

Schedule

Issue date: 20 March 2020
Valid until: 5 May 2023



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LABORATORY LOCATION:
(PERMANENT LABORATORY)



TOYOTECH ENGINEERING SDN. BHD.
2G, BLOK E, JALAN PERUBATAN 3
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55100 KUALA LUMPUR
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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 AND SITE: **CATEGORY I**

Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
1. INDICATING INSTRUMENTS			
(a) DC Voltage	0 mV to 220 mV 221 mV to 1100 V	0.4 μ V 2 μ V/V	Generating using Calibrator model Fluke 5700A
(b) DC Current	0 μ A to 220 μ A 221 μ A to 220 mA 221 mA to 2.2 A 2.3 A to 11 A	2 nA 13 nA 73 μ A 2 mA	Generating using Calibrator model Fluke 5700A Generating using Calibrator model Fluke 5500A

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
1. INDICATING INSTRUMENTS			
(c) AC Voltage	<u>1 mV to 22 mV</u> 45 Hz to 1 kHz	3 μ V	Generating using Calibrator model Fluke 5700A
	<u>23 mV to 220 mV</u> 45 Hz to 1 MHz	7 μ V	
	<u>221 mV to 2.2 V</u> 45 Hz to 1 MHz	39 μ V	
	<u>2.3 V to 22 V</u> 45 Hz to 1 MHz	440 μ V	
	<u>23 V to 220 V</u> 45 Hz to 100 kHz	5 mV	
	<u>221 V to 1100 V</u> 45 Hz to 10 kHz	33 mV	
(d) AC Current	<u>10 μA to 220 μA</u> 45 Hz to 10 kHz	5 nA	Generating using Calibrator model Fluke 5500A
	<u>0.23 mA to 2.2 mA</u> 45 Hz to 10 kHz	150 nA	
	<u>2.3 mA to 22 mA</u> 45 Hz to 10 kHz	2 μ A	
	<u>23 mA to 220 mA</u> 45 Hz to 10 kHz	18 μ A	
	<u>0.23 A to 2.2 A</u> 45 Hz to 10 kHz	210 μ A	
	<u>2.2 A to 11 A</u> 45 Hz to 10 kHz	5 mA	
(e) AC Current at 60 Hz	11 A to 50 A	85 mA	Generating using AC Voltage Current Standard model Yokogawa 2558

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
1. INDICATING INSTRUMENTS			
(f) DC Resistance	0 Ω to 10 Ω 11 Ω to 100 k Ω 101 Ω to 1 M Ω 1.1 M Ω to 10 M Ω 11 M Ω to 100 M Ω	0.1 m Ω 3 m Ω 7 Ω 89 Ω 4 k Ω	Generating using Calibrator model Fluke 5700A
(g) Insulation resistance	0.1 Ω to 1 Ω 1.1 Ω to 10 Ω 10.1 Ω to 100 Ω 100.1 Ω to 1000 Ω 1000.1 Ω to 10 k Ω 10.1 k Ω to 100 k Ω 100.1 k Ω to 1 M Ω 1.1 M Ω to 10 M Ω 10.1 M Ω to 110 M Ω 111 M Ω to 1 G Ω 1 G Ω to 10 G Ω	0.5 m Ω 0.6 m Ω 1 m Ω 27 m Ω 0.1 Ω 1 Ω 14 Ω 0.6 k Ω 36 k Ω 53 k Ω 30 M Ω	Generating using Decade Resistance Box Yokogawa 2793-01 and 2793-03
(h) Temperature R-Type K-Type E-Type J-Type T-Type	0 to 1600 $^{\circ}\text{C}$ -200 to 1200 $^{\circ}\text{C}$ 0 to 700 $^{\circ}\text{C}$ -200 to 600 $^{\circ}\text{C}$ -200 to 200 $^{\circ}$	0.3 $^{\circ}\text{C}$ 0.4 $^{\circ}\text{C}$ 0.2 $^{\circ}\text{C}$ 0.2 $^{\circ}\text{C}$ 0.1 $^{\circ}\text{C}$	Generating using DC Voltage Current Standard Yokogawa 2553
(i) Frequency	1 Hz to 10 kHz 11 kHz to 100 kHz 101 kHz to 1 MHz 1.1 MHz to 10 MHz 11 MHz to 100 MHz 101 MHz to 1 GHz 1.1 GHz to 2 GHz 2.1 GHz to 3 GHz	8 mHz 36 mHz 2 mHz 18 mHz 0.2 Hz 2 Hz 9 Hz 7 Hz	Generating using Function Generator Yokogawa FG- 120 Generating using Signal Generator Agilent E4436B
(j) RF Power	100 kHz to 3 GHz 10 dBm to - 120 dBm	0.3 dB	Generating using Signal Generator Agilent E4436B

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
(k) Frequency Modulation Deviation	<u>Carrier Frequency: 100 kHz to 3 GHz @ Internal Rate : 1 Hz to 500 kHz</u> 0.5 kHz to 1 kHz 1.1 kHz to 10 kHz 10.1 kHz to 100 kHz	20 Hz 200 Hz 2 kHz	Generating using Signal Generator Agilent E4436B
(l) Amplitude Modulation Depth	<u>Carrier Frequency: 100 kHz to 3 GHz @ Internal Rate : 1Hz to 500 kHz</u> 0 % to 30 % 31 % to 60 % 61 % to 100 %	1 % 2 % 4 %	Generating using Signal Generator Agilent E4436B
(m) Distortion	<u>20 Hz to 20 kHz</u> -10 dB -20 dB -30 dB to -60 dB	0.5 dB 0.6 dB 0.8 dB	Generating using Distortion Calibrator Meguro MKS-682
2. SOURCES			
(a) DC Voltage	0 mV to 100 mV 101 mV to 1 V 1.1 V to 10 V 10.1 V to 100V 100.1 V to 1000 V	0.6 μ V 8 μ V 45 μ V 0.7 mV 7 mV	Measurement using Multimeter Agilent 3458A
(b) DC Current	0 mA to 10 mA 10.1 mA to 100 mA 100.1 mA to 1 A 1.1 A to 3 A	17 μ A 2 μ A 54 mA 0.6 mA	Measurement using Multimeter Agilent 3458A Measurement using Multimeter Agilent 34401A

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(c) AC Voltage	<u>1 mV to 10 mV</u> 45 Hz to 1 kHz	4 μ V	Measurement using Multimeter Agilent 3458A
	<u>11 mV to 100 mV</u> 45 Hz to 1 MHz	4 μ V	
	<u>101 mV to 1 V</u> 45 Hz to 1 MHz	22 μ V	
	<u>1.1 V to 10 V</u> 45 Hz to 1 MHz	0.3 mV	
	<u>11 V to 100 V</u> 45 Hz to 100 kHz	4 mV	
	<u>101 V to 1000 V</u> 45 Hz to 1 kHz	32 mV	
(d) AC Current	<u>1 mA to 1 A</u> 45 Hz to 1 kHz	0.4 mA	Measurement using Multimeter Agilent 34401A
	<u>1.1 A to 3 A</u> 45 Hz to 1 kHz	0.5 mA	
(e) DC Resistance	0 Ω 10 $\mu\Omega$	0.3 m Ω	Measurement using Multimeter Agilent 3458A
	10.1 $\mu\Omega$ to 100 Ω	2 m Ω	
	100.1 Ω to 100 Ω	17 m Ω	
	1.1 k Ω to 10 k Ω	180 m Ω	
	10.1 k Ω to 1 k Ω	2 Ω	
	100.1 k Ω to 1 M Ω	25 Ω	
	1.1 M Ω to 10 M Ω	0.7 k Ω	
	10.1 M Ω to 100 M Ω	13 k Ω	
100.1 M Ω to 1 G Ω	0.7 M Ω		
(f) DC High Voltage	1 kV to 2 kV	6 V	Measurement using High Voltage Meter Kikusui 149-10A
	2.1 kV to 4 kV	7 V	
	4.1 kV to 6 kV	8 V	
	6.1 kV to 8 kV	8 V	
	8.1 kV to 10 kV	10 V	

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
(g) AC High Voltage at 50 Hz	1 kV to 2 kV	12 V	Measurement using High Voltage Meter Kikusui 149-10A
	2.1 kV to 4 kV	13 V	
	4.1 kV to 6 kV	23 V	
	6.1 kV to 8 kV	26 V	
	8.1 kV to 10 kV	29 V	
(h) Leakage DC Current	0.4 mA	24 μ A	Measurement using Current Calibrator for W. Tester Kikusui TOS1200
	0.5 mA	24 μ A	
	0.8 mA	11 μ A	
	1.0 mA	11 μ A	
	1.6 mA	11 μ A	
	2.0 mA	11 μ A	
	4.0 mA	23 μ A	
	5.0 mA	23 μ A	
(i) Leakage AC Current at 50 Hz	0.4 mA	27 μ A	Measurement using Current Calibrator for W. Tester Kikusui TOS1200
	0.5 mA	27 μ A	
	0.8 mA	10 μ A	
	1.0 mA	10 μ A	
	1.6 mA	20 μ A	
	2.0 mA	20 μ A	
	4.0 mA	50 μ A	
	5.0 mA	50 μ A	
	8.0 mA	100 μ A	
	10.0 mA	100 μ A	
	16.0 mA	200 μ A	
	20.0 mA	200 μ A	
	40.0 mA	400 μ A	
50.0 mA	400 μ A		

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
(j) Time interval	1 s to 2 s (250 ms/div)	0.6 s	Measurement using Oscilloscope Tektronix TDS350
	2 s to 4 s (500 ms/div)	0.6 s	
	4 s to 8 s (1 s/div)	0.6 s	
	8 s to 20 s (2.5 s/div)	0.6 s	
	20 s to 60 s (5 s/div)	0.6 s	
(k) Time base	10 MHz	0.3 Hz	Measurement using Frequency Counter Agilent 5335A
(l) Frequency	10 Hz to 100 Hz	50 μ Hz	Measurement using Frequency Counter Agilent 5385A
	100 Hz to 1 kHz	110 μ Hz	
	1 kHz to 10 kHz	0.4 mHz	
	10 kHz to 100 kHz	4 mHz	
	100 kHz to 1 MHz	66 mHz	
	1 MHz to 10 MHz	360 mHz	
	10 MHz to 100 MHz	3 Hz	
	100 Mhz to 1 GHz	27 Hz	
	1 GHz to 2 GHz	2 Hz	Measurement using Frequency Counter Anritsu MF76A
2 GHz to 3 GHz	20 Hz		

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Instrument Calibrated/ Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty(\pm)*	Remarks
(m) Distortion	<u>10 Hz to 20 kHz</u> -10 dB to -60 dB	0.1 dB	Measurement using Audio Analyzer Agilent 8903B
(n) Attenuation	<u>10 Hz to 20 kHz</u> -10 dB to -60 dB	0.2 dB	Measurement using Audio Analyzer Agilent 8903B
(o) RF power	<u>100 kHz to 1.3 GHz</u> 10 dBm to -120 dBm -20 dBm to - 120 dBm	0.9 dB 1 dB	Measurement using Measuring Receiver Agilent 8902A
(p) Frequency Modulation Deviation	<u>Carrier Frequency: 100</u> <u>kHz to 1.3 GHz @</u> <u>internal rate</u> <u>20 Hz to 200 Hz</u> 0.5 kHz to 1 kHz 1 kHz to 10 khz 10 kHz to 100 kHz	11 Hz 110 Hz 1 kHz	Measurement using Measuring Receiver Agilent 8902A
(q) Amplitude Modulation Deviation	<u>Carrier Frequency: 100</u> <u>kHz to 1.3 GHz @</u> <u>internal rate</u> <u>20 Hz to 200 kHz</u> 0% to 30% 30% to 60% 60% to 90%	1 % 2 % 3 %	Measurement using Measuring Receiver Agilent 8902A

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3. OSCILLOSCOPE			
(a) Vertical Deflection	Amplitude (Peak-to-peak) 1 M Ω Load 200 μ V to 100 V	2.5 mV/V + 1 μ	Generating using Calibration Generator Tektronix PG506
(b) Time Mark	1 ns to 5 s	1 ms/s	Generating using Time Mark Generator Tektronix TG501
(c) Frequency Range	50 kHz to 250 MHz	0.7 of the least significant displayed digit	Measurement using Levelled Sine Wave Generator Tektronix SG503
(d) Amplitude Range	<u>X0.01 Range</u> 5 mV to 50 mV	5 % of reading	
	<u>X0.1 Range</u> 50 mV to 500 mV	4 % of reading	
	<u>X1 Range</u> 500 mV to 5 V	3 % of reading	
4. DC Current via shunt (1 m Ω)	0 A to 30 A	1 mA/A	Measurement using Agilent 3458A through Current Shunt Yokogawa 2215

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Signatories:

1. Phang Kwai Choong
2. Chick Choon Fai
3. Tan Chee Kuong