CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

SP Metrology System (Thailand) Co., Ltd.
69/29 Moo 1 T.Klongsi A.Klongluang
Pathumthani, Thailand 12120

Fulfills the requirements of

ISO/IEC 17025:2017

In the fields of

CALIBRATION and **DIMENSIONAL MEASUREMENT**

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

Jason Stine, Vice President

Expiry Date: 16 May 2024
Certificate Number: ACT-2050

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

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CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: **May 16, 2024** Certificate Number: **ACT-2050**

CALIBRATION

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Sound Level Meter	94 dB 114 dB	0.15 dB 0.15 dB	Sound Level Calibrator
[1] Vibration Meter w/Sensor Acceleration	40 Hz (0 to 50) m/s^2 (RMS) 160 Hz (0 to 50) m/s^2 (RMS) 1 kHz (0 to 20) m/s^2 (RMS) 5 kHz (0 to 20) m/s^2 (RMS)	 1.6 % of reading 1.5 % of reading 1.5 % of reading 2.4 % of reading	Vibration Calibrator
Velocity	40 Hz (0 to 50) mm/s (RMS) 160 Hz (0 to 50) mm/s (RMS)	 1.5 % of reading 2.7 % of reading	
Displacement	40 Hz (0 to 50) µm (RMS) 160 Hz (0 to 50) µm (RMS)	 3.2 % of reading 3.2 % of reading	

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1,2] pH Meter	4.01 pH 7.01 pH 10.01 pH	0.012 pH 0.012 pH 0.012 pH	pH Solution Buffer
[1,2] Conductivity Meter	84 µS/cm 1 413 µS/cm 12 880 µS/cm	0.6 µS/cm 8.2 µS/cm 75 µS/cm	STD Conductivity Solution
[1] Refractometer	5 %Brix 10 %Brix 20 %Brix 30 %Brix 60 %Brix	0.075 %Brix 0.074 %Brix 0.074 %Brix 0.073 %Brix 0.072 %Brix	Sucrose Standard Solution
[1] Refractometer Refractive Index	1.340 27 nD 1.347 84 nD 1.363 85 nD 1.381 14 nD 1.441 89 nD	0.000 11 nD 0.000 11 nD 0.000 11 nD 0.000 11 nD 0.000 11 nD	Sucrose Standard Solution
[1] Turbidity meter	20 NTU 100 NTU 200 NTU 800 NTU	0.12 NTU 0.4 NTU 1.2 NTU 6 NTU	Turbidity Standard Solution
[1] Viscometer Rotational @25°C	101.1 cP 6 618 cP 15 608 cP	0.16 cP 15 cP 36 cP	STD Viscosity Solution
[1] Total Dissolved Solids (TDS) Meter	1 000 mg/l	32 mg/l	TDS Solution
Breath Alcohol Tester/Analyzer	44 mg/dL 70 mg/dL	1 % of reading 1 % of reading	Alcohol Standard Solutions
[1] Gas Detectors Carbon Dioxide Methane Oxygen Sulphur Dioxide	 100 µmol/mol 22 mmol/mol 18 cmol/mol 1 000 µmol/mol	 1 % of reading 1.5 % of reading 1.1 % of reading 1 % of reading	Accredited Gas Mixtures
[1] Salinity Meter Nominal	 50 000 mg/l (5 %Salinity) 180 000 mg/l (18 %Salinity)	 0.014 %Salinity 0.054 % Salinity	Accredited Sodium Chloride Solution

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] RTD Temperature Indicator (Simulator) Temperature Indicator	RTD (Pt100) (-200 to 800) °C 10 Ω, Cu 427 (-100 to 260) °C	 0.25 °C 0.42 °C	Fluke 744 Process Calibrator
[1] Thermocouple Temperature Indicator (Simulator) Temperature Indicator	Type E (-250 to 1 000) °C Type J (-210 to 1 200) °C Type K (-200 to 1 372) °C Type R and S (0 to 1 768) °C Type T (-250 to 400) °C	 0.42 °C 0.45 °C 0.38 °C 0.96 °C 0.64 °C	Fluke 744 Process Calibrator
[1] DC Voltage Source	Up to < 330 mV 330 mV to < 3.3 V (3.3 to < 33) V (33 to < 330) V (330 to 1 000) V	48 µV/V + 9 µV 40 µV/V + 60 µV 40 µV/V + 0.6 mV 45 µV/V + 6 mV 45 µV/V + 60 mV	Fluke 5502A Multiproduct Calibrator
[1] DC Current Source	Up to < 3.3 mA (3.3 to < 33) mA (33 to < 330) mA (0.33 to < 1.1) A (1.1 to < 3) A (3.0 to < 11) A (11 to 20) A	0.08 mA/A + 85 nA 0.08 mA/A + 0.65 µA 0.08 mA/A + 7.8 µA 0.3 mA/A + 80 µA 0.3 mA/A + 85 µA 0.47 mA/A + 0.8 mA 0.78 mA/A + 5.8 mA	Fluke 5502A Multiproduct Calibrator
[1] AC Voltage Source	(1 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 450) 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 450) kHz	 1.5 mV/V + 20 µV 0.8 mV/V + 20 µV 1.5 mV/V + 20 µV 1.6 mV/V + 20 µV 3 mV/V + 30 µV 8 mV/V + 50 µV 0.5 mV/V + 20 µV 0.25 mV/V + 20 µV 0.6 mV/V + 20 µV 0.8 mV/V + 35 µV 1.9 mV/V + 0.15 mV 4 mV/V + 0.3 mV	Fluke 5502A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] AC Voltage Source	(0.33 to < 3.3) V		Fluke 5502A Multiproduct Calibrator
	(10 to 45) Hz	0.4 mV/V + 80 µV	
	> 45 Hz to 10 kHz	0.25 mV/V + 0.1 mV	
	(> 10 to 20) kHz	0.6 mV/V + 0.1 mV	
	(> 20 kHz to 50) kHz	0.8 mV/V + 0.1 mV	
	(> 50 kHz to 100) kHz	1.9 mV/V + 0.2 mV	
	(> 100 kHz to 450) kHz	4 mV/V + 0.8 mV	
	(3.3 to < 33) V		
	(10 Hz to 45) Hz	0.4 mV/V + 0.9 mV	
	> 45 Hz to 10 kHz	0.25 mV/V + 0.8 mV	
	(> 10 kHz to 20) kHz	0.6 mV/V + 0.9 mV	
	(> 20 kHz to 50) kHz	0.8 mV/V + 0.9 mV	
	(> 50 kHz to 90) kHz	1.9 mV/V + 2 mV	
	(33 to < 330) V		
	45 Hz to 1 kHz	0.4 mV/V + 7 mV	
	(> 1 to 10) kHz	0.65 mV/V+ 10 mV	
	(> 10 kHz to 18) kHz	0.7 mV/V + 15 mV	
	(330 to 1 000) V		
	45 Hz to 1 kHz	0.4 mV/V + 60 mV	
	(> 1 kHz to 5) kHz	0.65 mV/V + 78 mV	
	(> 5 kHz to 10) kHz	0.7 mV/V + 78 mV	
[1] AC Current Source	(0.029 to < 0.33) mA		Fluke 5502A Multiproduct Calibrator
	(20 Hz to 45) Hz	1.6 mA/A + 80 nA	
	> 45 Hz to 1 kHz	1 mA/A + 80 nA	
	(> 1 to 5) kHz	2.4 mA/A + 0.12 µA	
	(> 5 to 10) kHz	6.3 mA/A + 0.16 µA	
	(0.33 to < 3.3) mA		
	(20 Hz to 45) Hz	1.6 mA/A + 0.15 µA	
	> 45 Hz to 1 kHz	0.8 mA/A + 0.15 µA	
	(> 1 to 5) kHz	1.6 mA/A + 0.2 µA	
	(> 5 to 10) kHz	4 mA/A + 0.25 µA	
	(3.3 to < 33) mA		
	(20 Hz to 45 Hz	1.4 mA/A + 2 µA	
	> 45 Hz to 1) kHz	0.32 mA/A + 1.8 µA	
	(> 1 to 5) kHz	0.65 mA/A + 1.8 µA	
	(> 5 to 10) kHz	1.6 mA/A + 2.5 µA	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] AC Current Source	(33 to < 330) mA		Fluke 5502A Multiproduct Calibrator
	(20 Hz to 45) Hz	1.5 mA/A + 18 µA	
	> 45 Hz to 1 kHz	0.32 mA/A + 18 µA	
	(> 1 to 5) kHz	0.8 mA/A + 40 µA	
	(> 5 to 10) kHz	1.6 mA/A + 80 µA	
	(0.33 to < 1.1) A		
	(20 to 45) Hz	1.4 mA/A + 0.15 mA	
	> 45 Hz to 1 kHz	0.4 mA/A + 0.15 mA	
	(> 1 to 5) kHz	5 mA/A + 0.8 mA	
	(1.1 to < 3) A		
	(45 to 65) Hz	1.5 mA/A + 0.15 mA	
	(> 65 to 500) Hz	0.5 mA/A + 0.15 mA	
	> 500 Hz to 1 kHz	0.5 mA/A + 0.15 mA	
	(> 1 to 5) kHz	4.8 mA/A + 6 mA	
	(3 to < 11) A		
	(45 to 65) Hz	0.5 mA/A + 1.8 mA	
	> 65 Hz to 1 kHz	0.8 mA/A + 2 mA	
	(11 to 20) A		
	(45 to 65) Hz	0.95 mA/A + 7 mA	
	> 65 Hz to 1 kHz	1.2 mA/A + 8.2 mA	
[1] Resistance Source	(0 to 11) Ω	0.1 mΩ/Ω + 10 mΩ	Fluke 5502A Multiproduct Calibrator
	(11 to 33) Ω	0.1 mΩ/Ω + 15 mΩ	
	(33 to 110) Ω	80 µΩ/Ω + 15 mΩ	
	(110 to 330) Ω	80 µΩ/Ω + 20 mΩ	
	330 Ω to 1.1 kΩ	80 µΩ/Ω + 0.1 Ω	
	(1.1 to 3.3) kΩ	80 µΩ/Ω + 0.2 Ω	
	(3.3 to 11) kΩ	80 µΩ/Ω + 0.8 Ω	
	(11 to 33) kΩ	80 µΩ/Ω + 1.2 Ω	
	(33 to 110) kΩ	0.1 mΩ/Ω + 6 Ω	
	(110 to 330) kΩ	0.11 mΩ/Ω + 12 Ω	
	330 kΩ to 1.1 MΩ	0.13 mΩ/Ω + 70 Ω	
	(1.1 to 3.3) MΩ	0.13 mΩ/Ω + 0.15 kΩ	
	(3.3 to 11) MΩ	0.48 mΩ/Ω + 1 kΩ	
	(11 to 33) MΩ	0.8 mΩ/Ω + 3 kΩ	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Capacitance Source			Fluke 5502A Multiproduct Calibrator
10 Hz to 10 kHz	(0.1 to 0.5) nF	0.4 % of reading + 8pF	
10 Hz to 10 kHz	(0.5 to 1.09) nF	0.4 % of reading + 10 pF	
10 Hz to 3 kHz	(1.1 to 3.29) nF	0.4 % of reading + 10 pF	
10 Hz to 1 kHz	(3.3 to 10.9) nF	0.2 % of reading + 12 pF	
10 Hz to 1 kHz	(11 to 32.9) nF	0.2 % of reading + 0.1 nF	
10 Hz to 1 kHz	(33 to 109.9) nF	0.2 % of reading + 0.1 nF	
10 Hz to 1 kHz	(110 to 329.9) nF	0.2 % of reading + 0.7 nF	
10 Hz to 600 Hz	(0.33 to 1.09) µF	0.2 % of reading + 1.3 nF	
10 Hz to 300 Hz	(1.1 to 3.29) µF	0.2 % of reading + 7 nF	
10 Hz to 150 Hz	(3.3 to 10.9) µF	0.2 % of reading + 10 nF	
10 Hz to 120 Hz	(11 to 32.9) µF	0.32 % of reading + 0.08 µF	
10 Hz to 80 Hz	(33 to 109.9) µF	0.37 % of reading + 0.11 µF	
50 Hz	(110 to 329.9) µF	0.37 % of reading + 0.7 µF	
20 Hz	(0.33 to 1.09) mF	0.37 % of reading + 1 µF	
6 Hz	(1.1 to 3.29) mF	0.37 % of reading + 6.5 µF	
2 Hz	(3.3 to 10.9) mF	0.37 % of reading + 10 µF	
0.6 Hz	(11 to 32.9) mF	0.6 % of reading + 63 µF	
0.2 Hz	(33 to 50) mF	0.85 % of reading + 98 µF	
[1] DC Current Clamp Source	Up to 200 A	3.8 mA/A + 60 mA	Fluke 5502A Multiproduct Calibrator with Current Coil
	(> 200 to 550) A	3.3 mA/A + 80 mA	
	(> 550 to 1 000) A	3.2 mA/A + 70 mA	
[1] AC Current Clamp Source	Up to 20 A		Fluke 5502A Multiproduct Calibrator with Current Coil
	(45 to 100) Hz	5 mA/A + 80 mA	
	(> 100 to 440) Hz	12 mA/A + 80 mA	
	(> 20 to 200) A		
	(45 to 65) Hz	5 mA/A + 80 mA	
	(> 65 to 100) Hz	9.5 mA/A + 80 mA	
	(> 100 to 440) Hz	14 mA/A + 80 mA	
	(> 200 to 550) A		
	(45 to 65) Hz	3.7 mA/A + 72 mA	
	(> 65 to 100) Hz	9 mA/A + 60 mA	
	(> 550 to 1 000) A		
	(45 to 65) Hz	3.7 mA/A + 80 mA	
	(> 65 to 100) Hz	9.3 mA/A + 80 mA	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Insulation Resistance Source Test Voltage @ 50 V, 100 V, 250 V, 500 V, 1 000 V	(0.1 to 10) MΩ (10 to 20) MΩ (20 to 30) MΩ (30 to 50) MΩ (50 to 100) MΩ (100 to 200) MΩ (200 to 500) MΩ (500 to 1 000) MΩ	5.8 kΩ 32 kΩ 69 kΩ 75 kΩ 94 kΩ 2.8 MΩ 4.5 MΩ 7.1 MΩ	Resistance Decade Box
[1] Electrical Simulation of Thermocouple Indicating Devices – Source/Measure	Type K (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 1 000) °C (1 000 to 1 372) °C Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C Type E (-250 to -100) °C (-100 to -25) °C (-25 to 350) °C (350 to 650) °C (650 to 1 000) °C Type J (-210 to -100) °C (-100 to -25) °C (-25 to 150) °C (150 to 760) °C (760 to 1 200) °C Type N (-250 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1 300) °C	 0.46 °C 0.26 °C 0.23 °C 0.37 °C 0.56 °C 0.61 °C 0.48 °C 0.42 °C 0.46 °C 0.7 °C 0.23 °C 0.2 °C 0.23 °C 0.3 °C 0.56 °C 0.32 °C 0.28 °C 0.24 °C 0.33 °C 0.56 °C 0.32 °C 0.28 °C 0.26 °C 0.38 °C	Fluke 5502A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Electrical Simulation of Thermocouple Indicating Devices – Source/Measure	Type R (0 to 250) °C (250 to 400) °C (400 to 1 000) °C (1 000 to 1 767) °C Type S (0 to 250) °C (250 to 400) °C (400 to 1 000) °C (1 000 to 1 767) °C Type U (-200 to 0) °C (0 to 600) °C Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	 0.8 °C 0.5 °C 0.47 °C 0.56 °C 0.66 °C 0.51 °C 0.52 °C 0.65 °C 0.79 °C 0.38 °C 0.88 °C 0.34 °C 0.23 °C 0.21 °C	Fluke 5502A Multiproduct Calibrator
[1] Electrical Simulation of RTD Indicating Devices – Source	100 Ω, Pt385 (-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 200 Ω, Pt385 (-200 to -80) °C (-80 to 0) °C (0 to 100) °C (100 to 260) °C (260 to 300) °C (300 to 400) °C (400 to 600) °C (600 to 630) °C	 0.09 °C 0.09 °C 0.14 °C 0.14 °C 0.15 °C 0.18 °C 0.33 °C 0.08 °C 0.08 °C 0.08 °C 0.09 °C 0.18 °C 0.19 °C 0.2 °C 0.23 °C	Fluke 5502A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Electrical Simulation of RTD Indicating Devices – Source	500 Ω, Pt385		Fluke 5502A Multiproduct Calibrator
	(-200 to -80) °C	0.08 °C	
	(-80 to 0) °C	0.09 °C	
	(0 to 100) °C	0.09 °C	
	(100 to 260) °C	0.1 °C	
	(260 to 300) °C	0.13 °C	
	(300 to 400) °C	0.13 °C	
	(400 to 600) °C	0.14 °C	
	(600 to 630) °C	0.16 °C	
	1 000 Ω, Pt385		
	(-200 to -80) °C	0.08 °C	
	(-80 to 0) °C	0.09 °C	
	(0 to 100) °C	0.09 °C	
	(100 to 260) °C	0.1 °C	
	(260 to 300) °C	0.13 °C	
	(300 to 400) °C	0.13 °C	
	(400 to 600) °C	0.14 °C	
	(600 to 630) °C	0.16 °C	
	100 Ω, Pt3916		
	(-200 to -190) °C	0.36 °C	
	(-190 to -80) °C	0.08 °C	
	(- 80 to 0) °C	0.09 °C	
	(0 to 100) °C	0.11 °C	
	(100 to 260) °C	0.11 °C	
	(260 to 300) °C	0.13 °C	
	(300 to 400) °C	0.14 °C	
	(400 to 600) °C	0.15 °C	
	(600 to 630) °C	0.33 °C	
	100 Ω, Pt3926		
	(-200 to - 80) °C	0.08 °C	
	(-80 to 0) °C	0.09 °C	
	(0 to 100) °C	0.12 °C	
	(100 to 300) °C	0.14 °C	
	(300 to 400) °C	0.16 °C	
	(400 to 630) °C	0.18 °C	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] DC Power Source	(0.33 to 1 000) V, Up to 0.33 A (0.108 9 to < 330) W (0.33 to 1 000) V, (0.33 to < 3) A 330 W to < 3 kW (0.33 to 1 000) V, (3 to < 10.9) A (3.0 to < 10.9) kW (0.33 to 1 000) V, (10.99 to 20) A (10.9 to 20) kW	0.10 mW/W + 6 mW 0.31 mW/W + 60 mW 0.5 mW/W + 0.6 W 0.81 mW/W + 0.6 W	Fluke 5502A Multiproduct Calibrator
[1] AC Power Source	(45 to 65) Hz, PF=1 (0.33 to 1 000) V Up to 0.329 A (0.109 to < 10.9) W (10.9 to < 330) W (0.33 to 1 000) V, (0.33 to < 3) A 330 W to < 3 kW (0.33 to 1 000) V, (3 to < 10.9) A (3 to < 3.5) kW (3.5 to < 10.9) kW (0.33 to 1 000) V, (10.9 to 20) A (10.9 to 20) kW	0.55 mW/W + 1.5 mW 0.8 mW/W + 6 mW 1.2 mW/W + 60 mW 1.4 mW/W + 60 mW 1.4 mW/W + 0.6 W 1.2 mW/W + 0.6 W	Fluke 5502A Multiproduct Calibrator
[1] DC Voltage Measure	Up to 100 mV (> 0.1 to 1) V (> 1 to 10) V (> 10 to 100) V (>100 to 1 000) V	14 µV/V + 0.35 µV 4.9 µV/V + 0.35 µV 4.7 µV/V + 0.58 µV 7 µV/V + 35 µV 21 µV/V + 0.12 mV	HP 3458A 8.5 Digit Multimeter
[1] AC Voltage Measure	100 mV to 10 V (10 to 50) Hz > 50 Hz to 1 kHz (> 1 to 20) kHz (> 20 to 50) kHz (> 50 to 100) kHz (> 100 to 300) kHz > 300 kHz to 1 MHz	85 µV/V + 0.46 mV 85 µV/V+0.23 mV 0.16 mV/V+0.23 mV 0.35 mV/V +0.23 mV 0.93 mV/V+0.23 mV 3.5 mV/V+1.2 mV 12 mV/V+1.2 mV	HP 3458A 8.5 Digit Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] AC Voltage Measure	(> 10 to 100) V (10 to 50) Hz > 50 Hz to 1kHz (> 1 to 20) kHz (> 20 to 50) kHz (> 50 to 100) kHz (> 100 to 1 000) V (10 to 50) Hz > 50 Hz to 1 kHz (> 1 to 20) kHz (> 20 to 50) kHz (> 50 to 100) kHz	 0.23 mV/V + 4.6 mV 0.23 mV/V + 2.3 mV 0.23 mV/V + 2.3 mV 0.41 mV/V + 2.3 mV 1.4 mV/V + 2.3 mV 0.46 mV/V + 46 mV 0.46 mV/V + 23 mV 0.69 mV/V + 23 mV 1.4 mV/V + 23 mV 3.5 mV/V + 23 mV	HP 3458A 8.5 Digit Multimeter
[1] DC Current Measure	(> 10 to 100) µA (> 0.1 to 1) mA (> 1.0 to 10) mA (> 10 to 100) mA (> 0.10 to 1.0) A	24 µA/A + 0.92 nA 24 µA/A + 5.8 nA 24 µA/A + 58 nA 41 µA/A + 0.58 µA 0.13 mA/A + 12 µA	HP 3458A 8.5 Digit Multimeter
[1] DC Current Measure	(>1 to 3) A	2.4 mA/A + 1.1 mA	Keysight 34460A 6.5 Digit Multimeter
[1] AC Current Measure	(0.1 to 1) mA (10 to 20) Hz (>20 to 45) Hz (>45 to 100) Hz >100 Hz to 1 kHz (1 to 100) mA (10 to 20) Hz (>20 to 45) Hz (>45 to 100) Hz >100 Hz to 1 kHz (0.1 to 1) A (10 to 20) Hz (>20 to 45) Hz (>45 to 100) Hz >100 Hz to 1 kHz	 4.6 mA/A + 0.35 µA 1.7 mA/A + 0.35 µA 0.7 mA/A + 0.35 µA 0.7 mA/A + 0.35 µA 4.6 mA/A + 0.23 mA 1.7 mA/A + 23 µA 0.7 mA/A + 23 µA 0.35 mA/A + 23 µA 4.6 mA/A + 0.23 mA 1.8 mA/A + 0.23 mA 0.93 mA/A+ 0.23 mA 1.2 mA/A + 0.23 mA	HP 3458A 8.5 Digit Multimeter
[1] AC Current Measure	(>1 to 3) A 50 Hz to 5 kHz	 2.7 mA/A + 2 mA	Keysight 34460A 6.5 Digit Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Resistance Measure	Up to 10 Ω (> 10 to 100) Ω > 100 Ω to 1 kΩ (> 1 to 10) kΩ (> 10 to 100) kΩ (> 0.1 to 1) MΩ (> 1 to 10) MΩ (> 10 to 100) MΩ > 100 MΩ to 1 GΩ	18 μΩ/Ω + 58 μΩ 14 μΩ/Ω + 0.58 mΩ 12 μΩ/Ω + 0.58 mΩ 1 μΩ/Ω + 5.8 mΩ 12 μΩ/Ω + 58 mΩ 19 μΩ/Ω + 2.3 Ω 59 μΩ/Ω + 0.12 kΩ 0.58 mΩ/Ω + 1.2 kΩ 5.8 mΩ/Ω + 12 kΩ	HP 3458A 8.5 Digit Multimeter
[1] DC High Voltage Measure	Up to 1 kV (> 1 to 3) kV (> 3 to 5) kV (> 5 to 10) kV	24 mV/V + 60 μV 24 mV/V + 70 μV 24 mV/V + 90 μV 24 mV/V + 0.18 mV	Keysight 34460A 6.5 Digit Multimeter with Fluke 80K-40 High Voltage Probe
[1] AC High Voltage Measure	(1 to 6) kV (50 to 60) Hz	58 mV/V + 4 mV	Keysight 34460A 6.5 Digit Multimeter with Fluke 80K-40 High Voltage Probe
LCR Meter Inductance (L)	1 μH to 10 H @ 100 mV, 1 V, 1 kHz	1.2 % of reading + 0.9 μH	IET 1492 Decade Inductor
LCR Meter Capacitance (C)	1 pF to 1 μF @ 1 V, 1 kHz	0.06 % of reading + 0.6 pF	General Radio 1413 Precision Decade Capacitor
LCR Meter Resistance (R)	1 Ω to 100 kΩ @ 1 V, 1 kHz	0.2 % of reading + 2.4 mΩ	Decade Resistance Box
Inductance Source	1 μH to 10 H @ 1 V, 1 kHz	0.06 % of reading	Agilent E4980A LCR Meter
Capacitance Source	1pF to 1μF @ 1 V, 0.1 kHz to 1 MHz	0.06 % of reading	Agilent E4980A LCR Meter
[1] Oscilloscope Vertical Deflection DC 50 Ω and 1 MΩ	2 mV 5 mV 10 mV 20 mV 50 mV 100 mV 200 mV 500 mV 1 V 2 V 5 V 10 V 20 V	0.84 % of reading 0.49 % of reading 0.34 % of reading 0.26 % of reading 0.29 % of reading 0.23 % of reading 0.21 % of reading 0.28 % of reading 0.27 % of reading 0.22 % of reading 0.28 % of reading 0.2 % of reading 0.2 % of reading	Fluke 5502A Multiproduct Calibrator, Fluke PM6685R Universal Frequency Counter, HP 3458A 8.5 Digit Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Oscilloscope Vertical Bandwidth 3 dB down from Reference Amplitude	50 kHz to 100 MHz (>100 to 300) MHz	1.4 % of reading 1.8 % of reading	Fluke 5502A Multiproduct Calibrator, Fluke PM6685R Universal Frequency Counter, HP 3458A 8.5 Digit Multimeter
[1] Oscilloscope Horizontal Deflection: Time Mark	1 ns 2 ns 5 ns 10 ns 20 ns 50 ns 100 ns 200 ns 500 ns 1 µs 2 µs 5 µs	0.01 % of reading 0.04 % of reading 0.01 % of reading 0.01 % of reading 0.04 % of reading 0.01 % of reading 0.01 % of reading 0.04 % of reading 0.01 % of reading 0.01 % of reading 0.04 % of reading 0.01 % of reading	Fluke 5502A Multiproduct Calibrator
[1] Oscilloscope Horizontal Deflection: Time Mark	10 µs 20 µs 50 µs 100 µs 200 µs 500 µs 1 ms 2 ms 5 ms 10 ms 20 ms 50 ms 100 ms 200 ms 500 ms 1 s 2 s 5 s 10 s	0.01 % of reading 0.04 % of reading 0.01 % of reading 0.01 % of reading 0.04 % of reading 0.01 % of reading 0.01 % of reading 0.04 % of reading 0.01 % of reading 0.01 % of reading 0.04 % of reading 0.01 % of reading 0.01 % of reading 0.04 % of reading 0.01 % of reading 0.62 % of reading 1.2 % of reading 3.1 % of reading 6.2 % of reading	Fluke 5502A Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Oscilloscope DC Accuracy 50 Ω and 1 MΩ (Digital)	2 mV 5 mV 10 mV 20 mV 50 mV 100 mV 200 mV 500 mV 1 V 2 V 5 V 10 V 20 V	0.11 % of reading 0.39 % of reading 0.19 % of reading 0.1 % of reading 0.38 % of reading 0.19 % of reading 0.1 % of reading 0.38 % of reading 0.19 % of reading 0.1 % of reading 0.04 % of reading 0.02 % of reading 0.01 % of reading	Fluke 5502A Multiproduct Calibrator, Fluke PM6685R Universal Frequency Counter, HP 3458A 8.5 Digit Multimeter
[1,3] Oscilloscope Time Base	10 MHz	$2.4 \times 10^{-10} f$	Fluke 5502A Multiproduct Calibrator, Fluke PM6685R Universal Frequency Counter, HP 3458A 8.5 Digit Multimeter
[1] Oscilloscope Calibrator Calibration	≤10 Vp-p @ ≤10 kHz	0.02 % of reading	Fluke 5502A Multiproduct Calibrator, Fluke PM6685R Universal Frequency Counter, HP 3458A 8.5 Digit Multimeter
Rise Time, Fall Time, Phase Source	Rise/Fall Time 10 ns to 10 ms Phase (0 to 360) °	 2 ns 1.2 °	Fluke PM6685R Universal Frequency Counter, Agilent 53132A Universal Frequency Counter
Single and Three Phase Power Meter	AC Voltage @ 50/60 Hz (0 to 600) V AC Current @ 50/60 Hz (0 to 1 000) A AC Power @ 50/60 Hz (0 to 60) kW Power Factor (0.5 to 1)	 0.58 % of reading 1.3 % of reading 1.3 % of reading 1.2 % of reading	Power Meter, Hioki 3197 And Clamp Sensor, Hioki 9669 (Compare with Power Meter Standard)

Electrical – RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[4] Tuned RF Level Measure 10 dB/step	(-40 to 0) dB 10 MHz 50 MHz 100 MHz 400 MHz 1 000 MHz 2 000 MHz 3 000 MHz 4 000 MHz 5 000 MHz 6 000 MHz 7 000 MHz 8 000 MHz 9 000 MHz	 0.11 dB 0.10 dB 0.10 dB 0.10 dB 0.10 dB 0.11 dB 0.11 dB 0.13 dB 0.11 dB 0.13 dB 0.17 dB 0.15 dB 0.12 dB	HP 8902A Measuring Receiver, HP 11722A/11792A Power Sensor
[4] Tuned RF Level Measure 10 dB/step	(-40 to 0) dB 1 0000 MHz 11 000 MHz 12 000 MHz 13 000 MHz 14 000 MHz 15 000 MHz 16 000 MHz 17 000 MHz 18 000 MHz	 0.12 dB 0.11 dB 0.16 dB 0.15 dB 0.14 dB 0.23 dB 0.26 dB 0.17 dB 0.21 dB	HP 8902A Measuring Receiver, HP 11722A/11792A Power Sensor
Distortion Source	@ 20 Hz to 20 kHz (-80 to -40) dB @ (>20 to 100) kHz (-80 to -40) dB	 1.2 dB 2.3 dB	HP 8903B Audio Analyzer

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] External Micrometer V-Anvil, Screw Thread, Indicating	Up to 2.5 mm (2.5 to 5.1) mm (5.1 to 7.7) mm (7.7 to 10.3) mm (10.3 to 12.9) mm (12.9 to 15) mm (15 to 17.6) mm (17.6 to 20.2) mm (20.2 to 22.8) mm (22.8 to 25) mm (25 to 50) mm (50 to 75) mm (75 to 100) mm (100 to 125) mm (125 to 150) mm (150 to 175) mm (175 to 200) mm (200 to 250) mm (250 to 300) mm (300 to 400) mm (400 to 500) mm (500 to 600) mm (600 to 1 000) mm	94 nm 0.12 µm 0.14 µm 0.17 µm 0.2 µm 0.23 µm 0.26 µm 0.29 µm 0.32 µm 0.35 µm 0.89 µm 1.2 µm 1.5 µm 1.8 µm 2.1 µm 2.4 µm 2.8 µm 3.4 µm 4.1 µm 5.4 µm 6.8 µm 8.1 µm 13.5 µm	Gauge Block Set, Optical Flats
[1] Vernier Caliper Dial and Digital	Up to 200 mm (200 to 300) mm (300 to 400) mm (400 to 500) mm (500 to 600) mm (600 to 700) mm (700 to 800) mm (800 to 900) mm (900 to 1 000) mm (1 000 to 1 500) mm	6 µm 7 µm 8 µm 9 µm 10 µm 11 µm 12 µm 13 µm 15 µm 21 µm	Gauge Block Set
[1] Can Seam Micrometer	Up to 13 mm	2.3 µm	Gauge Block Set

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Internal Micrometer All type Snap Micrometer (Up to 100 mm)	Up to 30 mm (30 to 45) mm (45 to 50) mm (50 to 60) mm (60 to 70) mm (70 to 80) mm (80 to 87) mm (87 to 97) mm (97 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 (500 to 600) mm	0.7 µm 0.8 µm 0.9 µm 1 µm 1.1 µm 1.2 µm 1.3 µm 1.4 µm 1.5 µm 1.8 µm 2.1 µm 2.4 µm 2.8 µm 3.4 µm 4.1 µm 5.4 µm 6.8 µm 8.1 µm	Gauge Block Set
[1] Caliper Gauge External	Up to 25 mm (25 to 50) mm	1.2 µm 1.3 µm	Gauge Blocks
[1] Caliper Gauge Internal (0.005 mm) Internal (0.01 mm)	 2.5 to 15 mm (10 to 180) mm	 3 µm 6 µm	Gauge Blocks
[1] Thickness Gauge	Up to 20 mm (20 to 25) mm	0.6 µm 0.7 µm	Gauge Blocks
[1] Height Gauge (Dial and Digital)	Up to 20 mm (20 to 50) mm (50 to 100) mm (100 to 150) mm (150 to 200) mm (200 to 250) mm (250 to 300) mm (300 to 400) mm (400 to 500) mm (500 to 600) mm (600 to 700) mm (700 to 800) mm (800 to 900) mm (900 to 1 000) mm	0.6 µm 0.9 µm 1.5 µm 2.1 µm 2.8 µm 3.4 µm 4.1 µm 5.4 µm 6.8 µm 8.1 µm 9.5 µm 11 µm 12 µm 14 µm	Gauge Block Set
Feeler Gauge / Thickness Plate	Up to 1 mm (1 to 5) mm	0.21 µm 0.22 µm	ULM

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Measuring Foil Standard Foil	Up to 1 mm (1 to 5) mm	0.21 µm 0.22 µm	ULM
[1]Indicator	Up to 20 mm (20 to 30) mm (30 to 40) mm (40 to 50) mm (50 to 60) mm (60 to 70) mm (70 to 80) mm (80 to 90) mm (90 to 100) mm	0.6 µm 0.7 µm 0.8 µm 0.9 µm 1 µm 1.1 µm 1.2 µm 1.3 µm 1.5 µm	Gauge Blocks
[1]Linear Length Gauge / Electrical Comparators / Mu Checker	Up to 5 mm (5 to 12) mm (12 to 20) mm (20 to 25) mm (25 to 50) mm	0.1 µm 0.2 µm 0.3 µm 0.4 µm 0.7 µm	Gauge Blocks
Steel Ruler	Up to 100 mm (100 to 200) mm (200 to 300) mm (300 to 400) mm (400 to 500) mm (500 to 600) mm (600 to 700) mm (700 to 800) mm (800 to 900) mm (900 to 1 200) mm (1 200 to 1 500) mm (1 500 to 1 800) mm (1 800 to 2 000) mm	3 µm 4 µm 5 µm 6 µm 7 µm 9 µm 10 µm 11 µm 12 µm 16 µm 20 µm 24 µm 27 µm	3D Vision Measuring Machine
Steel Tape & Textile Tape	Up to 200 mm (200 to 400) mm (400 to 600) mm (600 to 800) mm (800 to 1 000) mm (1 000 to 1 200) mm (1 200 to 1 400) mm	8 µm 9 µm 11 µm 13 µm 16 µm 18 µm 20 µm	3D Vision Measuring Machine

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Steel Tape & Textile Tape	(1 400 to 1 600) mm (1 600 to 1 800) mm (1 800 to 2 000) mm (2 000 to 3 000) mm (3 000 to 4 000) mm (4 000 to 5 000) mm (5 000 to 6 000) mm (6 000 to 7 000) mm (7 000 to 8 000) mm (8 000 to 9 000) mm (9 000 to 10 000) mm (10 000 to 15 000) mm (15 000 to 20 000) mm (20 000 to 25 000) mm (25 000 to 30 000) mm (30 000 to 35 000) mm (35 000 to 40 000) mm (40 000 to 45 000) mm (45 000 to 50 000) mm	23 µm 25 µm 28 µm 41 µm 54 µm 67 µm 80 µm 94 µm 0.11 mm 0.12 mm 0.14 mm 0.2 mm 0.3 mm 0.34 mm 0.4 mm 0.47 mm 0.54 mm 0.6 mm 0.67 mm	3D Vision Measuring Machine
[1] Depth Micro Checker, Step Gauge, Inside Checker, Anvil Block	Up to 100 mm (100 to 200) mm (200 to 250) mm (250 to 300) mm Up to 25 mm	2 µm 3 µm 4 µm 5 µm 2 µm	Gauge Blocks, Linear Height Master
[1] Depth Gauge, Depth Micrometer	Up to 25 mm (25 to 50) mm (50 to 100) mm (100 to 150) mm (150 to 250) mm (250 to 300) mm (300 to 400) mm (400 to 450) mm	0.7 µm 0.9 µm 1 µm 2 µm 3 µm 4 µm 5 µm 6 µm	Gauge Block Set
[1] Surface Plate Overall Flatness Local Area Flatness (Repeat Reading)	Up to 4 m Diagonal (>4 to 10) m Up to 0.1 µm	1.5 µm 6.5 µm 1 µm	Planekator (Straight Edge) Dial Indicator

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Plain Plug Gauge, Pin Gauge, Three Wires, T-probe	Up to 15 mm (15 to 22) mm (22 to 30) mm (30 to 40) mm (40 to 50) mm (50 to 60) mm (60 to 70) mm (70 to 80) mm (80 to 90) mm (90 to 100) mm (100 to 150) mm (150 to 200) mm (200 to 250) mm (250 to 300) mm	0.3 µm 0.4 µm 0.5 µm 0.6 µm 0.7 µm 0.9 µm 1 µm 1.2 µm 1.3 µm 1.4 µm 2 µm 2.7 µm 3.4 µm 4 µm	ULM, Master Gauge Blocks
Plain Ring Gauge	Up to 3 mm (3 to 6) mm (6 to 10) mm (10 to 12) mm (12 to 16) mm (16 to 18) mm (18 to 20) mm (20 to 22) mm (22 to 25) mm (25 to 28) mm (28 to 30) mm (30 to 75) mm (75 to 100) mm (100 to 300) mm	0.44 µm 0.45 µm 0.46 µm 0.48 µm 0.5 µm 0.51 µm 0.53 µm 0.57 µm 0.59 µm 0.61 µm 0.63 µm 2.3 µm 3.1 µm 4.9 µm	ULM, Master Plain Ring Gauges
[1] Check Master /Caliper Checker	Up 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 (500 to 600) mm (600 to 700) mm	2.7 µm 2.9 µm 3.1 µm 3.3 µm 3.6 µm 4.1 µm 4.7 µm 5.9 µm 7.1 µm 8.4 µm 9.7 µm	Linear Height Master, Gauge Blocks

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Plug Gauges			
Pitch Diameter	(M2 to M10) mm	0.47 µm	
	(M10 to M20) mm	0.49 µm	
	(M20 to M50) mm	0.51 µm	
	(M50 to M70) mm	0.55 µm	
	(M70 to M100) mm	0.61 µm	
	(M100 to M150) mm	0.63 µm	
Major Diameter	(M2 to M10) mm	0.3 µm	ULM, Thread Measuring Wire, Gauge Blocks
	(M10 to M20) mm	0.4 µm	
	(M20 to M30) mm	0.5 µm	
	(M30 to M40) mm	0.6 µm	
	(M40 to M50) mm	0.7 µm	
	(M50 to M60) mm	0.9 µm	
	(M60 to M70) mm	1 µm	
	(M70 to M80) mm	1.2 µm	
	(M80 to M90) mm	1.3 µm	
	(M90 to M100) mm	1.4 µm	
	(M100 to M125) mm	1.7 µm	
	(M125 to M150) mm	2 µm	
Thread Ring Gauge			
Pitch Diameter	(M2 to M5) mm	0.57 µm	ULM, Plain Ring Gauges
	(M5 to M8) mm	0.58 µm	
	(M8 to M10) mm	0.59 µm	
	(M10 to M12) mm	0.6 µm	
	(M12 to M18) mm	0.63 µm	
	(M18 to M20) mm	0.64 µm	
	(M20 to M25) mm	0.68 µm	
	(M25 to M30) mm	0.72 µm	
	(M30 to M75) mm	2.3 µm	
	(M75 to M90) mm	2.4 µm	
	(M90 to M100) mm	2.5 µm	
	(M100 to M125) mm	2.7 µm	
	(M125 to M150) mm	2.9 µm	

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Thread Ring Gauge Minor Diameter	(M2 to M8) mm (M8 to M20) mm (M20 to M30) mm (M30 to M75) mm (M75 to M90) mm (M90 to M100) mm (M100 to M125) mm (M125 to M150) mm	0.4 µm 0.5 µm 0.6 µm 1.1 µm 1.3 µm 1.4 µm 1.8 µm 2.1 µm	ULM, Master Plain Ring Gauges
[1] Dial Gauge Tester, Calibration Tester	Up to 5 mm (5 to 12) mm (12 to 20) mm (20 to 25) mm (25 to 50) mm	0.65 µm 0.66 µm 0.68 µm 0.7 µm 0.73 µm	Liner Gauge w/Display
Plain Snap Gauge/Gap Gauge (External)	(2 to 4) mm (4 to 16) mm (16 to 22) mm (22 to 30) mm (30 to 75) mm (75 to 100) mm (100 to 200) mm (200 to 300) mm (300 to 400) mm (400 to 500) mm	0.2 µm 0.3 µm 0.4 µm 0.5 µm 1.1 µm 1.4 µm 2.7 µm 4 µm 5.4 µm 6.7 µm	ULM, Gauge Blocks
Plain Snap Gauge / Gap Gauge (Internal)	(2 to 6) mm (6 to 20) mm (20 to 30) mm (30 to 75) mm (75 to 100) mm (100 to 300) mm	0.4 µm 0.5 µm 0.6 µm 2.3 µm 2.4 µm 4.5 µm	ULM, Master Plain Ring Gauges
[1] Hole test, Three-Point Micrometer	(2 to 3) mm (3 to 8) mm (8 to 18) mm (18 to 20) mm (20 to 25) mm (25 to 28) mm (28 to 30) mm 75 mm	0.8 µm 0.9 µm 1.2 µm 1.3 µm 1.4 µm 1.5 µm 1.7 µm 3 µm	Master Ring Gauges
Dial Test Indicator	Up to 1.6 mm	0.3 µm	ULM

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Universal Length Measuring Machine	Up to 1 mm (1 to 3) mm (3 to 5) mm (5 to 10) mm (10 to 25) mm (25 to 50) mm (50 to 75) mm (75 to 100) mm (100 to 125) mm (125 to 150) mm (150 to 175) mm (175 to 200) mm (200 to 250) mm (250 to 300) mm (300 to 400) mm (400 to 500) mm	0.06 µm 0.07 µm 0.09 µm 0.15 µm 0.34 µm 0.67 µm 1 µm 1.3 µm 1.7 µm 2.1 µm 2.4 µm 2.7 µm 3.4 µm 4.1 µm 5.4 µm 6.7 µm	Gauge Blocks
[1] Vernier Depth Gauge	Up to 200 mm (200 to 300) mm (300 to 400) mm (400 to 500) mm (500 to 600) mm (600 to 700) mm (700 to 800) mm (800 to 900) mm (900 to 1 000) mm	6 µm 7 µm 8 µm 9 µm 10 µm 11 µm 12 µm 13 µm 15 µm	Gauge Block Set
Bore Gauge / Cylinder Gauge	(0.5 to 10) mm (10 to 30) mm (30 to 50) mm (50 to 70) mm (70 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 (500 to 600) mm (600 to 700) mm (700 to 800) mm	0.6 µm 0.8 µm 0.9 µm 1.1 µm 1.5 µm 1.8 µm 2.1 µm 2.5 µm 2.8 µm 3.5 µm 4.1 µm 5.4 µm 6.8 µm 8.1 µm 9.5 µm 11 µm	ULM, Gauge Blocks

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1,3] Profile Projector Linearity Angle	 Up to 50 mm (50 to 200) mm (200 to 410) mm (0.25 to 30)°	 2 µm 3 µm 7 µm 12″	 Glass Scale Angle Block Set
[1] Measuring Microscope, Optical Comparator, 3D Vision Measuring System	Up to 50 mm (50 to 200) mm (200 to 410) mm	2 µm 3 µm 7 µm	Glass Scale
[1] Height Master	Up to 175 mm (175 to 250) mm (250 to 300) mm (300 to 400) mm (400 to 500) mm (500 to 600) mm (600 to 700) mm	3 µm 4 µm 5 µm 6 µm 7 µm 8 µm 10 µm	Gauge Block / Linear Height Master
[3] Bevel Protractor	Up to 30° (30 to 45)° (45 to 90)° Up to 100 mm (100 to 200) mm (200 to 300) mm	12″ 24″ 48″ 3 µm 4 µm 5 µm	Angle Block 3D Vision Measuring Machine
Chamfer Gauge	Up to 10 mm	3 µm	3D Vision Measuring Machine
Pitch Gauge	Up to 7 mm	3 µm	3D Vision Measuring Machine
Radius Gauge	Up to 100 mm	3 µm	3D Vision Measuring Machine
Taper Gauge (Scale Type)	Up to 100 mm	3 µm	3D Vision Measuring Machine
Taper Thread Ring	M2 to M5 M5 to M11 M11 to M22 M22 to M45 M45 to M180	0.9 µm 0.91 µm 1.8 µm 5.1 µm 11 µm	ULM, Ring Gauge
[1] Riser Block	150 mm 300 mm 600 mm	9 µm 10 µm 12 µm	Linear Height Master, Gauge Blocks

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Long Gauge Block (Grade 1, 2)	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	1.3 µm 1.7 µm 2.1 µm 2.4 µm 2.7 µm 3.4 µm 4.1 µm 5.4 µm 6.7 µm	ULM, Master Gauge Blocks
Standard Micrometer, Setting Rod, Length Bar	Up to 25 mm (25 to 50) mm (50 to 75) mm (75 to 100) mm (100 to 125) mm (125 to 150) mm (150 to 175) mm (175 to 200) mm (200 to 300) mm (300 to 400) mm (400 to 500) mm	0.4 µm 0.7 µm 1.1 µm 1.4 µm 1.7 µm 2 µm 2.4 µm 2.7 µm 4 µm 5.4 µm 6.7 µm	ULM, Gauge Blocks
Angle Block / Angular	(0.25 to 30)° (30 to 45)° (45 to 60)° (60 to 90)°	12″ 24″ 36″ 48″	Angle Block, 3D Vision Measuring Machine
Gauge Blocks	1 mm (1 to 5) mm (5 to 10) mm (10 to 25) mm (25 to 50) mm (50 to 75) mm (75 to 100) mm	0.22 µm 0.23 µm 0.26 µm 0.43 µm 0.72 µm 1.1 µm 1.4 µm	ULM, Master Gauge Blocks
Test Sieve	Up to 50 mm	3 µm	3D Vision Measuring Machine

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Taper Plug Gauges	Up to M7 M7 to M15 M15 to M25 M25 to M30 M30 to M40 M40 to M50 M50 to M60 M60 to M70 M70 to M80 M80 to M90 M90 to M100 M100 to M200 M200 to M300	0.2 µm 0.3 µm 0.4 µm 0.5 µm 0.6 µm 0.7 µm 0.9 µm 1 µm 1.1 µm 1.3 µm 1.4 µm 2.7 µm 4 µm	ULM, Gauge Blocks
Taper Ring Gauge	M2 to M6 M6 to M20 M20 to M30 M30 to M75 M75 to M100 M100 to M150	0.4 µm 0.5 µm 0.6 µm 2.3 µm 2.4 µm 2.9 µm	ULM, Ring Gauges
Taper Thread Plug	M2 to M5 M5 to M11 M11 to M22 M22 to M45 M45 to M180	0.92 µm 1.8 µm 1.1 µm 4.7 µm 7.6 µm	ULM, Thread Measuring Wire
[1] Coordinate Measuring Machine X, Y, Z Axis	Up to 10 mm (10 to 25) mm (25 to 50) mm (50 to 75) mm (75 to 100) mm (100 to 125) mm (125 to 150) mm (150 to 175) mm (175 to 200) mm (200 to 250) mm (250 to 300) mm (300 to 400) mm (400 to 500) mm (500 to 800) mm (800 to 1 000) mm (1 000 to 1 200) mm (1 200 to 1 500) mm	0.16 µm 0.34 µm 0.67 µm 1 µm 1.3 µm 1.7 µm 2.1 µm 2.4 µm 2.7 µm 3.4 µm 4.1 µm 5.4 µm 6.7 µm 11 µm 13 µm 16 µm 20 µm	Gauge Blocks

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Ultrasonic Thickness Gauge	Up to 100 mm	6 nm	Gauge Blocks
Standard Scale	Up to 50 mm (> 50 to 200) mm (> 200 to 410) mm	1.3 µm 2.4 µm 3.4 µm	3D Vision Measuring Machine, Standard Glass Scale
Coating Thickness Gauge	(30 to 1 470) µm	0.92 µm	Calibration Foils
Square	Up to 100 mm (> 100 to 200) mm (> 200 to 300) mm (> 300 to 400) mm (> 400 to 500) mm (> 500 to 700) mm	3.1 µm 3.8 µm 4.5 µm 6 µm 7.2 µm 9.8 µm	Coordinate Measuring Machine
Spirit Precision Level	10 µm/m 20 µm/m 40 µm/m 50 µm/m 0.1 mm/m	6.8 µm/m 12 µm/m 23 µm/m 29 µm/m 58 µm/m	Precision Level Calibrator, Gauge Blocks, Surface Plate
[1] Extensometer	Up to 55 mm	3.6 µm	Dial Gauge Tester

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Electronic Balance, Spring Balance, Load Cell			OIML Class E2, F1, M1 weight sets and internal calibration procedure utilized in the calibration of the weighing system.
Resolution: 0.000 01 g	Up to 10 g	0.04 mg	
0.000 01 g	(10 to 20) g	0.05 mg	
0.000 01 g	(20 to 50) g	0.08 mg	
0.000 01 g	(50 to 60) g	0.11 mg	
0.000 01 g	(60 to 70) g	0.12 mg	
0.000 01 g	(70 to 100) g	0.16 mg	
0.000 1 g	(100 to 150) g	0.2 mg	
0.000 1 g	(150 to 220) g	0.3 mg	
0.000 1 g	(220 to 300) g	0.4 mg	

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Electronic Balance, Spring Balance, Load Cell			
Resolution: 0.001 g	(300 to 1 000) g	1 mg	
0.001 g	(1 000 to 2 000) g	2 mg	
0.001 g	(2 to 3) kg	3 mg	
0.001 g	(3 to 5) kg	5 mg	
0.001 g	(5 to 6) kg	10 mg	OIML Class E2, F1, M1 weight sets and internal calibration procedure utilized in the calibration of the weighing system.
0.001 g	(6 to 8) kg	12 mg	
0.01 g	(8 to 10) kg	17 mg	
0.01 g	(10 to 12) kg	20 mg	
0.01 g	(12 to 20) kg	26 mg	
0.01 kg	(20 to 100) kg	5.8 g	
0.1 kg	(100 to 1 000) kg	58 g	
0.5 kg	(1 000 to 5 000) kg	0.33 kg	
1 kg	(5 000 to 10 000) kg	0.66 kg	
5 kg	(10 000 to 40 000) kg	3.2 kg	
10 kg	(40 000 to 80 000) kg	6.3 kg	
[1] Push-Pull Gauge, Force Gauge, Tension, Tensile	Up to 1 000 N	0.006 N	Weight Sets
	(1 000 to 3 000) N	0.01 N	
	(3 000 to 5 000) N	0.02 N	
	(5 000 to 10 000) N	0.03 N	
[1] Hand Torque Tool, Torque Wrench, Torque Driver, Electronic Torque	(0.2 to 20) N·m	0.06 N·m	Static Torque Transducer
	(20 to 40) N·m	0.07 N·m	
	(40 to 60) N·m	0.08 N·m	
	(60 to 80) N·m	0.09 N·m	
	(80 to100) N·m	0.1 N·m	
	(100 to 200) N·m	3.1 N·m	
	(200 to 400) N·m	3.5 N·m	
	(400 to 600) N·m	3.9 N·m	
	(600 to 800) N·m	4.4 N·m	
	(800 to 1 000) N·m	5 N·m	
[1] Hardness Tester, Duro Tester (Types A, B, C, D, DO, O) Indenter Dimensions			Based on ASTM D 2240-15 using Vision Measuring Machine
Length	Up to 3.57 mm	2.1 µm	
Angle	Up to 36°	0.003 4°	
Radius	Up to 0.51 mm	3 µm	
Spring Force	Up to 44.5 N	0.026 N	Durometer Calibrator

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Manometer	Up to 1 psig	0.001 9 psi	Fluke 700PD2 Pressure Module
[1] Pneumatic Pressure Devices	Up to 200 kPa (> 200 to 2 000) kPa	0.06 kPa 0.58 kPa	Pneumatic Pressure Calibrator
[1] Hydraulic Pressure Devices	Up to 7 MPa (> 7 to 70) MPa	4 kPa 21 kPa	Hydraulic Pressure Calibrator
[1] Vacuum Gauges	(-90 to 0) kPa	55 Pa	Vacuum Calibrator
[1] Barometric Pressure, Absolute Pressure	(100 to 1 034) hPa	0.6 hPa	Absolute Pressure Calibrator
Mass (Standard Weights)	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1 kg 2 kg 5 kg 10 kg 20 kg	6 µg 6 µg 6 µg 13 µg 14 µg 24 µg 26 µg 27 µg 30 µg 12 µg 14 µg 18 µg 24 µg 35 µg 87 µg 0.14 mg 0.26 mg 0.85 mg 2 mg 6.9 mg 11 mg 20 mg 69 mg	Electronic Balance, OIML Class E2, F1, and M1 Weights
Mass (Standard Weights)	50 kg 100 kg 200 kg 500 kg	1 g 1 g 5 g 5 g	Electronic Balance, OIML Class F2 Weights

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Torque Calibrators	(0.1 to 2) N·m (2 to 4) N·m (4 to 6) N·m (6 to 8) N·m (8 to 10) N·m (10 to 20) N·m (20 to 40) N·m (40 to 200) N·m (200 to 400) N·m (400 to 1 000) N·m (1 000 to 1 500) N·m	0.92 % of reading 0.46 % of reading 0.31 % of reading 0.23 % of reading 0.18 % of reading 0.1 % of reading 0.05 % of reading 0.03 % of reading 0.02 % of reading 0.01 % of reading 0.006 % of reading	Weights, Calibration Arms
[1] Universal Testing Machine, Crane Scales, Compression / Tensile Testing Machine	Compression Testing Machine (0.1 to 200) kN (> 200 to 1 000) kN Tensile Testing Machine 100 N to 30 kN	 0.32 % of reading 0.42 % of reading 0.16 % of reading	Master Load Cell
Volumetric Glassware, Burette	5 ml 10 ml 25 ml 50 ml 100 ml	0.003 5 ml 0.003 7 ml 0.006 5 ml 0.01 ml 0.018 ml	Electronic Balance
Volumetric Glassware, Volumetric Flask	2 ml 5 ml 10 ml 20 ml 25 ml 50 ml 100 ml 200 ml 250 ml 500 ml 1 000 ml	0.005 8 ml 0.005 8 ml 0.005 9 ml 0.006 2 ml 0.006 5 ml 0.01 ml 0.017 ml 0.028 ml 0.035 ml 0.063 ml 0.13 ml	Electronic Balance
Volumetric Glassware, Measuring Cylinder	5 ml 10 ml 25 ml 50 ml 100 ml 250 ml 500 ml 1 000 ml	0.005 8 ml 0.005 9 ml 0.006 5 ml 0.01 ml 0.017 ml 0.035 ml 0.063 ml 0.13 ml	Electronic Balance

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Volumetric Glassware, Measuring Pipette	0.5 ml 1 ml 2 ml 5 ml 10 ml 15 ml 25 ml 50 ml	0.002 3 ml 0.002 3 ml 0.002 3 ml 0.002 4 ml 0.003 7 ml 0.006 ml 0.006 5 ml 0.01 ml	Electronic Balance
Volumetric Glassware, Volumetric Pipette	0.5 ml 1 ml 2 ml 5 ml 10 ml 15 ml 25 ml 50 ml 100 ml	0.002 3 ml 0.002 3 ml 0.00 23 ml 0.002 4 ml 0.003 7 ml 0.006 ml 0.006 5 ml 0.01 ml 0016 ml	Electronic Balance
Piston Pipette	(10 to 1 000) µl	0.14 µl	Electronic Balance
[1] Anemometers (Air Velocity)	2.5 m/s 5 m/s 7.5 m/s 10 m/s 12.5 m/s 15 m/s	0.25 m/s 0.25 m/s 0.25 m/s 0.25 m/s 0.42 m/s 0.42 m/s	Lutron MHB-382SD Barometer, Trotec TA400 Dynamic Pressure Anemometer, Omega WTM-1000 Wind Tunnel
Liquid Flow Devices	(1 to 3) m^3/h (3 to 6) m^3/h (6 to 10) m^3/h (10 to 20) m^3/h (20 to 30) m^3/h	0.051 m^3/h 0.018 m^3/h 0.065 m^3/h 0.069 m^3/h 0.099 m^3/h	Ultrasonic Flow Meter, Calibration Rig
Liquid Flow Devices	(1 to 6) m3/h (6 to 12) m^3/h (12 to 24) m^3/h (24 to 42) m^3/h	0.029 m^3/h 0.037 m^3/h 0.056 m^3/h 0.069 m^3/h	Electromagnetic Flow Meter, Calibration Rig

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Air Flow Meters	(0 to 0.3) lpm (0.3 to 1) lpm (1 to 2) lpm (2 to 3) lpm (3 to 4) lpm (4 to 5) lpm (5 to 10) lpm (10 to 20) lpm (20 to 30) lpm (30 to 50) lpm (50 to 100) lpm (100 to 150) lpm (150 to 200) lpm	0.006 5 lpm 0.012 lpm 0.021 lpm 0.031 lpm 0.04 lpm 0.05 lpm 0.1 lpm 0.2 lpm 0.3 lpm 3.4 lpm 3.8 lpm 4.1 lpm 7.5 lpm	Air Flow Calibrator, Calibration Rig
Hydrometers	(600 to 850) kg/m^3 (> 850 to 1 350) kg/m^3 (> 1 350 to 2 000) kg/m^3	0.08 kg/m^3 0.1 kg/m^3 0.14 kg/m^3	Electronic Balance, Standard Rong Weight, Barometer

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1,3] Gloss Meters	(0 to 100) GU 20° 60° 85°	 0.93 GU 0.91 GU 1.1 GU	Standard Gloss Tile
Illuminance/Lux Meter	35 lux 50 lux 100 lux 500 lux 1 000 lux 1 500 lux 2 000 lux 3 000 lux 4 000 lux 5 000 lux	0.46 lux 0.66 lux 1.3 lux 6.6 lux 13 lux 20 lux 26 lux 39 lux 52 lux 65 lux	Comparison to Standard Illuminance/Lux Meter

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[5] Colorimeter Illuminant A, C, D50, D65 Observer: 2°, 10°	Geometry 8°: DI, 8°: DE Pale Grey x y Y u' v' L* a* b* C* H* Mid Grey x y Y u' v' L* a* b* C* H* Diff Grey x y Y u' v' L* a* b* C* H*	 0.000 3 0.000 3 0.42 0.000 3 0.000 3 0.21 0.14 0.14 0.18 0.18 0.000 3 0.000 3 0.21 0.000 3 0.000 3 0.21 0.14 0.18 0.21 0.22 0.000 3 0.000 3 0.21 0.000 3 0.000 3 0.21 0.14 0.18 0.21 0.22	Standard Color Tile

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[5] Colorimeter Illuminant A, C, D50, D65 Observer: 2°, 10°	Geometry 8°: DI, 8°: DE Deep Grey x y Y u' v' L* a* b* C* H* Deep Pink x y Y u' v' L* a* b* C* H* Red x y Y u' v' L* a* b* C* H*	 0.000 3 0.000 3 0.14 0.000 3 0.000 3 0.42 0.2 0.21 0.17 0.19 0.001 6 0.000 6 0.21 0.001 4 0.000 3 0.28 0.26 0.21 0.19 0.2 0.006 4 0.000 9 0.21 0.004 8 0.001 4 0.42 0.35 0.71 0.68 0.92	Standard Color Tile

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[5] Colorimeter Illuminant A, C, D50, D65 Observer: 2°, 10°	Geometry 8°: DI, 8°: DE, Orange		Standard Color Tile
	x	0.002	
	y	0.000 7	
	Y	0.35	
	u'	0.001	
	v'	0.000 6	
	L*	0.28	
	a*	0.28	
	b*	0.52	
	C*	0.44	
	H*	0.42	
	Bright Yellow		
	x	0.000 7	
	y	0.000 9	
	Y	0.5	
	u'	0.000 3	
	v'	0.000 3	
	L*	0.35	
	a*	0.21	
	b*	0.44	
	C*	0.35	
	H*	0.19	
	Green		
	x	0.000 7	
	y	0.001 4	
	Y	0.21	
	u'	0.000 7	
	v'	0.000 6	
	L*	0.3	
	a*	0.24	
	b*	0.3	
	C*	0.3	
	H*	0.31	

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[5] Colorimeter Illuminant A, C, D50, D65 Observer: 2°, 10°	Geometry 8°: DI, 8°: DE, Diff. Green		Standard Color Tile
	x	0.000 7	
	y	0.001 4	
	Y	0.21	
	u'	0.000 7	
	v'	0.000 6	
	L*	0.3	
	a*	0.24	
	b*	0.3	
	C*	0.3	
	H*	0.31	
	Cyan		
	x	0.001 7	
	y	0.000 7	
	Y	0.28	
	u'	0.001	
	v'	0.000 6	
	L*	0.28	
	a*	0.28	
	b*	0.21	
	C*	0.28	
	H*	0.28	
	Deep Blue		
	x	0.026	
	y	0.029	
	Y	0.14	
	u'	0.008 5	
	v'	0.028	
	L*	1.2	
	a*	1.8	
	b*	1.4	
	C*	2.9	
	H*	2.5	

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[5] Colorimeter Illuminant A, C, D50, D65 Observer: 2°, 10°	Geometry 0°:45°, Pale Grey x y Y u' v' L* a* b* C* H* Mid Grey x y Y u' v' L* a* b* C* H* Diff. Grey x y Y u' v' L* a* b* C* H*	 0.000 3 0.000 3 0.71 0.000 3 0.000 3 0.42 0.14 0.14 0.17 0.18 0.000 3 0.000 3 0.35 0.000 3 0.000 3 0.35 0.14 0.14 0.2 0.2 0.000 3 0.000 3 0.35 0.000 3 0.000 3 0.35 0.14 0.14 0.2 0.2	Standard Color Tile

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[5] Colorimeter Illuminant A, C, D50, D65 Observer: 2°, 10°	Geometry 0°:45°, Deep Grey		Standard Color Tile
	x	0.000 5	
	y	0.000 3	
	Y	0.28	
	u'	0.000 3	
	v'	0.000 3	
	L*	0.71	
	a*	0.14	
	b*	0.2	
	C*	0.19	
	H*	0.2	
	Deep Pink		
	x	0.001 6	
	y	0.000 6	
	Y	0.28	
	u'	0.001 4	
	v'	0.000 3	
	L*	0.42	
	a*	0.28	
	b*	0.21	
	C*	0.17	
	H*	0.19	
	Red		
	x	0.006 4	
	y	0.000 9	
	Y	0.35	
	u'	0.004 8	
	v'	0.001 4	
	L*	0.57	
	a*	0.42	
	b*	1.3	
	C*	0.86	
	H*	1	

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[5] Colorimeter Illuminant A, C, D50, D65 Observer: 2°, 10°	Geometry 0°:45°, Orange x y Y u' v' L* a* b* C* H* Bright Yellow x y Y u' v' L* a* b* C* H* Green x y Y u' v' L* a* b* C* H*	 0.002 0.000 7 0.57 0.001 0.000 6 0.42 0.28 0.86 0.44 0.41 0.000 7 0.000 8 0.78 0.000 3 0.000 3 0.42 0.21 0.42 0.32 0.2 0.000 7 0.001 4 0.28 0.000 7 0.000 6 0.35 0.21 0.28 0.29 0.3	Standard Color Tile

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[5] Colorimeter Illuminant A, C, D50, D65 Observer: 2°, 10°	Geometry 0°:45°, Diff. Green x y Y u' v' L* a* b* C* H* Cyan x y Y u' v' L* a* b* C* H* Deep Blue x y Y u' v' L* a* b* C* H*	 0.000 7 0.001 4 0.28 0.000 7 0.000 6 0.35 0.21 0.28 0.29 0.3 0.001 7 0.000 7 0.35 0.001 0.000 6 0.42 0.28 0.28 0.32 0.32 0.026 0.029 0.28 0.008 6 0.028 2.1 3.2 2.5 3 3.2	Standard Color Tile

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Temperature Controlled Chamber, Hot Air Oven, Incubator, Refrigerator, Low Temperature Incubator, Autoclave	(-40.0 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 250) °C	0.27 °C 0.19 °C 0.26 °C 0.31 °C	Agilent 34970A Data logger and Thermocouple with RTD sensor
[1] Temperature Gauge & Dial Thermometer	(-80 to 250) °C	0.07 °C	Hart Scientific 1575 PRT Standard
	(250 to 500) °C (500 to 650) °C	0.7 °C 2.6 °C	Fluke 1524 Thermocouple Standard
[1] Thermocouple Sensor TC	(-80 to 250) °C	0.07 °C	Hart Scientific 1575 PRT Standard
	(250 to 500) °C (500 to 1 200) °C	0.7 °C 2.6 °C	Fluke 1524 Thermocouple Standard
[1] Liquid Bath	(-40.0 to 0) °C (0 to 100) °C (100 to 200) °C (200 to 250) °C	0.27 °C 0.19 °C 0.26 °C 0.31 °C	Agilent 34970A Data logger and Thermocouple with RTD sensor
[1] Digital Thermometer with Thermocouple Sensors Types K, J, E, T, N, R, S	(-80 to 250) °C	0.07 °C	Hart Scientific 1575 PRT Standard
	(250 to 500) °C (500 to 1 200) °C	0.7 °C 2.6 °C	Fluke 1524 Thermocouple Standard
[1] Digital Thermometer with RTD or Thermistor Sensor	(-80 to 250) °C	0.07 °C	Hart Scientific 1575 PRT Standard
	(250 to 500) °C (500 to 850) °C	0.7 °C 2.6 °C	Fluke 1524 Thermocouple Standard
[1] RTD Sensor	(-80 to 250) °C	0.07 °C	Hart Scientific 1575 PRT Standard
	(250 to 500) °C (500 to 850) °C	0.7 °C 2.6 °C	Fluke 1524 Thermocouple Standard
Liquid-in-Glass Thermometers	(-80 to 250) °C	0.29 °C	Hart Scientific 1575 PRT Standard
Dry Block, Dry Well	Up to 250 °C	0.07 °C	Hart Scientific 1575 PRT Standard
	(250 to 450) °C (450 to 1 200) °C	0.7 °C 2.6 °C	Thermocouple Standard
[1] Furnace	(300 to 600) ºC (600 to 900) ºC (900 to 1 200) ºC	1.8 °C 2.5 °C 2.6 °C	Thermocouple Standard
Digital Thermometer with Surface Probe	(40 to 350) °C	2.4 °C	Digital Thermometer Fluke 714 with Surface Probe

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Infrared Thermometers	(-40 to 50) °C (> 50 to 100) °C (> 100 to 200) °C (> 200 to 400) °C	0.91 °C 0.92 °C 1.5 °C 2 °C	Comparison to Radiation Thermometer Ɛ = 0.95, λ = (8 to 14) µm
Thermo Hygrometer Temperature	(15 to 40) °C	0.2 °C	Fluke 5020A Thermo-hygrometer, Temp/Humidity Chamber
Thermo Hygrometer Humidity	(30 to 50) %RH (50 to 70) %RH (70 to 90) %RH	0.84 %RH 1.1 %RH 1.6 %RH	Fluke 5020A Thermo-hygrometer, Temp/Humidity Chamber
[1] Thermo Hygrometer Temperature Chamber	(20 to 40) °C	0.11 °C	Agilent 34901A Datalogger with RTD Sensor
[1] Thermo Hygrometer Humidity Chamber	(30 to 70) %RH	3.3 %RH	Comparison to Data Logger CEM DT-172

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1,3] Digital Photo Tachometers	(2.5 to 999.9) rpm (> 999.9 to 9 999.9) rpm (> 9 999.9 to 99 999) rpm	0.01 rpm 0.06 rpm 0.58 rpm	Fluke 5502A Multiproduct Calibrator with LED
[1,3] Digital Contact Tachometers	(0.5 to 999.9) rpm (> 999.9 to 9 999.9) rpm (> 9 999.9 to 19 999) rpm	0.01 rpm 0.06 rpm 0.58 rpm	Fluke 5502A Multiproduct Calibrator
[1,3] Stroboscopes	Up to 120 rpm (> 120 to 1 020) rpm (> 1 020 to 5 040) rpm (> 5 040 to 10 020) rpm (> 10 020 to 20 040) rpm (> 20 040 to 50 040) rpm (> 50 040 to 99 960) rpm	0.1 rpm 0.1 rpm 0.22 rpm 0.36 rpm 0.65 rpm 1.52 rpm 2.96 rpm	Fluke PM6685 Universal Counter, High-Speed Photo Transistor Box (PT523C-B1-T363)
[1] Stopwatch Photo Totalize Method Time Base Method	10 s to 1 h (1 to 86 400) s	27 ms 0.58 ms	Agilent 53132A Universal Frequency Counter, Fluke PM6685R Universal Frequency Counter, HP 8904A Multifunction Synthesizer

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Frequency Source	(0.01 to 500) Hz 500 Hz to 5 kHz (5 to 50) kHz	20 µHz/Hz + 5.9 mHz 20 µHz/Hz + 58 mHz 20 µHz/Hz + 0.58 Hz	Fluke 5502A Multiproduct Calibrator
[3] General Frequency Source	(1 to 1 000) Hz > 1 Hz to 10 kHz (> 0.01 to 225) MHz (> 225 to 300) MHz > 300 MHz to 1 GHz (> 1 to 1.8) GHz (> 1.8 to 18) GHz	$4.4 \times 10^{-10}\, f$ $2.4 \times 10^{-10}\, f$ $2.4 \times 10^{-10}\, f$ $2.4 \times 10^{-9}\, f$ $7 \times 10^{-10}\, f$ $4.2 \times 10^{-10}\, f$ $2.7 \times 10^{-10}\, f$	Agilent 53132A Universal Frequency Counter, Fluke PM6685R Universal Frequency Counter, HP 8902A Measuring Receiver
Radar Gun Speed	24.150 GHz 40.25 km/h 56.35 km/h 104.65 km/h 34.7 GHz 40.64 km/h 64.75 km/h	1 km/h 1 km/h	Using Tuning Forks
[1] Radar Speed (All Frequency Band)	60 km/h 90 km/h 120 km/h	0.4 km/h 0.6 km/h 0.9 km/h	Rasmi Racing Drag and Timer, Measuring Tape, Calculate speed (S) by known distance (D) and known elapse time (T) $S=\frac{D}{T}$
[1,3] Centrifuge Rotation	(50 to 999.99) rpm (1 000 to 3 000) rpm (3 000.1 to 9 999.9) rpm (10 000 to 20 000) rpm	0.53 rpm 1.9 rpm 5.3 rpm 13 rpm	Digital Tachometer
Universal Frequency Counter Time Base Frequency Time Interval Trigger Level	 1 MHz to 10 MHz DC to 18 GHz 1 µs to 1 ms (-5.25 to 5.25) V	 2.4×10^{-10} Hz 2.9×10^{-10} Hz 0.6 ps 1.9 µV	Agilent 53132A Universal Frequency Counter, Fluke PM6685R Universal Frequency Counter, Agilent N9310A RF Signal Generator, HP 33120A Function Generator/Arbitrary Waveform Generator, HP 83731A Synthesizer Signal Generator, HP 8904A Multifunction Synthesizer

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Time Interval Source	10 ns to 1 s (> 1 to 10) s (> 10 to 50) s (> 50 to 100) s	2 ns 4 ns 14 ns 26 ns	Agilent 53132A Universal Frequency Counter, Fluke PM6685R Universal Frequency Counter

DIMENSIONAL MEASUREMENT

1 Dimensional

Parameter	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Jig, Fixture and Mold, Die X-axis	Up to 25 mm (25 to 50) mm (50 to 75) mm (75 to 100) mm (100 to 125) mm (125 to 150) mm (150 to 175) mm (175 to 200) mm (200 to 250) mm (250 to 300) mm (300 to 400) mm (400 to 500) mm (500 to 600) mm	2.7 µm 2.8 µm 2.9 µm 3 µm 3.2 µm 3.4 µm 3.6 µm 3.8 µm 4.3 µm 4.9 µm 6 µm 7.2 µm 8.5 µm	Coordinate Measuring Machine
Jig, Fixture and Mold, Die Y-axis	Up to 25 mm (25 to 50) mm (50 to 75) mm (75 to 100) mm (100 to 125) mm (125 to 150) mm (150 to 175) mm (175 to 200) mm (200 to 250) mm (250 to 300) mm (300 to 400) mm (400 to 500) mm (500 to 700) mm	2.7 µm 2.8 µm 2.9 µm 3 µm 3.2 µm 3.4 µm 3.6 µm 3.8 µm 4.3 µm 4.9 µm 6 µm 7.2 µm 9.8 µm	Coordinate Measuring Machine

1 Dimensional

Parameter	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method and/or Equipment
Jig, Fixture and Mold, Die Z-axis	Up to 25 mm	2.7 µm	Coordinate Measuring Machine
	(25 to 50) mm	2.8 µm	
	(50 to 75) mm	2.9 µm	
	(75 to 100) mm	3 µm	
	(100 to 125) mm	3.2 µm	
	(125 to 150) mm	3.4 µm	
	(150 to 175) mm	3.6 µm	
	(175 to 200) mm	3.8 µm	
	(200 to 250) mm	4.3 µm	
	(250 to 300) mm	4.9 µm	
	(300 to 400) mm	6 µm	
	(400 to 500) mm	7.2 µm	

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. Nominal Values listed as approximate.
3. f = frequency in Hz; ″ = arc-second; GU = Gloss Units; rpm = revolutions per minute.
4. Mismatch Uncertainty is based on DUT SWR: 1.4 for < 2 GHz; 1.6 for < 18 GHz.
5. Unitless parameter.
6. This scope is formatted as part of a single document including Certificate of Accreditation No. ACT-2050.

Jason Stine, Vice President