5.5. Radiated Emissions Measurement

5.5.1. Standard Applicable

15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
\1\ 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293.	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	(\2\)
13.36-13.41			

\1\ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

\2\ Above 38.6

According to §15.247 (d): 20dBc in any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the restricted band specified on 15.205(a), then the 15.209(a) limit in the table below has to be followed.

Frequencies (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009~0.490	2400/F(KHz)	300
0.490~1.705	24000/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

5.5.2. Measuring Instruments and Setting

Please refer to section 6 of equipments list in this report. The following table is the setting of spectrum analyzer and receiver.

Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RB / VB (Emission in restricted band)	1MHz / 1MHz for Peak, 1 MHz / 10Hz for Average
RB / VB (Emission in non-restricted band)	1MHz / 1MHz for Peak, 1 MHz / 10Hz for Average

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~150kHz / RB 200Hz for QP/AVG
Start ~ Stop Frequency	150kHz~30MHz / RB 9kHz for QP/AVG
Start ~ Stop Frequency	30MHz~1000MHz / RB 100kHz for QP

5.5.3. Test Procedures

1) Sequence of testing 9 kHz to 30 MHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 0.8 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions.

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna height is 0.8 meter.

--- At each turntable position the analyzer sweeps with peak detection to find the maximum of all emissions

Final measurement:

--- Identified emissions during the premeasurement the software maximizes by rotating the turntable position (0° to 360°) and by rotating the elevation axes (0° to 360°).

--- The final measurement will be done in the position (turntable and elevation) causing the highest emissions with QPK detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

2) Sequence of testing 30 MHz to 1 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height changes from 1 to 3 meter.

--- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter.

--- The final measurement will be done with QP detector with an EMI receiver.

--- The final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

3) Sequence of testing 1 GHz to 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 3 meter.

--- The EUT was set into operation.

Premeasurement:

--- The turntable rotates from 0° to 315° using 45° steps.

--- The antenna is polarized vertical and horizontal.

--- The antenna height scan range is 1 meter to 2.5 meter.

--- At each turntable position and antenna polarization the analyzer sweeps with peak detection to find the maximum of all emissions.

Final measurement:

--- The final measurement will be performed with minimum the six highest peaks.

--- According to the maximum antenna and turntable positions of premeasurement the software maximize the peaks by changing turntable position (± 45°) and antenna movement between 1 and 4 meter. This procedure is repeated for both antenna polarizations.

--- The final measurement will be done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement with marked maximum final measurements and the limit will be stored.

4) Sequence of testing above 18 GHz

Setup:

--- The equipment was set up to simulate a typical usage like described in the user manual or described by manufacturer.

--- If the EUT is a tabletop system, a rotatable table with 1.5 m height is used.

--- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.

--- Auxiliary equipment and cables were positioned to simulate normal operation conditions

--- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.

--- The measurement distance is 1 meter.

--- The EUT was set into operation.

Premeasurement:

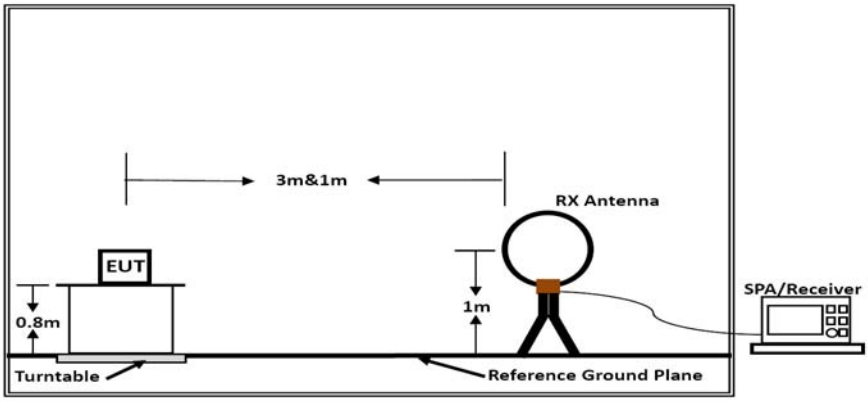
--- The antenna is moved spherical over the EUT in different polarisations of the antenna.

Final measurement:

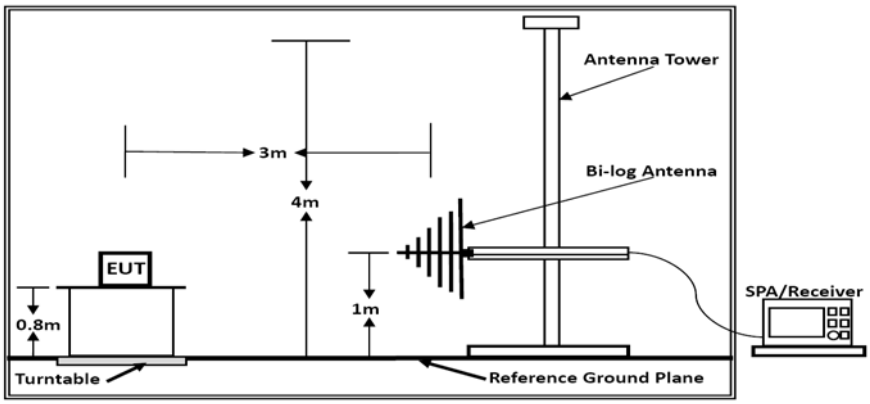
--- The final measurement will be performed at the position and antenna orientation for all detected emissions that were found during the premeasurements with Peak and Average detector.

--- The final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit will be recorded. Also a plot with the graph of the premeasurement and the limit will be stored.

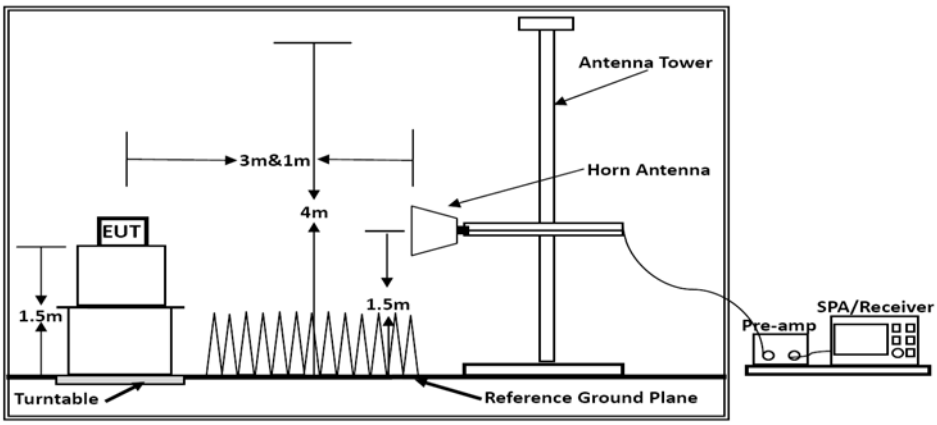
5.5.4. Test Setup Layout



Below 30MHz



Below 1GHz



Above 1GHz

Above 10 GHz shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade form 3m to 1.5m.

Distance extrapolation factor = 20 log (specific distanc [3m] / test distance [1.5m]) (dB);
Limit line = specific limits (dBuV) + distance extrapolation factor [6 dB].

5.5.5. EUT Operation during Test

The EUT was programmed to be in continuously transmitting mode.

5.5.6. Results of Radiated Emissions (9kHz~30MHz)

Temperature	25℃	Humidty	60%
Test Engineer	Chaz	Configurations	BT LE/802.11b/g/n

Freq. (MHz)	Level (dBuV)	Over Limit (dB)	Over Limit (dBuV)	Remark
-	-	-	-	See Note

Note:

The amplitude of spurious emissions which are attenuated by more than 20 dB below the permissible value has no need to be reported.

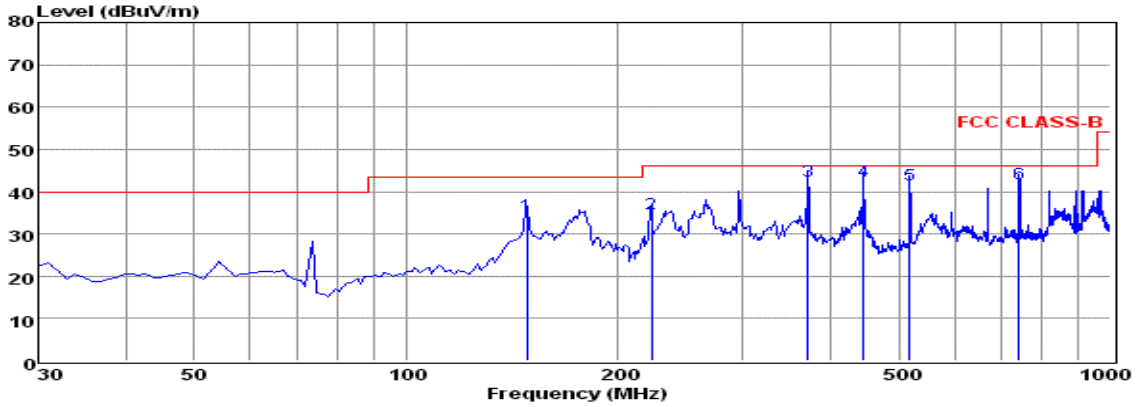
Distance extrapolation factor = 40 log (specific distance / test distance) (dB);
Limit line = specific limits (dBuV) + distance extrapolation factor.

5.5.7. Results of Radiated Emissions (30MHz~1GHz)

Temperature	25℃	Humidty	60%
Test Engineer	Chaz	Configurations	802.11b (Low CH)

Test result for 802.11b (Low Channel)

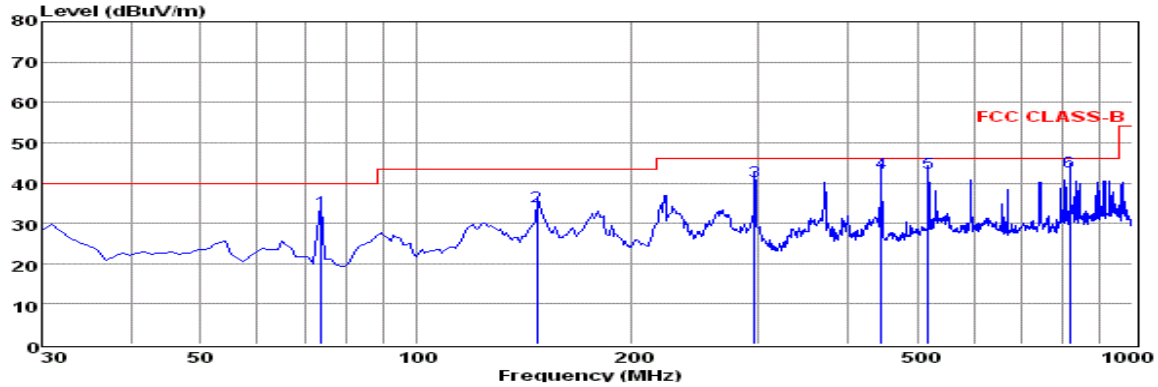
Horizontal:



	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	148.34	25.47	0.86	8.25	34.58	43.50	-8.92	QP
2	223.03	22.44	0.95	11.33	34.72	46.00	-11.28	QP
3	371.44	26.92	1.20	14.52	42.64	46.00	-3.36	QP
4	446.13	25.62	1.42	15.57	42.61	46.00	-3.39	QP
5	518.88	23.37	1.47	16.93	41.77	46.00	-4.23	QP
6	741.98	20.86	1.78	19.33	41.97	46.00	-4.03	QP

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that ate 20db blow the offficial limit are not reported

Vertical:



	Freq	Reading	CabLos	Antfac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB/m	dBuV/m	dBuV/m	dB	
1	73.65	24.54	0.54	8.03	33.11	40.00	-6.89	QP
2	147.37	25.16	0.86	8.24	34.26	43.50	-9.24	QP
3	296.75	26.42	1.12	13.00	40.54	46.00	-5.46	QP
4	446.13	25.58	1.42	15.57	42.57	46.00	-3.43	QP
5	518.88	24.00	1.47	16.93	42.40	46.00	-3.60	QP
6	817.64	20.90	1.79	20.24	42.93	46.00	-3.07	QP

Note: 1. All readings are Quasi-peak values.
2. Measured= Reading + Antenna Factor + Cable Loss
3. The emission that ate 20db blow the offficial limit are not reported

Note:

1). Pre-scan all mode and recorded the worst case results in this report (802.11b (Low Channel)@120VAC). Emission level (dBuV/m) = 20 log Emission level (uV/m).
2). Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level.

5.5.8. Results for Radiated Emissions (Above 1GHz)

Note: For BLE, only R-SMA antenna port is used, for 2.4GHz Wi-Fi, both antennas are used, and the main antenna(with R-SMA port) will refer to as ant0, the aux antenna(with FPC antenna) will refer to as ant1 below. For 2.4G Wi-Fi test result, only recorded the worst test data of ant 0.

BT LE

Channel 0

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4804.0	55.28	33.06	35.04	3.94	57.24	74	-16.76	Peak	Horizontal
4804.0	40.28	33.06	35.04	3.94	42.24	54	-11.76	Average	Horizontal
4804.0	59.10	33.06	35.04	3.94	61.06	74	-12.94	Peak	Vertical
4804.0	41.82	33.06	35.04	3.94	43.78	54	-10.22	Average	Vertical

Channel 19

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4880.0	55.23	33.16	35.15	3.96	57.20	74	-16.80	Peak	Horizontal
4880.0	44.20	33.16	35.15	3.96	46.17	54	-7.83	Average	Horizontal
4880.0	59.14	33.16	35.15	3.96	61.11	74	-12.89	Peak	Vertical
4880.0	42.28	33.16	35.15	3.96	44.25	54	-9.75	Average	Vertical

Channel 39

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4960.0	55.10	33.26	35.14	3.98	57.20	74	-16.80	Peak	Horizontal
4960.0	42.67	33.26	35.14	3.98	44.77	54	-9.23	Average	Horizontal
4960.0	58.64	33.26	35.14	3.98	60.74	74	-13.26	Peak	Vertical
4960.0	41.94	33.26	35.14	3.98	44.04	54	-9.96	Average	Vertical

802.11b

Channel 1

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4824.00	49.19	33.06	35.14	3.98	51.09	74	-22.91	Peak	Horizontal
4824.00	37.71	33.06	35.14	3.98	39.61	54	-14.39	Average	Horizontal
4824.00	51.84	33.06	35.14	3.98	53.74	74	-20.26	Peak	Vertical
4824.00	44.35	33.06	35.14	3.98	46.25	54	-7.75	Average	Vertical

Channel 6

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4874.00	47.05	33.16	35.15	3.96	49.02	74	-24.98	Peak	Horizontal
4874.00	38.17	33.16	35.15	3.96	40.14	54	-13.86	Average	Horizontal
4874.00	47.78	33.16	35.15	3.96	49.75	74	-24.25	Peak	Vertical
4874.00	40.39	33.16	35.15	3.96	42.36	54	-11.64	Average	Vertical

Channel 11

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4924.00	48.25	33.26	35.14	3.98	50.35	74	-23.65	Peak	Horizontal
4924.00	38.72	33.26	35.14	3.98	40.82	54	-13.18	Average	Horizontal
4924.00	48.64	33.26	35.14	3.98	50.74	74	-23.26	Peak	Vertical
4924.00	39.65	33.26	35.14	3.98	41.75	54	-12.25	Average	Vertical

802.11g

Channel 1

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4824.00	49.15	33.06	35.14	3.98	51.05	74	-22.95	Peak	Horizontal
4824.00	37.78	33.06	35.14	3.98	39.68	54	-14.32	Average	Horizontal
4824.00	52.05	33.06	35.14	3.98	53.95	74	-20.05	Peak	Vertical
4824.00	40.34	33.06	35.14	3.98	42.24	54	-11.76	Average	Vertical

Channel 6

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4874.00	46.83	33.16	35.15	3.96	48.80	74	-25.20	Peak	Horizontal
4874.00	37.64	33.16	35.15	3.96	39.61	54	-14.39	Average	Horizontal
4874.00	48.30	33.16	35.15	3.96	50.27	74	-23.73	Peak	Vertical
4874.00	41.62	33.16	35.15	3.96	43.59	54	-10.41	Average	Vertical

Channel 11

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4924.00	47.67	33.26	35.14	3.98	49.77	74	-24.23	Peak	Horizontal
4924.00	38.65	33.26	35.14	3.98	40.75	54	-13.25	Average	Horizontal
4924.00	48.63	33.26	35.14	3.98	50.73	74	-23.27	Peak	Vertical
4924.00	43.33	33.26	35.14	3.98	45.43	54	-8.57	Average	Vertical

802.11n HT20

Channel 1

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4824.00	49.29	33.06	35.14	3.98	51.19	74	-22.81	Peak	Horizontal
4824.00	37.69	33.06	35.14	3.98	39.59	54	-14.41	Average	Horizontal
4824.00	51.90	33.06	35.14	3.98	53.80	74	-20.20	Peak	Vertical
4824.00	39.78	33.06	35.14	3.98	41.68	54	-12.32	Average	Vertical

Channel 6

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4874.00	46.68	33.16	35.15	3.96	48.65	74	-25.35	Peak	Horizontal
4874.00	37.85	33.16	35.15	3.96	39.82	54	-14.18	Average	Horizontal
4874.00	48.11	33.16	35.15	3.96	50.08	74	-23.92	Peak	Vertical
4874.00	42.30	33.16	35.15	3.96	44.27	54	-9.73	Average	Vertical

Channel 11

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4924.00	47.95	33.26	35.14	3.98	50.05	74	-23.95	Peak	Horizontal
4924.00	38.76	33.26	35.14	3.98	40.86	54	-13.14	Average	Horizontal
4924.00	48.98	33.26	35.14	3.98	51.08	74	-22.92	Peak	Vertical
4924.00	42.70	33.26	35.14	3.98	44.80	54	-9.20	Average	Vertical

802.11n HT40

Channel 3

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4844.00	49.28	33.06	35.14	3.98	51.18	74	-22.82	Peak	Horizontal
4844.00	38.30	33.06	35.14	3.98	40.20	54	-13.80	Average	Horizontal
4844.00	51.98	33.06	35.14	3.98	53.88	74	-20.12	Peak	Vertical
4844.00	40.02	33.06	35.14	3.98	41.92	54	-12.08	Average	Vertical

Channel 6

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4874.00	47.01	33.16	35.15	3.96	48.98	74	-25.02	Peak	Horizontal
4874.00	37.67	33.16	35.15	3.96	39.64	54	-14.36	Average	Horizontal
4874.00	47.97	33.16	35.15	3.96	49.94	74	-24.06	Peak	Vertical
4874.00	42.36	33.16	35.15	3.96	44.33	54	-9.67	Average	Vertical

Channel 9

Freq. MHz	Reading dBuv	Ant. Fac. dB/m	Pre. Fac. dB	Cab. Loss dB	Measured dBuv/m	Limit dBuv/m	Margin dB	Remark	Pol.
4904.00	48.06	33.26	35.14	3.98	50.16	74	-23.84	Peak	Horizontal
4904.00	39.32	33.26	35.14	3.98	41.42	54	-12.58	Average	Horizontal
4904.00	48.62	33.26	35.14	3.98	50.72	74	-23.28	Peak	Vertical
4904.00	43.27	33.26	35.14	3.98	45.37	54	-8.63	Average	Vertical

Notes:

1). Measuring frequencies from 9k~10th harmonic or 26.5GHz (which is less), No emission found between lowest internal used/generated frequency to 30MHz.
2). Radiated emissions measured in frequency range from 9k~10th harmonic or 26.5GHz (which is less) were made with an instrument using Peak detector mode.
3). Data of measurement within this frequency range shown " --- " in the table above means the reading of emissions are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.

5.5.9. Results of Restricted Bands Test

Note: For BLE, only R-SMA antenna port is used, for 2.4GHz Wi-Fi, both antennas are used, and the main antenna(with R-SMA port) will refer to as ant0, the aux antenna(with FPC antenna) will refer to as ant1 below. For 2.4G Wi-Fi test result, only recorded the worst test data of ant 0.

802.11b (radiated-calculated)						
Freq. MHz	Reading Level dBm	Antenna Gain dBi	Calculated E dBuV/m	Limit dBuV/m	Margin dB	Remark
2310.000	-50.52	2.50	47.21	74.00	-26.79	Peak
2310.000	-60.06	2.50	37.67	54.00	-16.33	Average
2390.000	-49.08	2.50	48.65	74.00	-25.35	Peak
2390.000	-58.75	2.50	38.98	54.00	-15.02	Average
2483.500	-47.67	2.50	50.06	74.00	-23.94	Peak
2483.500	-57.77	2.50	39.96	54.00	-14.04	Average
2500.000	-50.34	2.50	47.39	74.00	-26.61	Peak
2500.000	-59.52	2.50	38.21	54.00	-15.79	Average

802.11g (radiated-calculated)						
Freq. MHz	Reading Level dBm	Antenna Gain dBi	Calculated E dBuV/m	Limit dBuV/m	Margin dB	Remark
2310.000	-49.25	2.50	48.48	74.00	-25.52	Peak
2310.000	-59.61	2.50	38.12	54.00	-15.88	Average
2390.000	-47.28	2.50	50.45	74.00	-23.55	Peak
2390.000	-57.89	2.50	39.84	54.00	-14.16	Average
2483.500	-40.69	2.50	57.04	74.00	-16.96	Peak
2483.500	-54.64	2.50	43.09	54.00	-10.91	Average
2500.000	-50.30	2.50	47.43	74.00	-26.57	Peak
2500.000	-58.80	2.50	38.93	54.00	-15.07	Average

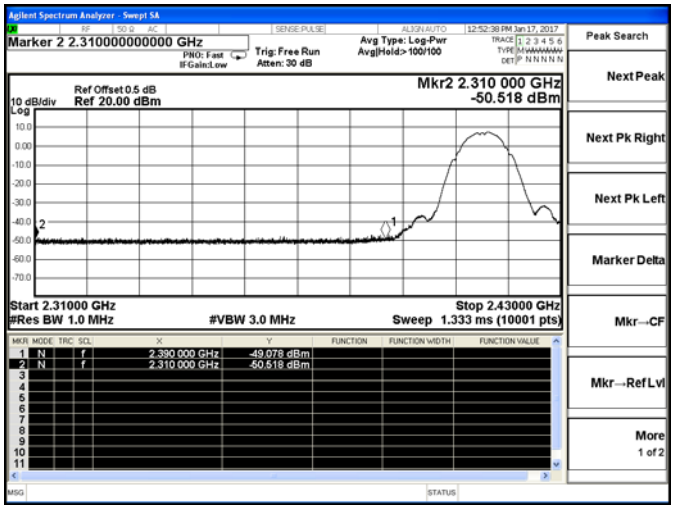
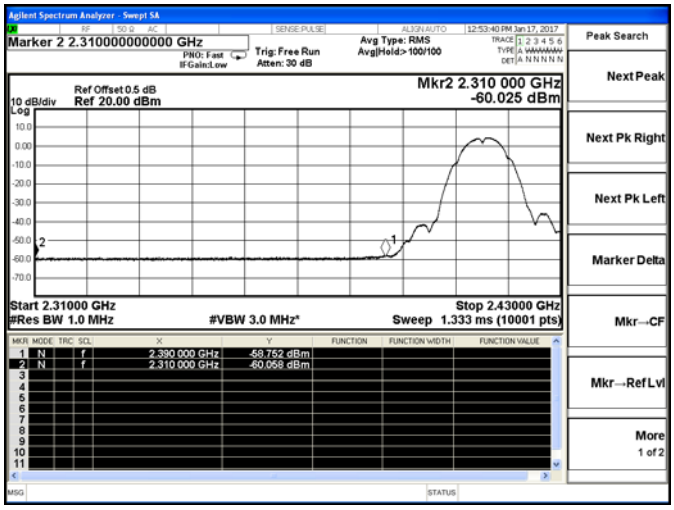
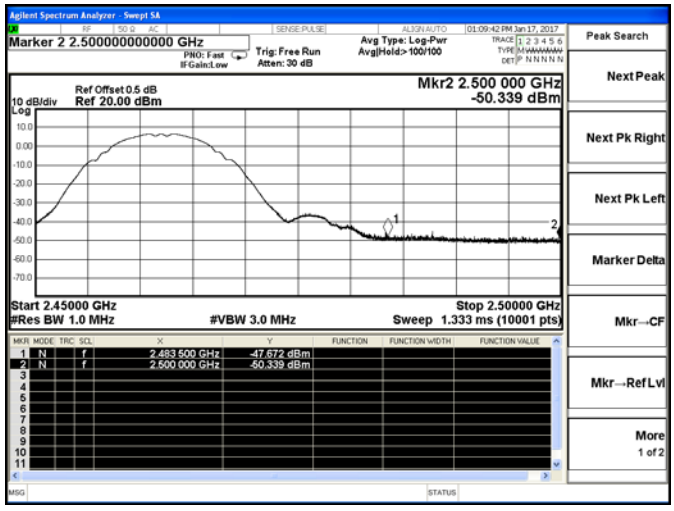
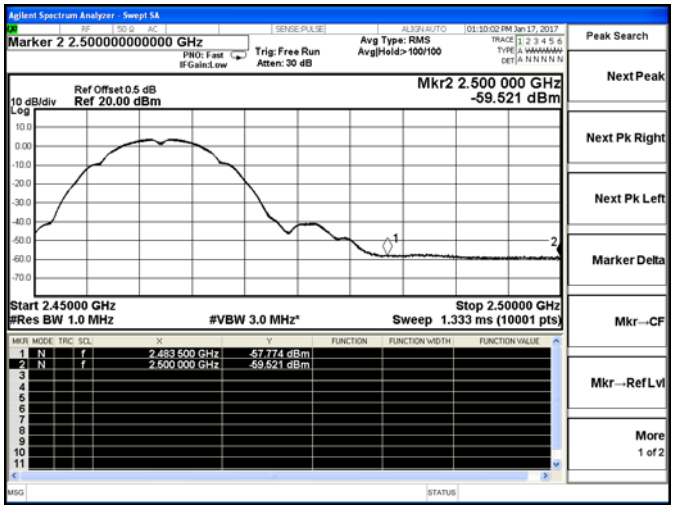
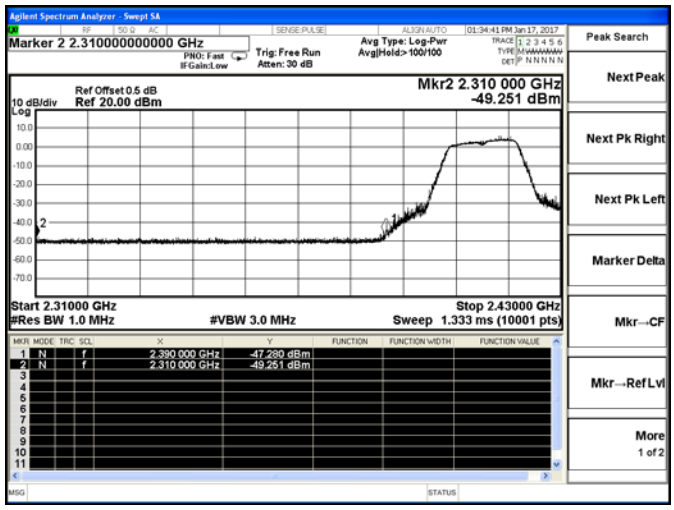
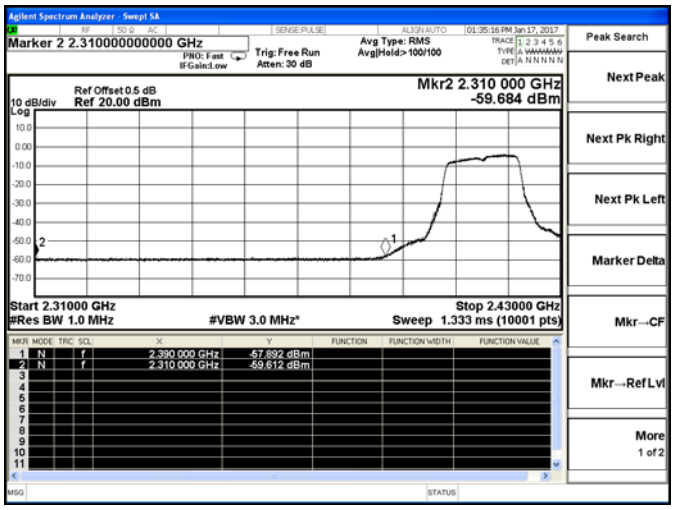
802.11n(HT20) (radiated-calculated)						
Freq. MHz	Reading Level dBm	Antenna Gain dBi	Calculated E dBuV/m	Limit dBuV/m	Margin dB	Remark
2310.000	-50.15	2.50	47.58	74.00	-26.42	Peak
2310.000	-59.78	2.50	37.95	54.00	-16.05	Average
2390.000	-47.42	2.50	50.31	74.00	-23.69	Peak
2390.000	-57.05	2.50	40.68	54.00	-13.32	Average
2483.500	-40.43	2.50	57.30	74.00	-16.70	Peak
2483.500	-52.24	2.50	45.49	54.00	-8.51	Average
2500.000	-50.12	2.50	47.61	74.00	-26.39	Peak
2500.000	-58.92	2.50	38.81	54.00	-15.19	Average

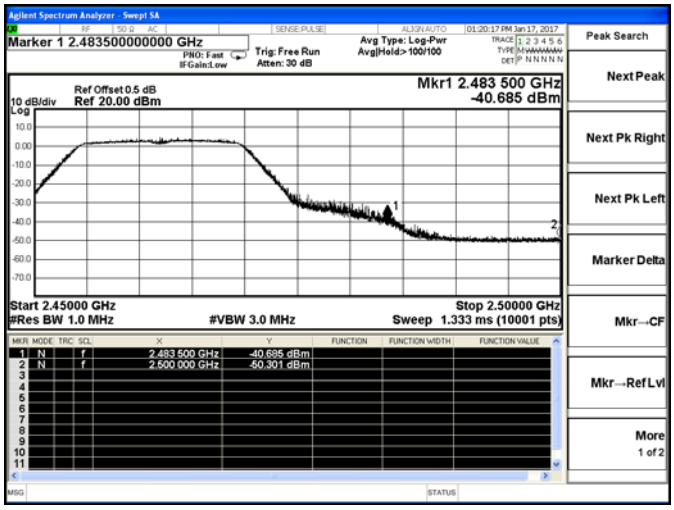
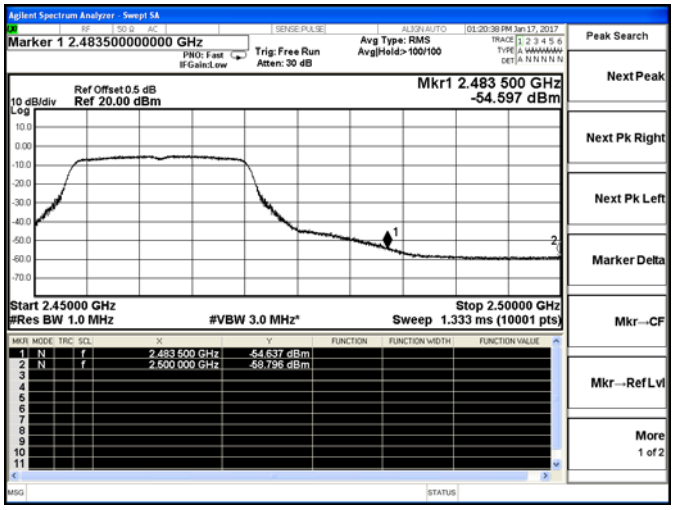
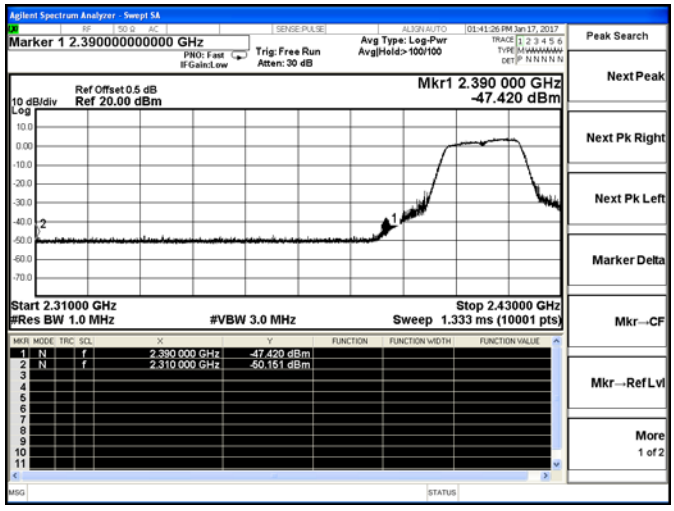
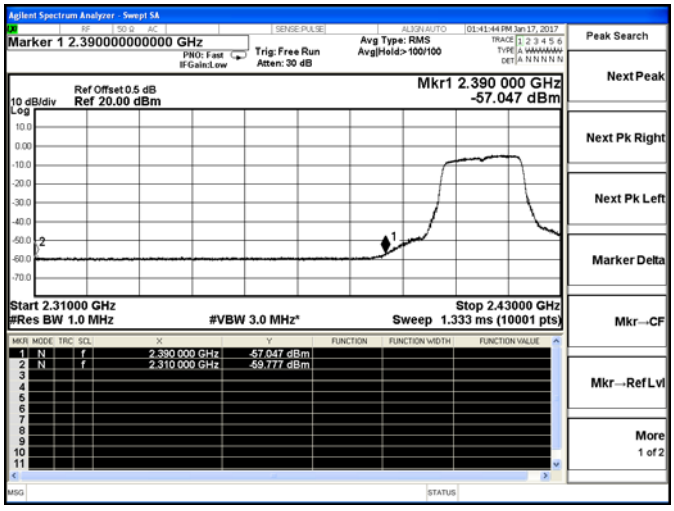
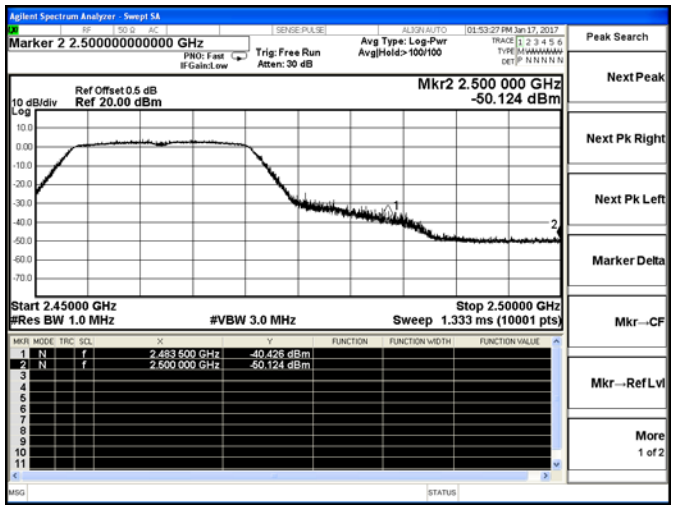
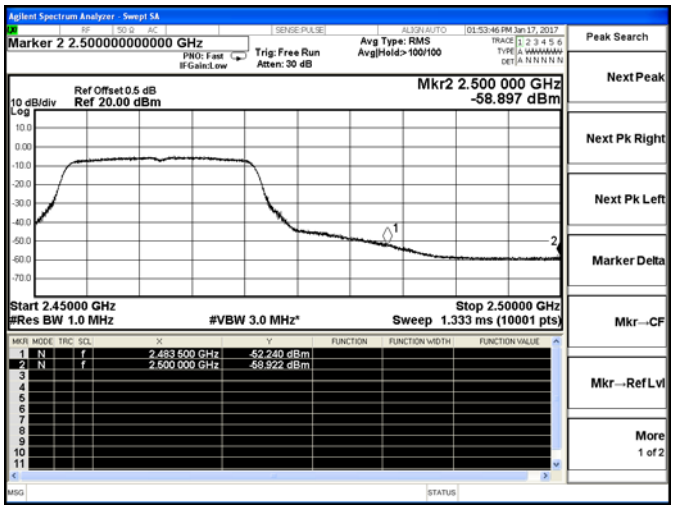
802.11n(HT40) (radiated-calculated)						
Freq. MHz	Reading Level dBm	Antenna Gain dBi	Calculated E dBuV/m	Limit dBuV/m	Margin dB	Remark
2310.000	-50.58	2.50	47.15	74.00	-26.85	Peak
2310.000	-60.16	2.50	37.57	54.00	-16.43	Average
2390.000	-40.53	2.50	57.20	74.00	-16.80	Peak
2390.000	-54.31	2.50	43.42	54.00	-10.58	Average
2483.500	-34.14	2.50	63.59	74.00	-10.41	Peak
2483.500	-46.54	2.50	51.19	54.00	-2.81	Average
2500.000	-50.14	2.50	47.59	74.00	-26.41	Peak
2500.000	-59.52	2.50	38.21	54.00	-15.79	Average

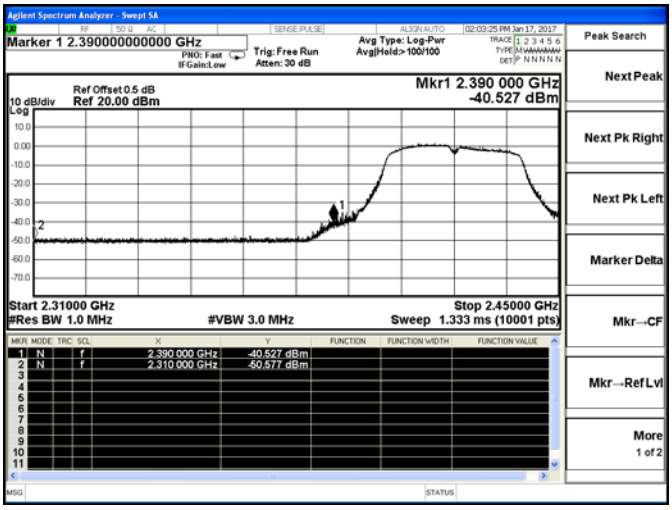
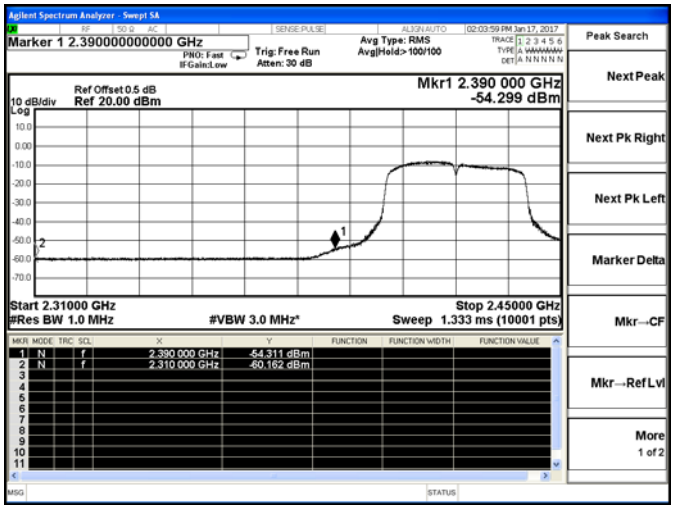
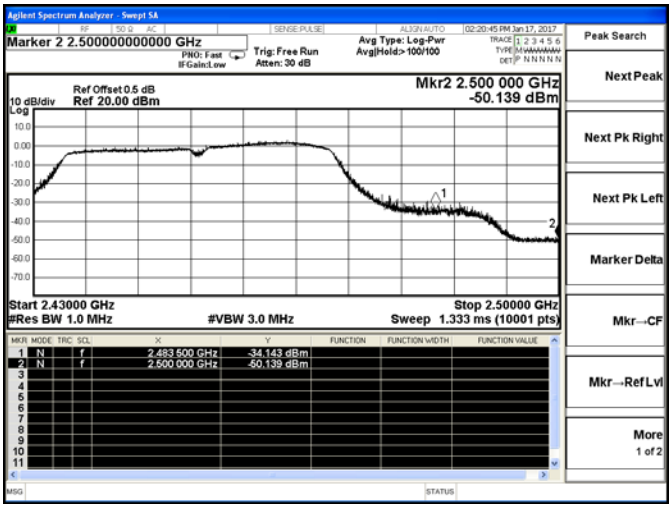
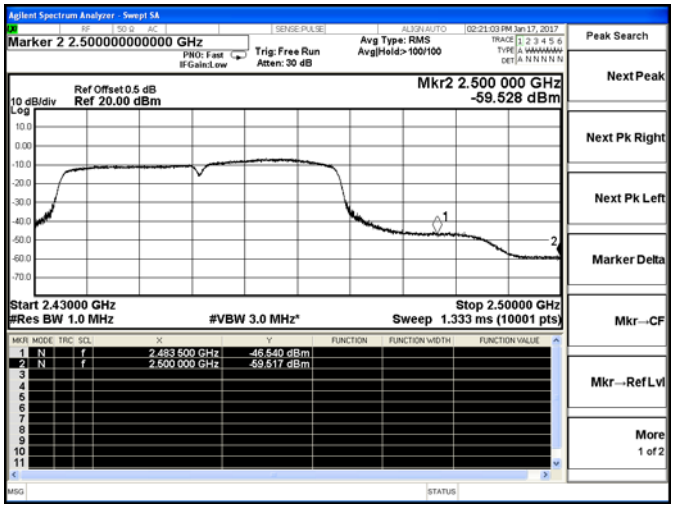
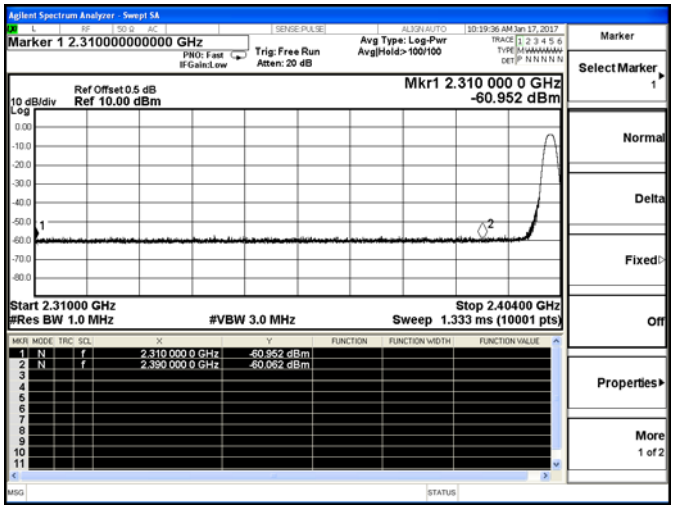
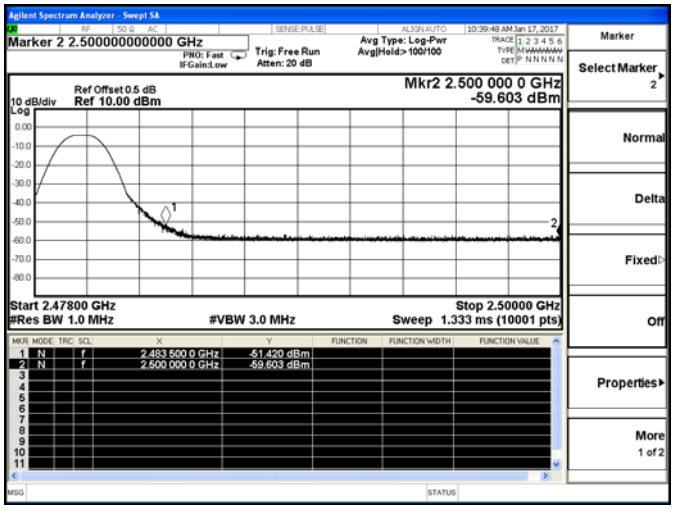
BT LE (radiated-calculated)						
Freq. MHz	Reading Level dBm	Antenna Gain dBi	Calculated E dBuV/m	Limit dBuV/m	Margin dB	Remark
2310.000	-60.95	2.50	36.78	74.00	-37.22	Peak
2390.000	-60.06	2.50	37.67	74.00	-36.33	Peak
2483.500	-51.42	2.50	46.31	74.00	-27.69	Peak
2500.000	-59.60	2.50	38.13	74.00	-35.87	Peak

Note:

1). All modes have been tested and we only record the worst test result;
2). Measured E=Reading Level+Antenna Gain+104.77-(20LogD), Where D is 3

Test plot of Restricted Bands (conducted)	
	
802.11b-Low channel(Peak)	802.11b-Low channel(Average)
	
802.11b-High channel(Peak)	802.11b-High channel(Average)
	
802.11g-Low channel(Peak)	802.11g-Low channel(Average)

Test plot of Restricted Bands (conducted)	
	
802.11g-High channel(Peak)	802.11g-High channel(Average)
	
802.11n(HT20)-Low channel(Peak)	802.11n(HT20)-Low channel(Average)
	
802.11n(HT20)-High channel(Peak)	802.11n(HT20)-High channel(Average)

Test plot of Restricted Bands (conducted)	
	
802.11n(HT40)-Low channel(Peak)	802.11n(HT40)-Low channel(Average)
	
802.11n(HT40)-High channel(Peak)	802.11n(HT40)-High channel(Average)
Test plot of Restricted Bands	
	
BT LE-Low channel(Peak)	BT LE-High channel(Peak)

5.6. Conducted Spurious Emissions and Band Edges Test

5.6.1. Standard Applicable

According to §15.247 (d): 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. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

5.6.2. Measuring Instruments and Setting

Please refer to section 6 of equipments list in this report. The following table is the setting of the spectrum analyzer.

Spectrum Parameter	Setting
Detector	Peak
Attenuation	Auto
RB / VB (Emission in restricted band)	100KHz/300KHz
RB / VB (Emission in non-restricted band)	100KHz/300KHz

5.6.3. Test Procedures

The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz

The spectrum from 9kHz to 26.5GHz is investigated with the transmitter set to the lowest,middle, and highest channels.

5.6.4. Test Setup Layout

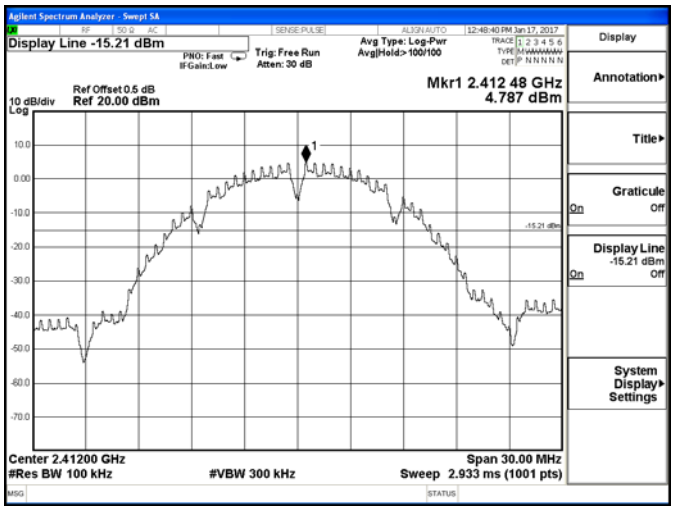
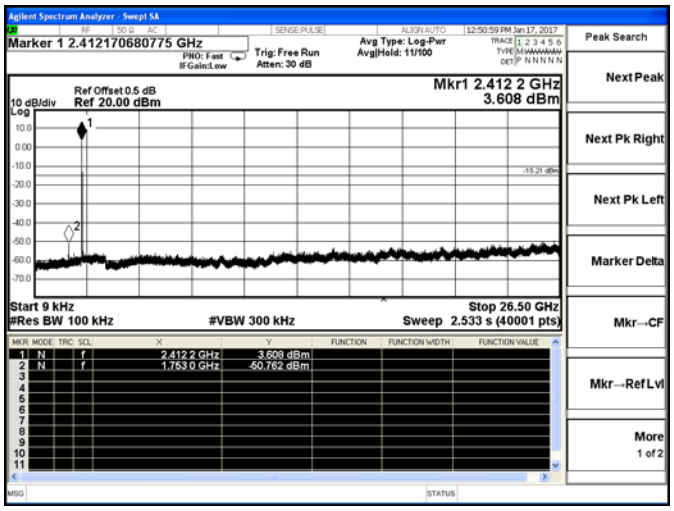
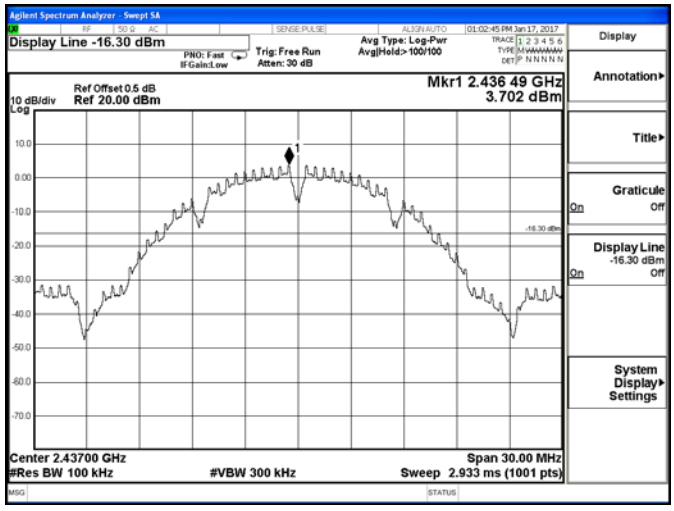
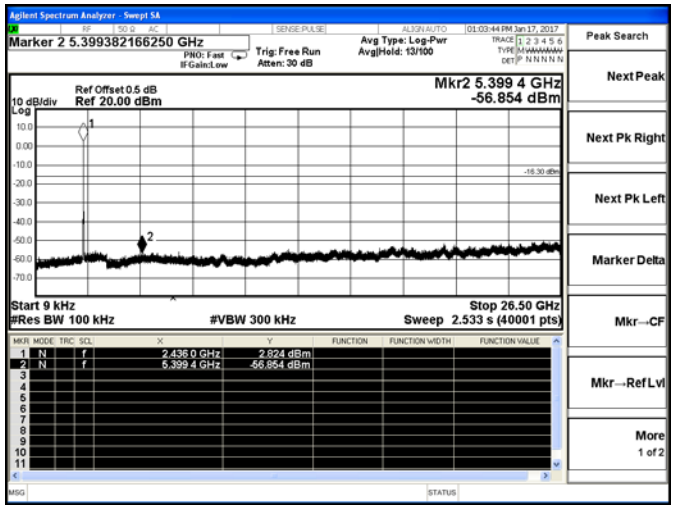
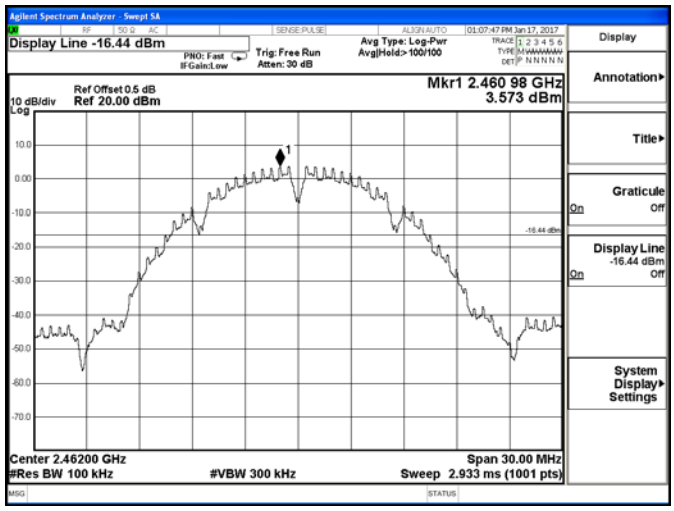
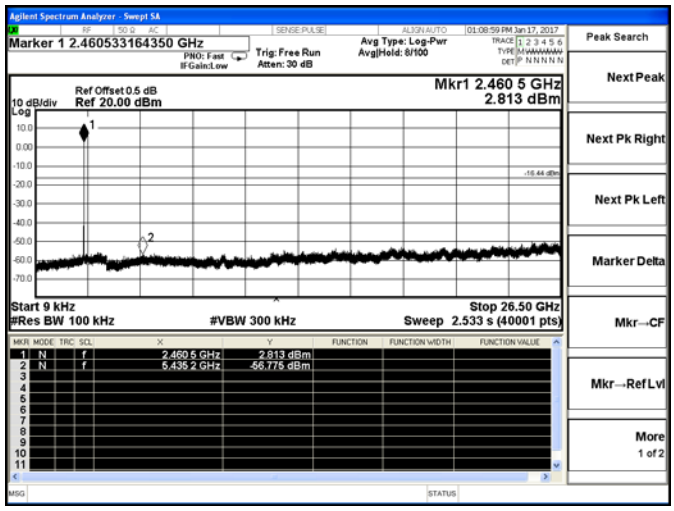
This test setup layout is the same as that shown in section 5.4.4.

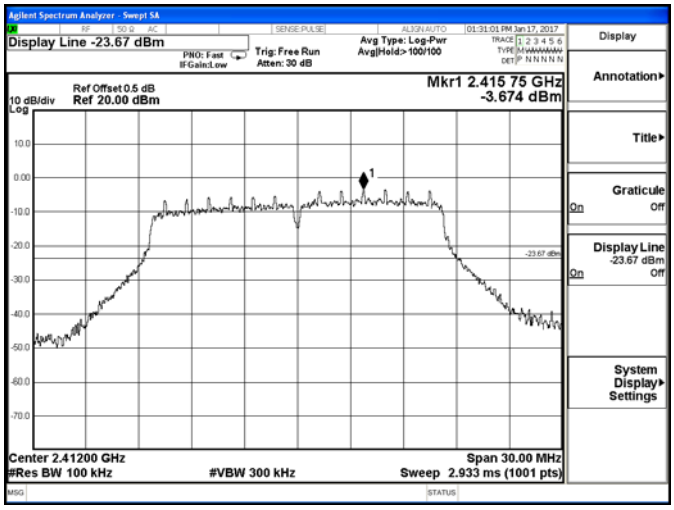
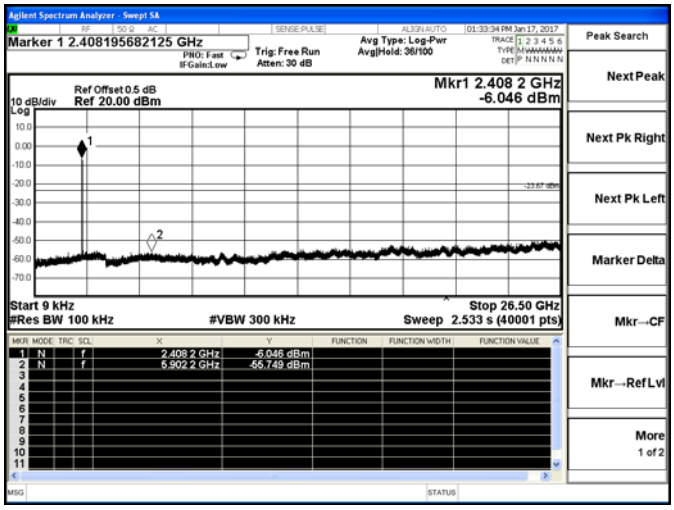
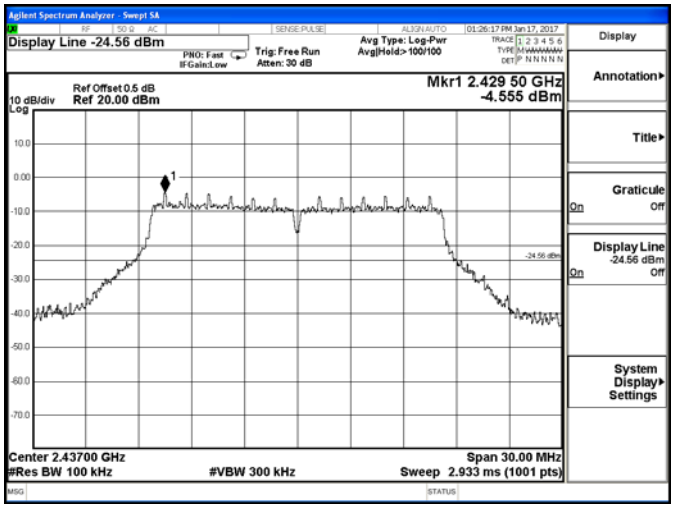
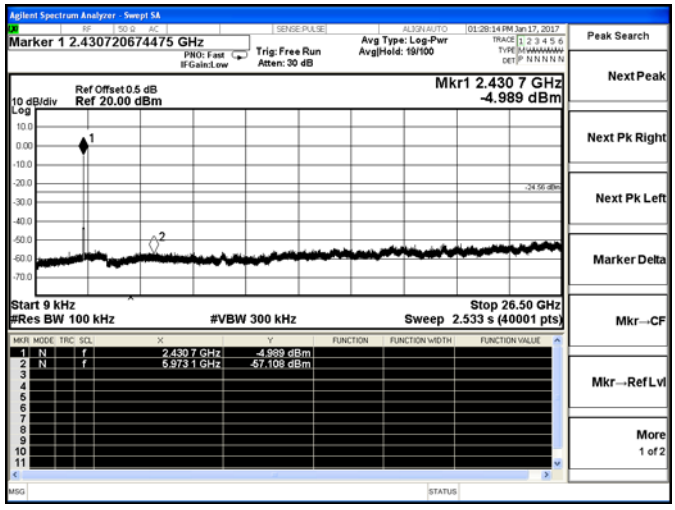
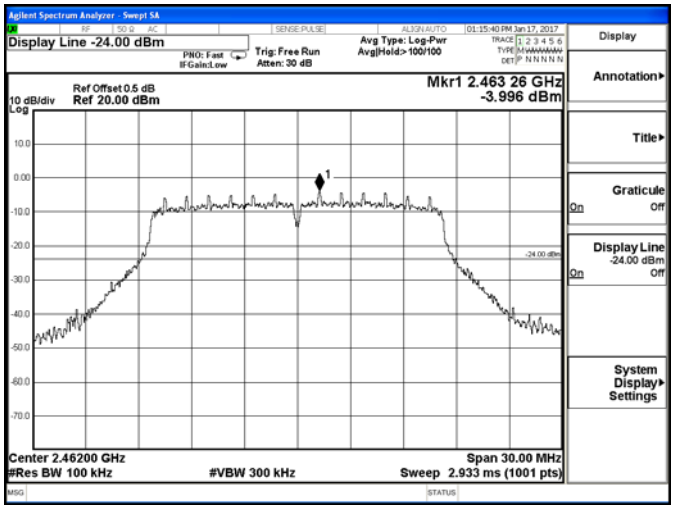
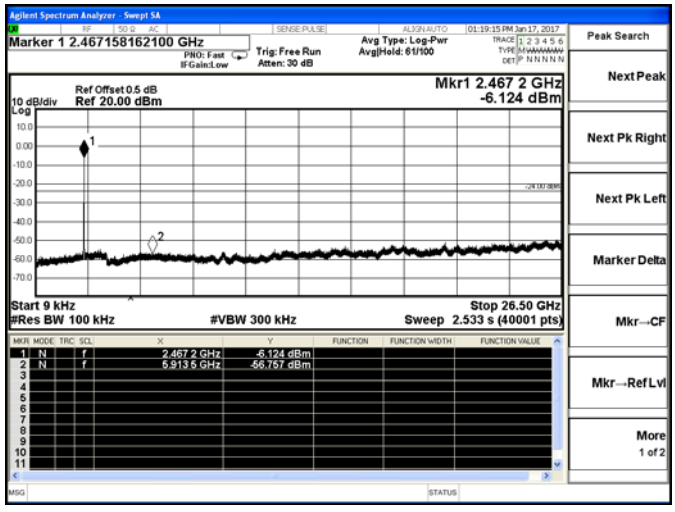
5.6.5. EUT Operation during Test

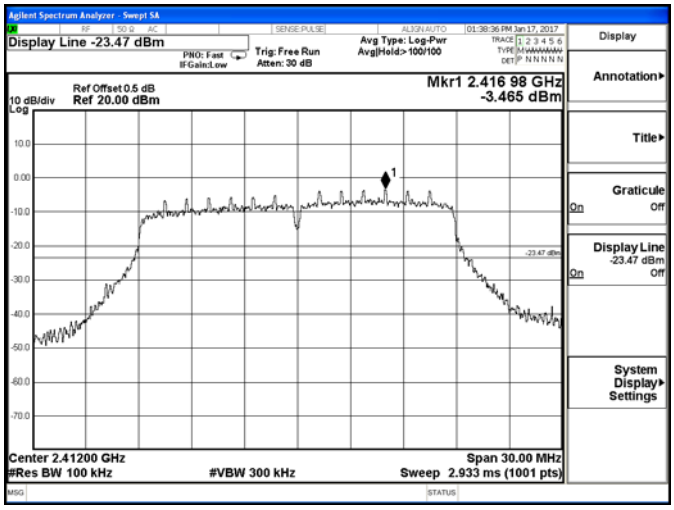
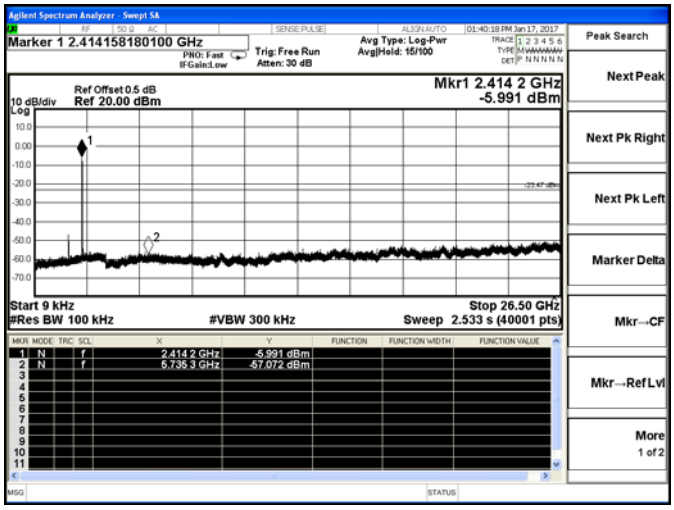
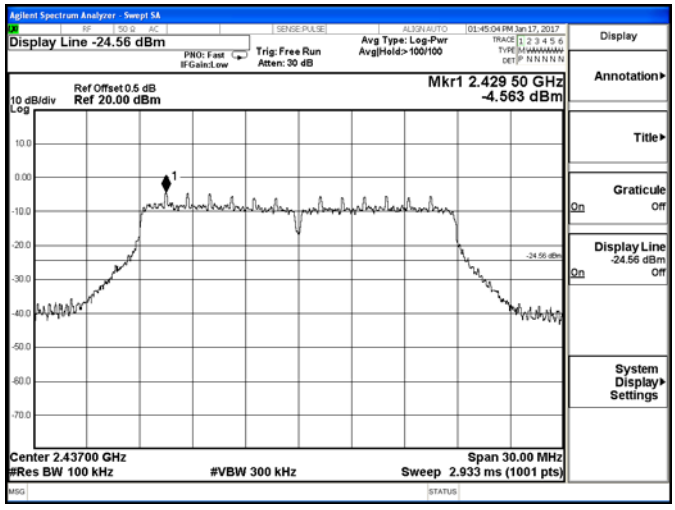
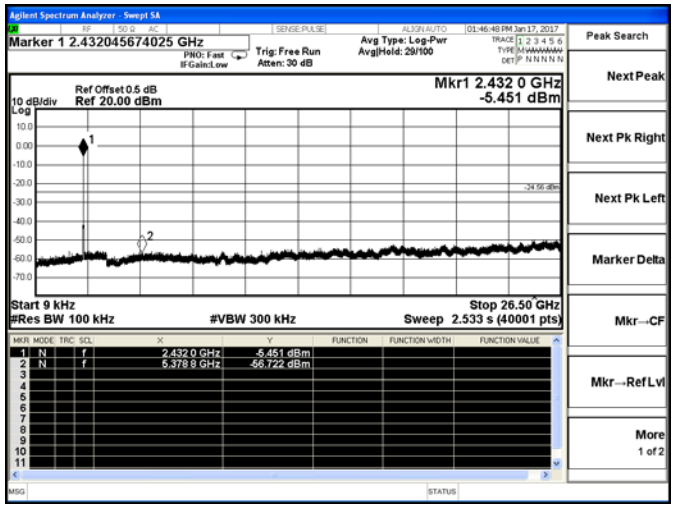
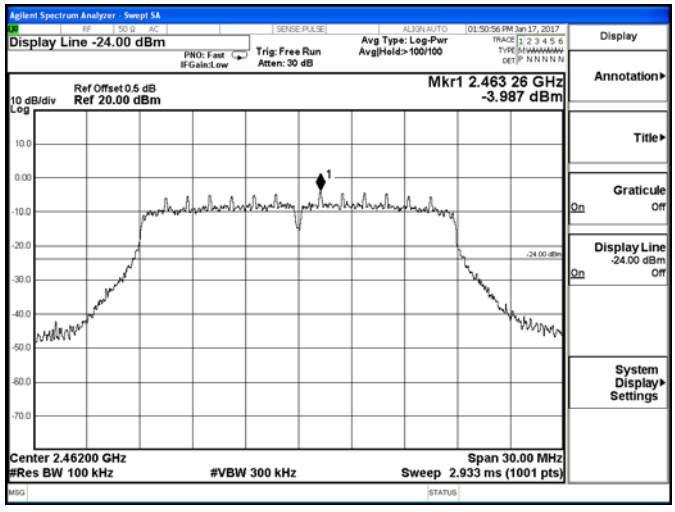
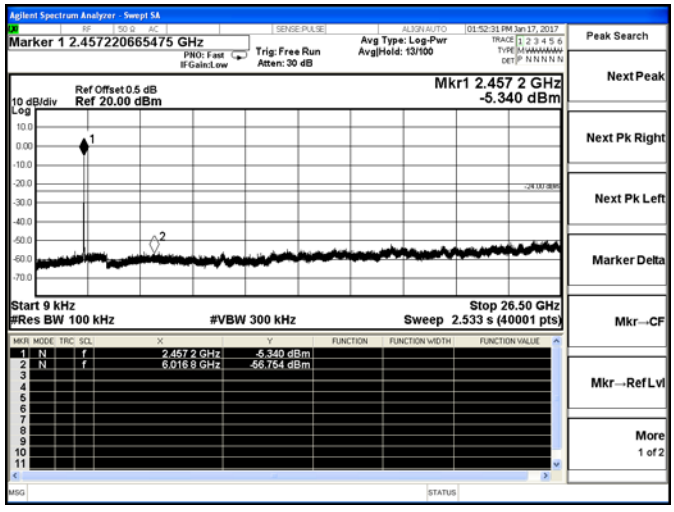
The EUT was programmed to be in continuously transmitting mode.

5.6.6. Test Results of Conducted Spurious Emissions

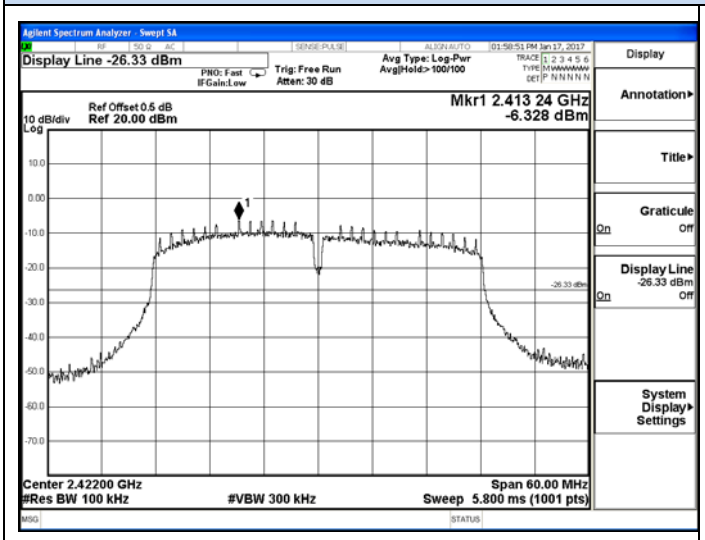
Note: For BLE, only R-SMA antenna port is used, for 2.4GHz Wi-Fi, both antennas are used, and the main antenna(with R-SMA port) will refer to as ant0, the aux antenna(with FPC antenna) will refer to as ant1 below. For 2.4G Wi-Fi test result, only recorded the worst test data of ant 0.

Test plot of Conducted Spurious Emission	
IEEE 802.11b	
	
Reference	Low channel
	
Reference	Middle channel
	
Reference	High channel

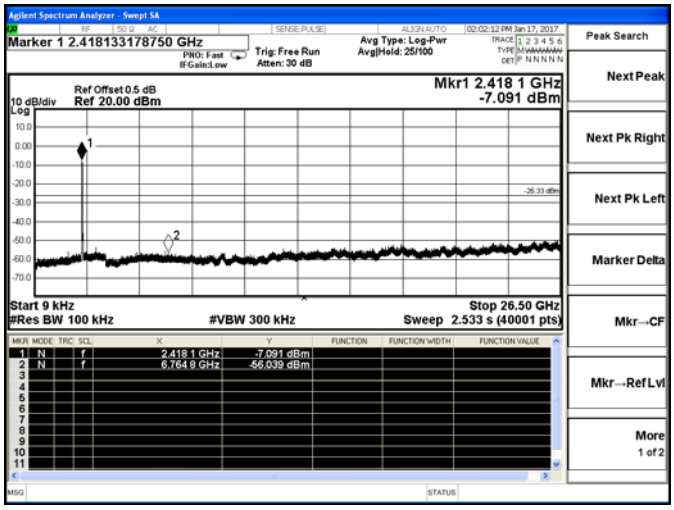
IEEE 802.11g	
	
Reference	Low channel
	
Reference	Middle channel
	
Reference	High channel

IEEE 802.11n-HT20	
	
Reference	Low channel
	
Reference	Middle channel
	
Reference	High channel

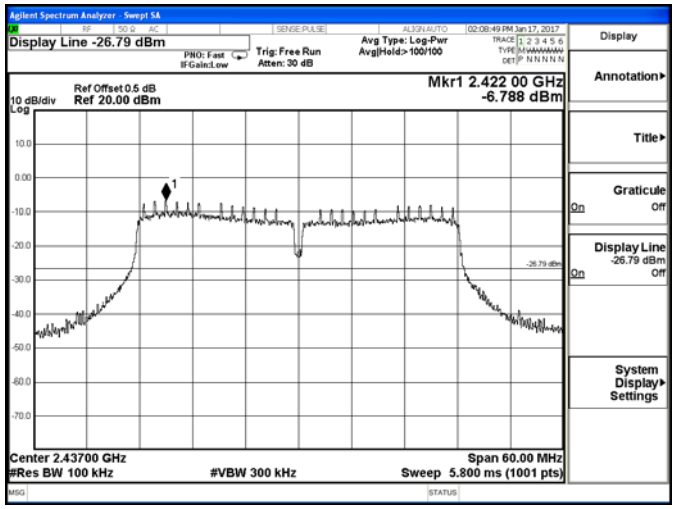
IEEE 802.11n-HT40



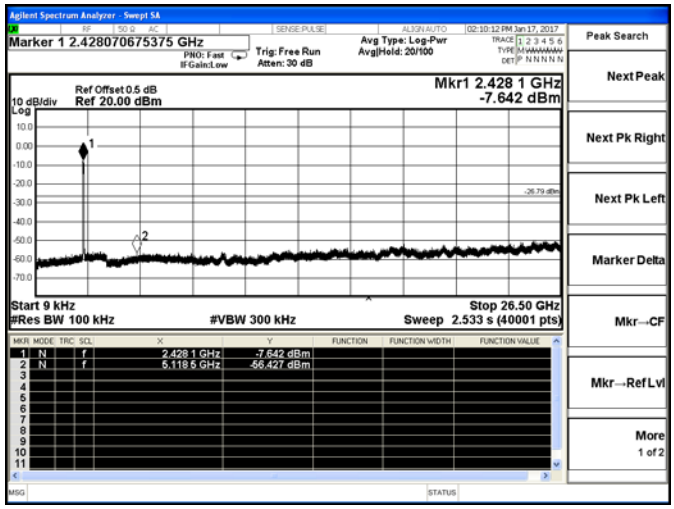
Reference



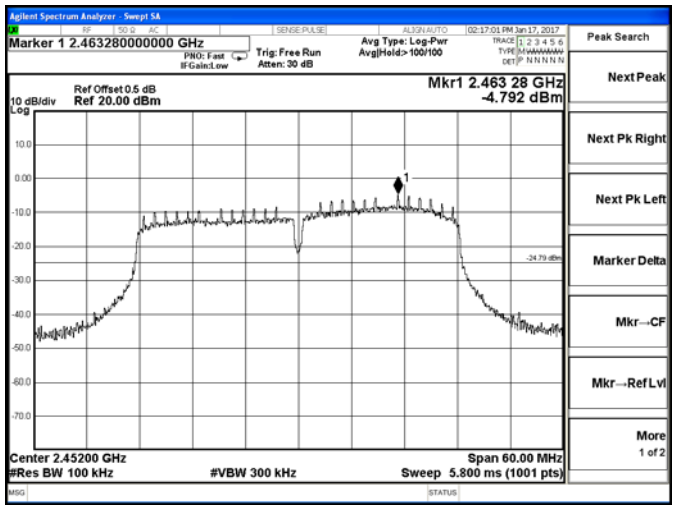
Low channel



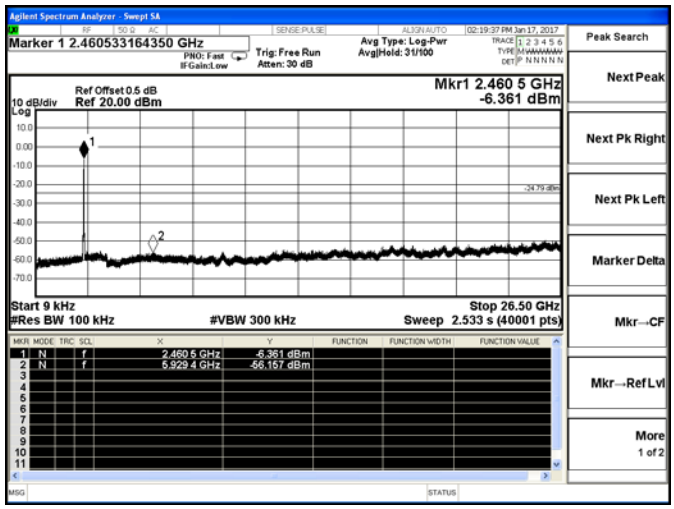
Reference



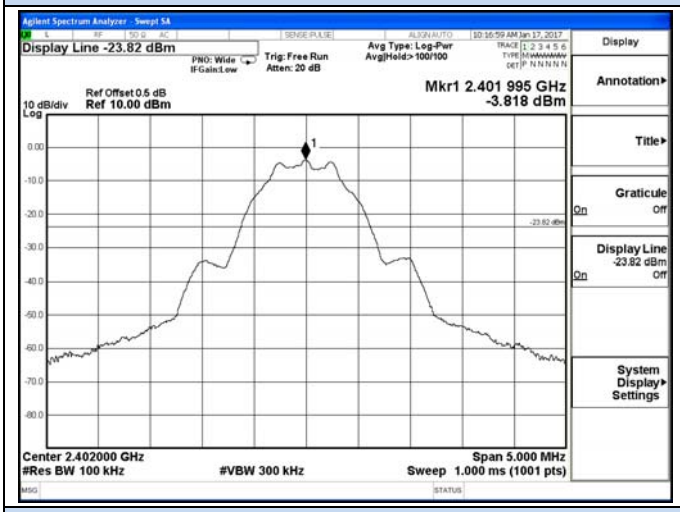
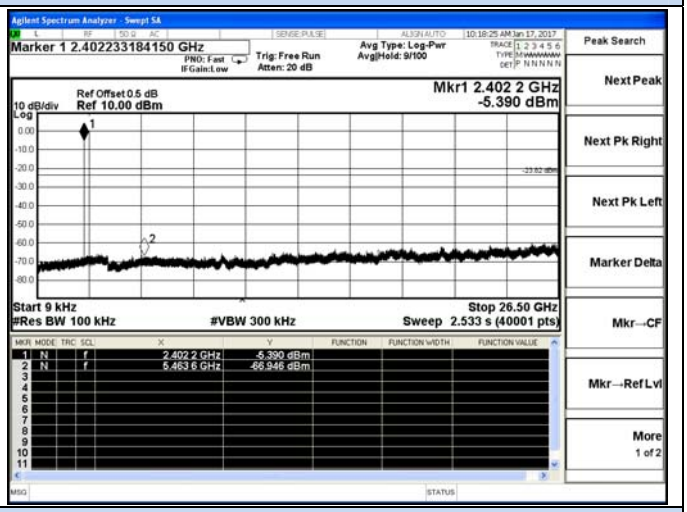
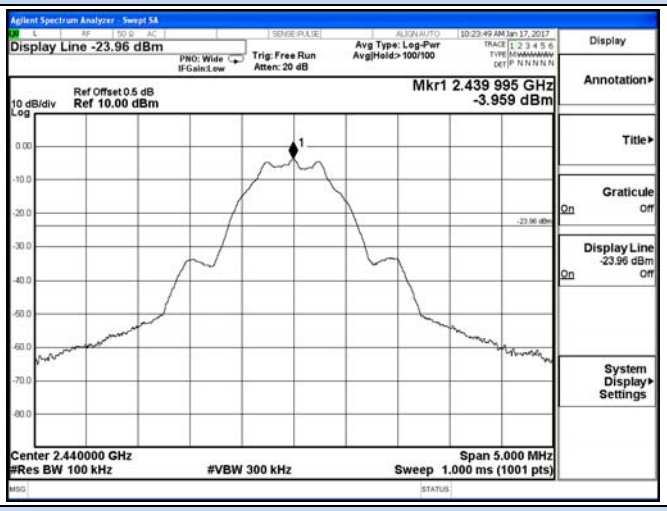
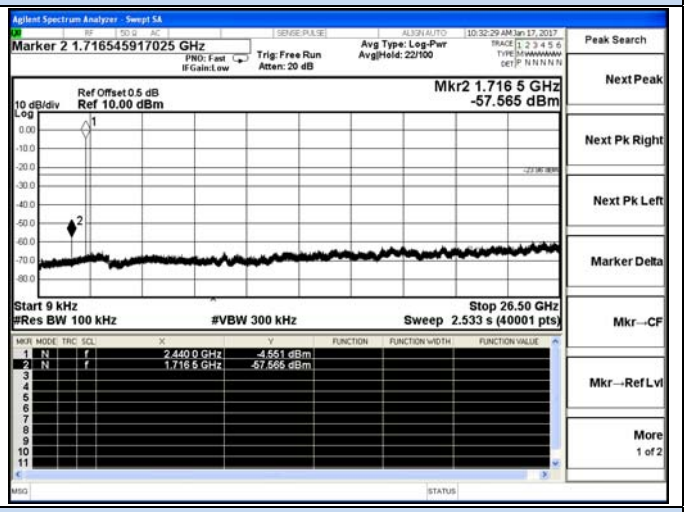
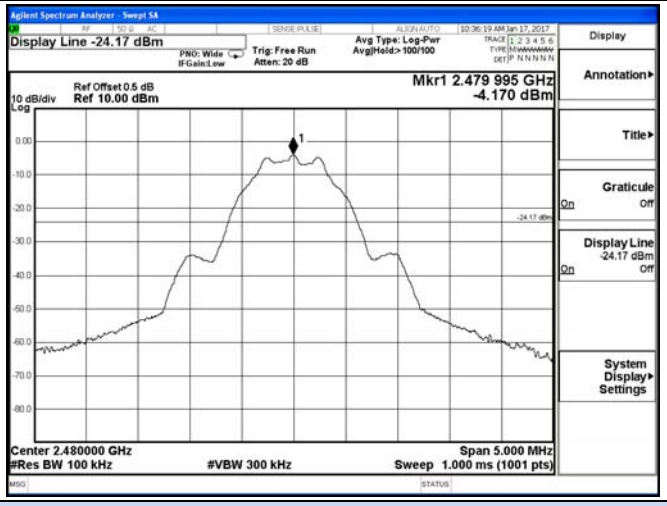
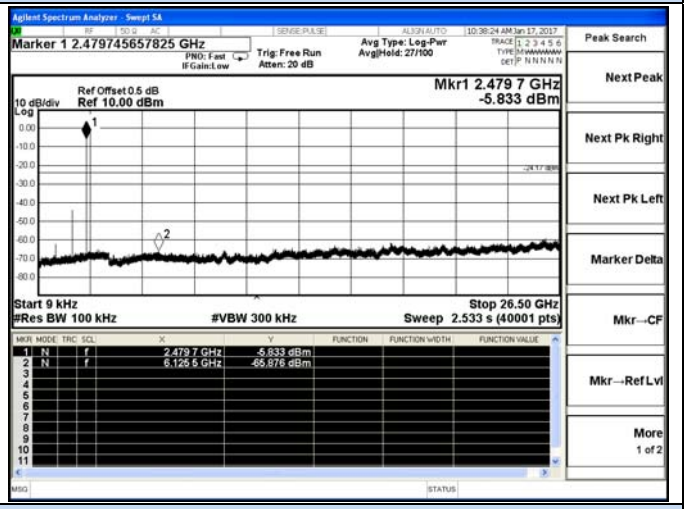
Middle channel



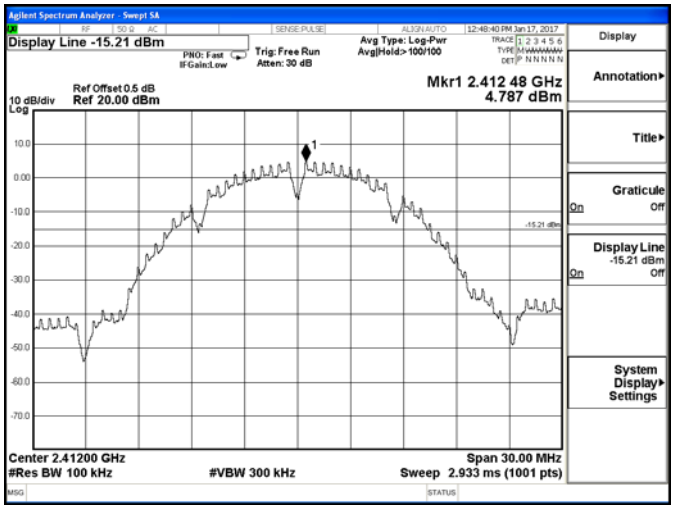
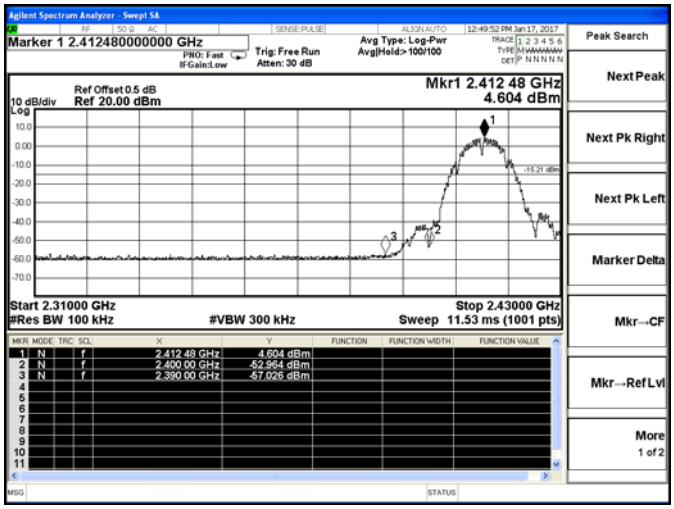
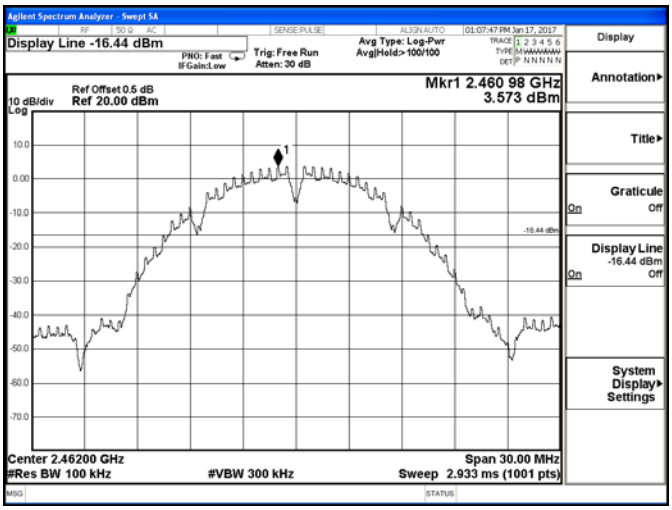
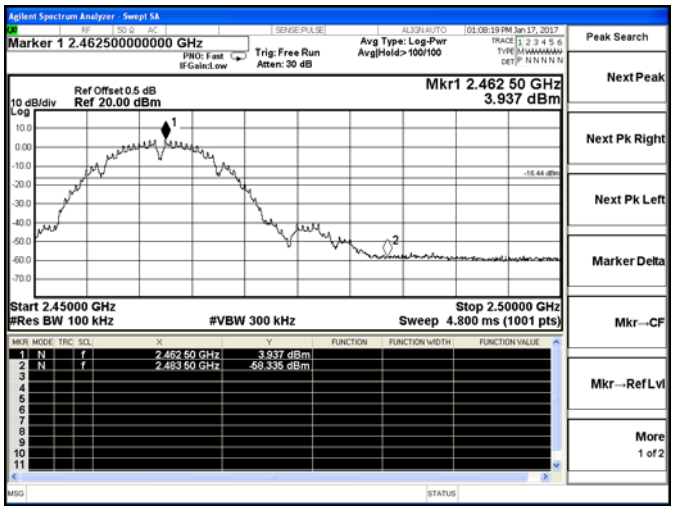
Reference

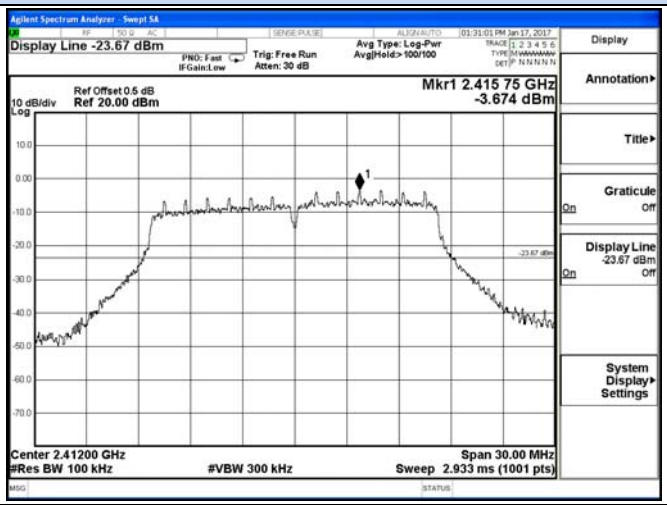
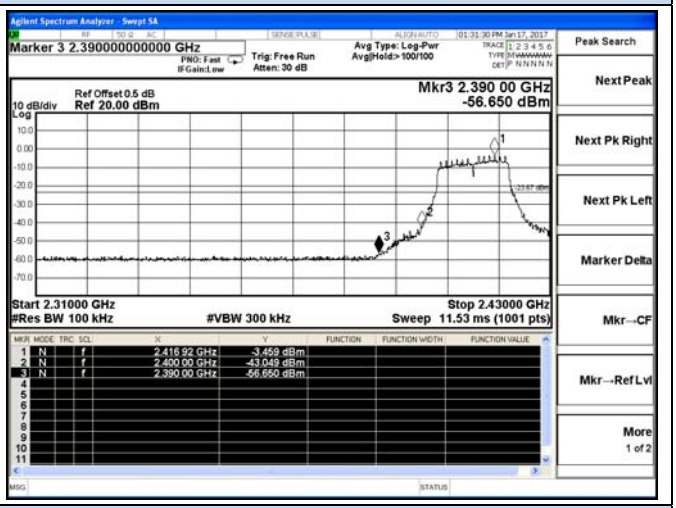
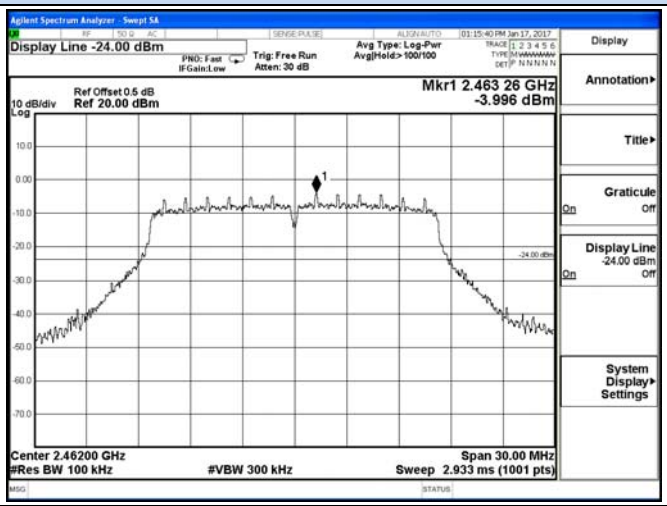
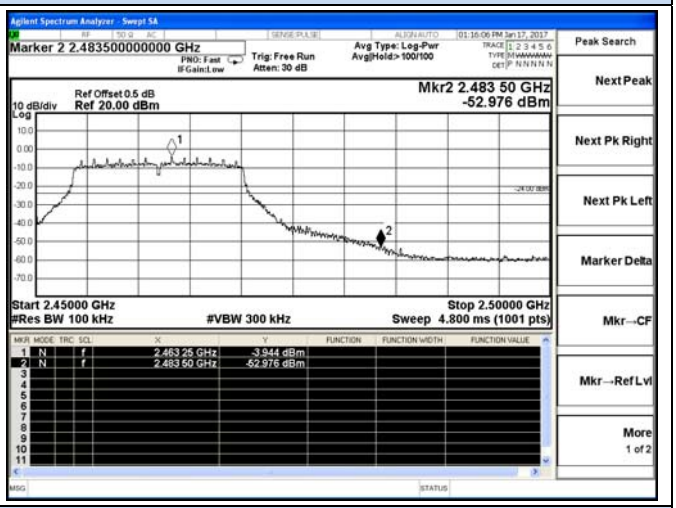


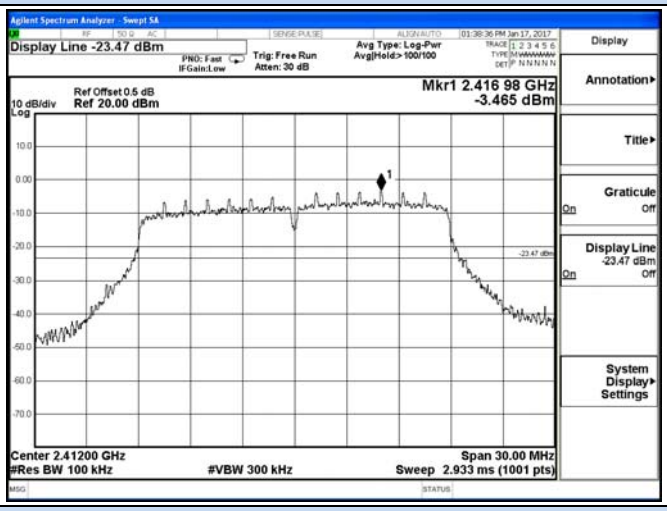
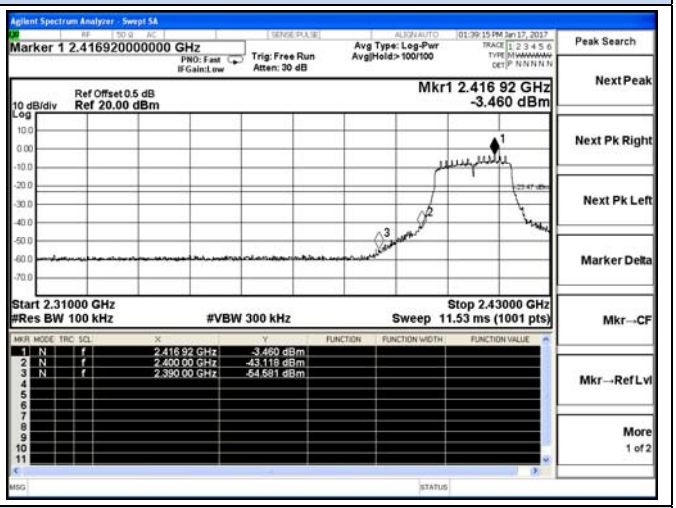
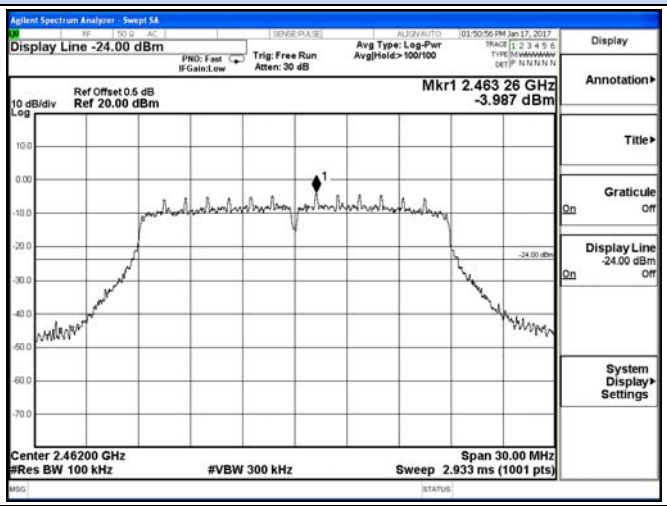
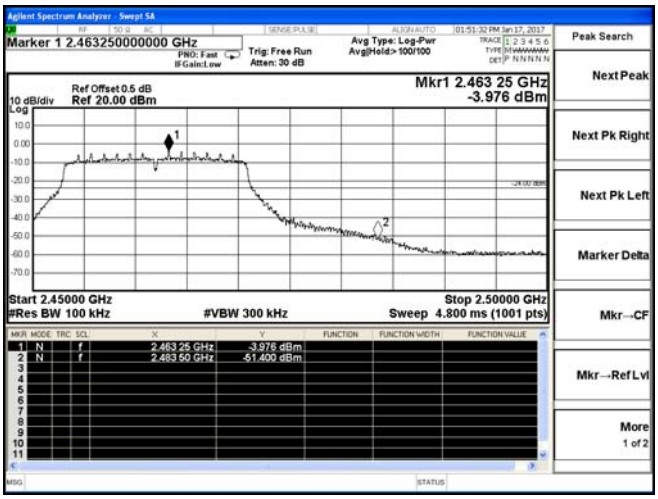
High channel

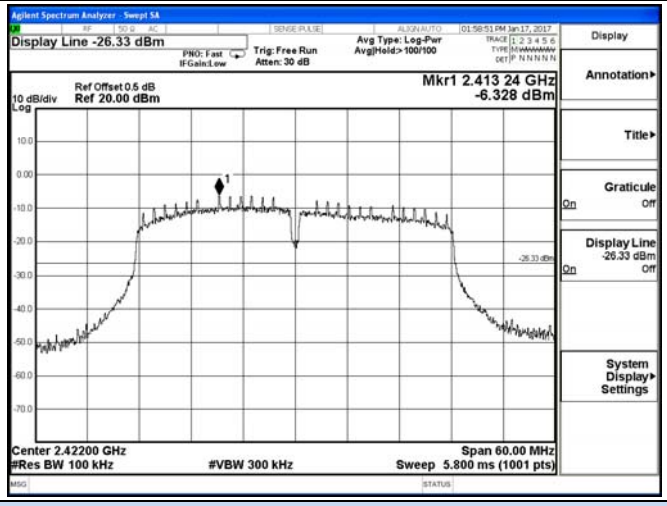
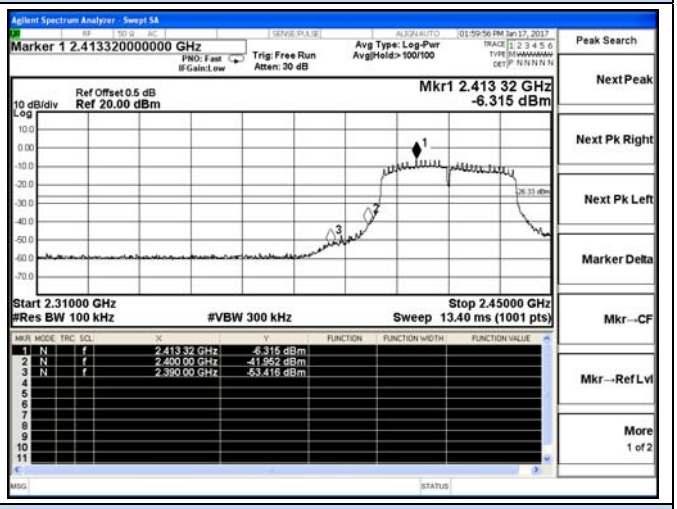
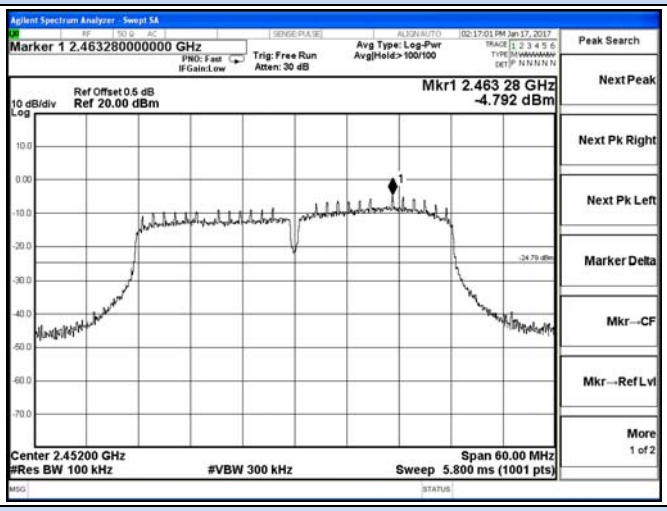
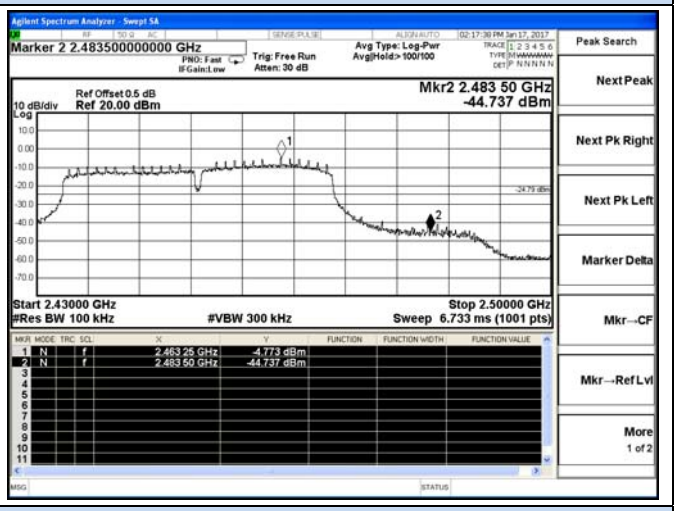
Test plot of Conducted Spurious Emission	
BT LE	
	
Reference	Low channel
	
Reference	Middle channel
	
Reference	High channel

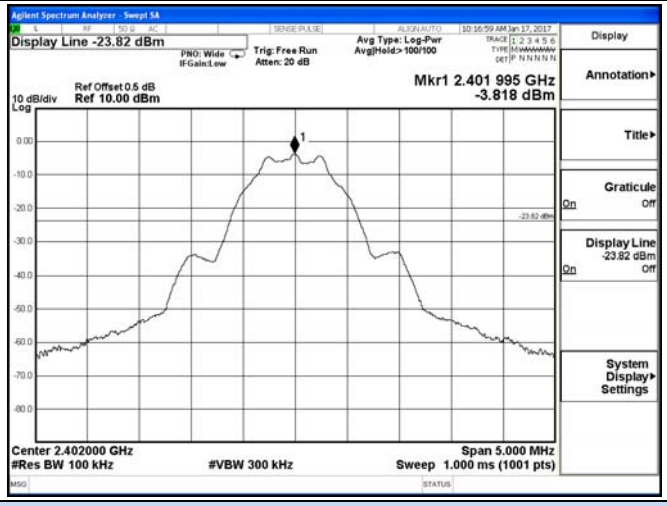
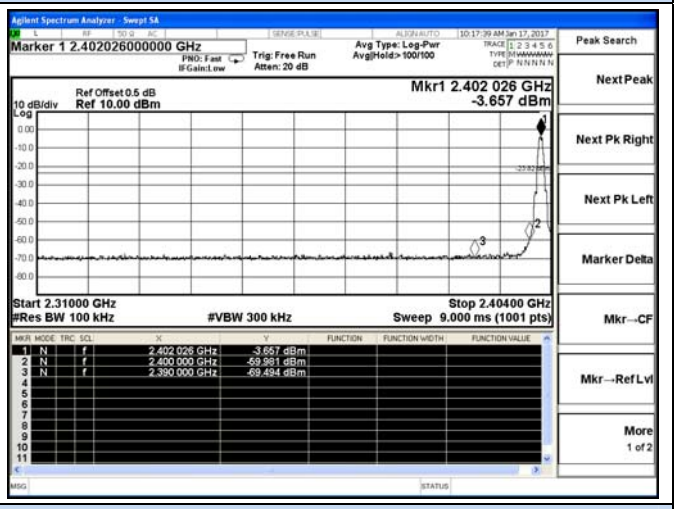
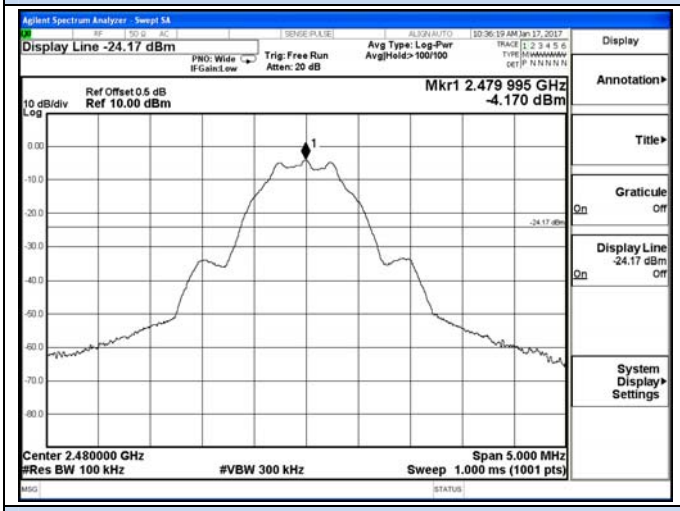
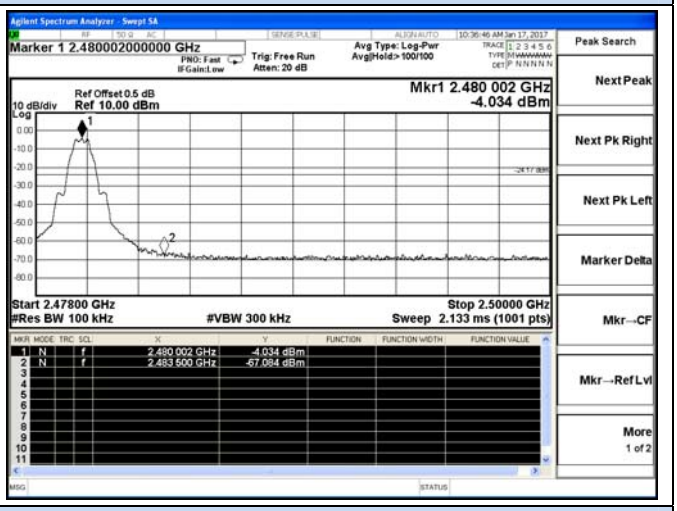
5.6.7. Test Results of Band Edges Test

Test plot of Band Edges Test	
IEEE 802.11b	
	
Reference	Low channel
	
Reference	High channel

Test plot of Band Edges Test	
IEEE 802.11g	
	
Reference	Low channel
	
Reference	High channel

Test plot of Band Edges Test	
IEEE 802.11n-HT20	
	
Reference	Low channel
	
Reference	High channel

Test plot of Band Edges Test	
IEEE 802.11n-HT40	
	
Reference	Low channel
	
Reference	High channel

Test plot of Band Edges Test	
BT LE	
	
Reference	Low channel
	
Reference	High channel

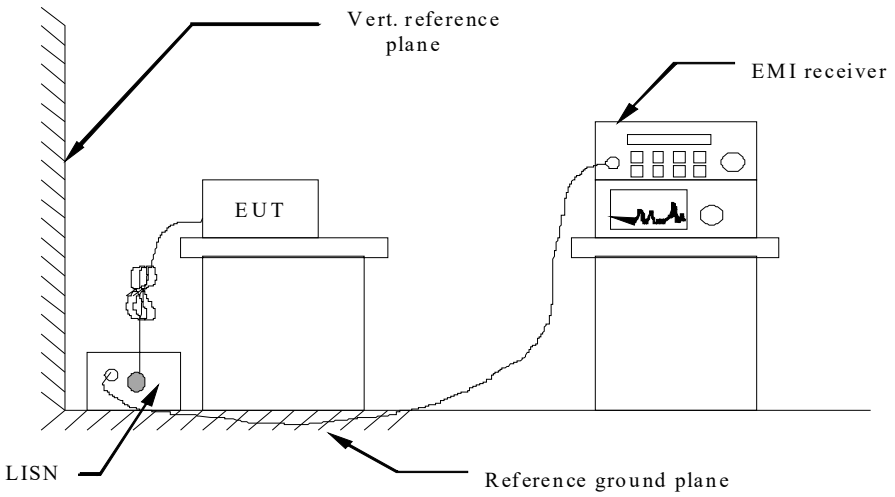
5.7. Power line conducted emissions

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 is 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

5.7.2 Block Diagram of Test Setup



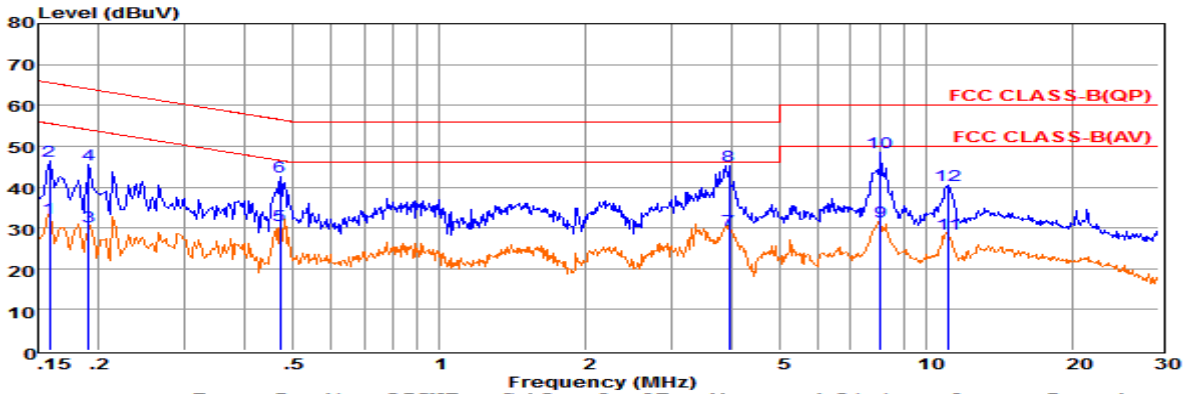
5.7.3 Test Results

PASS.

The test data please refer to following page.

Test result for 802.11b(AC 120V)

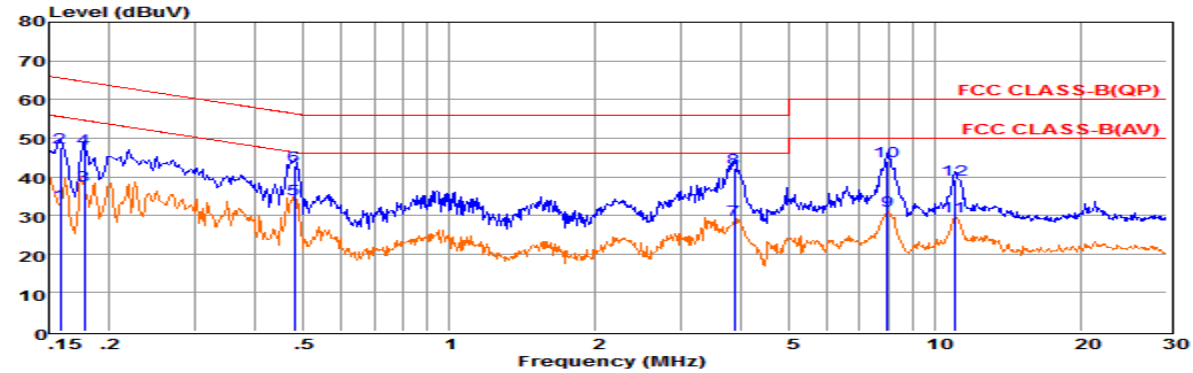
Live Line:



	Freq	Reading	LISNFac	CabLos	Aux2Fac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB	dB	dB	dBuV	dBuV	dB
1	0.16	12.94	9.58	0.02	10.00	32.54	55.56	-23.02	Average
2	0.16	26.91	9.58	0.02	10.00	46.51	65.56	-19.05	QP
3	0.19	10.77	9.62	0.02	10.00	30.41	54.02	-23.61	Average
4	0.19	25.88	9.62	0.02	10.00	45.52	64.02	-18.50	QP
5	0.47	10.94	9.62	0.04	10.00	30.60	46.49	-15.89	Average
6	0.47	22.92	9.62	0.04	10.00	42.58	56.49	-13.91	QP
7	3.94	9.72	9.65	0.06	10.00	29.43	46.00	-16.57	Average
8	3.94	25.42	9.65	0.06	10.00	45.13	56.00	-10.87	QP
9	8.06	11.66	9.68	0.07	10.00	31.41	50.00	-18.59	Average
10	8.06	28.86	9.68	0.07	10.00	48.61	60.00	-11.39	QP
11	11.14	8.70	9.70	0.09	10.00	28.49	50.00	-21.51	Average
12	11.14	20.67	9.70	0.09	10.00	40.46	60.00	-19.54	QP

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

Neutral Line:



	Freq	Reading	LISNFac	CabLos	Aux2Fac	Measured	Limit	Over	Remark
	MHz	dBuV	dB	dB	dB	dB	dBuV	dBuV	dB
1	0.16	13.28	9.68	0.02	10.00	32.98	55.56	-22.58	Average
2	0.16	28.02	9.68	0.02	10.00	47.72	65.56	-17.84	QP
3	0.18	17.97	9.64	0.02	10.00	37.63	54.59	-16.96	Average
4	0.18	27.71	9.64	0.02	10.00	47.37	64.59	-17.22	QP
5	0.48	14.66	9.62	0.04	10.00	34.32	46.32	-12.00	Average
6	0.48	23.07	9.62	0.04	10.00	42.73	56.32	-13.59	QP
7	3.86	9.09	9.65	0.06	10.00	28.80	46.00	-17.20	Average
8	3.86	22.49	9.65	0.06	10.00	42.20	56.00	-13.80	QP
9	7.98	11.59	9.70	0.07	10.00	31.36	50.00	-18.64	Average
10	7.98	24.39	9.70	0.07	10.00	44.16	60.00	-15.84	QP
11	10.96	9.99	9.73	0.09	10.00	29.81	50.00	-20.19	Average
12	10.96	19.47	9.73	0.09	10.00	39.29	60.00	-20.71	QP

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 mode and recorded the worst case results in this report (802.11b @120VAC).

5.8. Antenna Requirements

5.8.1 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.

5.8.2 Antenna Connected Construction

5.8.2.1. 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.

5.8.2.2. Antenna Connector Construction

The antenna gain used for transmitting is **2.5dBi for each antenna, the R-SMA antenna and FPC antenna have no consideration of replacement**. Please see EUT photo for details.

5.8.2.3. Results: Compliance.

Measurement parameters

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

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 Bluetooth, ant 0 is used; For normal WLAN devices, the IEEE 802.11b mode(ant 1) is used.

Limits

FCC	IC
Antenna Gain	
6 dBi	

Bluetooth(ant 0):

Tnom	Vnom	lowest channel 2402 MHz	middle channel 2440 MHz	highest channel 2480 MHz
Conducted power [dBm] Measured with GFSK modulation		-3.545	-3.719	-3.913
Radiated power [dBm] Measured with GFSK modulation		-2.08	-2.21	-2.17
Gain [dBi] Calculated		1.465	1.509	1.743
Measurement uncertainty			± 1.6 dB (cond.) / ± 3.8 dB (rad.)	

Wi-Fi(ant 1):

Tnom	Vnom	lowest channel 2412 MHz	middle channel 2437 MHz	highest channel 2462 MHz
Conducted power [dBm] Measured with DSSS modulation		16.38	16.11	15.96
Radiated power [dBm] Measured with DSSS modulation		17.63	17.52	17.16
Gain [dBi] Calculated		1.25	1.41	1.20
Measurement uncertainty			± 1.6 dB (cond.) / ± 3.8 dB (rad.)	

Result: -/-

6. LIST OF MEASURING EQUIPMENTS

Instrument	Manufacture	Model No.	Serial No.	Characteristics	Cal Date	Due Date
EMC Receiver	R&S	ESCS 30	100174	9kHz – 2.75GHz	Jun 18, 2016	Jun 17, 2017
Signal analyzer	Agilent	E4448A(External mixers to 40GHz)	US44300469	9kHz~40GHz	Jul 16, 2016	Jul 15, 2017
LISN	MESS Tec	NNB-2/16Z	99079	9KHz-30MHz	Jun 18, 2016	Jun 17, 2017
LISN	EMCO	3819/2NM	9703-1839	9KHz-30MHz	Jun 18, 2016	Jun 17, 2017
RF Cable-CON	UTIFLEX	3102-26886-4	CB049	9KHz-30MHz	Jun 18, 2016	Jun 17, 2017
ISN	SCHAFFNE	ISN ST08	21653	9KHz-30MHz	Jun 18, 2016	Jun 17, 2017
3m Semi Anechoic Chamber	SIDT FRANKONIA	SAC-3M	03CH03-HY	30M-18GHz	Jun 18, 2016	Jun 17, 2017
Amplifier	SCHAFFNE	COA9231A	18667	9kHz-2GHzz	Apr 18, 2016	Apr 17, 2017
Amplifier	Agilent	8449B	3008A021	1GHz-26.5GHz	Apr 18, 2016	Apr 17, 2017
Amplifier	MITEQ	AMF-6F-260400	9121372	26.5GHz-40GHz	Apr 18, 2016	Apr 17, 2017
Loop Antenna	R&S	HFH2-Z2	860004/00	9k-30MHz	Apr 18, 2016	Apr 17, 2017
By-log Antenna	SCHWARZB	VULB9163	9163-470	30MHz-1GHz	Apr 18, 2016	Apr 17, 2017
Horn Antenna	EMCO	3115	6741	1GHz-18GHz	Apr 18, 2016	Apr 17, 2017
Horn Antenna	SCHWARZB	BBHA9170	BBHA9170	15GHz-40GHz	Apr 18, 2016	Apr 17, 2017
RF Cable-R03m	Jye Bao	RG142	CB021	30MHz-1GHz	Jun 18, 2016	Jun 17, 2017
RF Cable-HIGH	SUHNER	SUCOFLEX 106	03CH03-H	1GHz-40GHz	Jun 18, 2016	Jun 17, 2017
Power Meter	R&S	NRVS	100444	DC-40GHz	Jun 18, 2016	Jun 17, 2017
Power Sensor	R&S	NRV-Z51	100458	DC-30GHz	Jun 18, 2016	Jun 17, 2017
Power Sensor	R&S	NRV-Z32	10057	30MHz-6GHz	Jun 18, 2016	Jun 17, 2017
AC Power Source	HPC	HPA-500E	HPA-9100	AC 0~300V	Jun 18, 2016	Jun 17, 2017
DC power Soure	GW	GPC-6030D	C671845	DC 1V-60V	Jun 18, 2016	Jun 17, 2017
Temp. and Humidigy Chamber	Giant Force	GTH-225-20-S	MAB0103-00	N/A	Jun 18, 2016	Jun 17, 2017
RF CABLE-1m	JYE Bao	RG142	CB034-1m	20MHz-7GHz	Jun 18, 2016	Jun 17, 2017
RF CABLE-2m	JYE Bao	RG142	CB035-2m	20MHz-1GHz	Jun 18, 2016	Jun 17, 2017
Signal Generator	R&S	SMR40	10016	10MHz~40GHz	Jul 16, 2016	Jul 15, 2017
Universal Radio Communication Tester	R&S	CMU200	112012	N/A	Oct 27, 2016	Oct 26, 2017
Wideband Radia Communication Tester	R&S	CMW500	1201.0002K50	N/A	Nov 19, 2016	Nov 18, 2017
MXG Vector Signal Generator	Agilent	N5182A	MY47071151	250KHz~6GHz	Oct 27, 2016	Oct 26, 2017
MXG Vector Signal Generator	Agilent	E4438C	MY42081396	250KHz~6GHz	Oct 27, 2016	Oct 26, 2017
PSG Analog Signal Generator	Agilent	N8257D	MY46520521	250KHz~20GHz	Nov 19, 2016	Nov 18, 2017
MXA Signal Analyzer	Agilent	N9020A	MY50510140	10Hz~26.5GHz	Oct 27, 2016	Oct 26, 2017
DC Power Supply	Agilent	E3642A	/	0-8V,5A/0-20V,2.5A	May 20, 2016	May 19, 2017
RF Control Unit	Tonscend	JS0806-1	/	/	Nov 19, 2016	Nov 18, 2017
LTE Test Software	Tonscend	JS1120-1	/	Version: 2.5.7.0	N/A	N/A

X-series USB Peak and Average Power Sensor Agilent	Agilent	U2021XA	MY54080022	/	Oct 27, 2016	Oct 26, 2017
4 Ch.Simultaneous Sampling 14 Bits 2 MS/s	Agilent	U2531A	MY54080016	/	Oct 27, 2016	Oct 26, 2017
Test Software	Ascentest	AT890-SW	20141230	Version:	N/A	N/A
Splitter/Combiner(Qty: 2)	Mini-Circuits	ZAPD-50W 4.2-6.0 GHz	NN256400424	/	Oct 27, 2016	Oct 26, 2017
Splitter/Combine(Qty: 2)	MCLI	PS3-7	4463/4464	/	Oct 27, 2016	Oct 26, 2017
ATT (Qty: 1)	Mini-Circuits	VAT-30+	30912	/	Oct 27, 2016	Oct 26, 2017
Radiated Emission test software	Audix	e3	/	/	N/A	N/A

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----------