ACCREDITED
CERT# 6677.01

TEST REPORT

Applicant:	Liberty Pumps Inc.
Address:	7000 Apple Tree Avenue Bergen, NY 14416 United States
Equipment Type:	NightEye ALM-Cellular
Model Name:	3750000
Brand Name:	Liberty Pumps
FCC ID:	2BQZ2-CELLNE
ISED Number:	34351-CELLNE
Test Standard:	47 CFR Part 15 Subpart C RSS-Gen Issue 5 RSS-247 Issue 3 (refer to section 3.1)
Sample Arrival Date:	Aug. 05, 2025
Test Date:	Aug. 05, 2025 - Aug. 18, 2025
Date of Issue:	Sep. 26, 2025

ISSUED BY:

Shanghai Tejet Communications Technology Co., Ltd. Testing Center

Prepared by: Zhang Rujie **Reviewed by:** Hai Su **Approved by:** Zhang Yanqing (Laboratory Manager)

Zhang Rujie Hai Su Zhang Yanqing

Revision History

Version	Issue Date	Revisions
Rev. 01	Sep. 26, 2025	Initial Issue

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1 GENERAL INFORMATION

1.1 Test Laboratory

Name	Shanghai Tejet Communications Technology Co., Ltd. Testing Center
Address	1-2/F., Building 1, No.222, Xuanlan Road, Xuanqiao, Pudong New District, Shanghai, China

1.2 Test Location

Name	Shanghai Tejet Communications Technology Co., Ltd. Testing Center
Location	1-2/F., Building 1, No.222, Xuanlan Road, Xuanqiao, Pudong New District, Shanghai, China
Accreditation Certificate	The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1352. The laboratory has been listed by Industry Canada to perform electromagnetic emission measurements. The recognition numbers of test site are 29671.

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	Liberty Pumps Inc.
Address	7000 Apple Tree Avenue Bergen, NY 14416 United States

2.2 Manufacturer Information

Manufacturer	Liberty Pumps Inc.
Address	7000 Apple Tree Avenue Bergen, NY 14416 United States

2.3 General Description for Equipment under Test (EUT)

EUT Name	NightEye ALM-Cellular
Model Name Under Test	3750000
Series Model Name	N/A
Description of Model name differentiation	N/A
Sample Number	SC-SH2580005-S04(conducted) SC-SH2580005-S02(radiated)
Hardware Version	v3.1
Software Version	1.0.0
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.4 Technical Information

Network and Wireless connectivity	LTE CATM 2/4/5/12/13/25/26/66/85 Bluetooth, 2.4G WIFI, GPS

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

Modulation Technology	FHSS
Modulation Type	GFSK, π/4-DQPSK, 8-DPSK
Transfer Rate	DH5: 1 Mbps 2DH5: 2 Mbps 3DH5: 3 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	PCB Antenna
Antenna Gain	3.40 dBi
Antenna Impedance	50Ω
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)
0	**2402**	21	2423	42	2444	63	2465
1	2403	22	2424	43	2445	64	2466
2	2404	23	2425	44	2446	65	2467
3	2405	24	2426	45	2447	66	2468
4	2406	25	2427	46	2448	67	2469
5	2407	26	2428	47	2449	68	2470
6	2408	27	2429	48	2450	69	2471
7	2409	28	2430	49	2451	70	2472
8	2410	29	2431	50	2452	71	2473
9	2411	30	2432	51	2453	72	2474
10	2412	31	2433	52	2454	73	2475
11	2413	32	2434	53	2455	74	2476
12	2414	33	2435	54	2456	75	2477
13	2415	34	2436	55	2457	76	2478
14	2416	35	2437	56	2458	77	2479
15	2417	36	2438	57	2459	**78**	**2480**
16	2418	37	2439	58	2460	-	-
17	2419	38	2440	59	2461	-	-
18	2420	**39**	**2441**	60	2462	-	-
19	2421	40	2442	61	2463	-	-
20	2422	41	2443	62	2464	-	-

3 SUMMARY OF TEST RESULTS

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 15 Subpart C	Intentional radiators of radio frequency equipment
2	RSS-Gen Issue 5	General Requirements for Compliance of Radio Apparatus
3	RSS-247 Issue 3	Digital Transmission Systems (DTSs), Frequency Hopping Systems(FHSs) and Licence-Exemp Local Area Network (LE-LAN) Devices
4	ANSI C63.10-2020	American National Standard for Testing Unlicensed Wireless Devices
5	KDB 558074 D01 15.247 Meas Guidance v05r02☆	Guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices operating under section 15.247 of the FCC rules

3.2 Test Verdict

No.	Description	FCC Part No.	ISED Part No.	Channel	Test Result	Verdict	Remark
1	Antenna Requirement	15.203	RSS-247, 5.4 (f)	N/A	--	Pass	Note [1]
2	Number of Hopping Frequencies	15.247(a)	RSS-247, 5.1 (d)	N/A	ANNEX A.1	N/A	Note [2]
3	Peak Output Power and E.I.R.P	15.247(b)	RSS-247, 5.4 (b)	Low/Middle/ High	ANNEX A.2	Pass	--
4	Occupied Bandwidth	15.247(a)	RSS-247, 5.1 (a)	N/A	ANNEX A.3	N/A	Note [2]
5	Carrier Frequency Separation	15.247(a)	RSS-247, 5.1 (b)	N/A	ANNEX A.4	N/A	Note [2]
6	Time of Occupancy (Dwell time)	15.247(a)	RSS-247, 5.1 (d)	N/A	ANNEX A.5	N/A	Note [2]
7	Conducted Spurious Emission & Authorized-band band-edge	15.247(d)	RSS-247, 5.5	N/A	ANNEX A.6	N/A	Note [2]
8	Conducted Emission	15.207	RSS-GEN, 8.8	Low/Middle/ High	ANNEX A.7	Pass	Note [2]
9	Radiated Spurious Emission	15.209 15.247(d)	RSS-247, 5.5	Hopping Mode, Low/Middle/	ANNEX A.8	Pass	Note [2]

				High			
10	Band Edge(Restricted-band band-edge)	15.209 15.247(d)	RSS-247, 5.5	Hopping Mode, Low/Middle/ High	ANNEX A.9	Pass	Note [2]
11	Receiver Spurious Emissions	--	RSS-Gen, 7.3	--	--	N/A	Note [3]

Note [1]: The EUT has a permanently and irreplaceable attached antenna, which complies with the requirement FCC 15.203.

Note [2]: π/4-DQPSK is the EDR 2M rate mode, 8-DPSK is the EDR 3M rate mode. The consistency of test results in π/4-DQPSK and 8-DPSK is very high. So we chose 8-DPSK as a typical representative to appear on the report. Another we will show all the modes on the RF output power test item.

Note [3]: 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.

Note [4]: Compared with the EUT of test report RSHD200218007-00B the EUT of this report has changed as below：

1. Change the applicant information and the manufacturer information.
2. Change the equipment type from Wi-Fi & Bluetooth Internet of Things Module to NightEye ALM CELL Series.
3. Change the model name from ESP32-WROOM-32E to 3590000.
4. Add hardware version v3.1.
5. Add software version 1.0.0.

Therefore, Peak Output Power and E.I.R.P, Conducted Emission, Radiated Spurious Emission and Band Edge (Restricted-band band-edge) were tested in this report, other test projects refer to the original report No. RSHD200218007-00B which issued by Bay Area Compliance Laboratories Corp. (Kunshan) on Apr. 02, 2020.

4 GENERAL TEST CONFIGURATIONS

4.1 Test Environments

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

Relative Humidity	50% to 58%	
Atmospheric Pressure	100 kPa to 102 kPa	
Temperature	NT (Normal Temperature)	+22.1℃ to +23.9℃
Working Voltage of the EUT	NV (Normal Voltage)	120 V

4.2 Test Equipment List

Description	Manufacturer	Model	Equipment No.	Cal. Date	Cal. Due
Spectrum Analyzer	KEYSIGHT	N9020A	BH-EMC-L066	2025.02.12	2026.02.11
Spectrum Analyzer	KEYSIGHT	N9010B	BH-EMC-L099	2025.02.12	2026.02.11
Signal Generator	Anritsu	MG3710E	BH-EMC-L131	2025.02.12	2026.02.11
Wideband Radio Communication Tester	R&S	CMW500	BH-EMC-L094	2025.02.11	2026.02.10
EMI Receiver	KEYSIGHT	N9038A	BH-EMC-L015	2025.07.04	2026.07.03
Test Antenna-Loop(9 kHz-30 MHz)	SCHWARZBECK	FMZB 1519 B	BH-EMC-L067	2024.03.11	2027.03.10
Test Antenna-Bi-Log(30 MHz-3 GHz)	SCHWARZBECK	VULB 9163	BH-EMC-L008	2024.03.11	2027.03.10
Test Antenna-Horn(1-18 GHz)	SCHWARZBECK	BBHA 9120D	BH-EMC-L044	2024.03.11	2027.03.10
Test Antenna-Horn (18-40 GHz)	A-INFO	LB-180400-KF	BH-EMC-L061	2024.03.11	2027.03.10
Anechoic Chamber	YiHeng	9m*6m*6m	BH-EMC-L001	2024.04.18	2027.04.17
EMI Receiver	KEYSIGHT	N9038A	BH-EMC-L127	2025.02.12	2026.02.11
LISN	SCHWARZBECK	NSLK 8127	BH-EMC-L011	2025.02.11	2026.02.10
10dB Limiter	SCHWARZBECK	VTSD 9561-F	BH-EMC-L014	2025.02.11	2026.02.10
Shielded Room	YiHeng	5m*4m*3.2m	BH-EMC-L006	2024.02.22	2027.02.21

4.3 Test Software List

Description	Manufacturer	Software Version	Serial No.	Applicable Test Setup
BL410R	BALUN	V2.1.1.496	N/A	The section 4.6.1
BL410E	BALUN	V21.919	N/A	The section 4.6.2&4.6.3&4.6.4&4.6.5

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	2.4 %
RF output power, conducted	0.41 dB
Power Spectral Density, conducted	1.73 dB
Unwanted Emissions, conducted	1.73 dB
All emissions, radiated	3.70 dB
Temperature	0.82 °C
Humidity	4.1 %

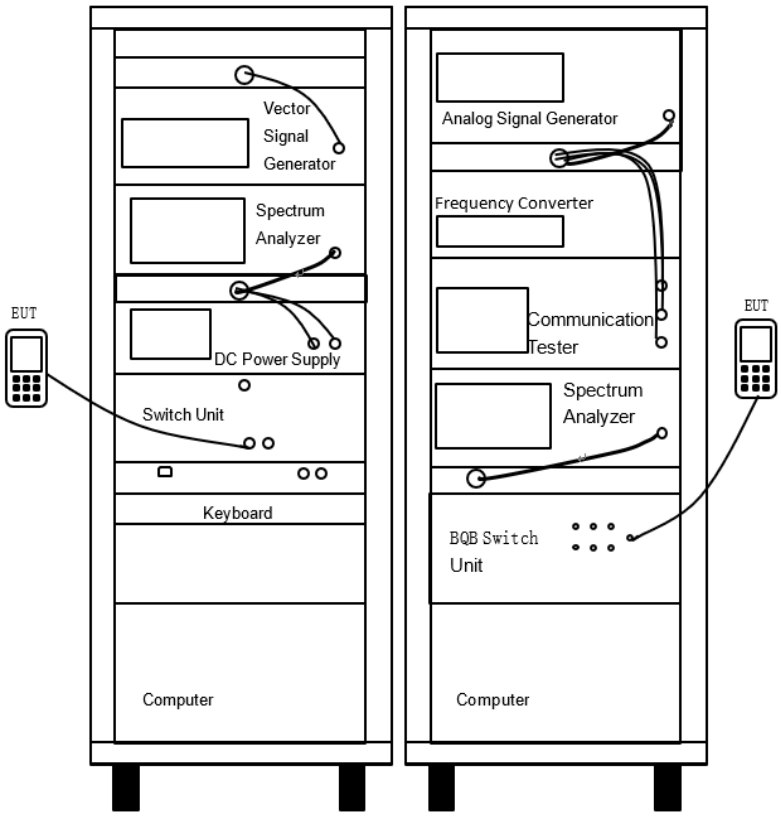
4.5 Decision Rule

☐ No Need
☒ Use General conformity decision rule (Consider uncertainty or not ☒No ☐Yes)
☐ Use Special Conformity Decision Rule (Consider uncertainty or not ☐No ☐Yes)

4.6 Description of Test Setup

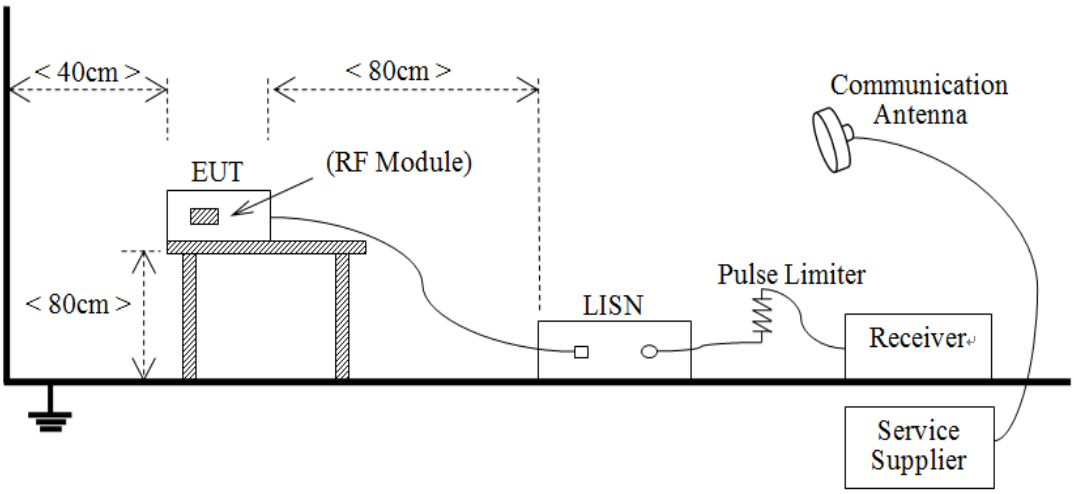
4.6.1 For Antenna Port Test

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



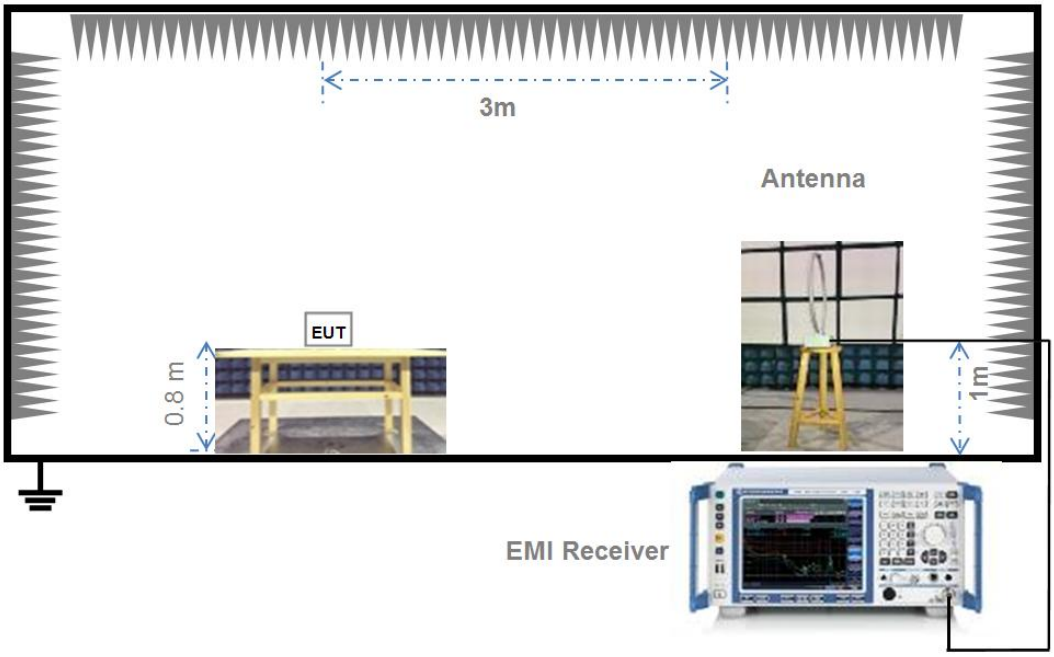
(Diagram 1)

4.6.2 For AC Power Supply Port Test



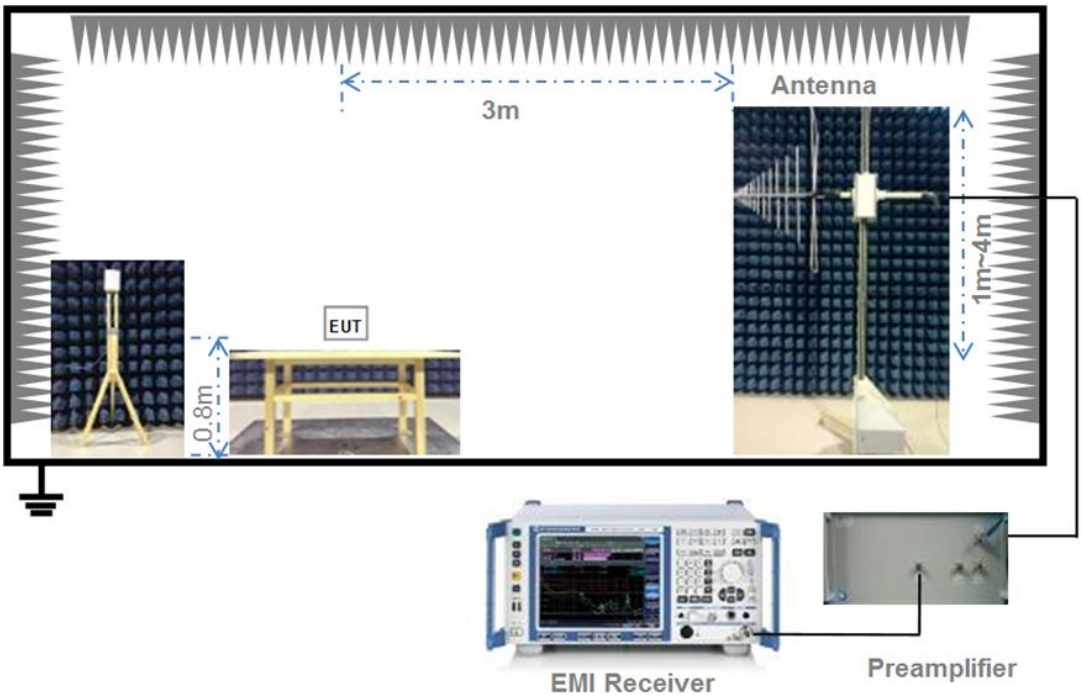
(Diagram 2)

4.6.3 For Radiated Test (Below 30 MHz)



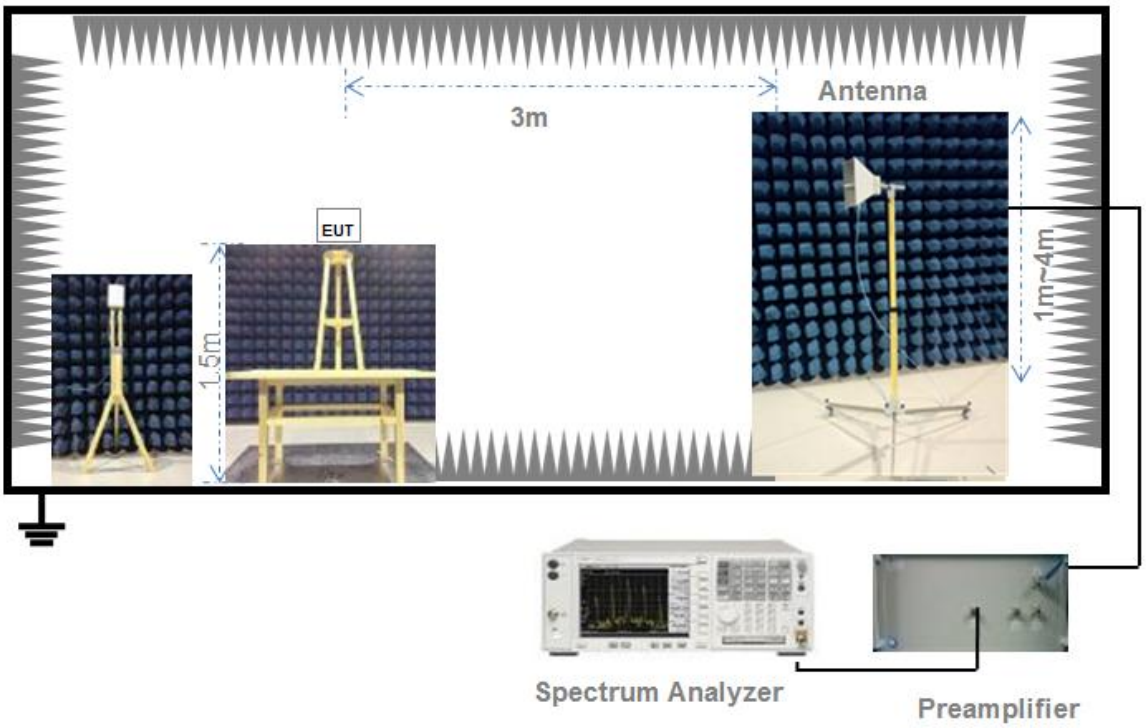
(Diagram 3)

4.6.4 For Radiated Test (30 MHz-1 GHz)



(Diagram 4)

4.6.5 For Radiated Test (Above 1 GHz)



(Diagram 5)

4.7 Measurement Results Explanation Example

4.7.1 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); RSS-247, 5.4 (f)

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 bandwith and transmitted bandwith 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) (iii); RSS-247, 5.1 (d)

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

5.3.3 Test Procedure

The 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 ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize

5.3.4 Test Result

Please refer to ANNEX A.1.

5.4 Peak Output Power and E.I.R.P

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.

RSS-247, 5.4 (b)

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).

5.4.2 Test Setup

See section 4.6.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

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 ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Allow the trace to stabilize.

5.4.4 Test Result

Please refer to ANNEX A.2.

5.5 Occupied Bandwidth

5.5.1 Limit

FCC §15.247(a); RSS-247, 5.1 (a)

Measurement of the 20dB bandwidth of the modulated signal.

5.5.2 Test Setup

See section 4.6.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

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 ≥ 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

Please refer to ANNEX A.3.

5.6 Carrier Frequency Separation

5.6.1 Limit

FCC §15.247(a); RSS-247, 5.1 (b)

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

5.6.3 Test Procedure

The 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.

5.6.4 Test Result

Please refer to ANNEX A.4.

5.7 Time of Occupancy (Dwell time)

5.7.1 Limit

FCC §15.247(a); RSS-247, 5.1 (d)

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

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 ≤ channel spacing and where possible RBW should be set >> 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 8-DPSK:
For DH1 package type
{Total of Dwell} = {Pulse Time} * (1600 / 2) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}
For DH3 package type
{Total of Dwell} = {Pulse Time} * (1600 / 4) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}
For DH5 package type
{Total of Dwell} = {Pulse Time} * (1600 / 6) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}
For AFH Mode:
For DH1 package type
{Total of Dwell} = {Pulse Time} * (800 / 2) / {Number of Hopping Frequency} * {Period}

{Period} = 0.4 s * {Number of Hopping Frequency}
For DH3 package type
{Total of Dwell} = {Pulse Time} * (800 / 4) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {Number of Hopping Frequency}
For DH5 package type
{Total of Dwell} = {Pulse Time} * (800 / 6) / {Number of Hopping Frequency} * {Period}
{Period} = 0.4 s * {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

Please refer to ANNEX A.5.

5.8 Conducted Spurious Emission & Authorized-band band-edge

5.8.1 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.

5.8.2 Test Setup

See section 4.6.1 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

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

Please refer to ANNEX A.6.

5.9 Conducted Emission

5.9.1 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
5 - 30	60	50

5.9.2 Test Setup

See section 4.6.2 for test setup description for the AC power supply port. The photo of test setup please refer to ANNEX B.

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

Please refer to ANNEX A.7.

5.10 Radiated Spurious Emission

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).

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).

5.10.2 Test Setup

See section 4.6.3 to 4.6.5 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.8.

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 4.6.3 to 4.6.5 for test setup description for the antenna port. The photo of test setup please refer to ANNEX B.

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 ≥ 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.

5.11.4 Test Result

Please refer to ANNEX A.9.

ANNEX A TEST RESULT

A.1 Number of Hopping frequencies

Note: The Number of Hopping frequencies, please refer to the Report No. RSHD200218007-00B which issued by Bay Area Compliance Laboratories Corp. (Kunshan) on Apr. 02, 2020. Section FCC §15.247(a) (1) (iii)-QUANTITY OF HOPPING CHANNEL TEST.

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

Peak Power Test Data

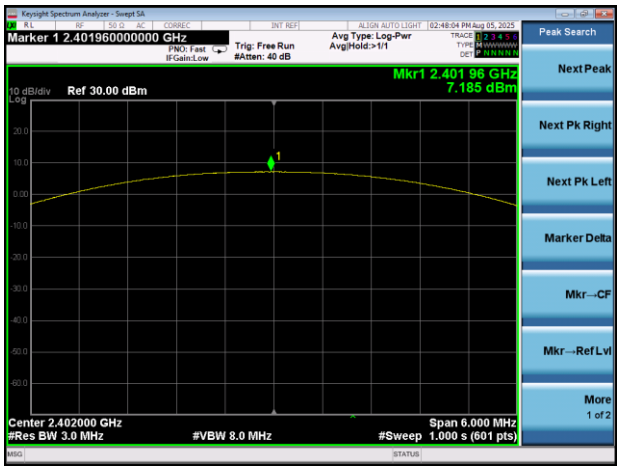
Channel	Measured Output Peak Power						Limit		Verdict
	GFSK		π/4-DQPSK		8-DPSK		dBm	mW	
	dBm	mW	dBm	mW	dBm	mW			
Low	7.19	5.23	9.35	8.60	9.84	9.64	21	125	Pass
Middle	7.29	5.36	9.55	9.02	9.94	9.87			Pass
High	6.89	4.89	9.17	8.27	9.51	8.94			Pass

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

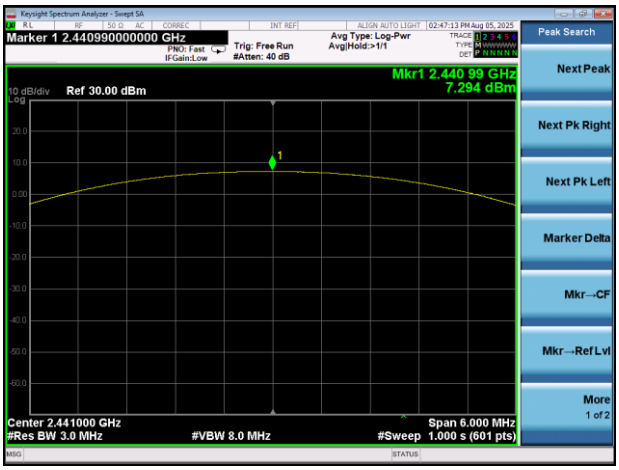
Channel	E.I.R.P						Limit		Verdict
	GFSK		π/4-DQPSK		8-DPSK		dBm	mW	
	dBm	mW	dBm	mW	dBm	mW			
Low	10.59	11.44	12.75	18.82	13.24	21.09	36	4000	Pass
Middle	10.69	11.73	12.95	19.73	13.34	21.60			Pass
High	10.29	10.70	12.57	18.09	12.91	19.56			Pass

Test Plots

GFSK LOW CHANNEL



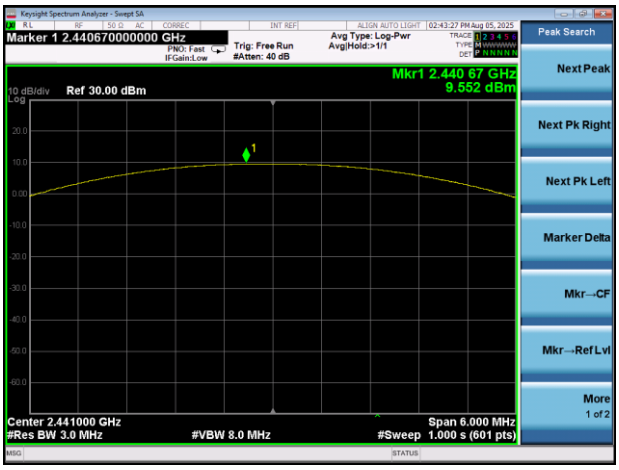
GFSK MIDDLE CHANNEL



GFSK HIGH CHANNEL

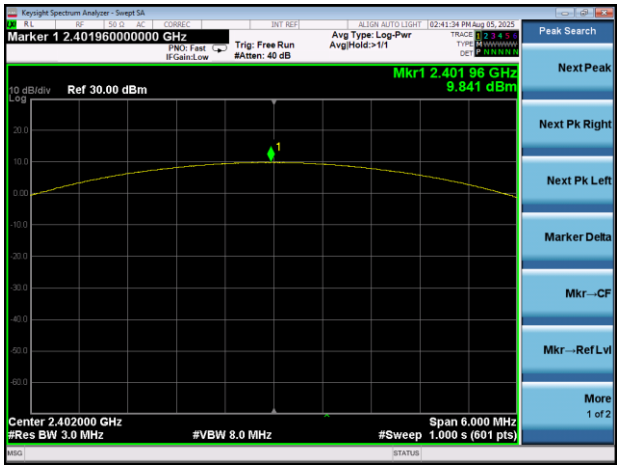
π/4-DQPSK LOW CHANNEL

π/4-DQPSK MIDDLE CHANNEL

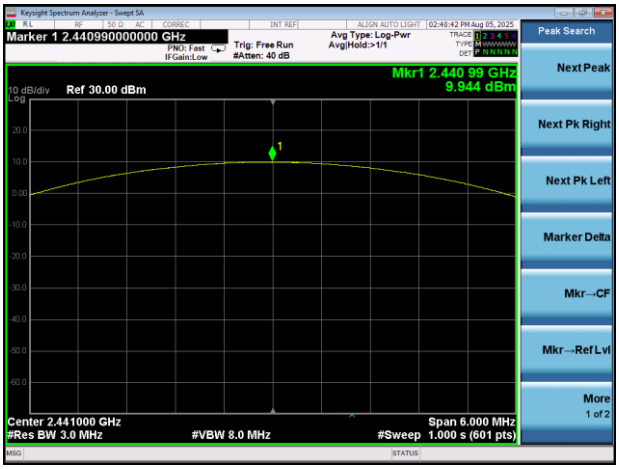


π/4-DQPSK HIGH CHANNEL

8-DPSK LOW CHANNEL



8-DPSK MIDDLE CHANNEL



8-DPSK HIGH CHANNEL

A.3 Occupied Bandwidth

Note: The Occupied Bandwidth, please refer to the Report No. RSHD200218007-00B which issued by Bay Area Compliance Laboratories Corp. (Kunshan) on Apr. 02, 2020. Section FCC §15.247(a) (1) – 20 dB EMISSION BANDWIDTH.

A.4 Carrier Frequency Separation

Note: The Carrier Frequency Separation, please refer to the Report No. RSHD200218007-00B which issued by Bay Area Compliance Laboratories Corp. (Kunshan) on Apr. 02, 2020. Section FCC §15.247(a) (1)-CHANNEL SEPARATION TEST.

A.5 Time of Occupancy (Dwell time)

Note: The Time of Occupancy (Dwell time), please refer to the Report No. RSHD200218007-00B which issued by Bay Area Compliance Laboratories Corp. (Kunshan) on Apr. 02, 2020. Section FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWELL TIME).

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

Note: The Conducted Spurious Emissions & Authorized-band band-edge, please refer to the Report No. RSHD200218007-00B which issued by Bay Area Compliance Laboratories Corp. (Kunshan) on Apr. 02, 2020. Section FCC §15.247(d) - BAND EDGES TESTING.

A.7 Conducted Emission

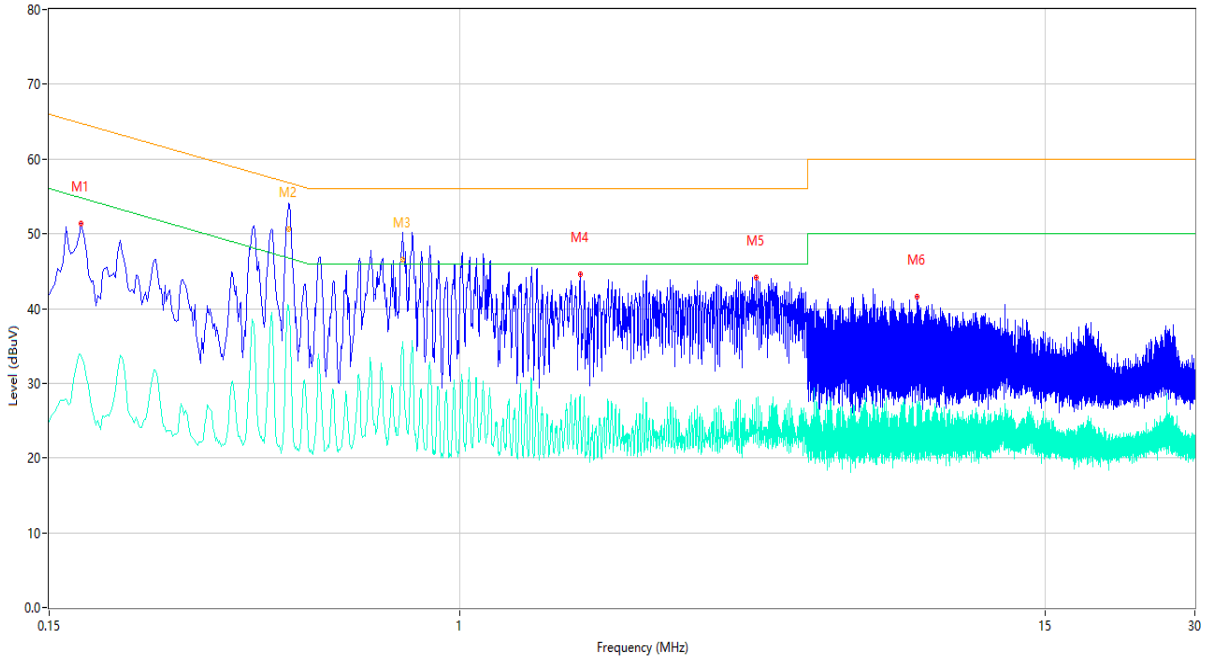
Note 1: The EUT is working in the Normal link mode. All modes have been tested and normal link mode is worst.

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

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

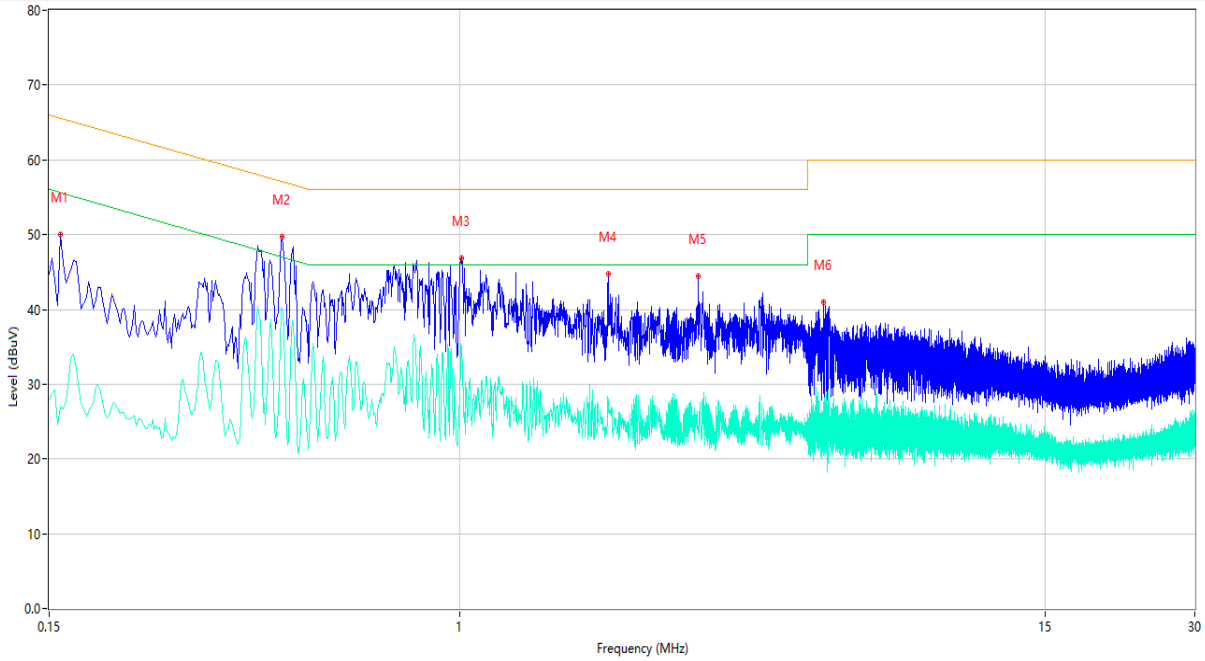
Test Data and Plots

PHASE L



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.174	51.31	10.08	64.77	13.46	Peak	L	Pass
1**	0.174	33.70	10.08	54.77	21.07	AV	L	Pass
2	0.454	54.41	10.14	56.80	2.39	Peak	L	N/A
2*	0.454	50.60	10.14	56.80	6.20	QP	L	Pass
2**	0.454	40.41	10.14	46.80	6.39	AV	L	Pass
3	0.768	50.34	10.22	56.00	5.66	Peak	L	N/A
3*	0.768	46.51	10.22	56.00	9.49	QP	L	Pass
3**	0.768	35.50	10.22	46.00	10.50	AV	L	Pass
4	1.748	44.60	10.31	56.00	11.40	Peak	L	Pass
4**	1.748	28.40	10.31	46.00	17.60	AV	L	Pass
5	3.948	44.15	10.42	56.00	11.85	Peak	L	Pass
5**	3.948	27.97	10.42	46.00	18.03	AV	L	Pass
6	8.308	41.53	10.82	60.00	18.47	Peak	L	Pass
6**	8.308	27.51	10.82	50.00	22.49	AV	L	Pass

PHASE N



No.	Frequency (MHz)	Results (dBuV)	Factor (dB)	Limit (dBuV)	Margin (dB)	Detector	Line	Verdict
1	0.158	49.95	10.15	65.57	15.62	Peak	N	Pass
1**	0.158	26.99	10.15	55.57	28.58	AV	N	Pass
2	0.440	49.76	10.17	57.06	7.30	Peak	N	Pass
2**	0.440	40.23	10.17	47.06	6.83	AV	N	Pass
3	1.012	46.84	10.24	56.00	9.16	Peak	N	Pass
3**	1.012	34.32	10.24	46.00	11.68	AV	N	Pass
4	1.994	44.68	10.24	56.00	11.32	Peak	N	Pass
4**	1.994	26.69	10.24	46.00	19.31	AV	N	Pass
5	3.018	44.41	10.30	56.00	11.59	Peak	N	Pass
5**	3.018	24.46	10.30	46.00	21.54	AV	N	Pass
6	5.394	40.96	10.48	60.00	19.04	Peak	N	Pass
6**	5.394	23.24	10.48	50.00	26.76	AV	N	Pass

A.8 Radiated Spurious Emission

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

Note 2: For the test data above 1 GHz, according the ANSI C63.10-2020, 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.

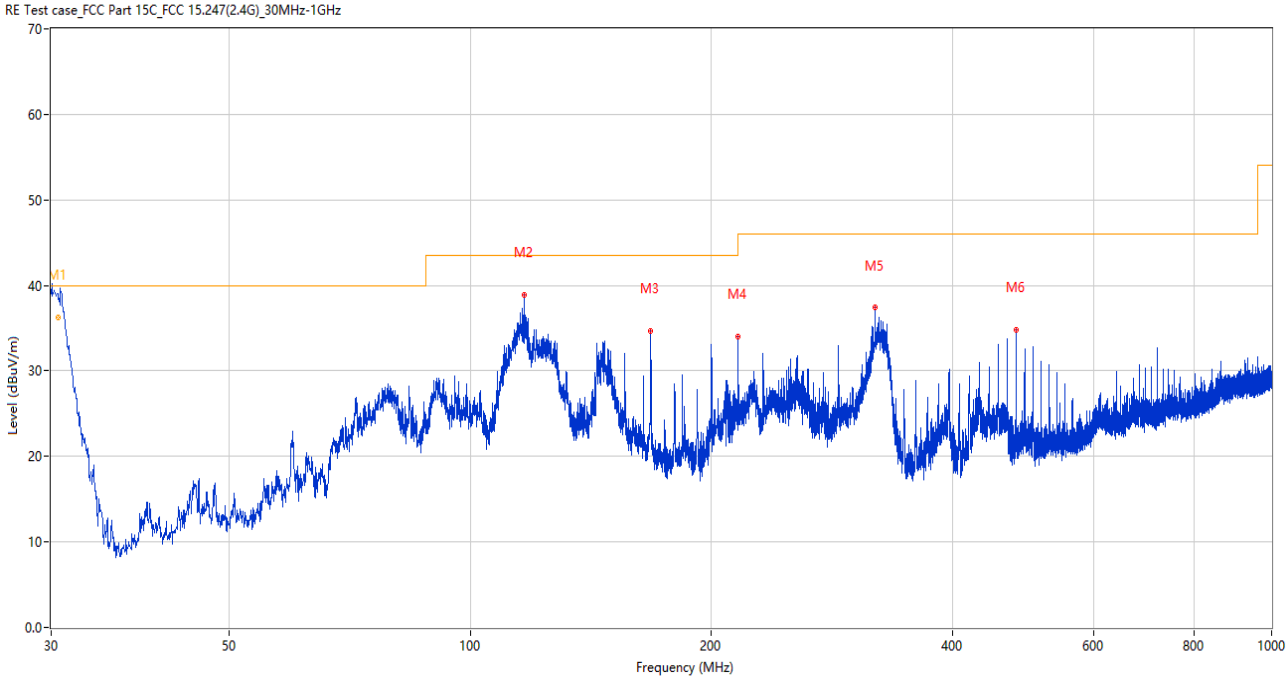
Note 3: The EUT is working in the Normal link mode below 1 GHz. All modes have been tested and DH5-Hopping mode is the worst.

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

Note 5: 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.

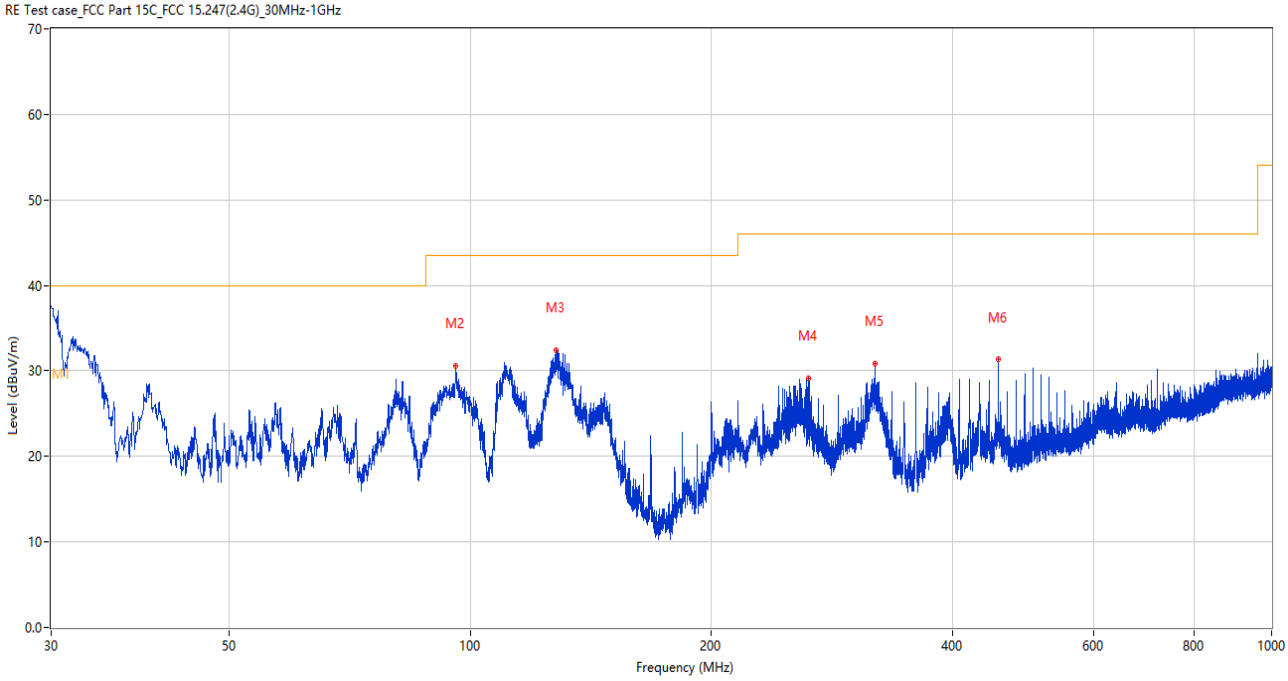
Test Data and Plots

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	30.626	41.34	-29.06	40.0	-1.34	Peak	9.00	154	Horizontal	N/A
1*	30.626	36.29	-29.06	40.0	3.71	QP	9.00	154	Horizontal	Pass
2	116.961	38.88	-27.69	43.5	4.62	Peak	151.00	200	Horizontal	Pass
3	168.031	34.61	-28.44	43.5	8.89	Peak	164.00	100	Horizontal	Pass
4	215.998	33.99	-26.12	43.5	9.51	Peak	295.00	100	Horizontal	Pass
5	320.030	37.38	-22.68	46.0	8.62	Peak	217.00	100	Horizontal	Pass
6	479.983	34.76	-18.70	46.0	11.24	Peak	105.00	100	Horizontal	Pass

30 MHz to 1 GHz, ANT V

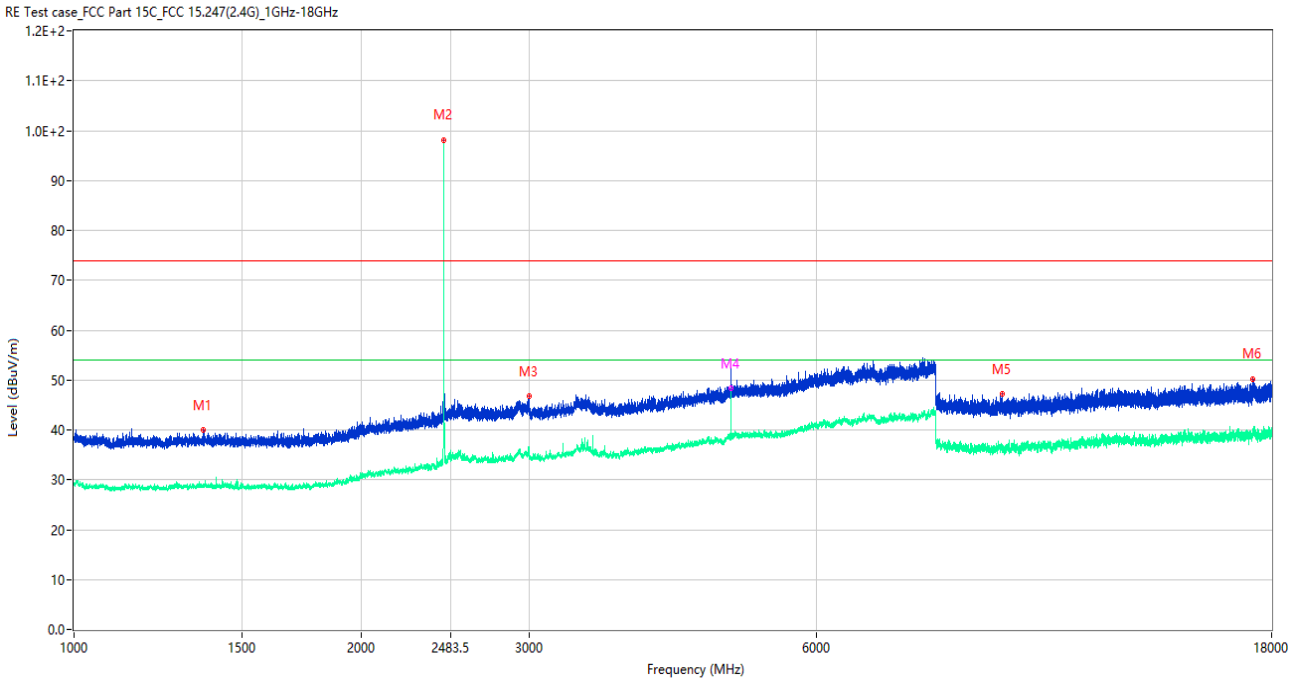


No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	29.549	28.51	-28.89	40.0	11.49	Peak	221.00	100	Vertical	Pass
1*	29.549	24.06	-28.89	40.0	15.94	QP	221.00	100	Vertical	N/A
2	96.008	30.57	-26.52	43.5	12.93	Peak	20.00	100	Vertical	Pass
3	128.018	32.45	-28.91	43.5	11.05	Peak	124.00	200	Vertical	Pass
4	263.964	29.17	-24.15	46.0	16.83	Peak	100.00	200	Vertical	Pass
5	319.982	30.87	-22.69	46.0	15.13	Peak	332.00	100	Vertical	Pass
6	455.975	31.32	-19.37	46.0	14.68	Peak	160.00	200	Vertical	Pass

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

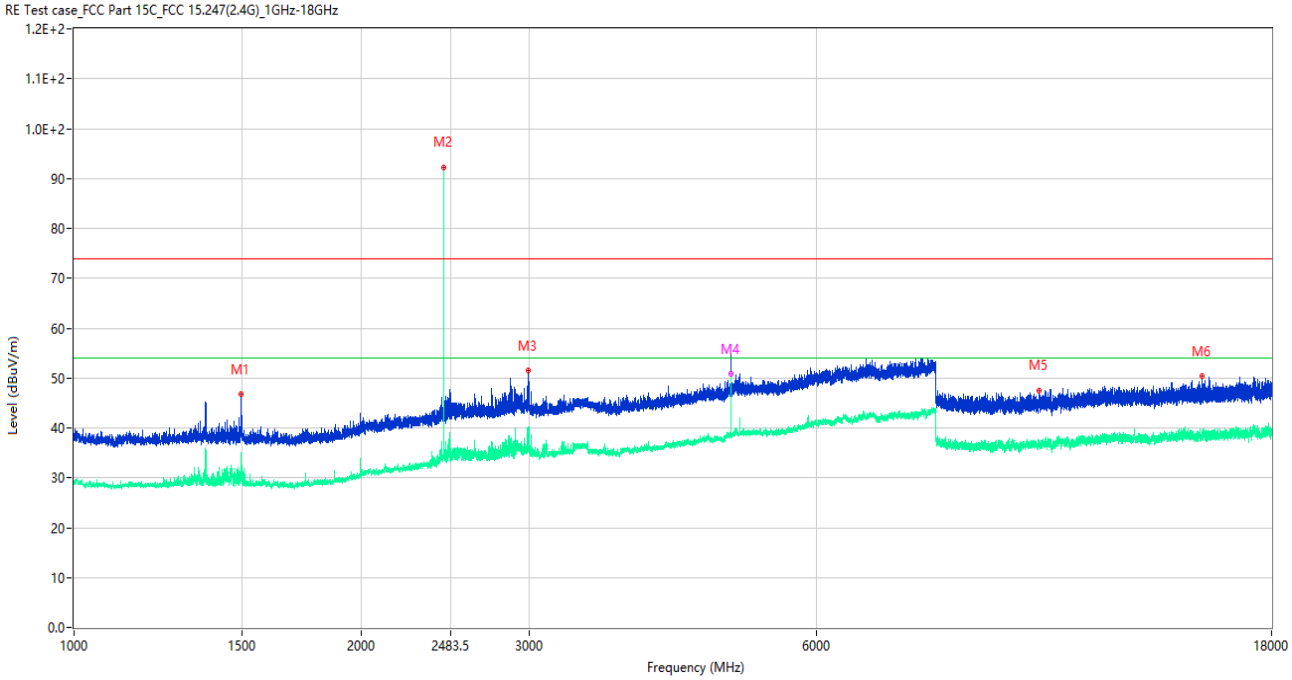
Note 2: The spurious from 18GHz-25GHz is noise only, do not show on the report.

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H



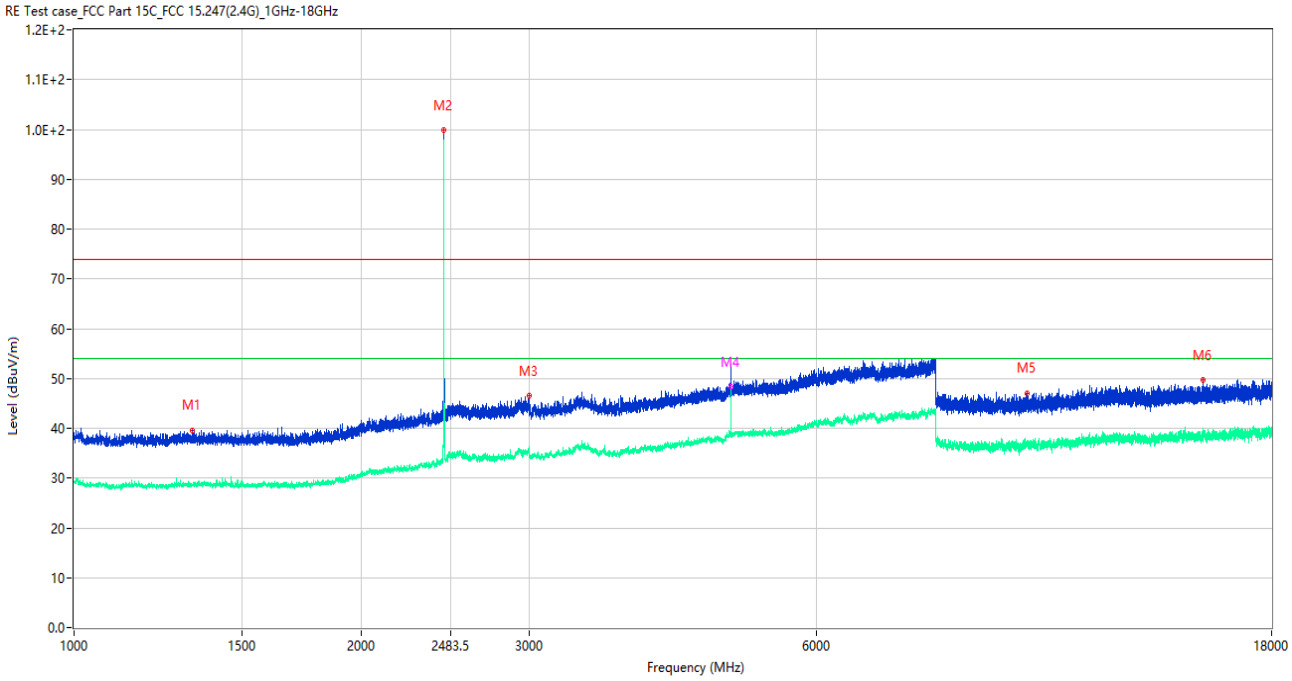
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1367.500	39.90	-15.88	74.0	34.10	Peak	104.00	150	Horizontal	Pass
1**	1367.500	28.85	-15.88	54.0	25.15	AV	104.00	150	Horizontal	Pass
2	2441.250	98.17	-12.40	74.0	-24.17	Peak	318.00	150	Horizontal	N/A
2**	2441.250	97.88	-12.40	54.0	-43.88	AV	318.00	150	Horizontal	N/A
3	2999.750	46.68	-8.74	74.0	27.32	Peak	7.00	150	Horizontal	Pass
3**	2999.750	35.97	-8.74	54.0	18.03	AV	7.00	150	Horizontal	Pass
4	4882.500	52.15	-2.31	74.0	21.85	Peak	65.00	150	Horizontal	Pass
4**	4882.500	48.34	-2.31	54.0	5.66	AV	65.00	150	Horizontal	Pass
5	9388.000	47.13	-4.54	74.0	26.87	Peak	351.00	150	Horizontal	Pass
5**	9388.000	36.75	-4.54	54.0	17.25	AV	351.00	150	Horizontal	Pass
6	17208.001	50.26	-0.11	74.0	23.74	Peak	295.00	150	Horizontal	Pass
6**	17208.001	39.17	-0.11	54.0	14.83	AV	295.00	150	Horizontal	Pass

GFSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V



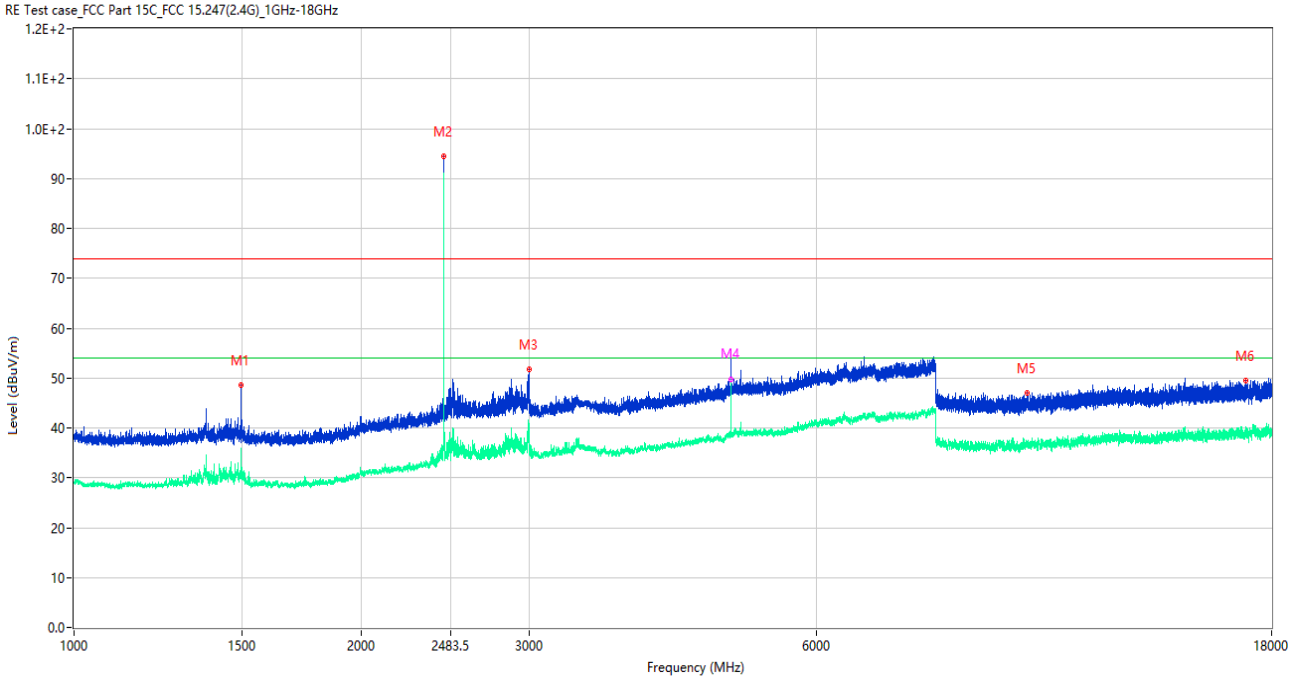
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1495.500	46.75	-16.17	74.0	27.25	Peak	124.00	150	Vertical	Pass
1**	1495.500	30.37	-16.17	54.0	23.63	AV	124.00	150	Vertical	Pass
2	2441.000	92.30	-12.39	74.0	-18.30	Peak	267.00	150	Vertical	N/A
2**	2441.000	91.52	-12.39	54.0	-37.52	AV	267.00	150	Vertical	N/A
3	2994.750	51.45	-8.91	74.0	22.55	Peak	139.00	150	Vertical	Pass
3**	2994.750	36.92	-8.91	54.0	17.08	AV	139.00	150	Vertical	Pass
4	4882.500	54.66	-2.31	74.0	19.34	Peak	80.00	150	Vertical	Pass
4**	4882.500	50.90	-2.31	54.0	3.10	AV	80.00	150	Vertical	Pass
5	10257.000	47.54	-3.16	74.0	26.46	Peak	210.00	150	Vertical	Pass
5**	10257.000	37.27	-3.16	54.0	16.73	AV	210.00	150	Vertical	Pass
6	15224.500	50.30	-1.85	74.0	23.70	Peak	95.00	150	Vertical	Pass
6**	15224.500	38.61	-1.85	54.0	15.39	AV	95.00	150	Vertical	Pass

8-DPSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT H



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1330.250	39.64	-15.99	74.0	34.36	Peak	137.00	150	Horizontal	Pass
1**	1330.250	28.61	-15.99	54.0	25.39	AV	137.00	150	Horizontal	Pass
2	2441.000	99.87	-12.39	74.0	-25.87	Peak	19.00	150	Horizontal	N/A
2**	2441.000	96.36	-12.39	54.0	-42.36	AV	19.00	150	Horizontal	N/A
3	2996.500	46.53	-8.80	74.0	27.47	Peak	9.00	150	Horizontal	Pass
3**	2996.500	35.64	-8.80	54.0	18.36	AV	9.00	150	Horizontal	Pass
4	4882.500	51.65	-2.31	74.0	22.35	Peak	66.00	150	Horizontal	Pass
4**	4882.500	48.25	-2.31	54.0	5.75	AV	66.00	150	Horizontal	Pass
5	9973.500	47.10	-3.67	74.0	26.90	Peak	96.00	150	Horizontal	Pass
5**	9973.500	36.43	-3.67	54.0	17.57	AV	96.00	150	Horizontal	Pass
6	15265.500	49.76	-1.02	74.0	24.24	Peak	360.00	150	Horizontal	Pass
6**	15265.500	39.31	-1.02	54.0	14.69	AV	360.00	150	Horizontal	Pass

8-DPSK MIDDLE CHANNEL 1 GHz to 18 GHz, ANT V



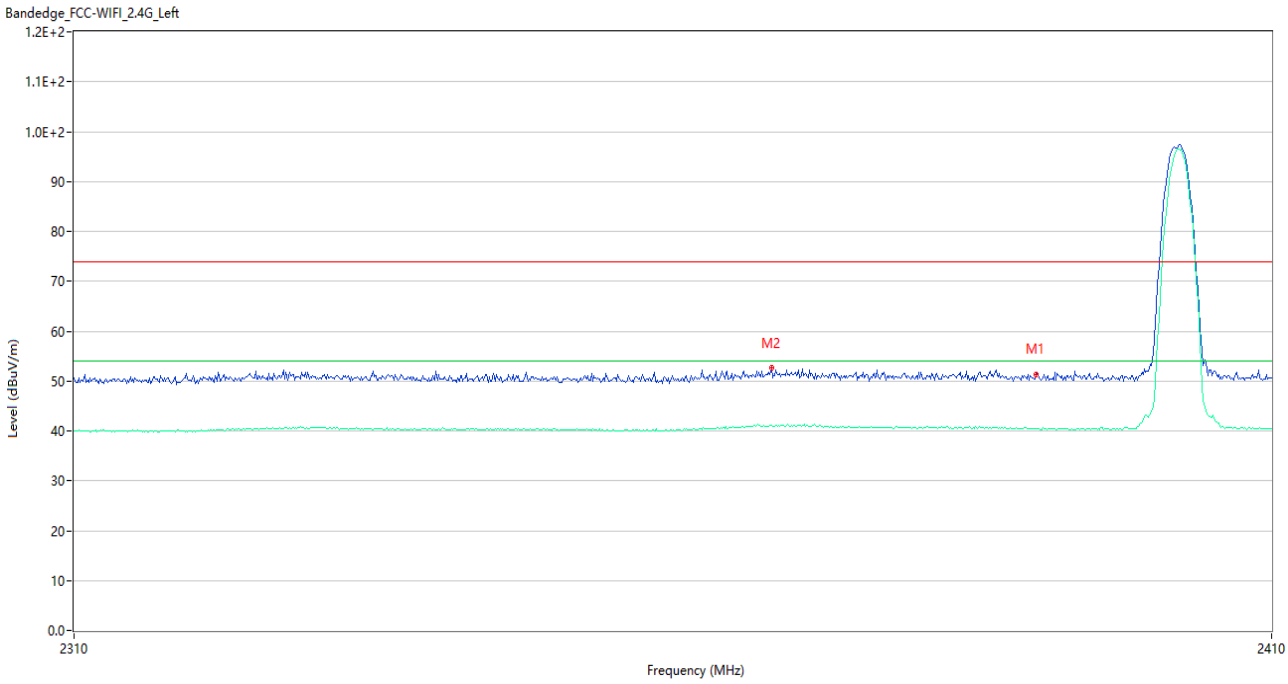
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	1495.750	48.53	-16.17	74.0	25.47	Peak	95.00	150	Vertical	Pass
1**	1495.750	31.26	-16.17	54.0	22.74	AV	95.00	150	Vertical	Pass
2	2441.000	94.39	-12.39	74.0	-20.39	Peak	267.00	150	Vertical	N/A
2**	2441.000	90.69	-12.39	54.0	-36.69	AV	267.00	150	Vertical	N/A
3	2998.000	51.76	-8.80	74.0	22.24	Peak	130.00	150	Vertical	Pass
3**	2998.000	40.31	-8.80	54.0	13.69	AV	130.00	150	Vertical	Pass
4	4882.500	53.76	-2.31	74.0	20.24	Peak	52.00	150	Vertical	Pass
4**	4882.500	49.83	-2.31	54.0	4.17	AV	52.00	150	Vertical	Pass
5	9975.500	47.00	-3.76	74.0	27.00	Peak	236.00	150	Vertical	Pass
5**	9975.500	36.68	-3.76	54.0	17.32	AV	236.00	150	Vertical	Pass
6	16924.500	49.38	-1.22	74.0	24.62	Peak	151.00	150	Vertical	Pass
6**	16924.500	38.40	-1.22	54.0	15.60	AV	151.00	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 C63.10-2020, where limits are specified for both average and peak (or quasi-peak) detector functions, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement.
Note 4: The Level (dBuV/m) has been corrected by factor.

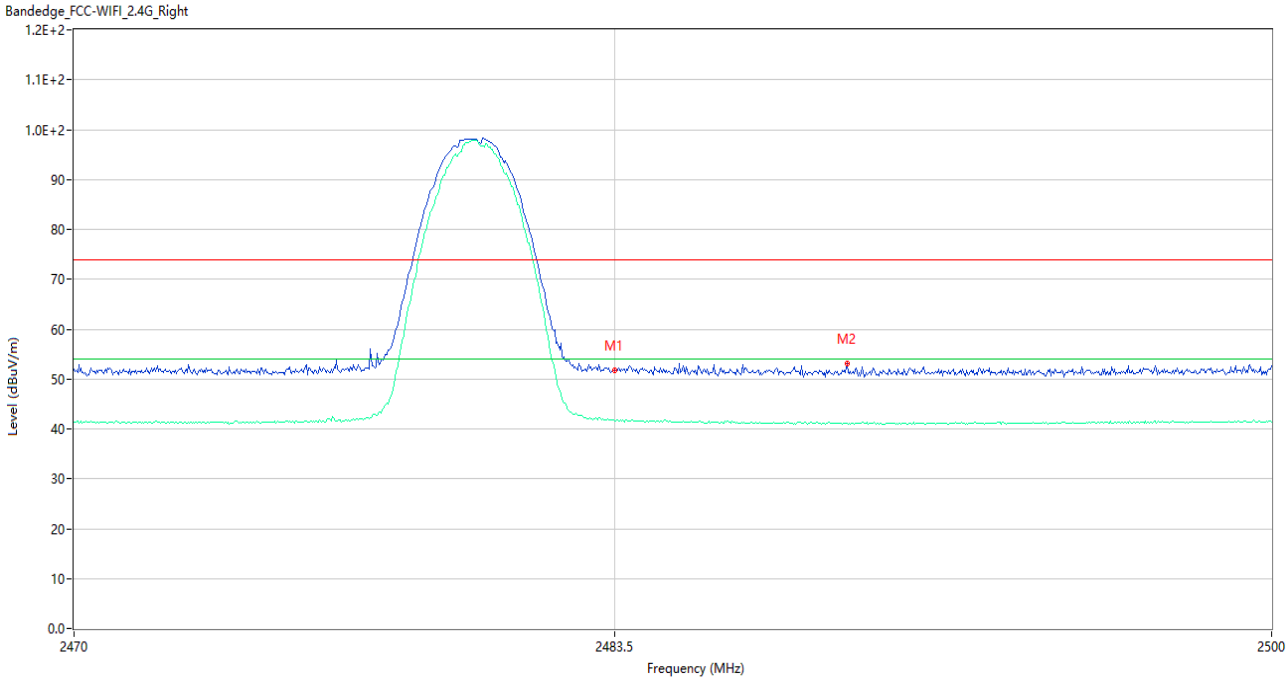
Test Data and Plots

GFSK LOW CHANNEL



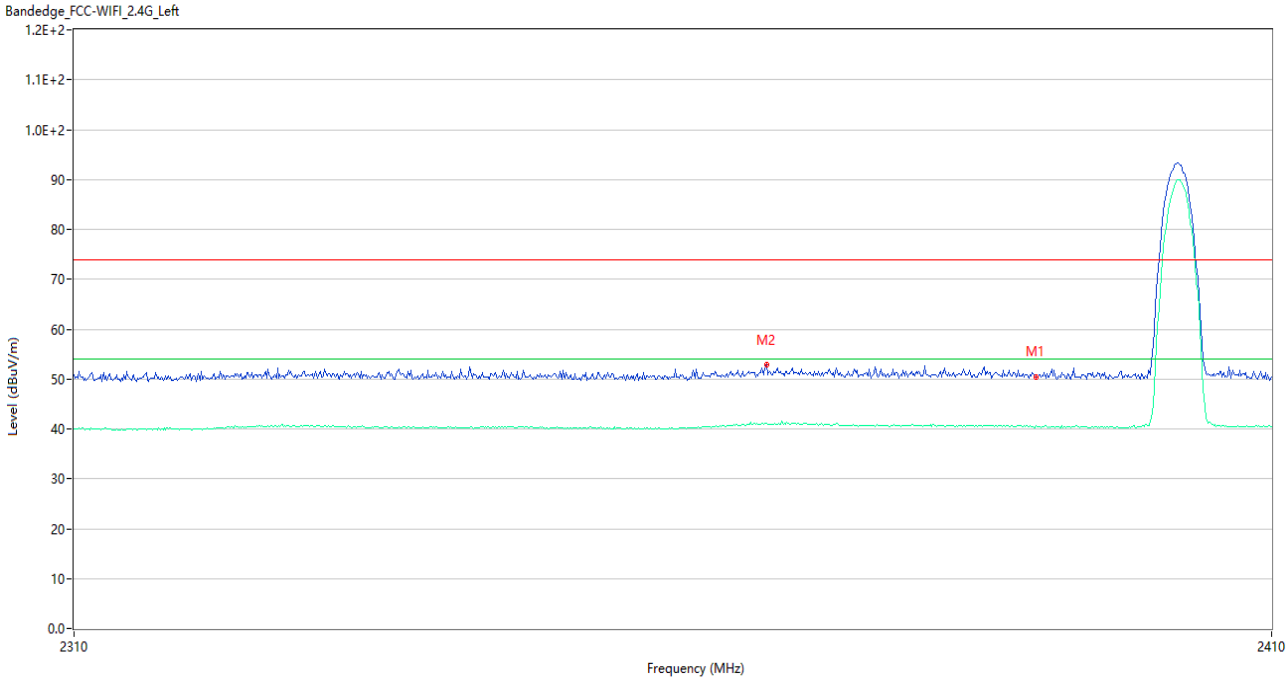
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2390.000	51.41	-4.87	74.0	22.59	Peak	212.97	150	Horizontal	Pass
1**	2390.000	40.52	-4.87	54.0	13.48	AV	212.97	150	Horizontal	Pass
2	2367.700	52.75	-4.26	74.0	21.25	Peak	282.00	150	Horizontal	Pass
2**	2367.700	41.11	-4.26	54.0	12.89	AV	282.00	150	Horizontal	Pass

GFSK HIGH CHANNEL



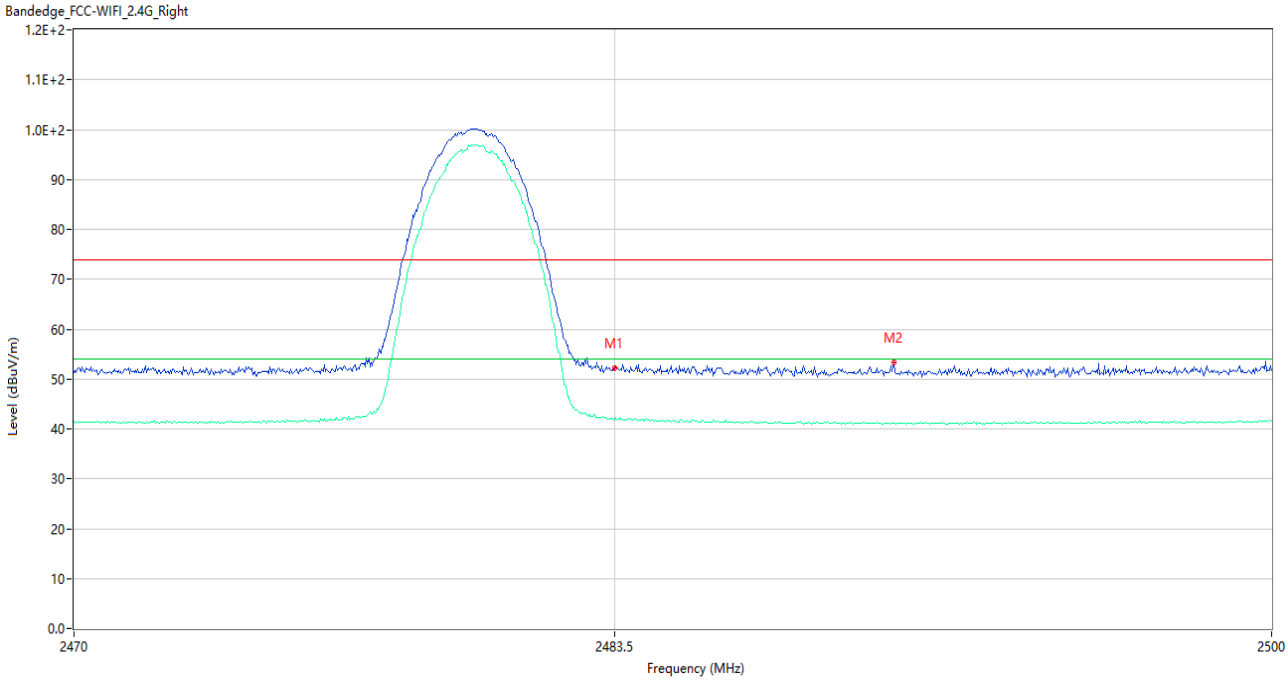
No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2483.500	51.74	-3.78	74.0	22.26	Peak	198.00	150	Horizontal	Pass
1**	2483.500	41.69	-3.78	54.0	12.31	AV	198.00	150	Horizontal	Pass
2	2489.320	53.03	-3.82	74.0	20.97	Peak	196.00	150	Horizontal	Pass
2**	2489.320	41.05	-3.82	54.0	12.95	AV	196.00	150	Horizontal	Pass

8-DPSK LOW CHANNEL



No.	Frequency (MHz)	Results (dBuV/m)	Factor (dB)	Limit (dBuV/m)	Margin (dB)	Detector	Table (Degree)	Height (cm)	Antenna	Verdict
1	2390.000	50.50	-4.87	74.0	23.50	Peak	269.82	150	Vertical	Pass
1**	2390.000	40.59	-4.87	54.0	13.41	AV	269.82	150	Vertical	Pass
2	2367.300	52.82	-4.30	74.0	21.18	Peak	341.00	150	Vertical	Pass
2**	2367.300	41.05	-4.30	54.0	12.95	AV	341.00	150	Vertical	Pass

8-DPSK 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	52.32	-3.78	74.0	21.68	Peak	0.00	150	Horizontal	Pass
1**	2483.500	41.91	-3.78	54.0	12.09	AV	0.00	150	Horizontal	Pass
2	2490.490	53.25	-3.84	74.0	20.75	Peak	289.00	150	Horizontal	Pass
2**	2490.490	41.17	-3.84	54.0	12.83	AV	289.00	150	Horizontal	Pass

ANNEX B TEST SETUP PHOTOS

Please refer the document “BL-SH2580871-AR-1.PDF”.

ANNEX C EUT EXTERNAL PHOTOS

Please refer the document “BL-SH2580871-AW.PDF”.

ANNEX D EUT INTERNAL PHOTOS

Please refer the document “BL-SH2580871-AI.PDF”.

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--END OF REPORT--