

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

According to 15.407(a)(2)

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

According to 15.407(a)(3)

For the band 5.725-5.85 GHz, 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 dB m in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dB i are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dB i. However, fixed point-to point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dB 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 MHz

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

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

6.2.2.1 Frequency band 5 250-5 350 MHz

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

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

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

b) The maximum e.i.r.p. shall not exceed 1.0 W or $17 + 10 \log_{10} B$, dB 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 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

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

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

The maximum e.i.r.p. shall not exceed 1.0 W or $17 + 10 \log_{10} B$, dB 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 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

6.2.4.1 Frequency band 5 725-5 850 MHz

For equipment operating in the band 5 725-5 850 MHz, the minimum 6 dB bandwidth shall be at least 500 kHz. The maximum conducted output power shall not exceed 1 W. The output power spectral density shall not exceed 30 dB m in any 500 kHz band. If transmitting antennas of directional gain greater than 6 dB i are used, both the maximum conducted output power and the output power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dB i. However, fixed point-to-point devices operating in this band may employ transmitting antennas with directional gain greater than 6 dB i without any corresponding reduction in transmitter conducted power. Fixed point-to-point operations exclude the use of point-to-multipoint³ 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 II.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 dB to the final result to compensate for the difference between linear averaging and power averaging.
5. The result is the Maximum PSD over 1 MHz reference bandwidth.
6. For devices operating in the bands 5.15-5.25 GHz, 5.25-5.35 GHz, and 5.47-5.725 GHz, the above procedures make use of 1 MHz RBW to satisfy directly the 1 MHz reference bandwidth specified in § 15.407(a)(5). For devices operating in the band 5.725-5.85 GHz, the rules specify a measurement bandwidth of 500 kHz. Many spectrum analyzers do not have 500 kHz RBW, thus a narrower RBW may need to be used. The rules permit the use of a RBWs less than 1 MHz, or 500 kHz, "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 MHz, or 500 kHz). If measurements are performed using a reduced resolution bandwidth ($< 1 \text{ MHz}$, or $< 500 \text{ kHz}$) and integrated over 1 MHz, or 500 kHz bandwidth, the following adjustments to the procedures apply:
 - a) Set $\text{RBW} \geq 1/T$, where T is defined in section II.B.1.a).
 - b) Set $\text{VBW} \geq 3 \text{ RBW}$.
 - c) If measurement bandwidth of Maximum PSD is specified in 500 kHz, add $10 \log(500 \text{ kHz}/\text{RBW})$ to the measured result, whereas $\text{RBW} (< 500 \text{ kHz})$ is the reduced resolution bandwidth of the spectrum analyzer set during measurement.
 - d) If measurement bandwidth of Maximum PSD is specified in 1 MHz, add $10 \log(1 \text{ MHz}/\text{RBW})$ to the measured result, whereas $\text{RBW} (< 1 \text{ MHz})$ 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) °C
Relative humidity : 47 % R.H.

Test mode: 11a

Band	Frequency (MHz)	Ch.	Data Rate (Mbps)	Measured PPSP (dB m)	Duty Cycle Correction Factor (dB)	Final PPSP (dB m)	Limit (dB m/1 MHz)
U-NII 1	5 180	36	6	-4.19	0.29	-3.90	11
	5 220	44		-4.69		-4.40	
	5 240	48		-3.98		-3.69	
U-NII 2A	5 260	52		-4.28		-3.99	
	5 300	60		-3.92		-3.63	
	5 320	64		-4.11		-3.82	
U-NII 2C	5 500	100		-4.23		-3.94	
	5 580	116		-3.57		-3.28	
	5 720	144		-3.15		-2.86	
Band	Frequency (MHz)	Ch.	Data Rate (Mbps)	Measured PPSP (dB m)	Duty Cycle Correction Factor (dB)	Final PPSP (dB m)	Limit (dB m/500 kHz)
U-NII 3	5 745	149	6	-5.28	0.29	-4.99	30
	5 785	157		-5.62		-5.33	
	5 825	165		-5.38		-5.09	
Band	Frequency (MHz)	Ch.	Data Rate (Mbps)	Final PPSP (dB m)	Antenna Gain (dB i)	E.I.R.P. PPSP (dB m)	IC Limit (dB m/1 MHz)
U-NII 1	5 180	36	6	-3.90	2.75	-1.15	10
	5 220	44		-4.40		-1.65	
	5 240	48		-3.69		-0.94	

Remark;

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

Test mode: 11n_HT20

Band	Frequency (MHz)	Ch.	Data Rate (Mbps)	Measured PPSD (dB m)	Duty Cycle Correction Factor (dB)	Final PPSD (dB m)	Limit (dB m/1 MHz)
U-NII 1	5 180	36	MCS2	-5.57	0.83	-4.74	11
	5 220	44		-5.14		-4.31	
	5 240	48		-5.03		-4.20	
U-NII 2A	5 260	52		-5.36		-4.53	
	5 300	60		-5.01		-4.18	
	5 320	64		-4.88		-4.05	
U-NII 2C	5 500	100		-4.64		-3.81	
	5 580	116		-4.53		-3.70	
	5 720	144		-4.10		-3.27	
Band	Frequency (MHz)	Ch.	Data Rate (Mbps)	Measured PPSD (dB m)	Duty Cycle Correction Factor (dB)	Final PPSD (dB m)	Limit (dB m/500 kHz)
U-NII 3	5 745	149	MCS2	-6.67	0.83	-5.84	30
	5 785	157		-6.54		-5.71	
	5 825	165		-6.21		-5.38	

Band	Frequency (MHz)	Ch.	Data Rate (Mbps)	Final PPSD (dB m)	Antenna Gain (dB i)	E.I.R.P. PPSD (dB m)	IC Limit (dB m/1 MHz)
U-NII 1	5 180	36	MCS2	-4.74	2.75	-1.99	10
	5 220	44		-4.31		-1.56	
	5 240	48		-4.20		-1.45	

Remark;

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

Test mode: 11n_HT40

Band	Frequency (MHz)	Ch.	Data Rate (Mbps)	Measured PPSD (dB m)	Duty Cycle Correction Factor (dB)	Final PPSD (dB m)	Limit (dB m/1 MHz)
U-NII 1	5 190	38	MCS0	-11.98	0.61	-11.37	11
	5 230	46		-12.23		-11.62	
U-NII 2A	5 270	54		-7.66		-7.05	
	5 310	62		-7.73		-7.12	
U-NII 2C	5 510	102		-7.43		-6.82	
	5 550	110		-7.57		-6.96	
	5 710	142		-6.56		-5.95	
Band	Frequency (MHz)	Ch.	Data Rate (Mbps)	Measured PPSD (dB m)	Duty Cycle Correction Factor (dB)	Final PPSD (dB m)	Limit (dB m/500 kHz)
U-NII 3	5 755	151	MCS0	-9.33	0.61	-8.72	30
	5 795	159		-9.20		-8.59	

Band	Frequency (MHz)	Ch.	Data Rate (Mbps)	Final PPSD (dB m)	Antenna Gain (dB i)	E.I.R.P. PPSD (dB m)	IC Limit (dB m/1 MHz)
U-NII 1	5 190	38	MCS0	-11.37	2.75	-8.62	10
	5 230	46		-11.62		-8.87	

Remark;

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

Test mode: 11ac_VHT80

Band	Frequency (MHz)	Ch.	Data Rate (Mbps)	Measured PPSD (dB m)	Duty Cycle Correction Factor (dB)	Final PPSD (dB m)	Limit (dB m/1 MHz)
U-NII 1	5 210	42	MCS0	-15.91	1.17	-14.74	11
U-NII 2A	5 290	58		-12.16		-10.99	
U-NII 2C	5 530	106		-10.71		-9.54	
	5 690	138		-10.14		-8.97	
Band	Frequency (MHz)	Ch.	Data Rate (Mbps)	Measured PPSD (dB m)	Duty Cycle Correction Factor (dB)	Final PPSD (dB m)	Limit (dB m/500 kHz)
U-NII 3	5 775	155	MCS0	-12.83	1.17	-11.66	30

Band	Frequency (MHz)	Ch.	Data Rate (Mbps)	Final PPSD (dB m)	Antenna Gain (dB i)	E.I.R.P. PPSD (dB m)	IC Limit (dB m/1 MHz)
U-NII 1	5 210	42	MCS0	-14.74	2.75	-11.99	10

Remark;

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

Band-crossing channels

Mode	Band	Frequency (MHz)	Ch.	Data Rate (Mbps)	Measured PPSD (dB m)	Duty Cycle Correction Factor (dB)	Final PPSD (dB m)	Limit (dB m/1 MHz or dB m/500 kHz)
11a	U-NII 2C	5 720	144	6	-2.90	0.29	-2.61	11
	U-NII 3				-7.99		-7.70	30
11n_HT20	U-NII 2C	5 720	144	MCS2	-3.64	0.83	-2.81	11
	U-NII 3				-8.67		-7.84	30
11n_HT40	U-NII 2C	5 710	142	MCS0	-6.69	0.61	-6.08	11
	U-NII 3				-12.68		-12.07	30
11ac_VHT80	U-NII 2C	5 690	138	MCS0	-9.96	1.17	-8.79	11
	U-NII 3				-16.68		-15.51	30

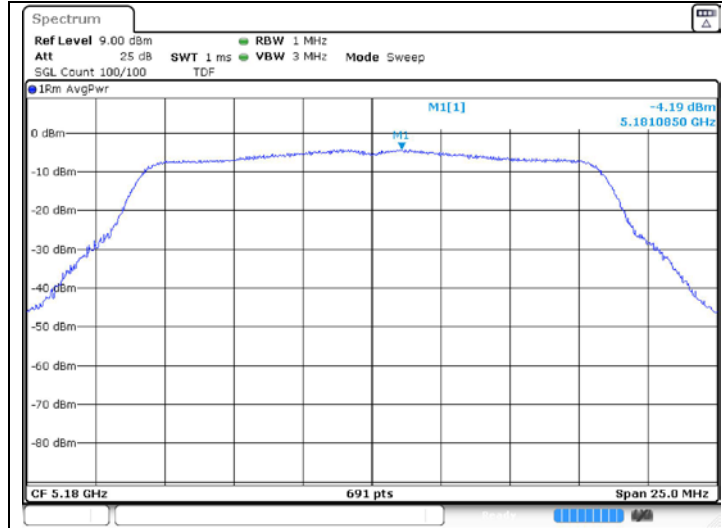
Remark;

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

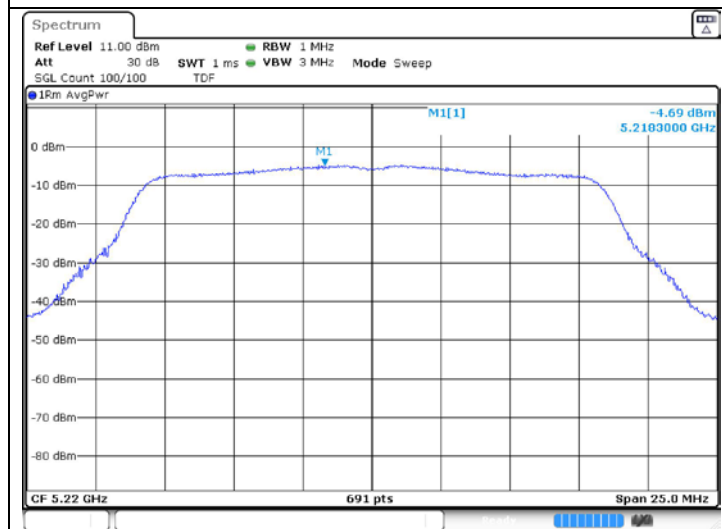
- Test plots

802.11a (Band 1)

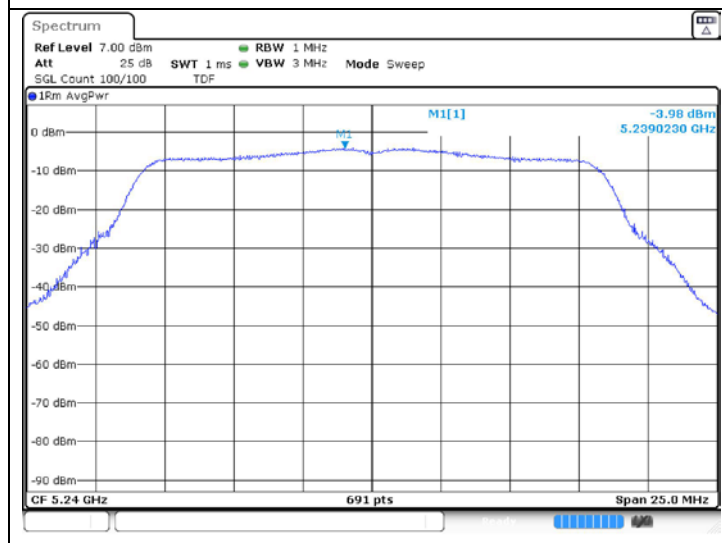
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Middle Channel
(5 220 MHz)

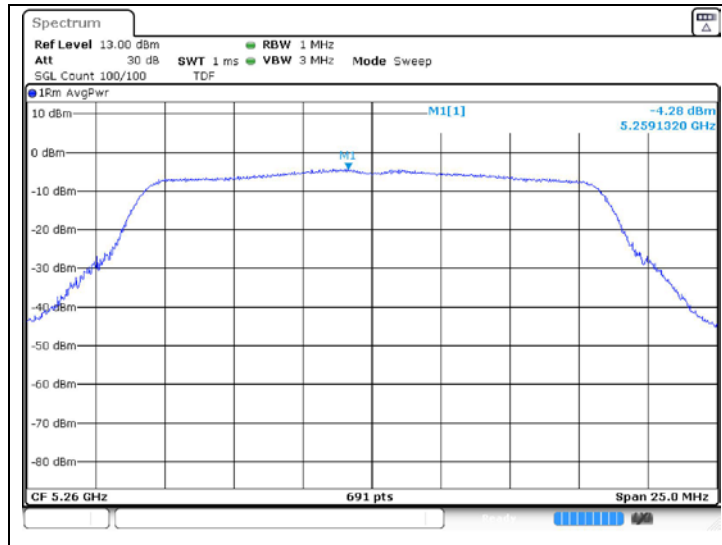


High Channel
(5 240 MHz)

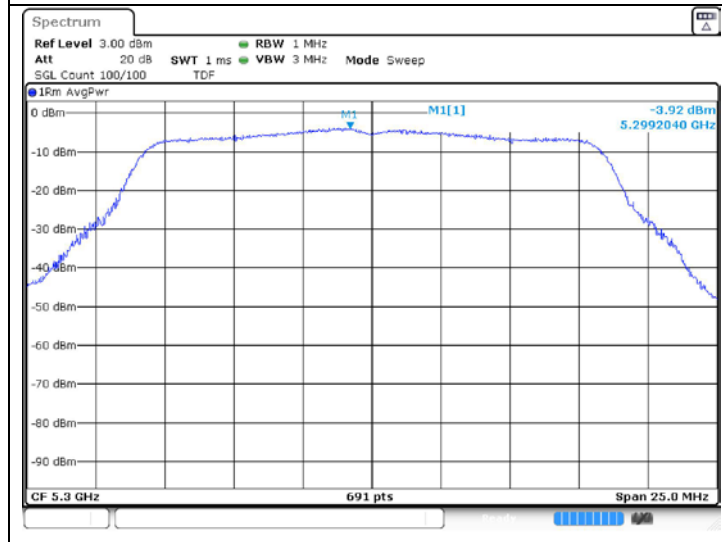


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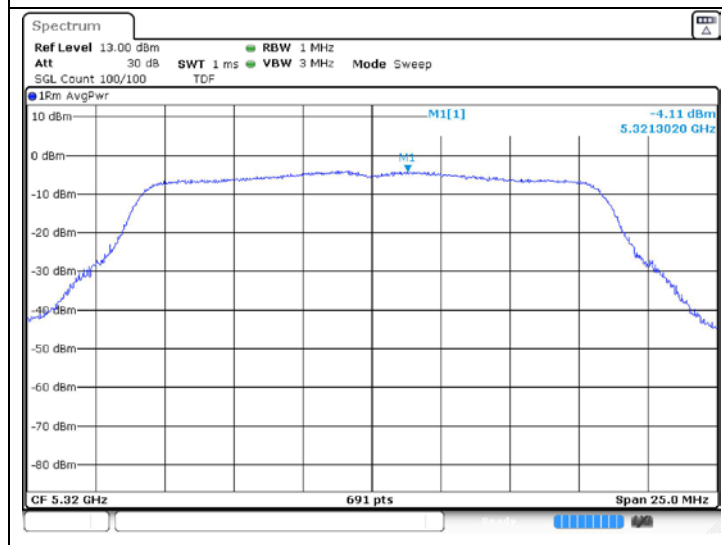
Low Channel
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Middle Channel
(5 300 MHz)

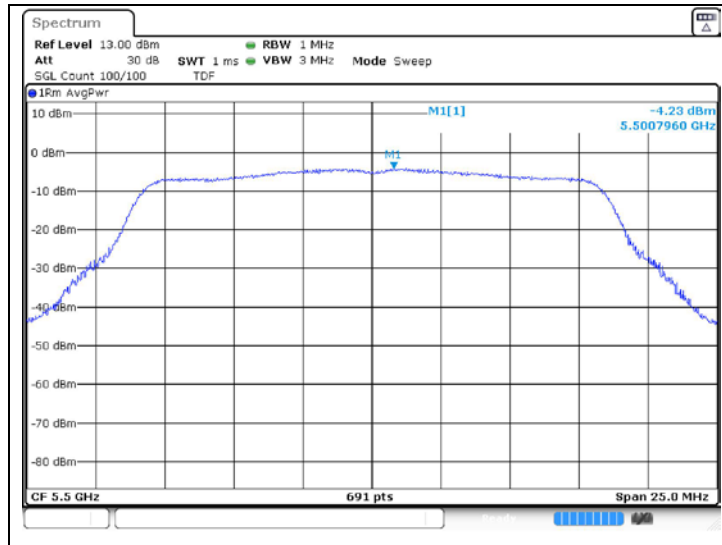


High Channel
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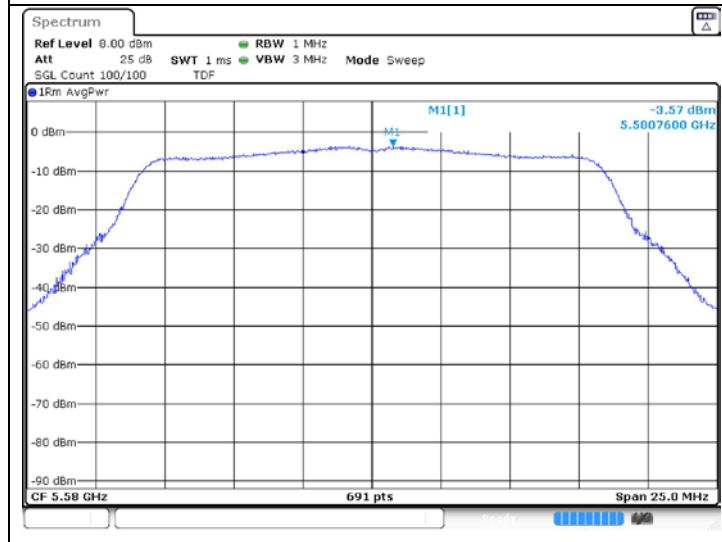


802.11a (Band 2C)

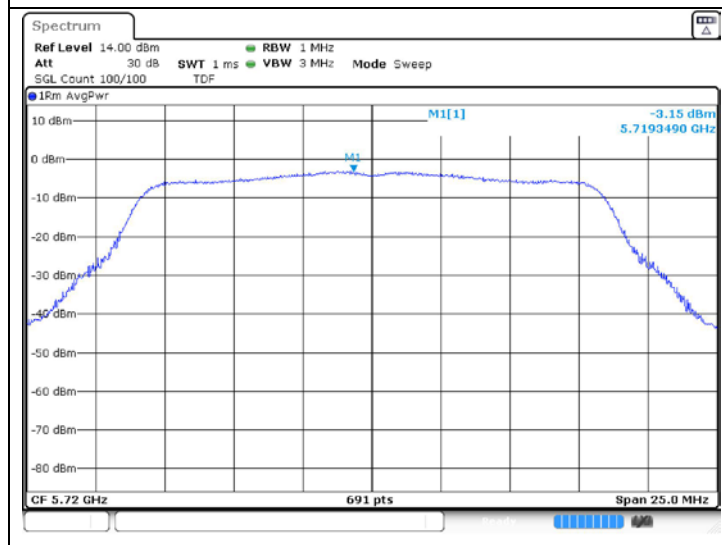
Low Channel
(5 500 MHz)



Middle Channel
(5 580 MHz)

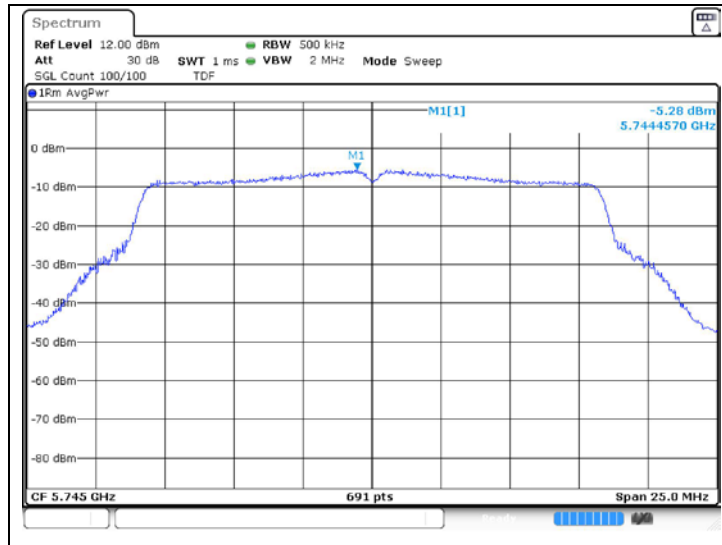


High Channel
(5 720 MHz)

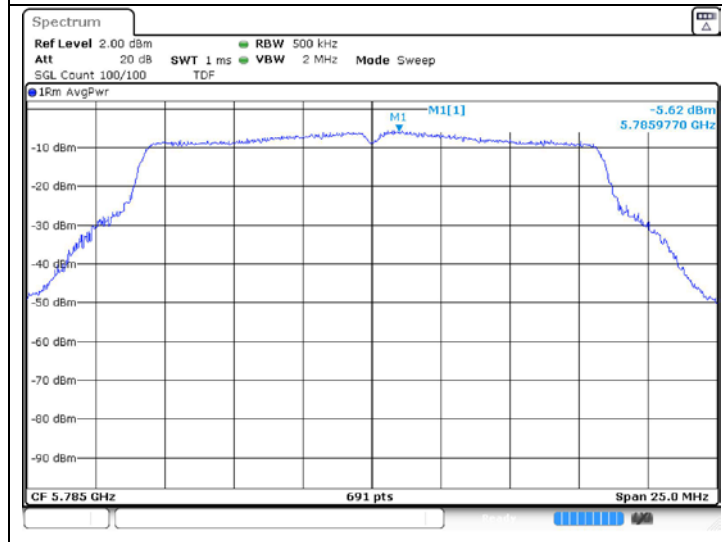


802.11a (Band 3)

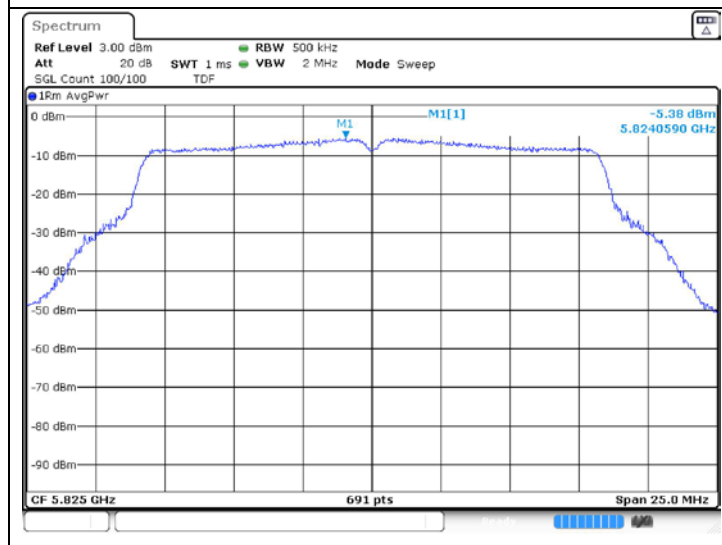
Low Channel
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Middle Channel
(5 785 MHz)

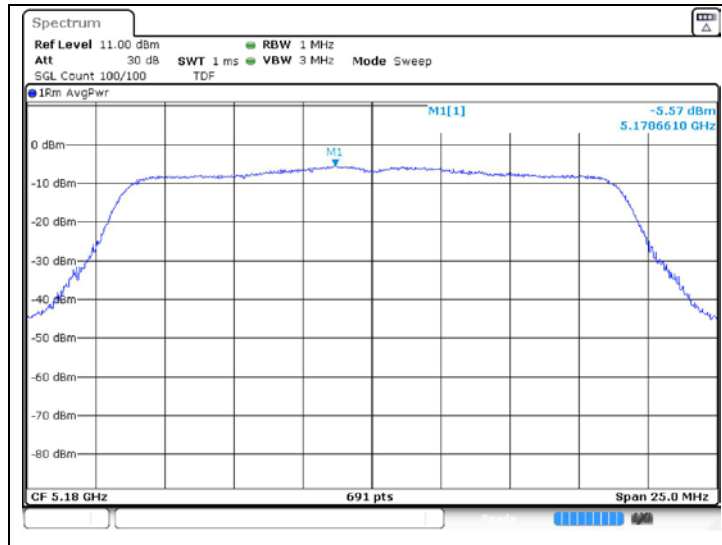


High Channel
(5 825 MHz)

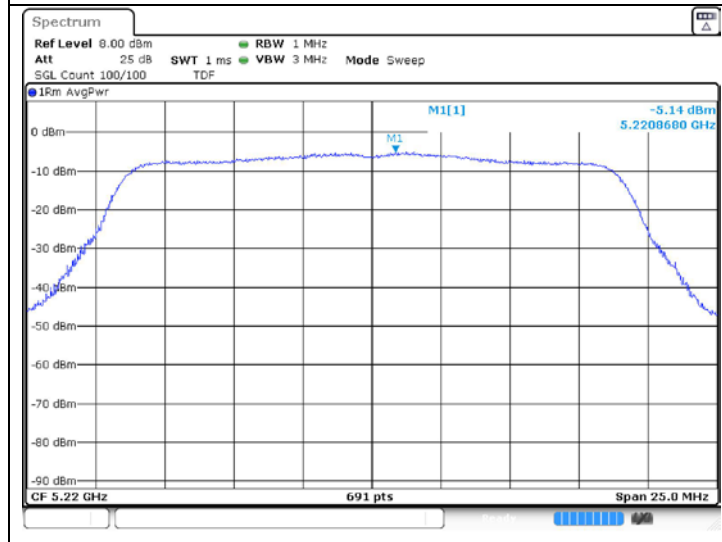


802.11n_HT20 (Band 1)

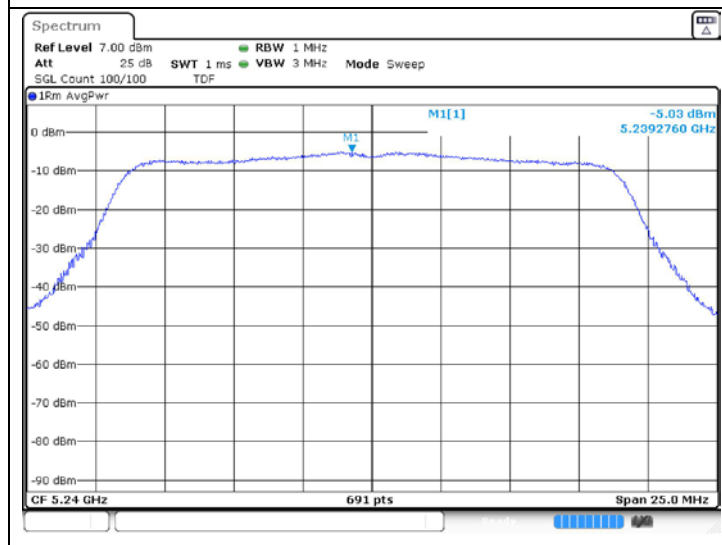
Low Channel
(5 180 MHz)



Middle Channel
(5 220 MHz)

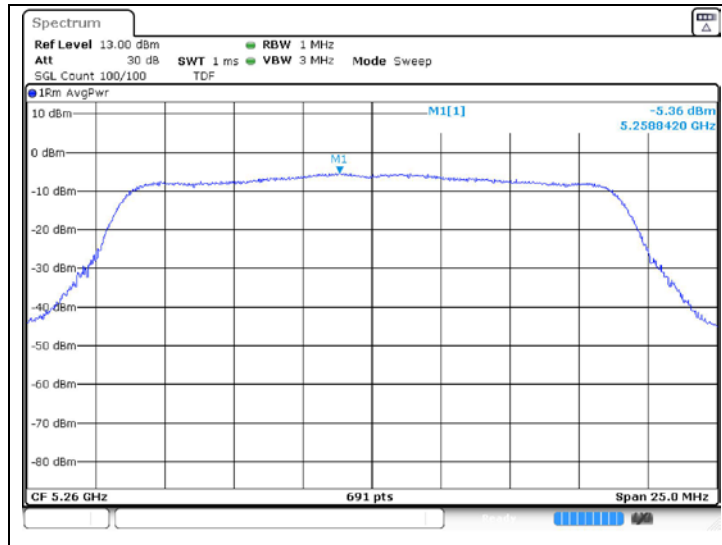


High Channel
(5 240 MHz)

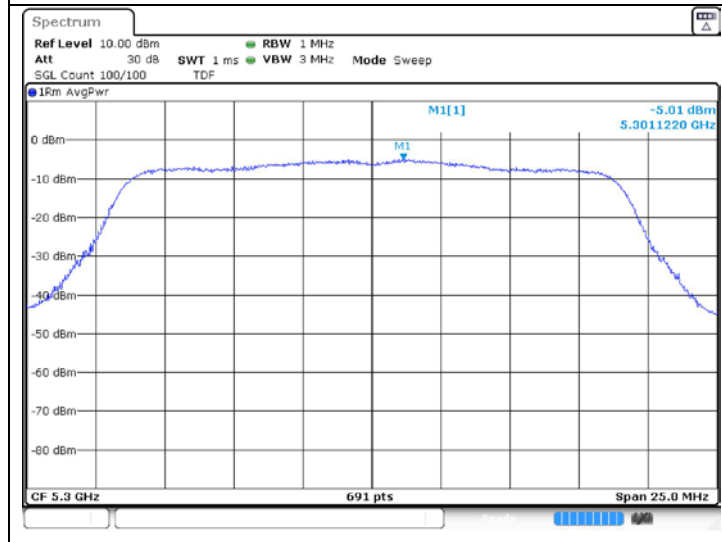


802.11n_HT20 (Band 2A)

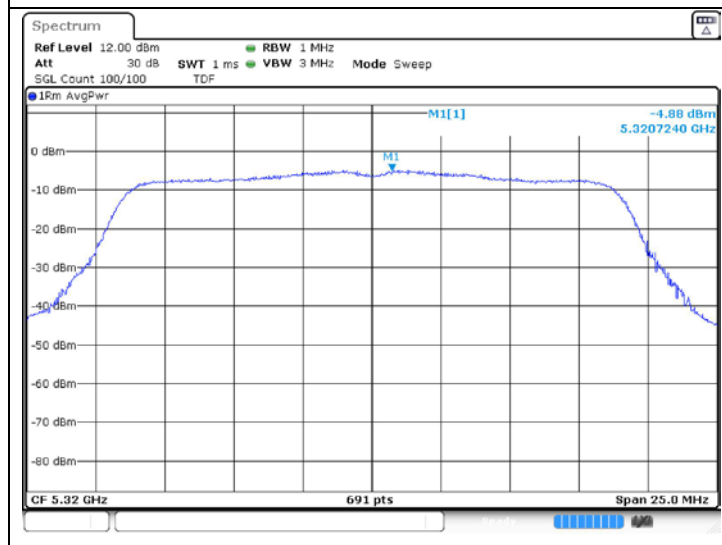
Low Channel
(5 260 MHz)



Middle Channel
(5 300 MHz)

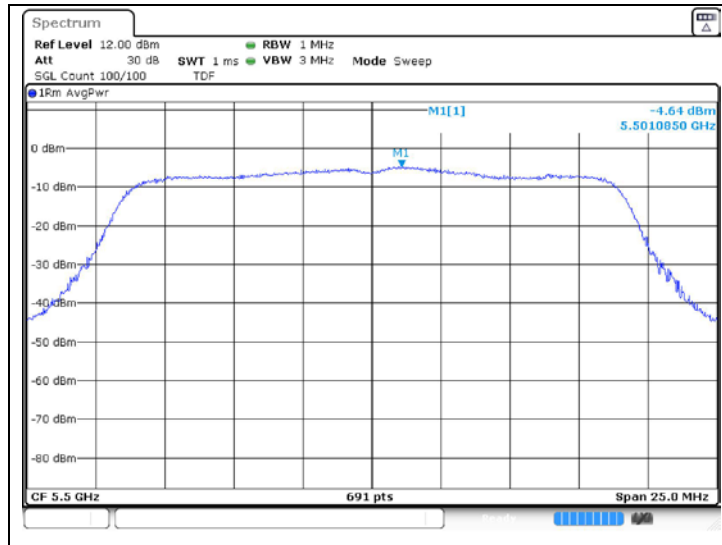


High Channel
(5 320 MHz)

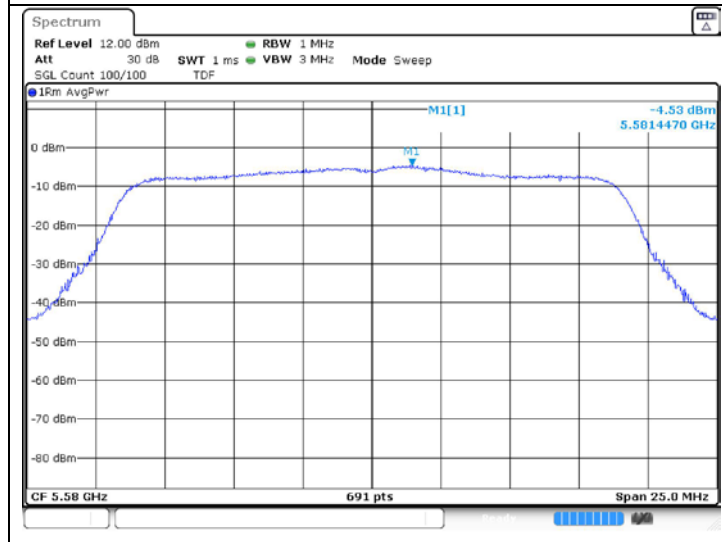


802.11n_HT20 (Band 2C)

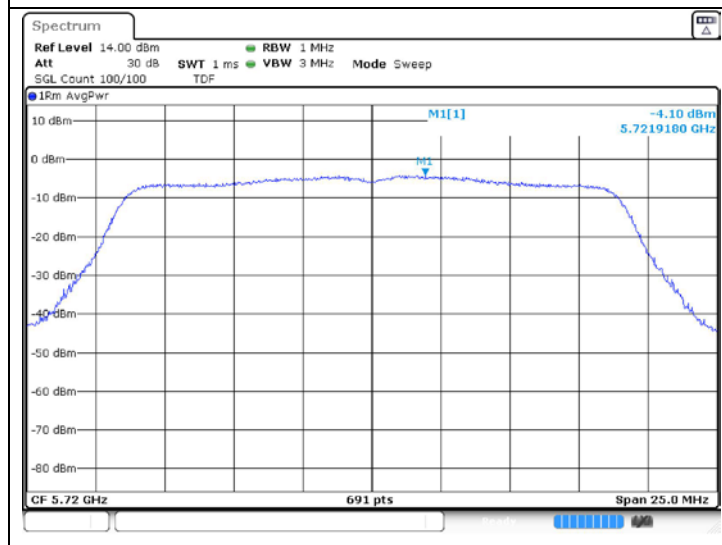
Low Channel
(5 500 MHz)



Middle Channel
(5 580 MHz)

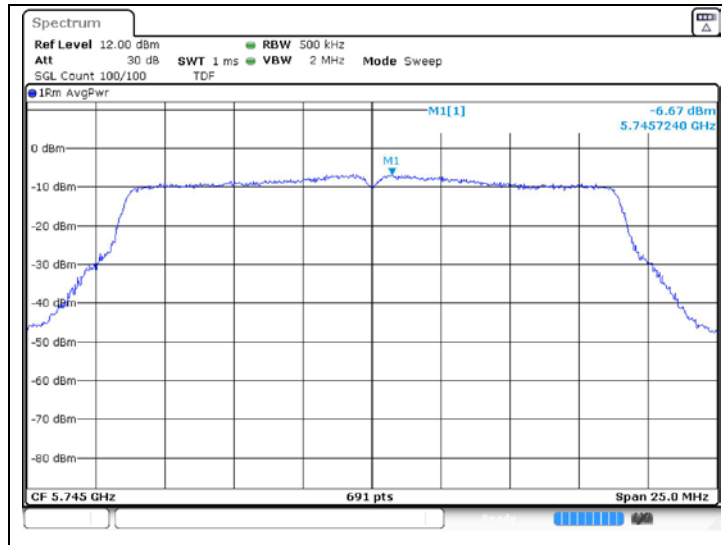


High Channel
(5 720 MHz)

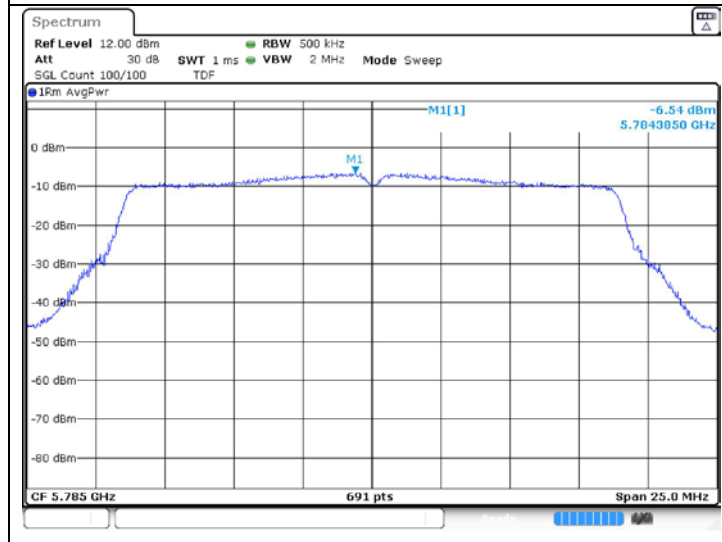


802.11n_HT20 (Band 3)

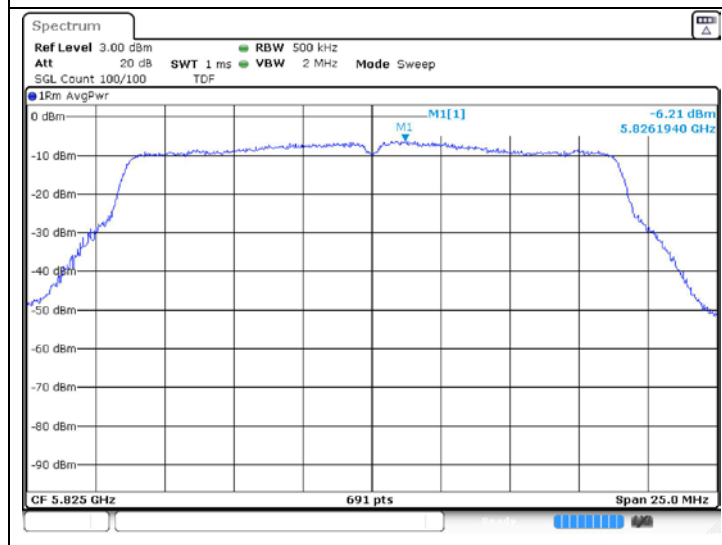
Low Channel
(5 745 MHz)



Middle Channel
(5 785 MHz)

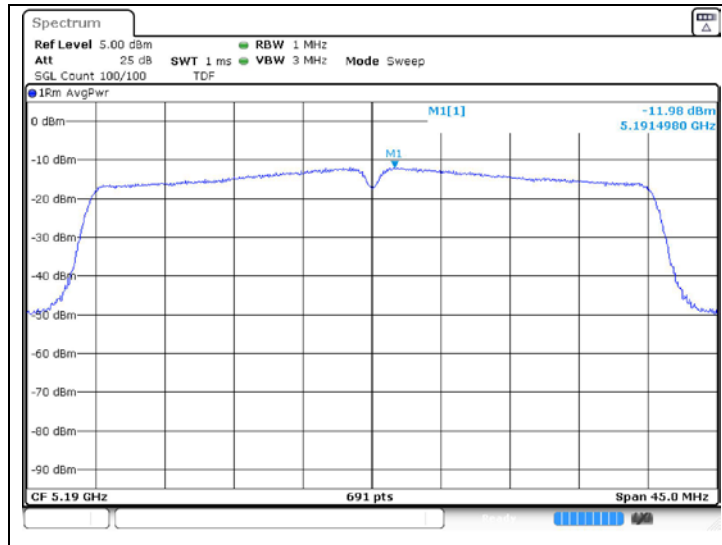


High Channel
(5 825 MHz)

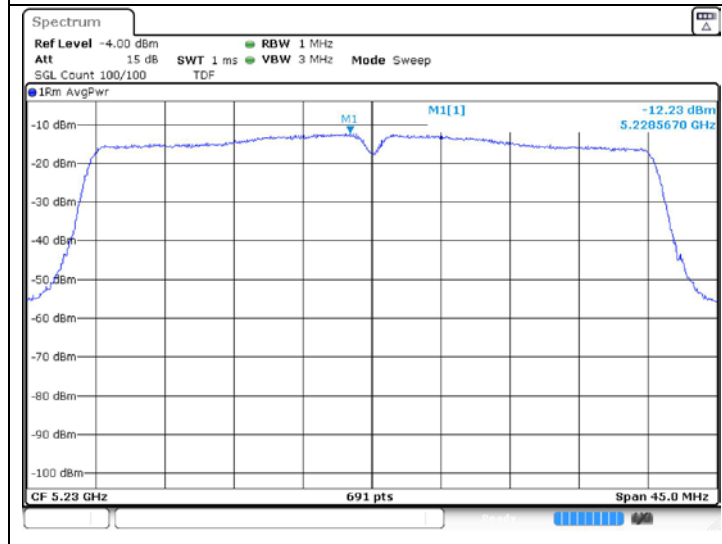


802.11n_HT40 (Band 1)

Low Channel
(5 190 MHz)

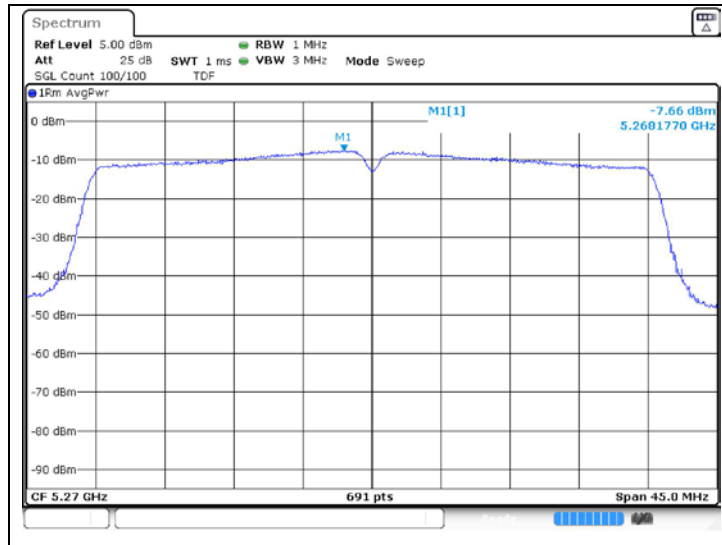


High Channel
(5 230 MHz)

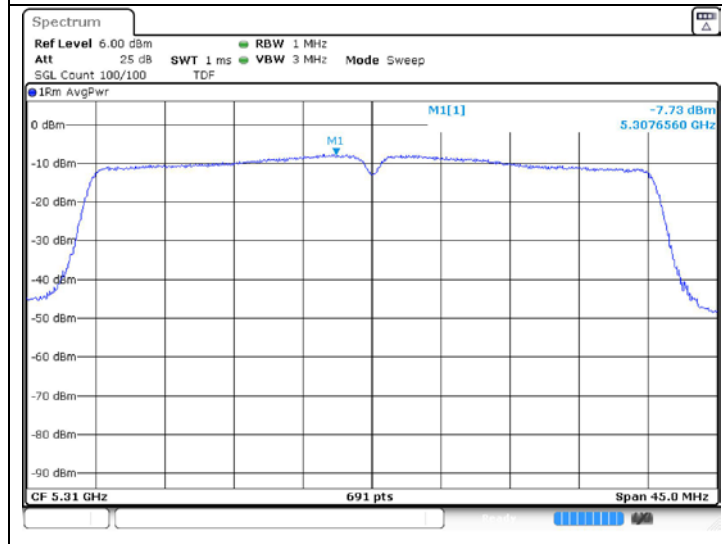


802.11n_HT40 (Band 2A)

Low Channel
(5 270 MHz)

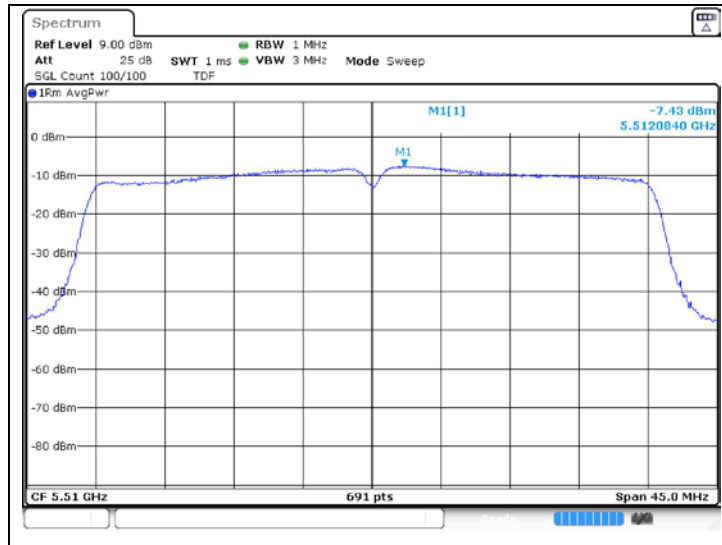


High Channel
(5 310 MHz)

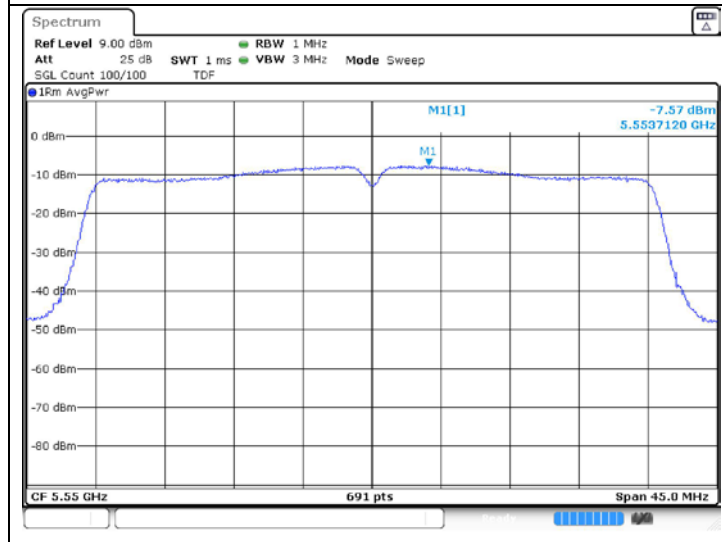


802.11n_HT40 (Band 2C)

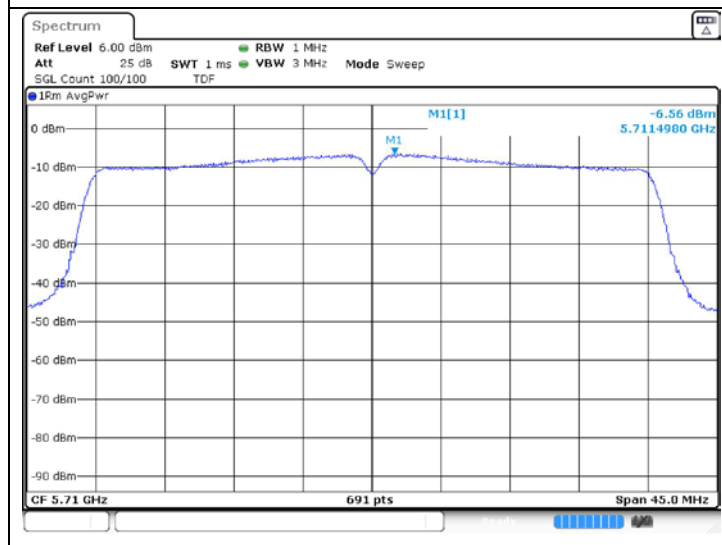
Low Channel
(5 510 MHz)



Middle Channel
(5 550 MHz)

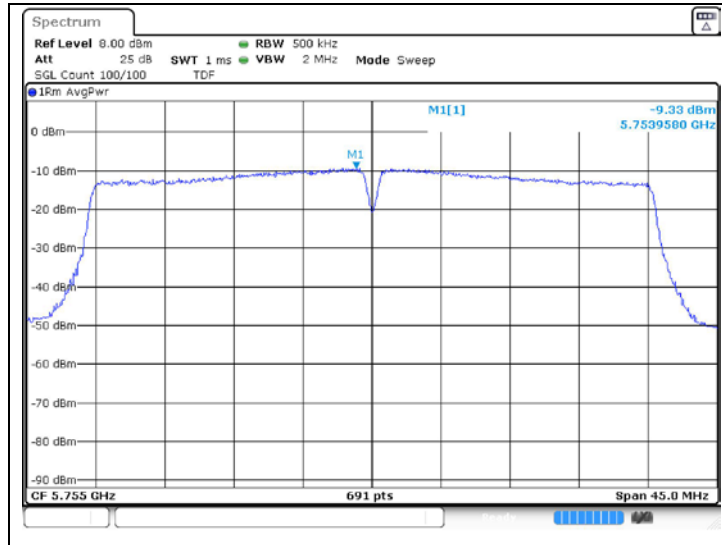


High Channel
(5 710 MHz)

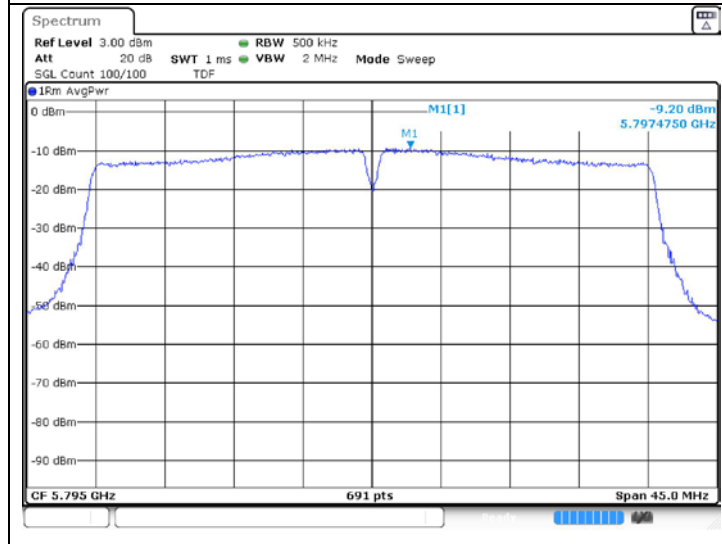


802.11n_HT40 (Band 3)

Low Channel
(5 755 MHz)

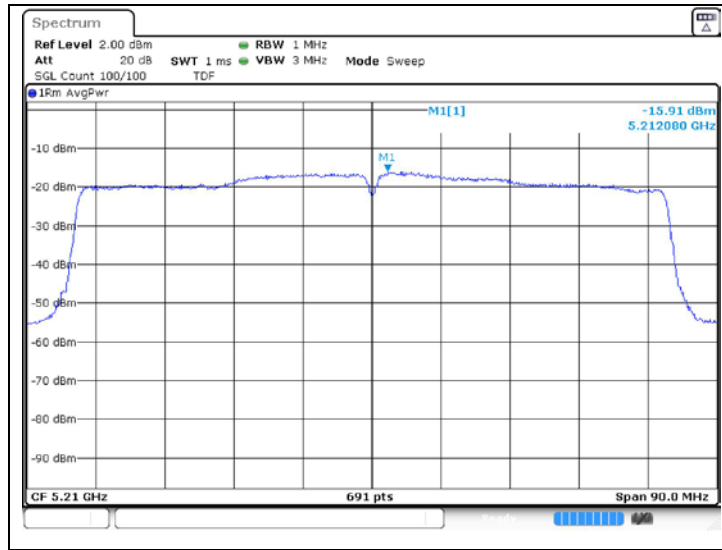


High Channel
(5 795 MHz)



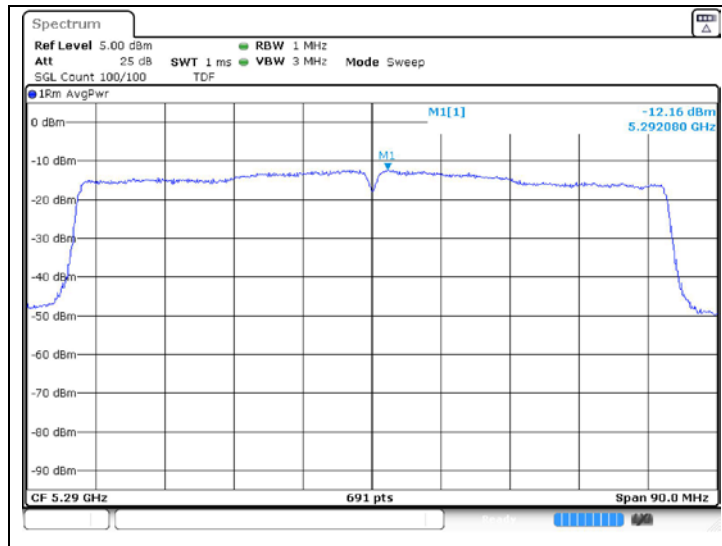
802.11ac_VHT80 (Band 1)

Middle Channel
(5 210 MHz)



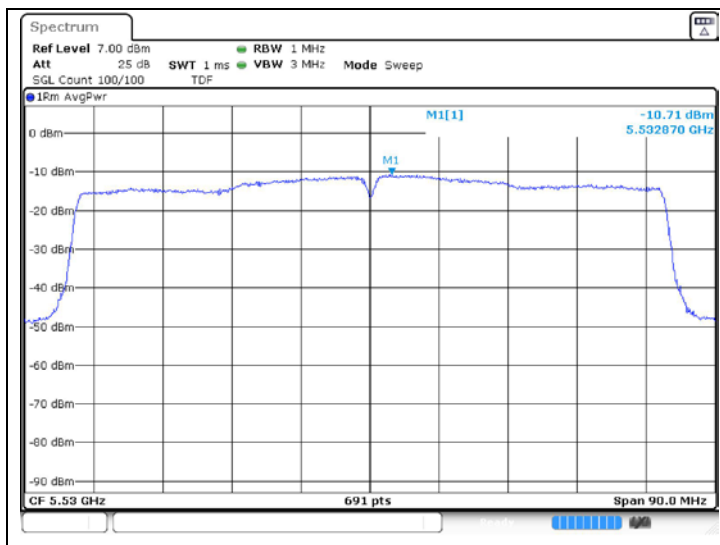
802.11ac_VHT80 (Band 2A)

Middle Channel
(5 290 MHz)

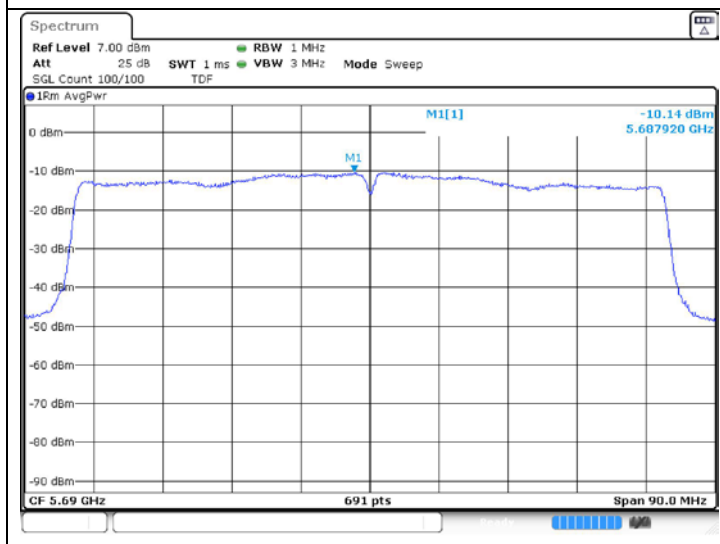


802.11ac_VHT80 (Band 2C)

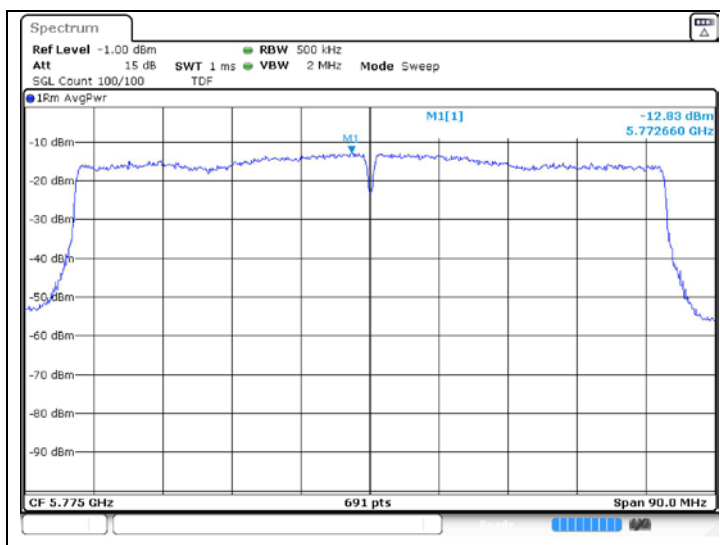
Low Channel
(5 530 MHz)



High Channel
(5 690 MHz)

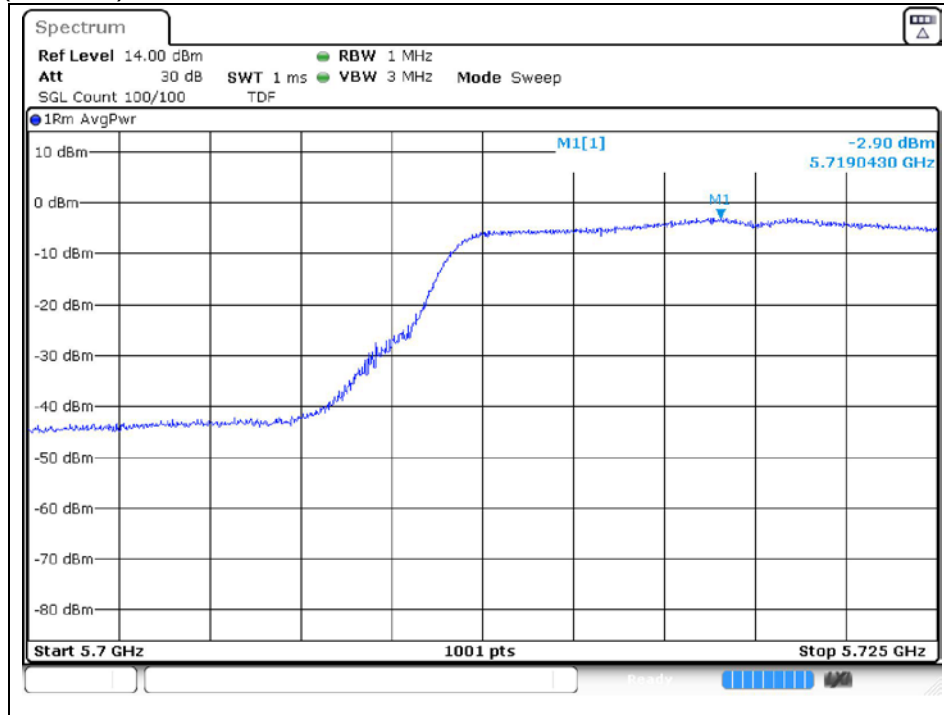

802.11ac_VHT80 (Band 3)

Middle Channel
(5 775 MHz)

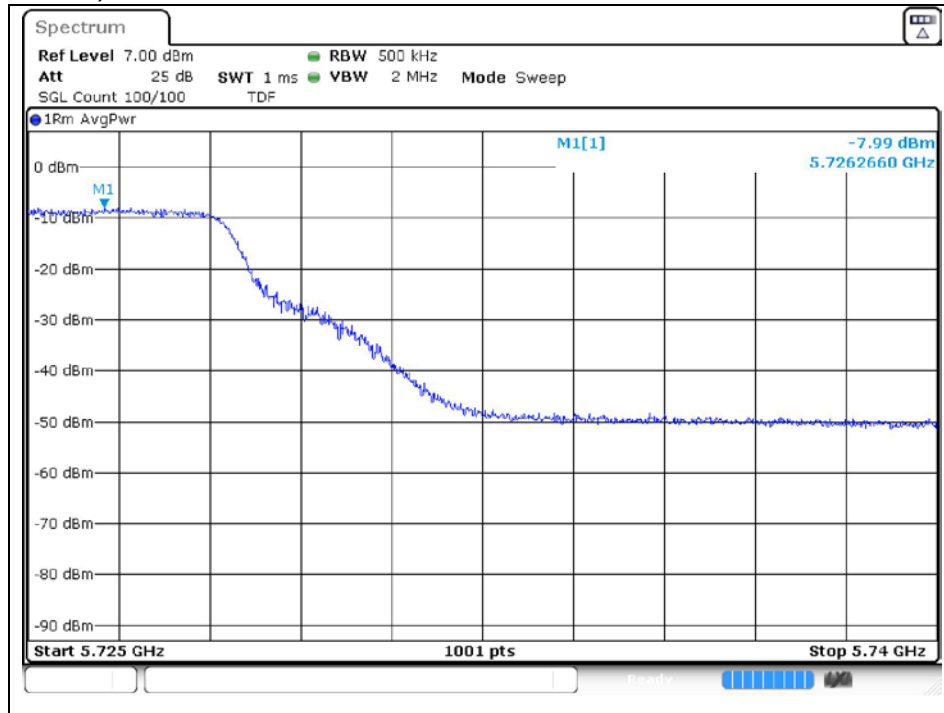


Band-crossing channels

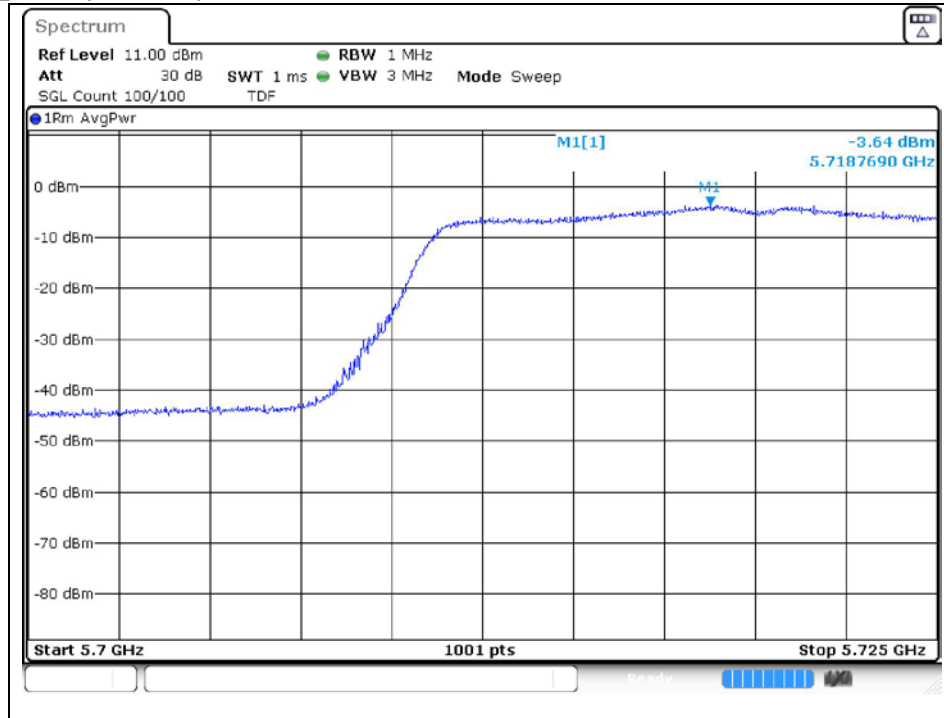
U-NII 2C 11a (5 720 MHz)



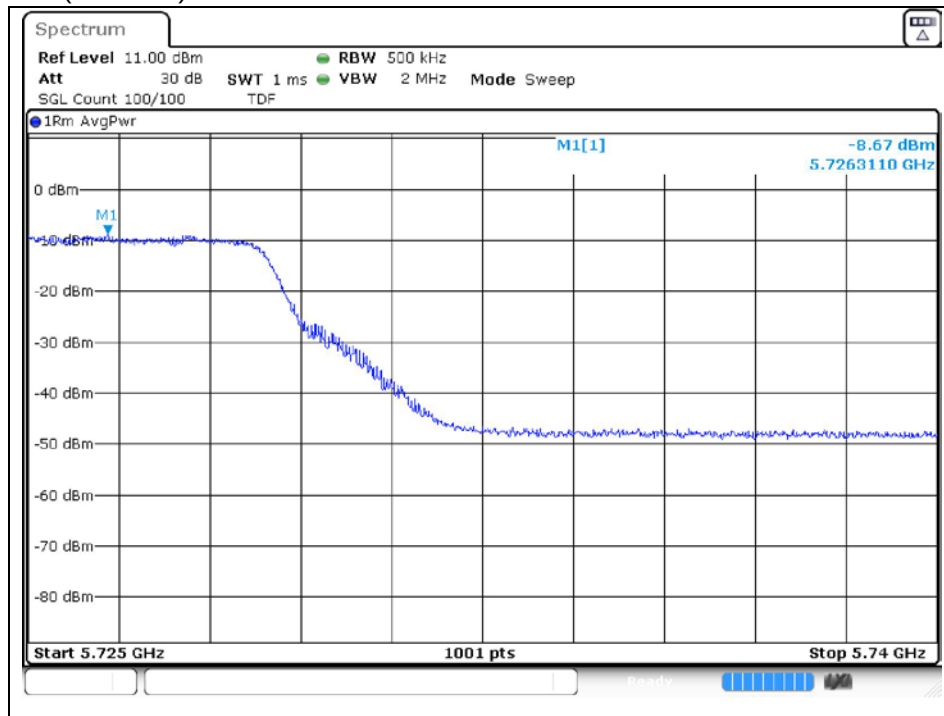
U-NII 3 11a (5 720 MHz)



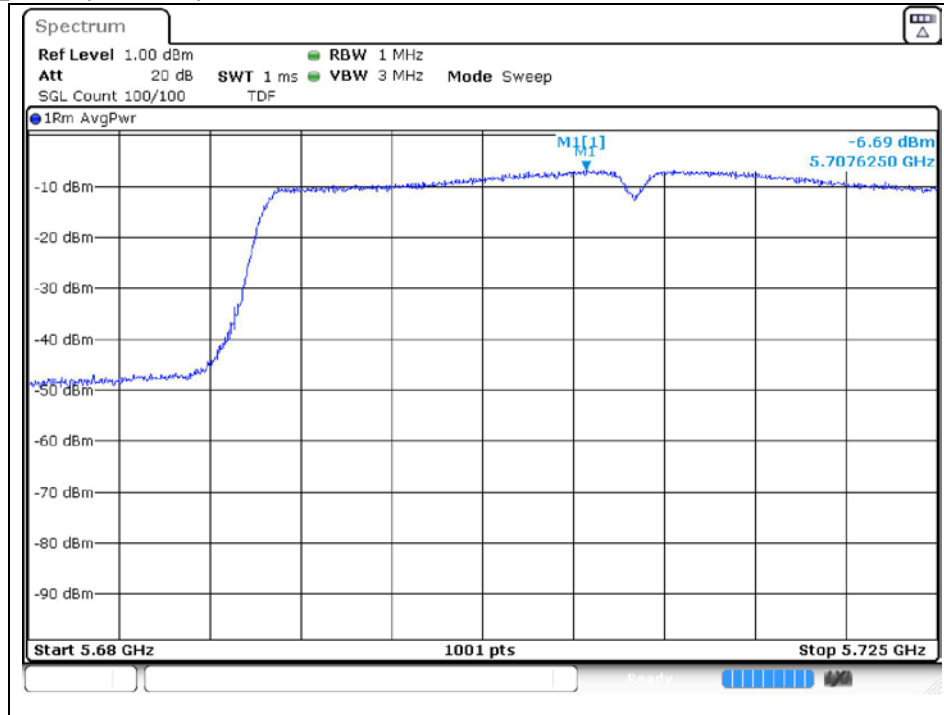
U-NII 2C 11n_HT20 (5 720 MHz)



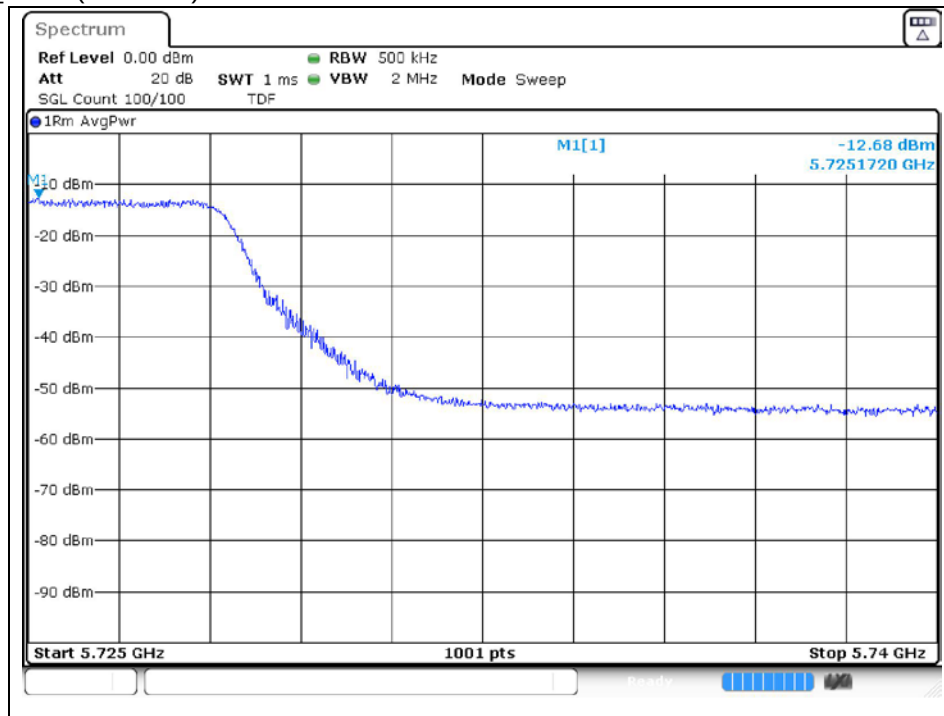
U-NII 3 11n_HT20 (5 720 MHz)



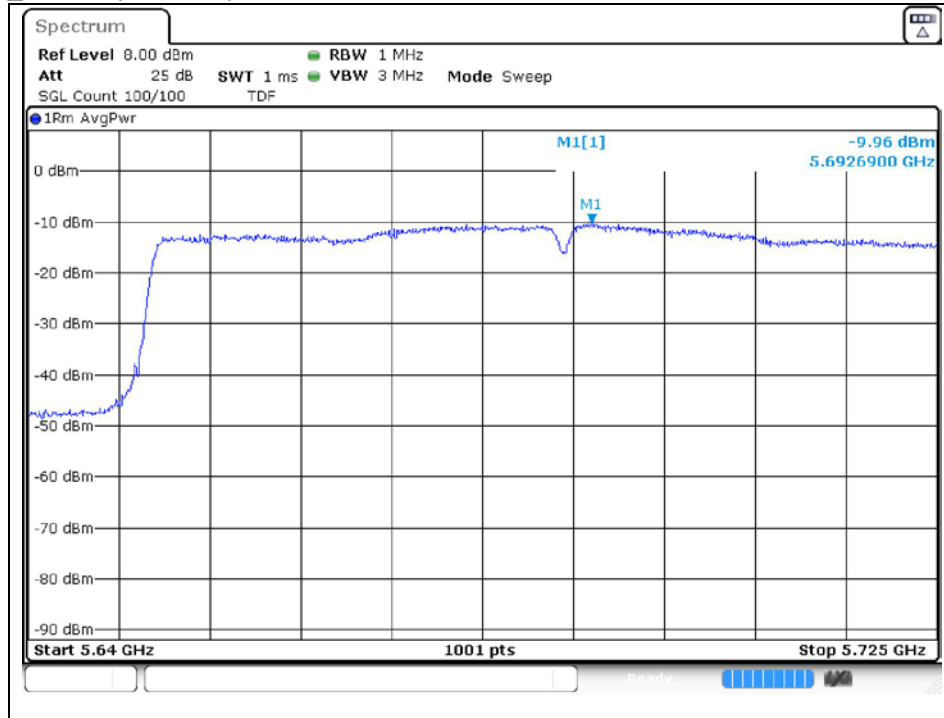
U-NII 2C 11n_HT40 (5 710 MHz)



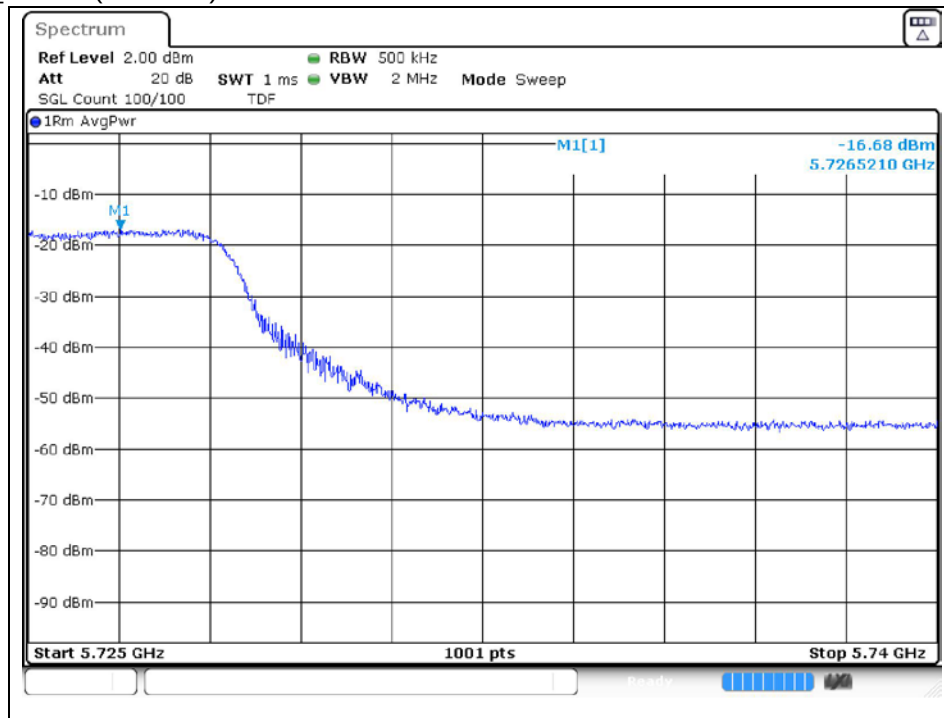
U-NII 3 11n_HT40 (5 710 MHz)



U-NII 2C 11ac_VHT80 (5 690 MHz)



U-NII 3 11ac_VHT80 (5 690 MHz)



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 dB i are used, the power shall be reduced by the amount in dB that the gain of the antenna exceeds 6 dB i.

7.2. Antenna Connected Construction

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

Band	5 150 MHz ~ 5 250 MHz	5 250 MHz ~ 5 350 MHz	5 470 MHz ~ 5 725 MHz	5 725 MHz ~ 5 850 MHz
Mode	11a/n_HT20, HT40, 11ac_VHT20, VHT40, VHT80			
Gain	2.75 dB i	2.75 dB i	-0.80 dB i	-1.24 dB i

- End of the Test Report -