LABORATORY LOCATION: (PERMANENT LABORATORY)

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FIELD OF CALIBRATION: **ELECTRICAL**

This laboratory has demonstrated its technical competence to operate in accordance with MS ISO/IEC 17025:2005 (ISO/IEC 17025:2005).

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: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
A. Indicating Meters/ Instruments **DC/Low Freq** 1. DC Voltage	0 mV to 329.9999 mV 0 V to 3.299999 V 0 V to 32.99999 V 0 V to 329.99999 V 0 V to 1000.000 V	(output + floor) 20 µV/ V + 1 µV 11 µV/ V + 2 µV 12 µV/ V + 20 µV 18 µV/ V + 150 µV 18 µV/ V + 1500 µV	Generation using calibrator model Fluke 5520A/5522A
2. AC Voltage	1.0 mV to 1020 V (See MatrixA)	(See Matrix A)	

Matrix A AC Voltage Source

Range		Frequency (kHz)								
		0.01 to 0.045	**0.045 to 10**	**10 to 20**	**20 to 50**	**50 to 100**	**100 to 500**	**0.045 to 1**	**1 to 5**	**5 to 10**
32.999 mV	1.0 mV to 32.999 mV	0.8 + 0.006	0.15 + 0.006	0.2 + 0.006	1.0 + 0.006	3.5 + 0.012	8.0 + 0.050	-	-	-
329.999 mV	33 mV to 329.999 mV	0.3 + 0.008	0.15 + 0.008	0.16 + 0.008	0.35 + 0.008	0.8 + 0.032	2.0 + 0.070	-	-	-
3.29999 V	330 mV to 3.29999 V	0.3 + 0.05	0.15 + 0.06	0.19 + 0.06	0.3 + 0.05	0.7 + 0.125	2.4 + 0.6	-	-	-
32.9999 V	3.3 V to 32.9999 V	0.3 + 0.65	0.15 + 0.6	0.24 + 0.6	0.35 + 0.6	0.9 + 1.6	-	-	-	-
329.999 V	33 V to 329.999 V	-	-	0.25 + 6	0.3 + 6	2.0 + 50	-	0.19 + 2	0.2 + 6	0.2 + 6
1020 V	330 V to 1020 V	-	-	-	-	-	-	0.3 + 10	0.25 + 10	0.3 + 10

The calibration uncertainties given in this table are expressed in mV/V + mV

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
3. DC Current	0 µA to 329.999 µA 0 mA to 3.29999 mA 0 mA to 32.9999 mA 0 mA to 329.999 mA 0 A to 1.09999 A 1.1 A to 2.99999 A 0 A to 10.9999 A 11 A to 20.0 A	150 µA/A + 0.02 µA 100 µA/A + 0.05 µA 100 µA/A + 0.25 µA 100 µA/A + 2.5 µA 200 µA/A + 40 µA 380 µA/A + 40 µA 500 µA/A + 500 µA 1.0 mA/A + 750 µA	Generation using calibrator model Fluke 5520A/5522A
4. AC Current	**29 µA to 20.5 A** (See Matrix B)	(See Matrix B)	

Matrix B AC Voltage Sources

Range		Frequency (kHz)								
		0.01 to 0.02	**0.02 to 0.045**	**0.045 to 1**	**1 to 5**	**5 to 10**	**10 to 30**	**0.010 to 0.045**	**0.045 to 0.1**	**0.1 to 1**
329.99 µA	29 µA to 329.99 µA	2.0 + 0.0001	1.5 + 0.0001	1.3 + 0.0001	3.0 + 0.00015	8.0 + 0.0002	16 + 0.0004	-	-	-
3.2999 mA	0.33 mA to 3.2999 mA	2.0 + 0.00015	1.3 + 0.00015	1.0 + 0.00015	2.0 + 0.0002	5.0 + 0.0003	10 + 0.0006	-	-	-
32.999 mA	3.3 mA to 32.999 mA	1.8 + 0.002	0.9 + 0.002	0.4 + 0.002	0.8 + 0.002	2.0 + 0.003	4.0 + 0.004	-	-	-
329.99 mA	33 mA to 329.99 mA	1.8 + 0.02	0.9 + 0.02	0.4 + 0.02	1.0 + 0.05	2.0 + 0.1	4.0 + 0.2	-	-	-
1.09999 A	330 mA to 1.09999 A	-	-	0.5 + 0.1	6.0 + 1	25 + 5	-	1.8 + 0.1	-	-
2.99999 A	1.1 A to 2.99999 A	-	-	0.6 + 0.1	6 + 1	25 + 5	-	1.8 + 0.1	-	-
10.9999 A	3 A to 10.9999 A	-	-	-	30 + 2	-	-	-	0.6 + 2	1 + 2
20.5 A	11 A to 20.5A	-	-	-	30 + 5	-	-	-	1.2 + 5	1.5 +5

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
5. DC Resistance	0 Ω to 10.9999 Ω 11 Ω to 32.9999 Ω 33 Ω to 109.9999 Ω 110 Ω to 1.099999 kΩ 1.1 kΩ to 10.99999 kΩ 11 kΩ to 109.9999 kΩ 110 kΩ to 1.099999 MΩ 1.1 MΩ to 3.299999 MΩ 3.3 MΩ to 10.99999 MΩ 11 MΩ to 32.99999 MΩ 33 MΩ to 109.9999 MΩ 110 MΩ to 329.9999 MΩ 330 MΩ to 1100 MΩ	40 μΩ/Ω+ 1.0 mΩ 30 μΩ/Ω+ 1.5 mΩ 28 μΩ/Ω+ 1.4 mΩ 28 μΩ/Ω+ 2.0 mΩ 28 μΩ/Ω + 20 mΩ 28 μΩ/Ω + 0.20 Ω 32 μΩ/Ω + 2.0 Ω 60 μΩ/Ω + 30 Ω 130 μΩ/Ω + 50 Ω 250 μΩ/Ω + 2.5 kΩ 500 μΩ/Ω + 3.0 kΩ 3.0 mΩ/Ω+ 100 kΩ 15 mΩ/Ω + 500 kΩ	Generation using calibrator model Fluke 5520A/5522A
6. Capacitance	0.19 nF to 3.2999 nF 3.3 nF to 10.9999 nF 11 nF to 109.999 nF 110 nF to 329.999 nF 0.33 μF to 1.09999 μF 1.1 μF to 3.29999 μF 3.3 μF to 10.9999 μF 11 μF to 32.9999 μF 33 μF to 109.999 μF 110 μF to 329.999 μF 330 μF to 1.09999 mF 1.1 mF to 3.2999 mF 3.3 mF to 10.9999 mF 11 mF to 32.9999 mF 33 mF to 110 mF	5.0 mF/F + 10 pF 2.5 mF/F + 10 pF 2.5 mF/F + 100 pF 2.5 mF/F + 300 pF 2.5 mF/F + 1.0 nF 2.5 mF/F + 3.0 nF 2.5 mF/F + 10 nF 4.0 mF/F + 30 nF 4.5 mF/F + 100 nF 4.5 mF/F + 300 nF 4.5 mF/F + 1.0 μF 4.5 mF/F + 3.0 μF 4.5 mF/F + 10 μF 7.5 mF/F + 30 μF 11 mF/F + 100 μF	Generation using calibrator model Fluke 5520A/5522A
7. Frequency a. Measure	50 kHz to 1100 MHz	2.5 μHz/Hz	Generation using calibrator model Fluke 5520A/5522A

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
7. Frequency b. Amplitude	<u>0.01 Vpp to 5.00 Vpp</u> 1 µHz to 100 kHz 100 kHz to 20 MHz 20 MHz to 30.2 MHz <u>5 Vpp to 10 Vpp</u> 1 µHz to 100 kHz 100 kHz to 20 MHz 20 MHz to 30.2 MHz	 47 mV/V 47 mV/V 59 mV/V 23 mV/V 23 mV/V 35 mV/V	Generated Using Calibrator Model DS345
<u>Oscilloscope</u>			
<u>B. Sources</u> 1. DC Voltage	0 mV to 210 mV 0.21 V to 2.1 V 2.1 V to 21 V 21 V to 210 V 210 V to 1100 V	23 µV/V + 0.0018 mV 14 µV/V + 0.0000018 V 13 µV/V + 0.000003 V 25 µV/V + 0.0004 V 26 µV/V + 0.004 V	Measured Using Calibrator Model Keithley 2002
2. AC Voltage	**200 mV to 750 V** (See Matrix C)	(See Matrix C)	

Matrix C
AC Voltage Measurements

Range	Frequency (kHz)									
	0.02 to 0.05	**0.05 to 0.1**	**0.1 to 2**	**2 to 10**	**10 to 30**	**30 to 50**	**50 to 100**	**100 to 200**	**200 to 1000**	**1000 to 2000**
200 mV	2.5 + 0.03	0.7 + 0.03	0.2 + 0.02	0.2 + 0.02	0.25 + 0.02	0.5 + 0.02	3.0 + 0.02	7.5 + 0.05	20 +0.2	50 + 0.4
2 V	2.5 + 0.3	0.7 + 0.3	0.2 + 0.2	0.2 + 0.2	0.25 + 0.2	0.5 + 0.2	3.0 + 0.2	7.5 + 0.2	20 + 2	50 + 4
20 V	2.5 + 3	0.7 + 3	0.3 + 3	0.4 + 3	0.5 + 3	0.7 + 3	30 + 3	7.5 + 3	20 + 40	-
200 V[1]	2.5 + 30	0.7 + 30	0.3 + 30	0.4 + 30	0.5 + 30	0.7 + 30	30 +30	-	-	-
750 V[1]	2.5 + 30	0.7 + 30	0.3 + 30	-	-	-	-	-	-	-

[1] Additional uncertainty 0.010 mV/V*(Vin/100V)^2 for input above 100V
The calibration uncertainties given in this table are expressed in mV/V + mV

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
3. DC Current	0 µA to 210 µA 0 mA to 2.1 mA 0 mA to 21 mA 0 mA to 210 mA 0 A to 2 A	400 µA/A + 0.005 µA 309 µA/A + 0.00004 mA 410 µA/A + 0.0004 mA 540 µA/A + 0.004 mA 880 µA/A + 0.00004 A	Measured Using Calibrator Model Keithley 2002
	2 A to 10 A	2mA/A + 0.7 mA	Measured Using Calibrator Model Fluke 45
4. AC Current	200 µA to 2 A (See Matrix D)	(See Matrix D)	Measured Using Calibrator Model Keithley 2002

Matrix D
AC Current Measurements

Range	Frequency (kHz)			
	0.02 to 0.05	**0.05 to 0.2**	**0.2 to 1**	**1 to 10**
200 µA	3.5 + 0.00003	20 + 0.00003	40 + 0.00003	50 + 0.00003
2 mA	3.0 + 0.0003	1.5 + 0.0003	1.2 + 0.0003	1.2 + 0.0003
20 mA	3.0 + 0.003	1.5 + 0.003	1.2 + 0.003	1.2 + 0.003
200 mA	3.0 + 0.03	1.5 + 0.03	1.2 + 0.03	1.2 + 0.03
2 A	3.5 + 0.3	20 + 0.3	30 + 0.3	4.5 + 0.3

The calibration uncertainties given in this table are expressed in mA/A + mA

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
5. DC Resistance	0Ω to 20 Ω 0Ω to 200 Ω 0Ω to 2 kΩ 0Ω to 20 kΩ 0Ω to 200 kΩ 0Ω to 2 MΩ 0Ω to 20 MΩ 0Ω to 200 MΩ	47 μΩ/Ω + 0.00012 Ω 25 μΩ/Ω + 0.0008 Ω 16 μΩ/Ω + 0.0000008 kΩ 17 μΩ/Ω + 0.000008 kΩ 43 μΩ/Ω + 0.00018 Ω 80 μΩ/Ω + 0.000001 MΩ 270 μΩ/Ω + 0.000012 MΩ 570 μΩ/Ω + 0.0006 MΩ	Measured Using Calibrator Model Keithley 2002
6. Frequency	1.0 Hz – 10 MHz 10 MHz – 100 MHz 100 MHz – 1.3 GHz	1 μHz/Hz + 0.1 Hz 1 μHz/Hz + 1 Hz 1 μHz/Hz + 10 Hz	Measured Using Calibrator Model CMC251
7. Vertical Amplitude Pk-Pk (1 MΩ Load)	200 μV to 1 mV	2.5 mV/V + 1 μV	Generation using calibrator model Tek PG506A
Pk-Pk (50 Ω Load)	1 mV to 130 V	1.0 mV/V + 40 μV	Generation using calibrator model Fluke 5520A/5522A
	100 μV to 5 V	2.5 mV/V + 1 μV	Generation using calibrator model Tek PG506A
	5 V to 6.6 V	2.5 mV/V + 40 μV	Generation using calibrator model Fluke 5520A/5522A
DC (1 MΩ Load)	0 V to 130 V	0.5 mV/V + 40 μV	
DC (50 Ω Load)	0 V to 6.6 V	2.5 mV/V + 40 μV	
8. Time Base	1 ns to 5 s	0.5 μs/s	Generation using calibrator model Fluke TG501A

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
9. Bandwith Amplitude Flatness			
50 kHz to 100 MHz	5 mV to 5.5 Vp-p	(15 mV/V + 100 µV) at ref.	Generated Using Calibrator Model Fluke 5520A/5522A
100 MHz to 300 MHz	5 mV to 5.5 V	(20 mV/V + 100 µV) at ref.	
300 MHz to 1050 MHz	0.5 V to 4 Vp-p	40 mV/V at ref.	Generated Using Calibrator Model Tek SG504
1050 MHz to 1100 MHz	5 mV to 3.5 V	(50 mV/V + 100 µV) at ref.	Generated Using Calibrator Model Fluke 5520A/5522A
1 GHz to 4 GHz	-60 dBm to 20 dBm	0.20 dB	Levelling Method (MG3694C, NRVS, NRV-Z15, Splitter)
4 GHz to 6 GHz		0.23 dB	
6 GHz to 12.4 GHz		0.24 dB	
12.4 GHz to 15 GHz		0.25 dB	
15 GHz to 16 GHz		0.26 dB	
16 GHz to 26.5 GHz		0.27 dB	
10. Bandwith Frequency	50 kHz to 26.5 GHz	5×10^{-10}	Generated Using Calibrator Model MG3694C

Signatories:

1. **Lim Aing Khoon**
2. * **Ramlah Mamat**
3. *** Rafizi Affandi**
4. *** Lalyn Soriano Duco**

***** Non-resident

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Active And Differential Probe 11. Rise Time	≥ 17.5 ps	12 ps	Generated Using Pulse Generator 80E04 and Measuring by DSA8200 and 80E03 Sampling Module

Signatories:

1. **Lim Aing Khoon**
2. *** Rafizi Affandi**
3. *** Lalyn Soriano Duco**

***** Non Resident

SCOPE OF CALIBRATION: ELECTRICAL

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
A. Indicating Meters/ Instruments **DC/Low Freq** 1. DC Voltage	0 mV to 329.9999 mV 0 V to 3.299999 V 0 V to 32.99999 V 0 V to 329.99999 V 0 V to 1000.000 V	(output + floor) 20 µV/ V + 1 µV 11 µV/ V + 2 µV 12 µV/ V + 20 µV 18 µV/ V + 150 µV 18 µV/ V + 1500 µV	Generation using calibrator model Fluke 5720A/5522A
2. AC Voltage	1.0 mV to 1020 V (See MatrixA)	(See Matrix A)	

Martrix A
AC Voltage Sources

Range		Frequency (kHz)								
		0.01 to 0.045	**0.045 to 10**	**10 to 20**	**20 to 50**	**50 to 100**	**100 to 500**	**0.045 to 1**	**1 to 5**	**5 to 10**
32.999 mV	1.0 mV to 32.999 mV	0.8 + 0.006	0.15 + 0.006	0.2 + 0.006	1.0 + 0.006	3.5 + 0.012	8.0 + 0.050	-	-	-
329.999 mV	33 mV to 329.999 mV	0.3 + 0.008	0.15 + 0.008	0.16 + 0.008	0.35 + 0.008	0.8 + 0.032	2.0 + 0.070	-	-	-
3.29999 V	330 mV to 3.29999 V	0.3 + 0.05	0.15 + 0.06	0.19 + 0.06	0.3 + 0.05	0.7 + 0.125	2.4 + 0.6	-	-	-
32.9999 V	3.3 V to 32.9999 V	0.3 + 0.65	0.15 + 0.6	0.24 + 0.6	0.35 + 0.6	0.9 + 1.6	-	-	-	-
329.999 V	33 V to 329.999 V	-	-	0.25 + 6	0.3 + 6	2.0 + 50	-	0.19 + 2	0.2 + 6	0.2 + 6
1020 V	330 V to 1020 V	-	-	-	-	-	-	0.3 + 10	0.25 + 10	0.3 + 10

The calibration uncertainties given in this table are expressed in mV/V + mV

SCOPE OF CALIBRATION: ELECTRICAL

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
3. DC Current	0 µA to 329.999 µA 0 mA to 3.29999 mA 0 mA to 32.9999 mA 0 mA to 329.999 mA 0 A to 1.09999 A 1.1 A to 2.99999 A 0 A to 10.9999 A 11 A to 20.0 A	150 µA/A + 0.02 µA 100 µA/A + 0.05 µA 100 µA/A + 0.25 µA 100 µA/A + 2.5 µA 200 µA/A + 40 µA 380 µA/A + 40 µA 500 µA/A + 500 µA 1.0 mA/A + 750 µA	Generation using calibrator model Fluke 5520A/5522A
4. AC Current	**29 µA to 20.5 A** (See Matrix B)	(See Matrix B)	

Matrix B
AC Current Sources

Range		Frequency (kHz)								
		0.01 to 0.02	**0.02 to 0.045**	**0.045 to 1**	**1 to 5**	**5 to 10**	**10 to 30**	**0.010 to 0.045**	**0.045 to 0.1**	**0.1 to 1**
329.99 µA	29 µA to 329.99 µA	2.0 + 0.0001	1.5 + 0.0001	1.3 + 0.0001	3.0 + 0.00015	8.0 + 0.0002	16 + 0.0004	-	-	-
3.2999 mA	0.33 mA to 3.2999 mA	2.0 + 0.00015	1.3 + 0.00015	1.0 + 0.00015	2.0 + 0.0002	5.0 + 0.0003	10 + 0.0006	-	-	-
32.999 mA	3.3 mA to 32.999 mA	1.8 + 0.002	0.9 + 0.002	0.4 + 0.002	0.8 + 0.002	2.0 + 0.003	4.0 + 0.004	-	-	-
329.99 mA	33 mA to 329.99 mA	1.8 + 0.02	0.9 + 0.02	0.4 + 0.02	1.0 + 0.05	2.0 + 0.1	4.0 + 0.2	-	-	-
1.09999 A	330 mA to 1.09999 A	-	-	0.5 + 0.1	6.0 + 1	25 + 5	-	1.8 + 0.1	-	-
2.99999 A	1.1 A to 2.99999 A	-	-	0.6 + 0.1	6 + 1	25 + 5	-	1.8 + 0.1	-	-
10.9999 A	3 A to 10.9999 A	-	-	-	30 + 2	-	-	-	0.6 + 2	1 + 2
20.5 A	11 A to 20.5A	-	-	-	30 + 5	-	-	-	1.2 + 5	1.5 +5

The calibration uncertainties given in this table are expressed in mA/A + mA

SCOPE OF CALIBRATION: ELECTRICAL

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
5. DC Resistance	0 Ω to 10.9999 Ω 11 Ω to 32.9999 Ω 33 Ω to 109.9999 Ω 110 Ω to 1.099999 kΩ 1.1 kΩ to 10.99999 kΩ 11 kΩ to 109.9999 kΩ 110 kΩ to 1.099999 MΩ 1.1 MΩ to 3.299999 MΩ 3.3 MΩ to 10.99999 MΩ 11 MΩ to 32.99999 MΩ 33 MΩ to 109.9999 MΩ 110 MΩ to 329.9999 MΩ 330 MΩ to 1100 MΩ	40 μΩ/Ω+ 1.0 mΩ 30 μΩ/Ω+ 1.5 mΩ 28 μΩ/Ω+ 1.4 mΩ 28 μΩ/Ω+ 2.0 mΩ 28 μΩ/Ω + 20 mΩ 28 μΩ/Ω + 0.20 Ω 32 μΩ/Ω + 2.0 Ω 60 μΩ/Ω + 30 Ω 130 μΩ/Ω + 50 Ω 250 μΩ/Ω + 2.5 kΩ 500 μΩ/Ω + 3.0 kΩ 3.0 mΩ/Ω+ 100 kΩ 15 mΩ/Ω + 500 kΩ	Generation using calibrator model Fluke 5520A/5522A
6. Capacitance	0.19 nF to 3.2999 nF 3.3 nF to 10.9999 nF 11 nF to 109.999 nF 110 nF to 329.999 nF 0.33 μF to 1.09999 μF 1.1 μF to 3.29999 μF 3.3 μF to 10.9999 μF 11 μF to 32.9999 μF 33 μF to 109.999 μF 110 μF to 329.999 μF 330 μF to 1.09999 mF 1.1 mF to 3.2999 mF 3.3 mF to 10.9999 mF 11 mF to 32.9999 mF 33 mF to 110 mF	5.0 mF/F + 10 pF 2.5 mF/F + 10 pF 2.5 mF/F + 100 pF 2.5 mF/F + 300 pF 2.5 mF/F + 1.0 nF 2.5 mF/F + 3.0 nF 2.5 mF/F + 10 nF 4.0 mF/F + 30 nF 4.5 mF/F + 100 nF 4.5 mF/F + 300 nF 4.5 mF/F + 1.0 μF 4.5 mF/F + 3.0 μF 4.5 mF/F + 10 μF 7.5 mF/F + 30 μF 11 mF/F + 100 μF	Generation using calibrator model Fluke 5520A/5522A
7. Frequency a. Source	50 kHz to 1100 MHz	2.5 μHz/Hz	Generation using calibrator model Fluke 5520A/5522A

SCOPE OF CALIBRATION: ELECTRICAL

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
7. Frequency b. Amplitude	<u>0.01 Vpp to 5.00 Vpp</u> 1 µHz to 100 kHz 100 kHz to 20 MHz 20 MHz to 30.2 MHz <u>5 Vpp to 10 Vpp</u> 1 µHz to 100 kHz 100 kHz to 20 MHz 20 MHz to 30.2 MHz	 47 mV/V 47 mV/V 59 mV/V 23 mV/V 23 mV/V 35 mV/V	Generated Using Calibrator Model DS345
<u>B. Sources</u> 1. DC Voltage	0 mV to 210 mV 0.21 V to 2.1 V 2.1 V to 21 V 21 V to 210 V 210 V to 1100 V	23 µV/V + 0.0018 mV 14 µV/V + 0.0000018 V 13 µV/V + 0.000003 V 25 µV/V + 0.0004 V 26 µV/V + 0.004 V	Measured Using Calibrator Model Keithley 2002
2. AC Voltage	**200 mV to 750 V** (See Matrix C)	(See Matrix C)	

Matrix C
AC Voltage Measurements

Range	Frequency (kHz)									
	0.02 to 0.05	**0.05 to 0.1**	**0.1 to 2**	**2 to 10**	**10 to 30**	**30 to 50**	**50 to 100**	**100 to 200**	**200 to 1000**	**1000 to 2000**
200 mV	2.5 + 0.03	0.7 + 0.03	0.2 + 0.02	0.2 + 0.02	0.25 + 0.02	0.5 + 0.02	3.0 + 0.02	7.5 + 0.05	20 +0.2	50 + 0.4
2 V	2.5 + 0.3	0.7 + 0.3	0.2 + 0.2	0.2 + 0.2	0.25 + 0.2	0.5 + 0.2	3.0 + 0.2	7.5 + 0.2	20 + 2	50 + 4
20 V	2.5 + 3	0.7 + 3	0.3 + 3	0.4 + 3	0.5 + 3	0.7 + 3	30 + 3	7.5 + 3	20 + 40	-
200 V[1]	2.5 + 30	0.7 + 30	0.3 + 30	0.4 + 30	0.5 + 30	0.7 + 30	30 +30	-	-	-
750 V[1]	2.5 + 30	0.7 + 30	0.3 + 30	-	-	-	-	-	-	-

[1] Additional uncertainty 0.010 mV/V*(Vin/100V)^2 for input above 100V
The calibration uncertainties given in this table are expressed in mV/V + mV

SCOPE OF CALIBRATION: ELECTRICAL

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
3. DC Current	0 µA to 210 µA 0 mA to 2.1 mA 0 mA to 21 mA 0 mA to 210 mA 0 A to 2 A	400 µA/A + 0.005 µA 309 µA/A + 0.00004 mA 410 µA/A + 0.0004 mA 540 µA/A + 0.004 mA 880 µA/A + 0.00004 A	Measured Using Calibrator Model Keithley 2002
	2 A to 10 A	2mA/A + 0.7 mA	Measured Using Calibrator Model Fluke 45
4. AC Current	200 µA to 2 A (See Matrix D)	(See Matrix D)	Measured Using Calibrator Model Keithley 2002

Matrix D
AC Current Measurements

Range	Frequency (kHz)			
	0.02 to 0.05	**0.05 to 0.2**	**0.2 to 1**	**1 to 10**
200 µA	3.5 + 0.00003	20 + 0.00003	40 + 0.00003	50 + 0.00003
2 mA	3.0 + 0.0003	1.5 + 0.0003	1.2 + 0.0003	1.2 + 0.0003
20 mA	3.0 + 0.003	1.5 + 0.003	1.2 + 0.003	1.2 + 0.003
200 mA	3.0 + 0.03	1.5 + 0.03	1.2 + 0.03	1.2 + 0.03
2 A	3.5 + 0.3	20 + 0.3	30 + 0.3	4.5 + 0.3

The calibration uncertainties given in this table are expressed in mA/A + mA

SCOPE OF CALIBRATION: ELECTRICAL

SITE: CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
5. DC Resistance	0Ω to 20 Ω 0Ω to 200 Ω 0Ω to 2 kΩ 0Ω to 20 kΩ 0Ω to 200 kΩ 0Ω to 2 MΩ 0Ω to 20 MΩ 0Ω to 200 MΩ	47 μΩ/Ω + 0.00012 Ω 25 μΩ/Ω + 0.0008 Ω 16 μΩ/Ω + 0.0000008 kΩ 17 μΩ/Ω + 0.000008 kΩ 43 μΩ/Ω + 0.00018 Ω 80 μΩ/Ω + 0.000001 MΩ 270 μΩ/Ω + 0.000012 MΩ 570 μΩ/Ω + 0.0006 MΩ	Measured Using Calibrator Model Keithley 2002
6. Frequency	1.0 Hz – 10 MHz 10 MHz – 100 MHz 100 MHz – 1.3 GHz	1 μHz/Hz + 0.1 Hz 1 μHz/Hz + 1 Hz 1 μHz/Hz + 10 Hz	Measured Using Calibrator Model CMC251
Oscilloscope			
7. Vertical Amplitude Pk-Pk (1 MΩ Load)	200 μV to 1 mV	2.5 mV/V + 1 μV	Generation using calibrator model Tek PG506A
Pk-Pk (50 Ω Load)	1 mV to 130 V	1.0 mV/V + 40 μV	Generation using calibrator model Fluke 5520A/5522A
	100 μV to 5 V	2.5 mV/V + 1 μV	Generation using calibrator model Tek PG506A
	5 V to 6.6 V	2.5 mV/V + 40 μV	Generation using calibrator model Fluke 5520A/5522A
DC (1 MΩ Load)	0 V to 130 V	0.5 mV/V + 40 μV	
DC (50 Ω Load)	0 V to 6.6 V	2.5 mV/V + 40 μV	
8. Time Base	1 ns to 5 s	0.5 μs/s	Generation using calibrator model Fluke TG501A

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
9. Bandwith Amplitude Flatness			
50 kHz to 100 MHz	5 mV to 5.5 Vp-p	(15 mV/V + 100 µV) at ref.	Generated Using Calibrator Model Fluke 5520A/5522A
100 MHz to 300 MHz	5 mV to 5.5 V	(20 mV/V + 100 µV) at ref.	
300 MHz to 1050 MHz	0.5 V to 4 Vp-p	40 mV/V at ref.	Generated Using Calibrator Model Tek SG504
1050 MHz to 1100 MHz	5 mV to 3.5 V	(50 mV/V + 100 µV) at ref.	Generated Using Calibrator Model Fluke 5520A/5522A
1 GHz to 4 GHz	-60 dBm to 20 dBm	0.20 dB	Levelling Method (MG3694C, NRVS, NRV-Z15, Splitter)
4 GHz to 6 GHz		0.23 dB	
6 GHz to 12.4 GHz		0.24 dB	
12.4 GHz to 15 GHz		0.25 dB	
15 GHz to 16 GHz		0.26 dB	
16 GHz to 26.5 GHz		0.27 dB	
10. Bandwith Frequency	50 kHz to 26.5 GHz	5×10^{-10}	Generated Using Calibrator Model MG3694C

Signatories:

1. **Lim Aing Khoon**
2. *** Ramlah Mamat**
3. *** Rafizi Affandi**
4. *** Lalyn Soriano Duco**

***** Non-resident

SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
Active And Differential Probe 11. Rise Time	≥ 17.5 ps	12 ps	Generated Using Pulse Generator 80E04 and Measuring by DSA8200 and 80E03 Sampling Module

Signatories:

1. **Lim Aing Khoon**
2. *** Rafizi Affandi**
3. *** Lalyn Soriano Duco**

***** Non Resident