

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 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 dBthat 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.

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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 Mtz 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, "BW, 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 ≥ 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 kHz) is the reduced resolution bandwidth of the spectrum analyzer set during measurement.
- e) If measurement bandwidth of Maximum PSD is specified in 1 Mb, add 10log(1 Mb/RBW) to the measured result, whereas RBW (< 1 Mb) 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 kHz is available on nearly all spectrum analyzers.

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5.4.3 Test Result

-Complied

802.11a

5 150 Band

Frequency	Reading (dBm)	Duty Cycle (dB)	Total result	Limit	Margin
(MHz)	Ant1	(db)	(dBm)	(dBm)	(dB)
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 (Mb)	Reading (dBm)	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
(IVIIIZ)	Ant1	(ub)	(dDIII)	(dDIII)	(dD)
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	Reading (dBm)	Duty Cycle	Total result	Limit	Margin
(MHz)	Ant1	(dB)	(dBm)	(dBm)	(dB)
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

Frequency (Mb)	Reading (dBm) Ant1	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
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	Reading (dBm)	Duty Cycle	Total result	Limit	Margin
(MHz)	Ant1	(dB)	(dBm)	(dBm)	(dB)
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 (妣)	Reading (dBm) Ant1	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
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	Reading (dBm)	Duty Cycle	Total result	Limit	Margin
(MHz)	Ant1	(dB)	(dBm)	(dBm)	(dB)
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

Frequency (州也)	Reading (dBm) Ant1	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
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	Reading (c	HBm)	Duty Cycle	Total result	Limit	Margin
(MHz)	Ant 1	Ant 2	(dB)	(dBm)	(dBm)	(dB)
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	Reading (c	Bm)	Duty Cycle	Total result	Limit	Margin
(MHz)	Ant 1	Ant 2	(dB)	(dBm)	(dBm)	(dB)
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	Reading (c	HBm)	Duty Cycle	Total result	Limit	Margin
(MHz)	Ant 1	Ant 2	(dB)	(dBm)	(dBm)	(dB)
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

Frequency	Reading (c	lBm)	Duty Cycle	Total result	Limit	Margin
(MHz)	Ant 1	Ant 2	(dB)	(dBm)	(dBm)	(dB)
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 (Mb)	Reading (dBm) Ant1	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
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 (Mb)	Reading (dBm)	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
(IVIIZ)	Ant1	(db)	(dbiii)	(dbiii)	(db)
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 (Mtz)	Reading (dBm) Ant1	Duty Cycle (dB)	Total result (dBm)	Limit (dBm)	Margin (dB)
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

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Frequency	Reading (dBm)	Duty Cycle	Total result	Limit	Margin
(MHz)	Ant1	(dB)	(dBm)	(dBm)	(dB)
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	Reading (c	HBm)	Duty Cycle	Total result	Limit	Margin
(MHz)	Ant 1	Ant 2	(dB)	(dBm)	(dBm)	(dB)
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	Reading (c	lBm)	Duty Cycle	Total result	Limit	Margin
(MHz)	Ant 1	Ant 2	(dB)	(dBm)	(dBm)	(dB)
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	Reading (c	HBm)	Duty Cycle	Total result	Limit	Margin
(MHz)	Ant 1	Ant 2	(dB)	(dBm)	(dBm)	(dB)
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	Reading (c	lBm)	Duty Cycle	Total result	Limit	Margin
(MHz)	Ant 1	Ant 2	(dB)	(dBm)	(dBm)	(dB)
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:

- 1. Total PSD calculation = $10\log(10^{\Lambda}(Ant1 PSD / 10) + 10^{\Lambda}(Ant2 PSD / 10))$
- 2. 802.11a: 5 825 M/z: Duty cycle = 0.952 1, Duty cycle factor = $10\log(1/\text{duty cycle}) = 10\log(1/0.952 1) = 0.21 \text{ dB}$. 802.11an HT20: 5 200 M/z: Duty cycle = 0.950 5, Duty cycle factor = $10\log(1/\text{duty cycle}) = 10\log(1/0.950 5) = 0.22 \text{ dB}$. 802.11an HT40: 5 795 M/z: Duty cycle = 0.906 9, Duty cycle factor = $10\log(1/\text{duty cycle}) = 10\log(1/0.906 9) = 0.42 \text{ dB}$.
- 3. Result = Ant1 Total PSD calculation + Duty Factor

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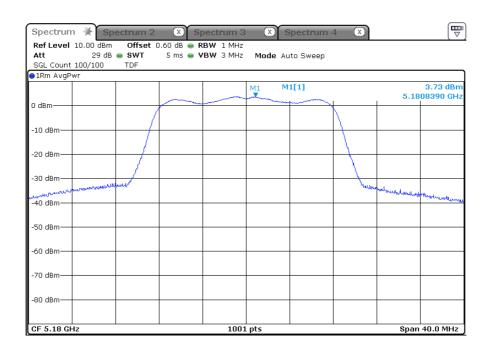


5.4.4 Test Plot

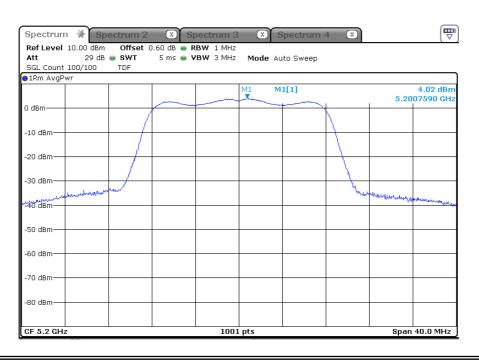
Figure 2. Plot of the Power Spectral Density

* 802.11a_5 150 Band

-5 180 Mbz

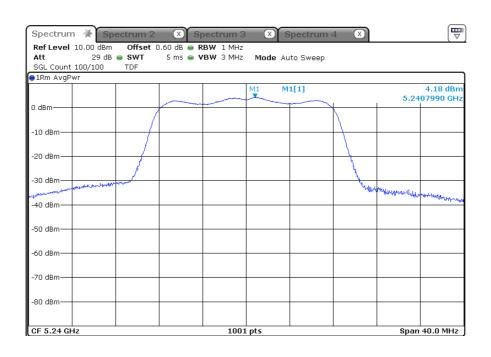


-5 200 MHz





-5 240 MHz

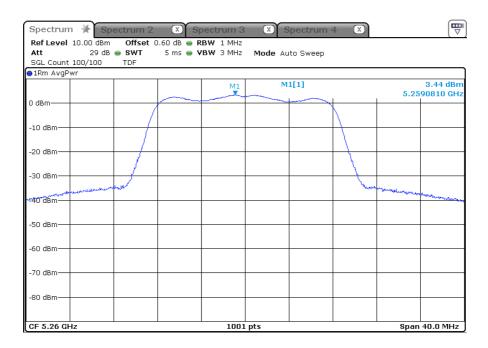


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* 802.11a_5 250 Band

-5 260 Mbz



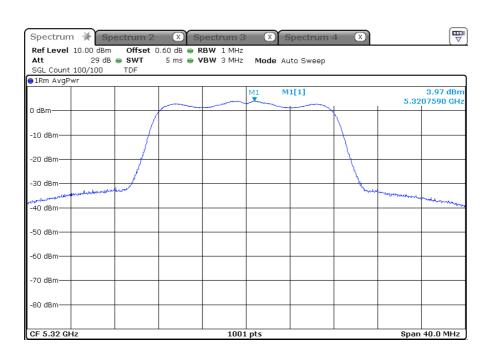
-5 280 MHz



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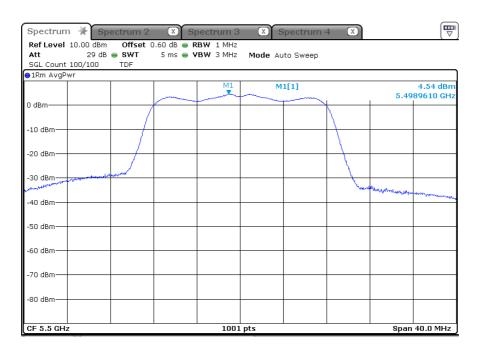






* 802.11a_5 470 Band

-5 500 MHz



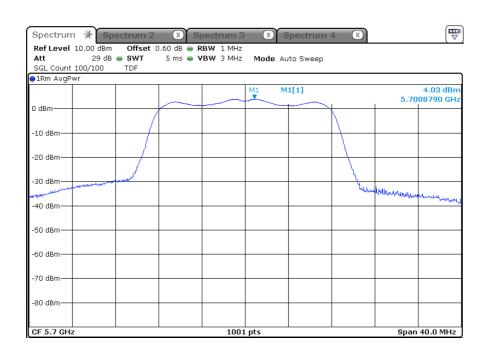
-5 580 MHz



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-5 700 MHz



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* 802.11a_5 725 Band

-5 745 Mbz



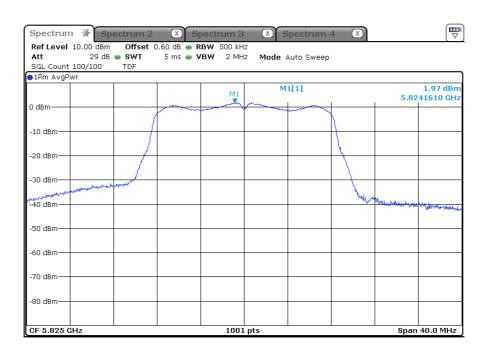
-5 785 MHz



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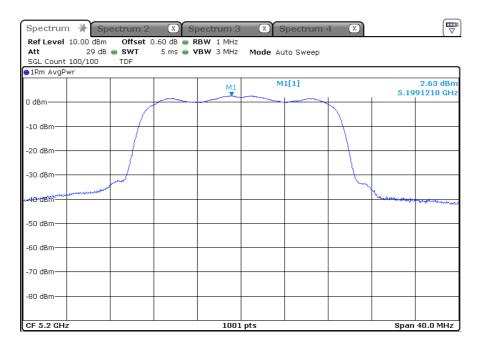


* 802.11an HT20 _5 150 Band

-5 180 Mbz



-5 200 MHz









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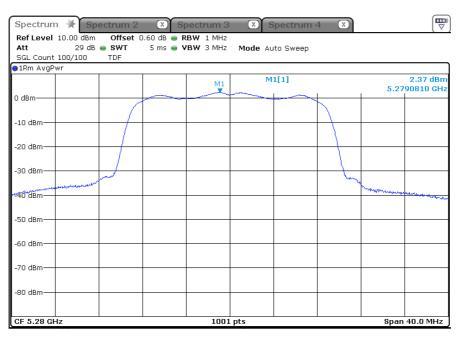


* 802.11an HT20_5 250 Band

-5 260 Mbz



-5 280 MHz





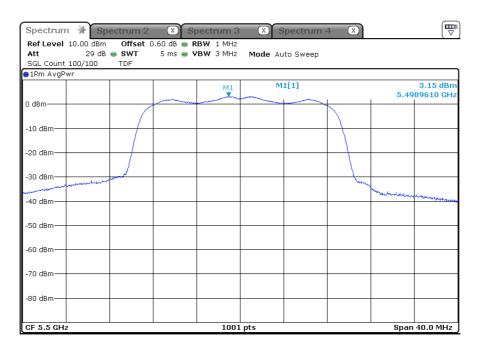






* 802.11an HT20_5 470 Band

-5 500 MHz



-5 580 MHz









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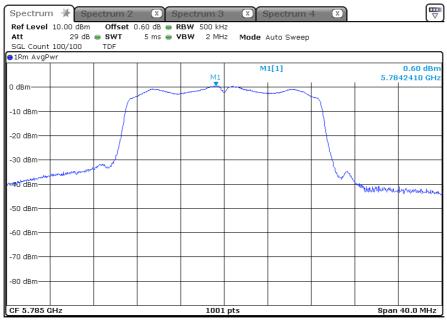


* 802.11an HT20_ 5 725 Band

-5 745 MHz

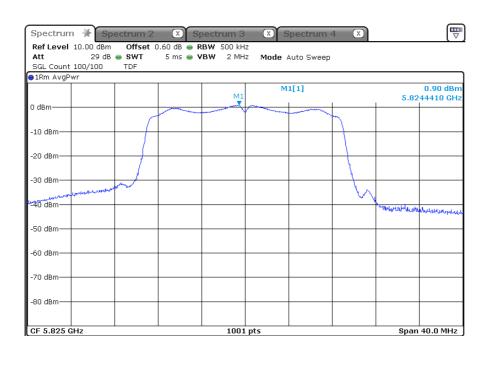


-5 785 MHz











* 802.11an HT20_MIMO(ANT 1+2)_5 150 Band -5 180 MHz ANT 1 Spectrum 2 Spectrum 3 Ref Level 10.00 dBm Offset 0.60 dB • RBW 1 MHz Att 29 dB • SWT SGL Count 100/100 TDF Mode Auto Sweep ●1Rm AvgPwr M1[1] 2.35 dBn 5.1789210 GH 0 dBm -10 dBm -20 dBm -30 dBm -40 dBm -50 dBm -60 dBm -70 dBm -80 dBm CF 5.18 GHz 1001 pts Span 40.0 MHz ANT 2 Spectrum 2 Spectrum 3 Spectrum 4 Ref Level 10.00 dBm Offset 0.60 dB RBW 1 MHz 29 dB 🅌 SWT 5 ms 🍎 **VBW** 3 MHz Mode Auto Sweep ● 1Rm AvqPwi 1.63 dBn 5.1789210 GH M1[1] 0 dBm -10 dBm -20 dBm 40 dBm -50 dBm -60 dBm -80 dBm Span 40.0 MHz CF 5.18 GHz 1001 pts

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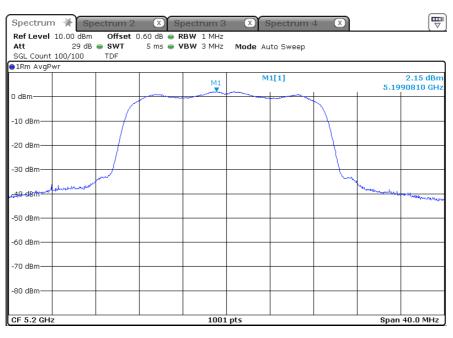




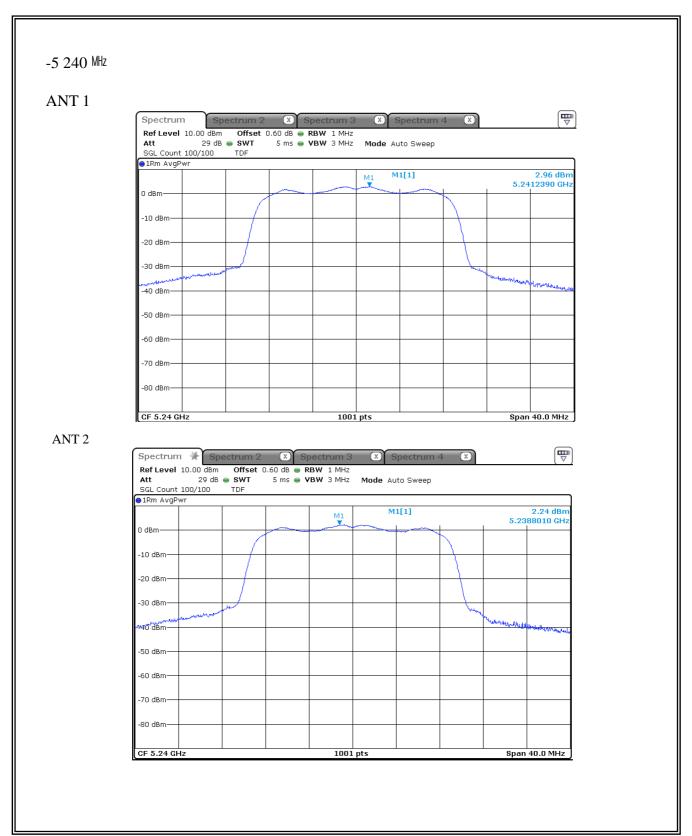
ANT 1



ANT 2







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* 802.11an HT20_MIMO(ANT 1+2)_5 250 Band -5 260 MHz ANT 1 Spectrum 2 Spectrum 3 Ref Level 10.00 dBm Offset 0.60 dB • RBW 1 MHz 29 dB 🎃 SWT Mode Auto Sweep SGL Count 100/100 TDF ●1Rm AvgPwr M1[1] 2.26 dBn 5.2590810 GH 0 dBm--20 dBm -30 dBm 40 dBm -50 dBm -60 dBm -70 dBm -80 dBm CF 5.26 GHz 1001 pts Span 40.0 MHz ANT 2 Spectrum Spectrum 2 × Spectrum 3 Spectrum 4 Ref Level 10.00 dBm Offset 0.60 dB @ RBW 1 MHz 29 dB 🅌 SWT 5 ms 🍎 **VBW** 3 MHz Mode Auto Sweep SGL Count 100/100 ● 1Rm AvqPwi 1.58 dBn 5.2609190 GH M1[1] 0 dBm -10 dBm -20 dBm -50 dBm -60 dBm -70 dBm -80 dBm Span 40.0 MHz 1001 pts CF 5.26 GHz

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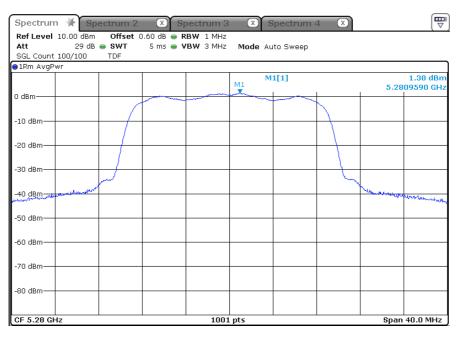


-5 280 MHz

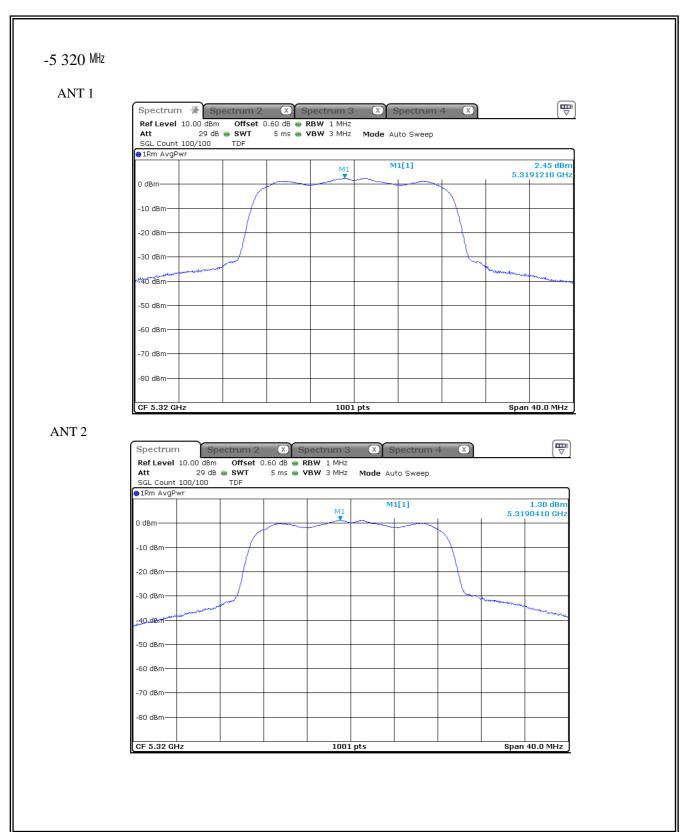
ANT 1



ANT 2

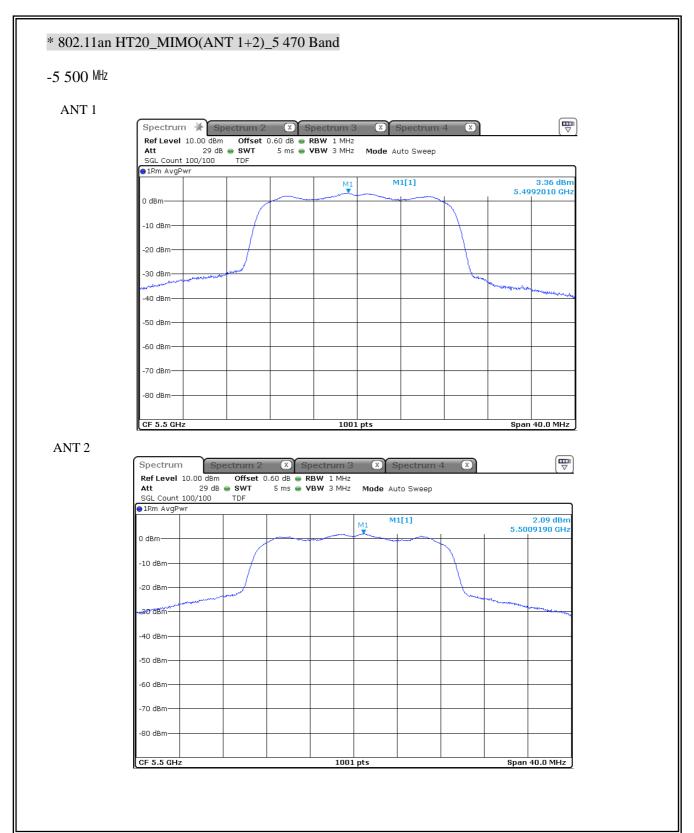






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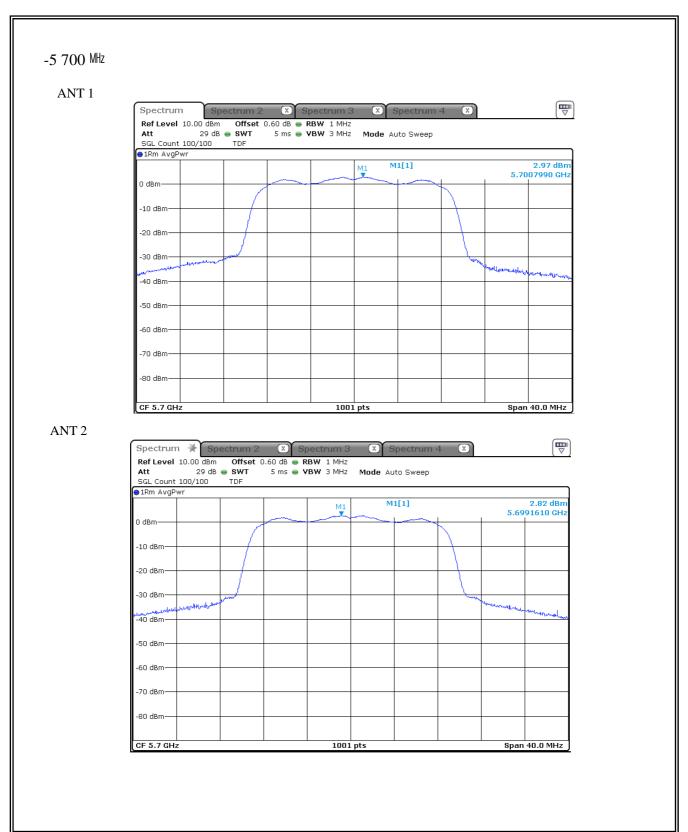
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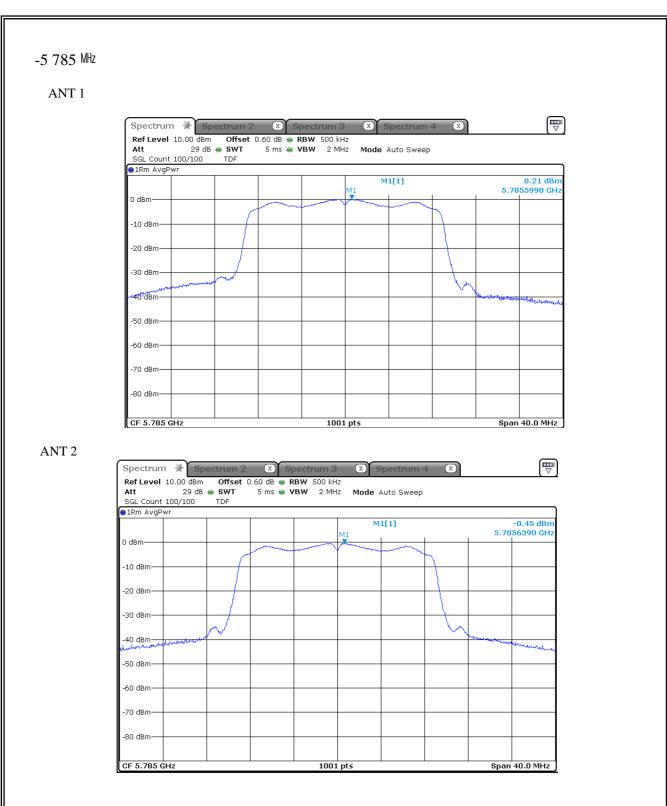
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* 802.11an HT20_MIMO(ANT 1+2)_5 725 Band -5 745 MHz ANT 1 Spectrum 2 Spectrum 3 Ref Level 10.00 dBm Offset 0.60 dB RBW 500 kHz Att 29 dB SWT 5 ms VBW 2 MHz Mode Auto Sweep SGL Count 100/100 TDF 1Rm AvgPwr M1[1] -0.07 dBm 5.7455990 GHz 0 dBm -20 dBm -30 dBm 40 dBff -50 dBm -60 dBm -70 dBm -80 dBm CF 5.745 GHz 1001 pts Span 40.0 MHz ANT 2 Spectrum 🛊 Spectrum **Offset** 0.60 dB **● RBW** 500 kHz **SWT** 5 ms **● VBW** 2 MHz Ref Level 10.00 dBm 29 dB 🁄 SWT Mode Auto Sweep SGL Count 100/100 ●1Rm AvgPwr -0.44 dBm 5.7454400 GH M1[1] -10 dBm -20 dBm -30 dBm -40 dBm--50 dBm -70 dBm Span 40.0 MHz CF 5.745 GHz 1001 pts

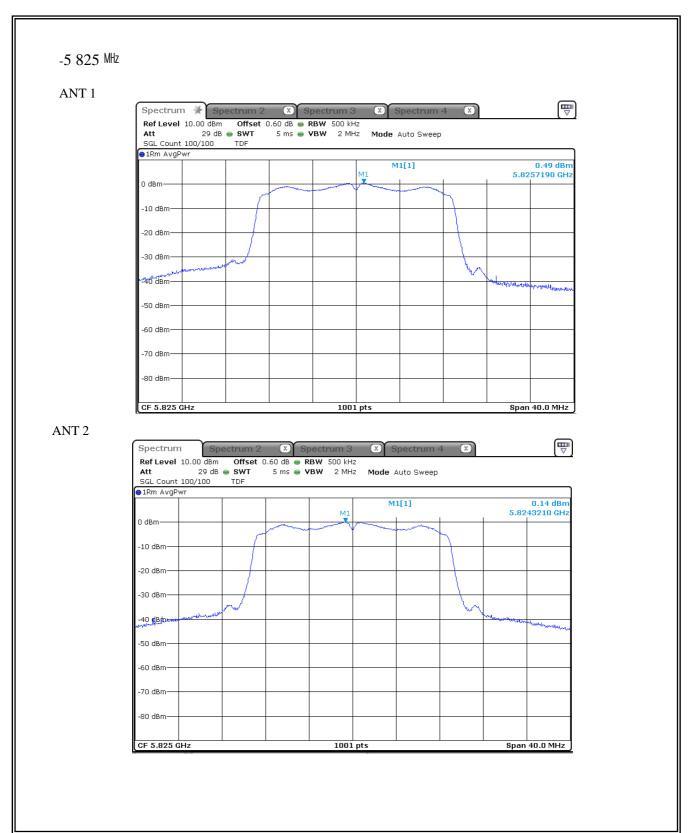
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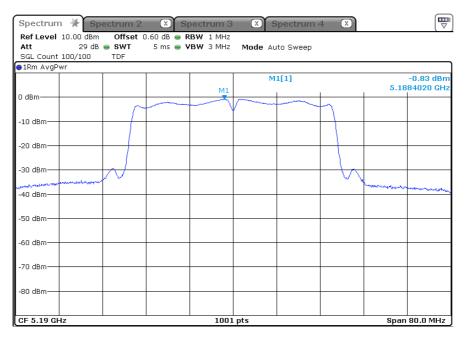


5.4.4 Test Plot

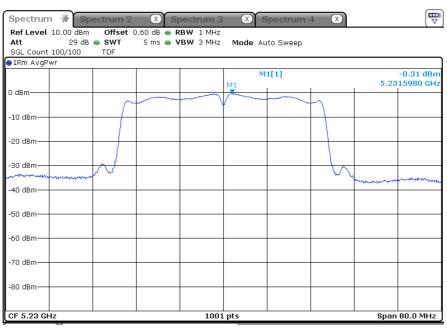
Figure 2. Plot of the Peak Power Spectral Density (Conducted)

* 802.11an HT40_5 150 Band (26 dB Bandwidth)

-5 190 Mb



-5 230 MHz





* 802.11an HT40_5 250 Band (26 dB Bandwidth)

-5 270 Mbz



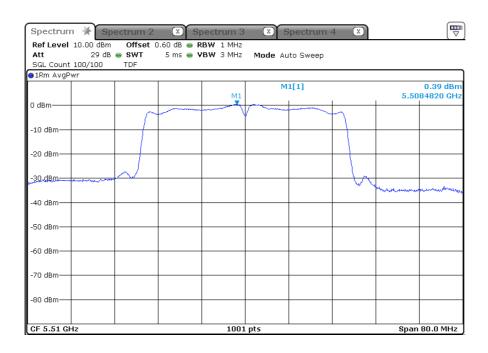
-5 310 MHz



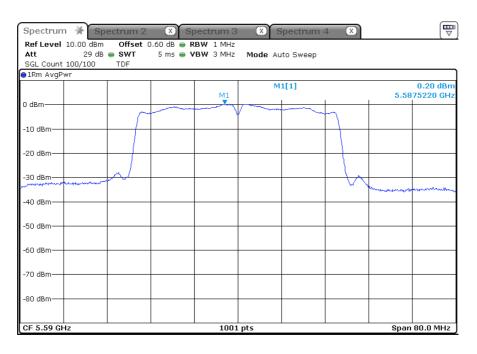


* 802.11an HT40_5 470 Band (26 dB Bandwidth)

-5 510 Mbz

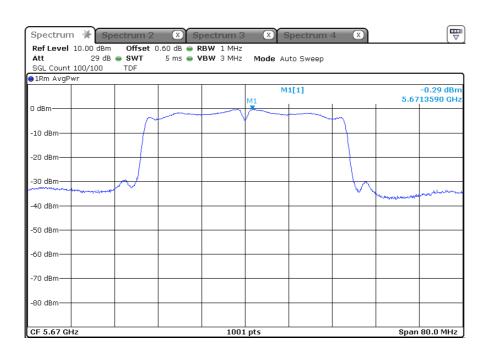


-5 590 Mz









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* 802.11an HT40_5 725 Band (6 dB Bandwidth)

-5 755 Mbz



-5 795 Mbz

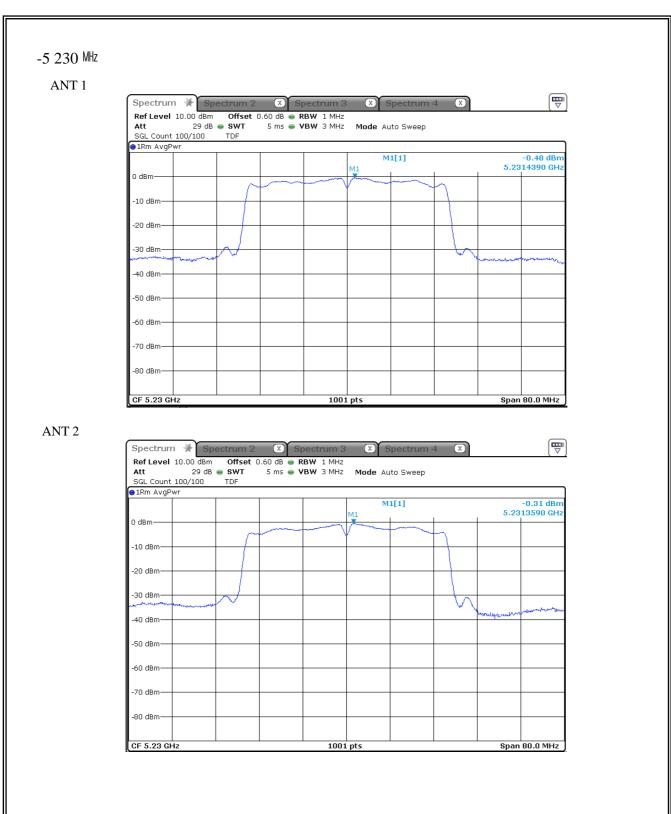




* 802.11an HT40_MIMO(ANT 1+2)_5 150 Band -5 190 Mbz ANT 1 Spectrum 2 Spectrum 3 X Spectrum 4 X Ref Level 10.00 dBm Offset 0.60 dB ■ RBW 1 MHz Att 29 dB ■ SWT 5 ms ■ VBW 3 MHz SGL Count 100/100 TDF TDF ■ VBW 3 MHz Mode Auto Sweep ●1Rm AvgPwr -0.45 dBm 5.1915180 GHz M1[1] 0 dBm--10 dBm -20 dBm -30 dBm -40 dBm -50 dBm -60 dBm -70 dBm -80 dBm Span 80.0 MHz CF 5.19 GHz 1001 pts ANT 2 Spectrum 2 Spectrum 3 Ref Level 10.00 dBm Offset 0.60 dB ■ RBW 1 MHz Att 29 dB ■ SWT 5 ms ■ VBW 3 MHz SGL Count 100/100 TDF Mode Auto Sweep ● 1Rm AvgPwr M1[1] -1.06 dBn 5.1913590 GH 0 dBm -10 dBm -20 dBm -40 dBm--60 dBm -70 dBm -80 dBm CF 5.19 GHz 1001 pts Span 80.0 MHz

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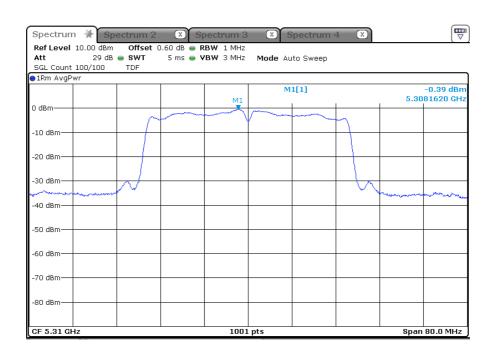
* 802.11an HT40_MIMO(ANT 1+2)_5 250 Band -5 270 Mbz ANT 1 Spectrum 2 Spectrum 3 X Spectrum 4 X Ref Level 10.00 dBm Offset 0.60 dB RBW 1 MHz Att 29 dB SWT 5 ms VBW 3 MHz Mode Auto Sweep SGL Count 100/100 ●1Rm AvgPwr -0.91 dBm 5.2680820 GH M1[1] 0 dBm--10 dBm -20 dBm -30 dBm -40 dBm -50 dBm -60 dBm -70 dBm -80 dBm Span 80.0 MHz CF 5.27 GHz 1001 pts ANT 2 Spectrum 2 × Spectrum 3 Ref Level 10.00 dBm Offset 0.60 dB ■ RBW 1 MHz Att 29 dB ■ SWT 5 ms ■ VBW 3 MHz SGL Count 100/100 TDF Mode Auto Sweep ● 1Rm AvgPwr M1[1] -1.45 dBn 0 dBm -10 dBm -20 dBm -40 dBm -60 dBm -70 dBm -80 dBm CF 5.27 GHz 1001 pts Span 80.0 MHz

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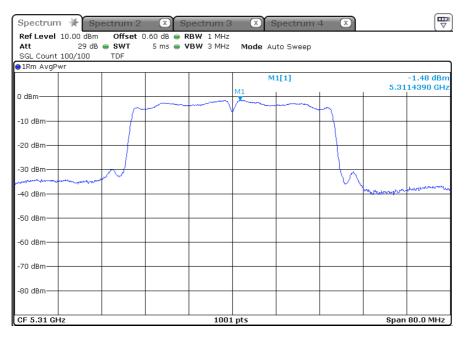




ANT 1



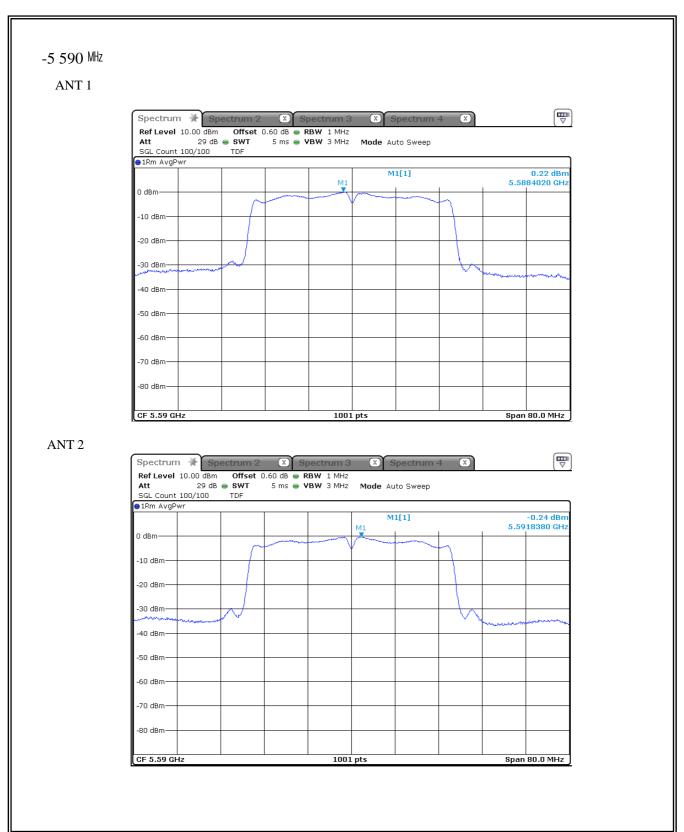
ANT 2



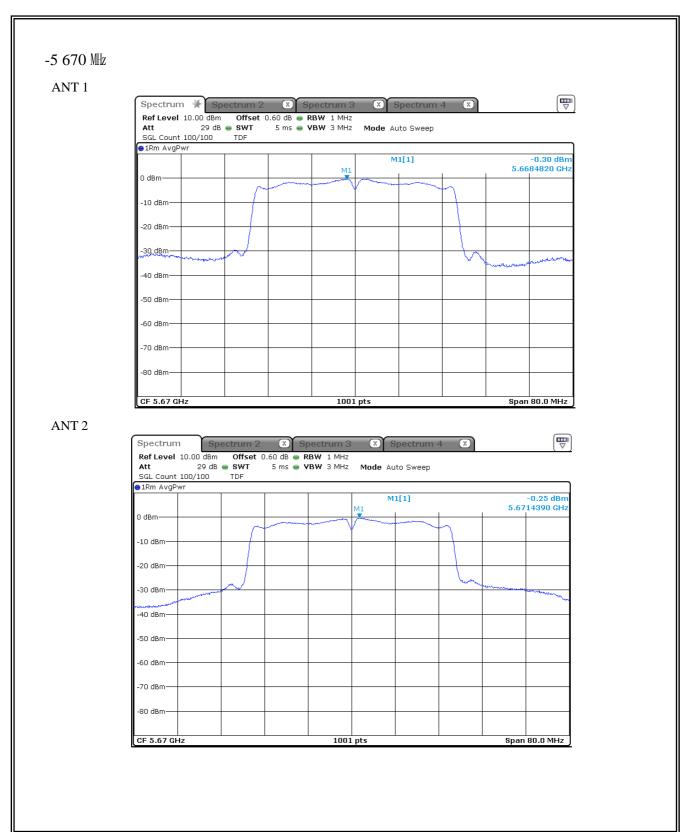


* 802.11an HT40_MIMO(ANT 1+2)_5 470 Band -5 510 Mbz ANT 1 Spectrum 2 Spectrum 3 Ref Level 10.00 dbm Offset 0.60 db RBW 1 MHz Att 29 db SWT 5 ms VBW 3 MHz SGL Count 100/100 TDF Mode Auto Sweep ●1Rm AvgPwr -0.14 dBn 5.5085610 GH M1[1] 0 dBm--10 dBm -20 dBm -30 dBm: -40 dBm -50 dBn -60 dBm -70 dBm -80 dBm Span 80.0 MHz CF 5.51 GHz 1001 pts ANT 2 Spectrum 2 ★ Spectrum 2 ★ Spectrum Ref Level 10.00 dBm Offset 0.60 dB ■ RBW 1 MHz 29 dB ■ SWT 5 ms ■ VBW 3 MHz Att 29 dB ● SWT SGL Count 100/100 TDF Mode Auto Sweep ●1Rm AvgPwr M1[1] -1.14 dBn 5.5116780 GH 0 dBm -10 dBm -20 dBm -30 dBm--40 dBm -50 dBm -60 dBm -70 dBm -80 dBm CF 5.51 GHz 1001 pts Span 80.0 MHz









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* 802.11an HT40_MIMO(ANT 1+2)_5 725 Band -5 755 Mbz ANT 1 Spectrum 2 Spectrum 3 Spectrum 4 Ref Level 10.00 dBm Offset 0.60 dB e RBW 500 kHz Att 29 dB e SWT 5 ms e VBW 2 MHz SGL Count 100/100 TDF Mode Auto Sweep ●1Rm AvgPwr -3.33 dBm 5.7539610 GHz M1[1] 0 dBm--10 dBm -20 dBm -30 dBm -40 dBm -50 dBm -60 dBm -70 dBm -80 dBm Span 80.0 MHz CF 5.755 GHz 1001 pts ANT 2 Spectrum 2 X Spectrum 3 Ref Level 10.00 dBm Offset 0.60 dB RBW 500 kHz Att 29 dB ● SWT SGL Count 100/100 TDF 5 ms 🅌 VBW Mode Auto Sweep ●1Rm AvgPwr M1[1] -3.02 dBn 5.7557990 GH 0 dBm -10 dBm





