

## Schedule

Issue date: 3 January 2017  
Valid until: 23 November 2017



### NO: SMM 082

(Issue 3, 3 January 2017 replacement  
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**FIELD OF CALIBRATION: ELECTRICAL**

**SCOPE OF ACCREDITATION:**

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks
Tachometer (Non- Contact)	0 rpm to 1,000 rpm	1.1 rpm	Calibrated using Tachometer Calibrator and Tachometer based on ASTM F2046
	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**

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
<u>Measuring Instrument</u>			
1. DC Volt	-300 mV to -220 mV	60 µV/V	Direct measurement with Wavetek 9100 Calibrator
	-200 mV to 220 mV -2.2 V to 2.2 V -11 V to 11 V -22 V to 22 V -220 V to 220 V -1100 V to 1100 V	8 µV/V 6 µV/V 4 µV/V 4 µV/V 5.5 µV/V 7 µV/V	
2. High Voltage Measure a. DC Volt	1 kV to 10 kV	0.003 V/V	Substitute measurement with Kikusui TOS 5101 Withstanding Voltage Tester, instrument KV-25 High Voltage Divider (25,000:1) and Fluke 45 Multimeter (In house method)
3. AC Volt	<u>0 to 2.2 mV</u> 40 Hz to 20 kHz 20 kHz to 50 kHz	200 µV/V 500 µV/V	Direct measurement with Fluke 5720A Calibrator
	<u>2.2 mV to 22 mV</u> (see matrix A)		
	<u>22 mV to 220 mV</u> (see matrix A)		
	<u>220 mV to 2.2 V</u> (see matrix A)		
	<u>2.2 V to 22 V</u> (see matrix A)		
	<u>22 V to 220 V</u> (see matrix A)		

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks	
3. AC Volt (continue)	<u>220 V to 1100 V</u> 15 Hz to 50 Hz 50 Hz to 1 kHz	300 $\mu$ V/V 70 $\mu$ V/V	Direct measurement with Fluke 5720A Calibrator	
	1 kHz to 3 kHz 3 kHz to 10 kHz 10 kHz to 20 kHz	0.8 mV/V 0.8 mV/V 1.2 mV/V	Direct measurement with Wavetek 9100 Calibrator	
	4. DC Current	-300 $\mu$ A to -220 $\mu$ A	0.14 mA/A	Direct measurement with Wavetek 9100 Calibrator
-220 $\mu$ A to 220 $\mu$ A -2.2 mA to 2.2 mA -22 mA to 22 mA -220 mA to 220 mA -2.2 A to 2.2 A		70 $\mu$ A/A 39 $\mu$ A/A 37 $\mu$ A/A 49 $\mu$ A/A 86 $\mu$ A/A	Direct measurement with Fluke 5720A Calibrator	
-20 A to -10 A -10 A to -3 A 3 A to 10 A 10 A to 20 A		0.55 mA/A 0.55 mA/A 0.55 mA/A 0.55 mA/A	Direct measurement with Wavetek 9100 Calibrator	
20 A to 30 A		2 mA/A	Direct measurement with Yokogawa 2552/2561 Calibrator	
5. AC Current		<u>0 <math>\mu</math>A to 30 <math>\mu</math>A</u> 10 Hz to 3 kHz 3 kHz to 10 kHz 10 kHz to 20 kHz 20 kHz to 30 kHz	0.7 mA/A 1 mA/A 2 mA/A 2.5 mA/A	Direct measurement with Wavetek 9100 Calibrator
		<u>30 <math>\mu</math>A to 220 <math>\mu</math>A</u> (see matrix B)		Direct measurement with Fluke 5720A Calibrator
		<u>220 <math>\mu</math>A to 2.2 mA</u> (see matrix B)		
	<u>2.2 mA to 22 mA</u> (see matrix B)			
	<u>22 mA to 2.2 A</u> (see matrix B)			

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5. AC Current (continue)	<u>3 A to 10 A</u> 10 Hz to 3 kHz 3 kHz to 10 kHz	2 mA/A 5 mA/A	Direct measurement with Wavetek 9100 Calibrator
	<u>10 A to 20 A</u> 10 Hz to 3 kHz 3 kHz to 10 kHz	2 mA/A 5 mA/A	Direct measurement with Wavetek 9100 Calibrator
	<u>20 A to 50 A</u> 50 Hz to 60 Hz 60 Hz to 400 Hz	0.15 mA/A 0.15 mA/A	Direct measurement with Yokogawa 2558 Calibrator
6. Resistance	<u>Variable Value</u> 0 to 40	0.25 m /	Direct measurement with Wavetek 9100 Calibrator
	40 to 400	0.25 m /	
	0.4 k to 4 k	0.15 m /	
	4 k to 40 k	0.2 m /	
	40 k to 400 k	0.2 m /	
	0.4 M to 4 M	0.5 m /	
	4 M to 40 M	1.5 m /	
	40 M to 400 M	2.6 m /	

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks	
6. Resistance (continue)	<u>Fixed Value</u>			
	0	10 μ /	Direct measurement with Yokogawa 2792 Standard Resistors	
	1 m	200 μ /		
	10 m	100 μ /		
		1	95 μ /	Direct measurement with Fluke 5720A Calibrator
		1.9	95 μ /	
		10	23 μ /	
		19	23 μ /	
		100	10 μ /	
		190	10 μ /	
		1 k	8.5 μ /	Direct measurement with Fluke 5720A Calibrator
		1.9 k	8.5 μ /	
		10 k	8.5 μ /	
		19 k	8.5 μ /	
		100 k	11 μ /	
		190 k	11 μ /	
		1 M	20 μ /	
		1.9 M	21 μ /	
		10 M	40 μ /	
		19 M	50 μ /	
	100 M	100 μ /		
7. Frequency	0.5 Hz to 10.0 MHz	25 μHz/Hz	Direct measurement with Wavetek 9100 Calibrator	
8. Capacitance	0.5 nF to 4 nF	3.4 mF/F	Direct measurement with Wavetek 9100 Calibrator	
	4 nF to 40 nF	3 mF/F		
	40 nF to 400 nF	3 mF/F		
	400 nF to 4 μF	4 mF/F		
	4 μF to 40 μF	5 mF/F		
	40 μF to 400μF	5 mF/F		
	400 μF to 4 mF	5 mF/F		
	4 mF to 40 mF	10 mF/F		

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks	
9. Wideband AC Voltage	<u>1 kHz</u>		Direct measurement with Fluke 5720A Calibrator	
	1.1 mV (-46 dBm)	0.8 µHz/Hz		
	3 mV (-37 dBm)	0.7 µHz/Hz		
	11 mV (-26 dBm)	0.7 µHz/Hz		
	33 mV (-17 dBm)	0.6 µHz/Hz		
	110 mV (-6.2 dBm)	0.6 µHz/Hz		
	330 mV (3.4 dBm)	0.5 µHz/Hz		
	1.1 V (14 dBm)	0.5 µHz/Hz		
	3.5 V (24 dBm)	0.4 µHz/Hz		
	10.a) DC Current Clamp 10 Turn Coil	<u>(+/- polarities)</u>		
3.2 A to 32 A		0.6 mA/A		
32 A to 105 A		0.55 mA/A		
105 A to 200 A		0.55 mA/A		
50 Turn Coil		16 A to 160 A	0.6 mA/A	
		160 A to 525 A	0.55 mA/A	
	525 A to 1000 A	0.55 mA/A		
10.b) AC Current Clamp 10 Turn Coil	<u>3 A to 30 A</u>			
	10 Hz to 100 Hz	4 mA/A		
	100 Hz to 440 Hz	9.8 mA/A		
	<u>30 A to 200 A</u>			
	10 Hz to 100 Hz	4.1 mA/A		
	100 Hz to 440 Hz	8.7 mA/A		
50 Turn Coil	<u>16 A to 160 A</u>			
	10 Hz to 100 Hz	4 mA/A		
	<u>160 A to 1000 A</u>			
	10 Hz to 100 Hz	4.1 mA/A		

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11. Insulation Tester a) Insulation Resistance	0.1 M to 10 M 10 M to 100 M 100 M to 1000 M 1000 M to 10 G 10 G to 100 G 100 G to 1000 G	2 m / 2 m / 1 m / 2 m / 5 m / 5 m /	Direct measurement with Yokogawa 2793-03 Decade Resistance Box and IET HRRS-5KV High Voltage-High Resistance Decade Substituter
b) Voltage Source Level	0.2 kV to 5 kV	5 mV/V	Direct measurement with Kikusui 149-10A High Voltage
12. Oscilloscope Instrument			Direct measurement with Wavetek 9500 Oscilloscope Calibrator
i) Vertical Deflection			
a. DC Voltage Load Impedance 1 M	± (888 µV to 222.4 V)	0.25 mV/V	
b. Square Voltage Load Impedance 1 M	<u>Voltage Peak-Peak</u> 35.52 µV to 999.9 µV 1 mV to 21 mV 21.001 mV to 556 mV 556.01 mV to 210 V	10 mV/V 1 mV/V 1 mV/V 0.5 mV/V	
50	35.52 µV to 999.9 µV 1 mV to 21 mV 21.001 mV to 556 mV 556.01 mV to 5.56 V	10 mV/V 1 mV/V 1 mV/V 0.5 mV/V	

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12. Oscilloscope Instrument (continue)			Direct measurement with Wavetek 9500 Oscilloscope Calibrator
ii) Horizontal Deflection	<u>Voltage Peak-Peak</u>		
a. Low Edge Load Impedance 50 and 1 M	4.44 mV to 3.1 V (Rise & Fall time : 500 ps)	0.03 V/V	
b. High Edge 50	888 mV to 5.56 V (Rise & Fall time : 100 ns)	0.03 V/V	
1 M	888 mV to 100 V (Rise & Fall time : 150 ns)	0.03 V/V	
c. Fast Edge 50	100 V to 210 V (Rise & Fall time : 200 ns)	0.03 V/V	
d. Time Markers Square/Sine 50 and 1 M	4.44 mV to 3.1 V (Rise & Fall time : 150 ps)	0.03 V/V	
	(Sine) 450.5 ps to 909.09 ps	0.25 $\mu$ s/s	
	(Sine) 909.1 ps to 9.009 ns	0.25 $\mu$ s/s	
	(Square) 9.0091 ns to 55 s	0.25 $\mu$ s/s	



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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
12. Oscilloscope Instrument (continue)			Direct measurement with Wavetek 9500 Oscilloscope Calibrator
ii) Horizontal Deflection			
e. Sine Voltage Load Impedance 50	<u>4.44 mV to 5.56 V</u> 50 Hz to 10 MHz	15 mV/V	
1 M / 50	<u>4.44 mV to 5.56 V</u> 10 MHz to 100 MHz	15 mV/V	
	<u>4.44 mV to 5.56 V</u> 100 MHz to 550 MHz	0.03 V/V	
	<u>4.44 mV to 3.336 V</u> 550 MHz to 1.1 GHz	0.04 V/V	
iii) Auxillary			
a. DC Current	± (88.8 µA to 111.2 mA)	2.5 mA/A	
b. Square Current	<u>Current Peak-Peak</u> 88.8 µA to 111.2 mA	2.5 mA/A	
c. Resistance	50 k to 12 M 800 k to 1.2 M	5 m / 1 m /	
d. Capacitance	1 pF to 35 pF 35 pF to 95 pF	0.02 F/F 0.03 F/F	
13. LCR Instrument			Direct measurement with IET 1491-G Decade Inductor
a. Inductance at 1 kHz	100 µH to 1000 µH 1 mH to 10 mH 10 mH to 100 mH 100 mH to 1000 mH 1 H to 10 H	20 mH/H 20 mH/H 20 mH/H 8 mH/H 8mH/H	

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13. LCR Instrument (continue) b. Capacitance at 1 kHz	1 pF to 10 pF 10 pF to 100 pF 100 pF to 1000 pF 1000 pF to 10 000 pF 0.01 $\mu$ F to 0.1 $\mu$ F 0.1 $\mu$ F to 1 $\mu$ F 1 $\mu$ F to 10 $\mu$ F 10 $\mu$ F to 100 $\mu$ F 100 $\mu$ F to 1000 $\mu$ F	0.5 mF/F 0.5 mF/F 0.5 mF/F 0.5 mF/F 0.5 mF/F 0.5 mF/F 0.2 mF/F 0.4 mF/F 4 mF/F	Direct measurement with IET 1413 Decade Capacitor, IET SC 10 $\mu$ F, IET SC 100 $\mu$ F and IET SC 1000 $\mu$ F Standard Capacitors
c. Resistance	1 to 10 10 to 100 100 to 1000 0.001 M to 0.01 M 0.01 M to 0.1 M 0.1 M to 1 M	0.1 m / 0.1 m / 0.1 m / 0.5 m / 0.5 m / 0.5 m /	Direct measurement with Yokogawa 2793-01 & 03 Decade Resistance Boxes
14. Earth Resistance	0.1 to 1000 1000 to 100 k	0.1 m / 1 m /	Direct measurement with Yokogawa 2793-01 & 03 Decade Resistance Boxes
15. RF Power Meter	-25 dBm to 20 dBm (3 $\mu$ W to 100 mW)	3 mW/W	Direct measurement with HP 11683A Range Calibrator, HP 432A Power Meter, HP 478-H75 Thermistor and HP 34401A Multimeter
16. FM Modulation a. Wow & Flutter	0 % to 3 %	3	Direct measurement with Minato 3101 Calibrator and Distortion Analyzer HP 8903E

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17. Stopwatch / Timer	10 s to 1 min	0.05 s	Direct measurement with HP 8662A Signal Generator, HP 53132A Universal Counter and Pendulum 6689 Frequency Reference Clock	
	1 min to 5 min	0.06 s		
	5 min to 10 min	0.06 s		
	10 min to 15 min	0.06 s		
	15 min to 30 min	0.06 s		
	30 min to 60 min	0.09 s		
	60 min to 3 hour	0.10 s		
18. Microohmmeter/ Miliohmmeter				
DC Resistance : Values	At 200A	50 μô	0.79 μô	Using Time Electronics - 5070
		100μô	0.45 μô	
		150 μô	0.20 μô	
		200 μô	1.1 μô	
	At 100A	0.5 m ô	1.4 μô	
		1.0 m ô	1.0 μô	
		1.5 m ô	1.7 μô	
		2.0 m ô	2.4 μô	
	At 30A	5 m ô	11 μô	
		10 m ô	8.6 μô	
		15 m ô	11 μô	
		20 m ô	8.2 μô	
	At 10A	50 m ô	79 μô	
		100 m ô	80 μô	
		150 m ô	81 μô	
		200 m ô	83 μô	

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<u>Generating Instrument</u>			
1. DC Power Supply			
a. DC Volt	(+/- polarities) 100 mV range	50 $\mu$ V	Direct measurement with HP 34401A Multimeter
	1 V range	40 $\mu$ V	
	10 V range	35 $\mu$ V	
	100 V range	45 $\mu$ V	
	1000 V range	45 $\mu$ V	
b. DC Current	10 mA range	0.5 mA/A	
	100 mA range	0.5 mA/A	
	1 A range	1 mA/A	
	3 A range	1.2 mA/A	
2. High Voltage Source			
a. DC Volt	0.5 kv to 10 kV	5 mV/V	Direct measurement with Kikusui 149-10A High Voltage Digitalmeter
	10 kV to 25 kV	2.4 mV/V	Direct measurement with Process Instruments KV-25 High Voltage Divider (25 000 : 1) and Fluke 45 Multimeter
	25 kV to 100 kV	1.5 mV/V	Direct measurement with Process Instruments JRL HV-100 High Voltage Divider (100 000 : 1) and Fluke 45 Multimeter

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2. High Voltage Source (continue) b. AC Volt	<u>0.5 kV to 10 kV</u> 50 Hz to 60 Hz	0.01 V/V	Direct measurement with Kikusui 149-10A High Voltage Digitalmeter
	<u>10 kV to 25 kV</u> 50 Hz to 60 Hz	0.4 V/V	Direct measurement with process instrument JRL HV-100 High Voltage Divider (100,000:1), Hewlett Packard 33401A Multimeter
	<u>25kV to 50 kV</u> 50 Hz to 60 Hz	0.8 V/V	
3. DC Voltage	-100 mv to 100 mV	9 $\mu$ V/V	Direct measurement with Wavetek 1281 Selfcal Digital Multimeter
	-1 V to 1 V	6.2 $\mu$ V/V	
	-10 V to 10 V	6.1 $\mu$ V/V	
	-100 V to 100 V	10.2 $\mu$ V/V	
	-1000 V to 1000 V	10.2 $\mu$ V/V	
4. DC Current	-100 $\mu$ A to 100 $\mu$ A	100 $\mu$ A/A	Direct measurement (differential) with Valhalla Scientific 2575A AC-DC Current Shunts and HP 34401A Multimeter
	-1 mA to 1 mA	100 $\mu$ A/A	
	-10 mA to 10 mA	100 $\mu$ A/A	
	-100 mA to 100 mA	100 $\mu$ A/A	
	-1 A to 1 A	210 $\mu$ A/A	
	-2 A to 2 A	0.2 mA/A	
	-20 A to 20 A	0.2 mA/A	
-100 A to 100 A	0.5 mA/A		
5. AC Voltage	<u>0 mV to 100 mV</u> 100 Hz to 2 kHz	1.1 $\mu$ V/V	Direct measurement with Fluke 5790A AC measurement standard
	30 kHz to 100 kHz	3.7 $\mu$ V/V	
	<u>1 V to 100 V</u> 100 Hz to 2 kHz	0.8 $\mu$ V/V	
	30 kHz to 100 kHz	1.9 $\mu$ V/V	
	<u>300 V to 1000 V</u> 40 Hz to 10 kHz	60 $\mu$ V/V	
	10 kHz to 30 kHz	170 $\mu$ V/V	

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6. AC Current	<u>0 µA to 100 µA</u> 10 Hz to 1 kHz	400 µA/A	Direct measurement with Wavetek 1281 Selfcal Digital Multimeter
	<u>100 µA to 1 mA</u> 10 Hz to 1 kHz	400 µA/A	
	<u>1 mA to 10 mA</u> 10 Hz to 1 kHz	400 µA/A	
	<u>10 mA to 100 mA</u> 10 Hz to 1 kHz	400 µA/A	
	<u>100 mA to 1 A</u> 10 Hz to 1 kHz 1kHz to 2 kHz	800 µA/A 2.4 mA/A	Direct measurement with Valhalla Scientific 2575A AC-DC Current Shunts
	<u>1 A to 2 A</u> 50 Hz to 1 kHz 1 kHz to 10 kHz	1 mA/A 5 mA/A	
	<u>2 A to 20 A</u> 50 Hz to 1 kHz 1 kHz to 10 kHz	1 mA/A 5 mA/A	
7. Resistance	<u>20 A to 100 A</u> 50 Hz to 1 kHz 1 kHz to 10 kHz	1 mA/A 5 mA/A	Direct measurement with Wavetek 1281 Selfcal Digital Multimeter
	0	10 µ /	
	10	30 µ /	
	100	12 µ /	
	1 k	9.5 µ /	
	10 k	9.5 µ /	
	100 k	12 µ /	
	1 M	25 µ /	
	10 M	30 µ /	
	100 M	350 µ /	

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8. Inductance at 1 kHz	100 µH to 1000 µH 1 mH to 10 mH 10 MH to 100 mH	3 mH/H 3 mH/H 3 mH/H	Direct measurement with GW Instek 819 LCR Meter
9. Capacitance at 1 kHz	1000 pF to 10 000 pF 0.01 µF to 0.1 µF 0.1 µF to 1 µF	0.5 mF/F 0.5 mF/F 0.5 mF/F	Direct measurement with GW Instek 819 LCR Meter
10. Time Base Generator			
a. Frequency	0.1 Hz to 225 MHz 100 MHz to 3GHz	0.2 µHz/Hz	Direct measurement with HP 53132A
b. Time	0.33 ns to 10 ns 4.44 ns to 10 s	0.2 µs/s	Universal Counter

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**Signatories :**

1. **Seah Leong Ho**
2. **Chin Inn Nkot**
3. **Shah □ulki □li Nor Bin Arshad**

## Schedule

Issue date: 3 January 2017  
Valid until: 23 November 2017



MS ISO/IEC 17025

**NO: SAMM 082**

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**FIELD OF CALIBRATION: ELECTRICAL**

**SITE CALIBRATION: CATE  OR  I**

**SCOPE OF ACCREDITATION:**

The valid scope of accreditation is in [www.ism.gov.my/cab-directories](http://www.ism.gov.my/cab-directories).

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks
<u>Measuring Instrument</u>			
1. DC Voltage	( $\pm$ polarities) 0mV to 300 mV	0.1 mV/V	Direct measurement with Wavetek 9100 Calibrator or Yokogawa 2552 and 2561 Calibrators
	0.3 V to 3 V	0.1 mV/V	
2. AC Voltage	3 V to 30 V	0.1 mV/V	Direct measurement with Wavetek 9100 Calibrator or Yokogawa 2558 Calibrator
	30 V to 300 V	0.1 mV/V	
	300 V to 1000 V	0.1 mV/V	
	<u>0 mV to 10 mV</u> (see matrix C)		
	<u>10 mV to 30 mV</u> (see matrix C)		
	<u>30 mV to 300 mV</u> (see matrix C)		
	<u>300 mV to 1.5 V</u> (see matrix C)		
	<u>1.5 V to 3 V</u> (see matrix C)		
<u>3 V to 30 V</u> (see matrix C)			
<u>30 V to 100 V</u> (see matrix C)			
<u>100 V to 300 V</u> (see matrix C)			
<u>300 V to 750 V</u> (see matrix C)			
<u>750 V to 1000 V</u> (see matrix C)			



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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
3. DC Current	(± polarities)		
	0 µA to 300 µA	0.2 ma/A	Direct measurement with Wavetek 9100 Calibrator or Yokogawa 2552 and 2561 Calibrators
	0.3 mA to 3 mA	0.2 mA/A	
	3 mA to 30 mA	0.2 mA/A	
	30 mA to 300 mA	0.2 mA/A	
	0.3 A to 3 A	0.6 mA/A	
	3 A to 10 A	0.6 mA/A	
10 A to 20 A	0.6 ma/A		
4. AC Current	<u>0 µA to 30 µA</u> (see matrix D)		Direct measurement with Wavetek 9100 Calibrator or Yokogawa 2558 Calibrator
	<u>30 µA to 300 µA</u> (see matrix D)		
	<u>0.03 mA to 0.3 mA</u> (see matrix D)		
	<u>0.3 mA to 3 mA</u> (see matrix D)		
	<u>3 mA to 30 mA</u> (see matrix D)		
	<u>30 mA to 300 mA</u> (see matrix D)		
	<u>0.3 A to 3 A</u> (see matrix D)		
	<u>3 A to 10 A</u> (see matrix D)		
	<u>10 A to 20 A</u> (see matrix D)		

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
5. Resistance	0.1 to 40 40 to 400 0.4 k to 4 k 4 k to 40 k 40 k to 400 k 0.4 M to 4 M 4 M to 40 M 40 M to 400 M	1 m / 0.4 m / 0.4 m / 0.3 m / 0.3 m / 0.5 m / 2 m / 3 m /	Direct measurement with Wavetek 9100 Calibrator or Yokogawa 2793-01 and 2793-03 Decade Resistance Boxes
6. Frequency	0.5 Hz to 10.0 MHz	25 µHz/Hz	Direct measurement with Wavetek 9100 Calibrator
7. Capacitance	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 mF/F 3 mF/F 3 mF/F 4 mF/F 10 mF/F 10 mF/F 10 mF/F 10 mF/F	
8. DC Current Clamp			Direct measurement with Wavetek 9100 Calibrator
a. X 10 Coil	3.2 A to 32 A 32 A to 105 A 105 A to 200 A	3 mA/A 3 mA/A 3 mA/A	
b. X 50 Coil	16 A to 160 A 160 A to 525 A 525 A to 1000 A	3 mA/A 3 mA/A 3 mA/A	

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**SCOPE OF ACCREDITATION:**

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks
9. AC Current Clamp a. X 10 Coil	<u>3 A to 30 A</u> 10 Hz to 100 Hz 100 Hz to 440 Hz	5 mA/A 10 mA/A	Direct measurement with Wavetek 9100 Calibrator
b. X 50 Coil	<u>30 A to 200 A</u> 10 Hz to 100 Hz 100 Hz to 440 Hz	5 mA/A 10 mA/A	
	<u>16 A to 160 A</u> 10 Hz to 100 Hz	5 mA/A	
	<u>160 A to 1000 A</u> 10 Hz to 100 Hz	5 mA/A	
10. Oscilloscope Instrument			Direct measurement with Wavetek 9100 Calibrator
i) Vertical Deflection	<u>Voltage Peak-Peak</u>		
a. Square Wave			
50 load	4.44 mV to 3.34 V	3 mV/V	
1 M load	4.44 mV to 133.44 V	3 mV/V	
b. DC Level	( $\pm$ polarities)		
50 load	4.44 mV to 2.78 V	3 mV/V	
1 M load	4.44 mV to 133.44 V	3 mV/V	
ii) Horizontal Deflection			
a. Time Markers			
50 load	4 ns/div to 5.5 s/div	25 $\mu$ s/s	
b. Edge Response			
Rise/Fall time at 50 load	Less than 1 ns Less than 100 ns	25 $\mu$ s/s 25 $\mu$ s/s	
Rise time at 1 M load			
c. Bandwidth			
50 load	50 kHz to 100 MHz	0.02 Hz/Hz	
1 M load	100 MHz to 250 MHz 10 Hz to 49.999 kHz	0.04 Hz/Hz 3 mHz/Hz	

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
11. Insulation Tester a. Insulation Resistance	10 M to 100 M 100 M to 1000 M 1000 M to 10 G 10 G to 100 G 100 G to 1000 G	5 m / 5 m / 5 m / 10 m / 10 m /	Direct measurement with Yokogawa 2793-03 Decade Resistance Box and IET HRRS-5KV High Voltage-High Resistance Decade Substituter
b. Voltage Level Source	0.2 kV to 5 kV	0.01 V/V	Direct measurement with Kikusui 149-10A High Voltage Digitalmeter
12. LCR Measurement a. Inductance at 1 kHz	100 µH to 1000 µH 1 mH to 10 mH 10 mH to 100 mH 100 mH to 1000 mH 1 H to 10 H	0.03 H/H 0.03 H/H 0.03 H/H 0.01 H/H 0.01 H/H	Direct measurement with IET 1491-G and 1491-D Decade Inductor Boxes
b. Capacitance at 1 kHz	1 pF to 10 pF 10 pF to 100 pF 100 pF to 1000 pF 1000 pF to 10 000 pF 0.01 µF to 0.1 µF 0.1 µF to 1 µF 1 µF to 10 µF 10 µF to 100 µF 100 µF to 1000 µF	1 mF/F 1 mF/F 1 mF/F 1 mF/F 1 mF/F 1 mF/F 1 mF/F 1 mF/F 10 mF/F	Direct measurement with IET 1413, IET 1412 BC Decade Capacitor Boxes, IET SC 10µF, IET SC 100µF and IET SC 1000µF Standard Capacitors
c. Resistance	1 to 10 10 to 100 100 to 1000 0.001 M to 0.01 M 0.01 M to 0.1 M 0.1 M to 1 M	1 m / 1 m / 1 m / 1 m / 1 m / 1 m /	Direct measurement with Yokogawa 2793-01 and 2793-03 Decade Resistor Boxes

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**FIELD OF CALIBRATION: ELECTRICAL**

**SITE CALIBRATION: CATE□OR□ I**

**SCOPE OF ACCREDITATION:**

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
<u>Generating Instrument</u>			
1. DC Power Source	<u>(± polarities)</u>		Direct measurement with HP 34401A Multimeter
a. DC Voltage	100 mV	0.1 mV/V	
	1 V	0.1 mV/V	
	10 V	0.1 mV/V	
	100 V	0.1 mV/V	
	1000 V	0.1 mV/V	
b. DC Current	10 mA	1 mA/A	
	100 mA	1 mA/A	
	1 A	2 mA/A	
	3 A	2 mA/A	
2. High Voltage Source			Direct measurement with Kikusui 149-10A High Voltage Digitalmeter
a. DC Voltage	0.5 kV to 10 kV	0.01 V/V	
b. AC Voltage	<u>0.5 kV to 10 kV</u> 50 Hz to 60 Hz	15 mV/V	

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1. **Seah Leong Ho**
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### FIELD OF CALIBRATION: ELECTRICAL

PERMANENT  SITE CALIBRATION : CATE  OR  I

### SCOPE OF ACCREDITATION:

#### MATRIX A TABLE (Direct measurement with Fluke 5720A Calibrator)

RANGE	20 Hz to 40 Hz	40 Hz to 20 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
2.2 mV to 22 mV	280 $\mu$ V/V	280 $\mu$ V/V	400 $\mu$ V/V	750 $\mu$ V/V	1500 $\mu$ V/V	2300 $\mu$ V/V	3600 $\mu$ V/V
22 mV to 220 mV	120 $\mu$ V/V	110 $\mu$ V/V	230 $\mu$ V/V	540 $\mu$ V/V	990 $\mu$ V/V	1500 $\mu$ V/V	2900 $\mu$ V/V
220 mV to 2.2 V	100 $\mu$ V/V	50 $\mu$ V/V	80 $\mu$ V/V	120 $\mu$ V/V	460 $\mu$ V/V	1100 $\mu$ V/V	1800 $\mu$ V/V
2.2 V to 22 V	97 $\mu$ V/V	48 $\mu$ V/V	80 $\mu$ V/V	110 $\mu$ V/V	300 $\mu$ V/V	1100 $\mu$ V/V	1700 $\mu$ V/V
22 V to 220 V	90 $\mu$ V/V	52 $\mu$ V/V	80 $\mu$ V/V	150 $\mu$ V/V	900 $\mu$ V/V		

#### MATRIX B TABLE (Direct measurement with Fluke 5720A Calibrator)

RANGE	20 Hz to 1 kHz	40 Hz to 1 kHz	1 kHz to 5 kHz	5 kHz to 10 kHz
30 $\mu$ A to 220 $\mu$ A		160 $\mu$ A/A	340 $\mu$ A/A	1400 $\mu$ A/A
220 $\mu$ A to 2.2 mA		140 $\mu$ A/A	250 $\mu$ A/A	1400 $\mu$ A/A
2.2 mA to 22 mA		130 $\mu$ A/A	210 $\mu$ A/A	1200 $\mu$ A/A
22 mA to 2.2 A	280 $\mu$ A/A		490 $\mu$ A/A	7100 $\mu$ A/A

#### MATRIX C TABLE (Direct measurement with Wavetek 9100 Calibrator or Yokogawa 2558 Calibrator)

RANGE	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 mV/V	1 mV/V	1 mV/V	1 mV/V	5 mV/V	
10 mV to 30 mV	1 mV/V	1 mV/V	1 mV/V	1 mV/V	5 mV/V	
30 mV to 300 mV	1 mV/V	1 mV/V	1 mV/V	1 mV/V	5 mV/V	
300 mV to 1.5 V	1 mV/V	1 mV/V	1 mV/V	1 mV/V	2 mV/V	
1.5 V to 3 V	1 mV/V	1 mV/V	1 mV/V	1 mV/V	2 mV/V	
3 V to 30 V	1 mV/V	1 mV/V	1 mV/V	2 mV/V	4 mV/V	
30 V to 100 V	1 mV/V	1 mV/V	1 mV/V	2 mV/V	4 mV/V	
RANGE	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 mV/V	1 mV/V	1 mV/V	1 mV/V	1 mV/V	2 mV/V
300 V to 750 V	1 mV/V	1 mV/V	1 mV/V	1 mV/V	1 mV/V	2 mV/V
750 V to 1000 V	1 mV/V	1 mV/V	1 mV/V	1 mV/V	2 mV/V	

#### MATRIX D TABLE (Direct measurement with Wavetek 9100 Calibrator or Yokogawa 2558 Calibrator)

RANGE	10 Hz to 3 kHz	3 kHz to 10 kHz	10 kHz to 20 kHz	20 kHz to 30 kHz
0 $\mu$ A to 30 $\mu$ A	1 mA/A	2 mA/A	3 mA/A	3 mA/A
30 $\mu$ A to 300 $\mu$ A	1 mA/A	2 mA/A	3 mA/A	3 mA/A
300 $\mu$ A to 0.3 mA	1 mA/A	1 mA/A	2 mA/A	3 mA/A
0.3 mA to 3 mA	1 mA/A	1 mA/A	2 mA/A	3 mA/A
3 mA to 30 mA	1 mA/A	1 mA/A	2 mA/A	3 mA/A
30 mA to 300 mA	1 mA/A	1 mA/A	2 mA/A	3 mA/A
0.3 A to 3 A	2 mA/A	3 mA/A		
3 A to 10 A	3 mA/A	10 mA/A		
10 A to 20 A	3 mA/A	10 mA/A		

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