6. 26DB & 99% EMISSION BANDWIDTH

6.1 APPLIED PROCEDURES / LIMIT

The maximum power spectral density is measured as a conducted emission by direct connection of a calibrated test instrument to the equipment under test. If the device cannot be connected directly, alternative techniques acceptable to the Commission may be used. Measurements in the 5.725-5.85 GHz band, the minimum bandwidth 6 dB bandwidth of U-NII devices shall be at least 500KHz. Measurements in the 5.15-5.25 GHz, 5.25-5.35 GHz, and the 5.47-5.725 GHz bands are made over a bandwidth of 1 MHz or the 26 dB emission bandwidth of the device, whichever is less. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full reference bandwidth.

6.2 TEST PROCEDURE

a) Set RBW = 100KHz.

b) Set the VBW > RBW.

c) Detector = Peak.

d) Trace mode = max hold.

e) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

The following procedure shall be used for measuring (99 %) power bandwidth:

1. Set center frequency to the nominal EUT channel center frequency.
2. Set span = 1.5 times to 5.0 times the OBW.
3. Set RBW = 1 % to 5 % of the OBW
4. Set VBW ≥ 3 · RBW
5. Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
6. Use the 99 % power bandwidth function of the instrument (if available).
7. If the instrument does not have a 99 % power bandwidth function, the trace data points are recovered and directly summed in power units. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 % of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5 % of the total is reached; that frequency is recorded as the upper frequency. The 99% occupied bandwidth is the difference between these two frequencies.

6.3 EUT OPERATION CONDITIONS

The EUT tested system was configured as the statements of 2.4 Unless otherwise a special operating condition is specified in the follows during the testing.

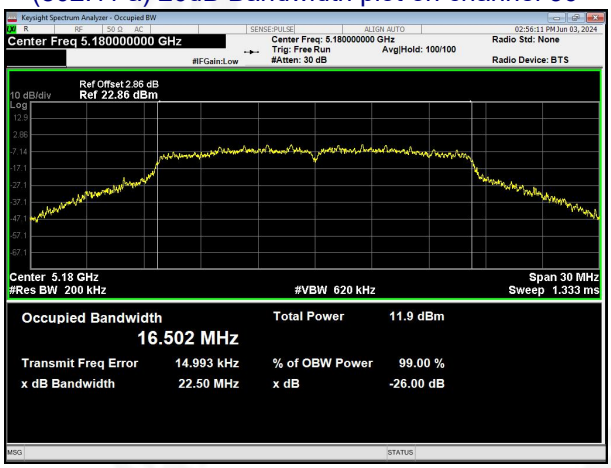
6.4 TEST RESULTS

Temperature：	26 ℃	Relative Humidity：	54%
Pressure：	101kPa	Test Voltage ：	AC 120V/60Hz
Test Mode ：	TX-Worst Case ANT1		

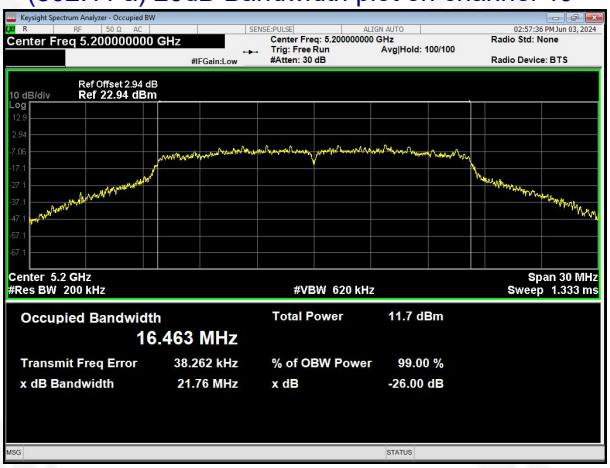
Mode	Channel	Frequency (MHz)	26dB bandwidth (MHz)	99% bandwidth(MHz)	Limit(KHz)	Result
802.11a	CH36	5180	22.5	16.50	>500	Pass
	CH40	5200	21.76	16.46		
	CH48	5240	22.01	16.50		
802.11 n20	CH36	5180	21.93	17.64		
	CH40	5200	22.00	17.60		
	CH48	5240	22.41	17.61		
802.11 n40	CH38	5190	43.40	36.04		
	CH46	5230	42.00	35.97		
802.11 ac20	CH36	5180	22.74	17.62		
	CH40	5200	23.03	17.61		
	CH48	5240	22.17	17.58		
802.11 ac40	CH38	5190	41.55	36.01		
	CH46	5230	42.62	36.00		
802.11 AC80	CH42	5210	84.99	75.09		

Test plot-ANT1

(802.11 a) 26dB Bandwidth plot on channel 36



(802.11 a) 26dB Bandwidth plot on channel 40

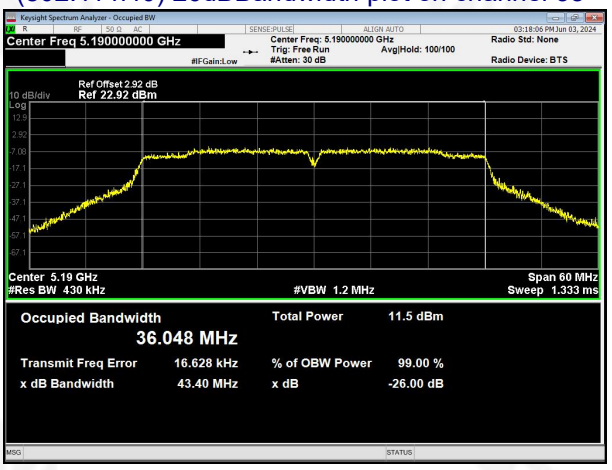


(802.11 a) 26dB Bandwidth plot on channel 48

Test plot

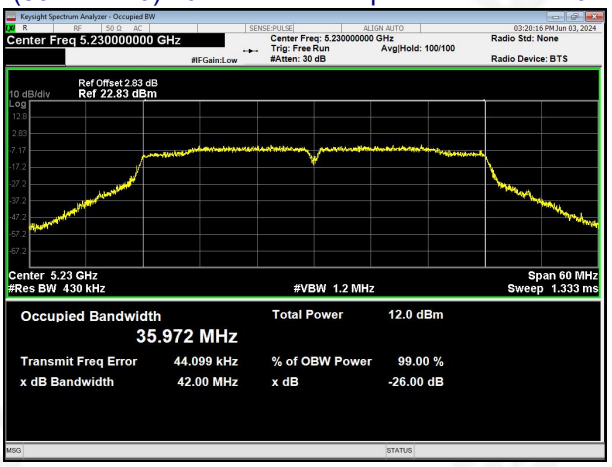
(802.11 n20) 26dB Bandwidth plot on channel 36

(802.11 n40) 26dBBandwidth plot on channel 38

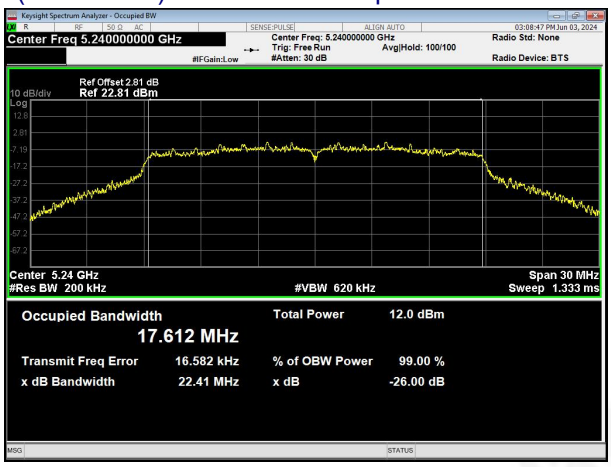


(802.11 n20) 26dB Bandwidth plot on channel 40

(802.11 n40) 26dB Bandwidth plot on channel 46

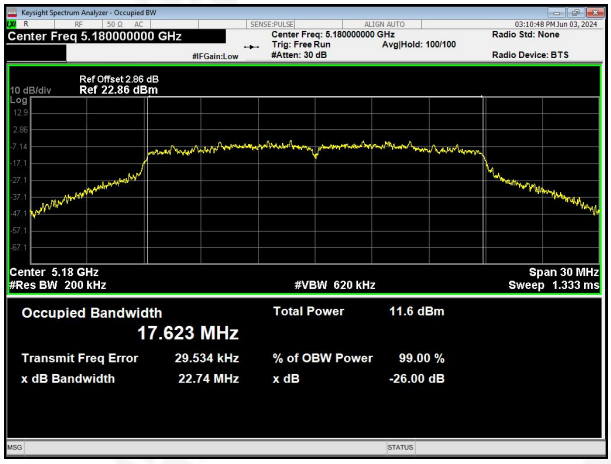


(802.11 n20) 26dB Bandwidth plot on channel 48

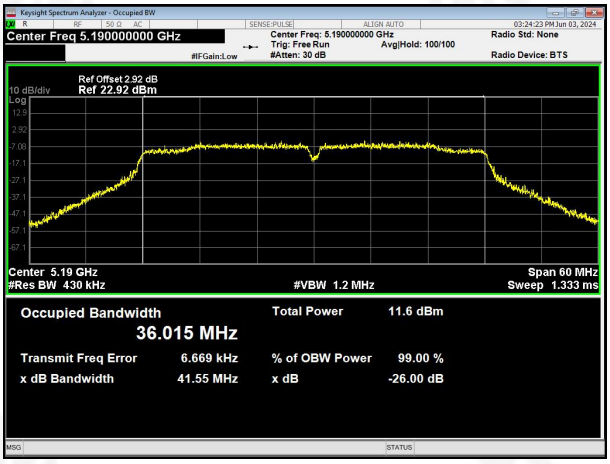


Test plot

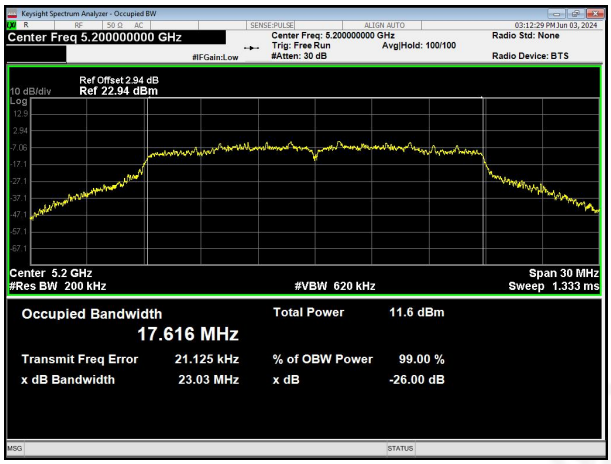
(802.11ac20) 99%Bandwidth plot on channel 36



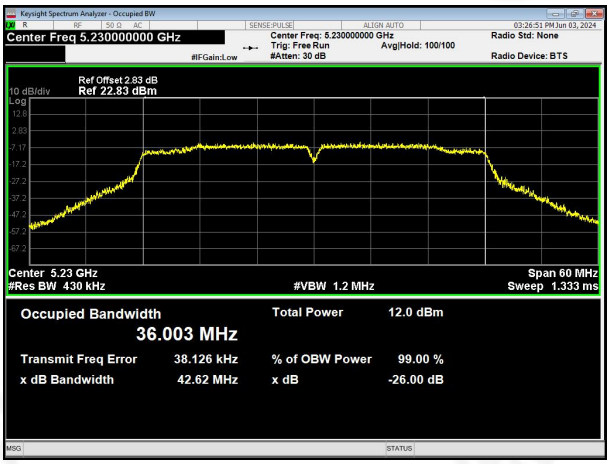
(802.11 ac40) 99% Bandwidth plot on channel 42



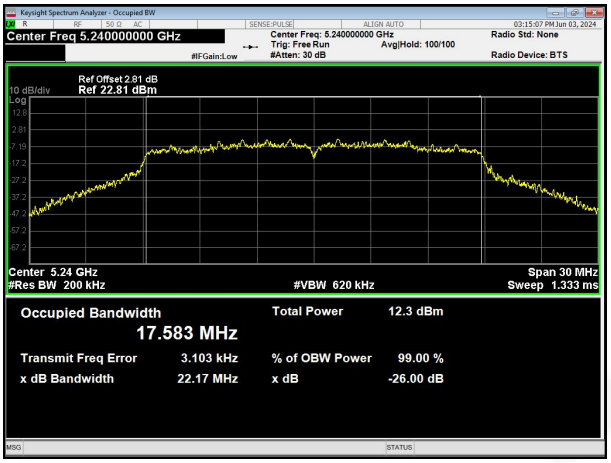
(802.11ac20) 99%Bandwidth plot on channel 40



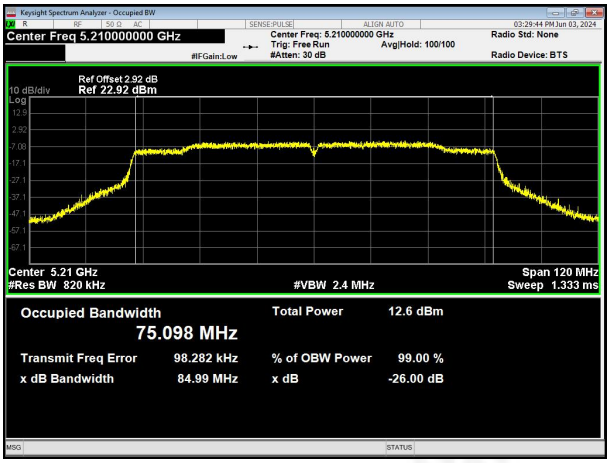
(802.11 ac40) 99% Bandwidth plot on channel 42



(802.11ac20) 99%Bandwidth plot on channel 48



(802.11 ac80) 26dB Bandwidth plot on channel 42



7.MAXIMUM CONDUCTED OUTPUT POWER

7.1 PPLIED PROCEDURES / LIMIT

According to FCC §15.407
The maximum conduced output power should not exceed:

Frequency Band(MHz)	Limit
5150~5250	250mW
5725~5850	1W

7.2 TEST PROCEDURE

The EUT was directly connected to the Power meter

1. Device Configuration
If possible, configure or modify the operation of the EUT so that it transmits continuously at its maximum power control level (see section II.B.).
a) The intent is to test at 100 percent duty cycle; however a small reduction in duty cycle (to no lower than 98 percent) is permitted if required by the EUT for amplitude control purposes. Manufacturers are expected to provide software to the test lab to permit such continuous operation.
b) If continuous transmission (or at least 98 percent duty cycle) cannot be achieved due to hardware limitations (e.g., overheating), the EUT shall be operated at its maximum power control level with the transmit duration as long as possible and the duty cycle as high as possible.

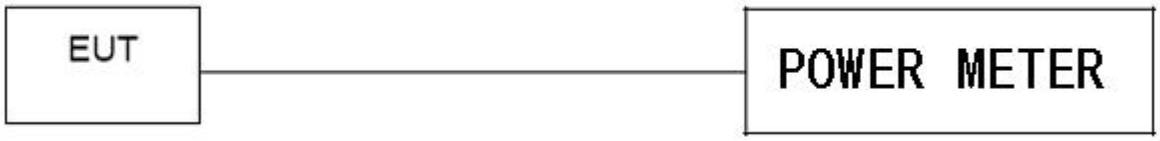
2. Measurement using a Spectrum Analyzer or EMI Receiver (SA)
Measurement of maximum conducted output power using a spectrum analyzer requires integrating the spectrum across a frequency span that encompasses, at a minimum, either the EBW or the 99-percent occupied bandwidth of the signal.1 However, the EBW must be used to determine bandwidth dependent limits on maximum conducted output power in accordance with § 15.407(a).
a) The test method shall be selected as follows: (i) Method SA-1 or SA-1 Alternative (averaging with the EUT transmitting at full power throughout each sweep) shall be applied if either of the following conditions can be satisfied:
• The EUT transmits continuously (or with a duty cycle ≥ 98 percent).
• Sweep triggering or gating can be implemented in a way that the device transmits at the maximum power control level throughout the duration of each of the instrument sweeps to be averaged. This condition can generally be achieved by triggering the instrument's sweep if the duration of the sweep (with the analyzer configured as in Method SA-1, below) is equal to or shorter than the duration T of each transmission from the EUT and if those transmissions exhibit full power throughout their durations.
(ii) Method SA-2 or SA-2 Alternative (averaging across on and off times of the EUT transmissions, followed by duty cycle correction) shall be applied if the conditions of (i) cannot be achieved and the transmissions exhibit a constant duty cycle during the measurement duration. Duty cycle will be considered to be constant if variations are less than ± 2 percent.
(iii) Method SA-3 (RMS detection with max hold) or SA-3 Alternative (reduced VBW with max hold) shall be applied if the conditions of (i) and (ii) cannot be achieved.
b) Method SA-1 (trace averaging with the EUT transmitting at full power throughout each sweep): (i) Set span to encompass the entire emission bandwidth (EBW) (or, alternatively, the entire 99% occupied bandwidth) of the signal.
(ii) Set RBW = 1 MHz.
(iii) Set VBW ≥ 3 MHz.
(iv) Number of points in sweep ≥ 2 Span / RBW. (This ensures that bin-to-bin spacing is ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
(v) Sweep time = auto.
(vi) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.
(vii) If transmit duty cycle < 98 percent, use a video trigger with the trigger level set to enable triggering only on full power pulses. Transmitter must operate at maximum power control level for the entire duration of every sweep. If the EUT transmits continuously (i.e., with no off intervals) or at duty cycle ≥ 98 percent, and if each transmission is entirely at the maximum power control level, then the trigger shall be set to "free run".
(viii) Trace average at least 100 traces in power averaging (i.e., RMS) mode.

(ix) Compute power by integrating the spectrum across the EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal using the instrument's band power measurement function with band limits set equal to the EBW (or occupied bandwidth) band edges. If the instrument does not have a band power function, sum the spectrum

7.3 DEVIATION FROM STANDARD

No deviation.

7.4 TEST SETUP



7.5 EUT OPERATION CONDITIONS

The EUT tested system was configured as the statements of 2.4 Unless otherwise a special operating condition is specified in the follows during the testing.

7.6 TEST RESULTS

Temperature :	26 ℃	Relative Humidity :	54%
Pressure :	1012 hPa	Test Voltage :	AC 120V/60Hz
Test Mode :	TX		

Test Channel	Frequency	Maximum output power			LIMIT	Result
	(MHz)	(dBm)			dBm	
TX 802.11 a Mode		ANT1	ANT2	Total		
CH36	5180	7.12	6.46	\	23.98	Pass
CH40	5200	7.08	7.58	\	23.98	Pass
CH48	5240	7.13	6.41	\	23.98	Pass
TX 802.11 n20M Mode						
CH36	5180	4.24	4.51	7.38	23.98	Pass
CH40	5200	4.31	4.68	7.50	23.98	Pass
CH48	5240	4.29	4.71	7.51	23.98	Pass
TX 802.11 n40M Mode						
CH38	5190	4.48	4.65	7.57	23.98	Pass
CH46	5230	4.27	4.42	7.35	23.98	Pass
TX 802.11 ac20M Mode						
CH36	5180	4.65	4.39	7.53	23.98	Pass
CH40	5200	4.48	4.48	7.49	23.98	Pass
CH48	5240	4.25	4.42	7.34	23.98	Pass
TX 802.11 ac40M Mode						
CH38	5190	4.46	4.65	7.56	23.98	Pass
CH46	5230	4.43	4.28	7.36	23.98	Pass
TX 802.11 ac80M Mode						
CH42	5210	4.72	4.74	7.74	23.98	Pass

8.OUT OF BAND EMISSIONS

8.1 APPLICABLE STANDARD

According to FCC §15.407(b)

Undesirable emission limits. Except as shown in paragraph (b)(7) of this section, the maximum emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

(1) For transmitters operating in the 5.15-5.25 GHz band: All emissions outside of the 5.15-5.35 GHz band shall not exceed an e.i.r.p. of −27 dBm/MHz.

(2)

(i) All emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

8.2 TEST PROCEDURE

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 1 MHz with a convenient frequency span.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

8.3 DEVIATION FROM STANDARD

No deviation.

8.4 TEST SETUP

8.5 EUT OPERATION CONDITIONS

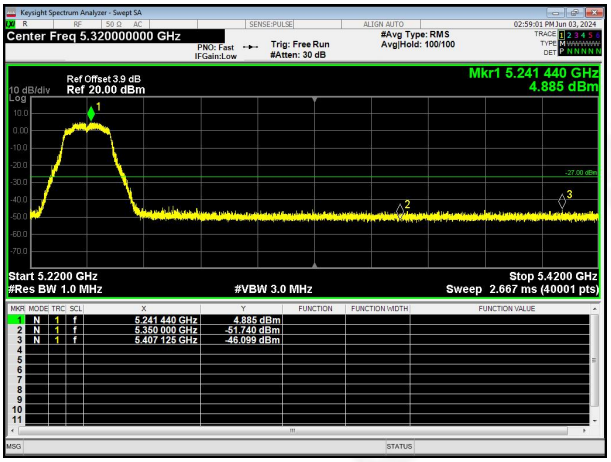
The EUT tested system was configured as the statements of 2.4 Unless otherwise a special operating condition is specified in the follows during the testing.

8.6 TEST RESULTS

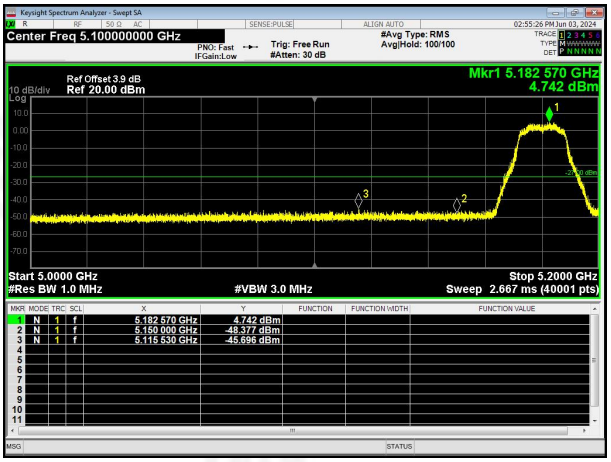
Temperature：	26 ℃	Relative Humidity：	54%
Pressure：	1012 hPa	Test Voltage ：	AC 120V/60Hz

5.180~5.240 GHz

(802.11a) Band Edge, Left Side

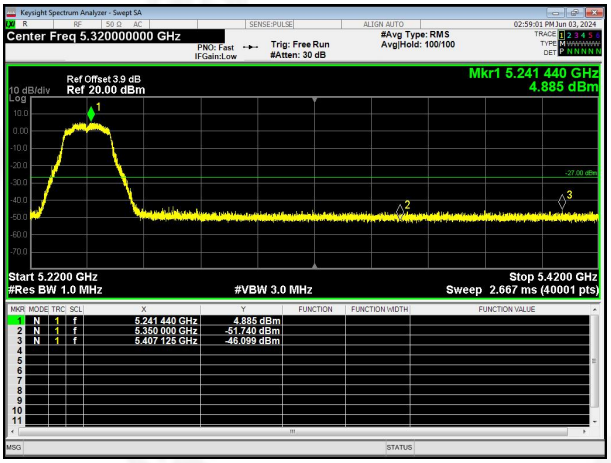


(802.11a) Band Edge, Right Side

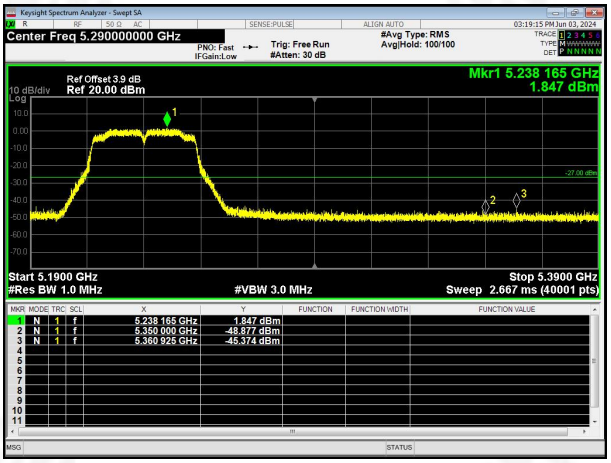


5.180~5.240 GHz

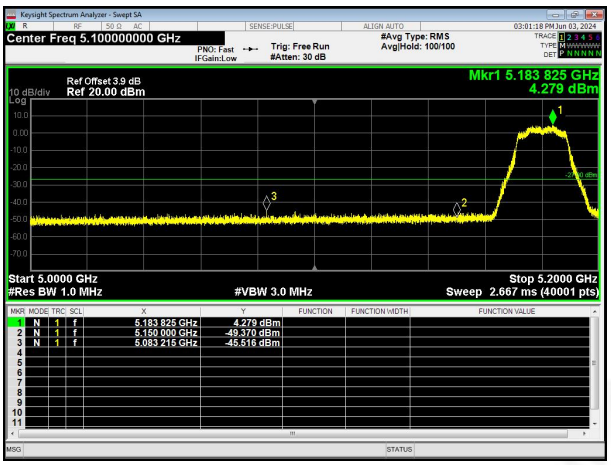
(802.11n20) Band Edge, Left Side



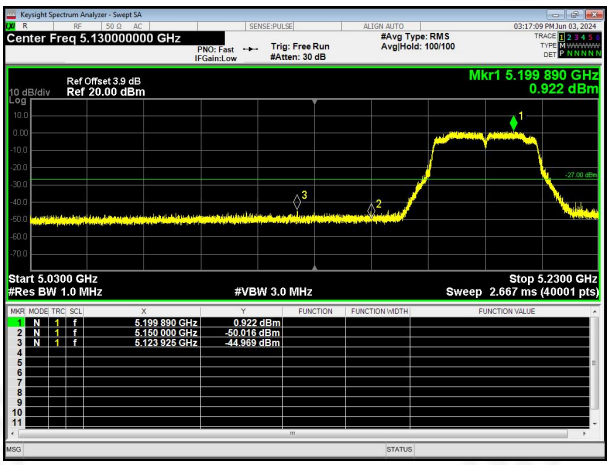
(802.11n40) Band Edge, Left Side



(802.11 n20) Band Edge, Right Side

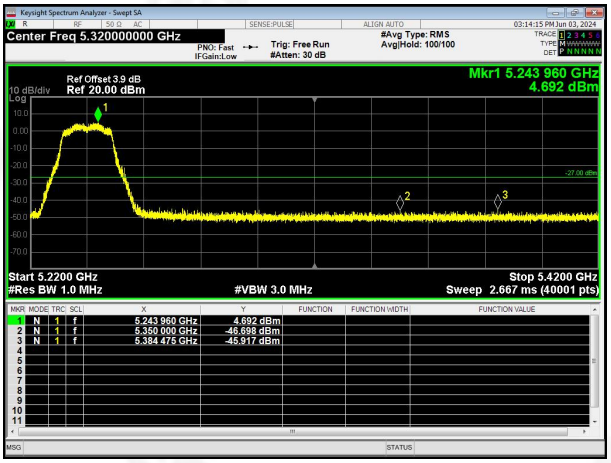


(802.11n40) Band Edge, Right Side

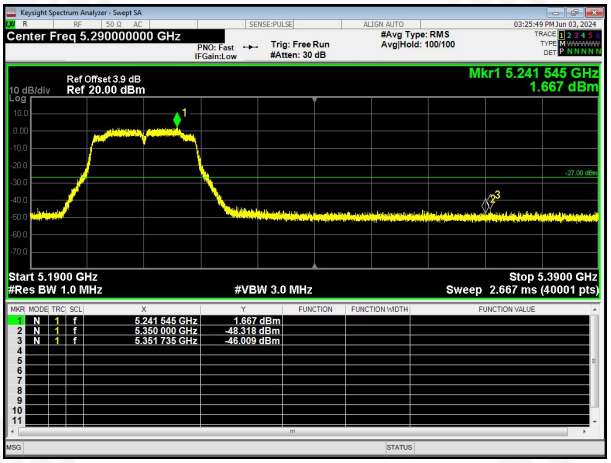


5.180~5.240 GHz

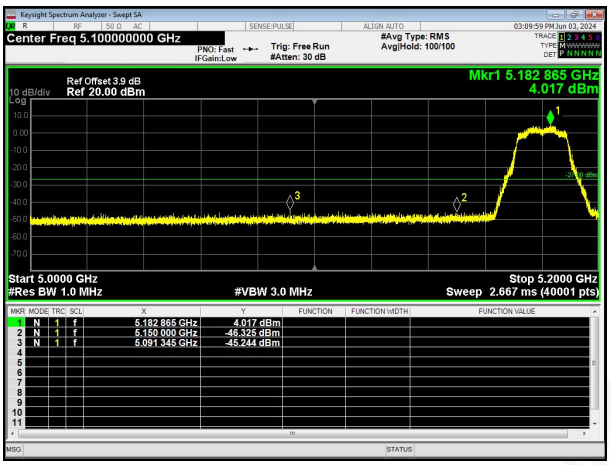
(802.1ac20) Band Edge, Left Side



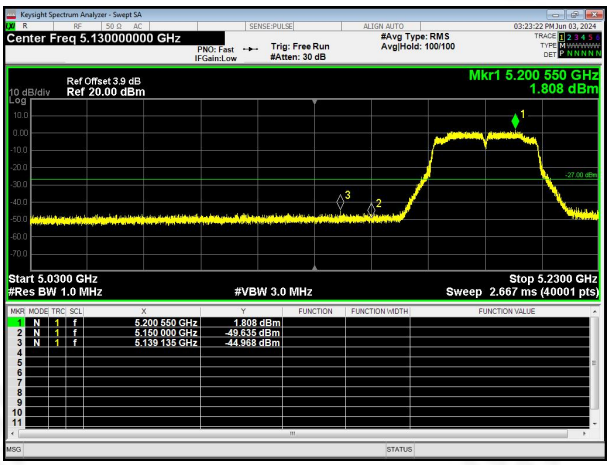
(802.11ac40) Band Edge, Left Side



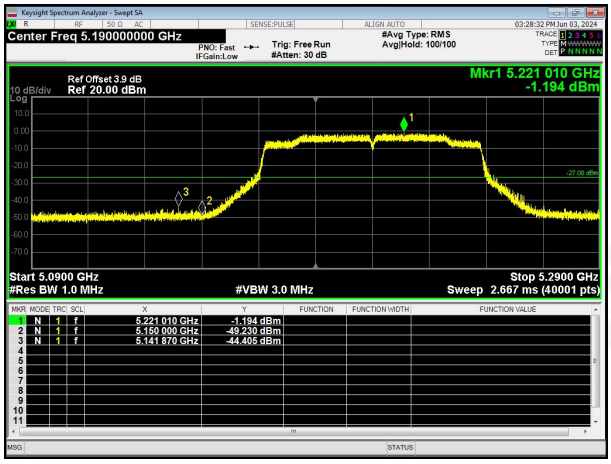
(802.11ac20) Band Edge, Right Side



(802.11ac40) Band Edge, Right Side



(802.11ac80) Band Edge



Note:
The test plot shows only the worst case ANT1.

9.SPURIOUS RF CONDUCTED EMISSIONS

9.1 CONFORMANCE LIMIT

Frequency Band (MHz)	Limit
5150 - 5250	Outside of the 5.15-5.35 GHz band: e.i.r.p. -27 dBm
5250 - 5350	Outside of the 5.15-5.35 GHz band: e.i.r.p. -27 dBm
5470 - 5725	Outside of the 5.47-5.725 GHz band: e.i.r.p. -27 dBm
5725 - 5850	All emissions shall be limited to a level of -27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

9.2 MEASURING INSTRUMENTS

The Measuring equipment is listed in the section 6.3 of this test report.

9.3 TEST SETUP

9.4 TEST PROCEDURE

The Spurious RF conducted emissions compliance of RF radiated emission should be measured by following the guidance in ANSI C63.10-2013 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization etc. Set RBW=1MHz and VBW= 3MHz to measure the peak field strength, and measure frequency range from 30MHz to 26.5GHz.

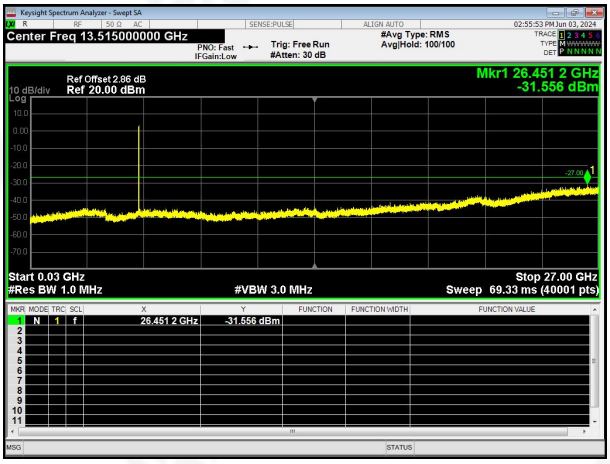
9.5 TEST RESULTS

Remark: The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. And above 26.5GHz of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported. The lowest, middle and highest channels are tested to verify the spurious emissions and band edge measurement data.

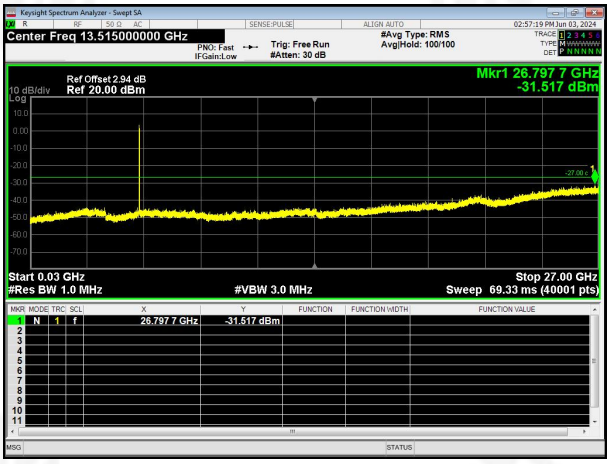
5.2G

Test Plot

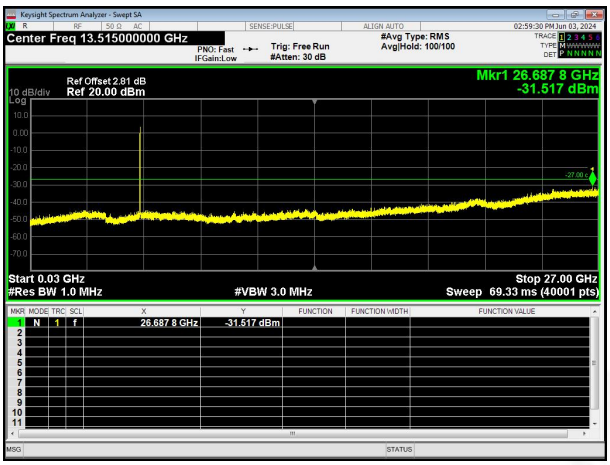
802.11a on channel 36



802.11n20 on channel 40

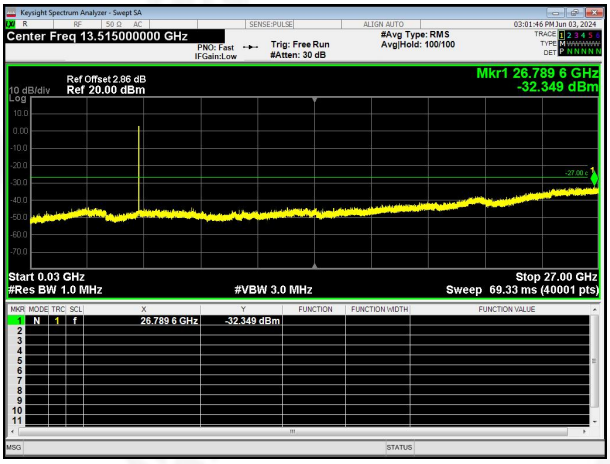


802.11a on channel 48

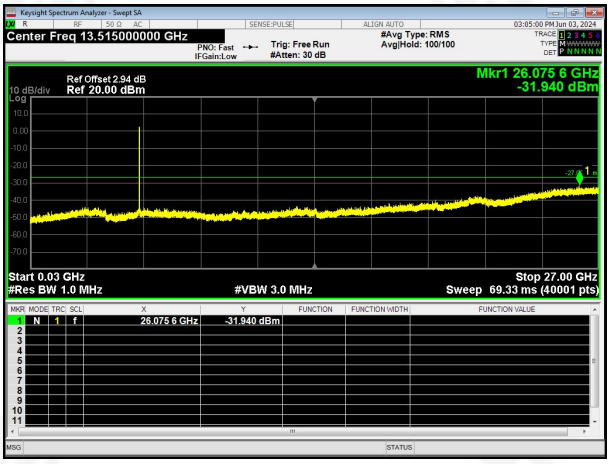


Test Plot

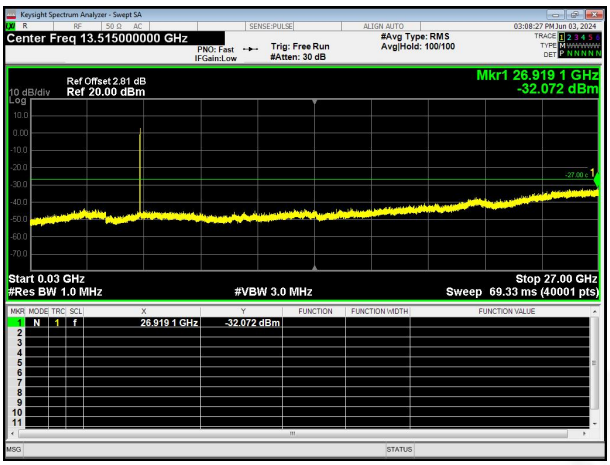
802.11n20 on channel 36



802.11n20 on channel 40

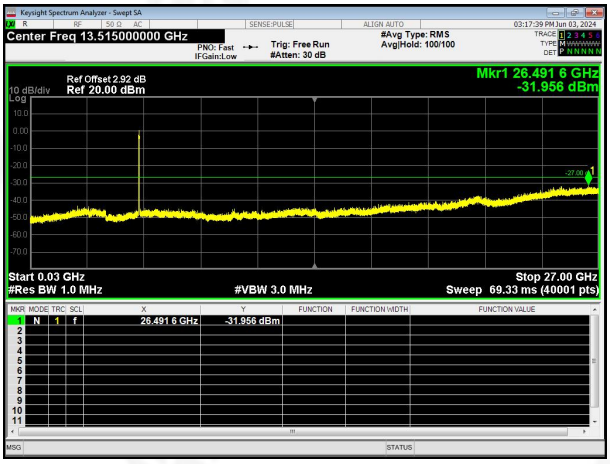


802.11n20 on channel 48

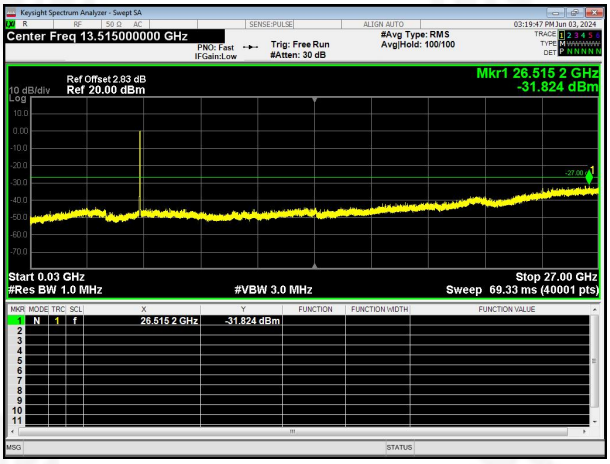


Test Plot

802.11n40 on channel 38

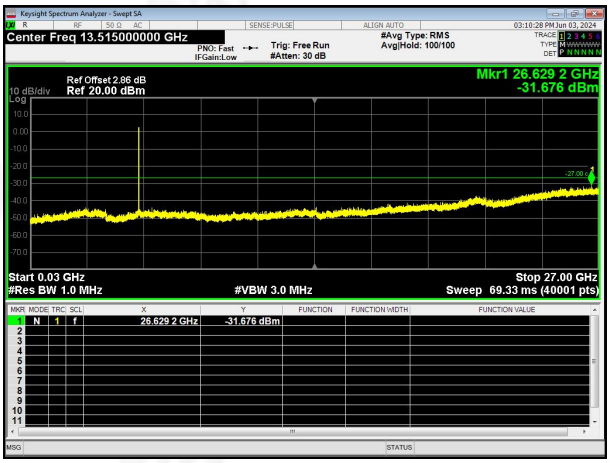


802.11n40 on channel 46

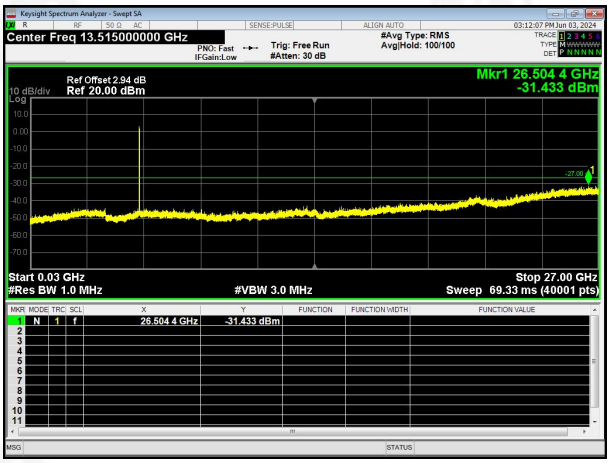


Test Plot

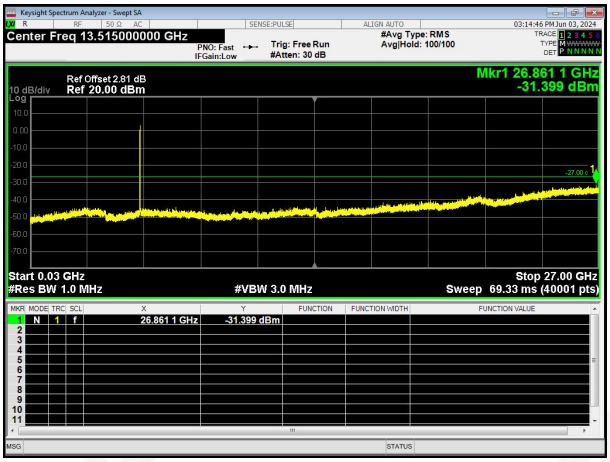
802.11ac20 on channel 36



802.11ac20 on channel 40

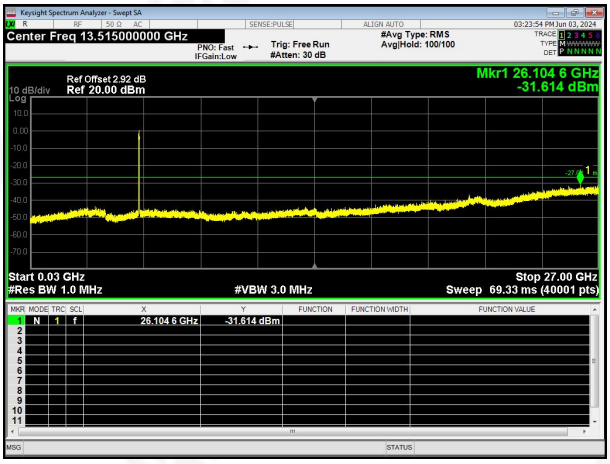


802.11ac20 on channel 48

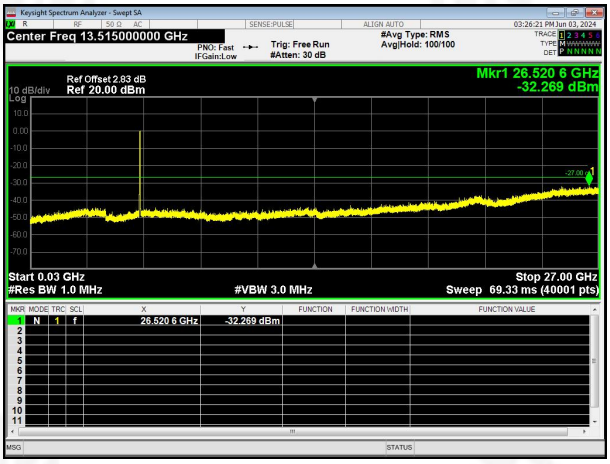


Test Plot

802.11ac40 on channel 38

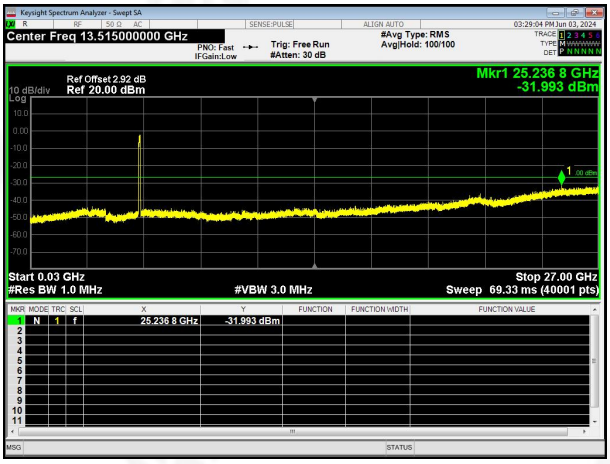


802.11ac40 on channel 46



Test Plot

802.11ac80 on channel 42



10.Frequency Stability Measurement

10.1 LIMIT

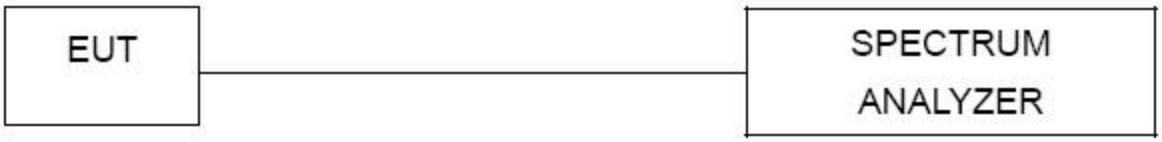
Manufactures of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual.

The transmitter center frequency tolerance shall be ± 20 ppm maximum for the 5 GHz band (IEEE 802.11n specification).

10.2 TEST PROCEDURES

1. The transmitter output (antenna port) was connected to the spectrum analyzer.
2. EUT have transmitted absence of modulation signal and fixed channelize.
3. Set the spectrum analyzer span to view the entire absence of modulation emissions bandwidth.
4. Set RBW = 10 kHz, VBW = 10 kHz with peak detector and maxhold settings.
5. fc is declaring of channel frequency. Then the frequency error formula is (fc-f)/fc × 106 ppm and the limit is less than ±20ppm (IEEE 802.11nspecification).
6. The test extreme voltage is to change the primary supply voltage from 85 to 115 percent of the nominal value
7. Extreme temperature is -20°C~70°C.

10.3 TEST SETUP LAYOUT



10.4 EUT OPERATION DURING TEST

The EUT was programmed to be in continuously un-modulation transmitting mode.

10.5 TEST RESULTS

Temperature：	26 ℃	Relative Humidity：	54%
Pressure：	1012 hPa	Test Voltage ：	AC 120V/60Hz
Test Mode ：	TX		

802.11a

Reference Frequency(Middle Channel): 5200MHz			
Environment Temperature (°C)	Power Supplied (VAC)	Frequency Measure with Time Elapsed	
		MCF	Error (ppm)
50	120	0.04	7.69
40	120	0.07	13.46
30	120	0.06	11.54
20	120	0.08	15.38
10	120	0.05	9.62
0	120	0.05	9.62
-10	120	0.05	9.62
-20	120	0.06	11.54
-30	120	0.07	13.46

802.11n_HT20

Reference Frequency(Middle Channel): 5200MHz			
Environment Temperature (°C)	Power Supplied (VAC)	Frequency Measure with Time Elapsed	
		MCF	Error (ppm)
50	120	0.05	9.62
40	120	0.04	7.69
30	120	0.06	11.54
20	120	0.05	9.62
10	120	0.04	7.69
0	120	0.06	11.54
-10	120	0.07	13.46
-20	120	0.05	9.62
-30	120	0.06	11.54

802.11n_HT40

Reference Frequency(Middle Channel): 5190MHz			
Environment Temperature (°C)	Power Supplied (VAC)	Frequency Measure with Time Elapsed	
		MCF	Error (ppm)
50	120	0.05	9.63
40	120	0.04	7.71
30	120	0.05	9.63
20	120	0.06	11.56
10	120	0.05	9.63
0	120	0.07	13.49
-10	120	0.07	13.49
-20	120	0.05	9.63
-30	120	0.06	11.56

802.11 ac20

Reference Frequency(Middle Channel): 5200 MHz			
Environment Temperature (°C)	Power Supplied (VAC)	Frequency Measure with Time Elapsed	
		MCF	Error (ppm)
50	120	0.05	9.62
40	120	0.07	13.46
30	120	0.05	9.62
20	120	0.06	11.54
10	120	0.05	9.62
0	120	0.04	7.69
-10	120	0.05	9.62
-20	120	0.06	11.54
-30	120	0.05	9.62

802.11ac40

Reference Frequency(Middle Channel): 5190MHz			
Environment Temperature (°C)	Power Supplied (VAC)	Frequency Measure with Time Elapsed	
		MCF	Error (ppm)
50	120	0.05	9.63
40	120	0.07	13.49
30	120	0.05	9.63
20	120	0.06	11.56
10	120	0.06	11.56
0	120	0.05	9.63
-10	120	0.06	11.56
-20	120	0.07	13.49
-30	120	0.04	7.71

802.11ac80

Reference Frequency(Middle Channel): 5210MHz			
Environment Temperature (°C)	Power Supplied (VAC)	Frequency Measure with Time Elapsed	
		MCF	Error (ppm)
50	120	0.03	5.76
40	120	0.06	11.52
30	120	0.05	9.60
20	120	0.06	11.52
10	120	0.06	11.52
0	120	0.05	9.60
-10	120	0.07	13.44
-20	120	0.08	15.36
-30	120	0.08	15.36

So, Frequency Stability Versus Input Voltage is:

802.11a

Reference Frequency(Middle Channel): 5200 MHz			
Environment Temperature (°C)	Power Supplied (VAC)	Frequency Measure with Time Elapsed	
		Frequency	Error (ppm)
20	120	0.06	11.54
	120	0.07	13.46
	120	0.06	11.54

802.11n_HT20

Reference Frequency(Middle Channel): 5200 MHz			
Environment Temperature (°C)	Power Supplied (VAC)	Frequency Measure with Time Elapsed	
		Frequency	Error (ppm)
20	120	0.03	5.77
	120	0.05	9.62
	120	0.05	9.62

802.11n_HT40

Reference Frequency(Middle Channel): 5190 MHz			
Environment Temperature (°C)	Power Supplied (VAC)	Frequency Measure with Time Elapsed	
		Frequency	Error (ppm)
20	120	0.07	13.49
	120	0.05	9.63
	120	0.06	11.56

802.11ac20

Reference Frequency(Middle Channel): 5200 MHz			
Environment Temperature (°C)	Power Supplied (VAC)	Frequency Measure with Time Elapsed	
		Frequency	Error (ppm)
20	120	0.05	9.62
	120	0.07	13.46
	120	0.06	11.54

802.11ac40

Reference Frequency(Middle Channel): 5190 MHz			
Environment Temperature (°C)	Power Supplied (VAC)	Frequency Measure with Time Elapsed	
		Frequency	Error (ppm)
20	120	0.08	15.41
	120	0.06	11.56
	120	0.08	15.41

802.11ac80

Reference Frequency(Middle Channel): 5210 MHz			
Environment Temperature (°C)	Power Supplied (VAC)	Frequency Measure with Time Elapsed	
		Frequency	Error (ppm)
20	120	0.05	9.60
	120	0.03	5.76
	120	0.04	7.68

Note:
The test plot shows only the worst case ANT1.

11.ANTENNA REQUIREMENT

Standard requirement:	FCC Part15 C Section 15.203
15.203 requirement: 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.	
EUT Antenna:	
The antenna is FPCB Antenna, the best case gain of the antenna is 2.5dBi, reference to the appendix II for details	

12. TEST SETUP PHOTO

Reference to the appendix I for details.

13. EUT CONSTRUCTIONAL DETAILS

Reference to the appendix II for details.

※※※※※ END OF REPORT ※※※※※