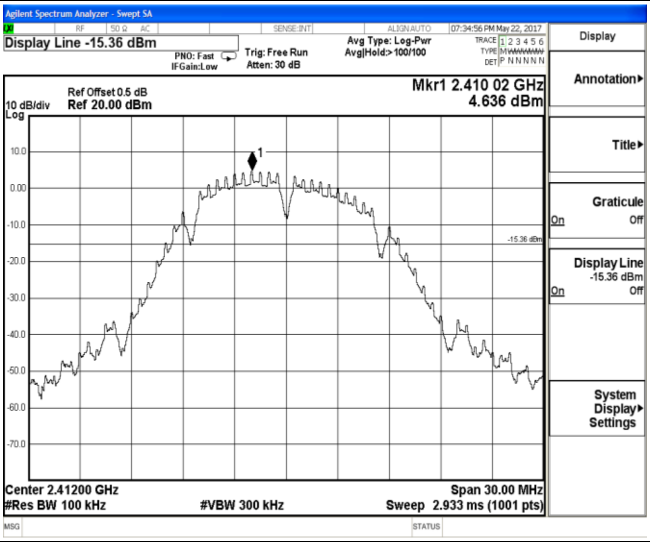
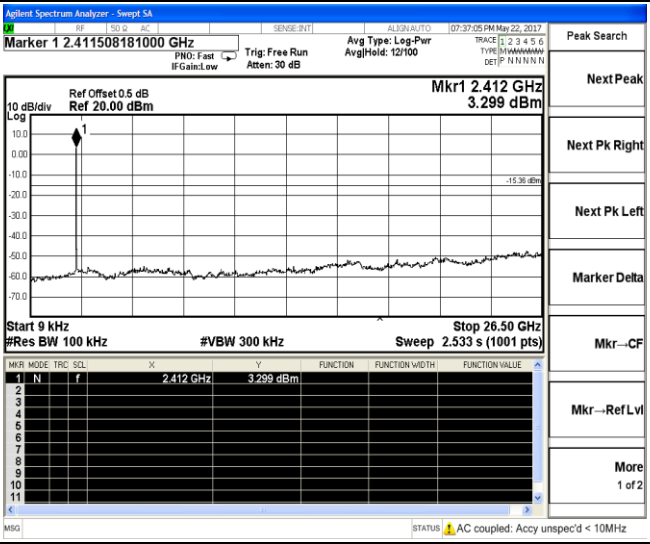
RF Conducted Spurious Emission

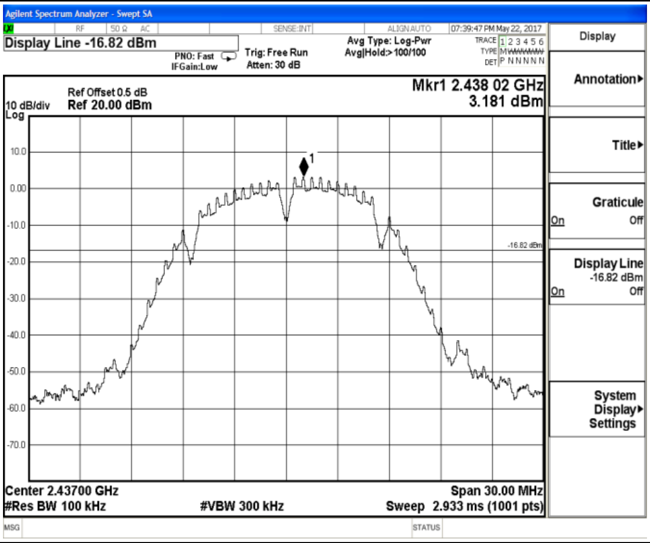
IEEE 802.11b



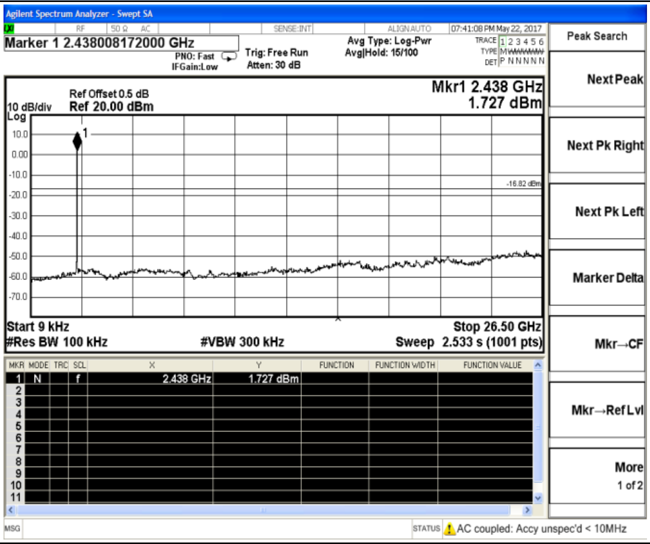
2397 MHz – 2427 MHz



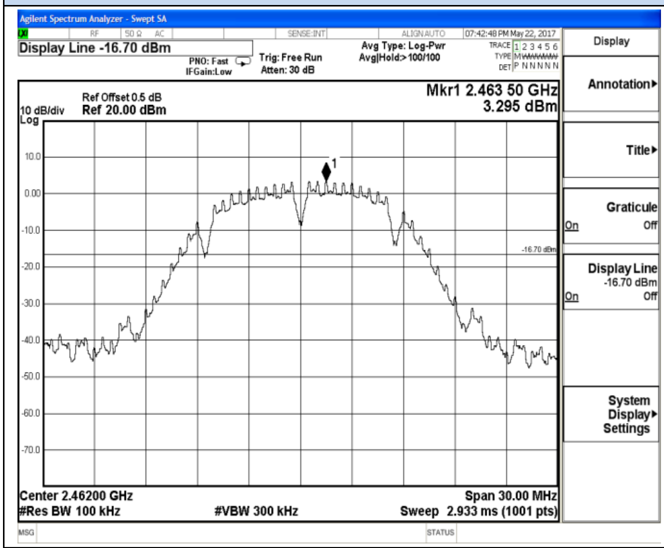
9 KHz – 26.5 GHz



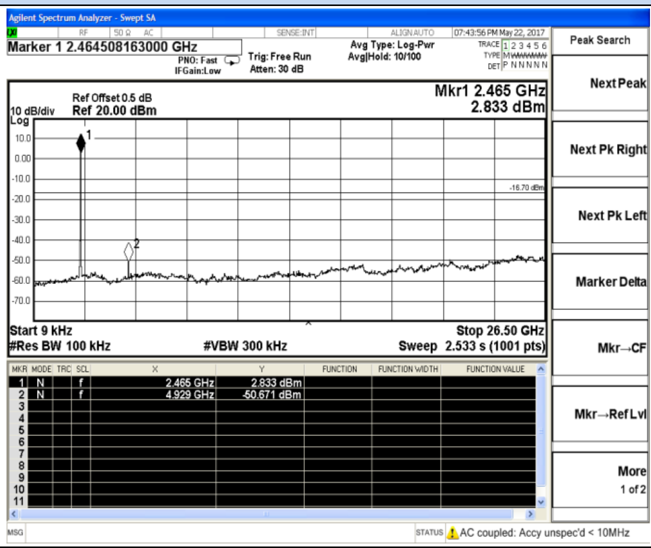
2422 MHz – 2452 MHz



9 KHz – 26.5 GHz



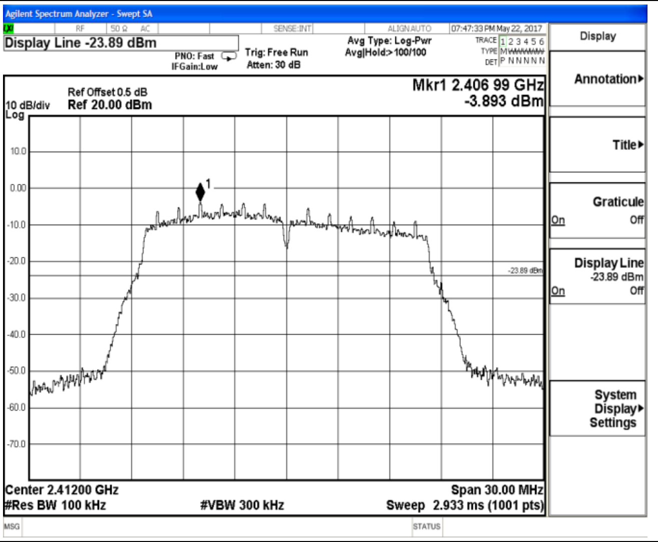
2447 MHz – 2477 MHz



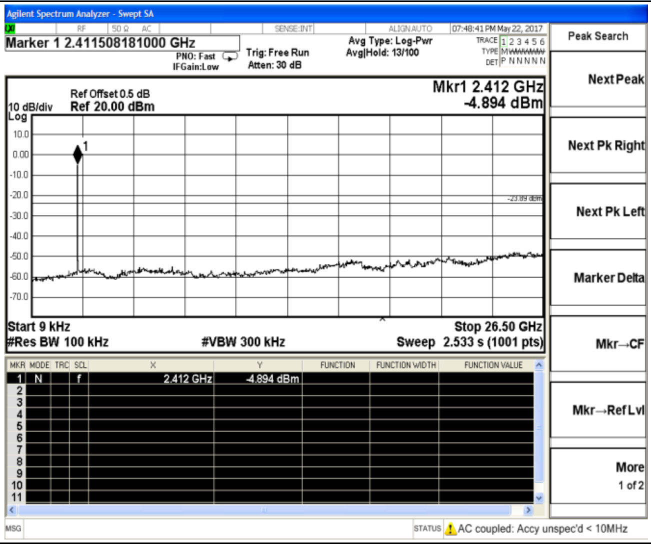
9 KHz – 26.5 GHz

RF Conducted Spurious Emission

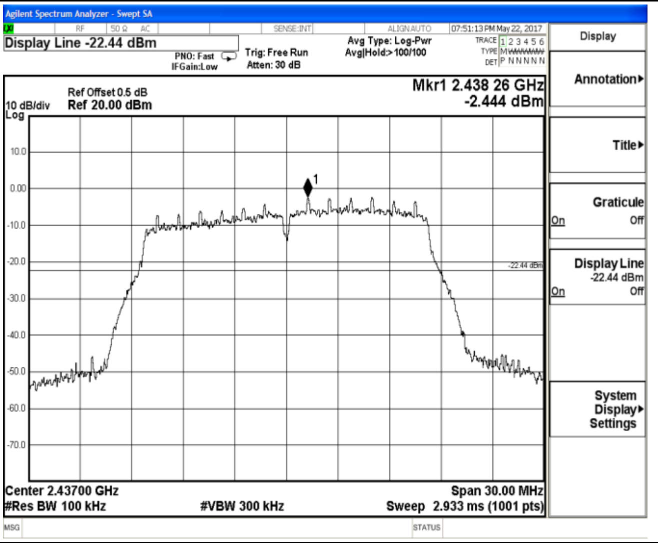
IEEE 802.11g



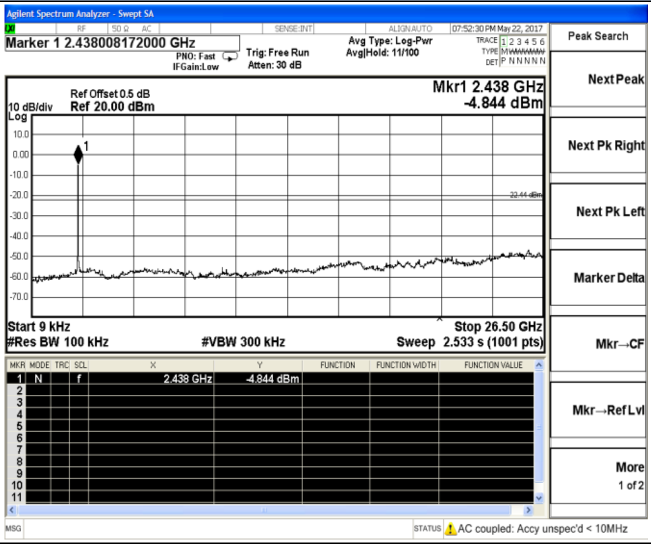
2397 MHz – 2427 MHz



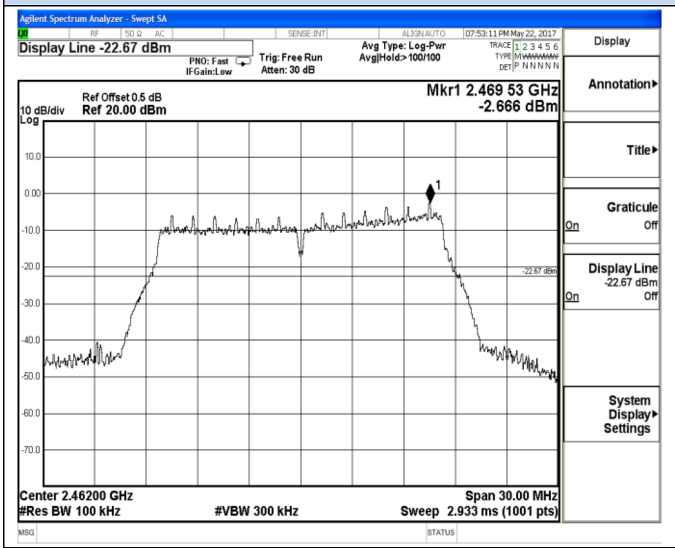
9 KHz – 26.5 GHz



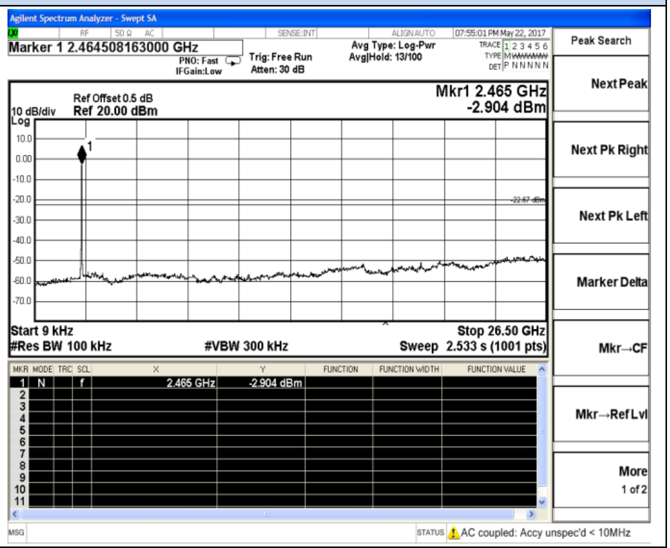
2422 MHz – 2452 MHz



9 KHz – 26.5 GHz



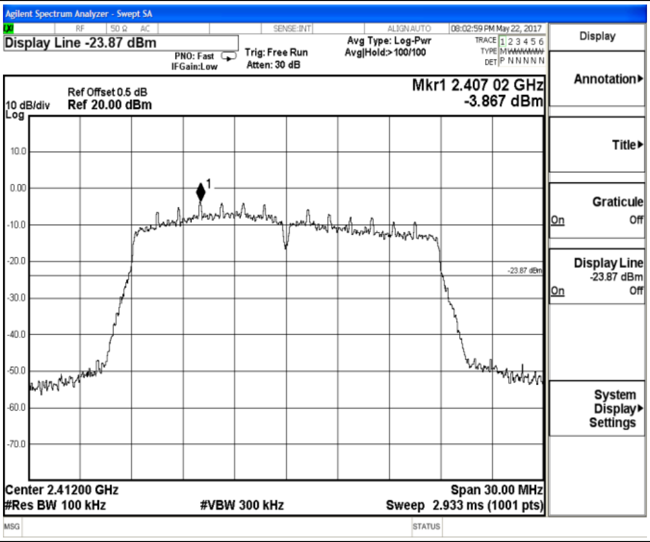
2447 MHz – 2477 MHz



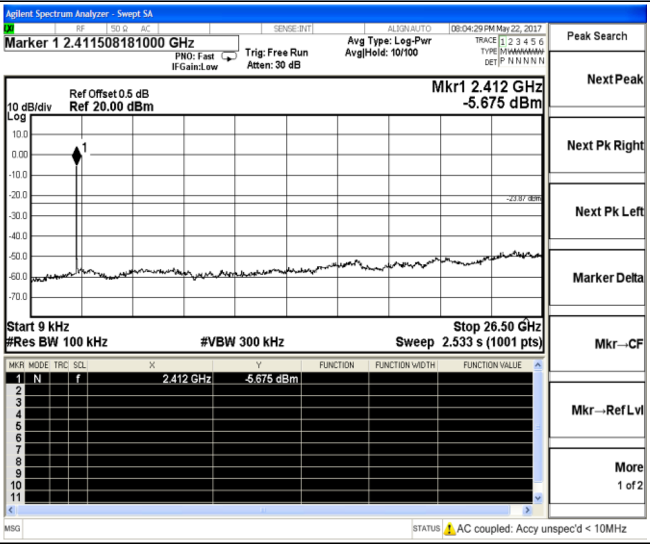
9 KHz – 26.5 GHz

RF Conducted Spurious Emission

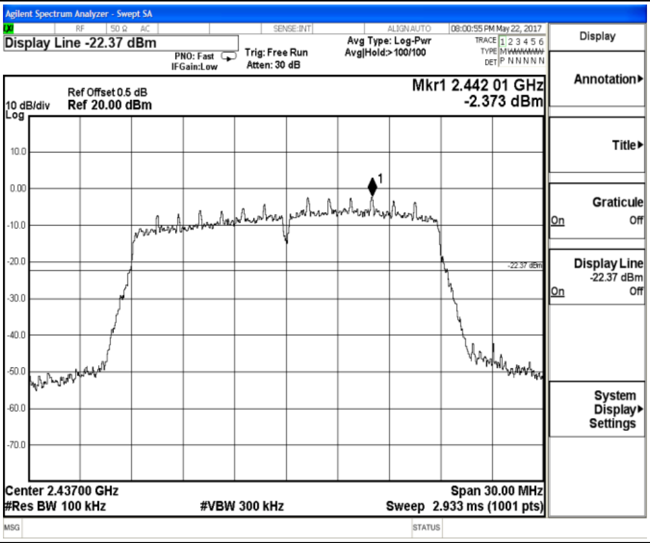
IEEE 802.11n HT20



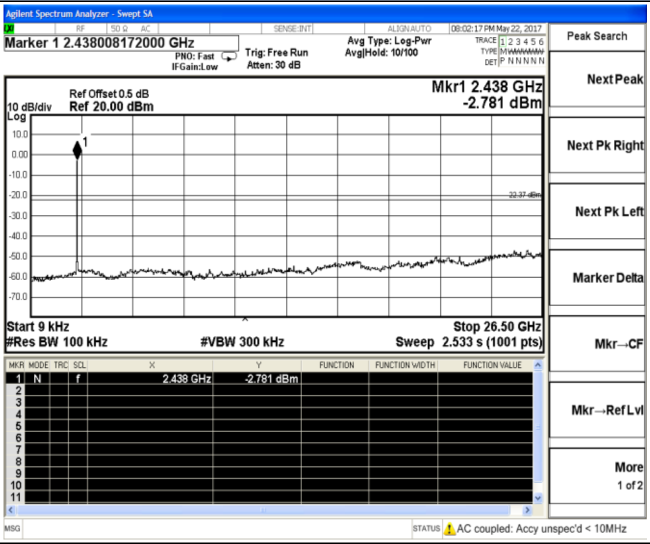
2397 MHz – 2427 MHz



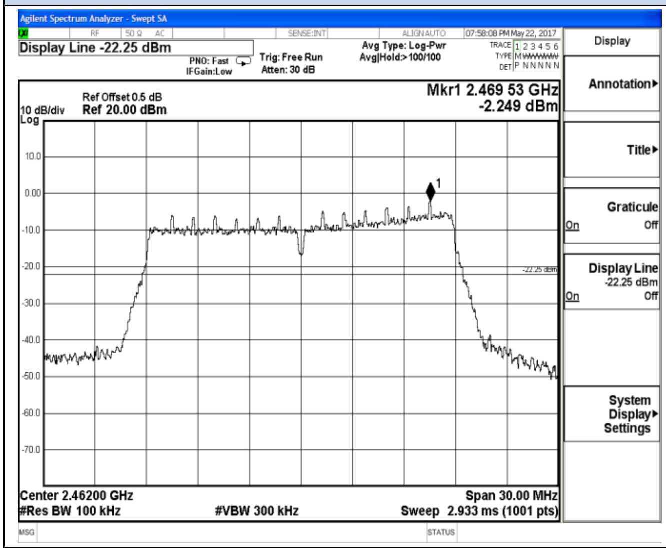
9 KHz – 26.5 GHz



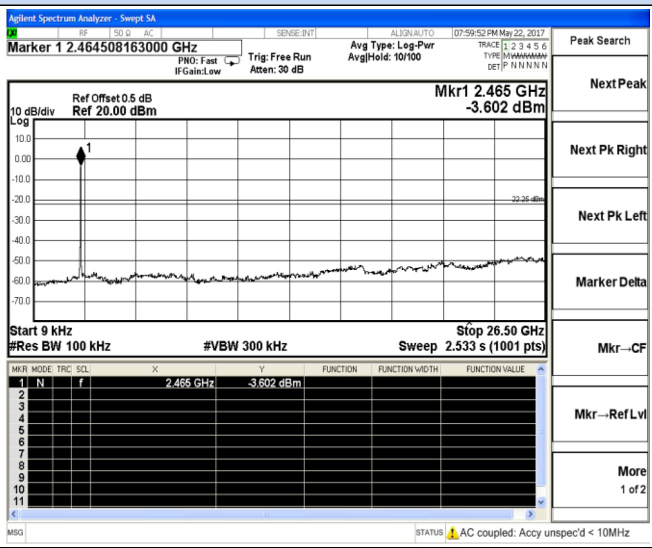
2422 MHz – 2452 MHz



9 KHz – 26.5 GHz



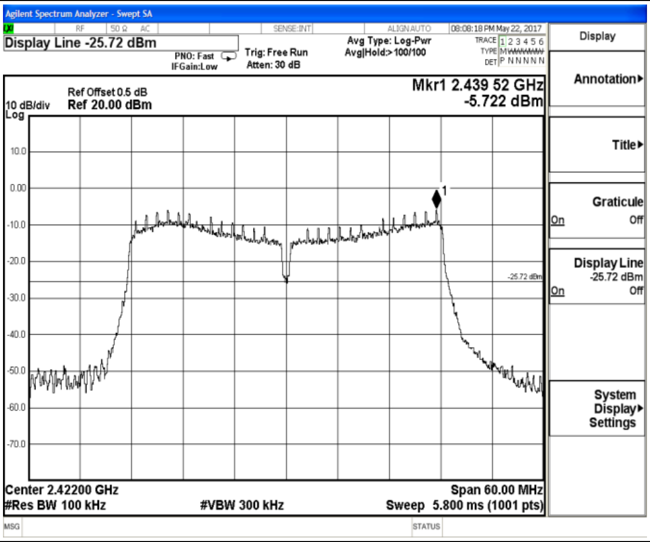
2447 MHz – 2477 MHz

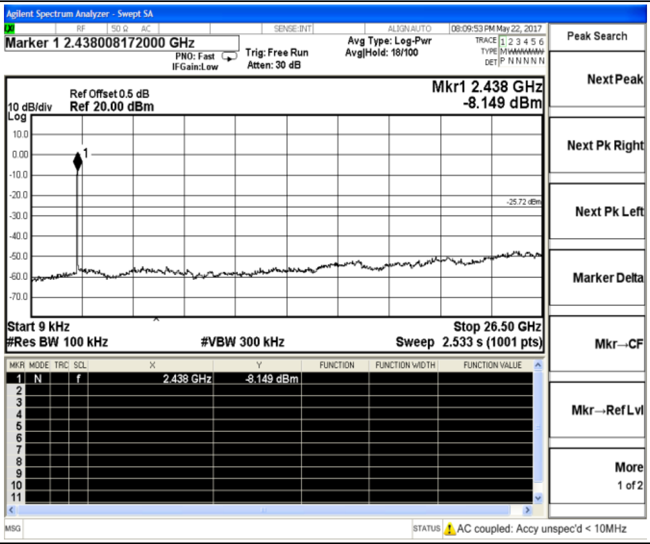


9 KHz – 26.5 GHz

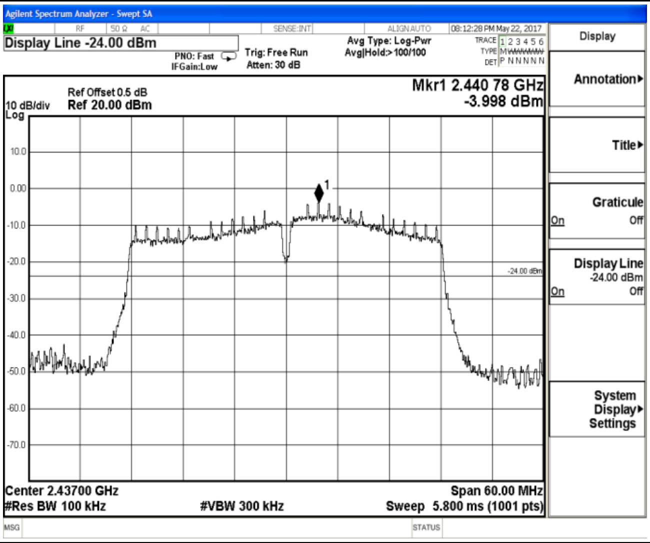
RF Conducted Spurious Emission

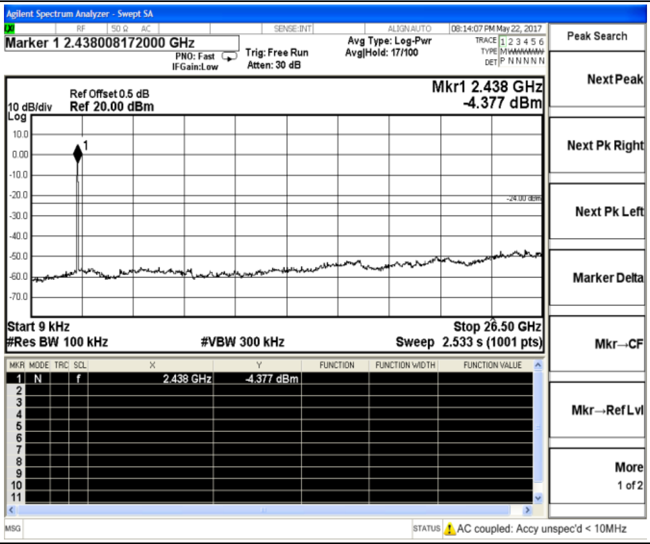
IEEE 802.11n HT40



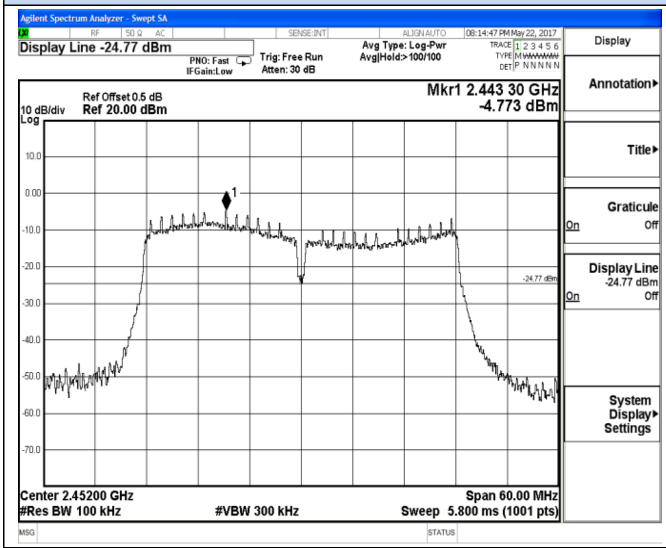


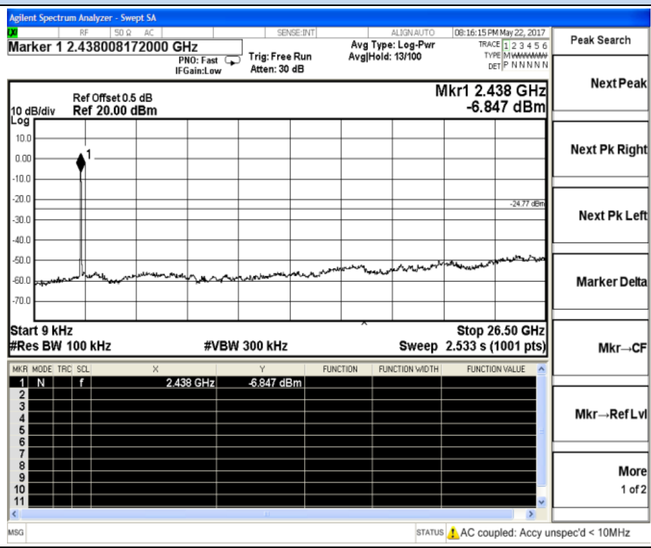
2392 MHz – 2452 MHz	9 KHz – 26.5 GHz





2407 MHz – 2467 MHz	9 KHz – 26.5 GHz

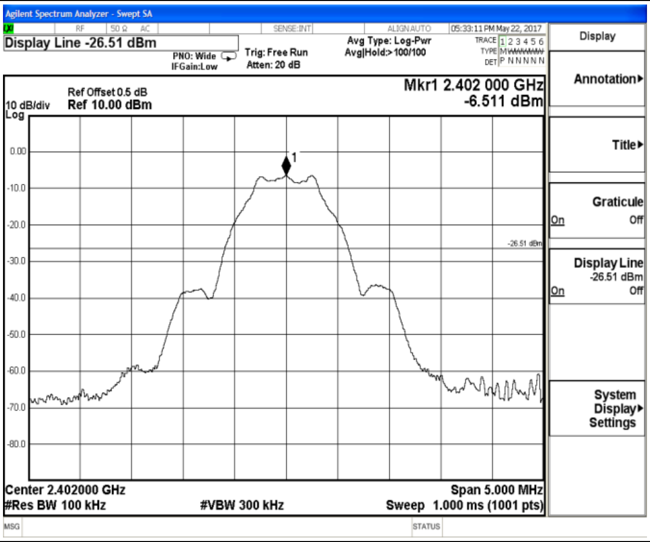




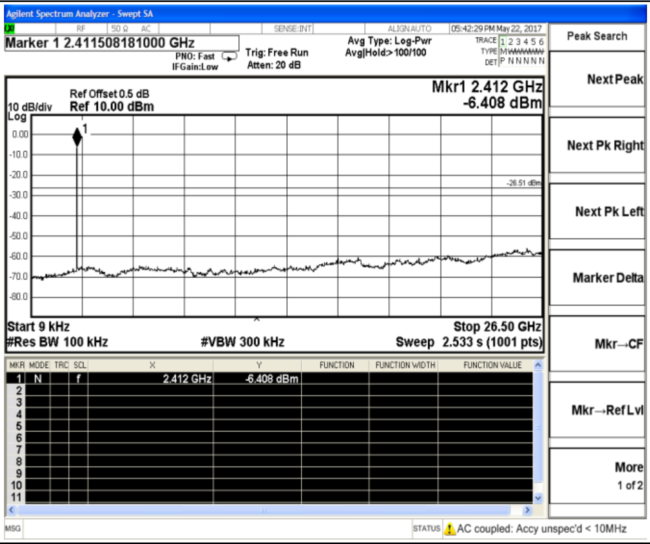
2422 MHz – 2482 MHz	9 KHz – 26.5 GHz

RF Conducted Spurious Emission

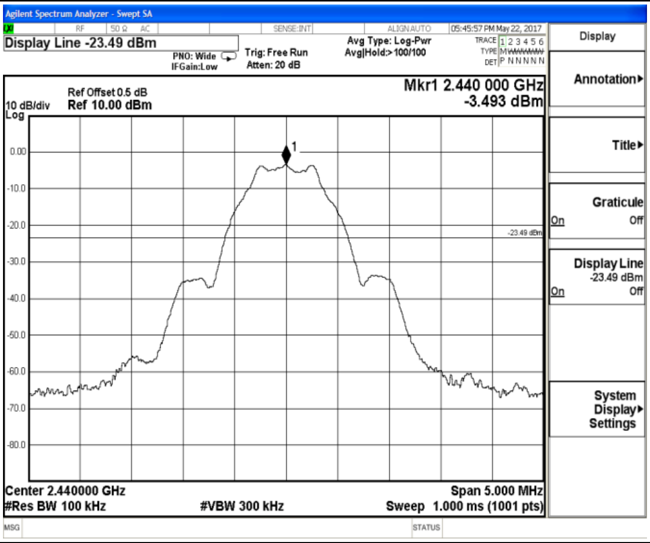
BT LE



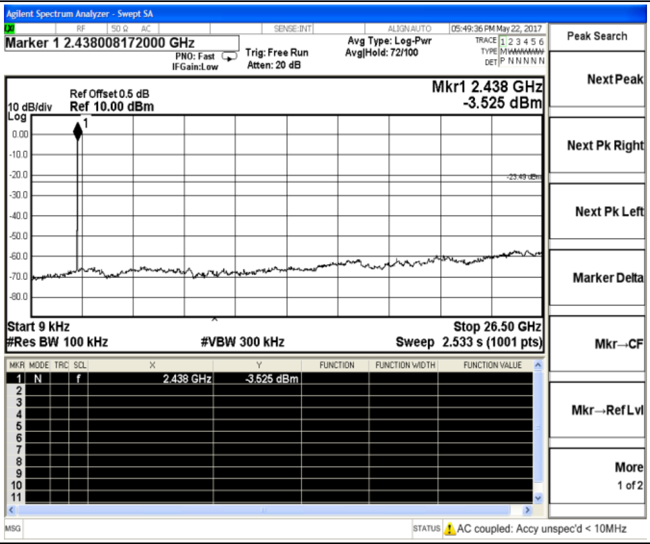
2399.5 MHz – 2404.5 MHz



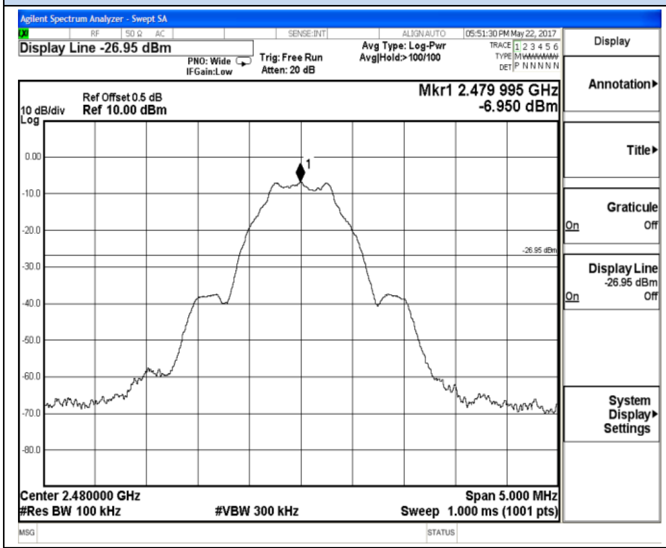
9 KHz – 26.5 GHz



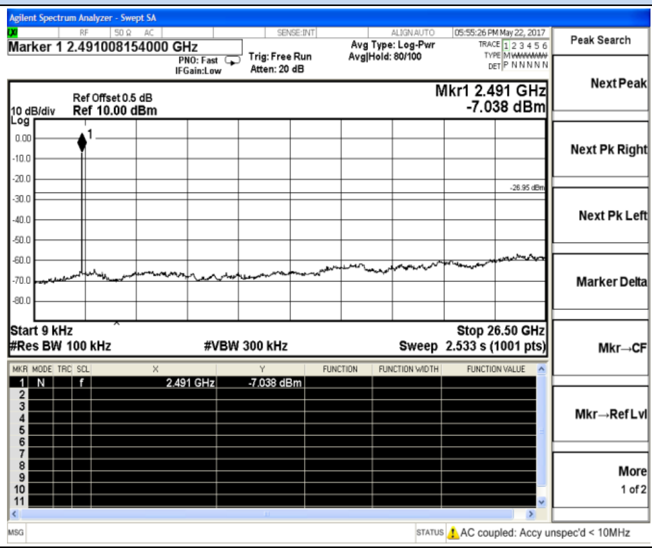
2437.5 MHz – 2442.5 MHz



9 KHz – 26.5 GHz



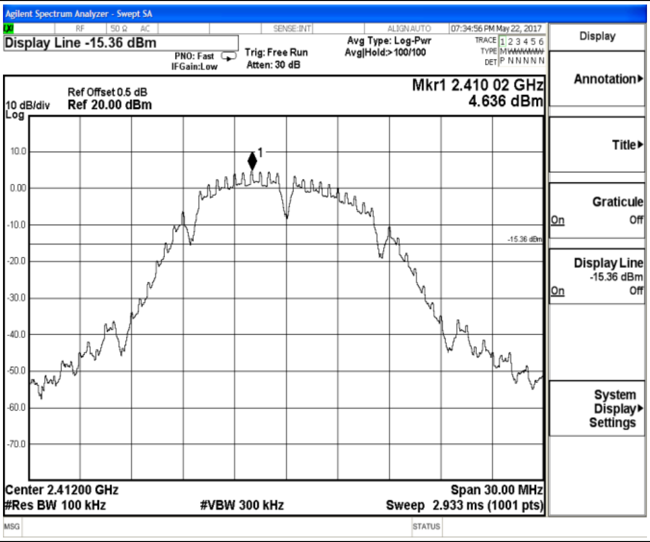
2477.5 MHz – 2482.5 MHz



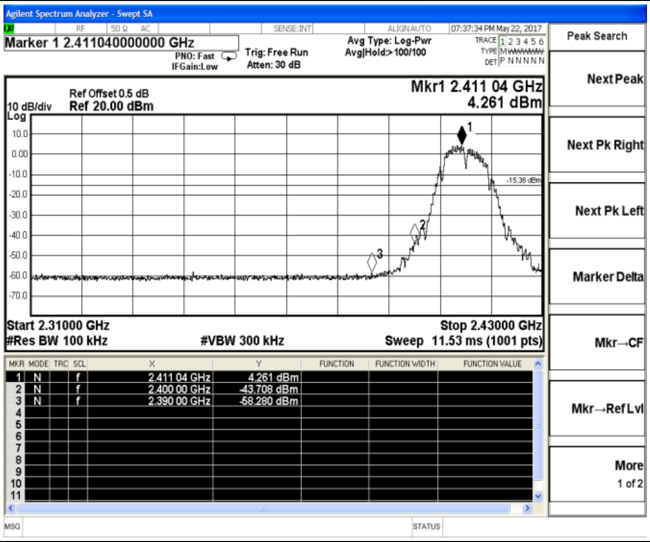
9 KHz – 26.5 GHz

Band-edge measurements for conducted emissions

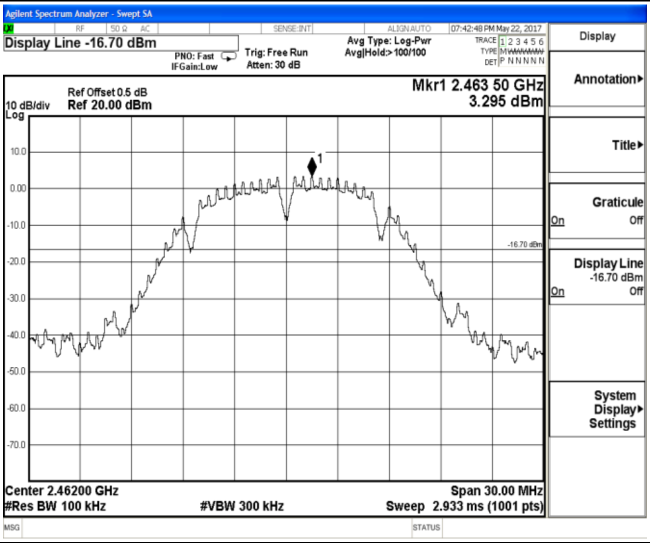
IEEE 802.11b



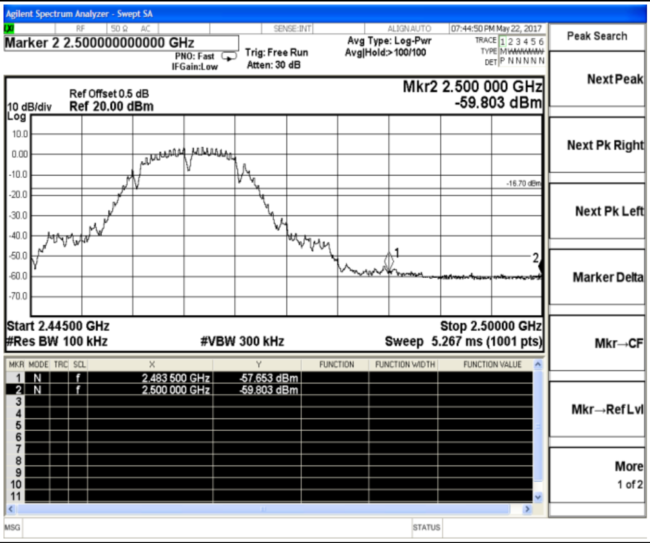
2397 MHz – 2427 MHz



Channel 1 / 2412 MHz

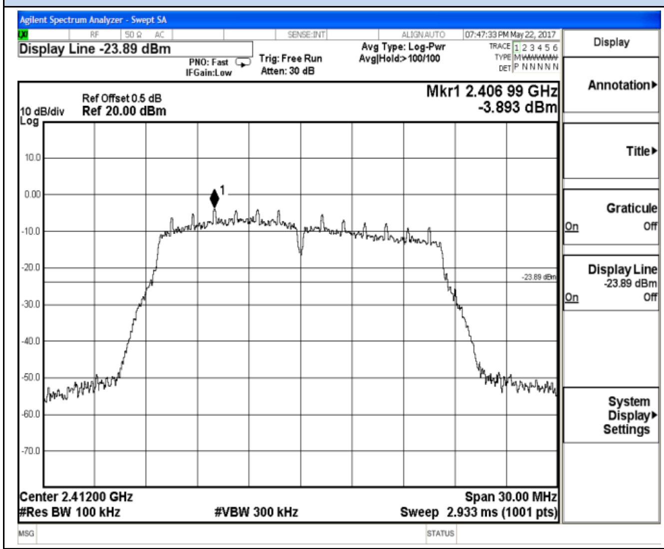


2447 MHz – 2477 MHz

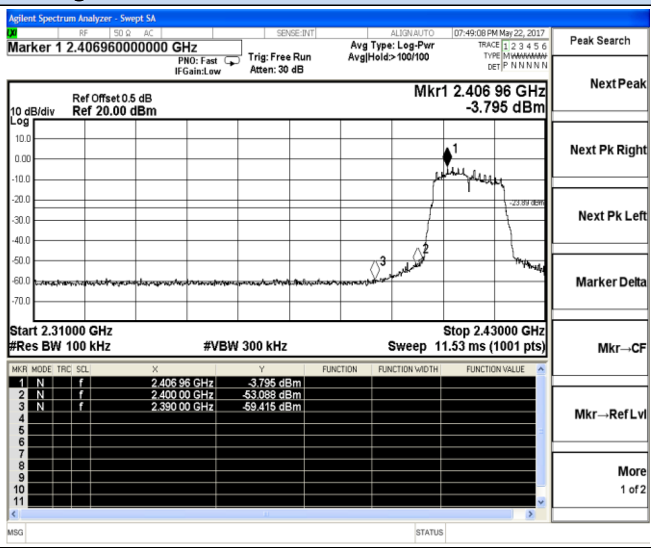


Channel 11 / 2462 MHz

IEEE 802.11g



2397 MHz – 2427 MHz



Channel 1 / 2412 MHz

<table>
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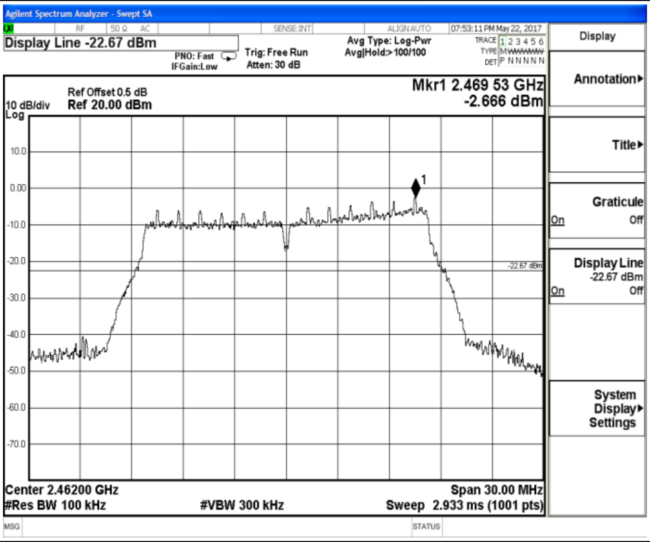
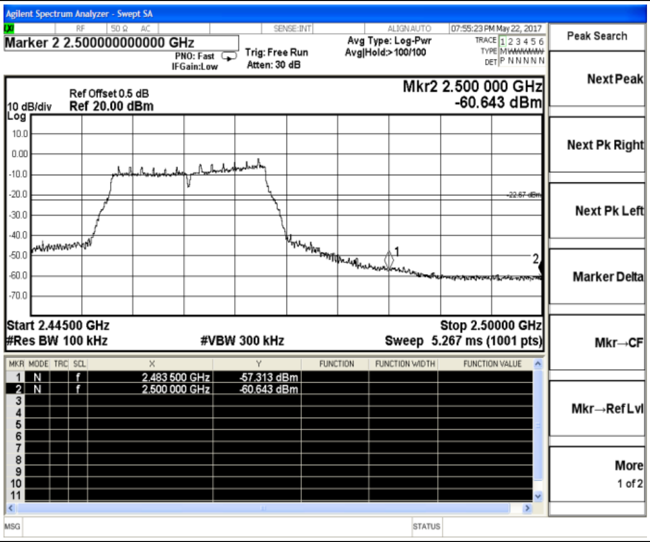
<tr><th colspan="2">IEEE 802.11g</th></tr>
<tr><td>
</td><td>
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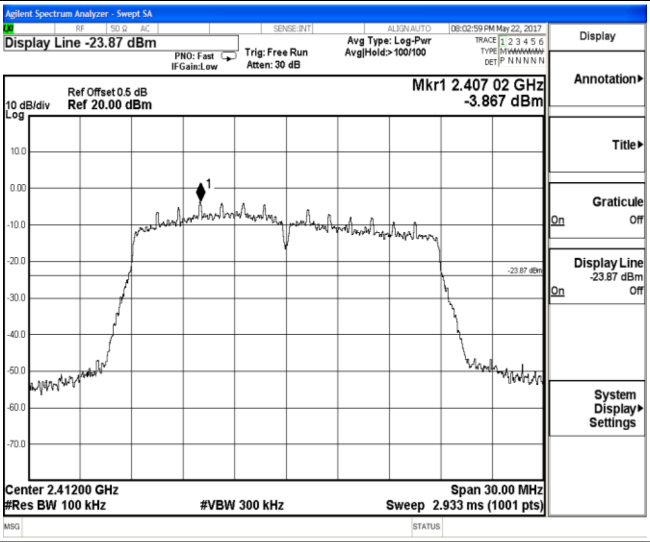
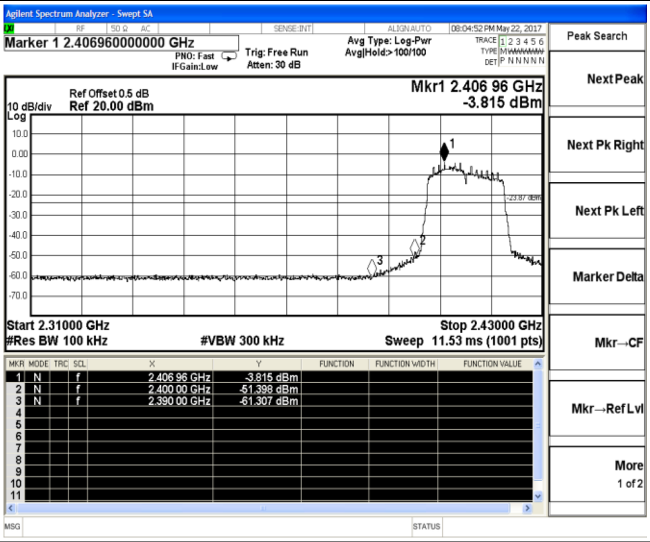
<tr><td>
</td><td>
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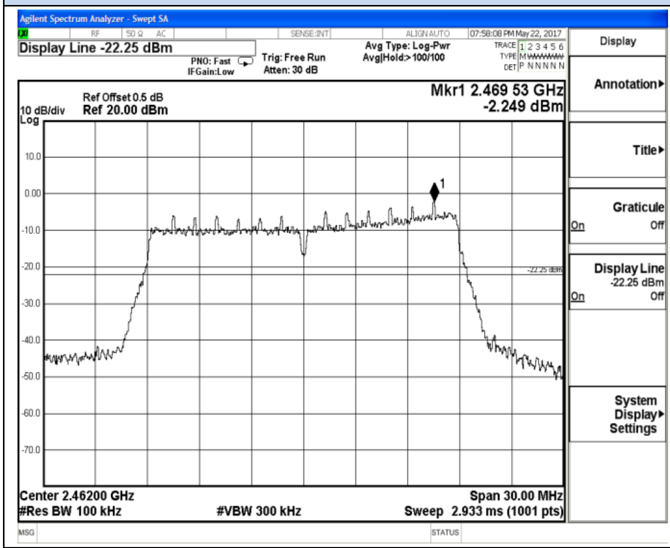
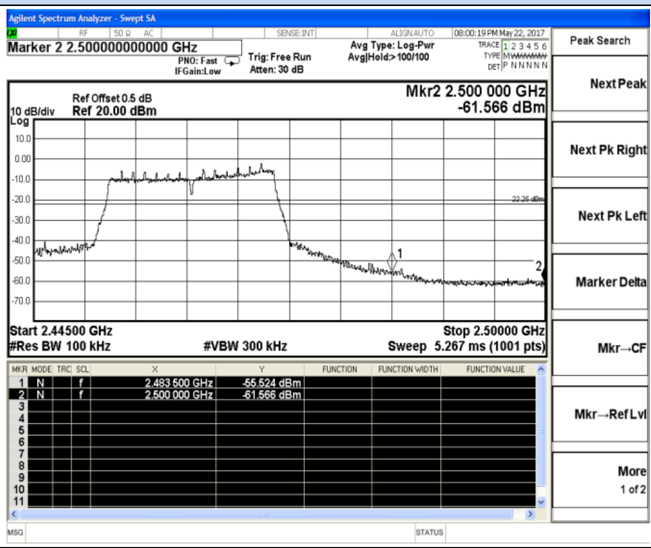
<tr><td>
</td><td>
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<tr><td>2447 MHz – 2477 MHz</td><td>Channel 11 / 2462 MHz</td></tr>
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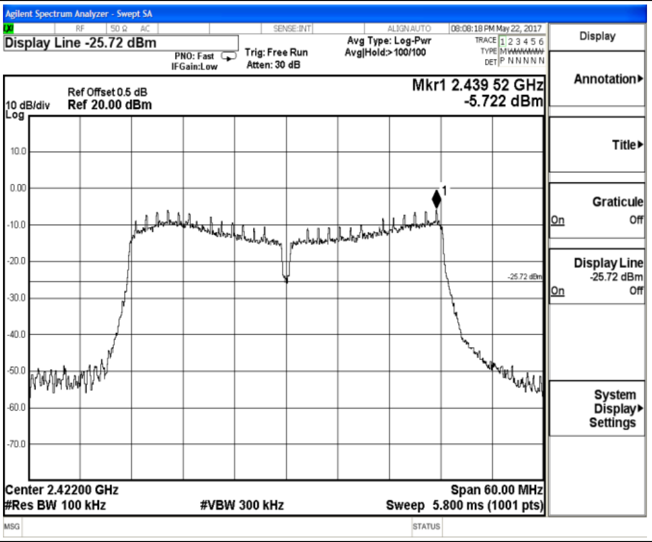
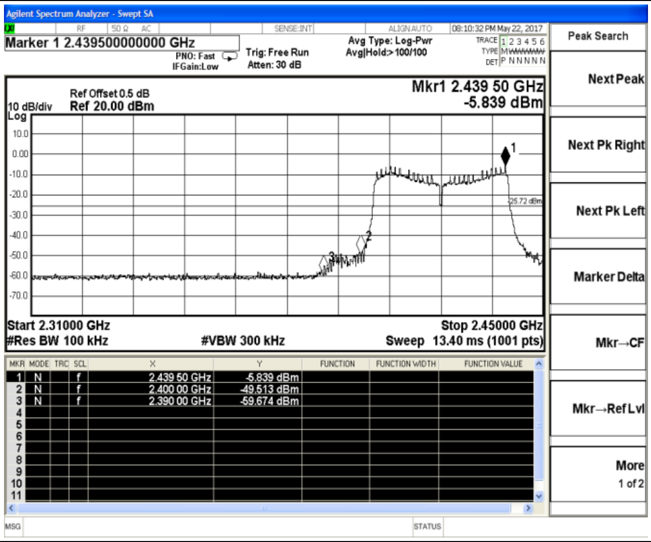
Band-edge measurements for conducted emissions

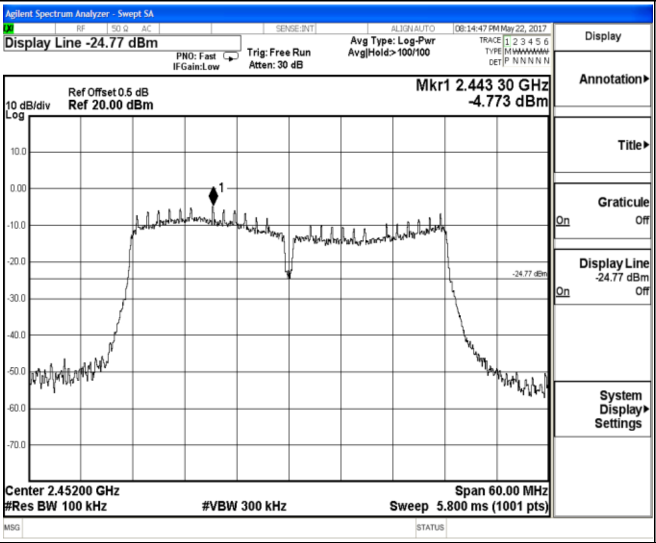
IEEE 802.11n HT40



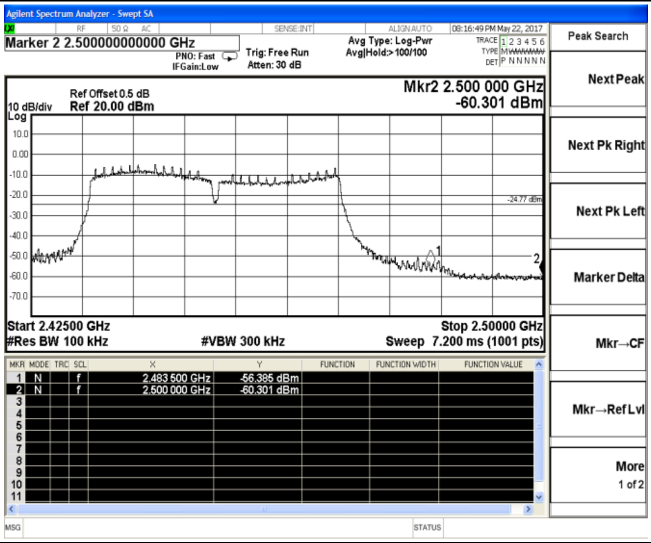
2392 MHz – 2452 MHz



Channel 3 / 2422 MHz



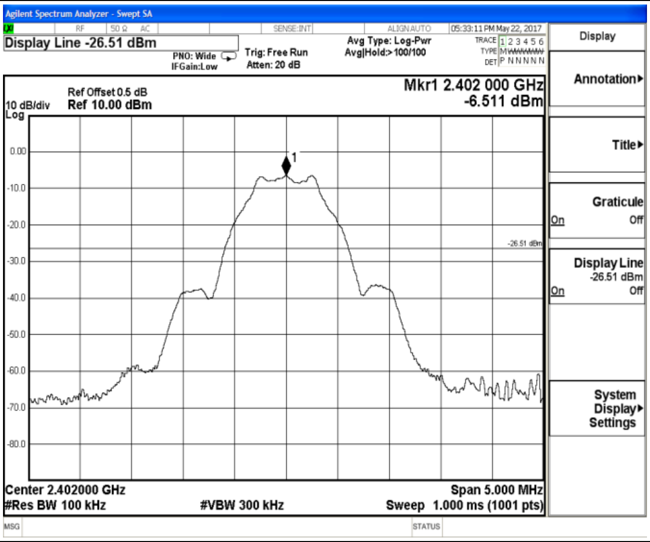
2422 MHz – 2482 MHz



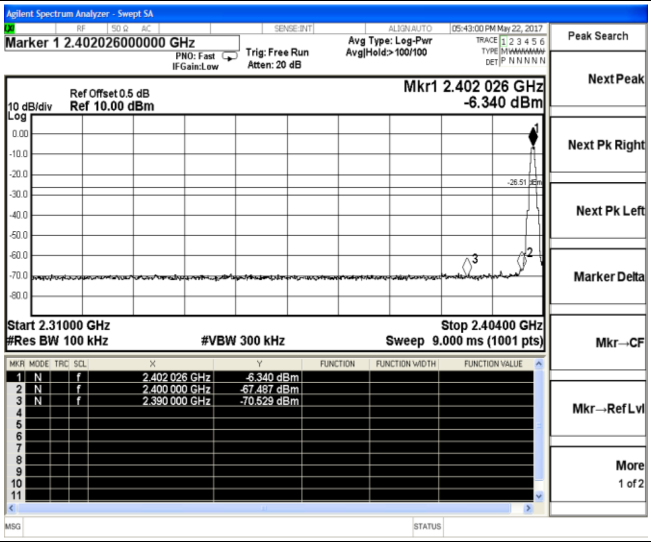
Channel 9 / 2452 MHz

Band-edge measurements for conducted emissions

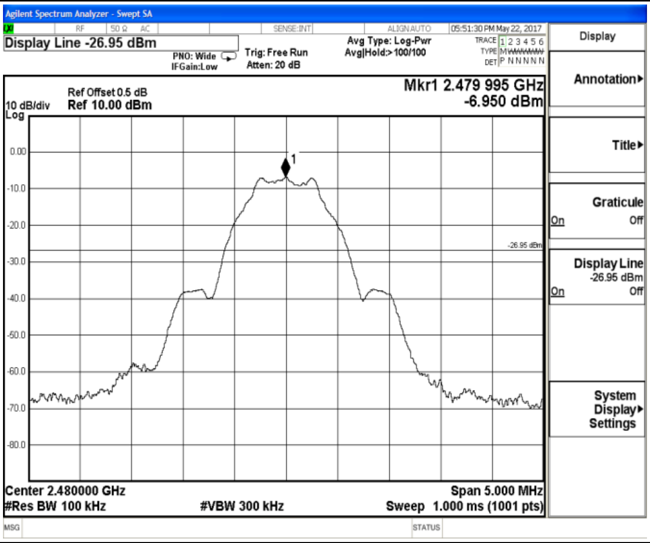
BT – LE



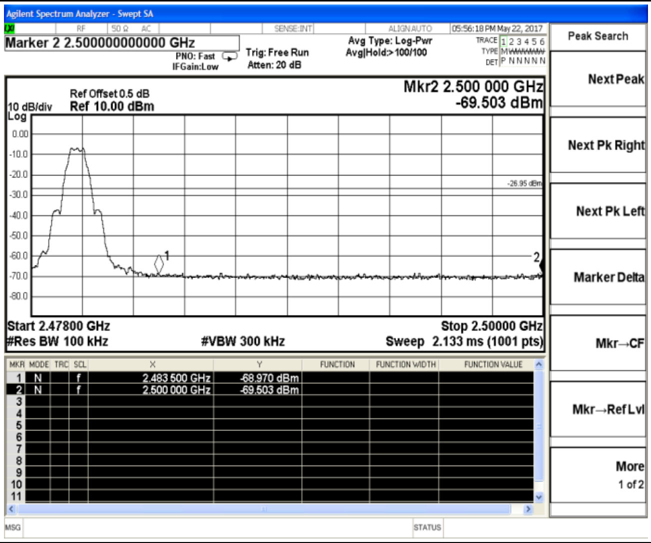
2399.5 MHz – 2404.5 MHz



Channel 0 / 2402 MHz



2477.5 MHz – 2482.5 MHz



Channel 39 / 2480 MHz

5.7. Power line conducted emissions

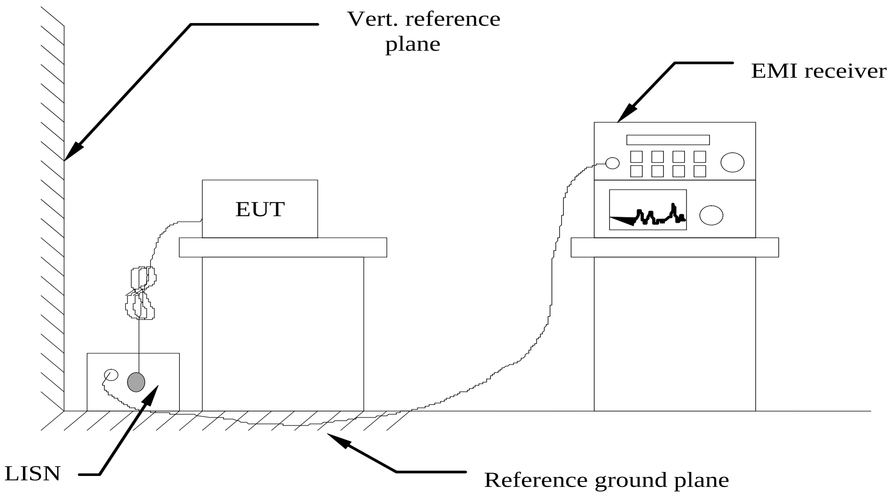
5.7.1 Standard Applicable

According to §15.207 (a): For an intentional radiator which is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range are listed as follows:

Frequency Range (MHz)	Limits (dBµV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

* Decreasing linearly with the logarithm of the frequency

5.7.2 Block Diagram of Test Setup



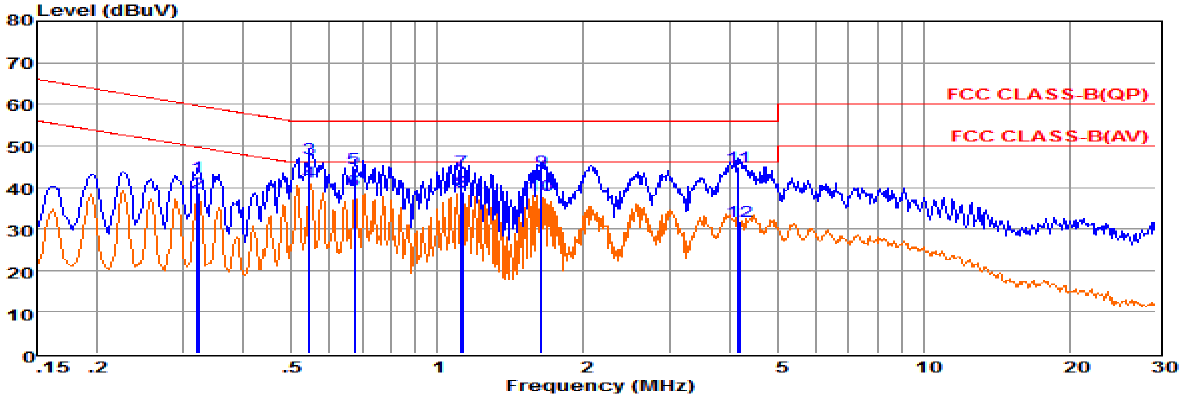
5.7.3 Test Results

PASS.

The test data please refer to following page.

AC Conducted Emission of power adapter @ AC 120V/60Hz @ IEEE 802.11b (worst case)

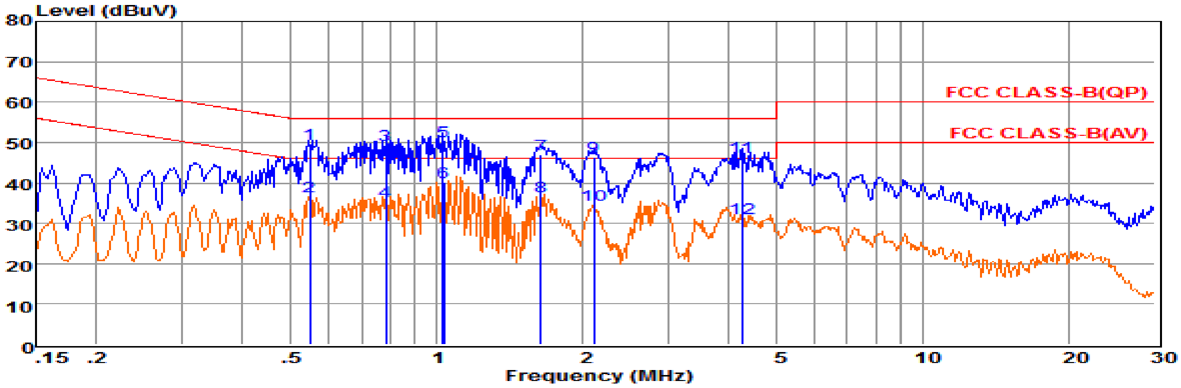
Line:



	Freq	Reading	LISNFac	CabLos	Aux2Fac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB	dB	dB	dBuV	dBuV	dB
1	0.32	22.87	9.62	0.03	10.00	42.52	59.66	-17.14	QP
2	0.32	18.88	9.62	0.03	10.00	38.53	49.66	-11.13	Average
3	0.55	27.37	9.63	0.04	10.00	47.04	56.00	-8.96	QP
4	0.55	21.55	9.63	0.04	10.00	41.22	46.00	-4.78	Average
5	0.68	24.99	9.64	0.04	10.00	44.67	56.00	-11.33	QP
6	0.68	19.52	9.64	0.04	10.00	39.20	46.00	-6.80	Average
7	1.12	24.24	9.63	0.05	10.00	43.92	56.00	-12.08	QP
8	1.12	19.34	9.63	0.05	10.00	39.02	46.00	-6.98	Average
9	1.64	24.18	9.64	0.05	10.00	43.87	56.00	-12.13	QP
10	1.64	18.36	9.64	0.05	10.00	38.05	46.00	-7.95	Average
11	4.16	25.31	9.65	0.06	10.00	45.02	56.00	-10.98	QP
12	4.16	12.00	9.65	0.06	10.00	31.71	46.00	-14.29	Average

Remarks: 1. Measured = Reading +Cable Loss +Aux2 Fac.
2. The emission levels that are 20dB below the official limit are not reported.

Neutral:



	Freq	Reading	LISNFac	CabLos	Aux2Fac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB	dB	dB	dBuV	dBuV	dB
1	0.55	30.09	9.62	0.04	10.00	49.75	56.00	-6.25	QP
2	0.55	16.86	9.62	0.04	10.00	36.52	46.00	-9.48	Average
3	0.79	29.75	9.63	0.04	10.00	49.42	56.00	-6.58	QP
4	0.79	15.61	9.63	0.04	10.00	35.28	46.00	-10.72	Average
5	1.03	30.69	9.63	0.05	10.00	50.37	56.00	-5.63	QP
6	1.03	20.38	9.63	0.05	10.00	40.06	46.00	-5.94	Average
7	1.64	27.37	9.63	0.05	10.00	47.05	56.00	-8.95	QP
8	1.64	16.88	9.63	0.05	10.00	36.56	46.00	-9.44	Average
9	2.11	26.66	9.63	0.05	10.00	46.34	56.00	-9.66	QP
10	2.11	14.86	9.63	0.05	10.00	34.54	46.00	-11.46	Average
11	4.25	26.78	9.65	0.06	10.00	46.49	56.00	-9.51	QP
12	4.25	11.45	9.65	0.06	10.00	31.16	46.00	-14.84	Average

Remarks: 1. Measured = Reading +Cable Loss +Aux2 Fac.
2. The emission levels that are 20dB below the official limit are not reported.

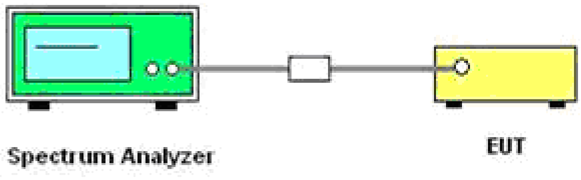
****Note: Pre-scan all modes and recorded the worst case results in this report (IEEE 802.11b).*

5.8. Restrict-band band-edge measurements for radiated emissions

5.8.1 Standard Applicable

Per the requirement of ANSI C63.10:2013 §6.10.5, Restricted-band band-edge tests shall be performed as radiated measurements, however, §12.7.2 that allowed a converted method from conducted measurement function

5.8.2. Test Setup Layout



5.8.3. Measuring Instruments and Setting

Please refer to section 6 of equipment list in this report. The following table is the setting of Spectrum Analyzer.

5.8.4. Test Procedures

According to KDB 558074 D01 v04 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=1/B for Peak 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:

$E = EIRP – 20\log D + 104.8$

Where:
E = electric field strength in dBμV/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 duress until all measured frequencies were complete.

5.8.5 Test Results

IEEE 802.11b							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
2310.000	-51.643	2.000	0.000	45.615	Peak	74.00	PASS
2310.000	-62.711	2.000	0.000	34.547	AV	54.00	PASS
2390.000	-50.012	2.000	0.000	47.246	Peak	74.00	PASS
2390.000	-61.690	2.000	0.000	35.568	AV	54.00	PASS
2483.500	-47.896	2.000	0.000	49.362	Peak	74.00	PASS
2483.500	-58.599	2.000	0.000	38.659	AV	54.00	PASS
2500.000	-52.428	2.000	0.000	44.830	Peak	74.00	PASS
2500.000	-62.381	2.000	0.000	34.877	AV	54.00	PASS

IEEE 802.11g							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
2310.000	-51.376	2.000	0.000	45.882	Peak	74.00	PASS
2310.000	-62.759	2.000	0.000	34.499	AV	54.00	PASS
2390.000	-51.100	2.000	0.000	46.158	Peak	74.00	PASS
2390.000	-61.992	2.000	0.000	35.266	AV	54.00	PASS
2483.500	-44.891	2.000	0.000	52.367	Peak	74.00	PASS
2483.500	-58.425	2.000	0.000	38.833	AV	54.00	PASS
2500.000	-51.227	2.000	0.000	46.031	Peak	74.00	PASS
2500.000	-62.426	2.000	0.000	34.832	AV	54.00	PASS

IEEE 802.11n HT20							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
2310.000	-51.291	2.000	0.000	45.967	Peak	74.00	PASS
2310.000	-62.691	2.000	0.000	34.567	AV	54.00	PASS
2390.000	-49.994	2.000	0.000	47.264	Peak	74.00	PASS
2390.000	-61.875	2.000	0.000	35.383	AV	54.00	PASS
2483.500	-43.582	2.000	0.000	53.676	Peak	74.00	PASS
2483.500	-58.028	2.000	0.000	39.230	AV	54.00	PASS
2500.000	-51.665	2.000	0.000	45.593	Peak	74.00	PASS
2500.000	-62.409	2.000	0.000	34.849	AV	54.00	PASS

IEEE 802.11n HT40							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
2310.000	-50.252	2.000	0.000	47.006	Peak	74.00	PASS
2310.000	-62.733	2.000	0.000	34.525	AV	54.00	PASS
2390.000	-44.757	2.000	0.000	52.501	Peak	74.00	PASS
2390.000	-61.288	2.000	0.000	35.970	AV	54.00	PASS
2483.500	-40.499	2.000	0.000	56.759	Peak	74.00	PASS
2483.500	-59.227	2.000	0.000	38.031	AV	54.00	PASS
2500.000	-50.951	2.000	0.000	46.307	Peak	74.00	PASS
2500.000	-62.381	2.000	0.000	34.877	AV	54.00	PASS

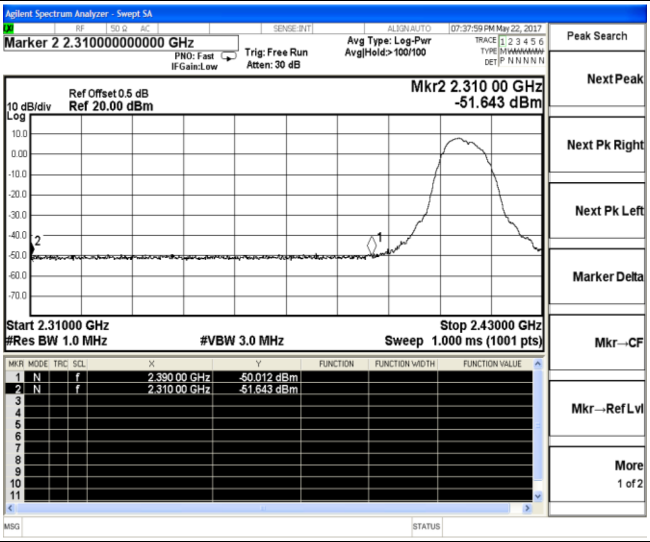
BT – LE							
Frequency (MHz)	Conducted Power (dBm)	Antenna Gain (dBi)	Ground Reflection Factor (dB)	Covert Radiated E Level At 3m (dBuV/m)	Detector	Limit (dBuV/m)	Verdict
2310.000	-60.849	2.000	0.000	36.409	Peak	74.00	PASS
2390.000	-60.168	2.000	0.000	37.090	Peak	74.00	PASS
2483.500	-59.965	2.000	0.000	37.293	Peak	74.00	PASS
2500.000	-61.984	2.000	0.000	35.274	Peak	74.00	PASS

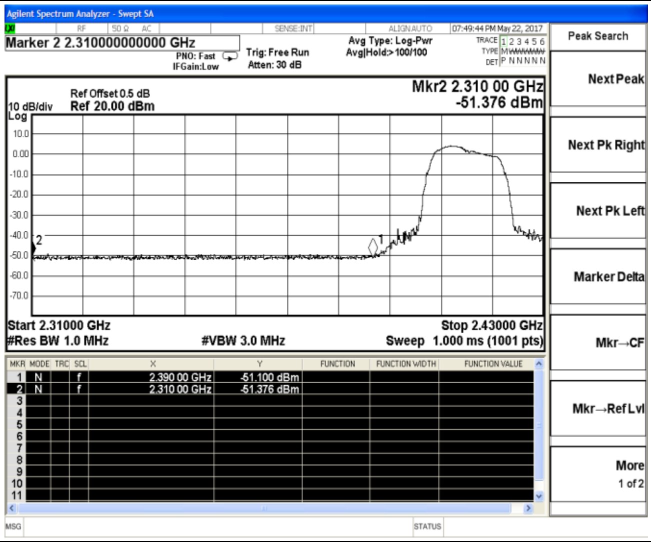
Remark:

1. *Measured Band edge measurement for radiated emission at difference data rate for each mode and recorded worst case for each mode.*
2. *Test results including cable loss;*
3. *Worst case data at 1Mbps at IEEE 802.11b; 6Mbps at IEEE 802.11g; 6.5Mbps at IEEE 802.11n HT20; 13.5Mbps at IEEE 802.11n HT40;*
4. *"---"means that the fundamental frequency not for 15.209 limits requirement.*
5. *Please refer to following plots;*

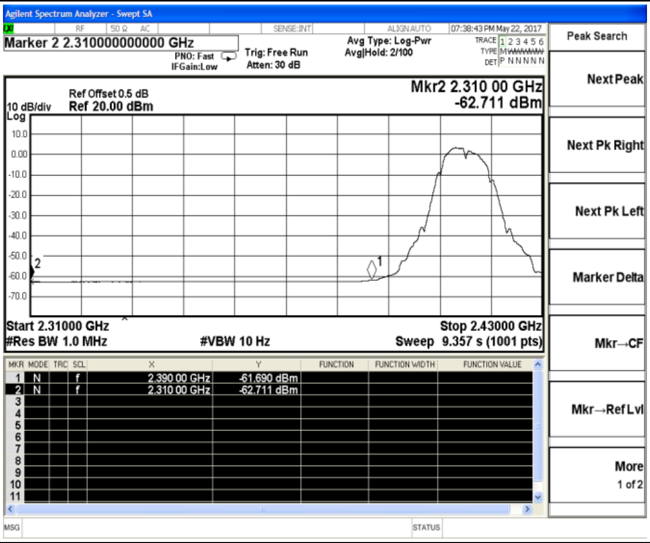
Restrict-band band-edge measurements for conducted emissions

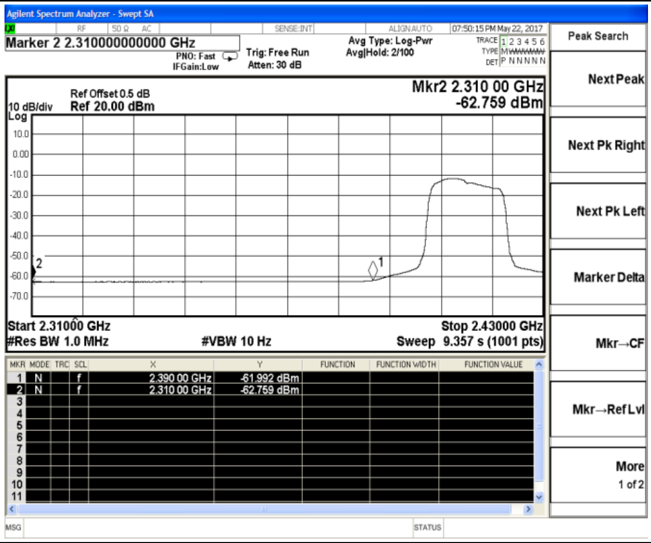
IEEE 802.11b	IEEE 802.11g



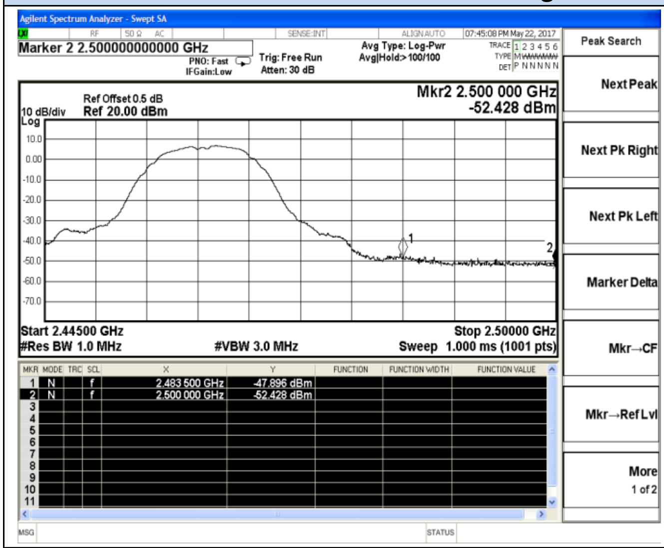


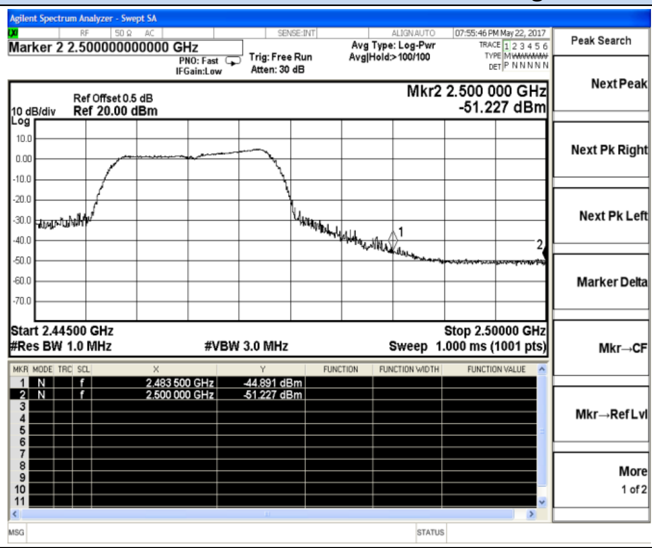
Channel 1 / 2412 MHz – Peak	Channel 1 / 2412 MHz – Peak



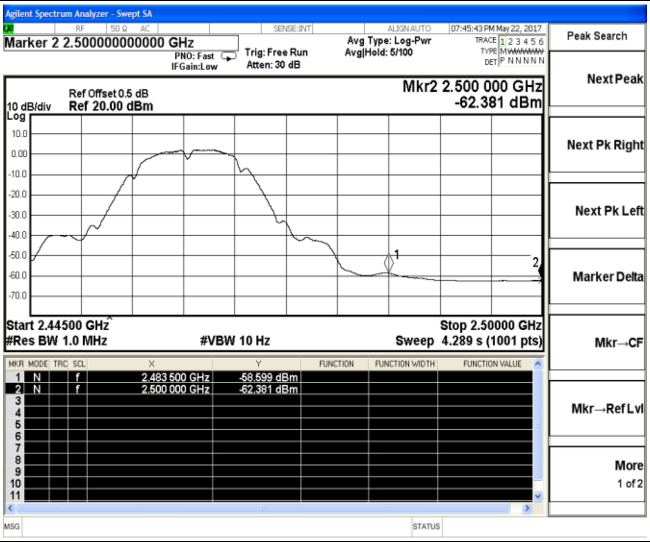
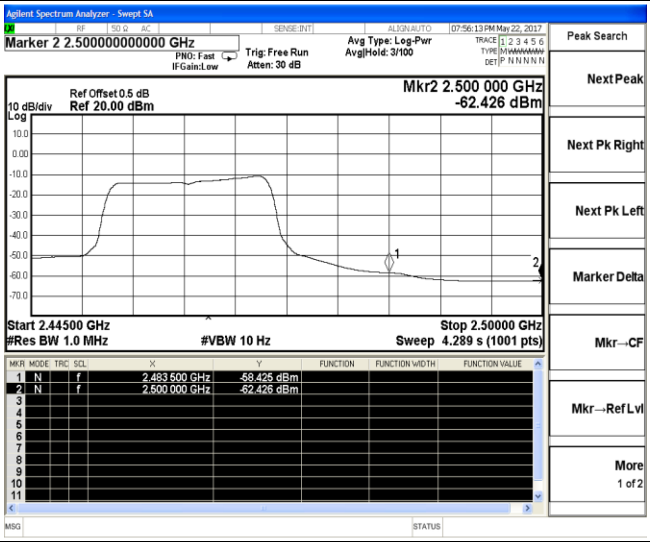
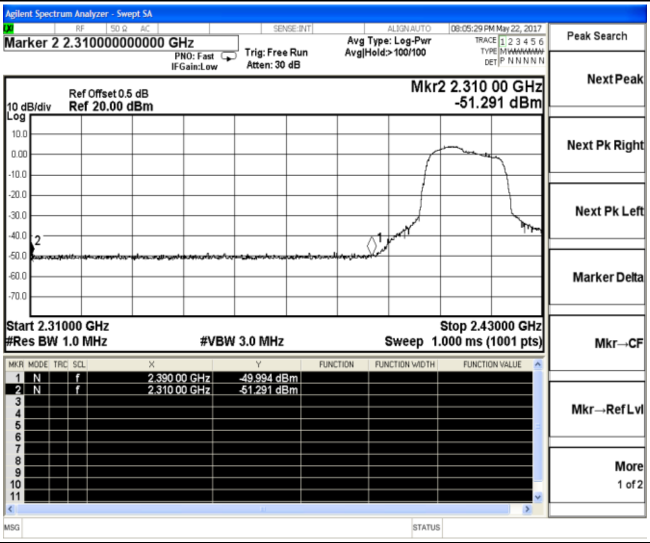
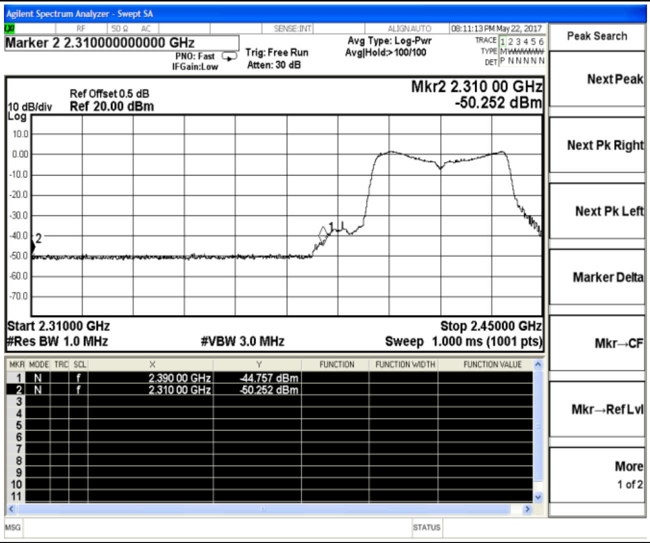
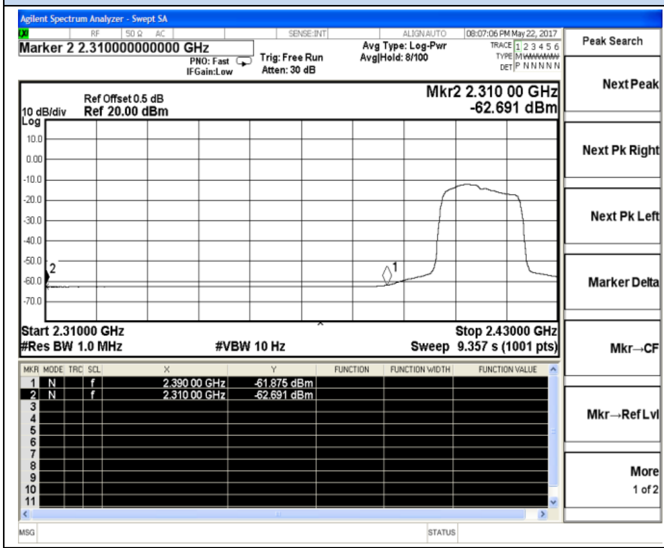
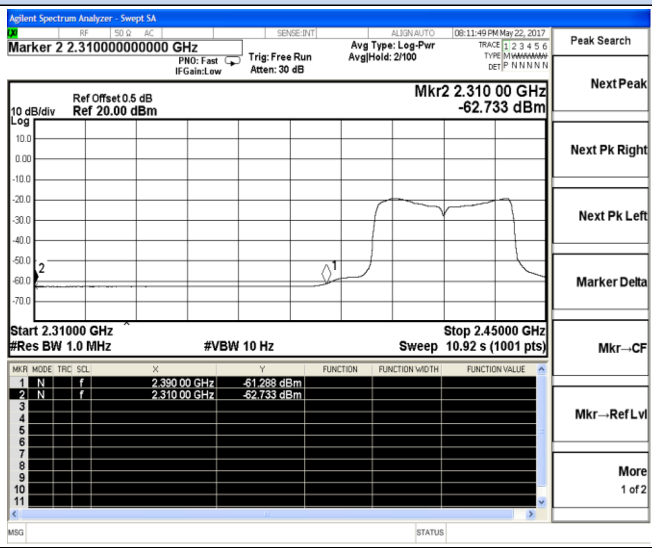


Channel 1 / 2412 MHz – Average	Channel 1 / 2412 MHz – Average



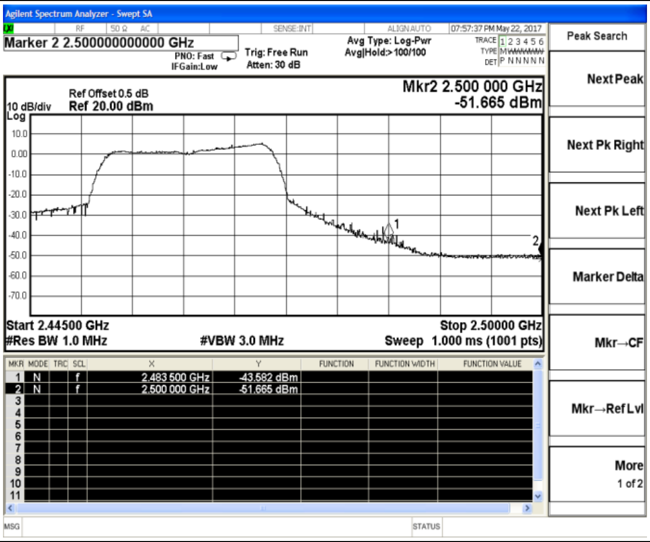


Channel 11 / 2412 MHz – Peak	Channel 11 / 2412 MHz – Peak

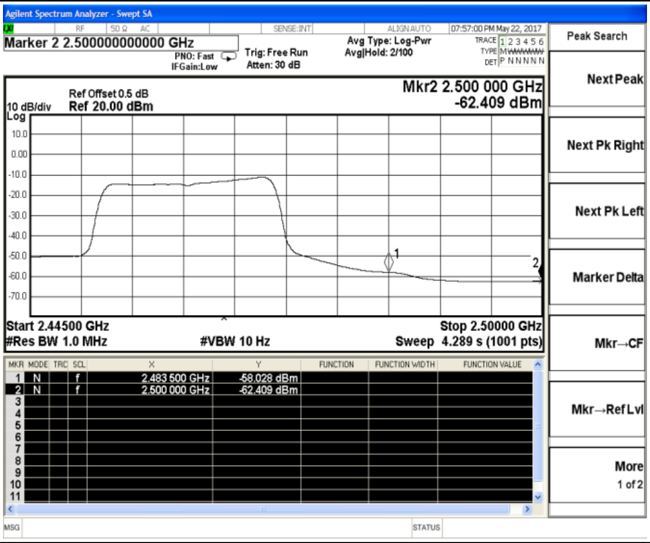
Restrict-band band-edge measurements for conducted emissions	
	
Channel 11 / 2412 MHz – Average	Channel 11 / 2412 MHz – Average
IEEE 802.11n HT20	IEEE 802.11n HT40
	
Channel 1 / 2412 MHz – Peak	Channel 3 / 2422 MHz – Peak
	
Channel 1 / 2412 MHz – Average	Channel 3 / 2422 MHz – Average

Restrict-band band-edge measurements for conducted emissions

IEEE 802.11n HT20

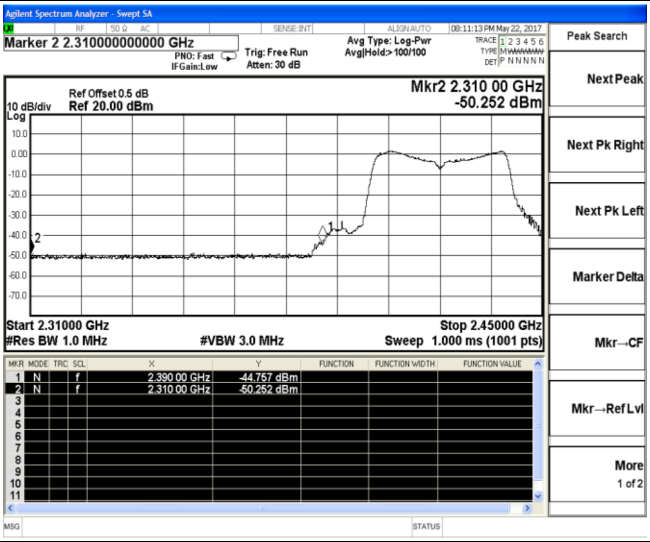


Channel 11 / 2462 MHz – Peak

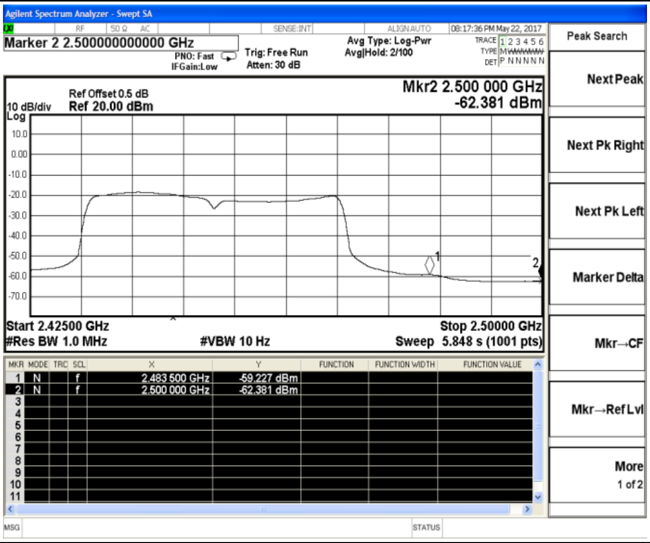


Channel 11 / 2462 MHz – Average

IEEE 802.11n HT40

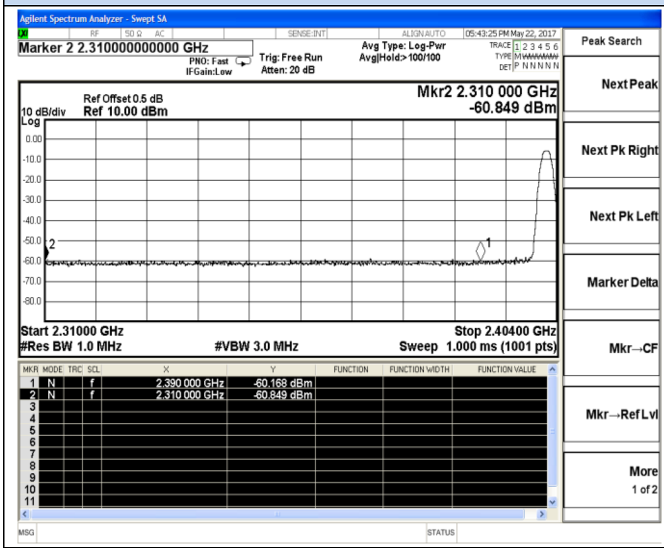


Channel 9 / 2452 MHz – Peak

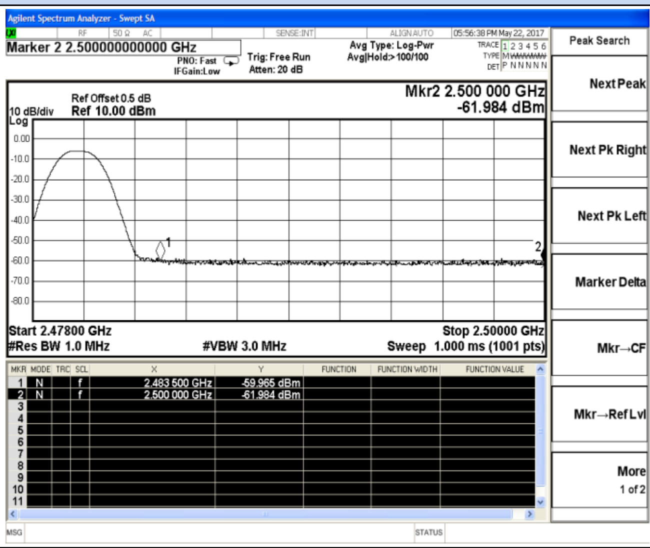


Channel 9 / 2452 MHz – Average

BT – LE



Channel 0 / 2402 MHz - Peak



Channel 39 / 2480 MHz - Peak

5.9. Antenna Requirements

5.9.1 Standard Applicable

According to antenna requirement of §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be re-placed by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

And according to §15.247(4)(1), system operating in the 2400-2483.5MHz bands that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

5.9.2 Antenna Connected Construction

5.9.2.1. Standard Applicable

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

5.9.2.2. Antenna Connector Construction

The directional gains of antenna used for transmitting is 2dBi, and the antenna is a PIFA antenna connect to PCB board and no consideration of replacement. Please see EUT photo for details.
The WLAN and BT share same antenna;

5.9.2.3. Results: Compliance.

Measurement

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.
Conducted power refers ANSI C63.10:2013 Output power test procedure for DTS devices.
Radiated power refers to ANSI C63.10:2013 Radiated emissions tests.

Measurement parameters

Measurement parameter	
Detector:	Peak
Sweep Time:	Auto
Resolution bandwidth:	1MHz
Video bandwidth:	3MHz
Trace-Mode:	Max hold

Limits

FCC	ISED
Antenna Gain	
6 dBi	

Note: The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module. For WLAN devices, the DSSS mode is used;

T_{nom}	V_{nom}	Lowest Channel 2412 MHz	Middle Channel 2437 MHz	Highest Channel 2462 MHz
Conducted power [dBm] Measured with DSSS modulation		7.078	6.914	6.977
Radiated power [dBm] Measured with DSSS modulation		7.515	1.952	8.039
Gain [dBi] Calculated		0.437	1.515	1.062
Measurement uncertainty			± 1.6 dB (cond.) / ± 3.8 dB (rad.)	

T_{nom}	V_{nom}	Lowest Channel 2402 MHz	Middle Channel 2440 MHz	Highest Channel 2480 MHz
Conducted power [dBm] Measured with DSSS modulation		-5.523	-2.571	-5.904
Radiated power [dBm] Measured with DSSS modulation		-5.220	-1.072	-5.057
Gain [dBi] Calculated		0.303	1.499	0.847
Measurement uncertainty			± 1.6 dB (cond.) / ± 3.8 dB (rad.)	

6. LIST OF MEASURING EQUIPMENTS

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
1	Power Sensor	R&S	NRV-Z81	100458	2016-06-18	2017-06-17
2	Power Sensor	R&S	NRV-Z32	10057	2016-06-18	2017-06-17
3	Power Meter	R&S	NRVS	100444	2016-06-18	2017-06-17
4	DC Filter	MPE	23872C	N/A	2016-06-18	2017-06-17
5	RF Cable	Harbour Industries	1452	N/A	2016-06-18	2017-06-17
6	SMA Connector	Harbour Industries	9625	N/A	2016-06-18	2017-06-17
7	Spectrum Analyzer	Agilent	N9020A	MY50510140	2016-10-27	2017-10-26
8	Signal analyzer	Agilent	E4448A(External mixers to 40GHz)	US44300469	2016-06-16	2017-06-15
9	RF Cable	Hubersuhne	Sucoflex104	FP2RX2	2016-06-18	2017-06-17
10	3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	2016-06-18	2017-06-17
11	Amplifier	SCHAFFNER	COA9231A	18667	2017-04-18	2018-04-17
12	Amplifier	Agilent	8449B	3008A02120	2017-04-18	2018-04-17
13	Amplifier	MITEQ	AMF-6F-260400	9121372	2017-04-18	2018-04-17
14	Loop Antenna	R&S	HFH2-Z2	860004/001	2017-04-18	2018-04-17
15	By-log Antenna	SCHWARZBECK	VULB9163	9163-470	2017-04-18	2018-04-17
16	Horn Antenna	EMCO	3115	6741	2017-04-18	2018-04-17
17	Horn Antenna	SCHWARZBECK	BBHA9170	BBHA9170154	2017-04-18	2018-04-17
18	RF Cable-R03m	Jye Bao	RG142	CB021	2016-06-18	2017-06-17
19	RF Cable-HIGH	SUHNER	SUCOFLEX 106	03CH03-HY	2016-06-18	2017-06-17
20	EMI Test Receiver	R&S	ESCI	101142	2016-06-18	2017-06-17
21	Artificial Mains	R&S	ENV216	101288	2016-06-18	2017-06-17
22	EMI Test Software	AUDIX	E3	N/A	2016-06-18	2017-06-17

7. TEST SETUP PHOTOGRAPHS OF EUT

Please refer to separated files for Test Setup Photos of the EUT.

8. EXTERIOR PHOTOGRAPHS OF THE EUT

Please refer to separated files for External Photos of the EUT.

9. INTERIOR PHOTOGRAPHS OF THE EUT

Please refer to separated files for Internal Photos of the EUT.

---------------THE END OF REPORT---------------