CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

APTITECH CALIBRATION CO., LTD.
50/40 Moo 5 T.Lat Sawai, A. Lamlukka
Pathumthani 12150 Thailand

Fulfills the requirements of

ISO/IEC 17025:2017

In the field 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: 11 September 2024
Certificate Number: ACDM-2906

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

APTITECH CALIBRATION CO., LTD.

50/40 Moo 5 T. Lat Sawai, A. Lamlukka,
Pathumthani 12150 Thailand
Mr. Anuwat Simsiriwat Mb: +668 8692 0101

CALIBRATION AND DIMENSIONAL MEASUREMENT

Valid to: **September 11, 2024** Certificate Number: **ACDM-2906**

CALIBRATION

Acoustics and Vibration

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Vibration Meter Acceleration (80 to 640) Hz	Up to 10 m/s^2 (> 10 to 20) m/s^2 (> 20 to 50) m/s^2 (> 50 to 100) m/s^2	0.15 m/s^2 0.22 m/s^2 0.33 m/s^2 3.9 m/s^2	Vibration Calibrator, Vibration Meter
[1] Vibration Meter Velocity (80 to 640) Hz	Up to 10 mm/s (> 10 to 20) mm/s (> 20 to 50) mm/s (> 50 to 100) mm/s	0.13 mm/s 0.21 mm/s 0.48 mm/s 0.95 mm/s	Vibration Calibrator, Vibration Meter
[1] Vibration Meter Displacement (80 to 320) Hz	Up to 10 µm (> 10 to 20) µm (> 20 to 50) µm (> 50 to 100) µm	0.2 µm 0.98 µm 3.8 µm 8.8 µm	Vibration Calibrator, Vibration Meter
[1] Acceleration	Up to 10 m/s^2 (> 10 to 20) m/s^2 (> 20 to 30) m/s^2 (> 30 to 50) m/s^2 (> 50 to 100) m/s^2	0.14 m/s^2 0.93 m/s^2 1.6 m/s^2 4.2 m/s^2 8.4 m/s^2	Vibration Calibrator, Vibration Meter
[1] Sound Level Meter	1 kHz 94 dB 114 dB	 0.6 dB 0.6 dB	Sound Level Calibrator

Chemical Quantities

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] pH Meter	4 pH 7 pH 10 pH	0.01 pH 0.012 pH 0.015 pH	pH solutions
[1] Conductivity Meter	84 µS/cm 1 413 µS/cm 12 880 µS/cm	0.8 µS/cm 16 µS/cm 100 µS/cm	Conductivity solutions
[1] Refractometer	5 %Brix 10 %Brix 20 %Brix 30 %Brix 50 %Brix 60 %Brix	0.03 %Brix 0.03 %Brix 0.04 %Brix 0.04 %Brix 0.05 %Brix 0.06 %Brix	Source Solution, Standard Refractometer
[1] Turbidity Meter	10 NTU 100 NTU 500 NTU 1 000 NTU	0.085 NTU 0.85 NTU 5 NTU 10 NTU	Turbidity Solution
[1] TDS Meter	10 mg/l 100 mg/l 500 mg/l 1 000 mg/l 2 000 mg/l	0.063 mg/l 0.62 mg/l 3.1 mg/l 6.2 mg/l 12 mg/l	TDS Buffer Solution
DO Meter	5.9 mg/l 31.1 mg/l	0.2 mg/l 0.2 mg/l	DO Buffer Solution
Gas Detector/Analyzer	100 parts in 10^6 CO 18% O_2 50 %LEL CH_4 25 parts in 10^6 H_2S	2.2 parts in 10^6 CO 0.38 % O_2 1.3 %LEL 1.5 parts in 10^6 H_2S	Standard Gas

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] DC Voltage – Source	(0 to 100) mV (> 0.1 to 1) V (> 1 to 10) V (> 10 to 100) V (> 100 to 1 000) V	70 µV/V + 3.5 µV 58 µV/V + 5.8 µV 59 µV/V + 58 µV 64 µV/V + 0.58 mV 64 µV/V + 1.8 mV	Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] DC Current - Source	Up to 3.3 mA (3.3 to 33) mA (33 to 330) mA (0.33 to 2.2) A (2.2 to 11) A	0.16 mA/A + 59 nA 0.12 mA/A + 0.3 µA 0.17 mA/A + 3.9 µA 0.35 mA/A + 52 µA 0.7 mA/A + 0.39 mA	Multiproduct Calibrator
[1] DC Current – Source Clamp-On Ammeter	(11 to 550) A	5.8 mA/A + 0.18 A 5.9 mA/A + 1 A	Multiproduct Calibrator with Coil
[1] AC Current – Source Clamp-On Ammeter	@ 45 to 1 kHz (11 to 50) A (> 50 to 550) A	 6.6 mA/A + 0.3 A 7.6 mA/A + 1.2 A	Multiproduct Calibrator with Coil
[1] AC Voltage – Source	@ 10 Hz to 45 Hz (1 to < 33 mV (33 to < 330 mV (0.33 to < 3.3 V (3.3 to 33 V @ > 45 Hz to 10 kHz (1 to < 33 mV (33 to < 330 mV (0.33 to < 3.3 V (3.3 to < 33 V @ > 10 kHz to 20 kHz (1 to < 33 mV (33 to < 330 mV (0.33 to < 3.3 V (3.3 to < 33 V (33 to < 330 V @ > 20 kHz to 50 kHz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V (3.3 to < 33) V @ > 50 kHz to 100 kHz (1 to < 33) mV (33 to < 330) mV (0.33 to < 3.3) V (3.3 to < 33) V	 4.1 mV/V + 24 µV 2.9 mV/V + 58 µV 1.8 mV/V + 0.29 mV 1.8 mV/V + 0.29 mV 2.4 mV/V + 24 µV 0.58 mV/V + 24 µV 0.35 mV/V + 70 µV 0.47 mV/V + 0.71 mV 2.9 mV/V + 24 µV 1.2 mV/V + 24 µV 0.93 mV/V + 70 µV 0.93 mV/V + 3.1 mV 1.1 mV/V + 39 mV 2.9 mV/V + 24 µV 1.9 mV/V + 47 µV 1.7 mV/V + 35 mV 2.2 mV/V + 5.8 mV 4.1 mV/V + 39 µV 2.8 mV/V + 0.2 mV 2.8 mV/V + 2 mV 2.8 mV/V + 20 mV	Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] AC Voltage – Source	@ > 100 kHz to 500 kHz		Multiproduct Calibrator
	(1 to < 33) mV	12 mV/V + 70 µV	
	(33 to < 330) mV	8.1 mV/V + 0.39 mV	
	(0.33 to < 3.3) V	5.8 mV/V + 3.9 mV	
	@ >45 Hz to 1 kHz		
	(33 to < 330) V	0.58 mV/V + 7.7 mV	
	(330 to 1 000) V	0.58 mV/V + 1 V	
	@ > 1 kHz to 10 kHz		
	(33 to < 330) V	0.93 mV/V + 18 mV	
	@ > 1 kHz to 5 kHz		
	(330 to 1 000) V	2.4 mV/V + 0.12 V	
	@ > 5 kHz to 10 kHz		
	(330 to 1 000) V	2.4 mV/V + 0.28 V	
	@ 10 Hz to 20 Hz		
	(0.029 to < 0.33) mA	2.9 mA/A + 0.18 µA	
	(0.33 to < 3.3) mA	2.4 mA/A + 0.36 µA	
	(3.3 to < 33) mA	2.4 mA /A + 3.6 µA	
	(33 to < 330) mA	2.4 mA/A + 36 µA	
	@ > 20 Hz to 45 Hz		
	(0.029 to < 0.33) mA	1.5 mA/A + 0.18 µA	
	(0.33 to < 3.3) mA	1.2 mA/A + 0.36 µA	
	(3.3 to < 33) mA	1.2 mA /A + 3.6 µA	
	(33 to < 330) mA	1.2 mA/A + 35 µA	
	@ > 45 Hz to 1 kHz		
	(0.029 to < 0.33) mA	1.5 mA/A + 0.28 µA	
	(0.33 to < 3.3) mA	1.2 mA/A + 0.37 µA	
	(3.3 to < 33) mA	1.1 mA /A + 3.6 µA	
	(33 to < 330) mA	1.1 mA/A + 37 µA	
	(0.33 to < 2.2) A	1.2 mA/A + 0.39 mA	
	@ > 1 kHz to 5 kHz		
	(0.029 to < 0.33) mA	15 mA/A + 0.18 µA	
	(0.33 to < 3.3) mA	2.4 mA/A + 0.36 µA	
	(3.3 to < 33) mA	1.1 mA /A + 3.6 µA	
	(33 to < 330) mA	1.1 mA/A + 37 µA	
	(0.33 to < 2.2) A	1.2 mA/A + 0.39 mA	
	@ > 5 kHz to 10 kHz		
	(0.029 to < 0.33) mA	15 mA/A + 0.18 µA	
	(0.33 to < 3.3) mA	7 mA/A + 0.37 µA	
	(3.3 to < 33) mA	7 mA /A + 3.6 µA	
	(33 to < 330) mA	7 mA/A + 35 µA	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] AC Current - Source	@ 10 Hz to 45 Hz (0.33 to < 2.2) A @ 45 Hz to 65 Hz (2.2 to 10) A @ > 65 Hz to 500 Hz (2.2 to 10) A @ > 500 Hz to 1 kHz (2.2 to 10) A	2.4 mA/A + 0.38 mA 0.71 mA/A + 2.4 mA 1.2 mA/A + 2.4 µA 3.9 mA/A + 2.4 µA	Multiproduct Calibrator
[1] Resistance - Source	0 Ω (> 0 to < 11) Ω (11 to 33) Ω (33 to 110) Ω (110 to < 330) Ω (0.33 to < 1.1) kΩ (1.1 to < 3.3) kΩ (3.3 to < 11) kΩ (11 to < 33) kΩ (33 to < 110) kΩ (110 to < 330) kΩ (0.33 to < 1.1) MΩ (1.1 to < 3.3) MΩ (3.3 to < 11) MΩ (11 to < 33) MΩ (33 to < 110) MΩ (110 to 330) MΩ	9.3 mΩ 140 µΩ/Ω + 9.3 mΩ 142 µΩ/Ω + 17 mΩ 106 µΩ/Ω + 17 mΩ 105 µΩ/Ω + 17 mΩ 105 µΩ/Ω + 70 mΩ 105 µΩ/Ω + 70 mΩ 105 µΩ/Ω + 0.7 Ω 128 µΩ/Ω + 0.7 Ω 110 µΩ/Ω + 0.7 Ω 105 µΩ/Ω + 0.7 Ω 175 µΩ/Ω + 64 Ω 176 µΩ/Ω + 72 Ω 0.7 mΩ/Ω + 0.78 kΩ 1.16 mΩ/Ω + 1.7 kΩ 5.8 mΩ/Ω + 7 kΩ 5.9 µΩ/Ω + 0.2 MΩ	Multiproduct Calibrator
[1] DC Power – Source 33 mV to 1 020 V @ 3.3 mA to < 9 mA @ 9 mA to < 33 mA @ 33 mA to < 90 mA @ 90 mA to < 330 mA @ 0.33 A to < 0.9 A @ 0.9 A to < 2.2 A @ 2.2 A to < 4.5 A @ 4.5 A to 11 A	 0.1089 mW to < 9 W 0.297 mW to < 33 W 1.089 mW to < 90 W 2.970 mW to < 330 W 10.89 mW to < 900 W 29.7 mW to < 2 200 W 72.6 mW to < 4 500 W (1.485 to 11 000) W	 0.47 mW/W + 58 mW 0.35 mW/W + 58 mW 0.47 mW/W + 76 mW 0.35 mW/W + 76 mW 0.35 mW/W + 76 mW 0.7 mW/W + 0.76 W 1.4 mW/W + 0.76 W 1.1 mW/W + 0.76 W	Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] AC Power – Source (45 to 65) Hz 0.33 V to < 1 020V @PF=1 @ 3.3 mA to < 9 mA @ 9 mA to < 33 mA @ 33 mA to < 90 mA @ 90 mA to < 330 mA @ 0.33 A to < 0.9 A @ 0.9 A to < 2.2 A @ 2.2 A to < 4.5 A @ 4.5 A to 11 A	 1.089 mW to < 9 W 2.97 mW to < 33 W 10.89 mW to < 90 W 29.7 mW to < 330 W 108.9 mW to < 900 W 297 mW to < 2 200 W 726 mW to < 4 500 W (1.485 to 11 000) W	 3 mW/W + 7.6 mW 1.8 mW/W + 7.6 mW 3 mW/W + 76 mW 1.8 mW/W + 76 mW 3 mW/W + 76 mW 1.8 mW/W + 0.76 W 2.4 mW/W + 0.76 W 1.8 mW/W + 0.76 W	Multiproduct Calibrator
[1] Capacitance – Source	@50 Hz to 10 kHz (0.33 to < 0.5) nF (0.5 to < 1.1) nF (1.1 to < 3.3) nF (3.3 to < 11) nF (11 to < 33) nF (33 to < 110) nF (110 to < 330) nF @50 Hz to 5 kHz 0.33 µF to < 1.1 µF @50 Hz to 2 kHz (1.1 to < 3.3) µF @50 Hz to 1.5 kHz (3.3 to 11) µF @ (50 to 800) Hz (11 to 33) µF @ (50 to 400) Hz (33 to 110) µF @ (50 to 200) Hz (110 to 330) µF @ (50 to 150) Hz (0.33 to 1) mF	 5.9 mF/F + 12 pF 5.9 mF/F + 12 pF 5.9 mF/F + 13 pF 5.9 mF/F + 13 pF 3 mF/F + 0.13 nF 3 mF/F + 0.13 nF 3 mF/F + 0.68 nF 3 mF/F + 1.3 nF 4.1 mF/F + 6.8 nF 4.1 mF/F + 14 nF 4.7 mF/F + 68 µF 5.9 mF/F + 0.14 µF 8.2 mF/F + 0.68 µF 12 mF/F + 0.68 µF	Multiproduct Calibrator
[1] Electrical Simulation of Thermocouple Indicators – Source	Type B (600 to 800) °C (800 to 1 000) °C (1 000 to 1 550) °C (1 550 to 1 820) °C	 0.32 °C 0.3 °C 0.27 °C 0.28 °C	Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Electrical Simulation of Thermocouple Indicators – Source	Type E		Multiproduct Calibrator
	(-250 to -100) °C	0.41 °C	
	(-100 to -25) °C	0.15 °C	
	(-25 to 350) °C	0.13 °C	
	(350 to 650) °C	0.15 °C	
	(650 to 1 000) °C	0.18 °C	
	Type J		
	(-210 to -100) ºC	0.23 °C	
	(-100 to -30) ºC	0.15 °C	
	(-30 to 150) ºC	0.13 °C	
	(150 to 760) ºC	0.15 °C	
	(760 to 1 200) ºC	0.2 °C	
	Type K		
	(-200 to -100) °C	0.23 °C	
	(-100 to -25) °C	0.15 °C	
	(-25 to 120) °C	0.13 °C	
	(120 to 1 000) °C	0.15 °C	
	(1 000 to 1 372) °C	0.2 °C	
	Type N		
	(-200 to -100) °C	0.32 °C	
	(-100 to -25) °C	0.19 °C	
	(-25 to 410) °C	0.17 °C	
	(410 to 1 300) °C	0.23 °C	
	Type R		
	(0 to 250) °C	0.48 °C	
	(250 to 400) °C	0.30 °C	
	(400 to 1 000) °C	0.28 °C	
	(1 000 to 1 767) °C	0.33 °C	
	Type S		
	(0 to 250) °C	0.41 °C	
	(250 to 1 000) °C	0.31 °C	
	(1 000 to 1 400) °C	0.38 °C	
	(1 400 to 1 767) °C	0.28 °C	
	Type T		
	(-250 to -150) °C	0.52 °C	
	(-150 to 0) °C	0.21 °C	
	(0 to 120) °C	0.15 °C	
	(120 to 400) °C	0.13 °C	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Electrical Simulation of RTD Indicators – Source	Pt 385, 100 Ω		Multiproduct Calibrator
	(-200 to -80) °C	0.082 °C	
	(-80 to 0) °C	0.082 °C	
	(0 to 100) °C	0.1 °C	
	(100 to 300) °C	0.12 °C	
	(300 to 400) °C	0.13 °C	
	(400 to 630) °C	0.16 °C	
	(630 to 850) °C	0.28 °C	
	Pt 3916, 100 Ω		
	(-200 to -190) °C	0.2 °C	
	(-190 to -80) °C	0.32 °C	
	(-80 to 0) °C	0.04 °C	
	(0 to 100) °C	0.047 °C	
	(100 to 260) °C	0.055 °C	
	(260 to 300) °C	0.063 °C	
	(300 to 400) °C	0.071 °C	
	(400 to 600) °C	0.078 °C	
	(600 to 630) °C	0.18 °C	
[1] Electrical Simulation of Thermocouple Indicators – Measure	Type B		8.5 Digit Multimeter; ITS-90
	(600 to 800) °C	0.38 °C	
	(800 to 1 000) °C	0.32 °C	
	(1 000 to 1 550) °C	0.27 °C	
	(1 550 to 1 820) °C	0.26 °C	
	Type E		
	(-250 to -100) °C	0.30 °C	
	(-100 to -25) °C	0.14 °C	
	(-25 to 350) °C	0.13 °C	
	(350 to 650) °C	0.13 °C	
	(650 to 1 000) °C	0.13 °C	
	Type J		
	(-210 to -100) ºC	0.16 °C	
	(-100 to -30) ºC	0.15 °C	
	(-30 to 150) ºC	0.14 °C	
	(150 to 760) ºC	0.14 °C	
	(760 to 1 200) ºC	0.14 °C	
	Type K		
	(-200 to -100) °C	0.23 °C	
	(-100 to -25) °C	0.17 °C	
	(-25 to 120) °C	0.16 °C	
	(120 to 1 000) °C	0.15 °C	
	(1 000 to 1 372) °C	0.16 °C	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Electrical Simulation of Thermocouple Indicators – Measure	Type N (-200 to -100) °C (-100 to -25) °C (-25 to 120) °C (120 to 410) °C (410 to 1 300) °C Type R (0 to 250) °C (250 to 400) °C (400 to 1 000) °C (1 000 to 1 767) °C Type S (0 to 250) °C (250 to 400) °C (400 to 1 000) °C (1 000 to 1 767) °C Type T (-250 to -150) °C (-150 to 0) °C (0 to 120) °C (120 to 400) °C	 0.18 °C 0.17 °C 0.16 °C 0.15 °C 0.15 °C 0.53 °C 0.32 °C 0.29 °C 0.25 °C 0.52 °C 0.33 °C 0.31 °C 0.29 °C 0.44 °C 0.18 °C 0.15 °C 0.14 °C	8.5 Digit Multimeter; ITS-90
Electrical Simulation of RTD Indicators – Measure	Pt 385, 100 Ω (-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 850) °C	 0.0068 °C 0.0068 °C 0.033 °C 0.035 °C 0.036 °C 0.039 °C 0.041 °C	8.5 Digit Multimeter
[1] DC Voltage – Measure	(0 to 100) mV (> 0.1 to 1) V (> 1 to 10) V (> 10 to 100) V (> 100 to 1 000) V	18 µV/V + 0.36 µV 14 µV/V + 0.4 µV 14 µV/V + 0.7 µV 17 µV/V + 35 µV 28 µV/V + 0.12 mV	8.5 Digit Multimeter
[1] AC Voltage – Measure	@ 1 Hz to 40 Hz (1 to 10) mV (> 10 to 100) mV > 0.1 V to 1 V (> 1 to 10) V (> 10 to 100) V (> 100 to 1 000) V	 0.35 mV/V + 3.5 µV 0.09 mV/V + 23.1 µV 0.09 mV/V + 47 µV 0.09 mV/V + 4.7 mV 0.24 mV/V + 4.7 mV 0.47 mV/V + 47 mV	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	@ > 40 Hz to 1 kHz		8.5 Digit Multimeter
	(1 to 10) mV	0.24 mV/V + 1.3 µV	
	(> 10 to 100) mV	0.09 mV/V + 2.4 µV	
	> 0.1 mV to 1 V	0.09 mV/V + 24 µV	
	(> 1 to 10) V	0.09 mV/V + 0.24 mV	
	(> 10 to 100) V	0.24 mV/V + 2.4 mV	
	(> 100 to 1 000) V	0.47 mV/V + 24 mV	
	@ > 1 kHz to 20 kHz		
	(1 to 10) mV	0.35 mV/V + 1.3 µV	
	(> 10 to 100) mV	0.17 mV/V + 2.4 µV	
	(> 0.1 to 1) V	0.17 mV/V + 24 µV	
	(> 1 to 10) V	0.17 mV/V + 0.24 mV	
	(> 10 to 100) V	0.24 mV/V + 2.4 mV	
	(> 100 to 1 000) V	0.7 mV/V + 24 mV	
	@ > 20 kHz to 50 kHz		
	(1 to 10) mV	11.6 mV/V + 1.3 µV	
	(> 10 to 100) mV	0.35 mV/V + 2.4 µV	
	(> 0.1 to 1) V	0.35 mV/V + 24 µV	
	(> 1 to 10) V	0.35 mV/V + 0.24 mV	
	(> 10 to 100) V	0.41 mV/V + 2.4 mV	
	(> 100 to 1 000) V	1.4 mV/V + 24 mV	
	@ > 50 kHz to 100 kHz		
	(1 to 10) mV	5.8 mV/V + 1.3 µV	
	(> 10 to 100) mV	0.93 mV/V + 2.4 µV	
	(> 0.1 to 1) V	0.93 mV/V + 24 µV	
	(> 1 to 10) V	0.93 mV/V + 0.24 mV	
	(> 10 to 100) V	1.4 mV/V + 2.4 mV	
	(> 100 to 1 000) V	3.5 mV/V + 24 mV	
	@ > 100 kHz to 300 kHz		
	(1 to 10) mV	47 mV/V + 2.4 µV	
	(> 10 to 100) mV	0.35 mV/V + 12 µV	
	(> 0.1 to 1) V	3.5 mV/V + 0.12 mV	
	(> 1 to 10) V	3.5 mV/V + 1.2 mV	
	(> 10 to 100) V	4.7 mV/V + 12 mV	
	@ > 300 kHz to 1 MHz		
	(10 to 100) mV	12 mV/V + 12 µV	
	(> 0.1 to 1) V	12 mV/V + 0.12 mV	
	(> 1 to 10) V	12 mV/V + 1.2 mV	
	(> 10 to 100) V	18 mV/V + 12 mV	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] AC Voltage – Measure	@ > 1 kHz to 2 MHz (10 to 100) mV (> 0.1 to 1) V (> 1 to 10) V (> 10 to 100) V	 18 mV/V + 12 µV 15 mV/V + 0.12 mV 18 mV/V + 1.2 mV 18 mV/V + 12 mV	8.5 Digit Multimeter
[1] DC High Voltage – Measure	(1 to 10) kV	5.8 mV/V + 0.004 kV	High Voltage Meter
[1] DC High Voltage – Measure	(1 to 20) kV	5.8 mV/V + 0.11 V	Oscilloscope, High Voltage Probe
[1] AC High Voltage – Measure	(1 to 10) kV 50 Hz	 12 mV/V + 0.006 kV	High Voltage Meter
[1] AC High Voltage – Measure	(1 to 20) kV 50 Hz	 5.8 mV/V + 0.11 V	Oscilloscope, High Voltage Probe
[1] DC Current – Measure	(0 to 100) µA (> 0.1 to 1) mA (> 1 to 10) mA (> 10 to 100) mA (> 0.1 to 1) A	0.03 µA/A + 0.12 pA 0.04 nA/A + 8.2 nA 0.04 mA/A + 82 nA 0.06 mA/A + 0.9 µA 0.17 mA/A + 12 µA	8.5 Digit Multimeter
[1] DC Current – Measure	(> 1 to 3) A (> 3 to 10) A (> 10 to 20) A (> 20 to 30) A (> 30 to 50) A (> 50 to 100) A (> 100 to 200) A	50 µA/A + 0.12 mA 55 µA/A + 1.2 mA 55 µA/A + 1.2 mA 3.5 mA/A 2.4 mA/A 2.4 mA/A 2.4 mA/A	8.5 Digit Multimeter, Standard Shunt
[1] Welding Cabinet – Measure AC Current @50 Hz, @60 Hz	Up to 600 A	0.002 4 mA/A + 0.82 A	Current Clamp, Multimeter
[1] Welding Cabinet – Measure DC Current	Up to 1 000 A	0.002 4 mA/A + 0.89 A	Current Clamp, Multimeter
[1] AC Current – Measure	@ 10 Hz to 20 Hz (10 to 100) µA (> 0.1 to 1) mA (> 1 to 10) mA (> 10 to 100) mA (> 0.1 to 1) A	 4.7 mA/A + 35 nA 4.7 mA/A + 0.25 µA 4.7 mA/A + 2.5 µA 4.7 mA/A + 25 µA 4.7 mA/A + 0.25 mA	8.5 Digit Multimeter

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] AC Current – Measure	@ > 20 Hz to 45 Hz		8.5 Digit Multimeter
	(10 to 100) µA	1.8 mA/A + 35 nA	
	(> 0.1 to 1) mA	1.8 mA/A + 0.25 µA	
	(> 1 to 10) mA	1.8 mA/A + 2.5 µA	
	(> 10 to 100) mA	1.8 mA/A + 25 µA	
	(> 0.1 to 1) A	1.9 mA/A + 0.25 mA	
	@ > 45 Hz to 100 Hz		
	(10 to 100) µA	0.7 mA/A + 35 nA	
	(> 0.1 to 1) mA	0.7 mA/A + 0.25 µA	
	(> 1 to 10) mA	0.7 mA/A + 2.5 µA	
	(> 10 to 100) mA	0.7 mA/A + 25 µA	
	(> 0.1 to 1) A	0.95 mA/A + 0.25 mA	
	@ > 100 Hz to 1 kHz		
	(10 to 100) µA	0.7 mA/A + 35 nA	
	@ > 100 Hz to 5 kHz		
	(> 0.1 to 1) mA	0.36 mA/A + 0.3 µA	
	(> 1 to 10) mA	0.36 mA/A + 2.4 µA	
	(> 10 to 100) mA	0.36 mA/A + 24 µA	
	(> 0.1 to 1) A	1.2 mA/A + 0.24 mA	
	@ > 5 kHz to 20 kHz		
	(> 0.1 to 1) mA	0.7 mA/A + 0.3 µA	
	(> 1 to 10) mA	0.7 mA/A + 2.4 µA	
	(> 10 to 100) mA	0.7 mA/A + 24 µA	
	(> 0.1 to 1) A	3.5 mA/A + 0.24 mA	
	@ > 20 kHz to 50 kHz		
	(> 0.1 to 1) mA	4.7 mA/A + 0.5 µA	
	(> 1 to 10) mA	4.7 mA/A + 4.7 µA	
	(> 10 to 100) mA	4.7 mA/A + 47 µA	
	(> 0.1 to 1) A	12 mA/A + 0.47 mA	
	@ > 50 kHz to 100 kHz		
	(> 0.1 to 1) mA	6.4 mA/A + 1.8 µA	
	(> 1 to 10) mA	6.4 mA/A + 17.4 µA	
	(> 10 to 100) mA	6.4 mA/A + 0.18 mA	
[1] AC Current – Measure	(1 to 3) A, 50 Hz	0.012 A	8.5 Digit Multimeter, Current Shunt
	(3 to 10) A, 50/60 Hz	0.041 A	
	(3 to 10) A, (0.3 to 1) kHz	0.039 A	

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] AC Current – Measure	(3 to 10) A, (1 to 5) kHz (10 to 20) A, 50 Hz (20 to 30) A, 50 Hz	 0.043 A 0.077 A 0.112 A	8.5 Digit Multimeter, Current Shunt
[1] Resistance – Measure	(> 0 to 10) Ω (> 10 to 100) Ω (> 100 to 1000) Ω (> 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	25 μΩ/Ω + 59 μΩ 22 μΩ/Ω + 0.59 mΩ 20 μΩ/Ω + 0.6 mΩ 20 μΩ/Ω + 7 mΩ 20 μΩ/Ω + 0.07 Ω 25 μΩ/Ω + 2.4 Ω 66 μΩ/Ω + 0.12 kΩ 0.59 mΩ/Ω + 1.2 kΩ 5.8 mΩ/Ω + 112 kΩ	8.5 Digit Multimeter
[1] Insulation Resistance – Measure 100 V to 1 kV	1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ 1 GΩ 10 GΩ 20 GΩ	0.58 kΩ 0.6 kΩ 6 kΩ 58 kΩ 0.06 MΩ 0.59 MΩ 5.8 MΩ 59 MΩ 82 MΩ	High Voltage Resistors
[1] Resistance – Source	(0.1 to 1) Ω (1 to 10) Ω (10 to 100) Ω (100 to 1 000) Ω (1 to 10) kΩ (10 to 100) kΩ 100 kΩ to 1 MΩ (1 to 10) MΩ (10 to 100) MΩ 1 GΩ 10 GΩ 20 GΩ	24 mΩ 27 mΩ 13 mΩ 1.2 Ω 12 Ω 120 Ω 1.2 kΩ 13 kΩ 180 kΩ 58 MΩ 0.58 GΩ 1.2 GΩ	Decade Resistors

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Inductance- Source 1 kHz	(1 to 10) µH (10 to 100) µH (0.1 to 1) mH (1 to 10) mH (10 to 100) mH (0.1 to 1) H (1 to 10) H	0.59 µH 5.9 µH 59 µH 0.59 mH 5.9 mH 59 mH 0.59 H	Inductor Box
[1] Capacitance- Source @ 1 kHz	(100 to 1000) pF (>1 to 10) nF (>10 to 100) nF (>100 to 1000) nF (>1 to 10) µF	0.058 pF 0.058 nF 0.058 nF 5.8 nF 0.058 µF	Capacitor Box
DC Magnetic Flux Density [1] Tesla Meter, Gauss Meter	Up to 50 G (> 50 to 200) G (> 200 to 500) G (> 500 to 1 000) G (> 1 000 to 3 000) G (> 3 000 to 5 000) G (> 5 000 to 10 000) G	1 G 1 G 1 G 6.9 G 7.8 G 16 G 18 G	Standard Magnet, Tesla Meter
[1] Magnets DC Magnetic Flux Density	Up to 50 G (> 50 to 200) G (> 200 to 500) G (> 500 to 1 000) G (> 1 000 to 3 000) G (> 3 000 to 5 000) G (> 5 000 to 10 000) G	0.69 G 0.69 G 1.7 G 5.7 G 5.7 G 12 G 12 G	Tesla Meter
[1] Oscilloscope Vertical Amplitude: (DC) DC Signal: Impedance 50 Ω / 1 M Ω Deflection – Source	(0 to 330) mV 330 mV to 3.3 V (3.3 to 33) V (33 to 150) V	70 µV/V + 0.006 8 µV 58 µV/V + 0.058 µV 58 µV/V + 0.58 µV 64 µV/V + 5.8 µV	8.5 Digit Multimeter, Multiproduct Calibrator
[1] Oscilloscope Amplitude: (AC) Square Wave, Sine Wave, Triangle Wave, Ramps Wave, Signal, @ 10 Hz to 1 MHz – Source	(1 to 2.999) mVp-p (> 3 to 9.999) mVp-p (> 10 to 29.99) mVp-p (> 30 to 299.9) mVp-p > 300 mVp-p to 2.999 Vp-p (> 3 to 130) Vp-p	1.8 mV/V + 5.8 µV 1.8 mV/V + 5.8 µV 1.8 mV/V + 5.8 µV 1.8 mV/V + 5.8 µV 0.35 mV/V + 35 µV 0.93 mV/V + 8.7 mV	Synthesizer Function Generator, 8.5 Digit Multimeter, Multiproduct Calibrator

Electrical – DC/Low Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Oscilloscope Horizontal Deflection: Time Mark – Source	1 s 0.5 s 0.2 s 0.1 s 50 ms 20 ms 10 ms 5 ms 2 ms 1 ms 0.5 ms 0.2 ms 0.1 ms 50 µs 20 µs 10 µs 5 µs 2 µs 1 µs 0.5 µs 0.2 µs 0.1 µs	5.8 µs/s + 0.8 ms 5.8 µs/s + 0.8 ms 5.8 µs/s + 0.8 ms 5.8 µs/s + 0.8 ms 5.8 µs/s + 0.77 µs 5.8 µs/s + 0.77 µs 5.8 µs/s + 0.77 µs 5.8 µs/s + 0.77 µs 5.8 µs/s + 0.77 µs 5.8 µs/s + 0.77 µs 5.8 µs/s + 0.75 µs 5.8 µs/s + 0.75 µs 5.8 µs/s + 0.75 ns 5.8 µs/s + 0.69 ns 5.8 µs/s + 0.69 ns 5.8 µs/s + 0.69 ns 5.8 µs/s + 0.69 ns 5.8 µs/s + 0.69 ns 5.8 µs/s + 0.69 ns 5.8 µs/s + 0.69 ns 5.8 µs/s + 0.69 ns	Synthesizer Function Generator

Electrical - RF/Microwave

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Amplitude – Source	Rates: 0.3 MHz to 6 GHz (13 to -136) dBm	0.18 dB	Signal Generator
[1] Amplitude Modulation – Source	Rates: 9 kHz to 3.2 GHz (5 to 90.0) %Depth ≤4 dBm Rates: 400 Hz or 1 kHz	1.7 %Depth	Signal Generator

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Calipers	Up to 150 mm (> 150 to 200) mm (> 200 to 300) mm (> 300 to 450) mm (> 450 to 600) mm (> 600 to 1000 mm	0.007 mm 0.007 mm 0.007 mm 0.007 mm 0.008 mm 0.01 mm	Gauge Blocks, Caliper Checker
[1] Dial & Digital Indicator	Up to 1 mm (> 1 to 12.7) mm (> 12.7 to 25) mm (> 25 to 50) mm (> 50 to 100) mm	0.000 5 mm 0.000 65 mm 0.000 75 mm 0.000 85 mm 0.000 95 mm	Calibration Tester, Gauge Blocks
[12] Dial & Digital Indicator	Up to 100 mm	(0.37 + 0.002 5*L*) µm	Universal Length Measuring Machine
[1] Dial Test Indicator	Up to 0.14 mm (> 0.14 to 0.6) mm (> 0.8 to 1) mm (> 1 to 1.5) mm	0.000 5 mm 0.000 75 mm 0.000 8 mm 0.001 6 mm	Calibration Tester, Gauge Blocks
[1] Dial Test Indicator	Up to 1 mm (> 1 to 2) mm	0.000 5 mm 0.001 1 mm	Universal Length Measuring Machine
[1] Electrical Comparator/ Mu Checker	(0 to 0.5) mm (> 0.5 to 1) mm (> 1 to 5) mm (> 5 to 10) mm	0.000 09 mm 0.000 13 mm 0.000 13 mm 0.000 15 mm	Calibration Tester, Gauge Blocks
[1] Inside Micrometer	(5 to 30) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm (> 100 to 125) mm (> 125 to 200) mm (> 200 to 300) mm (> 300 to 500) mm (> 500 to 600) mm	0.000 6 mm 0.000 7 mm 0.000 7 mm 0.000 8 mm 0.001 mm 0.002 mm 0.003 mm 0.004 mm 0.005 mm	Gauge Blocks
[1,2] Inside Micrometer	Up to 600 mm	(0.68 + 0.002 5*L*) µm	Universal Length Measuring Machine

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Outside Micrometer	(0 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm (> 100 to 125) mm (> 125 to 200) mm (> 200 to 300) mm (> 300 to 500) mm (> 500 to 600) mm (> 600 to 700) mm (> 700 to 825) mm (> 825 to 1 000) mm	0.000 6 mm 0.000 7 mm 0.000 7 mm 0.000 8 mm 0.001 mm 0.002 mm 0.003 mm 0.004 mm 0.005 mm 0.006 mm 0.007 mm 0.008 mm	Gauge Blocks
[1] Indicating Micrometer	(0 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm	0.000 75 mm 0.000 75 mm 0.000 8 mm 0.000 85 mm	Gauge Blocks
[1] Depth Micrometer	(0 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm (> 100 to 125) mm (> 125 to 150) mm (> 150 to 175) mm (> 175 to 200) mm (> 200 to 225) mm (> 225 to 250) mm (> 250 to 275) mm (> 275 to 300) mm	0.001 3 mm 0.001 3 mm 0.001 3 mm 0.001 4 mm 0.001 5 mm 0.001 9 mm 0.002 mm 0.002 1 mm 0.002 2 mm 0.002 4 mm 0.002 6 mm 0.002 7 mm	Gauge Blocks
[1] Height Gauge Linear Height	Up to 75 mm (> 750 to 100) mm (> 100 to 200) mm (> 200 to 300) mm (> 300 to 450) mm (> 450 to 600) mm (> 600 to 1 000) mm	0.001 1 mm 0.001 5 mm 0.002 mm 0.002 5 mm 0.003 5 mm 0.004 5 mm 0.007 mm	Gauge Blocks, Surface Plate
[1] Depth Gauge	Up to 300 mm (> 300 to 600) mm (> 600 to 1 000) mm (>1 000 to 1 200) mm	0.000 7 mm 0.000 8 mm 0.001 mm 0.001 3 mm	Gauge Blocks, Surface Plate
[1] Feeler Gauge, Thickness Plate	(0.01 to 10) mm	0.001 1 mm	Digital Linear Gauge, Gauge Blocks

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Feeler Gauge, Thickness Plate	Up to 10 mm	0.000 4 mm	Universal Length Measuring Machine
[1] Thickness Gauge	Up to 12 mm (> 12 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm	0.000 2 mm 0.000 3 mm 0.000 4 mm 0.000 6 mm 0.000 8 mm	Gauge Blocks
[1] Holtest, Three-points internal micrometer	(3 to 16) mm (> 16 to 35) mm (> 35 to 75) mm (> 75 to 100) mm (> 100 to 125) mm	0.000 7 mm 0.001 mm 0.001 5 mm 0.002 mm 0.002 3 mm	Ring Gauges
[1,2] Holtest, Three-points internal micrometer	(3 to 300) mm	(0.9 + 0.001 8L) µm	Universal Length Measuring Machine
Caliper Checker Height Master	Up to 100 mm (> 100 to 300) mm (> 300 to 600) mm (> 600 to 800) mm (> 800 to 1 000) mm	0.001 5 mm 0.002 mm 0.002 5 mm 0.003 mm 0.003 5 mm	Gauge Blocks
[1] Setting Rod, Length Bar	(0 to 100) mm (> 100 to 300) mm (> 300 to 425) mm (> 425 to 500) mm	0.001 5 mm 0.002 mm 0.003 mm 0.003 5 mm	Gauge Blocks
[1,2] Setting Rod, Length Bar	Up to 600 mm	(0.36 + 0.002 5L) µm	Universal Length Measuring Machine
[1] Micrometer Head, Dial Gauge Tester, Calibration Tester	Up to 1 mm (> 1 to 25) mm (> 25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm	0.000 6 mm 0.000 8 mm 0.000 9 mm 0.001 mm 0.001 1 mm	Digital Linear Gauge
[1] Micrometer Head, Dial Gauge Tester, Calibration Tester	Up to 100 mm	(0.38 + 0.002 2L) µm	Universal Length Measuring Machine

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Vision Measuring Machine Length Angle	Up to 50 mm (> 50 to 100) mm (> 100 to 150) mm (> 150 to 200) mm (> 200 to 250) mm (> 250 to 300) mm (0 to 360)°	0.001 2 mm 0.001 3 mm 0.001 5 mm 0.001 8 mm 0.002 mm 0.002 3 mm 0.007°	Glass Scales
[1] Digital Microscope, Shop Microscope, Scale Lupe	Up to 1.00 mm (> 1.00 to 50.00) mm	0.00 08 mm 0.001 mm	Glass Scales
[1] Profile Projector Linear of Axis (X and Y) Angle Accuracy Magnification	Up to 50 mm (> 50 to 100) mm (> 100 to 150) mm (> 150 to 200) mm (> 200 to 250) mm (> 250 to 300) mm (0 to 360)° (5 to 100) X	0.6 µm 0.65 µm 0.71 µm 0.81 µm 0.73 µm 0.81 µm 0.008 5° 0.06 % of reading	Glass Scales, Reticle 360 ° Comparator, and JIS B 7184-1999 utilized as the method for the calibration of this device.
[1] Thread Plug Gauge Pitch Diameter	Up to 10 mm (> 10 to 25) mm (>25 to 50) mm (> 50 to 75) mm (> 75 to 100) mm	0.001 7 mm 0.001 7 mm 0.001 7 mm 0.001 8 mm 0.001 8 mm	Thread Micrometer, Thread Wires
[1] Pin Gauge, Plain Plug Gauge, Ball Gauge	Up to 30 mm	0.000 7 mm	Laserscan Micrometer
[1,2] Pin Gauge, Plain Plug Gauge, Ball Gauge	Up to 400 mm	(0.36 + 0.003*L*) µm	Universal Length Measuring Machine
[1] Laser Scan Micrometer	Up to 60 mm	0.000 6 mm	Standard Pin Gauge, Gauge Blocks
[1] Surface Roughness Tester Roughness Accuracy	3 µm Ra 10 µm Rz	0.15 µm Ra 0.25 µm Rz	Surface Roughness Specimen
Roughness Specimen	Up to 100 µm Ra	0.15 µm Ra	Roughness Tester

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Flatness Measurement	Up to 900 cm²	1.5 µm	Granite Surface Plate, Electrical Comparator
[1,2] Surface Plate Overall Flatness Only	Up to 424 D*L* mm (> 424 to 540 D*L*) mm (> 540 to 849 D*L*) mm (> 849 to 901 D*L*) mm (> 901 to 1 250 D*L*) mm (> 1 250 to 1 414 D*L*) mm (> 1 414 to 1 803 D*L*) mm (> 1 803 to 2 823 D*L*) mm (> 2 823to 3 606 D*L*) mm	0.7 µm 1 µm 1.3 µm 1.6 µm 2.1 µm 2.3 µm 3.5 µm 4.3 µm 6.3 µm	Electronic Level
Pitch Gauge	Up to 6 mm	0.002 5 mm	Video Measuring System
Radius Gauge Taper Gauge	Up to 50 mm	0.002 5 mm	Video Measuring System
Angle Gauge/ Bevel Protractor	Up to 360°	0.001 5°	Video Measuring System
Precision Square Outer Length Inner Length	 Up to 200 mm Up to 100 mm	 0.001 5 mm 0.001 5 mm	Video Measuring System
Glass Scale	Up to 50 mm (> 50 to 100) mm (> 100 to 150) mm (> 150 to 200) mm	0.001 5 mm 0.001 7 mm 0.001 8 mm 0.002 2 mm	Video Measuring System
[2] Glass Scale	Up to 100 mm	(0.36 + 0.002*L*) µm	Universal Length Measuring Machine
[1] Air Micrometer	Up to 10 µm (> 10 to 20) µm (> 20 to 50) µm (> 50 to 100) µm (> 100 to 200) µm (> 200 to 500) µm (> 500 to 1 000) µm	0.15 µm 0..2 µm 0.35 µm 0.65 µm 1.5 µm 3 µm 5.8 µm	Calibration Tester
[1] Precision Level, Electronic Level	Up to 0.5 mm/m (> 0.51 to 1) mm/m (> 1 to 1.5) mm/m (> 1.5 to 1.9) mm/m	0.001 6 mm/m 0.001 7 mm/m 0.001 8 mm/m 0.002 mm/m	Angle Generator, Digital Indicator
[1] Coating Thickness Gauge	(Up to 99) µm (> 99 to 2 845) µm	0.51 µm 0.71 µm	Calibration Foil

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Steel Tape Textile Tape	Up to 1 m (> 1 to 2) m (> 2 to 3) m (> 3 to 4) m (> 4 to 5) m (> 5 to 6) m (> 6 to 7) m (> 7 to 8) m (> 8 to 9) m (> 9 to 10) m (> 10 to 15) m (> 15 to 20) m (> 20 to 25) m (> 25 to 30) m (> 30 to 35) m (> 35 to 40) m (> 40 to 45) m (> 45 to 50) m	0.015 mm 0.024 mm 0.036 mm 0.048 mm 0.06 mm 0.072 mm 0.084 mm 0.096 mm 0.11 mm 0.12 mm 0.18 mm 0.25 mm 0.3 mm 0.36 mm 0.42 mm 0.48 mm 0.55 mm 0.6 mm	Scale Calibrator
[1] Steel Ruler	Up to 200 mm (> 200 to 500) mm (> 500 to 1 000) mm (>1 000 to 1 500) mm (> 1 500 to 2 000) mm	0.005 mm 0.02 mm 0.025 mm 0.04 mm 0.045 mm	Scale Calibrator, Video Measuring System, Standard Rule
[1] Contour Measuring Machine Radius Length Measurement	Up to 30 mm (Up to 25) mm (> 25 to 100) mm (> 100 to 150) mm	0.85 µm 0.6 µm 0.9 µm 1.2 µm	Standard Gauge Blocks, Pin Gauge
[1] Coordinate Measuring Machine, Layout Machine	Up to 50 mm (> 50 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 1000) mm (> 1000 to 1200) mm	0.5 µm 1 µm 1.5 µm 2.5 µm 3 µm 3.6 µm 4.5 µm 5 µm 5.7 µm 6.5 µm 7 µm 8.5 µm	ISO 10360-2 Standard Gauge Block

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Ultrasonic Thickness Gauge	Up to 100 mm (>100 to 220) mm	0.000 1 mm 0.003 2 mm	Gauge Blocks
Plain Ring Gauge	(0.5 to 10) mm (> 10 to 20) mm (> 20 to 30) mm (> 30 to 50) mm (> 50 to 100) mm (> 100 to 150) mm (> 150 to 200) mm	0.4 µm 0.53 µm 0.56 µm 0.8 µm 1.5 µm 1.8 µm 2 µm	Ring Gauge, Master Height
[2] Plain Ring Gauge	(0.1 to 400) mm	(0.36 + 0.004 5*L*) µm	Universal Length Measuring Machine
[1] Angle Measurement	Up to 180°	0.002 2°	Angle Blocks
Gauge Blocks	Up to 0.5 mm (> 0.5 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	0.09 µm 0.09 µm 0.094 µm 0.11 µm 0.13 µm 0.15 µm 0.17 µm 0.19 µm 0.22 µm 0.25 µm 0.3 µm 0.35 µm	JIS B 7506, Gauge Blocks, Gauge Block Comparator
Gauge Blocks	(> 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 (> 4000 to 500) mm	0.23 µm 0.23 µm 0.27 µm 0.28 µm 0.33 µm 0.39 µm 0.60 µm 0.72 µm	Universal Length Measuring Machine, Gauge Blocks
[2] Universal Length Measuring Machine	Up to 100 mm (> 100 to 600) mm	(0.09 + 0.002 1*L*) µm (0.11 + 0.003 3*L*) µm	Master Gauge Blocks
[2] Taper Plug Gauge Diameter Half Angle Thickness/Step	 Up to 300 mm Up to 45° Up to 100 mm	 (0.88 + 0.003 2*L*) µm 0.01° (0.35 + 0.003 3*L*) µm	Universal Length Measuring Machine, Standard Pin Gauges, Gauge Blocks

Length – Dimensional Metrology

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[2] Thread Plug Gauge Pitch Diameter Major Diameter	Up to 150 mm Up to 150 mm	(0.79 + 0.003*L*) µm (0.36 + 0.003*L*) µm	Universal Length Measuring Machine, Thread Wires
[2] Taper Thread Plug Gauge Pitch Diameter Major Diameter Thickness/Step	Up to 150 mm Up to 150 mm Up to 100 mm	(0.94 + 0.005 5*L*) µm (0.36 + 0.002 5*L*) µm (0.36 + 0.002 5*L*) µm	Universal Length Measuring Machine, Thread Wires, Gauge Blocks
[2] Taper Ring Gauge Diameter Half Angle Thickness/Step	Up to 300 mm Up to 45° Up to 100 mm	(0.62 + 0.003 3*L*) µm 0.005° (0.62 + 0.003 3*L*) µm	Universal Length Measuring Machine, Master Ring Gauge
[2] Thread Ring Gauge Pitch Diameter Minor Diameter	Up to 150 mm Up to 150 mm	(0.62 + 0.005*L*) µm (3.5 + 0.005 8*L*) µm	Universal Length Measuring Machine, Master Ring Gauges, 3D Vision Measuring System
[2] Taper Thread Ring Gauge Pitch Diameter Taper Thickness/Step	Up to 150 mm Up to 15° Up to 100 mm	(0.94 + 0.003*L*) µm 0.01° (0.36 + 0.003*L*) µm	Universal Length Measuring Machine, Master Ring Gauge
[2] Snap Gauge, Gap Gauge (Internal & External)	Up to 400 mm	(0.62 + 0.006*L*) µm	Universal Length Measuring Machine, Master Ring Gauges, Gauge Blocks
[1,2] Cylinder Gauge, Bore Gauge Indication Error Repeatability	Up to 12.7 mm Up to 600 mm	(0.43 + 0.003 8*L*) µm (0.43 + 0.003 5*L*) µm	Universal Length Measuring Machine, Calibration Tester, Master Ring Gauges, Gauge Blocks

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1,3] Scales and Balances	Up to 500 mg (> 0.5 to 100) g (> 100 to 220) g (> 220 to 500) g (> 500 to 600) g (> 600 to 1 000) g (> 1 000 to 1 200) g (> 1 200 to 1 500) g (> 1 500 to 2 000) g (> 2 000 to 3 000) g (> 3 000 to 5 000) g (> 5 000 to 6 000) g	39 µg 0.32 mg 0.32 mg 1.4 mg 1.9 mg 2.8 mg 8.8 mg 12 mg 13 mg 14 mg 18 mg 84 mg	OIML Class E2, F1 or F2 Weights and UKAS Publication Reference LAB 14, Edition 6 utilized for the calibration of the weighing system.
[1,3] Electronic/Mechanical Scales and Balances	(> 6 to 10) kg (> 10 to 20) kg (> 20 to 30) kg (> 30 to 60) kg (> 60 to 100) kg (> 100 to 150) kg (> 150 to 300) kg (> 300 to 500) kg (> 500 to 1 000) kg (> 1 000 to 2 000) kg	84 mg 0.17 g 0.25 g 0.84 g 0.88 g 4.1 g 8.2 g 8.3 g 82 g 95 g	OIML Class E2, F1 or F2 Weights and UKAS Publication Reference LAB 14, Edition 6 utilized for the calibration of the weighing system
[1] Hand Torque Tools	0.01 cN·m to 1 500 N·m	1 % of reading	Torque Analyzer
[1] Rockwell Hardness Tester	(10 to 30) HRC (> 30 to 50) HRC (> 50 to 90) HRC (10 to 30) HRB (> 30 to 50) HRB (> 50 to 90) HRB (10 to 30) HRA (> 10 to 50) HRA (> 50 to 90) HRA	0.38 HRC 0.38 HRC 0.46 HRC 0.9 HRB 0.9 HRB 0.9 HRB 0.68 HRA 0.68 HRA 0.68 HRA	Indirect Verification using Hardness Test Blocks
[1] Brinell Hardness Tester	(> 95 to 250) HBW (> 250 to 450) HBW (> 450 to 650) HBW	0.71 HBW 1.8 HBW 2.9 HBW	Indirect Verification using Hardness Test Block
[1] Vickers Micro Hardness Tester	279 HV 700 HV	11 HV 37 HV	Indirect Verification using Hardness Test Block

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Leeb Hardness Tester	545 HLD 785 HLD	6.4 HLD 4.8 HLD	Indirect Verification using Hardness Test Block
[1] Torque Tester/ Torque Gauge	0.01 cN·m to 1 N·m (> 1 to 10) N·m (> 10 to 200) N·m (> 200 to 500) N·m	0.4 % of reading 0.2 % of reading 0.13 % of reading 0.1 % of reading	Standard Weight, Torque Arm
[1] Vacuum Gauge	(-15 to 0) psi	0.03 psi	Pressure Calibrator
[1] Pressure Measuring (Pneumatic & Hydraulic)	(0 to 300) psig (> 120 to 240) psig (> 240 to 300) psig (> 300 to 10 000) psig	0.05 psi 0.15 psi 0.19 psi 1.5 psi	Pressure Calibrator
[1] Differential Pressure	(-120 to 120) mbar	1 mbar	Pressure Calibrator
[1] Mass (None-OIML Specification)	Up to 200 g (> 200 to 500) g (> 500 to 1 000) g (> 1 000 to 2 000) g (> 2 000 to 5 000) g (> 5 to 10) kg (> 10 to 20) kg (> 20 to 30) kg	0.16 mg 1.5 mg 3 mg 15 mg 18 mg 160 mg 210 mg 290 mg	Standard Weights, Electronic Balance
Mass (OIML-Specification)	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	58 µg 58 µg 58 µg 58 µg 58 µg 58 µg 58 µg 58 µg 58 µg 58 µg 58 µg 58 µg 58 µg 58 µg 58 µg 58 µg 58 µg 0.58 mg	Standard Weights and OIML R-111 utilized as the method of calibration for mass.

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Mass (OIML Specification)	1 kg 2 kg 5 kg 10 kg 20 kg	0.58 mg 5.8 mg 5.8 mg 58 mg 58 mg	Standard Weights and OIML R-111 utilized as the method of calibration for mass.
[1] Force Measuring	Up to 5 N (> 5 to 10) N (> 10 to 500) N (> 500 to 1 000) N	0.000 6 N 0.000 65 N 0.006 N 0.58 N	Standard Weights
[1] Viscometer / Visco Cup 20 °C to 50 °C	Dynamic Viscosity Up to 100 000 mPa·s Kinematic Viscosity Up to 100 000 mPa·s	 0.5% of reading + 0.01 mPa·s 0.5% of reading + 0.01 mPa·s	Standard Reference Viscosity
Volumetric Glass Ware and Operated Volumetric Apparatus – Burette, Volumetric Pipette, Measuring Pipette, Volumetric Flask, Graduated Cylinder, Beaker, Single channel Piston Pipette, Multichannel Piston Pipette, Positive-displacement Pipette, Piston Burette, Dilutor, Dispenser	Up to 200) µL (> 200 to 1000) µL (> 1 to 200) mL (> 200 to 1 000) mL (> 1 000 to 30 000) mL	0.25 µL 0.65 µL 0.3 µL 1.6 µL 0.29 mL	Electronic Balance, ASTM E542-01 and ISO 8655-6 utilized as the methods in the calibration of these devices.
Hydrometer	(0.6 to 2) g/cm³	50 µg/cm³	Electronic Balance, Cuckow's Method
[1] Flow Meter (Air Flow)	Up to 50 L/min (> 50 to 100) L/min (> 100 to 200) L/min (> 200 to 300) L/min	0.47 L/min 0.45 L/min 0.93 L/min 1.1 L/min	Comparison to Master Flow Meter
Silk Screen Tension Meter	(Up to 20) N/cm (> 20 to 50) N/cm	0.15 N/cm 0.25 N/cm	Standard Tension Meter, Screen Tension Calibration Set
[1] Universal Testing Machine – Tension and Compression	(5 to 50) N (50 to 500) N (2 to 20) kN (20 to 200) kN	0.1 % of reading 0.18% of Reading 0.18% of Reading 0.23% of Reading	Force Transducers

Mass and Mass Related

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Durometer			Direct Verification using
Spring Force			
Types A, B, E, & O	(10 to 90) Duro	0.2 Duro	Force Transducer
Types C, D, & DO	(10 to 90) Duro	0.2 Duro	
Types OO & OOO	(10 to 90) Duro	0.2 Duro	
Type OOO-S	(10 to 90) Duro	0.2 Duro	
Type M	(10 to 90) Duro	0.2 Duro	
Indenter Extension & Shape			
Diameter	(0 to 25) mm	0.003 7 mm	Video Measuring System
Radius	(0 to 25) mm	0.003 7 mm	
Angle	(0 to 90)°	0.009°	
Extension	(0 to 25) mm	0.003 7 mm	
[1] Air Velocity	(Up to 15) m/s	0.32 m/s	Comparison to Standard Anemometer

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1,2] Gloss Meter	(20, 60, 85)° 95.5 GU	0.2 GU	Comparison to Standard Gloss Meter
UV-A Meter	(10 to 500) mW/cm² 365 nm	3.5 % of reading	UV Light Source, Standard UV Meter
[1] UV Light Source	(10 to 500) mW/cm² 365 nm	3.6 % of reading	Comparison to Standard UV Meter
Lux Meter	(Up to 5 000) lx	1.8 % of reading – Missing contributions	Comparison to Standard Lux Meter
[1,2] Color Meter, Color Reader Illuminant C, D65	Black Color L* a* b* Y x y	 0.25 0.28 0.22 0.28 0.15 0.15	Chroma Meter, Glossy Tile

Photometry and Radiometry

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1,2] Color Meter Color Reader Illuminant C, D65	White Color L* a* b* Y x y	 0.015 0.015 0.015 0.015 0.015 0.015	Chroma Meter, Glossy Tile
[1] Fiber Optic Power – Measure	(-60 to 0) dBm 1 550 nm	0.16 dB	Optical Spectrum Analyzer
[1] Fiber Optic Wavelength - Measure	1 550 nm	0.032 nm	Optical Spectrum Analyzer
[1] Fiber Optic Attenuator	(0 to 55) dB 1 550 nm	0.32 dB	Optical Spectrum Analyzer, LED Light Source

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Digital and Mechanical Thermometry Systems	(-30 to 100) °C (> 100 to 125) °C	0.05 °C 0.07 °C	Reference PRT, 8.5 Digit Multimeter, Micro Bath
[1] Digital and Mechanical Thermometry Systems	(> 125 to 400) °C (> 400 to 600) °C	0.1 °C 0.1 °C	Reference PRT, 8.5 Digit Multimeter, Dry Block Calibrator
[1] Digital and Mechanical Thermometry Systems	(> 600 to 800) °C (> 800 to 1 000) °C (> 1 000 to 1 200) °C	2.7 °C 0.27 °C 0.27 °C	Reference Thermocouple, Dry Block Calibrator
Hygrometers Relative Humidity Temperature	 (1 to 20) %RH (> 20 to 70) %RH (> 70 to 90) %RH (20 to 60) °C	 1.5 %RH 1.5 %RH 1.9 %RH 0.35 °C	Humidity Chamber, Vaisala Hygrometer
Chambers Relative Humidity	 (1 to 70) %RH (> 70 to 90) %RH	 1.5 %RH 1.9 %RH	Comparison to Vaisala Hygrometer
Liquid-in-Glass Thermometers	(-30 to 100) °C (> 100 to 200) °C	0.075 °C 0.1 °C	Thermometer, Oil Bath

Thermodynamic

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Temperature Controlled Chamber & Oven	(-40 to 100) °C (> 100 to 200) °C (> 200 to 300) °C	0.41 °C 0.41 °C 0.41 °C	Datalogger with Sensor
Incubator	(10 to 100) °C	0.41 °C	
Refrigerator & Freezer	(-40 to 0) °C	0.41 °C	
[1] Temperature Controlled Furnace	(300 to 600) °C (> 600 to 1200) °C	0.4 °C 2.7 °C	Temperature Indicator with Reference PRT, Reference Thermocouple
[1] Autoclave	(50 to 125) °C	0.4 °C	High Temperature Datalogger
[1] Infrared Thermometer	(-30 to 0) °C (> 0 to 30) °C (> 30 to 100) °C	1.2 °C 1.2 °C 1.2 °C	Blackbody Source (Cavity), Temperature Sensor λ = 8 to 14 µm, ε = 0.95
[1] Infrared Thermometer	(35 to 100) °C (> 100 to 200) °C (> 200 to 500) °C	1.2 °C 1.2 °C 1.3 °C	Blackbody Source (Flat Point), Temperature Sensor λ = 8 to 14 µm, ε = 0.95

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Frequency – Source	100 mHz to 100 Hz 100 Hz to 1 kHz (> 1 to 10) kHz (> 10 to 100) kHz 100 kHz to 1 MHz (> 1 to 15) MHz	2.4 mHz 23 mHz 0.23 Hz 2.3 Hz 24 Hz 0.35 kHz	Function Generator
[1] Frequency – Source	10 mHz to 119.99 Hz (0.12 to 1 199.9) Hz (1.2 to 11.999) kHz (12 to 119.99) kHz (120 to 1 199.9) kHz (1.2 to 2) MHz	0.2 % of reading + 7.1 µHz 0.2 % of reading + 7.1 µHz 0.2 % of reading + 7.1 µHz 0.2 % of reading + 7.1 µHz 0.2 % of reading + 7.1 µHz 0.2 % of reading + 7.1 µHz	Multiproduct Calibrator

Time and Frequency

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] Frequency – Source	300 kHz (> 300 to 500) kHz > 500 kHz to 1 MHz (> 1 to 100) MHz (> 100 to 500) MHz > 500 MHz to 1 GHz (> 1 to 2) GHz (>2 to 3) GHz (> 3 to 4) GHz (> 4 to 5) GHz (> 5 to 6) GHz	0.49 Hz 0.82 Hz 1.7 Hz 0.16 kHz 0.82 kHz 1.6 kHz 3.3 kHz 4.9 kHz 6.5 kHz 8.2 kHz 9.8 kHz	Signal Generator
[1] Frequency – Measure	(1 to 40) Hz 40 Hz to 10 MHz	0.58 mHz + 19 µHz 0.12 mHz + 60 mHz	8.5 Digit Multimeter (30 min)
[1] Frequency – Measure	100 kHz (> 100 to 300) kHz > 300 kHz to 1 MHz (> 1 to 10) MHz (> 10 to 100) MHz (> 100 to 225) MHz > 225 MHz to 1 GHz (> 1 to 3) GHz (> 3 to 5) GHz (> 5 to 12.4) GHz	1.2 mHz 3.6 mHz 12 mHz 0.12 Hz 51 mHz 0.52 Hz 1.1 Hz 15 Hz 25 Hz 65 Hz	Universal Counter (24 hr)
[1,2] Tachometer	Up to 99.99) rpm (> 99.99 to 999.99) rpm (> 999.99 to 99 999) rpm	0.072 rpm 0.1 rpm 0.58 rpm	Multiproduct Calibrator
[1] Stopwatches, Timers	Up to 60 s (60 to 6 00) s (600 to 1 200) s (1 200 to 1 800) s (1 800 to 3 600) s	0.033 s 0.039 s 0.046 s 0.053 s 0.074 s	Universal Counter – Totalize Method
[1,2] Rotation Speed (Total Revolutions)	(0.1 to 30) rpm (> 30 to 1 000) rpm (> 1 000 to 10 000) rpm (> 10 000 to 90 000) rpm	0.5 % of Reading 0.2 % of Reading 0.07 % of Reading 0.07 % of Reading	Comparison to Master Tachometer

DIMENSIONAL MEASUREMENT

1 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Geometric Measurements of CF Jigs, Fixtures, and Mold/Die	Up to 25 mm (> 25 to 50) mm (> 50 to 100) mm (> 100 to 200) mm (> 200 to 300) mm (> 300 to 450) mm (> 450 to 600) mm (> 600 to 1 000) mm	2.5 µm 2.6 µm 2.8 µm 3.3 µm 3.9 µm 4.8 µm 5.8 µm 9.2 µm	Scale Calibrator, Height Master
[2] Geometric Measurements of CF Jigs, Fixtures, and Mold/Die	Up to 600 mm	(0.36 + 0.002 5*L*) µm	Universal Length Measuring Machine, Master Ring Gauges, Gauge Blocks

2 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
Geometric Measurements of CF Jigs, Fixtures, and Mold/Die	X = Up to 200 mm Y = Up to 100 mm	5 µm 5 µm	Video Measuring System

3 Dimensional

Parameter/Equipment	Range	Expanded Uncertainty of Measurement (+/-)	Reference Standard, Method, and/or Equipment
[1] CF Jigs, Fixtures, and Mold/Die	X = Up to 3 000 mm Y = Up to 3 000 mm Z = Up to 1 500 mm	95 µm 95 µm 95 µm	Articulating Arm CMM (Portable)

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. *DL* = diagonal length; *L* = length in mm; GU = gloss unit; rpm = revolutions per minute.
3. This parameter is a unitless parameter.
4. This scope is formatted as part of a single document including Certificate of Accreditation No. ACDM-2906.

Jason Stine, Vice President