

4.6. Band Edge Compliance of RF Emission

TEST REQUIREMENT

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

TEST PROCEDURE

According to KDB 558074 D01 for Antenna-port conducted measurement. Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set both RBW and VBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100kHz bandwidth from band edge, for Radiated emissions restricted band RBW=1MHz, VBW=3MHz for peak detector and RBW=1MHz, VBW=10Hz for average detector.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.
6. Measure the conducted output power (in dBm) using the detector specified by the appropriate regulatory agency (see 12.2.2, 12.2.3, and 12.2.4 for guidance regarding measurement procedures for determining quasi-peak, peak, and average conducted output power, respectively).
7. Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see 12.2.5 for guidance on determining the applicable antenna gain)
8. Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).
9. For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (e.g., Watts, mW).
10. Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:

$$E = \text{EIRP} - 20\log D + 104.8$$

where:

E = electric field strength in dB μ V/m,

EIRP = equivalent isotropic radiated power in dBm

D = specified measurement distance in meters.

11. Since the out-of-band characteristics of the EUT transmit antenna will often be unknown, the use of a conservative antenna gain value is necessary. Thus, when determining the EIRP based on the measured conducted power, the upper bound on antenna gain for a device with a single RF output shall be selected as the maximum in-band gain of the antenna across all operating bands, or 2 dBi, whichever is greater. However, for devices that operate in multiple frequency bands while using the same transmit antenna, the highest gain of the antenna within the operating band nearest in frequency to the restricted band emission being measured may be used in lieu of the overall highest gain when the emission is at a frequency that is within 20 percent of the nearest band edge frequency, but in no case shall a value less than 2 dBi be used.
12. Compare the resultant electric field strength level to the applicable regulatory limit.
13. Perform radiated spurious emission test dures until all measured frequencies were complete.

LIMIT

Below -20dB of the highest emission level in operating band.

Radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a).

TEST RESULTS

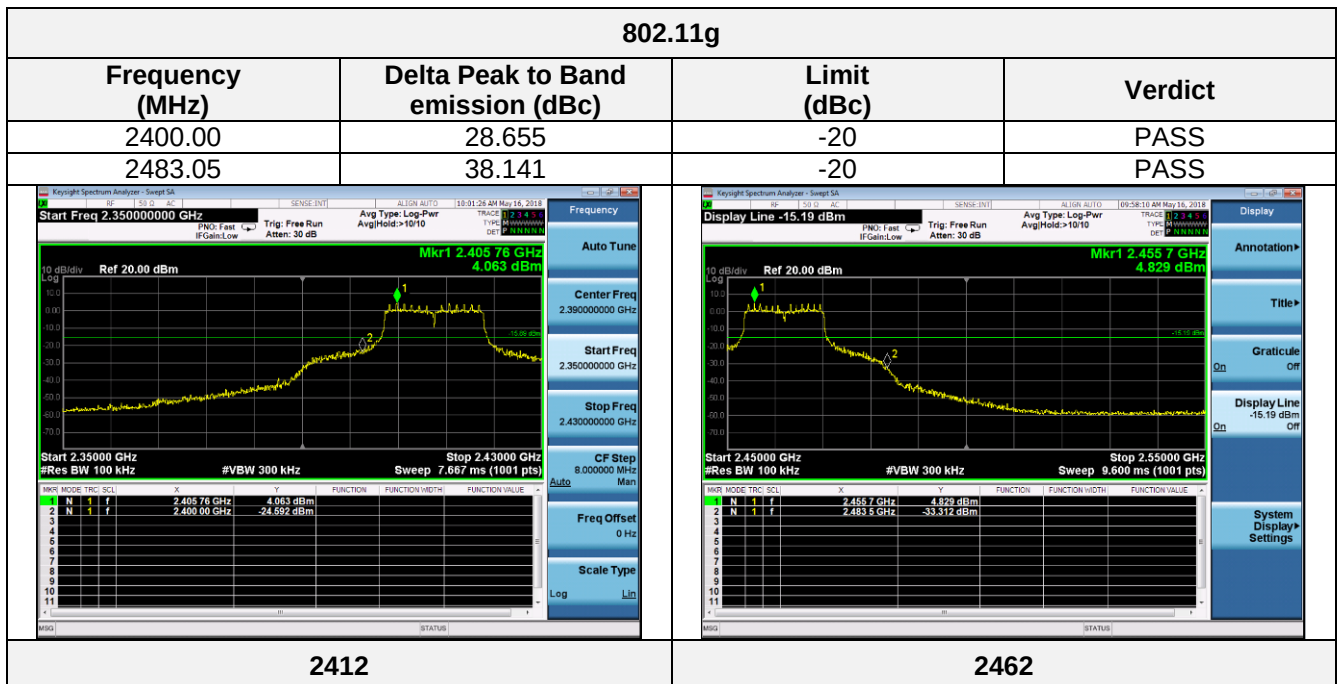
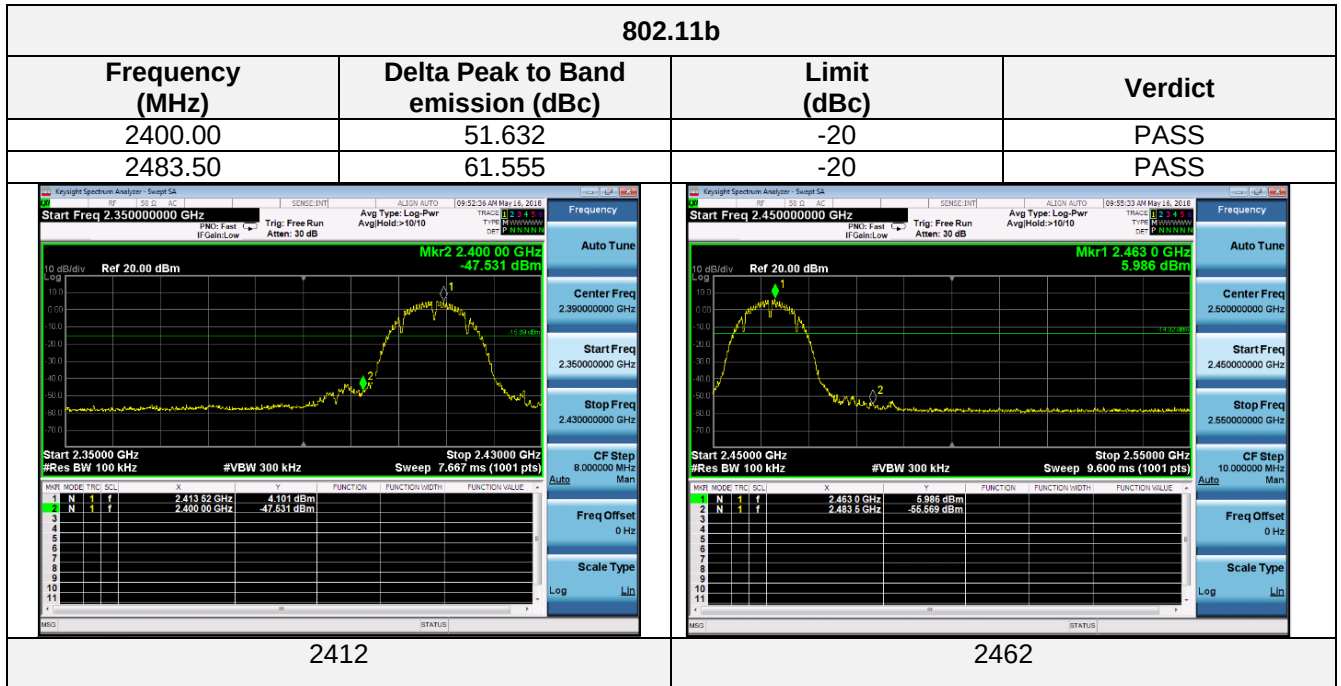
Remark: We tested at 802.11b/802.11g/802.11n HT20/802.11n HT40 mode at the antenna single transmitting mode and 802.11n HT20/802.11n HT40 at the Mimo mode, and recored the worst data at the antenna single transmitting mode.

4.6.1 For Radiated Bandedge Measurement

Frequency	Meter Reading	antenna Factor	cable loss	preamp factor	Level	Limit	Margin	Polar	Result
(MHz)	(dBμV)	(dB)	(dB)	(dB)	(dBμV/m)	(dBμV/m)	[dB]	(H/V)	
802.11b									
2390	44.85	27.72	3.36	26.32	49.61	74	-24.39	V	Pass
2483.5	45.32	27.79	3.48	26.34	50.25	74	-23.75	V	Pass
2390	43.29	27.72	3.36	26.32	48.05	74	-25.95	H	Pass
2483.5	42.76	27.79	3.48	26.34	47.69	74	-26.31	H	Pass
802.11g									
2390	42.52	27.72	3.36	26.32	47.28	74	-26.72	V	Pass
2483.5	43.58	27.79	3.48	26.34	48.51	74	-25.49	V	Pass
2390	41.19	27.72	3.36	26.32	45.95	74	-28.05	H	Pass
2483.5	40.26	27.79	3.48	26.34	45.19	74	-28.81	H	Pass
802.11n20									
2390	40.25	27.72	3.36	26.32	45.01	74	-28.99	V	Pass
2483.5	40.07	27.79	3.48	26.34	45.00	74	-29.00	V	Pass
2390	41.08	27.72	3.36	26.32	45.84	74	-28.16	H	Pass
2483.5	40.86	27.79	3.48	26.34	45.79	74	-28.21	H	Pass
802.11n40									
2390	39.65	27.72	3.36	26.32	44.41	74	-29.59	V	Pass
2483.5	39.76	27.79	3.48	26.34	44.69	74	-29.31	V	Pass
2390	38.67	27.72	3.36	26.32	43.43	74	-30.57	H	Pass
2483.5	39.48	27.79	3.48	26.34	44.41	74	-29.59	H	Pass

4.6.2 For Conducted Bandedge Measurement

Antenna 1



802.11n HT20

Frequency (MHz)	Delta Peak to Band emission (dBc)	Limit (dBc)	Verdict
2400.00	27.133	-20	PASS
2483.50	33.245	-20	PASS

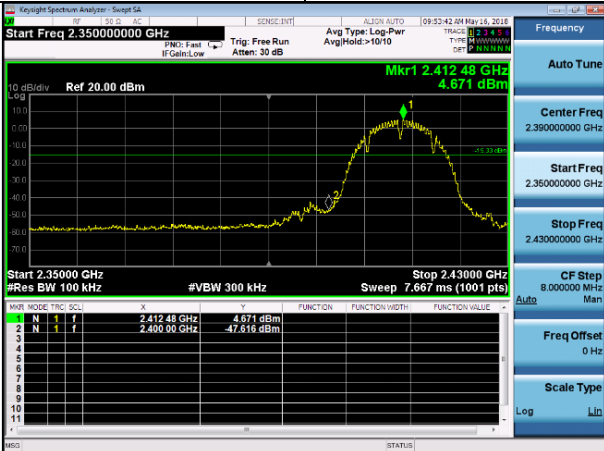
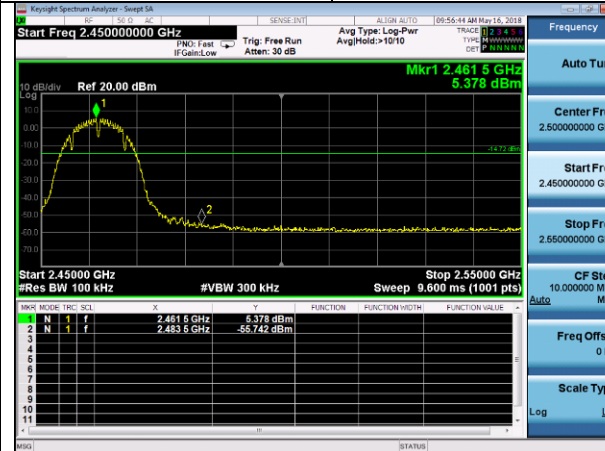
Screenshot 1 (Left)		Screenshot 2 (Right)	
	2412		2462

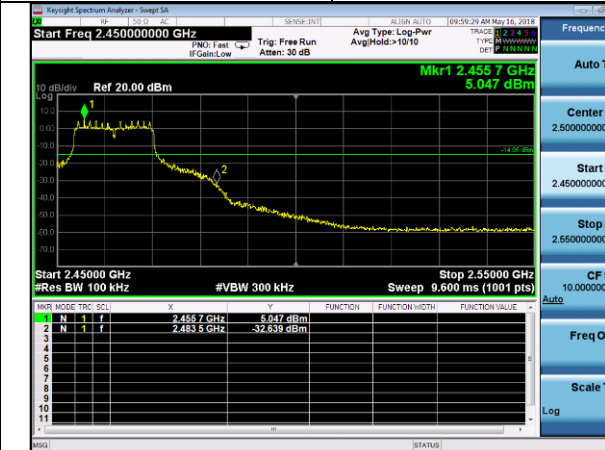
802.11n HT40

Frequency (MHz)	Delta Peak to Band emission (dBc)	Limit (dBc)	Verdict
2400.00	27.647	-20	PASS
2483.50	28.747	-20	PASS

Screenshot 1 (Left)		Screenshot 2 (Right)	
	2422		2452

Antenna 2

802.11b			
Frequency (MHz)	Delta Peak to Band emission (dBc)	Limit (dBc)	Verdict
2400.00	52.287	-20	PASS
2483.50	61.120	-20	PASS
		2412	
		2462	

802.11g			
Frequency (MHz)	Delta Peak to Band emission (dBc)	Limit (dBc)	Verdict
2400.00	28.953	-20	PASS
2483.05	37.686	-20	PASS
		2412	
		2462	

802.11n HT20

802.11n HT20			
Frequency (MHz)	Delta Peak to Band emission (dBc)	Limit (dBc)	Verdict
2400.00	29.865	-20	PASS
2483.50	33.497	-20	PASS

Start Freq 2.350000000 GHz #Res BW 100 kHz #VBW 300 kHz Sweep 7.667 ms (1001 pts) Mkr1 2.406 96 GHz 3.149 dBm Center Freq 2.390000000 GHz Start Freq 2.350000000 GHz Stop Freq 2.430000000 GHz CF Step 8.0000000 MHz Freq Offset 0 Hz Scale Type Log	Start Freq 2.450000000 GHz #Res BW 100 kHz #VBW 300 kHz Sweep 9.600 ms (1001 pts) Mkr1 2.460 8 GHz 3.776 dBm Center Freq 2.500000000 GHz Start Freq 2.450000000 GHz Stop Freq 2.550000000 GHz CF Step 10.0000000 MHz Freq Offset 0 Hz Scale Type Log		
2412	2462		

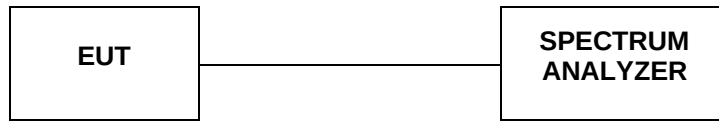
802.11n HT40

802.11n HT40			
Frequency (MHz)	Delta Peak to Band emission (dBc)	Limit (dBc)	Verdict
2400.00	27.833	-20	PASS
2483.50	29.138	-20	PASS

Start Freq 2.430000000 GHz #Res BW 100 kHz #VBW 300 kHz Sweep 11.53 ms (1001 pts) Mkr1 2.435 76 GHz 1.030 dBm Center Freq 2.490000000 GHz Start Freq 2.430000000 GHz Stop Freq 2.550000000 GHz CF Step 12.0000000 MHz Freq Offset 0 Hz Scale Type Log	Start Freq 2.350000000 GHz #Res BW 100 kHz #VBW 300 kHz Sweep 9.600 ms (1001 pts) Mkr1 2.407 0 GHz 0.302 dBm Center Freq 2.400000000 GHz Start Freq 2.350000000 GHz Stop Freq 2.450000000 GHz CF Step 10.0000000 MHz Freq Offset 0 Hz Scale Type Log
2422	2452

4.7. Spurious RF Conducted Emission

TEST CONFIGURATION



TEST PROCEDURE

The Spurious RF conducted emissions compliance of RF radiated emission should be measured by following the guidance in ANSI C63.10-2013, For 9KHz-150kHz, Set RBW=1kHz and VBW= 3KHz; For 150KHz-10MHz, Set RBW=10kHz and VBW= 30KHz; For 10MHz-25GHz, Set RBW=100kHz and VBW= 300KHz in order to measure the peak field strength, and measure frequency range from 9KHz to 25GHz.

LIMIT

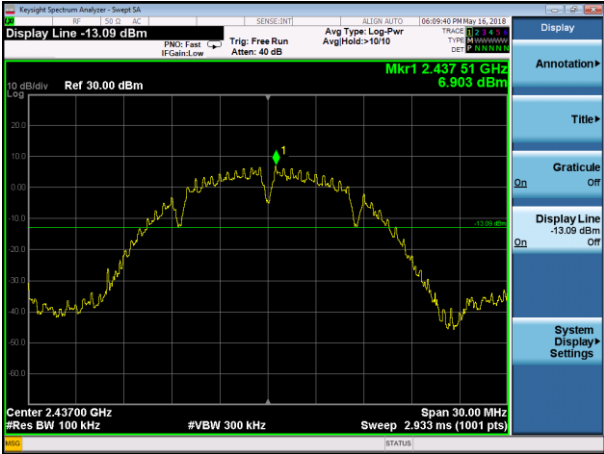
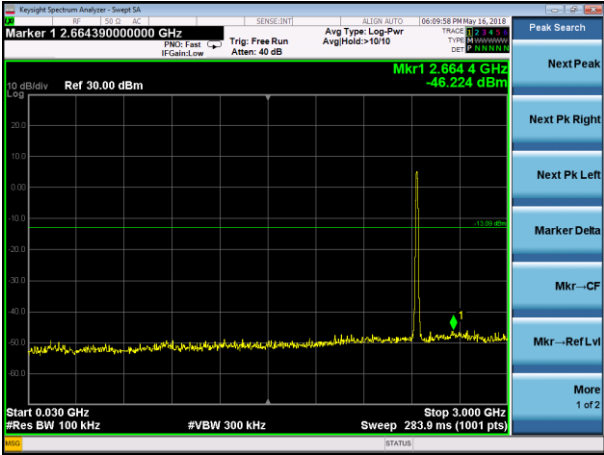
1. Below -20dB of the highest emission level in operating band.
2. Fall in the restricted bands listed in section 15.205. The maximum permitted average field strength is listed in section 15.209.
3. For below 30MHz, For 9KHz-150kHz, 150K-10MHz, We use the RBW 1KHz, 10KHz, So the limit need to be calculated by $10\lg(BW1/BW2)$. for example For 9KHz-150kHz, RBW 1KHz, The Limit= the highest emission level-20-10log(100/1)= the highest emission level-40.

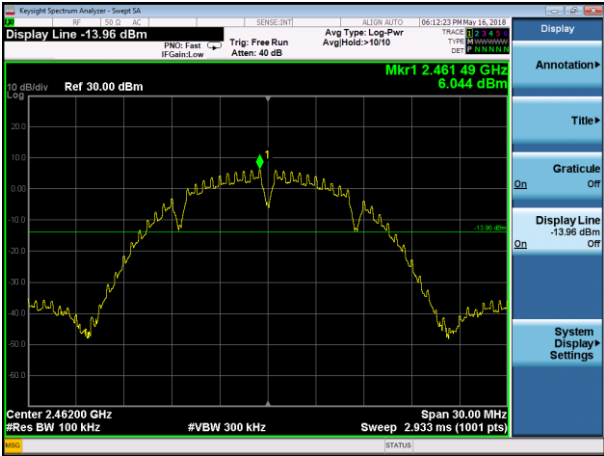
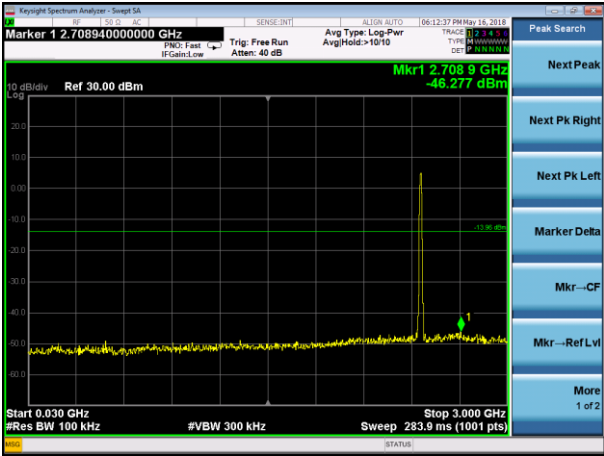
TEST RESULTS

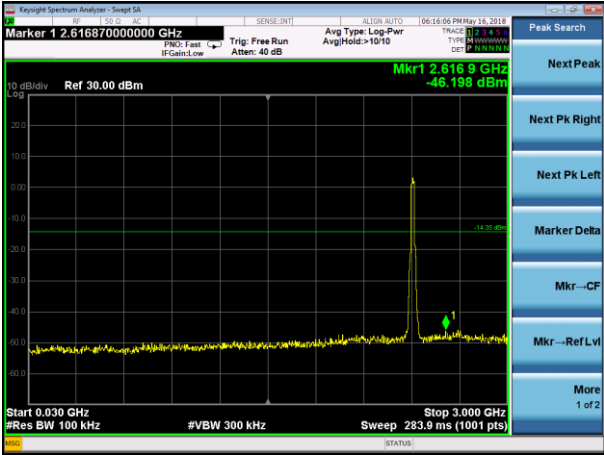
Remark: The measurement frequency range is from 9KHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions and band edge measurement data.

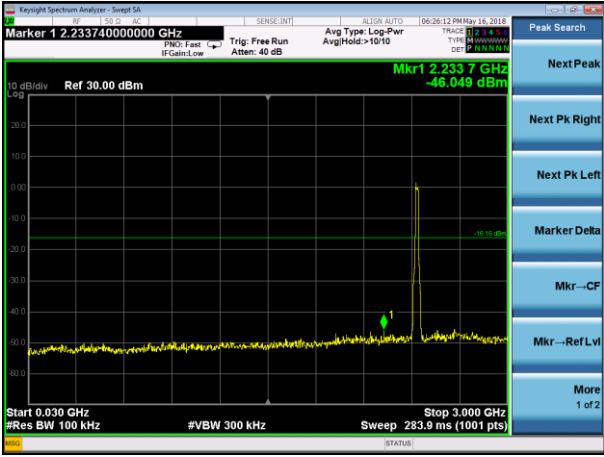
Antenna 1

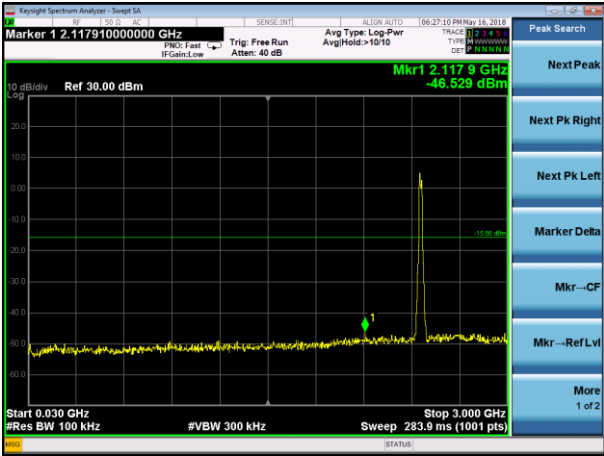
Test Mode:	802.11b	Test channel :	01
Keyight Spectrum Analyzer - Sweep SA Center Freq 2.412000000 GHz Ref 30.00 dBm Span 30.00 MHz #Res BW 100 kHz #VBW 300 kHz Sweep 2.933 ms (1001 pts) Frequency Auto Tune Center Freq 2.412000000 GHz Start Freq 2.397000000 GHz Stop Freq 2.427000000 GHz CF Step 3.000000 MHz Auto Freq Offset 0 Hz Scale Type Log			
Channel 01			
Keyight Spectrum Analyzer - Sweep SA Marker 1 2.708940000000 GHz Ref 30.00 dBm Start 0.030 GHz #Res BW 100 kHz #VBW 300 kHz Sweep 283.9 ms (1001 pts) Mkr1 2.7089 GHz -46.534 dBm Stop 3.000 GHz Peak Search Next Peak Next Pk Right Next Pk Left Marker Delta Mkr--CF Mkr--Ref Lvl More 1 of 2			
30MHz ~3GHz			
Keyight Spectrum Analyzer - Sweep SA Marker 1 24.692000000000 GHz Ref 30.00 dBm Start 3.00 GHz #Res BW 100 kHz #VBW 300 kHz Sweep 2.103 s (1001 pts) Mkr1 24.692 GHz -38.068 dBm Stop 25.00 GHz Peak Search Next Peak Next Pk Right Next Pk Left Marker Delta Mkr--CF Mkr--Ref Lvl More 1 of 2			
3GHz~25GHz			

Test Mode:	802.11b	Test channel :	06
			
Channel 06			
			
30MHz ~3GHz			
			
3GHz~25GHz			

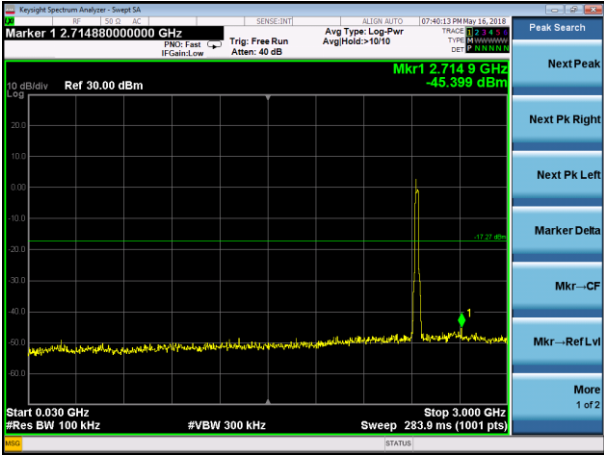
Test Mode:	802.11b	Test channel :	11
			
Channel 11			
			
30MHz ~3GHz			
			
3GHz~25GHz			

Test Mode:	802.11g	Test channel :	01
			
Channel 01			
			
30MHz ~3GHz			
			
3GHz~25GHz			

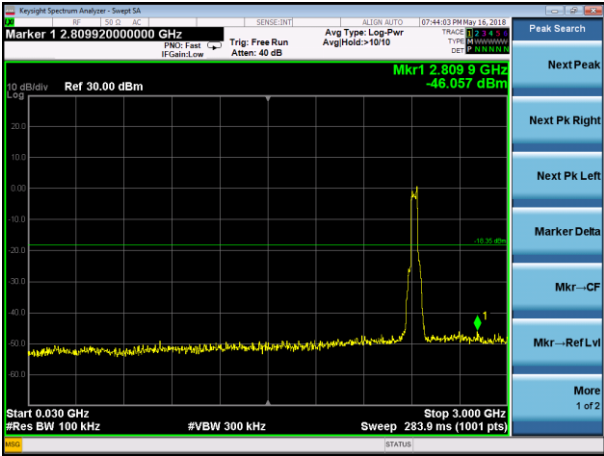
Test Mode:	802.11g	Test channel :	06
			
Channel 06			
			
30MHz ~3GHz			
			
3GHz~25GHz			

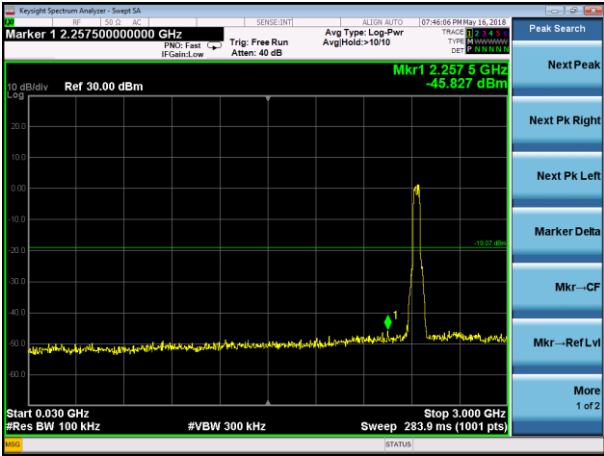
Test Mode:	802.11g	Test channel :	11
			
Channel 11			
			
30MHz ~3GHz			
			
3GHz~25GHz			

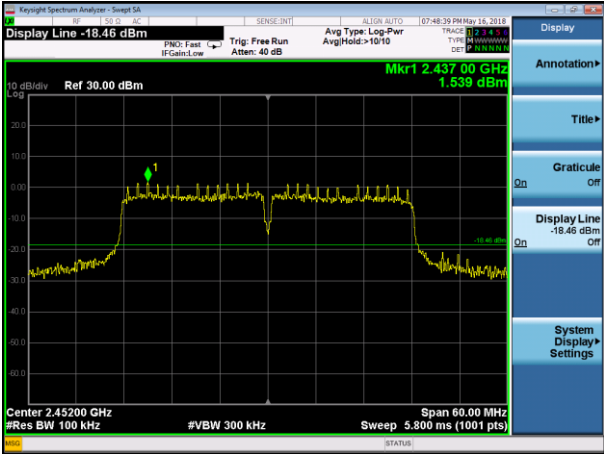
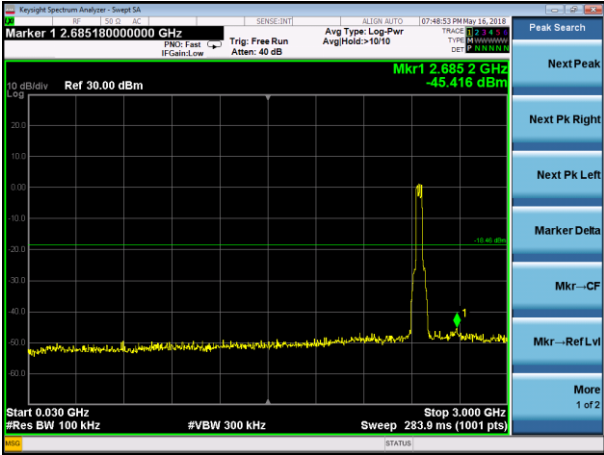
Test Mode:	802.11n HT20	Test channel :	01
Keysight Spectrum Analyzer - Sweep SA Display Line -17.80 dBm 10 dB/div Ref 30.00 dBm Mkr1 2.416 98 GHz 2.298 dBm Center 2.41200 GHz #Res BW 100 kHz #VBW 300 kHz Sweep 2.933 ms (1001 pts) Display Annotation Title Graticule Display Line System Display Settings			
Channel 01			
Keysight Spectrum Analyzer - Sweep SA Marker 1 2.649540000000 GHz 10 dB/div Ref 30.00 dBm Mkr1 2.649 5 GHz -45.391 dBm Start 0.030 GHz #Res BW 100 kHz #VBW 300 kHz Sweep 283.9 ms (1001 pts) Peak Search Next Peak Next Pk Right Next Pk Left Marker Delta Mkr--CF Mkr--Ref Lvl More 1 of 2			
30MHz ~3GHz			
Keysight Spectrum Analyzer - Sweep SA Marker 1 24.846000000000 GHz 10 dB/div Ref 30.00 dBm Mkr1 24.846 GHz -37.745 dBm Start 3.00 GHz #Res BW 100 kHz #VBW 300 kHz Sweep 2.103 s (1001 pts) Peak Search Next Peak Next Pk Right Next Pk Left Marker Delta Mkr--CF Mkr--Ref Lvl More 1 of 2			
3GHz~25GHz			

Test Mode:	802.11n HT20	Test channel :	06
			
Channel 06			
			
30MHz ~3GHz			
			
3GHz~25GHz			

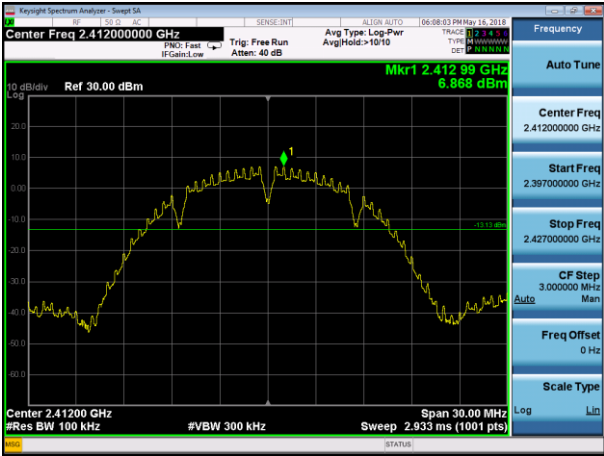
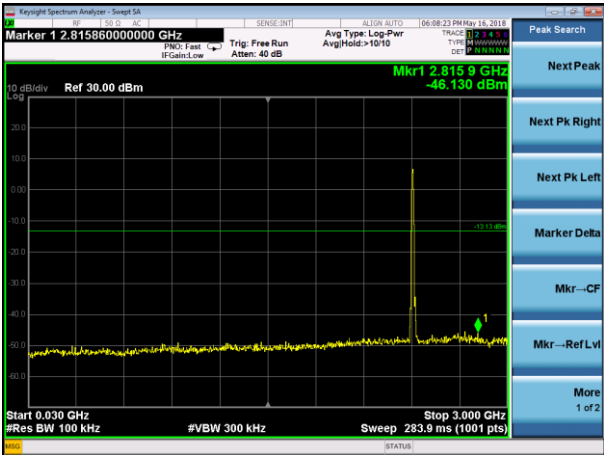
Test Mode:	802.11n HT20	Test channel :	11
Keysight Spectrum Analyzer - Sweep SA Display Line -16.77 dBm 10 dB/div Ref 30.00 dBm Mkr1 2.456 99 GHz 3.227 dBm Center 2.46200 GHz #Res BW 100 kHz #VBW 300 kHz Sweep 2.933 ms (1001 pts) Display Annotation Title Graticule Off Display Line -16.77 dBm Off System Display Settings			
Channel 11			
Keysight Spectrum Analyzer - Sweep SA Marker 1 2.670330000000 GHz 10 dB/div Ref 30.00 dBm Mkr1 2.670 3 GHz -45.691 dBm Start 0.030 GHz #Res BW 100 kHz #VBW 300 kHz Sweep 283.9 ms (1001 pts) Peak Search Next Peak Next Pk Right Next Pk Left Marker Delta Mkr--CF Mkr--Ref Lvl More 1 of 2			
30MHz ~3GHz			
Keysight Spectrum Analyzer - Sweep SA Marker 1 21.370000000000 GHz 10 dB/div Ref 30.00 dBm Mkr1 21.370 GHz -38.300 dBm Start 3.00 GHz #Res BW 100 kHz #VBW 300 kHz Sweep 2.103 s (1001 pts) Peak Search Next Peak Next Pk Right Next Pk Left Marker Delta Mkr--CF Mkr--Ref Lvl More 1 of 2			
3GHz~25GHz			

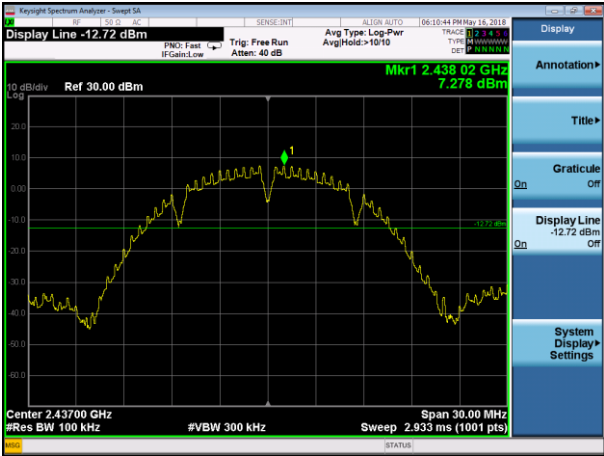
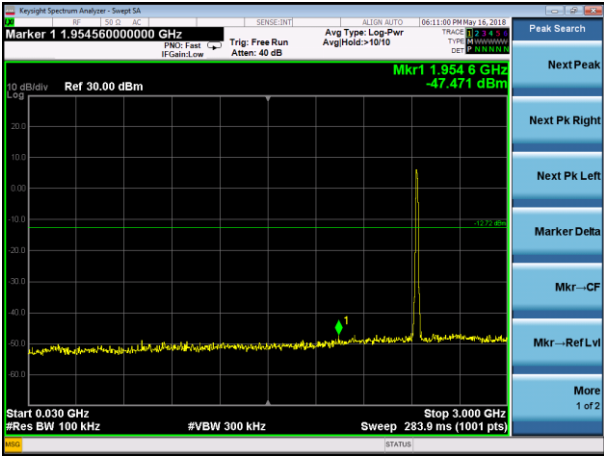
Test Mode:	802.11n HT40	Test channel :	03
			
Channel 03			
			
30MHz ~3GHz			
			
3GHz~25GHz			

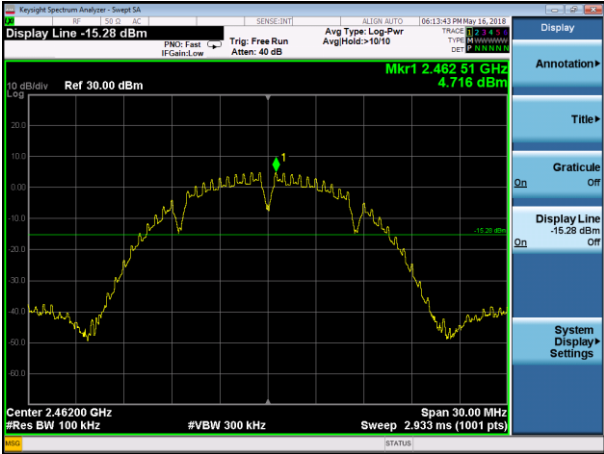
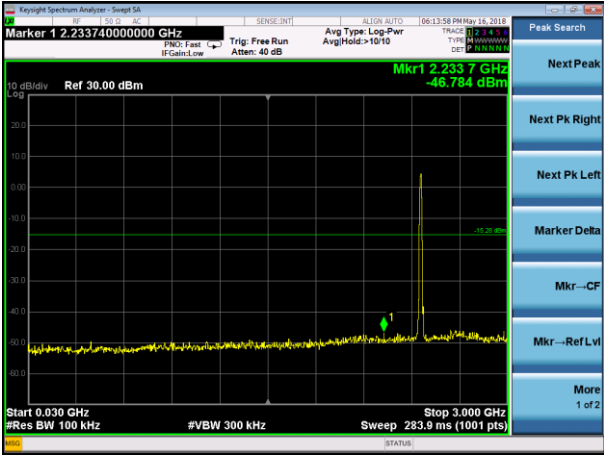
Test Mode:	802.11n HT40	Test channel :	06
			
Channel 06			
			
30MHz ~3GHz			
			
3GHz~25GHz			

Test Mode:	802.11n HT40	Test channel :	09
			
Channel 09			
			
30MHz ~3GHz			
			
3GHz~25GHz			

Antenna 2

Test Mode:	802.11b	Test channel :	01
			
Channel 01			
			
30MHz ~3GHz			
			
3GHz~25GHz			

Test Mode:	802.11b	Test channel :	06
			
Channel 06			
			
30MHz ~3GHz			
			
3GHz~25GHz			

Test Mode:	802.11b	Test channel :	11
			
Channel 11			
			
30MHz ~3GHz			
			
3GHz~25GHz			