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TEST CONDITIONS

POWER SUPPLY (V):

V nonimal:	12 Vdc.
Type of Power Supply:	DC External (Car Battery).

ANTENNA:

Type of Antenna:	External.
Maximum Declared Antenna Gain:	-6.2 dBi

TEST FREQUENCIES FOR 802.11 bgn20:

Low Channel (1):	2412 MHz
Middle Channel (6):	2437 MHz
High Channel (11):	2462 MHz

The sample was used to configure the EUT to continuously transmit at a specified output power in all channels with different modes and modulation schemes.

The field strength at the band edges was evaluated for each mode for the channel under test.

During transmitter test the EUT was being controlled by the SW tool to operate in a continuous transmit mode on the test channel as required and in each of the different modulation modes.

The EUT has four separate antennas which correspond to one port of the equipment.

The data rates of 1 Mbps for 802.11 b, 6.5 Mbps for 802.11 g, MCS0 for 802.11 n20 were selected based on preliminary testing that identified those rates corresponding to the worst cases for output power and band edge levels at restricted bands.

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is connected to the spectrum analyser using a low loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.

The DC supply voltage is applied using an external calibrated power supply with a multimeter.

RADIATED MEASUREMENTS

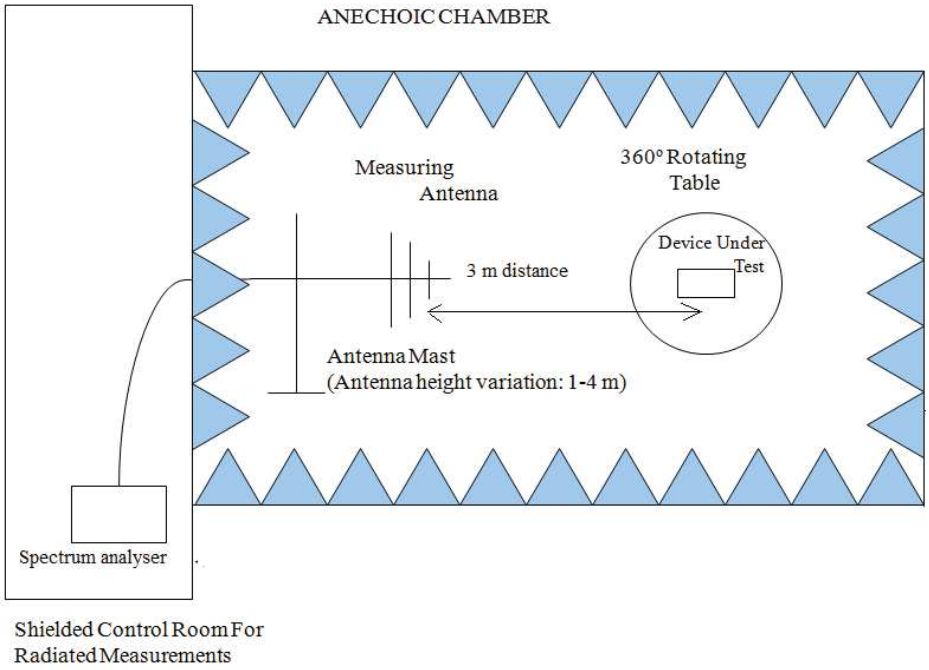
All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range between 30 MHz to 1000 MHz) and 1 GHz-18 GHz Double ridge horn antenna is situated at a distance of 3 m and a distance of 1m for the frequency range 17 GHz-26 GHz (18 GHz-40 GHz horn antenna).

For radiated emissions in the range 17 GHz-26 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

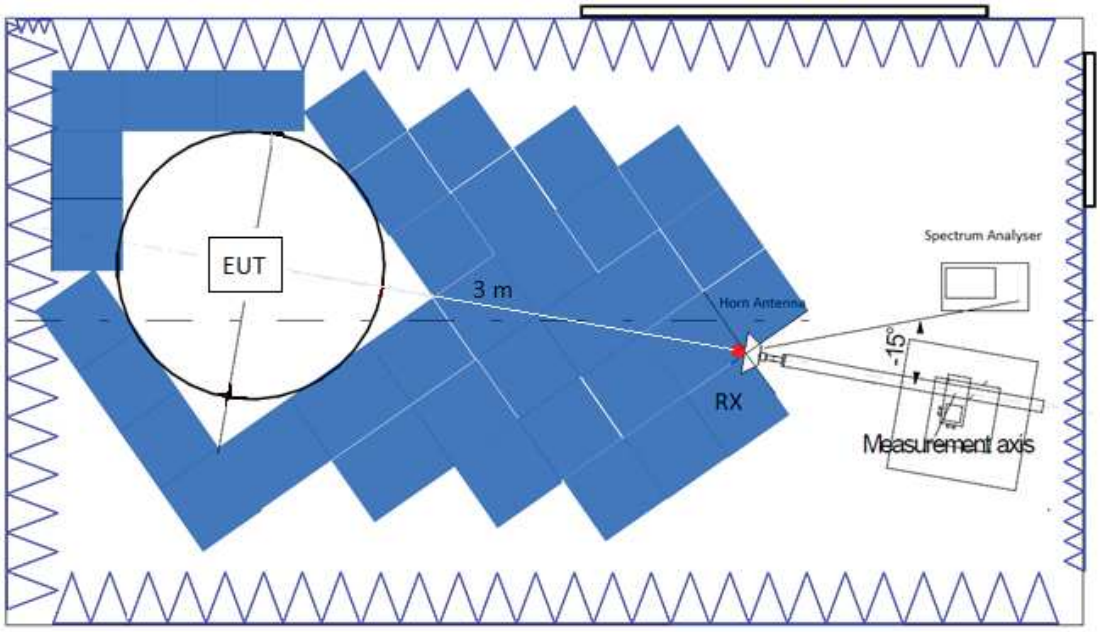
The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height (Bilog antenna and Double ridge horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

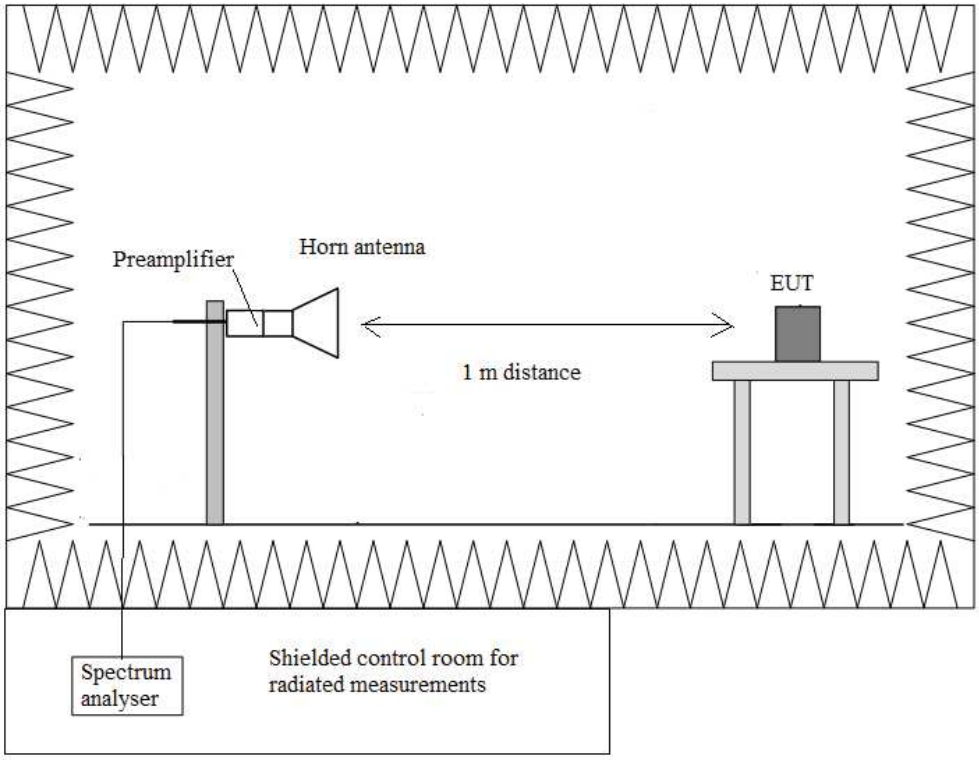
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup f > 17 GHz:



Occupied Bandwidth

RESULTS:

- **Mode 802.11 b:**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
99% bandwidth (MHz)	10.963	11.076	11.081
-26 dBc bandwidth (MHz)	14.298	14.325	14.328
Measurement uncertainty (kHz)	<± 35.41		

- **Mode 802.11 g:**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
99% bandwidth (MHz)	16.845	16.849	16.837
-26 dBc bandwidth (MHz)	21.193	21.257	21.193
Measurement uncertainty (kHz)	<± 35.41		

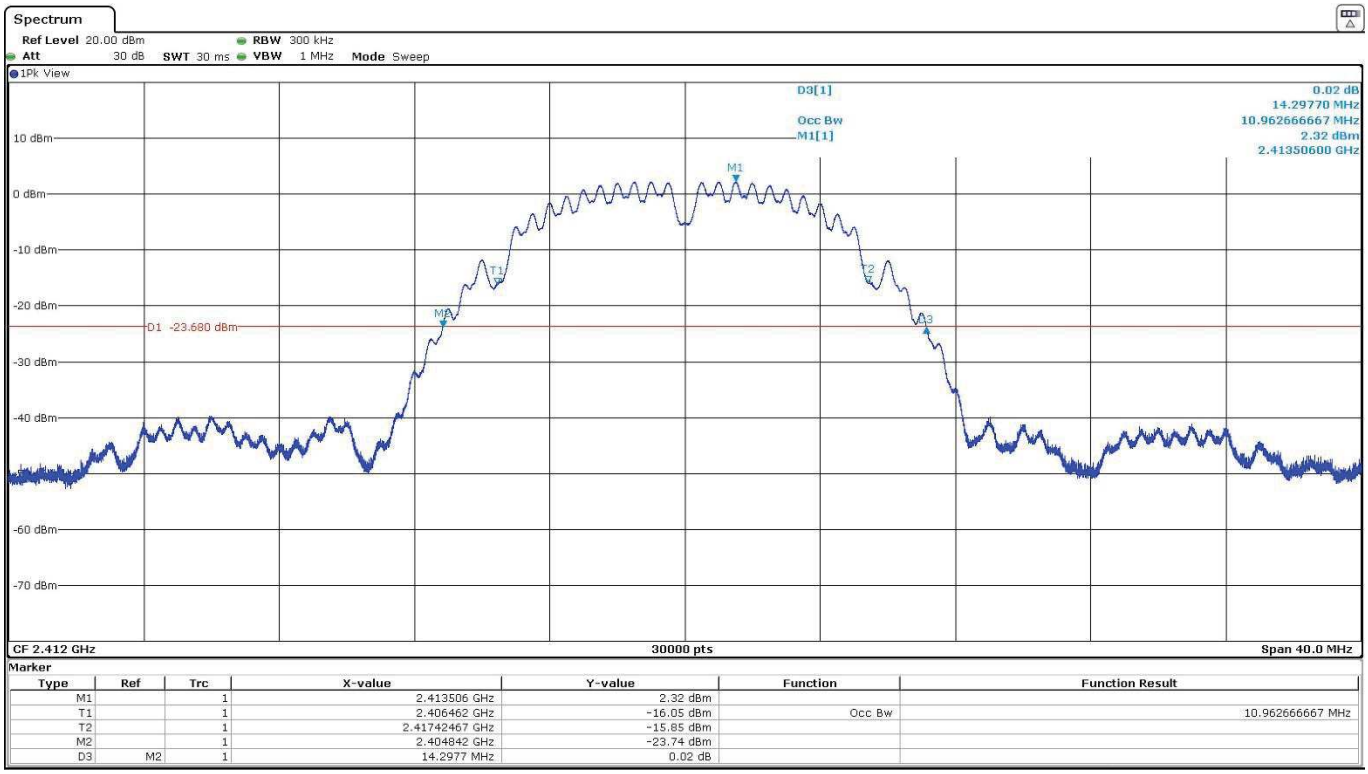
- **Mode 802.11 n20**

	Low Channel 2412 MHz	Middle Channel 2437 MHz	High Channel 2462 MHz
99% bandwidth (MHz)	17.941	17.941	17.952
-26 dBc bandwidth (MHz)	21.693	21.693	21.670
Measurement uncertainty (kHz)	<± 35.41		

Verdict: PASS

- **Mode 802.11 b – Occupied Bandwidth**

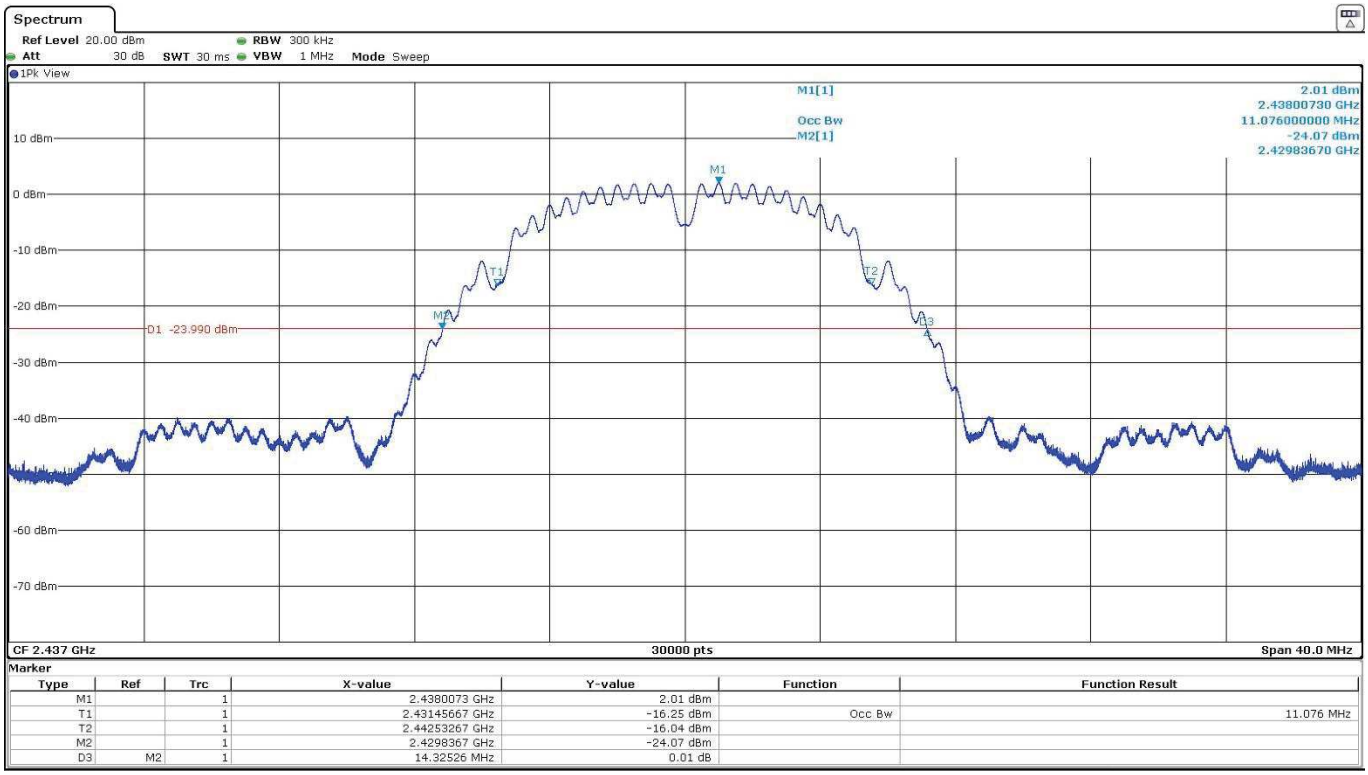
- Low Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.413506 GHz	2.32 dBm		
T1		1	2.406462 GHz	-16.05 dBm	Occ Bw	10.962666667 MHz
T2		1	2.41742467 GHz	-15.85 dBm		
M2		1	2.404842 GHz	-23.74 dBm		
D3	M2	1	14.2977 MHz	0.02 dB		

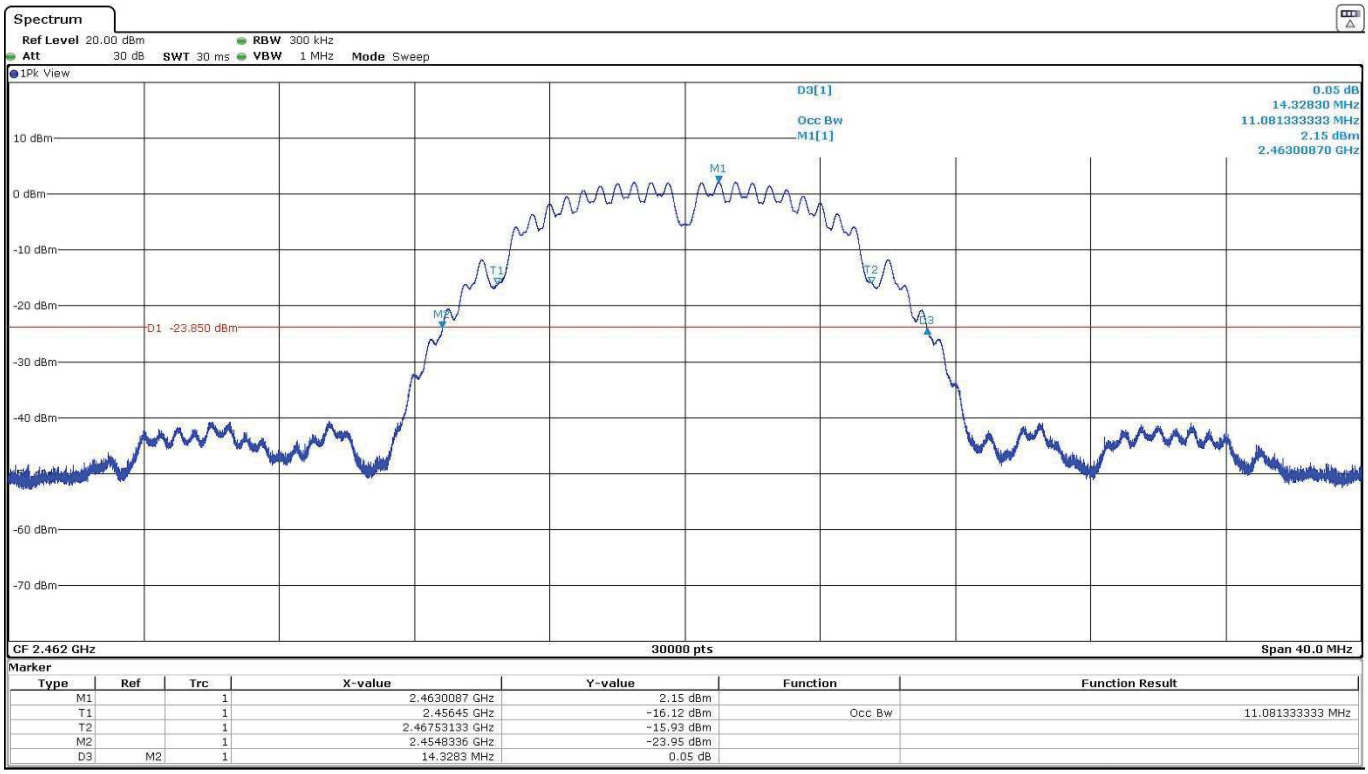
- Middle Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4380073 GHz	2.01 dBm		
T1		1	2.43145667 GHz	-16.25 dBm	Occ Bw	11.076 MHz
T2		1	2.44253267 GHz	-16.04 dBm		
M2		1	2.4298367 GHz	-24.07 dBm		
D3	M2	1	14.32526 MHz	0.01 dB		

- High Channel:

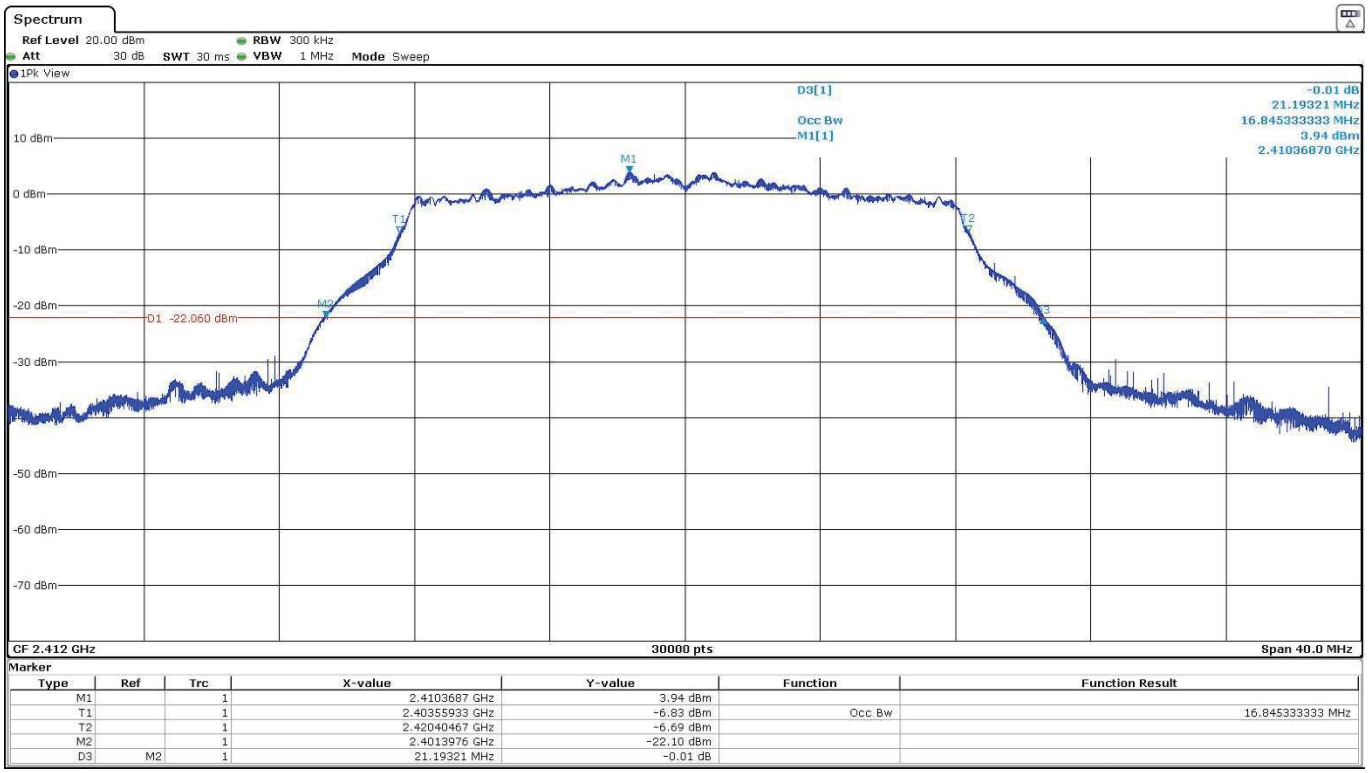


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4630087 GHz	2.15 dBm		
T1		1	2.45645 GHz	-16.12 dBm	Occ Bw	11.081333333 MHz
T2		1	2.46753133 GHz	-15.93 dBm		
M2		1	2.4548336 GHz	-23.95 dBm		
D3	M2	1	14.3283 MHz	0.05 dB		

- **Mode 802.11 g – Occupied Bandwidth**

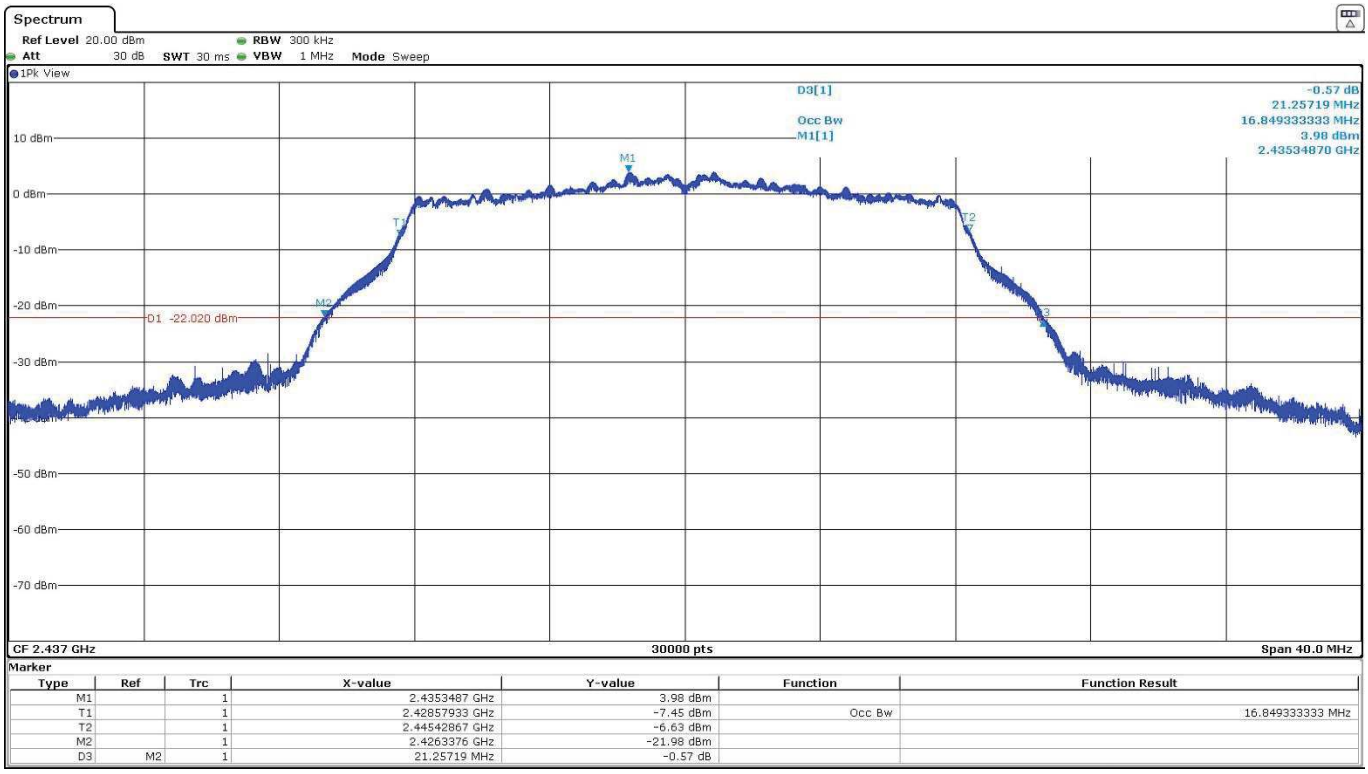
- Low Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4103687 GHz	3.94 dBm		
T1		1	2.40355933 GHz	-6.83 dBm	Occ Bw	16.845333333 MHz
T2		1	2.42040467 GHz	-6.69 dBm		
M2		1	2.4013976 GHz	-22.10 dBm		
D3	M2	1	21.19321 MHz	-0.01 dB		

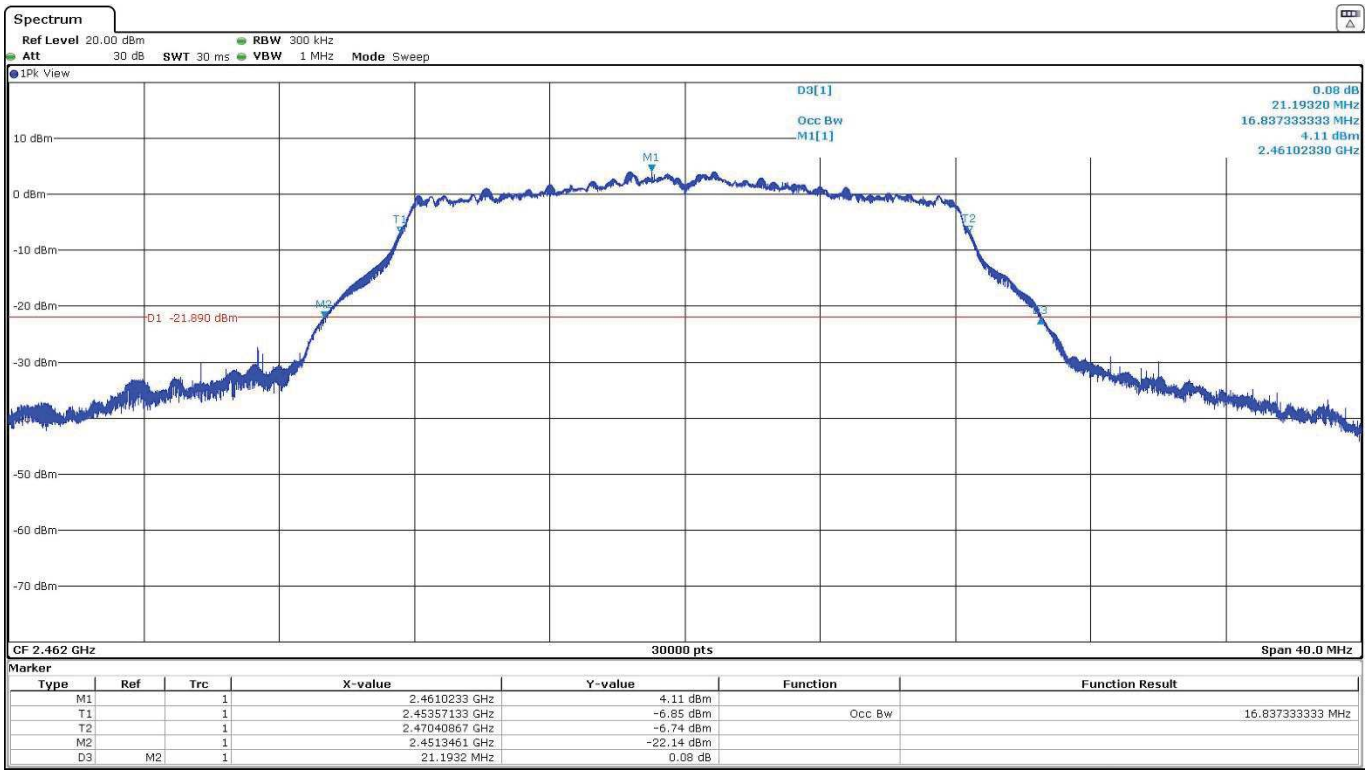
- Middle Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4353487 GHz	3.98 dBm		
T1		1	2.42857933 GHz	-7.45 dBm	Occ Bw	16.849333333 MHz
T2		1	2.44542867 GHz	-6.63 dBm		
M2		1	2.4263376 GHz	-21.98 dBm		
D3	M2	1	21.25719 MHz	-0.57 dB		

- High Channel:

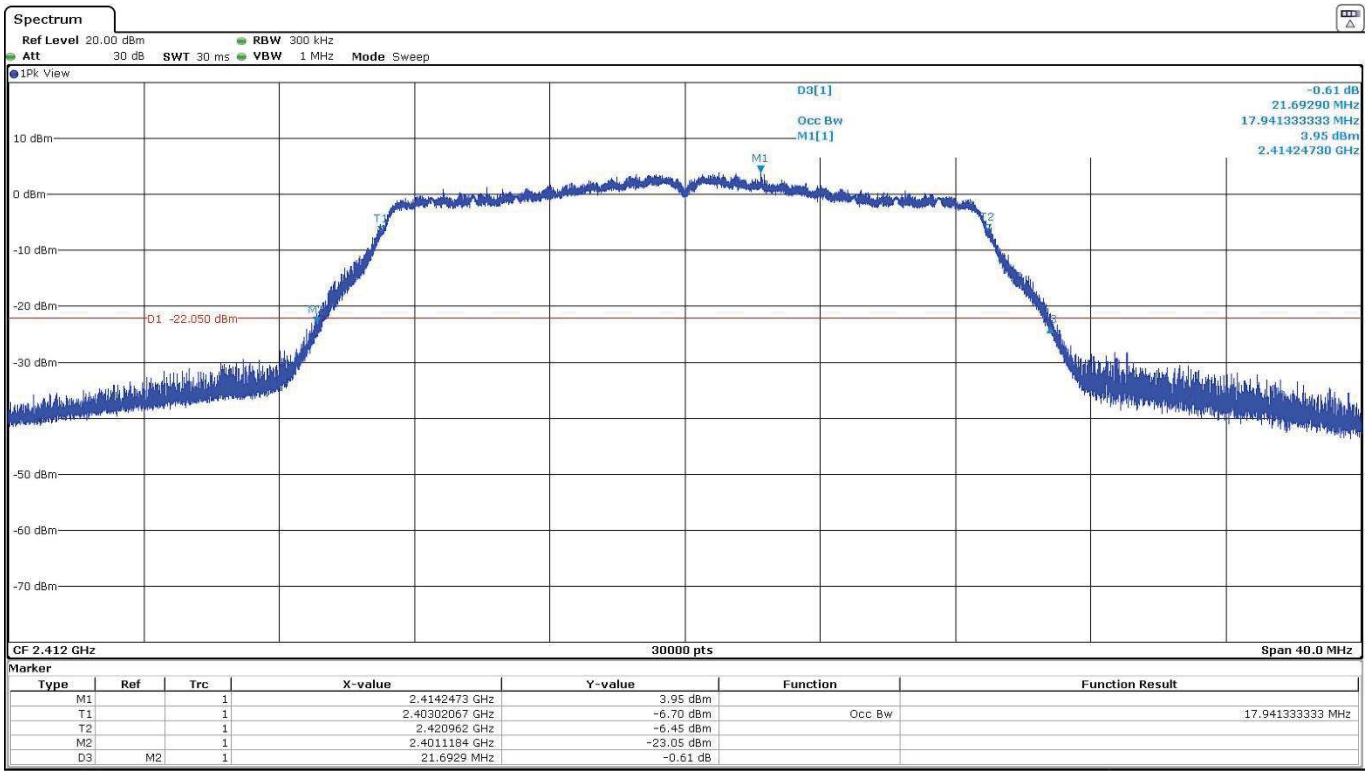


Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4610233 GHz	4.11 dBm		
T1		1	2.45357133 GHz	-6.85 dBm	Occ Bw	16.837333333 MHz
T2		1	2.47040867 GHz	-6.74 dBm		
M2		1	2.4513461 GHz	-22.14 dBm		
D3	M2	1	21.1932 MHz	0.08 dB		

- **Mode 802.11 n20 – Occupied Bandwidth**

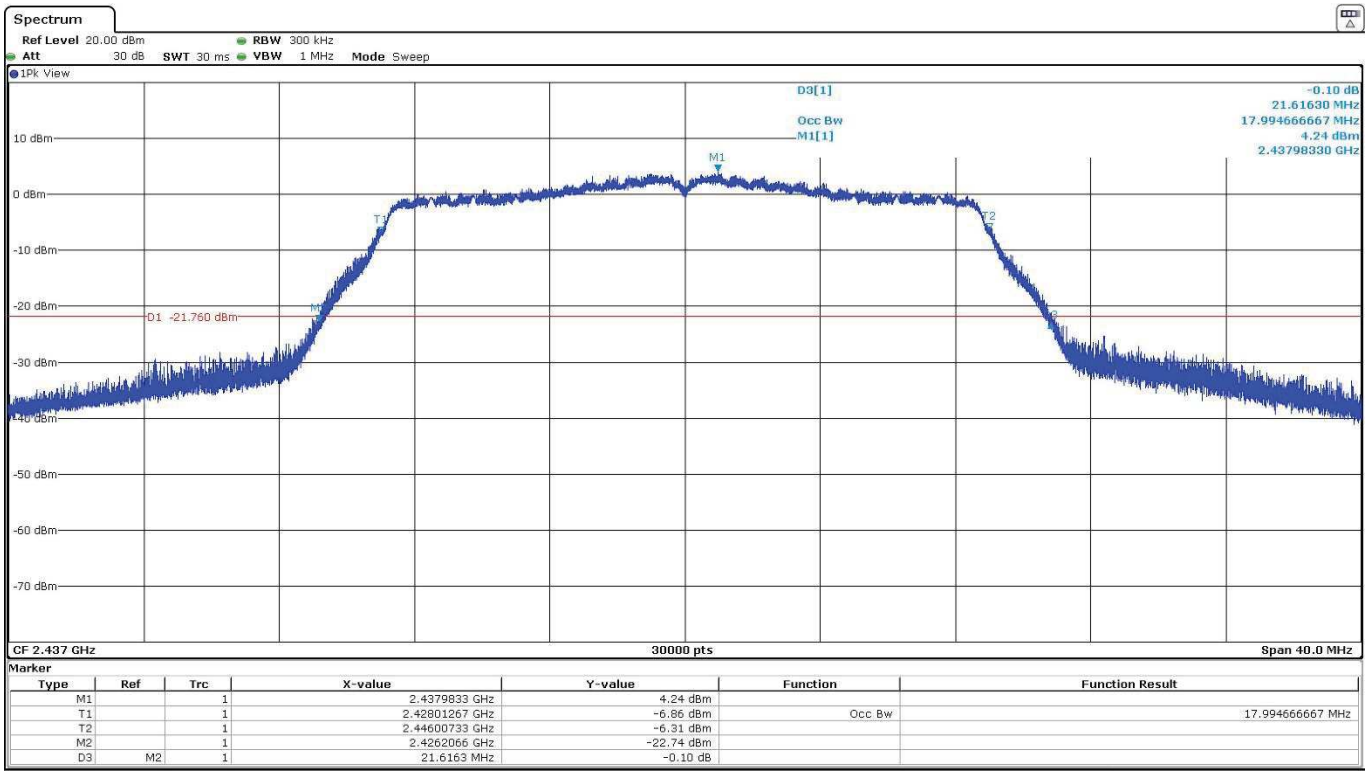
- Low Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4142473 GHz	3.95 dBm		
T1		1	2.40302067 GHz	-6.70 dBm	Occ Bw	17.941333333 MHz
T2		1	2.420962 GHz	-6.45 dBm		
M2		1	2.4011184 GHz	-23.05 dBm		
D3	M2	1	21.6929 MHz	-0.61 dB		

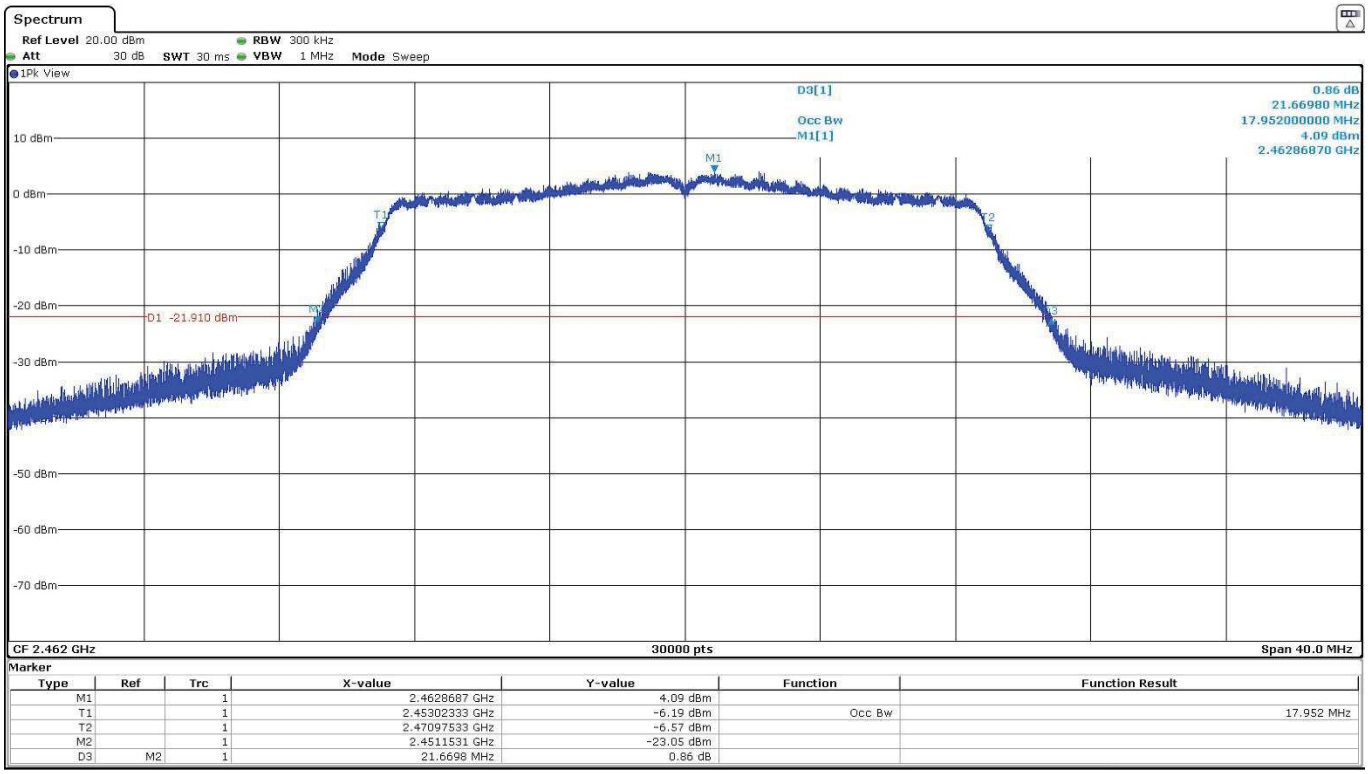
- Middle Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4379833 GHz	4.24 dBm		
T1		1	2.42801267 GHz	-6.86 dBm	Occ Bw	17.994666667 MHz
T2		1	2.44600733 GHz	-6.31 dBm		
M2		1	2.4262066 GHz	-22.74 dBm		
D3	M2	1	21.6163 MHz	-0.10 dB		

- High Channel:



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	2.4628687 GHz	4.09 dBm		
T1		1	2.45302333 GHz	-6.19 dBm	Occ Bw	17.952 MHz
T2		1	2.47097533 GHz	-6.57 dBm		
M2		1	2.4511531 GHz	-23.05 dBm		
D3	M2	1	21.6698 MHz	0.86 dB		

FCC 15.247 (a) (2) / RSS-247 5.2 (a) 6 dB Bandwidth

SPECIFICATION:

The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS:

- **Mode 802.11 b**

	Low Channel	Middle Channel	High Channel
6 dB Spectrum Bandwidth (kHz)	9.0084	8.0844	9.0253
Measurement uncertainty (kHz)	<± 35.41		

- **Mode 802.11 g**

	Low Channel	Middle Channel	High Channel
6 dB Spectrum Bandwidth (kHz)	16.3014	16.3018	16.2902
Measurement uncertainty (kHz)	<± 35.41		

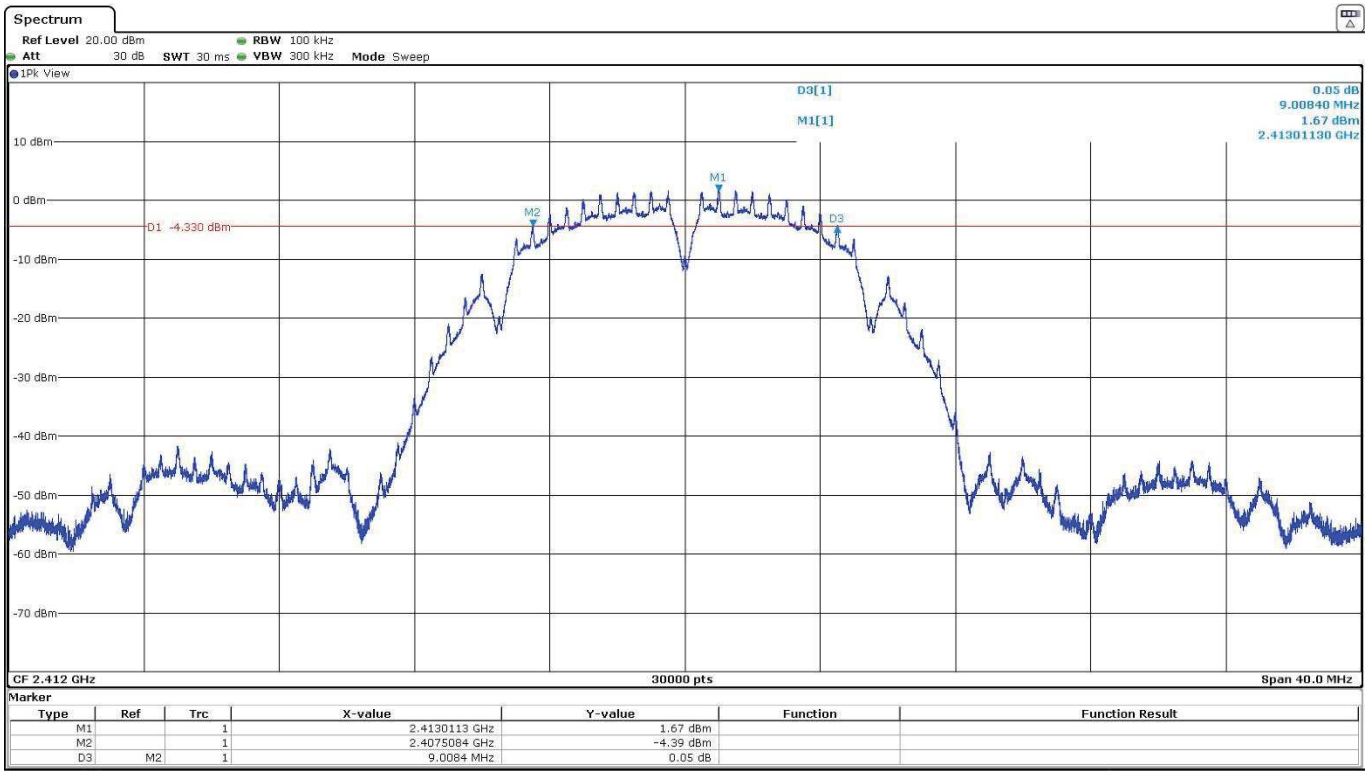
- **Mode 802.11 n20**

	Low Channel	Middle Channel	High Channel
6 dB Spectrum Bandwidth (kHz)	17.5141	17.5222	17.2803
Measurement uncertainty (kHz)	<± 35.41		

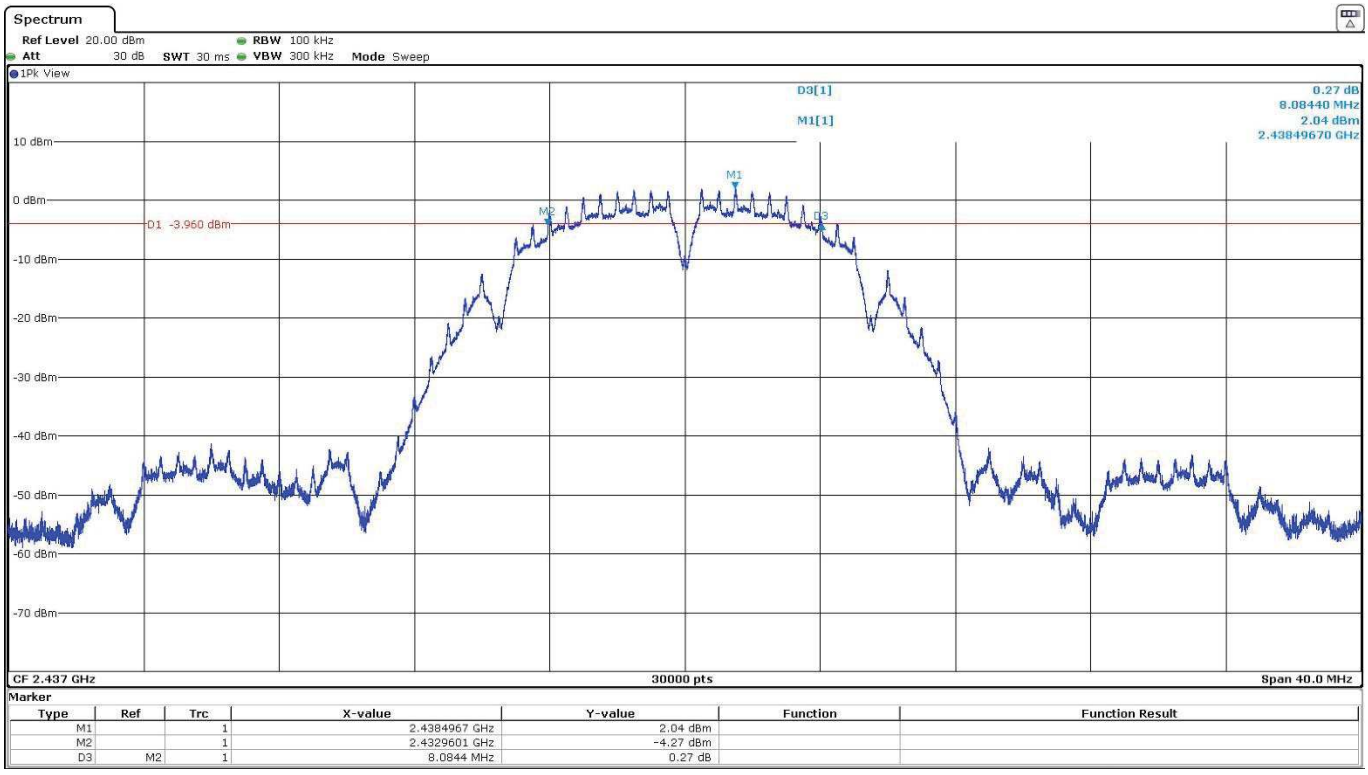
Verdict: PASS

- **Mode 802.11 b – 6 dB Bandwidth**

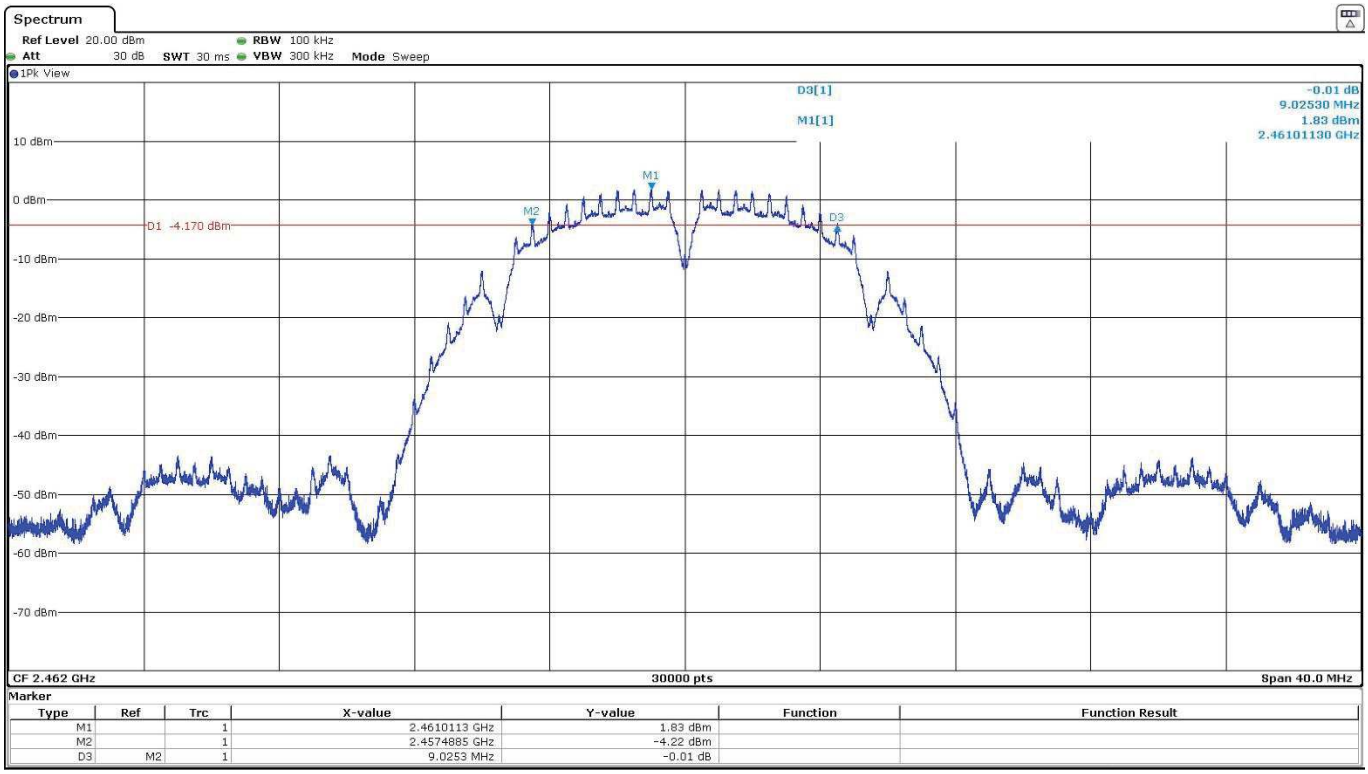
- Low Channel:



- Middle Channel:

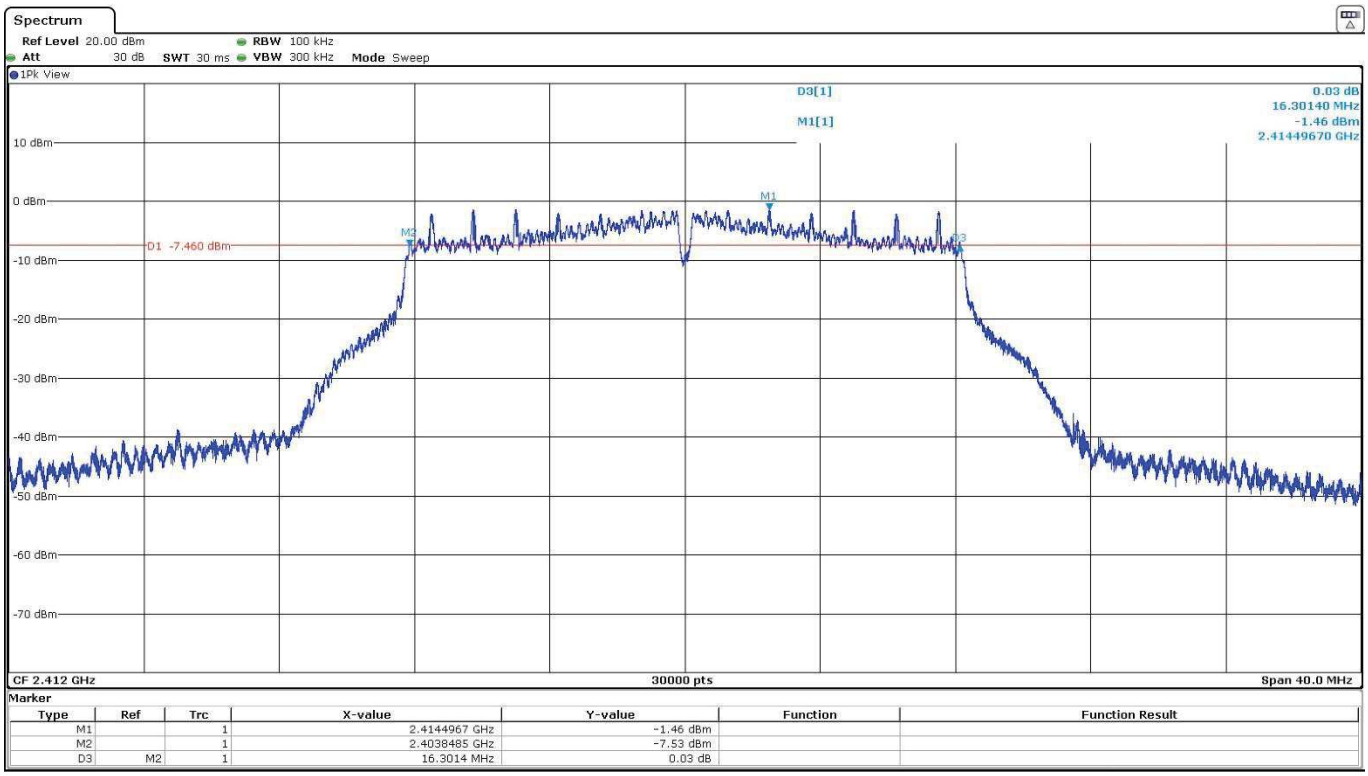


- High Channel:

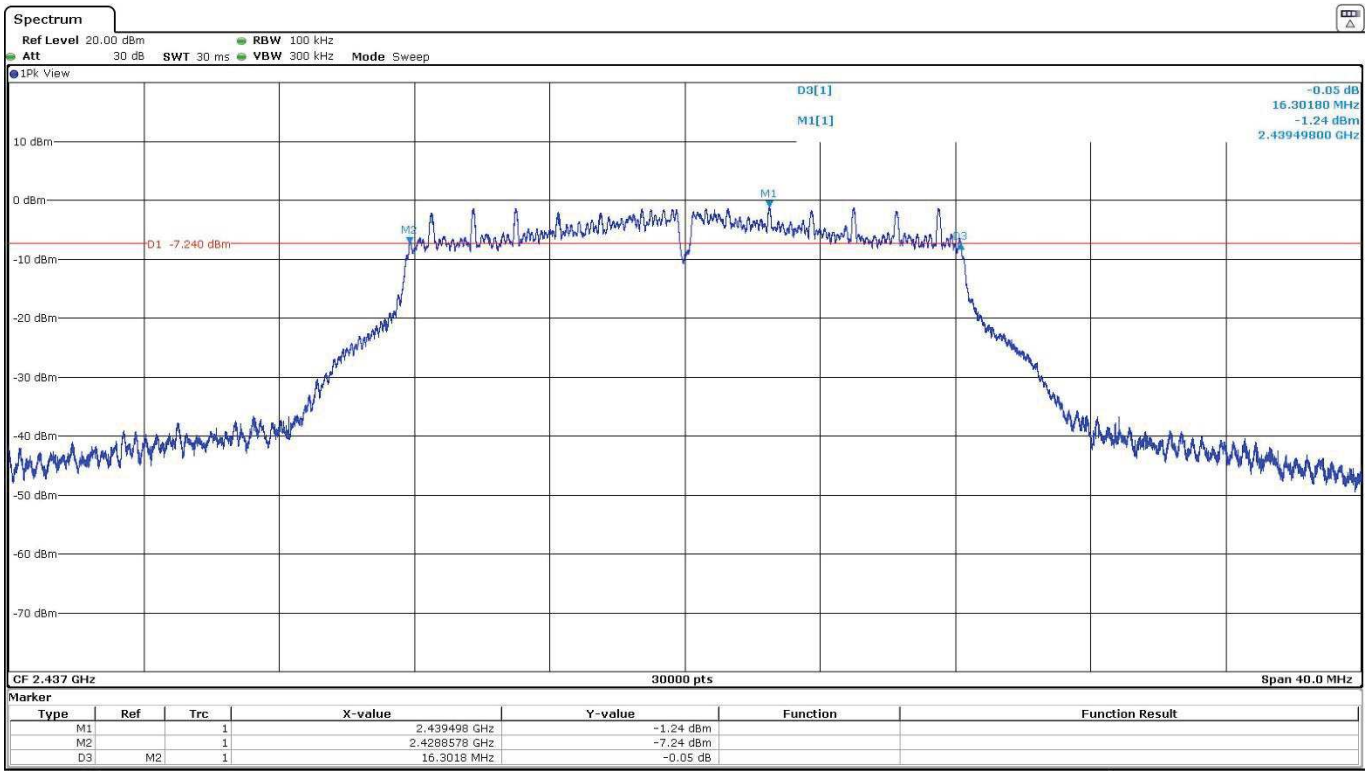


- **Mode 802.11 g – 6 dB Bandwidth**

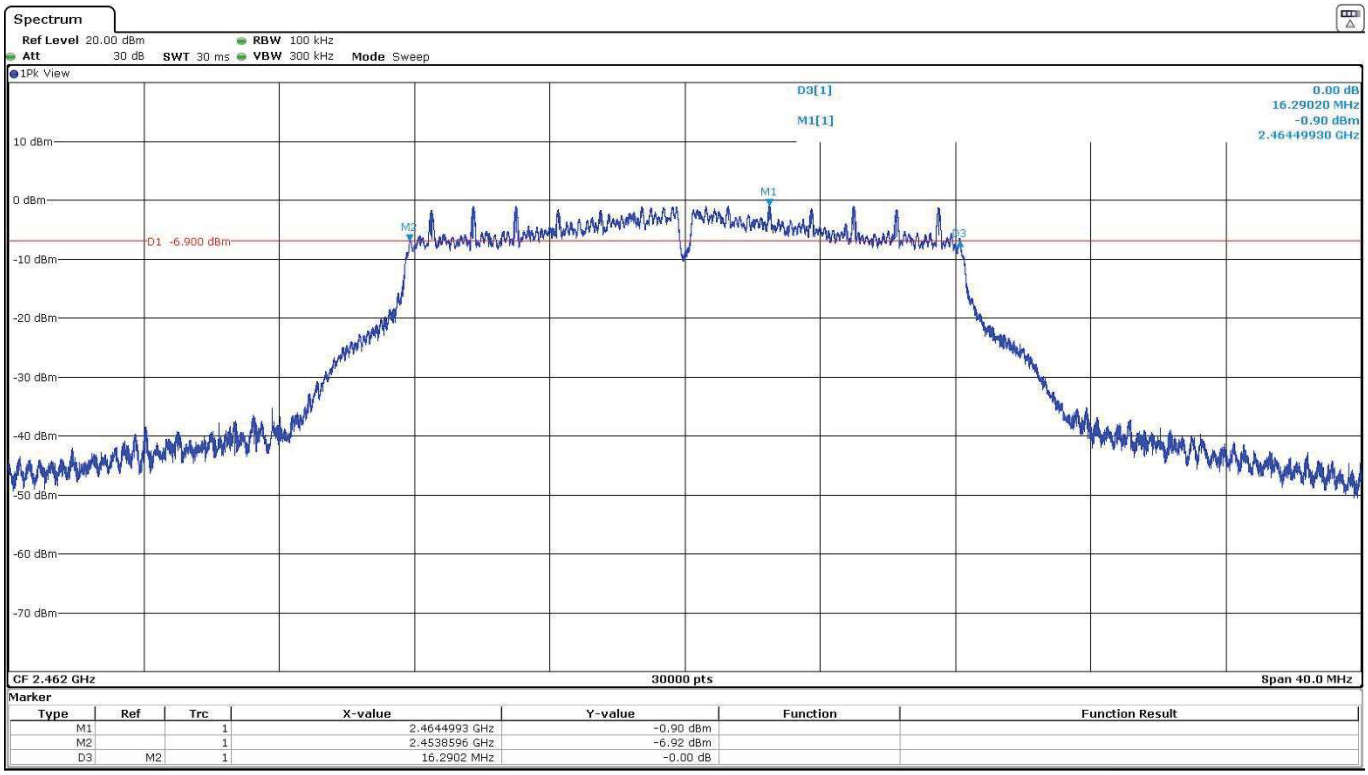
- Low Channel:



- Middle Channel:

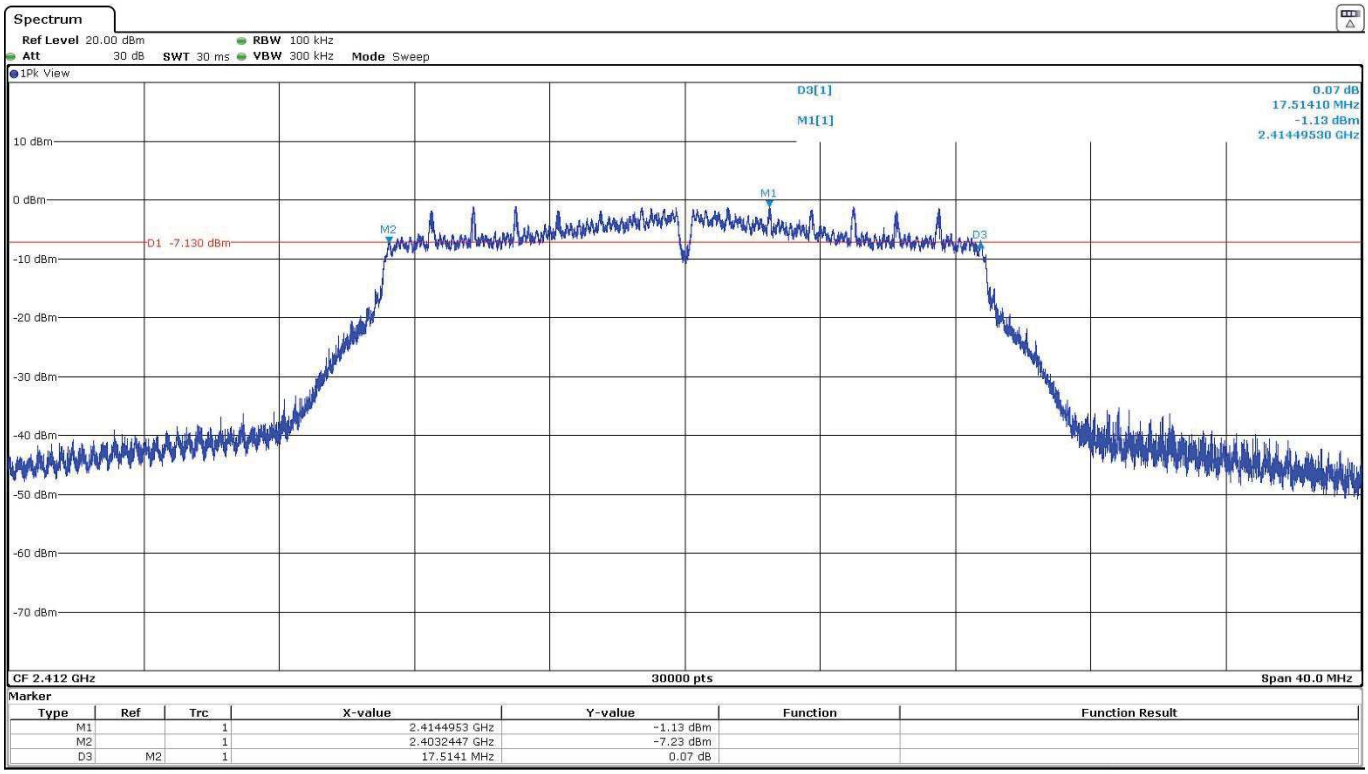


- High Channel:

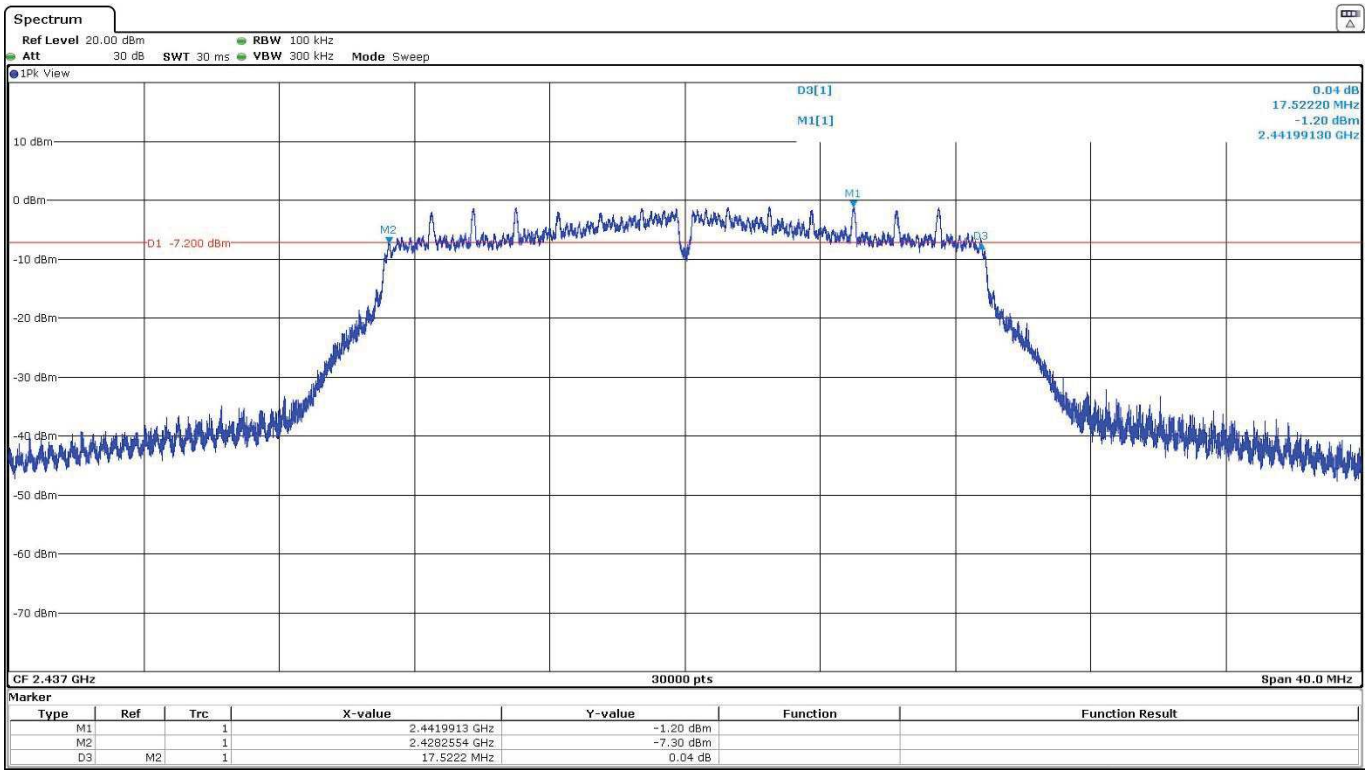


- **Mode 802.11 n20 – 6 dB Bandwidth**

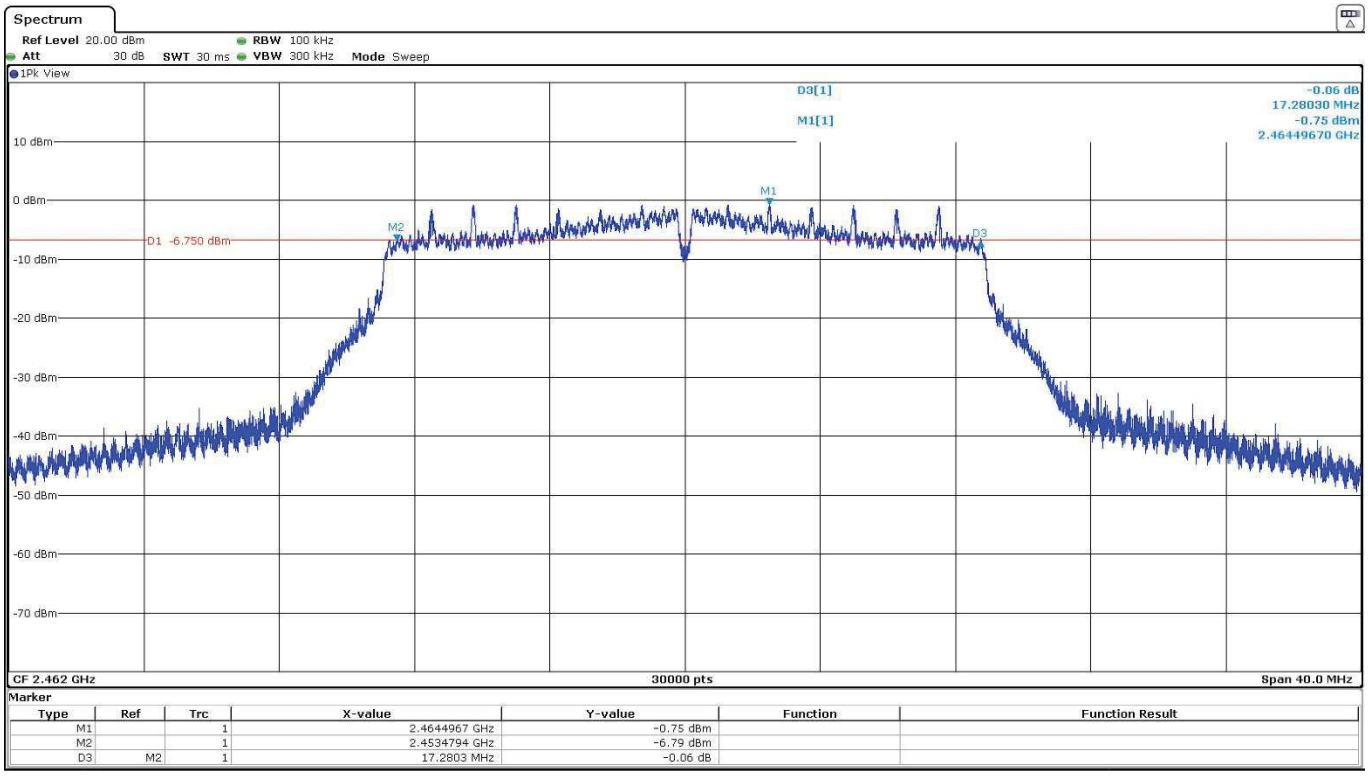
- Low Channel:



- Middle Channel:



- High Channel:



FCC 15.35 (c) / RSS-Gen 6.10. Transmitter Duty Cycle

SPECIFICATION:

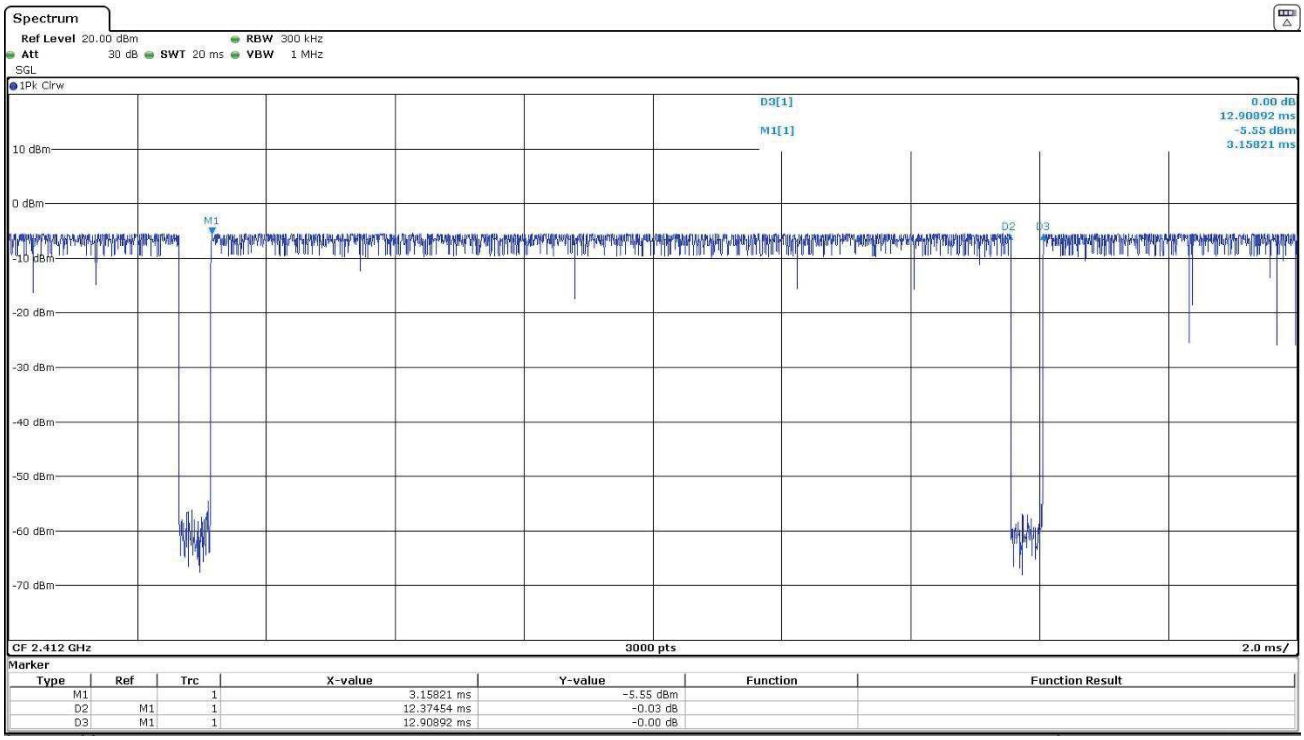
When the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value.

RESULTS:

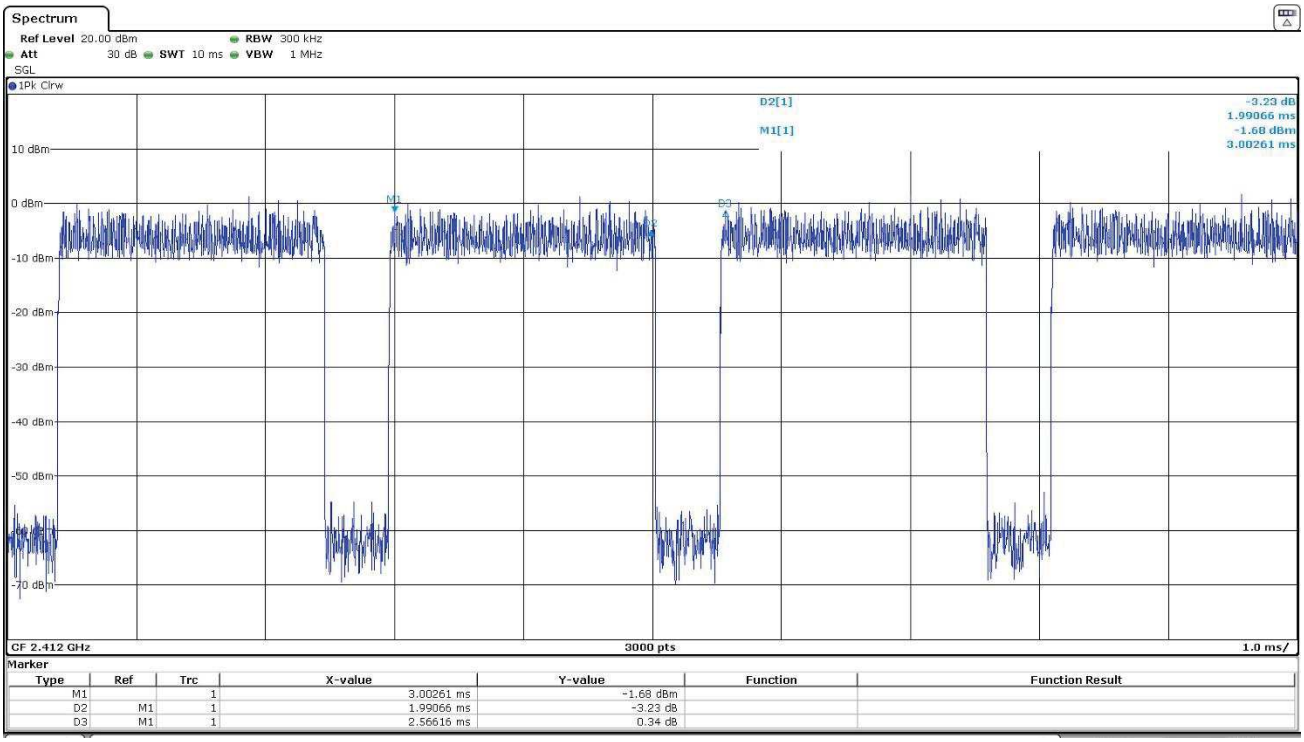
The results below are for data rates with a duty cycle less than 98%. The results for all rest of modes having a value > 98%.

Technique	Mode	Pulse Duration (ms)	Period (ms)	Duty Cycle Correction (dB)
SISO	802.11 b	12.37454	12.90892	0.183608455
SISO	802.11 g	1.99066	2.56616	1.102866412
SISO	802.11 n20	1.86152	2.40968	1.120916665

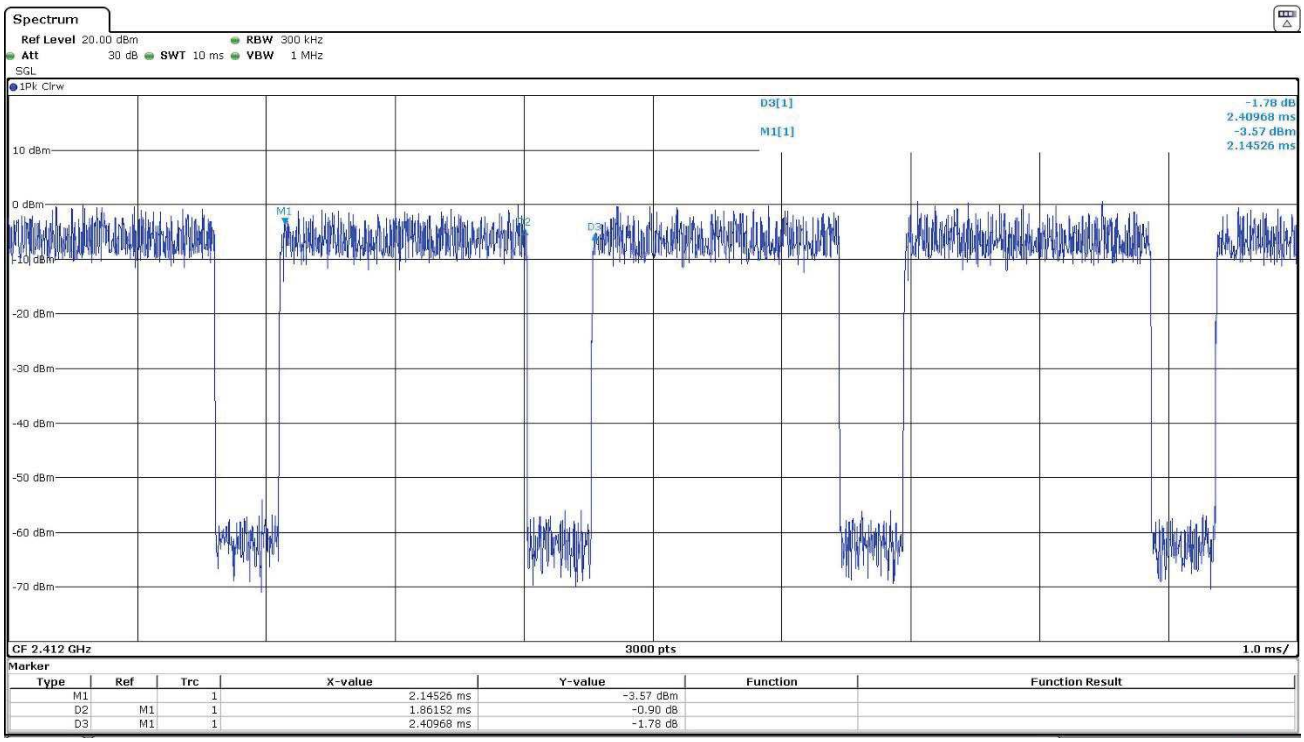
- **Mode 802.11 b**



- **Mode 802.11 g**



- **Mode 802.11 n20**



FCC 15.247 (b) / RSS-247 5.4 (d) Maximum output power and antenna gain

SPECIFICATION:

For systems using digital modulation in the 2400-2483.5 MHz band: 1 watt (30 dBm).
The e.i.r.p. shall not exceed 4 W (36 dBm) (Canada).

RESULTS:

Maximum Declared Antenna Gain: -6.2 dBi

For modes b, g, n20, the maximum conducted output power was measured using the method according to point 11.9.2.2.2 “Method AVGSA-1” of ANSI C.63.10-2013.

The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

- **Mode 802.11 b**

	Low Channel	Middle Channel	High Channel
Maximum Average Conducted Power (dBm)	10.99	11.16	11.60
Maximum EIRP Power with Duty Cycle Correction (dBm)	4.79	4.96	5.40
Measurement uncertainty (dB)	<±2.57		

- **Mode 802.11 g**

	Low Channel	Middle Channel	High Channel
Maximum Average Conducted Power (dBm)	10.79	10.98	11.24
Maximum EIRP Power with Duty Cycle Correction (dBm)	4.59	4.78	5.04
Measurement uncertainty (dB)	<±2.57		

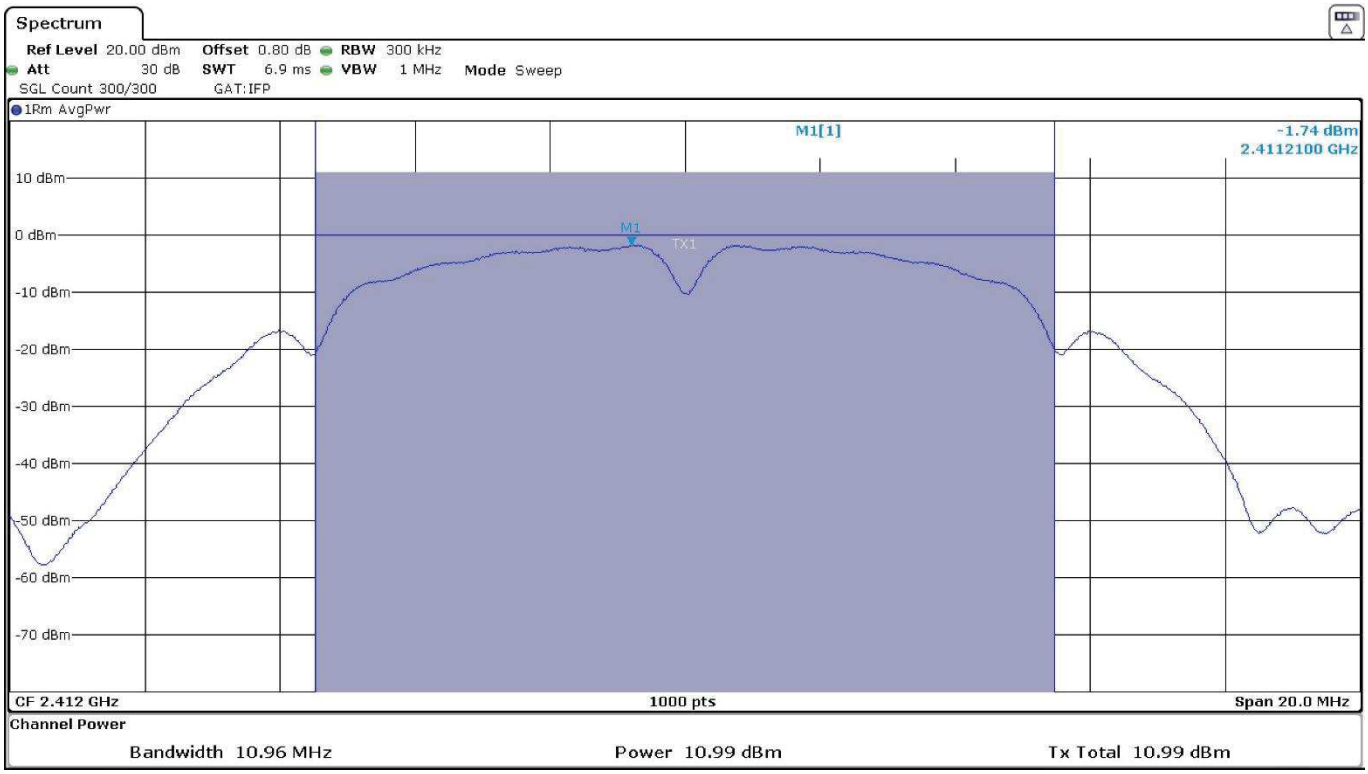
- **Mode 802.11 n20**

	Low Channel	Middle Channel	High Channel
Maximum Average Conducted Power (dBm)	11.08	11.3	11.57
Maximum EIRP Power with Duty Cycle Correction (dBm)	4.88	5.1	5.37
Measurement uncertainty (dB)	<±2.57		

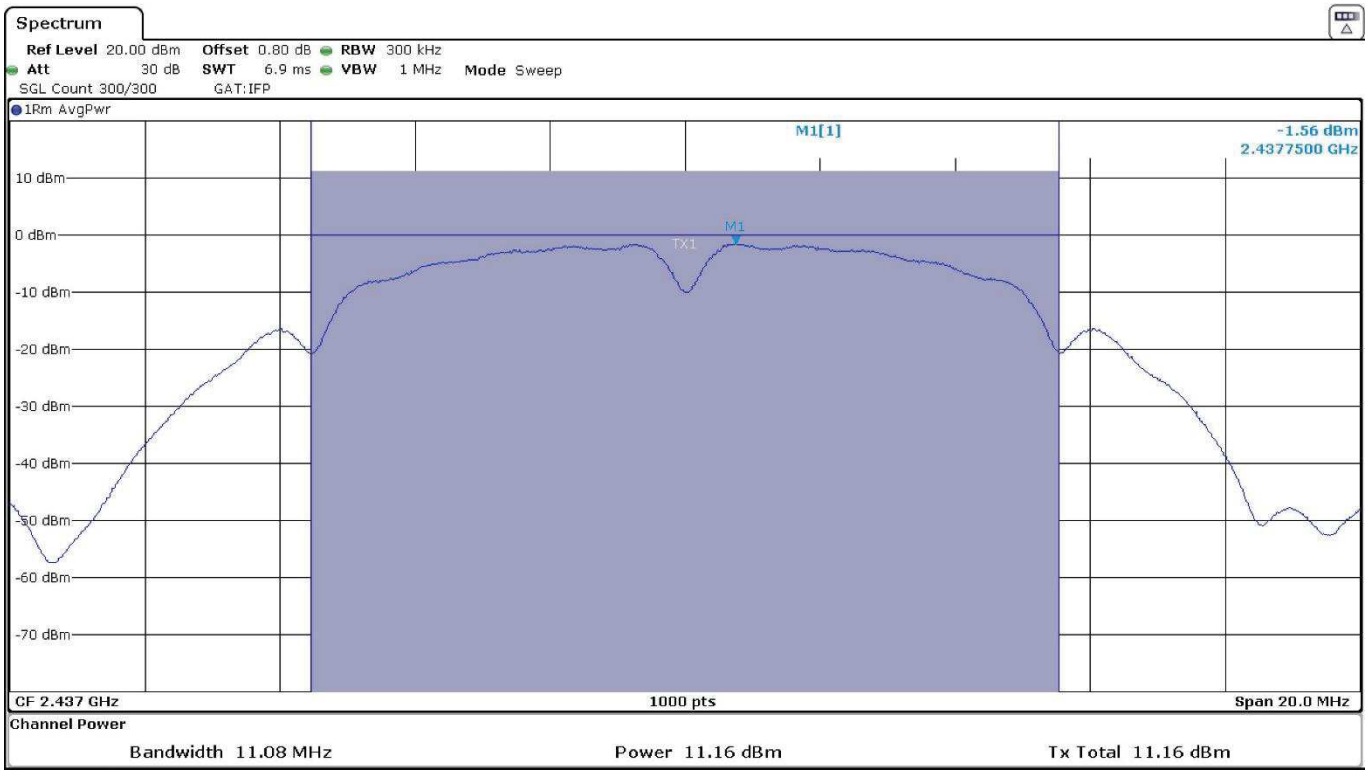
Verdict: PASS

- **Mode 802.11 b**

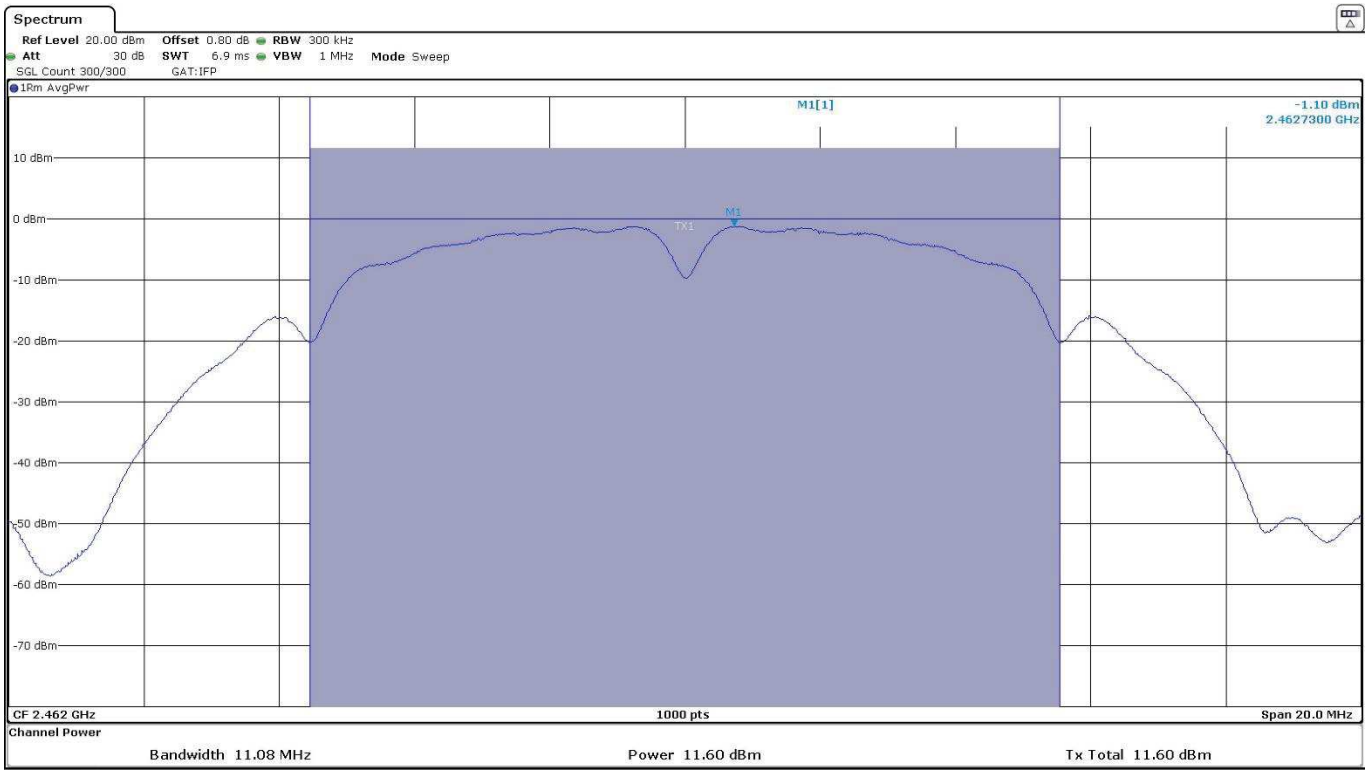
- Low Channel:



- Middle Channel:

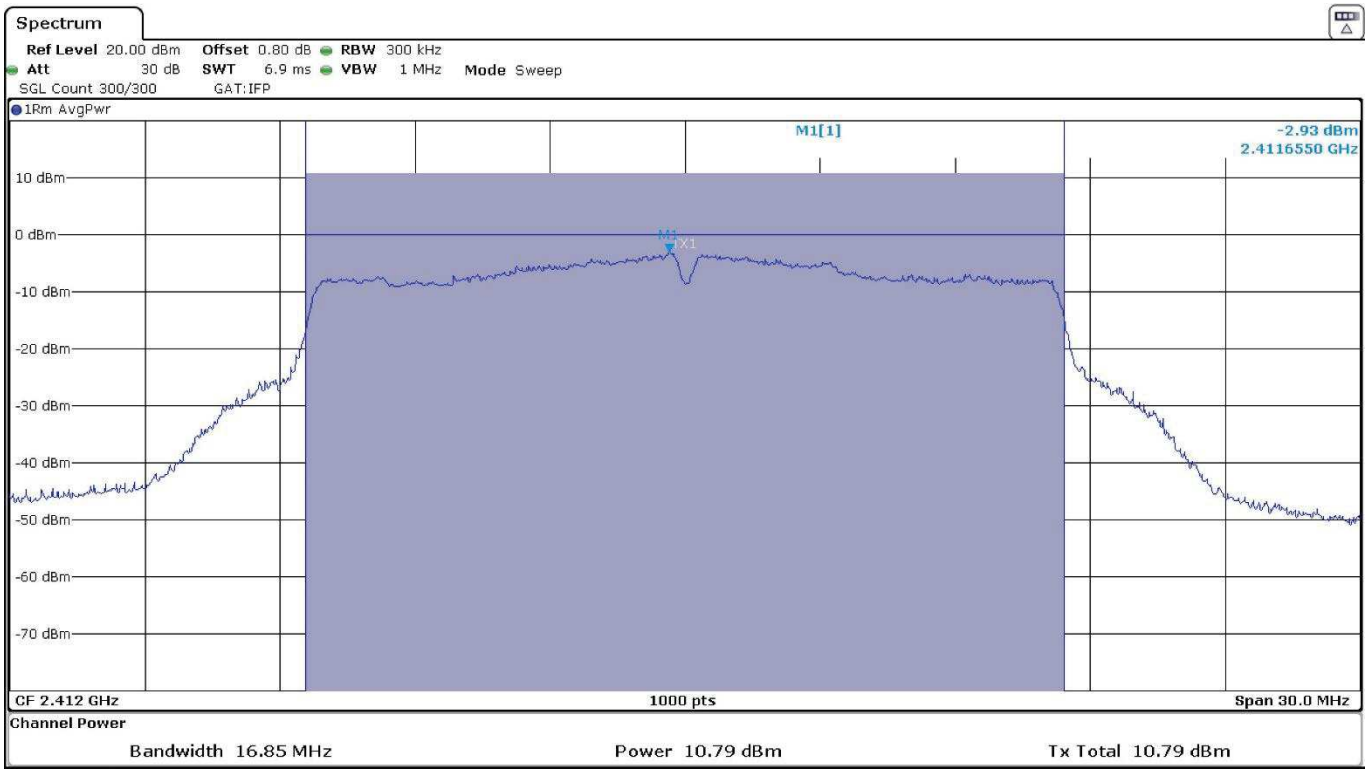


- High Channel:

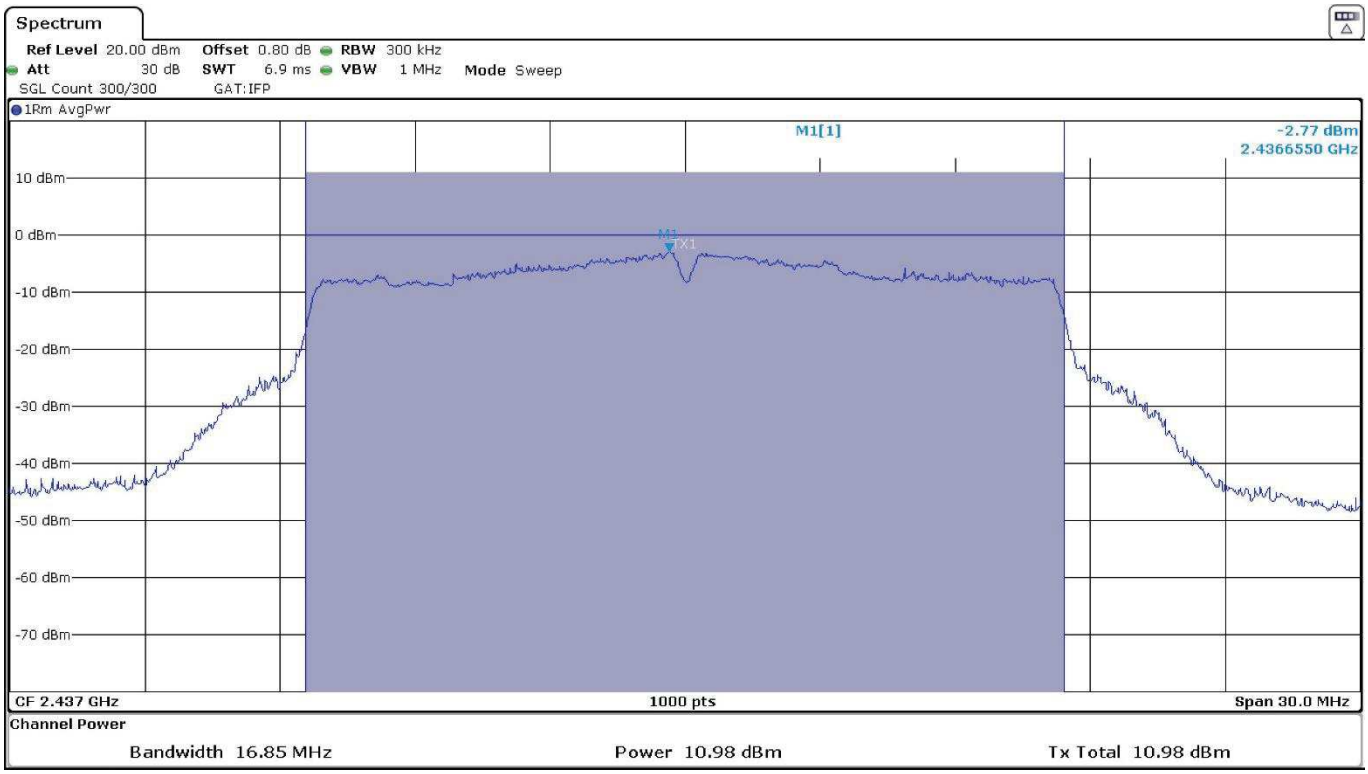


- **Mode 802.11 g**

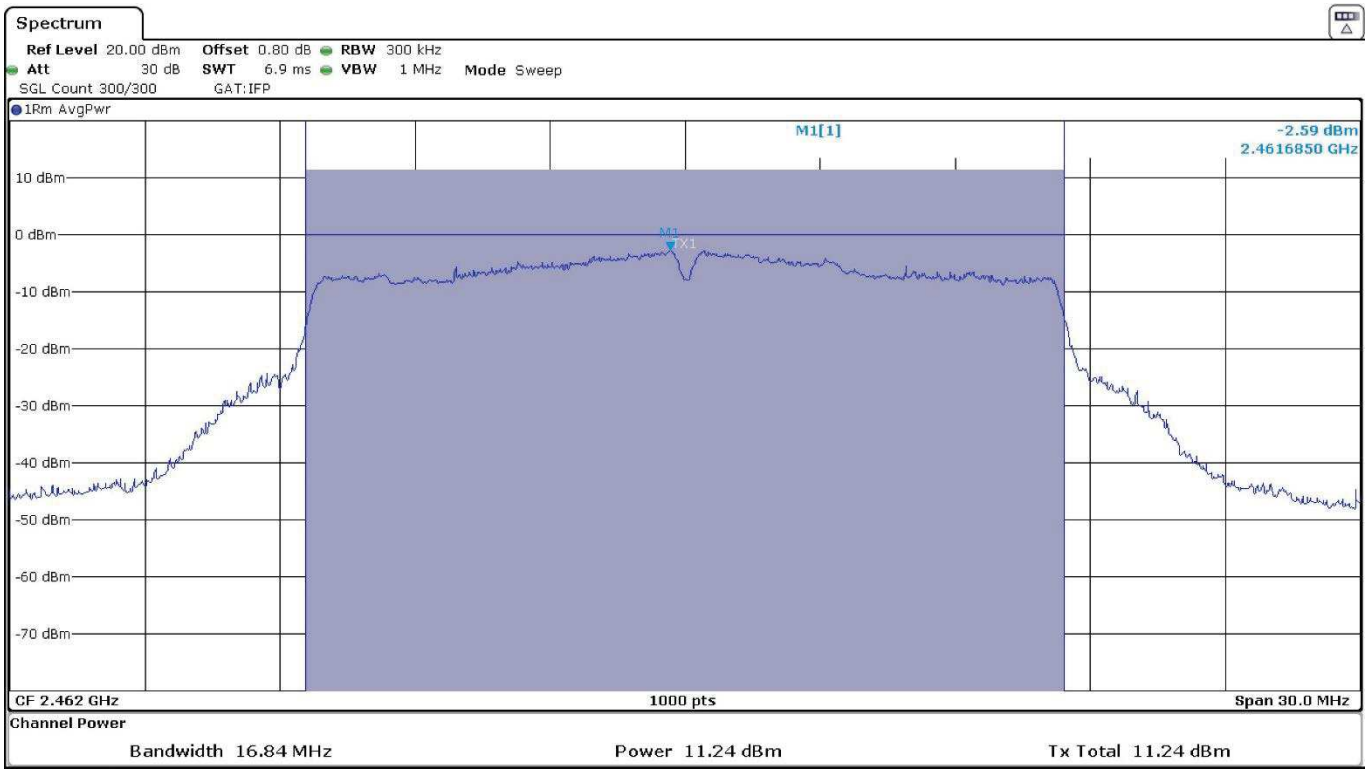
- Low Channel:



- Middle Channel:

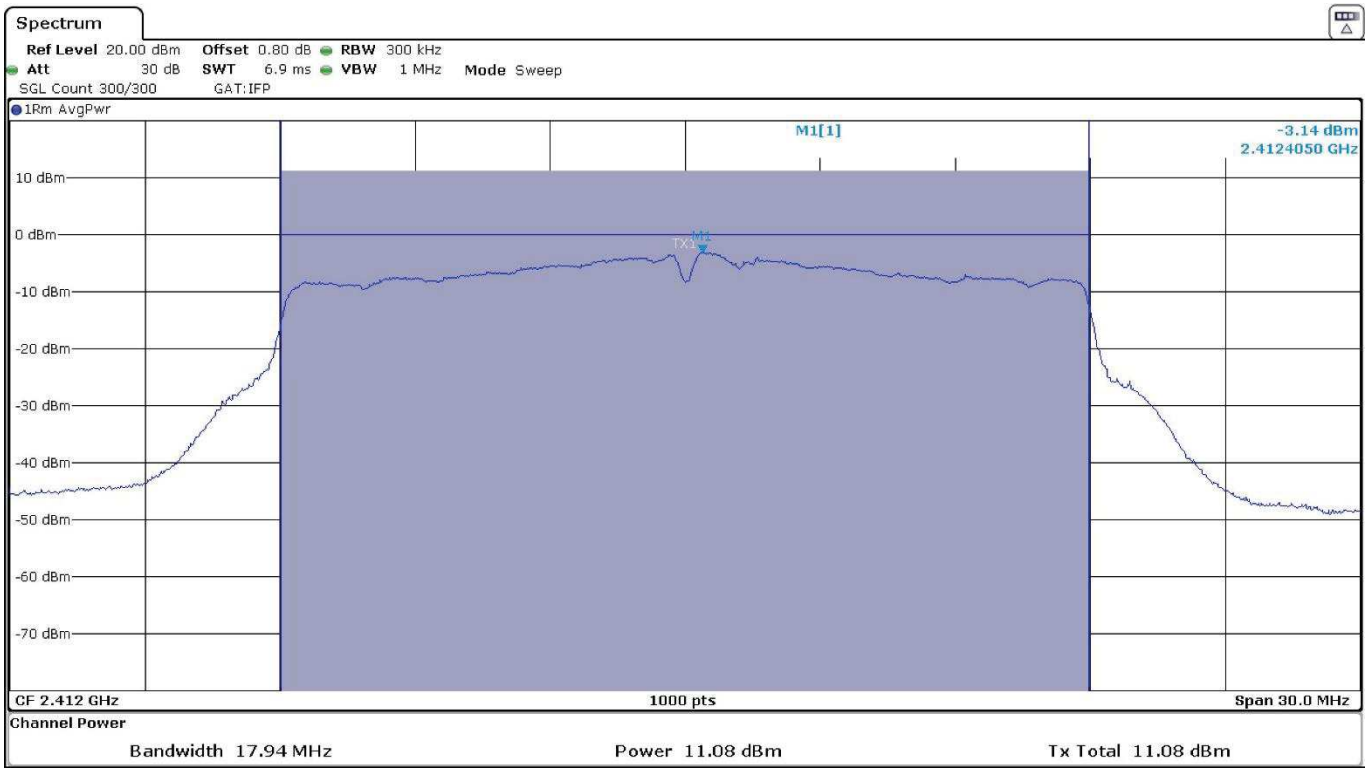


- High Channel:

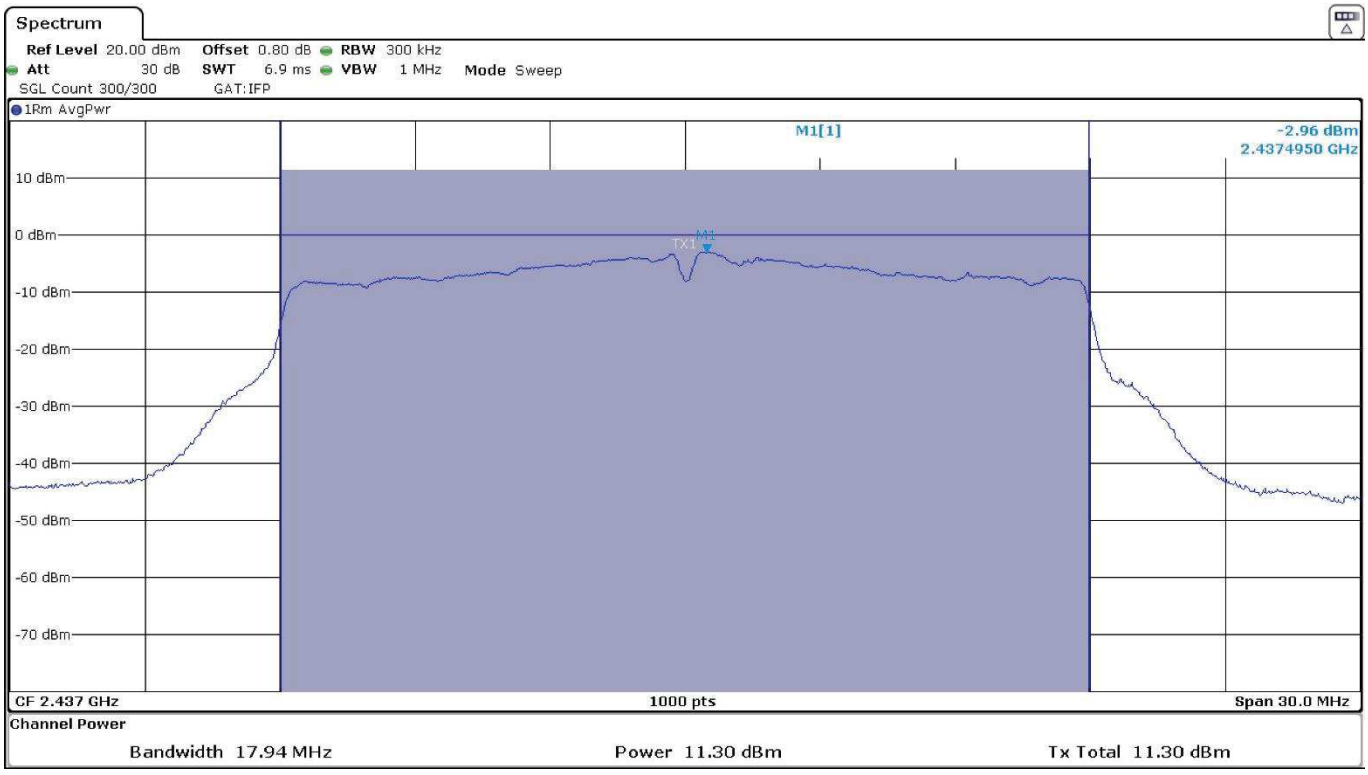


- **Mode 802.11 n20**

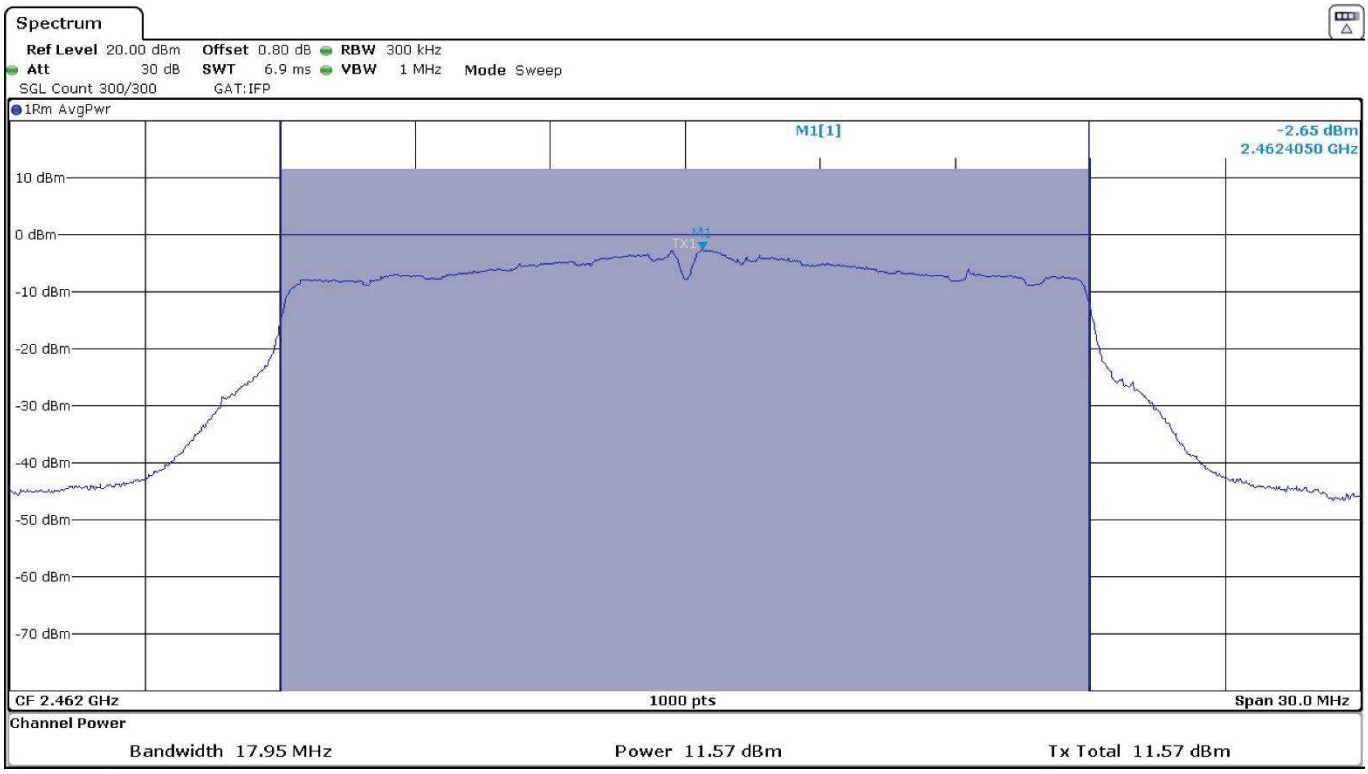
- Low Channel:



- Middle Channel:



- High Channel:



FCC 15.247 (d) / RSS-247 5.5. Band-edge emissions compliance (Transmitter)

SPECIFICATION:

In any 100 kHz bandwidths outside the frequency band in which the 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, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

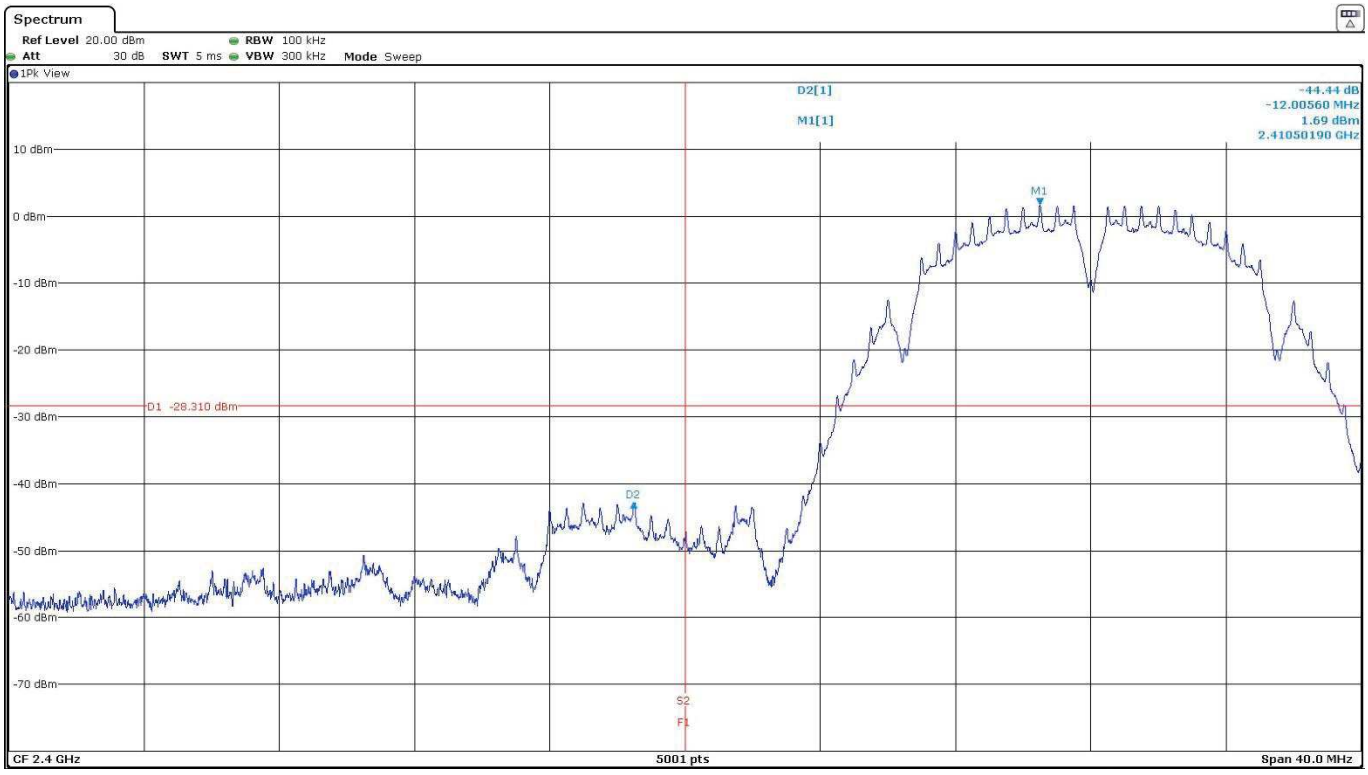
RESULTS:

Radiated measurements were used to show compliance with the limits in the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Measurement uncertainty (dB)	<±2.574

- **Mode 802.11 b – Band-edge emissions compliance:**

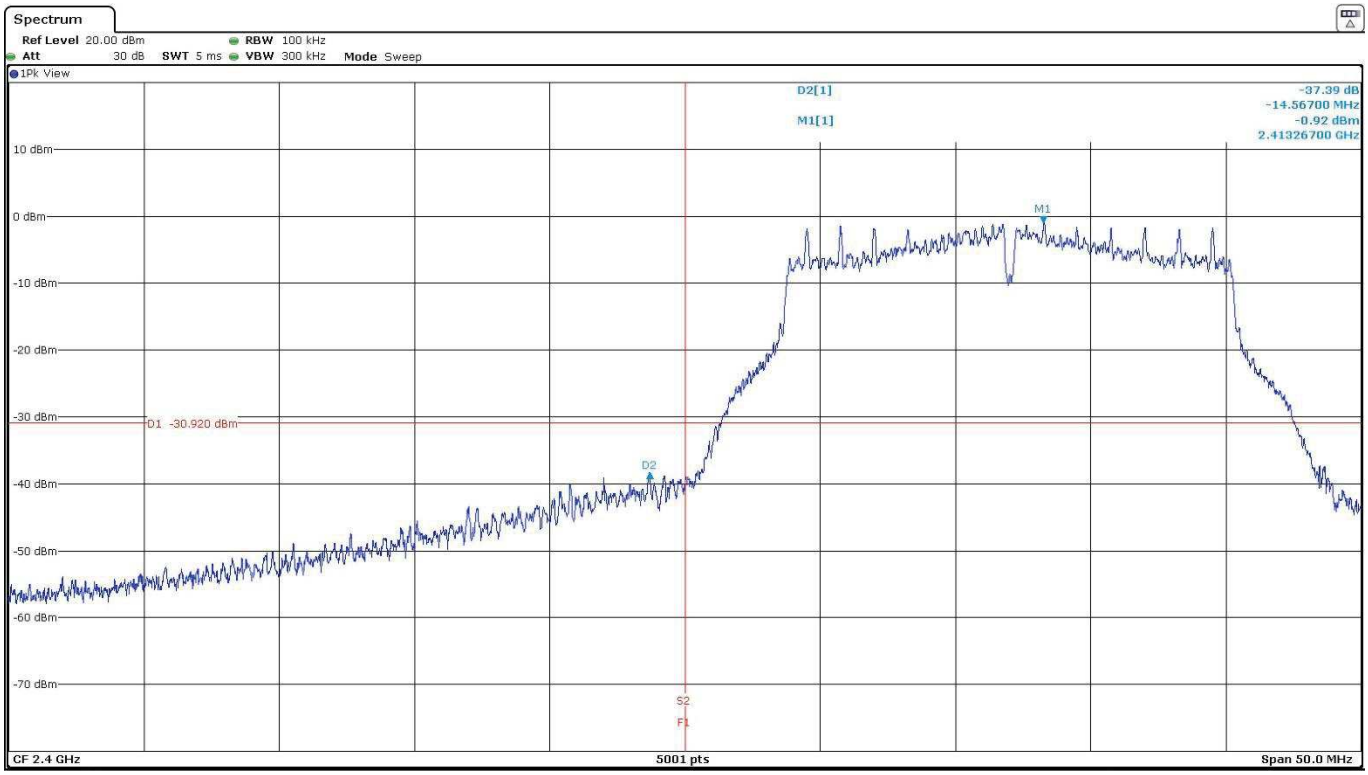
- Low Channel:



Verdict: PASS

- **Mode 802.11 g – Band-edge emissions compliance:**

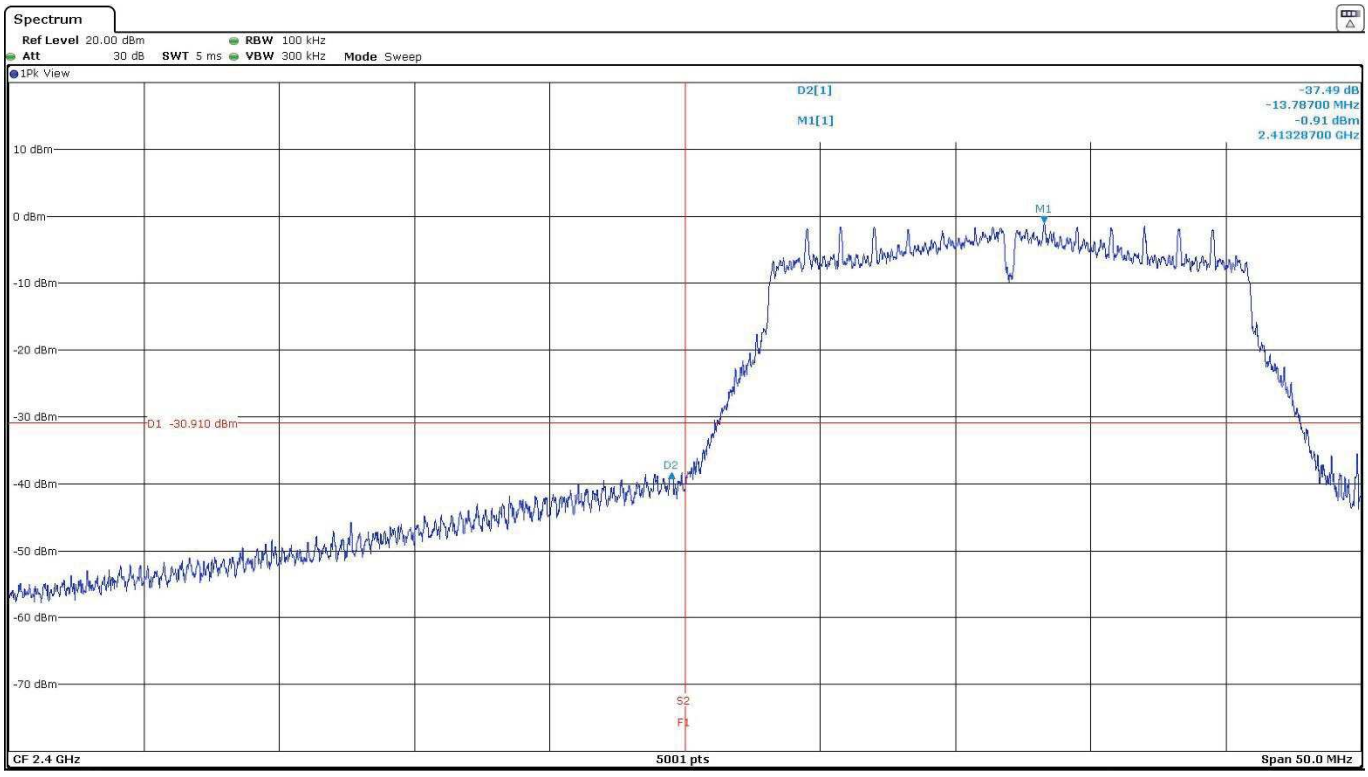
- Low Channel:



Verdict: PASS

- **Mode 802.11 n20 – Band-edge emissions compliance:**

- Low Channel:



Verdict: PASS

FCC 15.247 (e) / RSS-247 5.2. (b) Power spectral density

SPECIFICATION:

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

RESULTS:

The power spectral density was measured using the method according to point “11.10.3 Method AVGPSD-1” of ANSI C.63.10-2013.

- **Mode 802.11 b**

	Low Channel	Middle Channel	High Channel
Average Power Spectral Density (dBm)	-5.93	-5.54	-5.55
Measurement uncertainty (dB)	<±2.574		

- **Mode 802.11 g**

	Low Channel	Middle Channel	High Channel
Average Power Spectral Density (dBm)	-6.13	-5.84	-5.54
Measurement uncertainty (dB)	<±2.574		

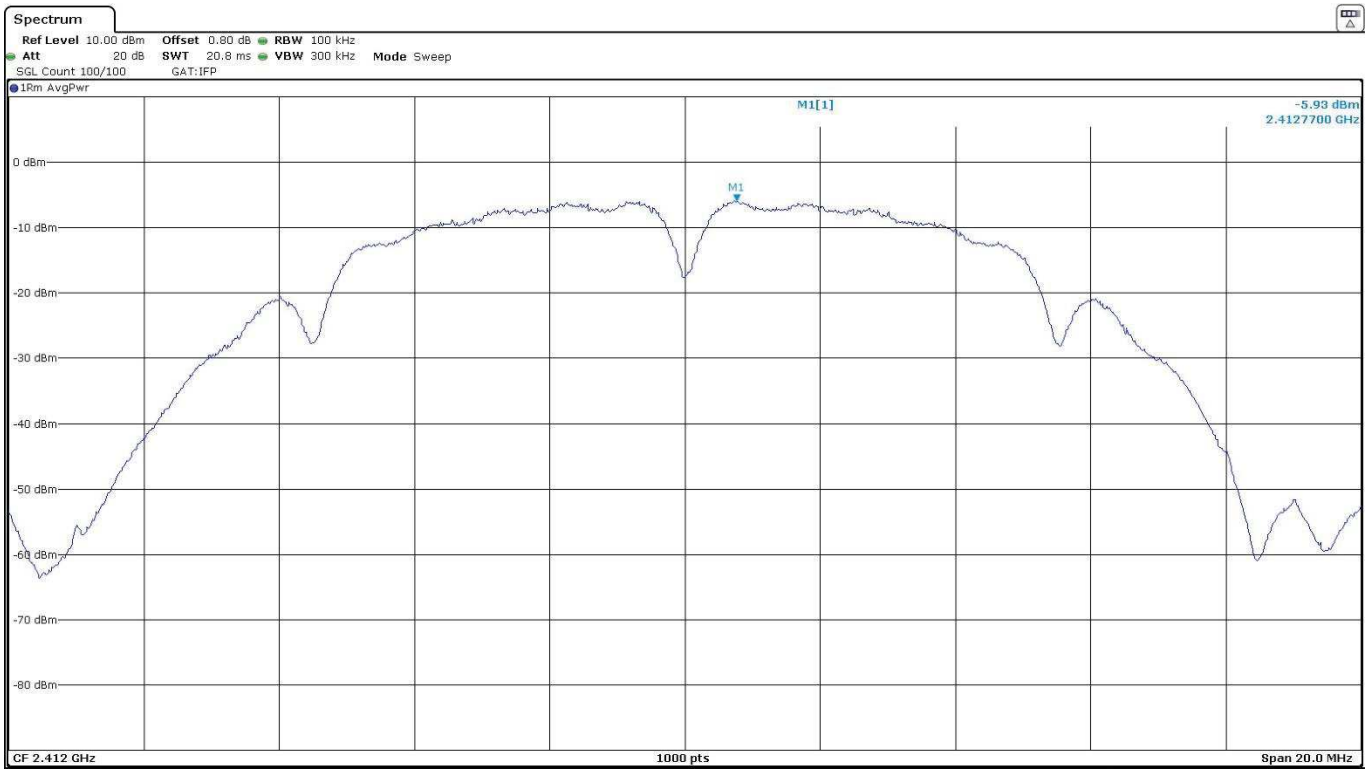
- **Mode 802.11 n20**

	Low Channel	Middle Channel	High Channel
Average Power Spectral Density (dBm)	-6.32	-6.27	-5.87
Measurement uncertainty (dB)	<±2.574		

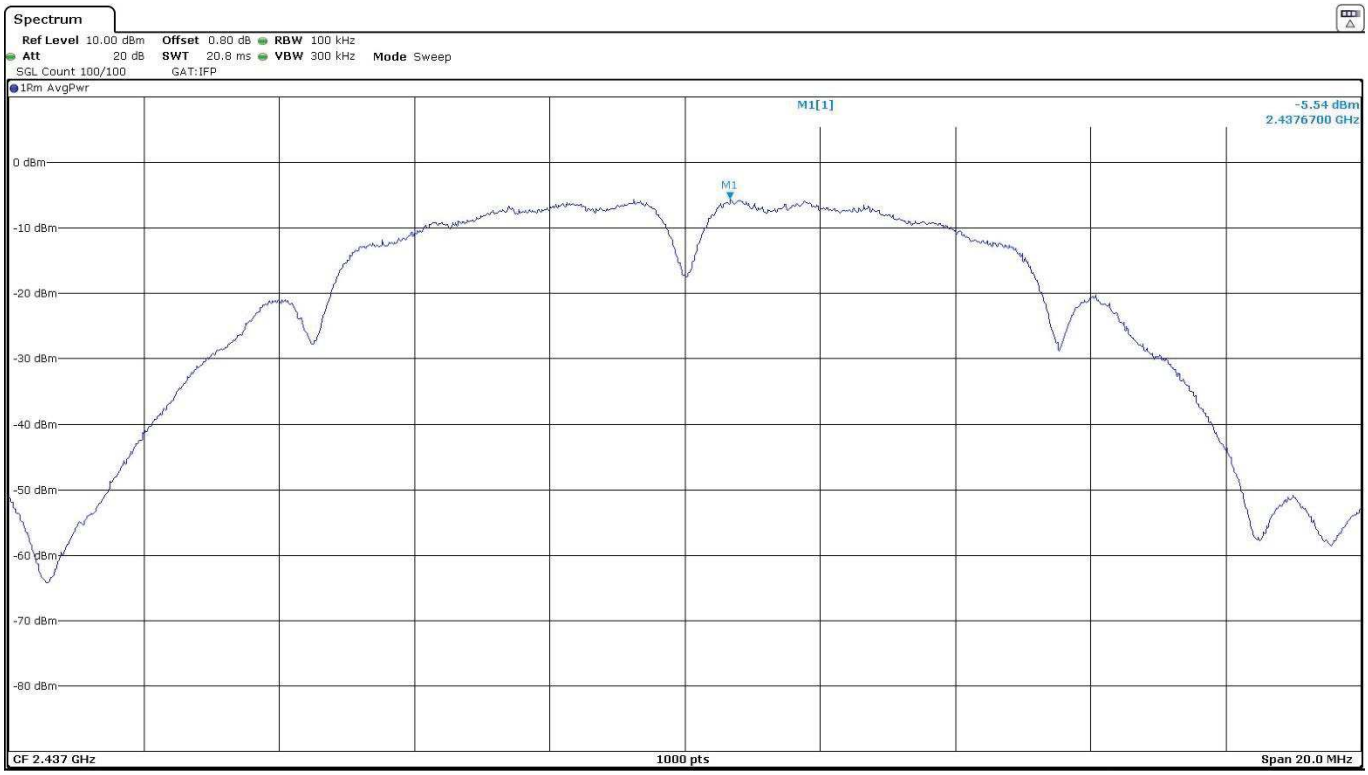
Verdict: PASS

- **Mode 802.11 b – Power Spectral Density**

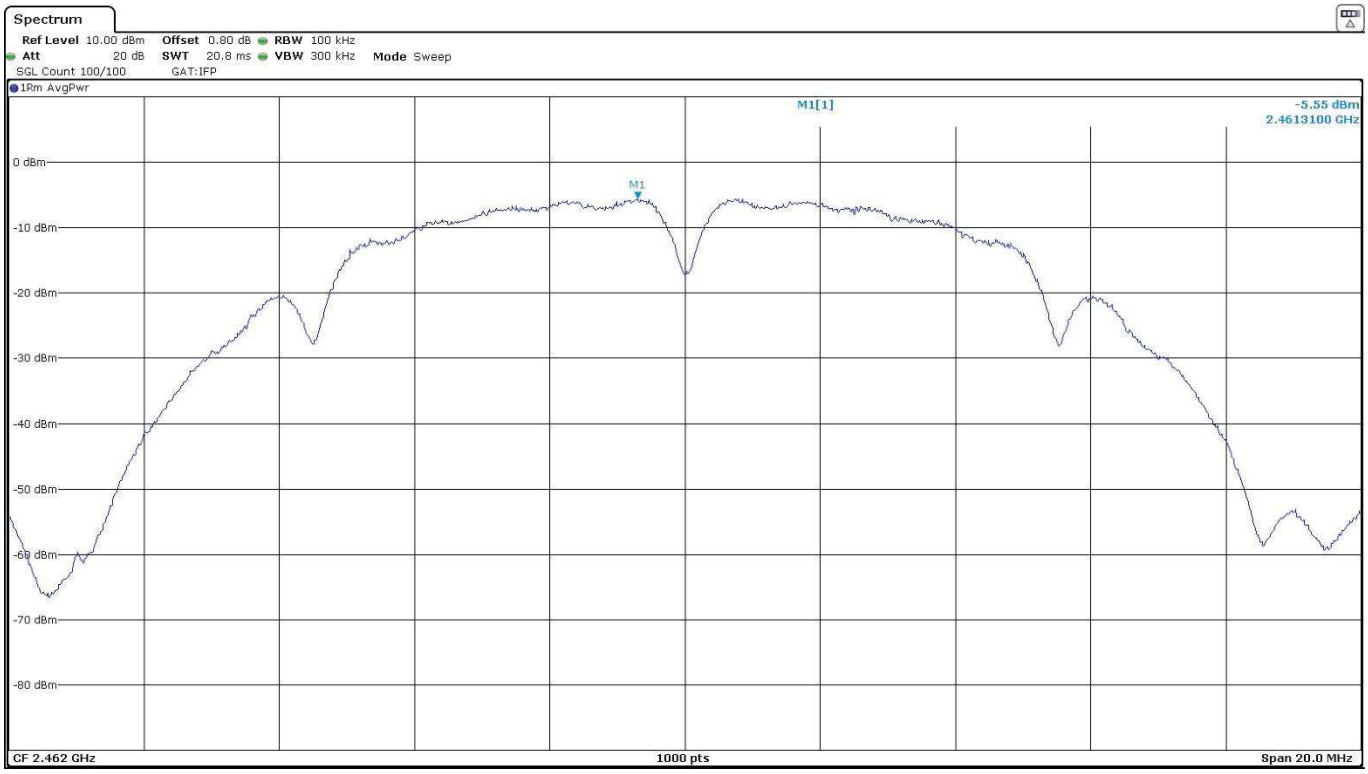
- Low Channel:



- Middle Channel:

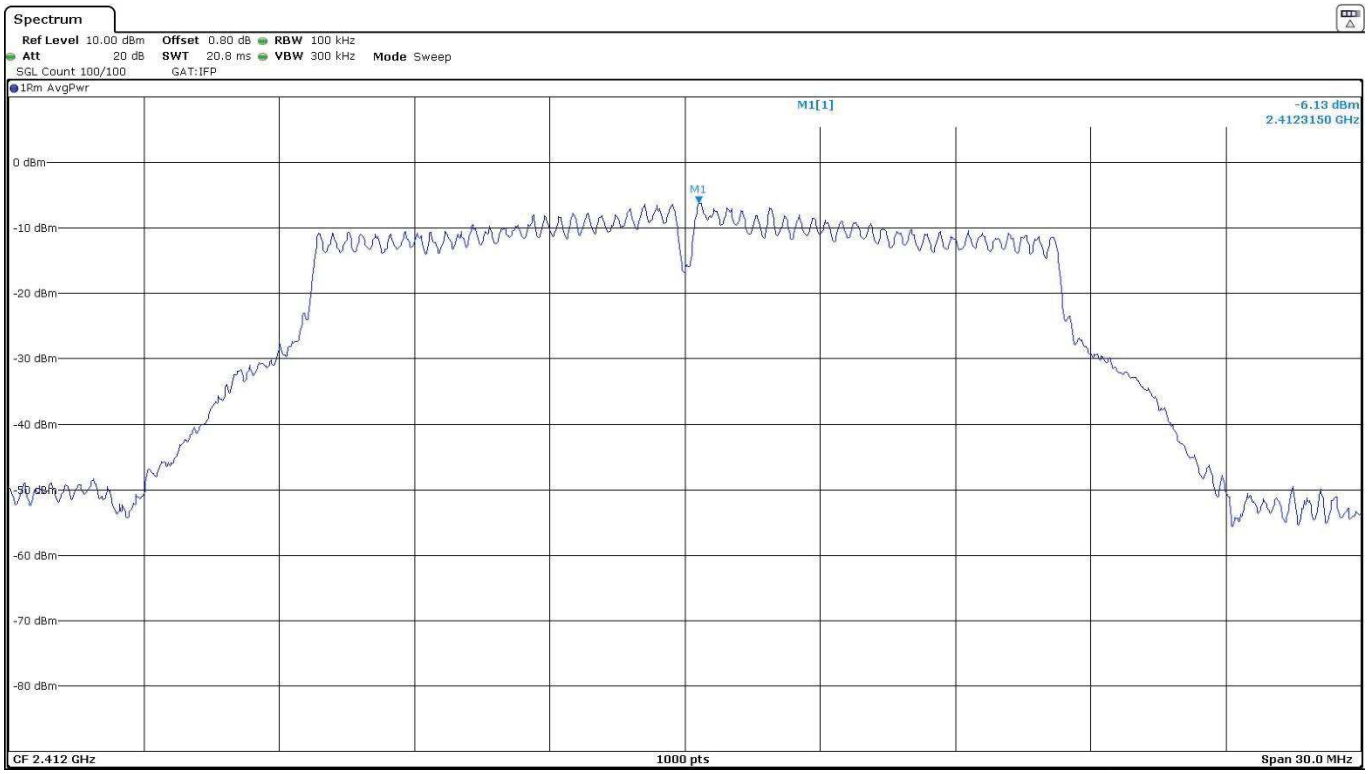


- High Channel:

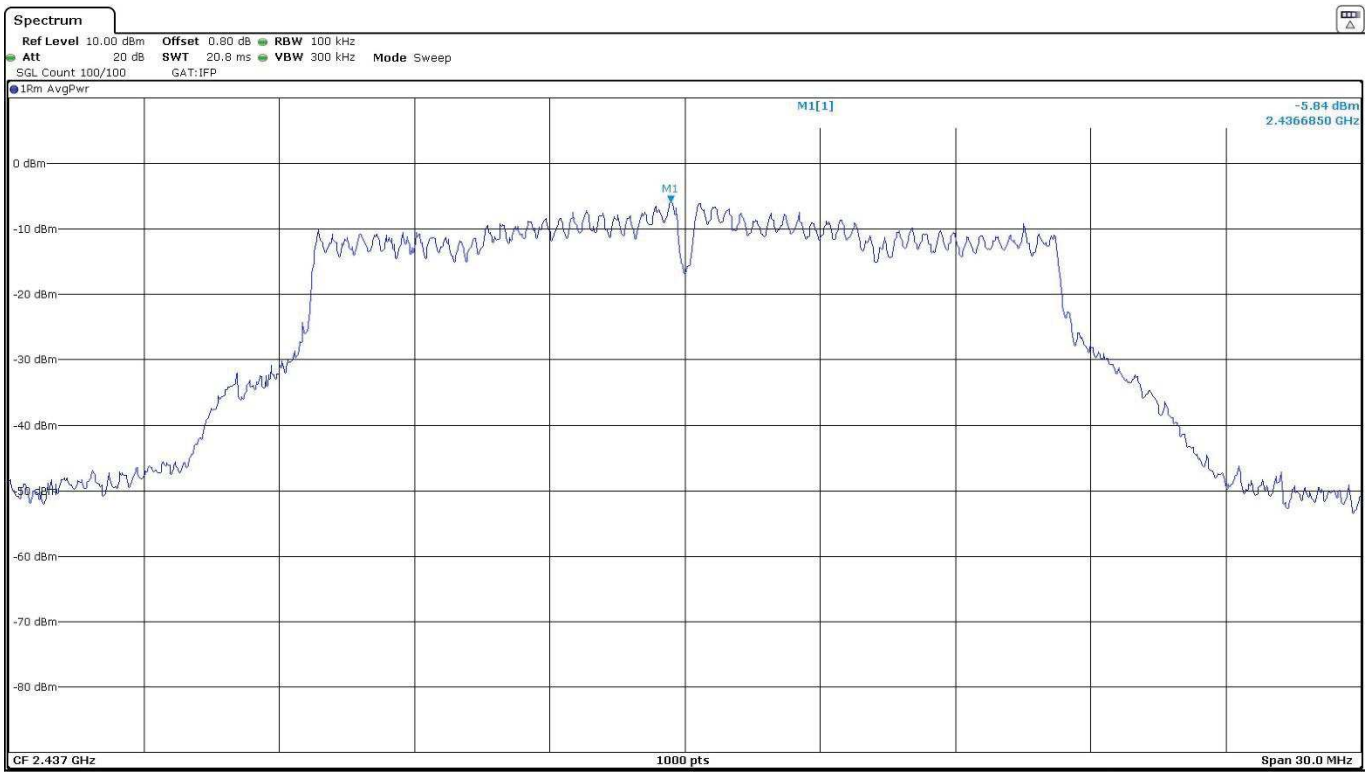


- **Mode 802.11 g – Power Spectral Density**

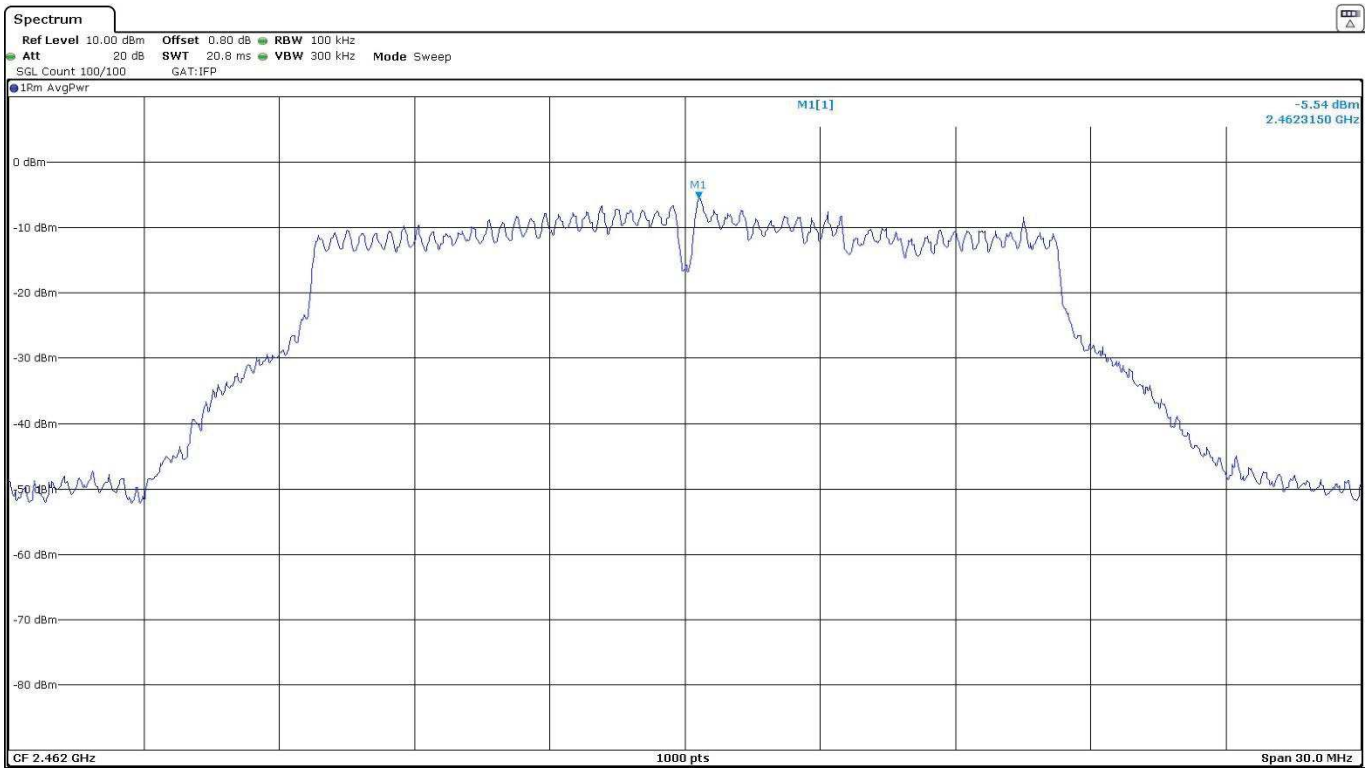
- Low Channel:



- Middle Channel:

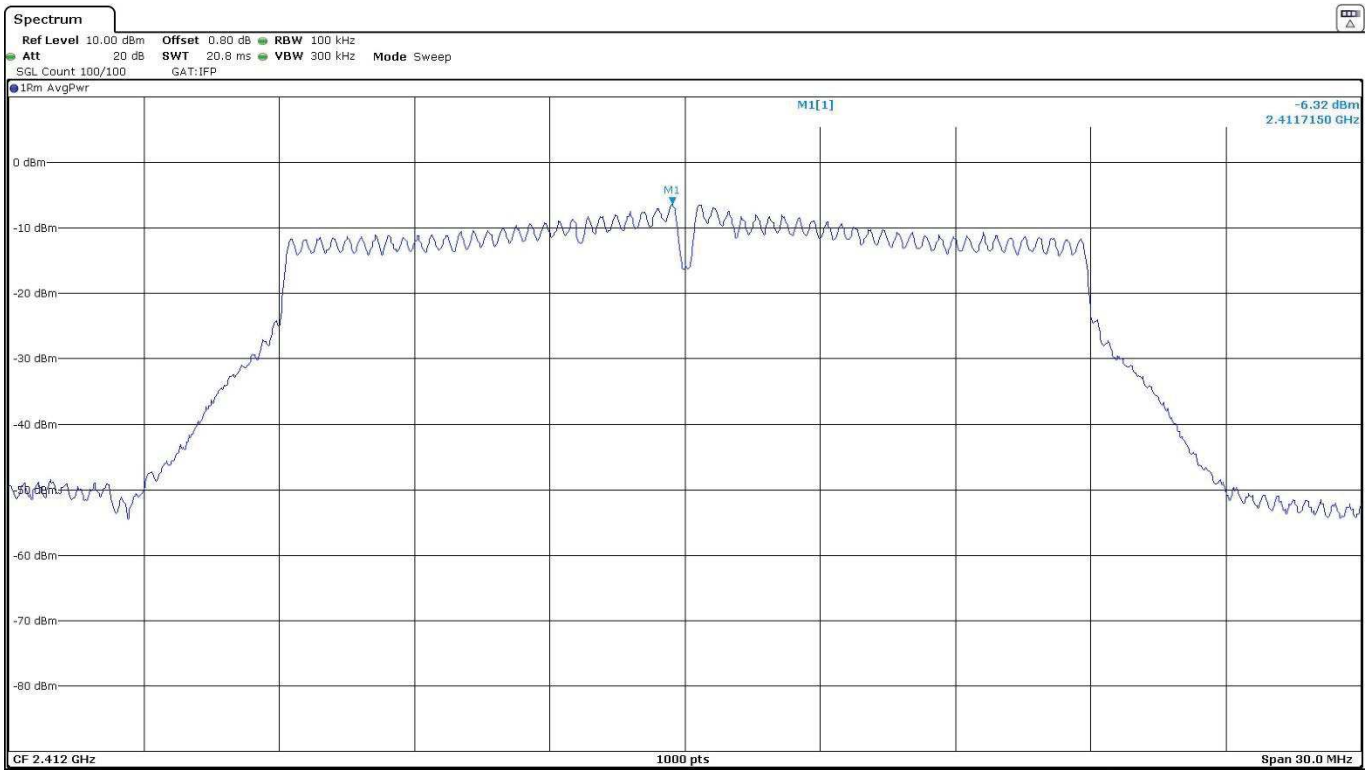


- High Channel:

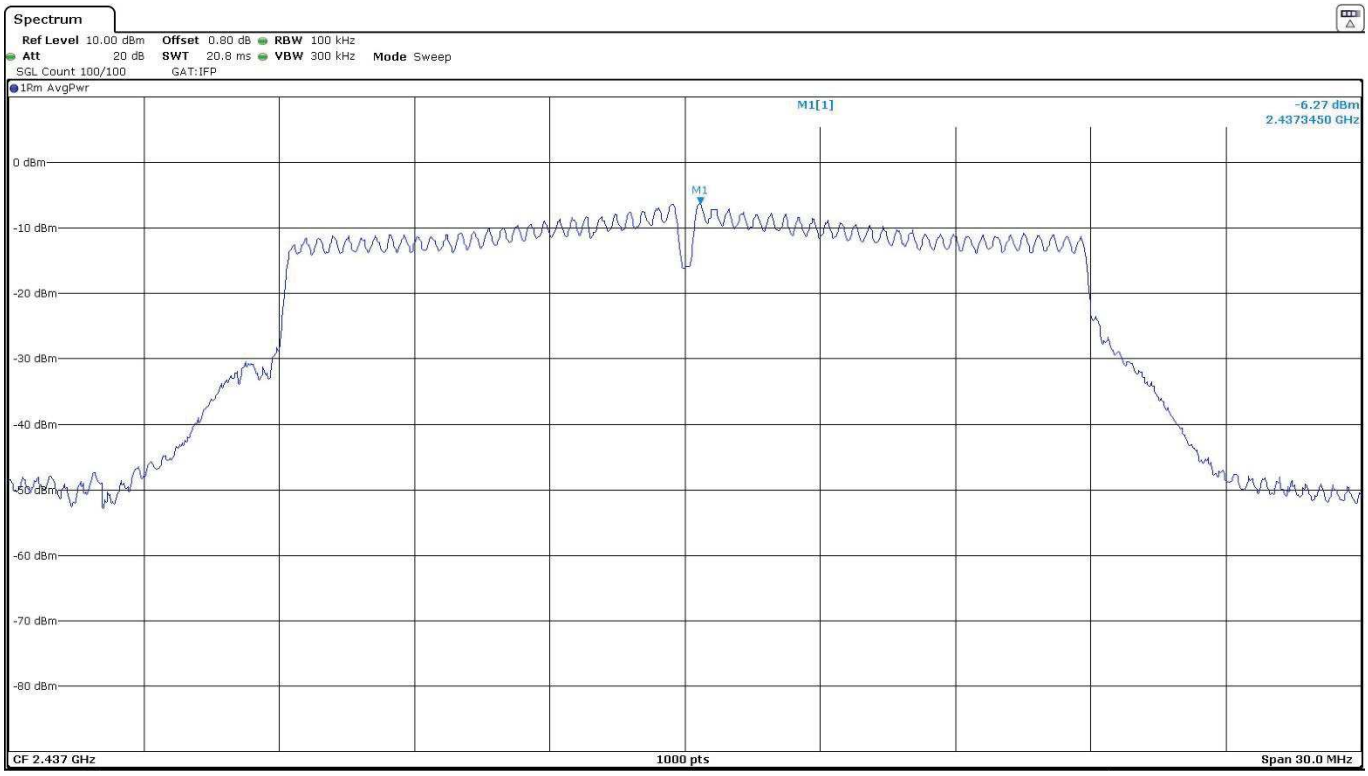


- **Mode 802.11 n20 – Power Spectral Density**

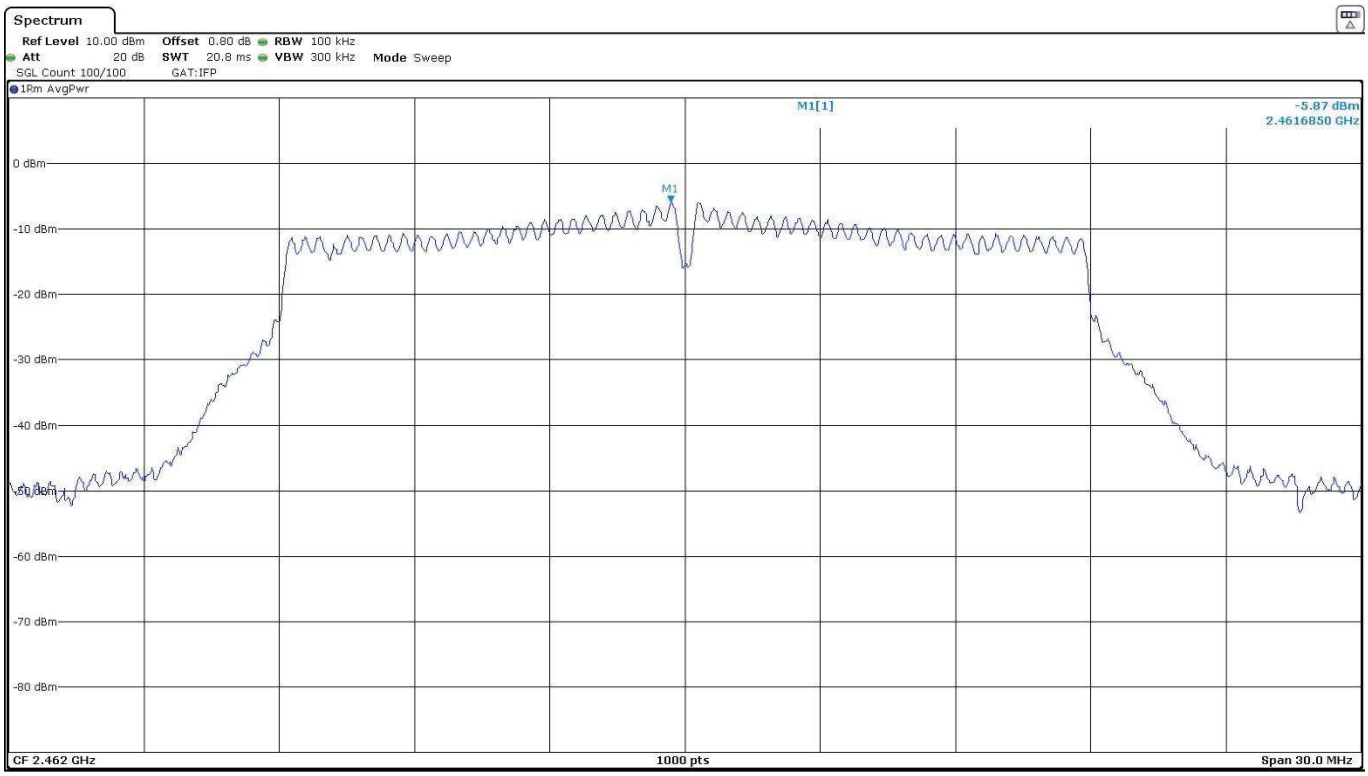
- Low Channel:



- Middle Channel:



- High Channel:



FCC 15.247 (d) / RSS-247 5.5. Emission limitations radiated (Transmitter)

SPECIFICATION:

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) / RSS-Gen):

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
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	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
960 - 25000	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-17 GHz and at distance of 1m for the frequency range 17 GHz-26 GHz.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

Frequency range 30 MHz - 1 GHz:

The spurious frequencies do not depend neither on the operating channel nor the modulation mode.

No spurious frequencies at less than 20 dB below the limit.

Measurement Uncertainty: <± 5.1 dB

- **Mode 802.11 b:**

  Frequency range 1 - 26 GHz:

  The results in the next tables show the maximum measured levels in the 1-26 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

  Spurious signals with peak levels above the average limit (54 dBµV/m at 3 m) are measured with average detector for checking compliance with the average limit.

  - LOW CHANNEL. Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
7.235	46.26	--	46.26	V	Peak	<± 5.13

  - MIDDLE CHANNEL. Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5	43.59	--	43.59	V	Peak	<± 5.13

  - HIGH CHANNEL.

  No spurious frequencies at less than 20 dB below the limit.

  Measurement Uncertainty (dB): 1 GHz ≤ f ≤ 17 GHz: <± 5.13
  17 GHz ≤ f ≤ 26 GHz: <± 5.08

  Verdict: PASS

OFDM modes:

For spurious emissions in the range 30 MHz - 26 GHz (except field strength at the band edges that was performed for all modes) a preliminary scan was performed to determine the worst case mode.

Herein the results for the worst case OFDM mode for spurious emissions: 802.11 g.

Spurious emissions in the Restricted Bands 2.31-2.39 GHz and 2.4835-2.5 GHz are measured for all modes.

- **Mode 802.11 g (OFDM worst case for spurious emissions):**

  Frequency range 1 - 26 GHz:

  The results in the next tables show the maximum measured levels in the 1-26 GHz range including the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

  Spurious signals with peak levels above the average limit (54 dBµV/m at 3 m) are measured with average detector for checking compliance with the average limit.

  - LOW CHANNEL. Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2.3872	60.10	--	60.10	V	Peak	<± 5.13
	44.89	1.103	45.99		Average	<± 5.13
5.0005	42.72	--	42.72	V	Peak	<± 5.13
7.2255	50.37	--	50.37	H	Peak	<± 5.13

  - MIDDLE CHANNEL. Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
5	43.35	--	43.35	V	Peak	<± 5.13
7.310	50.20	--	50.20	H	Peak	<± 5.13

  - HIGH CHANNEL. Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2.4836	62.45	--	62.45	H	Peak	<± 5.13
	45.19	1.103	46.29		Average	<± 5.13
2.484333333	60.39	--	60.39	H	Peak	<± 5.13
	45.08	1.103	46.18		Average	<± 5.13
5.0005	43.04	--	43.04	V	Peak	<± 5.13

Measurement Uncertainty (dB): 1 GHz ≤ f ≤ 17 GHz: <± 5.13
17 GHz ≤ f ≤ 26 GHz: <± 5.08

Verdict: PASS

- **Mode 802.11 n20:**

  The results in the next tables show the maximum measured levels in the Restricted Bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

  Spurious frequencies with peak levels above the average limit (54 dBµV/m at 3 m) are measured with average detector for checking compliance with the average limit.

  - RESTRICTED BAND 2.31-2.39 GHz. LOW CHANNEL:

  Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2.3898	63.33	--	63.33	H	Peak	<± 5.13
	46.49	1.121	47.49		Average	<± 5.13

  - RESTRICTED BAND 2.4835-2.5 GHz. HIGH CHANNEL:

  Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Emission Level (dBµV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBµV/m)	Polarization	Detector	Measurement Uncertainty (dB)
2.483533333	65.72	--	65.72	H	Peak	<± 5.13
	45.70	1.121	46.82		Average	<± 5.13
2.4838	59.71	--	59.71	H	Peak	<± 5.13
	44.43	1.121	45.55		Average	<± 5.13

Verdict: PASS