

5.4 Peak Power Spectral Density

5.4.1 Regulation

According to §15.407(a) (1) (iv) For mobile and portable 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 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi 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 dBi.

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 $11 \text{ dBm} + 10 \log B$, where B is the 26 dB emission bandwidth in megahertz. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi 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 dBi.

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 dBm in any 500-kHz band. If transmitting antennas of directional gain greater than 6 dBi 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 dBi. However, fixed point-to-point U-NII devices operating in this band may employ transmitting antennas with directional gain greater than 6 dBi 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.

5.4.2 Measurement Procedure

These test measurement settings are specified in section F of 789033 D02 General UNII Test Procedures New Rules v01.

5.4.2.1 Maximum power spectral density (PSD)

1. 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.)
2. Use the peak search function on the instrument to find the peak of the spectrum and record its value.
3. 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.
4. The result is the Maximum PSD over 1 MHz reference bandwidth.
5. 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 MHz, or < 500 kHz) and integrated over 1 MHz, or 500 kHz bandwidth, the following adjustments to the procedures apply:
 - a) Set $RBW \geq 1/T$, where T is defined in section II.B.1.a).
 - c) Set $VBW \geq 3$ RBW.
 - d) If measurement bandwidth of Maximum PSD is specified in 500 kHz, add $10\log(500\text{kHz}/RBW)$ to the measured result, whereas $RBW (< 500 \text{ kHz})$ is the reduced resolution bandwidth of the spectrum analyzer set during measurement.
 - e) If measurement bandwidth of Maximum PSD is specified in 1 MHz, add $10\log(1\text{MHz}/RBW)$ to the measured result, whereas $RBW (< 1 \text{ MHz})$ is the reduced resolution bandwidth of spectrum analyzer set during measurement.
 - f) Care must be taken to ensure that the measurements are performed during a period of continuous transmission or are corrected upward for duty cycle.

Note: As a practical matter, it is recommended to use reduced RBW of 100 kHz for the sections 5.c) and 5.d) above, since $RBW=100 \text{ kHz}$ is available on nearly all spectrum analyzers.

5.4.3 Test Result

-Complied

802.11a

5 150 Band

Frequency (MHz)	Reading (dBm)	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant1				
5 180	3.73	0.21	3.94	11.00	7.06
5 200	4.02	0.21	4.23	11.00	6.77
5 240	4.18	0.21	4.39	11.00	6.61

5 250 Band

Frequency (MHz)	Reading (dBm)	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant1				
5 260	3.44	0.21	3.65	11.00	7.35
5 280	3.90	0.21	4.11	11.00	6.89
5 320	3.97	0.21	4.18	11.00	6.82

5 470 Band

Frequency (MHz)	Reading (dBm)	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant1				
5 500	4.54	0.21	4.75	11.00	6.25
5 580	4.38	0.21	4.59	11.00	6.41
5 700	4.03	0.21	4.24	11.00	6.76

5 725 Band

Frequency (MHz)	Reading (dBm)	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant1				
5 745	1.29	0.21	1.50	30.00	28.50
5 785	1.60	0.21	1.81	30.00	28.19
5 825	1.97	0.21	2.18	30.00	27.82

802.11an HT20

5 150 Band

Frequency (MHz)	Reading (dBm)	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant1				
5 180	2.29	0.22	2.51	11.00	8.49
5 200	2.63	0.22	2.85	11.00	8.15
5 240	2.68	0.22	2.90	11.00	8.10

5 250 Band

Frequency (MHz)	Reading (dBm)	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant1				
5 260	2.44	0.22	2.66	11.00	8.34
5 280	2.37	0.22	2.59	11.00	8.41
5 320	2.30	0.22	2.52	11.00	8.48

5 470 Band

Frequency (MHz)	Reading (dBm)	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant1				
5 500	3.15	0.22	3.37	11.00	7.63
5 580	2.92	0.22	3.14	11.00	7.86
5 700	2.97	0.22	3.19	11.00	7.81

5 725 Band

Frequency (MHz)	Reading (dBm)	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant1				
5 745	-0.16	0.22	0.06	30.00	29.94
5 785	0.06	0.22	0.28	30.00	29.72
5 825	0.90	0.22	1.12	30.00	28.88

802.11an HT20_MIMO (ANT 1+2)

5 150 Band

Frequency (MHz)	Reading (dBm)		Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant 1	Ant 2				
5 180	2.35	1.63	0.22	5.24	11.00	5.76
5 200	2.45	2.15	0.22	5.53	11.00	5.47
5 240	2.96	2.24	0.22	5.85	11.00	5.15

5 250 Band

Frequency (MHz)	Reading (dBm)		Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant 1	Ant 2				
5 260	2.26	1.58	0.22	5.16	11.00	5.84
5 280	2.16	1.38	0.22	5.02	11.00	5.98
5 320	2.45	1.30	0.22	5.14	11.00	5.86

5 470 Band

Frequency (MHz)	Reading (dBm)		Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant 1	Ant 2				
5 500	3.36	2.09	0.22	6.00	11.00	5.00
5 580	3.00	2.77	0.22	6.12	11.00	4.88
5 700	2.97	2.82	0.22	6.13	11.00	4.87

5 725 Band

Frequency (MHz)	Reading (dBm)		Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant 1	Ant 2				
5 745	-0.07	-0.44	0.22	2.98	30.00	27.02
5 785	0.21	-0.45	0.22	3.12	30.00	26.88
5 825	0.49	0.14	0.22	3.55	30.00	26.45

802.11an HT40

5 150 Band

Frequency (MHz)	Reading (dBm)	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant1				
5 190	-0.83	0.42	-0.41	11.00	11.41
5 230	-0.31	0.42	0.11	11.00	10.89

5 250 Band

Frequency (MHz)	Reading (dBm)	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant1				
5 270	-1.01	0.42	-0.59	11.00	11.59
5 310	-0.64	0.42	-0.22	11.00	11.22

5 470 Band

Frequency (MHz)	Reading (dBm)	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant1				
5 510	0.39	0.42	0.81	11.00	10.19
5 590	0.20	0.42	0.62	11.00	10.38
5 670	-0.29	0.42	0.13	11.00	10.87

5 725 Band

Frequency (MHz)	Reading (dBm)	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant1				
5 755	-3.21	0.42	-2.79	30.00	32.79
5 795	-2.72	0.42	-2.30	30.00	32.30

802.11an HT40_MIMO (ANT 1+2)

5 150 Band

Frequency (MHz)	Reading (dBm)		Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant 1	Ant 2				
5 190	-0.45	-1.06	0.42	2.69	11.00	8.31
5 230	-0.48	-0.31	0.42	3.04	11.00	7.96

5 250 Band

Frequency (MHz)	Reading (dBm)		Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant 1	Ant 2				
5 270	-0.91	-1.45	0.42	2.26	11.00	8.74
5 310	-0.39	-1.48	0.42	2.53	11.00	8.47

5 470 Band

Frequency (MHz)	Reading (dBm)		Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant 1	Ant 2				
5 510	-0.14	-1.14	0.42	2.82	11.00	8.18
5 590	0.22	-0.24	0.42	3.43	11.00	7.57
5 670	-0.30	-0.25	0.42	3.16	11.00	7.84

5 725 Band

Frequency (MHz)	Reading (dBm)		Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
	Ant 1	Ant 2				
5 755	-3.33	-3.02	0.42	0.26	30.00	29.74
5 795	-2.69	-2.75	0.42	0.71	30.00	29.29

-NOTE:

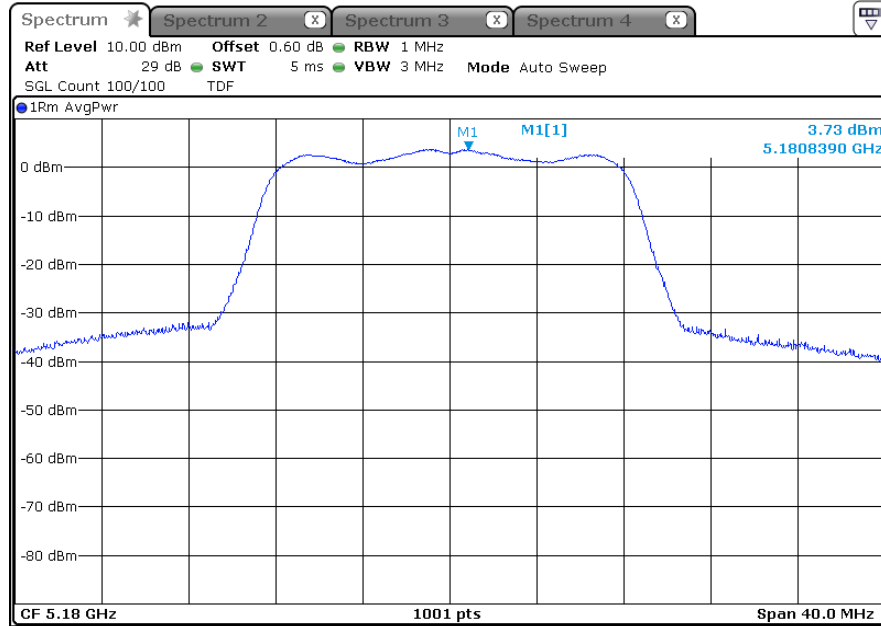
- Total PSD calculation = $10\log(10^{Ant1\ PSD / 10} + 10^{Ant2\ PSD / 10})$
- 802.11a: 5 825 MHz : Duty cycle = 0.952 1, Duty cycle factor = $10\log(1/duty\ cycle) = 10\log(1/0.952\ 1) = 0.21\ dB$.
802.11an HT20 : 5 200 MHz : Duty cycle = 0.950 5, Duty cycle factor = $10\log(1/duty\ cycle) = 10\log(1/0.950\ 5) = 0.22\ dB$.
802.11an HT40 : 5 795 MHz : Duty cycle = 0.906 9, Duty cycle factor = $10\log(1/duty\ cycle) = 10\log(1/0.906\ 9) = 0.42\ dB$.
- Result = Ant1 Total PSD calculation + Duty Factor

5.4.4 Test Plot

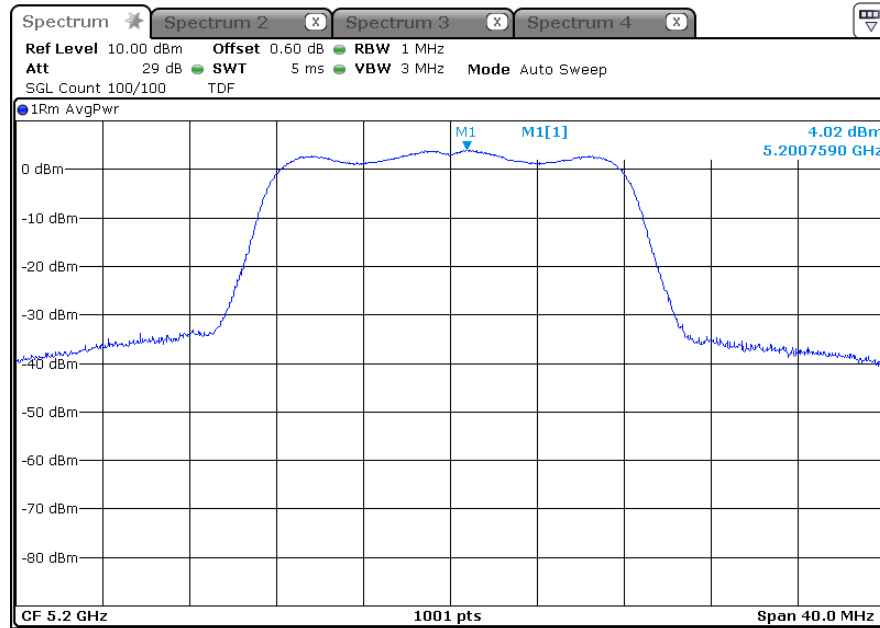
Figure 2. Plot of the Power Spectral Density

* 802.11a_5 150 Band

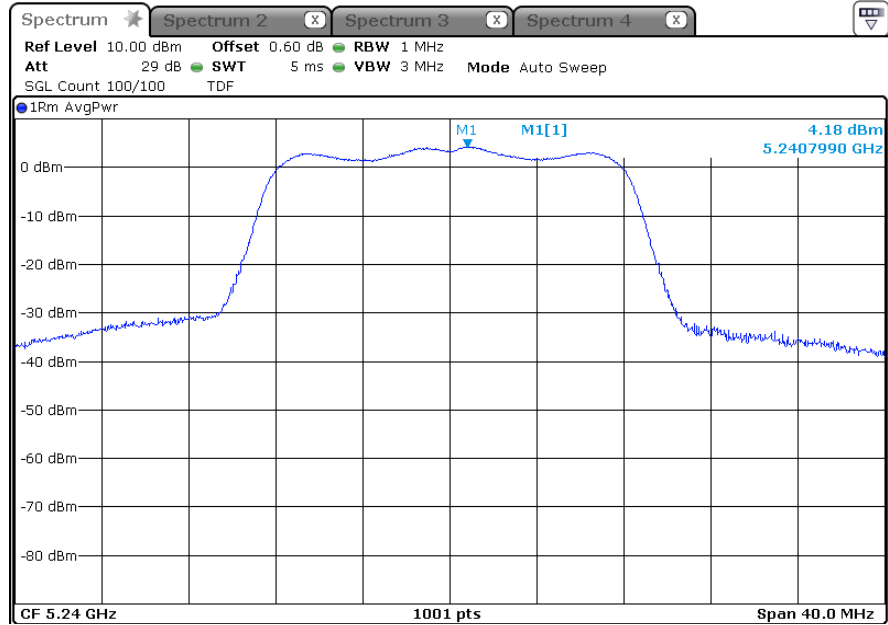
-5 180 MHz



-5 200 MHz

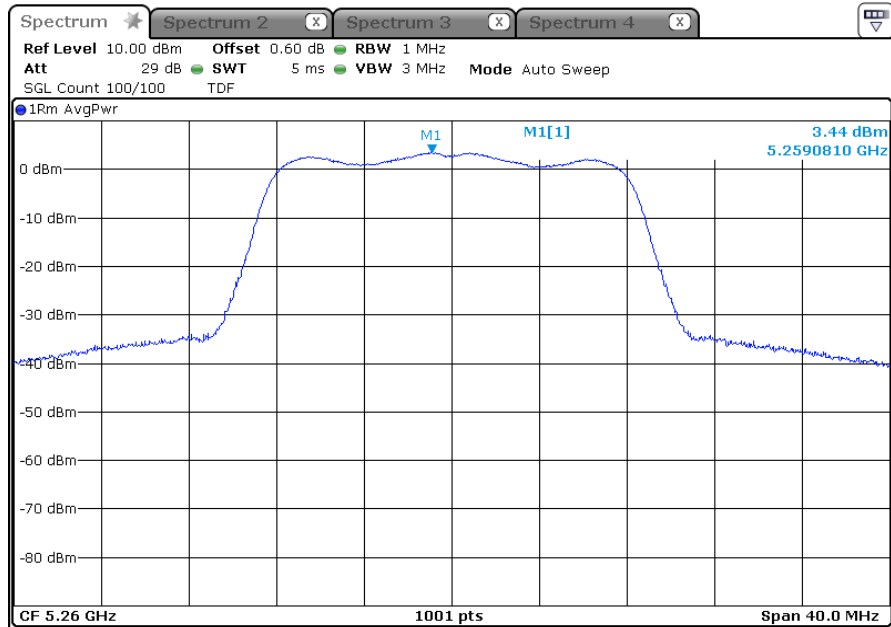


-5 240 MHz

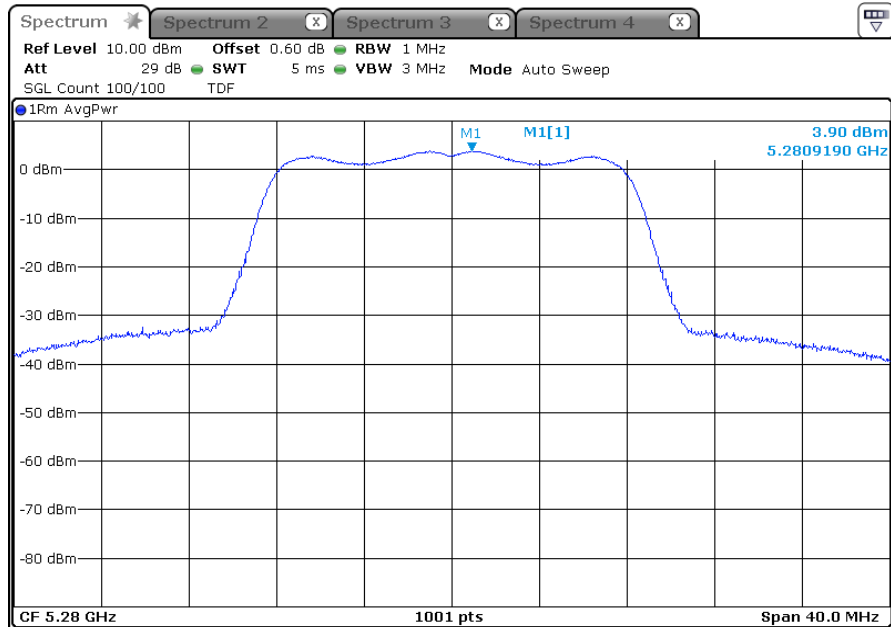


* 802.11a_5 250 Band

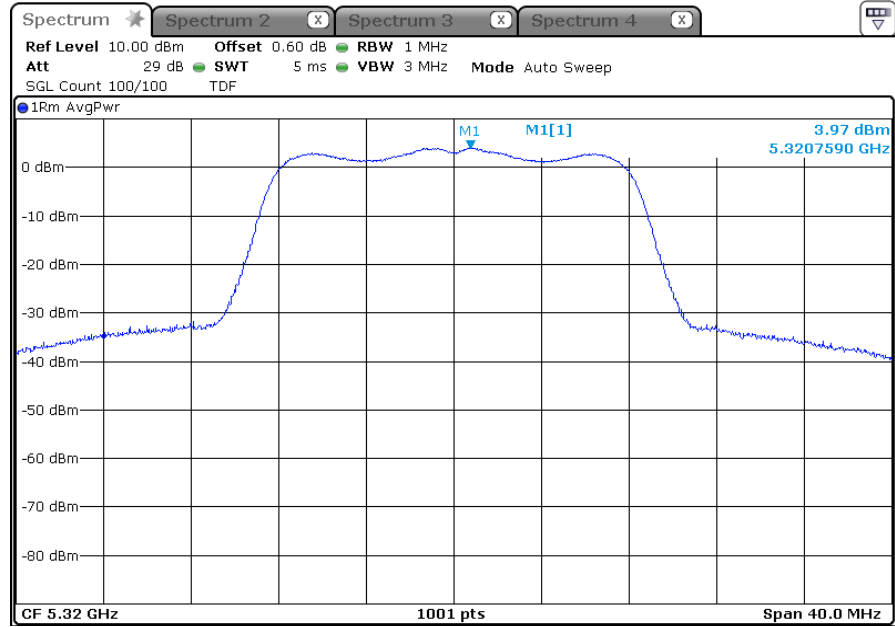
-5 260 MHz



-5 280 MHz

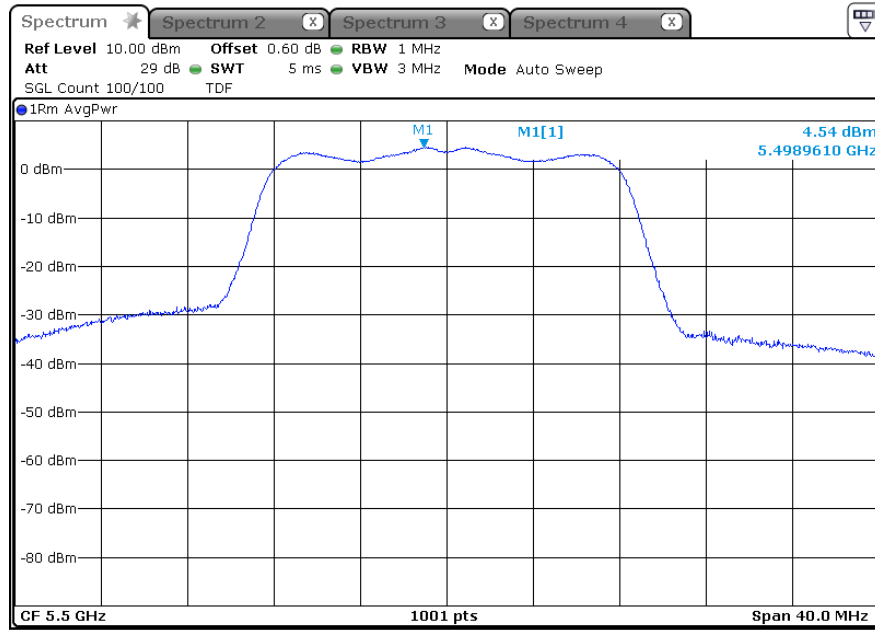


-5 320 MHz

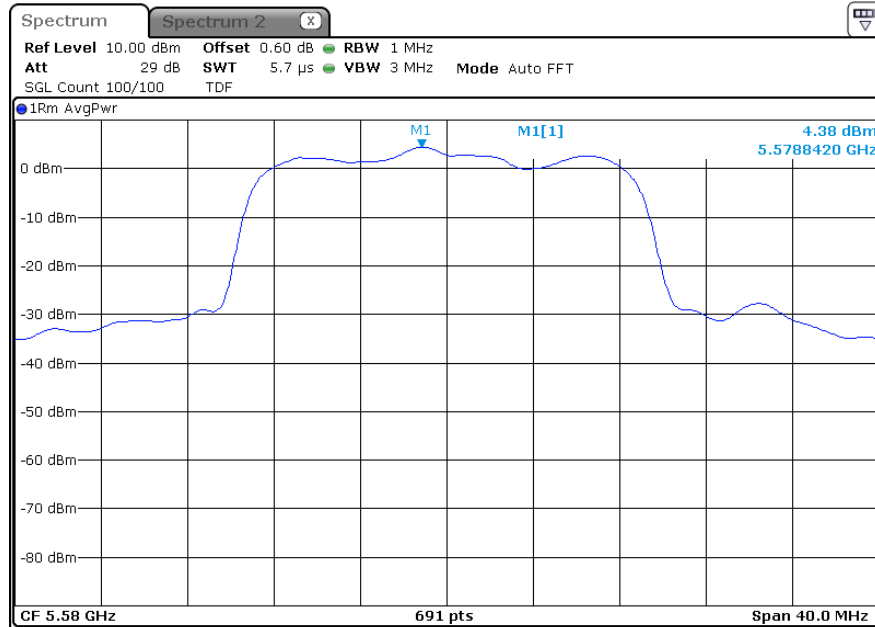


* 802.11a_5 470 Band

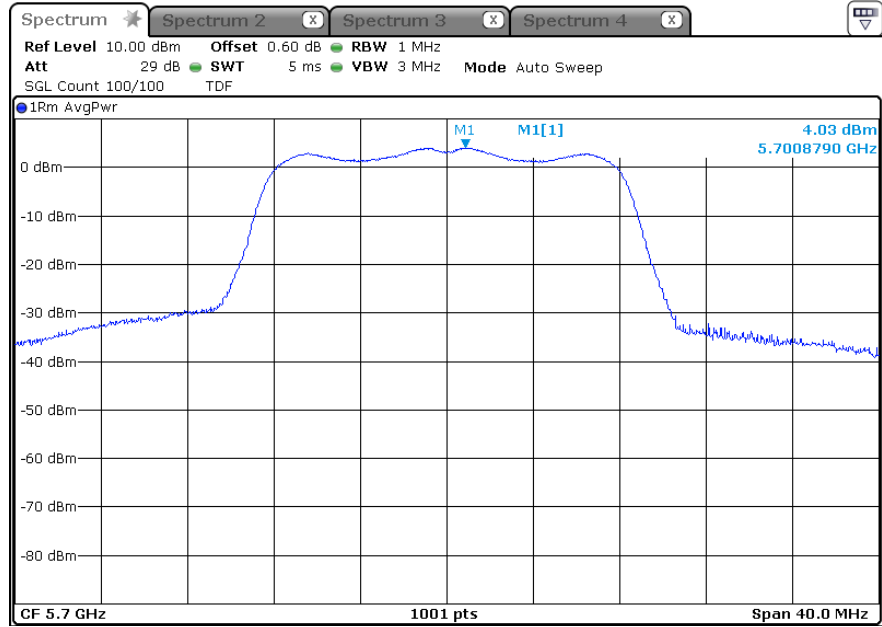
-5 500 MHz



-5 580 MHz

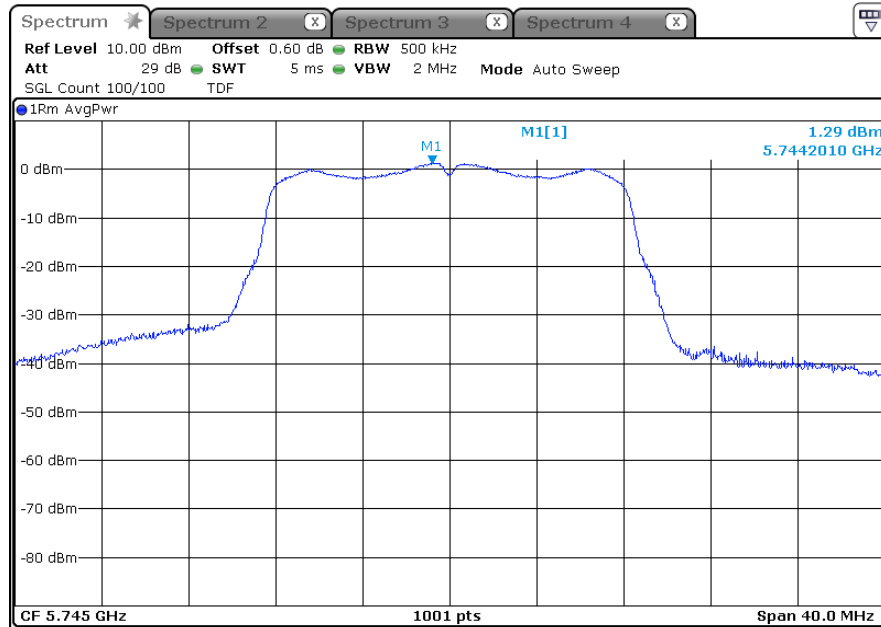


-5 700 MHz

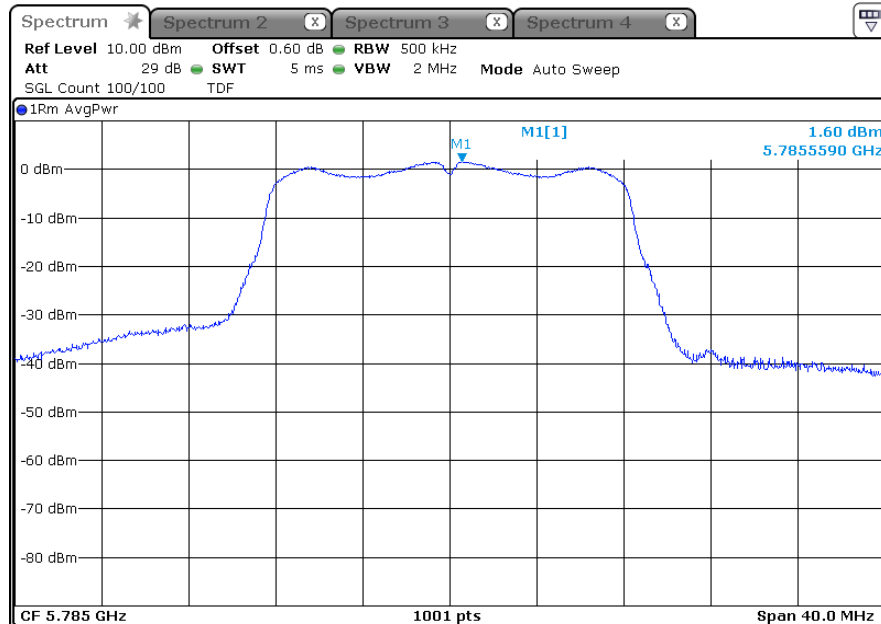


* 802.11a_5 725 Band

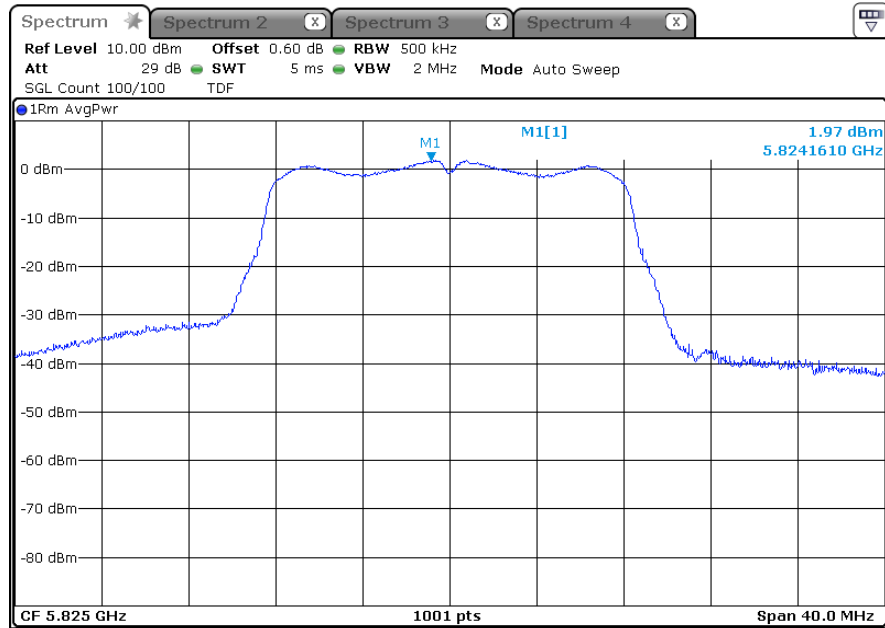
-5 745 MHz



-5 785 MHz

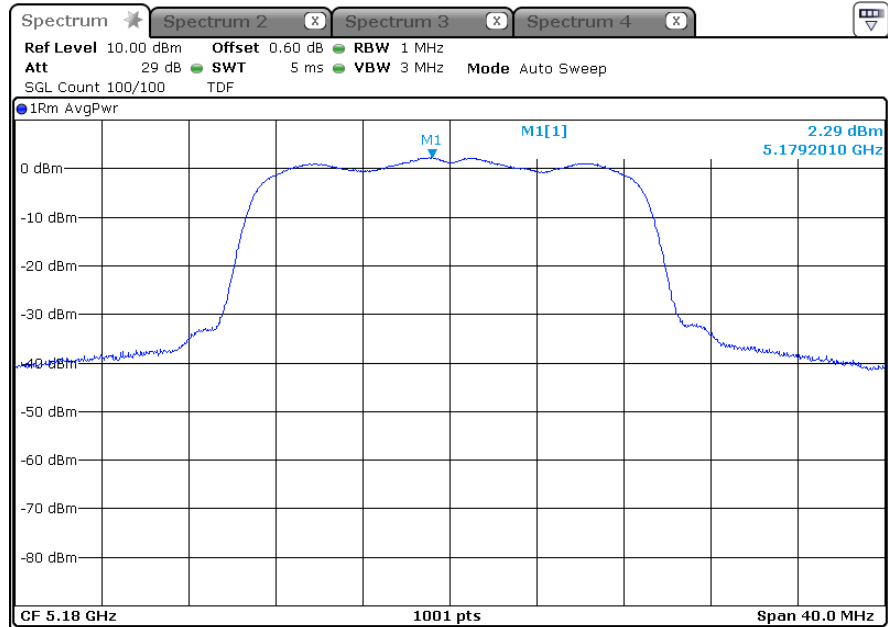


-5 825 MHz

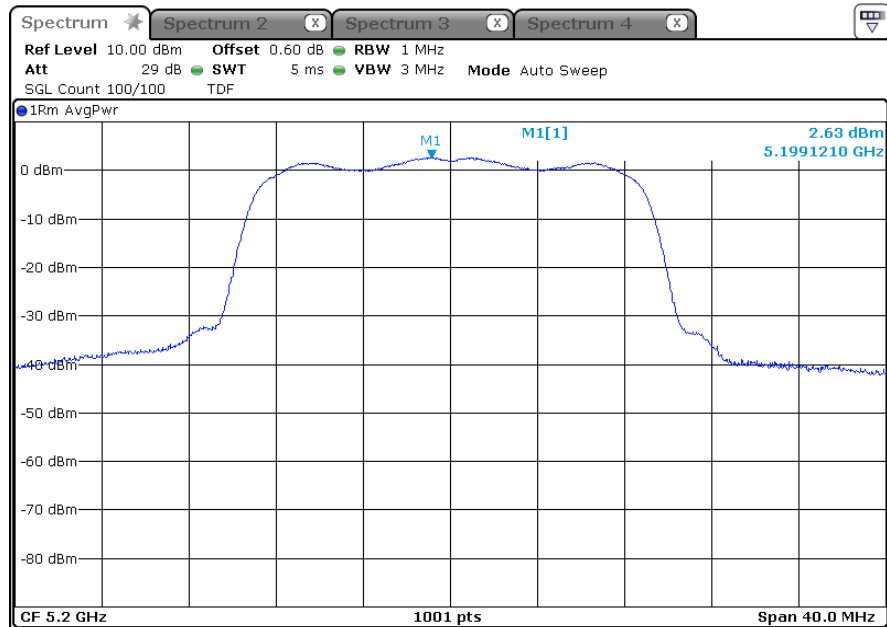


* 802.11an HT20_5 150 Band

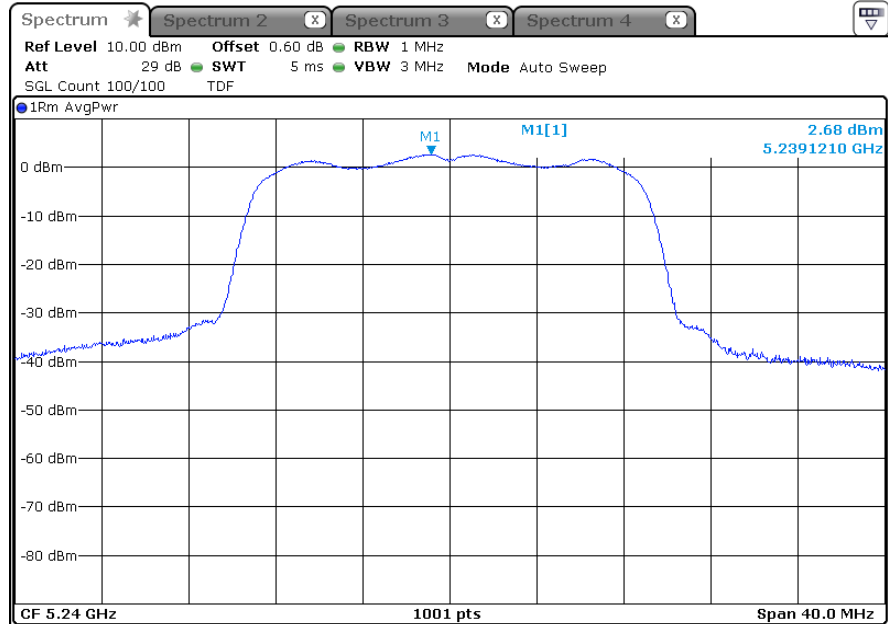
-5 180 MHz



-5 200 MHz

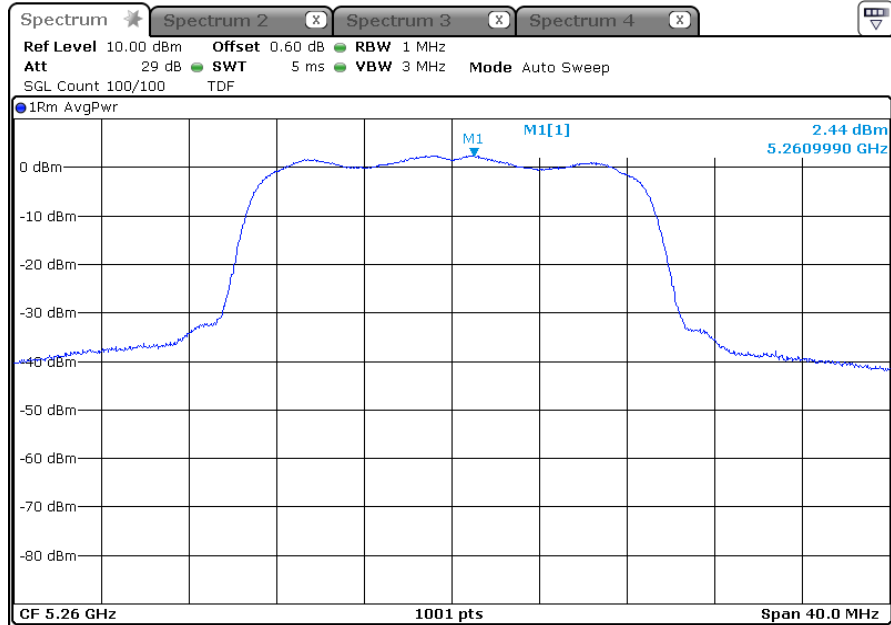


-5 240 MHz

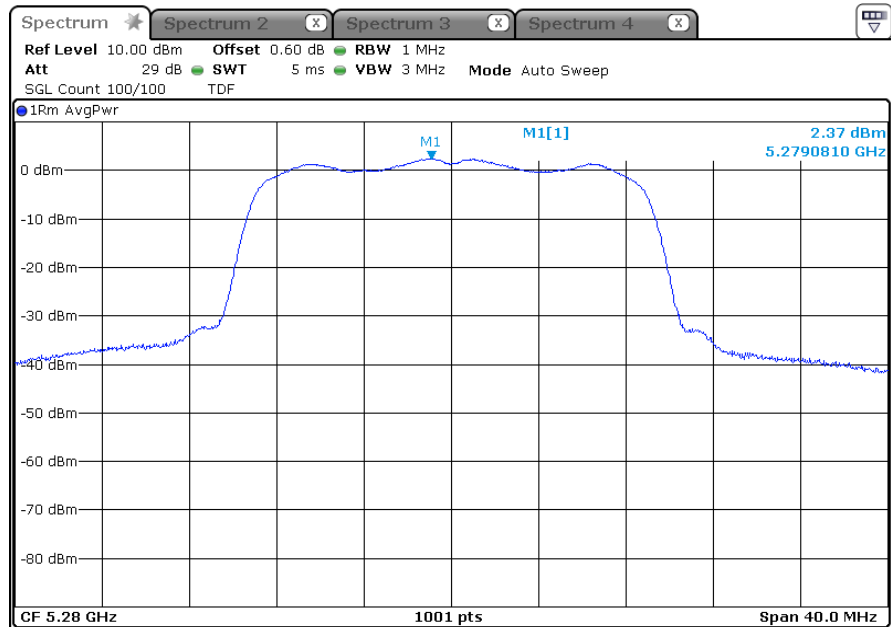


* 802.11an HT20_5 250 Band

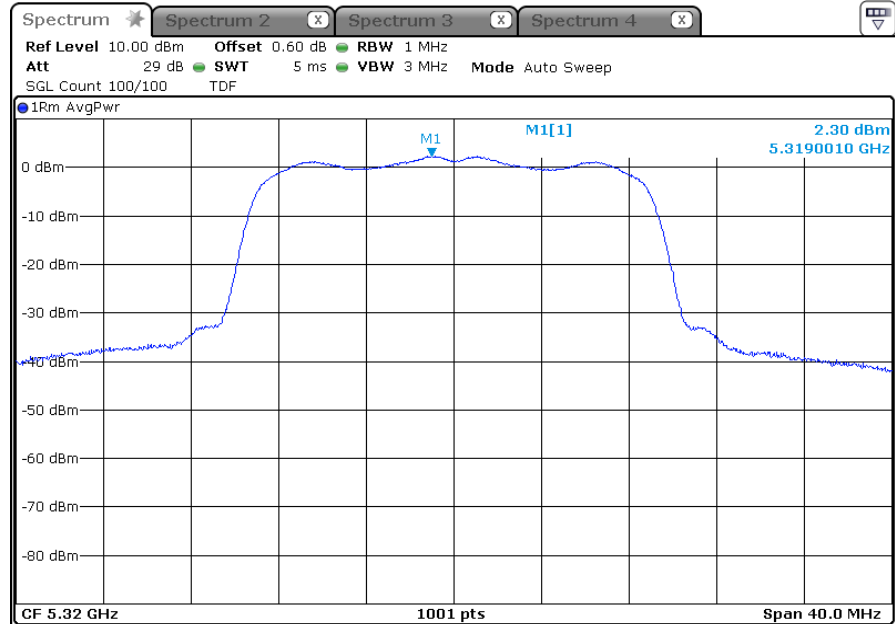
-5 260 MHz



-5 280 MHz

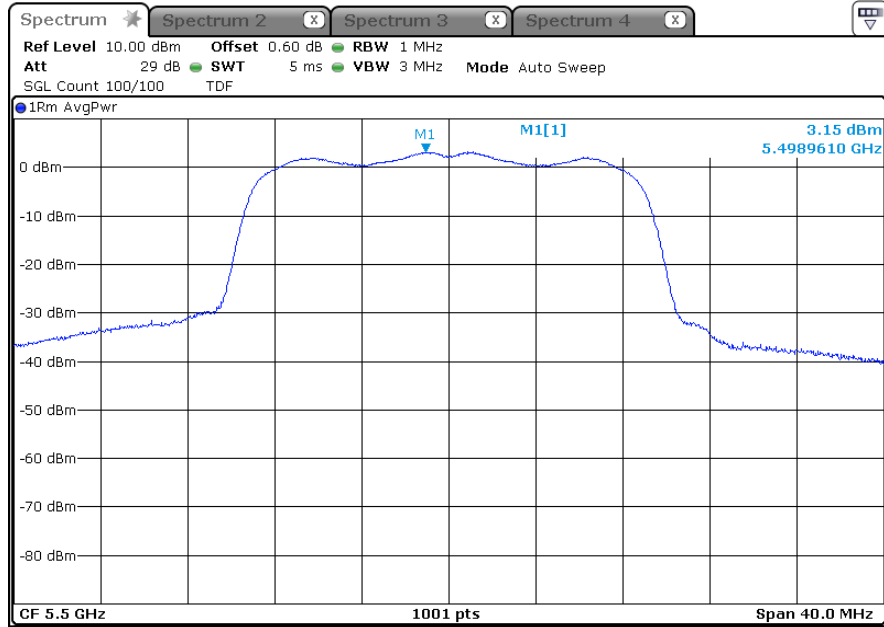


-5 320 MHz

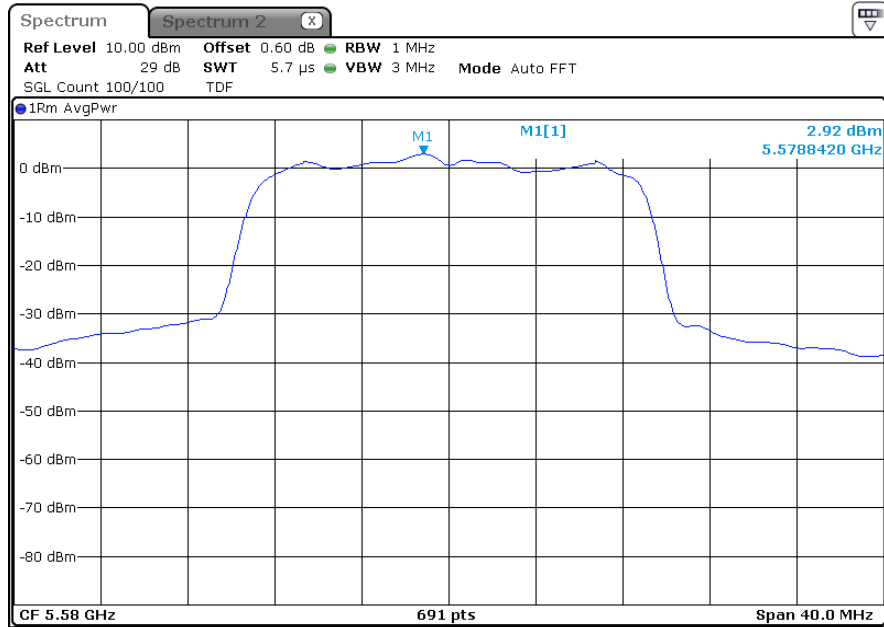


* 802.11an HT20_5 470 Band

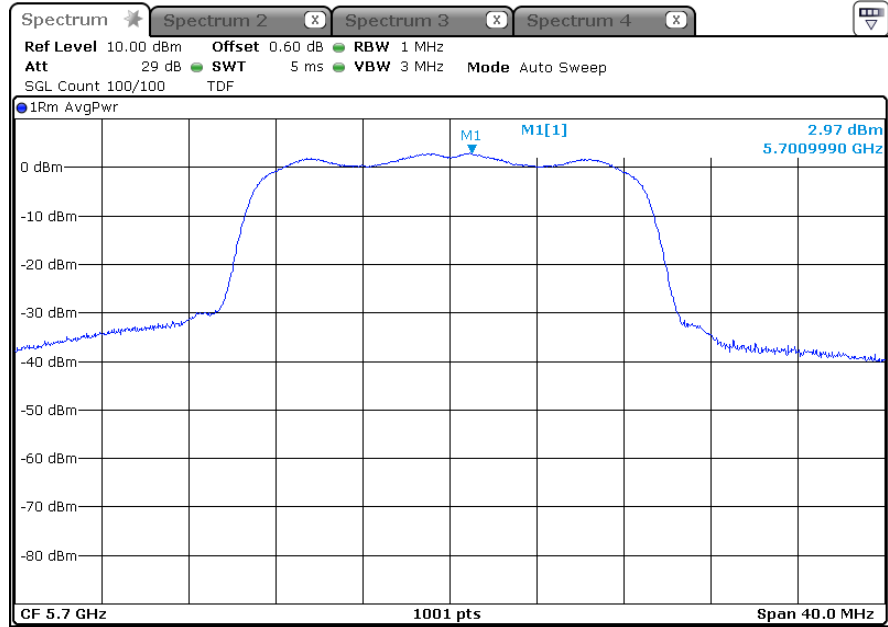
-5 500 MHz



-5 580 MHz



-5 700 MHz

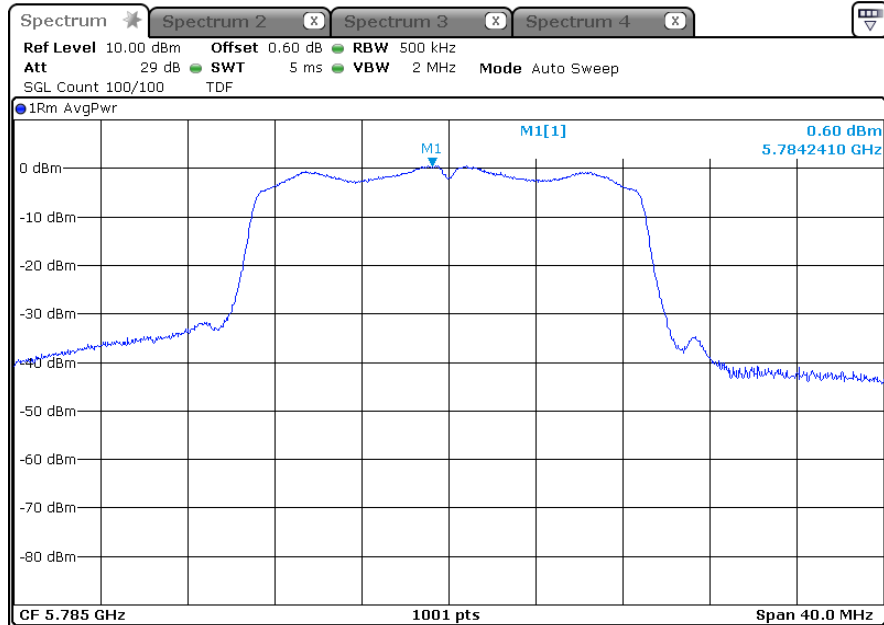


* 802.11an HT20_ 5 725 Band

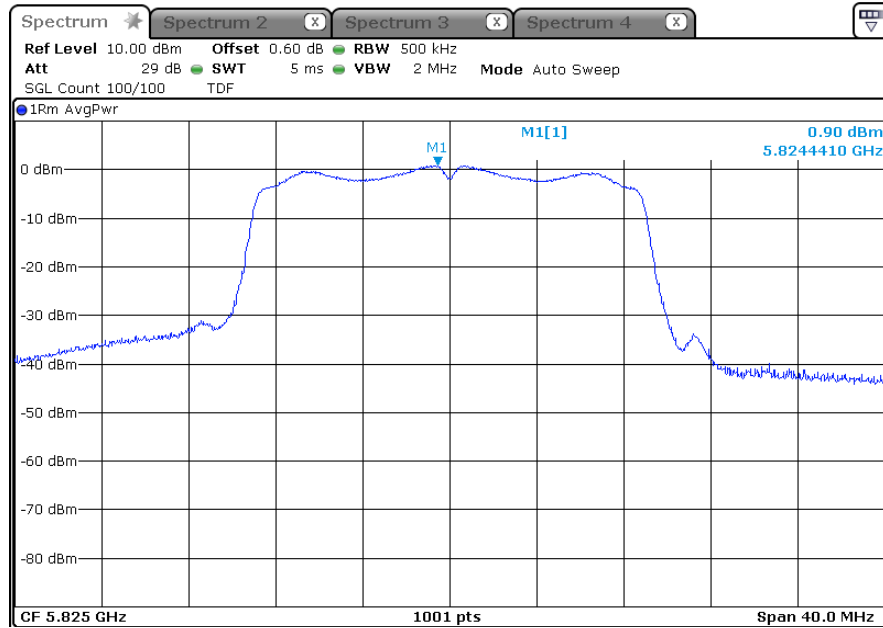
-5 745 MHz



-5 785 MHz



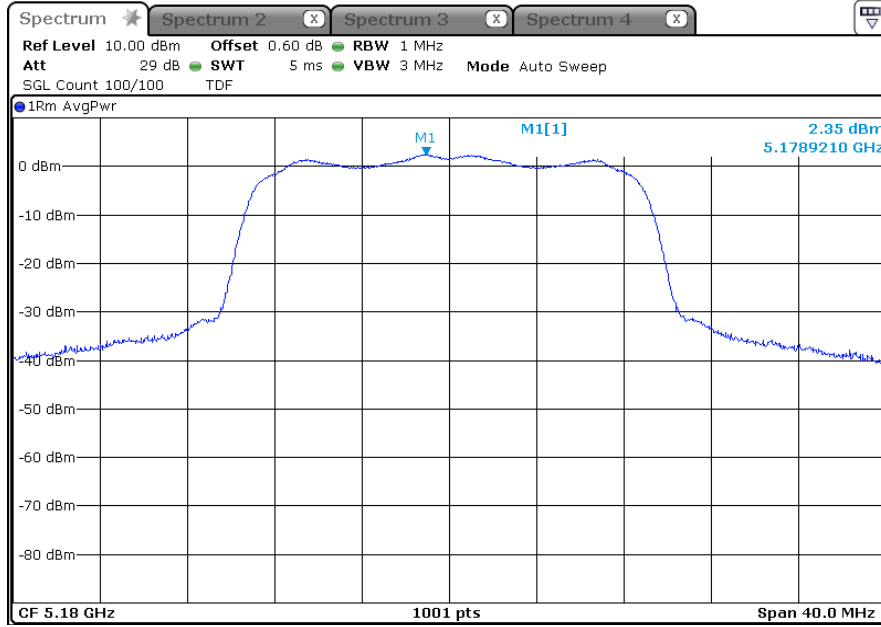
-5 825 MHz



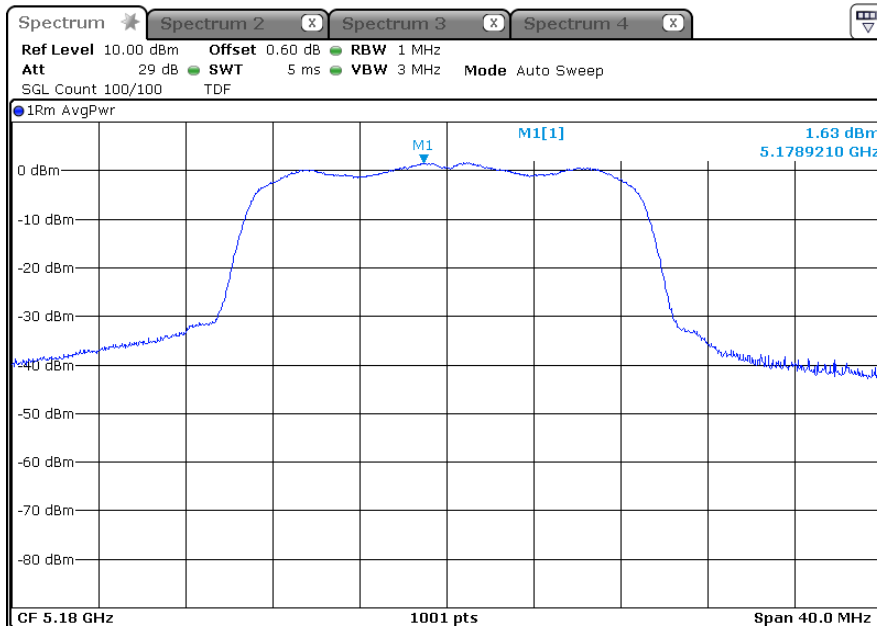
* 802.11an HT20_MIMO(ANT 1+2)_5 150 Band

-5 180 MHz

ANT 1

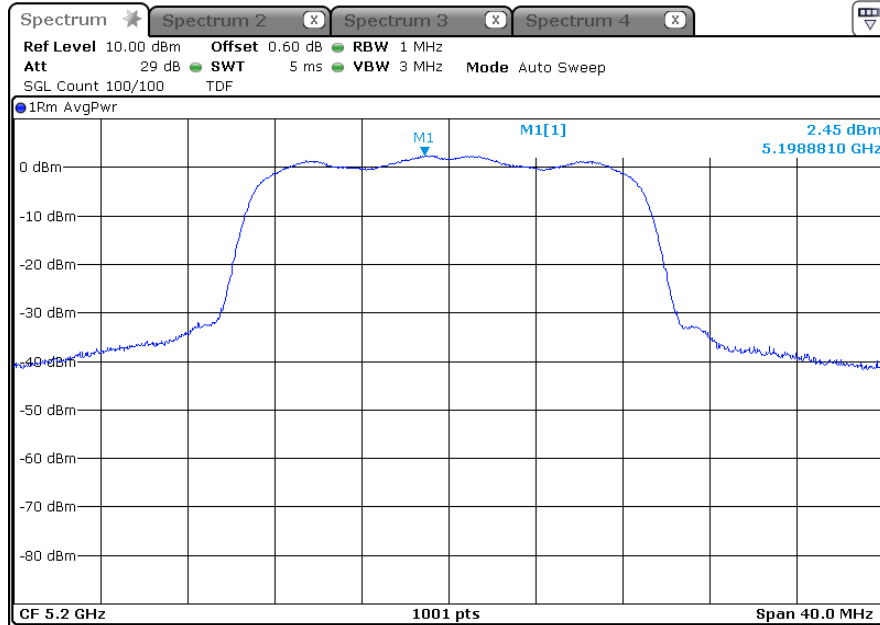


ANT 2

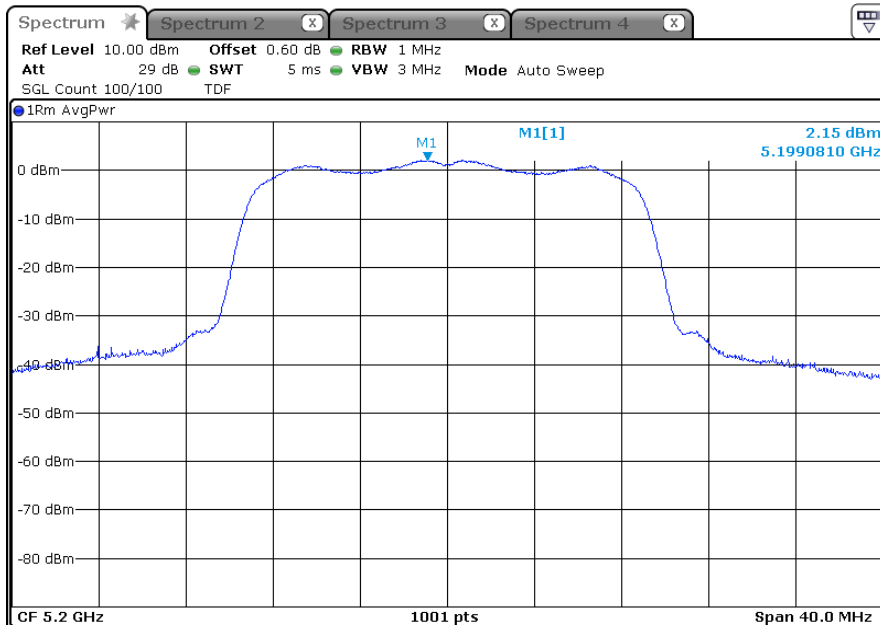


-5 200 MHz

ANT 1

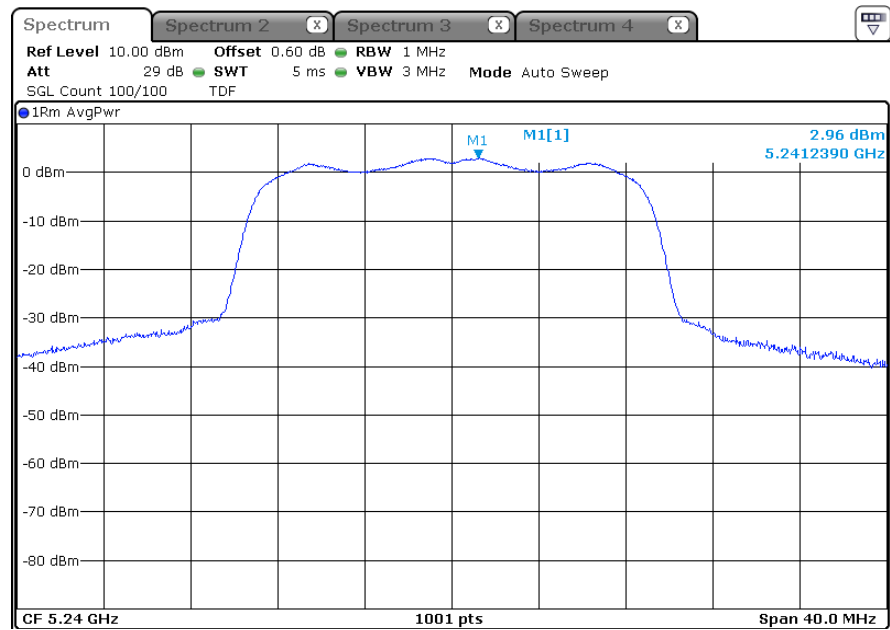


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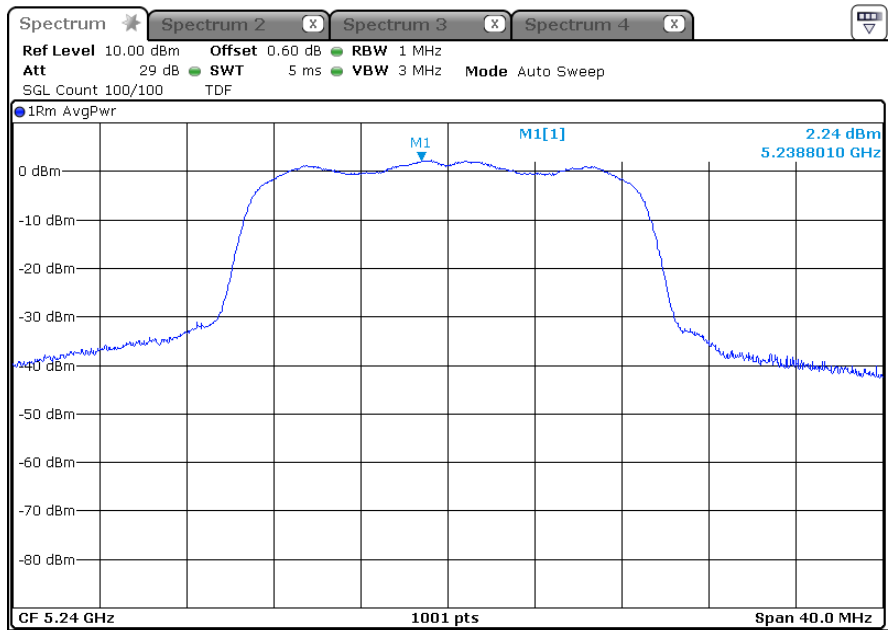


-5.240 MHz

ANT 1



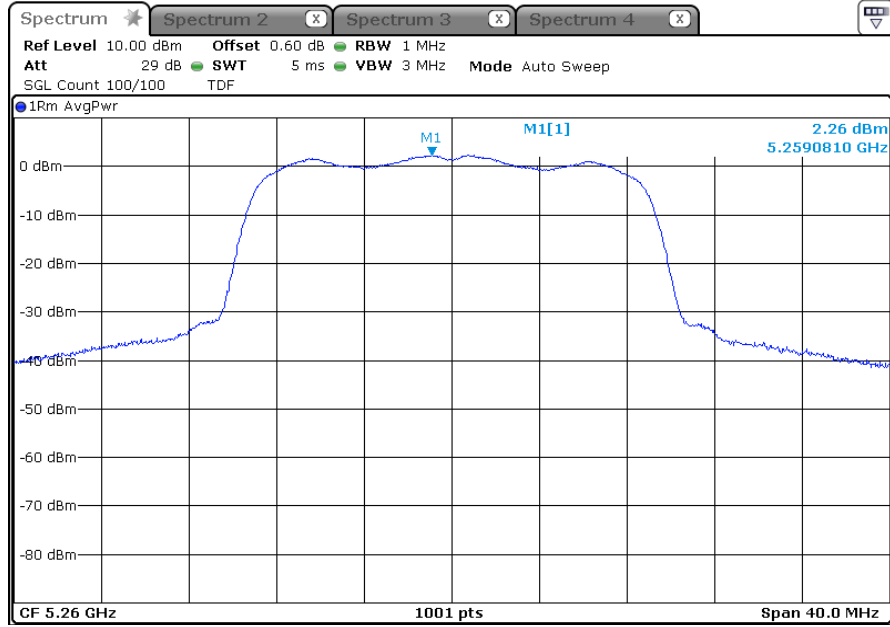
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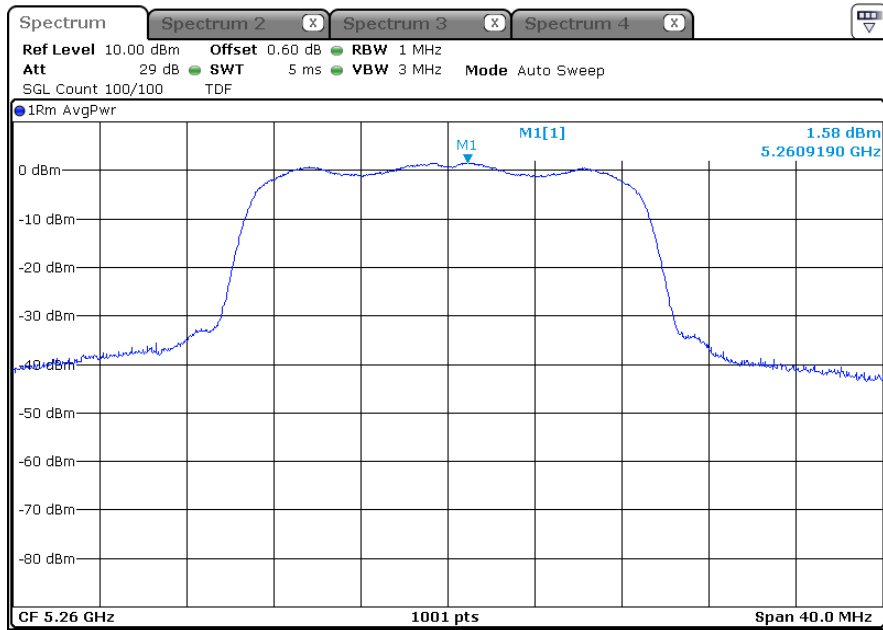
* 802.11an HT20_MIMO(ANT 1+2)_5 250 Band

-5 260 MHz

ANT 1

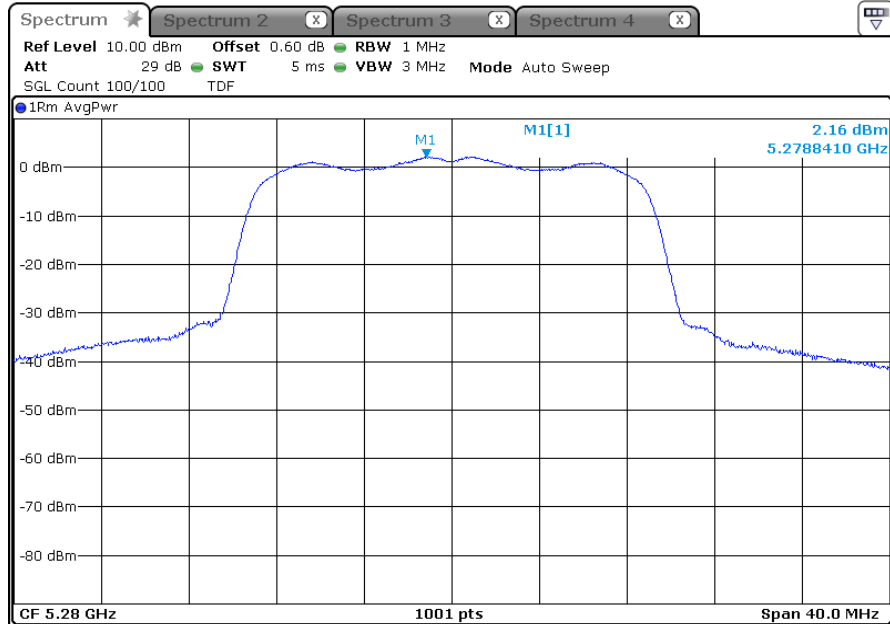


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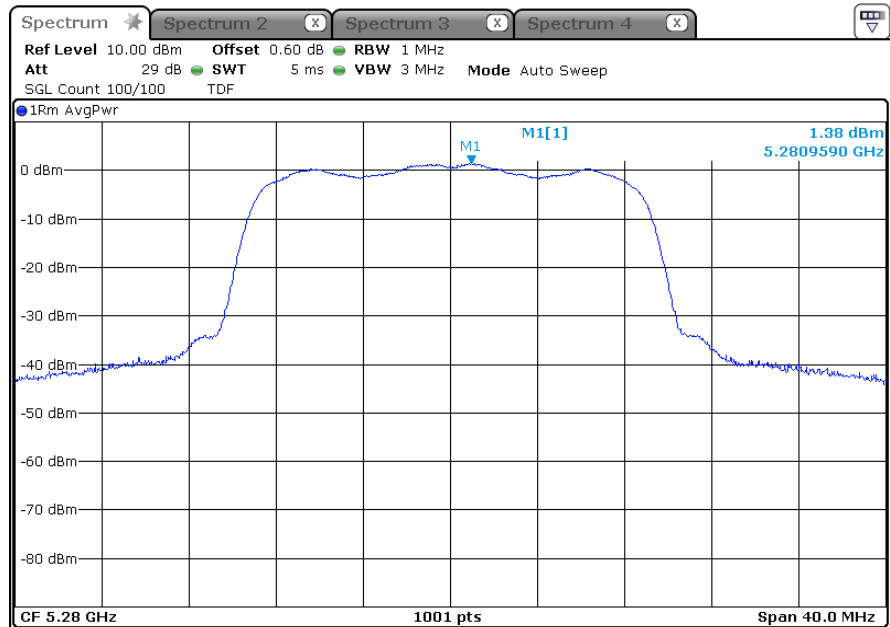


-5 280 MHz

ANT 1

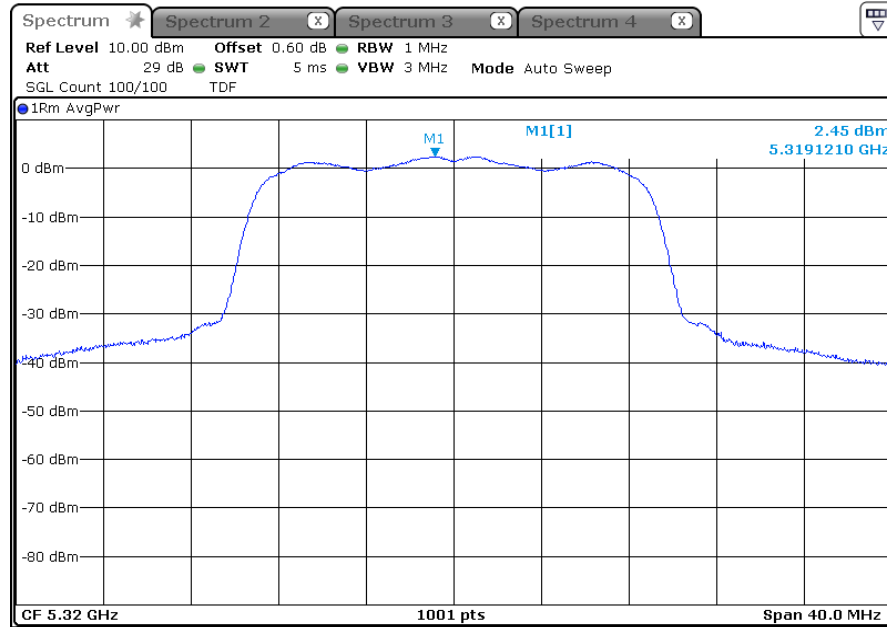


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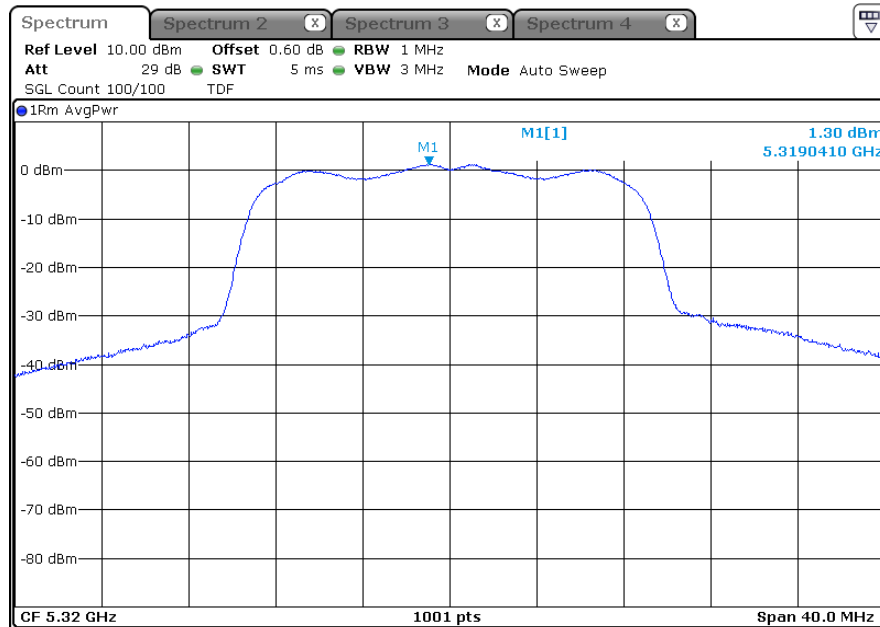


-5 320 MHz

ANT 1



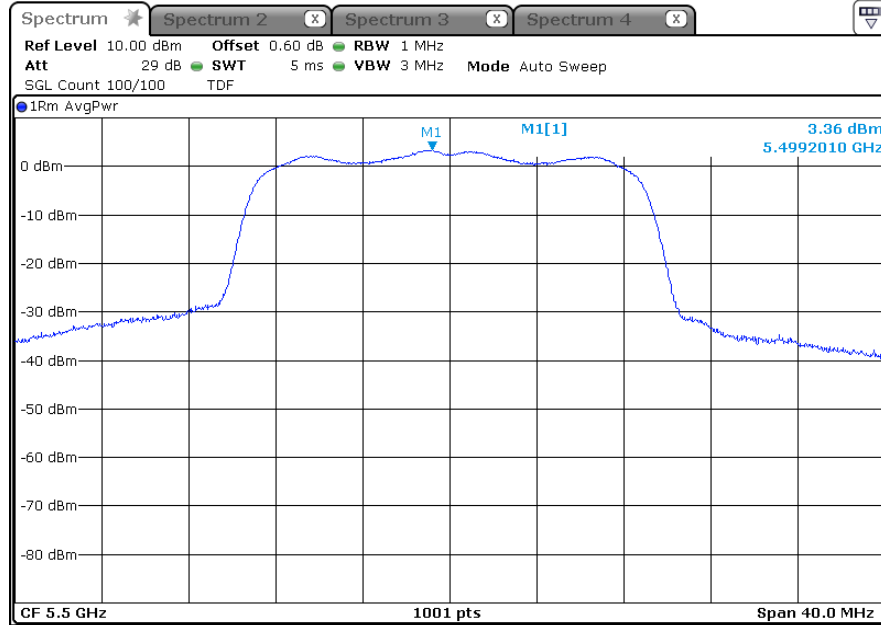
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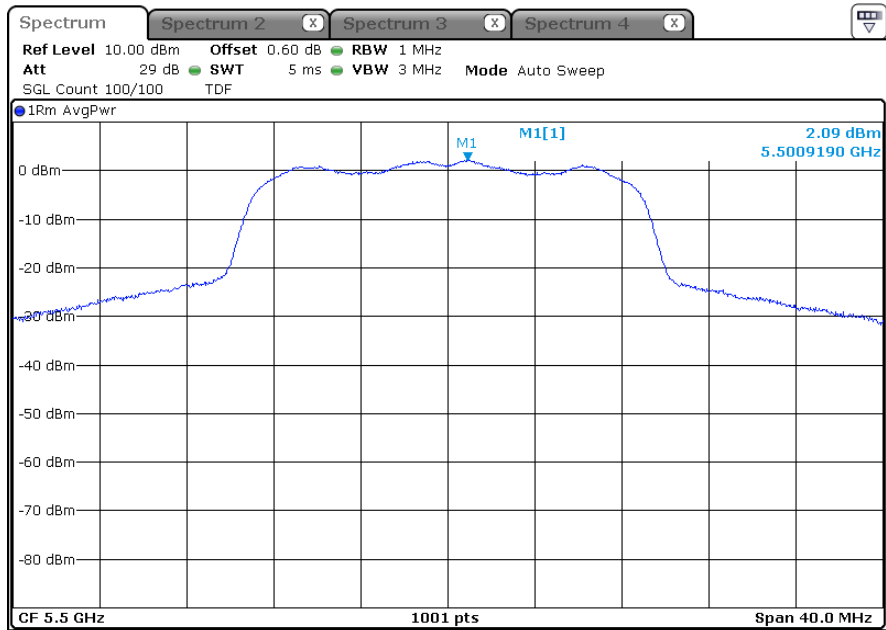
* 802.11an HT20_MIMO(ANT 1+2)_5 470 Band

-5 500 MHz

ANT 1

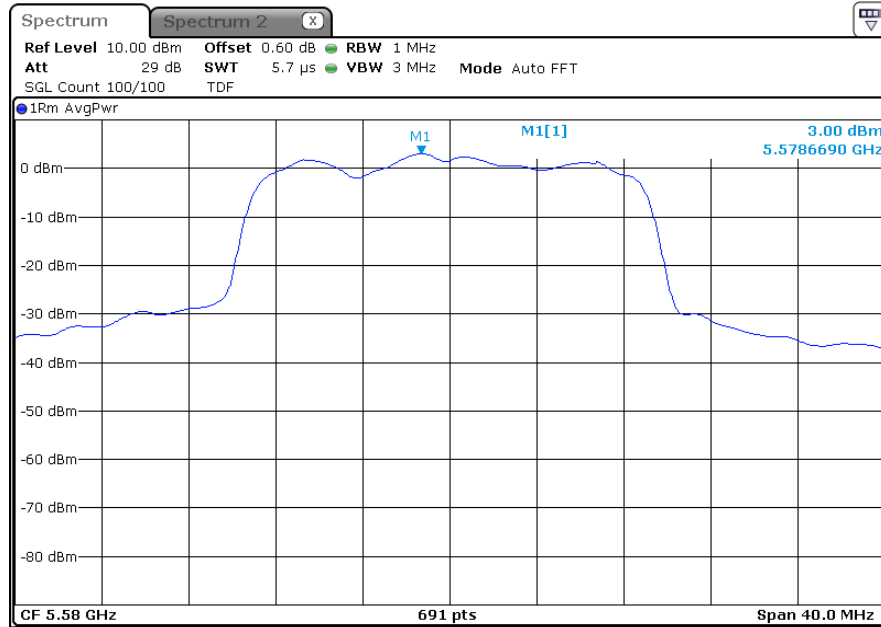


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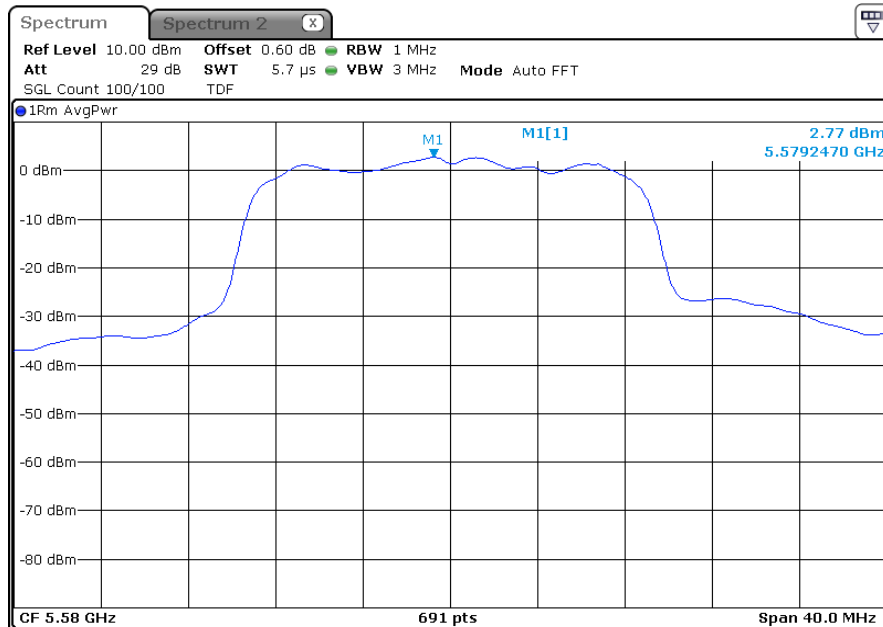


-5 580 MHz

ANT 1

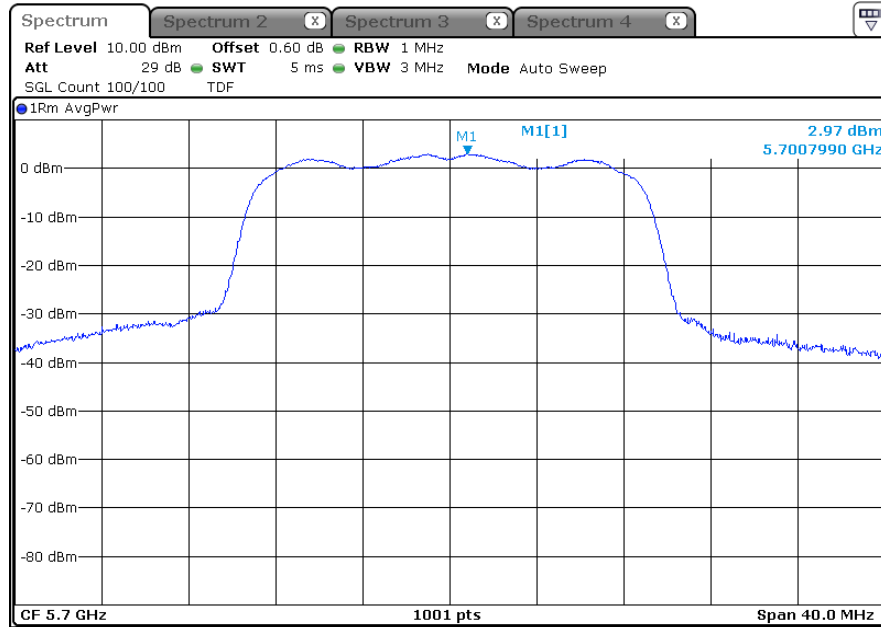


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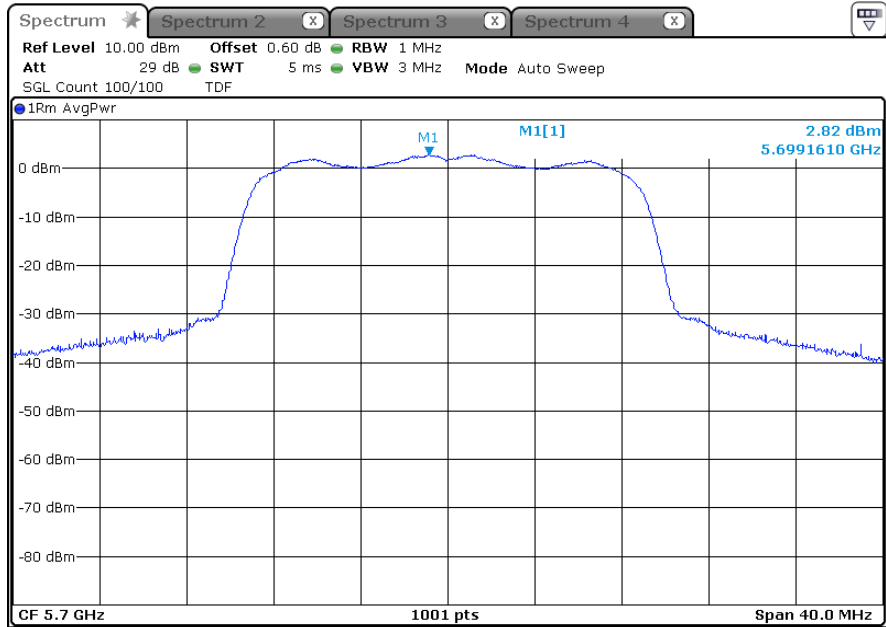


-5 700 MHz

ANT 1



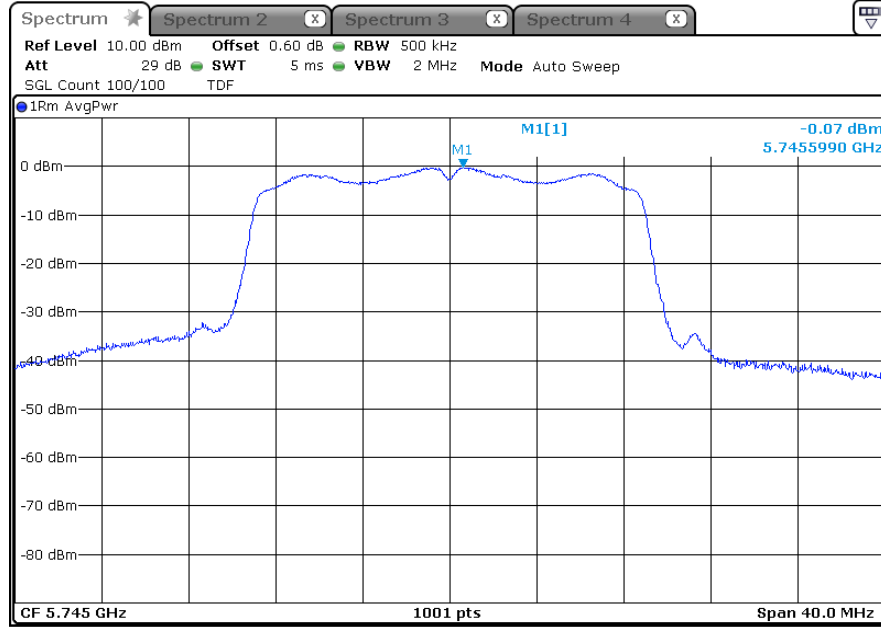
ANT 2



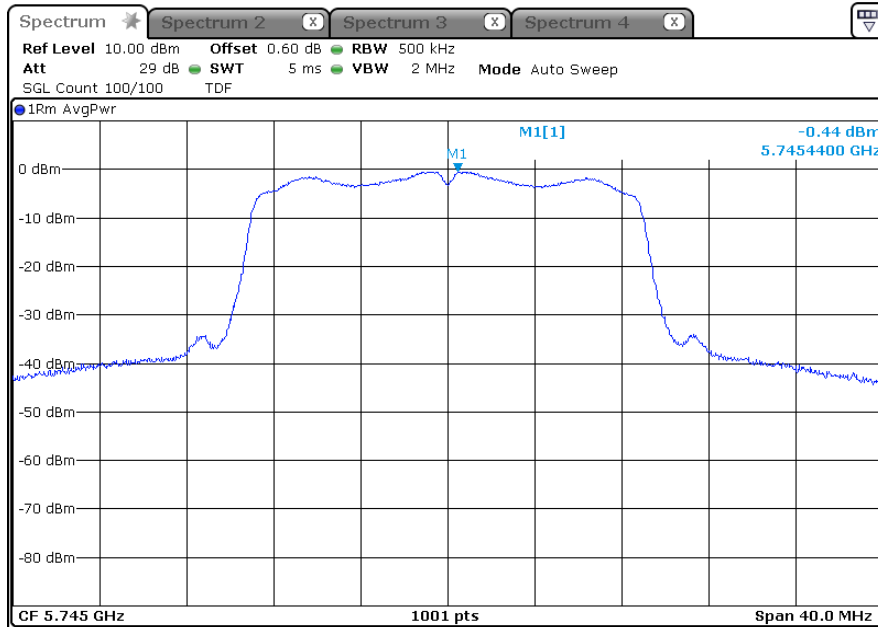
* 802.11an HT20_MIMO(ANT 1+2)_5 725 Band

-5 745 MHz

ANT 1



ANT 2

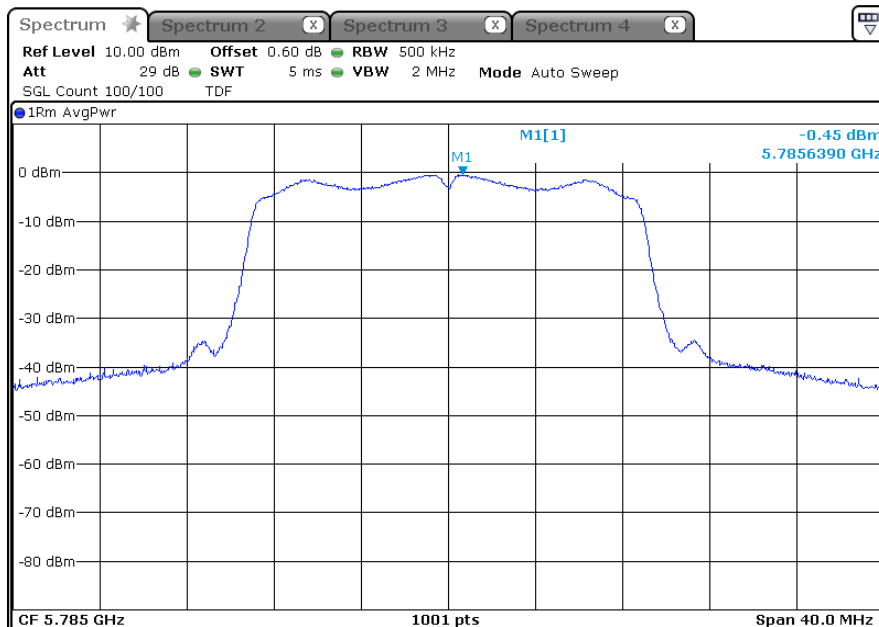


-5 785 MHz

ANT 1

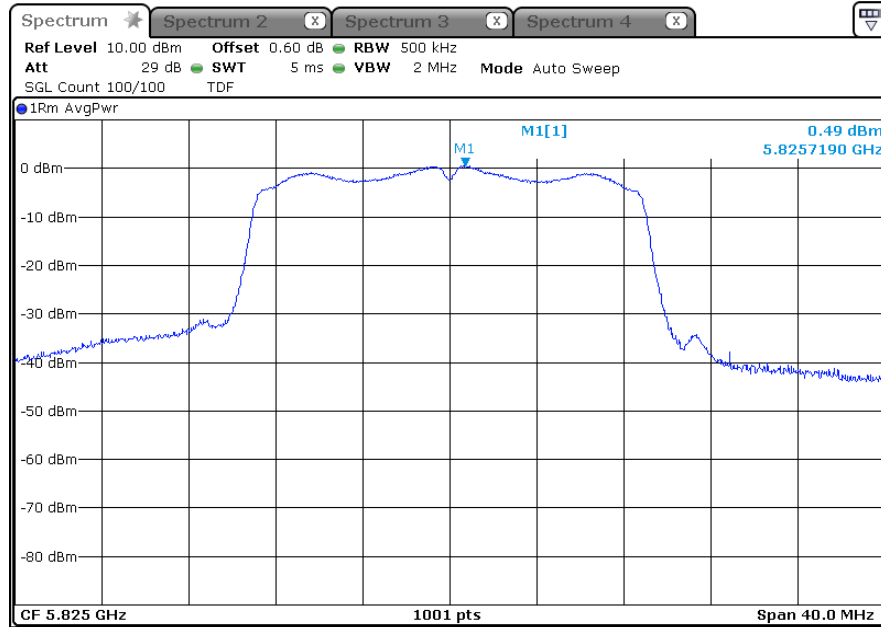


ANT 2

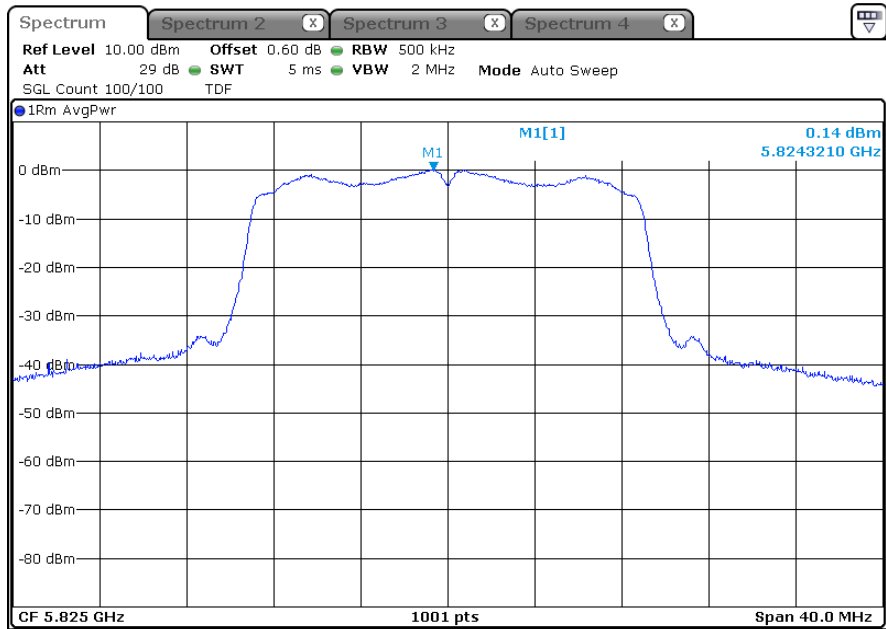


-5 825 MHz

ANT 1



ANT 2

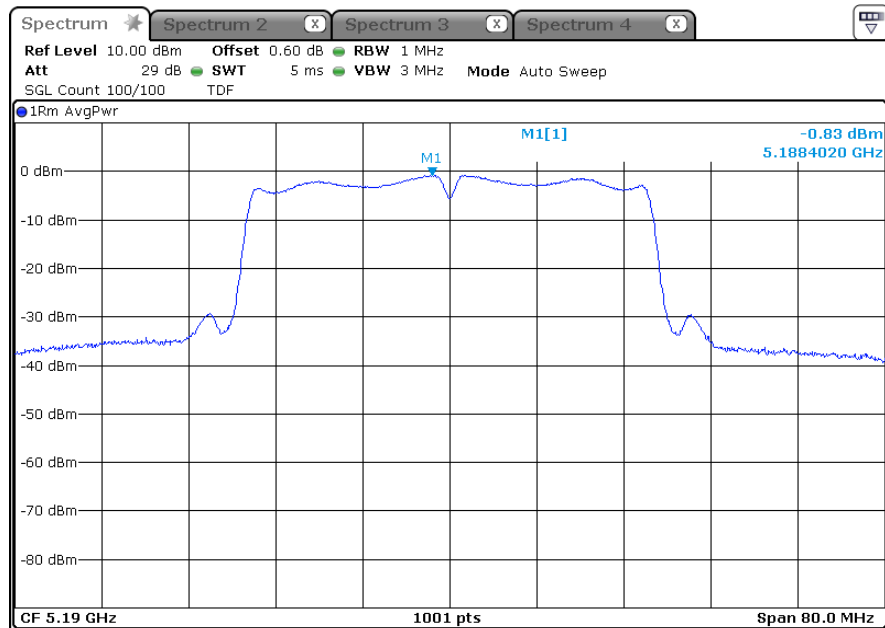


5.4.4 Test Plot

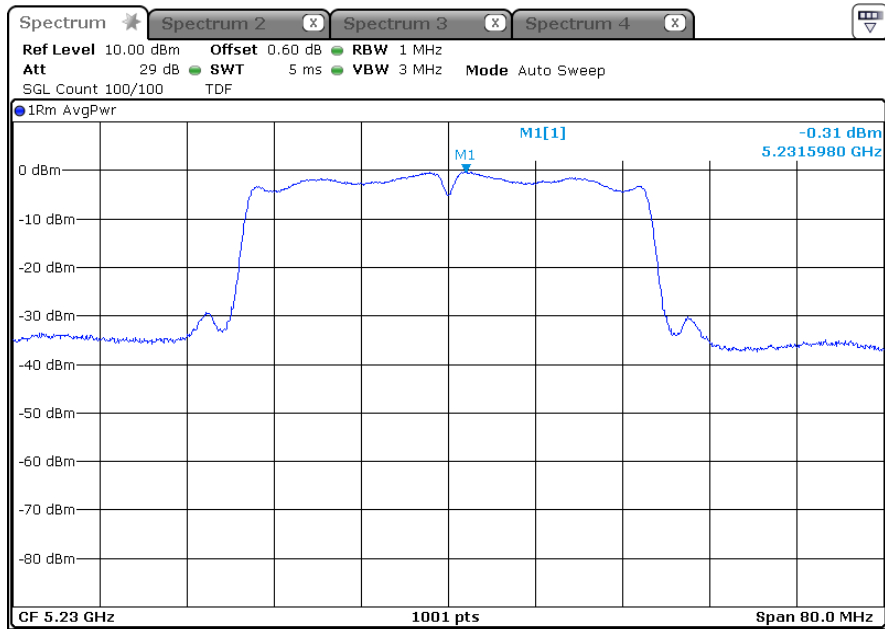
Figure 2. Plot of the Peak Power Spectral Density (Conducted)

* 802.11an HT40_5 150 Band (26 dB Bandwidth)

-5 190 MHz

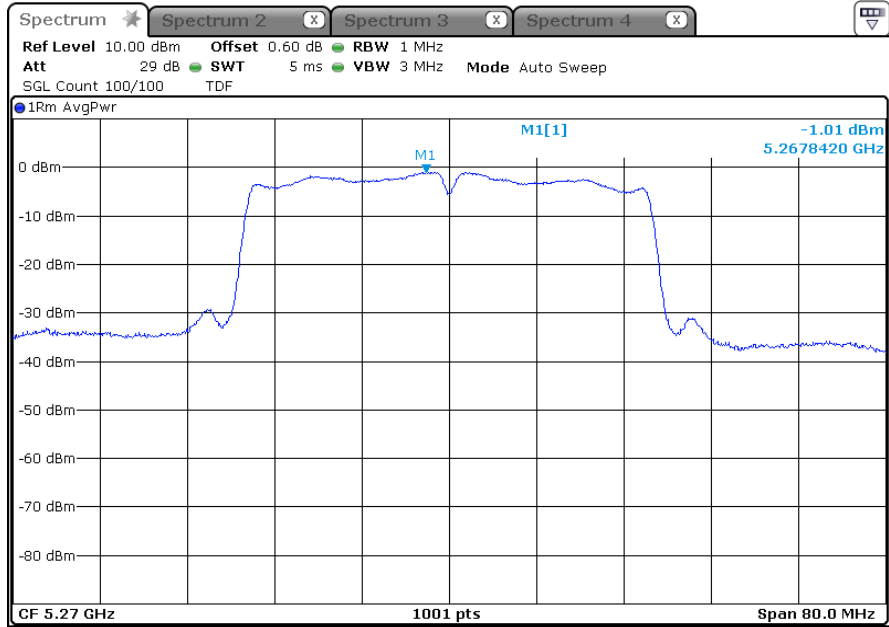


-5 230 MHz

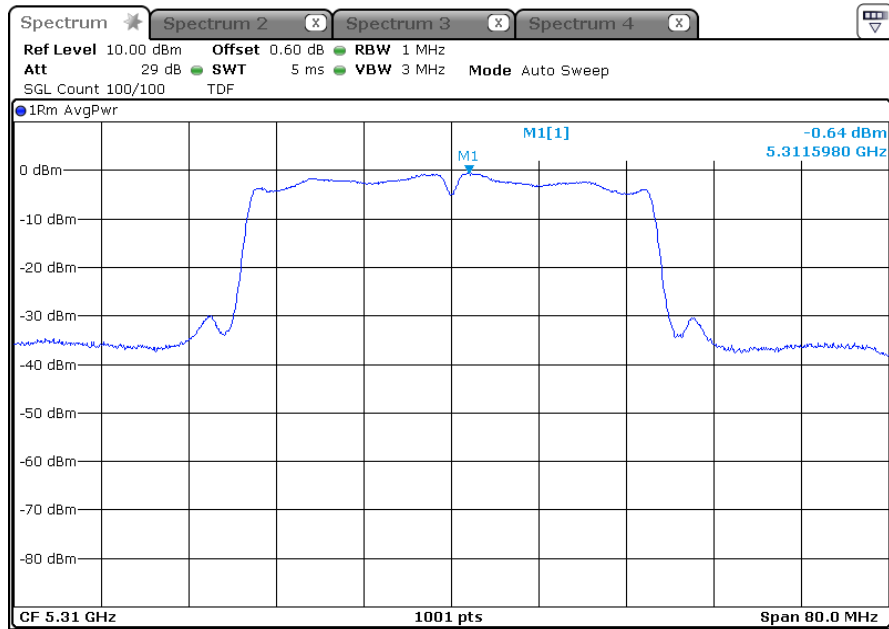


* 802.11an HT40_5 250 Band (26 dB Bandwidth)

-5 270 MHz

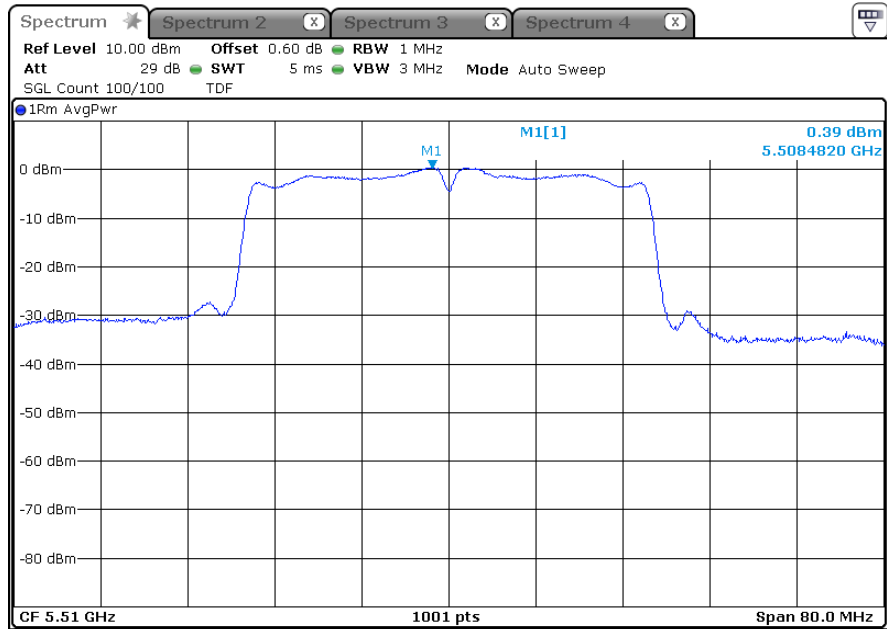


-5 310 MHz

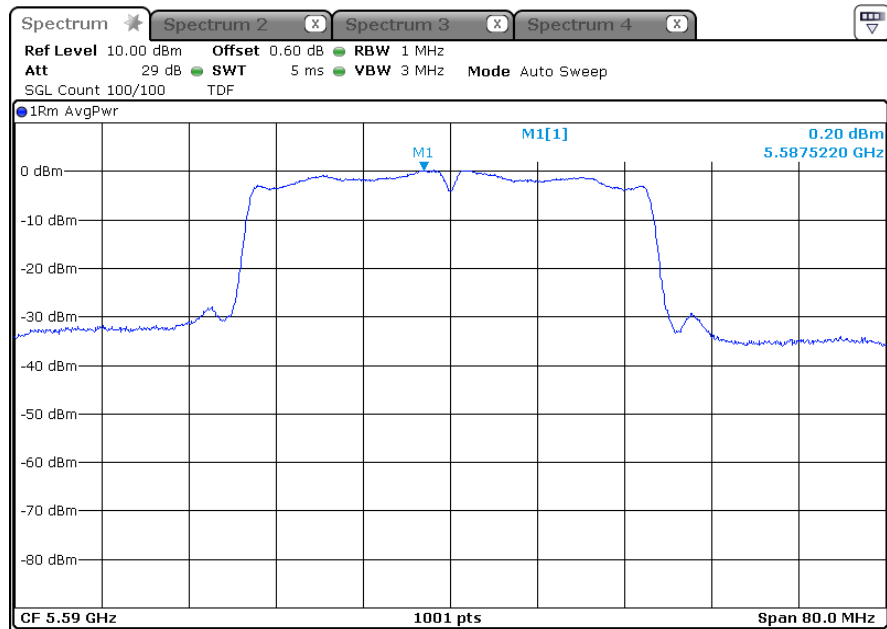


* 802.11an HT40_5 470 Band (26 dB Bandwidth)

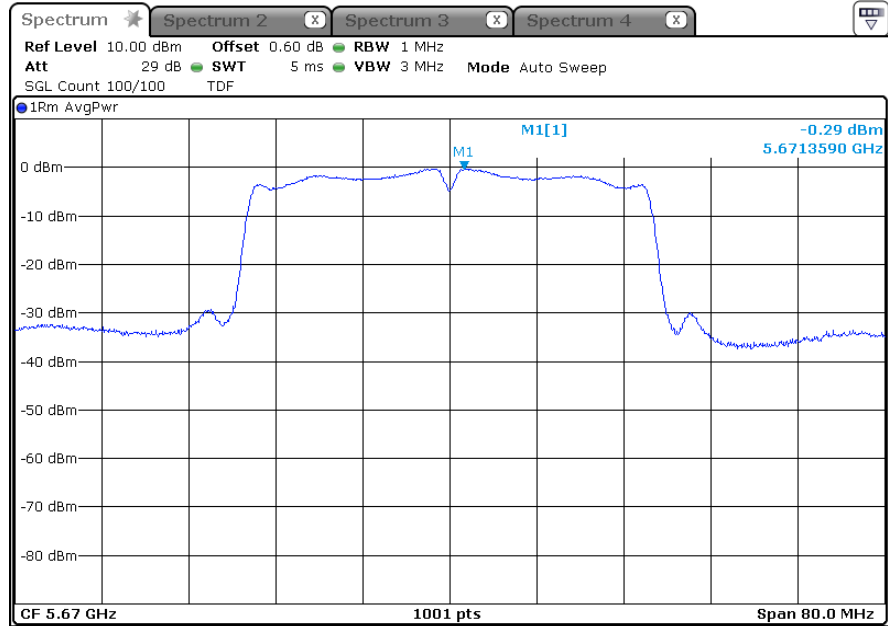
-5 510 MHz



-5 590 MHz

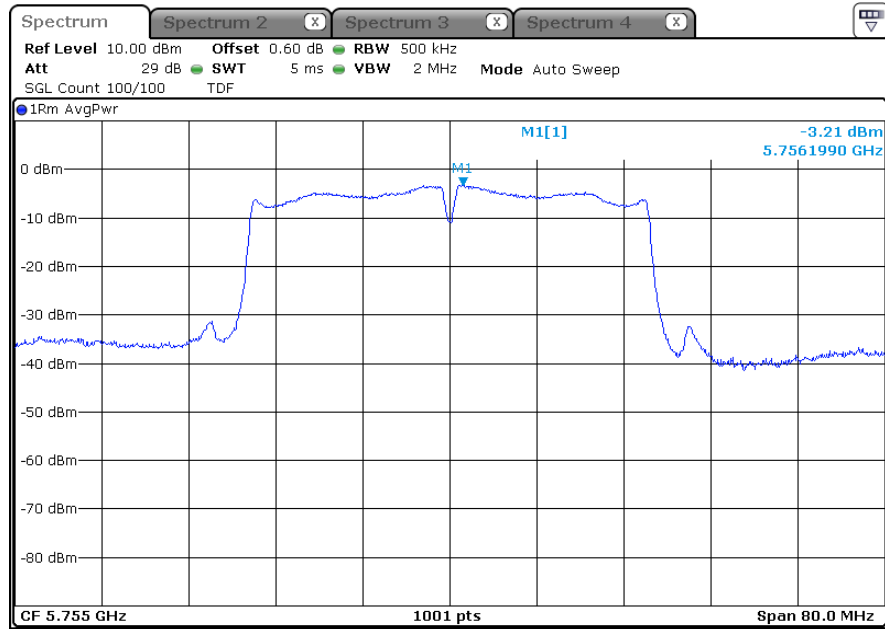


-5 670 MHz



* 802.11an HT40_5 725 Band (6 dB Bandwidth)

-5 755 MHz



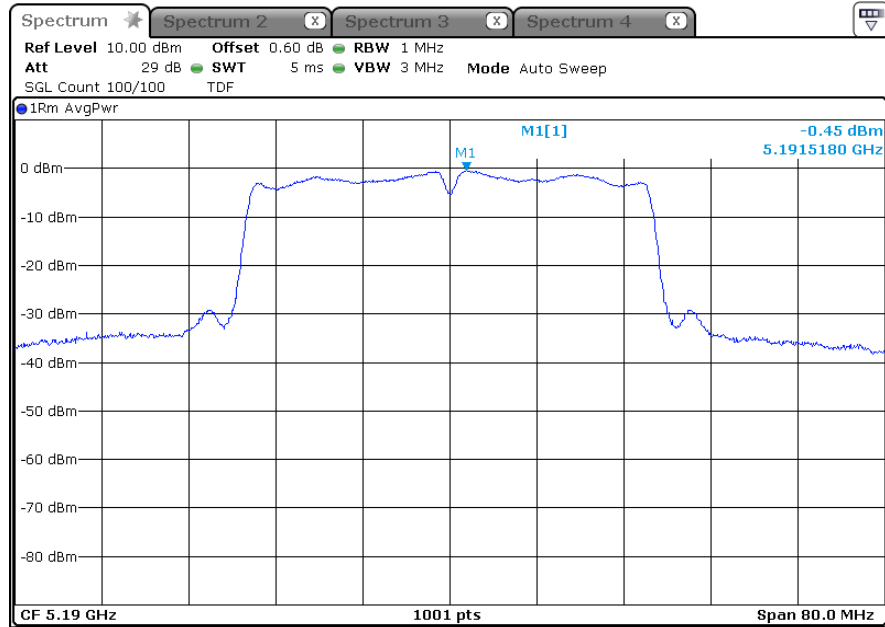
-5 795 MHz



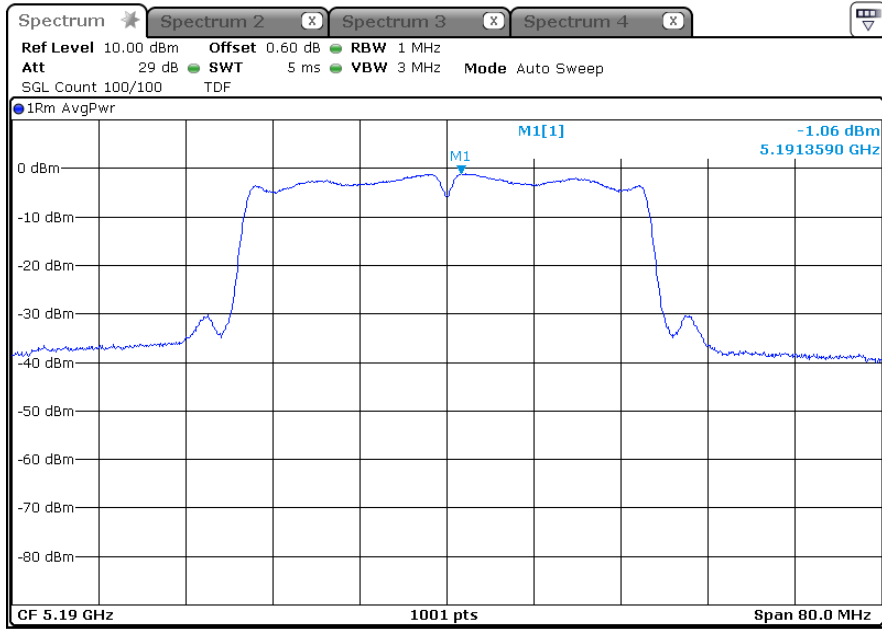
* 802.11an HT40_MIMO(ANT 1+2)_5 150 Band

-5 190 MHz

ANT 1

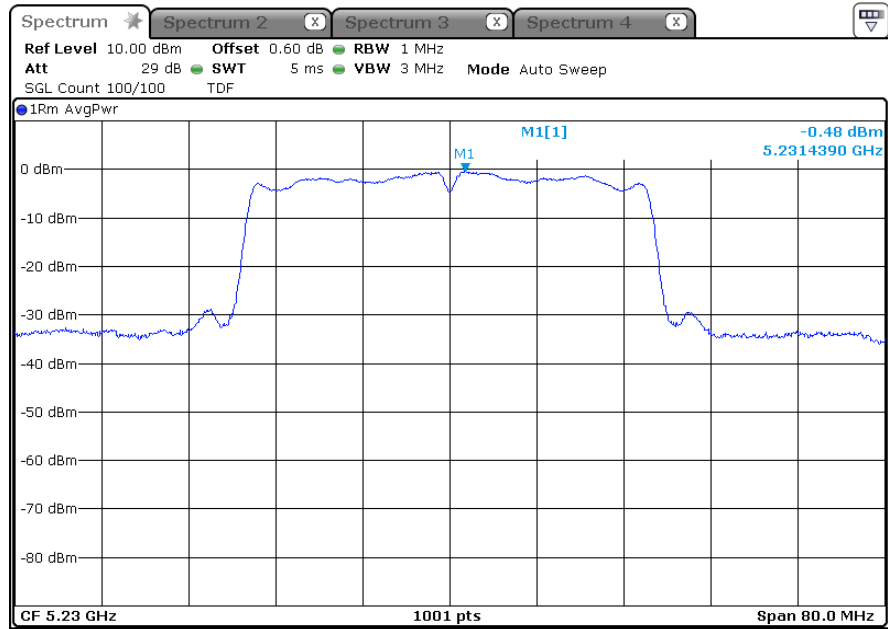


ANT 2



-5 230 MHz

ANT 1



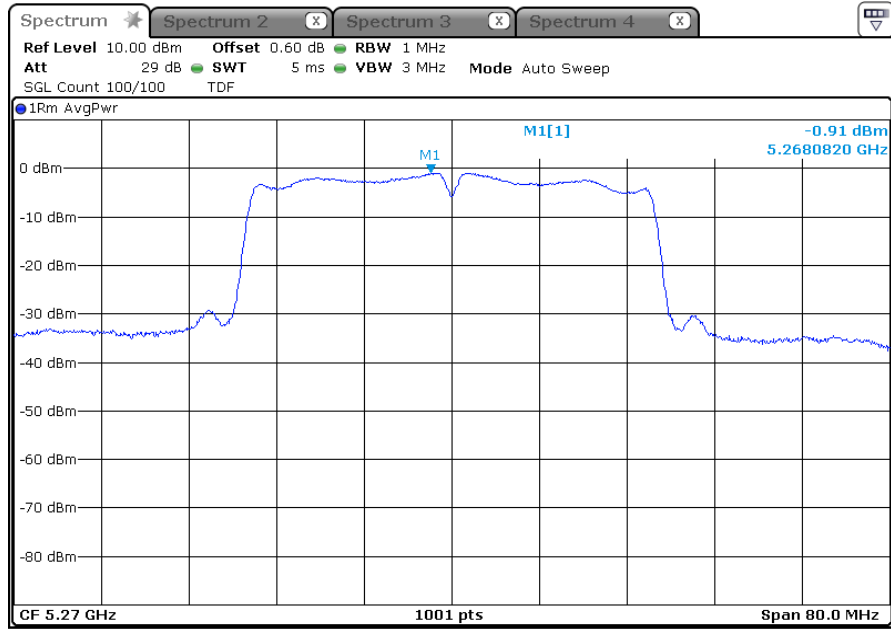
ANT 2



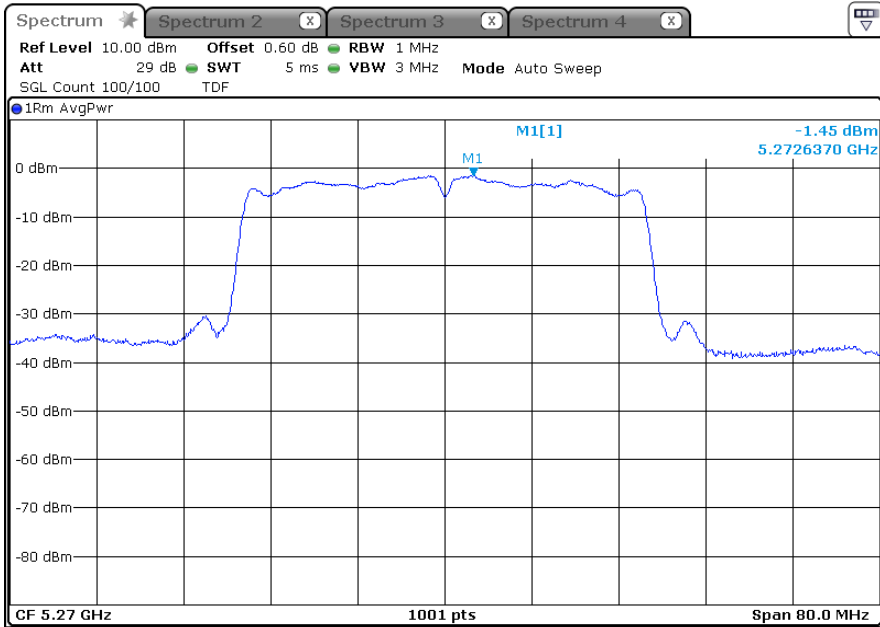
* 802.11an HT40_MIMO(ANT 1+2)_5 250 Band

-5 270 MHz

ANT 1

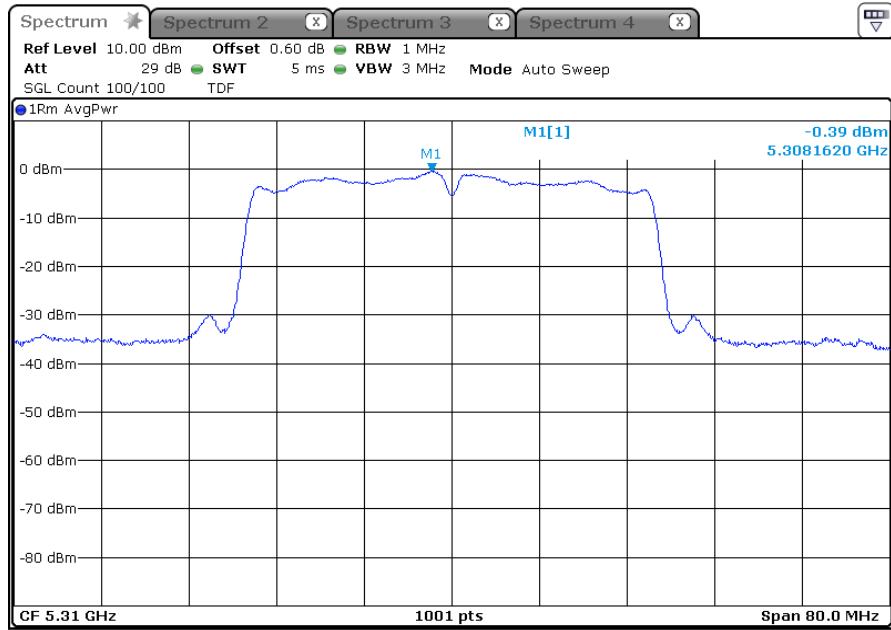


ANT 2

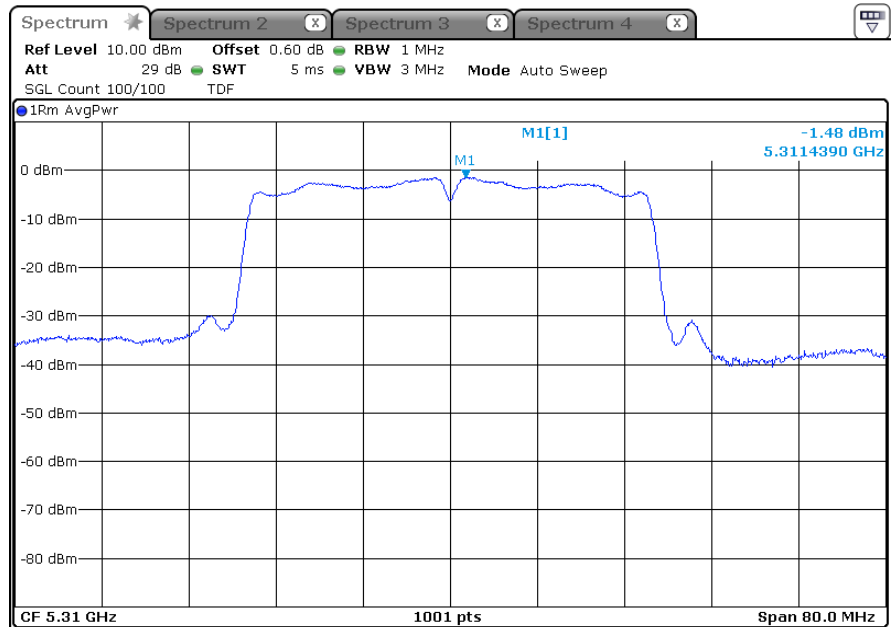


-5 310 MHz

ANT 1



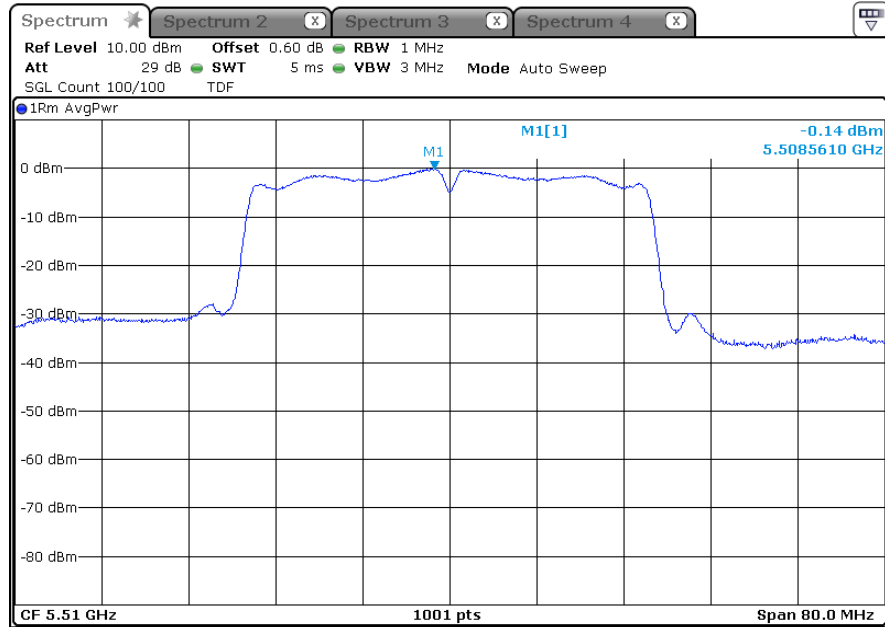
ANT 2



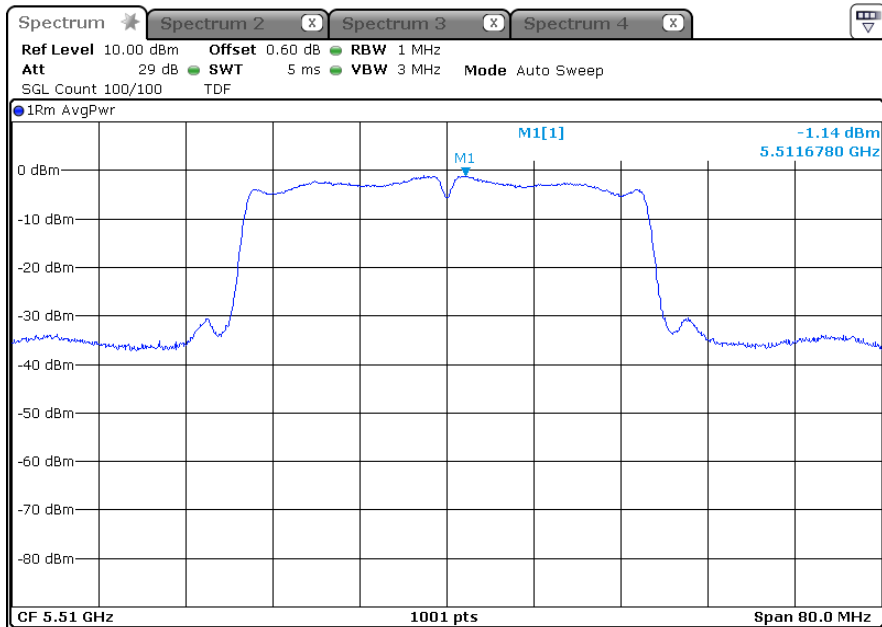
* 802.11an HT40_MIMO(ANT 1+2)_5 470 Band

-5 510 MHz

ANT 1

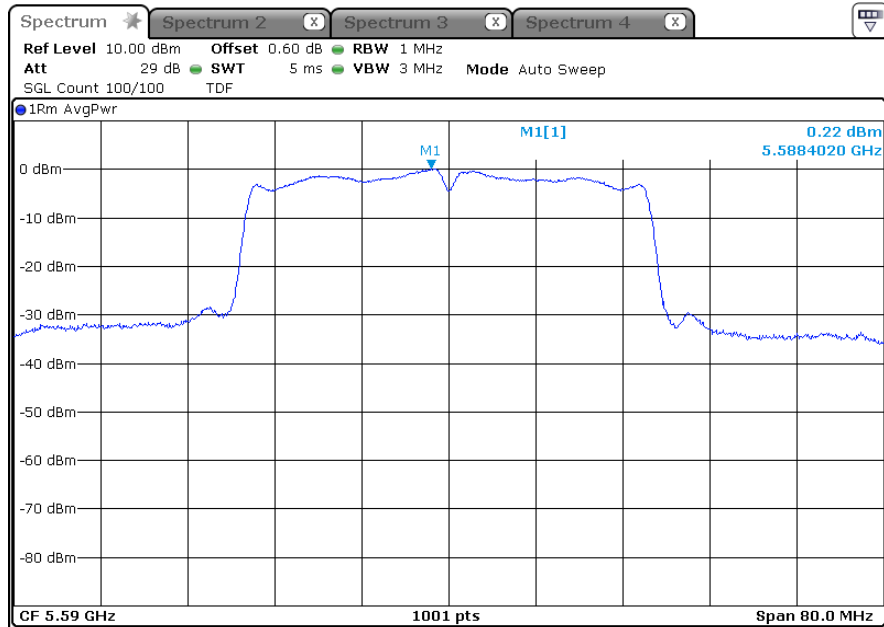


ANT 2

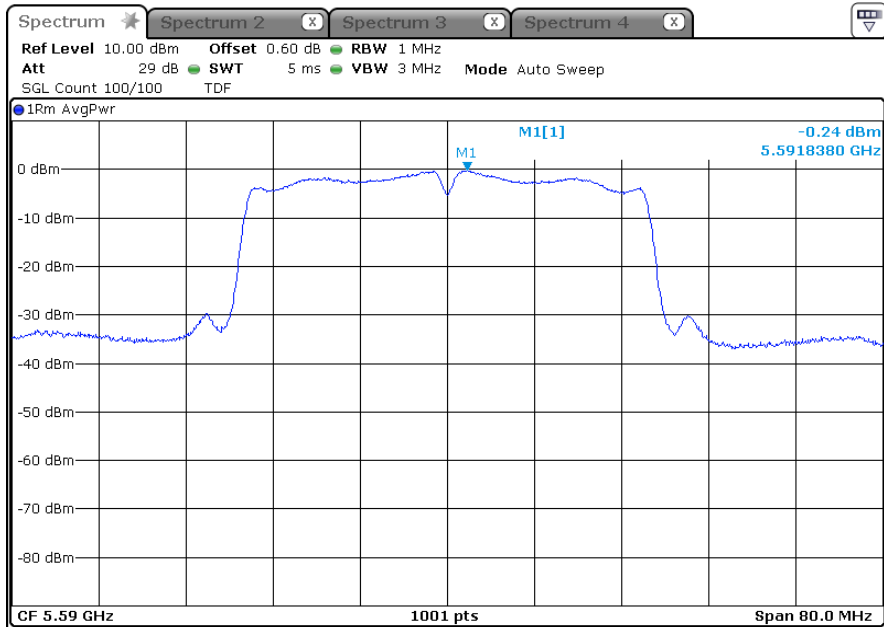


-5 590 MHz

ANT 1

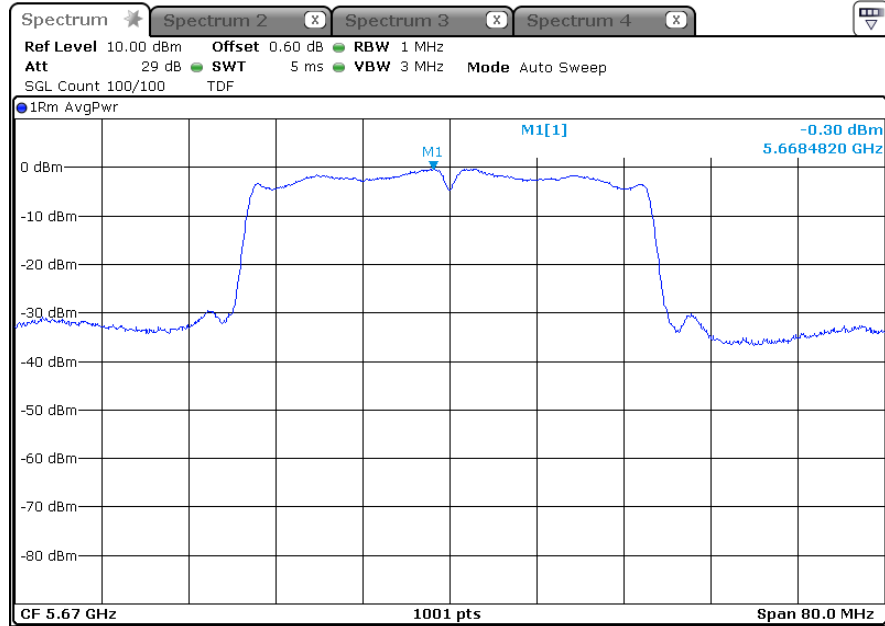


ANT 2

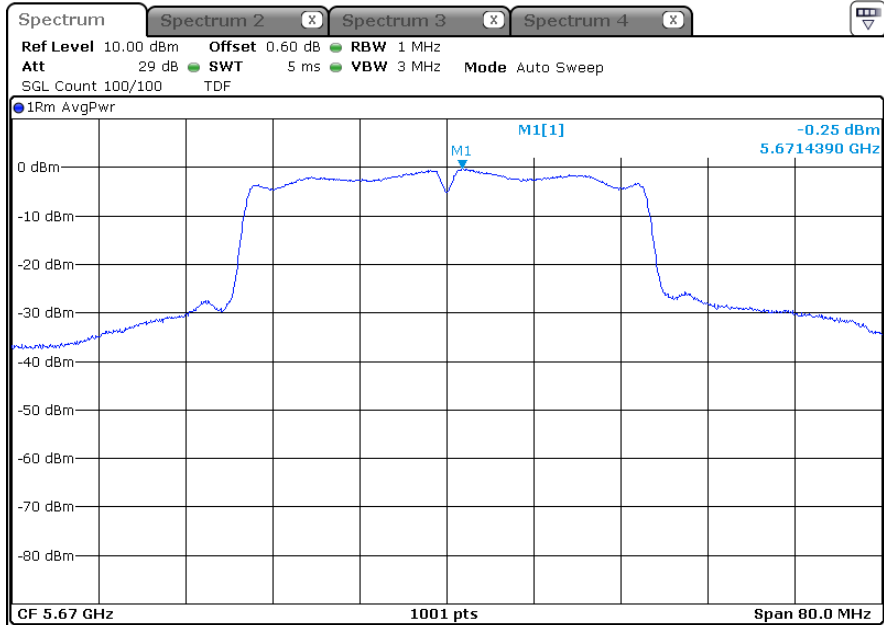


-5 670 MHz

ANT 1



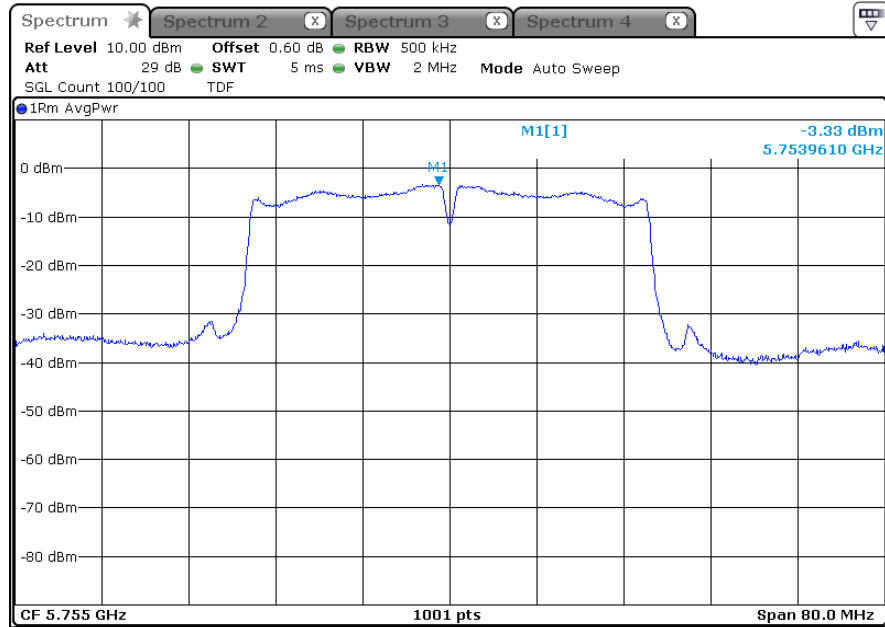
ANT 2



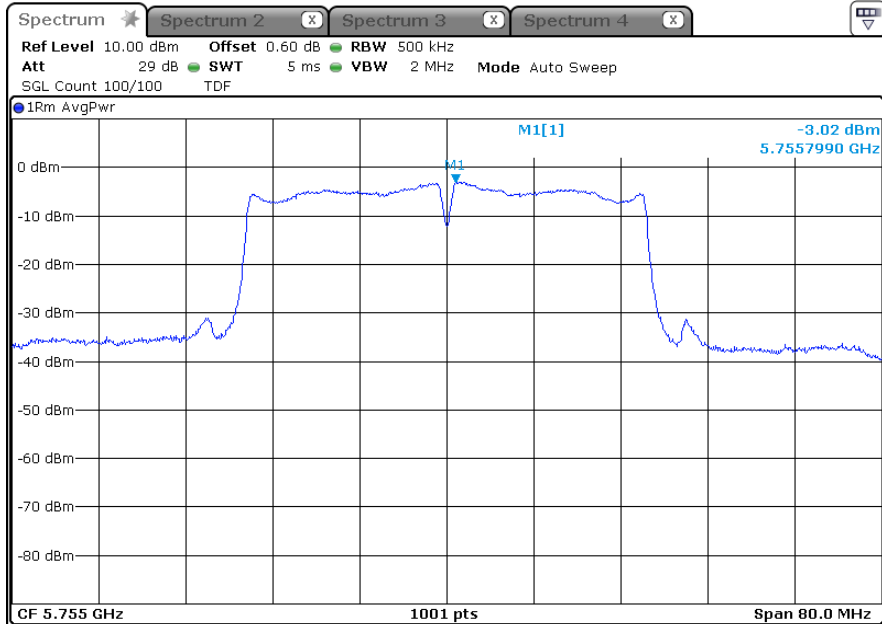
* 802.11an HT40_MIMO(ANT 1+2)_5 725 Band

-5 755 MHz

ANT 1



ANT 2



-5 795 MHz

ANT 1



ANT 2

