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 18 Mechanical Numpad
Model Name:	85HB
Brand Name:	8BITDO
FCC ID:	2AOWF-24GRMN
ISED Number:	29401-24GRMN
Test Standard:	47 CFR Part 15 Subpart C RSS-Gen Issue 5 RSS-247 Issue 3 (refer to section 3.1)
Sample Arrival Date:	Apr. 18, 2024
Test Date:	Apr. 26, 2024 - Jul. 10, 2024
Date of Issue:	Jul. 26, 2024

ISSUED BY:

Shenzhen BALUN Technology Co., Ltd.

Tested by: Si Xiao

Checked by: Ye Hongji

Approved by: Liao Jianming

(Technical Director)

Revision History

Version	Issue Date	Revisions
Rev. 01	Jul. 26, 2024	Initial Issue

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1 GENERAL INFORMATION

1.1 Test Laboratory

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

1.2 Test Location

Name	Shenzhen BALUN Technology Co., Ltd.
Location	☑ Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
	☐ 1/F, Building B, Ganghongji High-tech Intelligent Industrial Park, No. 1008, Songbai Road, Yangguang Community, Xili Sub-district, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196. The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 11524A.

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 18 Mechanical Numpad
Model Name Under Test	85HB
Series Model Name	N/A
Description of Model name differentiation	N/A
Serial Number	85HB01026548000326
Hardware Version	V6
Software Version	V1.01
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	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
Tested Channel	Low (2402 MHz), Middle (2441 MHz), High (2480 MHz)
Antenna Type	Wire Antenna
Antenna Gain	1.45 dBi
Adaptive or non-adaptive	Non-Adaptive
The Max RF Output power	-3.70 dBm

All channel was listed on the following table:

Channel number	Freq. (MHz)	Channel number	Freq. (MHz)	Channel number	Freq. (MHz)	Channel number	Freq. (MHz)
1	**2402**	21	2422	41	2442	61	2462
2	2403	22	2423	42	2443	62	2463
3	2404	23	2424	43	2444	63	2464
4	2405	24	2425	44	2445	64	2465
5	2406	25	2426	45	2446	65	2466
6	2407	26	2427	46	2447	66	2467
7	2408	27	2428	47	2448	67	2468
8	2409	28	2429	48	2449	68	2469
9	2410	29	2430	49	2450	69	2470
10	2411	30	2431	50	2451	70	2471
11	2412	31	2432	51	2452	71	2472
12	2413	32	2433	52	2453	72	2473
13	2414	33	2434	53	2454	73	2474
14	2415	34	2435	54	2455	74	2475
15	2416	35	2436	55	2456	75	2476
16	2417	36	2437	56	2457	76	2477
17	2418	37	2438	57	2458	77	2478
18	2419	38	2439	58	2459	78	2479
19	2420	39	2440	59	2460	**79**	**2480**
20	2421	**40**	**2441**	60	2461	--	--

Note: The modulation is GFSK with FHSS, there are total 79 channels (frequency range is 2402-2480 MHz, channel step is 1 MHz, totally 79 channels), when this part works, it will choose 79 channels, each channel band width is 1 MHz, if one channel is chosen, adjacent 1 channels cannot be chosen to make sure step of working channels is more than 1 MHz. the equipment select the lowest, middle and highest channel from 40 channels, Which are 2402 MHz, 2441 MHz and 2480 MHz. The more information please refer to the manufacturer's instructions.

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15, Subpart C	Intentional radiators of radio frequency equipment
2	RSS-Gen Issue 5	General Requirements for Compliance of Radio Apparatus
3	RSS-247 Issue 3	Digital Transmission Systems (DTSs), Frequency Hopping Systems(FHSs) and Licence-Exemp Local Area Network (LE-LAN) Devices
4	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
5	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.	ISED Part No.	Test Result	Verdict
1	Antenna Requirement	15.203	RSS-247, 5.4 (6)	--	Pass Note 1
2	Number of Hopping Frequency	15.247(a)	RSS-247, 5.1 (4)	ANNEX A.1	Pass
3	Peak Output Power and E.I.R.P	15.247(b)	RSS-247, 5.4 (2)	ANNEX A.2	Pass
4	Occupied Bandwidth	15.247(a)	RSS-247, 5.1 (1)	ANNEX A.3	Pass
5	Hopping Frequency Separation	15.247(a)	RSS-247, 5.1 (2)	ANNEX A.4	Pass
6	Time of Occupancy (Dwell time)	15.247(a)	RSS-247, 5.1 (4)	ANNEX A.5	Pass
7	Conducted Spurious Emission & Authorized-band band-edge	15.247(d)	RSS-247, 5.5	ANNEX A.6	Pass
8	Conducted Emission	15.207	RSS-GEN, 8.8	ANNEX A.7	Pass
9	Radiated Spurious Emission	15.209 15.247(d)	RSS-247, 5.5	ANNEX A.8	Pass
10	Band Edge (Restricted-band band-edge)	15.209 15.247(d)	RSS-247, 5.5	ANNEX A.9	Pass
11	Receiver Spurious Emissions	--	RSS-Gen, 7.1.2	--	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	48% to 71%	
Atmospheric Pressure	98 kPa to 102 kPa	
Temperature	NT (Normal Temperature)	+21.6℃ to +25.1℃
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	MY46471071	2023.07.25	2024.07.24
Spectrum Analyzer	KEYSIGHT	N9020A	MY50531259	2023.09.05	2024.09.04
Test Antenna-Horn	SCHWARZBECK	BBHA 9120D	02460	2021.05.20	2024.05.19
				2024.05.16	2027.05.15
Test Antenna-Horn	A-INFO	LB-180400KF	J211060273	2021.07.02	2024.07.01
				2024.06.15	2027.06.14
Anechoic Chamber	RAINFORD	9m*6m*6m	140	2022.02.19	2024.08.15
Amplifier	COM-MV	LSCX_LNA1-12G-01	7210214	2023.09.05	2024.09.04
Amplifier	COM-MV	XKu_LNA7-18G-01	7210209	2023.09.05	2024.09.04
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2023.09.05	2024.09.04
Test Antenna-Bi-Log	SCHWARZBECK	VULB 9168	9168-01162	2023.08.04	2024.08.03
Test Antenna-Loop	SCHWARZBECK	FMZB 1519	1519-037	2024.01.23	2025.01.22
Amplifier	COM-MV	ZT30-1000M	B2018054558	2023.12.05	2024.12.04
Anechoic Chamber	EMC Electronic Co., Ltd	20.10*11.60*7.35m	130	2021.08.15	2024.08.14
EMI Receiver	Agilent	N9038A	MY55330120	2023.09.05	2024.09.04
Test Antenna-Bi-Log	SCHWARZBECK	VULB 9168	9168-00867	2022.04.12	2025.04.11
Amplifier	COM-MV	ZT30-1000M	B2017119081	2023.12.05	2024.12.04
Anechoic Chamber	YiHeng	9m*6m*6m	142	2021.08.19	2024.08.18
EMI Receiver	KEYSIGHT	N9010B	MY57110309	2023.09.05	2024.09.04
LISN	SCHWARZBECK	NSLK 8127	8127-687	2023.05.16	2024.05.15
				2024.05.09	2025.05.08
Shielded Enclosure	YiHeng Electronic Co., Ltd	3.5m*3.1m*2.8m	112	2022.02.19	2025.02.18

4.3 Test Software List

Description	Manufacturer	Software Version	Serial No.	Applicable test Setup
BL410R	BALUN	V2.1.1.488	N/A	The section 4.5.1
BL410E	BALUN	V19.8.28.435	N/A	The section 4.5.2&4.5.3&4.5.4&4.5.5

4.4 Measurement Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2.

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

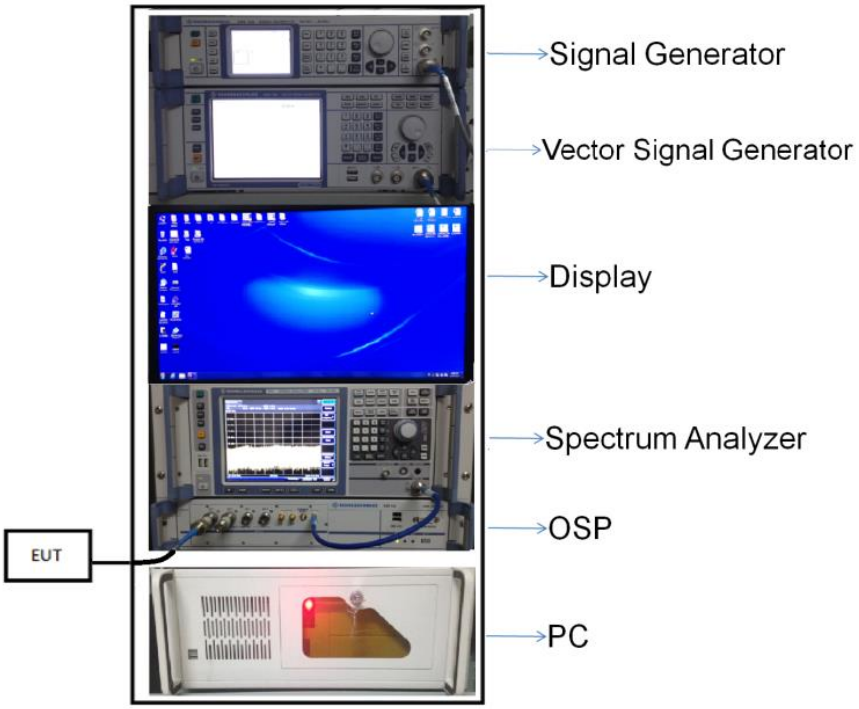
Parameters	Uncertainty
Occupied Channel Bandwidth	2.8%
RF output power, conducted	1.28 dB
Power Spectral Density, conducted	1.30 dB
Unwanted Emissions, conducted	1.84 dB
All emissions, radiated	5.36 dB
Temperature	0.8°C
Humidity	4%

4.5 Description of Test Setup

4.5.1 For Antenna Port Test

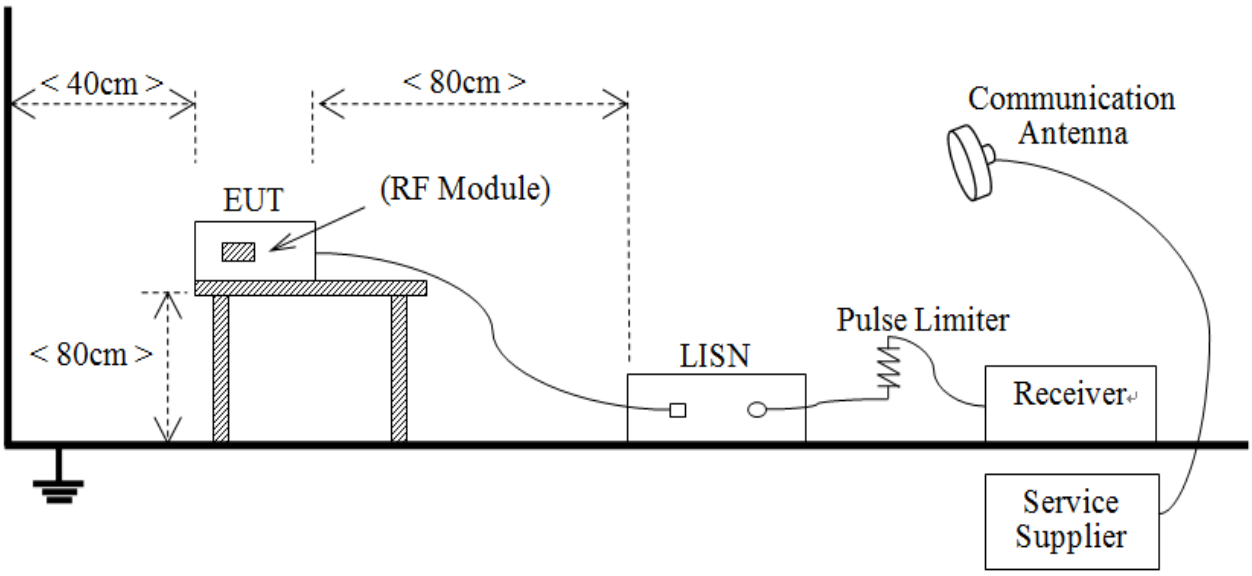
Conducted value (dBm) = Measurement value (dBm) + cable loss (dB)

For example: the measurement value is 10 dBm and the cable 0.5dBm used, then the final result of EUT:
Conducted value (dBm) = 10 dBm + 0.5 dB = 10.5 dBm



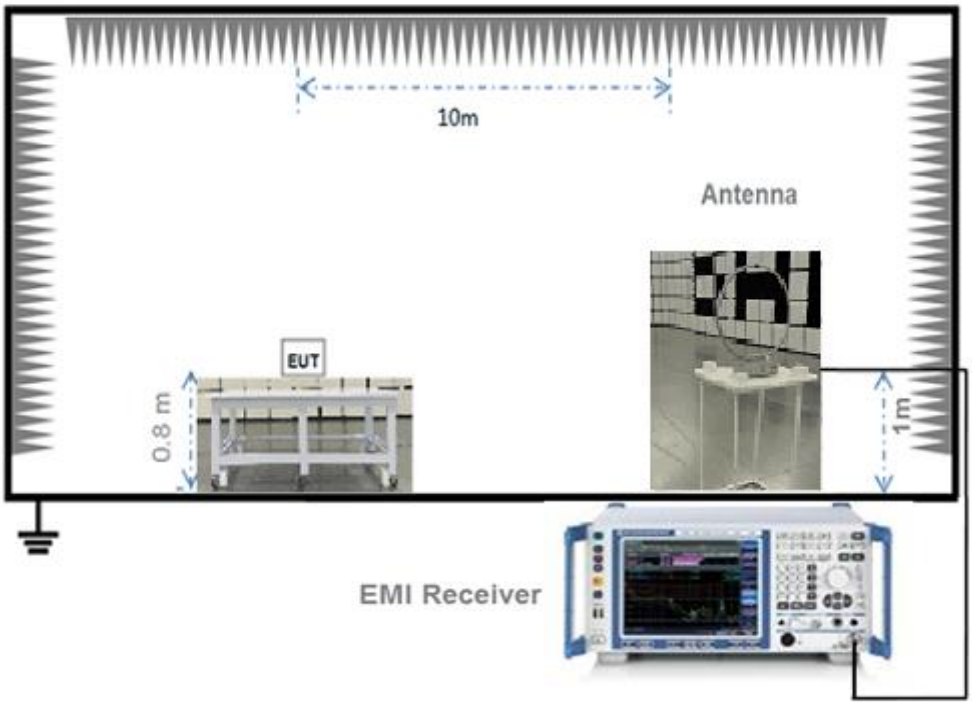
(Diagram 1)

4.5.2 For AC Power Supply Port Test



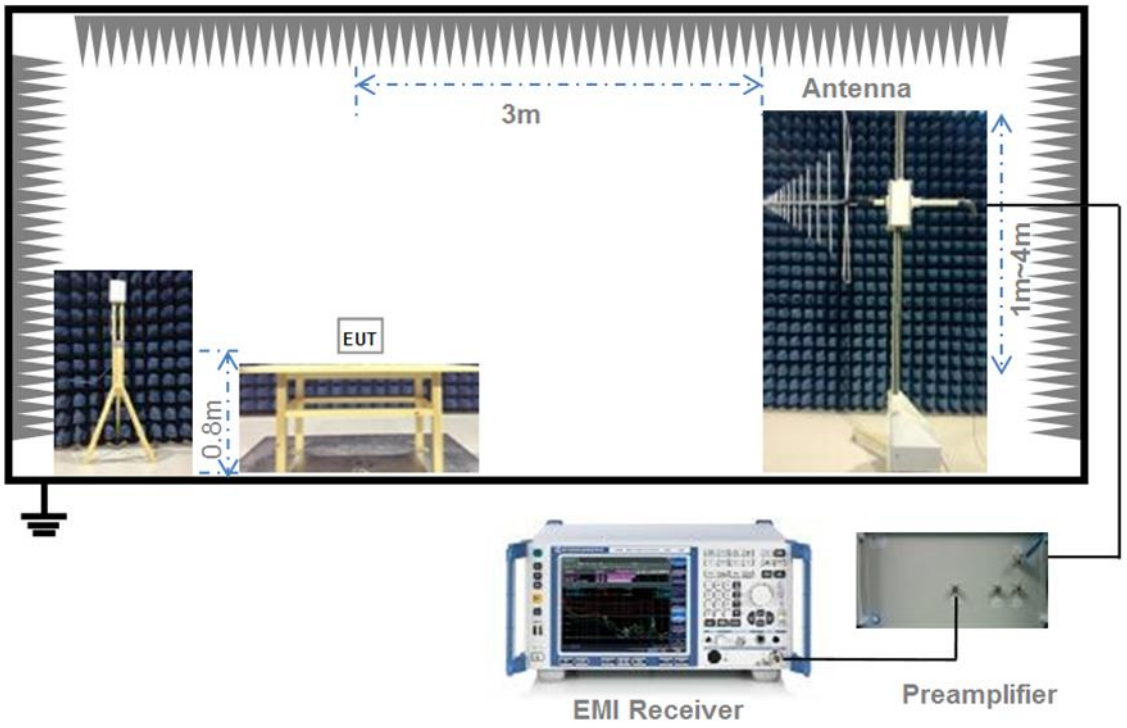
(Diagram 2)

4.5.3 For Radiated Test (Below 30 MHz)



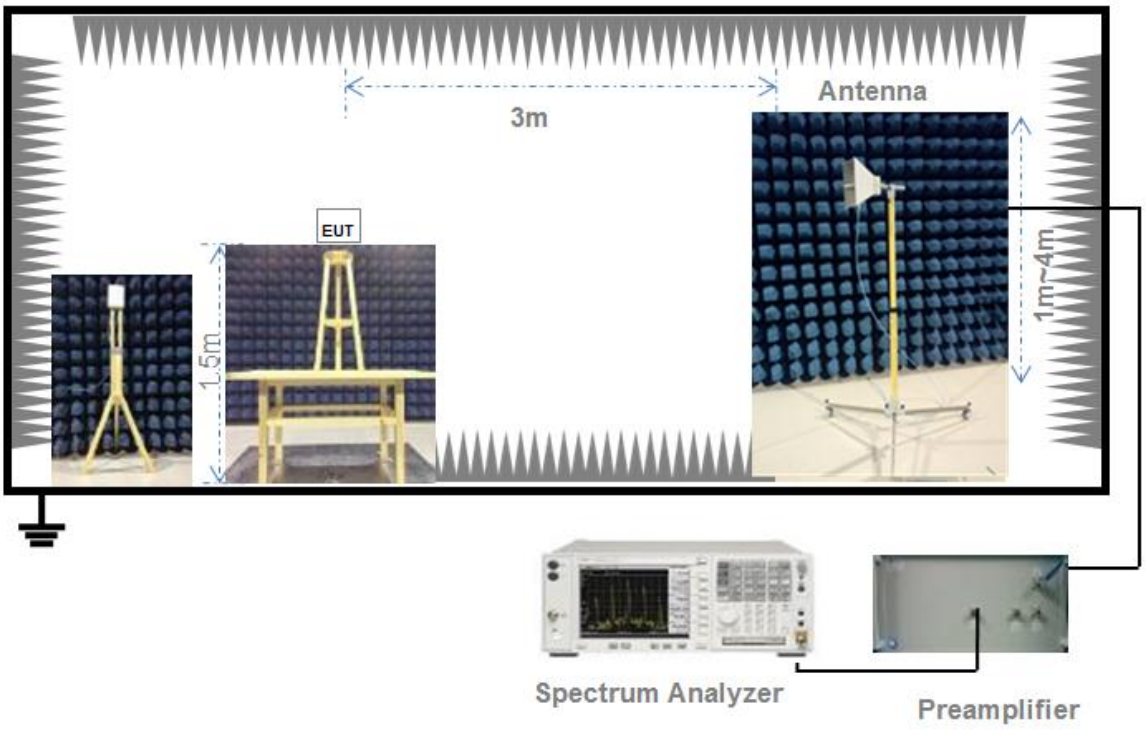
(Diagram 3)

4.5.4 For Radiated Test (30 MHz-1 GHz)



(Diagram 4)

4.5.5 For Radiated Test (Above 1 GHz)



(Diagram 5)

4.6 Measurement Results Explanation Example

4.6.1 For conducted test items:

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

4.6.2 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); RSS-247, 5.4 (6)
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); RSS-247, 5.1 (4)

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

5.2.2 Test Setup

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

5.2.3 Test Procedure

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

Span = the frequency band of operation

RBW ≥ 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 and E.I.R.P

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.

RSS-247, 5.4 (2)

For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W and the e.i.r.p. shall not exceed 4 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W and the e.i.r.p. shall not exceed 0.5 W if the hopset uses less than 75 hopping channels (see Section 5.4(5) for exceptions).

5.3.2 Test Setup

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

5.3.3 Test Procedure

The 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); RSS-247, 5.1 (1)

Measurement of the 20dB bandwidth of the modulated signal.

5.4.2 Test Setup

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

5.4.3 Test Procedure

Use the following spectrum analyzer settings:

Span = approximately 2 to 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); RSS-247, 5.1 (2)

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 4.5.1 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); RSS-247, 5.1 (4)

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

5.6.2 Test Setup

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

5.6.3 Test Procedure

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

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

{Period} = 0.4s * {Number of Hopping Frequency}

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

5.6.4 Test Result

Please refer to ANNEX A.5

5.7 Conducted Spurious Emission & Authorized-band band-edge

5.7.1 Limit

FCC §15.247(d); RSS-247, 5.5

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

5.7.2 Test Setup

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

5.7.3 Test Procedure

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz
VBW ≥ 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; RSS-GEN, 8.8

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

5.8.3 Test Procedure

The maximum conducted interference is searched using Peak (PK), if the emission levels more than the AV and QP limits, and that have narrow margins from the AV and QP limits will be re-measured with AV and QP detectors. Tests for both L phase and N phase lines of the power mains connected to the EUT are performed. Refer to recorded points and plots below.

5.8.4 Test Result

Please refer to ANNEX A.7.

5.9 Radiated Spurious Emission

5.9.1 Limit

FCC §15.209&15.247(d); RSS-247, 5.5

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

5.9.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

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

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 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); RSS-247, 5.5

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

5.10.2 Test Setup

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

5.10.3 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented.

The power of the EUT transmitting frequency should be ignored.

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

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 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

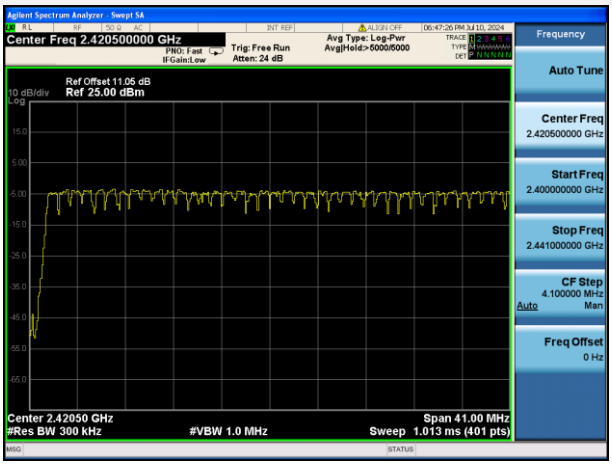
A.1 Number of Hopping Frequency

Test Data

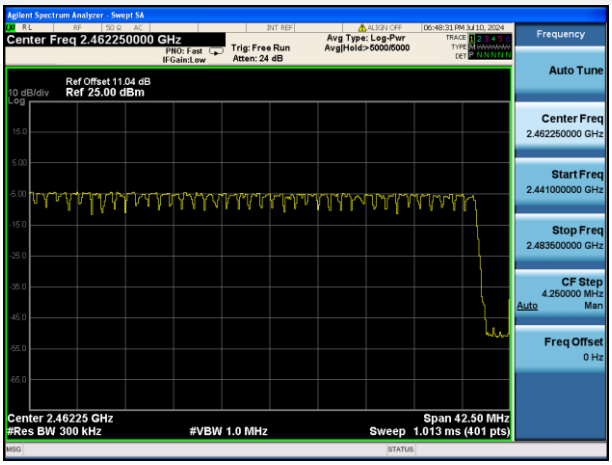
Test Mode	Frequency Block (MHz)	Measured Channel Numbers	Min. Limit	Verdict
GFSK	2400 - 2483.5	79	15	Pass

Test Plots

GFSK 2.4 GHz ~ 2.4835 GHz



GFSK 2.4 GHz ~ 2.4835 GHz



A.2 Peak Output Power and E.I.R.P

Peak Power Test Data

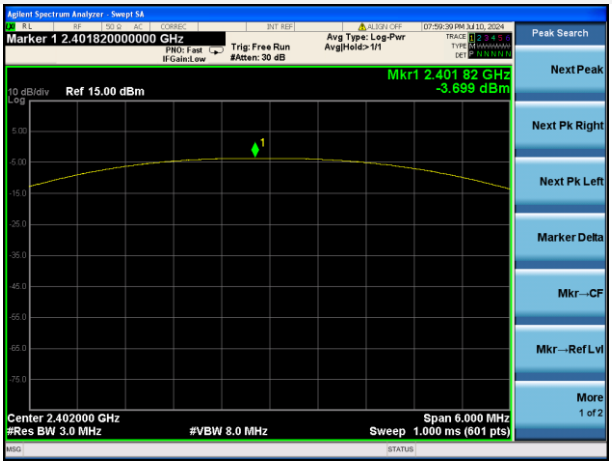
Channel	Measured Output Peak Power		Limit		Verdict
	dBm	mW	dBm	mW	
Low	-3.70	0.43	21	125	Pass
Middle	-3.83	0.41			Pass
High	-4.12	0.39			Pass

E.I.R.P Test Data (For ISED)

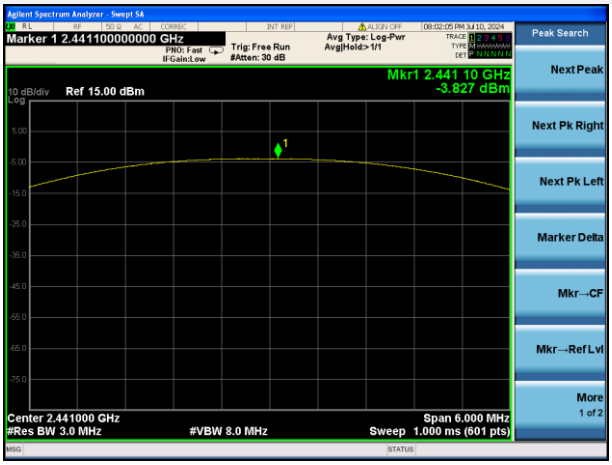
Channel	E.I.R.P		Limit		Verdict
	dBm	mW	dBm	mW	
Low	-2.25	0.60	36	4000	Pass
Middle	-2.38	0.58			Pass
High	-2.67	0.54			Pass

Test Plots

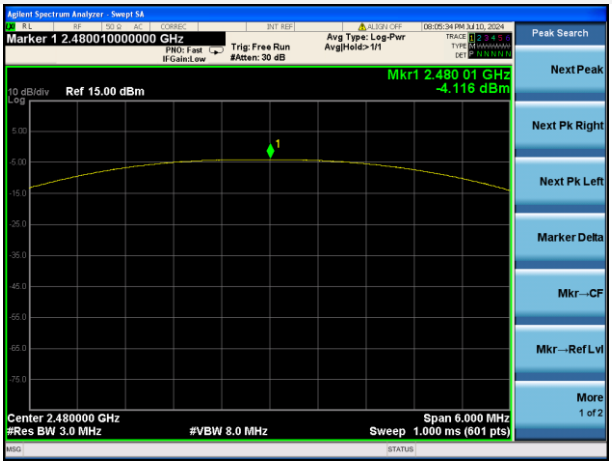
GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL

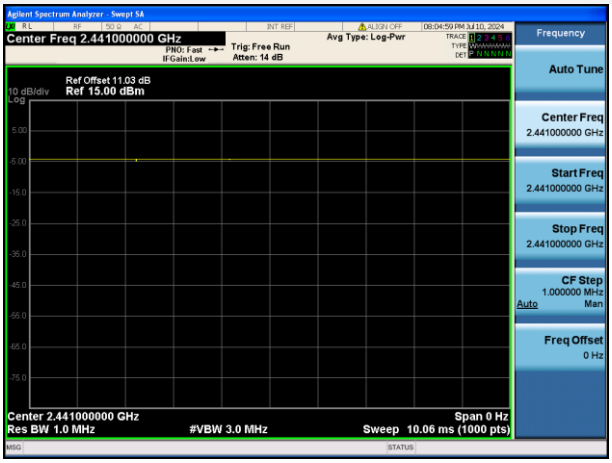


Duty Cycle Test Data

Band	On Time (ms)	On+Off Time (ms)	Duty Cycle (%)
GFSK	1	1	100.00

Test Plots

GFSK



A.3 Occupied Bandwidth

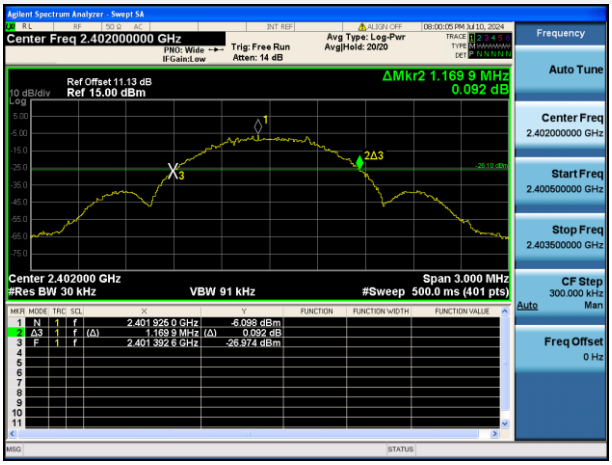
Test Data

Test Mode	GFSK	
Channel	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low Channel	1.169900	1.019300
Middle Channel	1.177500	1.011000
High Channel	1.185100	1.012200

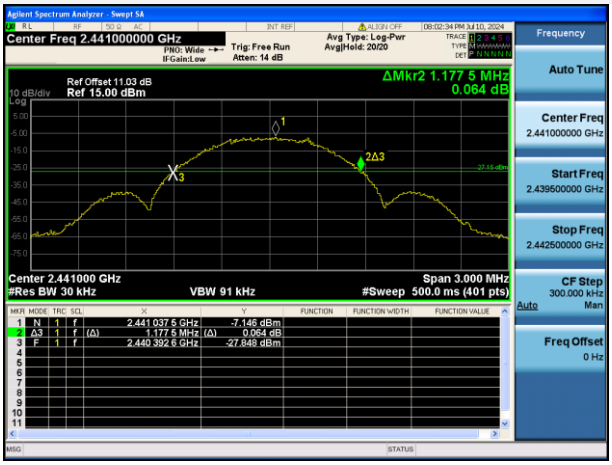
Test Plots

20 dB Bandwidth

GFSK LOW CHANNEL



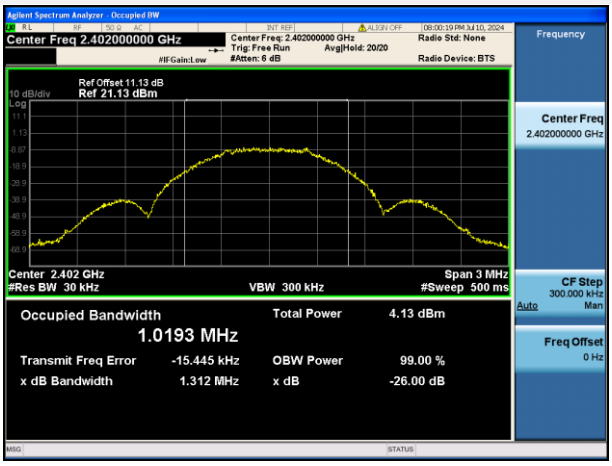
GFSK MIDDLE CHANNEL



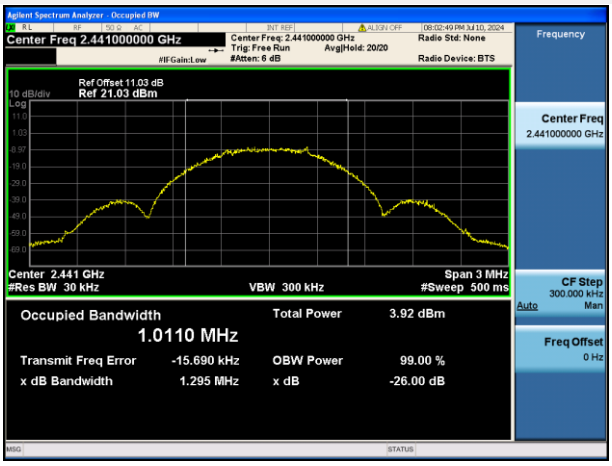
GFSK HIGH CHANNEL

99% Bandwidth

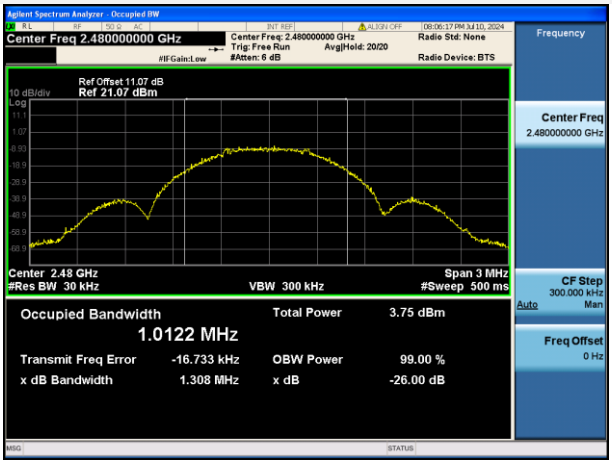
GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL



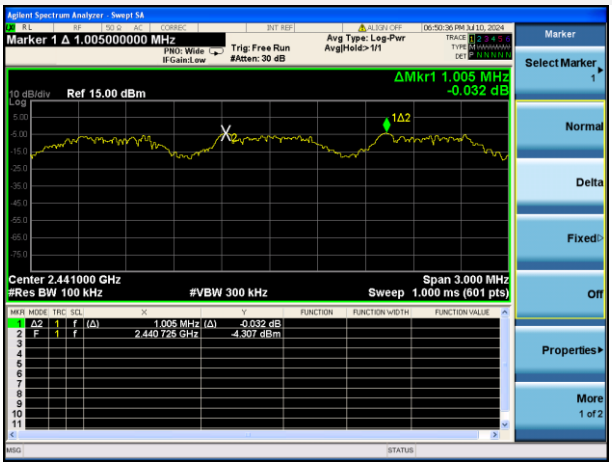
A.4 Hopping Frequency Separation

Test Data

Mode	Frequency separation (MHz)	2/3 of the 20 dB Bandwidth (MHz)	Verdict
GFSK	1.005	0.790	Pass

Test Plots

GFSK



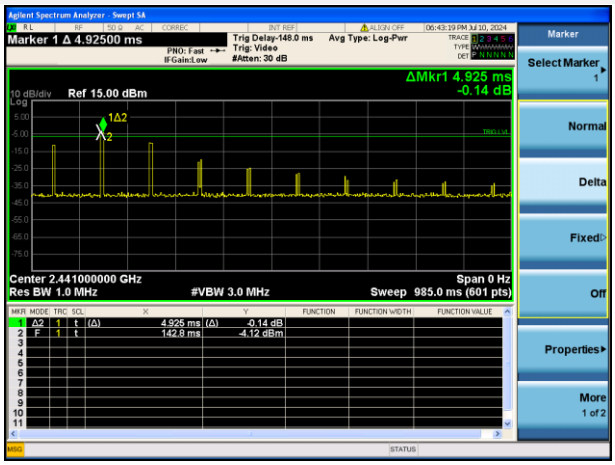
A.5 Time of Occupancy (Dwell time)

Test Data

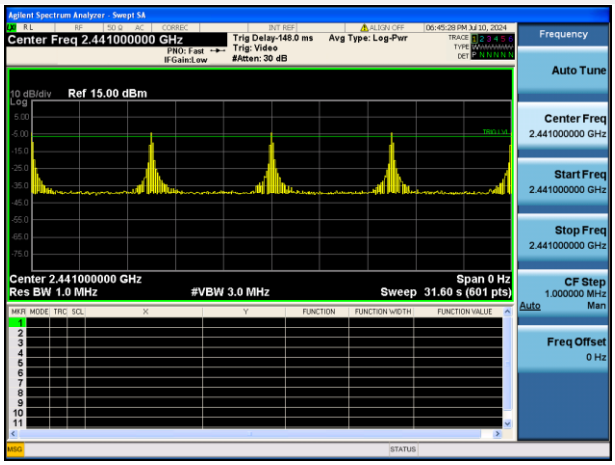
GFSK			
Pulse Width (ms)	Total of Dwell (ms)	Limit (sec)	Verdict
4.92500	24.625	0.4	Pass

Test Plots

on time



on+off time



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	-35.46	-4.15	-24.15	Pass
Middle	-35.49	-4.25	-24.25	Pass
High	-34.79	-4.53	-24.53	Pass

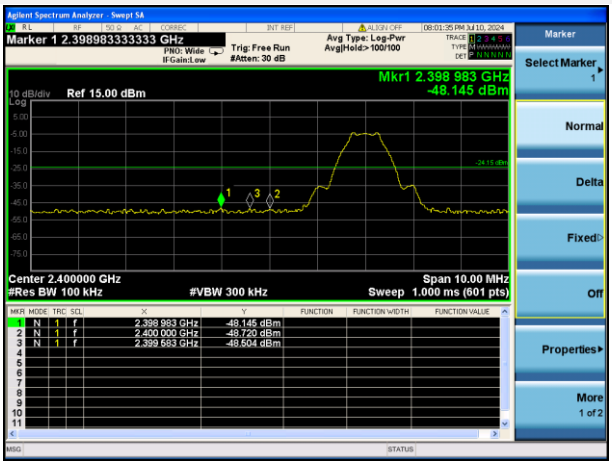
Hopping Mode:

GFSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
GFSK	-36.43	-3.59	-23.59	Pass

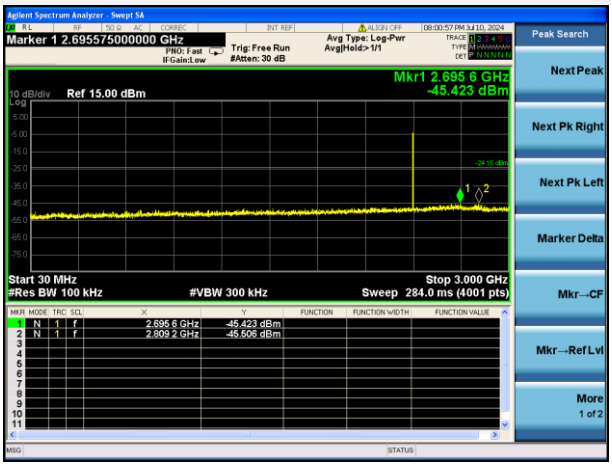
Test Plots

GFSK LOW CHANNEL, CARRIER LEVEL

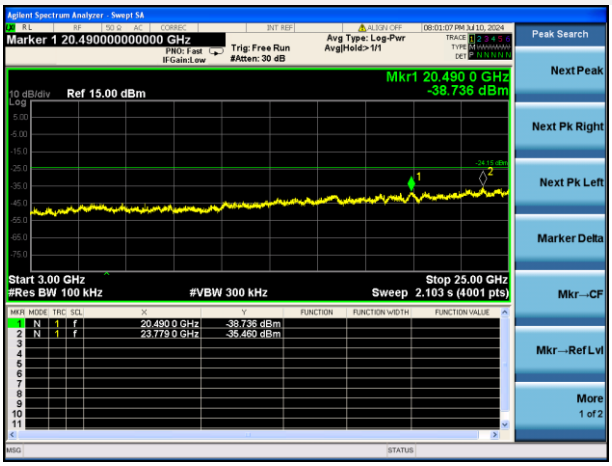
GFSK LOW CHANNEL, BAND EDGE



GFSK LOW CHANNEL, SPURIOUS 30 MHz ~ 3 GHz

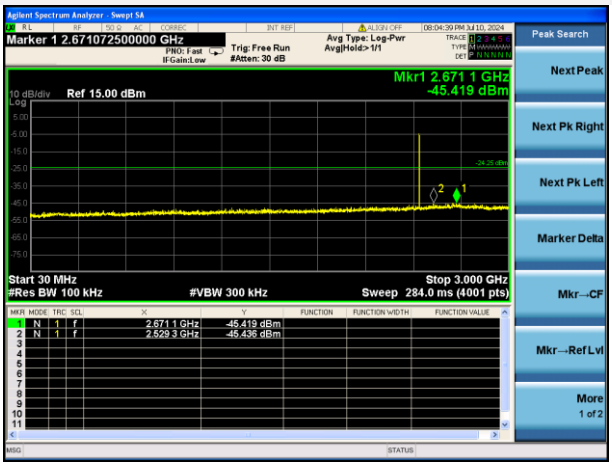


GFSK LOW CHANNEL, SPURIOUS 3 GHz ~ 25 GHz

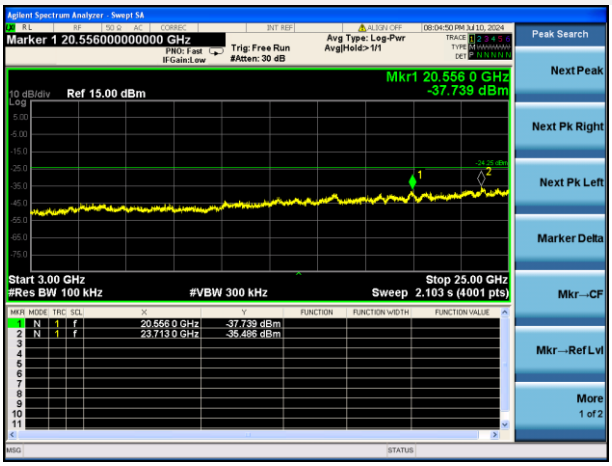


GFSK MIDDLE CHANNEL, CARRIER LEVEL

GFSK MIDDLE CHANNEL, SPURIOUS 30 MHz ~ 3 GHz

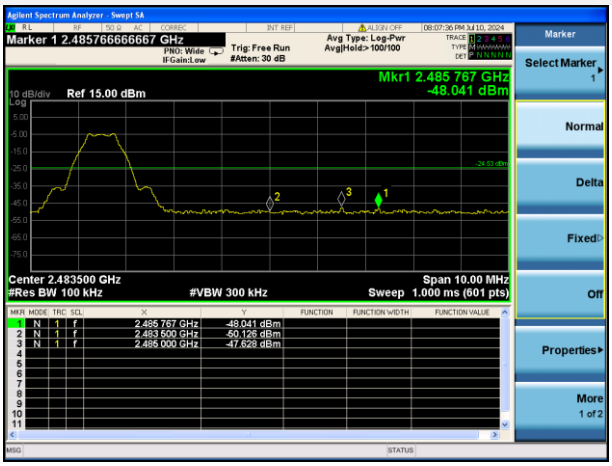


GFSK MIDDLE CHANNEL, SPURIOUS 3 GHz ~ 25 GHz

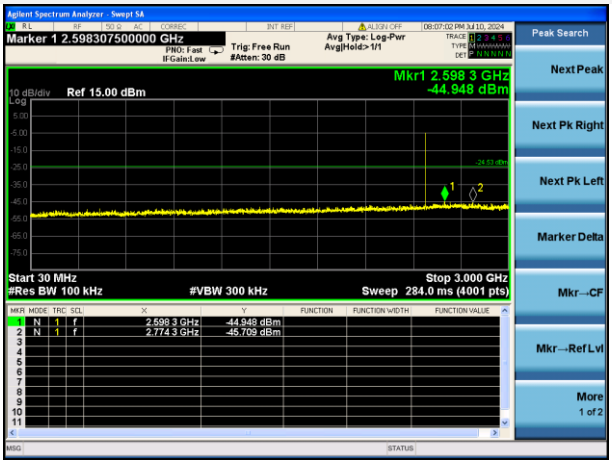


GFSK HIGH CHANNEL, CARRIER LEVEL

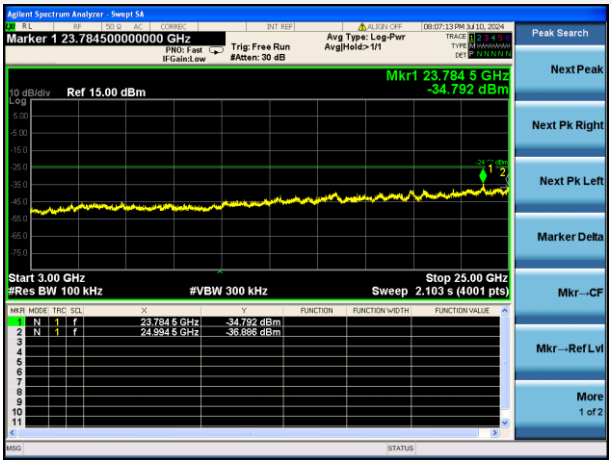
GFSK HIGH CHANNEL, BAND EDGE



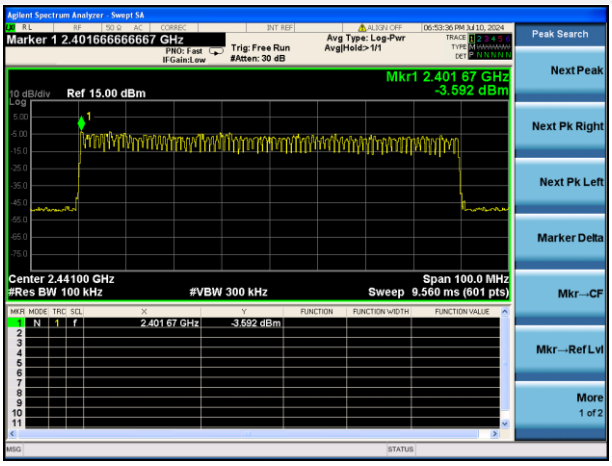
GFSK HIGH CHANNEL, SPURIOUS 30 MHz ~ 3 GHz



GFSK HIGH CHANNEL, SPURIOUS 3 GHz ~ 25 GHz

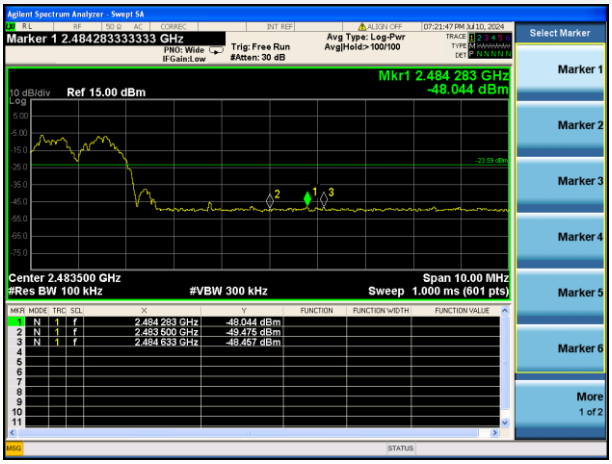


GFSK HOPPING, CARRIER LEVEL

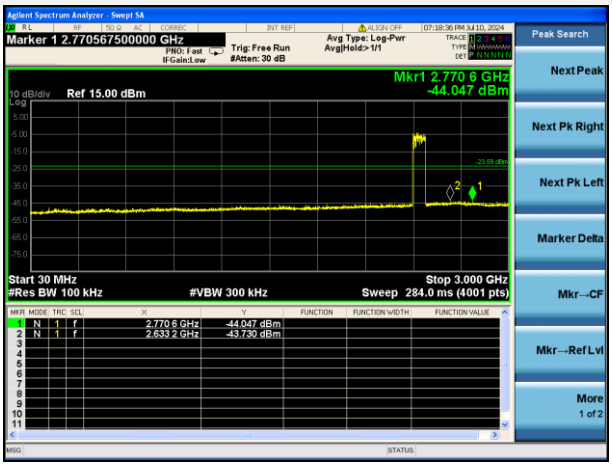


GFSK HOPPING BAND EDGE (LOW)

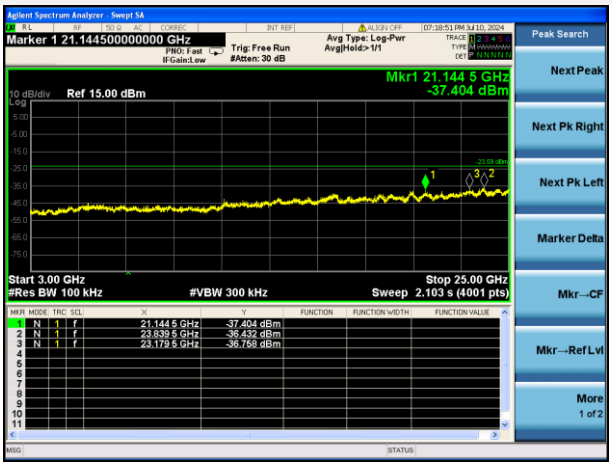
GFSK HOPPING BAND EDGE (HIGH)



GFSK Hopping Mode, SPURIOUS 30 MHz ~ 3 GHz



GFSK Hopping Mode, SPURIOUS 3GHz ~ 25 GHz



A.7 Conducted Emissions

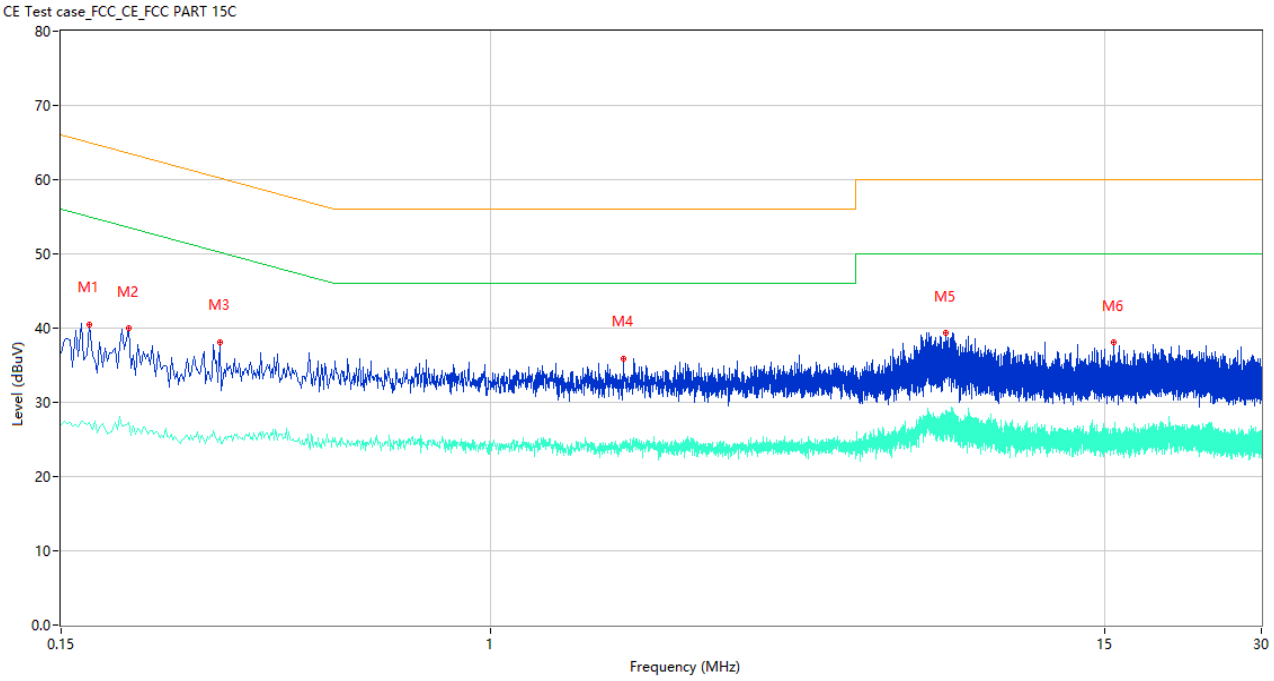
Note [1]: The EUT is working in the Normal link mode. All modes have been tested and normal link mode is worst.

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 (120 VAC, 60 Hz) shown here.

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

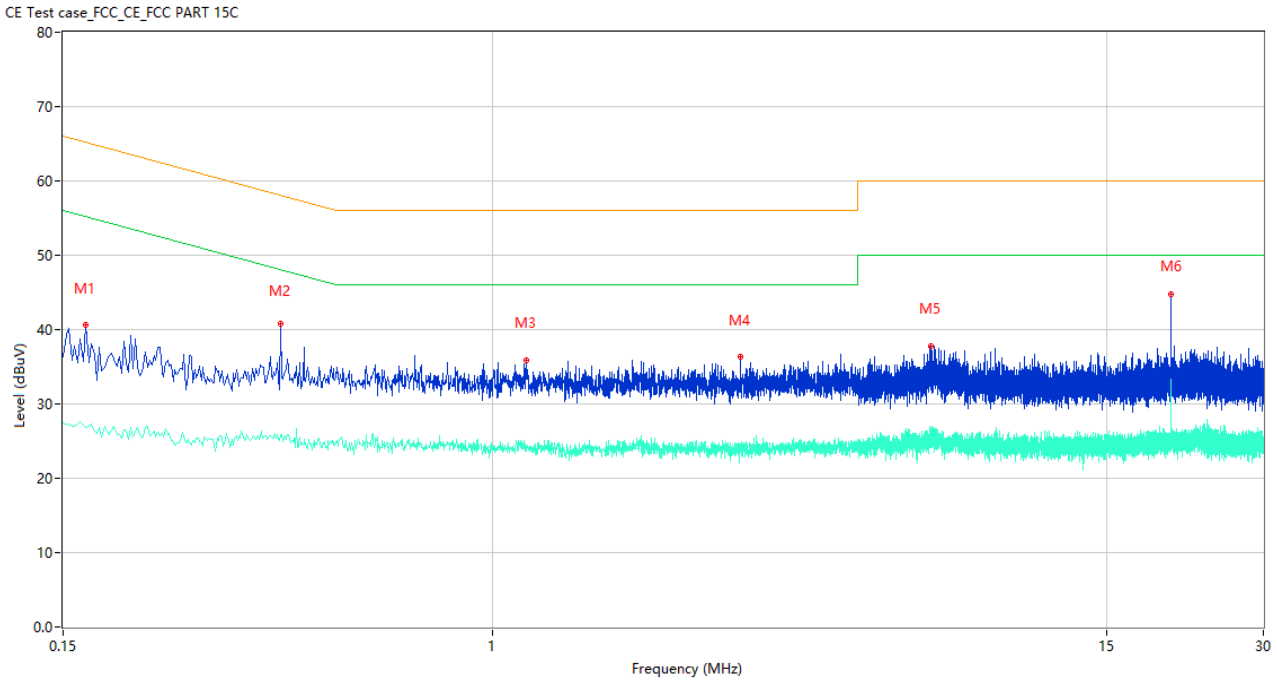
Test Data and Plots

PHASE L



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.170	40.51	9.78	64.96	24.45	Peak	L	Pass
1**	0.170	27.36	9.78	54.96	27.60	AV	L	Pass
2	0.202	40.00	9.77	63.53	23.53	Peak	L	Pass
2**	0.202	27.26	9.77	53.53	26.27	AV	L	Pass
3	0.302	38.13	9.80	60.19	22.06	Peak	L	Pass
3**	0.302	25.44	9.80	50.19	24.75	AV	L	Pass
4	1.796	35.90	10.19	56.00	20.10	Peak	L	Pass
4**	1.796	24.53	10.19	46.00	21.47	AV	L	Pass
5	7.456	39.35	10.51	60.00	20.65	Peak	L	Pass
5**	7.456	26.93	10.51	50.00	23.07	AV	L	Pass
6	15.598	38.07	10.63	60.00	21.93	Peak	L	Pass
6**	15.598	25.13	10.63	50.00	24.87	AV	L	Pass

PHASE N



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.166	40.60	9.78	65.16	24.56	Peak	N	Pass
1**	0.166	26.79	9.78	55.16	28.37	AV	N	Pass
2	0.392	40.72	10.59	58.02	17.30	Peak	N	Pass
2**	0.392	25.92	10.59	48.02	22.10	AV	N	Pass
3	1.160	35.93	10.29	56.00	20.07	Peak	N	Pass
3**	1.160	23.60	10.29	46.00	22.40	AV	N	Pass
4	2.986	36.33	10.27	56.00	19.67	Peak	N	Pass
4**	2.986	24.66	10.27	46.00	21.34	AV	N	Pass
5	6.906	37.83	10.49	60.00	22.17	Peak	N	Pass
5**	6.906	26.45	10.49	50.00	23.55	AV	N	Pass
6	19.950	44.76	11.04	60.00	15.24	Peak	N	Pass
6**	19.950	28.67	11.04	50.00	21.33	AV	N	Pass

A.8 Radiated Emission

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

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

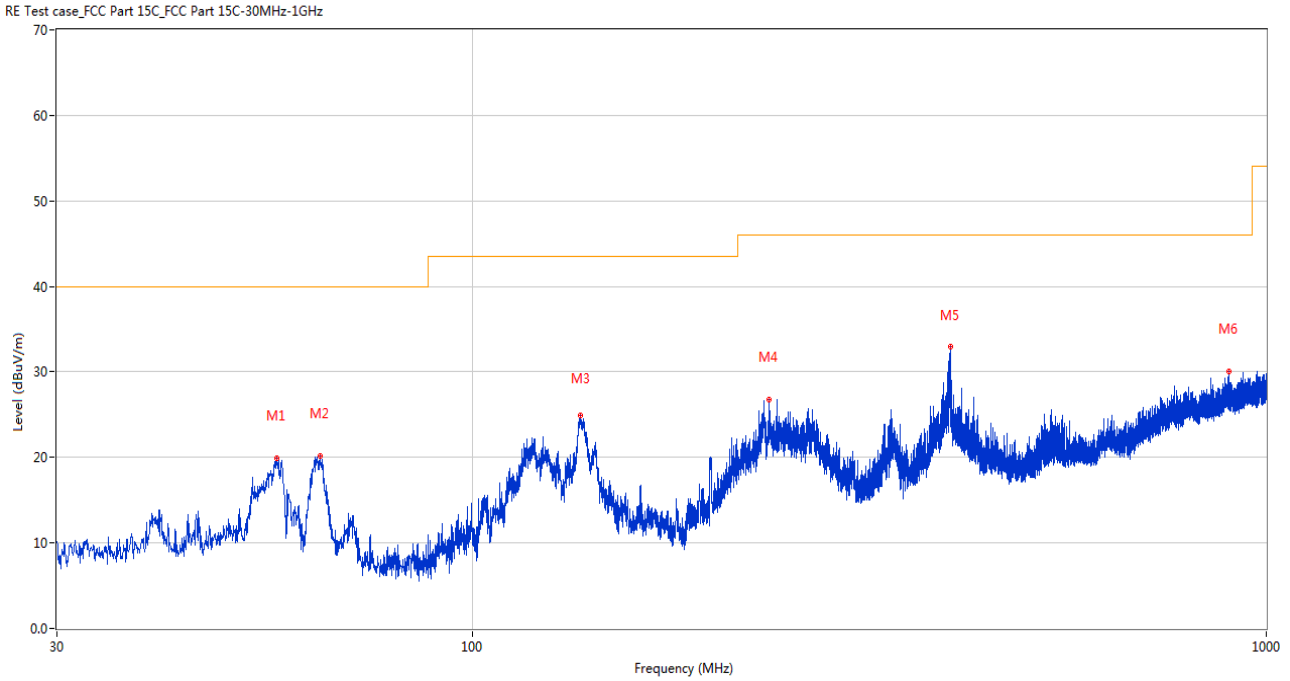
Note [3]: The EUT is working in the Normal link mode below 1 GHz. All modes have been tested and DH5-Hopping mode is the worst.

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

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

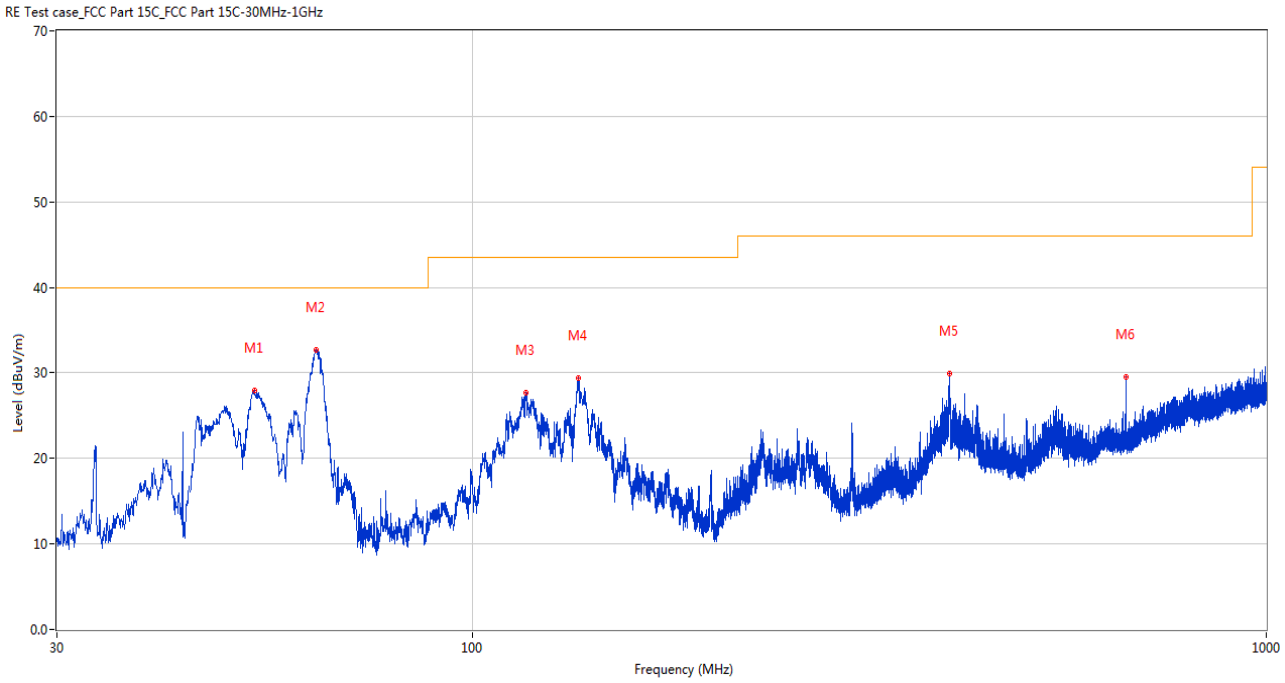
Test Data and Plots

30 MHz to 1 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	56.821	19.87	-26.82	40.0	20.13	Peak	282.00	100	Horizontal	Pass
2	64.338	20.16	-28.12	40.0	19.84	Peak	193.00	200	Horizontal	Pass
3	136.700	24.96	-26.41	43.5	18.54	Peak	0.00	200	Horizontal	Pass
4	236.755	26.70	-27.62	46.0	19.30	Peak	81.00	100	Horizontal	Pass
5	399.909	32.95	-21.32	46.0	13.05	Peak	66.00	100	Horizontal	Pass
6	896.404	30.09	-10.75	46.0	15.91	Peak	4.00	100	Horizontal	Pass

30 MHz to 1 GHz, ANT V

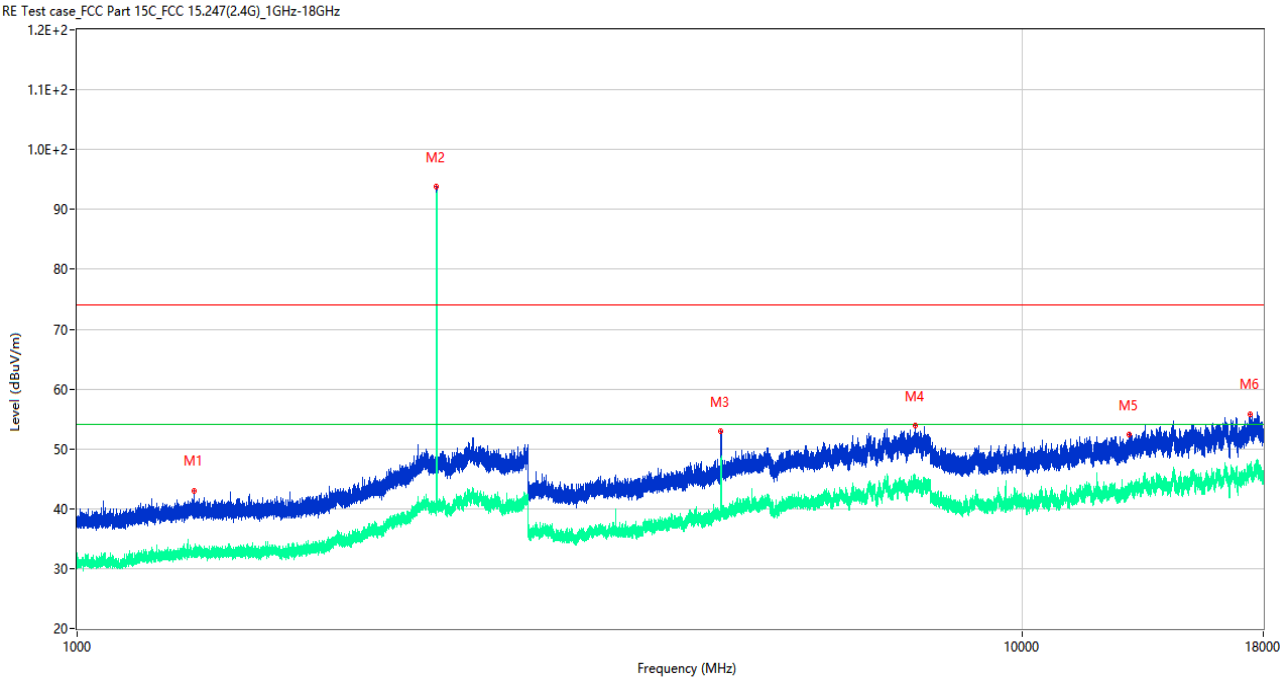


No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	53.231	27.91	-26.77	40.0	12.09	Peak	33.00	100	Vertical	Pass
2	63.611	32.72	-28.06	40.0	7.28	Peak	249.00	100	Vertical	Pass
3	116.864	27.66	-28.51	43.5	15.84	Peak	105.00	100	Vertical	Pass
4	136.070	29.41	-26.39	43.5	14.09	Peak	125.00	100	Vertical	Pass
5	398.988	29.91	-21.29	46.0	16.09	Peak	173.00	100	Vertical	Pass
6	666.466	29.55	-15.59	46.0	16.45	Peak	318.00	100	Vertical	Pass

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

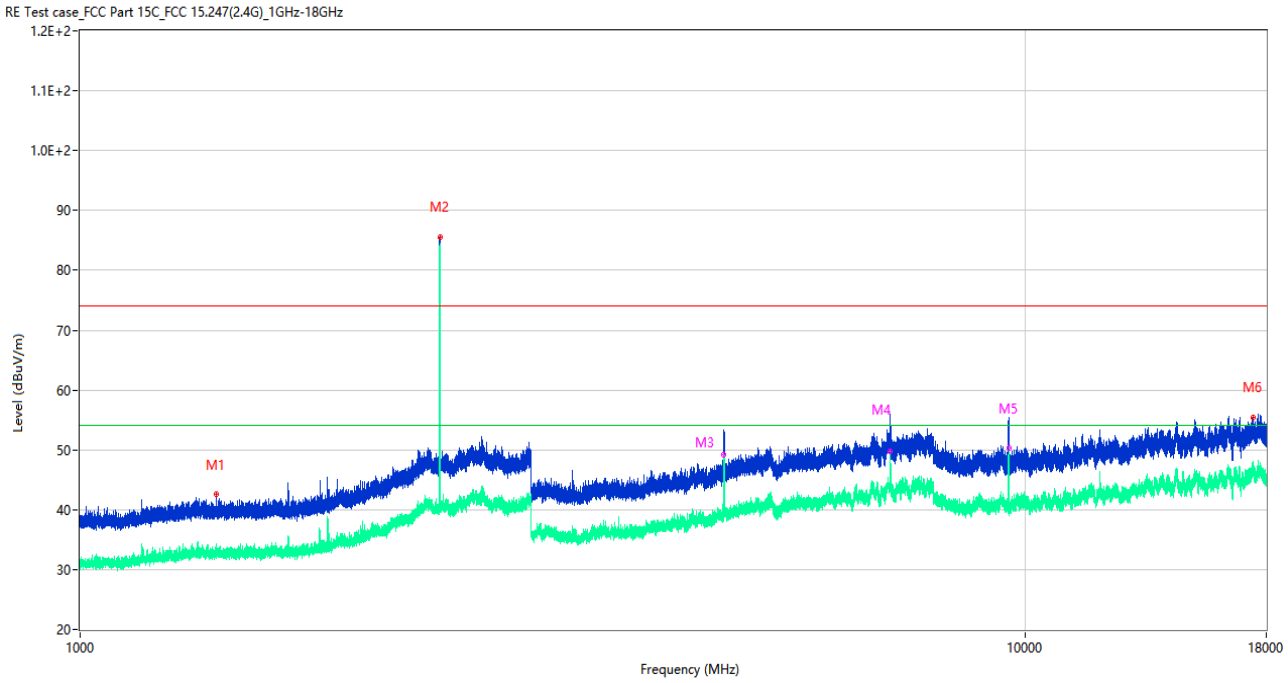
Note 2: The spurious from 18GHz-25GHz is noise only, do not show on the report.

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT H



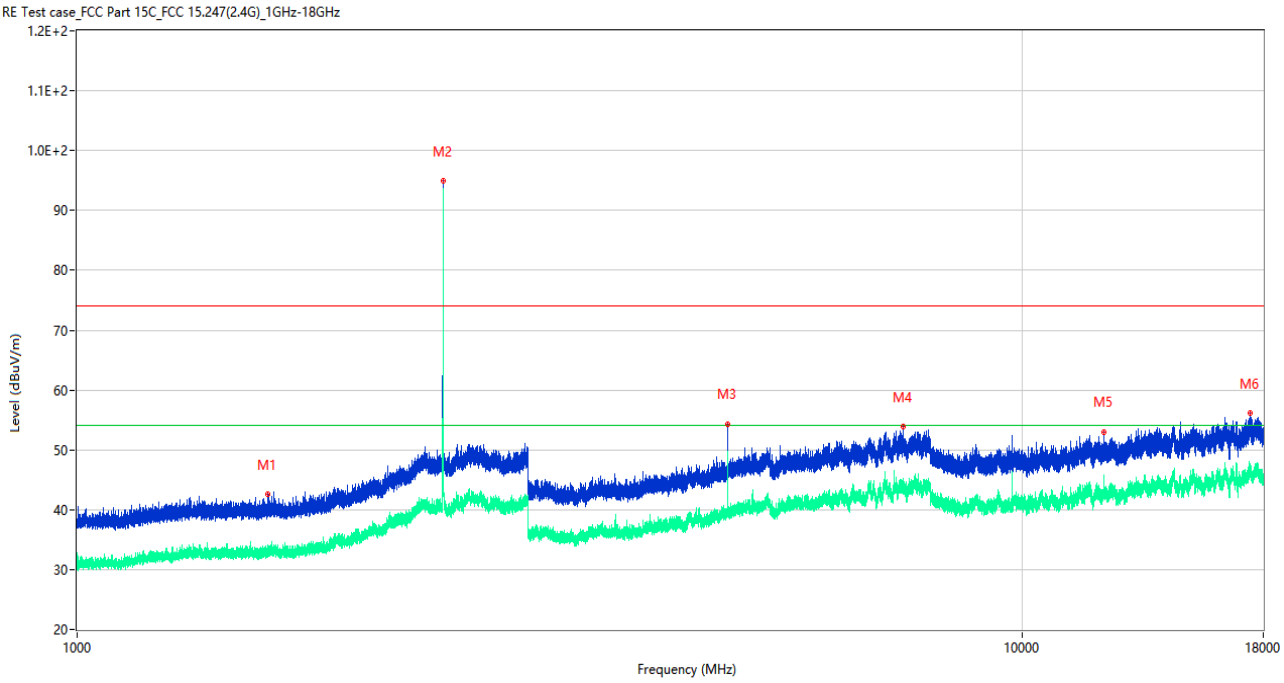
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1330.900	43.01	-16.93	74.0	30.99	Peak	48.00	100	Horizontal	Pass
1**	1330.900	32.41	-16.93	54.0	21.59	AV	48.00	100	Horizontal	Pass
2	2401.500	93.80	-10.63	74.0	-19.80	Peak	67.00	150	Horizontal	N/A
2**	2401.500	91.87	-10.63	54.0	-37.87	AV	67.00	150	Horizontal	N/A
3	4803.250	52.86	-3.44	74.0	21.14	Peak	58.00	100	Horizontal	Pass
3**	4803.250	48.20	-3.44	54.0	5.80	AV	58.00	100	Horizontal	Pass
4	7712.750	53.88	1.76	74.0	20.12	Peak	58.00	400	Horizontal	Pass
4**	7712.750	44.83	1.76	54.0	9.17	AV	58.00	400	Horizontal	Pass
5	12979.687	52.31	1.86	74.0	21.69	Peak	256.00	200	Horizontal	Pass
5**	12979.687	43.07	1.86	54.0	10.93	AV	256.00	200	Horizontal	Pass
6	17442.714	55.85	5.55	74.0	18.15	Peak	144.00	300	Horizontal	Pass
6**	17442.714	46.66	5.55	54.0	7.34	AV	144.00	300	Horizontal	Pass

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT V



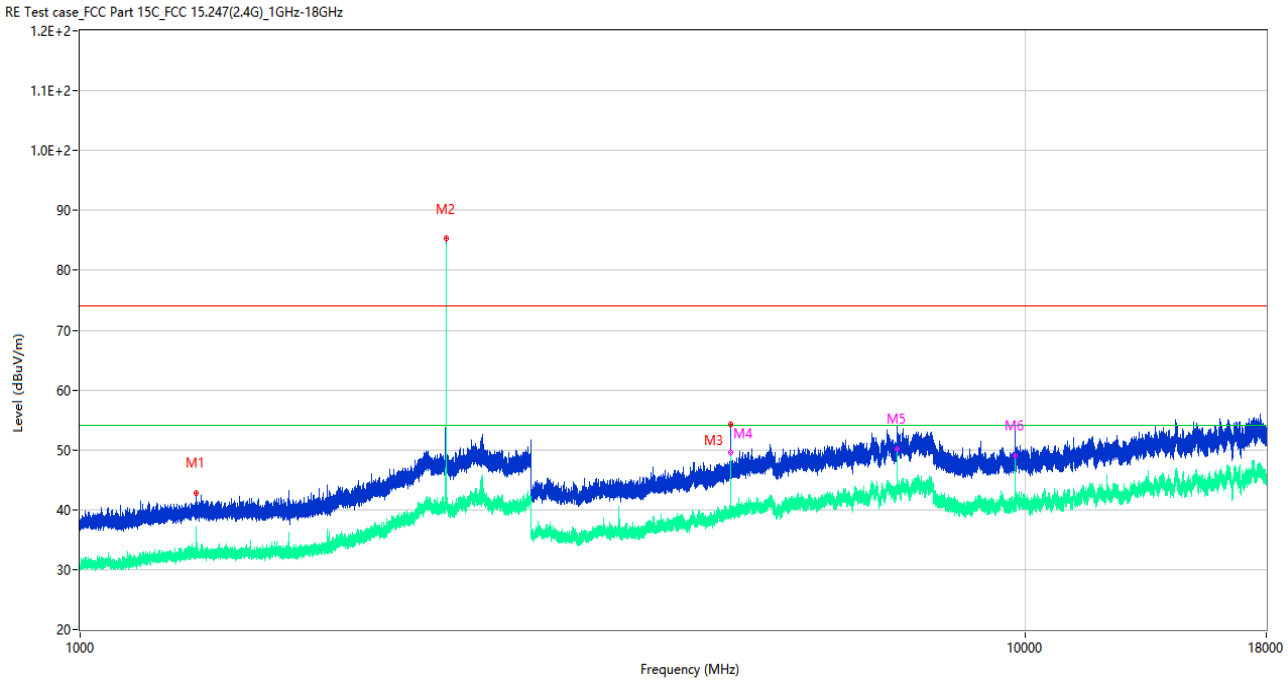
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1393.200	42.57	-17.12	74.0	31.43	Peak	174.00	100	Vertical	Pass
1**	1393.200	33.25	-17.12	54.0	20.75	AV	174.00	100	Vertical	Pass
2	2402.500	85.61	-10.63	74.0	-11.61	Peak	42.00	150	Vertical	N/A
2**	2402.500	83.48	-10.63	54.0	-29.48	AV	42.00	150	Vertical	N/A
3	4803.250	52.51	-3.44	74.0	21.49	Peak	295.00	300	Vertical	Pass
3**	4803.250	49.14	-3.44	54.0	4.86	AV	295.00	300	Vertical	Pass
4	7204.750	54.84	0.44	74.0	19.16	Peak	109.00	150	Vertical	Pass
4**	7204.750	50.04	0.44	54.0	3.96	AV	109.00	150	Vertical	Pass
5	9606.450	54.07	-2.98	74.0	19.93	Peak	323.00	100	Vertical	Pass
5**	9606.450	50.27	-2.98	54.0	3.73	AV	323.00	100	Vertical	Pass
6	17447.176	55.48	5.56	74.0	18.52	Peak	305.00	100	Vertical	Pass
6**	17447.176	46.29	5.56	54.0	7.71	AV	305.00	100	Vertical	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H



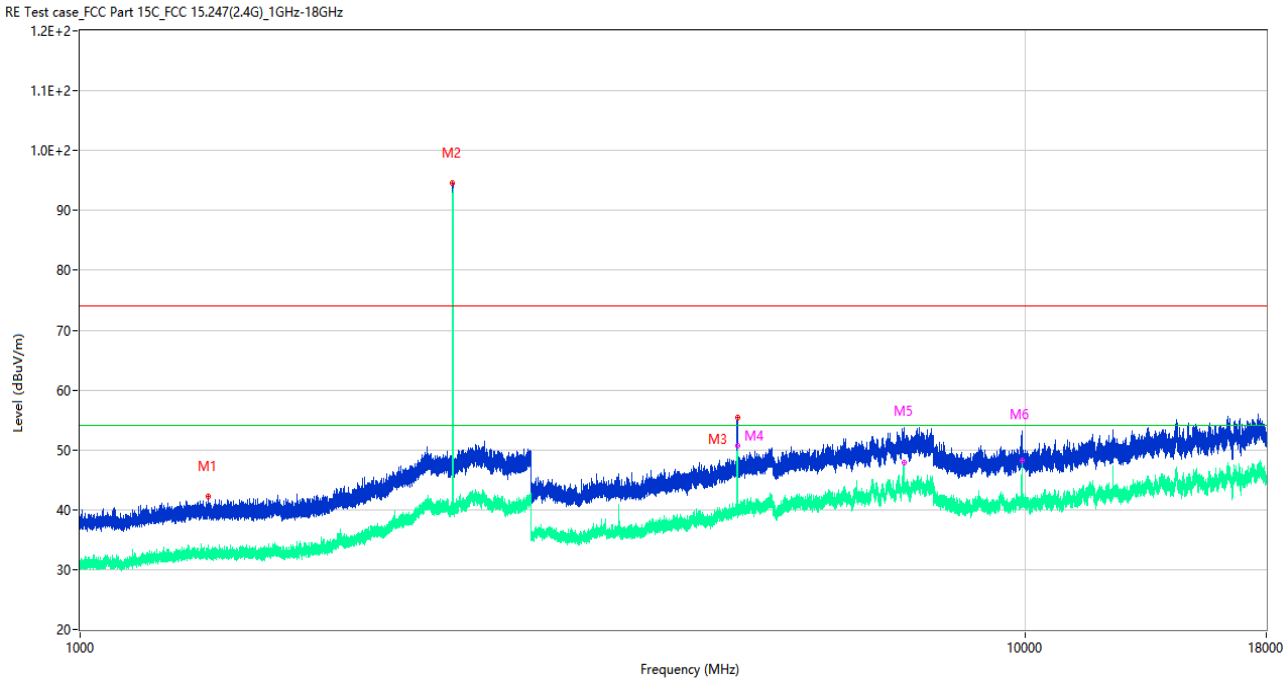
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1590.400	42.54	-17.09	74.0	31.46	Peak	226.00	300	Horizontal	Pass
1**	1590.400	32.67	-17.09	54.0	21.33	AV	226.00	300	Horizontal	Pass
2	2440.600	94.93	-9.80	74.0	-20.93	Peak	70.00	100	Horizontal	N/A
2**	2440.600	92.87	-9.80	54.0	-38.87	AV	70.00	100	Horizontal	N/A
3	4881.000	54.34	-3.82	74.0	19.66	Peak	43.00	200	Horizontal	Pass
3**	4881.000	49.80	-3.82	54.0	4.20	AV	43.00	200	Horizontal	Pass
4	7490.750	53.81	1.51	74.0	20.19	Peak	221.00	400	Horizontal	Pass
4**	7490.750	44.68	1.51	54.0	9.32	AV	221.00	400	Horizontal	Pass
5	12197.576	53.05	0.38	74.0	20.95	Peak	0.00	100	Horizontal	Pass
5**	12197.576	45.27	0.38	54.0	8.73	AV	0.00	100	Horizontal	Pass
6	17418.301	56.10	5.48	74.0	17.90	Peak	276.00	200	Horizontal	Pass
6**	17418.301	45.87	5.48	54.0	8.13	AV	276.00	200	Horizontal	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V



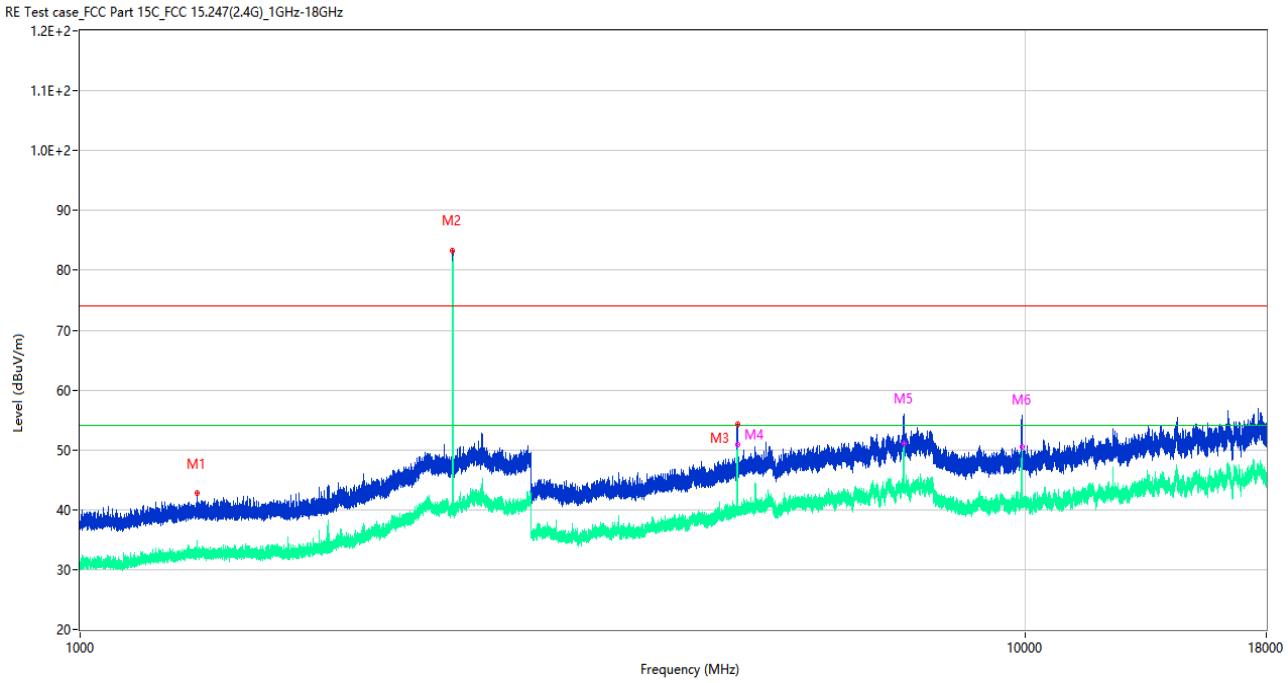
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1327.500	42.87	-16.95	74.0	31.13	Peak	155.00	300	Vertical	Pass
1**	1327.500	32.81	-16.95	54.0	21.19	AV	155.00	300	Vertical	Pass
2	2440.500	85.26	-9.86	74.0	-11.26	Peak	40.00	150	Vertical	N/A
2**	2440.500	83.07	-9.86	54.0	-29.07	AV	40.00	150	Vertical	N/A
3	4881.000	54.28	-3.82	74.0	19.72	Peak	319.00	100	Vertical	Pass
3**	4881.000	49.43	-3.82	54.0	4.57	AV	319.00	100	Vertical	Pass
4	4879.250	53.38	-3.83	74.0	20.62	Peak	107.00	300	Vertical	Pass
4**	4879.250	49.55	-3.83	54.0	4.45	AV	107.00	300	Vertical	Pass
5	7318.500	53.63	0.59	74.0	20.37	Peak	319.00	150	Vertical	Pass
5**	7318.500	50.14	0.59	54.0	3.86	AV	319.00	150	Vertical	Pass
6	9758.213	53.83	-2.06	74.0	20.17	Peak	319.00	100	Vertical	Pass
6**	9758.213	49.02	-2.06	54.0	4.98	AV	319.00	100	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	1366.700	42.21	-17.07	74.0	31.79	Peak	189.00	400	Horizontal	Pass
1**	1366.700	32.04	-17.07	54.0	21.96	AV	189.00	400	Horizontal	Pass
2	2479.600	94.57	-11.19	74.0	-20.57	Peak	63.00	200	Horizontal	N/A
2**	2479.600	92.16	-11.19	54.0	-38.16	AV	63.00	200	Horizontal	N/A
3	4960.750	55.36	-3.50	74.0	18.64	Peak	64.00	200	Horizontal	Pass
3**	4960.750	50.49	-3.50	54.0	3.51	AV	64.00	200	Horizontal	Pass
4	4961.000	54.22	-3.67	74.0	19.78	Peak	64.00	100	Horizontal	Pass
4**	4961.000	50.66	-3.67	54.0	3.34	AV	64.00	100	Horizontal	Pass
5	7441.750	52.63	0.73	74.0	21.37	Peak	360.00	100	Horizontal	Pass
5**	7441.750	47.79	0.73	54.0	6.21	AV	360.00	100	Horizontal	Pass
6	9922.088	52.57	-2.49	74.0	21.43	Peak	316.00	200	Horizontal	Pass
6**	9922.088	48.20	-2.49	54.0	5.80	AV	316.00	200	Horizontal	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT V



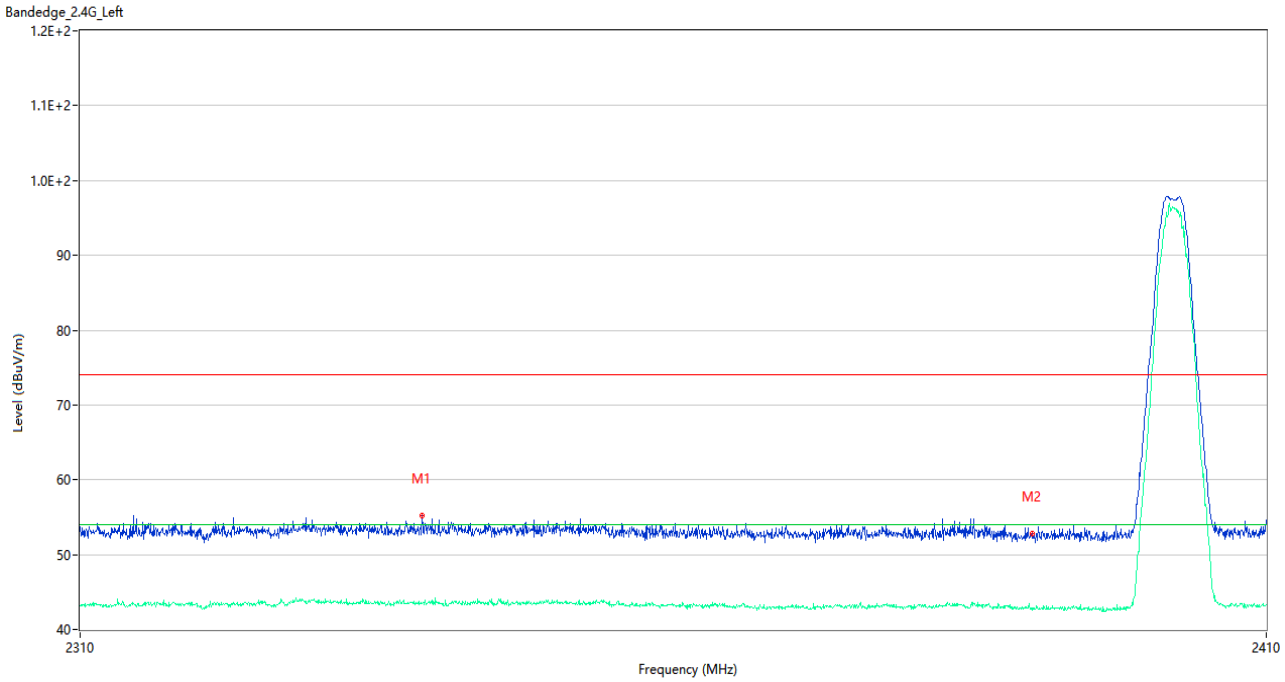
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1330.500	42.77	-17.18	74.0	31.23	Peak	161.00	100	Vertical	Pass
1**	1330.500	33.15	-17.18	54.0	20.85	AV	161.00	100	Vertical	Pass
2	2479.600	83.29	-11.19	74.0	-9.29	Peak	38.00	100	Vertical	N/A
2**	2479.600	80.47	-11.19	54.0	-26.47	AV	38.00	100	Vertical	N/A
3	4961.000	55.82	-3.67	74.0	18.18	Peak	337.00	200	Vertical	Pass
3**	4961.000	50.12	-3.67	54.0	3.88	AV	337.00	200	Vertical	Pass
4	4961.250	54.96	-3.66	74.0	19.04	Peak	316.00	400	Vertical	Pass
4**	4961.250	50.83	-3.66	54.0	3.17	AV	316.00	400	Vertical	Pass
5	7441.750	55.11	0.73	74.0	18.89	Peak	16.00	200	Vertical	Pass
5**	7441.750	51.00	0.73	54.0	3.00	AV	16.00	200	Vertical	Pass
6	9922.088	55.24	-2.49	74.0	18.76	Peak	322.00	200	Vertical	Pass
6**	9922.088	50.52	-2.49	54.0	3.48	AV	322.00	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.

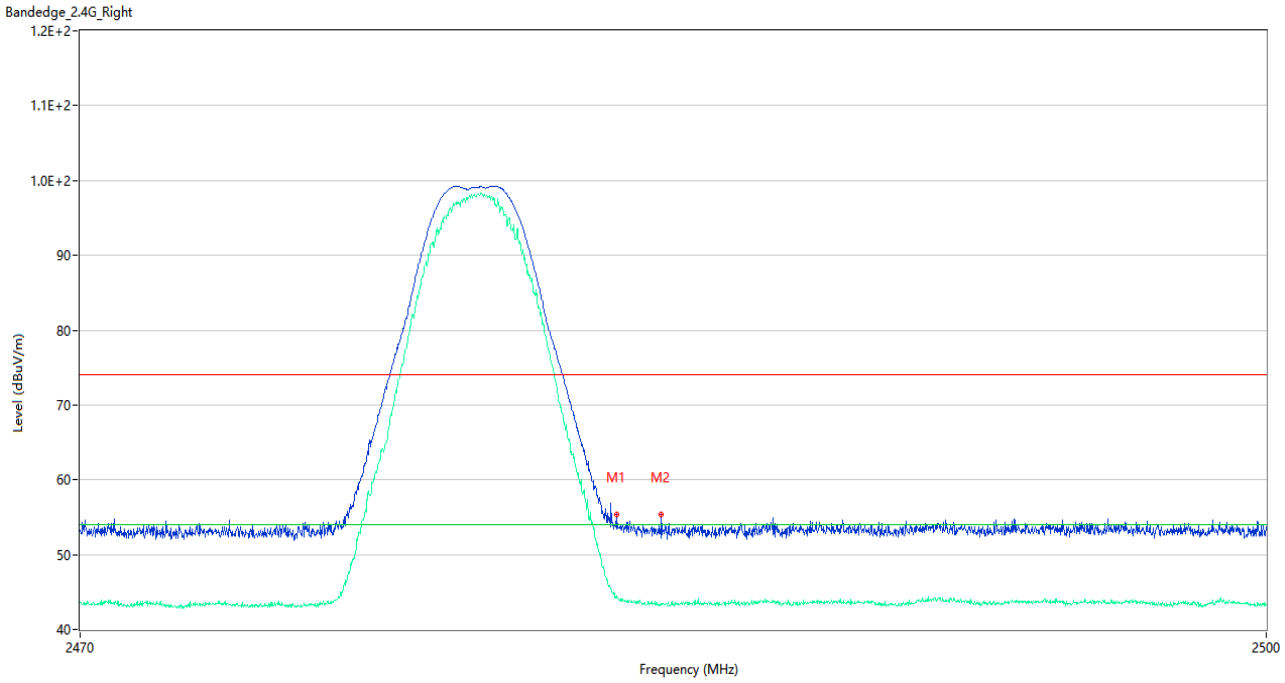
Test Data and Plots

GFSK LOW CHANNEL



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2338.400	55.24	-1.03	74.0	18.76	Peak	19.00	150	Horizontal	Pass
1**	2338.400	43.39	-1.03	54.0	10.61	AV	19.00	150	Horizontal	Pass
2	2389.950	52.85	-1.82	74.0	21.15	Peak	180.00	150	Horizontal	Pass
2**	2389.950	42.81	-1.82	54.0	11.19	AV	180.00	150	Horizontal	Pass

GFSK HIGH CHANNEL



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2483.515	55.31	-1.10	74.0	18.69	Peak	268.00	200	Horizontal	Pass
1**	2483.515	44.55	-1.10	54.0	9.45	AV	268.00	200	Horizontal	Pass
2	2484.655	55.37	-1.24	74.0	18.63	Peak	132.00	100	Horizontal	Pass
2**	2484.655	43.34	-1.24	54.0	10.66	AV	132.00	100	Horizontal	Pass

ANNEX B TEST SETUP PHOTOS

Please refer the document “BL-SZ2430860-AR.PDF”.

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document “BL-SZ2430860-AW.PDF”.

ANNEX D EUT INTERNAL PHOTOS

Please refer the document “BL-SZ2430860-AI.PDF”.

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--END OF REPORT--