Issue date: 8 December 2023
Valid until: 23 November 2028

NO: SAMM 082

LABORATORY LOCATION:
(PERMANENT LABORATORY)

SENDI MAHIR SDN. BHD.
NO. 6, 8, 10 & 12, JALAN KAPAR 27/89
MEGAH INDUSTRIAL PARK
40400 SHAH ALAM, SELANGOR
MALAYSIA

FIELD OF TESTING: **MECHANICAL**

FIELDS OF CALIBRATION: **FORCE, TORQUE, DIMENSIONAL, MASS, FLOW, PRESSURE, TEMPERATURE, VOLUMETRIC, ELECTRICAL & OPTICAL AND PHOTOMETRIC MEASUREMENTS**

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).

SCOPE OF TESTING: MECHANICAL

Materials/ Products Tested	Type of Test/ Properties Measured/ Range of Measurement	Standard Test Methods/ Equipment/Techniques
Reinforcement Bar	Tensile Test (Yield strength, Ratio of tensile strength/ yield strength, Percentage of total elongation at maximum force)	Based on MS 146:2014 (Cl. 7.3.3) BS 4449:2005+A3:2016 (Clause 7.2.3) ISO 6892-1:2019

Signatories:

1. **Seah Leong Ho**
2. **Mohd Alias bin Majid**

*** 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.**

SCOPE OF CALIBRATION: FORCE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Push-Pull Gauge Tension Gauge	0 kgf to 100 kgf 0 kgf to 100 kgf	0.5 % of reading 0.5 % of reading	Calibrated using Deadweight Standard Weight with reference to ISO 376:2011
Load Measuring Device Tension	0 kgf to 500 kgf 500 kgf to 1 tonf 1 tonf to 5 tonf 5 tonf to 10 tonf 10 tonf to 30 tonf	15 gf 0.58 kgf 1.7 kgf 7 kgf 28 kgf	Calibrated using Load Cell, Proving Ring and Tension/ Compression Testing Machine with reference to ISO 376:2011
Load Measuring Device (Continue) Compression	0 kgf to 500 kgf 500 kgf to 1 tonf 1 tonf to 5 tonf 5 tonf to 10 tonf 10 tonf to 30 tonf 30 tonf to 40 tonf	15 gf 0.56 kgf 1.7 kgf 7 kgf 28 kgf 28 kgf	Calibrated using Load Cell, Proving Ring and Tension/ Compression Testing Machine with reference to ISO 376:2011
Shore Hardness Tester (spring load) 1. Type A, B, E, O 2. Type C, D, DO 3. Type OO	 0 to 100 shore hardness index 0 to 100 shore hardness index 0 to 100 shore hardness index	 0.24 shore hardness index 0.23 shore hardness index 0.23 shore hardness index	Calibrated using Durometer tester with reference to ASTM D 2240:2015

SCOPE OF CALIBRATION: FORCE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Adhesion Tester (pressure)	0 N/mm^2 to 25 N/mm^2	0.14 N/mm^2	Calibrated using Load Cell with reference to ASTM D 4541:2017

Signatory:

1. **Seah Leong Ho**

SCOPE OF CALIBRATION: FORCE

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Universal Testing Machine 1. Tensile mode (0~10,000 kgf) 2. Compress mode (0~200,000 kgf)	0 kgf to 100 kgf 100 kgf to 1,000 kgf 1,000 kgf to 5,000 kgf 5,000 kgf to 10,000 kgf 10,000 kgf to 50,000 kgf 50,000 kgf to 200,000 kgf	4 gf 0.26 kgf 1 kgf 15 kgf 60 kgf 260 kgf	Calibrated using Deadweight up to 500 kgf or Load Cell based on ISO 7500-1:2018
Hardness Tester	20 HRA to 88 HRA 30 HRB to 100 HRB 10 HRC to 70 HRC	± 0.6 HRA ± 0.6 HRB ± 0.6 HRC	Calibrated using Load Cell and Hardness Block set based on ISO 6508-2:2015 under method clause 5 indirect verification

Signatory:

1. **Seah Leong Ho**

SCOPE OF CALIBRATION: TORQUE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Torque Measuring Device	0 N.m to 10 N.m	0.49 % of reading	Calibration using a double-ended torque beam with reference to BS 7882:2017.
	2 N.m to 10 N.m Above 10 N.m to 100 N.m Above 100 N.m to 500 N.m Above 500 N.m to 1,000 N.m	0.62 % of reading 0.18 % of reading 0.38 % of reading 0.22 % of reading	Calibration using reference torque transducers with reference to BS 7882:2017.
Hand Torque Tools	0.2 N.m to < 10 N.m 10 N.m to < 100 N.m 100 N.m to < 500 N.m 500 N.m to < 1,000 N.m 1,000 N.m to 3,000 N.m	0.9 % of reading 1.0 % of reading 1.0 % of reading 0.5 % of reading 0.3 % of reading	Calibration using reference torque transducers with reference to ISO 6789-2:2017.

Signatories:

1. **Seah Leong Ho**
2. **Mohd Alias bin Majid**

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Plain Plug Gauge / Pin Gauge (Diameter)	0 mm to 10 mm 10 mm to 100 mm 100 mm to 300 mm	0.6 µm 1.0 µm 1.7 µm	Calibrated using ULM
Plain Ring Gauge (Diameter)	1.7 mm to 10 mm 10 mm to 100 mm 100 mm to 300 mm	0.4 µm 0.6 µm 1.0 µm	Calibrated using ULM
External Micrometer Up to 25 mm 50 mm frame 100 mm frame 150 mm frame 200 mm frame 300 mm frame 400 mm frame 500 mm frame 600 mm frame	 25 mm traverse 25 mm traverse 25 mm traverse 25 mm traverse 25 mm traverse 25 mm traverse 25 mm traverse 25 mm traverse	 0.5 µm 1.1 µm 1.3 µm 1.3 µm 1.5 µm 2.0 µm 2.0 µm 2.3 µm 2.5 µm	Calibrated using Gauge Blocks based on BS EN ISO 3611:2010
Caliper Checker	0 mm to 300 mm 300 mm to 600 mm	3 µm 3 µm	Calibrated using Gauge Blocks based on ISO 7863:1984
Dial / Digimatic & Vernier Caliper	0 mm to 200 mm 200 mm to 450 mm 450 mm to 1,000 mm 1,000 mm to 1,500 mm 1,500 mm to 2,000 mm	6 µm 7 µm 8 µm 17 µm 23 µm	Calibrated using Gauge Blocks based on BS EN ISO 13385-1:2019
Dial Gauge	0 mm to 50 mm	1.5 µm	Calibrated using Dial Gauge Calibrator based on BS EN ISO 463:2006
Dial Test Indicator	0 mm to 50 mm	1.5 µm	Calibrated using Dial Gauge Calibrator based on BS EN ISO 9493:2010
Dial / Digimatic & Vernier Height Gauge	0 mm to 450 mm 450 mm to 600 mm 600 mm to 1,000 mm	6 µm 8 µm 9 µm	Calibrated using Gauge Blocks based on BS EN ISO 13225:2012

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Height Setting Micrometer & Riser Block	0 mm to 600 mm	4 µm	Calibrated using Gauge Blocks based on ISO 7863:1984
Screw Plug (simple pitch diameter)	0 mm to 20 mm 20 mm to 100 mm	0.6 µm 1.1 µm	Calibrated using ULM
Screw Ring (simple pitch diameter)	0 mm to 20 mm 20 mm to 100 mm	0.5 µm 1.0 µm	Calibrated using ULM
Gauge Block Set Grade '0' and below	0 mm to 10 mm 10 mm to 25 mm 25 mm to 50 mm 50 mm to 75 mm 75 mm to 100 mm	0.10 µm 0.10 µm 0.11 µm 0.12 µm 0.13 µm	Calibrated using Gauge Blocks based on ISO 3650:1998
Steel Rulers	0 mm to 1,000 mm 1,000 mm to 3,000 mm	0.2 mm 0.3 mm	Calibrated using Standard Scale based on JIS B 7516:2005
Vee Blocks	220 mm x 160 mm x 80 mm	3 µm	Calibrated using Dial Test Indicator based on JIS B 7540:1972
Bubble Levelling Gauge	Height in respect to length 0.02 mm/m to 0.25 mm/m	6 µm/m	Calibrated using Bubble Tube Tester and Dial Test Indicator based on JIS B 7510:1993
Cylinder Gauge	0 mm to 600 mm	1.2 µm	Calibrated using ULM and Gauge Blocks based on JIS B 7515:1982
Internal Micrometer	0 mm to 25 mm 25 mm to 100 mm 100 mm to 600 mm	1.5 µm 2 µm 10 µm	Calibrated using ULM and Gauge Blocks based on BS 959:2008

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Setting Rod	0 mm to 25 mm 25 mm to 100 mm 100 mm to 600 mm	0.5 µm 0.5 µm 2.3 µm	Calibrated using ULM and Gauge Blocks
Thickness Coating Film	0 mm to 2.5 mm	0.6 µm	Calibrated using ULM and Gauge Blocks based on BS 5411
Pitch Gauge	0 mm to 12 mm	10 µm	Calibrated using Profile Projector
Radius Gauge	0 mm to 100 mm	10 µm	Calibrated using Profile Projector
Test Sieves	0 mm to 200 mm	10 µm	Calibrated using Profile Projector
Mµ Checker	0 mm to 3 mm	0.2 µm	Calibrated using Gauge Blocks based on JIS B 7536 : 1982
Feeler Gauge (Thickness)	0.01 mm to 10 mm	2 µm	Calibrated using Precision Micrometer based on BS 957:2008
Dial Gauge Calibrator	0 mm to 25 mm	0.4 µm	Calibrated using Precision Digital Linear Probe based on JIS B 7519:1994
Depth Gauge	0 mm to 25 mm 25 mm to 100 mm 100 mm to 300 mm	2.0 µm 2.0 µm 3.0 µm	Calibrated using Gauge Blocks based on BS 6468:2008
Thickness Gauge	0 mm to 10 mm 10 mm to 65 mm	1.2 µm 1.5 µm	Calibrated using Gauge Blocks based on JIS B 7519:1994

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Snap Gauge	0 mm to 100 mm 100 mm to 200 mm	0.3 µm 0.8 µm	Calibrated using ULM and Setting Ring
<u>Taper Plain Plug</u> Diameter	0 mm to 20 mm 20 mm to 100 mm 100 mm to 200 mm 200 mm to 300 mm	0.5 µm 0.6 µm 0.9 µm 1.0 µm	Calibrated using ULM and Setting Ring
Angle	1.78°	0.003°	Calibrated using ULM
<u>Taper Plain Ring</u> Diameter	0 mm to 20 mm 20 mm to 100 mm 100 mm to 300 mm	0.5 µm 1.1 µm 1.0 µm	Calibrated using ULM and Setting Ring
Angle	1.78°	0.003°	Calibrated using ULM
<u>Taper Thread Plug</u> Pitch Diameter	0 mm to 20 mm 20 mm to 100 mm	0.5 µm 1.0 µm	Calibrated using ULM
Angle	1.78°	0.002°	Calibrated using ULM
<u>Taper Thread Ring</u> Pitch Diameter	0 mm to 20 mm 20 mm to 50 mm 50 mm to 100 mm	0.5 µm 1.0 µm 1.0 µm	Calibrated using ULM and Setting Ring
Angle	1.78°	0.003°	Calibrated using ULM
Long Gauge Block	125 mm 150 mm 175 mm 200 mm 250 mm 300 mm 400 mm 500 mm	0.7 µm 0.8 µm 0.8 µm 0.9 µm 1.0 µm 1.6 µm 1.4 µm 2.5 µm	Calibrated using ULM and Gauge Blocks

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Measuring Tape 1. Steel type	Up to 1,000 mm 2,000 mm 5,000 mm 8,000 mm 10,000 mm 20,000 mm 30,000 mm 50,000 mm 100,000 mm	0.12 mm 0.18 mm 0.28 mm 0.35 mm 0.39 mm 0.56 mm 0.68 mm 0.88 mm 1.2 mm	Calibrated using scale and tape calibration unit based on JIS B 7512:2018
2. Fabric type	Up to 1,000 mm 2,000 mm 5,000 mm 8,000 mm 10,000 mm 20,000 mm 50,000 mm 100,000 mm	0.13 mm 0.18 mm 0.28 mm 0.36 mm 0.40 mm 0.56 mm 0.89 mm 1.3 mm	Calibrated using scale and tape calibration unit based on JIS B 7522:2016
Holtest	0 mm to 175 mm 175 mm to 200 mm	1 µm 2 µm	Calibrated using Master Ring Gauge based on DIN 863-4:1999 for repeatability test only
Bevel Protractor	0° to 360°	0.6°	Calibrated using inclinometer and Feeler Gauge based on BS 1685:2008

Signatories:

1. **Seah Leong Ho**
2. **Chin Inn Nkot**
3. **Kayalvili a/p Munusamy**
4. **Norita binti Md. Ali**

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Geometric measurement			
Length measurement 1) 2D & 3 D measurement 2) Single Direct Measurement	 <u>Contact</u> Up to 1000 mm <u>Contact</u> Up to 600 mm <u>Non-contact</u> Up to 100 mm	 0.0064 mm 0.003 mm 0.0056 mm	Calibrated using: Coordinate Measuring Machine Length Measuring Instrument Profile Projector
Diameter measurement 1) 2D & 3 D measurement 2) Single Direct Measurement	 <u>Contact</u> Up to 1000 mm <u>Contact</u> Up to 600 mm <u>Non-contact</u> Up to 100 mm	 0.0064 mm 0.003 mm 0.0056 mm	Calibrated using: Coordinate Measuring Machine Length Measuring Instrument Profile Projector
Angle measurement	Up to 360º	0.013º	Calibrated using Coordinate Measuring Machine, Profile Projector

SCOPE OF CALIBRATION: DIMENSIONAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Geometric measurement			
Plane Flatness.	Up to 1000 mm	0.0069 mm	Calibrated using: Coordinate Measuring Machine
		0.0057 mm	Dial Test indicator
Straightness,		0.0069 mm	Coordinate Measuring Machine
Parallelism		0.010 mm	
Squareness		0.010 mm	

Signatories:

1. **Seah Leong Ho**
2. **Norita binti Md. Ali**
3. **Kayalvili a/p Munusamy**
4. **Nurul Zuraiha binti Yessuan**

SCOPE OF CALIBRATION: DIMENSIONAL

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Measuring Projector (individual linear axis only)	0 mm to 50 mm	1.7 µm Magnification 0.1%	Calibrated using Glass Scale, Precision Ball and Reading Scale based on JIS B7184:1999
	50 mm to 100 mm	1.9 µm Magnification 0.1%	
	100 mm to 200 mm	2.5 µm Magnification 0.1%	
	200 mm to 300 mm	3.5 µm Magnification 0.1%	
Co-Ordinate Measuring Machine	0 mm to 1,000 mm	10 µm	Calibrated using Ball Bar Set, Long Gauge Block, Gauge Block Set and Thermometer with Sensor based on ANSI/ASME B89:1997
Caliper	0 mm to 1,000 mm 1,000 mm to 1,500 mm 1,500 mm to 2,000 mm	7.5 µm 17 µm 23 µm	Calibrated using Gauge Blocks based on BS EN ISO 13385-1:2011
External Micrometer			
Up to 25 mm		0.5 µm	Calibrated using Gauge Blocks based on BS EN ISO 3611-2010
50 mm frame	25 mm traverse	1.1 µm	
100 mm frame	25 mm traverse	1.3 µm	
150 mm frame	25 mm traverse	1.3 µm	
200 mm frame	25 mm traverse	1.5 µm	
300 mm frame	25 mm traverse	2.0 µm	
400 mm frame	25 mm traverse	2.0 µm	
500 mm frame	25 mm traverse	2.3 µm	
600 mm frame	25 mm traverse	2.5 µm	
Linear Height Gauge	0 mm to 1,000 mm	7.5 µm	Calibrated using Gauge Blocks based on BS EN ISO 13225:2012

SCOPE OF CALIBRATION: DIMENSIONAL

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Surface Plate Flatness	600 mm x 600 mm 800 mm x 800 mm 1m x1m	1.3 µm 1.8 µm 2.2 µm	Calibrated using Planekator, Repeat-O-Meter and Micro-Comparator based on BS 817:2008

Signatories:

1. **Seah Leong Ho**
2. **Chin Inn Nkot**

SCOPE OF CALIBRATION: DIMENSIONAL

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Measuring Microscope (Individual linear axis only)	0 mm to 200 mm	2.2 µm	Calibrated using Glass Scale based on JIS B 7153:1995

Signatory:

1. **Seah Leong Ho**

SCOPE OF CALIBRATION: MASS

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Standard Weight	1 mg 2 mg 5 mg 10 mg 20 mg 50 mg 100 mg 200 mg 500 mg 1 g 2 g 5 g 10 g 20 g 50 g 100 g 200 g 500 g 1 kg 2 kg 5 kg 10 kg 20 kg 25 kg	4 µg 4 µg 4 µg 5 µg 5 µg 5 µg 5 µg 6 µg 7 µg 8 µg 10 µg 14 µg 20 µg 30 µg 78 µg 0.15 mg 0.27 mg 0.72 mg 1.3 mg 2.8 mg 7.5 mg 26 mg 52 mg 0.28 g	Calibrated using Standard Weight Sets and Mass Comparator based on OIML R111-2:2004

Signatories:

1. **Seah Leong Ho**

SCOPE OF CALIBRATION: MASS

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Analytical Balance and Weighing Scale	0 g to 5 g 0 g to 20 g 0 g to 50 g 0 g to 100 g 0 g to 200 g 0 g to 500 g 0 kg to 1 kg 0 kg to 2 kg 0 kg to 3 kg 0 kg to 5 kg 0 kg to 10 kg 0 kg to 20 kg 0 kg to 30 kg 0 kg to 50 kg 0 kg to 100 kg 0 kg to 200 kg 0 kg to 500 kg 0 kg to 750 kg 0 kg to 1,000 kg 0 kg to 1,500 kg 0 kg to 2,000 kg	0.03 mg 0.04 mg 0.2 mg 0.2 mg 0.2 mg 0.6 mg 1.1 mg 3 mg 5 mg 6 mg 0.05 g 0.1 g 2 g 3 g 6 g 11 g 22 g 47 g 52 g 60 g 103 g	Calibrated using Standard Weight Sets based on ASTM E898:2020 The uncertainty quoted is based on adjustment made to the sensitivity of the weighing instrument immediately before calibration.
Standard Weight	1 kg 2 kg 5 kg 10 kg 20 kg 25 kg	14 mg 14 mg 16 mg 0.14 g 0.15 g 0.15 g	Mass comparison with reference to OIML R111-2:2004

Signatory:

1. **Seah Leong Ho**

SCOPE OF CALIBRATION: PRESSURE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Pressure Measuring Device			
Vacuum	0 bar to -0.95 bar	0.42 mbar	Calibrated using Multifunction Calibrator based on AS 1349:2018
Pneumatic	0 bar to 20 bar	7 mbar	
Hydraulic	1 bar to 700 bar	0.015% of reading	Calibrated using Deadweight Tester with reference to AS 1349:2018
	700 bar to 1,100 bar	0.015% of reading	

Signatories:

1. **Seah Leong Ho**
2. **Ng Meng Kok**

SCOPE OF CALIBRATION: PRESSURE

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Pressure Measuring Device	-700 mbar to 700 mbar 0 bar to 20 bar 0 psi to 11,000 psi	1.7 mbar 50 mbar 0.025% of reading	Calibrated using Pressure Calibrator with reference to AS 1349:2018

Signatory:

1. **Seah Leong Ho**

SCOPE OF CALIBRATION: FLOW

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Anemometer	0.15 m/s to 5 m/s 5 m/s to 20 m/s 20 m/s to 45 m/s	0.12 m/s 0.26 m/s 0.59 m/s	Calibrated using Anemometer Calibrator

Signatories:

1. **Seah Leong Ho**
2. **Zairul Aini binti Sarnon @ Kusenin**

SCOPE OF CALIBRATION: TEMPERATURE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Temperature Measuring Device	-20 °C to 50 °C	0.2° C	Calibrated using Temperature Recorder, PRT, Humidity Chamber and Thermohygrometer
Relative Humidity Measuring Device	20 %RH to 95 %RH	2 %RH	
Liquid-In-Glass Thermometer (Total & Partial Immersion)	-30 °C to 0 °C 0 °C to 250 °C 250 °C to 400 °C	0.03 °C 0.04 °C 0.11 °C	Calibrated using Resistance Thermometer Display & PRT, Temperature Recorder, Constant Stirred Low Temperature Liquid Bath, Constant Stirred High Temperature Liquid Bath, Metal Block Bath and Ice Point
Temperature Sensor (Thermocouple, PRT, Mechanical Thermometer & Thermistor)	-80 °C to -50 °C -50 °C to -30°C -30 °C to 0 °C 0 °C to 250 °C 250 °C to 400 °C 400 °C to 660 °C 660 °C to 800 °C 800 °C to 1,000 °C 1,000 °C to 1,200 °C	0.08 °C 0.06 °C 0.03 °C 0.04 °C 0.11 °C 0.13 °C 2.1 °C 3.1 °C 4.0 °C	Calibrated using Resistance Thermometer Display & PRT, Type R Thermocouple, Temperature Recorder, Constant Stirred Low Temperature Liquid Bath, Constant Stirred High Temperature Liquid Bath, Temperature Block Calibrator and Ice Point

SCOPE OF CALIBRATION: TEMPERATURE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Temperature Block Calibrator	-80 °C to -50 °C -50 °C to 660 °C 660 °C to 1,200 °C	0.06 °C 0.01 °C 2.7 °C	Calibrated using PRT, Thermocouple Type R and Temperature Display with reference to EA-10/13:1999
Liquid Bath	-50 °C to 300 °C	0.01 °C	
Temperature Indicating Device Resistance Type PT100	-200 °C to 850 °C	0.1 °C	Calibrated by electrical simulation using Calibrator and Ice point
Thermocouple Type			
K	-270 °C to -100 °C -100 °C to 1,370 °C	1.5 °C 0.1 °C	
J	-210 °C to 1,200 °C	0.1 °C	
T	-270 °C to -100 °C -100 °C to 400 °C	0.5 °C 0.1 °C	
E	-270 °C to -100 °C -100 °C to 1,000 °C	0.3 °C 0.1 °C	
R	0 °C to 500 °C 500 °C to 1,760 °C	0.4 °C 0.1 °C	
S	0 °C to 500 °C 500 °C to 1,760 °C	0.4 °C 0.1 °C	
N	-100 °C to 1,300 °C	0.1 °C	

SCOPE OF CALIBRATION: TEMPERATURE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Temperature Calibrator Resistance Type PT100	-200 °C to 850 °C	0.1 °C	Calibrated by electrical measurement using Multimeter and Ice Point with reference to ITS 90:1990
JPT100	-200 °C to 500 °C	0.1 °C	
Thermocouple Type K	-270 °C to -100 °C -100 °C to 1,370 °C	1.5 °C 0.1 °C	
J	-210 °C to 1,200 °C	0.1 °C	
T	-270 °C to -100 °C -100 °C to 400 °C	0.5 °C 0.1 °C	
E	-270 °C to -100 °C -100 °C to 1,000 °C	0.3 °C 0.1 °C	
N	-270 °C to -100 °C -100 °C to 1,300 °C	1.5 °C 0.1 °C	
B	600 °C to 1,820 °C	0.3 °C	
R	0 °C to 500 °C 500 °C to 1,760 °C	0.4 °C 0.2 °C	
S	0 °C to 500 °C 500 °C to 1,760 °C	0.4 °C 0.2 °C	
Radiation Thermometer	-20 °C to 150 °C 150 °C to 200 °C 200 °C to 400 °C 400 °C to 600 °C 600 °C to 800 °C 800 °C to 1,000 °C 1,000 °C to 1,200 °C	0.45 °C 0.86 °C 1.4 °C 1.9 °C 2.7 °C 3.4 °C 4.7 °C	Calibrated using Temperature Recorder, Thermocouple, Single Blackbody Calibrator and Cyclops Spherical Blackbody Source with reference to ASTM E 1256:2017

Signatories:

1. **Seah Leong Ho**
2. **Mohamad Azlan bin Mohamed Aris**

SCOPE OF CALIBRATION: TEMPERATURE

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Temperature Sensor (Thermocouple, PRT, Mechanical Thermometer & Thermistor)	-30 °C to 30 °C 30 °C to 650 °C	0.051 °C 0.17 °C	Calibrated using Resistance Thermometer Display & PRT, Temperature Recorder, Constant Stirred Temperature Liquid Bath, Constant Stirred High Temperature Liquid Bath, Temperature Block Calibrator and Ice Point
Temperature Controlled Enclosure	-80 °C to -20 °C -20 °C to 250 °C 250 °C to 800 °C 800 °C to 1,000 °C 1,000 °C to 1,200 °C	0.6 °C 1 °C 2 °C 3 °C 5 °C	Calibrated using Temperature Recorder, PRT and Thermocouple with reference to AS 2853:1986
Liquid Bath	-30 °C to 300 °C	0.1 °C	Calibrated using Temperature Recorder, PRT, Thermocouple and Barometer with reference to AS 2853:1986
Humidity Controlled Enclosure	30 %RH to 98 %RH	5 %RH	

SCOPE OF CALIBRATION: TEMPERATURE

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Temperature Indicating Device Resistance Type PT100 JPT100	 -200 °C to 650 °C -200 °C to 500 °C	 0.1 °C 0.1 °C	Calibrated by electrical simulation using Calibrator and Ice Point
Thermocouple Type K J T E R S N	 -270 °C to -100 °C -100 °C to 1,370 °C -210 °C to 1,200 °C -270 °C to 400 °C -270 °C to 1,000 °C 0 °C to 1,760 °C 0 °C to 1,760 °C -100 °C to 1,300 °C	 1.5 °C 1 °C 1 °C 1 °C 1 °C 1 °C 1 °C 1 °C	

Signatories:

1. **Seah Leong Ho**
2. **Mohd Safiee bin Ngadirin**

SCOPE OF CALIBRATION: VOLUMETRIC

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Burette	1 ml to 10 ml 10 ml to 25 ml 25 ml to 50 ml 50 ml to 100 ml	6 µl 20 µl 30 µl 70 µl	Calibrated using Analytical Balance and Distilled Water based on ISO 385:2005(E)
Measuring Cylinder	5 ml 5 ml to 10 ml 10 ml to 25 ml 25 ml to 100 ml 100 ml to 250 ml 250 ml 500 ml 500 ml to 1,000 ml 1,000 ml to 2,000 ml	40 µl 70 µl 0.2 ml 0.4 ml 0.7 ml 1.6 ml 3 ml 5 ml	Calibrated using Analytical Balance and Distilled Water based on ISO 4788:2005(E)
One Mark Volumetric Flask	5 ml to 10 ml 10 ml to 25 ml 25 ml to 100 ml 100 ml to 500 ml 500 ml 2,000 ml	20 µl 30 µl 60 µl 0.2 ml 0.3 ml	Calibrated using analytical Balance and Distilled Water based on ISO 1042:1998
Pipette	Type 1, Type 2, Type 3 0.5 ml to 1 ml 1 ml to 2 ml 2 ml to 5 ml 5 ml to 10 ml 10 ml to 25 ml	 4 µl 7 µl 15 µl 29 µl 57 µl	Calibrated using Analytical Balance and Distilled Water based on ISO 835:2007(E)
	25 ml to 100 ml	7 µl	Calibrated using Analytical Balance and Distilled Water based on ISO 4787:2010
Piston Operated Volumetric Apparatus (POVA)	10 µl to 200 µl 200 µl to 500 µl 500 µl to 1,000 µl 1 ml to 2 ml 2 ml to 5 ml 5 ml to 10 ml	0.10 µl 0.12 µl 0.15 µl 0.25 µl 0.57 µl 1.20 µl	Calibrated using Analytical Balance and Distilled Water based on ISO 8655-6:2002 and ISO 8655-2:2002

SCOPE OF CALIBRATION: VOLUMETRIC

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Viscosity Flow Cup i. Ford Cup	Cup no. 1 (10 cSt to 35 cSt) Cup no. 2 (25 cSt to 120 cSt) Cup no. 3 (49 cSt to 220 cSt) Cup no. 4 (70 cSt to 370 cSt) Cup no. 5 (200 cSt to 1,200 cSt)	0.07 cSt 0.2 cSt 0.5 cSt 0.6 cSt 2 cSt	Calibrated using Standard Solution and Stop Watch based on ASTM D 1200:2010 (reapproved 2018)
ii. Zahn Cup	Cup no.1 (5 cSt to 60 cSt) Cup no. 2 (20 cSt to 250 cSt) Cup no. 3 (100 cSt to 800 cSt) Cup no. 4 (200 cSt to 1,200 cSt) Cup no. 5 (400 cSt to 1,800 cSt)	0.1 cSt 0.5 cSt 1.5 cSt 2 cSt 3 cSt	Calibrated using Standard Solution and Stop Watch based on ASTM D 4212:2016
Hydrometer	0.600 g/ml to 1.500 g/ml	0.7 mg/ml	Compare using Hydrometer based on BS 718:1991

Signatories:

1. **Seah Leong Ho**
2. **Kayalvili a/p Munusamy**
3. **Komakal a/p Chinnasamy**

SCOPE OF CALIBRATION: TIME & FREQUENCY

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Tachometer (Non-Contact)	0 rpm to 1,000 rpm	1.1 rpm	Calibrated using Tachometer Calibrator and Tachometer based on ASTM F2046:2011
	1,000 rpm to 10,000 rpm	2.3 rpm	
	10,000 rpm to 20,000 rpm	4.2 rpm	
Tachometer (Contact)	0 rpm to 1,000 rpm	1.1 rpm	
	1,000 rpm to 10,000 rpm	2.3 rpm	

Signatory:

1. **Seah Leong Ho**

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Stopwatch & Timer	10 s to 60 s 60 s to 300 s 300 s to 600 s 600 s to 900 s 900 s to 1800 s 0.5 h to 1 h 1 h to 3 h	50 ms 60 ms 60 ms 60 ms 60 ms 90 ms 0.10 s	Pendulum 6689, HP 8662 & HP 53132A

Signatories:

1. **Seah Leong Ho**
2. **Chin Inn Nkot**
3. **Shah Zulkifli Nor Bin Arshad**
4. **Husna Binti Abdul Rahim**

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Basic DC-LF Measuring Equipment (Multimeter, Clamp Meter, Data Acquisition, etc)			
DC Voltage	0 to 220 mV 220 mV to 2.2 V 2.2 V to 11 V 11 V to 22 V 22 V to 220 V 220 V to 1000 V	8.5 µV/V + 0.46 µV 5.6 µV/V + 0.91 µV 3.7 µV/V + 5.9 µV 3.9 µV/V + 6.3 µV 5.6 µV/V + 59 µV 7.2 µV/V + 0.64 mV	Generating using a Multifunction / Multiproduct Calibrator
DC Current	-300 µA to -220 µA -220 µA to 220 µA -2.2 mA to 2.2 mA -22 mA to 22 mA -220 mA to 220 mA -2.2 A to 2.2 A -20 A to -10 A -10 A to -3 A 3 A to 10 A 10 A to 20 A 20 A to 30 A	0.14 m/A/A 70 µA/A 39 µA/A 37 µA/A 49 µA/A 86 µA/A 0.55 mA/A 0.55 mA/A 0.55 mA/A 0.55 mA/A 2.0 mA/A	
AC Voltage	0 V to 1100 V	See Matrix A	
AC Current	0 A to 50 A	See Matrix B	
DC Current Clamp	10 A to 16.5 A 16.5 A to 150 A 150 A to 1000 A	2.8 mA/A + 3.6 mA 2.9 mA/A + 19 mA 3.2 mA/A + 17 mA	Generating using a combination of Multiproduct Calibrator & Current Coil
AC Current Clamp	<u>45 Hz to 65 Hz</u> 10 A to 16.5 A 16.5 A to 150 A 150 A to 1000 A <u>65 Hz to 440 Hz</u> 10 A to 16.5 A 16.5 A to 150 A	 3.3 mA/A + 5.0 mA 3.5 mA/A + 32 mA 3.5 mA/A + 0.12 A 9.3 mA/A + 5.2 mA 9.8 mA/A + 25 mA	
Frequency	0.5 Hz to 10 MHz	25 µHz/Hz	Generating using a Multiproduct Calibrator

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Basic DC-LF Measuring Equipment (Multimeter, Clamp Meter, Data Acquisition, etc)			
Resistance • Fixed Resistance	0 Ω 1 mΩ 10 mΩ 1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ 1.9 Ω 19 Ω 190 Ω 1.9 kΩ 19 kΩ 190 kΩ 1.9 MΩ 19 MΩ	10 µΩ 0.20 µΩ 1.0 µΩ 95 µΩ 0.23 mΩ 1.0 mΩ 8.5 mΩ 85 mΩ 1.1 Ω 20 Ω 0.40 kΩ 10 kΩ 0.18 mΩ 0.44 mΩ 1.9 mΩ 16 mΩ 0.16 Ω 2.1 Ω 40 Ω 0.95 kΩ	Generating using a Multifunction / Multiproduct Calibrator
• Variable Resistance	0 Ω to 40 Ω 40 Ω to 400 Ω 400 Ω to 4 kΩ 4 kΩ to 40 kΩ 40 kΩ to 400 kΩ 400 kΩ to 4 MΩ 4 MΩ to 40 MΩ 40 MΩ to 400 MΩ	0.25 mΩ/Ω 0.25 mΩ/Ω 0.15 mΩ/Ω 0.20 mΩ/Ω 0.20 mΩ/Ω 0.50 mΩ/Ω 1.5 mΩ/Ω 2.6 mΩ/Ω	
Capacitance (Variable)	0.5 nf to 4 nF 4 nF to 40 nF 40 nF to 400 nF 400 nF to 4 µF 4 µF to 40 µF 40 µF to 400 µF 400 µF to 4 mF 4 mF to 40 mF	3.4 mF/F 3.0 mF/F 3.0 mF/F 4.0 mF/F 5.0 mF/F 5.0 mF/F 5.0 mF/F 10 mF/F	

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Basic DC-LF Generating Equipment (Calibrator, Power Supply, etc)			
DC Voltage	0 to 200 mV 200 mV to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V	5.6 µV/V + 0.12 µV 3.9 µV/V + 0.58 µV 3.9 µV/V + 5.6 µV 6.3 µV/V + 50 µV 6.1 µV/V + 0.68 mV	Measuring using a Precision Multimeter
DC Current	0 to 200 µA 200 µA to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2A	13 µA/A + 0.64 nA 13 µA/A + 6.4 nA 15 µA/A + 63 nA 54 µA/A + 0.98 µA 0.21 mA/A + 18 µA	
AC Voltage	0 to 1000 V	See Matrix C	
AC Current	0 to 2 A	See Matrix D	
Resistance	0 Ω to 2 Ω 2 Ω to 20 Ω 20 Ω to 200 Ω 200 Ω to 2 kΩ 2 kΩ to 20 kΩ 20 kΩ to 200 kΩ 200 kΩ to 2 MΩ 2 MΩ to 20 MΩ 20 MΩ to 100 MΩ	7.3 µΩ/Ω + 25 µΩ 9.4 µΩ/Ω + 45 µΩ 9.0 µΩ/Ω + 62 µΩ 9.1 µΩ/Ω + 0.58 mΩ 9.1 µΩ/Ω + 5.8 mΩ 9.1 µΩ/Ω + 58 mΩ 10 µΩ/Ω + 1.1 Ω 23 µΩ/Ω + 0.11 kΩ 0.14 mΩ/Ω + 11 kΩ	Measuring using a Precision Multimeter
Capacitance (at 1kHz)	1 nF to 10 nF 10 nF to 100 nF 100 nF to 1 µF	0.50 mF/F 0.50 mF/F 0.50 mF/F	Measuring using a Precision LCR Meter
Inductance (at 1kHz)	100 µH to 1 mH 1 mH to 10 mH 10 mH to 100 mH	3.0 mH/H 3.0 mH/H 3.0 mH/H	

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Specific DC-LF Equipment			
Earth Resistance	0.1 Ω to 1 kΩ 1 kΩ to 100 kΩ	0.10 mΩ/Ω 1.0 mΩ/Ω	Generating using a Decade Resistance Box
Insulation Resistance (up to 5kV)	100 kΩ to 10 MΩ 10 MΩ to 100 MΩ 100 MΩ to 1 GΩ 1 GΩ to 10 GΩ 10 GΩ to 100 GΩ 100 GΩ to 1 TΩ	2.0 mΩ/Ω 2.0 mΩ/Ω 1.0 mΩ/Ω 2.0 mΩ/Ω 5.0 mΩ/Ω 5.0 mΩ/Ω	Generating using a combination of High Voltage & Decade Resistance Box
Milli-Micro Ohmmeter (at 10A)	50 mΩ 100 mΩ 150 mΩ 200 mΩ	79 µΩ 80 µΩ 81 µΩ 83 µΩ	Generating using a Micro-Ohmmeter Calibrator
(at 30A)	5 mΩ 10 mΩ 15 mΩ 20 mΩ	11 µΩ 8.6 µΩ 11 µΩ 8.2 µΩ	
(at 100A)	0.5 mΩ 1.0 mΩ 1.5 mΩ 2.0 mΩ	1.4 µΩ 1.0 µΩ 1.7 µΩ 2.4 µΩ	
(at 200A)	50 µΩ 100 µΩ 150 µΩ 200 µΩ	0.79 µΩ 0.45 µΩ 0.20 µΩ 1.1 µΩ	

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Specific DC-LF Equipment			
LCR Meter (at 1kHz)			
• Inductance	100 µH to 1 mH 1 mH to 10 mH 10 mH to 100 mH 100 mH to 1 H 1 H to 10 H	20 mH/H 20 mH/H 20 mH/H 8.0 mH/H 8.0 mH/H	Generating using a combination of Decade-Standard Inductance
• Capacitance	1 pF to 10 pF 10 pF to 100 pF 100 pF to 1 nF 1 nF to 10 nF 10 nF to 100 nF 100 nF to 1 µF 1 µF to 10 µF 10 µF to 100 µF 100 µF to 1 mF	0.50 mF/F 0.50 mF/F 0.50 mF/F 0.50 mF/F 0.50 mF/F 0.50 mF/F 0.20 mF/F 0.40 mF/F 4.0 mF/F	Generating using a combination of Decade-Standard Capacitance
• Resistance	1 Ω to 10 Ω 10 Ω to 100 Ω 100 Ω to 1 kΩ 1 kΩ to 10 kΩ 10 kΩ to 100 kΩ 100 kΩ to 1 MΩ	0.10 mΩ/Ω 0.10 mΩ/Ω 0.10 mΩ/Ω 0.50 mΩ/Ω 0.50 mΩ/Ω 0.50 mΩ/Ω	Generating using a combination of Decade-Standard Resistance
High Voltage Meter/Probe			
• DC Voltage	1 kV to 10 kV 10 kV to 30 kV	0.51 mV/V + 0.67 V 0.55 mV/V + 0.73 V	Generating using a combination of High Voltage Generator, High Voltage Divider & Precision Multimeter
• AC Voltage (at 50/60 Hz)	1 kV to 10 kV 10 kV to 20 kV	4.6 mV/V + 1.5 V 4.2 mV/V + 20 V	

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Specific DC-LF Equipment			
High Voltage Source/Tester • DC Voltage	0.5 kV to 10 kV 10 kV to 25 kV 25 kV to 100 kV	5.0 mV/V 2.4 mV/V 1.5 mV/V	Measuring using a combination of High Voltage Meter, High Voltage Divider & Precision Multimeter
• AC Voltage (at 50/60 Hz)	0.5 kV to 10 kV 10 kV to 25 kV 25 kV to 50 kV	10 mV/V 16 mV/V 16 mV/V	
High Current Source/Tester • DC Current	-20 A to 20 A -100 A to 100 A	0.20 mA/A 0.50 mA/A	Measuring using a combination of Precision Multimeter & Current Shunt
• AC Current	50 Hz to 1 kHz 2 A to 20 A 20 A to 100 A	1.0 mA/A 1.0 mA/A	
	1 kHz to 10 kHz 2 A to 20 A 20 A to 100 A	5.0 mA/A 5.0 mA/A	
Power Source (Welding - Std Grade) • DC Current	0 A to 40 A 40 A to 500 A	18 mA/A + 69 mA 17 mA/A + 0.57 A	Measuring using a combination of Load Banks & Clamp Meter
• AC Current (at 50/60 Hz)	0 A to 40 A 40 A to 500 A	19 mA/A + 69 mA 17 mA/A + 0.58 A	

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Specific DC-LF Equipment			
Oscilloscope			
i) Vertical Deflection			
a) DC Voltage Impedance 1MΩ	± (888 µV to 222.4 V)	0.25 mV/V	Generating using an Oscilloscope Calibrator
b) Square Voltage Impedance 1MΩ	35.52 µVpp to 999.9 µVpp 1 mVpp to 21 mVpp 21.001mVpp to 556mVpp 556.01 mVpp to 210Vpp	10 mVpp/Vpp 1.0 mVpp/Vpp 1.0 mVpp/Vpp 0.50 mVpp/Vpp	
Impedance 50Ω	35.52 µVpp to 999.9 µVpp 1 mVpp to 21 mVpp 21.001mVpp to 556mVpp 556.01 mVpp to 5.56Vpp	10 mVpp/Vpp 1.0 mVpp/Vpp 1.0 mVpp/Vpp 0.50 mVpp/Vpp	
ii) Horizontal Deflection			
a) Low Edge Impedance 50Ω/1MΩ	4.44 mVpp to 3.31 Vpp (Rise&Fall Time : 500ps)	30 mVpp/Vpp	
b) High Edge Impedance 50Ω	888 mVpp to 5.56 Vpp (Rise&Fall Time : 100ns)	30 mVpp/Vpp	
Impedance 1MΩ	888 mVpp to 100 Vpp (Rise&Fall Time : 150ns)	30 mVpp/Vpp	
c) Fast Edge Impedance 50Ω	100 Vpp to 210 Vpp (Rise&Fall Time : 200ns)	30 mVpp/Vpp	
	4.44 mVpp to 3.1 Vpp (Rise&Fall Time : 150ps)	30 mVpp/Vpp	
d) Time Markers Sine (50Ω/1MΩ)	450.5 ps to 909.09 ps 909.1 ps to 9.009 ns	0.25 µs/s 0.25 µs/s	
Square (50Ω/1MΩ)	9.0091 ns to 55 s	0.25 µs/s	

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Specific DC-LF Equipment			
Oscilloscope			
ii) Horizontal Deflection			
a) Sine Voltage Impedance 50Ω/1MΩ	4.44 mVpp to 5.56 Vpp 50 Hz to 10 MHz	15 mVpp/Vpp	Generating using an Oscilloscope Calibrator
	10 MHz to 100 MHz	15 mVpp/Vpp	
	100 MHz to 550 MHz	30 mVpp/Vpp	
	4.44 mVpp to 3.336 Vpp 550 MHz to 1.1 GHz	40 mVpp/Vpp	
iii) Auxiliary a) DC Current	± (88.8 µA to 111.2 mA)	2.5 mA/A	
b) Square Current	88.8 µApp to 111.2 mApp	2.5 mApp/App	
c) Resistance	50 kΩ to 12 MΩ	5.0 mΩ/Ω	
	800 kΩ to 1.2 MΩ	1.0 mΩ/Ω	
d) Capacitance	1 pF to 35 pF	20 mF/F	
	35 pF to 95 pF	30 mF/F	

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Specific RF Equipment			
Wideband AC Voltage Meter	1 kHz 1.1 mV (-46 dBm) 3.0 mV (-37 dBm) 11 mV (-26 dBm) 33 mV (-17 dBm) 110 mV (-6.2 dBm) 330 mV (-3.4 dBm) 1.1 V (14 dBm) 3.5 V (24 dBm)	 8.0 mV/V 7.0 mV/V 7.0 mV/V 6.0 mV/V 6.0 mV/V 5.0 mV/V 5.0 mV/V 4.0 mV/V	Generating using a Multifunction Calibrator
RF Power Meter	3 µW to 100 mW (-25 dBm to 20 dBm)	3.0 mW/W	HP 11683A, HP 432A, HP 478A, HP 34401A
Frequency Meter	0.5 Hz to 10 MHz	25 µHz /Hz	Generating using a Multiproduct Calibrator
Frequency Tester/Source	0.1 Hz to 3 GHz	0.2 µHz/Hz	Measuring using a Precision Frequency/ Universal Counter
Time Base	0.33 ns to 10 s	0.20 µs/s	

Signatories:

1. **Seah Leong Ho**
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3. **Shah Zulkifli Nor Bin Arshad**
4. **Husna Binti Abdul Rahim**

SCOPE OF CALIBRATION: ELECTRICAL

MATRIX A TABLE (AC Voltage Measuring Instruments)

i) Generated by using a Multifunction Calibrator

Voltage Range	Frequency								
	15 Hz to 50 Hz	20 Hz to 40 Hz	40 Hz to 20 kHz	50 Hz to 1 kHz	20 kHz to 50 kHz	50 kHz to 100 kHz	100 kHz to 300 kHz	300 kHz to 500 kHz	500 kHz to 1 MHz
0 mV to 2.2 mV	-	-	0.20 mV/V	-	0.50 mV/V	-	-	-	-
2.2 mV to 22 mV	-	0.28 mV/V	0.28 mV/V	-	0.40 mV/V	0.75 mV/V	1.5 mV/V	2.3 mV/V	3.6 mV/V
22 mV to 220 mV	-	0.12 mV/V	0.11 mV/V	-	0.23 mV/V	0.54 mV/V	0.99 mV/V	1.5 mV/V	2.9 mV/V
220 mV to 2.2 V	-	0.10 mV/V	50 µV/V	-	80 µV/V	0.12 mV/V	0.46 mV/V	1.1 mV/V	1.8 mV/V
2.2 V to 22 V	-	97 µV/V	48 µV/V	-	80 µV/V	0.11 mV/V	0.30 mV/V	1.1 mV/V	1.7 mV/V
22 V to 220 V	-	90 µV/V	52 µV/V	-	80 µV/V	0.15 mV/V	0.90 mV/V	-	-
220 V to 1100 V	0.30 mV/V	-	-	70 µV/V	-	-	-	-	-

ii) Generated by using a Multiproduct Calibrator

Voltage Range	Frequency								
	1 kHz to 3 kHz	3 kHz to 10 kHz	10 kHz to 20 kHz	-	-	-	-	-	-
220 V to 1100 V	0.80 mV/V	0.80 mV/V	1.2 mV/V	-	-	-	-	-	-

SCOPE OF CALIBRATION: ELECTRICAL

MATRIX B TABLE (AC Current Measuring Instruments)

i) Generated by using a Multifunction Calibrator

Current Range	Frequency			
	20 Hz to 1 kHz	**40 Hz to 1 kHz**	**1 kHz to 5 kHz**	**5 kHz to 10 kHz**
30 µA to 220 µA	-	0.16 mA/A	0.34 mA/A	1.4 mA/A
220 µA to 2.2 mA	-	0.14 mA/A	0.25 mA/A	1.4 mA/A
2.2 mA to 22 mA	-	0.13 mA/A	0.21 mA/A	1.2 mA/A
22 mA to 2.2 A	0.28 mA/A	-	0.49 mA/A	7.1 mA/A

ii) Generated by using a Multiproduct Calibrator

Current Range	Frequency			
	10 Hz to 3 kHz	**3 kHz to 10 kHz**	**10 kHz to 30 kHz**	-
0 µA to 30 µA	0.70 mA/A	1.0 mA/A	2.0 mA/A	-
3 A to 10 A	2.0 mA/A	5.0 mA/A	-	-
10 A to 20 A	2.0 mA/A	5.0 mA/A	-	-

iii) Generated by using a Multiproduct Calibrator

Current Range	Frequency			
	50 Hz to 60 Hz	**60 Hz to 400 Hz**	**-**	**-**
20 A to 50 A	0.15 mA/A	0.15 mA/A	-	-

SCOPE OF CALIBRATION: ELECTRICAL

MATRIX C TABLE (AC Voltage Generating Instruments)

i) Measured by using an AC Measurement Standard			
Voltage Range	**Frequency**		
	45 Hz to 20 kHz	**20 kHz to 50 kHz**	**50 kHz to 100 kHz**
7 mV to 22 mV	0.12 mV/V + 1.6 µV	0.24 mV/V + 2.3 µV	0.35 mV/V + 2.9 µV
22 mV to 70 mV	78 µV/V + 1.8 µV	0.15 mV/V + 2.3 µV	0.29 mV/V + 2.9 µV
70 mV to 220 mV	49 µV/V + 1.7 µV	83 µV/V + 2.3 µV	0.18 mV/V + 2.8 µV
220 mV to 700 mV	44 µV/V + 1.7 µV	64 µV/V + 2.2 µV	96 µV/V + 2.8 µV
700 mV to 2.2 V	32 µV/V	59 µV/V	86 µV/V
2.2 V to 7 V	34 µV/V	61 µV/V	0.1 mV/V
7 V to 22 V	35 µV/V	60 µV/V	96 µV/V
22 V to 70 V	45 µV/V	72 µV/V	0.12 mV/V
70 V to 220 V	43 µV/V	87 µV/V	0.12 mV/V
220 V to 700 V	54 µV/V	-	-
700 V to 1000 V	49 µV/V	-	-

MATRIX D TABLE (AC Current Generating Instruments)

i) Measured by using a Precision Multimeter			
Current Range	**Frequency**		
	40 Hz to 2 kHz	**45 Hz to 10 kHz**	**2 kHz to 10 kHz**
0 to 200 µA	-	0.56 mA/A + 23 nA	-
200 µA to 2 mA	-	0.34 mA/A + 0.23 µA	-
2 mA to 20 mA	-	0.34 mA/A + 2.3 µA	-
20 mA to 200 mA	-	0.33 mA/A + 23 µA	-
200 mA to 2 A	0.70 mA/A + 0.23 mA	-	0.83 mA/A + 0.23 mA

SCOPE OF CALIBRATION: ELECTRICAL

SITE : CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Basic DC-LF Measuring Equipment (Multimeter, Clamp Meter, Data Acquisition, etc)			
DC Voltage	± (0 to 300 mV) ± (300 mV to 3 V) ± (3 V to 30 V) ± (30 V to 300 V) ± (300 V to 1000 V)	0.10 mV/V 0.10 mV/V 0.10 mV/V 0.10 mV/V 0.10 mV/V	Generating using a Multifunction / Multiproduct Calibrator
DC Current	± (0 to 300 µA) ± (300 µA to 3 mA) ± (3 mA to 30 mA) ± (30 mA to 300 mA) ± (300 mA to 3 A) ± (3 A to 10 A) ± (10 A to 20 A)	0.20 mA/A 0.20 mA/A 0.20 mA/A 0.20 mA/A 0.60 mA/A 0.60 mA/A 0.60 mA/A	
AC Voltage	0 V to 1000 V	See Matrix E	
AC Current	0 A to 20 A	See Matrix F	
DC Current Clamp • 10-Coil	3.2 A to 32 A 32 A to 105 A 105 A to 200 A	3.0 mA/A 3.0 mA/A 3.0 mA/A	Generating using a combination of Multiproduct Calibrator & Current Coil
• 50-Coil	16 A to 160 A 160 A to 525 A 525 A to 1000 A	3.0 mA/A 3.0 mA/A 3.0 mA/A	
AC Current Clamp • 10-Coil	3 A to 30 A 10 Hz to 100 Hz 100 Hz to 440 Hz	5.0 mA/A 10 mA/A	
	30 A to 200 A 10 Hz to 100 Hz 100 Hz to 440 Hz	5.0 mA/A 10 mA/A	
• 50-Coil	16 A to 160 A 10 Hz to 100 Hz	5.0 mA/A	
	160 A to 1000 A 10 Hz to 100 Hz	5.0 mA/A	

SCOPE OF CALIBRATION: ELECTRICAL

SITE : CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Basic DC-LF Measuring Equipment (Multimeter, Clamp Meter, Data Acquisition, etc)			
Resistance (Variable)	0.1 Ω to 40 Ω 40 Ω to 400 Ω 400 Ω to 4 kΩ 4 kΩ to 40 kΩ 40 kΩ to 400 kΩ 400 kΩ to 4 MΩ 4 MΩ to 40 MΩ 40 MΩ to 400 MΩ	1.0 mΩ/Ω 0.40 mΩ/Ω 0.40 mΩ/Ω 0.30 mΩ/Ω 0.30 mΩ/Ω 0.50 mΩ/Ω 2.0 mΩ/Ω 3.0 mΩ/Ω	Generating using a Multifunction / Multiproduct Calibrator
Capacitance (Variable)	0.5 nf to 4 nF 4 nF to 40 nF 40 nF to 400 nF 400 nF to 4 µF 4 µF to 40 µF 40 µF to 400 µF 400 µF to 4 mF 4 mF to 40 mF	3.0 mF/F 3.0 mF/F 3.0 mF/F 4.0 mF/F 10 mF/F 10 mF/F 10 mF/F 10 mF/F	
Frequency	0.5 Hz to 10 MHz	25 µHz /Hz	
Basic DC-LF Generating Equipment (Calibrator, Power Supply, etc)			
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)	0.10 mV/V 0.10 mV/V 0.10 mV/V 0.10 mV/V 0.10 mV/V	Measuring using a Precision Multimeter
DC Current	± (0 mA to 10 mA) ± (10 mA to 100 mA) ± (100 mA to 1 A) ± (1 A to 3 A)	1.0 mA/A 1.0 mA/A 2.0 mA/A 2.0 mA/A	

SCOPE OF CALIBRATION: ELECTRICAL

SITE : CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Specific DC-LF Equipment			
Insulation Resistance (up to 5kV)	10 MΩ to 100 MΩ 100 MΩ to 1 GΩ 1 GΩ to 10 GΩ 10 GΩ to 100 GΩ 100 GΩ to 1 TΩ	5.0 mΩ/Ω 5.0 mΩ/Ω 5.0 mΩ/Ω 10 mΩ/Ω 10 mΩ/Ω	Generating using a combination of High Voltage & Decade Resistance Box
LCR Meter (at 1kHz) • Inductance	100 µH to 1 mH 1 mH to 10 mH 10 mH to 100 mH 100 mH to 1 H 1 H to 10 H	30 mH/H 30 mH/H 30 mH/H 10 mH/H 10 mH/H	Generating using a combination of Decade-Standard Inductance
• Capacitance	1 pF to 10 pF 10 pF to 100 pF 100 pF to 1 nF 1 nF to 10 nF 10 nF to 100 nF 100 nF to 1 µF 1 µF to 10 µF 10 µF to 100 µF 100 µF to 1 mF	1.0 mF/F 1.0 mF/F 1.0 mF/F 1.0 mF/F 1.0 mF/F 1.0 mF/F 1.0 mF/F 1.0 mF/F 10 mF/F	Generating using a combination of Decade-Standard Capacitance
• Resistance	1 Ω to 10 Ω 10 Ω to 100 Ω 100 Ω to 1 kΩ 1 kΩ to 10 kΩ 10 kΩ to 100 kΩ 100 kΩ to 1 MΩ	1.0 mΩ/Ω 1.0 mΩ/Ω 1.0 mΩ/Ω 1.0 mΩ/Ω 1.0 mΩ/Ω 1.0 mΩ/Ω	Generating using a combination of Decade-Standard Resistance
High Voltage Source/Tester • DC Voltage	0.2 kV to 5 kV 5 kV to 10 kV	10 mV/V 10 mV/V	Measuring using a combination of High Voltage Meter, High Voltage Divider & Precision Multimeter
• AC Voltage (at 50/60 Hz)	0.5 kV to 10 kV	15 mV/V	

SCOPE OF CALIBRATION: ELECTRICAL

SITE : CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Specific DC-LF Equipment			
Power Source (Welding - Std Grade) • DC Current	0 A to 40 A 40 A to 500 A	18 mA/A + 69 mA 17 mA/A + 0.57 A	Measuring using a combination of Load Banks & Clamp Meter
• AC Current (at 50/60 Hz)	0 A to 40 A 40 A to 500 A	19 mA/A + 69 mA 17 mA/A + 0.58 A	
Oscilloscope i) Vertical Deflection a) Square Wave 50 Ω 1 MΩ b) DC Level 50 Ω 1 MΩ ii) Horizontal Deflection a. Time Markers 50 Ω b. Edge Response (Rise/Fall Time) 50 Ω load 1 MΩ	 4.44 mV_{pp} to 3.34 V_{pp} 4.44 mV_{pp} to 133.44 V_{pp} ±(4.44 mV to 2.78 V) ±(4.44 mV to 133.44 V) 4 ns/div to 5.5 s/div < 1 ns < 100 ns	 3.0 mV/V_{pp} 3.0 $mV/_{Vpp}$ 3.0 mV/V 3.0 mV/V 25 µs/s 25 µs/s 25 µs/s	Generating using an Oscilloscope Calibrator

SCOPE OF CALIBRATION: ELECTRICAL

SITE : CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Specific DC-LF Equipment			
Oscilloscope c. Bandwidth 50 Ω 1 MΩ	 50 kHz to 100 MHz 100 MHz to 250 MHz 10 Hz to 49.999 kHz	 2.0 mHz/Hz 4.0 mHz/Hz 3.0 mHz/Hz	 Generating using an Oscilloscope Calibrator

Signatories:

1. **Seah Leong Ho**
2. **Chin Inn Nkot**
3. **Shah Zulkifli Nor Bin Arshad**
4. **Husna Binti Abdul Rahim**

SCOPE OF CALIBRATION: ELECTRICAL

SITE : CATEGORY I

MATRIX E TABLE (AC Voltage Measuring Instruments)

Generated by using a Multiproduct Calibrator						
Voltage Range	**Frequency**					
	10 Hz to 3 kHz	**3 kHz to 10 kHz**	**10 kHz to 30 kHz**	**30 kHz to 50 kHz**	**50 kHz to 100 kHz**	**-**
0 mV to 10 mV	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	5.0 mV/V	-
10 mV to 30 mV	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	5.0 mV/V	-
30 mV to 300 mV	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	5.0 mV/V	-
300 mV to 1.5 V	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	2.0 mV/V	-
1.5 V to 3 V	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	2.0 mV/V	-
3 V to 30 V	1.0 mV/V	1.0 mV/V	1.0 mV/V	2.0 mV/V	4.0 mV/V	-
30 V to 100 V	1.0 mV/V	1.0 mV/V	1.0 mV/V	2.0 mV/V	4.0 mV/V	-
Voltage Range	**Frequency**					
	40 Hz to 100 Hz	**100 Hz to 1 kHz**	**1 kHz to 3 kHz**	**3 kHz to 10 kHz**	**10 kHz to 20 kHz**	**20 kHz to 30 kHz**
100 V to 300 V	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	2.0 mV/V
300 V to 750 V	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	2.0 mV/V
750 V to 1000 V	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	2.0 mV/V	-

MATRIX F TABLE (AC Current Measuring Instruments)

Generated by using a Multiproduct Calibrator				
Current Range	**Frequency**			
	10 Hz to 3 kHz	**3 kHz to 10 kHz**	**10 kHz to 20 kHz**	**20 kHz to 30 kHz**
0 to 30 µA	1.0 mA/A	2.0 mA/A	3.0 mA/A	3.0 mA/A
30 µA to 300 µA	1.0 mA/A	2.0 mA/A	3.0 mA/A	3.0 mA/A
300 µA to 3 mA	1.0 mA/A	1.0 mA/A	2.0 mA/A	3.0 mA/A
3 mA to 30 mA	1.0 mA/A	1.0 mA/A	2.0 mA/A	3.0 mA/A
30 mA to 300 mA	1.0 mA/A	1.0 mA/A	2.0 mA/A	3.0 mA/A
300 mA to 3 A	2.0 mA/A	3.0 mA/A	2.0 mA/A	3.0 mA/A
3 A to 10 A	3.0 mA/A	10 mA/A	-	-
10 A to 20 A	3.0 mA/A	10 mA/A	-	-

SCOPE OF CALIBRATION: OPTICAL AND PHOTOMETRIC MEASUREMENTS

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Spectrophotometer (UV-Visible Range)			
a) Wavelength	240 nm to 645 nm	0.2 nm	Calibrated using Holmium perchlorate as standard based on ASTM E275:2013 and ASTM E925:2014
b) Absorbance (230 nm to 640 nm)	0.2 to 1.0	0.006	Calibrated using Potassium Dichromate and Neutral Density Filter as standard based on ASTM E275:2013 and ASTM E925:2014
Transmittance (Normal incidence)	380 nm to 780 nm	0.94 %	Calibrated using Agilent Cary 7000 Spectrophotometer based on ASTM D1746:2015 and ISO 9050:2003

Signatories:

1. **Seah Leong Ho**

SCOPE OF CALIBRATION: OPTICAL AND PHOTOMETRIC MEASUREMENTS

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Spectrophotometer (UV-Visible Range)			
a) Wavelength	240 nm to 645 nm	0.2 nm	Calibrated using Holmium perchlorate as standard based on ASTM E275:2013 and ASTM E925:2014
b) Absorbance (230 nm to 640 nm)	0.2 to 1.0	0.006	Calibrated using Potassium Dichromate and Neutral Density Filter as standard based on ASTM E275:2013 and ASTM E925:2014
Smoke Meter	20 ~ 80% Opacity	1.0% Opacity	Opacity filter as reference
Tint Tester	20 ~ 90% Transmittance	1.0% Transmittance	Transmittance filter and glass standards as reference

Signatories:

1. **Seah Leong Ho**