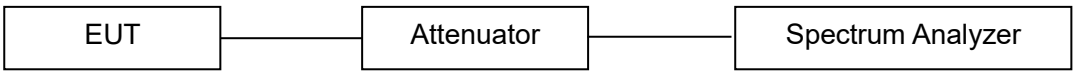
13.5 Power Spectral Density Measurement

LIMITS

The Maximum of Power Spectral Density Measurement is 8dBm in any 3 kHz.

BLOCK DIAGRAM OF TEST SETUP



TEST PROCEDURES

The antenna port of the EUT was connected to the input of a spectrum analyzer. Analyzer was set as below according to FCC DTS KDB 558074 D01 15.247 Meas Guidance v05r02:

a. Set analyzer center frequency to DTS channel center frequency.

b. Set the span to 1.5 times the DTS bandwidth.

c. Set the RBW to: 3 kHz ≤ RBW ≤ 100KHz

d. Set the VBW ≥ 3 x RBW.

e. Set the Detector = AVG.

f. Set the Sweep time = auto couple.

g. Set the Trace mode = max hold.

h. Allow trace to fully stabilize.

i. Use the AVG marker function to determine the maximum amplitude level within the RBW.

j. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

TEST RESULTS

PASS

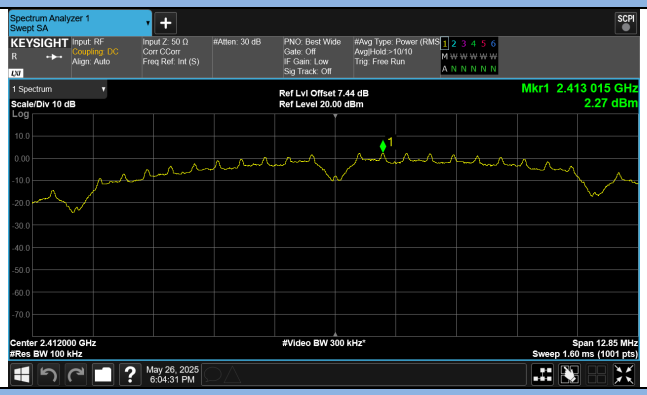
Please refer to the following tables.

U-NII-1						
Frequency MHz	Data Rate Mbps	Duty Cycle Factor (dB)	PSD dBm / 100kHz	PSD dBm / 3kHz	Total PSD with duty cycle factor	Limit dBm / 3kHz
IEEE 802.11b						
2412	1	0.04	2.27	-12.95	-12.91	8
2437	1		1.70	-13.52	-13.48	8
2462	1		3.02	-12.20	-12.16	8
IEEE 802.11g						
2412	6	0	-6.38	-21.60	-21.60	8
2437	6		-5.53	-20.75	-20.75	8
2462	6		-5.98	-21.20	-21.20	8
IEEE 802.11n(HT20)						
2412	MCS0	0	-6.86	-22.08	-22.08	8
2437	MCS0		-5.88	-21.10	-21.10	8
2462	MCS0		-5.85	-21.07	-21.07	8
IEEE 802.11n(HT40)						
2422	MCS0	0	-9.71	-24.93	-24.93	8
2437	MCS0		-8.34	-23.56	-23.56	8
2452	MCS0		-8.88	-24.10	-24.10	8
IEEE 802.11ax(HE20)						
2412	MCS0	0	-7.88	-23.10	-23.10	8
2437	MCS0		-6.58	-21.80	-21.80	8
2462	MCS0		-6.99	-22.21	-22.21	8
IEEE 802.11ax(HE40)						
2422	MCS0	0	-11.17	-26.39	-26.39	8
2437	MCS0		-10.02	-25.24	-25.24	8
2452	MCS0		-10.41	-25.63	-25.63	8

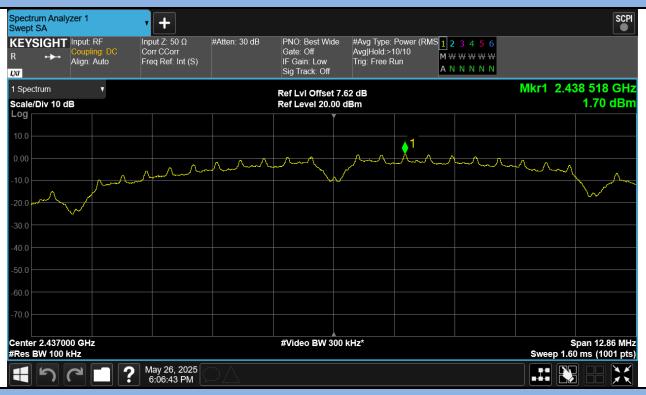
Note: 1. Duty cycle factor have been considered.
2. Different RBW with limit: Measured PSD + BWCF
Measured PSD + 10log(3/100) < 8dBm/3kHz

Test Plots of Power Spectral Density

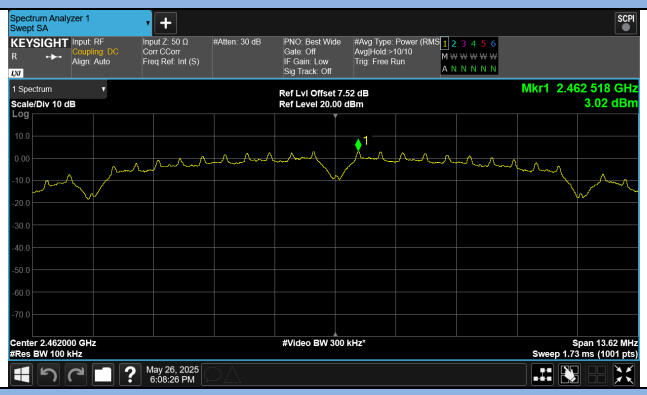
IEEE 802.11b - 2412MHz



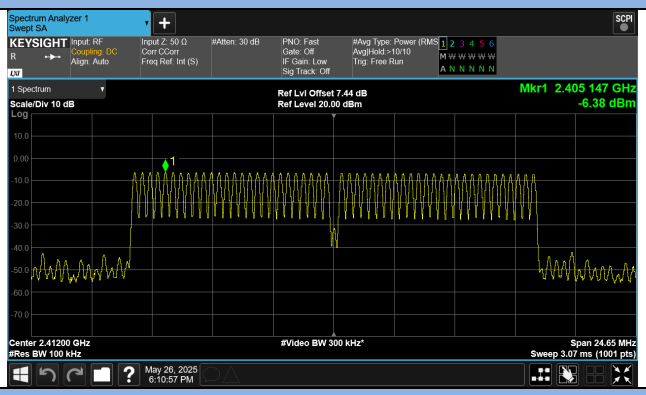
IEEE 802.11b - 2437MHz



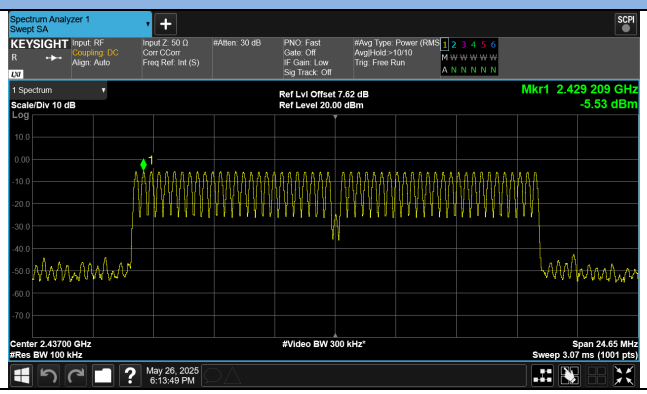
IEEE 802.11b - 2462MHz



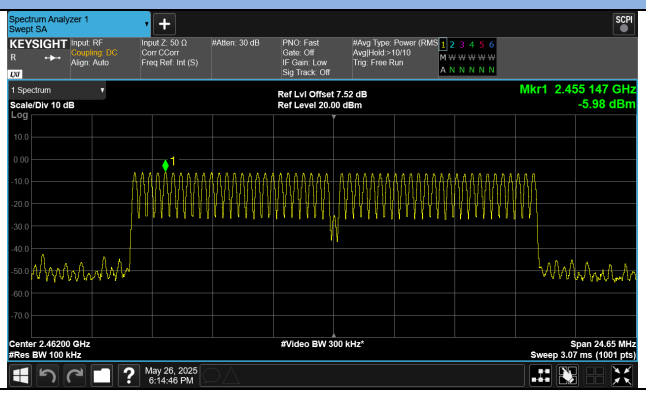
IEEE 802.11g - 2412MHz



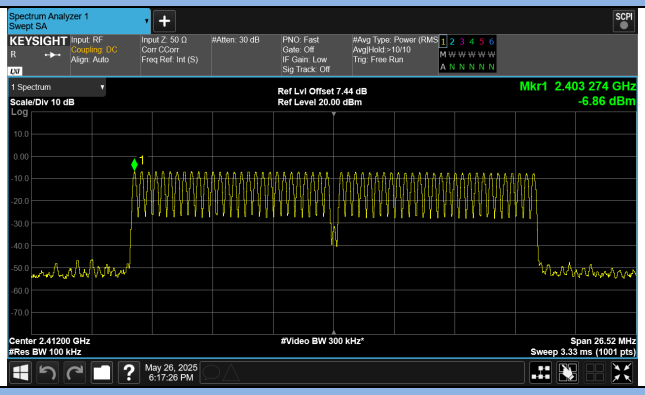
IEEE 802.11g - 2437MHz



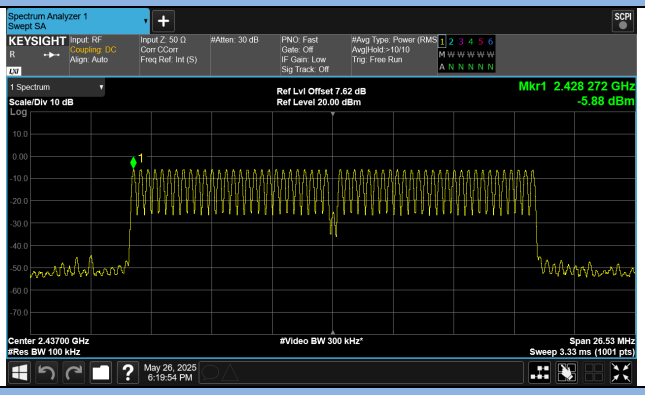
IEEE 802.11g - 2462MHz



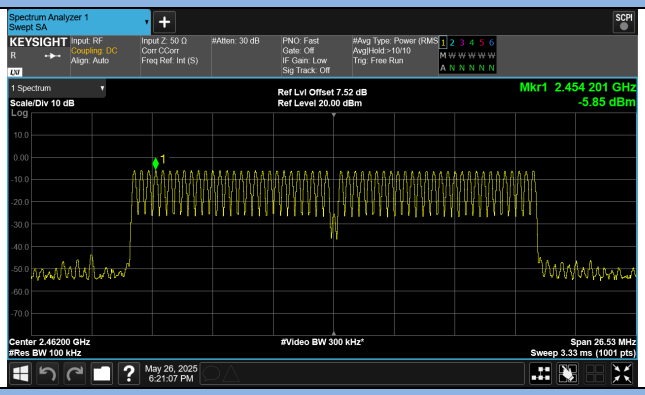
IEEE 802.11n(HT20) - 2412MHz



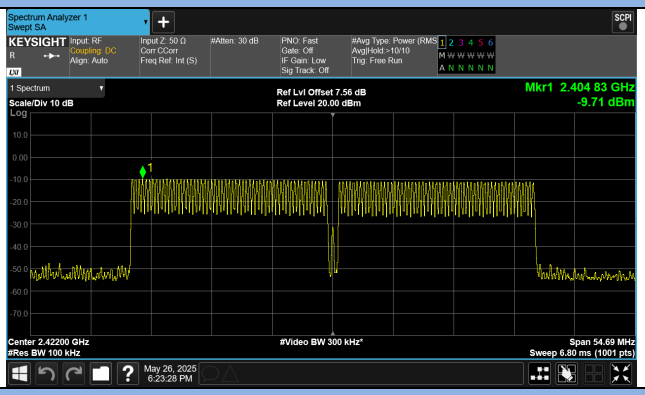
IEEE 802.11n(HT20) - 2437MHz



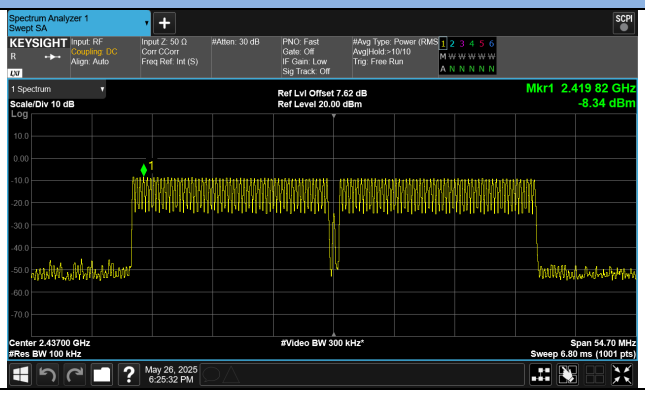
IEEE 802.11n(HT20) - 2462MHz



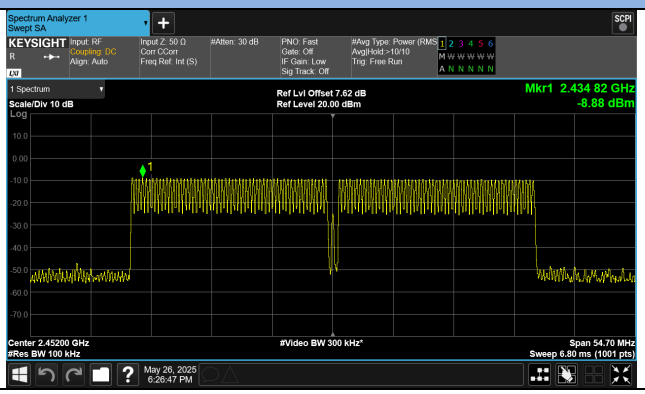
IEEE 802.11n(HT40) - 2422MHz



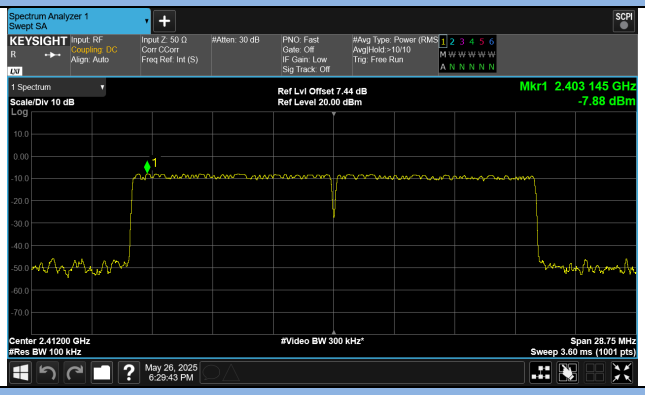
IEEE 802.11n(HT40) - 2437MHz



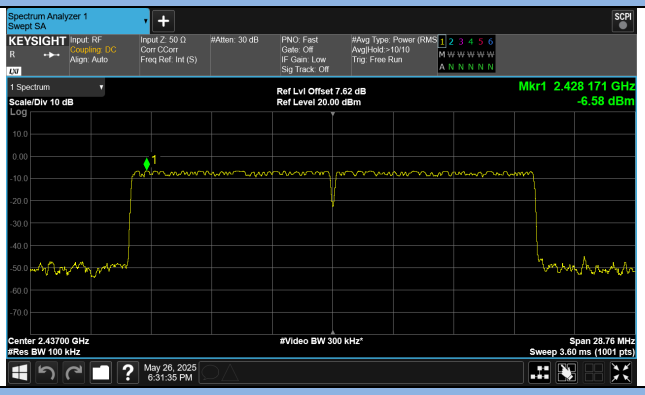
IEEE 802.11n(HT40) - 2452MHz



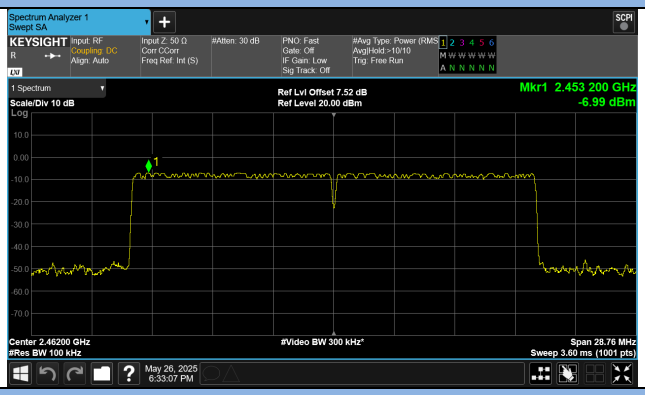
IEEE 802.11ax(HE20) - 2412MHz



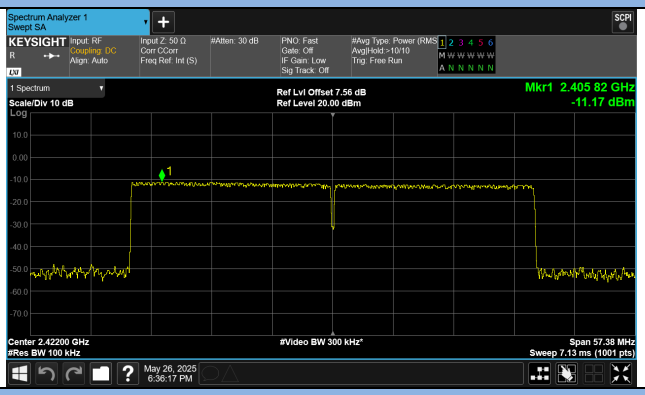
IEEE 802.11ax(HE20) - 2437MHz



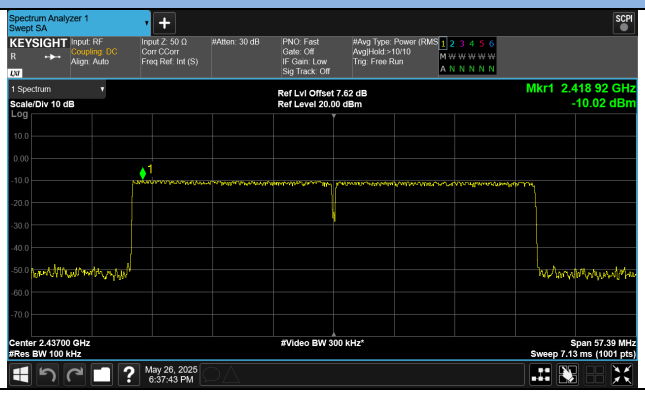
IEEE 802.11ax(HE20) - 2462MHz



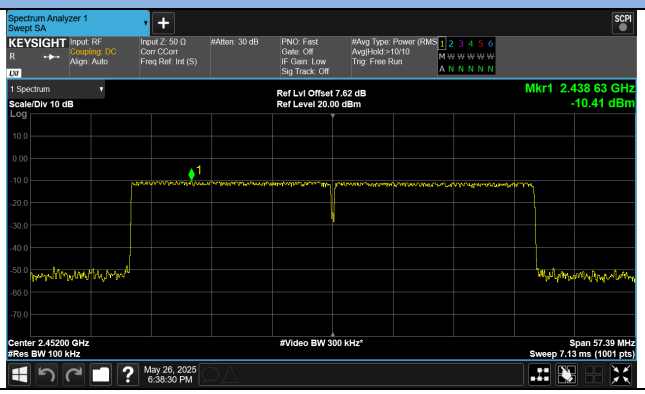
IEEE 802.11ax(HE40) - 2422MHz



IEEE 802.11ax(HE40) - 2437MHz



IEEE 802.11ax(HE40) - 2452MHz

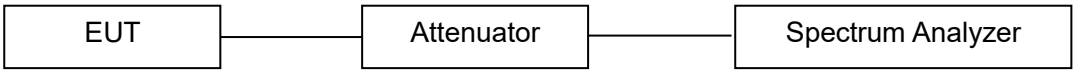


13.6 Band Edge and Conducted Spurious Emissions Measurement

LIMITS

In any 100KHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100KHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

BLOCK DIAGRAM OF TEST SETUP



TEST PROCEDURES

The antenna port of the EUT was connected to the input of a spectrum analyzer. Analyzer was set as below according to ANSI C63.10-2013, Section 11.11

Measurement Procedure REF

a. Set the RBW = 100 kHz.

b. Set the VBW ≥ 300 kHz.

c. Set the Detector = peak.

d. Set the Sweep time = auto couple.

e. Trace mode = max hold.

f. Allow trace to fully stabilize.

g. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

Measurement Procedure OOBE

a. Set RBW = 100 kHz.

b. Set VBW ≥ 300 kHz.

c. Set the Detector = peak.

d. Set the Sweep = auto couple.

e. Set the Trace Mode = max hold.

f. Allow trace to fully stabilize.

g. Use the peak marker function to determine the maximum amplitude level.

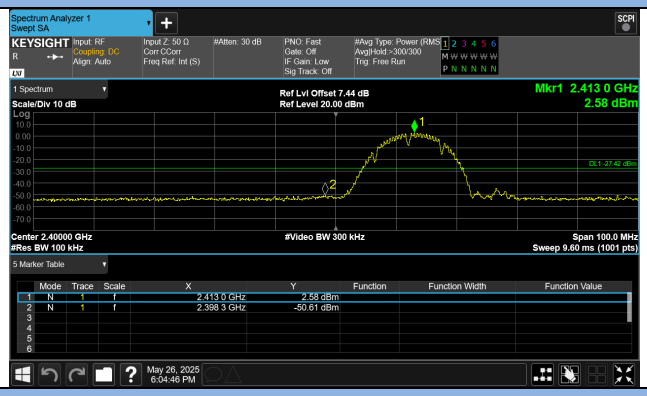
TEST RESULTS

PASS

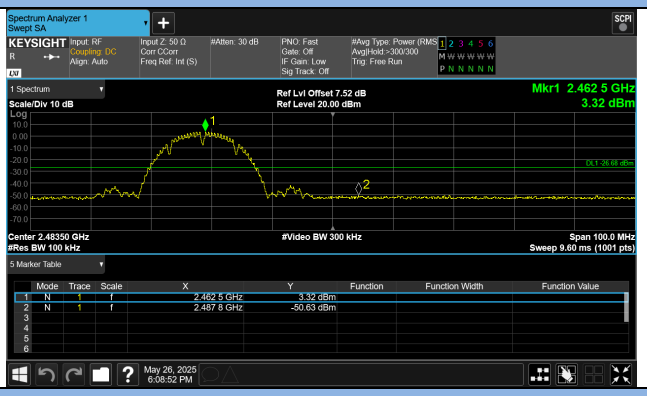
Please refer to the following test plots.

Band Edge

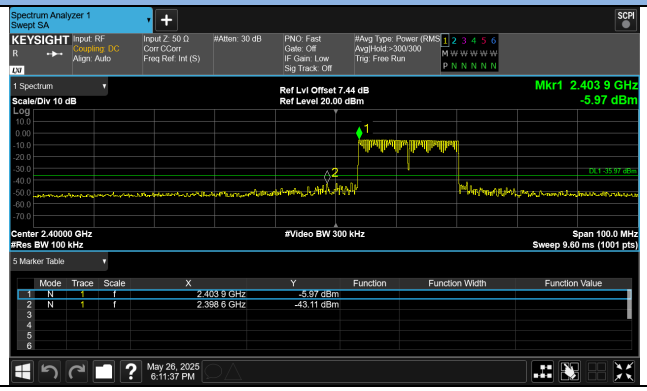
IEEE 802.11b / Low Channel



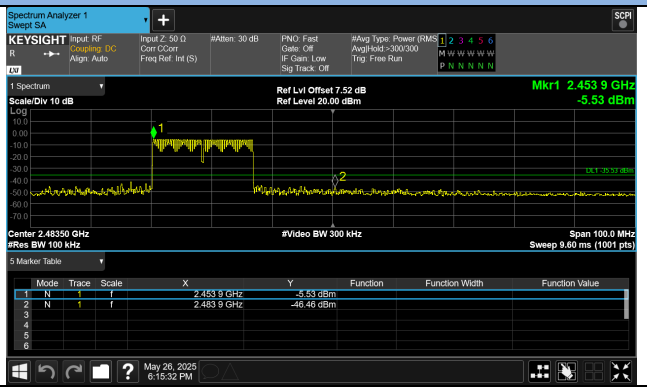
IEEE 802.11b / High Channel



IEEE 802.11g / Low Channel

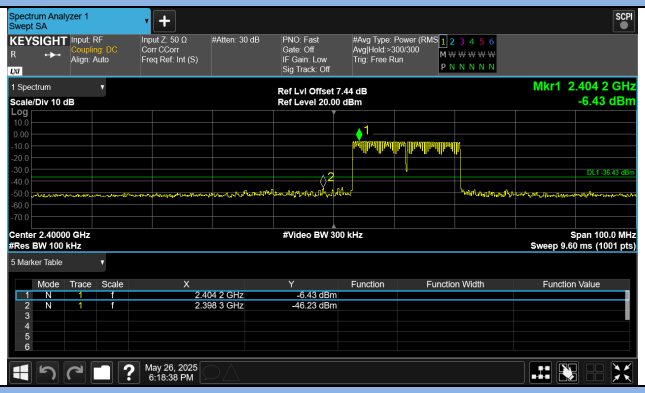


IEEE 802.11g / High Channel

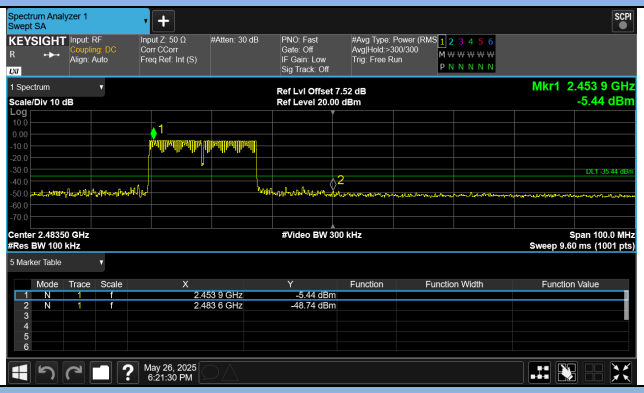


Band Edge

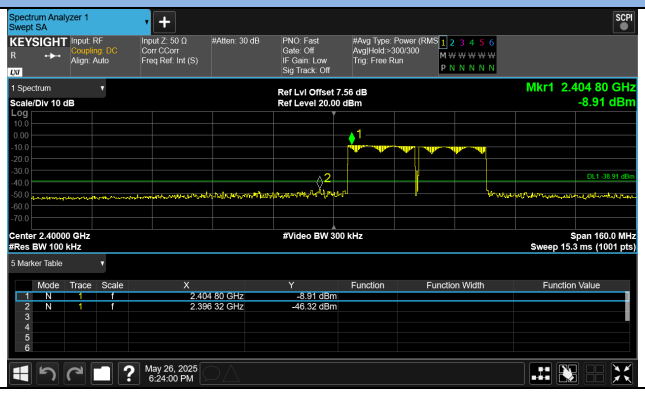
IEEE 802.11n(HT20) / Low Channel



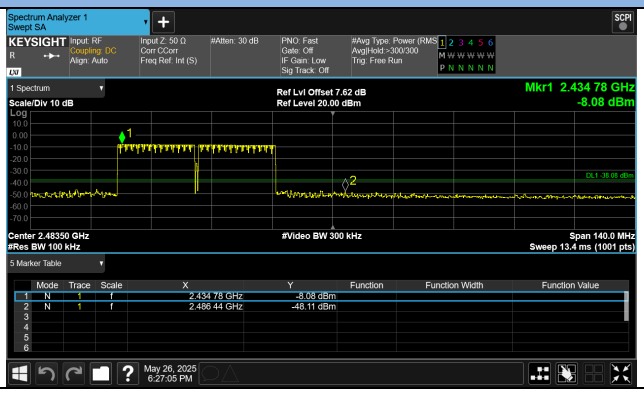
IEEE 802.11n(HT20) / High Channel



IEEE 802.11n(HT40) / Low Channel

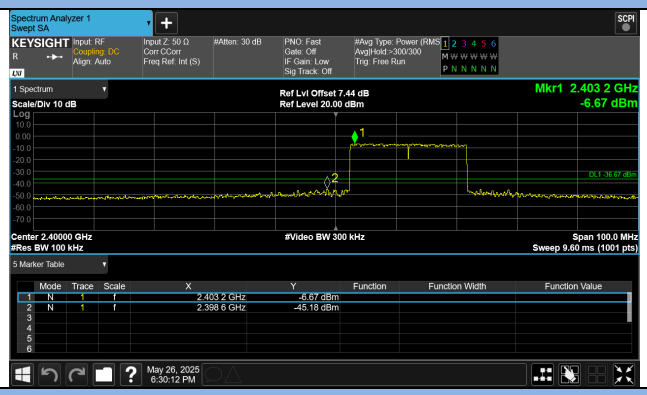


IEEE 802.11n(HT40) / High Channel

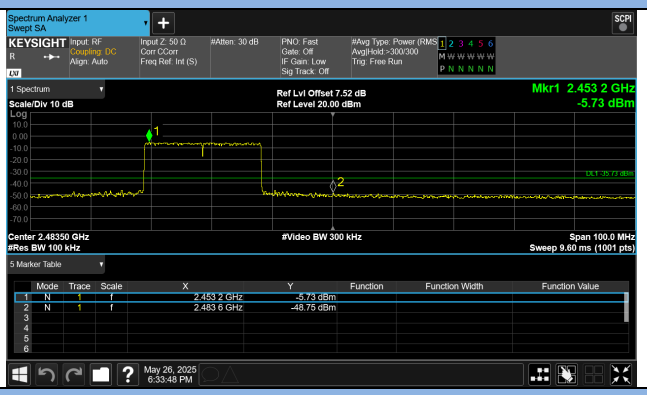


Band Edge

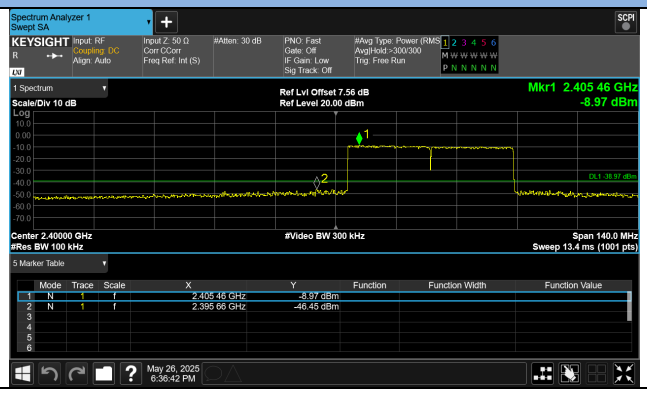
IEEE 802.11ax(HE20) / Low Channel



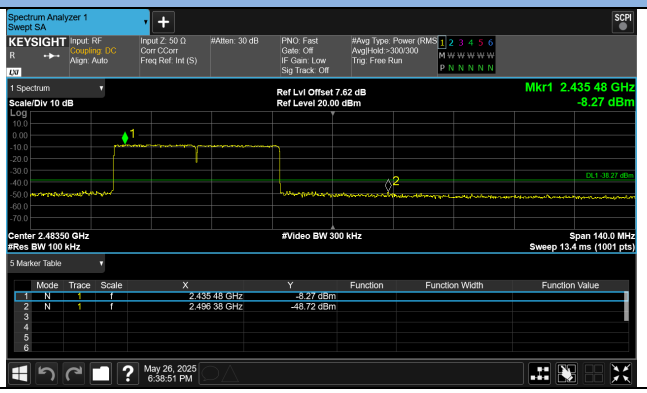
IEEE 802.11ax(HE20) / High Channel



IEEE 802.11ax(HE40) / Low Channel

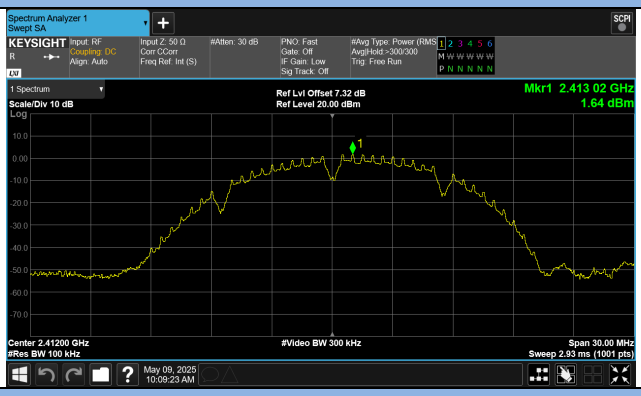


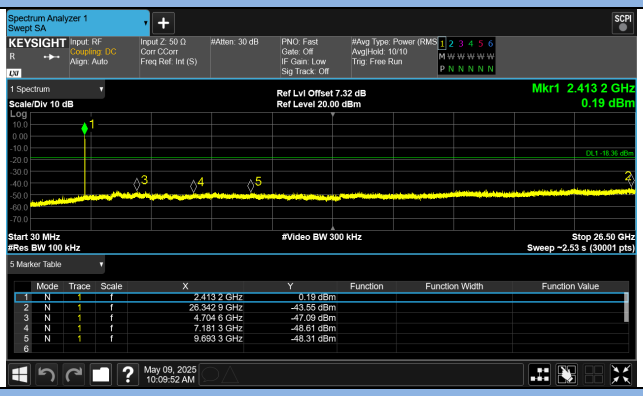
IEEE 802.11ax(HE40) / High Channel



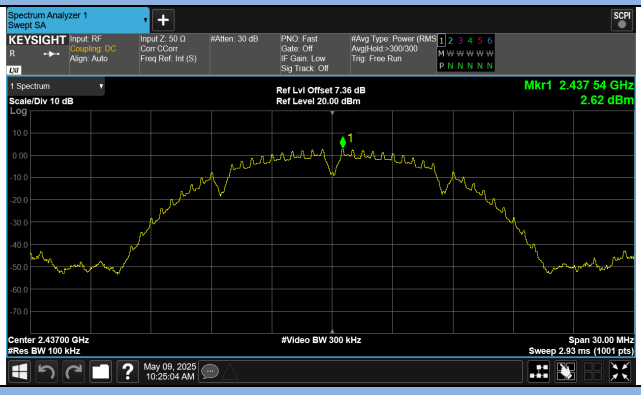
Conducted Spurious Emissions – IEEE 802.11b (The Worst Case)

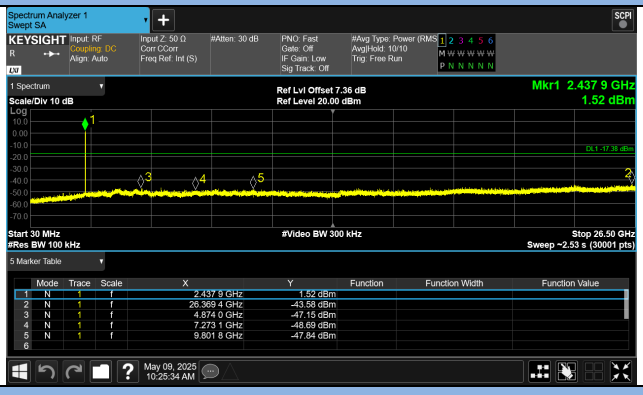
Lowest Channel



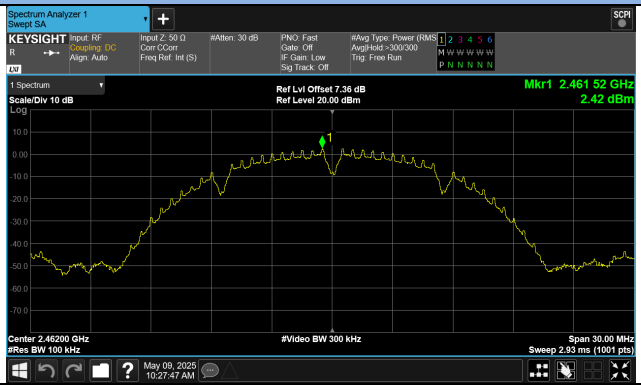


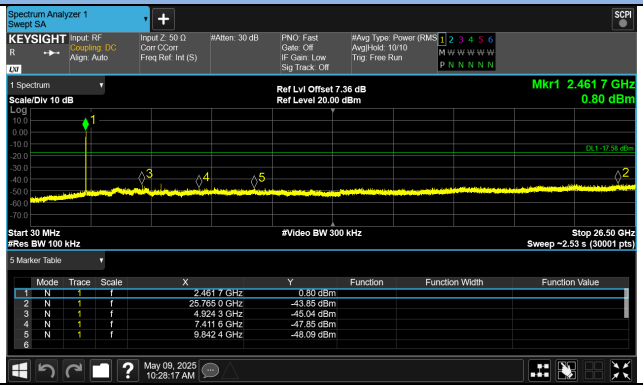
Middle Channel





Highest Channel





13.7 Radiated Spurious Emissions and Restricted Bands Measurement

LIMIT of Radiated Band Edges and non-restricted bands

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB.

LIMIT of Restricted bands

In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below:

Frequency range MHz	Distance Meters	Field Strengths Limit (15.209)
		μV/m
0.009 ~ 0.490	300	2400/F(kHz)
0.490 ~ 1.705	30	24000/F(kHz)
1.705 ~ 30	30	30
30 ~ 88	3	100
88 ~ 216	3	150
216 ~ 960	3	200
Above 960	3	500

Remark: (1) Emission level (dB)μV = 20 log Emission level μV/m

(2) The smaller limit shall apply at the cross point between two frequency bands.

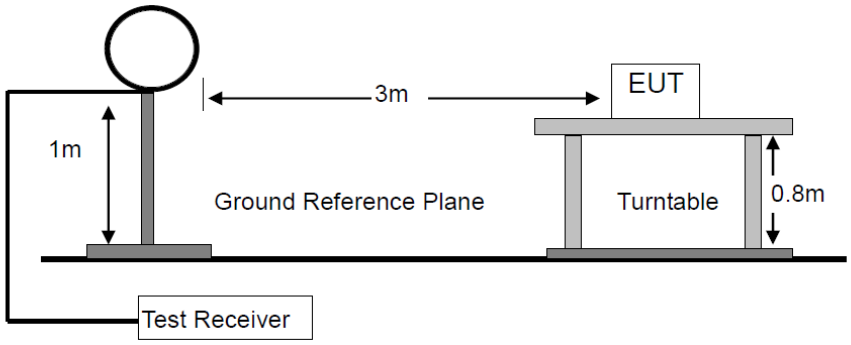
(3) As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

(4) The frequency range scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or 40 GHz, whichever is lower.

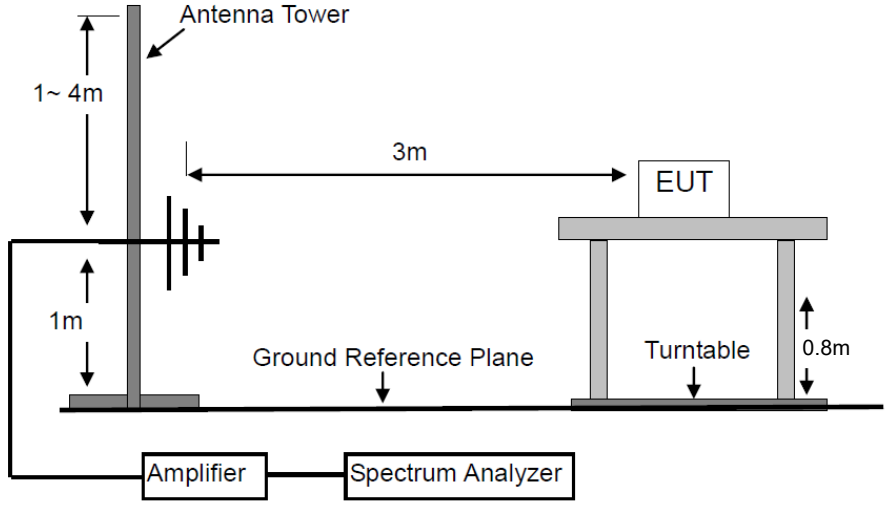
(5) §15.247(d) specifies that emissions which fall in the restricted bands, as defined in §15.205 comply with radiated emission limits specified in §15.209.

BLOCK DIAGRAM OF TEST SETUP

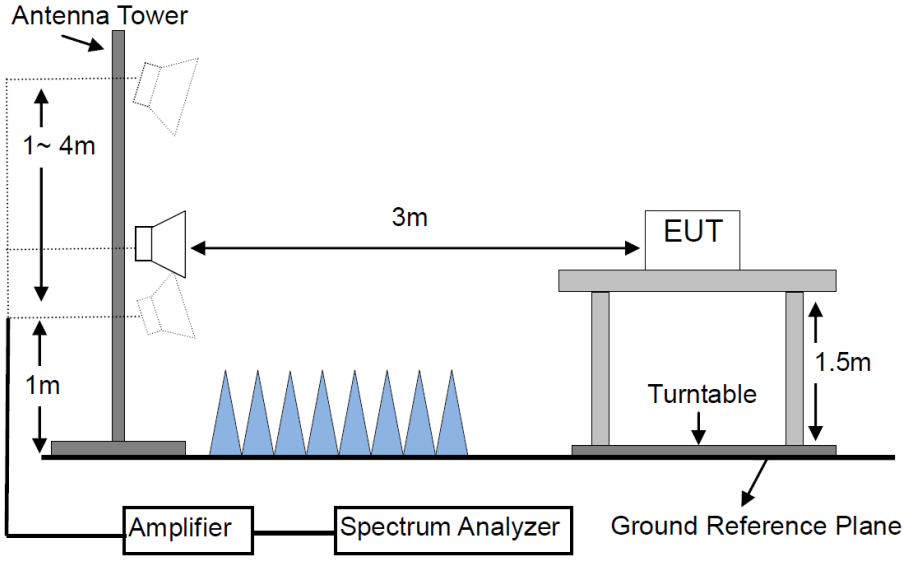
For Radiated Emission below 30MHz



For Radiated Emission 30-1000MHz



For Radiated Emission Above 1000MHz.



TEST PROCEDURES

a. Below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi- anechoic chamber room.

b. For the radiated emission test above 1GHz:

The EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter full anechoic chamber room. The table was rotated 360 degrees to determine the position of the highest radiation. Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, deSEC5000CAM2/RP on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal. The final measurement antenna elevation shall be that which maximizes the emissions. The measurement antenna elevation for maximum emissions shall be restricted to a range of heights of from 1 m to 4 m above the ground or reference ground plane.

c. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

d. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

e. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading. The test-receiver system was set to peak detect function and specified bandwidth with maximum hold mode.

f. A Quasi-peak measurement was then made for that frequency point for below 1GHz test. PK and AV for above 1GHz emission test.

During the radiated emission test, the spectrum analyzer was set with the following configurations:

Frequency Band (MHz)	Detector	Resolution Bandwidth	Video Bandwidth
0.009~0.15	QP & AVG	200 Hz	1 kHz
0.15~30	QP & AVG	10 kHz	30 kHz
30 to 1000	QP	120 kHz	300 kHz
Above 1000	Peak	1 MHz	3 MHz
	Average	1 MHz	10 Hz

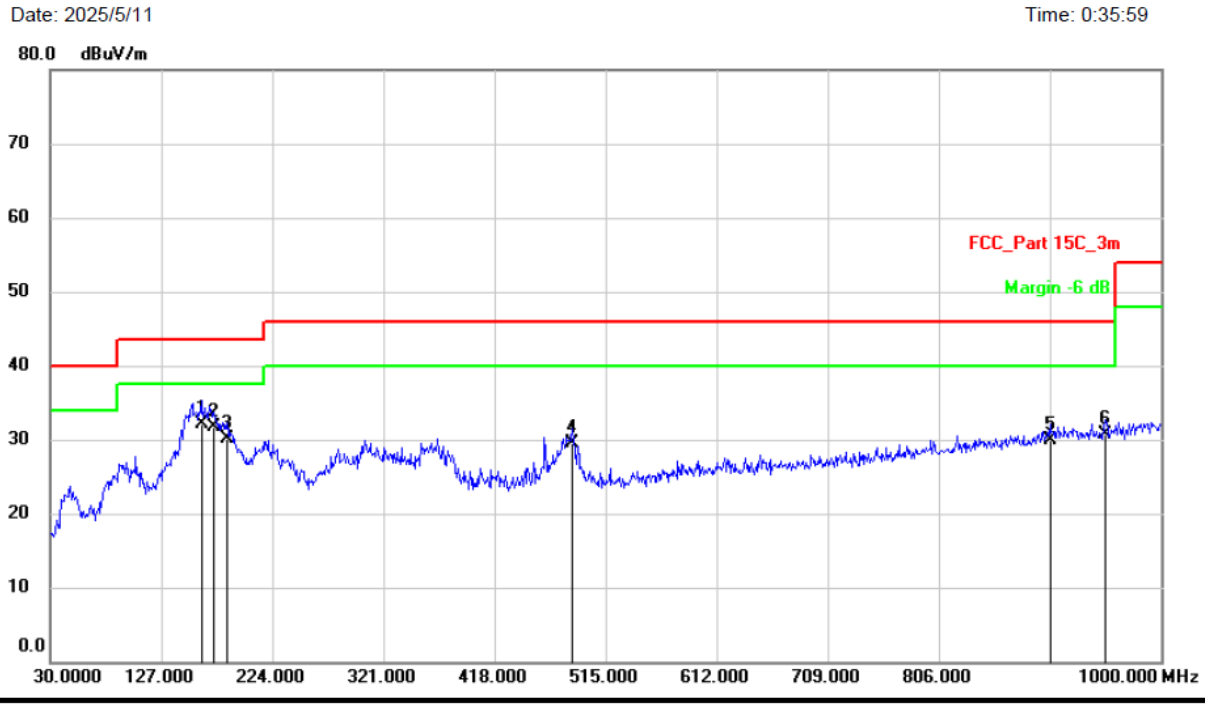
TEST RESULTS

PASS

Please refer to the following pages of the worst case.

M/N: SEC5000/CAM2/RP	Testing Voltage: AC 120V / 60Hz
Polarization: Horizontal	Detector: QP
Test Mode: 1	Distance: 3m

Radiated Emission Measurement

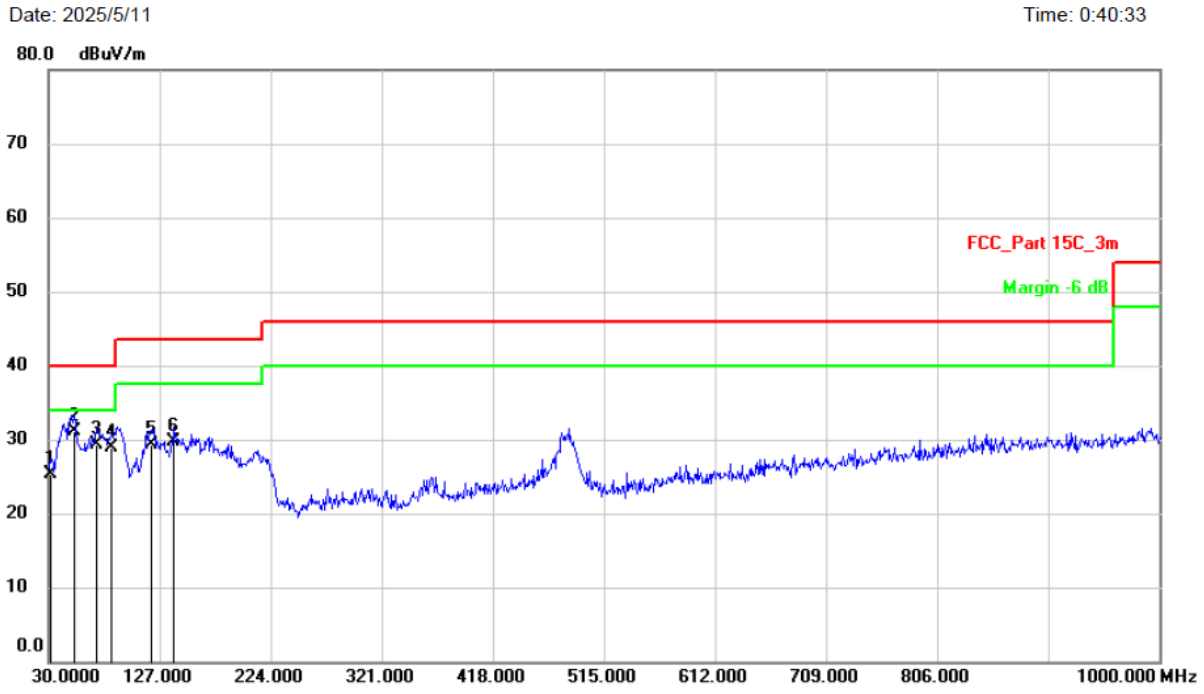


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector	Comment
1	*	161.9200	42.55	-10.35	32.20	43.50	-11.30	QP	
2		172.5900	41.53	-9.83	31.70	43.50	-11.80	QP	
3		184.2300	39.02	-8.82	30.20	43.50	-13.30	QP	
4		485.9000	31.46	-1.96	29.50	46.00	-16.50	QP	
5		903.0000	23.80	6.20	30.00	46.00	-16.00	QP	
6		951.5000	24.42	6.28	30.70	46.00	-15.30	QP	

Note: Below 30MHz, the emissions are lower than 20dB below the allowable limit.

M/N: SEC5000/CAM2/RP	Testing Voltage: AC 120V / 60Hz
Polarization: Vertical	Detector: QP
Test Mode: 1	Distance: 3m

Radiated Emission Measurement



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB/m	dBuV/m	dBuV/m	dB	Detector	Comment
1		31.9400	34.90	-9.60	25.30	40.00	-14.70	QP	
2	*	52.3100	38.50	-7.30	31.20	40.00	-8.80	QP	
3		71.7100	40.27	-10.87	29.40	40.00	-10.60	QP	
4		85.2900	39.62	-10.72	28.90	40.00	-11.10	QP	
5		119.2400	40.35	-11.05	29.30	43.50	-14.20	QP	
6		139.6100	41.18	-11.48	29.70	43.50	-13.80	QP	

Note: Below 30MHz, the emissions are lower than 20dB below the allowable limit.

Modulation: TX (IEEE 802.11ax (HE20))		Test Result: PASS					Test frequency range: 1-25GHz			
Freq. (MHz)	Ant. Pol. (H/V)	Reading Level(dBuV)		Factor (dB/m)	Emission Level (dBuV/m)		Limit 3m (dBuV/m)		Margin (dB)	
		PK	AV		PK	AV	PK	AV	PK	AV
Operation Mode: TX Mode (Low)										
4824	V	49.36	36.88	6.38	55.74	43.26	74.00	54.00	-18.26	-10.74
7236	V	44.87	30.54	10.48	55.35	41.02	74.00	54.00	-18.65	-12.98

4824	H	43.70	34.24	6.38	50.08	40.62	74.00	54.00	-23.92	-13.38
7236	H	45.21	30.66	10.48	55.69	41.14	74.00	54.00	-18.31	-12.86

Operation Mode: TX Mode (Mid)										
4874	V	50.13	38.56	6.56	56.69	45.12	74.00	54.00	-17.31	-8.88
7311	V	45.25	31.54	10.53	55.78	42.07	74.00	54.00	-18.22	-11.93

4874	H	48.42	37.40	6.56	54.98	43.96	74.00	54.00	-19.02	-10.04
7311	H	44.49	31.43	10.53	55.02	41.96	74.00	54.00	-18.98	-12.04

Operation Mode: TX Mode (High)										
4924	V	50.55	38.20	6.76	57.31	44.96	74.00	54.00	-16.69	-9.04
7386	V	44.90	31.76	10.57	55.47	42.33	74.00	54.00	-18.53	-11.67

4924	H	49.27	38.01	6.76	56.03	44.77	74.00	54.00	-17.97	-9.23
7386	H	44.65	31.57	10.57	55.22	42.14	74.00	54.00	-18.78	-11.86

Spurious Emission in restricted band:										
2390.000	V	62.23	48.91	0.09	62.32	49.00	74.00	54.00	-11.68	-5.00
2390.000	H	58.39	44.52	0.09	58.48	44.61	74.00	54.00	-15.52	-9.39
2483.500	V	61.86	46.72	0.34	62.20	47.06	74.00	54.00	-11.80	-6.94
2483.500	H	61.39	46.64	0.34	61.73	46.98	74.00	54.00	-12.27	-7.02

Remark: 1. All the points within the restricted band are lower than the edge punctuation of the restricted band shown in the data.
2. Data of measurement within this frequency range shown “---” in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits.

13.8 Antenna Requirement

STANDARD APPLICABLE

According to of FCC part 15C section 15.203 and 15.247:

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, 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.

Systems operating in the 2400-2483.5MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

ANTENNA CONNECTED CONSTRUCTION

The antenna is FPC antenna that no antenna other than furnished by the responsible party shall be used with the device, and the best case gain of the antenna is 3.88dBi, Therefore, the antenna is considered to meet the requirement.

14. Test Equipment List

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
1.	Test Receiver	Rohde & Schwarz	ESCI7	100837	Mar. 12, 2025	1 Year
2.	Antenna	Schwarzbeck	VULB9162	9162-010	Mar. 23, 2024	2 Year
3.	Spectrum Analyzer	Keysight	N9020A	MY54200831	Mar. 12, 2025	1 Year
4.	Spectrum Analyzer	Keysight	N9010B	MY62170254	Aug. 14, 2024	1 Year
5.	Power Sensor	Agilent	N1921A	MY48251036	Mar. 12, 2025	1 Year
6.	Power Meter	Agilent	N1912A	MY41497159	Mar. 12, 2025	1 Year
7.	Horn Antenna	COM-Power	AH-118	071078	Mar. 23, 2024	2 Year
8.	Pre-Amplifier	HP	HP 8449B	3008A00964	Mar. 12, 2025	1 Year
9.	Pre-Amplifier	HP	HP 8447D	1145A00203	Mar. 12, 2025	1 Year
10.	Loop Antenna	Schwarzbeck	FMZB 1513	1513-272	Mar. 23, 2024	2 Year
11.	Horn Antenna	COM-Power	AH-840	10100020	Mar. 23, 2024	2 Year
12.	Test Receiver	Rohde & Schwarz	ESCI	101152	Mar. 12, 2025	1 Year
13.	L.I.S.N	Rohde & Schwarz	ENV 216	101317	Mar. 12, 2025	1 Year
14.	L.I.S.N	Rohde & Schwarz	ESH2-Z5	893606/014	Mar. 12, 2025	1 Year
15.	RF Switching Unit	Compliance Direction Systems Inc.	RSU-M2	38311	Mar. 12, 2025	1 Year
16.	Temperature & Humidity Chamber	Wanshun	SS-HWHS-80	N/A	Mar. 12, 2025	1 Year
17.	DC Source	Maynuo	MY8811	N/A	Mar. 12, 2025	1 Year
18.	Temporary antenna connector	TESCOM	SS402	N/A	N/A	N/A
19.	Chamber	SAEMC	9*7*7m	N/A	Apr. 21, 2025	2 Year
20.	Attenuator	Mini-circuits	BW-S10W2+	N/A	N/A	N/A
21.	Test Software	EZ	EZ_EMC, NTC-3A1.1	N/A	N/A	N/A
22.	Test Software	MWRF	MTS 8310, V2.0.0.0	N/A	N/A	N/A

Note: For photographs of EUT and measurement, please refer to appendix in separate documents.

---End---