

TEST REPORT

Applicant: SHENZHEN 8BITDO TECH CO., LTD.
Address: Room 210, Building 1, Nanhai Ecool, No.6 Xinghua Road, Shekou, Nanshan District, Shenzhen, Guangdong, P.R. China
Equipment Type: 8BitDo Ultimate 2.4G wireless Controller
Model Name: 81HA (refer section 2.4)
Brand Name: 8BITDO
FCC ID: 2AOWF-24GULTIMATE
Test Standard: 47 CFR Part 15 Subpart C (refer section 3.1)
Test Date: Aug. 23, 2022 - Sep. 26, 2022
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ISSUED BY:

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Revision History		
Version	Issue Date	Revisions
<u>Rev. 01</u>	<u>Sep. 26, 2022</u>	<u>Initial Issue</u>

TABLE OF CONTENTS

1	GENERAL INFORMATION	4
1.1	Test Laboratory	4
1.2	Test Location	4
2	PRODUCT INFORMATION	5
2.1	Applicant Information	5
2.2	Manufacturer Information	5
2.3	Factory Information	5
2.4	General Description for Equipment under Test (EUT)	5
2.5	Technical Information	6
3	SUMMARY OF TEST RESULTS	8
3.1	Test Standards	8
3.2	Verdict	8
4	GENERAL TEST CONFIGURATIONS	9
4.1	Test Environments	9
4.2	Test Equipment List	9
4.3	Test Software List	9
4.4	Description of Test Setup	10
4.5	Measurement Results Explanation Example	13
5	TEST ITEMS	14
5.1	Antenna Requirements	14
5.2	Number of Hopping Frequency	15
5.3	Peak Output Power	16
5.4	Occupied Bandwidth	17
5.5	Carrier Frequency Separation	18

5.6	Time of Occupancy (Dwell time)	19
5.7	Conducted Spurious Emission & Authorized-band band-edge	20
5.8	Conducted Emission	21
5.9	Radiated Spurious Emission	22
5.10	Band Edge (Restricted-band band-edge).....	24
ANNEX A	TEST RESULT	25
A.1	Number of Hopping Frequency	25
A.2	Peak Output Power	26
A.3	Occupied Bandwidth	27
A.4	Hopping Frequency Separation.....	29
A.5	Time of Occupancy (Dwell time)	30
A.6	Conducted Spurious Emissions & Authorized-band band-edge	31
A.7	Conducted Emissions.....	35
A.8	Radiated Emission	37
A.9	Band Edge (Restricted-band band-edge).....	45
ANNEX B	TEST SETUP PHOTOS	47
ANNEX C	EUT EXTERNAL PHOTOS	47
ANNEX D	EUT INTERNAL PHOTOS	47

1 GENERAL INFORMATION

1.1 Test Laboratory

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

1.2 Test Location

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

2 PRODUCT INFORMATION

2.1 Applicant Information

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

2.3 Factory Information

Factory	Shenzhen Zhongxingda Electronic Co., Ltd.
Address	3-4/F, Bldg 10, Tongfuyu Industrial Zone, Lezhujiao Village, Xixiang, Baoan District, Shenzhen, Guangdong, P.R. China

2.4 General Description for Equipment under Test (EUT)

EUT Name	8BitDo Ultimate 2.4G wireless Controller
Model Name Under Test	81HA
Series Model Name	81HA01, 81HA02, 81HA03
Description of Model name differentiation	the hardware circuit and software are identical to the basic model, except the model names and screen printing of the shell (this information provided by the customer).
Hardware Version	V9
Software Version	V1.08
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.5 Technical Information

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

Modulation Technology	FHSS
Modulation Type	GFSK
Product Type	<input type="checkbox"/> Mobile <input checked="" type="checkbox"/> Portable <input type="checkbox"/> Fix Location
Transfer Rate	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	79 (at intervals of 1 MHz)
Tested Channel	0 (2402 MHz), 39 (2441 MHz), 78 (2480 MHz)
Antenna Type	PCB Antenna
Antenna Gain	0.84 dBi
Adaptive or non-adaptive	non-adaptive
The Max RF Output power	2.95 dBm

Channel List

Channel number	Freq. (MHz)	Channel number	Freq. (MHz)	Channel number	Freq. (MHz)	Channel number	Freq. (MHz)
0	2402	21	2423	42	2444	63	2465
1	2403	22	2424	43	2445	64	2466
2	2404	23	2425	44	2446	65	2467
3	2405	24	2426	45	2447	66	2468
4	2406	25	2427	46	2448	67	2469
5	2407	26	2428	47	2449	68	2470
6	2408	27	2429	48	2450	69	2471
7	2409	28	2430	49	2451	70	2472
8	2410	29	2431	50	2452	71	2473
9	2411	30	2432	51	2453	72	2474
10	2412	31	2433	52	2454	73	2475
11	2413	32	2434	53	2455	74	2476
12	2414	33	2435	54	2456	75	2477
13	2415	34	2436	55	2457	76	2478
14	2416	35	2437	56	2458	77	2479
15	2417	36	2438	57	2459	78	2480
16	2418	37	2439	58	2460	-	-
17	2419	38	2440	59	2461	-	-
18	2420	39	2441	60	2462	-	-
19	2421	40	2442	61	2463	-	-
20	2422	41	2443	62	2464	-	-

Note: The modulation is GFSK with FHSS, there are a total 79 channels (frequency range is 2402-2480MHz, channel step is 1MHz). In this report, the equipment selects the lowest, middle and highest channel from 79 channels, which are 2402 MHz, 2441 MHz and 2480 MHz. For 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	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	52% to 65%	
Atmospheric Pressure	100 kPa to 102 kPa	
Temperature	NT (Normal Temperature)	+18.0°C to +24.9°C
Working Voltage of the EUT	NV (Normal Voltage)	5 V

4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	KEYSIGHT	N9020A	MY50330200	2022.05.19	2023.05.18
Spectrum Analyzer	ROHDE&SCHWARZ	FSV-40	101544	2022.01.04	2023.01.03
Spectrum Analyzer	KEYSIGHT	N9020A	MY50531259	2021.09.08	2022.09.07
Spectrum Analyzer	KEYSIGHT	N9020A	MY50531259	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	02460	2021.05.19	2024.05.08
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	2021.08.16	2024.08.15
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2021.10.10	2022.10.09
Test Antenna-Bi-Log (30 MHz-1 GHz)	SCHWARZBECK	VULB 9168	00883	2022.04.01	2025.03.31
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	KEYSIGHT	N9010B	MY57110309	2021.10.10	2022.10.09
LISN	SCHWARZBECK	NSLK 8127	8127-687	2022.06.01	2023.05.31
Shielded Enclosure	YiHeng Electronic Co., Ltd	3.5m*3.1m* 2.8m	N/A	2022.02.19	2025.02.18

4.3 Test Software List

Description	Manufacturer	Software Version	Serial No.	Applicable test Setup
BL410R	BALUN	V2.1.1.488	N/A	The section 4.5.1
BL410E	BALUN	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

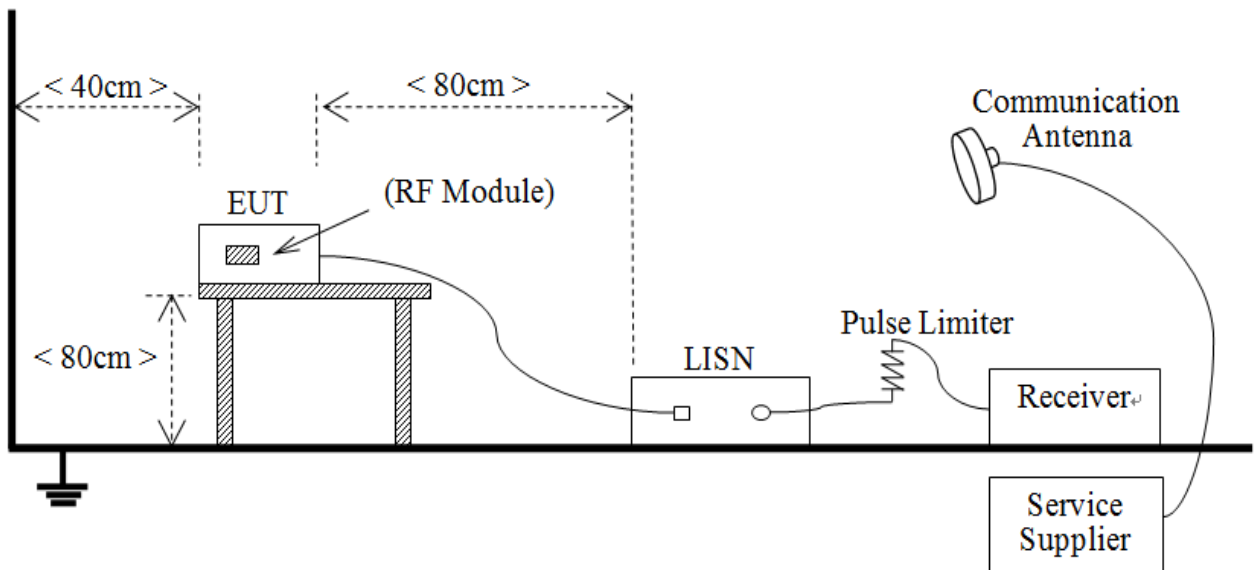
Conducted value (dBm) = Measurement value (dBm) + cable loss (dB)

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



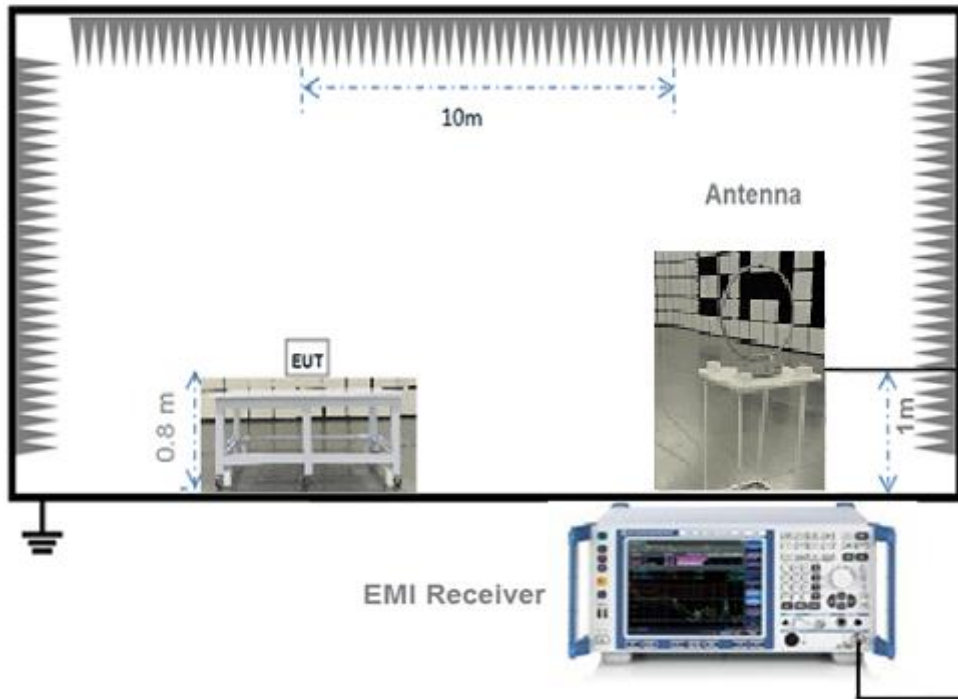
(Diagram 1)

4.4.2 For AC Power Supply Port Test



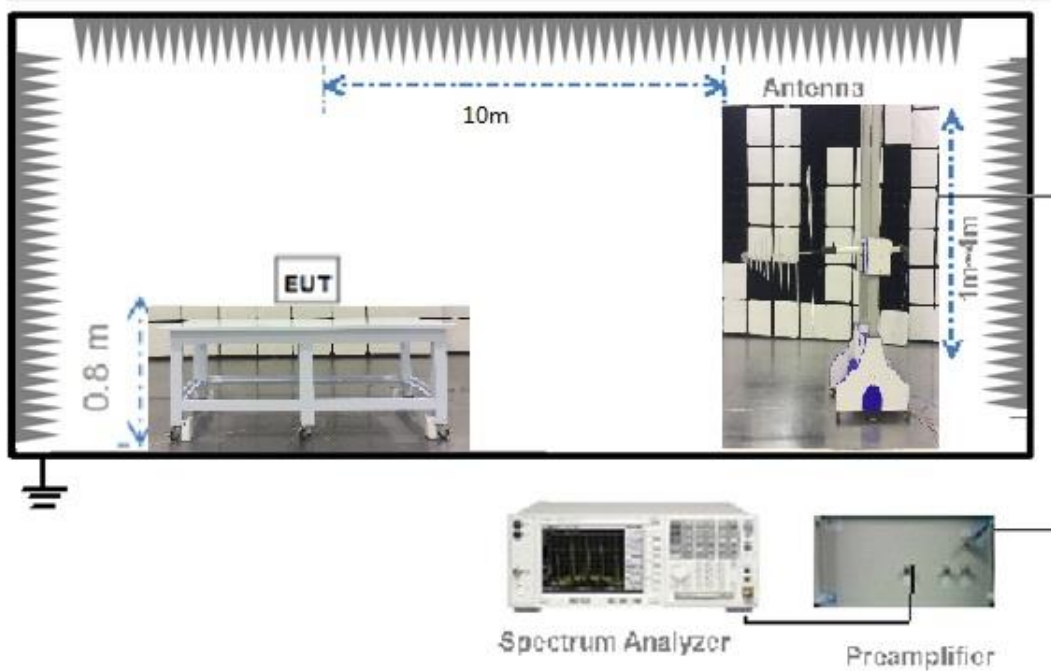
(Diagram 2)

4.4.3 For Radiated Test (Below 30 MHz)



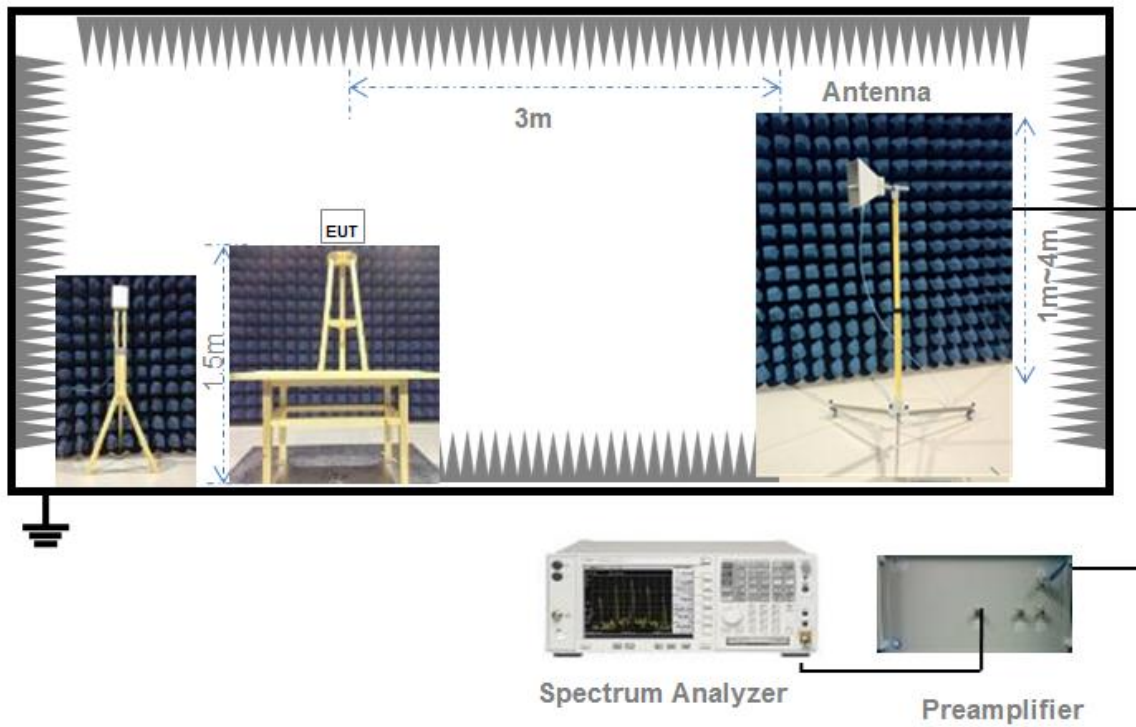
(Diagram 3)

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

Duty cycle = on time / 100 milliseconds

On time = dwell time * hopping number in 100 ms

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

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

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

Example:

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

5 TEST ITEMS

5.1 Antenna Requirements

5.1.1 Relevant Standards

FCC §15.203 & 15.247(b)

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

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

5.1.2 Antenna Anti-Replacement Construction

The Antenna Anti-Replacement as following method:

Protected Method	Description
The antenna is embedded in the product.	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 \geq 1% of the span

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

5.2.4 Test Result

Please refer to ANNEX A.1.

5.3 Peak Output Power

5.3.1 Test Limit

FCC § 15.247(b)

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels. 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 \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize.

5.3.4 Test Result

Please refer to ANNEX A.2.

5.4 Occupied Bandwidth

5.4.1 Limit

FCC §15.247(a)

Measurement of the 20dB bandwidth of the modulated signal.

5.4.2 Test Setup

See section 4.4.1 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 \geq 1% of the 20 dB bandwidth

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

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

5.4.4 Test Result

Please refer to ANNEX A.3.

5.5 Carrier Frequency Separation

5.5.1 Limit

FCC §15.247(a)

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

5.5.2 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) \geq 1% of the span

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

Sweep = auto

Detector function = peak

Trace = max hold

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

5.5.4 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 \geq 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 50 μ H/50 Ω line impedance stabilization network (LISN).

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

5.8.2 Test Setup

See section 4.4.2 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 ($\mu\text{V}/\text{m}$)	Measurement Distance (m)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100	3
88 - 216	150	3
216 - 960	200	3
Above 960	500	3

Note:

1. Field Strength (dB $\mu\text{V}/\text{m}$) = $20 \cdot \log[\text{Field Strength } (\mu\text{V}/\text{m})]$.
2. In the emission tables above, the tighter limit applies at the band edges.
3. For Above 1000 MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20dB above the maximum permitted average limit.
4. For above 1000 MHz, limit field strength of harmonics: 54dB $\mu\text{V}/\text{m}@3\text{m}$ (AV) and 74dB $\mu\text{V}/\text{m}@3\text{m}$ (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 $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

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

5.9.4 Test Result

Please refer to ANNEX A.8.

5.10 Band Edge (Restricted-band band-edge)

5.10.1 Limit

FCC §15.209&15.247(d)

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

5.10.2 Test Setup

See section 4.4.3 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 $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

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

5.10.4 Test Result

Please refer to ANNEX A.9.

ANNEX A TEST RESULT

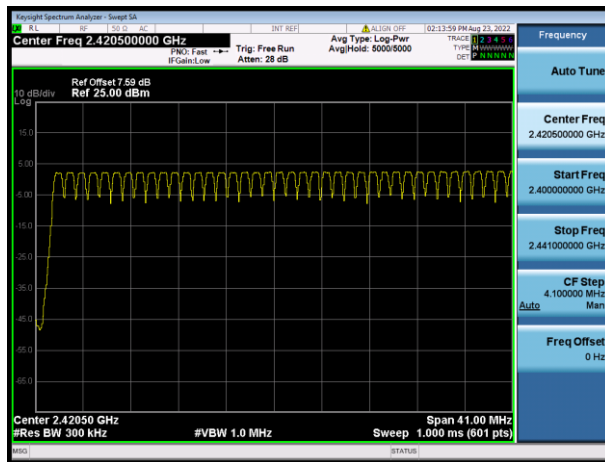
A.1 Number of Hopping Frequency

Test Data

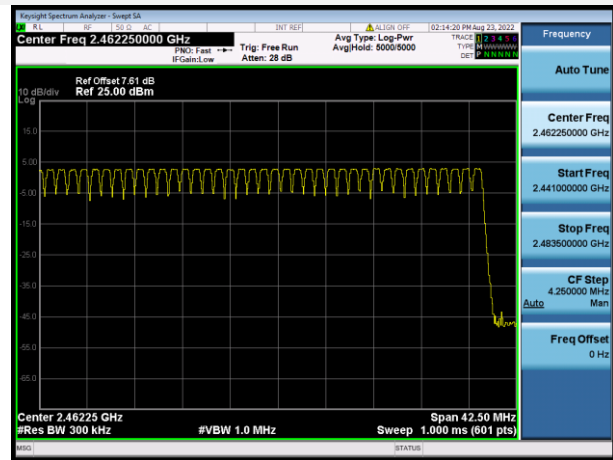
Test Mode	Frequency Block (MHz)	Measured Channel Numbers	Min. Limit	Verdict
GFSK	2400 - 2483.5	79	15	Pass

Test plots

GFSK 2.4 GHz ~ 2.4835 GHz



GFSK 2.4 GHz ~ 2.4835 GHz



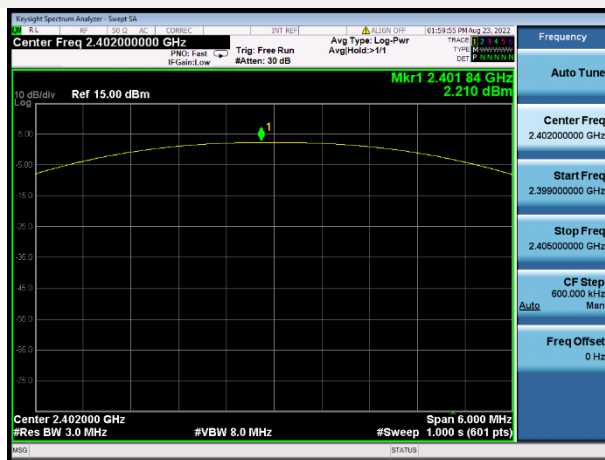
A.2 Peak Output Power

Peak Power Test Data

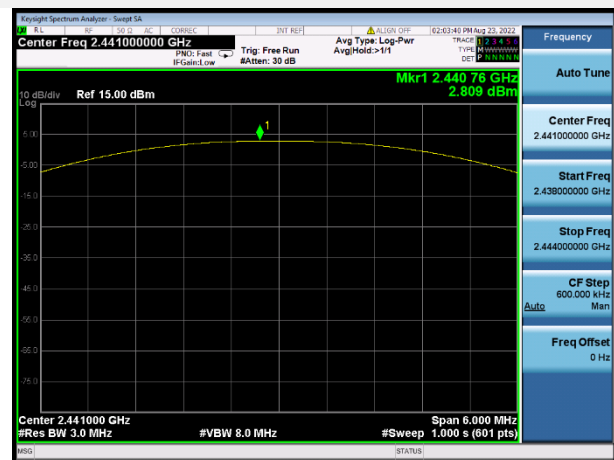
Channel	Measured Output Peak Power		Limit		Verdict
	dBm	mW	dBm	mW	
Low	2.21	1.66	30	1000	Pass
Middle	2.81	1.91			Pass
High	2.95	1.97			Pass

Test plots

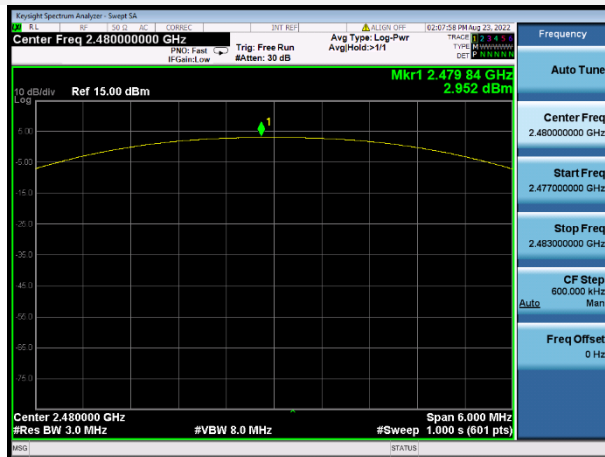
GFSK LOW CHANNEL



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	1.000000	0.894390
Middle Channel	1.030000	0.904910
High Channel	1.035000	0.914180

Test plots

20 dB Bandwidth

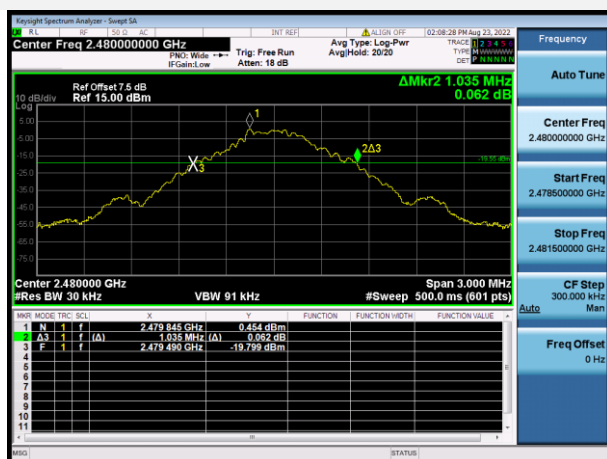
GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL



99% Bandwidth

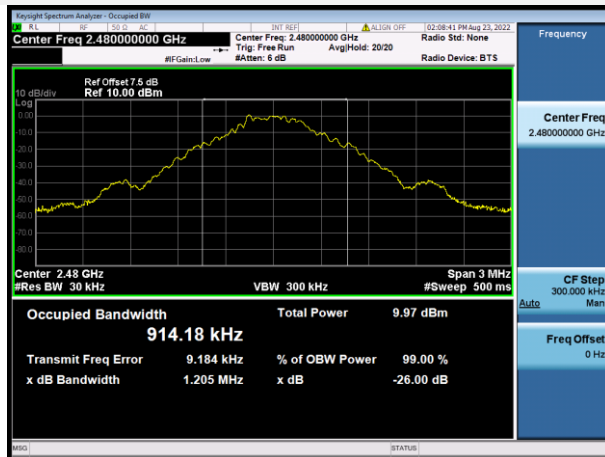
GFSK LOW CHANNEL



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	0.990	0.690	Pass

Test Plots

GFSK



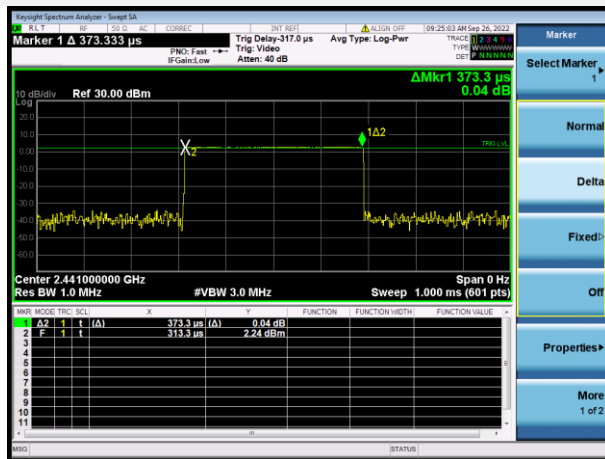
A.5 Time of Occupancy (Dwell time)

Test Data

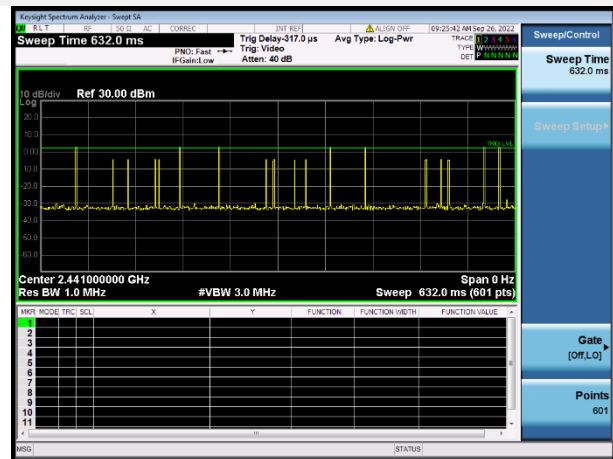
GFSK			
Pulse Width (ms)	Total of Dwell (ms)	Limit (sec)	Verdict
0.373	130.655	0.4	Pass

Test Plots

1 ms



632 ms



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

Test Data

GFSK Mode:

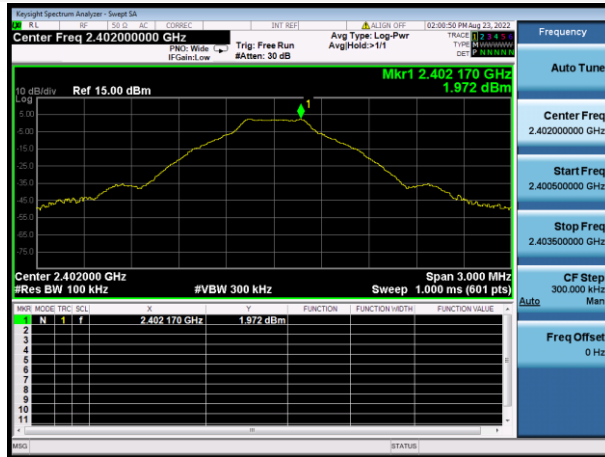
GFSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-37.99	1.97	-18.03	Pass
Middle	-37.05	2.68	-17.32	Pass
High	-37.68	2.78	-17.22	Pass

Hopping Mode:

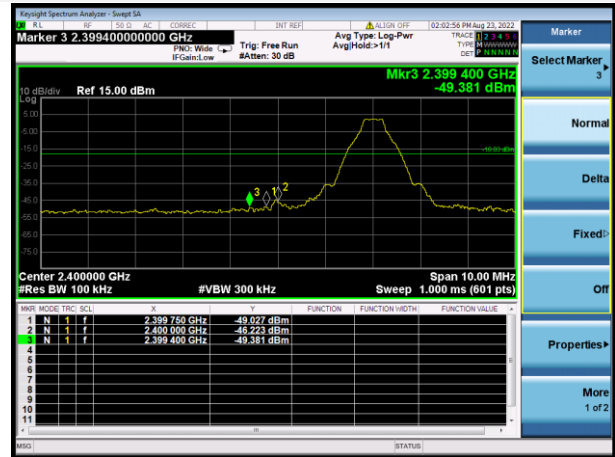
GFSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
GFSK	-38.06	2.77	-17.23	Pass

Test Plots

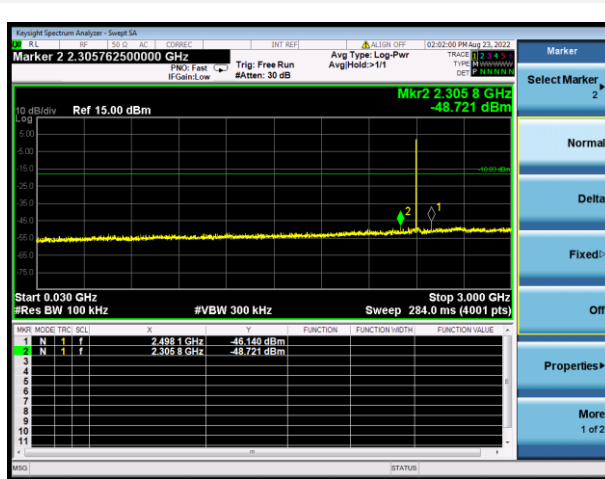
GFSK LOW CHANNEL, CARRIER LEVEL



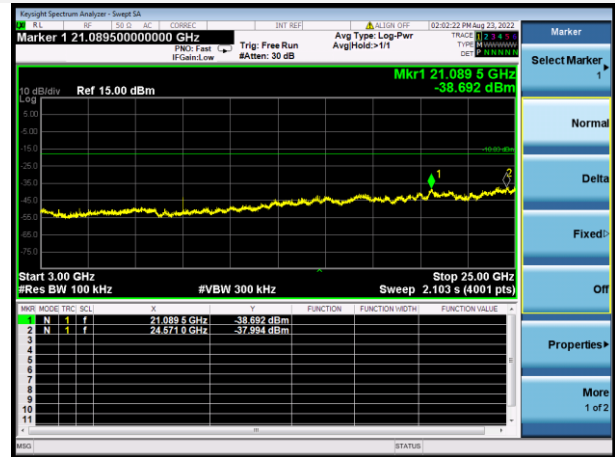
GFSK LOW CHANNEL, BAND EDGE



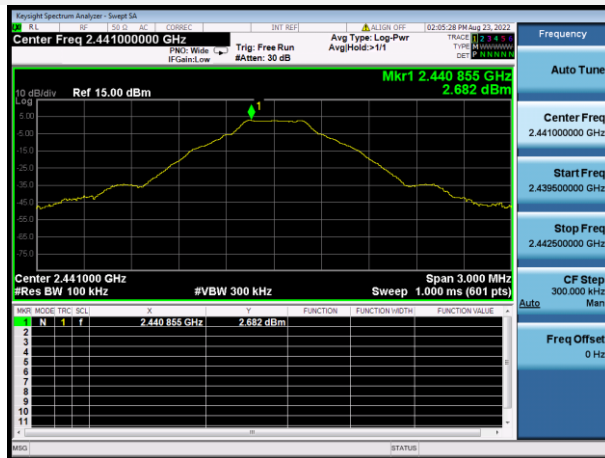
GFSK LOW CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



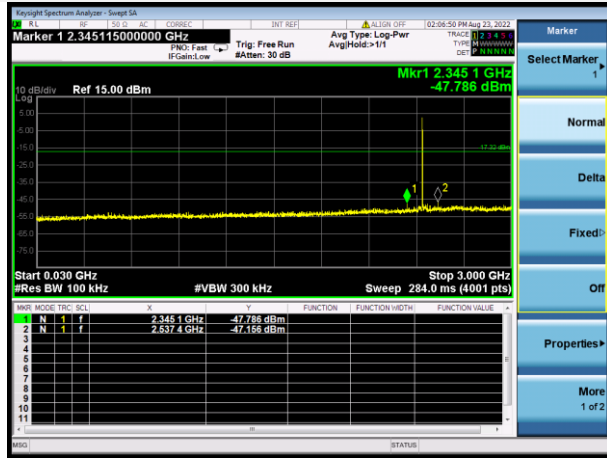
GFSK LOW CHANNEL, SPURIOUS 3 GHz ~ 25 GHz



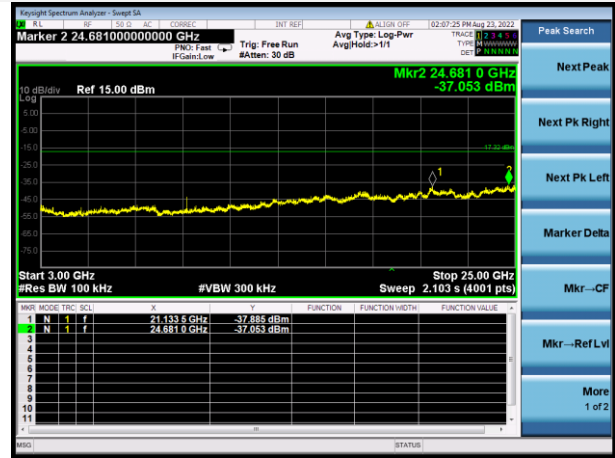
GFSK MIDDLE CHANNEL, CARRIER LEVEL



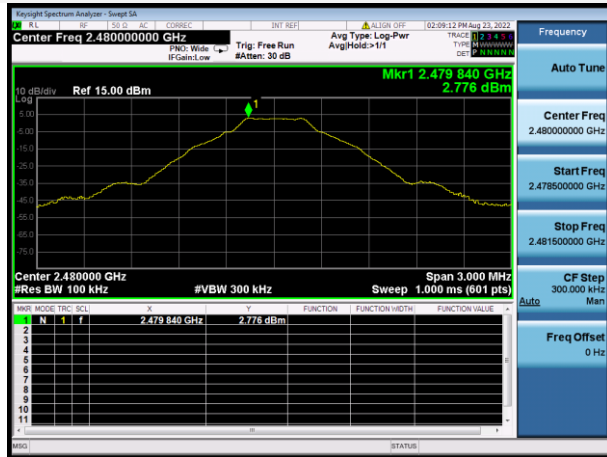
GFSK MIDDLE CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



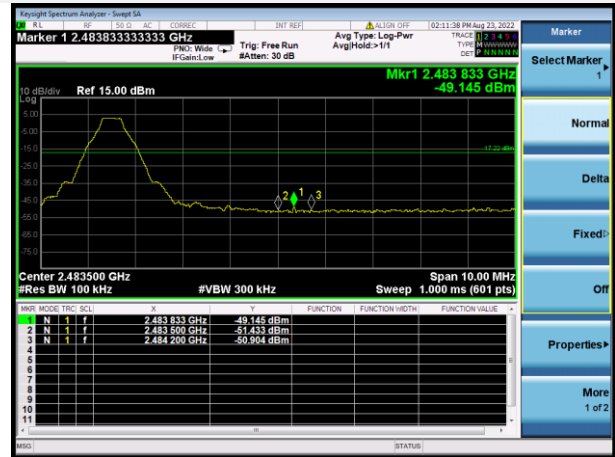
GFSK MIDDLE CHANNEL, SPURIOUS 3 GHz ~ 25 GHz



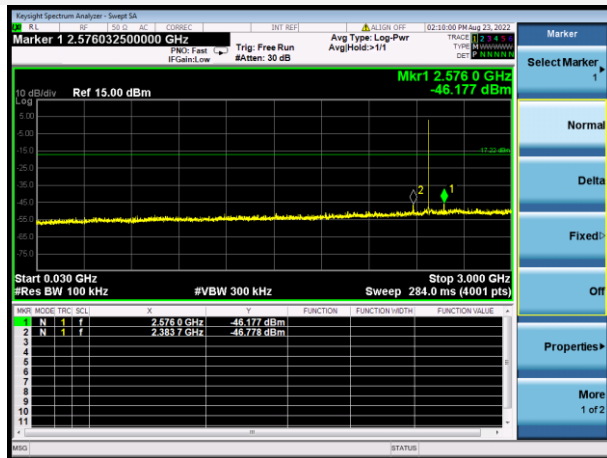
GFSK HIGH CHANNEL, CARRIER LEVEL



GFSK HIGH CHANNEL, BAND EDGE



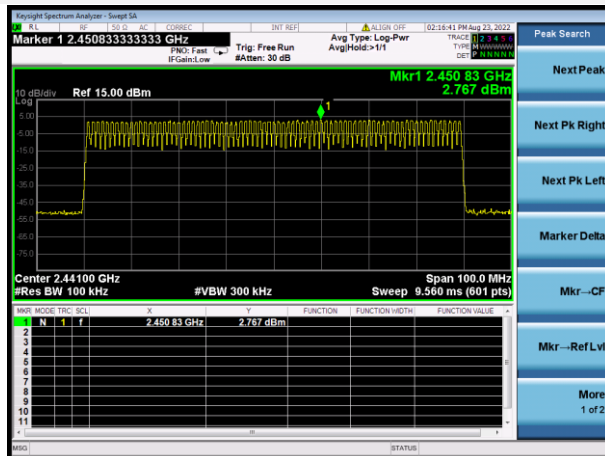
GFSK HIGH CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



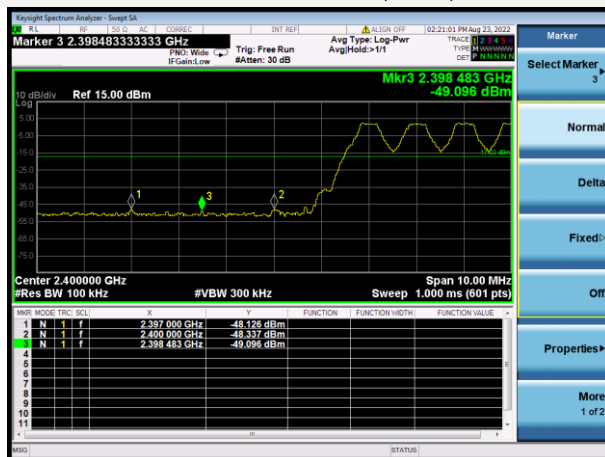
GFSK HIGH CHANNEL, SPURIOUS 3 GHz ~ 25 GHz



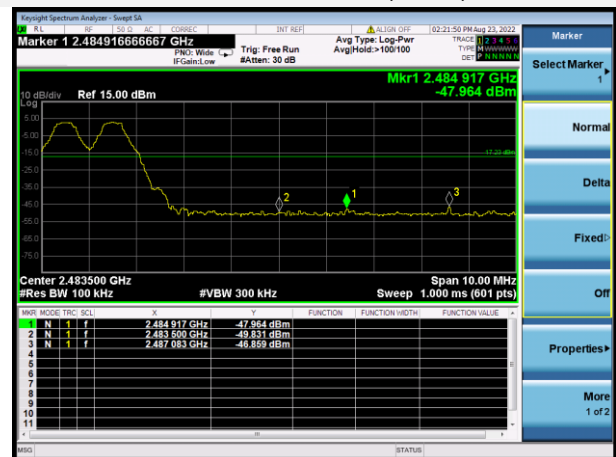
GFSK HOPPING, CARRIER LEVEL



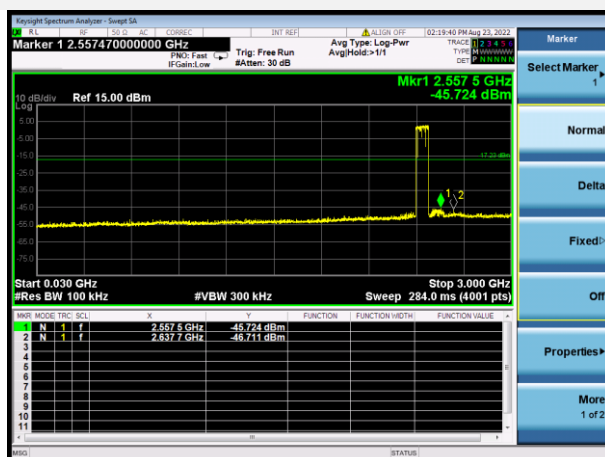
GFSK HOPPING BAND EDGE (LOW)



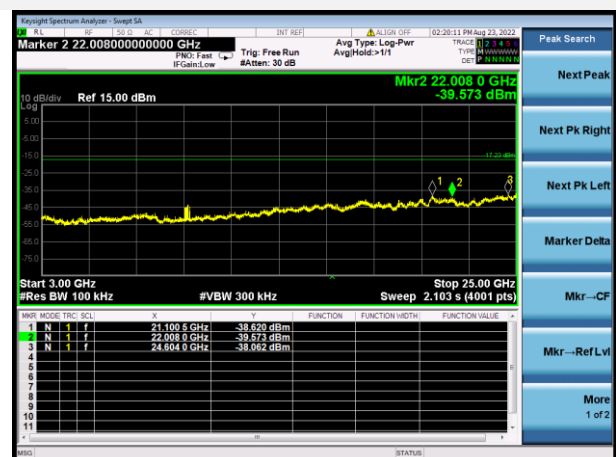
GFSK HOPPING BAND EDGE (HIGH)



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.

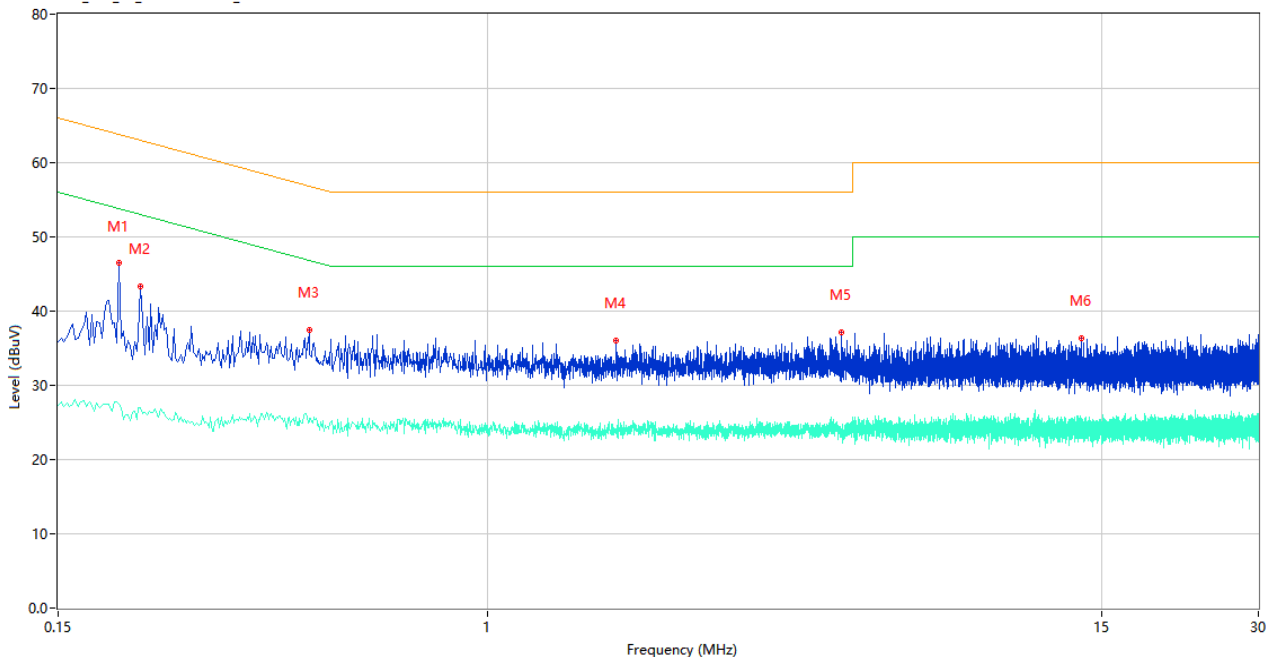
Note ²: Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 60 Hz and 240 VAC, 50 Hz) for which the device is capable of operation. So, The configuration 120 VAC, 60 Hz and 240 VAC, 50 Hz were tested respectively, but only the worst configuration (240 VAC, 50 Hz) shown here.

Note ³: Results (dBuV) = Original reading level of Spectrum Analyzer (dBuV) + Factor (dB)

Test Data and Plots

PHASE L

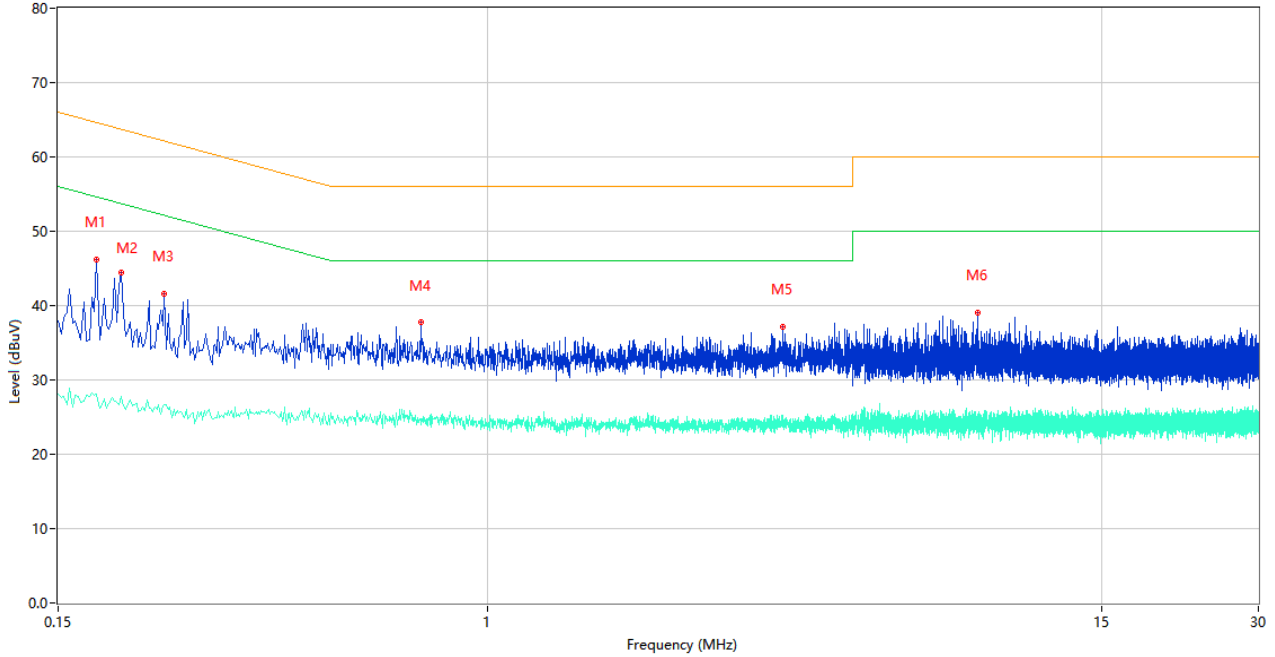
CE Test case_FCC_CE_FCC PART 15B_ Class B



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Over Limit (dB)	Detector	Line	Verdict
1	0.196	46.46	10.06	63.78	-17.32	Peak	L	Pass
1**	0.196	27.44	10.06	53.78	-26.34	AV	L	Pass
2	0.216	43.34	10.04	62.97	-19.63	Peak	L	Pass
2**	0.216	27.03	10.04	52.97	-25.94	AV	L	Pass
3	0.454	37.52	10.22	56.80	-19.28	Peak	L	Pass
3**	0.454	25.10	10.22	46.80	-21.70	AV	L	Pass
4	1.762	36.05	10.25	56.00	-19.95	Peak	L	Pass
4**	1.762	23.83	10.25	46.00	-22.17	AV	L	Pass
5	4.772	37.13	9.93	56.00	-18.87	Peak	L	Pass
5**	4.772	23.65	9.93	46.00	-22.35	AV	L	Pass
6	13.766	36.39	10.36	60.00	-23.61	Peak	L	Pass
6**	13.766	24.55	10.36	50.00	-25.45	AV	L	Pass

PHASE N

CE Test case_FCC_CE_FCC PART 15B_Class B



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Over Limit (dB)	Detector	Line	Verdict
1	0.178	46.23	10.07	64.58	-18.35	Peak	N	Pass
1**	0.178	28.09	10.07	54.58	-26.49	AV	N	Pass
2	0.198	44.47	10.06	63.69	-19.22	Peak	N	Pass
2**	0.198	27.81	10.06	53.69	-25.88	AV	N	Pass
3	0.240	41.58	10.02	62.10	-20.52	Peak	N	Pass
3**	0.240	26.69	10.02	52.10	-25.41	AV	N	Pass
4	0.744	37.77	10.38	56.00	-18.23	Peak	N	Pass
4**	0.744	24.72	10.38	46.00	-21.28	AV	N	Pass
5	3.684	37.22	10.35	56.00	-18.78	Peak	N	Pass
5**	3.684	25.25	10.35	46.00	-20.75	AV	N	Pass
6	8.706	39.13	10.25	60.00	-20.87	Peak	N	Pass
6**	8.706	24.27	10.25	50.00	-25.73	AV	N	Pass

A.8 Radiated Emission

Test Data and Plots

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

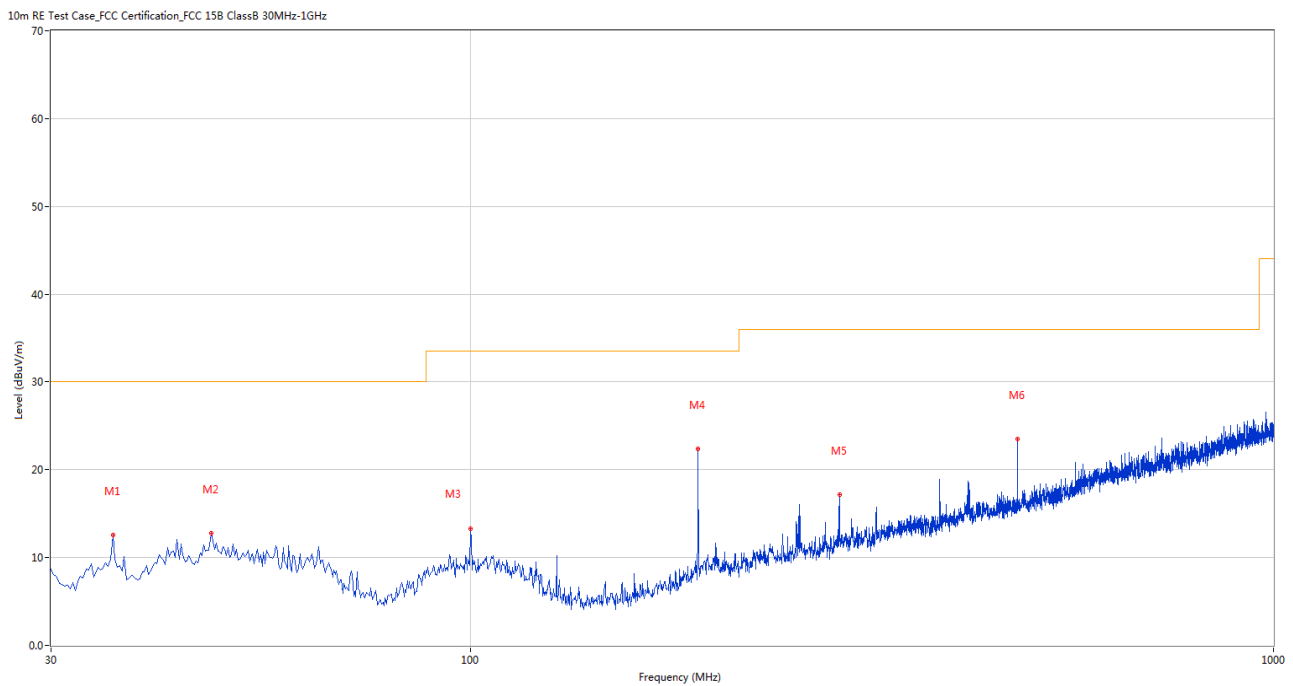
Note 2: For the test data above 1 GHz, according the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

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

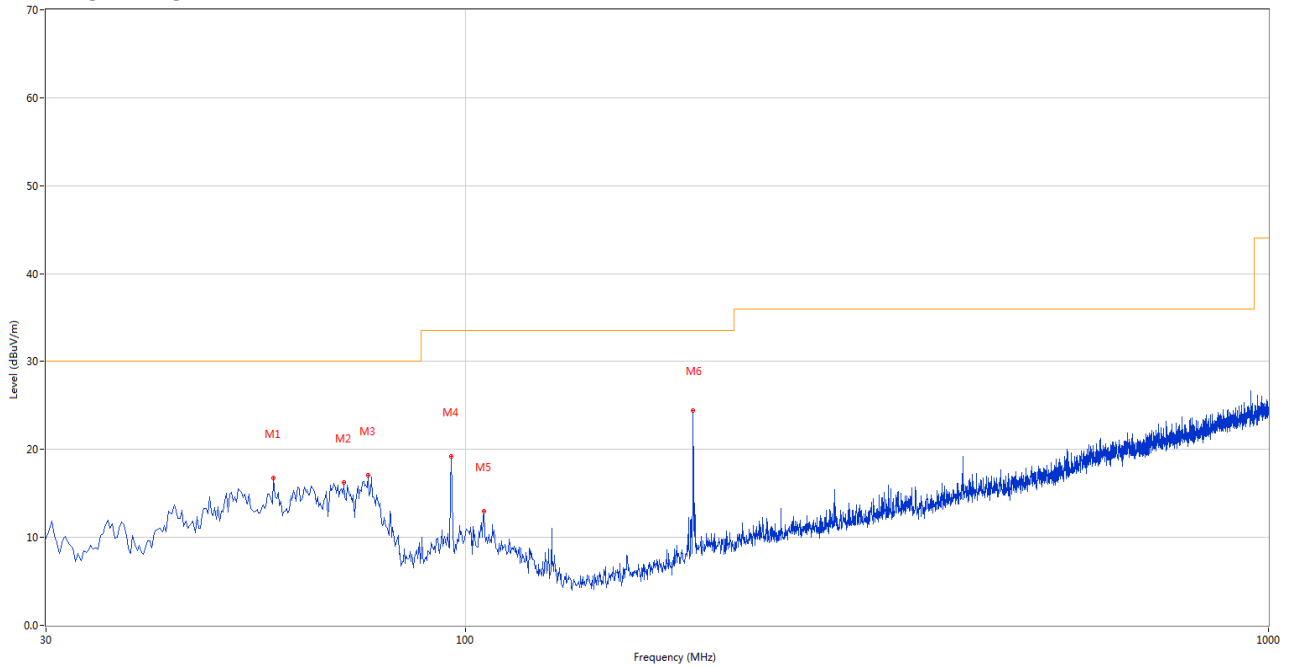
30 MHz to 1 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	35.819	12.55	-28.34	30.0	-17.45	Peak	360.00	200	Horizontal	Pass
2	47.456	12.75	-26.37	30.0	-17.25	Peak	193.00	100	Horizontal	Pass
3	99.823	13.26	-27.98	33.5	-20.24	Peak	360.00	200	Horizontal	Pass
4	191.950	22.38	-28.48	33.5	-11.12	Peak	341.00	200	Horizontal	Pass
5	287.956	17.14	-25.19	36.0	-18.86	Peak	288.00	200	Horizontal	Pass
6	479.968	23.50	-20.77	36.0	-12.50	Peak	360.00	200	Horizontal	Pass

30 MHz to 1 GHz, ANT V

10m RE Test Case_FCC Certification_FCC 15B ClassB 30MHz-1GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	57.638	16.76	-27.26	30.0	-13.24	Peak	360.00	200	Vertical	Pass
2	70.487	16.25	-30.73	30.0	-13.75	Peak	22.00	200	Vertical	Pass
3	75.579	17.05	-31.98	30.0	-12.95	Peak	360.00	200	Vertical	Pass
4	95.944	19.18	-28.69	33.5	-14.32	Peak	137.00	200	Vertical	Pass
5	105.399	12.95	-27.79	33.5	-20.55	Peak	307.00	200	Vertical	Pass
6	191.950	24.42	-28.48	33.5	-9.08	Peak	44.00	100	Vertical	Pass

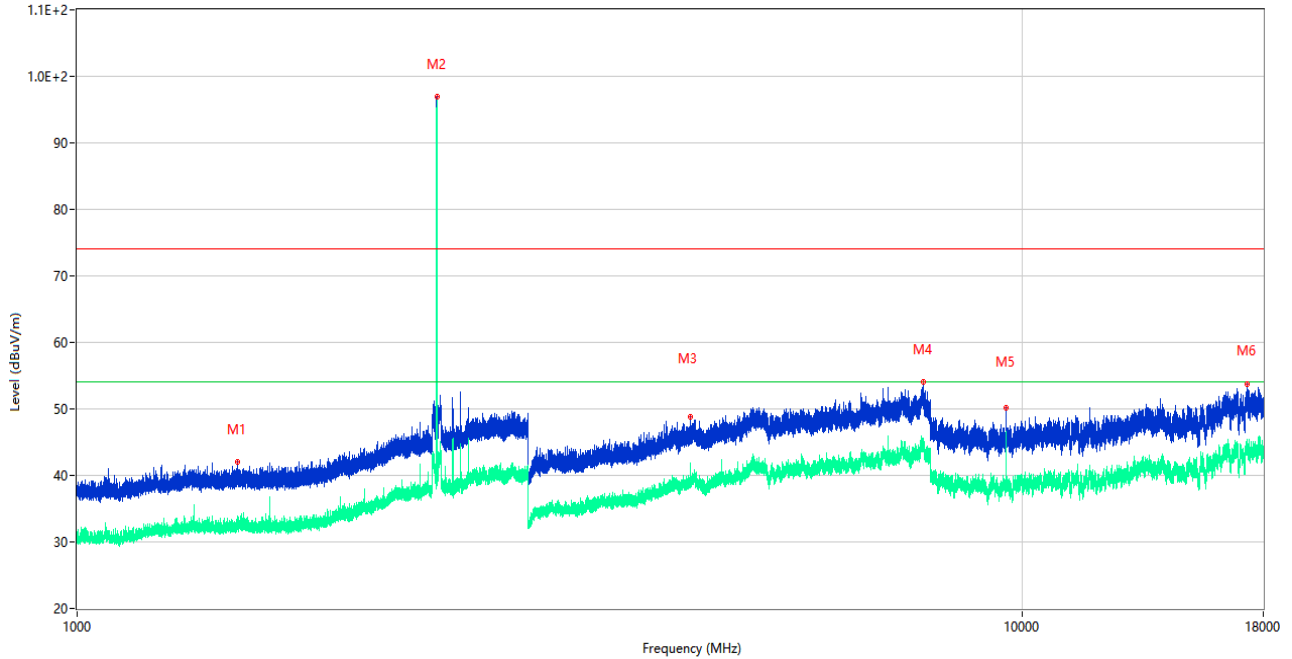
Test Data and Plots (1 GHz ~ 10th Harmonic)

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

RSE (SRD)_FCC Part 15C_FCC 15.247(2.4G)_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1478.000	41.97	-17.39	74.0	-32.03	Peak	78.00	300	Horizontal	Pass
1**	1478.000	32.11	-17.39	54.0	-21.89	AV	78.00	300	Horizontal	Pass
2	2402.100	96.94	-13.33	74.0	22.94	Peak	254.00	200	Horizontal	N/A
2**	2402.100	96.64	-13.33	54.0	42.64	AV	254.00	200	Horizontal	N/A
3	4455.250	48.75	-4.29	74.0	-25.25	Peak	90.00	200	Horizontal	Pass
3**	4455.250	40.71	-4.29	54.0	-13.29	AV	90.00	200	Horizontal	Pass
4	7868.000	54.06	1.68	74.0	-19.94	Peak	319.00	400	Horizontal	Pass
4**	7868.000	44.36	1.68	54.0	-9.64	AV	319.00	400	Horizontal	Pass
5	9607.875	50.14	-5.09	74.0	-23.86	Peak	68.00	100	Horizontal	Pass
5**	9607.875	44.32	-5.09	54.0	-9.68	AV	68.00	100	Horizontal	Pass
6	17297.551	53.74	2.01	74.0	-20.26	Peak	172.00	200	Horizontal	Pass
6**	17297.551	44.24	2.01	54.0	-9.76	AV	172.00	200	Horizontal	Pass

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT V

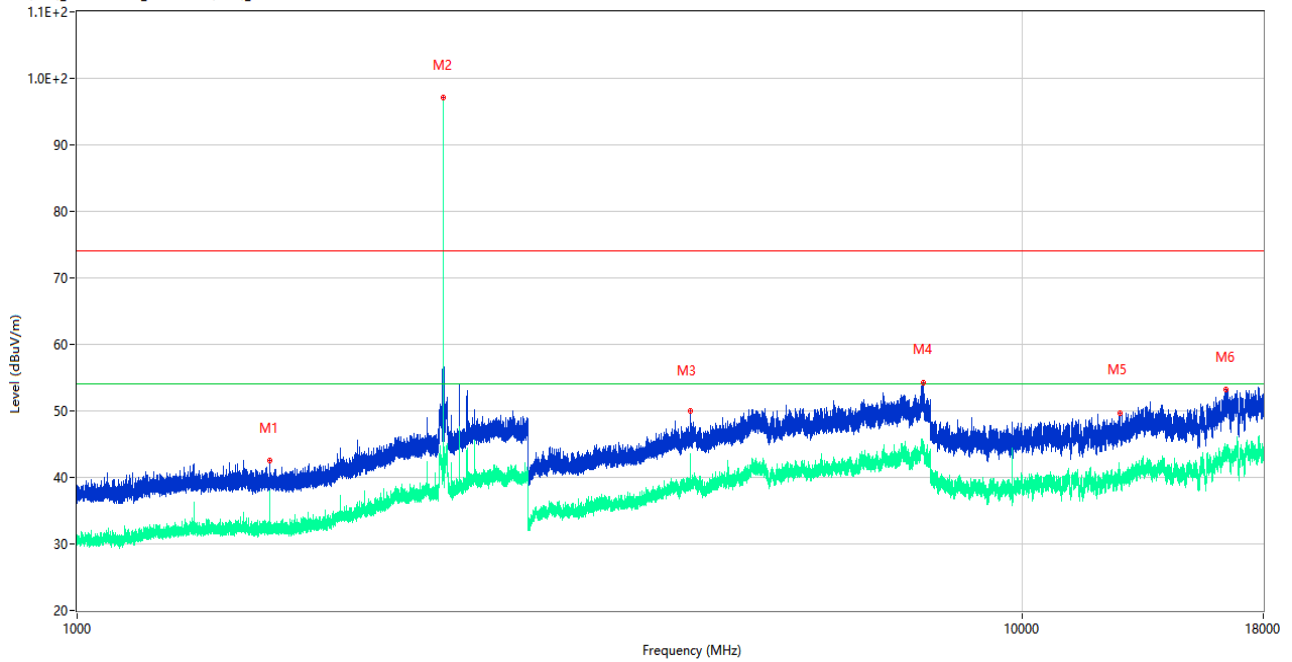
RSE (SRD)_FCC Part 15C_FCC 15.247(2.4G)_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1328.000	44.49	-17.13	74.0	-29.51	Peak	245.00	200	Vertical	Pass
1**	1328.000	40.11	-17.13	54.0	-13.89	AV	245.00	200	Vertical	Pass
2	2402.100	86.83	-13.33	74.0	12.83	Peak	235.00	150	Vertical	N/A
2**	2402.100	86.53	-13.33	54.0	32.53	AV	235.00	150	Vertical	N/A
3	2878.900	49.66	-10.35	74.0	-24.34	Peak	216.00	200	Vertical	Pass
3**	2878.900	39.86	-10.35	54.0	-14.14	AV	216.00	200	Vertical	Pass
4	7861.500	53.51	1.33	74.0	-20.49	Peak	315.00	400	Vertical	Pass
4**	7861.500	45.20	1.33	54.0	-8.80	AV	315.00	400	Vertical	Pass
5	12461.200	49.97	-2.22	74.0	-24.03	Peak	268.00	100	Vertical	Pass
5**	12461.200	39.76	-2.22	54.0	-14.24	AV	268.00	100	Vertical	Pass
6	16368.037	53.84	-0.06	74.0	-20.16	Peak	95.00	300	Vertical	Pass
6**	16368.037	43.16	-0.06	54.0	-10.84	AV	95.00	300	Vertical	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H

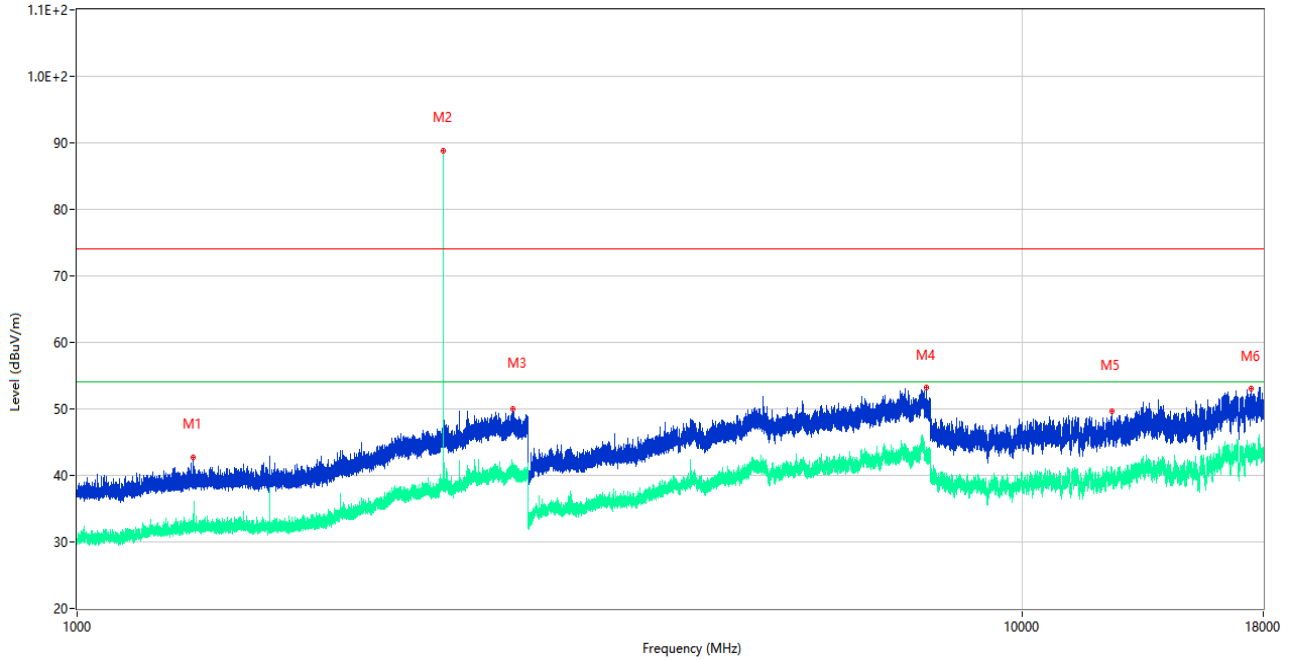
RSE (SRD)_FCC Part 15C_FCC 15.247(2.4G)_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1599.900	42.54	-17.75	74.0	-31.46	Peak	123.00	200	Horizontal	Pass
1**	1599.900	37.77	-17.75	54.0	-16.23	AV	123.00	200	Horizontal	Pass
2	2441.000	97.03	-12.31	74.0	23.03	Peak	282.00	100	Horizontal	N/A
2**	2441.000	96.82	-12.31	54.0	42.82	AV	282.00	100	Horizontal	N/A
3	4455.000	49.92	-4.26	74.0	-24.08	Peak	331.00	100	Horizontal	Pass
3**	4455.000	43.62	-4.26	54.0	-10.38	AV	331.00	100	Horizontal	Pass
4	7860.500	54.26	1.29	74.0	-19.74	Peak	305.00	400	Horizontal	Pass
4**	7860.500	43.87	1.29	54.0	-10.13	AV	305.00	400	Horizontal	Pass
5	12692.763	49.69	-2.33	74.0	-24.31	Peak	185.00	200	Horizontal	Pass
5**	12692.763	40.23	-2.33	54.0	-13.77	AV	185.00	200	Horizontal	Pass
6	16416.074	53.15	0.21	74.0	-20.85	Peak	360.00	100	Horizontal	Pass
6**	16416.074	43.36	0.21	54.0	-10.64	AV	360.00	100	Horizontal	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V

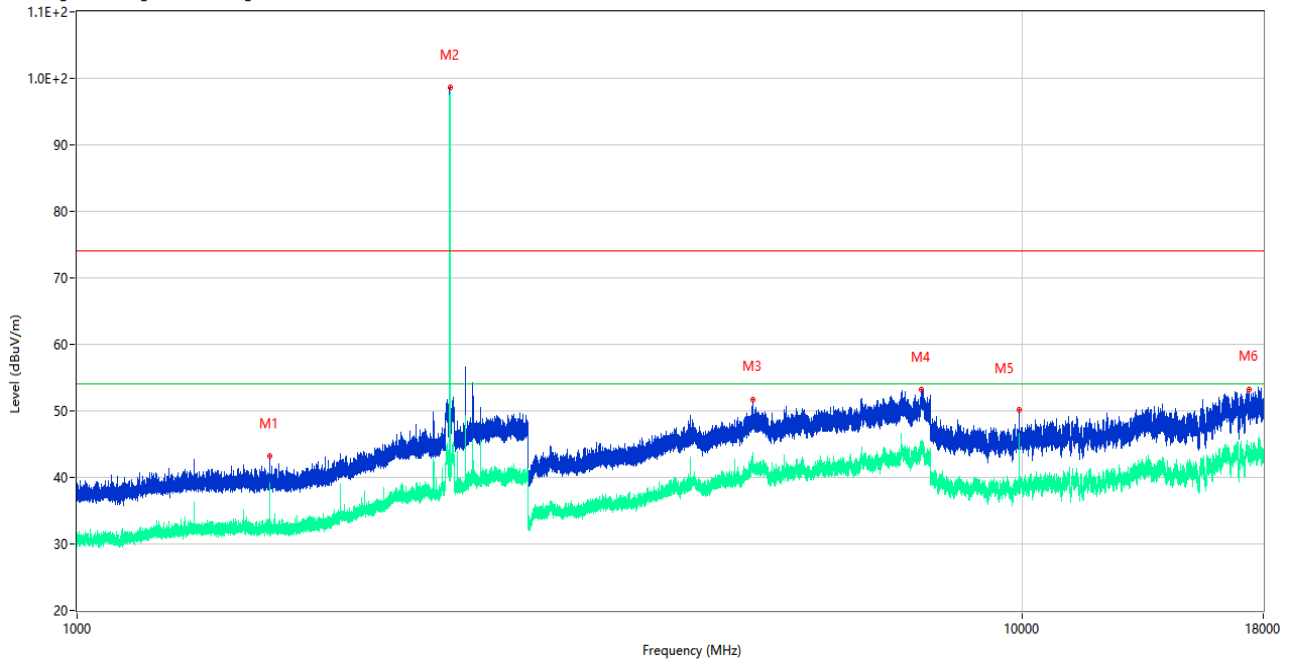
RSE (SRD)_FCC Part 15C_FCC 15.247(2.4G)_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1326.900	42.77	-17.29	74.0	-31.23	Peak	260.00	100	Vertical	Pass
1**	1326.900	33.02	-17.29	54.0	-20.98	AV	260.00	100	Vertical	Pass
2	2441.200	88.83	-12.29	74.0	14.83	Peak	241.00	200	Vertical	N/A
2**	2441.200	88.58	-12.29	54.0	34.58	AV	241.00	200	Vertical	N/A
3	2891.200	50.04	-9.99	74.0	-23.96	Peak	278.00	150	Vertical	Pass
3**	2891.200	40.59	-9.99	54.0	-13.41	AV	278.00	150	Vertical	Pass
4	7928.250	53.17	0.56	74.0	-20.83	Peak	175.00	200	Vertical	Pass
4**	7928.250	43.68	0.56	54.0	-10.32	AV	175.00	200	Vertical	Pass
5	12435.550	49.64	-2.37	74.0	-24.36	Peak	224.00	200	Vertical	Pass
5**	12435.550	40.88	-2.37	54.0	-13.12	AV	224.00	200	Vertical	Pass
6	17458.199	52.97	3.09	74.0	-21.03	Peak	272.00	200	Vertical	Pass
6**	17458.199	42.35	3.09	54.0	-11.65	AV	272.00	200	Vertical	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT H

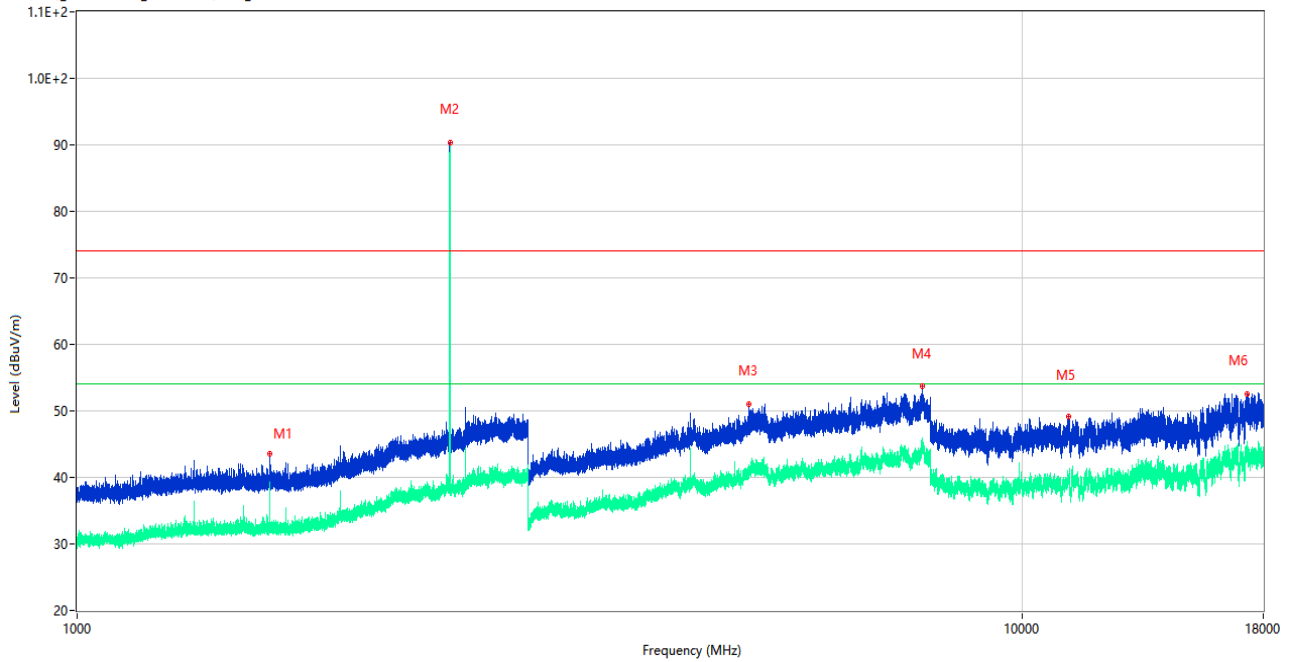
RSE (SRD)_FCC Part 15C_FCC 15.247(2.4G)_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1599.900	43.20	-17.75	74.0	-30.80	Peak	92.00	100	Horizontal	Pass
1**	1599.900	39.10	-17.75	54.0	-14.90	AV	92.00	100	Horizontal	Pass
2	2479.900	98.63	-13.07	74.0	24.63	Peak	274.00	150	Horizontal	N/A
2**	2479.900	97.89	-13.07	54.0	43.89	AV	274.00	150	Horizontal	N/A
3	5185.250	51.69	-2.35	74.0	-22.31	Peak	132.00	100	Horizontal	Pass
3**	5185.250	42.46	-2.35	54.0	-11.54	AV	132.00	100	Horizontal	Pass
4	7829.500	53.20	1.95	74.0	-20.80	Peak	35.00	300	Horizontal	Pass
4**	7829.500	44.61	1.95	54.0	-9.39	AV	35.00	300	Horizontal	Pass
5	9919.475	50.22	-5.14	74.0	-23.78	Peak	104.00	100	Horizontal	Pass
5**	9919.475	41.13	-5.14	54.0	-12.87	AV	104.00	100	Horizontal	Pass
6	17397.301	53.24	2.72	74.0	-20.76	Peak	197.00	200	Horizontal	Pass
6**	17397.301	43.14	2.72	54.0	-10.86	AV	197.00	200	Horizontal	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT V

RSE (SRD)_FCC Part 15C_FCC 15.247(2.4G)_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1600.100	43.63	-17.77	74.0	-30.37	Peak	343.00	100	Vertical	Pass
1**	1600.100	38.56	-17.77	54.0	-15.44	AV	343.00	100	Vertical	Pass
2	2480.000	90.36	-13.08	74.0	16.36	Peak	241.00	150	Vertical	N/A
2**	2480.000	89.95	-13.08	54.0	35.95	AV	241.00	150	Vertical	N/A
3	5144.000	50.93	-3.75	74.0	-23.07	Peak	244.00	100	Vertical	Pass
3**	5144.000	40.55	-3.75	54.0	-13.45	AV	244.00	100	Vertical	Pass
4	7849.250	53.72	1.17	74.0	-20.28	Peak	356.00	100	Vertical	Pass
4**	7849.250	44.18	1.17	54.0	-9.82	AV	356.00	100	Vertical	Pass
5	11196.750	49.09	-4.07	74.0	-24.91	Peak	43.00	200	Vertical	Pass
5**	11196.750	39.16	-4.07	54.0	-14.84	AV	43.00	200	Vertical	Pass
6	17297.551	52.50	2.01	74.0	-21.50	Peak	361.00	200	Vertical	Pass
6**	17297.551	43.33	2.01	54.0	-10.67	AV	361.00	200	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.

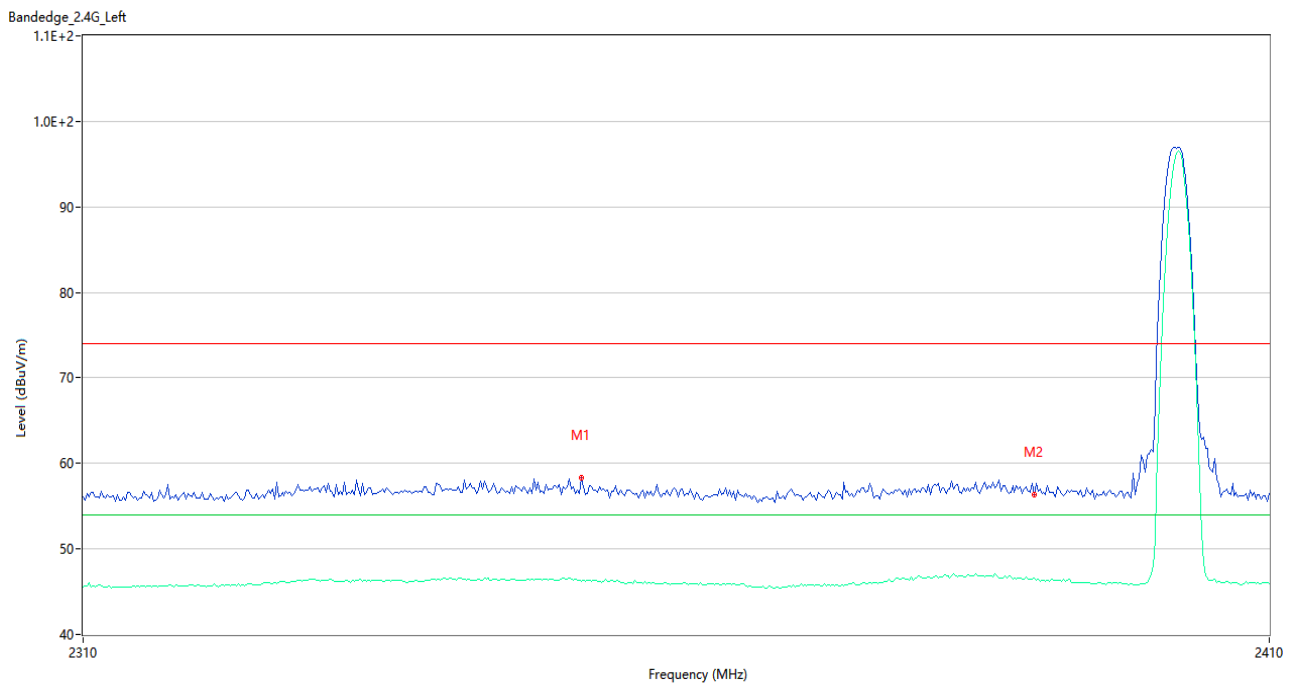
Note ²: The test data all are tested in the vertical and horizontal antenna which the trace is max hold. So these plots have shown the worst case.

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.

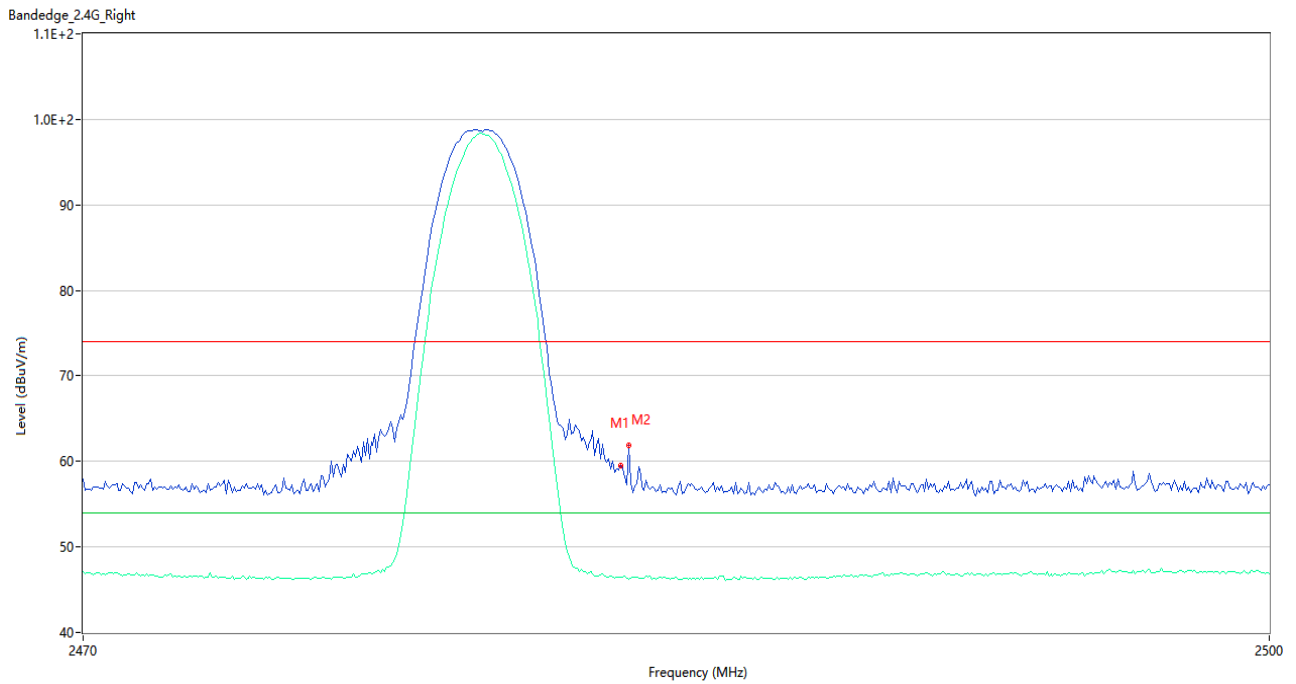
Test Data

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	2351.500	58.28	2.40	74.0	-15.72	Peak	286.00	100	Horizontal	Pass
1**	2351.500	46.24	2.40	54.0	-7.76	AV	286.00	100	Horizontal	Pass
2	2389.833	56.40	1.64	74.0	-17.60	Peak	277.00	100	Horizontal	Pass
2**	2389.833	46.59	1.64	54.0	-7.41	AV	277.00	100	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	2483.550	59.50	1.98	74.0	-14.50	Peak	250.00	200	Horizontal	Pass
1**	2483.550	46.42	1.98	54.0	-7.58	AV	250.00	200	Horizontal	Pass
2	2483.750	61.85	1.99	74.0	-12.15	Peak	280.00	200	Horizontal	Pass
2**	2483.750	46.25	1.99	54.0	-7.75	AV	280.00	200	Horizontal	Pass

ANNEX B TEST SETUP PHOTOS

Please refer the document “BL-SZ2280656-AR.PDF”.

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document “BL-SZ2280656-AW.PDF”.

ANNEX D EUT INTERNAL PHOTOS

Please refer the document “BL-SZ2280656-AI.PDF”.

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--END OF REPORT--