



**STANDARDS
MALAYSIA**

Certificate of Accreditation

No: SAMM 693

Accredited since: 29 January 2015

This is to certify that

RADIO & FREQUENCY (RF) LABORATORY
SIRIM CALIBRATION SDN. BHD.
PERMATANG PAUH, PULAU PINANG
MALAYSIA



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for the current scope of accreditation

has been granted accreditation in respect of the scope of accreditation described in the schedule, 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. This Malaysian Standard is identical with ISO/IEC 17025 published by the International Organization for Standardization (ISO).



(SHAHARUL SADRI BIN ALWI)
Director General
Department of Standards Malaysia

Date of issue: 3 January 2023
(Issue 2, 3 January 2023 replacement of
SAMM 693 dated 12 March 2020)

Schedule

Issue date: 3 January 2023
Valid until: 29 January 2024



NO: SAMM 693

Issue 3, 3 January 2023 replacement
of SAMM 693 dated 27 April 2022)

LABORATORY LOCATION: RADIO & FREQUENCY (RF) LABORATORY
(PERMANENT LABORATORY)
SIRIM CALIBRATION SDN. BHD.
BANGUNAN UTAMA, SIRIM BERHAD
483, MUKIM 6, JALAN PERMATANG PAUH
13500 PERMATANG PAUH
SEBERANG PERAI, PULAU PINANG
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 uncertainty covered by the CMC is expressed as the expanded uncertainty corresponding to a coverage probability of approximately 95 % and have a coverage factor of k=2 unless stated otherwise.

SCOPE OF CALIBRATION: ELECTRICAL - DC & LOW FREQUENCY

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) *	Remarks
1. Measuring Instrument DC VOLTAGE	0 to 330 mV	(of reading) 7.5 μ V	Generation using calibrator model Fluke 5500A
	0 to 3.3 V	0.2 mV	
	0 to 33 V	0.8 mV	
	33 to 330 V	8 mV	
	330 to 1000 V	74 mV	
DC RESISTANCE	0 to 11 Ω	(of reading) 7 m Ω	Generation using calibrator model Fluke 5500A
	11 to 33 Ω	7 m Ω	
	33 to 110 Ω	7 m Ω	
	110 to 330 Ω	8 Ω	
	0.33 to 1.1 k Ω	0.2 Ω	
	1.1 to 3.3 k Ω	1 Ω	
	3.3 to 11 k Ω	0.7 Ω	
	11 to 33 k Ω	0.8 Ω	
	33 to 110 k Ω	11 Ω	
	110 to 330 k Ω	10 Ω	
	0.33 to 1.1 M Ω	0.1 k Ω	
	1.1 to 3.3 M Ω	0.2 k Ω	
	3.3 to 11 M Ω	0.7 k Ω	
	11 to 33 M Ω	12 k Ω	
	33 to 110 M Ω	17 k Ω	
110 to 330 M Ω	67 k Ω		

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SCOPE OF CALIBRATION:

ELECTRICAL - DC & LOW FREQUENCY

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) *	Remarks
1. Measuring Instrument DC CURRENT	0 to 3.3 mA	(of reading) 0.1 μ A	Generation using calibrator model Fluke 5500A
	0 to 33 mA	2.1 μ A	
DC CURRENT	0 to 330 mA	0.1 mA	
	0 to 2.2 A	1.2 mA	
DC CURRENT	0 to 11 A	7.8 mA	
AC CURRENT	<u>0.03 to 0.33 mA</u>		
	10 Hz to 20 Hz	0.3 μ A	
AC CURRENT	20 Hz to 45 Hz	0.3 μ A	
	45 Hz to 1 kHz	0.3 μ A	
AC CURRENT	1 kHz to 5 kHz	0.3 μ A	
	5 kHz to 10 kHz	0.3 μ A	
AC CURRENT	<u>0.33 to 3.3 mA</u>		
	10 Hz to 45 Hz	3 μ A	
AC CURRENT	45 Hz to 1 kHz	3 μ A	
	1 kHz to 5 kHz	3 μ A	
AC CURRENT	5 kHz to 10 kHz	3 μ A	
AC CURRENT	<u>3.3 to 33 mA</u>		Generation using calibrator model Fluke 5500A
	10 Hz to 45 Hz	28 μ A	
AC CURRENT	45 Hz to 1 kHz	28 μ A	
	1 kHz to 5 kHz	28 μ A	
AC CURRENT	5 kHz to 10 kHz	28 μ A	
AC CURRENT	<u>33 to 330 mA</u>		
	10 Hz to 45 Hz	0.4 mA	
AC CURRENT	45 Hz to 1 kHz	0.4 mA	
	1 kHz to 5 kHz	0.4 mA	
AC CURRENT	5 kHz to 10 kHz	0.4 mA	
AC CURRENT	<u>0.33 to 2.2 A</u>		
	10 Hz to 45 Hz	4 mA	
AC CURRENT	45 Hz to 1 kHz	4 mA	
	1 kHz to 5 kHz	7 mA	
AC CURRENT	<u>2.2 to 11 A</u>		
	45 Hz to 65 Hz	12 mA	
AC CURRENT	65 Hz to 500 Hz	13 mA	
	500 Hz to 1 kHz	14 mA	

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of SAMM 693 dated 27 April 2022)**SCOPE OF CALIBRATION: ELECTRICAL - DC & LOW FREQUENCY**

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) *	Remarks
1. Measuring Instrument AC VOLTAGE	<u>1.0 to 33 mV</u>		Generation using calibrator model Fluke 5500A
	10 Hz to 45 Hz	3.6 μ V	
	45 Hz to 10 kHz	43 μ V	
	10 kHz to 20 kHz	3.6 μ V	
	20 kHz to 50 kHz	5.7 μ V	
	50 kHz to 100 kHz	11 μ V	
	100 kHz to 500 kHz	26 μ V	
	<u>33 to 330 mV</u>		
	10 Hz to 45 Hz	13 μ V	
	45 Hz to 10 kHz	77 μ V	
	10 kHz to 20 kHz	13 μ V	
	20 kHz to 50 kHz	18 μ V	
	50 kHz to 100 kHz	45 μ V	
	100 kHz to 500 kHz	110 μ V	
	<u>0.33 to 3.3 V</u>		
	10 Hz to 45 Hz	0.1 mV	
	45 Hz to 10 kHz	0.1 mV	
	10 kHz to 20 kHz	0.1 mV	
	20 kHz to 50 kHz	0.2 mV	
	50 kHz to 100 kHz	0.2 mV	
	100 kHz to 500 kHz	1.1 mV	
	<u>3.3 to 33 V</u>		
	10 Hz to 45 Hz	1.2 mV	
	45 Hz to 10 kHz	1.1 mV	
10 kHz to 20 kHz	1.2 mV		
20 kHz to 50 kHz	2.1 mV		
50 kHz to 100 kHz	2.8 mV		
<u>33 to 330 V</u>			
10 Hz to 45 Hz	17 mV		
45 Hz to 10 kHz	14 mV		
10 kHz to 20 kHz	14 mV		
<u>330 to 1020 V</u>			
45 Hz to 1 kHz	39 mV		
1 kHz to 5 kHz	52 mV		

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) * (of reading)	Remarks
2. Source/Generating Instrument DC VOLTAGE	$\frac{100 \text{ mV}}$ + 100 μV to + 100 mV - 100 mV to - 100 μV	1.8 μV 1.8 μV	HP3458A
	$\frac{1 \text{ V}}$ + 100 mV to 1 V - 1 V to -100 mV	9 μV 9 μV	
	$\frac{10 \text{ V}}$ + 1 V to + 10 V - 10 V to -1 V	0.1 mV 0.1 mV	
	$\frac{100 \text{ V}}$ + 10 V to +100 V -100 V to -10 V	1 mV 1 mV	
	$\frac{1000 \text{ V}}$ + 100 V to + 1000 V - 1000 V to -100 V	12 mV 12 mV	
DC RESISTANCE	10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω 10 M Ω 100 M Ω	0.3 m Ω 2.0 m Ω 15 m Ω 0.1 Ω 1.6 Ω 23 Ω 0.5 k Ω 13 k Ω	HP3458A

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) *	Remarks
2. Source/Generating Instrument (continue) DC CURRENT	<p style="text-align: center;"><u>100 μA</u></p> +10 μ A to +100 μ A -100 μ A to - 10 μ A	(of reading) 16 nA 16 nA	HP 3458A
AC VOLTAGE	<p style="text-align: center;"><u>1 mA</u></p> +100 μ A to +1 mA -1 mA to -100 μ A	69 nA 69 nA	HP 3458A
3. High Current Generating DC CURRENT	<p style="text-align: center;"><u>10 mA</u></p> +1 mA to +10 mA -10 mA to -1 mA	0.7 μ A 0.7 μ A	HP 6060B / 6050A w/ 60503A module
AC VOLTAGE	<p style="text-align: center;"><u>100 mA</u></p> +10 mA to +100 mA -100 mA to -10 mA	7.8 μ A 7.8 μ A	HP 3458A
AC VOLTAGE	<p style="text-align: center;"><u>1 A</u></p> +100 mA to + 1 A -1 A to -100 mA	0.1 mA 0.1 mA	HP 3458A
AC VOLTAGE	<p style="text-align: center;"><u>10 mV range</u></p> 0 mV to 10 mV	(See Matrix A)	HP 3458A
AC VOLTAGE	<p style="text-align: center;"><u>100 mV range</u></p> 10 mV to 100 mV		
AC VOLTAGE	<p style="text-align: center;"><u>1 V range</u></p> 100 mV to 1 V		
AC VOLTAGE	<p style="text-align: center;"><u>10 V range</u></p> 1 V to 10 V		
AC VOLTAGE	<p style="text-align: center;"><u>100 V range</u></p> 10 V to 100 V		
AC VOLTAGE	<p style="text-align: center;"><u>1000 V range</u></p> 100 V to 700 V	(See Matrix A)	HP 3458A
AC VOLTAGE	(See Matrix A)		

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) * (of reading)	Remarks
4. OSCILLOSCOPE			
Vertical Deflection DC Signal	0 V to ± 6.6 V (50 Ω Load)	1 mV/V + 0.04 mV	Generating using Oscilloscope Calibrator Fluke 5820A & E8257D
	0 V to ± 130 V (1 M Ω Load)	0.5 mV/V + 0.04 mV	
Vertical Deflection Square Wave Signal	± 1 mVp-p to ± 6.6 Vp-p (50 Ω Load)	1.0 mVp-p/Vp-p + 0.04 mV	
	± 1 mVp-p to 130 Vp-p (1 M Ω Load)	0.5 mVp-p/Vp-p + 0.04 mV	
Horizontal Deflection Time Markers (50 Ω Load)	2 ns/div to 20 ms/div	2.5 us/s	
	50 ms/div to 5 s/div	2.2 ms/s	
Rise time	≤ 300 ps	0.3 ns	
Bandwidth Amplitude	50 kHz to 600 MHz	17 mVp-p	
	600 MHz to 2100 MHz	23 mVp-p	
5. AUDIO ANALYZER			
	<u>Frequency</u> 20 Hz to 150 kHz	0.006 kHz	Fluke 5500A
	<u>Amplitude</u> 1 mV to 300 V	0.11 V	
	Residual Distortion (-99 to 0 dB) 20 Hz to 20 kHz 20 kHz to 100 kHz	1 dB 1 dB	8903B

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Matrix A

AC Voltage (Source / Generating Instrument)

Range		Frequency				
		Hz		kHz		
		10 to 20	20 to 40	0.04 to 1	1 to 20	20 to 50
10 mV	0 mV to 10 mV	-	-	7.1 μ	7.1 μ	-
100 mV	10 mV to 100 mV	-	-	21 μ	21 μ	-
1 V	100 mV to 1 V	-	-	110 μ	110 μ	-
10 V	1 V to 10 V	2.5 mV	1.7 mV	14 mV	1.7 mV	2.1 mV
100 V	10 V to 100 V	-	-	10 mV	10 mV	28 mV
1000 V	100 V to 700 V	-	-	66 mV	-	-

Range		Frequency				
		Hz		kHz		
		50 to 100	100 to 300	300 to 500	0.3 to 1	0.5 to 1
10 mV	0 mV to 10 mV	17 μ	28 mV	-	-	-
100 mV	10 mV to 100 mV	120 μ	0.1 mV	-	0.5 mV	-
1 V	100 mV to 1 V	0.4 mV	0.6 mV	-	3.3 mV	-
10 V	1 V to 10 V	3.4 mV	8 mV	19 mV	-	38 mV
100 V	10 V to 100 V	69 mV	-	-	-	-
1000 V	100 V to 700 V	-	-	-	-	-

Signatories:

1. Mohd Zaini Mustapa
2. Shukor Yahaya
3. Che Rashimi Che Yob

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SCOPE OF CALIBRATION: ELECTRICAL – RF/MICROWAVE (50 Ω SYSTEM)

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) * (of reading)	Remarks
6. RF Measuring Equipment FREQUENCY COUNTER	<u>Time Base</u> 10 MHz	0.1 mHz	Fluke 910R. (GPS-disciplined.)
	<u>Frequency Range</u> 100 Hz to 60 MHz 0.1 MHz to 2.1 GHz 10 MHz to 20 GHz 250 kHz to 40 GHz	0.8 mHz 0.8 mHz 0.8 Hz 0.8 Hz	HP 3325A/B HP 8642A/B HP 83620A E8257D (GPS-disciplined.)
MODULATION ANALYZER	<u>Frequency</u> 150kHz to 1.3GHz	0.8 Hz	HP8642A/B
	<u>Power Level</u> -25 dBm to 20 dBm (3 μ W to 100 mW)	0.06 dBm	HP 11683A
	<u>FM, Flatness</u> 20 Hz to 100 kHz rates 100 kHz to 200 kHz rates	0.1 kHz 0.5 kHz	HP 11715A
	<u>AM, Flatness</u> 50 Hz to 50 kHz 20 Hz to 100 kHz	0.05 kHz 0.25 kHz	HP 11715A
	<u>Distortion</u> Audio Distortion -70 dB minimum	1 dB	HP 8903B
RF POWER METER	<u>Power Level</u> -25 dBm to 20 dBm (3 μ W to 100 mW)	0.06 dBm	HP 11683A
NETWORK ANALYZER	<u>Frequency</u> 9 kHz to 26.5 GHz	(of reading) 0.18 Hz	E4448A
	<u>Power Level</u> <u>0 dBm to +20 dBm</u> 9 kHz to 2 GHz >2 GHz to 8 GHz >8 GHz to 13.5 GHz >13.5 GHz to 26.5 GHz	0.31 dB 0.57 dB 0.60 dB 0.67 dB	
	<u>0 dBm to -30 dBm</u> 9 kHz to 2 GHz >2 GHz to 8 GHz >8 GHz to 13.5 GHz >13.5 GHz to 26.5 GHz	0.30 dB 0.57 dB 0.60 dB 0.64 dB	

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SCOPE OF CALIBRATION: ELECTRICAL – RF/MICROWAVE (50 Ω SYSTEM)

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (±) *	Remarks	
RF POWER SENSOR 100 kHz to 4.2 GHz	<u>Power Level</u> -30 dBm to +20 dBm	(of reading) (%)	Calibration Factor in a 50 Ω system, Type-N(m) 50 Ω Calibrated at 1 mW input power, referenced to 50 MHz at 1 mW	
	100 kHz to 300 kHz	1		
	300 kHz to 1 MHz	1		
	3 MHz to 30 MHz	1		
	100 MHz to 3.5 GHz	1		
	3.7 GHz to 4.2 GHz	1		
	10 MHz to 18 GHz	<u>Power Level</u> -30 dBm to +20 dBm		
		10 MHz to 300 MHz		2
		300 MHz to 1.5 GHz		2
		1.5 GHz to 8 GHz		2
		8 GHz to 13 GHz		2
		13 GHz to 18 GHz		2
	100 kHz to 4.0 GHz	<u>Power Level</u> -10 dBm to +35 dBm		
		100 kHz to 500 kHz		1
		500 kHz to 10 MHz		1
10 MHz to 50 MHz		1		
50 MHz to 2 GHz		1		
2 GHz to 4 GHz		1		
SPECTRUM ANALYZER	<u>Frequency Range</u> 10 MHz to 20 GHz	0.16 Hz	HP 83620A HP 83630A E8257D (GPS-disciplined)	
	10 MHz to 26.5 GHz	0.18 Hz		
	250 kHz to 40 GHz	0.18 Hz		
	Resolution Bandwidth 1 kHz to 3 MHz	1 MHz		
	Reference Level Freq.: 250 kHz to 40 GHz -90 dBm to 0 dBm	1 dB	E8257D	

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SCOPE OF CALIBRATION: ELECTRICAL – RF/MICROWAVE (50 Ω SYSTEM)

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Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) *	Remarks
7. RF Generating Equipment			
SIGNAL GENERATOR			
Frequency	150 kHz to 1300 MHz 1 Hz to 12 GHz 9 kHz to 50 GHz	3.0×10^{-5} Hz 3.0×10^{-5} Hz 3.0×10^{-5} Hz	HP 8902A w/ 11722A HP 53132A E4448A (GPS-disciplined)
Amplitude Modulation (AM)	150 kHz to 10 MHz	4 % of reading	HP 8902A w/ 11722A
Depth: 10 % to 90 % Rate: 50Hz to 10 kHz	10 MHz to 1300 MHz	4 % of reading	
Rate: 50Hz to 100kHz			
Frequency Modulation (FM)			
Rate: 20 Hz to 10 kHz Dev.: ≤ 40 kHz peak	150 kHz to 10 MHz	1.2 kHz	HP 8902A w/ 11722A
Rate: 20 Hz to 200 kHz Dev.: ≤ 400 kHz peak	10 MHz to 1300 MHz	8 kHz	
RF Power: Measure			
+30 dBm to -20 dBm - 30 dBm to +20 dBm	Frequency 100 kHz to 2.6 GHz 2.6 GHz to 4 GHz	0.1 dB 0.3 dB	HP 8902A w/ 11722A E4418A w/ HP8482A
	Tune Frequency 2.5 MHz to 1300 MHz (+20 dBm to -127 dBm)	0.2 dB	HP 8902A w/ 11722A
- 30 dBm to +30 dBm	9 kHz to 2 GHz >2 GHz to 20 GHz >20 GHz to 50 GHz	0.43 dB 0.73 dB 0.96 dB	E4448A
- 170 dBm to -30 dBm	9 kHz to 2 GHz >2 GHz to 20 GHz >20 GHz to 50 GHz	0.36 dB 0.73 dB 0.95 dB	
Audio Distortion: (-80 dB to 0 dB)	Frequency 400 Hz 1 kHz	1 dB 1 dB	HP 8903B

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SCOPE OF CALIBRATION: ELECTRICAL – RF/MICROWAVE (50 Ω SYSTEM)

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (±) *	Remarks
FUNCTION GENERATOR	Frequency 0.01 Hz to 60 MHz Amplitude 1 mV to 10 Vp-p (+23.98 to -56.02 dBm)	3.0 x 10 ⁻⁵ Hz 0.1 Vp-p 1 dB	HP 53132A (GPS-disciplined) HP 54502A HP 8903B

Signatories:

1. Mohd Zaini Mustapa
2. Shukor Yahaya
3. Che Rashimi Che Yob

SCOPE OF CALIBRATION: ELECTRICAL– RF/MICROWAVE (50 Ω SYSTEM)

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (±) *	Remarks
6. Noise Source / Analyzer			
Noise Source Frequency Noise Floor	10 MHz to 26.5 GHz -2 ENR to +20 ENR(dB)	0.1 dB	Comparison using Agilent 346A, 346B & 346C
Noise Figure Analyzer Frequency Noise Floor	10 MHz to 26.5 GHz - 2 ENR to +20 ENR(dB)	0.4 dB	Generate from Agilent 346A, 346B & 346C
Noise Figure Meter Frequency Noise Floor	10 MHz to 26.5 GHz - 2 ENR to +20 ENR(dB)	0.4 dB	

Signatory:

1. Shukor Yahaya
2. Che Rashimi Che Yob

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SCOPE OF CALIBRATION: ELECTRICAL – DC & LOW FREQUENCY

SITE CALIBRATION: CATEGORY 1

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) *	Remarks
1. Measuring Instrument DC VOLTAGE	0 to 330 mV 0 to 3.3 V 0 to 33 V 33 to 330 V 330 to 1000 V	(of reading) 30 μ V 0.2 mV 2.2mV 24 mV 110 mV	Generation using calibrator model Fluke 5500A
DC RESISTANCE	0 to 11 Ω 11 to 33 Ω 33 to 110 Ω 110 to 330 Ω 0.33 to 1.1 k Ω 1.1 to 3.3 k Ω 3.3 to 11 k Ω 11 to 33 k Ω 33 to 110 k Ω 110 to 330 k Ω 0.33 to 1.1 M Ω 1.1 to 3.3 M Ω 3.3 to 11 M Ω 11 to 33 M Ω 33 to 110 M Ω 110 to 330 M Ω	(of reading) 13 m Ω 22 m Ω 29 m Ω 37 Ω 0.3 Ω 1.1 Ω 1.9 Ω 3.8 Ω 23 Ω 49 Ω 0.2 k Ω 0.6 k Ω 7.4 k Ω 36 k Ω 0.6 M Ω 1.9 M Ω	Generation using calibrator model Fluke 5500A
DC CURRENT	0 to 3.3 mA 0 to 33 mA 0 to 330 mA 0 to 2.2 A 0 to 11 A	(of reading) 0.5 μ A 4.2 μ A 0.1 mA 1.4 mA 11 mA	Generation using calibrator model Fluke 5500A

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SCOPE OF CALIBRATION: ELECTRICAL– DC & LOW FREQUENCY

SITE CALIBRATION: CATEGORY 1

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) *	Remarks
1. Measuring Instrument AC CURRENT	<u>0.03 to 0.33 mA</u>		Generation using calibrator model Fluke 5500A
	10 Hz to 20 Hz	1 μ A	
	20 Hz to 45 Hz	1 μ A	
	45 Hz to 1 kHz	1 μ A	
	1 kHz to 5 kHz	2 μ A	
	5 kHz to 10 kHz	5 μ A	
	<u>0.33 to 3.3 mA</u>		
	10 Hz to 45 Hz	5 μ A	
	45 Hz to 1 kHz	5 μ A	
	1 kHz to 5 kHz	8 μ A	
	5 kHz to 10 kHz	23 μ A	
	<u>3.3 to 33 mA</u>		
	10 Hz to 45 Hz	49 μ A	
	45 Hz to 1 kHz	46 μ A	
	1 kHz to 5 kHz	83 μ A	
	5 kHz to 10 kHz	0.2 mA	
	<u>33 to 330 mA</u>		
	10 Hz to 45 Hz	0.6 mA	
	45 Hz to 1 kHz	0.5 mA	
	1 kHz to 5 kHz	0.9 mA	
	5 kHz to 10 kHz	2.3 mA	
	<u>0.33 to 2.2 A</u>		
	10 Hz to 45 Hz	6 mA	
	45 Hz to 1 kHz	5 mA	
1 kHz to 5 kHz	20 mA		
<u>2.2 to 11 A</u>			
45 Hz to 65 Hz	15 mA		
65 Hz to 500 Hz	20 mA		
500 Hz to 1 kHz	45 mA		

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SITE CALIBRATION: CATEGORY 1

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) *	Remarks
1. Measuring Instrument AC VOLTAGE	<u>1.0 to 33 mV</u>		
	10 Hz to 45 Hz	0.14 mV	
	45 Hz to 10 kHz	85 μ V	
	10 kHz to 20 kHz	91 μ V	
	20 kHz to 50 kHz	0.11 mV	
	50 kHz to 100 kHz	0.16 mV	
	100 kHz to 500 kHz	0.41 mV	
	<u>33 to 330 mV</u>		
	10 Hz to 45 Hz	0.9 mV	
	45 Hz to 10 kHz	0.2 mV	
	10 kHz to 20 kHz	0.4 mV	
	20 kHz to 50 kHz	0.6 mV	
	50 kHz to 100 kHz	1.0 mV	
	100 kHz to 500 kHz	2.8 mV	
	<u>0.33 to 3.3 V</u>		
	10 Hz to 45 Hz	5.9 mV	
	45 Hz to 10 kHz	1.2 mV	
	10 kHz to 20 kHz	3.1 mV	
	20 kHz to 50 kHz	5.6 mV	
	50 kHz to 100 kHz	11 mV	
100 kHz to 500 kHz	22 mV		
<u>3.3 to 33 V</u>			
10 Hz to 45 Hz	59 mV		
45 Hz to 10 kHz	16 mV		
10 kHz to 20 kHz	33 mV		
20 kHz to 50 kHz	76 mV		
50 kHz to 100 kHz	110 mV		
<u>33 to 330 V</u>			
10 Hz to 45 Hz	0.2 V		
45 Hz to 10 kHz	0.3 V		
10 kHz to 20 kHz	0.3 V		
<u>330 to 1020 V</u>			
45 Hz to 1 kHz	0.7 V		
1 kHz to 5 kHz	2.3 V		
			Generation using calibrator model Fluke 5500A

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SCOPE OF CALIBRATION: ELECTRICAL – DC & LOW FREQUENCY

SITE CALIBRATION: CATEGORY 1

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) *	Remarks
2. Source/Generating Instrument DC VOLTAGE	100 mV + 100 μ V to + 100 mV - 100 mV to - 100 μ V	(of reading) 2.2 μ V 2.2 μ V	HP3458A
	1 V + 100 mV to 1 V -1 V to -100 mV	0.12 mV 0.12 mV	
	10 V + 1 V to + 10 V - 10 V to -1 V	1.5 mV 1.5 mV	
	100 V + 10 V to +100 V -100 V to -10 V	1.5 mV 1.5 mV	
	1000 V + 100 V to + 1000 V - 1000 V to -100 V	17 mV 17 mV	
AC VOLTAGE	<u>10 mV range</u> 0 mV to 10 mV <u>100 mV range</u> 10 mV to 100 mV <u>1 V range</u> 100 mV to 1 V <u>10 V range</u> 1 V to 10 V <u>100 V range</u> 10 V to 100 V <u>1000 V range</u> 100 V to 700 V (See Matrix B)	(See Matrix B)	HP 3458A

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SCOPE OF CALIBRATION: ELECTRICAL – DC & LOW FREQUENCY

SITE CALIBRATION: CATEGORY 1

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) *	Remarks
Source/Generating Instrument DC CURRENT	<u>100 μA</u> +10 μ A to +100 μ A -100 μ A to - 10 μ A <u>1 mA</u> +100 μ A to +1 mA -1 mA to -100 μ A <u>10 mA</u> +1 mA to +10 mA -10 mA to -1 mA <u>100 mA</u> +10mA to +100 mA -100 mA to -10 mA <u>1 A</u> +100 mA to + 1 A -1 A to -100 mA	(of reading) 16 nA 16 nA 74 nA 74 nA 0.7 μ A 0.7 μ A 8 μ A 8 μ A 0.2 mA 0.2 mA	HP 3458A
DC RESISTANCE	10 Ω 100 Ω 1 k Ω 10 k Ω 100 k Ω 1 M Ω 10 M Ω 100 M Ω	0.4 m Ω 3 m Ω 19 m Ω 0.2 Ω 2 Ω 30 Ω 0.8 k Ω 59 k Ω	HP3458A
3. High Current Generating DC CURRENT	1 A to 10 A	0.10 A	HP 6060B / 605 0A w/ 60503A module

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SCOPE OF CALIBRATION: ELECTRICAL – DC & LOW FREQUENCY

SITE CALIBRATION: CATEGORY 1

Matrix B
AC Voltage (Source / Generating Instrument)

Range		Frequency				
		Hz		kHz		
		10 to 20	20 to 40	0.04 to 1	1 to 20	20 to 50
10 mV	0 mV to 10 mV	-	-	8 μ	9 μ	-
100 mV	10 mV to 100 mV	-	-	23 μ	27 μ	-
1 V	100 mV to 1 V	-	-	150 μ	210 μ	-
10 V	1 V to 10 V	2.8 mV	2.1 mV	1.7 mV	2.5 mV	4.2 mV
100 V	10 V to 100 V	-	-	27 mV	27 mV	51 mV
1000 V	100 V to 700 V	-	-	340 mV	-	-

Range		Frequency				
		Hz		kHz		
		50 to 100	100 to 300	300 to 500	0.3 to 1	0.5 to 1
10 mV	0 mV to 10 mV	60 μ	0.5 mV	-	-	-
1 V	100 mV to 1 V	1 mV	4 mV	-	12 mV	-
100 V	10 V to 100 V	160 mV	-	-	-	-
1000 V	100 V to 700 V	-	-	-	-	-

Signatories:

1. Mohd Zaini Mustapa
2. Shukor Yahaya
3. Che Rashimi Che Yob

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SCOPE OF CALIBRATION: ELECTRICAL – DC & LOW FREQUENCY

SITE CALIBRATION: CATEGORY 1

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) *	Remarks
4. OSCILLOSCOPE		(of reading)	Generating using Oscilloscope Calibrator Fluke 5820A & E8257D
Vertical Deflection DC Signal	0 V to ± 6.6 V (50 Ω Load)	3 mV/V + 0.04 mV	
	0 V to ± 130 V (1 M Ω Load)	0.6 mV/V + 0.04 mV	
Vertical Deflection Square Wave Signal	± 1 mVp-p to ± 6.6 Vp-p (50 Ω Load)	3.1 mVp-p/Vp-p + 0.04 Mv	
	± 1 mVp-p to 130 Vp-p (1 M Ω Load)	1 mVp-p/Vp-p + 0.04 mV	
Horizontal Deflection Time Markers (50 Ω Load)	2 ns/div to 20 ms/div 50 ms/div to 5 s/div	2.5 us/s 2.2 ms/s	
Risetime	≤ 300 ps	0.3 ns	
Bandwidth Amplitude	50 kHz to 600 MHz 600 MHz to 2100 MHz	17 mVp-p 23 mVp-p	
5. AUDIO ANALYZER	Frequency 20 Hz to 150 kHz	0.006 kHz	Fluke 5500A
	Amplitude 1 mV to 300 V	0.11 V	
	Residual Distortion (-90.00 to 0 dB)		
	20 Hz to 20 kHz 20 kHz to 100 kHz	1 dB 1 dB	8903B
6. FUNCTION GENERATOR	Frequency 0.01 Hz to 60 MHz	0.6 mHz	HP 53132A
	Amplitude 1 mV to 10 Vp-p (+23.98 to -56.02 dBm)	0.1 Vp-p 1 dB	HP 54502A HP 8903B

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SCOPE OF CALIBRATION: ELECTRICAL – RF/MICROWAVE (50 Ω SYSTEM)

SITE CALIBRATION: CATEGORY 1

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) *	Remarks
RF Measuring Equipment 1. MODULATION ANALYZER	<u>Frequency</u> 150kHz to 1.3GHz	(of reading) 3.0 x 10 ⁻⁵ Hz	HP8642A/B
	Power Level: -25 dBm to 20 dBm (3 μ W to 100 mW)	0.06 dBm	HP 11683A
	<u>FM, Flatness</u> 20 Hz to 100 kHz rates 100 kHz to 200 kHz rates	0.1 kHz 0.5 kHz	HP 11715A
	<u>AM, Flatness</u> 50 Hz to 50 kHz 20 Hz to 100 kHz	0.05 kHz 0.25 kHz	HP 11715A
	<u>Distortion</u> Audio Distortion -70 dB minimum	1 dB	HP 8903B
2. RF POWER METER	<u>Power Level</u> -25 dBm to 20 dBm (3 μ W to 100 mW)	0.06 dBm	HP 11683A
3. SPECTRUM ANALYZER	<u>Frequency Range</u> 250 kHz to 40 GHz	0.74 Hz	E8257D
	<u>Resolution Bandwidth</u> 1 kHz to 3 MHz	1 MHz	
	<u>Reference Level</u> 250 kHz to 40 GHz -90 dBm to 0 dBm	1 dB	

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SCOPE OF CALIBRATION: ELECTRICAL - RF/MICROWAVE (50 Ω SYSTEM)

SITE CALIBRATION: CATEGORY 1

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (±)*	Remarks
4. RF POWER SENSOR		(of reading)	Calibration Factor in a 50 Ω system, Type-N(m) 50 Ω Calibrated at 1mW input power, referenced to 50 MHz at 1 mW
100 kHz to 4.2 GHz	<u>Power Level</u> -30 dBm to +20 dBm	(%)	
	100 kHz to 300 kHz	1	
	300 kHz to 1 MHz	1	
	3 MHz to 30 MHz	1	
	100 MHz to 3.5 GHz	1	
	3.7 GHz to 4.2 GHz	1	
10 MHz to 18 GHz	<u>Power Level</u> -30 dBm to +20 dBm		
	10 MHz to 300 MHz	2	
	300 MHz to 1.5 GHz	2	
	1.5 GHz to 8.0 GHz	2	
	8.0 GHz to 13.0 GHz	2	
	13.0 GHz to 18.0 GHz	2	
100 kHz to 4.0 GHz	<u>Power Level</u> -10 dBm to +35 dBm		
	100 kHz to 500 kHz	1	
	500 kHz to 10 MHz	1	
	10 MHz to 50 MHz	1	
	50 MHz to 2 GHz	1	
	2 GHz to 4 GHz	1	
5. NETWORK ANALYZER	Frequency 9 kHz to 26.5 GHz	(of reading) 0.19 Hz	E4448A
	Power Level 0 dBm to +20 dBm		
	9 kHz to 2 GHz	0.31 dB	
	>2 GHz to 8 GHz	0.57 dB	
	>8 GHz to 13.5 GHz	0.60 dB	
	>13.5 GHz to 26.5 GHz	0.67 dB	
	0 dBm to -30 dBm		
	9 kHz to 2 GHz	0.30 dB	
	>2 GHz to 8 GHz	0.57 dB	
	>8 GHz to 13.5 GHz	0.60 dB	
	>13.5 GHz to 26.5 GHz	0.64 dB	

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SCOPE OF CALIBRATION: ELECTRICAL– RF/MICROWAVE (50 Ω SYSTEM)

SITE CALIBRATION: CATEGORY 1

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) *	Remarks
6. RF Generating Equipment			
(of reading)			
SIGNAL GENERATOR	150 kHz to 1300 MHz	0.7 Hz	HP 8902A w/11722A HP 53132A E4448A
Frequency	1 Hz to 12.4 GHz	0.6 mHz	
	9 kHz to 50 GHz	4.2 Hz	
Amplitude Modulation (AM)			
Depth: 10 % to 90 %	150 kHz to 10 MHz	4 % of reading	HP 8902A w/ 11722A
Rate : 50Hz to 10 kHz			
Rate: 50Hz to 100kHz	10 MHz to 1300 MHz	4 % of reading	
Frequency Modulation (FM)			
Rate: 20 Hz to 10 kHz	150 kHz to 10 MHz	1.2 kHz	HP 8902A w/ 11722A
Dev.: <= 40 kHz peak			
Rate: 20Hz to 200 kHz	10 MHz to 1300 MHz	8 kHz	
Dev.: <= 400 kHz peak			
RF Power: Measure	<u>Frequency</u>		
+30 dBm to -20 dBm	100 kHz to 2.6 GHz	0.1 dB	HP 8902A w/ 11722A E4418A w/ HP8482A
- 30 dBm to +20 dBm	2.6 GHz to 4 GHz	0.3 dB	
	<u>Tune Frequency</u>		
	2.5 MHz to 1300 MHz (+20 dBm to -127 dBm)	0.2 dB	HP 8902A w/ 11722A
- 30 dBm to +30 dBm	9 kHz to 2 GHz	0.49 dB	E4448A
	>2 GHz to 20 GHz	0.77 dB	
	>20 GHz to 50 GHz	0.98 dB	
- 170 dBm to -30 dBm	9 kHz to 2 GHz	0.43 dB	
	>2 GHz to 20 GHz	0.76 dB	
	>20 GHz to 50 GHz	0.98 dB	
Audio Distortion:	<u>Frequency</u>		
(-80 dB to 0 dB)	400 Hz	1 dB	HP 8903B
	1 kHz	1 dB	

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Signatories:

1. Mohd Zaini Mustapa
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SCOPE OF CALIBRATION: ELECTRICAL– RF/MICROWAVE (50 Ω SYSTEM)

SITE CALIBRATION: CATEGORY 1

Instrument Calibrated / Measurement Parameter	Range	Calibration and Measurement Capability Expressed as an Uncertainty (\pm) *	Remarks
7. Noise Source / Analyzer			
Noise Source Frequency Noise Floor	10 MHz to 26.5 GHz -2 ENR to +20ENR(dB)	0.1 dB	Comparison using Agilent 346A, 346B & 346C
Noise Figure Analyzer Frequency Noise Floor	10 MHz to 26.5 GHz - 2 ENR to +20 ENR(dB)	0.4 dB	Generate from Agilent 346A, 346B & 346C
Noise Figure Meter Frequency Noise Floor	10 MHz to 26.5 GHz -2 ENR to +20 ENR(dB)	0.4 dB	

Signatory:

1. Shukor Yahaya
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