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MS ISO/IEC 17025

NO: SAMM 605

LABORATORY LOCATION: (PERMANENT LABORATORY)

TEKTRONIX MALAYSIA CALIBRATION LABORATORY
TEKTRONIX INSTRUMENTS MALAYSIA SDN. BHD.
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PENANG, MALAYSIA

FIELD OF CALIBRATION: **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: ELECTRICAL

PERMANENT LABORATORY AND SITE CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
DC Voltage Source	0 mV to 100 mV 100 mV to 1 V 1 V to 10 V 10 V to 100 V 100 V to 1000 V	5.5 µV/V + 0.78 µV 4.7 µV/V + 0.78 µV 4.7 µV/V + 1.6 µV 6.2 µV/V + 24 µV 6.2 µV/V + 78 uV + 9.3×10^{-6} * Vin^2 µV/V	Measurement using Agilent 3458A
	0 mv to 200 mV 200 mV to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V	4.5 µV/V + 0.1 µV 3 µV/V + 0.4 µV 3 µV/V + 4 µV 4.5 µV/V + 40 µV 4.5 µV/V + 1000 µV	Measurement using Fluke 8508A
DC Current Source	0 nA to 100 nA 0.1 µA to 1 µA 1 µA to 10 µA 10 µA to 100 µA 100 µA to 1 mA 1 mA to 10 mA 10 mA to 100 mA 100 mA to 1 A	27 µA/A + 0.031 nA 20 µA/A + 0.000031 µA 20 µA/A + 0.000078 µA 20 µA/A + 0.00062 µA 20 µA/A + 0.0039 µA 20 µA/A + 0.039 µA 31 µA/A + 0.39 µA 90 µA/A + 7.8 µA	Measurement using Agilent 3458A

SCOPE OF CALIBRATION: ELECTRICAL

PERMANENT LABORATORY AND SITE CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
DC Current Source (continue)	0 µA to 200 µA 200 µA to 2mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A 2 A to 20 A	12 µA/A + 0.00042 µA 12 µA/A + 0.00042 µA 13 µA/A + 0.042 µA 36 µA/A + 0.042 µA 170 µA/A + 0.17 µA 380 µA/A + 420 µA	Measurement using Fluke 8508A
Resistance Source	0 Ω to 10 Ω 10 Ω o 100 Ω 100 Ω to 1 kΩ 1 kΩ to 10 kΩ 10 kΩ to 100 kΩ 100 kΩ to 1 MΩ 1 MΩ to 10 MΩ 10 MΩ to 100 MΩ	14 µΩ/Ω + 39 µΩ 12 µΩ/Ω + 390 µΩ 10 µΩ/Ω + 390 µΩ 10 µΩ/Ω + 3.9 mΩ 10 µΩ/Ω + 39 mΩ 14 µΩ/Ω +1.6 Ω 41 µΩ/Ω + 78 Ω 390 µΩ/Ω + 780 Ω	Measurement using Agilent 3458A
	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 200 MΩ	15 µΩ/Ω + 4 µΩ 9 µΩ/Ω + 14 µΩ 7.5 µΩ/Ω + 50 µΩ 7.5 µΩ/Ω + 500 µΩ 7.5 µΩ/Ω + 5 mΩ 7.5 µΩ/Ω + 50 mΩ 8.5 µΩ/Ω + 1 Ω 15 µΩ/Ω + 100 µΩ 60 µΩ/Ω + 10 kΩ	Measurement using Fluke 8508A
AC Voltage Source	0 V to 1000 V (See Matrix A)	See Matrix A	Measurement using Agilent 3458A
	0 V to 1000 V (See Matrix B)	See Matrix B	Measurement using Fluke 8508A
AC Current Source	0 µA to 1 A (See Matrix C)	See Matrix C	Measurement using Agilent 3458A
	0 µA to 1 A (See Matrix D)	See Matrix D	Measurement using Fluke 8508A

SCOPE OF CALIBRATION: ELECTRICAL

PERMANENT LABORATORY AND SITE CATEGORY I

Matrix A – AC Voltage Source

Range	Frequency								
	Hz			kHz			MHz		
	10 to 20	20 to 40	40 to 100	0.1 to 20	20 to 50	50 to 100	0.1 to 0.25	0.25 to 0.5	0.5 to 1
0 mV to 10 mV	3.1 + 0.025	1.2 + 0.02	0.47 + 0.02	0.16 + 0.02	1.2 + 0.02	5.5 + 0.028	31 + 0.055	-	-
10 mV to 100 mV	3.1 + 0.016	1.2 + 0.016	0.47 + 0.0078	0.16 + 0.0078	1.2 + 0.031	4.7 + 0.062	16 + 0.39	-	-
100 mV to 1 V	-	1.2 + 0.16	0.47 + 0.078	0.16 + 0.078	1.2 + 0.31	4.7 + 0.62	16 + 3.9	24 + 4.7	39 + 16
1 V to 10 V	-	1.2 + 1.6	0.47 + 0.78	0.16 + 0.78	1.2 + 3.1	4.7 + 6.2	16 + 39	24 + 47	39 + 160
10 V to 100 V	-	1.2 + 1.6	0.47 + 7.8	0.24 + 7.8	1.2 + 31	4.7 + 62	16 + 390	-	-
100 V to 1000 V	-	-	0.63 + 160	0.47 + 160	1.2 + 310	4.7 + 1600	-	-	-

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

Matrix B – AC Voltage Source

Range	Frequency							
	Hz		kHz					MHz
	10 to 40	40 to 100	0.1 to 2	2 to 10	10 to 30	30 to 100	100 to 300	0.3 to 1
0 to 200 mV	0.13 + 0.004	0.11 + 0.004	0.11 + 0.002	0.11 + 0.004	0.31 + 0.008	0.71 + 0.02	-	-
200 mV to 2 V	0.11 + 0.02	0.085 + 0.02	0.065 + 0.02	0.085 + 0.02	0.21 + 0.04	0.51 + 0.2	-	-
2 V to 20 V	0.11 + 0.2	0.085 + 0.2	0.065 + 0.2	0.085 + 0.2	0.21 + 0.4	0.51 + 2	3 + 20	10 +200
20 V to 200 V	0.11 + 2	0.085 + 2	0.065 + 2	0.085 + 2	0.21 + 4	0.51 +20	-	-

Range	Frequency	
	kHz	
	0.04 to 10	10 to 30
200 V to 300 V	0.095 + 40	0.21 + 80
300 to 1000 V	[0.095 + (0.0000004*(Vin-300)^2)] + 40	[0.21 + (0.0000024*(Vin-300)^2)] + 80

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

SCOPE OF CALIBRATION: ELECTRICAL

PERMANENT LABORATORY AND SITE CATEGORY I

Matrix C – AC Current Source

Range	Frequency				
	Hz			kHz	
	10 to 20	20 to 45	45 to 100	0.1 to 5	5 to 20
0 µA to 100 µA	3.1 + 0.024	1.2 + 0.024	0.47 + 0.024	0.47 + 0.024	-
100 µA to 1 mA	3.1 + 0.16	1.2 + 0.16	0.47 + 0.16	0.24 + 0.16	0.47 + 0.16
1 mA to 10 mA	3.1 + 1.6	1.2 + 1.6	0.47 + 1.6	0.24 + 1.6	0.47 + 1.6
10 mA to 100 mA	3.1 + 16	1.2 + 16	0.47 + 16	0.24 + 16	0.47 + 16
100 mA to 1 A	3.1 + 160	1.3 + 160	0.63 + 160	0.78 + 160	2.4 + 160

Matrix D – AC Current Source

Range	Frequency
	kHz
	0.01 to 10
0 µA to 200 µA	0.48 + 0.02
200 µA to 2 mA	0.28 + 0.2
2 mA to 20 mA	0.28 + 2
20 mA to 200 mA	0.25 +20

Range	Frequency	
	kHz	
	0.01 to 2	2 to 10
200 mA to 2 A	0.6 + 0.2	0.71 + 0.2
2 A to 20 A	0.8 + 2	2.5 + 2

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

SCOPE OF CALIBRATION: ELECTRICAL

PERMANENT LABORATORY AND SITE CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
DC Voltage Measurement	0 mV 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 1100 V	7.5 µV/V + 0.4 µV 5 µV/V + 0.7 µV 3.5 µV/V + 2.5 µV 3.5 µV/V + 4 µV 5 µV/V + 40 µV 6.5 µV/V + 400 µV	Measurement using Fluke 5720A
DC Current Measurement	0 µA to 220 µA 220 µA to 2.2 mA 2.2 mA to 22 mA 22 mA to 100 mA 100 mA to 220 mA 220 mA to 1 A 1 A to 2.2 A	40 µA/A + 6 nA 35 µA/A + 7 nA 35 µA/A + 40 nA 45 µA/A + 0.7 µA (45 µA/A + 200 µA/A *I^2) + 0.7 µA 80 µA/A + 12 µA (80 µA/A + 10 µA/A * I^2) + 12 µA	Measurement using Fluke 5720A
	2.2 A to 11 A	360 µA/A + 480 µA	Measurement using Fluke 5725A
Resistance Measurement (Specific Value)	1 Ω 1.9 Ω 10 Ω 19 Ω 100 Ω 190 Ω 1 kΩ 1.9 kΩ 10 kΩ 19 kΩ 100 kΩ 190 kΩ 1 MΩ 1.9 MΩ 10 MΩ 19 MΩ 100 MΩ	95 µΩ/Ω 95 µΩ/Ω 23 µΩ/Ω 23 µΩ/Ω 10 µΩ/Ω 10 µΩ/Ω 8.5 µΩ/Ω 8.5 µΩ/Ω 8.5 µΩ/Ω 8.5 µΩ/Ω 11 µΩ/Ω 11 µΩ/Ω 20 µΩ/Ω 21 µΩ/Ω 40 µΩ/Ω 47 µΩ/Ω 100 µΩ/Ω	Measurement using Fluke 5720A
AC Voltage Measurement	2.2 mV to 220 V (See Matrix E)	See Matrix E	Measurement using Fluke 5720A
	220 V to 1100 V (See Matrix E)	See Matrix E	Measurement using Fluke 5725A

SCOPE OF CALIBRATION: ELECTRICAL

PERMANENT LABORATORY AND SITE CATEGORY I

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
AC Current Measurement	0 µA to 2.2 A (see Matrix F)	see Matrix F	Measurement using Fluke 5720A
	2.2 A to 11 A (see Matrix F)	see Matrix F	Measurement using Fluke 5725A

Matrix E – AC Voltage Measurement

Range	Frequency							
	Hz		kHz			MHz		
	10 to 20	20 to 40	0.04 to 20	20 to 50	50 to 100	0.1 to 0.3	0.3 to 0.5	0.5 to 1
2.2 mV to 22 mV	0.24 + 0.004	0.09 + 0.004	0.08 + 0.004	0.2 + 0.004	0.5 + 0.005	1.1 + 0.01	-	-
22mV to 220 mV	0.24 + 0.012	0.09 + 0.007	0.08 + 0.007	0.2 + 0.007	0.46 + 0.017	0.9 + 0.02	-	-
220 mV to 2.2 V	0.24 + 0.04	0.09 + 0.015	0.045 + 0.008	0.075 + 0.01	0.11 + 0.03	0.42 + 0.08	1 + 0.2	1.7 + 0.3
2.2 V to 22 V	0.24 + 0.4	0.09 + 0.15	0.045 + 0.05	0.075 + 0.1	0.1 + 0.2	0.28 + 0.6	1 + 2	1.5 + 3.2
22 V to 220 V	0.24 + 4	0.09 + 1.5	0.052 + 0.6	0.08 + 1	0.15 + 2.5	-	-	-

Range	Frequency				
	kHz				
	0.04 to 1	1 to 20	20 to 30	30 to 50	50 to 100
220 V to 750 V	-	-	-	0.6 +11	2.3 + 45
750 V to 1100 V	0.09 + 4	0.17 + 6	0.6 + 11	-	-

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

SCOPE OF CALIBRATION: ELECTRICAL

PERMANENT LABORATORY AND SITE CATEGORY I

Matrix F – AC Current Measurement

Range	Frequency				
	Hz		kHz		
	10 to 20	20 to 40	0.04 to 1	1 to 5	5 to 10
0 µA to 220 µA	0.25 + 0.016	0.16 + 0.01	0.12 + 0.008	0.28 + 0.012	1.1 + 0.065
220 µA to 2.2 mA	0.25 + 0.04	0.16 + 0.035	0.12 + 0.035	0.2 + 0.11	1.1 + 0.65
2.2 mA to 22 mA	0.25 + 0.4	0.16 + 0.35	0.12 + 0.35	0.2 + 0.55	1.1 + 5
22 mA to 220 mA	0.25 +4	0.16 + 3.5	0.12 + 2.5	0.2 + 3.5	1.1 + 10

Range	Frequency		
	kHz		
	0.02 to 1	1 to 5	5 to 10
220 mA to 2.2 A	0.26 + 35	0.45 + 80	7 + 160

Range	Frequency		
	kHz		
	0.04 to 1	1 to 5	5 to 10
2.2 A to 11 A	0.46 + 170	0.95 + 380	3.6 + 750

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

Signatories:

1. **Ching Gin Kong**
2. **Tan Chin Seong**