



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

JAPAN QUALITY ASSURANCE ORGANIZATION

Chubu Testing Center

22, Gotan, Okimura, Kitagoya-shi

Aichi, 481-0043, JAPAN

Konomu Tanaka Phone: +81 568 24 5115

CALIBRATION

Valid To: March 31, 2026

Certificate Number: 1400.04

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory for the following calibrations^{1, 8}:

I. Chemical Quantities

Parameter/Equipment	Range	CMC ² (±)	Comments
pH Indicator ^{3, 4} – Instrumental Error Linearity Repeatability	(0 to 14) pH units (0 to 14) pH units (0 to 14) pH units	0.0080 pH units 0.016 pH units 0.013 pH units	DC voltage
pH Detector ^{3, 4} – Instrumental Error: @ 4 & 9 pH Units Linearity: @ 4, 7 & 9 pH Units Repeatability @ 4 & 7 pH Units @ 9 pH Units	(-414.12 to 414.12) mV	0.40 mV/pH units 1.1 mV 1.0 mV 2.0 mV	Standard solutions DC voltage

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
pH Meter ^{3, 4} – Instrumental Error	4 pH units (3p) 7 pH units (3p) 9 pH units (3p) 4 pH units, 9 pH units (2p) 7 pH units (2p) 4 pH units, 7 pH units, 9 pH units (1p)	0.011 pH units 0.012 pH units 0.031 pH units 0.024 pH units 0.014 pH units 0.18 pH units	Standard solutions
CO ₂ Meter	0 parts in 10 ⁶ 2000 parts in 10 ⁶ 5000 parts in 10 ⁶ 200, 400, 600, 800, 1000 parts in 10 ⁶ 1200, 1400, 1600, 1800 parts in 10 ⁶ 500, 1500, 2500, 3000, 3500, 4000, 4500 parts in 10 ⁶	40 parts in 10 ⁶ 60 parts in 10 ⁶ 80 parts in 10 ⁶ 50 parts in 10 ⁶ 60 parts in 10 ⁶ 110 parts in 10 ⁶	Standard gas: CO ₂ in N ₂ Standard gas & gas divider
Electrical Conductivity Meters	14.7 mS/m 141 mS/m 1280 mS/m	5 % 2.6 % 2.4 %	Calibrated electrical conductivity meters

II. Dimensional

Parameter/Equipment	Range	CMC ² (±)	Comments
Gage Blocks	(≥ 0.5 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	0.070 µm 0.090 µm 0.11 µm 0.13 µm 0.15 µm 0.19 µm 0.23 µm	By mechanical comparison

Parameter/Equipment	Range	CMC ² (±)	Comments
Step Gage	≤ 200 mm $(> 200 \text{ to } 500)$ mm $(> 500 \text{ to } 700)$ mm $(> 700 \text{ to } 1000)$ mm	$1.0 \mu\text{m}$ $1.6 \mu\text{m}$ $2.5 \mu\text{m}$ $3.2 \mu\text{m}$	Gage blocks, surface plate indicators
Standard Bar	≤ 300 mm $(> 300 \text{ to } 500)$ mm $(> 500 \text{ to } 800)$ mm $(> 800 \text{ to } 1000)$ mm	$1.0 \mu\text{m}$ $1.5 \mu\text{m}$ $2.5 \mu\text{m}$ $3.0 \mu\text{m}$	Comparison to gage blocks
Ring Gage	$(\geq 1 \text{ to } 100)$ mm $(> 100 \text{ to } 200)$ mm	$0.8 \mu\text{m}$ $2.0 \mu\text{m}$	IDM Master ring gage, ULM
Universal Measuring Machines ³	Up to 100 mm	$0.4 \mu\text{m}$	Gage blocks
Depth Gage ³	≤ 12 mm $(> 12 \text{ to } 300)$ mm	0.004 mm 0.02 mm	Gage blocks, step gages
Height Gages ³	Up to 600 mm	$5 \mu\text{m}$	Gage blocks, step gages

Parameter/Equipment	Range	CMC ^{2, 5, 7} ($\pm$)	Comments
Rules & Tape – Measure			
Rule	≤ 1 m (> 1 to 5) m	11 μ m 11L μ m	Master scales, laser, micrometer & digital depth gage Note: Range is the diameter indicated on the tape
Rule (End Gage)	≤ 3 m	0.070 mm	
Steel Tape Measure	≤ 5 m (> 5 to 100) m	0.10 mm 0.020L mm	
Textile Tape Measure	≤ 5 m (> 5 to 100) m	0.30 mm 0.060L mm	
Tank Scale	≤ 5 m (> 5 to 100) m	0.30 mm (0.30 + 0.020(L - 5)) mm	
Convex Rule	≤ 5.5 m (> 5.5 to 10.5) m (> 10.5 to 15) m	0.30 mm 0.40 mm 0.50 mm	
Tape Measure for Diameter Measurement	≤ 1500 mm (> 1500 to 1800) mm	0.040 mm 0.080 mm	
Water Level Tape Measure	≤ 5 m (> 5 to 100) m	0.40 mm (0.40 + 0.060(L - 5)) mm	
Plug & Pin Gage	(≥ 0.3 to 30) mm (> 30 to 100) mm	0.50 μ m 0.90 μ m	Gage blocks, ULM, master pins & laser scan
Feeler gages	≤ 3 mm	1.6 μ m	ULM Gage blocks
Caliper ³	≤ 200 mm (> 200 to 300) mm (> 300 to 600) mm (> 600 to 1000) mm	0.030 mm 0.040 mm 0.050 mm 0.070 mm	Gage blocks, step gages
Centerline Caliper ³	≤ 300 mm (> 300 to 1000) mm	0.050 mm 0.060 mm	Centerline caliper checker

Parameter/Equipment	Range	CMC ^{2, 5} ($\pm$)	Comments
Coordinate Measuring Machine ³ – Accuracy			
Each Axis	Up to 1000 mm	$(1.8 + L/700) \mu\text{m}$	Gage blocks, step gages
In Space	Up to 1000 mm	$3.3 \mu\text{m}$	Step gages
Micrometer ³ –			
Outside	$\leq 25 \text{ mm}$ $(> 25 \text{ to } 50) \text{ mm}$ $(> 50 \text{ to } 150) \text{ mm}$ $(> 150 \text{ to } 200) \text{ mm}$ $(> 200 \text{ to } 300) \text{ mm}$ $(> 300 \text{ to } 400) \text{ mm}$ $(> 400 \text{ to } 500) \text{ mm}$	$0.6 \mu\text{m}$ $2.0 \mu\text{m}$ $3.0 \mu\text{m}$ $4.0 \mu\text{m}$ $5.0 \mu\text{m}$ $6.0 \mu\text{m}$ $7.0 \mu\text{m}$	Gage blocks
Inside (Caliper)	$\leq 50 \text{ mm}$ $(> 50 \text{ to } 200) \text{ mm}$ $(> 200 \text{ to } 300) \text{ mm}$ $(> 300 \text{ to } 400) \text{ mm}$ $(> 400 \text{ to } 500) \text{ mm}$	$3.0 \mu\text{m}$ $4.0 \mu\text{m}$ $5.0 \mu\text{m}$ $6.0 \mu\text{m}$ $8.0 \mu\text{m}$	
Bar Inside	$\leq 150 \text{ mm}$ $(> 150 \text{ to } 200) \text{ mm}$ $(> 200 \text{ to } 300) \text{ mm}$ $(> 300 \text{ to } 400) \text{ mm}$ $(> 400 \text{ to } 500) \text{ mm}$	$4.0 \mu\text{m}$ $5.0 \mu\text{m}$ $6.0 \mu\text{m}$ $7.0 \mu\text{m}$ $9.0 \mu\text{m}$	
Depth Micrometer ³	$\leq 300 \text{ mm}$	$3.3 \mu\text{m}$	Gage blocks, step gages
Holtest ³	$\leq 125 \text{ mm}$ $(> 125 \text{ to } 200) \text{ mm}$	$2.7 \mu\text{m}$ $5.9 \mu\text{m}$	Master ring gage
Dial Gage ³	$\leq 5 \text{ mm}$ $(> 5 \text{ to } 20) \text{ mm}$ $(> 20 \text{ to } 50) \text{ mm}$ $(> 50 \text{ to } 100) \text{ mm}$	$1.0 \mu\text{m}$ $1.3 \mu\text{m}$ $1.8 \mu\text{m}$ $2.1 \mu\text{m}$	Dial gage tester, inspection machine for indicator

Parameter/Equipment	Range	CMC ^{2, 5} ($\pm$)	Comments
Electrical Comparator	≤ 5 mm	0.16 μ m	Gage blocks, inspection machine for indicator
Digital Measuring Instrument ³	≤ 100 mm	0.90 μ m	Gage blocks, inspection machine for indicator
Screw Plug Gage – Pitch Diameter Major Diameter	≤ 30 mm	3.1 μ m 1.0 μ m	ULM Three wires for screw thread measuring
Precision Surface Plate ^{3, 4} (Flatness Only) Diagonal Length	≤ 430 mm (> 430 to 1810) mm (> 1810 to 2830) mm	1.5 μ m 3.0 μ m 3.2 μ m	Electronic level
Contact Stylus Instrument ³	Ra: Up to 3 μ m Rz: Up to 10 μ m	5 % 6 %	Roughness measurement standard
Measuring Projectors ³ – Error of Magnification Linear Accuracy	Up to 600 mm (Screen Size) Up to 100 mm (> 100 to 300) mm	0.06 % of projected reading 2.7 μ m 3.7 μ m	Glass line standard scales
Measuring Microscope ³ – Parallelism Straightness in X-Y Plane X-Y Squareness Linear Accuracy	Up to 300 mm Up to 300 mm Up to 300 mm Up to 200 mm (> 200 to 300) mm	6.3 μ m 2.2 μ m 3.9 μ m 2.8 μ m 3.0 μ m	Glass line standard scales & electrical comparators

Parameter/Equipment	Range	CMC ² ($\pm$)	Comments
Cylinder Gage ³	Up to 1.6 mm	1.5 μ m	Dial gage tester, inspection machine for indicator & dial gage
Thickness Gage ³	Up to 50 mm	2.0 μ m	Gage blocks
Caliper Gage ³	Up to 200 mm	3.0 μ m	Gage blocks
Coating Thickness Standard	Up to 1550 μ m (>1550 to 5500) μ m	1.4 μ m 1.5 μ m	ULM
Coating Thickness Gage	Up to 1550 μ m	3.0 μ m	Coating thickness standards

III. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 5, 9} ($\pm$)	Comments
DC Voltage – Generate ³	(0 to 10) mV (10 to 50) mV (50 to 100) mV 100 mV to 1 V (1 to 100) V (100 to 1000) V	1.3 μ V 0.011 % 68 μ V/V 19 μ V/V 13 μ V/V 18 μ V/V	Calibrator
	(1 to 50) kV	0.24 %	Voltage divider, multimeter
DC Voltage – Measure ³	(0 to 10) mV (10 to 20) mV (20 to 100) mV 100 mV to 1000 V	1.1 μ V 0.011 % 85 μ V/V 33 μ V/V	Multimeter
	(1 to 50) kV	0.24 %	Voltage divider, multimeter

Parameter/Equipment	Range	CMC ^{2, 5, 9} (±)	Comments
DC Current – Generate ³	(0 to 1) μ A	0.045 nA	Multimeter, standard resistor
	(1 to 10) μ A	47 μ A/A	
	(10 to 100) μ A	55 μ A/A	
	100 μ A to 1 mA	55 μ A/A	
	(1 to 10) mA	65 μ A/A	
	(10 to 100) mA	67 μ A/A	
	100 mA to 1 A	85 μ A/A	
	(1 to 10) A	0.011 %	
	(10 to 20) A	0.027 %	
	(20 to 50) A	0.036 %	
	(50 to 100) A	0.044 %	
	(100 to 1000) A	0.30 %	Current generator, coil
	(1000 to 2500) A	0.54 %	
DC Current – Measure ³	100 pA to 1 nA	1.2 %	Calibrator, standard resistor
	(1 to 10) nA	0.64 %	
	(10 to 100) nA	0.61 %	
	100 nA to 1 μ A	0.57 %	
	(0 to 1) μ A	0.045 nA	Multimeter, standard resistor
	(1 to 10) μ A	47 μ A/A	
	(10 to 100) μ A	55 μ A/A	
	100 μ A to 1 mA	55 μ A/A	
	(1 to 10) mA	65 μ A/A	
	(10 to 100) mA	67 μ A/A	
	100 mA to 1 A	85 μ A/A	
	(1 to 10) A	0.011 %	
	(10 to 20) A	0.027 %	
	(20 to 50) A	0.036 %	
	(50 to 100) A	0.044 %	
	(100 to 1000) A	0.19 %	Current generator, coil, (clamp meter)
	(1000 to 2000) A	0.16 %	
	100 pA to 1 nA	1.2 %	Calibrator, standard resistor
	(1 to 10) nA	0.64 %	
	10 nA to 1 μ A	0.30 %	High resistance meter

Parameter/Equipment	Range	CMC ^{2, 5, 9} ($\pm$)	Comments
DC Power – Generate ³	(0 to 0.1) W (0.1 to 10) W	0.079 mW 0.026 %	Calibrator
	10 W to 100 kW	0.062 %	Calibrator, transconductance amplifier
	(100 to 1000) kW (1000 to 2500) kW	0.32 % 0.54 %	Calibrator, transconductance amplifier, coil
DC Power – Measure ³	(0 to 0.1) W (0.1 to 10) W 10 W to 100 kW (100 to 200) kW (200 to 500) kW (500 to 1000) kW	0.023 mW 0.035 % 0.042 % 0.24 % 0.26 % 0.31 %	Multimeter, shunt
DC Energy – Generate ³	(0 to 0.17) mW·h (0.17 to 0.33) mW·h (0.33 to 0.84) mW·h (0.84 to 1.7) mW·h	0.0033 mW·h 0.99 % 0.40 % 0.20 %	Calibrator, millisecond counter
	1.7 mW·h to 3.3 kW·h	0.25 %	Calibrator, transconductance amplifier, millisecond counter
	(3.3 to 167) kW·h (167 to 417) kW·h	0.40 % 0.58 %	Current coil, amplifier
DC Resistance – Generate ³	(30 to 100) m Ω 100 m Ω to 1 Ω (1 to 10) Ω 10 Ω to 10 k Ω 10 k Ω to 1 M Ω	0.013 m Ω 0.029 m Ω 31 $\mu\Omega/\Omega$ 25 $\mu\Omega/\Omega$ 60 $\mu\Omega/\Omega$	Multimeter
	(1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω (1 to 10) G Ω (10 to 100) G Ω 100 G Ω to 1 T Ω	0.051 % 0.051 % 0.57 % 0.61 % 0.61 % 1.1 %	Decade resistor

Parameter/Equipment	Range	CMC ^{2, 5, 9} ($\pm$)	Comments
DC Resistance – Generate ³ (cont)	(1 to 5) Ω (5 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω 100 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω	0.97 m Ω 0.020 % 0.014 % 41 $\mu\Omega/\Omega$ 42 $\mu\Omega/\Omega$ 64 $\mu\Omega/\Omega$ 64 $\mu\Omega/\Omega$ 0.11 % 0.12 % 1.8 %	Calibrator (simulated)
Fixed Points	1 m Ω 10 m Ω 100 m Ω 1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω 10 M Ω 100 M Ω	0.033 % 49 $\mu\Omega/\Omega$ 52 $\mu\Omega/\Omega$ 25 $\mu\Omega/\Omega$ 22 $\mu\Omega/\Omega$ 22 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 22 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 53 $\mu\Omega/\Omega$ 53 $\mu\Omega/\Omega$	Standard resistor
DC Resistance – Measure ³	1 m Ω to 10 m Ω 10 m Ω to 100 m Ω 100 m Ω to 1 Ω (1 to 10) Ω 10 Ω to 10 k Ω 10 k Ω to 1 M Ω (1 to 10) M Ω (10 to 100) M Ω 100 M Ω to 1 G Ω (1 to 100) G Ω 100 G Ω to 1 T Ω (1 to 10) T Ω	0.005 m Ω 0.013 m Ω 0.029 m Ω 31 $\mu\Omega/\Omega$ 25 $\mu\Omega/\Omega$ 55 60 $\mu\Omega/\Omega$ 75 $\mu\Omega/\Omega$ 0.027 % 0.57 % 0.61 % 1.1 % 4.1 %	Multimeter Standard resistor Decade resistor High resistance meter
Fixed Points	1 m Ω 10 m Ω 100 m Ω 1 Ω 10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω 10 M Ω 100 M Ω	0.033 % 49 $\mu\Omega/\Omega$ 52 $\mu\Omega/\Omega$ 25 $\mu\Omega/\Omega$ 22 $\mu\Omega/\Omega$ 22 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 23 $\mu\Omega/\Omega$ 22 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 53 $\mu\Omega/\Omega$ 53 $\mu\Omega/\Omega$	Standard resistor

Parameter/Range	Frequency	CMC ^{2, 5, 9} (±)	Comments
AC Voltage – Generate ³			
300 mV to 3.3 V (3.3 to 30) V	(10 to 50) Hz	0.036 % 0.033 %	Calibrator
(1 to 10) mV 10 mV to 1000 V	50 Hz to 1 kHz	0.065 % 0.018 %	
(1 to 3) mV (3 to 10) mV (10 to 100) mV (100 to 300) mV 300 mV to 1000 V	(1 to 10) kHz	0.80 % 0.40 % 0.065 % 0.022 % 0.018 %	
300 mV to 100 V (100 to 300) V	(10 to 50) kHz	0.019 % 0.035 %	
300 mV to 300 V 300 mV to 3 V	(50 to 100) kHz (100 to 500) kHz	0.045 % 0.17 %	Calibrator
(1 to 30) kV	(50 & 60) Hz	0.52 %	Voltage divider, multimeter
AC Voltage – Measure ³			
300 mV to 100 V	(10 to 50) Hz	0.034 %	Multimeter
(1 to 10) mV (10 to 300) mV 300 mV to 121 V (121 to 1000) V	50 Hz to 1 kHz	0.28 % 0.013 % 85 µV/V 65 µV/V	
(1 to 10) mV (10 to 300) mV 300 mV to 1000 V	(1 to 10) kHz	0.57 % 0.048 % 97 µV/V	
300 mV to 1000 V	(10 to 30) kHz	0.019 %	
300 mV to 10 V (10 to 500) V	(30 to 100) kHz	0.016 % 0.055 %	
300 mV to 1 V (1 to 20) V	(100 to 300) kHz	0.29 % 0.075 %	

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
AC Voltage – Measure ³ (cont)			
300 mV to 20 V	300 kHz to 1 MHz	0.30 %	
(1 to 300) mV	10 kHz to 1 MHz	0.71 %	Lock-in amplifier
(1 to 30) kV	(50 & 60) Hz	0.52 %	Voltage divider, multimeter
AC Current – Generate ³			
(100 to 330) µA	50 Hz to 1 kHz	0.025 %	Multimeter
330 µA to 33 mA		0.040 %	Calibrator
33 mA to 3 A		0.044 %	
(3 to 20) A		0.055 %	
(20 to 60) A	(50 to 60) Hz	0.16 %	Multimeter, standard resistor
(60 to 100) A	(50 to 60) Hz	0.24 %	Calibrator, transconductance amplifier
(100 to 1000) A	(50 to 60) Hz	0.34 %	Calibrator, transconductance amplifier
(1000 to 3000) A	(50 to 60) Hz	0.58 %	amplifier, current coil
AC Current – Measure ³			
100 µA to 2 A	50 Hz to 1 kHz	0.030 %	Multimeter
(2 to 20) A		0.055 %	Calibrator
(20 to 60) A	(50 to 60) Hz	0.16 %	Multimeter, standard resistor
(60 to 100) A	(50 to 60) Hz	0.25 %	Calibrator, transconductance amplifier
(100 to 1000) A	(50 to 60) Hz	0.19 %	Calibrator, transconductance amplifier
(1000 to 2000) A	(50 to 60) Hz	0.28 %	amplifier, current coil, (clamp meter)

Parameter/Range	Frequency	CMC ^{2, 5, 9} (±)	Comments
AC Power – Generate ³			
PF: 1 (Single Phase) ≤ 1000 V, ≤ 120 A (1 to 10) mW 10 mW to 20 kW	(50 to 60) Hz	0.085 % 0.080 %	Calibrator
(20 to 50) kW		0.12 %	Power calibrator
(50 to 100) kW		0.29 %	Calibrator, transconductance amplifier
≤ 1000 V, ≤ 1 000 A 20 W to 1000 kW		0.38 %	Calibrator, current coil
≤ 1000 V, ≤ 3000 A (1000 to 3000) kW		0.59 %	Calibrator, transconductance amplifier, current coil.
≤ 1000 V, ≤ 20 A (1 to 10) mW 10 mW to 20 kW	400 Hz	0.085 % 0.080 %	Calibrator
PF: 0 (Lag) to 1 to 0 (Lead) (Single Phase) ≤ 1000 V, ≤ 120 A (1 to 10) mW 10 mW to 20 kW	(50 to 60) Hz	0.85 mW / (V·A) 0.80 mW / (V·A)	Calibrator
(20 to 50) kW		1.2 mW / (V·A)	Power calibrator
(50 to 120) kW		2.9 mW / (V·A)	Calibrator, transconductance amplifier.
PF: 0 (Lag) to 1 to 0 (Lead) (Single Phase) ≤ 1000 V, ≤ 1000 A 20 W to 1000 kW	(50 to 60) Hz	3.8 mW / (V·A)	Calibrator, current coil

Parameter/Range	Frequency	CMC ^{2, 5, 9} ($\pm$)	Comments
AC Power – Generate ³ (cont)			
$\leq 1000 \text{ V}, \leq 3000 \text{ A}$ (1000 to 3000) kW		5.9 mW / (V·A)	Calibrator, transconductance amplifier, current coil
$\leq 1000 \text{ V}, \leq 20 \text{ A}$ (1 to 10) mW, 10 mW to 20 kW	400 Hz	0.85 mW / (V·A) 0.80 mW / (V·A)	Calibrator
AC Power – Measure ³			
PF = 1, Single Phase $\leq 1000 \text{ V}, \leq 50 \text{ A}$ (1 to 10) mW 10 mW to 20 kW	(50 to 60) Hz	0.085 % 0.080 %	Calibrator, (power analyzer)
(20 to 50) kW		0.12 %	Power calibrator, (power analyzer)
$\leq 1000 \text{ V}, \leq 20 \text{ A}$ (1 to 10) mW 10 mW to 20 kW	400 Hz	0.085 % 0.080 %	Calibrator, (power analyzer)
PF: 0 (Lag) to 1 to 0 (Lead) (Single Phase) $\leq 1000 \text{ V}, \leq 50 \text{ A}$ (1 to 10) mW 10 mW to 20 kW	(50 to 60) Hz	0.85 mW / (V·A) 0.80 mW / (V·A)	Calibrator, (power analyzer)
(20 to 50) kW		1.2 mW / (V·A)	Power calibrator, (power analyzer)
$\leq 1000 \text{ V}, \leq 20 \text{ A}$ (1 to 10) mW 10 mW to 20 kW	400 Hz	0.85 mW / (V·A) 0.80 mW / (V·A)	Calibrator (power analyzer)

Parameter/Range	Frequency	CMC ^{2, 5, 9} (±)	Comments
AC Energy – Generate ³			
PF: 1 (Single Phase) ≤ 1000 V, ≤ 120 A (0.17 to 0.34) mW·h (0.34 to 0.84) mW·h (0.84 to 1.7) mW·h 1.7 mW·h to 20 kW·h	(50 to 60) Hz	2.0 % 0.99 % 0.40 % 0.15 %	Calibrator, millisecond counter
(20 to 50) kW·h		0.26 %	Power calibrator millisecond counter
(50 to 100) kW·h		0.26 %	Calibrator, transconductance amplifier, millisecond counter
PF: 1 (Single Phase) ≤ 1000 V, ≤ 1000 A 2 W·h to 1000 kW·h	(50 to 60) Hz	0.41 %	Calibrator, current coil millisecond counter
≤ 1000 V, ≤ 3 000 A (1000 to 3000) kW·h		0.59 %	Calibrator, transconductance amplifier, current coil, millisecond counter
≤ 1000 V, ≤ 20 A (0.17 to 0.34) mW·h (0.34 to 0.84) mW·h (0.84 to 1.7) mW·h 1.7 mW·h to 20 kW·h	400 Hz	2.0 % 0.99 % 0.40 % 0.17 %	Calibrator, millisecond counter
PF: 0 (Lag) to 1 to 0 (Lead)(Single Phase) ≤ 1000 V, ≤ 120 A (0.17 to 0.34) mW·h (0.34 to 0.84) mW·h (0.84 to 1.7) mW·h 1.7 mW·h to 20 kW·h	(50 to 60) Hz	20 mW·h / (V·A·h) 9.9 mW·h / (V·A·h) 4.0 mW·h / (V·A·h) 1.5 mW·h / (V·A·h)	Calibrator
(20 to 50) kW·h		2.6 mW·h / (V·A·h)	Power calibrator
(50 to 100) kW·h		2.6 mW·h / (V·A·h)	Calibrator, transconductance amplifier

Parameter/Range	Frequency	CMC ^{2, 5, 9} (±)	Comments
AC Energy – Generate ³ (cont) PF: 0 (Lag) to 1 to 0 (Lead) (Single Phase) ≤ 1000 V, ≤ 1 000 A 2 W·h to 1000 kW·h ≤ 1000 V, ≤ 3 000 A (1000 to 3000) kW·h ≤ 1000 V, ≤ 20 A (0.17 to 0.34) mW·h (0.34 to 0.84) mW·h (0.84 to 1.7) mW·h 1.7 mW·h to 20 kW·h	 (50 to 60) Hz 400 Hz	 4.1 mW·h / (V·A·h) 5.9 mW·h / (V·A·h) 20 mW·h / (V·A·h) 9.9 mW·h / (V·A·h) 4.0 mW·h / (V·A·h) 1.7 mW·h / (V·A·h)	 Calibrator, current coil Calibrator, transconductance amplifier, current coil Calibrator
AC Resistance – Generate ³ Impedance 10 mΩ 100 mΩ 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ Impedance 50 mΩ 200 mΩ Resistance 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ	 50 Hz to 1 kHz 1 kHz (50 to 60) Hz 1 kHz	 0.26 % 0.091 % 0.091 % 0.091 % 0.091 % 0.091 % 0.091 % 0.091 % 0.16 % 0.16 % 0.021 %	 Standard resistor

Parameter/Range	Frequency	CMC ^{2, 5, 9} ($\pm$)	Comments
AC Resistance – Measure ³			
Fixed Points			
Impedance:			
10 m Ω	50 Hz to 1 kHz	0.1 %	Calibrator, multimeter
100 m Ω		0.091 %	Standard resistor
1 Ω		0.091 %	
10 Ω		0.091 %	
100 Ω		0.091 %	
1 k Ω		0.091 %	
10 k Ω		0.091 %	
100 k Ω	1 kHz	0.091 %	
Resistance:			
10 Ω	1 kHz	0.023 %	
100 Ω			
1 k Ω			
10 k Ω			
100 k Ω			
Impedance:			
100 m Ω to 1 Ω	50 Hz to 1 kHz	1.1 % + 1 m Ω	LCR meter
(1 to 10) Ω		0.81 % + 0.01 Ω	
(10 to 100) Ω		0.36 % + 0.1 Ω	
100 Ω to 1 k Ω		0.17 % + 1 Ω	
(1 to 10) k Ω		0.18 % + 0.01 k Ω	
(10 to 100) k Ω	1 kHz	0.11 % + 0.1 k Ω	
Resistance:			
(10 to 100) Ω	1 kHz	0.097 % + 0.02 Ω	
100 to 1 k Ω		0.094 % + 0.2 Ω	
(1 to 10) k Ω		0.42 % + 2 Ω	
(10 to 100) k Ω		0.42 % + 0.02 k Ω	

Parameter/Range	Frequency	CMC ^{2, 5, 9} (±)	Comments
Inductance – Generate ³ 100 µH 1 mH 10 mH 100 mH 1 H	1 kHz	0.71 % 0.034 % 0.034 % 0.034 % 0.034 %	LCR standard
Inductance – Measure ³ 100 µH to 1 mH (1 to 10) mH (10 to 100) mH 100 mH to 1 H (1 to 10) H	1 kHz	0.015 % + 0.7 µH 0.015 % + 3 µH 0.015 % + 0.03 mH 0.015 % + 0.3 mH 0.3 % + 0.05 H	LCR standard, (LCR meter)
Capacitance – Generate ³ 1 pF 10 pF 100 pF 1 nF 10 nF 100 nF 1 µF 10 µF	1 kHz	0.016 % 0.016 % 0.016 % 0.016 % 0.016 % 0.016 % 0.016 % 0.024 %	Standard capacitor, LCR standard
Capacitance – Measure ³ 1 pF (1 to 10) pF (10 to 100) pF 100 pF to 1 nF (1 to 10) nF (10 to 100) nF 100 nF to 1 µF (1 to 10) µF Fixed Points: 10 nF 100 nF 1 µF	1 kHz 120 Hz	0.060 % 0.059 % + 0.001 pF 0.014 % + 0.01 pF 0.014 % + 0.1 pF 0.014 % + 1 pF 0.014 % + 0.01 nF 0.014 % + 0.1 nF 0.015 % + 2 nF 0.13 % 0.12 % 0.12 %	Standard capacitor, LCR standard, (LCR meter) LCR meter

Parameter/Range	Frequency	CMC ^{2, 5, 9} (±)	Comments
Capacitance – Measure ³ (cont)			
Fixed Points: 10 nF 100 nF 1 µF	10 kHz	0.12 % 0.13 % 0.29 %	LCR meter
10 nF 100 nF 1 µF	100 kHz	0.13 % 0.3 % 0.91 %	
1 pF 10 pF 100 pF 1 nF	1 MHz	3.6 % 1.3 % 0.48 % 0.26 %	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Simulation of Temperature Indicators /Temperature Calibrators ³			
Resistance Temperature Devices	(-200 to 100) °C (> 100 to 400) °C (>400 to 850) °C	0.011 °C 0.020 °C 0.034 °C	Digital multimeter (Decade resistor)
Thermocouples Type K: (Internal Reference Junction)	(-270 to < -260) °C (-260 to < -250) °C (-250 to < -240) °C (-240 to < -230) °C (-230 to < -220) °C (-220 to < -210) °C (-210 to < -200) °C (-200 to < -180) °C (-180 to < -150) °C (-150 to < -100) °C (-100 to 1372) °C	12 °C 3.5 °C 2.0 °C 1.4 °C 1.1 °C 0.84 °C 0.72 °C 0.63 °C 0.51 °C 0.41 °C 0.32 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Simulation of Temperature Indicators /Temperature Calibrators ³ – (cont)			
(External Reference Junction)	(-270 to < -260) °C (-260 to < -250) °C (-250 to < -240) °C (-240 to < -230) °C (-230 to < -220) °C (-220 to < -170) °C (-170 to 1372) °C	1.2 °C 0.36 °C 0.20 °C 0.14 °C 0.11 °C 0.09 °C 0.08 °C	Digital multimeter, ice point
Thermocouples Type E: (Internal Reference Junction)	(-270 to < -260) °C (-260 to < -250) °C (-250 to < -240) °C (-240 to < -230) °C (-230 to < -220) °C (-220 to < -210) °C (-210 to < -190) °C (-190 to < -160) °C (-160 to < -90) °C (-90 to < 200) °C (200 to 1000) °C	7.0 °C 2.1 °C 1.3 °C 0.94 °C 0.76 °C 0.64 °C 0.56 °C 0.46 °C 0.37 °C 0.27 °C 0.18 °C	
(External Reference Junction)	(-270 to < -260) °C (-260 to < -250) °C (-250 to < -240) °C (-240 to < -210) °C (-210 to 1000) °C	0.54 °C 0.16 °C 0.10 °C 0.08 °C 0.05 °C	
Thermocouples Type J: (Internal Reference Junction)	(-210 to < -190) °C (-190 to < -170) °C (-170 to < -100) °C (-100 to 1200) °C	0.57 °C 0.45 °C 0.38 °C 0.27 °C	
(External Reference Junction)	(-210 to < -200) °C (-200 to 1200) °C	0.06 °C 0.05 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Simulation of Temperature Indicators /Temperature Calibrators ³ – (cont)			
Thermocouples Type N: (Internal Reference Junction)	(-270 to < -260) °C (-260 to < -250) °C (-250 to < -240) °C (-240 to < -230) °C (-230 to < -220) °C (-220 to < -210) °C (-210 to < -200) °C (-200 to < -190) °C (-190 to < -180) °C (-180 to < -160) °C (-160 to < -130) °C (-130 to < -60) °C (-60 to 1300) °C	16 °C 3.7 °C 2.1 °C 1.4 °C 1.1 °C 0.83 °C 0.70 °C 0.61 °C 0.54 °C 0.48 °C 0.41 °C 0.33 °C 0.26 °C	Digital multimeter, ice point
(External Reference Junction)	(-270 to < -260) °C (-260 to < -250) °C (-250 to < -240) °C (-240 to < -230) °C (-230 to < -220) °C (-220 to < -210) °C (-210 to < -170) °C (-170 to < -110) °C (-110 to 1300) °C	2.5 °C 0.60 °C 0.33 °C 0.23 °C 0.17 °C 0.14 °C 0.12 °C 0.08 °C 0.05 °C	
Thermocouples Type T: (Internal Reference Junction)	(-270 to < -260) °C (-260 to < -250) °C (-250 to < -240) °C (-240 to < -230) °C (-230 to < -220) °C (-220 to < -210) °C (-210 to < -190) °C (-190 to < -180) °C (-180 to < -140) °C (-140 to < -80) °C (-80 to < 200) °C (200 to 400) °C	7.2 °C 2.2 °C 1.4 °C 0.97 °C 0.78 °C 0.67 °C 0.60 °C 0.50 °C 0.46 °C 0.36 °C 0.28 °C 0.16 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Simulation of Temperature Indicators /Temperature Calibrators ³ – (cont)			
(External Reference Junction)	(-270 to < -260) °C (-260 to < -250) °C (-250 to < -240) °C (-240 to < -230) °C (-230 to < -200) °C (-200 to 400) °C	0.82 °C 0.25 °C 0.16 °C 0.12 °C 0.09 °C 0.07 °C	Digital multimeter, ice point
Thermocouples Type R: (Internal Reference Junction)	(-50 to < -40) °C (-40 to < -20) °C (-20 to < -10) °C (-10 to < 20) °C (20 to < 60) °C (60 to < 200) °C (200 to 1768) °C	1.2 °C 1.1 °C 0.90 °C 0.84 °C 0.73 °C 0.63 °C 0.48 °C	
(External Reference Junction)	(-50 to < -40) °C (-40 to < -30) °C (-30 to < -10) °C (-10 to < 30) °C (30 to < 200) °C (200 to 1768) °C	0.29 °C 0.27 °C 0.25 °C 0.22 °C 0.18 °C 0.31 °C	
Thermocouples Type S: (Internal Reference Junction)	(-50 to < -40) °C (-40 to < -20) °C (-20 to < -10) °C (-10 to < 20) °C (20 to < 60) °C (60 to < 200) °C (200 to 1768) °C	0.84 °C 0.78 °C 0.68 °C 0.65 °C 0.57 °C 0.50 °C 0.35 °C	
(External Reference Junction)	(-50 to < -40) °C (-40 to < -20) °C (-20 to < -10) °C (-10 to < 20) °C (20 to < 60) °C (60 to < 1768) °C	0.27 °C 0.30 °C 0.22 °C 0.21 °C 0.18 °C 0.16 °C	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Calibration of Strain Calibrators ³	(10 to 2000) · 10 ⁻⁶ (2000 to 5000) · 10 ⁻⁶ (5000 to 10 000) · 10 ⁻⁶ (10 000 to 20 000) · 10 ⁻⁶ (20 000 to 40 000) · 10 ⁻⁶ (40 000 to 100 000) · 10 ⁻⁶ (100 000 to 200 000) · 10 ⁻⁶	0.18 · 10 ⁻⁶ 0.39 · 10 ⁻⁶ 0.76 · 10 ⁻⁶ 0.62 · 10 ⁻⁶ 1.3 · 10 ⁻⁶ 3.1 · 10 ⁻⁶ 6.1 · 10 ⁻⁶	Multimeter, calibrator mV/V (Ratio)
Electrical Calibration of Strain Indicators ³	(10 to 200) · 10 ⁻⁶ (200 to 500) · 10 ⁻⁶ (500 to 1000) · 10 ⁻⁶ (1000 to 2000) · 10 ⁻⁶ (2000 to 5000) · 10 ⁻⁶ (5000 to 10 000) · 10 ⁻⁶ (10 000 to 20 000) · 10 ⁻⁶ (20 000 to 50 000) · 10 ⁻⁶ (50 000 to 100 000) · 10 ⁻⁶ (100 000 to 200 000) · 10 ⁻⁶	0.30 · 10 ⁻⁶ 0.38 · 10 ⁻⁶ 0.40 · 10 ⁻⁶ 0.59 · 10 ⁻⁶ 1.3 · 10 ⁻⁶ 1.7 · 10 ⁻⁶ 4.3 · 10 ⁻⁶ 7.8 · 10 ⁻⁶ 14 · 10 ⁻⁶ 43 · 10 ⁻⁶	Strain calibrator mV/V (ratio)

Parameter/Range	Frequency	CMC ^{2,9} (±)	Comments
Phase – Measure / Measuring Equipment			
(0 to 360)°	10 Hz to 1 kHz (1 to 30) kHz	0.24° 2.6°	Calibrator
Power Factor	(50 to 65) Hz (0 to 1) PF	cos (<i>A</i>) – cos (<i>A</i> + 0.15)	Calibrator, (<i>A</i> is the angle in degrees)

III. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2, 5, 9} (±)	Comments
High Frequency Voltage – Measure & Measuring Equipment ³			
(22.36 to 70.71) mV (70.71 to 500) mV 500 mV to 0.7071 V (0.707 1 to 2.236) V	9 kHz to 10 MHz	0.68 % 0.6 % 0.6 % 0.68 %	Power sensor
(22.36 to 70.71) mV (70.71 to 500) mV 500 mV to 0.7071 V (0.707 1 to 2.236) V	(10 to 50) MHz	0.72 % 0.67 % 0.67 % 0.72 %	Power sensor
(22.36 to 70.71) mV (70.71 to 500) mV 500 mV to 0.7071 V (0.707 1 to 2.236) V	(50 to 100) MHz	1.3 % 1.2 % 1.2 % 1.3 %	
22.36 mV to 2.236 V	(100 to 500) MHz	1.3 %	
22.36 mV to 2.236 V	500 MHz to 1 GHz	1.7 %	
(2.236 to 22.36) µV 22.36 µV to 2.236 mV (2.236 to 223.6) mV (223.6 to 500) mV	(2.5 to 300) MHz	1.6 % 1.3 % 1.2 % 1.1 %	Measuring receiver
(2.236 to 22.36) µV 22.36 µV to 223.6 mV (223.6 to 500) mV	300 MHz to 1 GHz	2.1 % 1.9 % 1.8 %	

Parameter/Range	Frequency	CMC ^{2, 5, 9} ($\pm$)	Comments
RF Power – Measure / Measuring Equipment ³			
10 μ W to 100 mW	9 kHz to 10 MHz 10 MHz to 2.4 GHz (2.4 to 6) GHz	2.9 % 1.9 % 2.1 %	Power sensor
10 pW to 100 mW	(2.5 to 10) MHz 10 MHz to 1 GHz	2.7 % 2.5 %	Measuring receiver

Parameter/Equipment	Range	CMC ^{2, 5} ($\pm$)	Comments
Oscilloscopes ³ –			
Amplitude – DC: 50 Ω Load	(6 to 60) mV (60 to 600) mV 600 mV to 6.6 V	0.95 % 0.39 % 0.34 %	55XXA/SC600
Amplitude – Square Wave: 50 Ω Load 50 Hz to 10 kHz	(6 to 60) mV _{p-p} (60 to 600) mV _{p-p} 600 mV _{p-p} to 6.6 V _{p-p}	1.1 % 0.69 % 0.66 %	
Leveled Sinewave Flatness: 50 Ω Load 50 kHz to 10 MHz (10 to 600) MHz	600 mV _{p-p} to 1.3 V _{p-p}	1.4 % 2.5 %	
600 MHz to 6 GHz	(0 to -3) dB	3.5 %	Power sensor
Time Marker	0.45 ns to 0.1 ms	0.16 μ s/s	Signal generator
	0.1 ms to 10 s	0.056 μ s/s	Frequency counter

IV. Mechanical

Parameter/Equipment	Range	CMC ² (±)	Comments
Graduated Cylinders, Internal & External	5 ml (> 5 to 20) ml (> 20 to 25) ml (> 25 to 50) ml (> 50 to 100) ml (> 100 to 200) ml (> 200 to 300) ml (> 300 to 500) ml (> 500 to 1000) ml (> 1000 to 2000) ml	0.030 ml 0.066 ml 0.078 ml 0.14 ml 0.25 ml 0.51 ml 0.75 ml 1.6 ml 3.0 ml 6.0 ml	Mass method
Flasks – Internal External	 10 ml (> 10 to 25) ml (> 25 to 50) ml (> 50 to 100) ml (> 100 to 200) ml (> 200 to 500) ml (> 500 to 1000) ml (> 1000 to 2000) ml (> 2000 to 3000) ml (> 3000 to 5000) ml (> 5000 to 10 000) ml 10 ml (> 10 to 25) ml (> 25 to 50) ml (> 50 to 100) ml (> 100 to 200) ml (> 200 to 500) ml (> 500 to 1000) ml (> 1000 to 2000) ml (> 2000 to 3000) ml (> 3000 to 5000) ml (> 5000 to 10 000) ml	 0.016 ml 0.020 ml 0.030 ml 0.050 ml 0.070 ml 0.13 ml 0.20 ml 0.30 ml 0.70 ml 1.0 ml 2.0 ml 0.030 ml 0.030 ml 0.040 ml 0.070 ml 0.090 ml 0.15 ml 0.30 ml 0.40 ml 0.80 ml 1.3 ml 2.5 ml	Mass method
Volumetric Pipette – External	1 ml (> 1 to 2) ml (> 2 to 5) ml (> 5 to 10) ml (> 10 to 20) ml (> 20 to 50) ml (> 50 to 100) ml (> 100 to 200) ml	0.0060 ml 0.0090 ml 0.016 ml 0.023 ml 0.025 ml 0.030 ml 0.040 ml 0.070 ml	Mass method

Parameter/Equipment	Range	CMC ² (±)	Comments
Graduated Pipette	1 ml (> 1 to 2) ml (> 2 to 5) ml (> 5 to 10) ml (> 10 to 25) ml (> 25 to 50) ml	0.0070 ml 0.010 ml 0.020 ml 0.025 ml 0.050 ml 0.10 ml	Mass method
Burette – External	5 ml (> 5 to 10) ml (> 10 to 25) ml (> 25 to 50) ml (> 50 to 100) ml	0.010 ml 0.020 ml 0.030 ml 0.040 ml 0.060 ml	Mass method

Parameter/Range	Frequency	CMC ^{2, 5} (±)	Comments
Vibration Meter System			
Acceleration, Up to 250 m/s ²	(5 to < 10) Hz (10 to 1250) Hz (> 1.25 to 2.5) kHz (> 2.5 to 5) kHz (> 5 to 10) kHz	4.5 % 2.0 % 3.0 % 3.5 % 6.0 %	Secondary vibration calibration system Vibration meter, accelerometer
Velocity, Up to 150 mm/s	(5 to < 10) Hz (10 to 1250) Hz (> 1.25 to 2.5) kHz (> 2.5 to 5) kHz (> 5 to 10) kHz	4.0 % 2.0 % 3.0 % 3.5 % 6.0 %	
Displacement, Up to 10 mm	(5 to < 10) Hz (10 to 315) Hz	4.0 % 2.0 %	

Parameter/Range	Frequency	CMC ^{2,5} (±)	Comments
Vibration Exciter with Accelerometer ^{3,4} –			
Acceleration, Up to 500 m/s ²	(5 to < 10) Hz (0.01 to 5) kHz	5.0 % 4.0 %	Vibration meter, accelerometer & counter
Velocity, Up to 100 mm/s	(5 to < 10) Hz (10 to 80) Hz (> 80 to 160) Hz (> 0.16 to 1) kHz (> 1 to 3) kHz	6.0 % 4.0 % 5.0 % 7.0 % 12 %	
Displacement, Up to 10 mm	(5 to 40) Hz (> 40 to 100) Hz (> 100 to 160) Hz (> 160 to 315) Hz	4.0 % 5.0 % 10 % 17 %	
Frequency	(5 to < 10) Hz (10 to < 20) Hz (20 to < 30) Hz (0.03 to 5) kHz	0.12 % 0.06 % 0.03 % 0.02 %	
Accelerometer Sensitivity –			
Voltage Sensitivity, (10 ⁻⁵ to 10 ³) V/(m/s ²)	20 Hz (20 to < 160) Hz 160 Hz (160 < to 315) Hz (315 < 630) Hz (0.63 to < to 1.25) kHz (1.25 < to 2.5) kHz (2.5 < to 5) kHz (5 < to 10) kHz	1.1 % 1.0 % 0.8 % 1.4 % 1.4 % 0.9 % 2.7 % 2.9 % 4.1 %	Secondary vibration calibration
Charge Sensitivity, (10 ⁻⁴ to 10 ⁶) pC/(m/s ²)	20 Hz (20 to < 160) Hz 160 Hz (160 to < 315) Hz (315 to < 630) Hz (0.63 to < 1.25) kHz (1.25 to < 2.5) kHz (2.5 to < 5) kHz (5 to < 10) kHz	1.3 % 1.1 % 0.9 % 1.5 % 1.5 % 1.0 % 2.7 % 2.9 % 4.1 %	Secondary vibration calibration

Parameter/Equipment	Range	CMC ^{2,4} (±)	Comments
Scales & Balances ³ – Electronic Type	(> 60 to 500) kg	73 µg/g	Comparison with Class E2, F1, F2, M1 & M2 weights.
	(> 2 to 60) kg	2.4 µg/g	
	(1 to 2) kg	0.86 µg/g	
	(> 0.5 to < 1) kg	0.96 µg/g	
	500 g	0.98 µg/g	
	(> 200 to < 500) g	1.1 µg/g	
	200 g	0.93 µg/g	
	(> 100 to < 200) g	1.5 µg/g	
	100 g	1.2 µg/g	
	(> 50 to < 100) g	1.8 µg/g	
	50 g	1.3 µg/g	
	(> 20 to < 50) g	2.5 µg/g	
	20 g	2.2 µg/g	
	(> 10 to < 20) g	5.2 µg/g	
	10 g	3.2 µg/g	
	(> 5 to < 10) g	7.9 µg/g	
	5 g	5.3 µg/g	
	(> 2 to < 5) g	13 µg/g	
	2 g	10 µg/g	
	(> 1 to < 2) g	28 µg/g	
	1 g	17 µg/g	
	(> 0.5 to < 1) g	43 µg/g	
	500 mg	32 µg/g	
	(> 200 to < 500) mg	61 µg/g	
	200 mg	51 µg/g	
	(> 100 to < 200) mg	0.14 mg/g	
	100 mg	80 µg/g	
	(> 50 to < 100) mg	0.20 mg/g	
	50 mg	0.13mg/g	
	(> 20 to < 50) mg	0.33 mg/g	
	20 mg	0.26 mg/g	
	(> 10 to < 20) mg	0.83 mg/g	
	10 mg	0.45 mg/g	
	9 mg	1.2 mg/g	
	8 mg	1.4 mg/g	
	7 mg	1.1 mg/g	
	6 mg	1.2 mg/g	
	5 mg	0.72 mg/g	
	4 mg	1.8 mg/g	
	3 mg	2.4 mg/g	
	2 mg	1.8 mg/g	
	1 mg	3.6 mg/g	
	(300 to 10000) kg	0.70 mg/g	Comparison with Class M1 weights & using a doubling device
	(30 to < 300) kg	1.0 mg/g	

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Scales & Balances – Mechanical Type	(>60 to 500) kg	0.16 mg/g	Comparison with Class E2, F1, F2, M1 and M2 weights. ^{3, 4}
	60 kg	0.21 mg/g	
	(>6 to <60) kg	0.13 mg/g	
	6 kg	0.21 mg/g	
	(5 to <6) kg	0.10 mg/g	
	(1 to <5) kg	2.3 µg/g	
	(>0.5 to <1) kg	4.5 µg/g	
	500 g	5.0 µg/g	
	(>200 to <500) g	6.6 µg/g	
	200 g	1.5 µg/g	
	(>100 to <200) g	2.0 µg/g	
	100 g	2.5 µg/g	
	(>50 to <100) g	4.4 µg/g	
	50 g	7.0 µg/g	
	(>20 to <50) g	11 µg/g	
	20 g	2.2 µg/g	
	(>10 to <20) g	5.2 µg/g	
	10 g	3.3 µg/g	
	(>5 to <10) g	7.9 µg/g	
	5 g	5.3 µg/g	
	(>2 to <5) g	13 µg/g	
	2 g	10 µg/g	
	(>1 to <2) g	28 µg/g	
	1 g	17 µg/g	
	(>0.5 to <1) g	43 µg/g	
	500 mg	32 µg/g	
	(>200 to <500) mg	61 µg/g	
	200 mg	51 µg/g	
	(>100 to <200) mg	0.14 mg/g	
	100 mg	81 µg/g	
	(>50 to <100) mg	0.20 mg/g	
	50 mg	0.13 mg/g	
	(>20 to <50) mg	0.33 mg/g	
	20 mg	0.27 mg/g	
	(>10 to <20) mg	0.84 mg/g	
	10 mg	0.47 mg/g	
	9 mg	1.2 mg/g	
	8 mg	1.4 mg/g	
	7 mg	1.1 mg/g	
	6 mg	1.3 mg/g	
	5 mg	0.76 mg/g	
	4 mg	1.9 mg/g	
	3 mg	2.5 mg/g	
	2 mg	1.9 mg/g	
	1 mg	3.8 mg/g	
	(300 to 10000) kg	0.70 mg/g	Comparison with Class M1 weights and using a doubling device
	(30 to <300) kg	1.0 mg/g	

Parameter/Equipment	Range	CMC ^{2, 5, 7} (±)	Comments
Force – Measuring Device Proving Ring, Standardizing Box, Load Cell, Push-Pull Gauge, etc.	Compression: 0.1 N to 3 MN Tension: 0.1 N to 300 kN	0.030 % 0.030 %	Calibration method per JIS B 7728 (ISO 376) or JIS B 7721 or JIS B 7602 or ASTM E74 weights, force calibration machine
Pressure Balances – Air Pressure: Gauge Pressure Absolute Pressure Oil Pressure: Gauge Pressure	(8 to 5000) kPa (8 to 350) kPa (0.1 to <1) MPa (1 to 100) MPa	Larger of 0.0045 % or 1.4 Pa Larger of 0.0055 % or 6.6 Pa 1.0 kPa Larger of 0.0065 % or 0.65 kPa	Pressure balances
Liquid Column Manometer Gauge Pressure	(0 to 20) kPa (> 20 to 220) kPa	0.010 kPa 0.10 kPa	Pressure controller
Pressure Gauge ^{3,4} – Air Pressure: Gauge Pressure Absolute Pressure Gauge Pressure	(8 to 100) kPa (> 100 to 500) kPa (> 500 to 5000) kPa (8 to 100) kPa (> 100 to 350) kPa (> 350 to 5100) kPa (-100 to 0) kPa (> 0 to 100) kPa (> 100 to 500) kPa (> 500 to 700) kPa (> 700 to 5000) kPa	0.0040 kPa 0.0040 % 0.0060 % 0.0050 kPa 0.0050 % 0.0080 % 0.016 kPa 0.014 kPa 0.014 % 0.022 % 0.018 %	Pressure balances Pressure controller Digital pressure gauge

Parameter/Equipment	Range	CMC ^{2, 5} (±)	Comments
Pressure Gauge ^{3,4} – (cont)			
Absolute Pressure	(8 to 100) kPa (> 100 to 350) kPa (> 350 to 500) kPa (> 500 to 700) kPa (> 700 to 5100) kPa	0.015 kPa 0.015 % 0.014 % 0.023 % 0.018 %	Pressure controller Digital pressure gauge
Gauge Pressure	(-20 to < -15) kPa (-15 to < -10) kPa (-10 to < -7.5) kPa (-7.5 to < -1) kPa (-1 to 1) kPa (> 1 to 7.5) kPa (> 7.5 to 10) kPa (> 10 to 15) kPa (> 15 to 20) kPa	1.8 Pa 1.5 Pa 1.2 Pa 0.75 Pa 0.55 Pa 0.75 Pa 1.2 Pa 1.5 Pa 1.8 Pa	Low pressure controller Digital pressure gauge
Differential Pressure	(-20 to < -15) kPa (-15 to < -10) kPa (-10 to < -7.5) kPa (-7.5 to < -1) kPa (-1 to 1) kPa (> 1 to 7.5) kPa (> 7.5 to 10) kPa (> 10 to 15) kPa (> 15 to 20) kPa	1.8 Pa 1.5 Pa 1.2 Pa 0.75 Pa 0.50 Pa 0.75 Pa 1.2 Pa 1.5 Pa 1.8 Pa	[Line pressure: 100 kPa ± 5kPa (absolute pressure)]
Absolute Pressure	(75 to 115) kPa	0.050 kPa	Digital pressure gauge
Oil Pressure : Gauge Pressure	(0 to < 1) MPa (1 to 100) MPa	1.0 kPa Larger of: 0.0080 % or 0.80 kPa	Pressure balances
Absolute Pressure	(0 to < 1.1) MPa (1.1 to 100.1) MPa	1.0 kPa Larger of: 0.0081 % or 0.81 kPa	
Gauge Pressure	(0 to 7) MPa (> 7 to 40) MPa (> 40 to 70) MPa (> 70 to 100) MPa	0.020 MPa 0.050 MPa 0.10 MPa 0.20 MPa	Digital pressure gauge

Parameter/Equipment	Range	CMC ^{2, 4, 5, (±)}	Comments
Torque Measuring Devices ³ – Torque Transducer Torque Meter Torque Wrench Tester Torque Tester, Torque Checker, Torque Gauge, etc.	(0.01 to < 0.05) N·m 0.05 N·m to 10 kN·m 20 mN·m to 1 k·m 20 mN·m to 100 N·m	0.10 % 0.040 % 0.20 % 0.20 %	Torque calibration machine Reference torque meter Lever-Mass-System (moment-arm & weights)
Torque Tools ³ – Torque Wrench, Torque Screwdriver, Torque Gauge	20 mN·m to 1000 N·m	0.40 %	Torque wrench tester, torque tester

V. Thermodynamic

Parameter/Equipment	Range	CMC ² (±)	Comments
Thermometers – Digital ^{3, 6}	(-100 to < -80) °C (-80 to < 0) °C (0 to 250) °C (> 250 to 420) °C (> 420 to 500) °C (> 500 to 660) °C (> 660 to 960) °C (> 960 to 1100) °C (> 1100 to 1200) °C (> 1200 to 1350) °C (> 1350 to 1500) °C (> 1500 to 1554) °C	0.053 °C 0.017 °C 0.013 °C 0.017 °C 0.059 °C 0.14 °C 0.30 °C 0.80 °C 1.9 °C 2.2 °C 2.9 °C 3.3 °C	Standard platinum resistance thermometer, standard platinum resistance thermometers for high temperature; thermocouple type R/S, freezing point, baths, furnace; Accredited calibrations are only offered for complete systems including the sensor & indicator

Parameter/Equipment	Range	CMC ² (±)	Comments
Platinum Resistance Thermometer Sensors –			Standard platinum resistance thermometer, water triple point cell, baths.
4-Wire	(-100 to < -80) °C (-80 to < 0) °C (0 to 100) °C (> 100 to 250) °C (> 250 to 420) °C (> 420 to 500) °C	0.053 °C 0.016 °C 0.012 °C 0.014 °C 0.018 °C 0.059 °C	4-wire: Calibration resistance ratio: R(t)/R(0.01) or R(t)/R(0) Calibration value: R(t)
3-Wire	(-100 to < -80) °C (-80 to < 0) °C 0 °C (> 0 to 250) °C (> 250 to 420) °C (> 420 to 500) °C	0.055 °C 0.025 °C 0.020 °C 0.025 °C 0.035 °C 0.065 °C	3-wire: Calibration value: R(t) Note: R(t): resistance value in calibration temperature R(0.01): resistance value in triple point of water R(0): resistance value in freezing point
Thermocouple Sensor –			
Type E	(-100 to < -80) °C (-80 to 250) °C (> 250 to 960) °C (> 960 to 1000) °C	0.30 °C 0.20 °C 0.30 °C 0.80 °C	Indicating thermometers, thermocouple type R/S, freezing point, baths, furnace, voltage standard & voltmeter. Standard platinum resistance thermometers for high temperature
Type J	(-100 to < -80) °C (-80 to 250) °C (> 250 to 960) °C (> 960 to 1100) °C (> 1100 to 1200) °C	0.30 °C 0.20 °C 0.30 °C 0.8 °C 1.9 °C	
Type K	(-100 to < -80) °C (-80 to 250) °C (> 250 to 960) °C (> 960 to 1100) °C (> 1100 to 1200) °C (> 1200 to 1350) °C (> 1350 to 1372) °C	0.30 °C 0.20 °C 0.30 °C 0.80 °C 1.9 °C 2.2 °C 2.9 °C	
Type N	(-100 to < -80) °C (-80 to 250) °C (> 250 to 960) °C (> 960 to 1100) °C (> 1100 to 1200) °C (> 1200 to 1300) °C	0.30 °C 0.20 °C 0.30 °C 0.80 °C 1.9 °C 2.2 °C	

Parameter/Equipment	Range	CMC ^{2, 7} (±)	Comments
Thermocouple Sensor – (cont)			
Type R	(-50 to < -40) °C (-40 to < 0) °C (0 to 960) °C (> 960 to 1100) °C (> 1100 to 1200) °C (> 1200 to 1350) °C (> 1350 to 1500) °C (> 1500 to 1554) °C	0.90 °C 0.70 °C 0.50 °C 0.80 °C 1.9 °C 2.2 °C 2.9 °C 3.3 °C	Indicating thermometers, thermocouple type R/S, freezing point, baths, furnace, voltage standard & voltmeter. Standard platinum resistance thermometers for high temperature
Type S	(-50 to < -40) °C (-40 to < 0) °C (0 to 960) °C (> 960 to 1100) °C (> 1100 to 1200) °C (> 1200 to 1350) °C (> 1350 to 1500) °C (> 1500 to 1554) °C	0.70 °C 0.60 °C 0.50 °C 0.90 °C 1.9 °C 2.2 °C 2.9 °C 3.3 °C	
Type T	(-100 to < -80) °C (-80 to 250) °C (> 250 to 400) °C	0.30 °C 0.20 °C 0.30 °C	
Cold Junction Compensator –			
Type E, J, K, N, T	0 °C	0.25 °C	Indicating thermometers, thermocouple, freezing point, & voltmeter
Type R, S	0 °C	0.70 °C	
Dry Well Type	0 °C	0.050 °C	
Temperature Calibration Instrument ^{3, 4} – Measure Only (Metrology Wells)	(-100 to < -80) °C (-80 to < -50) °C (-50 to 100) °C (> 100 to 250) °C (> 250 to 300) °C (> 300 to 420) °C (> 420 to 500) °C (> 500 to 600) °C (> 600 to 700) °C	0.09 °C 0.07 °C 0.030 °C 0.050 °C 0.060 °C 0.070 °C 0.090 °C 0.12 °C 0.15 °C	Standard platinum resistance thermometer, indicating resistance thermometer, standard thermocouple, voltage standard & voltmeter

Parameter/Equipment	Range	CMC ^{2,5,7} ($\pm$)	Comments
Non-Contact Type Thermometer (Radiation Thermometer, Infrared Thermograph, Et. Al.)	(-50 to < 0) °C (0 to < 35) °C (35 to 100) °C (> 100 to 200) °C (> 200 to 250) °C (> 250 to 350) °C (> 350 to 500) °C (> 500 to 600) °C (> 600 to 700) °C (> 700 to 800) °C (> 800 to 900) °C (> 900 to 1000) °C	1.2 °C, ϵ = 0.997 0.60 °C, ϵ = 0.997 0.60 °C, ϵ = 0.9 to 1.0 0.90 °C, ϵ = 0.9 to 1.0 1.2 °C, ϵ = 0.9 to 1.0 1.3 °C, ϵ = 0.9 to 1.0 1.4 °C, ϵ = 0.9 to 1.0 1.8 °C, ϵ = 1.0 2.0 °C, ϵ = 1.0 2.1 °C, ϵ = 1.0 2.2 °C, ϵ = 1.0 2.3 °C, ϵ = 1.0	Blackbody, tammann tube (Cavity) & reference PRT ϵ = emissivity radiation thermometer λ = (8 to 14) μ m
Infrared Calibrator	(-50 to < 0) °C 0 °C (> 0 to 50) °C (> 50 to 100) °C (> 100 to 200) °C (> 200 to 250) °C (> 250 to 300) °C (> 300 to 350) °C (> 350 to 400) °C (> 400 to 500) °C (> 500 to 600) °C (> 600 to 700) °C (> 700 to 800) °C (> 800 to 900) °C (> 900 to 1000) °C	1.5 °C, ϵ = 0.997 0.60 °C, ϵ = 1.000 0.70 °C, ϵ = 1.000 0.70 °C, ϵ = 1.000 1.3 °C, ϵ = 1.000 1.4 °C, ϵ = 1.000 1.5 °C, ϵ = 1.000 1.6 °C, ϵ = 1.000 1.7 °C, ϵ = 1.000 1.7 °C, ϵ = 1.000 1.9 °C, ϵ = 1.000 2.0 °C, ϵ = 1.000 2.1 °C, ϵ = 1.000 2.1 °C, ϵ = 1.000 2.2 °C, ϵ = 1.000	Radiation thermometer ϵ = emissivity
Contact Thermometry ^{3,4} – Surface Plates	(30 to 100) °C (> 100 to 200) °C (> 200 to 300) °C (> 300 to 400) °C (> 400 to 500) °C	0.60 °C 0.70 °C 0.90 °C 1.0 °C 1.1 °C	Contact thermometer
Temperature Installations – Furnaces, Ovens, Incubators, Stirred Water Baths, Fridges & Freezers ^{3,6}	(-80 to < -50) °C (-50 to 100) °C (> 100 to 300) °C (> 300 to 950) °C	0.10 °C 0.05 °C 0.11 °C 2.5 °C	PRT (includes uncertainty of transfer from measurand) JTM K09, JTM K07, IEC 60068-3-6, IEC 60068-3-5 T/C's

Parameter/Equipment	Range	CMC ^{2, 7} (±)	Comments
Humidity Controlled Chamber ^{3, 6}	(10 to 98) %RH	1.6 % RH	Dew point hygrometer & Reference PRT JTM K09, JTM K07, IEC 60068-3-6, IEC 60068-3-5
Dew / Frost Point – Measuring Equipment	(-30 to -10) °C (-10 to -50) °C (> 50 to 85) °C	0.20 °C 0.14 °C 0.15 °C	Optical dew point meter
Hygrometer – Measuring Equipment	(5 to < 20) % RH (20 to 30) % RH (> 30 to 50) % RH (> 50 to 80) % RH (> 80 to 95) % RH	1.2 % RH 0.7 % RH 1.0 % RH 1.5 % RH 1.8 % RH	Optical dew point meter

VI. Time & Frequency

Parameter/Equipment	Range	CMC ^{2, 7} (±)	Comments
Stopwatches	(1 to 900) s (> 900 to 1800) s (> 1800 to 3600) s (> 3600 to 18000) s	0.034 s 0.043 s 0.068 s 0.31 s	Stopwatch, inspection device (Timer counter)
Rise Time – Measuring Equipment ³	5 ns	0.16 ns	Signal generator
Rise Time – Measure ³	5 ns to 10 ms	1.8 % + 0.17 ns	Digital oscilloscope, signal generator
Frequency – Measure ³	1.6 mHz to 350 MHz 350 MHz to 1 GHz	5.6 parts in 10 ⁸ 5.8 parts in 10 ⁸	Frequency counter Frequency counter (measuring receiver)
Frequency – Measuring Equipment ³	1.6 mHz to 350 MHz 350 MHz to 6 GHz	5.6 parts in 10 ⁸ 1.4 parts in 10 ⁷	Frequency counter Signal generator

Parameter/Equipment	Range	CMC ² (±)	Comments
Rotational Frequency (RPM) ³ – Optical Tachometers (Non-Contact)	(0.5 to 100) rpm (100 to 1000) rpm (1000 to 100 000) rpm (100 000 to 300 000) rpm (300 000 to 600 000) rpm	0.000 58 rpm 0.0058 rpm 0.058 rpm 0.74 rpm 1.1 rpm	Frequency counter
Rotational Frequency (RPM) ³ – Stroboscopes (Non-Contact)	(0.5 to 100) rpm (100 to 1000) rpm (1000 to 100 000) rpm (100 000 to 300 000) rpm (300 000 to 600 000) rpm	0.000 58 rpm 0.0058 rpm 0.058 rpm 0.74 rpm 1.1 rpm	Frequency counter

¹ This laboratory offers commercial calibration and field calibration service.

² Calibration and Measurement Capability (CMC) Uncertainty is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards or nearly ideal measuring equipment. CMCs represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of $k = 2$. The actual measurement uncertainty of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer's device and to influences from the circumstances of the specific calibration.

³ Field calibration service is available for this calibration. Please note the actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the CMC found on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the actual uncertainty introduced by the item being calibrated, (e.g., resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC.

⁴ The CMC stated for calibrations performed in the laboratory is applicable for the calibrations performed in the field.

⁵ In the statement of CMC, % is the uncertainty percentage of the relative value of the reading. L is the numerical value of the nominal length of the device measured in meters.

⁶ The contributions from the “best existing device” are not included in the CMC claim.

⁷ The type of instrument or material being calibrated is defined by the parameter. This indicates the laboratory is capable of calibrating instruments that measure or generate the values in the ranges indicated for the listed measurement parameter.

⁸ This scope meets A2LA's *PI12 Flexible Scope Policy*.

⁹ The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.



Accredited Laboratory

A2LA has accredited

JAPAN QUALITY ASSURANCE ORGANIZATION

Aichi, JAPAN

for technical competence in the field of

Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets R205 – Specific Requirements: Calibration Laboratory Accreditation Program. 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).



Presented this 28th day of March 2024.

A blue ink signature of Mr. Trace McInturff.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 1400.04
Valid to March 31, 2026
Revised April 10, 2024.

For the calibrations to which this accreditation applies, please refer to the laboratory's Calibration Scope of Accreditation.