

TEST REPORT

Applicant: SG Wireless Limited
Address: Unit 4, 5/F, Sun Fung Industrial Building, 8 Ma Kok Street, Tsuen Wan, New Territories, Hong Kong
Equipment Type: F1 Smart Module
Model Name: SGW3531
Brand Name: SG Wireless
FCC ID: 2AS9410
Test Standard: 47 CFR Part 15 Subpart B
ANSI C63.4-2014
Sample Arrival Date: Feb. 29, 2023
Test Date: Mar. 13, 2024 - Jun. 21, 2024
Date of Issue: Aug. 13, 2024

ISSUED BY:

Shenzhen BALUN Technology Co., Ltd.

Tested by: Xin Liao

Checked by: Liu Zhenxiang

Approved by: Tolan Tu
(Testing Director)

Xin Liao

Liu zhenxiang

Tolan Tu

Revision History

Version	Issue Date	Revisions
<u>Rev. 01</u>	<u>Aug. 13, 2024</u>	<u>Initial Issue</u>

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1 GENERAL INFORMATION

1.1 Test Laboratory

Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100

1.2 Test Location

Name	Shenzhen BALUN Technology Co., Ltd.
Location	☒ Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
	☐ 1/F, Building B, Ganghongji High-tech Intelligent Industrial Park, No. 1008, Songbai Road, Yangguang Community, Xili Sub-district, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	SG Wireless Limited
Address	Unit 4, 5/F, Sun Fung Industrial Building, 8 Ma Kok Street, Tsuen Wan, New Territories, Hong Kong

2.2 Manufacturer Information

Manufacturer	SG Wireless Limited
Address	Unit 4, 5/F, Sun Fung Industrial Building, 8 Ma Kok Street, Tsuen Wan, New Territories, Hong Kong

2.3 General Description for Equipment under Test (EUT)

EUT Name	F1 Smart Module
Model Name Under Test	SGW3531
Series Model Name	N/A
Description of Model name differentiation	N/A
Hardware Version	1.2.3
Software Version	B0.2.0b0
Dimensions (Approx.)	N/A
Weight (Approx.)	4.6g

2.4 Ancillary Equipment

Note: Not applicable.

2.5 Technical Information

Network and Wireless connectivity	4G Network FDD LTE-M1 Band 2/4/5/12/13/14/17/18/19/25/26/66/71/85 FDD NB-IoT Band 2/4/5/12/13/14/17/18/19/25/26/66/71/85 Bluetooth (BLE) WIFI 802.11b, 802.11g, 802.11n(HT20/40) LoRa
Classification of equipment	Class B
The highest internal frequency of EUT	2480 MHz

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15 Subpart B	Unintentional Radiators
2	ANSI C63.4-2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

3.2 Verdict

No.	Description	FCC Rule	Test Verdict	Remark
1	Radiated Emission	15.109	Pass	--
2	Conducted Emission, AC Ports	15.107	Pass	--

3.3 Test Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$.

Measurement	Value
Conducted emissions (9 kHz-30 MHz)	3.2 dB
Radiated emissions (30 MHz-1 GHz)-966#2	4.4 dB
Radiated emissions (1 GHz-18 GHz)-966#2	5.0 dB

4 GENERAL TEST CONFIGURATIONS

4.1 Test Enclosure List

Description	Manufacturer	Model	Serial No.	Length	Description	Use
RF Cable	N/A	N/A	N/A	30cm	N/A	☒
2.4G Antenna	N/A	JZC-RPF-N-ZBG196	N/A	196*13mm	N/A	☒
LTE Antenna	N/A	HX-AP4G-19513-D1	N/A	195*13mm	N/A	☒
LORA Antenna	N/A	2.521.053B	N/A	200mm	N/A	☒
Adapter	OPPO	AK931JH	N/A	N/A	N/A	☒
USB Cable	UGREEN	L1	N/A	N/A	1m	☒
PCB Board	SG Wireless	F1 STARTER KIT	Wi-Fi:7C:51:89:02:03:4C	N/A	CB-23036-01-V00	☒

4.2 Test Configurations

All test modes of EUT are listed in the table below.

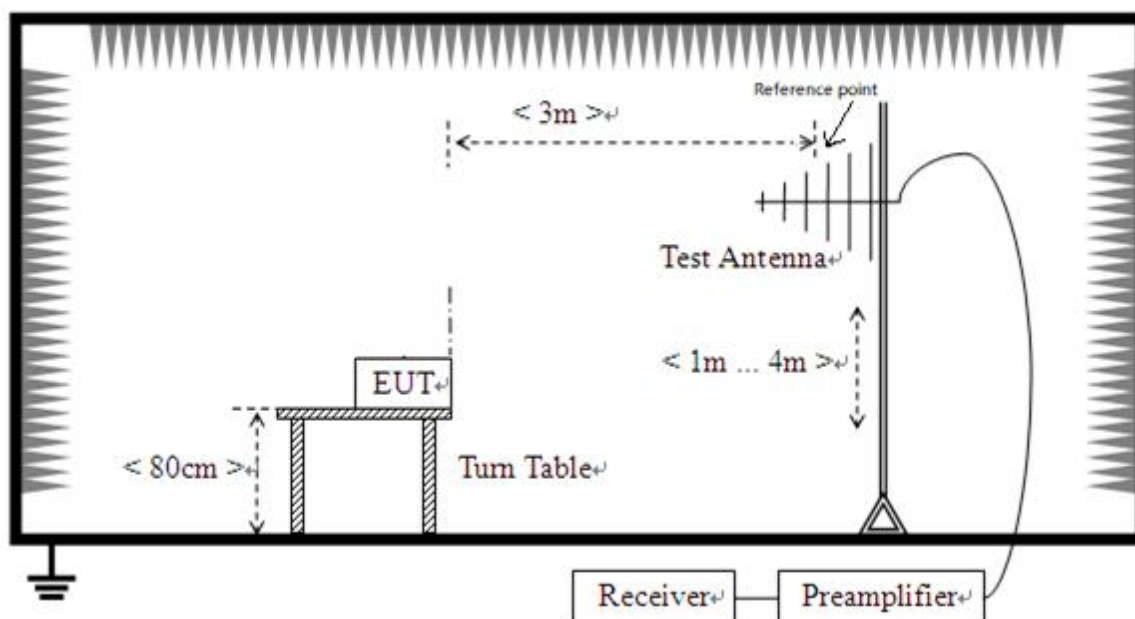
Test Mode Configuration	Description
Mode 1	<u>The Standby Test Mode</u> EUT + Adapter + USB Cable + PCB Board + RF Cable + 2.4G Antenna + LTE Antenna + LORA Antenna
Mode 2	<u>The Normal Operating Test Mode</u> EUT + Adapter + USB Cable + PCB Board + RF Cable + 2.4G Antenna + LTE Antenna + LORA Antenna

Test Case	Test Mode Configuration	Worst Mode
Radiated Emission	Mode 1~Mode 2	1
Conducted Emission, AC Ports	Mode 1~Mode 2	1

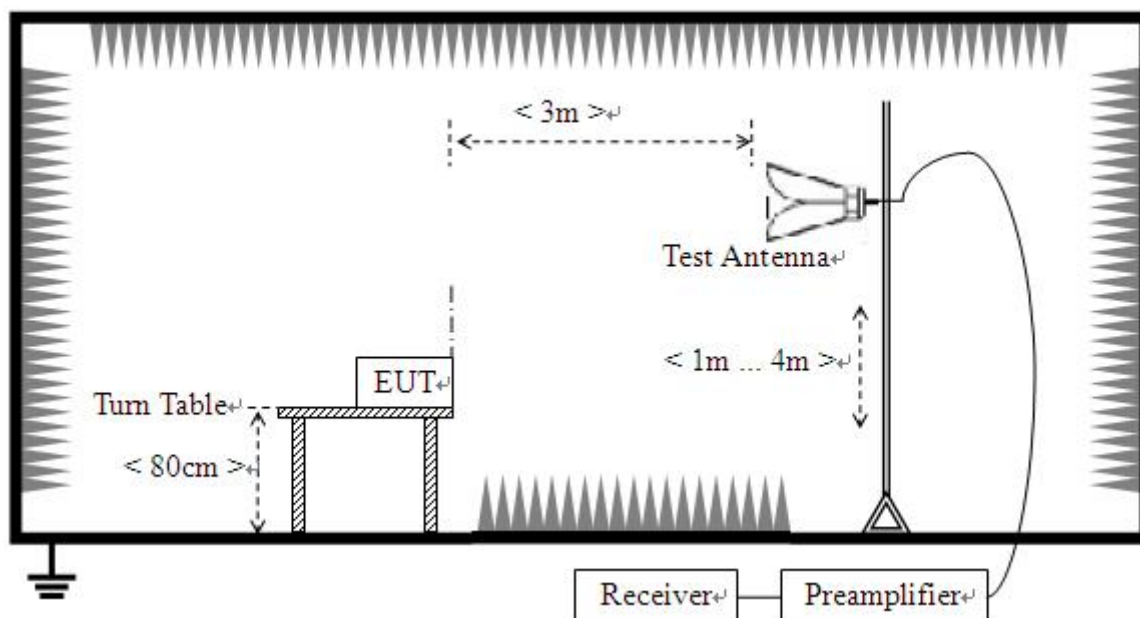
Note: All operation modes were tested, but only test data of the worst mode was presented in this report.

4.3 Test Setups

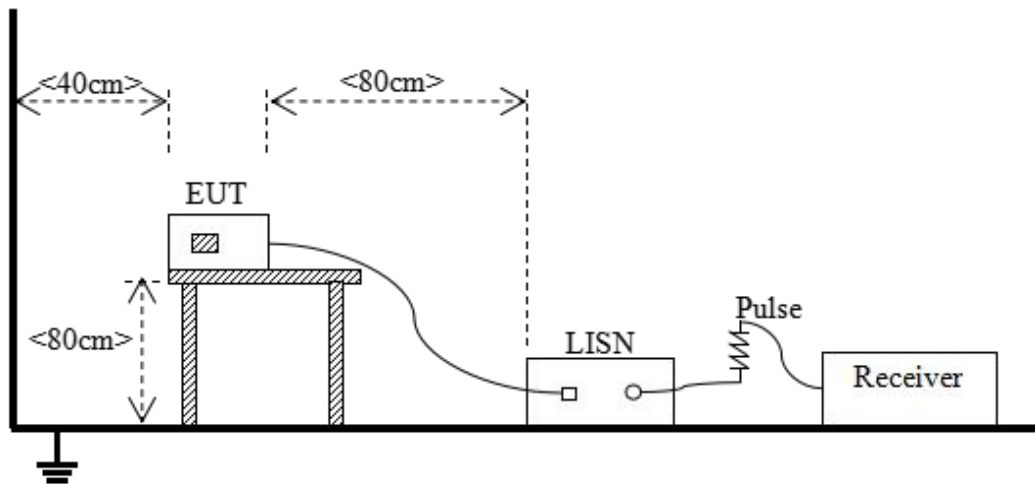
Test Setup 1



Radiated Emission (30 MHz-1 GHz)



Radiated Emission (above 1 GHz)

Test Setup 2

Conducted Emissions, AC Ports

5 TEST ITEMS

5.1 Emission Tests

5.1.1 Radiated Emission

5.1.1.1 Limit

Frequency range (MHz)	Class B (at 3 m)		Class A (at 3 m)
	Field Strength ($\mu\text{V/m}$)	Field Strength (dB $\mu\text{V/m}$)	Field Strength (dB $\mu\text{V/m}$)
30 - 88	100	40	49.5
88 - 216	150	43.5	54
216 - 960	200	46	56.9
Above 960	500	54	60

NOTE:

- 1) Field Strength (dB $\mu\text{V/m}$) = $20 \cdot \log [\text{Field Strength } (\mu\text{V/m})]$.
- 2) In the emission tables above, the tighter limit applies at the band edges.
- 3) For 30 MHz to 1000 MHz, the CISPR quasi-peak is employed.

For above 1000 MHz, according to the requirements of FCC 15.35, unless otherwise specified, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

Frequency range (GHz)	Class B (at 3 m)			Class A (at 3 m)	
	Field Strength ($\mu\text{V/m}$)	Field Strength Average (dB $\mu\text{V/m}$)	Field Strength Peak (dB $\mu\text{V/m}$)	Field Strength Average (dB $\mu\text{V/m}$)	Field Strength Peak (dB $\mu\text{V/m}$)
1 - F_M	500	54	74	60	80

Note 1: The highest measurement frequency, F_M , in GHz, shall be determined as next Table.

Note 2: Average Class A limit at 3m L_{3m} is determined by the following conversion formula:

$$L_{3m} = L_{10m} + 20 \cdot \log(d_{10m}/d_{3m})$$

Where:

L_{3m} is Average Class A limit at 3m;

L_{10m} is Average Class A limit at 10m;

d_{10m} is Measurement distance in 10m;

d_{3m} is Measurement distance in 3m.

For this case: $L_{3m} = 49.5 + 20 \cdot \log(10/3) = 60$ (dB $\mu\text{V/m}$).

Highest internal frequency (F_X)	Highest measurement frequency (F_M)
$F_X \leq 108 \text{ MHz}$	1 GHz
$108 \text{ MHz} \leq F_X \leq 500 \text{ MHz}$	2 GHz
$500 \text{ MHz} \leq F_X \leq 1 \text{ GHz}$	5 GHz
$F_X \geq 1 \text{ GHz}$	$5 * F_X$ or 40 GHz, whichever is lower.
Note: F_X is Highest frequency generated or used in the device or on which the device operates or tunes.	

5.1.1.2 Test Setup

Refer to 4.3 section (test setup 1) for radiated emission test, the photo of test setup please refer to ANNEX B.

5.1.1.3 Test Procedure

All Radiated Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

An initial pre-scan was performed in the chamber using the EMI Receiver in peak detection mode. Quasi-peak measurements were conducted based on the peak sweep graph. The EUT was measured by Bi-Log antenna with 2 orthogonal polarities.

The measurement frequency range is from 30 MHz to the 5th harmonic of the maximum frequency of the EUT internal source. The Turn Table is actuated to turn from 0° to 360° , and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for $f \geq 1 \text{ GHz}$, 100 kHz for $f < 1 \text{ GHz}$

VBW $\geq$ RBW

Sweep = auto

Detector function = peak for $f < 1 \text{ GHz}$, peak & RMS Average for $f \geq 1 \text{ GHz}$

Trace = max hold

5.1.1.4 Test Result and Test Equipment List

Please refer to ANNEX A.1.

NOTE:

1. $\text{Results (dB}\mu\text{V/m)} = \text{Reading (dB}\mu\text{V)} + \text{Factor (dB/m)}$

The reading level is calculated by software which is not shown in the sheet

2. $\text{Factor (dB/m)} = \text{Antenna Factor (dB/m)} + \text{Cable Factor (dB)} - \text{Amplifier Gain (dB)}$

3. $\text{Margin} = \text{Limit} - \text{Results}$

5.1.2 Conducted Emission, AC Ports

5.1.2.1 Test Limit

Frequency range (MHz)	Class A	
	Quasi-peak (dB μ V)	Average (dB μ V)
0.15 - 0.50	79	66
0.50 - 30	73	60

Frequency range (MHz)	Class B	
	Quasi-peak (dB μ V)	Average (dB μ V)
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
5 - 30	60	50

NOTE:

- 1) The lower limit shall apply at the band edges.
- 2) The limit decreases linearly with the logarithm of the frequency in the range 0.15 - 0.50 MHz.

5.1.2.2 Test Setup

Refer to 4.3 section test (test setup 2) for conducted emission, the photo of test setup please refer to ANNEX B.

5.1.2.3 Test Procedure

The EUT is connected to the power mains through a LISN which provides 50 Ω /50 μ H of coupling impedance for the measuring instrument. The test frequency range is from 150 kHz to 30 MHz. The maximum conducted interference is searched using Peak (PK), Quasi-peak (QP) and Average (AV) detectors; the emission levels that are more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed.

Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz) for which the device is capable of operation. A device rated for 50/60 Hz operation need not be tested at both frequencies provided the radiated and line conducted emissions are the same at both frequencies.

Use the following spectrum analyzer settings:

RBW = 9 kHz

VBW $\geq$ RBW

Sweep = 10ms

Detector function =peak & Average

Trace = max hold

5.1.2.4 Test Result and Test Equipment List

Please refer to ANNEX A.2.

NOTE:

1. Results (dB μ V) = Reading (dB μ V) + Factor (dB)

The reading level is calculated by software which is not shown in the sheet

2. Factor = Insertion loss + Cable loss

3. Margin = Limit - Results

ANNEX A TEST RESULTS

A.1 Radiated Emission

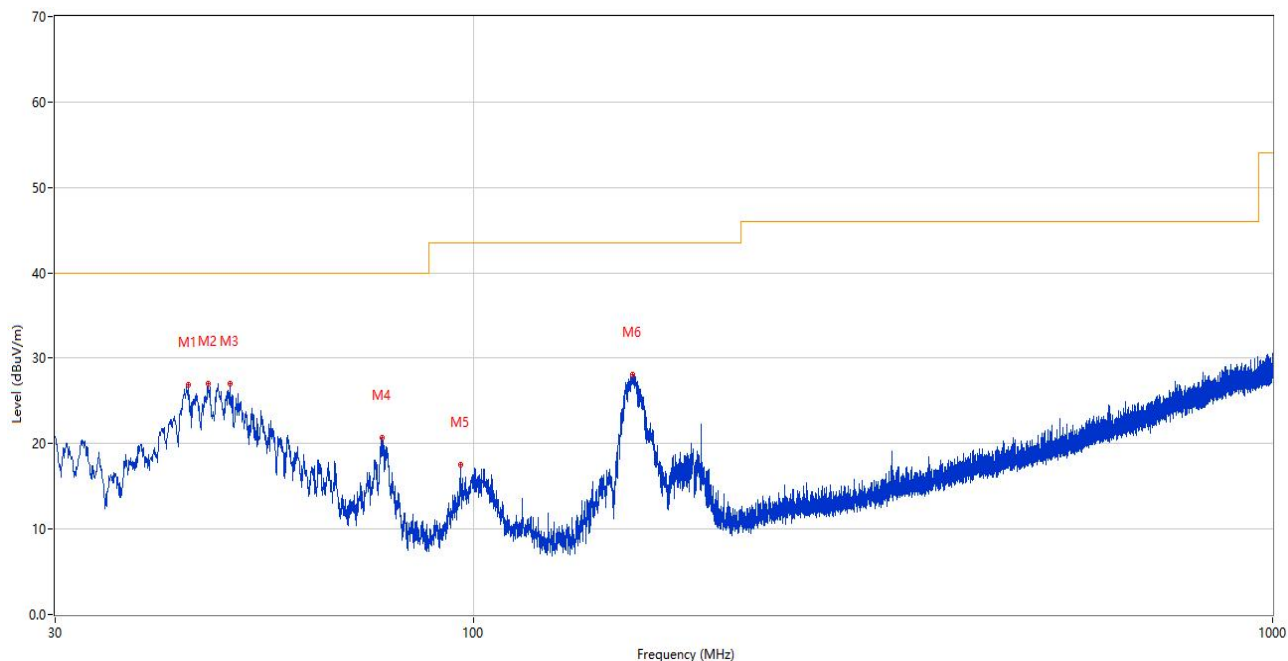
Note 1: The symbol of “--” in the table which means not application.

Note 2: For the test data above 1 GHz, according the ANSI C63.4-2014, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

Sample No.	S12	Temperature	22.1℃
Humidity	41%RH	Pressure	101kPa
Test Engineer	He Shichang	Test Date	2024.06.14

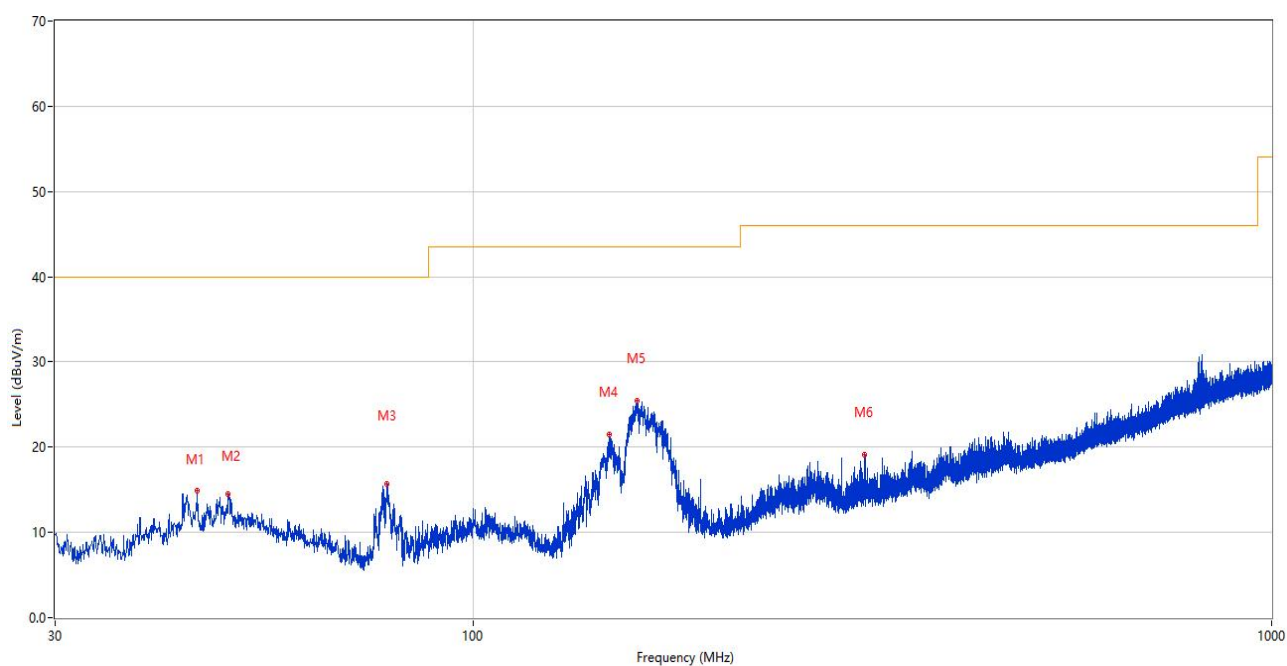
Test Mode 1

1) Test Antenna Vertical, 30 MHz – 1 GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	44.017	26.89	-25.74	40.0	13.11	Peak	157.00	100	Vertical	Pass
2	46.636	27.05	-25.56	40.0	12.95	Peak	191.00	100	Vertical	Pass
3	49.594	27.06	-25.54	40.0	12.94	Peak	287.00	100	Vertical	Pass
4	76.996	20.64	-31.13	40.0	19.36	Peak	100.00	100	Vertical	Pass
5	96.396	17.52	-27.30	43.5	25.98	Peak	300.00	100	Vertical	Pass
6	158.234	28.11	-29.71	43.5	15.39	Peak	314.00	100	Vertical	Pass

2) Test Antenna Horizontal, 30 MHz – 1 GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	45.181	14.96	-25.52	40.0	25.04	Peak	138.00	200	Horizontal	Pass
2	49.400	14.52	-25.51	40.0	25.48	Peak	305.00	100	Horizontal	Pass
3	78.112	15.64	-31.11	40.0	24.36	Peak	120.00	200	Horizontal	Pass
4	148.389	21.54	-30.12	43.5	21.96	Peak	124.00	200	Horizontal	Pass
5	160.756	25.45	-29.54	43.5	18.05	Peak	69.00	200	Horizontal	Pass
6	309.360	19.12	-23.39	46.0	26.88	Peak	233.00	100	Horizontal	Pass

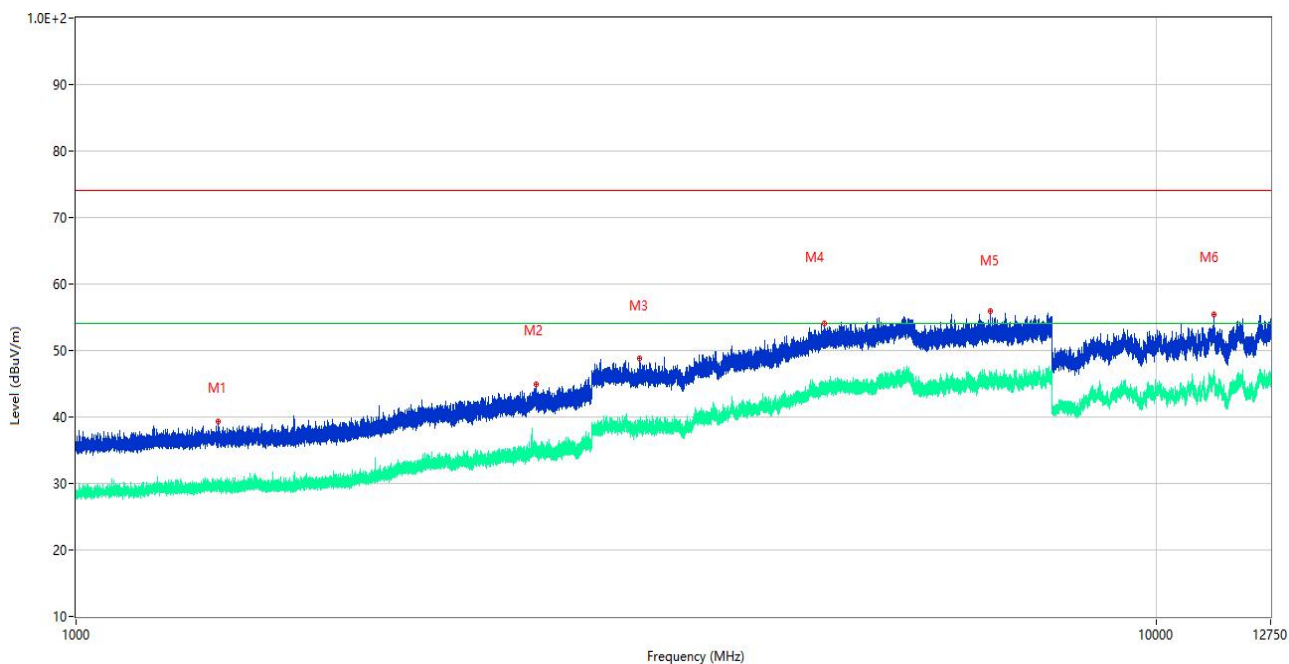
Equipment Information						
Equipment Name	Supplier	Model	Serial No.	Cal. Date	Cal. Due	Use
Frequency Below 1 GHz						
EMI Receiver	Keysight	N9038A	MY55330120	2023.09.05	2024.09.04	☒
Amplifier (30-1GHz)	COM-MV	ZT30-1000M	B2017119081	2023.12.05	2024.12.04	☒
Test Antenna- Bi-Log	SCHWARZB ECK	VULB 9168	9168-00867	2022.04.12	2025.04.11	☒
Anechoic Chamber (#2)	YiHeng	9m*6m*6m	142	2021.08.19	2024.08.18	☒
Description	Supplier	Name	Version	/		Use
Test Software	BALUN	BL410-E	V22.930	/		☒

3) Test Antenna Vertical, 1 GHz – 12.75 GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1250.100	38.74	-16.09	74.0	35.26	Peak	133.00	100	Vertical	Pass
1**	1250.100	29.08	-16.09	54.0	24.92	AV	133.00	100	Vertical	Pass
2	1850.700	40.67	-15.03	74.0	33.33	Peak	310.00	100	Vertical	Pass
2**	1850.700	31.01	-15.03	54.0	22.99	AV	310.00	100	Vertical	Pass
3	4045.000	50.83	-1.00	74.0	23.17	Peak	163.00	100	Vertical	Pass
3**	4045.000	41.03	-1.00	54.0	12.97	AV	163.00	100	Vertical	Pass
4	4915.750	53.67	2.40	74.0	20.33	Peak	200.00	100	Vertical	Pass
4**	4915.750	44.13	2.40	54.0	9.87	AV	200.00	100	Vertical	Pass
5	6831.000	55.02	1.49	74.0	18.98	Peak	181.00	100	Vertical	Pass
5**	6831.000	44.02	1.49	54.0	9.98	AV	181.00	100	Vertical	Pass
6	11916.000	54.99	2.40	74.0	19.01	Peak	44.00	100	Vertical	Pass
6**	11916.000	45.44	2.40	54.0	8.56	AV	44.00	100	Vertical	Pass

4) Test Antenna Horizontal, 1 GHz – 12.75 GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1354.500	39.37	-16.03	74.0	34.63	Peak	38.00	100	Horizontal	Pass
1**	1354.500	29.31	-16.03	54.0	24.69	AV	38.00	100	Horizontal	Pass
2	2666.200	44.88	-8.78	74.0	29.12	Peak	123.00	100	Horizontal	Pass
2**	2666.200	34.79	-8.78	54.0	19.21	AV	123.00	100	Horizontal	Pass
3	3321.000	48.80	-4.48	74.0	25.20	Peak	39.00	100	Horizontal	Pass
3**	3321.000	37.63	-4.48	54.0	16.37	AV	39.00	100	Horizontal	Pass
4	4924.500	54.09	2.42	74.0	19.91	Peak	120.00	100	Horizontal	Pass
4**	4924.500	43.89	2.42	54.0	10.11	AV	120.00	100	Horizontal	Pass
5	7018.000	56.01	1.65	74.0	17.99	Peak	138.00	100	Horizontal	Pass
5**	7018.000	45.13	1.65	54.0	8.87	AV	138.00	100	Horizontal	Pass
6	11308.500	55.51	2.16	74.0	18.49	Peak	222.00	100	Horizontal	Pass
6**	11308.500	46.24	2.16	54.0	7.76	AV	222.00	100	Horizontal	Pass

Equipment Information						
Equipment Name	Supplier	Model	Serial No.	Cal. Date	Cal. Due	Use
Frequency Above 1 GHz						
EMI Receiver	Keysight	N9038A	MY55330120	2023.09.05	2024.09.04	☒
Amplifier (1-12GHz)	Advanced Microwave	WLA652A	1740103	2023.12.05	2024.12.04	☒
Amplifier (0.8-21GHz)	Mini-Circuits	ZVA-213-S+	225321316	2023.12.05	2024.12.04	☒
Amplifier (18-40GHz)	COM-MV	KA LNA18- 40G-01	18050001	2023.12.05	2024.12.04	☒
Test Antenna- Horn	SCHWARZB ECK	BBHA 9120D	01917	2022.06.09	2025.06.08	☒
Test Antenna- Horn	A-INFOMW	LB- 180400KF	J211060273	2021.07.02	2024.07.01	☒
Anechoic Chamber (#2)	YiHeng	9m*6m*6m	142	2021.08.19	2024.08.18	☒
Description	Supplier	Name	Version	/		Use
Test Software	BALUN	BL410-E	V22.930	/		☒

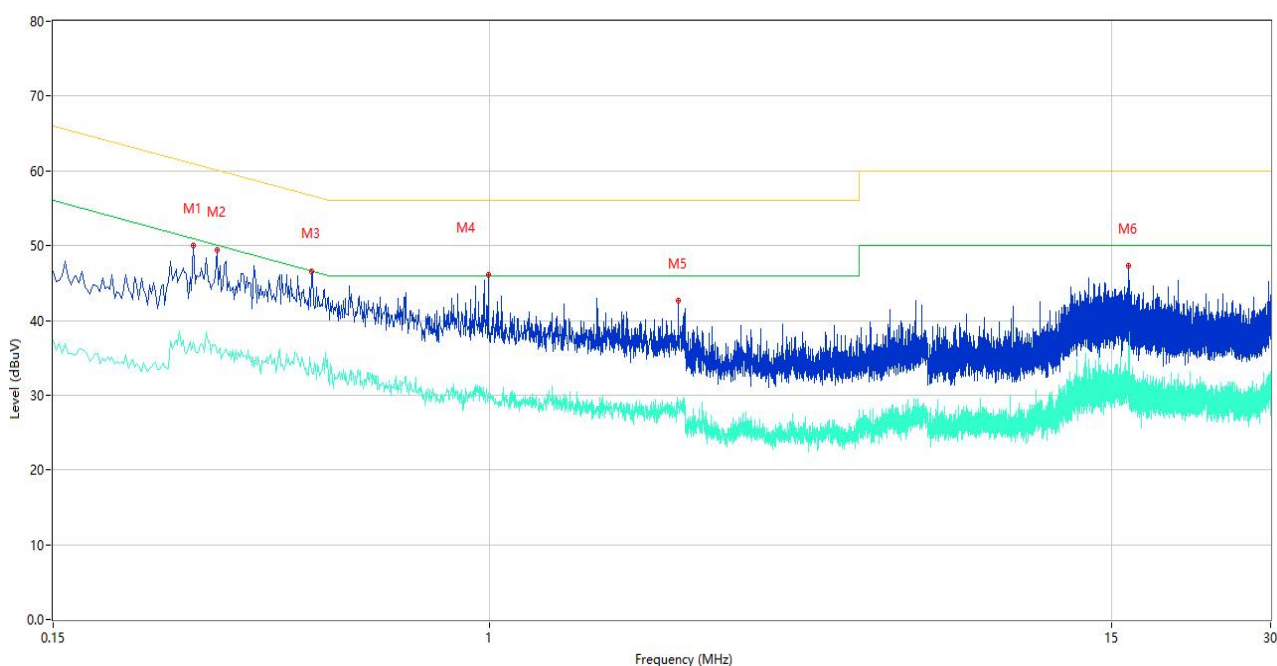
A.2 Conducted Emission, AC Ports

Note: Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz) for which the device is capable of operation. So, The configuration 120 VAC, 60 Hz and 240 VAC, 50 Hz were tested respectively, but only the worst configuration (120 VAC, 60 Hz) shown here.

Sample No.	S12	Temperature	22.1℃
Humidity	41%RH	Pressure	101kPa
Test Engineer	Yang Yang	Test Date	2024.04.08

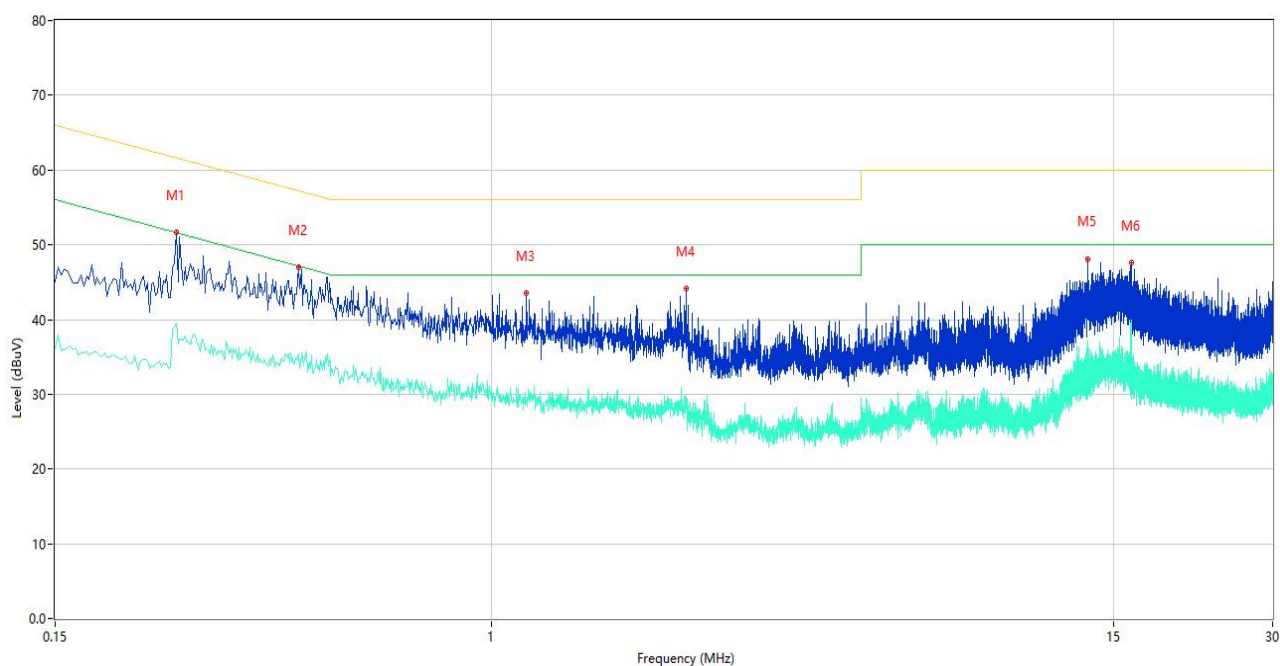
Test Mode 1

1) AC Ports - L Phase



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.276	50.07	19.46	60.94	10.87	Peak	L	Pass
1**	0.276	37.04	19.46	50.94	13.90	AV	L	Pass
2	0.306	49.39	19.45	60.08	10.69	Peak	L	Pass
2**	0.306	35.72	19.45	50.08	14.36	AV	L	Pass
3	0.462	46.60	19.92	56.66	10.06	Peak	L	Pass
3**	0.462	33.38	19.92	46.66	13.28	AV	L	Pass
4	0.996	46.08	19.78	56.00	9.92	Peak	L	Pass
4**	0.996	30.08	19.78	46.00	15.92	AV	L	Pass
5	2.280	42.68	19.97	56.00	13.32	Peak	L	Pass
5**	2.280	28.65	19.97	46.00	17.35	AV	L	Pass
6	16.166	47.32	21.27	60.00	12.68	Peak	L	Pass
6**	16.166	36.54	21.27	50.00	13.46	AV	L	Pass

2) AC Ports - N Phase



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.254	51.68	19.45	61.63	9.95	Peak	N	Pass
1**	0.254	39.49	19.45	51.63	12.14	AV	N	Pass
2	0.432	46.98	20.01	57.21	10.23	Peak	N	Pass
2**	0.432	35.38	20.01	47.21	11.83	AV	N	Pass
3	1.166	43.54	19.86	56.00	12.46	Peak	N	Pass
3**	1.166	28.94	19.86	46.00	17.06	AV	N	Pass
4	2.334	44.14	19.94	56.00	11.86	Peak	N	Pass
4**	2.334	29.31	19.94	46.00	16.69	AV	N	Pass
5	13.416	48.11	20.83	60.00	11.89	Peak	N	Pass
5**	13.416	36.18	20.83	50.00	13.82	AV	N	Pass
6	16.228	47.54	21.08	60.00	12.46	Peak	N	Pass
6**	16.228	39.96	21.08	50.00	10.04	AV	N	Pass

Equipment Information						
Equipment Name	Supplier	Model	Serial No.	Cal. Date	Cal. Due	Use
EMI Receiver	KEYSIGHT	N9010B	MY57110309	2023.09.05	2024.09.04	☒
LISN	SCHWARZB ECK	NSLK 8127	8127-687	2024.05.09	2025.05.08	☒
Shielded Room	YiHeng Electronic Co., Ltd	3.5m*3.1m*2. 8m	112	2022.02.19	2025.02.18	☒
Description	Supplier	Name	Version	/		Use
Test Software	BALUN	BL410-E	V22.930	/		☒

ANNEX B TEST SETUP PHOTOS

Please refer the document “BL-SZ2430170-AE.PDF”.

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document “BL-SZ2430170-AW.PDF”.

ANNEX D EUT INTERNAL PHOTOS

Please refer the document “BL-SZ2430170-AI.PDF”.

Statement

1. The laboratory guarantees the scientificity, accuracy and impartiality of the test, and is responsible for all the information in the report, except the information provided by the customer. The customer is responsible for the impact of the information provided on the validity of the results.
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