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检测
TESTING
CNAS L6791

TEST REPORT

Applicant:	Ugreen Group Limited
Address:	Ugreen Building, Longcheng Industrial Park, Longguanxi Road, Longhua, ShenZhen, China
Equipment Type:	2.4G Wireless Mouse
Model Name:	MU105 (refer section 2.4)
Brand Name:	UGREEN
FCC ID:	2AQI5-MU105
Test Standard:	47 CFR Part 15 Subpart C (refer section 3.1)
Sample Arrival Date:	Jan. 06, 2023
Test Date:	Jan. 09, 2023 - Mar. 03, 2023
Date of Issue:	Mar. 07, 2023

ISSUED BY:

Shenzhen BALUN Technology Co., Ltd.

Tested by: Julie Zhu **Checked by:** Ye Hongji **Approved by:** Wei Yanquan (Chief Engineer)

Revision History

Version	Issue Date	Revisions
Rev. 01	Mar. 07, 2023	Initial Issue

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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	Ugreen Group Limited
Address	Ugreen Building, Longcheng Industrial Park, Longguanxi Road, Longhua, ShenZhen, China

2.2 Manufacturer Information

Manufacturer	Ugreen Group Limited
Address	Ugreen Building, Longcheng Industrial Park, Longguanxi Road, Longhua, ShenZhen, China

2.3 Factory Information

Factory	Dongguan Mingcan Electronic Technology Co., Ltd.
Address	Floors 1-6, building 1, No. 3 Jiaoping Road, Tangxia Town, Dongguan City, Guangdong Province, P. R. China

2.4 General Description for Equipment under Test (EUT)

EUT Name	2.4G Wireless Mouse
Model Name Under Test	MU105
Series Model Name	90550, 90669, 90671, 90672, 90686, 15255 90550P, 90669P, 90671P, 90672P, 90686P, 15255P 90550P2, 90669P2, 90671P2, 90672P2, 90686P2, 15255P2 90550P3, 90669P3, 90671P3, 90672P3, 90686P3, 15255P3 90550X, 90669X, 90671X, 90672X, 90686X, 15255X 90550A, 90669A, 90671A, 90672A, 90686A, 15255A 90550B, 90669B, 90671B, 90672B, 90686B, 15255B 90550U, 90669U, 90671U, 90672U, 90686U, 15255U 90550JP, 90669JP, 90671JP, 90672JP, 90686JP, 15255JP 90550AU, 90669AU, 90671AU, 90672AU, 90686AU, 15255AU 90550EU, 90669EU, 90671EU, 90672EU, 90686EU, 15255EU 90550US, 90669US, 90671US, 90672US, 90686US, 15255US 90550UK, 90669UK, 90671UK, 90672UK, 90686UK, 15255UK 90550SG, 90669SG, 90671SG, 90672SG, 90686SG, 15255SG
Description of Model name differentiation	All models are same with electrical parameters and internal circuit structure, but only differ in model name. (this information provided by the customer)
Hardware Version	A1
Software Version	0004-X8
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.5 Technical Information

Network and Wireless connectivity	2.4G ISM Band

The requirement for the following technical information of the EUT was tested in this report:

Modulation Technology	FHSS
Modulation Type	GFSK
Product Type	☐ Mobile ☒ Portable ☐ Fix Location
Transfer Rate	1 Mbps
Frequency Range	The frequency range used is 2402 MHz – 2480 MHz; The frequency block is 2400 MHz to 2483.5 MHz.
Number of Channel	40
Tested Channel	Low channel (2402 MHz), Middle channel(2440 MHz), High channel (2480 MHz)
Antenna Type	PCB Antenna
Antenna Gain	-1.78 dBi
Adaptive or non-adaptive	Non-Adaptive
The Max RF Output power	-9.83 dBm

Channel List

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

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 1MHz. 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 Verdict

No.	Description	FCC Part No.	Test Result	Verdict
1	Antenna Requirement	15.203	--	Pass Note 1
2	Number of Hopping Frequency	15.247(a)	5.2.4	Pass
3	Peak Output Power	15.247(b)	5.3.4	Pass
4	Occupied Bandwidth	15.247(a)	5.4.4	Pass
5	Hopping Frequency Separation	15.247(a)	5.5.4	Pass
6	Time of Occupancy (Dwell time)	15.247(a)	5.6.4	Pass
7	Conducted Spurious Emission& Authorized-band band-edge	15.247(d)	5.7.4	Pass
8	Conducted Emission	15.207	5.8.4	N/A Note 3
9	Radiated Spurious Emission	15.209 15.247(d)	5.9.4	Pass
10	Band Edge (Restricted-band band-edge)	15.209 15.247(d)	5.10.4	Pass
11	Receiver Spurious Emissions	--	--	N/A Note 2

Note [1]: The EUT has a permanently and irreplaceable attached antenna, which complies with the requirement FCC 15.203.

Note [2]: Only radio communication receivers operating in stand-alone mode within the band 30-960 MHz, as well as scanner receivers, are subject to Industry Canada requirements, so this test is not applicable.

Note [3]: The EUT is powered only by battery, so Conducted Emission is not applicable.

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

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

Relative Humidity	37% to 58%	
Atmospheric Pressure	100 kPa to 102 kPa	
Temperature	NT (Normal Temperature)	18.9℃ to +21.8℃
Working Voltage of the EUT	NV (Normal Voltage)	1.5 V

4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	KEYSIGHT	N9020A	MY46471071	2022.07.26	2023.07.25
Spectrum Analyzer	ROHDE&SCHWARZ	FSV-40	101544	2022.12.28	2023.12.27
Spectrum Analyzer	KEYSIGHT	N9020A	MY52510065	2022.09.06	2023.09.05
Signaling Unit	ROHDE&SCHWARZ	CMW500	171150	2022.06.29	2023.06.28
Test Antenna-Horn (1-18 GHz)	SCHWARZBECK	BBHA 9120D	01631	2022.02.03	2025.02.02
Test Antenna-Horn (18-40 GHz)	A-INFO	LB-180400KF	J211060273	2021.07.02	2024.07.01
Anechoic Chamber	RAINFORD	9m*6m*6m	N/A	2021.09.04	2024.09.03
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2022.09.09	2023.09.08
Test Antenna-Loop (9 kHz-30 MHz)	SCHWARZBECK	FMZB 1519	1519-037	2021.04.16	2024.04.15
Anechoic Chamber	EMC Electronic Co., Ltd	20.10*11.60 *7.35m	N/A	2021.08.15	2024.08.14
EMI Receiver	Agilent	N9038A	MY55330120	2022.09.09	2023.09.08
Amplifier (30-1GHz)	COM-MV	ZT30-1000M	B2017119081	2022.09.09	2023.09.08
Test Antenna-Bi-Log	SCHWARZBECK	VULB 9168	9168-00867	2022.04.12	2025.04.11
Anechoic Chamber	YiHeng	9m*6m*6m	966#2	2022.02.19	2024.08.18
Amplifier (1-12GHz)	COM-MV	LSCX_LNA 1-12G-01	180602	2020.09.08	2023.09.07
Amplifier (7-18GHz)	COM-MV	XKu_LNA7-18G-01	180601	2020.09.08	2023.09.07
Amplifier (18-40GHz)	COM-MV	KA_LNA18-40G-01	18050001	2020.09.08	2023.09.07

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	V19.8.28.435	N/A	The section 4.5.2&4.5.3&4.5.4&4.5.5

4.4 Description of Test Setup

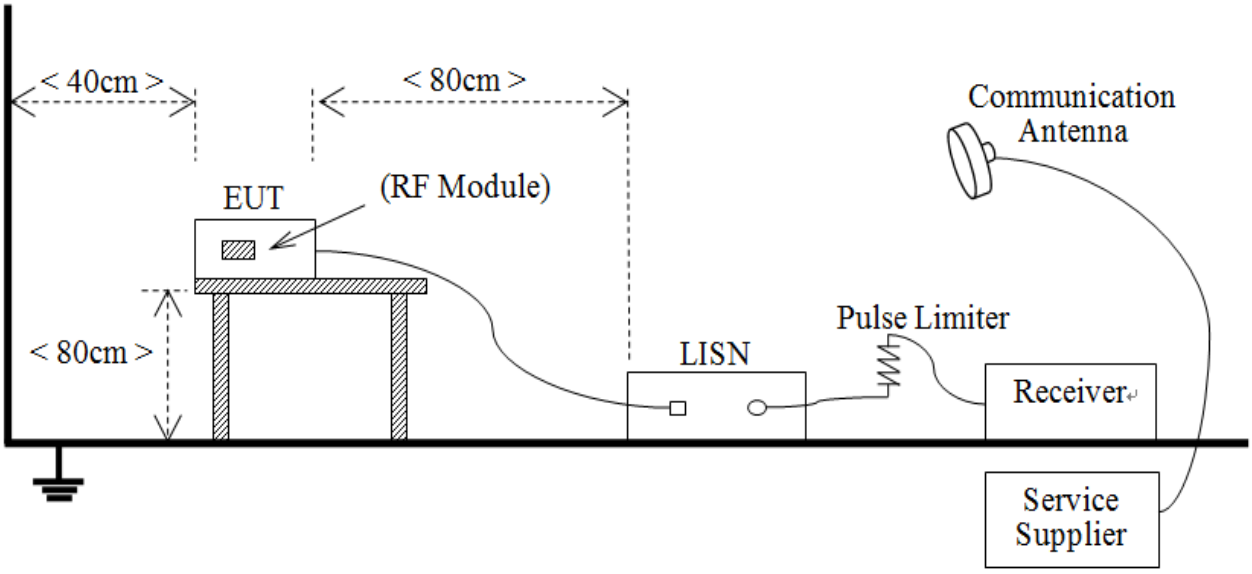
4.4.1 For Antenna Port Test

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

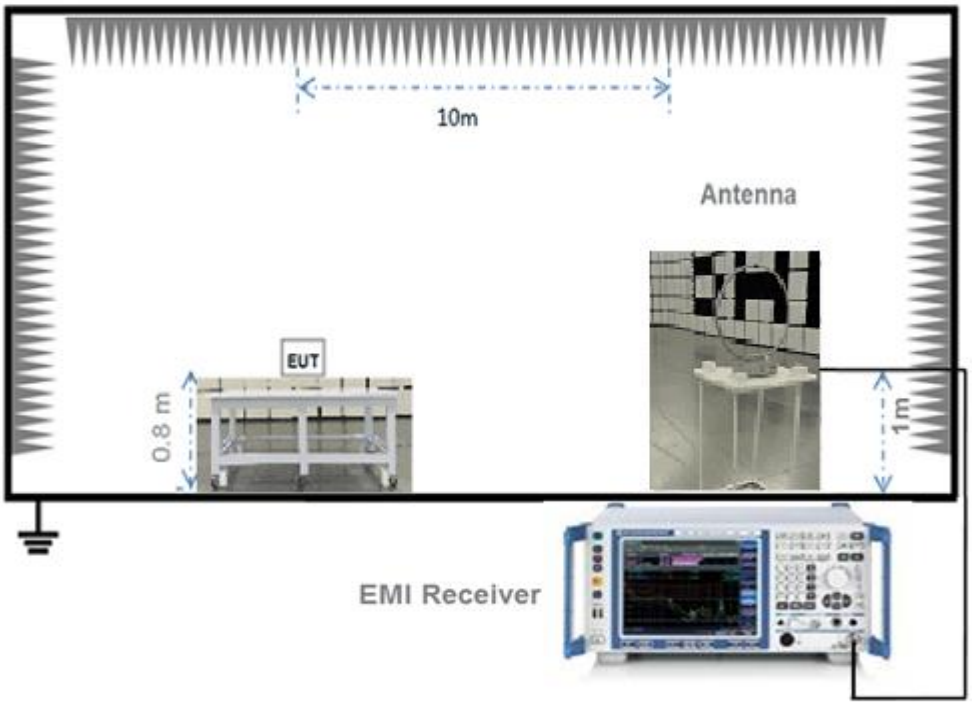
(Diagram 1)

4.4.2 For AC Power Supply Port Test



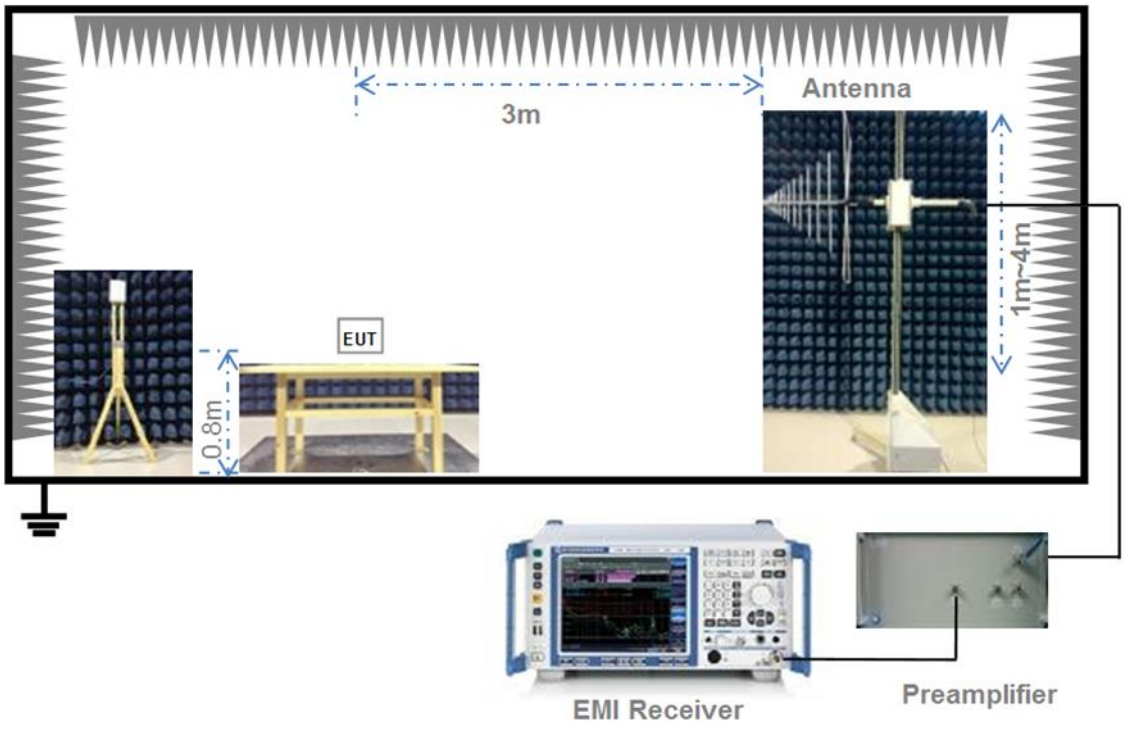
(Diagram 2)

4.4.3 For Radiated Test (Below 30 MHz)



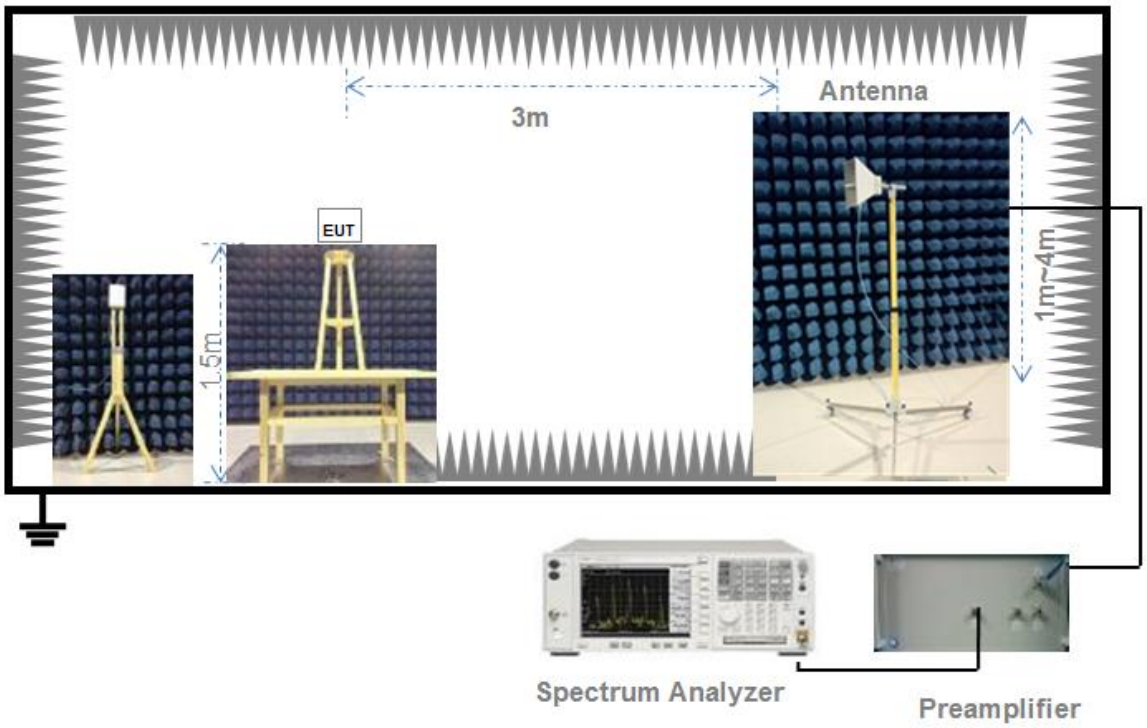
(Diagram 3)

4.4.4 For Radiated Test (30 MHz-1 GHz)



(Diagram 4)

4.4.5 For Radiated Test (Above 1 GHz)



(Diagram 5)

4.5 Measurement Results Explanation Example

4.5.1 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.

4.5.2 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 (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 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 (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.	The antenna is welded on the mainboard, can’t be replaced by the consumer

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 Frequency

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 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

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 ≥ 1% of the span

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

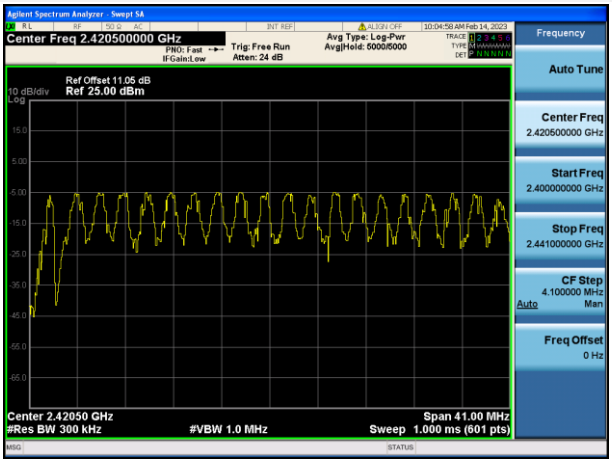
5.2.4 Test Result

Test Data

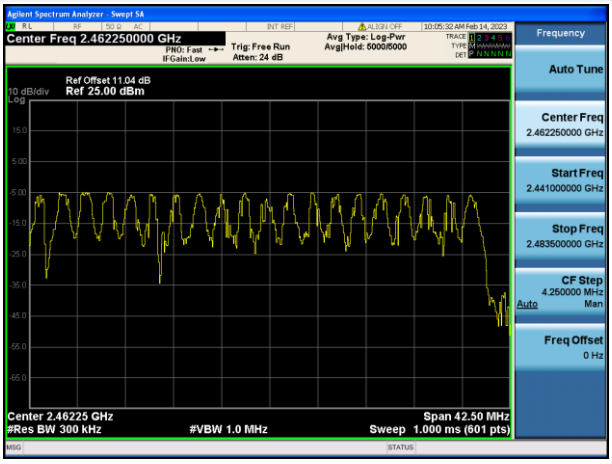
Test Mode	Frequency Block (MHz)	Measured Channel Numbers	Min. Limit	Verdict
GFSK	2400 - 2483.5	40	15	Pass

Test plots

GFSK 2.4 GHz ~ 2.4835 GHz



GFSK 2.4 GHz ~ 2.4835 GHz



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. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

5.3.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.3.3 Test Procedure

The Bluetooth 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 ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize.

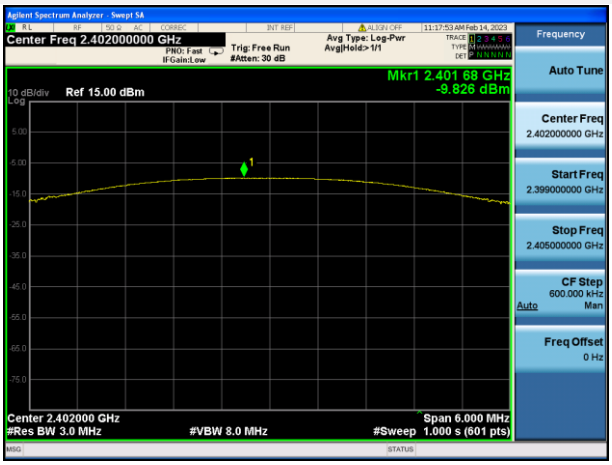
5.3.4 Test Result

Peak Power Test Data

Channel	Measured Output Peak Power		Limit		Verdict
	dBm	mW	dBm	mW	
Low	-9.83	0.10	30	1000	Pass
Middle	-9.84	0.10			Pass
High	-9.88	0.10			Pass

Test plots

GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL

GFSK HIGH CHANNEL

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 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.4.3 Test Procedure

Use the following spectrum analyzer settings:

Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel

RBW ≥ 1% of the 20 dB bandwidth

VBW ≥ 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

Test Data

Test Mode	GFSK	
Channel	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low Channel	1.870000	1.841200
Middle Channel	1.870000	1.876500
High Channel	1.910000	1.911900

Test plots

20 dB Bandwidth

GFSK LOW CHANNEL

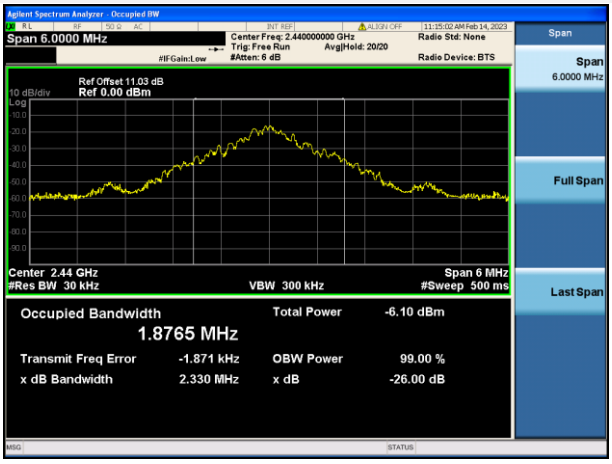
GFSK MIDDLE CHANNEL

GFSK HIGH CHANNEL

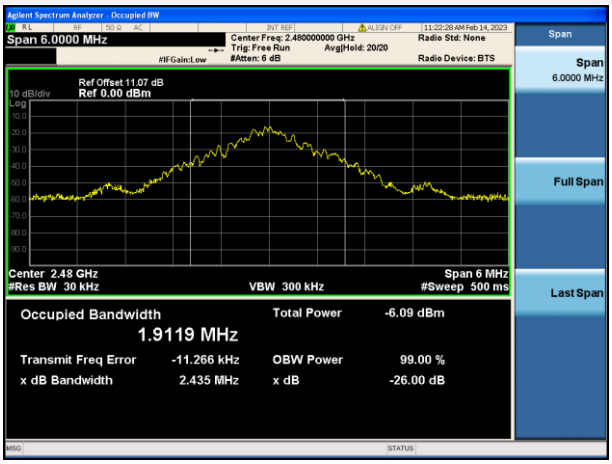
99% Bandwidth

GFSK LOW CHANNEL

GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL



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.

5.5.2 Test Setup

See section 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.5.3 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) ≥ 1% of the span

Video (or Average) Bandwidth (VBW) ≥ 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.

5.5.4 Test Result

Test Data

Mode	Frequency separation (MHz)	Frequency separation (MHz)	2/3 of the 20 dB Bandwidth (MHz)	Verdict
GFSK	2440	1.910	1.273	Pass

Test Plots

GFSK

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 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

5.6.3 Test Procedure

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

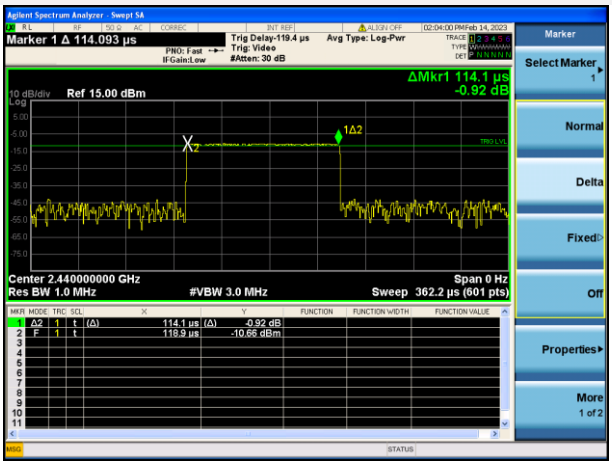
5.6.4 Test Result

Test Data

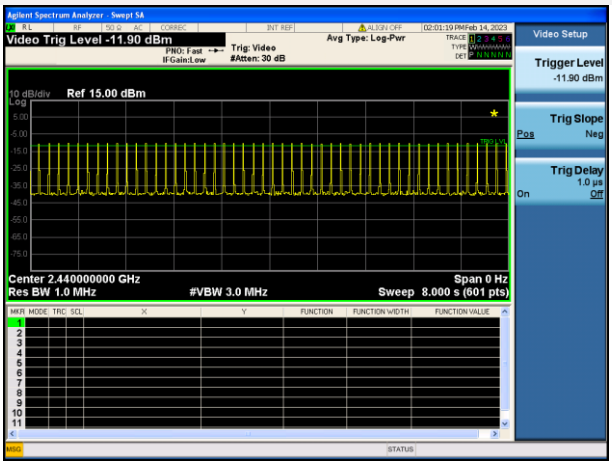
GFSK			
Pulse Width (ms)	Total of Dwell (ms)	Limit (sec)	Verdict
0.114	11.410	0.4	Pass

Test Plots

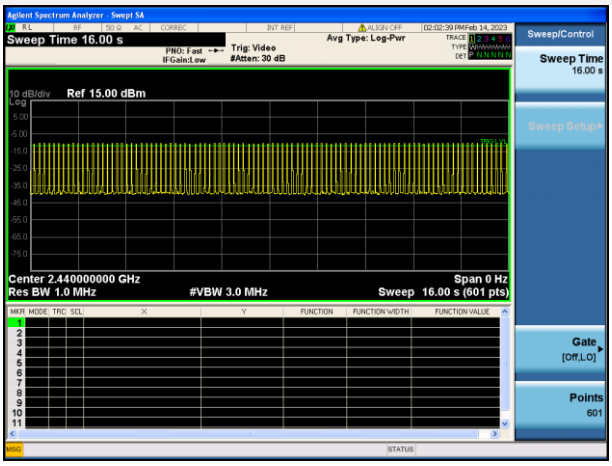
Pulse Time



8s



16s



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 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

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 ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Allow the trace to stabilize

5.7.4 Test Result

Test Data

GFSK Mode:

GFSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-38.88	-12.15	-32.15	Pass
Middle	-42.77	-12.28	-32.28	Pass
High	-42.46	-12.32	-32.32	Pass

Hopping Mode:

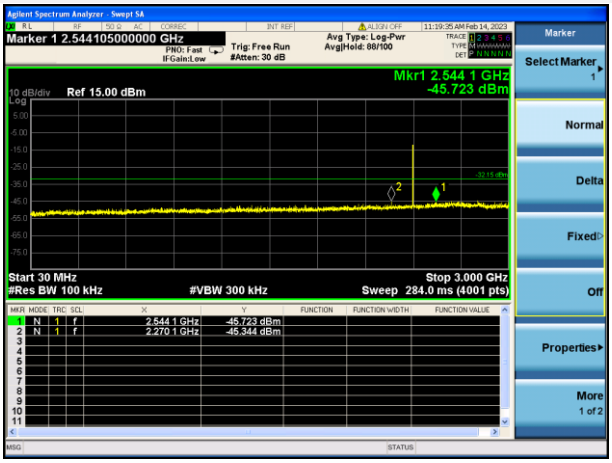
GFSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
GFSK	-47.05	-11.04	-31.04	Pass

Test Plots

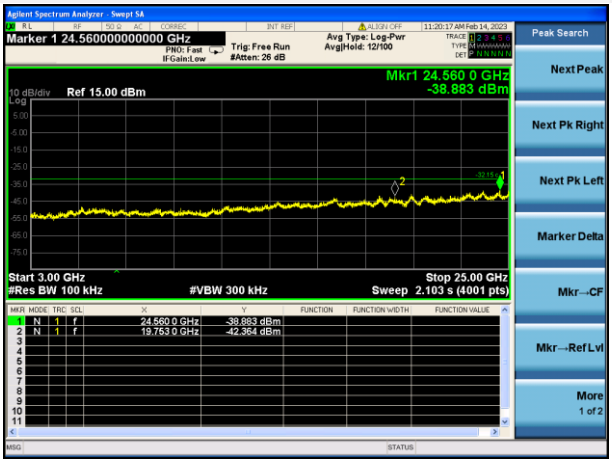
GFSK LOW CHANNEL, CARRIER LEVEL

GFSK LOW CHANNEL, BAND EDGE

GFSK LOW CHANNEL, SPURIOUS 30 MHz ~ 3 GHz

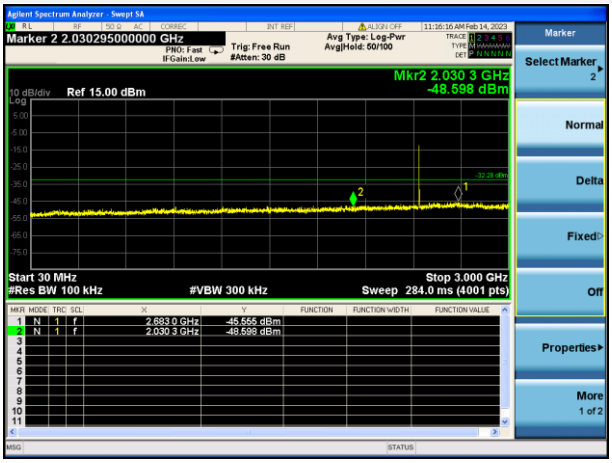


GFSK LOW CHANNEL, SPURIOUS 3 GHz ~ 25 GHz

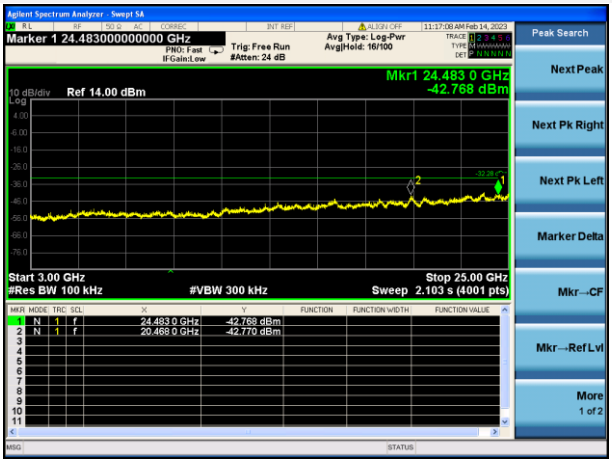


GFSK MIDDLE CHANNEL, CARRIER LEVEL

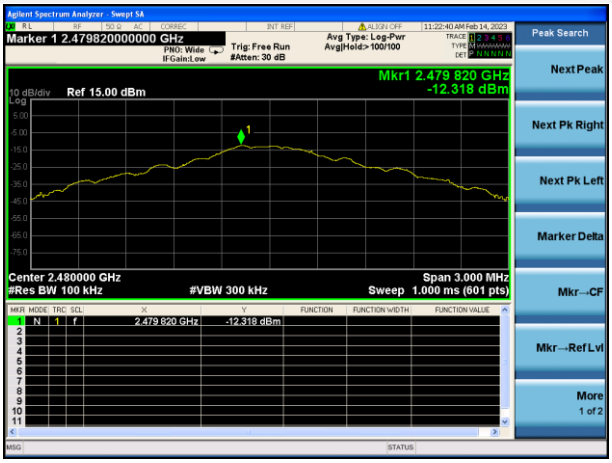
GFSK MIDDLE CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



GFSK MIDDLE CHANNEL, SPURIOUS 3 GHz ~ 25 GHz

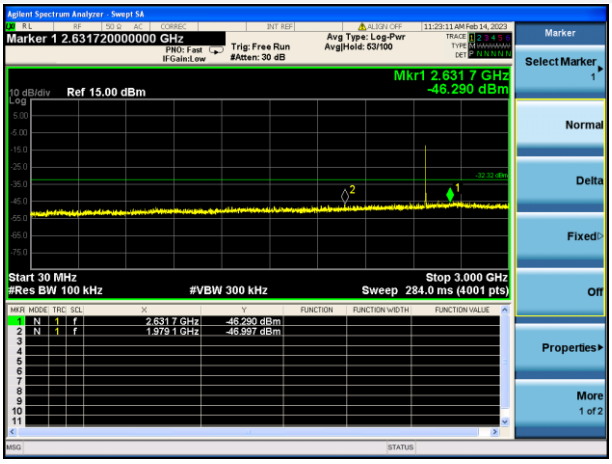


GFSK HIGH CHANNEL, CARRIER LEVEL

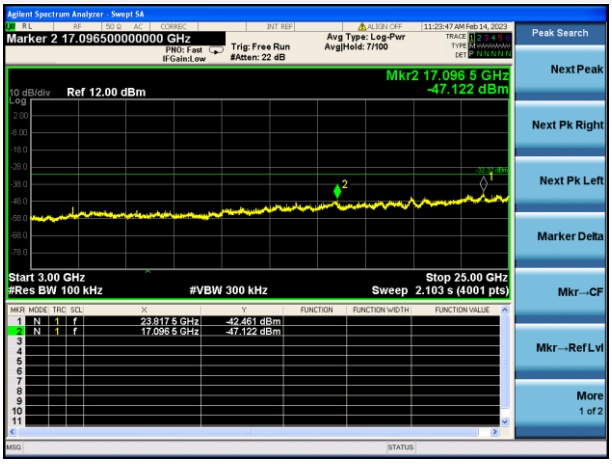


GFSK HIGH CHANNEL, BAND EDGE

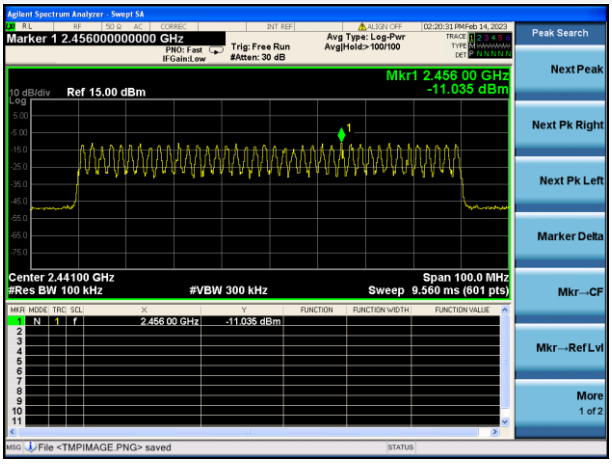
GFSK HIGH CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



GFSK HIGH CHANNEL, SPURIOUS 3 GHz ~ 25 GHz



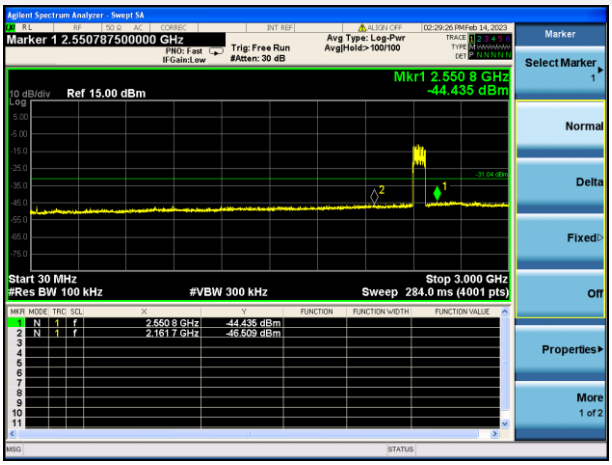
GFSK HOPPING, CARRIER LEVEL



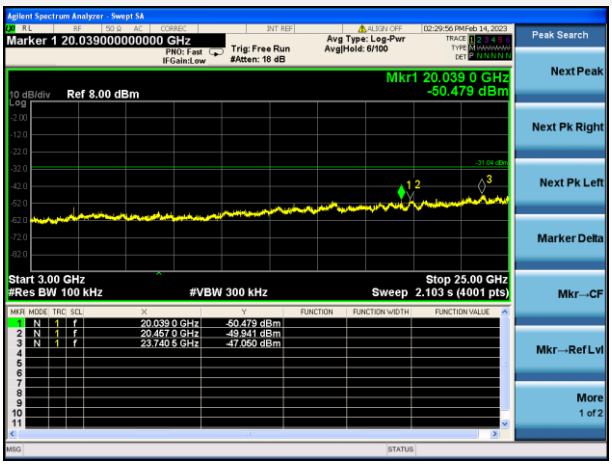
GFSK HOPPING BAND EDGE (LOW)

GFSK HOPPING BAND EDGE (HIGH)

GFSK Hopping Mode, SPURIOUS
30 MHz ~ 3 GHz



GFSK Hopping Mode, SPURIOUS
3GHz ~ 25 GHz



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 50μH/50Ω line impedance stabilization network (LISN).

Frequency range (MHz)	Conducted Limit (dBμV)	
	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 4.4.2 for test setup description for the AC power supply port. The photo of test setup please refer to ANNEX A.

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

Note: Not applicable.

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 (μV/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 (dBμV/m) = 20*log[Field Strength (μV/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 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

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 ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ 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

Test Data and Plots

Note [1]: The symbol of "--" in the table which means not application.

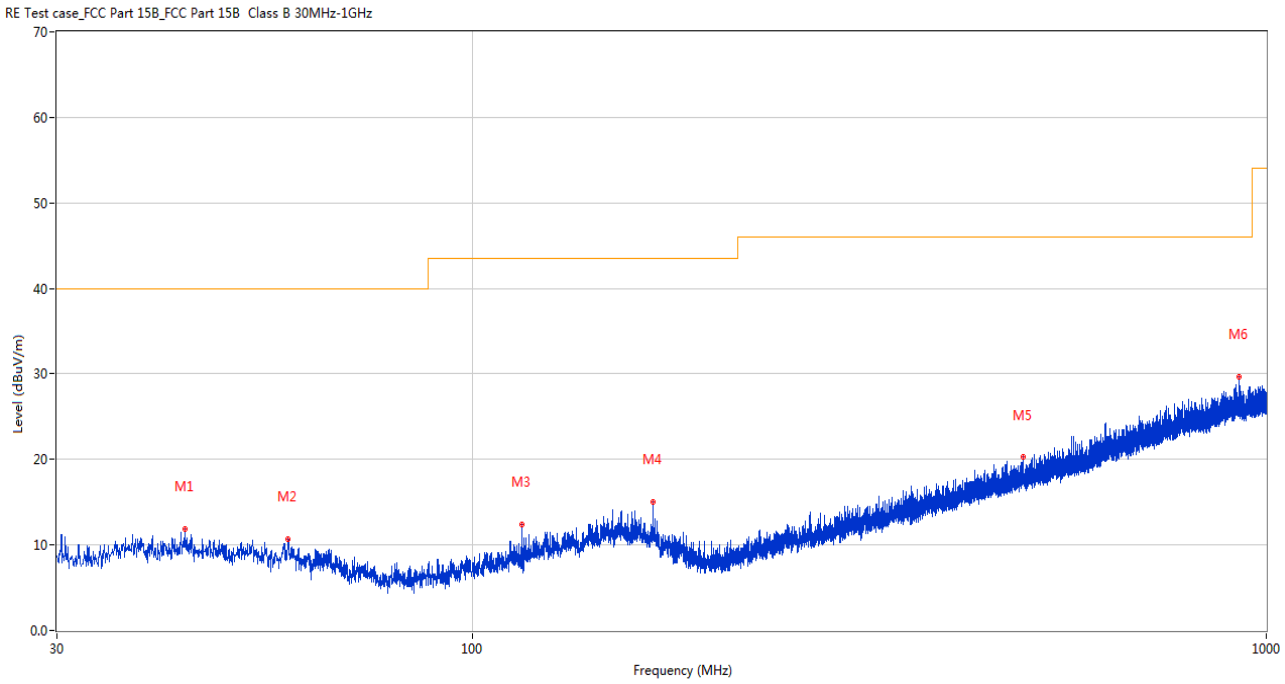
Note [2]: For the test data above 1 GHz, according the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

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)

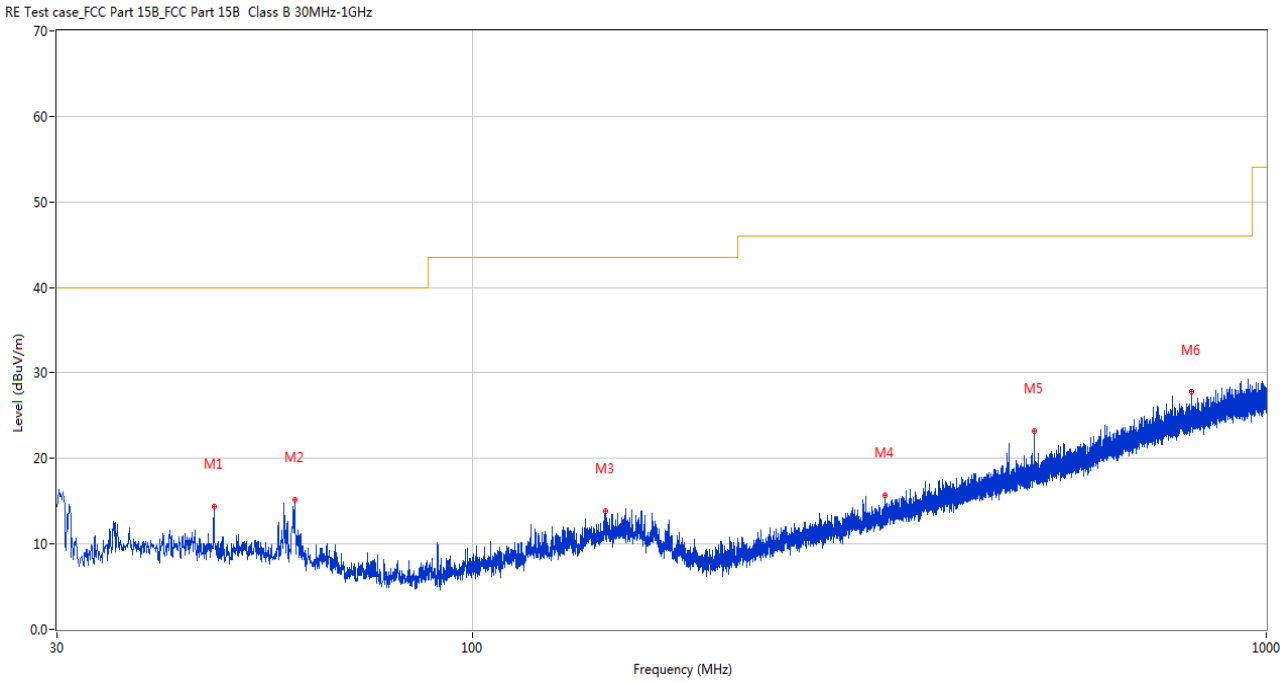
The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

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	43.434	11.86	-26.57	40.0	28.14	Peak	295.00	200	Horizontal	Pass
2	58.663	10.63	-27.29	40.0	29.37	Peak	24.00	200	Horizontal	Pass
3	115.409	12.41	-27.85	43.5	31.09	Peak	1.00	200	Horizontal	Pass
4	168.904	14.99	-25.34	43.5	28.51	Peak	307.00	100	Horizontal	Pass
5	493.612	20.24	-18.78	46.0	25.76	Peak	79.00	200	Horizontal	Pass
6	924.873	29.66	-10.74	46.0	16.34	Peak	360.00	200	Horizontal	Pass

30 MHz to 1 GHz, ANT V



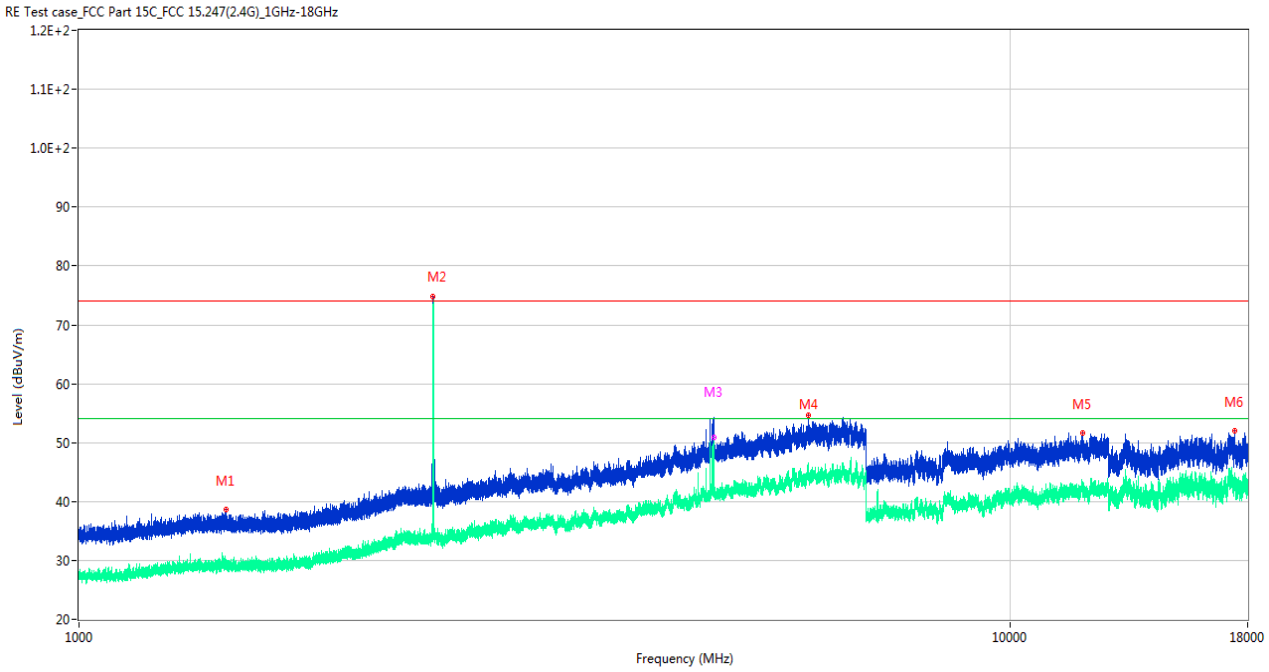
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	47.315	14.43	-26.54	40.0	25.57	Peak	105.00	100	Vertical	Pass
2	59.828	15.12	-27.59	40.0	24.88	Peak	348.00	100	Vertical	Pass
3	147.467	13.87	-24.94	43.5	29.63	Peak	266.00	100	Vertical	Pass
4	330.894	15.68	-23.40	46.0	30.32	Peak	194.00	200	Vertical	Pass
5	510.490	23.22	-18.55	46.0	22.78	Peak	352.00	100	Vertical	Pass
6	804.545	27.76	-12.67	46.0	18.24	Peak	69.00	200	Vertical	Pass

Test Data and Plots (1 GHz ~ 10th Harmonic)

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

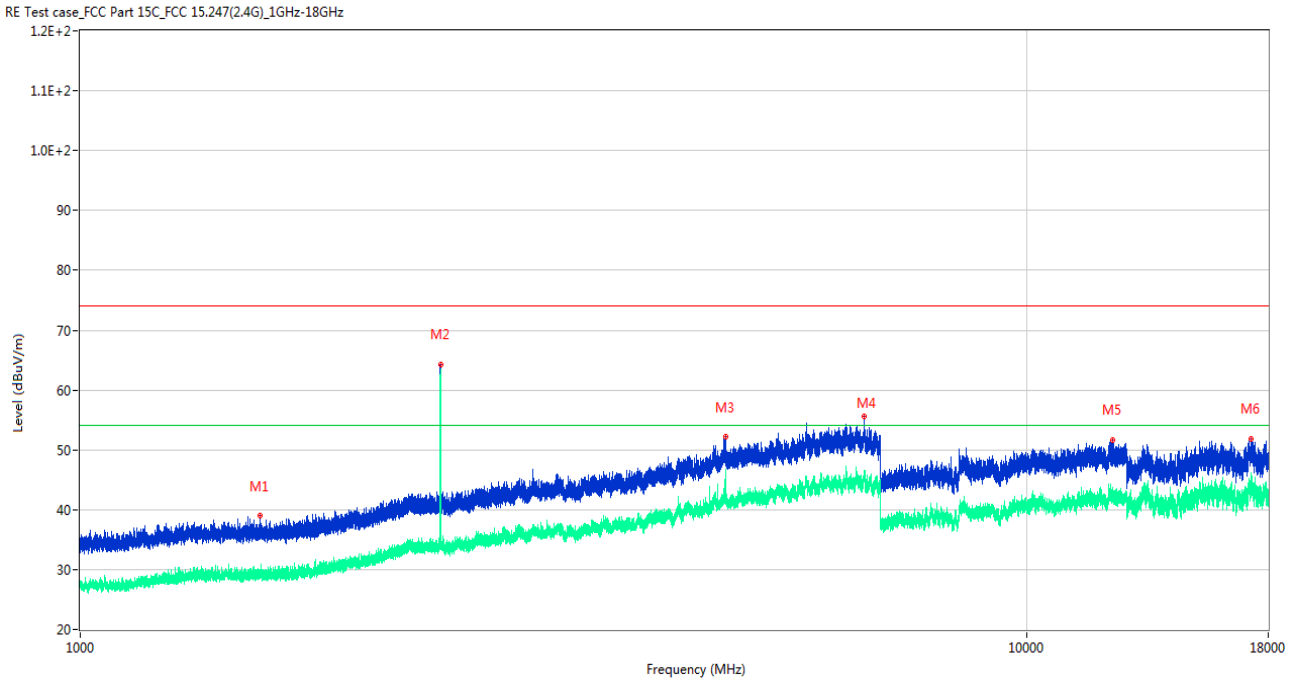
Note 2: The spurious from 18GHz-25GHz is noise only, do not show on the report.

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT H



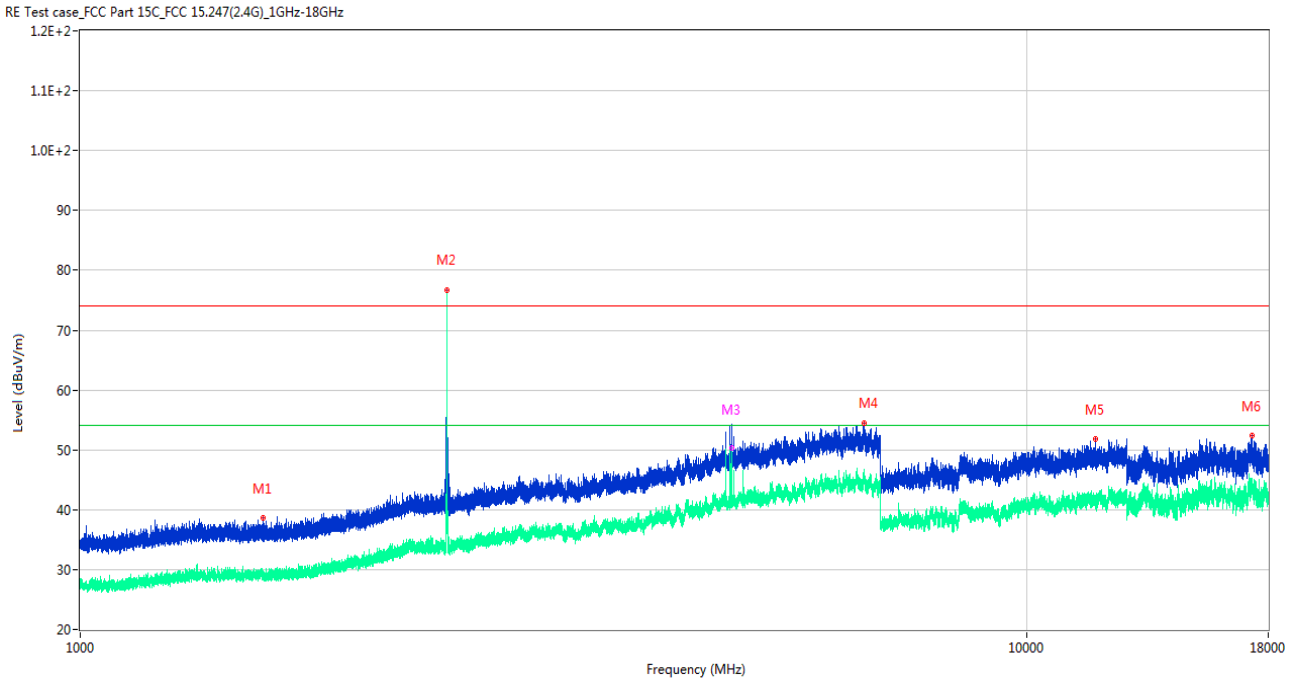
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1438.300	38.58	-16.97	74.0	35.42	Peak	360.00	200	Horizontal	Pass
1**	1438.300	28.63	-16.97	54.0	25.37	AV	360.00	200	Horizontal	Pass
2	2401.700	74.82	-11.74	74.0	-0.82	Peak	110.00	150	Horizontal	N/A
2**	2401.700	73.29	-11.74	54.0	-19.29	AV	110.00	150	Horizontal	N/A
3	4804.400	53.64	-2.08	74.0	20.36	Peak	330.00	100	Horizontal	Pass
3**	4804.400	50.88	-2.08	54.0	3.12	AV	330.00	100	Horizontal	Pass
4	6068.600	54.64	0.19	74.0	19.36	Peak	19.00	200	Horizontal	Pass
4**	6068.600	45.12	0.19	54.0	8.88	AV	19.00	200	Horizontal	Pass
5	11964.550	51.59	0.86	74.0	22.41	Peak	235.00	200	Horizontal	Pass
5**	11964.550	42.88	0.86	54.0	11.12	AV	235.00	200	Horizontal	Pass
6	17425.388	51.98	3.61	74.0	22.02	Peak	143.00	300	Horizontal	Pass
6**	17425.388	44.54	3.61	54.0	9.46	AV	143.00	300	Horizontal	Pass

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT V



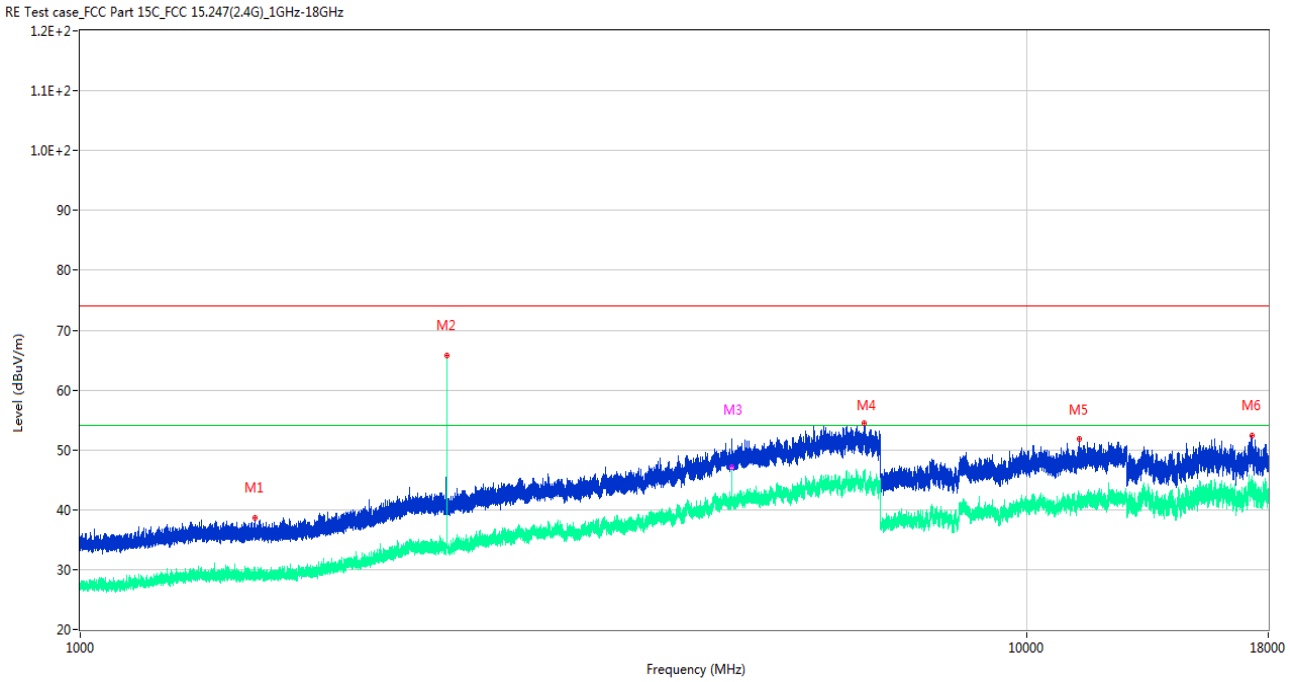
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1548.200	38.99	-17.17	74.0	35.01	Peak	176.00	100	Vertical	Pass
1**	1548.200	29.00	-17.17	54.0	25.00	AV	176.00	100	Vertical	Pass
2	2402.300	64.26	-11.74	74.0	9.74	Peak	12.00	150	Vertical	N/A
2**	2402.300	63.08	-11.74	54.0	-9.08	AV	12.00	150	Vertical	N/A
3	4804.600	52.19	-2.10	74.0	21.81	Peak	88.00	150	Vertical	Pass
3**	4804.600	46.18	-2.10	54.0	7.82	AV	88.00	150	Vertical	Pass
4	6736.800	55.58	2.40	74.0	18.42	Peak	191.00	300	Vertical	Pass
4**	6736.800	45.60	2.40	54.0	8.40	AV	191.00	300	Vertical	Pass
5	12331.112	51.73	1.40	74.0	22.27	Peak	251.00	100	Vertical	Pass
5**	12331.112	42.51	1.40	54.0	11.49	AV	251.00	100	Vertical	Pass
6	17252.661	51.86	1.55	74.0	22.14	Peak	274.00	300	Vertical	Pass
6**	17252.661	43.41	1.55	54.0	10.59	AV	274.00	300	Vertical	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H



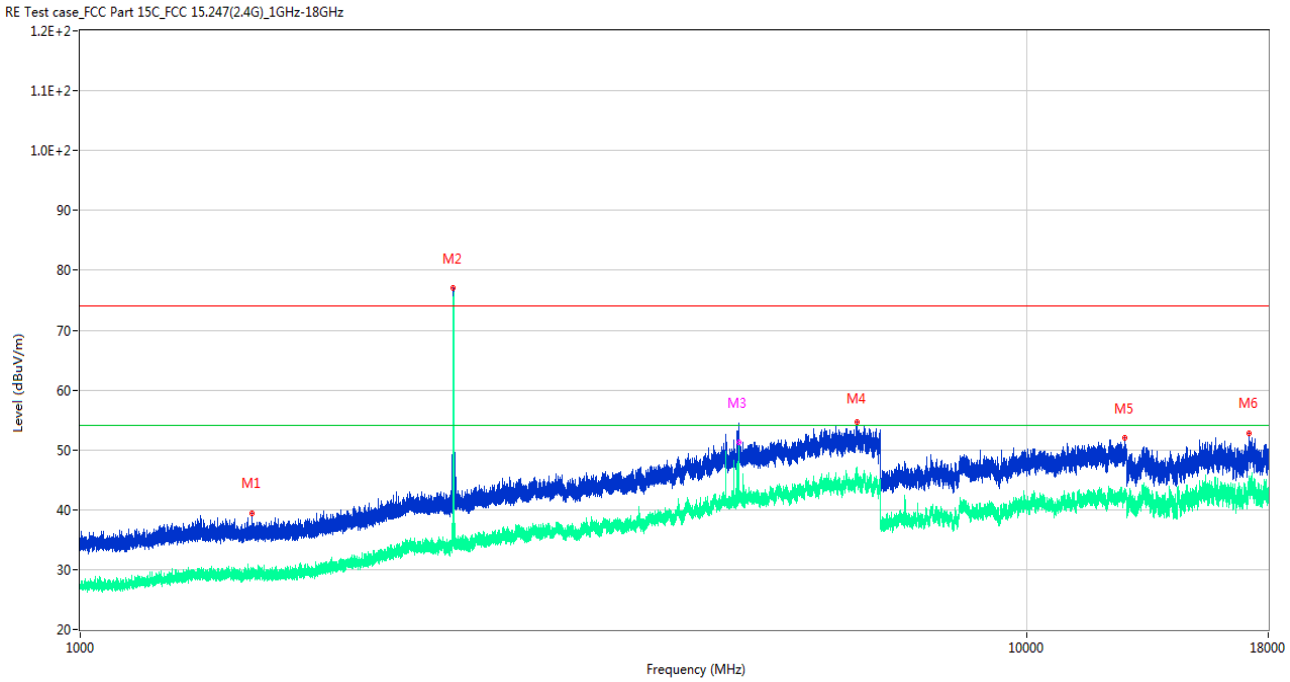
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1560.600	38.62	-17.36	74.0	35.38	Peak	25.00	100	Horizontal	Pass
1**	1560.600	29.03	-17.36	54.0	24.97	AV	25.00	100	Horizontal	Pass
2	2440.300	76.73	-12.24	74.0	-2.73	Peak	244.00	200	Horizontal	N/A
2**	2440.300	75.75	-12.24	54.0	-21.75	AV	244.00	200	Horizontal	N/A
3	4885.600	50.95	-2.49	74.0	23.05	Peak	0.00	100	Horizontal	Pass
3**	4885.600	50.33	-2.49	54.0	3.67	AV	0.00	100	Horizontal	Pass
4	6741.800	54.46	2.23	74.0	19.54	Peak	92.00	300	Horizontal	Pass
4**	6741.800	46.40	2.23	54.0	7.60	AV	92.00	300	Horizontal	Pass
5	11836.613	51.80	1.14	74.0	22.20	Peak	159.00	400	Horizontal	Pass
5**	11836.613	41.43	1.14	54.0	12.57	AV	159.00	400	Horizontal	Pass
6	17287.838	52.32	1.68	74.0	21.68	Peak	80.00	300	Horizontal	Pass
6**	17287.838	43.76	1.68	54.0	10.24	AV	80.00	300	Horizontal	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V



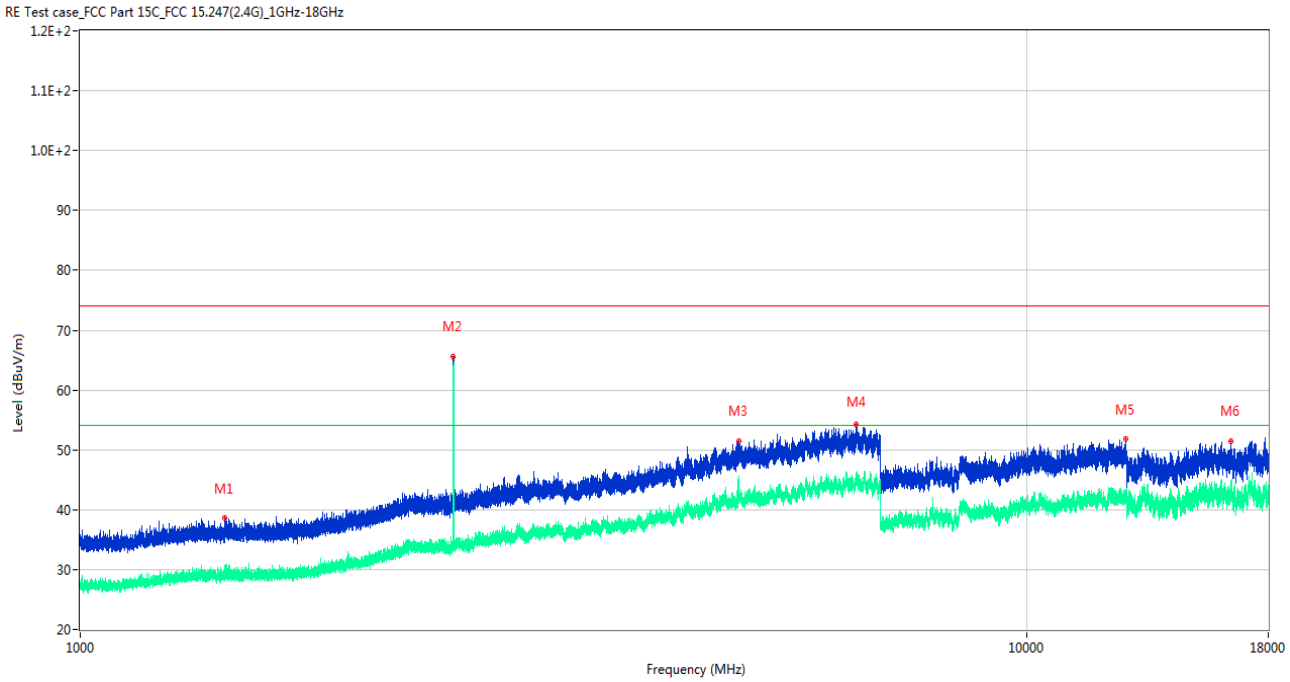
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1529.000	38.69	-17.51	74.0	35.31	Peak	44.00	300	Vertical	Pass
1**	1529.000	29.56	-17.51	54.0	24.44	AV	44.00	300	Vertical	Pass
2	2440.200	65.82	-12.25	74.0	8.18	Peak	150.00	150	Vertical	N/A
2**	2440.200	65.10	-12.25	54.0	-11.10	AV	150.00	150	Vertical	N/A
3	4879.600	51.07	-2.59	74.0	22.93	Peak	214.00	100	Vertical	Pass
3**	4879.600	47.18	-2.59	54.0	6.82	AV	214.00	100	Vertical	Pass
4	6731.800	54.52	1.79	74.0	19.48	Peak	43.00	400	Vertical	Pass
4**	6731.800	45.63	1.79	54.0	8.37	AV	43.00	400	Vertical	Pass
5	11355.912	51.76	-0.17	74.0	22.24	Peak	294.00	400	Vertical	Pass
5**	11355.912	42.23	-0.17	54.0	11.77	AV	294.00	400	Vertical	Pass
6	17298.864	52.44	1.57	74.0	21.56	Peak	25.00	300	Vertical	Pass
6**	17298.864	43.57	1.57	54.0	10.43	AV	25.00	300	Vertical	Pass

GFSK HIGH 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	1517.100	39.44	-17.33	74.0	34.56	Peak	309.00	200	Horizontal	Pass
1**	1517.100	29.56	-17.33	54.0	24.44	AV	309.00	200	Horizontal	Pass
2	2479.700	77.01	-12.21	74.0	-3.01	Peak	245.00	200	Horizontal	N/A
2**	2479.700	75.41	-12.21	54.0	-21.41	AV	245.00	200	Horizontal	N/A
3	4962.200	52.90	-1.87	74.0	21.10	Peak	352.00	100	Horizontal	Pass
3**	4962.200	51.21	-1.87	54.0	2.79	AV	352.00	100	Horizontal	Pass
4	6612.200	54.65	2.16	74.0	19.35	Peak	232.00	300	Horizontal	Pass
4**	6612.200	45.10	2.16	54.0	8.90	AV	232.00	300	Horizontal	Pass
5	12686.463	51.95	0.85	74.0	22.05	Peak	94.00	300	Horizontal	Pass
5**	12686.463	41.81	0.85	54.0	12.19	AV	94.00	300	Horizontal	Pass
6	17178.113	52.82	2.61	74.0	21.18	Peak	158.00	300	Horizontal	Pass
6**	17178.113	43.93	2.61	54.0	10.07	AV	158.00	300	Horizontal	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT V



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1421.600	38.57	-17.40	74.0	35.43	Peak	238.00	100	Vertical	Pass
1**	1421.600	28.52	-17.40	54.0	25.48	AV	238.00	100	Vertical	Pass
2	2479.700	65.57	-12.21	74.0	8.43	Peak	135.00	150	Vertical	N/A
2**	2479.700	63.41	-12.21	54.0	-9.41	AV	135.00	150	Vertical	N/A
3	4960.400	51.53	-2.00	74.0	22.47	Peak	226.00	100	Vertical	Pass
3**	4960.400	45.21	-2.00	54.0	8.79	AV	226.00	100	Vertical	Pass
4	6610.400	54.23	2.07	74.0	19.77	Peak	41.00	400	Vertical	Pass
4**	6610.400	45.56	2.07	54.0	8.44	AV	41.00	400	Vertical	Pass
5	12725.850	51.81	1.26	74.0	22.19	Peak	360.00	100	Vertical	Pass
5**	12725.850	43.12	1.26	54.0	10.88	AV	360.00	100	Vertical	Pass
6	16436.551	51.50	1.06	74.0	22.50	Peak	17.00	200	Vertical	Pass
6**	16436.551	42.65	1.06	54.0	11.35	AV	17.00	200	Vertical	Pass

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 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX A.

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 ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

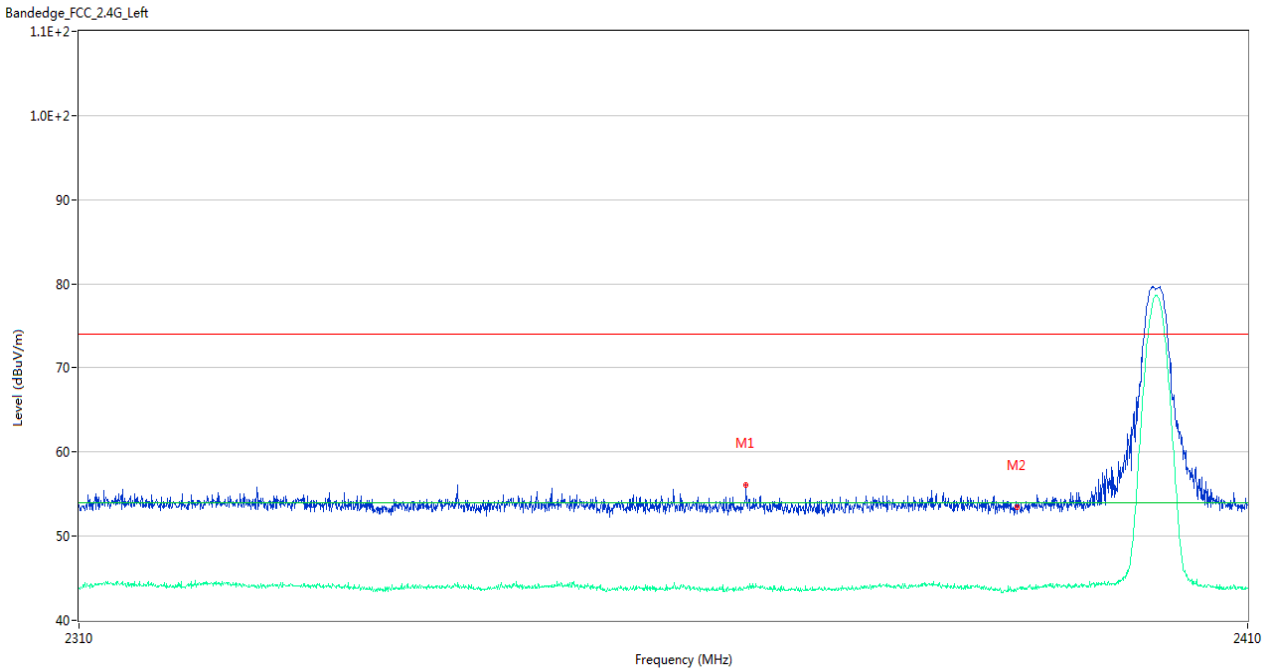
For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported, Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

5.10.4 Test Result

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.

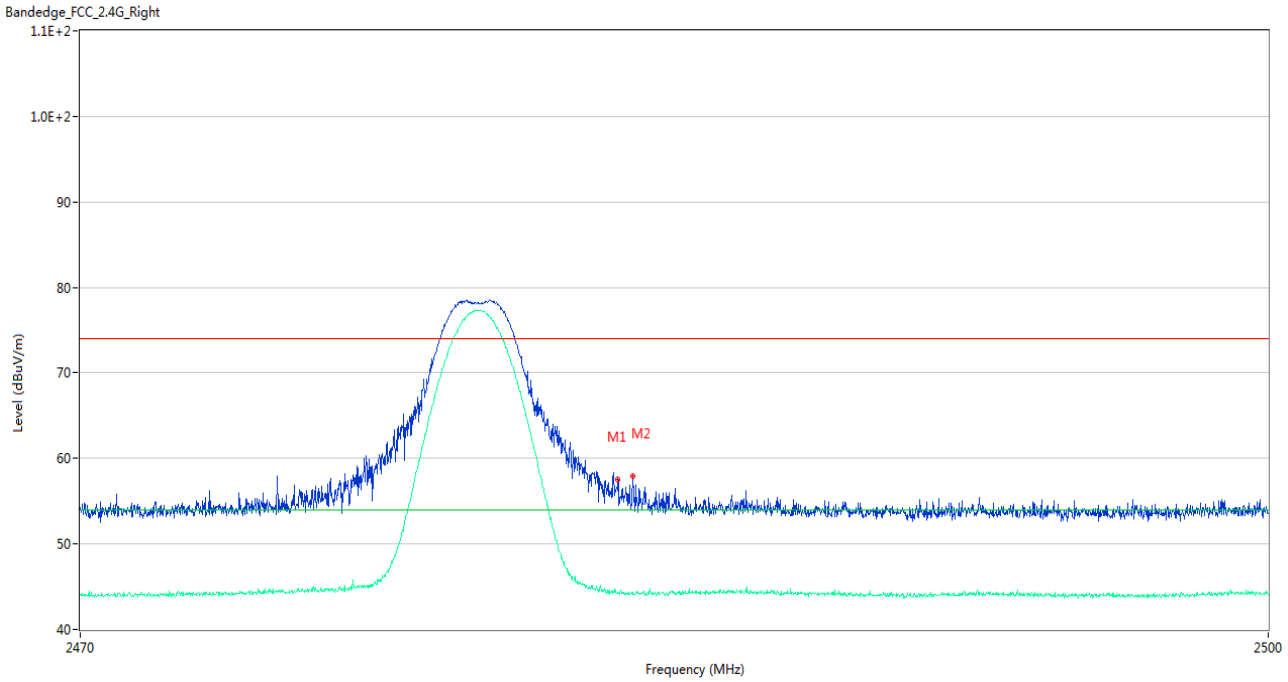
Test Data

GFSK LOW CHANNEL



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2366.550	56.10	-0.48	74.0	17.90	Peak	204.00	150	Horizontal	Pass
1**	2366.550	43.87	-0.48	54.0	10.13	AV	204.00	150	Horizontal	Pass
2	2389.950	53.46	-0.59	74.0	20.54	Peak	150.00	100	Horizontal	Pass
2**	2389.950	43.79	-0.59	54.0	10.21	AV	150.00	100	Horizontal	Pass

GFSK HIGH CHANNEL

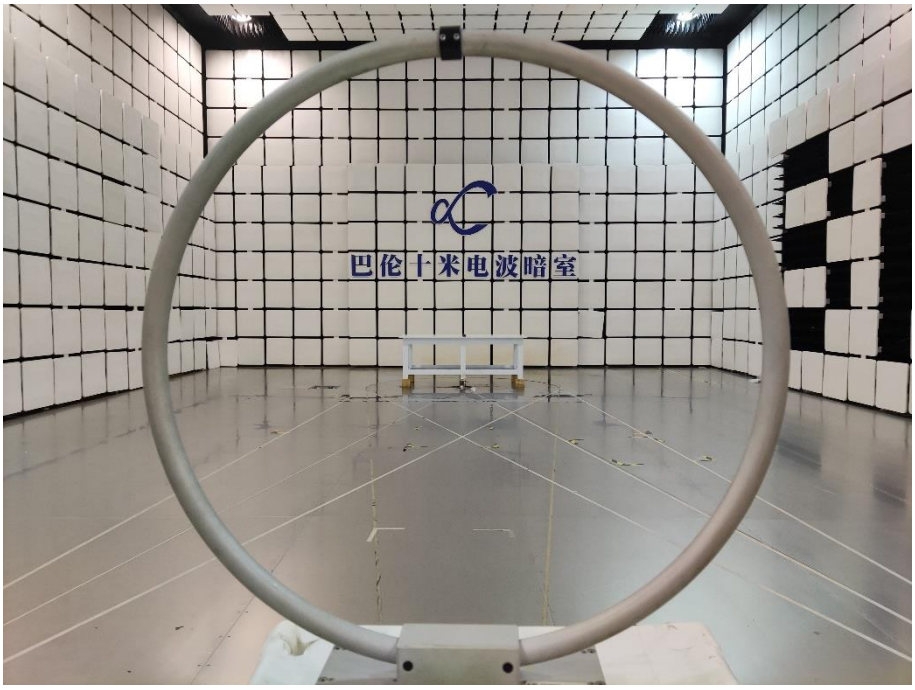


No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2483.530	57.58	-0.20	74.0	16.42	Peak	178.00	150	Horizontal	Pass
1**	2483.530	44.37	-0.20	54.0	9.63	AV	178.00	150	Horizontal	Pass
2	2483.920	57.87	-0.18	74.0	16.13	Peak	178.00	100	Horizontal	Pass
2**	2483.920	44.10	-0.18	54.0	9.90	AV	178.00	100	Horizontal	Pass

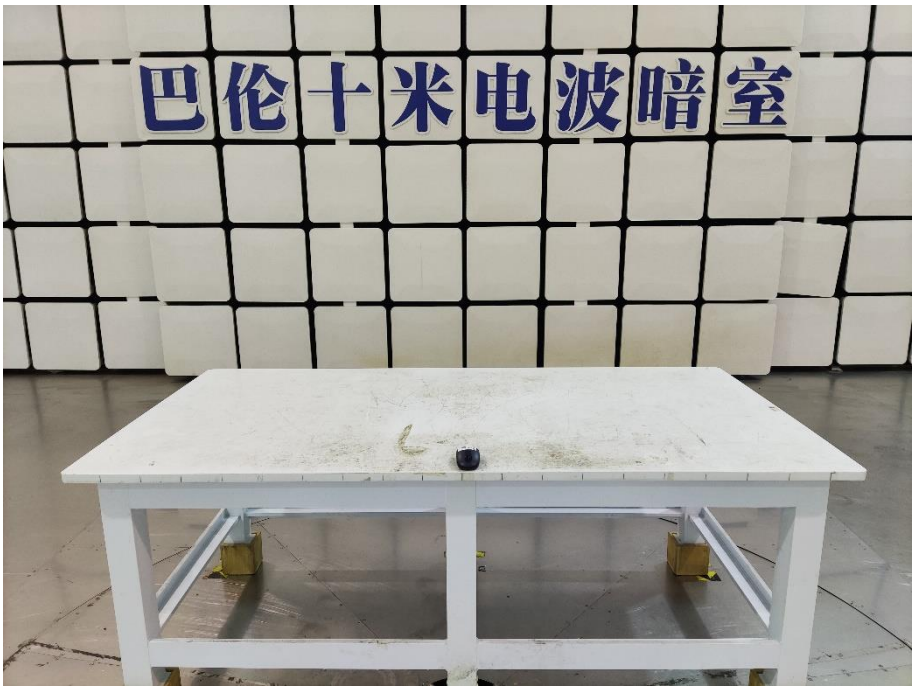
ANNEX A TEST SETUP PHOTOS

1 Radiated Test Photo

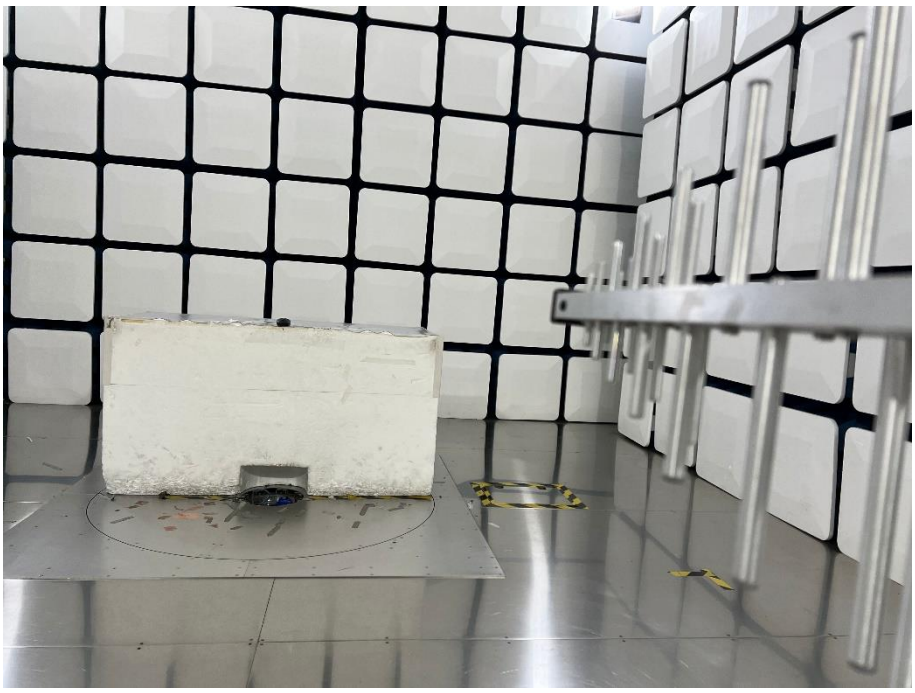
Below 30MHz



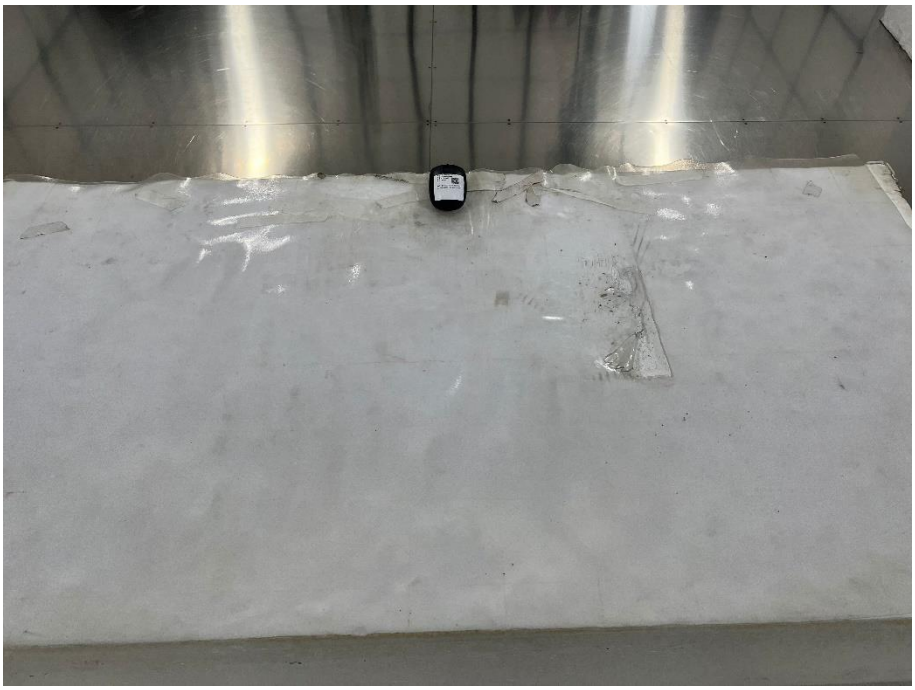
Close-up



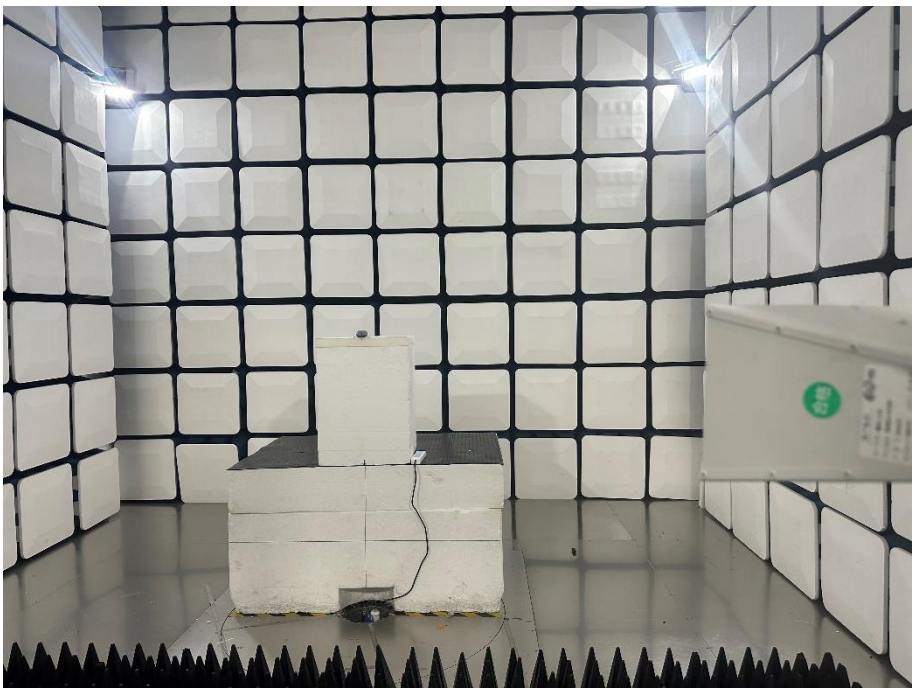
30MHz-1GHz



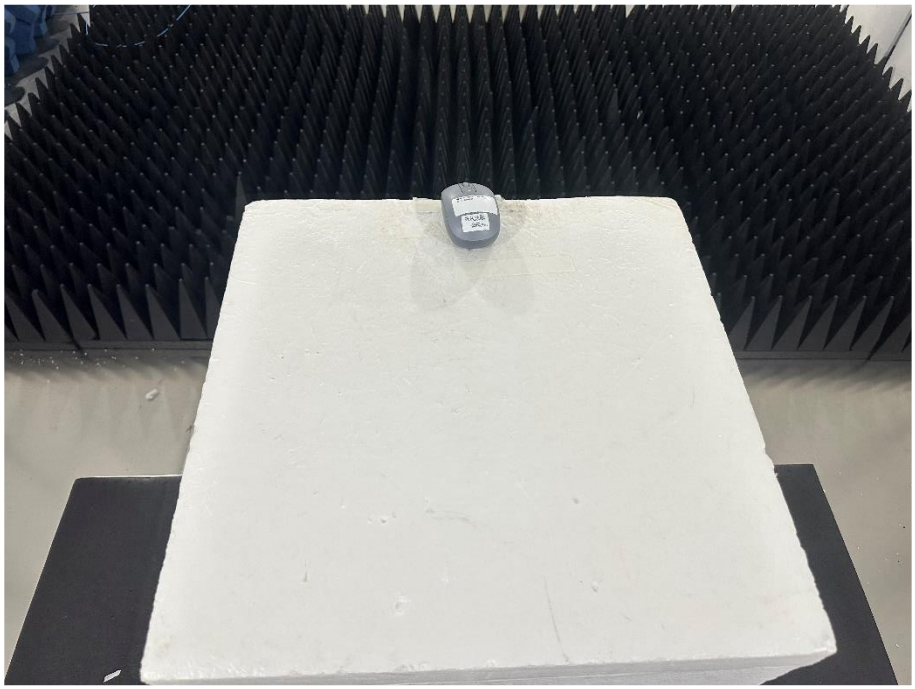
Close-up



Above 1GHz

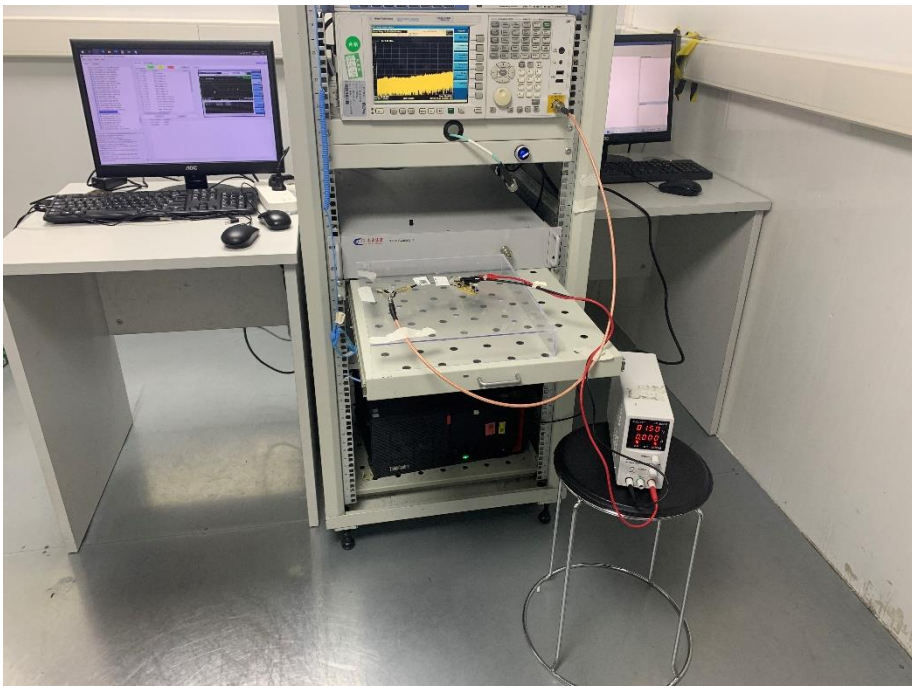


Close-up



2 Conducted Test Photo

Conducted Test-2.4G ISM Band



ANNEX B EUT EXTERNAL PHOTOS

FRONT VIEW OF EUT

REAR VIEW OF EUT

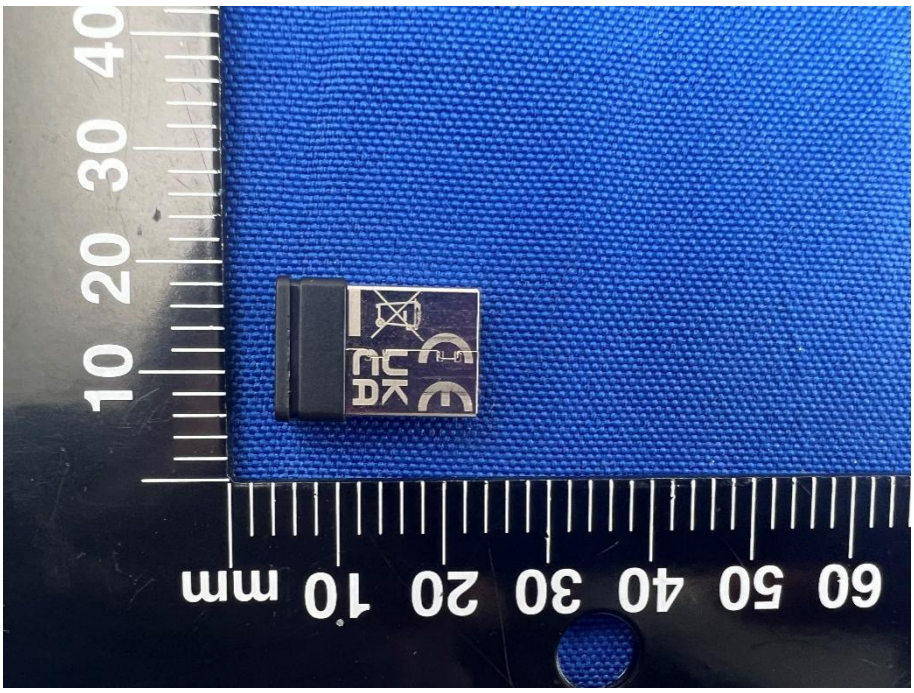
LEFT VIEW OF EUT

RIGHT VIEW OF EUT

TOP VIEW OF EUT

BOTTOM VIEW OF EUT

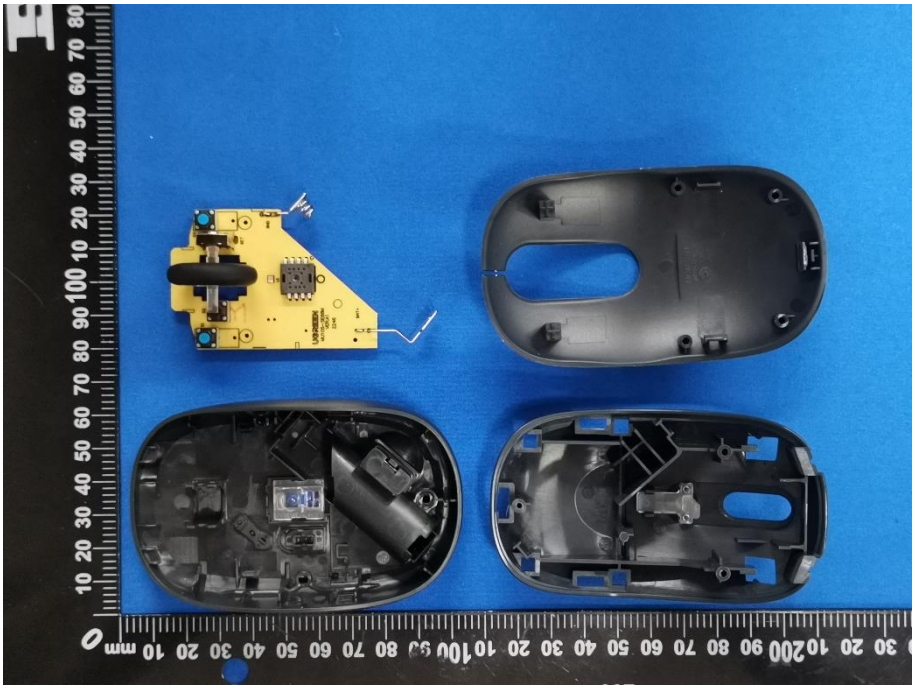
Accessory-Dongle



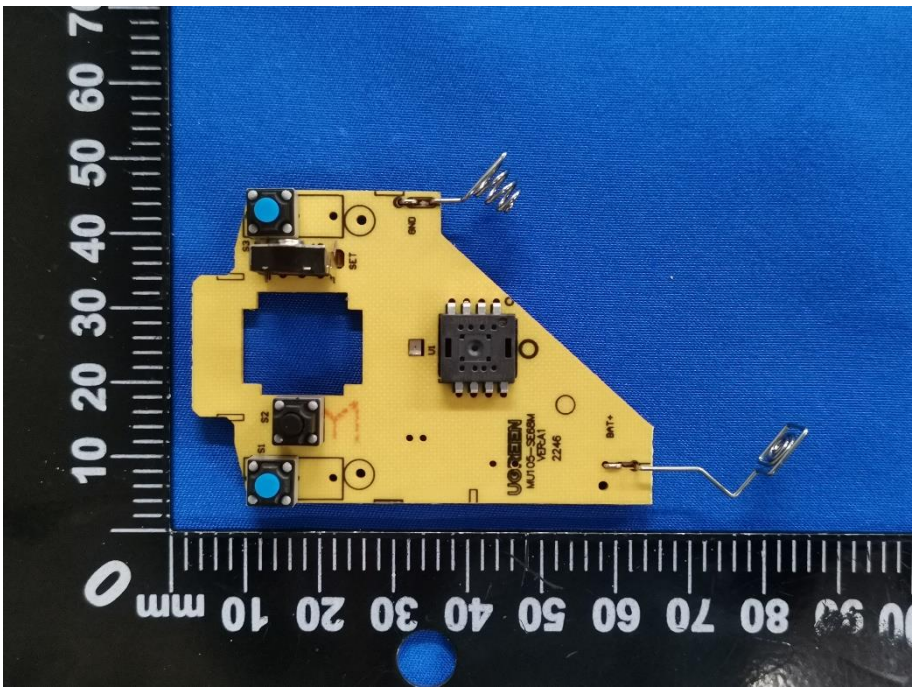
ANNEX C EUT INTERNAL PHOTOS

EUT UNCOVER VIEW 1

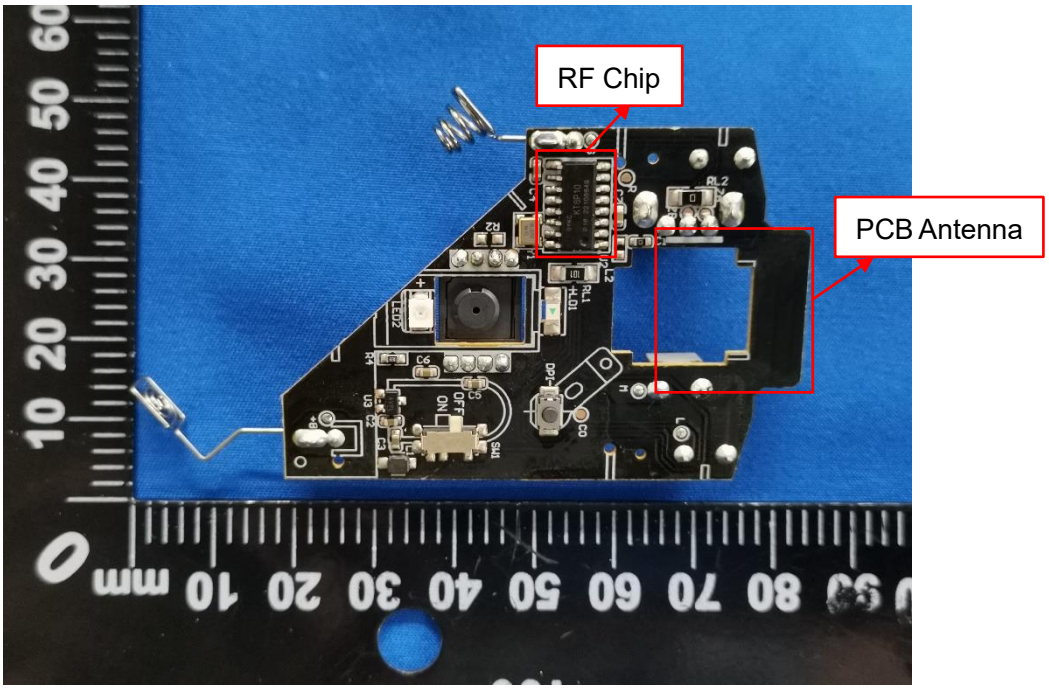
EUT UNCOVER VIEW 2



MAIN BOARD TOP VIEW



MAIN BOARD REAR VIEW



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--END OF REPORT--