

8 MAXIMUM CONDUCTED OUTPUT POWER MEASUREMENT

8.1 Test Equipment

The following test equipment was used during the maximum peak output power measurement:

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Spectrum Analyzer	Agilent	N9010A	MY52221182	2020.09.16	1 Year
2.	Coaxial Cable	WOKEN	SFL402-105F LEX	F02-150819-045	2021.03.08	1 Year
3.	20 dB Attenuator	Mini-Circuits	VAT-20+	001	2020.08.06	1 Year

8.2 Block Diagram of Test Setup

The Same as Section. 6.2.

8.3 Specification Limits ((§15.407(a))

(1) For the band 5.15-5.25 GHz.

(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 dBi.

(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.

(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.

8.4 Operating Condition of EUT

The switch ON/OFF was used to enable the EUT to change the channel one by one.

8.5 Test Procedure

The transmitter output was connected to the spectrum analyzer.

(i) Measure the duty cycle, x, of the transmitter output signal.

(ii) Set span to encompass the 99% occupied bandwidth of the signal.

(iii) Set RBW = 1 MHz.

(iv) Set VBW $\geq$ 3 MHz.

(v) Number of points in sweep $\geq 2 \times \text{span} / \text{RBW}$. (This ensures that bin-to-bin spacing is $\leq \text{RBW}/2$, so that narrowband signals are not lost between frequency bins.)

(vi) Sweep time = auto.

(vii) Detector = power averaging (rms).

(viii) Allow the sweep to “free run.”

(ix) Trace average at least 100 traces in power averaging (rms) mode; however, the number of traces to be averaged shall be increased above 100 as needed to

ensure that the average accurately represents the true average over the on and off periods of the transmitter.

(x) Compute power by integrating the spectrum across the 99% occupied bandwidth of the signal using the instrument's band power measurement function with band limits set equal to the occupied bandwidth band edges.

(xi) Add $10 \log (1/x)$, where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times (because the measurement represents an average over both the on and off times of the transmission). For example, add $10 \log (1/0.25) = 6$ dB if the duty cycle is 25%.

The test procedure is defined in KDB789033 D02 (the clause II.E.2.d) Measurement Procedure "Method SA-2" was used).

8.6 Test Results

PASSED.

All the test results are listed below.

(Test Date: 2020.12.17 Temperature: 23°C Humidity: 51 %)

Modulation	Transmission Duration (ms)	Transmission Period (ms)	Duty Cycle (%)	Correct Factor (dB)
802.11a	1.398	1.438	97.2	0.12
802.11n-HT20	1.308	1.35	96.9	0.14
802.11n-HT40	0.651	0.69	94.3	0.25
802.11ac-VHT 80	0.3265	0.3655	89.3	0.49

Modulation	Channel	Frequency (MHz)	Average Conducted Output Power (dBm)	Maximum Conducted Output Power (dBm)	Limit (dBm)
802.11a	36	5180	9.7	9.82	24
	40	5200	9.57	9.69	24
	48	5240	10.09	10.21	24
	52	5260	10.44	10.56	24
	60	5300	11.38	11.50	24
	64	5320	11.63	11.75	24
	100	5500	8.91	9.03	24
	120	5600	8.73	8.85	24
	140	5700	9.69	9.81	24
	149	5745	10.09	10.21	30
	157	5785	9.99	10.11	30
	165	5825	10.35	10.47	30

Modulation	Channel	Frequency (MHz)	Average Conducted Output Power (dBm)	Maximum Conducted Output Power (dBm)	Limit (dBm)
802.11n-HT20	36	5180	9.12	9.26	24
	40	5200	9.49	9.63	24
	48	5240	10.06	10.20	24
	52	5260	10.07	10.21	24
	60	5300	11.12	11.26	24
	64	5320	11.11	11.25	24
	100	5500	8.55	8.69	24
	120	5600	8.53	8.67	24
	140	5700	9.53	9.67	24
	149	5745	9.88	10.02	30
	157	5785	9.45	9.59	30
	165	5825	9.65	9.79	30

Modulation	Channel	Frequency (MHz)	Average Conducted Output Power (dBm)	Maximum Conducted Output Power (dBm)	Limit (dBm)
802.11n-HT40	38	5190	8.97	9.22	24
	46	5230	9.65	9.90	24
	54	5270	10.04	10.29	24
	62	5310	10.71	10.96	24
	102	5510	8.14	8.39	24
	118	5590	7.86	8.11	24
	134	5670	8.76	9.01	24
	151	5755	9.62	9.87	30
	159	5795	9.16	9.41	30

Modulation	Channel	Frequency (MHz)	Average Conducted Output Power (dBm)	Maximum Conducted Output Power (dBm)	Limit (dBm)
802.11ac-VHT80	42	5210	9.09	9.58	24
	58	5290	10.56	11.05	24
	106	5530	8.3	8.79	24
	122	5610	8.43	8.92	24
	155	5775	9.52	10.01	30

802.11a CH5180MHz



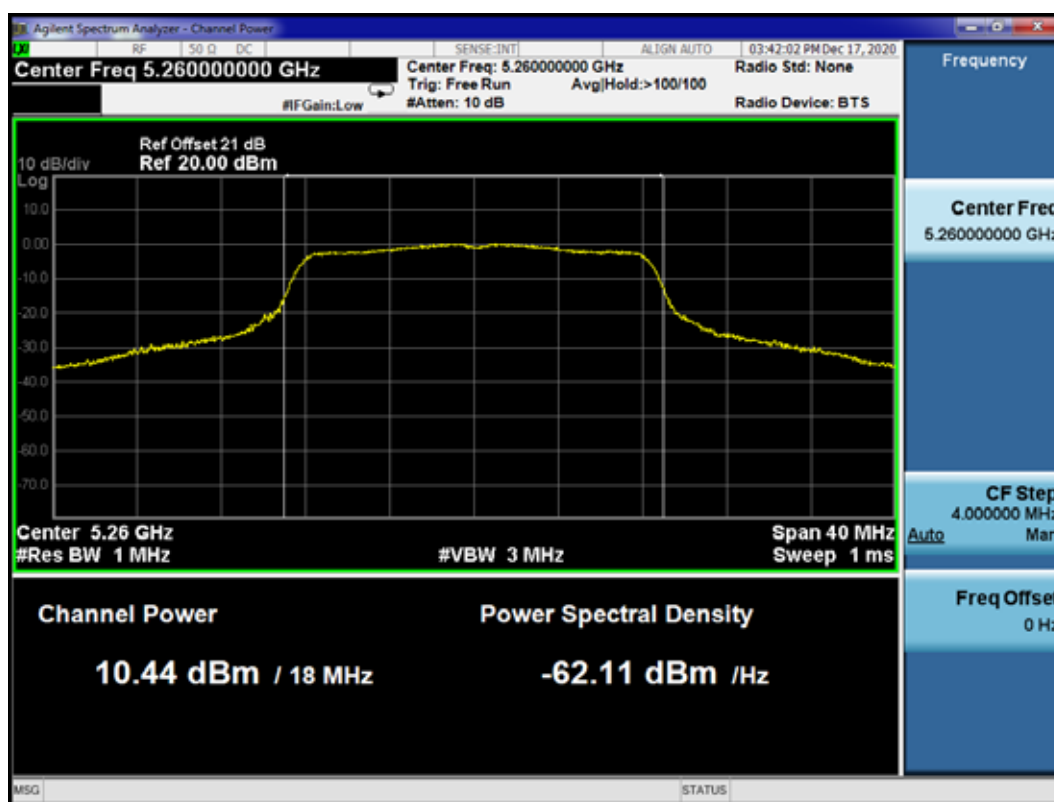
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802.11a CH5240MHz



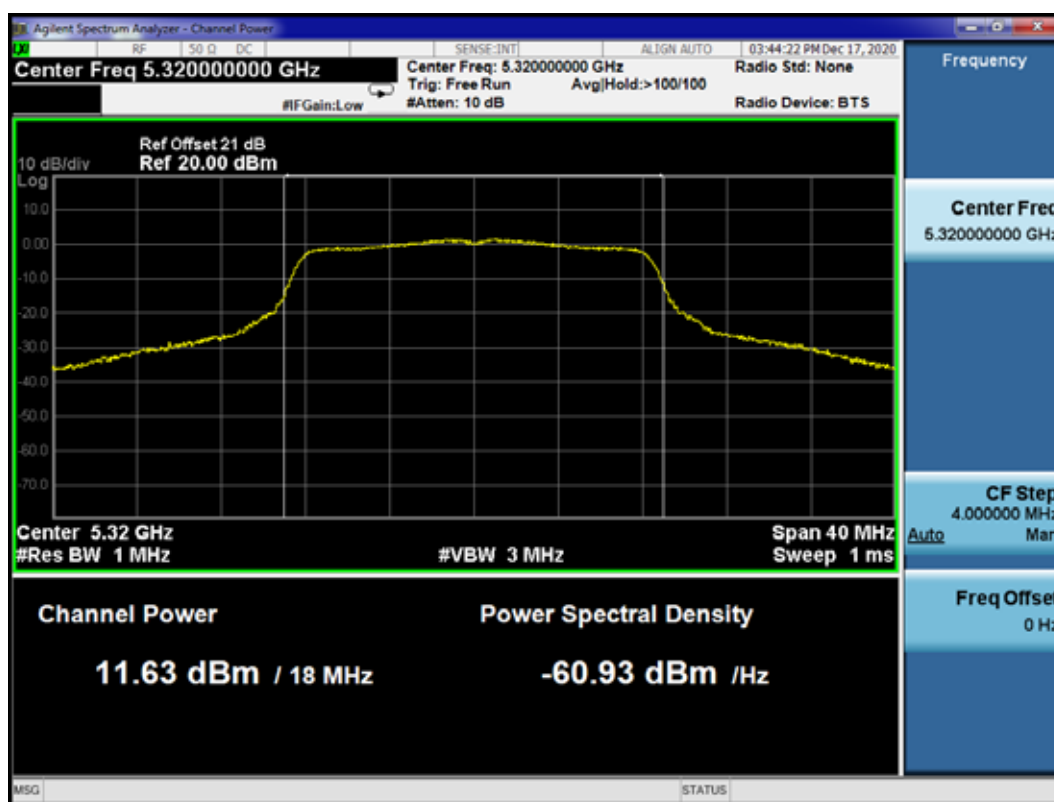
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802.11a CH5300MHz



802.11a CH5320MHz



802.11a CH5500MHz



802.11a CH5600MHz



802.11a CH5700MHz



802.11a CH5745MHz



802.11a CH5785MHz



802.11a CH5825MHz



801.11n-HT20 CH5180MHz



801.11n-HT20 CH5200MHz



801.11n-HT20 CH5240MHz



801.11n-HT20 CH5260MHz



801.11n-HT20 CH5300MHz



801.11n-HT20 CH5320MHz



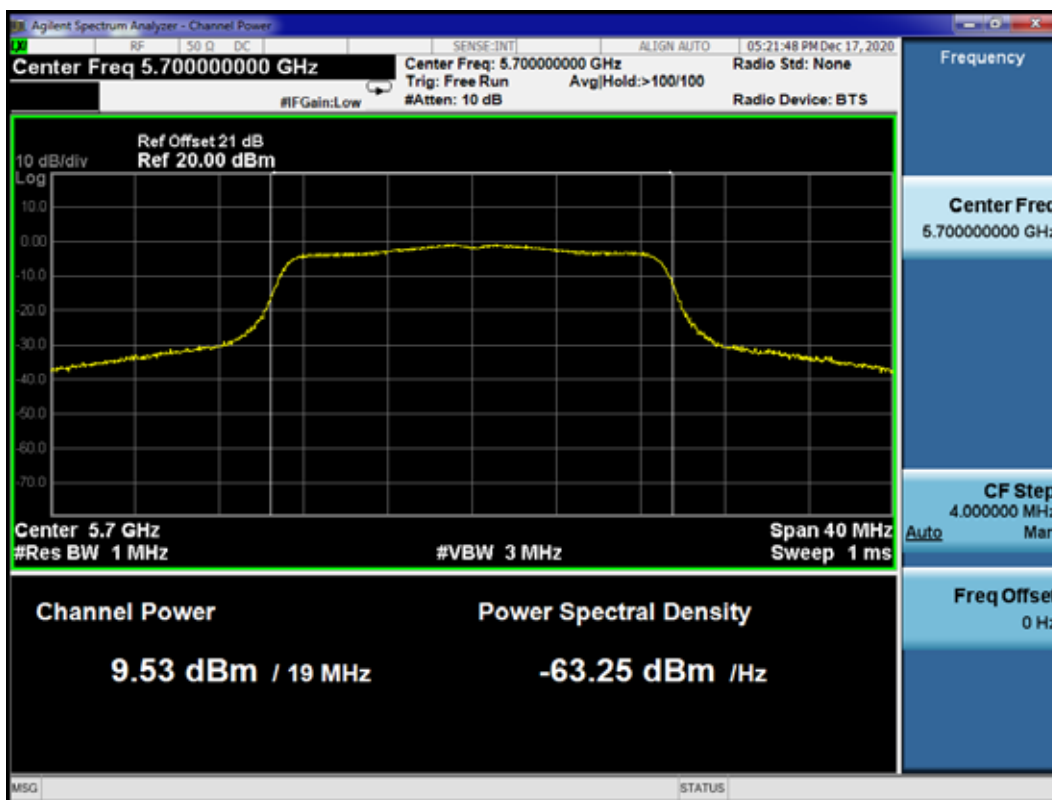
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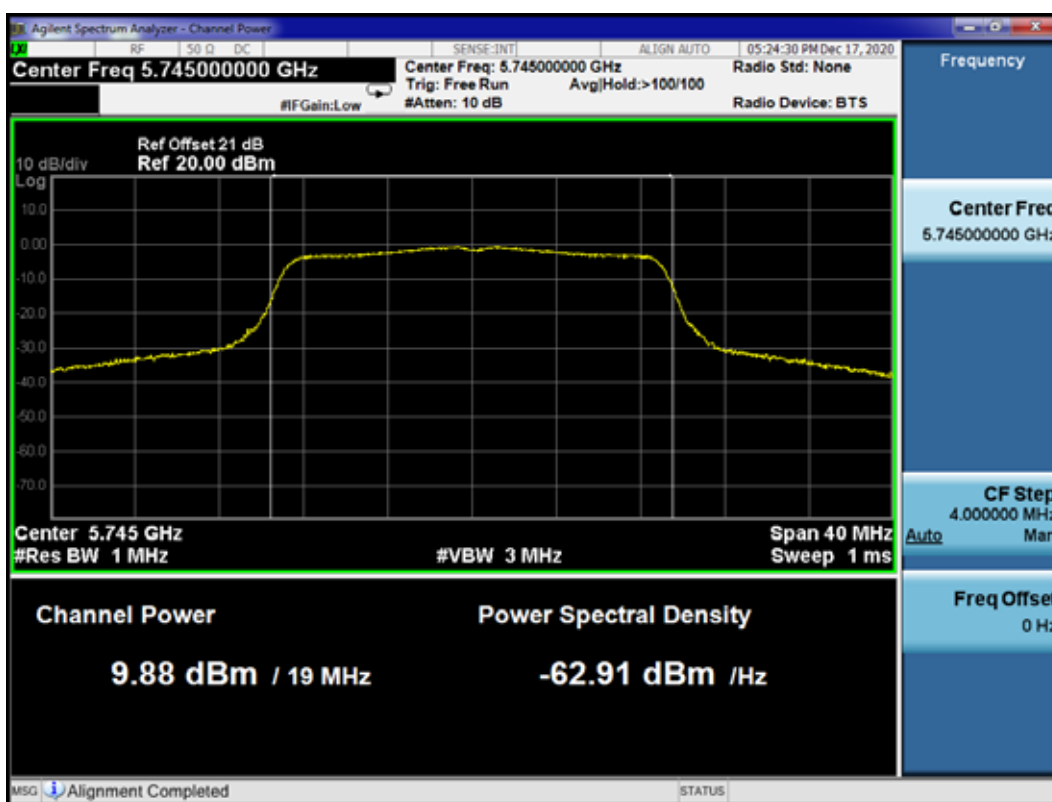
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801.11n-HT20 CH5700MHz



801.11n-HT20 CH5745MHz



801.11n-HT20 CH5785MHz



801.11n-HT20 CH5825MHz



801.11n-HT40 CH5190MHz



801.11n-HT40 CH5230MHz



801.11n-HT40 CH5270MHz



801.11n-HT40 CH5310MHz



801.11n-HT40 CH5510MHz



801.11n-HT40 CH5590MHz



801.11n-HT40 CH5670MHz



801.11n-HT40 CH5755MHz



801.11n-HT40 CH5795MHz



801.11ac-VHT80 CH5210MHz



801.11ac-VHT80 CH5290MHz



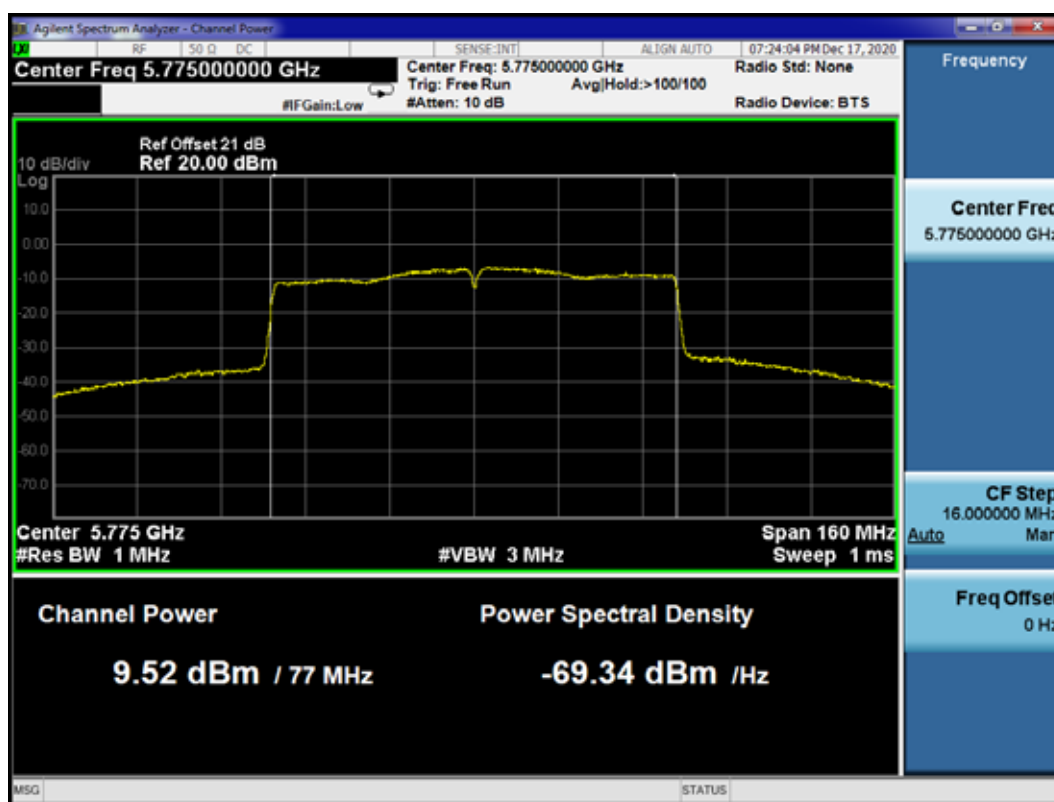
801.11ac-VHT80 CH5530MHz



801.11ac-VHT80 CH5610MHz



801.11ac-VHT80 CH5775MHz



9 MAXIMUM POWER SPECTRAL DENSITY

MEASUREMENT

9.1 Test Equipment

The following test equipment was used during the power spectral density measurement:

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
1.	Spectrum Analyzer	Agilent	N9010A	MY52221182	2020.09.16	1 Year
2.	Coaxial Cable	WOKEN	SFL402-105F LEX	F02-150819-045	2021.03.08	1 Year
3.	20 dB Attenuator	Mini-Circuits	VAT-20+	001	2020.08.06	1 Year

9.2 Block Diagram of Test Setup

The Same as section 6.2.

9.3 Specification Limits (§15.407(a))

- (1) For the band 5.15-5.25 GHz.
- (iv) For client devices in the 5.15-5.25 GHz band, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band.
- (2) For the 5.25-5.35 GHz and 5.47-5.725 GHz bands, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band.
- (3) For the band 5.725-5.85 GHz, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band.

9.4 Operating Condition of EUT

The switch ON/OFF was used to enable the EUT to change the channel one by one.

9.5 Test Procedure

The transmitter output was connected to the spectrum analyzer.

- (i) Measure the duty cycle, x , of the transmitter output signal.
- (ii) For the 5.15-5.25 GHz, 5.25-5.35 GHz and 5.47-5.725 GHz bands. set $RBW = 1 \text{ MHz}$. For the band 5.725-5.85 GHz set $RBW = 300 \text{ kHz}$.
- (iii) Set $VBW \geq 3 \times RBW$.
- (iv) Number of points in sweep $\geq 2 \times \text{span} / RBW$. (This ensures that bin-to-bin spacing is $\leq RBW/2$, so that narrowband signals are not lost between frequency bins.)
- (v) Sweep time = auto.
- (vi) Detector = power averaging (rms).
- (vii) Allow the sweep to “free run.”
- (viii) Trace average at least 100 traces in power averaging (rms) mode; however, the number of traces to be averaged shall be increased above 100 as needed to ensure that the average accurately represents the true average over the on and off periods of the transmitter.

- (ix) Use the peak search function on the instrument to find the peak of the spectrum.
- (x) As the Method SA-2 was used, add $10 \log (1/x)$, where x is the duty cycle, to the peak of the spectrum. The result is the Peak Power Spectral Density.
- (xi) For the band 5.725-5.85 GHz, additional add $10 \log (500 \text{ kHz}/300 \text{ kHz}) = 2.22 \text{ dB}$ to the measured result, whereas RBW is set to 300 kHz (<500 kHz) during measurement.

The test procedure is defined in KDB789033 D02 (the clause II.F Measurement Procedure “ Maximum Power Spectral Density (PSD)” was used).

9.6 Test Results

PASSED.

All the test results are attached in next pages.

(Test Date: 2021.01.20 Temperature: 23°C Humidity: 51 %)

Modulation	Channel	Frequency (MHz)	Average Power Spectral Density (dBm/MHz)	Maximum Power Spectral Density (dBm/MHz)	Limit (dBm/MHz)
802.11a	36	5180	-7.382	-7.26	24
	40	5200	-7.047	-6.93	24
	48	5240	-7.307	-7.19	24
	52	5260	-7.649	-7.53	24
	60	5300	-7.659	-7.54	24
	64	5320	-7.354	-7.23	24
	100	5500	-10.409	-10.29	24
	120	5600	-12.444	-12.32	24
	140	5700	-11.348	-11.23	24

Modulation	Channel	Frequency (MHz)	Average Power Spectral Density (dBm/MHz)	Maximum Power Spectral Density (dBm/MHz)	Limit (dBm/MHz)
802.11n-HT20	36	5180	-7.202	-7.06	24
	40	5200	-7.394	-7.25	24
	48	5240	-7.598	-7.46	24
	52	5260	-7.998	-7.86	24
	60	5300	-7.902	-7.76	24
	64	5320	-7.747	-7.61	24
	100	5500	-11.034	-10.89	24
	120	5600	-12.499	-12.36	24
	140	5700	-11.785	-11.65	24

Modulation	Channel	Frequency (MHz)	Average Power Spectral Density (dBm/MHz)	Maximum Power Spectral Density (dBm/MHz)	Limit (dBm/MHz)
802.11n-HT40	38	5190	-11.348	-11.10	24
	46	5230	-11.166	-10.92	24
	54	5270	-11.759	-11.51	24
	62	5310	-11.334	-11.08	24
	102	5510	-15.291	-15.04	24
	118	5590	-16.431	-16.18	24
	134	5670	-15.637	-15.39	24

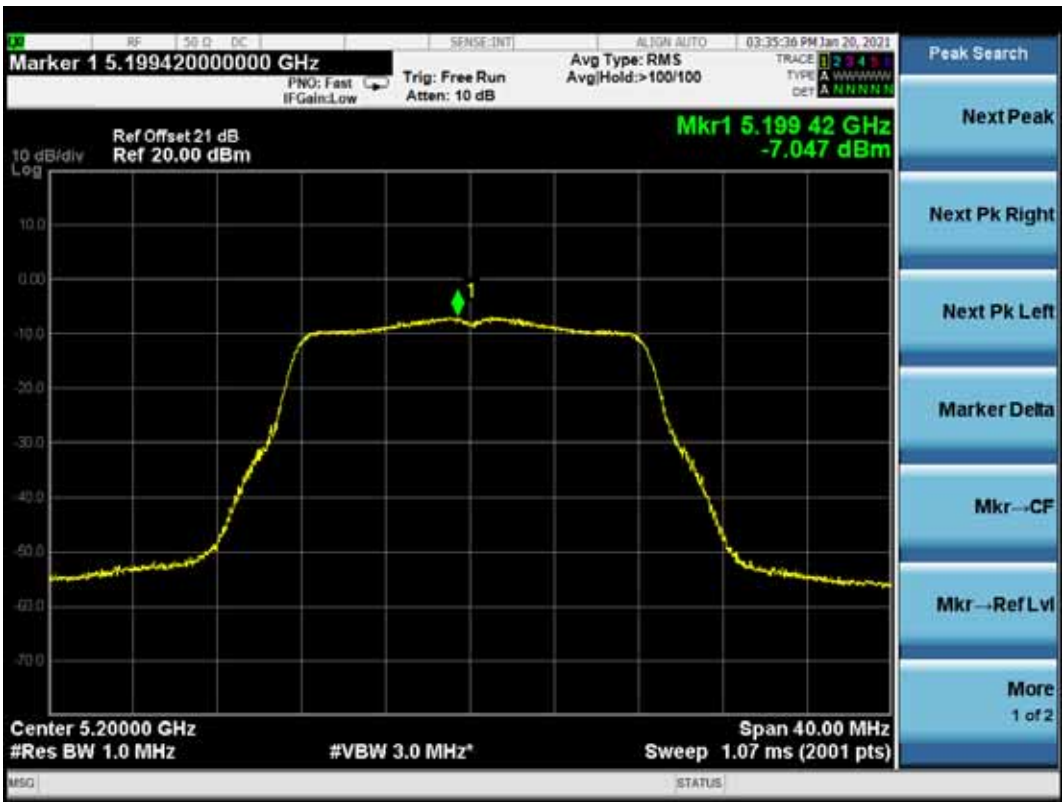
Modulation	Channel	Frequency (MHz)	Average Power Spectral Density (dBm/MHz)	Maximum Power Spectral Density (dBm/MHz)	Limit (dBm/MHz)
802.11ac-VHT80	42	5210	-14.399	-13.91	24
	58	5290	-14.529	-14.04	24
	106	5530	-18.813	-18.32	24
	122	5610	-19.783	-19.29	24

Modulation	Channel	Frequency (MHz)	Average Power Spectral Density (dBm/300kHz)	Maximum Power Spectral Density (dBm/500kHz)	Limit (dBm/500kHz)
802.11a	149	5745	-14.88	-12.54	30
	157	5785	-14.17	-11.83	30
	165	5825	-12.438	-10.10	30
802.11n-HT20	149	5745	-15.445	-13.085	30
	157	5785	-14.46	-12.100	30
	165	5825	-13.027	-10.667	30
802.11n-HT40	151	5755	-18.857	-16.387	30
	159	5795	-17.734	-15.264	30
802.11ac-VHT80	155	5775	-21.829	-19.119	30

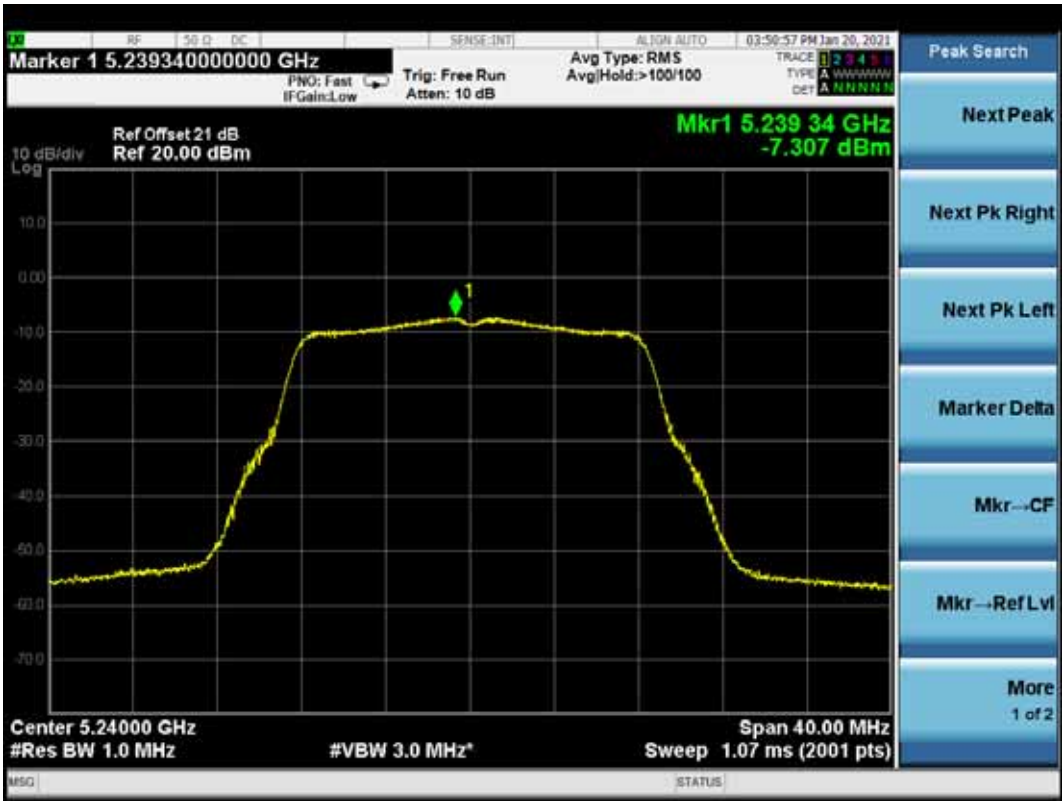
802.11a CH5180MHz



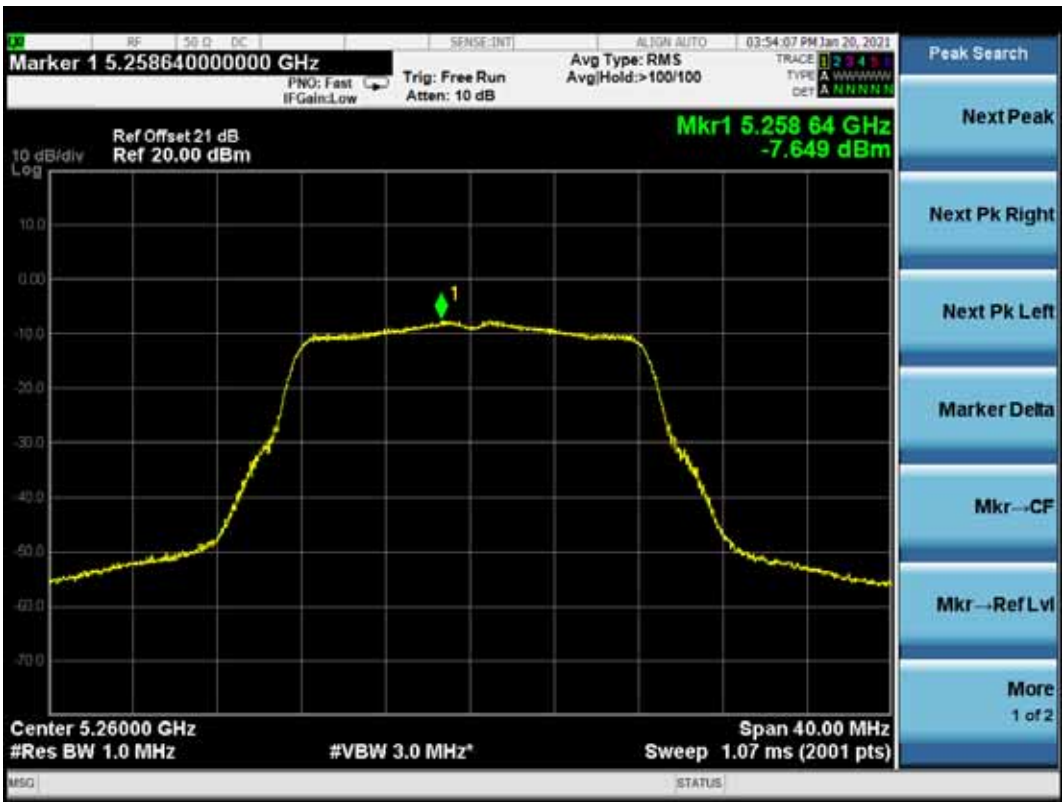
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802.11a CH5240MHz



802.11a CH5260MHz



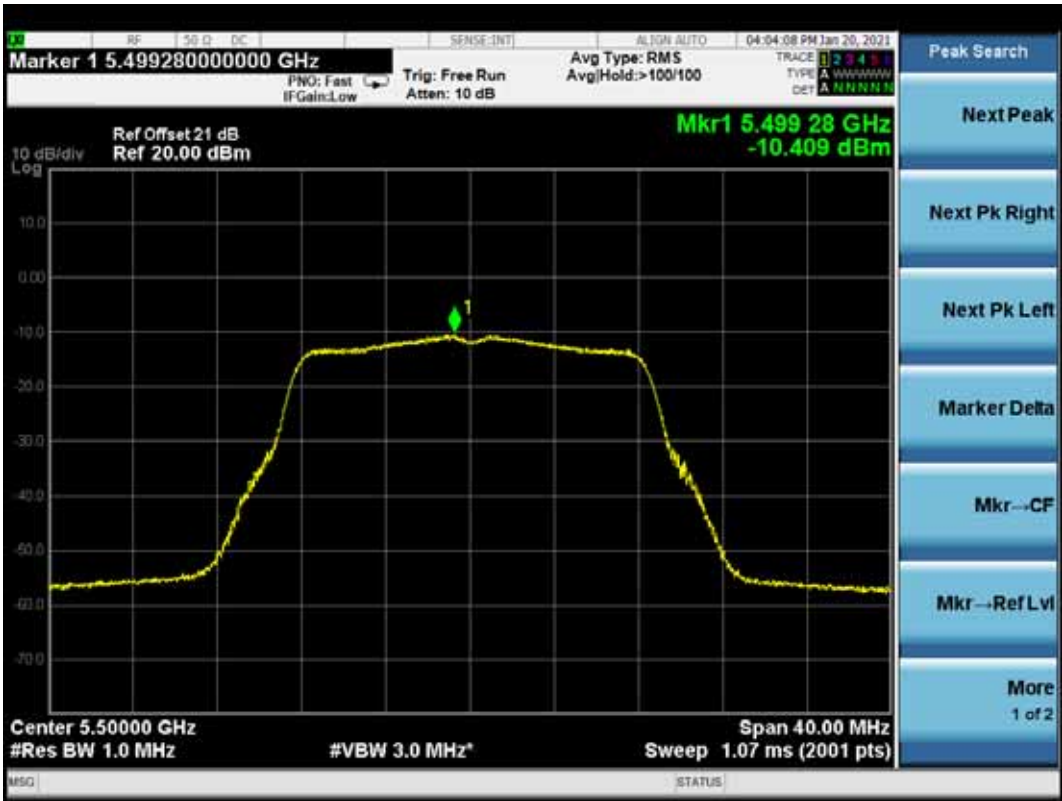
802.11a CH5300MHz



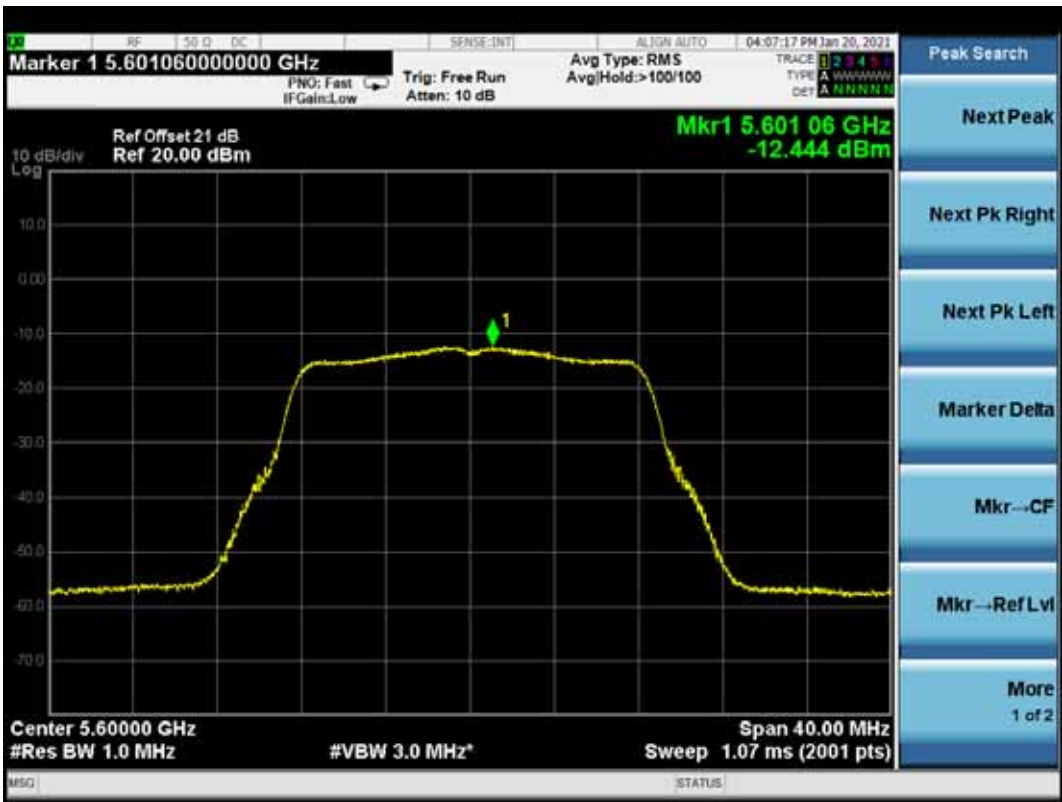
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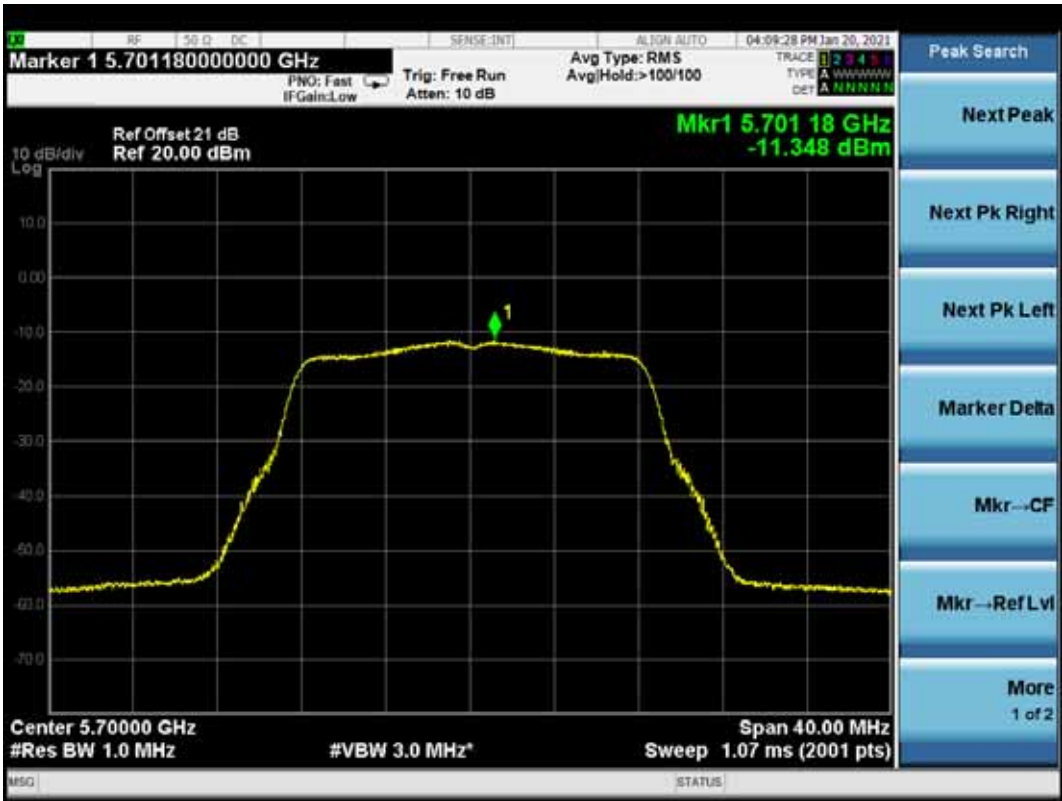
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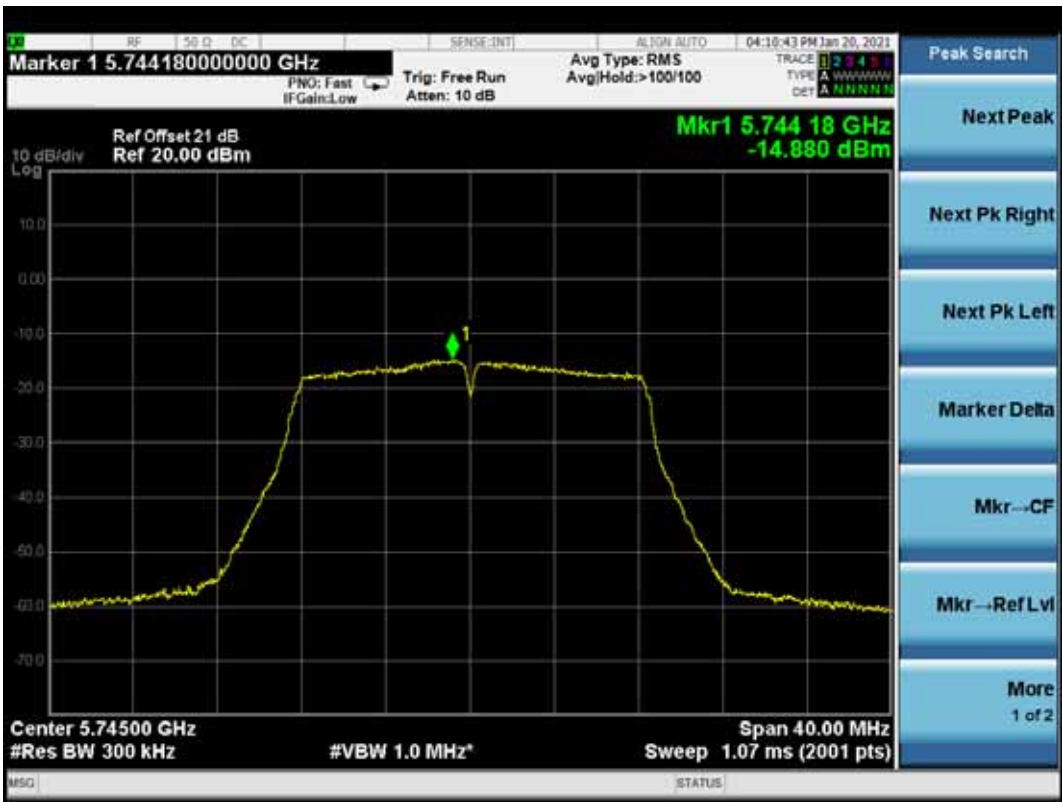
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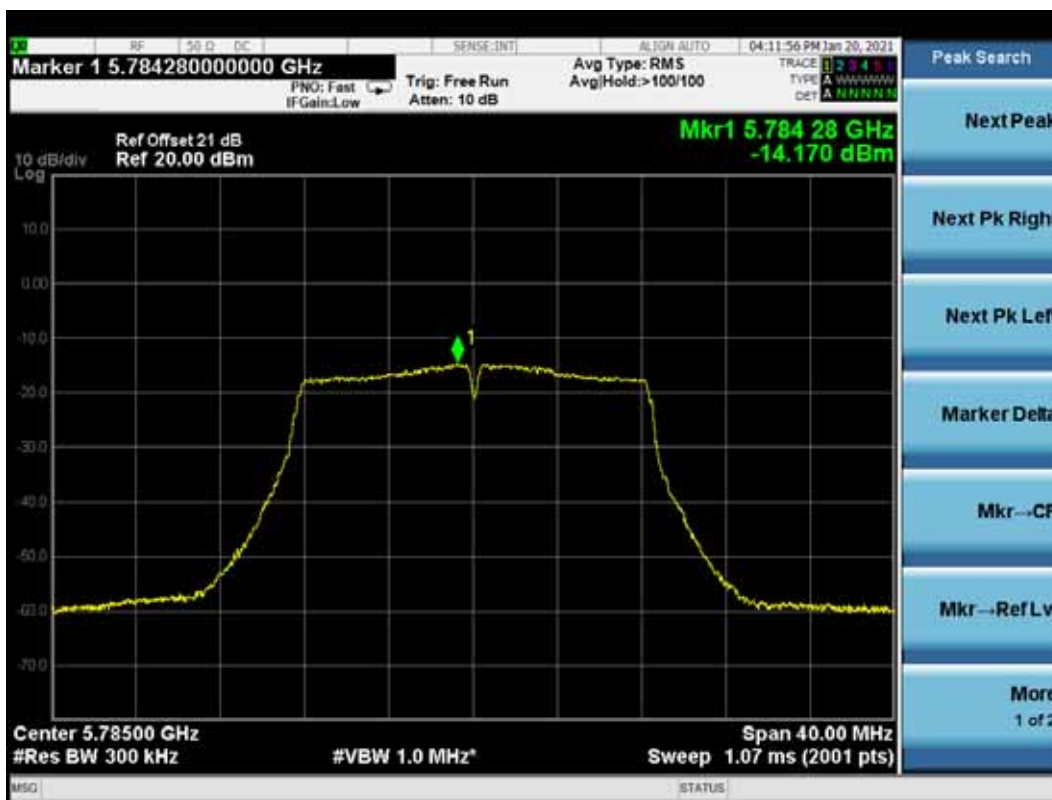
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802.11a CH5745MHz



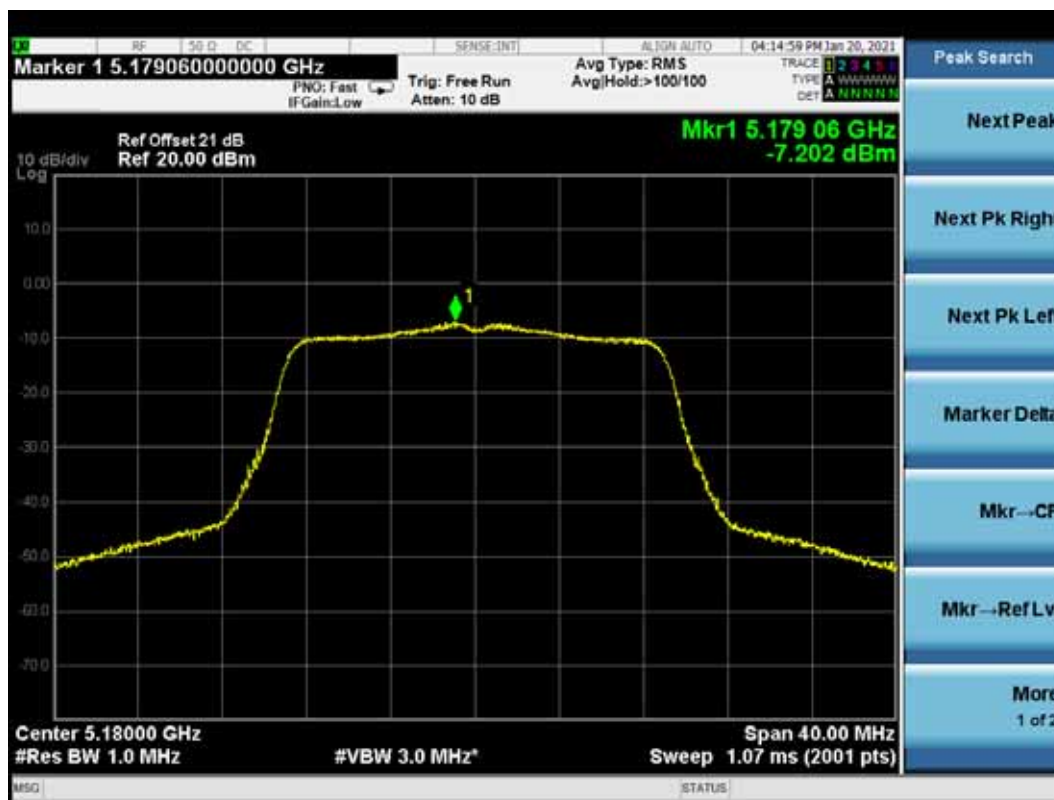
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802.11a CH5825MHz



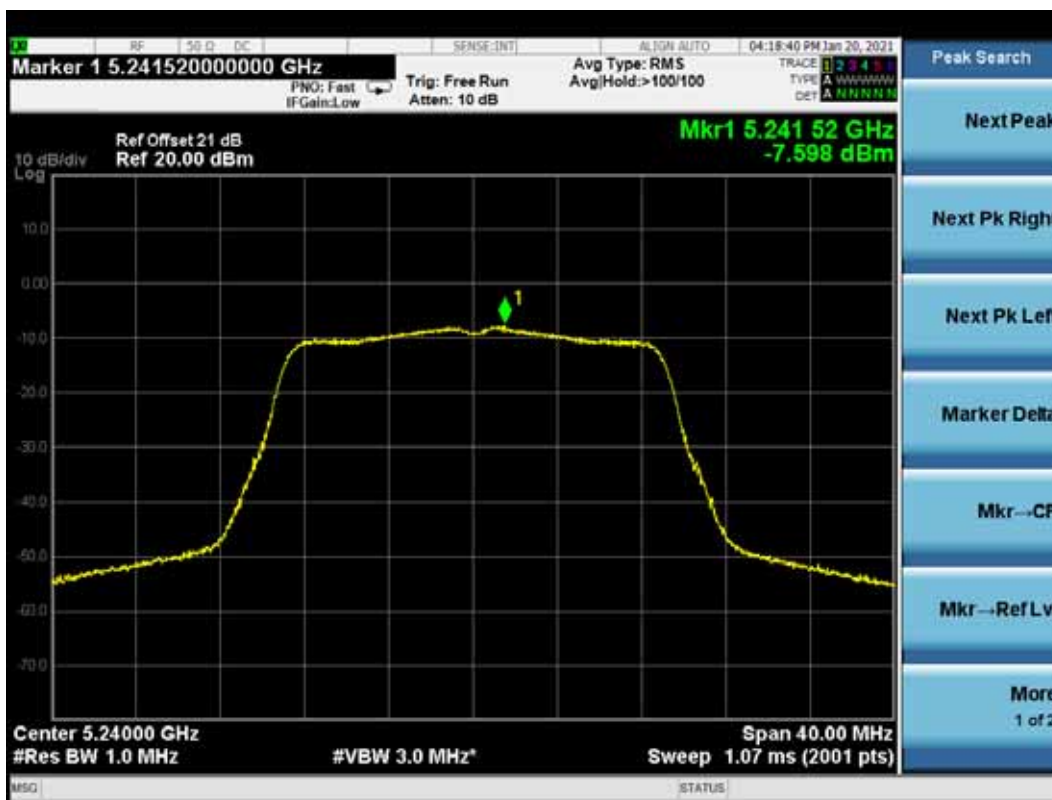
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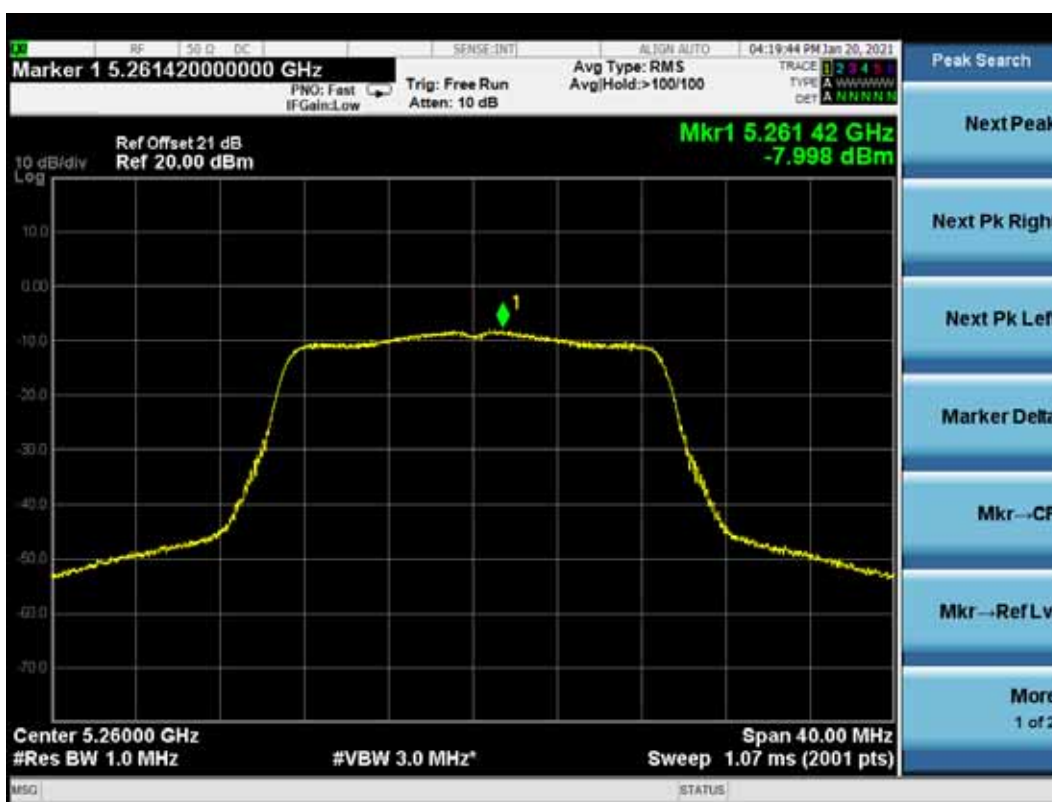
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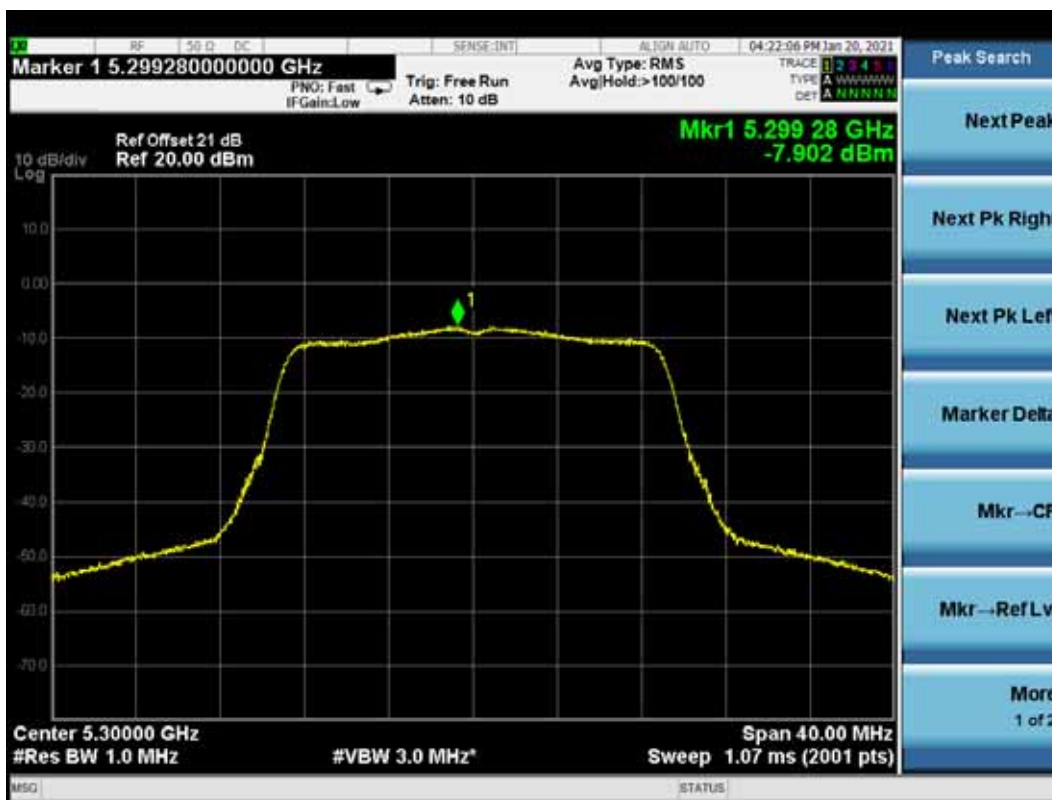
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801.11n-HT20 CH5260MHz



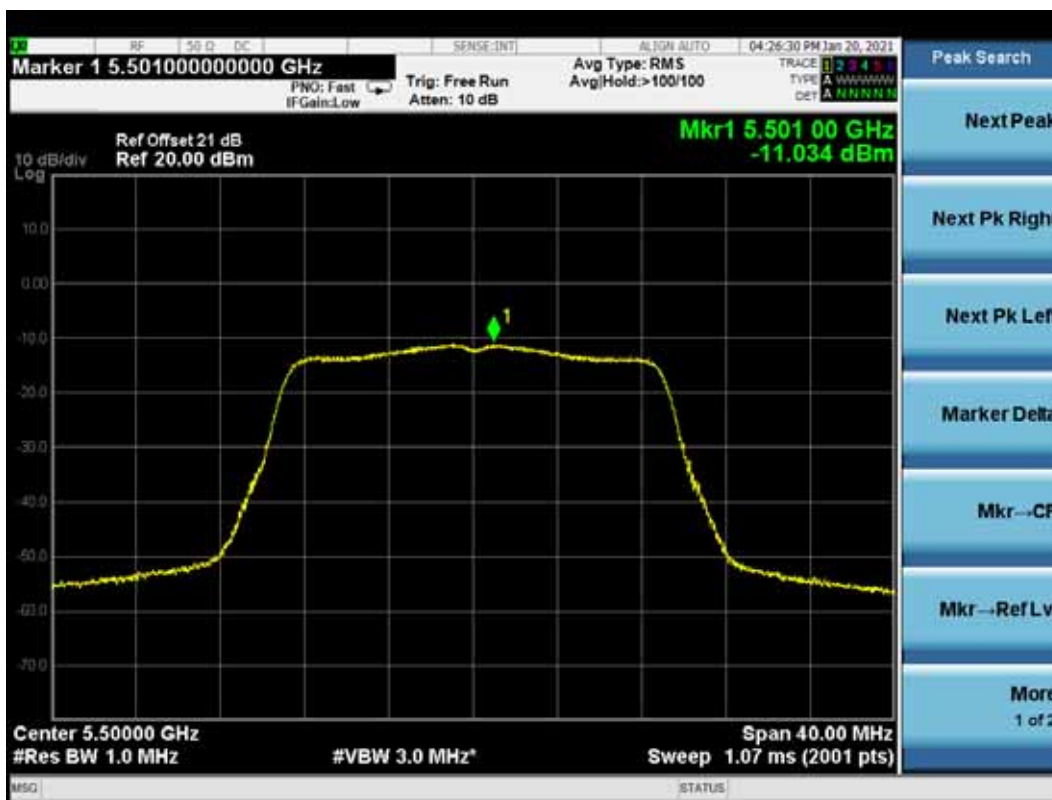
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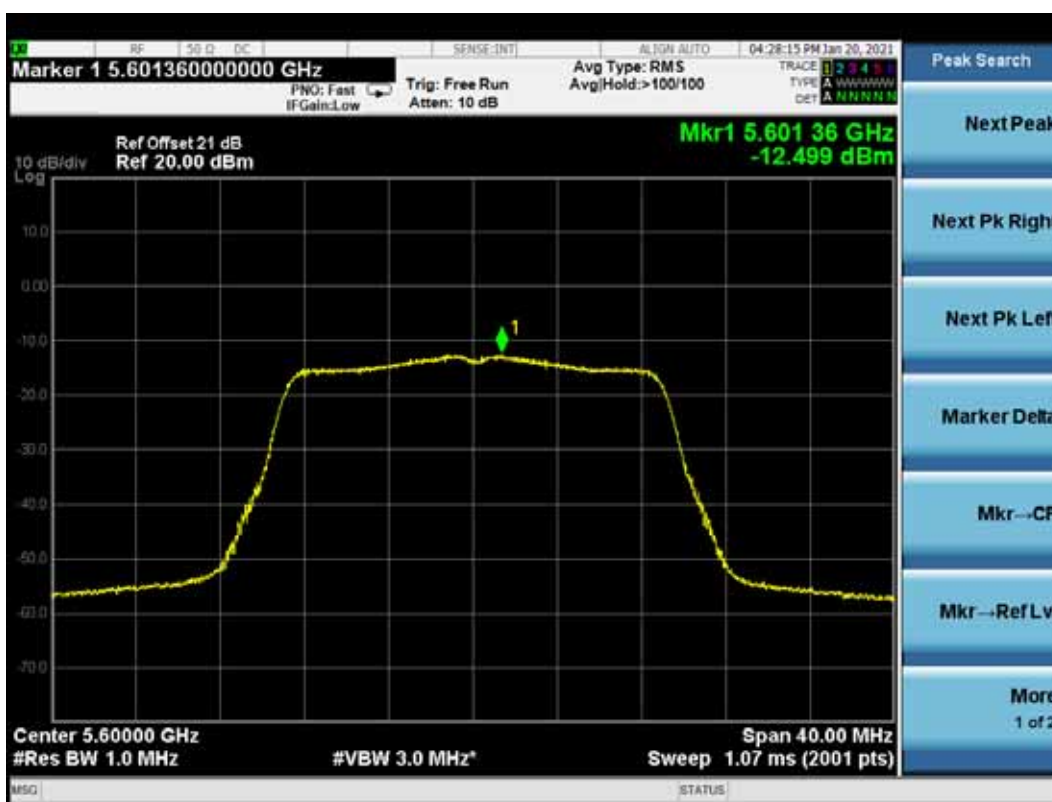
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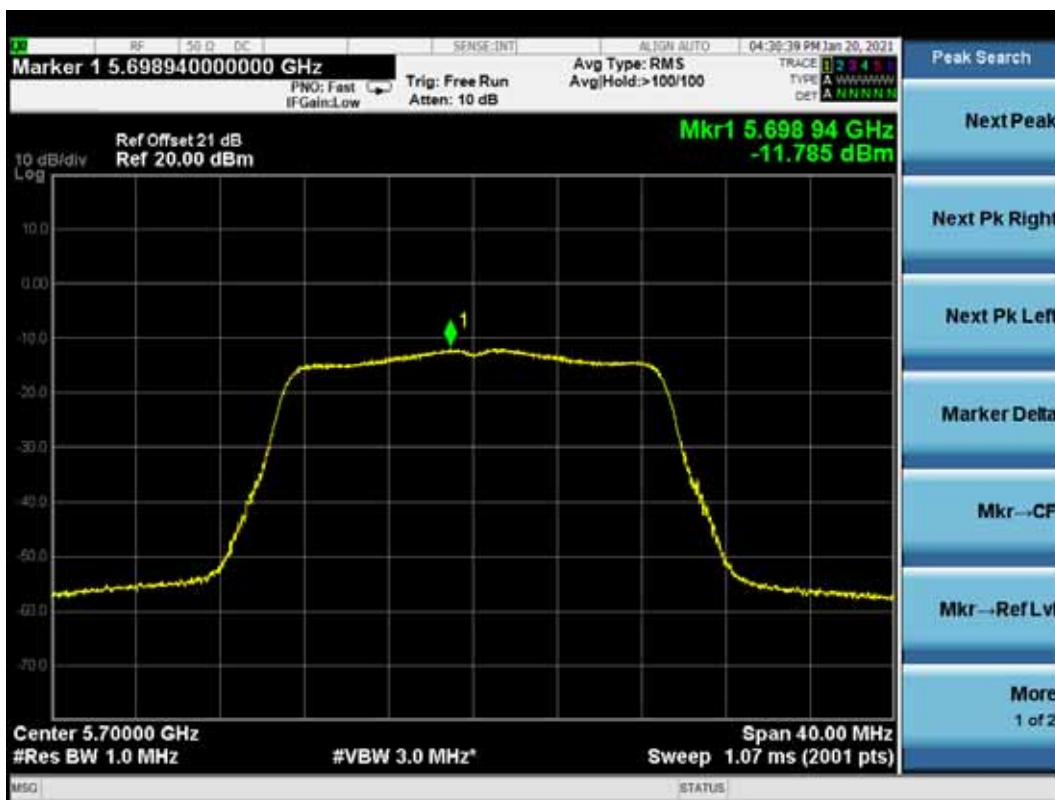
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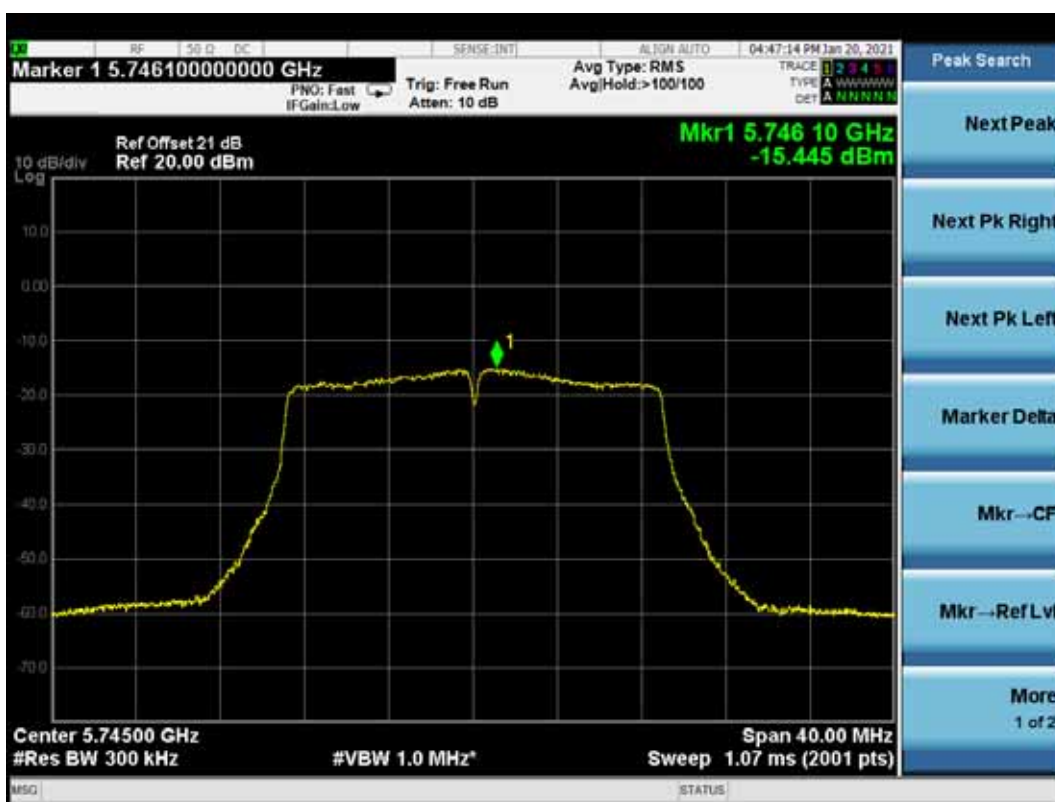
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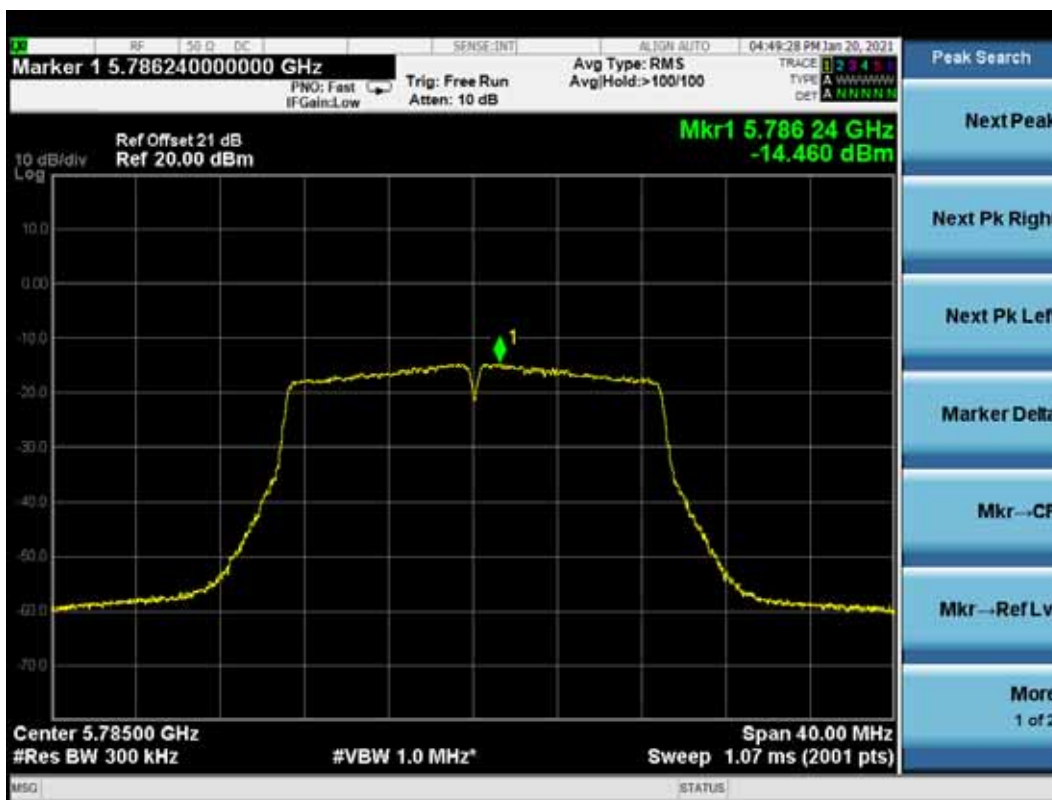
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801.11n-HT20 CH5745MHz



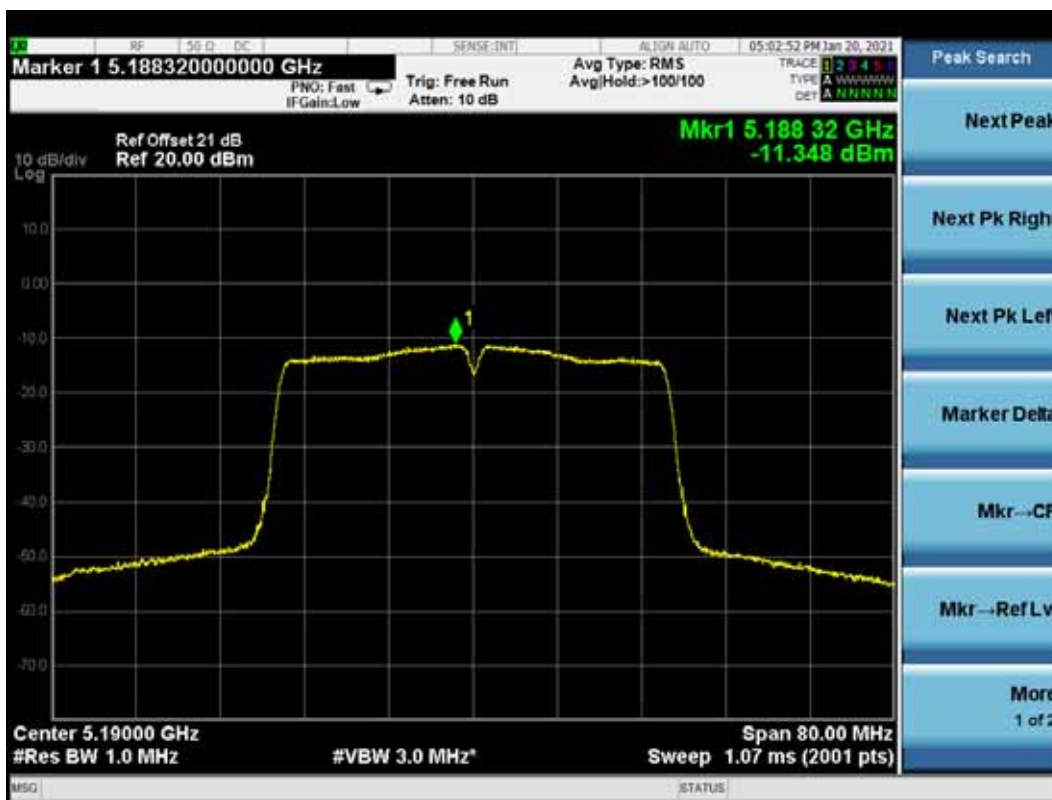
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801.11n-HT20 CH5825MHz



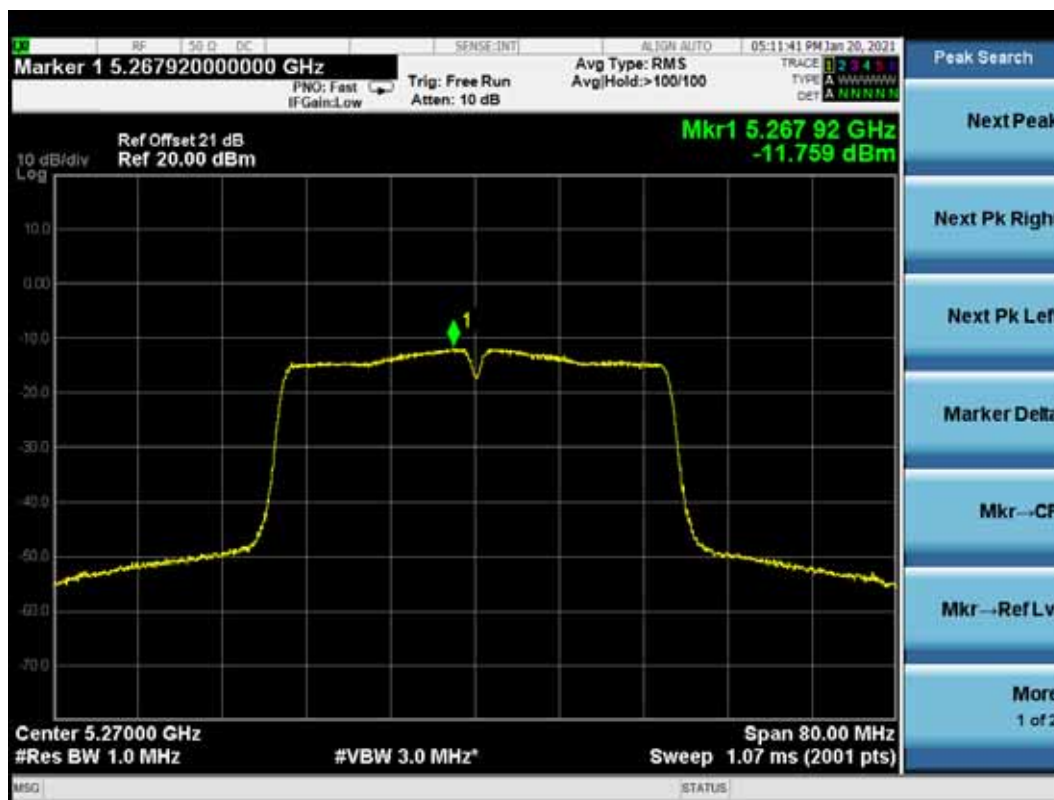
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801.11n-HT40 CH5230MHz



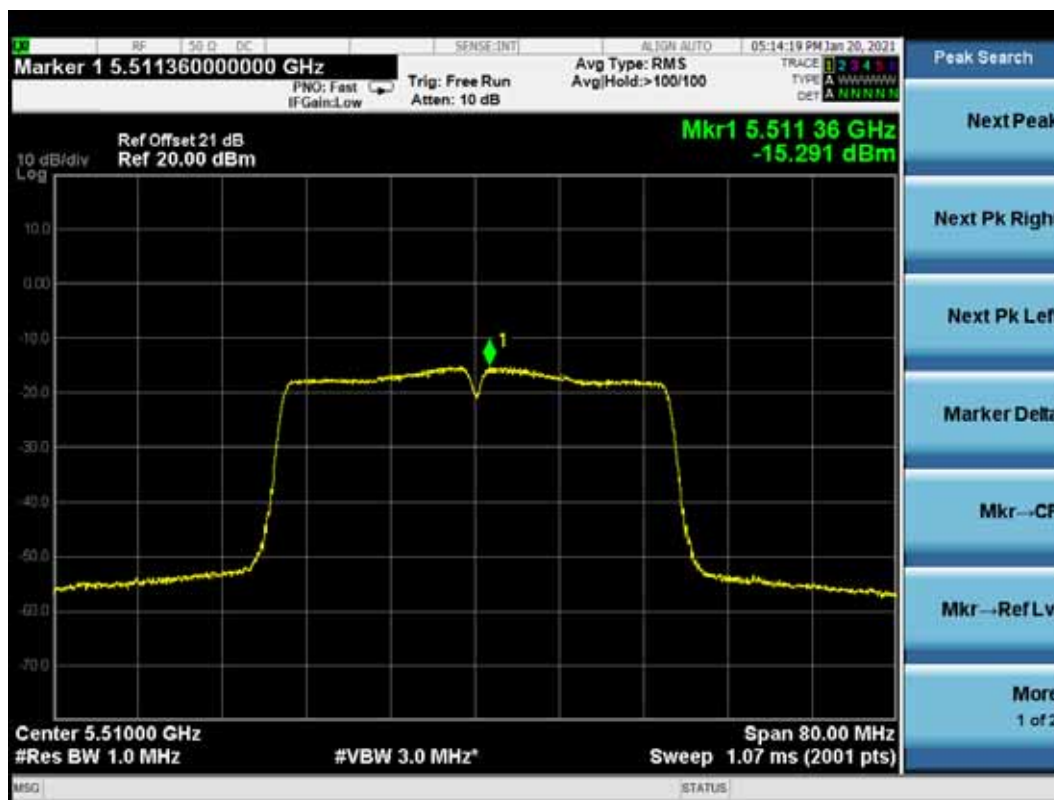
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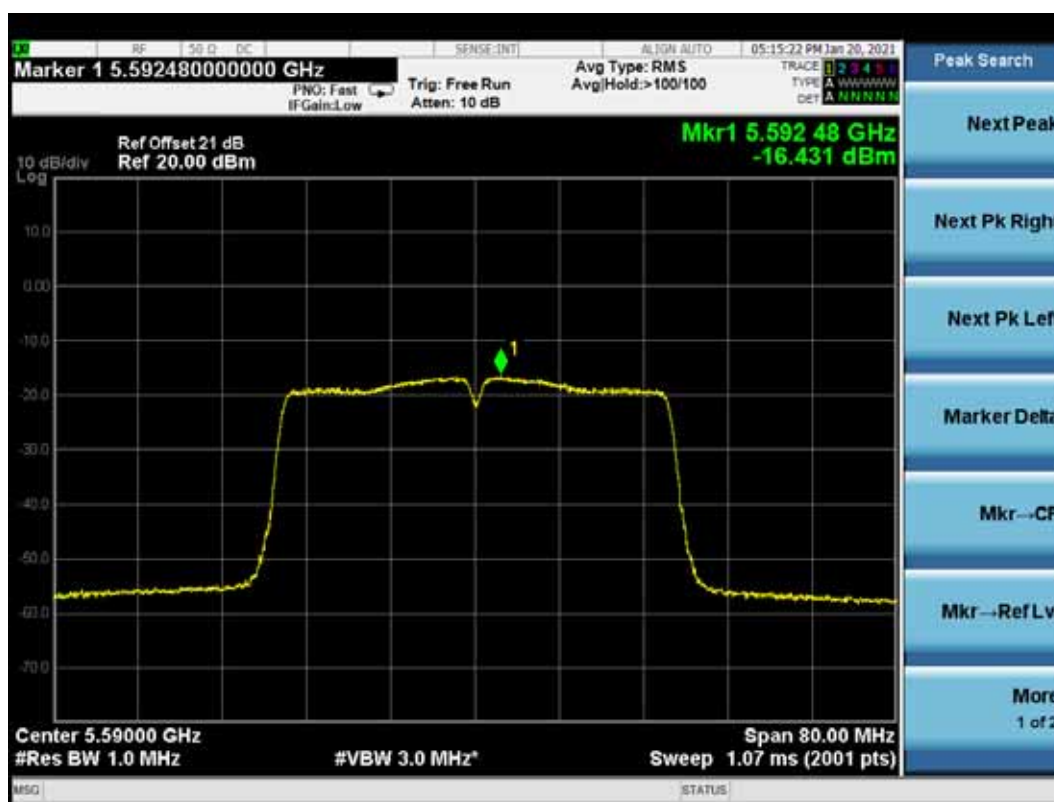
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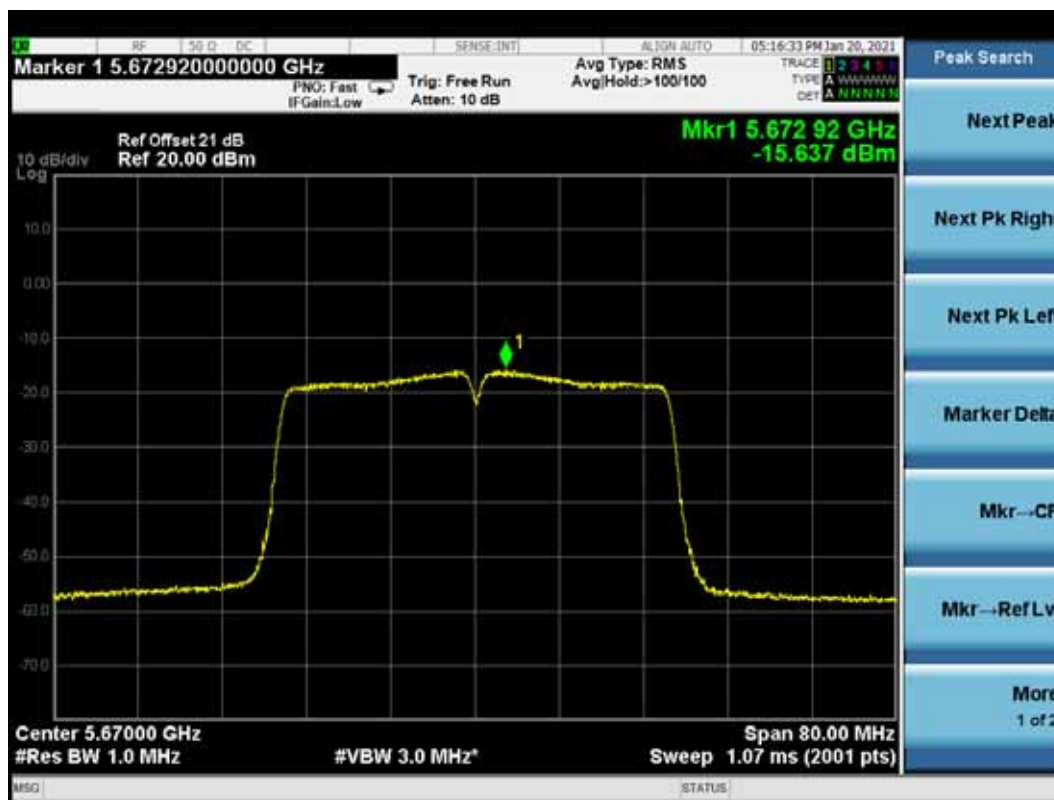
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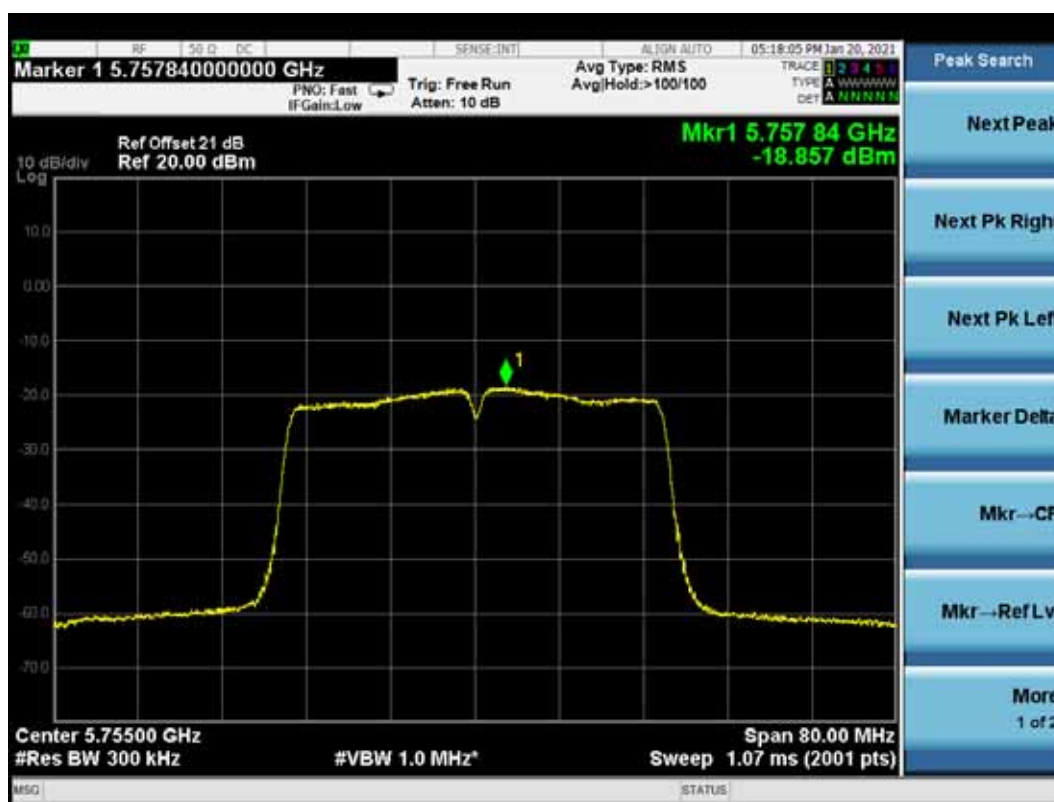
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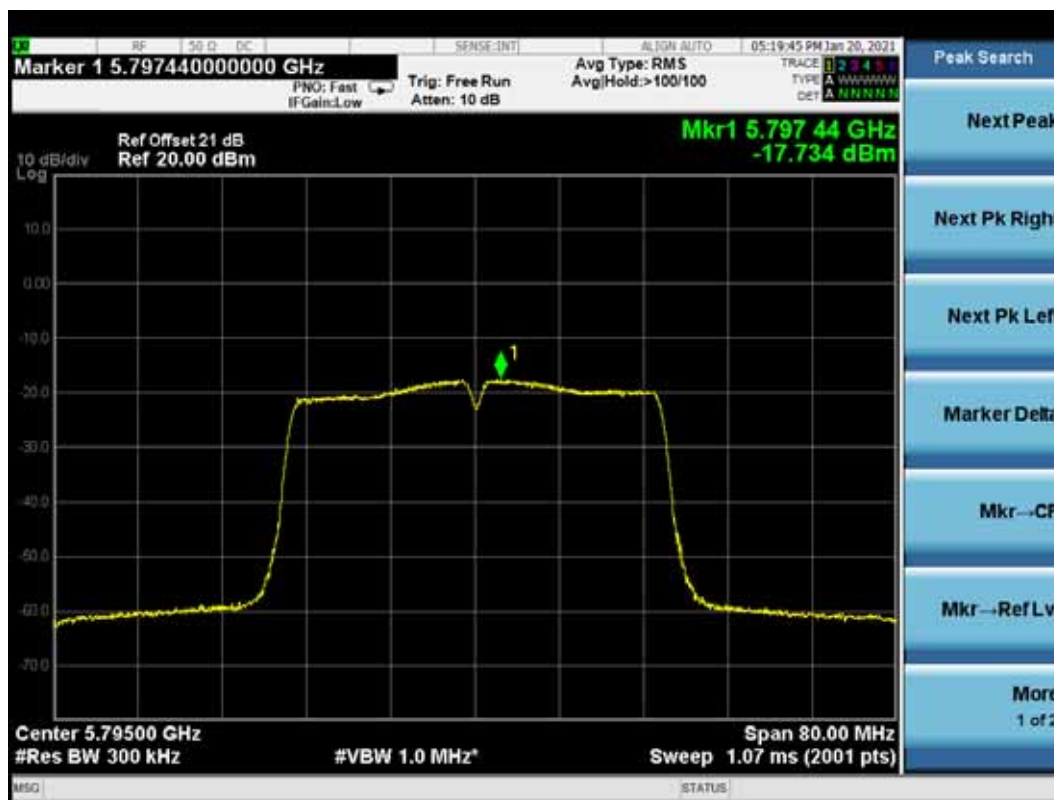
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801.11n-HT40 CH5755MHz



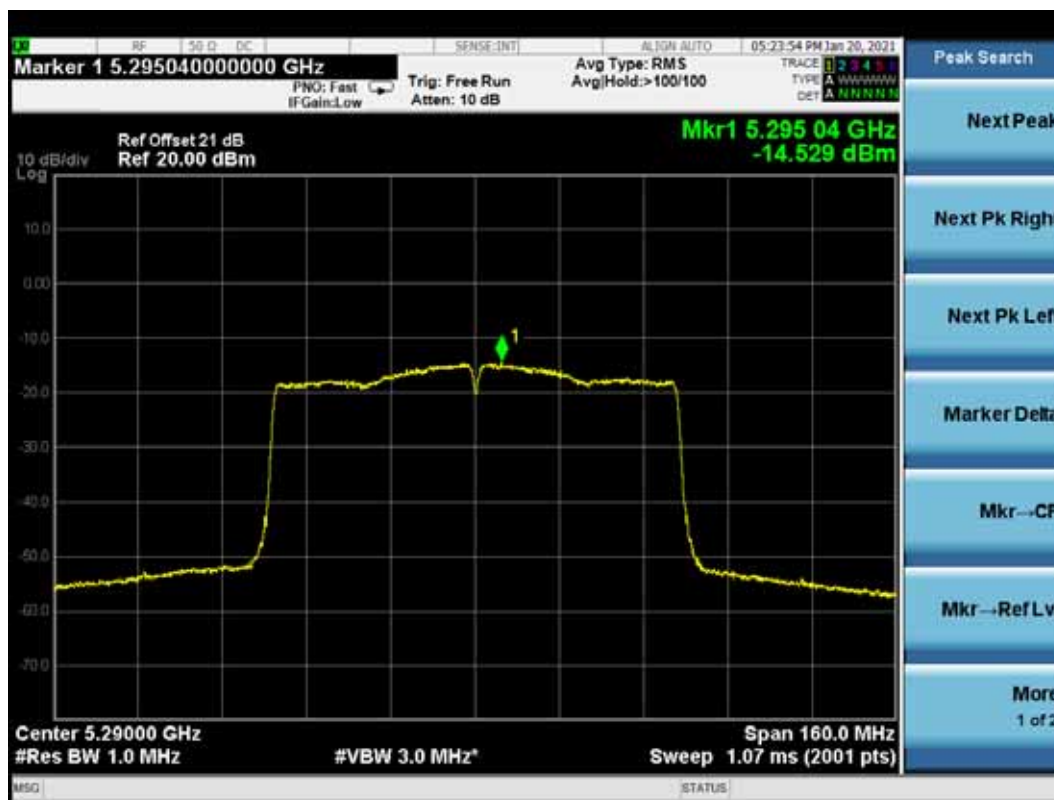
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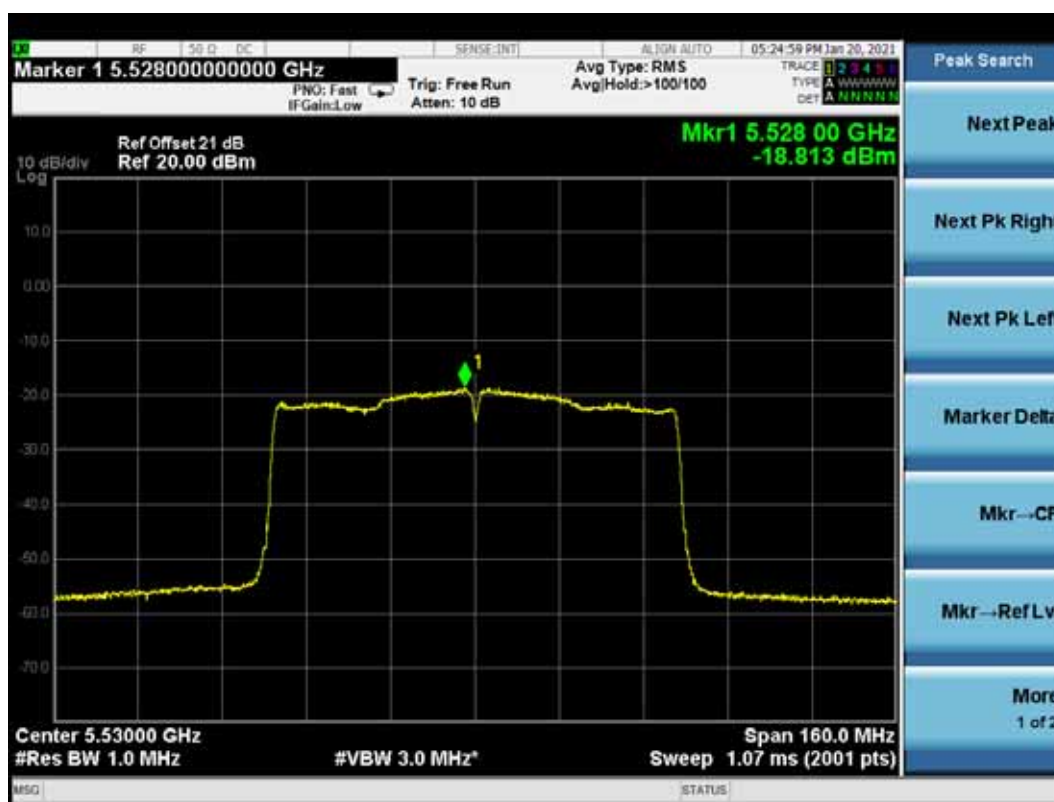
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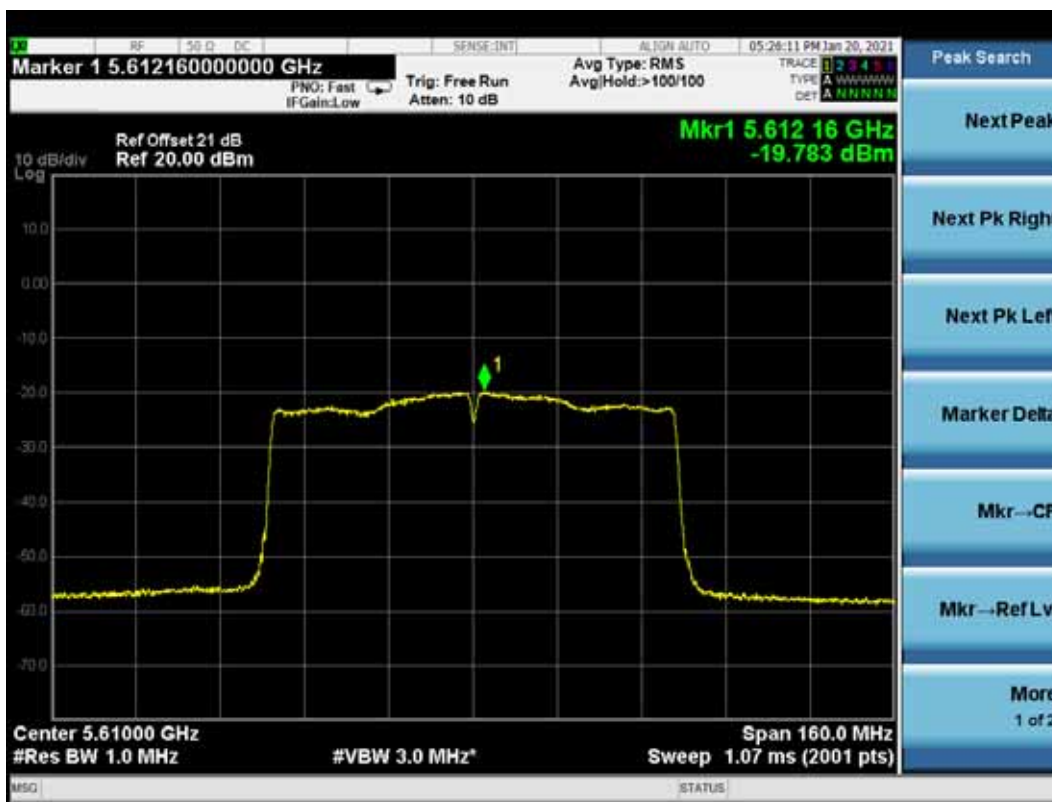
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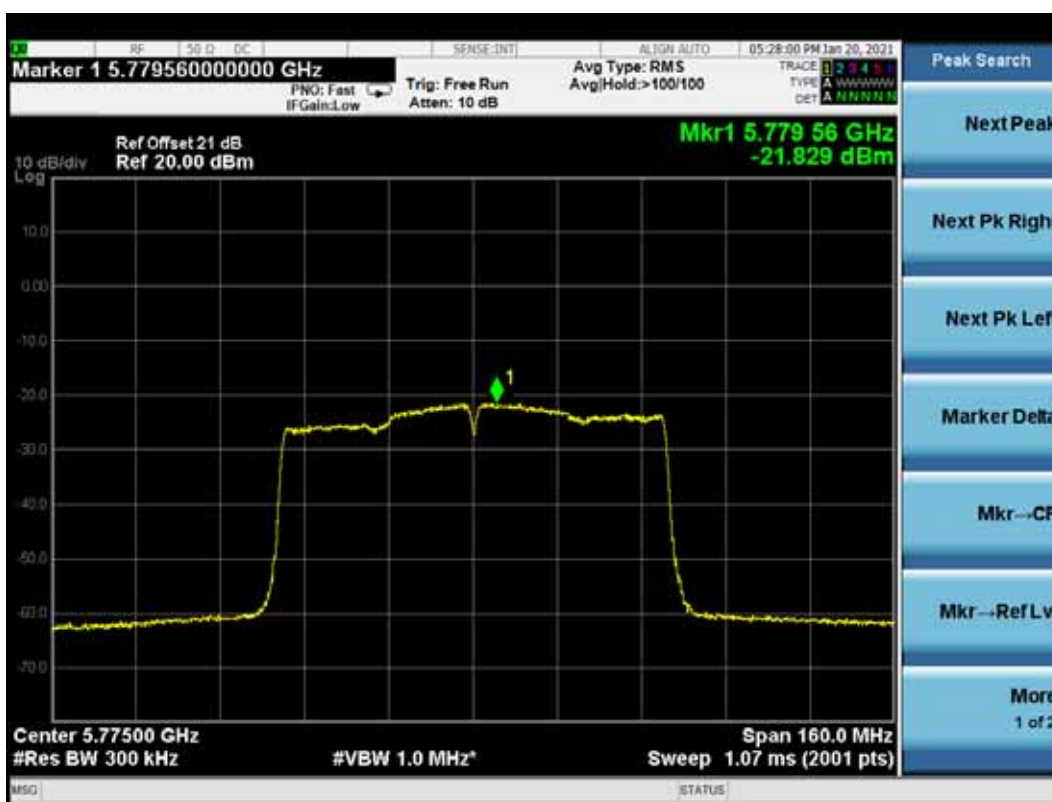
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801.11ac-VHT80 CH5610MHz



801.11ac-VHT80 CH5775MHz



10 FREQUENCY STABILITY MEASUREMENT

10.1 Test Equipment

The following test equipment was used during the power spectral density measurement:

Item	Type	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
4.	Spectrum Analyzer	Agilent	N9010A	MY52221182	2020.09.16	1 Year
5.	Coaxial Cable	WOKEN	SFL402-105F LEX	F02-150819-045	2021.03.08	1 Year
6.	20 dB Attenuator	Mini-Circuits	VAT-20+	001	2020.08.06	1 Year

10.2 Block Diagram of Test Setup

The Same as section 6.2.

10.3 Specification Limits (§15.407(g))

Manufacturers of U-NII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the user's manual or ± 20 ppm.

10.4 Operating Condition of EUT

The switch ON/OFF was used to enable the EUT to change the channel one by one.

10.5 Test Procedure

The transmitter output was connected to the spectrum analyzer.

- (i) Set RBW = 10 kHz
- (ii) Set VBW = 10 kHz.
- (iii) Detector = Positive Peak.
- (iv) Trace = Max Hold.
- (v) Use the peak search function of the spectrum analyzer to mark the max peak value. The frequency as f_c .
- (vi) The frequency error is $(f_c - f)/f \times 10^6$ ppm and must less than ± 20 ppm.
- (vii) All condition of normal operation as specified in the user's manual should be considered.

10.6 Test Results

PASSED.

All the test results are attached in next pages.

(Test Date: 2020.12.17 Temperature: 23°C Humidity: 51 %)

Test Voltage (V)	Temperature (°C)	Channel	Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (ppm)	Limit (ppm)
DC 5V	25	36	5180	5180.0715	13.8	±20
		40	5200	5200.072	13.8	±20
		44	5220	5220.072	13.8	±20
		48	5240	5240.0725	13.8	±20
		52	5260	5260.073	13.9	±20
		56	5280	5280.0735	13.9	±20
		60	5300	5300.074	14	±20
		64	5320	5320.074	13.9	±20
		100	5500	5500.077	14	±20
		104	5520	5520.077	13.9	±20
		108	5540	5540.0775	14	±20
		112	5560	5560.078	14	±20
		116	5580	5580.078	14	±20
		120	5600	5600.0785	14	±20
		124	5620	5620.0785	14	±20
		128	5640	5640.079	14	±20
		132	5660	5660.0795	14	±20
		136	5680	5680.0795	14	±20
		140	5700	5700.08	14	±20
		149	5745	5745.0805	14	±20
		153	5765	5765.081	14.1	±20
		157	5785	5785.0815	14.1	±20
		161	5805	5805.0815	14	±20
		165	5825	5825.082	14.1	±20

Test Voltage (V)	Temperature (°C)	Channel	Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (ppm)	Limit (ppm)
DC 4.5V	25	36	5180	5180.07	13.7	±20
		40	5200	5200.07	13.8	±20
		44	5220	5220.07	13.7	±20
		48	5240	5240.07	13.6	±20
		52	5260	5260.07	13.7	±20
		56	5280	5280.07	13.6	±20
		60	5300	5300.07	13.7	±20
		64	5320	5320.07	13.7	±20
		100	5500	5500.08	13.7	±20
		104	5520	5520.08	13.7	±20
		108	5540	5540.08	13.7	±20
		112	5560	5560.08	13.7	±20
		116	5580	5580.08	13.7	±20
		120	5600	5600.08	13.7	±20
		124	5620	5620.08	13.7	±20
		128	5640	5640.08	13.7	±20
		132	5660	5660.08	13.8	±20
		136	5680	5680.08	13.8	±20
		140	5700	5700.08	13.8	±20
		149	5745	5745.08	13.8	±20
		153	5765	5765.08	13.8	±20
		157	5785	5785.08	13.8	±20
		161	5805	5805.08	13.9	±20
		165	5825	5825.08	13.8	±20

Test Voltage (V)	Temperature (°C)	Channel	Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (ppm)	Limit (ppm)
DC 5.5V	25	36	5180	5180.07	13.7	±20
		40	5200	5200.07	13.8	±20
		44	5220	5220.07	13.7	±20
		48	5240	5240.07	13.7	±20
		52	5260	5260.07	13.7	±20
		56	5280	5280.07	13.7	±20
		60	5300	5300.07	13.8	±20
		64	5320	5320.07	13.8	±20
		100	5500	5500.08	13.7	±20
		104	5520	5520.08	13.8	±20
		108	5540	5540.08	13.7	±20
		112	5560	5560.08	13.8	±20
		116	5580	5580.08	13.7	±20
		120	5600	5600.08	13.8	±20
		124	5620	5620.08	13.8	±20
		128	5640	5640.08	13.7	±20
		132	5660	5660.08	13.9	±20
		136	5680	5680.08	13.8	±20
		140	5700	5700.08	13.9	±20
		149	5745	5745.08	13.8	±20
		153	5765	5765.08	14	±20
		157	5785	5785.08	13.9	±20
		161	5805	5805.08	14	±20
		165	5825	5825.08	13.9	±20

Test Voltage (V)	Temperature (°C)	Channel	Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (ppm)	Limit (ppm)
DC 5V	0	36	5180	5180.07	14	±20
		40	5200	5200.07	13.9	±20
		44	5220	5220.07	14	±20
		48	5240	5240.07	13.9	±20
		52	5260	5260.07	14	±20
		56	5280	5280.07	13.9	±20
		60	5300	5300.07	14.1	±20
		64	5320	5320.08	14.1	±20
		100	5500	5500.08	14.1	±20
		104	5520	5520.08	14.1	±20
		108	5540	5540.08	14.2	±20
		112	5560	5560.08	14.2	±20
		116	5580	5580.08	14.2	±20
		120	5600	5600.08	14.2	±20
		124	5620	5620.08	14.1	±20
		128	5640	5640.08	14.3	±20
		132	5660	5660.08	14.2	±20
		136	5680	5680.08	14.3	±20
		140	5700	5700.08	14.2	±20
		149	5745	5745.08	14.2	±20
		153	5765	5765.08	14.3	±20
		157	5785	5785.08	14.3	±20
		161	5805	5805.08	14.3	±20
		165	5825	5825.08	14.2	±20

Test Voltage (V)	Temperature (°C)	Channel	Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (ppm)	Limit (ppm)
DC 5V	50	36	5180	5180.07	14	±20
		40	5200	5200.07	14	±20
		44	5220	5220.07	14	±20
		48	5240	5240.07	14	±20
		52	5260	5260.07	14.1	±20
		56	5280	5280.07	14	±20
		60	5300	5300.07	14.1	±20
		64	5320	5320.07	14	±20
		100	5500	5500.08	13.9	±20
		104	5520	5520.08	13.9	±20
		108	5540	5540.08	13.8	±20
		112	5560	5560.08	13.8	±20
		116	5580	5580.08	13.8	±20
		120	5600	5600.08	13.8	±20
		124	5620	5620.08	13.8	±20
		128	5640	5640.08	13.7	±20
		132	5660	5660.08	13.8	±20
		136	5680	5680.08	13.8	±20
		140	5700	5700.08	13.9	±20
		149	5745	5745.08	13.8	±20
		153	5765	5765.08	13.9	±20
		157	5785	5785.08	13.8	±20
		161	5805	5805.08	13.9	±20
		165	5825	5825.08	14	±20

11 DEVIATION TO TEST SPECIFICATIONS

None.

12 MEASUREMENT UNCERTAINTY LIST

The measurement uncertainty was estimated for test on the EUT according to CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage of K=2.

The uncertainties value is not used in determining the PASS/FAIL results.

Test Items/Facilities	Frequency/Equipment/Unit	Uncertainty
Conducted Emission No.1 Shielded Room	9kHz~150kHz	±3.2 dB
	150kHz~30MHz	±3.1 dB
Conducted Emission No.3 Shielded Room	150kHz~30MHz	±3.1 dB
Radiated Emission	30MHz~200MHz, Horizontal	±3.4 dB
	30MHz~200MHz, Vertical	±4.0 dB
	200MHz~1000MHz, Horizontal	±3.7 dB
	200MHz~1000MHz, Vertical	±5.1 dB
	1GHz~6GHz	±5.7 dB
	6GHz~18GHz	±4.7 dB
Output Power Test	50MHz~18GHz	0.77 dB
Power Density Test	9kHz~6GHz	1.08 dB
RF Frequency Test	9kHz~40GHz	6×10^{-4}
Bandwidth Test	9kHz~6GHz	1.5×10^{-3}
RF Radiated Power Test	30MHz~1000MHz	3.06 dB
Conducted Output Power Test	50MHz~18GHz	0.83 dB
AC Voltage(<10kHz) Test	120V~230V	0.04 %
DC Power Test	0V~30V	0.4 %
Temperature	-40°C~+100°C	0.52 °C
Humidity	30%~95%	2.6 %