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Release Control Record

Issue No.	Description	Date Issued
210128EL19-RF-US-01	Original Release	Sep. 27, 2021



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.
15.205 & 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.
15.247(a)(2)	6dB Bandwidth	Pass	Meet the requirement of limit.
---	Occupied Bandwidth Measurement	Pass	Reference only
15.247(b)	Conducted power	Pass	Meet the requirement of limit.
15.247(e)	Power Spectral Density	Pass	Meet the requirement of limit.
15.203	Antenna Requirement	Pass	No antenna connector is used. The device is professionally installed

Note: The EUT has been verified to comply with the requirements of FCC Part 15, Subpart B, Class B (DoC). 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 EUT as specified in CISPR 16-4-2:

The listed uncertainties are the worst cases 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	Expanded Uncertainty (k=2) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	2.66 dB
Radiated Emissions up to 1 GHz	9KHz ~ 30MHz	2.90dB
	30MHz ~ 1000MHz	3.47 dB
Radiated Emissions above 1 GHz	1GHz ~ 18GHz	4.84 dB
	18GHz ~ 40GHz	4.62 dB

1.2 Modification Record

There were no modifications required for compliance.



2. General Information

2.1 General Description of EUT

Product	Bluetooth and ANC Headphone
Brand	Mark Levinson
Test Model(s)	No5909
Series Model(s)	N/A
FCC ID:	APIMLNO5909
Status of EUT	Engineeringprototype
Power Supply Rating	DC5V from USB or DC 3.7V from battery
Modulation Type	BT-LE(GFSK)
Transfer Rate	1 Mbps/2 Mbps
Operating Frequency	2402 ~ 2480MHz
Number of Channel	40
Maximum Output Power	1.1070mW
Antenna Type	PFCB antenna with1.47dBi gain
Antenna Connector	I-PEX
Radio HW	V2.3
Radio FW	V1208
Accessory Device	Aux in Line: 125cm; DC Line: 132cm Please see Note 1
Data Cable Supplied	N/A

Note:

1. Please refer to the EUT photo document (Reference No.: 210128EL19) 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 Channels

40 channels are provided to this EUT:

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

2.3 Test Mode Applicability and Tested Channel Detail

EUT Configure Mode	Applicable test items	X-Axis	Y-Axis	Z-Axis	Voltage Supply
Radiated	AC Power Conducted Emission	N/A	N/A	N/A	DC3.7V from battery
Radiated	Radiated Emissions	√	√	√*	
Antenna Port Conducted Measurement	Band Edge Measurement	N/A	N/A	N/A	
	Antenna Port Emission	N/A	N/A	N/A	
	6dB Bandwidth	N/A	N/A	N/A	
	Occupied Bandwidth Measurement	N/A	N/A	N/A	
	Conducted power	N/A	N/A	N/A	
	Power Spectral Density	N/A	N/A	N/A	

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

Test Condition:

Applicable test items	Environmental Conditions	Power supply	Tested by
AC Power Conducted Emission	25deg. C, 65%RH	DC5V from USB	Banson
Radiated Emissions	25deg. C, 65%RH	DC3.7V from battery	Jim Xu
Antenna Port Conducted Measurement	25deg. C, 65%RH	DC3.7V from battery	Dragonlong



Radiated Emission Test (Above 1GHz):

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.

EUT Configure Mode	Available Channel	Tested Channel	Modulation Type	Data Rate (Mbps)
-	0 to 39	0, 19, 39	GFSK	1
-	0 to 39	0, 19, 39	GFSK	2

Radiated Emission Test (Below 1GHz):

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.

EUT Configure Mode	Available Channel	Tested Channel	Modulation Type	Data Rate (Mbps)
-	0 to 39	0	GFSK	1

Power Line Conducted Emission Test:

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.

EUT Configure Mode	Available Channel	Tested Channel	Modulation Type	Data Rate (Mbps)
-	0 to 39	0, 19, 39	GFSK	1

Antenna Port Conducted Measurement:

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

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.

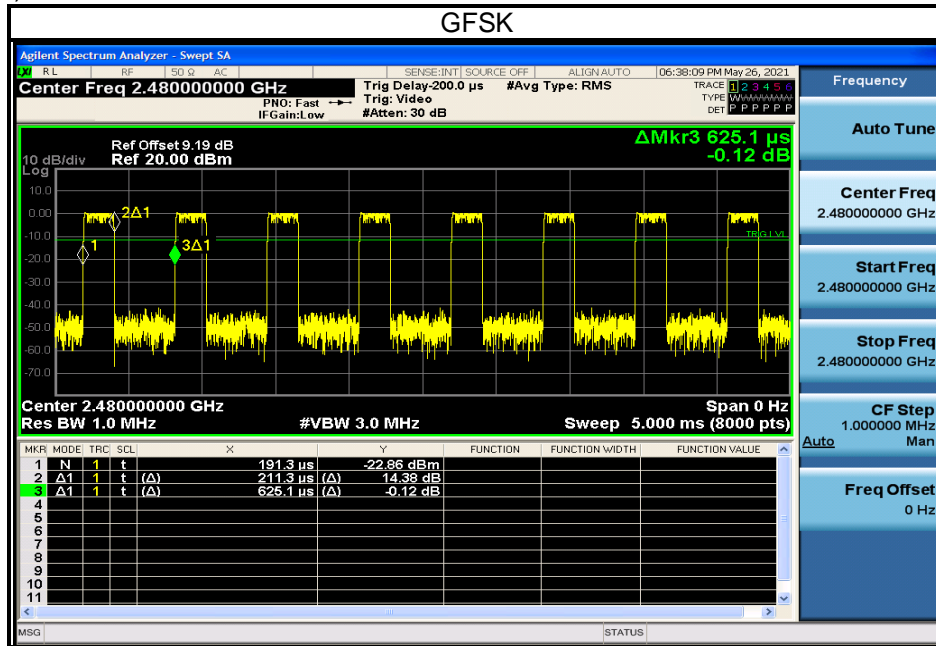
EUT Configure Mode	Available Channel	Tested Channel	Modulation Type	Data Rate (Mbps)
-	0 to 39	0, 19, 39	GFSK	1
-	0 to 39	0, 19, 39	GFSK	2



2.4 Duty Cycle of Test Signal

GFSK: Duty cycle of test signal is 33.80%, Duty cycle of test signal is <98%

$$10 * \log(1/0.338) = 4.71\text{dB}$$





2.5 Description of Support Units

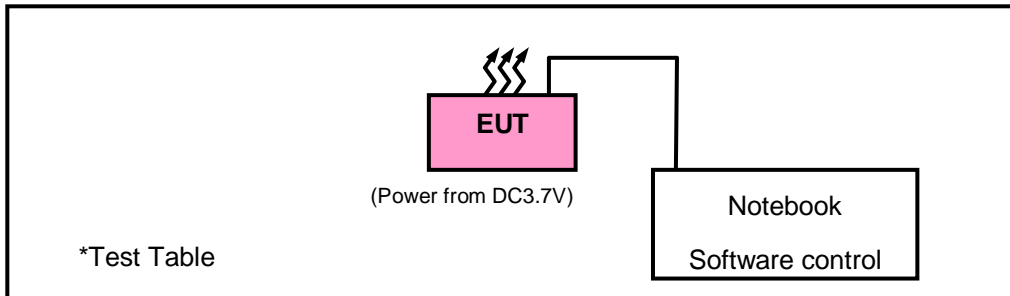
The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

No.	Product	Brand	Model No.	Serial No.	FCC ID
1.	Notebook	Lenovo	TP0093A	PF-12HMBU	N/A

Insert Cable Connections to/from EUT provided by test team.

No.	Signal Cable Description Of The Above Support Units
1.	USB Line: Un-shielding 1.0m

2.6 Configuration of System under Test





3. Test Types and Results

3.1 Radiated Emission and Band-edge Measurement

3.1.1 Limits of radiated emission and band-edge 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 20dB 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

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 1000MHz, 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 20dB under any condition of modulation.



3.1.2 Test Instruments

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
EMI Test Receiver	Rohde&Schwarz	ESCI 7	100962	2021/01/06	2022/01/05
Broadband antenna	Schwarzbeck	VULB 9168	00937	2021/04/16	2022/04/15
3m Semi-anechoic Chamber	MAORUI	9m*6m*6m	NSEMC003	2021/04/15	2022/04/14
Signal Amplifier	Com-power	PAM-103	18020051	2021/03/15	2022/03/14
Attenuator	Rohde&Schwarz	TS2GA-6dB	18101101	N/A	N/A
Test software	FARAD	FARAD	EZ_EMCV1.1.4.2	N/A	N/A
Fixed Attenuator	Mini-Circuits	MDCS18N-10	MDCS18N-10-01	2020/10/18	2021/10/17
Loop Antenna	EMCI	HLA 6121	45745	2020/04/14	2022/04/13
Preamplifier	EMCI	EMC001340	980201	2020/10/18	2021/10/17
Digital Multimeter	FLUKE	15B+	43512617WS	2020/09/17	2021/09/16
Horn Antenna	Schwarzbeck	BBHA 9170	01959	2020/04/16	2022/04/15
Spectrum Analyzer	Rohde&Schwarz	FSV-40N	101783	2021/03/15	2022/03/14
Broadband Coaxial Preamplifier	Schwarzbeck	BBV 9718	00025	2021/03/15	2022/03/14
Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170242	2020/04/16	2022/04/15
Pre-Amplifier	EMCI	EMC 184045	980102	2021/03/15	2022/03/14
Antenna Tower	MF	MFA-440H	NA	NA	NA
Turn Table	MF	MFT-201SS	NA	NA	NA
Antenna Tower&Turn Table Controller	MF	MF-7802	NA	NA	NA
Spectrum	Keysight	N9020A	MY51240612	2020/09/17	2021/09/16
Power Meter 10Hz~18GHz	Tonscend	JS0806-2	188060126	2020/09/17	2021/09/16
Spectrum Analyzer	Rohde&Schwarz	FSV-40N	101783	2020/09/17	2021/09/16
Signal generator	Keysight	N5182A	GB40051020	2020/09/17	2021/09/16
Signal generator	Keysight	N5182A	MY47420944	2020/09/17	2021/09/16
Universal Switch Control Unit	Rohde&Schwarz	CMW500	12010002K50	2020/09/17	2021/09/16
Test Software	Tonscend	JS0806-2	NA	NA	NA

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



3.1.3 Test Procedures

- a. 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.
- b. 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 1 meters away from the interference-receiving antenna (18-40GHz).
- c. 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.
- d. 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.
- e. 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.
- f. 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. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz & 360kHz for Quasi-peak detection (QP) at frequency below 1 GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 1/T for Average (Duty cycle < 98 %) detection at frequency above 1 GHz.
4. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.
5. All modes of operation were investigated and the worst-case emissions are reported.

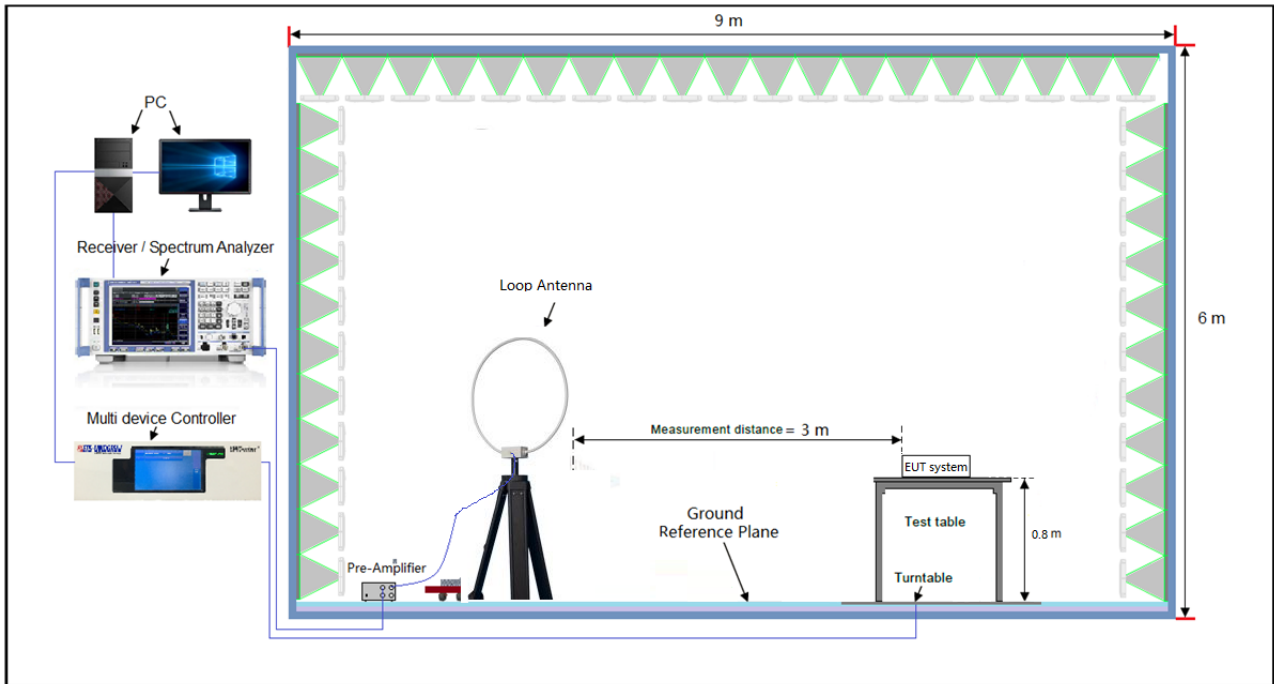
3.1.4 Deviation from Test Standard

No deviation.

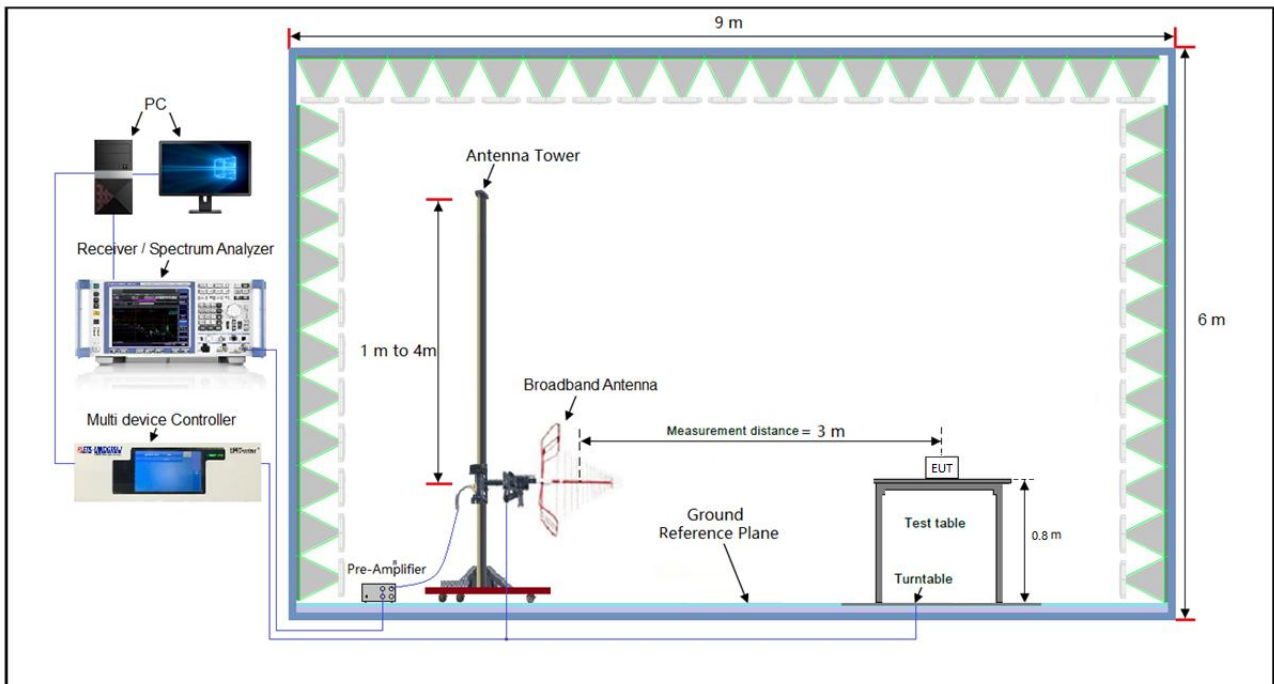


3.1.5 Test Setup

Radiated emission below 30MHz:

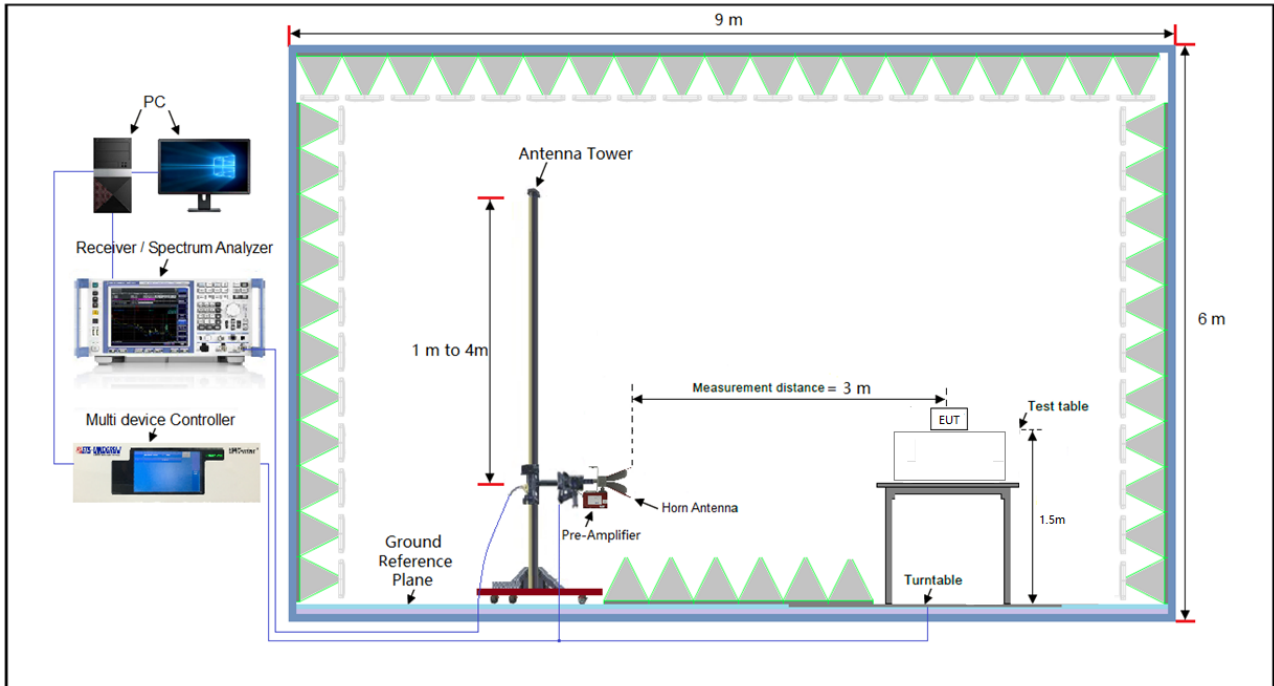


Frequency Range below 1GHz:

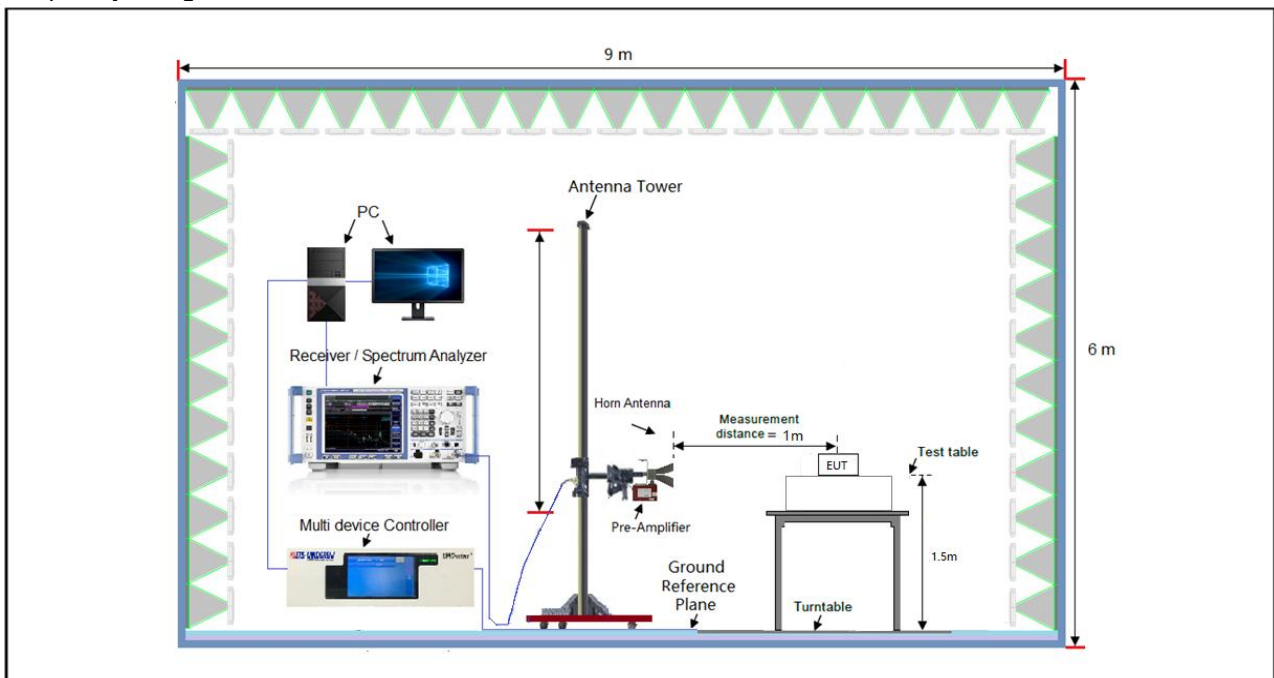




Frequency Range 1-18GHz:



Frequency Range 18-40GHz:



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

3.1.6 EUT Operating Conditions

- Placed the EUT on the testing table.
- Set the EUT under transmission condition continuously at specific channel frequency.



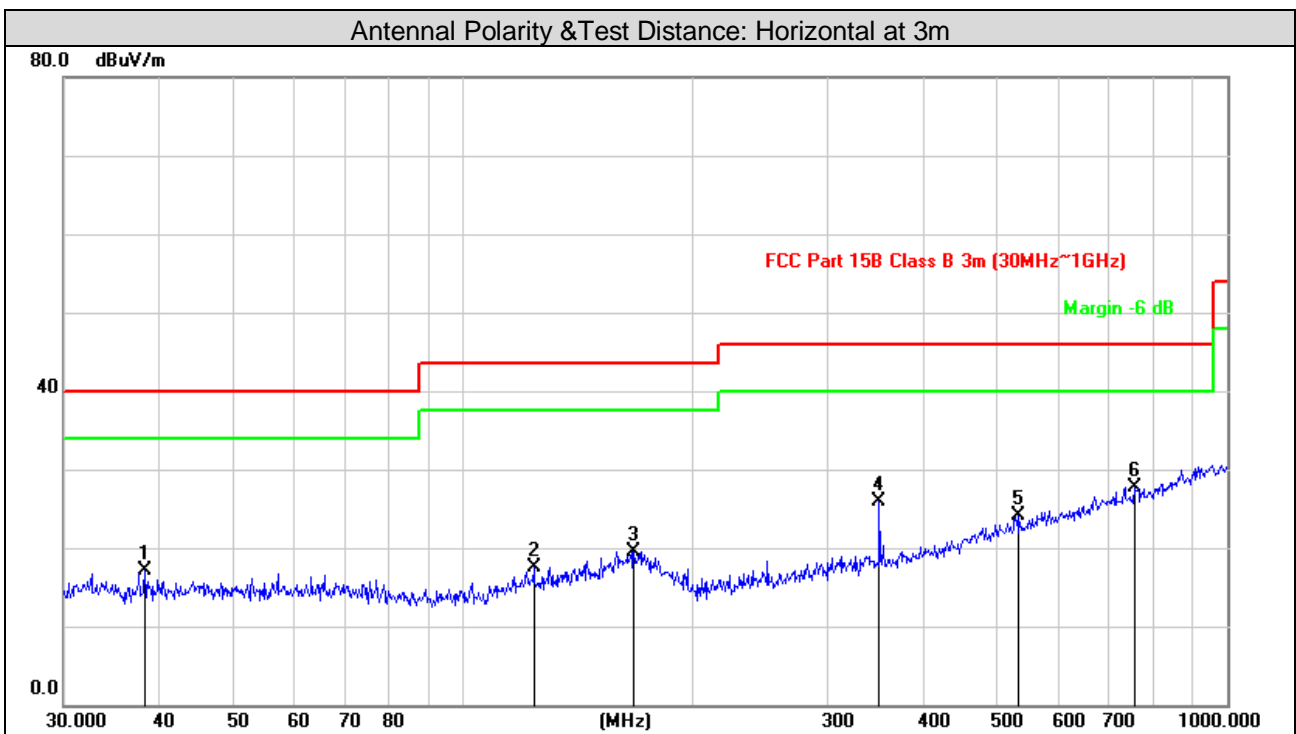
3.1.7 Test Results

9kHz ~ 30MHz Data:

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

30MHz ~ 1GHz Worst-Case Data:

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



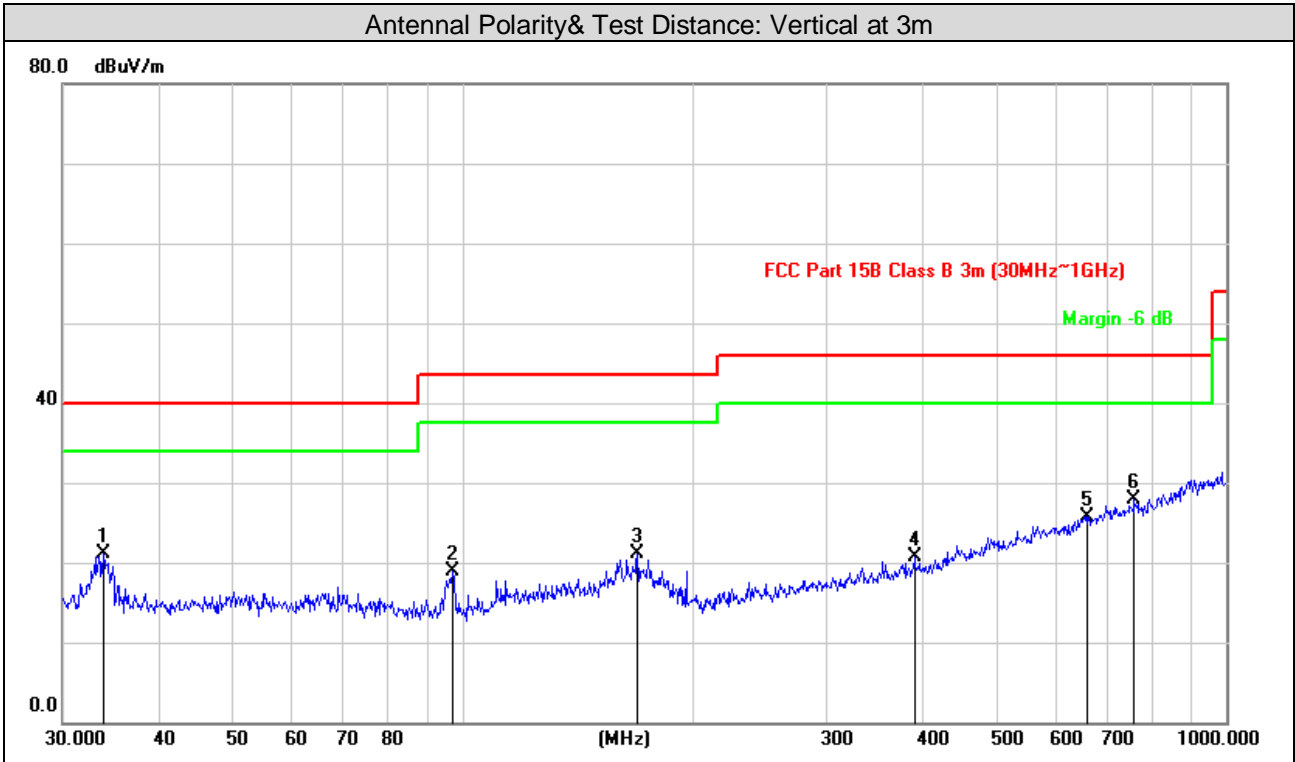
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Height (cm)	Table Angle (Degree)	Remark
1	38.3462	33.68	-16.58	17.10	40.00	-22.90	peak	200	146	
2	123.6985	33.28	-15.86	17.42	43.50	-26.08	peak	200	164	
3	167.2368	32.26	-12.68	19.58	43.50	-23.92	peak	300	288	
4	350.4768	38.59	-12.64	25.95	46.00	-20.05	peak	200	257	
5	531.9635	32.61	-8.43	24.18	46.00	-21.82	peak	200	142	
6	755.3873	31.57	-3.86	27.71	46.00	-18.29	peak	200	271	

Remarks:

1. Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
2. Margin value = Emission level – Limit value



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



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Height (cm)	Table Angle (Degree)	Remark
1	33.9174	37.74	-16.60	21.14	40.00	-18.86	peak	100	168	
2	97.1148	36.64	-17.66	18.98	43.50	-24.52	peak	100	148	
3	169.5990	33.77	-12.61	21.16	43.50	-22.34	peak	100	258	
4	390.7226	32.59	-11.98	20.61	46.00	-25.39	peak	200	113	
5	658.8362	31.32	-5.52	25.80	46.00	-20.20	peak	100	242	
6	758.0408	31.71	-3.83	27.88	46.00	-18.12	peak	100	278	

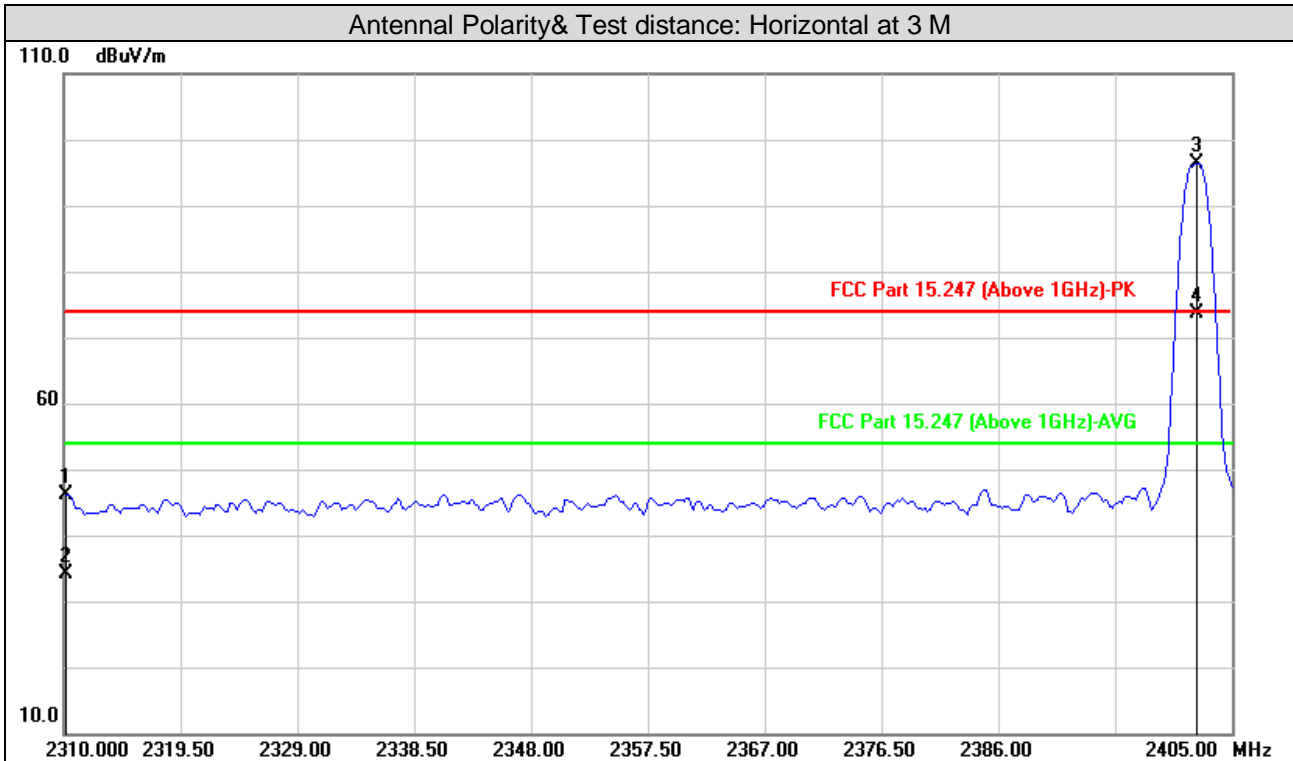
Remarks:

1. Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
2. Margin value = Emission level – Limit value



Above 1GHz Data:
BLE-1Mbps

Test channel	Channel 0	Frequency Range	1GHz ~ 25GHz
Detector Function	Peak (PK) Average (AVG)	Tested By	Jim Xu



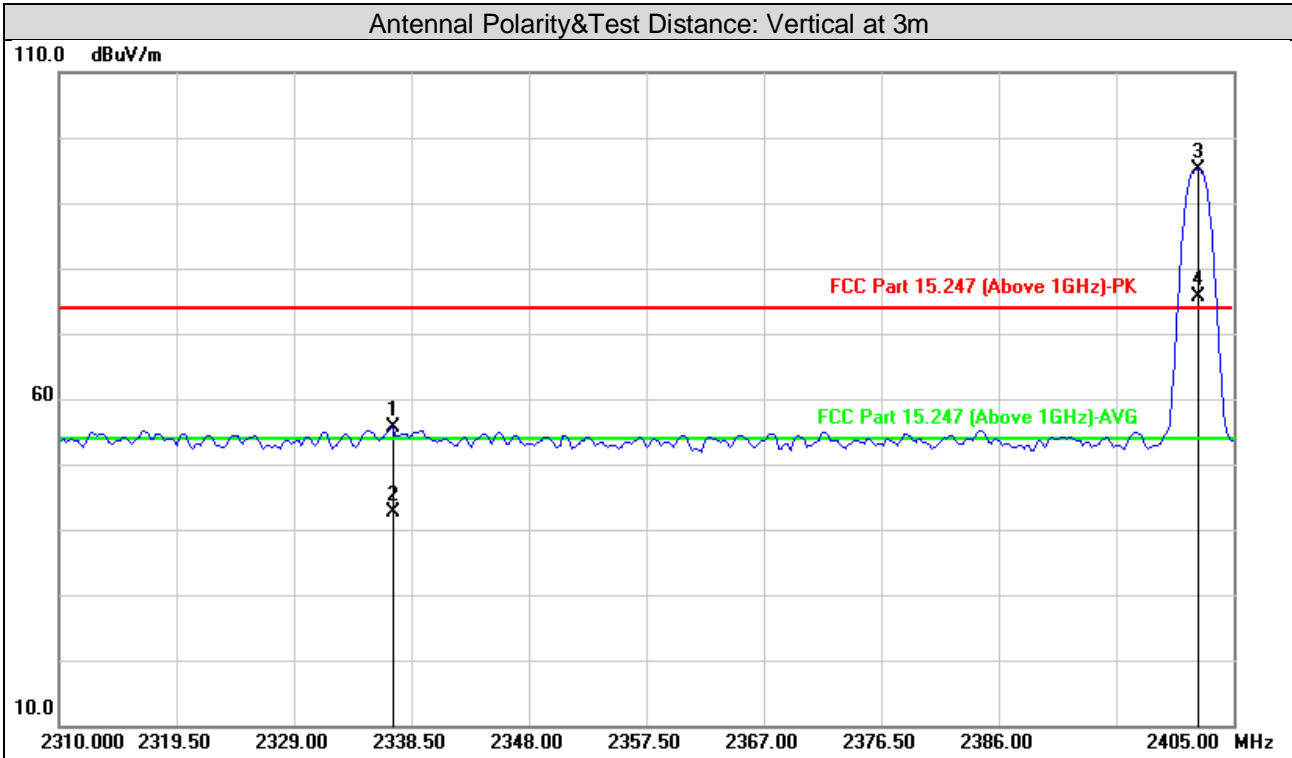
No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Height (cm)	Table Angle (Degree)	Remark
1	2310.190	48.73	-2.49	46.24	74.00	-27.76	peak	150	192	
2	2310.190	36.63	-2.49	34.14	54.00	-19.86	AVG	150	192	
3	2402.144	98.71	-2.39	96.32			peak	150	192	
4	2402.144	75.92	-2.39	73.53			AVG	150	192	
5	4804.000	50.51	2.63	53.14	74.00	-20.86	peak	100	220	
6	4804.000	35.87	2.63	38.50	54.00	-15.50	AVG	100	220	
7	7206.000	48.29	9.41	57.70	74.00	-16.30	peak	155	233	
8	7206.000	29.85	9.41	39.26	54.00	-14.74	AVG	155	233	

Remarks:

- Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
Margin value = Emission level – Limit value
- #2402MHz: Fundamental frequency.
- The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.



Test channel	Channel 0	Frequency Range	1GHz ~ 25GHz
Detector Function	Peak (PK) Average (AVG)	Tested By	Jim Xu



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Height (cm)	Table Angle (Degree)	Remark
1	2337.034	58.03	-2.46	55.57	74.00	-18.43	peak	100	268	
2	2337.034	45.03	-2.46	42.57	54.00	-11.43	AVG	100	268	
3	2402.144	97.56	-2.39	95.17			peak	100	268	
4	2402.144	78.12	-2.39	75.73			AVG	100	268	
5	4804.000	53.17	2.63	55.80	74.00	-18.20	peak	100	235	
6	4804.000	37.57	2.63	40.20	54.00	-13.80	AVG	100	235	
7	7206.000	49.59	9.41	59.00	74.00	-15.00	peak	150	210	
8	7206.000	34.90	9.41	44.31	54.00	-9.69	AVG	150	210	

Remarks:

- Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
Margin value = Emission level – Limit value
- #2402MHz: Fundamental frequency.
- The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.



Test channel	Channel 19	Frequency Range	1GHz ~ 25GHz
Detector Function	Peak (PK) Average (AVG)	Tested By	Jim Xu

Antennal Polarity& Test Distance: Horizontal at 3m										
No.	Frequency (MHz)	Reading (dBUV)	Correct Factor (dB)	Emission Level (dBUV/m)	Limit (dBUV/m)	Margin (dB)	Detector	Antenna Height (cm)	Table Angle (Degree)	Remark
1	2440.000	97.85	-2.35	95.50			peak	100	299	
2	2440.000	74.95	-2.35	72.60			AVG	100	299	
3	4880.000	47.62	3.58	51.20	74.00	-22.80	peak	150	210	
4	4880.000	34.92	3.58	38.50	54.00	-15.50	AVG	150	210	
5	7320.000	48.96	9.64	58.60	74.00	-15.40	peak	100	235	
6	7320.000	31.66	9.64	41.30	54.00	-12.70	AVG	100	235	
Antennal Polarity& Test Distance: Vertical at 3 M										
No.	Frequency (MHz)	Reading (dBUV)	Factor (dB)	Emission Level (dBUV/m)	Limit (dBUV/m)	Margin (dB)	Detector	Antenna Height (cm)	Table Angle (Degree)	Remark
1	2440.000	95.85	-2.35	93.50			peak	200	128	
2	2440.000	73.85	-2.35	71.50			AVG	200	128	
3	4880.000	50.72	3.58	54.30	74.00	-19.70	peak	130	251	
4	4880.000	36.72	3.58	40.30	54.00	-13.70	AVG	130	251	
5	7320.000	51.66	9.64	61.30	74.00	-12.70	peak	230	174	
6	7320.000	36.86	9.64	46.50	54.00	-7.50	AVG	230	174	

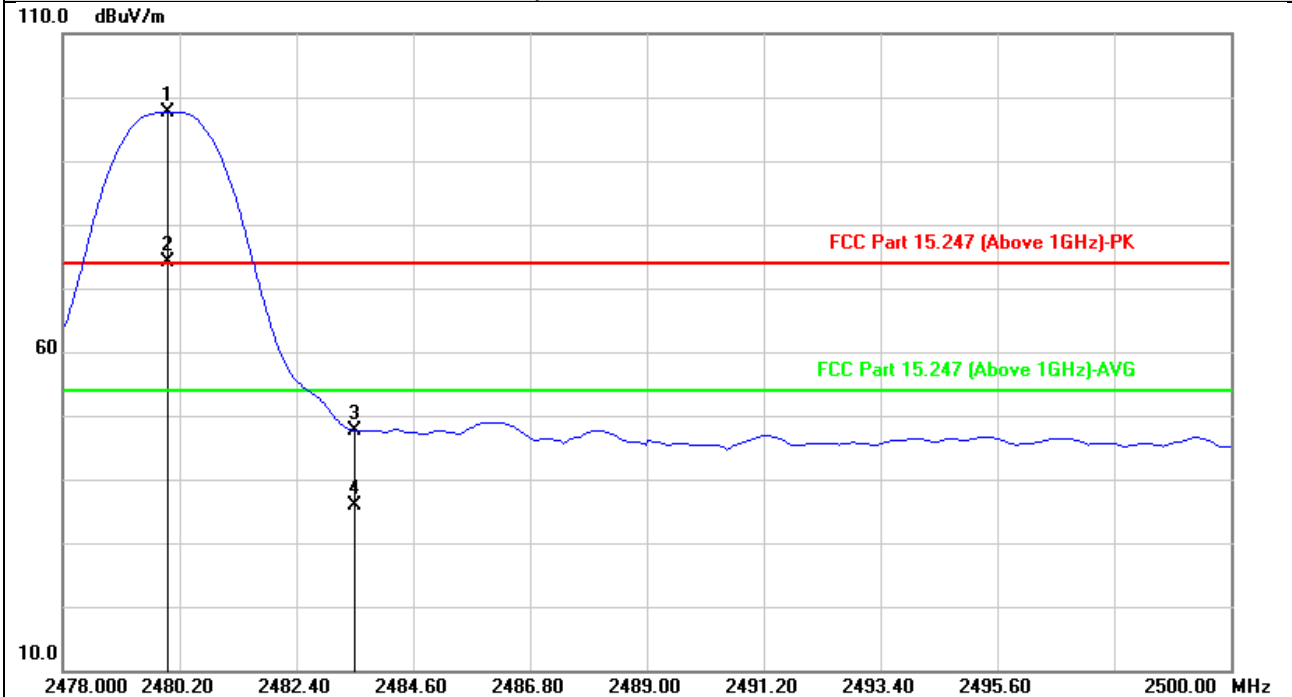
Remarks:

- Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
Margin value = Emission level – Limit value
- #2440MHz: Fundamental frequency.
- The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.



Test channel	Channel 39	Frequency Range	1GHz ~ 25GHz
Detector Function	Peak (PK) Average (AVG)	Tested By	Jim Xu

Antennal Polarity& Test Distance: Horizontal at 3 M



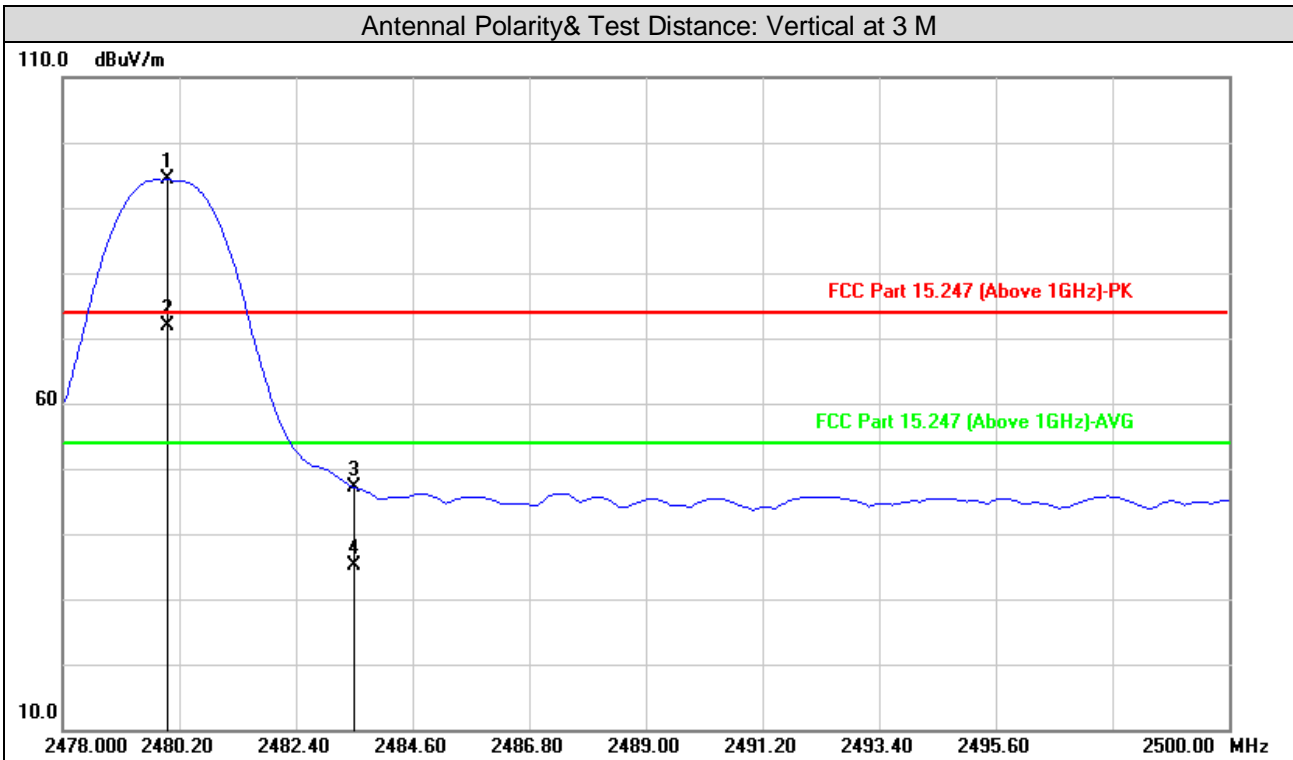
No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Height (cm)	Table Angle (Degree)	Remark
1	2479.984	100.00	-2.29	97.71			peak	133	221	
2	2479.984	76.39	-2.29	74.10			AVG	133	221	
3	2483.500	49.82	-2.29	47.53	74.00	-26.47	peak	133	221	
4	2483.500	38.29	-2.29	36.00	54.00	-18.00	AVG	133	221	
5	4960.000	48.75	3.50	52.25	74.00	-21.75	peak	120	188	
6	4960.000	35.80	3.50	39.30	54.00	-14.70	AVG	120	188	
7	7440.000	52.42	9.88	62.30	74.00	-11.70	peak	210	196	
8	7440.000	33.32	9.88	43.20	54.00	-10.80	AVG	210	196	

Remarks:

- Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
Margin value = Emission level – Limit value
- #2480MHz: Fundamental frequency.
- The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.



Test channel	Channel 39	Frequency Range	1GHz ~ 25GHz
Detector Function	Peak (PK) Average (AVG)	Tested By	Jim Xu



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Height (cm)	Table Angle (Degree)	Remark
1	2479.984	96.61	-2.29	94.32			peak	100	286	
2	2479.984	74.28	-2.29	71.99			AVG	100	286	
3	2483.500	49.33	-2.29	47.04	74.00	-26.96	peak	100	286	
4	2483.500	37.51	-2.29	35.22	54.00	-18.78	AVG	100	286	
5	4960.000	50.00	3.50	53.50	74.00	-20.50	peak	133	211	
6	4960.000	37.57	3.50	41.07	54.00	-12.93	AVG	133	211	
7	7440.000	53.32	9.88	63.20	74.00	-10.80	peak	100	154	
8	7440.000	38.51	9.88	48.39	54.00	-5.61	AVG	100	154	

Remarks:

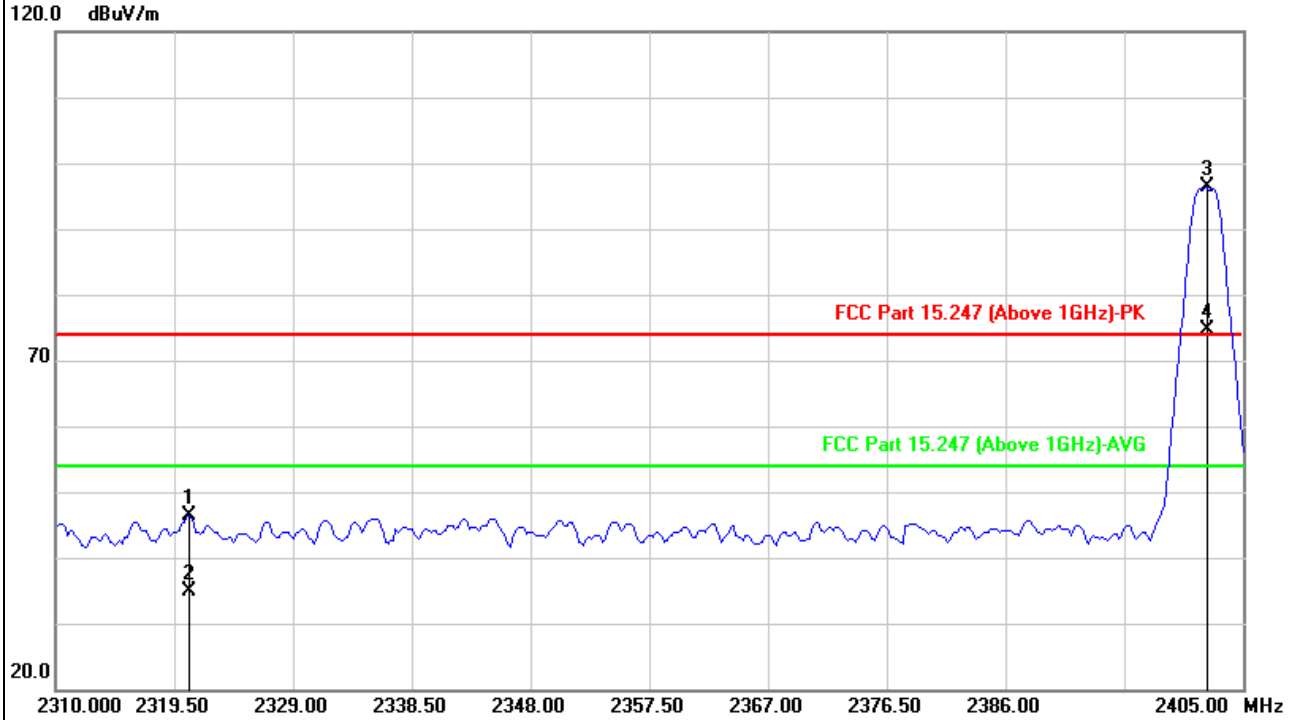
- Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
Margin value = Emission level – Limit value
- #2480MHz: Fundamental frequency.
- The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.



BLE-2Mbps

Test channel	Channel 0	Frequency Range	1GHz ~ 25GHz
Detector Function	Peak (PK) Average (AVG)	Tested By	Jim Xu

Antennal Polarity& Test distance: Horizontal at 3 M



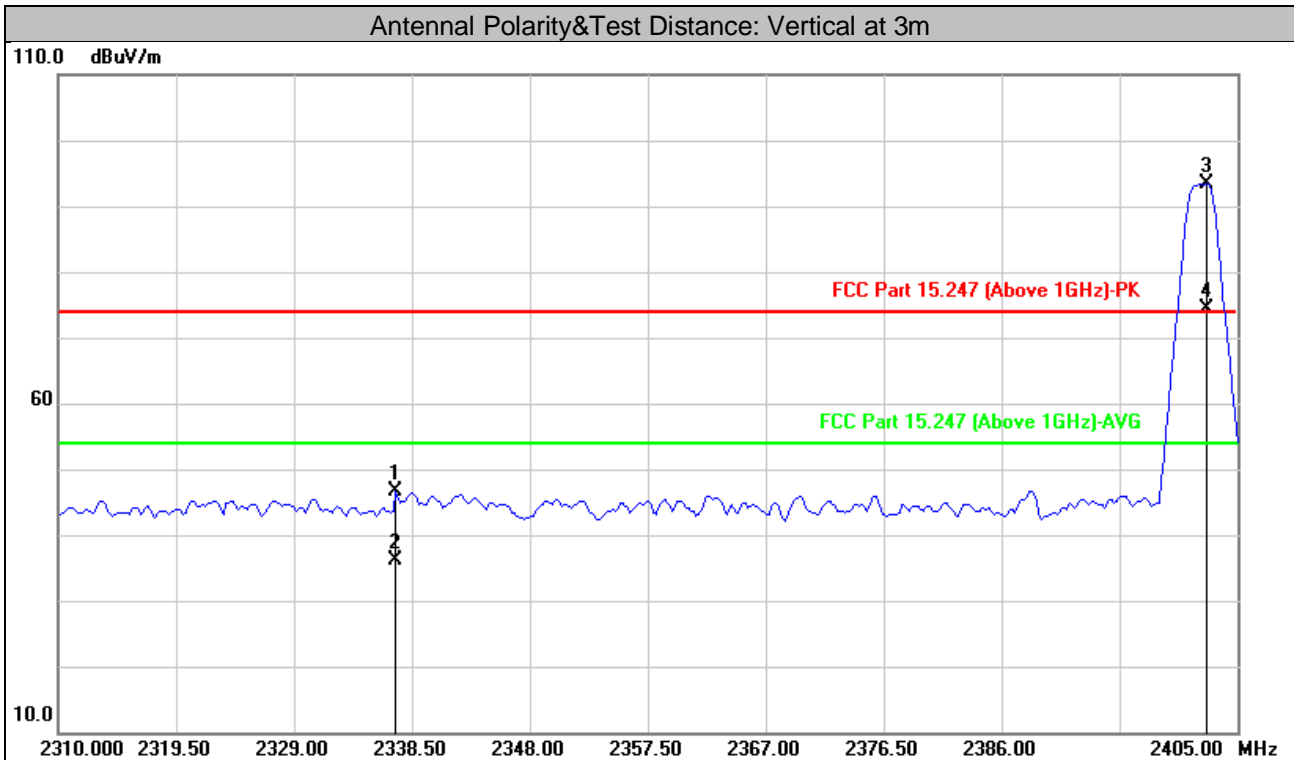
No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Height (cm)	Table Angle (Degree)	Remark
1	2320.661	48.85	-2.48	46.37	74.00	-27.63	peak	100	88	
2	2320.661	37.41	-2.48	34.93	54.00	-19.07	AVG	100	88	
3	2402.144	98.71	-2.39	96.32			peak	100	88	
4	2402.144	76.97	-2.39	74.58			AVG	100	88	
5	4804.000	51.87	2.63	54.50	74.00	-19.50	peak	136	263	
6	4804.000	36.67	2.63	39.30	54.00	-14.70	AVG	136	263	
7	7206.000	49.19	9.41	58.60	74.00	-15.40	peak	266	178	
8	7206.000	30.79	9.41	40.20	54.00	-13.80	AVG	266	178	

Remarks:

- Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
Margin value = Emission level – Limit value
- #2402MHz: Fundamental frequency.
- The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.



Test channel	Channel 0	Frequency Range	1GHz ~ 25GHz
Detector Function	Peak (PK) Average (AVG)	Tested By	Jim Xu



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Height (cm)	Table Angle (Degree)	Remark
1	2337.224	49.16	-2.46	46.70	74.00	-27.30	peak	185	176	
2	2337.224	38.51	-2.46	36.05	54.00	-17.95	AVG	185	176	
3	2402.525	95.86	-2.39	93.47			peak	185	176	
4	2402.525	76.74	-2.39	74.35			AVG	185	176	
5	4804.000	53.77	2.63	56.40	74.00	-17.60	peak	200	248	
6	4804.000	39.67	2.63	42.30	54.00	-11.70	AVG	200	248	
7	7206.000	49.89	9.41	59.30	74.00	-14.70	peak	185	139	
8	7206.000	35.89	9.41	45.30	54.00	-8.70	AVG	185	139	

Remarks:

- Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
Margin value = Emission level – Limit value
- #2402MHz: Fundamental frequency.
- The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.



Test channel	Channel 19	Frequency Range	1GHz ~ 25GHz
Detector Function	Peak (PK) Average (AVG)	Tested By	Jim Xu

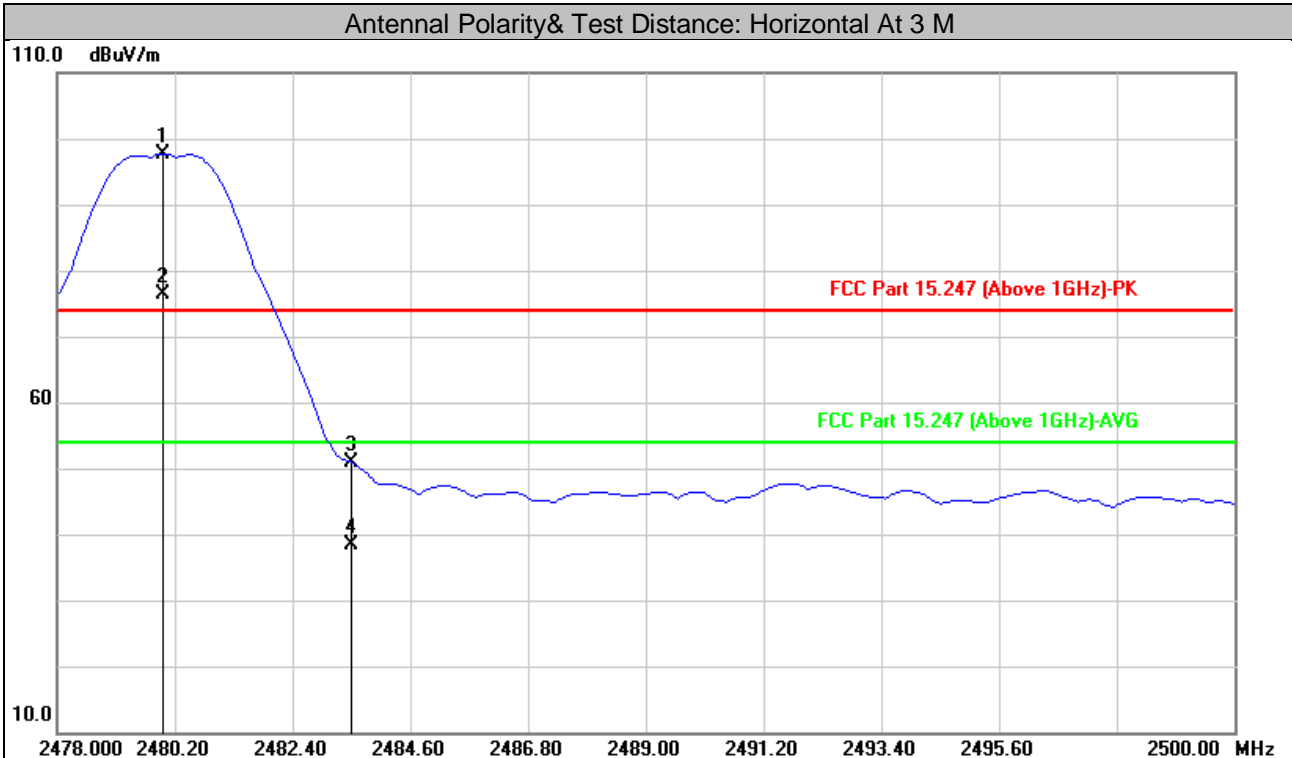
Antennal Polarity& Test Distance: Horizontal at 3m										
No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Height (cm)	Table Angle (Degree)	Remark
1	2440.000	96.65	-2.35	94.30			peak	100	163	
2	2440.000	73.85	-2.35	71.50			AVG	100	163	
3	4880.000	47.92	3.58	51.50	74.00	-22.50	peak	174	231	
4	4880.000	36.72	3.58	40.30	54.00	-13.70	AVG	174	231	
5	7320.000	50.86	9.64	60.50	74.00	-13.50	peak	100	184	
6	7320.000	35.96	9.64	45.60	54.00	-8.40	AVG	100	184	
Antennal Polarity& Test Distance: Vertical at 3 M										
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Height (cm)	Table Angle (Degree)	Remark
1	2440.000	93.85	-2.35	91.50			peak	155	235	
2	2440.000	72.65	-2.35	70.30			AVG	155	235	
3	4880.000	47.72	3.58	51.30	74.00	-22.70	peak	100	184	
4	4880.000	37.32	3.58	40.90	54.00	-13.10	AVG	100	184	
5	7320.000	51.86	9.64	61.50	74.00	-12.50	peak	185	163	
6	7320.000	37.56	9.64	47.20	54.00	-6.80	AVG	185	163	

Remarks:

- Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
Margin value = Emission level – Limit value
- #2440MHz: Fundamental frequency.
- The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.



Test channel	Channel 39	Frequency Range	1GHz ~ 25GHz
Detector Function	Peak (PK) Average (AVG)	Tested By	Jim Xu



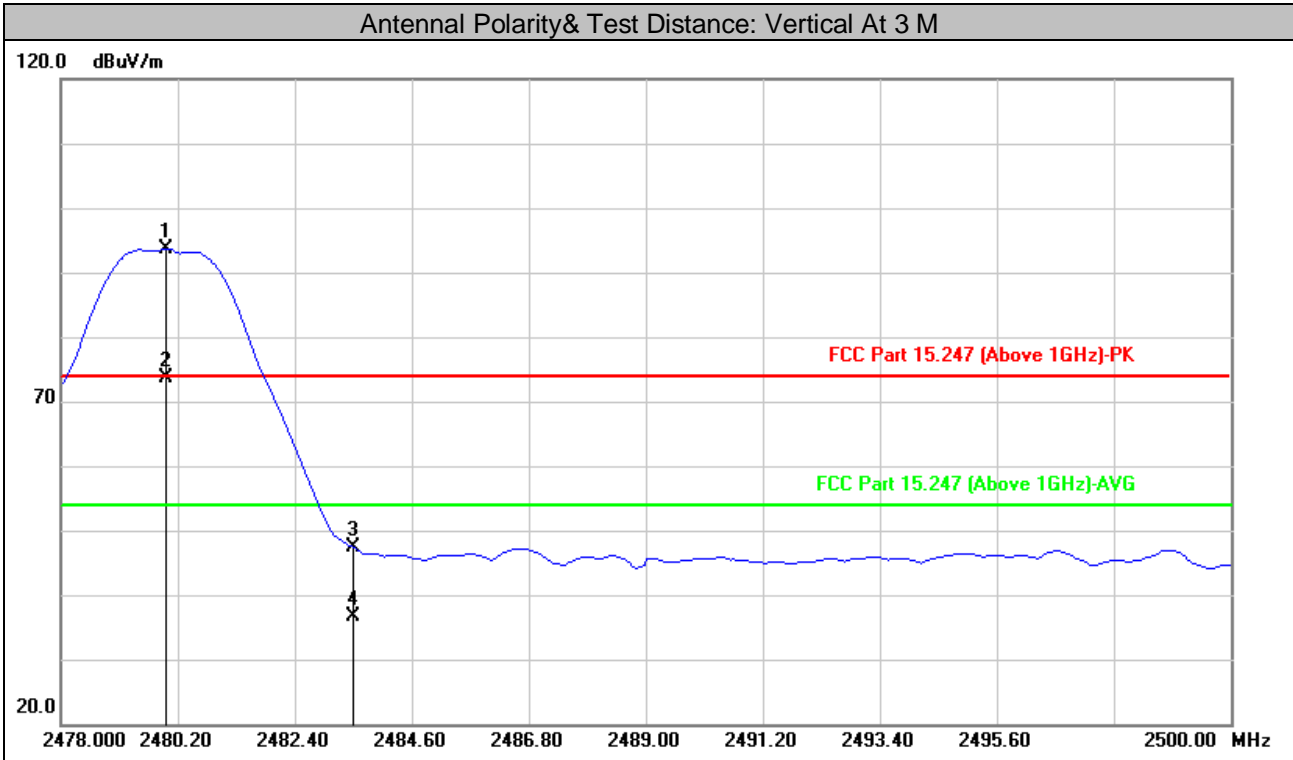
No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Height (cm)	Table Angle (Degree)	Remark
1	2479.984	100.01	-2.29	97.72			peak	236	156	
2	2479.984	78.56	-2.29	76.27			AVG	236	156	
3	2483.500	53.18	-2.29	50.89	74.00	-23.11	peak	236	156	
4	2483.500	40.79	-2.29	38.50	54.00	-15.50	AVG	236	156	
5	4960.000	49.80	3.50	53.30	74.00	-20.70	peak	100	236	
6	4960.000	36.40	3.50	39.90	54.00	-14.10	AVG	100	236	
7	7440.000	53.32	9.88	63.20	74.00	-10.80	peak	100	155	
8	7440.000	34.62	9.88	44.50	54.00	-9.50	AVG	100	155	

Remarks:

- Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
Margin value = Emission level – Limit value
- #2480MHz: Fundamental frequency.
- The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report



Test channel	Channel 39	Frequency Range	1GHz ~ 25GHz
Detector Function	Peak (PK) Average (AVG)	Tested By	Jim Xu



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Antenna Height (cm)	Table Angle (Degree)	Remark
1	2479.984	95.90	-2.29	93.61			peak	100	275	
2	2479.984	75.83	-2.29	73.54			AVG	100	275	
3	2483.500	49.60	-2.29	47.31	74.00	-26.69	peak	100	275	
4	2483.500	39.01	-2.29	36.72	54.00	-17.28	AVG	100	275	
5	4960.000	50.80	3.50	54.30	74.00	-19.70	peak	233	248	
6	4960.000	38.40	3.50	41.90	54.00	-12.10	AVG	233	248	
7	7440.000	54.42	9.88	64.30	74.00	-9.70	peak	210	156	
8	7440.000	39.42	9.88	49.30	54.00	-4.70	AVG	210	156	

Remarks:

- Emission Level = Read Level + Factor (Antenna Factor + Cable Loss - Preamp Factor)
Margin value = Emission level – Limit value
- #2480MHz: Fundamental frequency.
- The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.



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	2021/09/05
Artificial Mains Network Rohde&Schwarz	ENV216	3560.6550.15	2021/09/16
Test software FARAD	EZ_EMC V1.1.4.2	N/A	N/A
Hygrothermograph Yuhuaze	HTC-1	NA	2021/09/16
Digital Multimeter FLUKE	15B+	43512617WS	2021/09/16

- 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

- 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.
- Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
- 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 Deviation from Test Standard

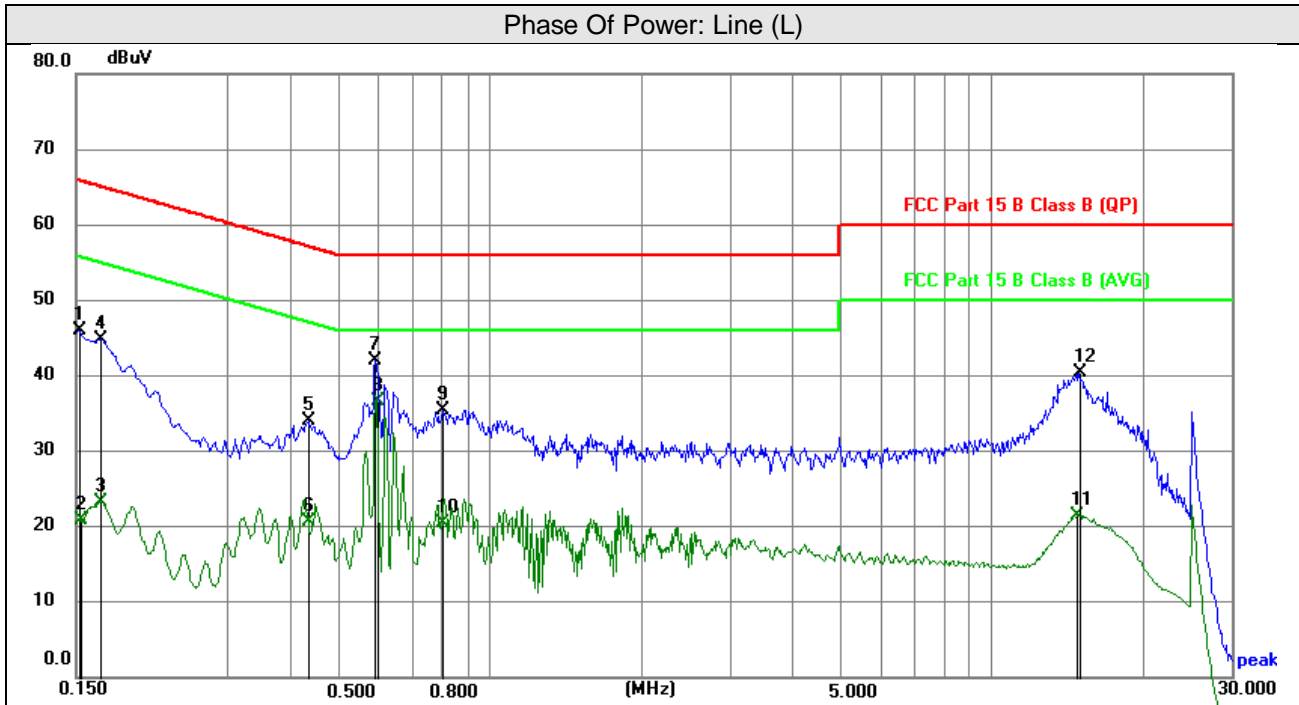
No deviation.



3.2.7 Test Results

Conducted worst-case data

Frequency Range	150kHz ~ 30MHz	Detector Function & Resolution bandwidth	Quasi-Peak (QP) / Average (AV), 9kHz
Power supply	DC3.7V from battery	Environmental Conditions	25°C, 60%RH



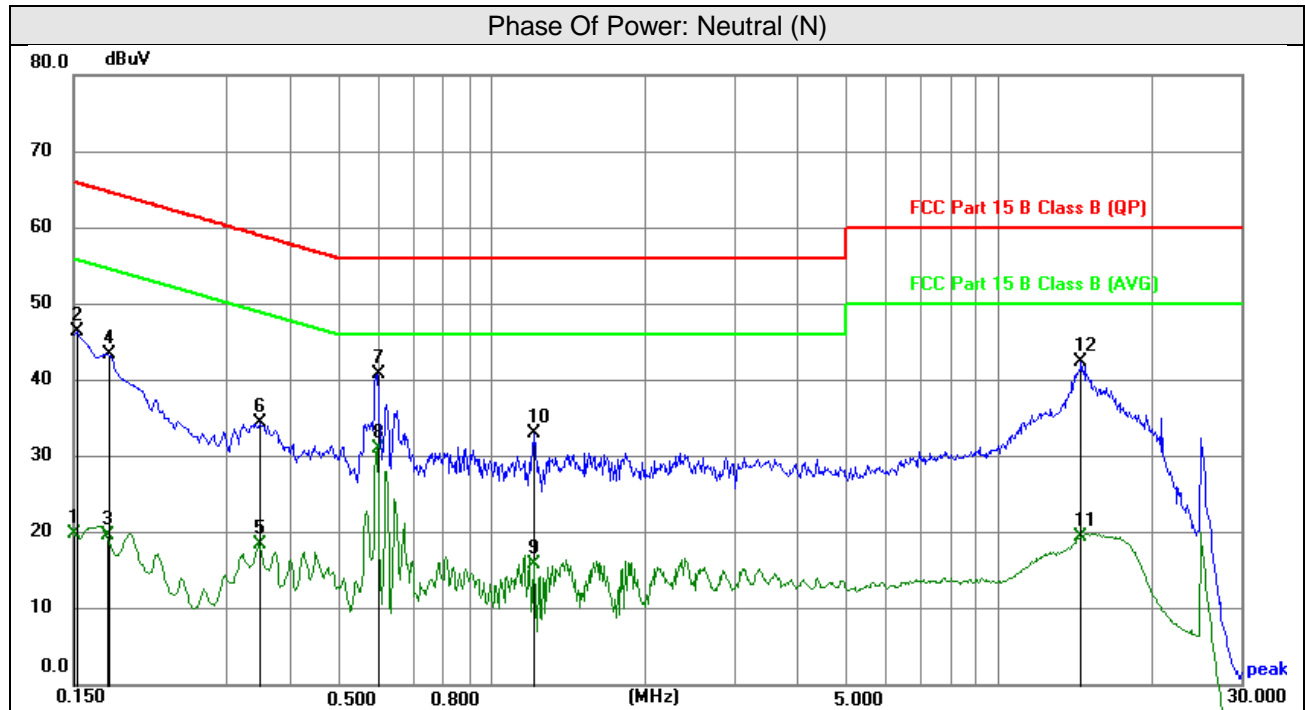
No	Frequency (MHz)	Reading (dBuV)	Correction Factor (dB)	Emission Level (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.1522	36.22	9.82	46.04	65.88	-19.84	peak
2	0.1532	10.95	9.82	20.77	55.82	-35.05	AVG
3*	0.1677	13.51	9.81	23.32	55.07	-31.75	AVG
4	0.1680	35.01	9.81	44.82	65.06	-20.24	peak
5	0.4357	24.13	9.82	33.95	57.14	-23.19	peak
6	0.4357	10.91	9.82	20.73	47.14	-26.41	AVG
7	0.5932	32.20	9.86	42.06	56.00	-13.94	peak
8	0.5955	26.79	9.86	36.65	46.00	-9.35	AVG
9	0.8070	25.59	9.88	35.47	56.00	-20.53	peak
10	0.8070	10.64	9.88	20.52	46.00	-25.48	AVG
11	14.7705	11.21	10.29	21.50	50.00	-28.50	AVG
12	14.9258	30.13	10.29	40.42	60.00	-19.58	peak

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 bandwidth	Quasi-Peak (QP) / Average (AV), 9kHz
Power supply	DC3.7V from battery	Environmental Conditions	25°C, 60%RH



No.	Frequency (MHz)	Reading (dBuV)	Correction Factor (dB)	Emission Level (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.1500	9.99	9.78	19.77	56.00	-36.23	AVG
2	0.1522	36.55	9.78	46.33	65.88	-19.55	peak
3	0.1740	9.81	9.77	19.58	54.77	-35.19	AVG
4	0.1748	33.66	9.77	43.43	64.73	-21.30	peak
5	0.3480	8.65	9.74	18.39	49.01	-30.62	AVG
6	0.3502	24.64	9.74	34.38	58.96	-24.58	peak
7	0.5955	31.08	9.78	40.86	56.00	-15.14	peak
8	0.5955	21.28	9.78	31.06	46.00	-14.94	AVG
9	1.2142	6.21	9.73	15.94	46.00	-30.06	AVG
10	1.2164	23.29	9.73	33.02	56.00	-22.98	peak
11	14.5140	9.33	10.15	19.48	50.00	-30.52	AVG
12*	14.5185	32.15	10.15	42.30	60.00	-17.70	peak

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 6dB Bandwidth Measurement

3.3.1 Limits of 6dB Bandwidth Measurement

The minimum of 6dB Bandwidth Measurement is 0.5MHz.

3.3.2 Test Setup



3.3.3 Test Instruments

Refer to section 5 to get information of above instrument.

3.3.4 Test Procedure

- Set resolution bandwidth (RBW) = 30kHz
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW, Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

3.3.5 Deviation from Test Standard

No deviation.

3.3.6 EUT Operating Conditions

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.



3.3.7 Test Result

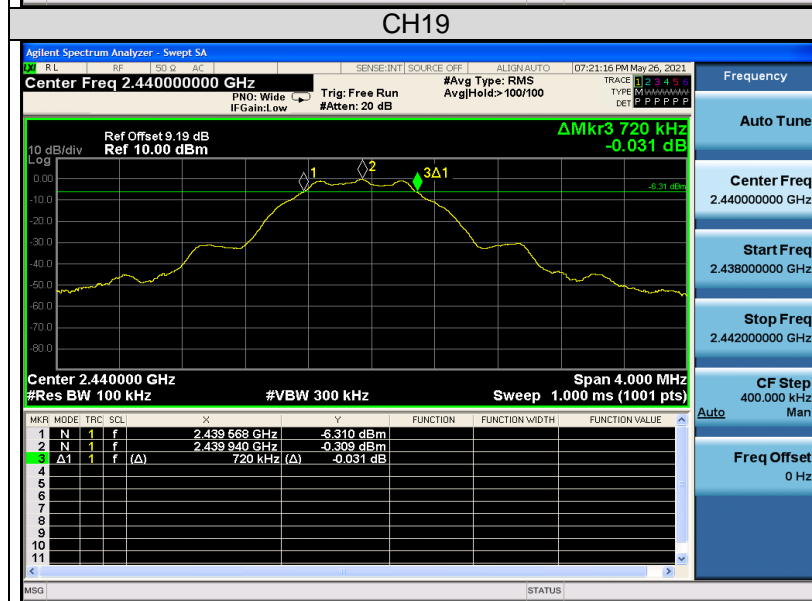
BLE-1Mbps

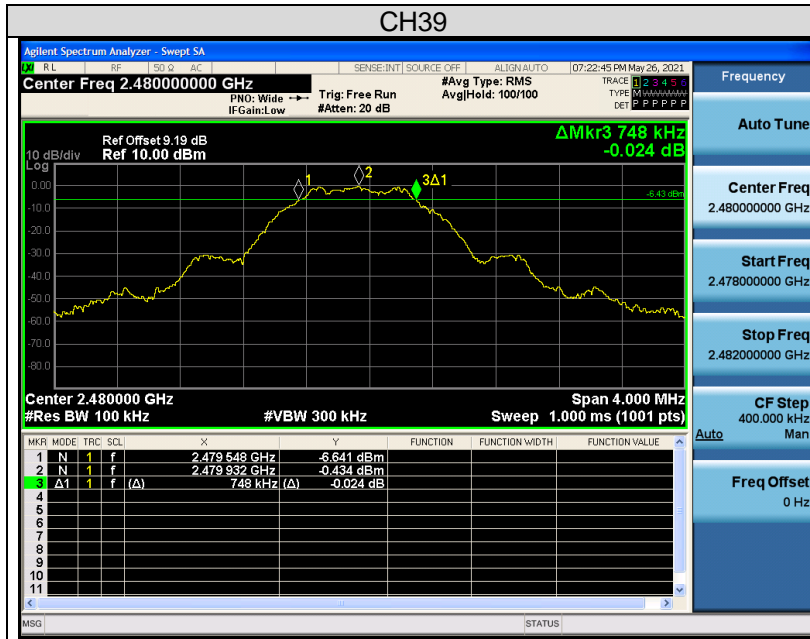
Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Minimum Limit (MHz)	Pass / Fail
0	2402	0.748	0.5	Pass
19	2440	0.720	0.5	Pass
39	2480	0.748	0.5	Pass

BLE-2Mbps

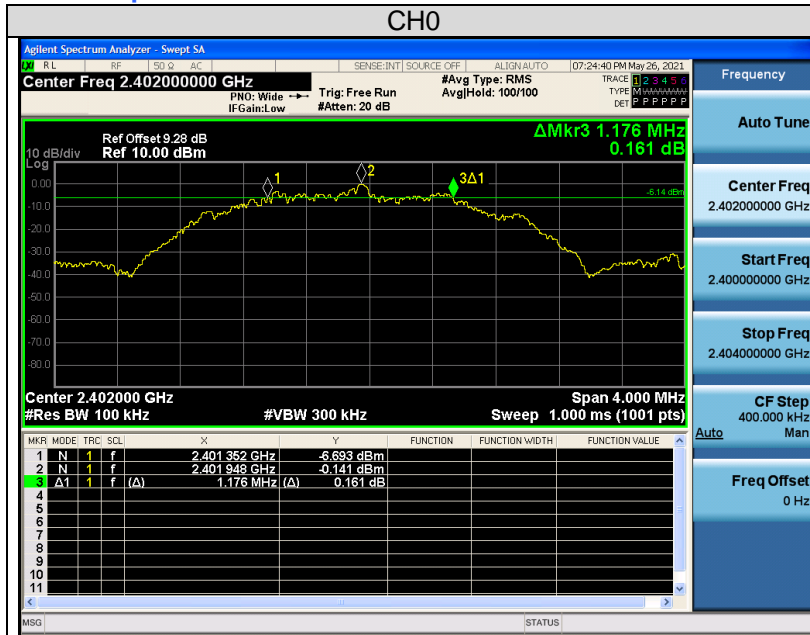
Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Minimum Limit (MHz)	Pass / Fail
0	2402	1.176	0.5	Pass
19	2440	1.220	0.5	Pass
39	2480	1.252	0.5	Pass

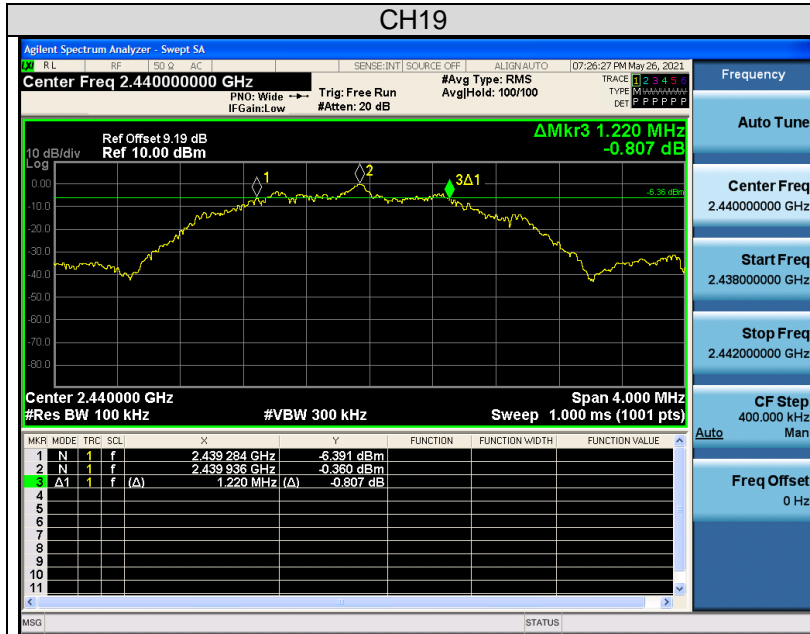
BLE-1Mbps





BLE-2Mbps

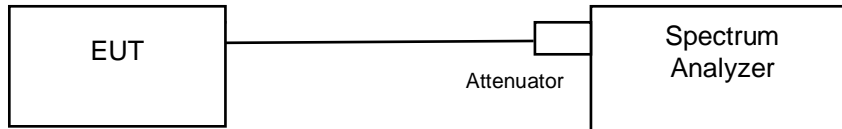






3.4 Occupied Bandwidth Measurement

3.4.1 Test Setup



3.4.2 Test Instruments

Refer to section 5 to get information of above instrument.

3.4.3 Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth and set the detector to peak. The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage 0.5 %of the total mean power of a given emission.

3.4.4 Deviation from Test Standard

No deviation.

3.4.5 EUT Operating Conditions

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.



3.4.6 Test Results

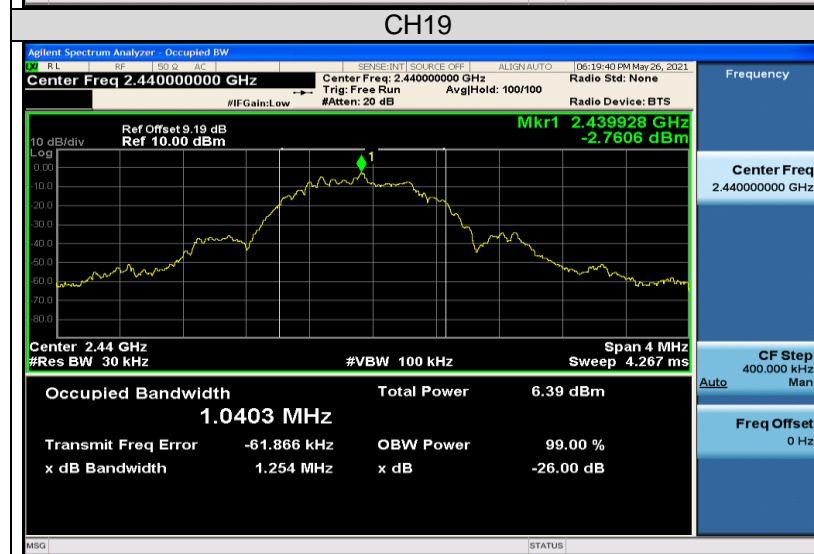
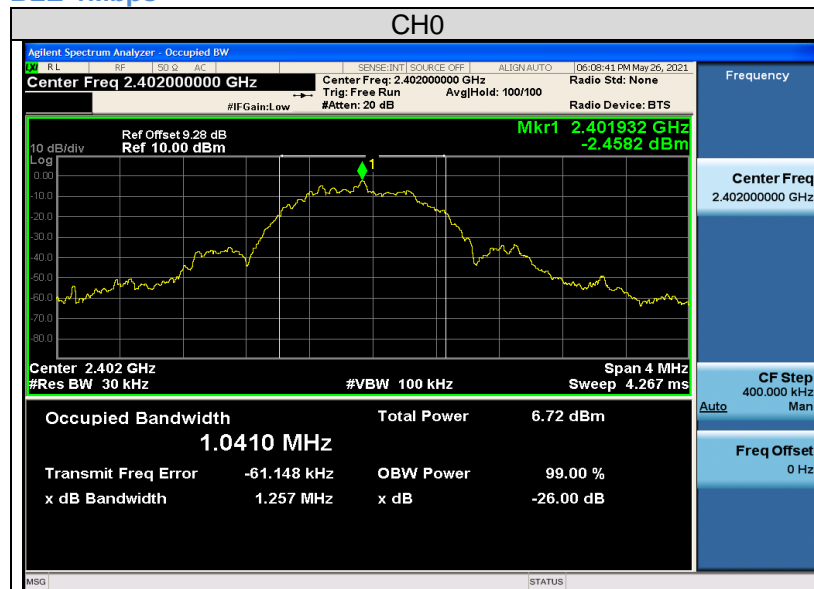
BLE-1Mbps

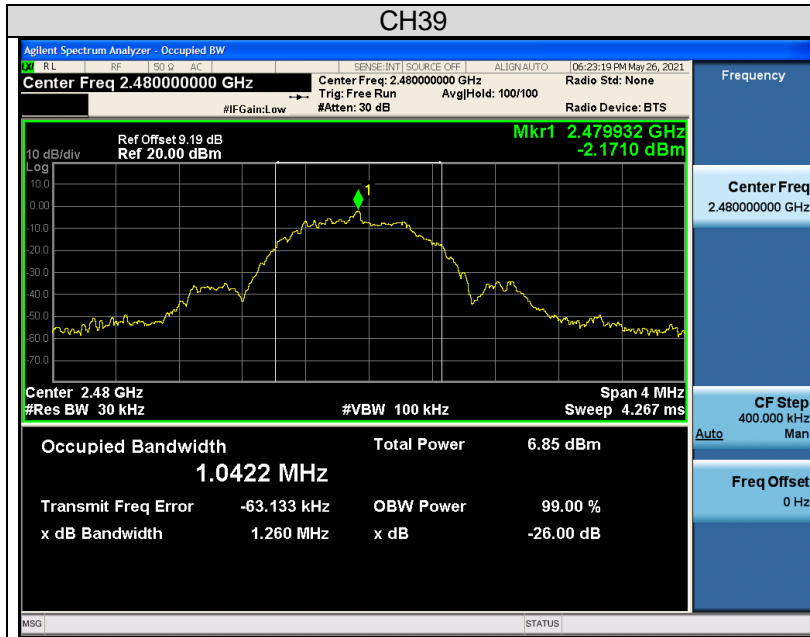
Channel	Frequency (MHz)	Occupied Bandwidth (MHz)	Pass / Fail
0	2402	1.0410	Pass
19	2440	1.0403	Pass
39	2480	1.0422	Pass

BLE-2Mbps

Channel	Frequency (MHz)	Occupied Bandwidth (MHz)	Pass / Fail
0	2402	2.0552	Pass
19	2440	2.0536	Pass
39	2480	2.0502	Pass

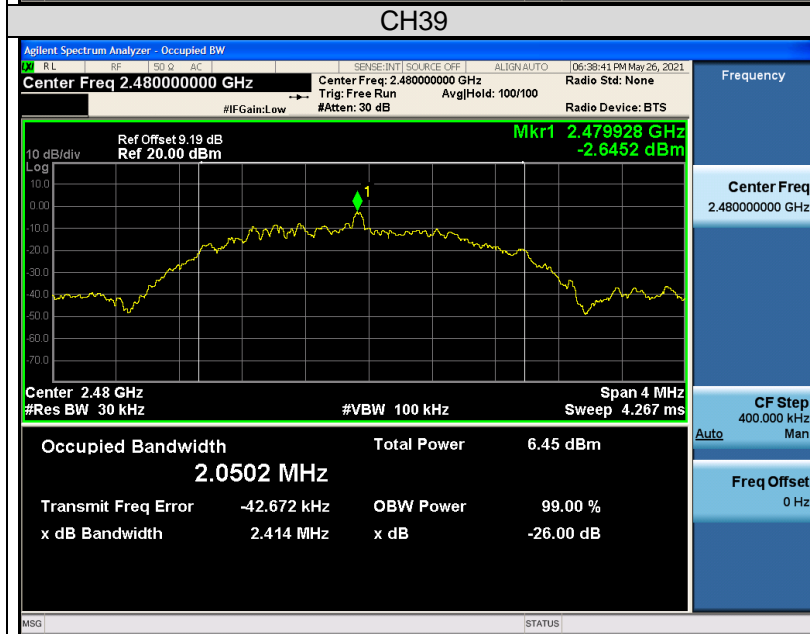
BLE-1Mbps





BLE-2Mbps





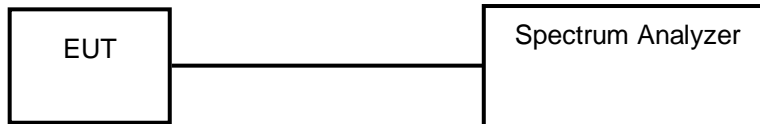


3.5 Conducted Output Power Measurement

3.5.1 Limits of Conducted Output Power Measurement

For systems using digital modulation in the 2400–2483.5 MHz bands: 1 Watt (30dBm)

3.5.2 Test Setup



3.5.3 Test Instruments

Refer to section 4 to get information of above instrument.

3.5.4 Test Procedures

- Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- 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 measuring instrument equal to the highest peak value.
- The center frequency of the spectrum analyzer is set to the fundamental frequency and using 1MHz RBW and 3 MHz VBW.
- Measure the captured power within the band and recording the plot.
- Repeat above procedures until all frequencies required were complete.

3.5.5 Deviation from Test Standard

No deviation.

3.5.6 EUT Operating Conditions

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.



3.5.7 Test Results

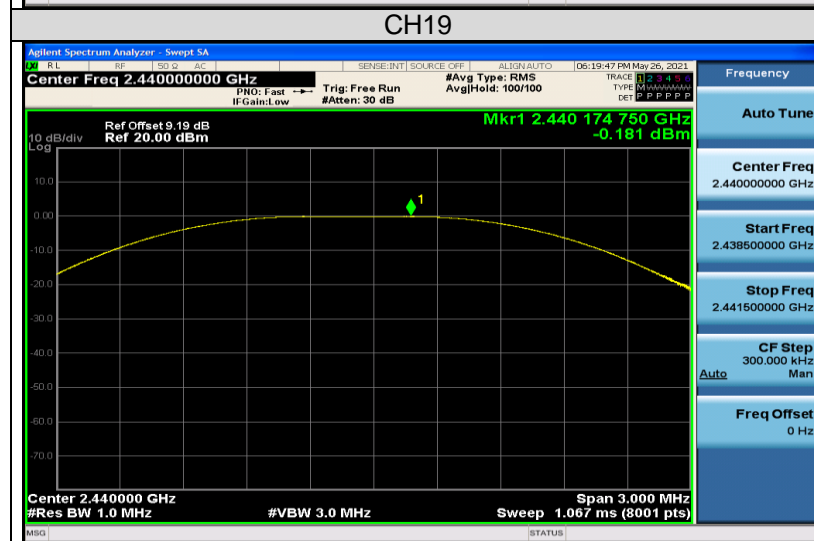
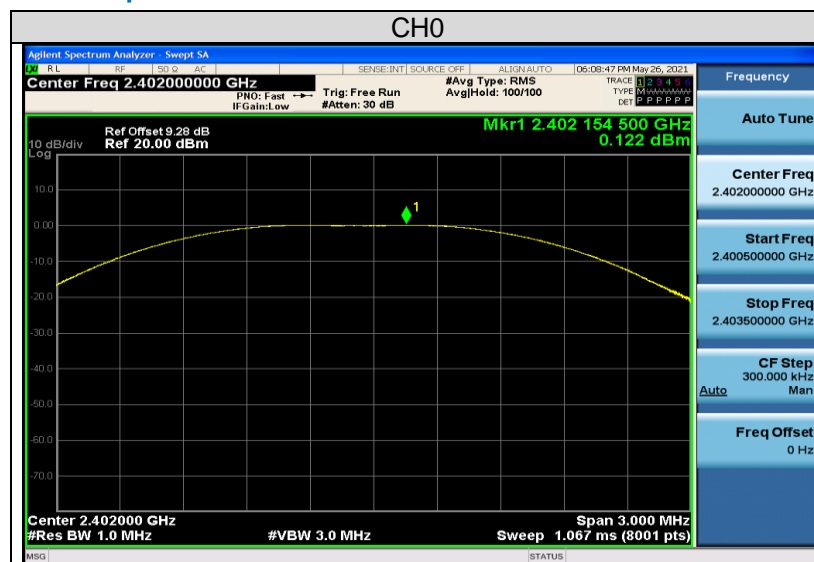
BLE-1Mbps

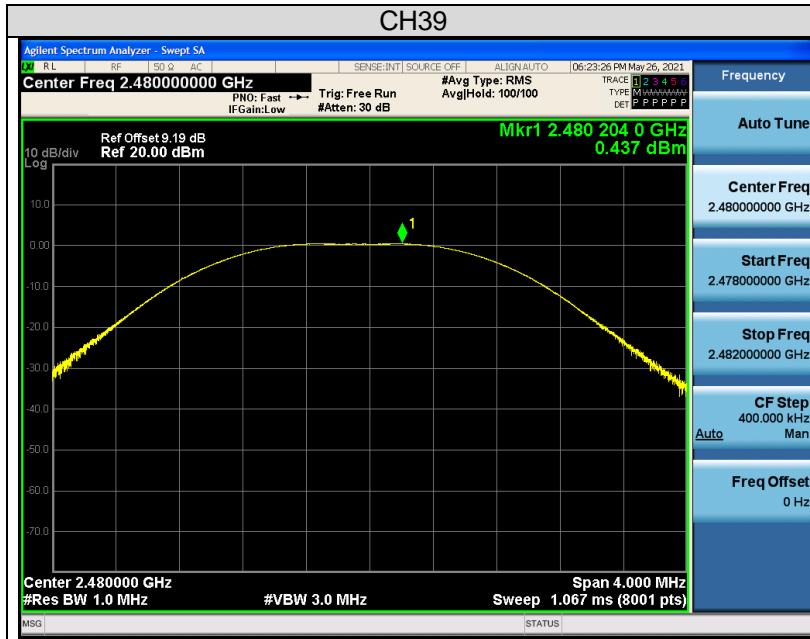
Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass / Fail
0	2402	1.0280	0.12	30	Pass
19	2440	0.9594	-0.18	30	Pass
39	2480	1.1070	0.44	30	Pass

BLE-2Mbps

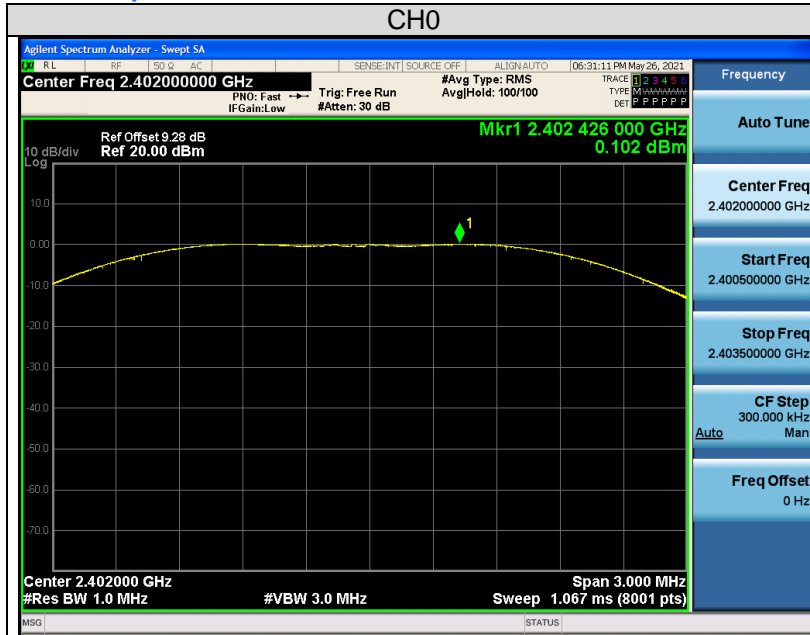
Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass / Fail
0	2402	1.0230	0.10	30	Pass
19	2440	0.9594	-0.18	30	Pass
39	2480	1.1070	0.44	30	Pass

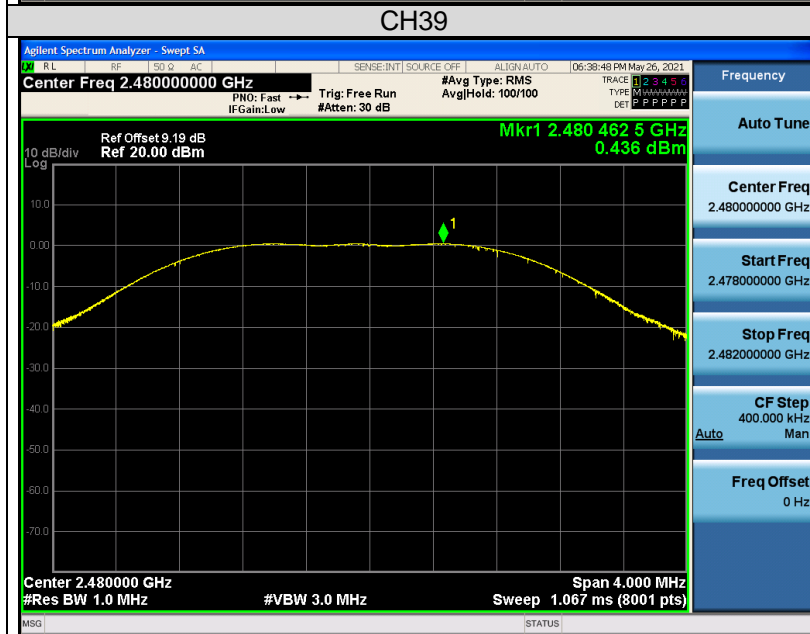
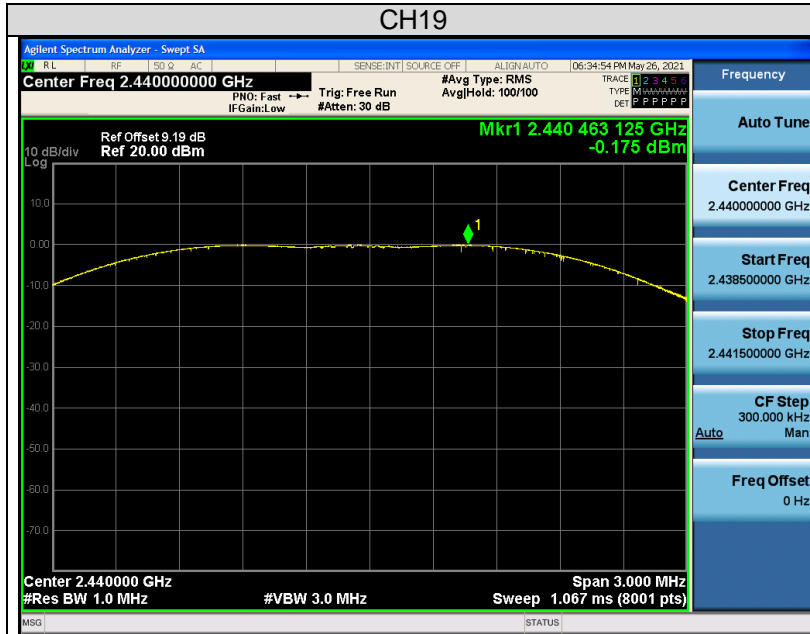
BLE-1Mbps





BLE-2Mbps





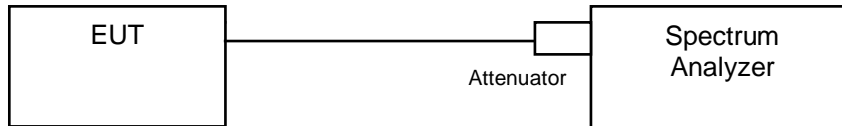


3.6 Power Spectral Density Measurement

3.6.1 Limits of Power Spectral Density Measurement

The Maximum of Power Spectral Density Measurement is 8dBm/3kHz.

3.6.2 Test Setup



3.6.3 Test Instruments

Refer to section 5 to get information of above instrument.

3.6.4 Test Procedure

- Set the RBW = 3 kHz, VBW =10 kHz, Detector = peak.
- Sweep time = auto couple, Trace mode = max hold, allow trace to fully stabilize.
- Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

3.6.5 Deviation from Test Standard

No deviation.

3.6.6 EUT Operating Condition

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.



3.6.7 Test Results

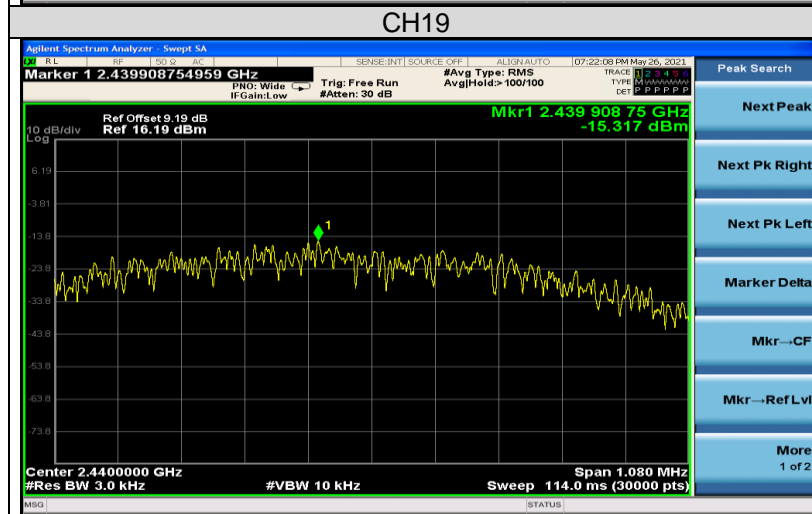
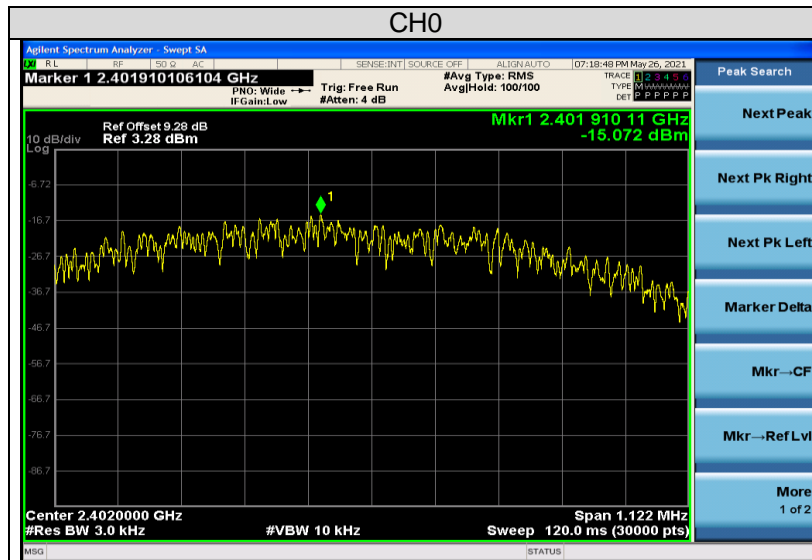
BLE-1Mbps

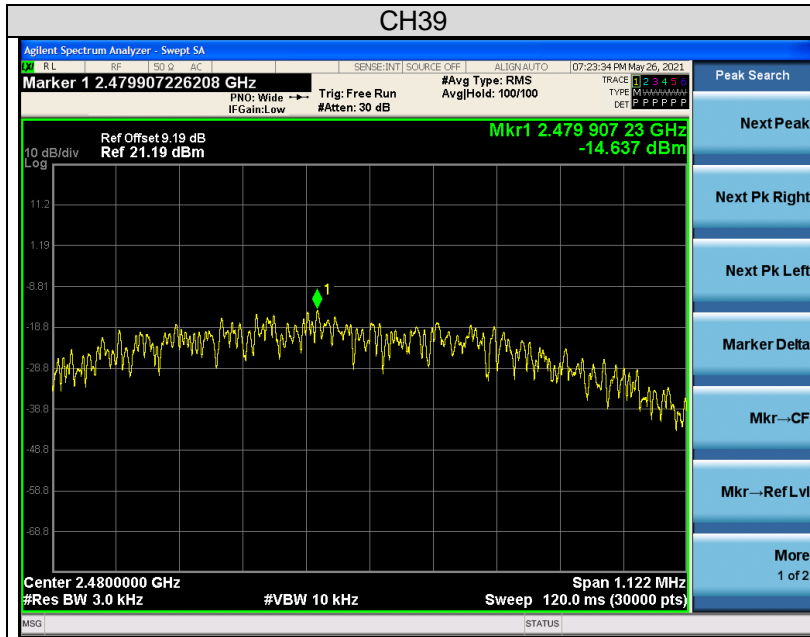
Channel	Frequency (MHz)	PSD (dBm/10kHz)	Limit (dBm/3kHz)	Pass / Fail
0	2402	-15.07	8	Pass
19	2440	-15.32	8	Pass
39	2480	-14.64	8	Pass

BLE-2Mbps

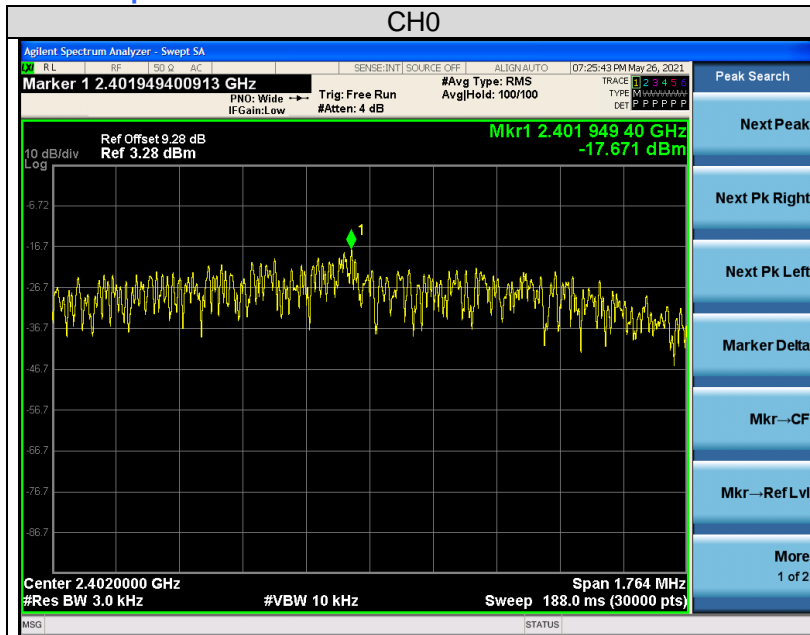
Channel	Frequency (MHz)	PSD (dBm/10kHz)	Limit (dBm/3kHz)	Pass / Fail
0	2402	-17.67	8	Pass
19	2440	-17.98	8	Pass
39	2480	-17.33	8	Pass

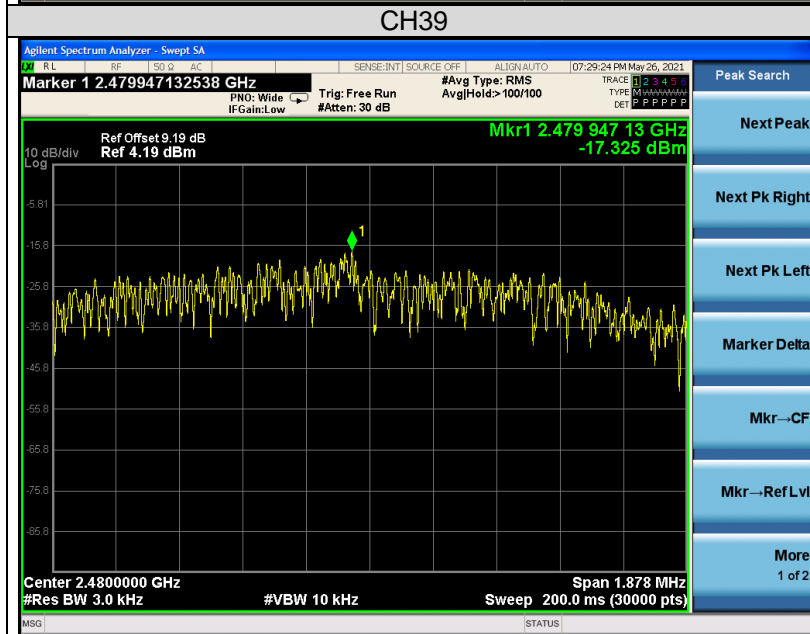
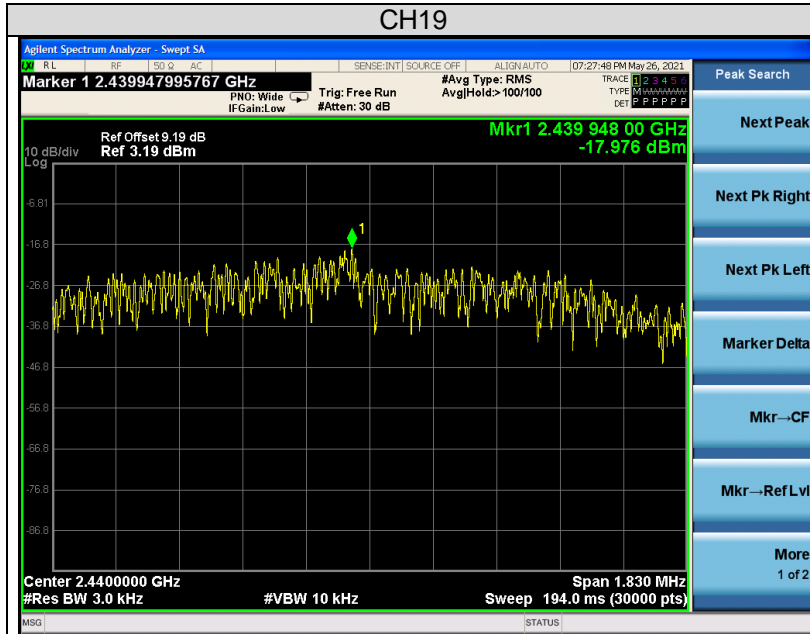
BLE-1Mbps





BLE-2Mbps







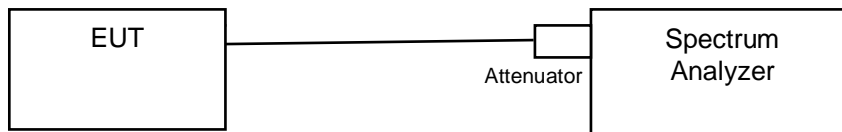
3.7 Conducted Out of Band Emission Measurement

3.7.1 Limits of Conducted Out of Band Emission Measurement

For average power: Below -30dB of the highest emission level of operating band (in 100kHz Resolution Bandwidth).

For peak power: Below -20dB of the highest emission level of operating band (in 100kHz Resolution Bandwidth)

3.7.2 Test Setup



3.7.3 Test Instruments

Refer to section 10.1 to get information of above instrument.

3.7.4 Test Procedure

Measurement procedure REF

1. Set the RBW = 100 kHz.
2. Set the VBW \geq 300 kHz.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

3.7.5 Measurement procedure OOBE

1. Set RBW = 100 kHz.
2. Set VBW \geq 300 kHz.
3. Detector = peak.
4. Sweep = auto couple.
5. Trace Mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

3.7.6 Deviation from Test Standard

No deviation.



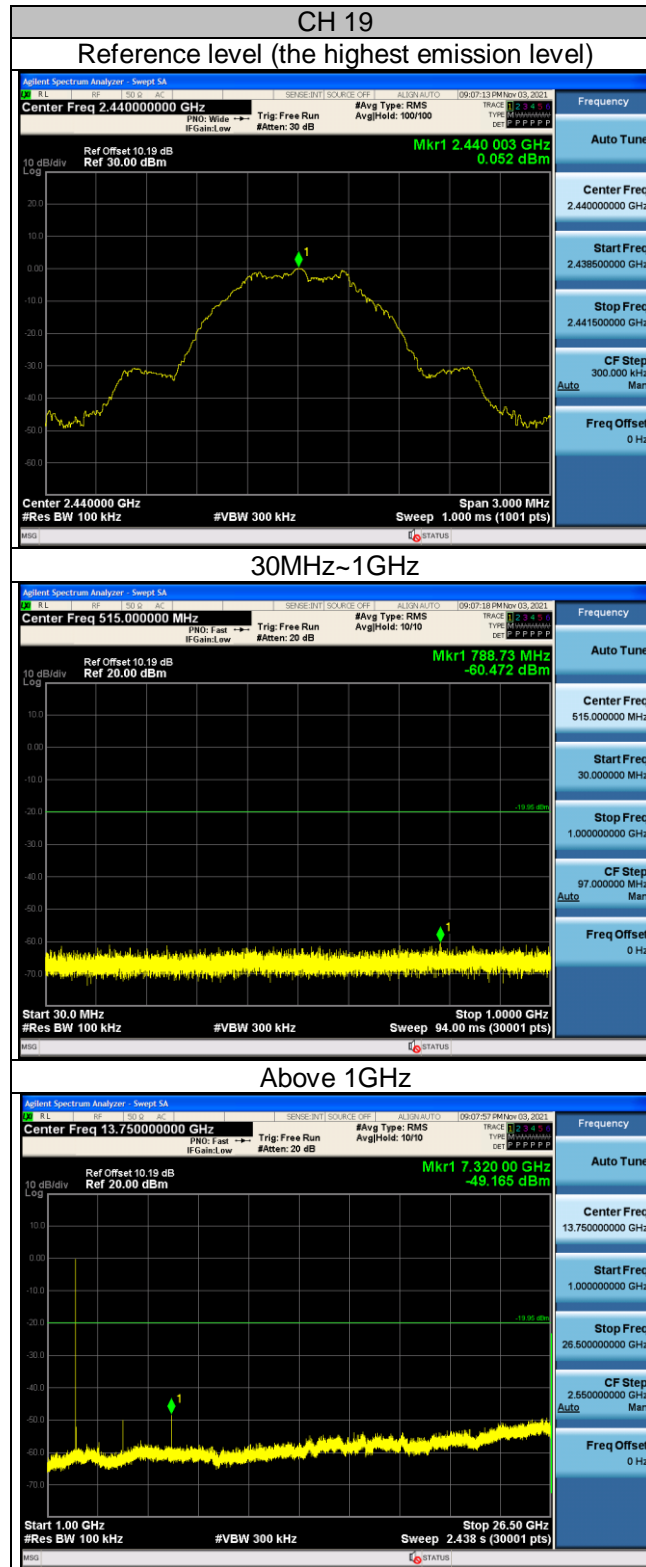
3.7.7 EUT Operating Condition

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

3.7.8 Test results

BLE-1Mbps

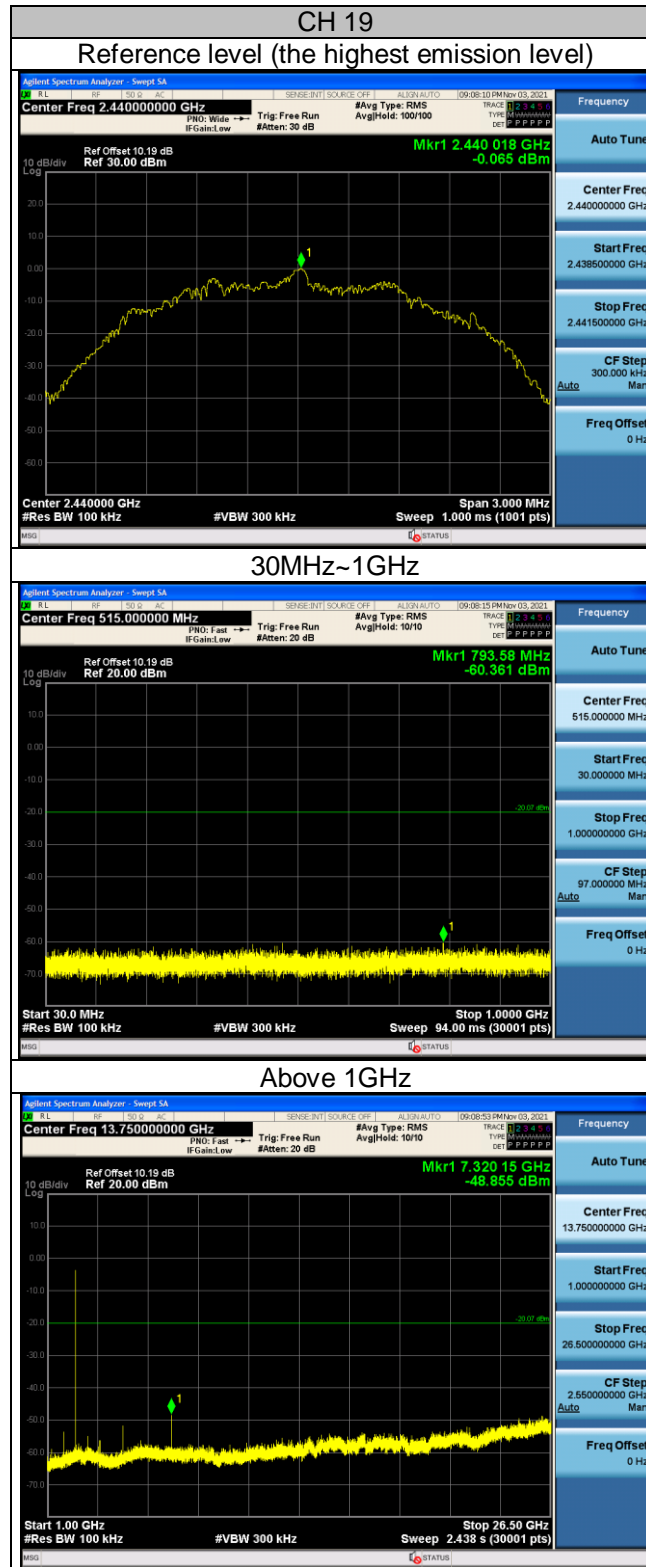






BLE-2Mbps







4. Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).



Appendix – Information on The Testing Laboratories

We, [Hwa-Hsing \(Dongguan\) Co., Ltd.](#), A global provider of TESTING and CERTIFICATION services for consumer products, electronic products and wireless information technology products. Adhering to the core values “HONEST and TRUSTWORTHY, OBJECTIVE and IMPARTIALITY, RIGOROUS and AFFICIENT”, commitment to provide professional, perfect and efficient comprehensive ONE-STOP solution of TESTING and CERTIFICATION services for Manufacturers, Buyers, Traders, Brands, Retailers. Assist client to better manage risk, protect their brands, reduce costs and cut time to over 150 markets in global. Our laboratories are FCC recognized accredited test firms and accredited and approved according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

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Contact Tel: [0769-83078199](tel:0769-83078199)

Email: Customerservice.dg@hwa-hsing.com

Web Site: www.hwa-hsing.com

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