

## Schedule

Issue date: 8 December 2023  
Valid until: 23 November 2028



NO: SMM 082

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### SCOPE OF CALIBRATION: TIME & FREQUENCY

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 F2046:2011
	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

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks
Stopwatch & Timer	10 s to 60 s	50 ms	Pendulum 6689, HP 8662 & HP 53132A
	60 s to 300 s	60 ms	
	300 s to 600 s	60 ms	
	600 s to 900 s	60 ms	
	900 s to 1800 s	60 ms	
	0.5 h to 1 h	90 ms	
	1 h to 3 h	0.10 s	

#### Signatories:

1. Seah Leong Ho
2. Chin Inn Nkot
3. Shah Zulkifli Nor Bin Arshad
4. Husna Binti Abdul Rahim

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### SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
<b>Basic DC-LF Measuring Equipment (Multimeter, Clamp Meter, Data Acquisition, etc )</b>			
DC Voltage	0 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 1000 V	8.5 μV/V + 0.46 μV 5.6 μV/V + 0.91 μV 3.7 μV/V + 5.9 μV 3.9 μV/V + 6.3 μV 5.6 μV/V + 59 μV 7.2 μV/V + 0.64 mV	Generating using a Multifunction / Multiproduct Calibrator
DC Current	-300 μA to -220 μA  -220 μA to 220 μA -2.2 mA to 2.2 mA -22 mA to 22 mA -220 mA to 220 mA -2.2 A to 2.2 A  -20 A to -10 A -10 A to -3 A 3 A to 10 A 10 A to 20 A  20 A to 30 A	0.14 mA/A  70 μA/A 39 μA/A 37 μA/A 49 μA/A 86 μA/A  0.55 mA/A 0.55 mA/A 0.55 mA/A 0.55 mA/A  2.0 mA/A	
AC Voltage	0 V to 1100 V	See Matrix A	
AC Current	0 A to 50 A	See Matrix B	
DC Current Clamp	10 A to 16.5 A 16.5 A to 150 A 150 A to 1000 A	2.8 mA/A + 3.6 mA 2.9 mA/A + 19 mA 3.2 mA/A + 17 mA	
AC Current Clamp	<u>45 Hz to 65 Hz</u>  10 A to 16.5 A 16.5 A to 150 A 150 A to 1000 A  <u>65 Hz to 440 Hz</u> 10 A to 16.5 A 16.5 A to 150 A	3.3 mA/A + 5.0 mA 3.5 mA/A + 32 mA 3.5 mA/A + 0.12 A  9.3 mA/A + 5.2 mA 9.8 mA/A + 25 mA	
Frequency	0.5 Hz to 10 MHz	25 μHz/Hz	Generating using a Multiproduct Calibrator

## SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks
<b>Basic DC-LF Measuring Equipment (Multimeter, Clamp Meter, Data Acquisition, etc )</b>			
Resistance <ul style="list-style-type: none"> <li>• Fixed Resistance</li> </ul>	0 $\Omega$ 1 m $\Omega$ 10 m $\Omega$  1 $\Omega$ 10 $\Omega$ 100 $\Omega$ 1 k $\Omega$ 10 k $\Omega$ 100 k $\Omega$ 1 M $\Omega$ 10 M $\Omega$ 100 M $\Omega$  1.9 $\Omega$ 19 $\Omega$ 190 $\Omega$ 1.9 k $\Omega$ 19 k $\Omega$ 190 k $\Omega$ 1.9 M $\Omega$ 19 M $\Omega$	10 $\mu\Omega$ 0.20 $\mu\Omega$ 1.0 $\mu\Omega$  95 $\mu\Omega$ 0.23 m $\Omega$ 1.0 m $\Omega$ 8.5 m $\Omega$ 85 m $\Omega$ 1.1 $\Omega$ 20 $\Omega$ 0.40 k $\Omega$ 10 k $\Omega$  0.18 m $\Omega$ 0.44 m $\Omega$ 1.9 m $\Omega$ 16 m $\Omega$ 0.16 $\Omega$ 2.1 $\Omega$ 40 $\Omega$ 0.95 k $\Omega$	Generating using a Multifunction / Multiproduct Calibrator
	<ul style="list-style-type: none"> <li>• Variable Resistance</li> </ul>	0 $\Omega$ to 40 $\Omega$ 40 $\Omega$ to 400 $\Omega$ 400 $\Omega$ to 4 k $\Omega$ 4 k $\Omega$ to 40 k $\Omega$ 40 k $\Omega$ to 400 k $\Omega$ 400 k $\Omega$ to 4 M $\Omega$ 4 M $\Omega$ to 40 M $\Omega$ 40 M $\Omega$ to 400 M $\Omega$	
Capacitance ( Variable )	0.5 nF to 4 nF 4 nF to 40 nF 40 nF to 400 nF 400 nF to 4 $\mu$ F 4 $\mu$ F to 40 $\mu$ F 40 $\mu$ F to 400 $\mu$ F 400 $\mu$ F to 4 mF 4 mF to 40 mF	3.4 mF/F 3.0 mF/F 3.0 mF/F 4.0 mF/F 5.0 mF/F 5.0 mF/F 5.0 mF/F 10 mF/F	

## SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks
<b>Basic DC-LF Generating Equipment ( Calibrator, Power Supply, etc )</b>			
DC Voltage	0 to 200 mV 200 mV to 2 V 2 V to 20 V 20 V to 200 V 200 V to 1000 V	5.6 $\mu$ V/V + 0.12 $\mu$ V 3.9 $\mu$ V/V + 0.58 $\mu$ V 3.9 $\mu$ V/V + 5.6 $\mu$ V 6.3 $\mu$ V/V + 50 $\mu$ V 6.1 $\mu$ V/V + 0.68 mV	Measuring using a Precision Multimeter
DC Current	0 to 200 $\mu$ A 200 $\mu$ A to 2 mA 2 mA to 20 mA 20 mA to 200 mA 200 mA to 2 A	13 $\mu$ A/A + 0.64 nA 13 $\mu$ A/A + 6.4 nA 15 $\mu$ A/A + 63 nA 54 $\mu$ A/A + 0.98 $\mu$ A 0.21 mA/A + 18 $\mu$ A	
AC Voltage	0 to 1000 V	See Matrix C	
AC Current	0 to 2 A	See Matrix D	
Resistance	0 $\Omega$ to 2 $\Omega$ 2 $\Omega$ to 20 $\Omega$ 20 $\Omega$ to 200 $\Omega$ 200 $\Omega$ to 2 k $\Omega$ 2 k $\Omega$ to 20 k $\Omega$ 20 k $\Omega$ to 200 k $\Omega$ 200 k $\Omega$ to 2 M $\Omega$ 2 M $\Omega$ to 20 M $\Omega$ 20 M $\Omega$ to 100 M $\Omega$	7.3 $\mu\Omega/\Omega$ + 25 $\mu\Omega$ 9.4 $\mu\Omega/\Omega$ + 45 $\mu\Omega$ 9.0 $\mu\Omega/\Omega$ + 62 $\mu\Omega$ 9.1 $\mu\Omega/\Omega$ + 0.58 m $\Omega$ 9.1 $\mu\Omega/\Omega$ + 5.8 m $\Omega$ 9.1 $\mu\Omega/\Omega$ + 58 m $\Omega$ 10 $\mu\Omega/\Omega$ + 1.1 $\Omega$ 23 $\mu\Omega/\Omega$ + 0.11 k $\Omega$ 0.14 m $\Omega/\Omega$ + 11 k $\Omega$	Measuring using a Precision Multimeter
Capacitance ( at 1kHz )	1 nF to 10 nF 10 nF to 100 nF 100 nF to 1 $\mu$ F	0.50 mF/F 0.50 mF/F 0.50 mF/F	Measuring using a Precision LCR Meter
Inductance ( at 1kHz )	100 $\mu$ H to 1 mH 1 mH to 10 mH 10 mH to 100 mH	3.0 mH/H 3.0 mH/H 3.0 mH/H	

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**SCOPE OF CALIBRATION: ELECTRICAL**

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks
<b>Specific DC-LF Equipment</b>			
Earth Resistance	0.1 $\Omega$ to 1 k $\Omega$ 1 k $\Omega$ to 100 k $\Omega$	0.10 m $\Omega$ / $\Omega$ 1.0 m $\Omega$ / $\Omega$	Generating using a Decade Resistance Box
Insulation Resistance ( up to 5kV )	100 k $\Omega$ to 10 M $\Omega$ 10 M $\Omega$ to 100 M $\Omega$ 100 M $\Omega$ to 1 G $\Omega$ 1 G $\Omega$ to 10 G $\Omega$ 10 G $\Omega$ to 100 G $\Omega$ 100 G $\Omega$ to 1 T $\Omega$	2.0 m $\Omega$ / $\Omega$ 2.0 m $\Omega$ / $\Omega$ 1.0 m $\Omega$ / $\Omega$ 2.0 m $\Omega$ / $\Omega$ 5.0 m $\Omega$ / $\Omega$ 5.0 m $\Omega$ / $\Omega$	Generating using a combination of High Voltage & Decade Resistance Box
Milli-Micro Ohmmeter (at 10A)	50 m $\Omega$ 100 m $\Omega$ 150 m $\Omega$ 200 m $\Omega$	79 $\mu\Omega$ 80 $\mu\Omega$ 81 $\mu\Omega$ 83 $\mu\Omega$	Generating using a Micro-Ohmmeter Calibrator
(at 30A)	5 m $\Omega$ 10 m $\Omega$ 15 m $\Omega$ 20 m $\Omega$	11 $\mu\Omega$ 8.6 $\mu\Omega$ 11 $\mu\Omega$ 8.2 $\mu\Omega$	
(at 100A)	0.5 m $\Omega$ 1.0 m $\Omega$ 1.5 m $\Omega$ 2.0 m $\Omega$	1.4 $\mu\Omega$ 1.0 $\mu\Omega$ 1.7 $\mu\Omega$ 2.4 $\mu\Omega$	
(at 200A )	50 $\mu\Omega$ 100 $\mu\Omega$ 150 $\mu\Omega$ 200 $\mu\Omega$	0.79 $\mu\Omega$ 0.45 $\mu\Omega$ 0.20 $\mu\Omega$ 1.1 $\mu\Omega$	

## SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks	
<b>Specific DC-LF Equipment</b>				
LCR Meter ( at 1kHz )	<ul style="list-style-type: none"> <li>• Inductance</li> </ul>	100 $\mu$ H to 1 mH 1 mH to 10 mH 10 mH to 100 mH 100 mH to 1 H 1 H to 10 H	20 mH/H 20 mH/H 20 mH/H 8.0 mH/H 8.0 mH/H	Generating using a combination of Decade-Standard Inductance
	<ul style="list-style-type: none"> <li>• Capacitance</li> </ul>	1 pF to 10 pF 10 pF to 100 pF 100 pF to 1 nF 1 nF to 10 nF 10 nF to 100 nF 100 nF to 1 $\mu$ F 1 $\mu$ F to 10 $\mu$ F 10 $\mu$ F to 100 $\mu$ F 100 $\mu$ F to 1 mF	0.50 mF/F 0.50 mF/F 0.50 mF/F 0.50 mF/F 0.50 mF/F 0.50 mF/F 0.20 mF/F 0.40 mF/F 4.0 mF/F	Generating using a combination of Decade-Standard Capacitance
	<ul style="list-style-type: none"> <li>• Resistance</li> </ul>	1 $\Omega$ to 10 $\Omega$ 10 $\Omega$ to 100 $\Omega$ 100 $\Omega$ to 1 k $\Omega$ 1 k $\Omega$ to 10 k $\Omega$ 10 k $\Omega$ to 100 k $\Omega$ 100 k $\Omega$ to 1 M $\Omega$	0.10 m $\Omega$ / $\Omega$ 0.10 m $\Omega$ / $\Omega$ 0.10 m $\Omega$ / $\Omega$ 0.50 m $\Omega$ / $\Omega$ 0.50 m $\Omega$ / $\Omega$ 0.50 m $\Omega$ / $\Omega$	Generating using a combination of Decade-Standard Resistance
High Voltage Meter/Probe	<ul style="list-style-type: none"> <li>• DC Voltage</li> </ul>	1 kV to 10 kV 10 kV to 30 kV	0.51 mV/V + 0.67 V 0.55 mV/V + 0.73 V	Generating using a combination of High Voltage Generator, High Voltage Divider & Precision Multimeter
	<ul style="list-style-type: none"> <li>• AC Voltage ( at 50/60 Hz )</li> </ul>	1 kV to 10 kV 10 kV to 20 kV	4.6 mV/V + 1.5 V 4.2 mV/V + 20 V	



**SCOPE OF CALIBRATION: ELECTRICAL**

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
<b>Specific DC-LF Equipment</b>			
High Voltage Source/Tester <ul style="list-style-type: none"> <li>DC Voltage</li> <li>AC Voltage ( at 50/60 Hz )</li> </ul>	0.5 kV to 10 kV 10 kV to 25 kV 25 kV to 100 kV	5.0 mV/V 2.4 mV/V 1.5 mV/V	Measuring using a combination of High Voltage Meter, High Voltage Divider & Precision Multimeter
	0.5 kV to 10 kV 10 kV to 25 kV 25 kV to 50 kV	10 mV/V 16 mV/V 16 mV/V	
High Current Source/Tester <ul style="list-style-type: none"> <li>DC Current</li> <li>AC Current</li> </ul>	-20 A to 20 A -100 A to 100 A	0.20 mA/A 0.50 mA/A	Measuring using a combination of Precision Multimeter & Current Shunt
	<u>50 Hz to 1 kHz</u> 2 A to 20 A 20 A to 100 A	1.0 mA/A 1.0 mA/A	
	<u>1 kHz to 10 kHz</u> 2 A to 20 A 20 A to 100 A	5.0 mA/A 5.0 mA/A	
Power Source (Welding - Std Grade) <ul style="list-style-type: none"> <li>DC Current</li> <li>AC Current (at 50/60 Hz )</li> </ul>	0 A to 40 A 40 A to 500 A	18 mA/A + 69 mA 17 mA/A + 0.57 A	Measuring using a combination of Load Banks & Clamp Meter
	0 A to 40 A 40 A to 500 A	19 mA/A + 69 mA 17 mA/A + 0.58 A	

## SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks	
<b>Specific DC-LF Equipment</b>				
<b>Oscilloscope</b>				
i) <u>Vertical Deflection</u>				
a) DC Voltage Impedance 1M $\Omega$	$\pm$ (888 $\mu$ V to 222.4 V)	0.25 mV/V	Generating using an Oscilloscope Calibrator	
b) Square Voltage Impedance 1M $\Omega$	35.52 $\mu$ Vpp to 999.9 $\mu$ Vpp 1 mVpp to 21 mVpp 21.001mVpp to 556mVpp 556.01 mVpp to 210Vpp	10 mVpp/Vpp 1.0 mVpp/Vpp 1.0 mVpp/Vpp 0.50 mVpp/Vpp		
Impedance 50 $\Omega$	35.52 $\mu$ Vpp to 999.9 $\mu$ Vpp 1 mVpp to 21 mVpp 21.001mVpp to 556mVpp 556.01 mVpp to 5.56Vpp	10 mVpp/Vpp 1.0 mVpp/Vpp 1.0 mVpp/Vpp 0.50 mVpp/Vpp		
ii) <u>Horizontal Deflection</u>				
a) Low Edge Impedance 50 $\Omega$ /1M $\Omega$	4.44 mVpp to 3.31 Vpp (Rise&Fall Time : 500ps)	30 mVpp/Vpp		
b) High Edge Impedance 50 $\Omega$	888 mVpp to 5.56 Vpp (Rise&Fall Time : 100ns)	30 mVpp/Vpp		
Impedance 1M $\Omega$	888 mVpp to 100 Vpp (Rise&Fall Time : 150ns)	30 mVpp/Vpp		
c) Fast Edge Impedance 50 $\Omega$	100 Vpp to 210 Vpp (Rise&Fall Time : 200ns)	30 mVpp/Vpp		
	4.44 mVpp to 3.1 Vpp (Rise&Fall Time : 150ps)	30 mVpp/Vpp		
d) Time Markers Sine (50 $\Omega$ /1M $\Omega$ )	450.5 ps to 909.09 ps 909.1 ps to 9.009 ns	0.25 $\mu$ s/s 0.25 $\mu$ s/s		
Square (50 $\Omega$ /1M $\Omega$ )	9.0091 ns to 55 s	0.25 $\mu$ s/s		



## SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks
<b>Specific DC-LF Equipment</b>			
<b>Oscilloscope</b>			
ii) <u>Horizontal Deflection</u>			
a) Sine Voltage Impedance 50 $\Omega$ /1M $\Omega$	<u>4.44 mVpp to 5.56 Vpp</u> 50 Hz to 10 MHz 10 MHz to 100 MHz 100 MHz to 550 MHz  <u>4.44 mVpp to 3.336 Vpp</u> 550 MHz to 1.1 GHz	15 mVpp/Vpp 15 mVpp/Vpp 30 mVpp/Vpp   40 mVpp/Vpp	Generating using an Oscilloscope Calibrator
iii) <u>Auxiliary</u>	$\pm$ (88.8 $\mu$ A to 111.2 mA)	2.5 mA/A	
a) DC Current	88.8 $\mu$ App to 111.2 mApp	2.5 mApp/App	
b) Square Current			
c) Resistance	50 k $\Omega$ to 12 M $\Omega$ 800 k $\Omega$ to 1.2 M $\Omega$	5.0 m $\Omega$ / $\Omega$ 1.0 m $\Omega$ / $\Omega$	
d) Capacitance	1 pF to 35 pF 35 pF to 95 pF	20 mF/F 30 mF/F	

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## SCOPE OF CALIBRATION: ELECTRICAL

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks
<b>Specific RF Equipment</b>			
Wideband AC Voltage Meter	<u>1 kHz</u> 1.1 mV (-46 dBm) 3.0 mV (-37 dBm) 11 mV (-26 dBm) 33 mV (-17 dBm) 110 mV (-6.2 dBm) 330 mV (-3.4 dBm) 1.1 V (14 dBm) 3.5 V (24 dBm)	8.0 mV/V 7.0 mV/V 7.0 mV/V 6.0 mV/V 6.0 mV/V 5.0 mV/V 5.0 mV/V 4.0 mV/V	Generating using a Multifunction Calibrator
RF Power Meter	3 $\mu$ W to 100 mW (-25 dBm to 20 dBm)	3.0 mW/W	HP 11683A, HP 432A, HP 478A, HP 34401A
Frequency Meter	0.5 Hz to 10 MHz	25 $\mu$ Hz /Hz	Generating using a Multiproduct Calibrator
Frequency Tester/Source	0.1 Hz to 3 GHz	0.2 $\mu$ Hz/Hz	Measuring using a Precision Frequency/ Universal Counter
Time Base	0.33 ns to 10 s	0.20 $\mu$ s/s	

## Signatories:

1. Seah Leong Ho
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## SCOPE OF CALIBRATION: ELECTRICAL

### MATRIX A TABLE (AC Voltage Measuring Instruments)

<b>i) Generated by using a Multifunction Calibrator</b>									
Voltage Range	Frequency								
	15 Hz to 50 Hz	20 Hz to 40 Hz	40 Hz to 20 kHz	50 Hz to 1 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
0 mV to 2.2 mV	-	-	0.20 mV/V	-	0.50 mV/V	-	-	-	-
2.2 mV to 22 mV	-	0.28 mV/V	0.28 mV/V	-	0.40 mV/V	0.75 mV/V	1.5 mV/V	2.3 mV/V	3.6 mV/V
22 mV to 220 mV	-	0.12 mV/V	0.11 mV/V	-	0.23 mV/V	0.54 mV/V	0.99 mV/V	1.5 mV/V	2.9 mV/V
220 mV to 2.2 V	-	0.10 mV/V	50 $\mu$ V/V	-	80 $\mu$ V/V	0.12 mV/V	0.46 mV/V	1.1 mV/V	1.8 mV/V
2.2 V to 22 V	-	97 $\mu$ V/V	48 $\mu$ V/V	-	80 $\mu$ V/V	0.11 mV/V	0.30 mV/V	1.1 mV/V	1.7 mV/V
22 V to 220 V	-	90 $\mu$ V/V	52 $\mu$ V/V	-	80 $\mu$ V/V	0.15 mV/V	0.90 mV/V	-	-
220 V to 1100 V	0.30 mV/V	-	-	70 $\mu$ V/V	-	-	-	-	-

  

<b>ii) Generated by using a Multiproduct Calibrator</b>									
Voltage Range	Frequency								
	1 kHz to 3 kHz	3 kHz to 10 kHz	10 kHz to 20 kHz	-	-	-	-	-	-
220 V to 1100 V	0.80 mV/V	0.80 mV/V	1.2 mV/V	-	-	-	-	-	-

**SCOPE OF CALIBRATION: ELECTRICAL****MATRIX B TABLE** (AC Current Measuring Instruments)

<b>i) Generated by using a Multifunction Calibrator</b>				
Current Range	Frequency			
	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	-	0.16 mA/A	0.34 mA/A	1.4 mA/A
220 $\mu$ A to 2.2 mA	-	0.14 mA/A	0.25 mA/A	1.4 mA/A
2.2 mA to 22 mA	-	0.13 mA/A	0.21 mA/A	1.2 mA/A
22 mA to 2.2 A	0.28 mA/A	-	0.49 mA/A	7.1 mA/A
<b>ii) Generated by using a Multiproduct Calibrator</b>				
Current Range	Frequency			
	10 Hz to 3 kHz	3 kHz to 10 kHz	10 kHz to 30 kHz	-
0 $\mu$ A to 30 $\mu$ A	0.70 mA/A	1.0 mA/A	2.0 mA/A	-
3 A to 10 A	2.0 mA/A	5.0 mA/A	-	-
10 A to 20 A	2.0 mA/A	5.0 mA/A	-	-
<b>iii) Generated by using a Multiproduct Calibrator</b>				
Current Range	Frequency			
	50 Hz to 60 Hz	60 Hz to 400 Hz	-	-
20 A to 50 A	0.15 mA/A	0.15 mA/A	-	-

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**SCOPE OF CALIBRATION: ELECTRICAL****MATRIX C TABLE (AC Voltage Generating Instruments)**

<b>i) Measured by using an AC Measurement Standard</b>			
Voltage Range	Frequency		
	45 Hz to 20 kHz	20 kHz to 50 kHz	50 kHz to 100 kHz
7 mV to 22 mV	0.12 mV/V + 1.6 $\mu$ V	0.24 mV/V + 2.3 $\mu$ V	0.35 mV/V + 2.9 $\mu$ V
22 mV to 70 mV	78 $\mu$ V/V + 1.8 $\mu$ V	0.15 mV/V + 2.3 $\mu$ V	0.29 mV/V + 2.9 $\mu$ V
70 mV to 220 mV	49 $\mu$ V/V + 1.7 $\mu$ V	83 $\mu$ V/V + 2.3 $\mu$ V	0.18 mV/V + 2.8 $\mu$ V
220 mV to 700 mV	44 $\mu$ V/V + 1.7 $\mu$ V	64 $\mu$ V/V + 2.2 $\mu$ V	96 $\mu$ V/V + 2.8 $\mu$ V
700 mV to 2.2 V	32 $\mu$ V/V	59 $\mu$ V/V	86 $\mu$ V/V
2.2 V to 7 V	34 $\mu$ V/V	61 $\mu$ V/V	0.1 mV/V
7 V to 22 V	35 $\mu$ V/V	60 $\mu$ V/V	96 $\mu$ V/V
22 V to 70 V	45 $\mu$ V/V	72 $\mu$ V/V	0.12 mV/V
70 V to 220 V	43 $\mu$ V/V	87 $\mu$ V/V	0.12 mV/V
220 V to 700 V	54 $\mu$ V/V	-	-
700 V to 1000 V	49 $\mu$ V/V	-	-

**MATRIX D TABLE (AC Current Generating Instruments)**

<b>i) Measured by using a Precision Multimeter</b>			
Current Range	Frequency		
	40 Hz to 2 kHz	45 Hz to 10 kHz	2 kHz to 10 kHz
0 to 200 $\mu$ A	-	0.56 mA/A + 23 nA	-
200 $\mu$ A to 2 mA	-	0.34 mA/A + 0.23 $\mu$ A	-
2 mA to 20 mA	-	0.34 mA/A + 2.3 $\mu$ A	-
20 mA to 200 mA	-	0.33 mA/A + 23 $\mu$ A	-
200 mA to 2 A	0.70 mA/A + 0.23 mA	-	0.83 mA/A + 0.23 mA

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**SCOPE OF CALIBRATION: ELECTRICAL****SITE : CATEGORY I**

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks
<b>Basic DC-LF Measuring Equipment ( Multimeter, Clamp Meter, Data Acquisition, etc )</b>			
DC Voltage	$\pm$ (0 to 300 mV) $\pm$ (300 mV to 3 V) $\pm$ (3 V to 30 V) $\pm$ (30 V to 300 V) $\pm$ (300 V to 1000 V)	0.10 mV/V 0.10 mV/V 0.10 mV/V 0.10 mV/V 0.10 mV/V	Generating using a Multifunction / Multiproduct Calibrator
DC Current	$\pm$ (0 to 300 $\mu$ A) $\pm$ (300 $\mu$ A to 3 mA) $\pm$ (3 mA to 30 mA) $\pm$ (30 mA to 300 mA) $\pm$ (300 mA to 3 A) $\pm$ (3 A to 10 A) $\pm$ (10 A to 20 A)	0.20 mA/A 0.20 mA/A 0.20 mA/A 0.20 mA/A 0.60 mA/A 0.60 mA/A 0.60 mA/A	
AC Voltage	0 V to 1000 V	See Matrix E	
AC Current	0 A to 20 A	See Matrix F	
DC Current Clamp	<ul style="list-style-type: none"> <li>• 10-Coil               <ul style="list-style-type: none"> <li>3.2 A to 32 A</li> <li>32 A to 105 A</li> <li>105 A to 200 A</li> </ul> </li> <li>• 50-Coil               <ul style="list-style-type: none"> <li>16 A to 160 A</li> <li>160 A to 525 A</li> <li>525 A to 1000 A</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>3.0 mA/A</li> <li>3.0 mA/A</li> <li>3.0 mA/A</li> <li>3.0 mA/A</li> <li>3.0 mA/A</li> <li>3.0 mA/A</li> <li>3.0 mA/A</li> </ul>	Generating using a combination of Multiproduct Calibrator & Current Coil
AC Current Clamp	<ul style="list-style-type: none"> <li>• 10-Coil               <ul style="list-style-type: none"> <li><u>3 A to 30 A</u></li> <li>10 Hz to 100 Hz</li> <li>100 Hz to 440 Hz</li> <li><u>30 A to 200 A</u></li> <li>10 Hz to 100 Hz</li> <li>100 Hz to 440 Hz</li> </ul> </li> <li>• 50-Coil               <ul style="list-style-type: none"> <li><u>16 A to 160 A</u></li> <li>10 Hz to 100 Hz</li> <li><u>160 A to 1000 A</u></li> <li>10 Hz to 100 Hz</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>5.0 mA/A</li> <li>10 mA/A</li> <li>5.0 mA/A</li> <li>10 mA/A</li> <li>5.0 mA/A</li> <li>5.0 mA/A</li> </ul>	

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**SCOPE OF CALIBRATION: ELECTRICAL****SITE : CATEGORY I**

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks
<b>Basic DC-LF Measuring Equipment ( Multimeter, Clamp Meter, Data Acquisition, etc )</b>			
Resistance ( Variable )	0.1 $\Omega$ to 40 $\Omega$ 40 $\Omega$ to 400 $\Omega$ 400 $\Omega$ to 4 k $\Omega$ 4 k $\Omega$ to 40 k $\Omega$ 40 k $\Omega$ to 400 k $\Omega$ 400 k $\Omega$ to 4 M $\Omega$ 4 M $\Omega$ to 40 M $\Omega$ 40 M $\Omega$ to 400 M $\Omega$	1.0 m $\Omega$ / $\Omega$ 0.40 m $\Omega$ / $\Omega$ 0.40 m $\Omega$ / $\Omega$ 0.30 m $\Omega$ / $\Omega$ 0.30 m $\Omega$ / $\Omega$ 0.50 m $\Omega$ / $\Omega$ 2.0 m $\Omega$ / $\Omega$ 3.0 m $\Omega$ / $\Omega$	Generating using a Multifunction / Multiproduct Calibrator
Capacitance ( Variable )	0.5 nF to 4 nF 4 nF to 40 nF 40 nF to 400 nF 400 nF to 4 $\mu$ F 4 $\mu$ F to 40 $\mu$ F 40 $\mu$ F to 400 $\mu$ F 400 $\mu$ F to 4 mF 4 mF to 40 mF	3.0 mF/F 3.0 mF/F 3.0 mF/F 4.0 mF/F 10 mF/F 10 mF/F 10 mF/F 10 mF/F	
Frequency	0.5 Hz to 10 MHz	25 $\mu$ Hz /Hz	
<b>Basic DC-LF Generating Equipment ( Calibrator, Power Supply, etc )</b>			
DC Voltage	$\pm$ (0 to 100 mV) $\pm$ (100 mV to 1 V) $\pm$ (1 V to 10 V) $\pm$ (10 V to 100 V) $\pm$ (100 V to 1000 V)	0.10 mV/V 0.10 mV/V 0.10 mV/V 0.10 mV/V 0.10 mV/V	Measuring using a Precision Multimeter
DC Current	$\pm$ (0 mA to 10 mA) $\pm$ (10 mA to 100 mA) $\pm$ (100 mA to 1 A) $\pm$ (1 A to 3 A)	1.0 mA/A 1.0 mA/A 2.0 mA/A 2.0 mA/A	

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**SCOPE OF CALIBRATION: ELECTRICAL**

**SITE : CATEGORY I**

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(±)*	Remarks
<b>Specific DC-LF Equipment</b>			
Insulation Resistance ( up to 5kV )	10 MΩ to 100 MΩ 100 MΩ to 1 GΩ 1 GΩ to 10 GΩ 10 GΩ to 100 GΩ 100 GΩ to 1 TΩ	5.0 mΩ/Ω 5.0 mΩ/Ω 5.0 mΩ/Ω 10 mΩ/Ω 10 mΩ/Ω	Generating using a combination of High Voltage & Decade Resistance Box
LCR Meter ( at 1kHz )			
<ul style="list-style-type: none"> <li>Inductance</li> </ul>	100 μH to 1 mH 1 mH to 10 mH 10 mH to 100 mH 100 mH to 1 H 1 H to 10 H	30 mH/H 30 mH/H 30 mH/H 10 mH/H 10 mH/H	Generating using a combination of Decade-Standard Inductance
<ul style="list-style-type: none"> <li>Capacitance</li> </ul>	1 pF to 10 pF 10 pF to 100 pF 100 pF to 1 nF 1 nF to 10 nF 10 nF to 100 nF 100 nF to 1 μF 1 μF to 10 μF 10 μF to 100 μF 100 μF to 1 mF	1.0 mF/F 1.0 mF/F 1.0 mF/F 1.0 mF/F 1.0 mF/F 1.0 mF/F 1.0 mF/F 1.0 mF/F 10 mF/F	Generating using a combination of Decade-Standard Capacitance
<ul style="list-style-type: none"> <li>Resistance</li> </ul>	1 Ω to 10 Ω 10 Ω to 100 Ω 100 Ω to 1 kΩ 1 kΩ to 10 kΩ 10 kΩ to 100 kΩ 100 kΩ to 1 MΩ	1.0 mΩ/Ω 1.0 mΩ/Ω 1.0 mΩ/Ω 1.0 mΩ/Ω 1.0 mΩ/Ω 1.0 mΩ/Ω	Generating using a combination of Decade-Standard Resistance
High Voltage Source/Tester			
<ul style="list-style-type: none"> <li>DC Voltage</li> </ul>	0.2 kV to 5 kV 5 kV to 10 kV	10 mV/V 10 mV/V	Measuring using a combination of High Voltage Meter, High Voltage Divider & Precision Multimeter
<ul style="list-style-type: none"> <li>AC Voltage ( at 50/60 Hz )</li> </ul>	0.5 kV to 10 kV	15 mV/V	

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**SCOPE OF CALIBRATION: ELECTRICAL****SITE : CATEGORY I**

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks
<b>Specific DC-LF Equipment</b>			
Power Source (Welding - Std Grade)			Measuring using a combination of Load Banks & Clamp Meter
• DC Current	0 A to 40 A	18 mA/A + 69 mA	
	40 A to 500 A	17 mA/A + 0.57 A	
• AC Current ( at 50/60 Hz )	0 A to 40 A	19 mA/A + 69 mA	
	40 A to 500 A	17 mA/A + 0.58 A	
<b>Oscilloscope</b>			Generating using an Oscilloscope Calibrator
i) Vertical Deflection			
a) Square Wave			
50 $\Omega$	4.44 mV <sub>pp</sub> to 3.34 V <sub>pp</sub>	3.0 mV/V <sub>pp</sub>	
1 M $\Omega$	4.44 mV <sub>pp</sub> to 133.44 V <sub>pp</sub>	3.0 mV/V <sub>pp</sub>	
b) DC Level			
50 $\Omega$	$\pm(4.44 \text{ mV to } 2.78 \text{ V})$	3.0 mV/V	
1 M $\Omega$	$\pm(4.44 \text{ mV to } 133.44 \text{ V})$	3.0 mV/V	
ii) Horizontal Deflection			
a. Time Markers	4 ns/div to 5.5 s/div	25 $\mu$ s/s	
50 $\Omega$			
b. Edge Response (Rise/Fall Time)			
50 $\Omega$ load	< 1 ns	25 $\mu$ s/s	
1 M $\Omega$	< 100 ns	25 $\mu$ s/s	

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**SCOPE OF CALIBRATION: ELECTRICAL****SITE : CATEGORY I**

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty( $\pm$ )*	Remarks
<b>Specific DC-LF Equipment</b>			
<b>Oscilloscope</b>			
c. Bandwidth			Generating using an Oscilloscope Calibrator
50 $\Omega$	50 kHz to 100 MHz	2.0 mHz/Hz	
	100 MHz to 250 MHz	4.0 mHz/Hz	
1 M $\Omega$	10 Hz to 49.999 kHz	3.0 mHz/Hz	

**Signatories:**

1. Seah Leong Ho
2. Chin Inn Nkot
3. Shah Zulkifli Nor Bin Arshad
4. Husna Binti Abdul Rahim

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**SCOPE OF CALIBRATION: ELECTRICAL****SITE : CATEGORY I****MATRIX E TABLE** (AC Voltage Measuring Instruments)

Generated by using a Multiproduct Calibrator						
Voltage Range	Frequency					
	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	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	5.0 mV/V	-
10 mV to 30 mV	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	5.0 mV/V	-
30 mV to 300 mV	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	5.0 mV/V	-
300 mV to 1.5 V	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	2.0 mV/V	-
1.5 V to 3 V	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	2.0 mV/V	-
3 V to 30 V	1.0 mV/V	1.0 mV/V	1.0 mV/V	2.0 mV/V	4.0 mV/V	-
30 V to 100 V	1.0 mV/V	1.0 mV/V	1.0 mV/V	2.0 mV/V	4.0 mV/V	-
Voltage Range	Frequency					
	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	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	2.0 mV/V
300 V to 750 V	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	2.0 mV/V
750 V to 1000 V	1.0 mV/V	1.0 mV/V	1.0 mV/V	1.0 mV/V	2.0 mV/V	-

**MATRIX F TABLE** (AC Current Measuring Instruments)

Generated by using a Multiproduct Calibrator				
Current Range	Frequency			
	10 Hz to 3 kHz	3 kHz to 10 kHz	10 kHz to 20 kHz	20 kHz to 30 kHz
0 to 30 $\mu$ A	1.0 mA/A	2.0 mA/A	3.0 mA/A	3.0 mA/A
30 $\mu$ A to 300 $\mu$ A	1.0 mA/A	2.0 mA/A	3.0 mA/A	3.0 mA/A
300 $\mu$ A to 3 mA	1.0 mA/A	1.0 mA/A	2.0 mA/A	3.0 mA/A
3 mA to 30 mA	1.0 mA/A	1.0 mA/A	2.0 mA/A	3.0 mA/A
30 mA to 300 mA	1.0 mA/A	1.0 mA/A	2.0 mA/A	3.0 mA/A
300 mA to 3 A	2.0 mA/A	3.0 mA/A	2.0 mA/A	3.0 mA/A
3 A to 10 A	3.0 mA/A	10 mA/A	-	-
10 A to 20 A	3.0 mA/A	10 mA/A	-	-