FCC Part 15, Subpart C
Test Report

FCC ID:	2AAGF-WILLEN
Applicant:	Zound Industries International AB
Address:	Centralplan 15 SE-111 20 Stockholm Sweden
Manufacturer:	Zound Industries International AB
Address:	Centralplan 15 SE-111 20 Stockholm Sweden
Product name:	Portable Loudspeaker
Brand name:	Marshall
Test model(s):	WILLEN
Series Model(s):	N/A
Test Date:	Jan. 12, 2022 ~ Feb. 11, 2022
Issued Date:	Feb. 17, 2022
Issued By:	Hwa-Hsing (Dongguan) Testing Co., Ltd.
Address:	No.101, Bld N1, Yuyuan 2Rd, Yuyuan Industrial Park, HuangJiang Town, Dongguan, China
Test Firm Registration No.:	915896
Standards:	47 CFR FCC Part 15, Subpart C (Section 15.247) ANSI C63.10:2013

The above equipment has been tested by **Hwa-Hsing (Dongguan) Testing Co., Ltd.**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by : Candy Zhang/ Report Engineer

Reviewed by : Tank tan/ Project Engineer

Approved by : Harry Li/ Technical Director

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Release Control Record

Issue No.	Description	Date Issued
210427EL31-RF-US-01	Original Release	Feb. 13, 2022

1 Summary of Test Results

47 CFR FCC Part 15, Subpart C (Section 15.247) KDB 558074 D01 15.247 Meas Guidance v05r02 ANSI C63.10:2013;			
Clause	Test Item	Result	Remarks
15.207	AC Power Conducted Emission	Pass	Meet the requirement of limit.
15.247(a)(1) (iii)	Number of Hopping Frequency Used	Pass	Meet the requirement of limit.
15.247(a)(1) (iii)	Dwell Time on Each Channel	Pass	Meet the requirement of limit.
15.247(a)(1)	1. Hopping Channel Separation 2. Spectrum Bandwidth of a Frequency Hopping Sequence Spread Spectrum System	Pass	Meet the requirement of limit.
15.247(b)	Maximum Peak Output Power	Pass	Meet the requirement of limit.
---	Occupied Bandwidth Measurement	Pass	Reference only
15.205 & 209	Radiated Emissions	Pass	Meet the requirement of limit.
15.247(d)	Band Edge Measurement	Pass	Meet the requirement of limit.
15.247(d)	Antenna Port Emission	Pass	Meet the requirement of limit.
15.203	Antenna Requirement	Pass	No antenna connector is used.

Note 1: If the Frequency Hopping System operating in 2400-2483.5MHz band and the output power less than 125mW. The hopping channel carrier frequencies separated by a minimum of 25kHz or two-thirds of the 20dB bandwidth of hopping channel whichever is greater.

Note 2: The EUT has been verified to comply with the requirements of FCC Part 15, Subpart B, Class B (sDoC). The test report has been issued separately.

1.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUTas specified in CISPR 16-4-2:

The listed uncertainties are the worst-case uncertainty for the entire range of measurement. Please note that the uncertainty values are provided for informational purposes only and are not used in determining the PASS/FAIL results.

Measurement	Frequency	Expended Uncertainty (k=2) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	2.66 dB
Radiated Emissions up to 1 GHz	9KHz ~ 30MHz	2.16 dB
	30MHz ~ 1000MHz	3.47 dB
Radiated Emissions above 1 GHz	1GHz ~ 18GHz	4.84 dB
	18GHz ~ 40GHz	4.67 dB

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

1.2 Modification Record

There were no modifications required for compliance.

2 General Information

2.1 General Description of EUT

Product	Portable Loudspeaker
Brand	Marshall
Test Model(s)	WILLEN
Series Model(s)	N/A
Status of EUT	Engineering Prototype
Power Supply Rating	DC 3.7V from Li-ion Battery or DC 5V from USB port
Modulation Type	GFSK, π/4DQPSK,8DPSK
Transfer Rate	1/2/3Mbps
Operating Frequency	2402 ~ 2480MHz
Number of Channel	79
Output Power（Peak）	6.57dBm
Antenna Type	FPCB Antenna
Antenna Gain	3.69dBi Maximum peak Gain
Antenna Connector	N/A
Accessory Device	N/A
Cable Supplied	USB Cable: Unshielded, 50cm

Note:

1. Please refer to the EUT photo document (Reference No.: 210427EL31-1&-2) for detailed product photo.
2. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or User's Manual.

2.2 Description of Test Modes

79 channels are provided to this EUT:

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

2.2.1 Test Mode Applicability and Tested Channel Detail

EUT Configure Mode	Applicable test items	X-Axis	Y-Axis	Z-Axis	Voltage Supply
Conducted	AC Power Conducted Emission	N/A	N/A	N/A	DC 5V
Radiated	Radiated Emissions	√	√	√	
Antenna Port Conducted Measurement	Number of Hopping Frequency Used	N/A	N/A	N/A	
	Dwell Time on Each Channel	N/A	N/A	N/A	
	Band Edge Measurement	N/A	N/A	N/A	
	Antenna Port Emission	N/A	N/A	N/A	
	Conducted power	N/A	N/A	N/A	
	Hopping Channel Separation	N/A	N/A	N/A	
	Spectrum Bandwidth of a Frequency Hopping Sequence Spread Spectrum System	N/A	N/A	N/A	

1. *: The EUT had been pre-tested on the positioned of each 3 Axis. The worst case was found when positioned on **Z-plane**.
2. "N/A" means no effect.

Test Condition:

Applicable test items	Environmental Conditions	Test Data	Tested by
AC Power Conducted Emission	21deg. C, 45%RH	Jan. 15, 2022	King Ye
Radiated Emissions	21deg. C, 45%RH	Jan. 14, 2022	King Ye
Antenna Port Conducted Measurement	21deg. C, 45%RH	Jan. 16, 2022	Dragon Long

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture). Following channel(s) was (were) selected for the final test as listed below.

Radiated Emission Test (Above 1 GHz):

EUT Configure Mode	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
-	0 to 78	0, 39, 78	FHSS	GFSK	DH5
-	0 to 78	0, 39, 78	FHSS	8DPSK	3DH5

Radiated Emission Test (Below 1 GHz):

EUT Configure Mode	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
-	0 to 78	0	FHSS	8DPSK	3DH5

Power Line Conducted Emission Test:

EUT Configure Mode	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
-	0 to 78	0	FHSS	8DPSK	3DH5

Antenna Port Conducted Measurement:

☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.

EUT Configure Mode	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Packet Type
-	0 to 78	0, 39, 78	FHSS	GFSK	DH5
-	0 to 78	0, 39, 78	FHSS	8DPSK	3DH5

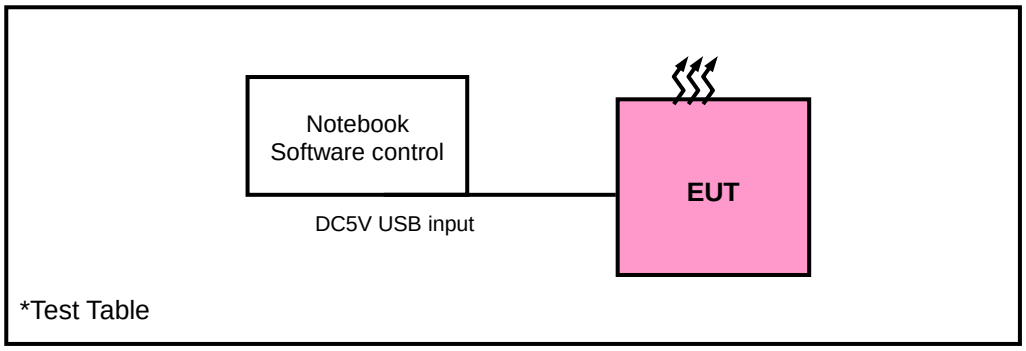
2.3 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

No.	Product	Brand	Model No.	Serial No.	FCC ID
1.	Notebook	Lenovo	ThinkPad X280	SL10P97665	N/A
2.	Adapter	UGREEN	CD132	30599	N/A
3.	Mobile Phone	SAMSUNG	SCH-I699	801A2A38	N/A

No.	Signal Cable Description of The Above Support Units
1.	USB serial cable Un-shieldin1.2m
2.	/
3.	/

2.3.1 Configuration of System under Test



3 Test Types and Results

3.1 Radiated Emission and Bandedge Measurement

3.1.1 Limits of Radiated Emission and Bandedge Measurement

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20 dB below the highest level of the desired power:

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
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
* DTS emissions in non-restricted frequency bands Subclause 11.11 of ANSI C63.10 is applicable. * DTS emissions in restricted frequency bands Subclause 11.12 of ANSI C63.10 is applicable		

Note:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000 MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20 dB under any condition of modulation.

3.1.2 Test Instruments

Radiated emission below 30MHz:

Equipment	Manufacturer	Model No.	Serial No.	Next Cal.
EMI Test Receiver	Rohde&Schwarz	ESR 7	101961	2023/01/12
3m Semi-anechoic Chamber	MAORUI	9m*6m*6m	NSEMC003	2022/04/14
Test software	FARAD	FARAD	EZ_EMCV1.1.4.2	N/A
Loop Antenna	EMCI	HLA 6121	45745	2022/04/13
Preamplifier	EMCI	EMC001340	980201	2022/09/12
Antenna Tower	MF	MFA-440H	NA	NA
Turn Table	MF	MFT-201SS	NA	NA
Antenna Tower&Turn Table Controller	MF	MF-7802	NA	NA

Frequency Range below 1GHz:

Equipment	Manufacturer	Model No.	Serial No.	Next Cal.
EMI Test Receiver	Rohde&Schwarz	ESR 7	101961	2023/01/12
Broadband antenna	Schwarzbeck	VULB 9168	00937	2022/04/15
3m Semi-anechoic Chamber	MAORUI	9m*6m*6m	NSEMC003	2022/04/14
Signal Amplifier	Com-power	PAM-103	18020051	2022/03/14
Attenuator	Rohde&Schwarz	TS2GA-6dB	18101101	N/A
Test software	FARAD	FARAD	EZ_EMCV1.1.4.2	N/A

Frequency Range 1-18GHz:

Equipment	Manufacturer	Model No.	Serial No.	Next Cal.
3m Semi-anechoic Chamber	MAORUI	9m*6m*6m	NSEMC003	2022/04/14
Horn Antenna	Schwarzbeck	BBHA 9170	01959	2022/04/15
Broadband Coaxial Preamplifier	Schwarzbeck	BBV 9718	00025	2022/03/14
Spectrum	Keysight	N9020A	MY51240612	2022/09/12
Antenna Tower	MF	MFA-440H	NA	NA
Turn Table	MF	MFT-201SS	NA	NA
Antenna Tower&Turn Table Controller	MF	MF-7802	NA	NA

Frequency Range 18-40GHz:

Equipment	Manufacturer	Model No.	Serial No.	Next Cal.
3m Semi-anechoic Chamber	MAORUI	9m*6m*6m	NSEMC003	2022/04/14
Spectrum Analyzer	Rohde&Schwarz	FSV-40N	101783	2022/03/14
Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170242	2022/04/15
Pre-Amplifier	EMCI	EMC 184045	980102	2022/03/14
Antenna Tower	MF	MFA-440H	NA	NA
Turn Table	MF	MFT-201SS	NA	NA
Antenna Tower&Turn Table Controller	MF	MF-7802	NA	NA

Note: 1. The calibration interval of the above test instruments is 12months (The Antenna and Chamber was 24 mounths) and the calibrations are traceable to CEPREI/CHINA.
2. The test was performed in 966.

3.1.3 Test Procedures

a. Peak emission levels are measured by setting the instrument as follow:

1) RBW& VBWsetting as a function of frequency:

Frequency	RBW	VBW
9kHz~150kHz	200Hz	600Hz
0.15MHz~30MHz	9kHz	30kHz
30MHz~1000MHz	120kHz	300kHz
>1000MHz	1MHz	3MHz

2) Detector = peak.
3) Sweep time = auto.
4) Trace mode = max hold.
5) Allow sweeps to continue until the trace stabilizes. (Note that the required measurement time may be lengthened for low-duty-cycle applications.)

Note: If the peak-detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement

b. Average emission levels are measured by setting the instrument as follow:

- **Trace averaging with continuous EUT transmission at full power**

If the EUT can be configured or modified to transmit continuously (D ≥ 98%). then the average emission levels shall be measured using the following method (with EUT transmitting continuously):

1) RBW=1 MHz (unless otherwise specified).
2) VBW≥ 3 *RBW.
3) Detector =RMS
4) Sweep time = auto.
5) Perform a trace average of at least 100 traces.

- **Trace averaging across ON and OFF times of the EUT transmissions followed by duty cycle correction**

If continuous transmission of the EUT (D≥98%) cannot be achieved and the duty cycle is constant (duty cycle variations are less than ±2%). then the following procedure shall be used

1) The EUT shall be configured to operate at the maximum achievable duty cycle.
2) Measure the duty cycle D of the transmitter output signal as described in 11.6.
3) RBW=1 MHz (unless otherwise specified).
4) VBW≥ 3 *RBW.
5) Detector =RMS
6) Sweep time = auto.
7) Perform a trace average of at least 100 traces.

A correction factor shall be added to the measurement results prior to comparing with the emission limit to compute the emission level that would have been measured had the test been performed at 100% duty cycle. The correction factor is computed as follows:

*If power averaging (rms) mode was used in step 5). then the applicable correction factor is [10 10g (1/ D)], where D is the duty cycle.

**If linear voltage averaging mode was used in step f). then the applicable correction factor is [20 10g (1/D)], where D is the duty cycle.

***If a specific emission is demonstrated to be continuous (D > 98%) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that

- **Reduced VBW Averaqing across ON and OFF times of the EUT transmissions with max hold**

If continuous transmission of the EUT (D > 98%) cannot be achieved and the duty cycle is not constant (duty cycle variations exceed ±2%), then the following procedure shall be used:

1) RBW = 1 MHz.
2) VBW≥1/T.
3) Detector =peak
4) Sweep time = auto.
5) Trace mode = max hold.
6) Allow max hold to run for at least [50 x (1/ D)] traces

c. The EUT was placed on the top of a rotating table 0.8 meters (below 1GHz) / 1.5 meters (1-18GHz) / 1.5 meters (18-40GHz) above the reference ground. The table was rotated 360 degrees to determine the position of the highest radiation.
d. The EUT was set 3 meters away from the interference-receiving antenna (Below 1GHz) & (Above 1-18GHz), which was mounted on the top of a variable-height antenna tower. The EUT was set 1meters away from the interference-receiving antenna (18-40GHz).
e. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
f. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
g. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.

The test-receiver system was set to peak and average detected function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

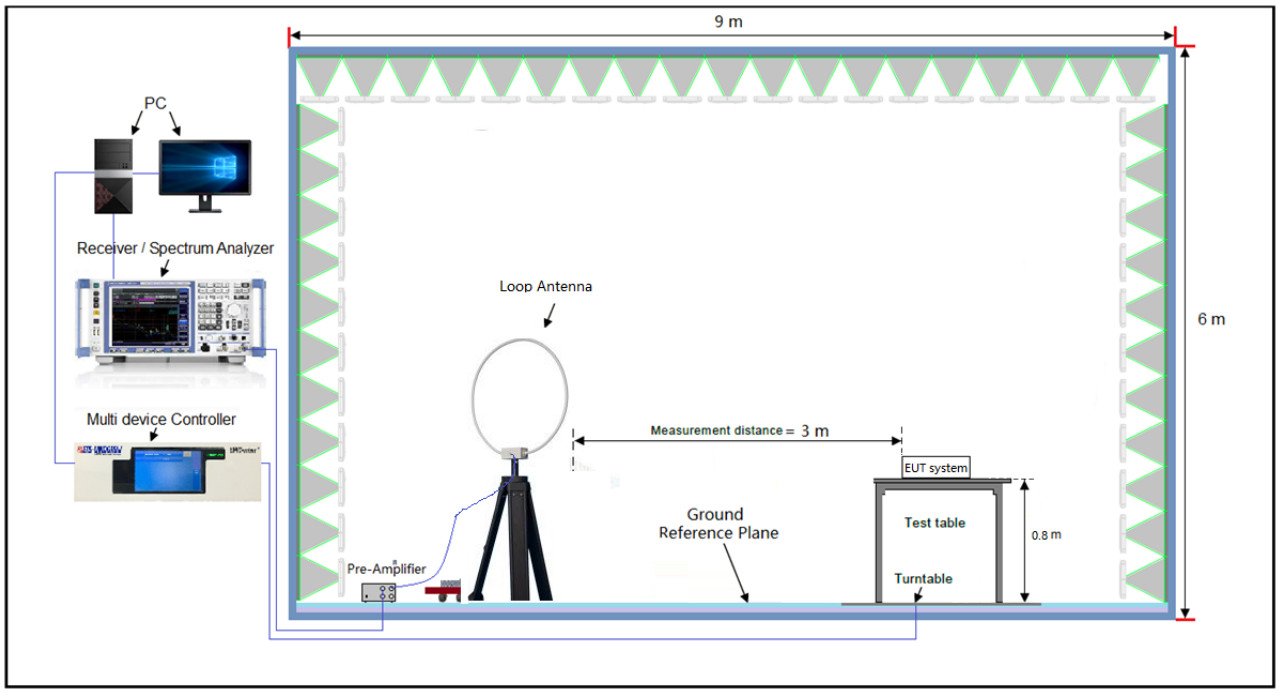
Note:
1. Test procedures for measuring FHSS device: The use of a duty cycle correction factor (DCCF) is permitted for calculating average radiated field strength emission levels for an FHSS device in 15.247. This DCCF can be applied when the unwanted emission limit is subject to an average field strength limit (e.g., within a Government Restricted band) and the conditions specified in Section 15.35(c) can be satisfied. The average radiated field strength is calculated by subtracting the DCCF from the maximum radiated field strength level as determined through measurement. The maximum radiated field strength level represents the worst-case (maximum amplitude) RMS measurement of the emission(s) during continuous transmission (i.e., not including any time intervals during which the transmitter is off or is transmitting at a reduced power level). It is also acceptable to apply the DCCF to a measurement performed with a peak detector instead of the specified RMS power averaging detector. Note that Section 15.35(c) specifies that the DCCF shall represent the worst-case (greatest duty cycle) over any 100 msec transmission period. Subclause 7.5 of ANSI C63.10 provides additional measurement guidance applicable to determination of the DCCF.
2. All modes of operation were investigated and the worst-case emissions are reported.

3.1.4 Deviation from Test Standard

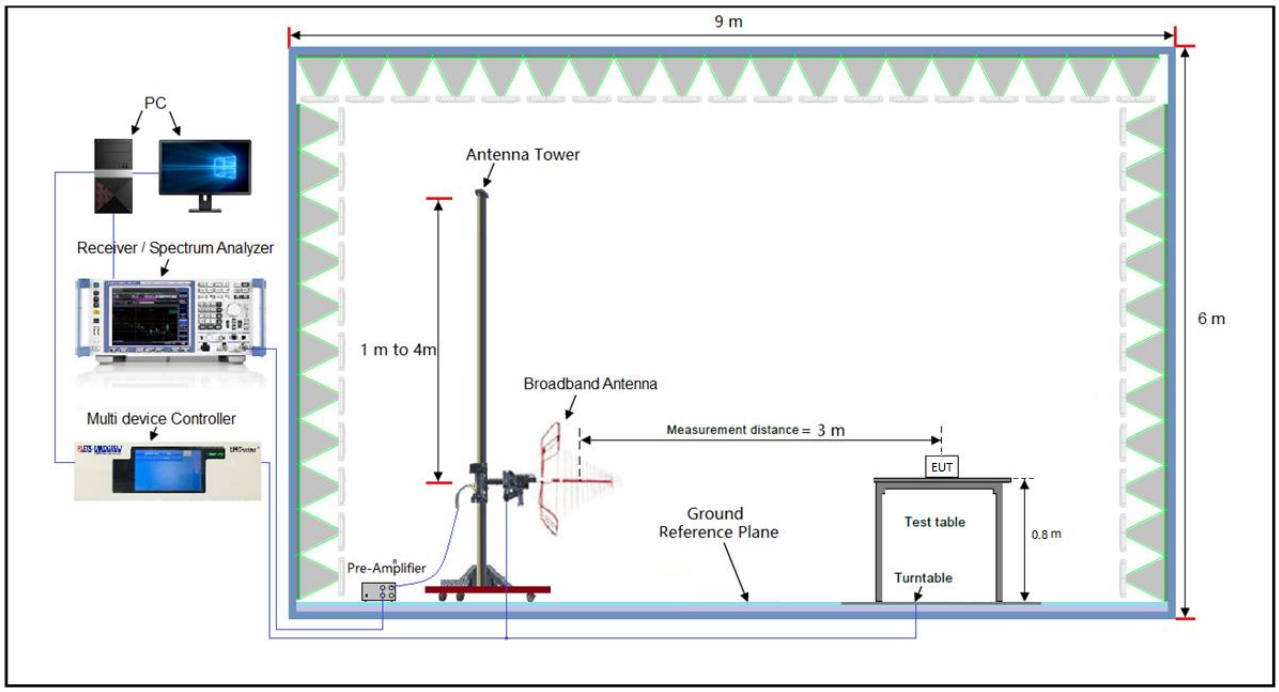
No deviation.

3.1.5 Test Setup

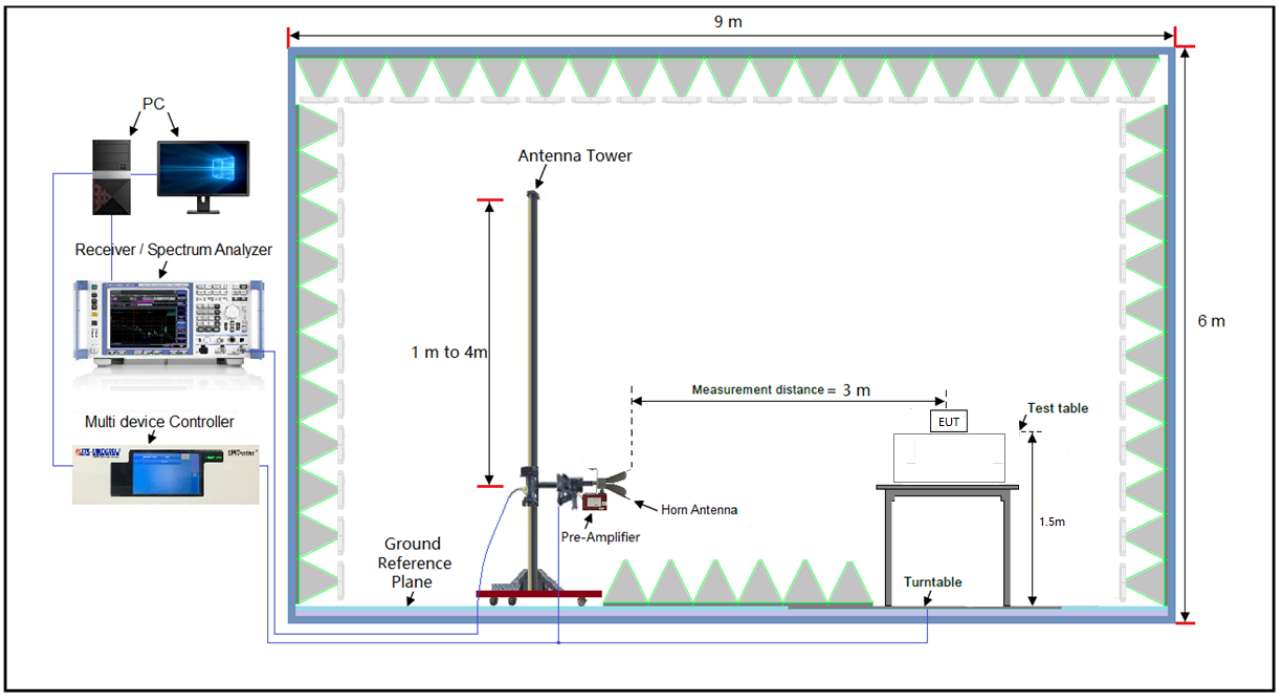
Radiated emission below 30MHz:



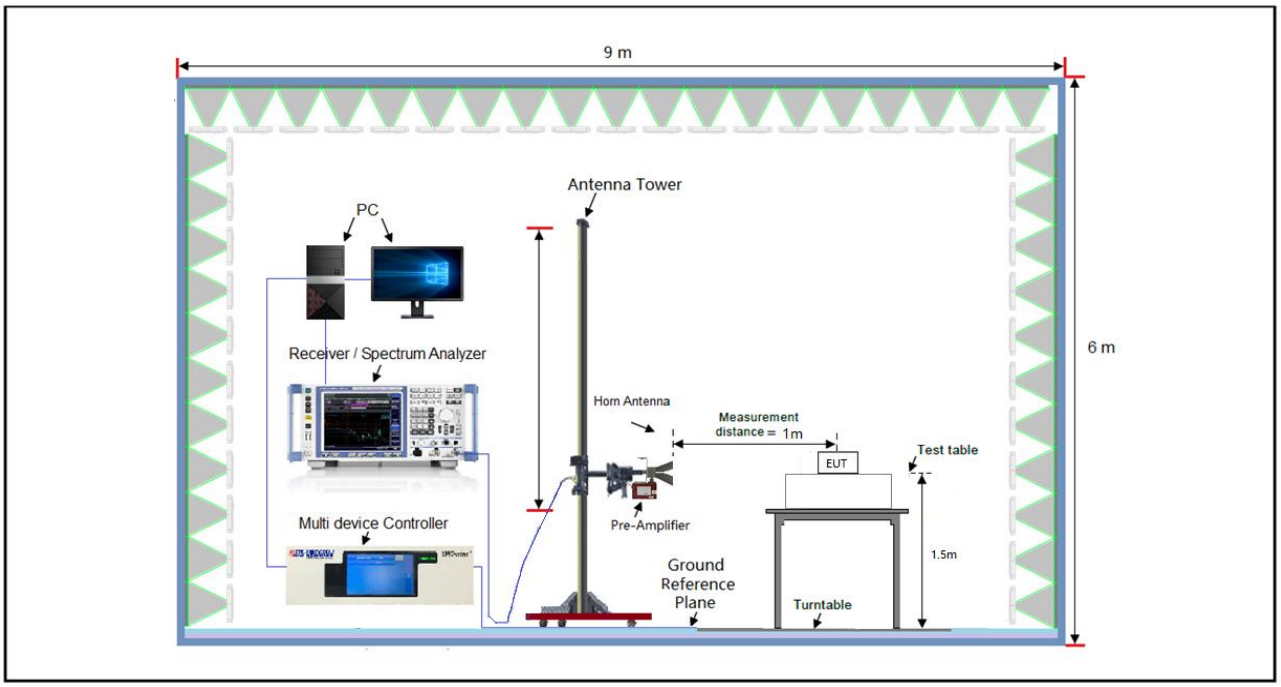
Frequency Range below 1GHz:



Frequency Range above 1GHz:



Frequency Range 18-40GHz:



*For the actual test configuration, please refer to the attached file (Test Setup Photo).

3.1.6 EUT Operating Conditions

Set the EUT under transmission condition continuously at specific channel frequency.

3.1.7 Test Results

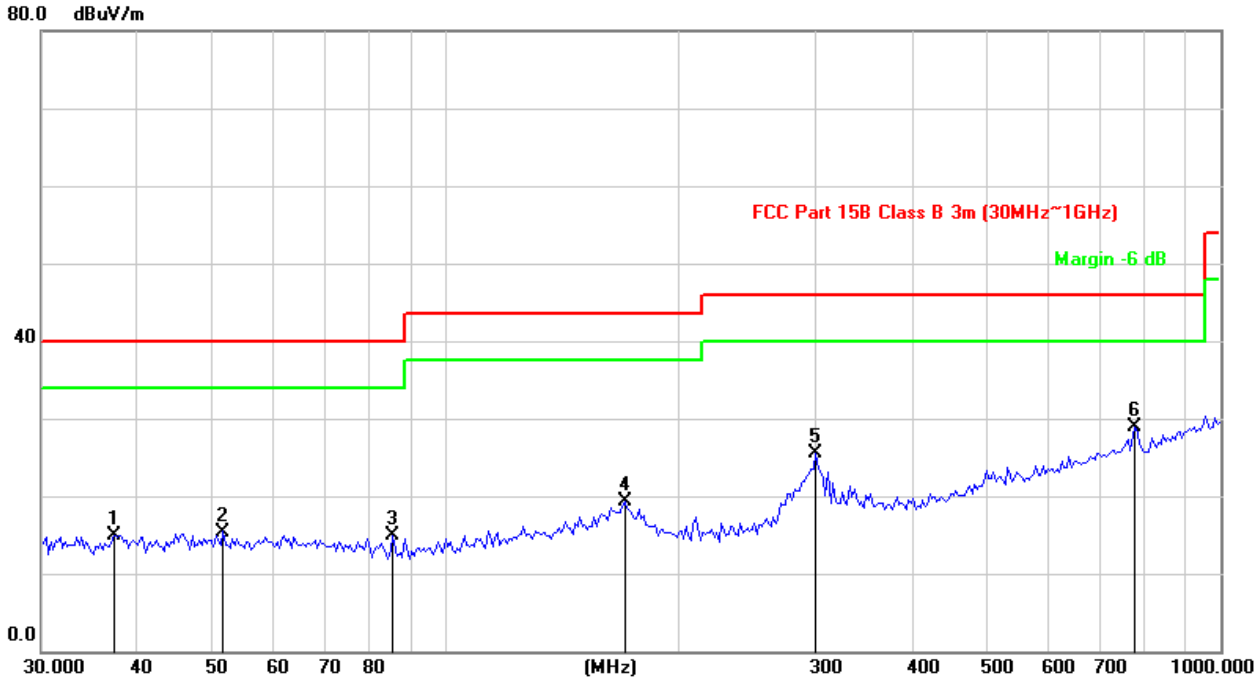
9 kHz ~ 30 MHz Data:

The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

30 MHz ~ 1GHz Worst-Case Data:

Frequency Range	30MHz ~ 1GHz	Detector Function	Peak (PK) Quasi-peak (QP)
Test Channel	Channel 0		

Antenna Polarity & Test Distance: Horizontal at 3 m



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detecter	Antenna Height (cm)	Table Angle (Degree)
1	37.3017	31.69	-16.75	14.94	40.00	-25.06	peak	300	246
2	51.5365	32.21	-16.81	15.40	40.00	-24.60	peak	200	297
3	85.4769	32.94	-18.12	14.82	40.00	-25.18	peak	200	234
4	170.1888	31.96	-12.68	19.28	43.50	-24.22	peak	300	114
5	300.6988	39.61	-14.17	25.44	46.00	-20.56	peak	200	185
6	776.4849	32.46	-3.55	28.91	46.00	-17.09	peak	300	78

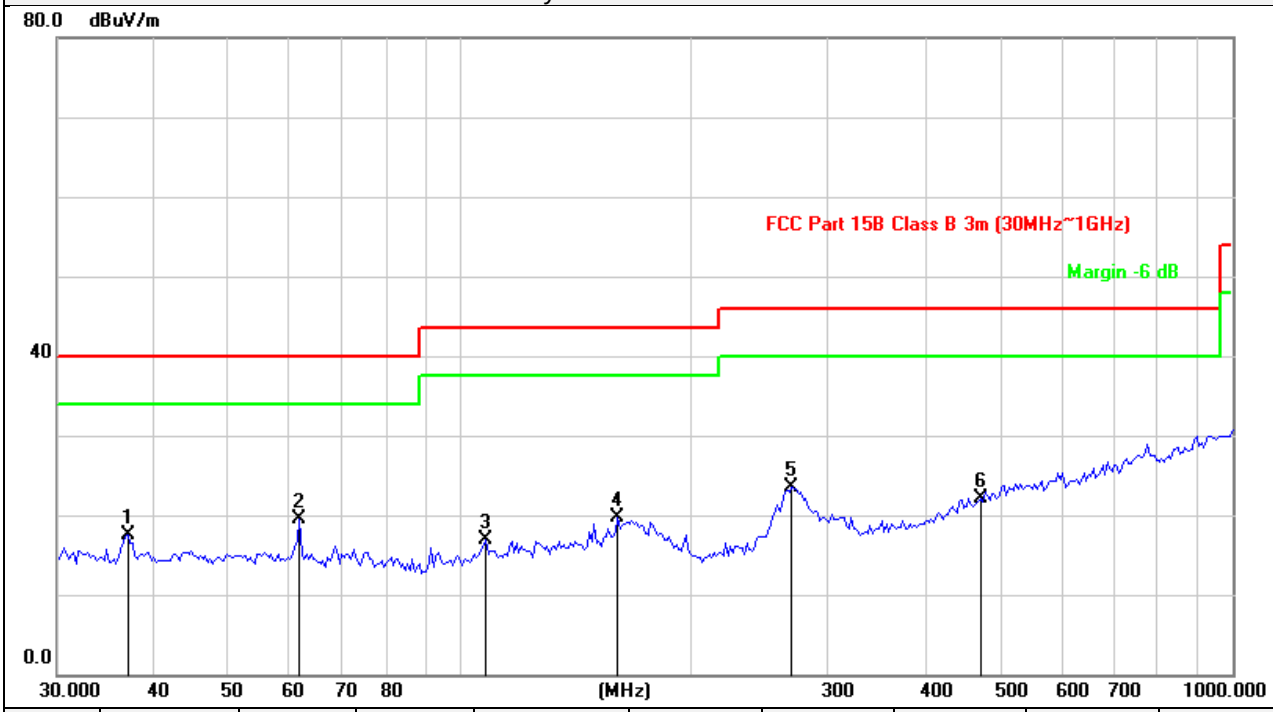
Remarks:

1.Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)

2.Margin value = Emission level – Limit value

Frequency Range	30MHz ~ 1GHz	Detector Function	Peak (PK) Quasi-peak (QP)
Test Channel	Channel 0		

Antenna Polarity & Test Distance: Vertical at 3 m



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detecter	Antenna Height (cm)	Table Angle (Degree)
1	37.0405	34.18	-16.75	17.43	40.00	-22.57	peak	100	266
2	61.8676	36.34	-16.90	19.44	40.00	-20.56	peak	100	185
3	107.7854	34.03	-17.12	16.91	43.50	-26.59	peak	200	287
4	159.7586	32.80	-13.04	19.76	43.50	-23.74	peak	100	103
5	268.7212	38.40	-14.85	23.55	46.00	-22.45	peak	200	269
6	471.4665	31.93	-9.78	22.15	46.00	-23.85	peak	100	118

Remarks:

1.Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)

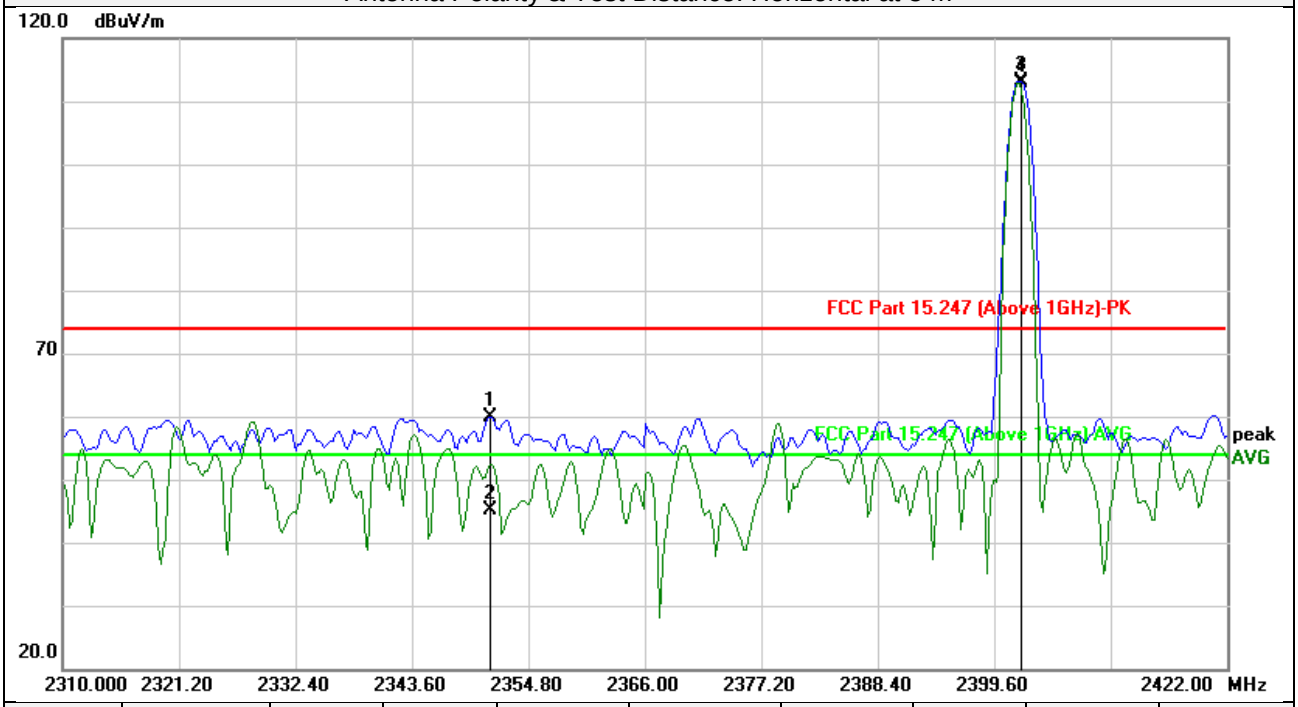
2. Margin value = Emission level – Limit value

Above 1GHz Data:

GFSK

Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AVG)
Test Channel	Channel 0		

Antenna Polarity & Test Distance: Horizontal at 3 m



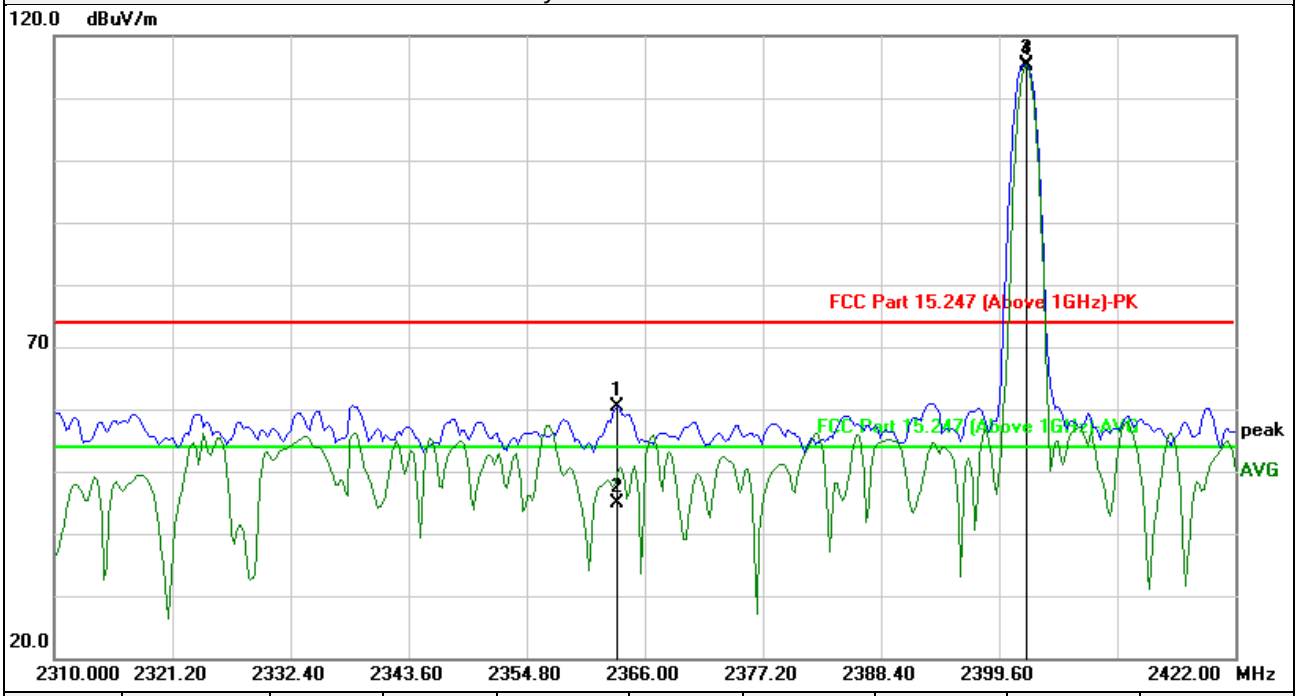
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detecter	Antenna Height (cm)	Table Angle (Degree)
1	2351.074	61.16	-1.32	59.84	74.00	-14.16	peak	100	232
2	2351.074	46.50	-1.32	45.18	54.00	-8.82	AVG	100	232
3#	2402.249	114.34	-1.30	113.04			peak	100	232
4#	2402.249	114.18	-1.30	112.88			AVG	100	232
5	4804.000	49.17	3.75	52.92	74.00	-21.08	peak	100	77
6	4804.000	40.96	3.75	44.71	54.00	-9.29	AVG	100	77
7	7206.000	42.22	8.14	50.36	74.00	-23.64	peak	100	225
8	7206.000	32.72	8.14	40.86	54.00	-13.14	AVG	100	225

Remarks:

1. Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
   Margin value = Emission level – Limit value
2. #2402MHz: Fundamental frequency.

Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AVG)
Test Channel	Channel 0		

Antenna Polarity & Test Distance: Vertical at 3 m



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detecter	Antenna Height (cm)	Table Angle (Degree)
1	2363.419	61.64	-1.31	60.33	74.00	-13.67	peak	100	207
2	2363.419	46.26	-1.31	44.95	54.00	-9.05	AVG	100	207
3#	2402.249	116.70	-1.30	115.40			peak	100	207
4#	2402.249	116.51	-1.30	115.21			AVG	100	207
5	4804.000	52.00	3.75	55.75	74.00	-18.25	peak	239	130
6	4804.000	44.95	3.75	48.70	54.00	-5.30	AVG	239	130
7	7206.000	43.54	8.14	51.68	74.00	-22.32	peak	140	177
8	7206.000	35.07	8.14	43.21	54.00	-10.79	AVG	140	177

Remarks:

1.Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)

Margin value = Emission level – Limit value

2.#2402MHz: Fundamental frequency.

Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AVG)
Test Channel	Channel 39		

Antenna Polarity & Test Distance: Horizontal at 3 m									
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detecter	Antenna Height (cm)	Table Angle (Degree)
1 #	2441.000	114.71	-1.70	113.01			peak	100	245
2 #	2441.000	114.68	-1.70	112.98			AVG	100	245
3	4882.000	46.89	3.97	50.86	74.00	-23.14	peak	100	123
4	4882.000	39.45	3.97	43.42	54.00	-10.58	AVG	100	123
5	7323.000	41.71	8.28	49.99	74.00	-24.01	peak	100	223
6	7323.000	30.96	8.28	39.24	54.00	-14.76	AVG	100	223
Antenna Polarity & Test Distance: Vertical at 3 m									
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detecter	Antenna Height (cm)	Table Angle (Degree)
1#	2441.000	116.38	-1.70	114.68			peak	100	200
2#	2441.000	115.95	-1.70	114.25			AVG	100	200
3	4882.000	51.42	3.97	55.39	74.00	-18.61	peak	223	132
4	4882.000	44.12	3.97	48.09	54.00	-5.91	AVG	223	132
5	7323.000	42.12	8.28	50.40	74.00	-23.60	peak	123	178
6	7323.000	31.71	8.28	39.99	54.00	-14.01	AVG	123	178

Remarks:

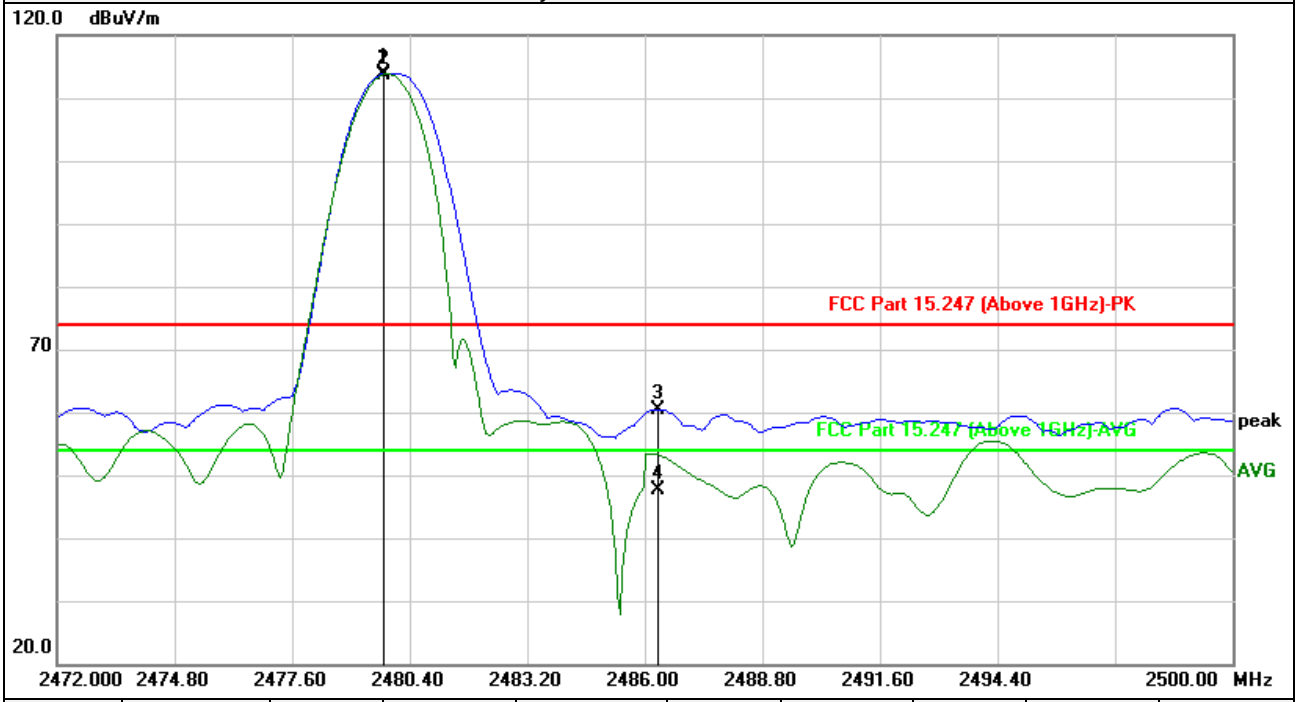
1.Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)

Margin value = Emission level – Limit value

2.#2441MHz: Fundamental frequency.

Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AVG)
Test Channel	Channel 78		

Antenna Polarity & Test Distance: Horizontal at 3 m



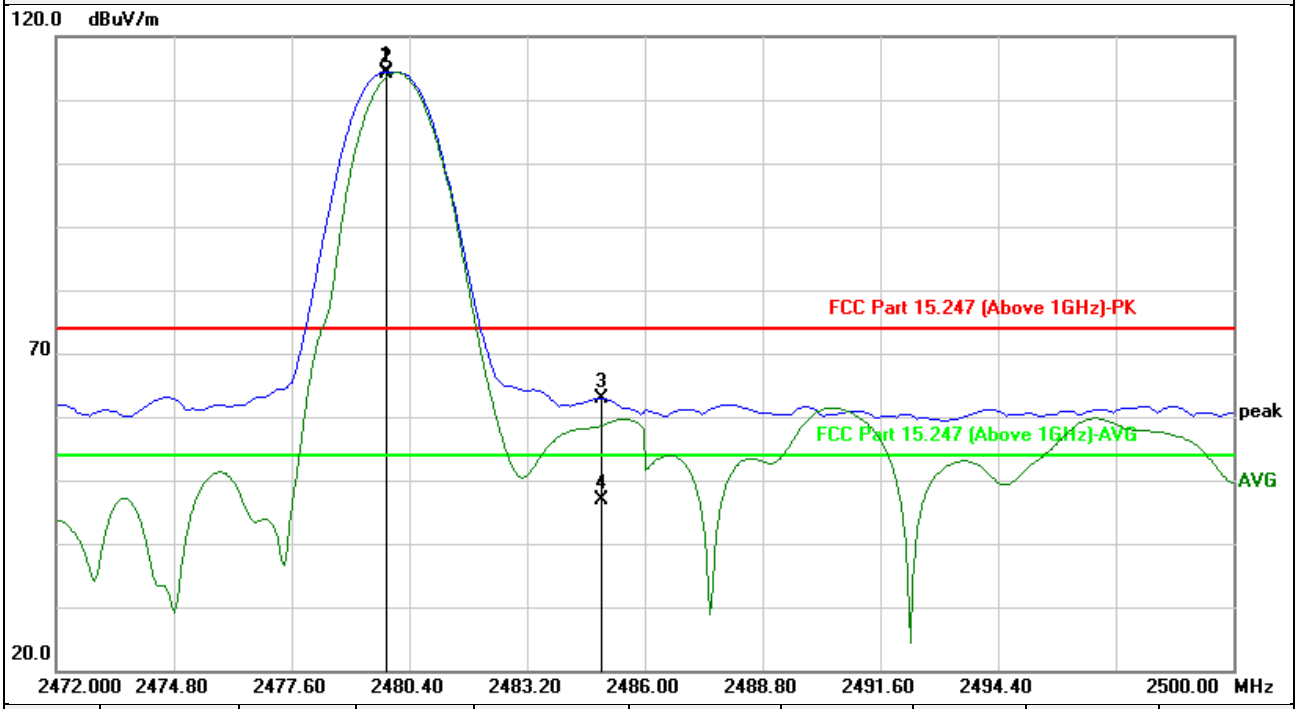
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detecter	Antenna Height (cm)	Table Angle (Degree)
1#	2479.800	115.13	-1.24	113.89			peak	100	233
2#	2479.800	114.92	-1.24	113.68			AVG	100	233
3	2486.309	61.69	-1.24	60.45	74.00	-13.55	peak	100	233
4	2486.309	48.80	-1.24	47.56	54.00	-6.44	AVG	100	233
5	4960.000	48.34	4.20	52.54	74.00	-21.46	peak	100	225
6	4960.000	40.67	4.20	44.87	54.00	-9.13	AVG	100	225
7	7440.000	43.19	8.43	51.62	74.00	-22.38	peak	100	217
8	7440.000	33.05	8.43	41.48	54.00	-12.52	AVG	100	217

Remarks:

1. Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
   Margin value = Emission level – Limit value
2. #2480MHz: Fundamental frequency.

Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AVG)
Test Channel	Channel 78		

Antenna Polarity & Test Distance: Vertical at 3 m



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detecter	Antenna Height (cm)	Table Angle (Degree)
1#	2479.856	115.56	-1.24	114.32			peak	100	110
2#	2479.856	115.33	-1.24	114.09			AVG	100	110
3	2484.962	64.18	-1.24	62.94	74.00	-11.06	peak	100	110
4	2484.962	48.11	-1.24	46.87	54.00	-7.13	AVG	100	110
5	4960.000	50.02	4.20	54.22	74.00	-19.78	peak	100	138
6	4960.000	42.82	4.20	47.02	54.00	-6.98	AVG	100	138
7	7440.000	45.08	8.43	53.51	74.00	-20.49	peak	157	177
8	7440.000	33.39	8.43	41.82	54.00	-12.18	AVG	157	177

Remarks:

1.Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)

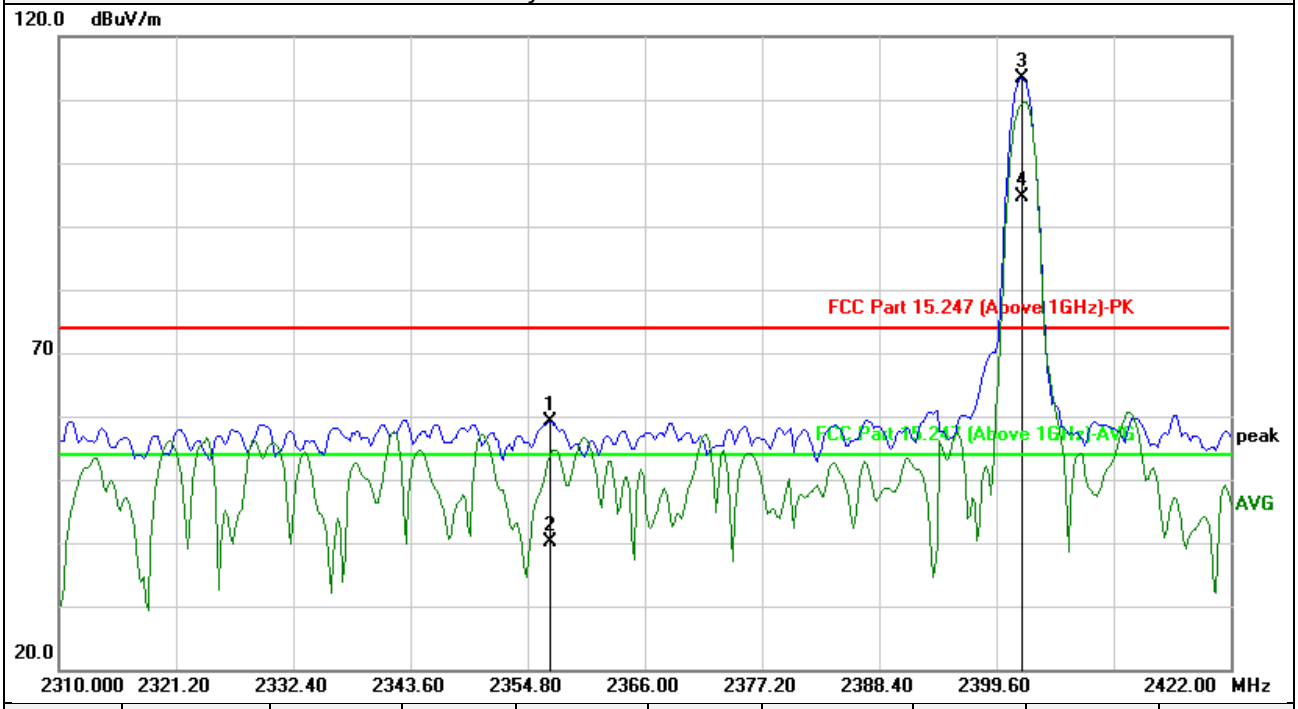
Margin value = Emission level – Limit value

2. #The 2480MHz: Fundamental frequency.

8DPSK

Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AVG)
Test Channel	Channel 0		

Antenna Polarity & Test Distance: Horizontal at 3 m



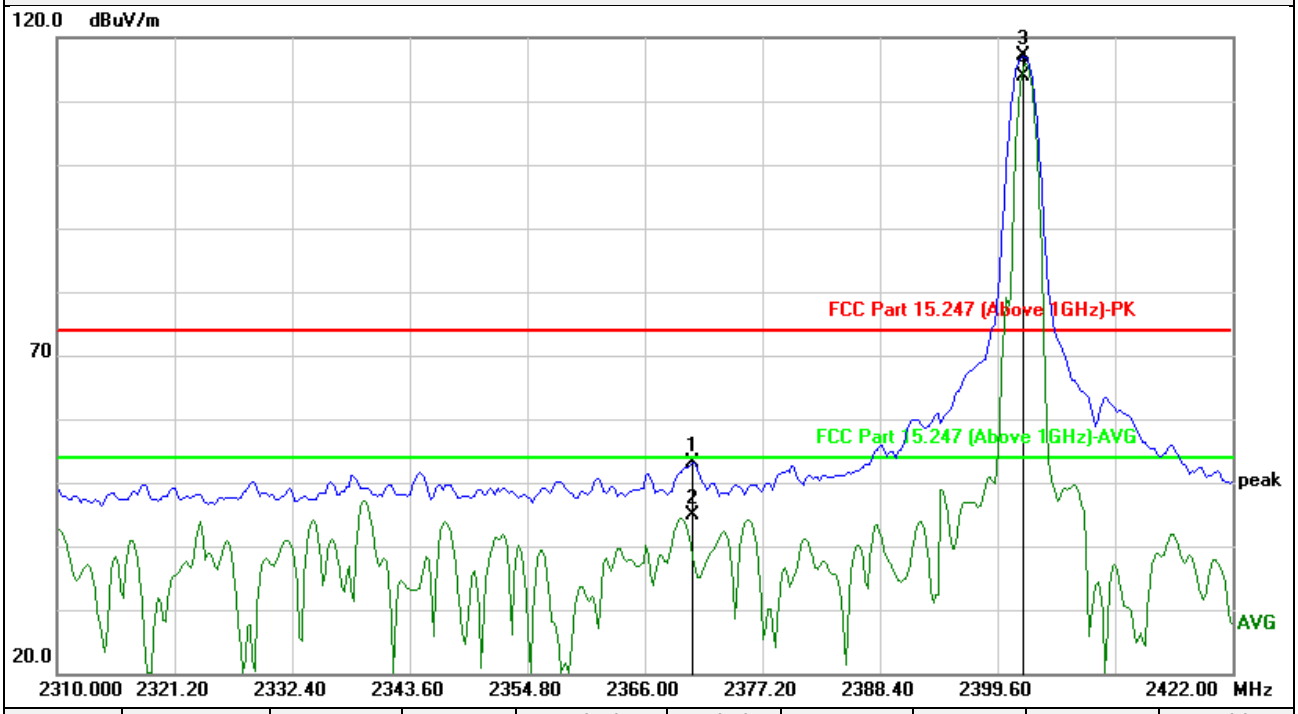
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detecter	Antenna Height (cm)	Table Angle (Degree)
1	2356.910	60.78	-1.74	59.04	74.00	-14.96	peak	100	230
2	2356.910	41.89	-1.74	40.15	54.00	-13.85	AVG	100	230
3#	2402.024	115.02	-1.73	113.29			peak	100	230
4#	2402.024	96.36	-1.73	94.63			AVG	100	230
5	4804.000	47.62	3.75	51.37	74.00	-22.63	peak	230	125
6	4804.000	37.91	3.75	41.66	54.00	-12.34	AVG	230	125
7	7206.000	44.38	8.14	52.52	74.00	-21.48	peak	335	239
8	7206.000	33.13	8.14	41.27	54.00	-12.73	AVG	335	239

Remarks:

3. Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
   Margin value = Emission level – Limit value
4. #2402MHz: Fundamental frequency.

Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AVG)
Test Channel	Channel 0		

Antenna Polarity & Test Distance: Vertical at 3 m



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detecter	Antenna Height (cm)	Table Angle (Degree)
1	2370.601	54.77	-1.74	53.03	74.00	-20.97	peak	100	110
2	2370.601	46.68	-1.74	44.94	54.00	-9.06	AVG	100	110
3#	2402.024	118.84	-1.73	117.11			peak	100	110
4#	2402.024	115.53	-1.73	113.80			AVG	100	110
5	4804.000	54.69	3.75	58.44	74.00	-15.56	peak	237	130
6	4804.000	43.69	3.75	47.44	54.00	-6.56	AVG	237	130
7	7206.000	44.16	8.14	52.30	74.00	-21.70	peak	100	181
8	7206.000	32.58	8.14	40.72	54.00	-13.28	AVG	100	181

Remarks:

1.Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)

Margin value = Emission level – Limit value

2.#2402MHz: Fundamental frequency.

Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AVG)
Test Channel	Channel 39		

Antenna Polarity & Test Distance: Horizontal at 3 m									
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detecter	Antenna Height (cm)	Table Angle (Degree)
1#	2441.000	111.18	-1.70	109.48			peak	100	245
2#	2441.000	99.34	-1.70	97.64			AVG	100	245
3	4882.000	46.96	3.97	50.93	74.00	-23.07	peak	100	121
4	4882.000	37.42	3.97	41.39	54.00	-12.61	AVG	100	121
5	7323.000	42.22	8.28	50.50	74.00	-23.50	peak	100	224
6	7323.000	30.50	8.28	38.78	54.00	-15.22	AVG	100	224
Antenna Polarity & Test Distance: Vertical at 3 m									
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detecter	Antenna Height (cm)	Table Angle (Degree)
1#	2441.000	110.62	-1.70	108.92			peak	100	169
2#	2441.000	106.94	-1.70	105.24			AVG	100	169
3	4882.000	53.36	3.97	57.33	74.00	-16.67	peak	216	133
4	4882.000	42.60	3.97	46.57	54.00	-7.43	AVG	216	133
5	7323.000	43.61	8.28	51.89	74.00	-22.11	peak	147	164
6	7323.000	30.95	8.28	39.23	54.00	-14.77	AVG	147	164

Remarks:

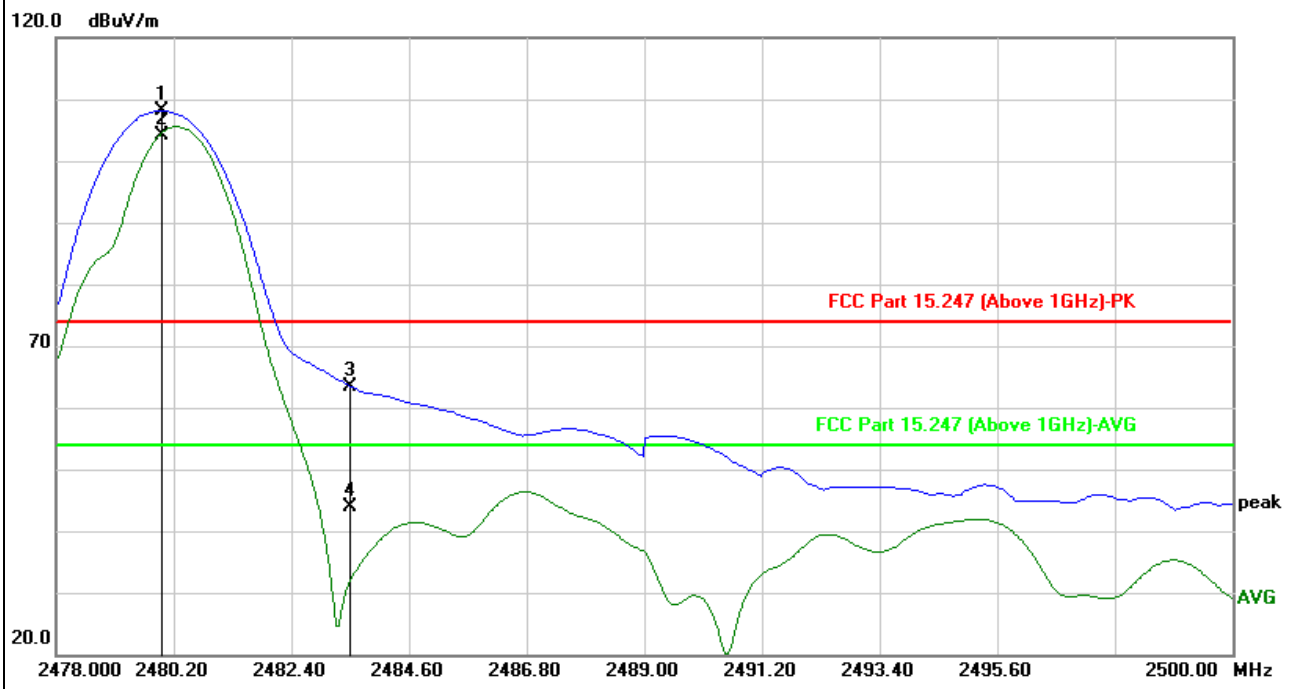
1.Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)

Margin value = Emission level – Limit value

2.#2441MHz: Fundamental frequency.

Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AVG)
Test Channel	Channel 78		

Antenna Polarity & Test Distance: Horizontal at 3 m



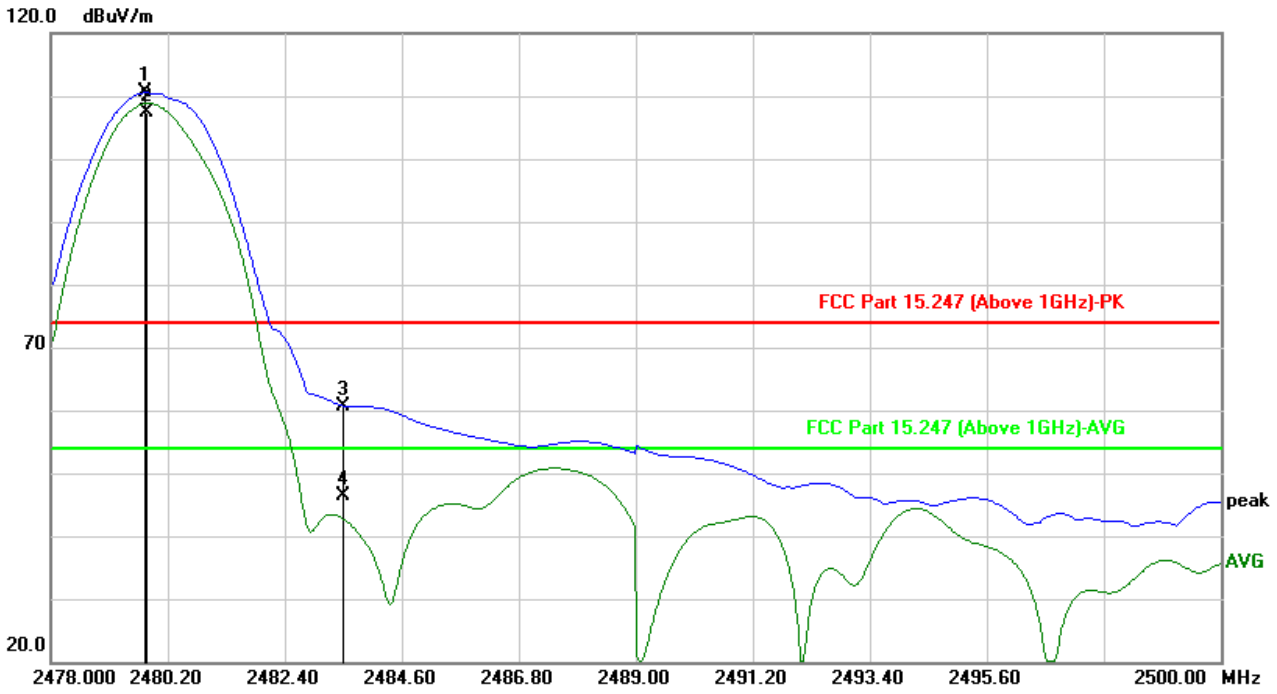
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detecter	Antenna Height (cm)	Table Angle (Degree)
1#	2479.984	110.48	-2.29	108.19			peak	100	218
2#	2479.984	106.48	-2.29	104.19			AVG	100	218
3	2483.500	65.74	-2.29	63.45	74.00	-10.55	peak	100	218
4	2483.500	46.06	-2.29	43.77	54.00	-10.23	AVG	100	218
5	4960.000	48.17	4.20	52.37	74.00	-21.63	peak	100	127
6	4960.000	38.42	4.20	42.62	54.00	-11.38	AVG	100	127
7	7440.000	41.69	8.43	50.12	74.00	-23.88	peak	211	203
8	7440.000	32.47	8.43	40.90	54.00	-13.10	AVG	211	203

Remarks:

3. Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
   Margin value = Emission level – Limit value
4. #2480MHz: Fundamental frequency.

Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AVG)
Test Channel	Channel 78		

Antenna Polarity & Test Distance: Vertical at 3 m



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detecter	Antenna Height (cm)	Table Angle (Degree)
1#	2479.764	112.81	-2.29	110.52			peak	270	190
2#	2479.808	109.77	-2.29	107.48			AVG	270	190
3	2483.500	63.03	-2.29	60.74	74.00	-13.26	peak	270	190
4	2483.500	48.70	-2.29	46.41	54.00	-7.59	AVG	270	190
5	4960.000	49.60	4.20	53.80	74.00	-20.20	peak	100	138
6	4960.000	41.05	4.20	45.25	54.00	-8.75	AVG	100	138
7	7440.000	44.74	8.43	53.17	74.00	-20.83	peak	131	183
8	7440.000	32.73	8.43	41.16	54.00	-12.84	AVG	1313	183

Remarks:

1.Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)

Margin value = Emission level – Limit value

2. #The 2480MHz: Fundamental frequency.

3.2 Conducted Emission Measurement

3.2.1 Limits of Conducted Emission Measurement

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	60	50

Note: 1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

3.2.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Due Date of Calibration
EMI Test Receiver Rohde&Schwarz	ESCI3	101418	2022/09/12
Artificial Mains Network Rohde&Schwarz	ENV216	3560.6550.15	2022/09/12
Test software FARAD	EZ_EMC V1.1.4.2	N/A	N/A
Hygrothermograph Yuhuaze	HTC-1	NA	2022/09/12
Digital Multimeter FLUKE	15B+	43512617WS	2022/09/12

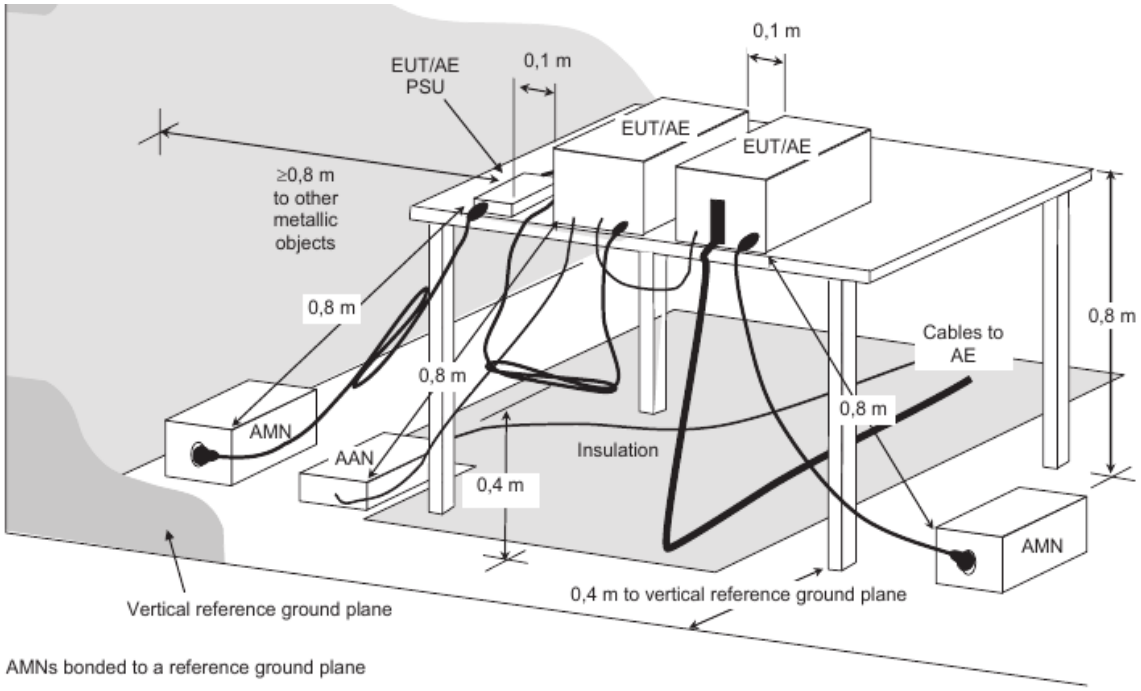
Note: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA.
2. The test was performed in Shielded Room 1.

3.2.3 Test Procedures

a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit – 20dB)was not recorded.

Note: All modes of operation were investigated and the worst-case emissions are reported.

3.2.4 Test Setup



AMNs bonded to a reference ground plane

For the actual test configuration, please refer to the attached file (Test Setup Photo).

3.2.5 EUT Operating Condition

Set the EUT under transmission condition continuously at specific channel frequency.

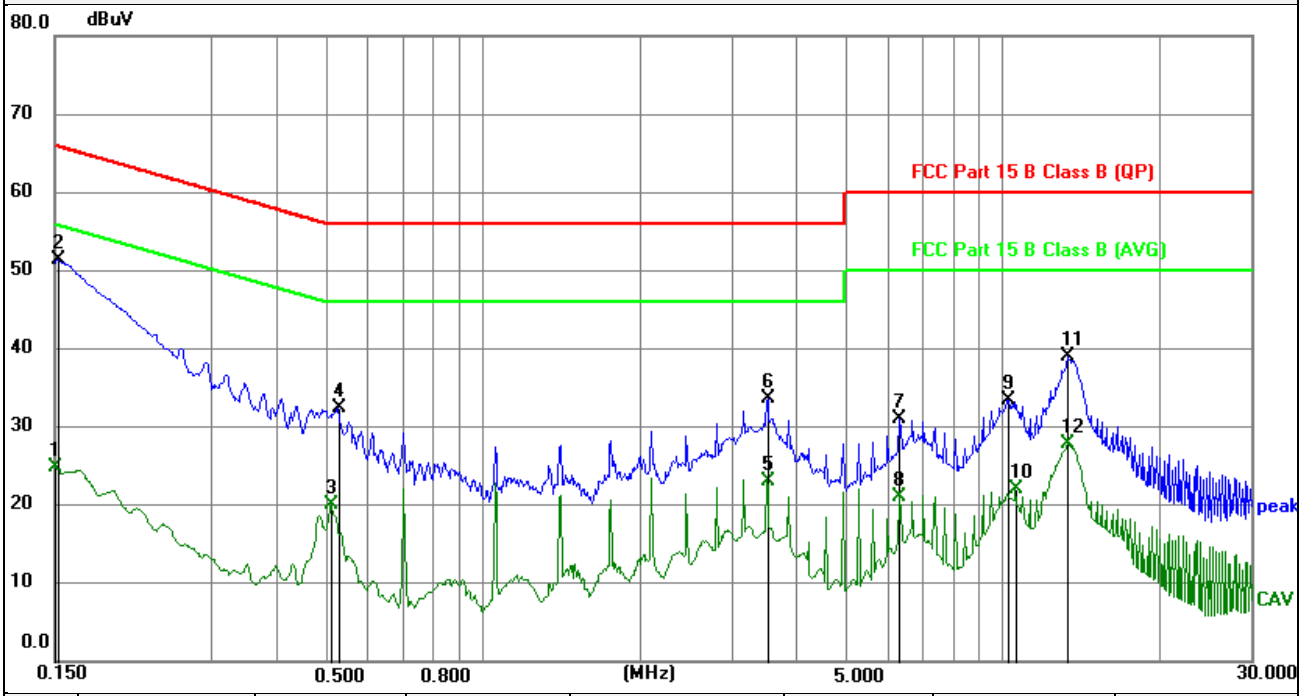
3.2.6 Deviation from Test Standard

No deviation.

3.2.7 Test Results

Frequency Range	150kHz ~ 30MHz	Detector Function & Resolution andwidth	Quasi-Peak (QP) / Average (AV), 9kHz

Phase of Power: Line (L)



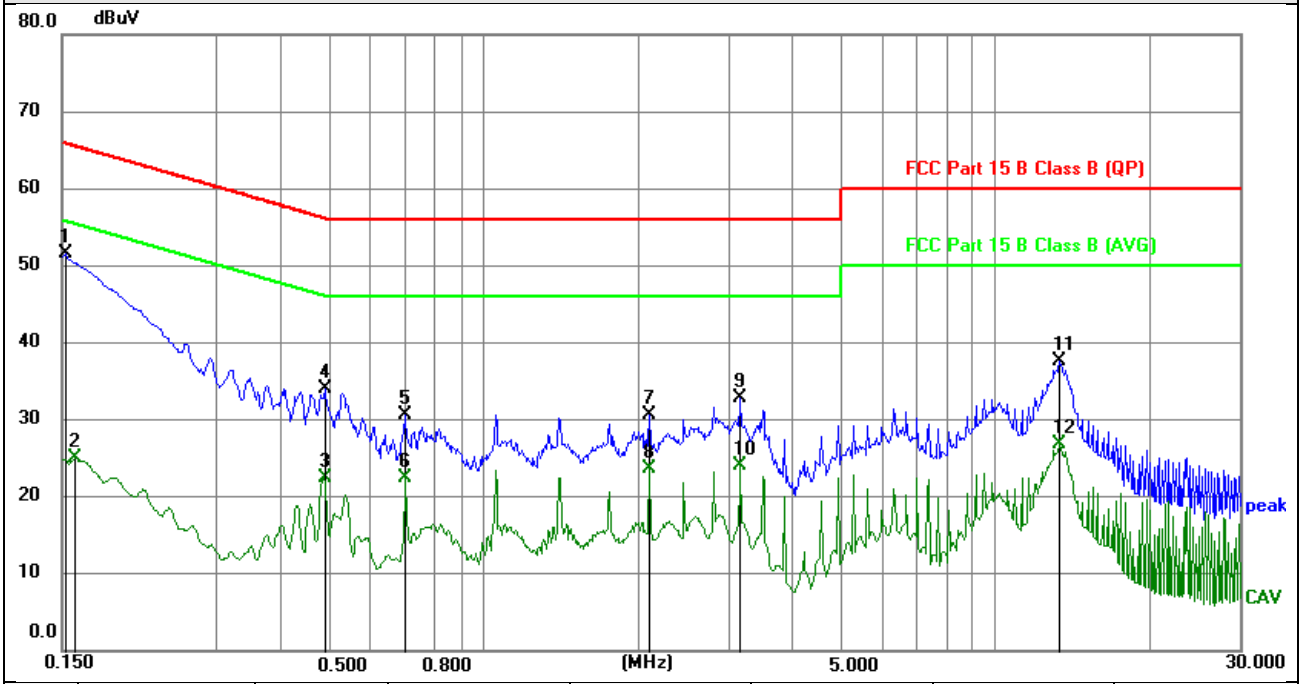
No.	Frequency	Reading	Correcttion Factor	Emission Level	Limit	Margin	Remark
	(MHz)	(dBuV)	dB	(dBuV)	(dBuV)	(dB)	Detecter
1	0.1500	14.73	10.19	24.92	56.00	-31.08	AVG
2	0.1522	41.28	10.18	51.46	65.88	-14.42	peak
3	0.5122	10.01	10.10	20.11	46.00	-25.89	AVG
4	0.5280	22.33	10.10	32.43	56.00	-23.57	peak
5	3.5273	12.90	10.10	23.00	46.00	-23.00	AVG
6	3.5295	23.45	10.10	33.55	56.00	-22.45	peak
7	6.3510	21.06	10.00	31.06	60.00	-28.94	peak
8	6.3510	10.98	10.00	20.98	50.00	-29.02	AVG
9	10.2323	23.32	10.11	33.43	60.00	-26.57	peak
10	10.5833	11.89	10.12	22.01	50.00	-27.99	AVG
11	13.4070	28.87	10.22	39.09	60.00	-20.91	peak
12	13.4070	17.59	10.22	27.81	50.00	-22.19	AVG

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level - Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value.

Frequency Range	150kHz ~ 30MHz	Detector Function & Resolution andwidth	Quasi-Peak (QP) / Average (AV), 9kHz

Phase of Power: Neutral (N)



No.	Frequency	Reading	Correct Factor	Emission Level	Limit	Margin	Remark
	(MHz)	(dBuV)	dB	(dBuV)	(dBuV)	(dB)	Detecter
1	0.1522	41.34	10.18	51.52	65.88	-14.36	peak
2	0.1590	14.79	10.17	24.96	55.52	-30.56	AVG
3	0.4875	12.37	10.11	22.48	46.21	-23.73	AVG
4	0.4897	23.84	10.11	33.95	56.17	-22.22	peak
5	0.7035	20.62	10.10	30.72	56.00	-25.28	peak
6	0.7056	12.39	10.10	22.49	46.00	-23.51	AVG
7	2.1165	20.47	10.10	30.57	56.00	-25.43	peak
8	2.1165	13.56	10.10	23.66	46.00	-22.34	AVG
9	3.1762	22.63	10.09	32.72	56.00	-23.28	peak
10	3.1762	13.96	10.09	24.05	46.00	-21.95	AVG
11	13.4070	27.34	10.25	37.59	60.00	-22.41	peak
12	13.4070	16.66	10.25	26.91	50.00	-23.09	AVG

Remarks:

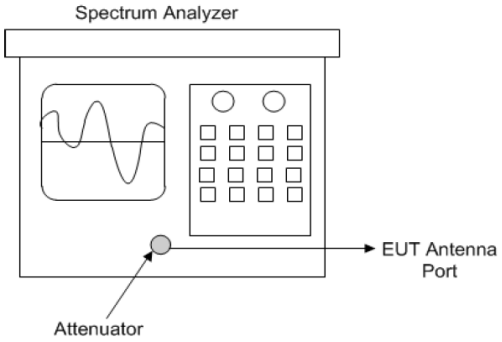
1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level - Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value.

3.3 Number of Hopping Frequency Used

3.3.1 Limits of Hopping Frequency Used Measurement

At least 15 channels frequencies, and should be equally spaced.

3.3.2 Test Setup



Spectrum analyzer test configuration

3.3.3 Test Instruments

Refer to section 5 to get information of above instrument.

3.3.4 Test Procedure

a. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
c. Set the SA on MaxHold Mode, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been recorded.
d. Set the SA on View mode and then plot the result on SA screen.
e. Repeat above procedures until all frequencies measured were complete.

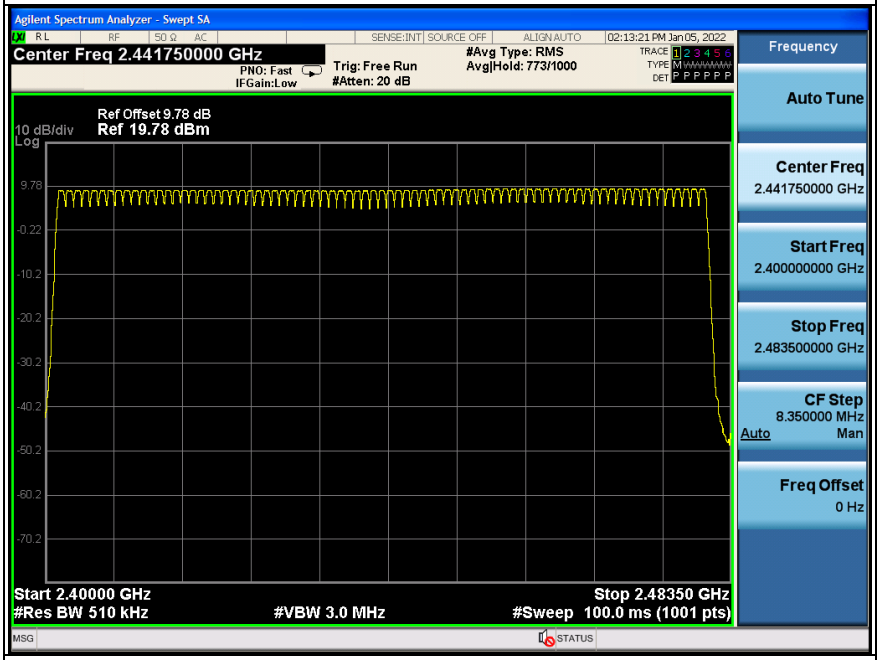
3.3.5 Deviation fromTest Standard

No deviation.

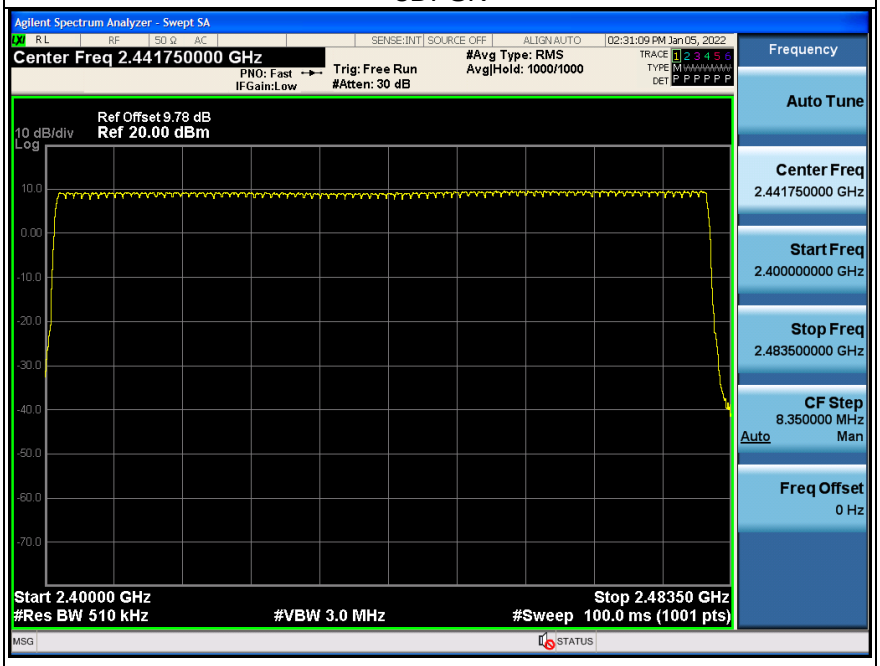
3.3.6 Test Results

There are 79 hopping frequencies in the hopping mode. Please refer to next page for the test result. On the plots, it shows that the hopping frequencies are equally spaced.

GFSK



8DPSK

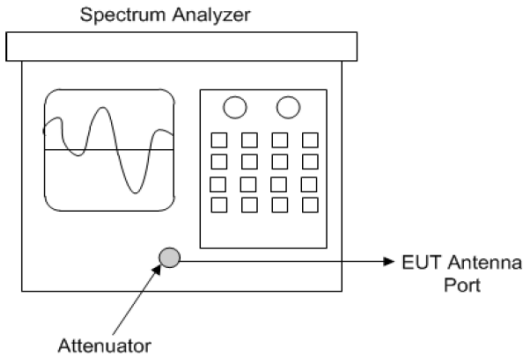


3.4 Dwell Time on Each Channel

3.4.1 Limits of Dwell Time on Each Channel Measurement

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.

3.4.2 Test Setup



Spectrum analyzer test configuration

3.4.3 Test Instruments

Refer to section 5 to get information of above instrument.

3.4.4 Test Procedures

a. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
c. Adjust the center frequency of SA on any frequency be measured and set SA to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
d. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
e. Repeat above procedures until all different time-slot modes have been completed.

3.4.5 Deviation from Test Standard

No deviation.

3.4.6 Test Results

GFSK

Mode	Number of Hopping Channel	Number of transmision in a period (channel number*0.4 sec)				Length of transmission time (msec)	Result (msec)	Limit (msec)	Verdict
		Period (sec)	Sweep time (sec)	times in a sweep	times in a period				
DH1	79	31.6	3.16	32	320	0.386	123.52	400	Pass
DH3	79	31.6	3.16	16	160	1.642	262.72	400	Pass
DH5	79	31.6	3.16	11	110	2.890	317.90	400	Pass

Note: Test plots of the transmitting time slot are shown as below.

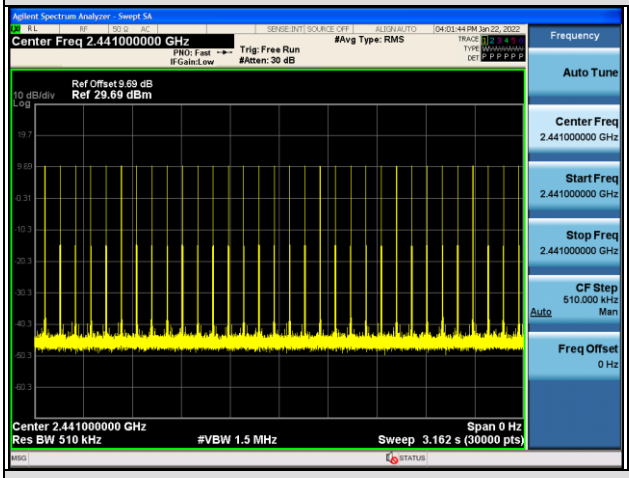
8DPSK

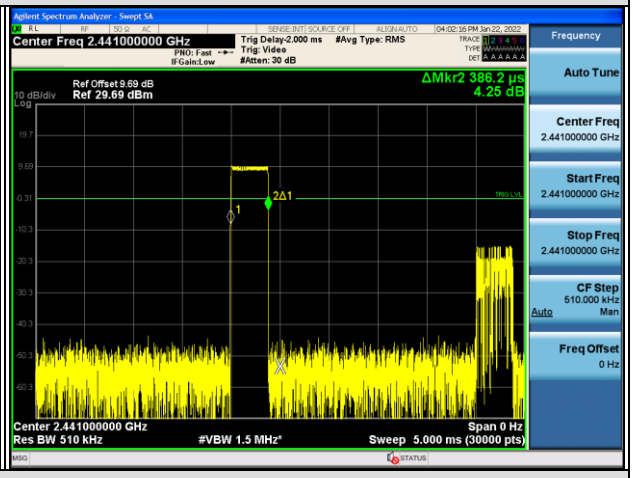
Mode	Number of Hopping Channel	Number of transmision in a period (channel number*0.4 sec)				Length of transmission time (msec)	Result (msec)	Limit (msec)	Verdict
		Period (sec)	Sweep time (sec)	times in a sweep	times in a period				
3DH1	79	31.6	3.16	32	320	0.397	127.04	400	Pass
3DH3	79	31.6	3.16	16	160	1.647	263.52	400	Pass
3DH5	79	31.6	3.16	10	100	2.898	289.80	400	Pass

Note: Test plots of the transmitting time slot are shown as below.

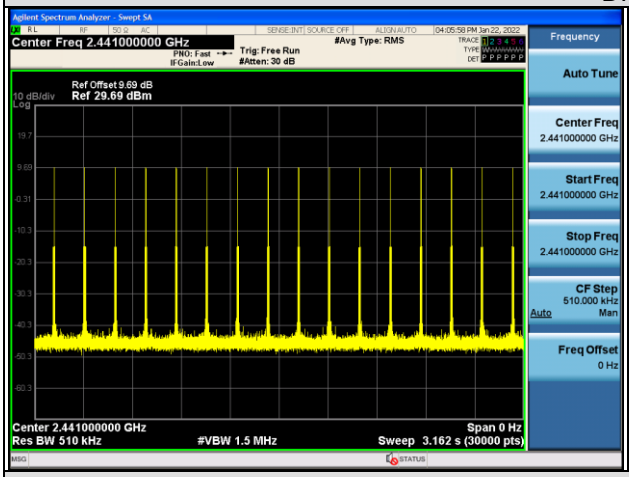
GFSK

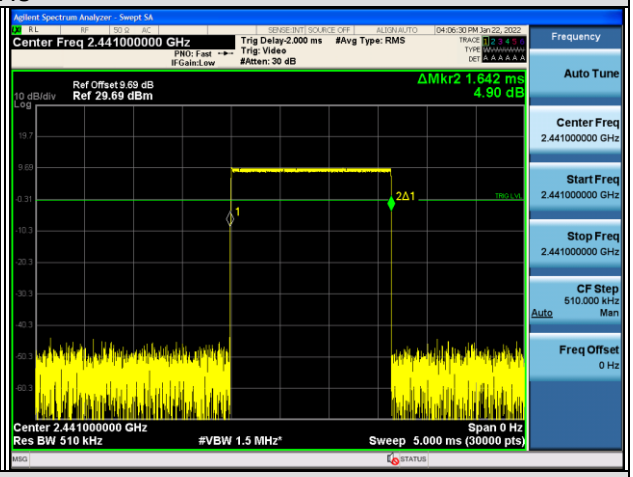
DH1



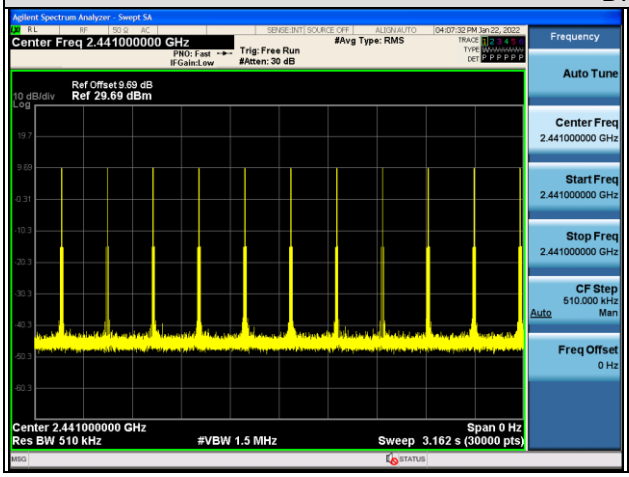


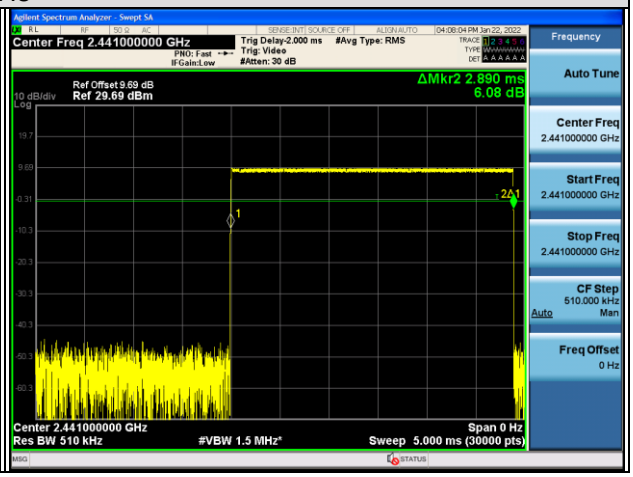
DH3





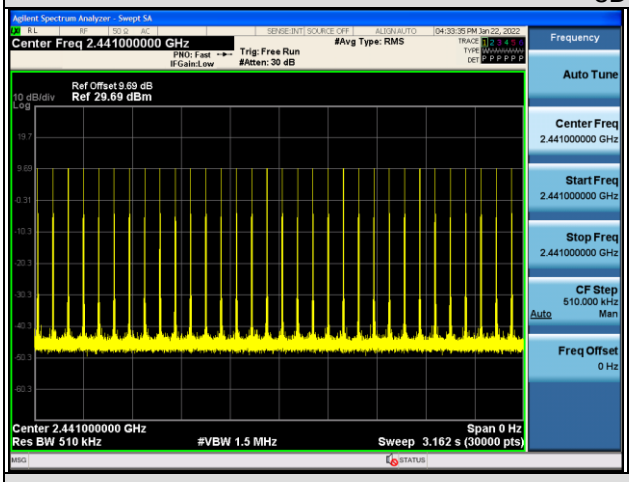
DH5

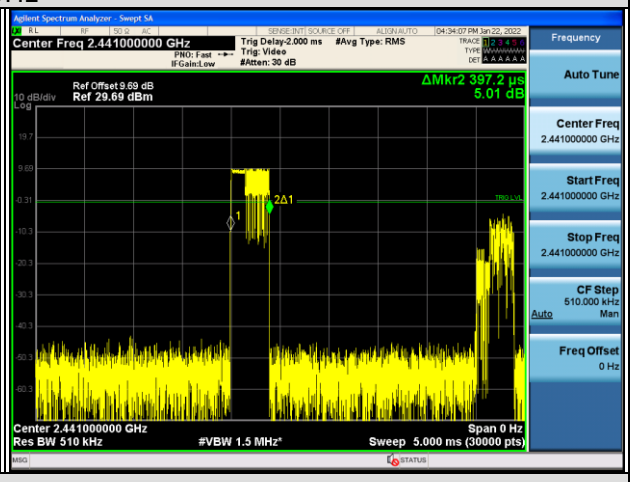




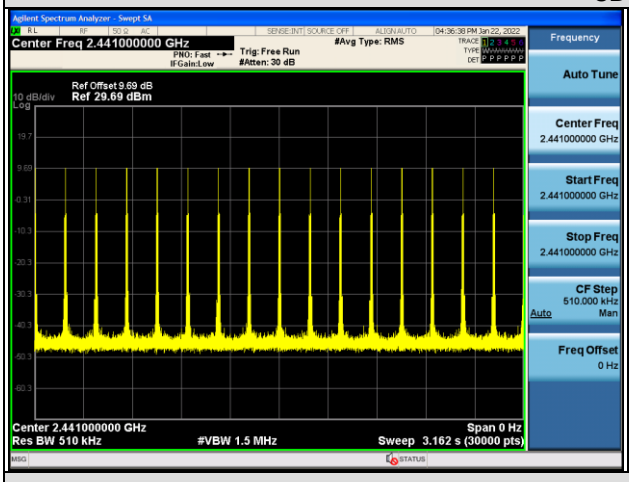
8DPSK

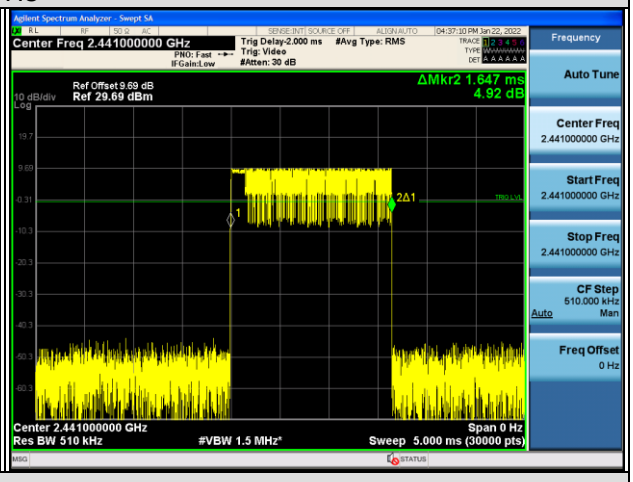
3DH1



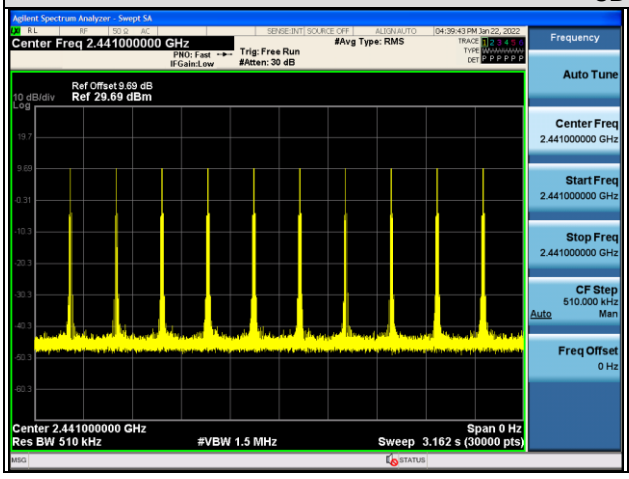


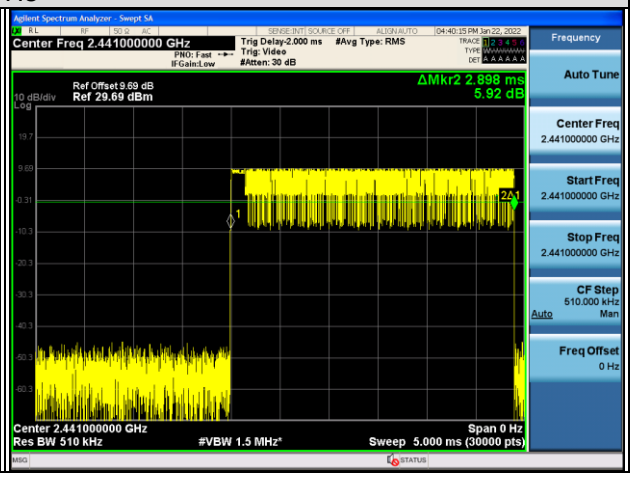
3DH3





3DH5



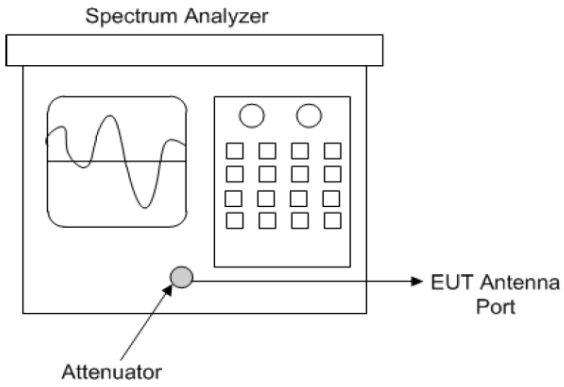


3.5 Channel Bandwidth

3.5.1 Limits of Channel Bandwidth Measurement

For frequency hopping system operating in the 2400-2483.5 MHz, if the 20 dB bandwidth of hopping channel is greater than 25 kHz, two-thirds 20 dB bandwidth of hopping channel shell be a minimum limit for the hopping channel separation.

3.5.2 Test Setup



Spectrum analyzer test configuration

3.5.3 Test Instruments

Refer to section 5 to get information of above instrument.

3.5.4 Test Procedure

a. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the instrument equal to the highest peak value.
c. Measure the frequency difference of two frequencies that were attenuated 20 dB from the reference level. Record the frequency difference as the emission bandwidth.
d. Repeat above procedures until all frequencies measured were complete.

3.5.5 Deviation from Test Standard

No deviation.

3.5.6 EUT Operating Condition

The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

3.5.7 Test Results

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	
		GFSK	8DPSK
0	2402	0.966	1.320
39	2441	0.963	1.305
78	2480	0.966	1.338