

8. Radiated Emissions

8.1.Limit

All the emissions appearing within 15.205 restricted frequency bands shall not exceed the limits shown in 15.209, all the other emissions shall be at least 20dB below the fundamental emissions, or comply with 15.209 limits.

15.205 Restricted frequency band

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
¹ 0.495 - 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	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	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)

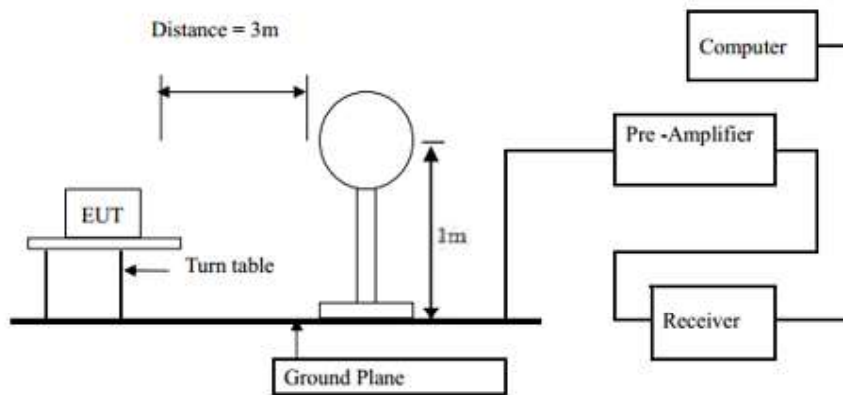
15.209 Limit

FREQUENCY MHz	DISTANCE Meters	FIELD STRENGTHS LIMIT	
		μV/m	dB(μV)/m
0.009-0.490	300	2400/F(KHz)	/
0.490-1.705	30	24000/F(KHz)	/
1.705-30	30	30	29.5
30 ~ 88	3	100	40.0
88 ~ 216	3	150	43.5
216 ~ 960	3	200	46.0
960 ~ 1000	3	500	54.0
Above 1000	3	74.0 dB(μV)/m (Peak) 54.0 dB(μV)/m (Average)	

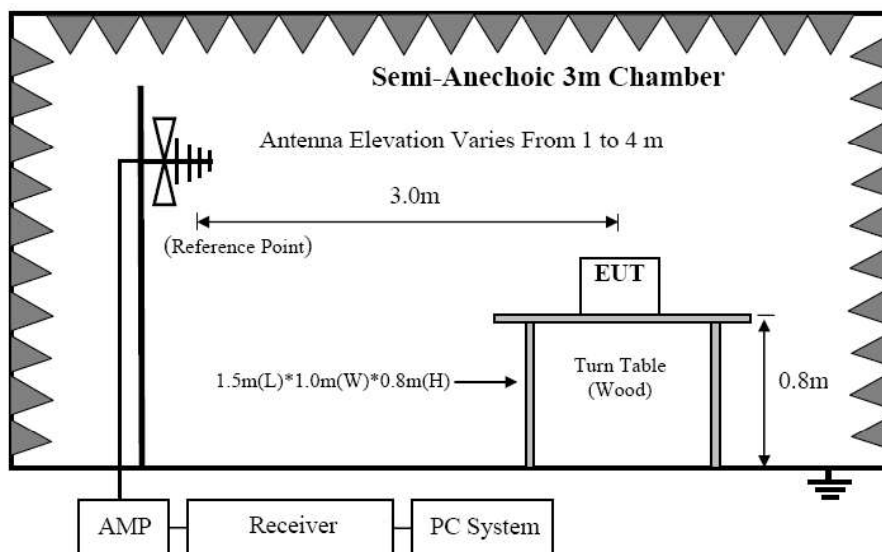
Note: The peak limit is 20 dB higher than the average limit

8.2. Block Diagram of Test setup

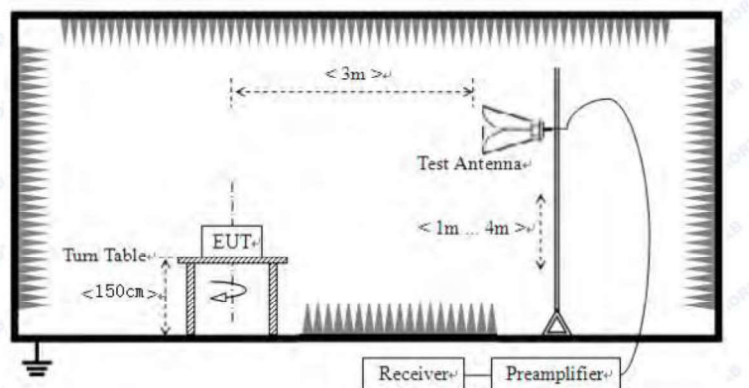
8.2.1 In 3m Anechoic Chamber Test Setup Diagram for below 30MHz



8.2.1 In 3m Anechoic Chamber Test Setup Diagram for below 1GHz



8.2.2 In 3m Anechoic Chamber Test Setup Diagram for frequency above 1GHz



Note: For harmonic emissions test a appropriate high pass filter was inserted in the input port of AMP.

8.3. Test Procedure

- (1) EUT was placed on a non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber.
- (2) Setup EUT and simulator
- (3) Test antenna was located 3m from the EUT on an adjustable mast. Below pre-scan procedure was first performed in order to find prominent radiated emissions.
 - (a) Change work frequency or channel of device if practicable.
 - (b) Change modulation type of device if practicable.
 - (c) Rotated EUT through three orthogonal axes to determine the attitude of EUT arrangement produces highest emissions
- (4) Spectrum frequency from 9KHz to 25GHz (tenth harmonic of fundamental frequency) was investigated
- (5) For final emissions measurements at each frequency of interest, the EUT were rotated and the antenna height was varied between 1m and 4m in order to maximize the emission. Measurements in both horizontal and vertical polarities were made and the data was recorded. In order to find the maximum emission, the relative positions of equipments and all of the interface cables were changed according to ANSI C63.10 :2013on Radiated Emission test.
- (6) For emissions above 1GHz, both Peak and Average level were measured with Spectrum Analyzer, and the RBW is set at 1MHz, VBW is set at 3MHz for Peak measure; RBW is set at 1MHz, VBW is set at 10Hz for Average measure.

8.4. Test Result

We have scanned from 9kHz to the 10th harmonic of the EUT's highest frequency.
Detailed information please see the following page.

From 9KHz to 30MHz: Conclusion: PASS

Note: The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.

From 30MHz to 1000MHz: Conclusion: PASS

Vertical:



No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna	Table	
		MHz	Level	Factor	ment			Height	Degree	
			dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree Comment
1	*	37.4493	16.95	14.12	31.07	40.00	-8.93	peak		
2		59.9376	16.10	13.25	29.35	40.00	-10.65	peak		
3		68.0022	17.08	11.75	28.83	40.00	-11.17	peak		
4		113.3660	15.96	12.21	28.17	43.50	-15.33	peak		
5		151.9298	14.52	14.99	29.51	43.50	13.99	peak		
6		216.0240	20.68	11.43	32.11	46.00	-13.89	peak		

Note: 1. *:Maximum data; x:Over limit; !:over margin.

2.Measurement=Reading Level+Correct Factor; Correct Factor=Antenna Factor+Cable Loss.

Horizontal:

No.	Mk.	Freq.	Reading	Correct	Measure-	Limit	Margin	Antenna	Table	
		MHz	Level	Factor	ment			Height	Degree	
			dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree
1		38.3967	14.34	14.26	28.60	40.00	-11.40	peak		
2		62.3493	15.04	12.74	27.78	40.00	-12.22	peak		
3		151.2652	16.09	14.99	31.08	43.50	-12.42	peak		
4		175.1903	17.26	13.30	30.56	43.50	-12.94	peak		
5	*	204.1482	21.25	10.96	32.21	43.50	-11.29	peak		
6		360.1319	14.64	15.41	30.05	46.00	-15.95	peak		

Note: 1. *: Maximum data; x: Over limit; !: over margin.

2. Measurement = Reading Level + Correct Factor; Correct Factor = Antenna Factor + Cable Loss.

Note: All modes were test, only the worst case was presented in this report. (GFSK 2402MHz)

From 1G-25GHz

Test Mode: GFSK TX Low									
Freq (MHz)	Read Level (dBuV/m)	Polar (H/V)	Antenna Factor (dB/m)	Cable loss(dB)	Amp Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
4804	46.38	V	33.95	10.18	34.26	56.25	74	-17.75	PK
4804	35.02	V	33.95	10.18	34.26	44.89	54	-9.11	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
4804	47.99	H	33.95	10.18	34.26	57.86	74	-16.14	PK
4804	34.39	H	33.95	10.18	34.26	44.26	54	-9.74	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
Test Mode: GFSK TX Mid									
4882	49.57	V	33.95	10.20	34.26	59.46	74	-14.54	PK
4882	34.53	V	33.95	10.20	34.26	44.42	54	-9.58	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
4882	48.02	H	33.95	10.20	34.26	57.91	74	-16.09	PK
4882	32.30	H	33.95	10.20	34.26	42.19	54	-11.81	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
Test Mode: GFSK TX High									
4960	46.16	V	33.98	10.22	34.25	56.11	74	-17.89	PK
4960	33.84	V	33.98	10.22	34.25	43.79	54	-10.21	AV
7440	/	/	/	/	/	/	/	/	/
9920	/	/	/	/	/	/	/	/	/
4960	47.37	H	33.98	10.22	34.25	57.32	74	-16.68	PK
4960	32.49	H	33.98	10.22	34.25	42.44	54	-11.56	AV
7440	/	/	/	/	/	/	/	/	/
9920	/	/	/	/	/	/	/	/	/

Note:

1, Result = Read level + Antenna factor + cable loss-Amp factor

2, All the other emissions not reported were too low to read and deemed to comply with FCC limit.

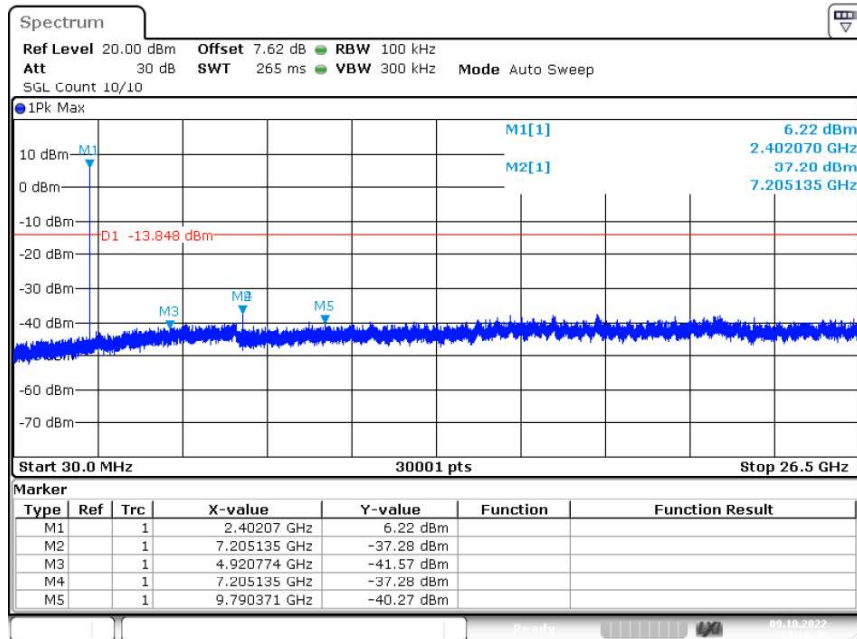
From 1G-25GHz

Test Mode: $\pi/4$ DQPSK TX Low									
Freq (MHz)	Read Level (dBuV/m)	Polar (H/V)	Antenna Factor (dB/m)	Cable loss(dB)	Amp Factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
4804	46.28	V	33.95	10.18	34.26	56.15	74	-17.85	PK
4804	35.75	V	33.95	10.18	34.26	45.62	54	-8.38	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
4804	47.07	H	33.95	10.18	34.26	56.94	74	-17.06	PK
4804	34.40	H	33.95	10.18	34.26	44.27	54	-9.73	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
Test Mode: $\pi/4$ DQPSK TX Mid									
4882	49.32	V	33.95	10.20	34.26	59.21	74	-14.79	PK
4882	34.13	V	33.95	10.20	34.26	44.02	54	-9.98	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
4882	48.79	H	33.95	10.20	34.26	58.68	74	-15.32	PK
4882	32.55	H	33.95	10.20	34.26	42.44	54	-11.56	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
Test Mode: $\pi/4$ DQPSK TX High									
4960	46.84	V	33.98	10.22	34.25	56.79	74	-17.21	PK
4960	33.51	V	33.98	10.22	34.25	43.46	54	-10.54	AV
7440	/	/	/	/	/	/	/	/	/
9920	/	/	/	/	/	/	/	/	/
4960	47.61	H	33.98	10.22	34.25	57.56	74	-16.44	PK
4960	32.21	H	33.98	10.22	34.25	42.16	54	-11.84	AV
7440	/	/	/	/	/	/	/	/	/
9920	/	/	/	/	/	/	/	/	/

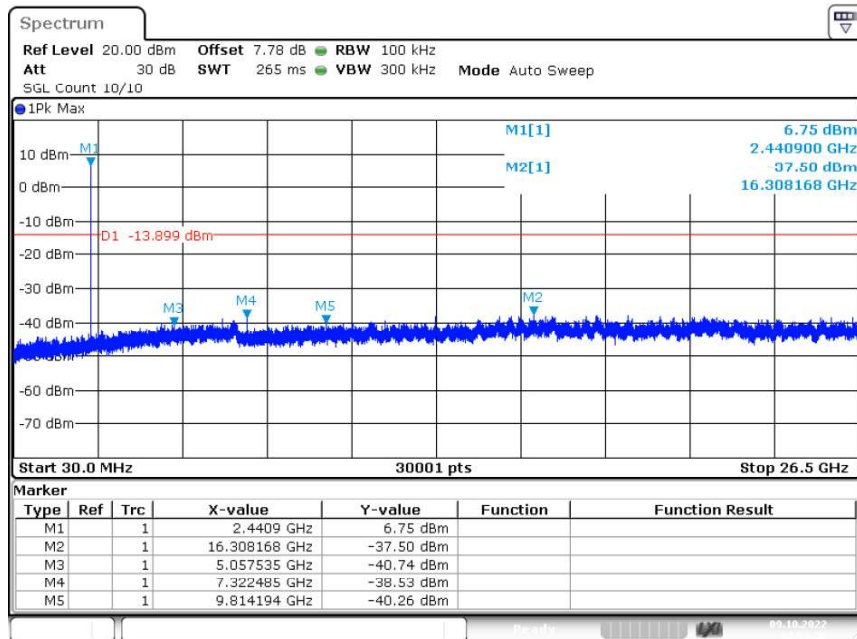
Note:

1, Result = Read level + Antenna factor + cable loss-Amp factor

2, All the other emissions not reported were too low to read and deemed to comply with FCC limit.

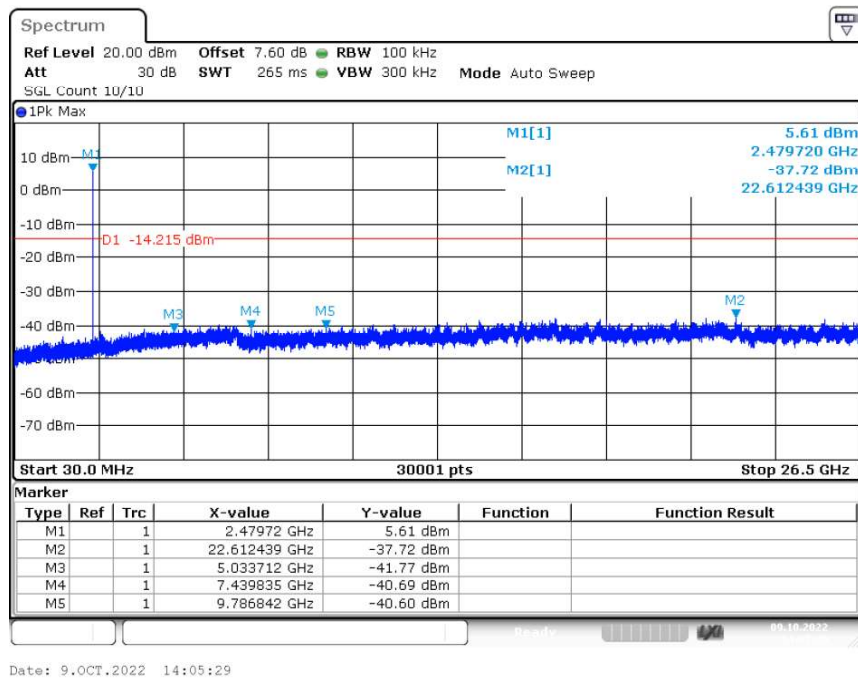
Conducted RF Spurious Emission**Tx. Spurious NVNT 1-DH1 2402MHz Ant1 Emission**

Date: 9.OCT.2022 14:10:29

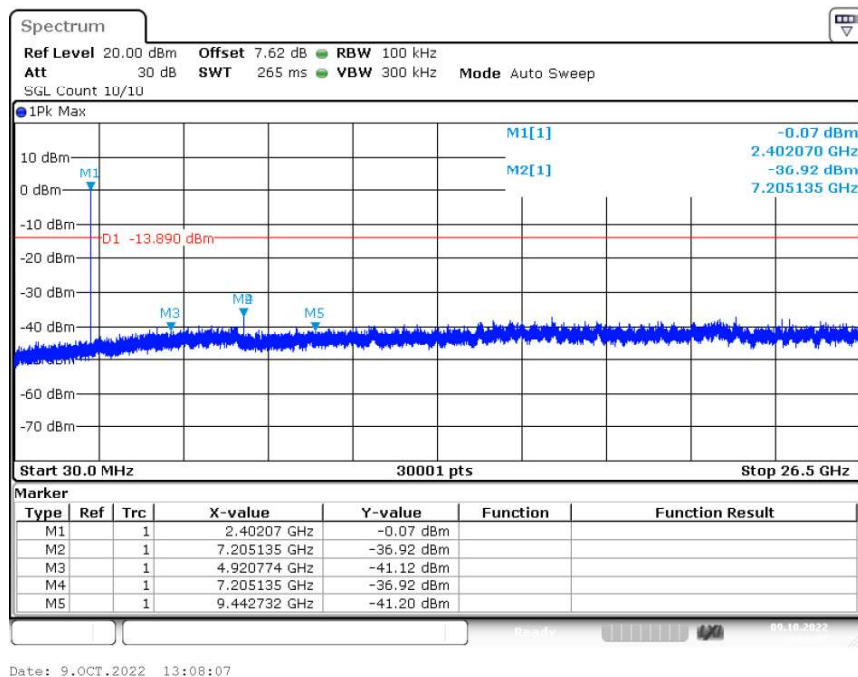
Tx. Spurious NVNT 1-DH1 2441MHz Ant1 Emission

Date: 9.OCT.2022 14:08:25

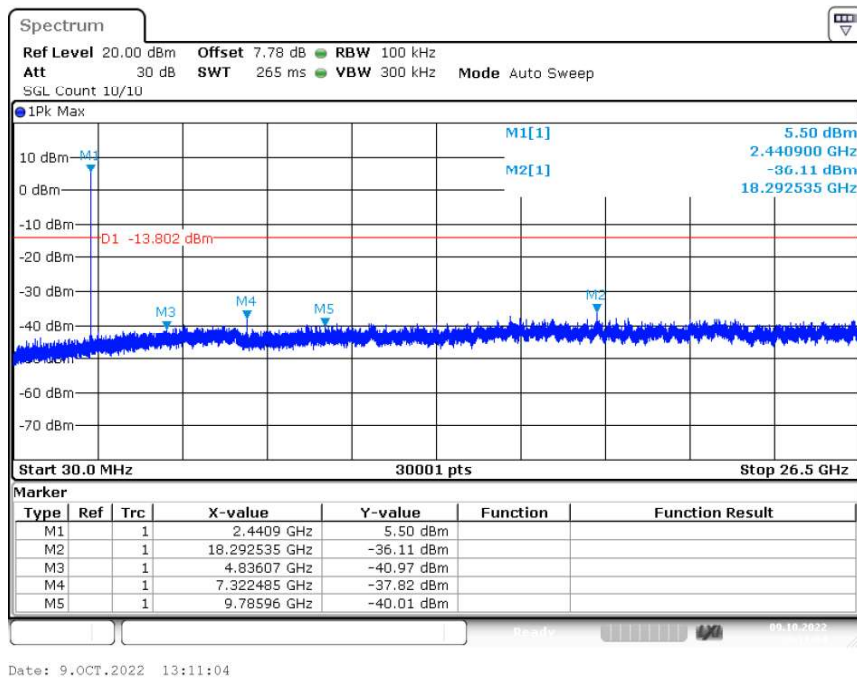
Tx. Spurious NVNT 1-DH1 2480MHz Ant1 Emission



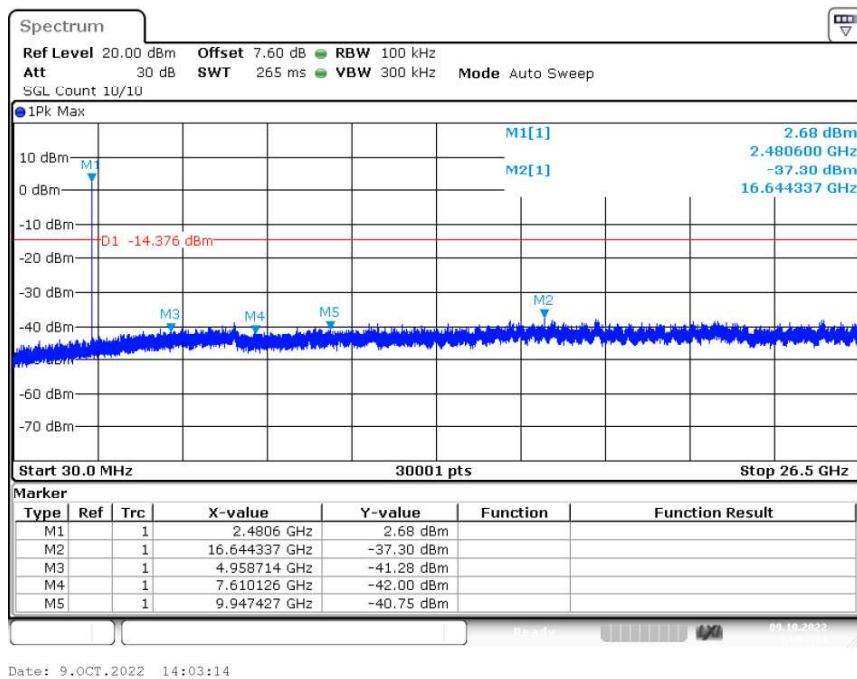
Tx. Spurious NVNT 2-DH1 2402MHz Ant1 Emission



Tx. Spurious NVNT 2-DH1 2441MHz Ant1 Emission

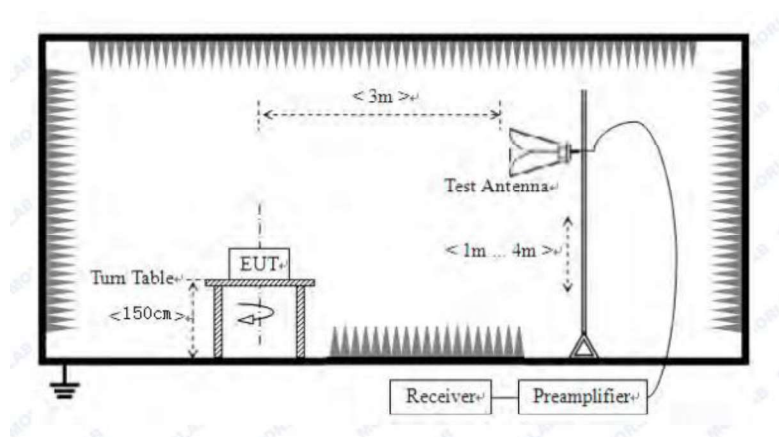


Tx. Spurious NVNT 2-DH1 2480MHz Ant1 Emission



9. Band Edge Compliance

9.1. Block Diagram of Test Setup



9.2. Limit

All the lower and upper band-edges emissions appearing within restricted frequency bands shall not exceed the limits shown in FCC part 15.209 and RSS-GEN, all the other emissions outside operation shall be at least 20dB below the fundamental emissions, or comply with FCC part 15.209 and RSS-GEN limits.

9.3. Test Procedure

Refer to ANSI C 63.10, Clause 6.10.

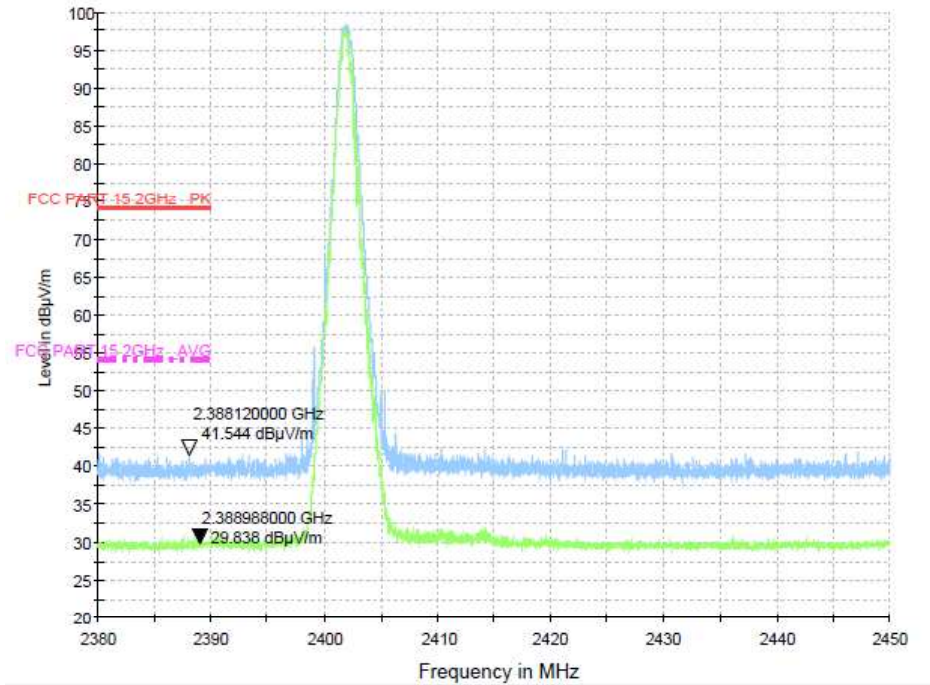
All restriction band and non- restriction band have been tested, only worse case is reported.

9.4. Test Result

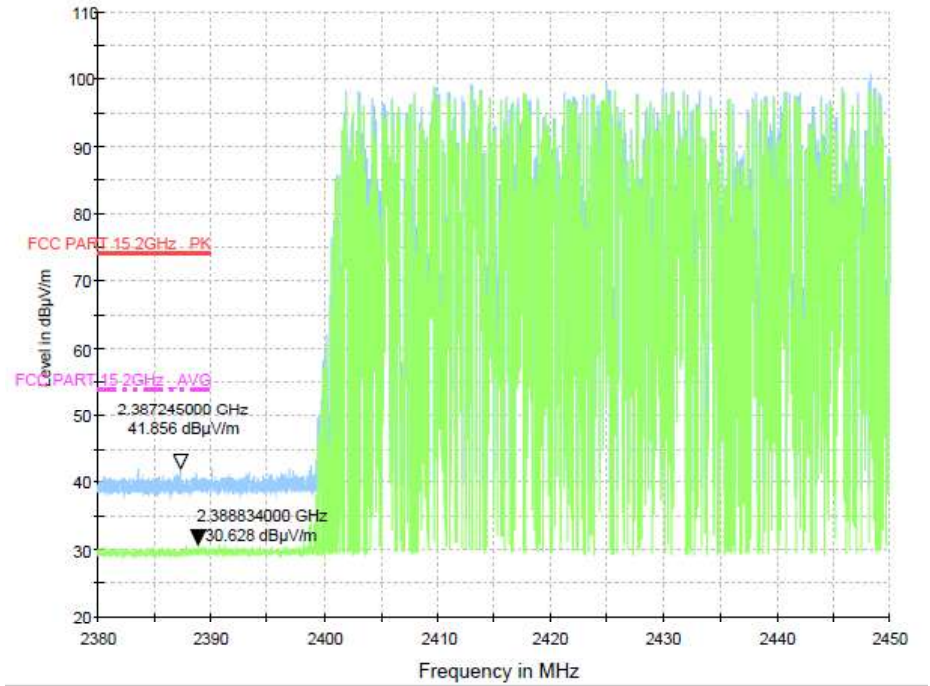
PASS. (See below detailed test data)

Radiated Method:

Test Mode: GFSK-Low

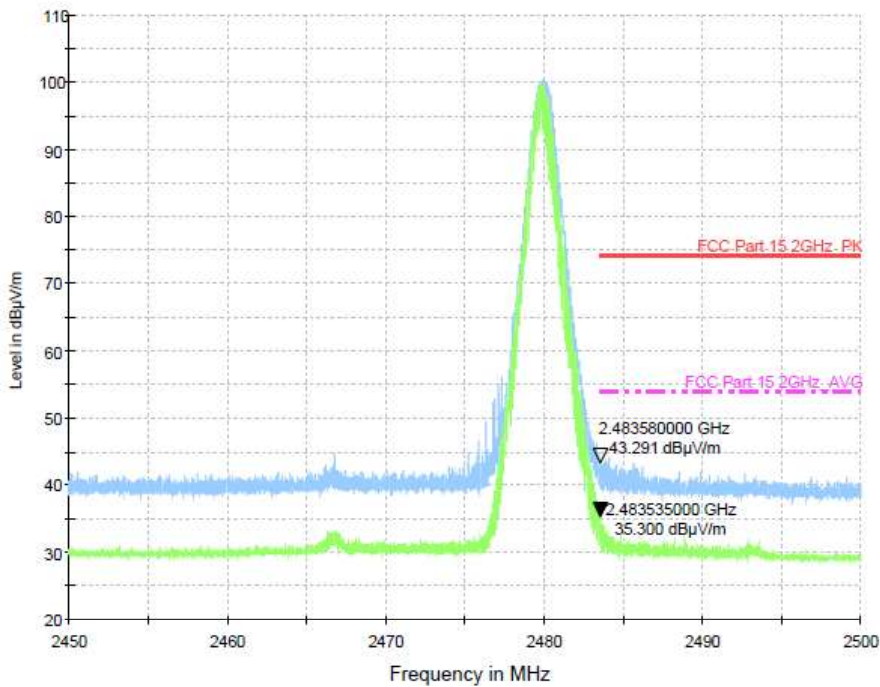


hopping-off

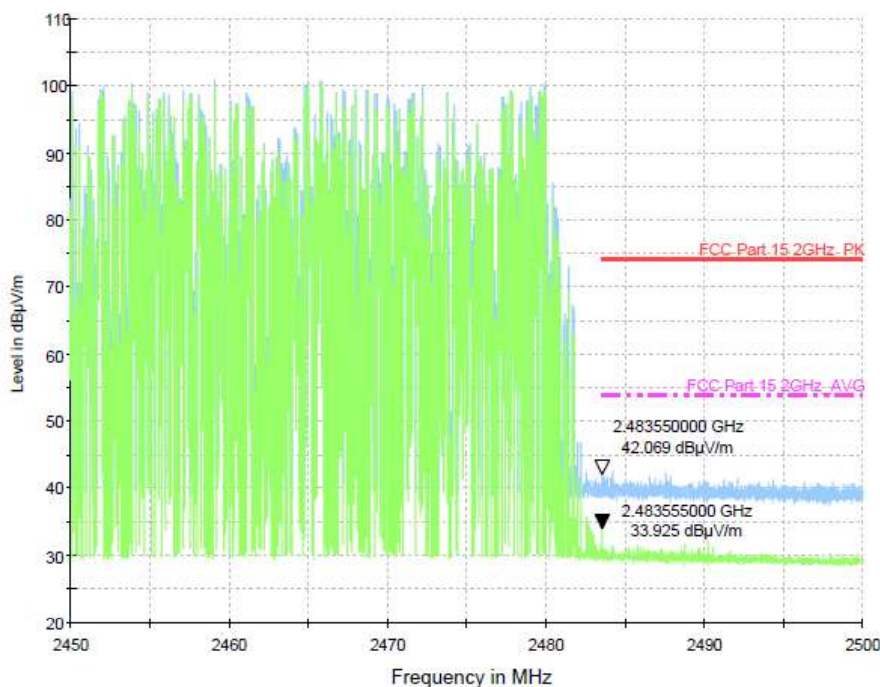


hopping-on

Test Mode: GFSK-High

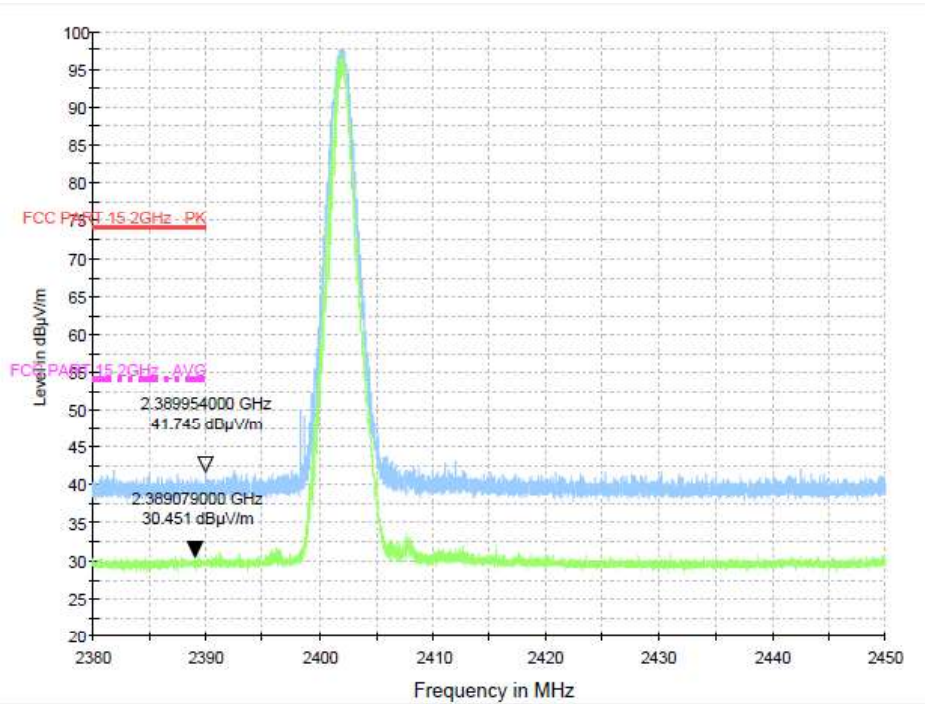


hopping-off

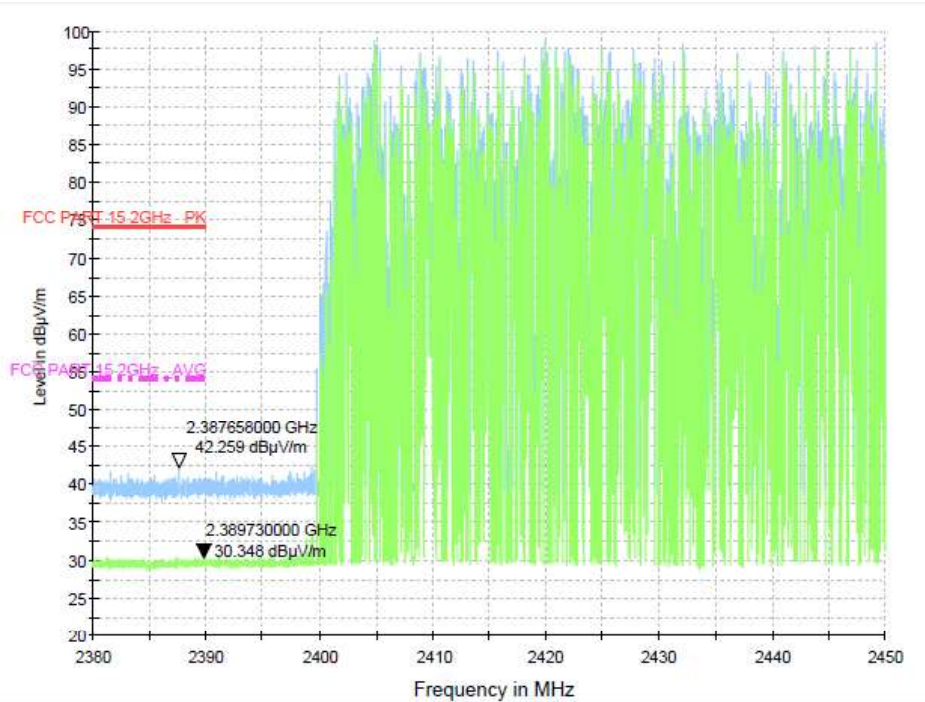


hopping-on

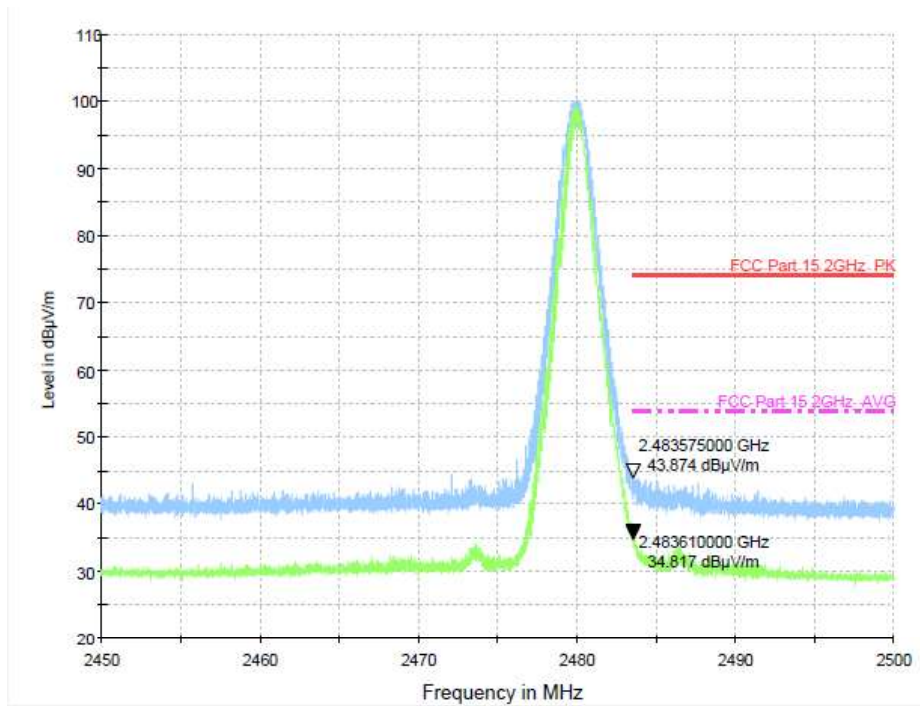
Test Mode: $\pi/4$ DQPSK-Low



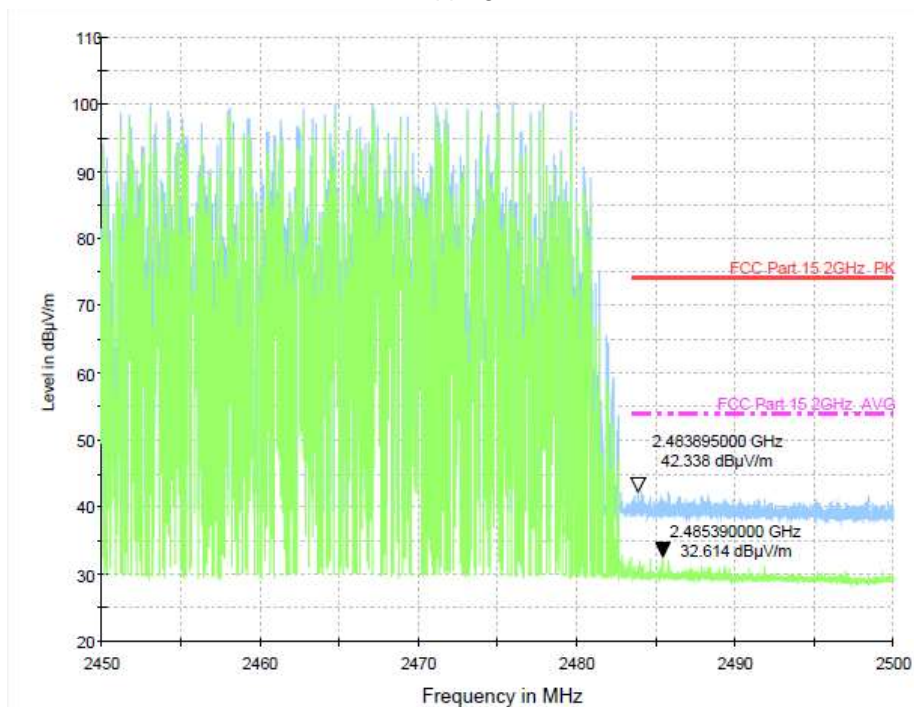
hopping-off



hopping-on

Test Mode: $\pi/4$ DQPSK-High

hopping-off



hopping-on

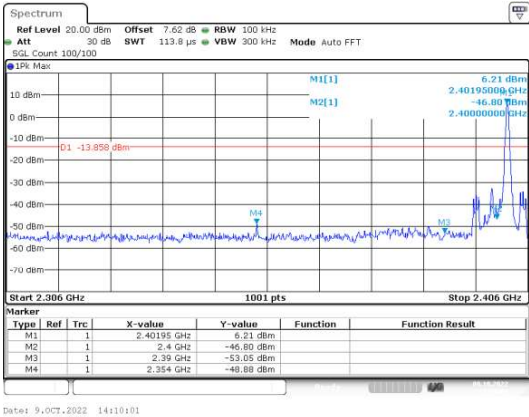
Note: 1. *:Maximum data; x:Over limit; !:over margin.

2.Measurement=Reading Level+Correct Factor; Correct Factor=Antenna Factor+Cable Loss.

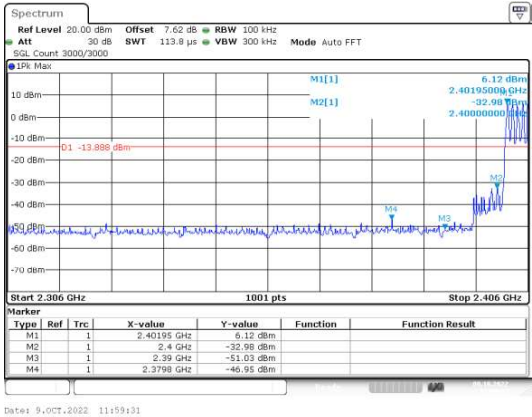
Conducted Method

GFSK Mode:

Test channel:	Lowest channel
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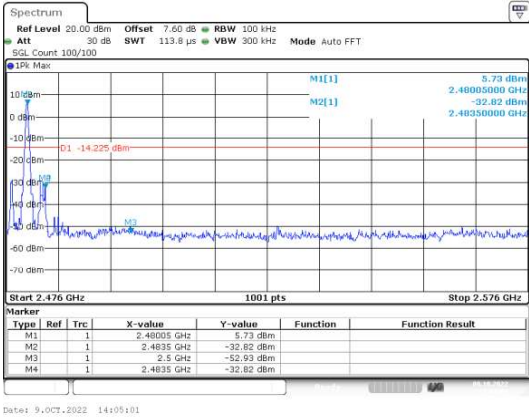


No-hopping mode

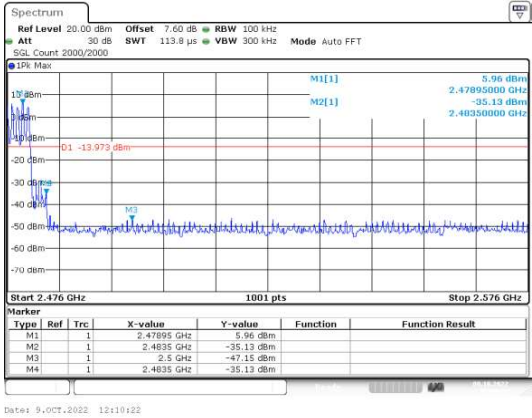


Hopping mode

Test channel:	Highest channel
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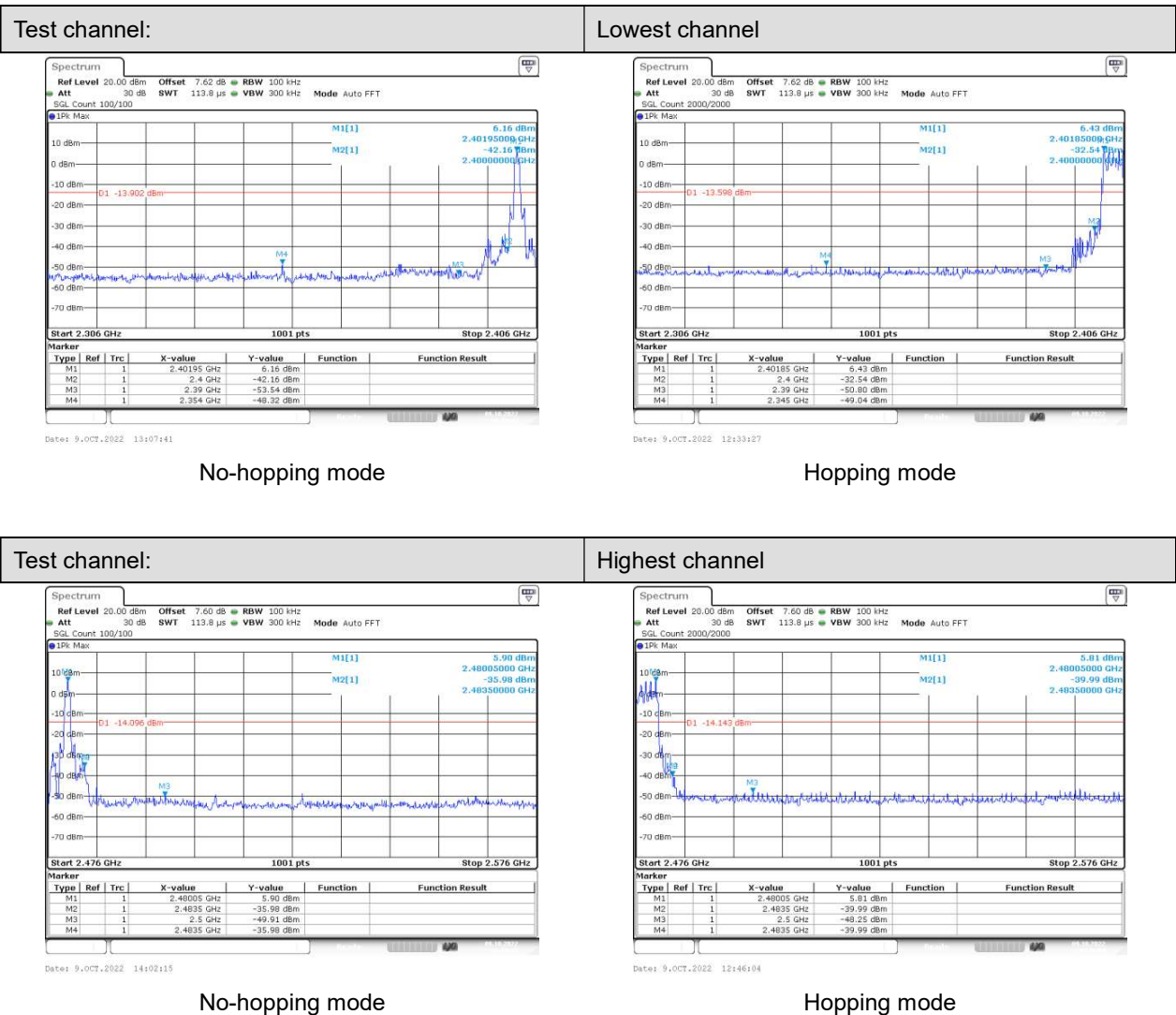


No-hopping mode



Hopping mode

Pi/4QPSK Mode:



No-hopping mode

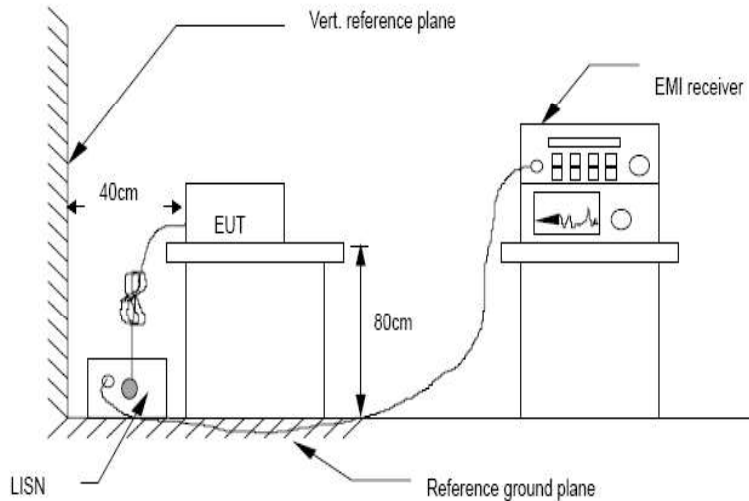
Hopping mode

No-hopping mode

Hopping mode

POWER LINE CONDUCTED EMISSIONS

9.5. Block Diagram of Test Setup



9.6. Limit

Frequency	Maximum RF Line Voltage	
	Quasi-Peak Level dB(μ V)	Average Level dB(μ V)
150kHz ~ 500kHz	66 ~ 56*	56 ~ 46*
500kHz ~ 5MHz	56	46
5MHz ~ 30MHz	60	50

Notes: 1. * Decreasing linearly with logarithm of frequency.

2. The lower limit shall apply at the transition frequencies.

9.7. Test Procedure

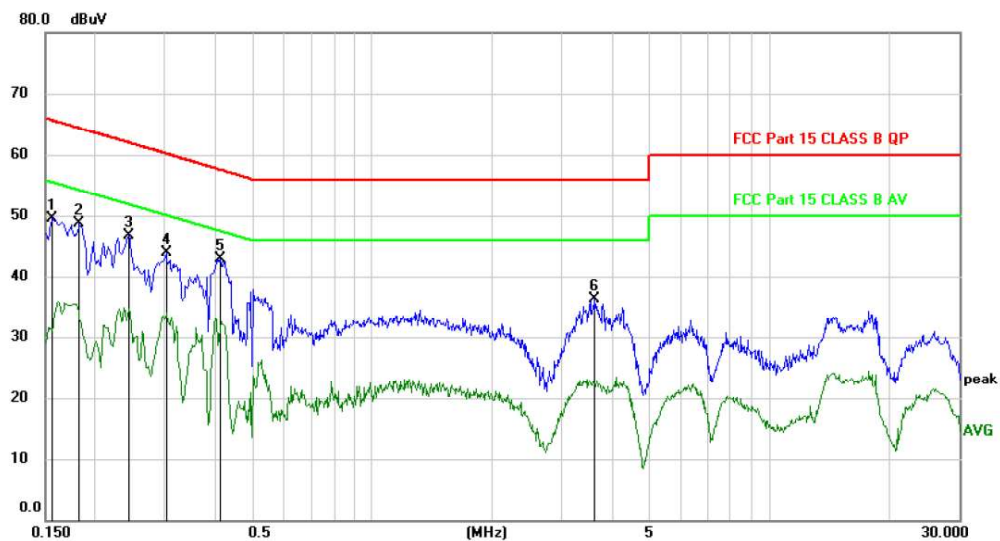
- (1) The EUT was placed on a non-metallic table, 80cm above the ground plane.
- (2) Setup the EUT and simulator as shown in 10.1
- (3) The EUT Power connected to the power mains through a power adapter and a line impedance stabilization network (L.I.S.N1). The other peripheral devices power cord connected to the power mains through a line impedance stabilization network (L.I.S.N2), this provided a 50-ohm coupling impedance for the EUT (Please refer to the block diagram of the test setup and photographs). Both sides of power line were checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipments and all of the interface cables were changed according to ANSI C63.10:2013on conducted Emission test.
- (4) The bandwidth of test receiver is set at 10KHz.
- (5) The frequency range from 150 KHz to 30MHz is checked.

9.8. Test Result

PASS. (See below detailed test data)

Note: If peak Result comply with AV limit, QP and AV Result is deemed to comply with AV limit

Line:

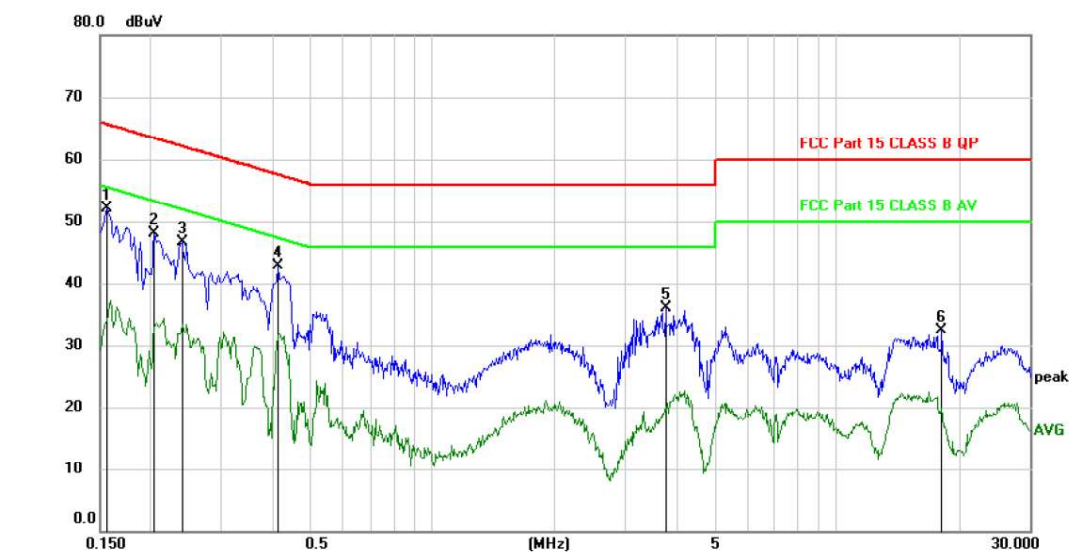


No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Margin dB	Detector	Comment
1		0.1560	39.56	9.94	49.50	65.67	-16.17	peak	
2		0.1830	38.69	9.93	48.62	64.35	-15.73	peak	
3		0.2430	36.75	9.96	46.71	61.99	-15.28	peak	
4		0.3030	33.91	9.92	43.83	60.16	-16.33	peak	
5	*	0.4140	32.88	9.94	42.82	57.57	-14.75	peak	
6		3.6360	26.37	9.96	36.33	56.00	-19.67	peak	

*:Maximum data x:Over limit !:over margin

〈Reference Only

Note: Measurement=Reading Level+Correc Factor. Factor=(LISN or ISN or PLC or Current Probe)Factor+Cable

Neutral:

No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin	
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector Comment
1	*	0.1560	42.08	9.94	52.02	65.67	-13.65	peak
2		0.2040	38.18	9.92	48.10	63.45	-15.35	peak
3		0.2400	36.71	9.96	46.67	62.10	-15.43	peak
4		0.4140	32.98	9.94	42.92	57.57	-14.65	peak
5		3.7770	26.20	9.96	36.16	56.00	-19.84	peak
6		18.1530	22.02	10.42	32.44	60.00	-27.56	peak

*:Maximum data x:Over limit !:over margin

⟨Reference Only

Note: Measurement=Reading Level+Correc Factor. Factor=(LISN or ISN or PLC or Current Probe)Factor+Cable

10. Antenna Requirements

10.1. Limit

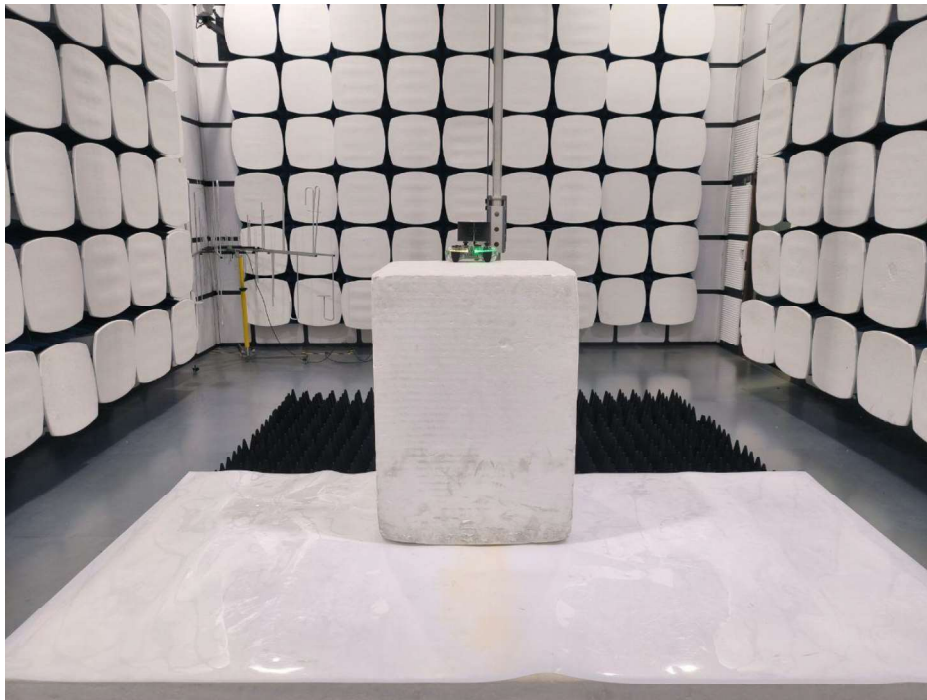
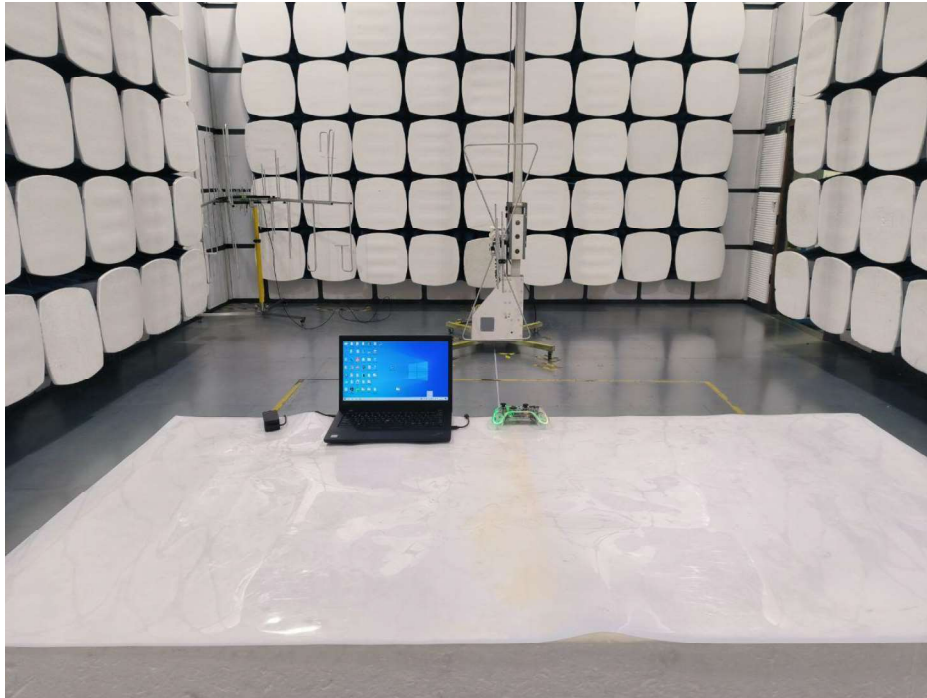
For intentional device, according to FCC 47 CFR Section 15.203 and RSS-GEN, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section 15.247 (b), if transmitting antennas of 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.

10.2. Result

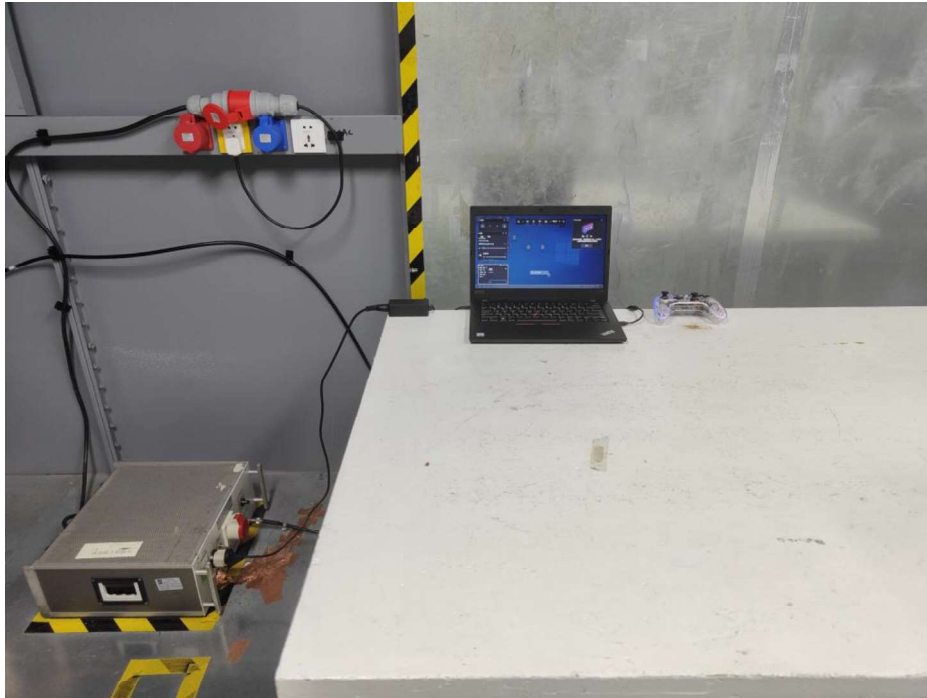
The EUT antenna is PCB Antenna. It complies with the standard requirement.

11. Test Setup Photo

11.1. Photos of Radiated emission

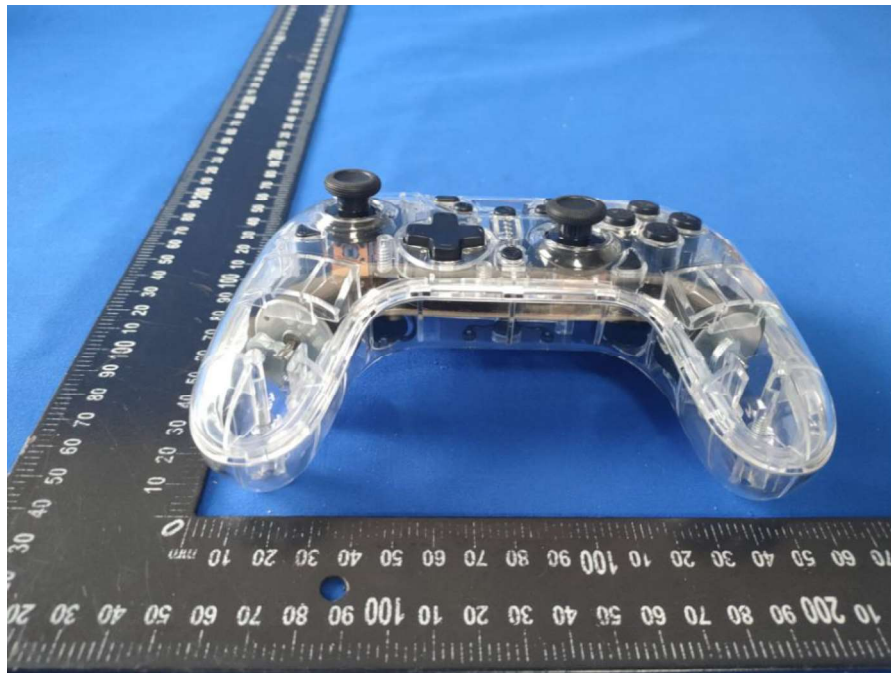


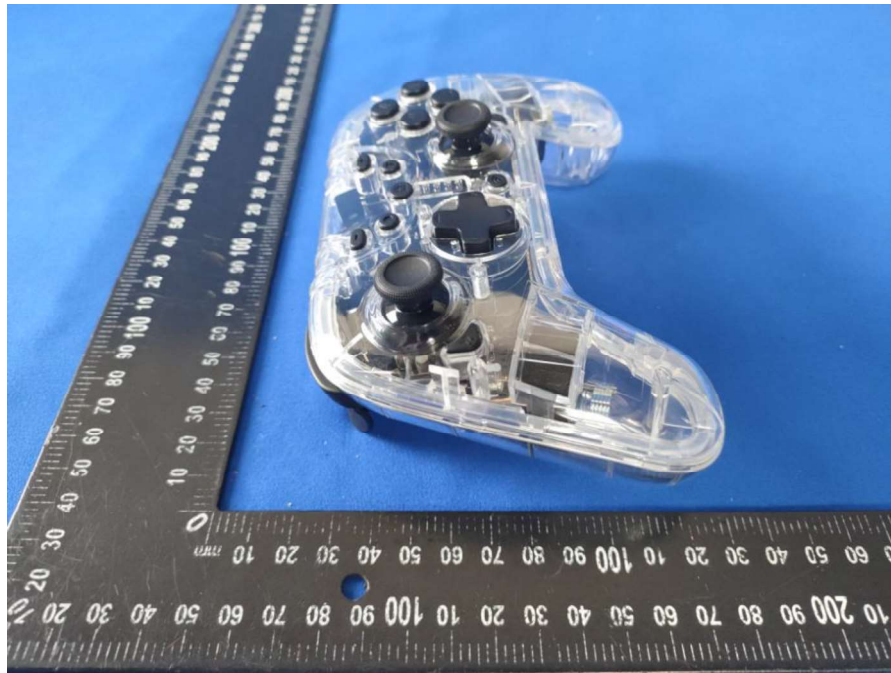
11.2.Photos of Conducted Emission test

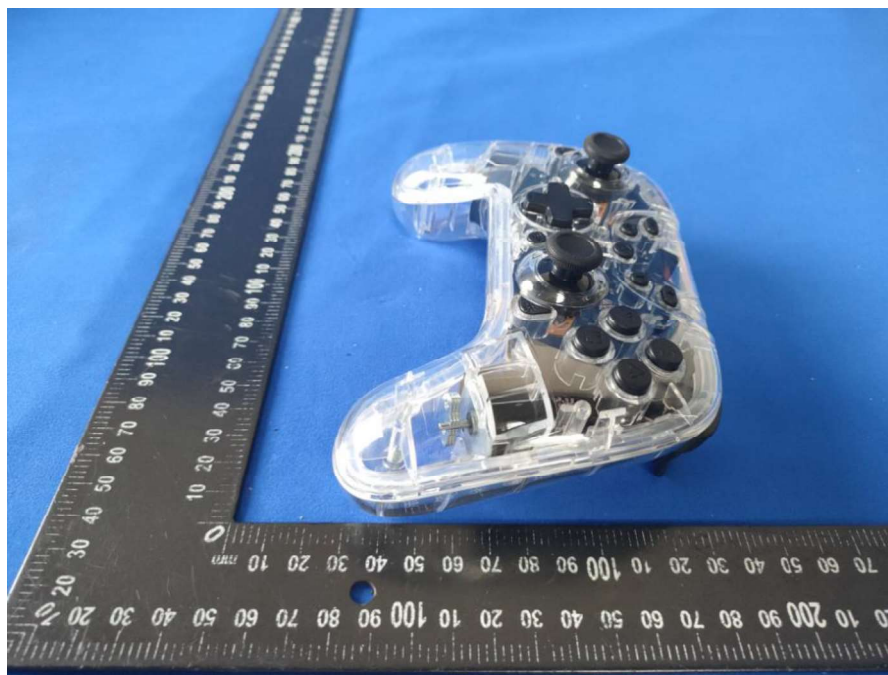


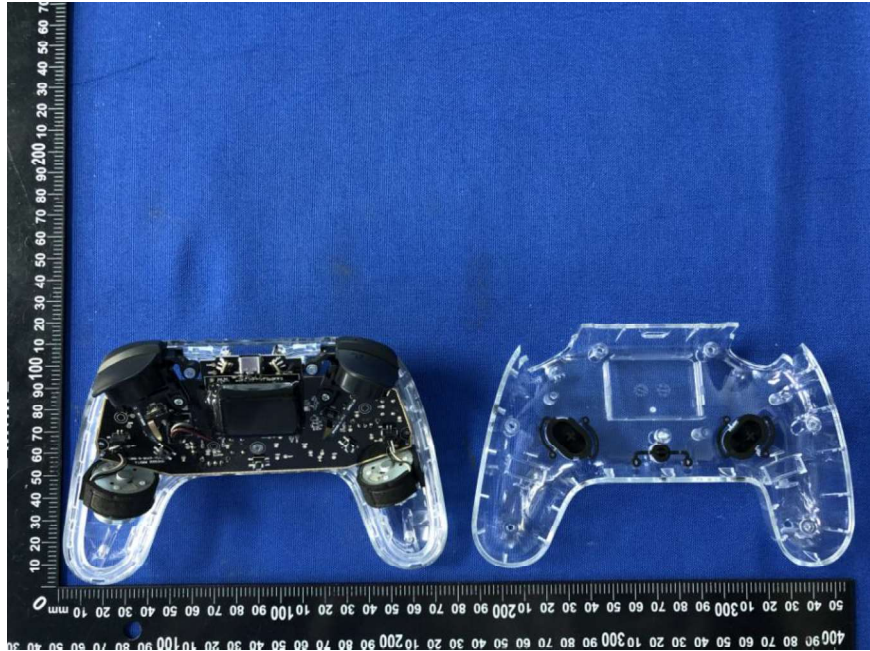
12. EUT Photo

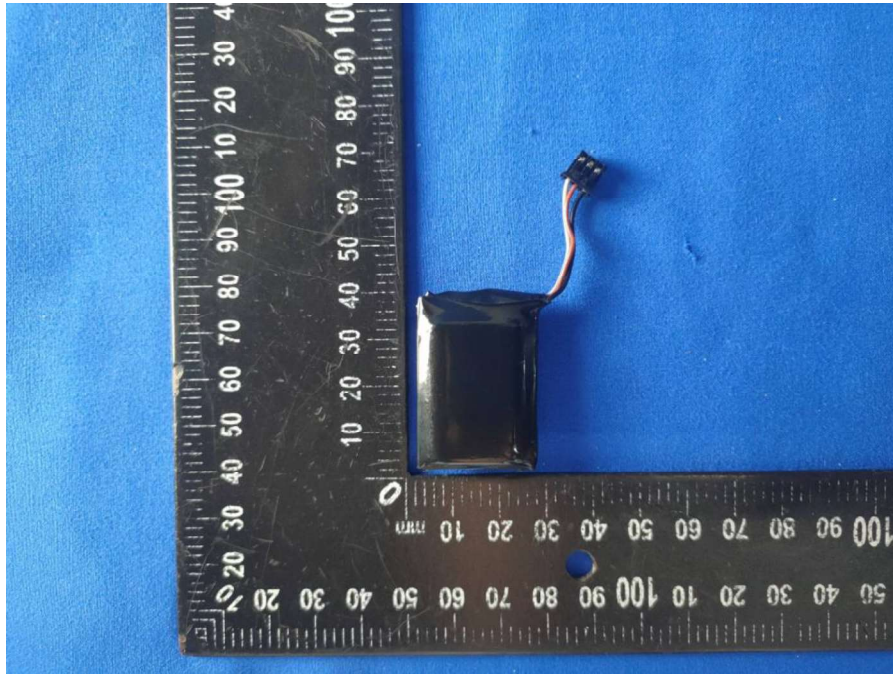


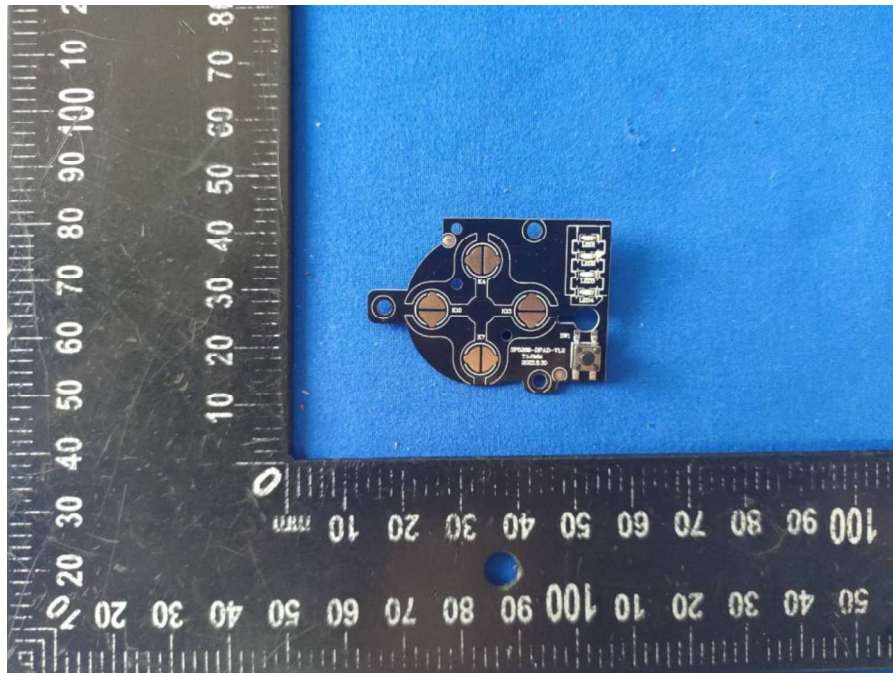
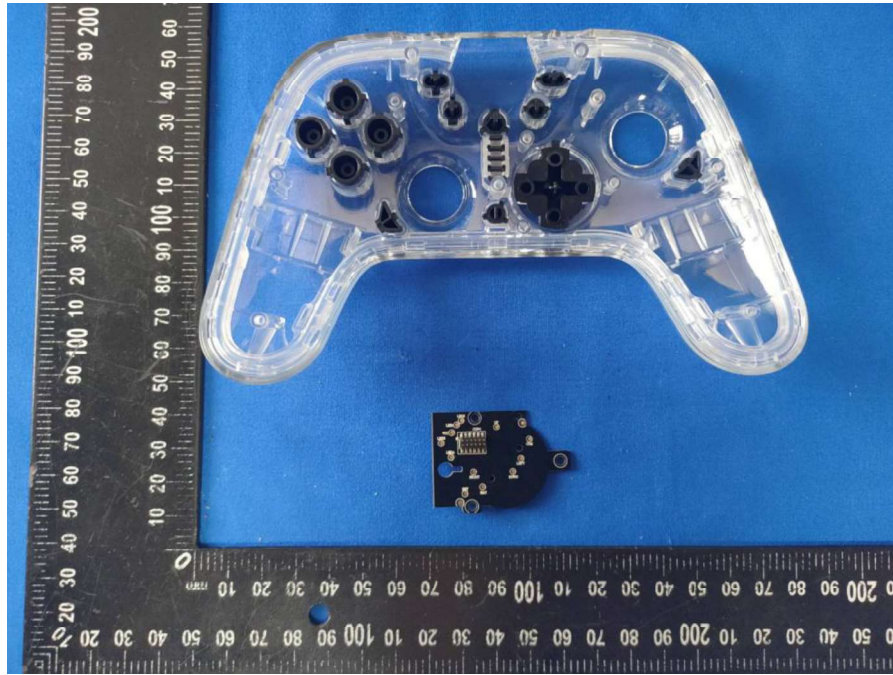


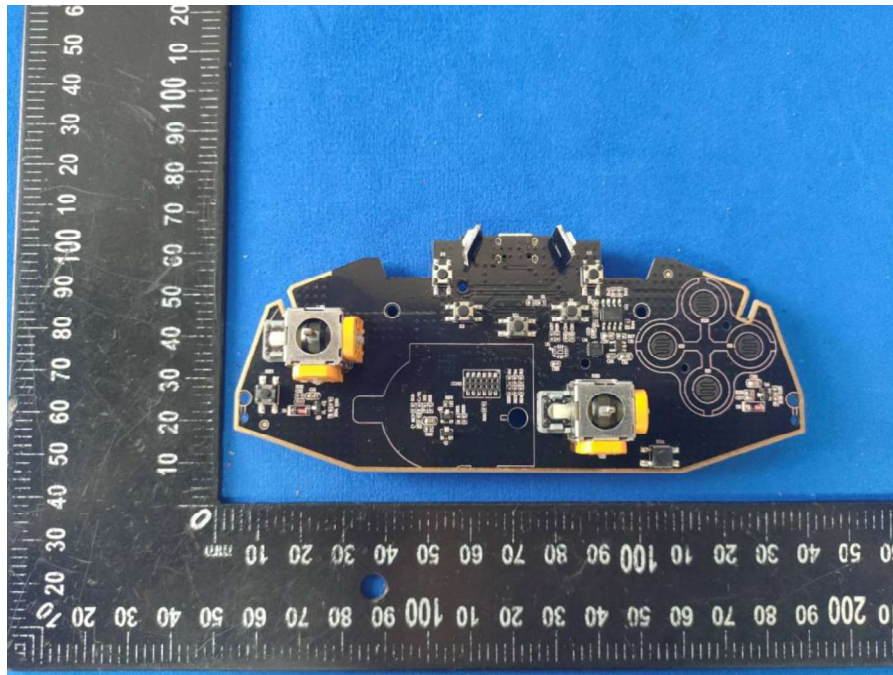
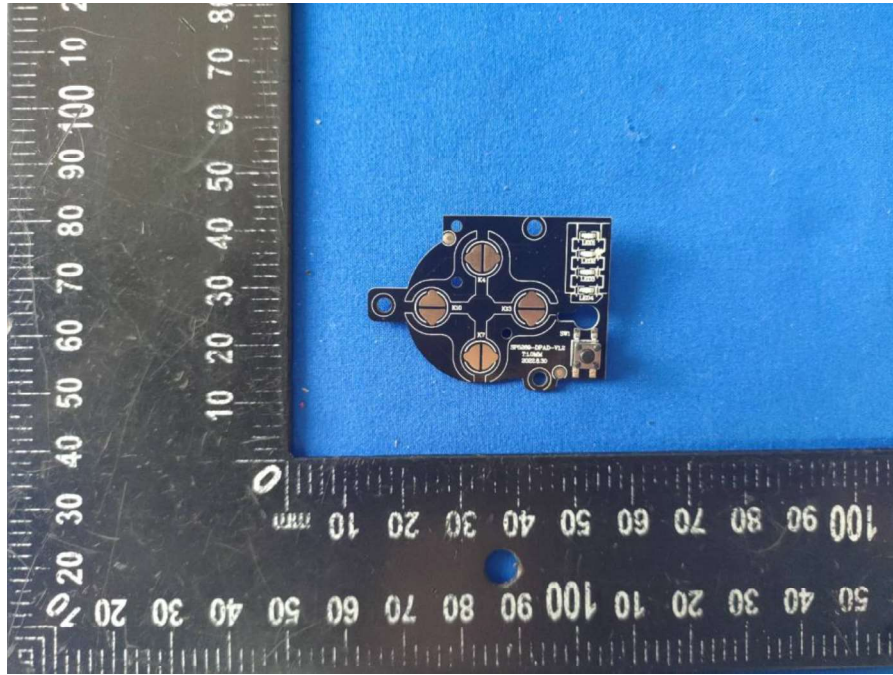


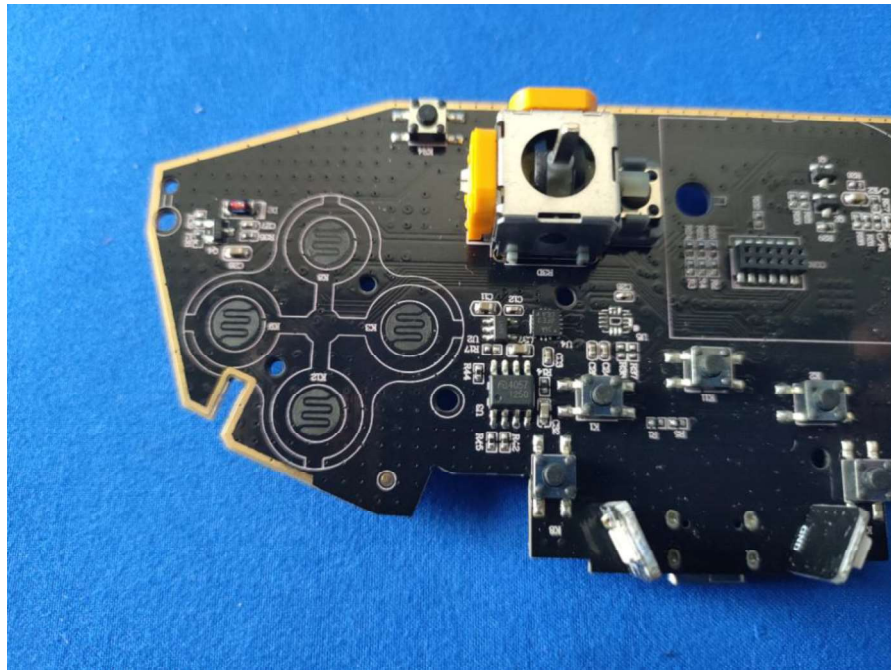
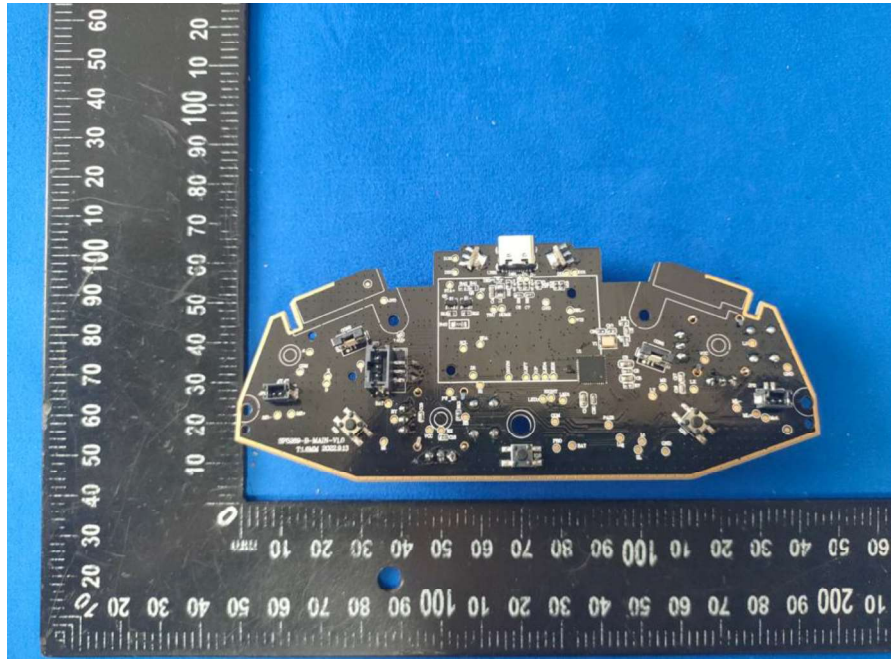


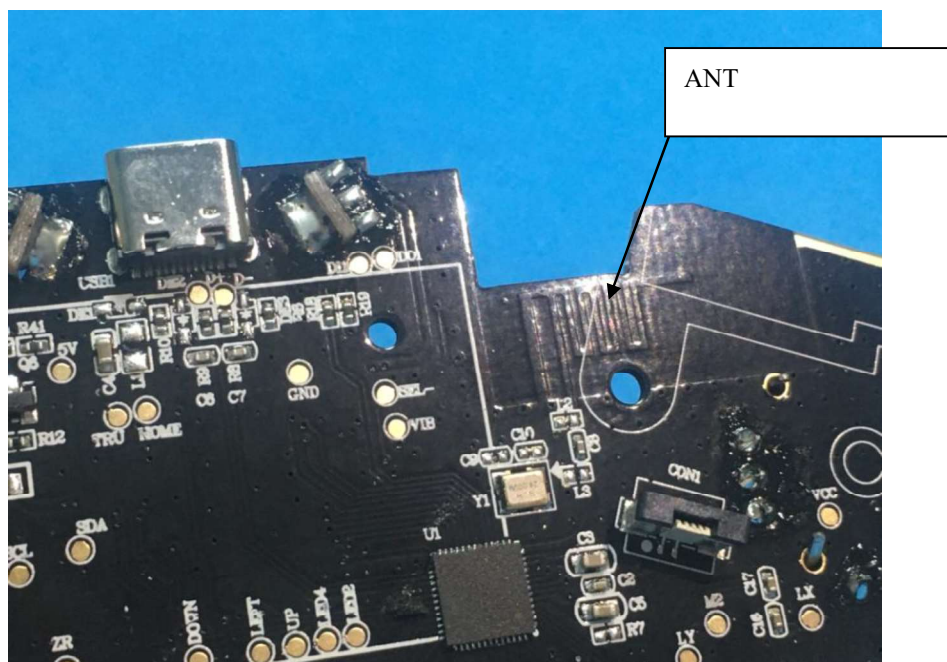












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