FCC TEST REPORT

FCC ID: 2BFMF-AC603H-WIFI

Report No.	:	SSP24030148-1E
Applicant	:	Ecostar Energy Solutions & Restoration Inc.
Product Name	:	Thermostat
Model Name	:	AC603H-WIFI
Test Standard	:	FCC Part 15.247
Date of Issue	:	2024-04-02

Shenzhen CCUT Quality Technology Co., Ltd.
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This test report is limited to the above client company and the product model only. It may not be duplicated without prior permitted by Shenzhen CCUT Quality Technology Co., Ltd.

Test Report Basic Information

Applicant.....:	Ecostar Energy Solutions & Restoration Inc.
Address of Applicant.....:	8520 NW 44th court Lauderhill Florida United States 33351
Manufacturer.....:	Hubei Telin energy-saving equipment Co., Ltd
Address of Manufacturer.....:	No.1 Lingcheng Industrial Park, Lingxiang Town, Daye, Huangshi City, Hubei Province, China
Product Name.....:	Thermostat
Brand Name.....:	Telin
Main Model.....:	AC603H-WIFI
Series Models.....:	See section 1.1 (Page 5)
Test Standard.....:	FCC Part 15 Subpart C ANSI C63.4-2014 ANSI C63.10-2013
Date of Test .....:	2024-03-20 to 2024-04-02
Test Result.....:	PASS
Tested By .....:	Colin Chen (Colin Chen)
Reviewed By.....:	Lieber Ouyang (Lieber Ouyang)
Authorized Signatory.....:	Lahm Peng (Lahm Peng)

Shenzhen CCUT Quality Technology Co., Ltd. APPROVED

Note : This test report is limited to the above client company and the product model only. It may not be duplicated without prior permitted by Shenzhen CCUT Quality Technology Co., Ltd.. All test data presented in this test report is only applicable to presented test sample.

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Revision History

Revision	Issue Date	Description	Revised By
V1.0	2024-04-02	Initial Release	Lahm Peng

1. General Information

1.1 Product Information

Product Name:	Thermostat
Trade Name:	Telin
Main Model:	AC603H-WIFI
Series Models:	AC605H-WIFI, AC829H-WIFI, AC8300H-WIFI, AC8400H-WIFI, AC8500H-WIFI
Rated Voltage:	AC 120V/60Hz
Battery:	-
Power Adaptor:	-
Hardware Version:	V1.0
Software Version:	V1.0
Note 1: The test data is gathered from a production sample, provided by the manufacturer. Note 2: The color of appearance and model name of series models listed are different from the main model, but the circuit and the electronic construction are the same, declared by the manufacturer.	

Wireless Specification	
Wireless Standard:	802.11b/g/n
Operating Frequency:	2412MHz ~ 2462MHz for 802.11b/g/n(HT20) 2422MHz ~ 2452MHz for 802.11n(HT40)
RF Output Power:	18.52dBm
Number of Channel:	11/7
Channel Separation:	5MHz
Modulation:	CCK, OFDM, QPSK, BPSK, 16QAM, 64QAM
Antenna Gain:	0dBi
Type of Antenna:	PCB Antenna
Type of Device:	☐ Portable Device ☒ Mobile Device ☐ Modular Device

1.2 Test Setup Information

List of Test Modes		
Test Mode	Description	Remark
TM1	802.11b	2412MHz/2437MHz/2462MHz
TM2	802.11g	2412MHz/2437MHz/2462MHz
TM3	802.11n(H20)	2412MHz/2437MHz/2462MHz
TM4	802.11n(H40)	2422MHz/2437MHz/2452MHz

List and Details of Auxiliary Cable			
Description	Length (cm)	Shielded/Unshielded	With/Without Ferrite
-	-	-	-
-	-	-	-

List and Details of Auxiliary Equipment			
Description	Manufacturer	Model	Serial Number
-	-	-	-
-	-	-	-

List of Channels							
No. of Channel	Frequency (MHz)	No. of Channel	Frequency (MHz)	No. of Channel	Frequency (MHz)	No. of Channel	Frequency (MHz)
01	2412	05	2432	09	2452	13	--
02	2417	06	2437	10	2457	14	--
03	2422	07	2442	11	2462	15	--
04	2427	08	2447	12	--	16	--

1.3 Compliance Standards

Compliance Standards	
FCC Part 15 Subpart C	FEDERAL COMMUNICATIONS COMMISSION, RADIO FREQUENCY DEVICES, Intentional Radiators
All measurements contained in this report were conducted with all above standards	
According to standards for test methodology	
FCC Part 15 Subpart C	FEDERAL COMMUNICATIONS COMMISSION, RADIO FREQUENCY DEVICES, Intentional Radiators
ANSI C63.4-2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.
ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Maintenance of compliance is the responsibility of the manufacturer or applicant. Any modification of the product, which result is lowering the emission, should be checked to ensure compliance has been maintained.	

1.4 Test Facilities

Laboratory Name:	**Shenzhen CCUT Quality Technology Co., Ltd.** 1F, Building 35, Changxing Technology Industrial Park, Yutang Street, Guangming District, Shenzhen, Guangdong, China
CNAS Laboratory No.:	L18863
A2LA Certificate No.:	6893.01
FCC Registration No:	583813
ISED Registration No.:	CN0164
All measurement facilities used to collect the measurement data are located at 1F, Building 35, Changxing Technology Industrial Park, Yutang Street, Guangming District, Shenzhen, Guangdong, China.	

1.5 List of Measurement Instruments

Description	Manufacturer	Model	Serial Number	Cal. Date	Due. Date
Conducted Emissions					
AMN	ROHDE&SCHWARZ	ENV216	101097	2023-10-21	2024-10-20
EMI Test Receiver	ROHDE&SCHWARZ	ESPI	100242	2023-07-31	2024-07-30
Radiated Emissions					
EMI Test Receiver	ROHDE&SCHWARZ	ESPI	100154	2023-07-31	2024-07-30
Spectrum Analyzer	KEYSIGHT	N9020A	MY48030972	2023-07-31	2024-07-30
Spectrum Analyzer	ROHDE&SCHWARZ	FSV40-N	101692	2023-07-31	2024-07-30
Amplifier	SCHWARZBECK	BBV 9743B	00251	2023-07-31	2024-07-30
Amplifier	HUABO	YXL0518-2.5-45	--	2023-07-31	2024-07-30
Amplifier	COM-MW	DLAN-18G-4G-02	10229104	2023-07-31	2024-07-30
Loop Antenna	DAZE	ZN30900C	21104	2023-08-07	2024-08-06
Broadband Antenna	SCHWARZBECK	VULB 9168	01320	2023-08-07	2024-08-06
Horn Antenna	SCHWARZBECK	BBHA 9120D	02553	2023-08-07	2024-08-06
Horn Antenna	COM-MW	ZLB7-18-40G-950	12221225	2023-08-07	2024-08-06
Conducted RF Testing					
RF Test System	MWRFTest	MW100-RFCB	220418SQS-37	2023-07-31	2024-07-30
Spectrum Analyzer	KEYSIGHT	N9020A	ATO-90521	2023-07-31	2024-07-30

1.6 Measurement Uncertainty

Test Item	Conditions	Uncertainty
Conducted Emissions	9kHz ~ 30MHz	±1.64 dB
Radiated Emissions	9kHz ~ 30MHz	±2.88 dB
	30MHz ~ 1GHz	±3.32 dB
	1GHz ~ 18GHz	±3.50 dB
	18GHz ~ 40GHz	±3.66 dB
Conducted Output Power	9kHz ~ 26GHz	±0.50 dB
Occupied Bandwidth	9kHz ~ 26GHz	±4.0 %
Conducted Spurious Emission	9kHz ~ 26GHz	±1.32 dB
Power Spectrum Density	9kHz ~ 26GHz	±0.62 dB

2. Summary of Test Results

FCC Rule	Description of Test Item	Result
FCC Part 15.203	Antenna Requirement	Passed
FCC Part 15.247(i)	RF Exposure(see the RF exposure report)	Passed
FCC Part 15.207	Conducted Emissions	Passed
FCC Part 15.209, 15.247(d)	Radiated Emissions	Passed
FCC Part 15.247(d)	Band-edge Emissions(Radiated)	Passed
FCC Part 15.247(b)(3)	Maximum Conducted Output Power	Passed
FCC Part 15.247(a)(2)	Occupied Bandwidth(-6dB)	Passed
FCC Part 15.247(e)	Maximum Power Spectral Density	Passed
FCC Part 15.247(d)	Band-edge Emissions(Conducted)	Passed
FCC Part 15.247(d)	Conducted RF Spurious Emissions	Passed
Passed: The EUT complies with the essential requirements in the standard Failed: The EUT does not comply with the essential requirements in the standard N/A: Not applicable		

3. Antenna Requirement

3.1 Standard and Limit

According to FCC 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.

3.2 Test Result

This product has an PCB antenna, fulfill the requirement of this section.

4. Conducted Emissions

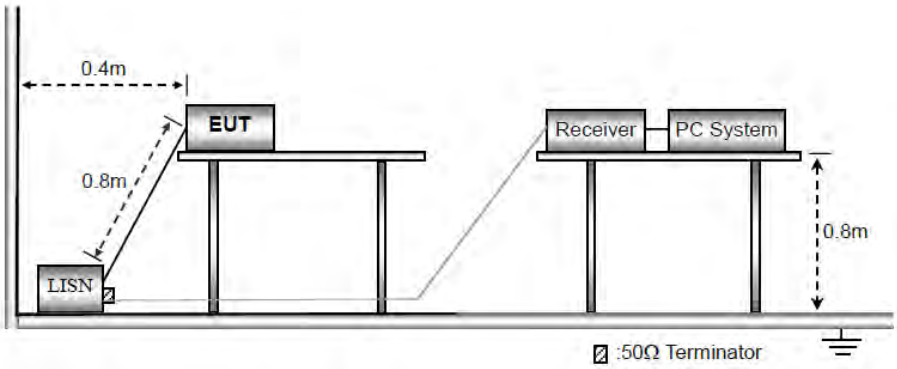
4.1 Standard and Limit

According to the rule FCC Part 15.207, Conducted emissions limit, the limit for a wireless device as below:

Frequency of Emission (MHz)	Conducted emissions (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50
Note 1: Decreases with the logarithm of the frequency in the range 0.15 MHz to 0.5 MHz Note 2: The lower limit applies at the band edges		

4.2 Test Procedure

Test is conducting under the description of ANSI C63.10 - 2013 section 6.2.



Test Setup Block Diagram

a) The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.

b) The following is the setting of the receiver
Attenuation: 10dB
Start Frequency: 0.15MHz
Stop Frequency: 30MHz
IF Bandwidth: 9kHz

c) The EUT was placed 0.8 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipment powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.

d) Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
e) I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.

f) LISN is at least 80 cm from nearest part of EUT chassis.

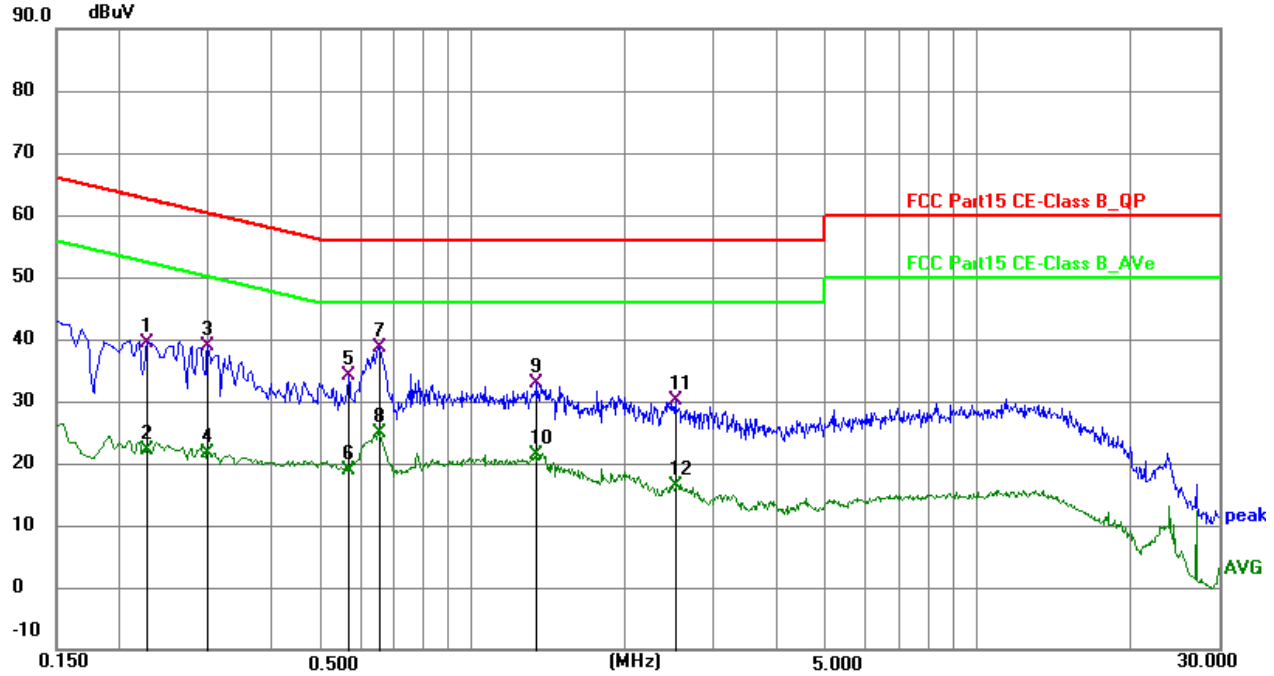
g) For the actual test configuration, please refer to the related Item - photographs of the test setup.

4.3 Test Data and Results

All of the 802.11b, 802.11g and 802.11n modes have been tested, the EUT complied with the FCC Part 15.247 standard limit for a wireless device, and with the worst case 802.11b_2412MHz as below:

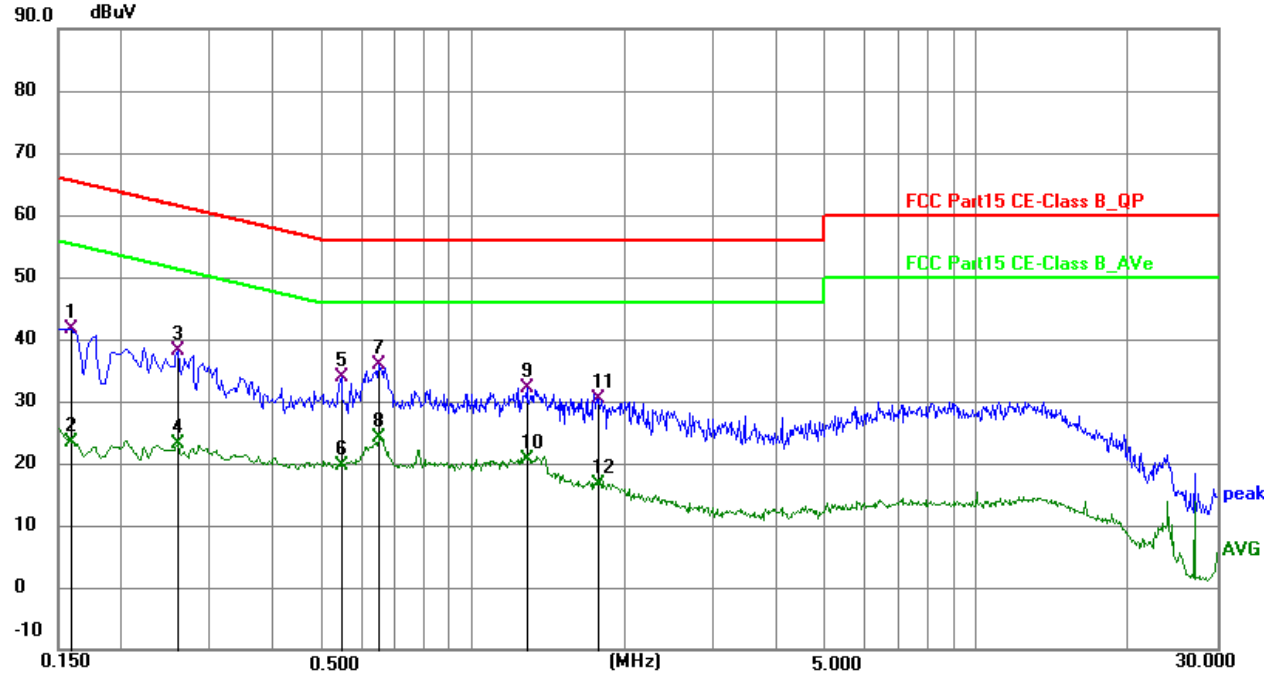
Remark: Level = Reading + Factor, Margin = Level - Limit

Test Plots and Data of Conducted Emissions	
Tested Mode:	TM4
Test Voltage:	AC 120V/60Hz
Test Power Line:	Neutral
Remark:	



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.2265	29.78	9.63	39.41	62.58	-23.17	QP	P	
2	0.2265	12.52	9.63	22.15	52.58	-30.43	AVG	P	
3	0.2985	29.15	9.69	38.84	60.28	-21.44	QP	P	
4	0.2985	12.06	9.69	21.75	50.28	-28.53	AVG	P	
5	0.5685	24.24	9.78	34.02	56.00	-21.98	QP	P	
6	0.5685	9.18	9.78	18.96	46.00	-27.04	AVG	P	
7 *	0.6540	29.06	9.66	38.72	56.00	-17.28	QP	P	
8	0.6540	15.20	9.66	24.86	46.00	-21.14	AVG	P	
9	1.3380	22.96	10.02	32.98	56.00	-23.02	QP	P	
10	1.3380	11.43	10.02	21.45	46.00	-24.55	AVG	P	
11	2.5215	20.06	10.08	30.14	56.00	-25.86	QP	P	
12	2.5215	6.31	10.08	16.39	46.00	-29.61	AVG	P	

Test Plots and Data of Conducted Emissions	
Tested Mode:	TM4
Test Voltage:	AC 120V/60Hz
Test Power Line:	Live
Remark:	



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB)	Level (dBuV)	Limit (dBuV)	Margin (dB)	Detector	P/F	Remark
1	0.1590	32.43	9.17	41.60	65.52	-23.92	QP	P	
2	0.1590	14.33	9.17	23.50	55.52	-32.02	AVG	P	
3	0.2580	28.50	9.57	38.07	61.50	-23.43	QP	P	
4	0.2580	13.48	9.57	23.05	51.50	-28.45	AVG	P	
5	0.5460	23.88	9.94	33.82	56.00	-22.18	QP	P	
6	0.5460	9.62	9.94	19.56	46.00	-26.44	AVG	P	
7 *	0.6495	25.96	9.90	35.86	56.00	-20.14	QP	P	
8	0.6495	14.16	9.90	24.06	46.00	-21.94	AVG	P	
9	1.2795	22.14	10.03	32.17	56.00	-23.83	QP	P	
10	1.2795	10.72	10.03	20.75	46.00	-25.25	AVG	P	
11	1.7745	20.34	10.05	30.39	56.00	-25.61	QP	P	
12	1.7745	6.48	10.05	16.53	46.00	-29.47	AVG	P	

5. Radiated Emissions

5.1 Standard and Limit

According to §15.247(d), In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, 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 the rule FCC Part 15.209, Radiated emission limit for a wireless device as below:

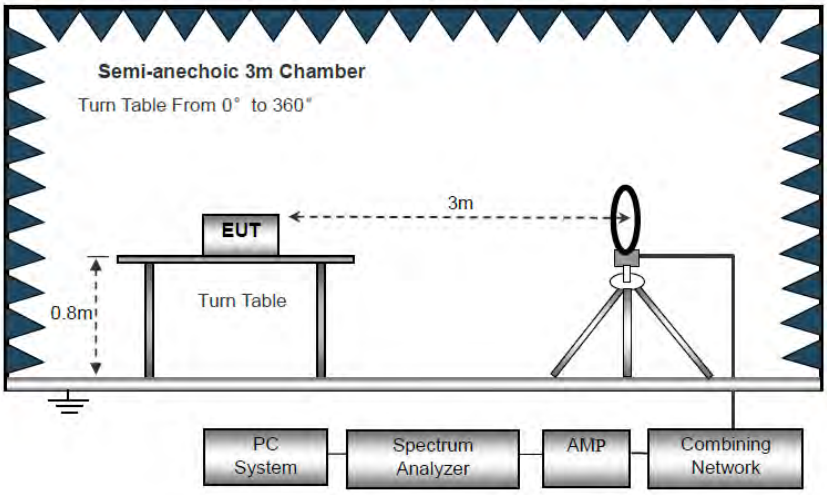
Frequency of Emission (MHz)	Field Strength (micorvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(kHz)	300
0.490~1.705	24000/F(kHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3
Note: The more stringent limit applies at transition frequencies.		

The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply. Spurious Radiated Emissions measurements starting below or at the lowest crystal frequency.

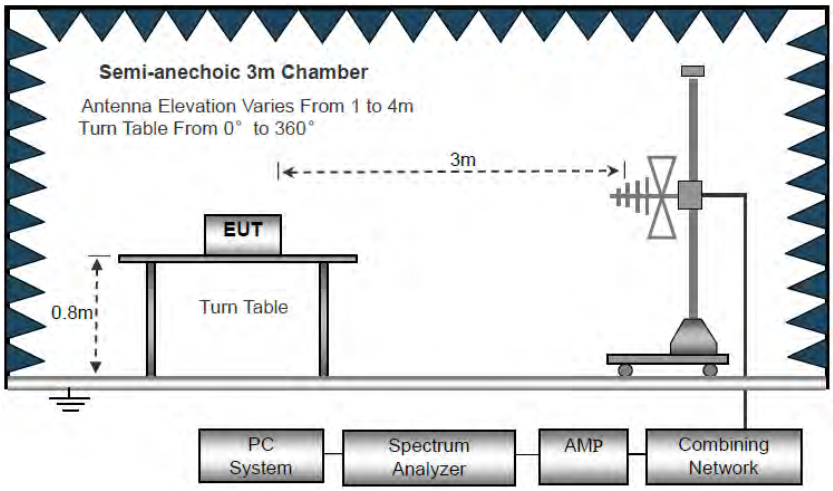
Note: Spurious Radiated Emissions measurements starting below or at the lowest crystal frequency.

5.2 Test Procedure

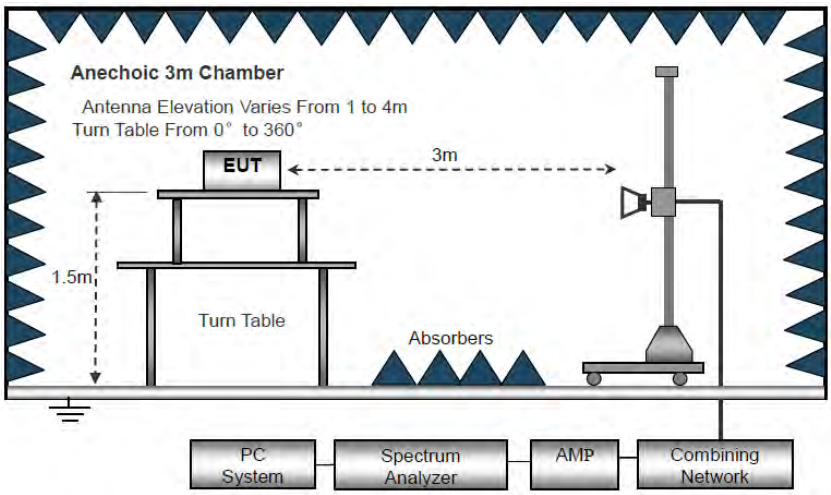
Test is conducting under the description of ANSI C63.10 - 2013 section 6.3 to 6.6.



Block Diagram of Radiated Emission Below 30MHz



Block Diagram of Radiated Emission From 30MHz to 1GHz



Block Diagram of Radiated Emission Above 1GHz

a) The EUT is placed on a turntable, which is 0.8m above ground plane for test frequency range blew 1GHz, and 1.5m above ground plane for test frequency range above 1GHz.

b) EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.

c) Use the following spectrum analyzer settings:
Span = wide enough to fully capture the emission being measured
RBW = 1 MHz for f ≥ 1GHz, 100 kHz for f < 1 GHz, 10kHz for f < 30MHz
VBW ≥ RBW, Sweep = auto
Detector function = peak
Trace = max hold

d) Follow the guidelines in ANSI C63.4-2014 with respect to maximizing the emission by rotating the EUT, adjusting the measurement antenna height and polarization, etc. The peak reading of the emission, after being corrected by the antenna factor, cable loss, pre-amp gain, etc., is the peak field strength, submit this data. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.

e) The peak level, once corrected, must comply with the limit specified in Section 15.209. Set the RBW = 1MHz, VBW = 10Hz, Detector = PK for AV value, while maintaining all of the other instrument settings.

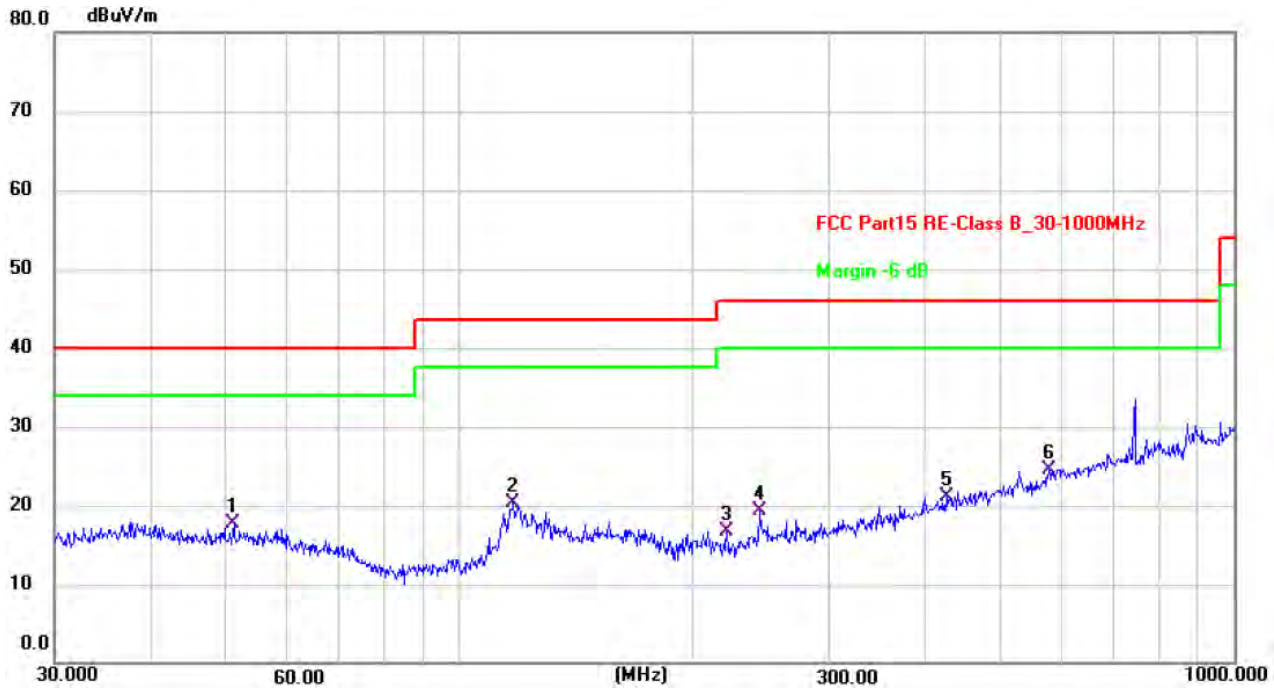
f) For the actual test configuration, please refer to the related item - EUT test photos.

5.3 Test Data and Results

All of the 802.11b, 802.11g and 802.11n modes have been tested, the EUT complied with the FCC Part 15.247 standard limit for a wireless device, and with the worst case 802.11b_2412MHz as below:

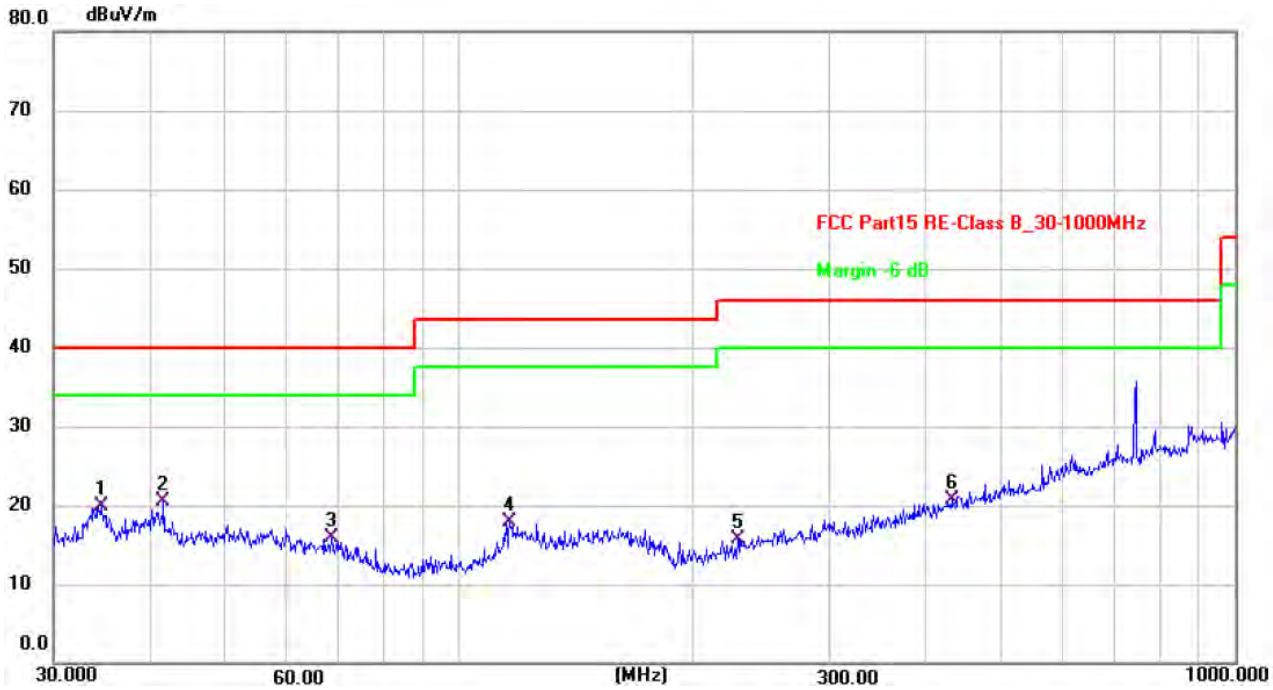
Remark: Level = Reading + Factor, Margin = Level - Limit

Radiated Emission Test Data (30MHz to 1GHz)	
Tested Mode:	TM1
Test Antenna Polarization:	Horizontal
Remark:	



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg.)	P/F	Remark
1	51.1209	26.53	-8.81	17.72	40.00	-22.28	QP	100	164	P	
2	117.3603	31.21	-10.92	20.29	43.50	-23.21	QP	100	11	P	
3	221.3921	27.87	-11.17	16.70	46.00	-29.30	QP	100	359	P	
4	244.2321	29.22	-9.86	19.36	46.00	-26.64	QP	100	41	P	
5	425.0280	26.68	-5.61	21.07	46.00	-24.93	QP	100	276	P	
6 *	576.6443	26.32	-1.91	24.41	46.00	-21.59	QP	100	318	P	

Radiated Emission Test Data (30MHz to 1GHz)	
Tested Mode:	TM1
Test Antenna Polarization:	Vertical
Remark:	



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg.)	P/F	Remark
1	34.5173	28.61	-8.75	19.86	40.00	-20.14	QP	100	296	P	
2 *	41.5670	28.85	-8.38	20.47	40.00	-19.53	QP	100	5	P	
3	68.3908	26.61	-10.75	15.86	40.00	-24.14	QP	100	266	P	
4	116.1321	29.00	-11.06	17.94	43.50	-25.56	QP	100	173	P	
5	228.4904	26.47	-10.68	15.79	46.00	-30.21	QP	100	348	P	
6	431.0316	26.18	-5.44	20.74	46.00	-25.26	QP	100	0	P	

Radiated Emission Test Data (Above 1GHz)							
Frequency	Reading	Correct	Result	Limit	Margin	Polar	Detector
MHz	dBuV/m	dB/m	dBuV/m	dBuV/m	dB	H/V	PK/AV
802.11b Lowest Channel (2412MHz)							
4824	79.08	-14.72	64.36	74	-9.64	H	PK
4824	59.76	-14.72	45.04	54	-8.96	H	AV
7236	65.14	-8.41	56.73	74	-17.27	H	PK
7236	46.84	-8.41	38.43	54	-15.57	H	AV
4824	76.38	-14.72	61.66	74	-12.34	V	PK
4824	57.73	-14.72	43.01	54	-10.99	V	AV
7236	65.28	-8.41	56.87	74	-17.13	V	PK
7236	45.93	-8.41	37.52	54	-16.48	V	AV
802.11b Middle Channel (2437MHz)							
4874	76.32	-14.64	61.68	74	-12.32	H	PK
4874	59.72	-14.64	45.08	54	-8.92	H	AV
7311	65.29	-8.28	57.01	74	-16.99	H	PK
7311	48.04	-8.28	39.76	54	-14.24	H	AV
4874	77	-14.64	62.36	74	-11.64	V	PK
4874	58.88	-14.64	44.24	54	-9.76	V	AV
7311	63.81	-8.28	55.53	74	-18.47	V	PK
7311	49.56	-8.28	41.28	54	-12.72	V	AV
802.11b Highest Channel (2462MHz)							
4924	75.88	-14.53	61.35	74	-12.65	H	PK
4924	62.22	-14.53	47.69	54	-6.31	H	AV
7386	65.12	-8.13	56.99	74	-17.01	H	PK
7386	50.1	-8.13	41.97	54	-12.03	H	AV
4924	78.45	-14.53	63.92	74	-10.08	V	PK
4924	57.94	-14.53	43.41	54	-10.59	V	AV
7386	64.29	-8.13	56.16	74	-17.84	V	PK
7386	48.37	-8.13	40.24	54	-13.76	V	AV

Note 1: this EUT was tested in 3 orthogonal positions and the worst case position data was reported.

Note 2: Testing is carried out with frequency rang 9kHz to the tenth harmonics. The measurements greater than 20dB below the limit from 9kHz to 30MHz.

Other emissions are attenuated 20dB below the limits from 9kHz to 30MHz, so it does not recorded in report.

18GHz-26GHz not recorded for no spurious point have a margin of less than 6 dB with respect to the limits.

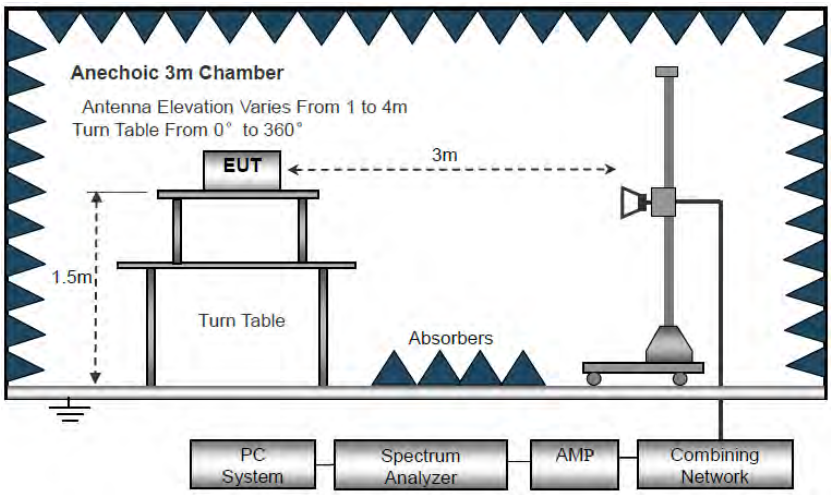
6. Band-edge Emissions(Radiated)

6.1 Standard and Limit

According to §15.247(d), In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, 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)).

6.2 Test Procedure

Test is conducting under the description of ANSI C63.10 - 2013 section 6.3 to 6.6 and section 6.10.



Test Setup Block Diagram

As the radiated emissions testing, set the Lowest and Highest Transmitting Channel, observed the outside band of 2310MHz to 2400MHz and 2483.5MHz to 2500MHz, than mark the higher-level emission for comparing with the FCC rules.

6.3 Test Data and Results

Based on all tested data, the EUT complied with the FCC Part 15.247 standard limit, and with the worst case as below:

Test Mode	Frequency	Limit	Result
	MHz	dBuV/dBc	
Lowest	2310.00	<54 dBuV	Pass
	2390.00	<54 dBuV	Pass
Highest	2483.50	<54 dBuV	Pass
	2500.00	<54 dBuV	Pass

Radiated Emission Test Data (Band edge emissions)							
Frequency	Reading	Correct	Result	Limit	Margin	Polar	Detector
MHz	dBuV/m	dB/m	dBuV/m	dBuV/m	dB	H/V	PK/AV
802.11b Lowest Channel (2412MHz)							
2310	64.36	-21.34	43.02	74	-30.98	H	PK
2310	52.44	-21.34	31.1	54	-22.9	H	AV
2390	67.41	-20.96	46.45	74	-27.55	H	PK
2390	51.72	-20.96	30.76	54	-23.24	H	AV
2400	69.48	-20.91	48.57	74	-25.43	H	PK
2400	54.43	-20.91	33.52	54	-20.48	H	AV
2310	64.3	-21.34	42.96	74	-31.04	V	PK
2310	52.44	-21.34	31.1	54	-22.9	V	AV
2390	66.98	-20.96	46.02	74	-27.98	V	PK
2390	50.28	-20.96	29.32	54	-24.68	V	AV
2400	74.42	-20.91	53.51	74	-20.49	V	PK
2400	52.51	-20.91	31.6	54	-22.4	V	AV
802.11b Highest Channel (2462MHz)							
2483.50	64.27	-20.51	43.76	74	-30.24	H	PK
2483.50	52.73	-20.51	32.22	54	-21.78	H	AV
2500	64.64	-20.43	44.21	74	-29.79	H	PK
2500	50.91	-20.43	30.48	54	-23.52	H	AV
2483.50	65.35	-20.51	44.84	74	-29.16	V	PK
2483.50	51.69	-20.51	31.18	54	-22.82	V	AV
2500	68.29	-20.43	47.86	74	-26.14	V	PK
2500	49.45	-20.43	29.02	54	-24.98	V	AV

Remark: Level = Reading + Factor, Margin = Level - Limit

7. Maximum Conducted Output Power

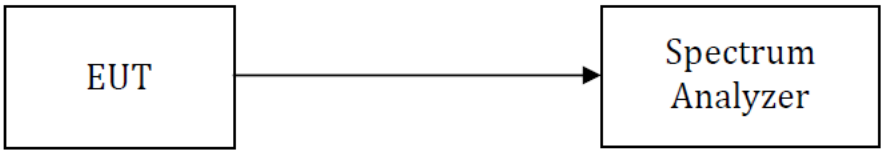
7.1 Standard and Limit

According to 15.247(b)(3). For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

7.2 Test Procedure

A spectrum analyzer or similar device shall be used to observe a sample of the modulated transmitter's radio frequency power output.

1) A measurement instrument with an integrated channel bandwidth function may be used to automate the test process.
2) Set center of frequency = operating frequency.
3) Connect the EUT to the RF input of the spectrum analyzer via a low loss RF cable
4) Set the RBW = 1MHz, VBW = 3MHz, Detector = Average, Sweep = Auto.
5) Set the SPAN to 40MHz/80MHz for 20MHz/40MHz emission bandwidth mode.
6) Measure the highest amplitude appearing on spectral display and mark the value.
7) Repeat the above procedures until all frequency measured was complete.

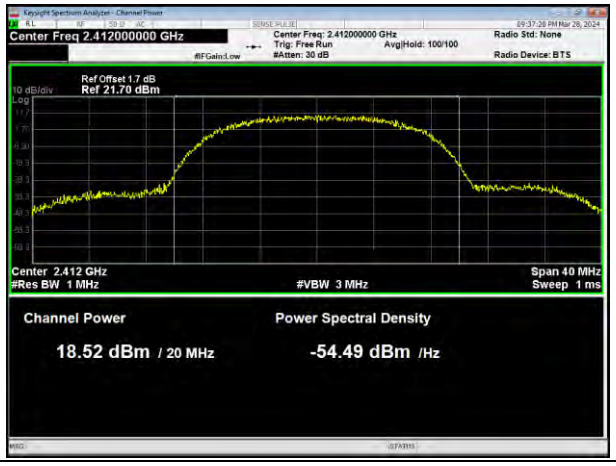
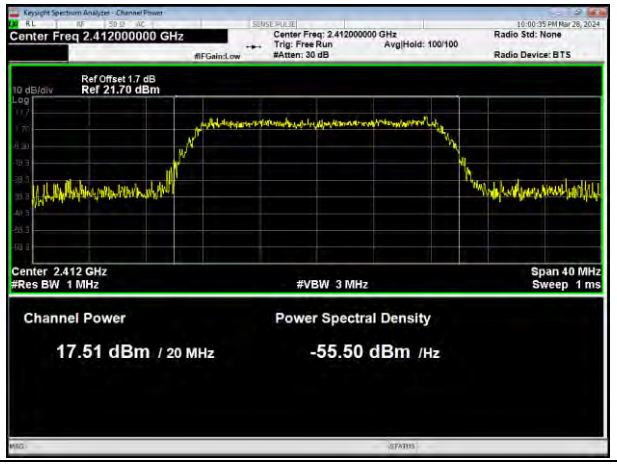
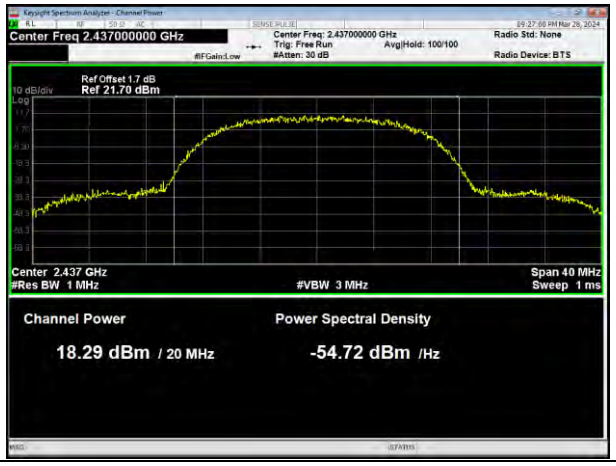
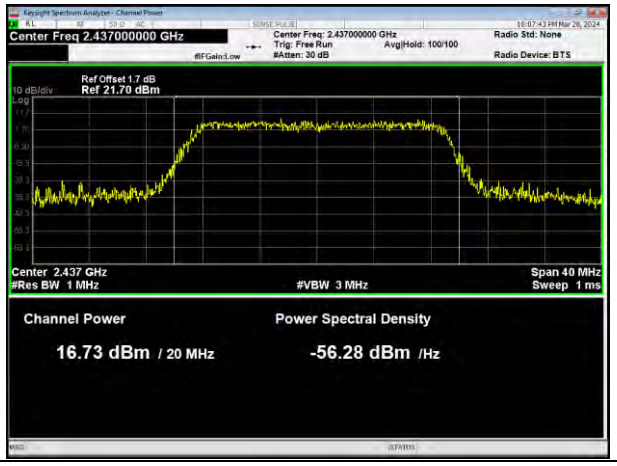
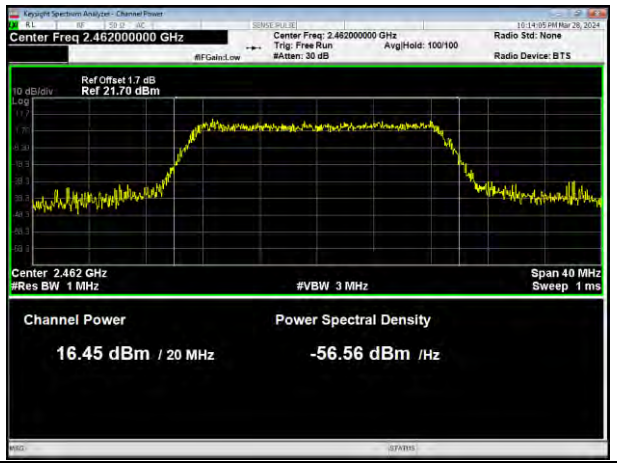


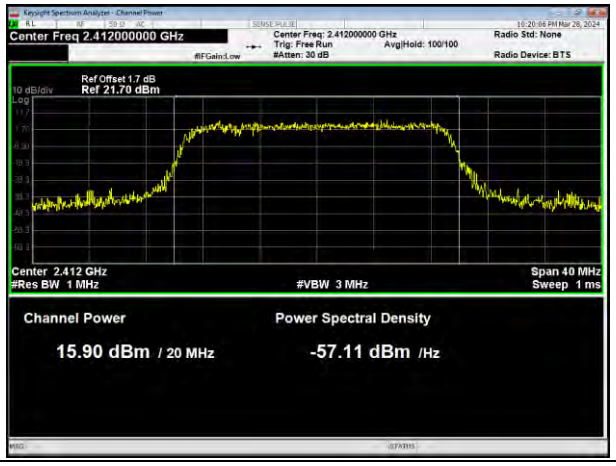
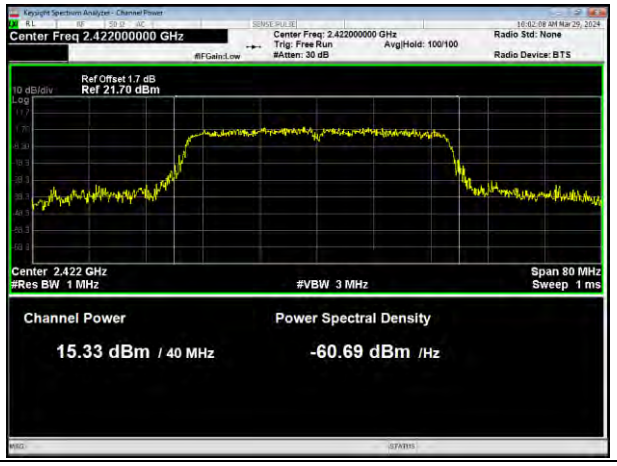
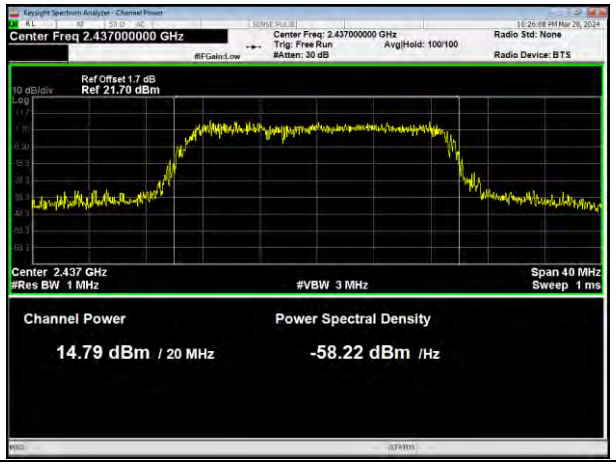
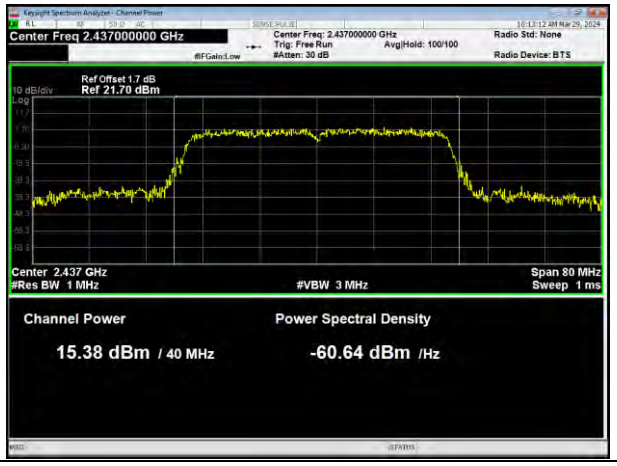
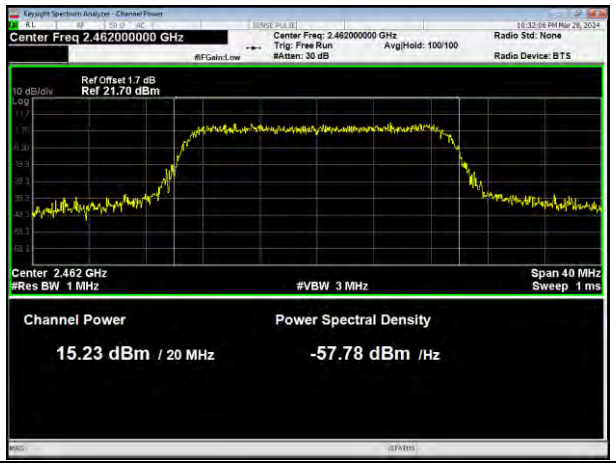
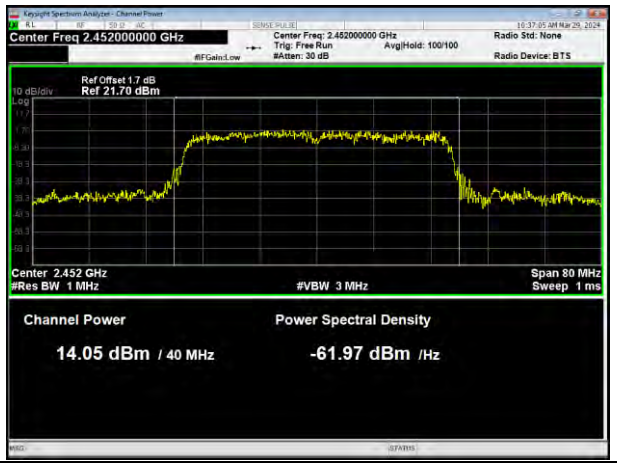
Test Setup Block Diagram

7.3 Test Data and Results

Test Mode	Test Channel MHz	Conducted Output Power (dBm)	Limit (dBm)	Test Result
802.11b	2412	18.52	30	Pass
	2437	18.29	30	Pass
	2462	17.45	30	Pass
802.11g	2412	17.51	30	Pass
	2437	16.73	30	Pass
	2462	16.45	30	Pass
802.11n(HT20)	2412	15.9	30	Pass
	2437	14.79	30	Pass
	2462	15.23	30	Pass
802.11n(HT40)	2422	15.33	30	Pass
	2437	15.38	30	Pass
	2452	14.05	30	Pass

Note: The tests are based on the EUT's wireless data transmission under 100% duty cycle.

802.11b	802.11g
2412MHz	2412MHz
	
2437MHz	2437MHz
	
2462MHz	2462MHz
	

802.11n(HT20)	802.11n(HT40)
2412MHz  	2422MHz 
2437MHz  	2437MHz 
2462MHz  	2452MHz 

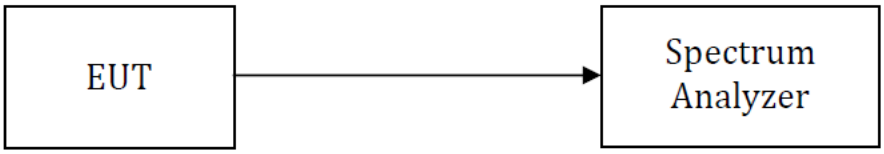
8. Occupied Bandwidth(-6dB)

8.1 Standard and Limit

According to 15.247(a)(2), Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

8.2 Test Procedure

According to the ANSI 63.10-2013, section 6.9, the emission bandwidth test method as follows.
1) Remove the antenna from the EUT and connect to the spectrum analyzer via a low loss RF cable.
2) Set the spectrum analyzer to any one measured frequency within its operating range.
3) Set RBW = 100kHz, VBW = 300kHz, Sweep = Auto.
4) Set a reference level on the measuring instrument equal to the highest peak value.
5) Measure the frequency difference of two frequencies that were attenuated 6dB from the reference level. Record the frequency difference as the emission bandwidth.
6) Repeat the above procedures until all frequencies measured were complete.

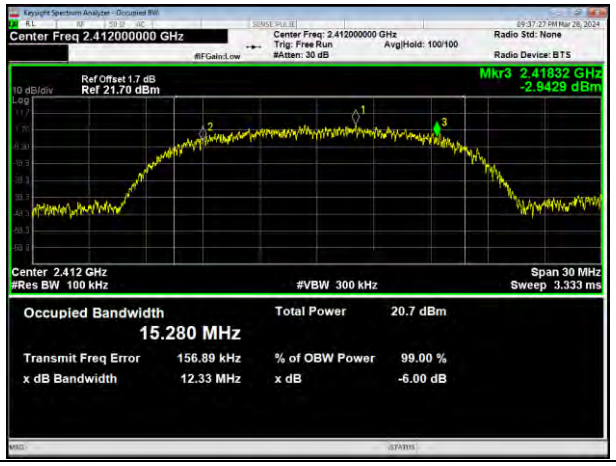
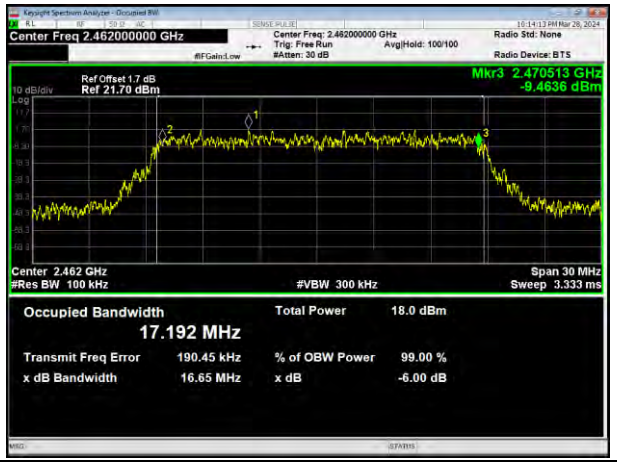


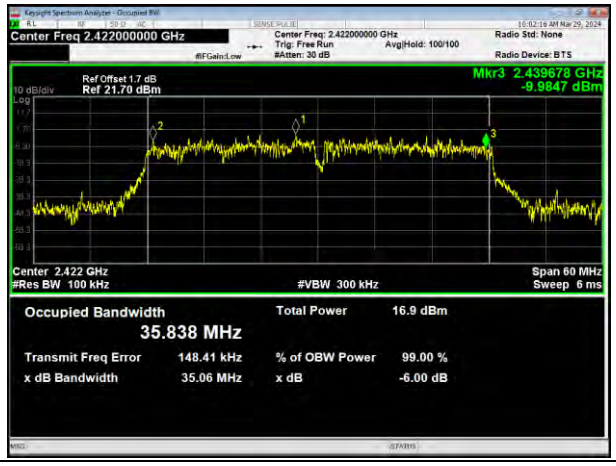
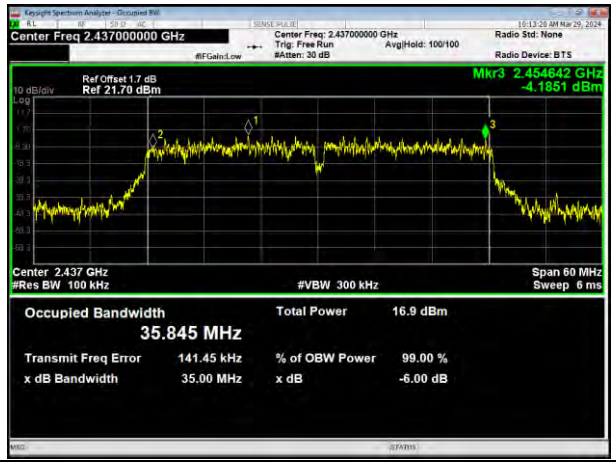
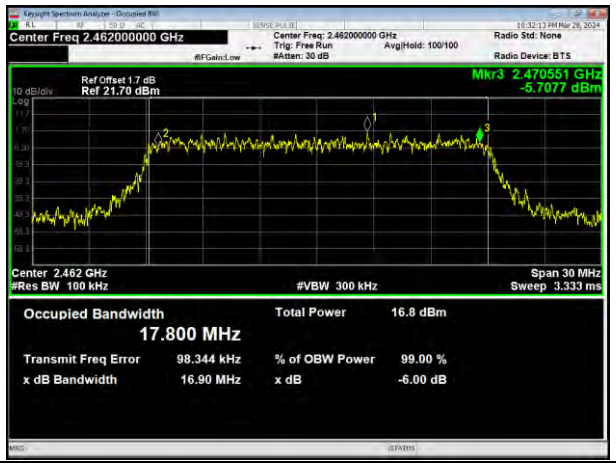
Test Setup Block Diagram

8.3 Test Data and Results

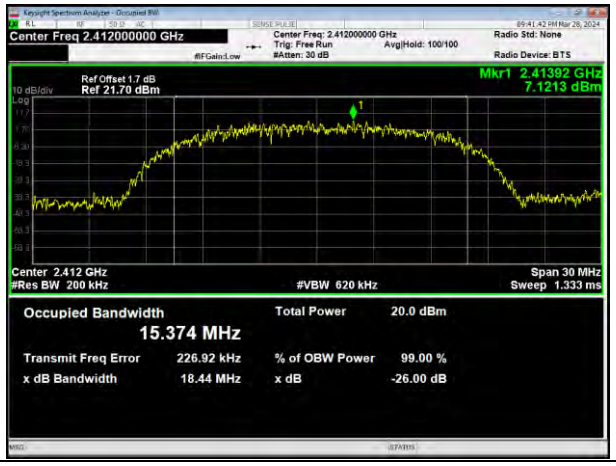
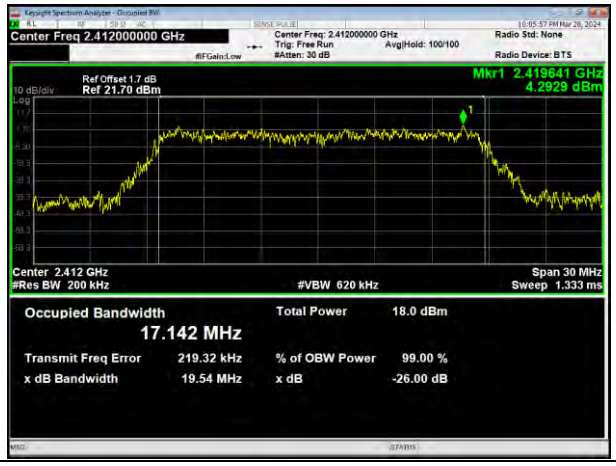
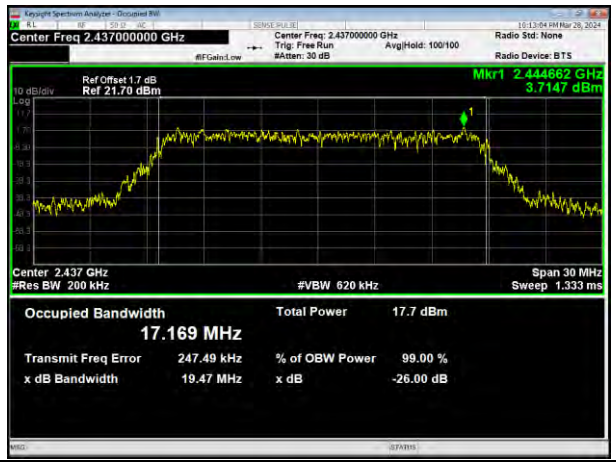
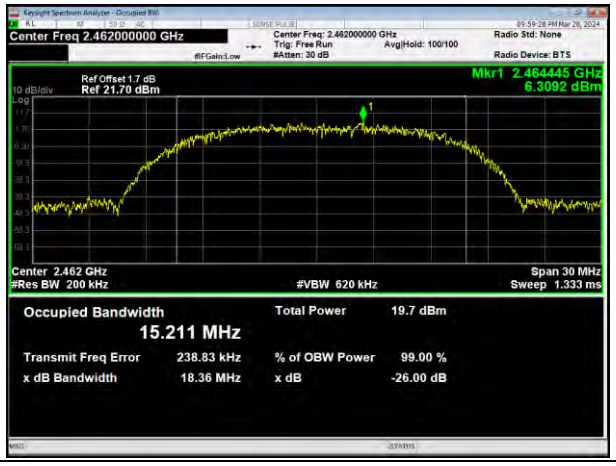
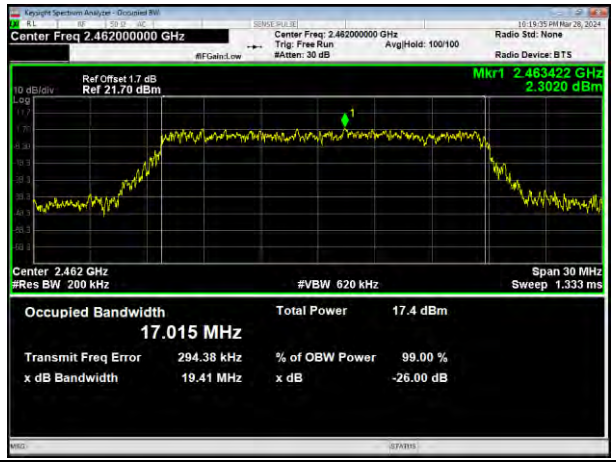
Test Mode	Test Channel (MHz)	6dB Bandwidth (MHz)	99% Bandwidth (MHz)	6bdBm Limit (MHz)	Test Result
802.11b	2412	12.326	15.374	0.5	Pass
	2437	10.195	15.335	0.5	Pass
	2462	11.531	15.211	0.5	Pass
802.11g	2412	16.377	17.142	0.5	Pass
	2437	16.39	17.169	0.5	Pass
	2462	16.645	17.015	0.5	Pass
802.11n(HT20)	2412	17.065	17.942	0.5	Pass
	2437	16.761	18.059	0.5	Pass
	2462	16.905	18.005	0.5	Pass
802.11n(HT40)	2422	35.059	35.897	0.5	Pass
	2437	35.001	35.969	0.5	Pass
	2452	35.086	36.108	0.5	Pass

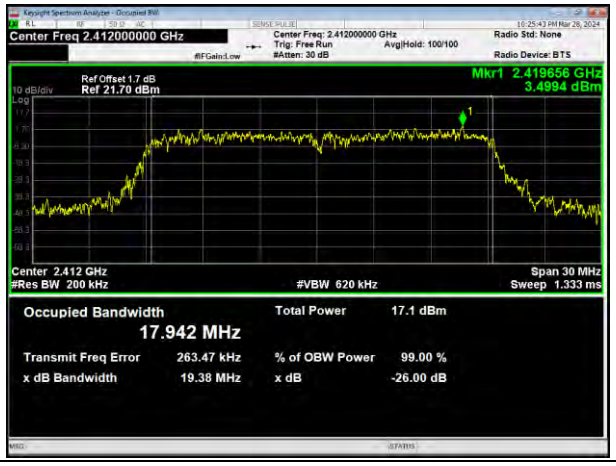
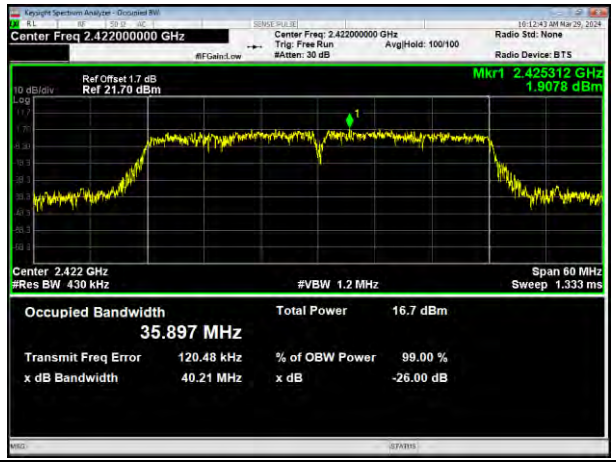
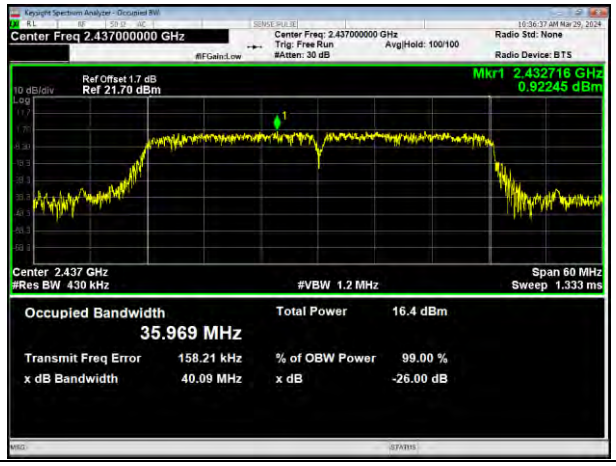
6dB Bandwidth:

802.11b	802.11g
2412MHz	2412MHz
	
2437MHz	2437MHz
2462MHz	2462MHz
	

802.11n(HT20)	802.11n(HT40)
2412MHz	2422MHz
	
2437MHz	2437MHz
	
2462MHz	2452MHz
	

99% Bandwidth:

802.11b	802.11g
2412MHz	2412MHz
	
2437MHz	2437MHz
	
2462MHz	2462MHz
	

802.11n(HT20)	802.11n(HT40)
2412MHz	2422MHz
	
2437MHz	2437MHz
	
2462MHz	2452MHz

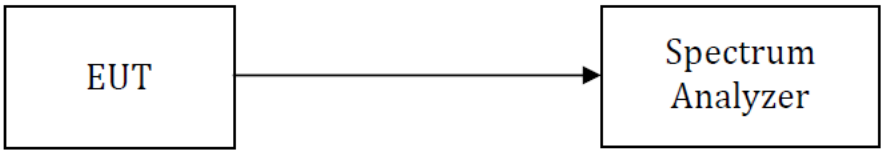
9. Maximum Power Spectral Density

9.1 Standard and Limit

According to FCC 15.247(e), For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

9.2 Test Procedure

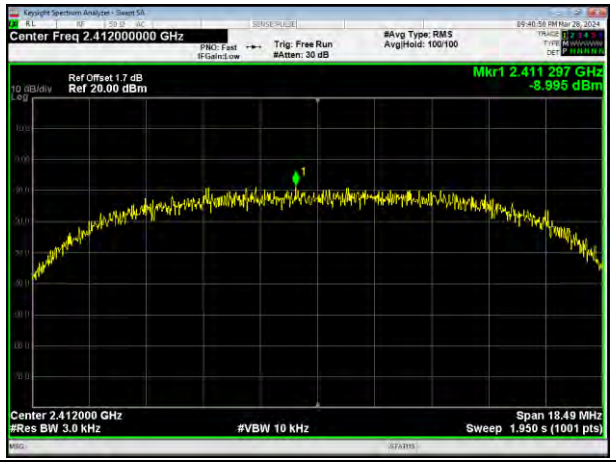
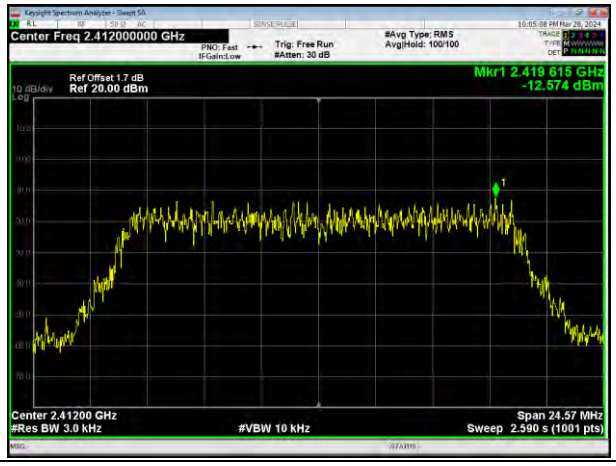
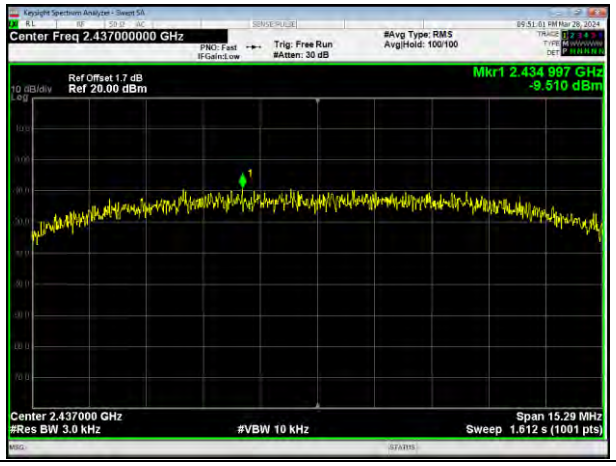
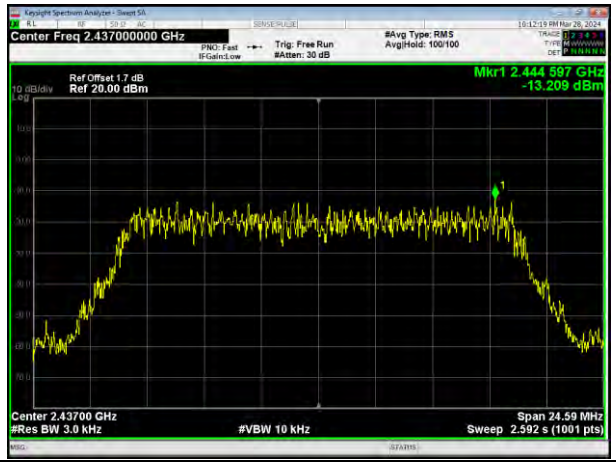
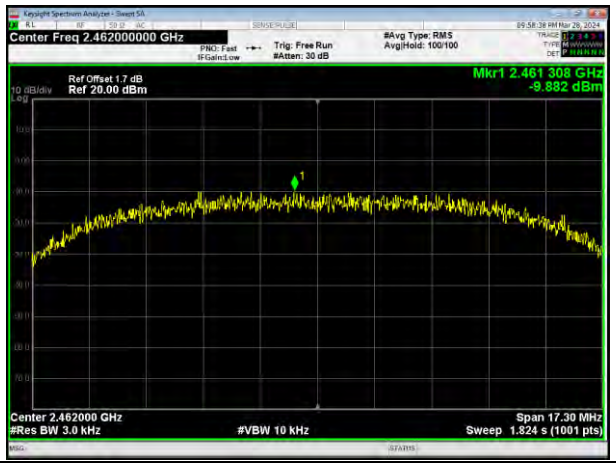
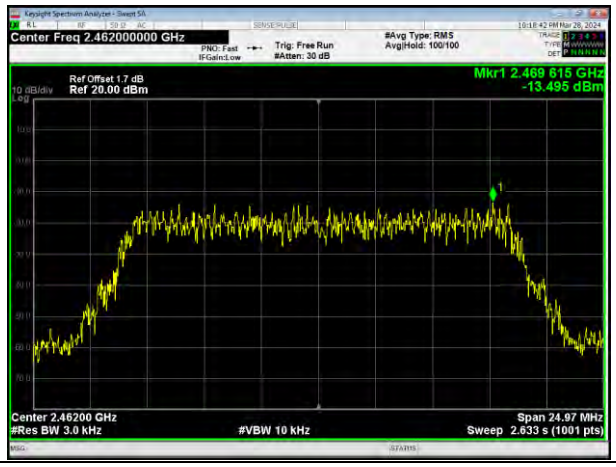
1) Remove the antenna from the EUT and connect to the spectrum analyzer via a low loss RF cable.
2) Set the spectrum analyzer to any one measured frequency within its operating range.
3) Set RBW = 3kHz, VBW = 10kHz, Sweep = Auto, Detector = RMS.
4) Measure the highest amplitude appearing on spectral display and mark the value.
5) Repeat above procedures until all frequencies measured were complete.

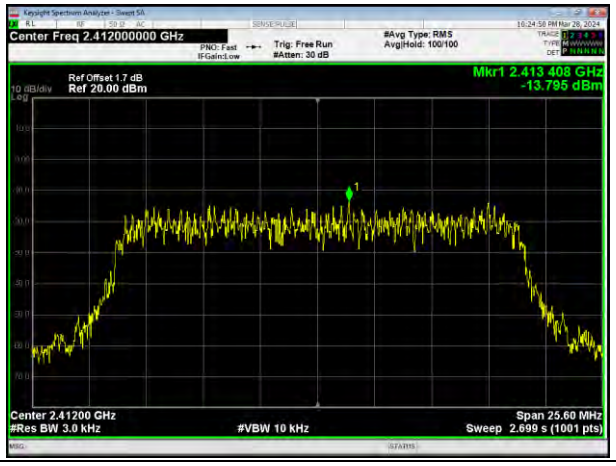
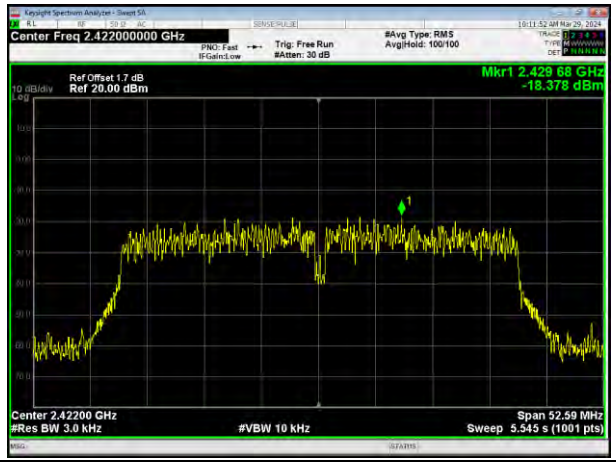
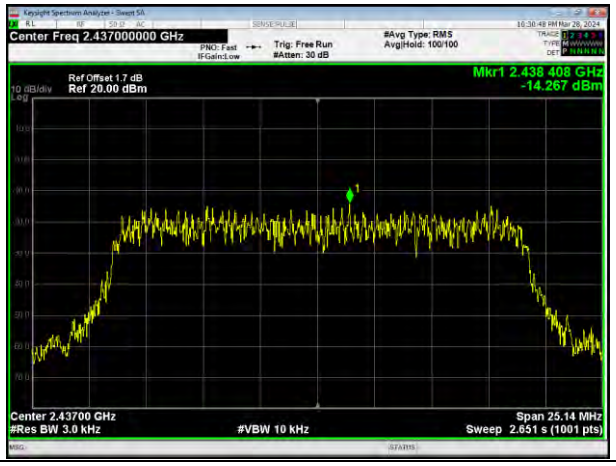
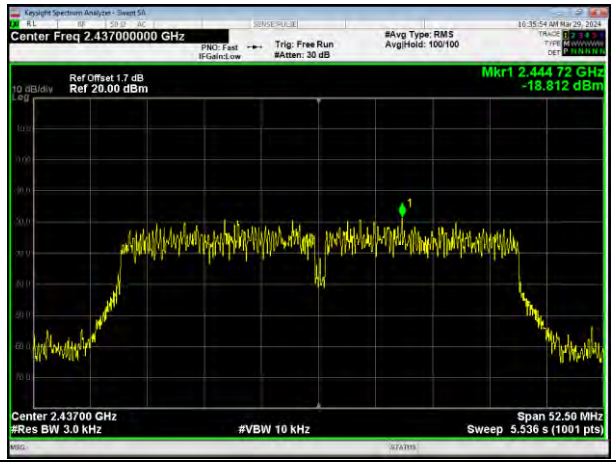
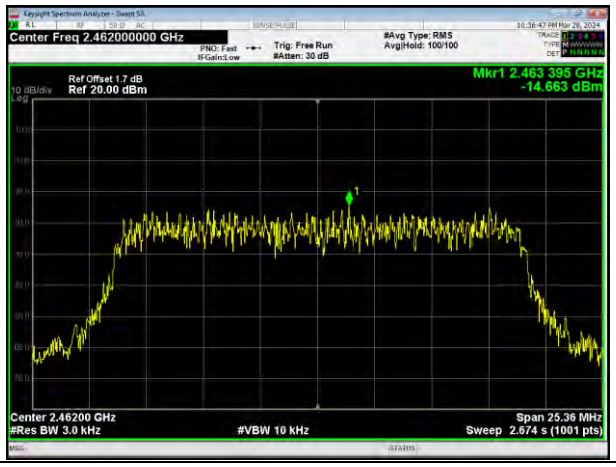
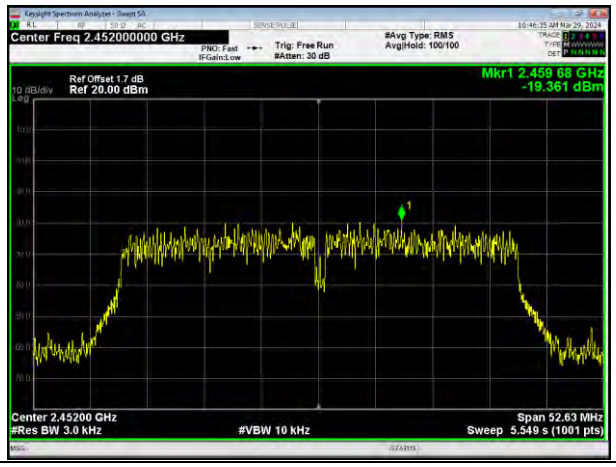


Test Setup Block Diagram

9.3 Test Data and Results

Test Mode	Test Channel MHz	Power Spectral Density (dBm/3kHz)	Limit (dBm/3kHz)	Test Result
802.11b	2412	-8.99	8	Pass
	2437	-9.51	8	Pass
	2462	-9.88	8	Pass
802.11g	2412	-12.57	8	Pass
	2437	-13.21	8	Pass
	2462	-13.5	8	Pass
802.11n(HT20)	2412	-13.8	8	Pass
	2437	-14.27	8	Pass
	2462	-14.66	8	Pass
802.11n(HT40)	2422	-18.38	8	Pass
	2437	-18.81	8	Pass
	2452	-19.36	8	Pass

802.11b	802.11g
2412MHz	2412MHz
	
2437MHz	2437MHz
	
2462MHz	2462MHz
	

802.11n(HT20)	802.11n(HT40)
2412MHz  	2422MHz 
2437MHz  	2437MHz 
2462MHz  	2452MHz 

10. Band-edge Emission(Conducted)

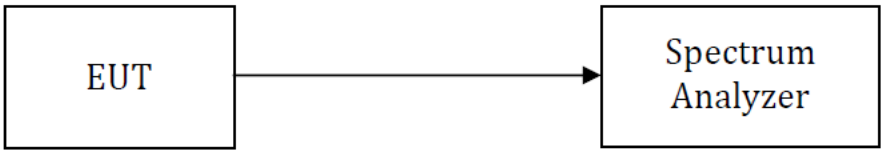
10.1 Standard and Limit

According to §15.247(d), In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, 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)).

10.2 Test Procedure

Test is conducting under the description of ANSI C63.10 - 2013 section 6.10.

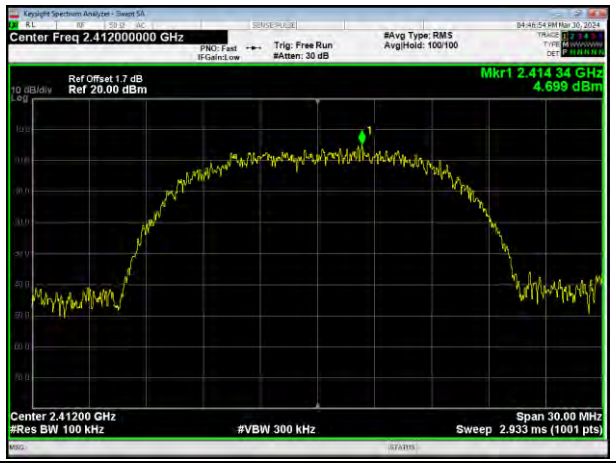
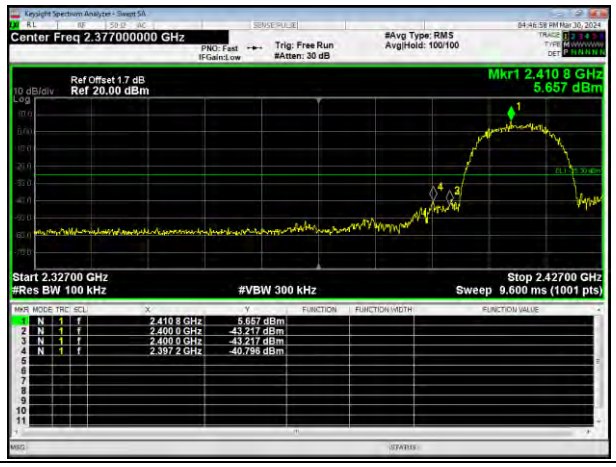
1) Remove the antenna from the EUT and connect to the spectrum analyzer via a low loss RF cable.
2) Set the spectrum analyzer to any one measured frequency within its operating range.
3) Set RBW = 100kHz, VBW = 300kHz, Sweep = Auto, Detector = RMS.
4) Measure the highest amplitude appearing on spectral display and set it as a reference level.
5) Set a convenient frequency span including 100 kHz bandwidth from band edge.
6) Measure the emission and marking the edge frequency.
7) Repeat above procedures until all frequencies measured were complete.

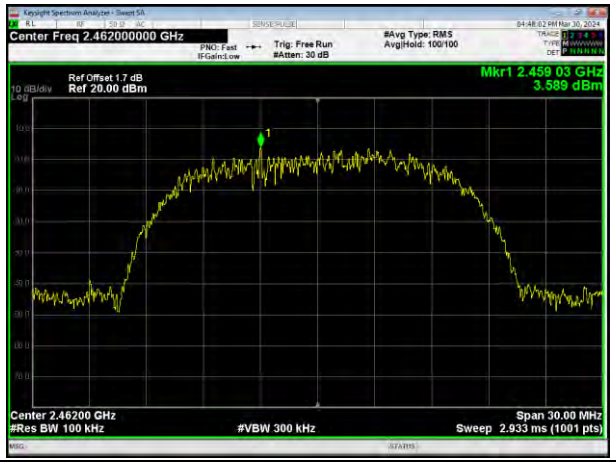
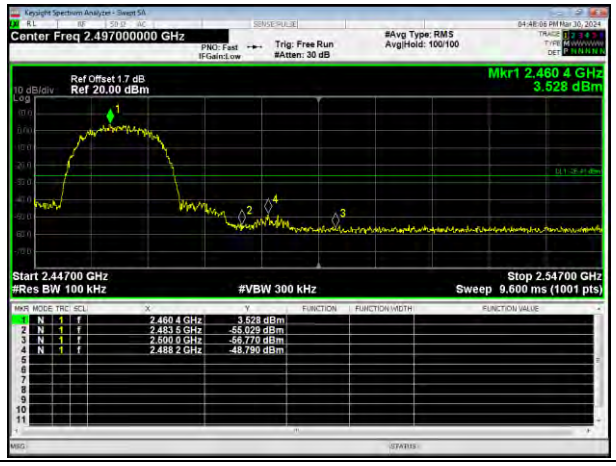


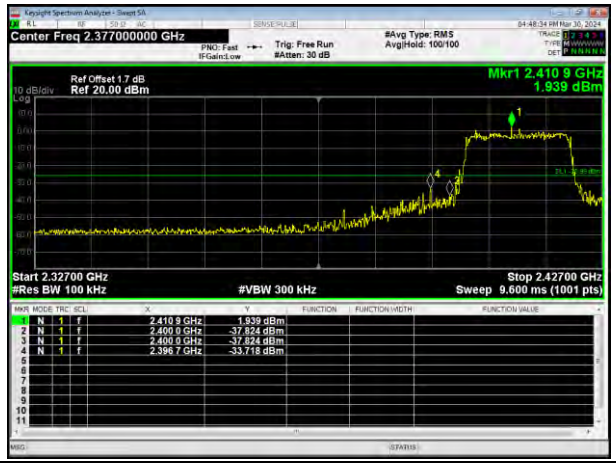
Test Setup Block Diagram

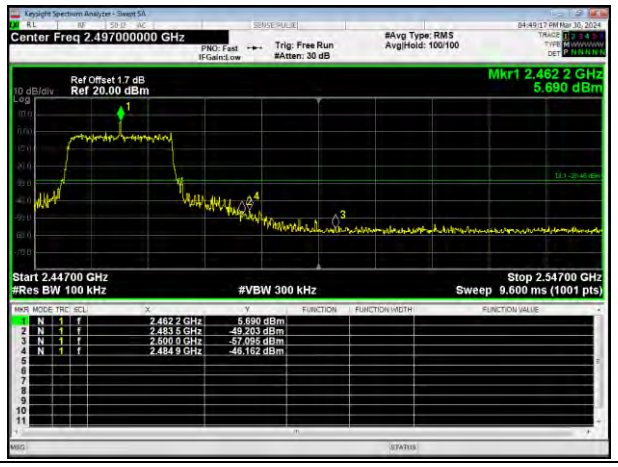
10.3 Test Data and Results

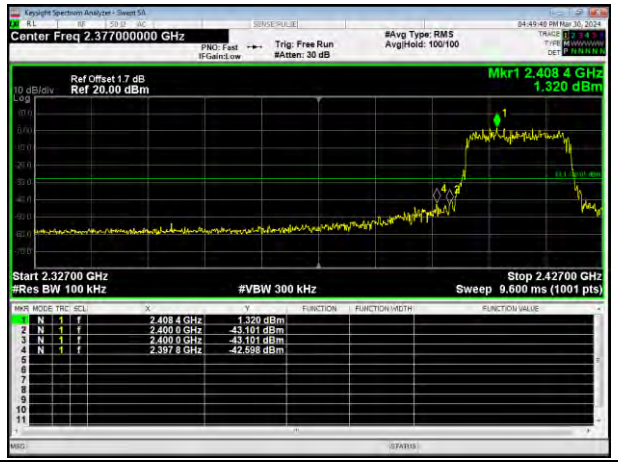
Test Mode	Band-edge	Test Channel (MHz)	Max. Value (dBc)	Limit (dBc)	Test Result
802.11b	Lowest	2412	-45.49	-30	Pass
	Highest	2462	-52.37	-30	Pass
802.11g	Lowest	2412	-37.72	-30	Pass
	Highest	2462	-47.7	-30	Pass
802.11n(HT20)	Lowest	2412	-44.58	-30	Pass
	Highest	2462	-53.15	-30	Pass
802.11n(HT40)	Lowest	2422	-32.41	-30	Pass
	Highest	2452	-39.61	-30	Pass

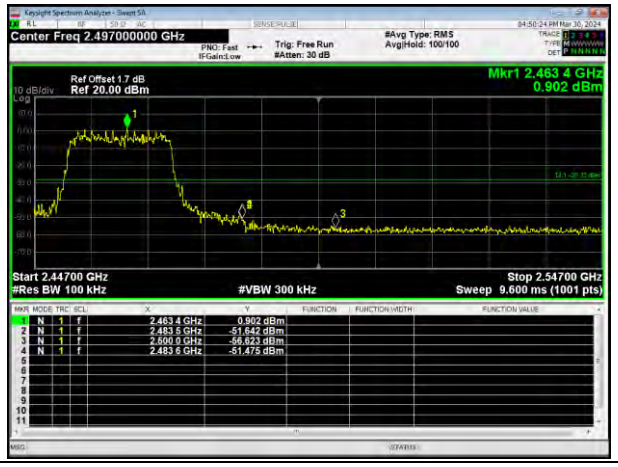
802.11b Lowest	
Reference Power	Band-edge Emission
	

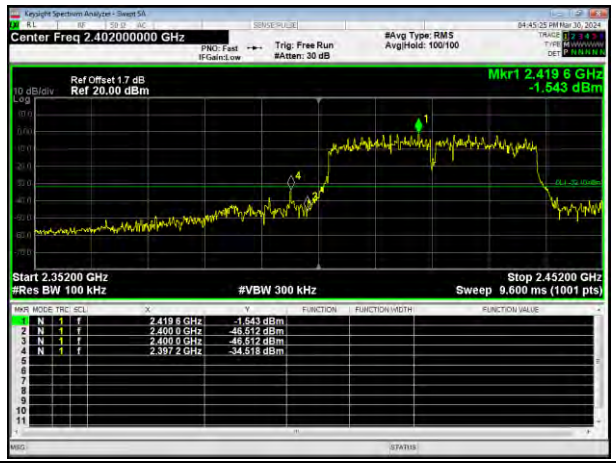
802.11b Highest	
Reference Power	Band-edge Emission
	

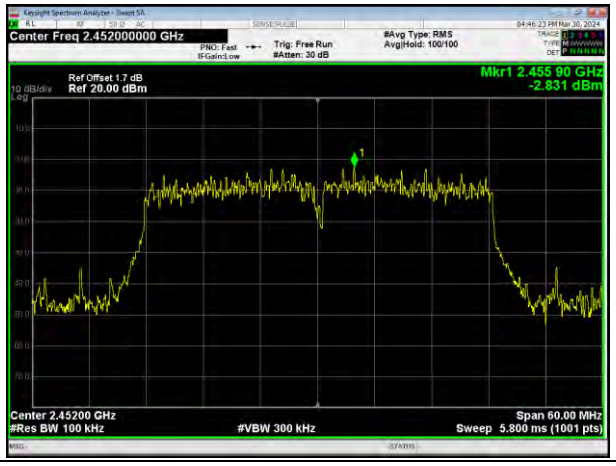
802.11g Lowest	
Reference Power	Band-edge Emission
	

802.11g Highest	
Reference Power	Band-edge Emission
	

802.11n(HT20) Lowest	
Reference Power	Band-edge Emission
	

802.11n(HT20) Highest	
Reference Power	Band-edge Emission
	

802.11n(HT40) Lowest	
Reference Power	Band-edge Emission
	

802.11n(HT40) Highest	
Reference Power	Band-edge Emission
	

11. Conducted RF Spurious Emissions

11.1 Standard and Limit

According to §15.247(d), In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, 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)).

11.2 Test Procedure

Test is conducting under the description of ANSI C63.10 - 2013 section 6.7.
1) Remove the antenna from the EUT and connect to the spectrum analyzer via a low loss RF cable.
2) Set the spectrum analyzer to any one measured frequency within its operating range.
3) Set RBW = 100kHz, VBW = 300kHz, Sweep = Auto, Detector = RMS.
4) Measure the highest amplitude appearing on spectral display and set it as a reference level.
5) Measure the spurious emissions with frequency range from 9kHz to 26.5GHz.
6) Repeat above procedures until all measured frequencies were complete.

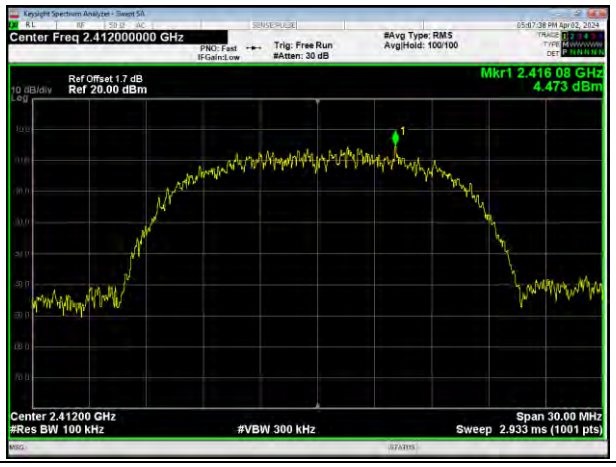
Test Setup Block Diagram

11.3 Test Data and Results

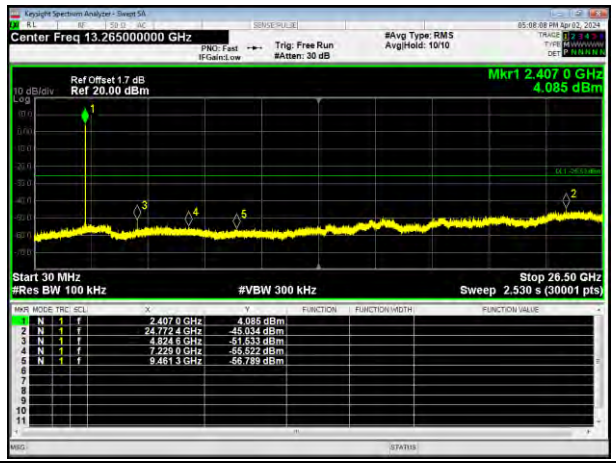
Note: The measurement frequency range is from 9kHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions measurement data.

802.11b Lowest

Reference Power



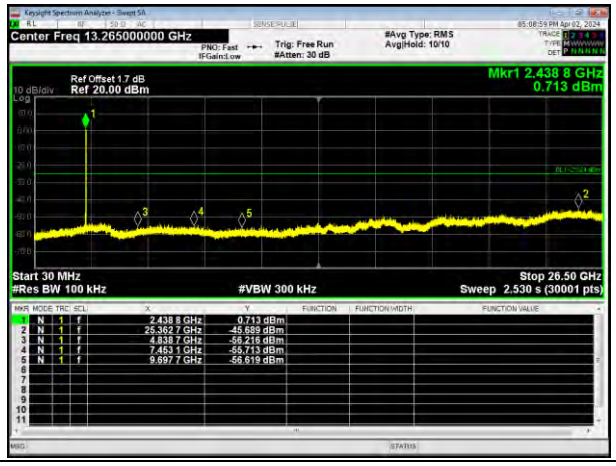
Spurious Emissions



802.11b Middle

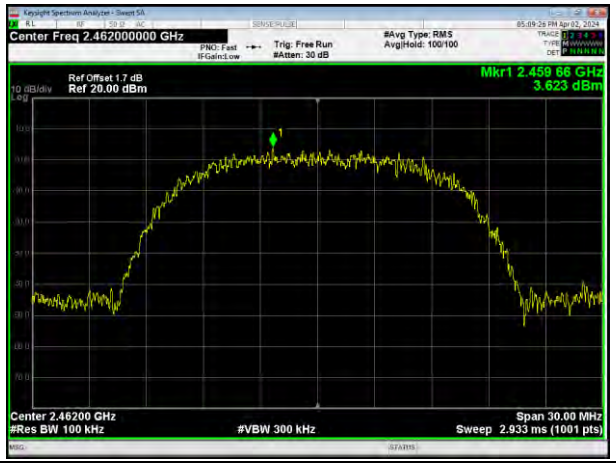
Reference Power

Spurious Emissions

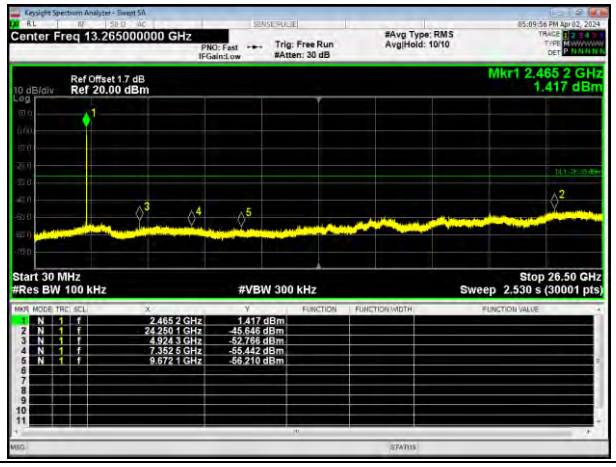


802.11b Highest

Reference Power



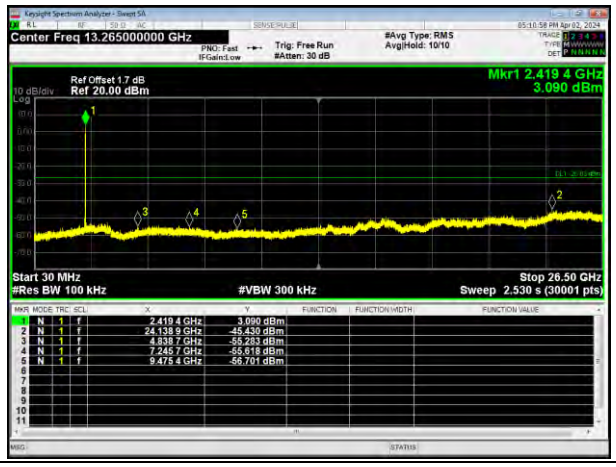
Spurious Emissions



802.11g Lowest

Reference Power

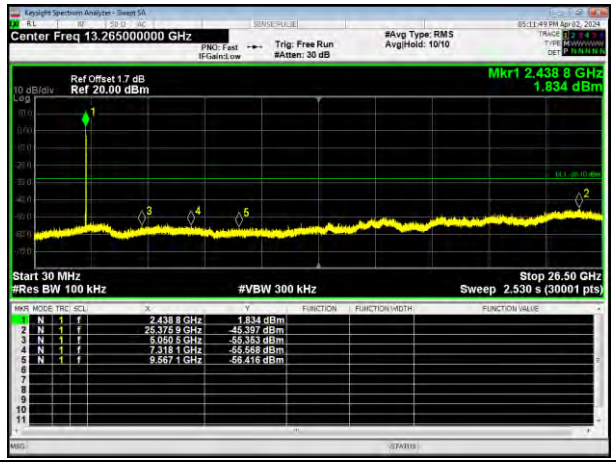
Spurious Emissions



802.11g Middle

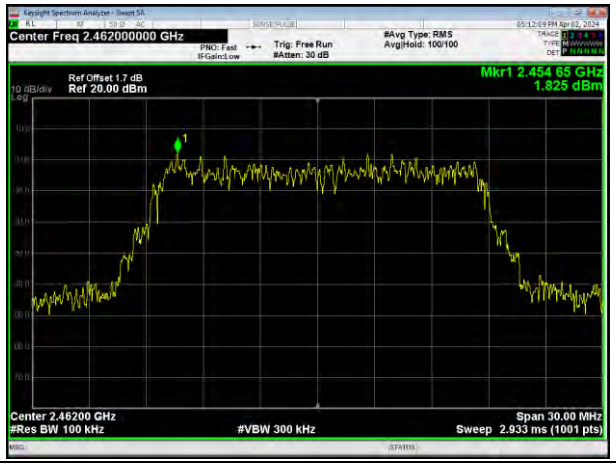
Reference Power

Spurious Emissions

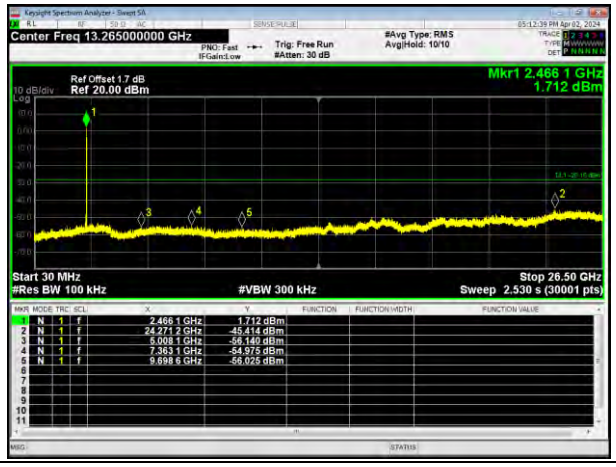


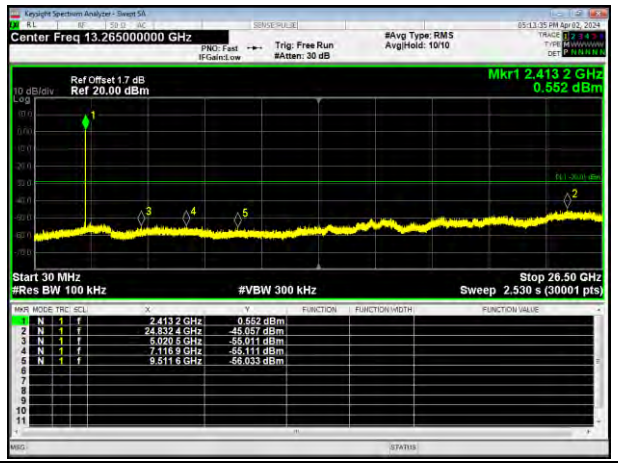
802.11g Highest

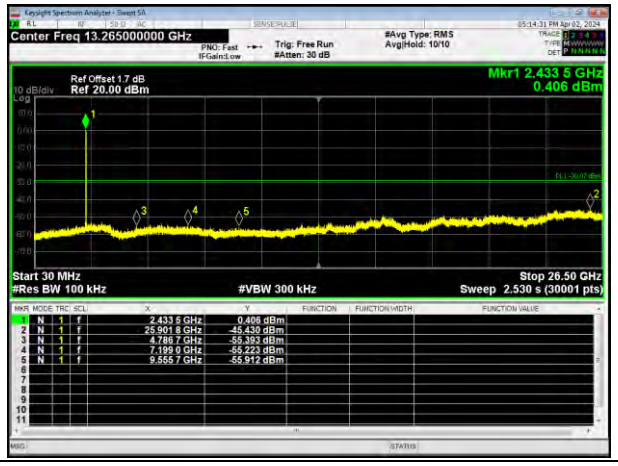
Reference Power

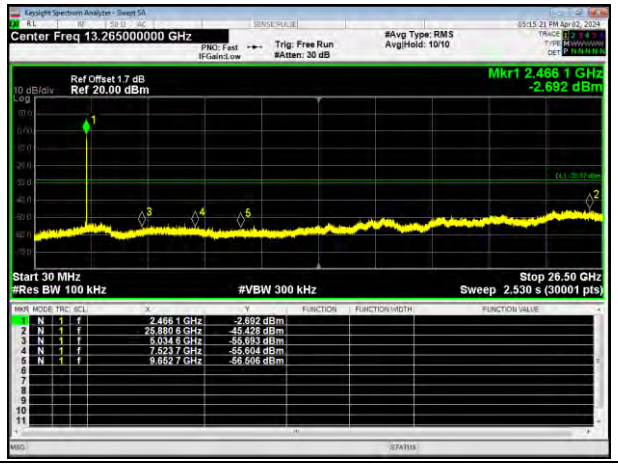


Spurious Emissions



802.11n(HT20) Lowest	
Reference Power	Spurious Emissions
	

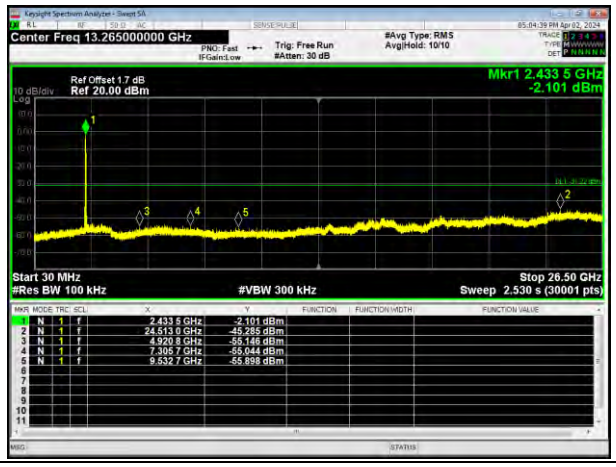
802.11n(HT20) Middle	
Reference Power	Spurious Emissions
	

802.11n(HT20) Highest	
Reference Power	Spurious Emissions
	

802.11n(HT40) Lowest

Reference Power

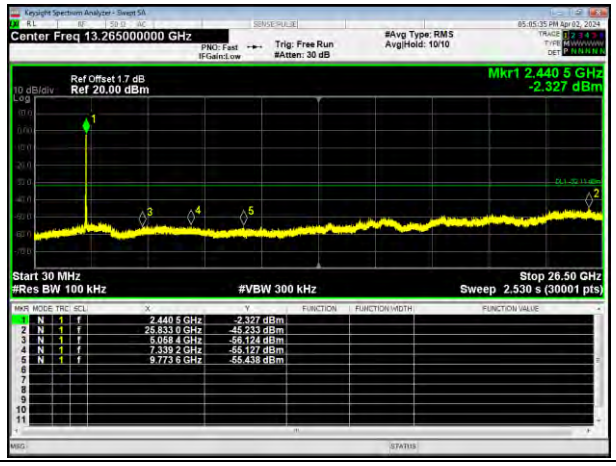
Spurious Emissions



802.11n(HT40) Middle

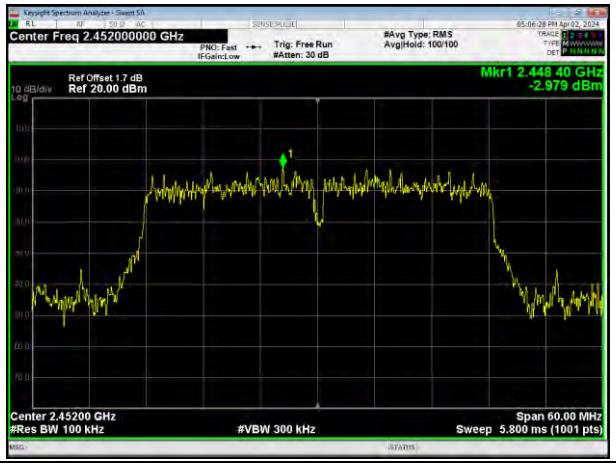
Reference Power

Spurious Emissions

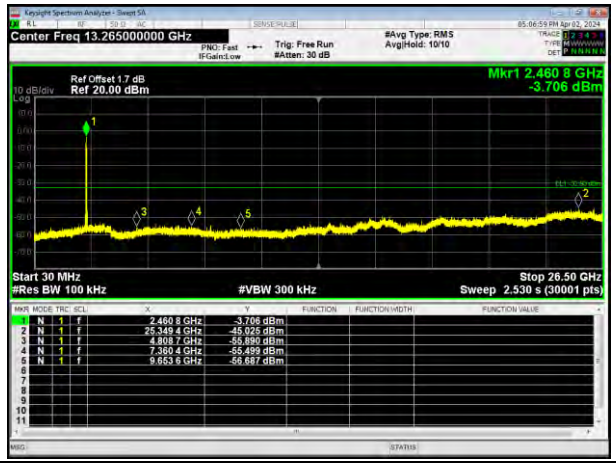


802.11n(HT40) Highest

Reference Power



Spurious Emissions



******* END OF REPORT *******