



中国认可  
国际互认  
检测  
TESTING  
CNAS L6791

# TEST REPORT

**Applicant:** Ugreen Group Limited

**Address:** UGREEN Building, Longcheng Industrial Park  
Longguanxi Road, Longhua, ShenZhen, China

**Equipment Type:** UGREEN HiTune H5 True Wireless Earbuds

**Model Name:** WS201 (refer to section 2.3)

**Brand Name:** **UGREEN**

**FCC ID:** 2AQI5-WS201L

**Test Standard:** 47 CFR Part 15 Subpart C  
(refer to section 3.1)

**Sample Arrival Date:** Aug. 18, 2023

**Test Date:** Aug. 18, 2023 - Aug. 25, 2023

**Date of Issue:** Sep. 04, 2023

**ISSUED BY:**

Shenzhen BALUN Technology Co., Ltd.

**Tested by:** Julie Zhu

**Checked by:** Ye Hongji

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(Vice General Manager)

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*Ye Hongji*

*Hanson Lin*

<b>Revision History</b>		
Version	Issue Date	Revisions
<u>Rev. 01</u>	<u>Sep. 04, 2023</u>	<u>Initial Issue</u>

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

## 2 PRODUCT INFORMATION

### 2.1 Applicant Information

Applicant	Ugreen Group Limited
Address	UGREEN Building, Longcheng Industrial Park Longguanxi Road, Longhua, ShenZhen, China

### 2.2 Manufacturer Information

Manufacturer	Ugreen Group Limited
Address	UGREEN Building, Longcheng Industrial Park Longguanxi Road, Longhua, ShenZhen, China

### 2.3 General Description for Equipment under Test (EUT)

EUT Name	UGREEN HiTune H5 True Wireless Earbuds
Model Name Under Test	WS201
Series Model Name	15612
Description of Model name differentiation	All models are same with electrical parameters and internal circuit structure, but only differ in model name. (this information provided by the applicant)
Hardware Version	N/A
Software Version	V0C
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

## 2.4 Technical Information

Network and Wireless connectivity	Bluetooth (BR+EDR+BLE)
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The requirement for the following technical information of the EUT was tested in this report:

Modulation Technology	FHSS
Modulation Type	GFSK, $\pi/4$ -DQPSK
Product Type	<input type="checkbox"/> Mobile <input checked="" type="checkbox"/> Portable <input type="checkbox"/> Fix Location
Transfer Rate	DH5: 1 Mbps 2DH5: 2 Mbps
Frequency Range	The frequency range used is 2400 MHz to 2483.5 MHz.
Number of Channel	79 (at intervals of 1 MHz)
Tested Channel	0 (2402 MHz), 39 (2441 MHz), 78 (2480 MHz)
Antenna Type	FPC Antenna
Antenna Gain	1.11 dBi
Antenna Impedance	50 $\Omega$
Antenna System (MIMO Smart Antenna)	N/A

All channel was listed on the following table:

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

### 3 SUMMARY OF TEST RESULTS

#### 3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15, Subpart C	Intentional radiators of radio frequency equipment
2	ANSI C63.10-2013	American National Standard for Testing Unlicensed Wireless Devices
3 ☆	KDB 558074 D01 15.247 Meas Guidance v05r02	Guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under section 15.247 of the FCC rules

#### 3.2 Test Verdict

No.	Description	FCC Part No.	Channel	Test Result	Verdict	Remark
1	Antenna Requirement	15.203	N/A	--	Pass	Note
2	Number of Hopping Frequencies	15.247(a)	Hopping Mode	5.3.4	Pass	--
3	Peak Output Power	15.247(b)	Low/Middle/High	5.4.4	Pass	--
4	Occupied Bandwidth	15.247(a)	Low/Middle/High	5.5.4	Pass	--
5	Carrier Frequency Separation	15.247(a)	Hopping Mode	5.6.4	Pass	--
6	Time of Occupancy (Dwell time)	15.247(a)	Hopping Mode	5.7.4	Pass	--
7	Conducted Spurious Emission & Authorized-band band-edge	15.247(d)	Hopping Mode; Low/Middle/High	5.8.4	Pass	--
8	Conducted Emission	15.207	Low/Middle/High	5.9.4	Pass	--
9	Radiated Spurious Emission	15.209 15.247(d)	Low/Middle/High	5.10.4	Pass	--
10	Band Edge(Restricted-band band-edge)	15.209 15.247(d)	Low/High	5.11.4	Pass	--

Note: The EUT has a permanently and irreplaceable attached antenna, which complies with the requirement FCC 15.203.



## 4 GENERAL TEST CONFIGURATIONS

### 4.1 Test Environments

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

Relative Humidity	54% to 63%	
Atmospheric Pressure	100 kPa to 102 kPa	
Temperature	NT (Normal Temperature)	+21.6°C to +25.1°C
Working Voltage of the EUT	NV (Normal Voltage)	5.0 V

### 4.2 Test Equipment List

Description	Manufacturer	Model	Serial No.	Cal. Date	Cal. Due
Spectrum Analyzer	KEYSIGHT	N9020A	MY50330200	2023.05.16	2024.05.15
Spectrum Analyzer	KEYSIGHT	N9020A	MY50531259	2022.09.06	2023.09.05
Test Antenna-Horn	SCHWARZBECK	BBHA 9120D	02460	2021.05.19	2024.05.08
Test Antenna-Horn	A-INFO	LB-180400KF	J211060273	2021.07.02	2024.07.01
Anechoic Chamber	RAINFORD	9m*6m*6m	140	2022.02.19	2024.08.15
EMI Receiver	ROHDE&SCHWARZ	ESRP	101036	2022.09.09	2023.09.08
Test Antenna-Bi-Log	SCHWARZBECK	VULB 9168	00883	2022.04.01	2025.03.31
Test Antenna-Loop	SCHWARZBECK	FMZB 1519	1519-037	2021.04.16	2024.04.15
Anechoic Chamber	EMC Electronic Co., Ltd	20.10*11.60*7.35m	130	2021.08.15	2024.08.14
EMI Receiver	KEYSIGHT	N9010B	MY57110309	2022.09.09	2023.09.08
LISN	SCHWARZBECK	NSLK 8127	8127-687	2023.05.16	2024.05.15
Shielded Enclosure	YiHeng Electronic Co., Ltd	3.5m*3.1m*2.8m	112	2022.02.19	2025.02.18
Amplifier	COM-MV	LSCX_LNA1-12G-01	180602	2020.09.08	2023.09.07
Amplifier	COM-MV	XKu_LNA7-18G-01	180601	2020.09.08	2023.09.07
Amplifier	COM-MV	KA_LNA18-40G-01	18050001	2020.09.08	2023.09.07
Amplifier	COM-MV	ZT30-1000M	B2017119082	2022.12.07	2023.12.06

### 4.3 Test Software List

Description	Manufacturer	Software Version	Serial No.	Applicable test Setup
BL410R	BALUN	V2.1.1.488	N/A	The section 4.5.1
BL410E	BALUN	V22.930	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%

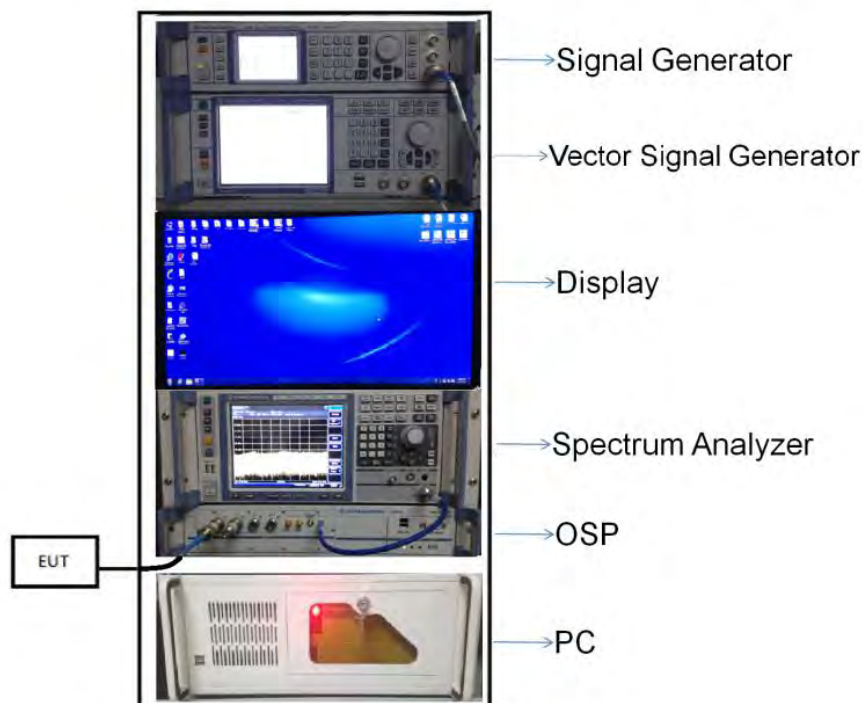
### 4.5 Description of Test Setup

#### 4.5.1 For Antenna Port Test

$$\text{Conducted value (dBm)} = \text{Measurement value (dBm)} + \text{cable loss (dB)}$$

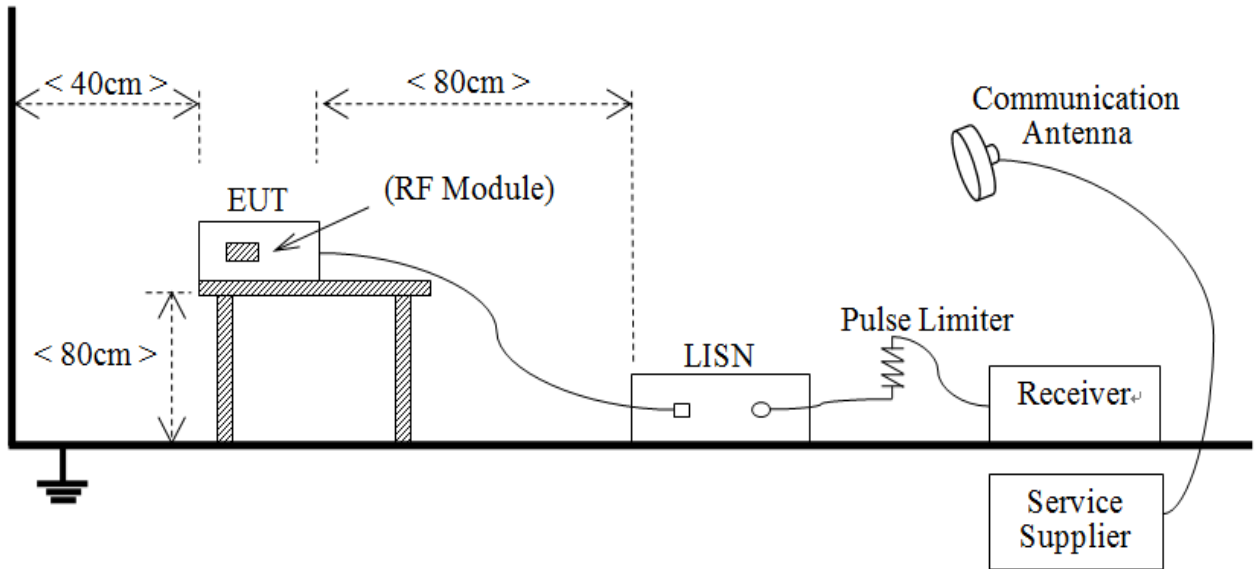
For example: the measurement value is 10 dBm and the cable 0.5dBm used, then the final result of EUT:

$$\text{Conducted value (dBm)} = 10 \text{ dBm} + 0.5 \text{ dB} = 10.5 \text{ dBm}$$



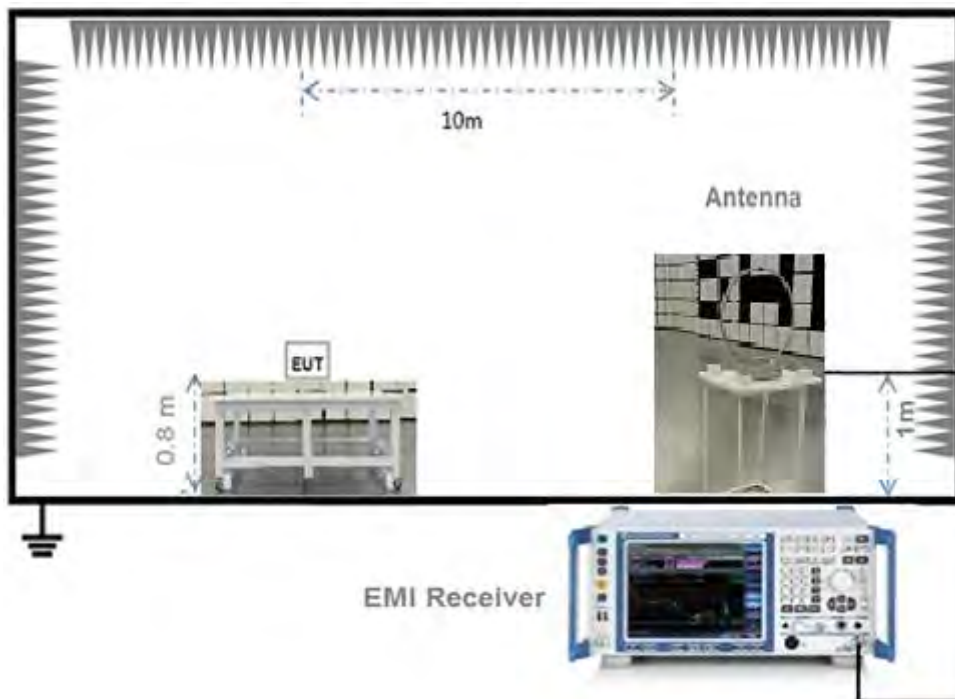
(Diagram 1)

### 4.5.2 For AC Power Supply Port Test



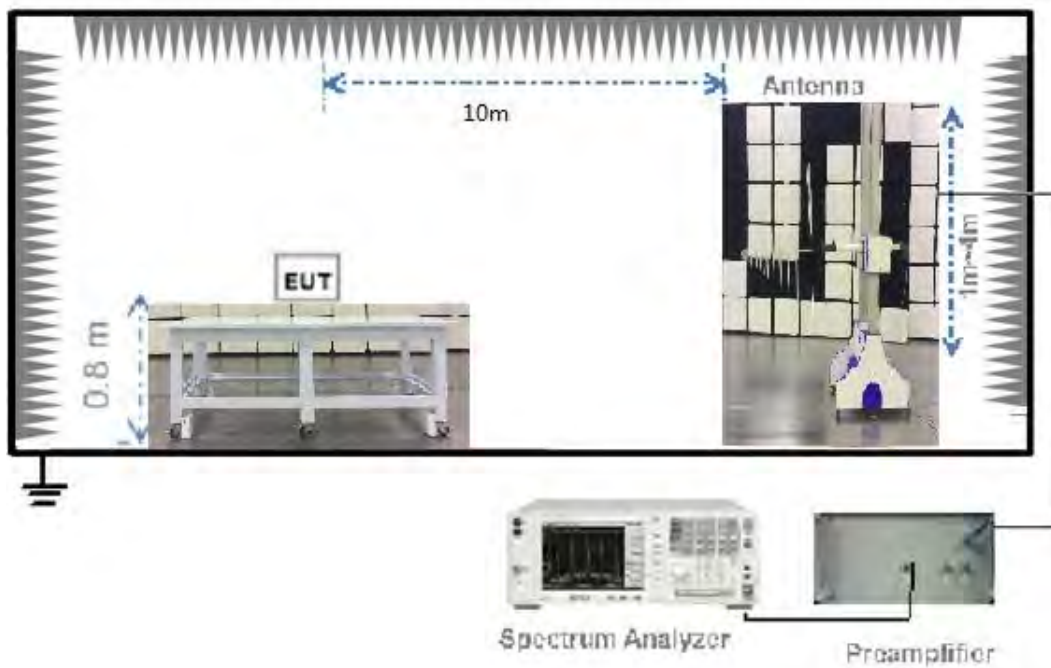
(Diagram 2)

### 4.5.3 For Radiated Test (Below 30 MHz)



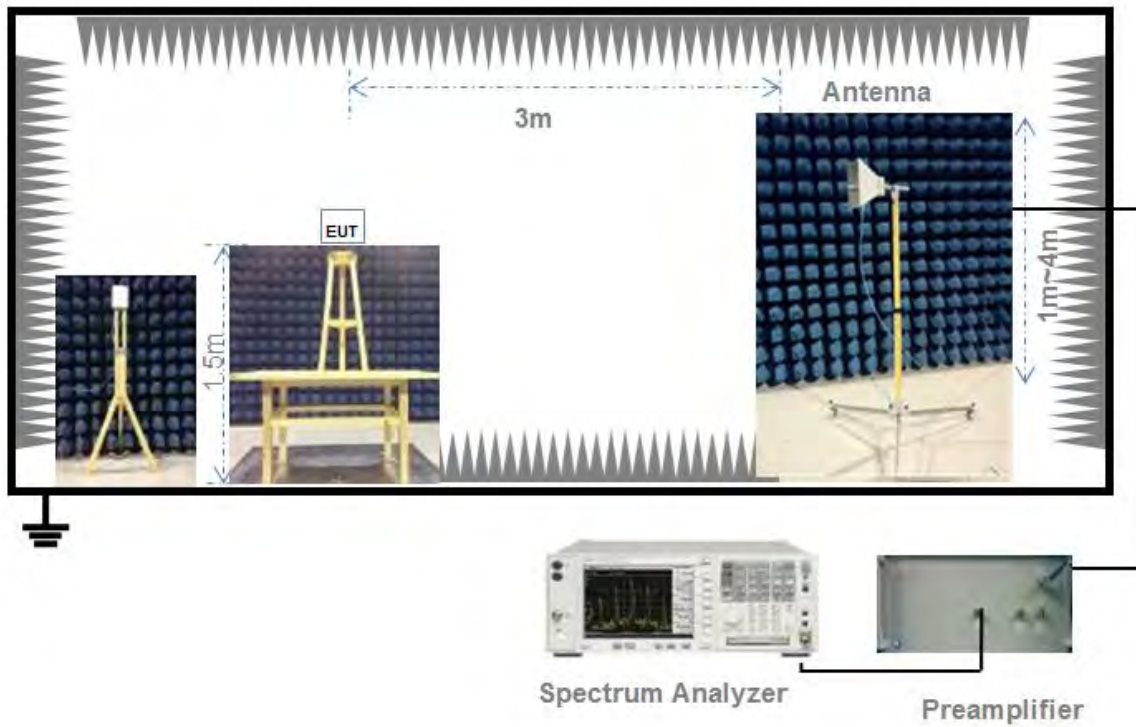
(Diagram 3)

#### 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.

## 5 TEST ITEMS

### 5.1 Antenna Requirements

#### 5.1.1 Relevant Standards

FCC §15.203 & 15.247(b)

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

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

#### 5.1.2 Antenna Anti-Replacement Construction

The Antenna Anti-Replacement as following method:

Protected Method	Description
The antenna is embedded in the product.	An embedded-in antenna design is used.

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 Frequency Hopping Systems

### 5.2.1 Relevant Standards

FCC §15.247(a) (1) (i) (ii) (iii) (iv); FCC §15.247(g); FCC §15.247(h)

Describe how the hopping sequence is generated. Provide an example of the hopping sequence channels, to demonstrate that the sequence meets the requirement specified in the definition of an FHSS system. Per the definition in Section 2.1(c), the hop set shall appear as random in the near term, shall appear as evenly distributed in the long term, and sequential hops shall be randomly distributed in both direction and magnitude of change.

Describe how each individual EUT meets the requirement that each of its hopping channels is used equally on average (e.g., that each new transmission event begins on the next channel in the hopping sequence after the final channel used in the previous transmission event).

Describe how the associated receiver(s) complies with the requirement that the input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal.

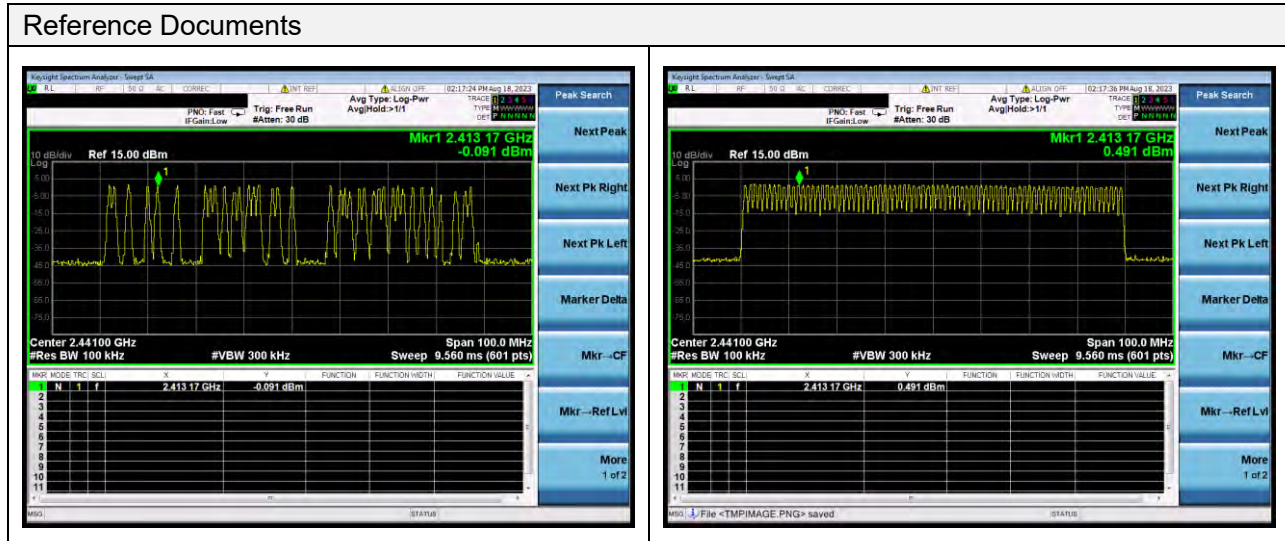
Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals.

For short burst systems, describe how the EUT complies with the requirement that it be designed to be capable of operating as a true frequency hopping system. Specifically, the device shall comply with the equal frequency use and pseudorandom hopping sequence requirement when transmitting in short bursts, and shall be designed to comply when presented with continuous data (or information) stream.

Describe how the EUT complies with the requirement that it not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

## 5.2.2 Description of the systems

1. According to the preset procedure of the whole network, all the stations in the automatic control network synchronously change the frequency multiple times within one second, and temporarily stay on each frequency hopping channel. Periodic synchronization signaling is sent from the primary station, instructing all slaves to simultaneously change the operating frequency, then the hopping sequence is generated.
2. The hop set shall appear as random in the near term, shall appear as evenly distributed in the long term, and sequential hops shall be randomly distributed in both direction and magnitude of change.



3. Channels are classified into two categories, used and unused, where used channels are part of the hopping sequence and unused channels are replaced in the hopping sequence by used channels in a pseudo-random way. Make each individual EUT meets the requirement that each of its hopping channels is used equally on average.
4. The input bandwidth and transmitted bandwidth are both 1MHz, the associated receiver(s) complies with the requirement that the input bandwidth matches the bandwidth of the transmitted signal.
5. Connected devices communicate on the same physical channel by synchronizing with a common clock and hopping sequence.
6. EUT isn't short burst systems.
7. EUT can't have the ability to be coordinated with other FHSS systems in an effort.



## 5.3 Number of Hopping Frequencies

### 5.3.1 Limit

FCC §15.247(a) (1)

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

### 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 A.

### 5.3.3 Test Procedure

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

Span = The frequency band of operation

RBW = To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

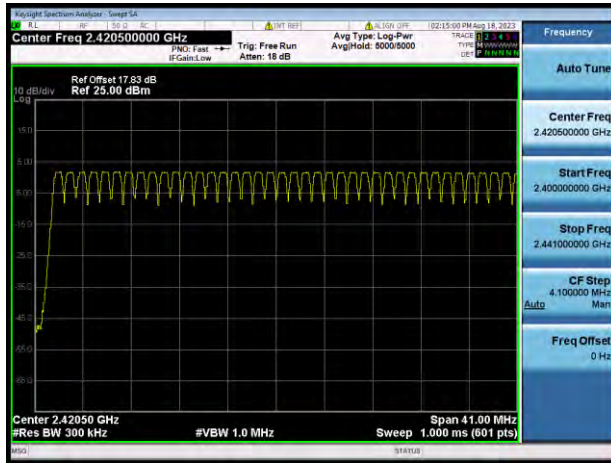
### 5.3.4 Test Result

#### Test Data

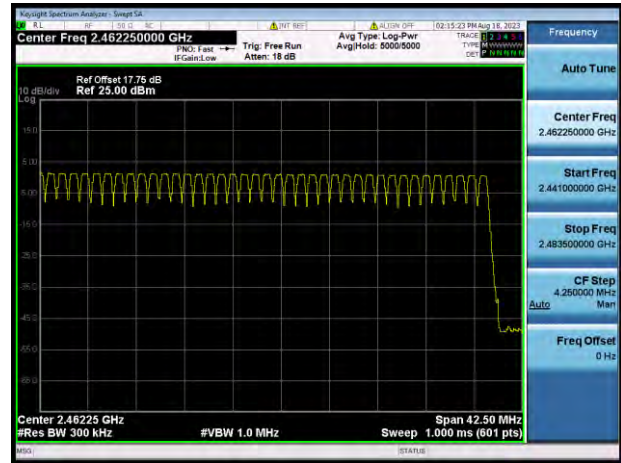
Test Mode	Frequency Block (MHz)	Measured Channel Numbers	Min. Limit	Verdict
GFSK	2400 - 2483.5	79	15	Pass
$\pi/4$ -DQPSK	2400 - 2483.5	79	15	Pass

#### Test Plots

GFSK 2.4 GHz ~ 2.4415 GHz



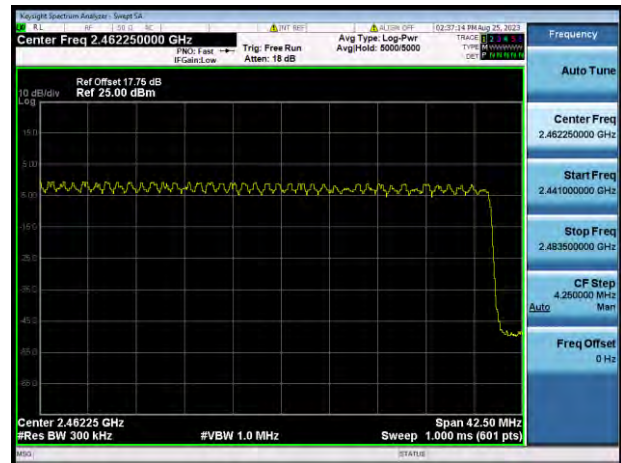
GFSK 2.4415 GHz ~ 2.4835 GHz



$\pi/4$ -DQPSK 2.4 GHz ~ 2.4415 GHz



$\pi/4$ -DQPSK 2.4415 GHz ~ 2.4835 GHz



## 5.4 Peak Output Power

### 5.4.1 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 band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

### 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 A.

### 5.4.3 Test Procedure

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

Use the following spectrum analyzer settings:

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

RBW > the 20 dB bandwidth of the emission being measured

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize.

## 5.4.4 Test Result

## Peak Power Test Data

Channel	Measured Output Peak Power				Limit		Verdict
	GFSK		$\pi/4$ -DQPSK		dBm	mW	
	dBm	mW	dBm	mW			
Low	2.73	1.87	1.23	1.33	21	125	Pass
Middle	2.43	1.75	0.83	1.21			Pass
High	1.53	1.42	-0.12	0.97			Pass

Test Plots

GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL



$\pi/4$ -DQPSK LOW CHANNEL



$\pi/4$ -DQPSK MIDDLE CHANNEL



$\pi/4$ -DQPSK HIGH CHANNEL



## 5.5 Occupied Bandwidth

### 5.5.1 Limit

FCC §15.247(a)

Measurement of the 20dB bandwidth of the modulated signal.

### 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 A.

### 5.5.3 Test Procedure

Use the following spectrum analyzer settings:

Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hopping channel

RBW = in the range of 1% to 5% of the OBW

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold

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

### 5.5.4 Test Result

#### Test Data

GFSK		
Channel	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	0.990000	0.888620
Middle	0.990000	0.887410
High	0.990000	0.884600
$\pi/4$ -DQPSK		
Channel	20 dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	1.295000	1.183400
Middle	1.295000	1.181800
High	1.295000	1.180100

Test Plots

20 dB Bandwidth

GFSK LOW CHANNEL



GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL



π/4-DQPSK LOW CHANNEL



π/4-DQPSK MIDDLE CHANNEL



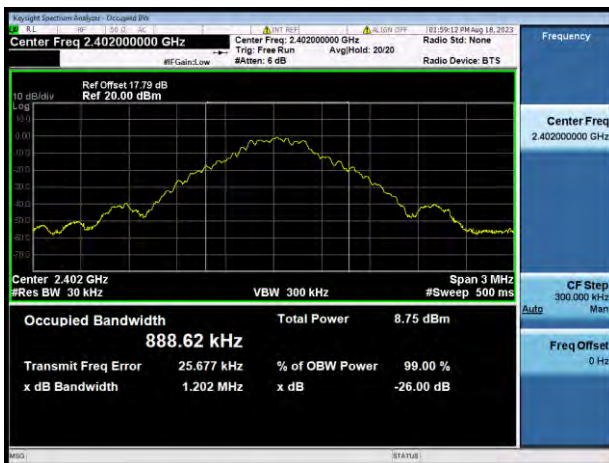


$\pi/4$ -DQPSK HIGH CHANNEL

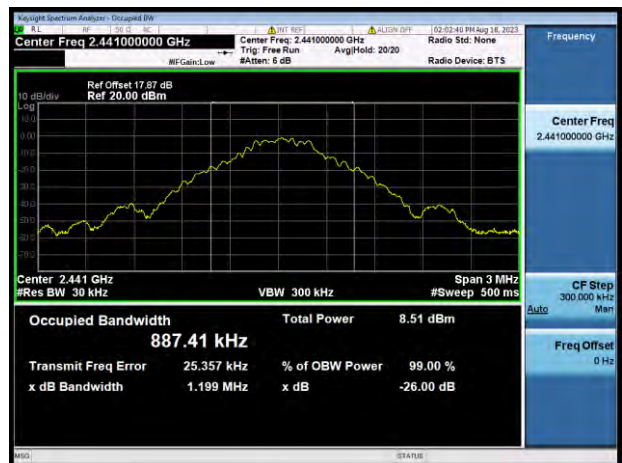


99% Bandwidth

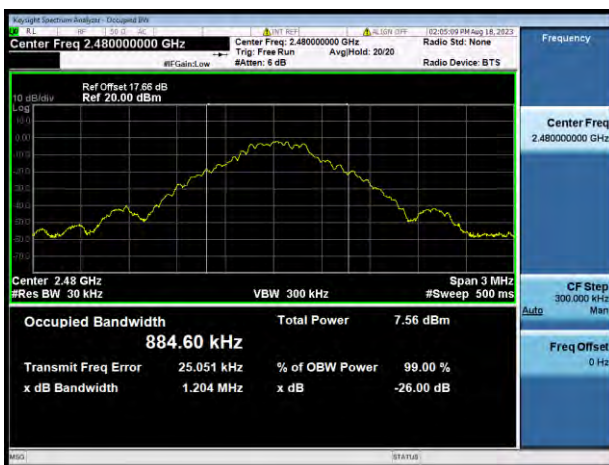
GFSK LOW CHANNEL



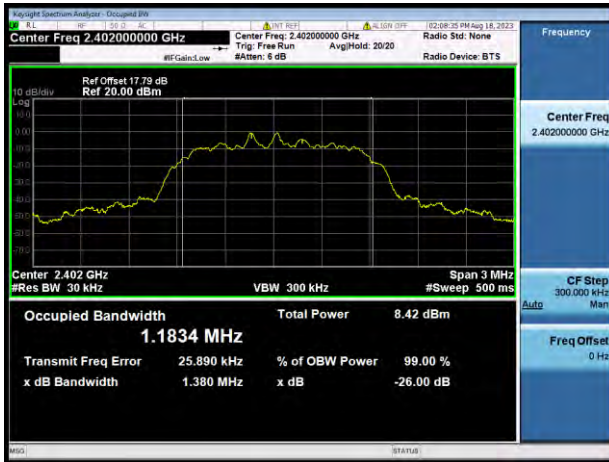
GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL



$\pi/4$ -DQPSK LOW CHANNEL



$\pi/4$ -DQPSK MIDDLE CHANNEL



$\pi/4$ -DQPSK HIGH CHANNEL



## 5.6 Carrier Frequency Separation

### 5.6.1 Limit

FCC §15.247(a)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 2/3 of the 20 dB bandwidth of the hopping channel, whichever is greater.

### 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 A.

### 5.6.3 Test Procedure

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

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

Resolution (or IF) Bandwidth (RBW)  $\geq$  1% of the span

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

Sweep = auto

Detector function = peak

Trace = max hold

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

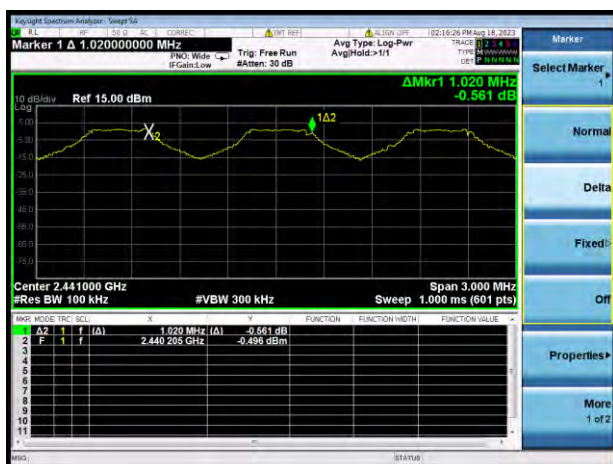
### 5.6.4 Test Result

#### Test Data

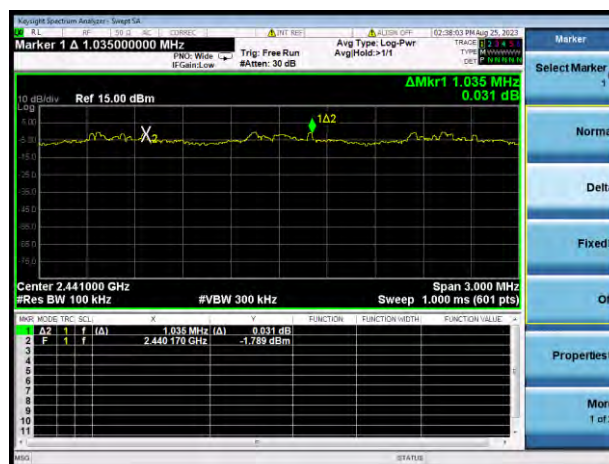
Mode	Frequency separation (MHz)	2/3 of the 20 dB Bandwidth (MHz)	Verdict
GFSK	1.020	0.660	Pass
$\pi/4$ -DQPSK	1.035	0.863	Pass

#### Test Plots

GFSK



$\pi/4$ -DQPSK



## 5.7 Time of Occupancy (Dwell time)

### 5.7.1 Limit

FCC §15.247(a)

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

### 5.7.2 Test Setup

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

### 5.7.3 Test Procedure

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

Span: Zero span, centered on a hopping channel

RBW shall be  $\leq$  channel spacing and where possible RBW should be set  $\gg 1/T$ , where T is the expected dwell time per channel

Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel

Detector function: Peak

Trace: Max hold

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

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

For GFSK and  $\pi/4$ -DQPSK:

For DH1 package type

$$\{\text{Total of Dwell}\} = \{\text{Pulse Time}\} * (1600 / 2) / \{\text{Number of Hopping Frequency}\} * \{\text{Period}\}$$

$$\{\text{Period}\} = 0.4 \text{ s} * \{\text{Number of Hopping Frequency}\}$$

For DH3 package type

$$\{\text{Total of Dwell}\} = \{\text{Pulse Time}\} * (1600 / 4) / \{\text{Number of Hopping Frequency}\} * \{\text{Period}\}$$

$$\{\text{Period}\} = 0.4 \text{ s} * \{\text{Number of Hopping Frequency}\}$$

For DH5 package type

$$\{\text{Total of Dwell}\} = \{\text{Pulse Time}\} * (1600 / 6) / \{\text{Number of Hopping Frequency}\} * \{\text{Period}\}$$

$$\{\text{Period}\} = 0.4 \text{ s} * \{\text{Number of Hopping Frequency}\}$$

For AFH Mode:

For DH1 package type

$$\{\text{Total of Dwell}\} = \{\text{Pulse Time}\} * (800 / 2) / \{\text{Number of Hopping Frequency}\} * \{\text{Period}\}$$

$$\{\text{Period}\} = 0.4 \text{ s} * \{\text{Number of Hopping Frequency}\}$$

For DH3 package type

$$\{\text{Total of Dwell}\} = \{\text{Pulse Time}\} * (800 / 4) / \{\text{Number of Hopping Frequency}\} * \{\text{Period}\}$$

$$\{\text{Period}\} = 0.4 \text{ s} * \{\text{Number of Hopping Frequency}\}$$

For DH5 package type

$$\{\text{Total of Dwell}\} = \{\text{Pulse Time}\} * (800 / 6) / \{\text{Number of Hopping Frequency}\} * \{\text{Period}\}$$

$$\{\text{Period}\} = 0.4 \text{ s} * \{\text{Number of Hopping Frequency}\}$$

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.

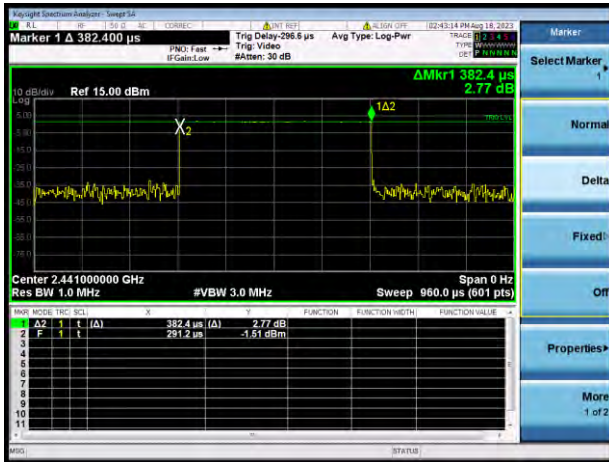
## 5.7.4 Test Result

### Test Data

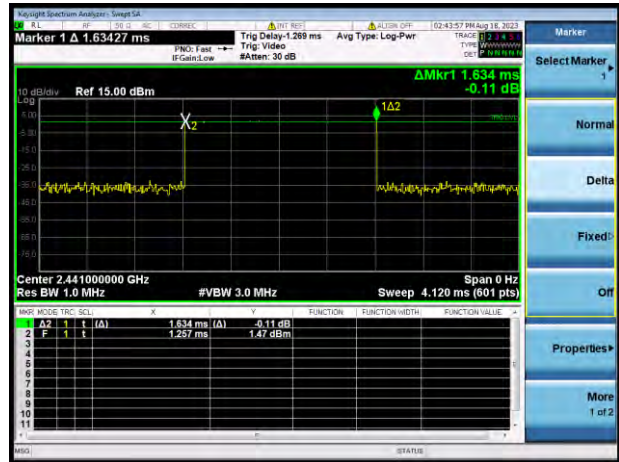
GFSK				
DH Packet	Pulse Width (ms)	Total of Dwell (ms)	Limit (sec)	Verdict
DH 1	0.38240	122.368	0.4	Pass
DH 3	1.63400	261.440	0.4	Pass
DH 5	2.87600	306.773	0.4	Pass
$\pi/4$ -DQPSK				
DH Packet	Pulse Width (ms)	Total of Dwell (ms)	Limit (sec)	Verdict
DH 1	0.39040	124.928	0.4	Pass
DH 3	1.64100	262.560	0.4	Pass
DH 5	2.90000	309.333	0.4	Pass
AFH Mode				
DH Packet	Pulse Width (ms)	Total of Dwell (ms)	Limit (sec)	Verdict
DH 1	0.38240	61.184	0.4	Pass
DH 3	1.63400	130.720	0.4	Pass
DH 5	2.88800	154.027	0.4	Pass

Test Plots

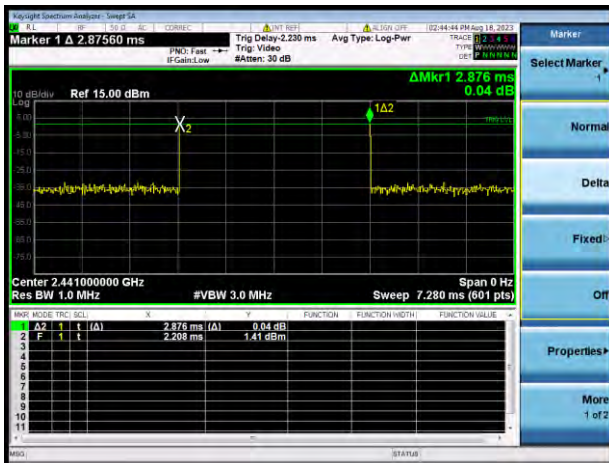
GFSK DH1



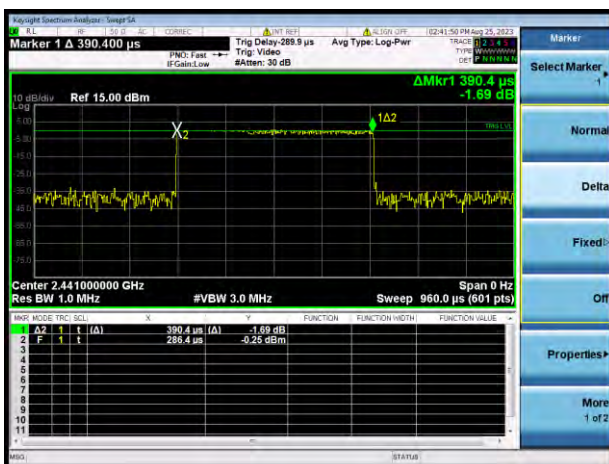
GFSK DH3



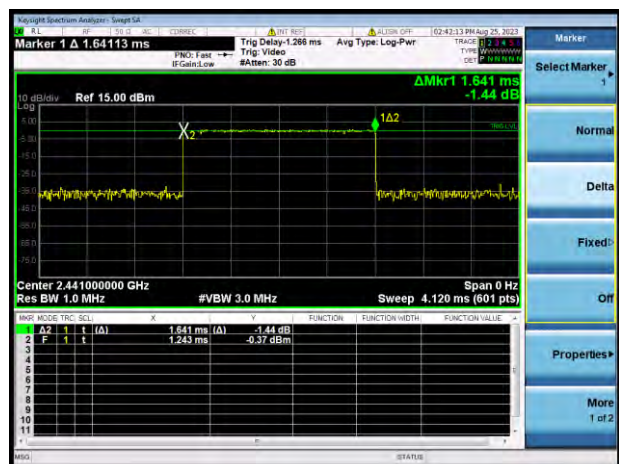
GFSK DH5



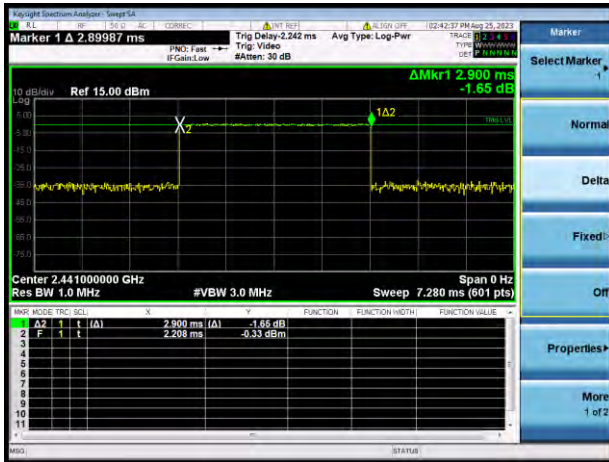
$\pi$ /4-DQPSK DH1



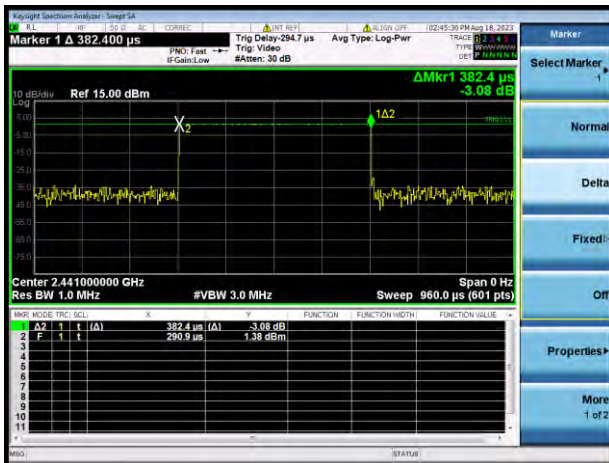
$\pi$ /4-DQPSK DH3



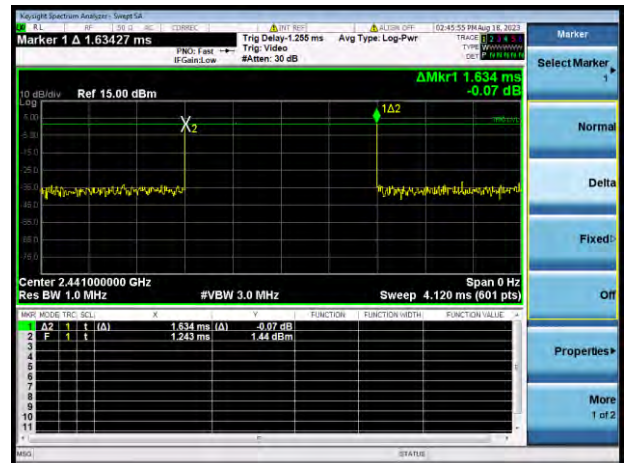
$\pi/4$ -DQPSK DH5



AFH Mode DH1



AFH Mode DH3



AFH Mode DH5





## 5.8 Conducted Spurious Emission & Authorized-band band-edge

### 5.8.1 Limit

#### FCC §15.247(d)

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

### 5.8.2 Test Setup

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

### 5.8.3 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 = 300 kHz

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

## 5.8.4 Test Result

## Test Data

GFSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-24.03	1.68	-18.32	Pass
Middle	-23.16	1.42	-18.58	Pass
High	-23.94	0.53	-19.47	Pass
$\pi/4$ -DQPSK				
Channel	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
Low	-24.52	-0.13	-20.13	Pass
Middle	-26.46	-0.44	-20.44	Pass
High	-25.57	-1.44	-21.44	Pass
Hopping Mode				
Mode	Measured Max. Out of Band Emission (dBm)	Limit (dBm)		Verdict
		Carrier Level	Calculated 20 dBc Limit	
GFSK	-22.98	1.72	-18.28	Pass
$\pi/4$ -DQPSK	-25.76	-0.19	-20.19	Pass

Test Plots

GFSK LOW CHANNEL, CARRIER LEVEL

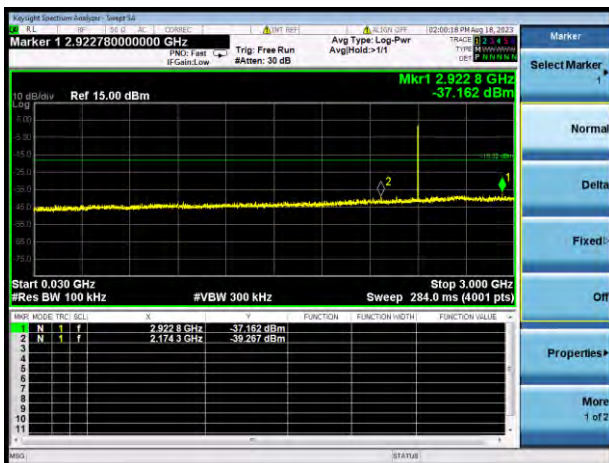


GFSK LOW CHANNEL, BAND EDGE



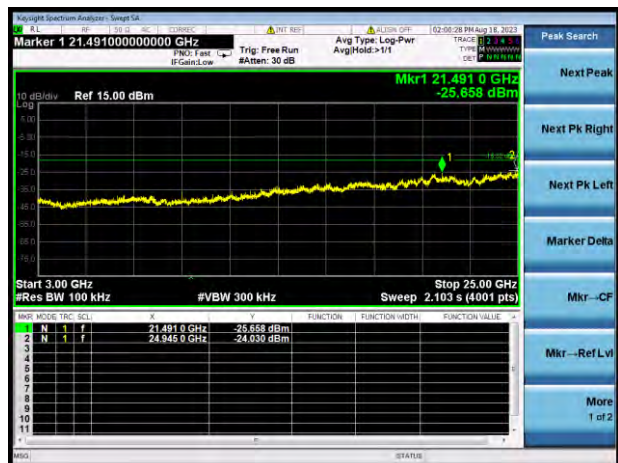
GFSK LOW CHANNEL, SPURIOUS

30 MHz ~ 3 GHz



GFSK LOW CHANNEL, SPURIOUS

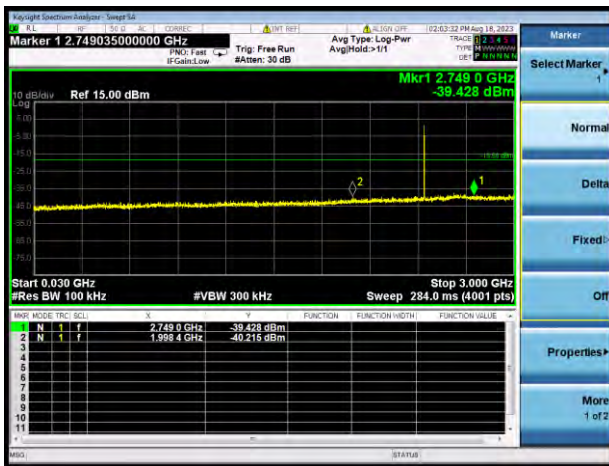
3 GHz ~ 25 GHz



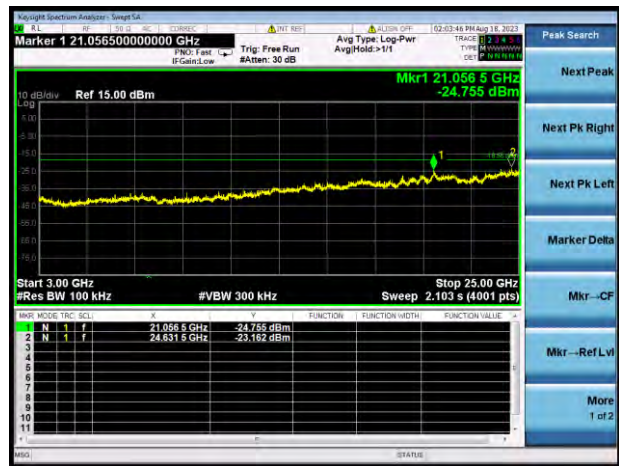
GFSK MIDDLE CHANNEL, CARRIER LEVEL



GFSK MIDDLE CHANNEL, SPURIOUS  
30 MHz ~ 3 GHz



GFSK MIDDLE CHANNEL, SPURIOUS  
3 GHz ~ 25 GHz



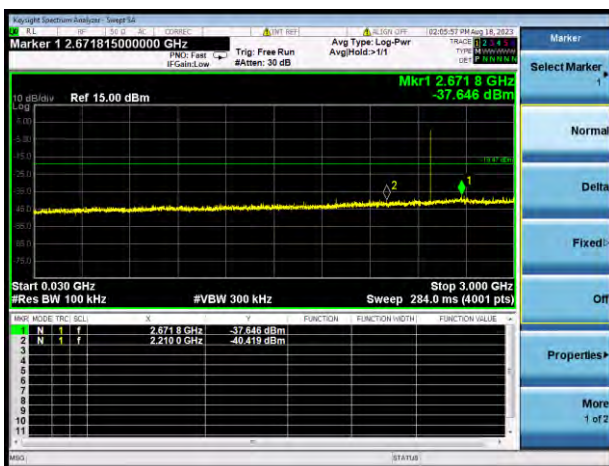
GFSK HIGH CHANNEL, CARRIER LEVEL



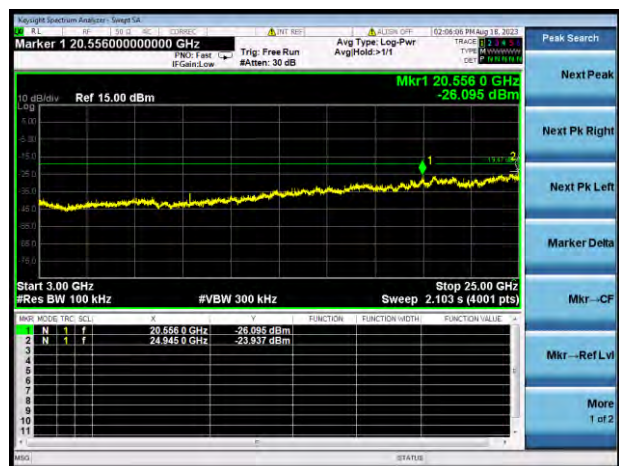
GFSK HIGH CHANNEL, BAND EDGE



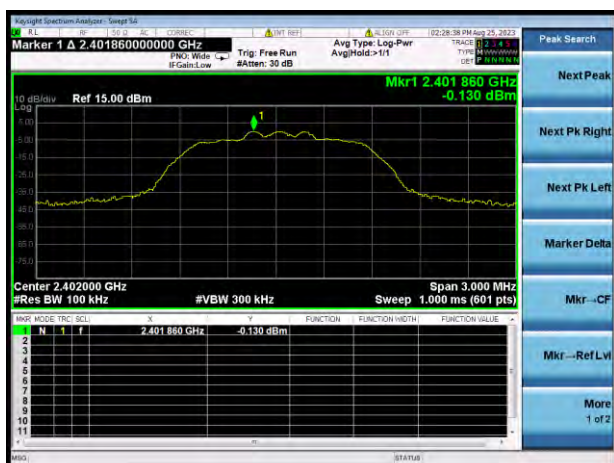
GFSK HIGH CHANNEL, SPURIOUS  
30 MHz ~ 3 GHz



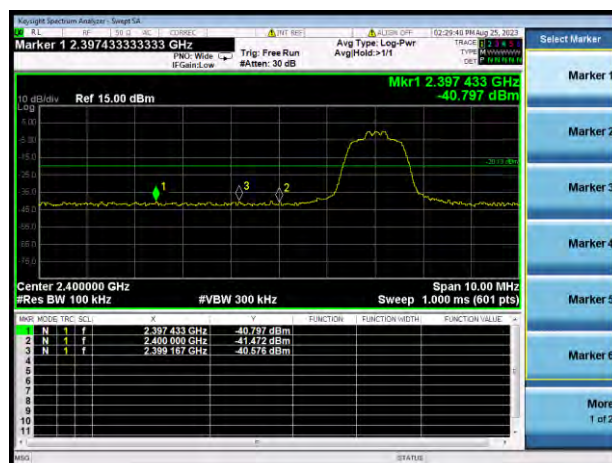
GFSK HIGH CHANNEL, SPURIOUS  
3 GHz ~ 25 GHz



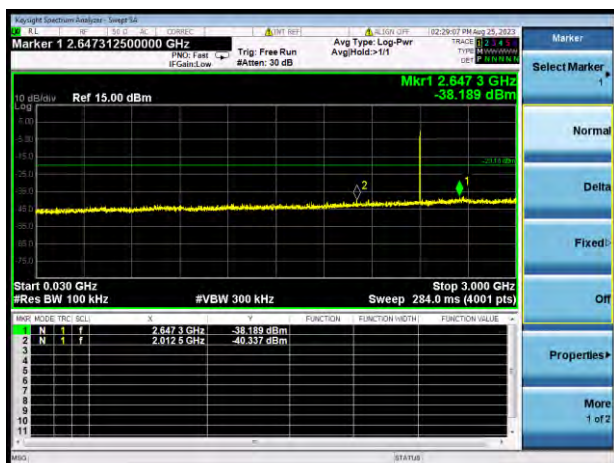
$\pi/4$ -DQPSK LOW CHANNEL, CARRIER LEVEL



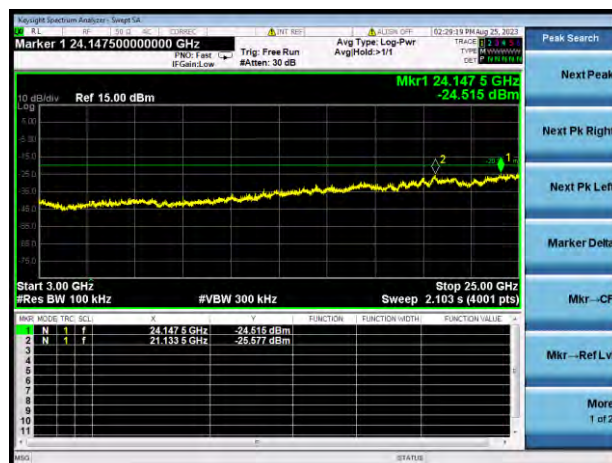
$\pi/4$ -DQPSK LOW CHANNEL, BAND EDGE



$\pi/4$ -DQPSK LOW CHANNEL, SPURIOUS  
30 MHz ~ 3 GHz



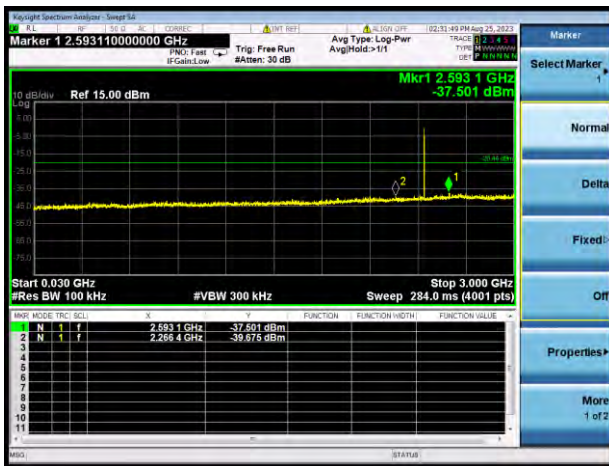
$\pi/4$ -DQPSK LOW CHANNEL, SPURIOUS  
3 GHz ~ 25 GHz



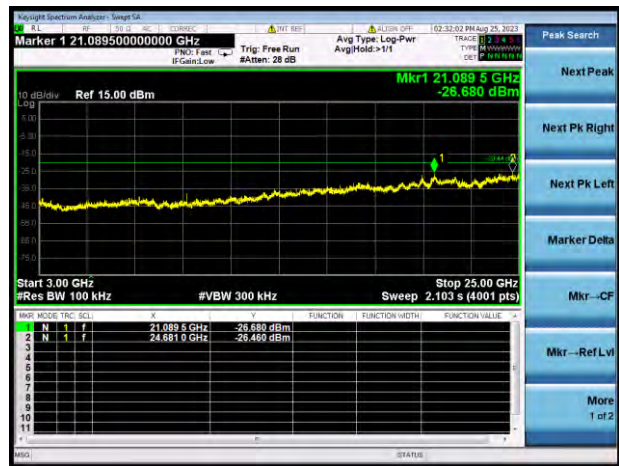
$\pi/4$ -DQPSK MIDDLE CHANNEL, CARRIER LEVEL



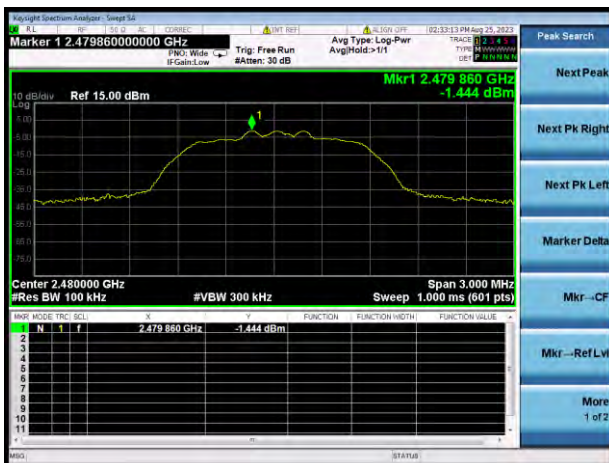
$\pi/4$ -DQPSK MIDDLE CHANNEL, SPURIOUS  
30 MHz ~ 3 GHz



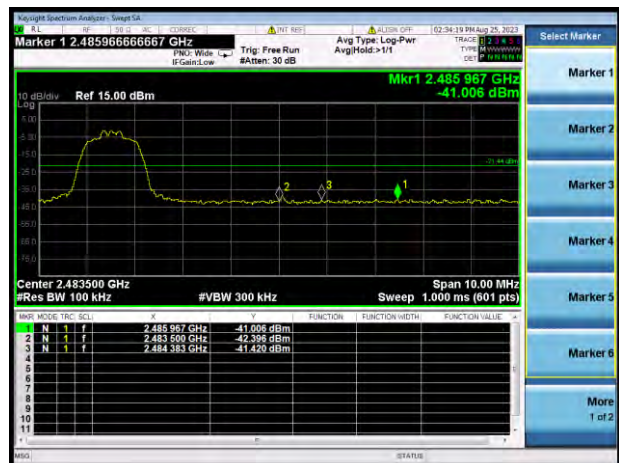
$\pi/4$ -DQPSK MIDDLE CHANNEL, SPURIOUS  
3 GHz ~ 25 GHz



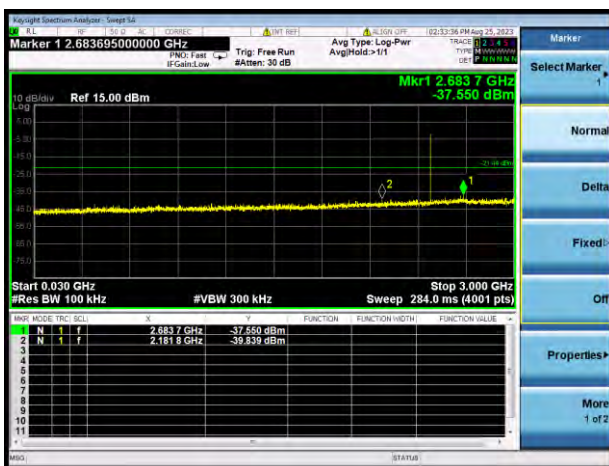
$\pi/4$ -DQPSK HIGH CHANNEL, CARRIER LEVEL



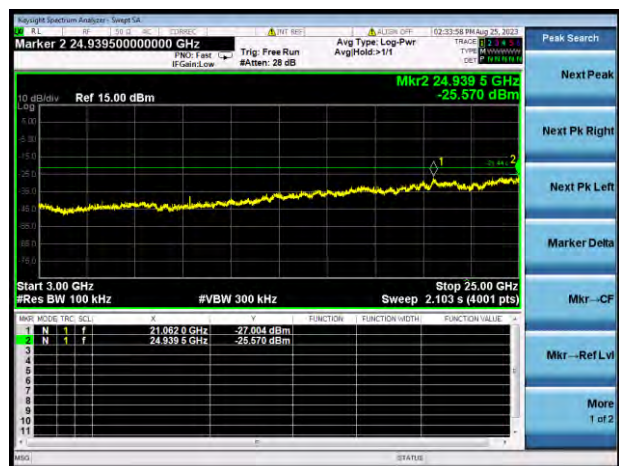
$\pi/4$ -DQPSK HIGH CHANNEL, BAND EDGE



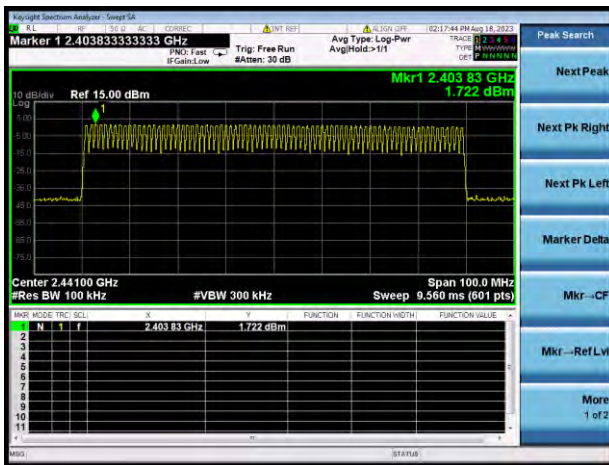
$\pi/4$ -DQPSK HIGH CHANNEL, SPURIOUS  
30 MHz ~ 3 GHz



$\pi/4$ -DQPSK HIGH CHANNEL, SPURIOUS  
3 GHz ~ 25 GHz



GFSK HOPPING, CARRIER LEVEL



GFSK HOPPING BAND EDGE (LOW)



GFSK HOPPING BAND EDGE (HIGH)



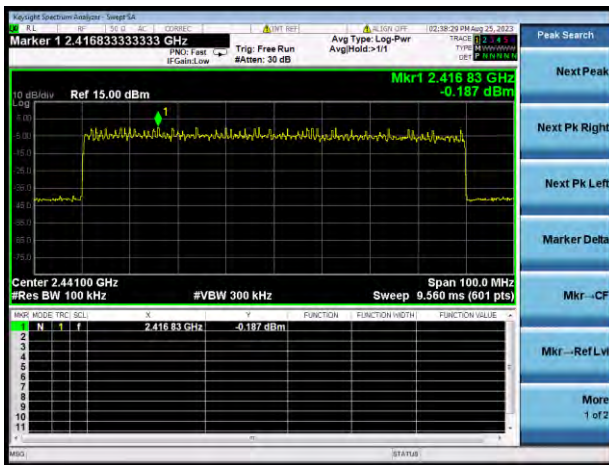
GFSK Hopping Mode, SPURIOUS  
30 MHz ~ 3 GHz



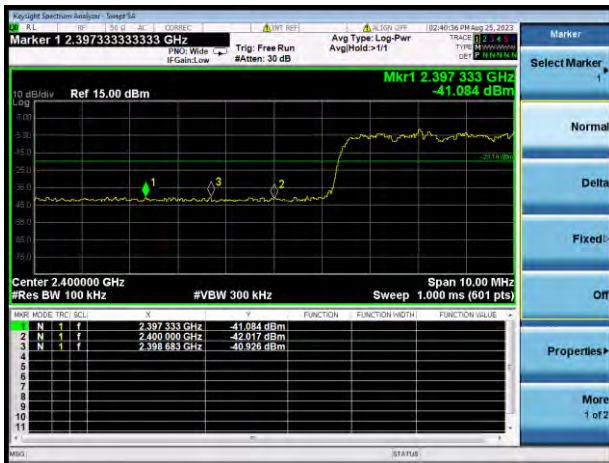
GFSK Hopping Mode, SPURIOUS  
3GHz ~ 25 GHz



$\pi/4$ -DQPSK HOPPING, CARRIER LEVEL



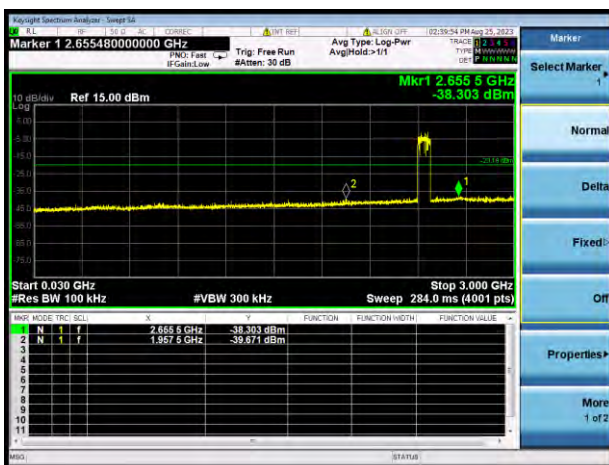
$\pi/4$ -DQPSK Hopping BAND EDGE (LOW)



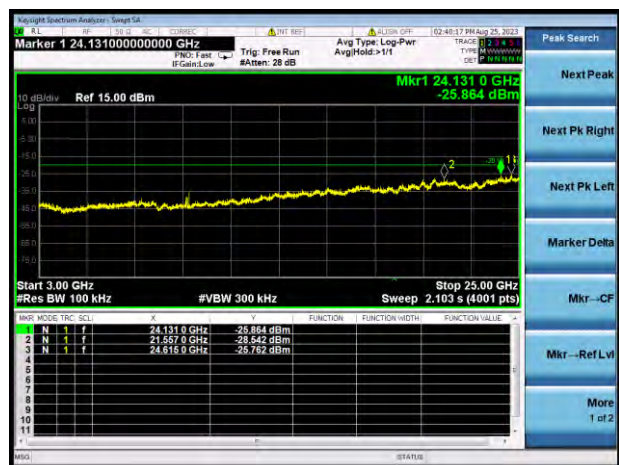
$\pi/4$ -DQPSK Hopping BAND EDGE (HIGH)



$\pi/4$ -DQPSK Hopping Mode, SPURIOUS  
30 MHz ~ 3 GHz



$\pi/4$ -DQPSK Hopping Mode, SPURIOUS  
3GHz ~ 25 GHz





## 5.9 Conducted Emission

### 5.9.1 Limit

#### FCC §15.207

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency within the band 150 kHz to 30 MHz shall not exceed the limits in the following table, as measured using a 50 $\mu$ H/50 $\Omega$  line impedance stabilization network (LISN).

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

### 5.9.2 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 A.

### 5.9.3 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.

Devices subject to Part 15 must be tested for all available U.S. voltages and frequencies (such as a nominal 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz) for which the device is capable of operation. A device rated for 50/60 Hz operation need not be tested at both frequencies provided the radiated and line conducted emissions are the same at both frequencies.

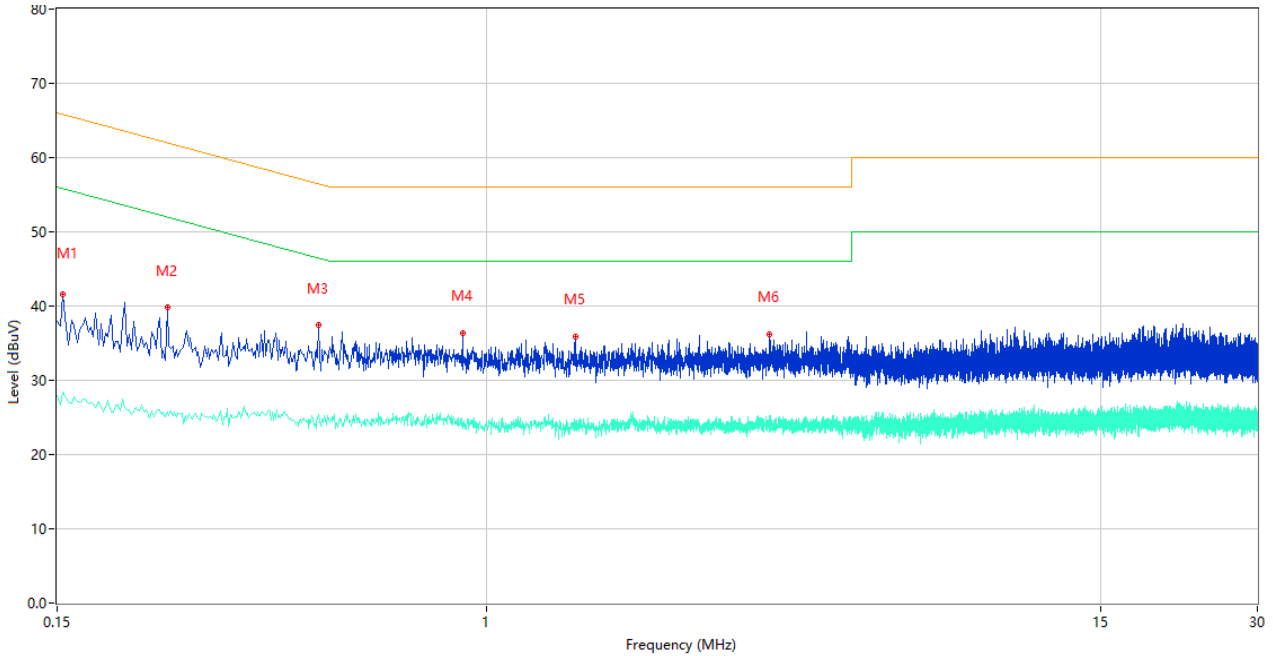
### 5.9.4 Test Result

Note <sup>1</sup>: The EUT was tested in charging mode.

Note <sup>2</sup>: Results (dBuV) = Original reading level of Spectrum Analyzer (dBuV) + Factor (dB)

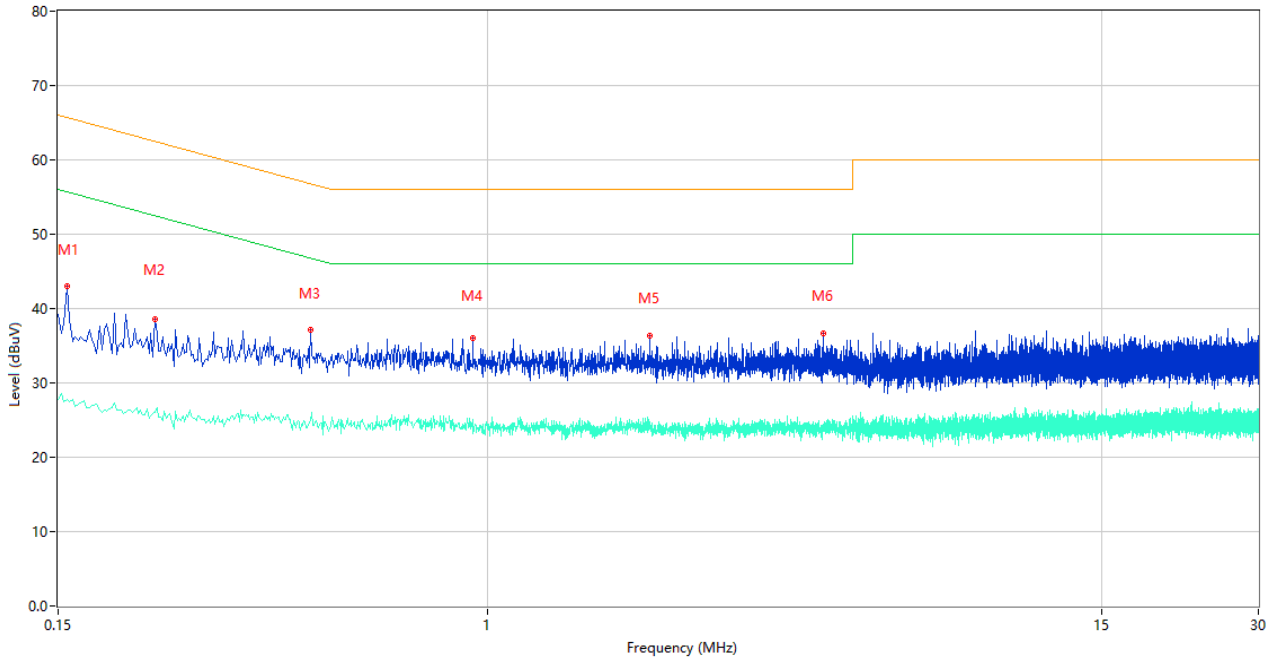
#### Test Data and Plots

##### PHASE L



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.154	41.64	9.78	65.78	24.14	Peak	L	Pass
1**	0.154	28.39	9.78	55.78	27.39	AV	L	Pass
2	0.244	39.77	9.77	61.96	22.19	Peak	L	Pass
2**	0.244	25.74	9.77	51.96	26.22	AV	L	Pass
3	0.476	37.39	10.01	56.41	19.02	Peak	L	Pass
3**	0.476	25.32	10.01	46.41	21.09	AV	L	Pass
4	0.898	36.42	10.19	56.00	19.58	Peak	L	Pass
4**	0.898	23.54	10.19	46.00	22.46	AV	L	Pass
5	1.476	35.95	10.17	56.00	20.05	Peak	L	Pass
5**	1.476	23.90	10.17	46.00	22.10	AV	L	Pass
6	3.478	36.26	10.15	56.00	19.74	Peak	L	Pass
6**	3.478	24.21	10.15	46.00	21.79	AV	L	Pass

PHASE N



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.156	42.98	9.78	65.67	22.69	Peak	N	Pass
1**	0.156	27.72	9.78	55.67	27.95	AV	N	Pass
2	0.230	38.63	9.77	62.45	23.82	Peak	N	Pass
2**	0.230	25.96	9.77	52.45	26.49	AV	N	Pass
3	0.458	37.12	10.02	56.73	19.61	Peak	N	Pass
3**	0.458	24.92	10.02	46.73	21.81	AV	N	Pass
4	0.936	36.02	10.09	56.00	19.98	Peak	N	Pass
4**	0.936	24.53	10.09	46.00	21.47	AV	N	Pass
5	2.046	36.38	10.49	56.00	19.62	Peak	N	Pass
5**	2.046	24.15	10.49	46.00	21.85	AV	N	Pass
6	4.386	36.71	10.35	56.00	19.29	Peak	N	Pass
6**	4.386	23.68	10.35	46.00	22.32	AV	N	Pass

## 5.10 Radiated Spurious Emission

### 5.10.1 Limit

FCC §15.209&15.247(d)

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

According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

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

Note:

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

### 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 A.

### 5.10.3 Test Procedure

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

The power of the EUT transmitting frequency should be ignored.

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

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for  $f \geq 1$  GHz, 100 kHz for  $f < 1$  GHz

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold

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

### 5.10.4 Test Result

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

Note <sup>2</sup>: 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.

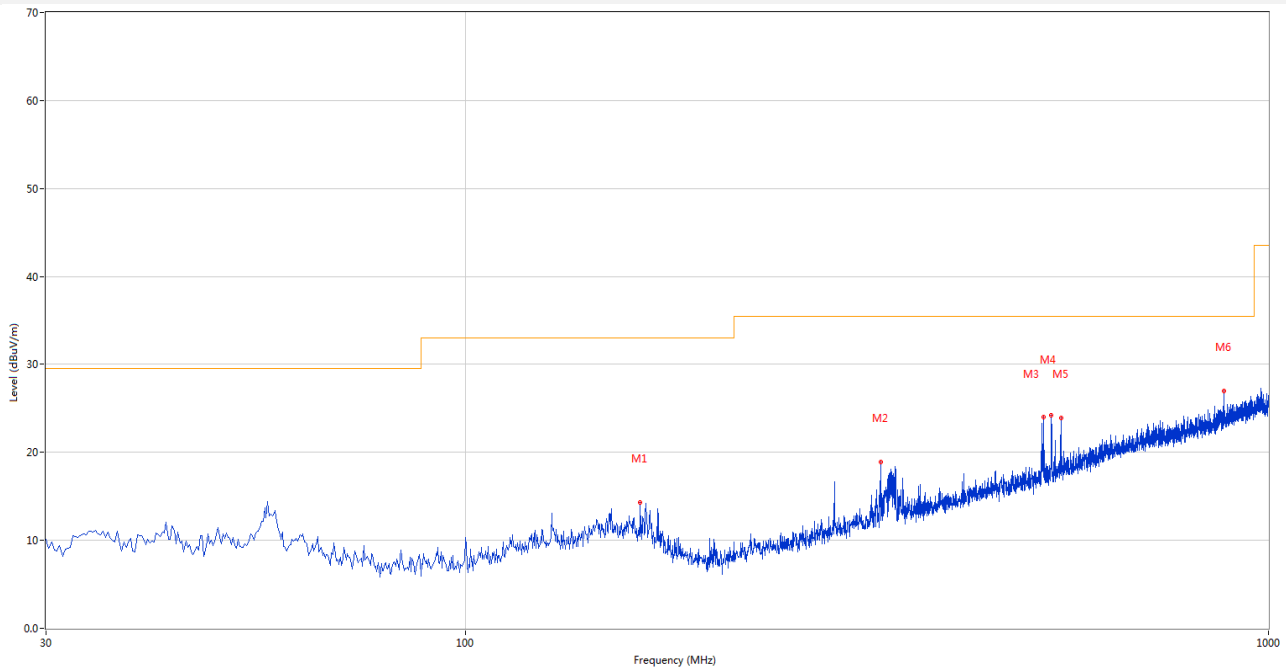
Note <sup>3</sup>: The EUT was tested in Link mode and the charging case is charging below 1 GHz.

Note <sup>4</sup>: 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.

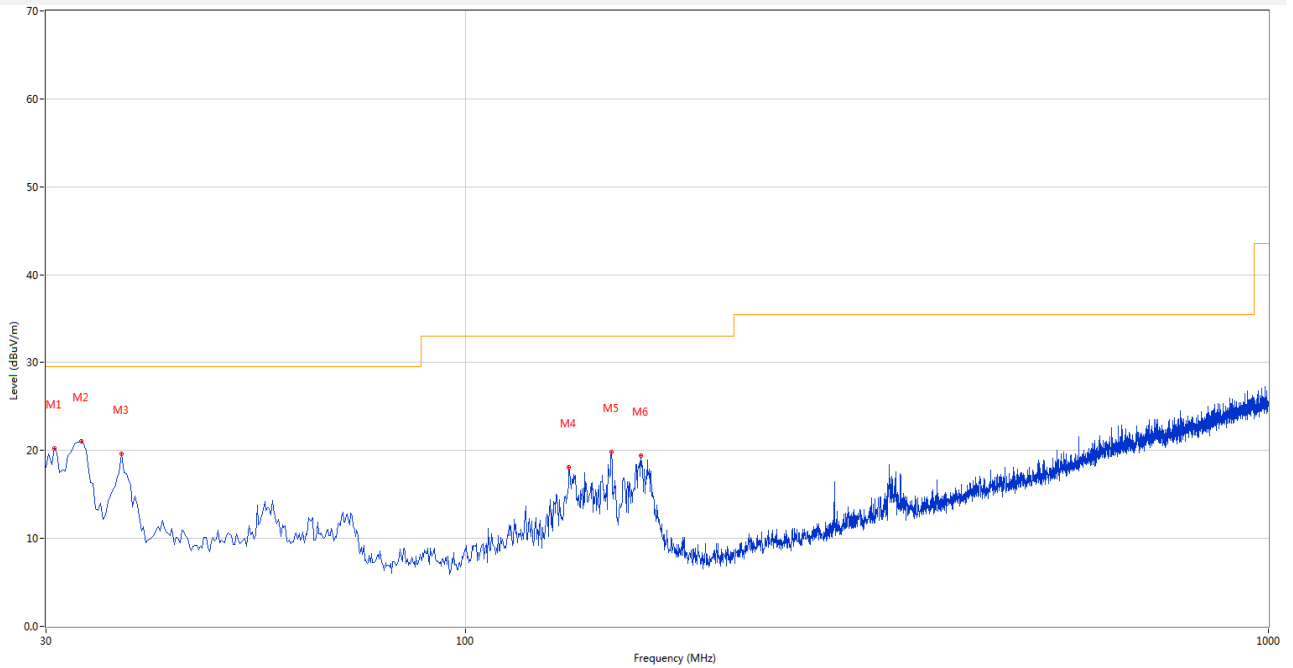
#### Test Data and Plots

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	165.039	14.26	-26.22	33.0	18.74	Peak	257.00	200	Horizontal	Pass
2	328.685	18.89	-24.77	35.5	16.61	Peak	152.00	200	Horizontal	Pass
3	524.091	23.98	-19.80	35.5	11.52	Peak	260.00	200	Horizontal	Pass
4	535.971	24.18	-19.51	35.5	11.32	Peak	248.00	200	Horizontal	Pass
5	551.730	23.89	-18.90	35.5	11.61	Peak	239.00	200	Horizontal	Pass
6	879.265	27.02	-12.55	35.5	8.48	Peak	360.00	200	Horizontal	Pass

30 MHz to 1 GHz, ANT V



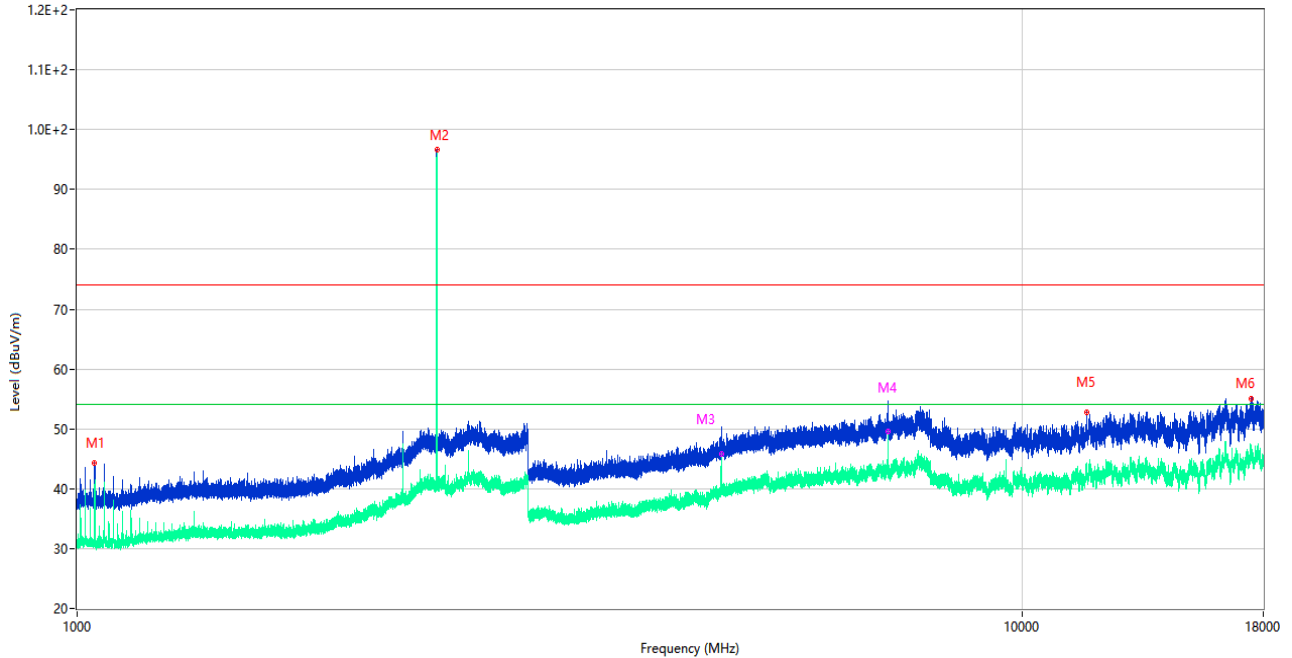
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	30.727	20.21	-27.57	29.5	9.29	Peak	183.00	100	Vertical	Pass
2	33.152	21.15	-27.04	29.5	8.35	Peak	360.00	200	Vertical	Pass
3	37.273	19.52	-26.99	29.5	9.98	Peak	81.00	100	Vertical	Pass
4	134.491	18.05	-26.88	33.0	14.95	Peak	326.00	100	Vertical	Pass
5	151.947	19.85	-25.66	33.0	13.15	Peak	261.00	100	Vertical	Pass
6	165.281	19.41	-26.22	33.0	13.59	Peak	360.00	200	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**

RE Test case\_FCC Part 15C\_FCC 15.247(2.4G)\_1GHz-18GHz

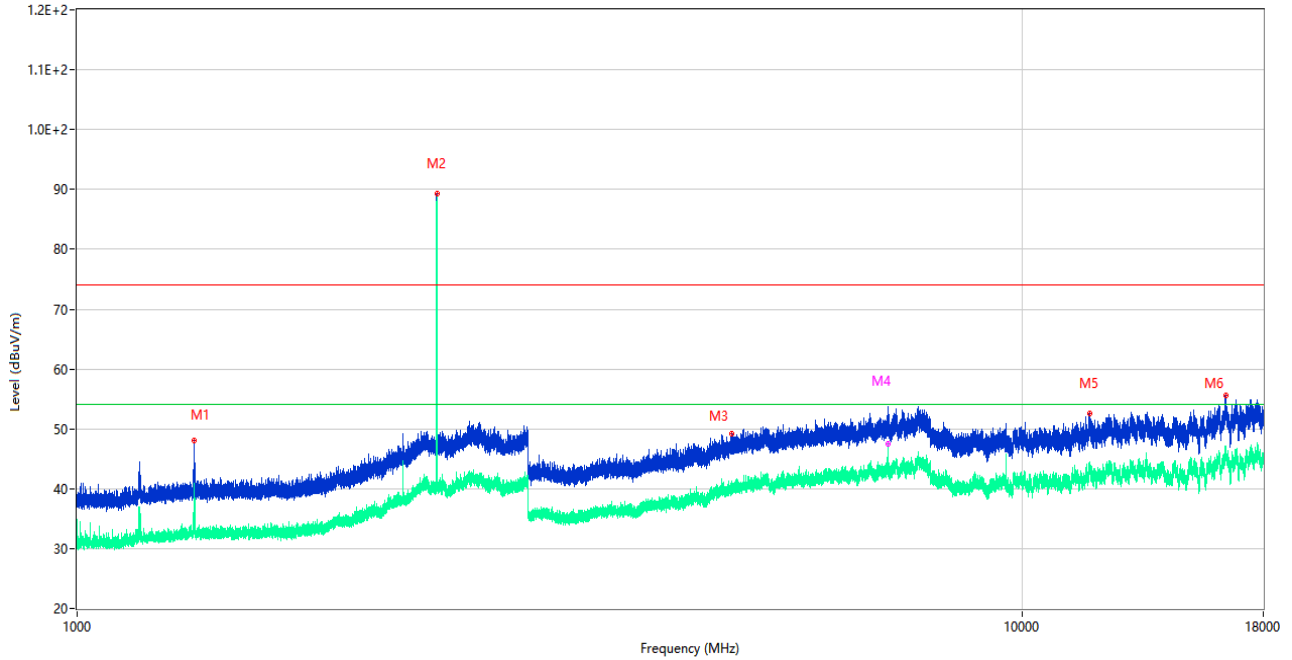


No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1043.900	44.32	-18.10	74.0	29.68	Peak	295.00	300	Horizontal	Pass
1**	1043.900	40.09	-18.10	54.0	13.91	AV	295.00	300	Horizontal	Pass
2	2401.800	96.65	-10.63	74.0	-22.65	Peak	306.00	150	Horizontal	N/A
2**	2401.800	95.92	-10.63	54.0	-41.92	AV	306.00	150	Horizontal	N/A
3	4804.250	49.33	-3.21	74.0	24.67	Peak	148.00	150	Horizontal	Pass
3**	4804.250	45.80	-3.21	54.0	8.20	AV	148.00	150	Horizontal	Pass
4	7206.000	54.74	0.19	74.0	19.26	Peak	0.00	150	Horizontal	Pass
4**	7206.000	49.56	0.19	54.0	4.44	AV	0.00	150	Horizontal	Pass
5	11703.338	52.82	-0.50	74.0	21.18	Peak	246.00	200	Horizontal	Pass
5**	11703.338	42.86	-0.50	54.0	11.14	AV	246.00	200	Horizontal	Pass
6	17465.813	55.02	5.27	74.0	18.98	Peak	60.00	400	Horizontal	Pass
6**	17465.813	46.08	5.27	54.0	7.92	AV	60.00	400	Horizontal	Pass



GFSK LOW CHANNEL 1 GHz to 18 GHz, ANT V

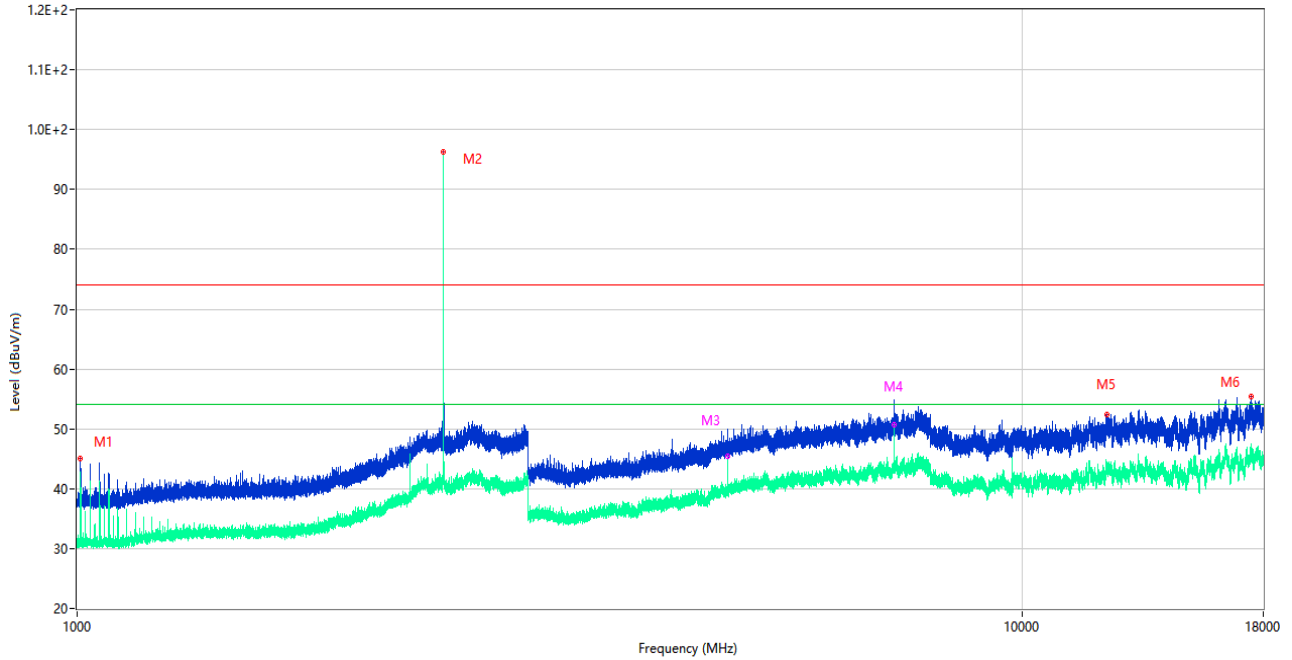
RE Test case\_FCC Part 15C\_FCC 15.247(2.4G)\_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1330.200	48.11	-17.03	74.0	25.89	Peak	267.00	200	Vertical	Pass
1**	1330.200	33.98	-17.03	54.0	20.02	AV	267.00	200	Vertical	Pass
2	2402.100	89.36	-10.60	74.0	-15.36	Peak	165.00	100	Vertical	N/A
2**	2402.100	89.12	-10.60	54.0	-35.12	AV	165.00	100	Vertical	N/A
3	4934.750	49.24	-3.66	74.0	24.76	Peak	360.00	200	Vertical	Pass
3**	4934.750	39.62	-3.66	54.0	14.38	AV	360.00	200	Vertical	Pass
4	7206.250	52.38	0.01	74.0	21.62	Peak	45.00	150	Vertical	Pass
4**	7206.250	47.50	0.01	54.0	6.50	AV	45.00	150	Vertical	Pass
5	11783.850	52.66	-0.16	74.0	21.34	Peak	353.00	400	Vertical	Pass
5**	11783.850	43.53	-0.16	54.0	10.47	AV	353.00	400	Vertical	Pass
6	16425.262	55.56	2.83	74.0	18.44	Peak	295.00	400	Vertical	Pass
6**	16425.262	47.04	2.83	54.0	6.96	AV	295.00	400	Vertical	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H

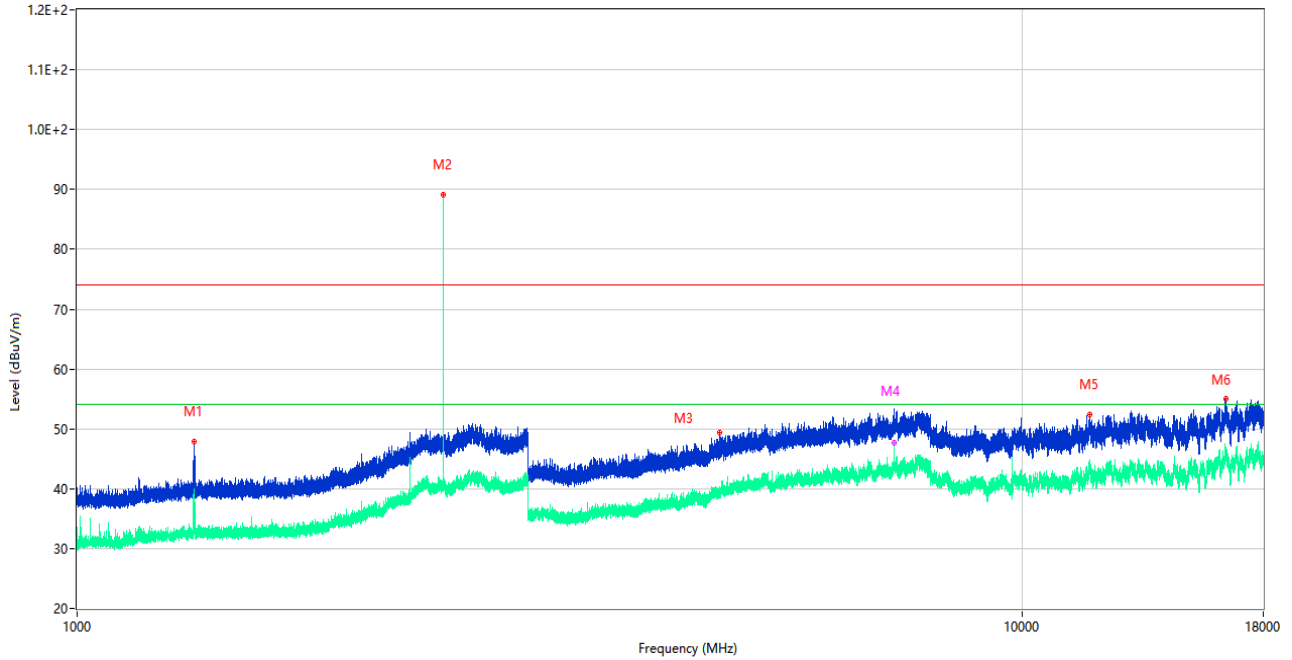
RE Test case\_FCC Part 15C\_FCC 15.247(2.4G)\_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1008.000	45.07	-18.15	74.0	28.93	Peak	64.00	300	Horizontal	Pass
1**	1008.000	42.08	-18.15	54.0	11.92	AV	64.00	300	Horizontal	Pass
2	2440.900	96.19	-9.79	74.0	-22.19	Peak	293.00	150	Horizontal	N/A
2**	2440.900	95.48	-9.79	54.0	-41.48	AV	293.00	150	Horizontal	N/A
3	4882.250	49.82	-3.72	74.0	24.18	Peak	145.00	150	Horizontal	Pass
3**	4882.250	45.52	-3.72	54.0	8.48	AV	145.00	150	Horizontal	Pass
4	7323.250	54.14	0.18	74.0	19.86	Peak	16.00	150	Horizontal	Pass
4**	7323.250	50.66	0.18	54.0	3.34	AV	16.00	150	Horizontal	Pass
5	12293.526	52.44	0.63	74.0	21.56	Peak	26.00	200	Horizontal	Pass
5**	12293.526	42.58	0.63	54.0	11.42	AV	26.00	200	Horizontal	Pass
6	17485.763	55.34	4.90	74.0	18.66	Peak	211.00	400	Horizontal	Pass
6**	17485.763	45.35	4.90	54.0	8.65	AV	211.00	400	Horizontal	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V

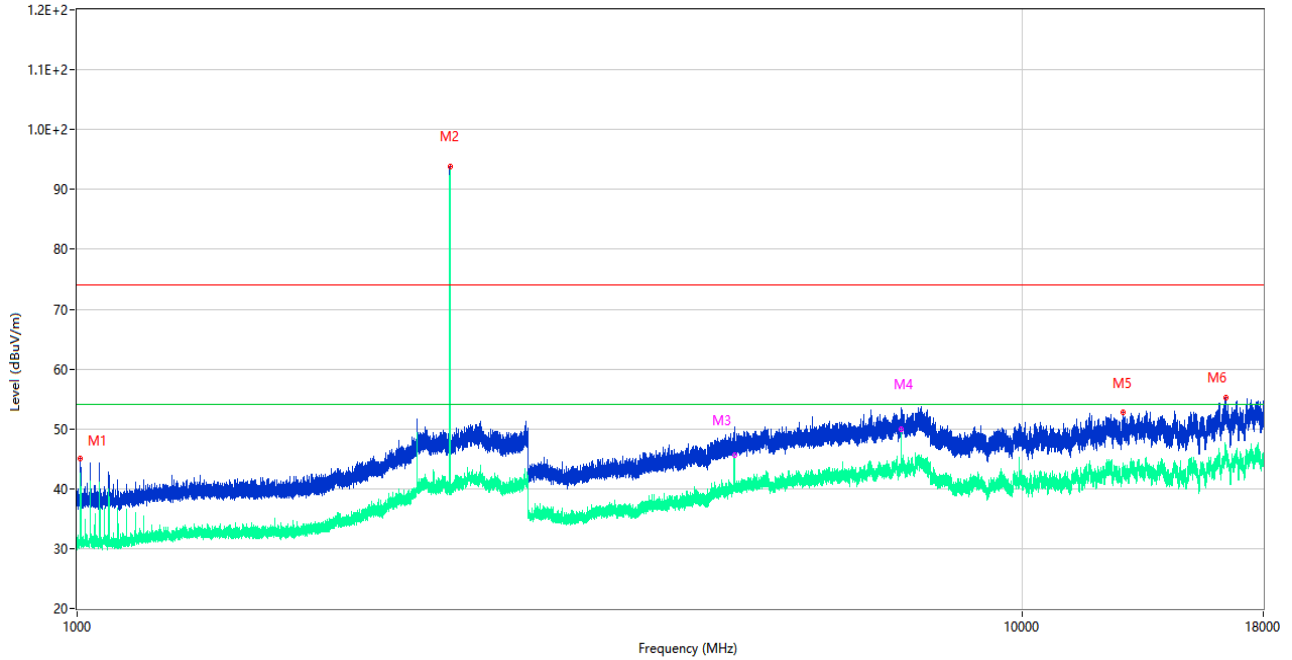
RE Test case\_FCC Part 15C\_FCC 15.247(2.4G)\_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1328.900	47.92	-16.94	74.0	26.08	Peak	237.00	400	Vertical	Pass
1**	1328.900	37.92	-16.94	54.0	16.08	AV	237.00	400	Vertical	Pass
2	2441.200	89.15	-9.79	74.0	-15.15	Peak	154.00	100	Vertical	N/A
2**	2441.200	88.82	-9.79	54.0	-34.82	AV	154.00	100	Vertical	N/A
3	4790.750	49.44	-3.72	74.0	24.56	Peak	168.00	150	Vertical	Pass
3**	4790.750	39.73	-3.72	54.0	14.27	AV	168.00	150	Vertical	Pass
4	7323.250	52.34	0.18	74.0	21.66	Peak	17.00	0	Vertical	Pass
4**	7323.250	47.66	0.18	54.0	6.34	AV	17.00	0	Vertical	Pass
5	11783.850	52.42	-0.16	74.0	21.58	Peak	199.00	400	Vertical	Pass
5**	11783.850	43.55	-0.16	54.0	10.45	AV	199.00	400	Vertical	Pass
6	16431.563	55.03	2.74	74.0	18.97	Peak	95.00	200	Vertical	Pass
6**	16431.563	45.22	2.74	54.0	8.78	AV	95.00	200	Vertical	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT H

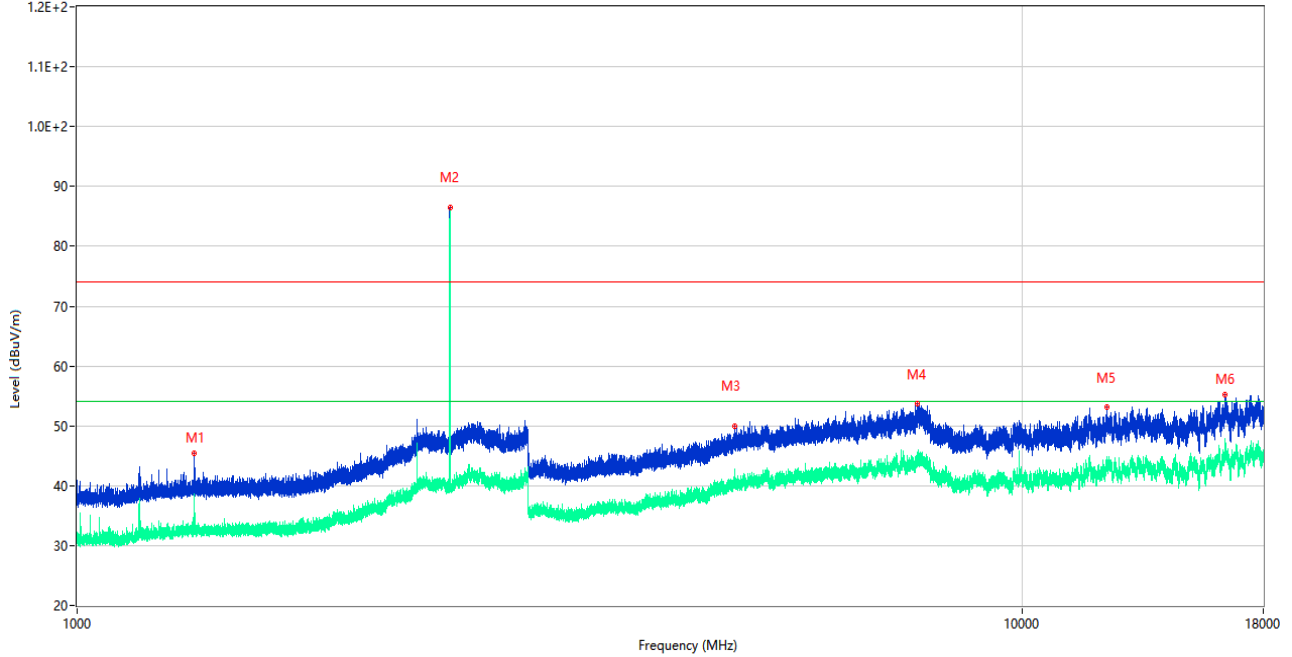
RE Test case\_FCC Part 15C\_FCC 15.247(2.4G)\_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1008.200	45.10	-18.04	74.0	28.90	Peak	51.00	300	Horizontal	Pass
1**	1008.200	42.52	-18.04	54.0	11.48	AV	51.00	300	Horizontal	Pass
2	2480.100	93.89	-11.10	74.0	-19.89	Peak	293.00	200	Horizontal	N/A
2**	2480.100	93.67	-11.10	54.0	-39.67	AV	293.00	200	Horizontal	N/A
3	4960.250	50.41	-3.64	74.0	23.59	Peak	162.00	150	Horizontal	Pass
3**	4960.250	45.56	-3.64	54.0	8.44	AV	162.00	150	Horizontal	Pass
4	7440.500	53.33	0.62	74.0	20.67	Peak	16.00	150	Horizontal	Pass
4**	7440.500	49.87	0.62	54.0	4.13	AV	16.00	150	Horizontal	Pass
5	12794.625	52.68	0.96	74.0	21.32	Peak	162.00	300	Horizontal	Pass
5**	12794.625	43.20	0.96	54.0	10.80	AV	162.00	300	Horizontal	Pass
6	16426.574	55.30	2.81	74.0	18.70	Peak	223.00	200	Horizontal	Pass
6**	16426.574	46.40	2.81	54.0	7.60	AV	223.00	200	Horizontal	Pass

GFSK HIGH CHANNEL 1 GHz to 18 GHz, ANT V

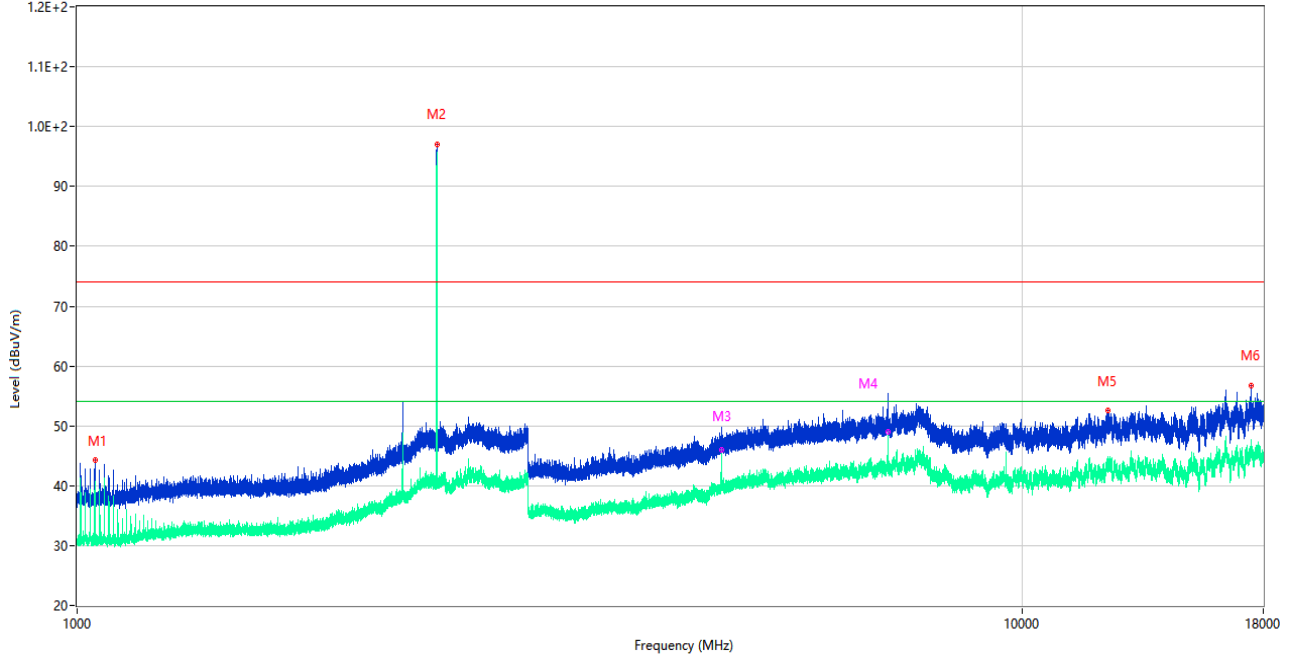
RE Test case\_FCC Part 15C\_FCC 15.247(2.4G)\_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1329.800	45.42	-16.84	74.0	28.58	Peak	251.00	400	Vertical	Pass
1**	1329.800	36.04	-16.84	54.0	17.96	AV	251.00	400	Vertical	Pass
2	2479.900	86.48	-11.13	74.0	-12.48	Peak	149.00	200	Vertical	N/A
2**	2479.900	85.80	-11.13	54.0	-31.80	AV	149.00	200	Vertical	N/A
3	4960.250	49.90	-3.64	74.0	24.10	Peak	235.00	150	Vertical	Pass
3**	4960.250	42.36	-3.64	54.0	11.64	AV	235.00	150	Vertical	Pass
4	7754.500	53.66	1.18	74.0	20.34	Peak	128.00	300	Vertical	Pass
4**	7754.500	44.55	1.18	54.0	9.45	AV	128.00	300	Vertical	Pass
5	12295.663	53.13	0.60	74.0	20.87	Peak	17.00	400	Vertical	Pass
5**	12295.663	43.21	0.60	54.0	10.79	AV	17.00	400	Vertical	Pass
6	16405.575	55.23	3.09	74.0	18.77	Peak	35.00	200	Vertical	Pass
6**	16405.575	46.98	3.09	54.0	7.02	AV	35.00	200	Vertical	Pass

$\pi/4$ -DQPSK LOW CHANNEL 1 GHz to 18 GHz, ANT H

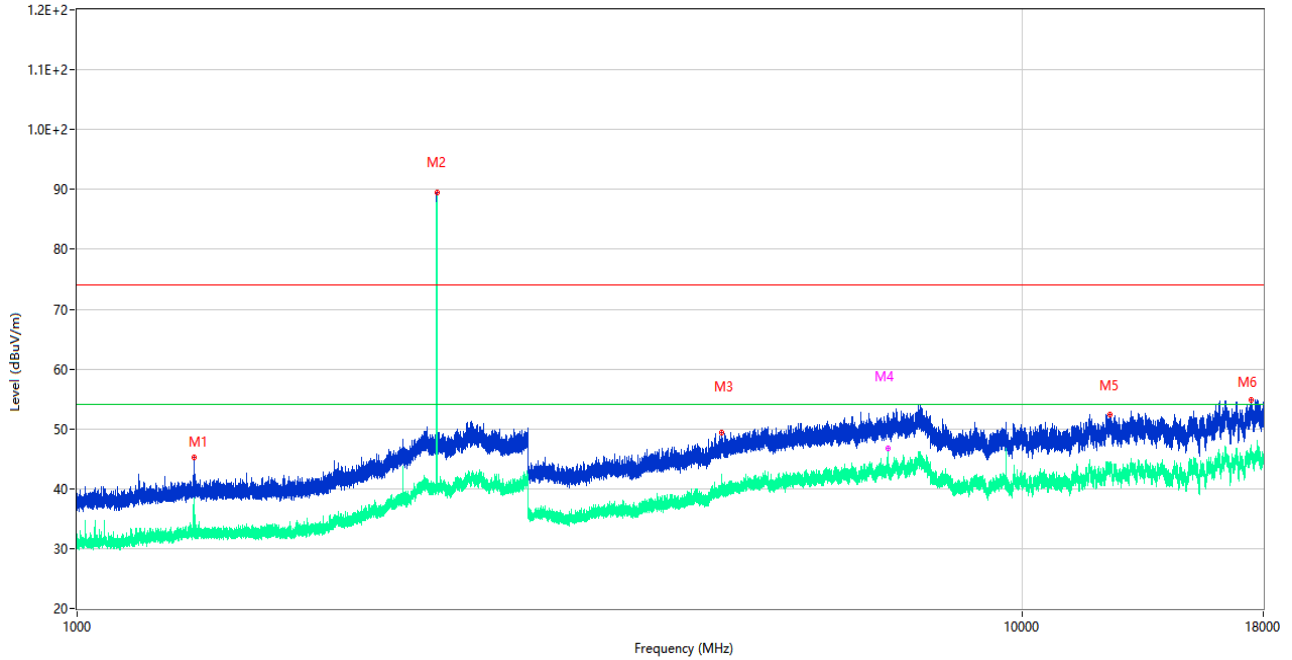
RE Test case\_FCC Part 15C\_FCC 15.247(2.4G)\_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1044.100	44.23	-18.19	74.0	29.77	Peak	304.00	100	Horizontal	Pass
1**	1044.100	40.40	-18.19	54.0	13.60	AV	304.00	100	Horizontal	Pass
2	2402.000	97.10	-10.61	74.0	-23.10	Peak	304.00	200	Horizontal	N/A
2**	2402.000	94.22	-10.61	54.0	-40.22	AV	304.00	200	Horizontal	N/A
3	4804.000	49.78	-3.32	74.0	24.22	Peak	149.00	150	Horizontal	Pass
3**	4804.000	46.05	-3.32	54.0	7.95	AV	149.00	150	Horizontal	Pass
4	7206.250	53.88	0.01	74.0	20.12	Peak	20.00	150	Horizontal	Pass
4**	7206.250	48.95	0.01	54.0	5.05	AV	20.00	150	Horizontal	Pass
5	12341.262	52.51	0.80	74.0	21.49	Peak	77.00	300	Horizontal	Pass
5**	12341.262	43.20	0.80	54.0	10.80	AV	77.00	300	Horizontal	Pass
6	17484.712	56.76	4.92	74.0	17.24	Peak	207.00	200	Horizontal	Pass
6**	17484.712	45.97	4.92	54.0	8.03	AV	207.00	200	Horizontal	Pass

$\pi/4$ -DQPSK LOW CHANNEL 1 GHz to 18 GHz, ANT V

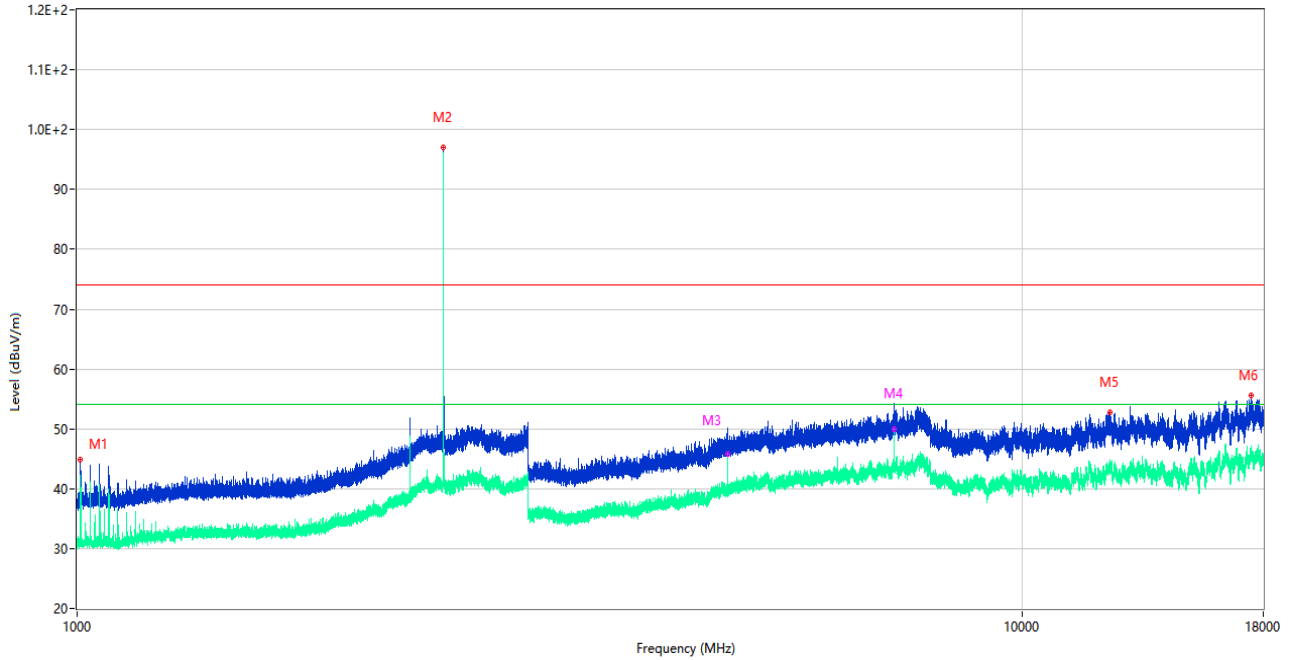
RE Test case\_FCC Part 15C\_FCC 15.247(2.4G)\_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1329.300	45.29	-16.91	74.0	28.71	Peak	132.00	100	Vertical	Pass
1**	1329.300	38.17	-16.91	54.0	15.83	AV	132.00	100	Vertical	Pass
2	2401.900	89.53	-10.62	74.0	-15.53	Peak	157.00	100	Vertical	N/A
2**	2401.900	88.75	-10.62	54.0	-34.75	AV	157.00	100	Vertical	N/A
3	4804.500	49.43	-3.20	74.0	24.57	Peak	200.00	100	Vertical	Pass
3**	4804.500	41.65	-3.20	54.0	12.35	AV	200.00	100	Vertical	Pass
4	7206.500	51.59	-0.05	74.0	22.41	Peak	322.00	0	Vertical	Pass
4**	7206.500	46.83	-0.05	54.0	7.17	AV	322.00	0	Vertical	Pass
5	12394.463	52.35	1.08	74.0	21.65	Peak	70.00	100	Vertical	Pass
5**	12394.463	43.17	1.08	54.0	10.83	AV	70.00	100	Vertical	Pass
6	17467.386	54.85	5.24	74.0	19.15	Peak	87.00	400	Vertical	Pass
6**	17467.386	46.23	5.24	54.0	7.77	AV	87.00	400	Vertical	Pass

$\pi/4$ -DQPSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H

RE Test case\_FCC Part 15C\_FCC 15.247(2.4G)\_1GHz-18GHz

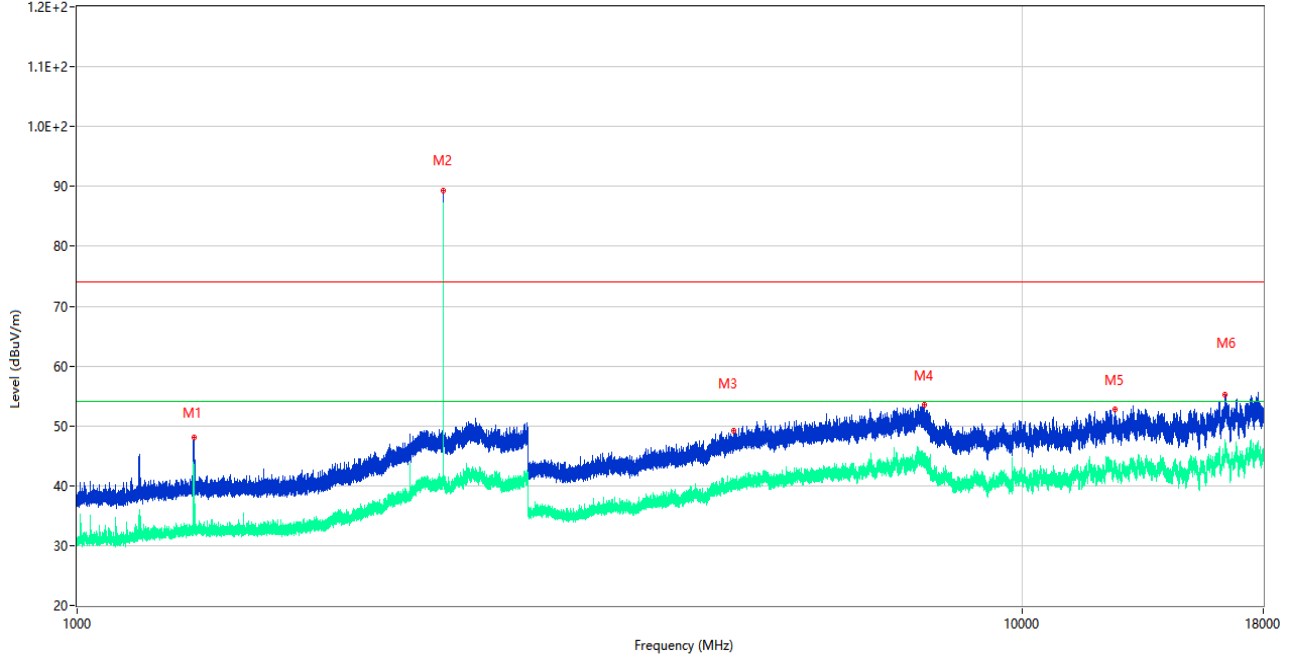


No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1008.100	44.92	-18.10	74.0	29.08	Peak	51.00	100	Horizontal	Pass
1**	1008.100	42.12	-18.10	54.0	11.88	AV	51.00	100	Horizontal	Pass
2	2440.900	97.08	-9.79	74.0	-23.08	Peak	290.00	100	Horizontal	N/A
2**	2440.900	94.85	-9.79	54.0	-40.85	AV	290.00	100	Horizontal	N/A
3	4882.500	48.12	-3.69	74.0	25.88	Peak	182.00	150	Horizontal	Pass
3**	4882.500	45.86	-3.69	54.0	8.14	AV	182.00	150	Horizontal	Pass
4	7323.250	53.82	0.18	74.0	20.18	Peak	16.00	150	Horizontal	Pass
4**	7323.250	49.94	0.18	54.0	4.06	AV	16.00	150	Horizontal	Pass
5	12397.312	52.78	1.09	74.0	21.22	Peak	360.00	400	Horizontal	Pass
5**	12397.312	43.01	1.09	54.0	10.99	AV	360.00	400	Horizontal	Pass
6	17460.038	55.51	5.38	74.0	18.49	Peak	189.00	200	Horizontal	Pass
6**	17460.038	45.42	5.38	54.0	8.58	AV	189.00	200	Horizontal	Pass



$\pi/4$ -DQPSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V

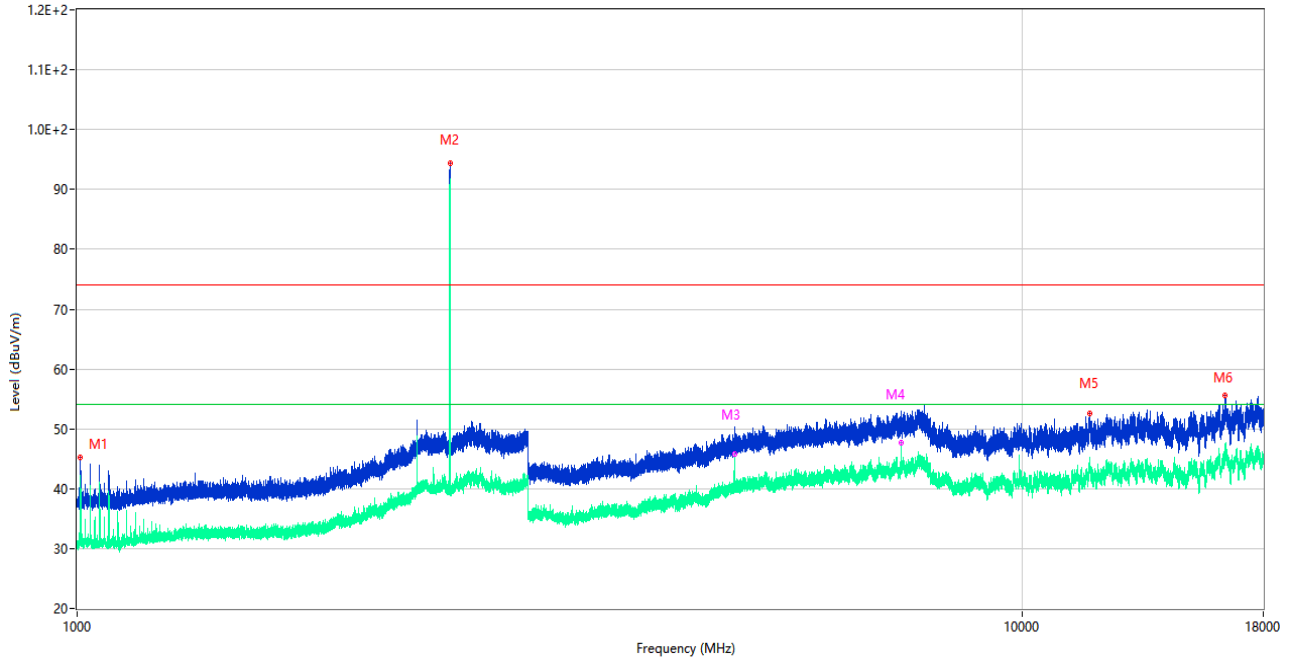
RE Test case\_FCC Part 15C\_FCC 15.247(2.4G)\_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1328.400	48.08	-17.09	74.0	25.92	Peak	234.00	300	Vertical	Pass
1**	1328.400	34.27	-17.09	54.0	19.73	AV	234.00	300	Vertical	Pass
2	2441.200	89.30	-9.79	74.0	-15.30	Peak	158.00	100	Vertical	N/A
2**	2441.200	86.77	-9.79	54.0	-32.77	AV	158.00	100	Vertical	N/A
3	4952.000	49.26	-3.59	74.0	24.74	Peak	245.00	150	Vertical	Pass
3**	4952.000	40.05	-3.59	54.0	13.95	AV	245.00	150	Vertical	Pass
4	7872.500	53.49	1.62	74.0	20.51	Peak	245.00	200	Vertical	Pass
4**	7872.500	43.71	1.62	54.0	10.29	AV	245.00	200	Vertical	Pass
5	12528.175	52.70	1.28	74.0	21.30	Peak	49.00	200	Vertical	Pass
5**	12528.175	42.64	1.28	54.0	11.36	AV	49.00	200	Vertical	Pass
6	16406.625	55.17	3.08	74.0	18.83	Peak	284.00	400	Vertical	Pass
6**	16406.625	46.00	3.08	54.0	8.00	AV	284.00	400	Vertical	Pass

$\pi/4$ -DQPSK HIGH CHANNEL 1 GHz to 18 GHz, ANT H

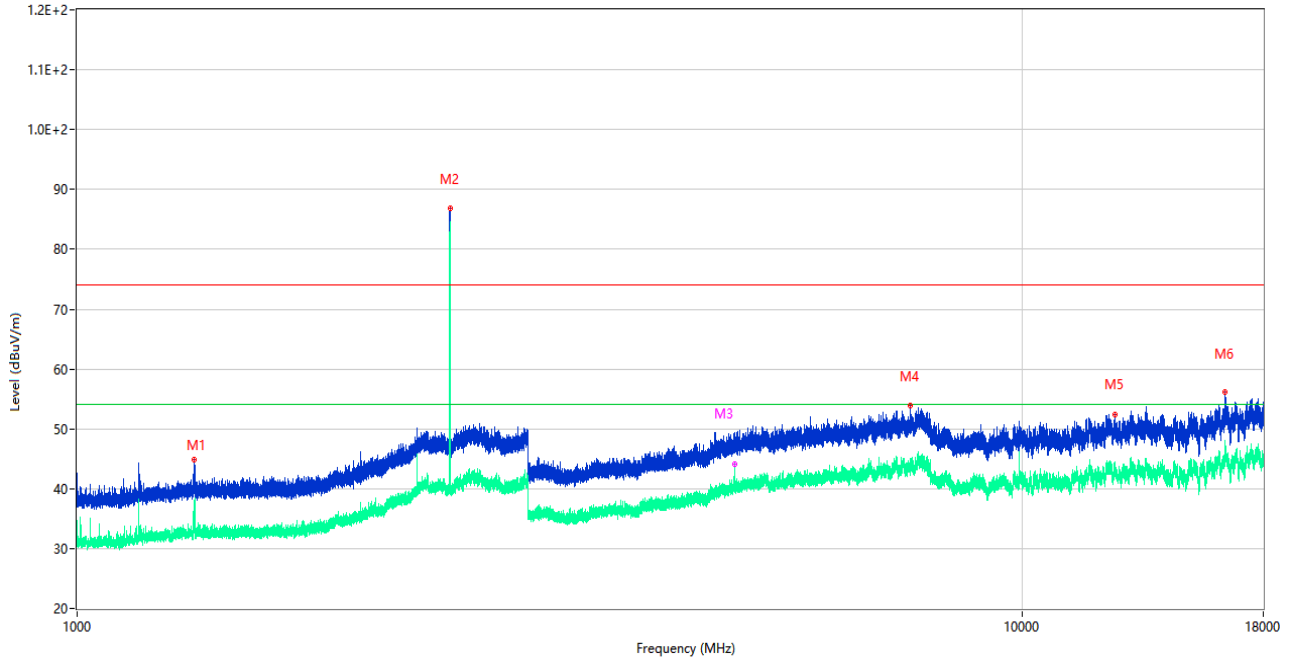
RE Test case\_FCC Part 15C\_FCC 15.247(2.4G)\_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1008.100	45.23	-18.10	74.0	28.77	Peak	66.00	300	Horizontal	Pass
1**	1008.100	42.07	-18.10	54.0	11.93	AV	66.00	300	Horizontal	Pass
2	2480.100	94.33	-11.10	74.0	-20.33	Peak	290.00	100	Horizontal	N/A
2**	2480.100	91.75	-11.10	54.0	-37.75	AV	290.00	100	Horizontal	N/A
3	4960.250	49.04	-3.64	74.0	24.96	Peak	172.00	150	Horizontal	Pass
3**	4960.250	45.78	-3.64	54.0	8.22	AV	172.00	150	Horizontal	Pass
4	7440.000	52.93	0.56	74.0	21.07	Peak	23.00	150	Horizontal	Pass
4**	7440.000	47.75	0.56	54.0	6.25	AV	23.00	150	Horizontal	Pass
5	11781.713	52.61	-0.16	74.0	21.39	Peak	199.00	300	Horizontal	Pass
5**	11781.713	44.75	-0.16	54.0	9.25	AV	199.00	300	Horizontal	Pass
6	16411.350	55.59	3.02	74.0	18.41	Peak	113.00	200	Horizontal	Pass
6**	16411.350	45.85	3.02	54.0	8.15	AV	113.00	200	Horizontal	Pass

$\pi/4$ -DQPSK HIGH CHANNEL 1 GHz to 18 GHz, ANT V

RE Test case\_FCC Part 15C\_FCC 15.247(2.4G)\_1GHz-18GHz



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1330.600	44.92	-17.12	74.0	29.08	Peak	251.00	300	Vertical	Pass
1**	1330.600	37.67	-17.12	54.0	16.33	AV	251.00	300	Vertical	Pass
2	2480.100	86.78	-11.10	74.0	-12.78	Peak	154.00	100	Vertical	N/A
2**	2480.100	84.59	-11.10	54.0	-30.59	AV	154.00	100	Vertical	N/A
3	4960.500	47.98	-3.57	74.0	26.02	Peak	0.00	150	Vertical	Pass
3**	4960.500	44.04	-3.57	54.0	9.96	AV	0.00	150	Vertical	Pass
4	7624.000	53.84	0.38	74.0	20.16	Peak	82.00	100	Vertical	Pass
4**	7624.000	43.60	0.38	54.0	10.40	AV	82.00	100	Vertical	Pass
5	12535.300	52.44	1.23	74.0	21.56	Peak	0.00	100	Vertical	Pass
5**	12535.300	42.81	1.23	54.0	11.19	AV	0.00	100	Vertical	Pass
6	16407.412	56.17	3.07	74.0	17.83	Peak	55.00	200	Vertical	Pass
6**	16407.412	46.47	3.07	54.0	7.53	AV	55.00	200	Vertical	Pass

## 5.11 Band Edge (Restricted-band band-edge)

### 5.11.1 Limit

FCC §15.209&15.247(d)

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

### 5.11.2 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 A.

### 5.11.3 Test Procedure

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

The power of the EUT transmitting frequency should be ignored.

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

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for  $f \geq 1$  GHz, 100 kHz for  $f < 1$  GHz

VBW  $\geq$  RBW

Sweep = auto

Detector function = peak

Trace = max hold

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

### 5.11.4 Test Result

Note <sup>1</sup>: The lowest and highest channels are tested to verify the band edge emissions. Please refer to the following the plots for emissions values.

Note <sup>2</sup>: 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 <sup>3</sup>: 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 <sup>4</sup>: The Level (dBuV/m) has been corrected by factor.

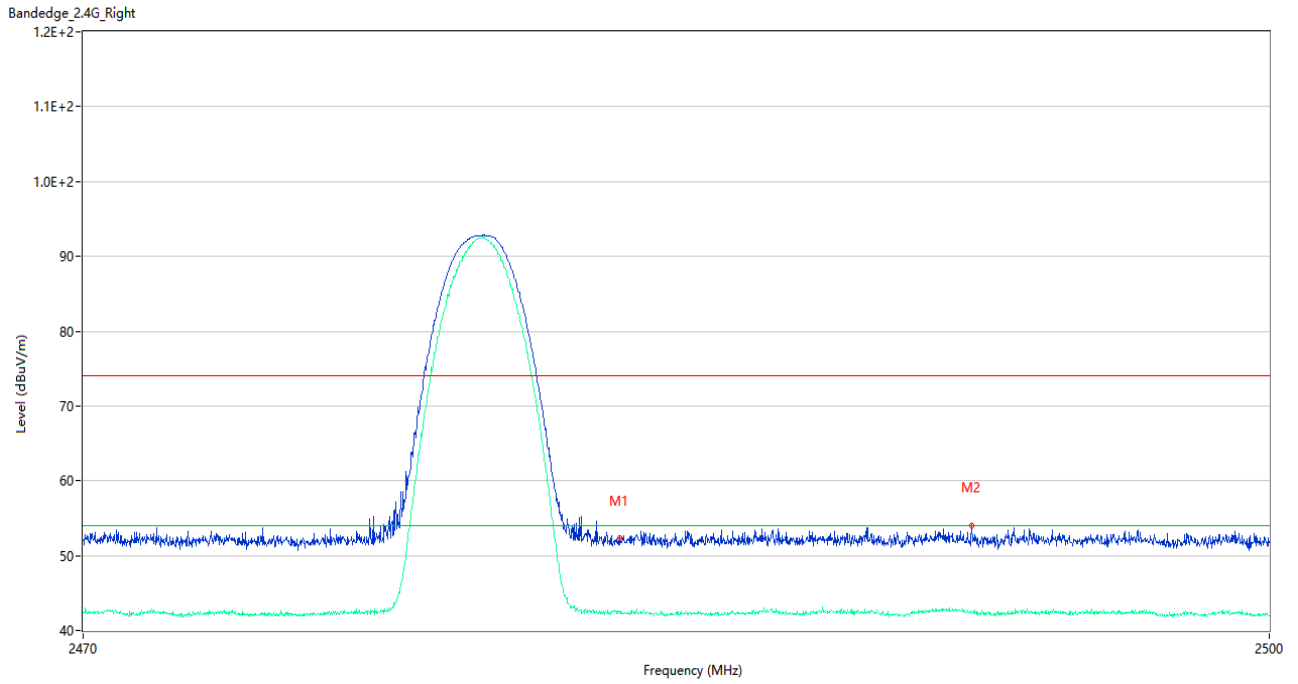
#### Test Data and Plots

##### GFSK LOW CHANNEL



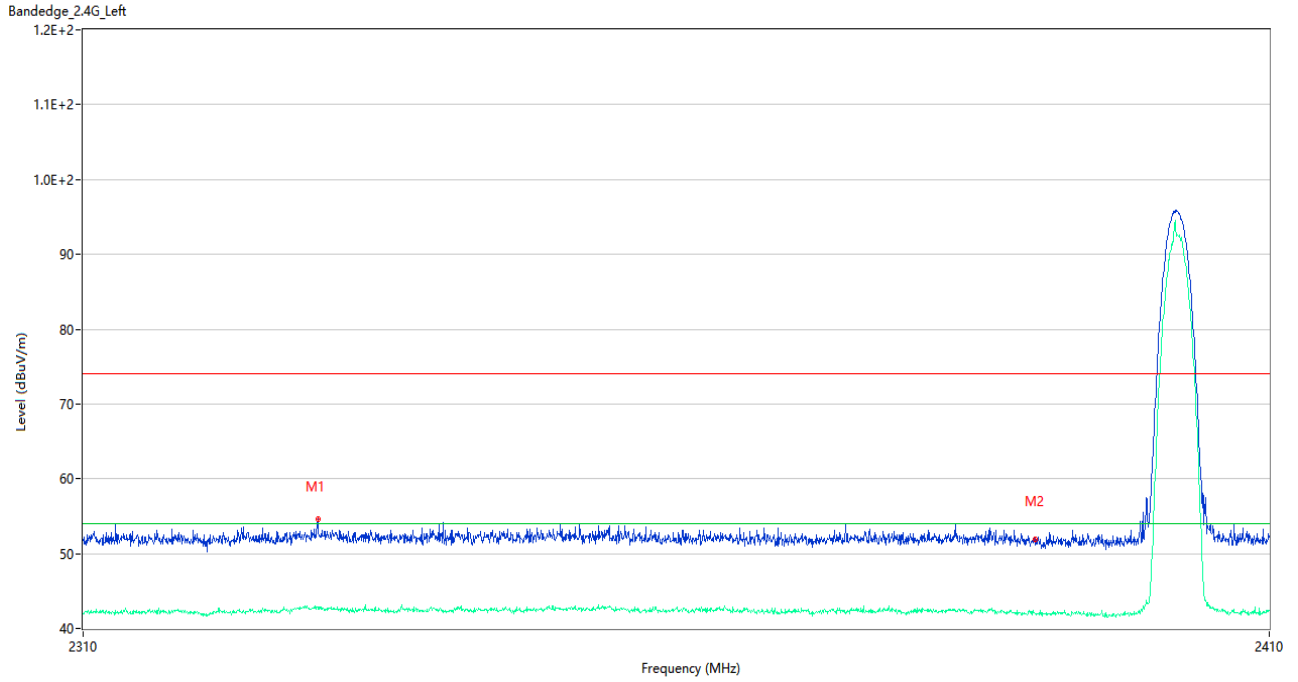
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2338.550	54.10	-1.00	74.0	19.90	Peak	236.00	100	Horizontal	Pass
1**	2338.550	42.27	-1.00	54.0	11.73	AV	236.00	100	Horizontal	Pass
2	2389.950	52.13	-1.82	74.0	21.87	Peak	106.00	200	Horizontal	Pass
2**	2389.950	41.87	-1.82	54.0	12.13	AV	106.00	200	Horizontal	Pass

**GFSK HIGH CHANNEL**



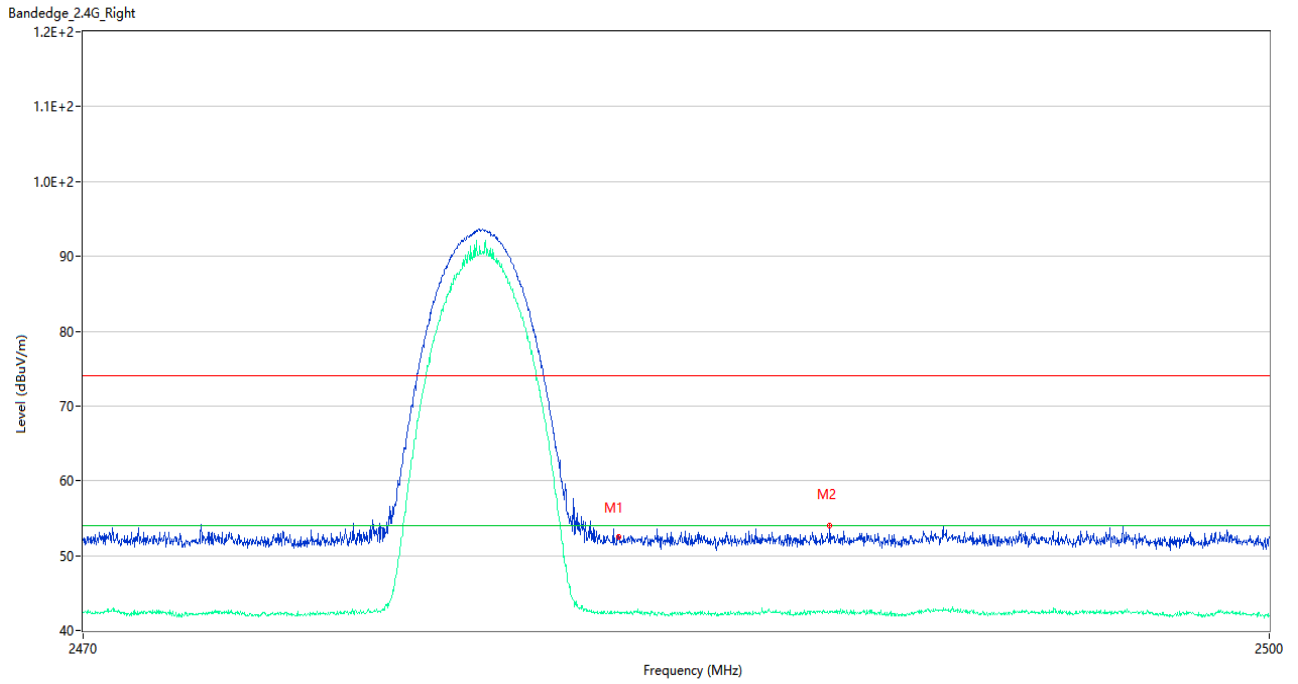
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2483.515	52.33	-1.10	74.0	21.67	Peak	288.00	150	Horizontal	Pass
1**	2483.515	42.54	-1.10	54.0	11.46	AV	288.00	150	Horizontal	Pass
2	2492.440	54.08	-0.92	74.0	19.92	Peak	251.00	100	Horizontal	Pass
2**	2492.440	42.55	-0.92	54.0	11.45	AV	251.00	100	Horizontal	Pass

**π/4-DQPSK LOW CHANNEL**



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2329.450	54.61	-0.75	74.0	19.39	Peak	208.00	100	Horizontal	Pass
1**	2329.450	42.84	-0.75	54.0	11.16	AV	208.00	100	Horizontal	Pass
2	2389.950	51.97	-1.82	74.0	22.03	Peak	276.00	200	Horizontal	Pass
2**	2389.950	41.92	-1.82	54.0	12.08	AV	276.00	200	Horizontal	Pass

**π/4-DQPSK HIGH CHANNEL**



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2483.500	52.47	-1.10	74.0	21.53	Peak	0.00	200	Horizontal	Pass
1**	2483.500	42.46	-1.10	54.0	11.54	AV	0.00	200	Horizontal	Pass
2	2488.840	54.06	-0.85	74.0	19.94	Peak	272.00	200	Horizontal	Pass
2**	2488.840	42.49	-0.85	54.0	11.51	AV	272.00	200	Horizontal	Pass



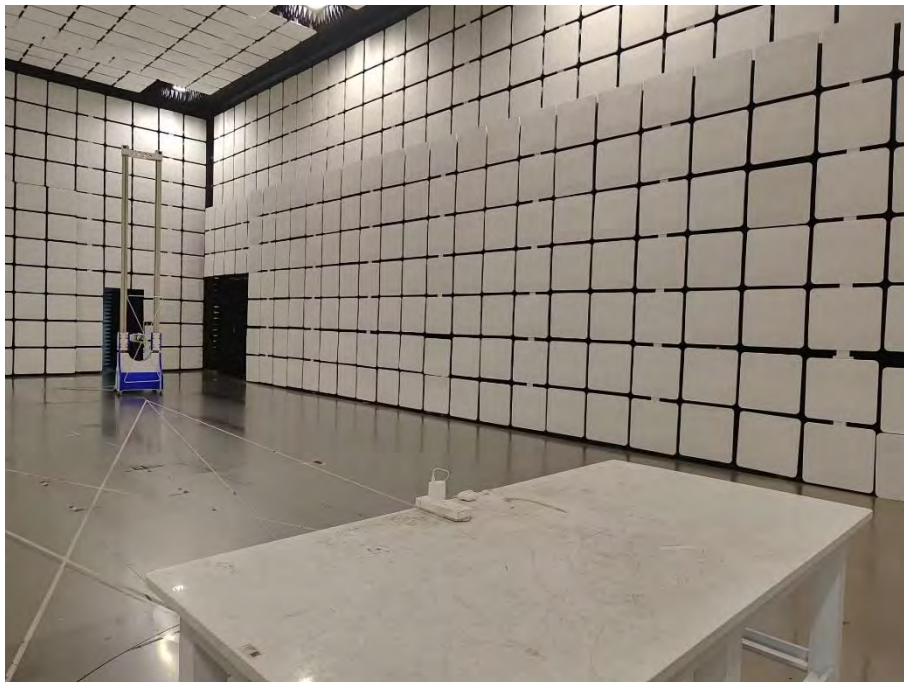
## ANNEX A TEST SETUP PHOTOS

### 1 Radiated Test Photo

Below 30MHz



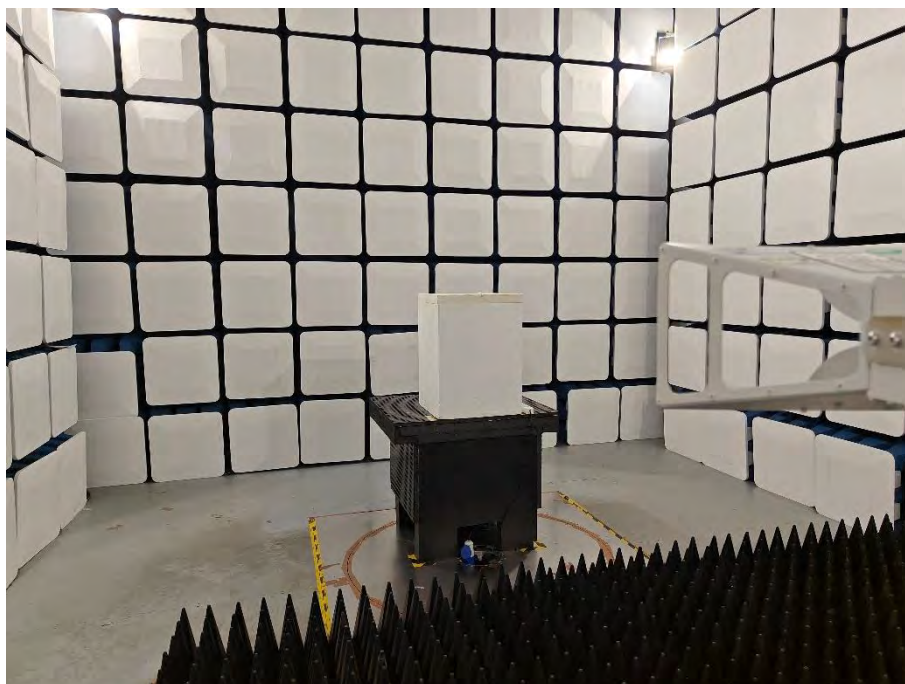
30MHz-1GHz



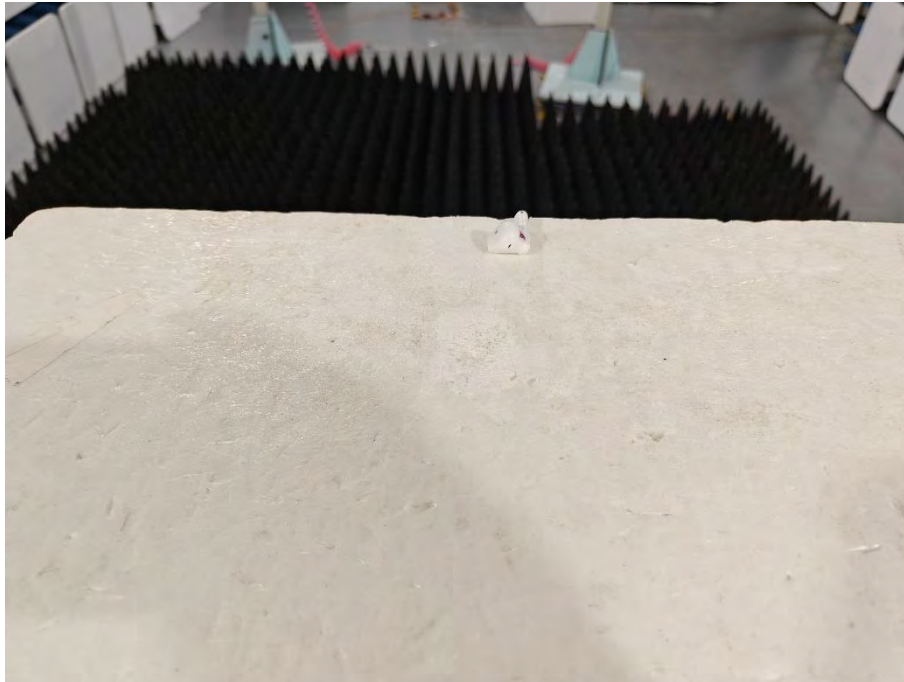
Close-up



Above 1GHz

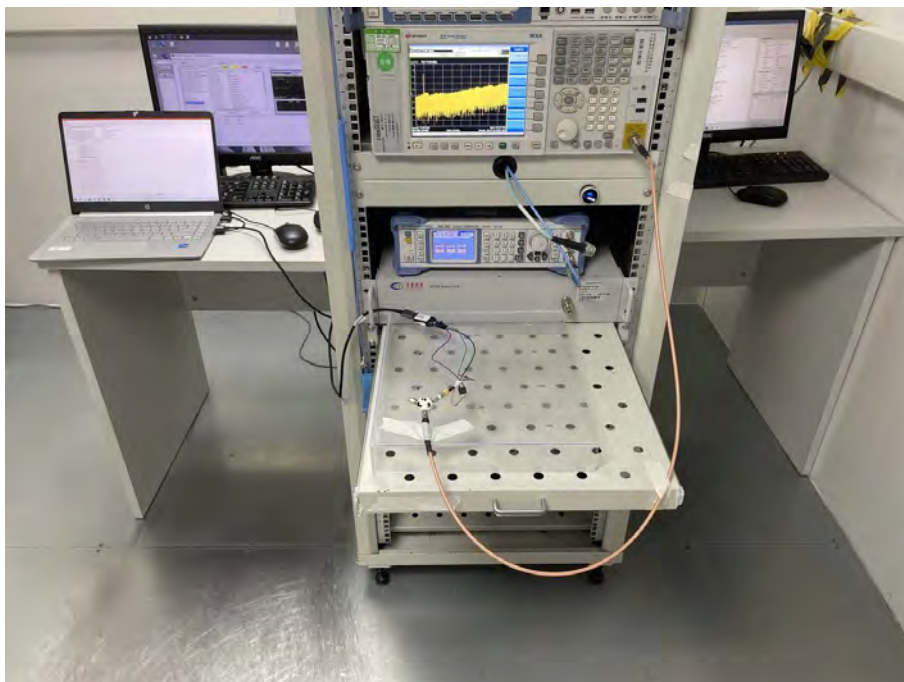


Close-up



## 2 Conducted Test Photo

Conducted Test



### 3 Conducted Emissions

Test Photo 1



Test Photo 2



## ANNEX B EUT EXTERNAL PHOTOS

FRONT VIEW OF EUT



REAR VIEW OF EUT



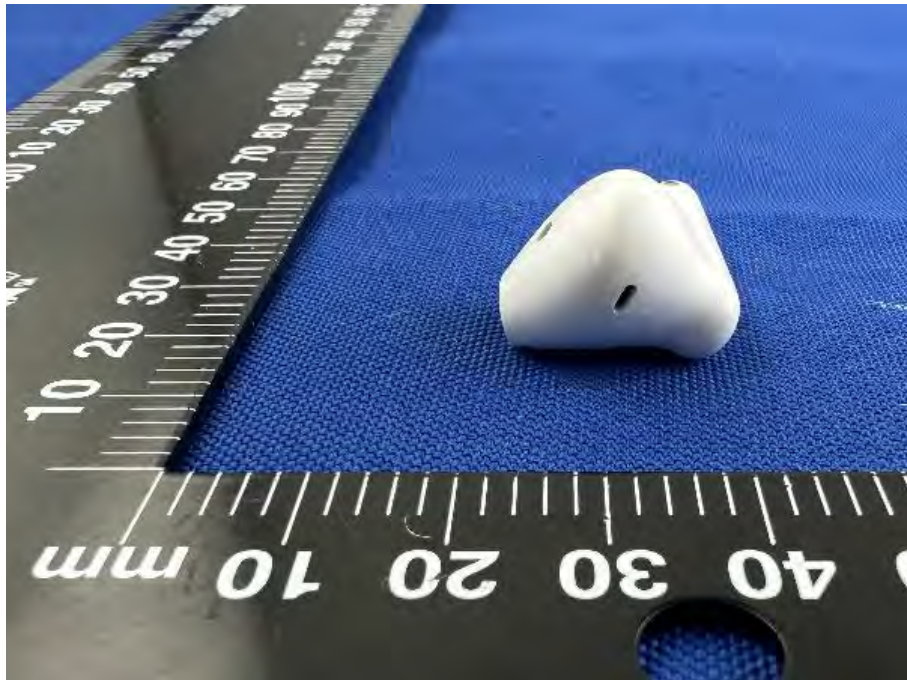
LEFT VIEW OF EUT



RIGHT VIEW OF EUT



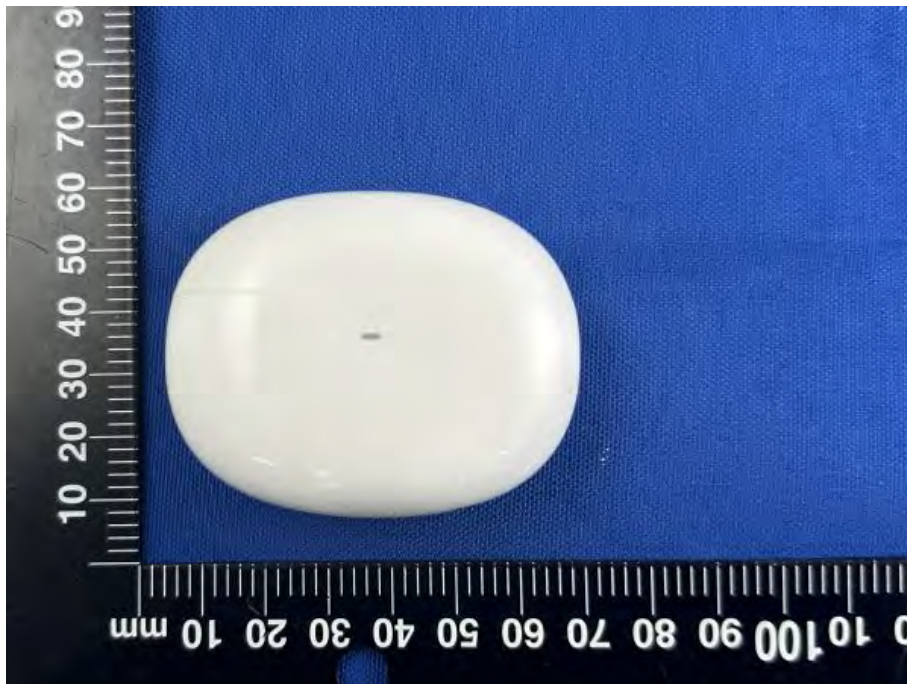
TOP VIEW OF EUT



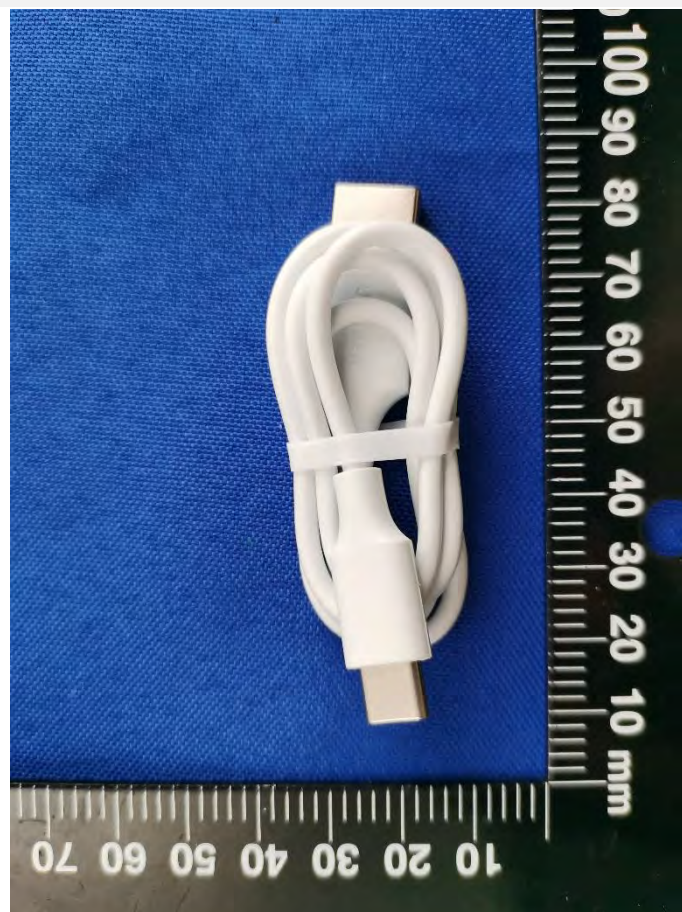
BOTTOM VIEW OF EUT



Accessory-Charging Case



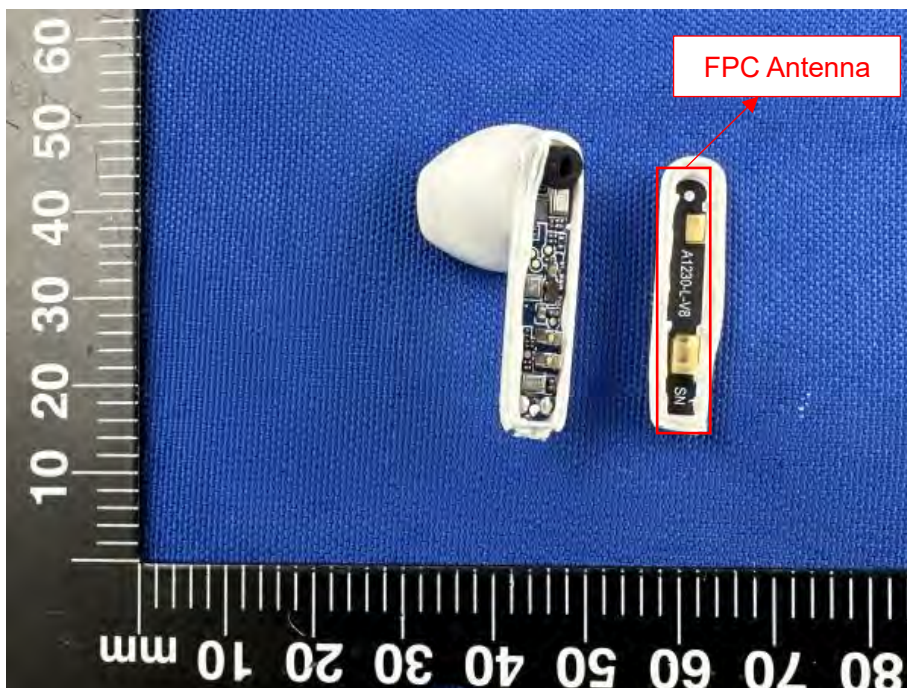
Accessory-Type-C Cable





## ANNEX C EUT INTERNAL PHOTOS

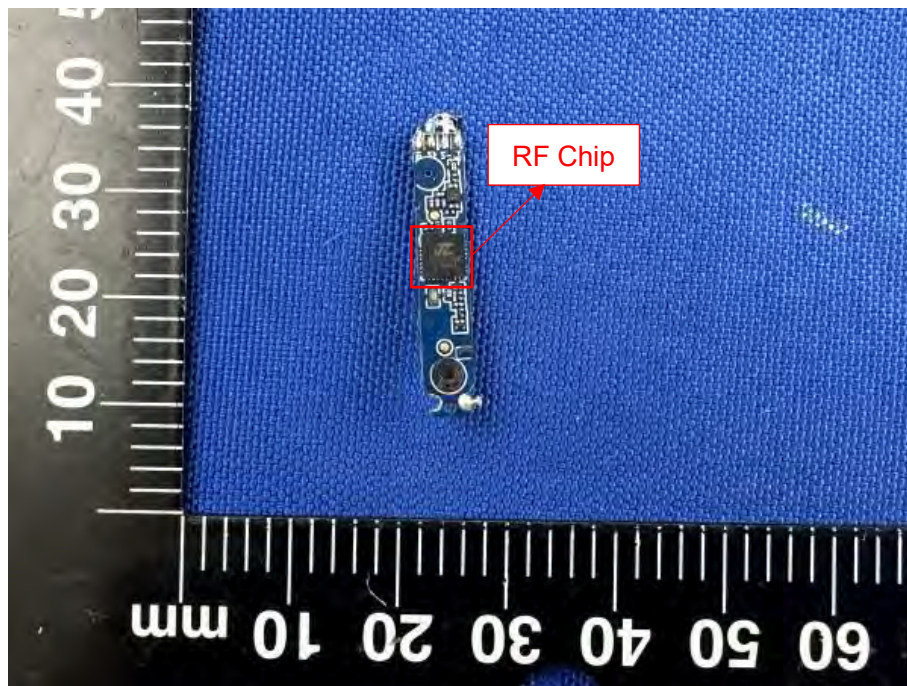
EUT UNCOVER VIEW 1



EUT UNCOVER VIEW 2



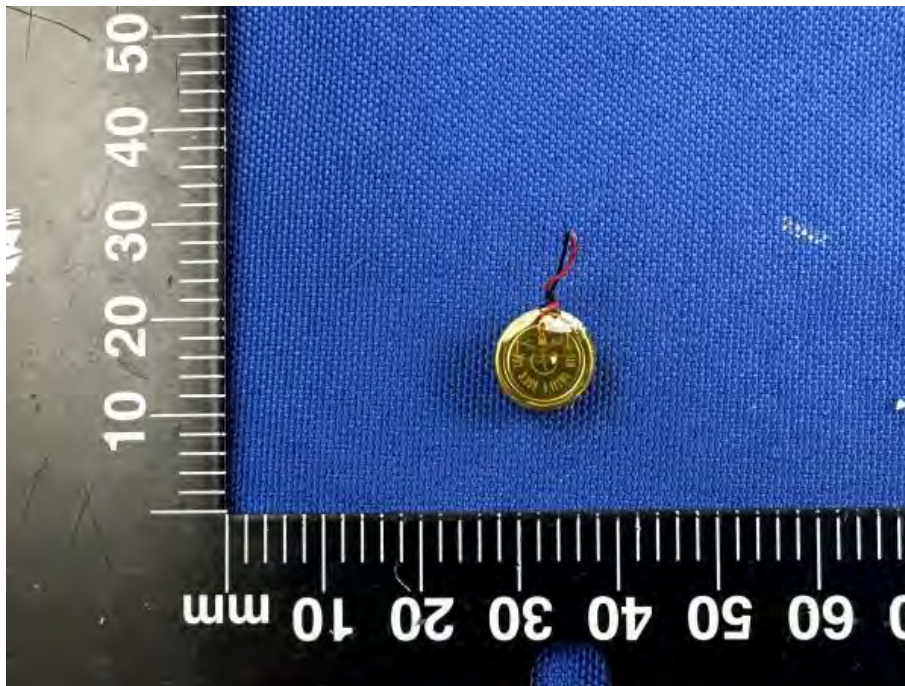
MAIN BOARD TOP VIEW



MAIN BOARD REAR VIEW



BATTERY



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--END OF REPORT--