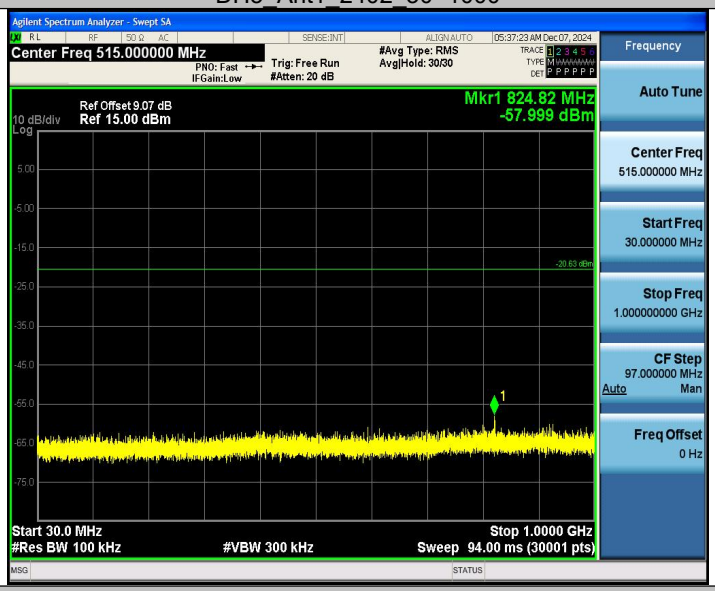
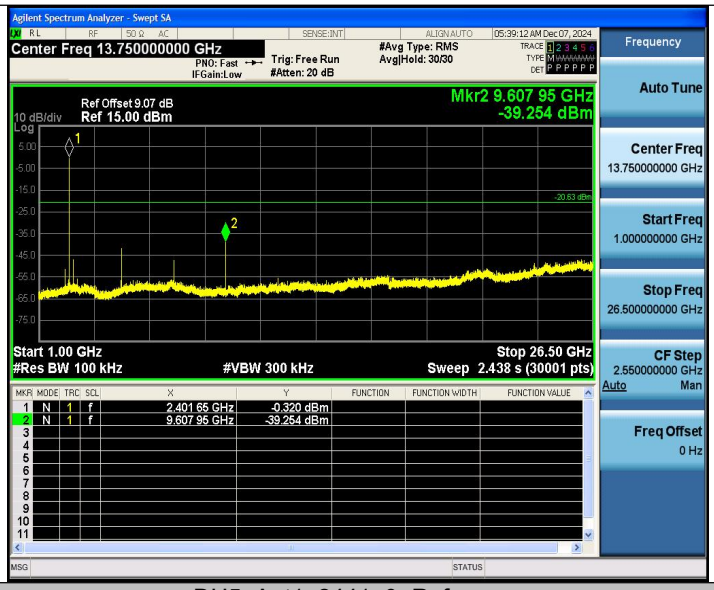
DH5_Ant1_2402_0~Reference

DH5_Ant1_2402_30~1000

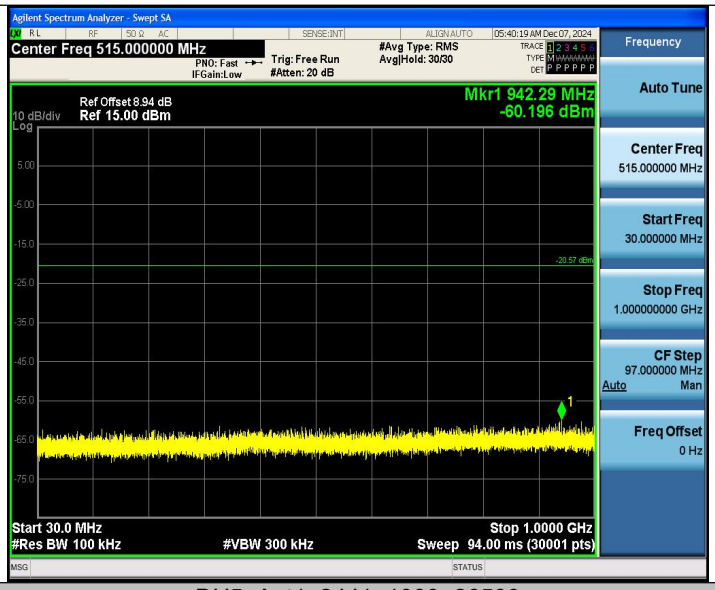


DH5_Ant1_2402_1000~26500

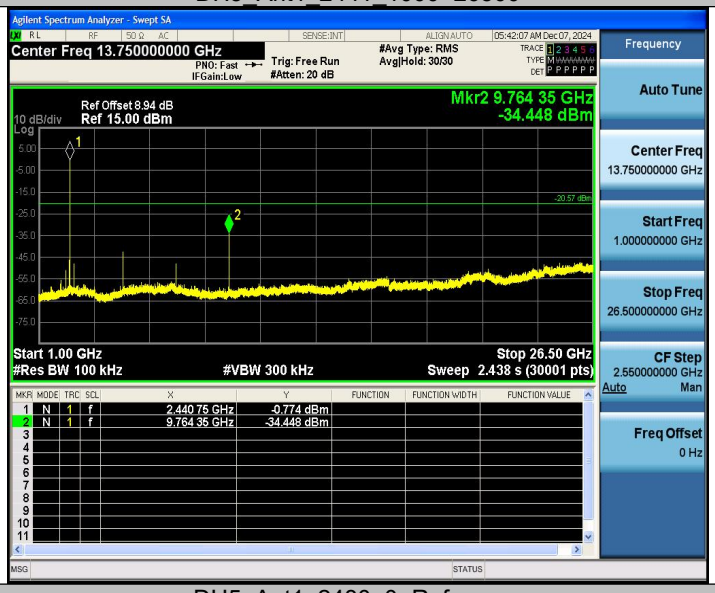


DH5_Ant1_2441_0~Reference

DH5_Ant1_2441_30~1000

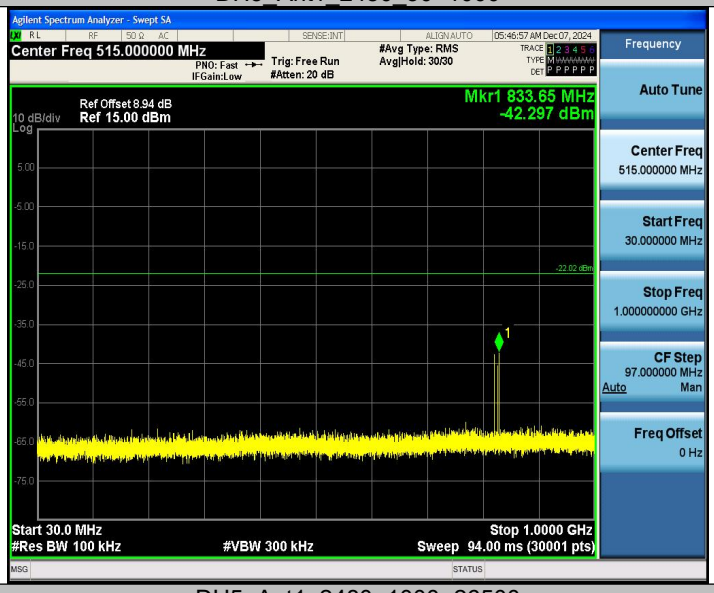


DH5_Ant1_2441_1000~26500

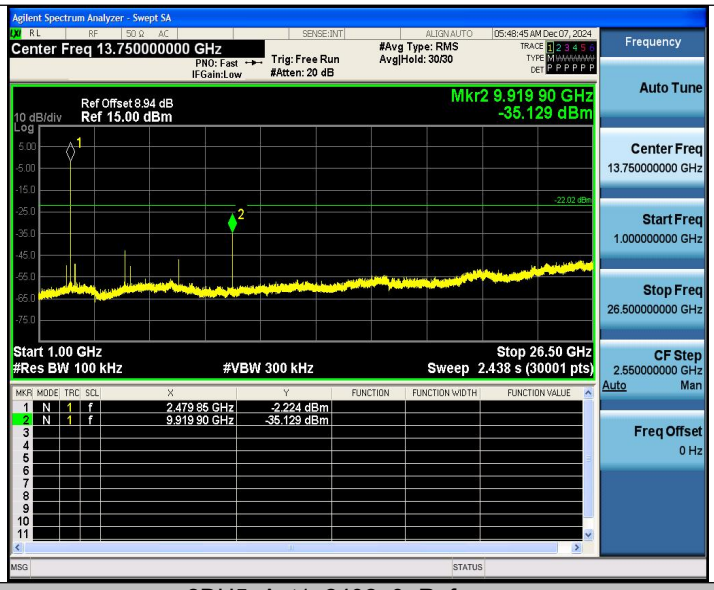


DH5_Ant1_2480_0~Reference

DH5_Ant1_2480_30~1000

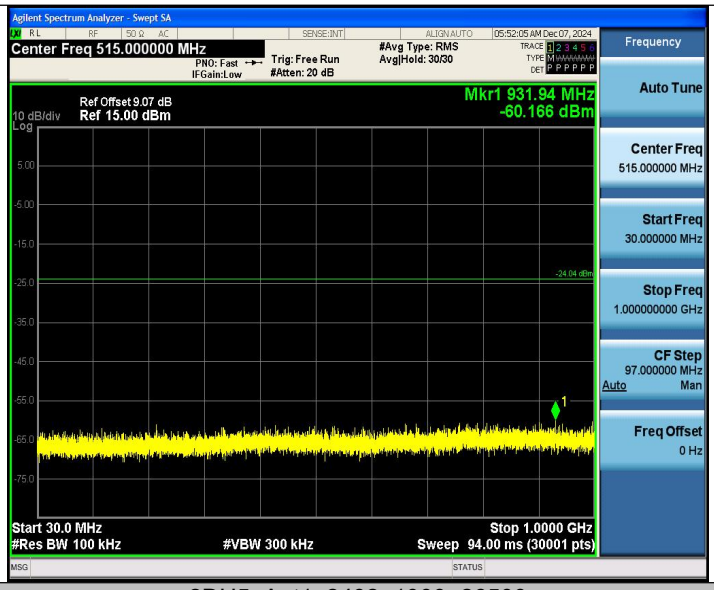


DH5_Ant1_2480_1000~26500



2DH5_Ant1_2402_0~Reference

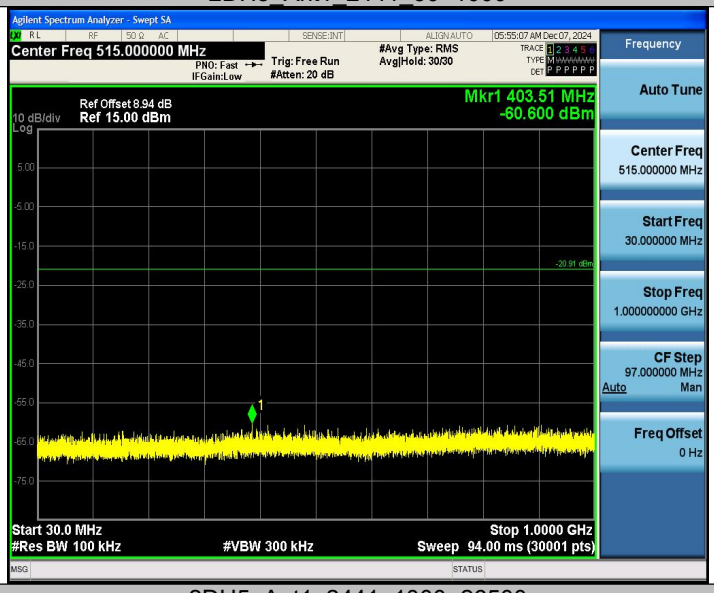
2DH5_Ant1_2402_30~1000



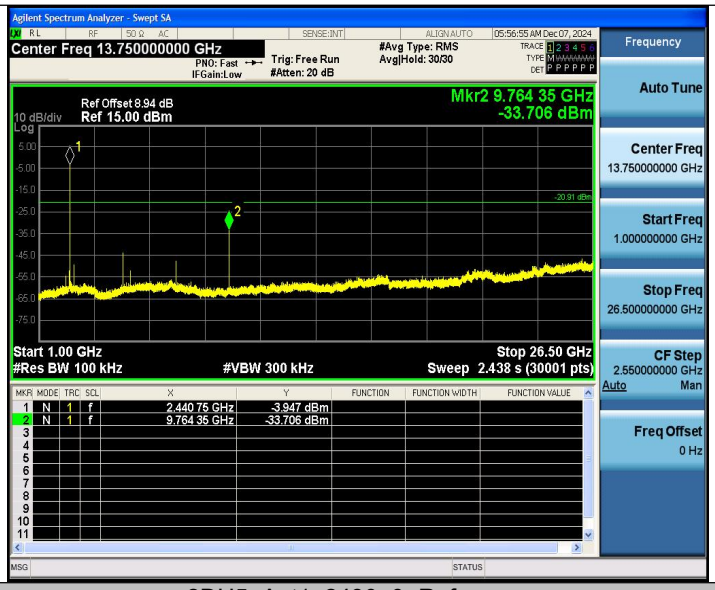
2DH5_Ant1_2402_1000~26500

2DH5_Ant1_2441_0~Reference

2DH5_Ant1_2441_30~1000

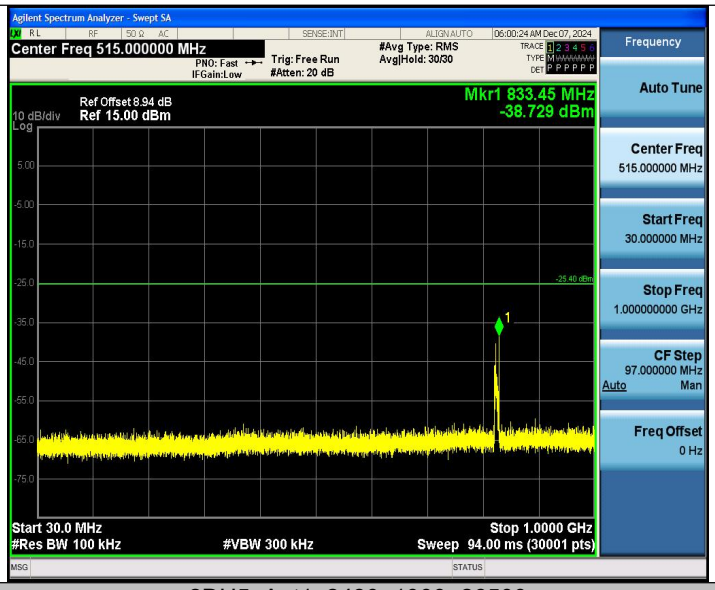


2DH5_Ant1_2441_1000~26500



2DH5_Ant1_2480_0~Reference

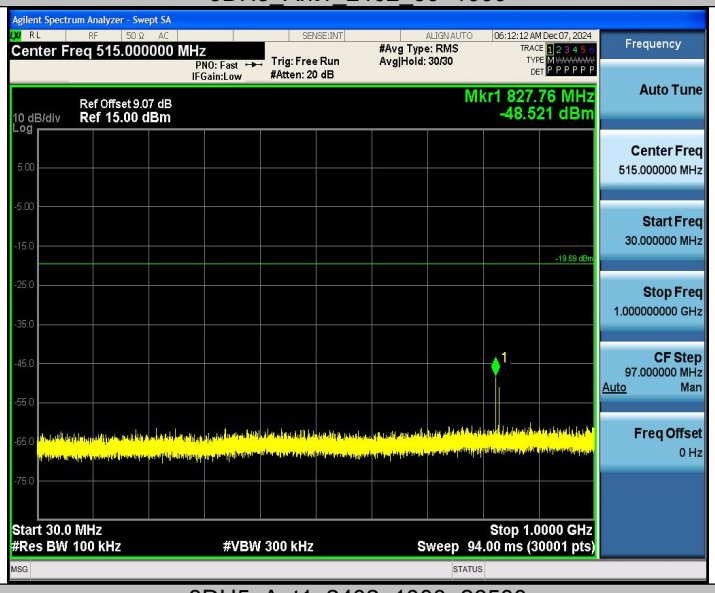
2DH5_Ant1_2480_30~1000



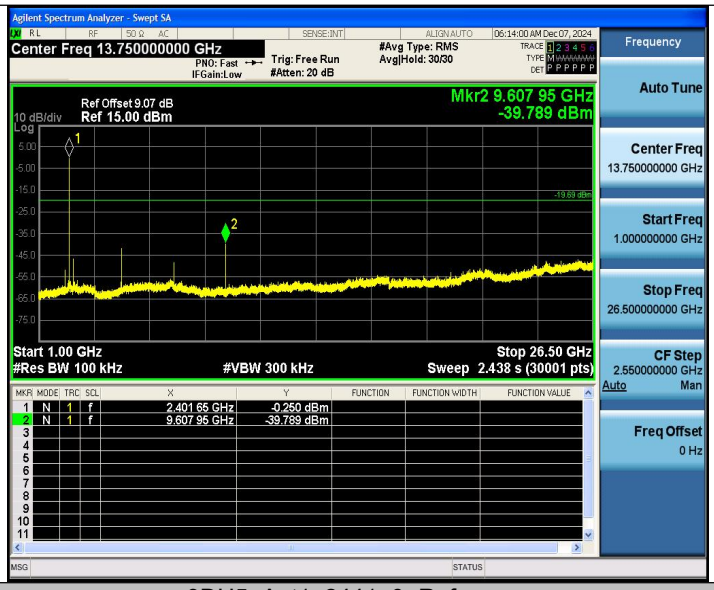
2DH5_Ant1_2480_1000~26500

3DH5_Ant1_2402_0~Reference

3DH5_Ant1_2402_30~1000

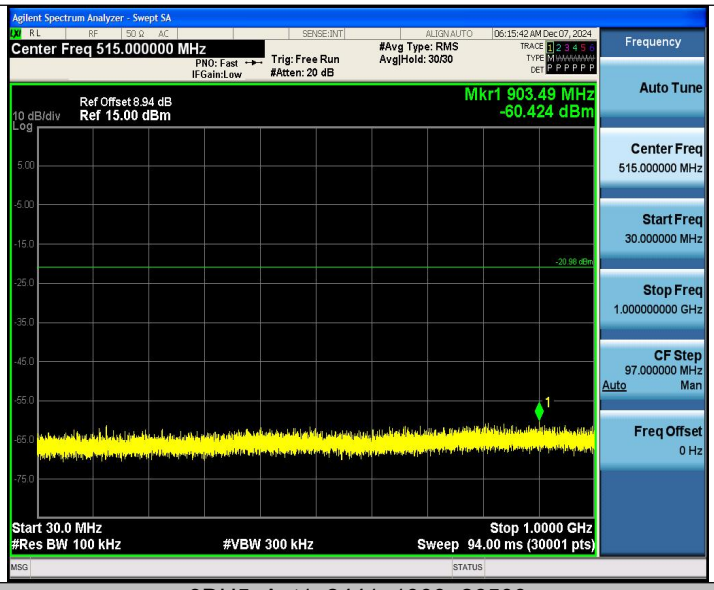


3DH5_Ant1_2402_1000~26500

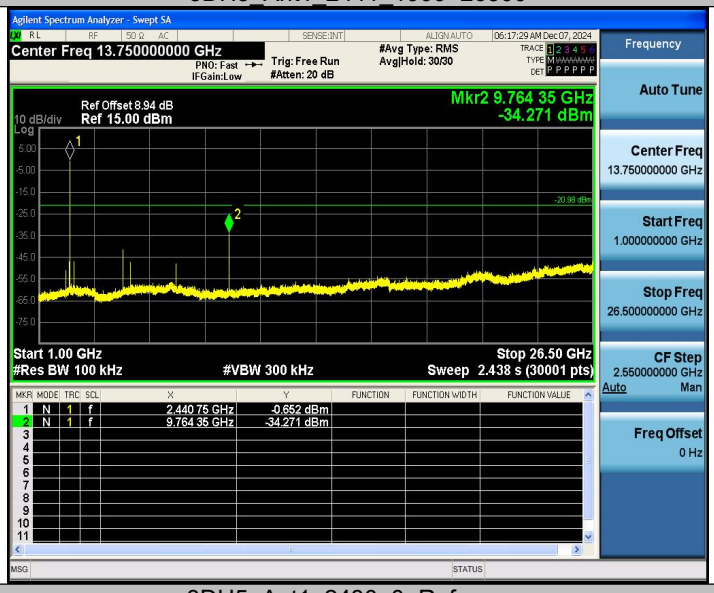


3DH5_Ant1_2441_0~Reference

3DH5_Ant1_2441_30~1000

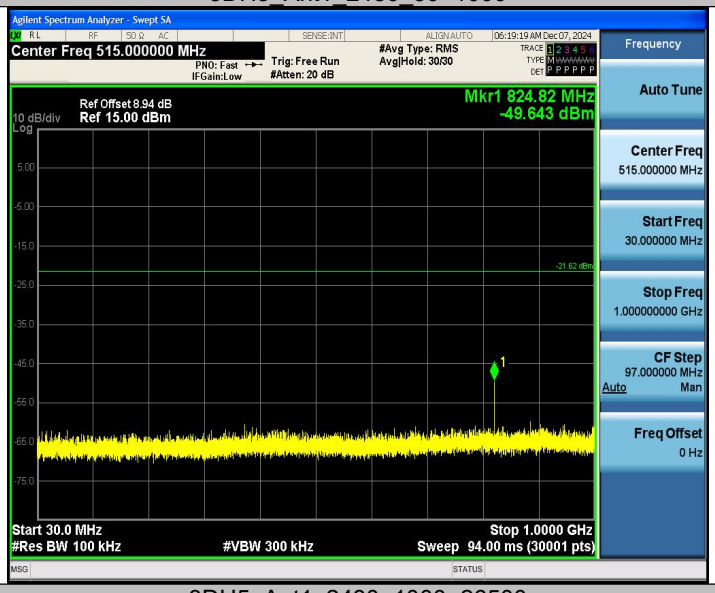


3DH5_Ant1_2441_1000~26500

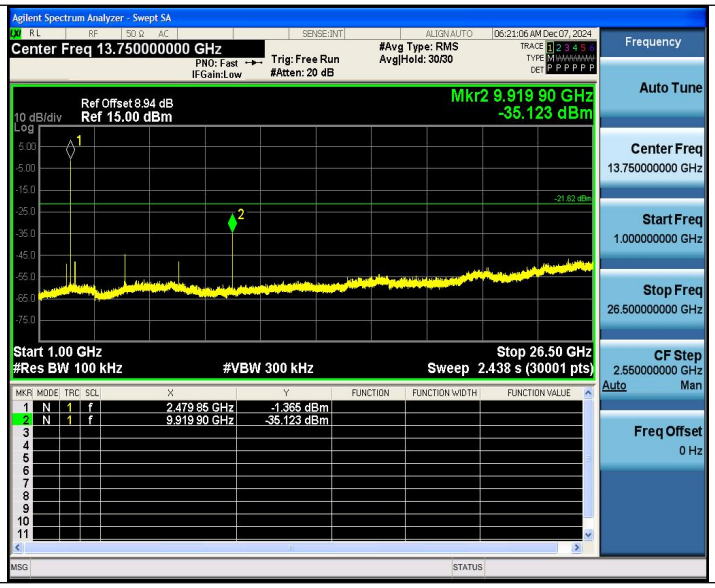


3DH5_Ant1_2480_0~Reference

3DH5_Ant1_2480_30~1000



3DH5_Ant1_2480_1000~26500


Agilent Spectrum Analyzer - Swept SA
Center Freq 13.750000000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
#Atten: 20 dB
#Avg Type: RMS
Avg|Hold: 30/30
06:21:06 AM Dec 07, 2024
Ref Offset 8.94 dB
10 dB/div
Log
Ref 15.00 dBm
Mkr2 9.919 90 GHz
-35.123 dBm
-21.62 dBm
Start 1.00 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 26.50 GHz
Sweep 2.438 s (30001 pts)
1 N 1 f 2.479 85 GHz -1.365 dBm
2 N 1 f 9.919 90 GHz -35.123 dBm
Frequency
Auto Tune
Center Freq
13.750000000 GHz
Start Freq
1.000000000 GHz
Stop Freq
26.500000000 GHz
CF Step
2.550000000 GHz
Auto
Man
Freq Offset
0 Hz
MSG
STATUS

4.7. RADIATED SPURIOUS EMISSION

4.7.1. Applicable Standard

According to FCC Part 15.247(d) and KDB 558074 D01 15.247 Meas Guidance v05r02

4.7.2. Conformance Limit

According to FCC Part 15.247(d): radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).
According to FCC Part15.205, Restricted bands

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
10.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(2)
13.36-13.41			

According to FCC Part15.205, the level of any transmitter spurious emission in Restricted bands shall not exceed the level of the emission specified in the following table

Restricted Frequency(MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)	Measurement Distance
0.009-0.490	2400/F(KHz)	20 log (uV/m)	300
0.490-1.705	24000/F(KHz)	20 log (uV/m)	30
1.705-30	30	29.5	30
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
Above 960	500	54	3

4.7.3. Test Configuration

Test according to clause 3.2 radio frequency test setup 2

4.7.4. Test Procedure

This test is required for any spurious emission that falls in a Restricted Band, as defined in Section 15.205. It must be performed with the highest gain of each type of antenna proposed for use with the EUT. Use the following spectrum analyzer settings:
For Above 1GHz:
The EUT was placed on a turn table which is 1.5m above ground plane.
Maximum procedure was performed on the highest emissions to ensure EUT compliance.
Span = wide enough to fully capture the emission being measured
RBW = 1 MHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
For Below 1GHz:
The EUT was placed on a turn table which is 0.8m above ground plane.
Maximum procedure was performed on the highest emissions to ensure EUT compliance.
Span = wide enough to fully capture the emission being measured
RBW = 100 kHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
For Below 30MHz:
The EUT was placed on a turn table which is 0.8m above ground plane.
Maximum procedure was performed on the highest emissions to ensure EUT compliance.
Span = wide enough to fully capture the emission being measured
RBW = 9kHz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
For Below 150KHz:
The EUT was placed on a turn table which is 0.8m above ground plane.
Maximum procedure was performed on the highest emissions to ensure EUT compliance.
Span = wide enough to fully capture the emission being measured
RBW = 200Hz
VBW ≥ RBW
Sweep = auto
Detector function = peak
Trace = max hold
Follow the guidelines in ANSI C63.10-2013 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization, etc. A pre-amp and a high pass filter are required for this test, in order to provide the measuring system with sufficient sensitivity. Allow the trace to stabilize. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength, which must comply with the limit specified in Section 15.35(b). Submit this data.
Now set the VBW to 10 Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100 ms, then the reading obtained with the 10 Hz VBW may be further adjusted by a “duty cycle correction factor”, derived from 20log(dwell time/100 ms), in an effort to demonstrate compliance with the 15.209 limit. Submit this data.
Repeat above procedures until all frequency measured was complete.

■ Spurious Emission below 30MHz (9KHz to 30MHz)

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type	Ant. Pol.
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)		H/V
--	--	--	--	--	--	--	--

Note: the amplitude of spurious emission that is attenuated by more than 20dB below the permissible limit has no need to be reported.
Distance extrapolation factor =40log(Specific distance/ test distance)(dB);
Limit line=Specific limits(dBuV) + distance extrapolation factor

■ Spurious Emission Above 1GHz (1GHz to 25GHz)

Bluetooth (GFSK, π/4-DQPSK, 8DPSK) mode have been tested, and the worst result(π/4-DQPSK) was report as below:

Test mode:	π/4-DQPSK	Frequency:	Channel 0: 2402MHz

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type	Ant. Pol.
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)		H/V
4808	45.08	-1.01	44.07	74	-29.93	peak	V
4825	32.17	-1.02	31.15	54	-22.85	AVG	V
7086	41.04	5.73	46.77	74	-27.23	AVG	V
7103	29.93	5.72	35.65	54	-18.35	peak	V
9602	41.78	7.57	49.35	74	-24.65	peak	V
9619	30.42	7.58	38	54	-16	AVG	V
4808	53.6	-1.01	52.59	74	-21.41	peak	H
4825	38.64	-1.02	37.62	54	-16.38	AVG	H
7103	30.49	5.72	36.21	54	-17.79	AVG	H
7120	40.07	5.72	45.79	74	-28.21	peak	H
9602	41.78	7.57	49.35	74	-24.65	peak	H
9619	30.24	7.58	37.82	54	-16.18	AVG	H

Test mode:	π/4-DQPSK	Frequency:	Channel 39: 2441MHz

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type	Ant. Pol.
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)		H/V
4876	46.37	-1.01	45.36	74	-28.64	peak	V
4893	33.15	-1	32.15	54	-21.85	AVG	V
7069	40.8	5.74	46.54	74	-27.46	peak	V
7103	30.1	5.72	35.82	54	-18.18	AVG	V
8633	41.23	6.49	47.72	74	-26.28	peak	V
8650	29.28	6.52	35.8	54	-18.2	AVG	V
4876	52.49	-1.01	51.48	74	-22.52	peak	H
4893	38.43	-1	37.43	54	-16.57	AVG	H
7137	40.38	5.71	46.09	74	-27.91	peak	H
7103	30.31	5.72	36.03	54	-17.97	AVG	H
9772	40.89	7.67	48.56	74	-25.44	peak	H
9857	30.17	7.73	37.9	54	-16.1	AVG	H

Test mode:	π/4-DQPSK	Frequency:	Channel 78: 2480MHz

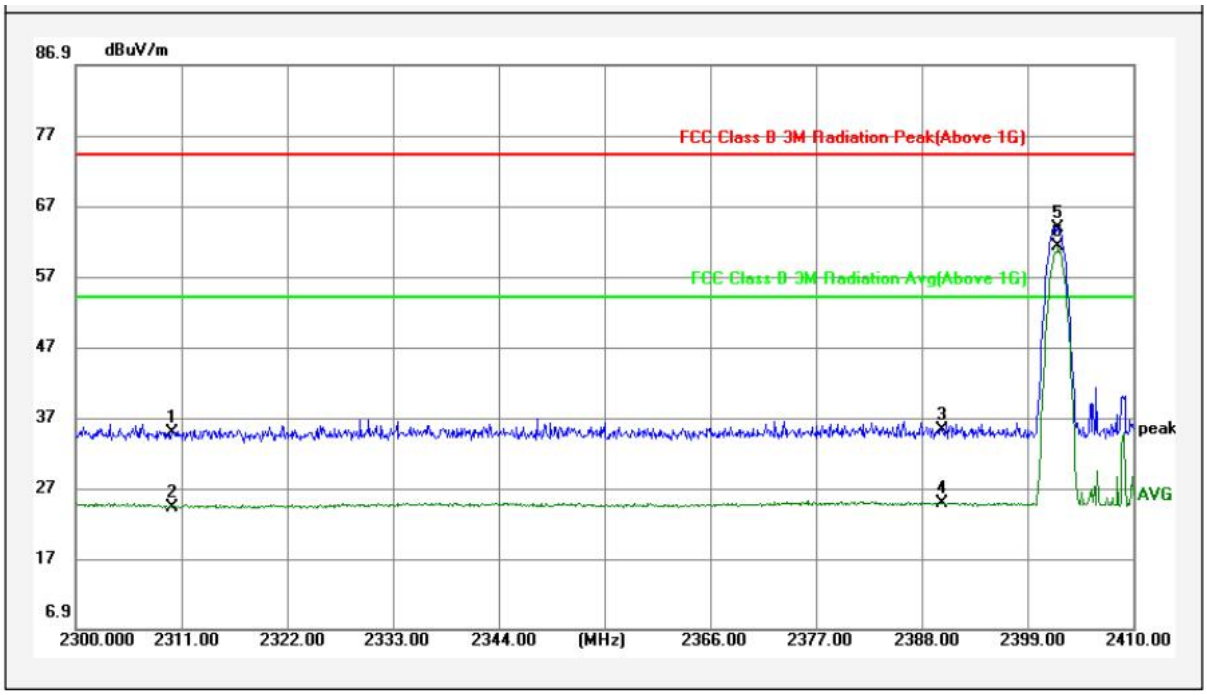
Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type	Ant. Pol.
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)		H/V
4961	48.78	-1	47.78	74	-26.22	peak	V
4978	34.47	-1.01	33.46	54	-20.54	AVG	V
7120	40.88	5.72	46.6	74	-27.4	peak	V
7103	30.31	5.72	36.03	54	-17.97	AVG	V
9925	42.35	7.77	50.12	74	-23.88	peak	V
9942	30.76	7.78	38.54	54	-15.46	AVG	V
4961	49.25	-1	48.25	74	-25.75	peak	H
4978	35.07	-1.01	34.06	54	-19.94	AVG	H
7137	39.89	5.71	45.6	74	-28.4	peak	H
7103	30.12	5.72	35.84	54	-18.16	AVG	H
8531	41.43	6.27	47.7	74	-26.3	peak	H
8531	29.78	6.27	36.05	54	-17.95	AVG	H

Note: (1) All Readings are Peak Value (VBW=3MHz) and Peak Value (VBW=10Hz).
(2) Emission Level= Reading Level+Probe Factor +Cable Loss.
(3) Data of measurement within this frequency range shown " -- " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

■ Spurious Emission in Restricted Band 2300-2390MHz and 2483.5-2500MHz

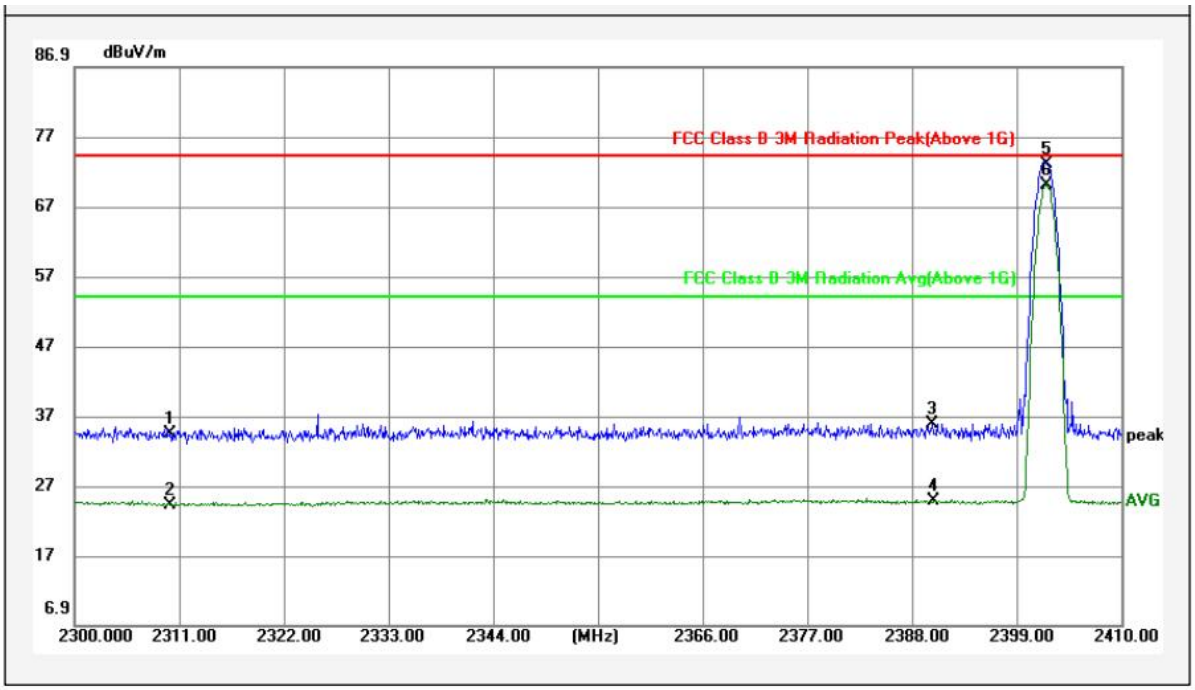
Bluetooth (GFSK, π/4-DQPSK, 8DPSK, Hopping) mode have been tested, and the worst result(π/4-DQPSK) was report as below:

Test Mode:	π/4-DQPSK	2402MHz	Test Channel	Lowest
Temperature:	22.2℃		Phase:	Vertical
Relative Humidity:	47%		Pressure:	101.5KPa



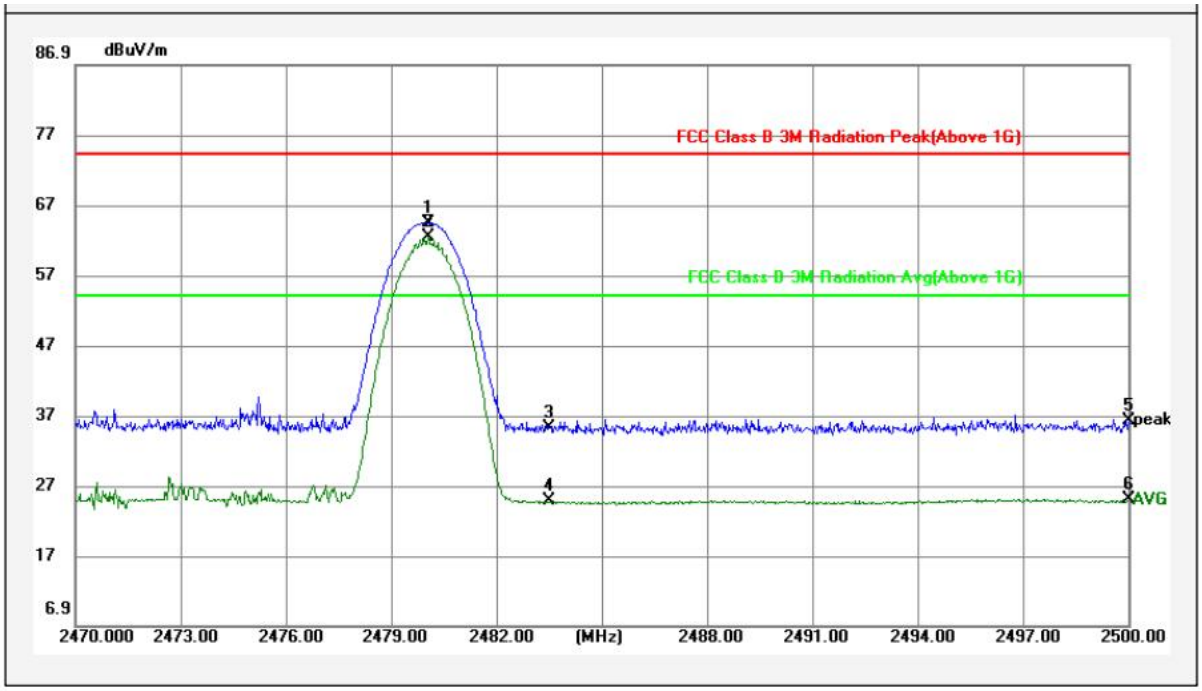
No.	Frequency (MHz)	Factor (dBuV/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	MK.	Remark
1	2310.000	-5.12	39.90	34.78	74.00	-39.22	peak		
2	2310.010	-5.12	29.36	24.24	54.00	-29.76	AVG		
3	2390.000	-4.83	40.01	35.18	74.00	-38.82	peak		
4	2390.090	-4.83	29.73	24.90	54.00	-29.10	AVG		
5	2402.000	-4.78	68.55	63.77	74.00	-10.23	peak		
6	2402.190	-4.78	65.92	61.14	54.00	7.14	AVG	*	

Test Mode:	π/4-DQPSK	2402MHz	Test Channel	Lowest
Temperature:	22.2℃		Phase:	Horizontal
Relative Humidity:	47%		Pressure:	101.5KPa



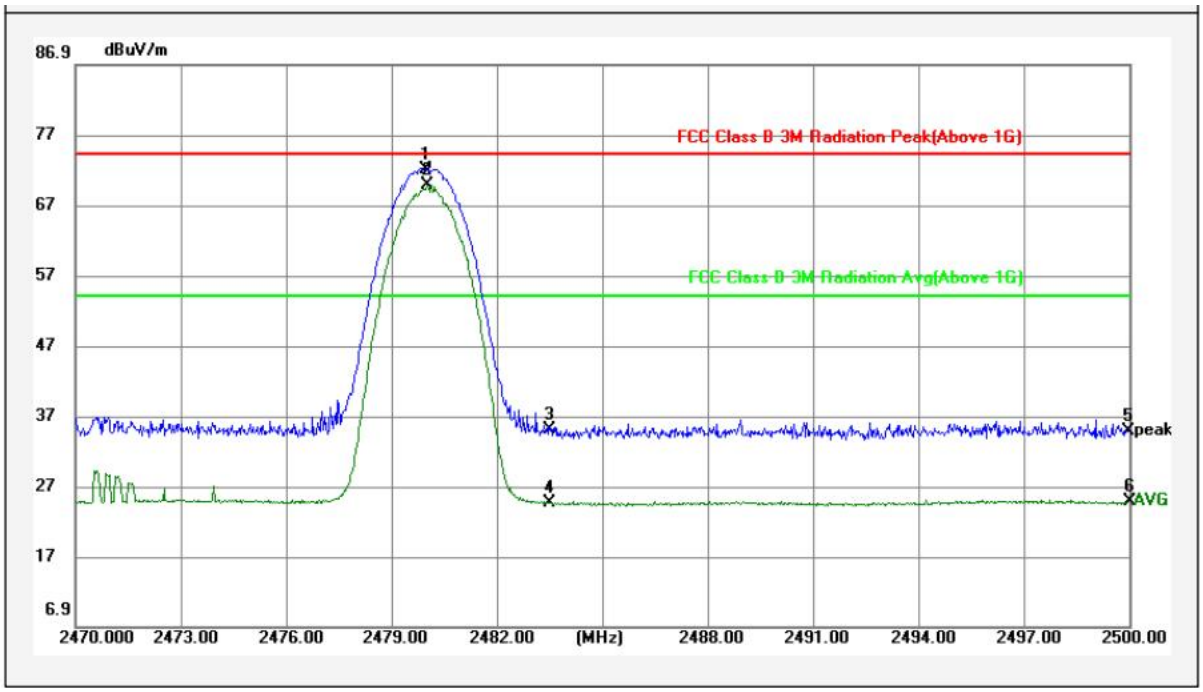
No.	Frequency (MHz)	Factor (dBuV/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	MK.	Remark
1	2310.000	-5.12	39.51	34.39	74.00	-39.61	peak		
2	2310.010	-5.12	29.41	24.29	54.00	-29.71	AVG		
3	2390.000	-4.83	40.56	35.73	74.00	-38.27	peak		
4	2390.200	-4.83	29.62	24.79	54.00	-29.21	AVG		
5	2402.190	-4.78	77.85	73.07	74.00	-0.93	peak		
6	2402.190	-4.78	74.73	69.95	54.00	15.95	AVG	*	

Test Mode:	π/4-DQPSK	2480MHz	Test Channel	Highest
Temperature:	22.2℃		Phase:	Vertical
Relative Humidity:	47%		Pressure:	101.5KPa



No.	Frequency (MHz)	Factor (dBuV/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	MK.	Remark
1	2480.050	-4.48	68.80	64.32	74.00	-9.68	peak		
2	2480.050	-4.48	66.90	62.42	54.00	8.42	AVG	*	
3	2483.500	-4.46	39.62	35.16	74.00	-38.84	peak		
4	2483.500	-4.46	29.35	24.89	54.00	-29.11	AVG		
5	2500.000	-4.41	40.56	36.15	74.00	-37.85	peak		
6	2500.000	-4.41	29.37	24.96	54.00	-29.04	AVG		

Test Mode:	π/4-DQPSK	2480MHz	Test Channel	Highest
Temperature:	22.2℃		Phase:	Horizontal
Relative Humidity:	47%		Pressure:	101.5KPa



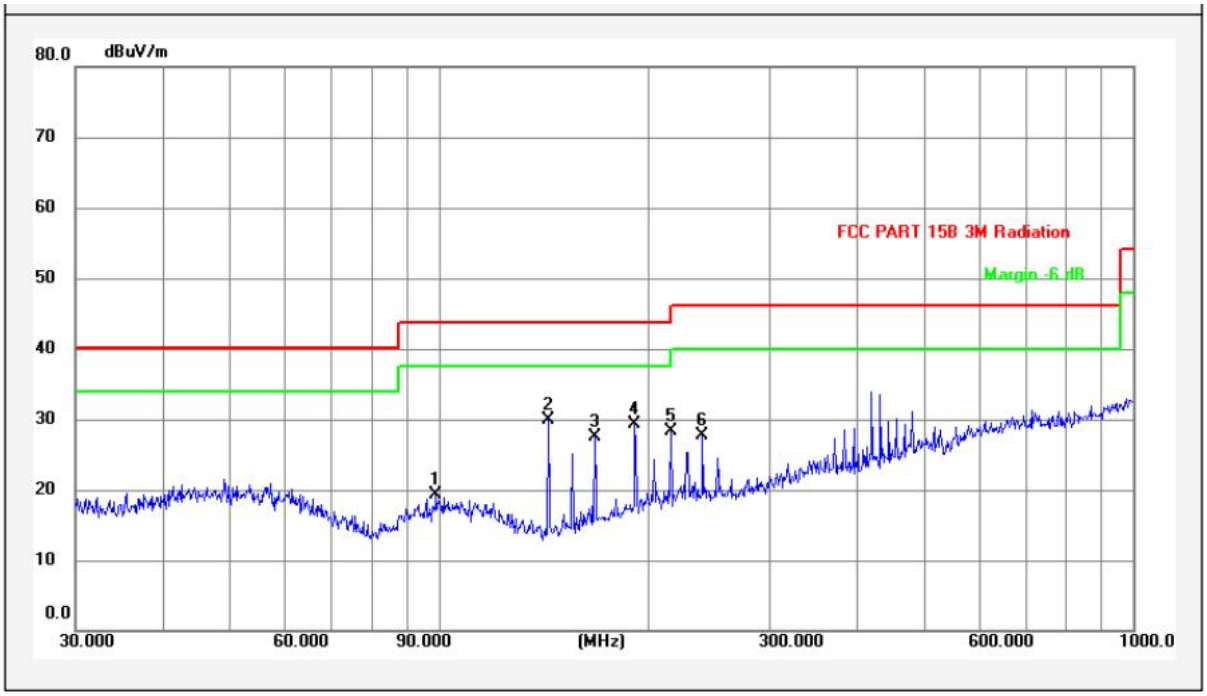
No.	Frequency (MHz)	Factor (dBuV/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	MK.	Remark
1	2479.990	-4.48	76.51	72.03	74.00	-1.97	peak		
2	2480.000	-4.48	74.36	69.88	54.00	15.88	AVG	*	
3	2483.500	-4.46	39.52	35.06	74.00	-38.94	peak		
4	2483.500	-4.46	29.14	24.68	54.00	-29.32	AVG		
5	2499.970	-4.41	39.25	34.84	74.00	-39.16	peak		
6	2500.000	-4.41	29.25	24.84	54.00	-29.16	AVG		

Note: (1) All Readings are Peak Value (VBW=3MHz) and Average Value (VBW=10Hz).
(2) Emission Level= Reading Level+Correct Factor.
(3) Correct Factor= Ant_F + Cab_L - Preamp
(4) The reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

■ Spurious Emission below 1GHz (30MHz to 1GHz)

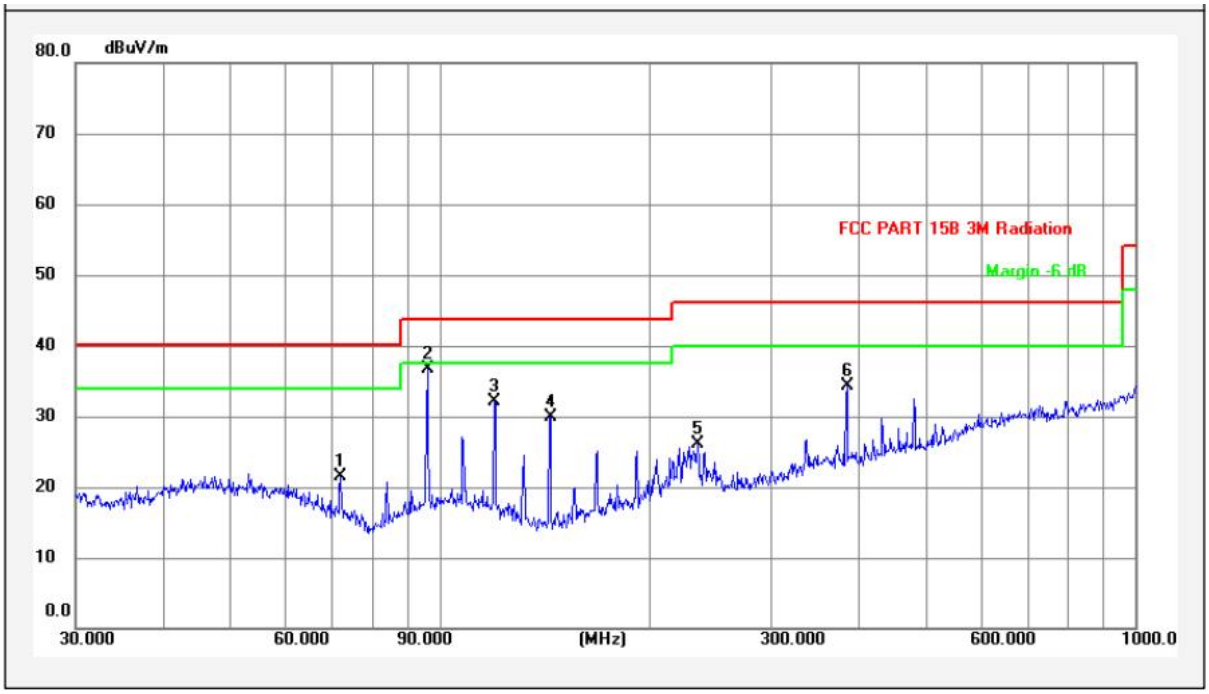
Bluetooth (GFSK, π/4-DQPSK, 8DPSK) mode have been tested, and the worst result(π/4-DQPSK) was report as below:

Test Mode:	π/4-DQPSK	2402MHz	Test Voltage:	DC 3.7V
Temperature:	24.1℃		Phase:	Vertical
Relative Humidity:	54%		Pressure:	101.4KPa



No.	Frequency (MHz)	Factor (dBuV/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	MK.	Remark
1	99.1797	10.44	8.80	19.24	43.50	-24.26	QP		
2	143.8295	6.93	23.07	30.00	43.50	-13.50	QP	*	
3	167.8242	8.47	19.08	27.55	43.50	-15.95	QP		
4	191.7450	9.48	19.79	29.27	43.50	-14.23	QP		
5	216.0239	10.94	17.34	28.28	46.00	-17.72	QP		
6	239.9873	11.13	16.66	27.79	46.00	-18.21	QP		

Test Mode:	π/4-DQPSK	2402MHz	Test Voltage:	DC 3.7V
Temperature:	24.1℃		Phase:	Horizontal
Relative Humidity:	54%		Pressure:	101.4KPa



No.	Frequency (MHz)	Factor (dBuV/m)	Reading (dBuV)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	MK.	Remark
1	72.0843	8.38	13.17	21.55	40.00	-18.45	QP		
2	96.0986	9.87	26.78	36.65	43.50	-6.85	QP	*	
3	119.8556	9.31	22.80	32.11	43.50	-11.39	QP		
4	144.3348	6.96	22.92	29.88	43.50	-13.62	QP		
5	234.9909	11.01	15.06	26.07	46.00	-19.93	QP		
6	385.2805	14.63	19.61	34.24	46.00	-11.76	QP		

4.8. CONDUCTED EMISSION TEST

4.8.1. Applicable Standard

According to FCC Part 15.207(a)

4.8.2. Conformance Limit

Conducted Emission Limit		
Frequency(MHz)	Quasi-peak	Average
0.15-0.5	66-56	56-46
0.5-5.0	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.		

Remark: Test results were obtained from the following equation:
Measurement (dBμV) = LISN Factor (dB) + Cable Loss (dB) + Reading (dBμV)
Margin (dB) = Measurement (dBμV) - Limit (dBμV)

4.8.3. Test Configuration

Test according to clause 3.3 conducted emission test setup

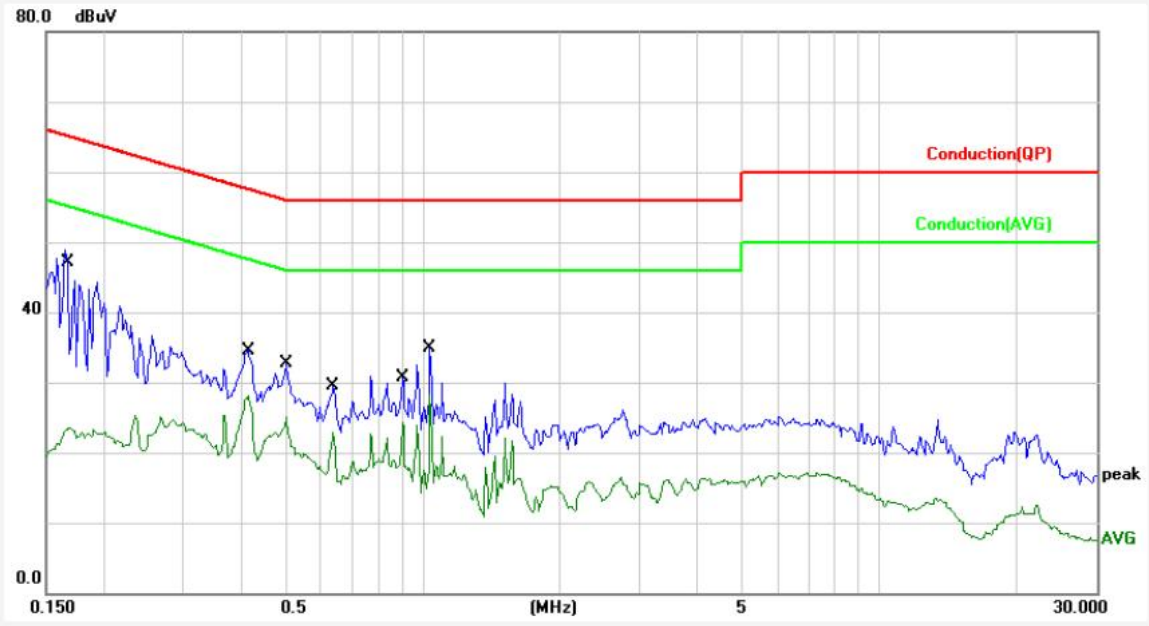
4.8.4. Test Procedure

The EUT was placed on a table which is 0.8m above ground plane.
Maximum procedure was performed on the highest emissions to ensure EUT compliance.
Repeat above procedures until all frequency measured were complete.

Test Results :PASS

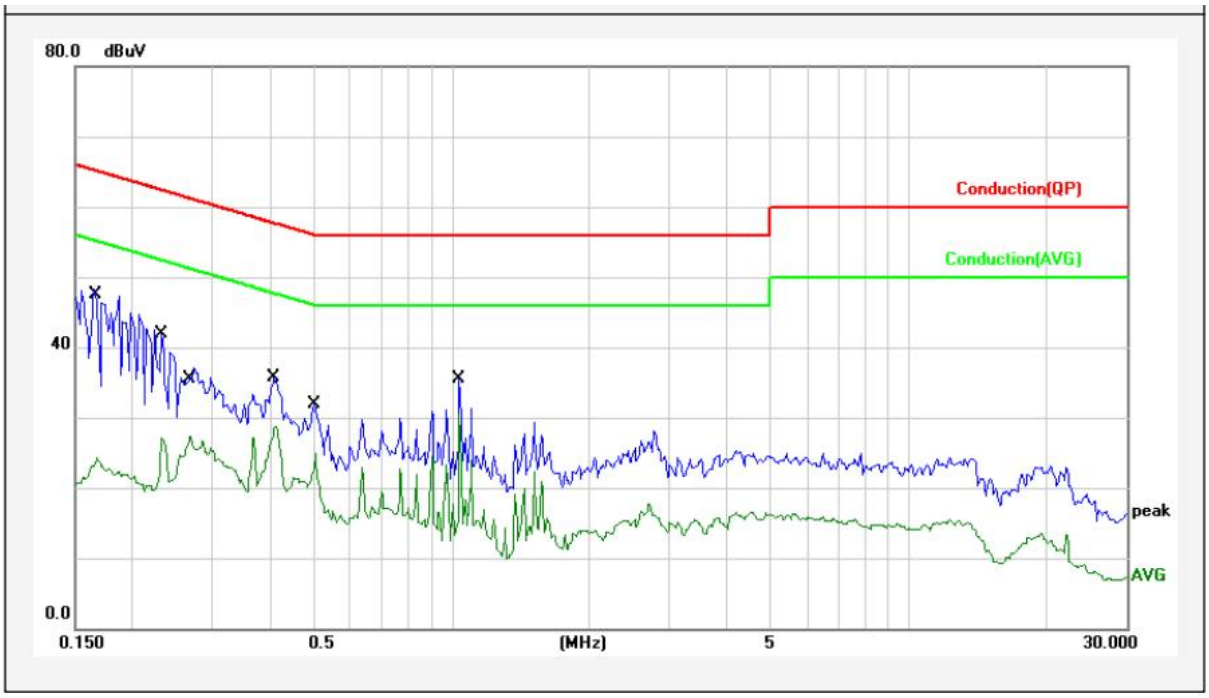
Bluetooth (GFSK, π/4-DQPSK, 8DPSK) mode have been tested, and the worst result(π/4-DQPSK) was report as below:

Test Mode:	π/4-DQPSK	2402MHz	Test Voltage:	AC 120V/60Hz
Temperature:	24.2℃		Phase:	L1
Relative Humidity:	53%		Pressure:	101.2KPa



No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.1690	10.30	35.64	45.94	65.01	-19.07	QP	P	
2	0.1690	10.30	13.20	23.50	55.01	-31.51	AVG	P	
3	0.4160	10.38	21.22	31.60	57.53	-25.93	QP	P	
4	0.4160	10.38	17.67	28.05	47.53	-19.48	AVG	P	
5	0.5036	10.40	19.32	29.72	56.00	-26.28	QP	P	
6	0.5036	10.40	14.69	25.09	46.00	-20.91	AVG	P	
7	0.6392	10.45	16.10	26.55	56.00	-29.45	QP	P	
8	0.6392	10.45	12.35	22.80	46.00	-23.20	AVG	P	
9	0.9081	10.52	17.22	27.74	56.00	-28.26	QP	P	
10	0.9081	10.52	13.82	24.34	46.00	-21.66	AVG	P	
11	1.0400	10.55	21.31	31.86	56.00	-24.14	QP	P	
12	1.0400	10.55	17.71	28.26	46.00	-17.74	AVG	P	

Test Mode:	π/4-DQPSK	2402MHz	Test Voltage:	AC 120V/60Hz
Temperature:	24.2℃		Phase:	N
Relative Humidity:	53%		Pressure:	101.5KPa



No.	Frequency (MHz)	Factor (dB)	Reading (dBuV)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.1675	10.35	35.00	45.35	65.08	-19.73	QP	P	
2	0.1675	10.35	13.90	24.25	55.08	-30.83	AVG	P	
3	0.2323	10.37	29.14	39.51	62.37	-22.86	QP	P	
4	0.2323	10.37	16.64	27.01	52.37	-25.36	AVG	P	
5	0.2680	10.37	23.77	34.14	61.18	-27.04	QP	P	
6	0.2680	10.37	17.01	27.38	51.18	-23.80	AVG	P	
7	0.4126	10.41	22.38	32.79	57.60	-24.81	QP	P	
8	0.4126	10.41	18.36	28.77	47.60	-18.83	AVG	P	
9	0.5036	10.43	18.47	28.90	56.00	-27.10	QP	P	
10	0.5036	10.43	14.53	24.96	46.00	-21.04	AVG	P	
11	1.0400	10.54	22.02	32.56	56.00	-23.44	QP	P	
12	1.0400	10.54	19.99	30.53	46.00	-15.47	AVG	P	

4.9. ANTENNA APPLICATION

4.9.1. Antenna Requirement

Standard	Requirement
FCC CRF Part 15.203	An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section 15.247 (b), if transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

4.9.2. Result

PASS.

The EUT has 1 antenna: Chip Antenna for BT with classic mode, the gain is 1.7dBi;

☒ Antenna use a permanently attached antenna which is not replaceable.
☐ Not using a standard antenna jack or electrical connector for antenna replacement
☐ The antenna has to be professionally installed (please provide method of installation)

Note: which in accordance to section 15.203, please refer to the internal photos.

--------- END OF REPORT --------