TEST REPORT

Applicant:	Shenzhen RuisiMai Electronics Limited
Address:	Room 609, Gangshun Building, Shangxing Village No.4, Xinqiao sub-district, Baoan District, Shenzhen, Guangdong, China
Equipment Type:	2.4G Wireless mouse
Model Name:	GWM-X03B (refer section 2.4)
Brand Name:	N/A
FCC ID:	2A6G2-GWMX03M
Test Standard:	47 CFR Part 15 Subpart C (refer section 3.1)
Test Date:	Apr. 02, 2022 - May 10, 2022
Date of Issue:	May 25, 2022

ISSUED BY:

Shenzhen BALUN Technology Co., Ltd.

Tested by: Julie zhu **Checked by:** Ye Hongji **Approved by:** Liao Jianming (Technical Director)

Revision History

Version	Issue Date	Revisions
Rev. 01	May 25, 2022	Initial Issue

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1 GENERAL INFORMATION

1.1 Identification of the Testing Laboratory

Company Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1/F, Baisha Science and Technology Park, Shahe West Road, Nanshan District, ShenZhen, GuangDong Province, China
Phone Number	+86 755 6685 0100

1.2 Identification of the Responsible Testing Location

Test Location	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1/F, Baisha Science and Technology Park, Shahe West Road, Nanshan District, ShenZhen, GuangDong Province, China
Accreditation Certificate	The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196.
Description	All measurement facilities used to collect the measurement data are located at Block B, 1/F, Baisha Science and Technology Park, Shahe West Road, Nanshan District, ShenZhen, GuangDong Province, China

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	Shenzhen RuisiMai Electronics Limited
Address	Room 609, Gangshun Building, Shangxing Village No.4, Xinqiao sub-district, Baoan District, Shenzhen, Guangdong, China

2.2 Manufacturer Information

Manufacturer	Shenzhen RuisiMai Electronics Limited
Address	Room 609, Gangshun Building, Shangxing Village No.4, Xinqiao sub-district, Baoan District, Shenzhen, Guangdong, China

2.3 Factory Information

Factory	N/A
Address	N/A

2.4 General Description for Equipment under Test (EUT)

EUT Name	2.4G Wireless mouse
Model Name Under Test	GWM-X03B
Series Model Name	GWM-X03W
Description of Model name differentiation	All models are same with electrical parameters and internal circuit structure, but only differ in shell color and model name.
Hardware Version	N/A
Software Version	N/A
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.5 Technical Information

Network and Wireless connectivity	2.4G ISM Band (GFSK modulation)

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	2 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 (at intervals of 2 MHz)
Tested Channel	Low channel (2402 MHz), Middle channel(2440 MHz), High channel (2480 MHz)
Antenna Type	PCB Antenna
Antenna Gain	-1.52 dBi (In test items related to antenna gain, the final results reflect this figure. This value is provided by the applicant.)
Adaptive or non-adaptive	non-adaptive
The Max RF Output power	-12.67 dBm

Channel List

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

Note: 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. But 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	Miscellaneous Wireless Communications Services
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)	ANNEX A.1	Pass
3	Peak Output Power	15.247(b)	ANNEX A.2	Pass
4	Occupied Bandwidth	15.247(a)	ANNEX A.3	Pass
5	Hopping Frequency Separation	15.247(a)	ANNEX A.4	Pass
6	Time of Occupancy (Dwell time)	15.247(a)	ANNEX A.5	Pass
7	Conducted Spurious Emission& Authorized-band band-edge	15.247(d)	ANNEX A.6	Pass
8	Conducted Emission	15.207	ANNEX A.7	N/A Note 3
9	Radiated Spurious Emission	15.209 15.247(d)	ANNEX A.8	Pass
10	Band Edge (Restricted-band band-edge)	15.209 15.247(d)	ANNEX A.9	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]: Not applicable for battery powered EUT.

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

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

Relative Humidity	45% to 55%	
Atmospheric Pressure	100 kPa to 102 kPa	
Temperature	NT (Normal Temperature)	20℃ to +25℃
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	ROHDE&SCHWARZ	FSV-40	101544	2022.01.04	2023.01.03
Spectrum Analyzer	KEYSIGHT	N9020A	MY50330200	2021.06.01	2022.05.31
Signaling Unit	ROHDE&SCHWARZ	CMW500	142028	2021.06.01	2022.05.31
EMI Receiver	KEYSIGHT	N9038A	MY53220118	2021.09.13	2022.09.12
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2021.10.10	2022.10.09
LISN	SCHWARZBECK	NSLK 8127	8127-687	2021.06.08	2022.06.07
Test Antenna-Loop(9 kHz-30 MHz)	SCHWARZBECK	FMZB 1519	1519-037	2021.04.16	2024.04.15
Test Antenna-Bi-Log(30 MHz-3 GHz)	SCHWARZBECK	VULB 9163	9163-624	2021.08.20	2024.08.19
Test Antenna-Horn(1-18 GHz)	SCHWARZBECK	BBHA 9120D	9120D-1917	2019.07.02	2022.07.01
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	2022.02.19	2024.09.03
Anechoic Chamber	EMC Electronic Co., Ltd	20.10*11.60*7.35m	N/A	2021.08.15	2024.08.14
Shielded Enclosure	ChangNing	CN-130701	130703	--	--

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

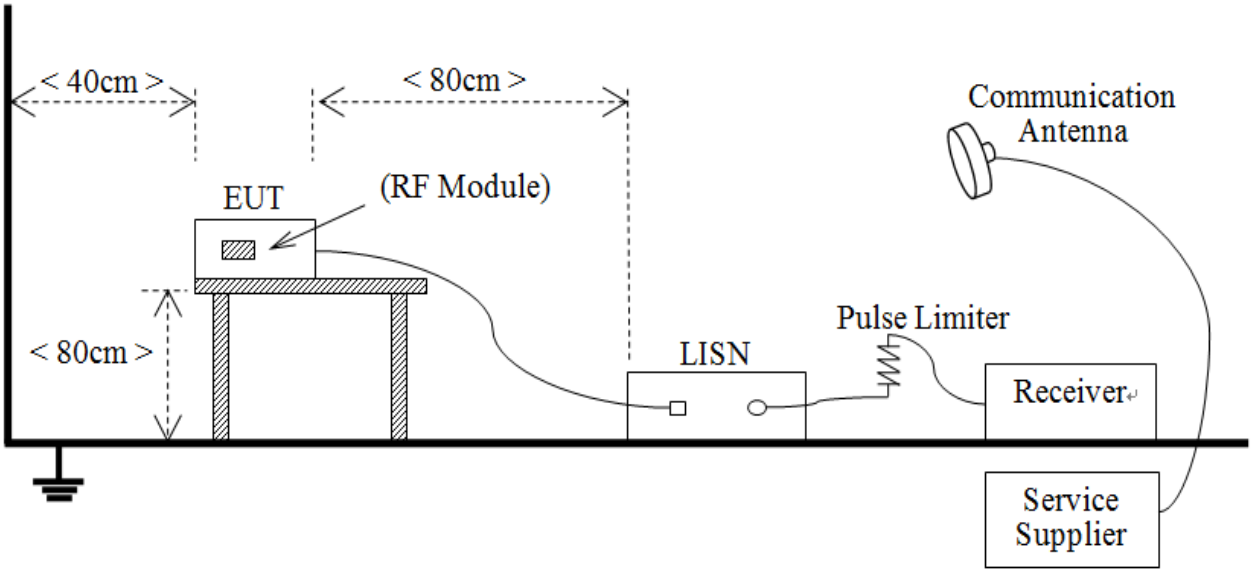
4.4.1 For Antenna Port Test

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

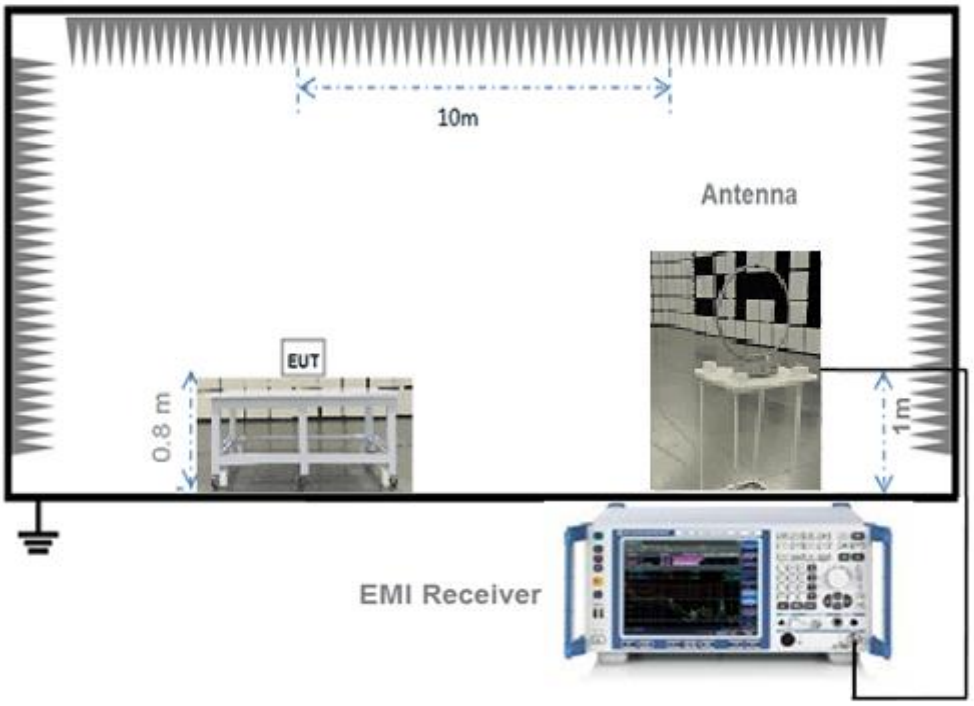
(Diagram 1)

4.4.2 For AC Power Supply Port Test



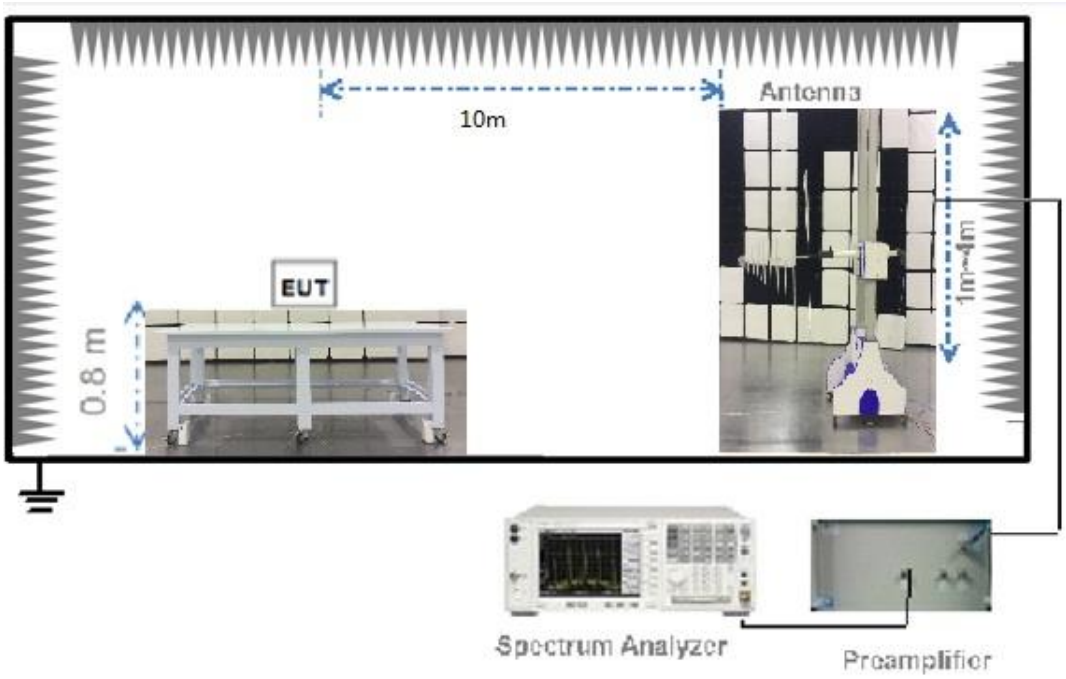
(Diagram 2)

4.4.3 For Radiated Test (Below 30 MHz)



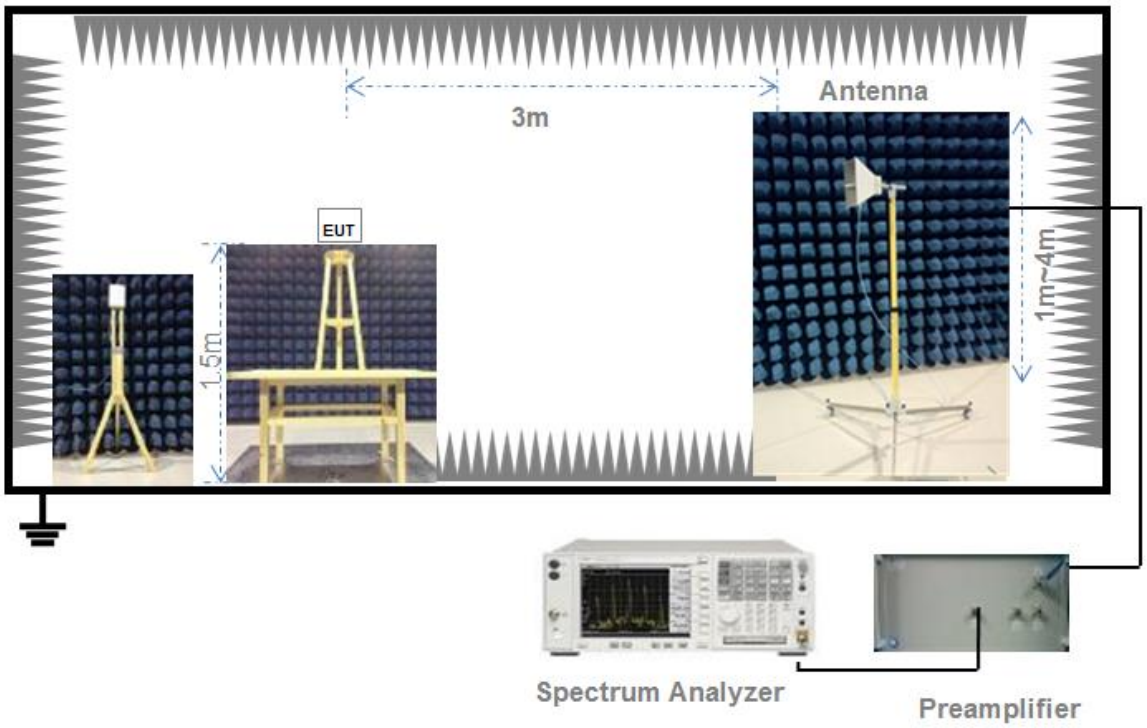
(Diagram 3)

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 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 ≥ 1% of the span

VBW ≥ 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. 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 B.

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

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 4.4.1 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 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

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.

5.5.2 Test Setup

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

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

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

5.6.3 Test Procedure

The 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

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 4.4.1 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 ≥ RBW
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 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 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 (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 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 ≥ 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

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 4.4.3 to 4.4.5 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 ≥ 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

Please refer to ANNEX A.9.

ANNEX A TEST RESULT

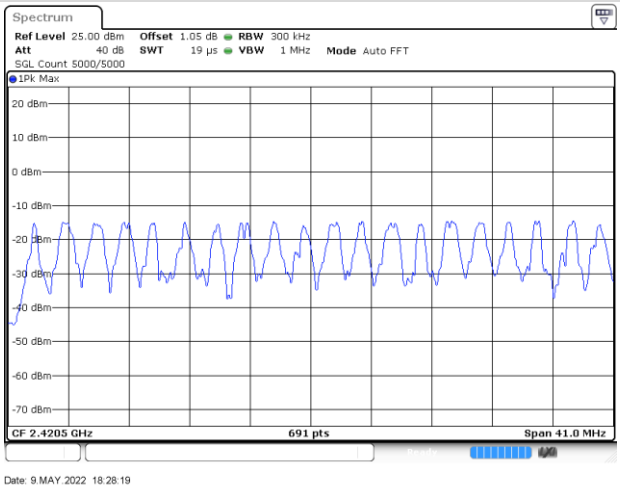
A.1 Number of Hopping Frequency

Test Data

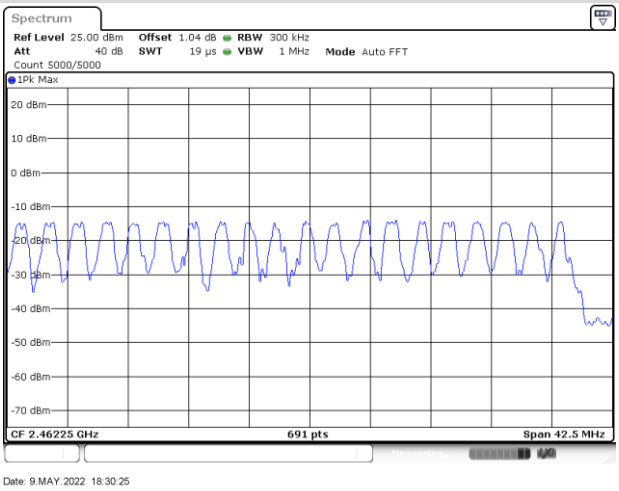
Test Mode	Frequency Block (MHz)	Measured Channel Numbers	Min. Limit	Verdict
GFSK	2400 - 2483.5	40	15	Pass

Test plots

GFSK 2.4 GHz ~ 2.4835 GHz



GFSK 2.4 GHz ~ 2.4835 GHz



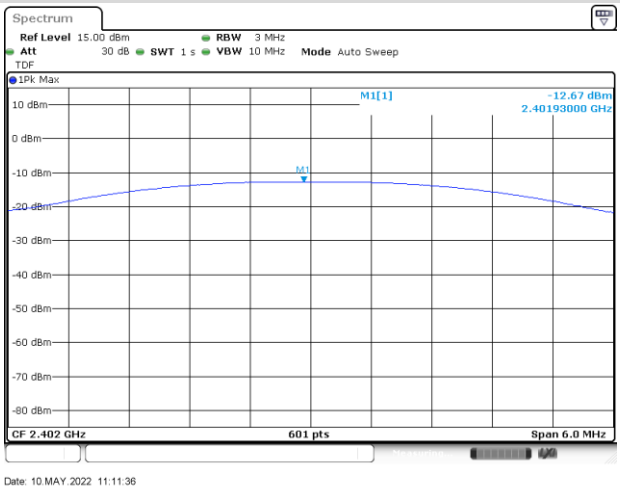
A.2 Peak Output Power

Peak Power Test Data

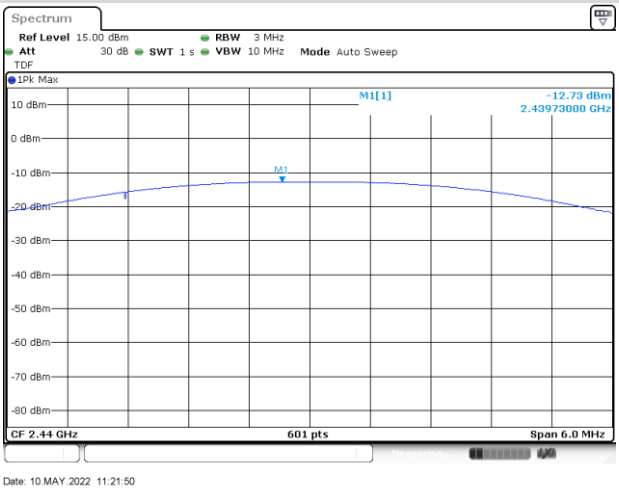
Channel	Measured Output Peak Power		Limit		Verdict
	dBm	mW	dBm	mW	
Low	-12.67	0.05	30	1000	Pass
Middle	-12.73	0.05			Pass
High	-12.88	0.05			Pass

Test plots

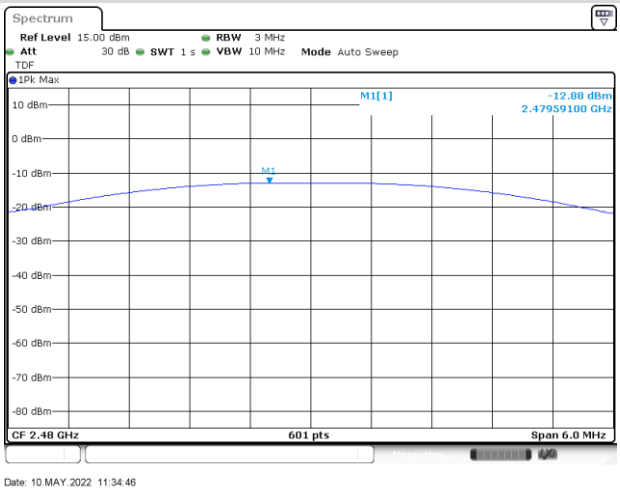
GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL



A.3 Occupied Bandwidth

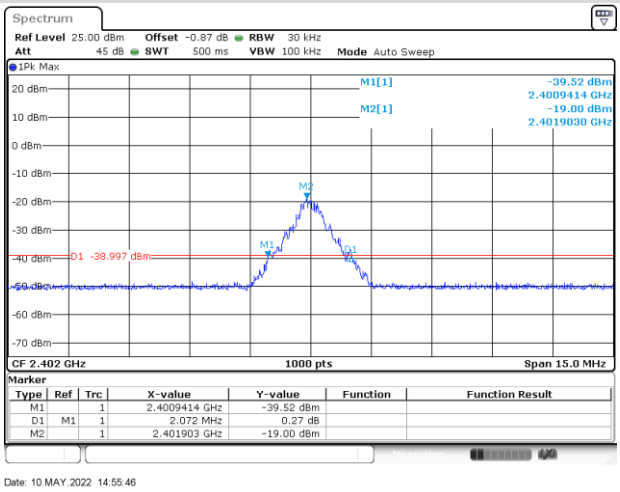
Test Data

Test Mode	GFSK	
Channel	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low Channel	2.072021	1.920000
Middle Channel	2.072021	1.956000
High Channel	2.117187	1.980000

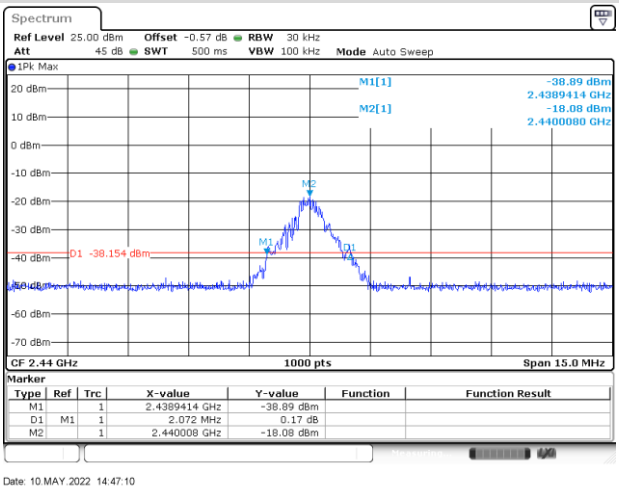
Test plots

20 dB Bandwidth

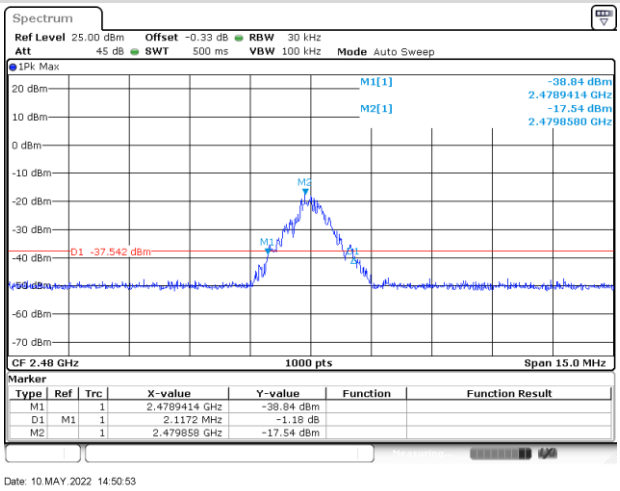
GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL

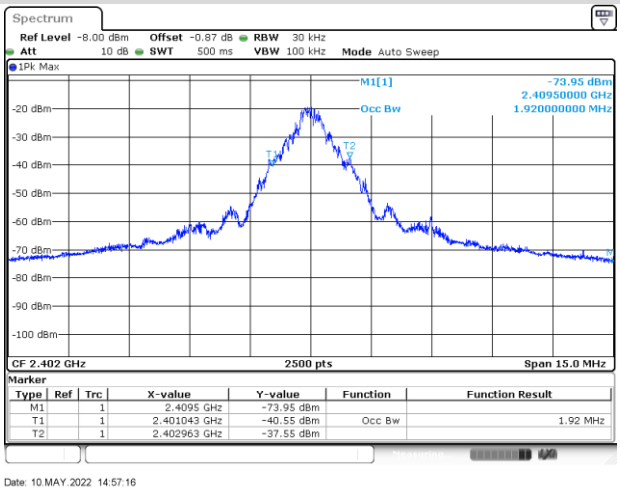


GFSK HIGH CHANNEL

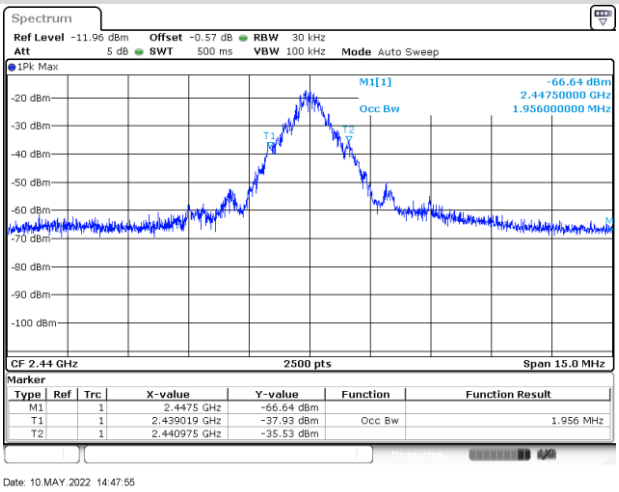


99% Bandwidth

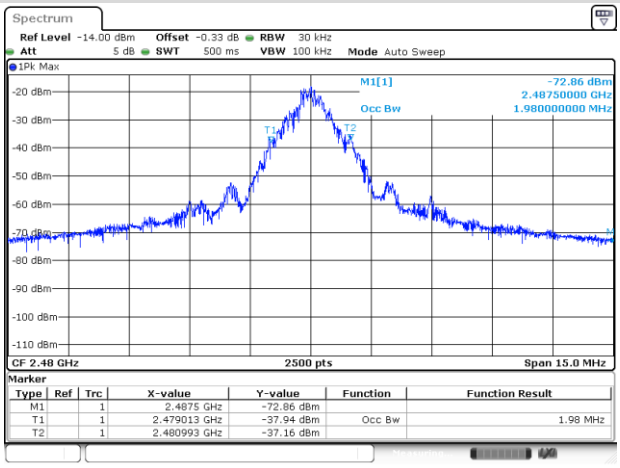
GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL



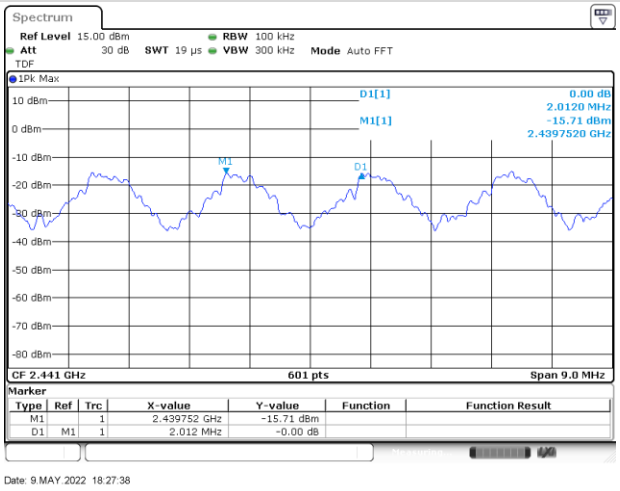
A.4 Hopping Frequency Separation

Test Data

Mode	Frequency separation (MHz)	2/3 of the 20 dB Bandwidth (MHz)	Verdict
GFSK	2.012	1.411	Pass

Test Plots

GFSK



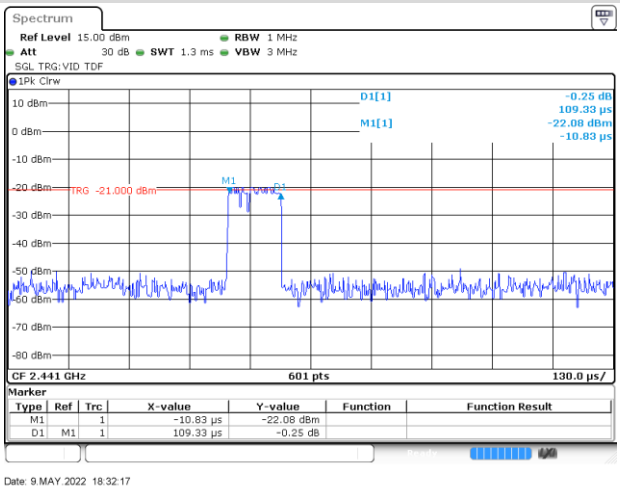
A.5 Time of Occupancy (Dwell time)

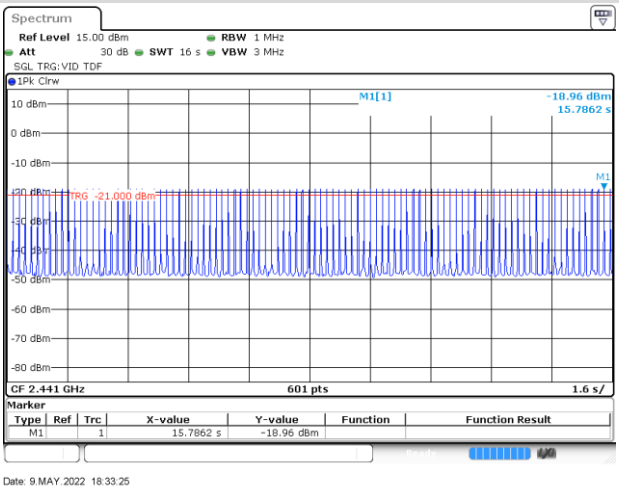
Test Data

GFSK			
Pulse Width (ms)	Total of Dwell (ms)	Limit (sec)	Verdict
0.109	10.933	0.4	Pass

Test Plots

GFSK





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

Test Data

GFSK Mode:

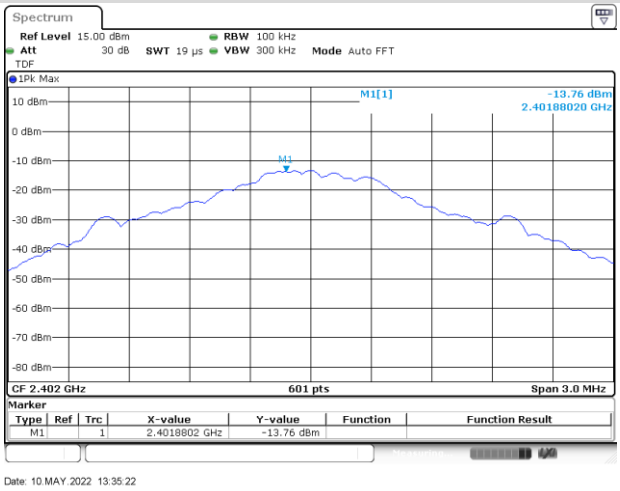
GFSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-49.40	-13.76	-33.76	Pass
Middle	-48.76	-13.98	-33.98	Pass
High	-49.36	-14.14	-34.14	Pass

Hopping Mode:

GFSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
GFSK	-47.48	-14.78	-34.78	Pass

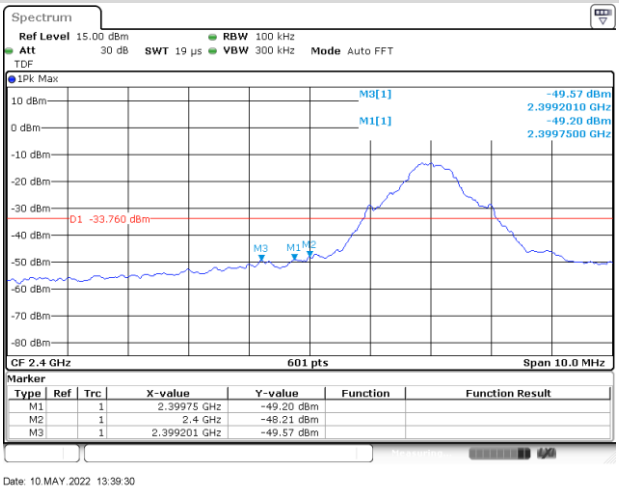
Test Plots

GFSK LOW CHANNEL, CARRIER LEVEL



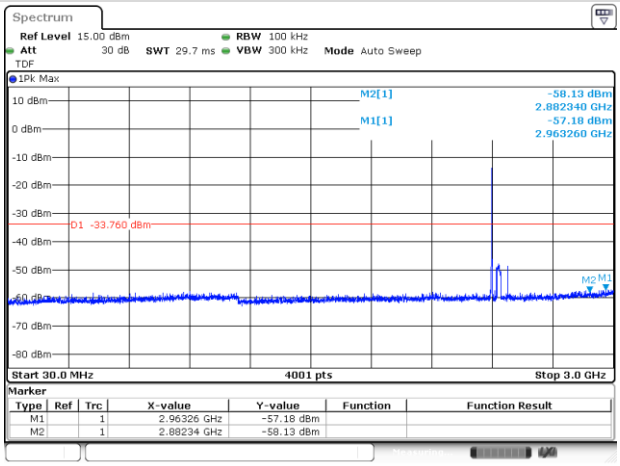
Date: 10.MAY.2022 13:35:22

GFSK LOW CHANNEL, BAND EDGE



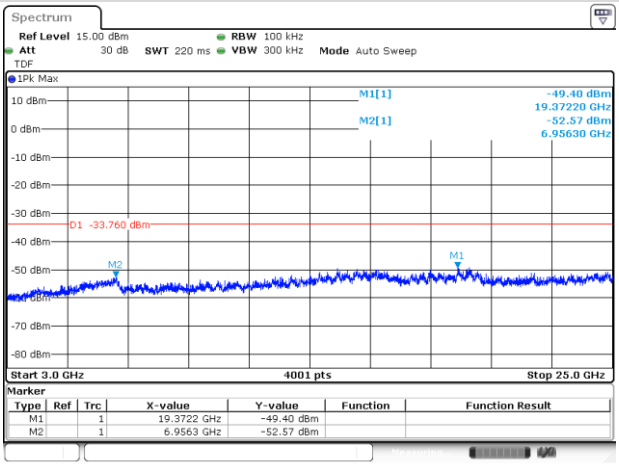
Date: 10.MAY.2022 13:39:30

GFSK LOW CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



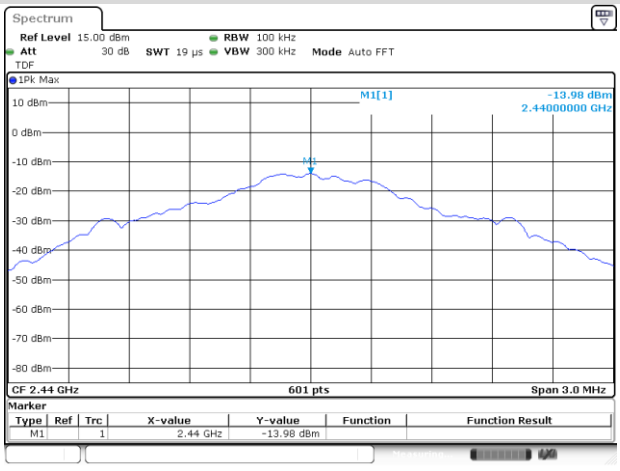
Date: 10.MAY.2022 13:37:18

GFSK LOW CHANNEL, SPURIOUS 3 GHz ~ 25 GHz



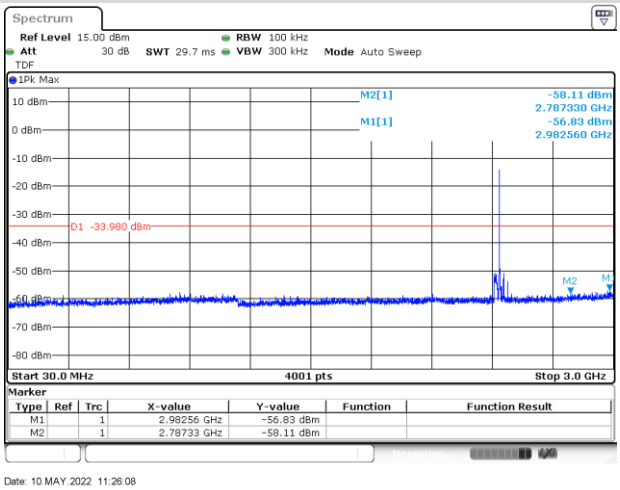
Date: 10.MAY.2022 13:37:32

GFSK MIDDLE CHANNEL, CARRIER LEVEL



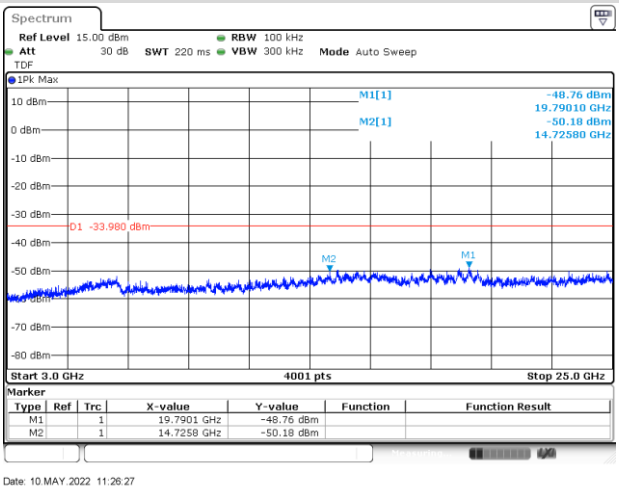
Date: 10.MAY.2022 11:24:03

GFSK MIDDLE CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



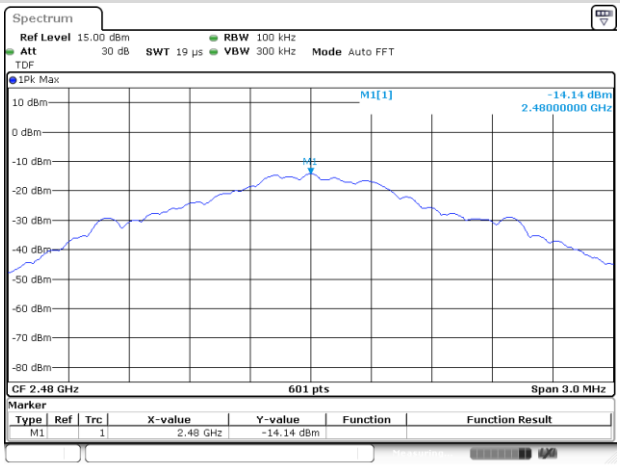
Date: 10.MAY.2022 11:26:08

GFSK MIDDLE CHANNEL, SPURIOUS 3 GHz ~ 25 GHz



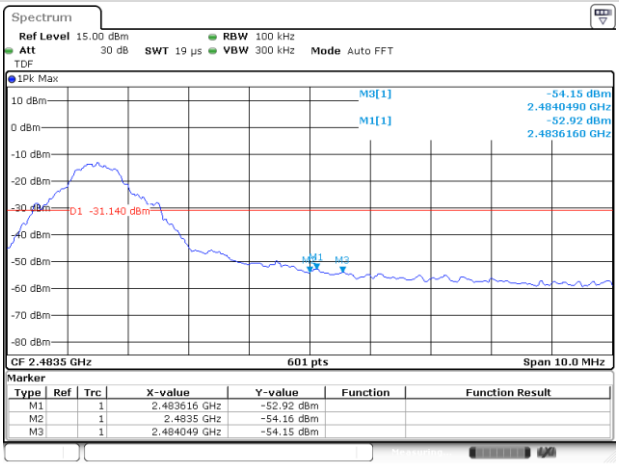
Date: 10.MAY.2022 11:26:27

GFSK HIGH CHANNEL, CARRIER LEVEL



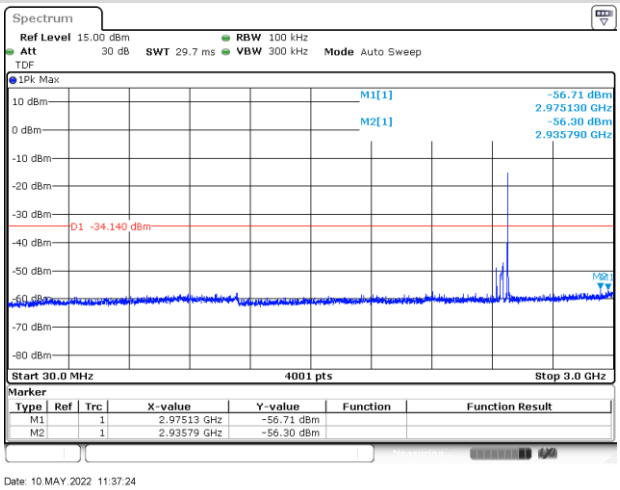
Date: 10.MAY.2022 11:36:08

GFSK HIGH CHANNEL, BAND EDGE



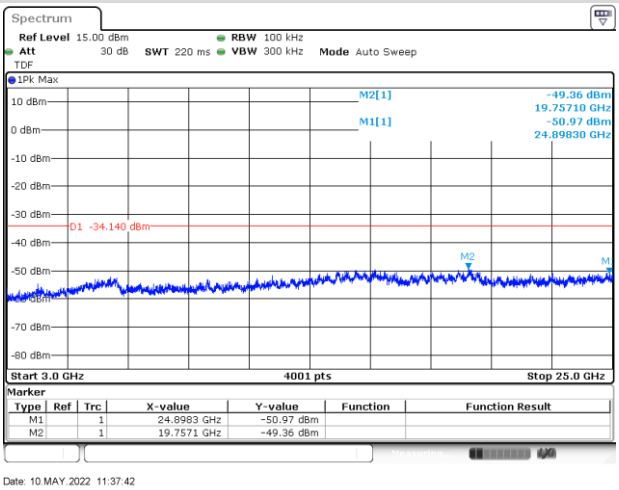
Date: 10.MAY.2022 13:40:54

GFSK HIGH CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



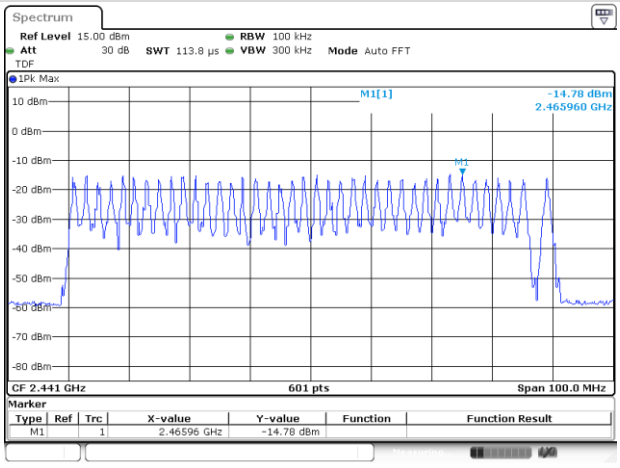
Date: 10.MAY.2022 11:37:24

GFSK HIGH CHANNEL, SPURIOUS 3 GHz ~ 25 GHz



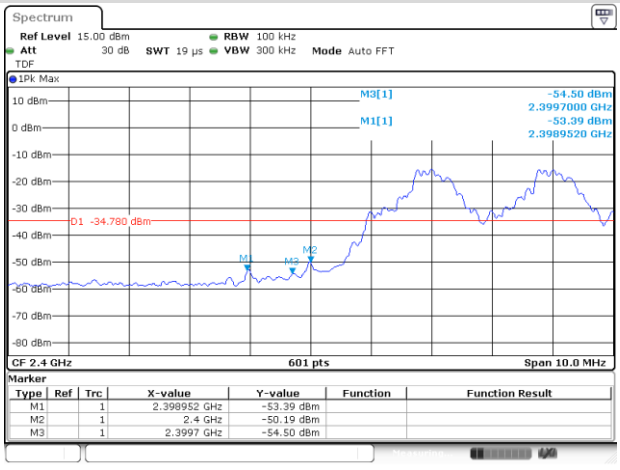
Date: 10.MAY.2022 11:37:42

GFSK HOPPING, CARRIER LEVEL



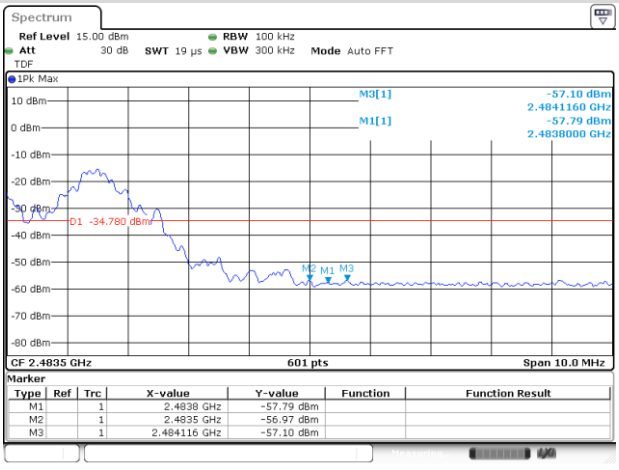
Date: 9.MAY.2022 18:35:16

GFSK HOPPING BAND EDGE (LOW)



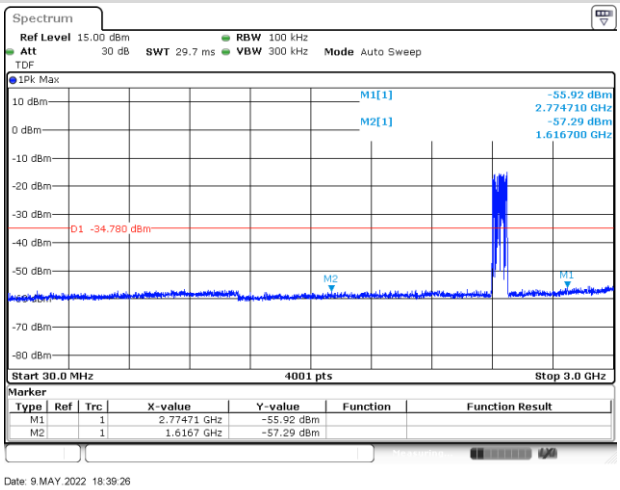
Date: 9.MAY.2022 18:40:30

GFSK HOPPING BAND EDGE (HIGH)

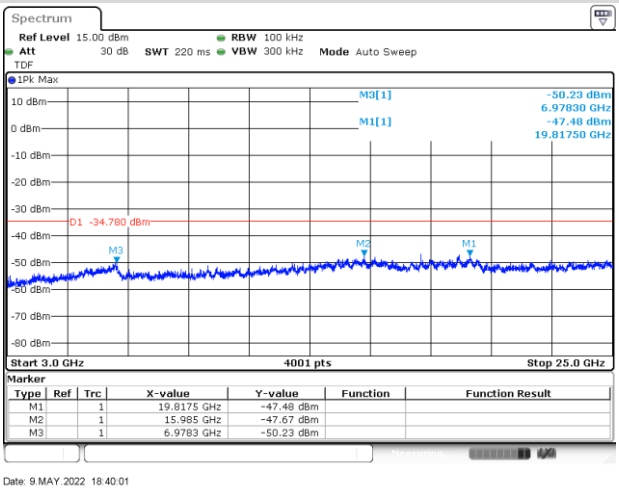


Date: 9.MAY.2022 18:40:56

GFSK Hopping Mode, SPURIOUS
30 MHz ~ 3 GHz



GFSK Hopping Mode, SPURIOUS
3GHz ~ 25 GHz



A.7 Conducted Emissions

Note: Not applicable.

A.8 Radiated Emission

Test Data and Plots

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

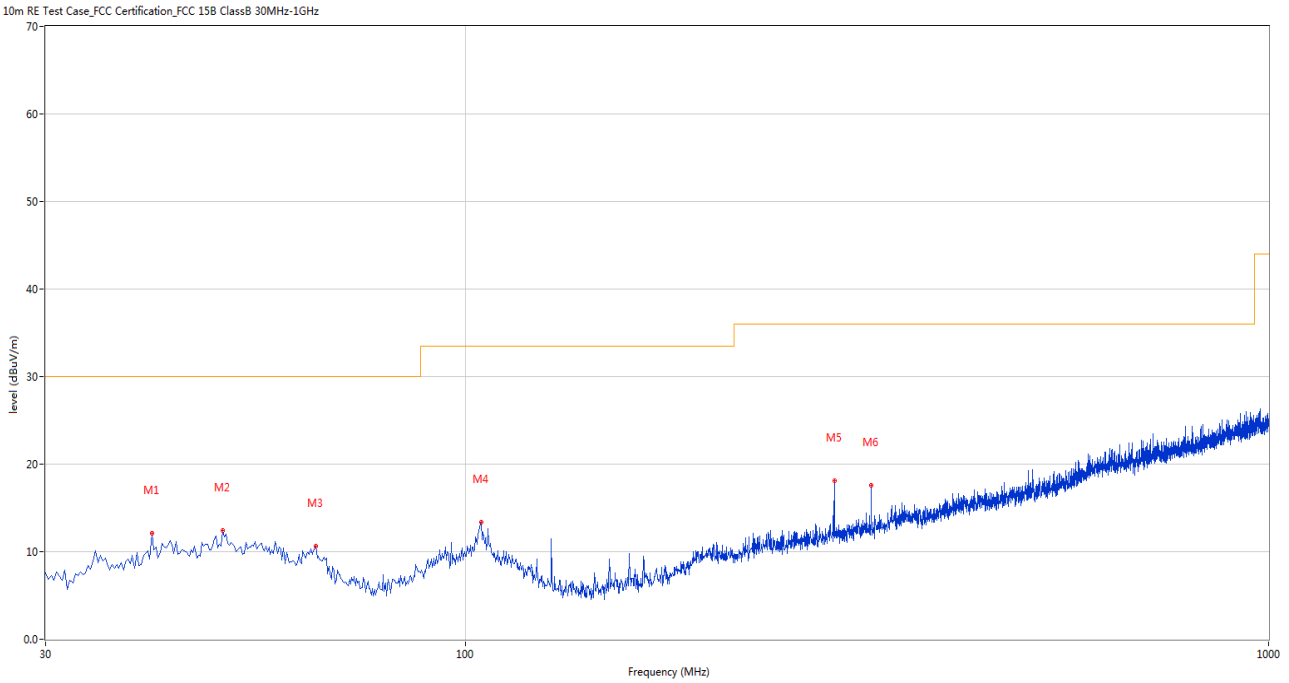
Note [2]: For the test data above 1 GHz, according the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

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)

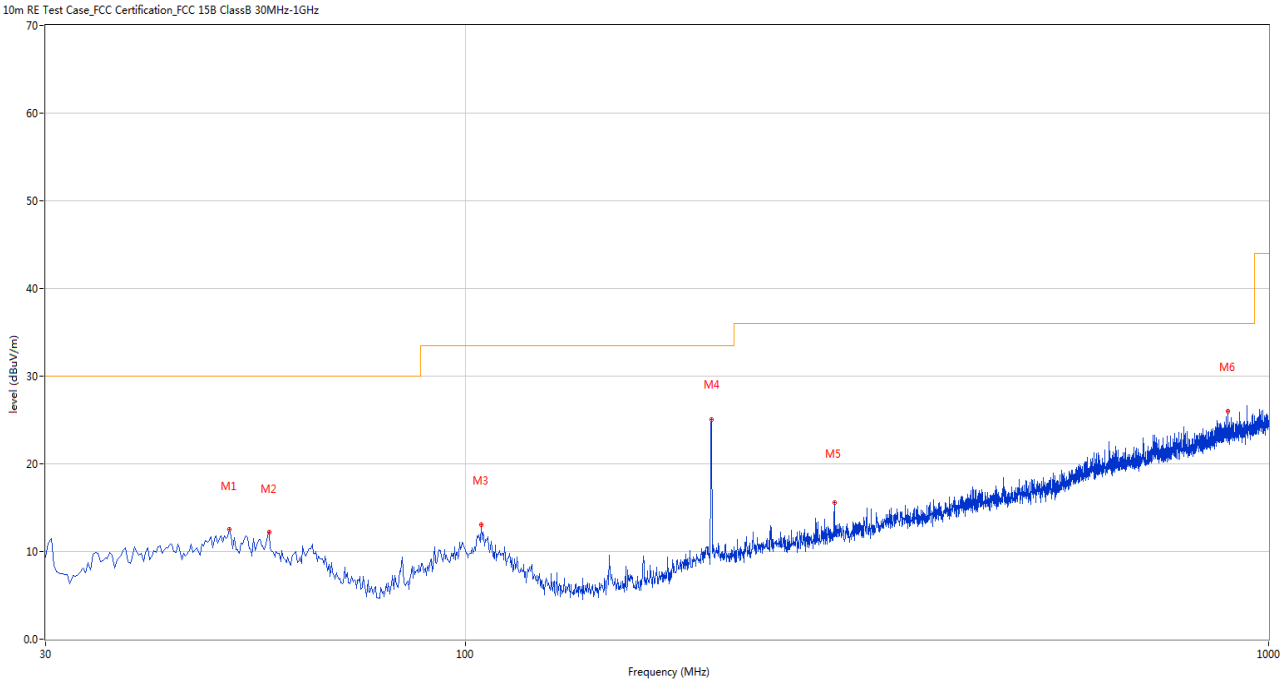
The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

30 MHz to 1 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	40.667	12.09	-27.01	30.0	-17.91	Peak	305.00	200	Horizontal	Pass
2	49.880	12.38	-26.25	30.0	-17.62	Peak	48.00	200	Horizontal	Pass
3	65.154	10.58	-28.36	30.0	-19.42	Peak	204.00	200	Horizontal	Pass
4	104.671	13.33	-27.76	33.5	-20.17	Peak	126.00	100	Horizontal	Pass
5	287.956	18.09	-25.38	36.0	-17.91	Peak	360.00	200	Horizontal	Pass
6	319.958	17.54	-24.63	36.0	-18.46	Peak	360.00	200	Horizontal	Pass

30 MHz to 1 GHz, ANT V



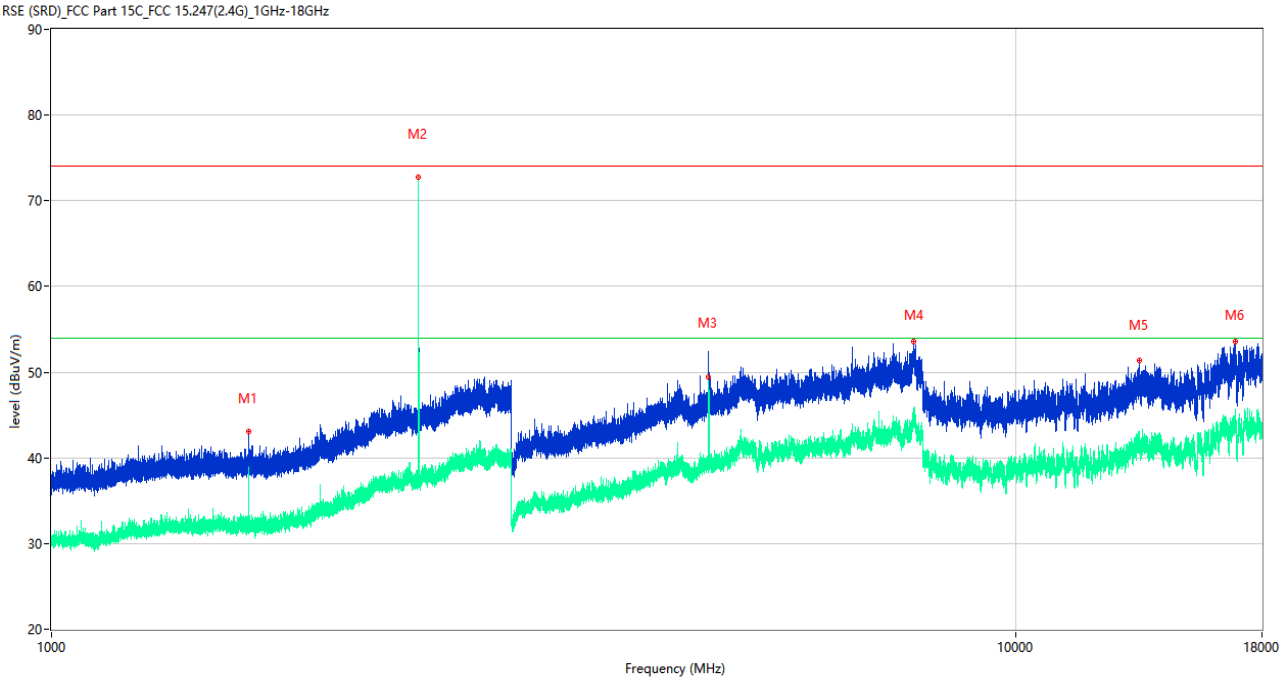
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	50.850	12.49	-26.20	30.0	-17.51	Peak	68.00	200	Vertical	Pass
2	56.911	12.16	-27.21	30.0	-17.84	Peak	360.00	200	Vertical	Pass
3	104.671	13.07	-27.76	33.5	-20.43	Peak	360.00	200	Vertical	Pass
4	202.374	25.04	-27.80	33.5	-8.46	Peak	78.00	200	Vertical	Pass
5	287.956	15.56	-25.38	36.0	-20.44	Peak	171.00	100	Vertical	Pass
6	890.417	26.01	-12.61	36.0	-9.99	Peak	312.00	100	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.

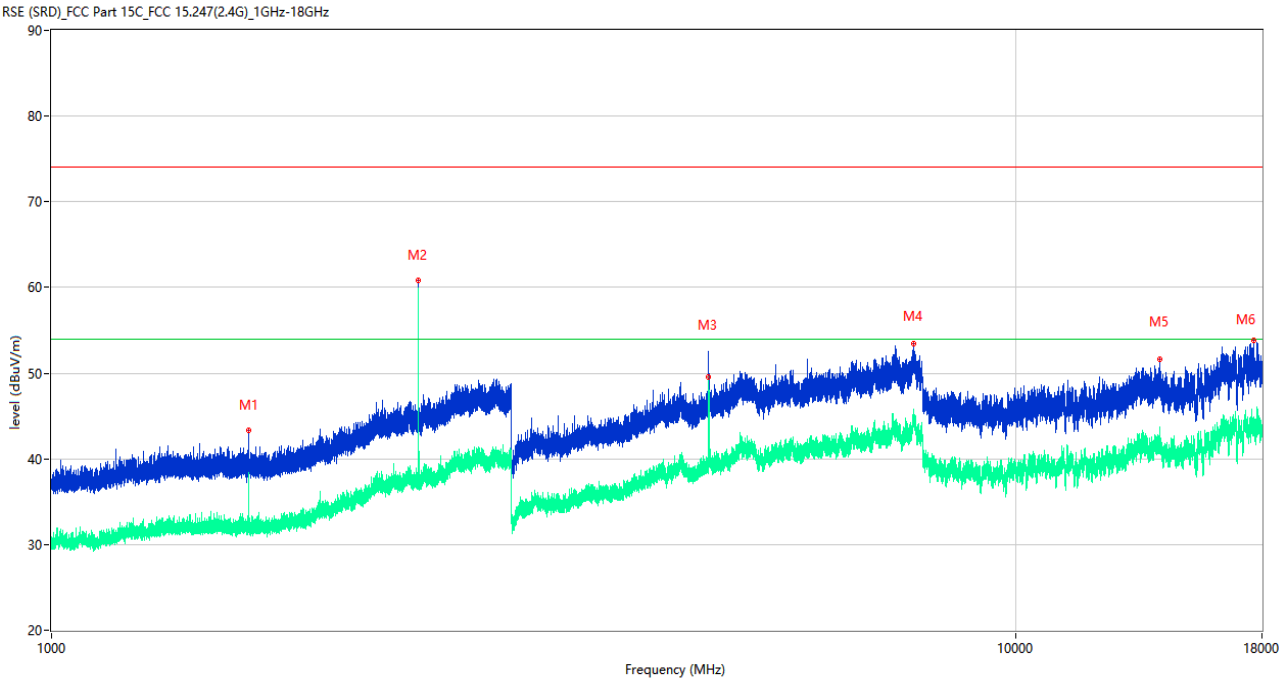
Note 2: The spurious from 18GHz-25GHz is noise only, do not show on the report.

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT H



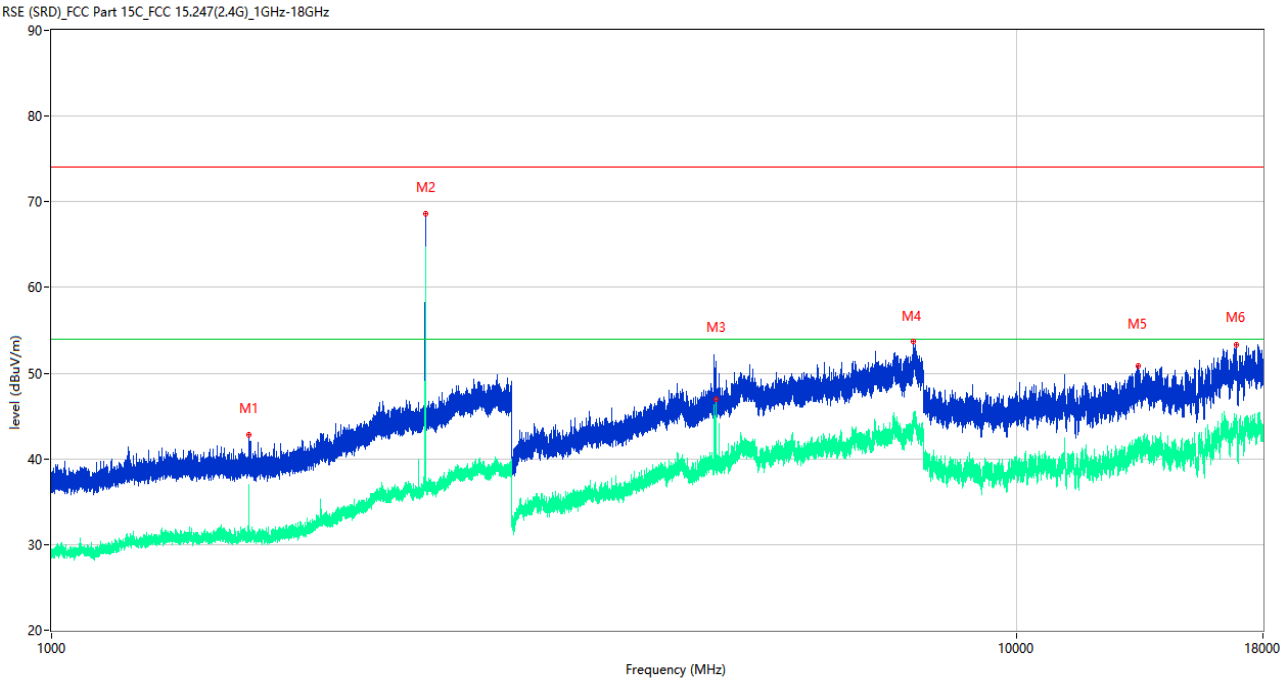
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1600.200	43.04	-17.78	74.0	-30.96	Peak	30.00	150	Horizontal	Pass
1**	1600.200	37.36	-17.78	54.0	-16.64	AV	30.00	150	Horizontal	Pass
2	2401.900	73.04	-13.34	74.0	-0.96	Peak	162.00	150	Horizontal	N/A
2**	2401.900	72.45	-13.34	54.0	18.45	AV	162.00	150	Horizontal	N/A
3	4804.250	52.17	-4.10	74.0	-21.83	Peak	219.00	150	Horizontal	Pass
3**	4804.250	49.38	-4.10	54.0	-4.62	AV	219.00	150	Horizontal	Pass
4	7833.750	53.57	2.25	74.0	-20.43	Peak	346.00	150	Horizontal	Pass
4**	7833.750	44.72	2.25	54.0	-9.28	AV	346.00	150	Horizontal	Pass
5	13419.900	51.39	0.02	74.0	-22.61	Peak	158.00	150	Horizontal	Pass
5**	13419.900	42.64	0.02	54.0	-11.36	AV	158.00	150	Horizontal	Pass
6	16888.051	53.56	1.41	74.0	-20.44	Peak	314.00	150	Horizontal	Pass
6**	16888.051	44.73	1.41	54.0	-9.27	AV	314.00	150	Horizontal	Pass

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT V



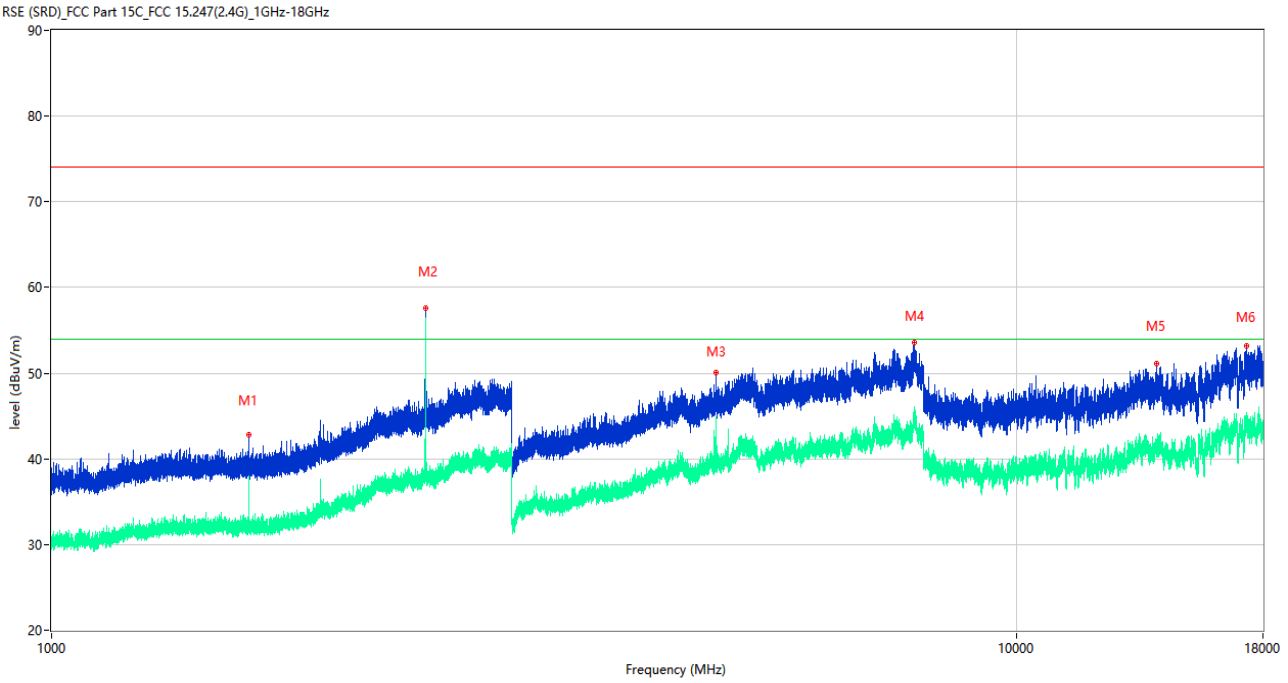
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1599.800	43.34	-17.74	74.0	-30.66	Peak	8.00	150	Vertical	Pass
1**	1599.800	37.24	-17.74	54.0	-16.76	AV	8.00	150	Vertical	Pass
2	2402.100	60.83	-13.33	74.0	-13.17	Peak	243.00	150	Vertical	N/A
2**	2402.100	59.98	-13.33	54.0	5.98	AV	243.00	150	Vertical	N/A
3	4804.250	51.89	-4.10	74.0	-22.11	Peak	0.00	150	Vertical	Pass
3**	4804.250	49.50	-4.10	54.0	-4.50	AV	0.00	150	Vertical	Pass
4	7834.000	53.39	2.24	74.0	-20.61	Peak	345.00	150	Vertical	Pass
4**	7834.000	44.44	2.24	54.0	-9.56	AV	345.00	150	Vertical	Pass
5	14087.437	51.63	-0.20	74.0	-22.37	Peak	80.00	150	Vertical	Pass
5**	14087.437	42.61	-0.20	54.0	-11.39	AV	80.00	150	Vertical	Pass
6	17652.976	53.79	2.84	74.0	-20.21	Peak	-1.00	150	Vertical	Pass
6**	17652.976	44.35	2.84	54.0	-9.65	AV	-1.00	150	Vertical	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H



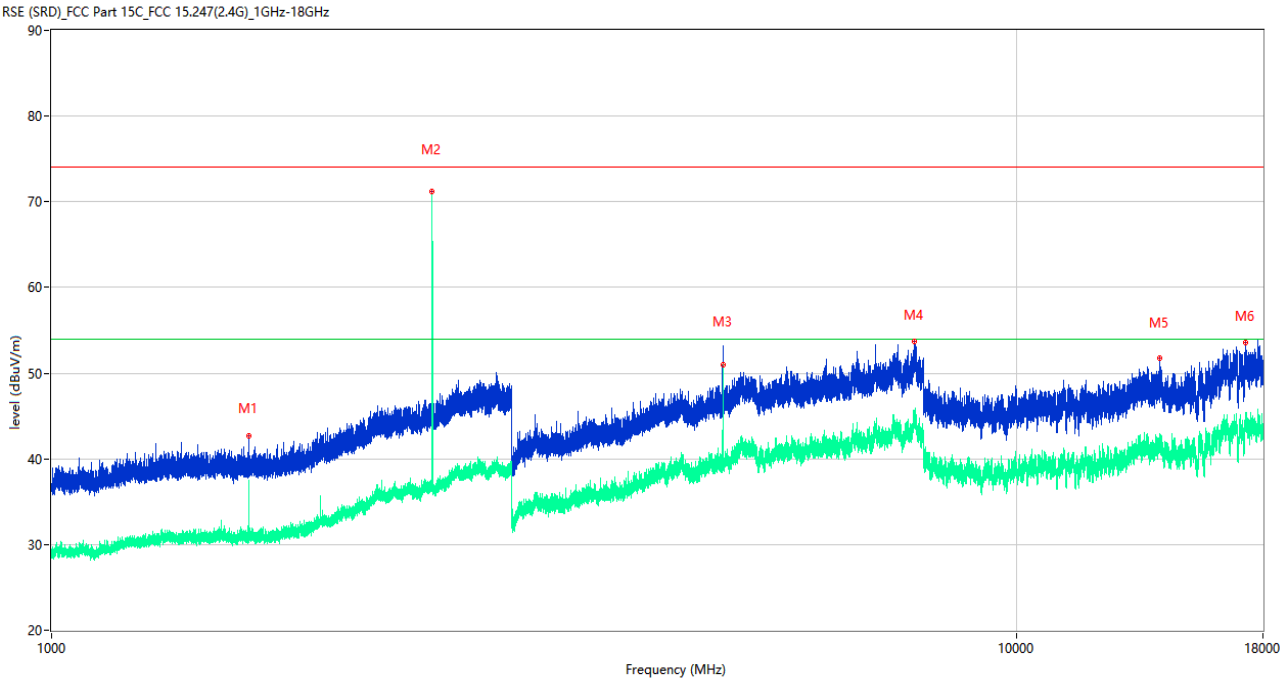
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1599.800	42.80	-17.74	74.0	-31.20	Peak	266.00	150	Horizontal	Pass
1**	1599.800	36.04	-17.74	54.0	-17.96	AV	266.00	150	Horizontal	Pass
2	2440.200	68.65	-12.37	74.0	-5.35	Peak	186.00	150	Horizontal	N/A
2**	2440.200	63.70	-12.37	54.0	9.70	AV	186.00	150	Horizontal	N/A
3	4879.750	51.08	-3.70	74.0	-22.92	Peak	209.00	150	Horizontal	Pass
3**	4879.750	46.96	-3.70	54.0	-7.04	AV	209.00	150	Horizontal	Pass
4	7821.750	53.74	1.64	74.0	-20.26	Peak	226.00	150	Horizontal	Pass
4**	7821.750	45.35	1.64	54.0	-8.65	AV	226.00	150	Horizontal	Pass
5	13382.362	50.87	-0.13	74.0	-23.13	Peak	194.00	150	Horizontal	Pass
5**	13382.362	41.68	-0.13	54.0	-12.32	AV	194.00	150	Horizontal	Pass
6	16910.364	53.37	1.35	74.0	-20.63	Peak	94.00	150	Horizontal	Pass
6**	16910.364	43.90	1.35	54.0	-10.10	AV	94.00	150	Horizontal	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V



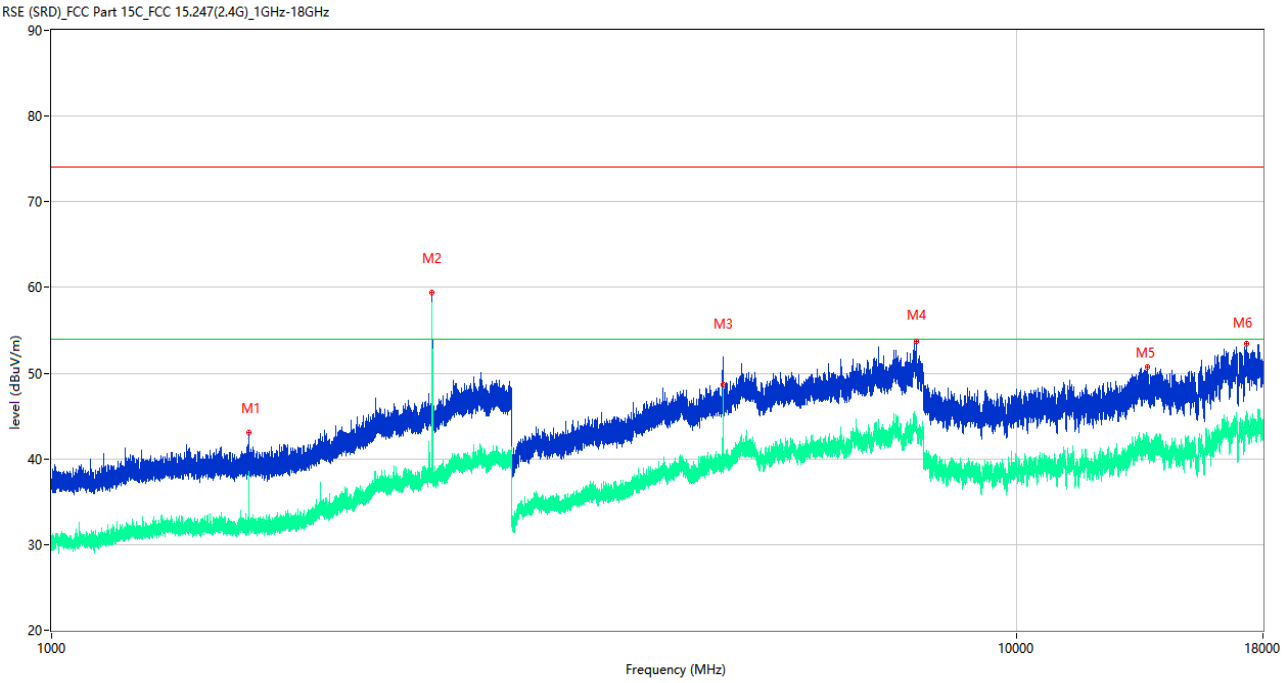
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1600.400	42.85	-17.78	74.0	-31.15	Peak	206.00	150	Vertical	Pass
1**	1600.400	36.43	-17.78	54.0	-17.57	AV	206.00	150	Vertical	Pass
2	2440.100	57.65	-12.37	74.0	-16.35	Peak	159.00	150	Vertical	N/A
2**	2440.100	54.94	-12.37	54.0	0.94	AV	159.00	150	Vertical	N/A
3	4879.750	50.02	-3.70	74.0	-23.98	Peak	60.00	150	Vertical	Pass
3**	4879.750	42.48	-3.70	54.0	-11.52	AV	60.00	150	Vertical	Pass
4	7840.000	53.54	1.88	74.0	-20.46	Peak	354.00	150	Vertical	Pass
4**	7840.000	44.22	1.88	54.0	-9.78	AV	354.00	150	Vertical	Pass
5	13955.138	51.09	-0.19	74.0	-22.91	Peak	252.00	150	Vertical	Pass
5**	13955.138	41.24	-0.19	54.0	-12.76	AV	252.00	150	Vertical	Pass
6	17316.712	53.23	1.97	74.0	-20.77	Peak	322.00	150	Vertical	Pass
6**	17316.712	44.44	1.97	54.0	-9.56	AV	322.00	150	Vertical	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1599.800	42.62	-17.74	74.0	-31.38	Peak	176.00	150	Horizontal	Pass
1**	1599.800	36.63	-17.74	54.0	-17.37	AV	176.00	150	Horizontal	Pass
2	2480.000	71.16	-13.08	74.0	-2.84	Peak	162.00	150	Horizontal	N/A
2**	2480.000	70.77	-13.08	54.0	16.77	AV	162.00	150	Horizontal	N/A
3	4960.250	53.03	-4.16	74.0	-20.97	Peak	277.00	150	Horizontal	Pass
3**	4960.250	50.92	-4.16	54.0	-3.08	AV	277.00	150	Horizontal	Pass
4	7831.250	53.74	2.07	74.0	-20.26	Peak	141.00	150	Horizontal	Pass
4**	7831.250	44.58	2.07	54.0	-9.42	AV	141.00	150	Horizontal	Pass
5	14076.151	51.73	-0.42	74.0	-22.27	Peak	205.00	150	Horizontal	Pass
5**	14076.151	41.36	-0.42	54.0	-12.64	AV	205.00	150	Horizontal	Pass
6	17249.249	53.60	1.92	74.0	-20.40	Peak	304.00	150	Horizontal	Pass
6**	17249.249	43.97	1.92	54.0	-10.03	AV	304.00	150	Horizontal	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT V



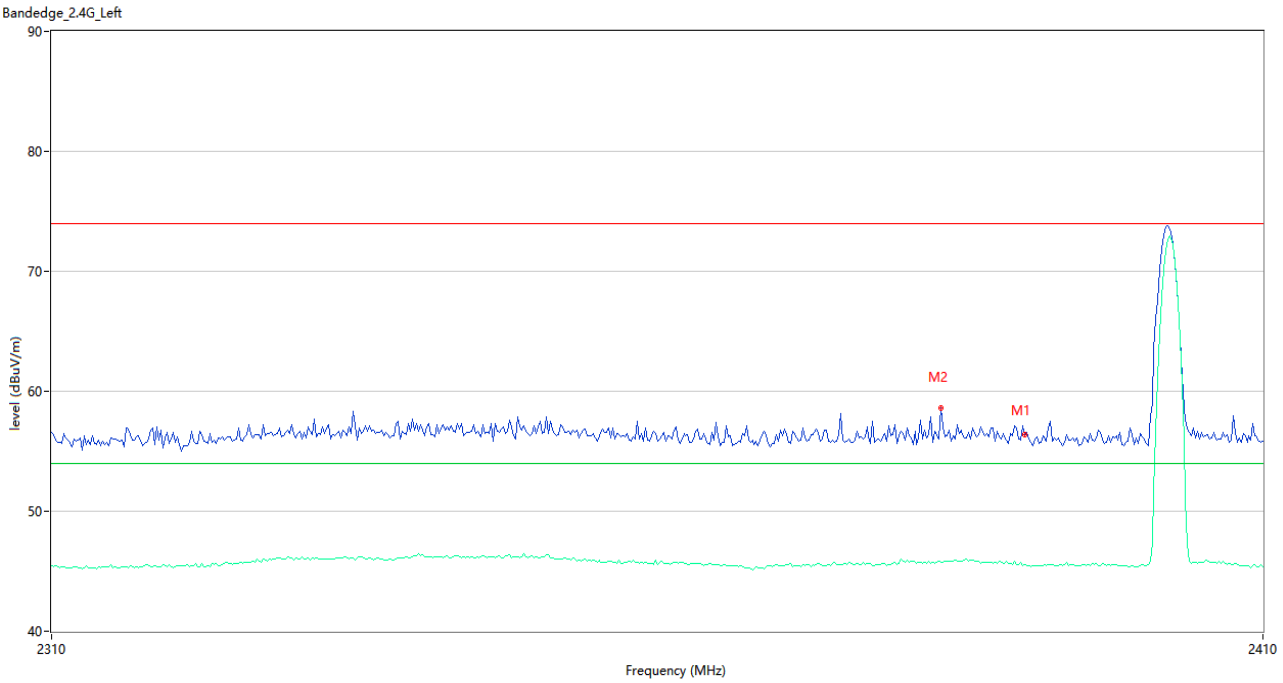
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1600.000	43.04	-17.76	74.0	-30.96	Peak	51.00	150	Vertical	Pass
1**	1600.000	38.37	-17.76	54.0	-15.63	AV	51.00	150	Vertical	Pass
2	2480.100	59.36	-13.08	74.0	-14.64	Peak	220.00	150	Vertical	N/A
2**	2480.100	58.24	-13.08	54.0	4.24	AV	220.00	150	Vertical	N/A
3	4960.000	51.94	-4.17	74.0	-22.06	Peak	289.00	150	Vertical	Pass
3**	4960.000	48.63	-4.17	54.0	-5.37	AV	289.00	150	Vertical	Pass
4	7866.500	53.64	1.52	74.0	-20.36	Peak	215.00	150	Vertical	Pass
4**	7866.500	43.92	1.52	54.0	-10.08	AV	215.00	150	Vertical	Pass
5	13658.512	50.74	0.30	74.0	-23.26	Peak	321.00	150	Vertical	Pass
5**	13658.512	41.00	0.30	54.0	-13.00	AV	321.00	150	Vertical	Pass
6	17311.988	53.44	1.98	74.0	-20.56	Peak	321.00	150	Vertical	Pass
6**	17311.988	44.00	1.98	54.0	-10.00	AV	321.00	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.

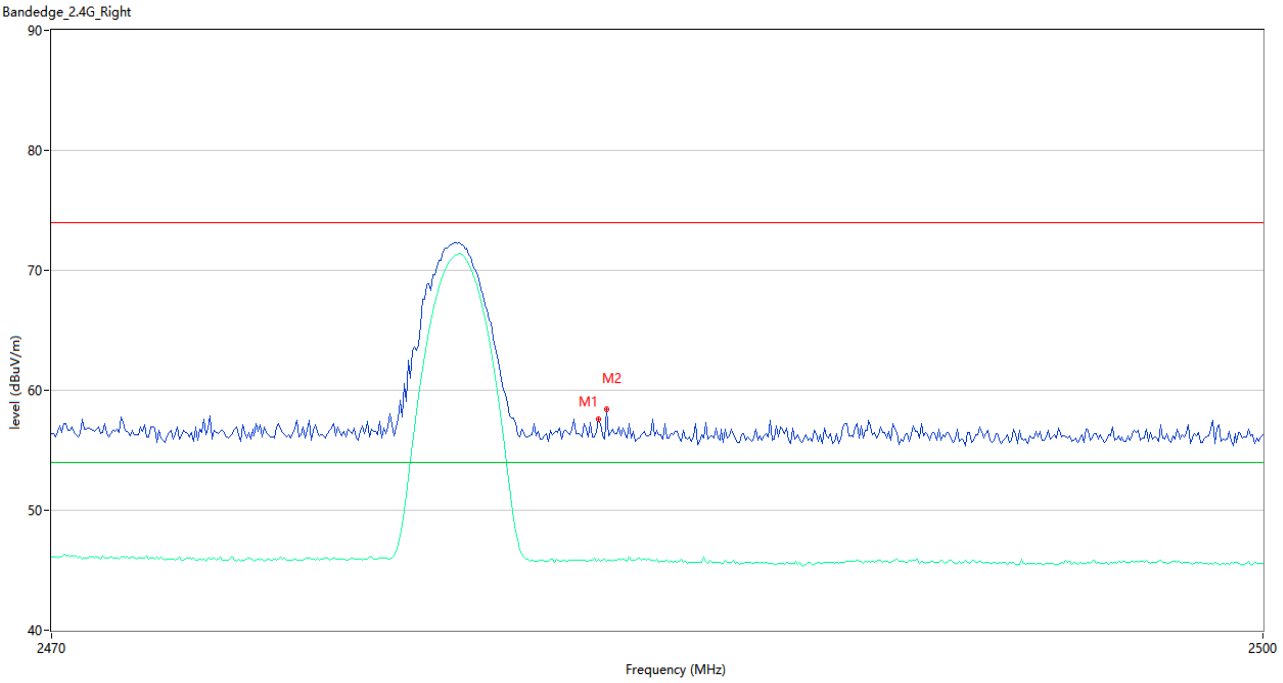
Test Data

GFSK LOW CHANNEL



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2390.000	56.42	1.62	74.0	-17.58	Peak	316.00	150	Horizontal	Pass
1**	2390.000	45.54	1.62	54.0	-8.46	AV	316.00	150	Horizontal	Pass
2	2383.000	58.63	1.73	74.0	-15.37	Peak	308.00	150	Horizontal	Pass
2**	2383.000	45.72	1.73	54.0	-8.28	AV	308.00	150	Horizontal	Pass

GFSK HIGH CHANNEL



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2483.500	57.61	1.98	74.0	-16.39	Peak	239.00	150	Horizontal	Pass
1**	2483.500	45.88	1.98	54.0	-8.12	AV	239.00	150	Horizontal	Pass
2	2483.700	58.40	1.99	74.0	-15.60	Peak	112.00	150	Horizontal	Pass
2**	2483.700	45.75	1.99	54.0	-8.25	AV	112.00	150	Horizontal	Pass

ANNEX B TEST SETUP PHOTOS

Please refer the document “BL-SZ2240487-AR.PDF”.

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document “BL-SZ2240487-AW.PDF”.

ANNEX D EUT INTERNAL PHOTOS

Please refer the document “BL-SZ2240487-AI.PDF”.

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--END OF REPORT--