RF TEST REPORT

ISSUED BY
Shenzhen BALUN Technology Co., Ltd.

FOR

Dock

ISSUED TO
Analogue Enterprises Ltd.

Flat J, 2/F, Po Ming Building, 2-6 Foo Ming Street, Causeway Bay, Hong Kong China

Report No.:	BL-SZ2130159-602
EUT Name:	Dock
Model Name:	AP-D01
Brand Name:	Analogue
Test Standard:	47 CFR Part 15 Subpart C (refer section 3.1)
FCC ID:	2AZVE-AP-D01
Test Conclusion:	Pass
Test Date:	Jul. 07, 2021 ~ Sep. 26, 2021
Date of Issue:	Sep. 26, 2021

Tested by: Ye Hongji
Date: Sep. 26. 2021

Approved by: Wei Yanquan (Chief Engineer)
Date: Sep. 26. 2021

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Revision History

Version	Issue Date	Revisions
Rev. 01	Sep. 17, 2021	Initial Issue
Rev. 02	Sep. 26, 2021	Add test data on section A.4

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1 ADMINISTRATIVE DATA (GENERAL INFORMATION)

1.1 Identification of the Testing Laboratory

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

1.2 Identification of the Responsible Testing Location

Test Location	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1st FL, Baisha Science and Technology Park, Shahe Xi Road, 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.
Description	All measurement facilities used to collect the measurement data are located at Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055

1.3 Laboratory Condition

Ambient Temperature	20℃ to 25℃
Ambient Relative Humidity	45% to 55%
Ambient Pressure	100 kPa to 102 kPa

1.4 Announce

(1) The test report reference to the report template version v2.2.

(2) The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.

(3) The test report is invalid if there is any evidence and/or falsification.

(4) The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein.

(5) This document may not be altered or revised in any way unless done so by BALUN and all revisions are duly noted in the revisions section.

(6) Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

(7) The laboratory is only responsible for the data released by the laboratory, except for the part provided by the applicant.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	Analogue Enterprises Ltd.
Address	Flat J, 2/F, Po Ming Building, 2-6 Foo Ming Street, Causeway Bay, Hong Kong China

2.2 Manufacturer Information

Manufacturer	Shenzhen Zhong Xing Da Electronics Co., Ltd.
Address	2/F., Block 10, Tongfuyu Industrial Zone, Lezhujiao Village, Xixiang Bao'an District, Shenzhen, 518057, China

2.3 Factory Information

Factory	Shenzhen Zhong Xing Da Electronics Co., Ltd.
Address	2/F., Block 10, Tongfuyu Industrial Zone, Lezhujiao Village, Xixiang Bao'an District, Shenzhen, 518057, China

2.4 General Description for Equipment under Test (EUT)

EUT Name	Dock
Model Name Under Test	AP-D01
Series Model Name	N/A
Description of Model name differentiation	N/A
Hardware Version	004
Software Version	1
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.5 Technical Information

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

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

Modulation Technology	FHSS
Modulation Type	GFSK
Product Type	☒ Mobile ☐ Portable ☐ Fix Location
Transfer Rate	1 Mbps
Frequency Range	The frequency range used is 2406 MHz – 2476 MHz; The frequency block is 2400 MHz to 2483.5 MHz.
Number of channel	16 (See note 1)
Tested Channel	Low (2406 MHz), Middle (2441 MHz), High (2476 MHz)
Antenna Type	Custom Antenna
Antenna Gain	-5.09 dBi (In test items related to antenna gain, the final results reflect this figure. This value is provided by the applicant.)
Adaptive or non-adaptive	Non-Adaptive
The Max RF Output power	-19.97 dBm

Channel List

Number	Frequency (MHz)	Number	Frequency (MHz)
6	2406(Low)	41	2441(Middle)
11	2411	47	2447
14	2414	51	2451
17	2417	55	2455
24	2424	59	2459
29	2429	67	2467
33	2433	73	2473
36	2436	76	2476(High)
Note: The modulation is GFSK, when this part works, it will choose 16 channels, in this report, the equipment select the lowest, middle and highest channel, Which are 2406 MHz, 2441 MHz and 2476 MHz. The more information please refer to the manufacturer's instructions.			

Test Case	Test Conditions			
	Modulation Technology	Modulation Type	Date rate	Channel
Number of Hopping Frequency	FHSS	GFSK	1 Mbps	Hopping
Peak Output Power	FHSS	GFSK	1 Mbps	Low/Middle/High
Occupied Bandwidth	FHSS	GFSK	1 Mbps	Low/Middle/High
Carrier Frequency Separation	FHSS	GFSK	1 Mbps	Hopping
Time of Occupancy (Dwell time)	FHSS	GFSK	1 Mbps	Hopping
Conducted Spurious Emission	FHSS	GFSK	1 Mbps	Low/Middle/High
Conducted Emission	FHSS	GFSK	1 Mbps	Low/Middle/High
Radiated Emission	FHSS	GFSK	1 Mbps	Low/Middle/High
Band Edge	FHSS	GFSK	1 Mbps	Low/High

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
4	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.	Channel	Test Result	Verdict
1	Antenna Requirement	15.203	N/A	--	Pass Note 1
2	Number of Hopping Frequency	15.247(a)	Hopping Mode	ANNEX A.1	Pass
3	Peak Output Power	15.247(b)	Low/Middle/High	ANNEX A.2	Pass
4	Occupied Bandwidth	15.247(a)	Low/Middle/High	ANNEX A.3	Pass
5	Carrier Frequency Separation	15.247(a)	Hopping Mode	ANNEX A.4	Pass
6	Time of Occupancy (Dwell time)	15.247(a)	Hopping Mode	ANNEX A.5	Pass
7	Conducted Spurious Emission& Authorized-band band-edge	15.247(d)	Hopping Mode, Low/Middle/High	ANNEX A.6	Pass
8	Conducted Emission	15.207	Low/Middle/High	ANNEX A.7	Pass
9	Radiated Spurious Emission	15.209 15.247(d)	Hopping Mode, Low/Middle/High	ANNEX A.8	Pass
10	Band Edge (Restricted-band band-edge)	15.209 15.247(d)	Hopping Mode, Low/Middle/High	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	45% to 55%	
Atmospheric Pressure	100 kPa to 102 kPa	
Temperature	NT (Normal Temperature)	20℃ to +25℃
Working Voltage of the EUT	NV (Normal Voltage)	5 V

4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	ROHDE&SCHWARZ	FSV-40	101544	2021.04.01	2022.03.31
Bluetooth Signaling Unit	ROHDE&SCHWARZ	CMW500	142028	2021.06.01	2022.05.31
EMI Receiver	KEYSIGHT	N9038A	MY53220118	2021.06.01	2022.05.31
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2021.06.01	2022.05.31
LISN	SCHWARZBECK	NSLK 8127	8127-687	2021.06.01	2022.05.31
Test Antenna-Loop(9 kHz-30 MHz)	SCHWARZBECK	FMZB 1519	1519-037	2019.10.29	2021.10.28
Test Antenna-Bi-Log(30 MHz-3 GHz)	SCHWARZBECK	VULB 9163	9163-624	2019.07.02	2022.07.01
Test Antenna-Horn(1-18 GHz)	SCHWARZBECK	BBHA 9120D	9120D-1917	2019.07.02	2022.07.01
Test Antenna-Horn (18-40 GHz)	A-INFO	LB-180400KF	J211060273	2021.01.05	2023.01.04
Anechoic Chamber	RAINFORD	9m*6m*6m	N/A	2017.02.21	2022.02.20
Anechoic Chamber	EMC Electronic Co., Ltd	20.10*11.60 *7.35m	N/A	2019.08.08	2022.08.07
Shielded Enclosure	ChangNing	CN-130701	130703	--	--

4.3 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.

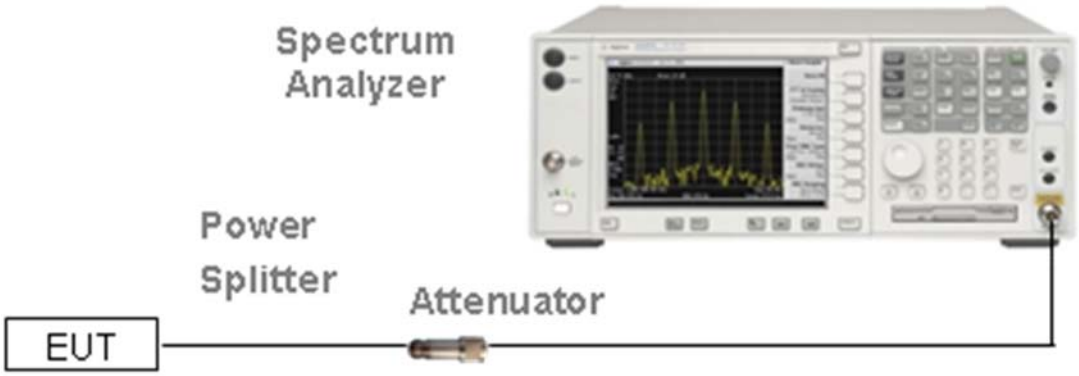
Parameters	Uncertainty
Occupied Channel Bandwidth	2.8%
RF output power, conducted	1.28 dB
Power Spectral Density, conducted	1.30 dB
Unwanted Emissions, conducted	1.84 dB
All emissions, radiated	5.36 dB
Temperature	0.82°C
Humidity	4.1%

4.4 Description of Test Setup

4.4.1 For Antenna Port Test

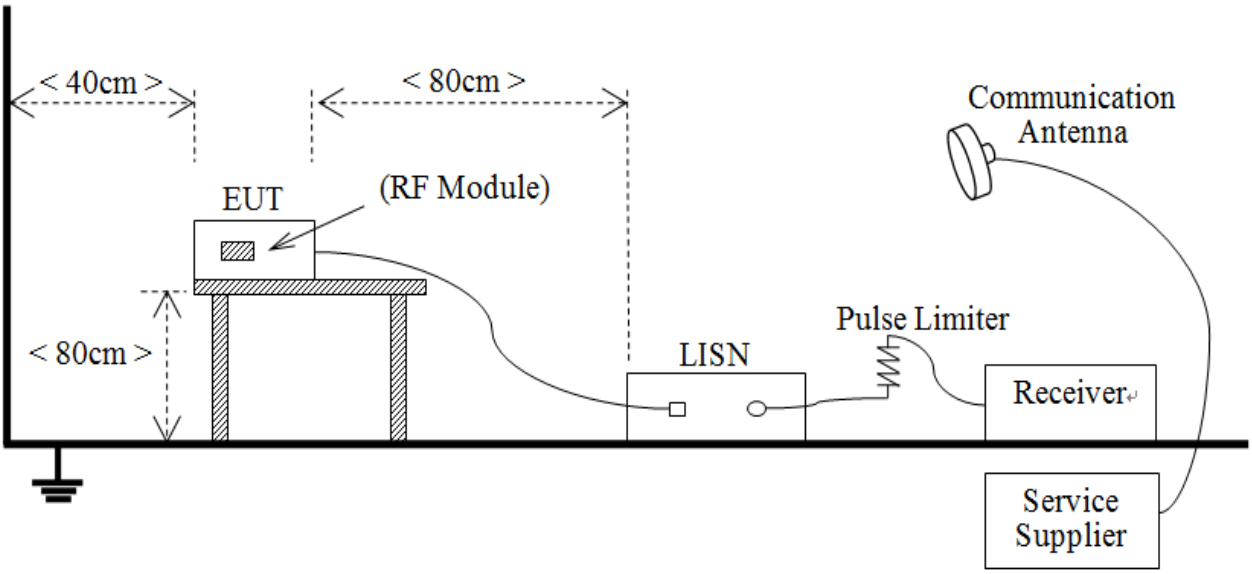
Conducted value (dBm) = Measurement value (dBm) + cable loss (dB)

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



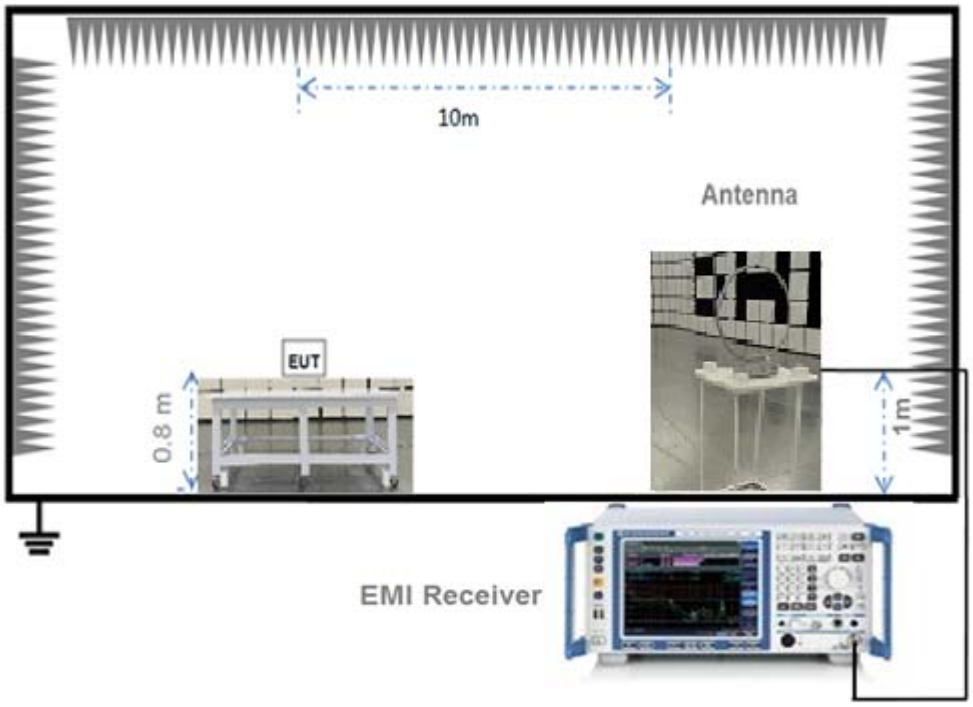
(Diagram 1)

4.4.2 For AC Power Supply Port Test



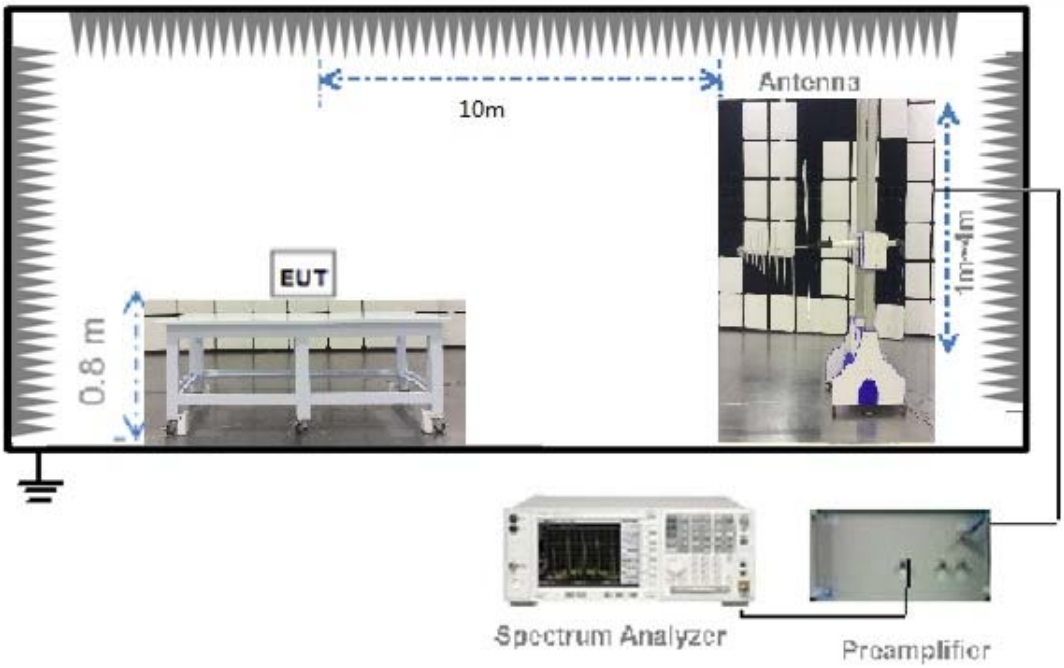
(Diagram 2)

4.4.3 For Radiated Test (Below 30 MHz)



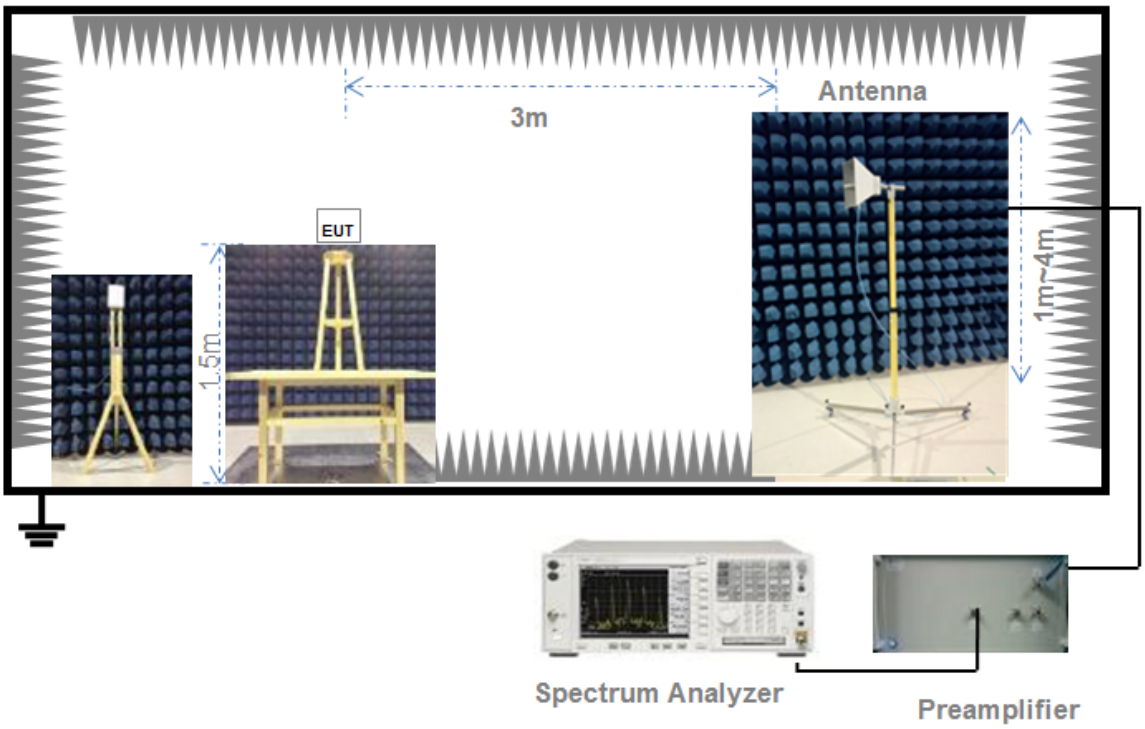
(Diagram 3)

4.4.4 For Radiated Test (30 MHz-1 GHz)



(Diagram 4)

4.4.5 For Radiated Test (Above 1 GHz)



(Diagram 5)

4.5 Measurement Results Explanation Example

4.5.1 For conducted test items:

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

4.5.2 For radiated band edges and spurious emission test:

Per part 15.35(c), the EUT Bluetooth average emission level could be determined by the peak emission level applying duty cycle correction factor, to represent averaging over the whole pulse train.
The average level is derived from the peak level corrected with “Duty cycle correction factor”.
Average Emission Level (dBuV/m) = Peak Emission Level (dBuV/m) + Duty cycle correction factor (dB)
Duty cycle correction factor (dB) = 20 * log (Duty cycle).
Duty cycle = on time / 100 milliseconds
On time = dwell time * hopping number in 100 ms
For example: bluetooth with dwell time 2.9 ms and 3 hops in 100 ms, then
Duty cycle correction factor (dB) = 20 * log ((2.9 * 3) / 100) = -21.21 dB
Following shows an average computation example with duty cycle correction factor = -21.21 dB, and the peak emission level is 45.61 dBuV/m.
Example:
Average Emission Level (dBuV/m) = Peak Emission Level (dBuV/m) + duty cycle correction factor (dB)
= 45.61 + (-21.21) = 24.4 (dBuV/m)

5 TEST ITEMS

5.1 Antenna Requirements

5.1.1 Relevant Standards

FCC §15.203 & 15.247(b); 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 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.2.3 Test Procedure

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

Span = the frequency band of operation

RBW ≥ 1% of the span

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

5.2.4 Test Result

Please refer to ANNEX A.1.

5.3 Peak Output Power

5.3.1 Test Limit

FCC § 15.247(b)

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

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

5.3.3 Test Procedure

The Bluetooth Module operates at hopping-off test mode. The lowest, middle and highest channels are selected to perform testing to verify the conducted RF output peak power of the Module.

Use the following spectrum analyzer settings:

Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel

RBW > the 20 dB bandwidth of the emission being measured

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize.

5.3.4 Test Result

Please refer to ANNEX A.2.

5.4 Occupied Bandwidth

5.4.1 Limit

FCC §15.247(a); RSS-247, 5.1 (1)

Measurement of the 20dB bandwidth of the modulated signal.

5.4.2 Test Setup

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

5.4.3 Test Procedure

Use the following spectrum analyzer settings:

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

RBW ≥ 1% of the 20 dB bandwidth

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

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

5.4.4 Test Result

Please refer to ANNEX A.3.

5.5 Carrier Frequency Separation

5.5.1 Limit

FCC §15.247(a); 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 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.5.3 Test Procedure

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

Span = wide enough to capture the peaks of two adjacent channels

Resolution (or IF) Bandwidth (RBW) ≥ 1% of the span

Video (or Average) Bandwidth (VBW) ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

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

5.5.4 Test Result

Please refer to ANNEX A.4.

5.6 Time of Occupancy (Dwell time)

5.6.1 Limit

FCC §15.247(a); 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 4.4.1 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); 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 4.4.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.7.3 Test Procedure

Use the following spectrum analyzer settings:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.
RBW = 100 kHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Allow the trace to stabilize

5.7.4 Test Result

Please refer to ANNEX A.6.

5.8 Conducted Emission

5.8.1 Limit

FCC §15.207; 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 4.4.2 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); 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 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.9.3 Test Procedure

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

The power of the EUT transmitting frequency should be ignored.

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

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW

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

5.9.4 Test Result

Please refer to ANNEX A.8.

5.10 Band Edge (Restricted-band band-edge)

5.10.1 Limit

FCC §15.209&15.247(d); 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 4.4.3 to 4.4.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

5.10.3 Test Procedure

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

The power of the EUT transmitting frequency should be ignored.

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

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1 GHz, 100 kHz for f < 1 GHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold

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

5.10.4 Test Result

Please refer to ANNEX A.9.

ANNEX A TEST RESULT

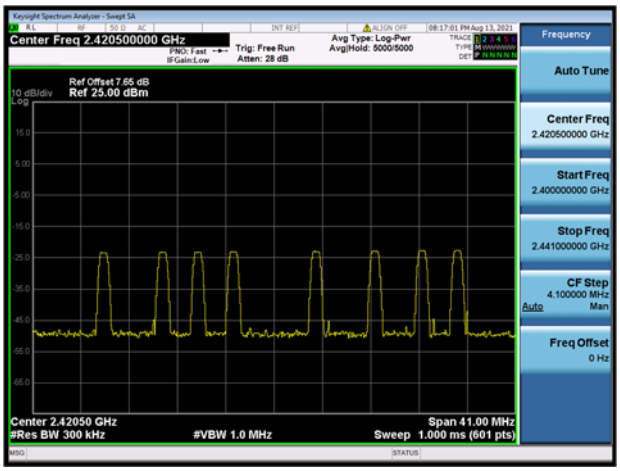
A.1 Number of Hopping Frequency

Test Data

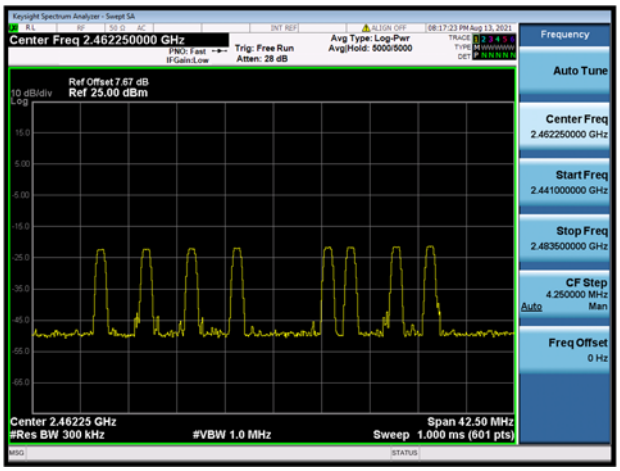
Test Mode	Frequency Block (MHz)	Measured Channel Numbers	Min. Limit	Verdict
GFSK	2400 - 2483.5	16	15	Pass

Test plots

GFSK 2.4 GHz ~ 2.4415 GHz



GFSK 2.4415 GHz ~ 2.4835 GHz



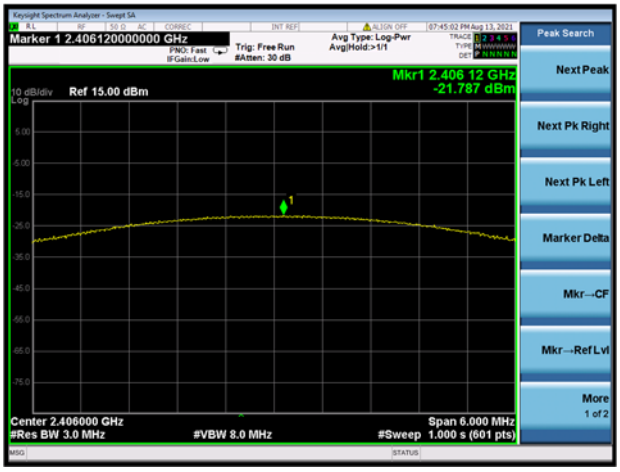
A.2 Peak Output Power

Peak Power Test Data

Channel	Measured Output Peak Power		Limit		Verdict
	GFSK		dBm	mW	
	dBm	mW			
Low	-21.79	0.01	21	125	Pass
Middle	-21.10	0.01			Pass
High	-19.97	0.01			Pass

Test plots

GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL

GFSK HIGH CHANNEL

A.3 20 dB and 99% bandwidth

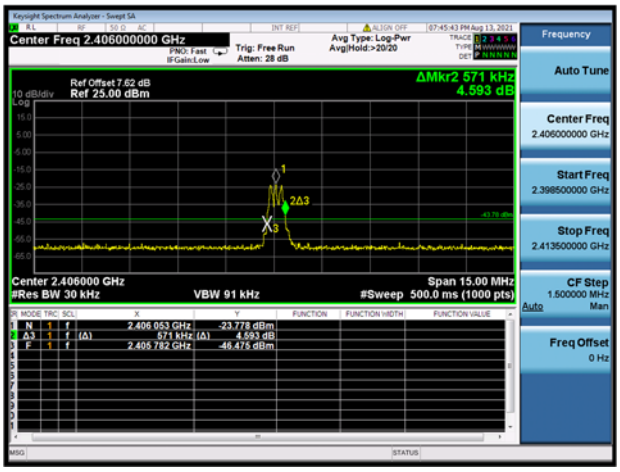
Test Data

GFSK		
Channel	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	0.571000	0.513100
Middle	0.571000	0.508100
High	0.555000	0.520660

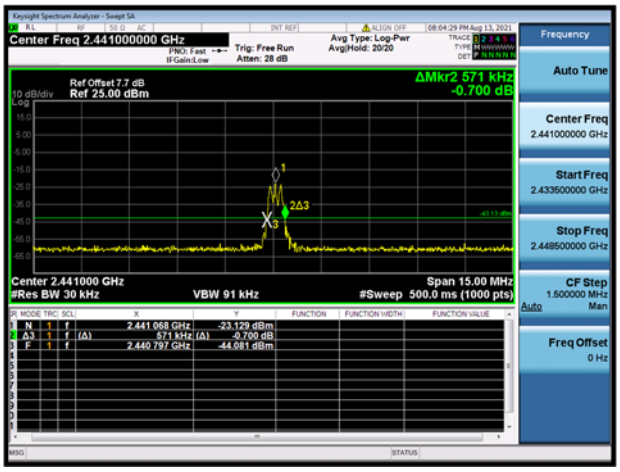
Test plots

20 dB Bandwidth

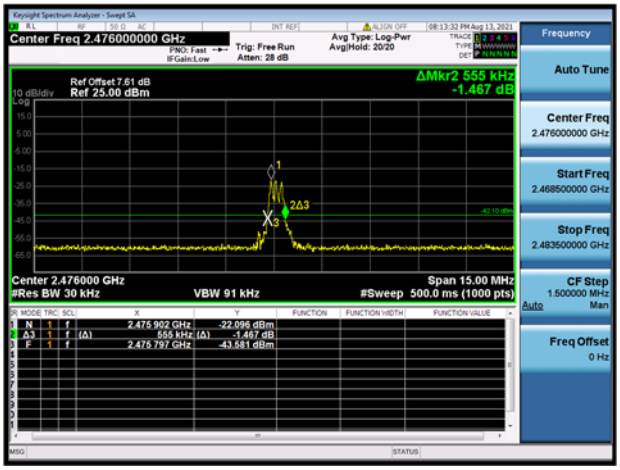
GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL

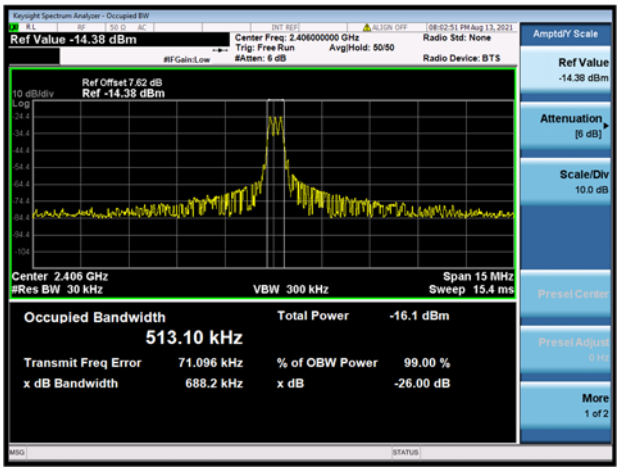


GFSK HIGH CHANNEL

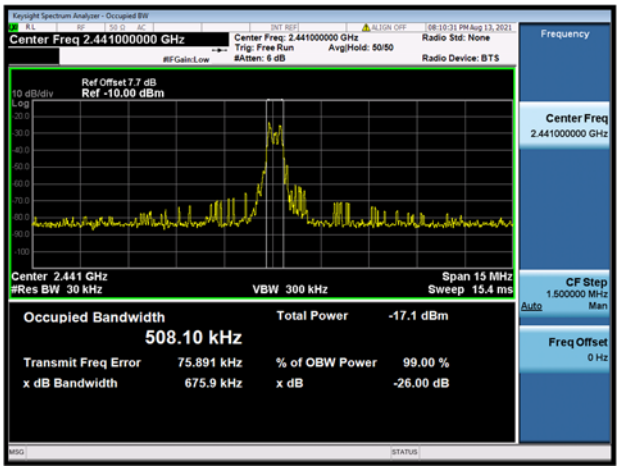


99% Bandwidth

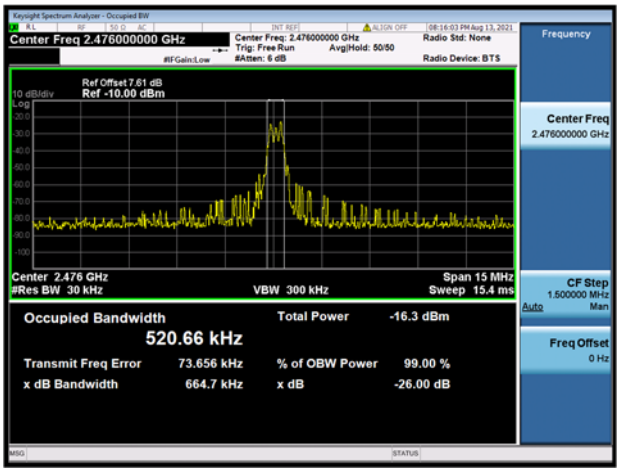
GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL



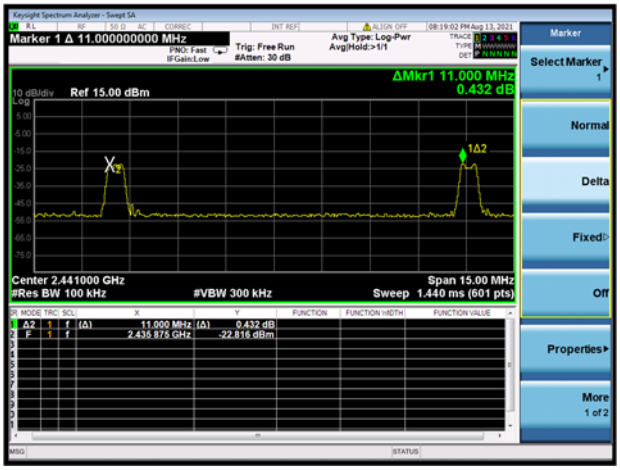
A.4 Hopping Frequency Separation

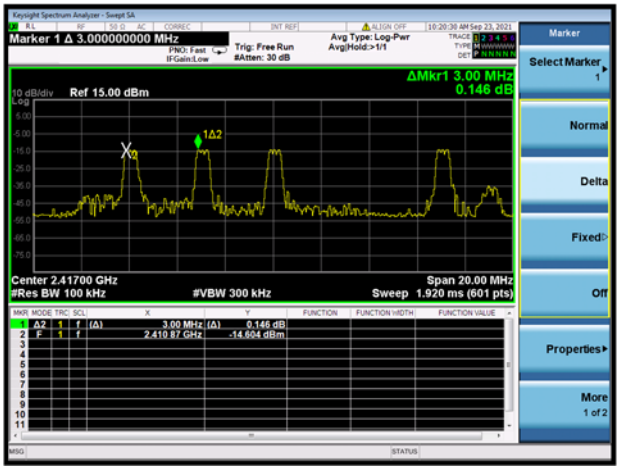
Test Data

Mode	Frequency separation (MHz)	2/3 of the 20 dB Bandwidth (MHz)	Verdict
GFSK	3	0.380667	Pass
GFSK	11	0.380667	Pass

Test Plots

GFSK



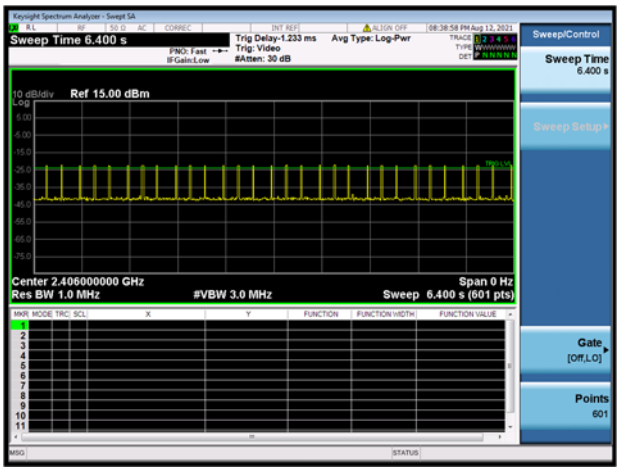
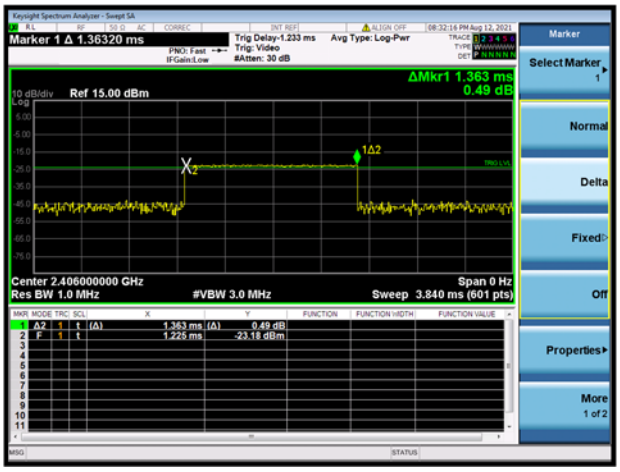


A.5 Average Time of Occupancy

Test Data

GFSK				
DH Packet	Pulse Width (ms)	Total of Dwell (ms)	Limit (sec)	Verdict
DH 1	1.36300	40.890	0.4	Pass

Test Plots

6.4s	3.84ms
	

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

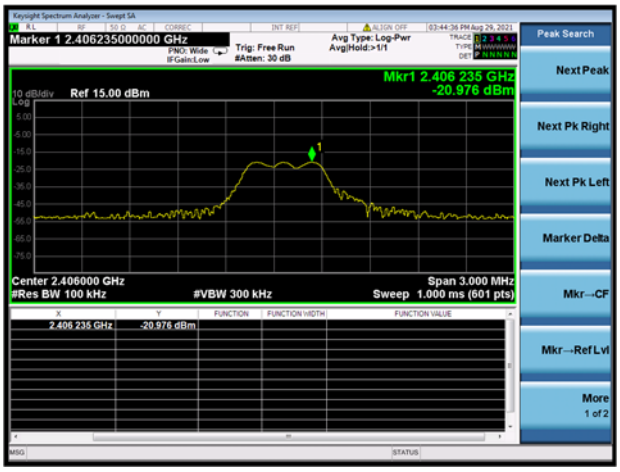
Test Data

GFSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-45.25	-20.98	-40.98	Pass
Middle	-44.69	-20.15	-40.15	Pass
High	-46.68	-21.50	-41.50	Pass

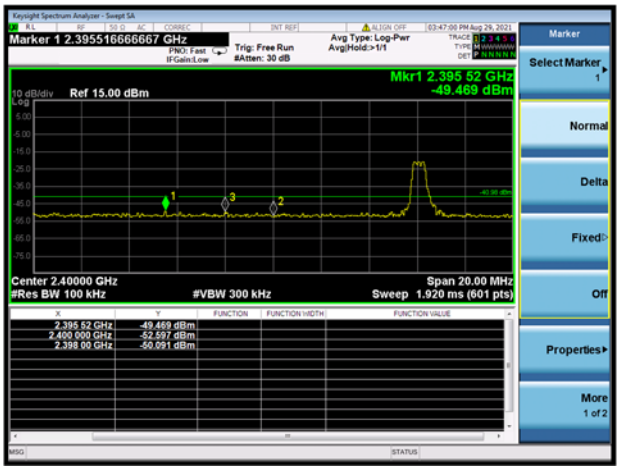
Hopping Mode				
Mode	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
GFSK	-46.23	-21.59	-41.59	Pass

Test Plots

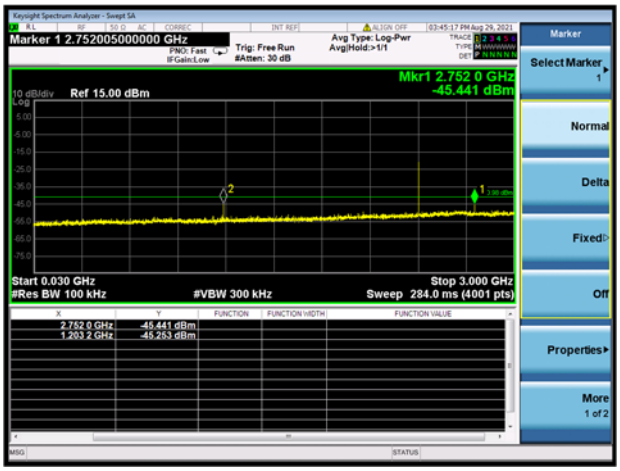
GFSK LOW CHANNEL, CARRIER LEVEL



GFSK LOW CHANNEL, BAND EDGE

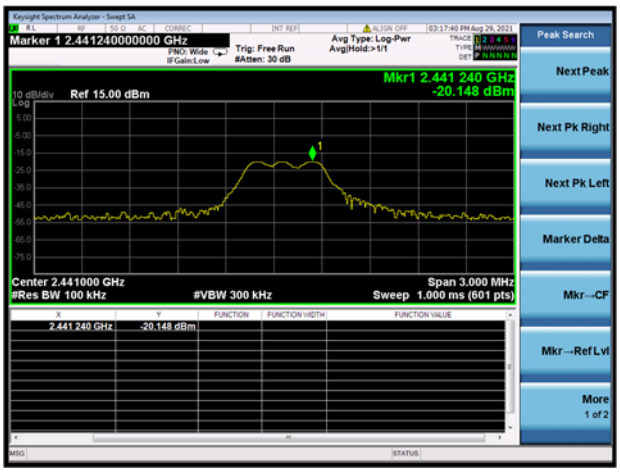


GFSK LOW CHANNEL, SPURIOUS 30 MHz ~ 3 GHz

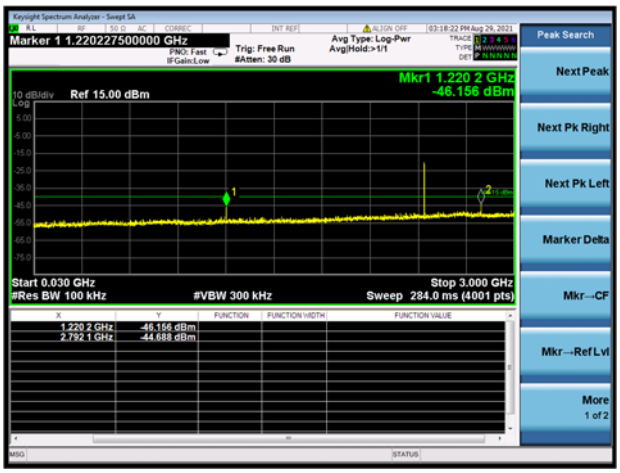


GFSK LOW CHANNEL, SPURIOUS 3 GHz ~ 25 GHz

GFSK MIDDLE CHANNEL, CARRIER LEVEL

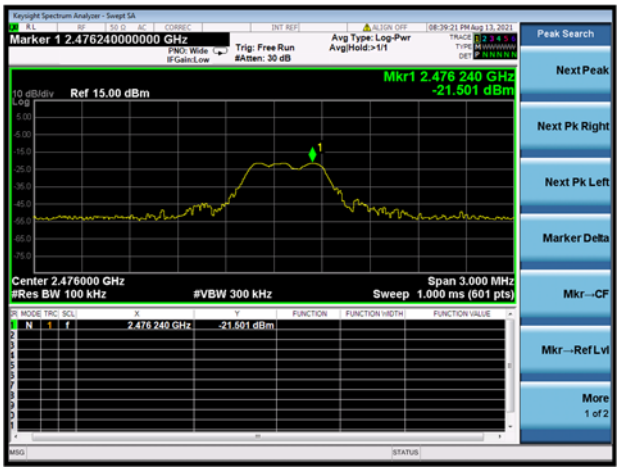


GFSK MIDDLE CHANNEL, SPURIOUS 30 MHz ~ 3 GHz

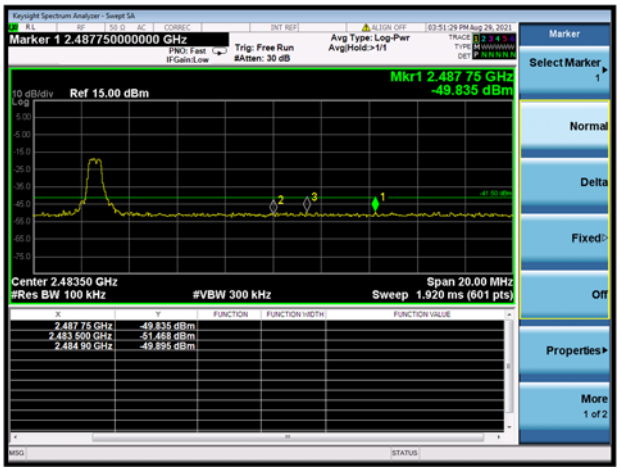


GFSK MIDDLE CHANNEL, SPURIOUS 3 GHz ~ 25 GHz

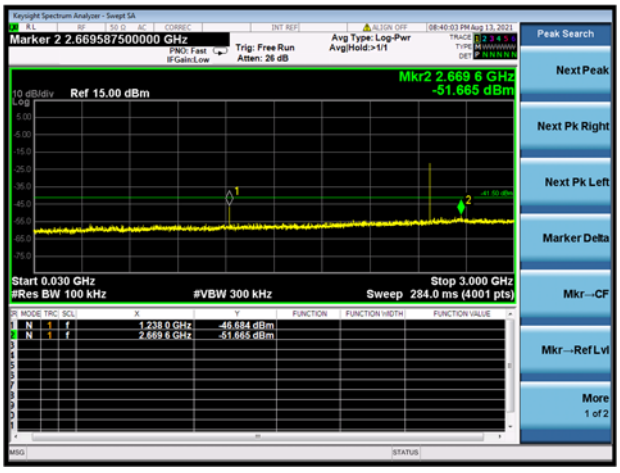
GFSK HIGH CHANNEL, CARRIER LEVEL



GFSK HIGH CHANNEL, BAND EDGE

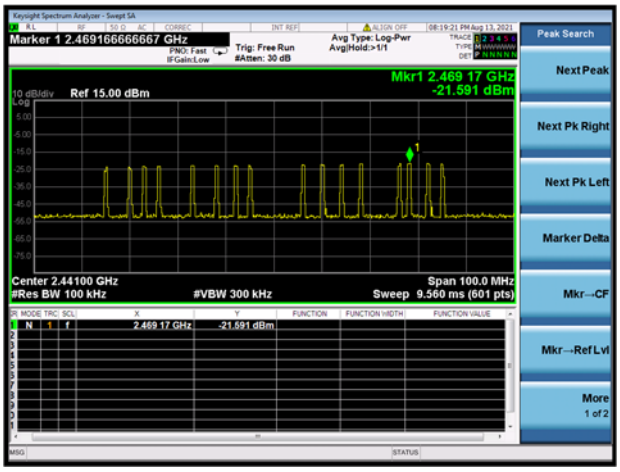


GFSK HIGH CHANNEL, SPURIOUS 30 MHz ~ 3 GHz

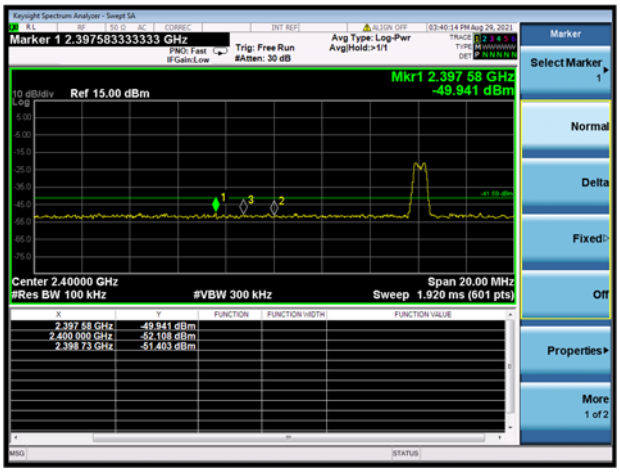


GFSK HIGH CHANNEL, SPURIOUS 3 GHz ~ 25 GHz

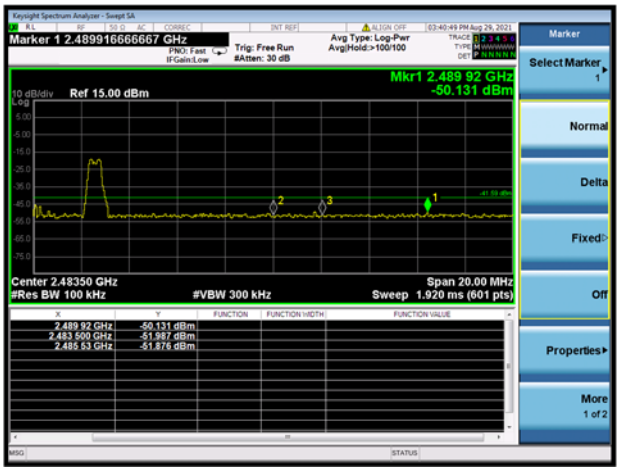
GFSK HOPPING, CARRIER LEVEL



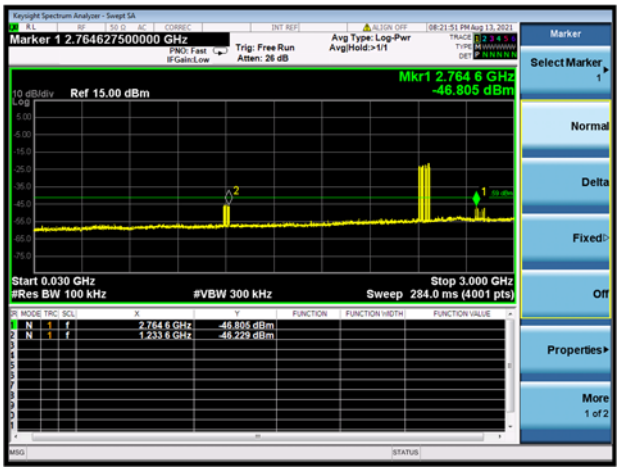
GFSK HOPPING BAND EDGE (LOW)



GFSK HOPPING BAND EDGE (HIGH)



GFSK Hopping Mode, SPURIOUS 30 MHz ~ 3 GHz



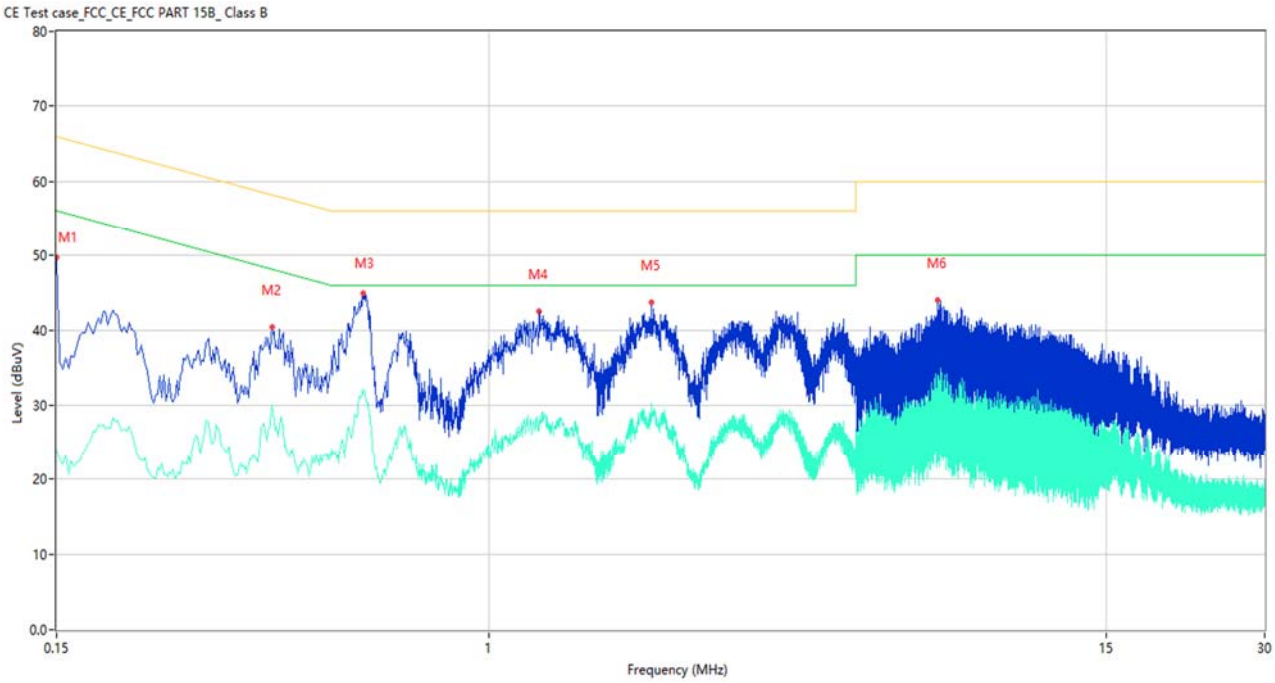
GFSK Hopping Mode, SPURIOUS 30 3GHz ~ 25 GHz

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)

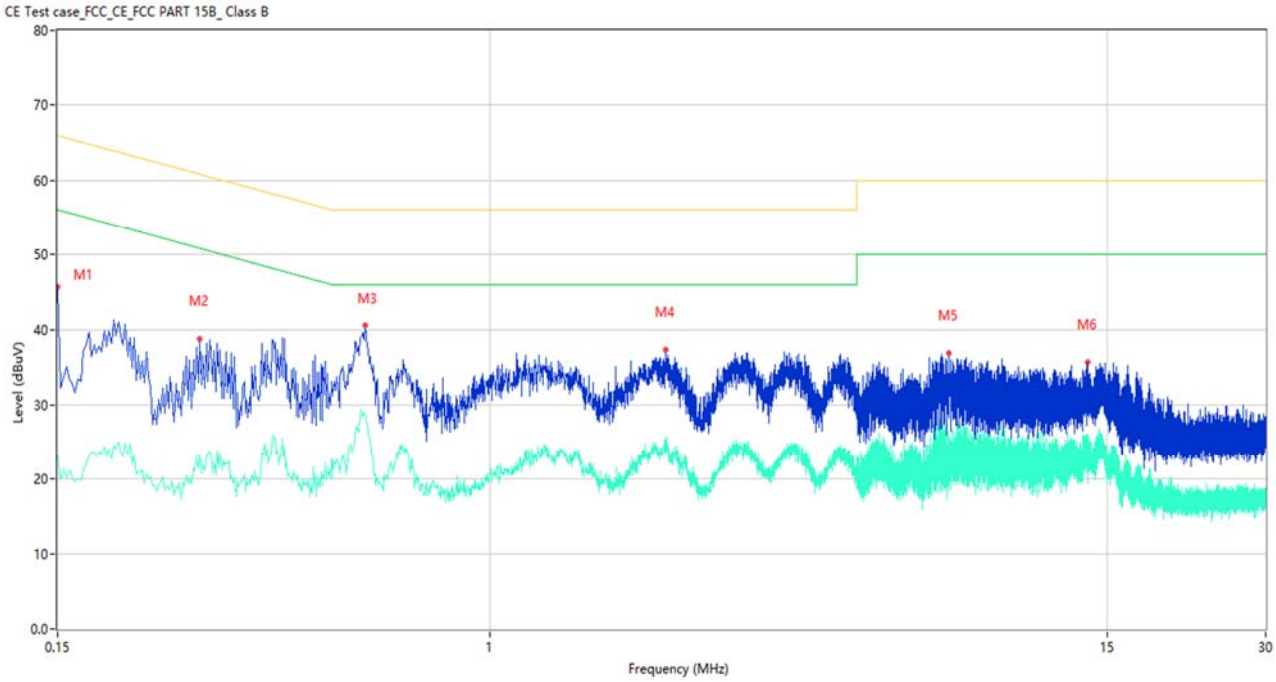
Test Data and Plots

PHASE L



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Over Limit (dB)	Detector	Line	Verdict
1	0.150	49.64	10.41	66.00	-16.36	Peak	L	Pass
1**	0.150	24.01	10.41	56.00	-31.99	AV	L	Pass
2	0.386	40.39	10.30	58.15	-17.76	Peak	L	Pass
2**	0.386	29.94	10.30	48.15	-18.21	AV	L	Pass
3	0.576	44.89	10.27	56.00	-11.11	Peak	L	Pass
3**	0.576	31.55	10.27	46.00	-14.45	AV	L	Pass
4	1.246	42.43	10.25	56.00	-13.57	Peak	L	Pass
4**	1.246	27.91	10.25	46.00	-18.09	AV	L	Pass
5	2.038	43.62	10.26	56.00	-12.38	Peak	L	Pass
5**	2.038	28.35	10.26	46.00	-17.65	AV	L	Pass
6	7.134	43.96	10.34	60.00	-16.04	Peak	L	Pass
6**	7.134	32.36	10.34	50.00	-17.64	AV	L	Pass

PHASE N



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Over Limit (dB)	Detector	Line	Verdict
1	0.150	45.65	10.41	66.00	-20.35	Peak	N	Pass
1**	0.150	23.16	10.41	56.00	-32.84	AV	N	Pass
2	0.280	38.77	10.34	60.82	-22.05	Peak	N	Pass
2**	0.280	23.37	10.34	50.82	-27.45	AV	N	Pass
3	0.578	40.49	10.27	56.00	-15.51	Peak	N	Pass
3**	0.578	28.63	10.27	46.00	-17.37	AV	N	Pass
4	2.162	37.38	10.27	56.00	-18.62	Peak	N	Pass
4**	2.162	25.14	10.27	46.00	-20.86	AV	N	Pass
5	7.482	36.96	10.34	60.00	-23.04	Peak	N	Pass
5**	7.482	23.91	10.34	50.00	-26.09	AV	N	Pass
6	13.764	35.67	10.40	60.00	-24.33	Peak	N	Pass
6**	13.764	26.08	10.40	50.00	-23.92	AV	N	Pass

A.8 Radiated Spurious Emission

Test Data and Plots

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

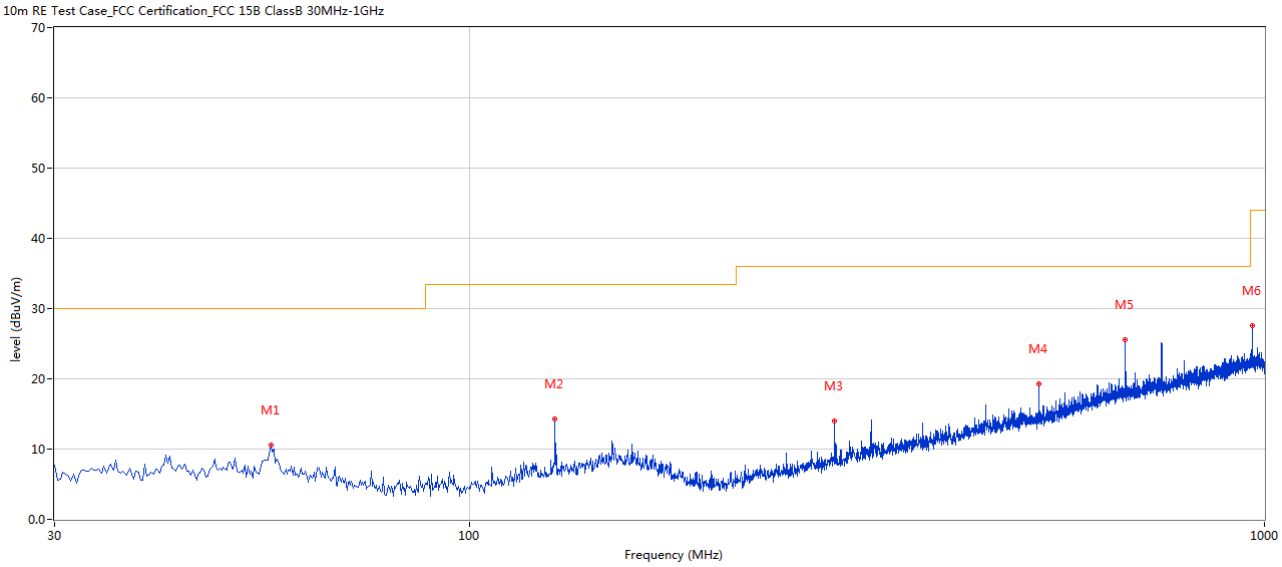
Note [2]: For the test data above 1 GHz, according the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.

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

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

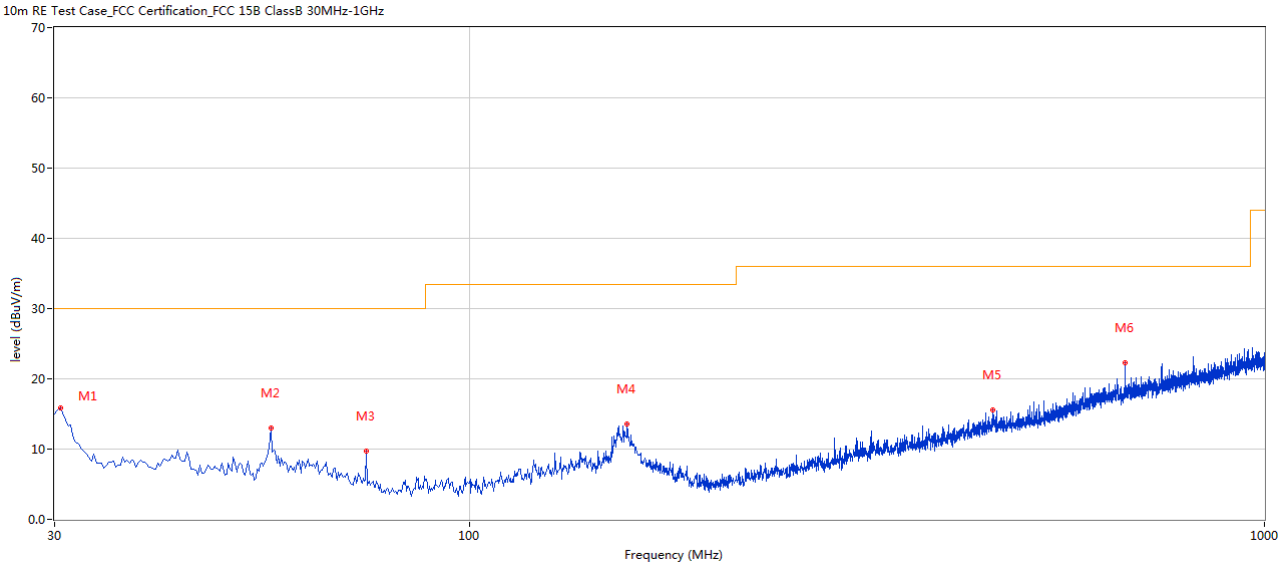
The low frequency, which started from 9 kHz to 30 MHz, was pre-scanned and the result which was 20 dB lower than the limit line per 15.31(o) was not reported.

30 MHz to 1 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	56.183	10.52	-27.55	30.0	-19.48	Peak	109.00	200	Horizontal	Pass
2	127.946	14.28	-27.34	33.5	-19.22	Peak	322.00	100	Horizontal	Pass
3	287.956	13.97	-26.09	36.0	-22.03	Peak	99.00	200	Horizontal	Pass
4	519.728	19.22	-20.21	36.0	-16.78	Peak	225.00	200	Horizontal	Pass
5	668.100	25.53	-16.44	36.0	-10.47	Peak	221.00	100	Horizontal	Pass
6	965.089	27.63	-11.28	44.0	-16.37	Peak	156.00	100	Horizontal	Pass

30 MHz to 1 GHz, ANT V



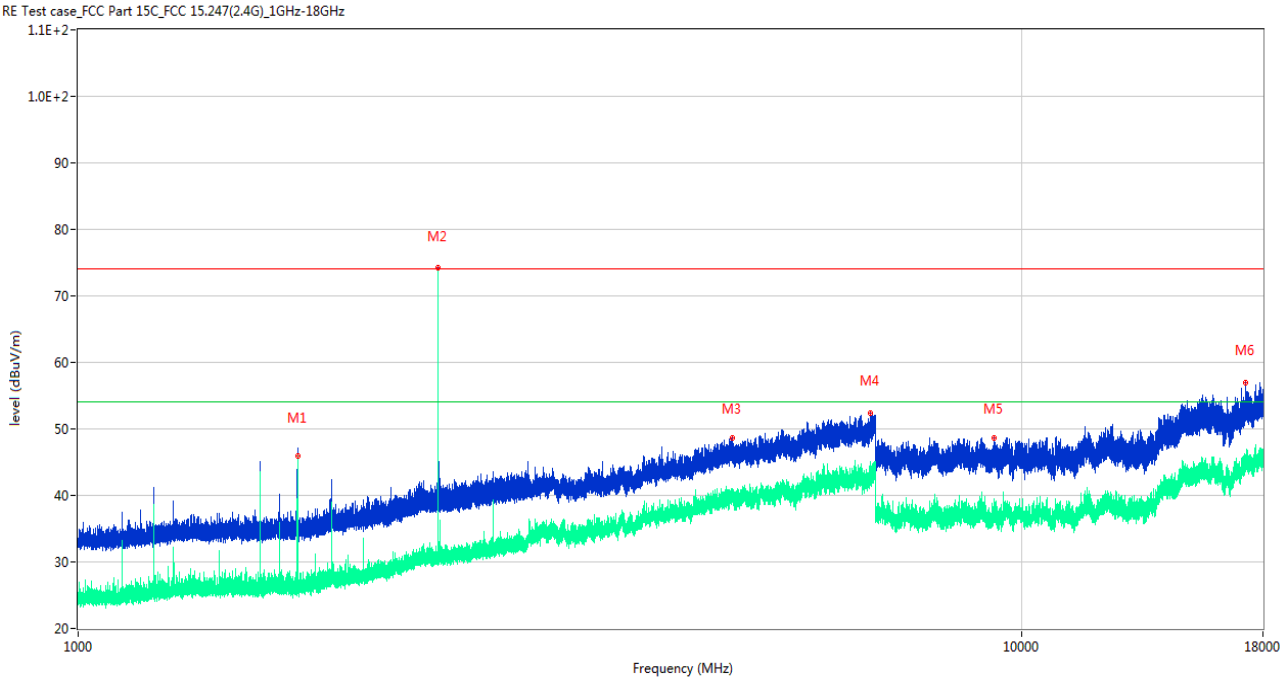
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	30.485	15.85	-27.46	30.0	-14.15	Peak	360.00	200	Vertical	Pass
2	56.183	13.06	-27.55	30.0	-16.94	Peak	342.00	100	Vertical	Pass
3	74.124	9.75	-30.52	30.0	-20.25	Peak	210.00	200	Vertical	Pass
4	157.766	13.55	-25.83	33.5	-19.95	Peak	266.00	100	Vertical	Pass
5	455.481	15.53	-21.42	36.0	-20.47	Peak	360.00	200	Vertical	Pass
6	668.100	22.30	-16.44	36.0	-13.70	Peak	216.00	100	Vertical	Pass

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

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

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

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT H

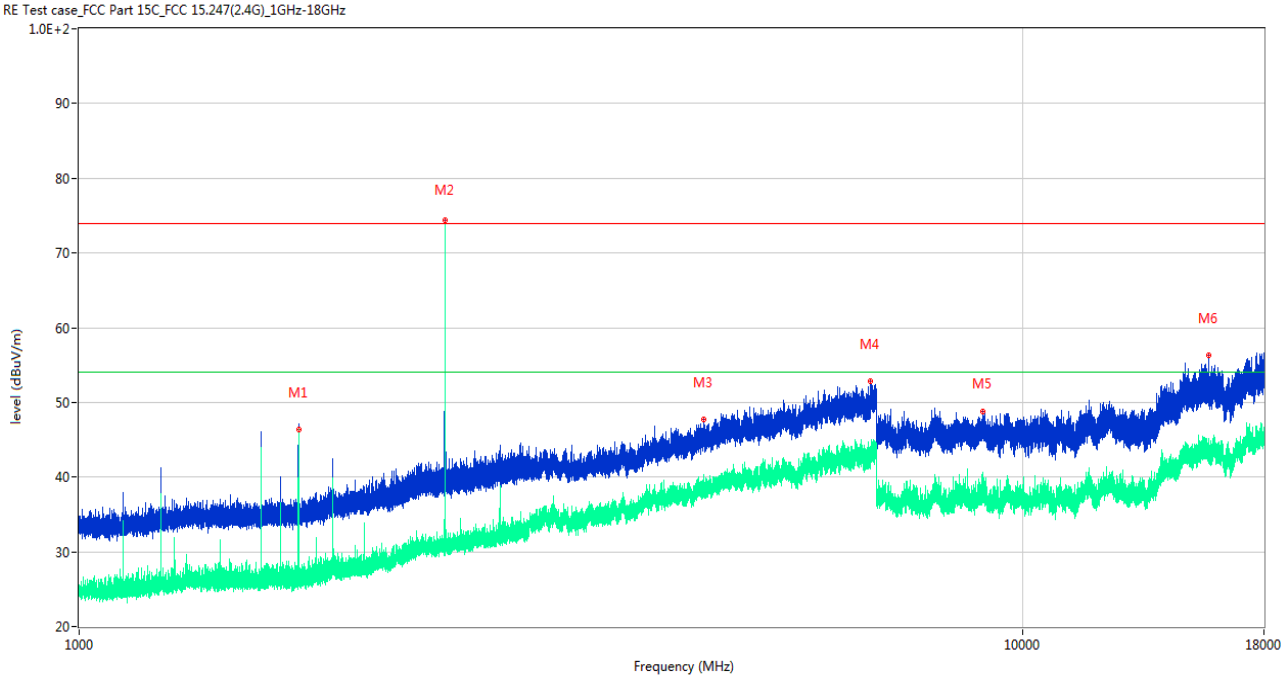


No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1707.900	46.50	-14.95	74.0	-27.50	Peak	147.00	150	Horizontal	Pass
1**	1707.900	45.73	-14.95	54.0	-8.27	AV	147.00	150	Horizontal	Pass
2	2405.900	74.17	-10.77	74.0	0.17	Peak	160.00	150	Horizontal	N/A
2**	2405.900	73.69	-10.77	54.0	19.69	AV	160.00	150	Horizontal	N/A
3	4936.000	48.59	-1.39	74.0	-25.41	Peak	114.00	150	Horizontal	Pass
3**	4936.000	40.00	-1.39	54.0	-14.00	AV	114.00	150	Horizontal	Pass
4	6915.200	52.40	4.79	74.0	-21.60	Peak	124.00	150	Horizontal	Pass
4**	6915.200	43.68	4.79	54.0	-10.32	AV	124.00	150	Horizontal	Pass
5	9345.424	48.69	17.08	74.0	-25.31	Peak	328.00	150	Horizontal	Pass
5**	9345.424	37.38	17.08	54.0	-16.62	AV	328.00	150	Horizontal	Pass
6	17273.401	57.00	24.41	74.0	-17.00	Peak	85.00	150	Horizontal	Pass
6**	17273.401	45.66	24.41	54.0	-8.34	AV	85.00	150	Horizontal	Pass

GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT V

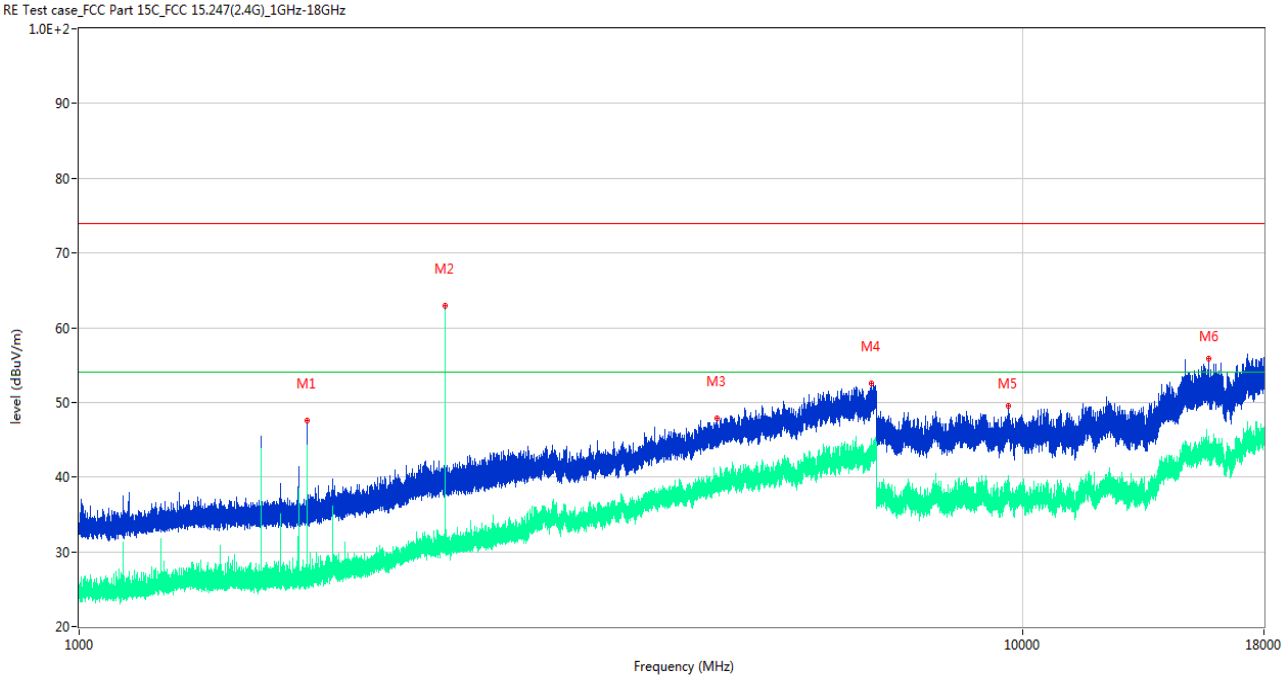
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1559.300	45.42	-15.08	74.0	-28.58	Peak	0.00	150	Vertical	Pass
1**	1559.300	43.30	-15.08	54.0	-10.70	AV	0.00	150	Vertical	Pass
2	2406.000	58.68	-10.76	74.0	-15.32	Peak	219.00	150	Vertical	N/A
2**	2406.000	56.47	-10.76	54.0	2.47	AV	219.00	150	Vertical	N/A
3	4653.400	47.89	-1.73	74.0	-26.11	Peak	220.00	150	Vertical	Pass
3**	4653.400	39.34	-1.73	54.0	-14.66	AV	220.00	150	Vertical	Pass
4	6762.600	52.06	4.13	74.0	-21.94	Peak	346.00	150	Vertical	Pass
4**	6762.600	42.83	4.13	54.0	-11.17	AV	346.00	150	Vertical	Pass
5	9586.350	48.58	18.57	74.0	-25.42	Peak	53.00	150	Vertical	Pass
5**	9586.350	38.42	18.57	54.0	-15.58	AV	53.00	150	Vertical	Pass
6	15941.213	57.08	23.91	74.0	-16.92	Peak	319.00	150	Vertical	Pass
6**	15941.213	43.81	23.91	54.0	-10.19	AV	319.00	150	Vertical	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H



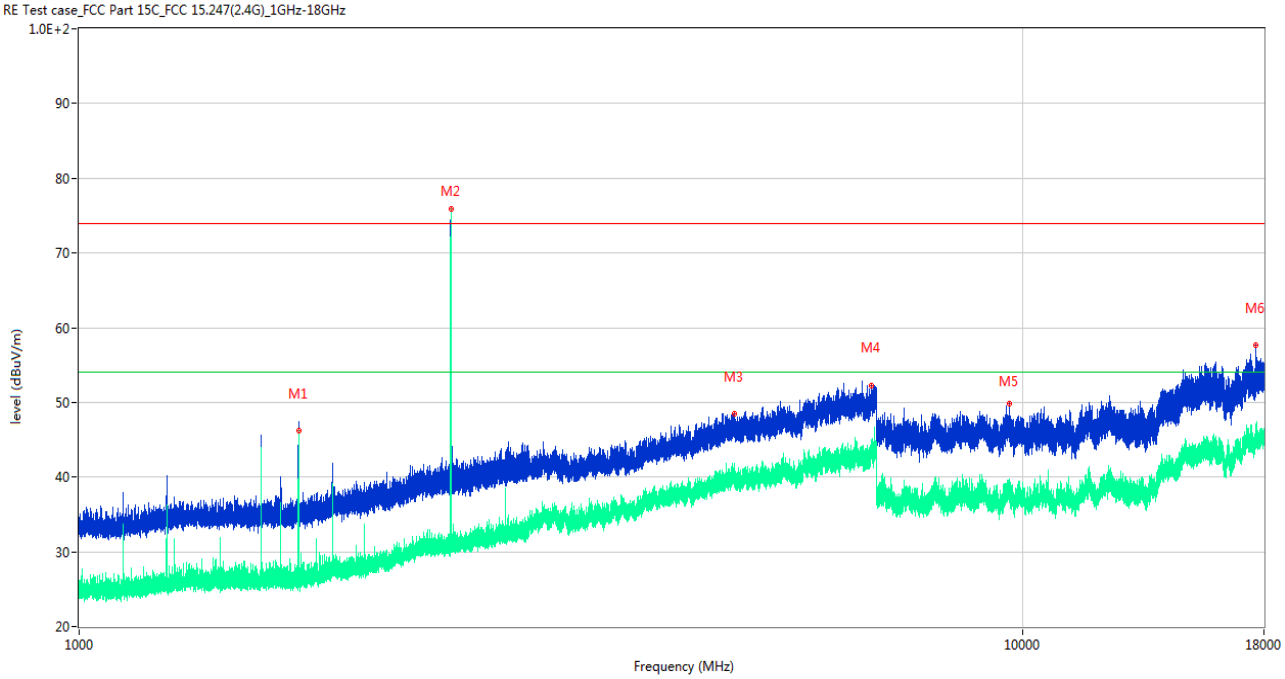
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1707.800	47.16	-14.95	74.0	-26.84	Peak	134.00	150	Horizontal	Pass
1**	1707.800	46.41	-14.95	54.0	-7.59	AV	134.00	150	Horizontal	Pass
2	2441.100	74.37	-10.52	74.0	0.37	Peak	180.00	150	Horizontal	N/A
2**	2441.100	73.68	-10.52	54.0	19.68	AV	180.00	150	Horizontal	N/A
3	4586.400	47.69	-2.33	74.0	-26.31	Peak	116.00	150	Horizontal	Pass
3**	4586.400	37.97	-2.33	54.0	-16.03	AV	116.00	150	Horizontal	Pass
4	6898.400	52.90	4.61	74.0	-21.10	Peak	107.00	150	Horizontal	Pass
4**	6898.400	43.50	4.61	54.0	-10.50	AV	107.00	150	Horizontal	Pass
5	9069.425	48.71	18.18	74.0	-25.29	Peak	292.00	150	Horizontal	Pass
5**	9069.425	38.50	18.18	54.0	-15.50	AV	292.00	150	Horizontal	Pass
6	15724.912	56.34	23.47	74.0	-17.66	Peak	241.00	150	Horizontal	Pass
6**	15724.912	43.02	23.47	54.0	-10.98	AV	241.00	150	Horizontal	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V



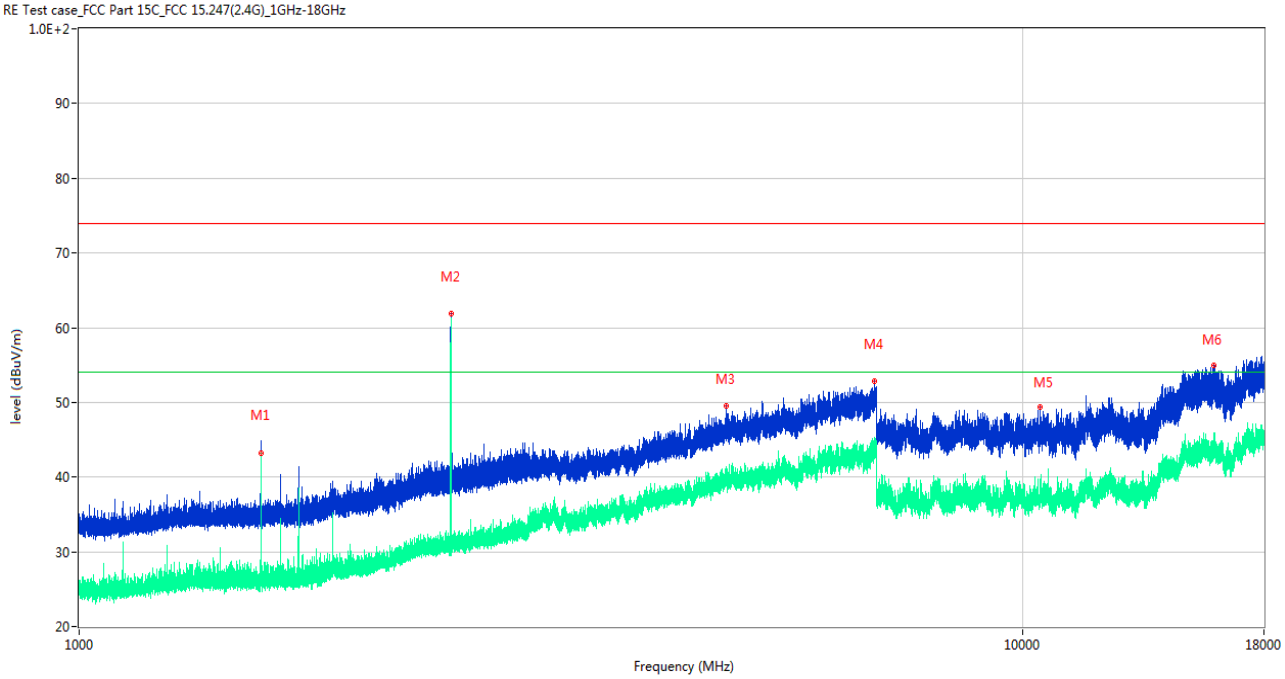
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1743.400	47.64	-14.97	74.0	-26.36	Peak	117.00	150	Vertical	Pass
1**	1743.400	43.52	-14.97	54.0	-10.48	AV	117.00	150	Vertical	Pass
2	2441.100	62.94	-10.52	74.0	-11.06	Peak	318.00	150	Vertical	N/A
2**	2441.100	62.00	-10.52	54.0	8.00	AV	318.00	150	Vertical	N/A
3	4742.600	47.90	-1.99	74.0	-26.10	Peak	67.00	150	Vertical	Pass
3**	4742.600	39.23	-1.99	54.0	-14.77	AV	67.00	150	Vertical	Pass
4	6899.800	52.50	4.82	74.0	-21.50	Peak	360.00	150	Vertical	Pass
4**	6899.800	43.47	4.82	54.0	-10.53	AV	360.00	150	Vertical	Pass
5	9643.563	49.53	18.95	74.0	-24.47	Peak	84.00	150	Vertical	Pass
5**	9643.563	37.39	18.95	54.0	-16.61	AV	84.00	150	Vertical	Pass
6	15725.700	55.88	23.47	74.0	-18.12	Peak	102.00	150	Vertical	Pass
6**	15725.700	44.73	23.47	54.0	-9.27	AV	102.00	150	Vertical	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1708.000	46.31	-14.95	74.0	-27.69	Peak	136.00	150	Horizontal	Pass
1**	1708.000	45.32	-14.95	54.0	-8.68	AV	136.00	150	Horizontal	Pass
2	2476.000	75.83	-10.48	74.0	1.83	Peak	170.00	150	Horizontal	N/A
2**	2476.000	75.84	-10.48	54.0	21.84	AV	170.00	150	Horizontal	N/A
3	4942.400	48.51	-1.47	74.0	-25.49	Peak	96.00	150	Horizontal	Pass
3**	4942.400	41.84	-1.47	54.0	-12.16	AV	96.00	150	Horizontal	Pass
4	6913.400	52.31	4.77	74.0	-21.69	Peak	134.00	150	Horizontal	Pass
4**	6913.400	43.19	4.77	54.0	-10.81	AV	134.00	150	Horizontal	Pass
5	9683.237	49.78	18.54	74.0	-24.22	Peak	31.00	150	Horizontal	Pass
5**	9683.237	36.96	18.54	54.0	-17.04	AV	31.00	150	Horizontal	Pass
6	17657.962	57.70	24.24	74.0	-16.30	Peak	241.00	150	Horizontal	Pass
6**	17657.962	44.76	24.24	54.0	-9.24	AV	241.00	150	Horizontal	Pass

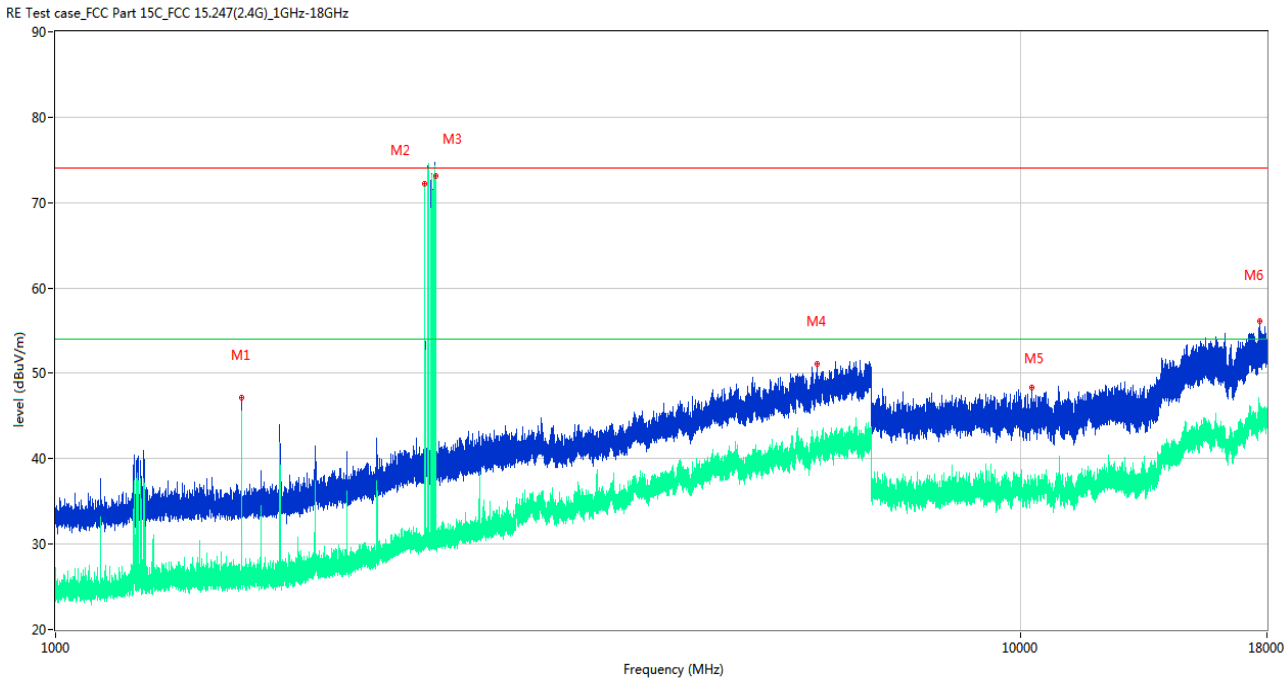
GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT V



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1559.400	44.85	-15.08	74.0	-29.15	Peak	0.00	150	Vertical	Pass
1**	1559.400	43.22	-15.08	54.0	-10.78	AV	0.00	150	Vertical	Pass
2	2475.800	61.85	-10.49	74.0	-12.15	Peak	231.00	150	Vertical	N/A
2**	2475.800	58.99	-10.49	54.0	4.99	AV	231.00	150	Vertical	N/A
3	4846.600	49.55	-1.31	74.0	-24.45	Peak	268.00	150	Vertical	Pass
3**	4846.600	39.01	-1.31	54.0	-14.99	AV	268.00	150	Vertical	Pass
4	6968.400	52.92	5.12	74.0	-21.08	Peak	72.00	150	Vertical	Pass
4**	6968.400	43.13	5.12	54.0	-10.87	AV	72.00	150	Vertical	Pass
5	10428.438	49.44	18.68	74.0	-24.56	Peak	80.00	150	Vertical	Pass
5**	10428.438	37.14	18.68	54.0	-16.86	AV	80.00	150	Vertical	Pass
6	15923.625	54.95	23.69	74.0	-19.05	Peak	211.00	150	Vertical	Pass
6**	15923.625	44.85	23.69	54.0	-9.15	AV	211.00	150	Vertical	Pass

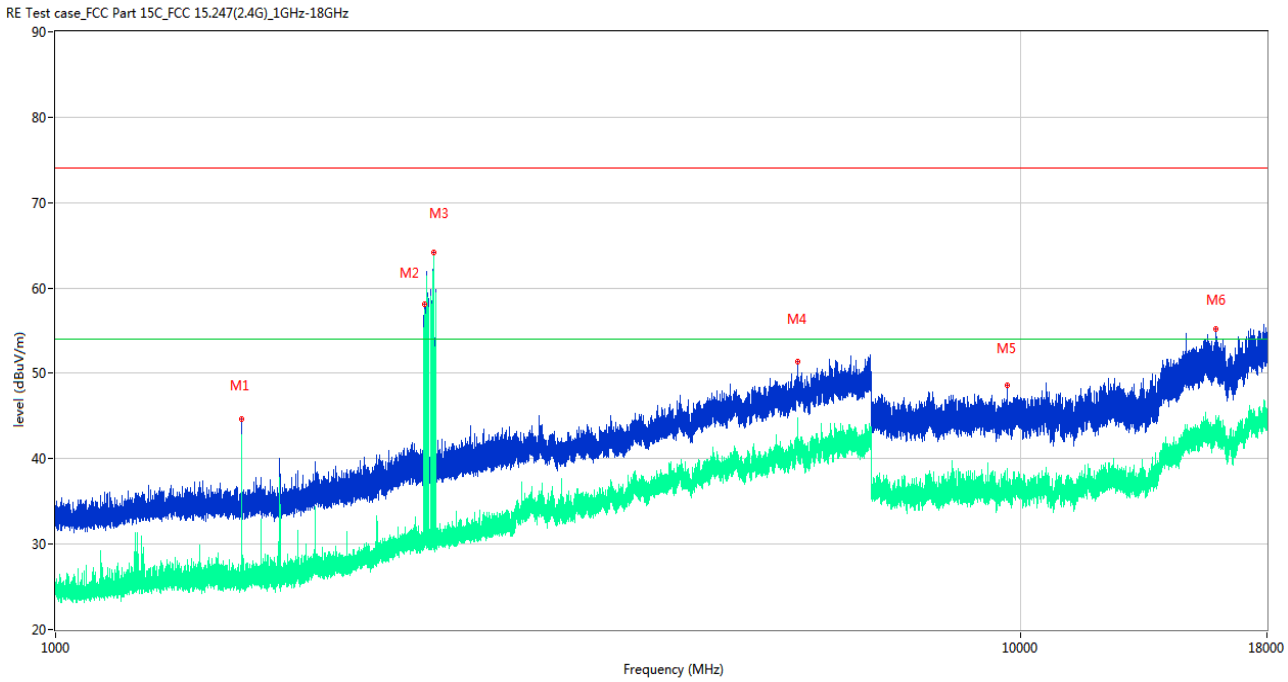
Hopping Mode:

GFSK MODE 1 GHz to 18 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1559.200	47.12	-15.08	74.0	-26.88	Peak	149.00	150	Horizontal	Pass
1**	1559.200	45.10	-15.08	54.0	-8.90	AV	149.00	150	Horizontal	Pass
2	2410.800	72.14	-10.38	74.0	-1.86	Peak	191.00	150	Horizontal	N/A
2**	2410.800	70.37	-10.38	54.0	16.37	AV	191.00	150	Horizontal	N/A
3	2475.900	73.08	-10.48	74.0	-0.92	Peak	276.00	150	Horizontal	N/A
3**	2475.900	72.82	-10.48	54.0	18.82	AV	276.00	150	Horizontal	N/A
4	6153.400	51.11	2.96	74.0	-22.89	Peak	331.00	150	Horizontal	Pass
4**	6153.400	41.73	2.96	54.0	-12.27	AV	331.00	150	Horizontal	Pass
5	10283.250	48.32	18.20	74.0	-25.68	Peak	185.00	150	Horizontal	Pass
5**	10283.250	36.89	18.20	54.0	-17.11	AV	185.00	150	Horizontal	Pass
6	17678.963	56.12	24.44	74.0	-17.88	Peak	229.00	150	Horizontal	Pass
6**	17678.963	44.60	24.44	54.0	-9.40	AV	229.00	150	Horizontal	Pass

GFSK MODE 1 GHz to 18 GHz, ANT V



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Over Limit (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1559.200	44.60	-15.08	74.0	-29.40	Peak	30.00	150	Vertical	Pass
1**	1559.200	42.17	-15.08	54.0	-11.83	AV	30.00	150	Vertical	Pass
2	2410.900	58.07	-10.38	74.0	-15.93	Peak	353.00	150	Vertical	N/A
2**	2410.900	55.73	-10.38	54.0	1.73	AV	353.00	150	Vertical	N/A
3	2467.200	64.18	-10.64	74.0	-9.82	Peak	233.00	150	Vertical	N/A
3**	2467.200	63.64	-10.64	54.0	9.64	AV	233.00	150	Vertical	N/A
4	5872.800	51.37	2.01	74.0	-22.63	Peak	70.00	150	Vertical	Pass
4**	5872.800	42.52	2.01	54.0	-11.48	AV	70.00	150	Vertical	Pass
5	9681.800	48.60	18.55	74.0	-25.40	Peak	307.00	150	Vertical	Pass
5**	9681.800	38.86	18.55	54.0	-15.14	AV	307.00	150	Vertical	Pass
6	15944.625	55.14	23.92	74.0	-18.86	Peak	303.00	150	Vertical	Pass
6**	15944.625	43.02	23.92	54.0	-10.98	AV	303.00	150	Vertical	Pass

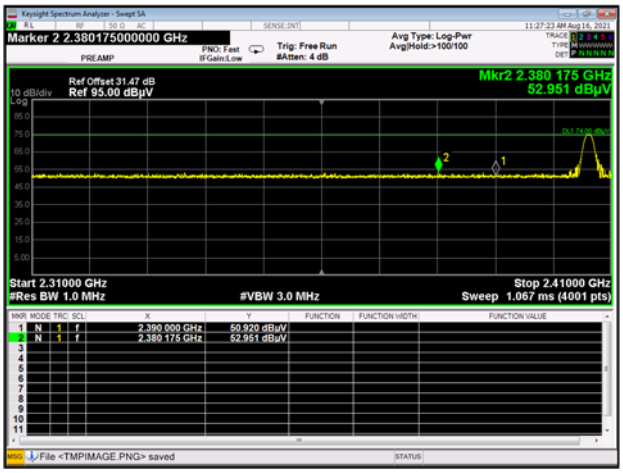
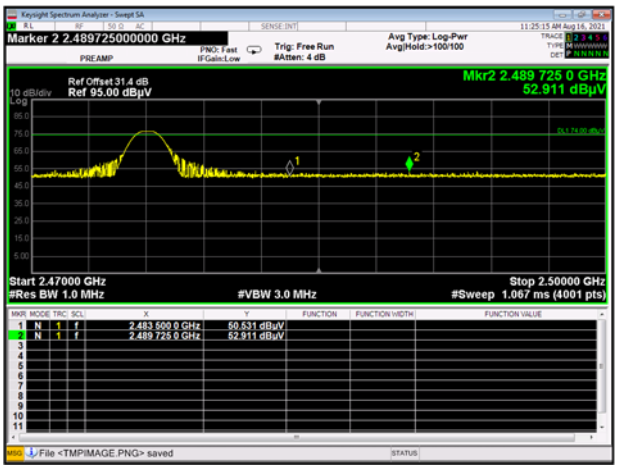
A.9 Band Edge (Restricted-band band-edge)

Note [1]: The lowest and highest channels are tested to verify the band edge emissions. Please refer to the following the plots for emissions values.
Note [2]: The test data all are tested in the vertical and horizontal antenna which the trace is max hold. So these plots have shown the worst case.
Note [3]: According the ANSI C63.10-2013, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.
Note [4]: The Level (dBuV/m) has been corrected by factor.

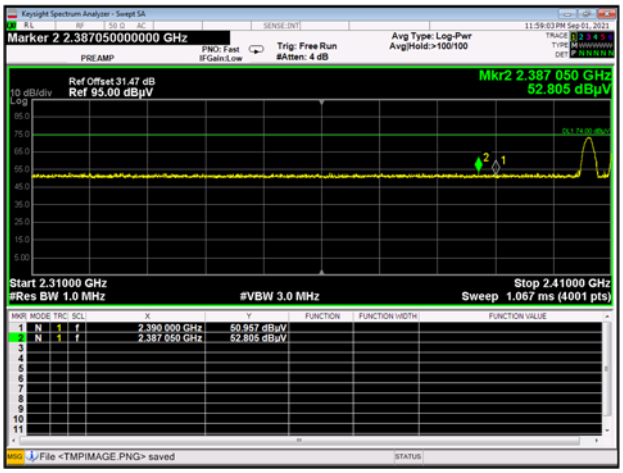
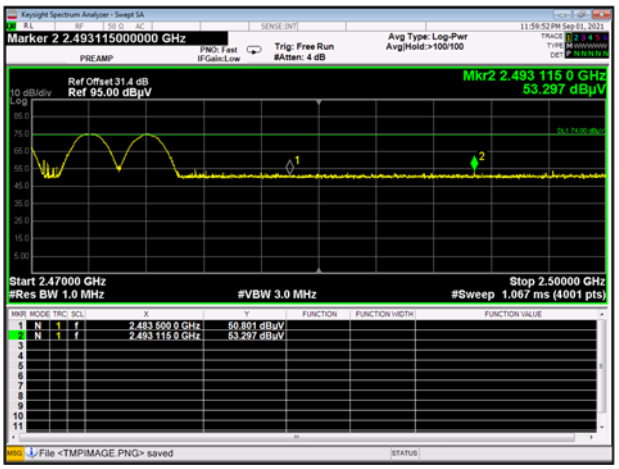
Test Data

Test Mode	Test Channel	Frequency (MHz)	Level (dBuV/m)	Factor (dB)	Limit Line (dBuV/m)	Margin (dB)	Remark	Verdict
GFSK	Low	2390.00	52.951	31.47	74	21.049	PEAK	Pass
		2390.00	N/A	N/A	54	N/A	AVERAGE	Pass
GFSK	HIGH	2483.50	52.911	31.40	74	21.089	PEAK	Pass
		2483.50	N/A	N/A	54	N/A	AVERAGE	Pass
GFSK(Hopping)	Low	2390.00	52.805	31.47	74	21.195	PEAK	Pass
		2390.00	N/A	N/A	54	N/A	AVERAGE	Pass
GFSK(Hopping)	HIGH	2483.50	53.297	31.40	74	20.703	PEAK	Pass
		2483.50	N/A	N/A	54	N/A	AVERAGE	Pass

Test Plots

GFSK LOW CHANNEL, PEAK	GFSK HIGH CHANNEL, PEAK
	

Hopping Mode:

GFSK LOW CHANNEL, PEAK	GFSK HIGH CHANNEL, PEAK
	

ANNEX B TEST SETUP PHOTOS

Please refer the document “BL-SZ2130159-AR.PDF”.

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document “BL-SZ2130159-AW.PDF”.

ANNEX D EUT INTERNAL PHOTOS

Please refer the document “BL-SZ2130159-AI.PDF”.

--END OF REPORT--