5. Receiver radiated spurious emissions

5.1. Test setup

Same as clause 5.1.

5.1.1. Receiver radiated spurious emissions

Same as clause 5.1.1

5.2. Limit

According to §15.109(a), Except for Class A digital devices, the field strength of radiated emission from unintentional radiator at a distance of 3 m shall not exceed the following values:

Frequency (㎒)	Distance (Meters)	Radiated (dB㎶/m)	Radiated (㎶/m)
0.009–0.490	300	See the remark	2400/F(㎑)
0.490–1.705	30		24000/F(㎑)
1.705–30.0	30		30
30 - 88	3	40.0	100
88 – 216	3	43.5	150
216 – 960	3	46.0	200
Above 960	3	54.0	500

5.3. Test procedures

Same as clause 5.3.
Radiated emissions from the EUT were measured according to the dictates of ANSI C63.4:2003
In case of the air temperature of the test site is out of the range is 10 to 40°C before the testing proceeds the warm-up time of EUT maintain adequately

5.3.1. Test procedures for radiated spurious emissions

Same as Clause 5.3.1.

5.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 42 % R.H.

5.4.1. Spurious radiated emission.

The frequency spectrum from 30 ㎒ to 26 ㎓ was investigated. Emission levels are not reported much lower than the limits by over 30 ㏈. All reading values are peak values.

Operation mode: 802.11b/g/n20 mode

A. LOW channel (2 412 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	Amp + CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
1703.50	45.59	Peak	H	28.86	43.65	30.8	74.00	43.20
-	-	-	-	-	-	-	-	-

B. MID channel (2 437 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	Amp + CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
1711.85	48.30	Peak	H	28.86	43.65	33.51	74.00	20.49
-	-	-	-	-	-	-	-	-

C. High channel (2 462 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (㏈㎶)	Detector mode	Pol.	Ant. factor (㏈/m)	Amp + CL (㏈)	Actual (㏈㎶/m)	Limit (㏈㎶/m)	Margin (㏈)
1705.60	45.01	Peak	H	28.86	43.65	30.22	74.00	43.78
-	-	-	-	-	-	-	-	-

※ Remark:
Actual = Reading + Ant. factor + Amp + CL (Cable loss)

Operation mode: 802.11a/an20/an40 mode

A. LOW channel (5 745 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1766.55	43.31	Peak	H	28.86	43.65	28.52	74.00	45.48
-	-	-	-	-	-	-	-	-

B. MID channel (5 785 ㎒)

Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1759.45	46.99	Peak	H	28.86	43.65	32.2	54.00	21.80
-	-	-	-	-	-	-	-	-

C. High channel (5 805 ㎒)

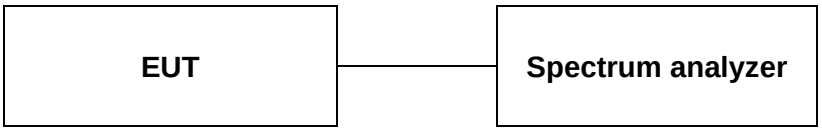
Radiated emissions			Ant.	Correction factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detector mode	Pol.	Ant. factor (dB/m)	Amp + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
1756.05	47.06	Peak	H	28.86	43.65	32.27	74.00	41.73
-	-	-	-	-	-	-	-	-

※ Remark:

Actual = Reading + Ant. factor + Amp + CL (Cable loss)

6. 6 dB bandwidth & 99 % bandwidth measurement

6.1. Test setup



6.2. Limit

According to §15.247(a)(2), systems using digital modulation techniques may operate in the 902~928 ㎒, 2 400~2 483.5 ㎒, and 5 725~5 825 ㎒ bands. The minimum of 6 dB Bandwidth shall be at least 500 ㎑

6.3. Test procedure

1. The 6 dB band width was measured with a spectrum analyzer connected to RF antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer. Display Line and Marker Delta functions, the 6 dB band width of the emission was determined.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW = 100 ㎑, VBW = 100 ㎑, Span = 5 ㎒.

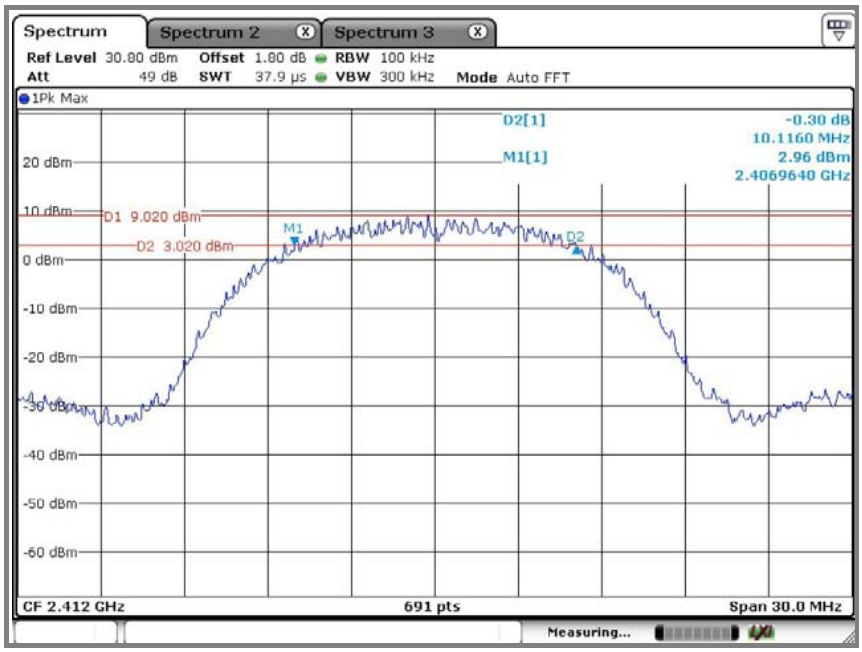
6.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 51 % R.H.

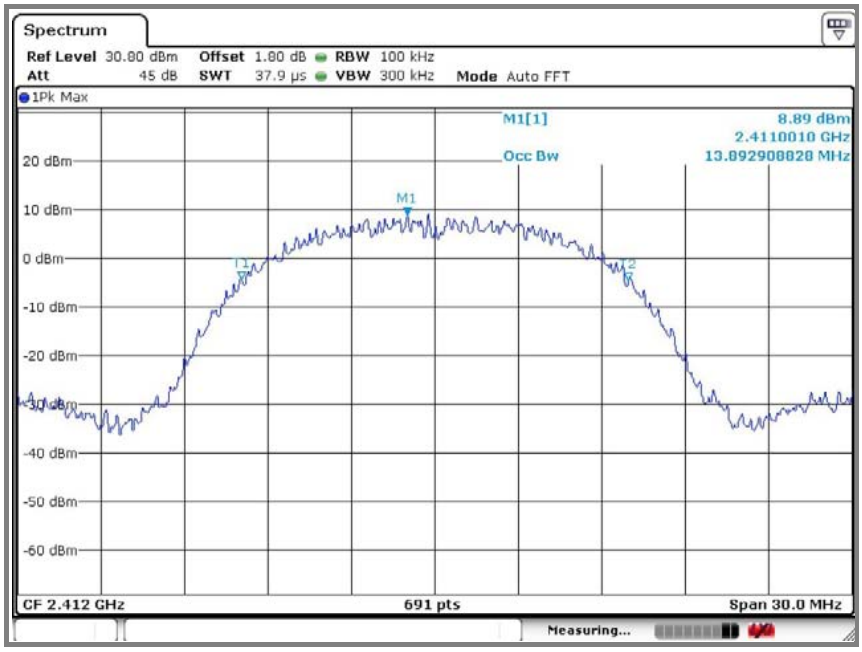
Mode	Frequency(㎒)	6 ㏈ bandwidth(㎒)	99% bandwidth(㎒)
802.11b (Ant 1)	2 412	10.12	13.89
	2 437	10.12	14.02
	2 462	10.25	14.15
802.11b (Ant 2)	2 412	10.59	13.85
	2 437	10.46	14.02
	2 462	10.51	14.15
802.11g (Ant 1)	2 412	16.50	16.41
	2 437	16.50	16.41
	2 462	16.50	16.50
802.11g (Ant 2)	2 412	16.50	16.41
	2 437	16.50	16.50
	2 462	16.50	16.50
802.11n_20 (MIMO)	2 412	17.76	17.63
	2 437	17.63	17.63
	2 462	17.76	17.63
802.11a (Ant 1)	5 745	16.24	16.50
	5 785	16.45	16.50
	5 805	16.45	16.45
802.11a (Ant 2)	5 745	16.50	16.50
	5 785	16.45	16.50
	5 805	16.50	16.45
802.11an_20 (MIMO)	5 745	17.54	17.63
	5 785	17.32	17.67
	5 805	17.28	17.67
802.11an_40 (MIMO)	5 755	36.40	36.11
	5 795	35.89	36.04

Operation mode: 802.11b mode (Ant 1)

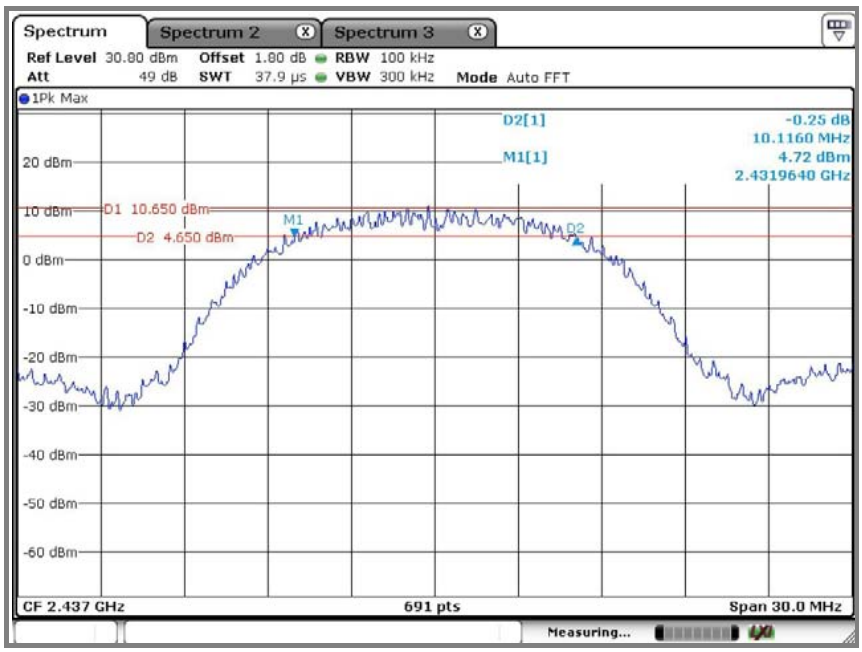
A. Low channel (2 412 ㎒) - 6 ㏈ bandwidth



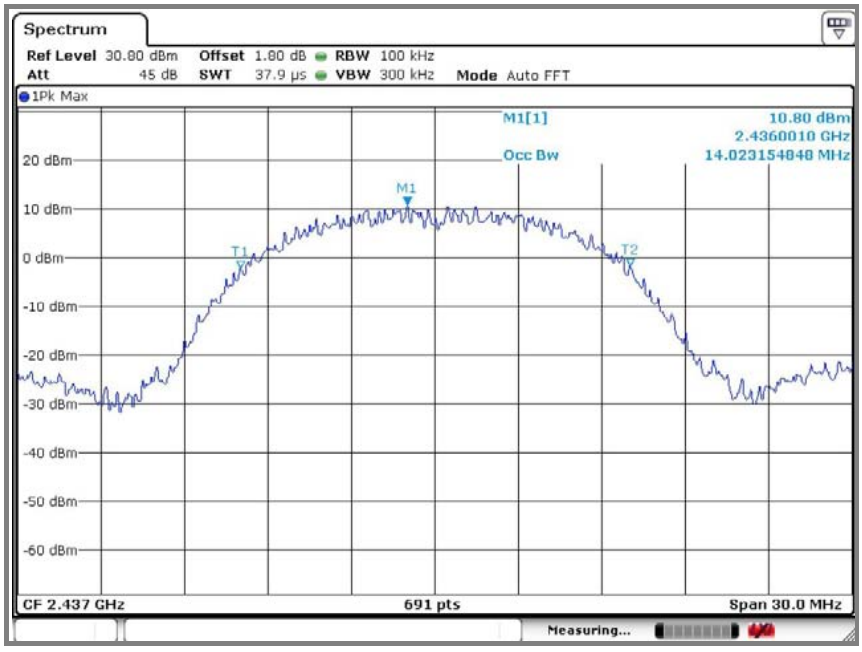
A. Low channel (2 402 ㎒) – 99 % bandwidth



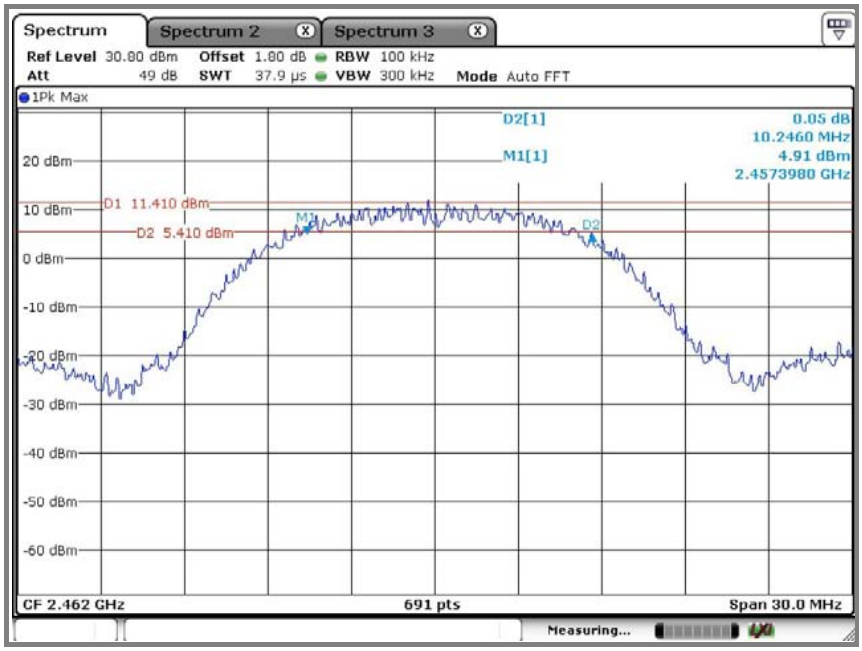
B. Middle channel (2 437 ㎒) - 6 ㏈ bandwidth



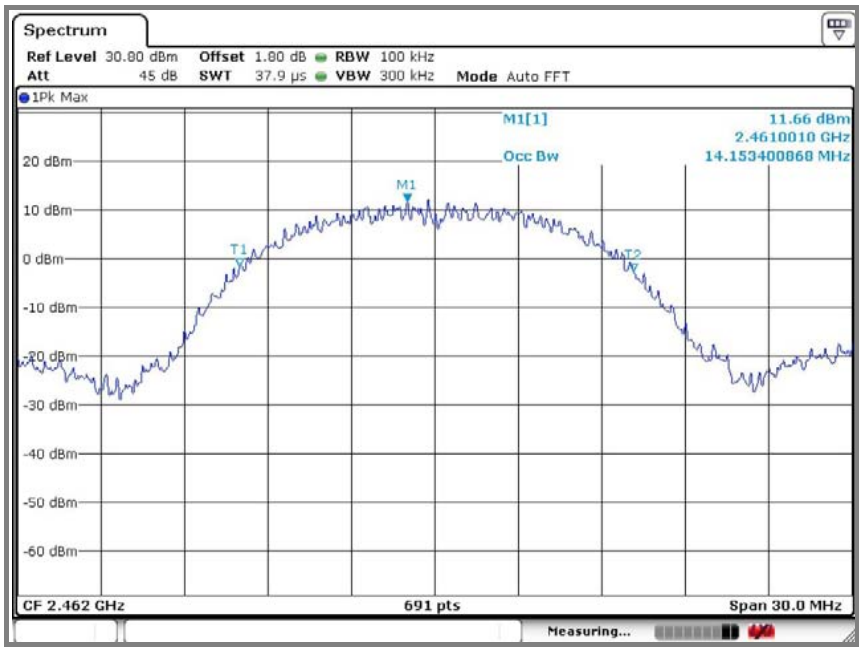
B. Middle channel (2 437 ㎒) – 99 % bandwidth



C. High channel (2 462 ㎒)

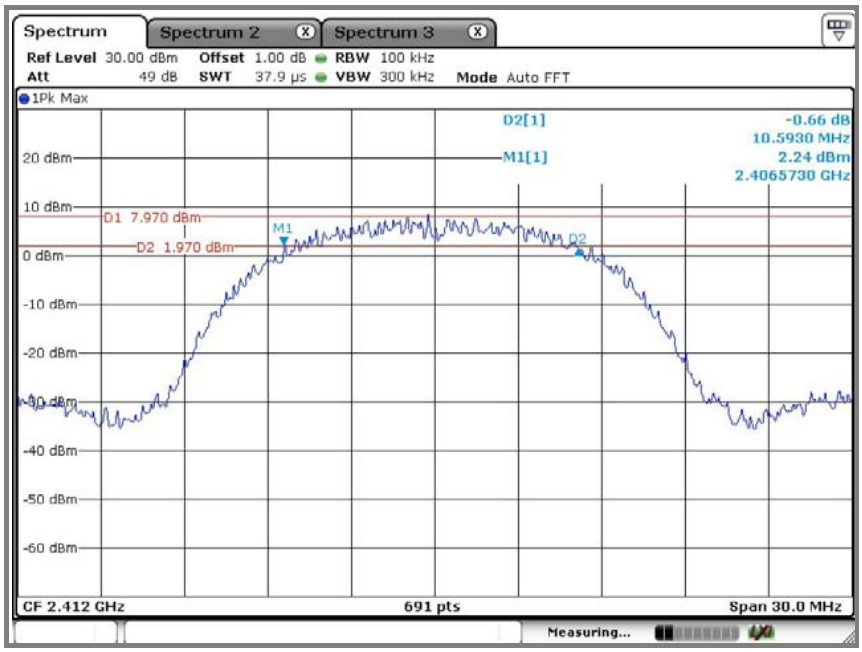


C. High channel (2 462 ㎒) – 99 % bandwidth

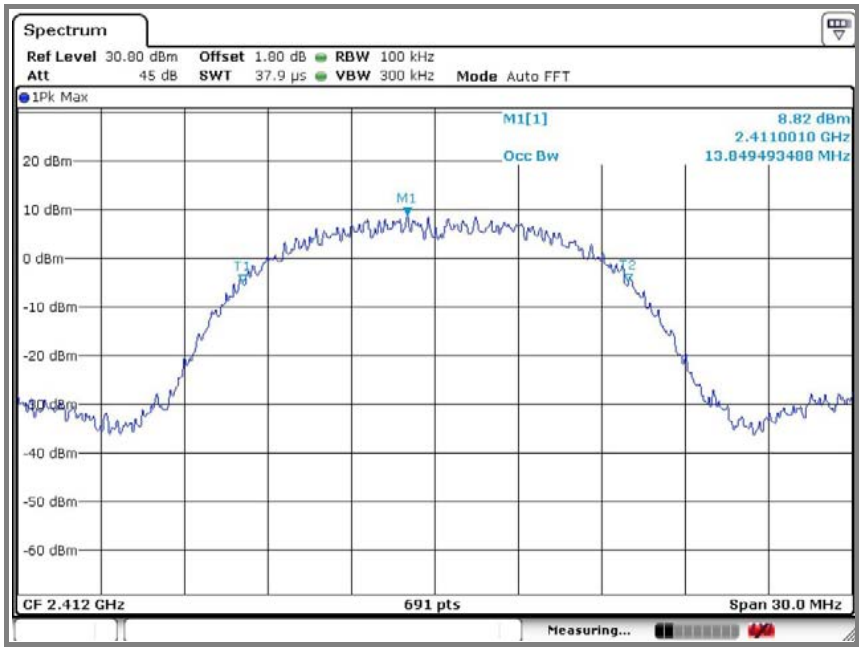


Operation mode: 802.11b mode (Ant 2)

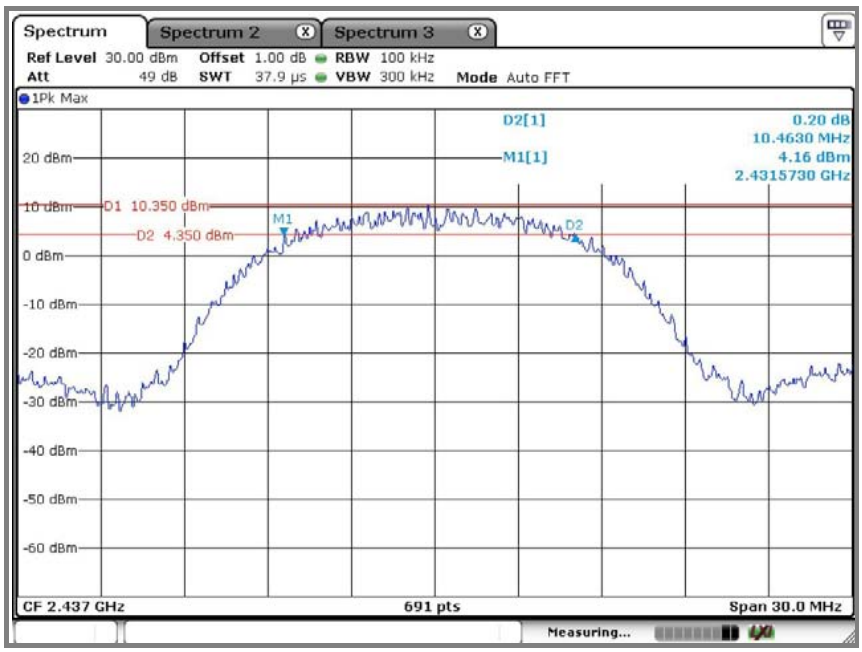
A. Low channel (2 412 ㎒) - 6 ㏈ bandwidth



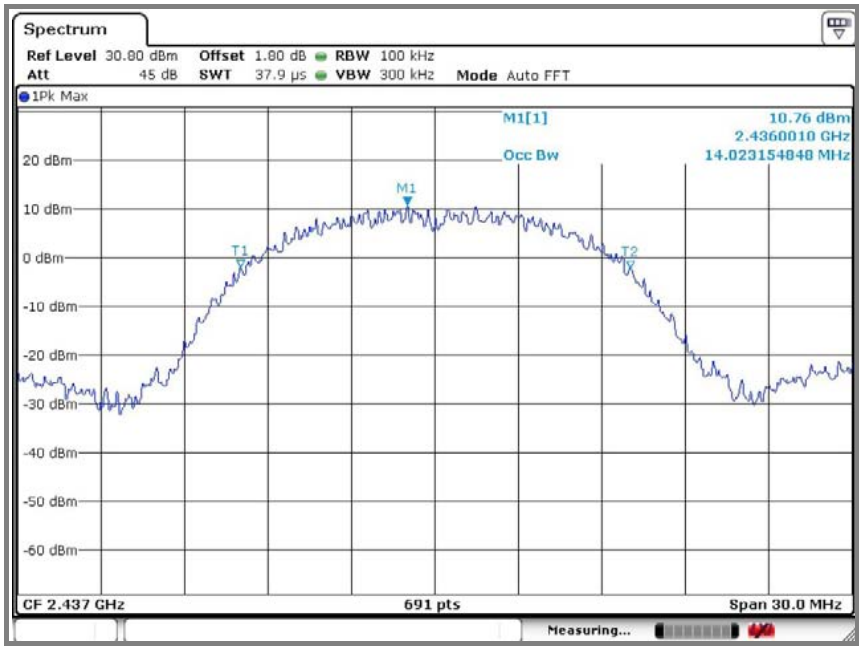
A. Low channel (2 402 ㎒) – 99 % bandwidth



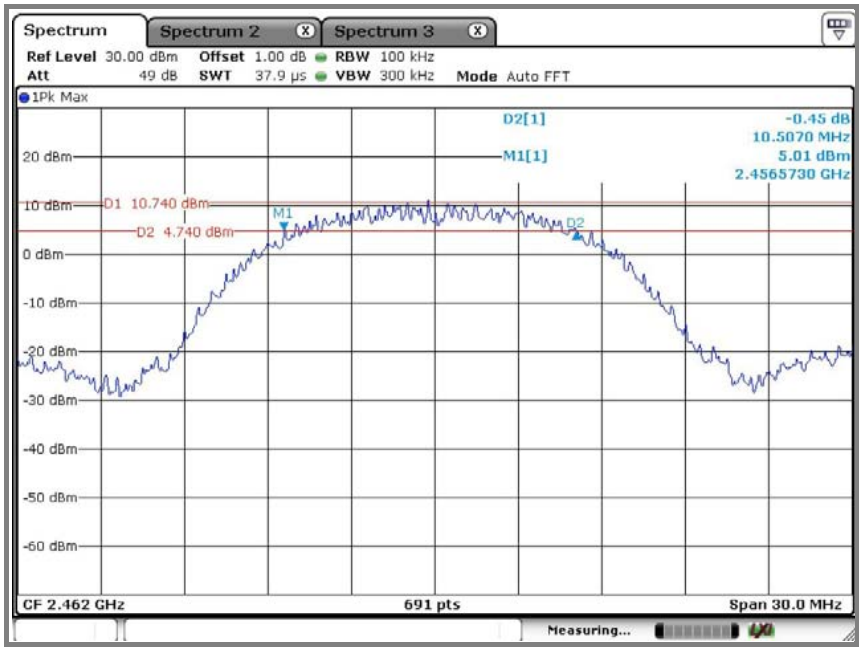
B. Middle channel (2 437 ㎒) - 6 ㏈ bandwidth



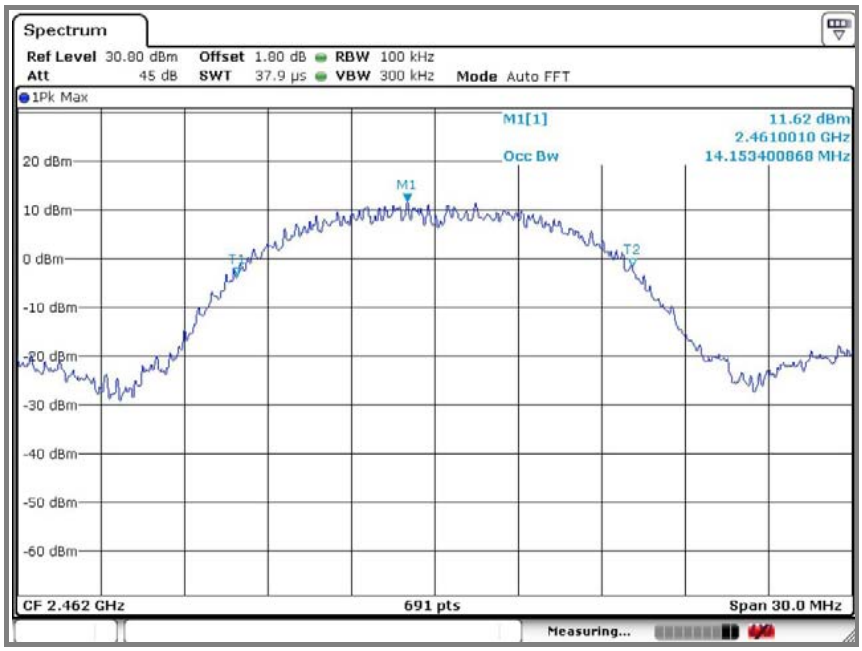
B. Middle channel (2 437 ㎒) – 99 % bandwidth



C. High channel (2 462 ㎒)

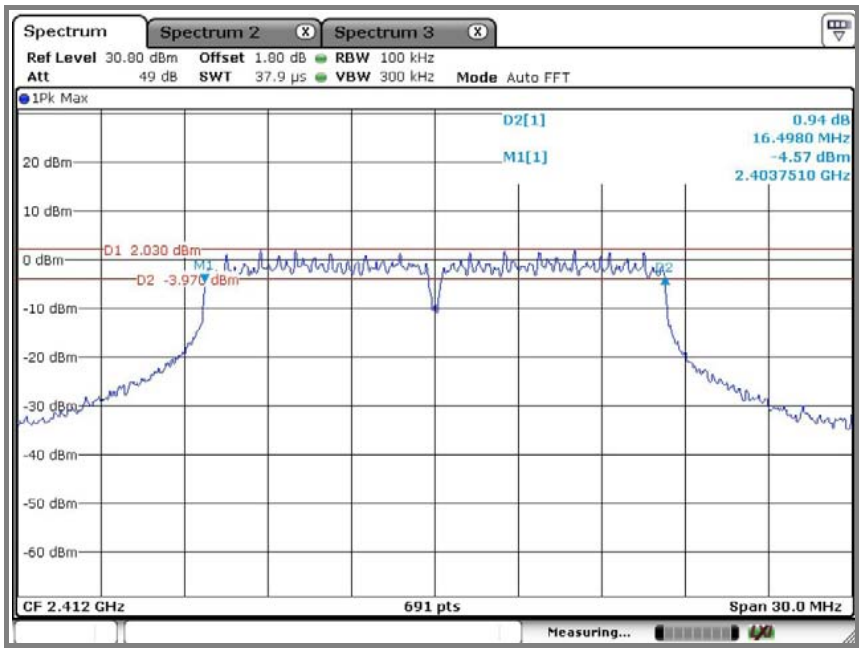


C. High channel (2 462 ㎒) – 99 % bandwidth

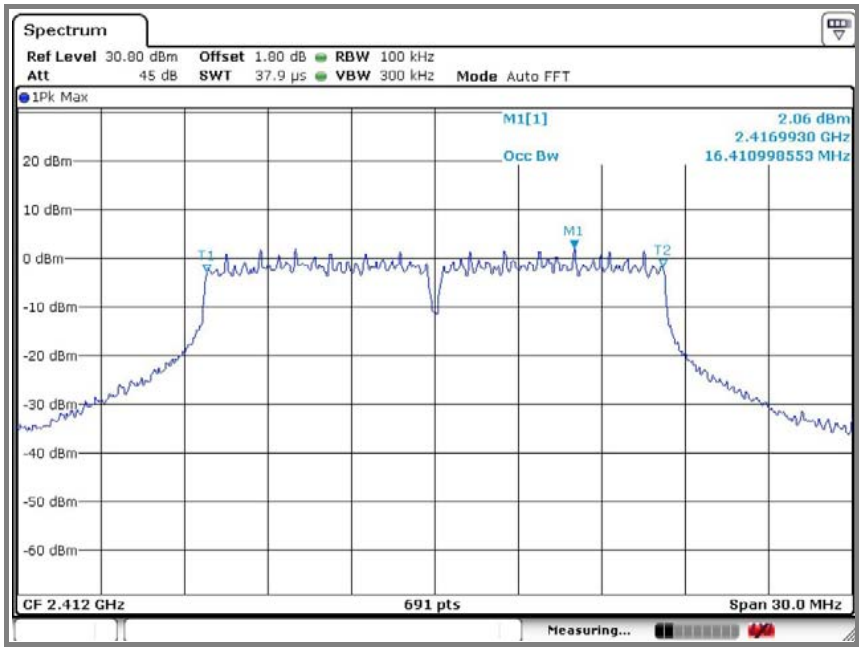


Operation mode: 802.11g mode (Ant 1)

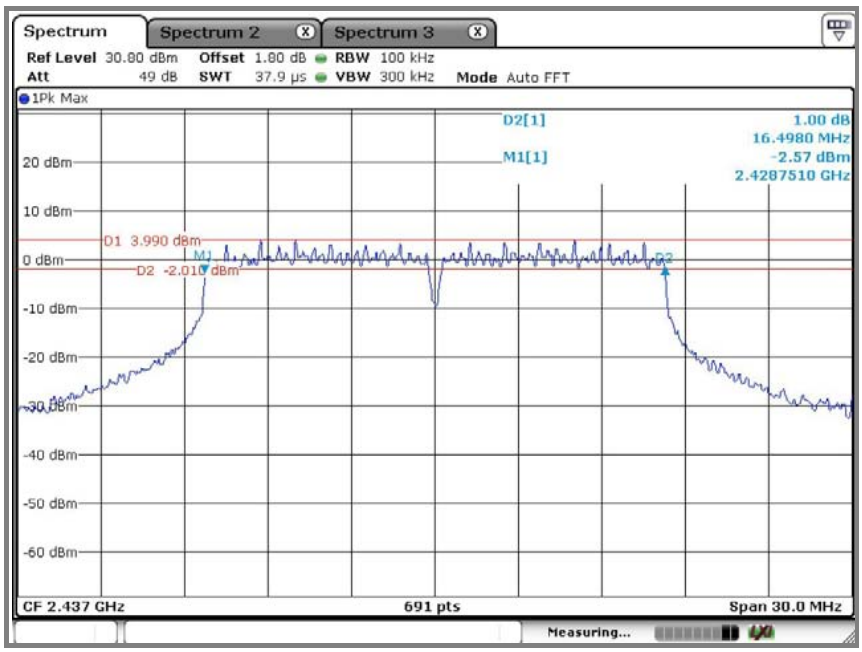
A. Low channel (2 412 ㎒) - 6 ㏈ bandwidth



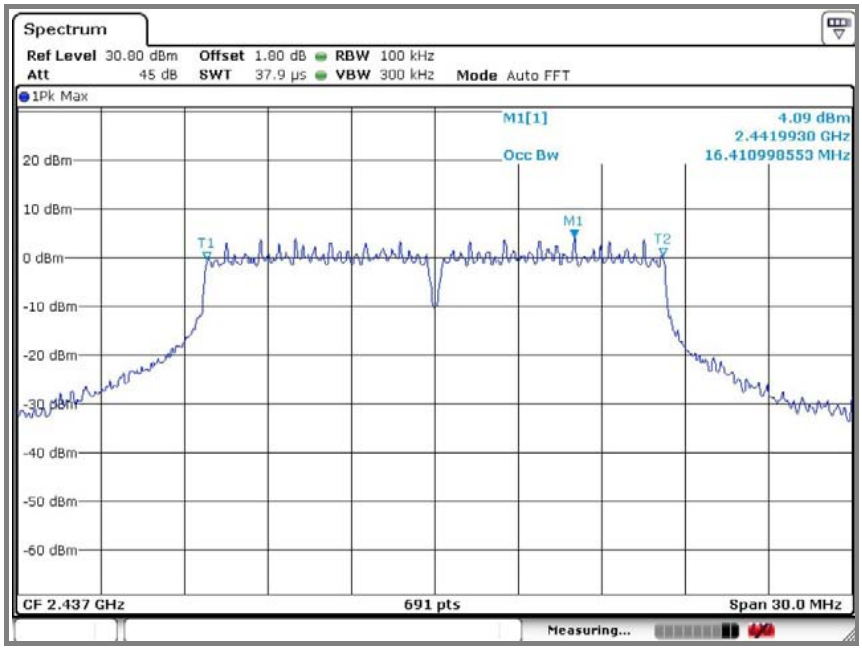
A. Low channel (2 402 ㎒) – 99 % bandwidth



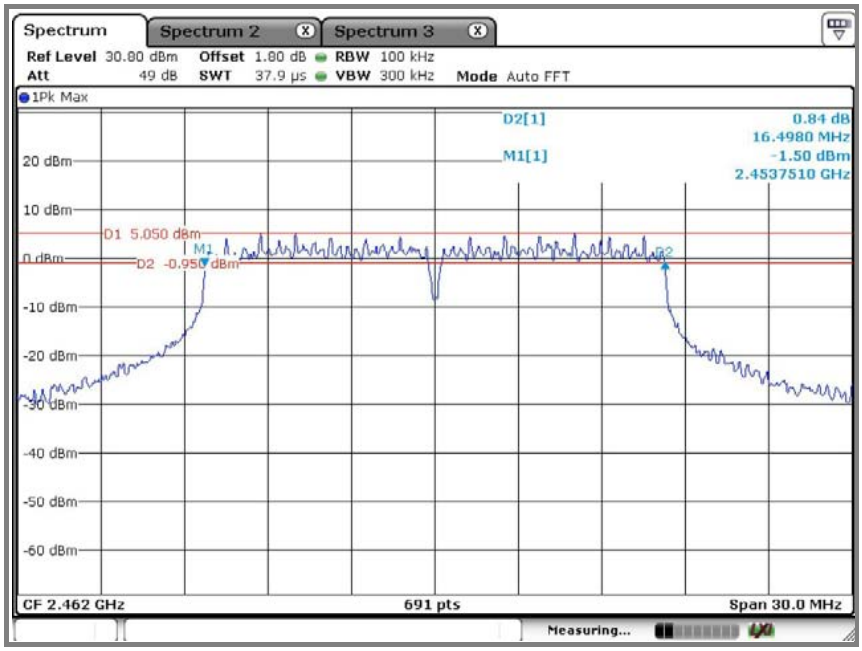
B. Middle channel (2 437 ㎒) - 6 ㏈ bandwidth



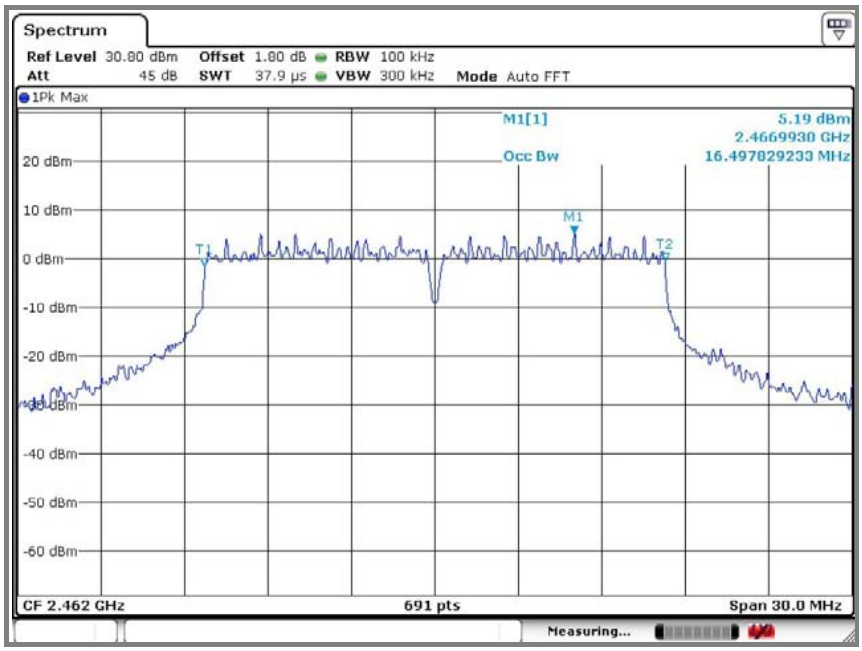
B. Middle channel (2 437 ㎒) – 99 % bandwidth



C. High channel (2 462 ㎒)

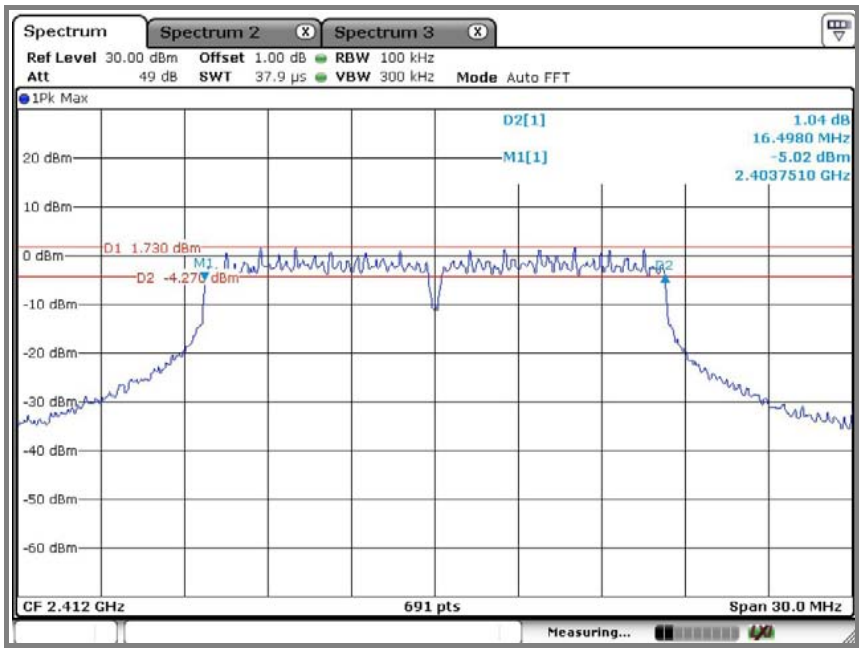


C. High channel (2 462 ㎒) – 99 % bandwidth

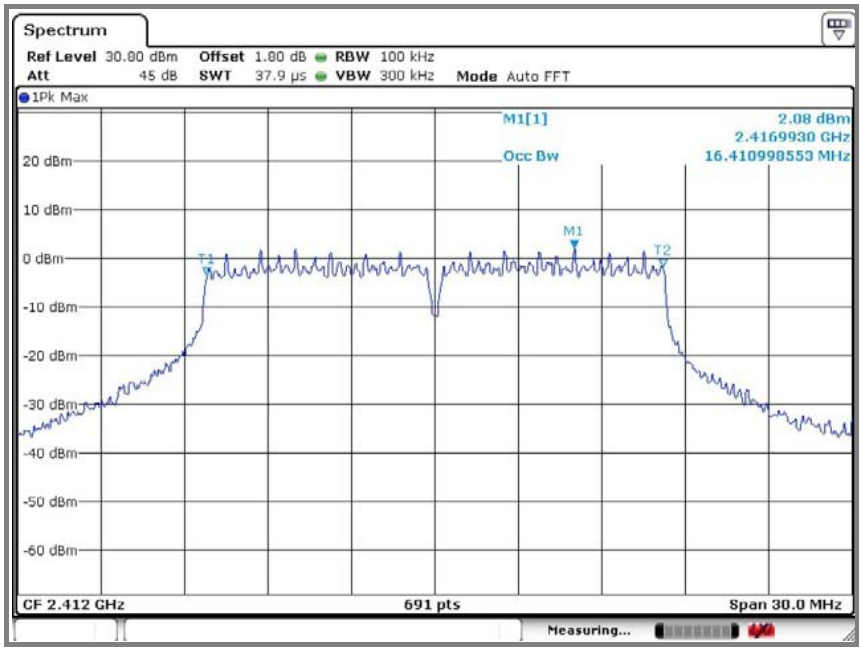


Operation mode: 802.11g mode (Ant 2)

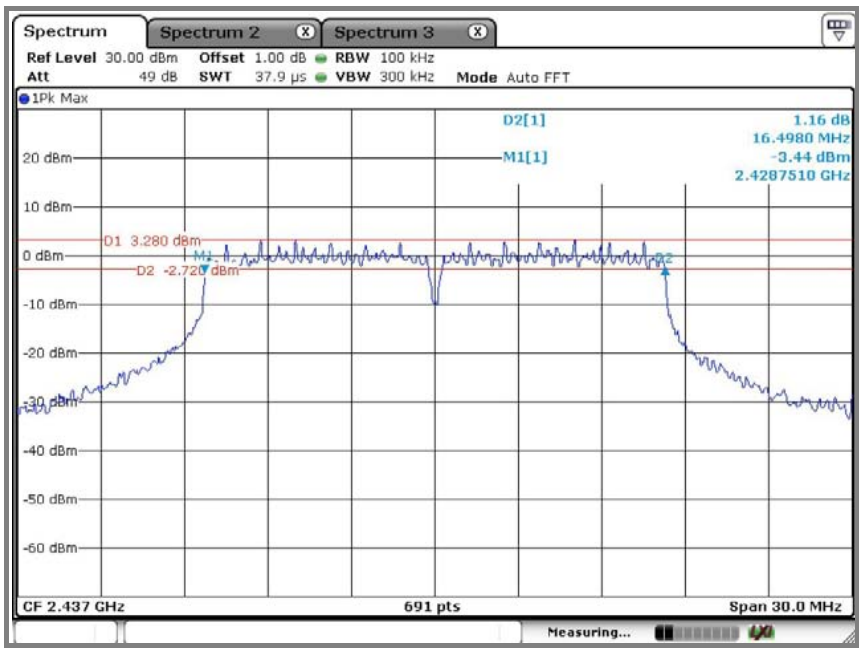
A. Low channel (2 412 ㎒) - 6 ㏈ bandwidth



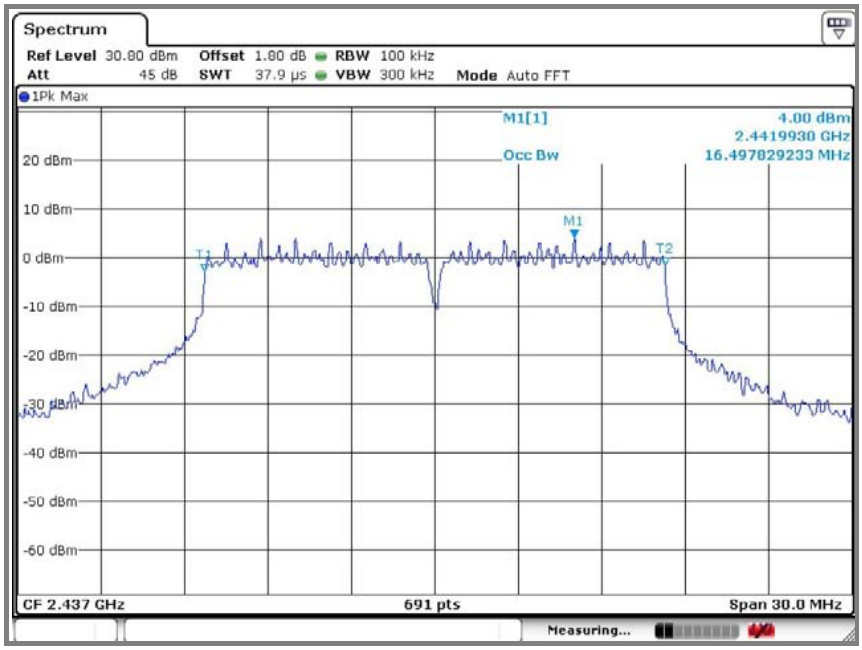
A. Low channel (2 402 ㎒) – 99 % bandwidth



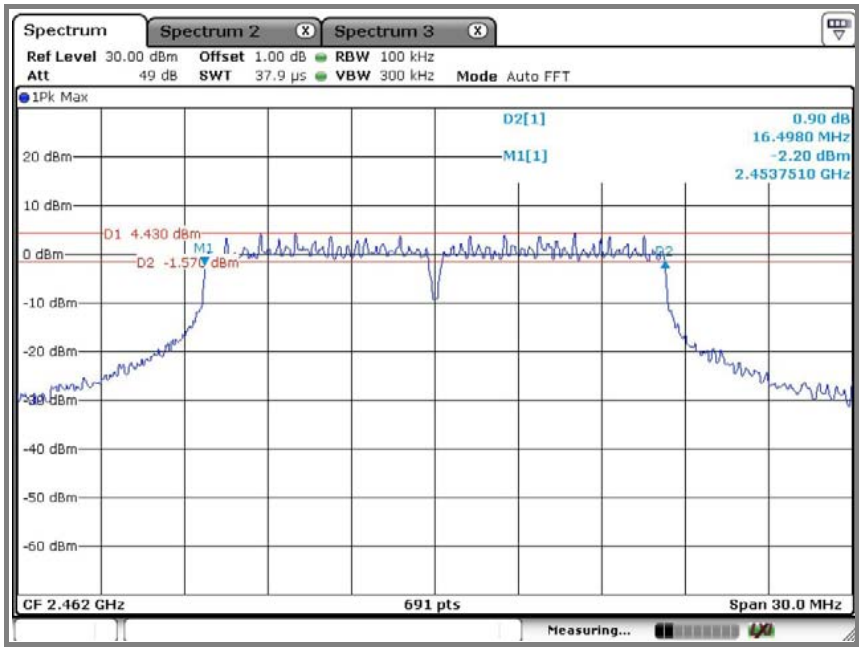
B. Middle channel (2 437 ㎒) - 6 ㏈ bandwidth



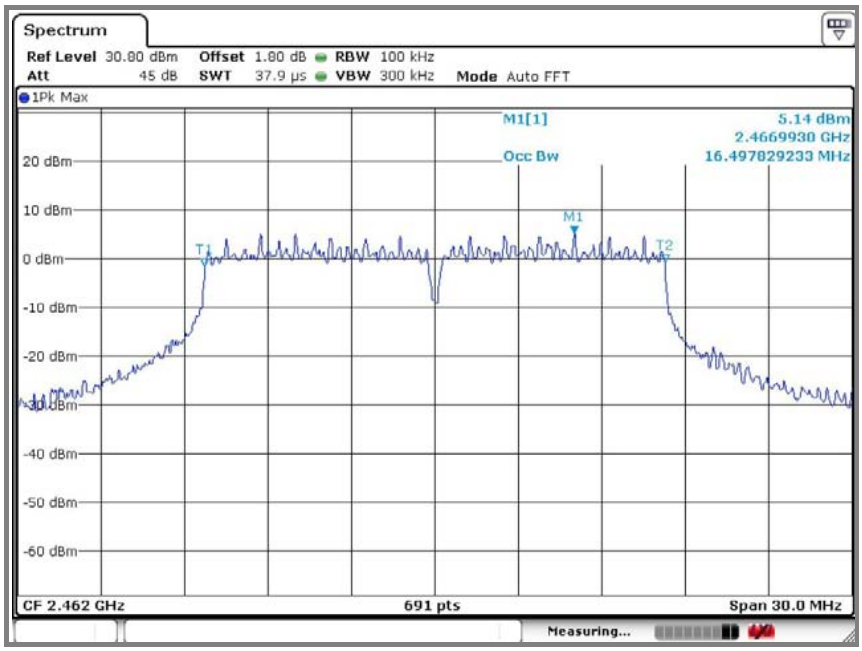
B. Middle channel (2 437 ㎒) – 99 % bandwidth



C. High channel (2 462 ㎒)

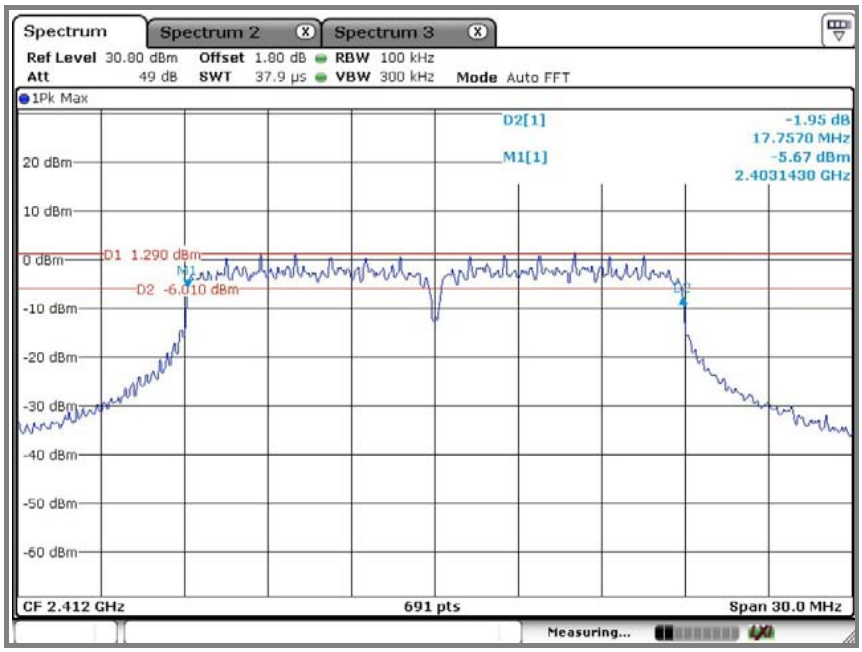


C. High channel (2 462 ㎒) – 99 % bandwidth

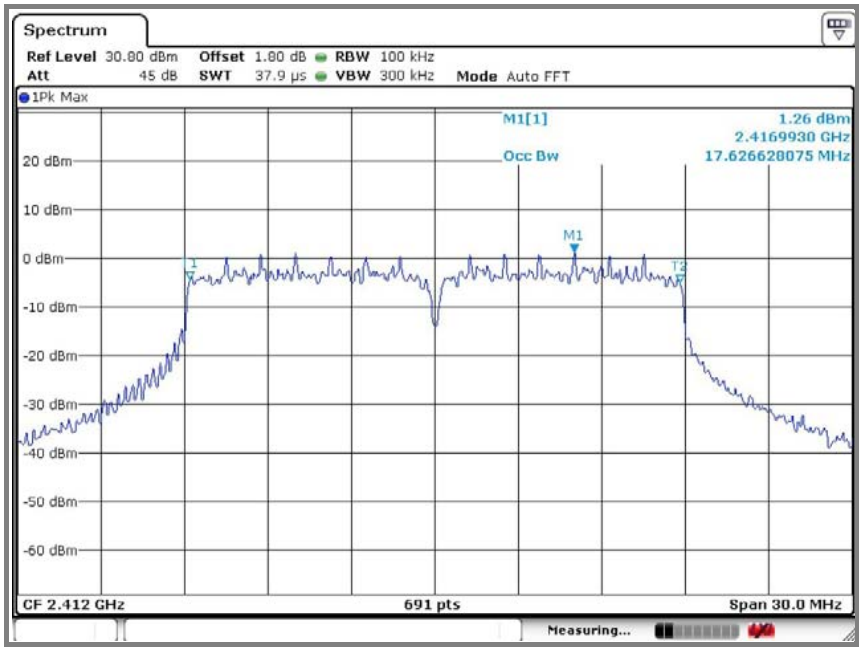


Operation mode: 802.11n20 mode (MIMO)

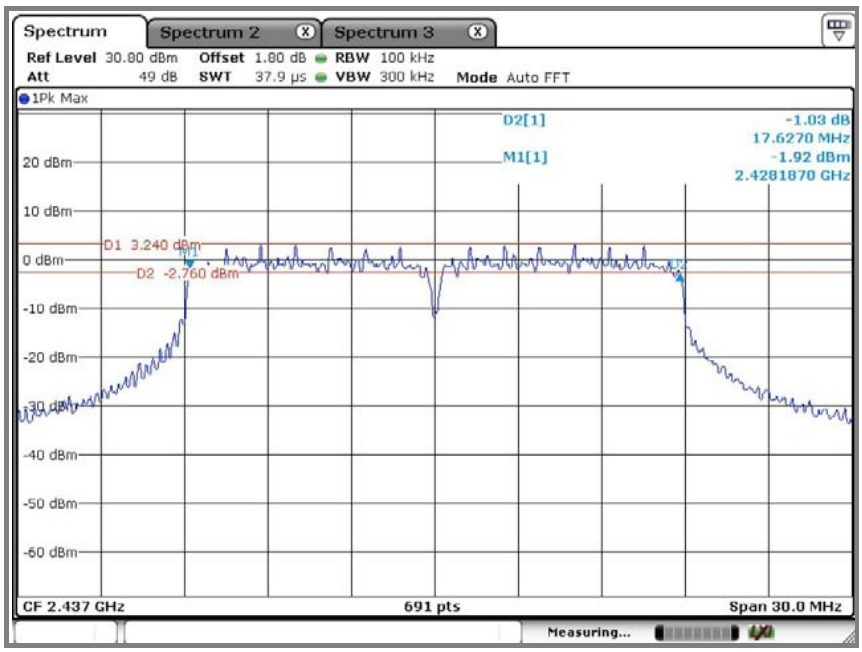
A. Low channel (2 412 ㎒) - 6 ㏈ bandwidth



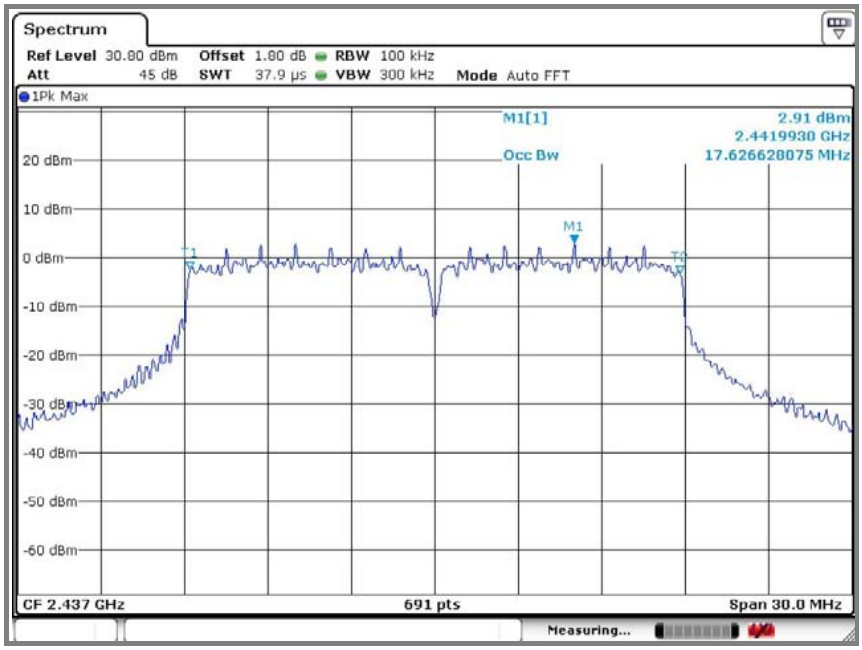
A. Low channel (2 402 ㎒) – 99 % bandwidth



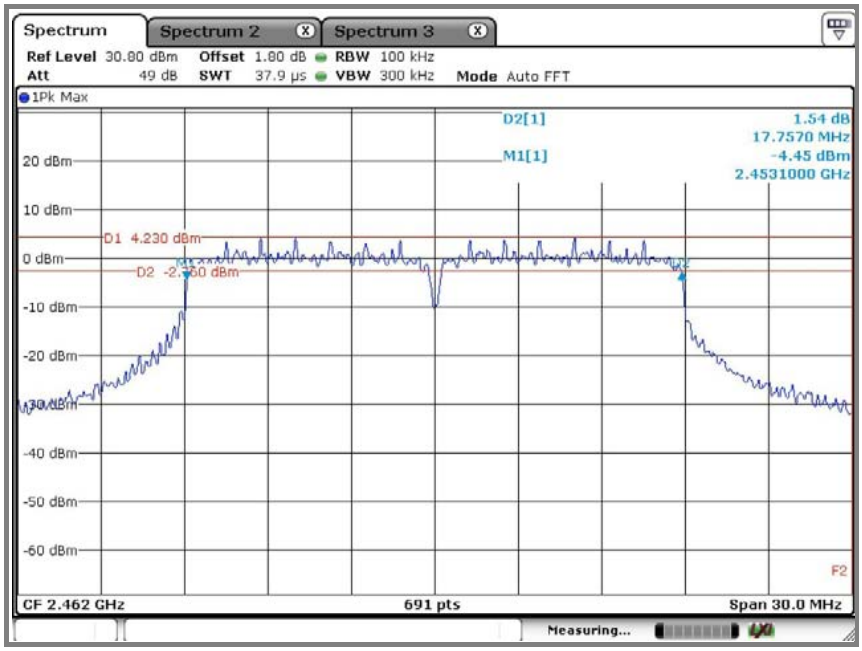
B. Middle channel (2 437 ㎒) - 6 ㏈ bandwidth



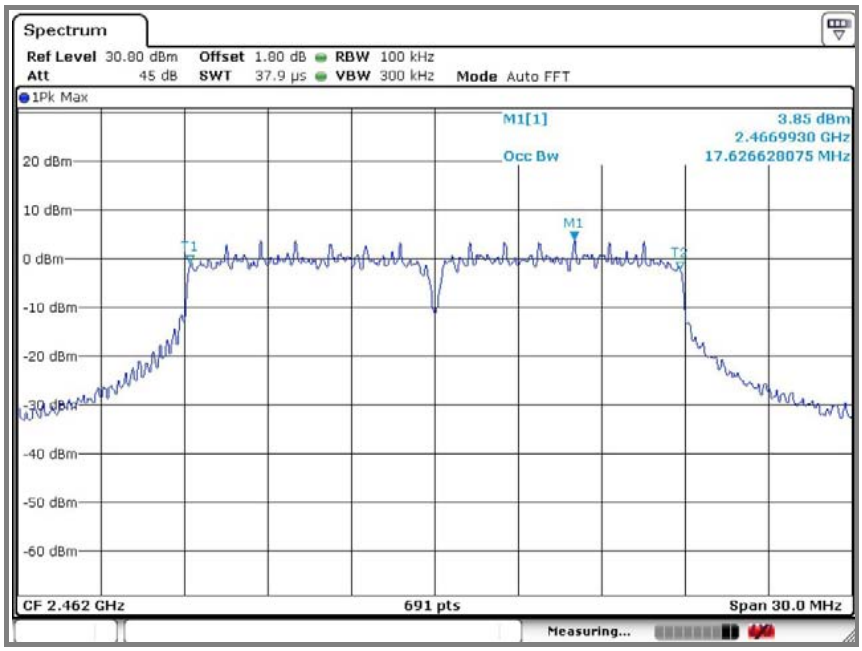
B. Middle channel (2 437 ㎒) – 99 % bandwidth



C. High channel (2 462 ㎒)

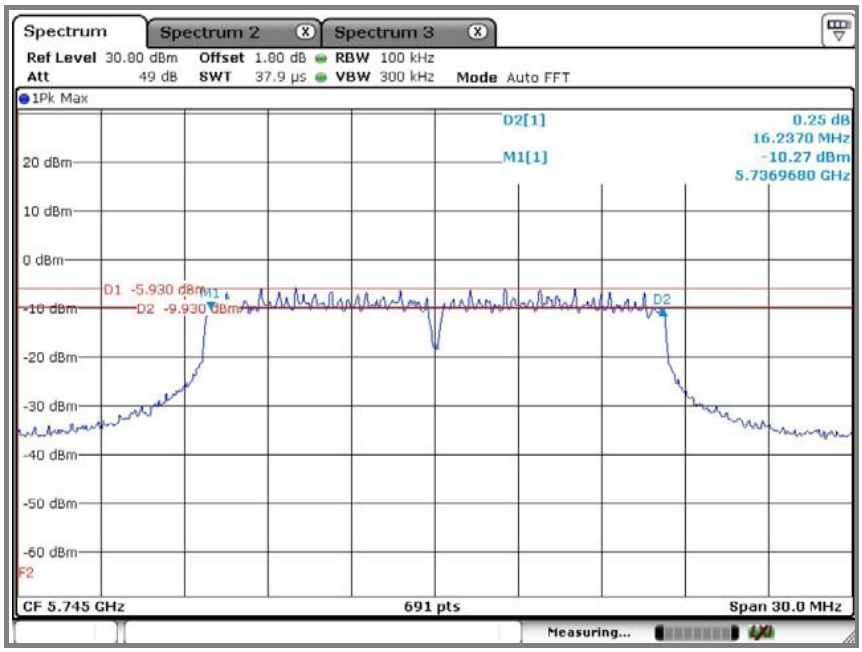


C. High channel (2 462 ㎒) – 99 % bandwidth

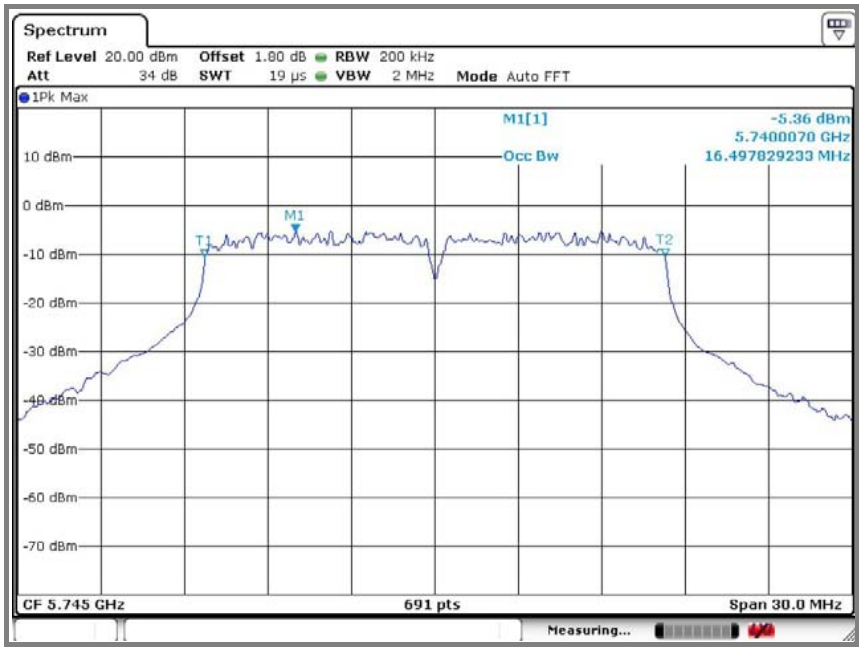


Operation mode: 802.11a mode (Ant 1)

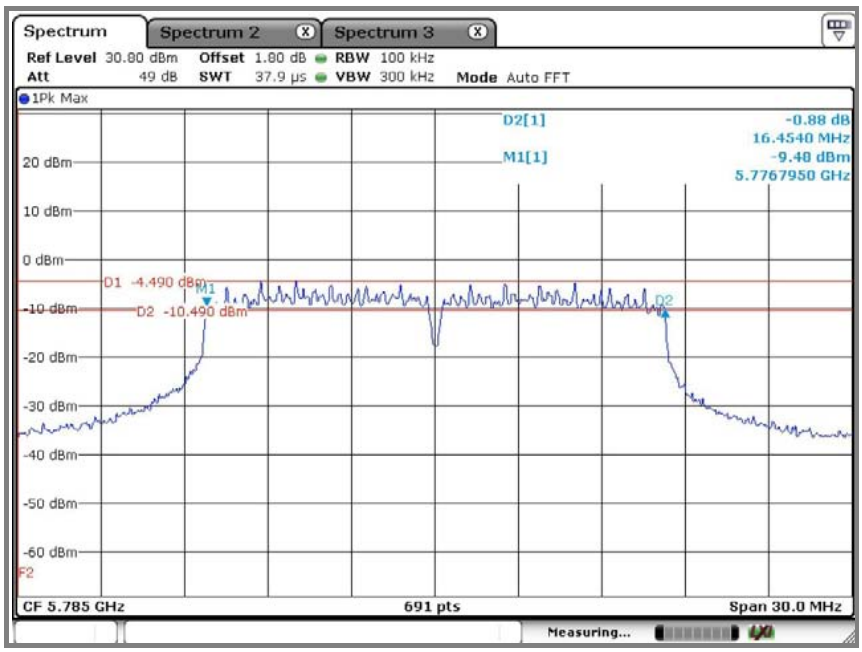
A. Low channel (5 745 ㎒) - 6 ㏈ bandwidth



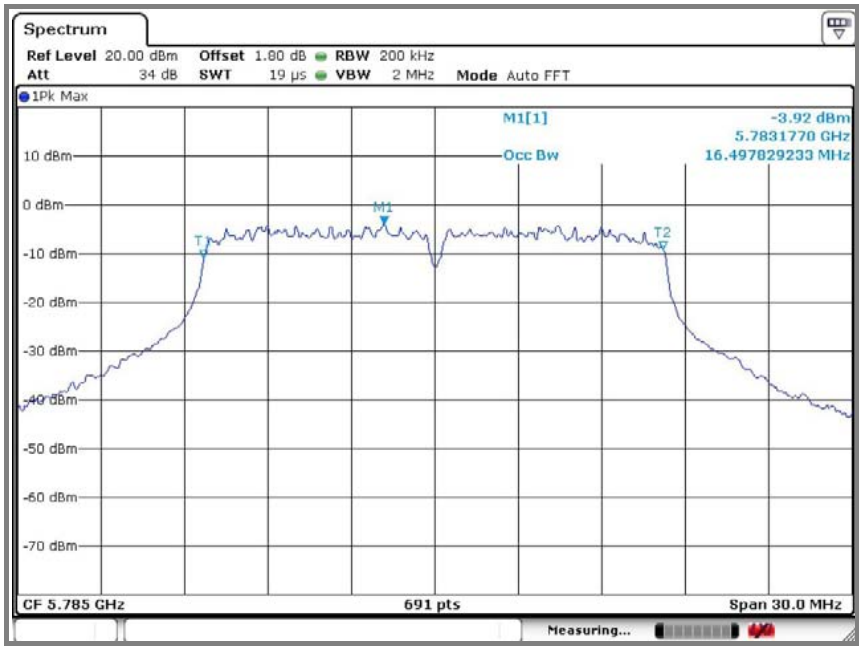
A. Low channel (5 745 ㎒) – 99 % bandwidth



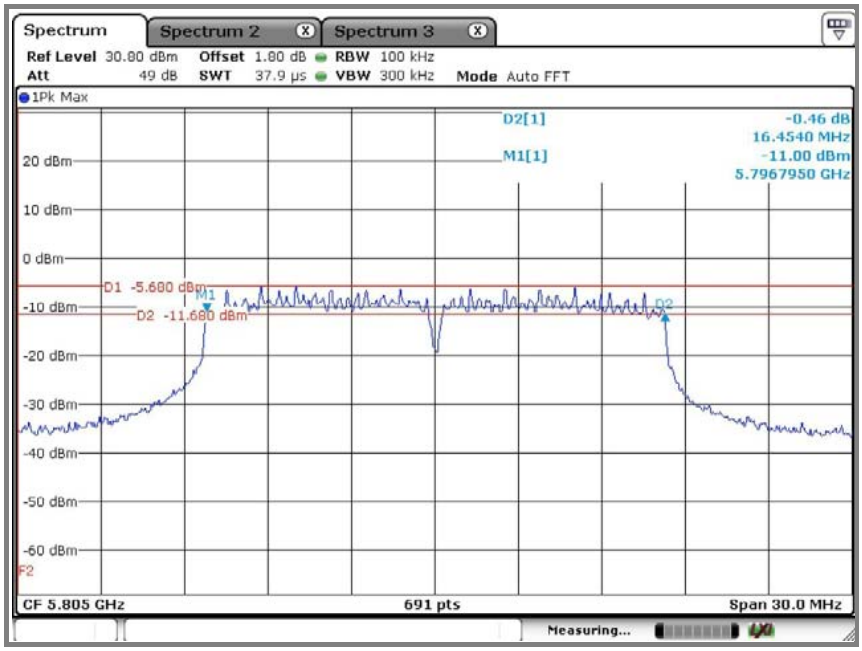
B. Middle channel (5 785 ㎒) - 6 ㏈ bandwidth



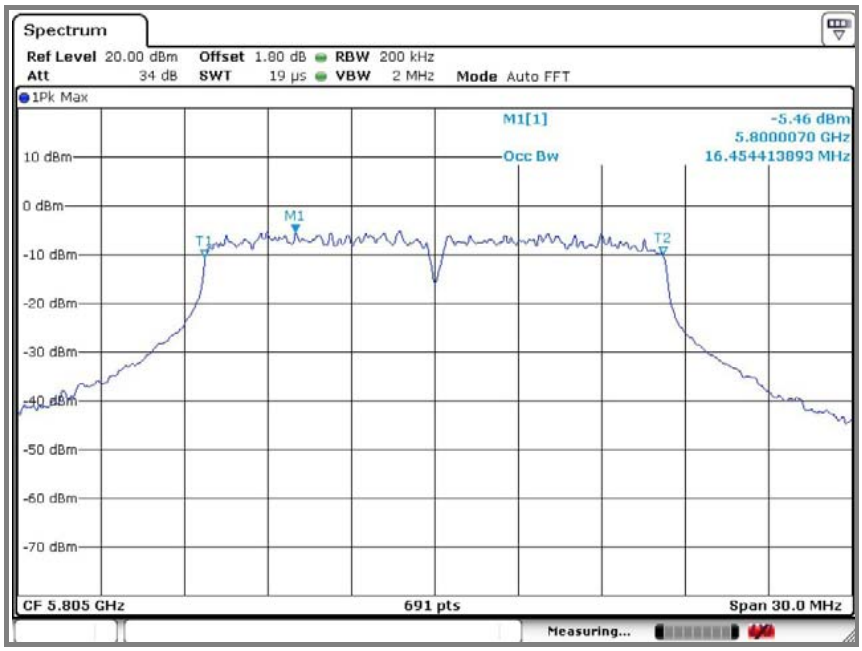
B. Middle channel (5 785 ㎒) – 99 % bandwidth



C. High channel (5 805 ㎒)

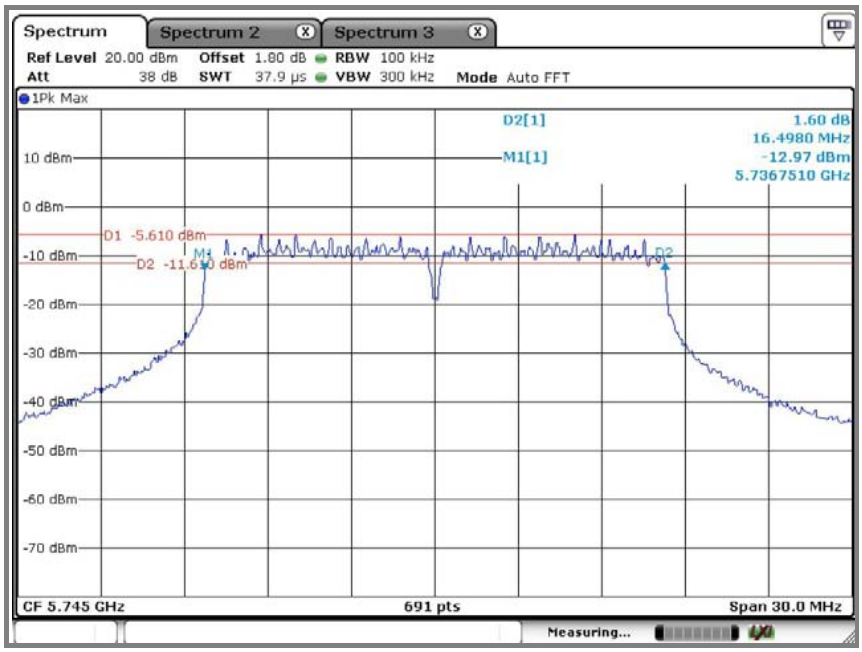


C. High channel (5 805 ㎒) – 99 % bandwidth

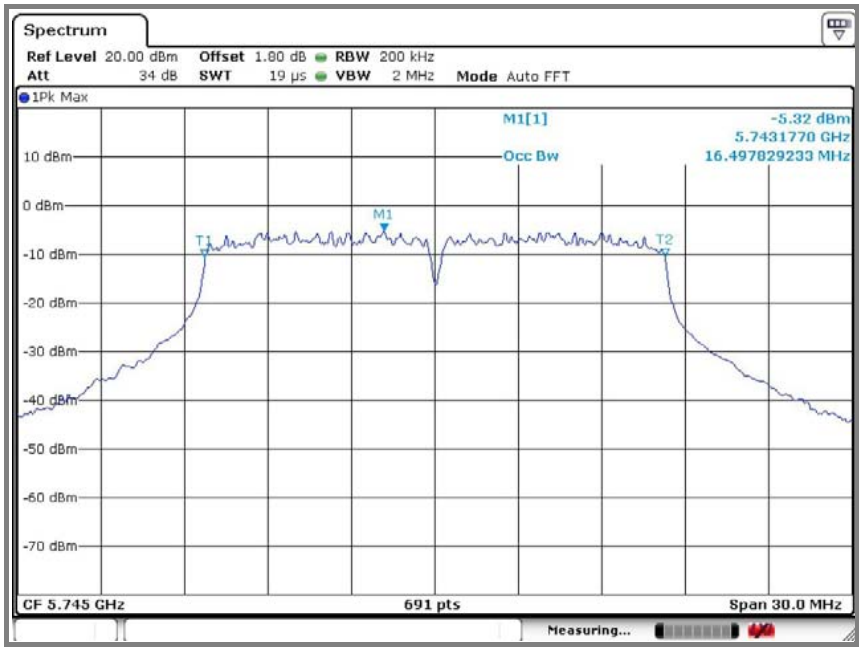


Operation mode: 802.11a mode (Ant 2)

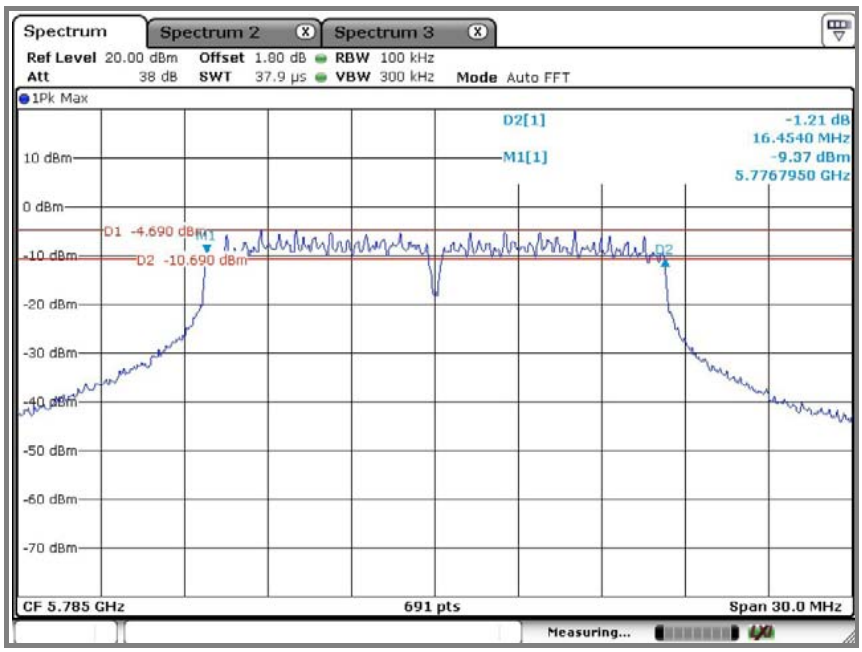
A. Low channel (5 745 ㎒) - 6 ㏈ bandwidth



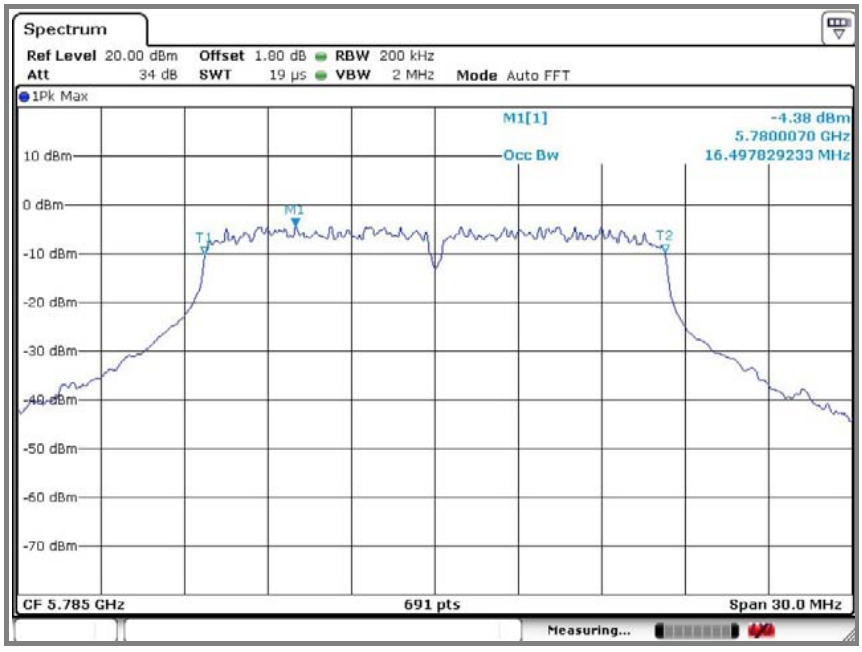
A. Low channel (5 745 ㎒) – 99 % bandwidth



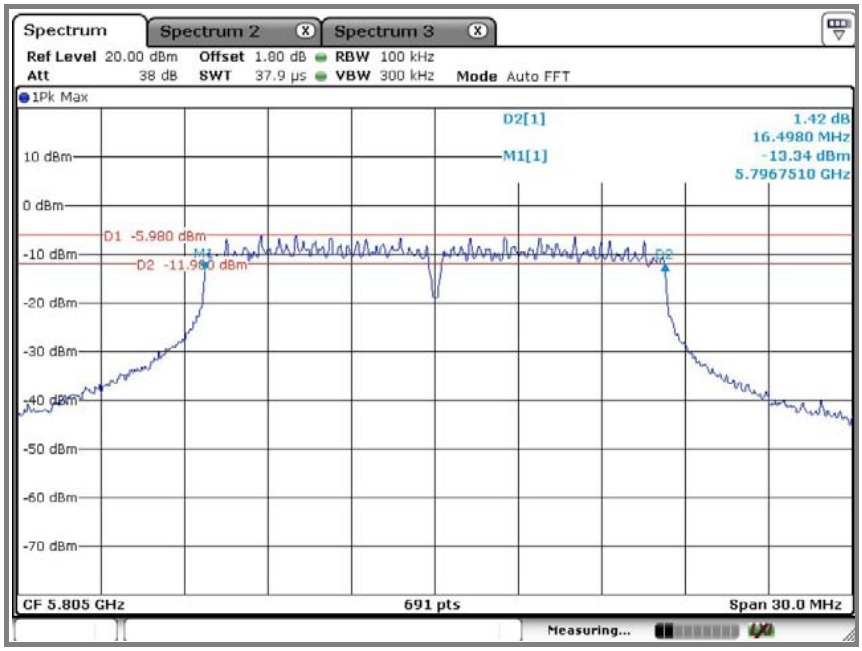
B. Middle channel (5 785 ㎒) - 6 ㏈ bandwidth



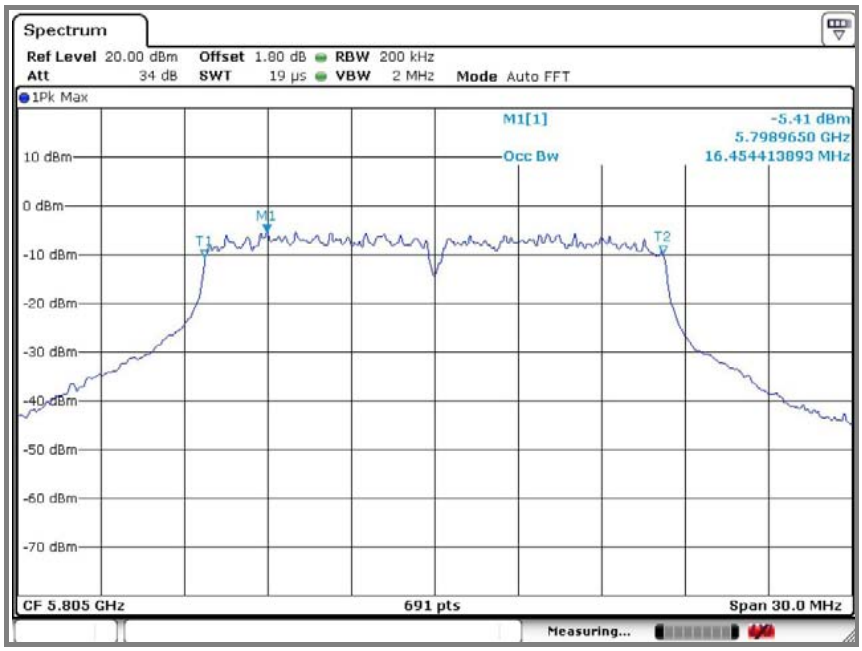
B. Middle channel (5 785 ㎒) – 99 % bandwidth



C. High channel (5 805 ㎒)

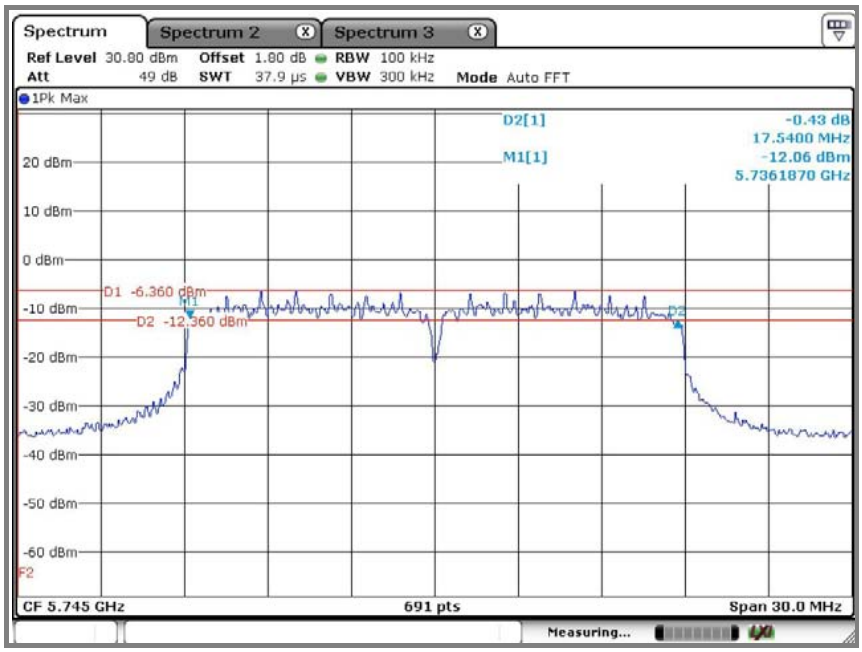


C. High channel (5 805 ㎒) – 99 % bandwidth

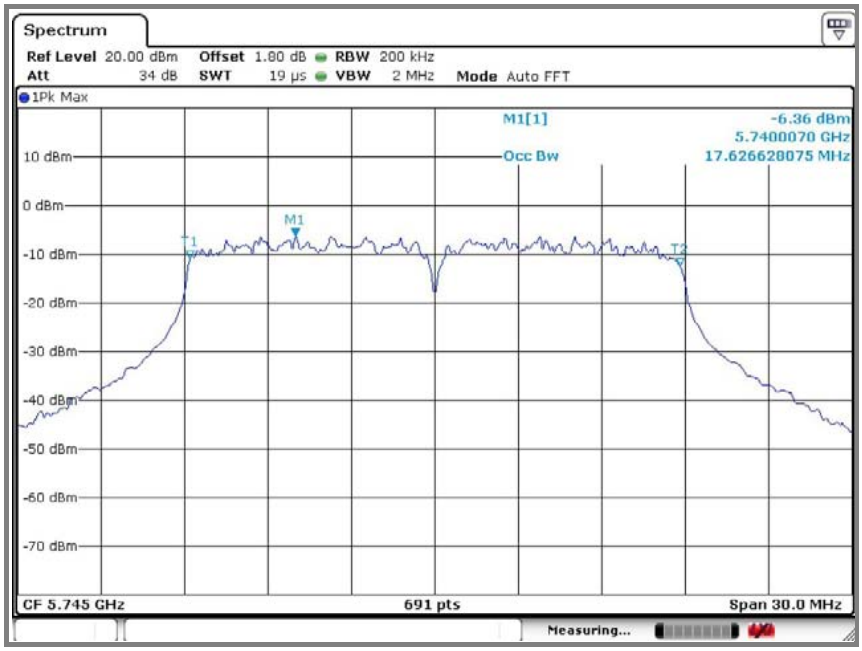


Operation mode: 802.11an_20 mode (MIMO)

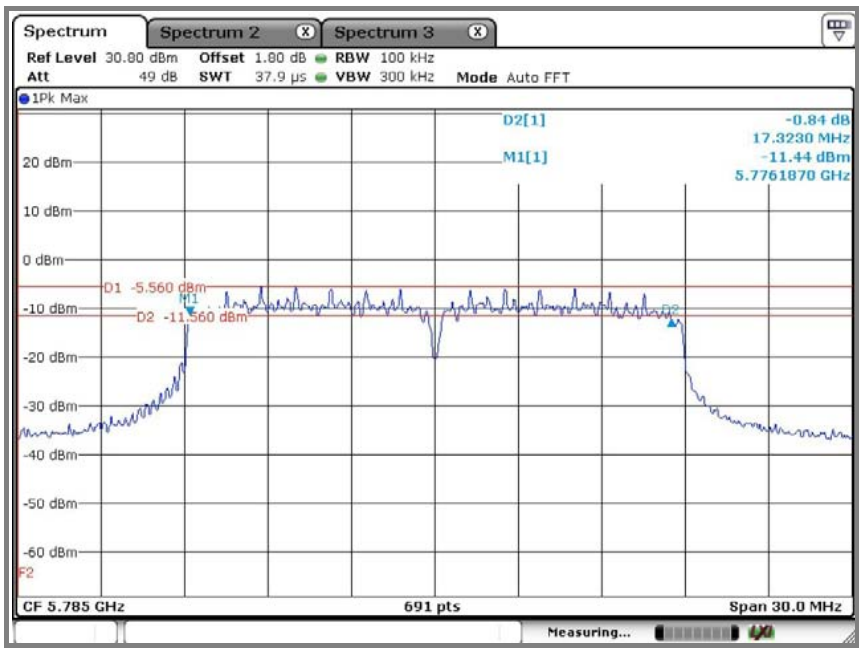
A. Low channel (5 745 ㎒) - 6 ㏈ bandwidth



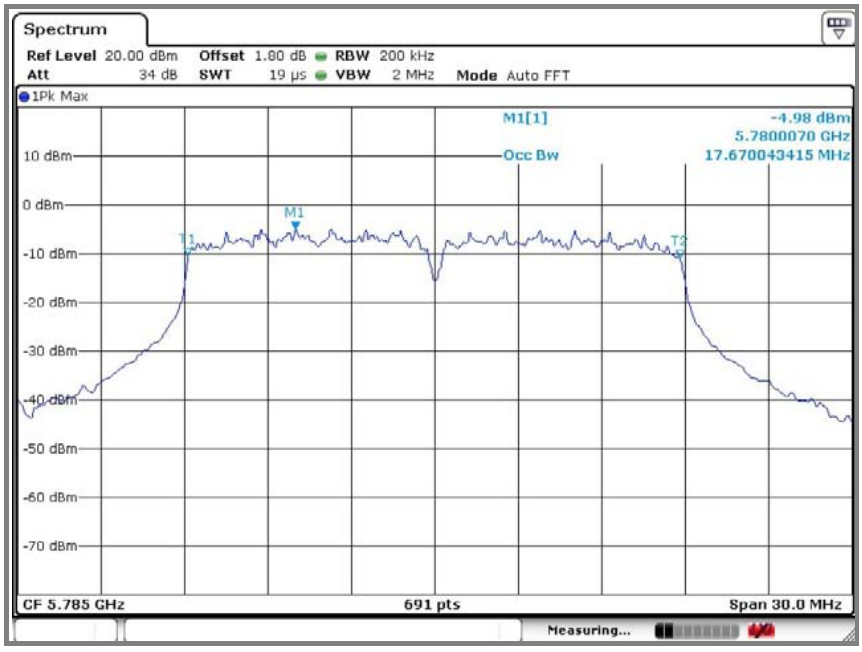
A. Low channel (5 745 ㎒) – 99 % bandwidth



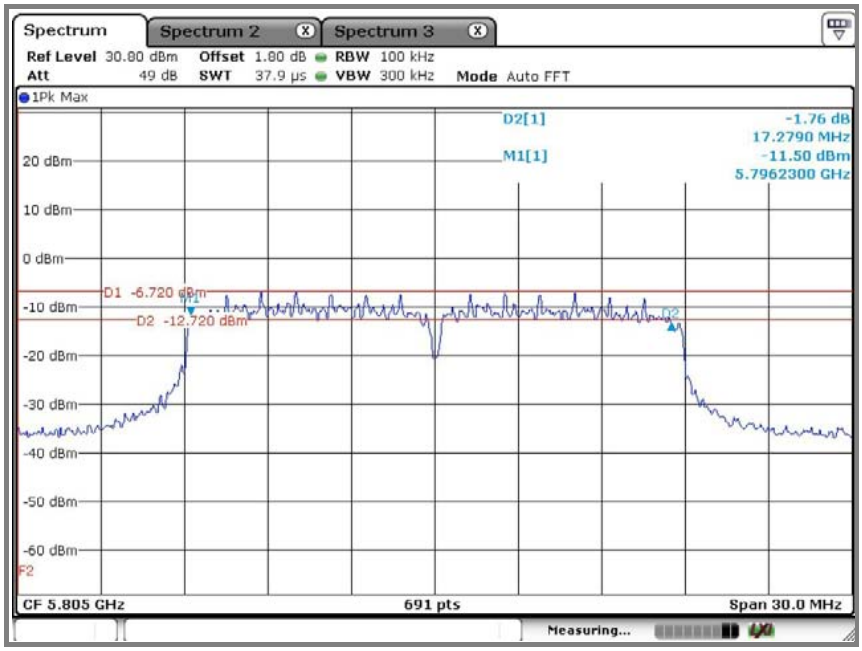
B. Middle channel (5 785 ㎒) - 6 ㏈ bandwidth



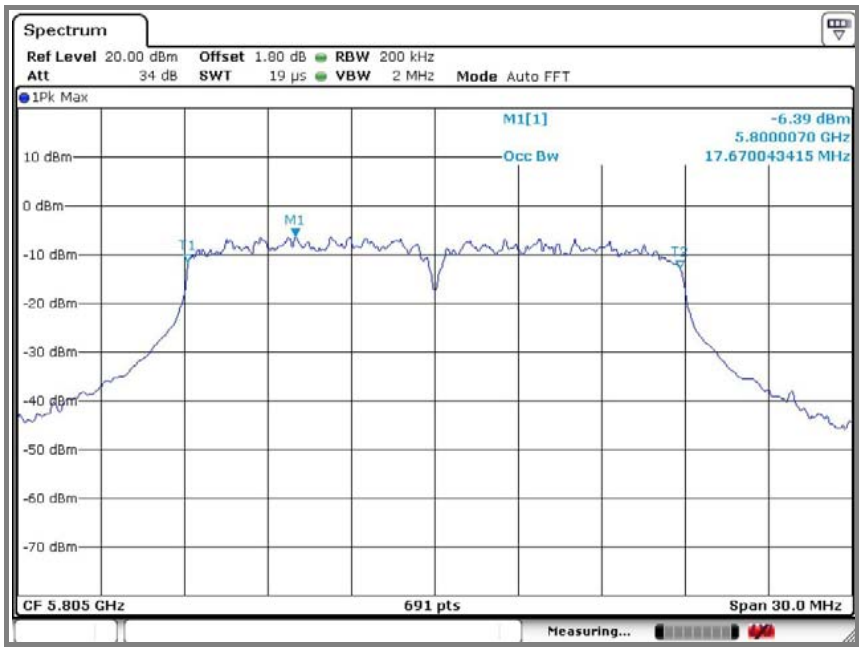
B. Middle channel (5 785 ㎒) – 99 % bandwidth



C. High channel (5 805 ㎒)

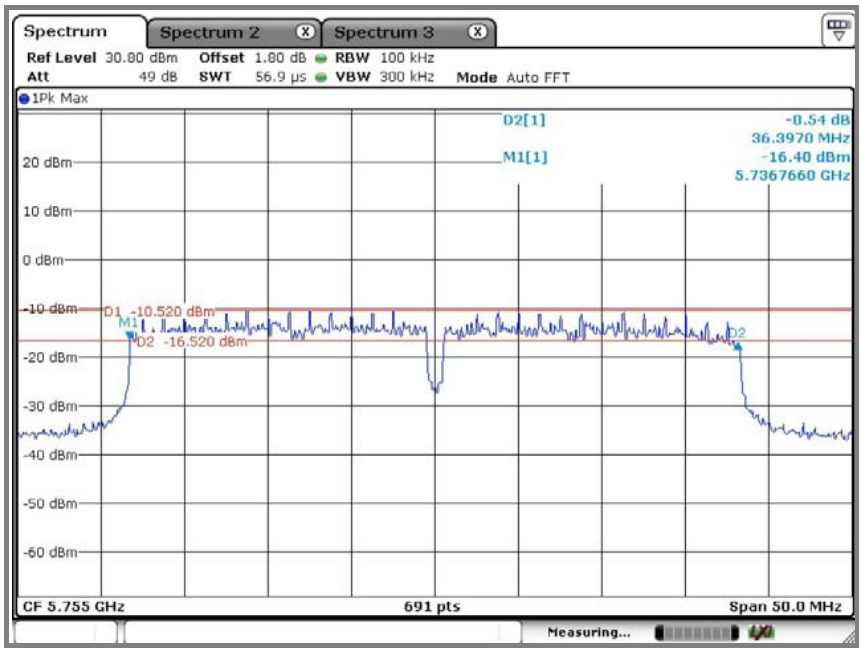


C. High channel (5 805 ㎒) – 99 % bandwidth

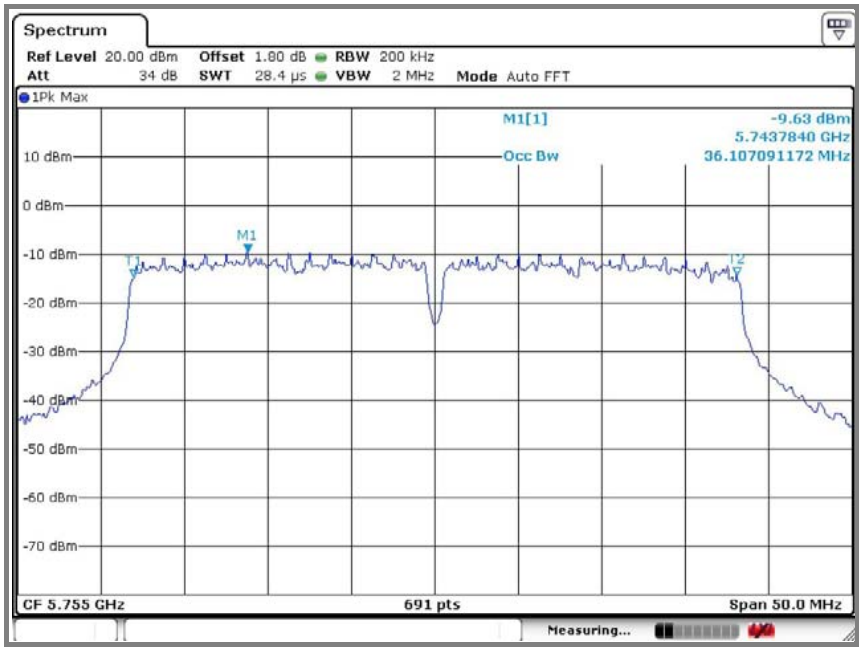


Operation mode: 802.11an_40 mode (MIMO)

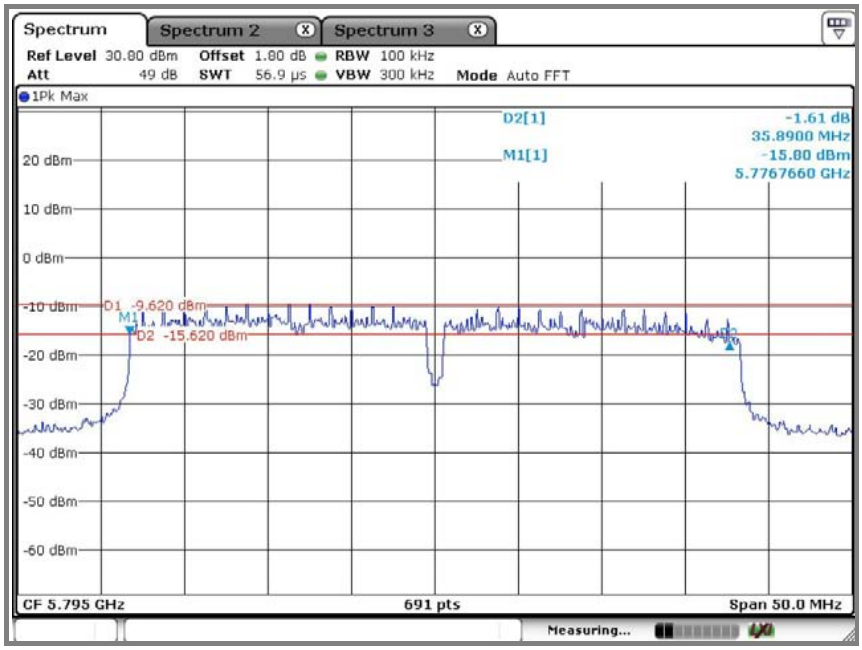
A. Low channel (5 755 ㎒) - 6 ㏈ bandwidth



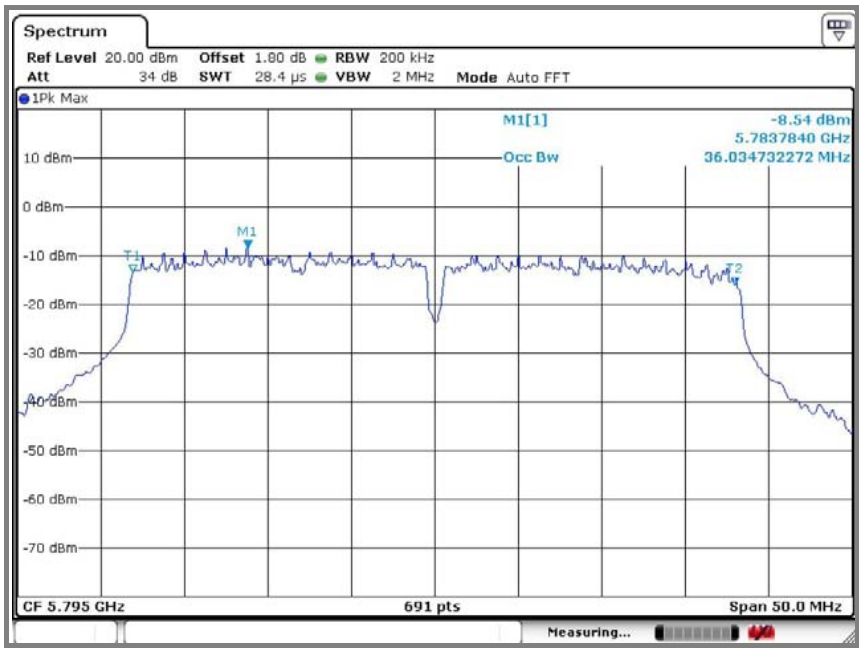
A. Low channel (5 755 ㎒) – 99 % bandwidth



B. High channel (5 795 ㎒)

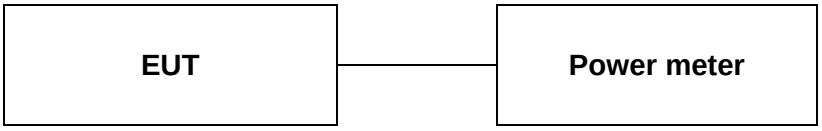


B. High channel (5 795 ㎒) – 99 % bandwidth



7. Maximum Output Power Measurement

7.1. Test setup.



7.2. Limit

The maximum peak output power of the intentional radiator shall not exceed the following:
1. §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 6 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽
2. §15.247(b)(1), For frequency hopping systems operating in the 2 400 – 2 483.5 ㎒ employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 – 5 805 ㎒ band: 1 Watt.

7.3 Test procedure

1. Test procedures refer KDB 558074 D01 v03r02 section 9.2.3.2 Measurement using a power meter(PM).
2. This procedure provides an alternative for determining the RMS output power using a broadband RF average power meter with a thermocouple detector.

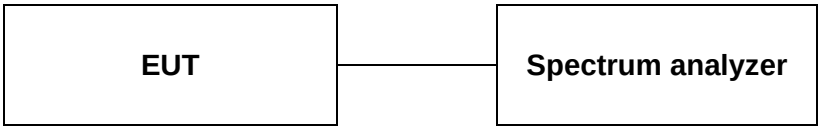
7.4 Test results

Ambient temperature: 23 ℃
Relative humidity: 42 % R.H.

Mode	Frequency (㎒)	Conducted power (㏈m)	Limit (㏈m)
802.11b (Ant 1)	2 412	18.00	30
	2 437	19.82	
	2 462	20.00	
802.11b (Ant 2)	2 412	17.72	30
	2 437	19.54	
	2 462	20.34	
802.11g (Ant 1)	2 412	10.06	30
	2 437	11.96	
	2 462	12.24	
802.11g (Ant 2)	2 412	10.15	30
	2 437	12.05	
	2 462	11.88	
802.11n_20 (MIMO)	2 412	8.12	30
	2 437	9.70	
	2 462	10.28	
802.11a (Ant 1)	5 745	4.28	30
	5 785	5.26	
	5 805	4.52	
802.11a (Ant 2)	5 745	3.97	30
	5 785	4.95	
	5 805	4.14	
802.11an_20 (MIMO)	5 745	2.52	30
	5 785	3.36	
	5 805	2.63	
802.11an_40 (MIMO)	5 755	0.94	30
	5 795	1.78	

8. Power Spectral Density Measurement

8.1. Test setup



7.2. Limit

< 8dBm @ 3kHz BW

7.3. Test procedure (PKPSD)

1. The RF power output was measured with a Spectrum analyzer connected to the RF Antenna connector(conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency, A spectrum analyzer was used to record the shape of the transmit signal.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using;
   Span = 1.5 times the DTS bandwidth
   RBW = 3㎑ ≤ RBW ≤ 100㎑
   VBW ≥ 3 x RBW, Sweep = Auto couple
   Detector function = peak, Trace = max hold

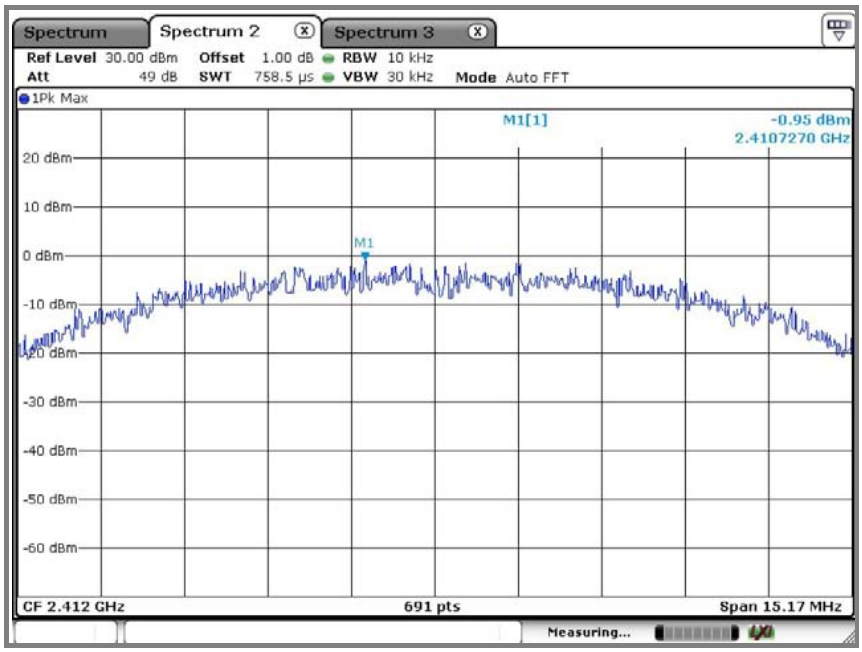
7.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 42 % R.H.

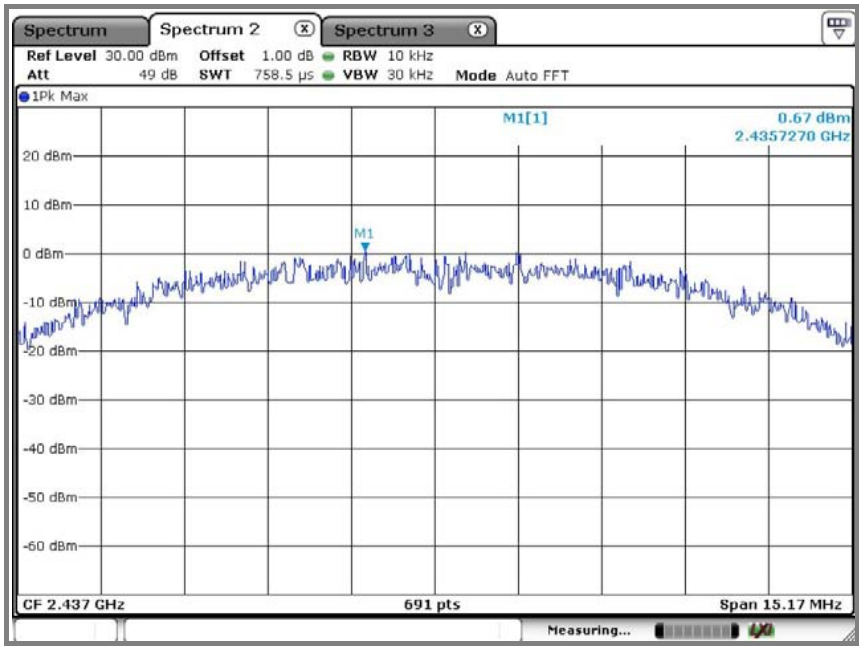
Operation mode	Frequency (㎒)	Peak output power(㏈m)	Limit (㏈m)
802.11b (Ant 1)	2 412	-0.95	8
	2 437	0.67	
	2 462	1.60	
802.11b (Ant 2)	2 412	-1.41	8
	2 437	0.42	
	2 462	1.33	
802.11g (Ant 1)	2 412	-8.28	8
	2 437	-6.18	
	2 462	-5.46	
802.11g (Ant 2)	2 412	-8.61	8
	2 437	-6.10	
	2 462	-4.97	
802.11n_20 (MIMO)	2 412	-9.59	8
	2 437	-7.68	
	2 462	-6.86	
802.11a (Ant 1)	5 745	-15.59	8
	5 785	-13.32	
	5 805	-15.57	
802.11a (Ant 2)	5 745	-15.27	8
	5 785	-13.59	
	5 805	-14.76	
802.11an_20 (MIMO)	5 745	-16.58	8
	5 785	-16.19	
	5 805	-16.99	
802.11an_40 (MIMO)	5 755	-19.70	8
	5 795	-18.89	

Operation mode: 802.11b mode (Ant 1)

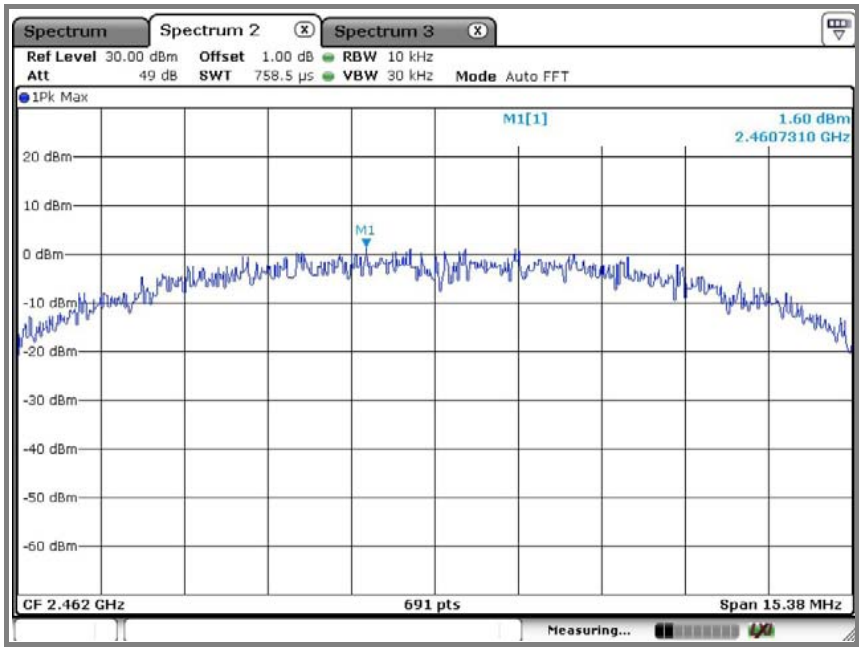
A. Low channel (2 412 ㎒)



B. Middle channel (2 437 ㎒)

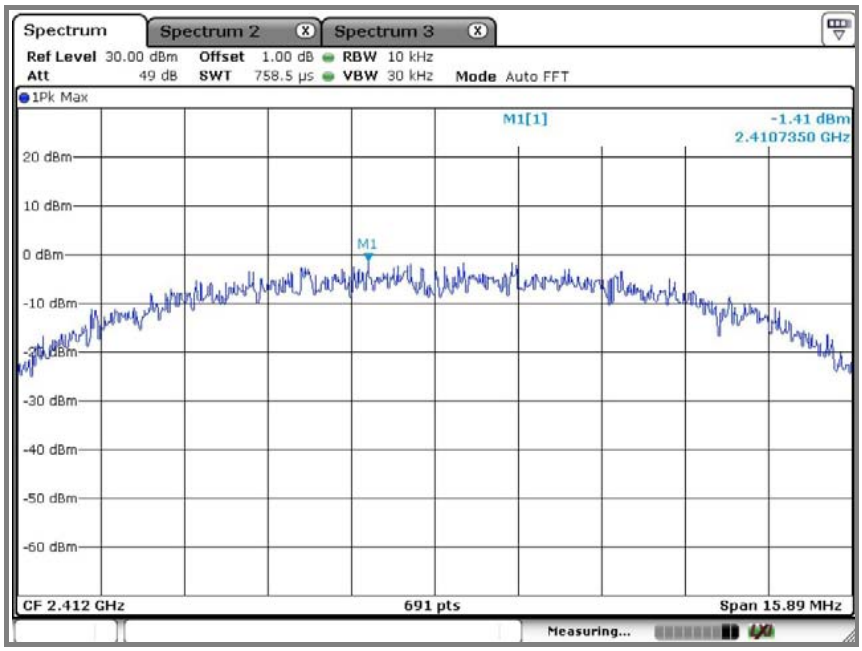


C. High channel (2 462 ㎒)

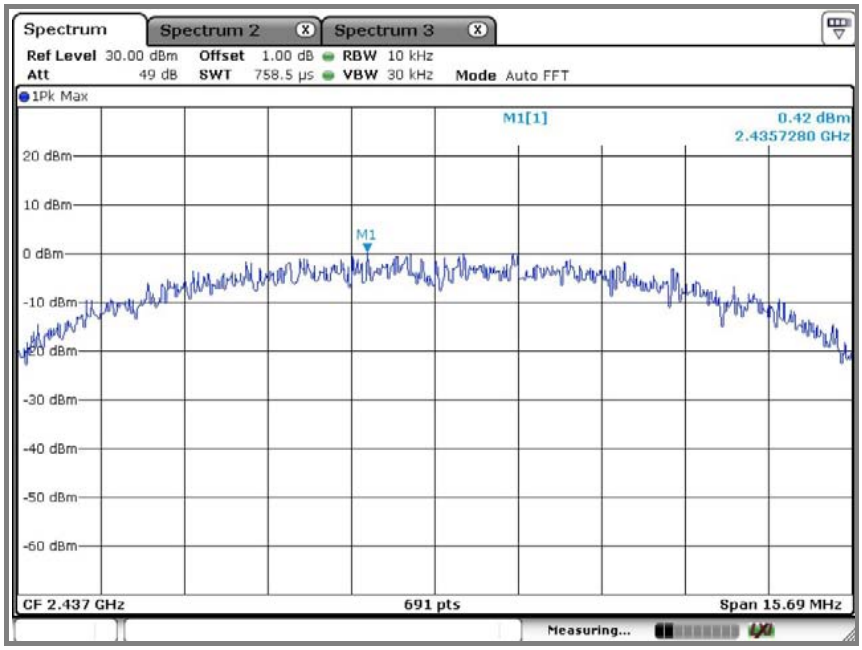


Operation mode: 802.11b mode (Ant 2)

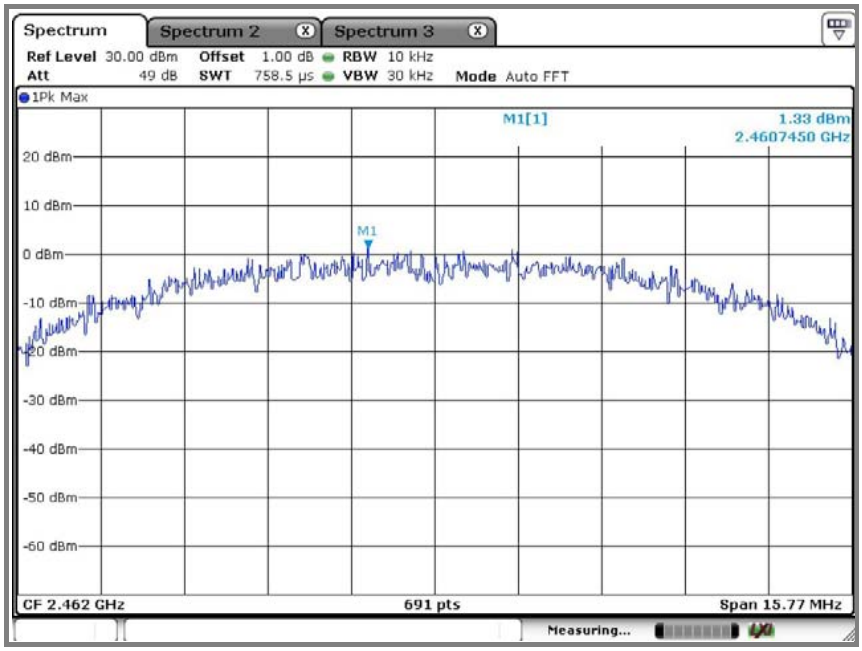
A. Low channel (2 412 ㎒)



B. Middle channel (2 437 ㎒)

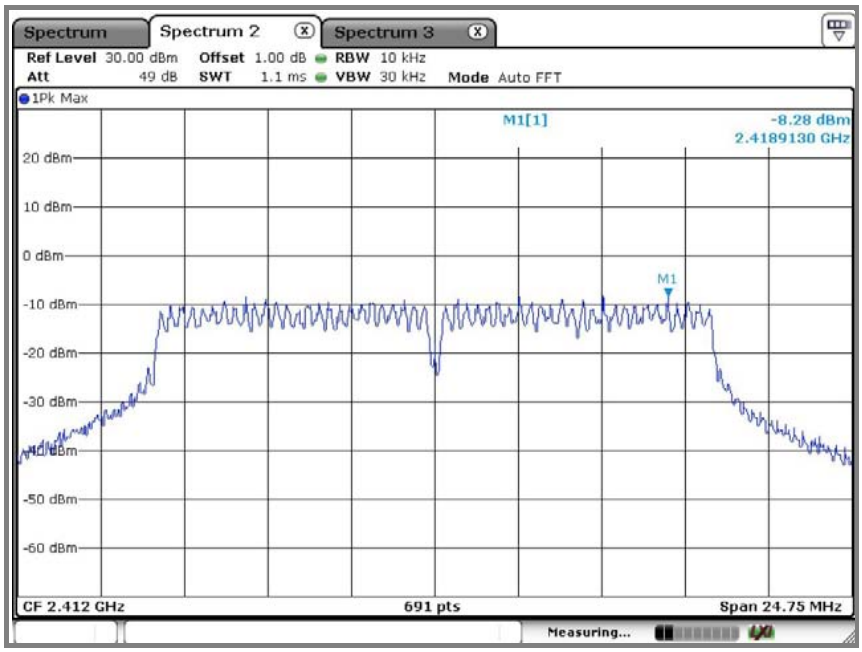


C. High channel (2 462 ㎒)

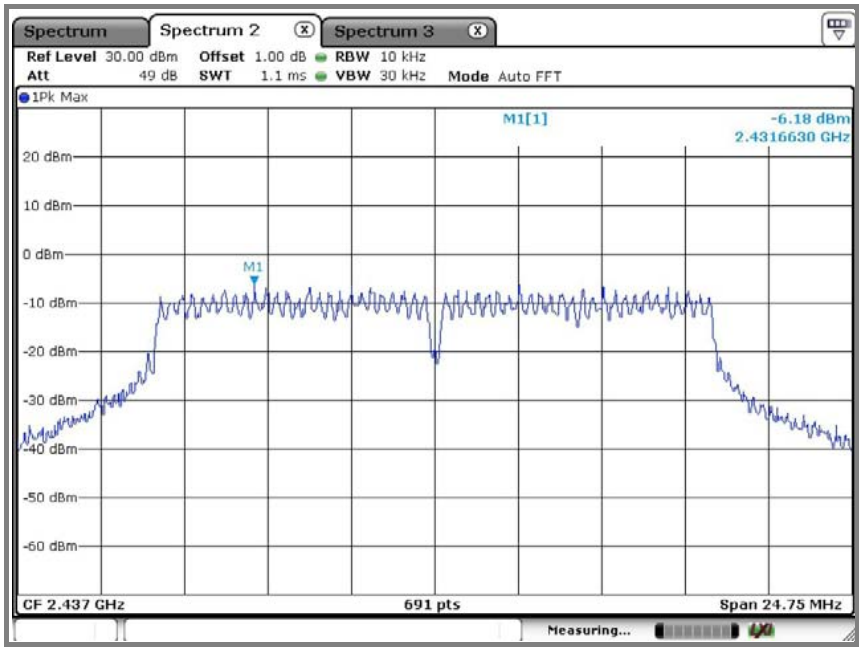


Operation mode: 802.11g mode (Ant 1)

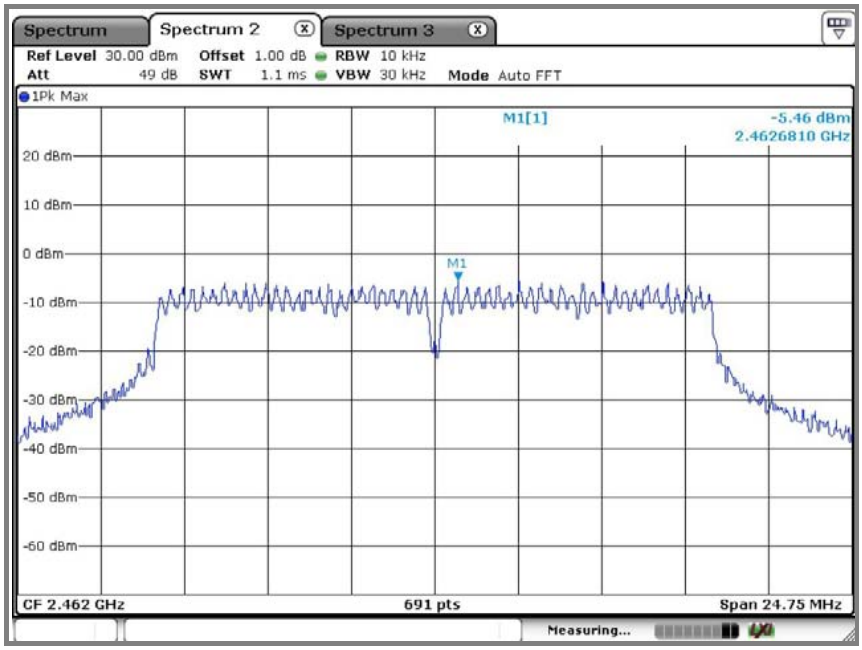
A. Low channel (2 412 ㎒)



B. Middle channel (2 437 ㎒)

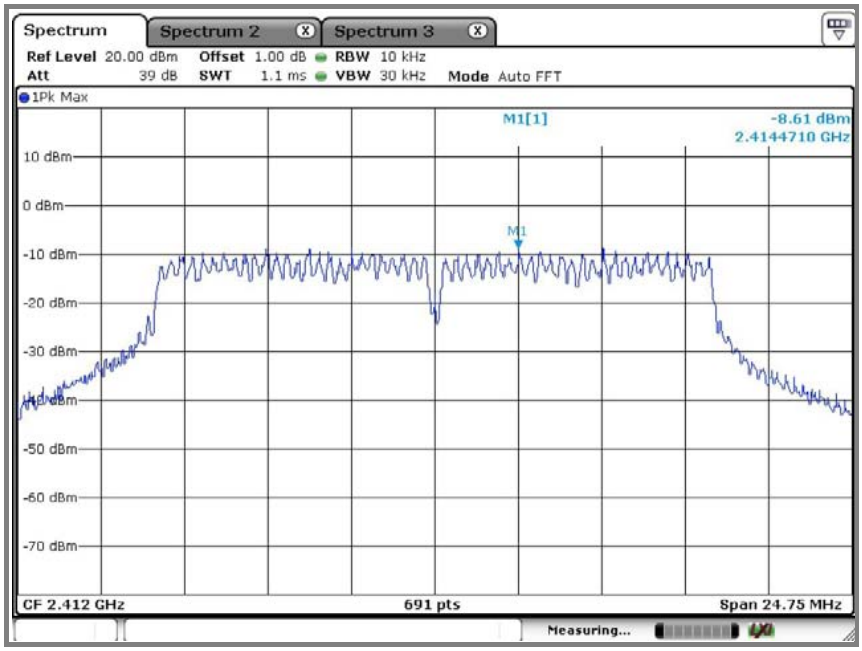


C. High channel (2 462 ㎒)

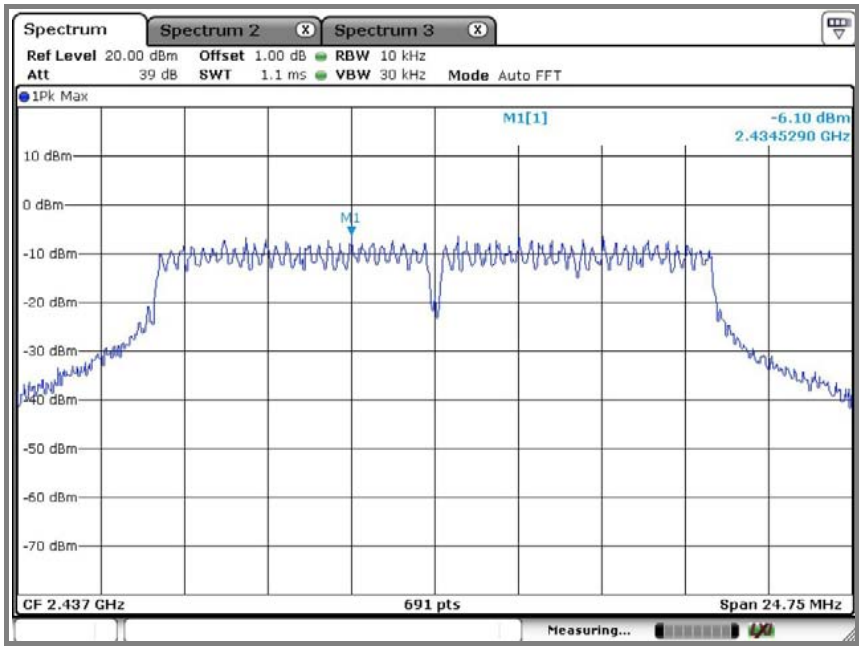


Operation mode: 802.11g mode (Ant 2)

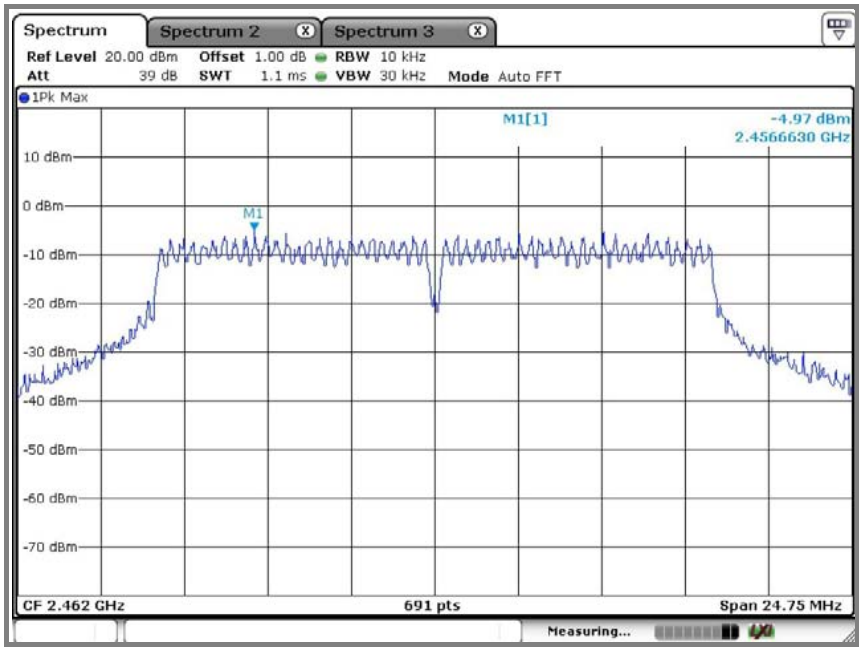
A. Low channel (2 412 ㎒)



B. Middle channel (2 437 ㎒)

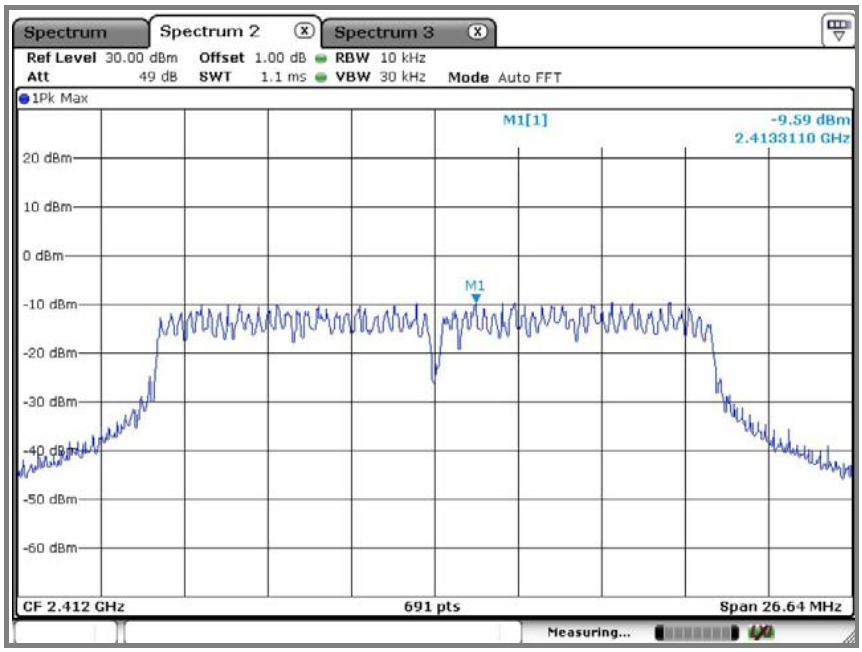


C. High channel (2 462 ㎒)

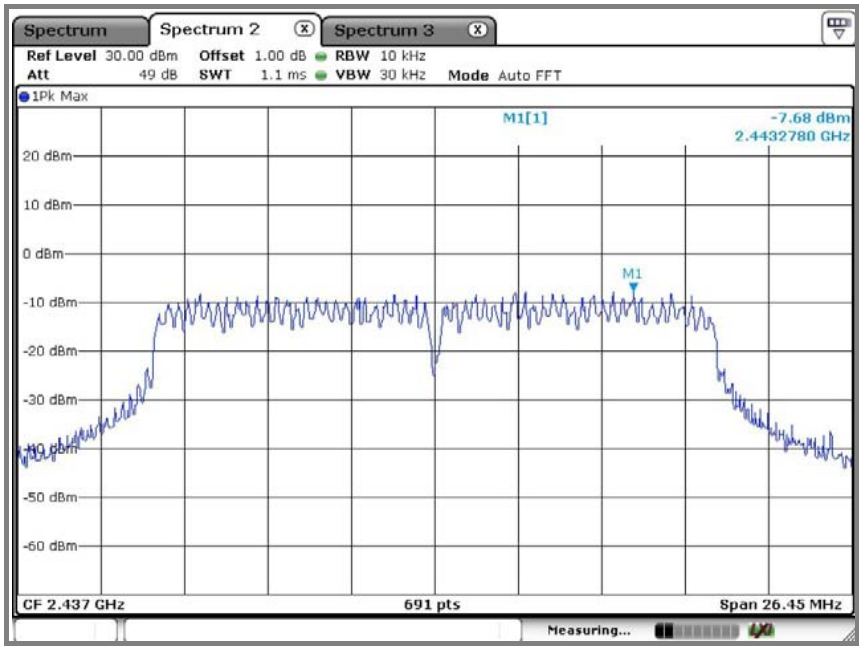


Operation mode: 802.11n_20 mode (MIMO)

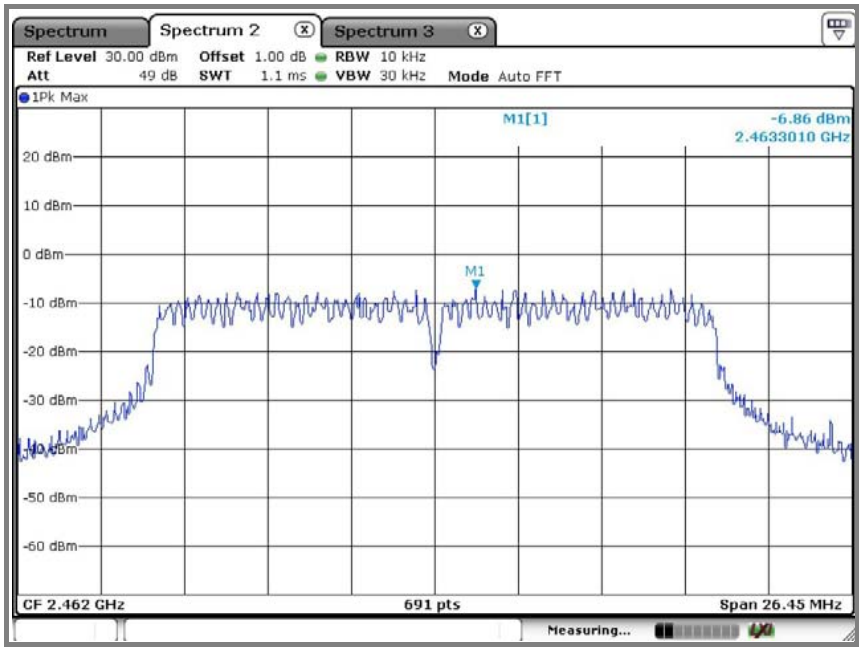
A. Low channel (2 412 ㎒)



B. Middle channel (2 437 ㎒)

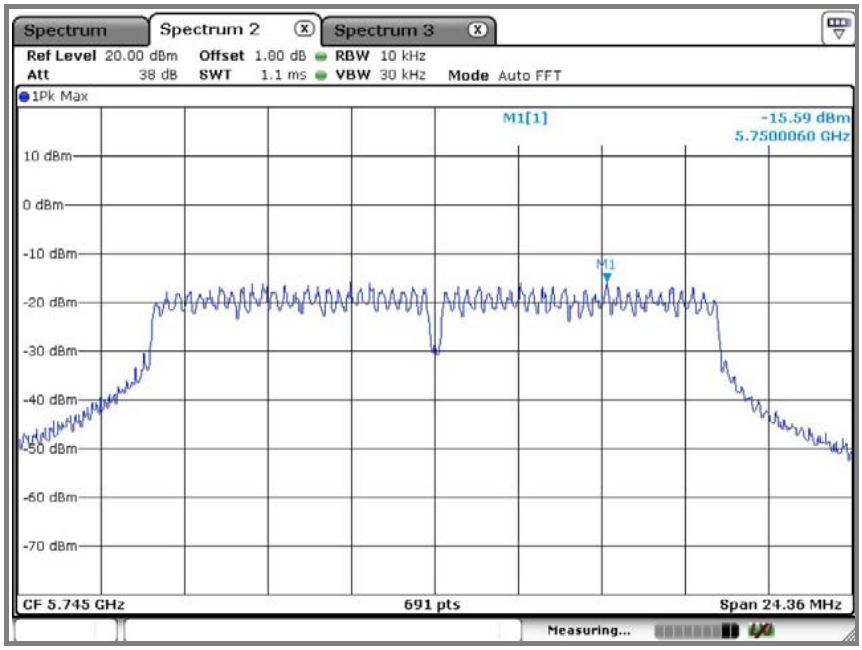


C. High channel (2 462 ㎒)

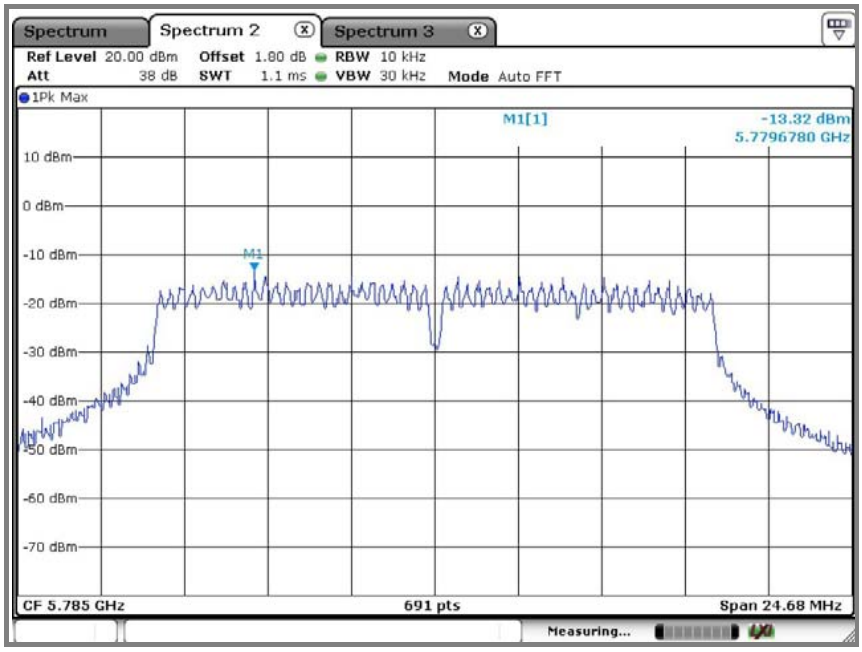


Operation mode: 802.11a mode (Ant 1)

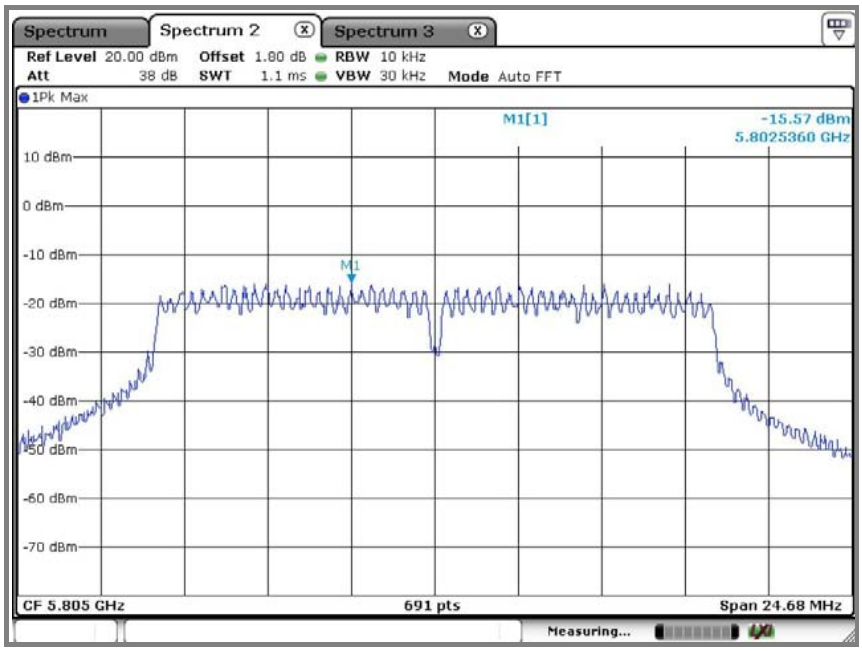
A. Low channel (5 745 ㎒)



B. Middle channel (5 785 ㎒)

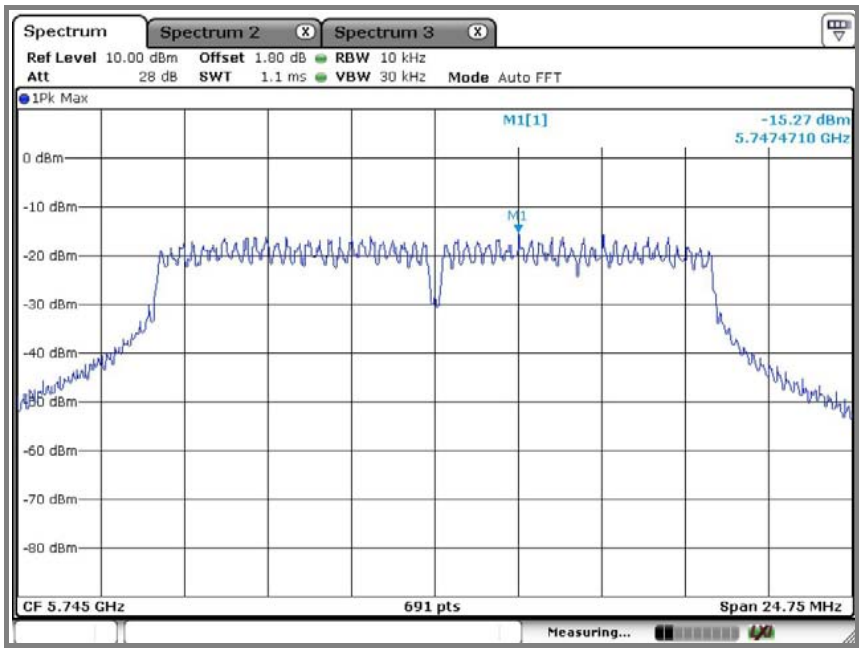


C. High channel (5 805 ㎒)

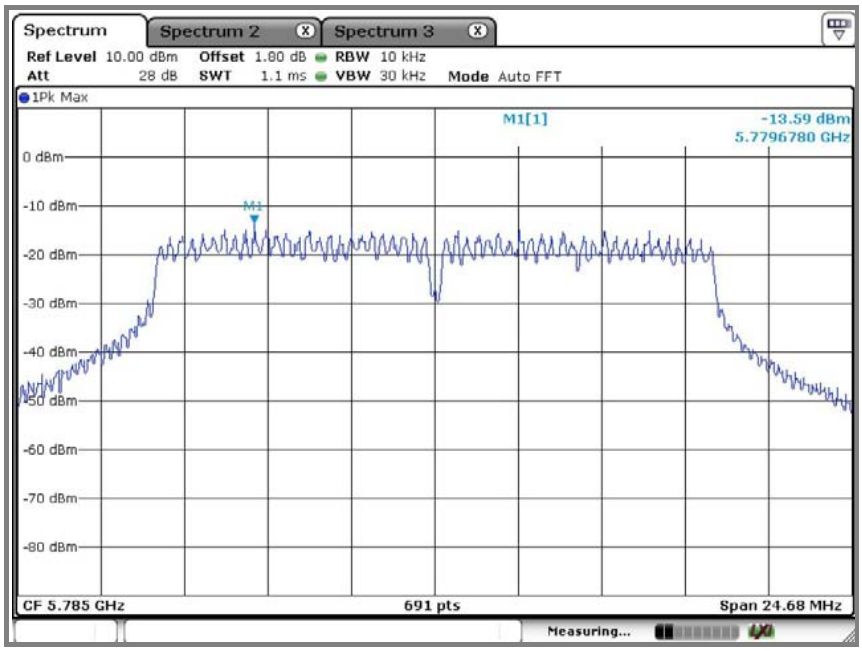


Operation mode: 802.11a mode (Ant 2)

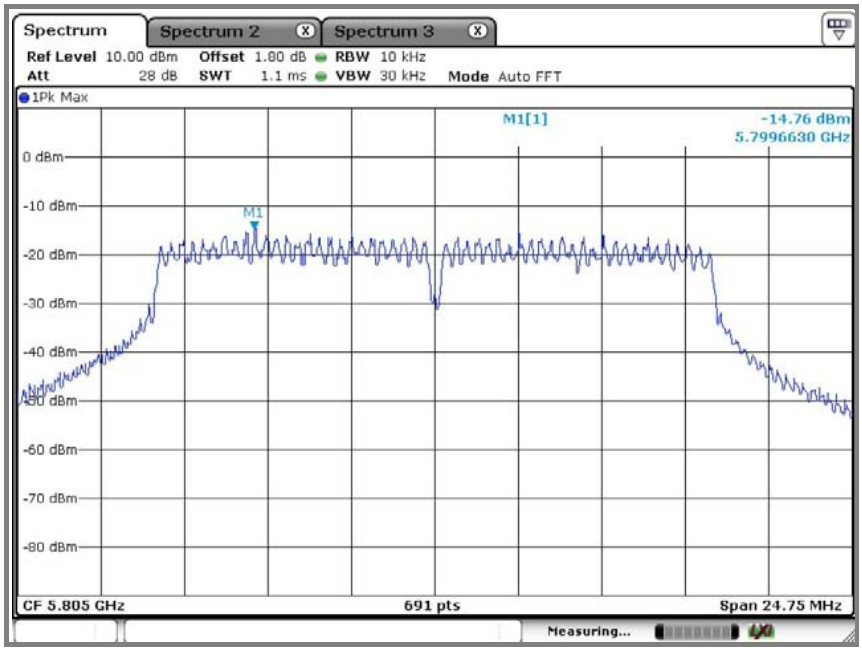
A. Low channel (5 745 ㎒)



B. Middle channel (5 785 ㎒)

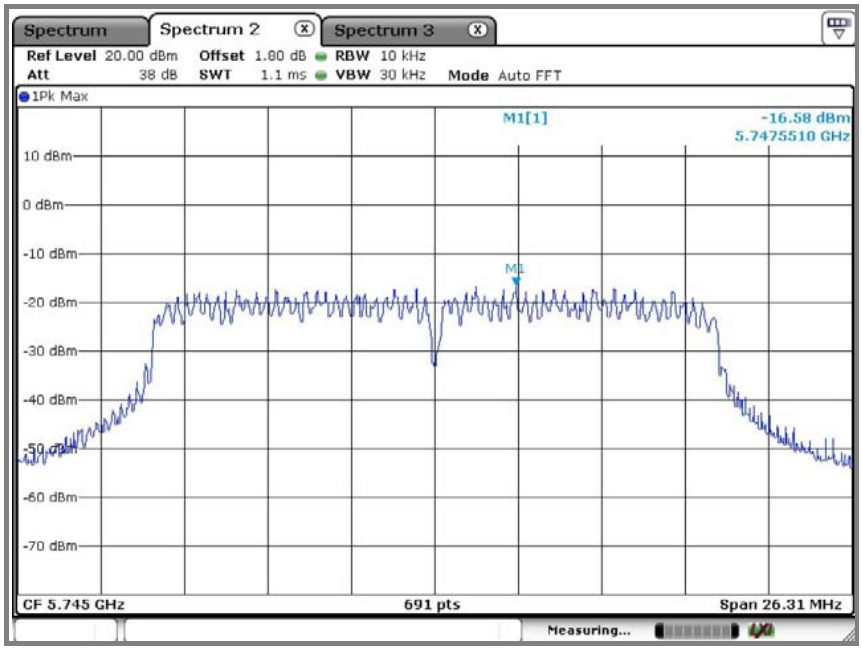


C. High channel (5 805 ㎒)

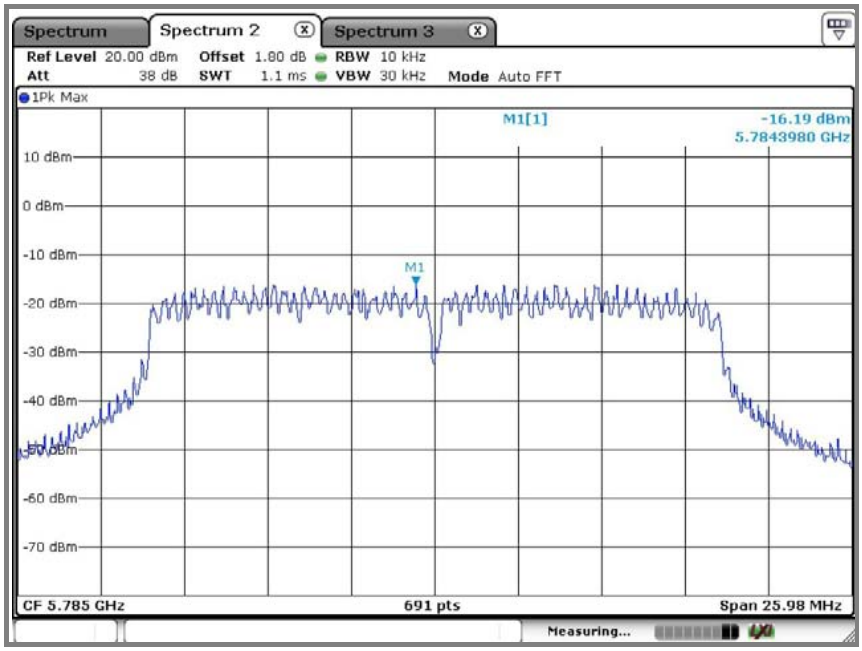


Operation mode: 802.11an_20 mode (MIMO)

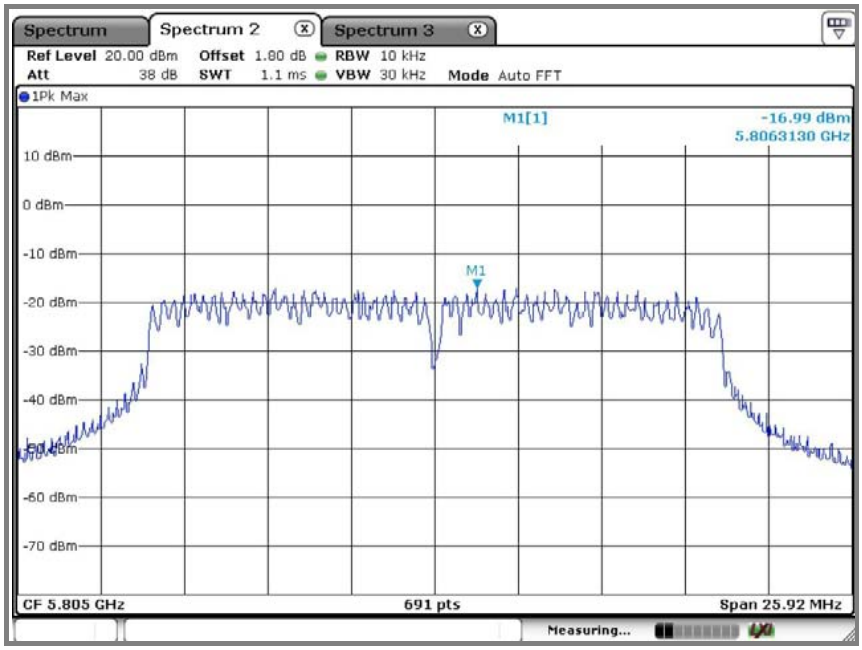
A. Low channel (5 745 ㎒)



B. Middle channel (5 785 ㎒)

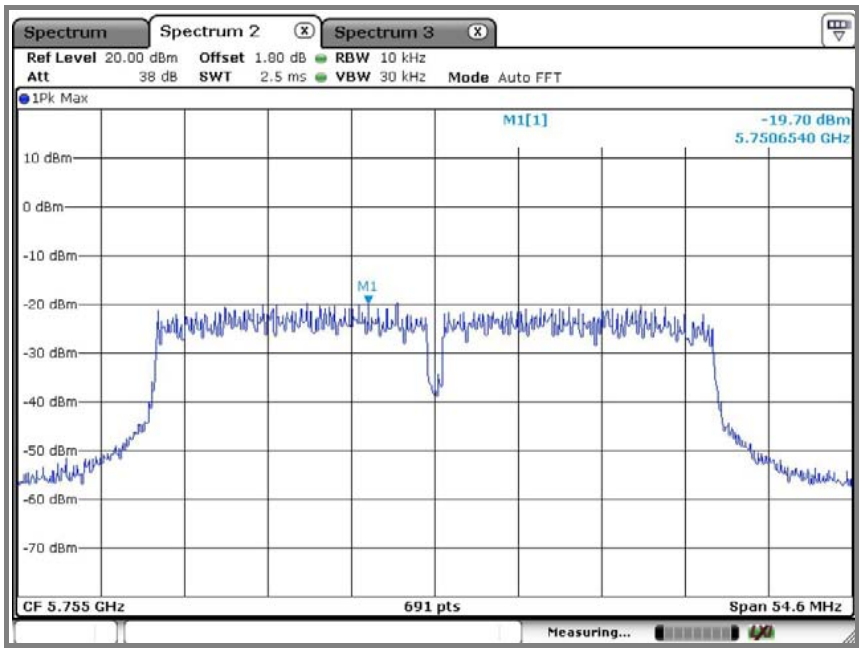


C. High channel (5 805 ㎒)

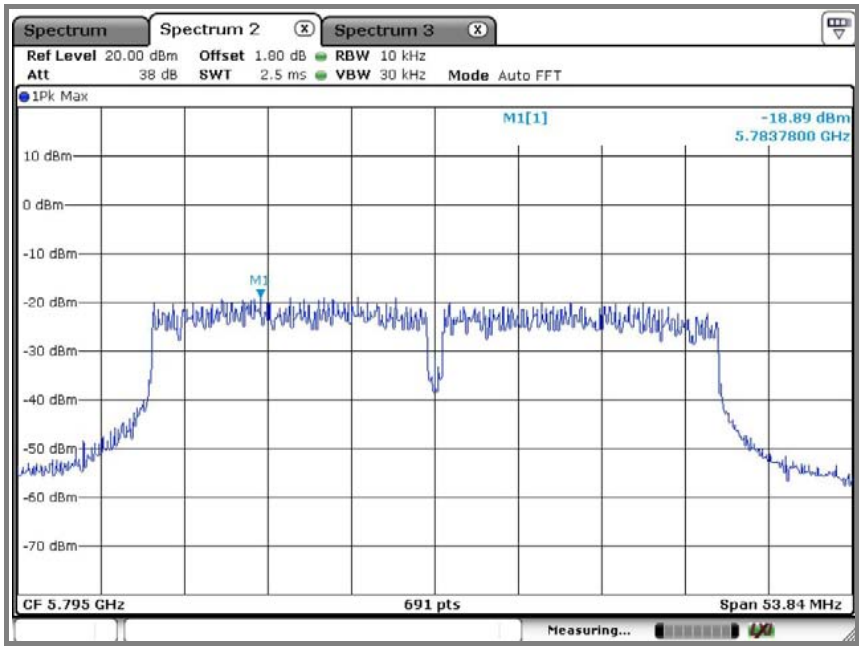


Operation mode: 802.11an_40 mode (MIMO)

A. Low channel (5 755 ㎒)



B. High channel (5 795 ㎒)



9. Antenna requirement

9.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. And according to FCC 47 CFR Section §15.247 (b) if transmitting antennas of directional gain greater than 6 dBi are used.

9.2. Antenna Connected Construction

Antenna used in this product is PCB Pattern antenna
Antenna gain is 2.39 dBi. (802.11b/g/n20) / 4.78 dBi. (802.11a/an20/an40)

10. RF exposure evaluation

10.1. Environmental evaluation and exposure limit according to FCC CFR 47 part 1, 1.1307(b), 1.1310

According to §15.247(e)(i) and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines. According to KDB 447498 (2)(a)(i)

Limits for maximum permissible exposure (MPE)

Frequency range (㎒)	Electric field strength(V/m)	Magnetic field strength (A/m)	Power density (㎽/㎠)	Average time
(A) Limits for Occupational / Control exposures				
300 – 1 500	--	--	F/300	6
1 500 – 100 000	--	--	5	6
(B) Limits for General Population / Uncontrol Exposures				
300 – 1 500	--	--	F/1 500	6
1 500 – 100 000	--	--	1	30

10.2. Friis transmission formula : Pd=(Pout*G)\(4*pi*R2)

Where
Pd= Power density in ㎽/㎠
Pout=output power to antenna in ㎽
G= Numeric gain of the antenna relative to isotropic antenna
Pi=3.1416
R= distance between observation point and center of the radiator in cm
Pd the limit of MPE, 1 ㎽/㎠. If we know the maximum gain of the antenna and total power input to the antenna, through the calculation, we will know the distance where the MPE limit is reached.

10.3. Test result of RF exposure evaluation

Test Item : RF Exposure evaluation data
Test Mode : Normal operation

10.4. Output power into antenna & RF exposure evaluation distance

Antenna gain: 2.39 dBi (802.11b/g/n20) / 4.78 dBi (802.11a/an20/an40)

Mode	Frequency (㎒)	Output Peak power to antenna (dBm)	Antenna gain (dBi)	Antenna Gain (dBi) Numeric	Power density at 20 ㎝ (㎽/㎠)	Power density Limits (㎽/㎠)
802.11b (Ant 1)	2 412	18.00	2.39	1.73	0.022	1
	2 437	19.82			0.033	
	2 472	20.00			0.035	
802.11b (Ant 2)	2 412	17.72	2.39	1.73	0.020	1
	2 437	19.54			0.031	
	2 472	20.34			0.037	
802.11g (Ant 1)	2 412	10.06	2.39	1.73	0.003	1
	2 437	11.96			0.005	
	2 472	12.24			0.006	
802.11g (Ant 2)	2 412	10.15	2.39	1.73	0.004	1
	2 437	12.05			0.006	
	2 472	11.88			0.005	
802.11 n_20 (MIMO)	2 412	8.12	2.39	1.73	0.002	1
	2 437	9.70			0.003	
	2 472	10.28			0.004	
802.11a (Ant 1)	5 745	4.28	4.78	3.01	0.002	1
	5 785	5.26			0.002	
	5 805	4.52			0.002	
802.11a (Ant 2)	5 745	3.97	4.78	3.01	0.001	1
	5 785	4.95			0.002	
	5 805	4.14			0.002	
802.11 an_20 (MIMO)	5 745	2.52	4.78	3.01	0.001	1
	5 785	3.36			0.001	
	5 805	2.63			0.001	
802.11 an_40 (MIMO)	5 755	0.94	4.78	3.01	0.001	1
	5 795	1.78			0.001	

※ Remark

The power density Pd (5th column) at a distance of 20 ㎝ calculated from the friis transmission formula is far below the limit of 1 ㎽/㎠ .