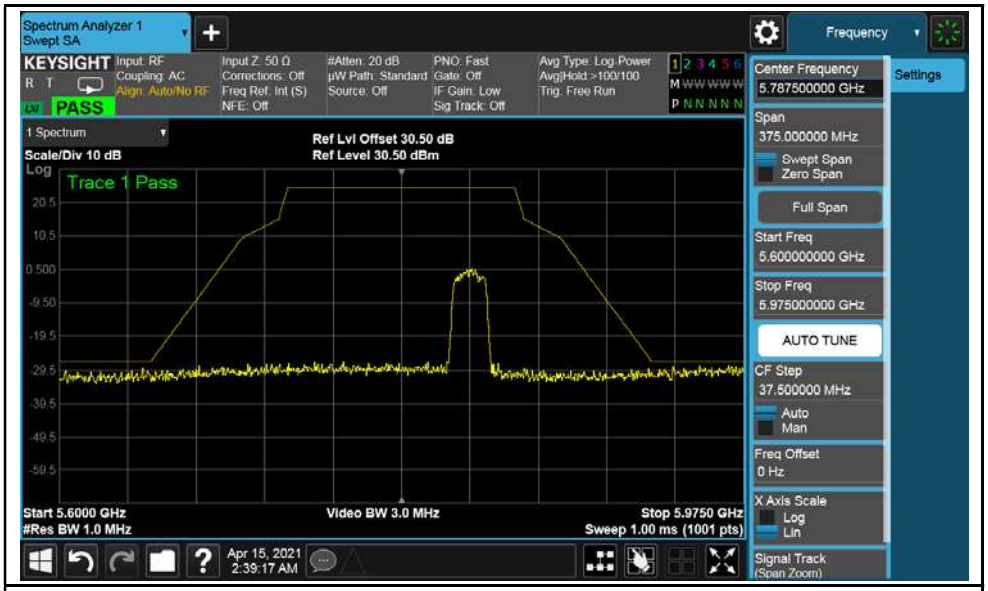
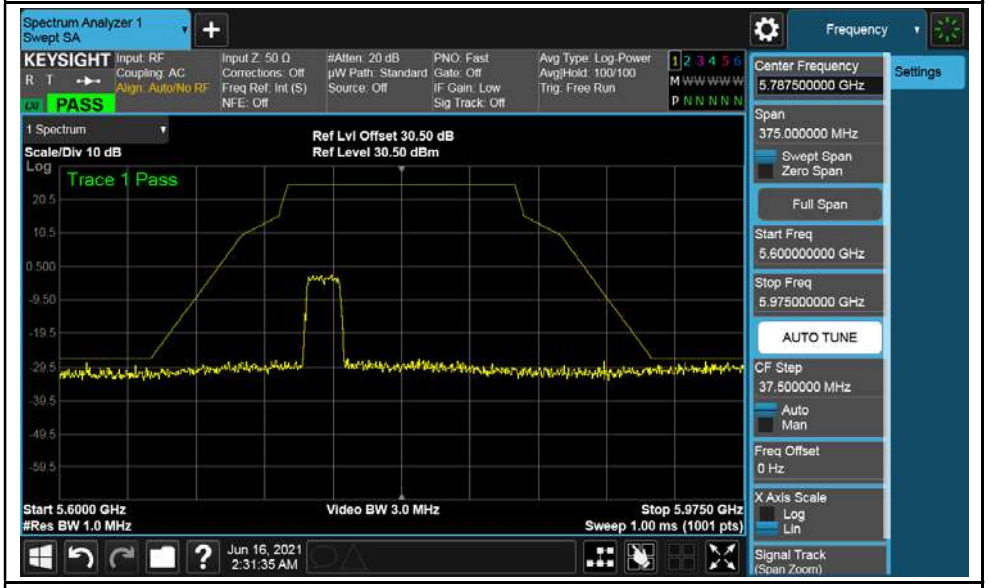
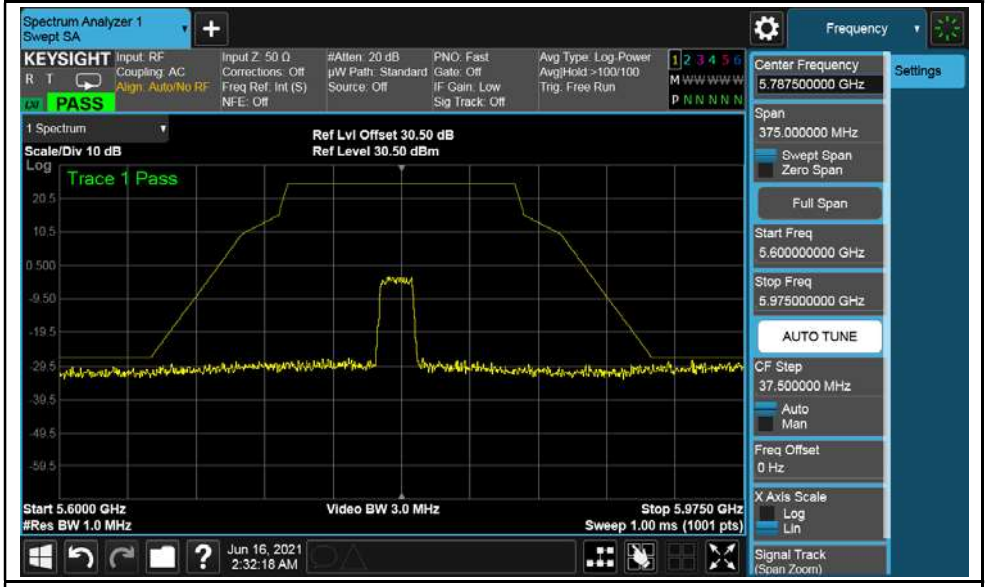


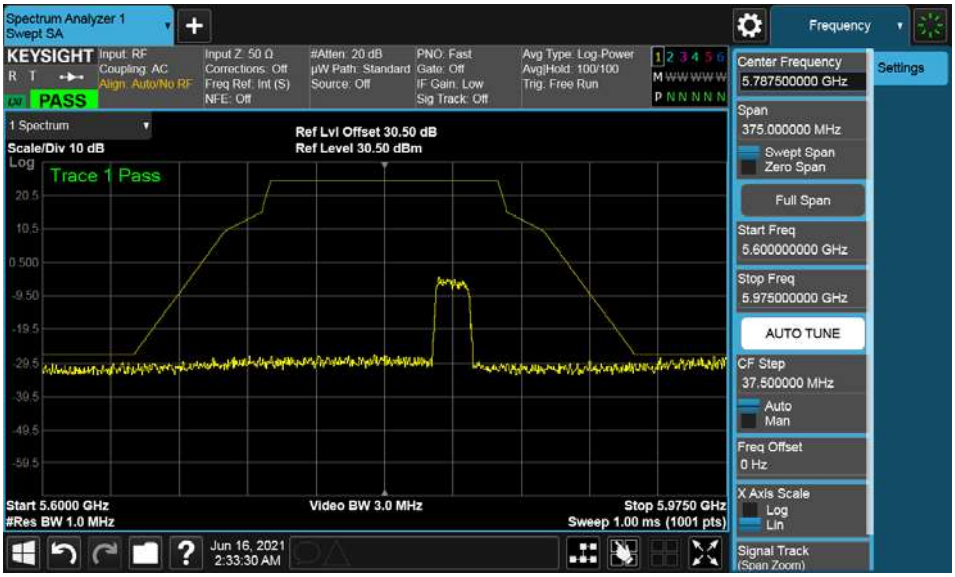
802.11n(HT20)-5825MHz



802.11ac (VHT20) – 5745MHz

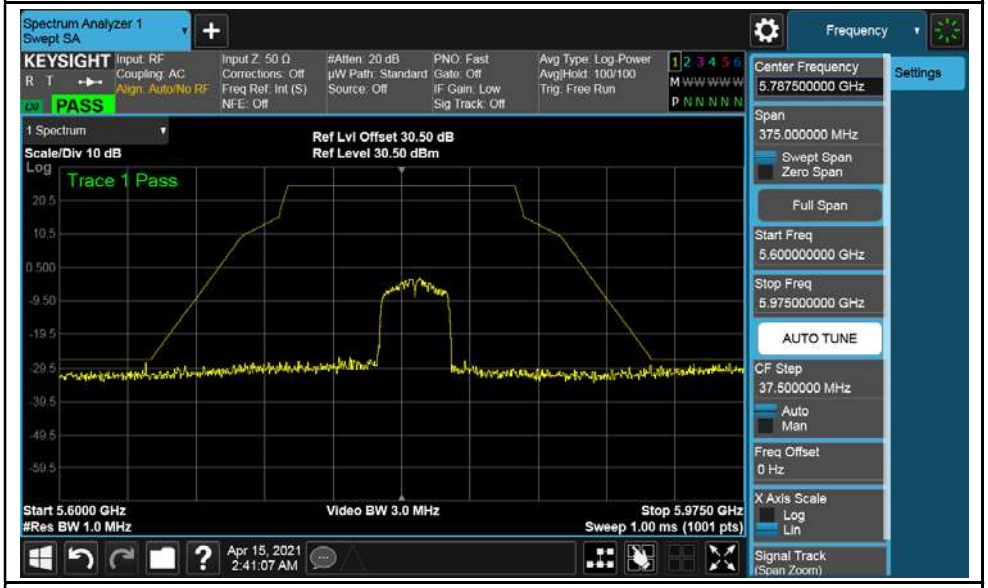


802.11ac (VHT20) – 5785MHz

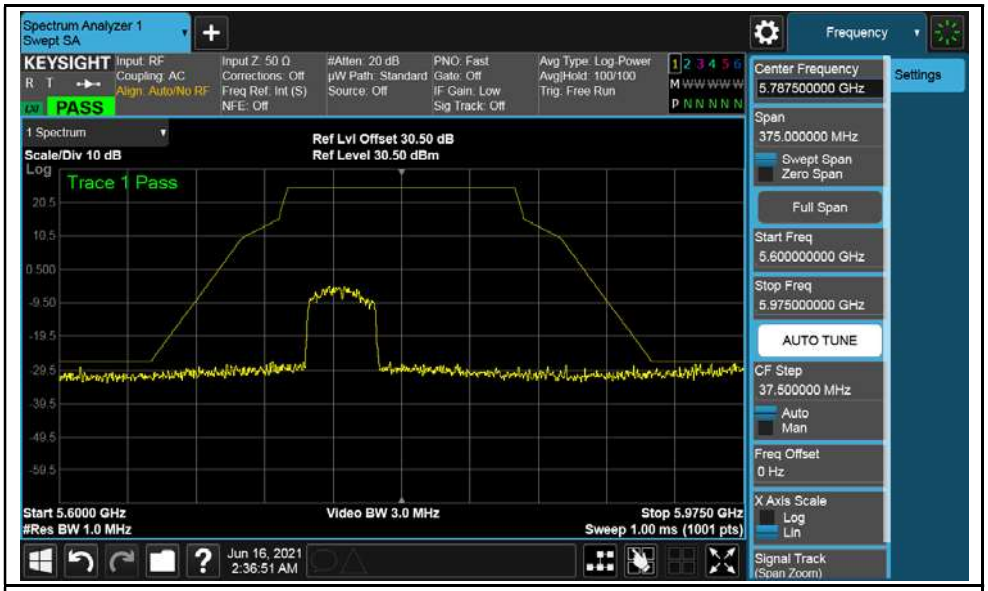


802.11ac (VHT20) – 5825MHz

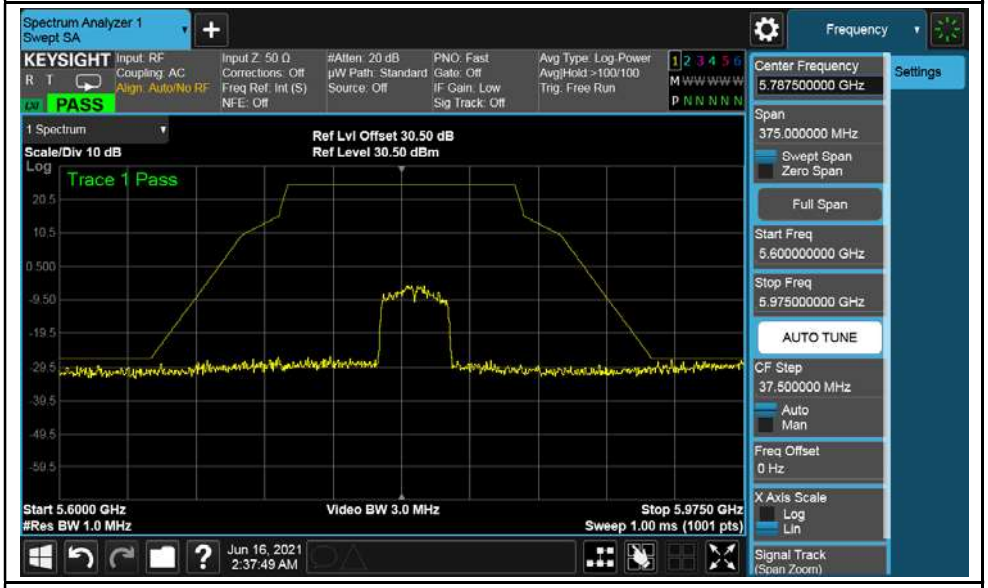
802.11n(HT40)-5755MHz



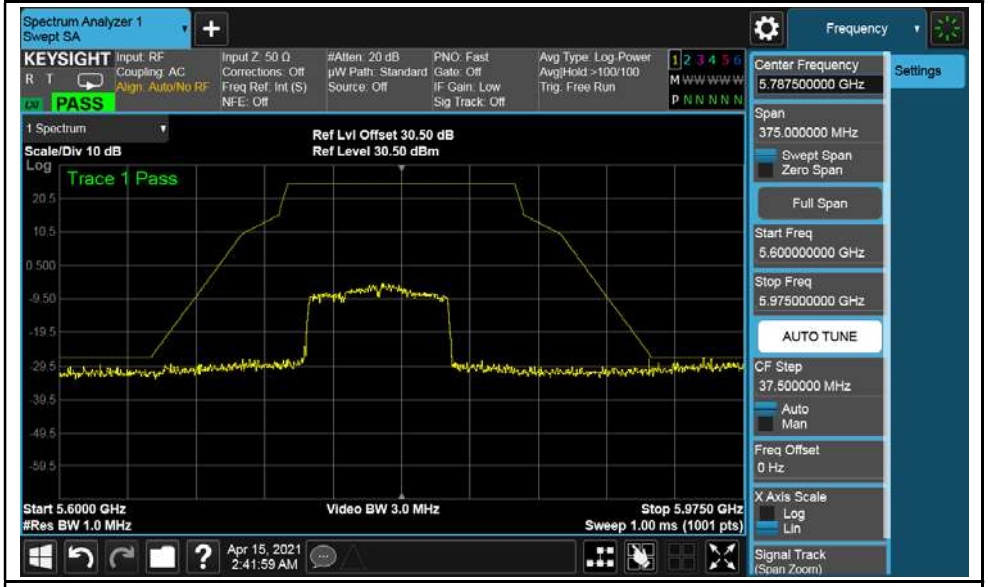
802.11n(HT40)-5795MHz



802.11ac (VHT40) - 5755MHz



802.11ac (VHT40) – 5795MHz



802.11n ac(VHT80)-5775MHz

4.3 Transmit Power Measurement

4.3.1 Limits of Transmit Power Measurement

Operation Band	EUT Category		Limit
U-NII-1		Outdoor Access Point	1 Watt (30 dBm) (Max. e.i.r.p ≦ 125mW(21 dBm) at any elevation angle above 30 degrees as measured from the horizon)
		Fixed point-to-point Access Point	1 Watt (30 dBm)
		Indoor Access Point	1 Watt (30 dBm)
	√	Client device	250mW (24 dBm)
U-NII-2A	---		250mW (24 dBm) or 11 dBm+10 log B*
U-NII-2C	---		250mW (24 dBm) or 11 dBm+10 log B*
U-NII-3	√		1 Watt (30 dBm)

*B is the 26 dB emission bandwidth in megahertz

Per KDB 662911 Method of conducted output power measurement on IEEE 802.11 devices,

Array Gain = 0 dB (i.e., no array gain) for $N_{ANT} \leq 4$;
Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any N_{ANT};
Array Gain = 5 log(N_{ANT}/N_{SS}) dB or 3 dB, whichever is less for 20-MHz channel widths with $N_{ANT} \geq 5$.

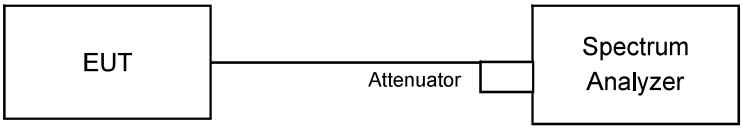
For power measurements on all other devices: Array Gain = 10 log(N_{ANT}/N_{SS}) dB.

4.3.2 Test Setup

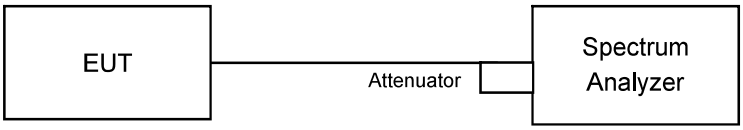
FOR POWER OUTPUT MEASUREMENT

◆ **Power Meter Measurement**

◆ **Spectrum Measurement**



FOR 26dB OCCUPIED BANDWIDTH



4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 Test Procedure

For Average Power Measurement

For 802.11a, 802.11n (HT20), 802.11n (HT40)

Method PM is used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst and set the detector to AVERAGE. Duty factor is not added to measured value.

For 802.11ac (VHT80)

1) Set span to encompass the entire 26 dB EBW (or, alternatively, the entire 99% occupied bandwidth) of the signal.
2) Set sweep trigger to “free run”.
3) Set RBW = 1 MHz.
4) Set VBW ≥ 3 MHz
5) Number of points in sweep ≥ 2 Span / RBW.
6) Sweep time ≤ (number of points in sweep) * T
7) Using emission bandwidth to determine the frequency span for integration the channel bandwidth.
8) Detector = RMS.
9) Trace mode = max hold.
10) Allow max hold to run for at least 60 seconds, or longer as needed to allow the trace to stabilize.

◆ **Power Meter Measurement**

Method PM is used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.

◆ **Spectrum Measurement**

Follow FCC KDB 789033 UNII test procedure:
Method SA-1

1. Set span to encompass the entire emission bandwidth (EBW) of the signal.
2. Set RBW =1MHz.
3. Set the VBW ≥ 3 x RBW.
4. Number of points in sweep ≥ 2 Span / RBW.
5. Sweep time = auto.
6. Set trigger to free run (duty cycle ≥ 98 percent)
7. Detector = RMS.
8. Trace average at least 100 traces in power averaging mode
9. Compute power by integrating the spectrum across the 26 dB EBW of the signal.

Follow FCC KDB 789033 UNII test procedure:
Method SA-2

1. Set span to encompass the emission bandwidth (EBW) of the signal.
2. Set RBW =1MHz.
3. Set the VBW ≥ 3 x RBW.
4. Number of points in sweep ≥ 2 Span / RBW.
5. Sweep time = auto.
6. Detector = RMS.
7. Trace average at least 100 traces in power averaging mode
8. Compute power by integrating the spectrum across the 26 dB EBW of the signal.
9. Duty factor need added to measured value (duty cycle < 98 percent).

FOR 26dB OCCUPIED BANDWIDTH

1. Set RBW = approximately 1% of the emission bandwidth.
2. Set the VBW > RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

4.3.5 Deviation from Test Standard

No deviation.

4.3.6 EUT Operating Condition

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.3.7 Test Results

Output Power measurement result for UNII-1 Band

Type	Test mode	Freq (MHz)	CH	Conducted Power (dBm)	Limit (dBm)	Result
Output Power	802.11a	5180	Low	5.99	24	Pass
		5200	Mid	5.72	24	Pass
		5240	High	5.04	24	Pass
	802.11n-HT20	5180	Low	5.99	24	Pass
		5200	Mid	5.72	24	Pass
		5240	High	5.07	24	Pass
	802.11ac-VHT20	5180	Low	5.99	24	Pass
		5200	Mid	5.69	24	Pass
		5240	High	5.13	24	Pass
	802.11n-HT40	5190	Low	3.88	24	Pass
		5230	High	3.65	24	Pass
	802.11ac-VHT40	5190	Low	3.75	24	Pass
		5230	High	3.73	24	Pass
	802.11ac-VHT80	5210	Low	3.97	24	Pass

Output Power measurement result for UNII-3 Band

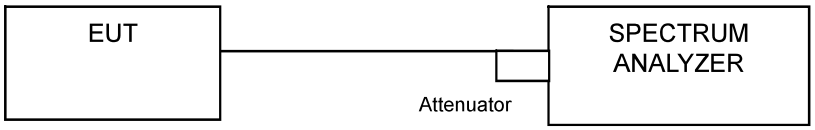
Type	Test mode	Freq (MHz)	CH	Conducted Power (dBm)	Limit (dBm)	Result
Output Power	802.11a	5745	Low	8.30	30	Pass
		5785	Mid	8.21	30	Pass
		5825	High	7.68	30	Pass
	802.11n-HT20	5745	Low	8.56	30	Pass
		5785	Mid	8.22	30	Pass
		5825	High	7.35	30	Pass
	802.11ac-VHT20	5745	Low	8.66	30	Pass
		5785	Mid	8.51	30	Pass
		5825	High	7.42	30	Pass
	802.11n-HT40	5755	Low	8.77	30	Pass
		5795	High	8.63	30	Pass
	802.11ac-VHT40	5755	Low	8.96	30	Pass
		5795	High	8.93	30	Pass
	802.11ac-VHT80	5775	Low	7.37	30	Pass

4.4 26dB Bandwidth & 6dB Bandwidth Measurement

4.4.1 Limits of 6 dB Bandwidth Measurement

The minimum of 6 dB Bandwidth Measurement is 0.5 MHz.

4.4.2 Test Setup



4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.4.4 Test Procedure

26dB Emission bandwidth measurement procedure (Other than 5.725-5.85 GHz)

- Allow the trace to stabilize.
- Use the spectrum analyzer built-in measurement function to determine the 26dB BW.
  Set RBW = around 1% of emission bandwidth
  Set VBW > RBW
  Detector = Peak
  Trace mode = max hold
- Capture the plot.
- Repeat above steps for different test channel and other modulation type.

6 dB Minimum emission bandwidth measurement procedure

- Allow the trace to stabilize.
- Use the spectrum analyzer built-in measurement function to determine the 6dB BW.
  Set RBW = 100 KHz
  Set VBW ≥ 3 x RBW
  Detector = Peak
  Trace mode = max hold
  Sweep = auto couple
- Capture the plot.
- Repeat above steps for different test channel and other modulation type.

4.4.5 Test Results

26dB Bandwidth measurement result for UNII-1 Band

Type	Test mode	Freq (MHz)	CH	99% OBW(MHz)	26 dB OBW(MHz)
26dB BW	802.11a	5180	Low	17.79	21.28
		5200	Mid	17.53	20.90
		5240	High	17.77	21.11
	802.11n-HT20	5180	Low	17.77	21.28
		5200	Mid	17.78	20.99
		5240	High	17.75	20.87
	802.11ac-VHT20	5180	Low	17.79	21.37
		5200	Mid	17.74	21.04
		5240	High	17.72	21.20
	802.11n-HT40	5190	Low	36.06	38.92
		5230	High	36.13	39.00
	802.11ac-VHT40	5190	Low	36.03	38.95
		5230	High	36.1	39.17
	802.11ac-VHT80	5210	Low	75.76	81.01

6dB Bandwidth measurement result for UNII-3 Band

Type	Test mode	Freq (MHz)	CH	99% OBW(MHz	6 dB OBW(MHz)	Limit (MHz)	Result
6dB BW	802.11a	5745	Low	17.79	17.67	0.5	Pass
		5785	Mid	17.81	17.83	0.5	Pass
		5825	High	17.83	17.88	0.5	Pass
	802.11n-HT20	5745	Low	17.77	17.77	0.5	Pass
		5785	Mid	17.77	17.73	0.5	Pass
		5825	High	17.77	17.77	0.5	Pass
	802.11ac-VHT20	5745	Low	17.79	17.78	0.5	Pass
		5785	Mid	17.79	17.75	0.5	Pass
		5825	High	17.75	17.74	0.5	Pass
	802.11n-HT40	5755	Low	36.04	35.64	0.5	Pass
		5795	High	36.05	35.33	0.5	Pass
	802.11ac-VHT40	5755	Low	36.12	36.00	0.5	Pass
		5795	High	35.98	35.69	0.5	Pass
	802.11ac-VHT80	5775	Low	75.78	76.21	0.5	Pass

Occupied Bandwidth Test Plots
UNII-1 Band

802.11a-5180MHz

802.11a-5200MHz

802.11a-5240MHz

802.11n-HT20-5180MHz

802.11n-HT20-5200MHz

802.11n-HT20-5240MHz

802.11ac-VHT20-5180MHz

802.11ac-VHT20-5200MHz

802.11ac-VHT20-5240MHz

802.11n-HT40-5190MHz

802.11n-HT40-5230MHz

802.11ac-VHT40-5190MHz

802.11ac-VHT40-5230MHz

802.11ac-VHT80-5210MHz

6dB Bandwidth Test Plots
U-NII-3 Band:

802.11a-5745MHz

802.11a-5785MHz

802.11a-5825MHz

802.11n-HT20-5745MHz

802.11n-HT20-5785MHz

802.11n-HT20-5825MHz

802.11ac-HT20-5745MHz

802.11ac-HT20-5785MHz

802.11ac-HT20-5825MHz

802.11n-HT40-5755MHz

802.11n-HT40-5795MHz

802.11ac-VHT40-5795MHz

802.11ac-VHT40-5795MHz

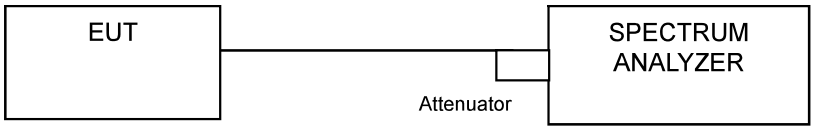
802.11ac-VHT80-5775MHz

4.5 Peak Power Spectral Density Measurement

4.5.1 Limits of Peak Power Spectral Density Measurement

Operation Band	EUT Category		Limit
U-NII-1		Outdoor Access Point	17dBm/ MHz
		Fixed point-to-point Access Point	
		Indoor Access Point	
	√	Client device	11dBm/ MHz
U-NII-2A	---		11dBm/ MHz
U-NII-2C	---		11dBm/ MHz
U-NII-3	√		30dBm/ 500kHz

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.5.4 Test Procedure

For U-NII-1, U-NII-2A, U-NII-2C band:

Using method SA-1

1. Set span to encompass the entire emission bandwidth (EBW) of the signal.
2. Set RBW = 1 MHz, Set VBW ≥ 3 MHz, Detector = RMS
3. Sweep time = auto, trigger set to “free run”.
4. Trace average at least 100 traces in power averaging mode.
5. Record the max value

For U-NII-3:

1. Set span to encompass the entire emission bandwidth (EBW) of the signal.
2. Set RBW = 300 kHz, Set VBW ≥ 1 MHz, Detector = RMS
3. Use the peak marker function to determine the maximum power level in any 300 kHz band segment within the fundamental EBW.
4. Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where BWCF = 10log(500 kHz/300kHz)
5. Sweep time = auto, trigger set to “free run”.
6. Trace average at least 100 traces in power averaging mode.
7. Record the max value

4.5.5 Deviation from Test Standard

No deviation.

4.5.6 EUT Operating Condition

Same as Item 4.3.6.

4.5.7 Test Results

PSD measurement result for UNII-1 Band

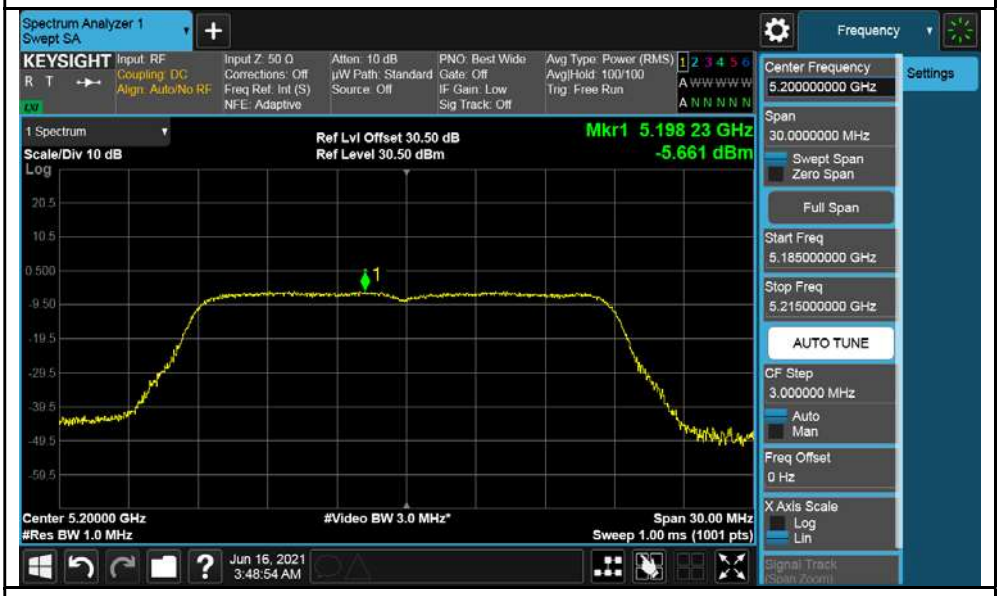
Type	Test mode	Freq (MHz)	CH	Conducted PSD (dBm/MHz)	Limit (dBm/MHz)	Result
Output Power	802.11a	5180	Low	-5.520	11	Pass
		5200	Mid	-5.661	11	Pass
		5240	High	-6.071	11	Pass
	802.11n-HT20	5180	Low	-4.972	11	Pass
		5200	Mid	-5.013	11	Pass
		5240	High	-5.535	11	Pass
	802.11ac-VHT20	5180	Low	-4.865	11	Pass
		5200	Mid	-5.330	11	Pass
		5240	High	-5.616	11	Pass
	802.11n-HT40	5190	Low	-9.015	11	Pass
		5230	High	-8.684	11	Pass
	802.11ac-vHT40	5190	Low	-8.702	11	Pass
		5230	High	-8.657	11	Pass
	802.11ac-VHT80	5210	Low	-12.732	11	Pass

PSD measurement result for UNII-3 Band

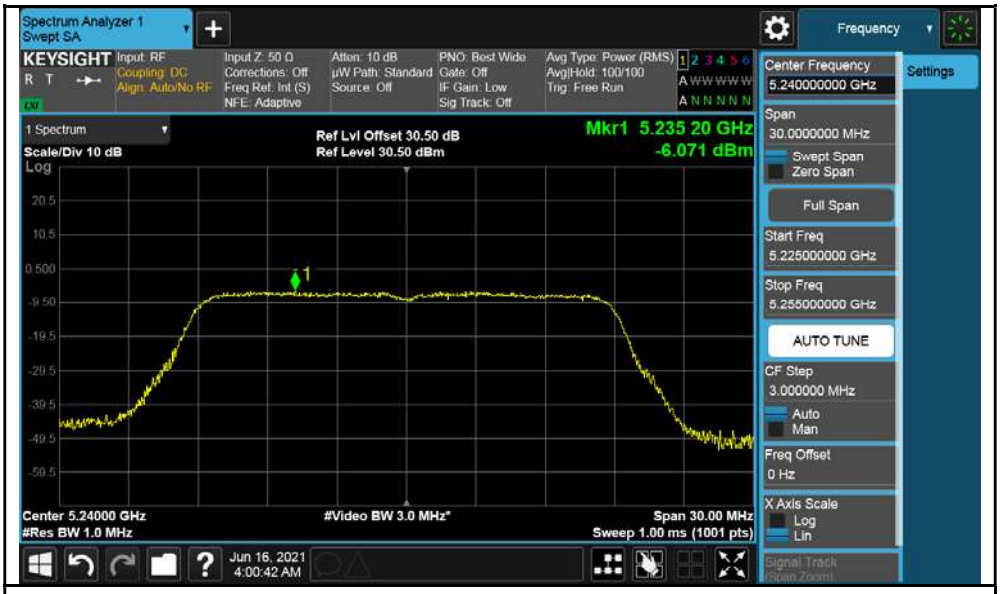
Type	Test mode	Freq (MHz)	CH	Conducted PSD (dBm/MHz)	Correction factor (dB)	Correction PSD (dBm/MHz)	Limit (dBm/MHz)	Result
Output Power	802.11a	5745	Low	-16.772	6.99	-9.782	30	Pass
		5785	Mid	-18.049	6.99	-11.059	30	Pass
		5825	High	-20.422	6.99	-13.432	30	Pass
	802.11n-HT20	5745	Low	-17.556	6.99	-10.566	30	Pass
		5785	Mid	-18.392	6.99	-11.402	30	Pass
		5825	High	-20.196	6.99	-13.206	30	Pass
	802.11ac-VHT20	5745	Low	-17.395	6.99	-10.405	30	Pass
		5785	Mid	-19.203	6.99	-12.213	30	Pass
		5825	High	-20.881	6.99	-13.891	30	Pass
	802.11n-HT40	5755	Low	-20.486	6.99	-13.496	30	Pass
		5795	High	-21.688	6.99	-14.698	30	Pass
	802.11ac-vHT40	5755	Low	-20.726	6.99	-13.736	30	Pass
		5795	High	-21.749	6.99	-14.759	30	Pass
	802.11ac-VHT80	5775	Low	-24.607	6.99	-17.617	30	Pass
NOTE	BW correction factor = 10log (500kHz/RBW), RBW was set to 100kHz during test.							

Test Plot for UNII-1 Band:

802.11a-5180MHz



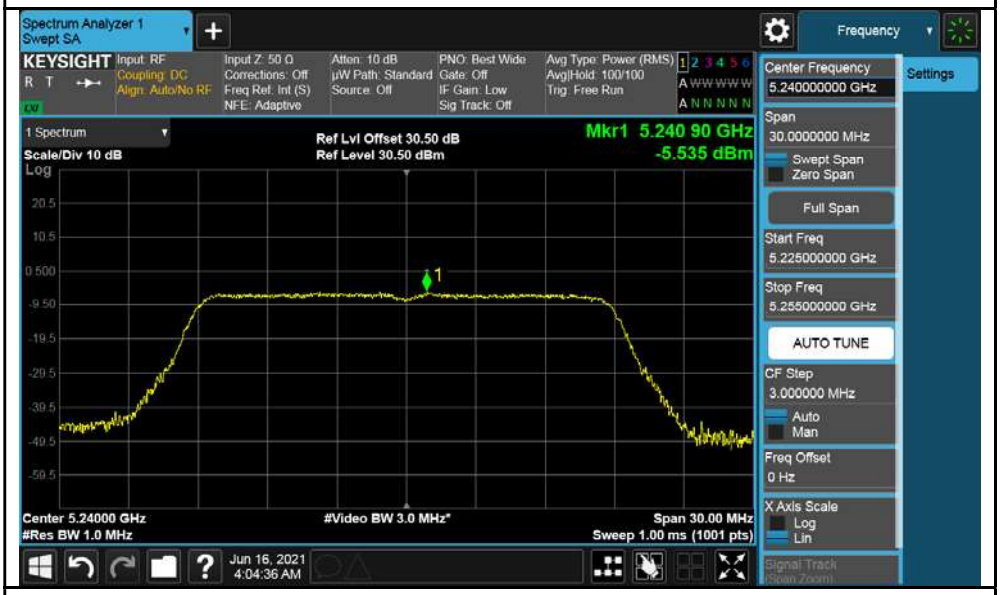
802.11a-5200MHz



802.11a-5240MHz

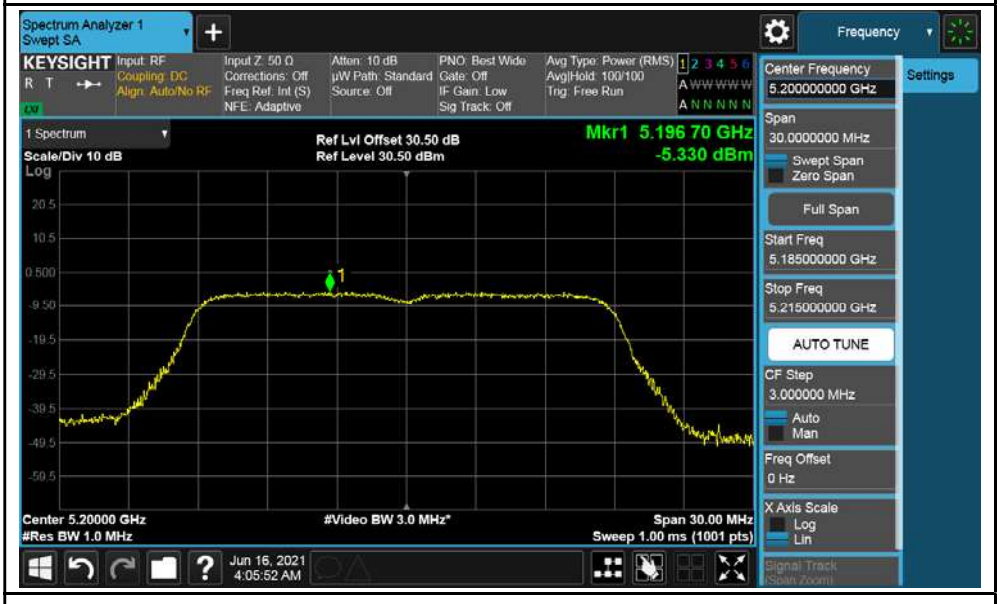
802.11n-HT20-5180MHz

802.11n-HT20-5200MHz



802.11n-HT20-5240MHz

802.11ac-VHT20-5180MHz



802.11ac-VHT20-5200MHz

802.11ac-VHT20-5240MHz

802.11n-HT40-5190MHz

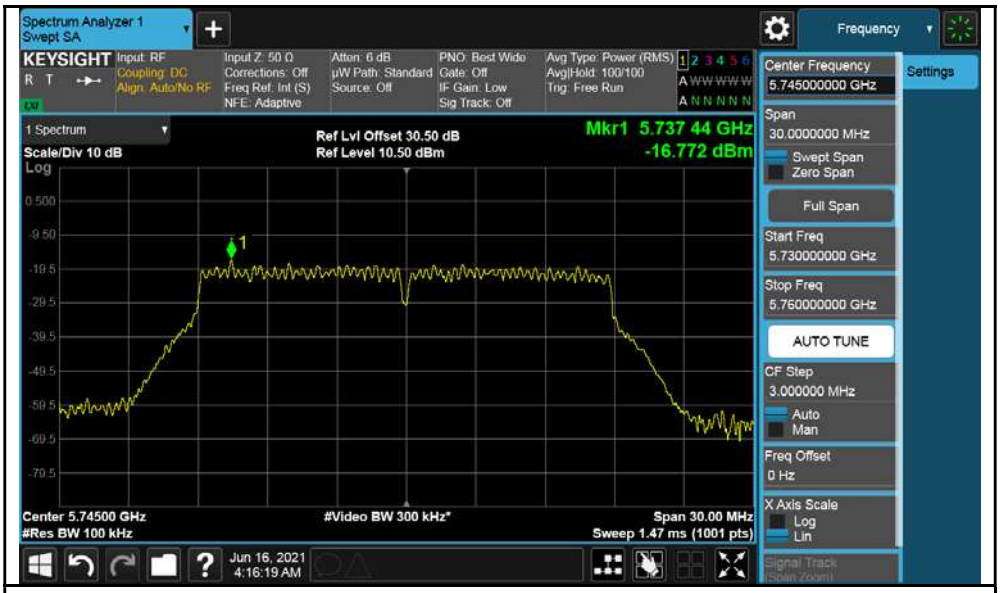
802.11n-HT40-5230MHz

802.11ac-VHT40-5190MHz

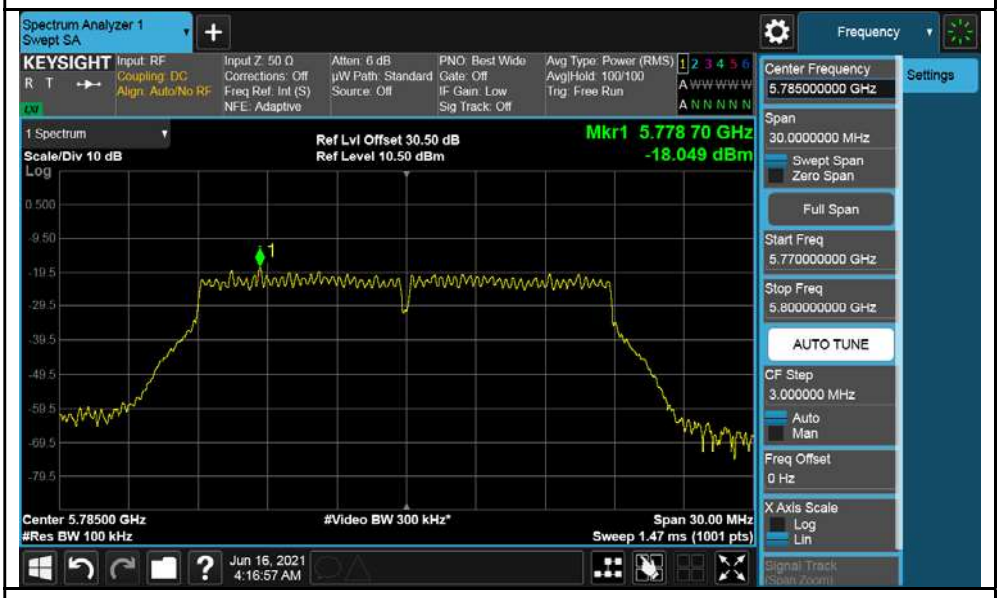
802.11ac-VHT40-5230MHz

802.11ac-VHT80-5210MHz

Test Plot for UNII-3 Band:

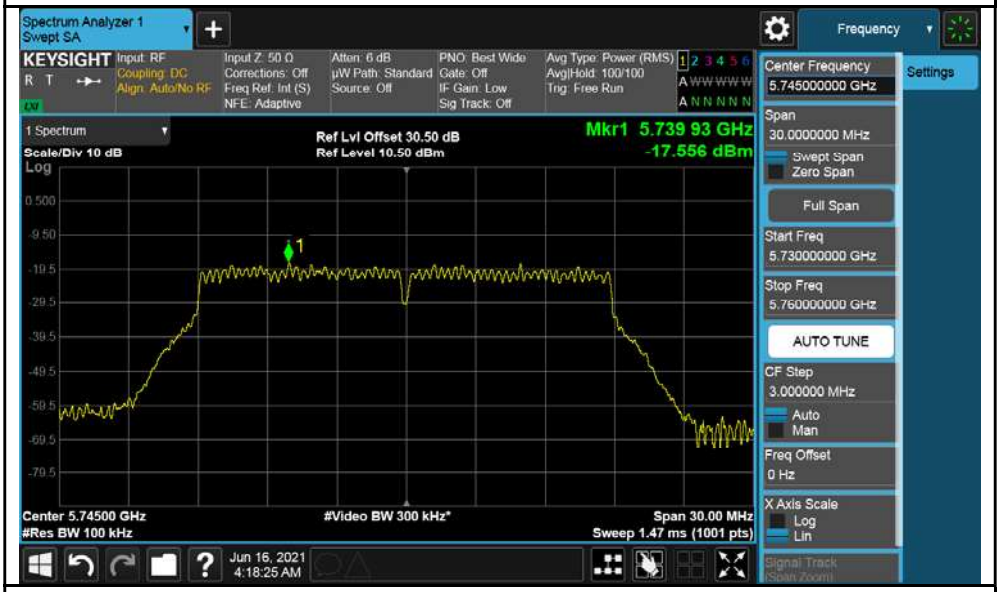


802.11a-5745MHz

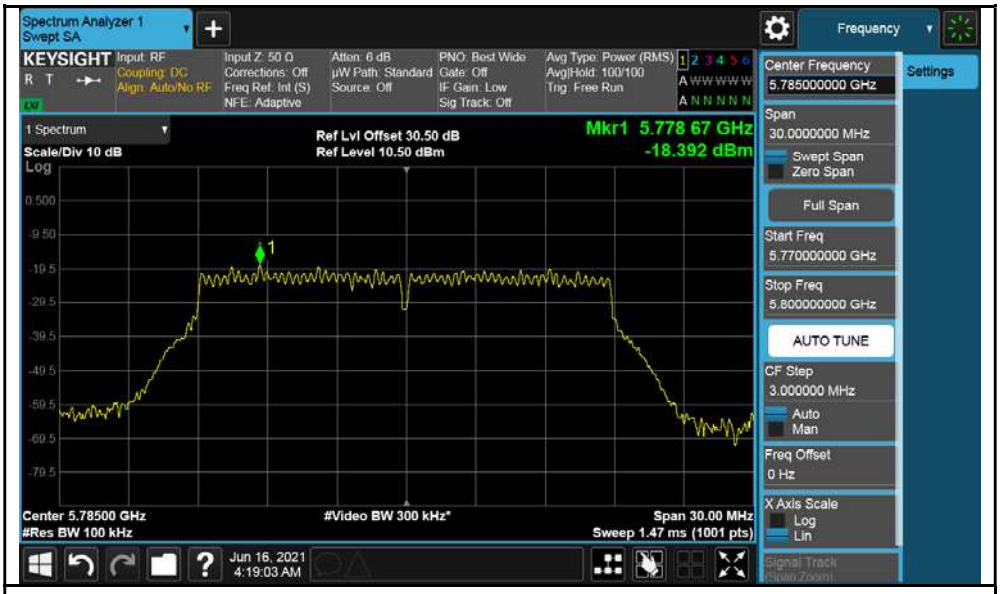


802.11a-5785MHz

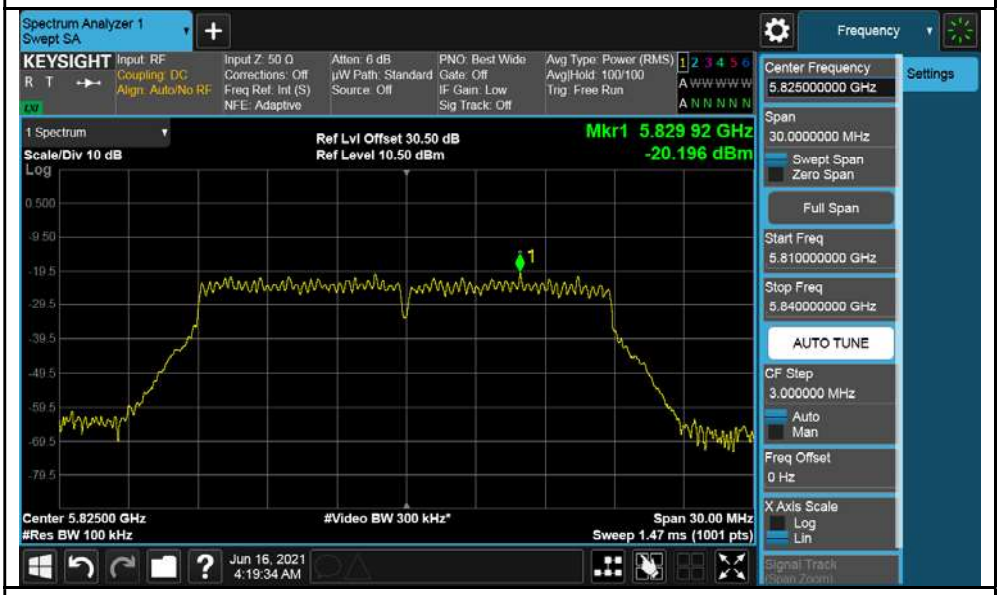
802.11a-5825MHz



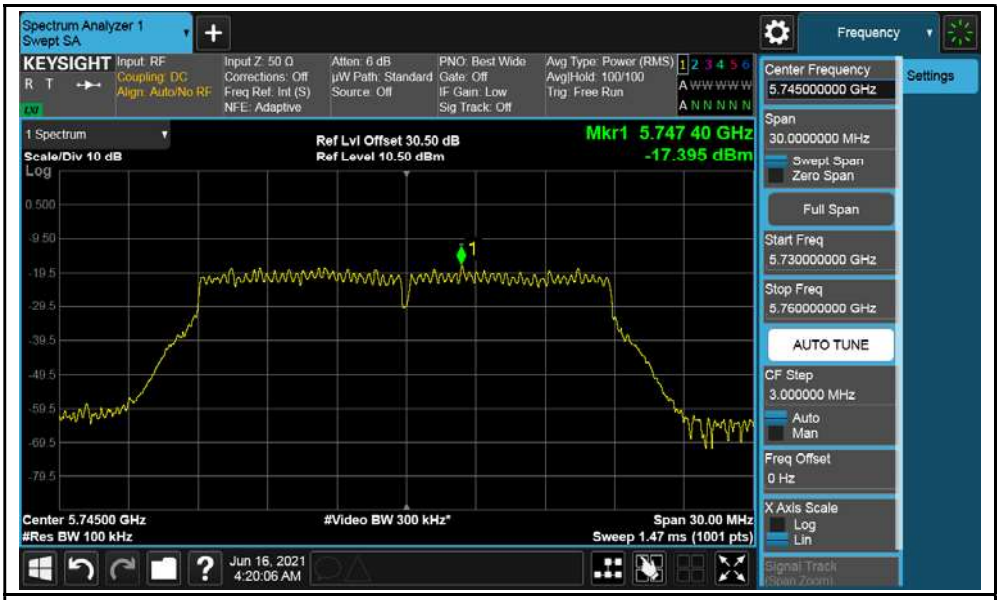
802.11n-HT20-5745MHz



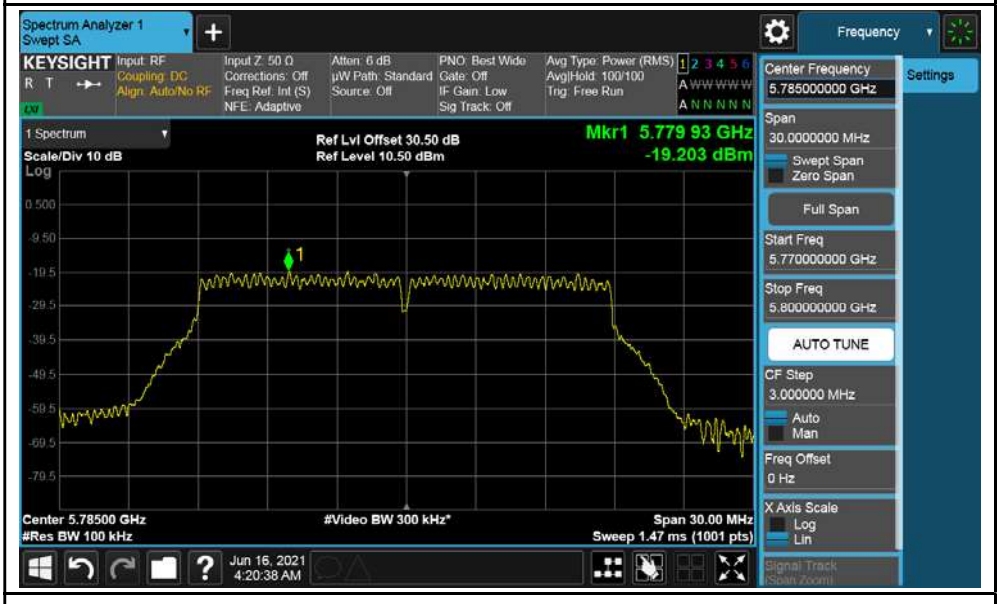
802.11n-HT20-5785MHz



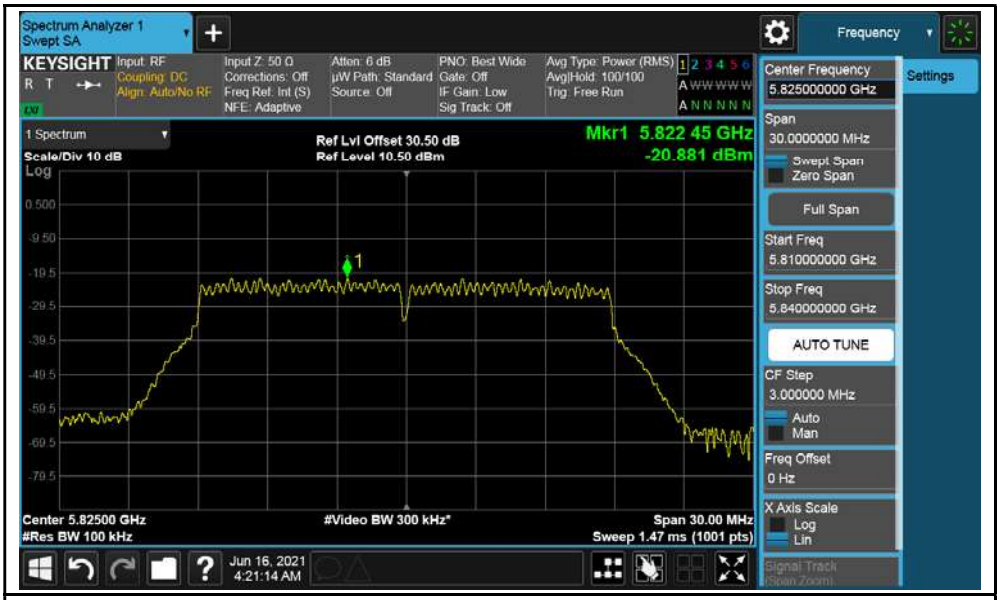
802.11n-HT20-5825MHz



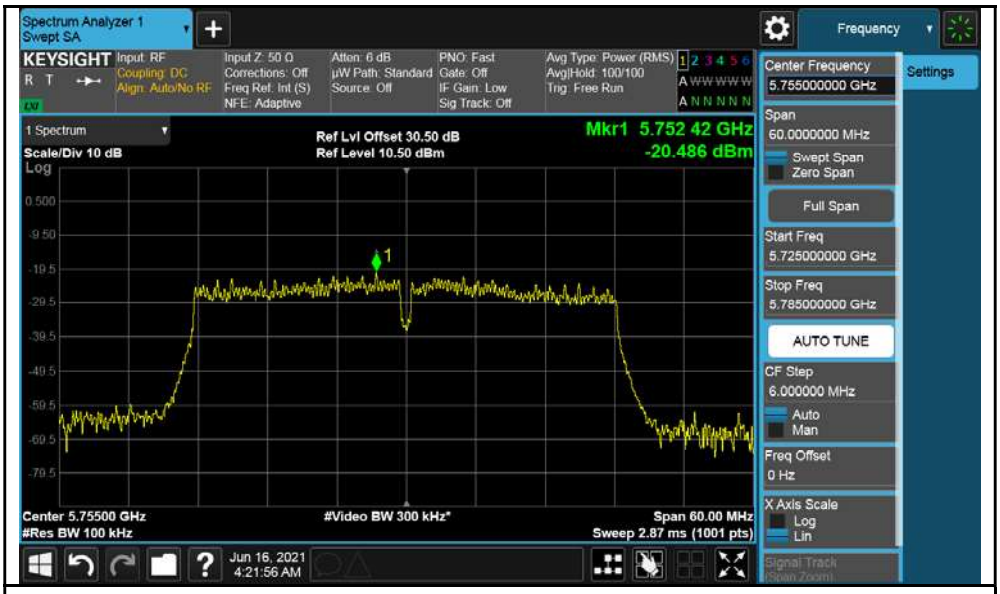
802.11ac-VHT20-5745MHz



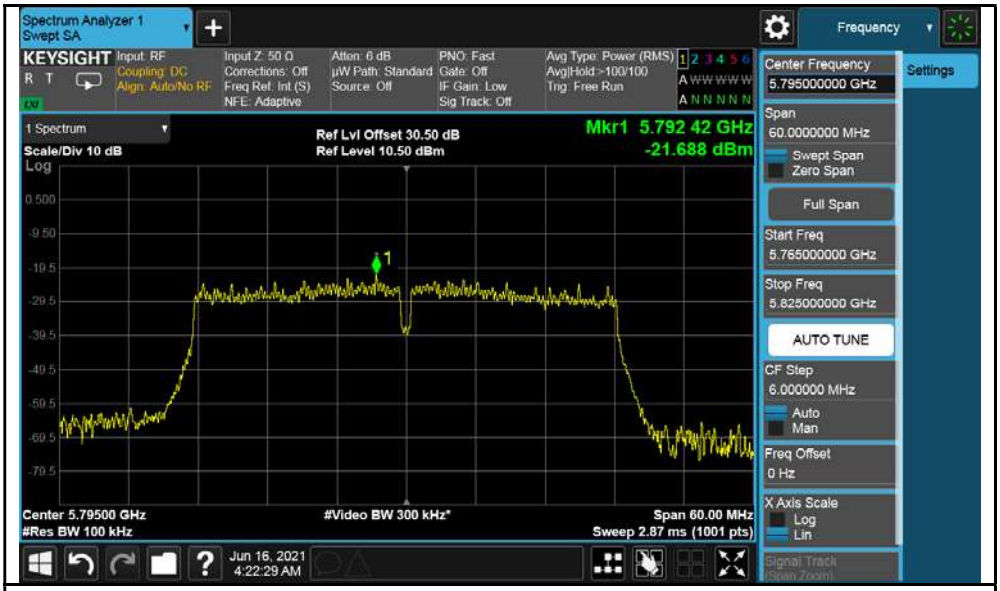
802.11ac-VHT20-5785MHz



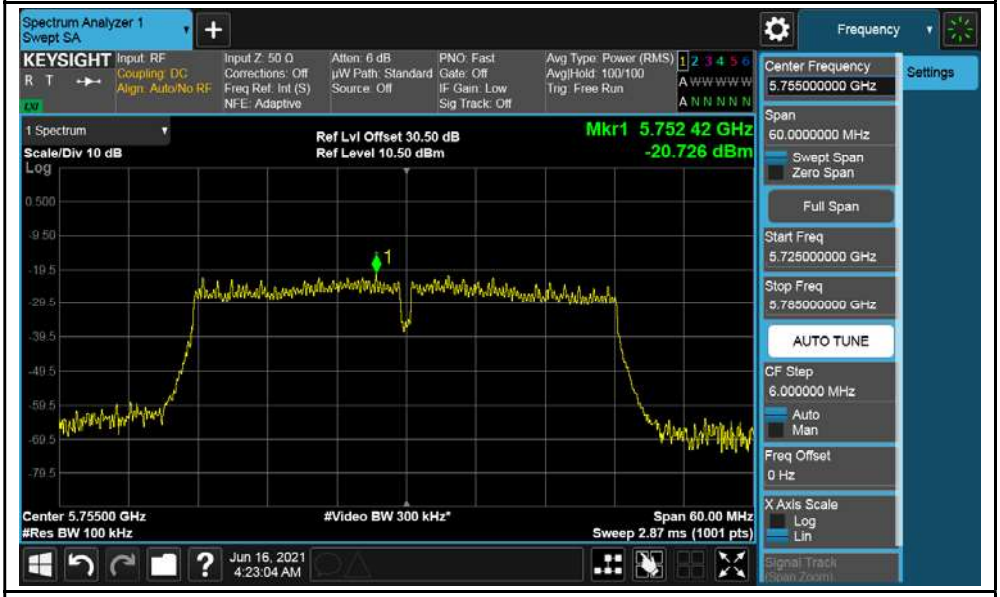
802.11ac-VHT20-5825MHz



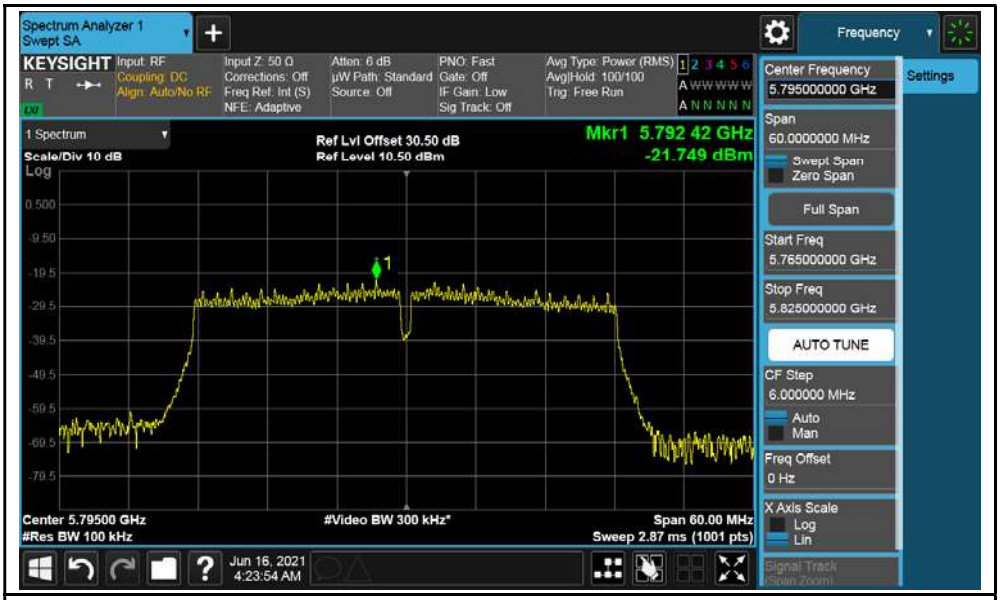
802.11n-HT40-5755MHz



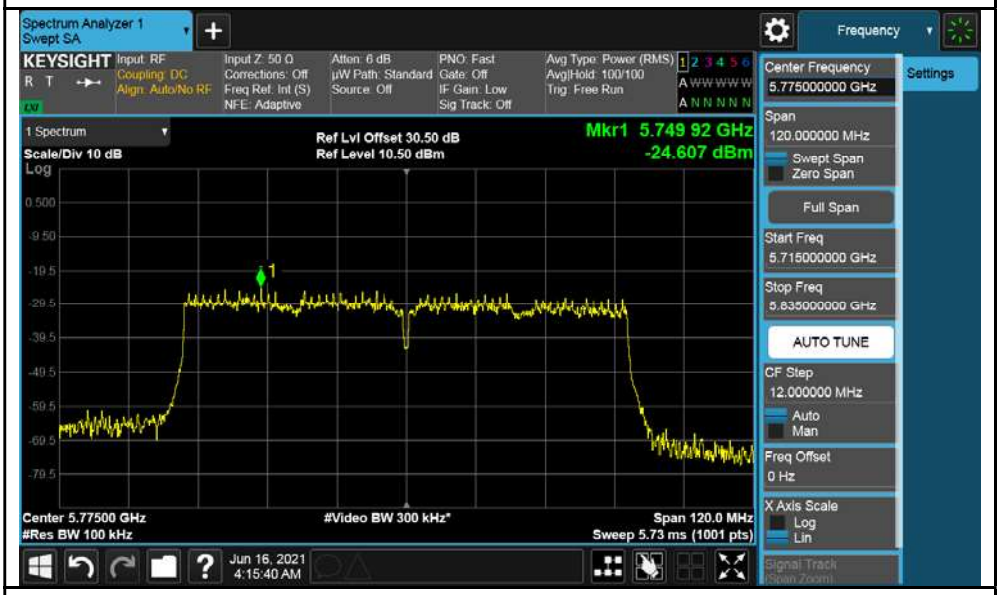
802.11n-HT40-5795MHz



802.11ac-VHT40-5755MHz



802.11ac-VHT40-5795MHz



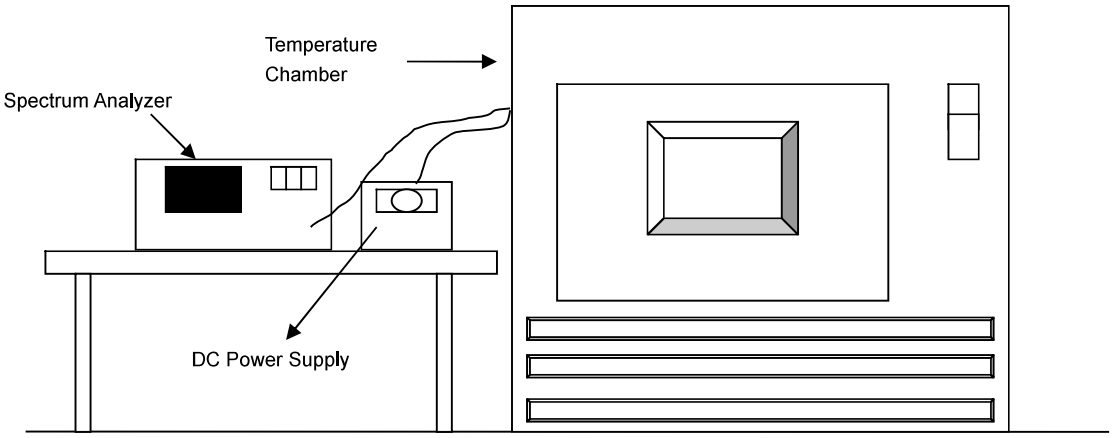
802.11n-HT40-5775MHz

4.6 Frequency Stability Measurement

4.6.1 Limits of Frequency Stability Measurement

The frequency of the carrier signal shall be maintained within band of operation.

4.6.2 Test Setup



4.6.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.6.4 Test Procedure

a. The EUT was placed inside the environmental test chamber and powered by nominal DC voltage.
b. Turn the EUT on and couple its output to a spectrum analyzer.
c. Turn the EUT off and set the chamber to the highest temperature specified.
d. Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize, turn the EUT on and measure the operating frequency after 2, 5, and 10 Minutes.
e. Repeat step (d) with the temperature chamber set to the next desired temperature until measurements down to the lowest specified temperature have been completed..
f. The test chamber was allowed to stabilize at +20 degree C for a minimum of 30 Minutes. The supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.
.

4.6.5 Deviation from Test Standard

No deviation.

4.6.6 EUT Operating Condition

Set the EUT transmit at un-modulation mode to test frequency stability.

4.6.7 Test Results

Frequency Stability Versus Temp.									
Operating Frequency: 5180 MHz									
TEMP. (℃)	Power Supply (Vdc)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency (MHz)	Pass/Fail	Measured Frequency (MHz)	Pass/Fail	Measured Frequency (MHz)	Pass/Fail	Measured Frequency (MHz)	Pass/Fail
50	12	5179.973	Pass	5180.06234	Pass	5179.98167	Pass	5179.98913	Pass
40	12	5180.050	Pass	5179.99516	Pass	5180.00110	Pass	5180.00202	Pass
30	12	5179.991	Pass	5180.00249	Pass	5179.99216	Pass	5179.99117	Pass
20	12	5179.994	Pass	5180.00197	Pass	5179.99441	Pass	5180.00916	Pass
10	12	5179.976	Pass	5179.97193	Pass	5179.998421	Pass	5180.00841	Pass
0	12	5180.003	Pass	5180.00419	Pass	5179.97138	Pass	5180.98419	Pass
-10	12	5179.974	Pass	5179.98167	Pass	5179.97419	Pass	5179.99555	Pass
-20	12	5179.905	Pass	5179.99128	Pass	5180.00298	Pass	5180.00916	Pass
-30	12	5180.004	Pass	5179.98792	Pass	5179.99110	Pass	5179.99188	Pass

Frequency Stability Versus Voltage									
Operating Frequency: 5180 MHz									
TEMP. (℃)	Power Supply (Vdc)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency (MHz)	Pass/Fail	Measured Frequency (MHz)	Pass/Fail	Measured Frequency (MHz)	Pass/Fail	Measured Frequency (MHz)	Pass/Fail
20	13.8	5180.010	Pass	5179.980	Pass	5180.009	Pass	5180.0023	Pass
	12	5179.986	Pass	5179.916	Pass	5180.023	Pass	5180.0018	Pass
	10.2	5180.120	Pass	5180.012	Pass	5179.889	Pass	5179.9812	Pass

5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

Appendix – Information on the Testing Laboratories

Bureau Veritas is a global leader in testing, inspection and certification (TIC) services. We help businesses improve safety, sustainability and productivity; and our clients include the majority of leading brands in retail, manufacturing and other industries. With a presence in every major country around the world, our quality assurance and compliance solutions are vital in helping our customers enhance product quality and concept-to-consumer journeys. We also assist with increasing speed to market, profitability and brand equity throughout the supply chain. Bureau Veritas is a leading wireless/IoT testing, inspection, audit and certification provider, with a global network of test laboratories to support the IoT industry in areas of connectivity, security, interoperability as well as quality, health & safety, and environmental/chemical requirements.

If you have any comments, please feel free to contact us at the following:

Milpitas EMC/RF/Safety/Telecom Lab
775 Montague Expressway, Milpitas, CA 95035
Tel: +1 408 526 1188

Sunnyvale OTA/Bluetooth Lab
1293 Anvilwood Avenue, Sunnyvale, CA 94089
Tel: +1 669 600 5293

Littleton EMC/RF/Safety/Environmental Lab
1 Distribution Center Cir #1, Littleton, MA 01460
Tel: +1 978 486 8880

Email: sales.eaw@us.bureauveritas.com
Web Site: www.cps.bureauveritas.com

The address and road map of all our labs can be found in our web site also.

--- END ---