

Schedule

Issue date: 11 June 2025
Valid until: 15 October 2028



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LABORATORY LOCATION/ CENTRAL OFFICE: 	METCAL TECHNOLOGIES (M) SDN. BHD. (PENANG) NO. 36, CANGKAT BUKIT BELAH 11920 BAYAN LEPAS PULAU PINANG MALAYSIA
ACCREDITED SINCE:	15 OCTOBER 2003
FIELD(S) OF CALIBRATION:	DIMENSIONAL, MASS, FORCE, TORQUE, TEMPERATURE, PRESSURE, VOLUME, ELECTRICAL, TIME & FREQUENCY
SITE:	
1. SITE LABORATORY:	SITE 1
FIELD(S) OF CALIBRATION:	DIMENSIONAL, MASS, FORCE, TORQUE, TEMPERATURE, PRESSURE, VOLUME, ELECTRICAL, TIME & FREQUENCY

This laboratory has demonstrated its technical competence to operate in accordance with MS ISO/IEC 17025:2017 (ISO/IEC 17025:2017).

This laboratory's fulfillment of the requirements of ISO/IEC 17025 means the laboratory meets both the technical competence requirements and management system requirements that are necessary for it to consistently deliver technically valid test results and calibrations. The management system requirements in ISO/IEC 17025 are written in language relevant to laboratory operations and operate generally in accordance with the principles of ISO 9001 (see Joint ISO-ILAC-IAF Communiqué dated April 2017).

*** The uncertainty covered by the CMC is expressed as the expanded uncertainty corresponding to a coverage probability of approximately 95 % and have a coverage factor of $k=2$ unless stated otherwise.**

CENTRAL LOCATION:	Metcal Technologies (M) Sdn. Bhd. (Penang) No. 36, Cangkat Bukit Belah, 11920 Bayan Lepas, Pulau Pinang
FIELD(S) OF TESTING:	DIMENSIONAL, MASS, FORCE, TORQUE, TEMPERATURE, PRESSURE, VOLUME, ELECTRICAL, TIME & FREQUENCY

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Gauge Block	0.5 mm to 100 mm 100 mm to 600 mm	$(0.11 + 2.3L) \mu\text{m}$ $(0.05 + 3L) \mu\text{m}$ <i>'L' in meter</i>	ULM / Reference Gauge Block based on ISO 3650:1998
High Accuracy Micrometer (0.0001 mm res.)	0 mm to 25 mm	$0.3 \mu\text{m}$	Comparison with Gauge Block based on JIS B 7502:2016
External Micrometer	0 mm to 500 mm	$(0.5 + 3.2L) \mu\text{m}$ <i>'L' in meter</i>	

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SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Vernier, Dial & Digital Caliper	0 mm to 600 mm	$(2.6 + 7L) \mu\text{m}$ <i>'L' in meter</i>	Comparison with Caliper Checker / Gauge Block based on JIS B 7507:2022
Dial Gauge / Digital Indicator	0 mm to 50 mm	$0.39 \mu\text{m}$	ULM Gauge Tester based on JIS B 7503:2017
Dial Test Indicator	0 mm to 1.6 mm	$1.6 \mu\text{m}$	Comparison with Gauge Tester based on JIS B 7533:2015
Vernier, Dial & Digital Height Gauge	0 mm to 600 mm	$(0.5 + 3L) \mu\text{m}$ <i>'L' in meter</i>	Comparison with Caliper Checker / Gauge Block based on JIS B 7517:2018
Depth Micrometer	0 mm to 300 mm	$(1.2 + 3.1L) \mu\text{m}$ <i>'L' in meter</i>	Comparison with Gauge Block based on JIS B 7544:1994
Depth Gauge	0 mm to 300 mm	$(5.8 + 3L) \mu\text{m}$ <i>'L' in meter</i>	Comparison with Gauge Block based on JIS B 7518:2018
Dial & Digital Thickness Gauge	0 to 20 mm	$(0.59 + 3L) \mu\text{m}$ <i>'L' in meter</i>	Comparison with Gauge Block based on JIS B 7503:2017
Ultrasonic Thickness Gauge	Up to 25 mm 25 to 300 mm	$3.2 \mu\text{m}$ $(2.2 + 0.04L) \mu\text{m}$ <i>'L' in mm</i>	Gauge Block / Step Wedge based on ASTM E797/E797M-15

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SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Three Point Micrometer / Holtest / Borematic (Accuracy & Repeatability)	2.0 mm to 150 mm	$(0.9 + 18L) \mu\text{m}$ <i>'L' in meter</i>	Master Ring Gauge based on DIN 863-4:1999 (R2017)
Feeler Gauge	0.01 mm to 3 mm	$0.61 \mu\text{m}$	Direct Measurement with Micrometer based on JIS B 7524:2008
Plain Pin / Plug Gauge (Diameter only)	0.10 mm to 25 mm	$(0.5 + 1.1L) \mu\text{m}$	ULM / Micrometer based on JIS B 7420:1997
	0.10 mm to 100 mm	$(0.5 + 6L) \mu\text{m}$ <i>'L' in meter</i>	
Plain Ring Gauge	2 mm to 15 mm 15 mm to 150 mm 150 mm to 300 mm	$(0.6 + 10L) \mu\text{m}$ <i>'L' in meter</i>	ULM, Master Ring, Length Comparator, Height Master based on JIS B 7420:1997
Glass Scale	0 mm to 200 mm	$(2 + 3.3L) \mu\text{m}$ <i>"L' in meter</i>	Measuring System and Reference Scale based on JIS B 7541:2001
Ruler	0 to 300 mm 0 to 1 m 0 to 2 m	0.023 mm 0.08 mm 0.12 mm	Measuring Projector / Reference Scale / Line Scale Calibrator based on JIS B 7516:2005
Measuring Tape (pi Tape, Textile Tape)	0 ~ 1 m 1 ~ 100 m	0.062 mm $(0.025 + 0.037L) \text{ mm}$ <i>'L' in meter</i>	Reference Scale with Line Scale Calibrator based on JIS B 7512:2018
Test Sieve	0.020 mm to 1.12 mm 1.12 mm to 125 mm	$(3.4 + 3.4L) \mu\text{m}$ $(7 + 0.4L) \mu\text{m}$ <i>'L' in mm</i>	Non-Contact Measuring System / Measuring Projector based on BS 410-1:2000

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SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Coating Thickness Foil	Up to 1 mm 1 mm to 7.6 mm 7.6 mm to 12.7 mm	$(0.3 + 1.0L) \mu\text{m}$ $(1.0 + 0.3L) \mu\text{m}$ $3.0 \mu\text{m}$ <i>'L' in mm</i>	Mu-Checker / Digital Indicator based on BS EN ISO 2178:2016
Coating Thickness Gauge	Up to 7.6 mm	$(0.5 + 1.7L) \mu\text{m}$ <i>'L' in mm</i>	Coating Thickness Foils based on AS 3894.3:2002
Level (Precision Level, Spirit Level, Square Level, Round Level, Bubble Level Gauge)	0.02 mm/m 0.05 mm/m 0.1 mm/m and lower	0.010 mm/m 0.014 mm/m 0.025 mm/m	Bubble Calibrator and Sine Bar based on JIS B 7510:1993 (R2012)
Angle Protractor (Angle Level Meter / Inclinator / Clinometer)	Up to ± 180 deg.	0.023 deg.	Comparator, Sine Bar, Gauge Blocks, Precision L-Square based on VDI/VDE/DGQ 2618/Part 7.2
Bevel Protractors (Digital / Analog)	Up to ± 180 deg.	0.025 deg.	Angle Blocks based on VDI/VDE/DGQ 2618/Part 7.2
Angle Blocks	Up to ± 90 deg.	0.011 deg.	Reference Angle Block Set with Non-Contact Measuring System
Planekator / Straight Edge	Up to 400 mm	$2.4 \mu\text{m}$	Reference Straight Edge with Digital Indicator based on JIS B 7514:1977
Height Master (Riser Block, Check Master, Caliper Checker)	Up to 300 mm 300 mm to 600 mm	$1.4 \mu\text{m}$ $3.7 \mu\text{m}$	Gauge Blocks / Long Gauge Block, Length Comparator
Electrical Comparator (M μ -checker)	$\pm 5 \mu\text{m}$ to $\pm 1500 \mu\text{m}$	$0.11 \mu\text{m}$	Comparison with Gauge Block based on JIS B 7536:1982

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SCOPE OF CALIBRATION: DIMENSIONAL

Instrument calibrated/ Measurement parameter	Range	Calibration and Measurement Capability expressed as an uncertainty ($\pm$)*	Remarks
Squares (Straightness / Parallelism)	Up to 75 mm 75 mm to 300 mm Up to 300 mm	2.5 μ m 4.2 μ m 3.4 μ m	Comparison with Master Square Block, Precision L-Square, Length Comparator and Mu-Checker based on JIS B 7526:1995
Geometric Measurement (Fixture, Jig, Machined Part, Workpiece)			
Length (Contact Method)	0 mm to 100mm 100 mm to 500 mm 500 mm to 600 mm	(0.2 + 3L) μ m (0.7 + 6L) μ m (1.2 + 9L) μ m 'L' in meter	Mu-Checker, Gauge Block, Long Gauge Block, Linear Height, Height Master, Caliper, Ruler
Length (Non-Contact Method)	0 mm to 300 mm	(3.6 + 18 L) μ m 'L' in meter	Non-Contact Measuring System
Diameter (Contact Method)	0 mm to 25 mm 25 mm to 100 mm 100 mm to 300 mm	0.49 μ m 2.4 μ m 3.2 μ m	High Accuracy Micrometer, Micrometer, Caliper, Linear Height
Diameter, Radius (Non-Contact Method)	0 mm to 300 mm	(1.4 + 24 L) μ m 'L' in meter	Ring Gauge, Non-Contact Measuring System
Angle (Contact Method)	0 to $\pm$ 180 deg.	0.1 deg.	Digital Protractor
Angle (Non-Contact Method)	0 to $\pm$ 180 deg.	0.011 deg.	Angle Blocks, Non-Contact Measuring System
Straightness	0 mm to 400 mm	2.3 μ m	Straight Edge, Indicator
Parallelism	0 mm to 600 mm	2.3 μ m	Linear Height, Indicator
Flatness	0 mm to 600 mm	2.3 μ m	Linear Height, Indicator
Squareness	0 mm to 300mm	4.9 μ m	Precision L-Square, Indicator

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SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Parallel Screw / Thread Plug Gauge Major diameter Pitch diameter Pitch	Up to 100 mm Up to 100 mm 0.25 mm to 6 mm	$(0.3 + 3.4L) \mu\text{m}$ $(1.6 + 1L) \mu\text{m}$ $2.1 \mu\text{m}$ <i>'L' in mm</i>	ULM, Three Wire Gauge, Micro-indicator, Non-Contact Measuring System based on JIS B 0261:2020 or ANSI/ASME B1.2-1983
Taper Screw / Thread Plug Gauge Major diameter Pitch diameter Step limits	Up to 100 mm Up to 100 mm Up to 100 mm	$(1.4 + 0.6L) \mu\text{m}$ $(1.6 + 0.8L) \mu\text{m}$ $(0.5 + 3.8L) \mu\text{m}$ <i>'L' in mm</i>	ULM, T-Probe, gauge block, Length Comparator based on JIS B 0262:1989, AS 2710:1984
Parallel Screw / Thread Ring Gauge Minor diameter Pitch diameter	Up to 50 mm Above 50 to 100 mm Up to 50 mm Above 50 to 100 mm	$(0.7 + 3.9L) \mu\text{m}$ $(0.6 + 1.3L) \mu\text{m}$ $(1.5 + 0.9L) \mu\text{m}$ $(2.5 + 0.4L) \mu\text{m}$ <i>'L' in mm</i>	ULM, T-Probe, Plain Plug Gauge / Screw Check Plugs based on JIS B 0261:2020 or ANSI/ASME B1.2-1983
Taper Screw / Thread Ring Gauge Pitch diameter Step limits	Up to 100 mm Up to 100 mm	$(1.6 + 0.8L) \mu\text{m}$ $(0.5 + 3.8L) \mu\text{m}$ <i>'L' in mm</i>	ULM, T-Probe, gauge block, Length Comparator based on JIS B 0262:1989, AS 2710:1984

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SCOPE OF CALIBRATION: MASS

Instrument calibrated/ Measurement parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Standard Weight	1 mg	0.002 mg	Comparison using the ABBA or AB1 ...BnA weighing sequence. “Intermediate values can be calibrated with uncertainty interpolated from the next higher and lower nominal value tabulated.”
	2 mg	0.002 mg	
	5 mg	0.002 mg	
	10 mg	0.002 mg	
	20 mg	0.002 mg	
	50 mg	0.002 mg	
	100 mg	0.003 mg	
	200 mg	0.003 mg	
	500 mg	0.005 mg	
	1 g	0.005 mg	
	2 g	0.006 mg	
	5 g	0.008 mg	
	10 g	0.014 mg	
	20 g	0.015 mg	
	50 g	0.018 mg	
	100 g	0.09 mg	
	200 g	0.12 mg	
	500 g	0.87 mg	
	1 kg	0.87 mg	
	2 kg	1.8 mg	
	5 kg	3.6 mg	
	10 kg	0.012 g	
	20 kg	0.019 g	
	50 kg	8.1 g	

SCOPE OF CALIBRATION: FORCE

Instrument calibrated/ Measurement parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Durometer Hardness	Spring force for Type A, B, E & O	0.49 durometer point	Durometer Calibrator based on ASTM D 2240:2015
	Spring force for Type C, D & DO	0.40 durometer point	
Force Indicating Device (Tension & Compression)	0 N to 10 N	± 0.0011 N	Dead Weight Method based on ISO 7500-1:2018 Calibrations may be made in terms of Newton (N), Pounds force (lbf) or kilogram force (kgf).
	10 N to 50 N	± 0.011 N	
	50 N to 500 N	± 0.080 N	
	500 N to 1000 N	± 0.80 N	

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SCOPE OF CALIBRATION: PRESSURE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Pressure Indicating Devices (Pressure Gauge, Vacuum Gauge, Manometer, Magnehelic)			
Manometer	-40 kPa to 40 kPa	0.0054 kPa	Comparison with Reference Pressure Calibrator. “Intermediate values can be calibrated with uncertainty interpolated from the next higher and lower nominal value tabulated.”
Vacuum	-83 kPa to 0 kPa	0.15 kPa	
Pneumatic/Hydraulic	0 MPa to 2 MPa	0.00034 MPa	
Hydraulic	2 MPa to 70 MPa	0.033 MPa	

SCOPE OF CALIBRATION: TORQUE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Torque Measuring Device	0 N.m to 1 N.m Above 1 N.m to 10 N.m Above 10 N.m to 40 N.m Above 40 N.m to 300 N.m Above 300 N.m to 1000 N.m Above 1000 N.m to 1500 N.m	0.0012 N.m 0.020 N.m 0.042 N.m 0.34 N.m 1.1 N.m 2.4 N.m	Calibration using dead weights and known radius of Torque Wheel / Double-ended Calibration Beam “Intermediate values can be calibrated with uncertainty interpolated from the next higher and lower nominal value tabulated.”
Torque Tools (Torque Wrench, Torque Driver, Fixed or Adjustable)	Up to 1 N.m Above 1 N.m to 5 N.m Above 5 N.m to 10 N.m Above 10 N.m to 40 N.m Above 40 N.m to 150 N.m Above 150 N.m to 600 N.m Above 600 N.m to 1000 N.m Above 1000 N.m to 1500 N.m	0.0055 N.m 0.048 N.m 0.054 N.m 0.18 N.m 0.48 N.m 1.4 N.m 1.8 N.m 2.7 N.m	Based on ISO 6789-1:2017 “Intermediate values can be calibrated with uncertainty interpolated from the next higher and lower nominal value tabulated.”

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SCOPE OF CALIBRATION: TEMPERATURE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Temperature Sensor	-95 °C to below -80 °C -80 °C to below -60 °C -60 °C to 200 °C Above 200 °C to 300 °C Above 300 °C to 600 °C Above 600 °C to 800 °C Above 800 °C to 1200 °C	0.025 °C 0.01 °C 0.009 °C 0.011 °C 0.44 °C 3.5 °C 4.1 °C	Comparison with PT100 / Type R Sensor in Metrology Well / Liquid Bath / Temperature Block Calibrator
Surface Sensor	0 °C to 50 °C 50 °C to 200 °C 200 °C to 300 °C	0.5 °C 0.55 °C 0.71 °C	Comparison with Reference Surface Sensor on Electronic Hotplate / Equalizing Block of Dry Bath
Temperature Block Calibrator	-95 °C to -20 °C Above -20 °C to 300 °C Above 300 °C to 600 °C Above 600 °C to 700 °C Above 700 °C to 900 °C Above 900 °C to 1200 °C	0.07 °C 0.061 °C 0.12 °C 1.0 °C 3.5 °C 4.2 °C	Comparison with PT 100 / Thermocouple Type R / EURAMET cg-13 Version 4.0, 0.9/2017
Liquid Bath Calibrator	-80 °C to 300 °C	0.011 °C	
Radiation / Infrared Thermometer	-30 °C to 0 °C Above 0 °C to 100 °C Above 100 °C to 200 °C Above 200 °C to 300 °C Above 300 °C to 400 °C Above 400 °C to 500 °C Above 500 °C to 650 °C	0.72 °C 0.44 °C 0.78 °C 1.2 °C 1.7 °C 2.1 °C 2.7 °C	Comparison with PT100 and Type K in Blackbody Source with reference to ASTM E 2847:2021

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SCOPE OF CALIBRATION: TEMPERATURE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (±)*	Remarks
<u>Thermohygro Devices</u>			
Relative Humidity at 25°C	20 %rh to 70 %rh	1.1 %rh	Comparison with Humidity Transmitter/ Thermohygro Device In Humidity Chamber
	Above 70 %rh to 97 %rh	1.7 %rh	
		Above 97 %rh to 98 %rh	1.1 %rh
Air Temperature	-86 °C to below -45 °C	0.06 °C	Comparison with PT100 / Type-K in Temperature or Humidity Chamber
	-45 °C to 30 °C	0.05 °C	
	Above 30 °C to 60 °C	0.08 °C	
	Above 60 °C to 90 °C	0.1 °C	
	Above 90 °C to 150 °C	0.6 °C	
	Above 150 °C to 250 °C	0.9 °C	
	Above 250 °C to 300 °C	1 °C	
Relative Humidity (Fixed Point) at 25 °C	11 %rh	0.8 %rh	Measurement of Relative Humidity by Means of Aqueous Solution with reference to ASTM E104:2020
	33 %rh	0.9 %rh	
	75 %rh	1.0 %rh	
	85 %rh	1.3 %rh	
	97 %rh	1.3%rh	
<u>Liquid – In – Glass</u>			
Total Immersion Thermometer	-80 °C to 300 °C	0.3 °C	Comparison with PT100 in a Stirred Liquid Bath
Partial Immersion Thermometer	-80 °C to 300 °C	0.4 °C	
Moisture Meter (Wood / Soil Resistive Pin Type)	5 %MC to 50 %MC	0.4 %MC	Resistance Simulation by using High Resistance Decade Substituter/ Decade Resistance Box

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SCOPE OF CALIBRATION: TEMPERATURE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Temperature Indicator			
K	-200 °C to 0 °C Above 0 °C to 1370 °C	0.07 °C 0.04 °C	Electrical Simulation using Multi-product Calibrator and reference table ITS-90
J	-210 °C to 0 °C Above 0 °C to 1200 °C	0.04 °C 0.03 °C	
T	-200 °C to 0 °C Above 0 °C to 400 °C	0.05 °C 0.02 °C	
E	-200 °C to 0 °C Above 0 °C to 1300 °C	0.04 °C 0.02 °C	
N	-200 °C to 0 °C Above 0 °C to 1300 °C	0.08 °C 0.03 °C	
B	250 °C to 600 °C Above 600 °C to 1820 °C	0.53 °C 0.13 °C	
R	-50 °C to 0 °C Above 0 °C to 1760 °C	0.19 °C 0.07 °C	
S	-50 °C to 0 °C Above 0 °C to 1760 °C	0.17 °C 0.08 °C	
C	0 °C to 2315 °C	0.2 °C	
D	0 °C to 2315 °C	0.2 °C	
G	0 °C to 100 °C Above 100 °C to 2315 °C	0.7 °C 0.2 °C	
L	-200 °C to 900 °C	0.2 °C	
U	-200 °C to 100 °C Above 100 °C to 600 °C	0.4 °C 0.2 °C	
PLII	0 °C to 1200 °C	0.9 °C	

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Temperature Indicator			Electrical Simulation using Multi-product Calibrator and reference table ITS-90
PT10 (385)	-200 °C to 850 °C	0.07 °C	
PT100 (385)	-200 °C to 850 °C	0.03 °C	
PT100 (3916)	-200 °C to 630 °C	0.07 °C	
PT100 (3926)	-200 °C to 850 °C	0.03 °C	
PT200 (385)	-200 °C to 850 °C	0.04 °C	
PT500 (385)	-200 °C to 850 °C	0.04 °C	
PT1000 (385)	-200 °C to 850 °C	0.03 °C	
Cu10 (427)	-200 °C to 260 °C	0.05 °C	
Cu50 (428)	-50 °C to 150 °C	0.02 °C	
Cu100 (428)	-50 °C to 150 °C	0.02 °C	
Ni100 (618)	-60 °C to 180 °C	0.01 °C	
Ni120 (672)	-80 °C to 260 °C	0.01 °C	

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SCOPE OF CALIBRATION: TEMPERATURE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Temperature Simulator	.		
K	-200 °C to 0 °C Above 0 °C to 1370 °C	0.16 °C 0.1 °C	Measurement using Multimeter and reference table ITS-90
J	-210 °C to 0 °C Above 0 °C to 1200 °C	0.14 °C 0.09 °C	
T	-200 °C to 0 °C Above 0 °C to 400 °C	0.15 °C 0.09 °C	
E	-200 °C to 0 °C Above 0 °C to 1000 °C	0.12 °C 0.09 °C	
N	-200 °C to 0 °C Above 0 °C to 1300 °C	0.22 °C 0.1 °C	
B	250 °C to 600 °C Above 600 to 1820 °C	0.78 °C 0.19 °C	
R	-50 °C to 0 °C Above 0 °C to 1760 °C	0.54 °C 0.18 °C	
S	-50 °C to 0 °C Above 0 °C to 1760 °C	0.51 °C 0.21 °C	
C	0 °C to 2315 °C	0.3 °C	
G	0 °C to 100 °C Above 100 °C to 2315 °C	1.6 °C 1.3 °C	
D	0 °C to 2315 °C	0.5 °C	
L	-200 °C to 900 °C	0.2 °C	
U	-200 °C to 600 °C	0.2 °C	

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Temperature Simulator			
PT10 (385)	-200 °C to 850 °C	0.2 °C	Measurement using Multimeter and reference table ITS-90
PT100 (385)	-200 °C to 850 °C	0.06 °C	
PT100 (3916)	-200 °C to 630 °C	0.06 °C	
PT100 (3926)	-200 °C to 850 °C	0.06 °C	
PT200 (385)	-200 °C to 850 °C	0.07 °C	
PT500 (385)	-200 °C to 850 °C	0.07 °C	
PT1000 (385)	-200 °C to 850 °C	0.06 °C	
Cu10 (427)	-200 °C to 260 °C	0.2 °C	
Cu50 (428)	-50 °C to 150 °C	0.07 °C	
Cu100 (428)	-50 °C to 150 °C	0.06 °C	
Ni100 (618)	-60 °C to 180 °C	0.06 °C	
Ni120 (672)	-80 °C to 260 °C	0.06 °C	

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SCOPE OF CALIBRATION: VOLUME

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
pH Meter	4.00 pH 7.00 pH 10.00 pH	0.032 pH 0.030 pH 0.032 pH	Standard Buffer Solution
pH Meter (pH Simulation)	-2.00 pH to 16.00 pH	0.011 pH	Electrical Simulation
Conductivity Meter	0 μ S/cm 15 μ S/cm 84 μ S/cm 1413 μ S/cm 12.880 mS/cm 111.3 mS/cm	0.7 μ S/cm 0.4 μ S/cm 2 μ S/cm 10 μ S/cm 0.2 mS/cm 2 mS/cm	Calibrated NIST Traceable Standard Solution based on ASTM D 1125-23
Refractometer / Sucrose Mass Fraction / Refractive Index	0 % to 10 % Brix (1.333 nD ~ 1.3478 nD) 10 % to 30 % Brix (1.3478 nD ~ 1.3812 nD) 30 % to 60 % Brix (1.3812 nD ~ 1.4419 nD)	0.10 % Brix 0.13 % Brix 0.16 % Brix	Sucrose Powder with Analytical Balance

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SCOPE OF CALIBRATION: VOLUME

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Dynamic Viscosity (Rotational Viscometer)	2 mPa.s to 50 mPa.s 50 mPa.s to 100,000 mPa.s	1.3 % of reading 1.0 % of reading	Comparison with Certified Viscosity Reference Standard
Kinematic Viscosity (Zahn Cup, DIN Cup, Flow Cup, ASTM / Ford Cup, ISO Cup, Frikmar Cup, Alfnor Cup and Dip Cup)	30 mm ² /s to 120 mm ² /s 120 mm ² /s to 400 mm ² /s	1.7% of readings 1.9% of readings	Comparison with Certified Viscosity Reference Standard
Volumetric Apparatus (To Deliver) Piston-Operated Pipette Burette / Dispenser (Accuracy, delivery time)	0.1 μ l to 20 μ l Above 20 μ l to 100 μ l Above 100 μ l to 200 μ l Above 200 μ l to 1000 μ l Above 1000 μ l to 5000 μ l Above 5000 μ l to 10000 μ l Above 10000 μ l to 20000 μ l 1 ml to 10 ml 10 ml to 25 ml 25 ml to 50 ml 50 ml to 100 ml	0.020 μ l 0.026 μ l 0.031 μ l 0.16 μ l 0.76 μ l 1.6 μ l 3.1 μ l 0.007 ml 0.011 ml 0.025 ml 0.078 ml	Gravimetric Method based on ISO 8655-6:2022
One-Mark Pipette	1 ml to 10 ml Above 10 ml to 100 ml Above 100 ml to 200 ml Above 200 ml to 500 ml Above 500 ml to 1000 ml	0.0012 ml 0.0025 ml 0.0045 ml 0.022 ml 0.029 ml	Gravimetric Method based on ASTM E 542-2022
Volumetric Apparatus (To Contain) (Measuring Cylinder, Flask, Beaker, BEVS Density Cup, Specific Gravity Cup, Pyknometer)	1 ml to 10 ml Above 10 ml to 100 ml Above 100 ml to 200 ml Above 200 ml to 500 ml Above 500 ml to 1000 ml	0.041 ml 0.24 ml 0.35 ml 0.58 ml 1.6 ml	Gravimetric Method based on ASTM E 542-2022
Density Hydrometer (S.G, API, Baume, g/cm ³ , Sikes, %Brix, Plato)	0.500 g/ml to 0.800 g/ml 0.800 g/ml to 2.000 g/ml 2.000 g/ml to 4.000 g/ml	0.00050 g/ml 0.00056 g/ml 0.00087 g/ml	Cuckow's Method by Hydrostatic Weighing

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
<u>OSCILLOSCOPE</u>			
Vertical Deflection (DC Signal)	(50 Ω Impedance Load) 0 mV to $\pm$ 110 mV 110 mV to $\pm$ 500 mV 0.5 V to $\pm$ 6.6 V	2.9 mV/V + 0.048 mV 2.9 mV/V + 0.10 mV 2.9 mV/V + 0.83 mV	Generation using Fluke 5820A / Fluke 5520A (SC 600)
	(1 MΩ Impedance Load) 0 mV to $\pm$ 110 mV 110 mV to $\pm$ 500 mV 0.5 V to $\pm$ 11 V 11 V to 130V	0.29 mV/V + 0.031 mV 0.29 mV/V + 0.087 mV 0.29 mV/V + 0.82 mV 0.30 mV/V + 8.2 mV	
Vertical Deflection (Square Wave Signal)	(50 Ω Impedance Load) 1 mV to $\pm$ 25 mV 25 mV to $\pm$ 500 mV 0.5 V to $\pm$ 6.6 V	3.0 mV/V + 0.049 mV 3.0 mV/V + 0.095 mV 2.9 mV/V + 0.83 mV	
	(1 MΩ Impedance Load) 1 mV to $\pm$ 25 mV 25 mV to $\pm$ 500 mV 0.5 V to $\pm$ 6 V 6 V to $\pm$ 130 V	0.61 mV/V + 0.0061 mV 0.58 mV/V + 0.083 mV 0.59 mV/V + 0.82 mV 0.59 mV/V + 8.2 mV	
Time Base / Time Marker	2 ns to 10 ns 10 ns to 100 ns 100 ns to 10 μ s 10 μ s to 50 ms 50 ms to 5 s	0.42 μ s/s + 0.0083 ns 0.42 μ s/s + 0.083 ns 0.42 μ s/s + 0.0083 μ s 0.42 μ s/s + 8.3 μ s 33 μ s/s + 1.7 ms	
	Rise Time 0.5 ns to 5ns 5 ns to 50 ns 50 ns to 500 ns	4.6 ps/ns + 38 ps 0.053 ns 0.082 ns	
Bandwidth	50 kHz to 100 MHz 100 MHz to 300 MHz 300 MHz to 500 MHz 500 MHz to 600 MHz 600 MHz to 2.1 GHz	0.39 Hz/MHz + 4.9 MHz 0.39 Hz/MHz + 12 MHz 0.39 Hz/MHz + 20 MHz 0.39 Hz/MHz + 30 MHz 0.40 Hz/MHz + 0.11 GHz	
Flatness	<u>Sine Wave relative to 50 kHz</u> 50 kHz to 100 MHz 100 MHz to 600 MHz	0.20 dB 0.43 dB	
	<u>Sine Wave relative to 10 MHz</u> 600 MHz to 2.1 GHz	0.62 dB	

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Measuring Instruments			
Inductance (Fixed Points)	100 μH		Generation using Standard Inductor General Radio 1482-B 1482-C 1482-E 1482-H 1482-L 1482-P
(Inductance Meter, LCR Meter)	100 Hz	5.0 μ H	
	120 Hz	3.7 μ H	
	1 kHz	0.30 μ H	
	200 μH		
	100 Hz	9.8 μ H	
	120 Hz	7.4 μ H	
	1 kHz	0.59 μ H	
	10 kHz	0.24 μ H	
	300 μH		
	100 Hz	11 μ H	
	120 Hz	8.2 μ H	
	1 kHz	0.65 μ H	
	1 mH		
	100 Hz	5.9 μ H	
	120 Hz	4.6 μ H	
	1 kHz	1.3 μ H	
	10 kHz	1.1 μ H	
	10 mH		
	100 Hz	10 μ H	
	120 Hz	8.7 μ H	
	1 kHz	5.5 μ H	
	10 kHz	5.3 μ H	
	100 mH		
	100 Hz	0.058 mH	
	120 Hz	0.057 mH	
	1 kHz	0.053 mH	
	1 H		
	100 Hz	0.54 mH	
	120 Hz	0.53 mH	
	1 kHz	0.54 mH	

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Measuring Instruments Inductance (Inductance Meter, LCR Meter)	100 Hz 100 μ H to 1000 μ H 1 mH to 10 mH 10 mH to 100 mH 100 mH to 1 H 1 H to 2.222 H 120 Hz 100 μ H to 1000 μ H 1 mH to 10 mH 10 mH to 100 mH 100 mH to 1 H 1 H to 2.222 H 1 kHz 100 μ H to 1000 μ H 1 mH to 10 mH 10 mH to 100 mH 100 mH to 1 H 1 H to 2.222 H	58 μ H/mH + 2.4 μ H 35 μ H/mH + 7.3 μ H 12 μ H/mH + 71 mH 12 μ H/mH + 0.71 mH 12 μ H/mH + 2.0 mH 58 μ H/mH + 2.0 μ H 35 μ H/mH + 7.6 μ H 12 μ H/mH + 71 mH 12 μ H/mH + 0.72 mH 12 μ H/mH + 2.0 mH 58 μ H/mH + 0.73 μ H 35 μ H/mH + 7.2 μ H 12 μ H/mH + 71 μ H 12 μ H/mH + 0.70 mH 12 μ H/mH + 2.0 mH	Generation using Decade Inductance Boxes Lionmount LD8
Measuring Instruments Capacitance (Capacitance Meter, LCR Meter)	100 Hz 50 pF to 10.05 nF 10.05 nF to 100.05 nF 100.05 nF to 1000.05 nF 120 Hz 50 pF to 10.50 nF 10.05 nF to 100.05 nF 100.05 nF to 1000.05 nF 1 kHz 50 pF to 10.50 nF 10.05 nF to 100.05 nF 100.05 nF to 1000.05 nF	5.9 pF/nF + 6.1 pF 5.9 nF/ μ F + 0.019 nF 5.9 nF/ μ F + 0.065 nF 5.9 pF/nF + 6.0 pF 5.9 nF/ μ F + 0.012 nF 5.9 nF/ μ F + 0.059 nF 6.0 pF/nF + 5.9 pF 5.9 nF/ μ F + 0.011 nF 5.9 nF/ μ F + 0.059 nF	Generation using General Radio 1412-BC /Decade Capacitance ED Lab CU-410A

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument calibrated / Measurement parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Measuring Instruments Resistance (Resistance Meter, LCR Meter, Earth Continuity Tester, Insulation Meter)	0 Ω 0.01 Ω to 0.1 Ω 0.1 Ω to 1.1 Ω 1.1 Ω to 10.1 Ω 10.1 Ω to 100.1 Ω 100.1 Ω to 1000.1 Ω 1 k Ω to 10 k Ω 10 k Ω to 100 k Ω 100 k Ω to 1000 k Ω 1 M Ω to 10 M Ω 10 M Ω to 100 M Ω 0.1 G Ω to 1 G Ω 1 G Ω to 10 G Ω 10 G Ω to 100 G Ω 100 G Ω to 1000 G Ω 1000 G Ω to 1111 G Ω	0.051 m Ω 0.12 m Ω/Ω + 4.0 m Ω 0.12 m Ω/Ω + 4.9 m Ω 0.12 m Ω/Ω + 4.8 m Ω 0.13 m Ω/Ω + 2.4 m Ω 0.12 m Ω/Ω + 2.4 m Ω 0.59 $\Omega/k\Omega$ + 0.082 Ω 0.59 $\Omega/k\Omega$ + 0.59 Ω 0.59 $\Omega/k\Omega$ + 5.9 Ω 0.59 k $\Omega/M\Omega$ + 0.16 k Ω 0.70 k $\Omega/M\Omega$ + 15 k Ω 12 M $\Omega/G\Omega$ + 0.57 M Ω 12 M $\Omega/G\Omega$ + 5.7 M Ω 13M $\Omega/G\Omega$ + 0.078 G Ω 13 M $\Omega/G\Omega$ + 1.5 G Ω 22 M $\Omega/G\Omega$ + 16 G Ω	Short Connection Generation using Decade Resistance Box TIME 1051/ Yokogawa 2793-01 Generation using Yokogawa 2793-03 / IET HRRS -F-6-1M-10 kV-WT/ Fluke 5320A
Dissipation Factor (LCR Meter)	0.000 to 2.000 Ω/Ω @ 100 Hz 0.000 to 2.000 Ω/Ω @ 1 kHz	0.034 Ω/Ω + 0.59 % 0.034 Ω/Ω + 0.59 %	Generation using Yokogawa Decade Box & General Radio 1412-BC

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Measuring Instruments			
DC Voltage Meter (High Voltage Meter, Electrostatic Field Meter)	0.5 kV to 10 kV	5.8 V/kV + 7.6 V	Kikusui TOS 5101 Comparison with Kikusui 149-10A
AC Voltage Meter (High Voltage Meter) @ 50 Hz	0.5 kV to 10 kV	12 V/kV + 19 V	

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Generating Instruments			
DC High Voltage (Hipot, Insulation Voltage)	0.5 kV to 10 kV 10 kV to 40 kV	5.8 V/kV + 9.5 V 0.58 kV	HV Digital Meter Kikusui 149-10A / HV Probe with DMM
AC High Voltage (Hipot, Insulation Voltage)	50 Hz / 60 Hz 0.5 kV to 10 kV 10 kV to 28 kV	12 V/kV + 20 V 0.58 kV	
DC Leakage Current (DC Withstand Current)	0.5 to 50 mA 50 mA to 100 mA	0.58 μ A/mA + 15 μ A 0.58 μ A/mA + 61 μ A	Kikusui TOS 1200 /Keysight U1282A
AC Leakage Current (AC Withstand Current)	50 Hz / 60 Hz 0.5 to 50 mA 50 mA to 100 mA	7.1 μ A/mA + 61 μ A 7.1 μ A/mA + 0.30 mA	

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Generating Instruments Capacitance	100 Hz 0 to 2 nF 2 nF to 20 nF 20 nF to 200 nF 0.2 μ F to 2 μ F 2 μ F to 20 μ F 20 μ F to 200 μ F 200 μ F to 1000 μ F	5.9 pF/nF + 0.91 pF 2.5 pF/nF + 2.5 pF 2.5 nF/ μ F + 0.024 nF 2.5 nF/ μ F + 0.24 nF 2.5 nF/ μ F + 2.4 nF 5.9 μ F/mF + 0.025 μ F 12 μ F/mF + 0.25 μ F	Measurement using GW Instek LCR Meter / Keysight E4980AL (032) Precision LCR Meter
	120 Hz 0 to 2 nF 2 nF to 20 nF 20 nF to 200 nF 0.2 μ F to 2 μ F 2 μ F to 20 μ F 20 μ F to 200 μ F 200 μ F to 1000 μ F	5.9 pF/nF + 0.90 pF 2.5 pF/nF + 2.5 pF 2.5 nF/ μ F + 0.025 nF 2.5 nF/ μ F + 0.25 nF 2.5 nF/ μ F + 2.5 nF 5.9 μ F/mF + 0.025 μ F 12 μ F/mF + 0.25 μ F	
	1000 Hz 0 to 2 nF 2 nF to 20 nF 20 nF to 200 nF 0.2 μ F to 2 μ F 2 μ F to 20 μ F	0.59 pF/nF + 0.59 pF 2.5 pF/nF + 2.4 pF 2.5 nF/ μ F + 0.024 nF 2.5 nF/ μ F + 0.24 nF 2.5 nF/ μ F + 2.4 nF	

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Generating Instruments Inductance	<u>100 Hz</u> 0 mH to 10 mH 10 mH to 100 mH 100 mH to 1000 mH 1 H to 10 H	6.1 μ H/mH + 5.9 μ H 2.7 mH/H + 0.025 mH 2.4 mH/H + 0.26 mH 2.8 mH/H + 2.6 mH	Measurement using GW Instek LCR Meter / Keysight E4980AL (032) Precision LCR Meter
	<u>120 Hz</u> 0 mH to 10 mH 10 mH to 100 mH 100 mH to 1000 mH 1 H to 10 H	6.1 μ H/mH + 5.9 μ H 2.7 mH/H + 0.025 mH 2.4 mH/H + 0.26 mH 2.8 mH/H + 2.6 mH	
	<u>1000 Hz</u> 0 mH to 10 mH 10 mH to 100 mH 100 mH to 1000 mH 1 H to 10 H	5.9 μ H/mH + 5.9 μ H 2.4 mH/H + 0.025 mH 2.4 mH/H + 0.25 mH 2.5 mH/H + 2.6 mH	

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Measuring Instrument			Generating using Fluke 5520A, Keysight 3458A
DC Voltage	0 V to 320 mV 0.32 V to 3.2 V 3.2 V to 32 V 32 V to 320 V 320 V to 1020 V	0.0096 mV/V + 0.0060mV 0.0095 mV/V + 0.042 mV 0.012 mV/V + 0.32 mV 0.012 mV/V + 2.1 mV 12 μ V/V + 2.1 mV	
AC Voltage	0 V to 1050 V	See Matrix A	
DC Current	0 A to 320 μ A 0.32 mA to 3.2 mA 3.2 mA to 32 mA 32 mA to 320 mA 0.32 A to 1 A 1 A to 20 A	0.026 mA/A + 0.0000059 mA 0.026 mA/A + 0.00054 mA 0.043 mA/A + 0.00059 mA 0.14 mA/A + 0.018 mA 0.14 mA/A + 0.019 mA 1.3 mA/A + 81 mA	
AC Current	0 A to 20 A	See Matrix B	
Resistance	0 Ω to 40 Ω 40 Ω to 400 Ω 400 Ω to 4 k Ω 4 k Ω to 40 k Ω 40 k Ω to 400 k Ω 400 k Ω to 4 M Ω 4 M Ω to 40 M Ω 40 M Ω to 400 M Ω	0.015 m Ω / Ω + 0.99 m Ω 0.012 m Ω / Ω + 1.6 m Ω 0.013 m Ω / Ω + 0.21 Ω 0.014 m Ω / Ω + 3.7 Ω 0.022 k Ω /M Ω + 370 Ω 0.68 k Ω /M Ω + 1.6 k Ω 0.62 k Ω /M Ω + 830 k Ω 5.9 k Ω /M Ω + 790 k Ω	

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SCOPE OF CALIBRATION: ELECTRICAL**Matrix A****AC Voltage Measurement**

Range	Frequency				
	Hz	kHz			
	10 to 50	0.05 to 1	1 to 20	20 to 50	50 to 100
0 mV to 320 mV	0.094 + 0.025	0.091 + 0.024	0.36 + 0.026	0.36 + 0.025	0.97 + 0.89
320 mV to 3.2 V	0.085 + 0.26	0.085 + 0.33	0.35 + 0.73	0.36 + 2.8	0.97 + 11
3.2 V to 32 V	0.24 + 2.4	0.24 + 2.7	0.42 + 25	0.42 + 41	1.4 + 4.2
32 V to 320 V	0.48 + 25	0.47 + 29	1.4 + 29		
320 V to 1020 V	0.43 + 18	0.43 + 17			

The expanded uncertainties given in above table are expressed in mV/V +mV

Matrix B**AC Current Measurement**

Range	Frequency (Hz)	Frequency (kHz)			
	10 to 45	0.045 to 1	1 to 5	5 to 10	10 to 30
29 μ A to 330 μ A	1.2 μ A/mA + 0.086 μ A	0.97 μ A/mA + 0.078 μ A	2.3 μ A/mA + 0.12 μ A	6.3 μ A/mA + 0.16 μ A	13 μ A/mA + 0.32 μ A
0.33 mA to 3.3 mA	0.98 μ A/mA + 1.2 μ A	0.79 μ A/mA + 1.0 μ A	1.6 μ A/mA + 1.0 μ A	3.9 μ A/mA + 1.8 μ A	7.8 μ A/mA + 1.9 μ A
3.3 mA to 33 mA	0.75 μ A/mA + 3.5 μ A	0.36 μ A/mA + 3.5 μ A	0.67 μ A/mA + 3.5 μ A	1.6 μ A/mA + 3.9 μ A	3.2 μ A/mA + 4.4 μ A
33 mA to 330 mA	0.72 mA/A + 0.091 mA	0.36 mA/A + 0.092 mA	0.80 mA/A + 0.098 mA	1.6 mA/A + 0.12 mA	3.1 mA/A + 0.18 mA
0.33 A to 1.1 A	1.4 mA/A + 0.12 mA	0.41 mA/A + 0.12 mA	4.6 mA/A + 0.77 mA	20 mA/A + 0.39 mA	
1.1 A to 3 A	1.6 mA/A + 0.55 mA	0.80 mA/A + 0.55 mA	4.8 mA/A + 0.91 mA	20 mA/A + 4.0 mA	
3 A to 11 A		0.78 mA/A + 2.1 mA	24 mA/A + 2.0 mA		
11 A to 20 A		1.2 mA/A + 4.0 mA	24 mA/A + 4.0 mA		

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Measuring Instruments Frequency	0.5 Hz to 120 Hz 120 Hz to 1.2 kHz 1.2 kHz to 12 kHz 12 kHz to 120 kHz 120 kHz to 1.2 MHz 1.2 MHz to 2 MHz 2 MHz to 10 MHz	2.0 ppm + 0.0082 Hz 2.0 ppm + 0.082 Hz 2.0 ppm + 0.82 Hz 2.0 ppm + 8.2 Hz 2.0 ppm + 82 Hz 2.0 ppm + 0.82 kHz 24 ppm + 0.32 kHz	Generating using Fluke 5520A / HP 33120A
Capacitance	0.5 nF to 1.1 nF 1.1 nF to 3.3 nF 3.3 nF to 11 nF 11 nF to 33 nF 33 nF to 110 nF 0.11 μ F to 0.33 μ F 0.33 μ F to 1.1 μ F 1.1 μ F to 3.3 μ F 3.3 μ F to 11 μ F 11 μ F to 33 μ F 33 μ F to 110 μ F 0.11 mF to 0.33 mF 0.33 mF to 1.1 mF 1.1 mF to 3.3 mF 3.3 mF to 11 mF 11 mF to 33 mF 33 mF to 40 mF	1.3 pF/nF + 7.9 pF 1.3pF/nF + 7.9 pF 0.45 pF/nF + 8.0 pF 0.62 pF/nF + 78 pF 0.59 pF/nF + 0.078 nF 0.61 nF/ μ F + 0.24 nF 0.59 nF/ μ F + 0.78 nF 0.61 nF/ μ F + 2.4 nF 0.59 nF/ μ F + 7.8 nF 0.61 nF/ μ F + 24 nF 0.21 nF/ μ F + 79 nF 0.36 μ F/mF + 0.29 μ F 0.13 μ F/mF + 0.78 μ F 0.13 μ F/mF + 2.4 μ F 0.16 μ F/mF + 8.7 μ F 0.13 μ F/mF + 24 μ F 0.17 μ F/mF + 0.13 mF	Generating using Fluke 5520A
Current Measuring Device (Clamp Meter, Current Probe, Current Sensor) DC Current - 50 Turn Coil	(+/- polarities) 1.6 A to 16 A 16 A to 160 A 160 A to 525 A 525 A to 1000 A	3.3 mA/A + 78 mA 4.7 mA/A + 0.16 A 8.3 mA/A + 0.33 A 3.0 mA/A + 0.29 A	Generating using Fluke 5520A with Current Coil

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Current Measuring Device (Clamp Meter, Current Probe, Current Sensor)	<u>1.6 A to 16 A</u> 10 Hz to 440 Hz	35 mA/A + 0.25 A	Generating using Fluke 5520A with Current Coil
	<u>16 A to 160A</u> 10 Hz to 440 Hz	23 mA/A + 0.2 A	
AC Current - 50 Turn Coil	<u>160 A to 1000 A</u> 10 Hz to 440 Hz	13 mA/A + 0.56 A	
Generating Instruments			Measurement using Keysight 3458A Digital Multimeter
DC Voltage ($\pm$)	0 mV to 100 mV 100 mV to 1 V 1 V to 10 V 10 V to 100 V 100 V to 1000 V	11 μ V/V + 6.4 μ V 9.4 μ V/V + 8.2 μ V 9.3 μ V/V + 70 μ V 12 μ V/V + 0.66 mV 12 μ V/V + 6.1 mV	
AC Voltage	0 V to 1000 V	See Matrix C	
DC Current (Rectifier, Power Supply Unit, Welding Machine)	0 μ A to 100 μ A 100 μ A to 1 mA 1 mA to 10 mA 10 mA to 100 mA 100 mA to 1 A	0.023 mA/A + 0.0000024 mA 0.027 mA/A + 0.0000083 mA 0.026 mA/A + 0.00053 mA 0.044 mA/A + 0.00083 mA 0.14 mA/A + 0.019 mA	
	1 A to 3 A	1.5 mA/A + 0.82 mA	Measurement using Agilent 34401A Multimeter
	3 A to 30 A	0.011 mA/A + 8.8 mA	Keysight 34330A Current Shunt with Keysight 3458A Multimeter / Fluke 376 Clamp Meter
AC Current (Rectifier, Power Supply Unit)	0 to 30 A	See Matrix D	
Resistance	0 Ω to 10 Ω 10 Ω to 100 Ω 100 Ω to 1 k Ω 1 k Ω to 10 k Ω 10 k Ω to 100 k Ω 100 k Ω to 1 M Ω 1 M Ω to 10 M Ω 10 M Ω to 100 M Ω 100 M Ω to 1 G Ω	0.020 m Ω / Ω + 1.8 m Ω 0.015 m Ω / Ω + 1.2 m Ω 0.012 m Ω / Ω + 6.0 m Ω 0.013 m Ω / Ω + 0.21 Ω 0.014 m Ω / Ω + 3.6 Ω 0.022 m Ω / Ω + 370 Ω 0.064 m Ω / Ω + 1.7 k Ω 0.62 m Ω / Ω + 0.83 M Ω 6.2 M Ω /G Ω + 0.85 M Ω	Measurement using Keysight 3458A Digital Multimeter



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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Generating Instruments Frequency	1 Hz to 40 Hz 40 Hz to 100 Hz 100Hz to 100 kHz 100 kHz to 10 MHz	0.024 Hz 0.012 Hz 12 Hz 1.2 kHz	Measurement using Keysight 3458A Digital Multimeter

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SCOPE OF CALIBRATION: ELECTRICAL**AC Voltage:****Matrix C**

Frequency Voltage	Hz	kHz			
	0 to 40	0.04 to 1	1 to 20	20 to 50	50 to 100
0 to 10 mV	0.40 mV/V + 0.35 mV	0.28 mV/V + 0.38 mV	0.40 mV/V + 38 mV	1.3 mV/V + 0.37 mV	6.1 mV/V + 0.35 mV
10 mV to 100 mV	0.15 mV/V + 0.089 mV	0.12 mV/V + 0.024 mV	0.20 mV/V + 0.0039 mV	0.41 mV/V + 0.13 mV	1.1 mV/V + 0.16 mV
100 mV to 1 V	0.086 mV/V + 0.048 mV	0.083 mV/V + 0.026 mV	0.17 mV/V + 0.028 mV	0.35 mV/V + 0.031 mV	0.93 mV/V + 11 mV
1 V to 10 V	0.085 mV/V + 0.47 mV	0.085 mV/V + 0.34 mV	0.17 mV/V + 0.73 mV	0.35 mV/V + 2.7 mV	0.94 mV/V + 11 mV
10 V to 100 V	0.24 mV/V + 4.7 mV	0.25 mV/V + 2.8 mV	0.24 mV/V + 24 mV	0.41 mV/V + 39 mV	0.11 mV/V + 3.6 mV
100 V to 1000 V	0.48 mV/V + 50 mV	0.48 mV/V + 30 mV	-	-	-

AC Current:**Matrix D**

Frequency Current	Hz	kHz			Measuring Instrument
	0 to 50	0.05 to 1	1 to 5	5 to 30	
0 A to 1 mA	0.71 mA/A + 0.24 µA	0.36 mA/A + 0.24 µA	0.38 mA/A + 0.24 µA	4.7 mA/A + 0.47 µA	Keysight 3458A
1 mA to 10 mA	0.70 mA/A + 2.7 µA	0.36 mA/A + 2.6 µA	0.37 mA/A + 2.7 µA	4.7 mA/A + 5.0 µA	
10 mA to 100 mA	0.70 mA/A + 24 µA	0.36 mA/A + 26 µA	0.37 mA/A + 26 µA	4.7 mA/A + 49 µA	
100 mA to 1 A	0.94 mA/A + 0.25 mA	1.2 mA/A + 0.26 mA	1.2 mA/A + 0.25 mA	-	
1 A to 3 A	1.8 mA/A + 2.6 mA	1.8 mA/A + 3.0 mA	1.8 mA/A + 3.0 mA	-	Agilent 34401A
3 A to 20 A	0.16 mA/A + 11 mA	0.13 mA/A + 18 mA	0.15 mA/A + 25 mA	-	Keysight 34330A Current Shunt with Keysight 3458A
20 to 30 A	0.16 mA/A + 16 mA			-	

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SCOPE OF CALIBRATION: TIME AND FREQUENCY

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Time Measuring Devices (Stopwatch and Timer)	0 to 9 hours	0.11 sec	Time measurement according to NIST Stopwatch and Timer calibration
RPM Measuring Devices (Tachometer, Pulse meter, Stroboscope, Centrifuge, Shaker, Engine Tachometer)	(Non-contact) 0 to 599 rpm 600 to 30,000 rpm	25 ppm 3.6 ppm + 0.13 rpm	Frequency Generator with Agilent 34401A Multimeter
	0 to 500 rpm 500 to 1,000 rpm 1,000 to 10,000 rpm 10,000 to 100,000 rpm	0.00067 rpm 0.0057 rpm 0.057 rpm 0.57 rpm	Frequency Generator HP33120A / Digital Tachometer
	(Contact) 0 to 5,000 rpm	1.6 rpm	Comparison with Reference Tachometer

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SITE LOCATION (HQ)	1. Site 1
FIELD(S) OF CALIBRATION:	DIMENSIONAL, MASS, FORCE, TORQUE, TEMPERATURE, PRESSURE, VOLUME, ELECTRICAL, TIME & FREQUENCY

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Coordinate Measuring Machine	X-axis : 0 to 1500 mm Y-axis : 0 to 1500 mm Z-axis : 0 to 1500 mm Diagonal : 0 to 1500 mm	$(0.2 + 13L) \mu\text{m}$ <i>'L' in meter</i>	Long Gauge Block, Ball Bar based on ISO 10360-2:2009 and 10360-5:2020
Profile Projector (Measuring Accuracy of Individual Axis)	X, Y-axis : 0 to 300 mm	$1.9 \mu\text{m}$	Comparison with Standard Scale based on JIS B 7184:1999
Measuring Scope (Measuring Accuracy of Individual Axis)	X, Y-axis : 0 to 300 mm	$1.9 \mu\text{m}$	Comparison with Standard Scale based on JIS B 7153:1995
Surface Plate	600 x 600 mm 1200 x 1200 mm 1800 x 1800 mm	$1.4 \mu\text{m}$ $1.5 \mu\text{m}$ $1.6 \mu\text{m}$	Planekator, Micro-indicator based on JIS B 7513:1992
Vernier, Dial & Digital Height Gauge / Linear Height	0 mm to 600 mm	$(0.4 + 5L) \mu\text{m}$ <i>'L' in meter</i>	Comparison with Gauge Block, Length Comparator, Height Master, Riser Block based on JIS B 7517:2018

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SCOPE OF CALIBRATION: MASS

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Weighing Balance (Analytical Balance, Scale, Electronic Type, Platform or Pallet)	Up to 2 g Up to 20 g Up to 120 g Up to 250 g Up to 500 g Up to 1 kg Up to 3 kg Up to 6 kg Up to 10 kg Up to 30 kg Up to 60 kg Up to 100 kg Up to 150 kg Up to 300 kg Up to 500 kg Up to 1000 kg Up to 3000 kg	0.01 mg 0.02 mg 0.10 mg 0.16 mg 0.35 mg 0.6 mg 2 mg 4 mg 13 mg 27 mg 0.16 g 0.6 g 6 g 6 g 0.12 kg 0.58 kg 1.6 kg	Standard Weight Weighing balances and scales with ranges intermediate from the values tabulated can be calibrated with uncertainty interpolated from the next higher and lower range values
Standard Weight	1 kg 2 kg 5 kg 10 kg 20 kg	9 mg 9 mg 14 mg 29 mg 50 mg	Comparison using the ABBA or AB1.... BnA weighing sequence. "Intermediate values can be calibrated with uncertainty interpolated from the next higher and lower nominal value tabulated."

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SCOPE OF CALIBRATION: FORCE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Hardness Testing Machine (HRC)	30 to 60 HRC	0.25 HRC	Standard Hardness Block
Force Indicating Device (Tension)	0 N to 10 N 10 N to 50 N 50 N to 100 N	0.0013 N 0.013 N 0.13 N	Dead Weight Method based on ISO 7500-1:2018 Calibrations may be made in terms of Newton (N), Pounds force (lbf) or kilogram force (kgf).
Force Indicating Device (Compression)	0 N to 10 N 10 N to 50 N 50 N to 100 N 100 N to 500 N	0.0013 N 0.013 N 0.13 N 1.3 N	

SCOPE OF CALIBRATION: PRESSURE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Pressure Indicating Devices (Pressure Gauge, Vacuum Gauge, Manometer, Magnehelic)			Comparison with Reference Pressure Calibrator. "Intermediate values can be calibrated with uncertainty interpolated from the next higher and lower nominal value tabulated."
Manometer	-40 kPa to 40 kPa	0.0054 kPa	
Vacuum	-83 kPa to 0 kPa	0.15 kPa	
Pneumatic/Hydraulic	0 MPa to 2 MPa	0.00034 MPa	
Hydraulic	2 MPa to 70 MPa	0.033 MPa	

SCOPE OF CALIBRATION: TORQUE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Torque Tools (Torque Wrench, Torque Driver Fixed or Adjustable)	0 N.m to 1 N.m Above 1 N.m to 5 N.m	0.0055 N.m 0.048 N.m	Based on ISO 6789-1:2017 "Intermediate values can be calibrated with uncertainty interpolated from the next higher and lower nominal value tabulated."

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SCOPE OF CALIBRATION: TEMPERATURE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Temperature Controlled Enclosure			
Temperature Chamber	-95 °C to -40 °C Above -40 °C to 200 °C Above 200 °C to 500 °C	0.9 °C 0.3 °C 0.6 °C	Using Temperature Sensor / Logger with reference to IEC 60068-3-5: 2018
Furnace	Above 500 °C to 900 °C Above 900 °C to 1200 °C	3.5 °C 4.7 °C	Using Temperature Sensor with reference to DKD-R 5-7
Humidity Enclosure	10 %rh to 98 %rh 10 °C to 95 °C	1.2 %rh 0.2 °C	Using Dry Bulb & Wet Bulb Sensor / Logger with reference to IEC 60068-3-6:2018 DKD-R 5-7

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SCOPE OF CALIBRATION: TEMPERATURE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Temperature Sensor	-95 °C to -90 °C -90 °C to -80 °C Above -80 °C to -40 °C Above -40 °C to 100 °C Above 100 °C to 300 °C Above 300 °C to 600 °C Above 600 °C to 800 °C Above 800 °C to 1200 °C	0.037 °C 0.09 °C 0.072 °C 0.043 °C 0.12 °C 0.44 °C 3.9 °C 4.2 °C	Comparison with PT 100 / Type R in Metrology Well / Liquid Bath/ Temperature Block Calibrator
Temperature Block Calibrator	-95 °C to -45 °C Above -45 °C to 0 °C Above 0 °C to 200 °C Above 200 °C to 600 °C Above 600 °C to 900 °C Above 900 °C to 1200 °C	0.1 °C 0.07 °C 0.2 °C 0.7 °C 3.5 °C 4.2 °C	Comparison with PT100 with reference to EURAMET cg-13 Version 4.0, 09/2017
Liquid Bath Calibrator	-80 °C to 100 °C Above 100 °C to 300 °C	0.11 °C 0.52 °C	
Moisture Meter (Wood / Soil Resistive Pin Type)	5 %MC to 50 %MC	0.4 %MC	Resistance Simulation by using High Resistance Decade Substituter / Decade Resistance Box
<u>Liquid – In - Glass</u>			
Total Immersion thermometer & Partial Immersion thermometer	-35 °C to 150 °C	0.3 °C	Comparison with PT100 in Stirred Liquid Bath

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SCOPE OF CALIBRATION: TEMPERATURE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Temperature Simulator			Measurement using Multifunction Temperature Calibrator
K	-100 °C to 1300 °C	0.11 °C	
J	-100 °C to 1200 °C	0.1 °C	
T	-100 °C to 400 °C	0.11 °C	
E	-100 °C to 950 °C	0.1 °C	
N	-200 °C to 1300 °C	0.2 °C	
B	600 to 1800 °C	0.52 °C	
R	0 to 1700 °C	0.4 °C	
S	0 to 1700 °C	0.4 °C	
C	0 °C to 400 °C Above 400 to 2315 °C	0.6 °C 1.2 °C	
D	0 °C to 400 °C Above 400 to 2315 °C	0.6 °C 1.1 °C	
G	0 °C to 100 °C Above 100 to 2315 °C	2.9 °C 1.5 °C	
L	-200 °C to 900 °C	0.3 °C	
U	-200 °C to -100 °C Above -100 °C to 600 °C	0.5 °C 0.3 °C	

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SCOPE OF CALIBRATION: TEMPERATURE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Temperature Simulator			Measurement using Multifunction Temperature Calibrator
PT10 (385)	-200 °C to 850 °C	0.3 °C	
PT100 (385)	-200 °C to 850 °C	0.12 °C	
PT100 (3916)	-200 °C to 630 °C	0.2 °C	
PT100 (3926)	-200 °C to 850 °C	0.2 °C	
PT200 (385)	-200 °C to 850 °C	0.2 °C	
PT500 (385)	-200 °C to 850 °C	0.2 °C	
PT1000 (385)	-200 °C to 850 °C	0.2 °C	
Cu10 (427)	-200 °C to 260 °C	0.3 °C	
Cu50 (428)	-50 °C to 150 °C	0.2 °C	
Cu100 (428)	-50 °C to 150 °C	0.2 °C	
Ni100 (618)	-60 °C to 180 °C	0.2 °C	
Ni120 (672)	-80 °C to 260 °C	0.2 °C	

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SCOPE OF CALIBRATION: TEMPERATURE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Temperature Indicator			
K	-100 °C to 1300 °C	0.08 °C	Electrical Simulation using Multifunction Temperature Calibrator with reference to EURAMET/cg-11/ Version 2.0, 03/2011
J	-100 °C to 1200 °C	0.06 °C	
T	-100 °C to 400 °C	0.08 °C	
E	-100 °C to 950 °C	0.05 °C	
N	-200 °C to 1300 °C	0.22 °C	
B	600 °C to 1800 °C	0.4 °C	
R	0 °C to 1700 °C	0.4 °C	
S	0 °C to 1700 °C	0.4 °C	
C	0 °C to 2315 °C	0.5 °C	
D	0 °C to 2315 °C	0.7 °C	
G	0 °C Above 0 °C to 2315 °C	2.5 °C 0.6 °C	
L	-200 °C to 900 °C	0.2 °C	
U	-200 °C to 600 °C	0.3 °C	
PL II	0 °C to 1200 °C	0.9 °C	

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SCOPE OF CALIBRATION: TEMPERATURE

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Temperature Indicator			Electrical Simulation using Temperature Calibrator with reference to EURAMET cg-11/Version 2.0
PT10 (385)	-200 °C to 0 °C 0 °C to 850 °C	2.0 °C 2.7 °C	
PT100 (385)	-200 °C to 850 °C	0.3 °C	
PT100 (3916)	- 200 °C to 630 °C	0.3 °C	
PT100 (3926)	-200 °C to 850 °C	0.3 °C	
PT200 (385)	-200 °C to 850 °C	0.2 °C	
PT500 (385)	-200 °C to 850 °C	0.1 °C	
PT1000 (385)	-200 °C to 850 °C	0.1 °C	
Cu10 (427)	-200 °C to 260 °C	2 °C	
Cu50 (428)	-50 °C to 150 °C	0.4 °C	
Cu100 (428)	-180 °C to 200 °C	0.2 °C	
Ni100 (618)	-100 °C to 260 °C	0.2 °C	
Ni120 (672)	-100 °C to 260 °C	0.2 °C	

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SCOPE OF CALIBRATION: VOLUME

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
pH Meter	4.00 pH 7.00 pH 10.00 pH	0.034 pH 0.032 pH 0.038 pH	Standard Buffer Solution
pH Meter (pH Simulation)	-2.00 pH to 16.00 pH	0.023 pH	Electrical Simulation
Conductivity Meter	0 μ S/cm 15 μ S/cm 84 μ S/cm 1413 μ S/cm 12.880 mS/cm 111.3 mS/cm	0.7 μ S/cm 0.4 μ S/cm 2 μ S/cm 10 μ S/cm 0.3 mS/cm 2 mS/cm	Calibrated NIST Traceable Standard Solution based on ASTM D 1125-23
Dynamic Viscosity (Rotational Viscometer)	2 mPa.s to 50 mPa.s 50 mPa.s to 100,000 mPa.s	1.9 % of reading 1.5 % of reading	Comparison with Certified Viscosity Reference Standard

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
<u>OSCILLOSCOPE</u>			
Vertical Deflection (DC Signal)	(50 Ω Impedance Load) 0 mV to ± 110 mV 110 mV to ± 500 mV 0.5 V to ± 6.6 V	2.9 mV/V + 0.096 mV 2.9 mV/V + 0.14 mV 2.9 mV/V + 1.1 mV	Generation using Fluke 5820A / Fluke 5520A (SC 600)
	(1 MΩ Impedance Load) 0 mV to ± 110 mV 110 mV to ± 500 mV 0.5 V to ± 11 V 11 V to ± 130 V	0.29 mV/V + 0.084 mV 0.29 mV/V + 0.12 mV 0.29 mV/V + 1.3 mV 0.30 mV/V + 11 mV	
Vertical Deflection (Square Wave Signal)	(50 Ω Impedance Load) 1 mV to ± 25 mV 25 mV to ± 500 mV 0.5 V to ± 6.6 V	3.0 mV/V + 0.096 mV 3.0 mV/V + 0.13 mV 2.9 mV/V + 0.99 mV	
	(1 MΩ Impedance Load) 1 mV to ± 25 mV 25 mV to ± 500 mV 0.5 V to ± 6 V 6 V to ± 130 V	0.61 mV/V + 0.014 mV 0.58 mV/V + 0.090 mV 0.59 mV/V + 0.82 mV 0.59 mV/V + 8.2 mV	
Time Base / TimeMarker	2 ns to 10 ns 10 ns to 100 ns 100 ns to 10 μ s 10 μ s to 50 ms 50 ms to 5 s	0.42 μ s/s + 0.0086 ns 0.42 μ s/s + 0.085 ns 0.42 μ s/s + 0.0085 μ s 0.42 μ s/s + 8.5 μ s 33 μ s/s + 1.7 ms	
Rise Time	0.5 ns to 5 ns 5 ns to 50 ns 50 ns to 500 ns	4.6 ps/ns + 40 ps 0.055 ns 0.083 ns	
Bandwidth	50 kHz to 100 MHz 100 MHz to 300 MHz 300 MHz to 500 MHz 500 MHz to 600 MHz 600 MHz to 2.1 GHz	0.39 Hz/MHz + 5.0 MHz 0.39 Hz/MHz + 12 MHz 0.39 Hz/MHz + 20 MHz 0.39 Hz/MHz + 30 MHz 0.39 Hz/MHz + 0.11 GHz	
Flatness	<u>Sine Wave relative to 50 kHz</u> 50 kHz to 100 MHz 100 MHz to 600 MHz	0.20 dB 0.43 dB	
	<u>Sine Wave relative to 10 MHz</u> 600 MHz to 2.1 GHz	0.62 dB	

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Measuring Instruments Inductance (Inductance Meter, LCR Meter)	100 Hz 100 μ H to 1000 μ H 1 mH to 10 mH 10 mH to 100 mH 100 mH to 1 H 1 H to 2.222 H 120 Hz 100 μ H to 1000 μ H 1 mH to 10 mH 10 mH to 100 mH 100 mH to 1 H 1 H to 2.222 H 1 kHz 100 μ H to 1000 μ H 1 mH to 10 mH 10 mH to 100 mH 100 mH to 1 H 1 H to 2.222 H	58 μ H/mH + 2.5 μ H 35 μ H/mH + 12 μ H 12 μ H/mH + 0.12 mH 12 μ H/mH + 1.2 mH 12 μ H/mH + 2.9 mH 58 μ H/mH + 2.1 μ H 35 μ H/mH + 13 μ H 12 μ H/mH + 0.12 mH 12 μ H/mH + 1.2 mH 12 μ H/mH + 2.9 mH 58 μ H/mH + 1.2 μ H 35 μ H/mH + 12 μ H 12 μ H/mH + 0.12 mH 12 μ H/mH + 1.2 mH 12 μ H/mH + 2.8 mH	Generation using Decade Inductance Boxes Lionmount LD8
Measuring Instruments Capacitance (Capacitance Meter, LCR Meter)	100 Hz 50 pF to 10.50 nF 10.05 nF to 100.05 nF 100.05 nF to 1000.05 nF 120 Hz 50 pF to 10.50 nF 10.05 nF to 100.05 nF 100.05 nF to 1000.05 nF 1 kHz 50 pF to 10.50 nF 10.05 nF to 100.05 nF 100.05 nF to 1000.05 nF	5.9 pF/nF + 6.1 pF 5.9 nF/ μ F + 0.019 nF 5.9 nF/ μ F + 0.065 nF 5.9 pF/nF + 6.0 pF 5.9 nF/ μ F + 0.010 nF 5.9 nF/ μ F + 0.059 nF 6.0 pF/nF + 5.9 pF 5.9 nF/ μ F + 0.010 nF 5.9 nF/ μ F + 0.067 nF	Generation using General Radio 1412-BC / Decade Capacitance ED Lab CU-410A

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Measuring Instruments			
Resistance	0 Ω	0.13 m Ω	Short connection
(Resistance Meter, LCR Meter, Earth Continuity Tester, Insulation Meter)	0.01 Ω to 0.1 Ω 0.1 Ω to 1.1 Ω 1.1 Ω to 10.1 Ω 10.1 Ω to 100.1 Ω 100.1 Ω to 1000.1 Ω	1.2 m Ω / Ω + 4.4 m Ω 0.12 m Ω / Ω + 5.1 m Ω 0.12 m Ω / Ω + 6.2 m Ω 0.13 m Ω / Ω + 2.4 m Ω 0.12 m Ω / Ω + 2.5 m Ω	Generation using Decade Resistance Box TIME 1051/ Yokogawa 2793-01
	1 k Ω to 10 k Ω 10 k Ω to 100 k Ω 100 k Ω to 1000 k Ω 1 M Ω to 10 M Ω 10 M Ω to 100 M Ω 0.1 G Ω to 1 G Ω 1 G Ω to 10 G Ω 10 G Ω to 100 G Ω 100 G Ω to 1000 G Ω 1000 G Ω to 1111 G Ω	0.59 Ω /k Ω + 0.059 Ω 0.61 Ω /k Ω + 0.23 Ω 0.61 Ω /k Ω + 4.1 Ω 0.61 k Ω /M Ω + 0.57 k Ω 0.71 k Ω /M Ω + 20 k Ω 12 M Ω /G Ω + 0.57 M Ω 12 M Ω /G Ω + 5.7 M Ω 13 M Ω /G Ω + 0.078 G Ω 13 M Ω /G Ω + 1.5 G Ω 22 M Ω /G Ω + 16 G Ω	Generation using Yokogawa 2793-03 / IET HRRS -F-6-1M-10 kV-WT
Dissipation Factor (LCR Meter)	0.000 to 2.000 Ω / Ω @ 100 Hz 0.000 to 2.000 Ω / Ω @ 1 kHz	0.59 % + 0.056 Ω / Ω 0.59 % + 0.056 Ω / Ω	Generation using Yokogawa Decade Box & General Radio 1412-BC

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Measuring Instruments			
DC Voltage Meter (High Voltage Meter, Electrostatic Field Meter)	0.5 kV to 10 kV	12 V/kV + 7.6 V	Kikusui TOS 5101 Comparison with Kikusui 149-10A
AC Voltage Meter (High Voltage Meter) @ 50Hz	0.5 kV to 10 kV	24 V/kV + 19 V	

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Generating Instruments			
DC High Voltage (Hipot, Insulation Voltage)	0.5 kV to 10 kV 10 kV + 40 kV	12 V/kV + 9.5 V 0.58 kV	HV Digital Meter Kikusui 149-10A / HV Probe with DMM
AC High Voltage (Hipot, Insulation Voltage)	50 Hz / 60 Hz 0.5 kV to 10 kV 10 kV + 28 kV	24 V/kV + 20 V 0.58 kV	
DC Leakage Current (DC Withstand Current)	0.5 to 50 mA 50 mA to 100 mA	1.2 μ A/mA + 13 μ A 1.2 μ A/mA + 60 μ A	Kikusui TOS 1200 / Keysight U1282A
AC Leakage Current (AC Withstand Current)	50 Hz / 60 Hz 0.5 to 50 mA 50 mA to 100 mA	14 μ A/mA + 60 μ A 14 μ A/mA + 0.30 mA	

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty($\pm$)*	Remarks
Generating Instruments Capacitance	100 Hz 0 to 2 nF 2 nF to 20 nF 20 nF to 200 nF 0.2 μ F to 2 μ F 2 μ F to 20 μ F 20 μ F to 200 μ F 200 μ F to 1000 μ F	5.9 pF/nF + 1.2 pF 2.6 pF/nF + 2.4 pF 2.6 nF/ μ F + 0.024 nF 2.6 nF/ μ F + 0.24 nF 2.6 nF/ μ F + 2.4 nF 5.9 μ F/mF + 0.024 μ F 12 μ F/mF + 0.25 μ F	Measurement using GWInstek LCR Meter / Keysight E4980AL (032) Precision LCR Meter
	120 Hz 0 to 2 nF 2 nF to 20 nF 20 nF to 200 nF 0.2 μ F to 2 μ F 2 μ F to 20 μ F 20 μ F to 200 μ F 200 μ F to 1000 μ F	5.9 pF/nF + 0.90 pF 2.6 pF/nF + 2.4 pF 2.6 nF/ μ F + 0.024 nF 2.6 nF/ μ F + 0.24 nF 2.6 nF/ μ F + 2.4 nF 5.9 μ F/mF + 0.024 μ F 12 μ F/mF + 0.25 μ F	
	1000 Hz 0 to 2 nF 2 nF to 20 nF 20 nF to 200 nF 0.2 μ F to 2 μ F 2 μ F to 20 μ F	5.9 pF/nF + 0.59 pF 2.6 pF/nF + 2.4 pF 2.6 nF/ μ F + 0.024 nF 2.6 nF/ μ F + 0.24 nF 2.6 nF/ μ F + 2.4 nF	

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty($\pm$)*	Remarks
Generating Instruments Inductance	<u>100 Hz</u> 0 mH to 10 mH 10 mH to 100 mH 100 mH to 1000 mH 1 H to 10 H	6.1 μ H/mH + 5.9 μ H 2.7 mH/H + 0.025 mH 2.4 mH/H + 0.26 mH 2.8 mH/H + 2.6 mH	Measurement using GW Instek LCR Meter / Keysight E4980AL (032) Precision LCR Meter
	<u>120 Hz</u> 0 mH to 10 mH 10 mH to 100 mH 100 mH to 1000 mH 1 H to 10 H	6.1 μ H/mH + 5.9 μ H 2.7 mH/H + 0.025 mH 2.4 mH/H + 0.26 mH 2.8 mH/H + 2.6 mH	
	<u>1000 Hz</u> 0 mH to 10 mH 10 mH to 100 mH 100 mH to 1000 mH 1 H to 10 H	5.9 μ H/mH + 5.9 μ H 2.4 mH/H + 0.025 mH 2.4 mH/H + 0.25 mH 2.5 mH/H + 2.6 mH	

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Measuring Instruments			Generation using Fluke 5520A, Keysight 3458A
DC Voltage	0 mV to 320 mV 0.32 V to 3.2 V 3.2 V to 32 V 32 V to 320 V 320 V to 1000 V	0.0096 mV/V + 0.0069 mV 0.0097 mV/V + 0.13 mV 0.012 mV/V + 0.43 mV 0.012 mV/V + 5.9 mV 12 μ V/V + 6.1 mV	
AC Voltage	0 V to 1020 V	12 μ V/V + 6.1 mV	
DC Current	0 μ A to 320 μ A 0.32 mA to 3.2 mA 3.2 mA to 32 mA 32 mA to 330 mA 0.33 A to 3 A 3 A to 20 A	0.025 mA/A + 0.000021 mA 0.026 mA/A + 0.00060 mA 0.043 mA/A + 0.0026 mA 0.14 mA/A + 0.14 mA 0.14 mA/A + 0.14 mA 0.80 mA/A + 18 mA	
AC Current	0 A to 20 A	See Matrix B	
Resistance	0 Ω to 40 Ω 40 Ω to 400 Ω 400 Ω to 4 k Ω 4 k Ω to 40 k Ω 40 k Ω to 400 k Ω 400 k Ω to 4 M Ω 4 M Ω to 40 M Ω 40 M Ω to 400 M Ω	0.015 m Ω / Ω + 2.9 m Ω 0.012 m Ω / Ω + 6.8 m Ω 0.013 m Ω / Ω + 0.22 Ω 0.014 m Ω / Ω + 24 Ω 0.022 k Ω /M Ω + 500 Ω 0.063 k Ω /M Ω + 13 k Ω 0.61 k Ω /M Ω + 1100 k Ω 5.9 k Ω /M Ω + 1500 k Ω	

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SCOPE OF CALIBRATION: ELECTRICAL**Matrix A****AC Voltage Measurement**

Range	Frequency				
	Hz	kHz			
	10 to 50	0.05 to 1	1 to 20	20 to 50	50 to 100
0 mV to 320 mV	0.094 + 0.025	0.091 + 0.024	0.36 + 0.026	0.36 + 0.025	0.97 + 0.89
320 mV to 3.2 V	0.085 + 0.26	0.085 + 0.33	0.35 + 0.73	0.36 + 2.8	0.97 + 11
3.2 V to 32 V	0.24 + 2.4	0.24 + 2.7	0.42 + 25	0.42 + 41	1.4 + 4.2
32 V to 320 V	0.48 + 25	0.47 + 29	1.4 + 29		
320 V to 1020 V	0.43 + 18	0.43 + 17			

The expanded uncertainties given in above table are expressed in mV/V + mV

Matrix B**AC Current Measurement**

Range	Frequency (Hz)	Frequency (kHz)			
	10 to 45	0.045 to 1	1 to 5	5 to 10	10 to 30
29 μ A to 330 μ A	1.2 μ A/mA + 0.086 μ A	0.97 μ A/mA + 0.078 μ A	2.3 μ A/mA + 0.12 μ A	6.3 μ A/mA + 0.16 μ A	13 μ A/mA + 0.32 μ A
0.33 mA to 3.3 mA	0.98 μ A/mA + 1.2 μ A	0.79 μ A/mA + 1.0 μ A	1.6 μ A/mA + 1.0 μ A	3.9 μ A/mA + 1.8 μ A	7.8 μ A/mA + 1.9 μ A
3.3 mA to 33 mA	0.75 μ A/mA + 3.5 μ A	0.36 μ A/mA + 3.5 μ A	0.67 μ A/mA + 3.5 μ A	1.6 μ A/mA + 3.9 μ A	3.2 μ A/mA + 4.4 μ A
33 mA to 330 mA	0.72 mA/A + 0.091 mA	0.36 mA/A + 0.092 mA	0.80 mA/A + 0.098 mA	1.6 mA/A + 0.12 mA	3.1 mA/A + 0.18 mA
0.33 A to 1.1 A	1.4 mA/A + 0.12 mA	0.41 mA/A + 0.12 mA	4.6 mA/A + 0.77 mA	20 mA/A + 0.39 mA	
1.1 A to 3 A	1.6 mA/A + 0.55 mA	0.80 mA/A + 0.55 mA	4.8 mA/A + 0.91 mA	20 mA/A + 4.0 mA	
3 A to 11 A		0.78 mA/A + 2.1 mA	24 mA/A + 2.0 mA		
11 A to 20 A		1.2 mA/A + 4.0 mA	24 mA/A + 4.0 mA		

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty($\pm$)*	Remarks
Measuring Instruments Frequency	0.5 Hz to 120 Hz 120 Hz to 1.2 kHz 1.2 kHz to 12 kHz 12 kHz to 120 kHz 120 kHz to 1.2 MHz 1.2 MHz to 2 MHz 2 MHz to 10 MHz	2.0 ppm + 0.0082 Hz 2.0 ppm + 0.082 Hz 2.0 ppm + 0.82 Hz 2.0 ppm + 8.2 Hz 2.0 ppm + 82 Hz 2.0 ppm + 0.82 kHz 24 ppm + 0.32 kHz	Generation using Fluke 5520A / HP 33120A
Capacitance	0.5 nF to 1.1 nF 1.1 nF to 3.3 nF 3.3 nF to 11 nF 11 nF to 33 nF 33 nF to 110 nF 0.11 μ F to 0.33 μ F 0.33 μ F to 1.1 μ F 1.1 μ F to 3.3 μ F 3.3 μ F to 11 μ F 11 μ F to 33 μ F 33 μ F to 110 μ F 0.11 mF to 0.33 mF 0.33 mF to 1.1 mF 1.1 mF to 3.3 mF 3.3 mF to 11 mF 11 mF to 33 mF 33 mF to 40 mF	1.3 pF/nF + 7.9 pF 1.3pF/nF + 7.9 pF 0.45 pF/nF + 8.0 pF 0.62 pF/nF + 78 pF 0.59 pF/nF + 0.078 nF 0.61 nF/ μ F + 0.24 nF 0.59 nF/ μ F + 0.78 nF 0.61 nF/ μ F + 2.4 nF 0.59 nF/ μ F + 7.8 nF 0.61 nF/ μ F + 24 nF 0.21 nF/ μ F + 79 nF 0.36 μ F/mF + 0.29 μ F 0.13 μ F/mF + 0.78 μ F 0.13 μ F/mF + 2.4 μ F 0.16 μ F/mF + 8.7 μ F 0.13 μ F/mF + 24 μ F 0.17 μ F/mF + 0.13 mF	Generation using Fluke 5520A
Current Measuring Device (Clamp Meter, Current Probe, Current Sensor) DC Current - 50 Turn Coil	(+/- polarities) 1.6 to 16 A 16 to 160 A 160 to 525 A 525 to 1000 A	0.12 A + 3.3 mA/A 0.21 A + 4.7 mA/A 0.36 A + 8.3 mA/A 0.31 A + 3.0 mA/A	Generation using Fluke 5520A with Current Coil

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty($\pm$)*	Remarks
Current Measuring Device (Clamp Meter, Current Probe, Current Sensor)	<u>1.6 to 16 A</u> 10 to 440 Hz <u>16 to 160 A</u> 10 to 100 Hz 100 to 440 Hz	0.27 A + 35 mA/A 0.26 A + 23 mA/A 0.23 A + 23 mA/A	Generation using Fluke 5520A with Current Coil
AC Current - 50 Turn Coil	<u>160 to 1000 A</u> 10 to 440 Hz	0.80 A + 13 mA/A	
Generating Instruments			
DC Voltage	0 to 100 mV 100 mV to 1 V 1 V to 10 V 10 V to 100 V 100 V to 1000 V	6.2 μ V + 11 μ V/V 9.1 μ V + 9.4 μ V/V 0.14 mV + 9.4 μ V/V 0.76 mV + 12 μ V/V 8.4 mV + 12 μ V/V	Measurement Keysight 3458A Digital Multimeter
AC Voltage	0 to 1000 V	See Matrix C	
DC Current (Rectifier, Power Supply Unit, Welding Machine)	0 to 100 μ A 100 μ A to 1 mA 1 mA to 10 mA 10 mA to 100 mA 100 mA to 1 A	0.0000047 mA + 0.023 mA/A 0.000036 mA + 0.025 mA/A 0.00065 mA + 0.026 mA/A 0.0040 mA + 0.043 mA/A 0.14 mA + 0.14 mA/A	
	1 A to 3 A	2.6 mA + 1.4 mA/A	Measurement Agilent 34401A Multimeter
	3 A to 30 A	0.011 mA/A + 8.8 mA	Keysight 34330A Current Shunt with Keysight 3458A Multimeter / Fluke 376 Clamp Meter
AC Current (Rectifier, Power Supply Unit)	0 to 30 A	See Matrix D	Measurement using Keysight 3458A Multimeter

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty($\pm$)*	Remarks
Resistance	0 to 10 Ω 10 Ω to 100 Ω 100 Ω to 1 k Ω 1 k Ω to 10 k Ω 10 k Ω to 100 k Ω 100 k Ω to 1 M Ω 1 M Ω to 10 M Ω 10 M Ω to 100 M Ω 100 M Ω to 1 G Ω	3.4 m Ω + 0.020 m Ω / Ω 3.3 m Ω + 0.015 m Ω / Ω 15 m Ω + 0.012 m Ω / Ω 0.25 Ω + 0.012 m Ω / Ω 24 Ω + 0.14 m Ω / Ω 500 Ω + 0.022 m Ω / Ω 13 k Ω + 0.064 m Ω / Ω 0.61 m Ω / Ω + 0.83 M Ω 9.7 M Ω /G Ω + 1.1 M Ω	Measurement Keysight 3458A Digital Multimeter
Frequency	1 Hz to 40 Hz 40 Hz to 100 Hz 100 Hz to 100 kHz 100 kHz to 10 MHz	0.024 Hz 0.012 Hz 12 Hz 1.2 kHz	

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SCOPE OF CALIBRATION: ELECTRICAL**Generating Instruments****AC Voltage:****Matrix C**

Frequency Voltage	Hz	kHz			
	0 to 40	0.04 to 1	1 to 20	20 to 50	50 to 100
0 to 10 mV	0.50 mV + 0.40 mV/V	0.40 mV + 0.28 mV/V	0.67 mV + 0.40 mV/V	0.38 mV + 1.3 mV/V	0.37 mV + 6.1 mV/V
10 mV to 100 mV	0.11 mV + 0.15 mV/V	0.092 mV + 0.13 mV/V	0.092 mV + 0.21 mV/V	0.19 mV + 0.41 mV/V	0.18 mV + 1.1 mV/V
100 mV to 1 V	0.15 mV + 0.082 mV/V	0.14 mV + 0.082 mV/V	0.14 mV + 0.17 mV/V	0.14 mV + 0.35 mV/V	0.91 mV + 0.93 mV/V
1 V to 10 V	1.4 mV + 0.084 mV/V	1.5 mV + 0.084 mV/V	1.5 mV + 0.17 mV/V	2.7 mV + 0.35 mV/V	12 mV + 0.93 mV/V
10 V to 100 V	14 mV + 0.24 mV/V	13 mV + 0.24 mV/V	28 mV + 0.24 mV/V	42 mV + 0.41 mV/V	19 mV + 0.11 mV/V
100 V to 1000 V	50 mV + 0.48 mV/V	31 mV + 0.48 mV/V			

AC Current:**Matrix D**

Frequency Current	Hz	kHz			Measuring Instrument
	0 to 50	0.05 to 1	1 to 5	5 to 30	
0 A to 1 mA	0.37 μ A + 0.70 mA/A	0.33 μ A + 0.36 mA/A	0.34 μ A + 0.37 mA/A	0.52 μ A + 4.7 mA/A	Keysight 3458A
1 mA to 10 mA	4.2 μ A + 0.70 mA/A	4.1 μ A + 0.36 mA/A	3.9 μ A + 0.37 mA/A	5.8 μ A + 4.7 mA/A	
10 mA to 100 mA	33 μ A + 0.70 mA/A	35 μ A + 0.36 mA/A	35 μ A + 0.37 mA/A	55 μ A + 4.7 mA/A	
100 mA to 1 A	0.40 mA + 0.94 mA/A	0.40 mA + 1.2 mA/A	0.34 mA + 1.2 mA/A	-	
1 A to 3 A	7.7 mA + 1.8 mA/A	7.9 mA + 1.8 mA/A	7.8 mA + 1.8 mA/A	-	Agilent 34401A
3 A to 20 A	0.16 mA/A + 11 mA	0.13 mA/A + 18 mA	0.15 mA/A + 25 mA	-	Keysight 34330A Current Shunt with Keysight 3458A
20 to 30 A	0.16 mA/A + 16 mA			-	

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SCOPE OF CALIBRATION: TIME AND FREQUENCY

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty ($\pm$)*	Remarks
Time Measuring Devices (Stopwatch and Timer)	0 to 9 hours	0.35 sec	Time measurement according to NIST Stopwatch and Timer Calibration
	(Non-contact) 0 to 599 rpm 600 to 30,000 rpm	25 ppm 3.6 ppm + 0.013 rpm	Frequency Generator with Agilent 34401A Multimeter
RPM Measuring Devices (Tachometer, Pulse meter, Stroboscope, Centrifuge, Shaker, Engine Tachometer)	0 to 500 rpm 500 to 1,000 rpm 1,000 to 10,000 rpm 10,000 to 30,000 rpm	0.0025 rpm 0.0073 rpm 0.073 rpm 0.59 rpm	Frequency Generator HP33120A / Digital Tachometer
	(Contact) 0 to 5,000 rpm	1.6 rpm	Comparison with Reference Tachometer