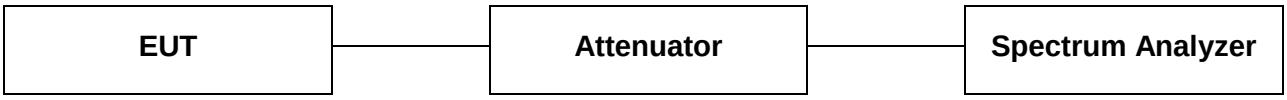
6. Peak Power Spectral Density

6.1. Test Setup



6.2. Limit

6.2.1 FCC

According to 15.407(a)(1)(iv)

For client devices in the 5.15-5.25 ㎓ band, the maximum conducted output power over the frequency band of operation shall not exceed 250 ㎽ provided the maximum antenna gain does not exceed 6 ㏈i. In addition, the maximum power spectral density shall not exceed 11 ㏈m in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 ㏈i are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

According to 15.407(a)(2)

For the 5.25-5.35 ㎓ and 5.47-5.725 ㎓ bands, the maximum conducted output power over the frequency bands of operation shall not exceed the lesser of 250 ㎽ or 11 ㏈m + 10 log B, where B is the 26 ㏈ emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 ㏈m in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 ㏈i are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i.

According to 15.407(a)(3)

For the band 5.725-5.85 ㎓, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 ㏈m in any 500-㎑ band. If transmitting antennas of directional gain greater than 6 ㏈i are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i. However, fixed point-to point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 ㏈ i without any corresponding reduction in transmitter conducted power. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

6.2.2 IC

According to RSS-247 Issue 2,

6.2.1.1 Frequency band 5 150-5 250 ㎒

For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 ㎽ or 1.76 + 10log$_{10}$B, ㏈m, whichever is less. Devices shall implement transmitter power control (TPC) in order to have the capability to operate at least 3 ㏈ below the maximum permitted e.i.r.p. of 30 ㎽.

For other devices, the maximum e.i.r.p. shall not exceed 200 ㎽ or 10 + 10log$_{10}$B, ㏈m, whichever power is less. B is the 99 % emission bandwidth in megahertz. The e.i.r.p. spectral density shall not exceed 10 ㏈m in any 1.0 ㎒ band.

6.2.2.1 Frequency band 5 250-5 350 ㎒

For OEM devices installed in vehicles, the maximum e.i.r.p. shall not exceed 30 ㎽ or 1.76 + 10log$_{10}$B, ㏈m, whichever is less. Devices shall implement TPC in order to have the capability to operate at least 3 ㏈ below the maximum permitted e.i.r.p. of 30 ㎽.

Devices, other than devices installed in vehicles, shall comply with the following:

a) The maximum conducted output power shall not exceed 250 ㎽ or 11 + 10log$_{10}$B, ㏈m, whichever is less. The power spectral density shall not exceed 11 ㏈m in any 1.0 ㎒ band;

b) The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10log$_{10}$B, ㏈m, whichever is less. B is the 99 % emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 ㎽ shall implement TPC in order to have the capability to operate at least 6 ㏈ below the maximum permitted e.i.r.p. of 1 W.

6.2.3.1 Frequency band 5 470-5 600 ㎒ and 5 650-5 725 ㎒

The maximum conducted output power shall not exceed 250 ㎽ or 11 + 10log$_{10}$B, ㏈m, whichever is less. The power spectral density shall not exceed 11 ㏈m in any 1.0 ㎒ band.

The maximum e.i.r.p. shall not exceed 1.0 W or 17 + 10log$_{10}$B, ㏈m, whichever is less. B is the 99% emission bandwidth in megahertz. Note that devices with a maximum e.i.r.p. greater than 500 ㎽ shall implement TPC in order to have the capability to operate at least 6 ㏈ below the maximum permitted e.i.r.p. of 1 W.

6.2.4.1 Frequency band 5 725-5 850 ㎒

For equipment operating in the band 5 725-5 850 ㎒, the minimum 6 ㏈ bandwidth shall be at least 500 ㎑. The maximum conducted output power shall not exceed 1 W. The output power spectral density shall not exceed 30 ㏈m in any 500 ㎑ band. If transmitting antennas of directional gain greater than 6 ㏈i are used, both the maximum conducted output power and the output power spectral density shall be reduced by the amount in ㏈ that the directional gain of the antenna exceeds 6 ㏈i. However, fixed point-to-point devices operating in this band may employ transmitting antennas with directional gain greater than 6 ㏈i without any corresponding reduction in transmitter conducted power. Fixed point-to-point operations exclude the use of point-to-multipoint[3] systems, omnidirectional applications and multiple collocated transmitters transmitting the same information.

6.3. Test Procedure

All data rates and modes were investigated for this test. The full data for the worst case data rate are reported in this section.

1. This measurement settings are specified in section F of KDB 789033 D02 General UNII Test Procedures New Rules v02r01.

2. Create an average power spectrum for the EUT operating mode being tested by following the instructions in section II.E.2. for measuring maximum conducted output power using a spectrum analyzer or EMI receiver: select the appropriate test method (SA-1, SA-2, SA-3, or alternatives to each) and apply it up to, but not including, the step labeled, “Compute power…”. (This procedure is required even if the maximum conducted output power measurement was performed using a power meter, method PM.)

3. Use the peak search function on the instrument to find the peak of the spectrum and record its value.

4. Make the following adjustments to the peak value of the spectrum, if applicable:

   a) **If Method SA-2 or SA-2 Alternative was used, add 10 log(1/x), where x is the duty cycle, to the peak of the spectrum.**
   b) If Method SA-3 Alternative was used and the linear mode was used in step II.E.2.g)(viii), add 1 ㏈ to the final result to compensate for the difference between linear averaging and power averaging.

5. The result is the Maximum PSD over 1 ㎒ reference bandwidth.

6. For devices operating in the bands 5.15-5.25 ㎓, 5.25-5.35 ㎓, and 5.47-5.725 ㎓, the above procedures make use of 1 ㎒ RBW to satisfy directly the 1 ㎒ reference bandwidth specified in § 15.407(a)(5). For devices operating in the band 5.725-5.85 ㎓, the rules specify a measurement bandwidth of 500 ㎑. Many spectrum analyzers do not have 500 ㎑ RBW, thus a narrower RBW may need to be used. The rules permit the use of a RBWs less than 1 ㎒, or 500 ㎑, “provided that the measured power is integrated over the full reference bandwidth” to show the total power over the specified measurement bandwidth (*i.e.,* 1 ㎒, or 500 ㎑). If measurements are performed using a reduced resolution bandwidth (< 1 ㎒, or < 500 ㎑) and integrated over 1 ㎒, or 500 ㎑ bandwidth, the following adjustments to the procedures apply:

   a) Set RBW ≥ 1/*T*, where *T* is defined in section II.B.1.a).
   b) Set VBW ≥ 3 RBW.
   c) If measurement bandwidth of Maximum PSD is specified in 500 ㎑, add 10log(500 ㎑/RBW) to the measured result, whereas RBW (< 500 ㎑) is the reduced resolution bandwidth of the spectrum analyzer set during measurement.
   d) If measurement bandwidth of Maximum PSD is specified in 1 ㎒, add 10log(1 ㎒/RBW) to the measured result, whereas RBW (< 1 ㎒) is the reduced resolution bandwidth of spectrum analyzer set during measurement.
   e) Care must be taken to ensure that the measurements are performed during a period of continuous transmission or are corrected upward for duty cycle.

7. In case of band crossing channels 138, 142 and 144, the measurement is complied with section Ⅲ.A of KDB 789033 D02 General UNII Test Procedures New Rules v02r01.

6.4. Test Result

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Test mode: 11a

Band	Frequency (㎒)	Ch.	Data Rate (Mbps)	Measured PPSD (㏈ m)	Duty Cycle Correction Factor (㏈)	Final PPSD (㏈ m)	Limit (㏈ m/1 ㎒)
U-NII 1	5 180	36	9	-3.72	0.31	-3.41	11
	5 220	44		-3.98		-3.67	
	5 240	48		-4.06		-3.75	
U-NII 2A	5 260	52		-3.45		-3.14	
	5 300	60		-3.90		-3.59	
	5 320	64		-4.00		-3.69	
U-NII 2C	5 500	100		-3.55		-3.24	
	5 580	116		-3.59		-3.28	
	5 720	144		-3.12		-2.81	
Band	**Frequency (㎒)**	**Ch.**	**Data Rate (Mbps)**	**Measured PPSD (㏈ m)**	**Duty Cycle Correction Factor (㏈)**	**Final PPSD (㏈ m)**	**Limit (㏈ m/500 ㎑)**
U-NII 3	5 745	149	9	-6.87	0.31	-6.56	30
	5 785	157		-6.46		-6.15	
	5 825	165		-6.58		-6.27	

Band	Frequency (㎒)	Ch.	Data Rate (Mbps)	Final PPSD (㏈ m)	Antenna Gain (㏈ i)	E.I.R.P. PPSD (㏈ m)	IC Limit (㏈ m/1 ㎒)
U-NII 1	5 180	36	9	-3.41	-0.61	-4.02	10
	5 220	44		-3.67		-4.28	
	5 240	48		-3.75		-4.36	

Remark;

1. Final PPSD (㏈ m) = Measured PPSD (㏈ m) + Duty Cycle Correction Factor (㏈)
2. E.I.R.P. PPSD (㏈ m) = Final PPSD (㏈ m) + Antenna Gain (㏈ i)

Test mode: 11n_HT20

Band	Frequency (㎒)	Ch.	Data Rate (Mbps)	Measured PPSD (㏈ m)	Duty Cycle Correction Factor (㏈)	Final PPSD (㏈ m)	Limit (㏈ m/1 ㎒)
U-NII 1	5 180	36	MCS0	-4.65	0.24	-4.41	11
	5 220	44		-4.21		-3.97	
	5 240	48		-4.69		-4.45	
U-NII 2A	5 260	52		-4.03		-3.79	
	5 300	60		-4.12		-3.88	
	5 320	64		-4.10		-3.86	
U-NII 2C	5 500	100		-4.21		-3.97	
	5 580	116		-3.71		-3.47	
	5 720	144		-4.10		-3.86	
Band	**Frequency (㎒)**	**Ch.**	**Data Rate (Mbps)**	**Measured PPSD (㏈ m)**	**Duty Cycle Correction Factor (㏈)**	**Final PPSD (㏈ m)**	**Limit (㏈ m/500 ㎑)**
U-NII 3	5 745	149	MCS0	-7.21	0.24	-6.97	30
	5 785	157		-6.80		-6.56	
	5 825	165		-6.79		-6.55	

Band	Frequency (㎒)	Ch.	Data Rate (Mbps)	Final PPSD (㏈ m)	Antenna Gain (㏈ i)	E.I.R.P. PPSD (㏈ m)	IC Limit (㏈ m/1 ㎒)
U-NII 1	5 180	36	MCS0	-4.41	-0.61	-5.02	10
	5 220	44		-3.97		-4.58	
	5 240	48		-4.45		-5.06	

Remark;

1. Final PPSD (㏈ m) = Measured PPSD (㏈ m) + Duty Cycle Correction Factor (㏈)
2. E.I.R.P. PPSD (㏈ m) = Final PPSD (㏈ m) + Antenna Gain (㏈ i)

Test mode: 11n_HT40

Band	Frequency (㎒)	Ch.	Data Rate (Mbps)	Measured PPSD (㏈ m)	Duty Cycle Correction Factor (㏈)	Final PPSD (㏈ m)	Limit (㏈ m/1 ㎒)
U-NII 1	5 190	38	MCS5	-13.18	2.23	-10.95	11
	5 230	46		-12.84		-10.61	
U-NII 2A	5 270	54		-10.07		-7.84	
	5 310	62		-10.25		-8.02	
U-NII 2C	5 510	102		-9.56		-7.33	
	5 550	110		-9.14		-6.91	
	5 710	142		-10.11		-7.88	
Band	**Frequency (㎒)**	**Ch.**	**Data Rate (Mbps)**	**Measured PPSD (㏈ m)**	**Duty Cycle Correction Factor (㏈)**	**Final PPSD (㏈ m)**	**Limit (㏈ m/500 ㎑)**
U-NII 3	5 755	151	MCS5	-12.81	2.23	-10.58	30
	5 795	159		-12.51		-10.28	

Band	Frequency (㎒)	Ch.	Data Rate (Mbps)	Final PPSD (㏈ m)	Antenna Gain (㏈ i)	E.I.R.P. PPSD (㏈ m)	IC Limit (㏈ m/1 ㎒)
U-NII 1	5 190	38	MCS5	-10.95	-0.61	-11.56	10
	5 230	46		-10.61		-11.22	

Remark;

1. Final PPSD (㏈ m) = Measured PPSD (㏈ m) + Duty Cycle Correction Factor (㏈)
2. E.I.R.P. PPSD (㏈ m) = Final PPSD (㏈ m) + Antenna Gain (㏈ i)

Test mode: 11ac_VHT80

Band	Frequency (㎒)	Ch.	Data Rate (Mbps)	Measured PPSD (㏈ m)	Duty Cycle Correction Factor (㏈)	Final PPSD (㏈ m)	Limit (㏈ m/1 ㎒)
U-NII 1	5 210	42	MCS8	-17.88	3.73	-14.15	11
U-NII 2A	5 290	58		-15.29		-11.56	
U-NII 2C	5 530	106		-15.09		-11.36	
	5 690	138		-14.84		-11.11	
Band	**Frequency (㎒)**	**Ch.**	**Data Rate (Mbps)**	**Measured PPSD (㏈ m)**	**Duty Cycle Correction Factor (㏈)**	**Final PPSD (㏈ m)**	**Limit (㏈ m/500 ㎑)**
U-NII 3	5 775	155	MCS8	-17.79	3.73	-14.06	30

Band	Frequency (㎒)	Ch.	Data Rate (Mbps)	Final PPSD (㏈ m)	Antenna Gain (㏈ i)	E.I.R.P. PPSD (㏈ m)	IC Limit (㏈ m/1 ㎒)
U-NII 1	5 210	42	MCS8	-14.15	-0.61	-14.76	10

Remark;

1. Final PPSD (㏈ m) = Measured PPSD (㏈ m) + Duty Cycle Correction Factor (㏈)
2. E.I.R.P. PPSD (㏈ m) = Final PPSD (㏈ m) + Antenna Gain (㏈ i)

Band-crossing channels

Mode	Band	Frequency (㎒)	Ch.	Data Rate (Mbps)	Measured PPSD (㏈m)	Duty Cycle Correction Factor (㏈)	Final PPSD (㏈m)	Limit (㏈m/1㎒ or ㏈m/500㎑)
11a	U-NII 2C	5 720	144	9	-3.36	0.31	-3.05	11
	U-NII 3	5 720	144		-8.47		-8.16	30
11n_HT20	U-NII 2C	5 720	144	MCS0	-3.08	0.24	-2.84	11
	U-NII 3	5 720	144		-8.52		-8.28	30
11n_HT40	U-NII 2C	5 710	142	MCS5	-9.42	2.23	-7.19	11
	U-NII 3	5 710	142		-14.22		-11.99	30
11ac_VHT80	U-NII 2C	5 690	138	MCS8	-15.01	3.73	-11.28	11
	U-NII 3	5 690	138		-18.41		-14.68	30

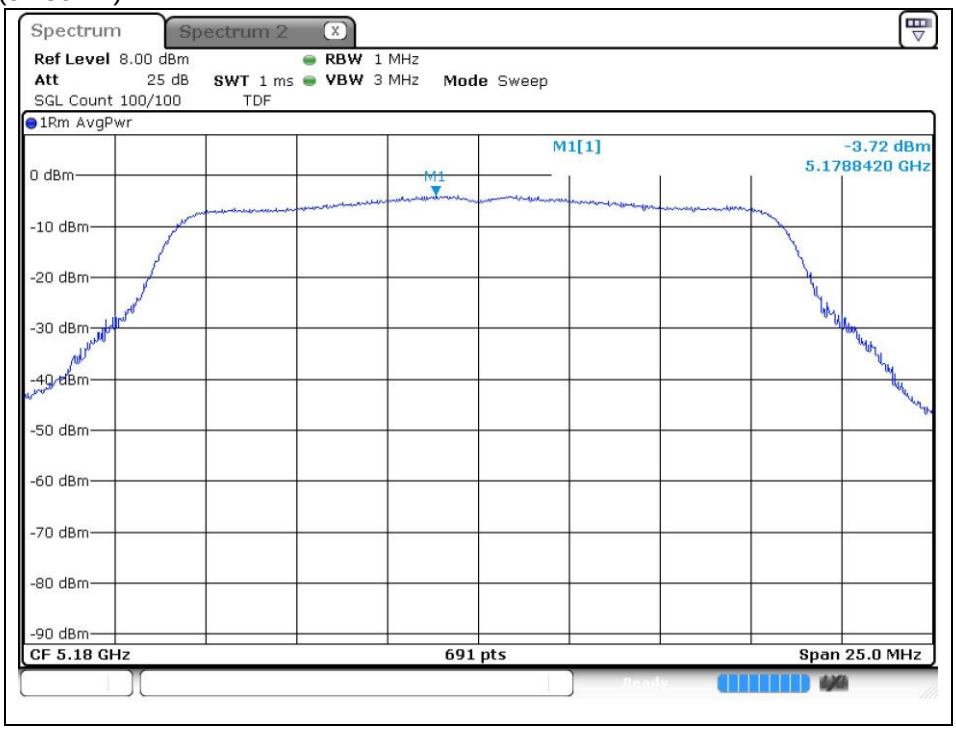
Remark;

1. Final PPSD (㏈m) = Measured PPSD (㏈m) + Duty Cycle Correction Factor (㏈)

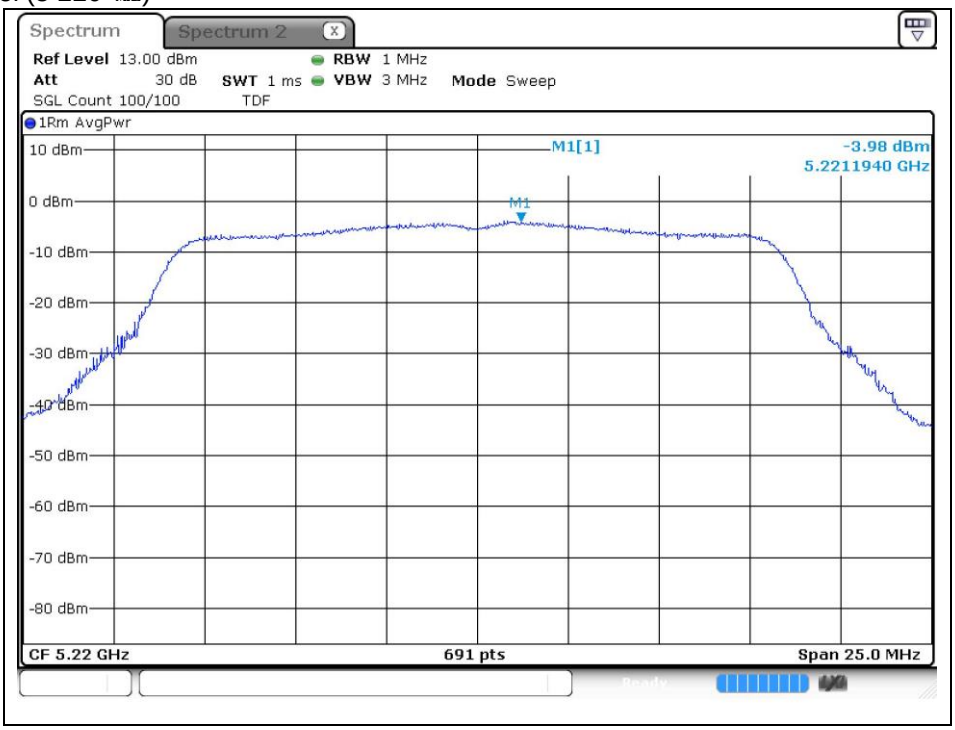
- Test plots

802.11a (Band 1)

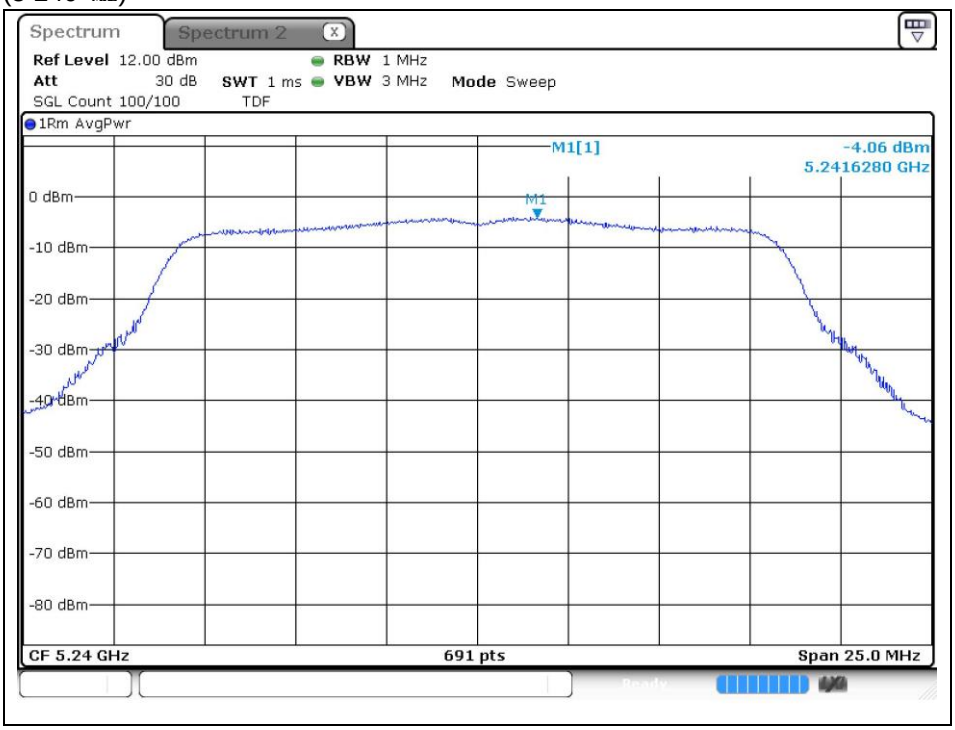
Low Channel (5 180 ㎒)



Middle Channel (5 220 ㎒)

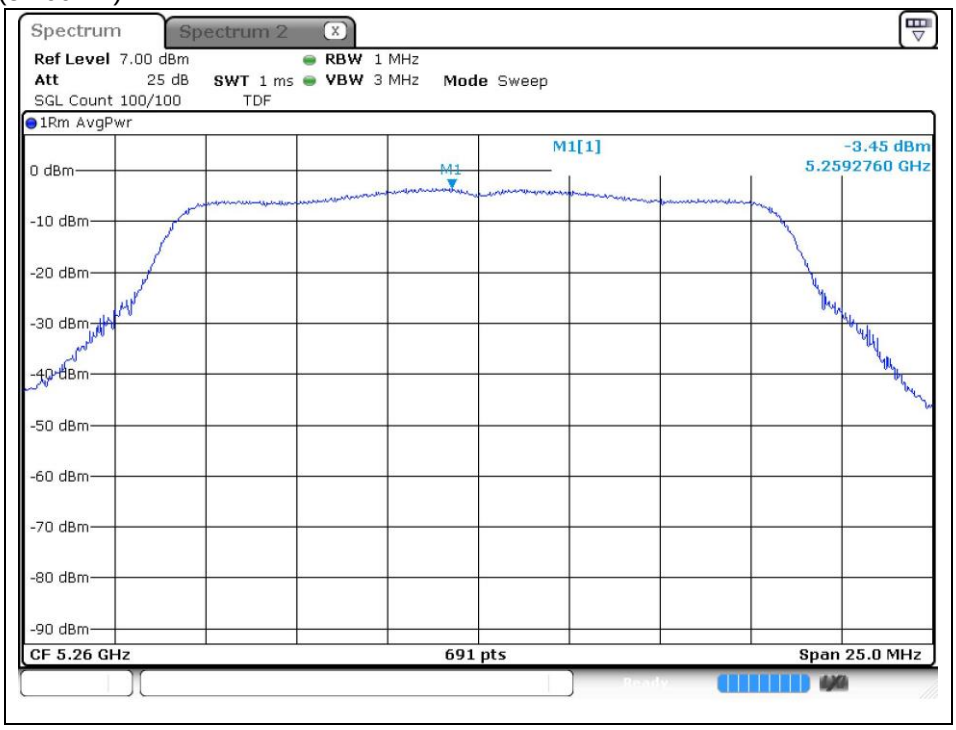


High Channel (5 240 ㎒)

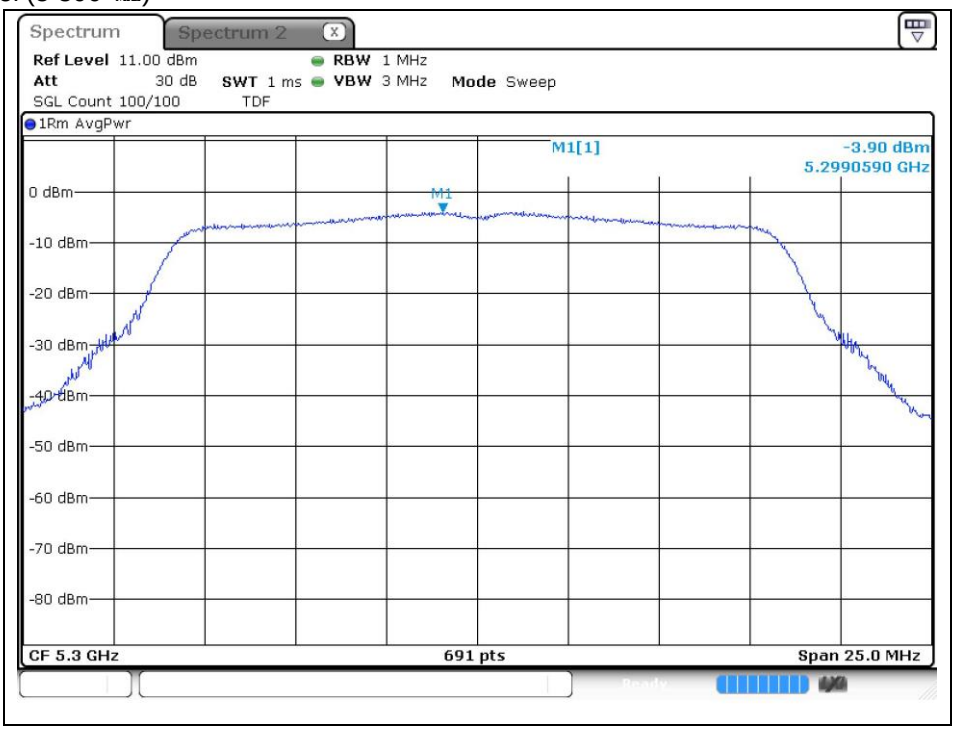


802.11a (Band 2A)

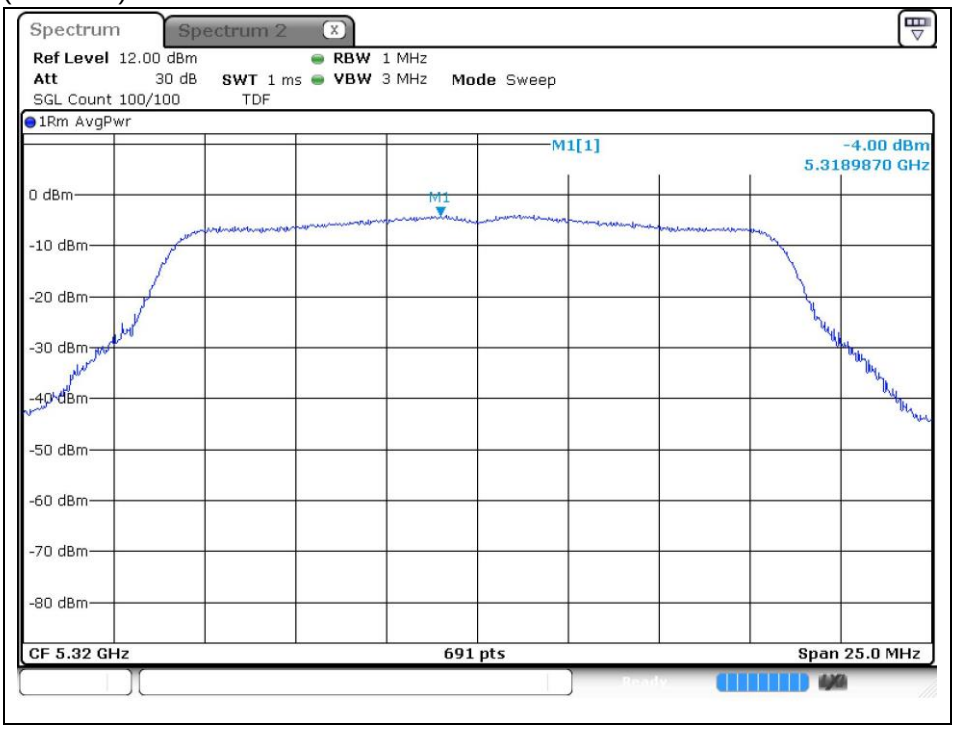
Low Channel (5 260 ㎒)



Middle Channel (5 300 ㎒)

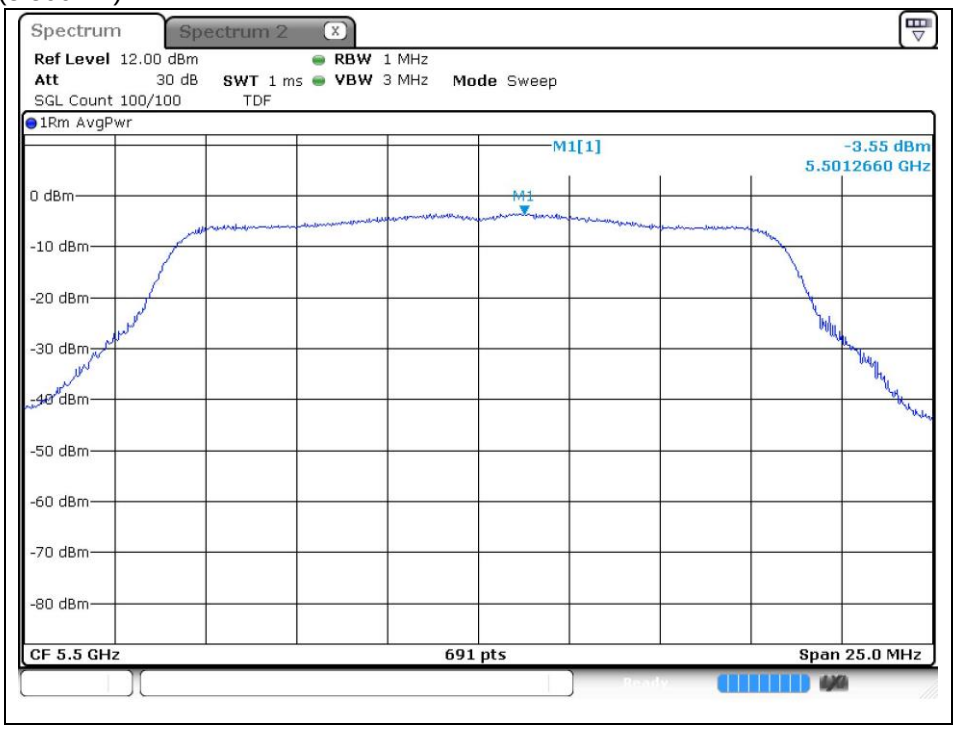


High Channel (5 320 ㎒)

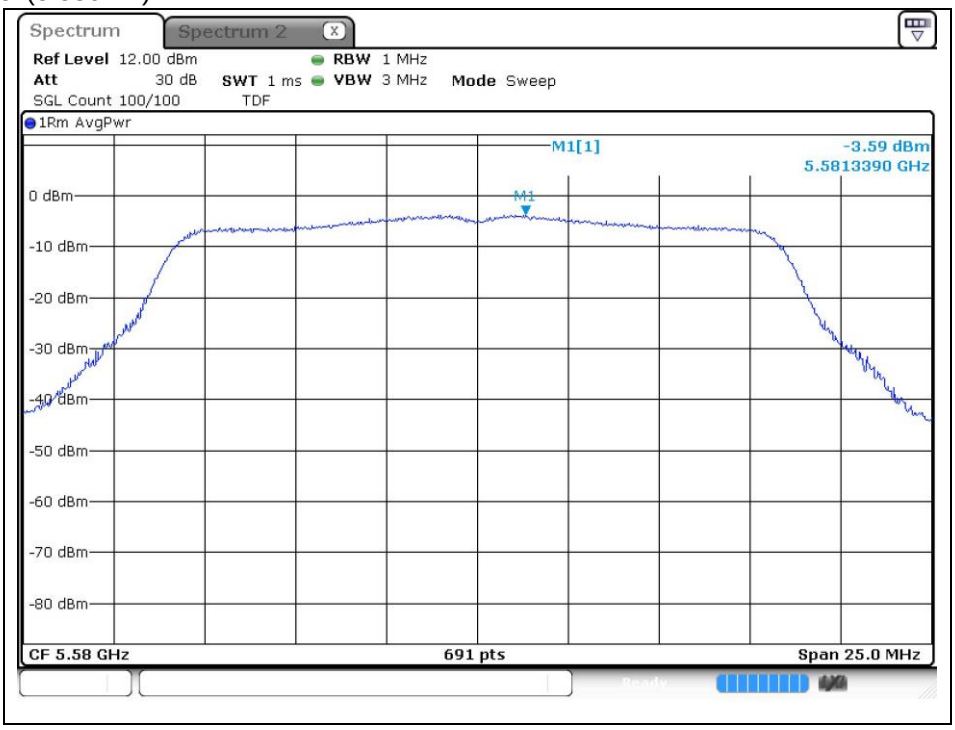


802.11a (Band 2C)

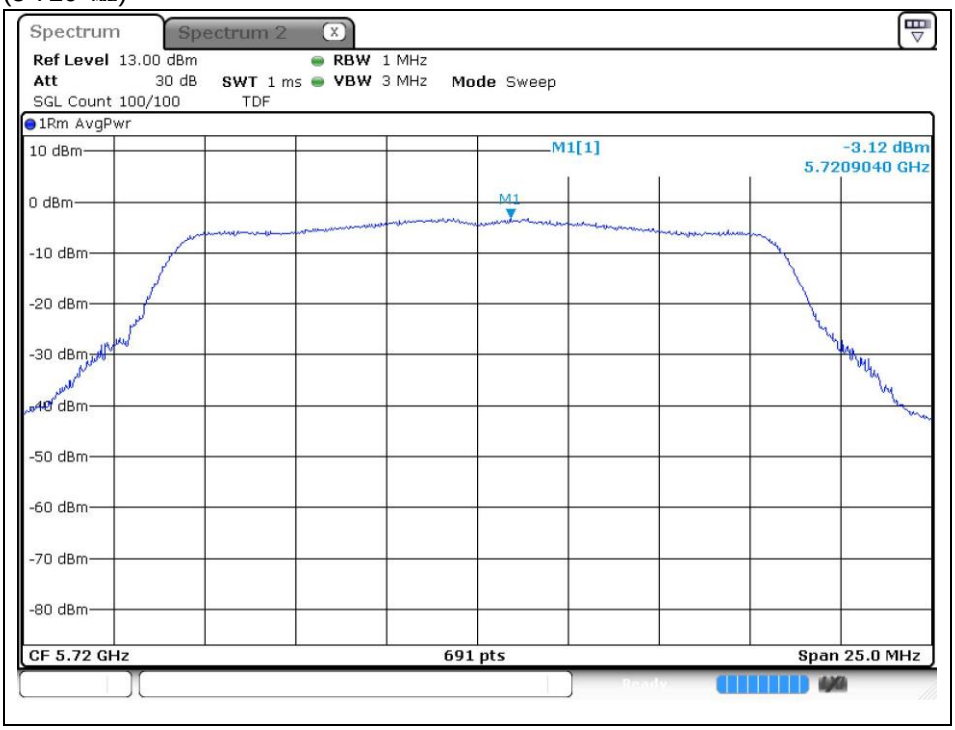
Low Channel (5 500 ㎒)



Middle Channel (5 580 ㎒)

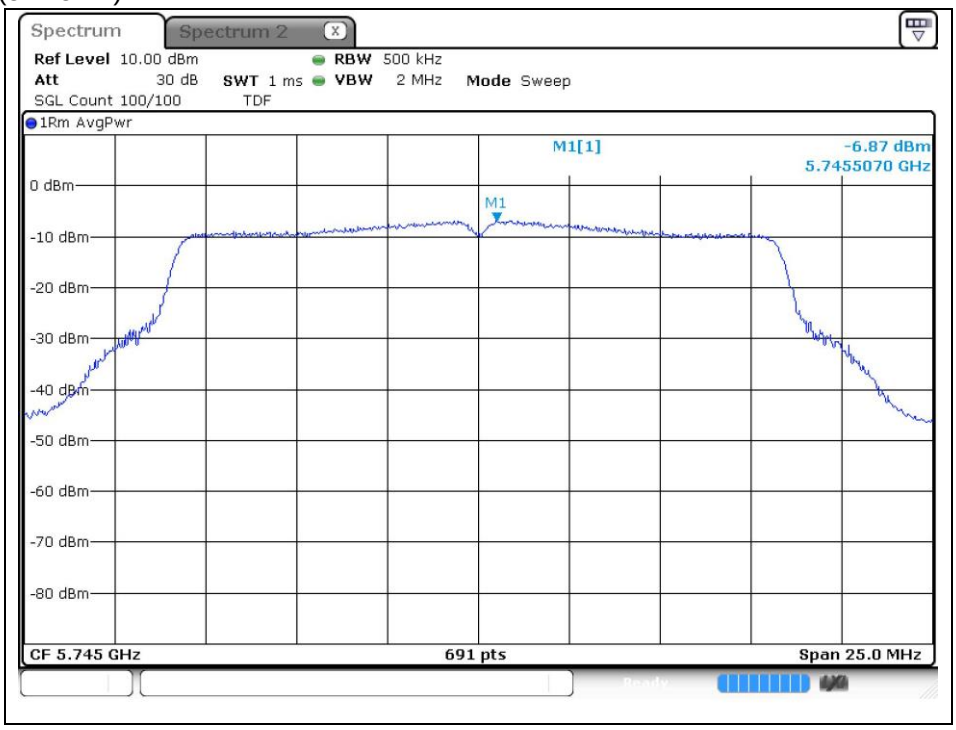


High Channel (5 720 ㎒)

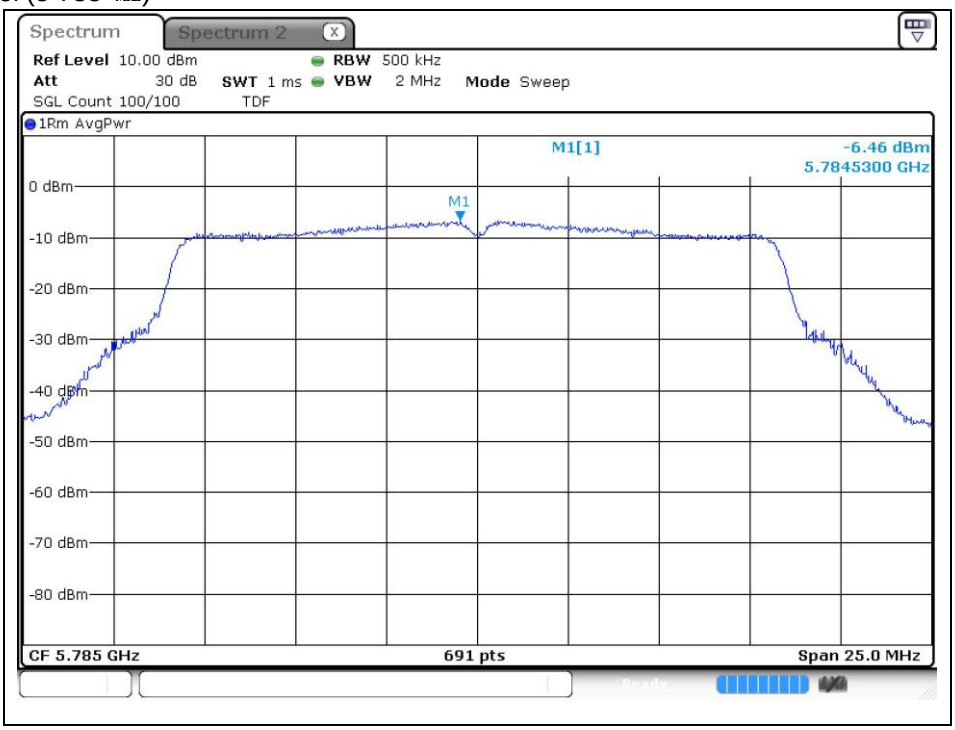


802.11a (Band 3)

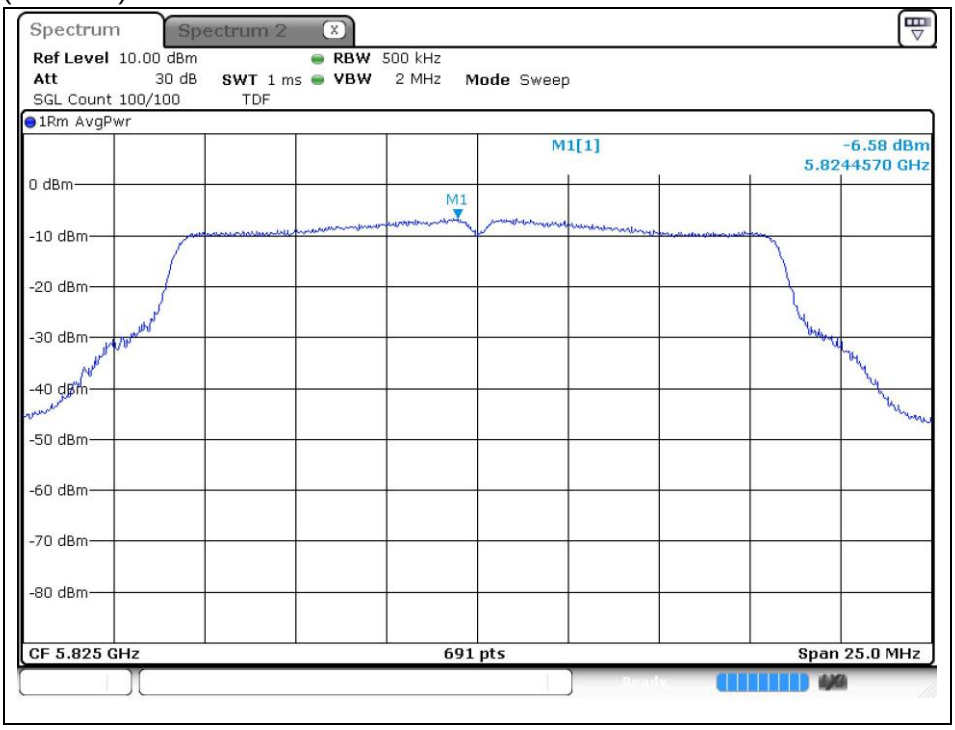
Low Channel (5 745 ㎒)



Middle Channel (5 785 ㎒)

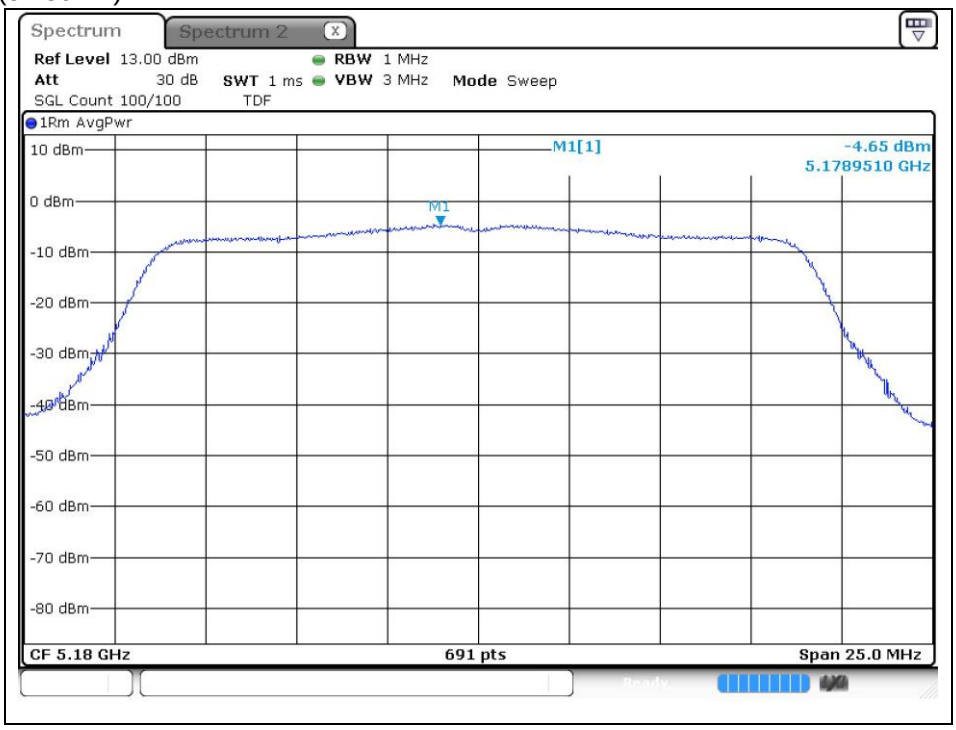


High Channel (5 825 ㎒)

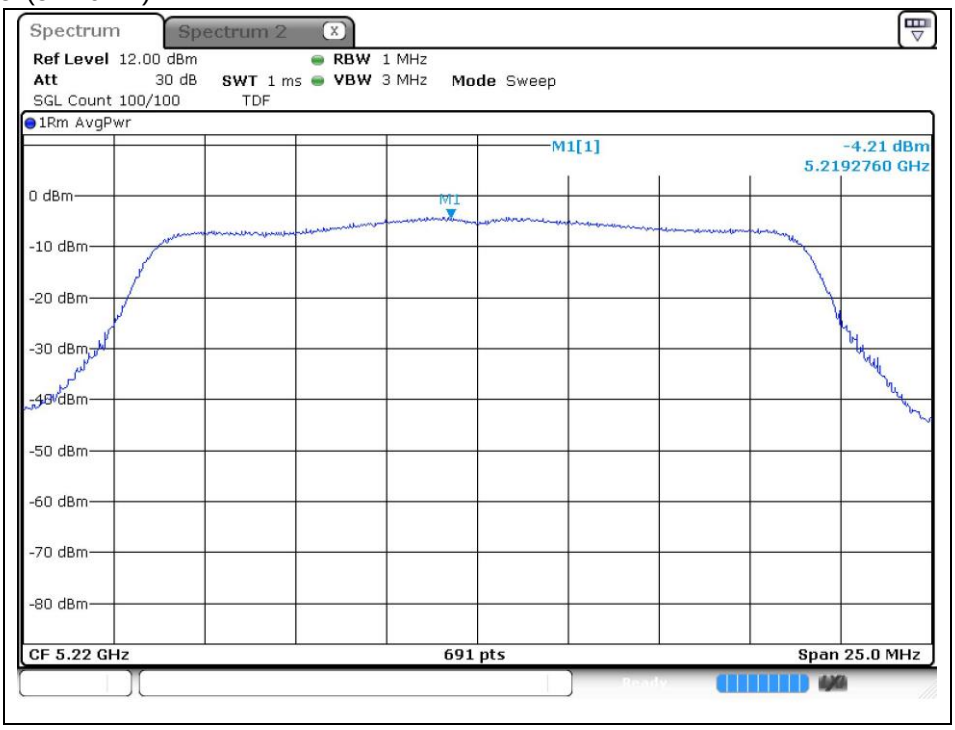


802.11n_HT20 (Band 1)

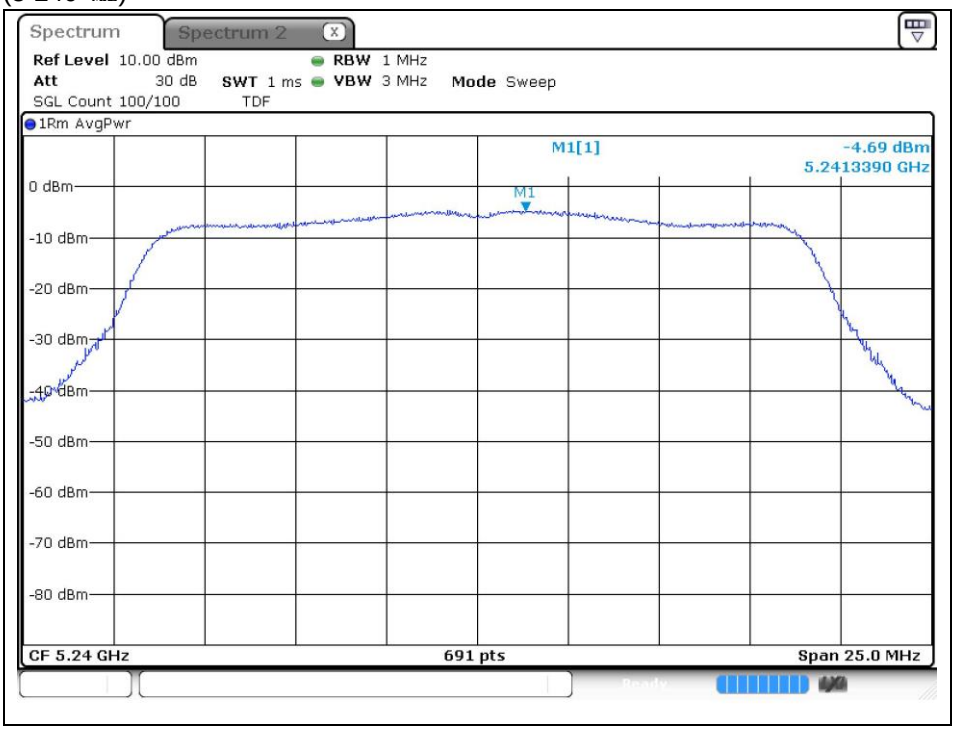
Low Channel (5 180 ㎒)



Middle Channel (5 220 ㎒)

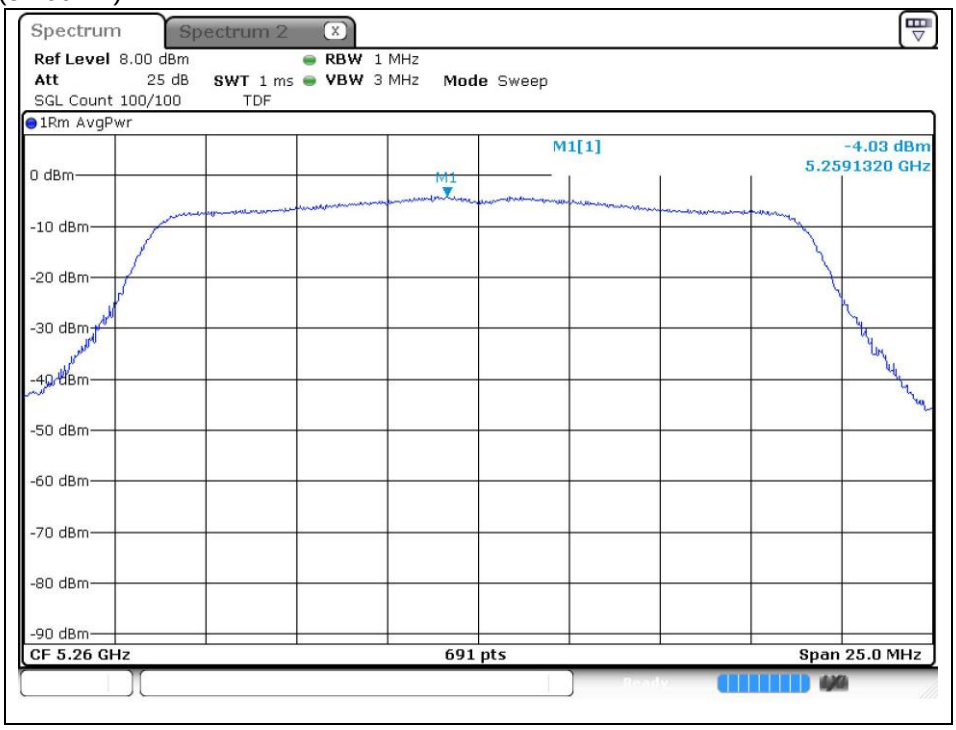


High Channel (5 240 ㎒)

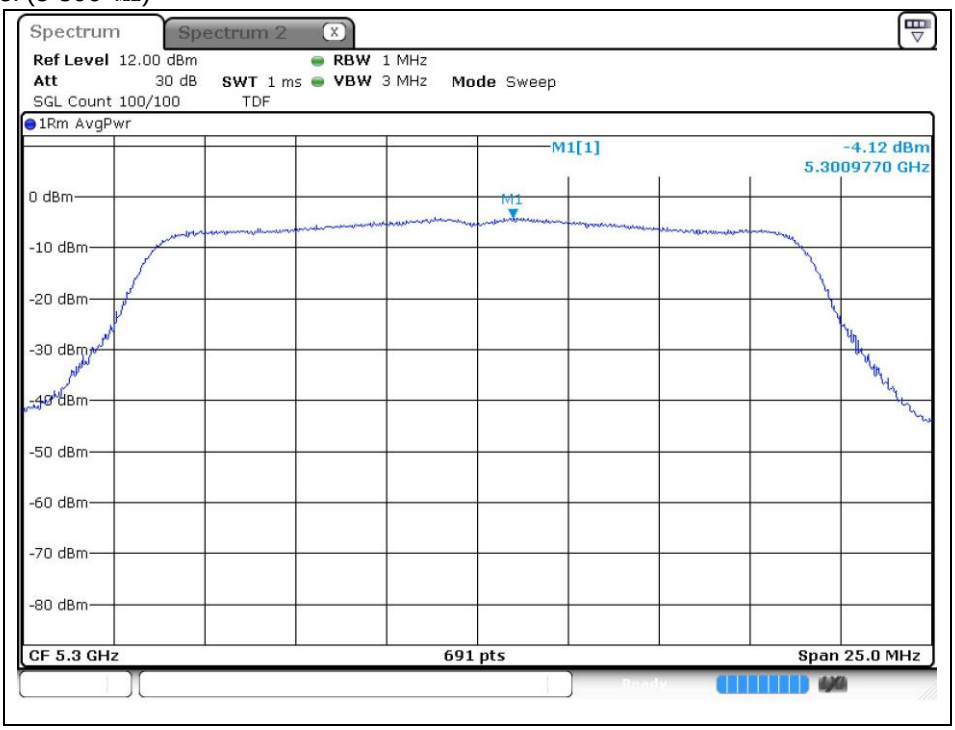


802.11n_HT20 (Band 2A)

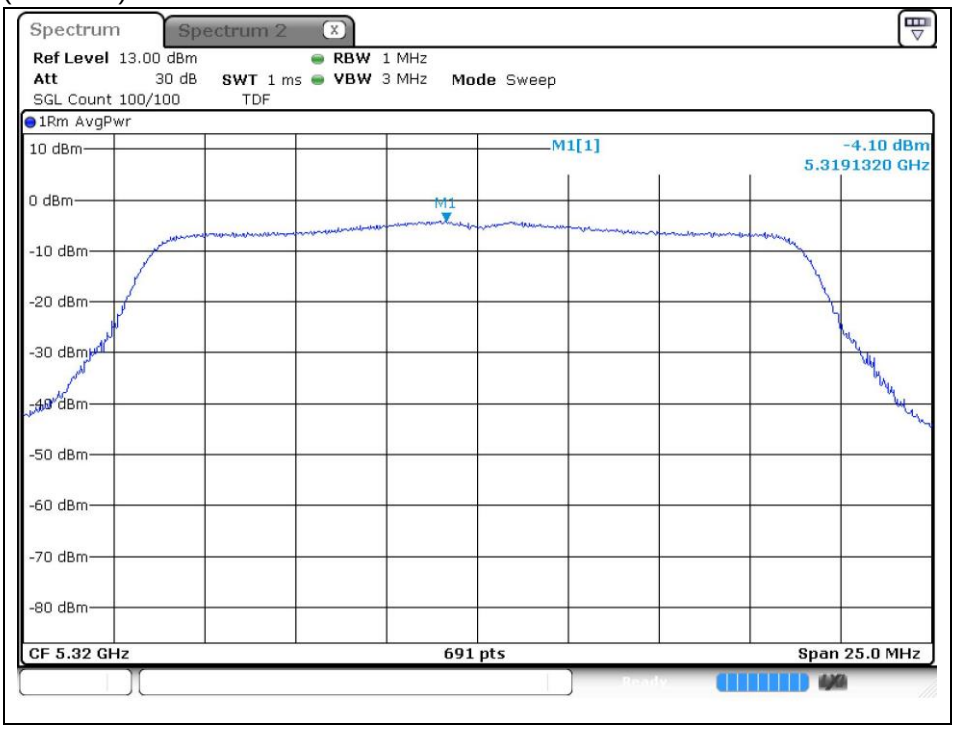
Low Channel (5 260 ㎒)



Middle Channel (5 300 ㎒)

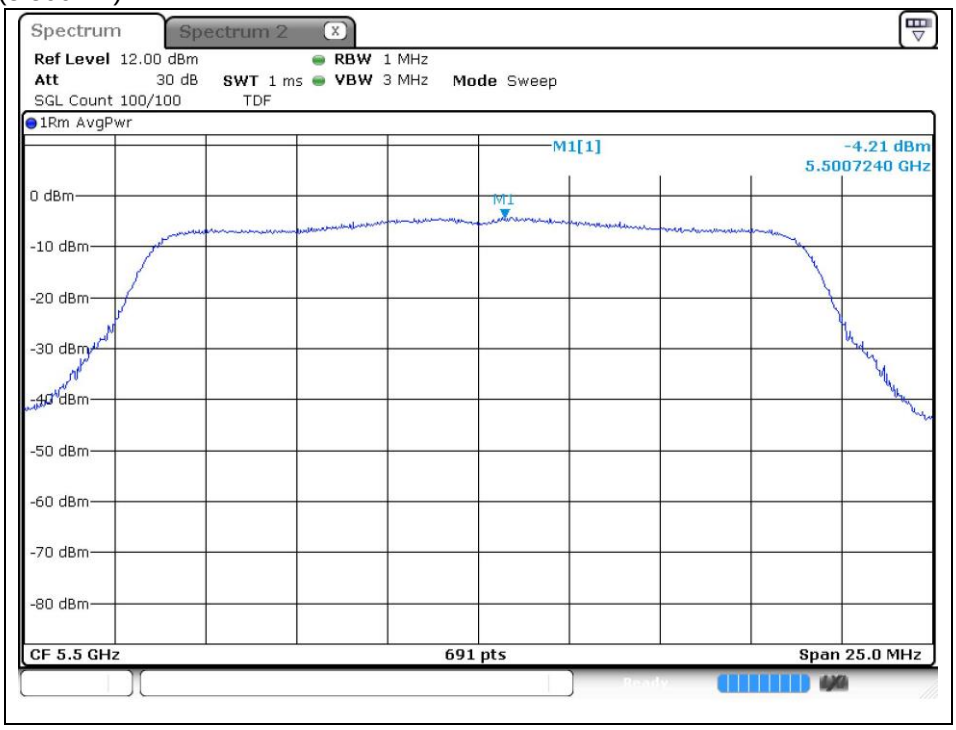


High Channel (5 320 ㎒)

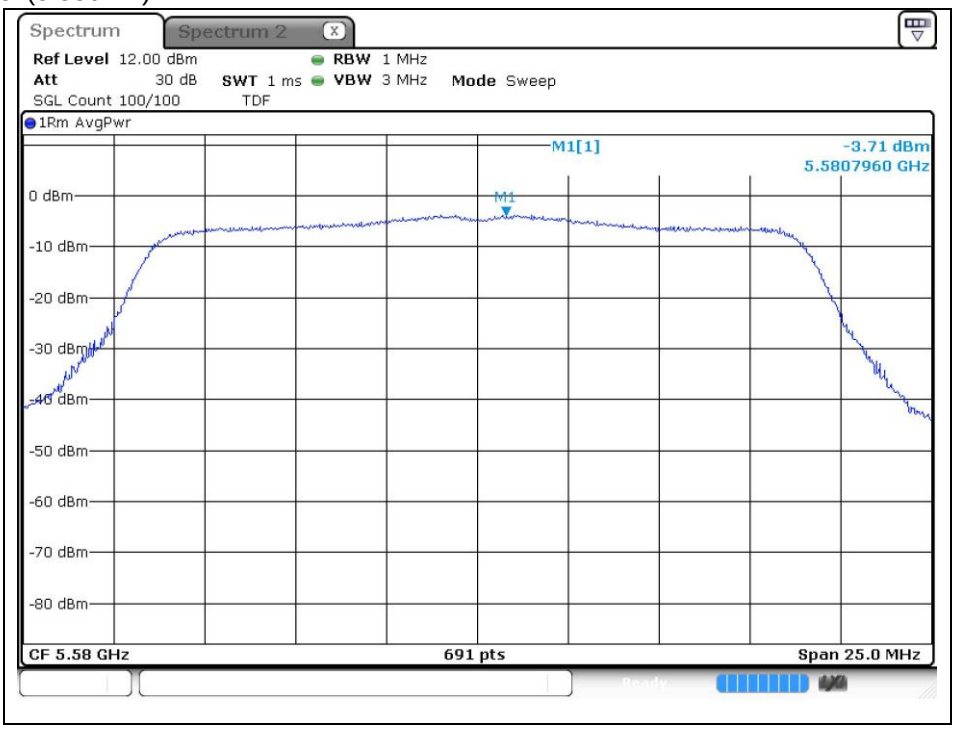


802.11n_HT20 (Band 2C)

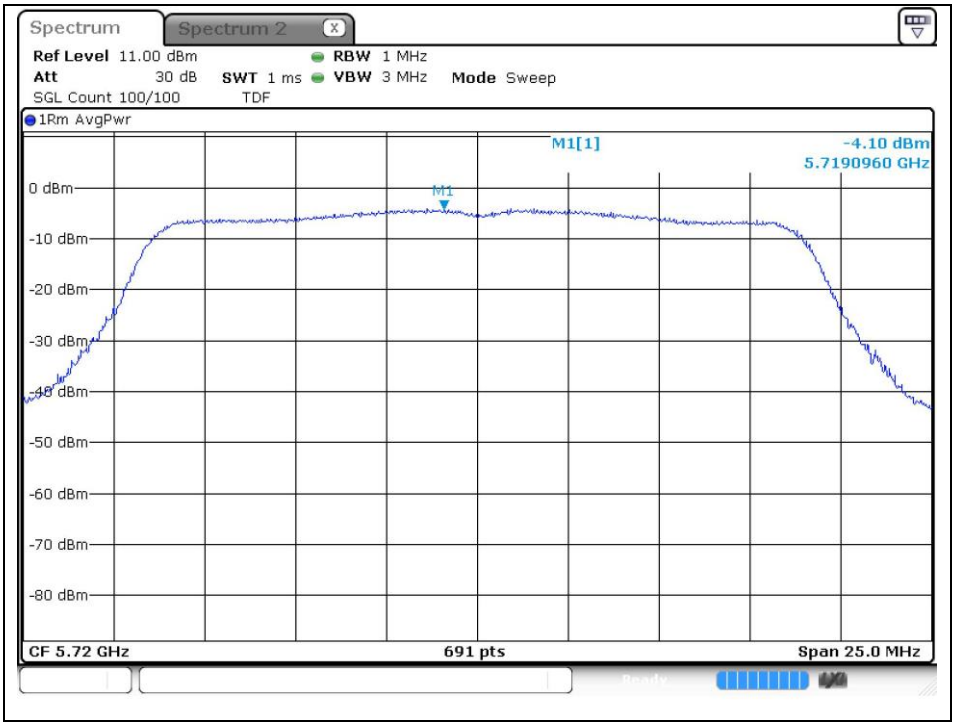
Low Channel (5 500 ㎒)



Middle Channel (5 580 ㎒)

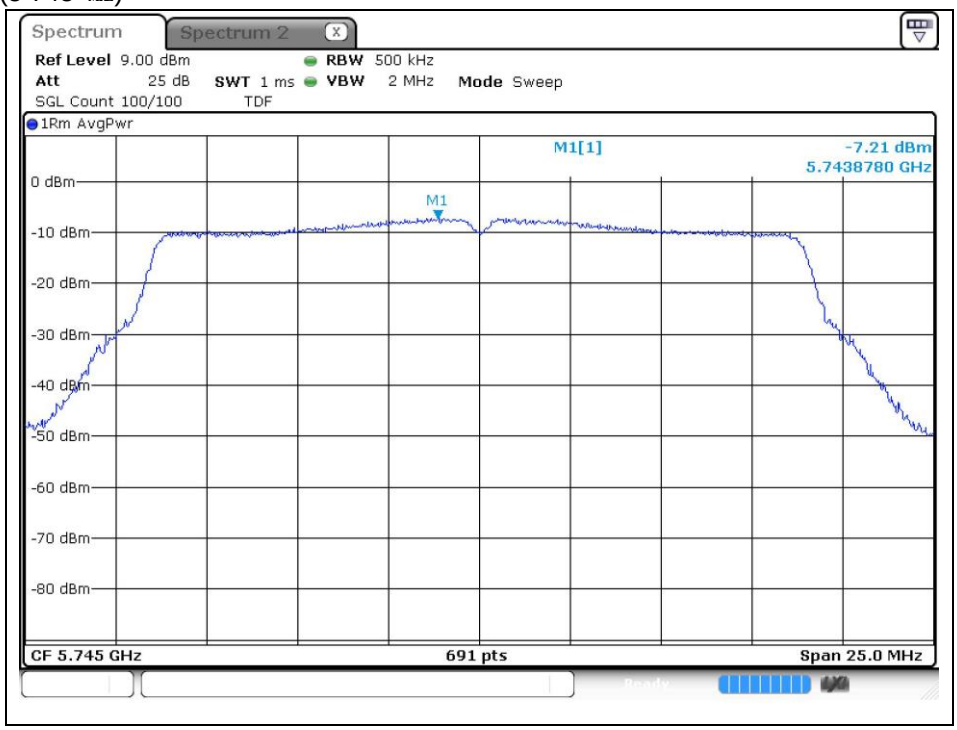


High Channel (5 720 ㎒)

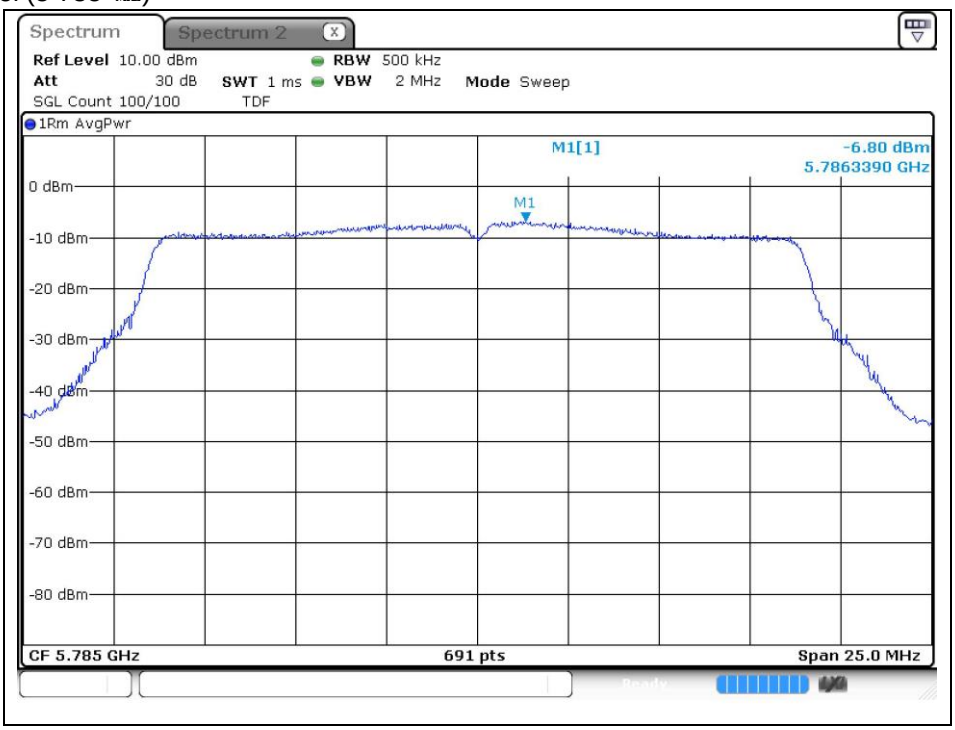


802.11n_HT20 (Band 3)

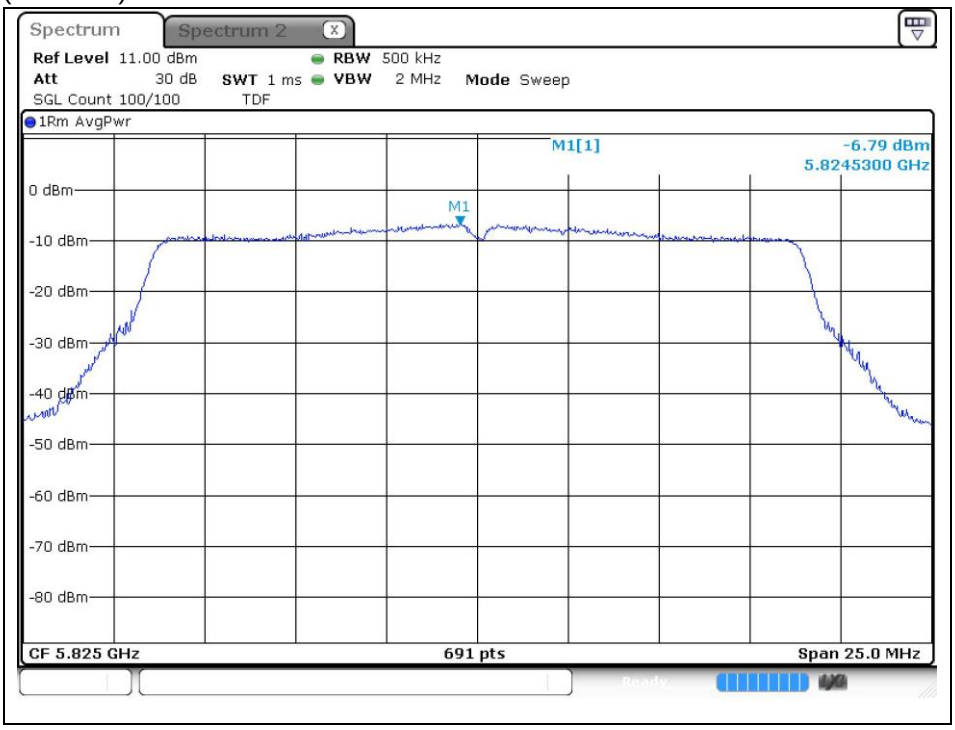
Low Channel (5 745 ㎒)



Middle Channel (5 785 ㎒)

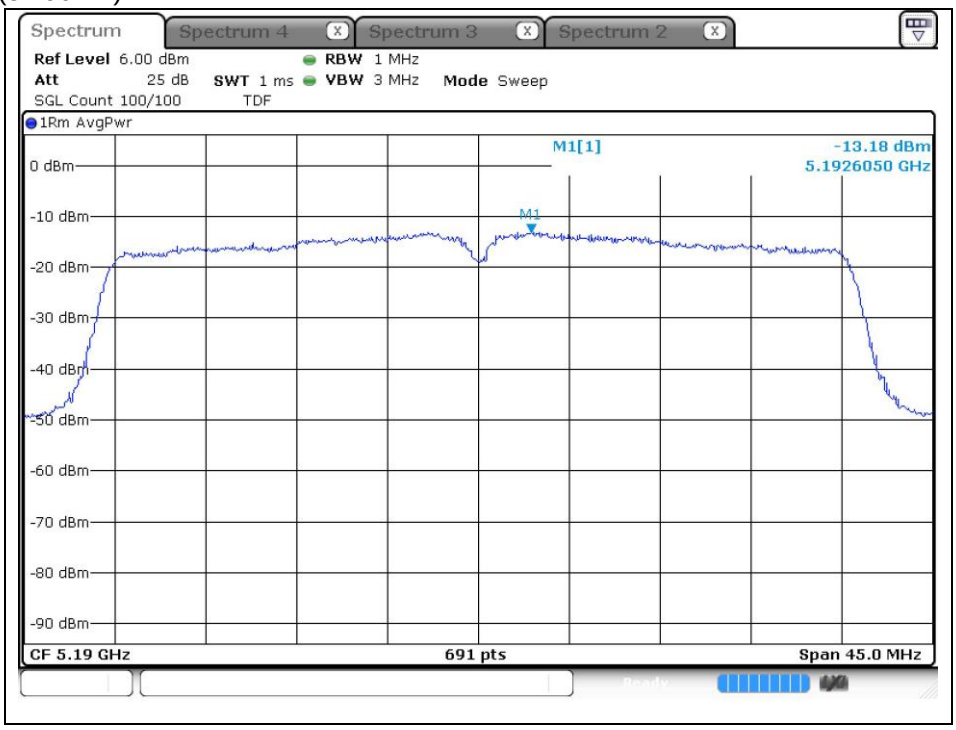


High Channel (5 825 ㎒)

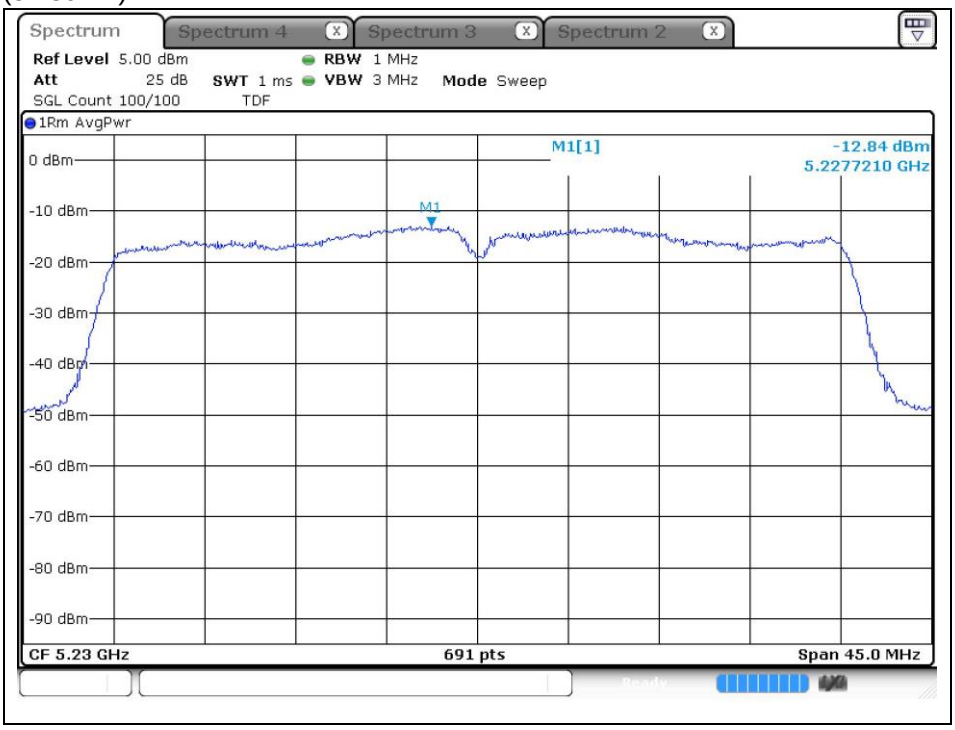


802.11n_HT40 (Band 1)

Low Channel (5 190 ㎒)

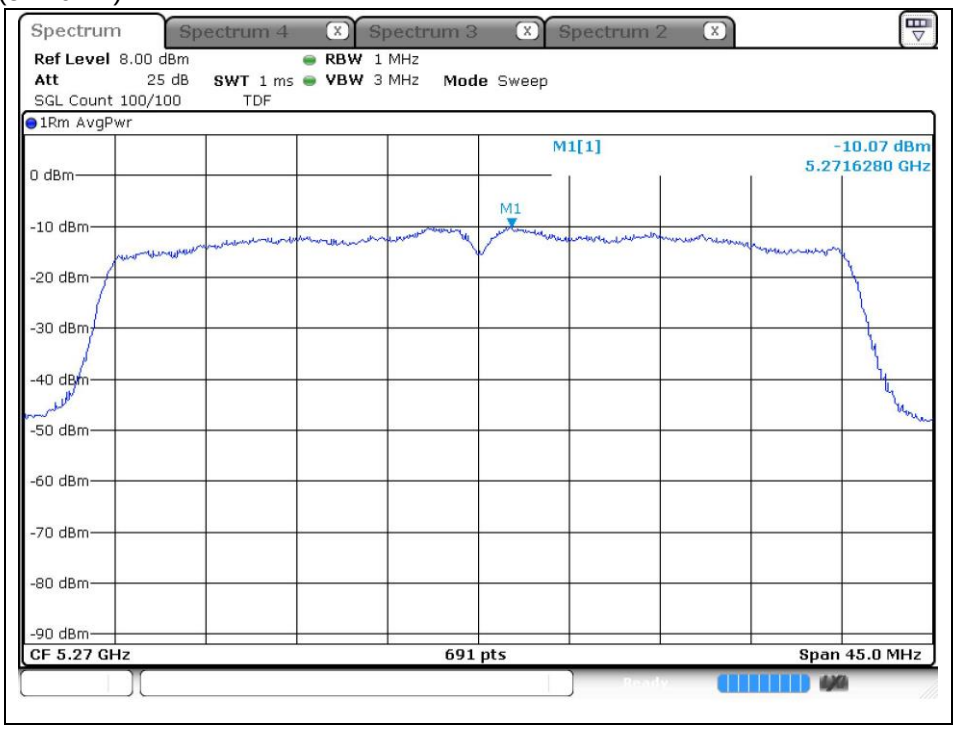


High Channel (5 230 ㎒)

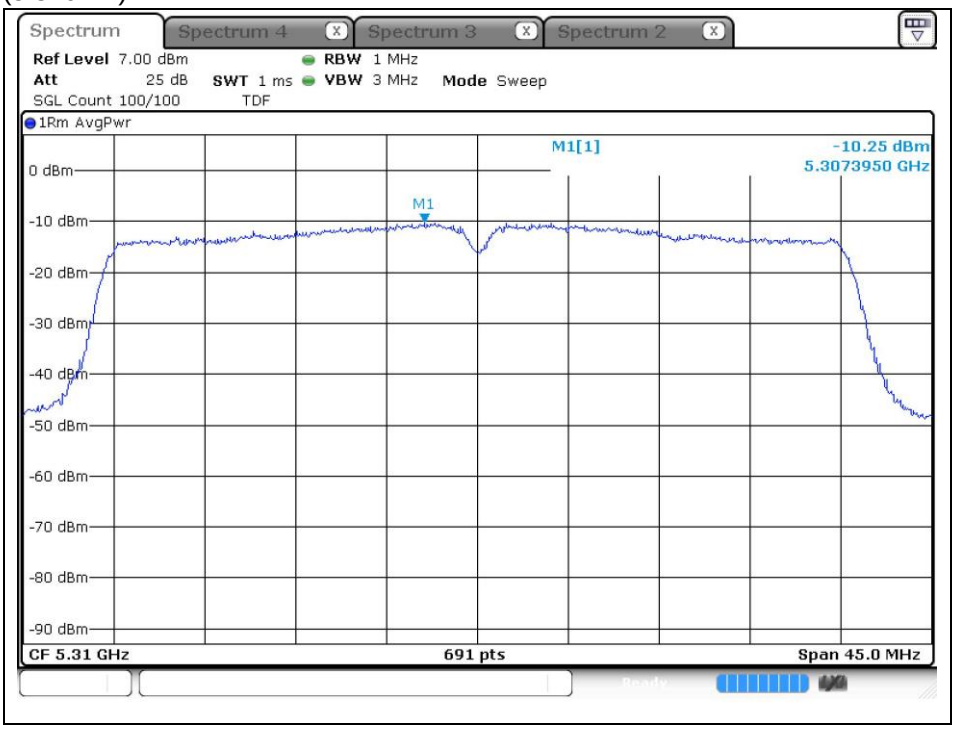


802.11n_HT40 (Band 2A)

Low Channel (5 270 ㎒)

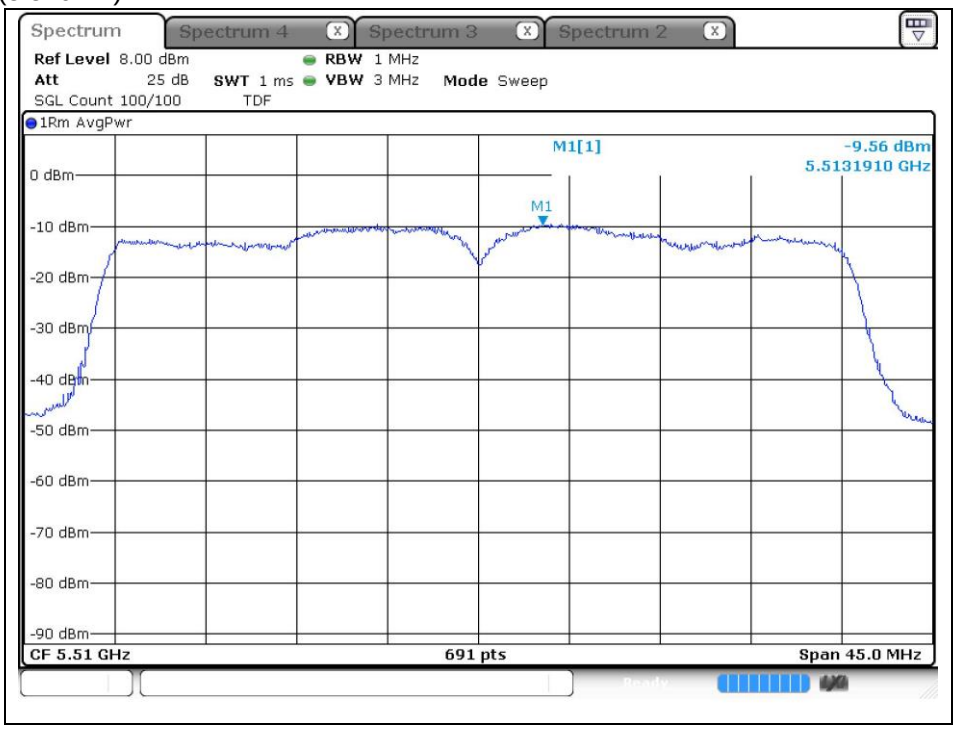


High Channel (5 310 ㎒)

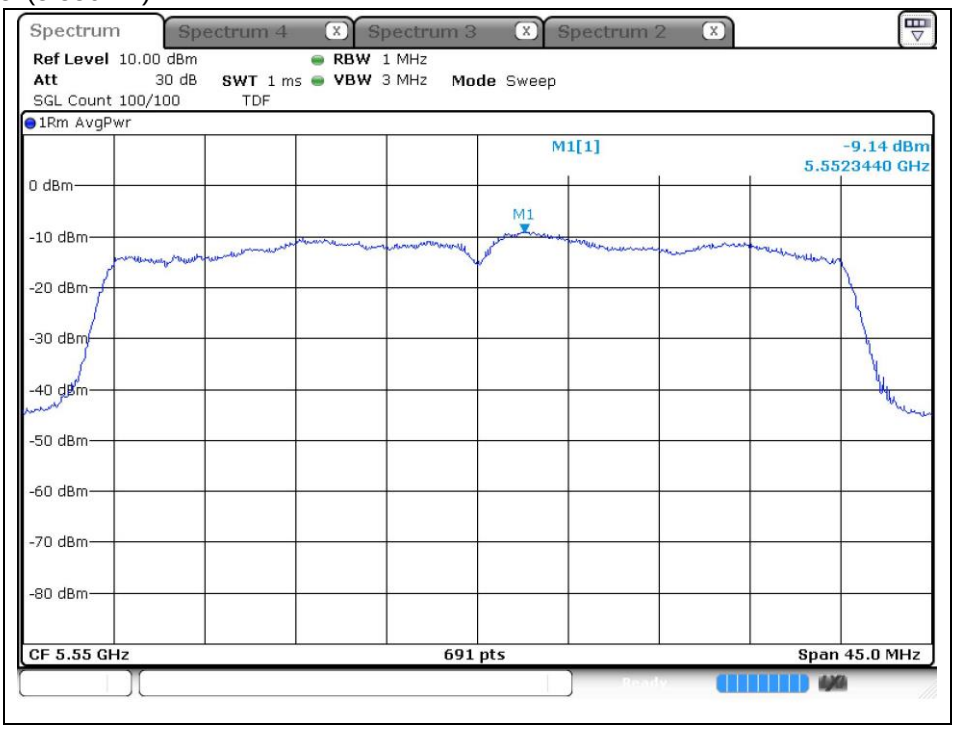


802.11n_HT40 (Band 2C)

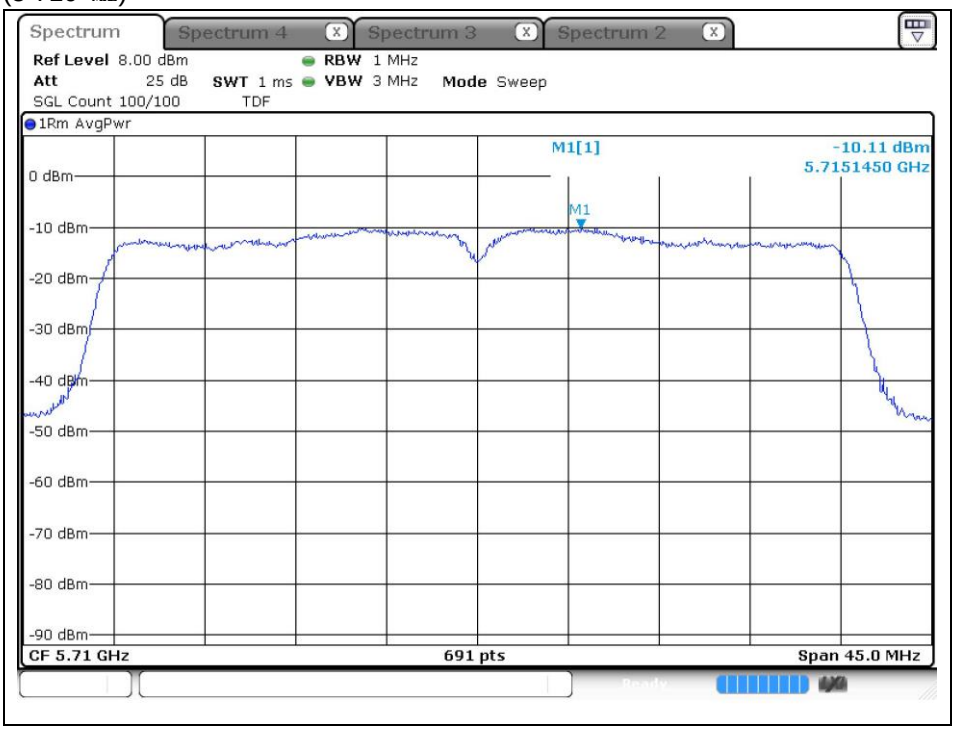
Low Channel (5 510 ㎒)



Middle Channel (5 550 ㎒)

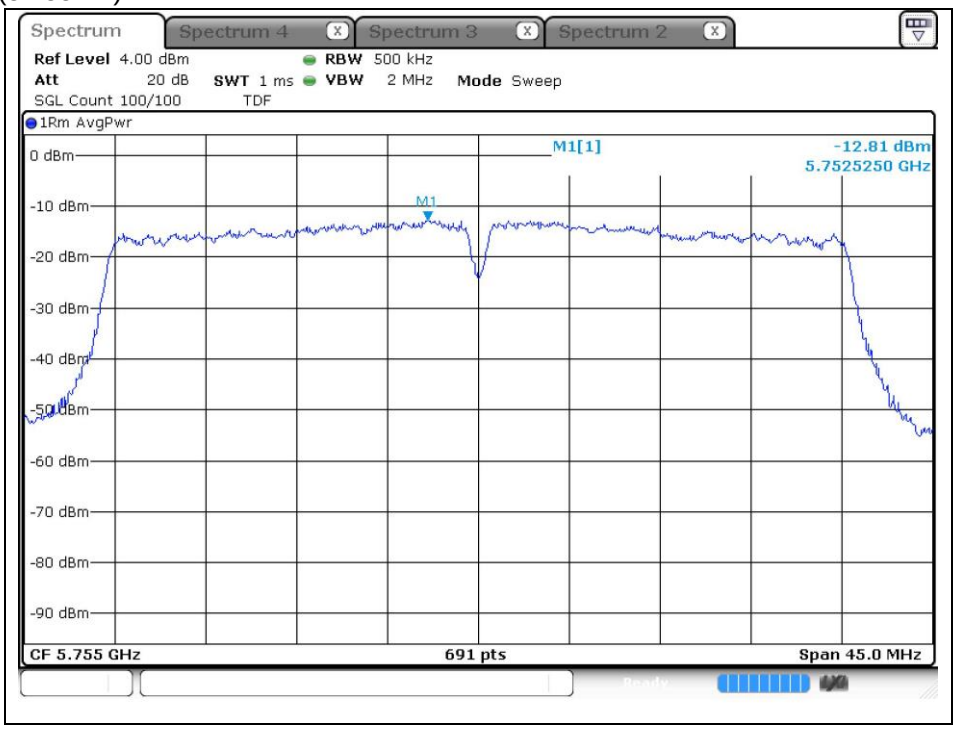


High Channel (5 710 ㎒)

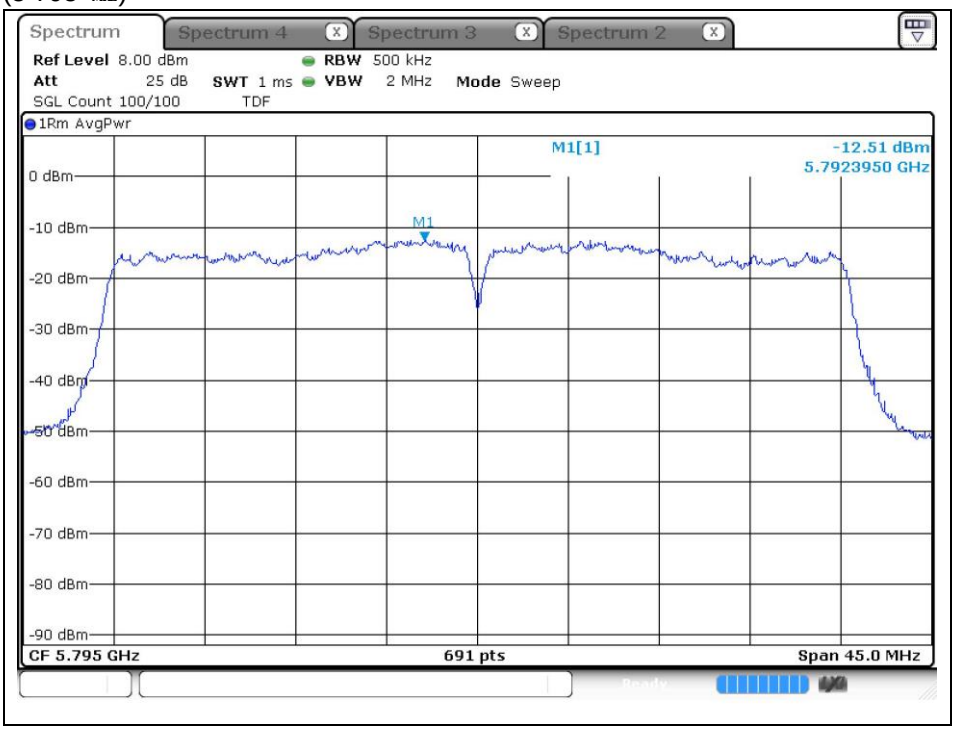


802.11n_HT40 (Band 3)

Low Channel (5 755 ㎒)

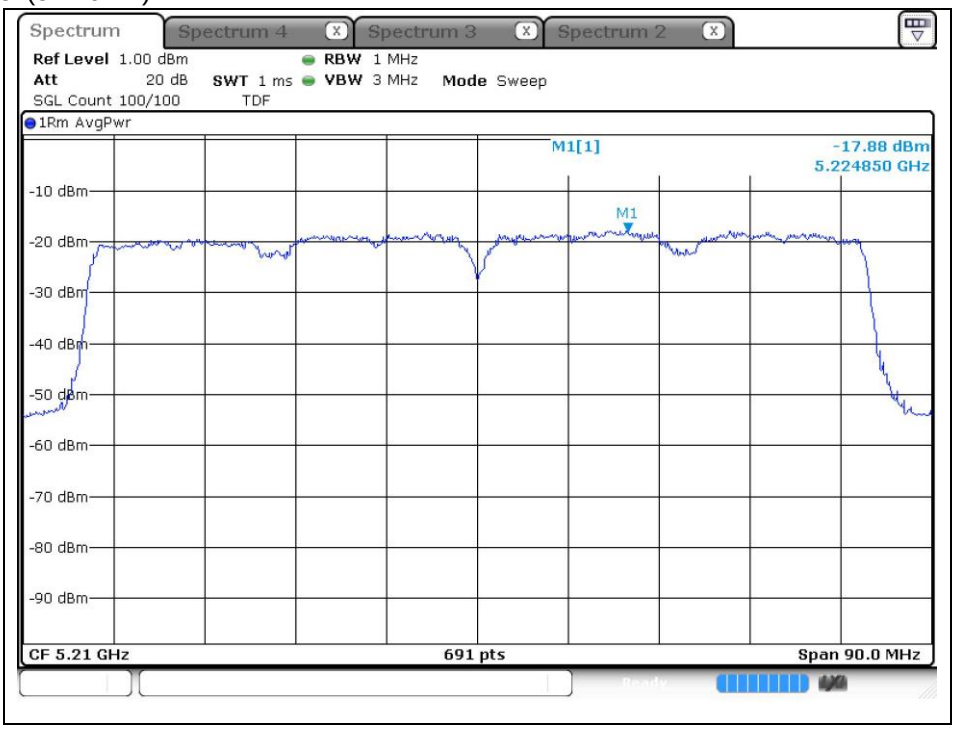


High Channel (5 795 ㎒)



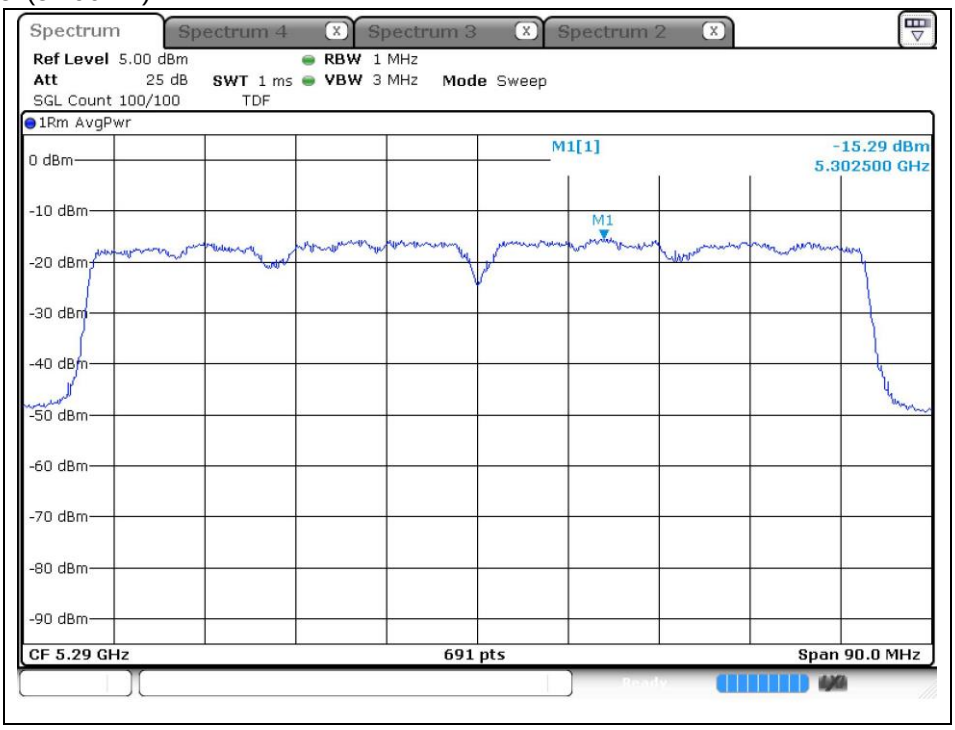
802.11ac_VHT80 (Band 1)

Middle Channel (5 210 ㎒)



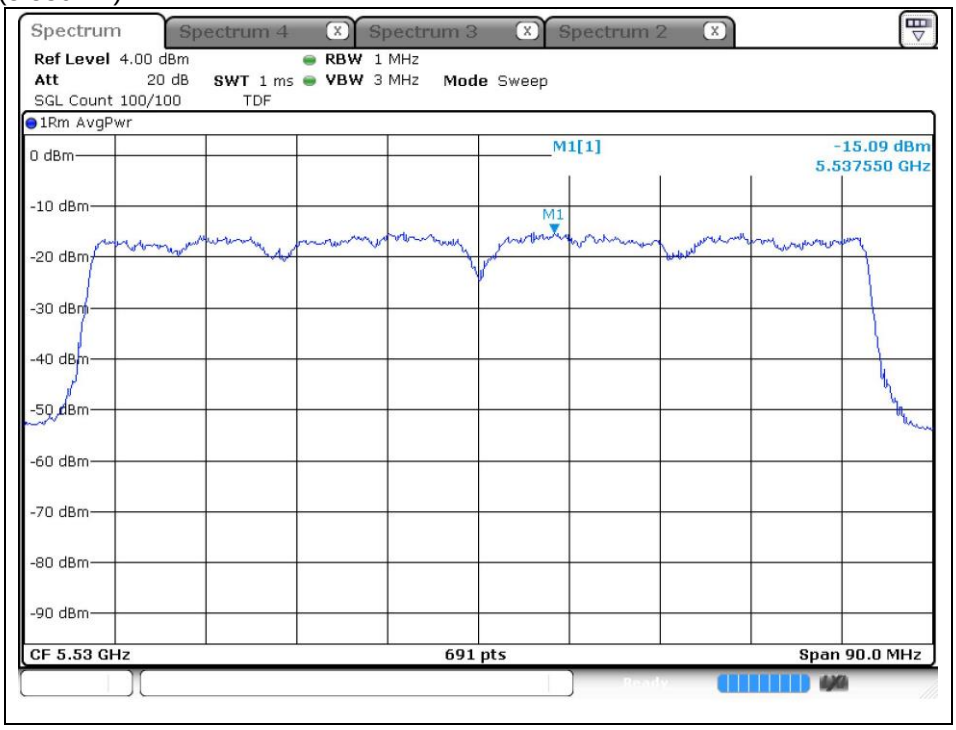
802.11ac_VHT80 (Band 2A)

Middle Channel (5 290 ㎒)



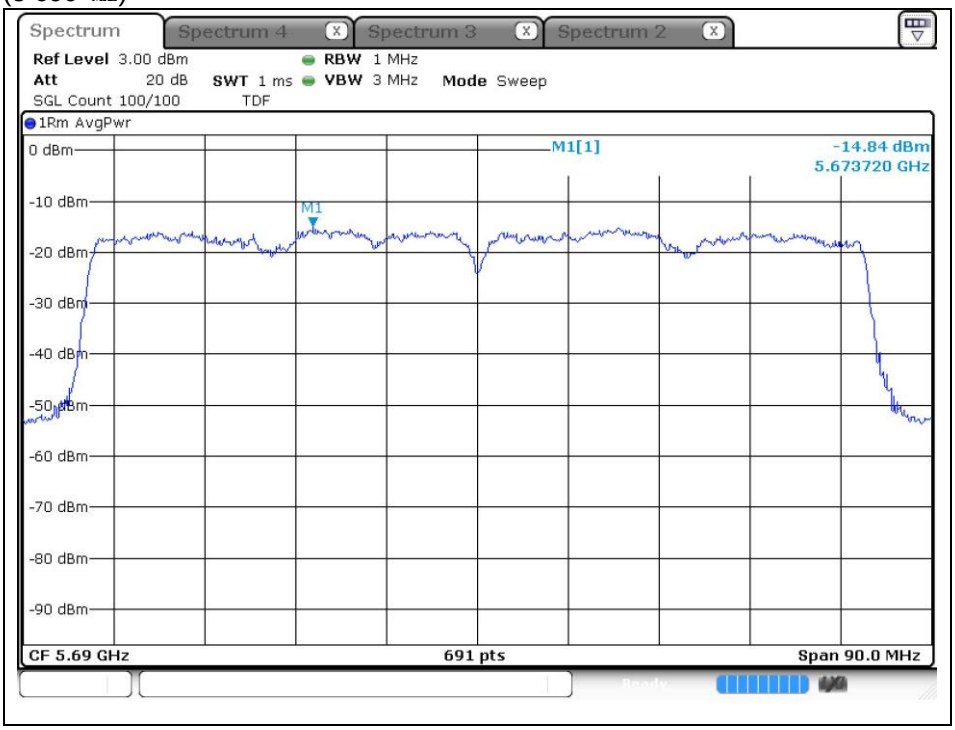
802.11ac_VHT80 (Band 2C)

Low Channel (5 530 ㎒)



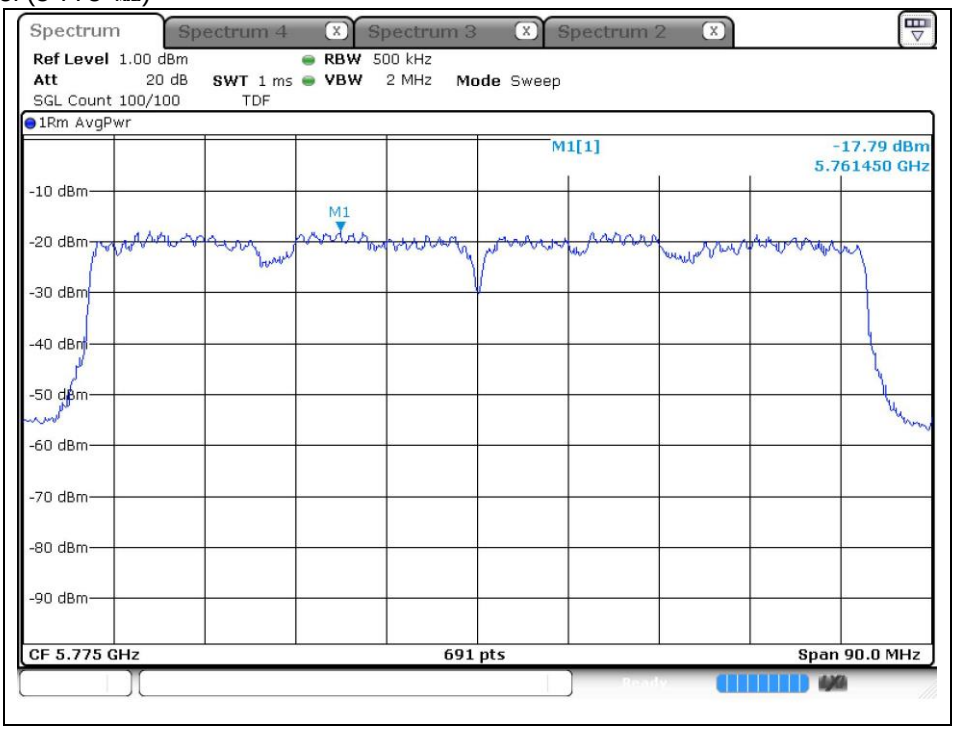
802.11ac_VHT80 (Band 2C)

High Channel (5 690 ㎒)



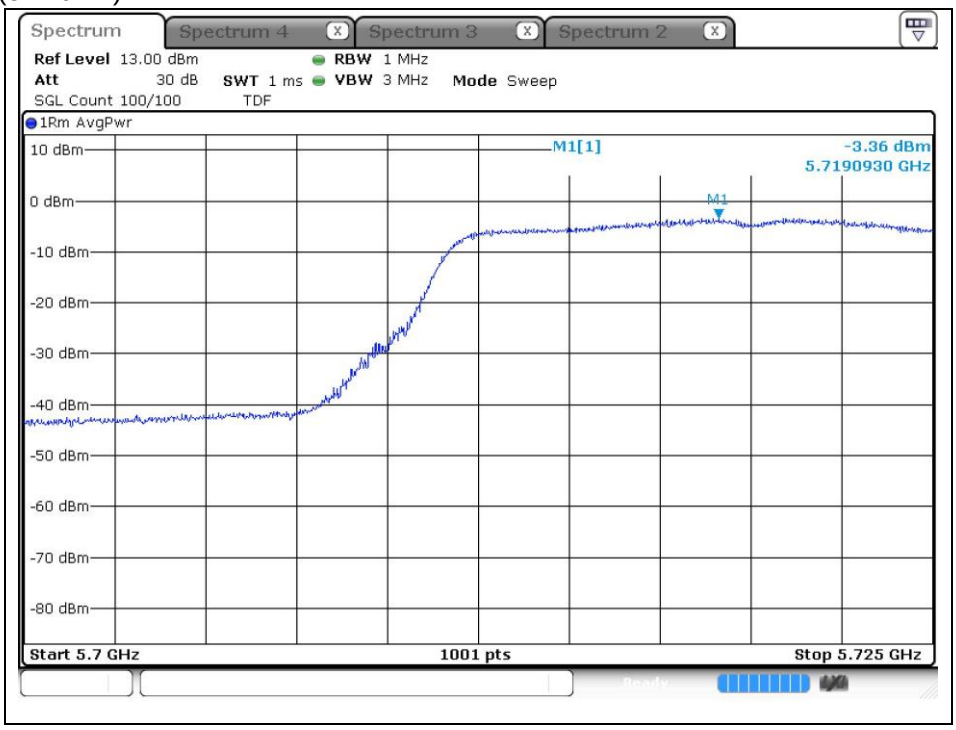
802.11ac_VHT80 (Band 3)

Middle Channel (5 775 ㎒)

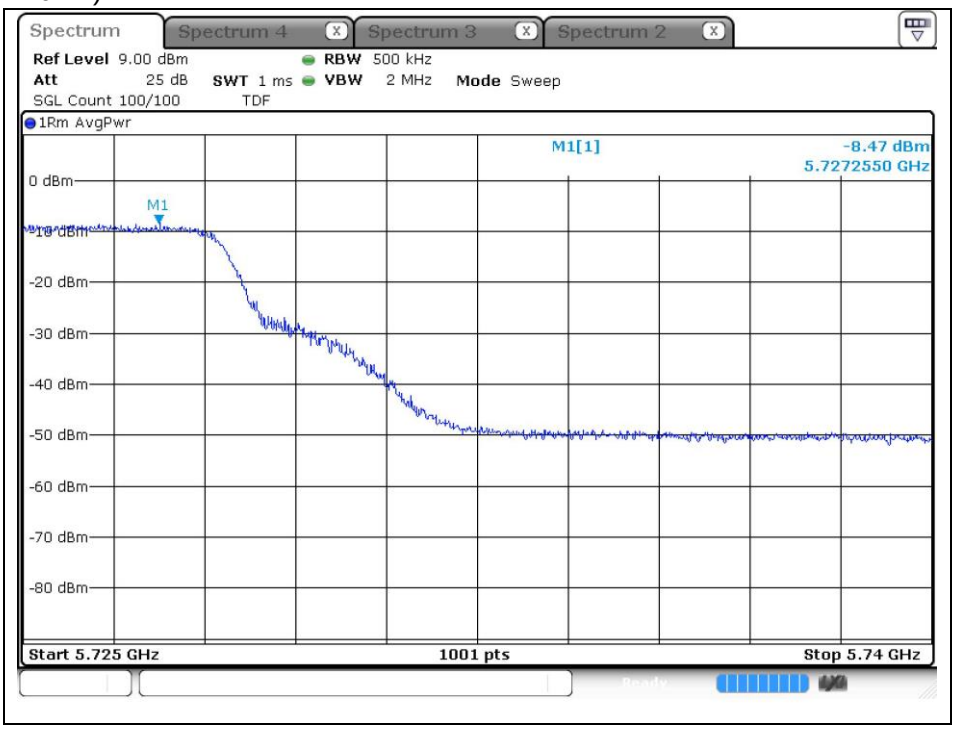


Band-crossing channels

U-NII 2C 11a (5 720 ㎒)

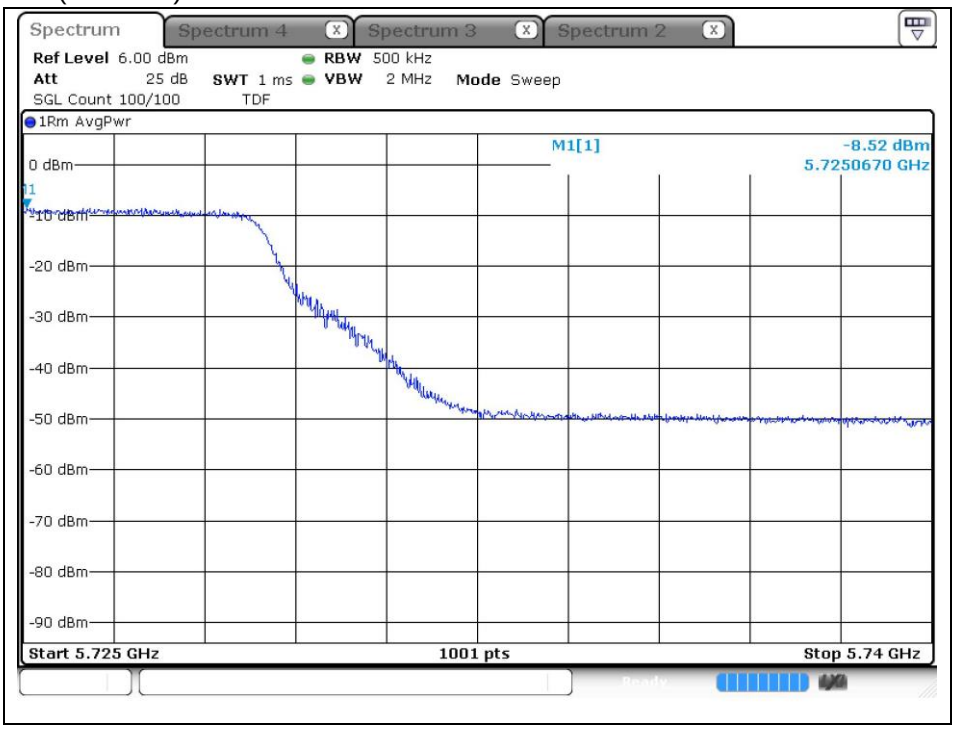


U-NII 3 11a (5 720 ㎒)

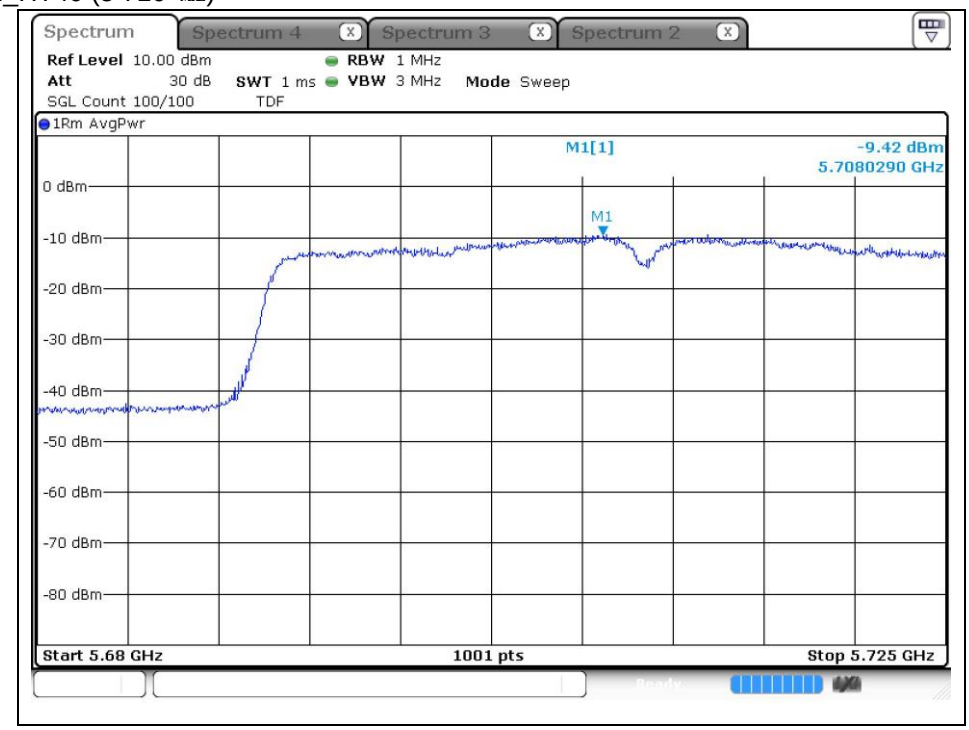


U-NII 2C 11n_HT20 (5 720 ㎒)

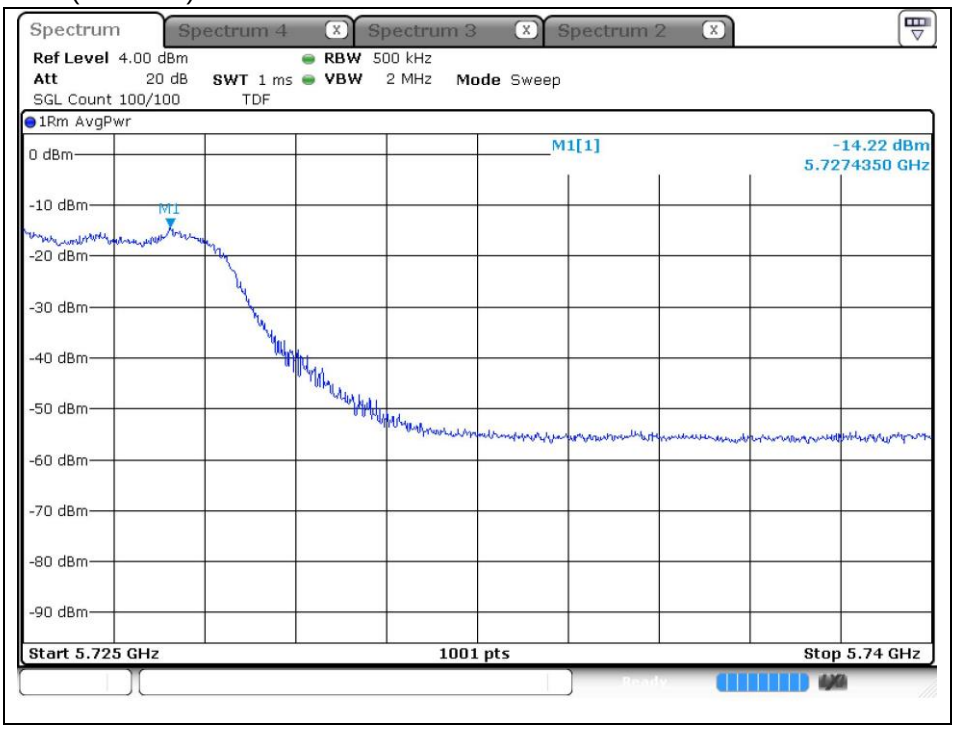
U-NII 3 11n_HT20 (5 720 ㎒)



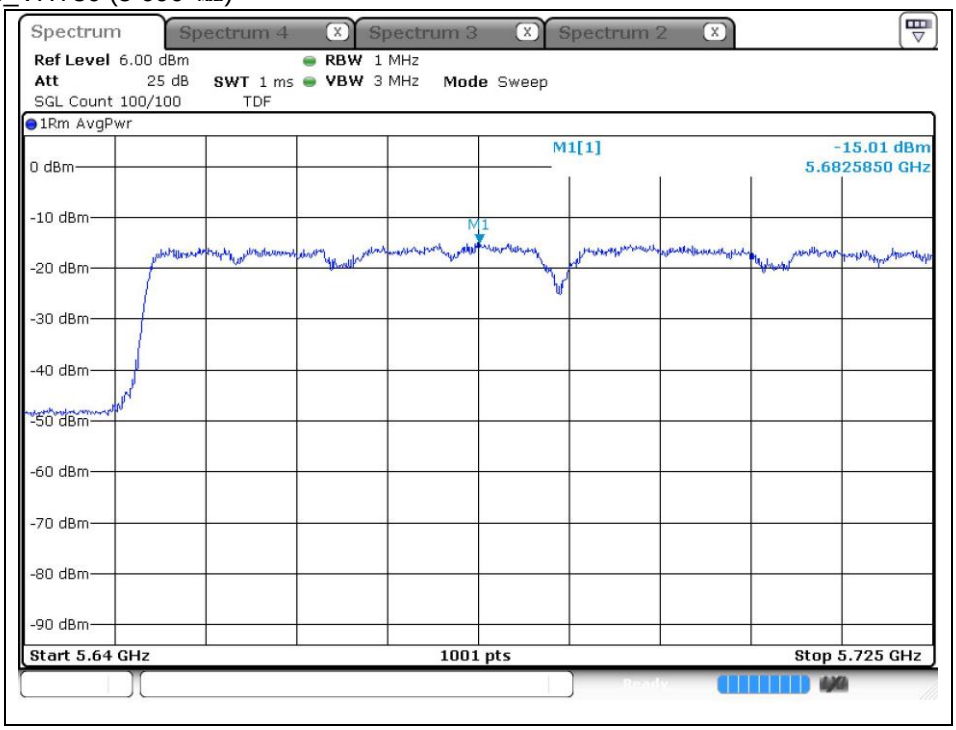
U-NII 2C 11n_HT40 (5 710 ㎒)



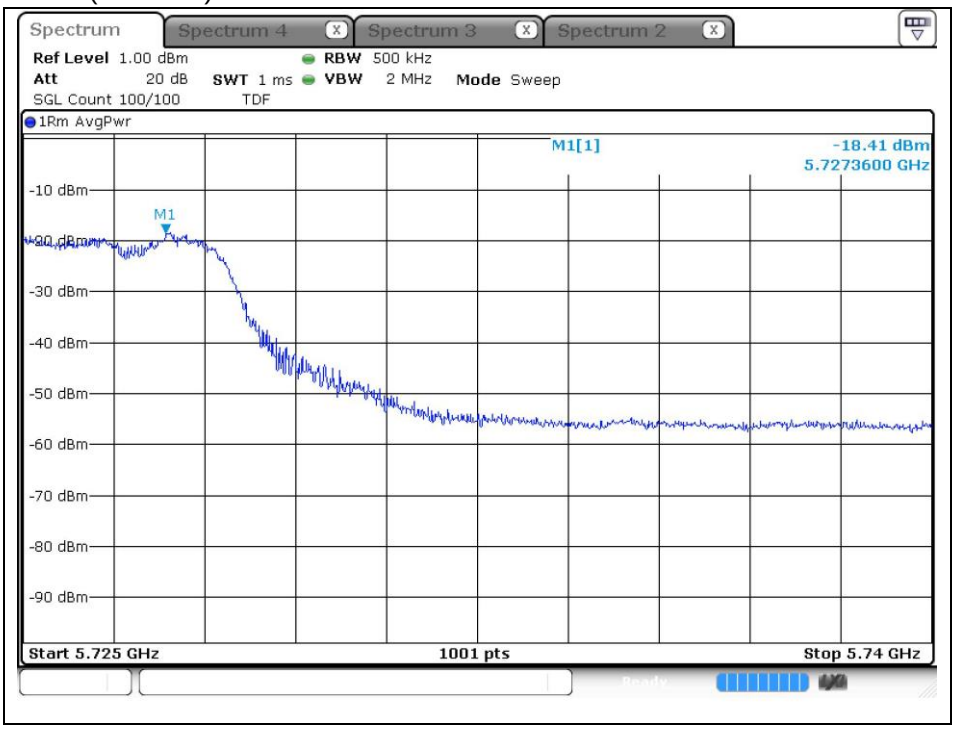
U-NII 3 11n_HT40 (5 710 ㎒)



U-NII 2C 11ac_VHT80 (5 690 ㎒)



U-NII 3 11ac_VHT80 (5 690 ㎒)



7. Antenna Requirement

7.1. 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 §15.407(a) if transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the gain of the antenna exceeds 6 dBi.

7.2. Antenna Connected Construction

Antenna used in this product is Pattern antenna and peak max gain of antenna as below.

Band	5 150 ㎒ ~ 5 250 ㎒	5 250 ㎒ ~ 5 350 ㎒	5 470 ㎒ ~ 5 725 ㎒	5 725 ㎒ ~ 5 850 ㎒
Mode	11a/n_HT20, HT40, 11ac_VHT20, VHT40, VHT80			
Gain	-0.61 dBi	-0.18 dBi	-0.77 dBi	-0.18 dBi

- End of the Test Report -