STANDARDS MALAYSIA

ACCREDITED LABORATORY

MS ISO/IEC 17025

Certificate of Accreditation

No: SAMM 122 Valid until: 21 October 2011

This is to certify that

INTEGRAJAYA CALIBRATION TECHNOLOGIES SDN BHD
PULAU PINANG
MALAYSIA
(FIELDS OF CALIBRATION: ELECTRICAL & TEMPERATURE)

has been granted accreditation in respect of the scope of accreditation described in the SCHEDULE attached, subject to the terms and conditions governing the *Skim Akreditasi Makmal Malaysia* (SAMM), the Laboratory Accreditation Scheme of Malaysia.

Laboratories accredited under SAMM meet the requirements of MS ISO/IEC 17025 'General requirements for the competence of testing and calibration laboratories'. This Malaysian Standard is identical with ISO/IEC 17025 published by the International Organization for Standardization (ISO).

"This laboratory is accredited in accordance with recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF Communique dated 18 June 2005)"

STANDARDS MALAYSIA

(RIDZWAN KASIM)
for the Director General
Department of Standards Malaysia
Date of issue: 20 October 2008

Issuance of this certificate is governed by Section 16 Subsection (2) and (3) of Standards of Malaysia Act 1996, (Act 549)

Issue date : 26 October 2010
Valid until : 21 October 2011

MS ISO/IEC 17025

NO. SAMM 122
(Issue 3, 26 October 2010 replacement of SAMM 122 dated 5 October 2009)

LABORATORY LOCATION: (PERMANENT LABORATORY)

INTEGRAJAYA CALIBRATION TECHNOLOGIES SDN BHD
NO. 737-5-5, KOMPLEKS SRI SUNGAI NIBONG
JALAN SULTAN AZLAN SHAH
11900 PENANG, MALAYSIA

The standard used for assessment of this laboratory is MS ISO/IEC 17025:2005

*** The expanded uncertainties are based on an estimated confidence probability of not less than 95% and have a coverage factor of k=2 unless stated otherwise.**

(1) The CMC is expressed as ± (Of Indication in µV/V + floor value in µV)

FIELD OF CALIBRATION **ELECTRICAL**

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability expressed as an uncertainty (±)*	Remarks
1. Indicating instrument			
DC VOLTAGE	0 µV to 200 µV 0.2 mV to 2.0 mV 2 mV to 20 mV 20 mV to 200 mV 0.2 V to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V	6.4 µV/V + 0.44 µV 6.5 µV/V + 0.43 µV 6.9 µV/V + 0.43 µV 7.9 µV/V + 0.42 µV 6.5 µV/V + 0.82 µV 6.0 µV/V + 3.3 µV 9.5 µV/V + 55 µV 8.7 µV/V + 0.41 mV	Generation using calibrator model Wavetek 4800A
DC CURRENT	0 to 200 µA 0.2 m to 2 mA 2 mA to 20 mA 20 mA to 200 mA 0.2 A to 2 A	97 µA/A + 1.7 nA 51 µA/A + 17 nA 57 µA/A + 85 nA 50 µA/A + 0.84 µA 0.11 mA/A + 25 µA	Generation using calibrator model Wavetek 4800A
	0.32 A to 3.2 A 3.2 A to 10.5 A	0.68 mA/A + 0.14 mA 0.61 mA/A + 1.1 mA	Generation using calibrator model Wavetek 9100

FIELD OF CALIBRATION **ELECTRICAL**

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability expressed as an uncertainty (±)*	Remarks
1. Indicating instrument			
DC CURRENT	3.2 A to 32 A 32 A to 105 A 105 A to 200 A	1.3mA/A + 50mA 2.2mA/A + 25mA 2.3mA/A + 29mA	Generation using calibrator model Wavetek 9100 & 10 turn coil
	16 A to 160 A 160 A to 525 A 525 A to 1000 A	2.2mA/A + 29mA 2.3mA/A + 23mA 2.3mA/A + 0.1A	Generation using calibrator model Wavetek 9100 & 50 turn coil
AC VOLTAGE	0.09 mV to 1000 V	(See Matrix A)	Generation using calibrator model Wavetek 4800A
AC CURRENT	0 µA to 10.5 A	(See Matrix B)	Generation using calibrator model Wavetek 9100

Range	Frequency	
	(0.01 to 1) kHz	(1 to 5) kHz
9 µA to 200 µA	0.16 mA/A + 8.2 nA	0.34 mA/A + 12 nA
0.2 mA to 2 mA	0.12 mA/A + 82 nA	0.25 mA/A + 80 nA
2 mA to 20 mA	0.11 mA/A + 0.8 µA	0.25 mA/A + 0.81 µA
20 mA to 200 mA	0.11 mA/A + 8 µA	0.25 mA/A + 8.1 µA
0.2 A to 2 A	0.28 mA/A + 85 µA	0.46 mA/A + 110 µA

Generation using calibrator model Wavetek 4800A

Range	Frequency	
	(10 to 100) Hz	(100 to 440) Hz
3.2 A to 32 A	2.2 mA/A + 48 mA	8.5 mA/A + 52 mA
32 A to 200 A	3.2 mA/A + 96 mA	7.9 mA/A + 280 mA
16 A to 160 A	3.1 mA/A + 43 mA	-
160 A to 1000 A	3.2 mA/A + 440 mA	-

Generation using calibrator model Wavetek 9100 & 10/50 turn coil

DC RESISTANCE (Specific Value)	10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	0.32 mΩ 15 mΩ 14 mΩ 14 Ω 18 Ω 36 Ω 0.72 kΩ 7 kΩ	Generation using calibrator model Wavetek 4800A

FIELD OF CALIBRATION **ELECTRICAL**

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability expressed as an uncertainty (±)*	Remarks
1. Indicating instrument			
DC 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	0.56 mΩ/Ω + 23 mΩ 0.17 mΩ/Ω + 25 mΩ 0.17 mΩ/Ω + 0.1 Ω 0.17 mΩ/Ω + 1 Ω 0.20 mΩ/Ω + 12 Ω 0.22 mΩ/Ω + 0.14 kΩ 0.56 mΩ/Ω + 2.4 kΩ 0.64 mΩ/Ω + 64 kΩ	Generation using calibrator model Wavetek 9100
CAPACITANCE	**Range** / **Frequency**		Generation using calibrator model Wavetek 9100
		≤ 350 Hz / **0.35 to 1.5 kHz**	
	0.5 nF to 4.0 nF	3.4 + 17 pF / 6.8 + 34 pF	
	4 nF to 40 nF	3.4 + 34 pF / 6.8 + 68 pF	
	40 nF to 400 nF	3.4 + 0.18 nF / 6.8 + 0.36 nF	
	400 nF to 4 µF	4.5 + 1.8 nF / 9.1 + 3.6 nF	
	4 µF to 40 µF	5.7 + 18 nF / 11 + 36 nF	
	40 µF to 400 µF	5.7 + 0.18 µF / 11 + 0.36 µF	
	400 µF to 4 mF	5.7 + 1.8 µF / 11 + 3.6 µF	
	4 mF to 40 mF	11 + 68 µF / 23 + 0.14 mF	
CAPACITANCE (Specific Value)	**1 kHz** 1 pF 10 pF 100 pF 1000 pF	1.2 fF 12 fF 0.12 pF 1.2 pF	Generation using calibrator model Agilent 16380A
	1 kHz 0.01 µF 0.1 µF 1 µF	11 pF 0.11 nF 1.1 nF	Generation using calibrator model Agilent 16380C

FIELD OF CALIBRATION **ELECTRICAL**

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability expressed as an uncertainty (±)*	Remarks
1. Indicating instrument			
INDUCTANCE	**1 kHz** 1mH to 900 mH	23 mH/H + 0.57 µH	Generation using calibrator model IET LS-400A
INDUCTANCE (Specific Value)	**100 Hz, 120Hz, 1 kHz, 10 kHz, 100 kHz** 100 µH 1 mH 10 mH 100 mH 1 H	61 nH 0.61 µH 6.1 µH 61 µH 0.61 mH	Generation using calibrator model General Radio 1482
FREQUENCY	0.1 Hz to 1 GHz	85 nHz/Hz	Using 10 MHz Reference model Fluke PM6680B
2. Oscilloscope			
a) Bandwidth	100 mHz to 100 MHz 100.01 MHz to 550 MHz 550.01 MHz to 1.1 GHz	22 mHz/Hz 34 mHz/Hz 43 mHz/Hz	Generation using calibrator model Fluke 9500/9510
b) Time Base	450 ps to 900 ps @ 100 mV to 500 mV 900 ps to 55 sec @ 100 mV to 1 V	1.1 ms/s 1.1 ms/s	Generation using calibrator model Fluke 9500/9510

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FIELD OF CALIBRATION **ELECTRICAL**

SCOPE OF ACCREDITATION:

<table>
<tr><th>Instrument Calibrated/ Measurement Parameter</th><th>Range</th><th>Calibration and Measurement Capability expressed as an uncertainty (±)*</th><th>Remarks</th></tr>
<tr><td colspan="4">2. Oscilloscope</td></tr>
<tr><td>c) Amplitude</td><td colspan="2"><table>
<tr><th rowspan="2">Range</th><th colspan="2">DC Signal (±)</th><th colspan="2">Square Signal (10Hz to 10kHz)</th></tr>
<tr><th>Into 50Ω</th><th>Into 1MΩ</th><th>Into 50Ω</th><th>Into 1MΩ</th></tr>
<tr><td>35µV to 1 mV</td><td>0.25mV/V + 26µV</td><td>0.25mV/V + 25µV</td><td>10mV/V + 1.1µV</td><td>10mV/V + 1.1µV</td></tr>
<tr><td>1mV to 21mV</td><td>0.25mV/V + 26µV</td><td>0.25mV/V + 25µV</td><td>2.4mV/V + 3.6µV</td><td>2.5mV/V + 1µV</td></tr>
<tr><td>21mV to 100mV</td><td>0.25mV/V + 26µV</td><td>0.25mV/V + 25µV</td><td>0.99mV/V + 1.7µV</td><td>0.99mV/V + 1.8µV</td></tr>
<tr><td>100mV to 556mV</td><td>0.25mV/V + 26µV</td><td>0.25mV/V + 45µV</td><td>0.98mV/V + 16µV</td><td>0.98mV/V + 16µV</td></tr>
<tr><td>556mV to 5.5V</td><td>0.25mV/V + 26µV</td><td>0.25mV/V + 45µV</td><td>0.44mV/V + 0.33mV</td><td>0.47mV/V + 0.3mV</td></tr>
<tr><td>5.5V to 10V</td><td>-</td><td>0.25mV/V + 45µV</td><td>-</td><td>0.47mV/V + 0.3mV</td></tr>
<tr><td>10V to 100V</td><td>-</td><td>0.25mV/V + 81µV</td><td>-</td><td>0.40mV/V + 35mV</td></tr>
<tr><td>100V to 210V</td><td>-</td><td>0.25mV/V + 93µV</td><td>-</td><td>0.40mV/V + 35mV</td></tr>
<tr><td>210V to 222V</td><td>-</td><td>0.25mV/V + 93µV</td><td>-</td><td>-</td></tr>
</table></td><td>Generation using calibrator model Fluke 9500/9510</td></tr>
<tr><td colspan="4">3. Source</td></tr>
<tr><td rowspan="2">DC VOLTAGE</td><td>0 to 200 mV
0.2 V to 2 V
2 V to 20 V
20 V to 200 V
200 V to 1000 V</td><td>9.1 µV/V + 0.11 µV
7.6 µV/V + 0.41 µV
7.2 µV/V + 2.1 µV
12 µV/V + 43 µV
12 µV/V + 42 µV</td><td>Measurement using Multimeter model Wavetek 1281</td></tr>
<tr><td>1 kV to 10 kV</td><td>0.57 mV/V + 0.57 V</td><td>Measurement using High Voltage Meter model Vallaha 4600</td></tr>
<tr><td rowspan="3">AC VOLTAGE</td><td>0 to 1000 V</td><td>(See Matrix C)</td><td>Measurement using Multimeter model Wavetek 1281</td></tr>
<tr><td>1 kV to 2 kV
@ 20 Hz to 60 Hz</td><td>1.1 mV/V + 2.3 V</td><td>Measurement using High Voltage Meter model Vallaha 4600</td></tr>
<tr><td>2 kV to 15 kV
@ 20 Hz to 60 Hz</td><td>5.7 mV/V + 57 V</td><td>Measurement using High Voltage Meter model Vallaha 4600</td></tr>
<tr><td>DC CURRENT</td><td>0 to 200 µA
0.2 mA to 2 mA
2 mA to 20 mA
20 mA to 200 mA
0.2 A to 2 A
2 A to 10 A</td><td>0.12 mA/A + 0.45 nA
0.12 mA/A + 4.5 nA
0.12 mA/A + 45 nA
0.11 mA/A + 1.1 µA
0.23 mA/A + 22 µA
0.10 mA/A + 0.6 µA</td><td>Measurement using Multimeter model Wavetek 1281</td></tr>
</table>

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FIELD OF CALIBRATION **ELECTRICAL**

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability expressed as an uncertainty (±)*	Remarks
3. Source			
AC CURRENT	0 to 2 A	(See Matrix D)	Measurement using Multimeter model Wavetek 1281
	2 A to 10 A	(See Matrix D)	Measurement using Multimeter & Current Shunt model Wavetek 1281 & Wavetek 4953
DC RESISTANCE	0 to 20 Ω 20 Ω to 200 Ω 0.2 kΩ to 2 kΩ 2 kΩ to 20 kΩ 20 kΩ to 200 kΩ 0.2 MΩ to 2 MΩ 2 MΩ to 20 MΩ 20 MΩ to 200 MΩ 0.2 GΩ to 1GΩ	18 μΩ/Ω + 22 μΩ 13 μΩ/Ω + 65 μΩ 11 μΩ/Ω + 0.63 mΩ 11 μΩ/Ω + 6.3 mΩ 13 μΩ/Ω + 56 mΩ 20 μΩ/Ω + 1.3 Ω 37 μΩ/Ω + 87 Ω 0.35 mΩ/Ω + 10 kΩ 3.5 mΩ/Ω + 0.5 MΩ	Measurement using Multimeter model Wavetek 1281
RF POWER	**Range** / **Frequency**: (100 to 300) kHz		Measurement using Power Meter & Power Sensor model Agilent EPM441A & 8482A
	(0.3 to 1) MHz		
	(0.001 to 2) GHz		
	(2.0 to 4.2) GHz		
	-30 dBm to 20 dBm (1 μW to 100 mW into 50Ω)	2.8 % / 2.3 % / 2.3 % / 2.4 %	
FREQUENCY	100 mHz to 2.7 GHz	85 nHz/Hz	Measurement using Frequency Counter model Fluke PM6680B

Signatory:

NO.	NAME	I/C NO.
1.	Lam Sik Lee	731122-07-5254

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FIELD OF CALIBRATION **ELECTRICAL**

SCOPE OF ACCREDITATION:

Matrix A - AC Voltage Measurement

Range	Frequency						
	(10 to 31) Hz	(32 to 330) Hz	(0.3 to 10) kHz	(10 to 33) kHz	(30 to 100) kHz	(100 to 330) kHz	(0.300 to 1) MHz
0.09 mV to 2 mV	0.20 + 0.0051	0.20 + 0.0051	0.17 + 0.0051	0.27 + 0.0051	0.52 + 0.0051	1.1 + 0.021	2.2 + 0.024
0.2 mV to 20 mV	0.18 + 0.005	0.15 + 0.005	0.15 + 0.005	0.23 + 0.005	0.55 + 0.0049	1.1 + 0.021	2.3 + 0.024
20 mV to 200 mV	0.17 + 0.0077	0.13 + 0.0077	0.11 + 0.0074	0.21 + 0.0071	0.44 + 0.007	1.2 + 0.033	2.3 + 0.12
0.2 V to 2 V	0.12 + 0.026	0.073 + 0.017	0.074 + 0.0083	0.074 + 0.0082	0.13 + 0.017	0.39 + 0.084	2.1 + 0.34
2 V to 20 V	0.12 + 0.25	0.073 + 0.17	0.074 + 0.083	0.074 + 0.082	0.14 + 0.17	0.36 + 0.84	2.3 + 4.2
20 V to 200 V	0.17 + 2.6	0.11 + 1.7	0.074 + 0.82	0.083 + 1.7	0.27 + 2.5	0.77 + 42	8.2 + 110
200 V to 1000 V	0.2 + 17	0.2 + 17	0.16 + 17	0.19 + 33	0.28 + 10	-	-

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

Matrix B - AC Current Measurement

Range	Frequency			
	(0.01 to 3) kHz	(3 to 10) kHz	(10 to 20) kHz	(20 to 30) kHz
0 µA to 32 µA	0.79 + 1	1.1 + 2	2.3 + 6.8	2.8 + 10
32 µA to 320 µA	0.79 + 0.35	1.1 + 0.68	2.3 + 2.3	2.8 + 3.4
0.32 mA to 3.2 mA	0.75 + 0.48	1.1 + 0.68	2.3 + 2.3	2.8 + 3.4
3.2 mA to 32 mA	0.79 + 4.7	1.1 + 7.3	2.3 + 15	2.8 + 25
32 mA to 320 mA	0.91 + 36	1.1 + 55	2.3 + 73	2.8 + 110
0.32 A to 3.2 A	1.1 + 570	2.8 + 2900	-	-
3.2 A to 10.5 A	2.3 + 3400	5.7 + 11000	-	-

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

FIELD OF CALIBRATION **ELECTRICAL**

SCOPE OF ACCREDITATION:

Matrix C - AC Voltage Source

Range	Frequency							
	(10 – 40) Hz	(40 – 100) Hz	(0.1 – 2) kHz	(2 – 10) kHz	(10 – 30) kHz	(30 – 100) kHz	(100 – 300) kHz	(0.3 – 1) MHz
0 to 200mV	0.27+0.0044	0.25 +0.0045	0.23 +0.0023	0.23 +0.0045	0.48 +0.0089	0.90 +0.022	-	-
0.2V to 2V	0.20 +0.022	0.17 +0.022	0.15 +0.022	0.17 +0.022	0.28 +0.045	0.57 +0.23	3.4 +2.3	11 +23
2V to 20V	0.20 +0.22	0.17 +0.22	0.15 +0.22	0.17 +0.22	0.28 +0.45	0.57 +2.3	3.4 +2.3	11 +230
20V to 200V	0.20 +2.2	0.17 +2.2	0.15 +2.2	0.17 +2.2	0.28 +4.5	0.57 +23	3.4 +230	11 +2300
200V to 1000V	0.22 +10	0.20 +10	0.20 +10	0.20 +10	0.30 +22	0.60 +110	-	-

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

Matrix D - AC Current Source

Range	Frequency				
	(10 – 40) Hz	(40 – 300) Hz	(0.3 – 1) kHz	(1 – 5) kHz	(5 – 10) kHz
0 to 200 µA	0.38 + 0.022	0.38 + 0.022	0.38 + 0.022	0.38 + 0.022	-
0.2 mA to 2 mA	0.36 + 0.22	0.36 + 0.22	0.36 + 0.22	0.36 + 0.22	-
2 mA to 20 mA	0.35 + 2.3	0.35 + 2.3	0.35 + 2.3	0.35 + 2.3	-
20 mA to 200 mA	0.36 + 22	0.36 + 22	0.36 + 22	0.36 + 22	-
0.2 A to 2 A	0.69 + 450	0.69 + 450	0.69 + 450	2.3 + 910	-
2 A to 10 A	0.63 + 110	0.61 + 100	0.61 + 48	0.61 + 100	0.61 + 100

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

FIELD OF CALIBRATION **ELECTRICAL**

SITE CALIBRATION – CATEGORY 1

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability expressed as an uncertainty (±)*	Remarks
1. Indicating instrument			
DC VOLTAGE	0 µV to 200 µV 0.2 mV to 2.0 mV 2 mV to 20 mV 20 mV to 200 mV 0.2 V to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V	6.4 µV/V + 0.44 µV 6.5 µV/V + 0.43 µV 6.9 µV/V + 0.43 µV 7.9 µV/V + 0.40 µV 6.6 µV/V + 0.82 µV 6.0 µV/V + 3.3 µV 9.5 µV/V + 55 µV 8.7 µV/V + 0.41 mV	Generation using calibrator model Wavetek 4800A
DC CURRENT	0 to 200 µA 0.2 m to 2 mA 2 mA to 20 mA 20 mA to 200 mA 0.2 A to 2 A	97 µA/A + 1.7 nA 51 µA/A + 17 nA 57 µA/A + 85 nA 50 µA/A + 0.84 µA 0.11 mA/A + 25 µA	Generation using calibrator model Wavetek 4800A
	0.32 A to 3.2 A 3.2 A to 10.5 A	0.6 mA/A + 0.44 mA 0.6 mA/A + 1.2 mA	Generation using calibrator model Wavetek 9100
AC VOLTAGE	0.09 mV to 1000 V	(See Matrix E)	Generation using calibrator model Wavetek 4800A
AC CURRENT	0 µA to 10.5 A	(See Matrix F)	Generation using calibrator model Wavetek 9100

Range	Frequency	
	(0.01 to 1) kHz	(1 to 5) kHz
9 µA to 200 µA	0.16 mA/A + 8.2 nA	0.34 mA/A + 12 nA
0.2 mA to 2 mA	0.12 mA/A + 82 nA	0.25 mA/A + 80 nA
2 mA to 20 mA	0.11 mA/A + 0.8 µA	0.25 mA/A + 0.31 µA
20 mA to 200 mA	0.11 mA/A + 8 µA	0.25 mA/A + 8.1 µA
0.2 A to 2 A	0.28 mA/A + 83 µA	0.46 mA/A + 110 µA

Generation using calibrator model Wavetek 4800A

FIELD OF CALIBRATION **ELECTRICAL**

SITE CALIBRATION – CATEGORY 1

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability expressed as an uncertainty (±)*	Remarks
1. Indicating instrument			
DC RESISTANCE (Specific Value)	10 Ω 100 Ω 1 kΩ 10 kΩ 100 kΩ 1 MΩ 10 MΩ 100 MΩ	0.32 mΩ 15 mΩ 14 mΩ 14 Ω 18 Ω 36 Ω 0.72 kΩ 7 kΩ	Generation using calibrator model Wavetek 4800A
DC 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	0.56 mΩ/Ω + 23 mΩ 0.17 mΩ/Ω + 25 mΩ 0.17 mΩ/Ω + 0.1 Ω 0.17 mΩ/Ω + 1 Ω 0.20 mΩ/Ω + 12 Ω 0.22 mΩ/Ω + 0.14 kΩ 0.56 mΩ/Ω + 2.4 kΩ 0.64 mΩ/Ω + 64 kΩ	Generation using calibrator model Wavetek 9100
CAPACITANCE	**Range** / **Frequency**		
		≤ 350 Hz	**0.35 to 1.5 kHz**
	0.5 nF to 4.0 nF	3.4 + 17 pF	6.8 + 34 pF
	4 nF to 40 nF	3.4 + 34 pF	6.8 + 68 pF
	40 nF to 400 nF	3.4 + 0.18 nF	6.8 + 0.36 nF
	400 nF to 4 µF	4.5 + 1.8 nF	9.1 + 3.6 nF
	4 µF to 40 µF	5.7 + 18 nF	11 + 36 nF
	40 µF to 400 µF	5.7 + 0.18 µF	11 + 0.36 µF
	400 µF to 4 mF	5.7 + 1.8 µF	11 + 3.6 µF
	4 mF to 40 mF	11 + 68 µF	23 + 0.14 mF
			Generation using calibrator model Wavetek 9100
FREQUENCY	0.1 Hz to 1 GHz	85 nHz/Hz	Using 10 MHz Reference model Fluke PM6680B

FIELD OF CALIBRATION **ELECTRICAL**

SITE CALIBRATION – CATEGORY 1

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability expressed as an uncertainty (±)*	Remarks
2. Oscilloscope			
a. Bandwidth	100 mHz to 100 MHz 100.01 MHz to 550 MHz 550.01 MHz to 1.1 GHz	22 mHz/Hz 34 mHz/Hz 43 mHz/Hz	Generation using calibrator model Fluke 9500/9510
b. Time Markers	450 ps to 900 ps 100 mV to 500 mV 900 ps to 55 sec 100 mV to 1 V	1.1 ms/s 1.1 ms/s	Generation using calibrator model Fluke 9500/9510
c. Amplitude	See sub-table below		Generation using calibrator model Fluke 9500/9510
3. Source			
DC VOLTAGE	0 to 200 mV 0.2 V to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V	9.1 µV/V + 0.11 µV 7.6 µV/V + 0.41 µV 7.2 µV/V + 2.1 µV 12 µV/V + 43 µV 12 µV/V + 42 µV	Measurement using Multimeter model Wavetek 1281
AC VOLTAGE	0 to 1000 V	(See Matrix G)	Measurement using Multimeter model Wavetek 1281

Range	DC Signal (±)		Square Signal (10Hz to 10kHz)	
	Into 50Ω	Into 1MΩ	Into 50Ω	Into 1MΩ
35µV to 1 mV	0.25mV/V + 26µV	0.25mV/V + 25µV	10mV/V + 1.1µV	10mV/V + 1.1µV
1mV to 21mV	0.25mV/V + 26µV	0.25mV/V + 25µV	2.4mV/V + 3.6µV	2.5mV/V + 1µV
21mV to 100mV	0.25mV/V + 26µV	0.25mV/V + 25µV	0.99mV/V + 1.7µV	0.99mV/V + 1.8µV
100mV to 556mV	0.25mV/V + 26µV	0.25mV/V + 45µV	0.98mV/V + 16µV	0.98mV/V + 16µV
556mV to 5.5V	0.25mV/V + 26µV	0.25mV/V + 45µV	0.44mV/V + 0.33mV	0.47mV/V + 0.3mV
5.5V to 10V	-	0.25mV/V + 45µV	-	0.47mV/V + 0.3mV
10V to 100V	-	0.25mV/V + 81µV	-	0.40mV/V + 35mV
100V to 210V	-	0.25mV/V + 93µV	-	0.40mV/V + 35mV
210V to 222V	-	0.25mV/V + 93µV	-	-

FIELD OF CALIBRATION **ELECTRICAL**

SITE CALIBRATION – CATEGORY 1

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability expressed as an uncertainty (±)*	Remarks
3. Source			
DC CURRENT	0 to 200 µA 0.2 mA to 2 mA 2 mA to 20 mA 20 mA to 200 mA 0.2 A to 2 A 2 A to 10 A	0.12 mA/A + 0.45 nA 0.12 mA/A + 4.5 nA 0.12 mA/A + 45 nA 0.11 mA/A + 1.1 µA 0.23 mA/A + 22 µA 0.10 mA/A + 11 µA	Measurement using Multimeter model Wavetek 1281
AC CURRENT	0 to 2 A	(See Matrix H)	Measurement using Multimeter model Wavetek 1281
	2 A to 10 A	(See Matrix H)	Measurement using Multimeter & Current Shunt model Wavetek 1281&4953
DC RESISTANCE	0 to 20 Ω 20 Ω to 200 Ω 0.2 kΩ to 2 kΩ 2 kΩ to 20 kΩ 20 kΩ to 200 kΩ 0.2 MΩ to 2 MΩ 2 MΩ to 20 MΩ 20 MΩ to 200 MΩ 0.2 GΩ to 1GΩ	18 µΩ/Ω + 22 µΩ 13 µΩ/Ω + 65 µΩ 11 µΩ/Ω + 0.63 mΩ 11 µΩ/Ω + 6.3 mΩ 13 µΩ/Ω + 56 mΩ 20 µΩ/Ω + 1.3 Ω 37 µΩ/Ω + 87 Ω 0.35 mΩ/Ω + 10 kΩ 3.5 mΩ/Ω + 0.5 MΩ	Measurement using Multimeter model Wavetek 1281
FREQUENCY	100 mHz to 2.7 GHz	85 nHz/Hz	Measurement using Frequency Counter model Fluke PM6680B

Signatory:

NO.	NAME	I/C NO.
1.	Lam Sik Lee	731122-07-5254

FIELD OF CALIBRATION **ELECTRICAL**

SITE CALIBRATION – CATEGORY 1

SCOPE OF ACCREDITATION:

Matrix E - AC Voltage Measurement

Range	Frequency						
	(10 to 31) Hz	(32 to 330) Hz	(0.3 to 10) kHz	(10 to 33) kHz	(30 to 100) kHz	(100 to 330) kHz	(0.300 to 1) MHz
0.09 mV to 2 mV	0.21 + 0.0051	0.20 + 0.0051	0.18 + 0.0051	0.27 + 0.0051	0.52 + 0.0051	1.1 + 0.021	2.2 + 0.024
0.2 mV to 20 mV	0.18 + 0.005	0.15 + 0.005	0.15 + 0.005	0.23 + 0.005	0.55 + 0.0049	1.1 + 0.021	2.3 + 0.024
20 mV to 200 mV	0.17 + 0.0077	0.13 + 0.0077	0.11 + 0.0074	0.21 + 0.0071	0.44 + 0.007	1.2 + 0.033	2.3 + 0.12
0.2 V to 2 V	0.12 + 0.026	0.073 + 0.017	0.074 + 0.0083	0.074 + 0.0082	0.13 + 0.017	0.39 + 0.084	2.1 + 0.34
2 V to 20 V	0.12 + 0.25	0.073 + 0.17	0.074 + 0.083	0.074 + 0.082	0.14 + 0.17	0.36 + 0.84	2.3 + 4.2
20 V to 200 V	0.17 + 2.6	0.11 + 1.7	0.074 + 0.82	0.083 + 1.7	0.27 + 2.5	0.77 + 42	8.2 + 110
200 V to 1000 V	0.2 + 17	0.2 + 17	0.16 + 17	0.19 + 33	0.28 + 10	-	-

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

Matrix F - AC Current Measurement

Range	Frequency			
	(0.01 to 3) kHz	(3 to 10) kHz	(10 to 20) kHz	(20 to 30) kHz
0 µA to 32 µA	0.79 + 1	1.1 + 2	2.3 + 6.8	2.8 + 10
32 µA to 320 µA	0.79 + 0.35	1.1 + 0.68	2.3 + 2.3	2.8 + 3.4
0.32 mA to 3.2 mA	0.79 + 0.48	1.1 + 0.68	2.3 + 2.3	2.8 + 3.4
3.2 mA to 32 mA	0.79 + 4.7	1.1 + 7.3	2.3 + 15	2.8 + 25
32 mA to 320 mA	0.91 + 36	1.1 + 55	2.3 + 73	2.8 + 110
0.32 A to 3.2 A	1.1 + 570	2.8 + 2900	-	-
3.2 A to 10.5 A	2.3 + 3400	5.7 + 11000	-	-

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

FIELD OF CALIBRATION **ELECTRICAL**

SITE CALIBRATION – CATEGORY 1

SCOPE OF ACCREDITATION:

Matrix G - AC Voltage Source

Range	Frequency							
	(10 – 40) Hz	(40 – 100) Hz	(0.1 – 2) kHz	(2 – 10) kHz	(10 – 30) kHz	(30 – 100) kHz	(100 – 300) kHz	(0.3 – 1) MHz
0 to 200mV	0.27+0.0044	0.25 +0.0045	0.23 +0.0023	0.23 +0.0045	0.48 +0.0089	0.90 +0.022	-	-
0.2V to 2V	0.20 +0.022	0.17 +0.022	0.15 +0.022	0.17 +0.022	0.28 +0.045	0.57 +0.23	3.4 +2.3	11 +23
2V to 20V	0.20 +0.22	0.17 +0.22	0.15 +0.22	0.17 +0.22	0.28 +0.45	0.57 +2.3	3.4 +2.3	11 +230
20V to 200V	0.20 +2.2	0.17 +2.2	0.15 +2.2	0.17 +2.2	0.28 +4.5	0.57 +23	3.4 +230	11 +2300
200V to 1000V	0.22 +10	0.20 +10	0.20 +10	0.20 +10	0.30 +22	0.60 +110	-	-

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

Matrix H - AC Current Source

Range	Frequency				
	(10 – 40) Hz	(40 – 300) Hz	(0.3 – 1) kHz	(1 – 5) kHz	(5 – 10) kHz
0 to 200 µA	0.38 + 0.022	0.38 + 0.022	0.38 + 0.022	0.38 + 0.022	-
0.2 mA to 2 mA	0.36 + 0.22	0.36 + 0.22	0.36 + 0.22	0.36 + 0.22	-
2 mA to 20 mA	0.35 + 2.3	0.35 + 2.3	0.35 + 2.3	0.35 + 2.3	-
20 mA to 200 mA	0.36 + 22	0.36 + 22	0.36 + 22	0.36 + 22	-
0.2 A to 2 A	0.69 + 450	0.69 + 450	0.69 + 450	2.3 + 910	-
2 A to 10 A	0.63 + 110	0.61 + 100	0.61 + 48	0.61 + 100	0.61 + 100

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

NO. SAMM 122
(Issue 3, 26 October 2010 replacement of SAMM 122 dated 5 October 2009)

FIELD OF CALIBRATION **TEMPERATURE**

SCOPE OF ACCREDITATION:

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability expressed as an uncertainty (±)*	Remarks
1. Temperature Indicator / Recorder / Controller			
Type K	–250°C to –200°C –200°C to –100°C –100°C to +100°C +100°C to +600°C +600°C to +1372°C	0.66 °C 0.32 °C 0.23 °C 0.28 °C 0.32 °C	By electrical simulation using Wavetek 9100 Calibrator and reference table to ITS-90
Type J	–210°C to –100°C –100°C to +800°C +800°C to +1000°C +1000°C to +1200°C	0.30 °C 0.23 °C 0.26 °C 0.28 °C	By electrical simulation using Wavetek 9100 Calibrator and reference table to ITS-90
Type T	–250°C to –200°C –200°C to –100°C -100°C to 0°C 0°C to +400°C	0.68 °C 0.32 °C 0.27 °C 0.21 °C	By electrical simulation using Wavetek 9100 Calibrator and reference table to ITS-90
2. Temperature Sensors			
Thermocouple / Temperature probe	50°C to 250°C 250°C to 400°C 400°C to 650°C	0.30 °C 0.98 °C 3.5 °C	Comparison with Standard PT100 probe in calibration dry block
3. Temperature & Humidity Indicator			
Thermohygragraph / Thermohygrameter	20 °C to 40°C 41°C to 60°C	0.68 °C 1.7 °C	Comparison with Vaisala HMM211 in Temperature Chamber
	30 %RH to 95 %RH	2.4 %RH	Comparison with Vaisala HMM211 in Humidity Chamber

Signatory:

NO.	NAME	I/C NO.
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