

NO: SAMM 141(Issue 4, 2 March 2020 replacement
of SAMM141 dated 22 October 2019)

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LABORATORY LOCATION:
(PERMANENT LABORATORY)

SIRIM STANDARDS TECHNOLOGY SDN. BHD.
BANGUNAN SIRIM, LOT PT 483
MUKIM 6 JALAN PERMATANG PAUH
13500 PERMATANG PAUH, PULAU PINANG
MALAYSIA

FIELDS OF CALIBRATION: TEMPERATURE, DIMENSIONAL, MASS, PRESSURE,
FORCE, TORQUE AND ELECTRICAL

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 expanded uncertainties are based on an estimated confidence probability of approximately 95% and have a coverage factor of $k=2$ unless stated otherwise.

SCOPE OF CALIBRATION: TEMPERATURE

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
Liquid-in-glass Thermometer (Total immersion)	-30 °C to 70 °C 70 °C to 300 °C	0.1 °C 0.3 °C	Comparison with PT100 in: temperature bath
Temperature Sensor 1) Thermocouple 2) Pt 100	-30 °C to 70 °C 70 °C to 400 °C	0.1 °C 0.3 °C	
Temperature Indicating Instruments Thermocouple: K Type J Type T Type E Type PT100	-100 °C to 1300 °C -100 °C to 1100 °C -100 °C to 400 °C -100 °C to 800 °C -100 °C to 900 °C	0.5 °C 0.4 °C 0.6 °C 0.5 °C 0.6 °C	By electrical simulation using calibrator
Dry Block Calibrator	0 °C to 400 °C	0.2 °C	Comparison with PT100
Temperature switch	0 °C to 400 °C	1.6 °C	Comparison with Dry Block Calibrator or temperature bath

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
Mechanical Thermometer	30 °C to 300 °C	1.3 °C	Comparison with Dry Block Calibrator or temperature bath
Thermohygrograph / Thermohygrometer	25 %rh to 95 %rh 0 °C to 50 °C	5 %rh 0.8 °C	Comparison with thermohygrometer humidity chamber

Signatories:

1. Norihan Zainal
2. Hasni Jamaluddin

SCOPE OF CALIBRATION: TEMPERATURE**SITE CALIBRATION: CATEGORY 1**

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
Temperature Indicating Instruments (by electrical simulation)	K Type -100 °C to 1300 °C J Type -100 °C to 1100 °C T Type -100 °C to 400 °C E Type -100 °C to 800 °C	0.5 °C 0.4 °C 0.6 °C 0.5 °C	By electrical simulation using calibrator & temperature reference to ITS-90
Thermocouple: (with cold junction compensation)	R Type 0 °C to 1700 °C S Type 0°C to 1700 °C	1.4 °C 1.4 °C	
Resistant Temperature Detector	PT100 -200 °C to 850 °C	0.6 °C	
Temperature Controlled Enclosures	-60 °C to 200 °C 200 °C to 400 °C	0.6 °C 1.3 °C	using temperature recorder and Thermocouple Wires with reference to AS 2853-1986
Humidity Chamber	35 %rh to 95 %rh	3.5 %rh	Comparison with Humidity Temperature Recorder & wet and dry bulb thermocouple

Signatories:

1. Norihan Zainal
2. Hasni Jamaluddin

NO: SAMM 141(Issue 4, 2 March 2020 replacement
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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
Digital Thickness Gauge	Up to 50 mm	1.5 μ m	Calibrated using gauge block as standard
Depth-Micro-Checker	Up to 300 mm	3 μ m	Calibrated using gauge block as standard
Height Gauge	Up to 300 mm 300 mm to 600 mm	3.5 μ m 5.5 μ m	Calibrated using gauge block as standard JIS B 7517: 1993
Standard Rod (Length Only)	Up to 300 mm 300 mm to 600 mm	3 μ m 5 μ m	Calibrated using gauge block as standard
Micrometer (External)	Up to 25 mm	1.3 μ m	Calibrated using gauge block and related accessories as standard according ISO 3611: 2010
Caliper (Vernier, Dial, Digital)	Up to 300 mm 300 mm to 600 mm 600mm to 1000 mm	8 μ m 12 μ m 20 μ m	Calibrated using caliper checker as standard according to JIS B 7507: 1993
Caliper Checker -External measurement only	Up to 300 mm 300 mm to 600 mm	3 μ m 5 μ m	Calibrated using steel gauge block as standard
Feeler Gauge (Thickness and Wrap)	Up to 1 mm	2.5 μ m	Calibrated by Sylvac digital probe as reference standard
Dial Gauge	Up to 50 mm	3.0 μ m	
Pin Gauge (External diameter only)	Up to 40 mm	2.5 μ m	Calibrated using Master Pin Gauge as reference standard
Ruler	0.1 mm to 1000 mm	0.1 mm	Liner Scale
Tape	0 m to 10 m	(0.24 + 0.05L) mm L is length in unit meter	Linear Scale

Signatories:

1. **Norihan Zainal**
2. **Ibnu Sina Muhamad**

NO: SAMM 141(Issue 4, 2 March 2020 replacement
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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
Surface Plate Overall Flatness	600 mm x 600 mm Up to 1500 mm x 2000 mm	3 μ m 4 μ m	Calibrated using planeator as Standards according to ISO 8512-2:1990
Profile Projector –Linear Scale Only	Up to 80 mm 80 mm to 200 mm	4 μ m 7 μ m	Calibrated using glass scale as reference standard

Signatories:

1. Norihan Zainal
2. Ibnu Sina Muhamad

NO: SAMM 141(Issue 4, 2 March 2020 replacement
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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
Standard Weights and Weight Block	1 mg	0.005 mg	Comparison against OIML class E2 weight
	2 mg	0.005 mg	
	5 mg	0.005 mg	
	10 mg	0.005 mg	
	20 mg	0.006 mg	
	50 mg	0.006 mg	
	100 mg	0.007 mg	
	200 mg	0.010 mg	
	500 mg	0.010 mg	
	1 g	0.012 mg	
	2 g	0.014 mg	
	5 g	0.016 mg	
	10 g	0.021 mg	
	20 g	0.025 mg	
	50 g	0.06 mg	
	100 g	0.06 mg	
	200 g	2 mg	
	500 g	3 mg	
	1 kg	3 mg	
	2 kg	14 mg	
	5 kg	15 mg	
10 kg	50 mg		
20 kg	155 mg		
50 kg	157 mg		
60 kg	167 mg		

Signatories:

1. Norihan Zainal

SCOPE OF CALIBRATION: MASS**SITE CALIBRATION: CATEGORY 1**

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
Analytical Balance	Up to 200 g	1.2 mg	Using standard weight
Balance / Scale (Mechanical, Electronic)	Up to 30 kg	50 mg	
	30 kg to 100 kg	10 g	
	100 kg to 500 kg	40 g	
	500 kg to 1000 kg	70 g	

Signatories:

1. Norihan Zainal

NO: SAMM 141(Issue 4, 2 March 2020 replacement
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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
Tension Gauge	10 gf to 100 gf 100 gf to 350 gf 35 gf to 1000 gf	0.2 gf 2.5 gf 7.0 gf	Standard weight & deadweight

Signatory:

1. Norihan Zainal

SCOPE OF CALIBRATION: FORCE**SITE CALIBRATION: CATEGORY 1**

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
Universal Testing Machine	0 kgf to 500 kgf 500 kgf to 1000 kgf 1000 kgf to 3000 kgf 3000 kgf to 5000 kgf 5000 kgf to 10000 kgf	0.24 kgf 2.5 kgf 4.6 kgf 12 kgf 6.2 kgf	BS EN ISO 7500-1: 2004 Load Cell 500 kgf, 1000 kgf, 3000 kgf, 5000 kgf, 10000 kgf operating in compression mode

Signatory:

1. Norihan Zainal

NO: SAMM 141(Issue 4, 2 March 2020 replacement
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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
Torque Wrench	0 N.m to 2 N.m 2 N.m to 25 N.m 26 N.m to 400 N.m 401 N.m to 1500 N.m	0.02 N.m 0.10 N.m 0.52 N.m 3.3 N.m	Comparison with torque transducers with reference to BS EN ISO 6789: 2003. Transducers 2 N.m, 25 N.m, 400 N.m and 1500 N.m

Signatories:

1. Norihan Zainal
2. Azizul Ehsan Alias

NO: SAMM 141(Issue 4, 2 March 2020 replacement
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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
Pressure Measuring Device (Oil Medium)	10 psi to 100 psi 100 psi to 200 psi 200 psi to 400 psi 400 psi to 600 psi 600 psi to 800 psi 800 psi to 1000 psi 2000 psi to 4000 psi 4000 psi to 8000 psi 8000 psi to 12000 psi 12000 psi to 16000 psi	0.04 psi 0.06 psi 0.10 psi 0.14 psi 0.19 psi 0.60 psi 1.13 psi 3.2 psi 4.5 psi 5.3 psi	Hydraulic Dead Weight Tester
Pressure Measuring Device (Air Medium)	Up to 60 psi 60 psi to 320 psi 320 psi to 640 psi 640 psi to 960 psi 960 psi to 1280 psi 1280 psi to 1600 psi	0.03 psi 0.09 psi 0.18 psi 0.27 psi 0.36 psi 0.47 psi	Electronic Pressure Test Gauge and Air Dead Weight Tester
Vacuum	Up to 14 psi	0.02 psi	

Signatories:

1. Norihan binti Zainal
2. Azizul Ehsan Alias

Schedule

Issue date: 2 March 2020

Valid until: 2 July 2021



MS ISO/IEC 17025

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SCOPE OF CALIBRATION: PRESSURE

SITE CALIBRATION: CATEGORY 1

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
Vacuum	Up to 14 psi	0.018 psi	Pressure sensor
Pressure Measuring Device (Air Medium)	0 psi to 30 psi 30 psi to 600 psi	0.04 psi 0.8 psi	Pressure sensor
Pressure Measuring Device (Oil Medium)	0 to 30 psi 30 psi to 600 psi 600 psi to 6000 psi 6000 psi to 10000 psi	0.04 psi 0.8 psi 8 psi 12 psi	Pressure sensor

Signatory:

- Norihan binti Zainal**

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NO: SAMM 141(Issue 4, 2 March 2020 replacement
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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
<u>A. Measuring Instrument</u> 1. Multimeter/ Indicating Meter			
DC Voltage	0 to 330 mV 0 to 3.3 V 0 to 33 V 33 to 330 V 334 to 1000 V	12 μ V 0.1 mV 1 mV 10 mV 80 mV	Generating using Multi Calibrator Fluke 5520A
Resistance	0 to 11 Ω 11 to 33 Ω 33 to 110 Ω 110 to 330 Ω 0.33 to 1.1 k Ω 1.1 to 3.3 k Ω 3.3 to 11 k Ω 11 to 33 k Ω 33 to 110 k Ω 110 to 330 k Ω 0.33 to 1.1 M Ω 1.1 to 3.3 M Ω 3.3 to 11 M Ω 11 to 33 M Ω 33 to 110 M Ω 110 to 330 M Ω	15 m Ω 19 m Ω 28 m Ω 28 m Ω 0.1 Ω 0.1 Ω 2.5 Ω 3.4 Ω 11 Ω 10 Ω 0.1 k Ω 0.4 k Ω 2 k Ω 17 k Ω 69 k Ω 1.2 M Ω	Generating using Multi Calibrator Fluke 5520A
DC Current	0 to 3.3 mA 0 to 33 mA 0 to 330 mA 0 to 1.1 A 0 to 3 A 0 to 11 A 11 to 20 A	0.4 μ A 4 μ A 95 μ A 0.3 mA 2 mA 17 mA 0.08 A	Generating using Multi Calibrator Fluke 5520A

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SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
A. Measuring Instrument			
1. Multimeter/ Indicating Meter (cont.)			
AC Voltage			
	<u>1 to 30 mV</u>		
	10 Hz to 45 Hz	0.03 mV	
	45 Hz to 10 kHz	0.01 mV	
	10 kHz to 20 kHz	0.01 mV	
	20 kHz to 50 kHz	0.04 mV	
	50 kHz to 100 kHz	0.12 mV	
	100 kHz to 500 kHz	0.27 mV	
	<u>33 to 330 mV</u>		
	10 Hz to 45 Hz	0.10 mV	
	45 Hz to 10 kHz	0.05 mV	
	10 kHz to 20 kHz	0.06 mV	
	20 kHz to 50 kHz	0.12 mV	
	50 kHz to 100 kHz	0.28 mV	
	100 kHz to 500 kHz	0.70 mV	
	<u>0.33 to 3.3 V</u>		
	10 Hz to 45 Hz	1.0 mV	
	45 Hz to 10 kHz	1.0 mV	
	10 kHz to 20 kHz	2.0 mV	
	20 kHz to 50 kHz	2.0 mV	
	50 kHz to 100 kHz	5.0 mV	
	100 kHz to 500 kHz	10.0 mV	
	<u>3.3 to 33 V</u>		
	10 Hz to 45 Hz	0.01 V	
	45 Hz to 10 kHz	0.01 V	
	10 kHz to 20 kHz	0.02 V	
	20 kHz to 50 kHz	0.02 V	
	50 kHz to 90 kHz	0.13 V	
	<u>33 to 330 V</u>		
	10 Hz to 45 Hz	0.13 V	
	45 Hz to 10 kHz	0.10 V	
	10 kHz to 18 kHz	0.10 V	
	<u>330 to 1020 V</u>		
	10 Hz to 45 Hz	0.36 V	
	45 Hz to 8 kHz	0.36 V	
			Generating using Multi Calibrator Product Fluke 5520A

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
<u>A. Measuring Instrument</u> 1. Multimeter/ Indicating Meter (cont.) AC Current	<u>0.03 mA to 0.33 mA</u> 10 Hz to 20 Hz 20 Hz to 45 Hz 45 Hz to 1 kHz 1 kHz to 5 kHz 5 kHz to 10 kHz	1 μ A 1 μ A 1 μ A 1 μ A 3 μ A	Generating using Multi Product Calibrator Fluke 5520A
	<u>0.33 mA to 3.3 mA</u> 10 Hz to 45 Hz 45 Hz to 1 kHz 1 kHz to 10 kHz	6.0 μ A 5.0 μ A 19 μ A	
	<u>3.3 mA to 33 mA</u> 10 Hz to 45 Hz 45 Hz to 1 kHz 1 kHz to 10 kHz	43 μ A 31 μ A 80 μ A	
	<u>33 mA to 330 mA</u> 10 Hz to 45 Hz 45 Hz to 1 kHz 1 kHz to 10 kHz	0.5 mA 0.4 mA 0.9 mA	
	<u>0.33 A to 2.2 A</u> 10 Hz to 45 Hz 45 Hz to 1 kHz 1 kHz to 10 kHz	3.0 mA 2.0 mA 5.0 mA	
	<u>2.2 A to 11 A</u> 45 Hz to 1 kHz	28 mA	
	<u>11 A to 20 A</u> 45 Hz to 1 kHz	0.04 A	

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
<u>A. Measuring Instrument</u> 1. Multimeter/ Indicating Meter (cont.) Frequency Capacitance (Test Frequency at 10 Hz to 10 kHz) Resistance	0.01 Hz to 120 Hz 150 Hz to 1200 Hz 12 kHz to 120 kHz 0.19 nF to 3.3 nF 3.3 nF to 33 nF 33 nF to 330 nF 0.33 μ F to 3.3 μ F 3.3 μ F to 33 μ F 33 μ F to 110 μ F 110 μ F to 330 μ F 330 M Ω to 1100 M Ω	12 mHz 95 mHz 9 Hz 2 pF 0.3 nF 1.2 nF 0.1 μ F 0.2 μ F 0.8 μ F 1.8 μ F 17 M Ω	Generating using Multi Product Calibrator Fluke 5520A
2. Impedance Meter Capacitance	Test Frequency <u>20 Hz to 1 MHz</u> 1 μ F 10 nF 100 nF 1000 pF 100 pF 10 pF 1 pF	1 nF 0.01 nF 0.1 nF 1.4 pF 0.1 pF 14 fF 2 fF	Generating using Standard Capacitance/Decade Capacitance General Radio 1423A/1409 series HP 16380A series & HP 4284A
Inductance	Test Frequency <u>20 Hz to 1 MHz</u> 100 μ H 1 mH 10 mH 100 mH 1 H 10 H	0.04 μ H 1.0 μ H 12 μ H 0.1 mH 1.0 mH 39 mH	Generating using Standard Inductance/Decade Inductance General Radio 1491-G/1482 series & HP 4284A

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
A. Measuring Instrument Resistance	10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω	0.4 m Ω 0.1 m Ω 0.03 m Ω 0.2 Ω 7.2 Ω 0.3 k Ω	Generating using Standard Resistance/Decade Resistance Yew 2793/742A series
3. Low Current Meter DC Current	1 nA 10 nA 100 nA 1 μ A 10 μ A 100 μ A 1 mA	8 pA 53 pA 0.5 nA 9 nA 19 nA 0.2 μ A 6 μ A	Generating using Multi Calibrator / Programmable Current Source
4. High Voltage Type High Voltage Meter High Voltage Probe	DCV: 0 kV to 5 kV 5 kV to 10 kV ACV (50Hz): 0 kV to 5 kV 5 kV to 10 kV	53 V 93 V 39 V 41 V	Generating using Withstanding Voltage Tester and Comparison with Standard High Voltage Meter (TOS 5101 & TDV 20ADS)
5. Frequency Counter Frequency	0.1 Hz to 2 GHz	56 μ Hz	Generating using Standard Function Generator- HP 3325B / Signal Generator- E4425B
6. Oscilloscope	Volt/Div (1 V to 20 V) Volt/Div (10 mV to 500 mV) Time/Div (5 ns to 500 ns) Time/Div (1 μ s to 500 μ s) Time/Div (1 ms to 500 ms) Time/Div (1 s to 5 s) Bandwith (3 MHz to 1 GHz) Risetime	90 mV 1.5 mV 0.46 ns 0.46 μ s 0.058 m s/s 5 m s/s 24 kHz/MHz 1 ps/ns	Generating using Standard Multi Calibrator Fluke 5820A

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
A. Measuring Instrument			
7. Oscilloscope	0 V to \pm 6.6 V (50 Ω Load)	49 μ V	Generating using Oscilloscope Calibrator Fluke 5820A & E4425B
Vertical Deflection DC Signal	0 V to \pm 130 V (1M Ω Load)	74 mV	
Vertical Deflection	\pm 1m Vpp to \pm 6.6 Vpp (50 Ω Load)	10 μ Vpp	
Square Wave Signal	\pm 1m Vpp to \pm 130 Vpp (1M Ω Load)	99 mVpp	
Horizontal Deflection Time Markers (50 Ω Load)	2 ns/div to 20 ms/div 50 ms/div to 5 s/div	1 ps 1 ms	
Rise Time	\leq 300 ps	5 fs	
Bandwidth Frequency	50 kHz to 600 MHz 600 MHz to 2100 MHz	0.4 kHz 0.5 kHz	
Bandwidth Amplitude	50 kHz to 600 MHz 600 MHz to 2100 MHz	16 mVpp 14 mVpp	
8. Timer/Stop Watch Time	1 s to 50 s 50 s to 10 minutes 10 minutes to 1 hour 1 hour to 3 hours	0.13 s 0.51 s 0.73 s 0.98 s	Generating using Time Calibrator/Stop Watch

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
<u>A. Measuring Instrument</u>			
9. Clamp Meter DC Current 50- Turn Coil AC Current 50- Turn Coil	3.2 to 32 A	0.04 A	Generating using Multi Calibrator Fluke 5520A & 50- Turn Coil Model Fluke 5500A/Coil
	32to 105 A	0.35 A	
	105to 200 A	1.7 A	
	16 to 160 A	0.12 A	
	160 to 525 A	1.1 A	
	525 to 1000 A	3.7 A	
	<u>3.2 A to 32 A</u>		
	10 Hz to 100 Hz	0.31 A	
	100 Hz to 440 Hz	0.33 A	
	<u>32 A to 200 A</u>		
	10 Hz to 100 Hz	0.23 A	
	100 Hz to 440 Hz	0.25 A	
<u>16 A to 160 A</u>			
10 Hz to 100 Hz	0.14 A		
100 Hz to 440 Hz	0.47 A		
<u>160 A to 1000 A</u>			
10 Hz to 100 Hz	2.9 A		
100 Hz to 440 Hz	13 A		
10. Power/Energy			
DC Current	0.1 W to 1 kW	0.1 mW	Generating using Multi Calibrator Fluke 5520A
	1 kW to 20 kW	0.1 kW	
AC Current (45 Hz to 65 Hz at PF=1)	0.1 W to 1 kW	0.1 mW	
	1 kW to 10 kW	5.1 W	
	10 kW to 20 kW	0.1 kW	

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A. Measuring Instrument 11. Tachometer	60 rpm to 600 rpm 600 rpm to 6000 rpm 6000 rpm to 60000 rpm 60000 rpm to 99960 rpm	0.7 rpm 7.1 rpm 71 rpm 120 rpm	In-House Method ESF/0303 (Generating using Function Generator HP 3325B)
12. Insulation Testers	(1 k Ω to 10 k Ω) @10 V (10 k Ω to 100 k Ω) @ 50 V (0.1 M Ω to 1 M Ω) @150 V (1 M Ω to 10 M Ω) @ 300 V (10 M Ω to 100 M Ω) @ 500 V (0.1 G Ω to 1 G Ω) @1000 V (1 G Ω to 10 G Ω) @ 5000 V (10 G Ω to 100 G Ω) @ 5000 V (100 G Ω to 500 G Ω) @ 5000 V	8 Ω 19 Ω 0.2 k Ω 8 k Ω 71 k Ω 1.6 M Ω 12 M Ω 0.2 G Ω 2.8 G Ω	Generating using IET HRRS-Q-9-10k-10kV High Resistance Decade Substituter
B. Generating Instruments 1. Calibrator DC Voltage	100 mV 1 V 10 V 100 V 1000 V	2 μ V 15 μ V 0.1 mV 2 mV 16 mV	Measurement using Digital Multimeter/ Direct Measurement HP/Agilent 3458A
Resistance	10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω 10 M Ω 100 M Ω	0.5 m Ω 2 m Ω 0.1 Ω 0.2 Ω 2.0 Ω 0.1 k Ω 0.8 k Ω 60 k Ω	
DC Current	100 μ A 1 mA 10 mA 100 mA 1 A	0.02 μ A 0.1 μ A 0.8 μ A 9.2 μ A 0.2 mA	

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B. Generating Instruments 1. Calibrator (cont.) AC Voltage	<u>100 mV</u> 1 kHz to 20 kHz	0.03 mV	Measurement using Digital Multimeter Direct Measurement HP/Agilent 3458A
	100 kHz	0.38 mV	
	300 kHz	1.2 mV	
	1 MHz	1.8 mV	
	<u>1V</u> 45 Hz to 20 kHz	0.4 mV	
	50 kHz	0.2 mV	
	100 kHz	3.6 mV	
	300 kHz	12 mV	
	500 kHz	12 mV	
	1 MHz	18 mV	
	<u>10 V</u> 45 Hz to 20 kHz	3.7 mV	
	50 kHz	2.4 mV	
	100 kHz	36 mV	
	300 kHz	0.1 V	
	500 kHz	0.1 V	
1 MHz	0.2 V		
<u>100 V</u> 45 Hz to 20 kHz	0.04 V		
50 kHz	0.14 V		
100 kHz	0.48 V		
<u>1000 V</u> 10 Hz to 45 Hz	0.49 V		
Frequency	<u>Input Signal</u> <u>1 mV to 700 V</u> 1 Hz 10 MHz	1 mHz 1 kHz	

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B. Generating Instruments 2. Standard Impedance Capacitance	Test Frequency 10 Hz to 1 MHz 10 pF 100 pF 1000 pF 1 μ F 100 nF 10 nF	19 fF 0.2 pF 1.6 pF 2 nF 0.2 nF 0.01 nF	Measurement using Standard Capacitance/Decade Capacitance General Radio 1423A/1409 series HP 16380A series & HP 4284A
Inductance	Test Frequency 10 Hz to 1 MHz 100 μ H 1 mH 10 mH 100 mH 1 H 10 H	0.1 μ H 1 μ H 0.01 mH 0.1 mH 1 mH 14 mH	Measurement using Standard Inductance/Decade Inductance General Radio 1491-G/1482 series & HP 4284A
Resistance	10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω 10 M Ω 100 M Ω	0.34 m Ω 0.02 Ω 0.03 Ω 0.18 Ω 7.0 Ω 0.05 k Ω 2.2 k Ω 20 k Ω	Measurement using Standard Resistance/Decade Resistance Yew 2793/742A series
3. High Voltage Type Generate	DCV: 0 kV to 20 kV ACV (50Hz): 0 kV to 20 kV	(of reading) 0.093 kV 0.041 kV	Measurement using Standard High Voltage Meter/High Voltage Probe/Digital Multimeter (TDV 20 ADS/Fluke 80 kV-40 & Fluke 289)
4. Signal Generator Frequency	0.1 Hz to 5 GHz	(of reading) 19.2 μ Hz	Measurement using Standard Universal Counter /HP 53132A

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
<u>B. Generating Instruments</u> 5. AC Current	<u>29 μA to 0.33 mA</u>		Measurement using Digital Multimeter Model 3458A
	10 Hz to 45 Hz	2.0 μ A	
	45 Hz to 100 Hz	0.3 μ A	
	100 Hz to 1 kHz	0.4 μ A	
	1 kHz to 5 kHz	0.3 μ A	
	<u>0.33 mA to 3.3 mA</u>		
	10 Hz to 45 Hz	6.0 μ A	
	45 Hz to 1 kHz	3.0 μ A	
	100 Hz to 1 kHz	2.0 μ A	
	1 kHz to 5 kHz	3.0 μ A	
	<u>3.3 mA to 33 mA</u>		
	10 Hz to 45 Hz	65 μ A	
	45 Hz to 100 Hz	65 μ A	
	100 Hz to 1 kHz	19 μ A	
	1 kHz to 5 kHz	31 μ A	
	5 kHz to 20 kHz	31 μ A	
	20 kHz to 50 kHz	17 μ A	
	50 kHz to 100 kHz	27 μ A	
	<u>33 mA to 330 mA</u>		
	10 Hz to 45 Hz	0.65 mA	
	45 Hz to 100 Hz	0.31 mA	
	100 Hz to 1 kHz	0.19 mA	
	1 kHz to 5 kHz	0.31 mA	
	5 kHz to 20 kHz	0.31 mA	
	20 kHz to 50 kHz	0.17 mA	
	<u>330 mA to 1A</u>		
	10 Hz to 45 Hz	1.6 mA	
	45 Hz to 100 Hz	0.6 mA	
100 Hz to 1 kHz	2.0 mA		
1 kHz to 5 kHz	4.0 mA		
5 kHz to 20 kHz	4.0 mA		
20 kHz to 50 kHz	2.7 mA		

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
<u>B. Generating Instruments</u> 6. Oscilloscope Calibrator (Calibration Generator, Time Mark Generator and Levelled Sine Wave Generator)	Frequency: 0.1 Hz to 5 GHz <u>Amplitude 100 mV to 10 V</u> 40 Hz to 1 kHz 1 kHz to 20 kHz 50 kHz to 100 kHz	(of reading) 19.2 μ Hz 1 mV 10 mV 36 mV	Measurement using Standard Universal Counter/ Digital Multimeter Digitizing Oscilloscope HP53132/HP3458A/TDS680C
7. DC Current Source	1 A to 10 A 11 A TO 100 A	32 mA 0.05 A	Measurement using Standard Current Shunt VS2575A and Digital Multimeter HP 3458A
8. AC Current Source	1 A to 10 A (50 Hz to 10 kHz)	72 mA	

Signatories:

1. Aminuddin Ahmad
2. Mohd Sahril Idrus

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
A. Measuring Instrument 1. Multimeter/ Indicating Meter			
DC Voltage	0 to 330 mV 0 to 3.3 V 0 to 33 V 33 to 330 V 334 to 1000 V	15 μ V 0.1 mV 1 mV 11 mV 81 mV	Generating using Multi Calibrator Fluke 5520A
Resistance	0 to 11 Ω 11 to 33 Ω 33 to 110 Ω 110 to 330 Ω 0.33 to 1.1 k Ω 1.1 to 3.3 k Ω 3.3 to 11 k Ω 11 to 33 k Ω 33 to 110 k Ω 110 to 330 k Ω 0.33 to 1.1 M Ω 1.1 to 3.3 M Ω 3.3 to 11 M Ω 11 to 33 M Ω 33 to 110 M Ω 110 to 330 M Ω 330 to 1100 M Ω	16 m Ω 19 m Ω 28 m Ω 0.2 Ω 3.0 Ω 2.8 Ω 2.7 Ω 4.0 Ω 24 Ω 30 Ω 0.1 k Ω 0.4 k Ω 2 k Ω 17 k Ω 180 k Ω 1.2 M Ω 2.1 M Ω	Generating using Multi Calibrator Fluke 5520A
DC Current	0 mA to 300 μ A 0 mA to 3.3 mA 0 mA to 33 mA 0 mA to 330 mA 0 A to 1.1 A 0 A to 3 A 0 A to 11 A 11 A to 20.5 A	0.1 μ A 0.4 μ A 4.0 μ A 0.1 mA 0.3 mA 2.0 mA 17 mA 26 mA	Generating using Multi Calibrator Fluke 5520A

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
<u>A. Measuring Instrument</u> 1. Multimeter/ Indicating Meter (cont.) AC Voltage	<u>1 to 30 mV</u>		Generating using Multi Calibrator Fluke 5520A
	10 Hz to 45 Hz	29 μ V	
	45 Hz to 10 kHz	6 μ V	
	10 kHz to 20 kHz	8 μ V	
	20 kHz to 50 kHz	35 μ V	
	50 kHz to 100 kHz	0.12 mV	
	100 kHz to 500 kHz	0.28 mV	
	<u>33 to 330 mV</u>		
	10 Hz to 45 Hz	0.11 mV	
	45 Hz to 10 kHz	0.06 mV	
	10 kHz to 20 kHz	0.06 mV	
	20 kHz to 50 kHz	0.12 mV	
	50 kHz to 100 kHz	0.28 mV	
	100 kHz to 500 kHz	0.70 mV	
	<u>0.33 to 3.3 V</u>		
	10 Hz to 45 Hz	1.0 mV	
	45 Hz to 10 kHz	1.0 mV	
	10 kHz to 20 kHz	2.0 mV	
	20 kHz to 50 kHz	2.0 mV	
	50 kHz to 100 kHz	5.0 mV	
	100 kHz to 500 kHz	10 mV	
	<u>3.3 to 33 V</u>		
	10 Hz to 45 Hz	10 mV	
45 Hz to 10 kHz	15 mV		
10 kHz to 20 kHz	17 mV		
20 kHz to 50 kHz	19 mV		
50 kHz to 90 kHz	0.13 V		
<u>33 to 330 V</u>			
10 Hz to 45 Hz	0.13 V		
45 Hz to 10 kHz	0.10 V		
10 kHz to 20 kHz	0.11 V		
20 kHz to 50 kHz	0.11 V		
50 kHz to 100 kHz	0.11 V		
<u>330 to 1020 V</u>			
45 Hz to 10 kHz	0.36 mV		

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
<u>A. Measuring Instrument</u> 1. Multimeter/ Indicating Meter (cont.) AC Current	<u>29 μA to 330 μA</u>		Generating using Multi Calibrator Fluke 5520A
	45 Hz to 1 kHz	1 μ A	
	1 kHz to 5 kHz	1 μ A	
	5 kHz to 10 kHz	3 μ A	
	<u>0.33 mA to 3.3 mA</u>		
	45 Hz to 1 kHz	6 μ A	
	1 kHz to 5 kHz	5 μ A	
	5 kHz to 10 kHz	20 μ A	
	<u>3.3 mA to 33 mA</u>		
	45 Hz to 1 kHz	32 μ A	
	1 kHz to 5 kHz	41 μ A	
	5 kHz to 10 kHz	81 μ A	
	<u>33 mA to 330 mA</u>		
	45 Hz to 1 kHz	0.4 mA	
1 kHz to 5 kHz	1 mA		
5 kHz to 10 kHz	1 mA		
<u>0.33 A to 1.1 A</u>			
45 Hz to 1 kHz	3 mA		
1 kHz to 5 kHz	2 mA		
5 kHz to 10 kHz	35 mA		
<u>1.1 A to 3 A</u>			
45 Hz to 1 kHz	5 mA		
1 kHz to 5 kHz	24 mA		
5 kHz to 10 kHz	93 mA		
<u>3 A to 11 A</u>			
45 Hz to 1 kHz	28 mA		
<u>11 A to 20 A</u>			
45 Hz to 1 kHz	44 mA		

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
A. Measuring Instrument 1. Multimeter/ Indicating Meter (cont.)			
Frequency	0.01 Hz to 120 Hz 120 Hz to 1200 Hz 12 kHz to 120 kHz	9 mHz 76 mHz 9 Hz	Generating using Multi Calibrator Fluke 5520A
Capacitance (Test Frequency at 10 Hz to 10 kHz)	0.19 nF to 3.3 nF 3.3 nF to 33 nF 33 nF to 330 nF 0.33 μ F to 3.3 μ F 3.3 μ F to 33 μ F 33 μ F to 110 μ F	2 pF 0.2 nF 1.2 nF 59 nF 0.2 μ F 0.5 μ F	Generating using Multi Calibrator Fluke 5520A
2. Timer/Stop Watch Time	1 s to 50 s 50 s to 10 minutes 10 minutes to 1 hour 1 hour to 3 hours	0.12 s 0.51 s 0.74 s 1.0 s	Generating using Time Calibrator
3. Insulation Testers	(1 k Ω to 10 k Ω) @10 V (10 k Ω to 100 k Ω) @ 50 V (0.1 M Ω to 1 M Ω) @150 V (1 M Ω to 10 M Ω) @ 300 V (10 M Ω to 100 M Ω) @ 500 V (0.1 G Ω to 1 G Ω) @1000 V (1 G Ω to 10 G Ω) @ 5000 V (10 G Ω to 100 G Ω) @ 5000 V (100 G Ω to 500 G Ω) @ 5000 V	8 Ω 19 Ω 0.2 k Ω 8 k Ω 71 k Ω 1.6 M Ω 12 M Ω 0.2 G Ω 2.8 G Ω	Generating Using IET HRRS-Q-9-10k- 10kV High Resistance Decade Substituter

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
<u>A. Measuring Instrument</u>			
4. Oscilloscope Vertical Deflection DC Signal	0 V to \pm 6.6 V (50 Ω Load) 0 V to \pm 130 V (1M Ω Load)	49 μ V 74 mV	Generating using Oscilloscope Calibrator Fluke 5820A & E4425B
Vertical Deflection	\pm 1m Vpp to \pm 6.6 Vpp (50 Ω Load)	10 μ Vpp	
Square Wave Signal	\pm 1m Vpp to \pm 130 Vpp (1M Ω Load)	99 μ Vpp	
Horizontal Deflection Time Markers (50 Ω Load)	2 ns/div to 20 ms/div 50 ms/div to 5 s/div	1 ps 1 ms	
Rise Time	\leq 300 ps	5 fs	
Bandwidth Frequency	50 kHz to 600 MHz 600 MHz to 2100 MHz	0.4 kHz 0.5 kHz	
Bandwidth Amplitude	50 kHz to 600 MHz 600 MHz to 2100 MHz	16 mVpp 14 mVpp	
<u>B. Generating Instruments</u>			
1. DC Power Supply DC Voltage	100 mV 1000 mV 10 V 100 V 1000 V	8 μ V 0.6 mV 18 mV 150 mV 0.5 V	Measurement using Digital Multimeter HP3458A & Current Shunt VS 2575A
DC Current	100 mA to 1 A 10 A to 100 A	0.01 μ A 0.05 A	

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
<u>B. Generating Instruments</u> 2. High Voltage Type	DCV: 0 kV to 20 kV ACV (50Hz): 0 kV to 20 kV	10 V/kV 17 V/kV	Measurement using Standard High Voltage Meter/High Voltage Probe/Digital Multimeter (TDV 20 ADS/Fluke 80 kV- 40 & Fluke 289)

Signatories:

1. Aminuddin Ahmad
2. Mohd Sahril Idrus