

RF TEST REPORT

Report number		RAPA22-O-055
Applicant	Name	Innonet Co., Ltd.
	Logo	N/A
	Address	Building C, Office 417, Munjeong Hyundai Knowledge Industry Center, 7, Beobwon-ro 11-gil, Songpa-gu, Seoul 05836
Manufacturer	Name	Innonet Co., Ltd.
	Address	Building C, Office 417, Munjeong Hyundai Knowledge Industry Center, 7, Beobwon-ro 11-gil, Songpa-gu, Seoul 05836
Type of equipment		Fixed TVWS Gateway
Basic model name		BUHST10
Multi model name		N/A
Serial number		N/A
FCC ID		2A9R3-BUHST10
Test duration		December 1, 2022 to December 26, 2022
Date of issue		December 27, 2022
Total page		44 Pages (including this page)

SUMMARY

The equipment complies with the regulation; FCC Part 15 Subpart C Section 15.247

This test report only contains the result of a single test of the sample supplied for the examination.
It is not a general valid assessment of the features of the respective products of the mass-production.

December 27, 2022

December 27, 2022

김민구

Tested by MinGu Ji
Tester

류우열

Reviewed by Wooyeol- Ryu
Executive Manager

Test Report Version History

Version	Date	Reason for revision
1.0	December 27, 2022	Original Document

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1. Description of EUT

1.1 Applicant

- Company name : Innonet Co., Ltd.
- Address : Building C, Office 417, Munjeong Hyundai Knowledge Industry Center, 7, Beobwon-ro 11-gil, Songpa-gu, Seoul 05836
- Contact person : Tae Hyun Kim / Researcher / thkim@innonet.net
- Phone/Fax : +82-2-406-8849 / +82-2-3012-8101

1.2 Manufacturer

- Company name : Innonet Co., Ltd.
- Address : Building C, Office 417, Munjeong Hyundai Knowledge Industry Center, 7, Beobwon-ro 11-gil, Songpa-gu, Seoul 05836
- Phone/Fax : +82-2-406-8849 / +82-2-3012-8101

1.3 Basic description

- Product name : Fixed TVWS Gateway
- Basic model name : BUHST10
- Alternative model name : N/A

1.4 General description

- EQUIPMENT CLASS : DTS – Digital Transmission Systems
- Frequency Range : 2 412 MHz ~ 2 462 MHz (802.11n(HT20))
: 2 402 MHz ~ 2 480 MHz (BT LE)
- Output Power : WLAN : 26.17 dBm
: BT : -0.356 dBm
- Modulation Type : QPSK, 16QAM, GFSK
- Antenna Type : WLAN : Dipole Antenna,
Chip Antenna
- Antenna Gain : WLAN : SISO : 5.54 dBi ,
MIMO(ANT0+ANT1) : 8.55 dBi
BT : 4.18 dBi
- Power Supply : DC 24.0 V

1.5 Alternative type(s)/model(s)

There is no alternative type(s) and/or model(s).

2. General information of test

2.1 Test standards and results

Applied Standards : FCC Part 15 Subpart C		
Section	Description of Test	Result
15.247 (a) (2)	Minimum 6 dB Bandwidth	Pass
15.247 (b) (3)	Maximum Peak Conducted Output Power	Pass
15.247 (d)	100 kHz Bandwidth Outside the Frequency Band	Pass
	Radiated Emission which fall in the Restricted Band	Pass
15.247 (e)	Peak Power Spectral Density	Pass
15.207	Conducted Limits	Pass
15.209	Radiated Emission Limits	Pass
15.203	Antenna Requirement	Pass

2.2 Description of EUT during the test

During the test, keep the EUT in continuously transmitting mode.

There was no mechanical or circuitry modification to improve RF and spurious characteristic, and any RF and spurious suppression device(s) was not added against the device tested.

The EUT was moved throughout the X, Y, and Z axis and worst case data was recorded in this report.

The BT module((2AUUG-BOT-CLE310) used a certified module.

2.3 Test configuration

• Type of peripheral equipment used

Model	Manufacturer	Description	Connected to
TVWS-GW-PSU	Innonet Co., Ltd.	AC/DC Adapter	EUT
650G1	HP	Notebook	EUT
PA-1900-32HT	LITE-ON TECHNOLOGY(CHANGZHOU_Co., Ltd.	Power Adapter	Notebook

2.4 Test Facility

- **FCC Registration No: 931589**
- **IC Company address code: 9355B**
- **RRA Designation Number: KR0027**

• Place of Test

Anyang Test Site(RF Test Room)

#101 & B104 Anyang Megavalley, 268, Hagui-ro, Dongan-gu, Anyang-si, Gyeonggi-do, 14056, Korea

2.5 PRELIMINARY TEST

2.5.1 AC Power line Conducted Emissions Tests

Operation Mode	The Worse operating condition (Please check one only)
Transmitting mode.	X

2.5.2 General Radiated Emissions Tests

During Preliminary Tests, the following operating modes were investigated

Operation Mode	The Worse operating condition (Please check one only)
Transmitting mode.	X

Antenna Gain

Antenna Gain	802.11n(HT20)	Ant 0	5.54
	802.11n(HT20)	Ant 1	5.54
Directional Antenna Gain	802.11n(HT20)	ANT 0+1	8.55

2.6 Mode of operation during the test

Modulation	Data Rate	Output Power[dBm]	
		Ant 0	Ant 1
802.11n(HT20)	14.4	22.09	18.87
	28.9	22.44	17.12
	43.3	22.18	17.47
	57.8	21.94	17.01
	86.7	21.81	16.88
	115.6	22.07	17.23
	130	21.93	17.17
	144.4	22.27	17.07

The worse case data rate for each modulation is determined 14.4 Mbps(Ant 0, 1) for HT20.

Mode	Operation Mode	Operation Ant.
802.11n(HT20)	MIMO	Ant 0+1

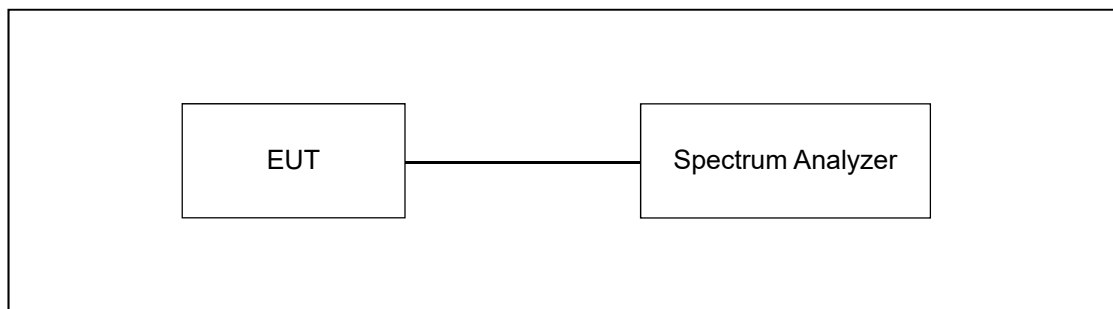
3. Measurement data

3.1 Minimum 6 dB Bandwidth

3.1.1 Requirement

- FCC Part15 subpart C Section 15.247

3.1.2 Test Procedure



The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz, and peak detection was used. The 6 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 6 dB.

3.1.3 Test environment

- 22 °C, 43 % R.H.

3.1.4 Test results

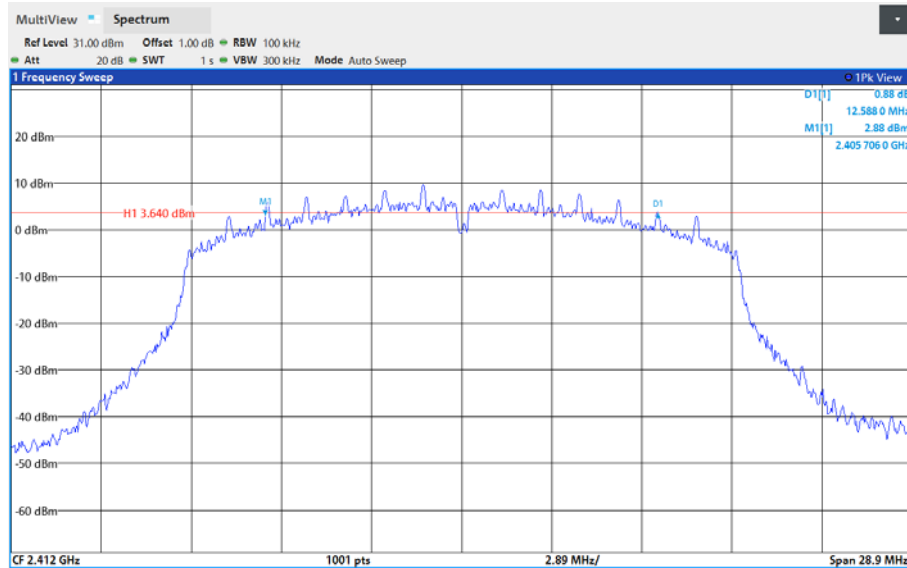
- Ant 0

Frequency [MHz]		Measured Value [MHz]	Limit [MHz]	Result
Low	2412	12.58	0.5	PASS
Middle	2442	14.70	0.5	
High	2462	15.28	0.5	

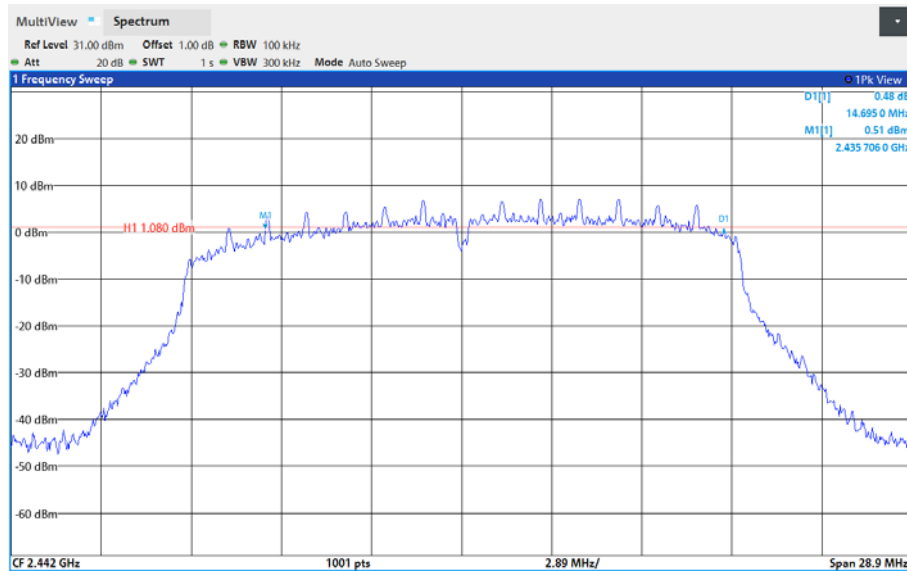
- Ant 1

Frequency [MHz]		Measured Value [MHz]	Limit [MHz]	Result
Low	2412	12.61	0.5	PASS
Middle	2442	14.69	0.5	
High	2462	15.67	0.5	

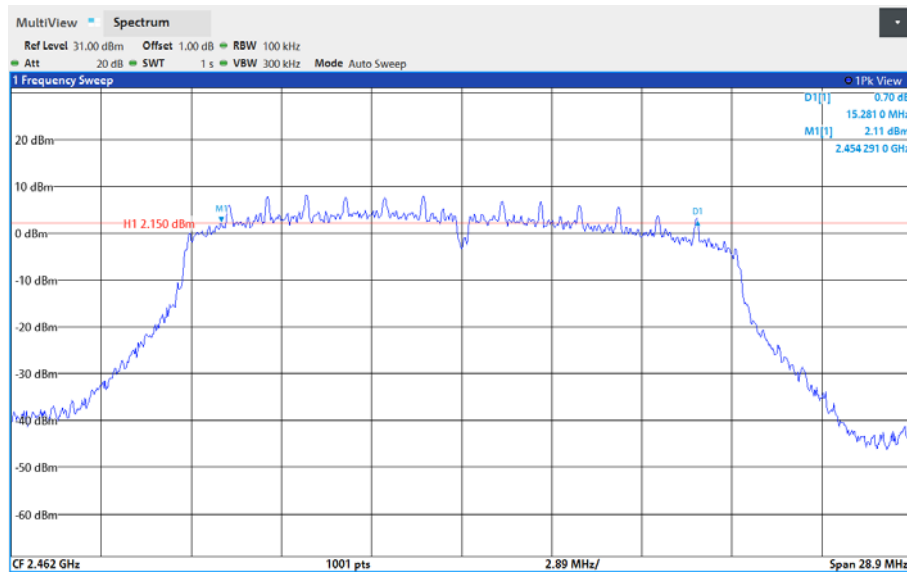
3.1.5 Test Plots



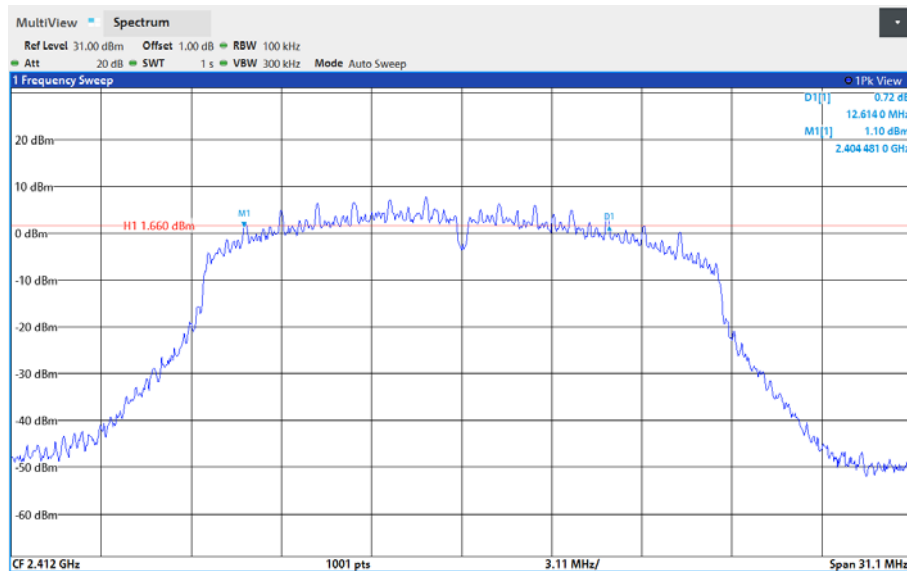
Ant0 Low Channel



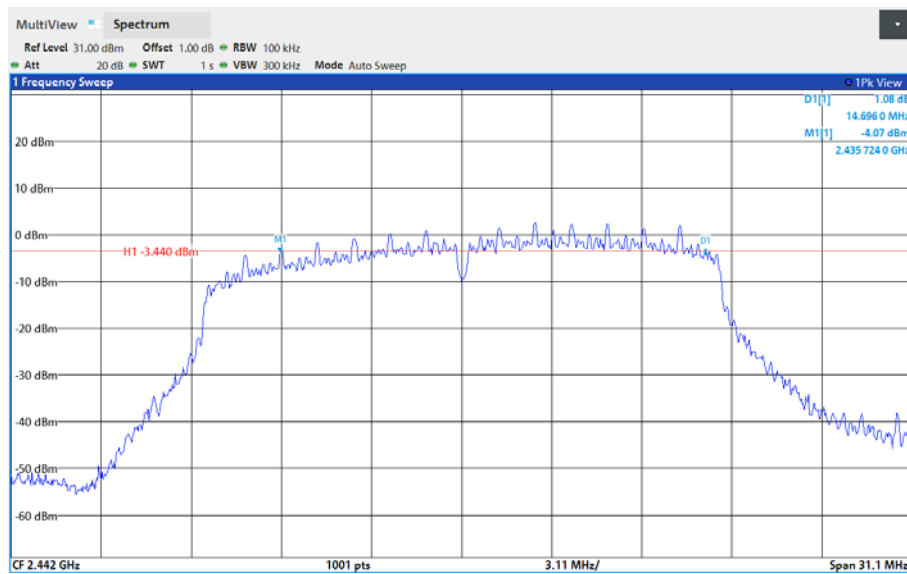
Ant0 Middle Channel



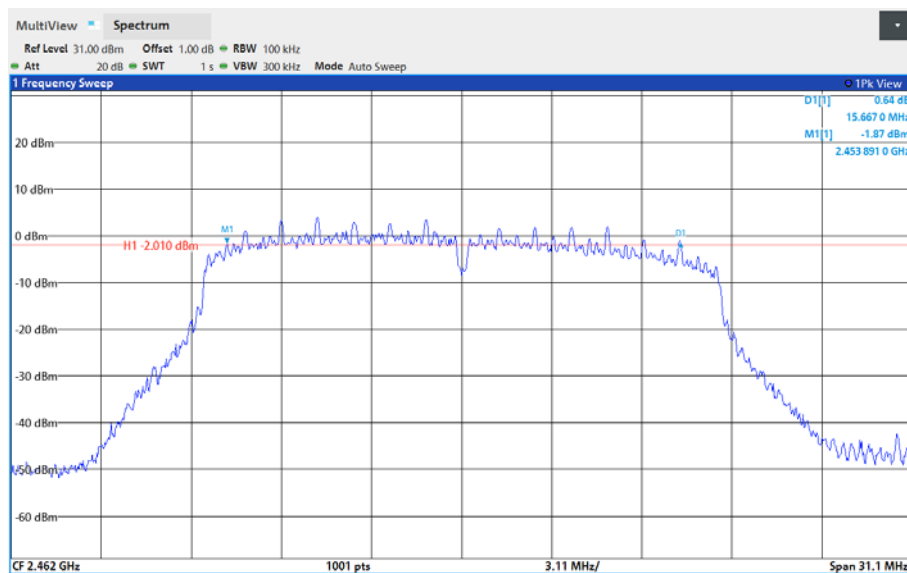
Ant0 High Channel



Ant1 Low Channel



Ant1 Middle Channel



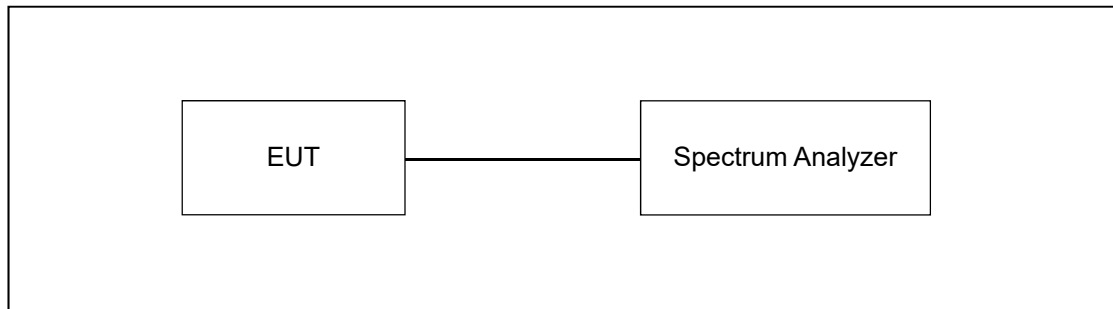
Ant1 High Channel

3.2 Maximum Peak Conducted Output Power

3.2.1 Requirement

- FCC Part15 subpart C Section 15.247

3.2.2 Test Procedure



The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to $\geq$ DTS Bandwidth, the video bandwidth is set to 3 times the resolution bandwidth.

3.2.3 Test environment

- 22 °C, 43 % R.H.

3.2.4 Test results

- Ant 0

Frequency [MHz]		Measured Value [dBm]	Limit [dBm]	Result
Low	2412	23.60	30.00	PASS
Middle	2442	21.60	30.00	
High	2462	22.68	30.00	

- Ant 1

Frequency [MHz]		Measured Value [dBm]	Limit [dBm]	Result
Low	2412	17.88	30.00	PASS
Middle	2442	19.40	30.00	
High	2462	23.60	30.00	

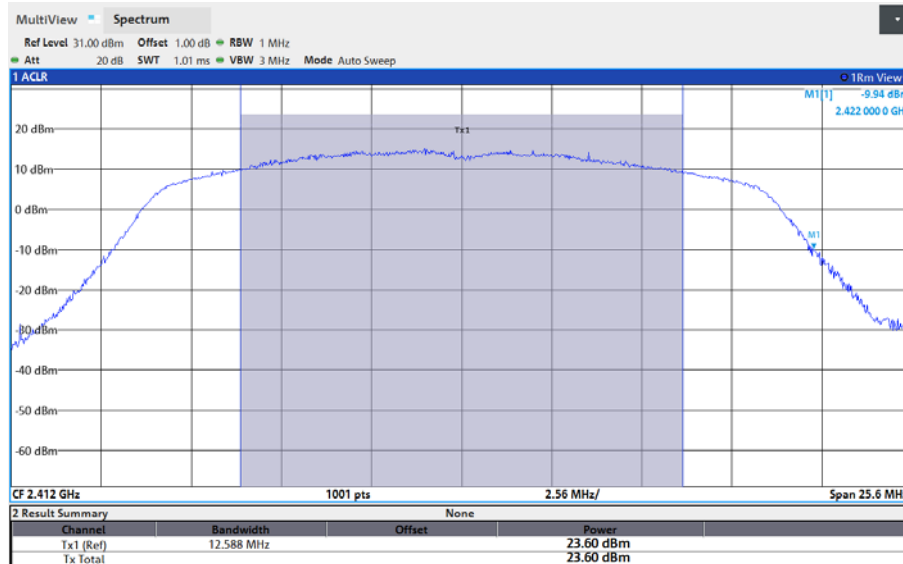
• Ant 0+1

Frequency [MHz]		Measured Value [dBm]	Limit [dBm]	Result
Low	2412	24.63	27.45	PASS
Middle	2442	23.65	27.45	
High	2462	26.17	27.45	

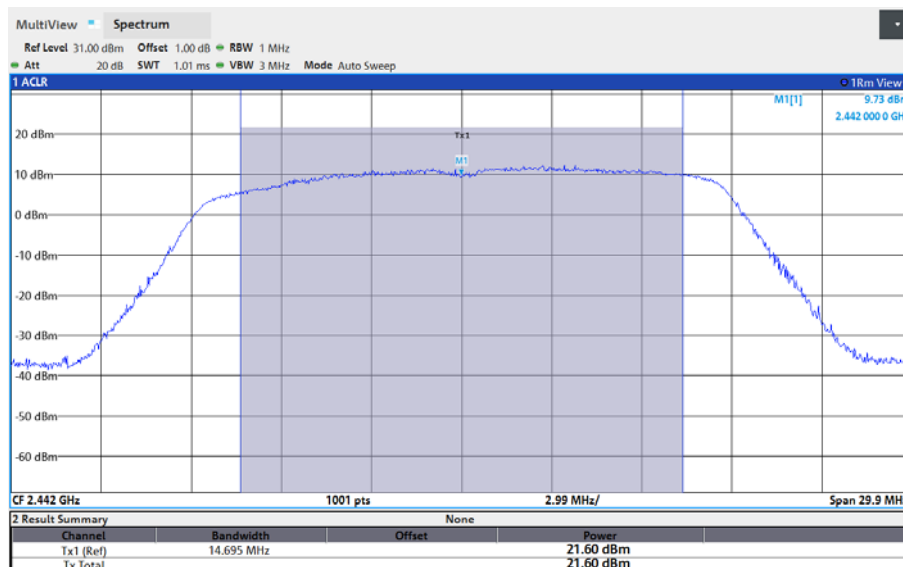
Remark 1 : Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

Remark 2 : Calculated Output Power= $10\log(10^{(\text{Antenna0 Output Power}/10)} + 10^{(\text{Antenna1 Output Power}/10)})$

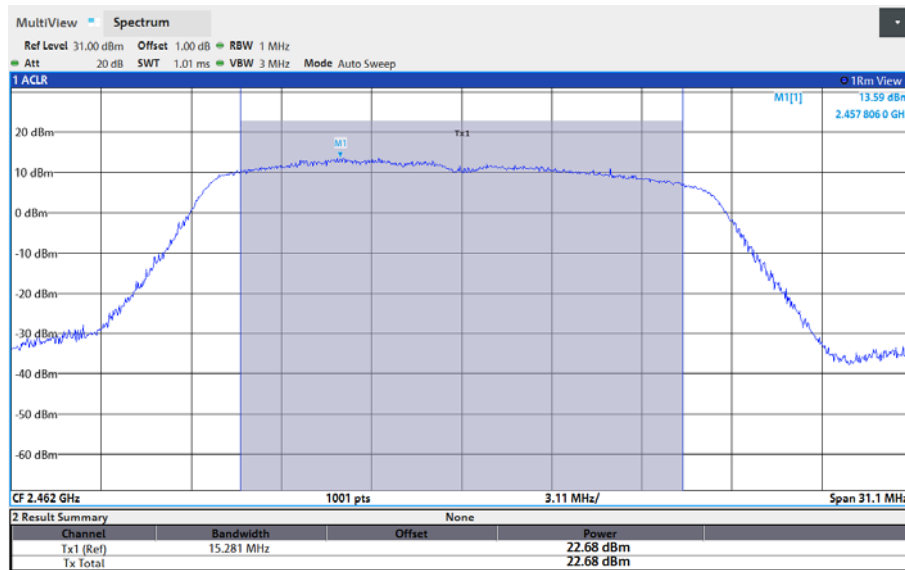
3.2.5 Test Plots



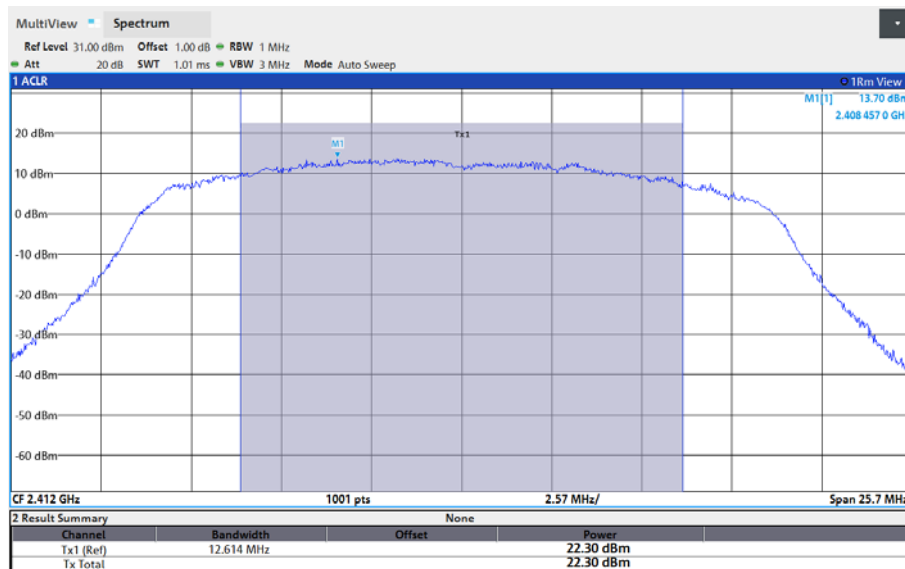
Ant 0 Low Channel



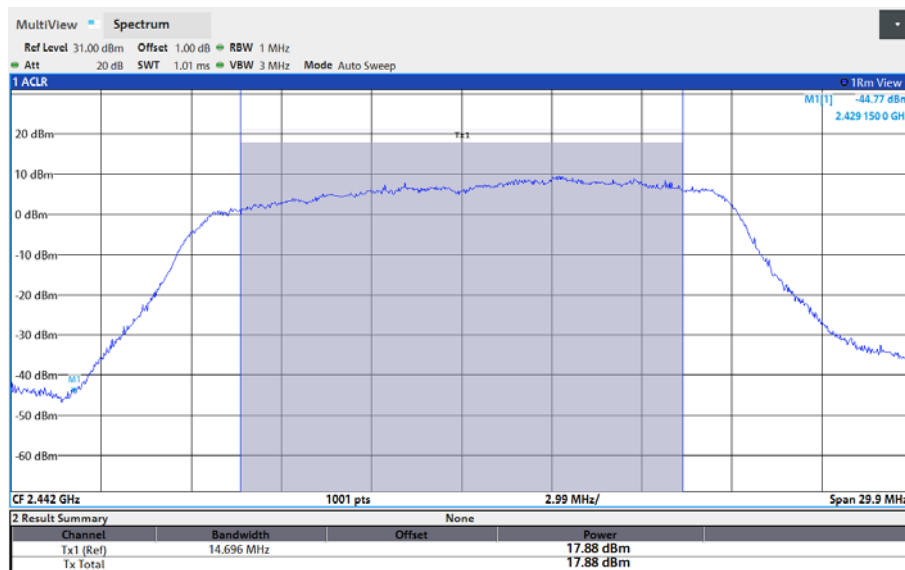
Ant 0 Middle Channel



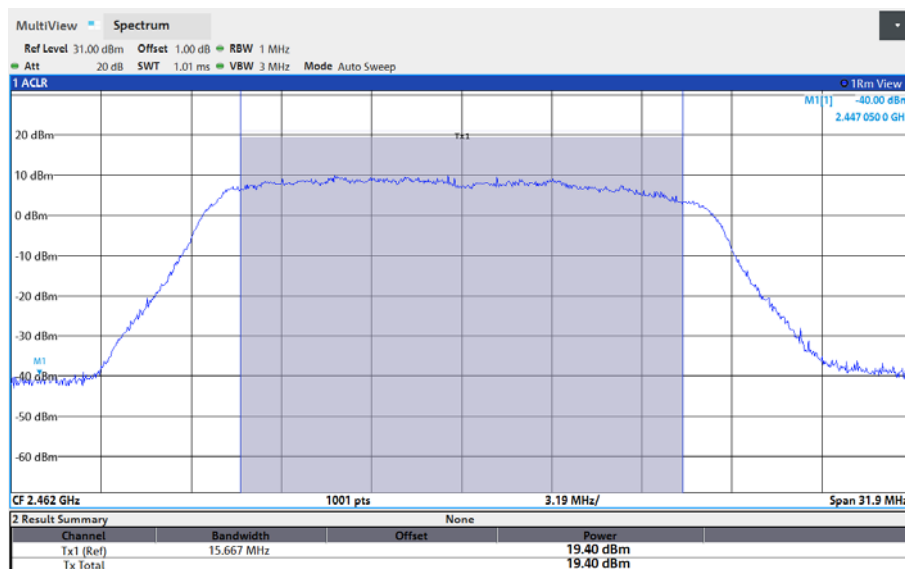
Ant 0 High Channel



Ant 1 Low Channel



Ant 1 Middle Channel



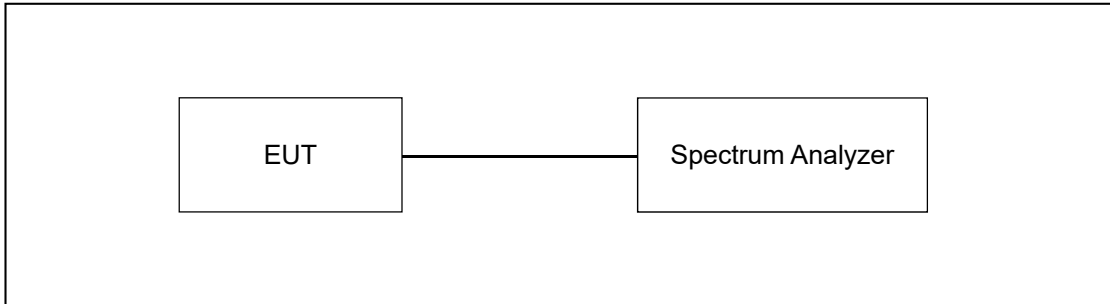
Ant 1 High Channel

3.3 100 kHz Bandwidth Outside the Frequency Band

3.3.1 Requirement

- FCC Part15 subpart C Section 15.247

3.3.2 Test Procedure



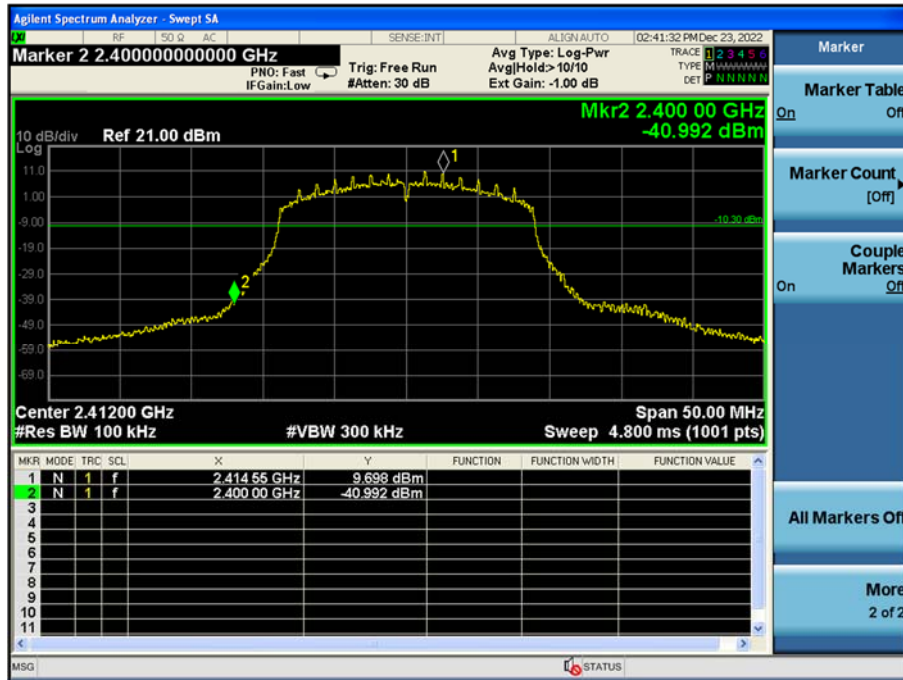
The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth and video bandwidth is set to 100 kHz, and peak detection was used.

3.3.3 Test environment

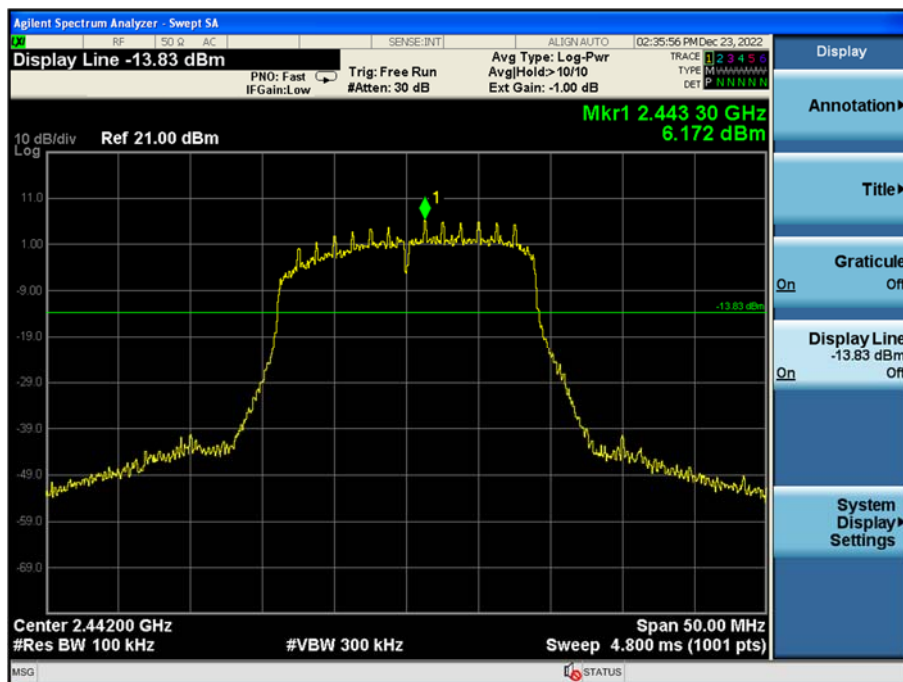
- 22 °C, 43 % R.H.

3.3.4 Test Plots

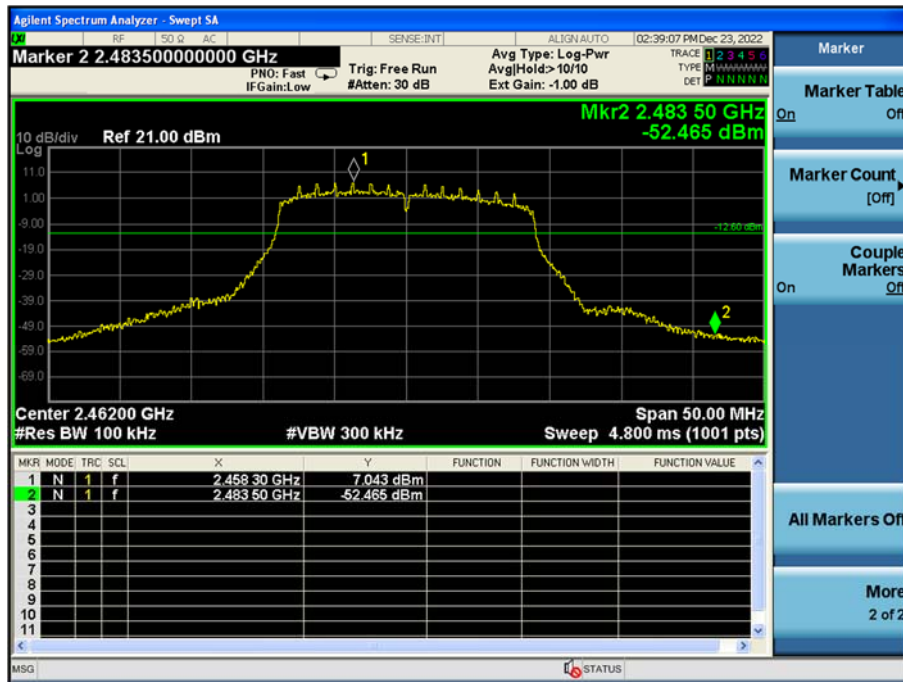
• Ant 0



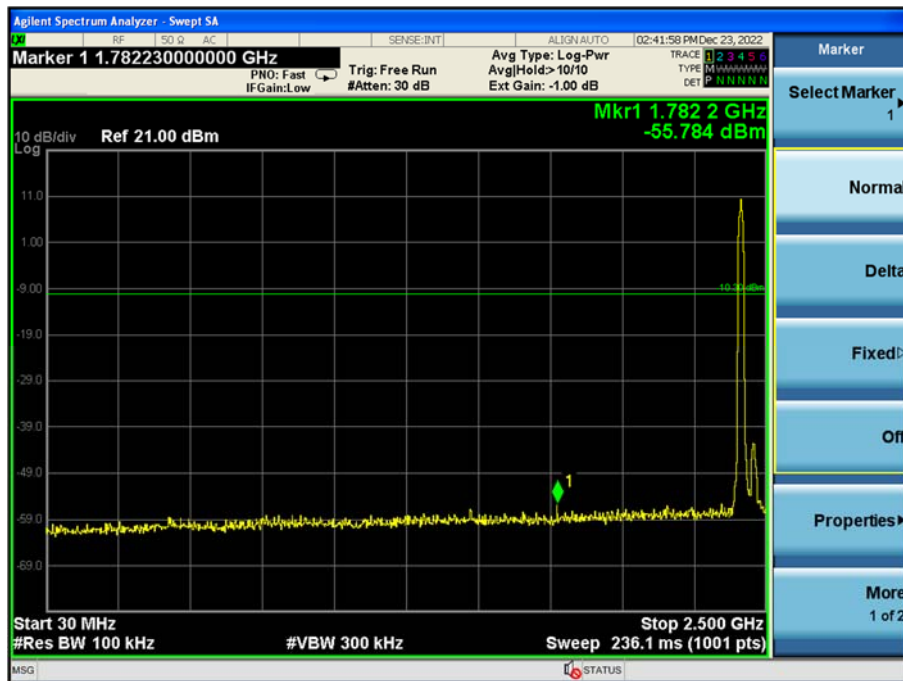
Low Channel



Middle Channel



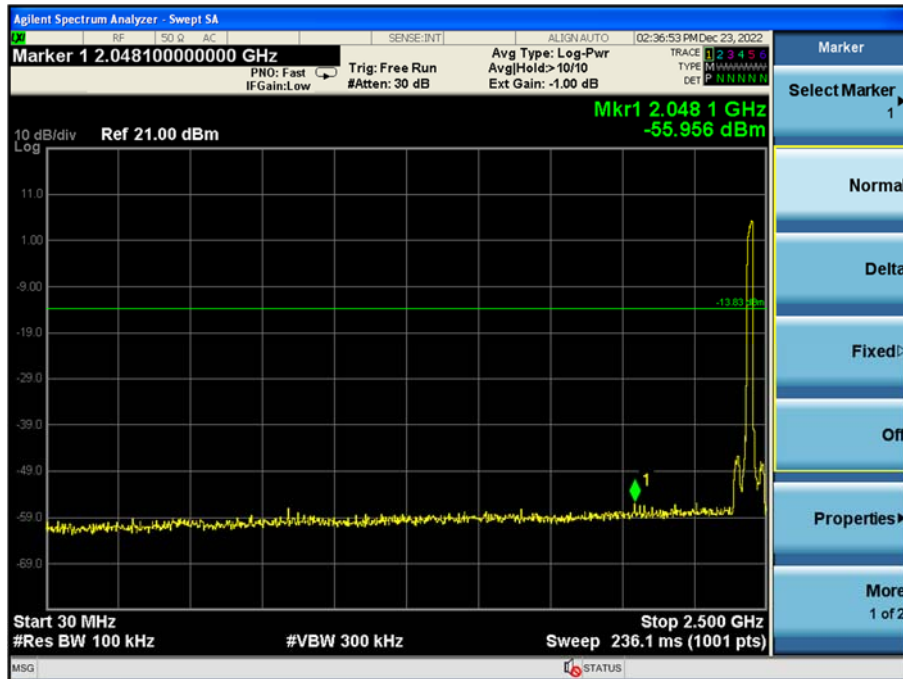
High Channel



Low Channel



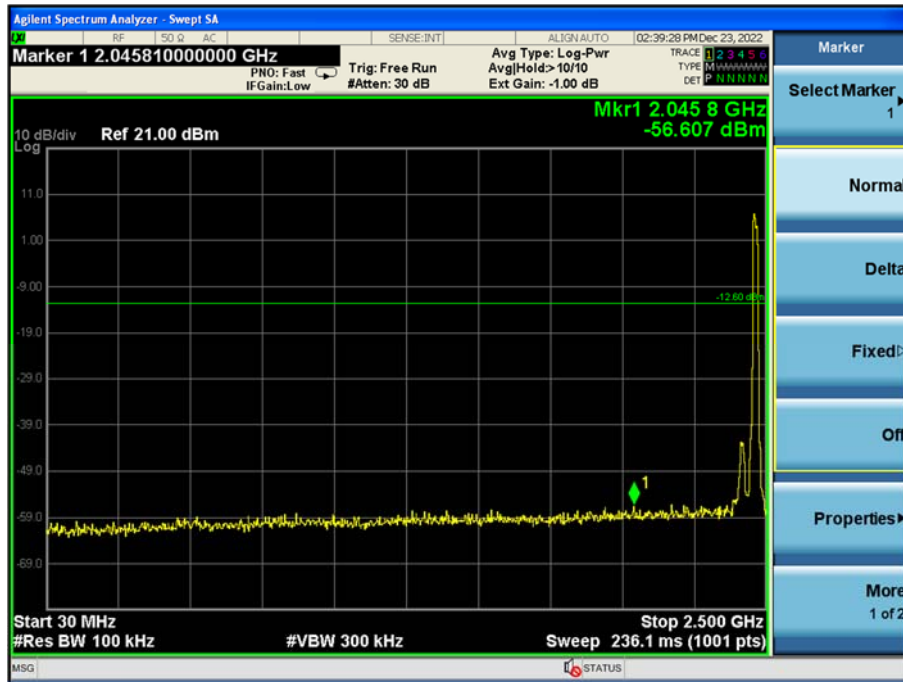
Low Channel



Middle Channel



Middle Channel

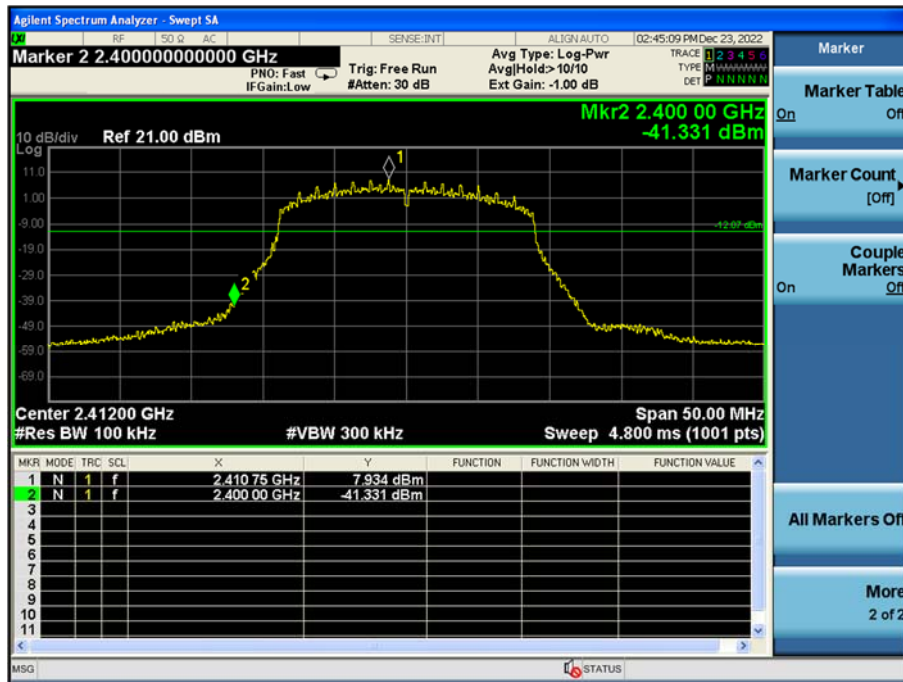


High Channel



High Channel

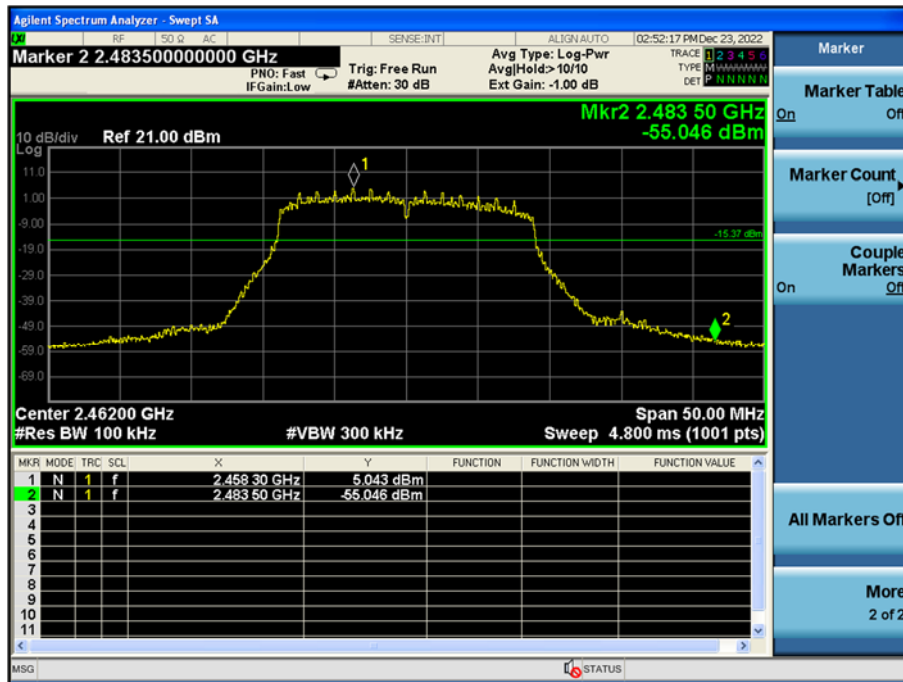
• Ant 1



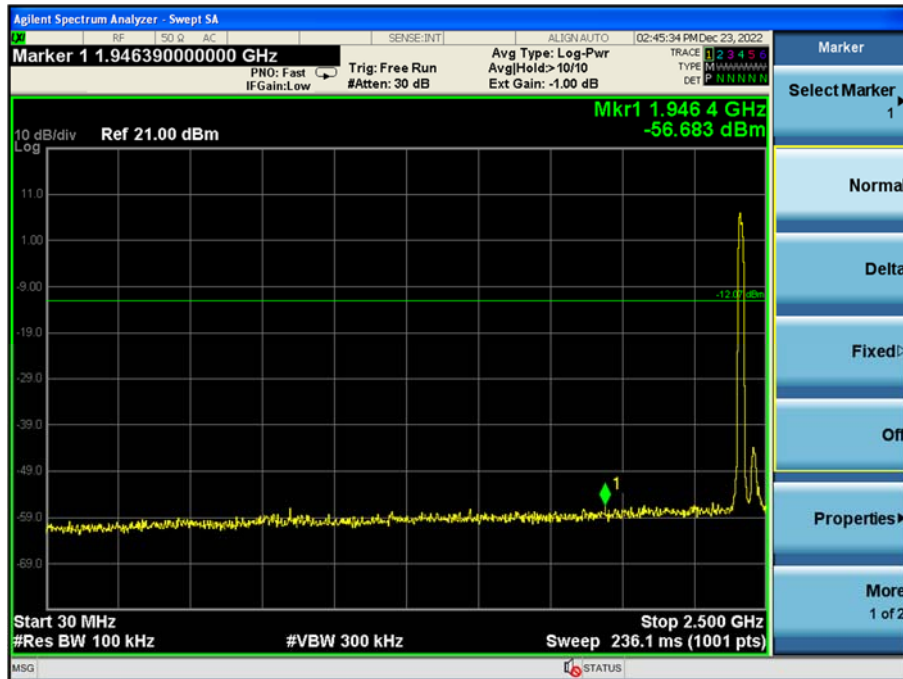
Low Channel



Middle Channel



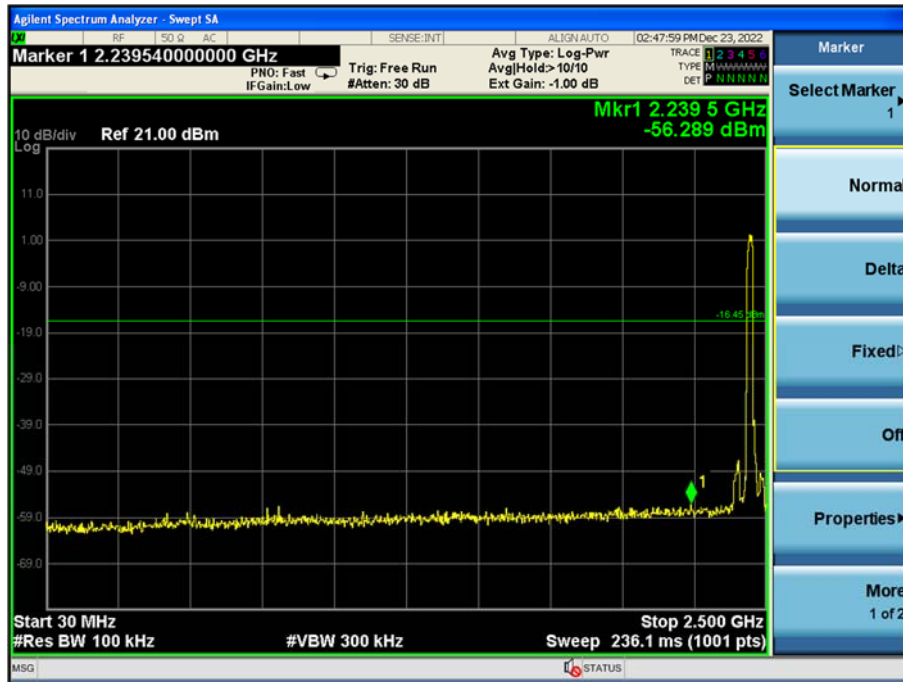
High Channel



Low Channel



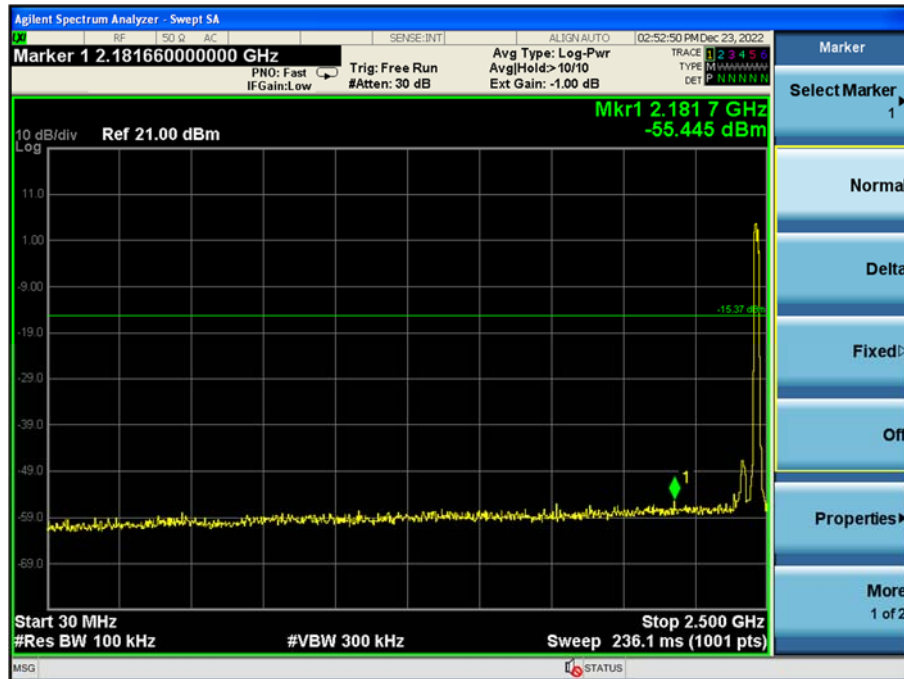
Low Channel



Middle Channel



Middle Channel



High Channel



High Channel

3.4 Radiated Emission

3.4.1 Requirement

- FCC Part15 subpart C Section 15.247

3.4.2 Test Procedure

The radiated emissions measurements were performed on the 3 m anechoic chamber. The EUT was placed on a non-conductive turntable above the ground plane. The frequency spectrum from 30 kHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

3.4.3 Test environment

- 22 °C, 43 % R.H.

3.4.4 Test results

3.4.4.1 Radiated Emission which fall in the Restricted Band

- Resolution bandwidth : 1 MHz
- Video bandwidth : 3 MHz
- Detector : Peak Mode(Peak), Average Mode(RMS)
- Measurement distance : 3 m
- Operating Condition : Highest Output Power Transmitting Mode(Low Channel and High Channel)
- Result : PASS

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Low Channel									
2382.68	44.51	Peak	H	28.20	8.80	35.30	46.21	74.00	27.79
2389.96	32.51	Average	H				34.21	54.00	19.79
2387.96	43.19	Peak	V				44.89	74.00	29.11
2336.73	32.74	Average	V				34.44	54.00	19.56
High Channel									
2490.71	45.24	Peak	H	28.30	9.20	35.30	47.44	74.00	26.56
2483.92	32.09	Average	H				34.29	54.00	19.71
2486.60	44.29	Peak	V				46.49	74.00	27.51
2483.50	32.71	Average	V				34.91	54.00	19.09

Note 1. Total = Reading + Ant.Factor + Cable Loss – Amp Gain

3.4.4.2 Spurious & Harmonic Radiated Emission

- Resolution bandwidth : 1 MHz
- Video bandwidth : 3 MHz
- Detector : Peak Mode(Peak), Average Mode(RMS)
- Measurement distance : 3 m
- Frequency range : 1 GHz ~ 26.5 GHz
- Operating Condition : Highest Output Power Transmitting Mode
- Result : PASS

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Low Channel									
4824.00	43.09	Peak	H	33.50	12.50	34.70	54.39	74.00	19.61
4824.00	32.31	Average	H				43.61	54.00	10.39
4824.00	45.38	Peak	V				56.68	74.00	17.32
4824.00	32.52	Average	V				43.82	54.00	10.18
Middle Channel									
4884.00	42.39	Peak	H	33.60	12.50	34.70	53.79	74.00	20.21
4884.00	31.22	Average	H				42.62	54.00	11.38
4884.00	42.53	Peak	V				53.93	74.00	20.07
4884.00	31.67	Average	V				43.07	54.00	10.93
High Channel									
4924.00	42.97	Peak	H	33.70	12.50	34.60	54.57	74.00	19.43
4924.00	32.41	Average	H				44.01	54.00	9.99
4924.00	42.31	Peak	V				53.91	74.00	20.09
4924.00	31.68	Average	V				43.28	54.00	10.72

Note 1. Total = Reading + Ant.Factor + Cable Loss – Amp Gain

3.4.4.3 Spurious Radiated Emission

3.4.4.3.1 Test Data for Below 30 MHz

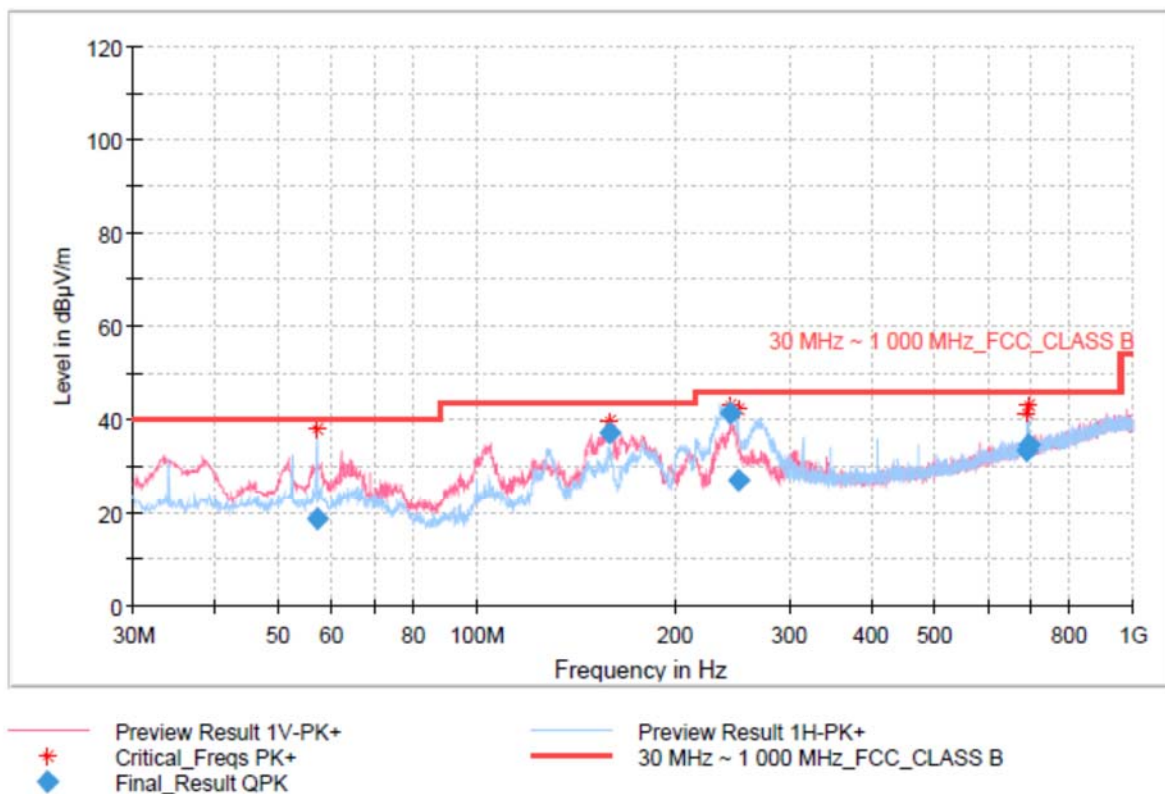
- . Detector : Quasi-Peak (6 dB Bandwidth: 200 Hz, 9 kHz)
- .Measurement distance : 3 m
- .Frequency range : 9 kHz ~ 30 MHz
- .Operating Condition : Highest Output Power Transmitting Mode
- .Result : PASS

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emissions observed were below the limit and thus not reported								

3.4.4.3.2 Test Data for 30 MHz ~ 1000 MHz

- . Detector : Quasi-Peak (6 dB Bandwidth: 120 kHz)
- .Measurement distance : 3 m
- .Frequency range : 30 MHz ~ 1000 MHz
- .Operating Condition : Highest Output Power Transmitting Mode
- .Result : PASS

RE Test Report



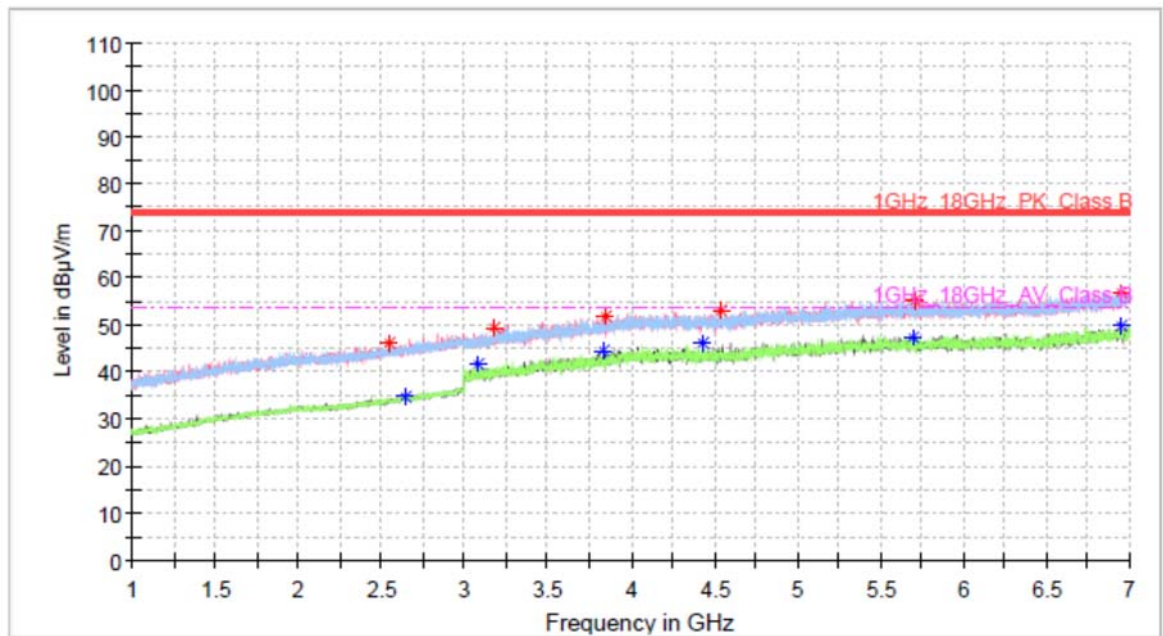
Final Result

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
57.04	18.68	40.00	21.32	15000.0	200.1	H	58.0	-11.9
159.74	37.36	43.50	6.14	15000.0	99.9	V	155.0	-9.8
244.13	41.23	46.00	4.77	15000.0	99.8	H	278.0	-9.3
251.16	27.13	46.00	18.87	15000.0	300.3	H	314.0	-9.1
690.21	33.54	46.00	12.46	15000.0	99.8	H	181.0	0.5
692.39	34.76	46.00	11.24	15000.0	99.8	H	181.0	0.5

3.4.4.3.3 Test Data for Above 1 GHz

- Detector : Peak, Average (6 dB Bandwidth: 1 MHz)
- Measurement distance : 3 m
- Frequency range : 1 GHz ~ 7 GHz
- Operating Condition : Highest Output Power Transmitting Mode
- Result : PASS
- Result : PASS
- 1 GHz ~ 7 GHz

EMI TEST Report



— Preview Result 2V-AVG
 — Preview Result 1H-PK+
 — 1GHz_18GHz_PK_Class B
 ◆ Final_Result CAV
 * Preview Result 1V-PK+ Critical_Freqs AVG
 - - - 1GHz_18GHz_AV_Class B
 * Preview Result 2H-AVG Critical_Freqs PK+
 ◆ Final_Result PK+

Final_Result

Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
5692.00	---	54.00	6.40	---	100.0	H	206.0	13.3
6955.00	56.81	74.00	17.19	---	200.0	H	0.0	15.4
2639.50	---	54.00	19.00	---	200.0	H	331.0	3.2
3086.50	---	54.00	12.25	---	200.0	H	331.0	5.6
4541.50	53.19	74.00	20.81	---	300.0	H	0.0	10.5
3832.75	---	54.00	9.45	---	300.0	H	39.0	9.4
3184.00	49.33	74.00	24.67	---	300.0	H	167.0	6.1
6954.25	---	54.00	4.07	---	400.0	H	52.0	15.4
5705.50	55.08	74.00	18.92	---	400.0	H	185.0	13.3
2540.50	46.12	74.00	27.88	---	200.0	V	62.0	2.6
3851.50	51.83	74.00	22.17	---	300.0	V	239.0	9.5
4437.25	---	54.00	7.62	---	300.0	V	261.0	10.4

- 7 GHz ~ 12.5 GHz
- Detector : Quasi-Peak (6 dB Bandwidth: 1 MHz)
- Measurement distance : 3 m
- Frequency range : 7 GHz ~ 26.5 GHz
- Operating Condition : Highest Output Power Transmitting Mode
- Result : PASS

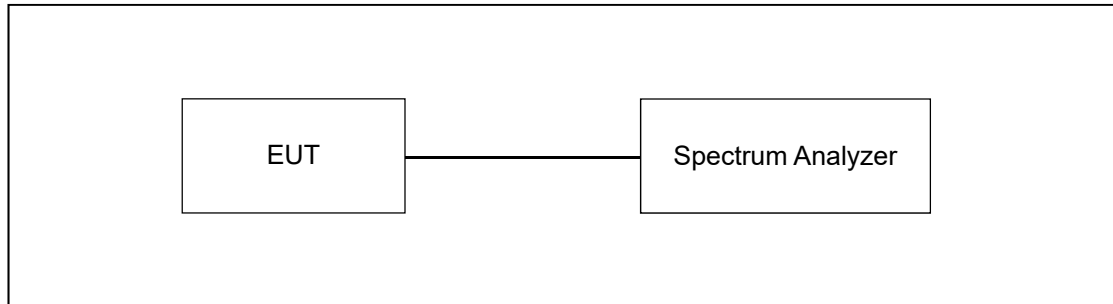
Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emissions observed were below the limit and thus not reported								

3.5 Peak Power Spectral Density

3.5.1 Requirement

- FCC Part15 subpart C Section 15.247

3.5.2 Test Procedure



The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to $3\text{ kHz} \leq \text{RBW} \leq 100\text{ kHz}$, the video bandwidth is set to 3 times the resolution bandwidth.

3.5.2 Test environment

- 22 °C, 43 % R.H.

3.5.2 Test data

- Ant 0

Frequency [MHz]		Measured Value [dBm]	Limit [dBm]	Result
Low	2412	-5.57	8.00	PASS
Middle	2442	-8.01	8.00	
High	2462	-7.63	8.00	

- Ant 1

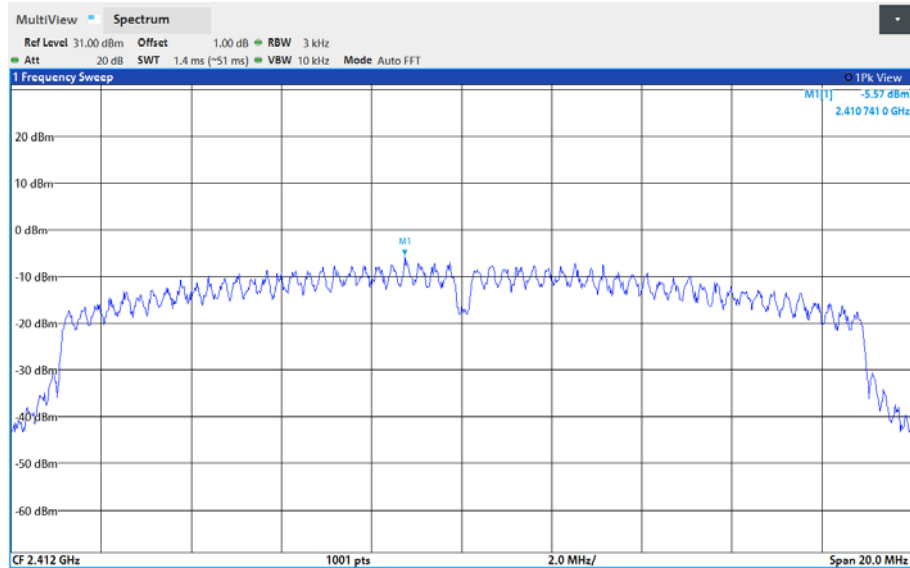
Frequency [MHz]		Measured Value [dBm]	Limit [dBm]	Result
Low	2412	-7.27	8.00	PASS
Middle	2442	-13.17	8.00	
High	2462	-10.90	8.00	

• Ant 0+1

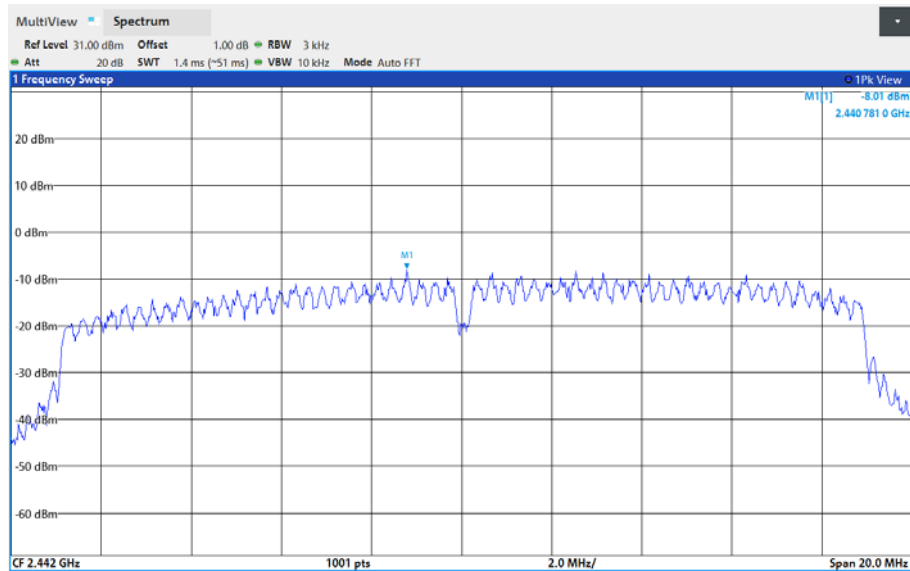
Frequency [MHz]		Measured Value [dBm]	Limit [dBm]	Result
Low	2412	-3.33	5.45	PASS
Middle	2442	-6.85	5.45	
High	2462	-5.95	5.45	

Remark 1 : Calculated Power Density = $10\log(10^{(\text{Antenna1 Power Density}/10)} + 10^{(\text{Antenna2 Power Density}/10)})$

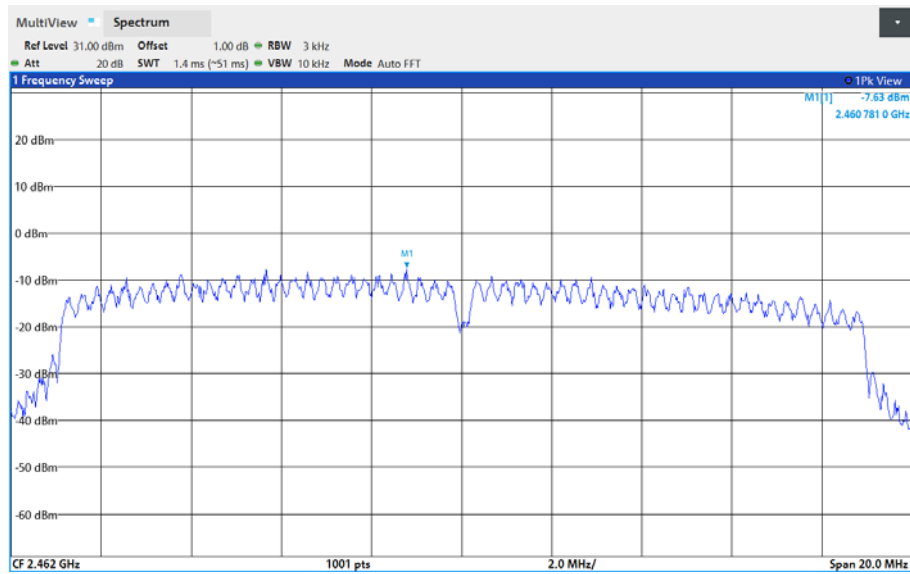
3.5.4 Test Plots



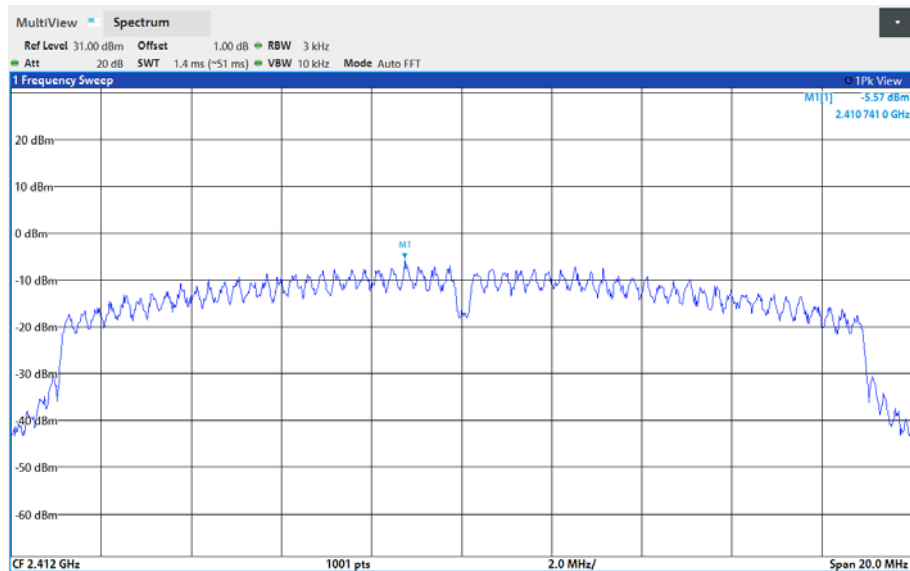
Ant 0 Low Channel



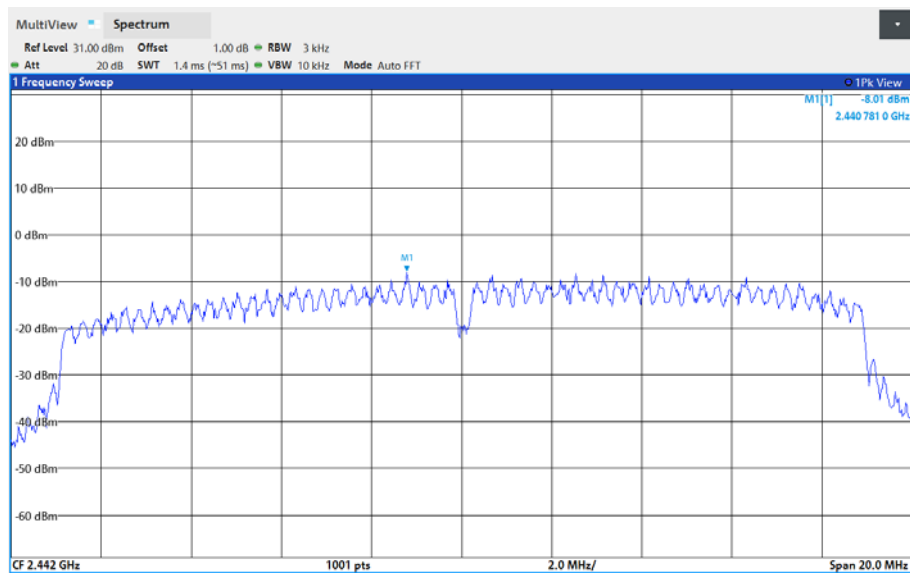
Ant 0 Middle Channel



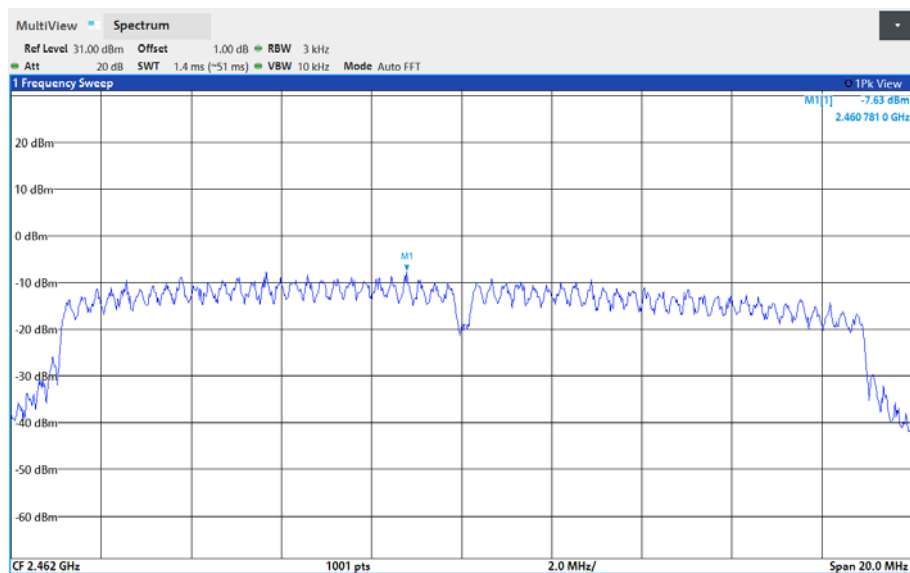
Ant 0 High Channel



Ant 1 Low Channel



Ant 1 Middle Channel



Ant 1 High Channel

3.6 Conducted Emission Test

3.6.1 Requirement

- FCC Part15 subpart C Section 15.207

3.6.2 Test Procedure

The EUT was placed on a wooden table, 0.8 m height above the floor. Power was fed to the EUT through a 50 Ω / 50 μ H + 5 Ω Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

3.6.3 Test data

- WLAN Mode
- Resolution bandwidth : 9 kHz
- Frequency range : 0.15 MHz ~ 30 MHz
- Tested Line : HOT LINE



-. Tested Line : NEUTRAL LINE

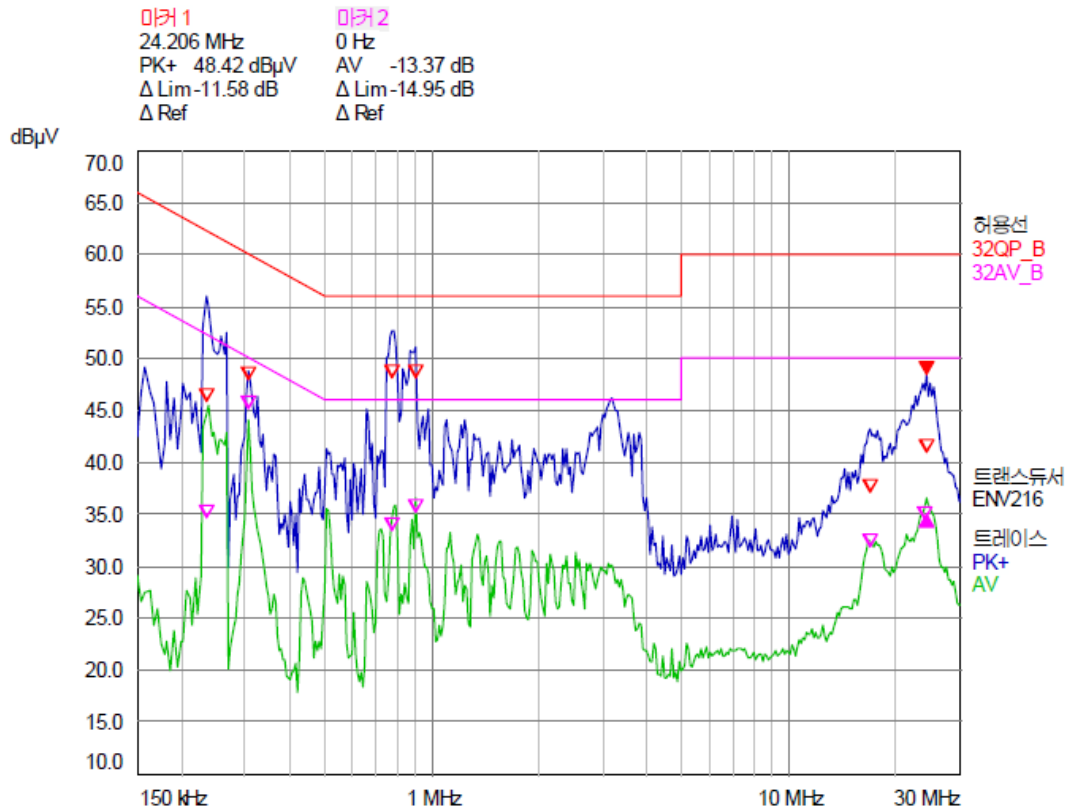


FREQ [MHz]	Corr.Fator [dB]		[H/N]	Quasi-peak [dBμV]			C-Average [dBμV]		
	LISN	cables		Measured	limit	Margin	Measured	limit	Margin
0.20	9.60	9.89	N	48.13	63.53	15.40	29.68	53.53	23.85
0.30	9.60	9.90	N	49.79	60.19	10.40	48.13	50.19	2.06
0.70	9.60	9.93	N	44.49	56.00	11.51	35.38	46.00	10.62
1.09	9.61	9.93	N	43.19	56.00	12.81	33.89	46.00	12.11
17.70	9.70	10.13	H	37.92	60.00	22.08	32.50	50.00	17.50
24.89	9.68	10.20	N	44.72	60.00	15.28	35.92	50.00	14.08

- BT Mode
- Resolution bandwidth : 9 kHz
- Frequency range : 0.15 MHz ~ 30 MHz
- Tested Line : HOT LINE



-. Tested Line : NEUTRAL LINE



FREQ [MHz]	Corr.Fator [dB]		[H/N]	Quasi-peak [dBμV]			C-Average [dBμV]		
	LISN	cables		Measured	limit	Margin	Measured	limit	Margin
0.23	9.60	9.89	N	45.91	62.31	16.40	34.66	52.31	17.65
0.31	9.60	9.90	N	47.93	60.08	12.15	45.09	50.08	4.99
0.79	9.60	9.93	H	49.70	56.00	6.30	33.86	46.00	12.14
0.90	9.60	9.93	N	48.10	56.00	7.90	35.25	46.00	10.75
16.96	9.70	10.12	N	37.05	60.00	22.95	31.82	50.00	18.18
24.21	9.68	10.19	N	41.00	60.00	19.00	34.55	50.00	15.45

3.7 Antenna Requirement

3.7.1 Requirement

- FCC Part15 subpart C 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 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.

3.7.2 Result

- The antenna of the EUT is a Dipole Antenna on the board in the EUT.

4. Test equipment list

Use	Model Number	Manufacturer	Description	Serial Number	Cal. Date.(Interval)
☒	AMP 20-1000	INFINITECH	Broardband Pre-amp	2013 05 00003	Jan 4, 2022(1Y)
☒	FSV3007	Rohde & Schwarz	Spectrum Analyzer	101334	Aug 22, 2022(1Y)
☐	66-30-33	Weinschel	Attenuator	CB0744	Dec 22, 2022(1Y)
☒	FSV30	Rohde & Schwarz	Spectrum Analyzer	101673	Jan 4, 2022(1Y)
☒	DS 2000S	Innco GmbH	Turn Table	N/A	N/A
☒	MA4000-EP-HS	Innco GmbH	Antenna Mast	N/A	N/A
☒	MA4640-XP-ET	Innco GmbH	Tilt Antenna Mast	N/A	N/A
☒	CO3000	Innco GmbH	Controller	N/A	N/A
☒	CO3000	Innco GmbH	Controller	N/A	N/A
☒	N9020A	Agilent	Spectrum Analyzer	MY50200260	Jan 10, 2022(1Y)
☒	6502	EMCO	Loop Antenna	9609-3087	Nov 11, 2021(2Y)
☒	VULB 9168	SCHWARZBECK	Bi-Log Antenna	180	Nov 16, 2022(2Y)
☒	8449B	Agilent	Preamplifier	3008A02013	Jan 7, 2022(1Y)
☒	3115	EMCO	Horn Antenna	9402-4229	Aug 3, 2022(2Y)
☒	ESCI7	Rohde & Schwarz	EMI Test Receiver	100938	Jan 4, 2022(1Y)
☒	ESH-Z2	Rohde & Schwarz	Pulse Limter	101631	Jan 4, 2022(1Y)
☒	ENV216	Rohde & Schwarz	LISN	101264	July 4, 2022(1Y)
☒	ES-SCAN	Rohde & Schwarz	EMI Software	N/A	N/A
☒	EMC32	Rohde & Schwarz	EMI Software	N/A	N/A
☒	SAS-574	A.H.Systems	Horn Antenna	595	Sep 7, 2021(2Y)
☒	PAM-840A	Com-power	Preamplifier	461334	Jan 7, 2022(1Y)