4.3 Power Spectral Density

Test Procedures

KDB 987594 – Section F
KDB 789033 – Section F (Method SA-2, Maximum Power Spectral Density)
KDB 662911 D01, D02 (Multiple Transmitter Output)

The peak power density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

Test Settings :

Center frequency = the highest, middle and the lowest channels

a) RBW = 1 MHz

b) VBW = 3 MHz

c) Sweep time = auto

d) Detector = power averaging (rms)

e) Trace mode = Average at least 100

f) Duty cycle factor = 10log(1/x)

Test mode	Duty Cycle Factor (dB)
802.11ax_HE20	0.80
802.11ax_HE40	0.81
802.11ax_HE80	0.87

Limit

Operating Mode	ANT Configuration	ANT Gain (dBi)	Mode	Band	Limit (dBm)
SISO	ANT1, ANT2	2.26, -5.58	802.11ax	UNII 5	-1.00 ERIP
				UNII 6	
				UNII 7	
				UNII 8	
MIMO (2Tx)	ANT1 + ANT2	2.21	802.11ax	UNII 5	
				UNII 6	
				UNII 7	
				UNII 8	

Test Data
ANT1

Test Mode	Frequency (MHz)	Measured Power Density (dBm)	Duty cycle Factor (dB)	Antenna Gain (dBi)	Result Output Power (dBm)	Limit (dBm)	Margin (dB)
802.11ax _HE20	5 955	-9.16	0.80	2.26	-6.10	-1.00	5.10
	6 175	-11.11	0.80		-8.05	-1.00	7.05
	6 415	-9.39	0.80		-6.33	-1.00	5.33
	6 435	-9.45	0.80		-6.39	-1.00	5.39
	6 475	-9.23	0.80		-6.17	-1.00	5.17
	6 515	-9.55	0.80		-6.49	-1.00	5.49
	6 535	-9.22	0.80		-6.16	-1.00	5.16
	6 695	-9.03	0.80		-5.97	-1.00	4.97
	6 855	-10.20	0.80		-7.14	-1.00	6.14
	6 875	-8.20	0.80		-5.14	-1.00	4.14
	6 995	-8.37	0.80		-5.31	-1.00	4.31
	7 095	-10.07	0.80		-7.01	-1.00	6.01
	7 115	-25.21	0.80		-22.15	-1.00	21.15
802.11ax _HE40	5 965	-8.82	0.81		-5.75	-1.00	4.75
	6 165	-11.18	0.81		-8.11	-1.00	7.11
	6 405	-8.92	0.81		-5.85	-1.00	4.85
	6 445	-9.20	0.81		-6.13	-1.00	5.13
	6 485	-9.46	0.81		-6.39	-1.00	5.39
	6 525	-9.77	0.81		-6.70	-1.00	5.70
	6 685	-8.71	0.81		-5.64	-1.00	4.64
	6 845	-8.97	0.81		-5.90	-1.00	4.90
	6 885	-7.96	0.81		-4.89	-1.00	3.89
	7 005	-8.58	0.81		-5.51	-1.00	4.51
	7 085	-9.67	0.81		-6.60	-1.00	5.60
802.11ax _HE80	5 985	-10.08	0.87		-6.95	-1.00	5.95
	6 145	-11.18	0.87		-8.05	-1.00	7.05
	6 385	-9.12	0.87		-5.99	-1.00	4.99
	6 465	-9.74	0.87		-6.61	-1.00	5.61
	6 545	-9.45	0.87		-6.32	-1.00	5.32
	6 705	-8.96	0.87		-5.83	-1.00	4.83
	6 865	-10.25	0.87		-7.12	-1.00	6.12
	6 945	-7.94	0.87		-4.81	-1.00	3.81
	7 025	-9.69	0.87		-6.56	-1.00	5.56
Measurement uncertainty	1.5 dB						

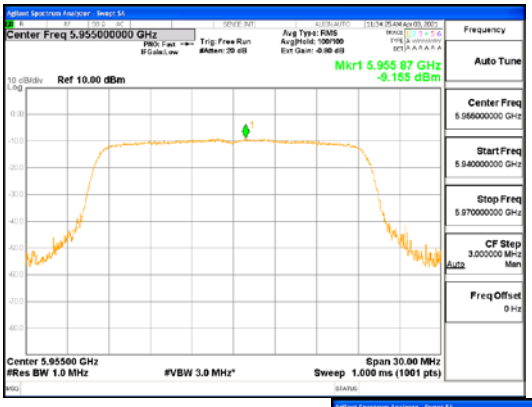
ANT2

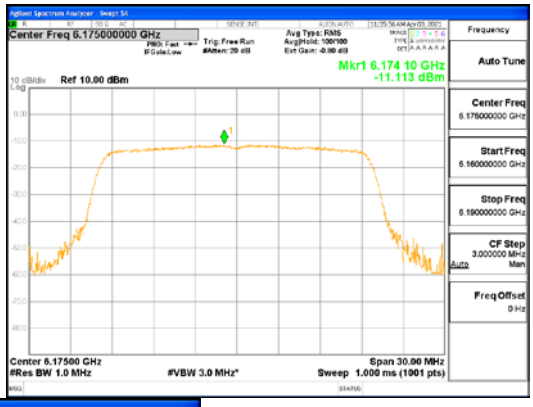
Test Mode	Frequency (MHz)	Measured Power Density (dBm)	Duty cycle Factor (dB)	Antenna Gain (dBi)	Result Output Power (dBm)	Limit (dBm)	Margin (dB)
802.11ax _HE20	5 955	-10.27	0.80	-5.58	-15.05	-1.00	14.05
	6 175	-12.26	0.80		-17.04	-1.00	16.04
	6 415	-8.15	0.80		-12.93	-1.00	11.93
	6 435	-8.78	0.80		-13.56	-1.00	12.56
	6 475	-8.36	0.80		-13.14	-1.00	12.14
	6 515	-8.63	0.80		-13.41	-1.00	12.41
	6 535	-8.00	0.80		-12.78	-1.00	11.78
	6 695	-10.90	0.80		-15.68	-1.00	14.68
	6 855	-12.14	0.80		-16.92	-1.00	15.92
	6 875	-9.84	0.80		-14.62	-1.00	13.62
	6 995	-8.85	0.80		-13.63	-1.00	12.63
	7 095	-8.91	0.80		-13.69	-1.00	12.69
	7 115	-23.00	0.80		-27.78	-1.00	26.78
802.11ax _HE40	5 965	-9.78	0.81		-14.55	-1.00	13.55
	6 165	-12.20	0.81		-16.97	-1.00	15.97
	6 405	-8.22	0.81		-12.99	-1.00	11.99
	6 445	-8.50	0.81		-13.27	-1.00	12.27
	6 485	-8.27	0.81		-13.04	-1.00	12.04
	6 525	-8.16	0.81		-12.93	-1.00	11.93
	6 685	-10.52	0.81		-15.29	-1.00	14.29
	6 845	-10.48	0.81		-15.25	-1.00	14.25
	6 885	-9.16	0.81		-13.93	-1.00	12.93
	7 005	-8.11	0.81		-12.88	-1.00	11.88
	7 085	-9.27	0.81		-14.04	-1.00	13.04
802.11ax _HE80	5 985	-9.09	0.87		-13.80	-1.00	12.80
	6 145	-11.39	0.87		-16.10	-1.00	15.10
	6 385	-7.73	0.87		-12.44	-1.00	11.44
	6 465	-8.17	0.87		-12.88	-1.00	11.88
	6 545	-7.48	0.87		-12.19	-1.00	11.19
	6 705	-9.67	0.87		-14.38	-1.00	13.38
	6 865	-11.01	0.87		-15.72	-1.00	14.72
	6 945	-9.53	0.87		-14.24	-1.00	13.24
	7 025	-8.50	0.87		-13.21	-1.00	12.21
Measurement uncertainty	1.5 dB						

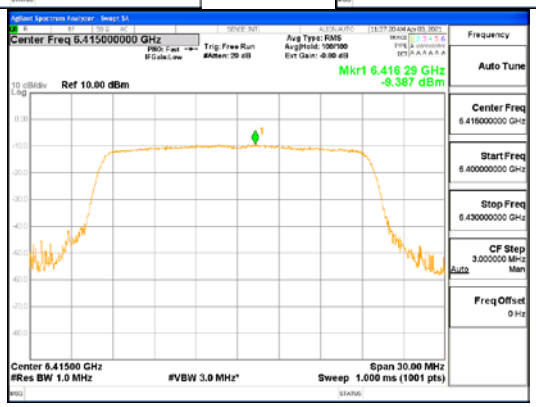
ANT1 + ANT2

Test Mode	Frequency (MHz)	Measured Power Density (dBm)	Duty cycle Factor (dB)	Antenna Gain (dBi)	Result Output Power (dBm)	Limit (dBm)	Margin (dB)
802.11ax _HE20	5 955	-6.67	0.80	2.21	-3.66	-1.00	2.66
	6 175	-8.64	0.80		-5.63	-1.00	4.63
	6 415	-5.72	0.80		-2.71	-1.00	1.71
	6 435	-6.09	0.80		-3.08	-1.00	2.08
	6 475	-5.76	0.80		-2.75	-1.00	1.75
	6 515	-6.06	0.80		-3.05	-1.00	2.05
	6 535	-5.56	0.80		-2.55	-1.00	1.55
	6 695	-6.85	0.80		-3.84	-1.00	2.84
	6 855	-8.05	0.80		-5.04	-1.00	4.04
	6 875	-5.93	0.80		-2.92	-1.00	1.92
	6 995	-5.59	0.80		-2.58	-1.00	1.58
	7 095	-6.44	0.80		-3.43	-1.00	2.43
	7 115	-20.96	0.80		-17.95	-1.00	16.95
802.11ax _HE40	5 965	-6.26	0.81		-3.24	-1.00	2.24
	6 165	-8.65	0.81		-5.63	-1.00	4.63
	6 405	-5.55	0.81		-2.53	-1.00	1.53
	6 445	-5.83	0.81		-2.81	-1.00	1.81
	6 485	-5.81	0.81		-2.79	-1.00	1.79
	6 525	-5.88	0.81		-2.86	-1.00	1.86
	6 685	-6.51	0.81		-3.49	-1.00	2.49
	6 845	-6.65	0.81		-3.63	-1.00	2.63
	6 885	-5.51	0.81		-2.49	-1.00	1.49
	7 005	-5.33	0.81		-2.31	-1.00	1.31
	7 085	-6.46	0.81		-3.44	-1.00	2.44
802.11ax _HE80	5 985	-6.55	0.87		-3.47	-1.00	2.47
	6 145	-8.27	0.87		-5.19	-1.00	4.19
	6 385	-5.36	0.87		-2.28	-1.00	1.28
	6 465	-5.87	0.87		-2.79	-1.00	1.79
	6 545	-5.34	0.87		-2.26	-1.00	1.26
	6 705	-6.29	0.87		-3.21	-1.00	2.21
	6 865	-7.60	0.87		-4.52	-1.00	3.52
	6 945	-5.65	0.87		-2.57	-1.00	1.57
	7 025	-6.04	0.87		-2.96	-1.00	1.96
Measurement uncertainty		1.5 dB					

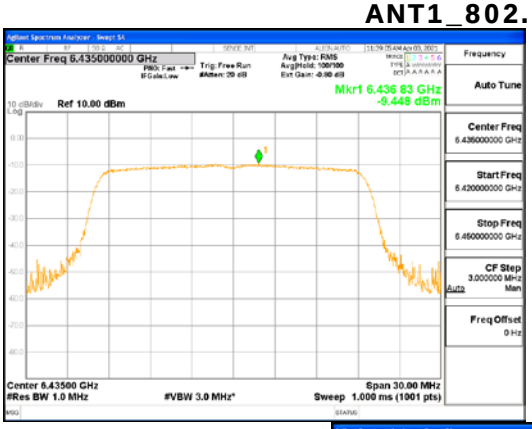
See next pages for actual measured spectrum plots.

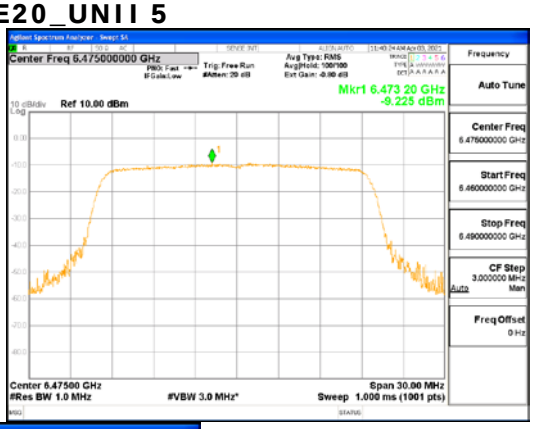


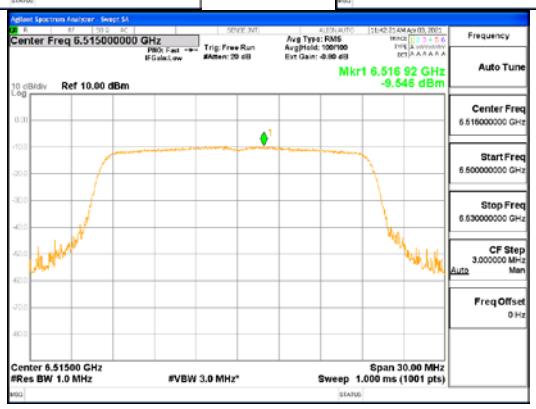




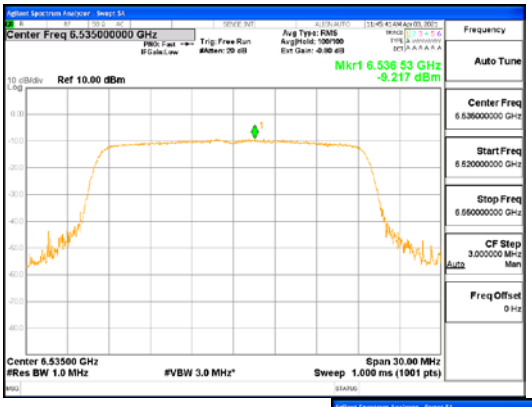
ANT1_802.11ax_HE20_UNII 5

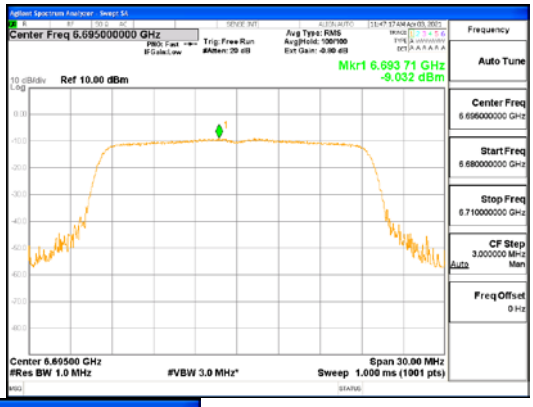


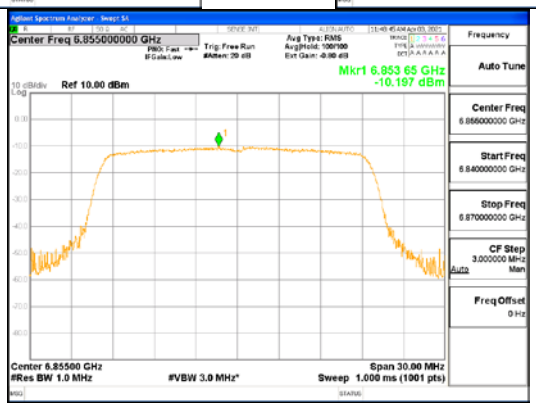




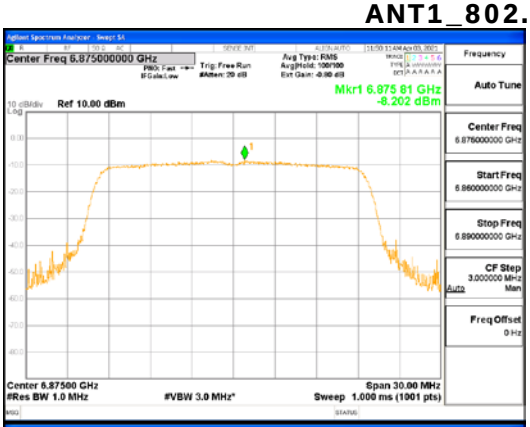
ANT1_802.11ax_HE20_UNII 6

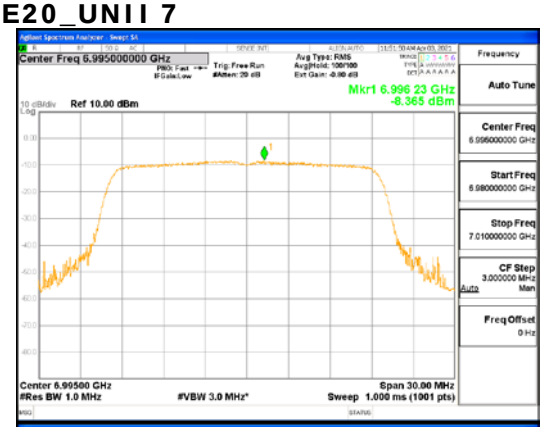


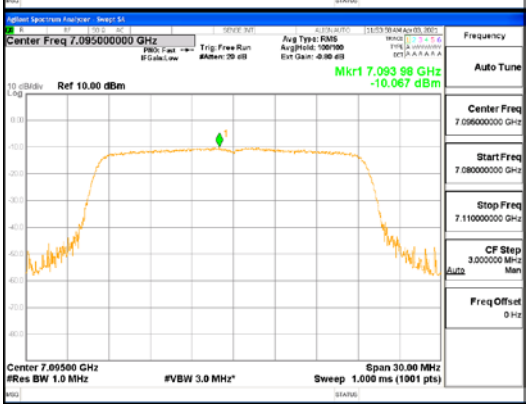


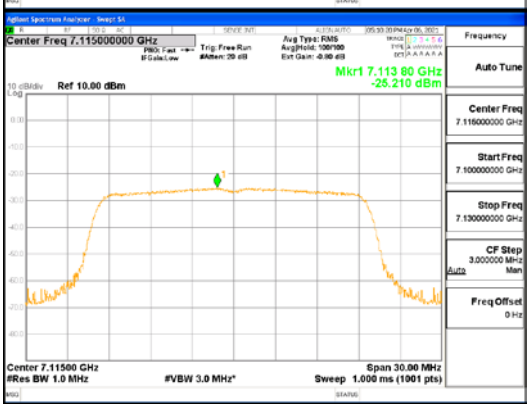


ANT1_802.11ax_HE20_UNII 7

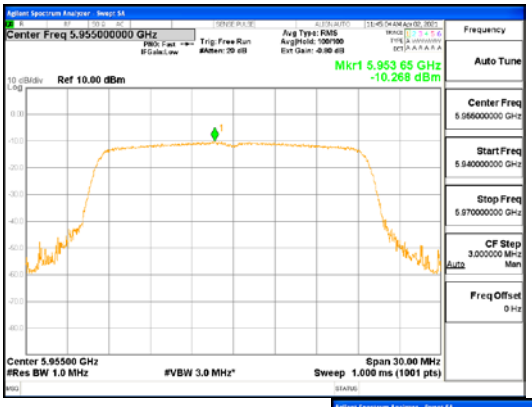


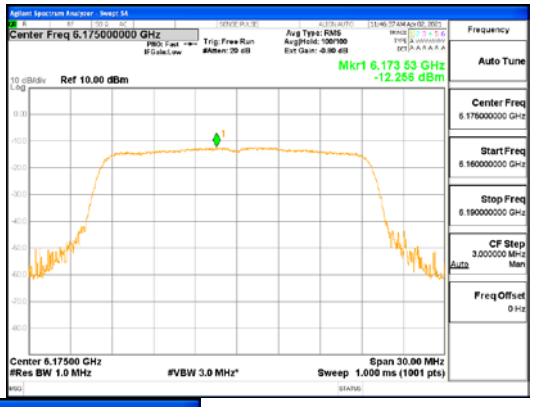


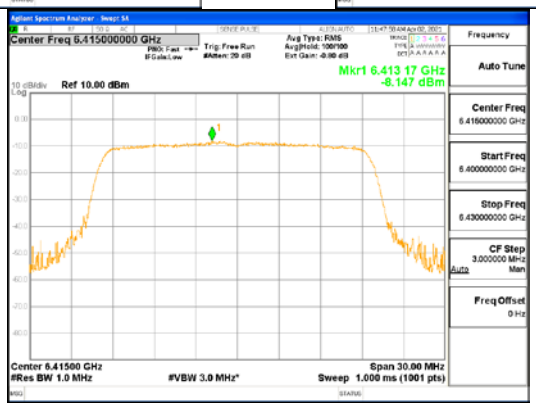




ANT1_802.11ax_HE20_UNII 8







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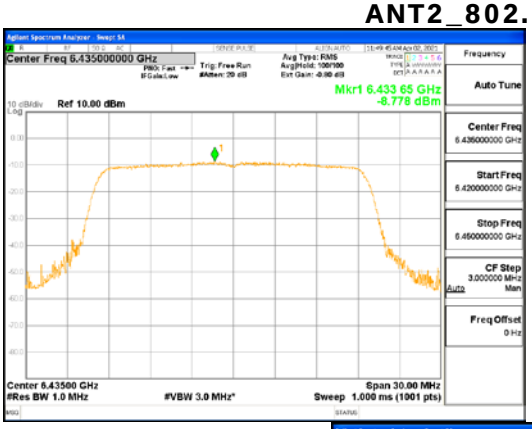
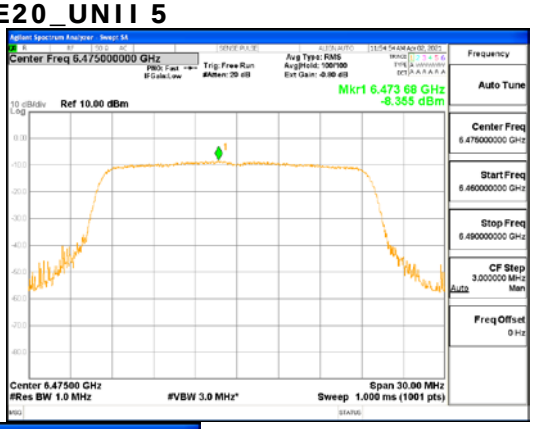
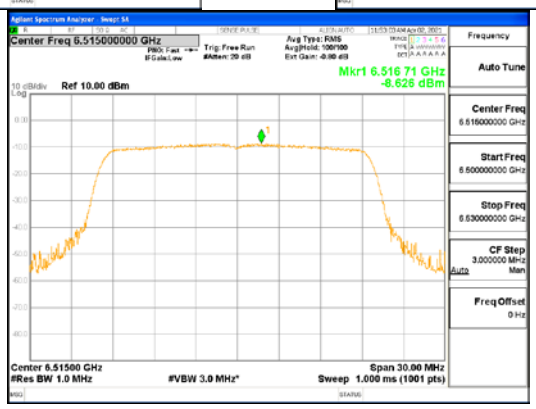
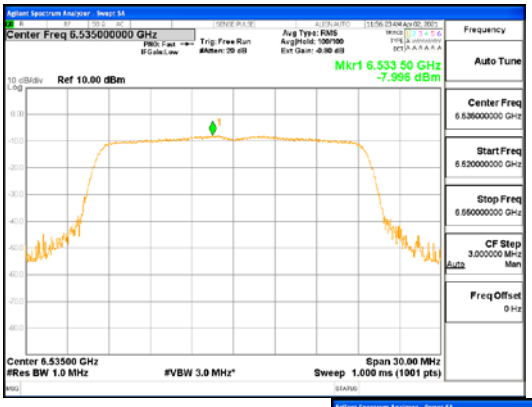
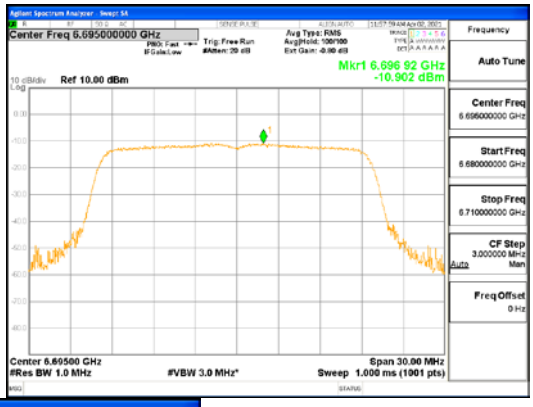


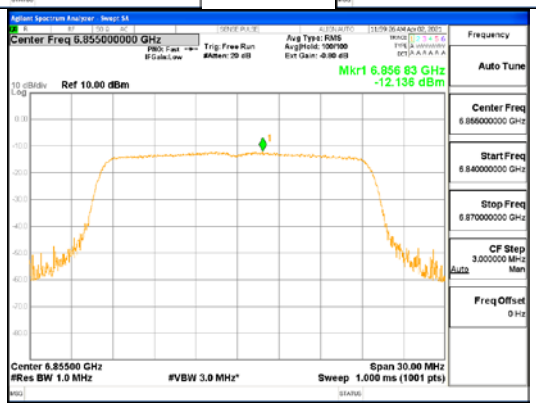




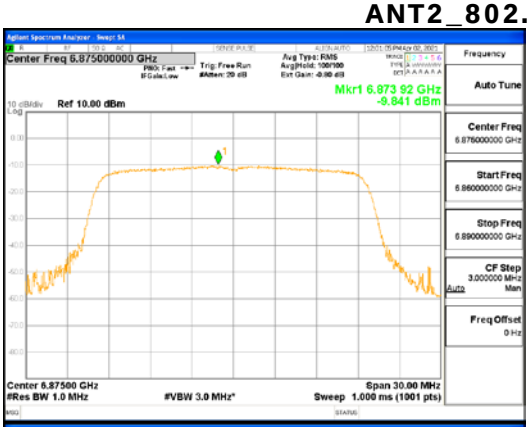
ANT2_802.11ax_HE20_UNII 6

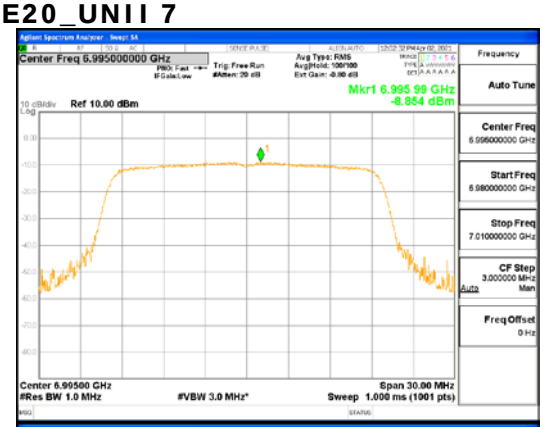


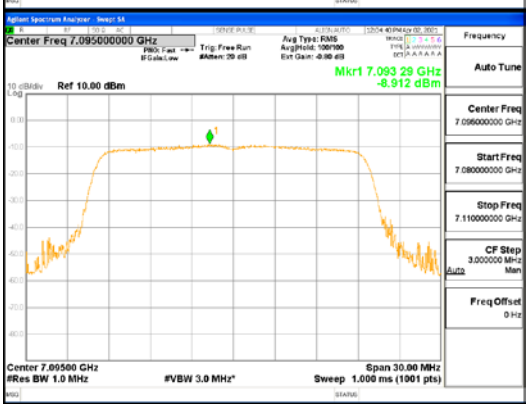


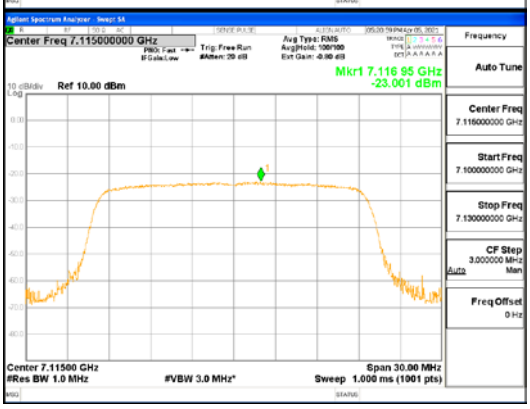


ANT2_802.11ax_HE20_UNII 7









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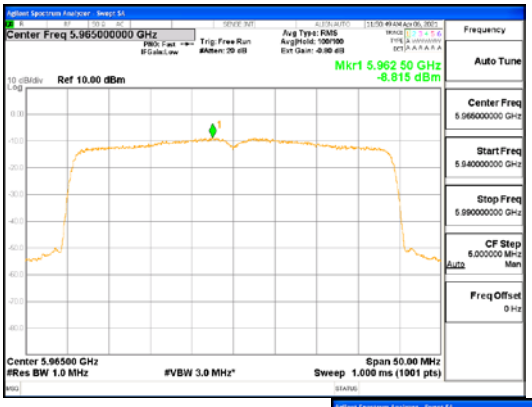
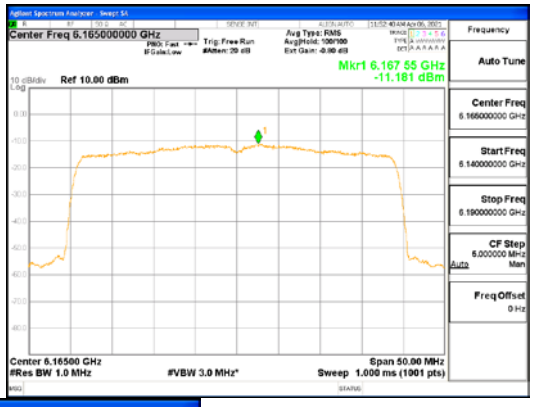
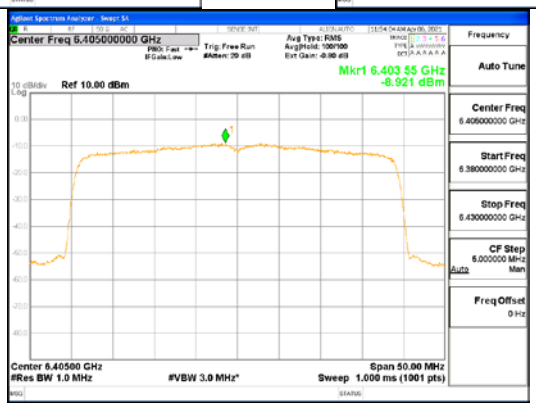
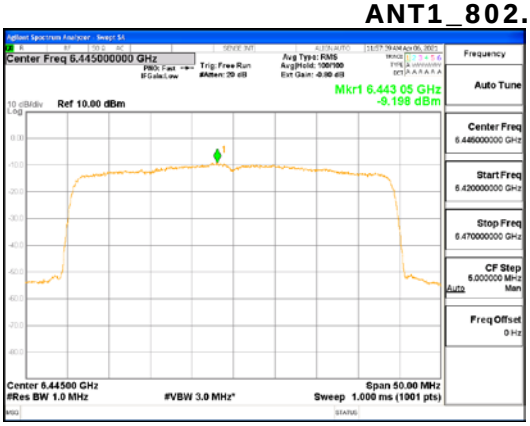
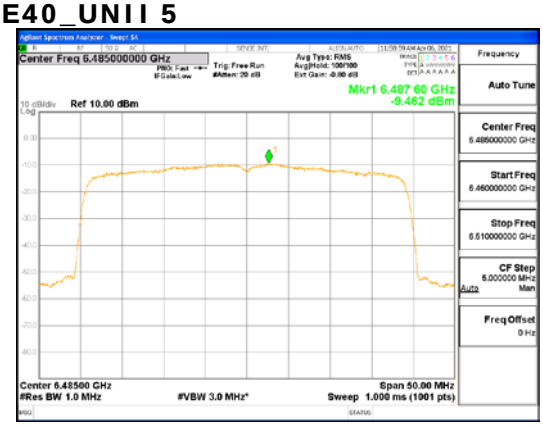




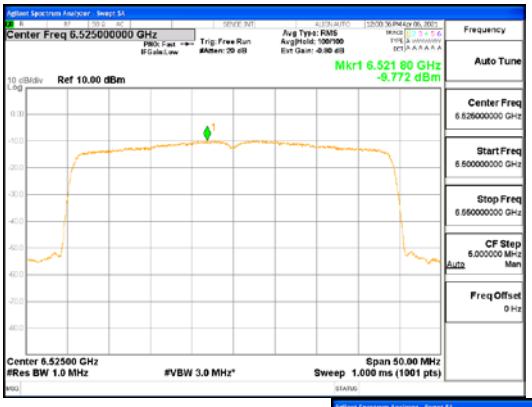


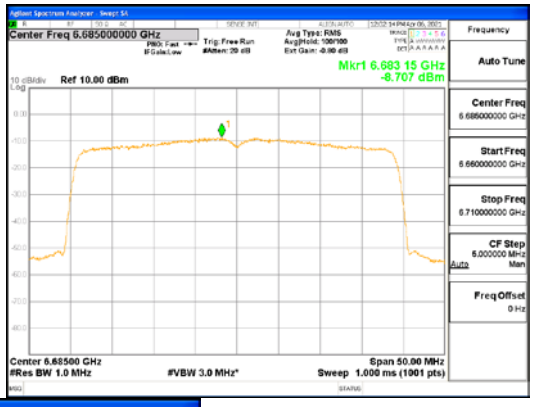
ANT1_802.11ax_HE40_UNII 5

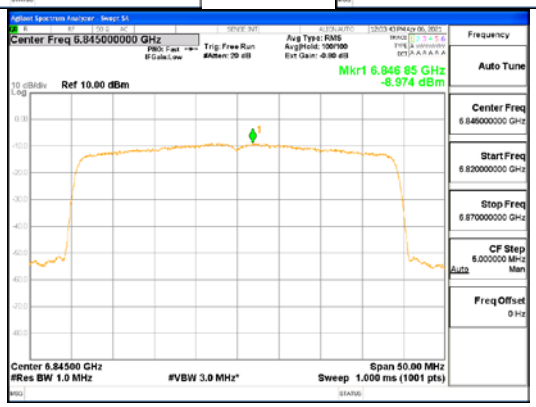




ANT1_802.11ax_HE40_UNII 6







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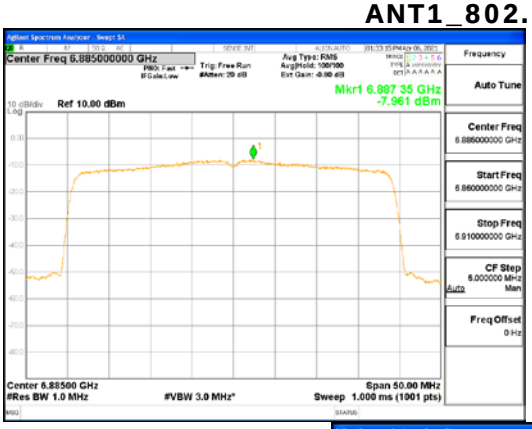

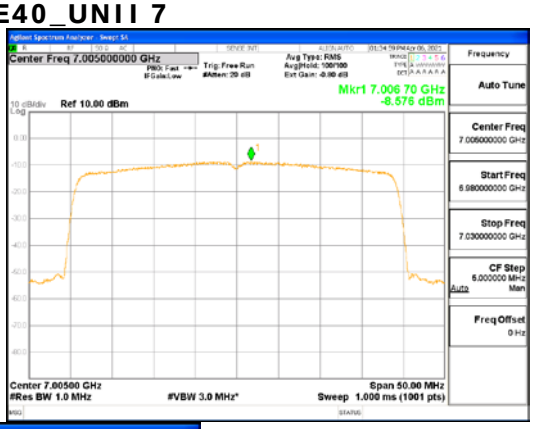

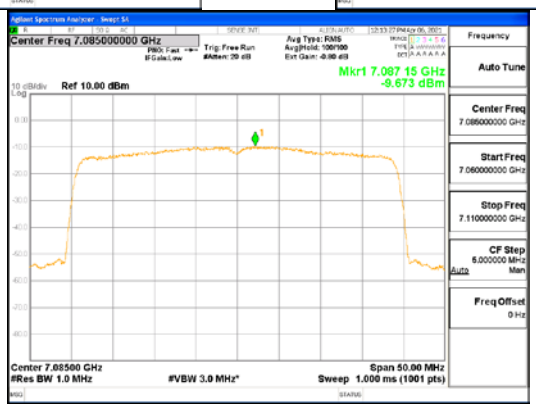

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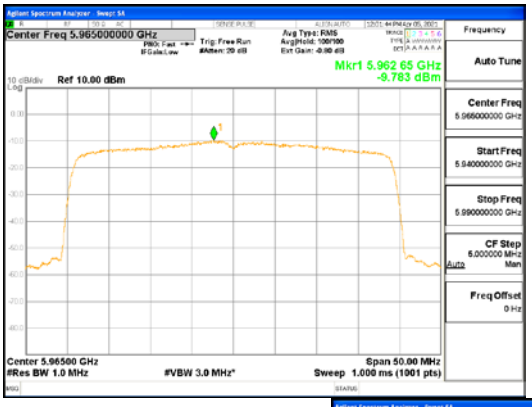

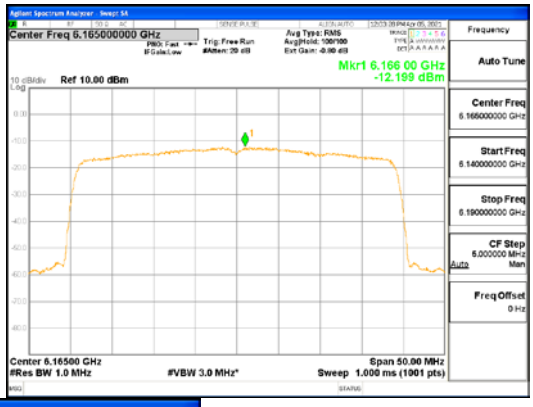

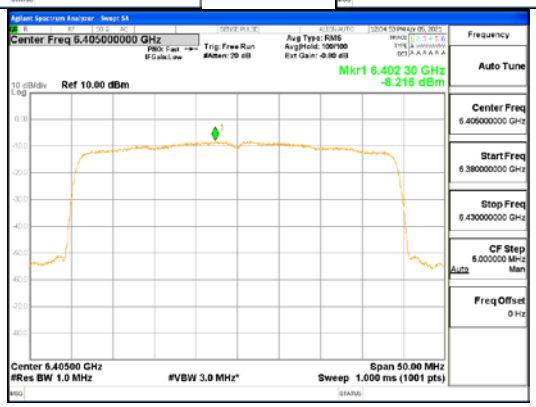

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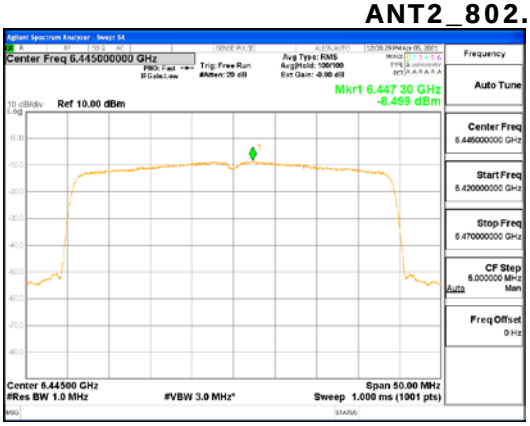

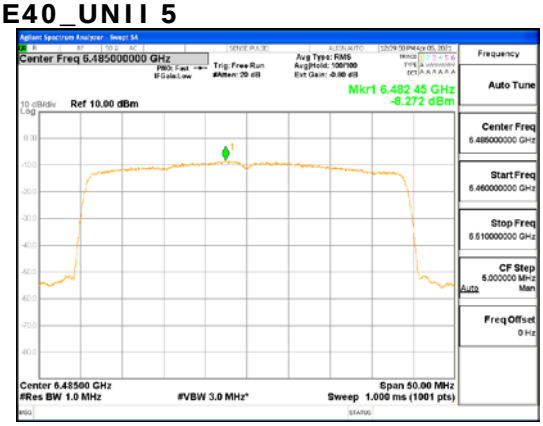

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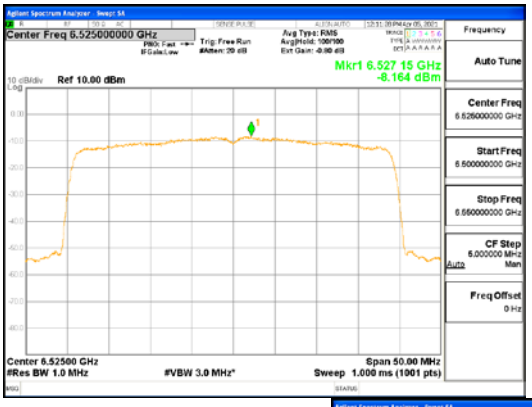

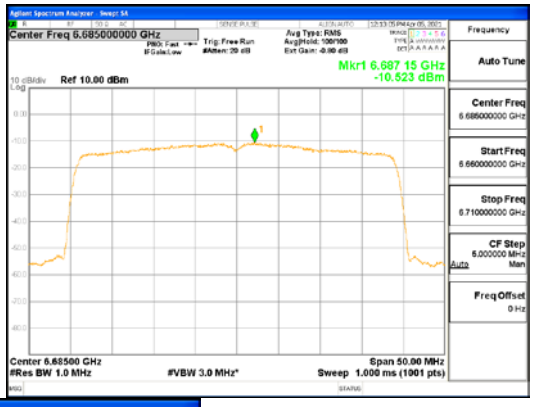

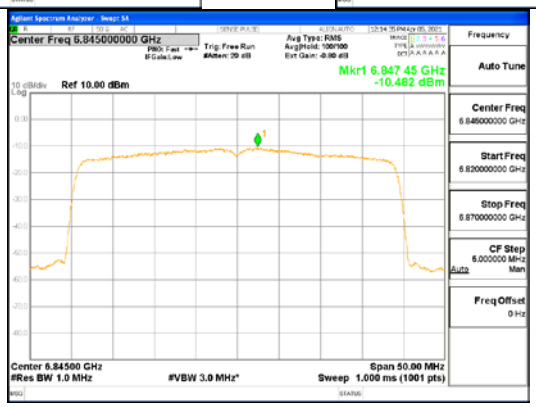

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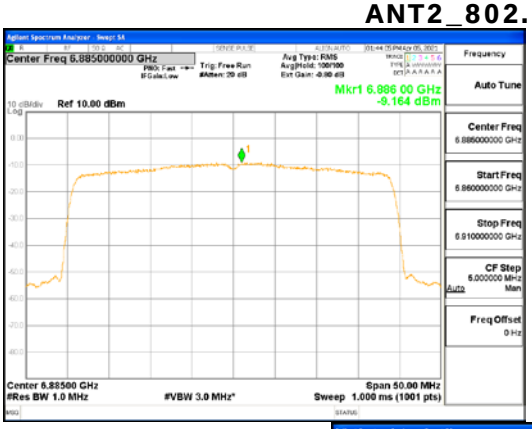

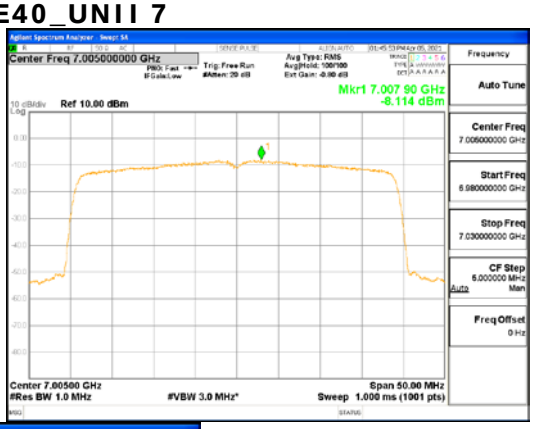

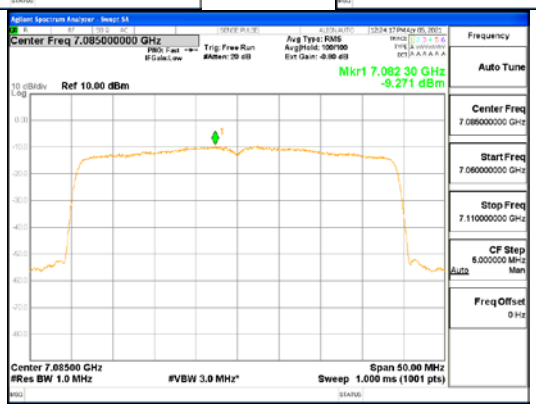

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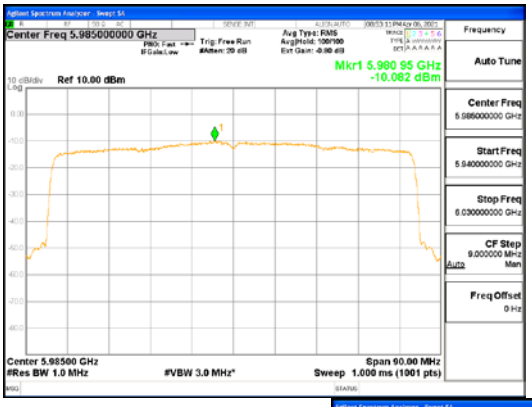

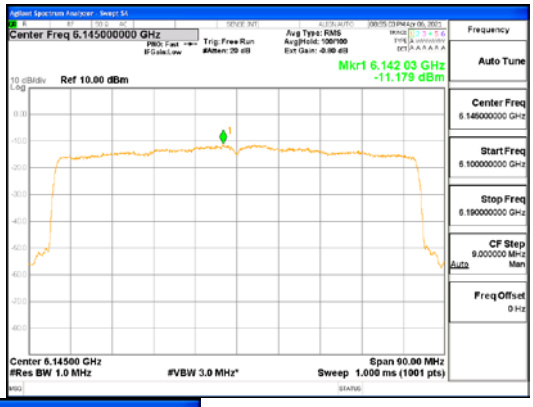

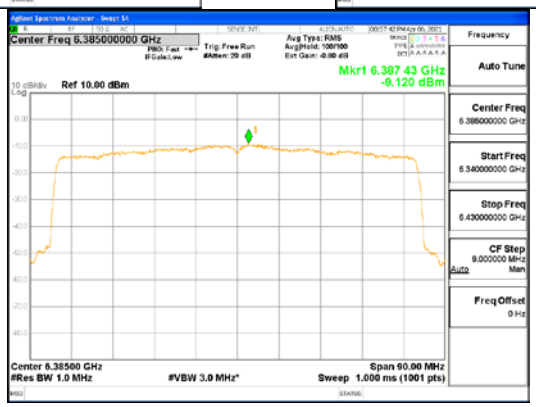

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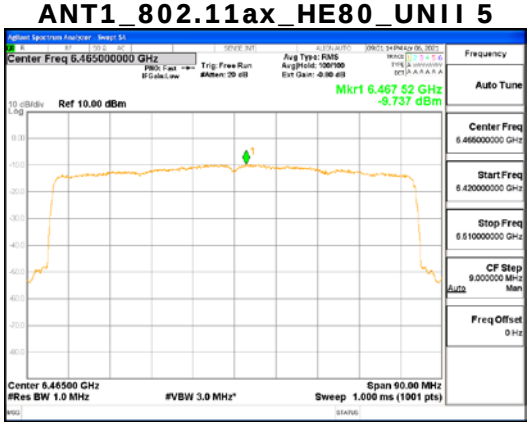

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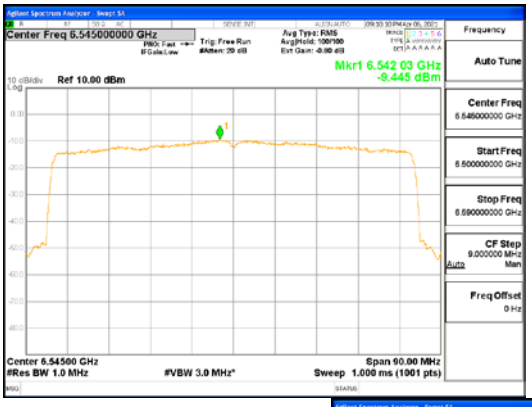
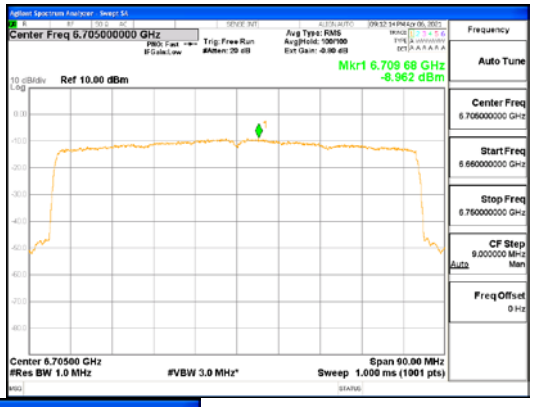
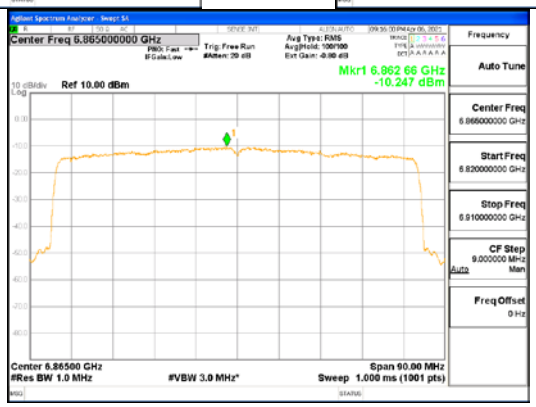
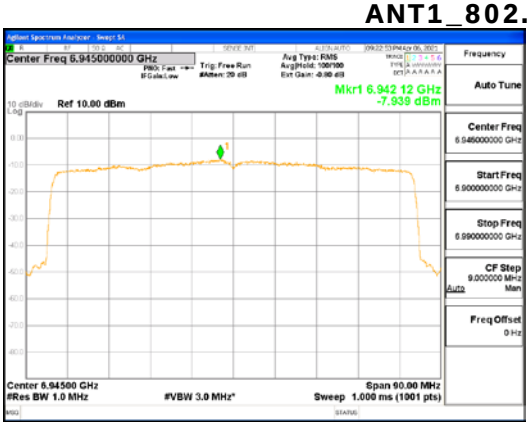
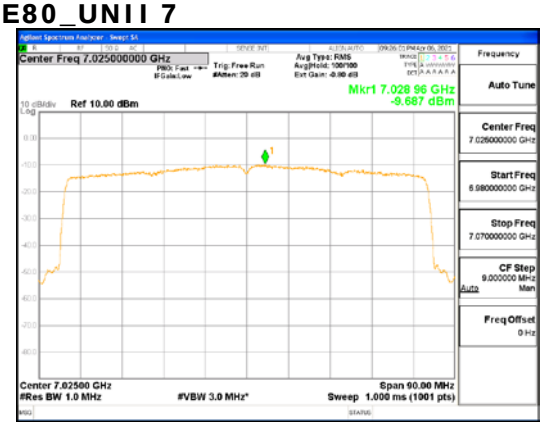






ANT1_802.11ax_HE80_UNII 7





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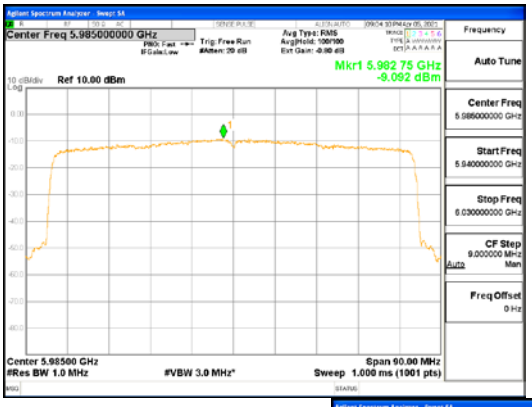

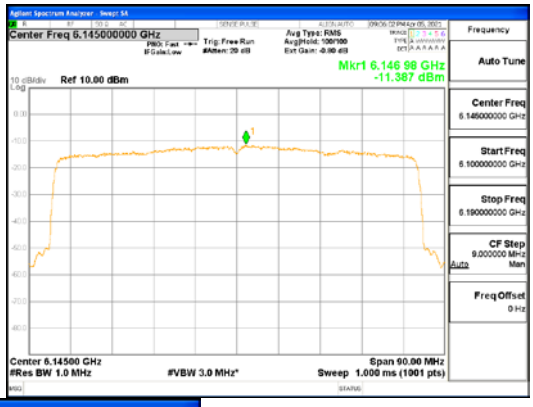

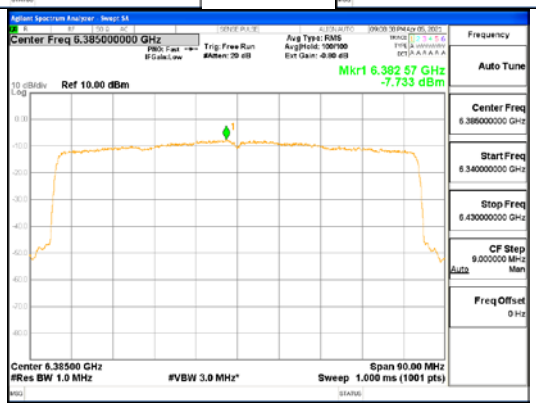

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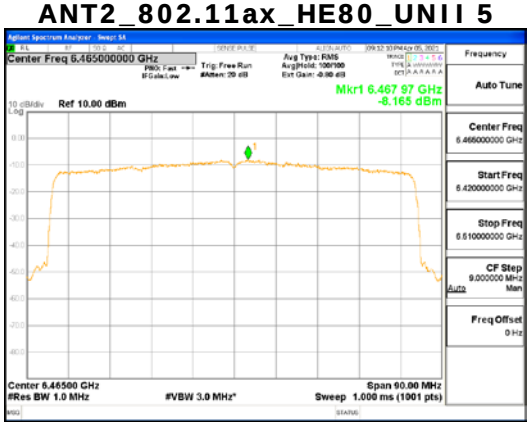

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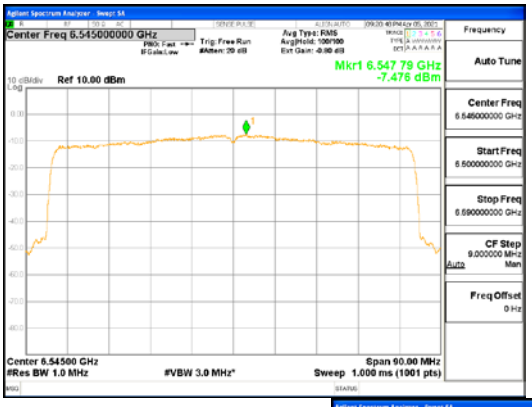
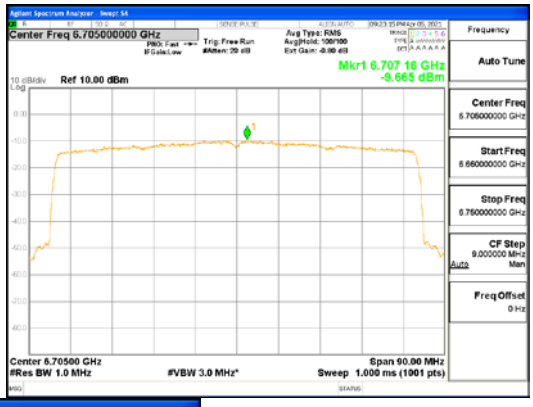
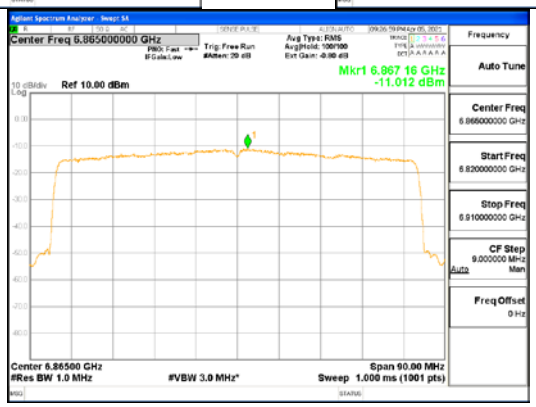
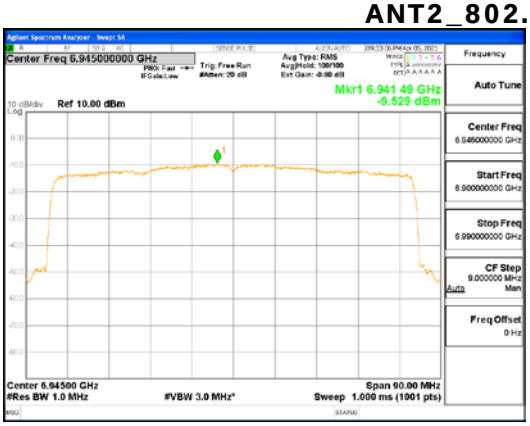
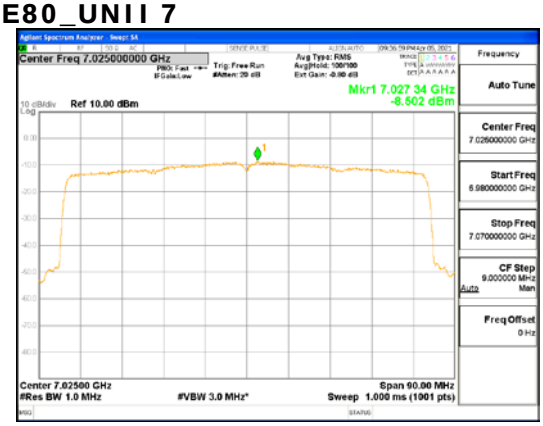






ANT2_802.11ax_HE80_UNII 7





ANT2_802.11ax_HE80_UNII 8

4.4 In-Band Emissions

Test Procedures

KDB 987594 – Section J

Test Settings :

1. Measure the power spectral density (which will be used for emissions mask reference) using the following procedure:
   a. Set the span to encompass the entire 26 dB EBW of the signal.
   b. Set RBW = same RBW used for 26 dB EBW measurement.
   c. Set VBW ≥ 3 X RBW
   d. Number of points in sweep ≥ [2 X span / RBW].
   e. Sweep time = auto.
   f. Detector = RMS (i.e., power averaging)
   g. Trace average at least 100 traces in power averaging (rms) mode.
   h. Use the peak search function on the instrument to find the peak of the spectrum.
2. For the purposes of developing the emission mask, the channel bandwidth is defined as the 26 dB EBW.
3. Clear trace.
4. Trace average at least 100 traces in power averaging (rms) mode.
5. Adjust the reference level as necessary so that the crest of the channel touches the top of the emission mask.

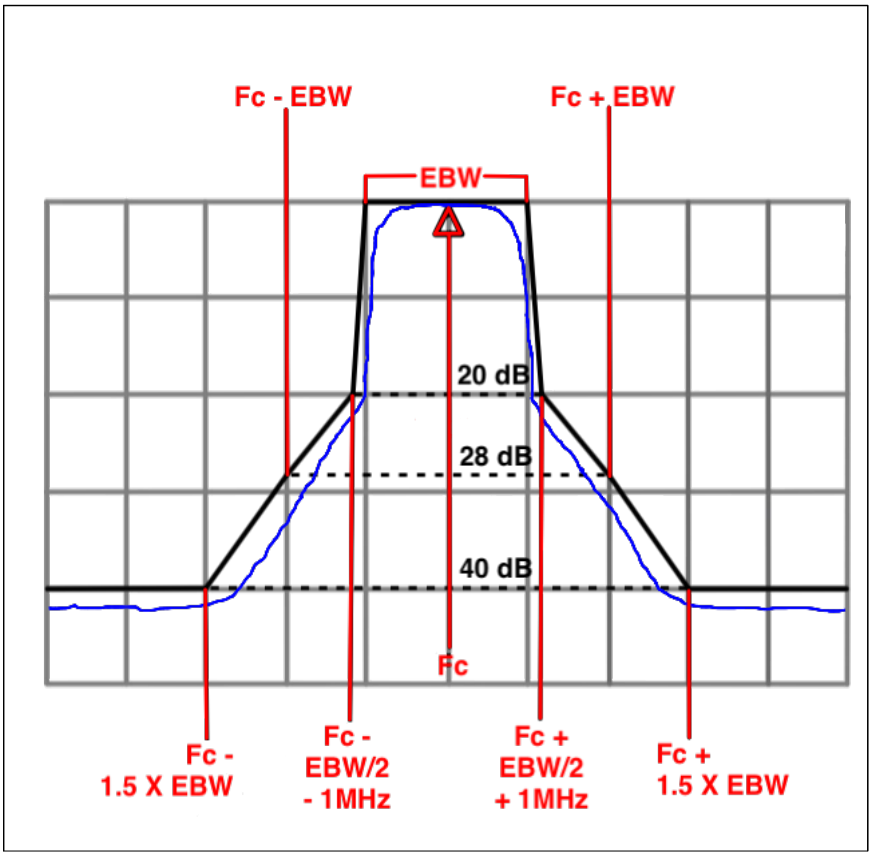
Limit

The emissions power spectral density must be reduced below the peak power spectral density (in dB) as follows:

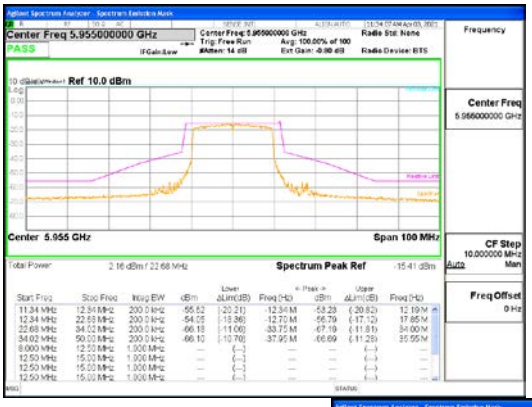
a. Suppressed by 20 dB at 1 MHz outside of the channel edge. (The channel edge is defined as the 26-dB point on either side of the carrier center frequency.)

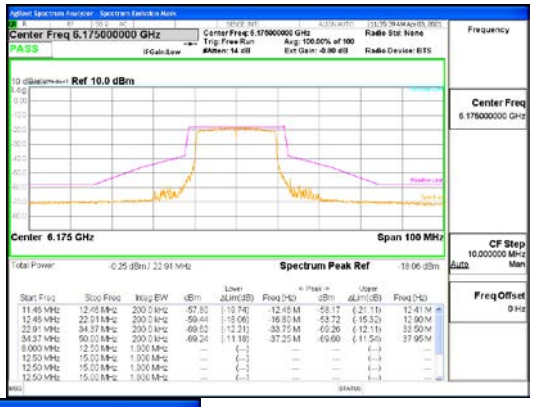
b. Suppressed by 28 dB at one channel bandwidth from the channel center.

c. Suppressed by 40 dB at one- and one-half times the channel bandwidth from the channel center.

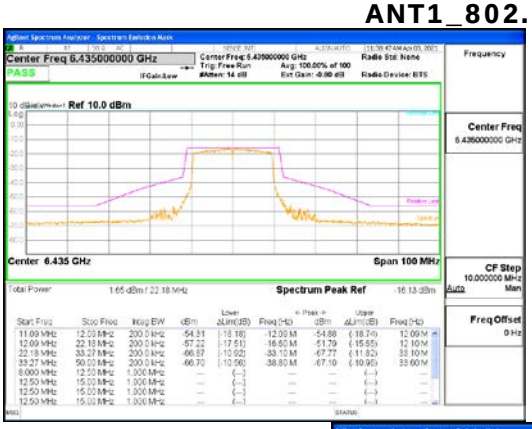


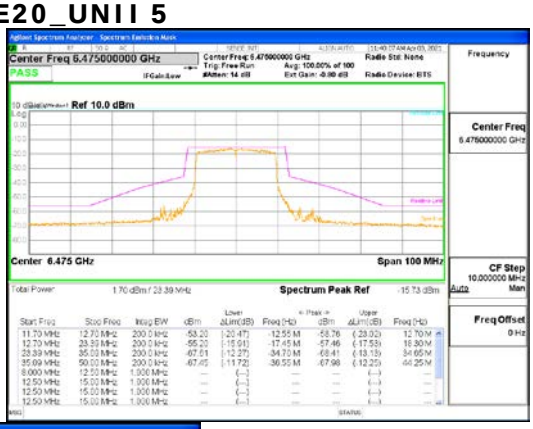
See next pages for actual measured spectrum plots.



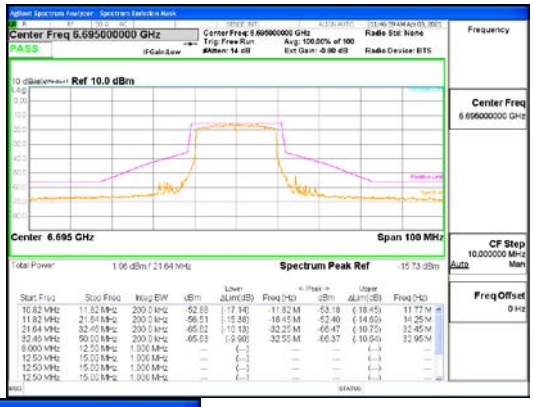


ANT1_802.11ax_HE20_UNII 5

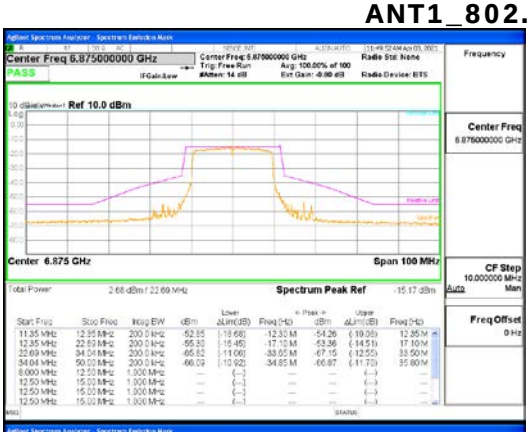


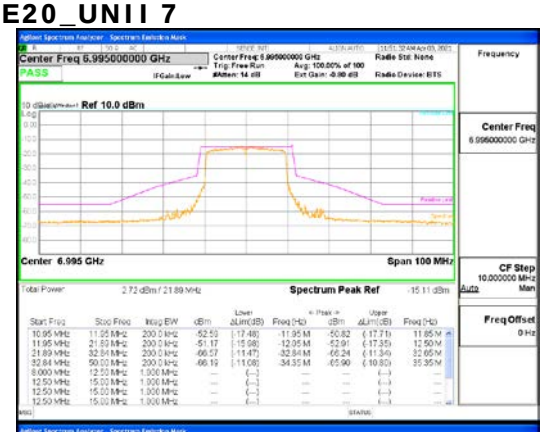


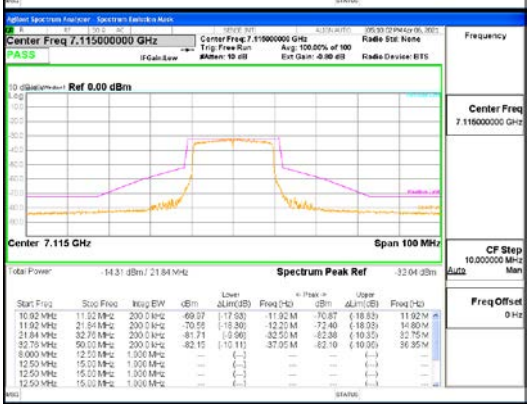
ANT1_802.11ax_HE20_UNII 6



ANT1_802.11ax_HE20_UNII 7







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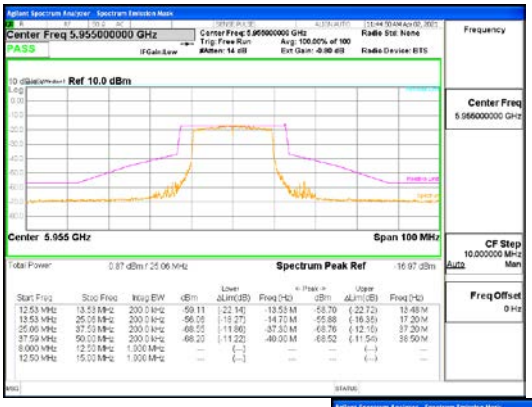

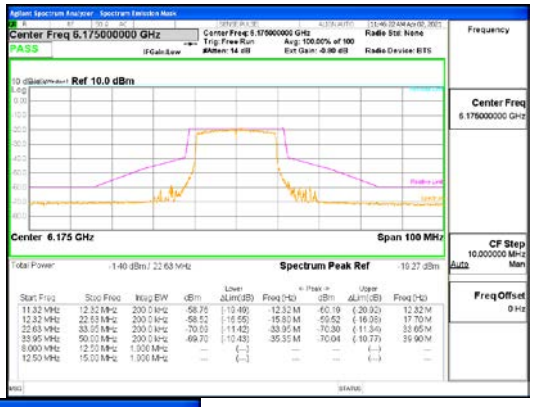

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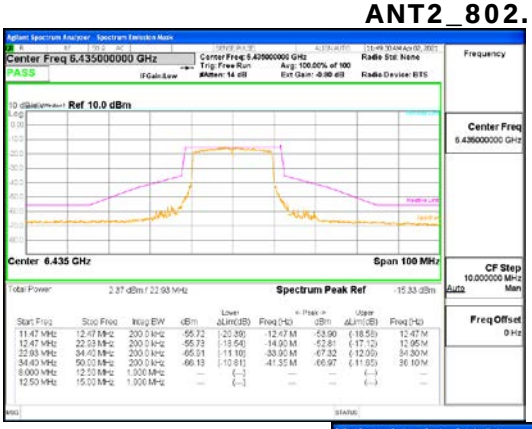

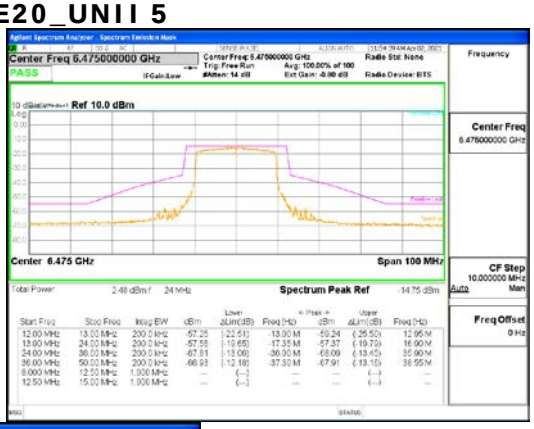

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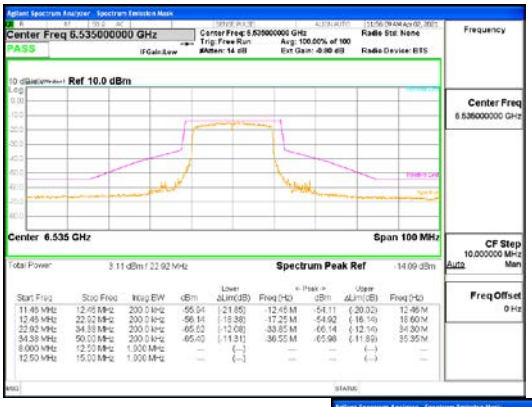

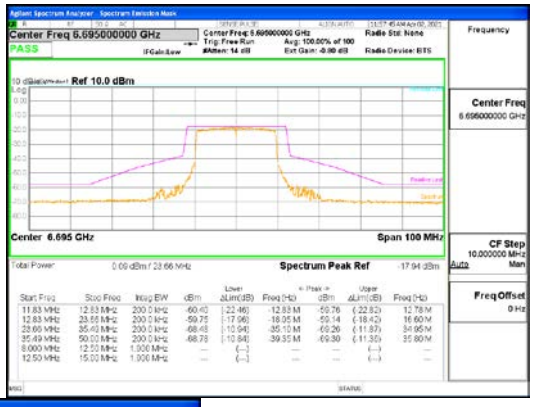

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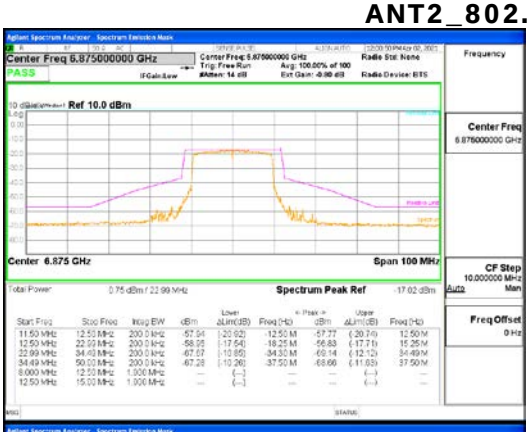

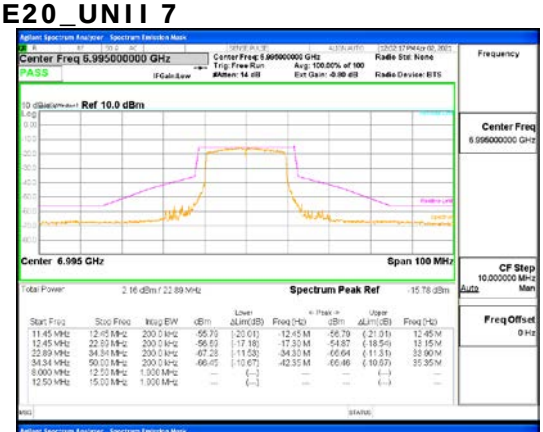

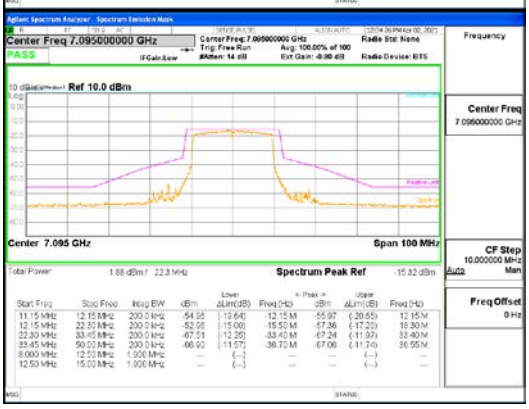

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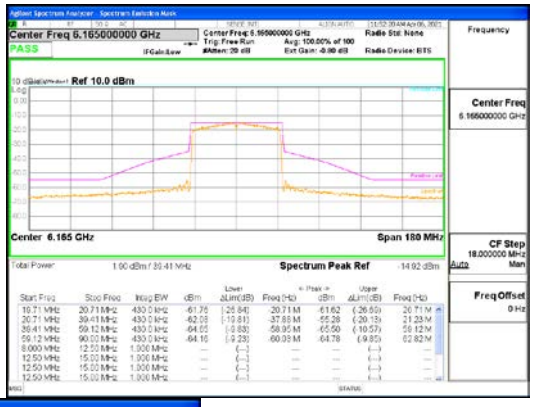

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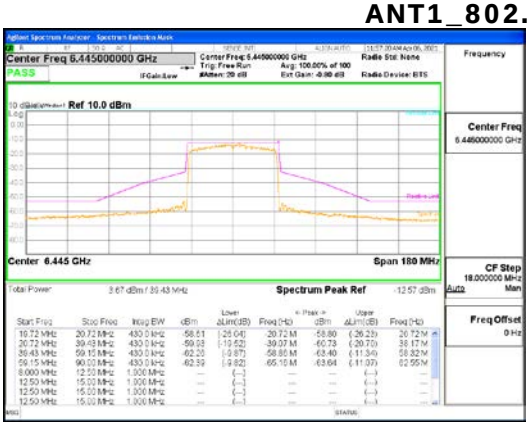

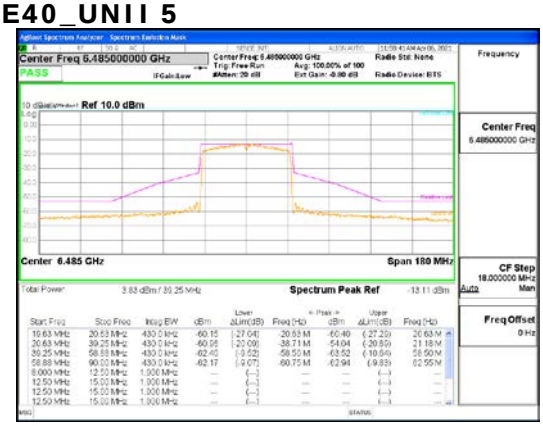

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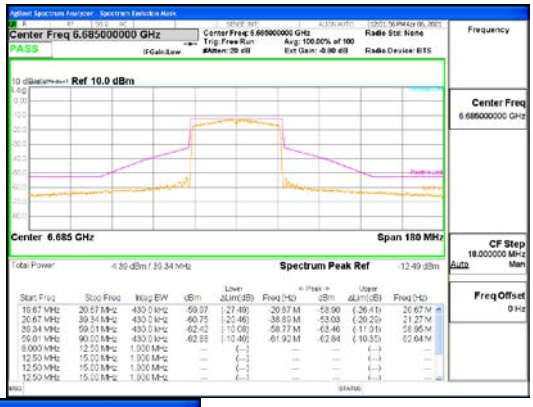

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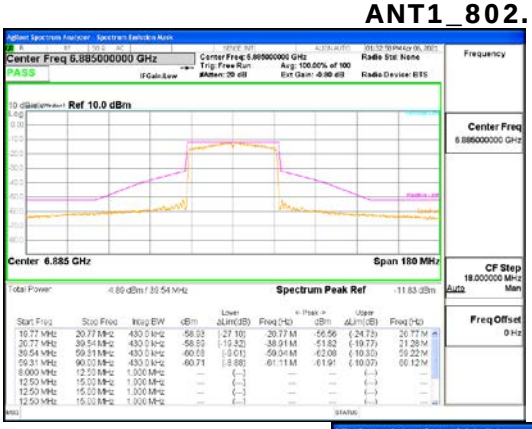

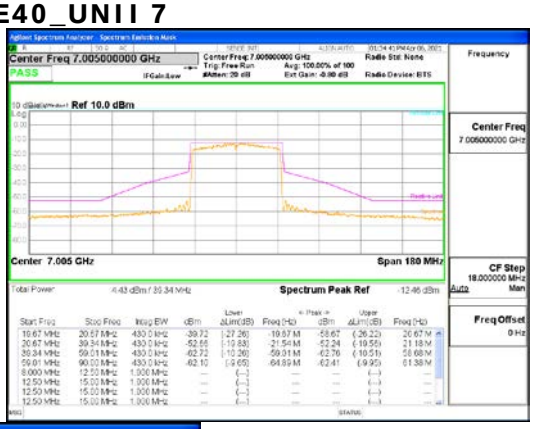

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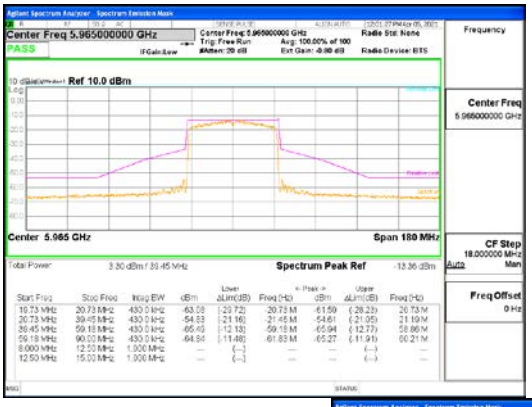

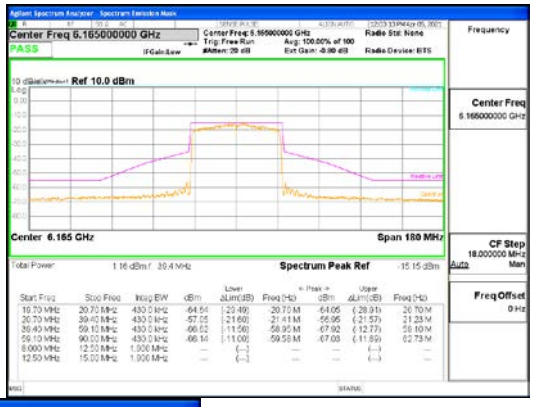

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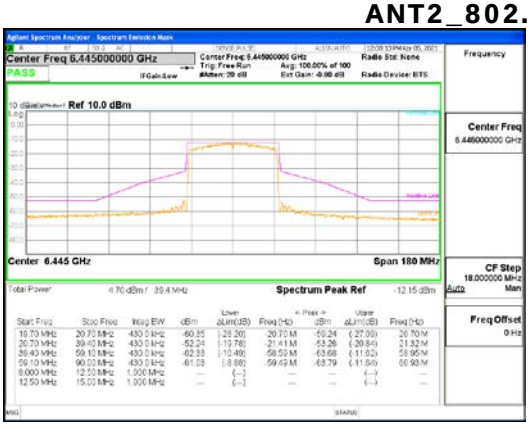

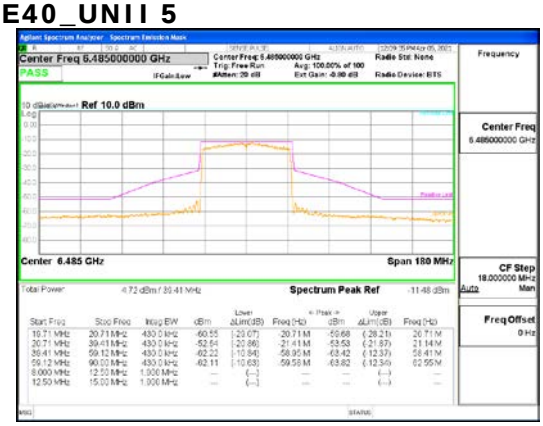

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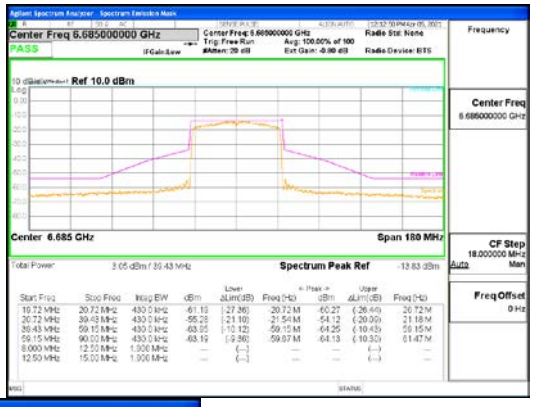

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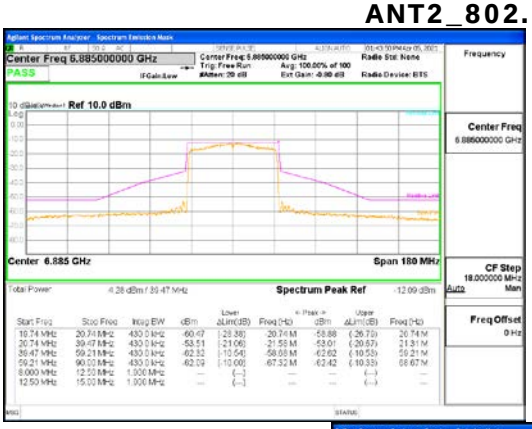

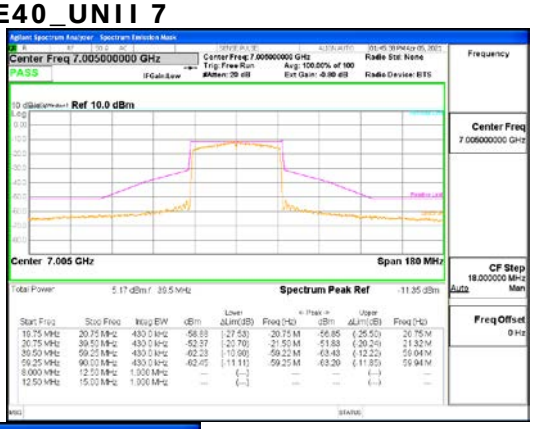

ANT2_802.11ax_HE40_UNII 8

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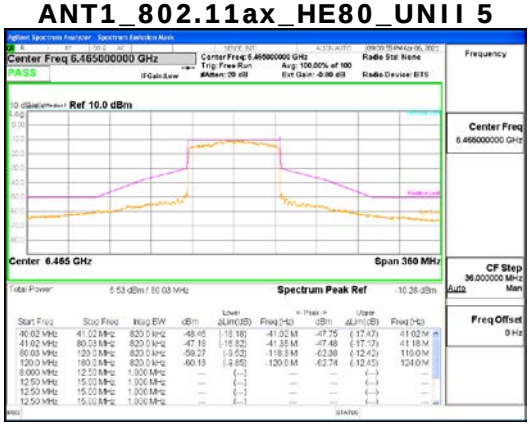

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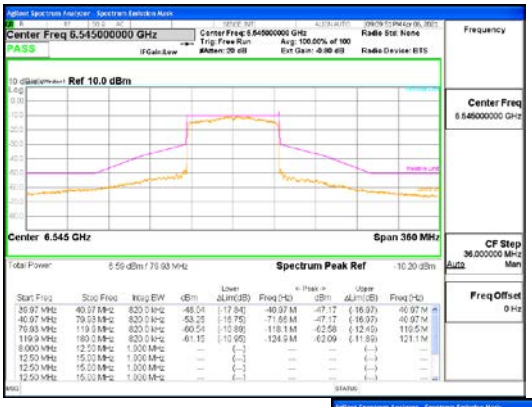

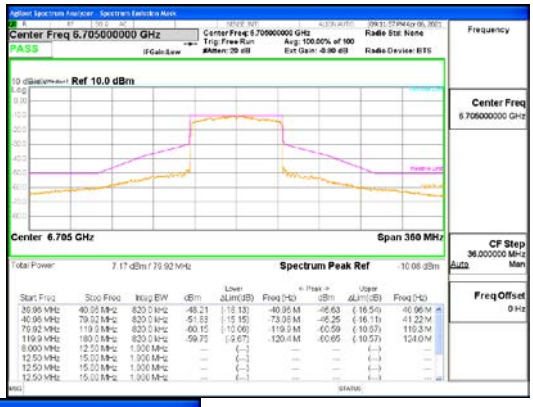

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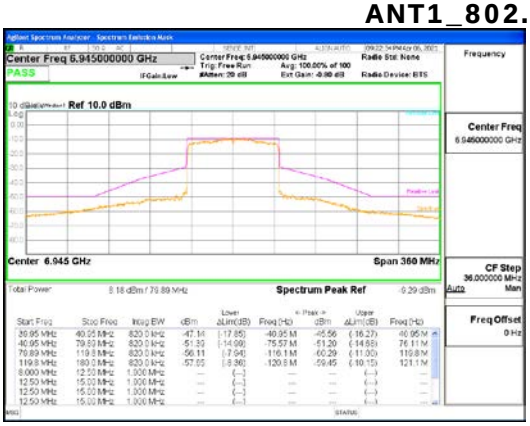

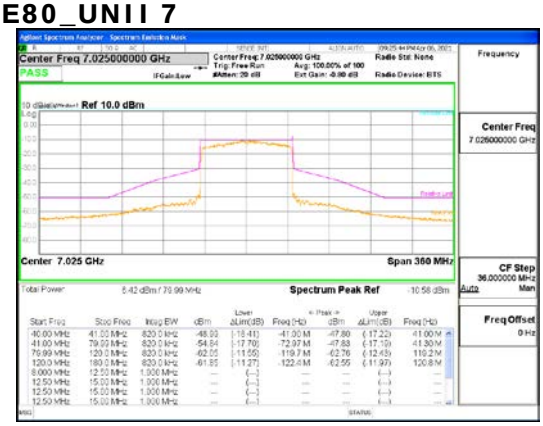

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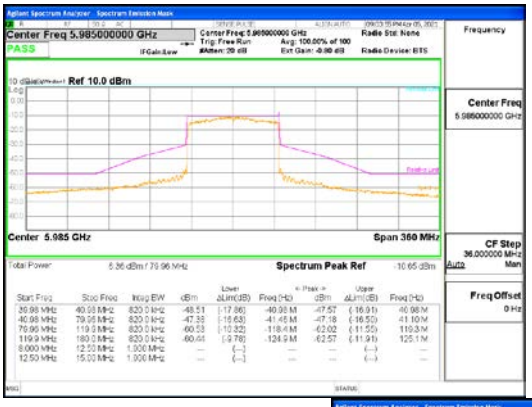

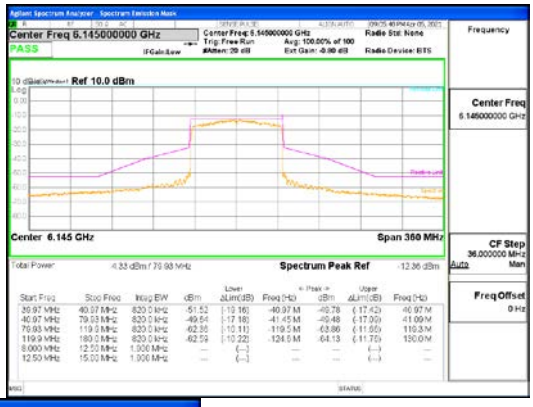

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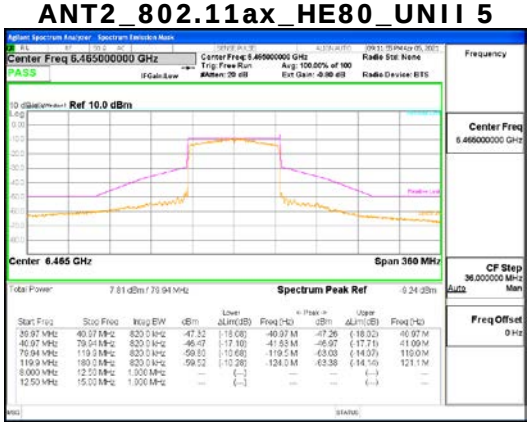

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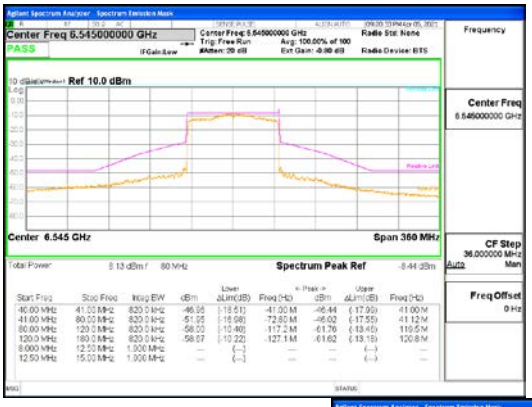

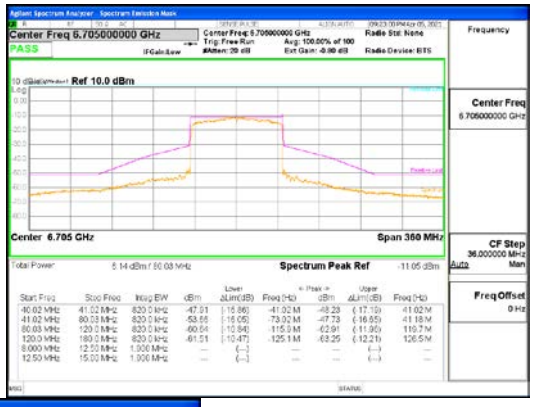

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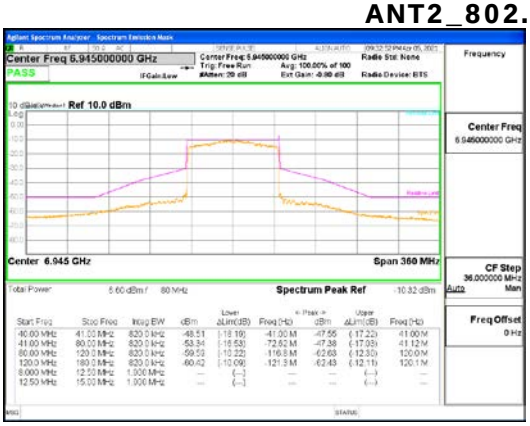
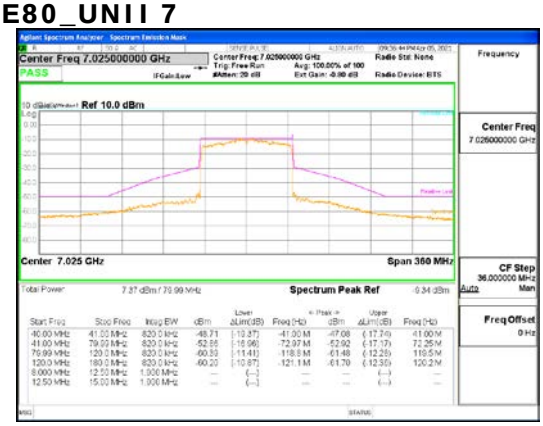




ANT2_802.11ax_HE80_UNII 8

4.5 Frequency Stability

Test Procedures

KDB 789033 – Section A.3

The EUT was placed inside of an environmental chamber as the temperature in the chamber was varied between -20 ℃ and +50 ℃(Declaration by the Manufacturer). The temperature was incremented by 10 ℃ intervals and the unit was allowed to stabilize at each temperature before each measurement. The center frequency of the transmitting channel was evaluated at each temperature and the frequency deviation from the channel's center frequency was recorded.
Data for the worst case channel is shown below.

Temperature (℃)	-20	-10	0	10	20	30	40	50
Frequency	Measured Frequency Error (kHz)							
5 955 MHz	10.949	9.169	-4.208	-21.942	-41.937	-60.706	-74.133	-81.922
6 175 MHz	12.283	8.681	-3.535	-27.764	-43.005	-62.603	-76.813	-84.712
6 415 MHz	12.710	8.977	-3.750	-32.239	-44.255	-64.834	-79.431	-87.772
6 435 MHz	12.894	9.609	-3.296	-30.286	-43.947	-64.757	-80.223	-87.988
6 475 MHz	12.974	9.579	-3.338	-30.331	-44.270	-65.055	-80.793	-88.491
6 515 MHz	12.983	9.564	-3.225	-30.260	-44.449	-65.268	-81.221	-88.987
6 535 MHz	13.056	9.585	-3.355	-36.971	-45.054	-65.972	-81.408	-89.268
6 695 MHz	13.411	9.950	-3.807	-37.750	-46.506	-67.753	-83.455	-91.422
6 855 MHz	13.590	9.934	-3.596	-41.903	-47.414	-69.546	-85.379	-93.748
6 875 MHz	13.672	10.169	-3.491	-42.800	-47.457	-69.374	-85.633	-93.812
6 995 MHz	14.039	10.386	-3.710	-38.200	-48.626	-70.499	-87.091	-95.466
7 095 MHz	14.175	10.314	-3.606	-37.312	-49.284	-72.011	-88.428	-96.748
7 115 MHz	14.139	10.149	-3.961	-37.244	-49.274	-72.372	-88.773	-97.075

Note :
Based on the results of the frequency stability test shown above the frequency deviation results measured are very small. As such it is determined that the channels at the band edge would remain in-band when the maximum measured frequency deviation noted during the frequency stability tests is applied. Therefore the device is determined to remain operating in band over the temperature range as tested.

4.6 Contention Based Protocol

Test Procedures

KDB 987594 – Section I

1. Configure the EUT to transmit with a constant duty cycle.
2. Set the operating parameters of the EUT including power level, operating frequency, modulation and bandwidth.
3. Set the signal analyzer center frequency to the nominal EEUT channel center frequency. The span range of the signal analyzer shall be between two times and five times the OBW of the EUT.
   Connect the output port of the EUT to the signal analyzer 2, as shown in Figure 2. Ensure that the attenuator 2 provides enough attenuation to not overload the signal analyzer 2 receiver.
4. Monitoring the signal analyzer 2, verify the EUT is operating and transmitting with the parameters set at step two.
5. Using an AWGN signal source, generate (but do not transmit, i.e., RF OFF) a 10 MHz-wide AWGN signal. Use Table 1 to determine the center frequency of the 10 MHz AWGN signal relative to the EUT's channel bandwidth and center frequency.
6. Set the AWGN signal power to an extremely low level (more than 20 dB below the -62 dBm threshold). Connect the AWGN signal source, via a 3-dB splitter, to the signal analyzer 1 and the EUT as shown in Figure 2.
7. Transmit the AWGN signal (RF ON) and verify its characteristics on the signal analyzer 1.
8. Monitor the signal analyzer 2 to verify if the AWGN signal has been detected and the EUT has ceased transmission. If the EUT continues to transmit, then incrementally increase the AWGN signal power level until the EUT stops transmitting.
9. (Including all losses in the RF paths) Determine and record the AWGN signal power level (at the EUT's antenna port) at which the EUT ceased transmission. Repeat the procedure at least 10 times to verify the EUT can detect an AWGN signal with 90% (or better) level of certainty.
10. Refer to Table 1 to determine number of times the detection threshold testing needs to be repeated. If testing is required more than once, then go back to step 5, choose a different center frequency for the AWGN signal and repeat the process.

Limit

Unlicensed low-power indoor devices must detect co-channel radio frequency power that is at least -62 dBm or lower.
Additionally, low-power indoor devices must detect co-channel energy with 90% or greater certainty.

Test Data

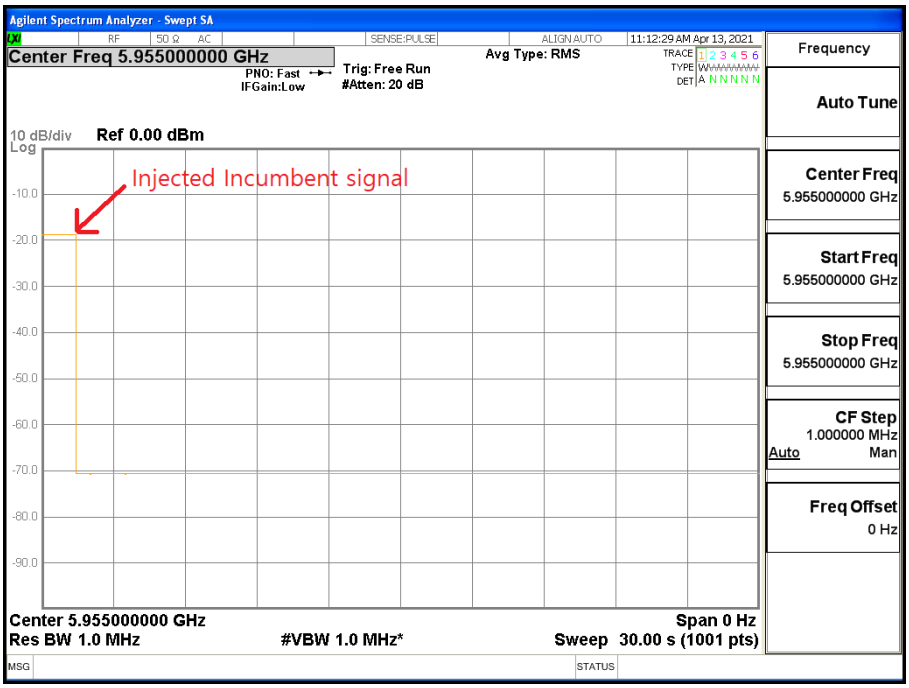
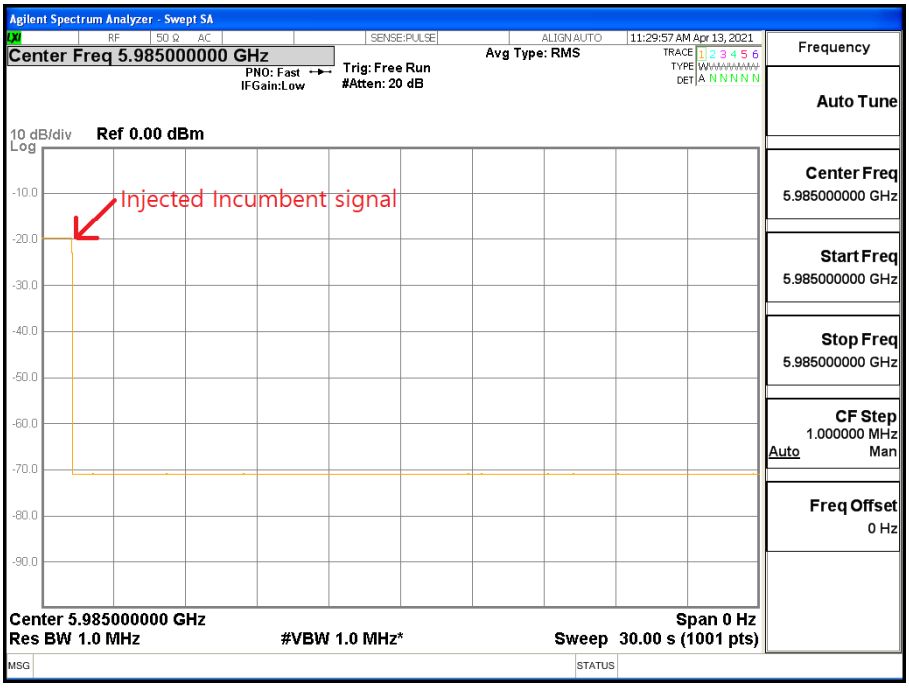
Test Mode	Frequency (MHz)	placement of Incumbent Transmission	Incumbent signal Level (dBm)		AWGN Detection Rate (%)	
			Result	Limit	Result	Limit
802.11ax _HE20	5 955 (UNII 5)	Center	-78.44	-67.58	100	90
	6 435 (UNII 6)	Center	-78.68		100	
	6 535 (UNII 7)	Center	-78.72		100	
	6 995 (UNII 8)	Center	-78.63		100	
802.11ax _HE80	5 985 (UNII 5)	Lower edge	-78.02		100	90
		Center	-78.70		100	
		Upper edge	-78.70		100	
	6 465 (UNII 6)	Lower edge	-78.15		100	
		Center	-77.66		100	
		Upper edge	-78.52		100	
	6 705 (UNII 7)	Lower edge	-78.66		100	
		Center	-78.36		100	
		Upper edge	-78.38		100	
	6 945 (UNII 8)	Lower edge	-78.12		100	
		Center	-78.28		100	
		Upper edge	-78.33		100	

See next pages for actual measured spectrum plots.

Incumbent signal Level (20 MHz BW)

Incumbent signal Level (80 MHz BW)

Monitoring live spectrum (20 MHz BW)



Monitoring live spectrum (80 MHz BW)