TEST REPORT

Applicant:	SHENZHEN 8BITDO TECH CO., LTD.
Address:	Room 210, Building 1, Nanhai Ecool, No.6 Xinghua Road, Shekou, Nanshan District, Shenzhen, China
Equipment Type:	8BitDo Retro Mechanical Keyboard
Model Name:	85HA (refer to section 2.3)
Brand Name:	8BITDO
FCC ID:	2AOWF-24GRMK
Test Standard:	47 CFR Part 15 Subpart C (refer to section 3.1)
Sample Arrival Date:	Jul. 25, 2023
Test Date:	Jul. 31, 2023 - Aug. 08, 2023
Date of Issue:	Aug. 18, 2023

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	Aug. 16, 2023	Initial Issue
Rev. 02	Aug. 18, 2023	Corrected the Occupied Bandwidth test data in Section A.3.

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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	SHENZHEN 8BITDO TECH CO., LTD.
Address	Room 210, Building 1, Nanhai Ecool, No.6 Xinghua Road, Shekou, Nanshan District, Shenzhen, China

2.2 Manufacturer Information

Manufacturer	SHENZHEN ONEBITDO TECH CO., LTD.
Address	Room 203, Building 1, Huajian Building, Xinghua Road, Shekou, Shuiwan Community, Zhaoshang Street, Nanshan District, Shenzhen, China

2.3 General Description for Equipment under Test (EUT)

EUT Name	8BitDo Retro Mechanical Keyboard
Model Name Under Test	85HA
Series Model Name	85HA01, 85HA02, 85HA03, 85HA04, 85HA05, 85HA06
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 applicant)
Hardware Version	V 1.00
Software Version	V 1.00
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.4 Technical Information

Network and Wireless connectivity	Bluetooth (BLE) 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	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	79
Tested Channel	Low (2402 MHz), Middle (2440 MHz), High (2480 MHz)
Antenna Type	PCB Antenna
Antenna Gain	1.45 dBi
Adaptive or non-adaptive	Non-adaptive
The Max RF Output power	2.08 dBm

All Channel List:

Channel	Frequency	Channel	Frequency	Channel	Frequency
CH1 (Low)	**2402 MHz**	CH28	2429 MHz	CH55	2456 MHz
CH2	2403 MHz	CH29	2430 MHz	CH56	2457 MHz
CH3	2404 MHz	CH30	2431 MHz	CH57	2458 MHz
CH4	2405 MHz	CH31	2432 MHz	CH58	2459 MHz
CH5	2406 MHz	CH32	2433 MHz	CH59	2460 MHz
CH6	2407 MHz	CH33	2434 MHz	CH60	2461 MHz
CH7	2408 MHz	CH34	2435 MHz	CH61	2462 MHz
CH8	2409 MHz	CH35	2436 MHz	CH62	2463 MHz
CH9	2410 MHz	CH36	2437 MHz	CH63	2464 MHz
CH10	2411 MHz	CH37	2438 MHz	CH64	2465 MHz
CH11	2412 MHz	CH38	2439 MHz	CH65	2466 MHz
CH12	2413 MHz	**CH39(Middle)**	**2440 MHz**	CH66	2467 MHz
CH13	2414 MHz	CH40	2441 MHz	CH67	2468 MHz
CH14	2415 MHz	CH41	2442 MHz	CH68	2469 MHz
CH15	2416 MHz	CH42	2443 MHz	CH69	2470 MHz
CH16	2417 MHz	CH43	2444 MHz	CH70	2471 MHz
CH17	2418 MHz	CH44	2445 MHz	CH71	2472 MHz
CH18	2419 MHz	CH45	2446 MHz	CH72	2473 MHz
CH19	2420 MHz	CH46	2447 MHz	CH73	2474 MHz
CH20	2421 MHz	CH47	2448 MHz	CH74	2475 MHz
CH21	2422 MHz	CH48	2449 MHz	CH75	2476 MHz
CH22	2423 MHz	CH49	2450 MHz	CH76	2477 MHz

CH23	2424 MHz	CH50	2451 MHz	CH77	2478 MHz
CH24	2425 MHz	CH51	2452 MHz	CH78	2479 MHz
CH25	2426 MHz	CH52	2453 MHz	**CH79(High)**	**2480 MHz**
CH26	2427 MHz	CH53	2454 MHz		
CH27	2428 MHz	CH54	2455 MHz		
Note: The modulation is GFSK with FHSS, there are total 79 channels (frequency range is 2402-2480MHz, channel step is 1MHz, totally 79 channels), when this part works, it will choose 79 channels, each channel band width is 1MHz, if one channel is chosen, adjacent two channels cannot be chosen to make sure step of working channels is more than 1MHz. the equipment select the lowest, middle and highest channel from 79 channels, Which are 2402 MHz, 2440 MHz and 2480MHz. 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)	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	Pass
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.

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

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

Relative Humidity	46% to 66%	
Atmospheric Pressure	100 kPa to 102 kPa	
Temperature	NT (Normal Temperature)	+22.1℃ to +24.9℃
Working Voltage of the EUT	NV (Normal Voltage)	3.7 V

4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	KEYSIGHT	N9020A	MY50330200	2023.05.16	2024.05.15
Spectrum Analyzer	KEYSIGHT	N9020A	MY52510065	2022.09.06	2023.09.05
Test Antenna-Horn	SCHWARZBECK	BBHA 9120D	01631	2022.02.03	2025.02.02
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
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2022.09.09	2023.09.08
Test Antenna-Loop	SCHWARZBECK	FMZB 1519	1519-037	2021.04.16	2024.04.15
Anechoic Chamber	EMC Electronic Co., Ltd	20.10*11.60*7.35m	130	2021.08.15	2024.08.14
Test Antenna-Bi-Log	SCHWARZBECK	VULB 9163	9163-624	2021.08.20	2024.08.19
EMI Receiver	KEYSIGHT	N9038A	MY53220118	2022.09.08	2023.09.07
Anechoic Chamber	RAINFORD	9m*6m*6m	101	2023.03.26	2026.03.03
EMI Receiver	KEYSIGHT	N9010B	MY57110309	2022.09.09	2023.09.08
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
Amplifier	COM-MV	LSCX_LNA1-12G-01	180602	2020.09.08	2023.09.07
Amplifier	COM-MV	XKu_LNA7-18G-01	180601	2020.09.08	2023.09.07
Amplifier	COM-MV	KA_LNA18-40G-01	18050001	2020.09.08	2023.09.07
Amplifier	COM-MV	ZT30-1000M	B2017119082	2022.12.07	2023.12.06

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

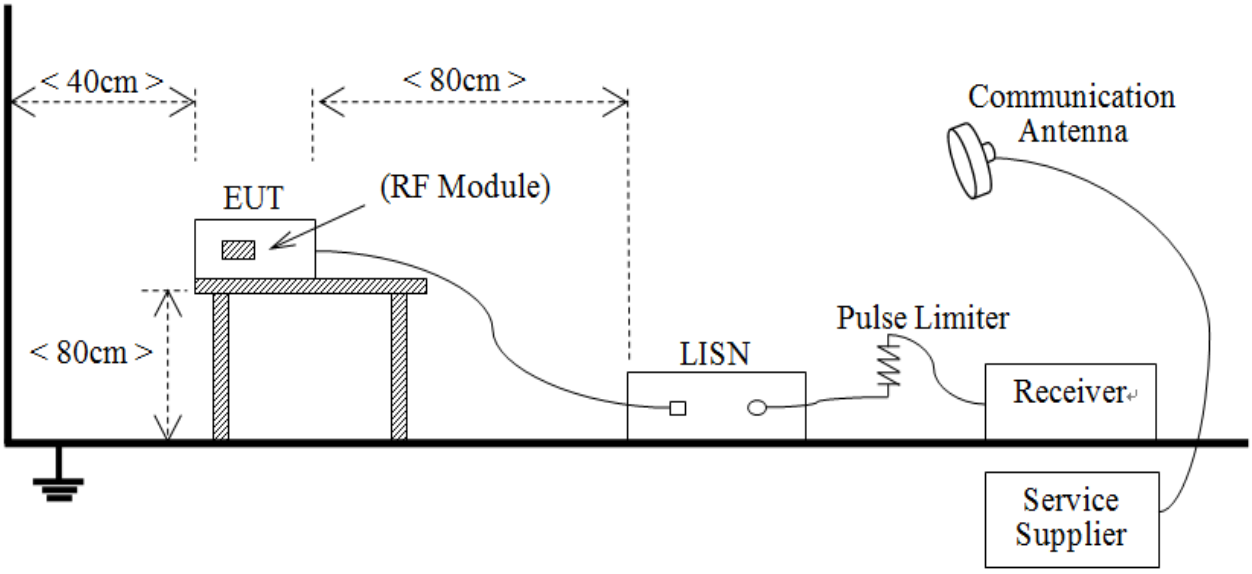
4.4.1 For Antenna Port Test

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

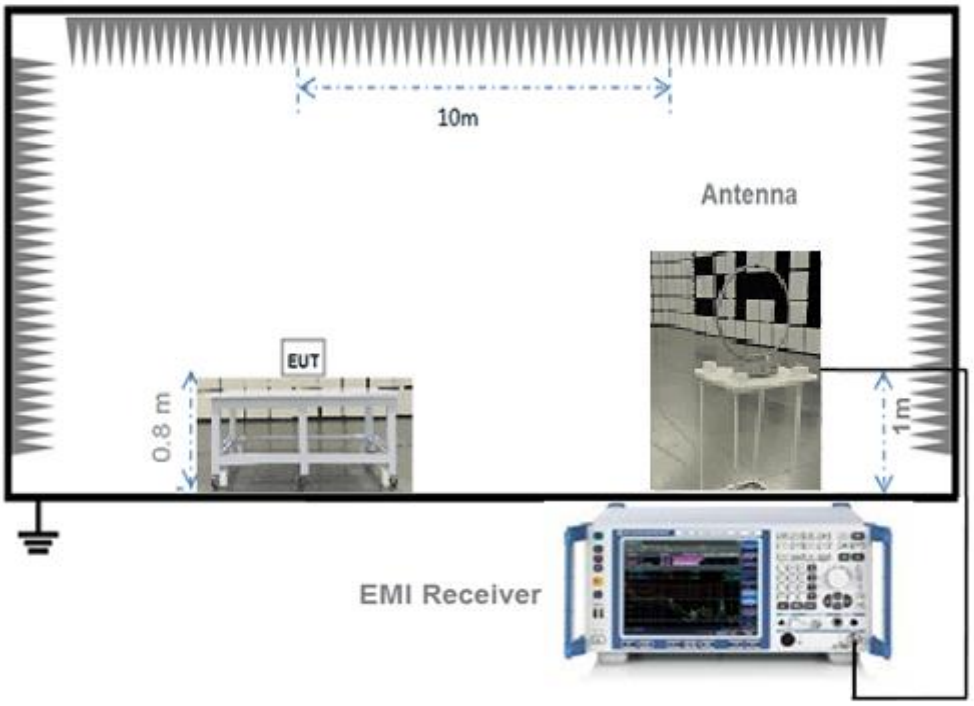
(Diagram 1)

4.4.2 For AC Power Supply Port Test



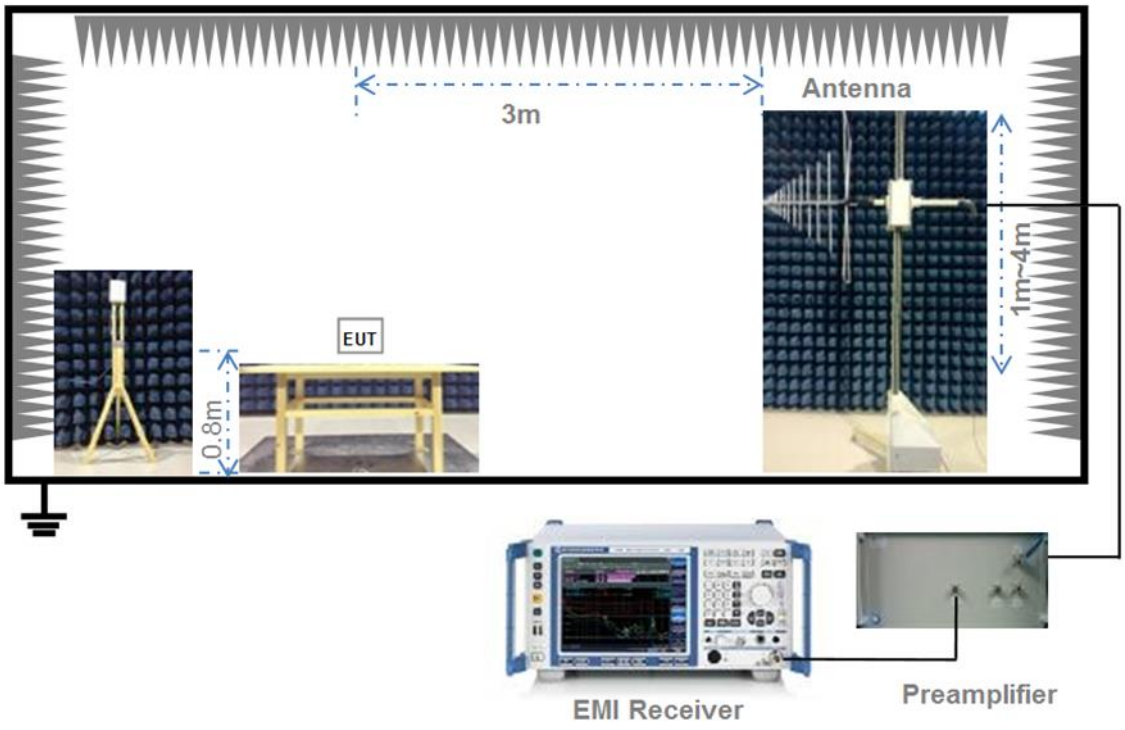
(Diagram 2)

4.4.3 For Radiated Test (Below 30 MHz)



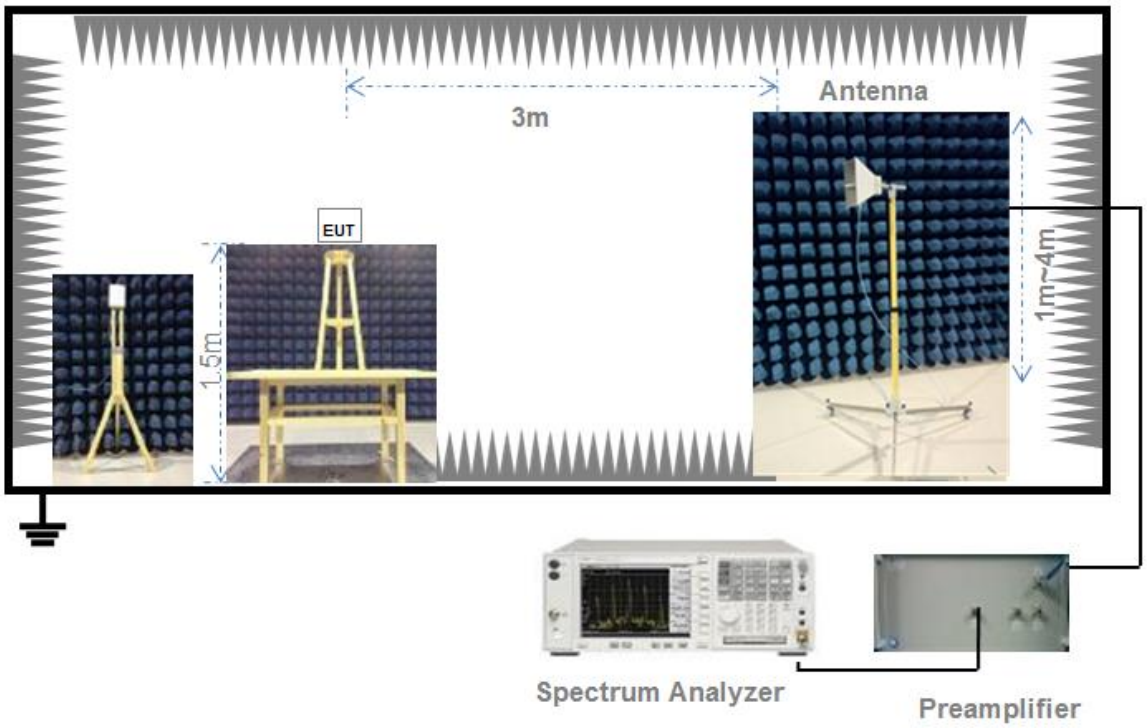
(Diagram 3)

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

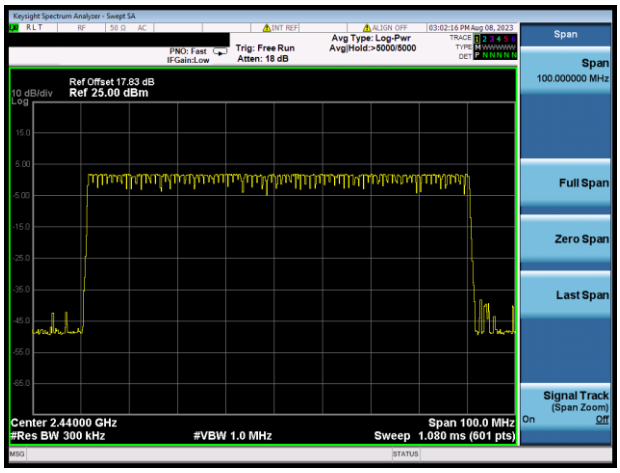
A.1 Number of Hopping Frequency

Test Data

Test Mode	Frequency Block (MHz)	Measured Channel Numbers	Min. Limit	Verdict
GFSK	2400 - 2483.5	79	15	Pass

Test plots

GFSK 2.4 GHz ~ 2.4835 GHz



A.2 Peak Output Power

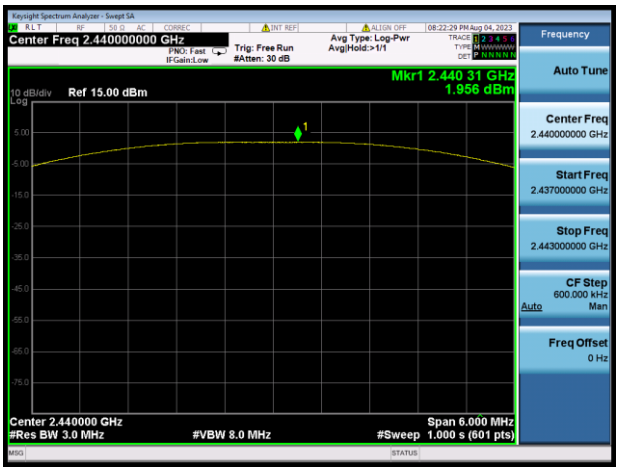
Peak Power Test Data

Channel	Measured Output Peak Power		Limit		Verdict
	dBm	mW	dBm	mW	
Low	2.08	1.62	30	1000	Pass
Middle	1.96	1.57			Pass
High	1.81	1.52			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	1.162000	1.011300
Middle Channel	1.174000	1.025900
High Channel	1.165000	1.018400

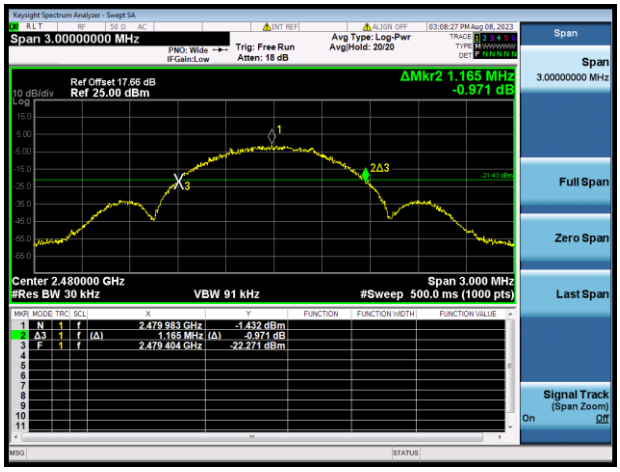
Test plots

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)	Frequency separation (MHz)	2/3 of the 20 dB Bandwidth (MHz)	Verdict
GFSK	0.995	1.026	0.684	Pass

Test Plots

GFSK

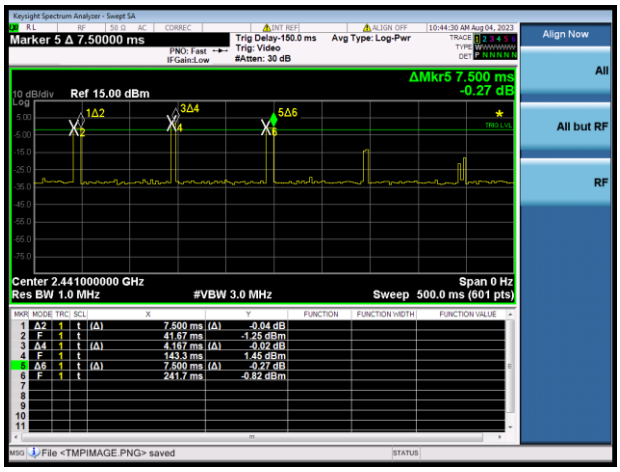
A.5 Time of Occupancy (Dwell time)

Test Data

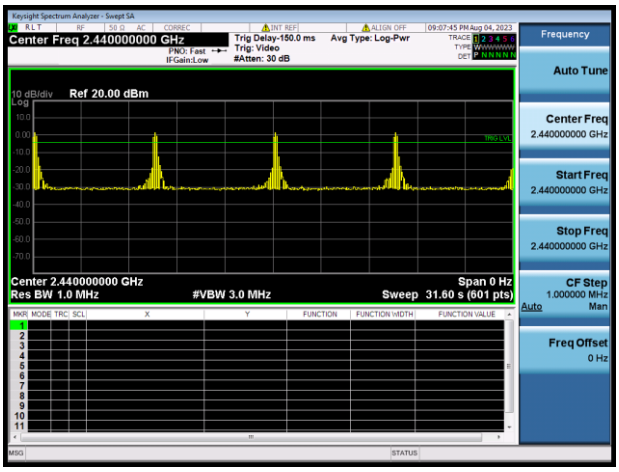
GFSK			
Pulse Width (ms)	Total of Dwell (ms)	Limit (sec)	Verdict
19.167	76.668	0.4	Pass

Test Plots

Pulse Width



Total of Dwell



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

Test Data

GFSK Mode:

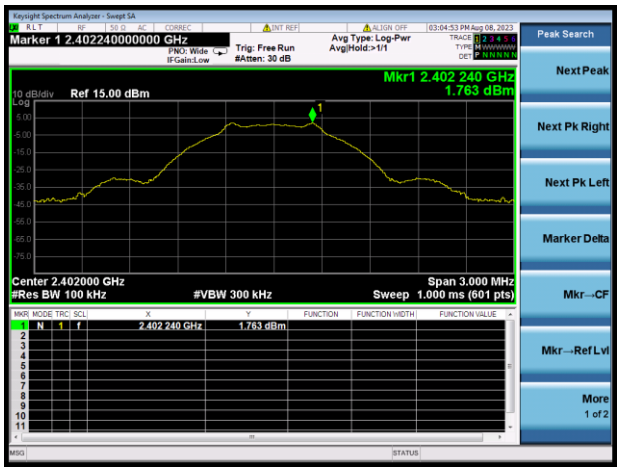
GFSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-23.04	1.76	-18.24	Pass
Middle	-25.60	1.64	-18.36	Pass
High	-24.32	1.26	-18.74	Pass

Hopping Mode:

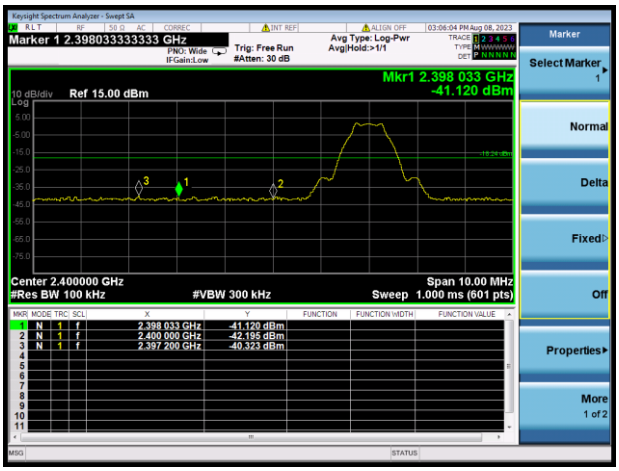
GFSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
GFSK	-24.58	1.65	-18.35	Pass

Test Plots

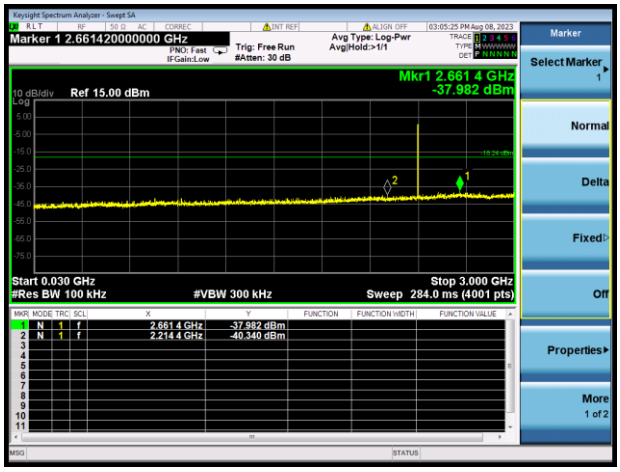
GFSK LOW CHANNEL, CARRIER LEVEL



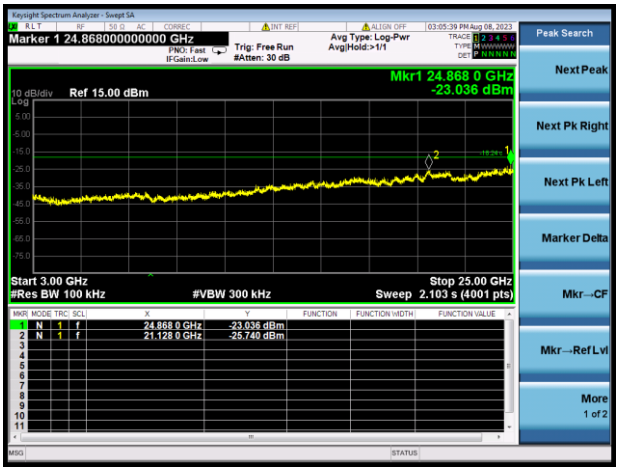
GFSK LOW CHANNEL, BAND EDGE



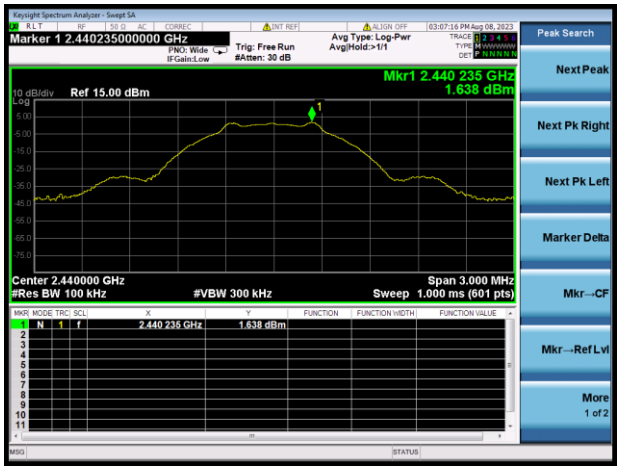
GFSK LOW CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



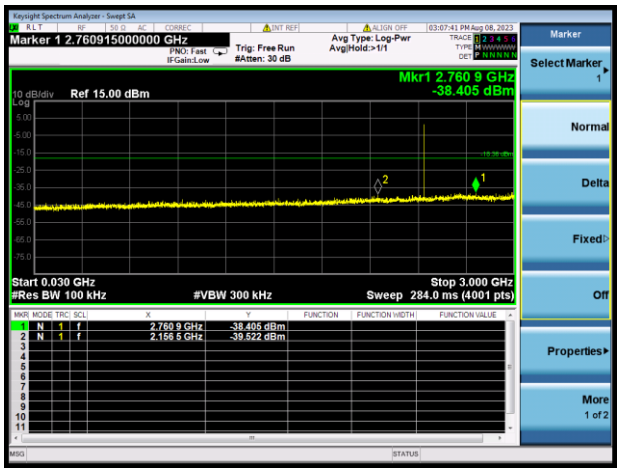
GFSK LOW CHANNEL, SPURIOUS 3 GHz ~ 25 GHz



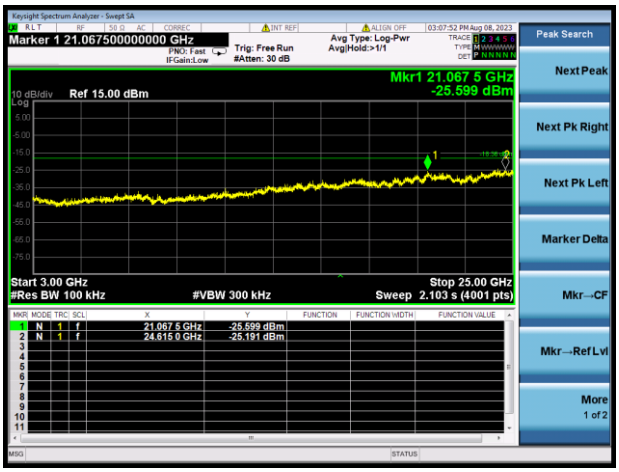
GFSK MIDDLE CHANNEL, CARRIER LEVEL



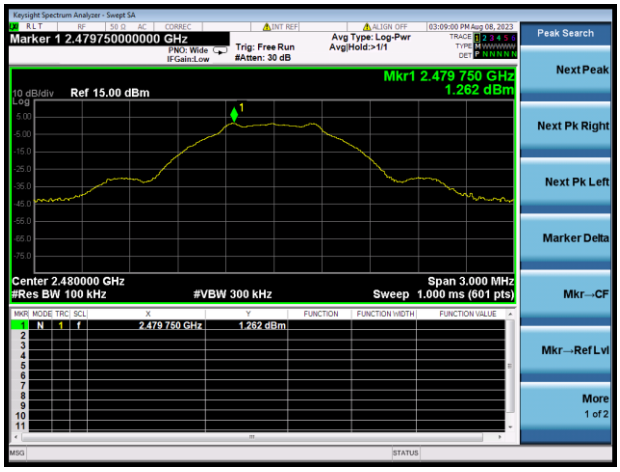
GFSK MIDDLE CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



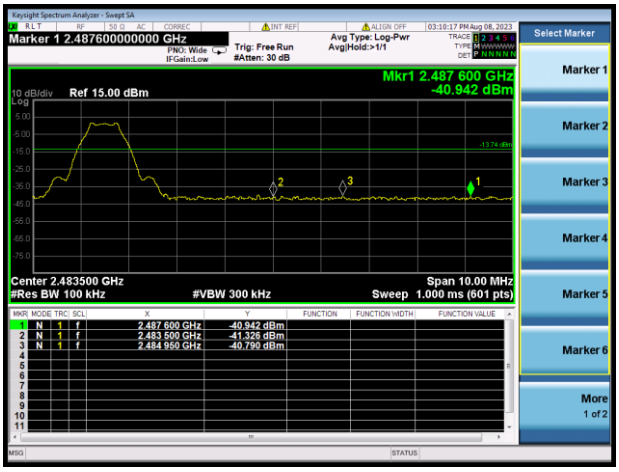
GFSK MIDDLE CHANNEL, SPURIOUS 3 GHz ~ 25 GHz



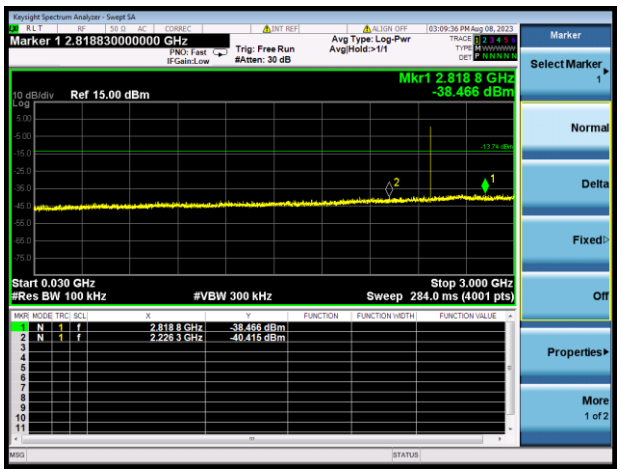
GFSK HIGH CHANNEL, CARRIER LEVEL



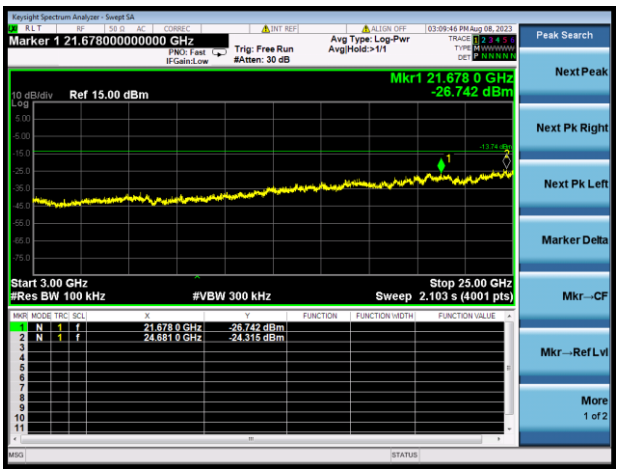
GFSK HIGH CHANNEL, BAND EDGE



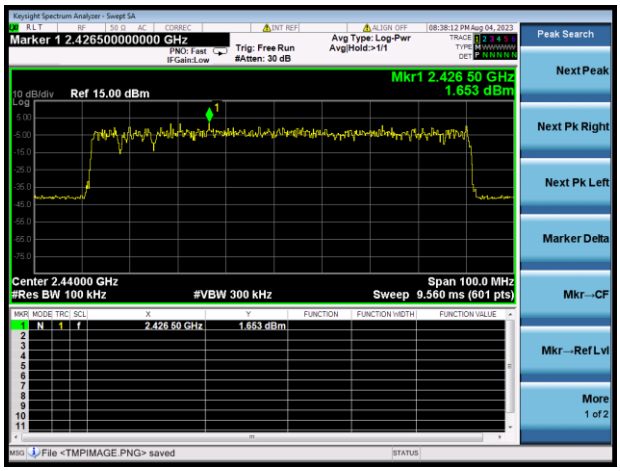
GFSK HIGH CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



GFSK HIGH CHANNEL, SPURIOUS 3 GHz ~ 25 GHz



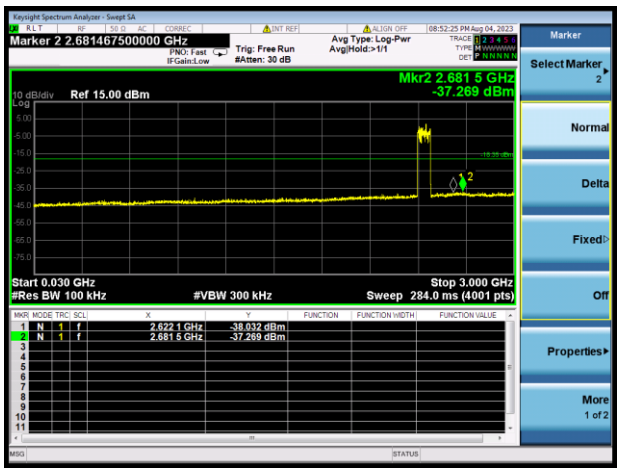
GFSK HOPPING, CARRIER LEVEL



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

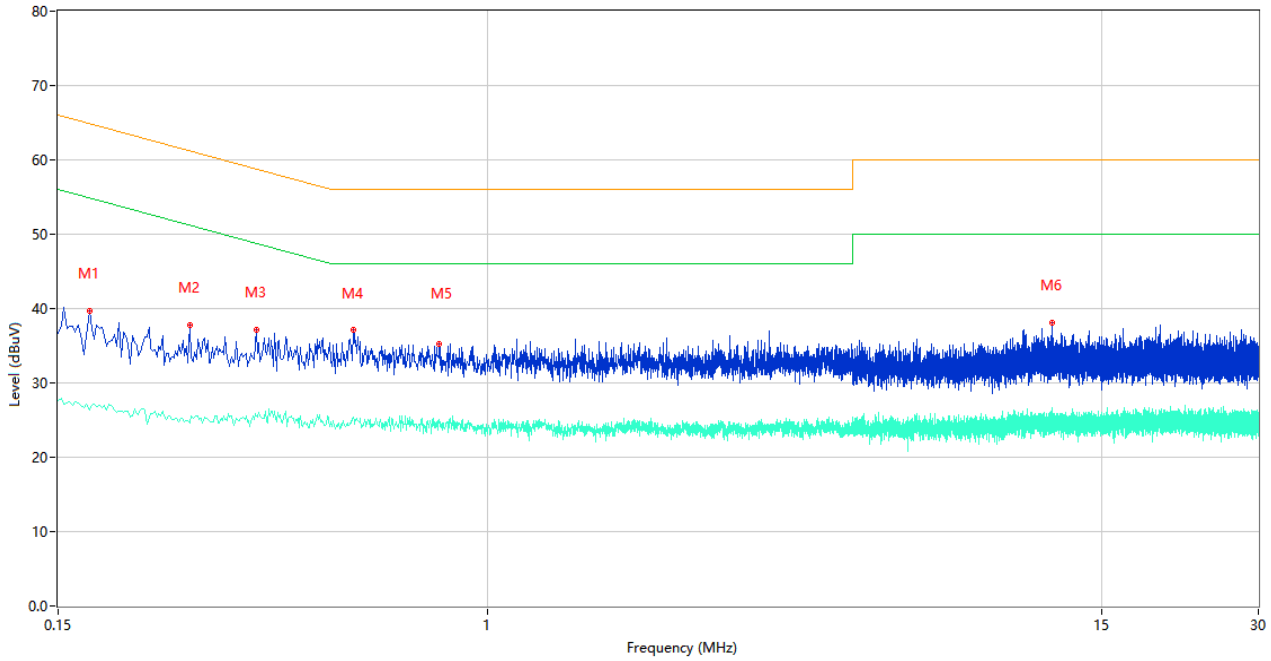
A.7 Conducted Emissions

Note [1]: The EUT is working in the Normal link mode. All modes have been tested and normal link mode is worst.

Note [2]: Results (dBuV) = Original reading level of Spectrum Analyzer (dBuV) + Factor (dB)

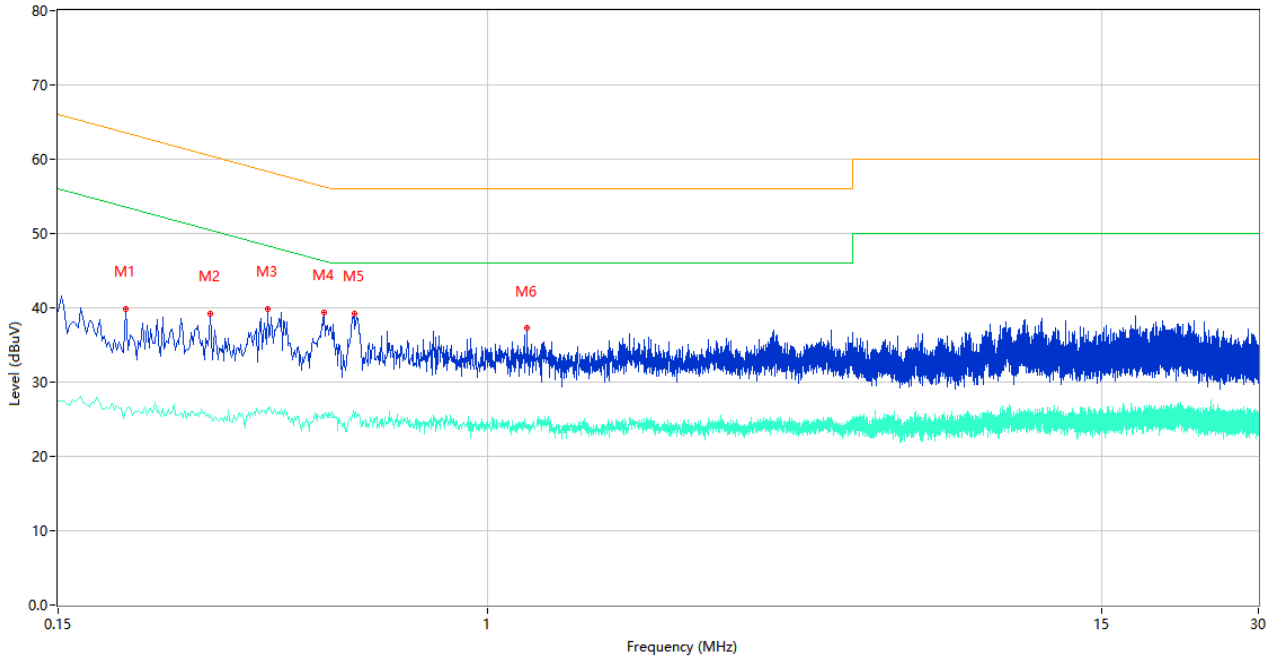
Test Data and Plots

PHASE L



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.172	39.69	9.78	64.86	25.17	Peak	L	Pass
1**	0.172	26.37	9.78	54.86	28.49	AV	L	Pass
2	0.268	37.83	9.76	61.18	23.35	Peak	L	Pass
2**	0.268	24.54	9.76	51.18	26.64	AV	L	Pass
3	0.360	37.19	10.72	58.73	21.54	Peak	L	Pass
3**	0.360	25.50	10.72	48.73	23.23	AV	L	Pass
4	0.552	37.08	10.04	56.00	18.92	Peak	L	Pass
4**	0.552	25.39	10.04	46.00	20.61	AV	L	Pass
5	0.808	35.25	10.54	56.00	20.75	Peak	L	Pass
5**	0.808	25.00	10.54	46.00	21.00	AV	L	Pass
6	12.064	38.14	10.43	60.00	21.86	Peak	L	Pass
6**	12.064	25.72	10.43	50.00	24.28	AV	L	Pass

PHASE N



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.202	39.80	9.77	63.53	23.73	Peak	N	Pass
1**	0.202	26.17	9.77	53.53	27.36	AV	N	Pass
2	0.294	39.27	9.76	60.41	21.14	Peak	N	Pass
2**	0.294	25.63	9.76	50.41	24.78	AV	N	Pass
3	0.378	39.84	10.64	58.32	18.48	Peak	N	Pass
3**	0.378	26.55	10.64	48.32	21.77	AV	N	Pass
4	0.486	39.37	10.00	56.24	16.87	Peak	N	Pass
4**	0.486	25.20	10.00	46.24	21.04	AV	N	Pass
5	0.554	39.22	10.04	56.00	16.78	Peak	N	Pass
5**	0.554	25.89	10.04	46.00	20.11	AV	N	Pass
6	1.190	37.27	9.99	56.00	18.73	Peak	N	Pass
6**	1.190	23.97	9.99	46.00	22.03	AV	N	Pass

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.

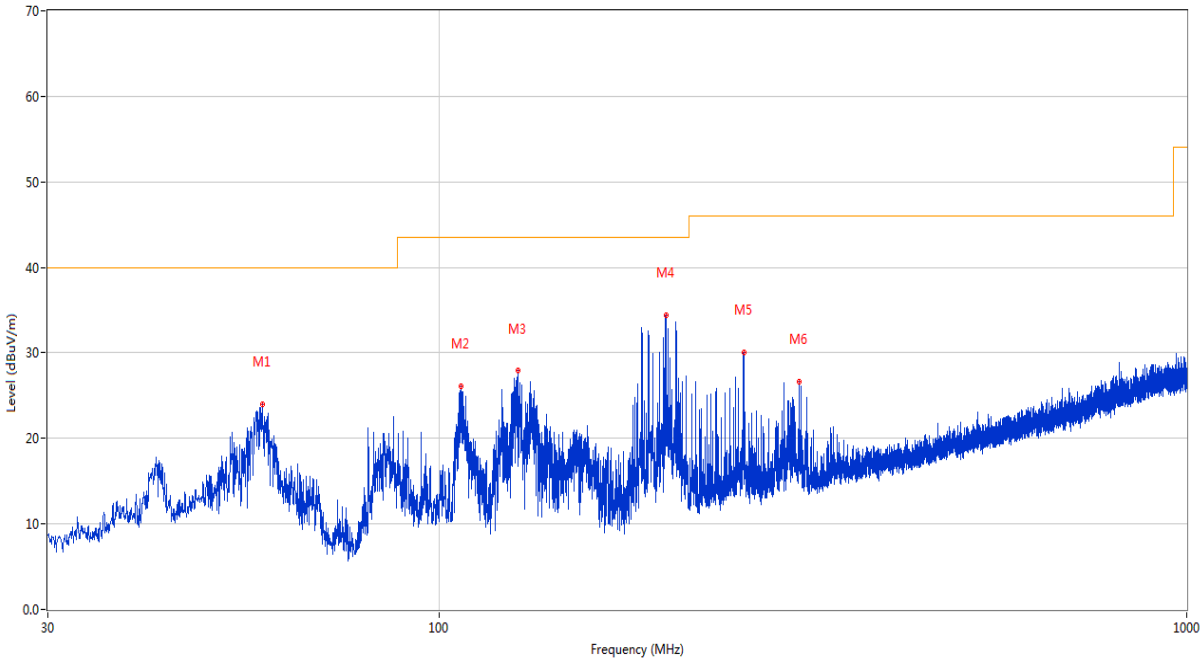
Note [3]: The EUT is working in the Normal link mode below 1 GHz. All modes have been tested and DH5-Hopping mode is the worst.

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.

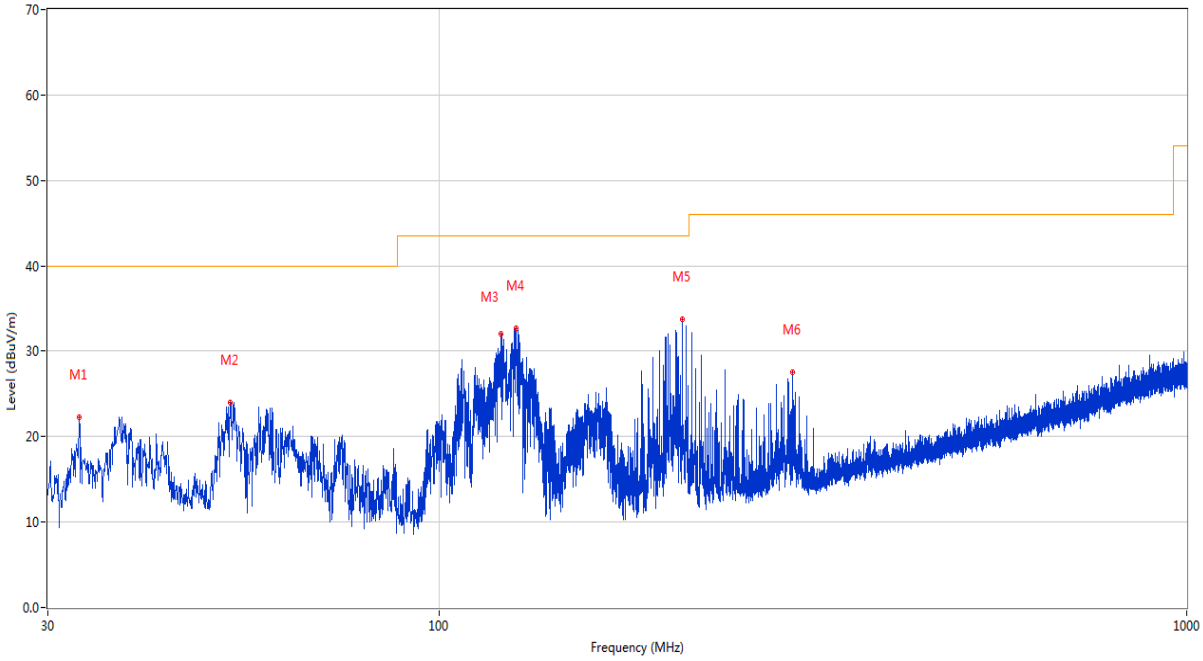
Test Data and Plots

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	58.130	24.03	-24.10	40.0	15.97	Peak	178.20	200	Horizontal	Pass
2	107.212	26.10	-24.21	43.5	17.40	Peak	171.60	200	Horizontal	Pass
3	127.582	27.89	-27.17	43.5	15.61	Peak	173.80	200	Horizontal	Pass
4	201.108	34.36	-23.93	43.5	9.14	Peak	213.10	200	Horizontal	Pass
5	255.574	30.02	-22.60	46.0	15.98	Peak	71.40	100	Horizontal	Pass
6	303.540	26.63	-21.15	46.0	19.37	Peak	193.60	100	Horizontal	Pass

30 MHz to 1 GHz, ANT V

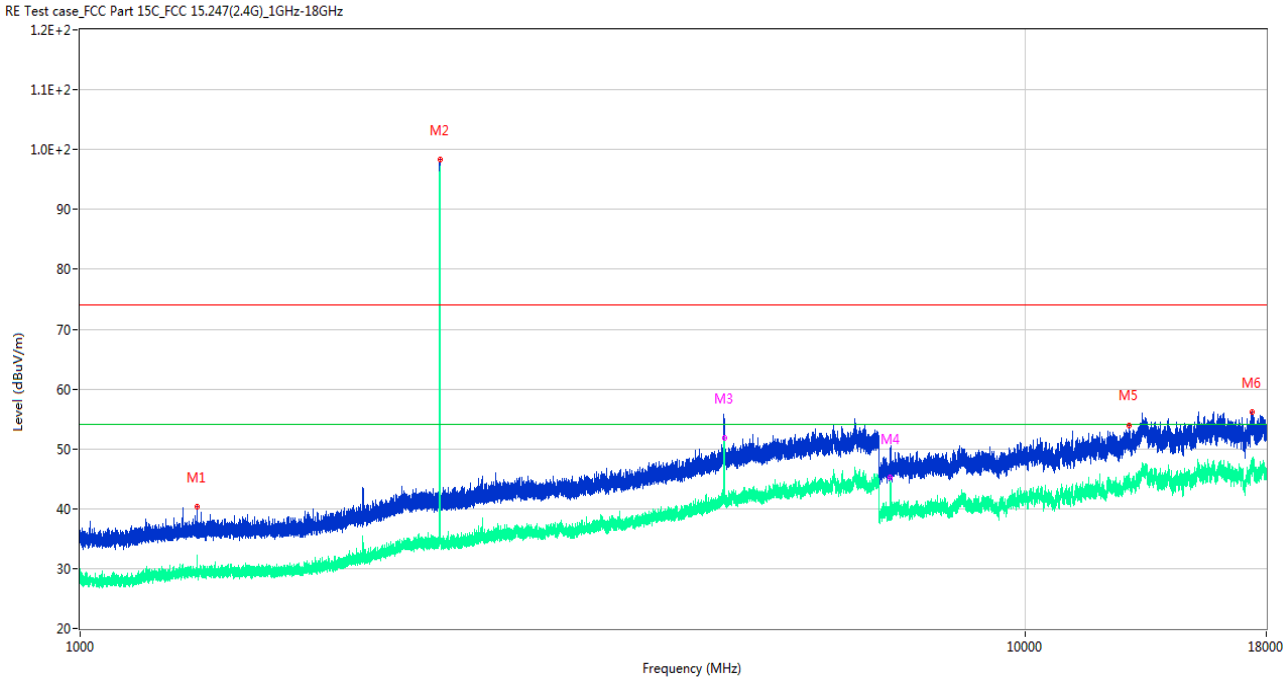


No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	33.056	22.26	-26.36	40.0	17.74	Peak	206.10	100	Vertical	Pass
2	52.601	23.96	-23.07	40.0	16.04	Peak	213.00	100	Vertical	Pass
3	121.083	32.07	-25.80	43.5	11.43	Peak	58.30	100	Vertical	Pass
4	126.951	32.71	-26.95	43.5	10.79	Peak	114.80	100	Vertical	Pass
5	211.487	33.74	-24.07	43.5	9.76	Peak	359.80	100	Vertical	Pass
6	297.090	27.61	-21.52	46.0	18.39	Peak	172.60	100	Vertical	Pass

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

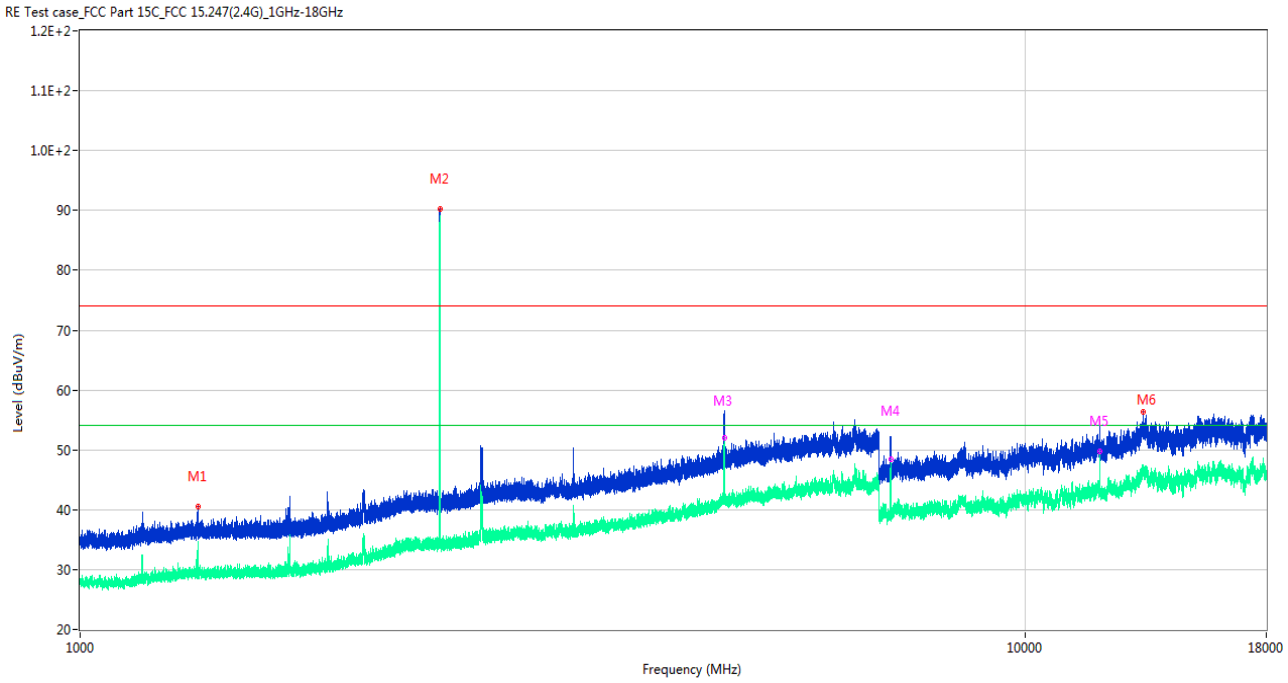
Note 2: The spurious from 18GHz-25GHz is noise only, do not show on the report.

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT H



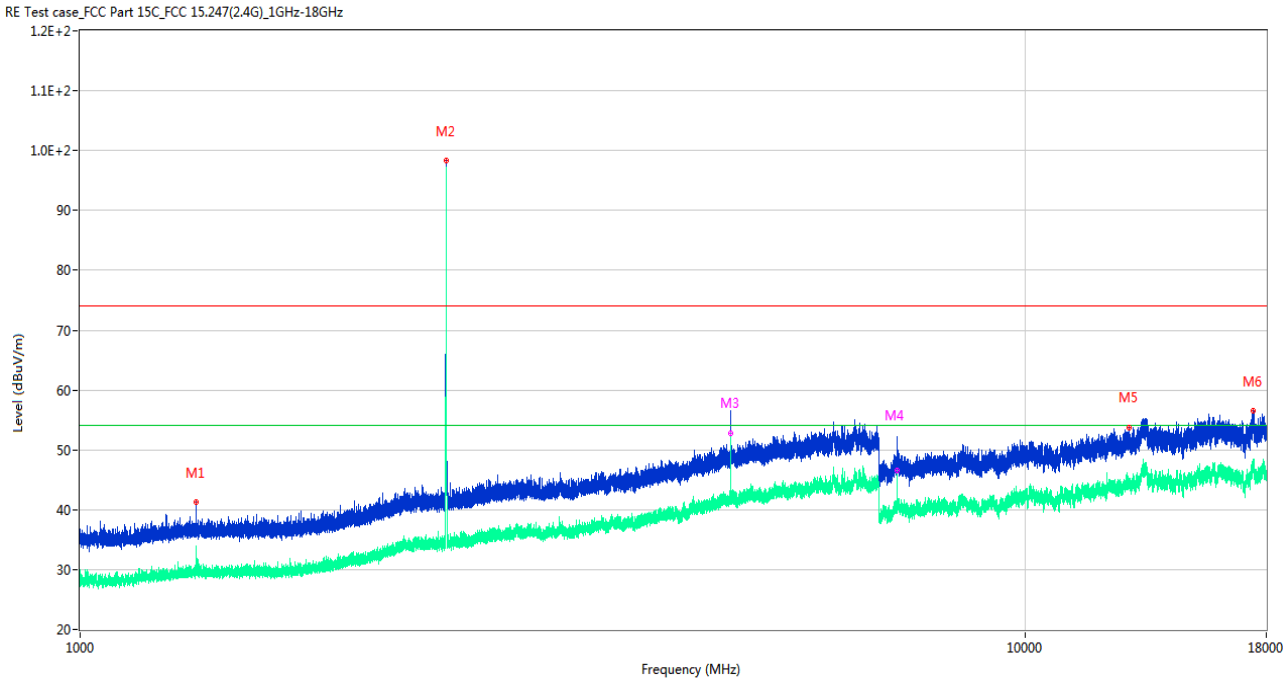
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1329.300	40.25	-17.60	74.0	33.75	Peak	110.00	200	Horizontal	Pass
1**	1329.300	28.57	-17.60	54.0	25.43	AV	110.00	200	Horizontal	Pass
2	2402.500	98.27	-12.38	74.0	-24.27	Peak	43.00	200	Horizontal	N/A
2**	2402.500	96.48	-12.38	54.0	-42.48	AV	43.00	200	Horizontal	N/A
3	4805.000	54.76	-3.20	74.0	19.24	Peak	67.00	150	Horizontal	Pass
3**	4805.000	51.81	-3.20	54.0	2.19	AV	67.00	150	Horizontal	Pass
4	7204.987	49.18	-4.34	74.0	24.82	Peak	308.00	150	Horizontal	Pass
4**	7204.987	45.18	-4.34	54.0	8.82	AV	308.00	150	Horizontal	Pass
5	12875.475	53.96	1.51	74.0	20.04	Peak	171.00	300	Horizontal	Pass
5**	12875.475	44.35	1.51	54.0	9.65	AV	171.00	300	Horizontal	Pass
6	17409.901	56.13	3.44	74.0	17.87	Peak	214.00	300	Horizontal	Pass
6**	17409.901	47.83	3.44	54.0	6.17	AV	214.00	300	Horizontal	Pass

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT V



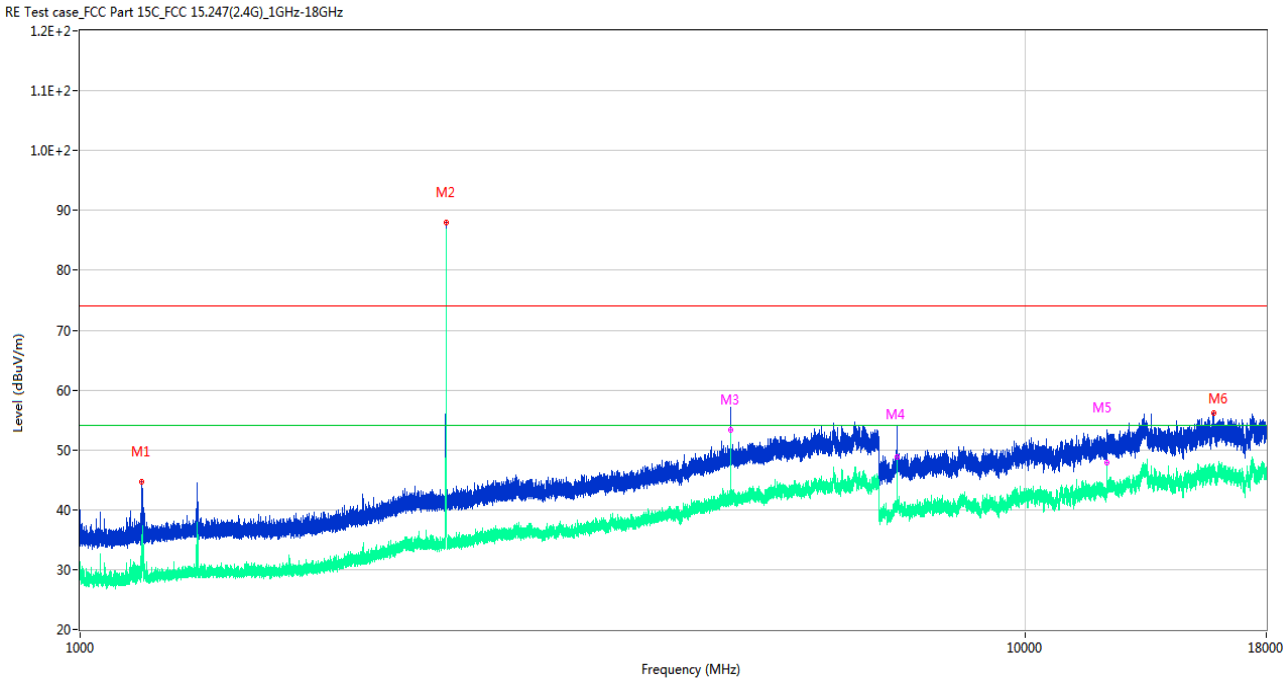
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1331.900	40.53	-17.51	74.0	33.47	Peak	50.00	200	Vertical	Pass
1**	1331.900	34.72	-17.51	54.0	19.28	AV	50.00	200	Vertical	Pass
2	2402.500	90.31	-12.38	74.0	-16.31	Peak	9.00	100	Vertical	N/A
2**	2402.500	88.53	-12.38	54.0	-34.53	AV	9.00	100	Vertical	N/A
3	4804.000	55.65	-3.14	74.0	18.35	Peak	295.00	150	Vertical	Pass
3**	4804.000	51.92	-3.14	54.0	2.08	AV	295.00	150	Vertical	Pass
4	7207.862	52.10	-4.08	74.0	21.90	Peak	55.00	150	Vertical	Pass
4**	7207.862	48.50	-4.08	54.0	5.50	AV	55.00	150	Vertical	Pass
5	12007.675	52.57	1.23	74.0	21.43	Peak	17.00	150	Vertical	Pass
5**	12007.675	49.83	1.23	54.0	4.17	AV	17.00	150	Vertical	Pass
6	13341.412	56.42	1.06	74.0	17.58	Peak	360.00	400	Vertical	Pass
6**	13341.412	46.98	1.06	54.0	7.02	AV	360.00	400	Vertical	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H



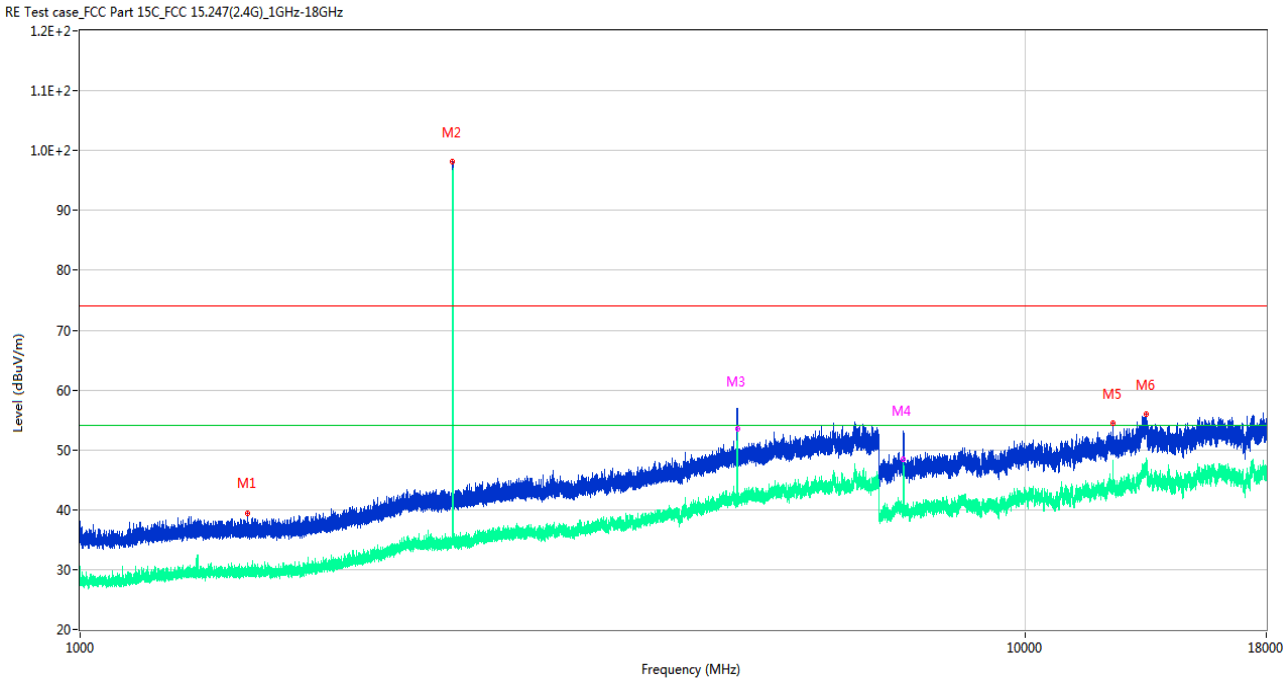
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1327.800	41.27	-17.64	74.0	32.73	Peak	53.00	400	Horizontal	Pass
1**	1327.800	33.53	-17.64	54.0	20.47	AV	53.00	400	Horizontal	Pass
2	2439.500	98.26	-12.40	74.0	-24.26	Peak	47.00	150	Horizontal	N/A
2**	2439.500	95.96	-12.40	54.0	-41.96	AV	47.00	150	Horizontal	N/A
3	4881.200	55.47	-3.35	74.0	18.53	Peak	70.00	150	Horizontal	Pass
3**	4881.200	52.78	-3.35	54.0	1.22	AV	70.00	150	Horizontal	Pass
4	7321.713	50.88	-3.51	74.0	23.12	Peak	21.00	150	Horizontal	Pass
4**	7321.713	46.60	-3.51	54.0	7.40	AV	21.00	150	Horizontal	Pass
5	12878.363	53.80	1.54	74.0	20.20	Peak	257.00	300	Horizontal	Pass
5**	12878.363	44.40	1.54	54.0	9.60	AV	257.00	300	Horizontal	Pass
6	17412.786	56.47	3.55	74.0	17.53	Peak	235.00	400	Horizontal	Pass
6**	17412.786	47.48	3.55	54.0	6.52	AV	235.00	400	Horizontal	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V



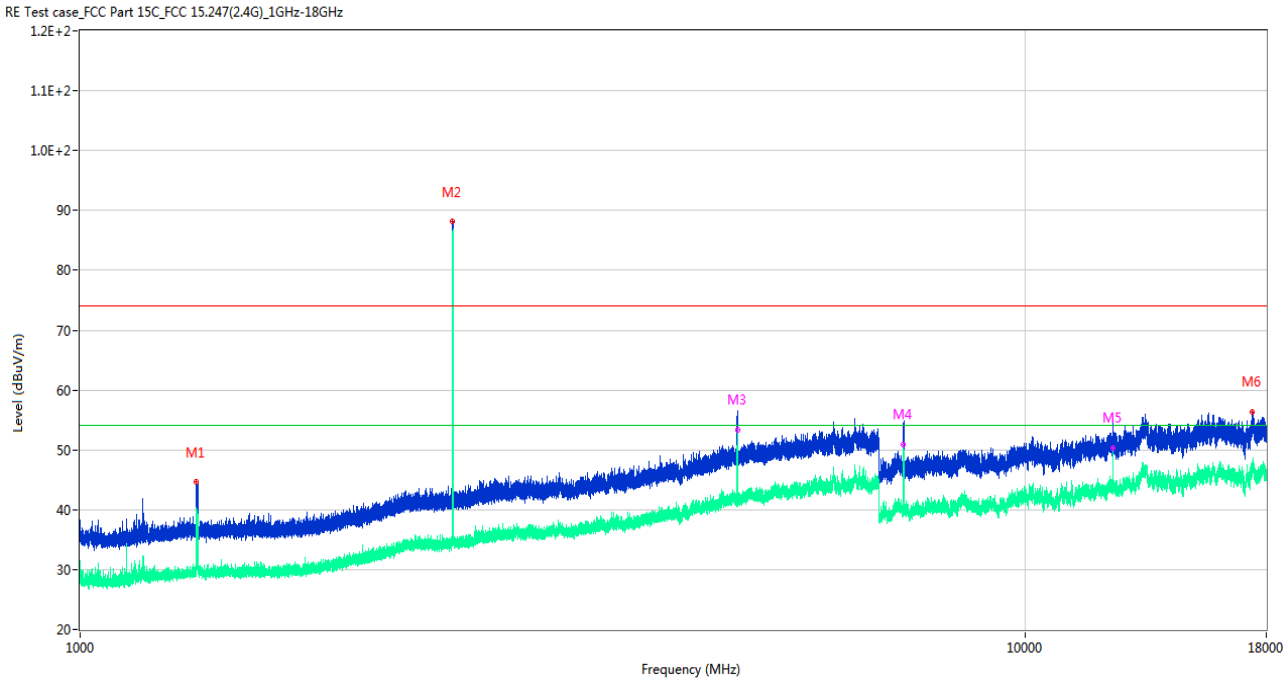
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1163.000	44.68	-17.94	74.0	29.32	Peak	286.00	200	Vertical	Pass
1**	1163.000	35.44	-17.94	54.0	18.56	AV	286.00	200	Vertical	Pass
2	2440.500	87.99	-12.42	74.0	-13.99	Peak	152.00	150	Vertical	N/A
2**	2440.500	85.30	-12.42	54.0	-31.30	AV	152.00	150	Vertical	N/A
3	4879.400	57.18	-3.38	74.0	16.82	Peak	173.00	150	Vertical	Pass
3**	4879.400	53.37	-3.38	54.0	0.63	AV	173.00	150	Vertical	Pass
4	7318.837	53.85	-3.33	74.0	20.15	Peak	61.00	150	Vertical	Pass
4**	7318.837	48.78	-3.33	54.0	5.22	AV	61.00	150	Vertical	Pass
5	12202.599	51.77	0.75	74.0	22.23	Peak	82.00	150	Vertical	Pass
5**	12202.599	47.96	0.75	54.0	6.04	AV	82.00	150	Vertical	Pass
6	15843.299	56.22	1.39	74.0	17.78	Peak	300.00	400	Vertical	Pass
6**	15843.299	46.91	1.39	54.0	7.09	AV	300.00	400	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	1504.700	39.46	-17.37	74.0	34.54	Peak	75.00	200	Horizontal	Pass
1**	1504.700	31.11	-17.37	54.0	22.89	AV	75.00	200	Horizontal	Pass
2	2479.500	98.13	-12.04	74.0	-24.13	Peak	40.00	150	Horizontal	N/A
2**	2479.500	95.66	-12.04	54.0	-41.66	AV	40.00	150	Horizontal	N/A
3	4961.000	57.72	-2.92	74.0	16.28	Peak	82.00	150	Horizontal	Pass
3**	4961.000	53.51	-2.92	54.0	0.49	AV	82.00	150	Horizontal	Pass
4	7438.725	52.73	-3.78	74.0	21.27	Peak	48.00	150	Horizontal	Pass
4**	7438.725	48.41	-3.78	54.0	5.59	AV	48.00	150	Horizontal	Pass
5	12402.413	54.38	1.53	74.0	19.62	Peak	221.00	300	Horizontal	Pass
5**	12402.413	46.67	1.53	54.0	7.33	AV	221.00	300	Horizontal	Pass
6	13428.825	55.88	0.40	74.0	18.12	Peak	31.00	200	Horizontal	Pass
6**	13428.825	46.18	0.40	54.0	7.82	AV	31.00	200	Horizontal	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT V



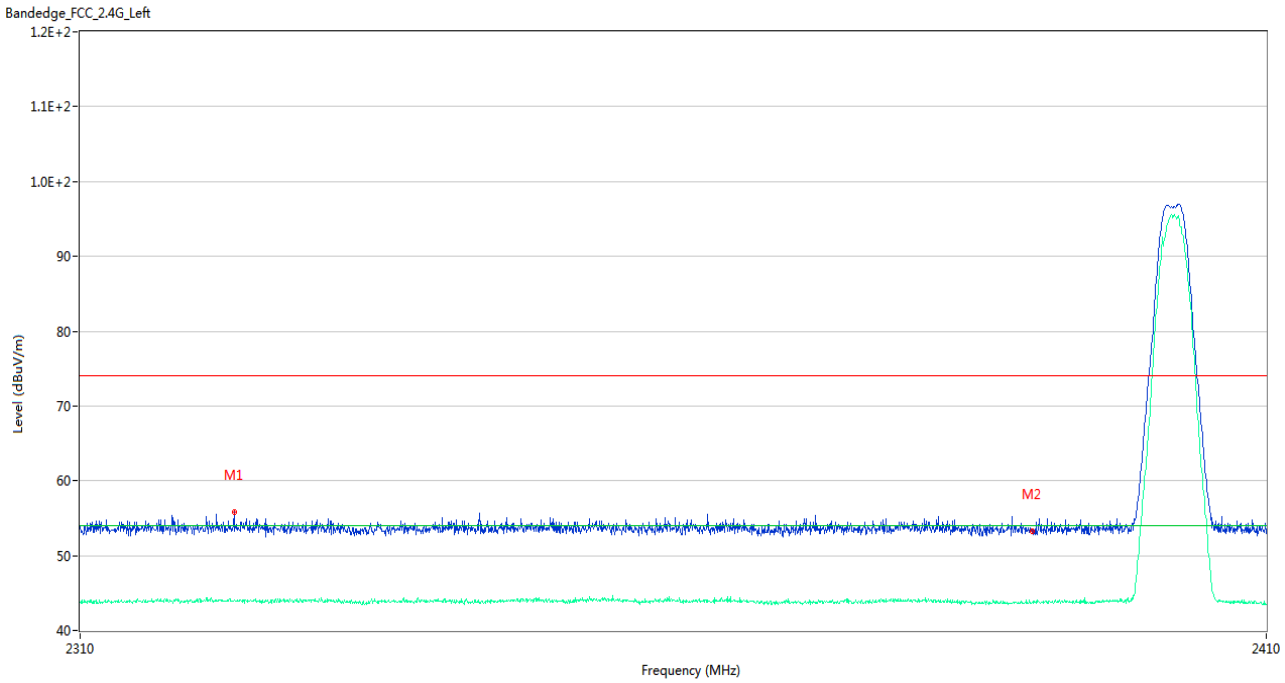
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1327.900	44.59	-17.65	74.0	29.41	Peak	282.00	300	Vertical	Pass
1**	1327.900	35.45	-17.65	54.0	18.55	AV	282.00	300	Vertical	Pass
2	2479.500	88.09	-12.04	74.0	-14.09	Peak	47.00	200	Vertical	N/A
2**	2479.500	85.19	-12.04	54.0	-31.19	AV	47.00	200	Vertical	N/A
3	4961.000	58.52	-2.92	74.0	15.48	Peak	171.00	150	Vertical	Pass
3**	4961.000	53.42	-2.92	54.0	0.58	AV	171.00	150	Vertical	Pass
4	7438.725	54.35	-3.78	74.0	19.65	Peak	73.00	150	Vertical	Pass
4**	7438.725	50.91	-3.78	54.0	3.09	AV	73.00	150	Vertical	Pass
5	12402.413	54.06	1.53	74.0	19.94	Peak	44.00	150	Vertical	Pass
5**	12402.413	50.37	1.53	54.0	3.63	AV	44.00	150	Vertical	Pass
6	17408.063	56.43	3.40	74.0	17.57	Peak	347.00	300	Vertical	Pass
6**	17408.063	47.48	3.40	54.0	6.52	AV	347.00	300	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.

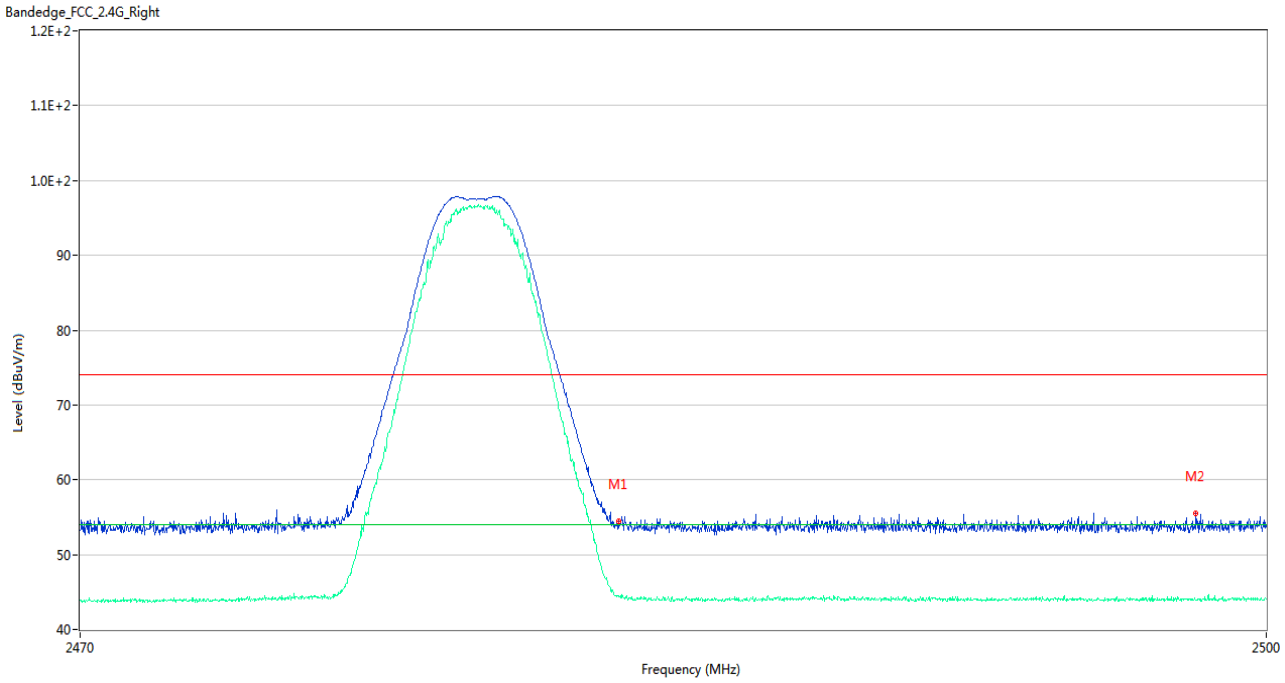
Test Data

GFSK LOW CHANNEL



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2322.750	55.79	-0.63	74.0	18.21	Peak	42.00	100	Horizontal	Pass
1**	2322.750	44.00	-0.63	54.0	10.00	AV	42.00	100	Horizontal	Pass
2	2389.950	53.29	-0.59	74.0	20.71	Peak	287.00	200	Horizontal	Pass
2**	2389.950	43.78	-0.59	54.0	10.22	AV	287.00	200	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	2483.575	54.40	-0.06	74.0	19.60	Peak	18.00	100	Horizontal	Pass
1**	2483.575	44.30	-0.06	54.0	9.70	AV	18.00	100	Horizontal	Pass
2	2498.215	55.56	-0.21	74.0	18.44	Peak	28.00	150	Horizontal	Pass
2**	2498.215	43.99	-0.21	54.0	10.01	AV	28.00	150	Horizontal	Pass

ANNEX B TEST SETUP PHOTOS

Please refer the document “BL-SZ2361067-AR.PDF”.

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document “BL-SZ2361067-AW.PDF”.

ANNEX D EUT INTERNAL PHOTOS

Please refer the document “BL-SZ2361067-AI.PDF”.

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--END OF REPORT--