

TEST REPORT

Applicant: E&S International Enterprises, Inc.
Address: 7801 Hayvenhurst Avenue, Van Nuys, California
91406, United States
Equipment Type: 2.4G Wireless Combo Set
Model Name: DONGLE
Brand Name: N/A
FCC ID: 2AYPE-RCARE
Test Standard: 47 CFR Part 15 Subpart C
(refer to section 3.1)
Sample Arrival Date: Mar. 15, 2024
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ISSUED BY:

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Revision History		
Version	Issue Date	Revisions
<u>Rev. 01</u>	<u>Apr. 28, 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	<input checked="" type="checkbox"/> Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
	<input type="checkbox"/> 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	E&S International Enterprises, Inc.
Address	7801 Hayvenhurst Avenue, Van Nuys, California 91406, United States

2.2 Manufacturer Information

Manufacturer	E&S International Enterprises, Inc.
Address	7801 Hayvenhurst Avenue, Van Nuys, California 91406, United States

2.3 General Description for Equipment under Test (EUT)

EUT Name	2.4G Wireless Combo Set
Model Name Under Test	DONGLE
Series Model Name	N/A
Description of Model name differentiation	N/A
Hardware Version	N/A
Software Version	N/A
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.4 Technical Information

Network and Wireless connectivity	2.4G ISM Band
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The requirement for the following technical information of the EUT was tested in this report:

Modulation Technology	FHSS
Modulation Type	GFSK
Product Type	<input type="checkbox"/> Mobile <input checked="" type="checkbox"/> Portable <input type="checkbox"/> Fix Location
Transfer Rate	2 Mbps
Frequency Range	The frequency range used is 2400 MHz to 2483.5 MHz.
Number of Channel	40 (at intervals of 2 MHz)
Tested Channel	1 (2402 MHz), 20 (2440 MHz), 40 (2480 MHz)
Antenna Type	PCB Antenna
Antenna Gain	2.08 dBi
Antenna Impedance	50Ω
Antenna System (MIMO Smart Antenna)	N/A

Channel List:

Channel number	Freq. (MHz)	Channel number	Freq. (MHz)	Channel number	Freq. (MHz)	Channel number	Freq. (MHz)
1	2402	11	2422	21	2442	31	2462
2	2404	12	2424	22	2444	32	2464
3	2406	13	2426	23	2446	33	2466
4	2408	14	2428	24	2448	34	2468
5	2410	15	2430	25	2450	35	2470
6	2412	16	2432	26	2452	36	2472
7	2414	17	2434	27	2454	37	2474
8	2416	18	2436	28	2456	38	2476
9	2418	19	2438	29	2458	39	2478
10	2420	20	2440	30	2460	40	2480

Note: The modulation is GFSK with FHSS, there are total 40 channels (frequency range is 2402-2480MHz, channel step is 2MHz, totally 40 channels), when this part works, it will choose 40 channels, each channel band width is 2MHz, if one channel is chosen, adjacent two channels cannot be chosen to make sure step of working channels is more than 2MHz in this report, the equipment select the lowest, middle and highest channel from 40 channels, Which are 2402 MHz, 2440 MHz and 2480 MHz. The more information please refer to the manufacturer's instructions.

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15, Subpart C	Intentional radiators of radio frequency equipment
2	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
3	KDB 558074 D01 15.247 Meas Guidance v05r02	Guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under section 15.247 of the FCC rules

3.2 Test Verdict

No.	Description	FCC Part No.	Channel	Test Result	Verdict	Remark
1	Antenna Requirement	15.203	N/A	--	Pass	Note
2	Number of Hopping Frequencies	15.247(a)	Hopping Mode	ANNEX A.1	Pass	--
3	Peak Output Power	15.247(b)	Low/Middle/High	ANNEX A.2	Pass	--
4	Occupied Bandwidth	15.247(a)	Low/Middle/High	ANNEX A.3	Pass	--
5	Carrier Frequency Separation	15.247(a)	Hopping Mode	ANNEX A.4	Pass	--
6	Time of Occupancy (Dwell time)	15.247(a)	Hopping Mode	ANNEX A.5	Pass	--
7	Conducted Spurious Emission & Authorized-band band-edge	15.247(d)	Hopping Mode; Low/Middle/High	ANNEX A.6	Pass	--
8	Conducted Emission	15.207	Low/Middle/High	ANNEX A.7	Pass	--
9	Radiated Spurious Emission	15.209 15.247(d)	Low/Middle/High	ANNEX A.8	Pass	--
10	Band Edge(Restricted-band band-edge)	15.209 15.247(d)	Low/High	ANNEX A.9	Pass	--

Note: The EUT has a permanently and irreplaceable attached antenna, which complies with the requirement FCC 15.203.

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

During the measurement, the normal environmental conditions were within the listed ranges:

Relative Humidity	43% to 61%	
Atmospheric Pressure	100 kPa to 102 kPa	
Temperature	NT (Normal Temperature)	+20.3°C to +25.3°C
Working Voltage of the EUT	NV (Normal Voltage)	5 V

4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	KEYSIGHT	N9020A	MY46471071	2023.07.25	2024.07.24
Spectrum Analyzer	KEYSIGHT	N9020A	MY52510065	2023.09.05	2024.09.04
Test Antenna-Horn	SCHWARZBECK	BBHA 9120D	01631	2022.02.23	2025.02.22
Test Antenna-Horn	A-INFO	LB-180400KF	J211060273	2021.07.02	2024.07.01
Anechoic Chamber	RAINFORD	9m*6m*6m	144	2022.02.19	2024.09.03
Amplifier	COM-MV	LSCX_LNA1-12G-01	180602	2023.09.05	2024.09.04
Amplifier	COM-MV	XKu_LNA7-18G-01	180601	2023.09.05	2024.09.04
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2023.09.05	2024.09.04
Test Antenna-Bi-Log	SCHWARZBECK	VULB 9168	9168-01162	2023.08.04	2024.08.03
Test Antenna-Loop	SCHWARZBECK	FMZB 1519	1519-037	2021.04.16	2024.04.15
Amplifier	COM-MV	ZT30-1000M	B2018054558	2023.12.05	2024.12.04
Anechoic Chamber	EMC Electronic Co., Ltd	20.10*11.60*7.35m	130	2021.08.15	2024.08.14
EMI Receiver	KEYSIGHT	N9010B	MY57110309	2023.09.05	2024.09.04
LISN	SCHWARZBECK	NSLK 8127	8127-687	2023.05.16	2024.05.15
Shielded Enclosure	YiHeng Electronic Co., Ltd	3.5m*3.1m*2.8m	112	2022.02.19	2025.02.18

4.3 Test Software List

Description	Manufacturer	Software Version	Serial No.	Applicable test Setup
BL410R	BALUN	V2.1.1.488	N/A	The section 4.5.1
BL410E	BALUN	V22.930	N/A	The section 4.5.2&4.5.3&4.5.4&4.5.5

4.4 Measurement 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 $k=2$.

Parameters	Uncertainty
Occupied Channel Bandwidth	2.8%
RF output power, conducted	1.28 dB
Power Spectral Density, conducted	1.30 dB
Unwanted Emissions, conducted	1.84 dB
All emissions, radiated	5.36 dB
Temperature	0.8°C
Humidity	4%

4.5 Description of Test Setup

4.5.1 For Antenna Port Test

Conducted value (dBm) = Measurement value (dBm) + cable loss (dB)

For example: the measurement value is 10 dBm and the cable 0.5dBm used, then the final result of EUT:

Conducted value (dBm) = 10 dBm + 0.5 dB = 10.5 dBm



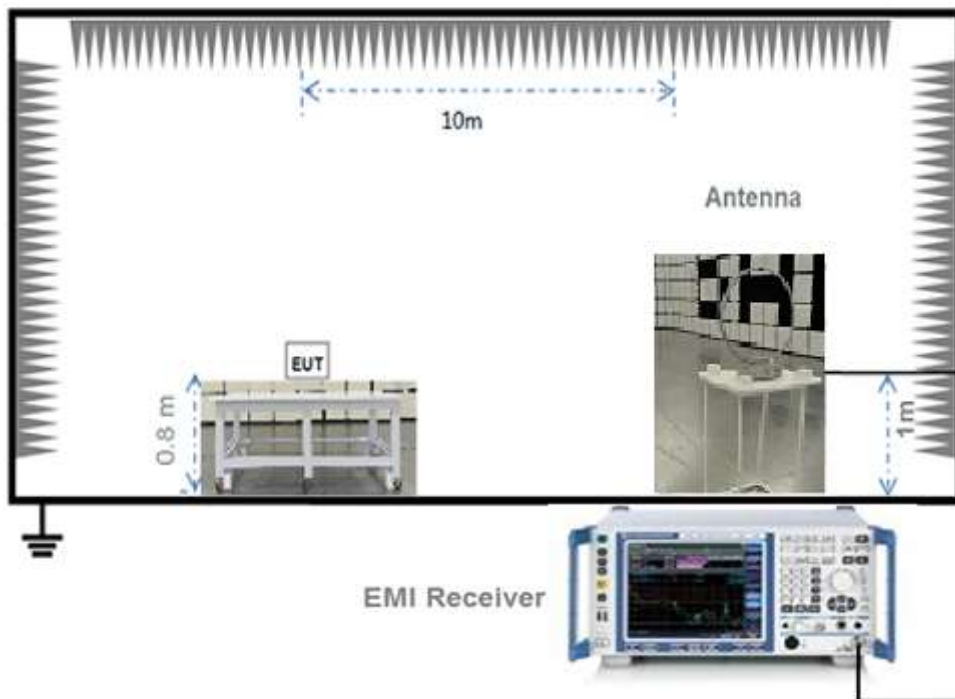
(Diagram 1)

4.5.2 For AC Power Supply Port Test



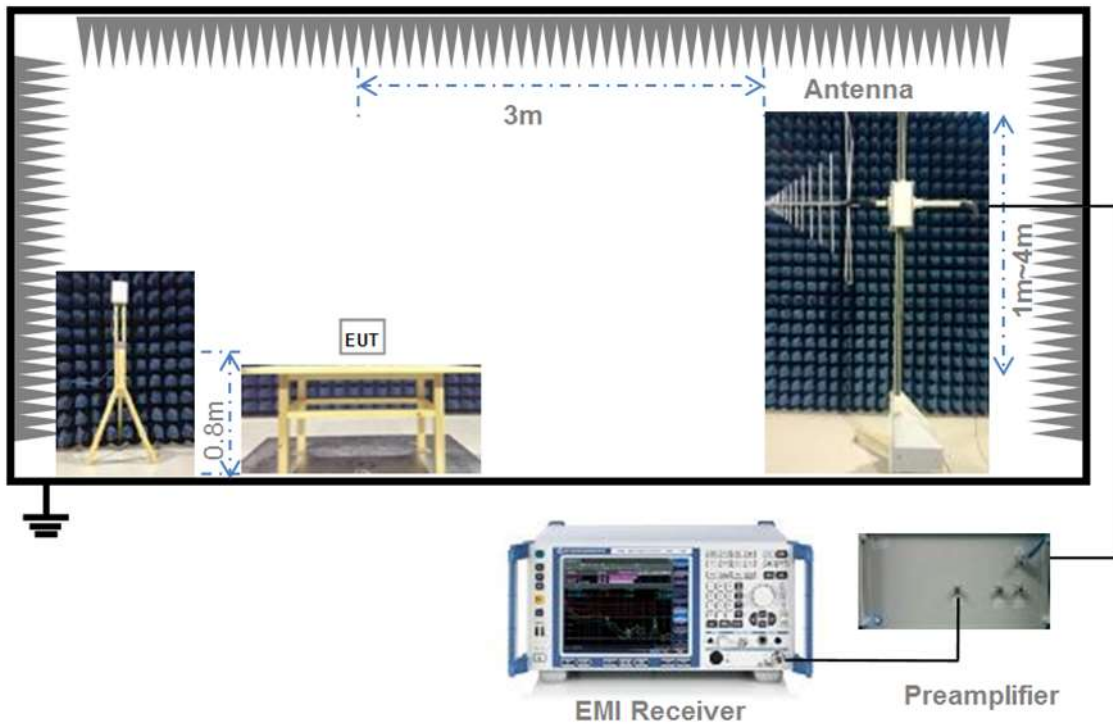
(Diagram 2)

4.5.3 For Radiated Test (Below 30 MHz)



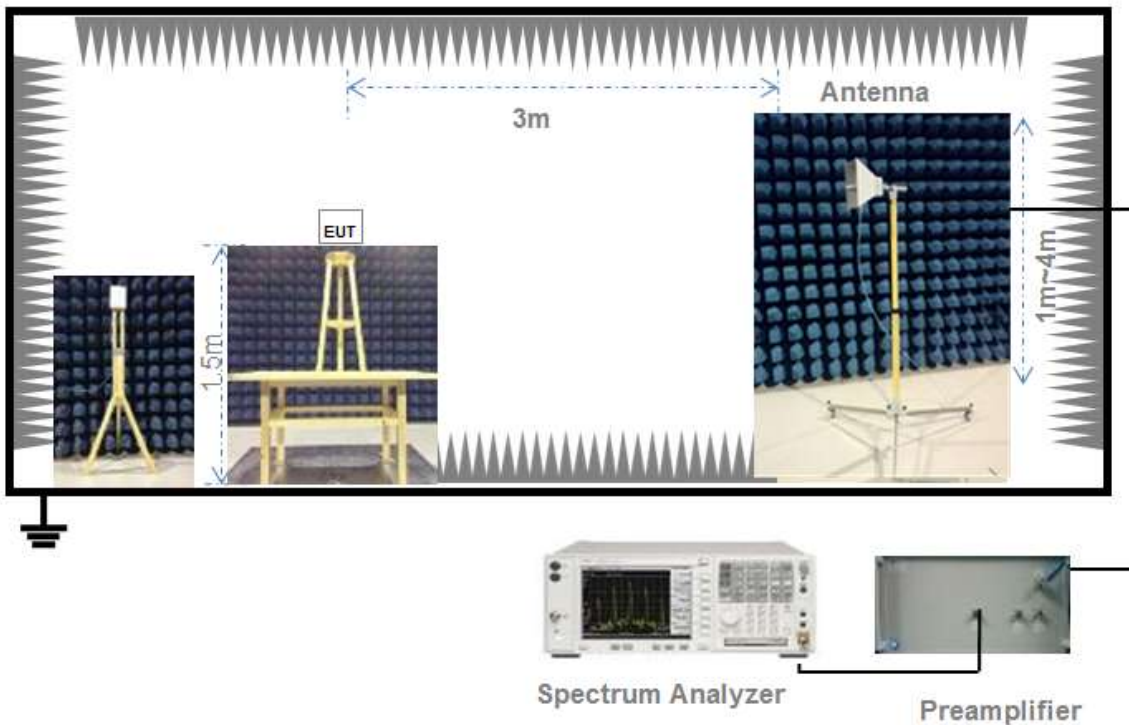
(Diagram 3)

4.5.4 For Radiated Test (30 MHz-1 GHz)



(Diagram 4)

4.5.5 For Radiated Test (Above 1 GHz)



(Diagram 5)

4.6 Measurement Results Explanation Example

4.6.1 For conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

4.5.1 For radiated band edges and spurious emission test:

Per part 15.35(c), the EUT Bluetooth average emission level could be determined by the peak emission level applying duty cycle correction factor, to represent averaging over the whole pulse train.

The average level is derived from the peak level corrected with "Duty cycle correction factor".

Average Emission Level (dBuV/m) = Peak Emission Level (dBuV/m) + Duty cycle correction factor (dB)

Duty cycle correction factor (dB) = $20 * \log(\text{Duty cycle})$.

Duty cycle = on time / 100 milliseconds

On time = dwell time * hopping number in 100 ms

For example: bluetooth with dwell time 2.9 ms and 3 hops in 100 ms, then

Duty cycle correction factor (dB) = $20 * \log((2.9 * 3) / 100) = -21.21 \text{ dB}$

Following shows an average computation example with duty cycle correction factor = -21.21 dB, and the peak emission level is 45.61 dBuV/m.

Example:

Average Emission Level (dBuV/m) = Peak Emission Level (dBuV/m) + duty cycle correction factor (dB)
= $45.61 + (-21.21) = 24.4 \text{ (dBuV/m)}$

5 TEST ITEMS

5.1 Antenna Requirements

5.1.1 Relevant Standards

FCC §15.203 & 15.247(b)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of § 15.211, § 15.213, § 15.217, § 15.219, or § 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

If directional gain of transmitting antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi. For the fixed point-to-point operation, the power shall be reduced by one dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the FCC rule.

5.1.2 Antenna Anti-Replacement Construction

The Antenna Anti-Replacement as following method:

Protected Method	Description
The antenna is embedded in the product.	An embedded-in antenna design is used.

Reference Documents	Item
Photo	Please refer to the EUT Photo documents.

5.1.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

5.2 Number of Hopping Frequencies

5.2.1 Limit

FCC §15.247(a) (1) (iii)

Frequency hopping systems operating in the 2400 MHz to 2483.5 MHz bands shall use at least 15 hopping frequencies.

5.2.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.2.3 Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = The frequency band of operation

RBW = To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

5.2.4 Test Result

Please refer to ANNEX A.1.

5.3 Peak Output Power

5.3.1 Test Limit

FCC § 15.247(b)

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

5.3.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.3.3 Test Procedure

The Module operates at hopping-off test mode. The lowest, middle and highest channels are selected to perform testing to verify the conducted RF output peak power of the Module.

Use the following spectrum analyzer settings:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel

RBW > the 20 dB bandwidth of the emission being measured

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize.

5.3.4 Test Result

Please refer to ANNEX A.2.

5.4 Occupied Bandwidth

5.4.1 Limit

FCC §15.247(a)

Measurement of the 20dB bandwidth of the modulated signal.

5.4.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.4.3 Test Procedure

Use the following spectrum analyzer settings:

Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hopping channel

RBW = in the range of 1% to 5% of the OBW

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

The EUT should be transmitting at its maximum data rate, Allow the trace to stabilize.

5.4.4 Test Result

Please refer to ANNEX A.3.

5.5 Carrier Frequency Separation

5.5.1 Limit

FCC §15.247(a)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

5.5.1 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.5.2 Test Procedure

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

Span = wide enough to capture the peaks of two adjacent channels

Resolution (or IF) Bandwidth (RBW) \geq 1% of the span

Video (or Average) Bandwidth (VBW) \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

5.5.3 Test Result

Please refer to ANNEX A.4.

5.6 Time of Occupancy (Dwell time)

5.6.1 Limit

FCC §15.247(a)

Frequency hopping systems in the 2400 MHz - 2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

5.6.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.6.3 Test Procedure

The average time of occupancy on any channel within the Period can be calculated with formulas:

$$\{\text{Total of Dwell}\} = \{\text{Pulse Time}\} * \{\text{Number of Hopping Frequency in Period}\}$$

$$\{\text{Period}\} = 0.4\text{s} * \{\text{Number of Hopping Frequency}\}$$

The middle channels are selected to perform testing to record the dwell time of each occupation measured in this channel, which is called Pulse Time here.

5.6.4 Test Result

Please refer to ANNEX A.5.

5.7 Conducted Spurious Emission & Authorized-band band-edge

5.7.1 Limit

FCC §15.247(d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

5.7.2 Test Setup

See section 4.5.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.7.3 Test Procedure

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.

RBW = 100 kHz

VBW = 300 kHz

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

5.7.4 Test Result

Please refer to ANNEX A.6.

5.8 Conducted Emission

5.8.1 Limit

FCC §15.207

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 μ H/50 Ω line impedance stabilization network (LISN).

Frequency range (MHz)	Conducted Limit (dB μ V)	
	Quai-peak	Average
0.15 - 0.50	66 to 56	56 to 46
0.50 - 5	56	46
0.50 - 30	60	50

5.8.2 Test Setup

See section 4.5.2 for test setup description for the AC power supply port. The photo of test setup please refer to ANNEX B.

5.8.3 Test Procedure

The maximum conducted interference is searched using Peak (PK), if the emission levels 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. Refer to recorded points and plots below.

5.8.4 Test Result

Please refer to ANNEX A.7.

5.9 Radiated Spurious Emission

5.9.1 Limit

FCC §15.209&15.247(d)

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength ($\mu\text{V}/\text{m}$)	Measurement Distance (m)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Note:

1. Field Strength (dB $\mu\text{V}/\text{m}$) = 20*log[Field Strength ($\mu\text{V}/\text{m}$)].
2. In the emission tables above, the tighter limit applies at the band edges.
3. For Above 1000 MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.
4. For above 1000 MHz, limit field strength of harmonics: 54dBuV/m@3m (AV) and 74dBuV/m@3m (PK).

5.9.2 Test Setup

See section 4.5.3 to 4.5.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.9.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. 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.

The power of the EUT transmitting frequency should be ignored.

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

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

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

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

5.9.4 Test Result

Please refer to ANNEX A.8.

5.10 Band Edge (Restricted-band band-edge)

5.10.1 Limit

FCC §15.209&15.247(d)

Radiated emission outside the frequency band attenuation below the general limits specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limits specified in FCC section 15.209(a).

5.10.2 Test Setup

See section 4.5.3 to 4.5.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.10.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. 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.

The power of the EUT transmitting frequency should be ignored.

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

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

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

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

5.10.4 Test Result

Please refer to ANNEX A.9.

ANNEX A TEST RESULT

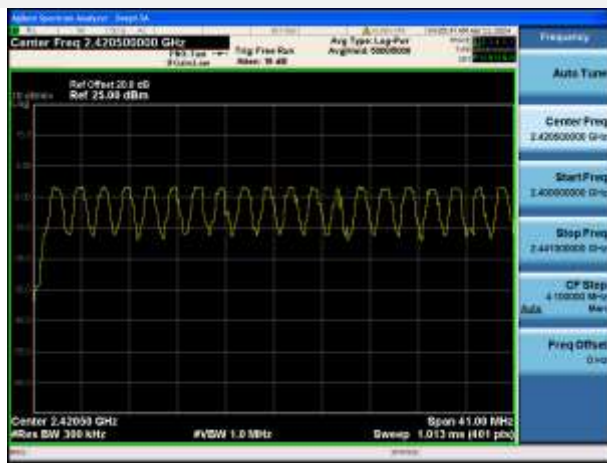
A.1 Number of Hopping Frequency

Test Data

Test Mode	Frequency Block (MHz)	Measured Channel Numbers	Min. Limit	Verdict
GFSK	2400 - 2483.5	40	15	Pass

Test Plots

GFSK 2.4 GHz ~ 2.4415 GHz



GFSK 2.4415 GHz ~ 2.4835 GHz



A.2 Peak Output Power

Peak Power Test Data

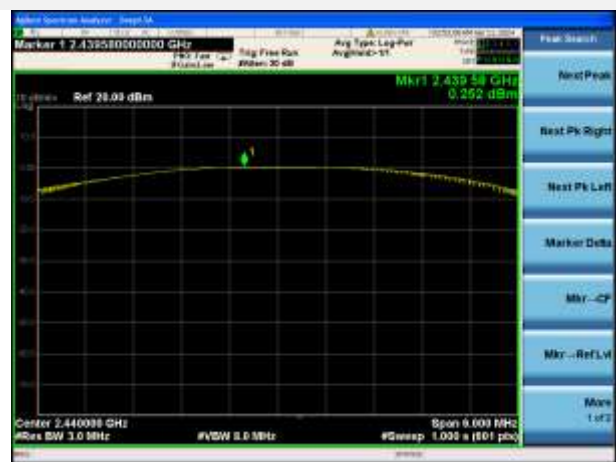
Channel	Measured Output Peak Power		Limit		Verdict
	GFSK		dBm	mW	
	dBm	mW			
Low	-0.03	0.99	21	125	Pass
Middle	0.25	1.06			Pass
High	0.34	1.08			Pass

Test Plots

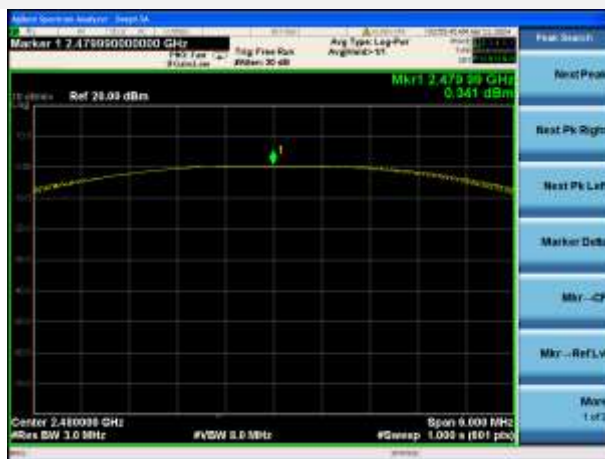
GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL



A.3 20 dB and 99% bandwidth

Test Data

GFSK		
Channel	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	1.875000	1.800000
Middle	1.905000	1.852400
High	2.092500	1.877800

Test Plots

20 dB Bandwidth

GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL



99% Bandwidth

GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL



A.4 Hopping Frequency Separation

Test Data

Mode	Frequency separation (MHz)	2/3 of the 20 dB Bandwidth (MHz)	Verdict
GFSK	1.975	1.395	Pass

Test Plot

GFSK



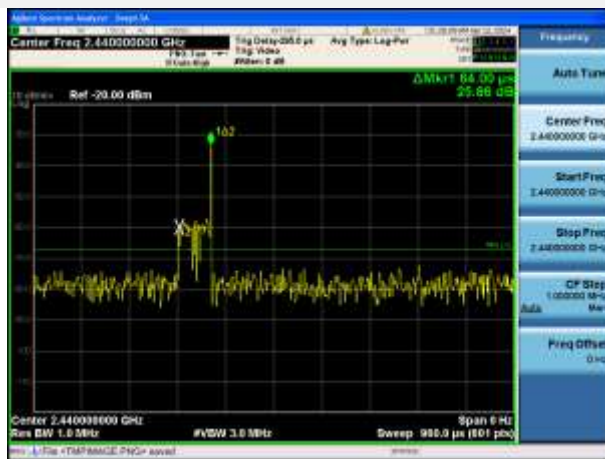
A.5 Time of Occupancy (Dwell time)

Test Data

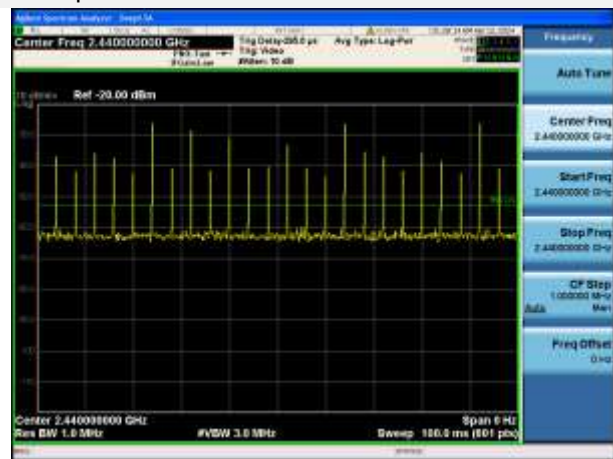
GFSK			
Pulse Width (ms)	Total of Dwell (ms)	Limit (sec)	Verdict
0.064	256.000	0.4	Pass

Test Plots

Pulse Width



Sweep time 100ms



A.6 Conducted Spurious Emissions & Authorized-band band-edge

Test Data

GFSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-35.33	-2.11	-22.11	Pass
Middle	-36.90	-1.91	-21.91	Pass
High	-35.45	-1.82	-21.82	Pass

Hopping Mode				
Mode	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
GFSK	-26.14	-1.93	-21.93	Pass

Test Plots

GFSK LOW CHANNEL, CARRIER LEVEL



GFSK LOW CHANNEL, BAND EDGE



GFSK LOW CHANNEL, SPURIOUS
30 MHz ~ 3 GHz



GFSK LOW CHANNEL, SPURIOUS
3 GHz ~ 25 GHz



GFSK MIDDLE CHANNEL, CARRIER LEVEL



GFSK MIDDLE CHANNEL, SPURIOUS
30 MHz ~ 3 GHz



GFSK MIDDLE CHANNEL, SPURIOUS
3 GHz ~ 25 GHz



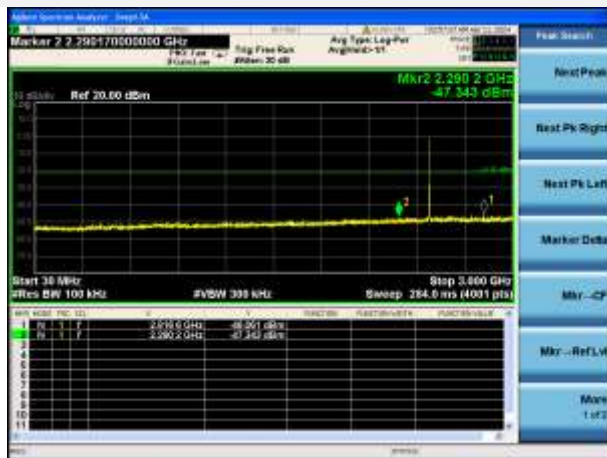
GFSK HIGH CHANNEL, CARRIER LEVEL



GFSK HIGH CHANNEL, BAND EDGE



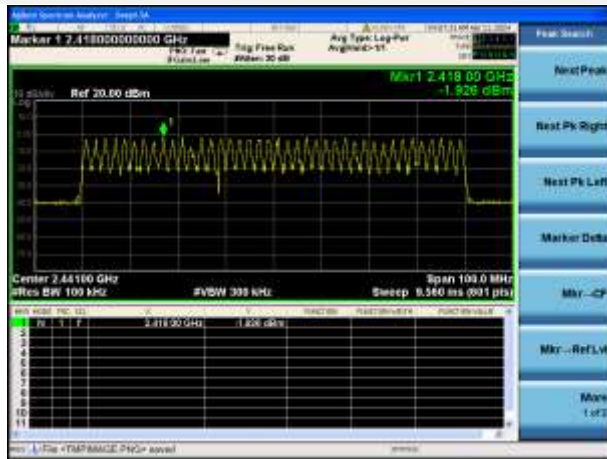
GFSK HIGH CHANNEL, SPURIOUS
30 MHz ~ 3 GHz



GFSK HIGH CHANNEL, SPURIOUS
3 GHz ~ 25 GHz



GFSK HOPPING, CARRIER LEVEL



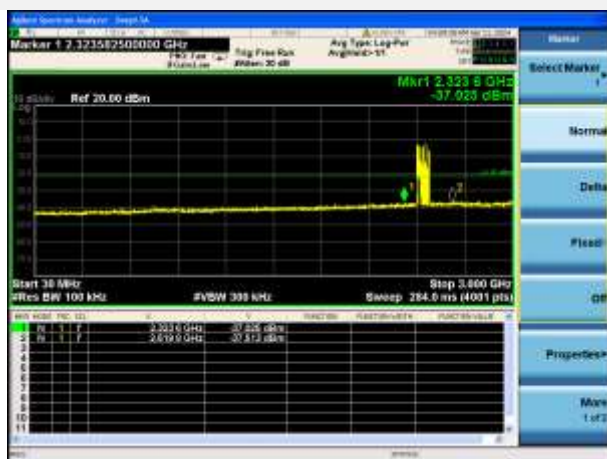
GFSK HOPPING BAND EDGE (LOW)



GFSK HOPPING BAND EDGE (HIGH)



GFSK Hopping Mode, SPUIOUS
 30 MHz ~ 3 GHz



GFSK Hopping Mode, SPURIOUS
 3GHz ~ 25 GHz



A.7 Conducted Emissions

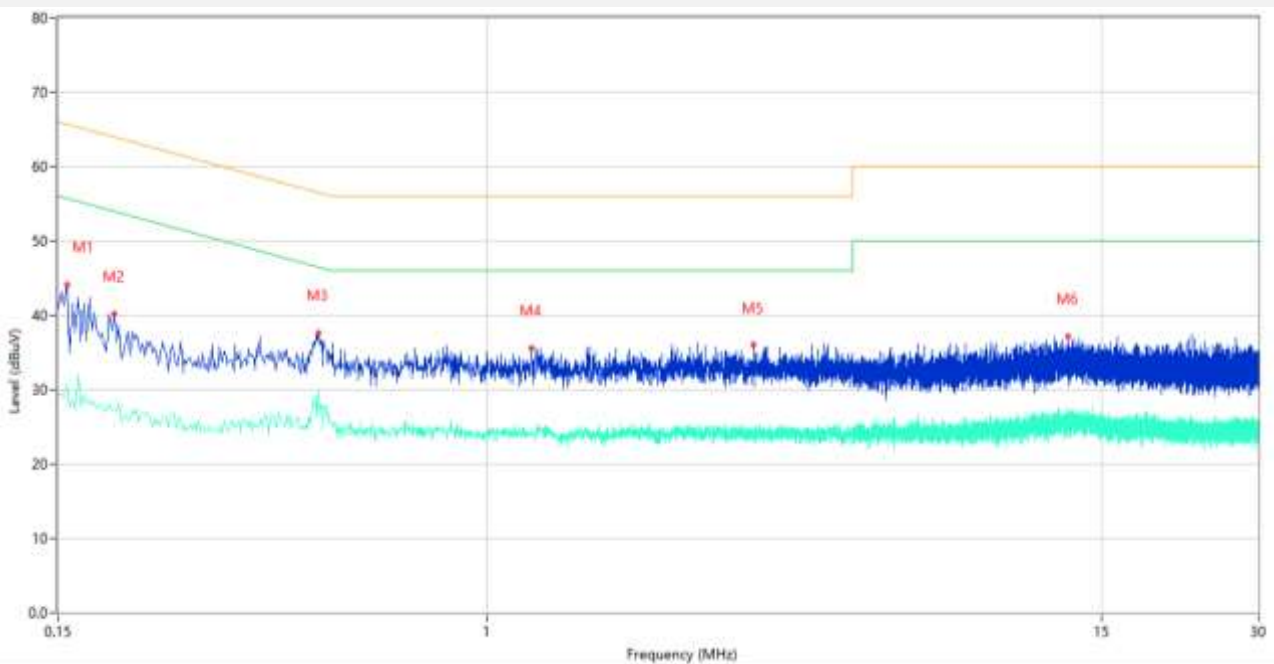
Note¹: The EUT is working in the Normal link mode. All modes have been tested and normal link mode is worst.

Note²: Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 60 Hz and 240 VAC, 50 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.

Note³: Results (dBuV) = Original reading level of Spectrum Analyzer (dBuV) + Factor (dB)

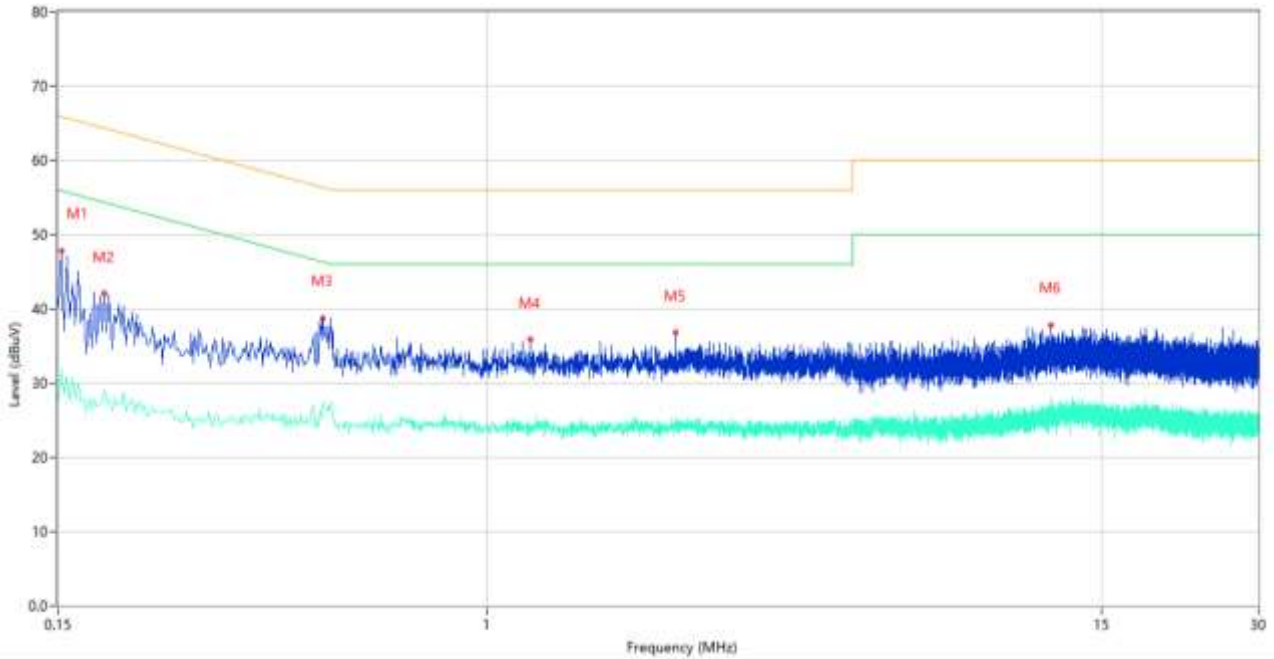
Test Data and Plots

PHASE L



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.156	44.14	9.78	65.67	21.53	Peak	L	Pass
1**	0.156	30.65	9.78	55.67	25.02	AV	L	Pass
2	0.192	40.23	9.77	63.95	23.72	Peak	L	Pass
2**	0.192	27.19	9.77	53.95	26.76	AV	L	Pass
3	0.474	37.62	10.00	56.44	18.82	Peak	L	Pass
3**	0.474	30.01	10.00	46.44	16.43	AV	L	Pass
4	1.214	35.61	10.07	56.00	20.39	Peak	L	Pass
4**	1.214	23.82	10.07	46.00	22.18	AV	L	Pass
5	3.228	35.97	10.13	56.00	20.03	Peak	L	Pass
5**	3.228	23.68	10.13	46.00	22.32	AV	L	Pass
6	12.944	37.21	10.66	60.00	22.79	Peak	L	Pass
6**	12.944	26.04	10.66	50.00	23.96	AV	L	Pass

PHASE N



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.152	47.72	9.78	65.89	18.17	Peak	N	Pass
1**	0.152	31.88	9.78	55.89	24.01	AV	N	Pass
2	0.184	42.01	9.78	64.30	22.29	Peak	N	Pass
2**	0.184	29.17	9.78	54.30	25.13	AV	N	Pass
3	0.484	38.79	10.00	56.27	17.48	Peak	N	Pass
3**	0.484	26.83	10.00	46.27	19.44	AV	N	Pass
4	1.204	35.83	9.96	56.00	20.17	Peak	N	Pass
4**	1.204	23.92	9.96	46.00	22.08	AV	N	Pass
5	2.288	36.76	10.30	56.00	19.24	Peak	N	Pass
5**	2.288	24.72	10.30	46.00	21.28	AV	N	Pass
6	12.002	37.81	10.43	60.00	22.19	Peak	N	Pass
6**	12.002	28.12	10.43	50.00	21.88	AV	N	Pass

A.8 Radiated Spurious 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 C63.10-2013, 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.

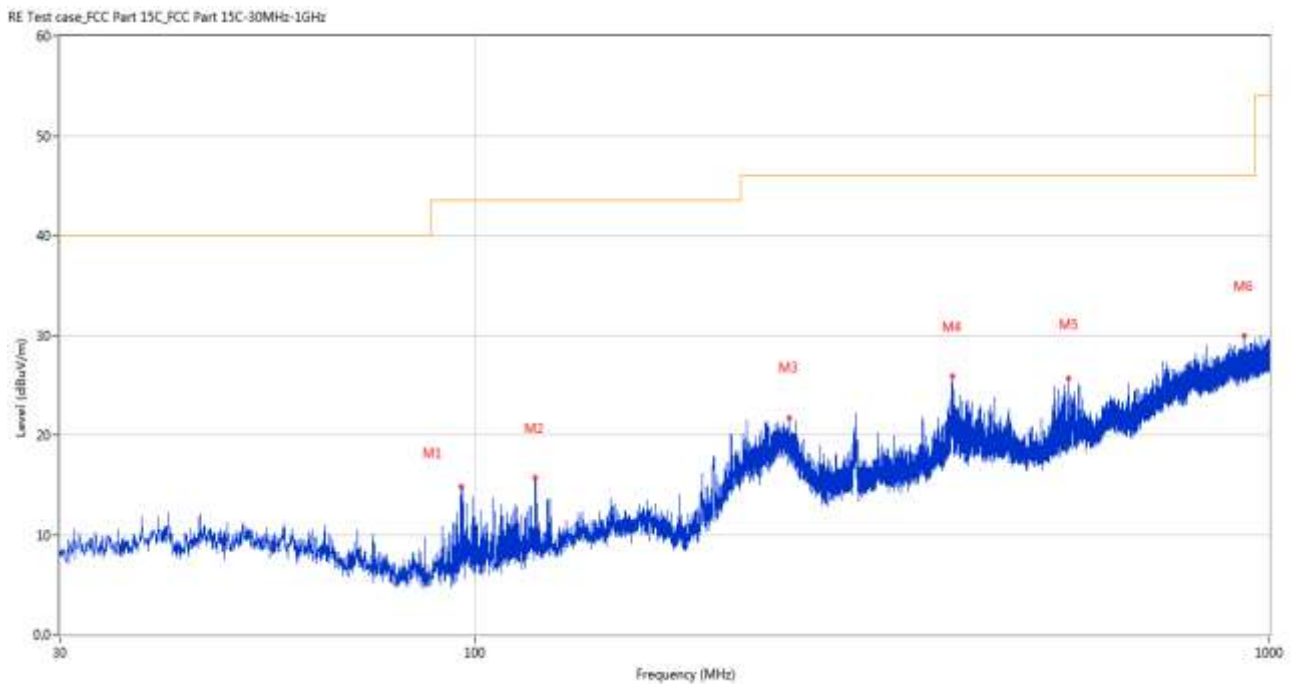
Note 3: The EUT is working in the Normal link mode below 1 GHz. All modes have been tested and DH5-Hopping mode is the worst.

Note 4: Results (dBuV/m) = Original reading level of Spectrum Analyzer (dBuV/m) + Factor (dB)

The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

Test Data and Plots

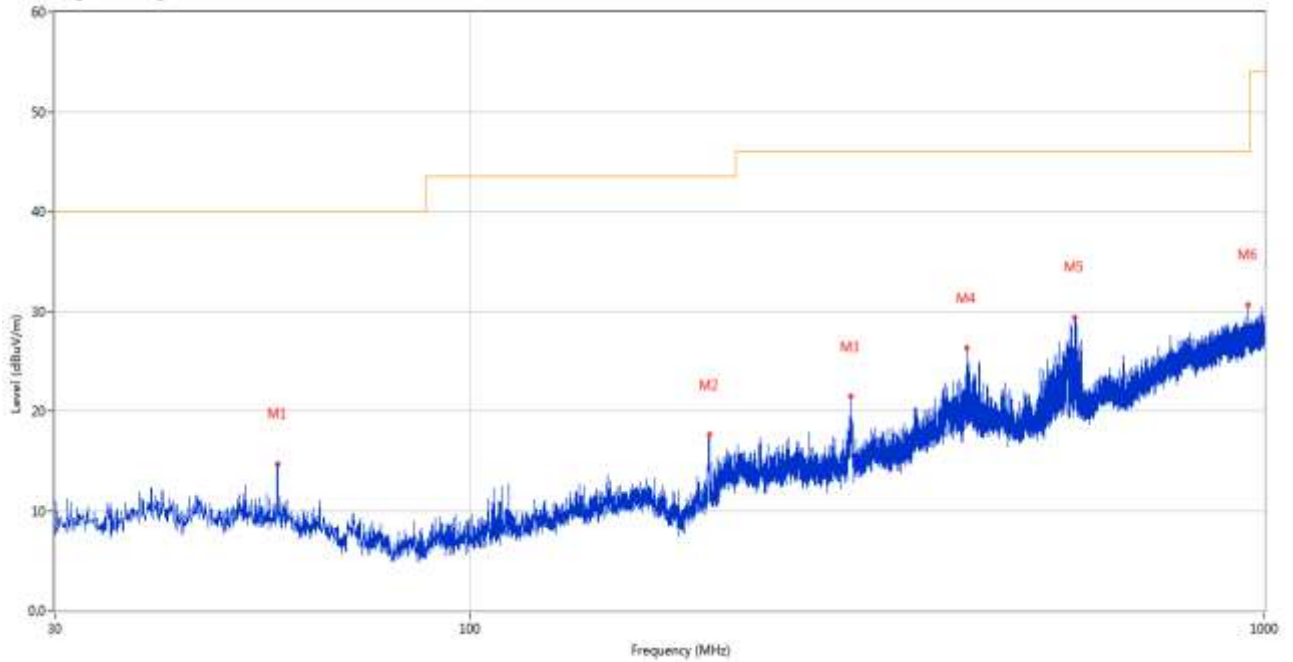
30 MHz to 1 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	96.202	14.80	-30.00	43.5	28.70	Peak	250.00	200	Horizontal	Pass
2	118.949	15.69	-28.19	43.5	27.81	Peak	91.00	200	Horizontal	Pass
3	248.880	21.73	-26.77	46.0	24.27	Peak	204.00	100	Horizontal	Pass
4	399.279	25.84	-21.29	46.0	20.16	Peak	83.00	100	Horizontal	Pass
5	558.795	25.64	-17.49	46.0	20.36	Peak	71.00	200	Horizontal	Pass
6	928.753	29.97	-10.84	46.0	16.03	Peak	174.00	100	Horizontal	Pass

30 MHz to 1 GHz, ANT V

RE Test case_FCC Part 15C_FCC Part 15C-30MHz-1GHz

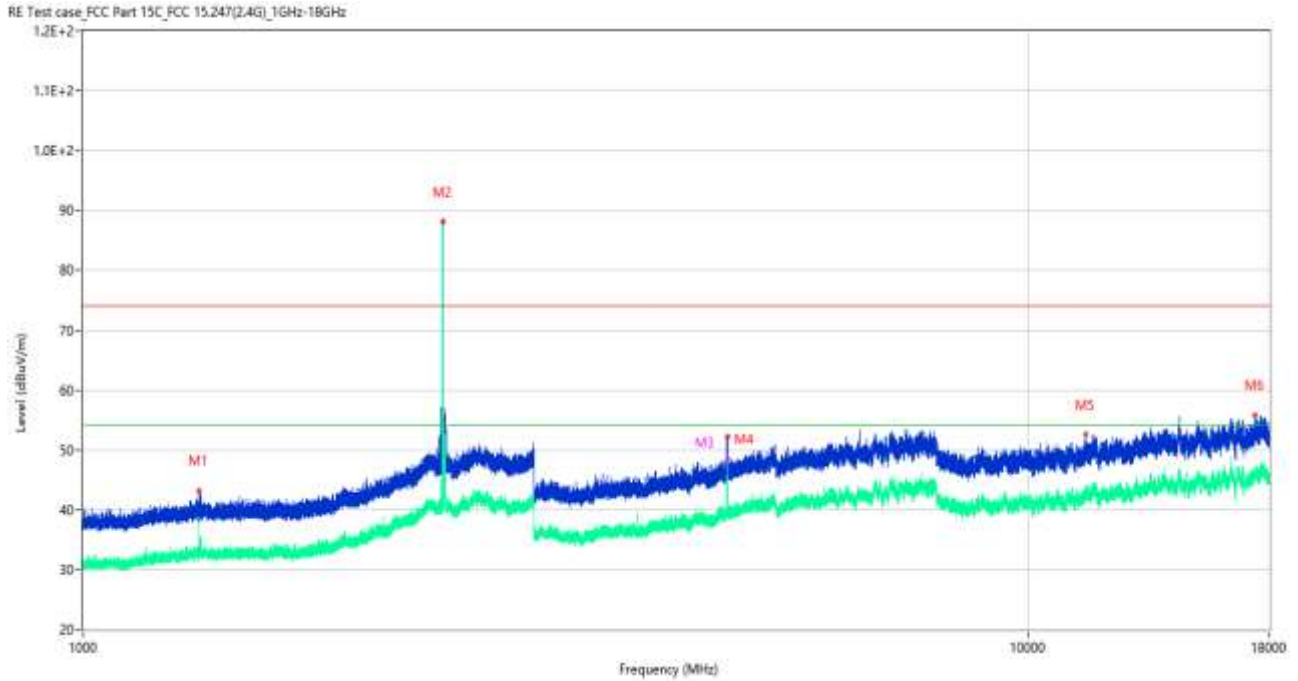


No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	57.209	14.72	-26.93	40.0	25.28	Peak	40.00	100	Vertical	Pass
2	199.895	17.60	-28.75	43.5	25.90	Peak	171.00	200	Vertical	Pass
3	301.261	21.47	-24.69	46.0	24.53	Peak	167.00	200	Vertical	Pass
4	421.686	26.34	-20.96	46.0	19.66	Peak	207.00	100	Vertical	Pass
5	577.711	29.43	-16.58	46.0	16.57	Peak	134.00	100	Vertical	Pass
6	953.877	30.66	-9.96	46.0	15.34	Peak	115.00	100	Vertical	Pass

Note 1: The marked spikes near 2400 MHz with circle should be ignored because they are Fundamental signal.

Note 2: The spurious from 18GHz-25GHz is noise only, do not show on the report.

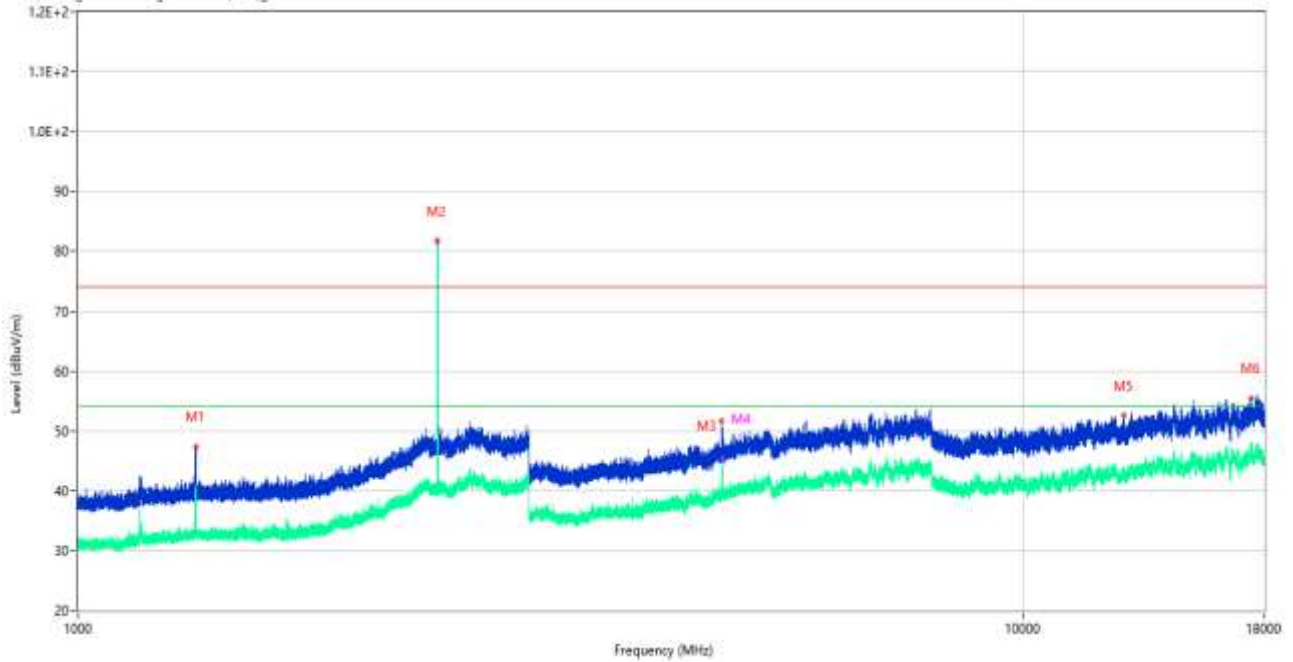
GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1327.700	43.18	-16.94	74.0	30.82	Peak	79.00	150	Horizontal	Pass
1**	1327.700	32.50	-16.94	54.0	21.50	AV	79.00	150	Horizontal	Pass
2	2402.300	88.14	-10.58	74.0	-14.14	Peak	326.00	150	Horizontal	N/A
2**	2402.300	87.45	-10.58	54.0	-33.45	AV	326.00	150	Horizontal	N/A
3	4804.250	51.57	-3.21	74.0	22.43	Peak	84.00	150	Horizontal	Pass
3**	4804.250	48.35	-3.21	54.0	5.65	AV	84.00	150	Horizontal	Pass
4	4804.500	52.23	-3.20	74.0	21.77	Peak	84.00	150	Horizontal	Pass
4**	4804.500	48.16	-3.20	54.0	5.84	AV	84.00	150	Horizontal	Pass
5	11497.662	52.55	-0.63	74.0	21.45	Peak	11.00	150	Horizontal	Pass
5**	11497.662	42.98	-0.63	54.0	11.02	AV	11.00	150	Horizontal	Pass
6	17412.262	55.78	5.46	74.0	18.22	Peak	34.00	150	Horizontal	Pass
6**	17412.262	45.84	5.46	54.0	8.16	AV	34.00	150	Horizontal	Pass

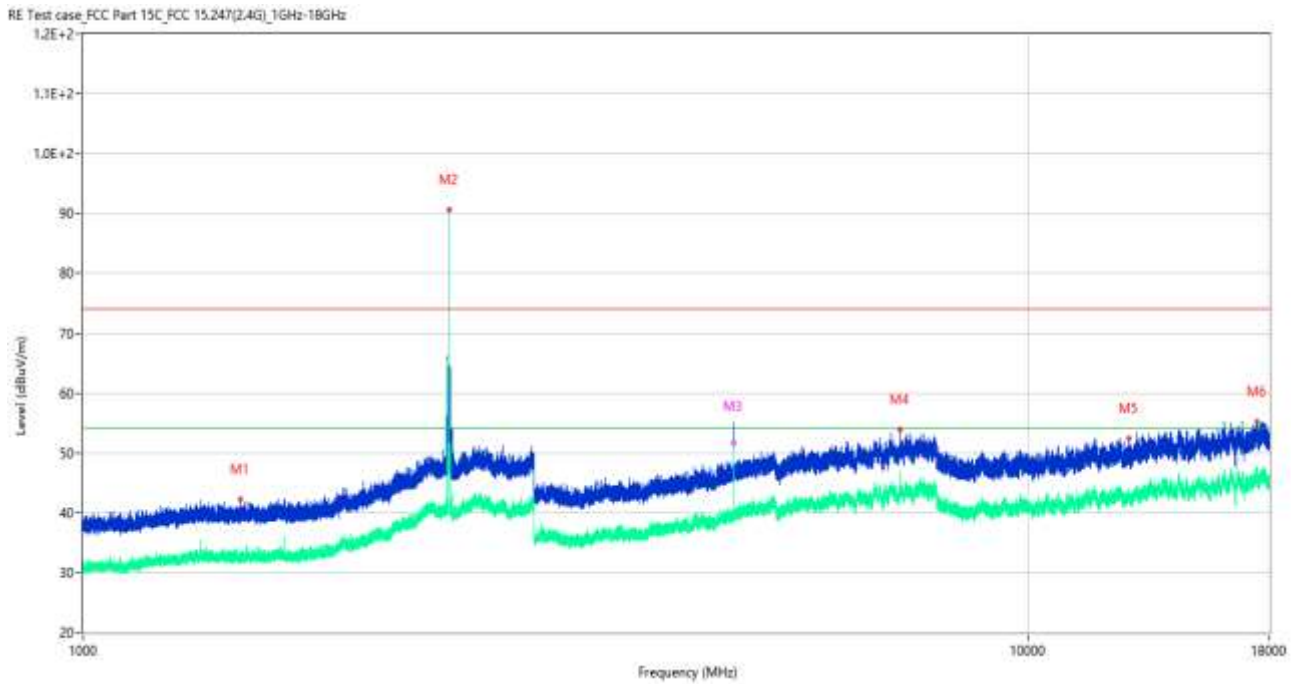
GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT V

RE Test case: FCC Part 15C_FCC 15.247(2.4G)_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1331.600	47.38	-16.92	74.0	26.62	Peak	261.00	150	Vertical	Pass
1**	1331.600	38.65	-16.92	54.0	15.35	AV	261.00	150	Vertical	Pass
2	2401.700	81.75	-10.63	74.0	-7.75	Peak	159.00	150	Vertical	N/A
2**	2401.700	80.59	-10.63	54.0	-26.59	AV	159.00	150	Vertical	N/A
3	4803.250	51.56	-3.44	74.0	22.44	Peak	121.00	150	Vertical	Pass
3**	4803.250	43.88	-3.44	54.0	10.12	AV	121.00	150	Vertical	Pass
4	4804.250	48.89	-3.21	74.0	25.11	Peak	121.00	150	Vertical	Pass
4**	4804.250	45.37	-3.21	54.0	8.63	AV	121.00	150	Vertical	Pass
5	12779.400	52.51	0.99	74.0	21.49	Peak	197.00	150	Vertical	Pass
5**	12779.400	42.22	0.99	54.0	11.78	AV	197.00	150	Vertical	Pass
6	17419.874	55.43	5.48	74.0	18.57	Peak	204.00	150	Vertical	Pass
6**	17419.874	45.64	5.48	54.0	8.36	AV	204.00	150	Vertical	Pass

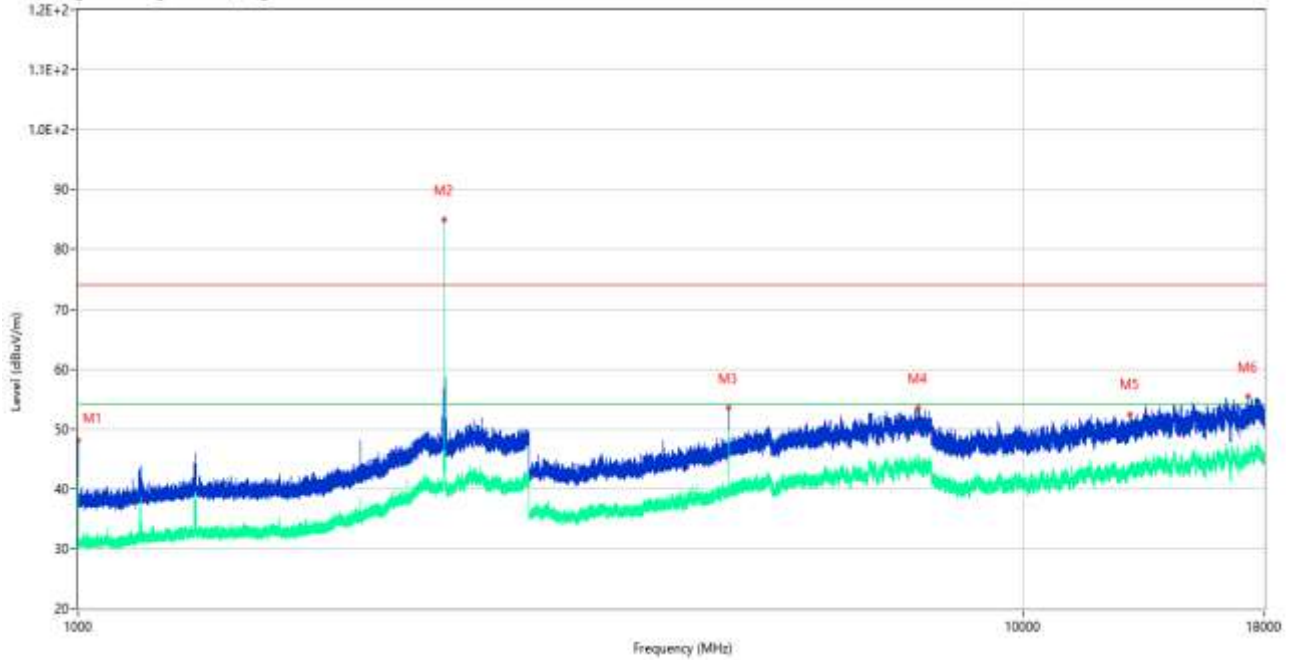
GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1468.200	42.27	-17.31	74.0	31.73	Peak	132.00	150	Horizontal	Pass
1**	1468.200	32.56	-17.31	54.0	21.44	AV	132.00	150	Horizontal	Pass
2	2440.400	90.63	-9.94	74.0	-16.63	Peak	324.00	150	Horizontal	N/A
2**	2440.400	89.58	-9.94	54.0	-35.58	AV	324.00	150	Horizontal	N/A
3	4880.000	54.55	-3.67	74.0	19.45	Peak	79.00	150	Horizontal	Pass
3**	4880.000	51.67	-3.67	54.0	2.33	AV	79.00	150	Horizontal	Pass
4	7318.750	53.97	0.59	74.0	20.03	Peak	17.00	150	Horizontal	Pass
4**	7318.750	44.22	0.59	54.0	9.78	AV	17.00	150	Horizontal	Pass
5	12797.776	52.46	0.96	74.0	21.54	Peak	234.00	150	Horizontal	Pass
5**	12797.776	42.68	0.96	54.0	11.32	AV	234.00	150	Horizontal	Pass
6	17467.912	55.27	5.24	74.0	18.73	Peak	336.00	150	Horizontal	Pass
6**	17467.912	45.50	5.24	54.0	8.50	AV	336.00	150	Horizontal	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V

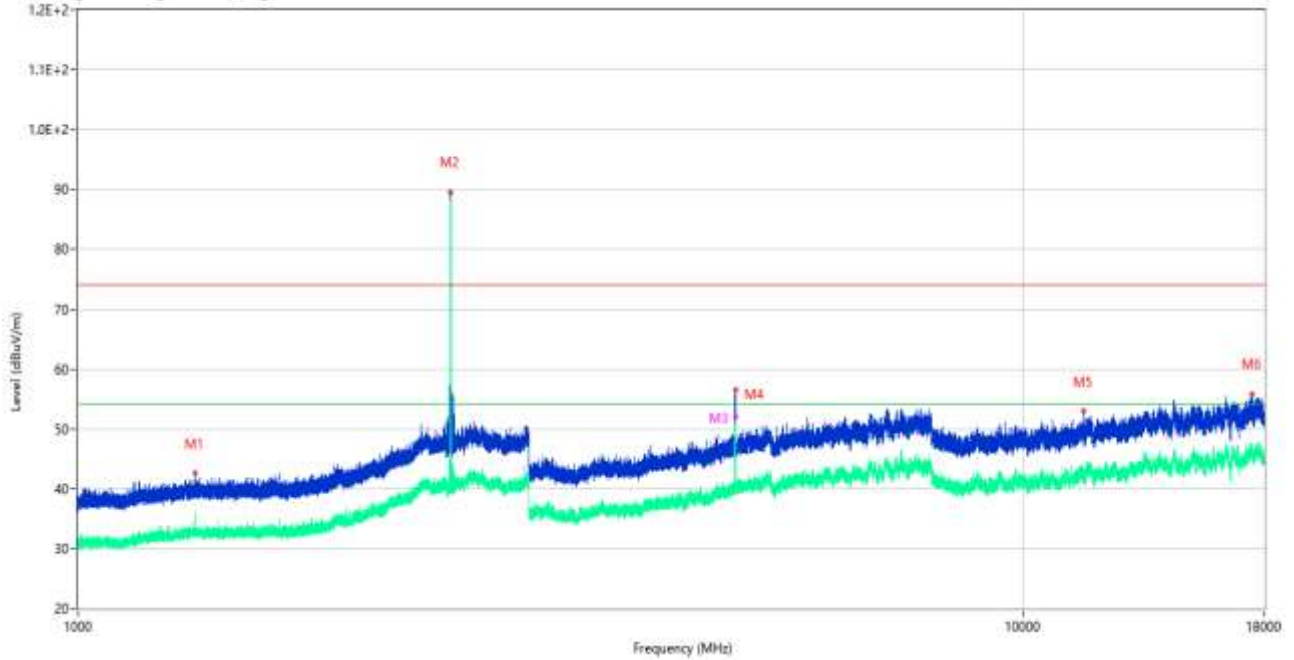
RE Test case: FCC Part 15C_FCC 15.247(2.4G)_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1000.100	48.05	-18.33	74.0	25.95	Peak	59.00	150	Vertical	Pass
1**	1000.100	34.37	-18.33	54.0	19.63	AV	59.00	150	Vertical	Pass
2	2440.400	84.88	-9.94	74.0	-10.88	Peak	140.00	150	Vertical	N/A
2**	2440.400	83.37	-9.94	54.0	-29.37	AV	140.00	150	Vertical	N/A
3	4879.750	53.46	-3.71	74.0	20.54	Peak	122.00	150	Vertical	Pass
3**	4879.750	49.74	-3.71	54.0	4.26	AV	122.00	150	Vertical	Pass
4	7754.000	53.44	1.14	74.0	20.56	Peak	101.00	150	Vertical	Pass
4**	7754.000	44.03	1.14	54.0	9.97	AV	101.00	150	Vertical	Pass
5	12981.262	52.48	1.87	74.0	21.52	Peak	120.00	150	Vertical	Pass
5**	12981.262	42.53	1.87	54.0	11.47	AV	120.00	150	Vertical	Pass
6	17311.988	55.38	2.75	74.0	18.62	Peak	273.00	150	Vertical	Pass
6**	17311.988	44.99	2.75	54.0	9.01	AV	273.00	150	Vertical	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT H

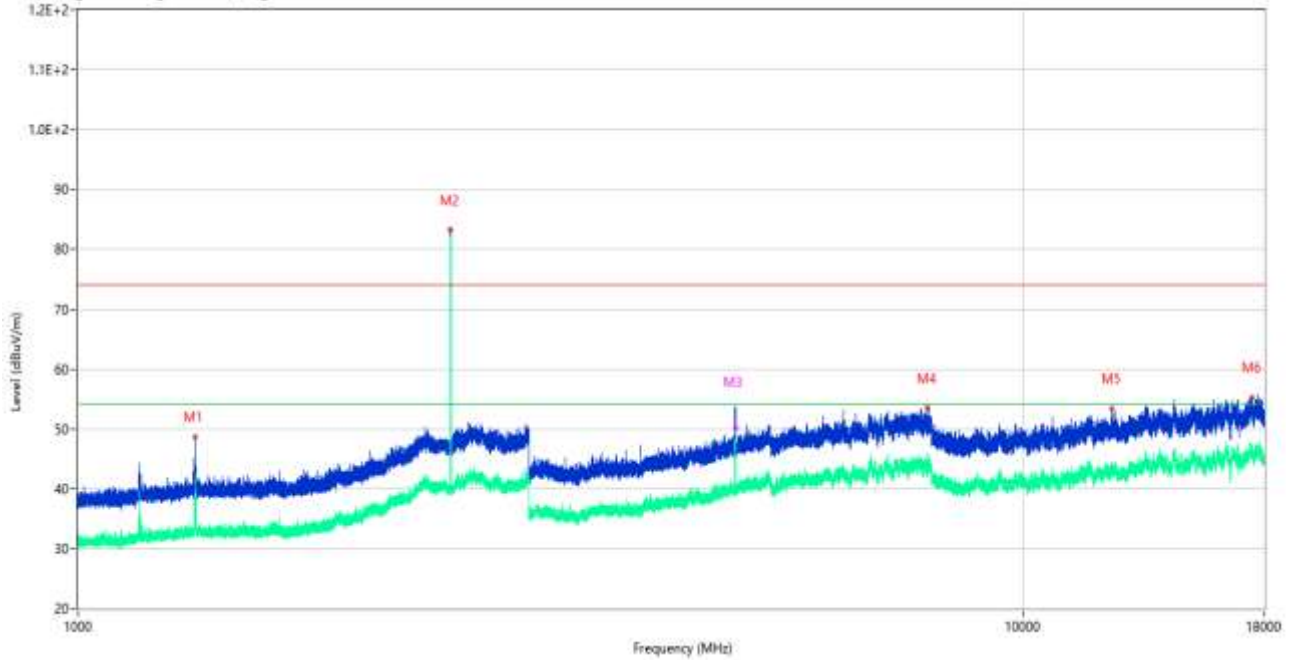
RE Test case: FCC Part 15C_FCC 15.247(2.4G)_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1329.200	42.53	-16.94	74.0	31.47	Peak	337.00	150	Horizontal	Pass
1**	1329.200	33.08	-16.94	54.0	20.92	AV	337.00	150	Horizontal	Pass
2	2479.700	89.59	-11.16	74.0	-15.59	Peak	82.00	150	Horizontal	N/A
2**	2479.700	87.99	-11.16	54.0	-33.99	AV	82.00	150	Horizontal	N/A
3	4960.250	55.24	-3.64	74.0	18.76	Peak	96.00	150	Horizontal	Pass
3**	4960.250	52.06	-3.64	54.0	1.94	AV	96.00	150	Horizontal	Pass
4	4960.750	56.57	-3.50	74.0	17.43	Peak	96.00	150	Horizontal	Pass
4**	4960.750	50.93	-3.50	54.0	3.07	AV	96.00	150	Horizontal	Pass
5	11599.075	52.87	-0.62	74.0	21.13	Peak	336.00	150	Horizontal	Pass
5**	11599.075	42.39	-0.62	54.0	11.61	AV	336.00	150	Horizontal	Pass
6	17464.500	55.83	5.30	74.0	18.17	Peak	240.00	150	Horizontal	Pass
6**	17464.500	46.36	5.30	54.0	7.64	AV	240.00	150	Horizontal	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT V

RE Test case: FCC Part 15C_FCC 15.247(2.4G)_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1330.700	48.61	-17.06	74.0	25.39	Peak	254.00	150	Vertical	Pass
1**	1330.700	38.12	-17.06	54.0	15.88	AV	254.00	150	Vertical	Pass
2	2479.700	83.19	-11.16	74.0	-9.19	Peak	145.00	150	Vertical	N/A
2**	2479.700	81.58	-11.16	54.0	-27.58	AV	145.00	150	Vertical	N/A
3	4960.000	53.27	-3.53	74.0	20.73	Peak	178.00	150	Vertical	Pass
3**	4960.000	50.15	-3.53	54.0	3.85	AV	178.00	150	Vertical	Pass
4	7926.500	53.44	1.77	74.0	20.56	Peak	137.00	150	Vertical	Pass
4**	7926.500	43.29	1.77	54.0	10.71	AV	137.00	150	Vertical	Pass
5	12415.362	53.34	1.09	74.0	20.66	Peak	79.00	150	Vertical	Pass
5**	12415.362	42.42	1.09	54.0	11.58	AV	79.00	150	Vertical	Pass
6	17473.161	55.24	5.14	74.0	18.76	Peak	26.00	150	Vertical	Pass
6**	17473.161	45.59	5.14	54.0	8.41	AV	26.00	150	Vertical	Pass

A.9 Band Edge (Restricted-band band-edge)

Note ¹: The lowest and highest channels are tested to verify the band edge emissions. Please refer to the following the plots for emissions values.

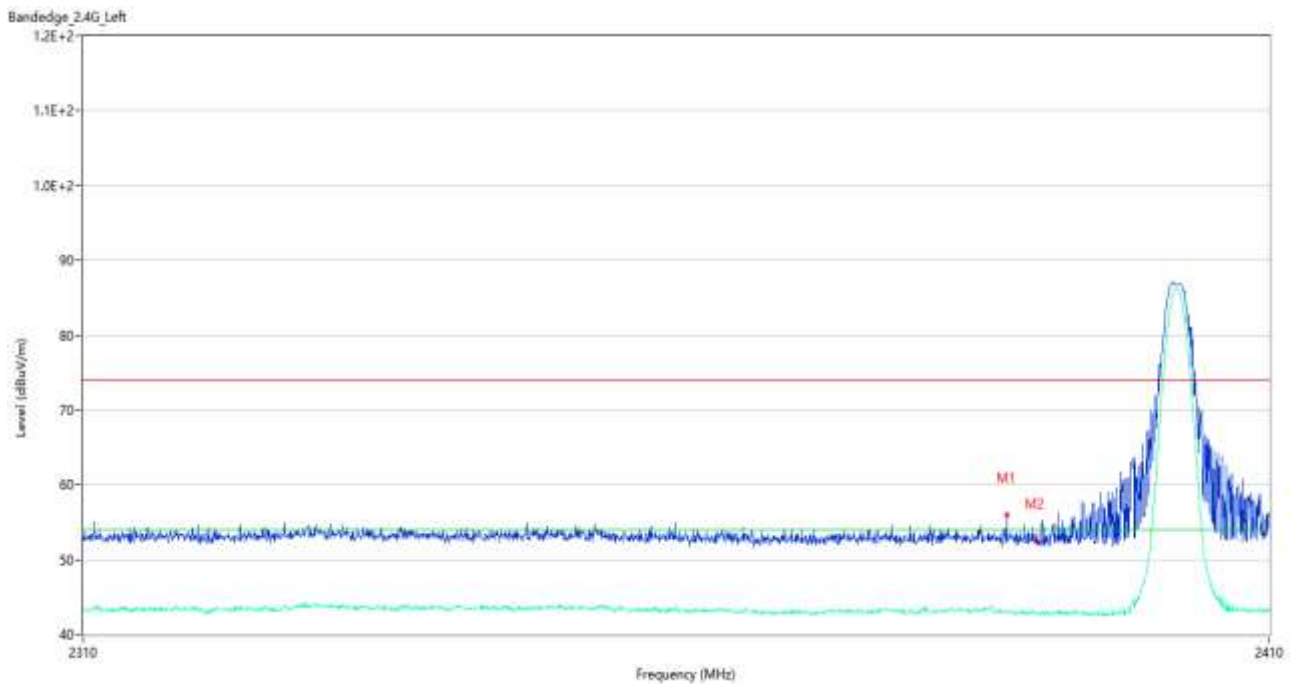
Note ²: The test data all are tested in the vertical and horizontal antenna which the trace is max hold. So these plots have shown the worst case.

Note ³: According the ANSI C63.10-2013, 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.

Note ⁴: The Level (dBuV/m) has been corrected by factor.

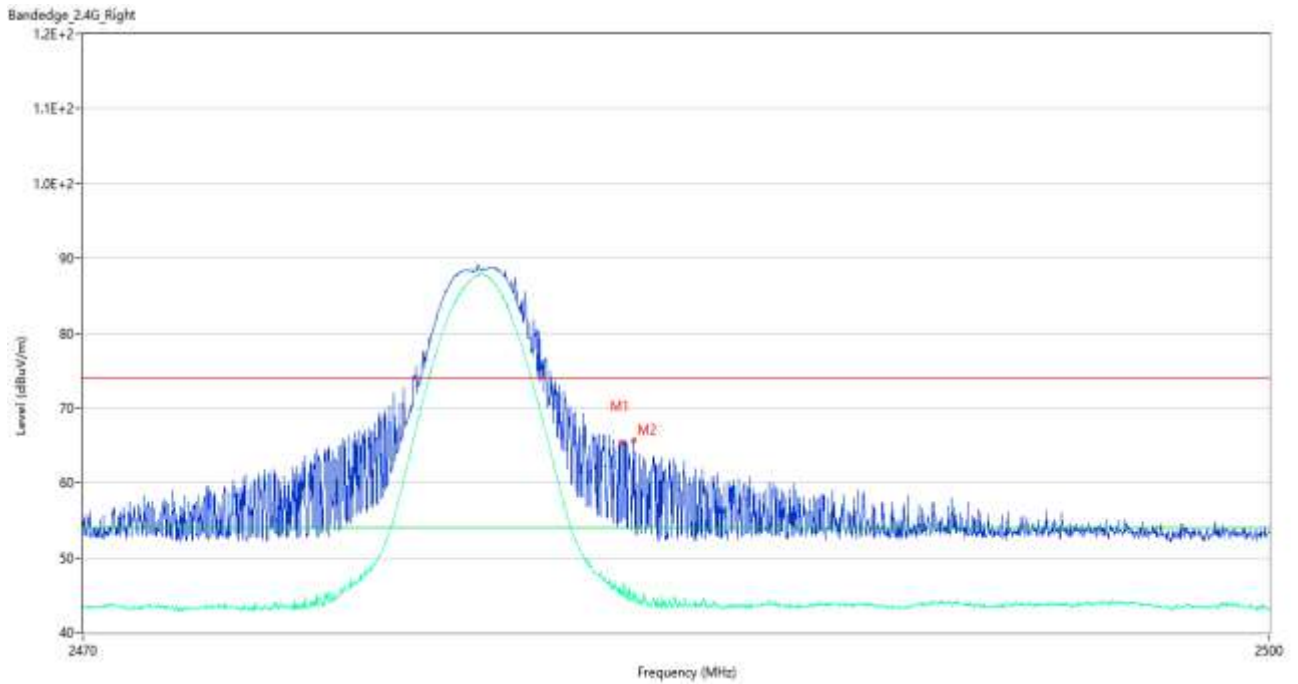
Test Data and Plots

GFSK LOW CHANNEL



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2387.500	55.95	-1.77	74.0	18.05	Peak	302.00	150	Horizontal	Pass
1**	2387.500	42.97	-1.77	54.0	11.03	AV	302.00	150	Horizontal	Pass
2	2389.950	52.51	-1.82	74.0	21.49	Peak	83.00	150	Horizontal	Pass
2**	2389.950	42.81	-1.82	54.0	11.19	AV	83.00	150	Horizontal	Pass

GFSK HIGH CHANNEL



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2483.545	65.32	-1.09	74.0	8.68	Peak	61.00	150	Horizontal	Pass
1**	2483.545	45.32	-1.09	54.0	8.68	AV	61.00	150	Horizontal	Pass
2	2483.875	65.56	-1.03	74.0	8.44	Peak	83.00	150	Horizontal	Pass
2**	2483.875	44.37	-1.03	54.0	9.63	AV	83.00	150	Horizontal	Pass

ANNEX B TEST SETUP PHOTOS

Please refer the document “BL-SZ2430686-AR.PDF”.

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document “BL-SZ2430686-AW.PDF”.

ANNEX D EUT INTERNAL PHOTOS

Please refer the document “BL-SZ2430686-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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