Block
Dry Block Calibrators	(-20 to 650) °C	0.18 ºC	Reference PRT
Surface Type Thermocouple Based Temperature Measuring Systems [1] (Up to 60 mm long)	(50 to 350) °C	1.3 ºC	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	Temperature Baths

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	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	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	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	 0.4 °C 1.1 °C 2 °C 3.5 °C 0.4 °C 1.1 °C 2 °C 3.3 °C	Dry Block

Thermodynamic **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Thermocouple Sensors [1]	Type K		Dry Block
	(-20 to 140) °C	0.4 °C	
	(140 to 400) °C	1.1 °C	
	(400 to 600) °C	2 °C	
	(600 to 1 000) °C	3.3 °C	
	(1 000 to 1 200) °C	5 °C	
	Type N		
	(-20 to 140) °C	0.4 °C	
	(140 to 400) °C	1.1 °C	
	(400 to 600) °C	2 °C	
	(600 to 1 000) °C	3.3 °C	
	Type R		
	(-20 to 140) °C	0.24 °C	
	(140 to 400) °C	0.55 °C	
	(400 to 600) °C	1.5 °C	
	(600 to 1 000) °C	2.4 °C	
	(1 000 to 1 200) °C	4.1 °C	
	Type S		
	(-20 to 140) °C	0.24 °C	
	(140 to 400) °C	0.55 °C	
	(400 to 600) °C	1.5 °C	
	(600 to 1 000) °C	2.4 °C	
	(1 000 to 1 200) °C	4.1 °C	
	Type T		
	(-20 to 140) °C	0.4 °C	
	(140 to 400) °C	1 °C	
Thermocouple Sensors [1]	Type E		Temperature Baths
	(-20 to 95) °C	0.24 °C	
	(95 to 200) °C	0.47 °C	
	Type J		
	(-20 to 95) °C	0.24 °C	
	(95 to 200) °C	0.47 °C	
	Type K		
	(-20 to 95) °C	0.24 °C	
	(95 to 200) °C	0.47 °C	
	Type N		
	(-20 to 95) °C	0.24 °C	
	(95 to 200) °C	0.47 °C	

Thermodynamic **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Thermocouple Sensors [1]	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	 0.1 °C 0.16 °C 0.1 °C 0.16 °C 0.24 °C 0.47 °C	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 with Semi-SPRT with indicator standard thermocouple or Dry block or Liquid Bath
Analog and Digital Thermometers [1]	(-20 to 140) °C (140 to 400) °C (400 to 600) °C (600 to 1 000) °C	0.2 °C 0.5 °C 1.5 °C 2.3 °C	Dry Block
Liquid in Glass Thermometers Scale Graduation: 0.1°C	(-20 to 200) °C	0.1 °C	Reference PRT with Temperature Baths
Autoclaves [1]	(110 to 130) °C	0.73 °C	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	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	Digital Motor Monitored with non-contact Tachometer
Frequency Measuring Instruments [1]	(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	5522A Multi Product Calibrator

Time and Frequency **Bangkok, Thailand**

Parameter / Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Timers and Stopwatches [1]	1 s to 120 min	0.11 s	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	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	Coordinate Measuring Machine (CMM)
Length	X: (0 to 680) mm	0.4 µm	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	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‘	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	Profile Projector
Geometric Dimensional Measurements of Jigs, Fixtures, Gauges, First Artefacts Angle [3]	(0 to 360)°	52"	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	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	0.06 pH 0.06 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 % 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
Refractometers [1,5]	(5, 10, 30, & 60) %Brix	0.07 %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	
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 8 nF	
10 Hz to 1 kHz	(3.3 to 11) nF	0.2 % of reading + 0.009 7 nF	Multiproduct Calibrator
10 Hz to 1 kHz	(11 to 33) nF	0.2 % of reading + 0.097 nF	
10 Hz to 1 kHz	(33 to 110) nF	0.2 % of reading + 0.097 nF	
10 Hz to 1 kHz	(110 to 330) nF	0.2 % of reading + 0.63 nF	
10 Hz to 600 Hz	(0.33 to 1.1) µF	0.2 % of reading + 0.97 nF	

Electrical – DC/Low Frequency **Singapore**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Capacitance Source [1]			Multiproduct Calibrator
10 Hz to 300 Hz	(1.1 to 3.3) µF	0.2 % of reading + 6.3 nF	
10 Hz to 150 Hz	(3.3 to 11) µF	0.2 % of reading + 13 nF	
0 Hz to 120 Hz	(11 to 33) µF	0.32 % of reading + 24 nF	
10 Hz to 80 Hz	(33 to 110) µF	0.35 % of reading + 0.13 µF	
(0 to 50) Hz	(110 to 330) µF	0.35 % of reading + 0.63 µF	
(0 to 20) Hz	(0.33 to 1.1) mF	0.35 % of reading + 1.1 µF	
(0 to 6) Hz	(1.1 to 3.3) mF	0.35 % of reading + 6.3 µF	
(0 to 2) Hz	(3.3 to 11) mF	0.35 % of reading + 13 µF	
(0 to 0.6) Hz	(11 to 33) mF	0.59 % of reading + 55 µF	
(0 to 0.2) Hz	(33 to 110) mF	0.86 % of reading + 78 µF	
DC Current Source [1]	(0 to 330) µA	0.012 % of reading + 0.02 µA	Multiproduct Calibrator
	(0.33 to 3.3) mA	0.007 8 % of reading + 0.04 µA	
	(3.3 to 33) mA	0.007 8 % of reading + 0.2 µA	
	(33 to 330) mA	0.007 8 % of reading + 2.1 µA	
	(0.33 to 1.1) A	0.016 % of reading + 0.04 mA	
	(1.1 to 3) A	0.03 % of reading + 0.05 mA	
	(3 to 11) A	0.039 % of reading + 0.7 mA	
	(11 to 20.5) A	0.078 % of reading + 0.59 mA	
DC Current Clamp Meters [1]	(0 to 16.5) A	0.01 % of reading + 58 mA	Multiproduct Calibrator and Coil
	(16.5 to 55) A	0.29 % of reading + 0.2 A	
	(55 to 150) A	0.29 % of reading + 0.2 A	
	(150 to 550) A	0.04 % of reading + 0.2 A	
	(550 to 1 000) A	0.08 % of reading + 0.2 A	
AC Current Source [1]	(29 to 330) µA		Multiproduct Calibrator
	(10 to 20) Hz	0.16 % of reading + 0.08 µA	
	(20 to 45) Hz	0.12 % of reading + 0.08 µA	
	45 Hz to 1 kHz	0.1 % of reading + 0.08 µA	
	(1 to 5) kHz	0.24 % of reading + 0.12 µA	
	(5 to 10) kHz	0.63 % of reading + 0.16 µA	
	(10 to 30) kHz	1.3 % of reading + 0.32 µA	
	(0.33 to 3.3) mA		
	(10 to 20) Hz	0.16 % of reading + 0.12 µA	
	(20 to 45) Hz	0.1 % of reading + 0.12 µA	
	45 Hz to 1 kHz	0.08 % of reading + 0.12 µA	
	(1 to 5) kHz	0.16 % of reading + 0.16 µA	
	(5 to 10) kHz	0.39 % of reading + 0.24 µA	
	(10 to 30) kHz	0.78 % of reading + 0.47 µA	

Electrical – DC/Low Frequency **Singapore**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Current Source [1]	(3.3 to 33) mA		Multiproduct Calibrator
	(10 to 20) Hz	0.14 % of reading + 1.6 µA	
	(20 to 45) Hz	0.07 % of reading + 1.6 µA	
	45 Hz to 1 kHz	0.04 % of reading + 1.6 µA	
	(1 to 5) kHz	0.07 % of reading + 1.6 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 20) Hz	0.14 % of reading + 0.02 mA	
	(20 to 45) Hz	0.07 % of reading + 0.02 mA	
	45 Hz to 1 kHz	0.04 % of reading + 0.02 mA	
	(1 to 5) kHz	0.08 % of reading + 0.04 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 + 0.13 mA	
	45 Hz to 1 kHz	0.05 % of reading + 0.09 mA	
	(1 to 5) kHz	0.47 % of reading + 0.78 mA	
	(5 to 10) kHz	2 % of reading + 3.9 mA	
	(3 to 11) A		
	(45 to 100) Hz	0.05 % of reading + 1.7 mA	
	100 Hz to 1 kHz	0.08 % of reading + 1.7 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	
AC Current Clamp Meters [1]	(10 to 16.5) A		Multiproduct Calibrator and Coil
	(45 to 65) Hz	0.33 % of reading + 58 mA	
	(65 to 100) Hz	0.92 % of reading + 58 mA	
	(100 to 440) Hz	0.93 % of reading + 58 mA	
	(16.5 to 150) A		
	(45 to 65) Hz	0.34 % of reading + 65 mA	
	(65 to 100) Hz	0.92 % of reading + 66 mA	
	(100 to 440) Hz	0.94 % of reading + 66 mA	
	(150 to 1 000) A		
	(45 to 65) Hz	0.34 % of reading + 0.12 A	
	(65 to 100) Hz	0.92 % of reading + 130 mA	
	(100 to 440) Hz	1.2 % of reading + 0.13 A	

Electrical – DC/Low Frequency **Singapore**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Resistance Source [1]	(0 to 11) Ω	0.003 2 % of reading + 0.78 mΩ	Multiproduct Calibrator
	(11 to 33) Ω	0.002 4 % of reading + 12 mΩ	
	(33 to 110) Ω	0.002 2 % of reading + 12 mΩ	
	(110 to 330) Ω	0.002 2 % of reading + 16 mΩ	
	(0.33 to 1.1) kΩ	0.002 2 % of reading + 16 mΩ	
	(1.1 to 3.3) kΩ	0.002 2 % of reading + 16 mΩ	
	(3.3 to 11) kΩ	0.002 2 % of reading + 78 mΩ	
	(11 to 33) kΩ	0.002 2 % of reading + 0.78 Ω	
	(33 to 110) kΩ	0.002 2 % of reading + 0.78 Ω	
	(110 to 330) kΩ	0.002 5 % of reading + 7.8 Ω	
	(0.33 to 1.1) MΩ	0.002 5 % of reading + 7.8 Ω	
	(1.1 to 3.3) MΩ	0.004 7 % of reading + 0.12 kΩ	
	(3.3 to 11) MΩ	0.01 % of reading + 20 kΩ	
	(11 to 33) MΩ	0.02 % of reading + 3 kΩ	
	(33 to 110) MΩ	0.039 % of reading + 2.9 kΩ	
	(110 to 330) MΩ	0.24 % of reading + 0.11 MΩ	
	(330 to 1 100) MΩ	1.2 % of reading + 1.4 MΩ	
RTD Indicating Instruments [1]	PT385, 100 Ω		Multiproduct Calibrator
	(-200 to 0) °C	0.04 °C	
	(0 to 100) °C	0.05 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.08 °C	
	(400 to 630) °C	0.09 °C	
	(630 to 800) °C	0.18 °C	
	PT3926, 100 Ω		
	(-200 to 0) °C	0.04 °C	
	(0 to 100) °C	0.05 °C	
	(100 to 300) °C	0.07 °C	
	(300 to 400) °C	0.08 °C	
	(400 to 630) °C	0.09 °C	
	PT385, 200 Ω		
	(-200 to 0) °C	0.04 °C	
	(0 to 100) °C	0.05 °C	
	(100 to 260) °C	0.07 °C	
	(260 to 300) °C	0.08 °C	
	(300 to 400) °C	0.09 °C	
	(400 to 630) °C	0.18 °C	

Electrical – DC/Low Frequency **Singapore**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
RTD Indicating Instruments [1]	PT385, 1 000 Ω		Multiproduct Calibrator
	(-200 to 0) °C	0.04 °C	
	(0 to 100) °C	0.05 °C	
	(100 to 260) °C	0.07 °C	
	(260 to 300) °C	0.08 °C	
	(300 to 630) °C	0.09 °C	
	PT3916, 100 Ω		
	(-200 to -190) °C	0.19 °C	
	(-190 to -80) °C	0.03 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 260) °C	0.05 °C	
	(260 to 300) °C	0.06 °C	
	(300 to 400) °C	0.07 °C	
	(400 to 600) °C	0.08 °C	
DC Voltage Source [1]	(0 to 330) mV	0.001 6 % of reading + 2 µV	Multiproduct Calibrator
	(0.33 to 3.3) V	0.000 9 % of reading + 2 µV	
	(3.3 to 33) V	0.001 % of reading + 17 µV	
	(33 to 330) V	0.001 4 % of reading + 0.14 mV	
	(330 to 1 000) V	0.001 4 % of reading + 1.4 mV	
AC Voltage Source [1]	(1.0 to 33) mV		Multiproduct Calibrator
	(10 to 45) Hz	0.063 % of reading + 5 µV	
	45 Hz to 10 kHz	0.012 % of reading + 5 µV	
	(10 to 20) kHz	0.016 % of reading + 5 µV	
	(20 to 50) kHz	0.078 % of reading + 5 µV	
	(50 to 100) kHz	0.28 % of reading + 10 µV	
	(100 to 500) kHz	0.63 % of reading + 40 µV	
	(33 to 330) mV		
	(10 to 45) Hz	0.024 % of reading + 7 µV	
	45 Hz to 10 kHz	0.012 % of reading + 7 µV	
	(10 to 20) kHz	0.013 % of reading + 7 µV	
	(20 to 50) kHz	0.028 % of reading + 7 µV	
	(50 to 100) kHz	0.063 % of reading + 25 µV	
	(100 to 500) kHz	0.16 % of reading + 55 µV	
	(0.33 to 3.3) V		
	(10 to 45) Hz	0.024 % of reading + 0.05 mV	
	45 Hz to 10 kHz	0.012 % of reading + 0.05 mV	
	(10 to 20) Hz	0.015 % of reading + 0.05 mV	
	(20 to 50) kHz	0.024 % of reading + 0.04 mV	
	(50 to 100) kHz	0.055 % of reading + 0.1 mV	
	(100 to 500) kHz	0.19 % of reading + 0.5 mV	

Electrical – DC/Low Frequency **Singapore**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
AC Voltage Source [1]	(3.3 to 33) V		Multiproduct Calibrator
	(10 to 45) Hz	0.024 % of reading + 0.6 mV	
	45 Hz to 10 kHz	0.012 % of reading + 0.5 mV	
	(10 to 20) kHz	0.019 % of reading + 0.5 mV	
	(20 to 50) kHz	0.028 % of reading + 0.5 mV	
	(50 to 100) kHz	0.07 % of reading + 1.5 mV	
	(33 to 330) V		
	45 Hz to 1 kHz	0.015 % of reading + 1.6 mV	
	1 kHz to 10 kHz	0.016 % of reading + 4.7 mV	
	(10 to 20) kHz	0.020 % of reading + 4.7 mV	
	(20 to 50) kHz	0.024 % of reading + 4.7 mV	
	(50 to 100) kHz	0.16 % of reading + 39 mV	
	(330 to 1 000) V		
	45 Hz to 1 kHz	0.024 % of reading + 7.9 mV	
	(1 to 5) kHz	0.02 % of reading + 7.9 mV	
	(5 to 10) kHz	0.024 % of reading + 8 mV	
Thermocouple Indicating Instruments [1]	Type E		Multiproduct Calibrator
	(-250 to -100) °C	0.5 °C	
	(-100 to 1 000) °C	0.2 °C	
	Type J		
	(-210 to 1 200) °C	0.3 °C	
	Type K		
	(-200 to 1 372) °C	0.4 °C	
	Type N		
	(-200 to 1 300) °C	0.4 °C	
	Type R		
	(0 to 1 767) °C	0.9 °C	
	Type S		
	(0 to 1 767) °C	0.7 °C	
	Type T		
	(-250 to -150) °C	0.5 °C	
	(-150 to 400) °C	0.3 °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	0.4 µm	Gauge Blocks
	(200 to 500) mm	2 µm	
	(500 to 1 000) mm	4 µm	

Length – Dimensional Metrology **Singapore**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
External Micrometers [1] Flatness Up to 25 mm diameter	(0 to 0.5) µm	0.1 µm	Optical Parallel or Optical Flat Dial Test Indicator
External Micrometers [1] Parallelism Up to 50 mm diameter	(0 to 1) µm	0.1 µm	Optical Parallel Dial Test Indicator
Depth Micrometer	(0 to 300) mm	1 µm	Gauge Blocks
Internal & Stick Micrometer [1]	(0 to 200) mm (200 to 500) mm (500 to 1 000) mm	2 µm 3 µm 4 µm	Gauge Blocks
Internal Micrometer [1] (2-leg type)	(0 to 300) mm	2 µm	Ring Gauges
Micrometer Head	(0 to 50) mm	0.9 µm	Universal Length Measuring Machine or Gauge Blocks
Screw Thread Micrometer [1]	(0 to 300) mm	1 µm	Gauge Block or Pin Gauge
Caliper [1]	(0 to 1 000) mm (1 000 to 2 000) mm	3 µm 20 µm	Caliper Checker or Gauge Block
Caliper Gauge [1]	(0 to 500) mm	1 µm	Gauge Blocks
Caliper Checker [1] (Step Gauges) Depth Micrometer Checker	(0 to 630) mm	0.9 µm	Gauge Blocks, Mu Checker
Optical Flats/Parallels Flatness Thickness	Up to 10 µm	0.1 µm 0.4 µm	Optical Flat
Optical Flats/ Parallels Parallelism	Up to 1 mm	0.1 µm	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	$0.04 + (1\times10^{-6}L)$ µm	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	Gauge Block Comparator with 1 mm Probe Radius

Length – Dimensional Metrology **Singapore**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Long Gauge Blocks (Dissimilar & Similar Material)	125 mm 150 mm 175 mm	0.37 µm 0.4 µm 0.46 µm	Gauge Block Comparator
Long Gage Blocks (Dissimilar & Similar Material)	125 mm 150 mm 175 mm 200 mm 250 mm 300 mm 400 mm 500 mm	0.46 µm 0.48 µm 0.5 µm 0.52 µm 0.57 µm 0.62 µm 0.73 µm 0.84 µm	Universal Length Measuring Machine (ULM)
Height Gauge [1]	(0 to 600) mm (600 to 1 000) mm	10 µm 20 µm	Gauge Block or Caliper Checker
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	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	0.7 µm	Gauge Blocks, Mu Checker
Vernier Depth Gauge [1]	(0 to 600) mm (600 to 1 000) mm	10 µm 20 µm	Gauge Blocks
Dial Depth Gauge [1]	(0 to 200) mm	2 µm	Gauge Blocks
Mu Checker	(0 to 5) mm	0.2 µm	Gauge Blocks or Calibration Tester
Dial Indicator [1]	Up to 100 mm	0.5 µm	Dial Gauge Calibrator
Dial Test Indicator [1]	(0 to 3) mm	0.5 µm	Dial Gauge Calibrator
Digimatic Indicator [1] Linear Gauge	Up to 100 mm	0.5 µm	Dial Gauge Calibrator
Digimatic Indicator [1] Linear Gauge	Up to 100 mm	0.2 µm	Gauge Blocks
Dial Thickness Gauge [1]	(0 to 200) mm	1 µm	Gauge Blocks
Dial Gauge Stand / Comparator stand [1]	(0 to 1) mm	0.5 µm	Dial Test Indicator

Length – Dimensional Metrology **Singapore**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Dial Gauge Calibrator [1]	(0 to 100) mm	0.2 µm	Gauge Blocks
Calibration Tester [1]	(0 to 100) mm	0.3 µm	Gauge Blocks
Bore Gauge	(0 to 600) mm	2 µm	Height Setting Micrometer
Holtest/ Boremetic	(0 to 200) mm	0.9 µm	Setting Ring Gauge or Universal Length Measuring Machine
Steel Rule	(0 to 1 500) mm (1 500 to 2 000) mm	0.07 mm 0.12 mm	Profile Projector
Steel Rule	(0 to 1 500) mm (1 500 to 2 000) mm	0.13 mm 0.16 mm	Comparison with Reference Ruler
Straight Edge [1]	Up to 1 200 mm	2 µm	Mu-Checker or Dial Test Indicator
Surface Plate [1,2] Overall Flatness Local Area Flatness (Repeat Readings)	Up to 2 500 mm×2 000 mm Up to 0.1 µm	1 µm	Planekator (Straight Edge)
Profile Projector [1] Optical Comparators	Up to 300 mm	2 µm	Glass Scale
Universal Length Measuring Machine [1] Length	(0 to 500) mm (>500 to 1 000) mm	0.2 µm 1.2 µm	Gauge Blocks
Setting Rod	Up to 1 000 mm	0.8 µm	Gauge Blocks and Mu-Checker
Bevel Protractor	Up to 300 mm (0 to 360)º	1.5 µm 5‘	Dial Test Indicator Angle Blocks or
Bevel Protractor	Up to 300 mm (0 to 360)º	33‘	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°	Sine Plate, Gauge Blocks
Measuring Microscope[1]	(0 to 300) mm	2 µm	Glass Scale
Sine Bars	(0 to 300) mm	0.5 µm	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	Levelling Plate, Square, Indicator
Precision Squares	(0 to 450) mm	3 µm	Granite Square
Parallel Bars	(0 to 1.2) mm	2 µm	Dial Indicator, Mu Checker, Micrometer
Centre Bench [1]	(0 to 1.2) mm	3 µm	Height Master, Gauge Blocks, Mu Checker
Coating Thickness Gauge	Up to 1 000 µm	0.5 µm	Thickness Standards
Roughness Machine [1]	(0.3 to 3) µm	0.021 µm	Roughness Specimen
Roughness Specimen [1]	(0.3 to 3) mm	0.021 µm	Roughness Machine
Feeler Gauge Shim Shock Calibration Foil	Up to 5 mm	0.4 µm	Universal Length Measuring Machine
Plain Ring Gauge / Snap Gauge, (Internal Diameter, Internal Length)	(>1 to 50) mm (>50 to100) mm (>100 to150) mm (>150 to 200) mm	0.5 µm 0.6 µm 0.7 µm 0.9 µm	Universal Length Measuring Machine, Master Ring Gauge
Thread Wires Diameter	Up to 10 mm	0.4 µm	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	Universal Length Measuring Machine
Thread Plug Gauge (> M1 to M50) Pitch Diameter Major Diameter Pitch	(1 to 200) mm	0.9 µm 0.5 µm 6 µm	Universal Length Measuring Machine, Thread Wires
Adjustable Thread Rings Pitch Diameter (tactile fit) Minor Diameter	(0 to 100) mm	2 µm	ULM, Internal Micrometer
Solid Thread Ring Gauge Pitch Diameter (tactile fit) Minor Diameter	Up to 2.5 mm (1.2 to 2.5) mm	N/A 2 µm	Thread Setting Plug, Internal Micrometer

Length – Dimensional Metrology **Singapore**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Solid Thread Ring Gauge (> M2.5 to M100) Pitch Diameter (measured) Minor Diameter	(2.5 to 100) mm	1 µm 0.8 µm	Universal Length Measuring Machine
Coordinate Measuring Machine [1]	Up to 1 500 mm	0.82 µm	Gauge Block, Step Gauge
Glass Scale	(0 to 150) mm	3.1 µm	Profile Projector
Tapered Ring Gauge Diameter	Up to 100 mm	1.3 µm	Universal Length Measuring Machine (ULM)
Tapered Ring Gauge Step Height	Up to 75 mm	2 µm	Micrometer
Tapered Plug Gauge Diameter	Up to 75 mm	1.2 µm	Universal Length Measuring Machine (ULM)
Tapered Plug Gauge Step Height	Up to 75 mm	2 µm	Micrometer
Tapered Thread Plug Gauges Pitch Diameter	Up to 150 mm	3.1 µm	Universal Length Measuring Machine (ULM)
Tapered Thread Plug Gauges Taper	(0 to 10)°	4‘	Profile Projector
Tapered Thread Plug Gauges Step Height	Up to 75 mm	2.2 µm	Micrometer
Tapered Thread Ring Gauges Step Height	Up to 75 mm	2.2 µm	Micrometer
Tapered Thread Ring Gauges Pitch Diameter	Up to 100 mm	1.6 µm	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	Steel Rule
Laser Scan Micrometer[1]	(0 to 25) mm	0.5 µm	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	Masses
Force Gauge [1]	(0 to 50) kN	0.01 kN	Load Cells
Universal Length Measuring Machine [1] Force	(0 to 5) N	0.1 N	Force Gauge
Force Testing Machines [1] and Load Cells Compression and Tension [1]	(0 to 10) N (10 to 100) N (100 to 1 000) N (1 to 5) kN (5 to 10) kN (10 to 50) kN (50 to 100) kN (100 to 250) kN	0.006 N 0.06 N 2.3 N 0.005 kN 0.001 kN 0.048 kN 0.11 kN 0.05 kN	Direct measurement to reference load cell or Standard Weight
Masses	1 mg to 10 g 20 g (50 to 200) g 500 g 1 000 g (2 000 to 5 000) g 10 kg 20 kg	0.08 mg 0.09 mg 0.2 mg 0.001 g 0.002 g 0.2 g 10 mg 61 mg	Analytical Balance, Mass
Scales and Balances [1,4]	(0 to 400) kg	0.002 g	Masses
Torque Tools [1]	(0 to 1 000) N·m	0.001 N·m	Torque Transducers
Torque Meter/Gauge	(0 to 150) kgf·cm	0.06 kgf·cm	Torque Arm, Masses
Durometers [1] (Force only) Types A, B, E & O Types C, D, & DO	(0 to 100)°	0.2°	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	Hardness Test Blocks
Vickers Hardness Testers [1]	(100 to 1000) HV	0.5 % of reading	Hardness Test Blocks
Brinell Hardness Testers [1]	(100 to 600) HBW	1 % of readings	Hardness Test Blocks
Pressure Gauges [1]	(-1 to 140) bar (0 to 2 700) bar	0.013 % of reading 0.018 % of reading	Pressure Calibrator Dead Weight Tester

Mass and Mass Related **Singapore**

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Flow Meters [1]	(0 to 5) LPM (5 to 10) LPM (50 to 500) LPM	0.042 LPM 0.29 LPM 2.2 LPM	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 5.3 lux 32 lux 320 lux	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	(-20 to 200) °C	2.1 °C	Datalogger, Thermocouples
Furnace [1] System Accuracy Test	(200 to 800) °C	3.1 °C	Datalogger, Thermocouples
Thermometers [1] (except liquid in glass)	(-20 to 150) °C (150 to 500) °C (500 to 650) °C	1.1 °C 1.3 °C 2.7°C	PRT Sensor, Dry Block Calibrator
Surface Style Thermometer	(30 to 300) °C	2 °C	Flat Plate Calibrator
Dry Block Calibrators	(-20 to 150) °C (150 to 500) °C	0.3 °C 0.9 °C	PRT sensor
Thermohygrometer Instruments	(18 to 70) °C (40 to 95) %RH	1.1 °C 4.8 %RH	Reference Thermohygrometer
RTD Based Temperature Measuring Systems [1]	(-20 to 95) °C (95 to 200) °C	0.06 ºC 0.08 ºC	Temperature Baths
RTD Based Temperature Measuring Systems [1]	(-20 to 140) °C (140 to 400) °C (400 to 600) °C	0.22 ºC 0.5 ºC 1.5 ºC	Dry Block

Thermodynamic **Singapore**

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 95) °C (95 to 200) °C	 0.27 °C 0.49 °C	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	 0.41 °C 1.1 °C 1.9 °C 4.7 °C 4.9 °C	Dry Block
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	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 1.4 °C 4.1 °C 4.1 °C	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 0.41 °C 1.1 °C 1.9 °C 4.7 °C 4.9 °C 0.4 °C 1.1 °C 2 °C 3.3 °C	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 1.4 °C 4.1 °C 4.1 °C 0.27 °C 0.57 °C 1.4 °C 4.1 °C 4.1 °C 0.4 °C 1.1 °C	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 0.28 °C 0.5 °C 0.24 °C 0.47 °C 0.18 °C 0.21 °C 0.18 °C 0.21 °C 0.24 °C 0.47 °C	Temperature Baths
Infrared (IR) Thermometers	(15 to 140) °C	1.9 °C	Blackbody Source and reference thermocouple thermometer $\varepsilon = 0.95$, $\lambda = (8 \text{ to } 14)$ µm

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 hr	0.22 s	Reference Stopwatch
Tachometers [1] Non-Contact	(0 to 99 999) rpm	1.7 rpm	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 + 71 µHz 0.000 2 % of reading + 0.49 mHz 0.000 2 % of reading + 7.6 mHz 0.000 2 % of reading + 71 mHz 0.000 2 % of reading + 0.76 Hz 0.000 2 % of reading + 0.99 Hz	Multiproduct Calibrator

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	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)°	10‘	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. Johor, Malaysia site withdrawn as of 07/17/2023 until further notice.
7. 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