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

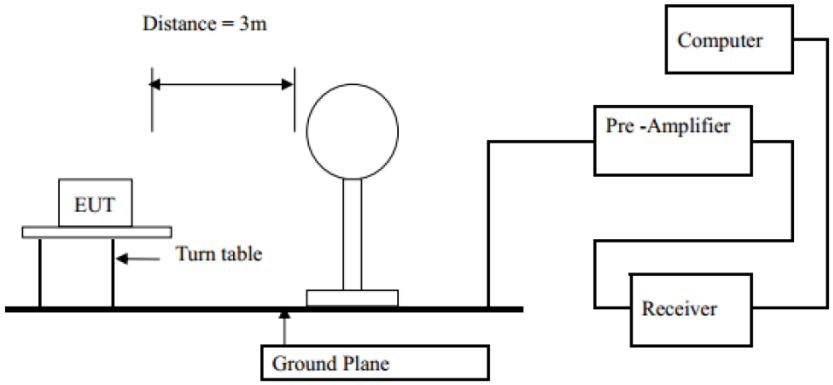
MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 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

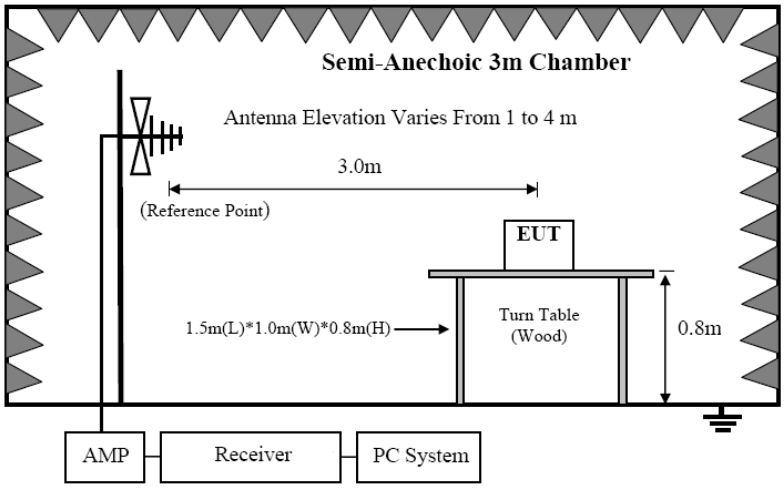
FREQUENCY MHz	DISTANCE Meters	FIELD STRENGTHS LIMIT	
		μV/m	dB(μV)/m
0.009-0.490	300	2400/F(KHz)	/
0.490-1.705	30	24000/F(KHz)	/
1.705-30	30	30	29.5
30 ~ 88	3	100	40.0
88 ~ 216	3	150	43.5
216 ~ 960	3	200	46.0
960 ~ 1000	3	500	54.0
Above 1000	3	74.0 dB(μV)/m (Peak) 54.0 dB(μV)/m (Average)	

8.2. Block Diagram of Test setup

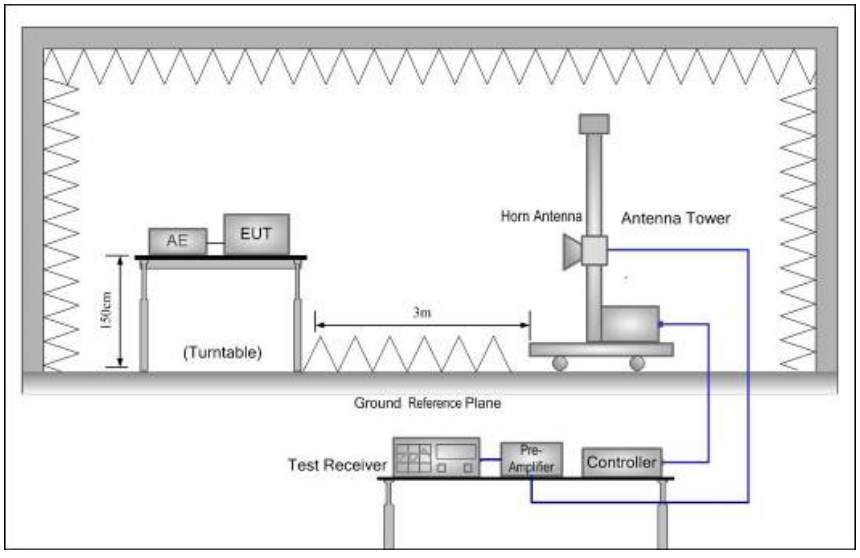
8.2.1 In 3m Anechoic Chamber Test Setup Diagram for below 30MHz



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 as shown in section 1.4 and 6.1

(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 though 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

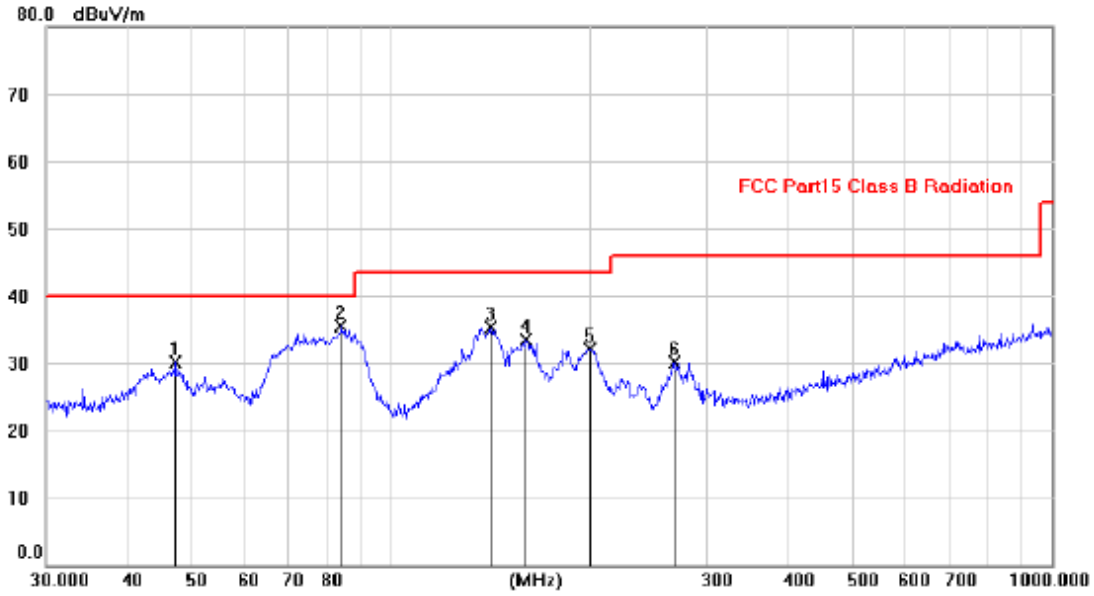
We have scanned the 10th harmonic from 9KHz to the EUT's highest frequency.
Detailed information please see the following page.

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

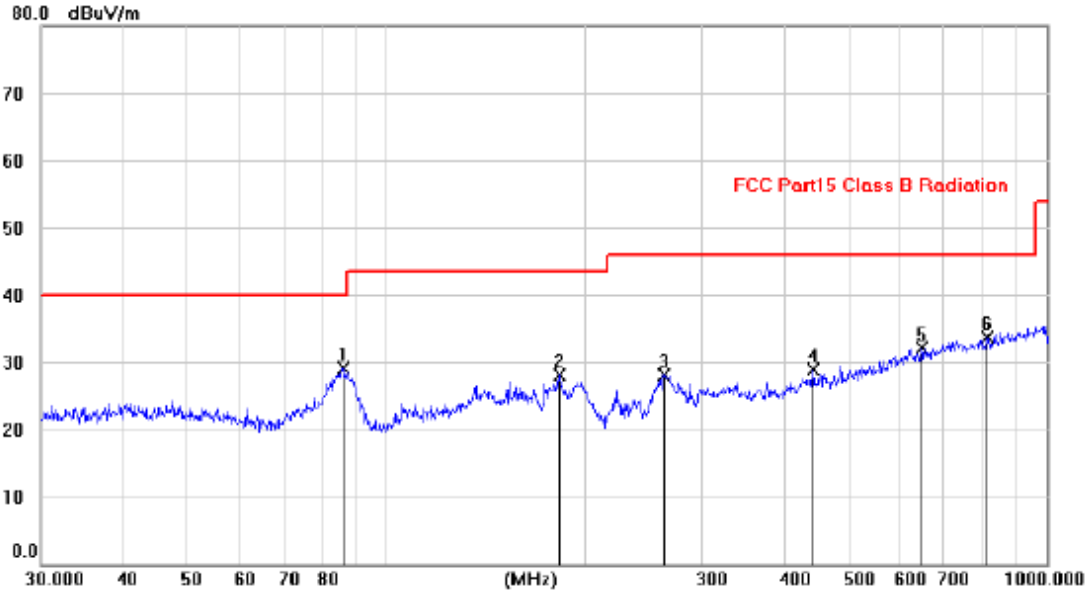
Vertical:



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1		47.2868	16.04	14.07	30.11	40.00	-9.89	peak			
2	*	84.0903	25.52	9.95	35.47	40.00	-4.53	peak			
3		141.7434	20.79	14.44	35.23	43.50	-8.27	peak			
4		159.8031	18.49	15.04	33.53	43.50	-9.97	peak			
5		199.9622	21.28	10.90	32.18	43.50	-11.32	peak			
6		267.8584	16.97	13.22	30.19	46.00	-15.81	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 Level	Correct Factor	Measure-ment	Limit	Margin		Antenna Height	Table Degree	
		MHz	dBuV	dB	dBuV/m	dBuV/m	dB	Detector	cm	degree	Comment
1	*	86.1900	19.20	9.99	29.19	40.00	-10.81	peak			
2		182.7941	15.75	12.34	28.09	43.50	-15.41	peak			
3		263.3261	15.03	13.08	28.11	46.00	-17.89	peak			
4		443.2425	11.58	17.40	28.98	46.00	-17.02	peak			
5		646.4782	11.11	21.05	32.16	46.00	-13.84	peak			
6		813.5869	10.65	23.09	33.74	46.00	-12.26	peak			

Note:1. *:Maximum data; x:Over limit; !:over margin.
2.Measurement=Reading Level+Correct Factor; Correct Factor=Antenna Factor+Cable Loss.

Remark: All modes have been tested, and only worst data of GFSK mode, Channel 2402MHz was listed in this report.

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	46.07	V	33.95	10.18	34.26	55.94	74	-18.06	PK
4804	35.70	V	33.95	10.18	34.26	45.57	54	-8.43	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
4804	47.82	H	33.95	10.18	34.26	57.69	74	-16.31	PK
4804	34.04	H	33.95	10.18	34.26	43.91	54	-10.09	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
Test Mode: GFSK TX Mid									
4882	49.75	V	33.93	10.20	34.29	59.59	74	-14.41	PK
4882	34.86	V	33.93	10.20	34.29	44.70	54	-9.30	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
4882	48.67	H	33.93	10.20	34.29	58.51	74	-15.49	PK
4882	32.70	H	33.93	10.20	34.29	42.54	54	-11.46	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
Test Mode: GFSK TX High									
4960	46.82	V	33.98	10.22	34.25	56.77	74	-17.23	PK
4960	33.96	V	33.98	10.22	34.25	43.91	54	-10.09	AV
7440	/	/	/	/	/	/	/	/	/
9920	/	/	/	/	/	/	/	/	/
4960	47.57	H	33.98	10.22	34.25	57.52	74	-16.48	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.

Test Mode: π/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	46.18	V	33.95	10.18	34.26	56.05	74	-17.95	PK
4804	35.86	V	33.95	10.18	34.26	45.73	54	-8.27	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
4804	47.28	H	33.95	10.18	34.26	57.15	74	-16.85	PK
4804	34.94	H	33.95	10.18	34.26	44.81	54	-9.19	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
Test Mode: π/4 DQPSK TX Mid									
4882	49.56	V	33.93	10.20	34.29	59.40	74	-14.60	PK
4882	34.41	V	33.93	10.20	34.29	44.25	54	-9.75	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
4882	48.32	H	33.93	10.20	34.29	58.16	74	-15.84	PK
4882	32.97	H	33.93	10.20	34.29	42.81	54	-11.19	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
Test Mode: π/4 DQPSK TX High									
4960	46.24	V	33.98	10.22	34.25	56.19	74	-17.81	PK
4960	33.46	V	33.98	10.22	34.25	43.41	54	-10.59	AV
7440	/	/	/	/	/	/	/	/	/
9920	/	/	/	/	/	/	/	/	/
4960	47.15	H	33.98	10.22	34.25	57.10	74	-16.90	PK
4960	32.98	H	33.98	10.22	34.25	42.93	54	-11.07	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.

Test Mode: 8DPSK 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	46.01	V	33.95	10.18	34.26	55.88	74	-18.12	PK
4804	35.59	V	33.95	10.18	34.26	45.46	54	-8.54	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
4804	47.48	H	33.95	10.18	34.26	57.35	74	-16.65	PK
4804	34.45	H	33.95	10.18	34.26	44.32	54	-9.68	AV
7206	/	/	/	/	/	/	/	/	/
9608	/	/	/	/	/	/	/	/	/
Test Mode: 8DPSK TX Mid									
4882	49.54	V	33.93	10.20	34.29	59.38	74	-14.62	PK
4882	34.97	V	33.93	10.20	34.29	44.81	54	-9.19	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
4882	48.62	H	33.93	10.20	34.29	58.46	74	-15.54	PK
4882	32.73	H	33.93	10.20	34.29	42.57	54	-11.43	AV
7323	/	/	/	/	/	/	/	/	/
9764	/	/	/	/	/	/	/	/	/
Test Mode: 8DPSK TX High									
4960	46.08	V	33.98	10.22	34.25	56.03	74	-17.97	PK
4960	33.07	V	33.98	10.22	34.25	43.02	54	-10.98	AV
7440	/	/	/	/	/	/	/	/	/
9920	/	/	/	/	/	/	/	/	/
4960	47.01	H	33.98	10.22	34.25	56.96	74	-17.04	PK
4960	32.50	H	33.98	10.22	34.25	42.45	54	-11.55	AV
7440	/	/	/	/	/	/	/	/	/
9920	/	/	/	/	/	/	/	/	/

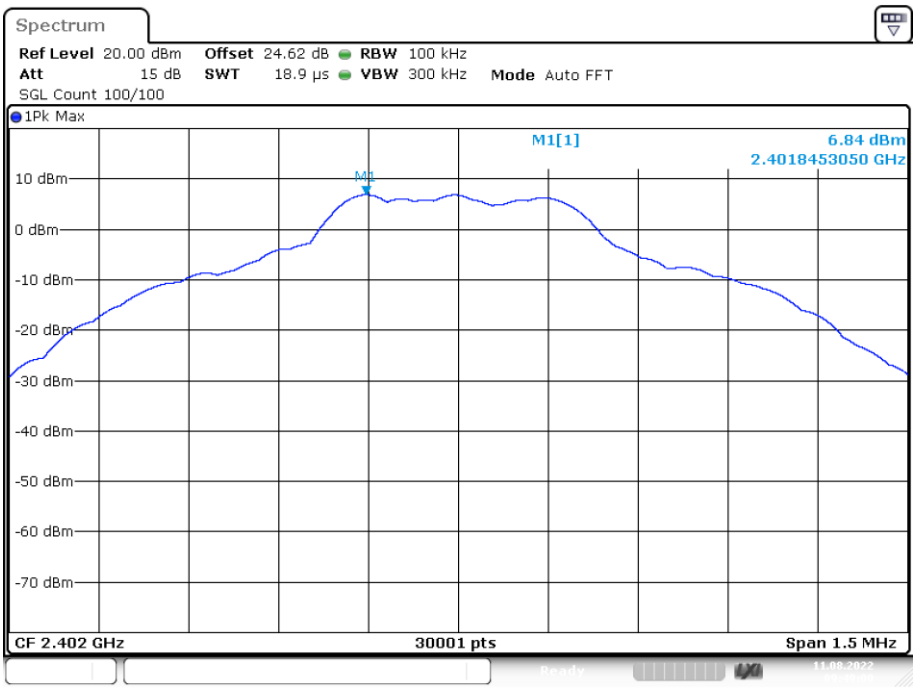
Note:

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.

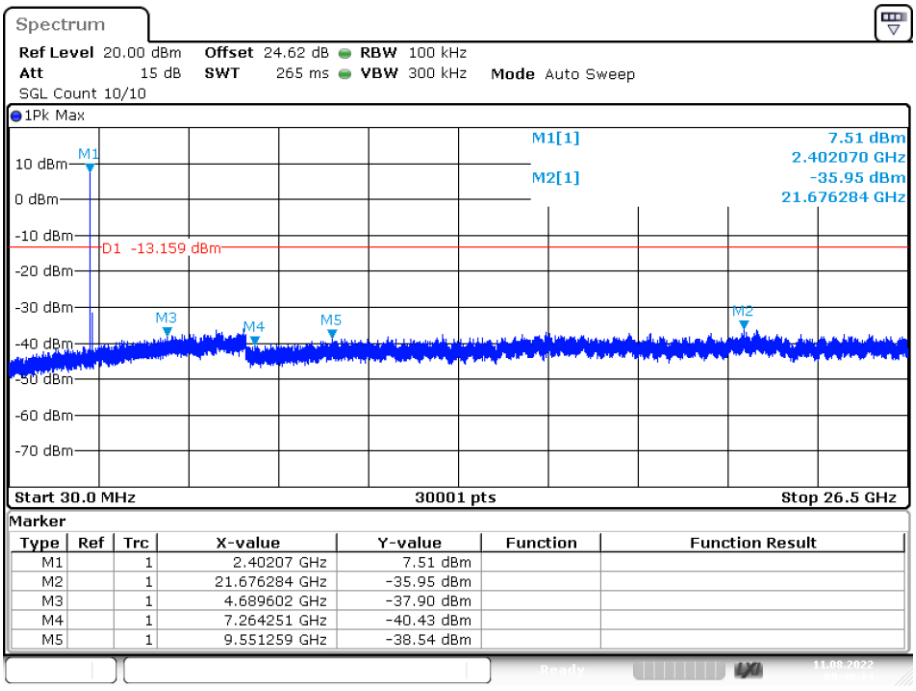
Conducted RF Spurious Emission

Tx. Spurious NVNT 1-DH1 2402MHz Ant1 Ref



Date: 11.AUG.2022 09:49:00

Tx. Spurious NVNT 1-DH1 2402MHz Ant1 Emission

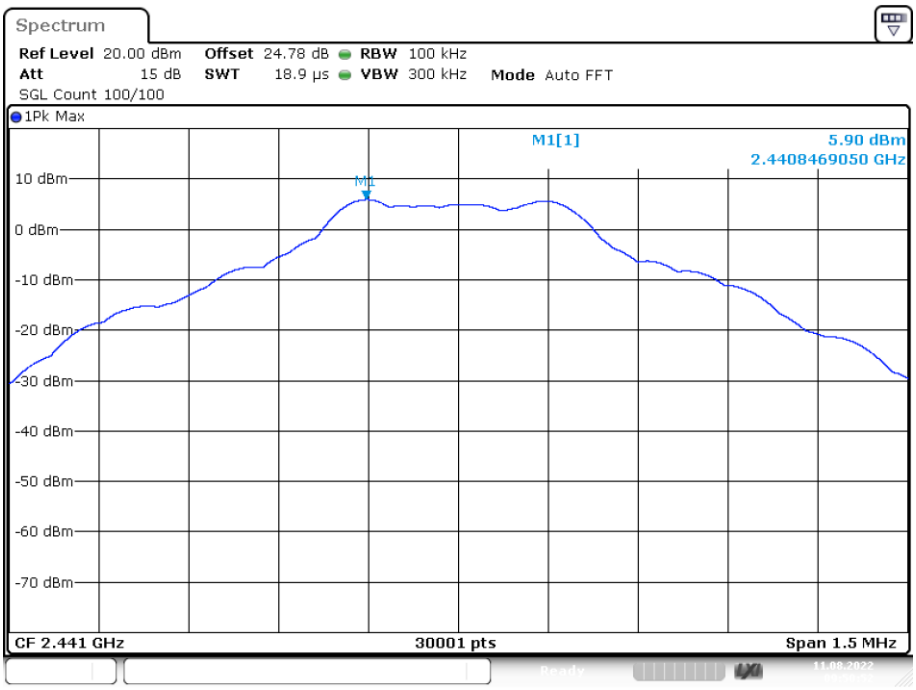


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40207 GHz	7.51 dBm		
M2		1	21.676284 GHz	-35.95 dBm		
M3		1	4.689602 GHz	-37.90 dBm		
M4		1	7.264251 GHz	-40.43 dBm		
M5		1	9.551259 GHz	-38.54 dBm		

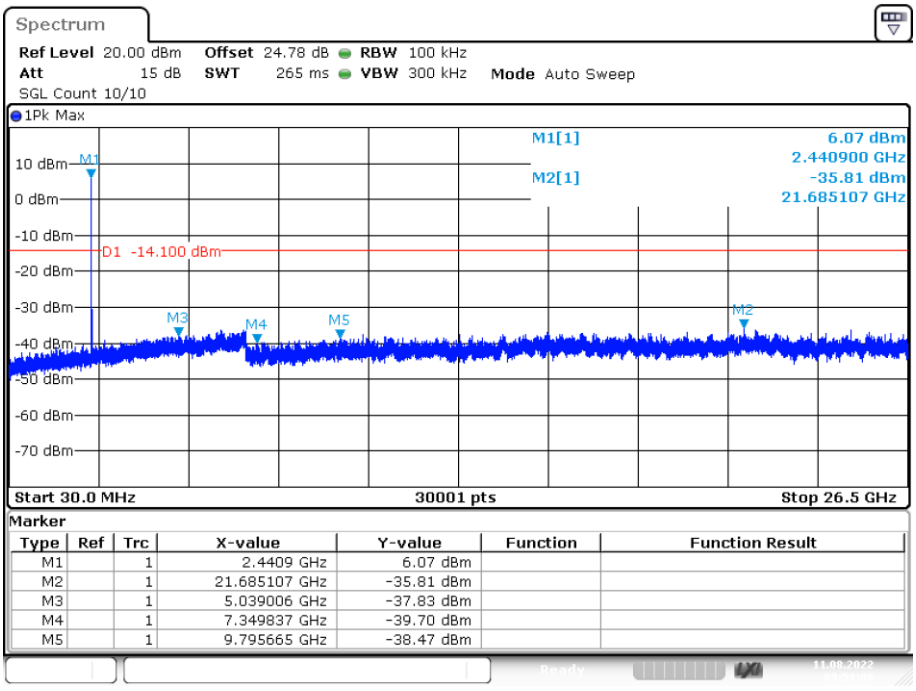
Date: 11.AUG.2022 09:49:14

Tx. Spurious NVNT 1-DH1 2441MHz Ant1 Ref



Date: 11.AUG.2022 09:50:52

Tx. Spurious NVNT 1-DH1 2441MHz Ant1 Emission

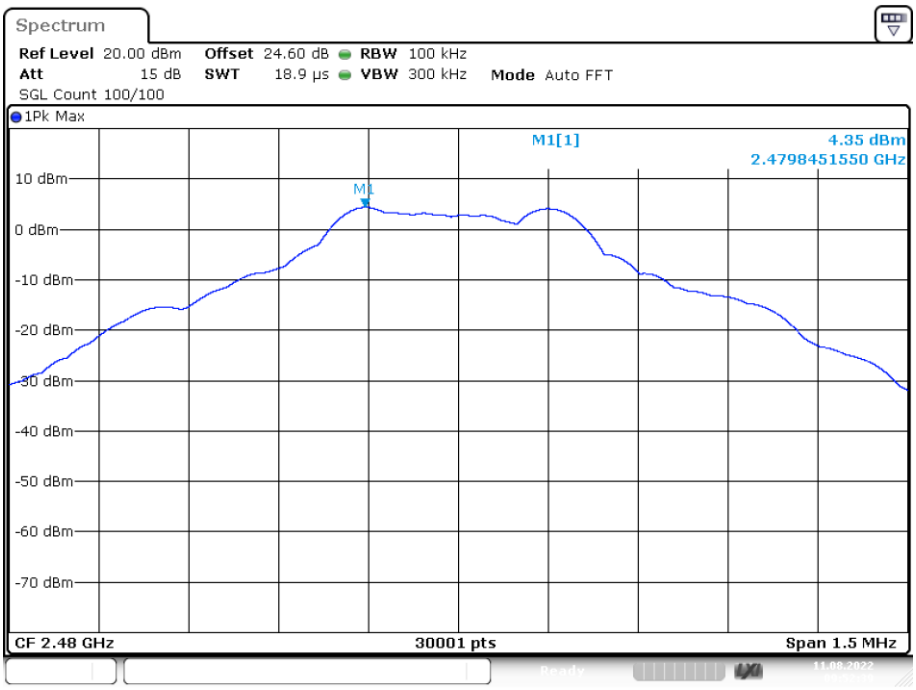


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4409 GHz	6.07 dBm		
M2		1	21.685107 GHz	-35.81 dBm		
M3		1	5.039006 GHz	-37.83 dBm		
M4		1	7.349837 GHz	-39.70 dBm		
M5		1	9.795665 GHz	-38.47 dBm		

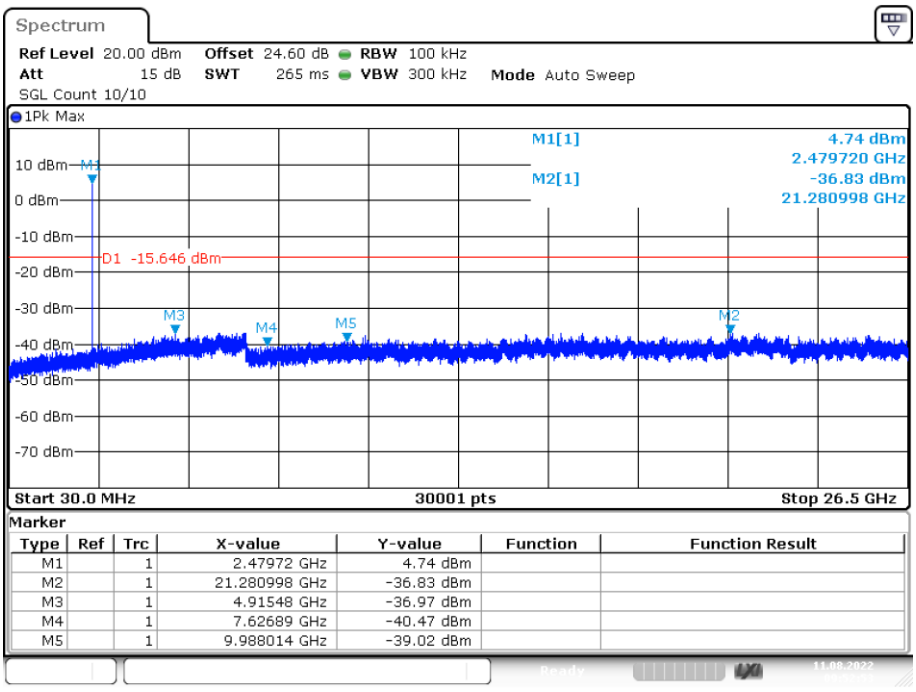
Date: 11.AUG.2022 09:51:06

Tx. Spurious NVNT 1-DH1 2480MHz Ant1 Ref



Date: 11.AUG.2022 09:52:39

Tx. Spurious NVNT 1-DH1 2480MHz Ant1 Emission

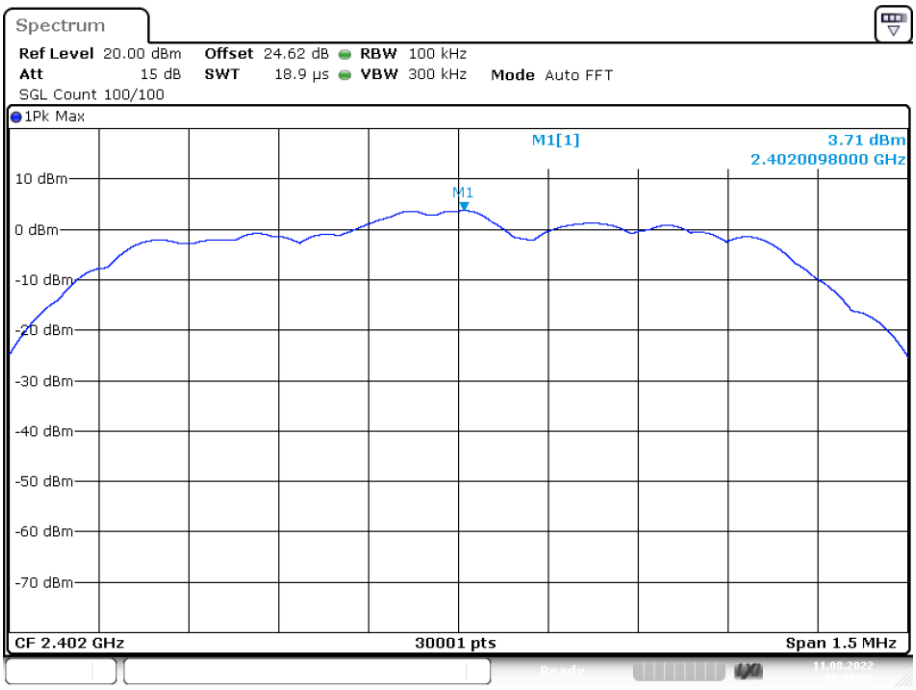


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47972 GHz	4.74 dBm		
M2		1	21.280998 GHz	-36.83 dBm		
M3		1	4.91548 GHz	-36.97 dBm		
M4		1	7.62689 GHz	-40.47 dBm		
M5		1	9.988014 GHz	-39.02 dBm		

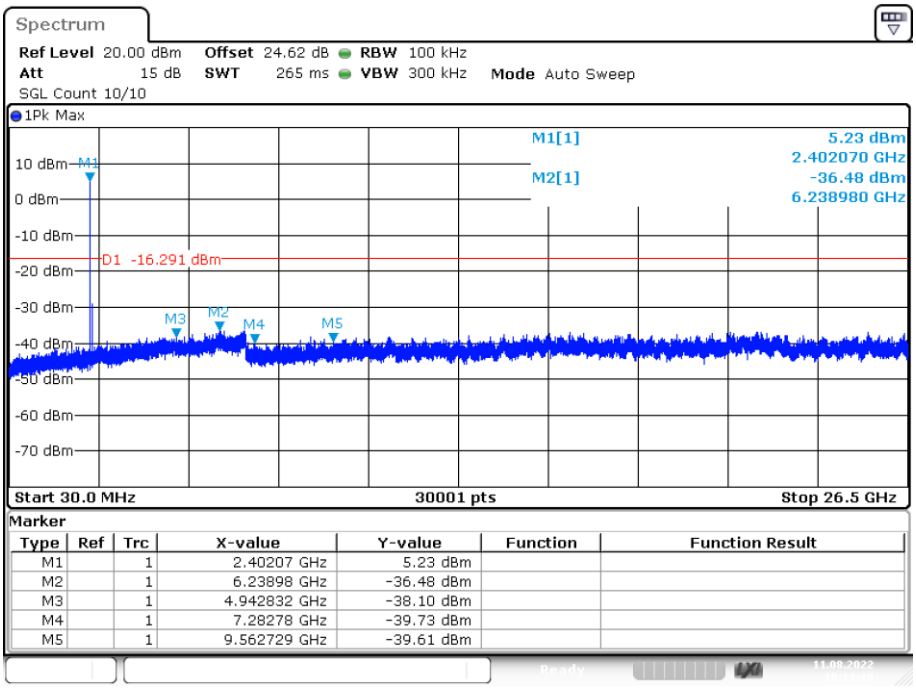
Date: 11.AUG.2022 09:52:53

Tx. Spurious NVNT 2-DH1 2402MHz Ant1 Ref



Date: 11.AUG.2022 10:12:56

Tx. Spurious NVNT 2-DH1 2402MHz Ant1 Emission

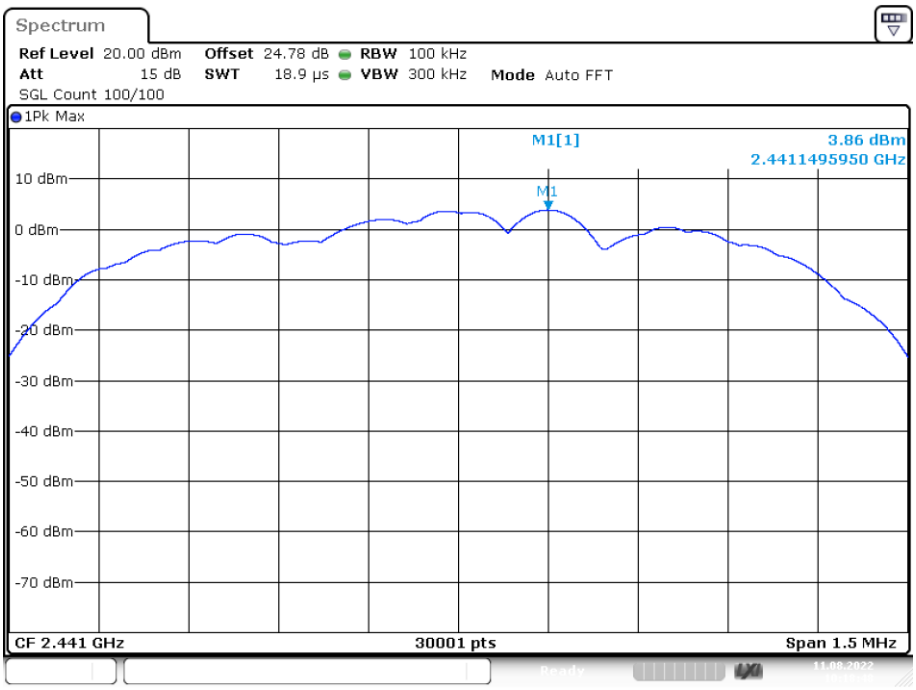


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40207 GHz	5.23 dBm		
M2		1	6.23898 GHz	-36.48 dBm		
M3		1	4.942832 GHz	-38.10 dBm		
M4		1	7.28278 GHz	-39.73 dBm		
M5		1	9.562729 GHz	-39.61 dBm		

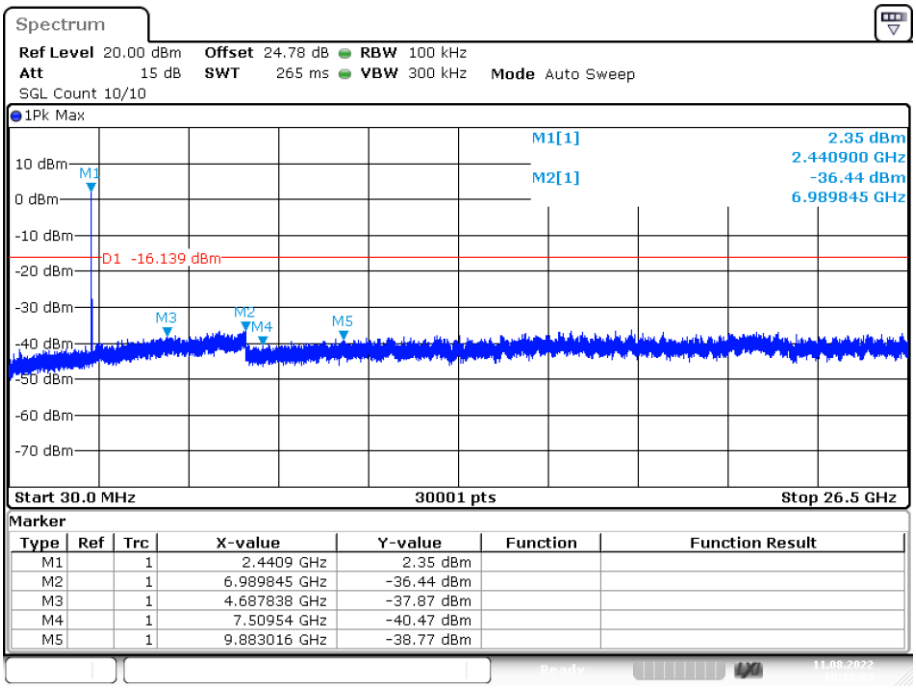
Date: 11.AUG.2022 10:13:09

Tx. Spurious NVNT 2-DH1 2441MHz Ant1 Ref



Date: 11.AUG.2022 10:18:49

Tx. Spurious NVNT 2-DH1 2441MHz Ant1 Emission

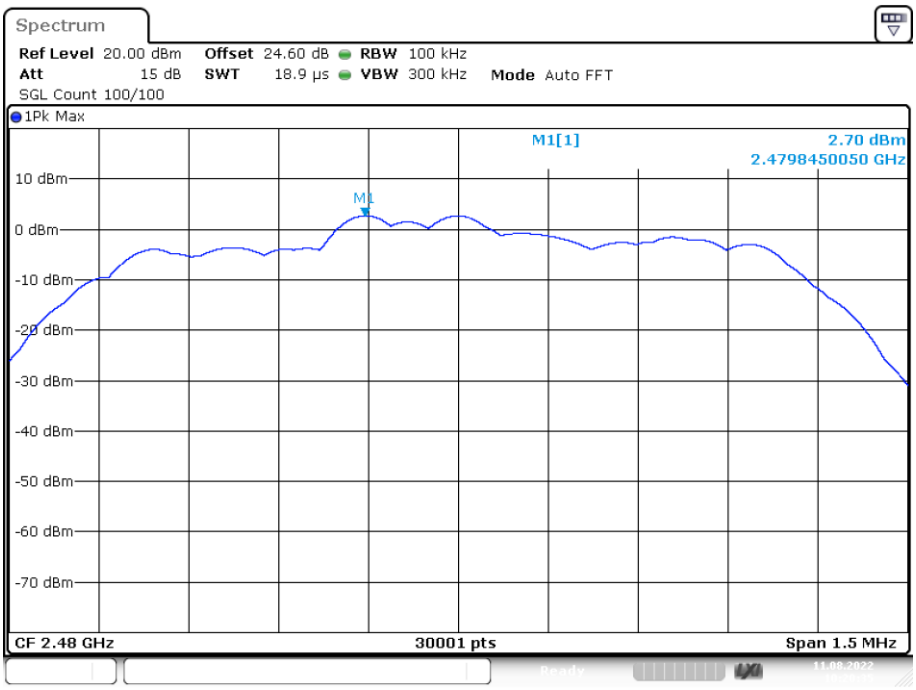


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4409 GHz	2.35 dBm		
M2		1	6.989845 GHz	-36.44 dBm		
M3		1	4.687838 GHz	-37.87 dBm		
M4		1	7.50954 GHz	-40.47 dBm		
M5		1	9.883016 GHz	-38.77 dBm		

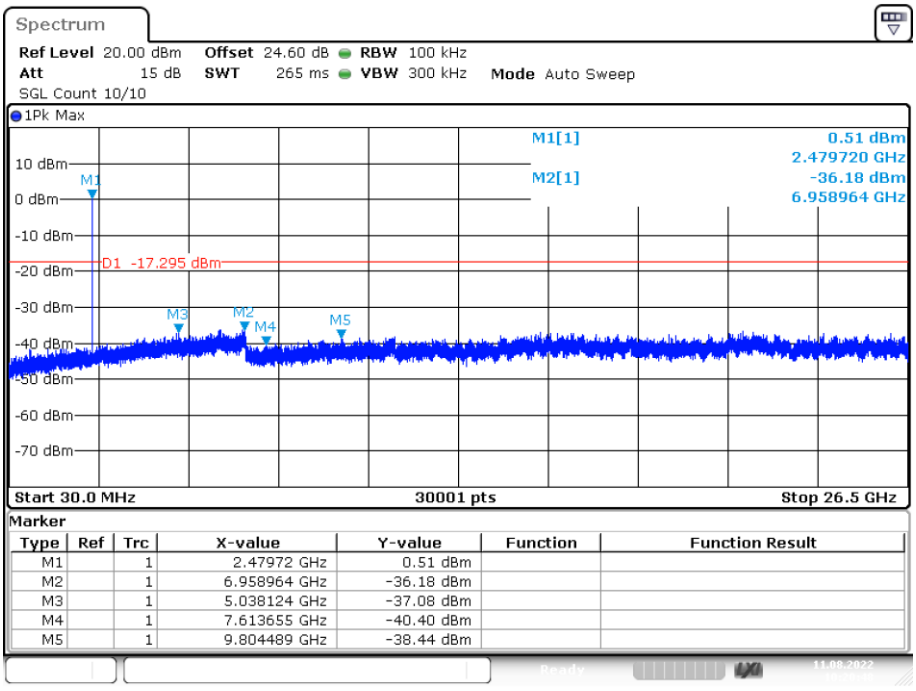
Date: 11.AUG.2022 10:19:03

Tx. Spurious NVNT 2-DH1 2480MHz Ant1 Ref



Date: 11.AUG.2022 10:20:34

Tx. Spurious NVNT 2-DH1 2480MHz Ant1 Emission

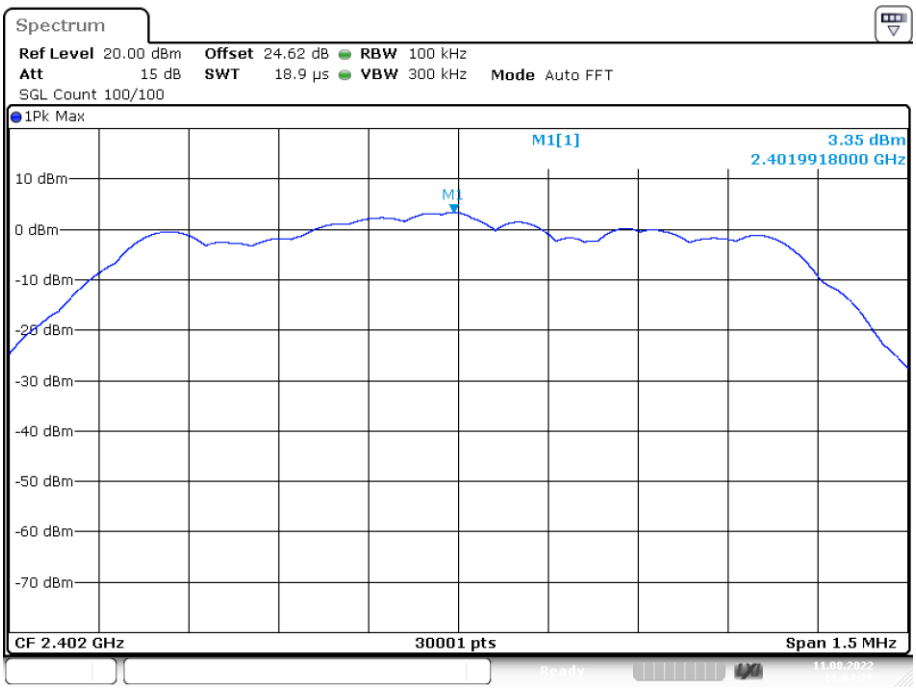


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47972 GHz	0.51 dBm		
M2		1	6.958964 GHz	-36.18 dBm		
M3		1	5.038124 GHz	-37.08 dBm		
M4		1	7.613655 GHz	-40.40 dBm		
M5		1	9.804489 GHz	-38.44 dBm		

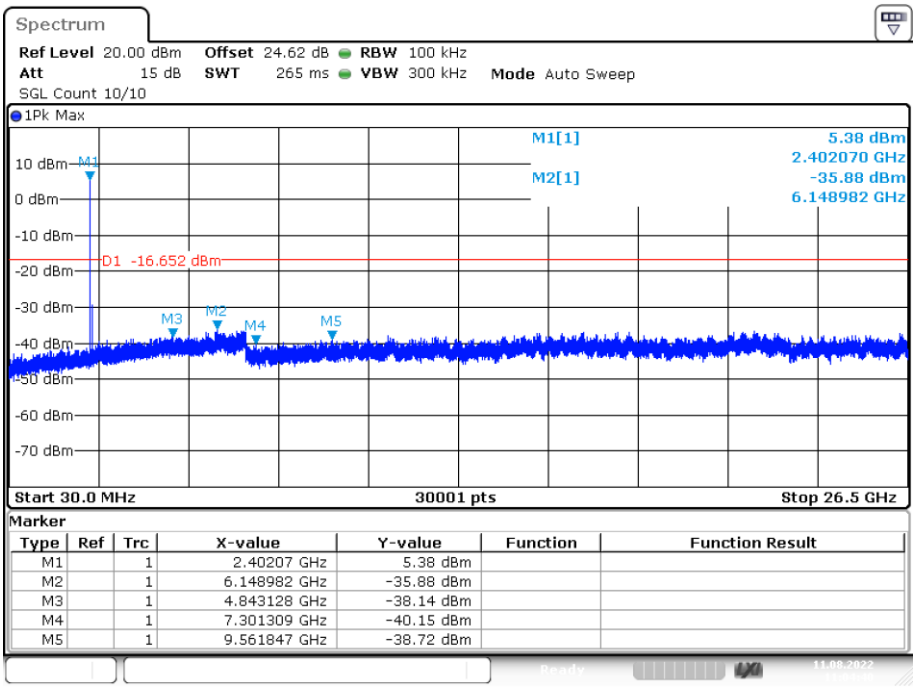
Date: 11.AUG.2022 10:20:48

Tx. Spurious NVNT 3-DH1 2402MHz Ant1 Ref



Date: 11.AUG.2022 11:04:26

Tx. Spurious NVNT 3-DH1 2402MHz Ant1 Emission

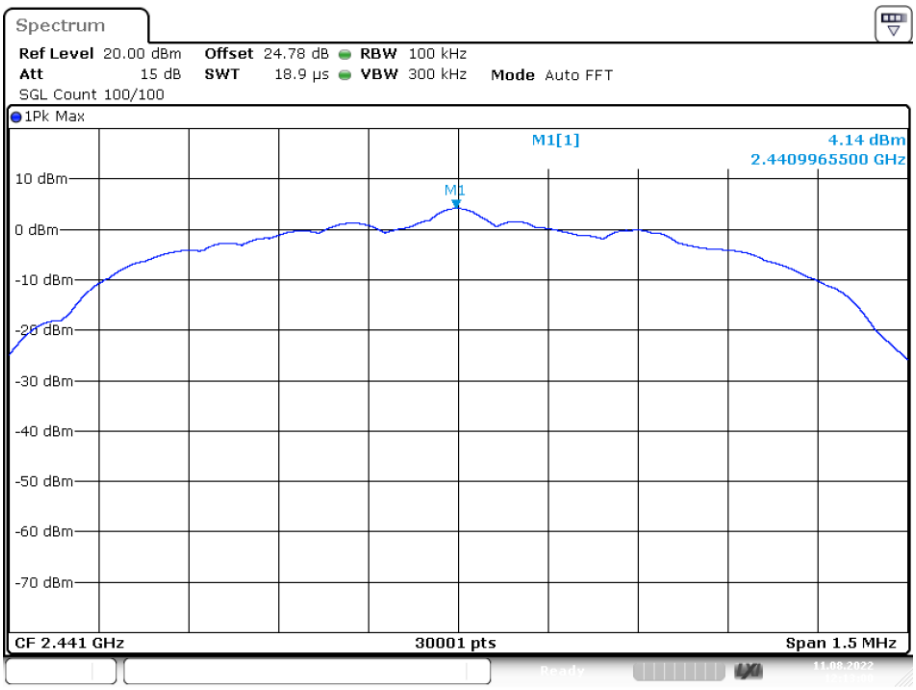


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.40207 GHz	5.38 dBm		
M2		1	6.148982 GHz	-35.88 dBm		
M3		1	4.843128 GHz	-38.14 dBm		
M4		1	7.301309 GHz	-40.15 dBm		
M5		1	9.561847 GHz	-38.72 dBm		

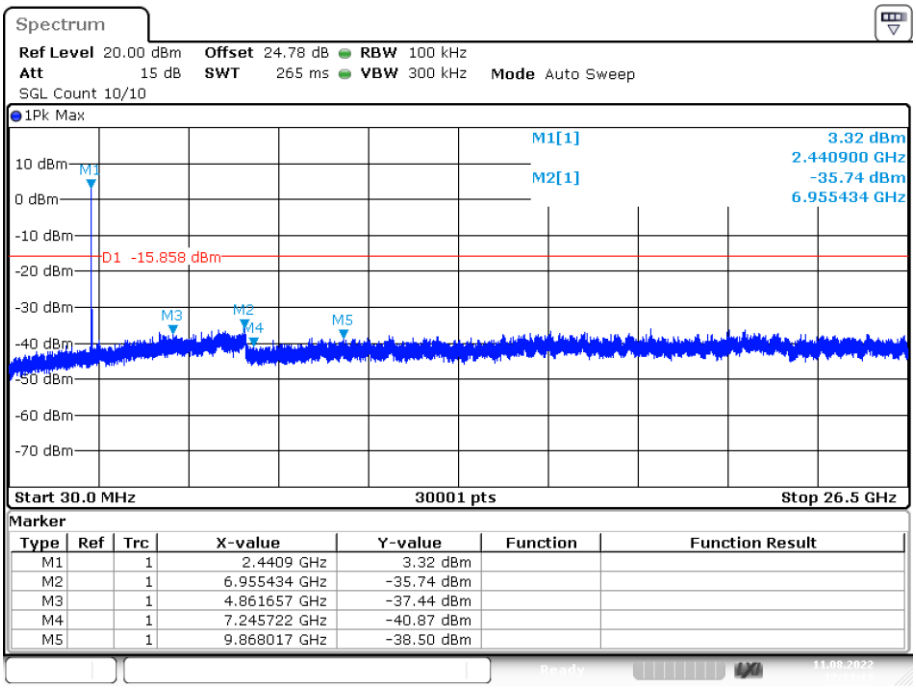
Date: 11.AUG.2022 11:04:39

Tx. Spurious NVNT 3-DH1 2441MHz Ant1 Ref



Date: 11.AUG.2022 12:13:00

Tx. Spurious NVNT 3-DH1 2441MHz Ant1 Emission

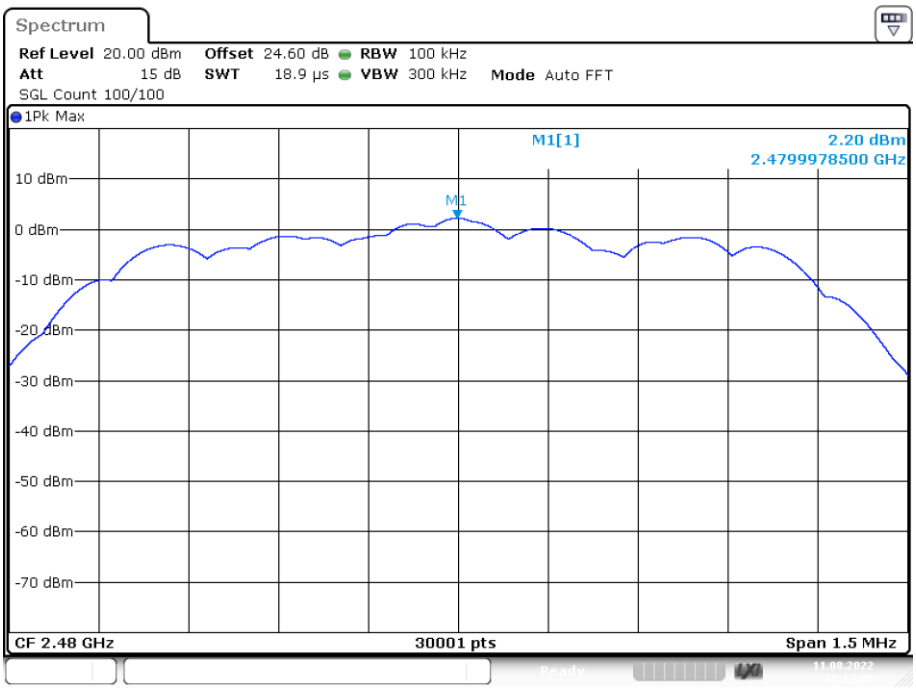


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4409 GHz	3.32 dBm		
M2		1	6.955434 GHz	-35.74 dBm		
M3		1	4.861657 GHz	-37.44 dBm		
M4		1	7.245722 GHz	-40.87 dBm		
M5		1	9.868017 GHz	-38.50 dBm		

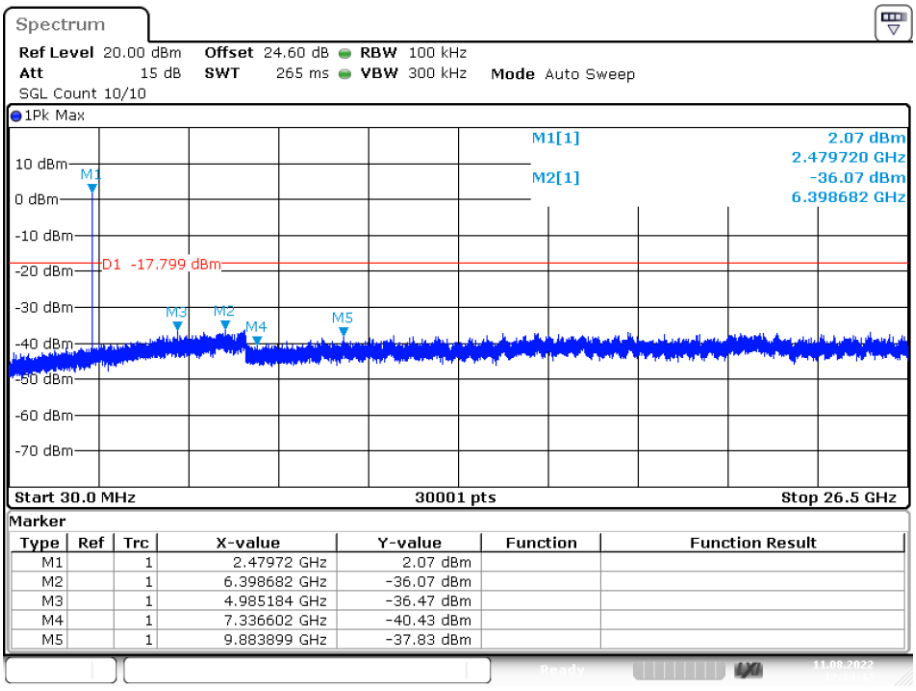
Date: 11.AUG.2022 12:13:13

Tx. Spurious NVNT 3-DH1 2480MHz Ant1 Ref



Date: 11.AUG.2022 12:14:28

Tx. Spurious NVNT 3-DH1 2480MHz Ant1 Emission



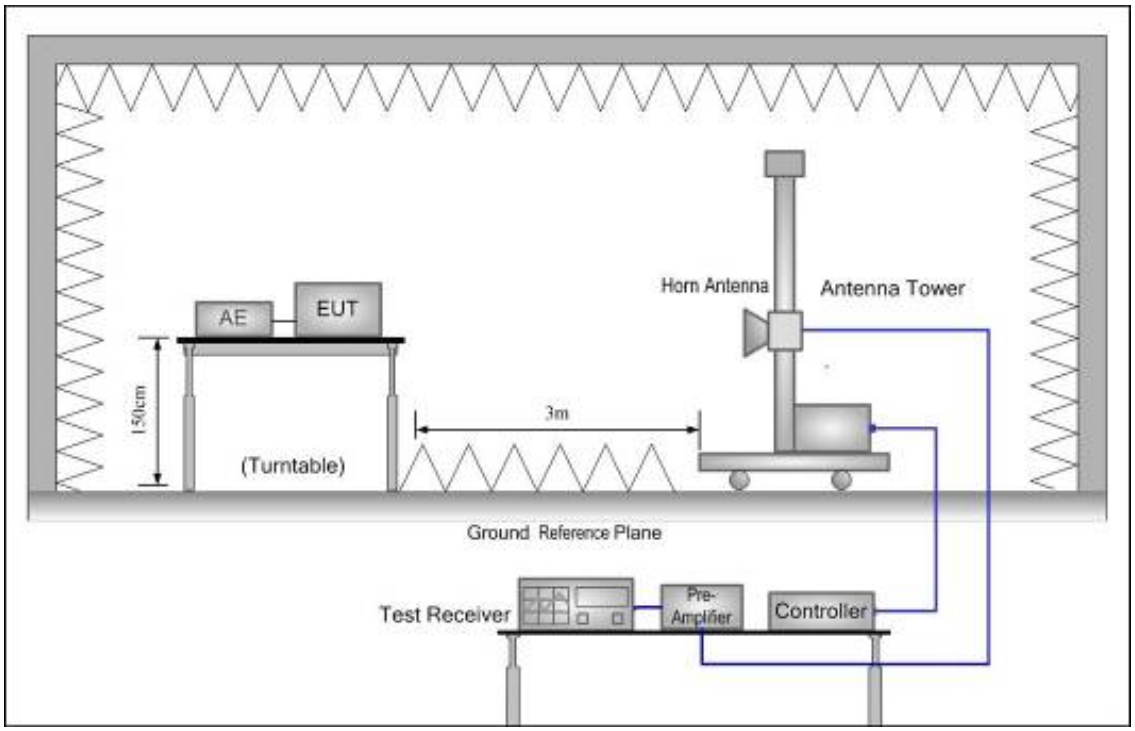
Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.47972 GHz	2.07 dBm		
M2		1	6.398682 GHz	-36.07 dBm		
M3		1	4.985184 GHz	-36.47 dBm		
M4		1	7.336602 GHz	-40.43 dBm		
M5		1	9.883899 GHz	-37.83 dBm		

Date: 11.AUG.2022 12:14:42

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 15.209, all the other emissions outside operation shall be at least 20dB below the fundamental emissions, or comply with 15.209 limits.

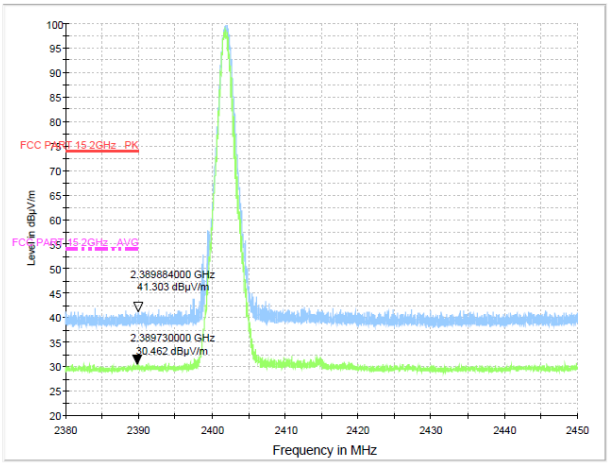
9.3. Test Procedure

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

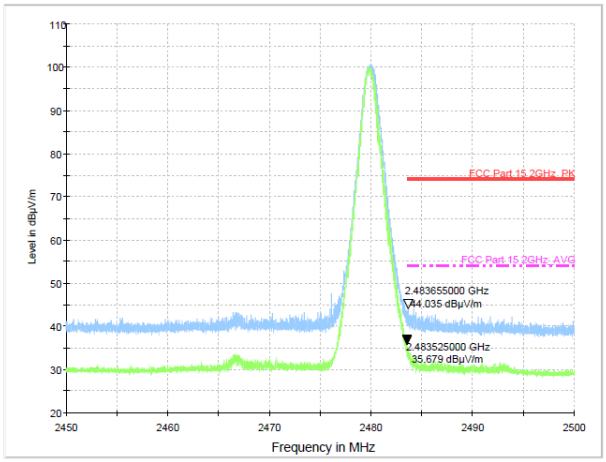
9.4. Test Result

PASS. (See below detailed test data)

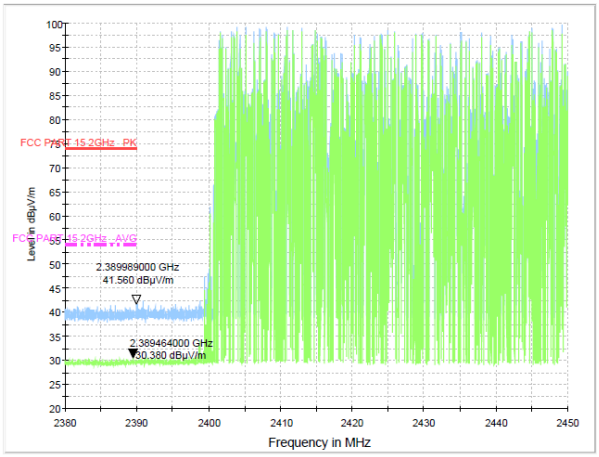
Test Mode: GFSK-Low Hopping-off



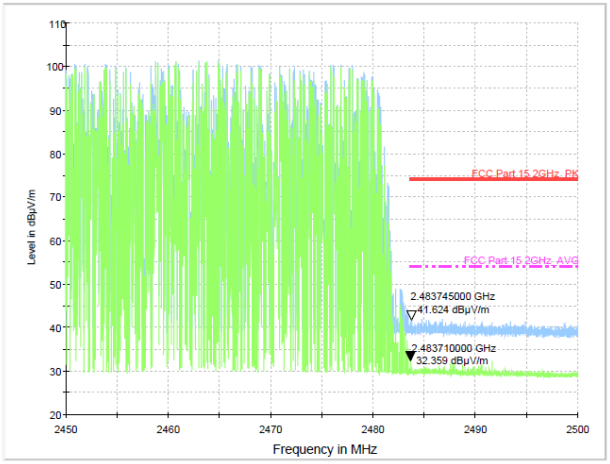
Test Mode: GFSK-High Hopping-off



Test Mode: GFSK-Low Hopping-on



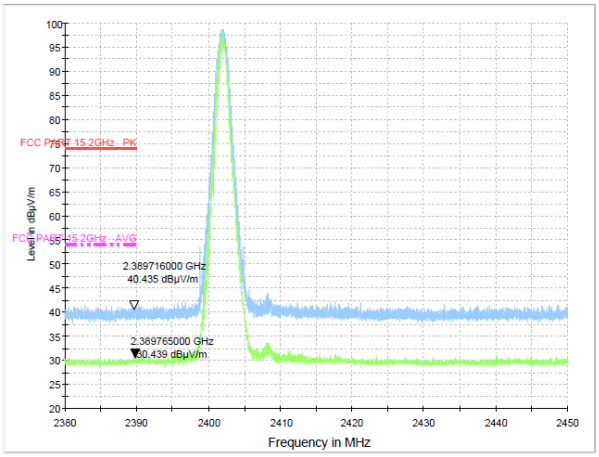
Test Mode: GFSK-High Hopping-on



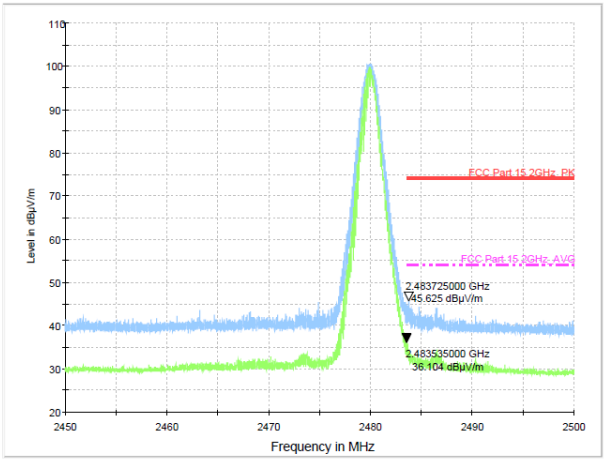
Note: 1. *:Maximum data; x:Over limit; !:over margin.

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

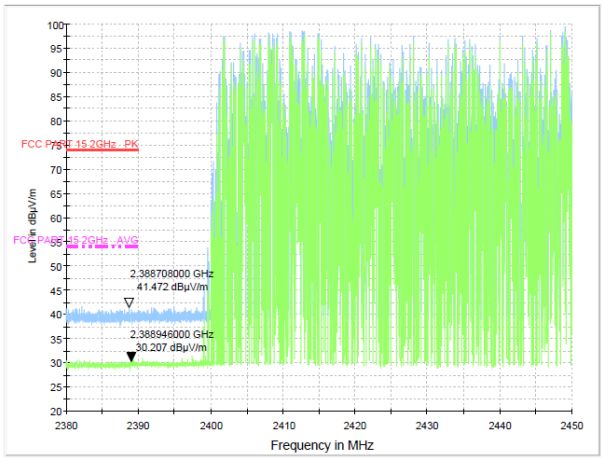
Test Mode: π/4 DQPSK-Low Hopping-off



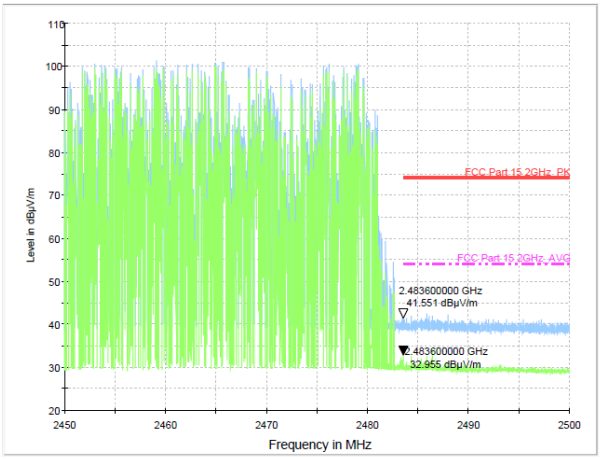
Test Mode: π/4 DQPSK-High Hopping-off



Test Mode: π/4 DQPSK-Low Hopping-on



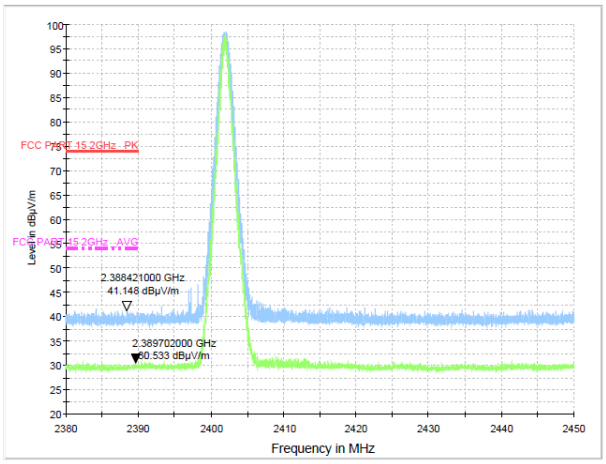
Test Mode: π/4 DQPSK-High Hopping-on



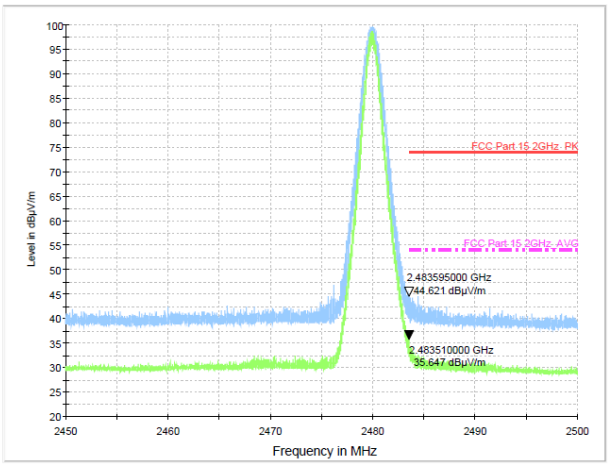
Note: 1. *:Maximum data; x:Over limit; !:over margin.

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

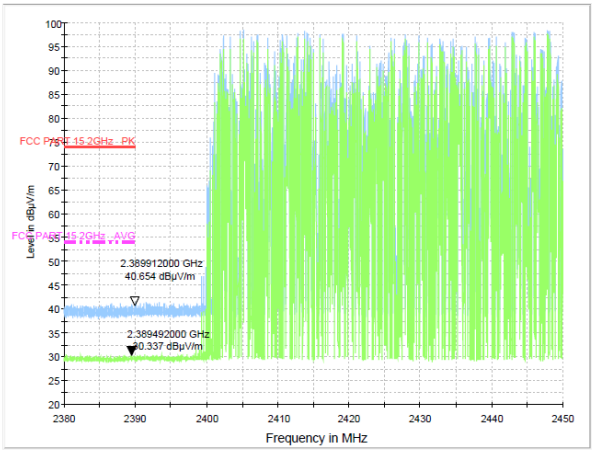
Test Mode: 8DPSK-Low Hopping-off



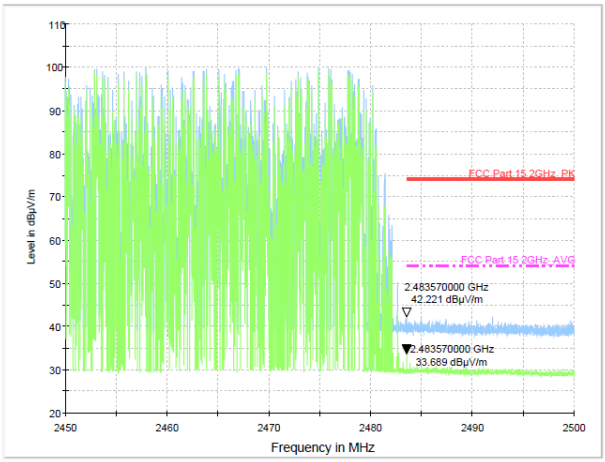
Test Mode: 8DPSK-High Hopping-off



Test Mode: 8DPSK-Low Hopping-on



Test Mode: 8DPSK-High Hopping-on



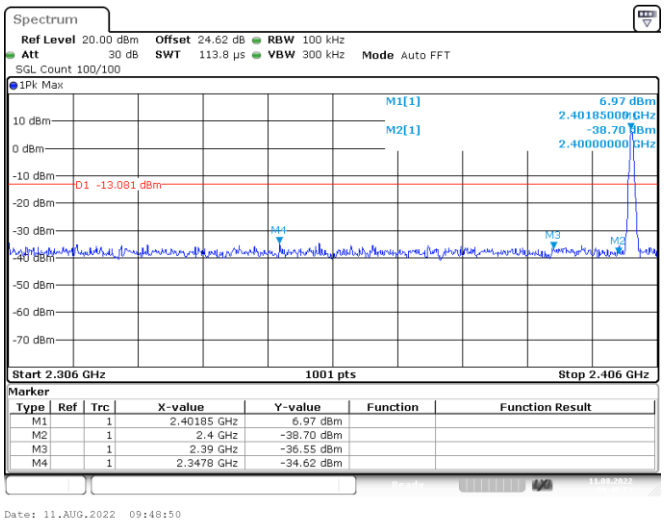
Note: 1. *:Maximum data; x:Over limit; !:over margin.

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

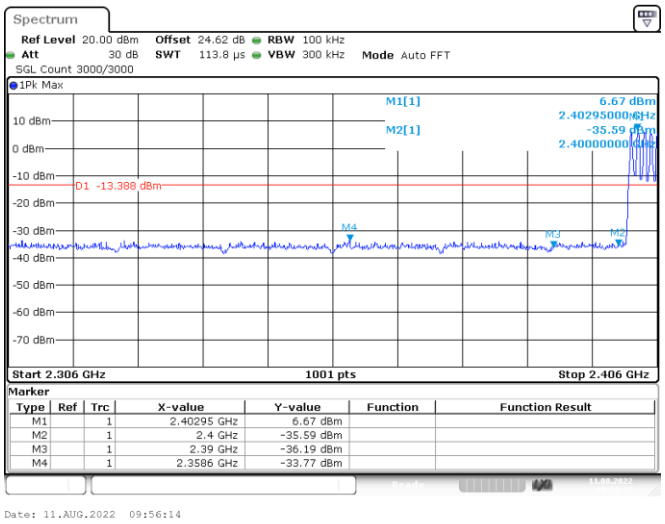
Conducted Method

GFSK Mode:

Test channel:	Lowest channel

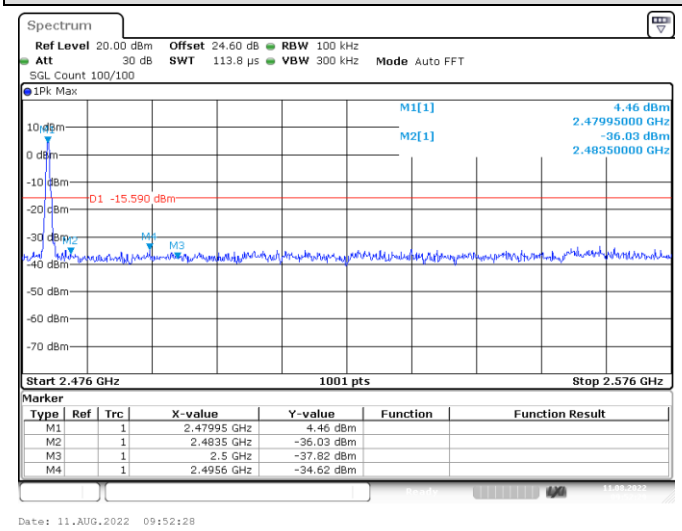


No-hopping mode

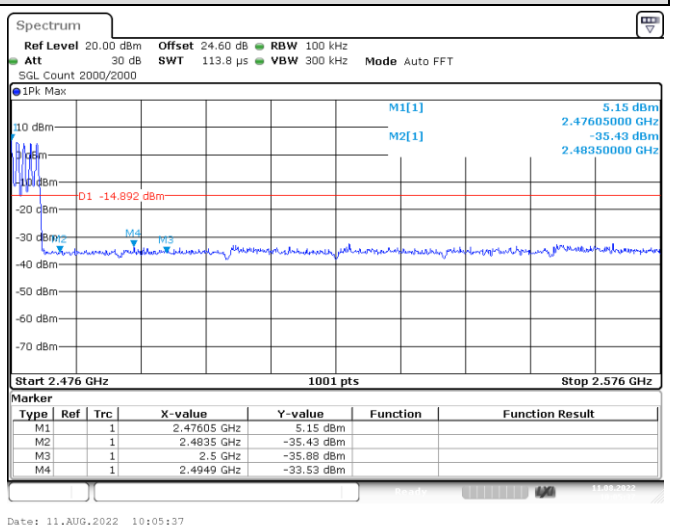


Hopping mode

Test channel:	Highest channel



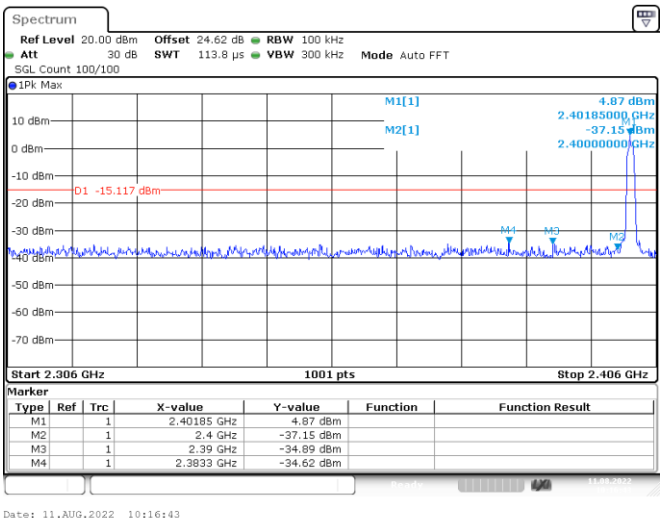
No-hopping mode



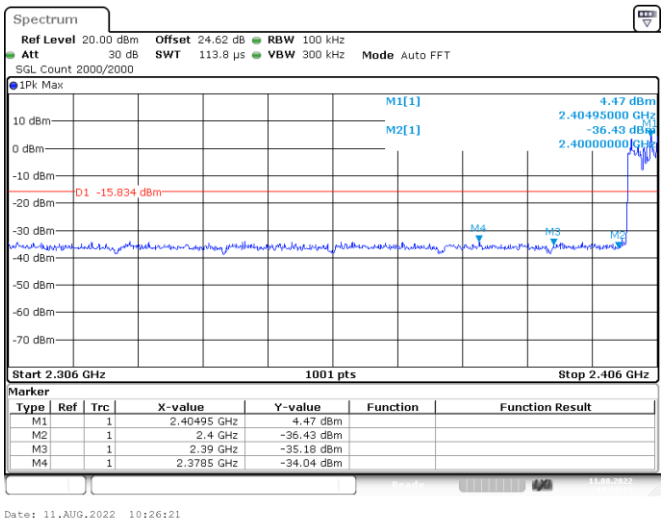
Hopping mode

π/4DQPSK Mode:

Test channel:	Lowest channel

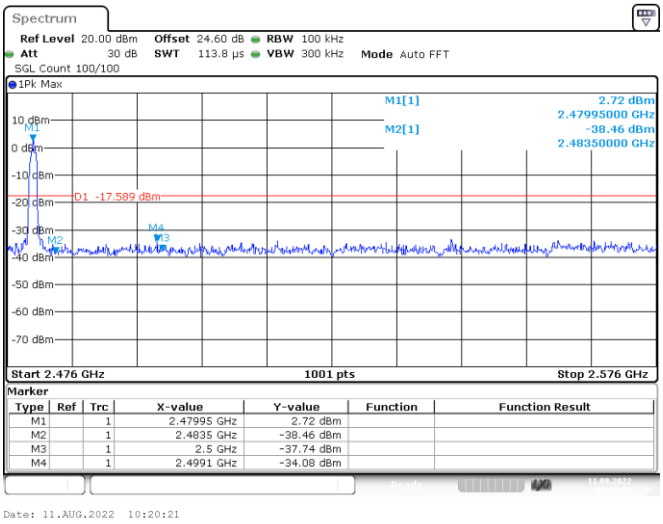


No-hopping mode

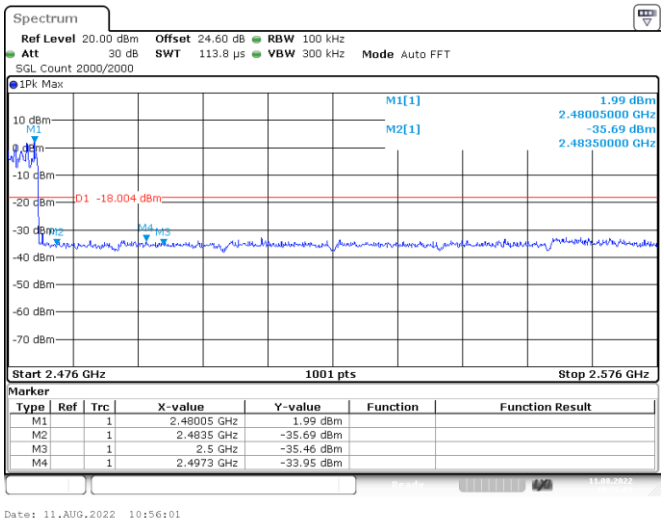


Hopping mode

Test channel:	Highest channel



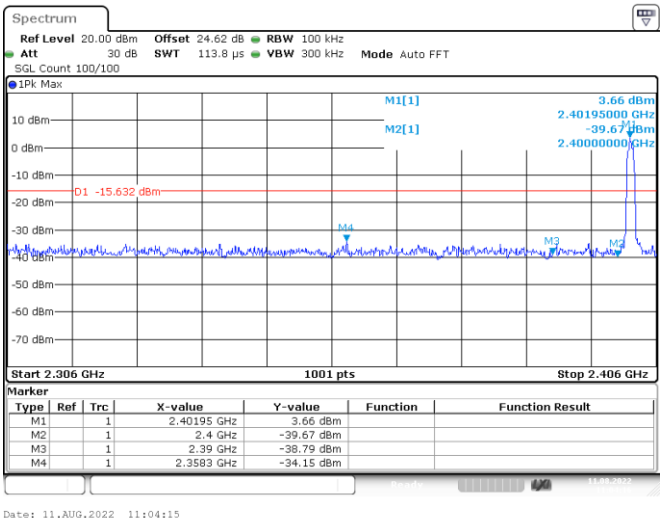
No-hopping mode



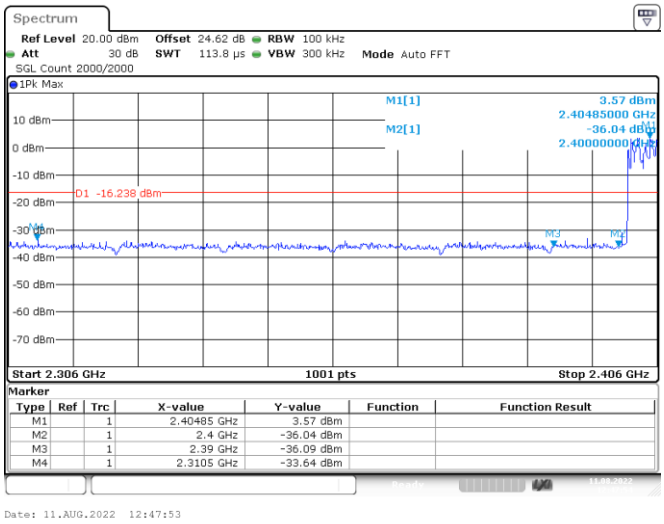
Hopping mode

8DPSK Mode:

Test channel:	Lowest channel

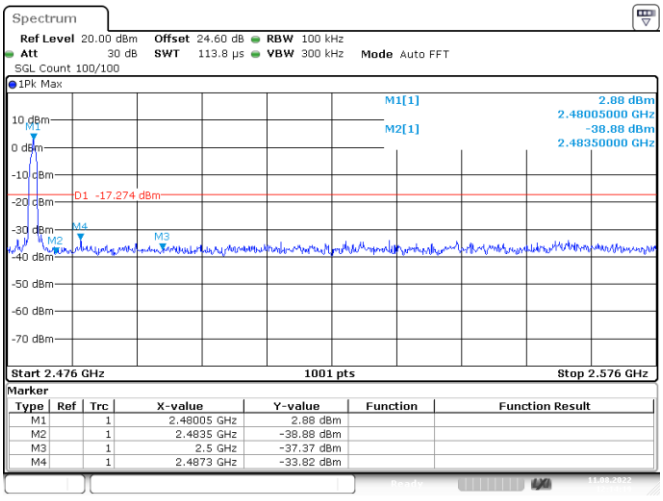


No-hopping mode

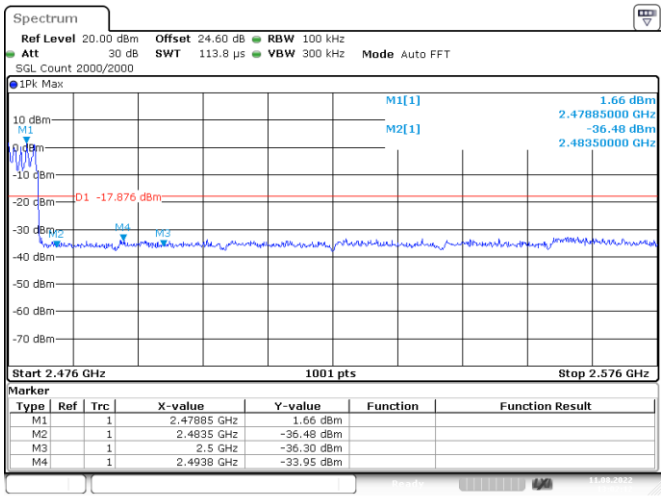


Hopping mode

Test channel:	Highest channel



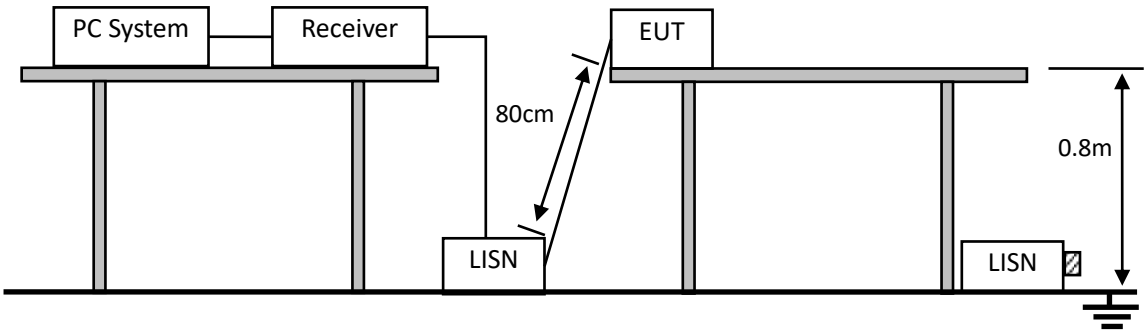
No-hopping mode



Hopping mode

10. POWER LINE CONDUCTED EMISSIONS

10.1.Block Diagram of Test Setup



:50Ω Terminator

10.2.Limit

Frequency	Maximum RF Line Voltage	
	Quasi-Peak Level dB(μV)	Average Level dB(μV)
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.

10.3.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.

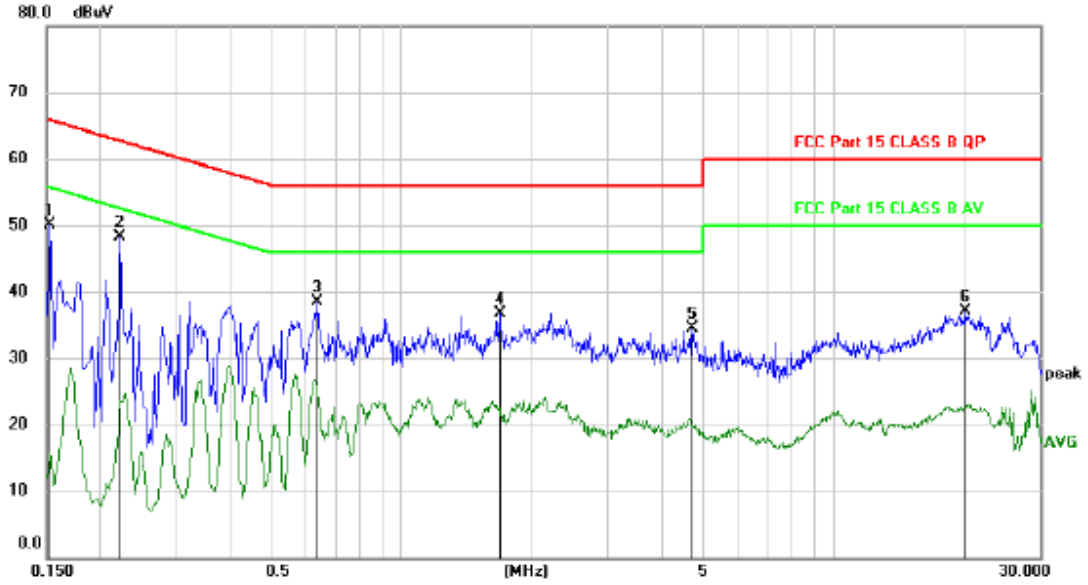
(5) The frequency range from 150 KHz to 30MHz is checked.

10.4.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:

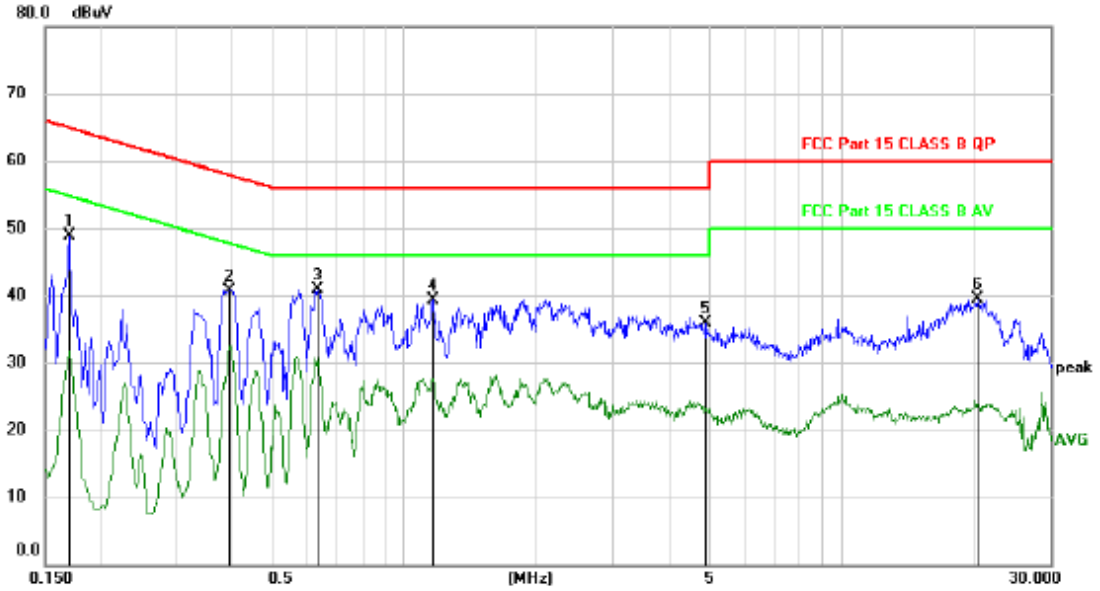


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Margin		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1530	40.13	9.94	50.07	65.84	-15.77	peak	
2	*	0.2220	38.40	9.94	48.34	62.74	-14.40	peak	
3		0.6390	28.58	9.92	38.50	56.00	-17.50	peak	
4		1.6860	26.87	9.89	36.76	56.00	-19.24	peak	
5		4.7010	24.43	10.02	34.45	56.00	-21.55	peak	
6		20.1299	26.60	10.47	37.07	60.00	-22.93	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	Measure-ment	Limit	Margin		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1710	38.95	9.93	48.88	64.91	-16.03	peak	
2		0.3960	30.75	9.94	40.69	57.94	-17.25	peak	
3	*	0.6330	30.97	9.92	40.89	56.00	-15.11	peak	
4		1.1610	29.51	9.89	39.40	56.00	-16.60	peak	
5		4.8930	25.90	10.04	35.94	56.00	-20.06	peak	
6		20.4420	28.96	10.47	39.43	60.00	-20.57	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

Note: All modes and channels have been tested and only the GFSK 2402MHz mode with the worst data is listed.

11. ANTENNA REQUIREMENTS

11.1.Limit

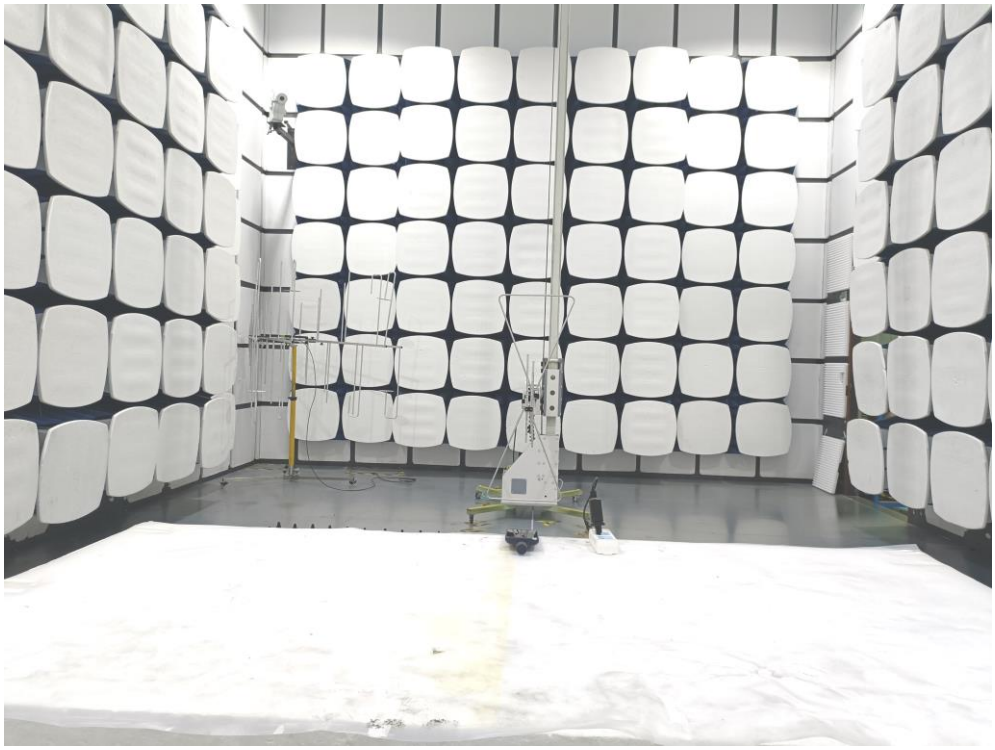
For intentional device, according to FCC 47 CFR Section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section 15.247 (b), if transmitting antennas of directional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

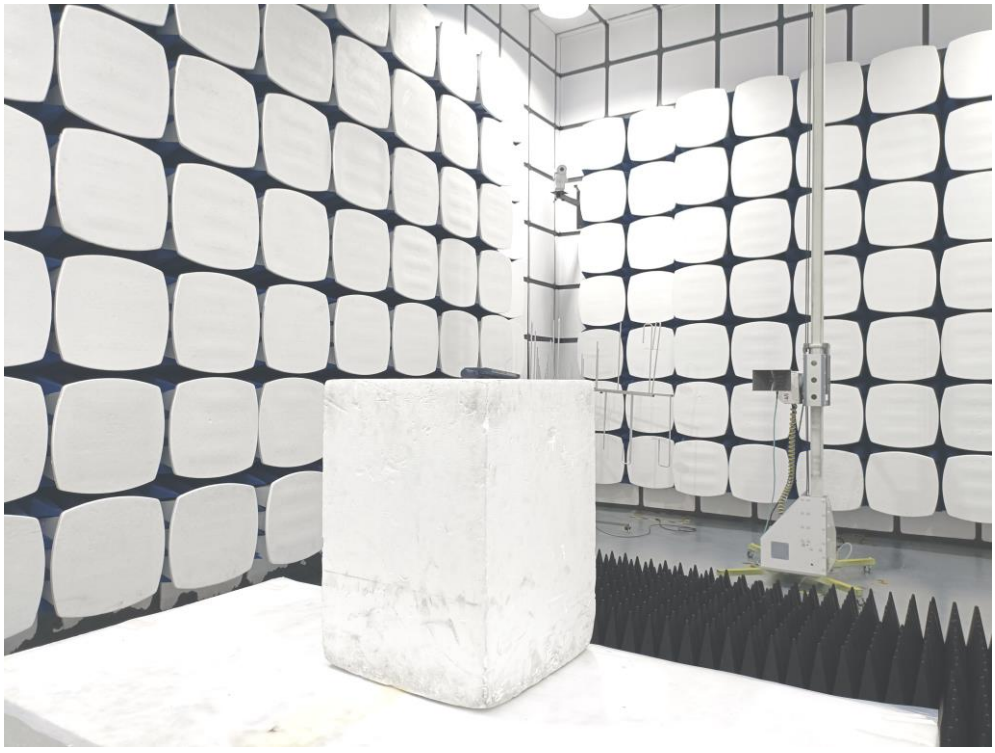
11.2.Result

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

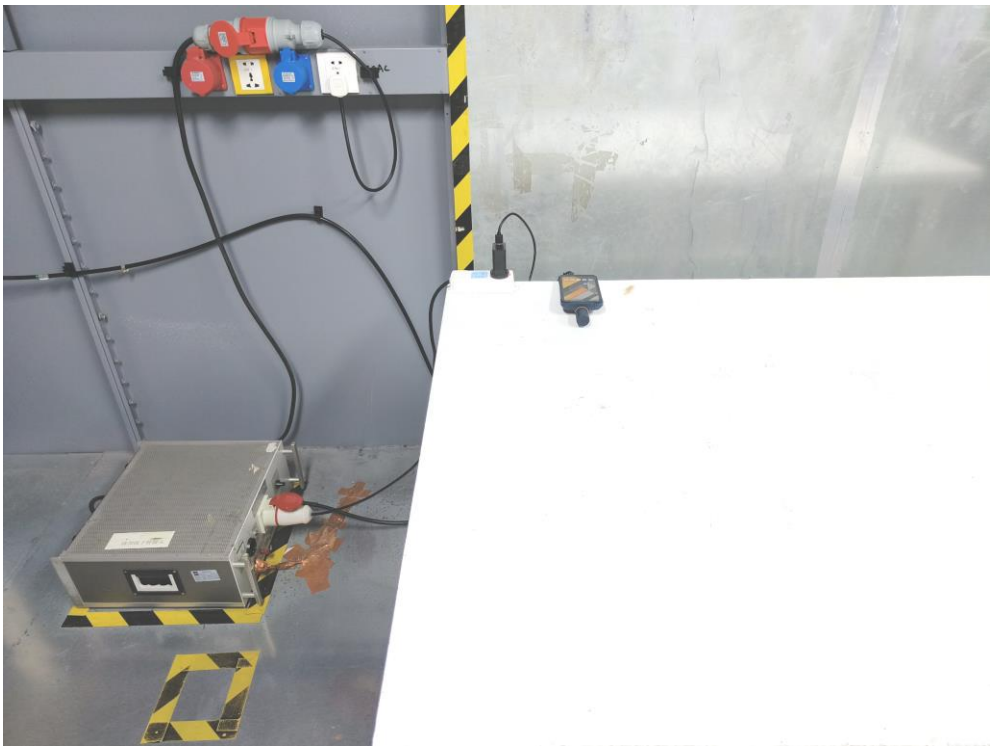
12. TEST SETUP PHOTO

12.1.Photo of Radiated Emission test





12.2.Photo of Conducted Emission test



13. EUT Photo

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